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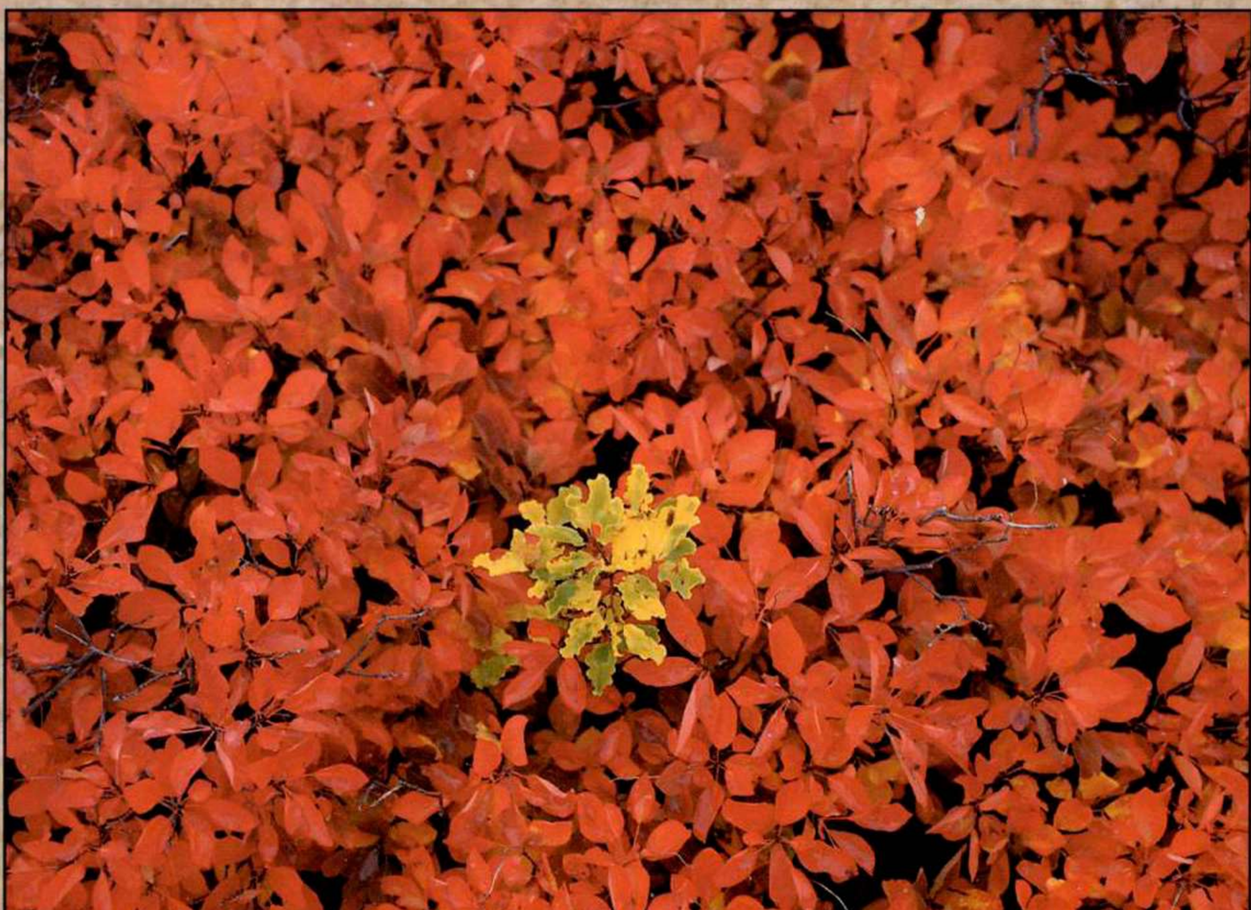

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SEZNAM KRATIC

BF ▸ Biotehniška fakulteta
CRS ASSA ▸ Centro di Ricerche Scientifiche dell'Academia Slovena delle Scienze e delle Arti
FJK ▸ Furlanija Julijska Krajina
FVG ▸ Friuli Venezia Giulia
HR ▸ Hrvaška / Croazia / Croatia
HU ▸ Madžarska / Ungheria / Hungary
IB ▸ Inštitut za biologijo, Ljubljana
IOR ▸ Institut za oceanografiju i ribarstvo Split (HR)
IT ▸ Italija /Italia / Italy
IUCN ▸ International Union for the Conservation of Nature
IZRK ▸ Inštitut za raziskovanje krasa, Postojna
LJU ▸ Kratica herbarija ljubljanske univerze
MBP ▸ Morska biološka postaja / Marine biological station
NGO ▸ Non-Governmental Organisation
NP ▸ Narodni park (National Park)
OAS ▸ Ornitološki atlas Slovenije
PMS ▸ Prirodoslovni Muzej Slovenije
R/V ▸ Research vessel/ raziskovalno plovilo
SI ▸ Slovenija / Slovenia
TR ▸ Turčija / Turchia / Turkey
UTM ▸ Universal Transverse Mercator
W/L ▸ Weight / Lenght relationship
WWF ▸ World Wildlife Fund
ZRC SAZU ▸ Znanstveno raziskovalni center Slovenske akademije znanosti in umetnosti / Science and Research Centre of the Slovene Academy of Sciences and Arts/
ZRS ▸ Znanstveno Raziskovalno Središče, Koper

OKRAJŠAVE

B.Sc. ▸ Bachelor of Science (diplomiranec iz znanosti)
e.g. ▸ exempli gratia; *(lat.)* npr., (for example)
et al. ▸ et alii; *(lat.)* in drugi (and others)
i.e. ▸ id est; *(lat).* to je (that is)
ibid. ▸ ibidem *(lat.)* prav tam
ined. ▸ inedito / neobjavljeno / unpublished
in litt ▸ pisno sporočilo
lat. ▸ latinsko
M.Sc. ▸ Master of Science (magister znanosti)
mscr. ▸ manuscript (rokopis)
pers. comm. ▸ Personal Communication / osebno sporočilo
Ph.D. ▸ Doctor of philosophy (doktor znanosti)

FLORA IN VEGETACIJA

FLORA E VEGETAZIONE

FLORA AND VEGETATION

compendio

UDC 016:58(497.4 Kras)
016:58(497.4/.5 Istra)

SOMMARIO BIBLIOGRAFICO SULLA FLORA E SULLA VEGETAZIONE DEL CARSO E DELL'ISTRIA CON PARTICOLARE RIGUARDO AL PRESENTE

BIBLIOGRAFSKI PREGLED RAZISKOVANJA FLORE IN VEGETACIJE KRASA IN ISTRE S POUDARKOM NA SEDANJEM STANJU

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Dipartimento di Biologia, IT-34127 Trieste, via L. Giorgieri 10

RIASSUNTO

Vengono passate in rassegna le principali tappe dell'esplorazione botanica del Carso, con inclusione dei versanti nordoccidentali della Selva di Tarnova, del Piro, e dell'Istria, comprendendovi anche le isole quarnerine di Cherso, Veglia e Lussino.

Parole chiave: Sommario bibliografia botanica, Carso, Istria

IZVLEČEK

V razpravi so predstavljene glavne faze botaničnih raziskav Krasa, vključno s severozahodnim pobočjem Trnovskega gozda in Hrušice, ter Istre s kvarnerskimi otoki Cresom, Krkom in Lošinjem.

Ključne besede: botanična bibliografija, Kras, Istra

Non sarà possibile, neanche in maniera approssimata, tracciare un quadro sommario delle principali tappe che l'esplorazione botanica, limitatamente alle tracheofite, ha percorso nella penisola istriana e nel Carso.

Innanzitutto è opportuno precisare che il territorio in parola, come qui lo si intende, include il Carso alle spalle di Trieste, dal mare fino ai fianchi sudoccidentali della Selva di Tarnova e della Selva di Piro con le grandi isole quarnerine di Cherso, Veglia e Lussino, escludendo però il Goriziano in senso stretto e il corso inferiore dell'Isonzo. Sono rimasti così esclusi i rilievi del Sabotino e di Medea, anche se per molti versi così "carsici".

Le principali fonti d'informazione per un'area così complessa rimangono Marchesetti (1895, 1896-97, 1931 postumo), Voss (1884-85), Mayer (1952, 1960), Lazar (1960), Petkovšek (1960), Poldini (1988, 1991), che di seguito riprenderemo per sommi capi.

L'enorme mole delle opere, prevalentemente floristiche in un primo tempo e in epoca successiva anche vegetazionali, è dovuta, tra l'altro, all'elevato numero di nazioni e di nazionalità coinvolte nelle alterne vicende storico-politiche dell'Istria e del Carso, così che i titoli

Celovite slike najpomembnejših etap botaničnih raziskav istrskega polotoka in Krasa, omejenih na višje rastline, ne bo mogoče predstaviti niti v približnih obrisih.

Najprej je treba pojasniti, da obravnavano območje zajema Kras v zaledju Trsta od morja do jugozahodnega pobočja Trnovskega gozda in Hrušice, Istre ter velike kvarnerske otoke Cres, Krk in Lošinj, vendar brez Goriške v ožjem smislu besede in spodnjega toka Soče. Izključeni sta tako pobočji Sabotina in Medveje, čeprav sta po številnih značilnostih zelo "kraški".

Glavni viri informacij za tako kompleksno območje so še zmeraj Marchesetti (1895, 1896-97, 1931 posthumno), Voss (1884-85), Mayer (1952, 1960), Lazar (1960), Petkovšek (1960), Poldini (1988, 1991), ki jih bomo v glavnih obrisih povzeli v nadaljevanju.

Ogromno število del, ki sprva obravnavajo samo floro, kasneje pa tudi vegetacijo, gre med drugim pripisati tudi velikemu številu različnih narodov in narodnosti, ki so bili vpleteni v zgodovinsko-politično dogajanje v Istri in na Krasu, tako da vsebuje botanična bibliografija tega območja tako nemške kot italijanske, nemške, slovenske, hrvaške in madžarske naslove.

Zaradi izjemnega vpliva, ki so ga imele najzgodnejše študije, je treba opozoriti na tri predlinejevske raz-della bibliografia botanica di questa terra vanno dal tedesco all'italiano, allo sloveno, al croato e all'ungherese.

Per la suggestione esercitata dai primordi, dobbiamo ricordare tre nomi del periodo prelinneano con i quali possono essere fatte iniziare le ricerche botaniche nei nostri territori: P. A. Mattioli (1501-1577) che nel 1554 indica nei famosi *"Commentari"* 53 specie da Gorizia e Trieste; G. F. Tommasini, omonimo del ben più famoso Muzio de' Tommasini, vescovo di Cittanova (1595-1654), che enumera i nomi volgari di ben 320 specie sia spontanee che coltivate, oltre ad alberi, arbusti e funghi, senza però indicarne le località di raccolta. La sua opera, chiamata pur essa *"Commentari"*, verrà pubblicata appena nel 1837 nell'*Archeografo Triestino*. Il terzo è G. G. Zannichelli (1662-1729), che intraprende un viaggio lungo le coste occidentali dell'Istria, da Capodistria a Rabac, donde cita numerose specie nei loro nomi popolari. La sua opera verrà pubblicata postuma nel 1730 dal figlio Giovanni Giacomo Zannichelli.

L'epoca classica può essere fatta iniziare con G. A. Scopoli (1723-1788), che chiamato a Idria quale medico nelle miniere di mercurio nel 1754, vi si trattiene per 16 anni, portando a termine la prima (1760) e la seconda edizione (1772) della famosa *"Flora Carniolica"*. La seconda edizione del 1772, notevolmente ampliata e riveduta rispetto alla prima, è adeguata al metodo di Linneo. Nella prefazione dell'opera l'Autore delinea i limiti geografici del territorio studiato, includendovi il Carso e il Goriziano, donde provengono ben 185 specie citate. Fra queste viene descritto per la prima volta il più esclusivo endemismo del Carso triestino, *Centaurea kartschiana,* diffuso in pochi esemplari sulle rocce a mare tra Sistiana e Duino. La vita e le opere di questo Autore vengono diffusamente ricordate in un recente lavoro di Petkovšek (1977).

Quando Scopoli nel 1767 viene trasferito in Ungheria, arriva ad Idria quale chirurgo camerale B. Hacquet (1739-1815), botanico e mineralogista, che prese in considerazione anche i nostri territori fino all'estremità meridionale dell'Istria, descrivendo alcune specie nuove (1782, 1785).

Anche F. S. von Wulfen (1728-1805) acquisisce meriti particolari nella conoscenza botanica di questi territori. Tra le sue opere più importanti è da ricordare la *"Flora Norica"*, pubblicata postuma nel 1858 da Fenzl e Graf, nella quale vengono citate ben 717 specie delle nostre regioni, di cui 167 dal Triestino.

Bartolomeo Biasoletto (1793-1859), farmacista a Trieste, compie numerose esplorazioni nei dintorni e nell'Istria. La sua farmacia diviene un luogo di riferimento e di raduno per molti studiosi d'Oltralpe, che trovano in lui un'infaticabile guida. Alcune relazioni scientifiche sono il frutto di questi viaggi (1829, 1841, 1846).

Di particolare interesse è anche il diario di Hoppe e

iskovalce, začetnike botaničnih raziskav v naših krajih: P. A. Mattiolija (1501-1577), ki je leta 1554 v svojem slovitem delu *"Commentari"* opisal 53 vrst z območja med Gorico in Trstom; novigrajskega škofa G. F. Tommasinija (1595-1654), soimenjaka veliko slavnejšega Muzia de' Tommasinija, ki je poleg imen dreves, grmov in gob zbral domača imena še za 320 drugih vrst, tako divjih kot gojenih, ni pa zabeležil krajev njihovih rastišč. Njegovo delo, prav tako naslovljeno *"Commentari"*, je bilo objavljeno v zborniku *"Archeografo Triestino"* šele leta 1837. Tretji, G. G. Zannichelli (1662-1729), se je napotil po obali zahodne Istre od Kopra do Rabca in na poti beležil številne vrste, z njihovimi ljudskimi imeni vred. Njegovo delo je šele leta 1730 izdal njegov sin Giovanni Giacomo Zannichelli.

Klasično obdobje se začenja z G. A. Scopolijem (1723-1788), ki se je leta 1754 preselil v Idrijo kot zdravnik v rudniku živega srebra, ostal tam polnih šestnajst let in napisal prvo (1760) in drugo (1772) izdajo slovitega dela *"Flora Carniolica"*. Druga izdaja iz leta 1772, občutno razširjena in dopolnjena v primerjavi s prvo, je prilagojena Linnejevi metodi. V predgovoru avtor zariše geografske meje obravnavanega območja ter vključi vanj Kras in Goriško, od koder izvira kar 185 navedenih vrst. Med njimi je prvič opisan najznamenitejši endemit tržaškega Krasa - *Centaurea kartschiana,* razširjen le v redkih primerkih na skalah ob morju med Sesljanom in Devinom. Življenje in delo G. A. Scopolija obširno obravnava Petkovšek v enem svojih zadnjih del (Petkovšek, 1977).

Ko je bil Scopoli leta 1767 premeščen na Madžarsko, se je v Idrijo kot kirurg območnega sindikata naselil B. Hacquet (1739-1815), botanik in mineralog, ki je preučeval tudi naše območje tja do skrajnih meja južne Istre in opisal nekatere nove vrste (1782-1785).

Tudi F. X. von Wulfen (1728-1805) je posebej zaslužen za botanično poznavanje teh krajev. Eno njegovih najpomembnejših del je *"Flora Norica"*, izdano posthumno leta 1858 pri založbi Fenzel in Graf, v katerem je navedenih kar 717 vrst iz naših krajev, od tega 167 s Tržaškega.

Bartolomeo Biasoletto (1793-1859), farmacevt iz Trsta, je pogosto raziskoval okolico mesta in Istro. Njegova lekarna je postala zbirališče številnih raziskovalcev iz krajev onkraj Alp, ki so v njem našle neutrudnega vodnika. Nekatere znanstvene razprave so nastale prav na podlagi teh izletov (1829, 1841, 1846).

Posebno je zanimiv tudi dnevnik Hoppa in Hornschucha iz leta 1818, v katerem opisujeta svoje 21-dnevno popotovanje od Bavarske do Trsta. Med bivanjem v Trstu opišeta *Crocus variegatus* Hoppe et Horn. (= *C. reticulatus* Stev. ex Adams). Poleg tega je Hoppe napisal številne prispevke o florističnih posebnostih avstrijskega Primorja, med katerimi so tudi taki, v katerih so prvič omenjene nekatere vrste (Hoppe, 1821; 1826; 1841).

Hornschuch del 1818, in cui si descrive il viaggio da loro intrapreso dalla Baviera fino a Trieste, durato ben 21 giorni. Durante il soggiorno in questa città viene descritto il *Crocus variegatus* Hoppe et Horn. (= *C. reticulatus* Stev. ex Adams). Il primo dei due è inoltre Autore di numerosi contributi riguardanti segnalazioni floristiche dal Litorale Austriaco; di queste ricordiamo alcune che contengono prime segnalazioni di specie (Hoppe 1821, 1826, 1841).

Nella storia della botanica interregionale campeggia la figura di G. M. Spirito de Tommasini (1794-1879), che esplorò il vastissimo e complesso territorio che va dalle Alpi Giulie fino alle Bocche di Cattaro (1837 in coll. con Biasoletto, 1839, 1840, 1851, 1895 con aggiunte e correzioni di C. Marchesetti). I suoi meriti nel campo della botanica possono essere così riassunti:

- prospezione sistematica della flora compresa fra Alpi Giulie e Dalmazia;
- allestimento di un erbario patrio di vaste proporzioni nel quale viene dato grande rilievo alla distribuzione, infatti le etichette portano l'indicazione della località di raccolta;
- collegamenti internazionali con eminenti studiosi dell'epoca;
- attività promozionali nel campo delle scienze naturali.

Botanico triestino e sindaco di Trieste M. de Tommasini.
Tržaški botanik in župan M. de Tommasini.

V zgodovini medregionalne botanike zbuja pozornost osebnost G. M. Spirita de Tommasinija (1794-1879), ki je raziskoval obsežno in kompleksno območje od Julijskih Alp do Boke Kotorske (1837 v sodelovanju z Biasolettom, 1839, 1840, 1851, 1895 z dopolnili in popravki C. Marchesettija). Na področju botanike je zaslužen za:

- sistematično preučevanje flore med Julijskimi Alpami in Dalmacijo;
- ureditev velikega domoznanskega herbarija s poudarkom na razširjenosti vrst: vse etikete so namreč opremljene z navedbo rastišča posamezne rastline;
- mednarodne stike z uglednimi raziskovalci tistega časa;
- promocijsko dejavnost na področju naravoslovnih znanosti.

O pomembnosti vloge, ki jo je odigral Tommasini na področju botaničnega raziskovanja na ilirskem območju in območju jugovzhodnih Alp, priča tudi veliko število rastlin, ki so jih po njem poimenovali: *Campanula tommasiniana* Koch, *Linum tommasinii* Rchb., *Moehringia tommasinii* Marchesetti, *Onobrychis arenaria* subsp. *tommasinii* (Jord.) Asch. & Graebn., *Seseli tommasinii* Rchb. fil., *Tommasinia altissima* (Mill.) Thell. (= *Peucedanum verticillare* (L.) Mert. & Koch, *Tragopogon tommasinii* C.H. Schultz, itd.

Veliko zaslug za poznavanje hribovite Istre gre Heufler-Hohenbüchlu, ki je leta 1845 izdal splošno preglednico čičarijskega hribovja.

Če opustimo kronološkost zapisa, bi veljalo opozoriti na izjemno zanimanje, ki ga je pri številnih botanikih vzbujal najvišji vrh v Istri, Učka. Nekateri med njimi, ki so posebej podrobno obdelovali reško območje, so namreč v svoje raziskave vključili tudi Učko. Med njimi, in pri tem izhajamo tudi iz Benl & Mayer (1975): Freyer (1839), Giacich (1844), Smith (1878), Freyn (1879), Hirc (1883, 1914, 1915), Stapf (1887), Simonkai (1888), Depoli (1901), Schiffner (1905), Rossi (1924, 1930), itd. Posebno pozornost je Učki posvečal tudi Madžar Borbás, vendar bomo tokrat navedli le del njegovega obsežnega opusa (1876, 1877, 1877a, 1878, 1880). Haračić se je posvečal lošinjski flori (1890-91, 1893, 1905, 1910).

Pomembno fazo sistematičnega raziskovanja Istre predstavlja A. Loser (1842-1878), ki je preučil okolico Kopra in je leta 1860 objavil obsežen katalog rastlin s tega območja (1016 vrst), nekaj let kasneje (1864) pa mu je dodal še 57 vrst. Leta 1874 se je med graditvijo istrske železnice v Pulj priselil inženir G. Freyn, ki se pri svojih botaničnih raziskavah ni omejil na pozorno in pretehtano preučevanje flore na območju Pulja in okolice ter južne Istre (1876-77, 1877, 1881), temveč je območje svojega dela razširil do tržaške okolice (1890-92).

Seveda na tem mestu ni mogoče spregledati Stefanija, ki je v svojem delu *"Flora di Pirano"* (1884, 1894-

A conferma del fondamentale ruolo svolto dal Tommasini nel campo dell'esplorazione botanica dei territori illirici e delle Alpi sud-orientali numerose sono le entità che lo ricordano nel nome, quali: *Campanula tommasiniana* Koch, *Linum tommasinii* Rchb., *Moehringia tommasinii* Marchesetti, *Onobrychis arenaria* ssp. *tommasinii* (Jord.) Asch. & Graebn., *Seseli tommasinii* Rchb. fil., *Tommasinia altissima* (Mill.) Thell. (= *Peucedanum verticillare* (L.) Mert. & Koch, *Tragopogon tommasinii* C.H. Schultz, ecc..

Un importante contributo alla conoscenza dell'Istria montana lo si deve a Heufler-Hohenbüchel, che nel 1845 dà alle stampe un prospetto generale dei Monti della Ciceria.

Tralasciando l'esposizione cronologica, è forse opportuno mettere in evidenza la grande attrazione esercitata dal più elevato rilievo istriano (M. Maggiore) sui vari botanici. Alcuni di essi, che hanno trattato in particolar modo il territorio fiumano, lo includono infatti nelle loro considerazioni. Tra questi ricordiamo, deducendoli anche da Benl & Mayer (1975): Freyer (1839), Giacich (1844), Smith (1878), Freyn (1879), Hirc (1883, 1914, 1915), Stapf (1887), Simonkai (1888), Depoli (1901), Schiffner (1905), Rossi (1924, 1930), ecc..

Anche l'ungherese Borbás dedica particolare attenzione al M. Maggiore e ai dintorni di Fiume e all'isola di Veglia, di cui riportiamo solo alcuni dei numerosi lavori (1876, 1877, 1877a, 1878, 1880). Alla flora di Lussino si dedica Haračić (1890-91, 1893, 1905, 1910).

Una tappa importante dell'esplorazione sistematica dell'Istria è costituita da A. Loser (1842-1878), che, perlustrando attivamente i dintorni del capodistriano, fu in grado di pubblicare nel 1860 un esteso catalogo delle piante di questo territorio (1016 specie), a cui alcuni anni più tardi (1864) ne aggiunse 57.

Nel 1874 si stabilì a Pola, a seguito della costruzione della ferrovia istriana, l'ingegnere G. Freyn, il quale non soltanto si occupò con oculatezza e sagacia della flora del polese e dell'Istria meridionale (1876-77, 1877, 1881), ma estese le sue esplorazioni botaniche fino al distretto triestino (1890-92).

Non si può poi tralasciare lo Stefani che nella sua *"Flora di Pirano"* (1884, 1894-95) elenca ben 1016 specie da questo territorio. Va ricordato inoltre il Beyer che segnala *Asplenium lepidum* dall'Istria settentrionale (1894), omesso nella *"Bibliografia botanica"* del Marchesetti.

Il più grande allievo del Tommasini è il triestino C. de Marchesetti (1850-1926), di cui l'opera principale è la "Flora di Trieste e de' suoi dintorni" (1896-97). Tale opera è divisa in due parti: una generale ed una speciale. Nella parte generale fa un commento delle condizioni geografiche e fisiche del territorio trattato, un bilancio fitogeografico, un erudita esposizione storico - bibliografica degli studi pregressi e conclude con una chiave analitica delle famiglie. La parte speciale, ordi-

95) zbral kar 1016 rastlinskih vrst. Opozoriti velja tudi na Beyerja, ki omenja vrsto *Asplenium lepidum* iz severne Istre (1894), ki jo je Marchesetti v svoji Botanični bibliografiji *("Bibliografia botanica")* spregledal.

Najpomembnejši Tommasinijev učenec je bil Tržačan C. de Marchesetti (1850-1926), katerega temeljno delo je *"Flora di Trieste e de' suoi dintorni"* (1896-97). Knjiga je razdeljena na dva dela: splošnega in posebnega. Splošni del vsebuje študijo geografskih razmer in fizičnih razmer obravnavanega območja, fitogeografsko oceno, poglobljeno zgodovinsko-bibliografsko razpravo o predhodnih raziskavah, zaokrožen pa je z analitičnim prikazom družin. V drugem delu, ki je razen v nekaterih podrobnostih urejen po sistemu de Candolla, je obdelanih prek 1700 enot, vsaka od njih pa je opremljena s podrobnim, čeprav strnjenim opisom, sinonimijo, domačimi poimenovanji, navedbami zgodovinsko pomembnih florističnih del in podrobno razširjenostjo. Med številnimi deli, ki jih je izdal, naj opozorimo na floro Izole (1879), Poreča (1890), Sv. Katarine pri Rovinju (1895), Škocjana (1887), predvsem pa na zelo natančno bibliografsko delo (1895), v katerem je navedenih in kritično povzetih kar 672 del, ki zadevajo takratno avstrijsko Primorje, in ki ga je avtor vse do smrti nenehno dopolnjeval in urejal. Delo je izšlo posthumno leta 1931.

Marchesettijev sodobnik je tudi E. Pospichal (1838-1904), ki je med 1897 in 1899 objavil delo *"Flora des österreichischen Küstenlandes"*. Geografske meje "Flore" so premaknjene skoraj do administrativne meje takratnega avstrijskega Primorja in zajemajo tako imenovano avstrijsko Furlanijo, Goriško, vključno s Trnovskim gozdom in Nanosom, tržaški Kras in Istro med izlivoma Raše in Mirne. Delo je posebej dragoceno zaradi izjemno natančnih opisov na podlagi svežega materijala, ki jih odlikuje pretanjen jezikovni stil in v katerih so izpostavljene bistvene značilnosti, po katerih se razlikujejo sorodne vrste. Nekatere vrste, kot so *Centaurea rupestris* var. *hirtella*, *Iris sibirica* var. *erirrhiza*, *Rubus trifoliatus* so opisane prvič. Žal je to delo, tako vsestransko in podatkovno bogato, zelo cenjeno tudi na mednarodni ravni, na lokalnem nivoju zaradi nemščine, v kateri je napisano, manj uporabno. Med bivanjem v Trstu je Pospichal razširil tamkajšnje domoznanske zbirke z bogatim herbarijem z okoli 5000 vrstami, ki je shranjen v Naravoslovnem muzeju v Trstu.

S Hrubyjem (1918) se zaključuje klasično obdobje florističnih raziskav določenega območja.

Z razpadom avstro-ogrskega imperija se začenja obdobje sodobnih botaničnih raziskav, v katerem se poleg florističnih začenjajo pojavljati in uveljavljati tudi fitogeografske, geobotanične in ekološke raziskave.

Med učenci in najbolj gorečimi privrženci Marchesettija je bil tudi C. Zirnich (1895-1978), po rodu Pirančan, Goričan po svoji intimni odločitvi, ki je zbral obsežen in podroben herbarij, osredotočen na severnonata, salvo lievi modifiche, secondo il sistema di de Candolle, tratta un complesso di oltre 1700 entità, per ognuna delle quali viene data accurata anche se succinta descrizione, sinonimia, denominazioni volgari, citazioni nelle opere floristiche di importanza storica e distribuzione dettagliata. Tra i numerosi lavori da lui pubblicati merita ricordare i lavori floristici di Isola (1879), di Parenzo (1890), di S. Caterina presso Rovigno (1875), di S. Canziano (1887) e soprattutto l'accuratissimo lavoro bibliografico (1895) nel quale elenca e sunteggia criticamente ben 672 lavori inerenti l'allora Litorale Austriaco, i cui aggiornamenti, che curerà continuamente fino alla morte, saranno pubblicati postumi nel 1931.

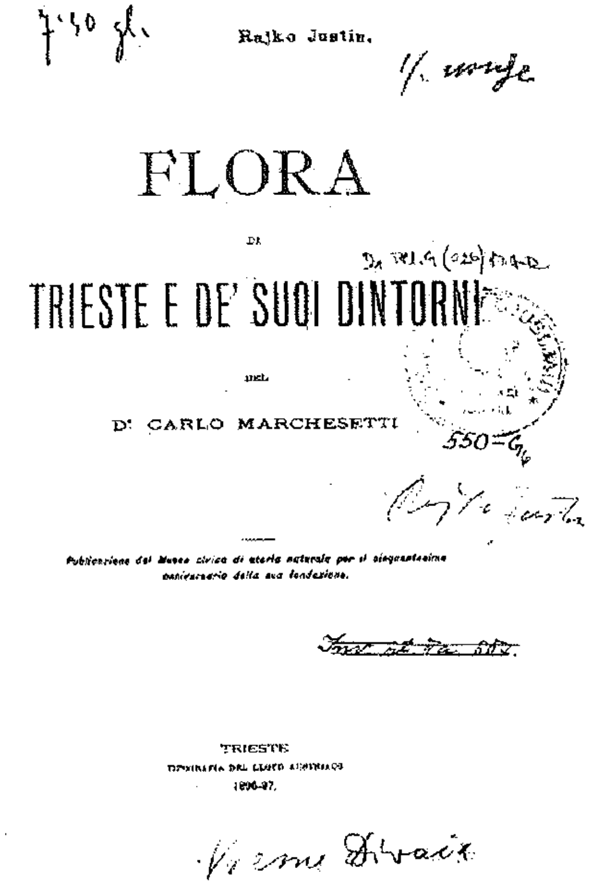
Contemporaneo del Marchesetti è E. Pospichal (1838-1904) che pubblica fra il 1897 e 1899 la *"Flora des österreichischen Küstenlandes"*. I limiti geografici della "Flora" si scostano alquanto dai limiti amministrativi dell'allora Litorale Austriaco e vengono a includere il cosiddetto Friuli Austriaco, il Goriziano, ivi compresa la Selva di Tarnova e il M. Nanos, il Carso triestino e l'Istria fra le foci dell'Arsa e del Quieto. Il pregio maggiore dell'opera consiste nella straordinaria accuratezza delle descrizioni, redatte su materiale fresco e con stile linguisticamente impareggiabile, nelle quali vengono messi in evidenza i caratteri essenziali alla distinzione fra specie affini. Alcune entità vengono descritte per la prima volta, quali *Centaurea rupestris* var. *hirtella, Iris sibirica* var. *erirrhiza, Rubus trifoliatus.* Purtroppo un'opera così complessa e ricca di informazioni, molto nota in campo internazionale, ormai è diventata localmente di difficile accesso a causa della lingua tedesca. Il soggiorno triestino del Pospichal ha altresì arricchito le collezioni patrie di un ponderoso erbario aggirantesi sui 5000 esemplari, depositati presso il Museo di Storia Naturale di Trieste.Con Hruby (1918) si conclude il periodo classico dell'esplorazione floristica del territorio in esame.

Con la dissoluzione dell'Impero austro-ungarico può essere fatto coincidere l'inizio del periodo contemporaneo dell'esplorazione botanica, nel quale, accanto a quello floristico, emergono e si affermano sempre più gli indirizzi fitogeografici, geobotanici ed ecologici.

Fra gli allievi e seguaci più attivi del Marchesetti ricordiamo C. Zirnich (1895-1978), nato a Pirano ma goriziano di elezione, che è riuscito a costituire un vasto e accuratissimo erbario inerente soprattutto i territori nordadriatici. Il materiale del suo erbario è stato parzialmente pubblicato da Cohrs (1953-54, 1963), il quale ha anche rivisto il materiale e fatto annotazioni critiche, e successivamente da Mezzena (1986), che si è limitato a trascriverne i cartellini.

Ricordiamo inoltre la flora del M. Auremiano dello Justin (1904), la *"Flora di Rovigno"* di Benacchio (1939) e per il M. Auremiano e la Cicceria slovena il lavoro di Accetto (1990).

Lusina si dedica con particolare attenzione alla flora delle isole quarnerine con una serie di lavori apparsi pre-


Rajko Justin.

FLORA

DI

TRIESTE E DE' SUOI DINTORNI

DEL

D.r CARLO MARCHESETTI

Pubblicazione del Museo civico di storia naturale per il cinquantesimo anniversario della sua fondazione.

TRIESTE
TIPOGRAFIA DEL LLOYD AUSTRIACO
1896-97.

Prva stran Marchesettijeve flore z rokopisom slovenskega botanika R. Justina.
La prima pagina della "Flora" di Marchesetti, manoscritto di R. Justin, botanico sloveno.

jadransko območje. Herbarij je delno objavil Cohrs (1953-54, 1963), ki je material tudi pregledal in ga opremil s kritičnimi pripombami, kasneje pa Mezzena (1896), ki se je omejil na prepis kartončkov.

Pomembna so še Justinova flora Vremščice (1904), Benacchieva *"Flora di Rovigno"* (1939) in Accettovi prispevki (1990, 1991) o Vremščici in slovenski Čičariji.

Lusina posveča posebno pozornost flori kvarnerskih otokov in jo obdela v delih, ki so izhajala povečini v Botaničnih analih *("Annali di Botanica")* v Rimu (1927, 1927a, 1932, 1933, 1934, 1934a, 1936, 1941, 1947, 1956).

Med sodobnimi publikacijami o flori Krasa in Istre so še: Baumgartner (1964); Benacchio (1963); Benl & Mayer (1975); Dakskobler (1995); Ferlan (1950); Jogan (1994); Kaligarič (1987, 1988, 1990, 1991, 1991a); Lausi (1962, 1964, 1964a); Lovasen-Eberhardt & Trinajstić (1978); Martinčič (1973); Martini (1990); Martini & Poldini (1990); Martini & Polli (1992); Mayer (1966); Melzer (1970, 1975, 1983, 1987, 1996); Melzer & Bregant (1989, 1991); Mlakar (1987); Morton (1935, 1936, valentemente negli *"Annali di Botanica"* di Roma (1927, 1927a, 1932, 1933, 1934, 1934a, 1936, 1941, 1947, 1956).

Fra i contributi contemporanei alla flora del Carso e dell'Istria ricordiamo i seguenti lavori: Baumgartner (1964); Benacchio (1963); Benl & Mayer (1975); Dakskobler (1995); Ferlan (1950); Jogan (1994); Kaligarič (1987, 1988, 1990, 1991, 1991 a); Lausi (1962, 1964, 1964 a); Lovasen-Eberhardt & Trinajstić (1978); Martinčič (1973); Martini (1990); Martini & Poldini (1990); Martini & Polli (1992); Mayer (1966); Melzer (1970, 1975, 1983, 1987, 1996); Melzer & Bregant (1989, 1991); Mlakar (1987); Morton (1935, 1936, 1939); Pericin (1992); Pertot (1996); Petauer (1979); Podobnik (1992); Poldini (1963, 1964, 1964a, 1965, 1966, 1966a, 1966b, 1969, 1971, 1980, 1984); Poldini & Rizzi Longo (1974-75); Poldini & Toselli, 1981; Polli (1985, 1990); Strgar (1985, 1990, 1991); Šugar & Trinajstić (1970); Sušnik & Lovka (1970); Trinajstić (1962, 1964, 1970); Trinajstić & Pavletić (1989); Zanotti & Cristofolini (1994); T. Wraber (1962, 1972, 1973, 1975, 1977, 1981, 1982, 1992, 1995) e la *"Lista rossa"* di Wraber & Skoberne (1989), in cui compaiono molte località istriane e carsiche di specie rare e minacciate.

Anche la flora avventizia ha assunto in questi ultimi anni sempre maggiore importanza, così che è oggetto di contributi floristici da parte di vari Autori. Oltre al già citato *Aster squamatus* di Wraber (1982), ricordiamo il reperimento di *Senecio inaequidens,* già segnalato per il Goriziano da Poldini (1980), che viene ritrovato per la prima volta nell'Istria slovena (Podpeč) da Kaligarič (1992) e successivamente da Pavletic & Trinajstić (1994) per Capodistria.

Altri lavori riguardanti contributi floristici sia dall'Istria slovena che croata, nei quali viene dedicata particolare attenzione all'ingresso di numerose neofite meso-americane che, come noto, è particolarmente intenso nelle fasce termofile che si affacciano sul Mediterraneo, sono opera di: Ilijanić (1957), Kaligarić & Jogan (1990), Jogan (1996, 1996a), Martini (1989).

I caratteri floro-vegetazionali più salienti del Carso e dell'Istria possono venir ricondotti a due ordini di fattori: uno temporale (storico) ed uno spaziale (ecologico). Il primo comprende fenomeni migratori che hanno modificato l'areale delle specie delineandone gli attuali quadri distributivi. Essi hanno subito un'accelerazione durante i periodi cata - e anatermici a seguito dell'espansione e del ritiro dei ghiacciai alpini nel Quaternario.

I movimenti migratori delle specie sono stati condizionati dalla struttura orotettonica del territorio a prevalente orientamento NW-SE, ed è infatti lungo questa direttrice che si distribuisce la massima diversità floristica. L'alto Carso (Selva di Tarnova, Selva di Piro) costituisce un'interessante e tipica cerniera fra il sistema alpico e quello dinarico; lungo i rilievi dell'Istria montana (Ciceria) sono penetrati nella regione mediterranea

1939); Pericin (1992); Pertot (1996); Petauer (1979); Podobnik (1992); Poldini (1963, 1964, 1964a, 1965, 1966, 1966a, 1966b, 1969, 1971, 1980, 1984); Poldini & Rizzi Longo (1974-75); Poldini & Toselli, 1981; Polli (1985, 1990); Strgar (1985, 1990, 1991); Šugar & Trinajstić (1970); Sušnik & Lovka (1970); Trinajstić (1962, 1964, 1970); Trinajstić & Pavletić (1989); Zanotti & Cristofolini (1994); T. Wraber (1962, 1972, 1973, 1975, 1977, 1981, 1982, 1992, 1995) in *"Rdeči seznam"* (Wraber & Skoberne, 1989), v katerem so navedeni številni istrski in kraški kraji z redkimi in ogroženimi vrstami.

Številni avtorji posvečajo v zadnjih letih posebno pozornost alohtoni flori. Poleg že omenjene Wraberjeve *Aster squamatus* (1982) je zanimiv tudi *Senecio inaequidens,* ki ga je na Goriškem prvi odkril in opisal Poldini (1980), na območju Slovenske Istre (v Podpeči) Kaligarič (1992), kasneje na Koprskem pa Pavletić & Trinajstić (1994).

Druga dela, ki zadevajo floristične prispevke tako iz Slovenske kot iz Hrvaške Istre, posebno pozornost pa posvečajo vdoru številnih ameriških neofitov, zlasti intenzivnem v toplotnih pasovih po Sredozemlju, so še: Ilijanić (1957), Kaligarič & Jogan (1990), Jogan (1996, 1996a), Martini (1989).

Najpomembnejše florno-vegetacijske značilnosti Krasa in Istre je mogoče pripisati dvema vrstama dejavnikov: časovnemu (zgodovinskemu) in prostorskemu (ekološkemu). V prvo vrsto sodijo migracijski pojavi, ki so spremenili areal določenih vrst in omejili njihovo sedanje območje rasti. Do teh procesov je zaradi širjenja in krčenja alpskih ledenikov v kvartaru prihajalo posebno pospešeno med kata- in anatermičnimi obdobji.

Na migracijo vrst je vplivala orotektonska struktura tega območja, ki se razteza pretežno v smeri SZ-JV; ta pobočja so zato izjemno bogata s pestro floro. Visoki Kras (Trnovski gozd, Hrušica) predstavlja zanimiv in značilen prehod med alpinskim in dinarskim sistemom; po obronkih montanske Istre (Čičarija) so se v sredozemsko območje prebile nekatere alpinske vrste *(Arabis alpina, Campanula carnica, Polysticum lonchitis, Primula auricula, Saxifraga paniculata, S. rotundifolia, Senecio abrotanifolius, S. doronicum, Tephroseris aurantiaca),* v višje lege pa so se ponovno vrnile kot sredozemski oreofiti *(Asphodelus albus, Satureja subspicata* s.l., *Vicia onobrychioides,* itd.).

Številne vrste imajo na tem območju svoja najbolj severozahodna rastišča; med sredozemskimi vrstami so tudi: *Alyssum medium, Anemone hortensis, Arceuthobium oxycedri, Bellis sylvestris, Cardamine maritima, Carlina corymbosa, Cistus salviifolius, Crepis blavii* (Stadlmann, 1908; Justin, 1911), *Cyclamen repandum, Ephedra major, Hornungia petraea, Juniperus phoenicea, Lonicera implexa, Lotus ornithopodioides, Narcissus tazetta, Ophioglossum lusitanicum, Ophrys* alcuni elementi alpici ed *alpidici (Arabis alpina, Campanula carnica, Polysticum lonchitis, Primula auricula, Saxifraga paniculata, S. rotundifolia, Senecio abrotanifolius, S. doronicum, Tephroseris aurantiaca)* e sono risalite orofite mediterranee *(Asphodelus albus, Satureja subspicata* s.l., *Vicia onobrychioides*, ecc.).

Innumerevoli sono inoltre le specie che qui hanno i limiti nordoccidentali della distribuzione. Per citarne alcune fra le mediterranee: *Alyssum medium, Anemone hortensis, Arceuthobium oxycedri, Bellis sylvestris, Cardamine maritima, Carlina corymbosa, Cistus salviifolius, Crepis blavii* (Stadlmann, 1908; Justin, 1911), *Cyclamen repandum, Ephedra major, Hornungia petraea, Juniperus phoenicea, Lonicera implexa, Lotus ornithopodioides, Narcissus tazetta, Ophioglossum lusitanicum, Ophrys bertolonii, O. bombyliflora* (Lussino), *O. fusca, O. scolopax, Orchis lactea, Pallenis spinosa, Phyllitis sagittata* (Veglia), *Pistacia lentiscus, Scilla autumnalis, Stehelina dubia* (Trinajstić & Pavletić, 1989), *Stipa bromoides, Teucrium arduini* (Draganović, 1994); fra le illiriche: *Anthriscus fumarioides, Arabis scopoliana, Astragalus illyricus, Carpinus orientalis, Cerastium decalvans, Corydalis acaulis, Digitalis laevigata, Euphorbia fragifera, E. triflora* ssp. *triflora, Gentiana tergestina, Genista sylvestris, G. holopetala, Melampyrum fimbriatum, Onopordon illyricum, Pedicularis friderici-augusti, Pseudofumaria alba, Satureja subspicata* ssp. *illyrica, Scrohularia laciniata, Serratula lycopifolia, S. radiata*, ecc. (v. inoltre Praprotnik, 1987).

A parte vanno considerate le endemiche: *Asperula woloszczakii* (Veglia), *Campanula istriaca, C. justiniana, C. tommasiniana, Leontopodium alpinum* var. *krasense* (M. Maggiore), *Phyllitis hybrida* (Cherso, Lussino, Veglia), *Moehringia tommasinii*.

Valenze floristiche e vegetazionali vengono per la prima volta utilizzate per la valutazione ambientale e per la conservazione della natura nell'Istria slovena da Kaligarič (1990).

Vanno ricordati altresì alcuni studi di citotassonomia (Honsell, 1962; Lausi, 1964b, 1966; Martinis & Lovasen-Eberhardt, 1973; Bedalov, 1983; Druškovič & Lovka, 1995).

Di alcune specie carsiche vengono studiati anche i principi attivi e la loro dipendenza dai fattori ecologici (Coassini Lokar *et al.*, 1980, 1983, 1986; Coassini Lokar & Poldini, 1985; Stancher & Poldini, 1969; Poldini *et al.*, 1971); per quanto riguarda il lavoro di Poldini *et al.* (1970) esso si riferisce a *Calamintha brauneana* e non a *C. nepetoides*, come invece appare nel titolo.

Sono stati inoltre eseguiti studi biometrici e biosistematici su *Satureja montana* (Feoli & Poldini, 1979) e su *Helleborus istriacus* (Coassini Lokar *et al.*, 1992).

I fattori ecologici sono i responsabili della zonazione verticale della vegetazione. Bartling (1820) è forse il primo che abbozza una suddivisione verticale dell'Istria in tre regioni: del mirto, del frassino e l'alpestre.

Il periodo contemporaneo, con forte accentuazione

bertolonii, O. bombyliflora (Lošinj), *O. fusca, O. scolopax, Orchis lactea, Pallenis spinosa, Phyllitis sagittata* (Krk), *Pistacia lentiscus, Scilla autumnalis, Stehelina dubia* (Trinajstić & Pavletić, 1989), *Stipa bromoides, Teucrium arduini* (Draganović, 1994); med ilirskimi: *Anthriscus fumarioides, Arabis scopoliana, Astragalus illyricus, Carpinus orientalis, Cerastium decalvans, Corydalis acaulis, Digitalis laevigata, Euphorbia fragifera, E. triflora* subsp. *triflora, Gentiana tergestina, Genista sylvestris, G. holopetala, Melampyrum fimbriatum, Onopordon illyricum, Pedicularis friderici-augusti, Pseudofumaria alba, Satureja subspicata* subsp. *illyrica, Scrophularia laciniata, Serratula lycopifolia, S. radiata*, itd. (glej tudi Praprotnik, 1987).

Posebej je treba upoštevati endemne vrste: *Asperula woloszczakii* (Krk), *Campanula istriaca, C. justiniana, C. tommasiniana, Leontopodium alpinum* var. *krasense* (Učka), *Phyllitis hybrida* (Cres, Lošinj, Krk), *Moehringia tommasinii*.

Pri vrednotenju okolja in ohranjanju narave v Slovenski Istri je bil Kaligarič prvi, ki je leta 1990 uporabil floristične in vegetacijske vrednosti.

Ob tem je treba omeniti tudi nekatere citotaksonomske študije (Honsell, 1962; Lausi, 1964b, 1966; Martinis & Lovasen-Eberhardt, 1973; Bedalov, 1983; Druškovič & Lovka, 1995).

Aktivne principe in njihovo odvisnost od ekoloških dejavnikov so preučevali na nekaterih kraških vrstah (Coassini Lokar *et al.*, 1980, 1983, 1986; Coassini Lokar & Poldini, 1985; Stancher & Poldini, 1969; Poldini *et al.*, 1971). Sicer pa se delo Poldini *et al.* (1970) nanaša na vrsto *Calamintha brauneana* in ne na *C. nepetoides*, kot bi bilo mogoče razbrati iz naslova.

Biometrično in biosistematsko sta bili obdelani vrsti *Satureja montana* (Feoli & Poldini, 1979) in *Helleborus istriacus* (Coassini Lokar *et al.*, 1992).

Zaradi ekoloških dejavnikov je bilo potrebno vertikalno predeljevanje (zoniranje) vegetacije. Barting (1820) je verjetno prvi nakazal vertikalno razdelitev Istre na tri območja: območje mirte, jesena in alpskega pasu.

Sodobno obdobje, za katerega je značilen močan poudarek na fitogeografski usmeritvi, se začenja z Beckom (1901), nadaljuje pa se z Adamovićem (1929), Horvatom (1954), Anićem (1958) in Horvatićem (1939, 1943, 1969). Slednji je prvič zarisal razdelitev Hrvaške Istre in Kvarnerskih otokov ter tako postavil temelje za kasnejše povezovanje.

Po tej shemi je Istra razdeljena na tri osnovne pasove: na pas črničevja, puhastega hrasta in bukve. Kasneje so to razpredelnico, kar zadeva hrvaški del Istre, dopolnili strokovnjaki iz zagrebške šole (Ilijanić, 1967, 1970, 1984; Ilijanić & Topić, 1981; Šugar, 1970, 1983, 1984, 1984a; Trinajstić, 1965, 1967, 1975, 1976, 1980, 1982, 1984, 1985, 1995; Trinajstić & Šugar, 1976), kar zadeva njen slovenski del, pa raziskovalci ljubljanske šole (Accetto, 1989, 1991; Dakskobler, 1994, 1996).

dell'indirizzo fitogeografico, può essere fatto iniziare con Beck (1901) e quindi con Adamović (1929), Horvat (1954), Anić (1958), Horvatić (1939, 1943, 1963). Con quest'ultimo Autore viene delineata per la prima volta una suddivisione dell'Istria croata e delle isole del Quarnero, che costituisce la base per le integrazioni successive.

L'Istria appare suddivisa nelle tre fondamentali fasce a leccio, a roverella e a faggio. Questo schema verrà successivamente completato dagli Autori della scuola di Zagabria per quanto concerne l'Istria in Croazia (Ilijanić, 1967, 1970, 1984; Ilijanić & Topić, 1981; Šugar, 1970, 1983, 1984, 1984a; Trinajstić, 1965, 1967, 1975, 1976, 1980, 1982, 1984, 1985, 1995; Trinajstić & Šugar, 1976) e dagli Autori di Lubiana per la parte d'Istria in Slovenia (Accetto, 1989, 1991; Dakskobler, 1994, 1996).

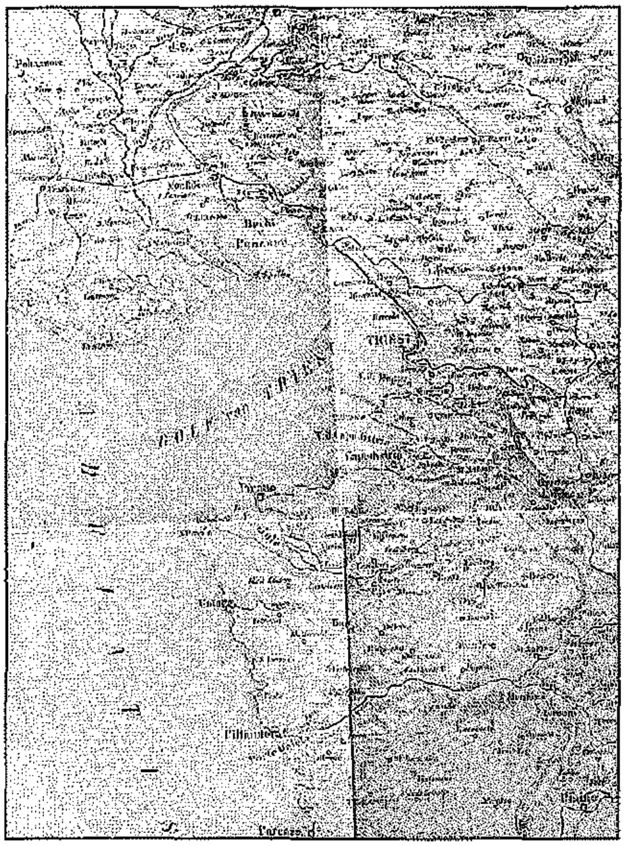
Una serie di lavori viene dedicata al Carso sloveno da M. Wraber (1954, 1958, 1963, 1967, 1969), che ne individua le unità fondamentali di vegetazione.

Altri lavori di cartografia vegetazionale su base fitosociologica riguardanti il Carso sloveno vengono prodotti da Puncer & Zupančič (1970, 1975) e da Zupančič *et al.* (1987).

Per cui alla fine si può arrivare a un bilancio delle cenosi forestali fin qui individuate, suddividendole in zonali (climatogene o climaciche) in extrazonali (topoclimaciche) e in azonali (paraclimaciche).

Le unità zonali vanno dal tipo termomediterraneo, localizzato all'estremità meridionale di Lussino, con il *Myrto-Quercetum ilicis* Trinajstić cfr. 1995 (Basion.: *Quercetum ilicis adriaprovinciale* Trinajstić 1973), al mesomediterraneo comprendente il *Fraxino orni-Quercetum ilicis* H-ić 1958 delle coste meridionali d'Istria fino al canale di Leme, l'*Ostryo-Quercetum ilicis* Trinajstić (1965) 1974 presente a Cherso anche in riva al mare ed extrazonale nel golfo di Trieste (sub *Orno-Quercetum ilicis* in Lausi & Poldini, 1962). Il supramediterraneo è occupato in Istria da due cenosi zonali: il *Querco-Carpinetum orientalis* H-ić 1939 e l'*Ostryo-Quercetum pubescentis* (Ht.) Trinajstić 1974. Seguono quindi la fascia delle faggete submontane con il *Seslerio autumnalis-Fagetum* (Ht. 1950) M. Wraber (1957) 1960, montane con il *Lamio orvalae-Fagetum* (Ht. 1938) Borhidi 1963, cui fa seguito, ma soltanto sulla massima elevazione del M. Maggiore (Vojak), la faggeta subalpina *Polysticho lonchitis-Fagetum* (Ht. 1938) Marinček in Poldini et Nardini 1993 (= *Homogyno alpinae-Fagetum* (Ht. 1938) Borhidi 1963) (Marinček *et al.*, 1992).

A queste cenosi forestali climaciche vanno aggiunte quelle a condizionamento prevalentemente edafico: l'*Asparago tenuifolii-Quercetum roboris* (Lausi 1966) Marinček 1994 (= *Querco-Carpinetum submediterraneum* Bertović 1968) (v. anche Bertović, 1975), bosco d'umidità nel quale rientra il bosco S. Marco nella valle del Quieto (Marinček, 1994), il *Molinio-Quercetum pubescentis* Šugar 1981 (Šugar *et al.*, 1995), il *Potentillo*



Zemljevid obravnavanega območja iz Pospichalove flore.
Mappa dell'area di studio, pubblicata nella "Flora" di Pospichal.

Slovenskemu Krasu je posvečenih več del M. Wraberja (1954, 1958, 1963, 1967, 1969), v njih pa so navedene tamkajšnje glavne vegetacijske enote.

Z vegetacijsko kartografijo slovenskega Krasa na fitocenološki osnovi se ukvarjata Puncer & Zupančič (1970, 1975) ter Zupančič *et al.* (1987).

Zato je na koncu mogoča ocena o doslej odkritih gozdnih združbah in njihova razdelitev na zonalne (klimatogene), ekstrazonalne (topoklimatske) in azonalne (paraklimatske).

Zonalne enote segajo od termomediteranskega tipa vegetacije, odkritega na skrajni južni strani Lošinja z *Myrto-Quercetum ilicis* Trinajstić cfr. 1995 (Basion.: *Quercetum ilicis adriaprovinciale* Trinajstić 1973), do srednjemediteranskega tipa, ki vključuje *Fraxino orni-Quercetum ilicis* H-ić 1958 južnih istrskih obal do Limskega kanala, *Ostryo-Quercetum ilicis* Trinajstić (1965) leta 1974 na Cresu tudi na južni obali ter azonalno v Tržaškem zalivu (sub *Orno-Quercetum ilicis* v Lausi & Poldini, 1962). Submediteran zastopata v Slovenski Istri dve zonalni združbi; *Querco-Carpinetum orientalis* H-ić 1939 in *Ostryo-Quercetum pubescentis* (Ht.) Trinajstić

Quercetum pubescentis A. Horv. 1973 (sic in Trinajstić, 1982) dei terreni flyschoidi dell'Istria centrale, il *Seslerio-Quercetum petraeae* (Poldini, 1964 n.n.) Poldini 1982, il *Melampyro vulgati-Quercetum petraeae* Puncer et Zupančič 1979 descritto per la Brkinja (Puncer & Zupančič, 1979) e quelle a condizionamento topoclimatico: l'*Asaro-Carpinetum betuli* Lausi 1964 (Poldini, 1985), l'*Anemono nemorosae-Carpinetum betuli* Trinajstić 1964 ed il *Corydalido ochroleucae-Aceretum* Accetto 1991 (Accetto, 1991).

Orli e margini boschivi vengono studiati da Gils *et al.* (1975) e da Čarni (1997). Anche il dinamismo della vegetazione (incespugliamento, successione) viene analizzato in una serie di lavori (Lausi *et al.*, 1979; Feoli & Feoli Chiapella, 1979; Feoli *et al.*, 1980; Feoli & Scimone, 1982; Favretto & Poldini, 1986; Čarni & Kaligarič, 1990; Čarni & Kaligarič, 1991).

Per quanto riguarda le formazioni erbacee, sia primarie che derivate, non è possibile delineare in questa sede gli aspetti fondamentali. Si rimanda pertanto ai lavori di Poldini (1989), Kaligarič (1994, 1994a), Čarni (1995) e Kaligarič & Poldini *(in pubbl.)* che, oltre a una trattazione esauriente, riportano anche numerosi riferimenti bibliografici.

Impollinazione e biotopi suburbani vengono studiati da Iunc & Poldini (1995) e da Pertot & Poldini (1995).

Il bilancio fitogeografico che si può trarre dalle due fondamentali fonti d'informazione flora e vegetazione, disposte secondo gli assi del tempo e dello spazio, è che Carso ed Istria, ancorchè con diverse specificità, costituiscono un raccordo fra il settore alpico e quello dinarico della provincia illirica e un'interfaccia fra la regione mediterranea (provincia adriatica) e la regione eurosibirica-nordamericana (provincia illirica). L'intreccio fra il gradiente floristico ed ecologico spiega l'elevata biodiversità di questi territori.

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1974. Sledi pas submontanskega bukovja z združbo *Seslerio autumnalis-Fagetum* (Ht. 1950) M. Wraber (1957) 1960, pas montanske združbe *Lamio orvalae-Fagetum* (Ht. 1938) Borhidi 1963, in nazadnje, a samo na skrajnih pobočjih Učke (Vojak), subalpinsko bukovje *Polysticho lonchitis-Fagetum* (Ht. 1938) Marinček v Poldini et Nardini 1993 (= *Homogyno alpinae-Fagetum* (Ht. 1938) Borhidi 1963) (Marinček *et al.*, 1992).

Tem klimatogenim gozdnim združbam gre dodati združbe pretežno edafskega tipa: *Asparago tenuifolii-Quercetum roboris* (Lausi 1966) Marinček 1994 (= *Querco-Carpinetum submediterraneum* Bertović 1968) (glej tudi Bertović, 1975), vlažni gozd, kamor sodi tudi gozd Sv. Marka v dolini Mirne (Marinček, 1994), *Molinio-Quercetum pubescentis* Šugar 1981 (Šugar *et al.*, 1995), *Potentillo albae-Quercetum pubescentis* A. Horv. 1973 (sic in Trinajstić, 1982) flišnih terenov osrednje Istre, *Seslerio-Quercetum petraeae* (Poldini, 1964 n.n.) Poldini 1982, *Melampyro vulgati-Quercetum petraeae* Puncer et Zupančič 1979, opisanih za Brkine (Puncer & Zupančič, 1979) in združbe topoklimatskega tipa: *Asaro-Carpinetum betuli* Lausi 1964 (Poldini, 1985), *Anemono nemorosae-Carpinetum betuli* Trinajstić 1964 in *Corydalido ochroleucae-Aceretum* Accetto 1991 (Accetto, 1991).

Robove in obronke gozdov so preučevali van Gils *et al.* (1975) in Čarni (1997). V številnih delih je razčlenjena tudi dinamika vegetacije (razraščanje grmičevja, sukcesija) (Lausi *et al.*, 1979; Feoli & Feoli Chiapella, 1979; Feoli *et al.*, 1980; Feoli & Scimone, 1982; Favretto & Poldini, 1986; Čarni & Kaligarič, 1990; Čarni & Kaligarič, 1991).

Temeljnih vidikov travnatih formacij, tako primarnih kot sekundarnih, na tem mestu ni mogoče podrobneje predstaviti. Zato navajamo dela Poldinija (1989), Kaligariča (1994, 1994a), Čarnija (1995) in Kaligariča & Poldinija (v tisku), ki poleg temeljite obdelave vsebujejo tudi obsežno bibliografijo.

Opraševanje in suburbani biotopi so obdelani v študijah avtorjev Iunc & Poldini (1995) in Pertot & Poldini (1995).

Po fitogeografski podobi, ki jo je mogoče razbrati iz dveh ključnih virov - flore in vegetacije, urejene glede na časovne in prostorske osi, predstavljata Kras in Istra, čeprav vsak s svojimi posebnostmi, stičišče med alpinskim in dinarskim predelom ilirske province ter vezni člen med mediteransko (jadransko provinco) in evrosibirsko-severnoameriško regijo (ilirsko provinco). Zaradi prepletanja florističnih in ekoloških spremenljivk pa je za to območje značilna visoka stopnja biotske pestrosti.

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A NEW SUBASS. OF DINARIC ALTIMONTANE BEECH FOREST *RANUNCULO PLATANIFOLII-FAGETUM* MARINČEK *ET AL.* 1993 VAR. GEOGR. *CALAMINTHA GRANDIFLORA* MARINČEK 1996 *SESLERIETOSUM AUTUMNALIS* FROM Mt. SNEŽNIK

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ABSTRACT

A new, the most thermophilous subassociation Ranunculo platanifolii-Fagetum *Marinček* et al. *1993 var. geogr.* Calamintha grandiflora *Marinček 1996* seslerietosum autumnalis *subass. nova is described. Its differential species are:* Sesleria autumnalis, Carex alba, Cirsium erisithales *and* Sorbus aria.

Key words: beech forests, *Ranunculo platanifolii-Fagetum*, *Sesleria autumnalis*, Mt. Snežnik, Slovenia

INTRODUCTION

The first to phytosociologically research beech forests in the altimontane belt of Mt. Snežnik and elsewhere in the Dinaric area of Slovenia were V. Tregubov and G. Tomažič. In the beginning V. Tregubov incorporated them in the association *Fagetum subalpinum* Ht. 1938 (1957: 48-49); later on they were denominated *Adenostylo glabrae-Fagetum praealpino-dinaricum* Tregubov 1962 in internal expert reports (Smole, 1988: 25). In 1983 Marinček classified them in the association *Fagetum altimontanum dinaricum*. By the same name he presented them also in the monographic review of beech forests in Slovenia (Marinček 1987: 97-101). According to the Code of Phytosociological Nomenclature (Barkmann *et al.*, 1987), Marinček and his associates (1993: 129) incorporated the altimontane beech forests of the Illyrian floral province into the association *Ranunculo platanifolii-Fagetum* Marinček *et al.* 1993. Marinček (1996: 199) described the Dinaric form of this association as a geographical variant by the name of *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora* Marinček 1996. In the period between 1970 and 1990 he gathered comprehensive phytosociological material on this geographical variant which is still in manuscript. On the basis of more than a hundred relevés he classified several subassociations. One of them is also a subassociation with *Sesleria autumnalis*, which is dealt with in this article.

METHODS

The vegetation was described according to the standard Central European method (Braun-Blanquet, 1964). We organized the relevés into a phytosociological table applying the methods of hierarchical classification. For this purpose we transformed combined estimations of cover and frequency with combined transformation as proposed by van der Maarel (1979).

As the subassociation *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora seslerietosum* is physiognomically and ecologically rather similar to the association *Seslerio autumnalis-Fagetum* (Ht.) M. Wraber ex Borhidi 1963, we made a comparison to one of its forms, namely to the geographical variant *Seslerio autumnalis-Fagetum* (Ht.) M. Wraber ex Borhidi 1963 var. geogr. *Phyteuma scheuchzeri* Dakskobler 1997 (mscr.) from the high karst plateaus of Otlica and Nanos.

The comparison included also a typical subassociation of the Dinaric altimontane beech forests *(Ranunculo platanifolii-Fagetum* Marinček *et al.* 1993 var. geogr *Calamintha grandiflora* Marinček 1996 *ranunculetosum* Marinček 1997, mscr.). We compared the syntaxa enumerated, applying the method of Principal Coordinates Analysis = Metric Multidimensional Scaling. The measure for clustering was dissimilarity coefficient 1-similarity ratio. In numerical processing, classification and ordination the computer program package SYN-TAX 5.0 (Podani, 1993) was applied.

We refer to Trpin & Vreš (1995) and Marinček *et al.* (1992) for the nomenclature of plant species and vegetation units, and to Martinčič (1968) for the nomenclature of mosses.

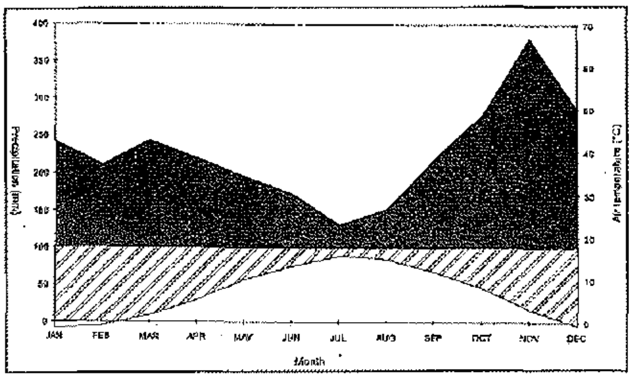

Fig. 1: Climatic Diagram (Zupančič, 1995; Mekinda-Majaron, 1995) - Gomance 1961-1990, according to Walter** et al.* ***(1964).
Sl. 1: Diagram klimatskih sprememb (Zupančič, 1995; Mekinda-Majaron, 1995) - Gomance 1961-1990, po Walterju** et al.* ***(1964).

RESULTS

Ecological Conditions

The subassociation *Ranunculo-Fagetum* var. geogr. *Calamintha grandiflora seslerietosum autumnalis* thrives on sunny slopes of Mt. Snežnik and its wider surroundings known as a distinctive Karst environment. However, the relief is not as diversified as this is the case by the majority of the subassociations of the association *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora*. Gentle to moderately steep slopes prevail, passing at spots to steeper ridges with more strongly expressed surface stoniness. Due to predominant dolomite parent material, the surface stoniness is weak in general.

The subassociation *Ranunculo-Fagetum* var. geogr. *Calamintha grandiflora seslerietosum* thrives at an altitude of 1170 to 1330 metres. Most frequently it is found at an altitude of 1200 to 1260 metres. At lower altitudes it is in direct contact with the association *Seslerio-Fagetum*. At higher altitudes the subassociation described does not border directly to Dinaric sub-Alpine beech forests - *Polysticho lonchitis-Fagetum* (I. Horvat, 1938) Marinček *et al.* 1993 var. geogr. *Allium victorialis* Marinček 1996 - between both communities mentioned there is more or less wide zone of typical subassociation of altimontane Dinaric beech forests - *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora ranunculetosum*.

Stands described thrive in explicitly sunny aspects.

The climate of Mt. Snežnik is one of the most humid in Slovenia. In the period from 1961 to 1990 the average annual precipitation was 2738 mm. The precipitation is relatively constantly distributed all over the year with the explicit maximum in November (383 mm) and minimum in July (132 mm) (Zupančič, 1995). Air humidity is very high, annually on an average over 80%. Average annual temperature ranges from 4.5 to 6 °C (Mekinda-Majaron, 1995). Heavy snowfalls are frequent, and in shady areas the snow does not melt till high spring. Vegetation period lasts for about five months, from the middle of May till the middle of October.

The community described thrives mostly on dolomite limestone, more rarely on limestone. Shallow to medium deep mull rendzina is very skeletony, especially on dolomite limestone.

Profile Description (Prus, 1997):

Location: the Mt. Snežnik, under the peak Maverski vrh, inclination 25°, southern aspect, 1230 m a.s.l.

O1 - 2 to 0, dry grass, litter consisting of beech leaves, sharply borders to A1.

A1 - 0 to 11, 7,5 YR 3/2 (dark brown), granular structure, well expressed, aggregate very stable, humose to very humose, roots very dense, individual skeleton up to 5 cm big, soft, brittle, dry to fresh.

A2 - 11 to 25 cm, 7,5 YR 3/2, (little less dark brown), sub-angular (blocky) structure, well expressed, aggregate very stable, sandy-silty-loamy texture, 25% skeleton of size from 5 to 10 cm, soft, brittle, dry to fresh, a little less humose, roots very dense, biologically active,

AC - 25 to 43 cm, 7,5 YR, 4/4, (between dark brown and brown), sub-angular (blocky) structure, well expressed, aggregate very stable, up to 70% of skeleton of size up to 20 cm, dry to fresh, soft, loose, medium humose, roots not dense.

Structure and Floristic Composition

Forests of the subassociation *seslerietosum autumnalis* are young crops in the transition to timbers and young timbers, from 15 to 25 m high. *Fagus sylvatica* predominates, being rarely accompanied by *Acer pseudoplatanus*. *Abies alba* was registered only once. We can notice loose sabre-shape form of trees, the consequence of high snow which often does not melt till the end of May.

Shrub layer is not well developed. Mainly it consists of: beech regeneration, *Acer pseudoplatanus, Sorbus aria, Daphne mezereum, Lonicera alpigena* and *Rosa pendulina*.

Herb layer is given its basic character by the grasses *Sesleria autumnalis* and *Calamagrostis varia,* and sedge *Carex alba*.

Character species of the association *Ranunculo platanifolii-Fagetum: Ranunculus platanifolius* and *Adenostyles glabra* reach medium frequency and cover; nevertheless, together with species *Polygonatum verticillatum,* they well indicate altimontane character of the community described. Also character species of the geographical variant *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora: Calamintha grandiflora* and *Aremonia agrimonioides*, species which thrive best in the area of the Dinaric region, are very frequent.

Differential species of the subassociation *seslerietosum autumnalis: Sesleria autumnalis, Cirsium erisithales, Carex alba* and *Sorbus aria,* character and differential species of order *Quercetalia pubescentis* indicate relatively warm site, very clearly differentiating the subassociation described from all other subassociations of the *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora*.

Mercurialis perennis, Cyclamen purpurascens and *Calamagrostis varia,* indicators of skeletony soils, also belong to the wide differential group. The last one appears as a facies in well lit places.

Character and differential species of the suballiance are not so frequent. *Saxifraga rotundifolia, Luzula sylvatica, Homogyne sylvestris, Polystichum lonchitis,* which have constant frequency in other subassociations of the *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora,* are completely absent. The species of the order *Adenostyletalia* also have low frequency in general. The absence of those species is not a consequence of a lower altitude, for the subassociation treated thrives approximatelly at the same altitude as other subassociations of the Dinaric altimontane forest, but a result of relatively warmer climate which is not favourable to formation of moder humus.

Character and differential species of the alliance *Aremonio-Fagion: Dentaria enneaphyllos, Cyclamen purpurascens, Vicia oroboides, Euphorbia carniolica, Hacquetia epipactis* and other reach high to medium frequency. We classified species *Rhamnus fallax* and *Isopyrum thalictroides* to the wider group of differential species of the alliance, too.

Character and differential species of the order *Fagetalia sylvaticae* are very frequent, with a note that explicitly mesophilous species, such as *Adoxa moschatellina, Actaea spicata, Geranium robertianum* and some other, appear only as accidental species.

Acidophilous species, with the exception of shrub species *Rosa pendulina,* appear rarely, due to already stated reasons.

We did not study moss layer thoroughly, but while collecting phytosociological data we found the following mosses: *Ctenidium molluscum, Isothecium myurum, Tortella tortuosa, Plagiothecium sylvaticum.*

Nomenclatural type of the *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora seslerietosum autumnalis* is relevé 2 in Phytosociological Table.

DISCUSSION

First we compared the subassociation *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora seslerietosum autumnalis* to the central subassociation of the association of altimontane Dinaric beech forests, *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora ranunculetosum platanifolii.* Comparison showed that the floristic composition of both subassociations is rather similar, especially regarding species of the alliance *Aremonio-Fagion* and order *Fagetalia sylvaticae.* They differ in frequency of the species of the suballiance *Saxifrago rotundifoliae-Fagenion,* above all. The subassociation *seslerietosum autumnalis,* which thrives at slightly lower altitudes, having somewhat thermophilous character due to prevailing sunny aspects, is lacking the species: *Saxifraga rotundifolia, Luzula sylvatica* and *Cicerbita alpina*, which are very frequent in the typical subassociation. In accordance with mesophilous nature of the central subassociation and great frequency of moder humus, there thrive moderately acidophilous species in its distribution area: *Oxalis acetosella, Picea abies* and *Abies alba,* both in the shrub layer, above all, and ferns: *Athyrium filix-femina, Polystichum aculeatum* and species *Aruncus dioicus* as the result of humid local climate of higher altitude. The subassociation *seslerietosum,* on the contrary, includes species of order *Quercetalia pubescentis* s. lat.: *Sesleria autumnalis, Carex alba* and *Sorbus aria,* in accordance with its moderately basophilous nature. Comparison of both subassociations showed that the floristic compositions of both communities differ a great deal, although not to such extent that they could be classified in two different associations.

Comparison of the subassociation *seslerietosum autumnalis* to contact community *Seslerio-Fagetum* (Ht.) M. Wraber ex Borhidi 1963 is even more interesting. We compared a geographical variant of this association, namely *Seslerio-Fagetum* var. geogr. *Phyteuma scheuchzeri* Dakskobler 1997 (mscr.), described in the area of the Otlica and Nanos plateaus. In the initial period of the vegetation research of altimontane beech forests in the fifties, the subassociation *seslerietosum* was classified in the association *Seslerio-Fagetum* (Tomažič et Tre-

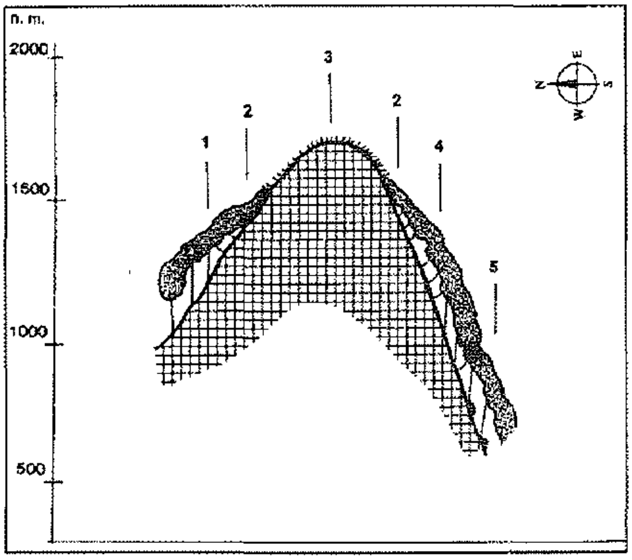

Fig. 2: Site of the subassociation *Ranunculo platanifolii-Fagetum* ***Marinček*** *et al.* ***1993 var. geogr.*** *Calamintha grandiflora* ***Marinček 1996*** *seslerietosum autumnalis*, ***according to Marinček (1987):***
Sl. 2: Rastišče subasociacije *Ranunculo platanifolii-Fagetum* ***Marinček*** *et al.* ***1993 var. geogr.*** *Calamintha grandiflora* ***Marinček 1996*** *seslerietosum autumnalis*, ***po Marinčku (1987):***
1. *Ranunculo platanifolii-Fagetum* ***Marinček*** *et al.* ***1993 var. geogr.*** *Calamintha grandiflora* ***Marinček 1996,***
2. *Polysticho lonchitis-Fagetum* ***(I. Horvat, 1938) Marinček 1993 var. geogr.*** *Allium victorialis* ***Marinček 1996,***
3. *Pinetum mugi dinaricum,*
4. *Ranunculo platanifolii-Fagetum* ***Marinček*** *et al.* ***1993 var. geogr.*** *Calamintha grandiflora* ***Marinček 1996*** *seslerietosum autumnalis* ***subass. nova,***
5. *Seslerio autumnalis-Fagetum* ***(Ht.) M. Wraber ex Borhidi 1963.***

gubov, 1956). The comparison of the subassociation described and the association *Seslerio-Fagetum* showed rather great floristic differences between both syntaxa. The subassociation *Ranunculo-Fagetum* var. geogr. *Calamintha grandiflora seslerietosum* includes many species of the order *Adenostyletalia* s. lat.: *Adenostyles glabra, Ranunculus platanifolius, Polygonaum verticillatum, Phyteuma ovatum, Veratrum album, Senecio ovatus, Aconitum vulparia, Ribes petraeum*, which indicate, beside mesophility, also altimontane character of the community. Regarding the species of the alliance *Aremonio-Fagion* and order *Fagetalia sylvaticae* there are no essential differences between the syntaxa compared.

Present in the association *Seslerio-Fagetum* are thermophilous species of the suballiance *Ostryo-Fagenion*: *Asparagus tenuifolius, Cornus mas, Euonymus verrucosa, Mercurialis ovata, Ostrya carpinifolia, Peucedanum austriacum, Fraxinus ornus* and order *Quercetalia pubescentis* s. lat.: *Arabis turrita, Campanula persicifolia, Lathyrus venetus, Melittis melissophyllum, Tanacetum corymbosum, Vincetoxicum hirundinaria;* order *Prunetalia spinosae* s. lat. *Clematis vitalba, Cornus sanguinea, Crataegus monogyna, Prunus mahaleb, Rhamnus carthartica, Viburnum lantana* and moderately termophilous species of the class *Querco-Fagetea* s. lat.: *Hedera helix, Cephalanthera rubra, Corylus avellana, Cruciata glabra* and some other species which are completely absent in the subassociation *seslerietosum autumnalis*.

The comparison, carried out by the application of the PCoA method (Figure 3), revealed great floristic differences, clearly indicating that the subasociation belongs to the association *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora*.

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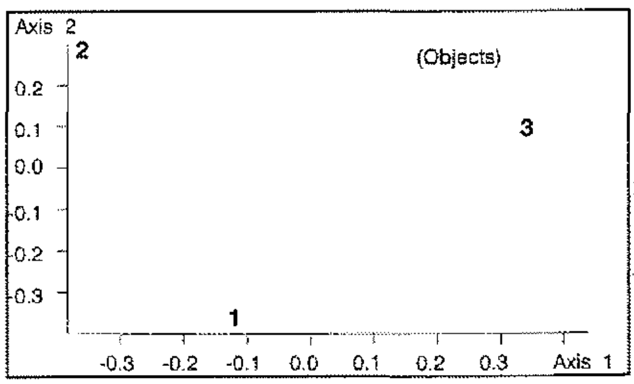

Fig. 3: Scatter Diagram of the associations:
Sl. 3: Diagram razpršenosti asociacij:
1. *Seslerio autumnalis-Fagetum* ***(Ht.) M. Wraber ex Borhidi 1963 var. geogr.*** *Phyteuma scheuchzeri* ***Dakskobler 1997 (mscr.),***
2. *Ranunculo platanifolii-Fagetum* ***Marinček*** *et al.* ***1993 var. geogr.*** *Calamintha grandiflora* ***Marinček 1996*** *seslerietosum autumnalis* ***subass. nova,***
3. *Ranunculo platanifolii-Fagetum* ***Marinček*** *et al.* ***1993 var. geogr.*** *Calamintha grandiflora* ***Marinček 1996*** *ranunculetosum* ***Marinček 1997 (mscr.).***

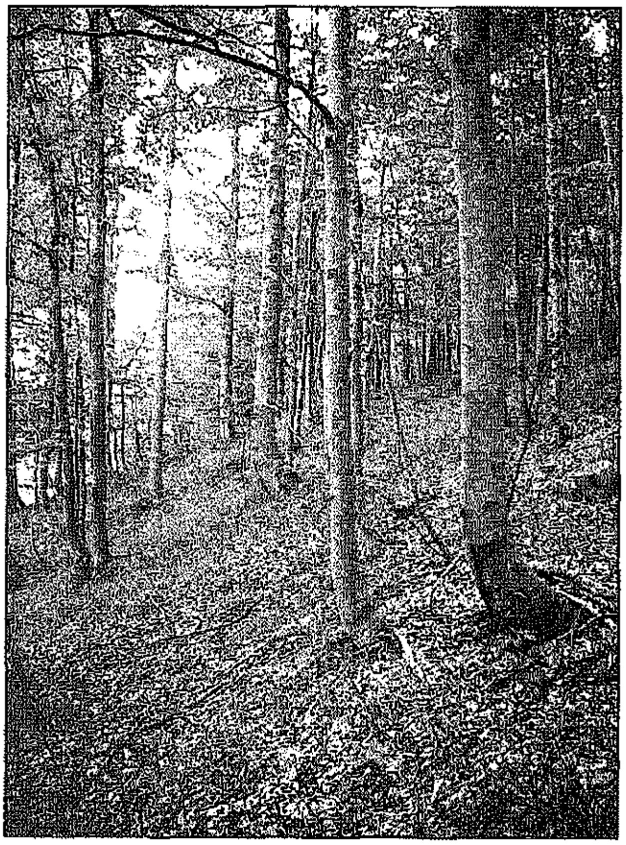

Fig. 4: Summer aspect of the association** Ranunculo platanifolii-Fagetum seslerietosum **on the slopes of Mt. Snežnik (Photo: U. Šilc).
Sl. 4: Poletni aspekt asociacije** Ranunculo platanifolii-Fagetum seslerietosum **na pobočjih Snežnika (Foto: U. Šilc).

NOVA SUBASOCIACIJA ALTIMONTANSKEGA BUKOVEGA GOZDA *RANUNCULO PLATANIFOLII-FAGETUM* MARINČEK *ET AL.* 1993 VAR. GEOGR. *CALAMINTHA GRANDIFLORA* MARINČEK 1996 *SESLERIETOSUM AUTUMNALIS* S SNEŽNIKA

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POVZETEK

Avtorja opisujeta novo subasociacijo Ranunculo platanifoliae-Fagetum *var. geogr.* Calamintha grandiflora seslerietosum autumnalis.

Dinarski altimontanski bukovi gozdovi so bili obravnavani kot samostojna asociacija že v šestdesetih letih. Gozdove te združbe, z imenom Fagetum altimontanum dinaricum, *je temeljito preučil Marinček v obdobju1970-1990. Pozneje so jih v skladu s kodeksom fitocenološke nomenklature preimenovali v* Ranunculo platanifolii-Fagetum *(Marinček* et al., *1993).*

V letu 1996 je skupaj z U. Šilcem popisal sestoje, ki so kot subasociacija seslerietosum autumnalis *predstavljeni v tej razpravi.*

Opisovana subasociacija seslerietosum autumnalis *uspeva na prisojnih pobočjih Snežnika in njegove širše okolice. Prevladujejo položna do zmerno strma pobočja, ki tu in tam prehajajo v strmejše grebene z močneje izraženo površinsko kamnitostjo. Subasociacija uspeva na nadmorski višini od 1170 do 1330 m. V nižjih legah neposredno prehaja v gozdove asociacije* Seslerietosum autumnalis-Fagetum.

Klima širšega območja Snežnika je ena najbolj humidnih v Sloveniji. V obdobju od leta 1961 do 1990 je padlo povprečno 2738 mm padavin letno (Zupančič, 1995). Zračna vlaga je zelo visoka, povprečno prek 80%. Povprečne letne temperature so od 4,5 do 6 °C (Mekinda-Majaron, 1995).

Geološka podlaga so dolomitizirani apnenci. Tla so plitve do srednje globoke sprsteninaste rendzine.

V drevesni plasti bukev skoraj povsem prevladuje, redko ji je primešan gorski javor. Pokrovnost grmovne plasti je majhna. Med zelišči prevladuje vrsta Sesleria autumnalis, *ki daje tem gozdovom značilen videz.*

Diferencialne vrste subasociacije seslerietosum autumnalis *so:* Sesleria autumnalis, Cirsium erisithales, Carex alba *in* Sorbus aria. *Te vrste (v širšem smislu značilnice in razlikovalnice reda* Quercetalia pubescentis) *nakazujejo relativno toplo krajevno klimo in zelo jasno ločijo subasociacijo* seslerietosum autumnalis *od drugih subasociacij združbe* Ranunculo platanifolii-Fagetum *var. geogr.* Calamintha grandiflora.

Primerjava floristične sestave opisane subasociacije s tipično subasociacijo visokogorskih dinarskih bukovih gozdov - Ranunculo platanifolii-Fagetum *var. geogr.* Calamintha grandiflora ranunculetosum platanifolii *in z geografsko varianto* Seslerio-Fagetum *(Ht.) M. Wraber ex Borhidi 1963 var. geogr* Phyteuma scheuchzeri *Dakskobler 1997 (mscr.), z Nanosa in Otlice, je potrdila pripadnost opisane subasociacije* seslerietosum autumnalis *altimontanskim dinarskim bukovim gozdovom.*

Ključne besede: bukovi gozdovi, *Ranunculo platanifolii-Fagetum, Sesleria autumnalis,* Snežnik, Slovenija

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PHYTOSOCIOLOGICAL TABLE: *Ranunculo platanifolii-Fagetum* ***Marinček*** *et al.* ***1993 var. geogr.*** *Calamintha grandiflora* ***Marinček 1996*** *seslerietosum autumnalis* ***subass. nova***

Relevé no.		1	2	3	4	5	6	7	8	9	10	*Ranunculo platanifolii-Fagetum seslerietosum autumnalis*	*Ranunculo platanifolii-Fagetum ranunculetosum**	*Seslerio autumnalis-Fagetum***
Altitude - m		1260	1290	1250	1220	1200	1330	1190	1240	1170	1190			
Aspect		EES	W	S	SW	SW	S	S	S	S	S			
Slope - degrees		20	25	25	15	25	25	30	25	30	30			
Stoniness - %		30	20	/	20	30	10	15	/	5	/			
Area of relevé- m^2		400	400	400	400	400	400	400	400	400	400			
Cover - %	L													
Tree - A	A	90	80	90	90	90	90	90	90	90	80			
Shrub - B	Y	20	10	10	10	5	5	2	5	10	5			
Herb - C	E	70	90	90	80	10	70	80	70	50	50			
Moos - D	R	5	/	/	/	/	/	/	/	1	/			
												Frequency (%)		
CHARACTER AND DIFFERENTIAL SPECIES OF THE ASSOCIATION														
Ranunculus platanifolius	C	1.1	1.1	+	+	1.1	+		1.1	+	+	90	53	
Adenostyles glabra	C	+	+				1.1	+.2	+		+	60	74	4
CHARACTER SPECIES OF THE GEOGR. VAR. *CALAMINTHA GRANDIFLORA*														
Aremonia agrimonoides	C	+	1.1		+	1.1	+.2	+	+			70	58	92
Calamintha grandiflora	C				+.2	+		+		+.2	(+)	50	53	100
DIFFERENTIAL SPECIES OF SUBASSOCIATION *SESLERIETOSUM AUTUMNALIS*														
Sesleria autumnalis	C	1.2	3.3	3.3	2.3	2.2	1.2	2.3	2.2	1.2	1.2	100		100
Cirsium erisithales	C	+	+.2	+			+	+	+	1.2	+	80	16	
Carex alba	C	+.2	+		+.2		+.2	+.2	1.2	+.2	+.2	80		
Sorbus aria	B	+	+	+	+			+		+	+	70		87
SAXIFRAGO ROTUNDIFOLIAE-FAGENION														
Polygonatum verticillatum	C	1.1	1.1	1.1	+	+.2		+	+.2	+	1.1	90	58	
AREMONIO-FAGION														
Dentaria enneaphyllos	C	1.1	1.1	1.1	1.1	1.1	2.2	1.1	1.1	2.2	2.2	100	74	79
Cyclamen purpurascens	C	+	+	+	+	+	+.2	+	+	+	1.1	100		87
Vicia oroboides	C	+	1.1	+	+	+	+	+	+		+	90	21	
Euphorbia carniolica	C	+	+	+					+	+		50	16	
Hacquetia epipactis	C	+	+		+		+			+		50	11	4
Cardamine trifolia	C	+		+	+		+.2					40	79	21
Helleborus niger	C		+						2.2	3.3	3.3	40	11	21
Lamium orvala	C			2.1		+.2	+		+			40		29
Aposeris foetida	C			+	+				+			30		37
Rhamnus fallax	B									+.2	+.2	20	11	
Isopyrum thalictroides	C						+					10	11	
FAGETALIA SYLVATICAE														
Fagus sylvatica	A	5.2	4.1	5.1	5.2	5.1	5.2	4.1	5.1	5.1	5.1	100	79	100
Fagus sylvatica	B	1.1	+	+	+	+	+.2	+	+	1.1	1.1	100	79	92
Fagus sylvatica	C	1.1	+	+			+		+			50	53	25
Daphne mezereum	B	+	1.1	1.1	1.1	+	+	+	+	+	+	100	68	96
Euphorbia amygdaloides	C	+	+	+	+	+	1.1	+	+	+	+	100	47	67
Heracleum sphondyllium	C	+	+	+	+	+	+	+.2	+		+.2	90	26	54
Lonicera alpigena	B	1.2	1.1		1.1	+	+	+	+	1.2	+.2	90	26	46
Mercurialis perennis	C	1.1	1.1	+	1.1		2.2	2.2	1.1	1.1	1.1	90	58	87
Dentaria bulbifera	C			+	1.1	+	1.1		+	+.2	+.2	70	26	46
Lilium martagon	C	1.1	+	+	+	+		+.2		+		70		
Mycelis muralis	C	+		+	+	+	+	+			+.2	70	63	92
Prenanthes purpurea	C	1.1	1.1	+	+	+		+	+			70	58	79
Acer pseudoplatanus	A		+		1.1	+	+	+			+	60	58	8
Acer pseudoplatanus	B	1.1	+	+					+	+	+	60	63	25
Acer pseudoplatanus	C			+	+	+				+		40	63	58
Lathyrus vernus	C				+	+	+	+	+	+		60	32	92
Euphorbia dulcis	C	+				+	+		+.2			40	11	67
Polygonatum multiflorum	C						+	+		1.1	+	40		58

		1	2	3	4	5	6	7	8	9	10			
Dryopteris filix-mas	C	+				+.2				+		30	63	75
Ranunculus lanuginosus	C	+	+	+								30	42	12
Sorbus aucuparia	B	+	+								+	30	11	4
Festuca altissima	C					+	+					20	26	
Galeobdolon flavidum	C		+	+		1.1	1.1					40	68	37
Galium odoratum	C			+						+		20	32	57
Rubus idaeus	B	+		+								20	32	42
Actaea spicata	C	+										10	26	37
Adoxa moschatellina	C					+						10	5	
Carex pilosa	C		+									10		
Geranium robertianum	C					+						10	11	21
Melica nutans	C			+								10		29
Neottia nidus-avis	C										+	10	5	54
Paris quadrifolia	C							+				10	32	21
Sambucus nigra	B					+						10		
ADENOSTYLETALIA														
Phyteuma ovatum	C	+	1.1	+		+	1.1	+	+.2	+	+.2	90		
Veratrum album	C	+.2	+	+	+	+	2.2		+			70	58	
Senecio ovatus	C	+		+		+.2	+			+	+	60	58	50
Aconitum vulparia	C						1.1		+.2			20		
Thalictrum aquilegiifolium	C		+		+							20		
Ribes petraeum	B		+									10		
QUERCO-FAGETEA														
Anemone nemorosa	C	2.2	1.1	1.1	1.1	1.1	1.1	+.2	1.1	1.1	1.1	100	79	83
Carex digitata	C		+.2					+.2		+		30		58
Fragaria moschata	C		+	+								20		
Lonicera xylosteum	B				+	+						20		79
Hepatica nobilis	C				+							10		62
VACCINIO-PICEETEA														
Rosa pendulina	B	1.1	1.1	+	+	+	+	+	+.2		+	90	11	37
Maianthemum bifolium	C	+.2	+		+				+		+	50	11	83
Valeriana tripteris	C	+	+			+						30	26	21
Gentiana asclepidiadea	C	+	+									20	26	29
Luzula luzuloides	C			+			+					20	11	46
Rubus saxatilis	B		+.2						+			20		
Veronica urticifoila	C	+	+									20	26	12
Abies alba	A							+				10	16	
Abies alba	C	+										10	21	
Clematis alpina	B		+									10		
Oxalis acetosella	C	1.1										10	68	
Picea abies	B		+									10	47	50
OTHER SPECIES														
Calamagrostis varia	C	2.3		+	1.2	1.2	2.3	2.3	1.2		+	80	21	54
Fragaria vesca	C				+		+	+		+	+	50	32	87
Galium laevigatum	C	+	+	+				+	+			50		
Dactylorhiza maculata subsp. maculata	C	+	+	+			+					40		
Verbascum nigrum	C			+					(+)			20		
Angelica sylvestris	C			+								10		
Convallaria majalis	C								+			10		87
Sambucus ebulus	B			+								10		
Sesleria albicans	C		2.2									10		
Taraxacum officinale	C		+									10		
Veronica chamaedrys	C										+	10		

* *Ranunculo platanifolii-Fagetum* Marinček *et al.* 1993 var. geogr. *Calamintha grandiflora* Marinček 1996 *ranunculetosum*
** *Seslerio autumnalis-Fagetum* (Ht.) M.Wraber ex Borhidi 1963 var. geogr. *Phyteuma scheuchzeri* Dakskobler 1997

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BOTANIČNI IN NARAVOVARSTVENI POMEN TRAVNIKOV ZDRUŽBE *DANTHONIO-SCORZONERETUM VILLOSAE* Ht. & H-ić (56)58 NAD RAKITOVCEM V ČIČARIJI (JUGOZAHODNA SLOVENIJA)

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IZVLEČEK

Predstavljeni so popisi združbe Danthonio-Scorzoneretum villosae *Ht. & H-ić (56)58 iz tradicionalno košenih travnikov v montanskem pasu nad Rakitovcem. Ugotovljeno je, da ti sestoji oblikujejo samostojno subasociacijo, ki pomeni jedro in najbogatejše sestoje v okviru asociacije, hkrati pa prehod med kraško in istrsko-kvarnersko raso te asociacije. Predstavljene so tudi floristične posebnosti območja in naravovarstveni problemi.*

Ključne besede: suhi travniki, *Danthonio-Scorzoneretum villosae* Ht. & H-ić (56)58, Čičarija, Slovenija

UVOD

V okviru obsežne raziskave suhih travišč slovenskega submediteranskega prostora (Kaligarič, 1993; Kaligarič & Poldini, 1997) so velika posebnost suha travišča nad Rakitovcem v Čičariji. Zbrali smo popise iz tega območja, jih tabelirali in ovrednotili s florističnega, fitocenološkega in fitogeografskega vidika. Posebej smo se posvetili naravovarstvenim problemom v zvezi z njihovim vzdrževanjem.

Območje Čičarije z njenimi travišči dosedaj še ni bilo niti floristično niti fitocenološko sistematično raziskano. Največ podatkov o flori tega jugozahodnega krila Čičarije (od Kojnika do Žbevnice) najdemo v starejši literaturi, tako že pri Tommasiniju, ki je s Slavnika opisal novo vrsto ušivca - bledorumenega ušivca (1839), pa še leto kasneje, ko Žbevnico posebej omenja celo v naslovu članka (1840), medtem ko jih konec stoletja, upoštevajoč tudi starejše podatke, najdemo predvsem pri Pospichalu (1897-99) in Marchesettiju (1896-97). Nadalje je tukaj botaniziral še Justin (1911), ki je poročal o najdbi dveh vrst iz rodu *Crepis,* po drugi svetovni vojni pa E. Mayer. Rezultati njegovih botaniziranj so herbarijske pole v Ljubljanskem herbariju (LJU). Kasneje so tukaj botanizirali še T. Wraber, S. Peterlin in L. Poldini ter avtor. Floristični podatki so bili objavljeni v "rdeči knjigi" (Wraber & Skoberne, 1989), nekatere floristične in vegetacijske podatke pa je objavil tudi avtor tega prispevka (Kaligarič 1987, 1989, 1990, 1994a, 1994b, 1997).

Če je objavljenih podatkov o flori razmeroma veliko, to ne velja za vegetacijo tega območja. Z gozdovi v Čičariji, predvsem mezofilnejšimi, se je ukvarjal Accetto (1990, 1991), s svojim pregledom vegetacije Tržaškega in Goriškega krasa pa sega na to območje tudi Poldini (1989). Traviščno vegetacijo pašnikov na hrvaški strani tega dela Čičarije je proučeval Trinajstić (1992), na slovenski strani pa avtor (Kaligarič, 1994). Nekaj podatkov, ki se nanašajo na hrvaško Čičarijo v širšem smislu, pa najdemo tudi v zbirnem delu Horvata in sodelavcev (1974).

Območja travnikov, ki zbujajo pozornost v vseh omenjenih ozirih, so v dolinici nad Rakitovcem, ki se razteza pod vrhom Kavčice, pod Istrskimi vrati in grebenom Žbevnice. Gre za dolinico v montanskem pasu, kjer je pedogeneza ustvarila nekoliko globljo plast prsti, kjer je stik z matično apnenčasto podlago slabši. Zato se tu razvijejo sestoji iz zveze *Scorzonerion villosae,* to je mezofilnejše zveze iz reda submediteransko-ilirskih suhih travišč *(Scorzoneretalia villosae).*

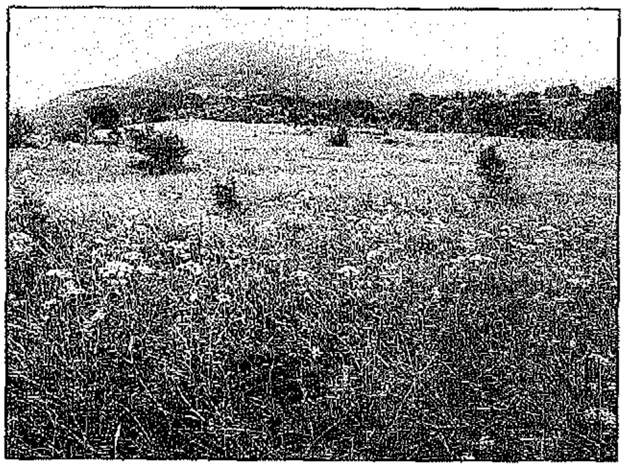
METODE

Pri popisovanju smo uporabili standardno srednjeevropsko metodo po Braun-Blanquetu (1964). Nomenklatura idiotaksonov je povzeta po Poldiniju (1991), sintaksonov pa prav tako po Poldiniju (1989).

REZULTATI

VEGETACIJSKA PROBLEMATIKA

Travniki nad Rakitovcem spadajo v razred srednje- in južnoevropskih suhih travišč *(Festuco-Brometea)* in sicer v red *Scorzoneretalia villosae*, ki predstavlja submediteransko-ilirska suha travišča, predvsem na apneni podlagi. Ta red skoraj izključno zastopa vsa travišča na Primorskem krasu in Slovenski Istri, sicer pa so značilna za vzhodnojadranski in severnojadranski kras tja do predgorij Jugovzhodnih apneniških Alp. Na našem območju jo delimo v dve zvezi, od katerih zveza *Satureion subspicatae* zastopa kserofilnejša in bazifilnejša travišča revnih, skeletnih tal, torej predvsem (nekdanje in redke še obstoječe) pašnike. Zveza *Scorzonerion villosae* pa je v okviru reda mezofilnejša: zastopa (košene) travnike na globljih, bolj razvitih bazičnih ali nevtralnih tleh, ki so na apnencu lahko delno dekalcificirana in vlažnejša (vrtače, doline, ravni). Tukaj je vegetacija relativno mezofilnejša z bogatejšo pokrovnostjo in biomaso (travniki!). Tipično obliko travišča te zveze najdemo razvito na obravnavanem območju nad Rakitovcem, saj gre tam za rahlo vbočeno ravan (dolinico), kjer veljajo opisane ekološke razmere. Edina asociacija v tem vegetacijskem pasu (črnega gabra, morda potencialno bukve) je asociacija *Danthonio-Scorzoneretum villosae*. Vsi popisi iz Čičarije nad Rakitovcem so bili uvrščeni v posebno subasociacijo *rhinanthetosum glacialis* Kaligarič & Poldini 1997. Ta pomeni pravzaprav jedro asociacije. Gre namreč za sestoje, ki so najbolj podobni originalno opisanim sestojem iz Gorskega Kotarja. Zato nima nobenih diferencialnih vrst, ki bi nakazovale ekološke posebnosti in značilnosti. Je torej tipična subasociacija te asociacije in je bila v Sloveniji doslej najdena le na tem območju. To velja tudi za eno od značilnic asociacije vrsto *Serratula lycopifolia*, ki je bila najdena le v Čičariji in na Vremščici (Wraber & Skoberne, 1989). Edina vrsta, zaradi katere se ta subasociacija razlikuje od drugih, ekološko bolj izraženih subasociacij, je *Rhinanthus glacialis*, po kateri se subasociacija tudi imenuje. Sicer pa so značilnice asociacije *Ononis spinosa, Danthonia alpina, Euphorbia verrucosa Ferulago galbanifera, Lathyrus latifolius* in *Serratula lycopifolia*. Dobro so zastopane vrste zveze, od katerih prevladujejo *Scorzonera villosa, Knautia illyrica, Centaurea weldeniana* in *Onobrychis arenaria*. Manj so zastopane vrste reda, saj so travniki nad Rakitovcem relativno mezofilni. Od pogostejših značilnic naj naštejemo vrste *Lotus corniculatus* var. *hirsutus, Betonica serotina* in *Plantago holosteum*. Bolje so zastopane nekoliko mezofilnejše vrste razreda. Od spremljevalk zbuja posebno pozornost le vrsta *Inula hirta (Trifolio-Geranietea)*.



Sl. 1: Travnik združbe** Danthonio-Scorzoneretum villosae **Ht. & H-ić (56)58, v ozadju Lipnik (Foto: M. Kaligarič).
Fig. 1: The meadow belonging to the association** Danthonio-Scorzoneretum villosae **Ht. & H-ić (56)58 and Mt. Lipnik in the background (Photo: M. Kaligarič).

Poldini (1989: 148) označuje popise združbe *Danthonio-Scorzoneretum* s Tržaškega Krasa za "kraško raso", ki se nekoliko razlikuje od istrskih in kvarnerskih oblik te združbe. Diferencirata jo vrsti *Achillea collina* in *Cirsium pannonicum*, ki se pojavljata na tem območju, ne pa v jugovzhodnem arealu asociacije na Hrvaškem. Subasociacija *rhinanthetosum glacialis* iz Čičarije pa oblikuje zvezo med tema "rasama", čeprav še vsebuje omenjeni regionalni diferencialni vrsti kraške rase, hkrati pa nosi značilnosti sestojev, od koder sta Horvat in Horvatić asociacijo opisala.

Geoelementno sestavo (geoelementi so povzeti po Poldiniju, 1994) prikazuje tabela 2.

Vrste po geoelementih:

1 - evrazijske	12,22%
2 - evrosibirske	14,52%
3 - evropske	13,57%
4 - pontske	13,57%
5 - evrimed. (J.-Evr)	11,71%
6 - mediter.-montanske	5,29%
7 - južnoilirske	12,29%
8 - jugovzhodnoevropske	6,75%
9 - paleotemperatne	6,35%
10 - ostalo	1,78%

Tab. 2: Geoelementna sestava asociacije** Danthonio-Scorzoneretum villosae **Ht. & H-ić (56)58 subas.** rhinanthetosum glacialis **Kaligarič & Poldini 1997.
Tab. 2: Geoelemental composition of the association** Danthonio-Scorzoneretum villosae **Ht. & H-ić (56)58 subas.** rhinanthetosum glacialis **Kaligarič & Poldini 1997.

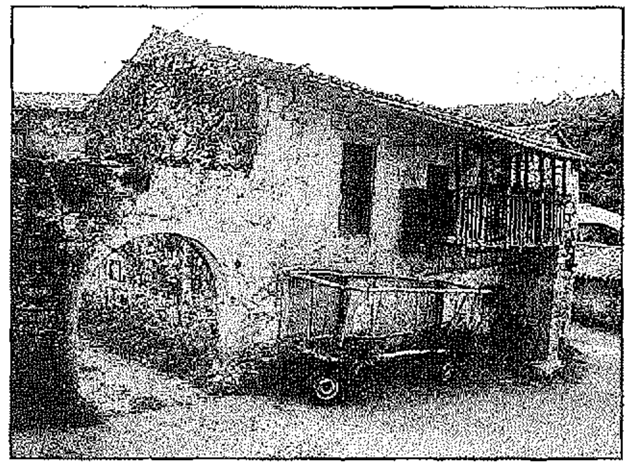
Na eni strani vidimo močno zastopanost "kontinentalnih", v ekološkem pogledu mezofilnejših geoelementov: evrosibirskega, evrazijskega in evropskega. Ta delež je razmeroma visok, predvsem v škodo toploljubnejših vrst, saj je evrimediteranskih vrst le slabih 12%. Presenetljivo dobro zastopane pa so pontske vrste. Nezanemarljiv delež, predvsem pa pomemben pečat dajejo ilirske vrste, posebej pa smo upoštevali še mediteransko-montanske vrste (pas bukve!) in širše razširjene jugovzhodnoevropske vrste.

NARAVOVARSTVENA PROBLEMATIKA

V samih popisih, ki so predstavljeni v tabeli, niso upoštevane nekatere redke vrste iz tega območja, ki še dodatno prispevajo k veliki naravni vrednosti tega območja. Poleg že komentirane redke vrste *Serratula lycopifolia*, ki je v Sloveniji omejena le na to območje in je ena izmed trinajstih slovenskih vrst, ki jih IUCN šteje za "globalno ogrožene vrste" (globally threatened species) (World Conservation Monitoring Center data base), najdemo tukaj še njegovo termofilnejšo sorodnico, vrsto *Serratula radiata*. Ta je v Sloveniji omejena le na Čičarijo (od Kavčic, Kojnika in Podgorja do Črnotič in Prešnice). V spomladanskem času je na travnikih nad Rakitovcem obilno zastopana redka vrsta *Fritillaria tenella*. Manj obilno sta zastopani visoki stebliki *Scorzonera hispanica* in *Nepeta pannonica*, ki sta prav tako redki vrsti v flori Slovenije. V skalovju nad dolinico (zahodno od Istrskih vrat) pa je rastišče redke vrste *Delphinium fissum*. V tem sklopu pa ne smemo pozabiti na redkost, ki jo najdemo na Kavčicah nad Rakitovcem, vrsto *Crepis blavii*. Njegovo pojavljanje v Sloveniji je omejeno le na to območje (Wraber & Skoberne, 1989), ki je hkrati severozahodna meja njegovega areala.

Enako visoka naravovarstvena vrednost tega območja pa je v združbi *Danthonio-Scorzoneretum* subas. *rhinanthetosum*, ki zastopa travniško vegetacijo. To so edine značilne oblike te asociacije v Sloveniji, ki jih še vedno kosijo. Sploh lahko rečemo, da so vsi ekstenzivni tradicionalno košeni in negnojeni suhi travniki ogroženi. Gospodarjenje z njimi se je spremenilo bodisi v smeri intenzifikacije ali pa so njihovo rabo opustili. Taki travniki se zaraščajo v grmišča in pionirske gozdove. Pognojeni travniki pa bistveno spremenijo svojo floristično sestavo, se osiromašijo oziroma se spremenijo v neko drugo fitocenozo.

Obe možnosti potencialno ogrožata združbo oklasnice in gadnjaka nad Rakitovcem. Socialnogospodarske razmere v Rakitovcu so se spremenile tako, da je dokončna opustitev košnje brez subvencioniranja le še vprašanje časa. Z opustitvijo košnje pa bi izgubili enkratne in najbolj tipične ter tudi najbogatejše sestoje te združbe na ozemlju Slovenije. Sklepamo da bi v tem primeru lahko sčasoma izginile s tega območja tudi posamezne rastlinske vrste, vezane na to združbo. Med



Sl. 2: Arhitektura v Rakitovcu je ozko povezana s tradicionalno rabo travnikov nad Rakitovcem (Foto: M. Kaligarič).
Fig. 2: The architecture in Rakitovec is closely tied with the traditionally mown meadows above the village (Photo: M. Kaligarič).

njimi seveda tudi tiste najredkejše iz naših in tujih "rdečih seznamov". V tujini poznamo nemalo primerov, ko že zaradi ene same vrste gospodarijo s travnikom na določen način, ki tisto vrsto ohranja - s pašo ali košnjo. Menimo, da bi takšno naravovarstveno gospodarjenje, ki bi ohranjalo floro in vegetacijo travnikov nad Rakitovcem, bila edina rešitev za ohranitev želenega stanja. Tako predlagamo, da se travniki pokosijo enkrat letno v juliju. Košnja naj bi potekala po možnosti ročno, sicer strojno. Pokošeno biomaso je treba pograbiti in odpeljati. Lokalna skupnost ali posamezniki, ki opravljajo košnjo oziroma lastniki ali najemniki parcel, naj bi bili deležni finančne kompenzacije za stroške in nagrade za opravljeno delo. Tako organizirano gospodarjenje je edina pot, ki vodi k ohranitvi takšnih in podobnih travnikov. Za financiranje naj poskrbi država (Ministrstvo za okolje in prostor, Uprava za varstvo narave), lahko pa tudi nevladne naravovarstvene organizacije.

DODATEK

Podatki o popisih (Localisations of the relevés): 1 - Rakitovec - Istrska vrata, 650 m n. m., A, 100%, 100 m², jul 92, 2 - dolinica med Lipnikom in Kavčicami, Čičarija, 750 m n.m., A, 100%, 100 m², jul 92, 3 - Lipnik - Kavčice, Čičarija, A, 770 m n.m., 100%, 100 m², jul 92, 4 - med Zazidom in Podpečjo, 500 m n.m., A, 100%, 50 m², jul 92, 5 - K, pod Istrskimi vrati, 750 m n.m., A, 100%, 100 m², jul 92, 6 - dolinica pod Istrskimi vrati, Čičarija, 700 m n.m., A, 100%, 100 m², jul 92, 7 - dolina med Istrskimi vrati in Rakitovcem, 700 m n. m., A, 100%, 150 m², jul

93, 8 - pod Istrskimi Vrati, 750 m n.m., A, 100%, 150 m², jul 92.

A = apnenec (limestone)

	Zaporedne štev. popisov	1	2	3	4	5	6	7	8	Fr.	Raz.
Karakter. vrste asociacije											
	Serratula lycopifolia	+	1	1	1		+	2	1	87	V
	Danthonia alpina	+	2	3		+	+	+		75	IV
	Ferulago galbanifera		1	1			+	+	+	62	IV
	Euphorbia verrucosa	+		1			+		+	50	III
	Lathyrus latifolius					1	+	+		37	II
	Ononis spinosa				+	+		+		37	II
Diferencial. vrste asociacije											
	Plantago media		+			1	2	1	+	62	IV
Reg.dif.v.	*Cirsium pannonicum*	1				1	1		3	50	III
	Carex flacca	1			+				2	37	II
	Trifolium rubens				+	+				25	II
	Achillea collina							+		12	I
Diferencialna vrsta subasociacije											
	Rhinanthus glacialis	+	+	+	+	+	1	1	+	100	V
Karakter. in diferencial. vrste zveze SCORZONERION VILLOSAE											
	Scorzonera villosa	3	+			2	3	2	+	75	IV
	Knautia illyrica	+	+	+	+		+		+	75	IV
	Onobrychis arenaria	1				+	1	+	+	62	IV
	Centaurea weldeniana		+		+	+	+		+	62	IV
	Leucanthemum liburnicum				+	+				25	II
	Scabiosa gramuntia					+	+			25	II
	Prunella laciniata							+		12	I
Karakter. vrste reda SCORZONERETALIA VILLOSAE											
	Betonica serotina	+		+			+	+	1	62	IV
	Lotus corniculatus var. hirsutus	+			1		+		+	50	III
	Salvia pratensis s.l.		+			1		+	+	50	III
	Plantago holosteum	+				+	+	+		50	III
	Leontodon crispus	+		+			+			37	II
	Plantago argentea subsp. liburnica				+		+		+	37	II
	Sanguisorba minor subsp. muricata				+	+				25	II
	Anthyllis vulneraria var. polyphylla	+					+			25	II
	Potentilla australis						+		+	25	II
	Chrysopogon gryllus				3					12	I
	Dorycnium germanicum				1					12	I
	Senecio doronicum			1						12	I
	Veronica barrelieri					+				12	I
	Thymus longicaulis		+							12	I
	Linum narbonense		+							12	I
	Muscari botryoides			+						12	I

	1	2	3	4	5	6	7	8	Fr	Raz.
Karakter. vrste razreda FESTUCO-BROMETEA										
Briza media	1	1	2	1	2	+	1	2	100	V
Buphthalmum salicifolium	+	+	+		+	+	1	+	87	V
Filipendula vulgaris		+	1	+	+		+	+	75	IV
Bromus erectus	1			2	2		1	3	62	IV
Trifolium montanum	+		+		+	+		+	62	IV
Galium verum	+			+	+	+		+	62	IV
Hypochoeris maculata	+		+			+	+	1	62	IV
Brachypodium rupestre		1			1		1	+	50	III
Carex humilis	2	2	2			+			50	III
Prunella grandiflora		+	+				+	+	50	III
Peucedanum oreoselinum		1	1		+				37	II
Koeleria pyramidata				+	+		+		37	II
Asperula cynanchica	+					+		+	37	II
Potentilla alba		2	3						25	II
Dactylis glomerata				+			1		25	II
Helianthemum ovatum	+							+	25	II
Linum catharticum	+			+					25	II
Festuca rupicola		+		+					25	II
Campanula glomerata		+	+						25	II
Euphorbia cyparissias					+				12	I
Linum tenuifolium	+								12	I
Teucrium montanum	+								12	I
Gymnadenia conopsea	+								12	I
Carlina acaulis		+							12	I
Gladiolus illyricus			+						12	I
Bupleurum exaltatum		+							12	I
Prunella vulgaris				+					12	I
Spremljevalke										
Inula hirta	+	+	+	+			+	+	75	IV
Leontodon hispidus		1		+	1	+			50	III
Danthonia decumbens		1	1						25	II
Anthericum ramosum		+	1						25	II
Thalictrum minus	+		+						25	II
Medicago prostrata				+	+				25	II
Koeleria splendens		+	+						25	II
Tragopogon orientalis	+							+	25	II
Iris graminea		+							12	I
Polygonatum odoratum			1						12	I
Scorzonera hispanica								+	12	I
Potentilla erecta			+						12	I
Hypochoeris radicata							+		12	I
Cichorium intybus				+					12	I

Tab. 1: ***Asoc.*** *Danthonio-scorzoneretum villosae* ***Ht-ić (56)58 subass.*** *rhinanthetosum glacialis* ***Kaligarič & Poldini 1997.***

BOTANICAL AND NATURE CONSERVATION MEANING OF THE MEADOWS BELONGING TO THE COMMUNITY *DANTHONIO-SCORZONERETUM VILLOSAE* Ht. & H-ić (56)58 ABOVE RAKITOVEC (SOUTHWESTERN SLOVENIA)

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SUMMARY

The article deals with the vegetation of dry meadows mown traditionally in the montane belt above Rakitovec (Čičarija, Slovenia). They belong to the assoc. Danthonio-Scorzoneretum villosae *Ht. & H-ić (56)58 subas. rhinanthetosum glacialis Kaligarič & Poldini 97. This subass. ecologically means the nucleus of the association (typical, the richest form with characteristic species), and at the same time the transition between the Istra-Kvarner (from where the assoc. was described) and the Karst race of this association. The geoelemental composition of the association highly represents Illyrian, Mediterranean-montane, and more mesophilous (Euro-Siberian, Eurasian, and European) elements to the detriment of thermophilous Mediterranean elements. In the stands above Rakitovec we find some rare and threatened species in the flora of Slovenia:* Serratula lycopifolia, Serratula radiata, Delphinium fissum, Nepeta pannonica *and* Scorzonera hispanica, *mentioned in the article. We believe that estimate these meadows are highly threatened, as they depend on extensive mowing that is to be interrupted soon. We therefore suggest that the Ministry of Environment as well as non-governmental organisations contribute, with subsidies to the extensive mowing.*

Key words: dry meadows, *Danthonio-Scorzoneretum villosae* Ht. & H-ić (56)58, Čičarija, Slovenia

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THE *HORDEETUM MURINI* AND *LEPIDIO DRABAE-AGROPYRETUM* IN THE COASTAL PART OF SLOVENIA

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ABSTRACT

In ruderal places of the coastal part of Slovenia, two associations dominated by winter annual species, Hordeetum murini *Libbert 1933* (Stellarietea mediae) *and* Lepidio drabae-Agropyretum repentis *T. Müller et Görs 1966* (Artemisietea vulgaris), *were studied.*

Key words: ruderal communities, *Stellarietea mediae*, *Artemisietea*, vegetation, Slovenia

INTRODUCTION

The aim of the work is to present two ruderal communities occurring in late spring in the coastal part of Slovenia. They appear close to each other on ruderal sites and are assigned to two different classes; the *Hordeetum murini* to the class of weed communities *Stellarietea mediae* and the *Lepidio drabae-Agropyretum* to the order of dry and initial semi-ruderal grasslands *Agropyretalia repentis* within the class of ruderal vegetation *Artemisietea vulgaris*.

Some investigations of this type of vegetation in the neighbouring regions have already been carried out: in NE Italy (Poldini, 1980, 1989), in the Goriško region (Seljak, 1989) and in the Koper region (Kaligarič, 1992).

From the respective alliances *(Sisymbrion* and *Convolvulo-Agropyrion)* the *Erigero-Lactucetum serriolae* Lohm. ap. Oberd. 1967, *Bromo-Hordeetum murini* (Allonge 1922) Lohm. 1950 and *Brometum sterilis* Görs 1966 of the *Sisymbrion* and *Brachypodio-Agropyretum intermedii* Poldini 1980 and *Conyzo-Cynodontetum* (Felf. 1942) Eliáš 1978 of the *Convolvulo-Agropyrion* were indicated by Poldini (1980). Later he indicates the *Urtico-Malvetum neglectae* Lohm. 1950, *Conyzo-Lactucetum serriolae* Lohm. in Oberd. 1957, *Hordeetum murini* Libbert 1932, *Bromus sterilis* comm. and *Mercurialis annua* comm. of the *Sisymbrion* and the *Brachypodio-Agropyretum intermedii* Poldini 1980 of the *Convolvulo-Agropyrion* (Poldini, 1989).

The *Convolvulo-Agropyretum repentis* Felf. 1943, *Cardario drabae-Agropyretum* Müller et Görs 1969 and *Cynodonto-Sorgetum halepensis* (Laban 1974) Kojić 1979 of the *Convolvulo-Agropyrion* were found by Seljak (1989).

The *Cynodonto-Sorgetum halepensis* (Laban 1974) Kojić 1979 of the *Convolvulo-Agropyrion* was recorded by Kaligarič (1992).

STUDY AREA

The research was carried out in the Submediterranean part of Slovenia (Wraber, 1969). According to the phytogeographical division proposed by Zupančič *et al.* (1989), this region can be divided into the district of Koper and Šavrinska Brda and partly into the district of Karst and Vipava valley (only Sežana, Senadolice, Črni Kal and Krvavi potok) of the Northern coast sector, Adriatic province of the Mediterranean region.

The soil develops mainly over terra rossa and, above all, in the district of Karst and Vipava valley over limestone bedrock. The climate is under the influence of the Mediterranean sea and can be treated as Submediterranean (Ogrin, 1993). Some climate data for Koper are as follows: the mean annual temperature is 13.8°C; the mean temperature in the coldest month (January) 4.5°C; the mean temperature of the warmest month (July) 23.3°C, the mean rainfall 960 mm. The potential natural vegetation is the *Ostryo-Quercetum pubescentis* (Ht.) Trinajstić 1974.

METHODS

The relevés were made and elaborated according to the standard procedure of the Braun-Blanquet method (Braun-Blanquet, 1964). The sample plots were visited several times during the year, in order to find also the species that did not blossom at the time when the relevé was made. The nomenclature of the plant species follows Trpin & Vreš (1994).

RESULTS

1. Sintaxonomical classification

Hordeetum murini Libbert 1933

Sisymbrion officinalis R. Tx., Lohmeyer, et Preising in R. Tx. 1950

Sisymbrietalia J. Tx. in Lohmeyer *et al.* 1962

Stellarietea mediae R. Tx., Lohmeyer et Preising in R. Tx. 1950

Lepidio drabae-Agropyretum repentis T. Müller et Görs 1966

Convolvulo-Agropyrion repentis Görs 1966

Agropyretalia repentis Oberd. *et al.* 1967

Artemisietea vulgaris Lohmeyer *et al.* in R. Tx. 1950

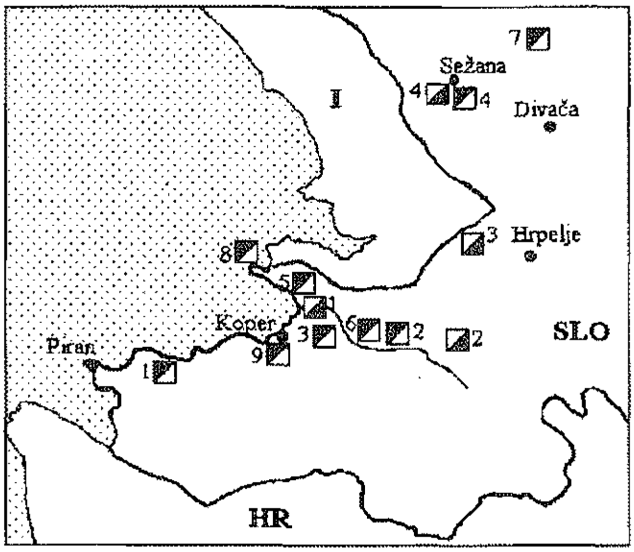

Fig. 1: Localisation of the relevés. Numbers correspond to those in the Tab 1 ( ) and 2 ( ).
Sl. 1: Prikaz lokalitet. Številke se ujemajo s tistimi iz tabele 1( ) in 2 ( ).

2. *Hordeetum murini* Libbert 1933

In April and May, communities dominated by *Hordeum murinum* can be found in the region. *Hordeum murinum* forms almost monodominant stands with *Bromus sterilis* as codominant species. Since *Hordeum murinum* is a winter annual species, these communities disappear later in the summer. In the respective territory, the communities were found on the road edges, in parking places, in parks and in other similar ruderal places. They thrive in places where gravel is metaled and where only a minor quantity of soil can be found between stones.

In the region of transitional type between central European and Mediterranean regions, it is also possible that, besides *Hordeum murinum, H. leporinum* occurs. The distinction between these taxa is rather difficult as differential characters were taken than those proposed by Pignatti (1982).

The vegetation is classified within the *Stellarietea mediae*, the *Sisymbrietalia* and the *Sisymbrion,* the alliance of small, erect, winter annual herbs and grasses. These species are typical of the regions with mild submediterranean climate in the south and southeast of Europe (Mucina, 1993).

	1	2	3	4	5	6	7	8	9
Ass. char. spec.									
Hordeum murinum	3	4	4	4	4	4	4	5	4
SISYMBRION & SISYMBRIETALIA									
Bromus sterilis	2	1	2				+	1	
Silene alba		+					+	+	
Lepidium virginicum	+			+					
Sisymbrium officinale				+				+	
Bromus tectorum					+	+			
Bromus hordeaceus							+		+
STELLARIETEA MEDIAE									
Capsella bursa-pastoris	+		+			+		+	+
Chenopodium album		+	1	1	+				
Avena barbata	1				+	+			
Sochus asper		+		+		+			
Fallopia convolvulus	+			1					
Stellaria media				1					+
Picris echioides					+			+	
Other species									
Convolvulus arvensis		+	+	+	+	+	+		+
Cichorium intybus	+	+		+	+	+	2		
Taraxacum officinale		+	1	+		+	+	+	
Lolium perenne		+			1	2	+	2	+
Plantago lanceolata	+	1	+	+	+				
Diplotaxis tenuifolia	+	2	+	1				+	
Trifolium repens	+						+	+	+
Agropyron repens			+		+		+	+	
Achillea collina				+	+		+	+	
Plantago major	+						+	1	
Clematis vitalba		+	+					+	
Dactylis glomerata		+			+	+			
Arrhenatherum elatius		+				+	+		
Poa sylvicola							+	+	+
Rumex crispus	+		+						
Poa annua	+								2
Artemisia absinthum			+		1				
Artemisia vulgaris			+				+		
Veronica agrestis				+					+
Polygonum arenastum						+			+

Tab. 1: Analytical table of the *Hordeetum murini.*
Tab. 1: Analitična tabela združbe *Hordeetum murini.*

Sites of the relevés: 1. Belveder, ruderal place, 21.5. 1997, coverage 80%, 3m²; 2. Cepki, road edge, 21.5. 1997, 90%, 7 m²; 3. Bertoki, road edge, 21.5.1997, 90%, 7 m²; 4. Sežana, 21.5.1997, on the railway, 100%, 2 m²; 5. Ankaran, road edge, 21.5.1997, 100%, SSW, 3°, 5 m²; 6. Dekani, road edge, 21.5.1997, 100%, 2 m²; 7. Senadolice, gravel deposit, 22.5.1997, 80%, 3 m²; 8. Debeli rtič, foot of hedge, 21.5.1997, 100%, E, 2°, 5 m²; 9. Koper, in a park, 21.5.1997, 100%, 6 m².

Less common species: 1. *Lepidium graminifolium* +, 2. *Pastinaca sativa* 1, *Rumex obtusifolius* +, 3. *Cardaria draba* +, *Daucus carota* +, *Medicago sativa* +, *Diplotaxis muralis* +, *Portulaca oleracea* +, 4. *Conyza canadensis* +, *Medicago lupulina* 1, *Geranium rotundifolium* +, 5. *Verbena officinalis* +, *Carex hirta* +, *Lapsana communis* +, *Potentilla reptans* +, 6. *Mercurialis annua* +, *Allium rotundatum* +, *Foeniculum vulgare* +, *Mentha* sp. +, *Sambucus ebulus* +, 7. *Picris hieracioides* +, *Chelidonium majus* +, *Pimpinella saxifraga* +, 8. *Cirsium arvense* 1, *Rumex conglomeratus* +, *Arctium lappa* +, *Euphorbia helioscopia* +, *Ranunculus acris* +, 9. *Bromus madritensis* +, *Torilis nodosa* +, *Alopecurus mysuroides* +.

3. *Lepidio drabae-Agropyretum repentis* T. Müller et Görs 1966

This association was found in the Goriško region, in Dornberg, Šmartno and Komen by Seljak (1989). It was established that these communities develop on the initial sites, mainly in renewed vineyards. According to Kaligarič (1992), similar communities do not appear in the vineyards of Koprsko gričevje, nor were the communities signalized from the neighbouring Italy (Poldini, 1989).

The communities are very well recognisable in late spring when the dominant species blossoms. The sites are dry and warm and it is found on road verges and in similar ruderal places. *Cardaria draba* (syn. *Lepidium draba)* forms almost monodominant stands, with only a few other species, such as *Convolvulus arvensis, Cichorium intybus, Picris hieracioides, Agropyron repens,* to mention only the most common ones.

This assocaition is classified witin the *Agropyretalia repentis* and *Convolvulo-Agropyrion repentis,* the alliance of species poor ruderal communities. Mucina (1993, 1997) defined this order as an order of the *Artemisietea*. These communities were considered as pioneer by Müller (1978). According to Mucina (1993) these communities are the next stage of succession of the *Stellarietea mediae* (e.g. in vineyards). This is also the case in our situation. In the course of a succession process on ruderal sites, the *Lepidio-Agropyretum* follows the *Hordeetum murini*.

	1	2	3	4
Ass. char. spec.				
Cardaria draba	4	3	4	4
CONVOLULO-AGROPYRION & AGROPYRETALIA				
Convolvulus arvensis	+	+	+	+
Agropyron repens		+	+	
Diplotaxis tenuifolia		+		+
ARTEMISIETEA				
Cichorium intybus	+	+	+	+
Picris hieracioides		+	+	+
Reseda lutea		2		+
Artemisia absinthum		+	1	
Melitotus officinalis		+	+	
Other species				
Plantago lanceolata	3			1
Verbena officinalis	2	+		
Trifolium repens	+	+		
Taraxacum officinale	+		+	
Arrhenatherum elatius	+		+	
Plantago major	+		+	
Lolium perenne	+			+
Rumex crispus		1		+
Sochus asper		+	+	
Calystegia sepium		+	+	
Bromus sterilis		+		+
Bromus tectorum		+		+
Lamium maculatum			+	+

Tab. 2: Analytical table of the *Lepidio drabae-Agropyretum repentis.*

Tab. 2: Analitična tabela združbe *Lepidio drabae-Agropyretum repentis.*

Sites of the relevés: 1. Ankaran, road edge, 21.5. 1997, 100%, 2 m²; 2. Črni kal, gravel deposit, 21.5. 1997, 80%, 10 m²; 3. Krvavi potok, road edge, 21.5. 1997, NNW, 10°, 5 m²; 4. Sežana, ruderal place, 21.5. 1997, 5 m².

Less common species: 1. *Bromus hordeaceus* +, *Poa annua* +, *Rumex conglomeratus* +, *Catopodium rigidum* +, 2. *Rubus fruticosus* 1, *Geranium rotundifolium* +, *Clematis vitalba* +, *Medicago lupulina* +, *Mercurialis annua* +, *Galeopsis pubescens* +, *Helianthus tuberosus* +, *Lactuca serriola* +, *Sanguisorba minor* +, 3. *Artemisia vulgaris* 2, *Achillea collina* +, *Dactylis glomerata* +, *Silene alba* +, *Fallopia convolvulus* +, *Cirsium arvense* +, *Daucus carota* +, *Medicago sativa* +, *Euphorbia cyparissias* +, *Festuca rubra* +, *Galium mollugo* agg. +, *Trifolium pratense* +, *Viola arvensis* +, *Euphorbia peplus* +, *Salvia verticillata* +, 4. *Capsella bursa-pastoris* +, *Poa sylvicola* +, *Trifolium repens* +, *Medicago falcata* +.

ZDRUŽBI *HORDEETUM MURINI* IN *LEPIDIO DRABAE-AGROPYRETUM* V OBALNEM DELU SLOVENIJE

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POVZETEK

Združbo, kjer dominira mišji ječmen (Hordeum murinum), *zlahka najdemo v aprilu in maju, ko vrsta cveti in gradi skoraj monodominantne sestoje na cestnih robovih, na parkiriščih, v parkih na podobnih ruderalnih rastiščih. Združba* Lepidio drabae-Agropyretum repentis *se prav tako razvije v pozni pomladi. Floristično revne sestoje najdemo na cestnih robovih, ob poteh in na drugih ruderalnih rastiščih. Združbi se razvijeta na podobnih rastiščih, vendar jih uvrščamo v različna vegetacijska razreda: združbo* Hordeetum murini *v razred plevelnih združb* Stellarietea mediae *in združbo* Lepidio drabae-Agropyretum *v red* Agropyretalia repentis, *ki ga po nekaterih novejših raziskavah uvrščamo v razred ruderalnih združb* Artemisietea vulgaris. *Iz sistematske uvrstitve lahko sklepamo tudi na njihove singenetske povezave: združbi* (Hordeetum murini) *iz skupine enoletnih plevelov sledi združba* (Lepidio-Agropyretum) *iz skupine dvo do večletnih ruderalnih združb.*

Ključne besede: ruderalne združbe, *Stellarietea mediae, Artemisietea,* vegetacija, Slovenia

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CARLINA ACANTHIFOLIA SUBSP. *UTZKA* (HACQ.) MEUSEL & KÄSTNER V SLOVENIJI

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IZVLEČEK

Avtor obravnava zgodovino odkrivanja in današnjo razširjenost vrste Carlina acanthifolia *subsp.* utzka *(Hacq.) Meusel & Kästner na skrajnem severozahodnem delu njenega areala.*

Ključne besede: *Carlina acanthifolia,* razširjenost, Slovenija

UVOD

Med svojim dolgoletnim botaniziranjem v Slovenski Istri sem imel vselej v kotičku zavesti spodbudo, naj poiščem bodečo nežo s strokovnim imenom *Carlina utzka,* ki mi jo je že leta 1979 dal profesor Tone Wraber. Ker flišno območje Slovenske Istre razmeroma dobro poznam, sem zato v zadnjih letih skoraj že opustil misel na morebitno najdbo. Zagotovo pa je ni več na njenem najbolj znanem rastišču pri Sv. Antonu pri Kopru. Ko sem leta 1995 po naključju naletel na rastišče te vrste v Istri pri Butarih na Hrvaškem, toda blizu slovenske meje, sem spoznal ekologijo rastišča in v letu 1996 poiskal vrsto tudi na slovenskem ozemlju ter sistematično raziskal njen areal v mejah Slovenije.

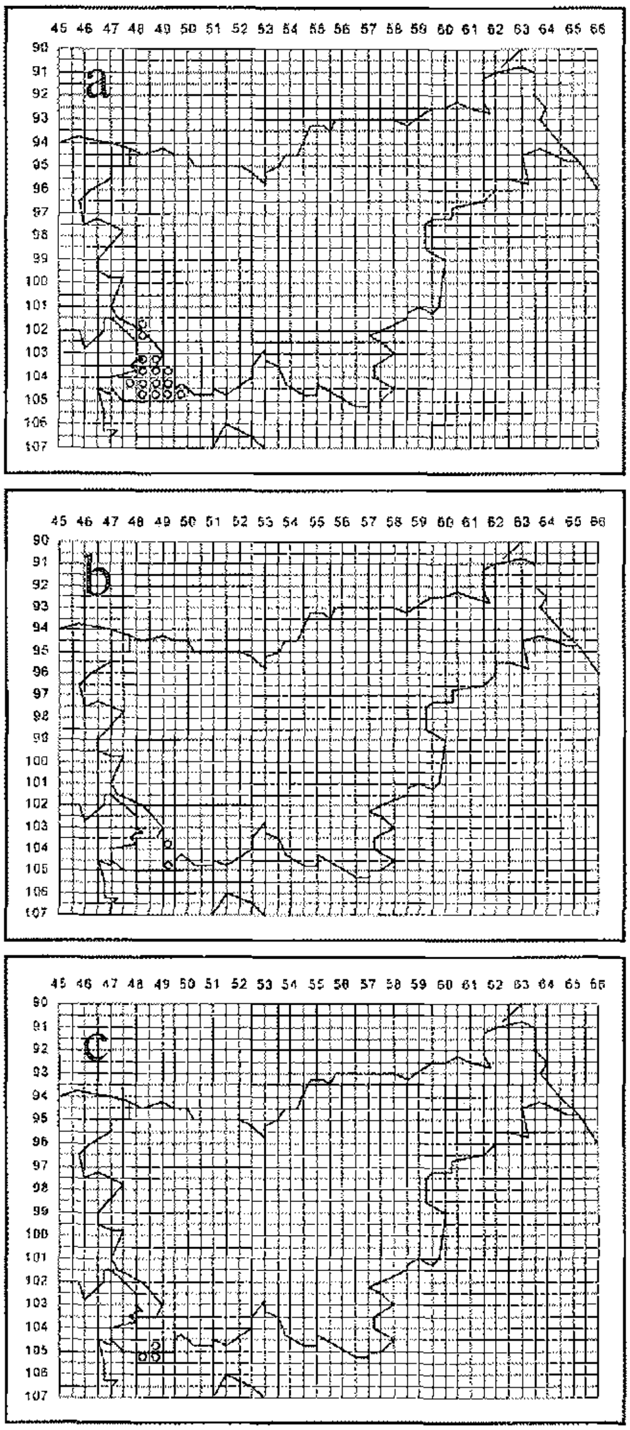
TAKSONOMSKA PROBLEMATIKA

Takson, o katerem pišem, je Hacquet (1782) opisal z imenom *Carlina Utzka* z ozemlja današnje Hrvaške Istre. V svojem delu "Plantae Alpinae Carniolicae" prinaša tudi risbo v naravni velikosti. Le nekaj let pred tem (1773) je Allioni opisal vrsto *Carlina acanthifolia* z Apeninskega polotoka, ki je kasneje, vse do vključno dela Flora Europaea (Webb, 1989: 210-211), veljala za veljaven sinonim Hacquetove vrste *Carlina utzka.* Flora Europaea omenja poleg tipične podvrste še podvrsto *Carlina acanthifolia* subsp. *cynara* (Pourret ex Duby) Rouy iz Pirenejev in *C. onopordifolia* Besser ex Szafer iz Karpatov. Tudi Mala flora Slovenije (Strgar, 1984: 570) in Register (Trpin, & Vreš, 1995: 30) imata takson *C. acanthifolia,* ki mu kot sinonim dodajata ime *C. utzka.* Šele monografija rodu *Carlina* (Meusel & Kästner, 1996) prinaša nove poglede, kjer je ohranjeno ime *Carlina acanthifolia* za vrsto, ki je v Evropi zastopana s tremi podvrstami: pirenejsko *Carlina acanthifolia* subsp. *cynara, C. acanthifolia* subsp. *acanthifolia* iz Apeninov in severozahodne Italije in jugovzhodne Francije ter *C. acanthifolia* subsp. *utzka* z Balkanskega polotoka in iz Karpatov. V to podenoto vključujeta tudi takson *C. onopordifolia.* Razlike med tremi podvrstami so predvsem v obliki zunanjih ovojkovih listov in listov rozete.

RAZŠIRJENOST

V Sloveniji rastoča podvrsta *C. acanthifolia* subsp. *utzka* je razširjena v delu Istre ter raztreseno v Bosni, Srbiji, Albaniji, Makedoniji, Grčiji, Bolgariji, Romuniji in delu Poljske in Ukrajine.

Kako je torej s primerki iz skrajnega severozahodnega areala, iz Istre? Prvi podatki po Hacquetu so najbrž Loserjevi, ki o najdbi poroča dvakrat - leta 1863, ko omenja Truške in Gradin in leto kasneje (1864), ko omenja Sv. Anton pri Kopru. Od tam sta herbarijski poli iz Pittonijevega (W) in Tommasinijevega herbarija (WU), ki obe prinašata lokaliteto Sv. Anton, nabiralec pa je bil najbrž Loser. Najbolj izčrpno poroča o rastiščih v Istri eden največjih poznavalcev istrske flore - E. Pospichal (1897-99). Omenja celo rastišča na Krasu, in sicer eno na ozemlju današnje Italije, pri Zgoniku, nato pa še iz Velikega Dola pri Pliskovici na Krasu proti pobočju Volnika, med Klancem in Kozino, pri Beki in v Črnem



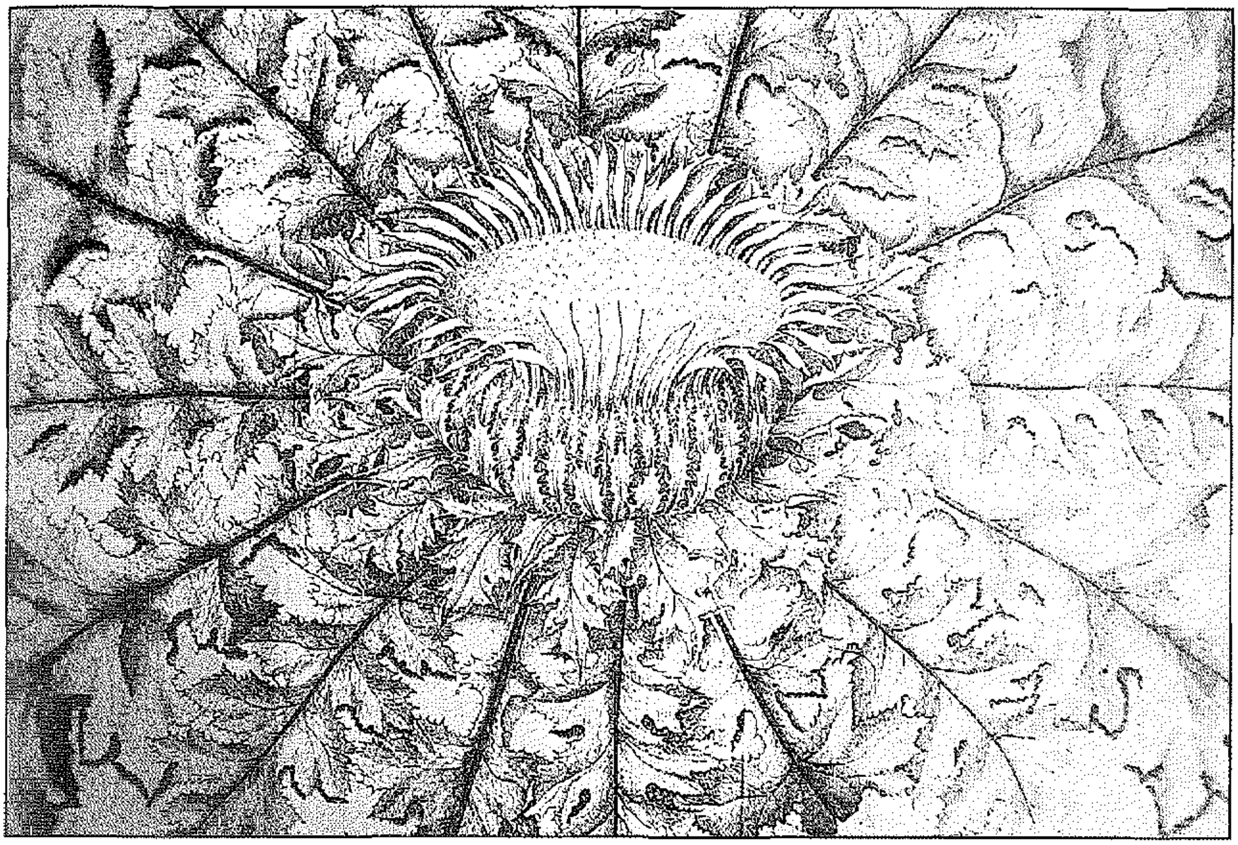
Sl. 1: Razširjenost vrste** Carlina acanthifolia **subsp.** utzka **(Hacq.) Meusel & Kästner v Sloveniji nekoč in danes (a - literaturni podatki iz 19. stoletja, b - Justin 1904 (LJU), 1911 (lit.) in c - Kaligarič, oktober 1996).

Fig. 1: Former and present distribution of** Carlina acanthifolia **subsp.** utzka **(Hacq.) Meusel & Kästner in Slovenia (a - published data from the 19th century, b - Justin 1904 (LJU) and 1911 (lit.) and c - Kaligarič, October 1996).

Kalu. Zanimivo je najdišče, ki leží zelo blizu morja - Sv. Brida pri Valdoltri. Našteva pa še Pomjan, najdišče med Pomjanom in Marezigami ter Sv. Anton, Hrib pri Truškah ter najdišča "povsod na južnih terasah Čičarije", v zvezi s katero posebej omenja Kojnik. Druga istrska najdišča, vendar na hrvaškem ozemlju, so še v območju od Bresta proti vznožju Učke ter v osrednji Istri (vasi Draguč, Sovinjak, Pazin, Borut itd.) Podobne so navedbe Marchesettija (1896-97), ki že omenjenim krajem dodaja vasi Loka, Nasirec pri Kozini in Gažon pri Kopru. Zadnji podatki starih avtorjev so od Justina (1904), ki je rastlino nabiral med Klancem in Kozino (LJU) in v Rakitovcu (1911). Nato rastlina dolgo ni bila najdena, zato lahko upravičeno sklepamo, da je z nekaterih starih lokalitet izginila, saj je kljub načrtnem iskanju nismo mogli več najti. V bistvu lahko rečemo, da je ni več na Tržaškem Krasu (Zgonik, Volnik), kar ugotavlja že Poldini (1991), na Ankaranskem polotoku ter na nekdanjih rastiščih v bližini Kopra in Trsta (Beka, Črni Kal, Pomjan, Marezige, Sv. Anton, Gažon itd.). V bistvu uspeva le v notranjem delu flišne Slovenske Istre v okolici vasi Abitanti, Gradin, Pregara, (kvadranti 0548/4, 0549/1, 0549/3), kjer je relativno pogosta, kar sem ugotovil z načrtnim iskanjem v letu 1996. "Rdeči seznam" (Wraber & Skoberne, 1989) povzema le najdišči Truške - Gradin od Loserja in Rakitovec od Justina.

EKOLOGIJA IN NARAVOVARSTVENA PROBLEMATIKA

Starejši viri navajajo rastišča tako na apnencu kot flišu, na Balkanu pa raste (Kästner & Meusel, 1996) celo na serpentinu. Posebej se je o rastišču razpisal Loser, ki obakrat (1863, 1864) poudarja, da rastlina raste na flišnih erodiranih tleh, skupaj z nekaterimi kserofilnimi vrstami, kot so *Fumana procumbens, Asperula cynanchica, Galium purpureum, Satureja montana* idr. Naša opazovanja potrjujejo uspevanje izključno na flišu, vendar ne na golih, erodiranih predelih, kjer uspevajo npr. *Carlina acaulis, Fumana procumbens, Teucrium montanum* itd., temveč na zmerno suhih traviščih asociacije *Danthonio-Scorzoneretum villosae peucedanetosum cervariae* na flišu, ki pa so - nekatera bolj, nekatera manj - že močno obkrožena z redkimi hrastovimi gozdiči, ki take travnike počasi preraščajo. Tako včasih najdemo vrsto *C. acanthifolia* subsp. *utzka* pravzaprav že v stadiju grmišča oziroma redkega gozda. Neredko se pojavi celo v družbi s travo *Molinia arundinacea*, ki označuje plitka, zakisana in bolj vlažna tla. Tudi takšni "molinietumi" se nato zarastejo s hrastovjem in dokler gozd ni sklenjen, ta bodeča neža še dobro uspeva. Zanimivo je, da so vsa najdišča na nadmorski višini od 350 do 400 metrov in zunaj t.i. območja oljke oziroma neposrednega vpliva morja. V neposredni bližini najdišč je razvit bukov gozd asoc. *Seslerio-Fagetum*. Njen areal v Sloveniji bi lahko označili tudi s prepletanjem dveh



Sl. 2: Bakrorez v naravni velikosti rastline je iz knjige "Plantae Alpinae Carniolicae" B. Hacqueta iz leta 1782, v kateri je bila ta vrsta prvič opisana za znanost.
Fig. 2: The above life-sized copperplate engraving of the plant is from the book "Plantae Alpinae Carniolicae" by. B Hacquet (1782), in which this species was scientifically described for the very first time.

sorodnih vrst šetraja, ki se sicer v arealih običajno izključujeta, saj *Satureja montana* subsp. *variegata* uspeva na nižji nadmorski višini, bližje morju in je bolj termofilna, vrsta *Satureja subspicata* subsp. *liburnica* pa je mediteransko-montanska ilirska vrsta, razširjena na apnencu Visokega Krasa. Na traviščih v omenjenih kvadrantih pa rasteta skupaj.

Od več kot sto primerkov, ki sem jih opazoval v letu 1996, so bili vsi brez razvitih koškov. En košek sem našel odrezan in odvržen na najdišču. Od primerkov, najdenih v letu 1995 na hrvaški strani meje pri Butarih, pa je eden cvetel. V bistvu mora rastlina več let zbirati rezervne snovi, da lahko nato tako obilno zacveti. To je zagotovo eden izmed vzrokov, da nima cvetov. Ali je to dejstvo tudi posledica nabiranja za suhe šopke? Težko verjetno, da bi bilo takšno početje množično razširjeno, saj tega dosedaj nisem imel priložnosti opaziti. Morda pa je slaba reprodukcija rastline posledica šibke vitalnosti istrske populacije kot take. Tako morda rastlina s samega roba areala počasi izginja, zaradi tega je na večini lokalitet iz prejšnjega stoletja ni več mogoče najti. Tako razmišljanje se nam vsiljuje tudi zato, ker se rastišča do danes niso bistveno spremenila; v nekem smislu zaradi opuščanja kultur travišča celo pridobivajo na površini. Znano je tudi dejstvo, da je vrsta najbolj občutljiva ravno na meji areala. Kje pa gre iskati vzrok za domnevno zmanjšano vitalnost vrste, ki lahko vodi celo v naravno izumiranje, pa seveda ne znamo pojasniti.

CARLINA ACANTHIFOLIA SUBSP. *UTZKA* (HACQ.) MEUSEL & KÄSTNER IN SLOVENIA

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SUMMARY

The paper discusses the present distribution of Carlina acanthifolia *subsp.* utzka *(Hacq.) Meusel & Kästner. The taxon's former and present distribution in the northwestern part of its range as well as the vegetation conditions at its sites were studied. After nearly hundred years the sites of this species were found again in Slovene and Croatian parts of Istria. It has been stated that in the former times the species used to be spread more to the east and north than nowadays. The author discusses the causes of sterility in the year 1996 and the causes of its reduced distribution.*

Key words: *Carlina acanthifolia,* distribution, Slovenia

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PRISPEVKI K POZNAVANJU MAKROBENTOŠKIH ALG SLOVENSKEGA OBALNEGA MORJA: ROD *CLADOPHORA* (CHLOROPHYTA)

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IZVLEČEK

V članku obravnavamo 8 vrst iz rodu Cladophora *Kützing (1843), ki živijo v slovenskem obalnem morju. Podajamo splošen opis vrst z osnovnimi značilnostmi in njihova rastišča ter predstavljamo ključ za določanje obravnavanih alg. Navajamo podatke o dveh vrstah, ki doslej nista bili zabeleženi v slovenskem obalnem morju. Podajamo tudi predlog za slovensko poimenovanje obravnavanih vrst.*

Ključne besede: rod *Cladophora*, ključ za določanje vrst, Chlorophyta, pojavljanje, slovensko obalno morje

UVOD

Članek je namenjen spoznavanju in prepoznavanju osmih predstavnic rodu *Cladophora* Kützing (1843), ki živijo v slovenskem obalnem morju. Vrste tega rodu živijo tako na zaščitenih kot na izpostavljenih območjih bibavičnega (mediolitoralnega) in zgornjega obrežnega (infralitoralnega) nadstropja. Tu sestavljajo sluzaste prevleke skupaj s predstavnicami zelenih makrobentoških rodov *Enteromorpha, Chaetomorpha* in *Ulva*. Pogoste so zlasti pozimi in spomladi. Razširjene so v Jadranskem in Sredozemskem morju ter Atlantiku in Pacifiku.

Podajamo osnovne morfološke, razmoževalne in ekološke značilnosti, predstavimo določevalni ključ in predlagamo tudi slovenska imena vrst. Obravnavane vrste so *Cladophora aegagropila* (Linnaeus, 1753) Rabenhorst, 1868, *C. coelothrix* Kützing, 1843, *C. echinus* (Biasoletto, 1841) Kützing, 1849, *C. feredayi* Harvey, 1858, *C. pellucida* (Hudson, 1762) Kützing, 1843, *C. prolifera* (Roth, 1797) Kützing, 1843, *C. pseudopellucida* Van den Hoek, 1963 in *C. retroflexa* (Bonnemaison ex P.L. *et* H.M. Crouan, 1867) Hoek, 1963. V seznamu sta vključeni dve vrsti *(C. aegagropila* in *C. pseudopellucida)*, ki doslej še nista bili omenjeni za slovensko obalno morje.

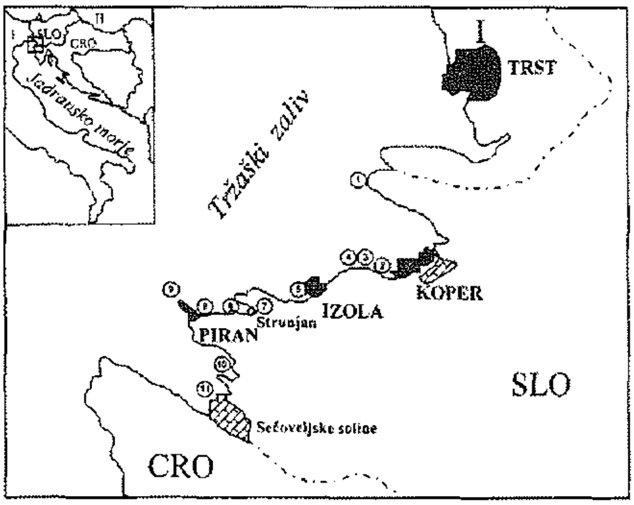
Članek je nadaljevanje del Battelli & Vukovič (1995) in Battelli (1996), kjer so obravnavane splošne značilnosti in pojavljanje rodu *Codium* Stackhouse (1797) v slovenskem obalnem morju z morfološkim ključem za njihovo določanje. Naša želja je približati bralce, ljubitelje narave in še posebno morja k spoznavanju in prepoznavanju najbolj razširjenih vrst makrobentoških zelenih alg slovenskega obalnega morja.

PREGLED OBJAV

Med starejšimi avtorji omenjamo Carla Marchesettija (1893), ki je v katalogu zbral 750 del in obravnavajo floro avstrijskega obrežja. Posebej pa bi omenili Giuseppeja Accurtija in Antonia Zaratina. Giuseppe Accurti (1858) je napisal zanimivo delo o flori alg Koprskega zaliva in pripravil tudi bogato zbirko alg, ki je še danes ohranjena v naravoslovnem muzeju v Trstu. Antonio Zaratin pa je izdelal algarij morske jadranske flore alg Istre in Trsta, v katerem je bogata zbirka alg Tržaškega, predvsem pa Koprskega in Piranskega zaliva. Del njegove zbirke je še danes ohranjen na koprski gimnaziji "Gian Rinaldo Carli".

Slovenski znanstveniki, ki so obravnavali floro alg slovenskega obalnega morja in prikazali inventarizacijo algovne flore so Matjašič & Štirn (1975), Vukovič (1980, 1981, 1982, 1984), Bussani & Vukovič (1987) in Munda (1992, 1993). Ti navajajo pojavljanje 17 vrst iz rodu *Cladophora* v slovenskem obalnem morju.

V algologiji je zelo odmevno delo Van den Hoeka (1963) o rodu *Cladophora*, kjer pogosto omenja kraje slovenske obale. Giuseppe Giaccone (1978) je napisal revizijo morske flore Jadranskega morja. To pomembno



Sl. 1: Zemljevid obravnavanega območja.
Fig. 1: Study area.

delo nam je služilo za orientacijo pojavljanja vrst iz rodu *Cladophora* v Tržaškem zalivu, še posebno v njegovem slovenskem delu. Noailles (1995) zelo podrobno obravnava rod *Cladophora* v regiji Roscoff v Franciji in poda tudi natančno obdelan ključ za določanje posameznih vrst.

Van den Hoek *et al.* (1995) so avtorji enega od najmodernejših prikazov novih pristopov k spoznavanju alg predvsem s citološkega, morfološkega, sistematskega in evolucijskega vidika.

MATERIAL IN METODE

Vzorci so bili nabrani na območju slovenskega obalnega morja od Debelega rtiča (Koprski zaliv) na severu do izliva reke Dragonje (Piranski zaliv) na jugu v bibavičnem in zgornjem obrežnem nadstropju do globine 6-8 m med prostim potapljanjem od februarja do avgusta na naslednjih postajah: 1. Debeli rtič, 2. Semedelski zaliv, 3. Žusterna, 4. Obala med Koprom in Izolo, 5. Simonov zaliv, 6. Strunjanski zaliv, 7. Strunjanska laguna, 8. Fiesa, 9. Piran - rt Madona, 10. Lucja - kanal in 11. Sečoveljske soline (sl. 1).

Vzorci so fiksirani in shranjeni kot mokri preparati v 4% metanalu (formalinu) v morski vodi in kot suhi preparati v algariju.

Predstavnice obravnavanih vrst smo razvrstili v večje skupine po avtorjih: Van den Hoek (1963), Giaccone (1972-73), Burrows (1991) in Noailles (1995). Določevalni ključ smo izdelali po zgoraj omenjenih avtorjih ter ga poenostavili in prilagodili našim zahtevam. Določevalne morfološke znake, ki sestavljajo osnovo za prepoznavanje in določanje alg, smo izbrali z analizo v naravi nabranih vzorcev, neposredno opazovanih s stereolupo in mikroskopom. Za vsako obravnavano vrsto smo zbrali najbolj ustrezne opise iz strokovne literature, iz lastnih opazovanj in meritev ter jih dopolnili z risbami. Risbe so shematične; njihov namen je predstaviti osnovne posebnosti, s katerimi bi laže določili opazovane primerke.

Za izdelavo ključa smo upoštevali zlasti merila za določanje vrst, ki jih predlaga Noailles (1995), merila pa so naslednja:

- dolžina pritrjevalne (bazalne) celice,
- premer končnih celic,
- organizacijska rast steljke, ki je lahko končna ali medcelična. Vrste s končno rastjo imajo vedno daljše nitke, če izhajamo od vrhnje celice proti spodnjemu delu steljke. Vrste z medcelično rastjo imajo izmenično razporejene daljše in krajše nitke na glavni nitki,
- lega celične stene, od koder izhaja stranska nitka (bolj ali manj navpična ali vodoravna),
- oblika končnih celic (valjasta, stožčasta, z zaobljenim ali koničastim vrhom).

REZULTATI

Obravnavane skupine s pripadajočimi vrstami so naslednje:

Skupine	Vrste
Longi-articulatae	*C. feredayi, C. pellucida, C. prolifera, C. pseudopellucida, C. retroflexa*
Aegagropila	*C. aegagropila, C. echinus*
Repentes	*C. coelothrix*

Ključ za določanje skupin (prilagojen in poenostavljen po Van den Hoeku (1963) in Giacconeju (1972-73)).

1	*Steljka s končno organizacijo rasti, stranske nitke nastajajo na končnem delu materinske celice z vodoravno ali rahlo poševno celično steno, spodnje celice steljke imajo rizoide s črevasto obliko in z obročastimi zožitvami, pritrjevalna celica je dolga.*	Longi-articulatae
1*	*Steljka z medcelično organizacijo rasti ali končno organizacijo, vendar samo v zgornjem delu steljke, stranske nitke nastajajo bočno z bolj ali manj navpično celično steno vedno pod vrhom materinske celice.*	
2	*Stranske nitke enoserijsko nameščene vzdolž glavne nitke, stene celic spodnjega dela steljke odebeljene, rast medcelična.*	Aegagropila
2*	*Stranske nitke drugače nameščene, stene celic na spodnjem delu steljke tanke, rast medcelična.*	Repentes

Znaki, ki smo jih uporabili v preglednicah:

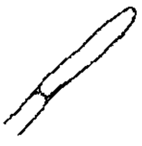
I. Videz steljke: (Glej preglednico)
II. Trdnost:
1. mehka, nežna, sluzasta,
2. trdna, krhka.
III. Premer končnih celic: (Glej preglednico)
IV. Lega celične stene na glavni nitki, od koder raste stranska nitka:
1. ± navpična (na glavno nitko),
2. vodoravna ali poševna (na glavno nitko).
V. Oblika končne celice:
1. valjasta z zaobljenim vrhom,
2. stožčasta s koničastim vrhom.
VI. Celična stena:
1. tanka (1-4 μm),
2. debela (5-10 μm ali več).
VII. Rizoidi:
1. preprosti,
2. združeni v pritrjevalno ploščico,
3. črevasti.
Drugi znaki:
a. spodnji del steljke,
b. srednji del steljke,
c. končni del steljke,
e. stranske nitke.

Vse vrednosti so podane v μm (če ni drugače označeno).

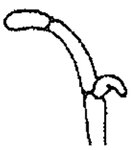
OPIS SKUPIN

Skupina - *Longi-articulatae*

Steljke grmičaste oblike, trde po otipu, temnozelene barve. Organizacija rasti je končna. Stranske nitke ne nadaljujejo smeri rasti glavnih nitk. Prirasle so bočno, pogosto rahlo pod samim vrhom materinske celice z vodoravno ali poševno celično steno. Končne celice so rahlo odebeljene na vrhu (Tab. 1 in 2).

Znaki	*Cladophora prolifera*	*Cladophora pellucida*
I.		
II.	2	2
III.	nad 110 (110-260)	100-150
IV.		
V.		
VI.	1	1
VII.	3 	2 

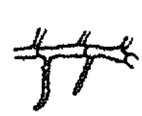
Tab. 1: Preglednica - Skupina Longi-articulatae.
Tab. 1: Synoptic table-Longi-articulatae group.

Znaki	*Cladophora feredayi*	*Cladophora retroflexa*	*Cladophora pseudopellucida*
I.			
II.	2	2	2
III.	30-40	90-140	70-110
IV.	2 		2 
V.			
VI.	1	1	1
VII.	2 	brez rizoidov	2 

Tab. 2: Preglednica - Skupina Longi-articulatae.
Tab. 2: Synoptic table-Longi-articulatae group.

Ključ za določanje vrst:

1	*Celice spodnjega dela steljke s črevastimi rizoidi, ki imajo obročaste zožitve po celotni dolžini, alga temno zelena (posušena postane rjava), končne celice rahlo odebeljene na vrhu, premer 110-260 µm.*	*Cladophora prolifera*
1*	*Rizoidi nikoli črevasti.*	
2	*Steljka brez posebnih pritrjevalnih organov, končne celice ukrivljene, ovita okoli drugih alg ali prosta, premer končnih celic 90-140 µm alga temno zelena (posušena postane črnorjava).*	*Cladophora retroflexa*
2*	*Rizoidi združeni v pritrjevalno ploščico.*	
3	*Celice postanejo postopoma daljše proti spodnjemu delu, premer končnih celic večinoma 100-150 µm, spodnja celica zelo dolga (2-3 cm).*	*Cladophora pellucida*
3*	*Končne celice s premerom pod 100 µm, celice postanejo postopoma daljše proti spodnjemu delu.*	
4	*Premer končnih celic 30-40 µm.*	*Cladophora feredayi*
4*	*Premer končnih celic večinoma 70-110 µm.*	*Cladophora pseudo-pellucida*

Znaki	*Cladophora aegagropila*	*Cladophora echinus*
I.		
II.	2	2
III.	20-70	90-190
IV.	1 	1-2 
V.		
VI.	a) 2	a) 2
VII.	rizoidi nastanejo lahko iz drugih celic 	1 

Tab. 3: Preglednica - Skupina Aegagropila.
Tab. 3: Synoptic table - Aegagropila group.

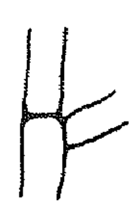
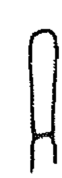
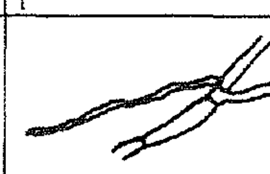
Skupina - *Aegagropila*

Steljke so trdne po otipu; spodnje celice so kratke, rizoidi nimajo obročastih zožitev. Celične stene so debele predvsem v spodnjem delu steljke. Stranske nitke so z navpično ali poševno celično steno bočno prirasle, pogosto pod vrhom materinske celice. Obravnavamo vrsti *Cladophora aegagropila* in *Cladophora echinus* (tab. 3).

Skupina - *Repentes*

Pritrjevalna celica je kratka; rizoidi so brez obročastih zožitev. Celične stene so navadno tanke. Celice so po obliki valjaste ali rahlo kijaste; stranske nitke nastajajo vedno na končnem delu materinske celice in so pogosto nasprotno razvrščene.

Obravnavamo le vrsto *Cladophora coelothrix* (tab. 4).

Znaki	*Cladophora coelothrix*
I.	
II.	1
III.	50-100
IV.	1 
V.	
VI.	1
VII.	 rastejo tudi iz ostalih celic

Tab. 4: Preglednica - Skupina Repentes.
Tab. 4: Synoptic table: Repentes group.

OPIS VRST

Cladophora aegagropila (Linnaeus, 1753) Rabenhorst, 1868

Etim.: Gr. *klados* veja, *pherein* nositi, ki nosi vejice (razrasel); *aigos* koza, *agrios* divji; *pilos* tlačena volna, klobučevina; Lat. *pilus* dlaka, las.

Slov.: klobčičasta kladofora

Ital.: cladofora egagropila

Steljka je bogato in nepravilno razrasla, po otipu trda, visoka približno 3 cm.

Barva je vedno temnozelena. Na trdno podlago je pritrjena z rizoidi, ki lahko sestavljajo pritrjevalno ploščico. Živi tudi na mehki podlagi (pesek, mulj) v obliki gostih klobčičev.

Stranske nitke so bočno nameščene pod končnim delom materinske celice z navpično celično steno. Celice v spodnjem delu steljke so kijaste. Rizoidi lahko nastanejo tudi iz drugih celic steljke. Celične stene so debele (približno 20 μm) zlasti v celicah spodnjega dela steljke, v zgornjih celicah pa do 10 μm. Premer končnih celic je 20-70 μm, glavne nitke do 100 μm.

Živi v manj slani vodi v bibavičnem in zgornjem obrežnem nadstropju. Vzorci so bili nabrani na postajah (2, 8, in 10) vedno pri izlivih sladke vode.

Cladophora coelothrix (Dillwyn, 1805) Kützing, 1843
= *Cladophora repens* (J. Agardh) Harvey

koilos votel; *chilos* trava, krma; *thrix* las

Slov.: ripeča kladofora

Ital.: cladofora celotrix

Steljka je grmičasta, bogato in nepravilno razrasla, visoka 4-8 cm. Na podlagi ustvarja spužvaste blazinice, široke 2-4 cm. Iz glavnih nitk rastejo stranske, ki so nepravilno razporejene. Barva je temnozelena (posušeni osebki so rjavkasti). Iz spodnjega dela glavne nitke rastejo številni tanjši rizoidi. Celične stene, ki ločijo stranske nitke, so vzporedne z osjo steljke. Mlade končne nitke so številne in se vegetativno razmnožujejo. Celice so po obliki valjaste. Zlasti v spodnjem delu steljke so celice krajše in kijaste. Končne celice so široke 50-100 μm. Celične stene so tanke od 1,5 do 5 μm. Rast je medcelična.

Vrsta živi predvsem v senčnatih območjih bibavičnega in zgornjega obrežnega nadstropja. Pogosta je v lužah bibavičnega nadstropja; živi na lupinah latvic. Vzorci so bili nabrani v Piranu (rt Madona) in pri Sečoveljskih solinah.

Cladophora echinus (Biasoletto, 1841) Kützing, 1849
= *Cladophora cornea* Kützing

Lat. *echinus* jež

Slov.: ježasta kladofora

Ital.: cladofora echinus

Steljka je gosto nepravilno razrasla, po otipu trda. Ježasta kladofora je temnozelena. Živi pritrjena na podlago ali prosto. Na rastišču oblikuje gosto zapletene blazinice kroglaste oblike, premera približno 6 cm.

Rast je medcelična. Celice so običajno kratke in valjaste. Zlasti v spodnjem delu steljke so celice podolgovate in kijaste. Celične stene končnih celic so debele od 5,5 do 35 μm; stene osrednjih nitk pa do 55 μm. Premer končnih celic je 90-190 μm.

Rizoidi nastanejo običajno bočno na spodnjem delu celic. Stranske nitke so nameščene na glavnem poganjku vsaka zase z vzporedno celično steno.

Pogosta je v bibavičnem in v zgornjem obrežnem nadstropju na trdi podlagi ali kot epifit. Vzorce smo nabrali v laguni v Strunjanu.

Cladophora feredayi Harvey, 1858

Etim.: Gr. *klados* veja, *pherein* nositi; ki nosi vejice (bogato razrasel)

Slov.: Feredayeva kladofora

Ital.: cladofora di Fereday

Steljka je pokončna, bogato grmičasto razrasla. Na podlagi ustvarja šopaste, travniku podobne, tvorbe. Je svetlo - do temnozelene barve. Steljka je končno razrasla. Nove celice nastajajo na končnem delu materinske celice s poševno celično steno, ki postane zelo hitro vodoravna. Celice, zlasti v spodnjem delu steljke, so podolgovate in kijaste. Premer končnih celic je 30-40 μm, spodnjih celic pa 120 μm. Celice imajo odebeljen vrh.

Živi v senčnatih in valovom izpostavljenih območjih v bibavičnem in zgornjem obrežnem nadstropju. Vzorci so bili nabrani v Žusterni in v Piranu (rt Madona).

Cladophora pellucida (Hudson, 1762) Kützing, 1843

Lat. *perlucidus* prozoren, zelo svetel; *per* skozi + *lucidus* svetleč

Slov.: prozorna kladofora

Ital.: cladofora pellucida

Steljka je pokončna, bogato češuljasto razrasla, po otipu je trda, visoka 4-10 cm.

Na podlagi ustvarja šopaste, grmičaste tvorbe. Barva je temnozelena, tudi ko se posuši.

Organizacija rasti je končna. Celice, zlasti v spodnjem delu steljke, so podolgovate in kijaste. Na končnem delu steljke raste 3-5 nitk, ki so razporejene bolj ali manj vretenasto. Celice so na vrhu rahlo odebeljene in daljše kot širše.

Premer končnih celic je 100-150 μm. Premer osrednje nitke meri približno 180 μm. Vsaka nova celica raste neposredno pod končno celico (apikalno). Na podlago je pritrjena z rizoidnimi celicami. Pritrjevalna celica je zelo dolga (3-4 cm) in široka 0,1-0,5 mm.

Vrste	Premer končnih celic v μm	Oblika rasti	Insercija stranskih nitk	Oblika celic	Celične stene
C. aegagropila	20-70	medcelična	navpična	kijasta	debele
C. coelothrix	50-100	medcelična	navpična	valjasta, kijasta na spodnjem delu steljke	tanke
C. echinus	90-190	medcelična	navpična	valjasta, kijasta na spodnjem delu steljke	debele v spodnjem delu steljke
C. feredayi	30-40	končna	poševna ali vodoravna	kijasta	tanke
C. pellucida	100-150	končna	poševna ali vodoravna	kijasta	tanke
C. prolifera	110-260	končna	poševna ali vodoravna	kijasta	tanke
C. pseudopellucida	70-110	končna	poševna ali vodoravna	kijasta	tanke
C. retroflexa	90-140	končna	poševna ali vodoravna	kijasta	tanke

Tab. 5: Splošna preglednica osnovnih lastnosti obravnavanih vrst iz rodu *Cladophora.*
Tab. 5: General synoptic table of the basic characteristics of the dealt with species of the genus *Cladophora.*

Živi v senčnatih in izpostavljenih območjih v bibavičnem in zgornjem obrežnem nadstropju. Vzorci so bili nabrani pri Žusterni in v Piranu (rt Madona).

Cladophora prolifera (Roth, 1797) Kützing, 1843
= *Conferva prolifera* Roth. 1797

Lat. *proles* potomstvo, naraščaj; *ferre* nositi, imeti
Slov.: bronasta kladofora
Ital.: cladofora prolifera

Steljka je pokončna v obliki gostih grmičkov, visokih 5-20 cm, po otipu je trda.

Razrast je bogata. Barva je temnozelena z bronastimi odsevi, črno rjava, ko je posušena. Na podlago je pritrjena z dolgimi črevastimi rizoidi.

Razraslost je končna dvovejnata, trovejnata ali večvejnata. Steljka ima na glavni nitki več stranskih nitk. Posamezne celice so večjedrne, vsebujejo mrežaste kloroplaste in so obdane z debelo celično steno. Končne celice so rahlo kijaste in odebeljene na vrhu; premer je 110-260 μm. Celice spodnjega dela so bolj ali manj kijaste z zaobljenim vrhom. Rizoidi so črevaste oblike (imajo značilne zožitve po celotni dolžini) in izhajajo iz spodnjega dela spodnjih celic.

V slovenskem obalnem morju je precej razširjena zlasti na kamnih in skalah bibavičnega in zgornjega obrežnega nadstropja v zaščitenih in senčnatih območjih. Živi tudi kot epifit na steljkah cistozir.

Vzorci so bili nabrani na postajah 1, 2, 4, 5, 6, 9, 10 in 11.

Algo uporabljajo v zdravstvu zaradi protibakterijskega in protivirusnega učinka (Bressan, 1986).

Cladophora pseudopellucida Van den Hoek, 1963

Etim.: Gr. *pseudos* laž, nepravi
Lat. *perlucidus* prozoren, zelo svetel
Slov.: bleda kladofora
Ital.: cladofora pseudopellucida

Steljka je pokončna, bogato grmičasto razrasla. Na podlagi ustvarja šopaste, travniku podobne, tvorbe, visoke 5-10 cm. Barva je svetlo- ali temnozelena. Steljka je končno razrasla. Vsaka nova celica raste iz končnega dela materinske celice s poševno celično steno, ki postane vodoravna. Celice, zlasti v spodnjem delu steljke, so podolgovate in kijaste. Premer končnih celic je približno 70-110 μm; spodnjih celic pa 250 μm.

Živi v senčnatih območjih v bibavičnem in zgornjem obrežnem nadstropju. Vzorci so bili nabrani pri Žusterni in v Piranu (rt Madona).

Cladophora retroflexa (Bonnemaison, 1867 ex P.L. et H. M. Crouan,1852) Hoek

Lat. *retro* nazaj, *flexus* upognjen
Slov.: lokasta kladofora
Ital.: cladofora retroflessa

Steljka nima pritrjevalnih organov (rizoidov), živi nepritrjena v obliki zapletenih klobčičev premera 1-2,5 cm. Pogosto živi zapletena na drugih rastlinah (zlasti semenkah). Barva je temnozelena; črnorjava, ko je posušena. Razraslost je končna.

Stranske nitke imajo značilno upognjeno obliko, pogosto srpasto. Premer končnih celic je 90-140 μm in so rahlo razširjene na vrhu. Celice v spodnjem delu steljke so kijaste in široke približno 170-200 μm.

Živi v bibavičnem in zgornjem obrežnem nadstropju v senčnatih območjih. Vzorci so bili nabrani med morskimi semenkami na postajah (1, 2, 6 in 9).

Alga je zelo podobna vrsti *C. prolifera* in vrsti *C. pellucida,* od katerih se loči po tem, da nima rizoidov.

RAZPRAVA IN ZAKLJUČKI

S člankom smo želeli bralcem ponuditi preprost, tudi nestrokovnjakom dostopen ključ za prepoznavanje 8 vrst iz rodu *Cladophora*, ki živijo v slovenskem obalnem morju, in jih predstaviti vsaj na morfološkem nivoju.

VRSTA	TRŽAŠKI ZALIV	SLOVENSKO MORJE
Cladophora aegagropila	-	+4
Cladophora albida	+1	+2, +3
Cladophora battersii	-	+2
Cladophora coelothrix	+1	+2, +3, +4
Cladophora dalmatica	+1	+2
Cladophora echinus	+1	+2, +3, +4
Cladophora feredayi	+1	+2, +3, +4
Cladophora glomerata	+1	+2
Cladophora hutchinsiae	+1	-
Cladophora laetevirens	+1	+2, +3
Cladophora lehmanniana	+1	-
Cladophora liniformis	+1	+2
Cladophora pellucida	+1	+2, +3, +4
Cladophora prolifera	+1	+2, +3, +4
Cladophora pseudopellucida	-	+4
Cladophora retroflexa	+1	+2, +3, +4
Cladophora ruchingeri	+1	+2
Cladophora rupestris	+1	+2
Cladophora sericea	+1	+2, +3
Cladophora socialis	+1	+2
Cladophora vagabunda	+1	+3

Legenda/Legend: + pojavljanje/presence, - odsotnost/ absence
Viri/Sources: 1 (Giaccone, 1978), 2 (Matjašič & Štirn, 1975), 3 (Vukovič, 1980, 1981, 1982, 1984), 4 (to delo).

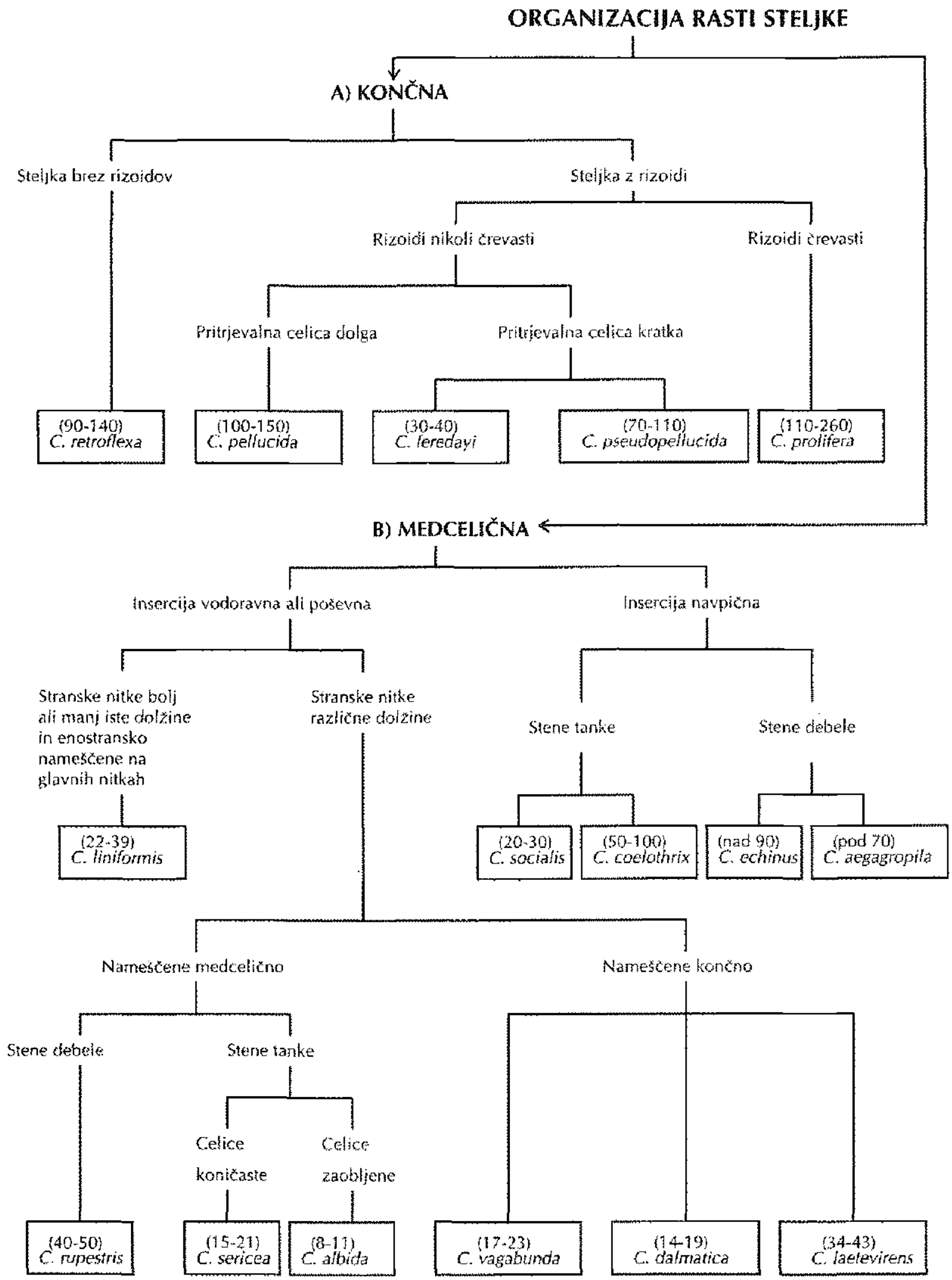
Tab. 6: Preglednica, ki ponazarja pojavljanje vrst rodu* Cladophora *v Tržaškem zalivu in v slovenskem obalnem morju.
Tab. 6: Synoptic table indicating the occurrence of species of the genus* Cladophora *in the Gulf of Trieste and in the coastal waters of Slovenia.

Glede na to, da so predstavnice rodu *Cladophora* ekološko izredno plastične, je proces določanja zaradi velikega polimorfizma zelo zapleten. To je osnovni razlog, zaradi katerega smo v našem delu podrobneje obravnavali le 8 vrst.

Za boljšo ponazoritev zaključkov smo pripravili splošen shematski prikaz določevalnega ključa (sl. 2), ki ponazarja osnovne razločevalne znake, s katerimi lahko določimo 16 vrst iz rodu *Cladophora,* ki so omenjene za slovensko obalno morje. Poleg 8 že omenjenih obravnavamo še naslednje vrste: *Cladophora albida* (Hudson, 1778) Kützing, 1843, *C. dalmatica* Kützing, 1843, *C. laetevirens* (Dillwyn), Kützing, 1843, *C. liniformis* Kützing, 1849, *C. rupestris* (Linnaeus, 1753), Kützing, 1843, *C. sericea* (Hudson, 1762), Kützing, 1843, *C. socialis* Kützing, 1849, *C. vagabunda* (Linnaeus, 1753), van den Hoek, 1953. Številke v oklepaju označujejo premer končnih celic v µm.

ZAHVALA

Posebno se zahvaljujem prof. dr. Tonetu Wrabru za pomoč pri oblikovanju slovenskih imen alg. Iskreno se zahvaljujem prof. dr. Giuseppeju Giacconeju z Univerze v Cataniji (Italija) za pomoč pri določanju alg. Kolegu dr. Aleksandru Vukoviču z Morske biološke postaje v Piranu se prisrčno zahvaljujem za pomoč pri zbiranju literature in za dragocene informacije o flori alg slovenskega obalnega morja.



Sl. 2: Shematski prikaz določevalnega ključa.
Fig. 2: Schematic representation of the key for determination.

A CONTRIBUTION TO THE KNOWLEDGE OF MACROBENTHIC ALGAE OF THE COASTAL WATERS OF SLOVENIA: GENUS *CLADOPHORA* (CHLOROPHYTA)

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SUMMARY

The paper deals with the occurrence of some of the most common species of the genus Cladophora *Kützing (1843) in the coastal waters of Slovenia and presents a key for their determination. Apart from the works by Battelli & Vukovič (1995) and Battelli (1996), in which general characteristics and occurrence of species of the genus* Codium *in the coastal waters of Slovenia are presented together with a morphological key, there are no works in which algae of the Slovene coastal waters would be dealt with morphologically and accompanied with a suitable key.*

With this presentation of some of the species of the genus Cladophora *we wish to acquaint nature lovers with the world of algae and to stimulate them in their attempts to recognize some of the most characteristic macrobenthic green algae inhabiting the coastal waters of Slovenia. Considering that the determination of individual species of this genus is often very problematic even for the experts, we have decided to describe, in detail, only 8 of the 17 representatives of this genus, which have to date been recorded in our coastal waters. Apart from their description, a Slovene name for each of the species is suggested, which is something of a novelty in the Slovene marine algology.*

The specimens were collected in the intertidal and upper coastal level to the depth of 6-8 m from Debeli rtič in the north to the mouth of the Dragonja river in the south. They have been preserved as wet preparations in 4-5% formaline and as dry preparations in algarium. The paper presents general morphological, reproductional and ecological characteristics of this genus and, while describing individual species, their morphological characteristics, which served as a basis for the elaboration of the morphological key for their determination. The determination key is morphological, which means that mainly morphological features were dealt with as a basis for their identification (particularly the form of rhizoids, width of the end cells, form of the cells, organizational level of the cells, thickness of the cellular wall, etc.). The key is enriched with synoptic tables and drawings. The latter are schematic; their aim is to present the basic characteristics with which the studied samples are easier to identify.

Data on two species which have not been referred to so far in respect of the algae of the Slovene coastal waters are also given, i.e. on Cladophora aegagropila *and* Cladophora pseudopellucida.

Key words: genus *Cladophora,* key for species determination, Chlorophyta, occurrence, Slovenian coastal sea

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ORNITOLOGIJA

ORNITOLOGIA

ORNITHOLOGY

pregledni članek

UDK 598.2(497.4)
502.74(497.4)

SLOVENSKA ORNITOLOGIJA NA PRAGU TRETJEGA TISOČLETJA

SLOVENE ORNITHOLOGY ON THE THRESHOLD OF THE THIRD MILLENIUM

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IZVLEČEK

Avtor primerja dva vrednostna pogleda na ptičji svet, kvalitativni Reiserjev z začetka tega stoletja in kvantitativni Tuckerjev pogled s konca stoletja. Oba pogleda sta obremenjena s prioritetnim vrednotenjem. Kakor je bila prerasla Reiserjev pogled, mora Slovenija v prihodnje preseči tudi Tuckerjev populacijska obrobja zanemarjujoči globalni pogled na varstvo ptic. Pri tem naj ji pomaga zavest o tem, kako pomembna je pestrost njene ornitofavne.

Ključne besede: tihožitje ptic, prioritetne vrste, pestrost vrst, populacijsko obrobje

ABSTRACT

The author compares two different views of the birds' world, the qualitative Reiser's view from the beginning of this century and Tucker's quantitative view from the end of the 20th century. Both, however, are burdened with prioritized assessments. The same as Slovenia has surpassed Reiser's view, so it should surpass, in future, Tucker's global view of bird conservation and his utter neglection of marginal populations. Slovenia should be in this respect aided by the cognition about how significant is the diversity of its ornithofauna.

Key words: "still life" of birds, priority species, diversity of species, marginal populations

1. UVODNI POMISLI

Ali bomo slovenski ornitologi zrli v novo tisočletje z daljnogledom optimizma ali daljnogledom pesimizma, je nemara temeljna dilema prihodnjega vrednotenja slovenske ornitofavne. Če primerjamo zgoščene podatke populacijskih nagnjenj minulih dveh desetletij z ohlapnimi podatki minulih dveh stoletij, lahko kljub kratkoročnim katastrofam izluščimo modrost dolgoročne stanovitnosti večine ptičjih populacij. Ta stanovitnost seveda ni merljiva s tisočletji, saj je slovenska ornitologija, če štejemo Freyerjev popis ptic iz leta 1841 za začetek tovrstnega delovanja na tedanjem Kranjskem, stara komaj nekaj več kot sto petdeset let.

Torej bi smeli, napovedujoč prihodnost, govoriti kvečjemu o tretjem stoletju slovenske ornitologije. Ta srednjeevropski tempo je slovenska ornitologija devetdesetih let kronala z objavo dveh temeljnih del s področja favnistike, atlasom gnezdilk (Geister, 1995) in atlasom prezimujočih vrst (Sovinc, 1994).

1. SOME INTRODUCTORY THOUGHTS

The question whether we, the Slovene ornithologists, are going to look into the new millennium through the field glasses of optimism or the field glasses of pessimism, is probably one of the basic dilemmas of the future assessment of Slovene ornithofauna. If we compare the rather condensed data on population trends of the last two decades with the rather loose data of the last two centuries, we may extract, in spite of some short-term disasters, the wisdom of the long-term stability in most bird populations. This stability of course cannot be measured with millennia, for Slovene ornithology is no more than a little over a century and a half old, if Freyer's bird survey from 1841 is taken as the actual beginning of this kind of activity in the former Carniola. In forecasting our future, we may thus speak of the third century of Slovene ornithology at the most. Slovene ornithology of the nineties has crowned this Central European pace with the publishing of two basic works

Naslednji pomislek zadeva vprašljivost zaupanja. Ali le ni preveč tvegano zaupati takšno nalogo, namreč pisanje o tem, kar naj bi se šele zgodilo, nekomu, ki je nostalgično zazrt v preteklost in je pri priči pripravljen spremeniti naslov, ki naj bi se poslej glasil *"Ko so ptice samo še številke"* - ornitologu, ki za duhovno pripravo na to nalogo vzame v roke dve popolnoma različni deli: najnovejšo knjigo ustanove BirdLife International *"Habitats for Birds in Europe"*, na kateri se je tiskarska barva komaj dodobra posušila, in klasično Reiserjevo favnistično delo *"Die Vögel von Marburg an der Drau"*, s katerega je bilo najprej treba obrisati prah?

2. PRIMERJAVA DVEH VREDNOSTNIH SISTEMOV

Obe deli, tako to s konca kot ono z začetka tega stoletja, temeljita na presenetljivem spoznanju, da se ptičja favna, razširjenost in številnost ptic na preučevanem območju, zelo hitro menja. Tuckerjev in Evansov kompendij upošteva podatke dvajsetletnega obdobja (1970-90), Reiserjevo retrospektivo pa zakoličuje njegovo zdomstvo, ko se je po potepanjih po Balkanu in Braziliji po 34 letih vrnil v rodne Pekre pri Mariboru.

Reiser je s svojega gozdnega in vinogradniškega posestva od leta 1880 hodil na izlete v bližnjo in daljno okolico, predvsem na Dravsko polje in Pohorje, kakor je sam zapisal *"mit Flinte und verschiedenen Sammelgeräten"*. Tucker je z dobro načrtovano pisno anketo v začetku devetdesetih let zbral toliko ornitoloških podatkov iz vse Evrope (z izjemo v vojaške spopade zapletenih držav), da sta do danes iz tega gradiva nastali dve zajetni knjigi *(Birds in Europe, Their Conservation Status, 1994,* in *Habitats for Birds in Europe, A Conservation Strategy for the Wider Environment, 1997).*

Pri tem je Reiser v letih po prvi svetovni vojni opazil, da *"so posebno v zadnjem času nekatere, prej ne ravno redke ptičje vrste izostale in da se druge pojavljajo le v majhnih in večjih časovnih intervalih"*, pri čemer omenja repaljščico, kupčarja, rumenega vrtnika, kovačka, vrtno penico, hribskega škrjanca, repnika, rjavoglavega srakoperja, črnoglavega muharja, srednjega detla in malo bobnarico. Tucker je ugotovil, da je bilo v obdobju 1970-90 v Evropi ogroženih 33, ranljivih 83, redkih 19 in v upadanju 39 vrst ptic.

Reiser je opazil, da je upad mnogih vrst ptic očiten in da se je slika pokrajine v mnogočem spremenila. Takole pravi: *"Tam, kjer je bilo svojčas najti jerebice, kito za kito, stojijo danes predmestja. Prej nedotaknjena listnata streha tihih pohorskih gozdov, kaže zdaj, kamorkoli se ozreš, vrzeli in podmladek ni več bukov in kostanjev, marveč smrekov."* Še danes ob koncu stoletja vpliva opustošenje gozda na ptičje vrste, katerih število se zmanjšuje, v višini 20% in pozidava ptičjih prebivališč v višini 10%. Daleč najmočnejši vpliv (več kot 40%) pa ima intenzifikacija kmetijstva.

from the field of faunistics, *i.e.* the atlas of breeding Birds (Geister, 1995) and the atlas of wintering Birds of Slovenia (Sovinc, 1994).

The next scruple concerns the questionableness of trust. Is it indeed not too risky to entrust this task, *i.e.* the writing about something which is still to happen to somebody who is nostalgically reverted to the past and is instantaneously prepared to change the title into *"When birds are merely numbers"* - to entrust it to an ornithologist who in his spiritual preparations for this task takes two utterly different books in his hands: the latest BirdLife International's publication "Habitats for Birds in Europe", in which the printing ink has hardly had time to dry up, and the classic Reiser's faunistic work *"Die Vögel von Marburg an der Drau"*, which had to be dusted first?

2. COMPARISON BETWEEN THE TWO EVALUATION SYSTEMS

Both works, the one from the end of this century as well as the one from its beginning, are based on the surprising cognition that the bird fauna, distribution of birds and number of birds in the studied area, changes very quickly indeed. In Tucker & Evans's compendium the data from two decades (1970-1990) were taken into account, while Reiser's retrospective is marked out by his absence from home, when he returned, after 34 years of roaming around the Balkans and Brazil, to his native Pekre near Maribor.

Reiser took a number short or long trips from his forest and winegrowing estate, particularly to Dravsko polje and the Pohorje mountains - *"mit Flinte und verschiedenen Sammelgeräten"*, as written by himself. Tucker, on the other hand, collected, with a well planned questionnaire at the beginning of the 90's, such a great amount of ornithological data from all over Europe (with the exception of the countries at war) that two thick books have sprung up from this material to date *(Birds in Europe, Their Conservation Status, 1994, and Habitats for Birds in Europe, A Conservation Strategy for the Wider Environment, 1997).*

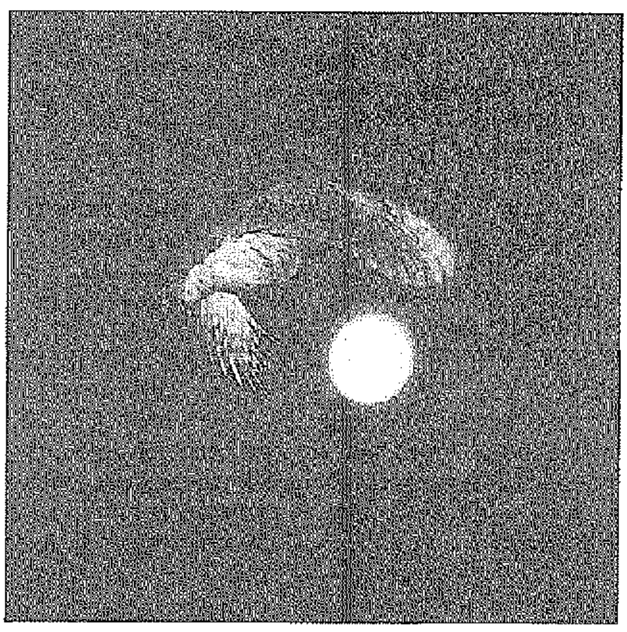
In the period following the first World War, Reiser noted that especially *"in the last few years some bird species, which had previously not been particularly rare, are now absent and that others occur only in shorter and longer intervals"*, namely Whinchat, Northern Wheatear, Icterine Warbler, Willow Warbler, Garden Warbler, Wood Lark, Linnet, Woodchat Shrike, Pied Flycatcher, Middle Spotted Woodpecker and Little Bittern. Tucker, on the other hand, established that in the 1970-1990 period, 33 European bird species were endangered, 83 vulnerable, 19 rare and 39 declining.

Reiser noted that the decrease in a number of bird species was obvious and that the landscape had changed

Omenili smo favnistična opažanja, navedli okoljevarstveno pomembna dejstva, tretja sestavina pronicljive presoje ogroženosti ptičjega sveta pa je vrednostno mnenje. Sloviti ornitolog prve četrtine tega stoletja se takole opredeli do tega, čemur danes pravimo biodiverziteta, po domače pestrost ptičjega sveta: *"Kako ne bi ljubitelj ptic čutil zadovoljstva, če s krmljenjem v hudem letnem času, s širogrudnim puščanjem naravnih gnezditvenih možnosti (votlih dreves, živih mej itd.) in predpisanim odstrelom kragulja in skobca, na mnogih mestih ohranja bogastvo ptičjega sveta."* Biodiverziteto pa si predstavlja za današnje pojmovanje karseda romantično: *"Pod nadstreškom stanovanjske hiše v Zgornjih Pekrah sta dve gnezdi mestne lastovke, na robu strešnega žlebu razpirajo nenasitna žrela štiri komaj speljane kmečke lastovke, zadaj za strešno lego skriva bela pastirica svoje gnezdo, na ovijalki, ki se vzpenja po verandi, je videti gnezdo grilčka, v špranji za desko na sosednji lopi skrbi za svoj zarod drevesni plezavček, v vrtnarsko pristriženo robinijo pred hišo znaša gnezdo sivi muhar in vsenaokrog nas s svojim gromkim petjem razveseljuje črnoglavka".* Reiser je ta popis ornitofavne kmečkega dvorišča imenoval tihožitje. Danes bi dodali, da upravičeno, saj po sodobnih pojmovanjih ptičja skupnost brez plenilcev, vzemimo skobca, ni življenja polnovredna združba.

Tucker seveda govori povsem drug jezik, čeprav se zakonitosti populacijske dinamike medtem pri pticah niso prav nič spremenile. Kot enega vodilnih ornitologov in many different ways. He wrote: *"In places where floks of Grey Partridges could once be found, nothing but suburbs can be seen today. The once untouched foliate roof of the tranquil Pohorje forests now shows, no matter where you look, numerous gaps, and the descendants of plant form are no longer beech and chestnut but spruce."* Today, at the end of this century, the devastation of forests still effects the bird species, the numbers of which are declining, to the amount of 20% and building up of bird habitats to the amount of 10%. By far greatest impact (more than 40%) can be attributed to intensive farming.

So far we have mentioned some faunistic observations and stated some environmentally significant facts. The third component of a clear-sighted judgement concerning the birds' threat status is, however, the evaluation of birds. The renowned above mentioned ornithologist from the first quarter of this century depicted the so-called biodiversity, informally diversity of species, as follows: *"How could a bird lover have not been pleased if by feeding birds in severe winter, by generously leaving untouched the birds' natural breeding possibilities (hollow trees, hedges, etc.) and by obligatory shooting of the Goshawk and Sparrowhawk he preserves, in many places, the richness of the birds' world."* At biodiversity he looks, from today's perception, in a romantic way. *"Under the jutting roof of a residental house at Zgornje Pekre there are two House Martin's nests, on the edge of a gutter a bunch of four just fledged Barn*



Sl. 1: Čuk** (Athene noctua), **globalno ali lokalno ogrožena vrsta? (Foto: I. Geister).
Fig. 1: The Little Owl** (Athene noctua), **globally or locally endangered species? (Photo: I. Geister).

na pragu tretjega tisočletja ga zanima le globalna rešitev naravovarstvenega problema ptic, čeravno se tudi ta doktrina sklicuje na pestrost ptičjih vrst. Pekrsko dvorišče je za Tuckerja domača Anglija, Reiserjev balkanski izziv kontinentalna Evropa in njegova eksotična Brazilija cel svet.

Medtem ko je Reiser pestrost ptičjega sveta na svojem dvorišču še doživljal pristno, četudi je pri tem nemara z nabasano puško oprezal za skobcem, Tucker biodiverziteto doživlja umišljeno, prek statističnih podatkov, četudi pri tem morda gleda na televizijskem zaslonu prizore nemočnih morskih ptic, ki so zabredle v oljni madež nekje daleč proč. Tuckerjeva iznajdba so "prioritetne vrste ptic". V vsakem od izbranih najbolj tipičnih evropskih habitatov je s pomočjo kar se da preproste računske operacije "odkril" vrste ptic, ki jih ogroženost njihovega habitata po statističnih zakonitostih najbolj prizadeva. Merili sta le dve: več kot 75% populacije mora prebivati v matičnem habitatu in vrsta mora v Evropi imeti neurejen naravovarstveni status. Od štirih prednostnih skupin je najpomembnejša prva, imenovana prioritetna skupina A.

3. SLOVENIJA V PRIMEŽU EVROPSKIH VELEMERIL

Slovenija bi glede na svoje zoogeografske zmožnosti lahko bila v tej, v prihodnje tisočletje segajoči obravnavi udeležena z dvema po obsegu omembe vrednima skupinama habitatov: gozdnimi ter kmetijskimi in travnatimi habitati. Od gozdnih habitatov prihajajo v poštev najmanj trije: nižinski gozd zmernega pasu, poplavni gozd in seveda prevladujoči gorski gozd. Od kmetijsko travnatih habitatov je treba omeniti obdelovalne in meliorirane travnate površine, pašnike in sadovnjake. Najbolj prednostne vrste (prioritetna kategorija A) v nižinskem gozdu zmernega pasu so veliki klinkač, kraljevi orel, zelena žolna, hribski škrjanec in pogorelček, v poplavnem gozdu veliki klinkač, medtem ko v gorskem gozdu ni nobene prioritetne vrste najvišje kategorije.

Najbolj prednostne vrste obdelovalnih in izboljšanih travnatih površin so rdečevratna gos, kraljevi orel, kotorna, kosec, velika droplja in vrtni strnad, pašnikov iberski orel in rjavoglavi srakoper, medtem ko v sadovnjakih ni nobene prioritetne vrste najvišje kategorije. Veliki klinkač, kraljevi orel, iberski orel in rdečevratna gos v Sloveniji verjetno niso nikdar živeli, velika droplja je z našega ozemlja izginila sredi dvajsetega stoletja, rjavoglavi srakoper v osemdesetih letih. S preostalimi vrstami pa je takole: kotorna je svojčas, ko je bila še pogosta, živela pretežno na pašnikih in ne na košenih travnikih, hribski škrjanec pri nas ni gozdna ptica, živi pretežno na obdelanih in izboljšanih travnatih površinah, vrtni strnad gnezdi predvsem na opuščenih košeninah in zastalih pašnikih, medtem ko sta zelena žolna in pogorelček pri nas do nedavnega bila najbolj pogosta v sadovnjakih, danes pa sta tako v sadovnjakih kot v

Swallows keep opening their insatiable gullets, behind the ridge purlin a Pied Wagtail has hidden its nest, on a creeper growing along the house veranda a Serin's nest can be seen, in a narrow opening behind a plank on the neighbour's shed a Treecreeper cares for its brood, in a trimmed robinia in front of the house a Spotted Flycatcher is building its nest, and at every step a Blackcap is cheering us up with its attractive rippling melody." Reiser termed this survey of farmyard birds a "still life". Today we could add that he did so absolutely righteously, for according to similar perceptions a bird community without predators, let us say a Sparrowhawk, is not an association fully worthy to live.

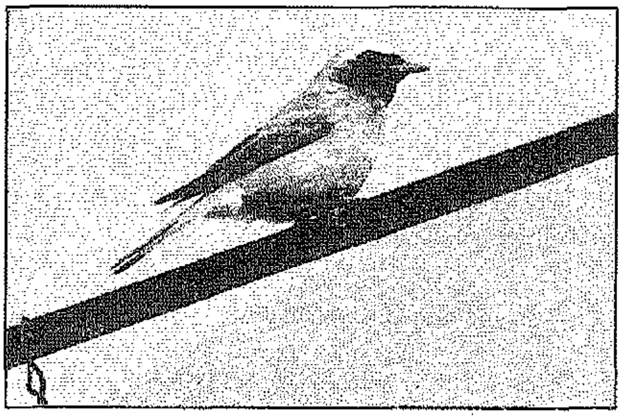
Tucker, of course, speaks an entirely different language, although the rules regarding population dynamics have in the meanwhile not changed at all. As one of the leading ornithologists on the threshold of the third millennium he is interested merely in a global solution of the bird conservationist problem, even though this doctrine, too, refers to diversity of birds. The Pekre courtyard is, to Tucker, his native England, Reiser's Balkan challenge the continental Europe, and Reiser's exotic Brazil the whole world.

While Reiser was experiencing diversity of the birds' world in his courtyard still genuinely, even though he was indeed pursuing a Sparrowhawk with a loaded gun in his hands, Tucker is experiencing it in an imaginary way through statistical data, although he might be watching, on the television set, the scenes of helpless seabirds caught in oil slick far far away. Tucker's invention are "priority bird species". In each of the selected most typical European habitats he "discovered", with the aid of the simplest possible arithmetic operation, those bird species which are according to the statistical principles most affected due to the threat status of their habitat. There are two criteria: more than 75% of the population must live in parental habitat, and the species must have, in Europe, still unsettled conservation status. The most important of the four priority groups is the first one, the so-called Priority group A.

3. SLOVENIA IN THE VICE OF EUROPEAN "SUPREME" CRITERIA

Considering its zoogeographical possibilities, Slovenia could participate in these into the following millennium extended proceedings with two groups of habitats worth mentioning on the account of their extent: forest and agriculture/grassland habitats.

As far as forest habitats are concerned, at least the following three can be taken into consideration: lowland temperate forest, riverine forest and, of course, the prevailing montane forest. Among the agricultural/grassland habitats let us mention arable and improved grassland, pastoral and operennial crops. The major species (priority group A) in lowland temperate forest are the



Sl. 2: Pogorelček** (Phoenicurus phoenicurus)* ***- naravovarstvena vez med začetkom in koncem stoletja; ptica iz Reiserjevega tihožitja in Tuckerjevega seznama prednostnih vrst (Foto: F. Bračko).
Fig. 2: Common Redstart** (Phoenicurus phoenicurus)* ***- a conservation link between the begining and the end of the century; a bird from Reiser's "still life" and Tucker's priority list (Photo: F. Bračko).

nižinskem gozdu redka gnezdilca, ki zlepa ne dosegata predpisanih 75% udeležbe populacije v obravnavanem habitatu. Preostane nam edinole kosec, ptica, ki živi pri nas pretežno na mokrih, vendar košenih travnikih. Eden najbolj razgledanih slovenskih ornitologov, Peter Trontelj, je kosca, to v očeh Evrope najbolj perspektivno ptico, skupaj s sodelavci v Sloveniji preštel že v začetku devetdesetih let (Trontelj, 1995). Skratka v Sloveniji živi po merilih v tretje tisočletje uzrte Evrope ena sama naravovarstvena prioritetna vrsta.

4. NARAVOVARSTVENA ALTERNATIVA POPULACIJSKEGA OBROBJA

Najnovejša evropska naravovarstvena strategija, ki jo poosebija Tuckerjeva statistična ornitologija, hoče prek habitatov varovati predvsem najbolj pogoste vrste izbranega prebivališča.V takšni izbiri vidi najbolj zanesljivo jamstvo za uspešnost naravovarstvene naložbe, kajti tudi varstvo narave je danes žal predvsem posel. Naravovarstvena strategija prihodnosti bo potemtakem investirala v najmočnejši člen ptičje skupnosti, najšibkejšega pa bo pustila na cedilu. Varstvo narave naj bi potemtakem ne bilo več nekakšna naravovarstvena sociala, ki bi ščitila predvsem šibke in nemočne, v krščanskem duhu najbolj potrebne pomoči, in tudi ne nikakršna naravovarstvena demokratična politika, ki bi manjšino varovala pred večino. Obrobne populacije, ki živijo v prebivališčih, ki niso sklenjeno povezan z matičnim habitatom ali prebivajo v atipičnih habitatih, blagodati naravovarstvene strategije v prihodnje ne bodo deležne. Zato pa je temboljnujno izdelati strategijo varovanja obrobnih populacij, to je izoliranih,

Spotted Eagle, Imperial Eagle, Green Woodpecker, Wood Lark and Common Redstart, in riverine forest the Spotted Eagle, while in montane forest there are no priority species of the highest category. The major species in arable and improved grassland are the Red-breasted Goose, Imperial Eagle, Rock Partridge, Corn Crake, Great Bustard and Corn Bunting, in pastoral woodland the Iberian Eagle and Woodchat Shrike, while orchards are not inhabited by any of the priority species of the highest category. It is very possible that the Imperial Eagle, Iberian Eagle and Red-breasted Goose have never lived in Slovenia, that the Great Bustard disappeared from our territory in the mid-twentieth century and Woodchat Shrike in the 80's. The situation as far as the remaining species are concerned is as follows: the Rock Partridge used to live, when still common, mainly in pastures and not in mown meadows, the Wood Lark is in our country not a forest species, for it inhabits mainly arable and improved grassland, the Ortolan Bunting breeds predominantly in abandoned hay meadows and pastures, while the Green Woodpecker and Common Blackstart have been until lately most common in orchards but are today rare breeders in orchards and lowland forests, for they can hardly reach 75% share of the population in the dealt with habitat. There remains only the Corn Crake, the bird which in our country lives in wet although mown meadows. Peter Trontelj, with his associates, one of the most knowledgeable Slovene ornithologists, counted this in the eyes of Europe most perspective bird already in the beginning of the 90's (Trontelj, 1995). In short, Slovenia is according to the criteria of Europe, which seems to be already in the 3rd millennium with its mind, inhabited by a single priority species.

4. CONSERVATIONIST ALTERNATIVE TO POPULATION MARGINS

The latest European conservationist strategy, embodied by Tucker's statistical ornithology, attempts to protect, through habitats, mainly the most common species of the selected habitat.

In such selection they see a firm guarantee for the success of conservationist investment, for nature conservation, too, is today unfortunately mainly business. The conservationist strategy of the future will therefore invest in the strongest segment of the bird community, leaving the weakest one in the lurch. Nature conservation should therefore no longer be a sort of conservationist social institution protecting mainly the weak and the powerless, in Christian sense those most in need of help, the same as it should not be a conservationist democratic policy protecting the minority from the majority. Marginal populations living in habitats which are not closely associated with parent habitat or live in atypical habitats, will in future not be able to share the benefits redkih, občasnih tako pričakovanih kot nepričakovanih gnezdilk, ki bi jih lahko z eno samo sicer konotacijsko obremenjeno, a sicer bistvo problema v popolnosti zaobsegajočo besedo imenovali alternativne gnezdilke. Slovenija kot majhna, a rastlinsko in živalsko pestra dežela bi morala biti zainteresirana za takšno alternativno naravovarstveno strategijo. Čas velikobesednih programov je minil, Slovenija s strategijo lokalnih atlasov poglablja naravovarstveno zanimanje za populacijska obrobja.

Po nauk te zgodbe se za konec vrnimo k Reiserju, ponovno premislimo njegovo prioritetno tihožitje brez skobca in ga primerjajmo s Tuckerjevo prioriteto prevladujoče populacije brez motečega obrobja. Nobeden od teh dveh naravovarstvenih scenarijev za Slovenijo ni sprejemljiv. Prvega, ki prezira naravno ravnovesje, je povozil čas, drugi, ki prezira populacijska obrobja v deželi naravne pestrosti, nima perspektive. Takšnega invalidnega začetka novega tisočletja pticam na ozemlju Slovenije vsekakor ne privoščimo. Nasprotno, kakor smo se dozdaj trudili, da se skobec vrne na domače dvorišče, se bomo tudi v prihodnje, da se obrobnim populacijam prizna pravica do naravovarstvene zaščite.

of conservation strategy. This is why a strategy for the protection of marginal populations should be urgently prepared, namely of isolated, rare, periodical expected as well as unexpected breeders which we could call, with a single connotatively burdened but to the heart of the problem reaching term, alternative breeders. Slovenia as a small but diverse country as far as its plants and animals are concerned, should of course be very interested in such conservationist strategy. The time of haughty programmes has passed and Slovenia is enhancing, with its strategy of local atlases, the conservationist interest in population margins.

For the moral of this story let us, in the end, return to Reiser, once again reflect on his prioritized "still life" void of Sparrowhawk, and compare it with Tucker's priority of predominating population void of disturbing margin. None of these two conservationist scenarios is acceptable by us. The first, which despises natural balance, has been run over by time, while the second, which despises population margins in the country of natural diversity, has no prospect at all. We certainly do not begrudge such decrepit beginning of the new millennium to the birds living in the territory of Slovenia. On the contrary, the same as we have done our best for the Sparrowhawk to return to our courtyards, we shall also do in future, in order that marginal populations are given the right to conservationist protection.

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DISTRIBUTION AND HABITAT OF THE CORN CRAKE *(CREX CREX)* AT THE UPPER SOČA BASIN (JULIAN ALPS, SLOVENIA)

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ABSTRACT

During 1993-1995, 30 singing Corn Crake males were recorded at nine sites in the mountains above the Upper Soča river basin. In most cases their habitats were abandoned alpine meadows and pastures at altitudes ranging from 700 to 1440 m, with an inclination of about 25-30 degrees and predominating southern to southwestern exposure. To prevent the area becoming overgrown by shrubs and woods, late mowing or controlled burning are recommended, while grazing should not be practised.

Key words: Corn Crake, alpine meadows, nature conservation, management, burning

INTRODUCTION

The Corn Crake *(Crex crex)* is one of 24 globally endangered bird species in Europe (Collar *et al.*, 1994). As a grassland bird it is threatened particularly by the destruction of its habitat (extensively farmed meadows) and modernization of grassland farming. Populations breeding in upland meadow are in a somewhat better position, for farming modernization is here practised to a much lesser extent than in the lowlands. In the mountains, the opposite phenomenon, *i. e.* abandonment of meadows is more widespread. These birds are losing their habitat as a result of overgrowth. In many places, however, the succession is due to poorer soil and harsher climate so slow that it does not present a critical threat so far. The Corn Crake's mountain populations may thus play a significant role for the species conservation, even though they are generally much smaller than lowland populations. Of particular interest for conservation is the potential mutual connection between the upland and lowland breeding sites. Questions, such as whether the upland populations are independent reproduction units, whether there exists a regular exchange between lowlands and uplands, whether upland populations can even compensate for the losses in low country, are still more or less unsolved.

The Corn Crake breeding grounds in the southeastern Alps (which also enclose the Upper Soča basin) have been discovered in the 1980's (Geister, 1985; Farronato & Fracasso, 1989; Utmar & Parodi, 1989). A number of calling sites at the Upper Soča basin have been surveyed also within the framework of the Slovene Corn Crake census (Trontelj, 1995). Breeding has been confirmed a number of times by the locals (see also Geister, 1985) and a gamekeeper from Kneža. As a supplement to the census, an additional habitat analysis and a survey of the accompanying bird community were carried out in some areas bearing high Corn Crake densities. The aim of this study was a more detailed characterization of the alpine habitat and thus an assessment of potential key factors for habitat choice in mountainous areas.

METHODS

The surveys were carried out in 1993 and 1994 by the national census survey method (Trontelj, 1995). The data concerning the surroundings of Srpenica and Trnovo ob Soči are from 1995 (T. Trilar, *in litt*). Mountainous areas were visited much more frequently in the mourning hours than in dusk or at night, since the first visits in the mountains had shown a higher calling activity during the day than at night (see also Discussion).

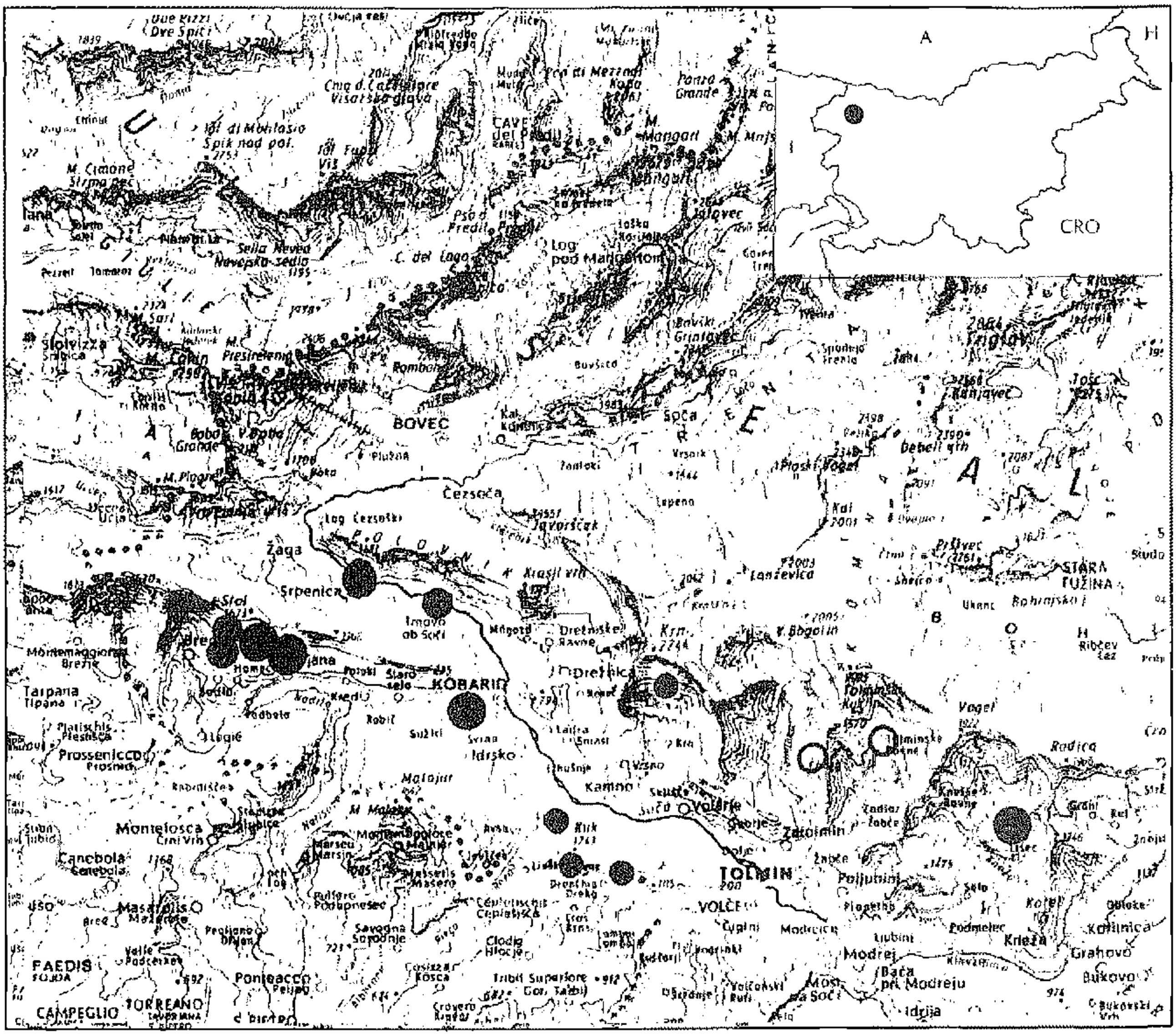

Fig. 1: Distribution of the Corn crake** (Crex crex) **at the upper Soča basin. Dot size app. reflects the number of calling males. Empty circles indicate abandoned sites.
Sl. 1: Razširjenost kosca** (Crex crex) **v zgornjem Posočju. Velikost krogov je prib. sorazmerna številu ugotovljenih koscev. Prazna kroga označujeta opuščeni lokaliteti.

"The Upper Soča basin" is in this paper understood as the range along the Soča river between Most na Soči in the south and Bovec in the north, bordering on the Italian frontier on one side and on Bohinj-Krn high-mountain range on the other. All mountain-dwelling Corn Crakes in Slovenia (with the exception of 2 records from the Snežnik Mountains) were recorded in this area. Habitat measurements were undertaken on June 16th 1994 at Kobariški Stol. Following parameters were measured:

* max. height of vegetation, measured from the ground;

* horizontal vegetation density at the layers from 20, 21-40, 41-60, 61-80 and 81-100 cm, estimated by observing a striped measuring board (divided into 10 cm sections) from a distance of 0.5 m and presented as the percentage of the measuring board covered by vegetation (Flade, 1991);

* relative humidity of soil (very dry/cracked, dry, damp, wet, flooded);

* five to ten characteristic plant species representing each site;

* cover (in percent of the area), type and height of ligneous plants;

* configuration of the ground, agricultural use and state.

Habitat parameters were measured at five calling sites and at four points in its vicinity - angles of a square with the centre in the calling site and with a 50 m long side. The calling sites were selected along the entire altitudinal range.

The density estimates of the accompanying bird species were obtained by transect counts at altitudes with the highest Corn Crake density. Transect routes were positioned at constant altitudes (along the contour line). Transect lengths were 0.9-1.5 km, the belt width was 100 m, and no corrections for detectability differences of bird species were made. For comparison, two transect counts in apparently very similar nearby areas void of Corn Crake were carried out.

Site	Number	Year	Altitude (in m)	Slope (in degrees)	Exposure	Description	area (km²)**
Kobariški Stol	14	1994	815-1280	22-33°	SSW	abandoned meadows/ pastures	2.5
Lisec	4	1994	app. 700	25-30°	S	partially abandoned meadows/pastures	0.5
Kobariško blato	3	1993	240	---	---	lowland meadow corn field	1.0
Srpenica*	3	1995	360	---	---	lowland meadow	0.5
Trnovo ob Soči*	2	1995	320	---	---	lowland meadow	0.5
Livek	1	1994	800	15°	NW	meadow/edge of ski slope	---
Livške Ravne	1	1994	1020	22°	SW	upland meadow, potato, beans	---
Kolovrat	1	1994	1080	27°	SW	densely overgrown meadow/ pasture	---
Krn	1	1993	1440	25°	S	sheep pasture, inactive	---

* T. Trilar, *in litt.*

** the estimate of Corn Crake occupied area, ± 0.5 km^2

Tab. 1: Sites occupied by Corn Crakes at the upper Soča river.
Tab. 1: Prebivališča kosca v zgornjem Posočju.

RESULTS

During the survey (including the year 1995), 30 calling Corn Crake males were recorded at 9 sites at the Upper Soča basin (Tab. 1, Fig. 1). Apart from these sites, other areas with potentially suitable habitat were visited at least once, but no Corn Crakes had been recorded there. These sites were: Zaprikraj, Planina, Drežnica, Drežniške Ravne, Čadrg, Tolminske Ravne, and the transect Ljubinj - Planina Stador.

The areas where singing males were recorded are of two types:

1. lowland areas: flat hay meadows in the valleys at altitudes ranging from 240 to 360 m;
2. upland areas: alpine grasslands on more or less steep slopes over 700 m a.s.l.

In the further analysis, only upland areas are dealt with.

The upland areas were frequented by Corn Crakes at altitudes ranging from 700 to 1440 m. The central half of the records were made in a relatively narrow belt between 820 and 980 m (median = 880 m). A little less than one fourth (23%) of the records were made above 1000 m. The mean inclination of the slopes on which Corn Crakes were registered, was about 25 degrees; in most cases they were exposed towards south to southwest.

The height of vegetation at the calling sites was 83 ± 25 cm, and 59 ± 11 cm in their vicinity. Vegetation density decreased rapidly with its height and was in the layer ranging from 41 to 60 cm only 10% of the density in the lowermost layer (Fig. 2). Hence, the vegetation providing cover was effectively much lower (40 cm high at the most) than the total vegetation height.

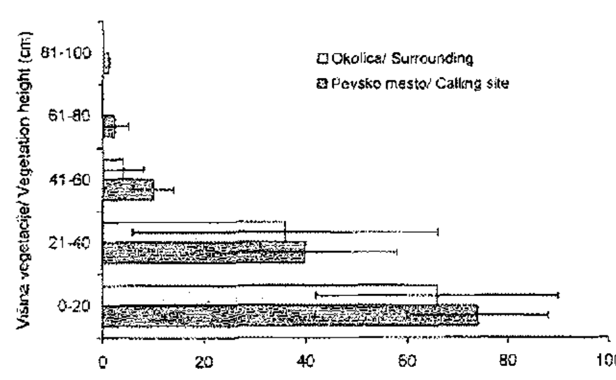

Fig. 2: Vegetation density in 20 cm-layers (mean values and standard errors), estimated from a distance of 0.5 m at the calling site as well as in four points in the surrounding; Kobariški Stol, June 16th, 1994.
Sl. 2: Gostota vegetacije v 20 cm visokih slojih (srednje vrednosti in standardni odkloni) ocenjena na oddaljenosti 0,5 m na mestih, kjer so peli kosci, ter na štirih točkah v bližnji okolici vsakega pevskega mesta; Kobariški Stol, 16.06.1994.

The most numerous and at the same time most characteristic herbs at Corn Crakes' calling sites and in their vicinity were: *Laserpitum siler, L. latifolium, Thalictrum saxatile, Veratrum album, Polygonatum odoratum, Cynanchum vincetoxicum, Arrhenantherum elatius, Aconitum napellus, Digitalis grandiflora* and *Valeriana officinalis.* It was vaguely estimated that the plant species structure did not differ much at the birds' calling sites and their vicinity. In the immediate vicinity of calling sites, ligneous plants were also found. At the highest singing post (1280 m) there was only an isolated 1.5 tall spruce *(Picea abies).* The vicinity of other singing posts was covered by shrubs (up to 20% of the area). Over half of these were dry bushes destroyed by fire in 1992. Predominating among them were *Corylus avellana, Rosa* sp., *Juniperus communis, Rubus* sp., *Sorbus aria* and *Fraxinus ornus.* One calling site was situated a little less than hundred metres from the edge of the surrounding forest. The soil was in all places "damp" and humusrich, but never stony. At some calling sites scattered rocks were present (up to 1 m in diameter). In the vicinity of one calling site there were two heaps of stones (with approx. 2 m in diameter).

At Kobariški Stol and Kolovrat (Tab. 2) the densities of the most numerous accompanying bird species were estimated. The slopes of Krn and Krnčica, two very similar adjacent areas void of Corn Crakes, were surveyed for comparison. From the former two they differed in their use as pastures (although there was no livestock there at the time of research) and partially in vegetation, predominated by grasses over other herbs. There was no evident difference in density and height of the vegetation.

	areas with Corn Crakes		areas without Corn Crakes	
Species	Kolovrat	Kobariški Stol	Krnčica	Krn
Anthus spinoletta	5.6	3.3	6.2	3.8
Anthus trivialis	2.2	10.0	1.5	1.1
Saxicola rubetra	6.7	11.5	3.1	4.2
Lanius collurio	1	3.6	2.3	2.1
Emberiza cia	0.6	3.3	--	0.5
Sylvia atricapilla	0.6	1.7	0.8	1.6
Fringilla coelebs	1	0.8	0.8	0.5
Alectoris graeca	0.6	0.9	--	1.6
Alauda arvensis	--	0.8	1.5	1.1
Acanthis cannabina	--	0.8	0.8	1.1
Oenanthe oenanthe	--	--	2.3	1.6
Coturnix coturnix	--	0.8	--	0.5
Monticola saxatilis	--	2.5	--	--
Turdus torquatus	1	--	--	--
Crex crex	0.6	1.7	--	--

Tab. 2: Densities of some bird species in alpine meadow areas with and without Corn Crakes (in territories/10 ha) estimated by transect counts.
Tab. 2: Gostote nekaterih vrst ptic na travnatih gorskih pobočjih z in brez koscev (v teritorijih/ 10 ha), ocenjene s transektnimi popisi.

DISCUSSION

Geographical and ecological analysis

The alpine grasslands on the mountains above the Upper Soča valley are the only known regular and confirmed Corn Crake's upland breeding sites in Slovenia. Due to the relatively low level of fieldwork input, new discoveries seem quite possible. However, discoveries of concentrations such as at Kobariški Stol seem unlikely, for the geographical and ecological conditions elsewhere in the Slovene Alps are not in favour of this species. The analysis of some geographical factors (Tab. 1) seemingly speaks in favour of a narrow habitat choice determined by an altitude from some 800 to 1000 meters, south to southwestern exposure of the slopes and inclination of about 25 degrees. On the other hand, the altitude coincides with the belt of predominantly abandoned mountain pastures. The exposure of the slopes is dictated by direction of mountain chains. On sunward slopes there predominated haymaking and grazing, while on shady slopes forests were prevalent. As there are almost no other extensive enough upland meadows in the Slovene Alps, it cannot be said for certain that the Corn Crakes selectively choose grassy slopes at certain altitude with certain exposure and inclination. Equally likely seems the presumption that they simply take what is available to them. In that case key factors should be looked for at a microgeographical and physiognomical scale.

Most Corn Crakes (63%) inhabit areas which have not be farmed for a number of decades. Characteristic of these habitats are high herbs which in succession super-

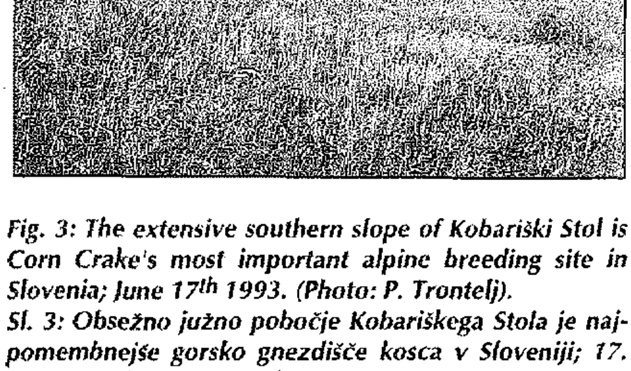

Fig. 3: The extensive southern slope of Kobariški Stol is Corn Crake's most important alpine breeding site in Slovenia; June 17th 1993. (Photo: P. Trontelj).
Sl. 3: Obsežno južno pobočje Kobariškega Stola je najpomembnejše gorsko gnezdišče kosca v Sloveniji; 17. 06.1993. (foto P. Trontelj).

sede grasses. Shrubs and trees in early succession stages are covering up to 20% of the area. Corn Crakes also inhabit farmed meadows and margins of pastures, as long as the vegetation there is high and dense enough. There were no records from pastures in use. Height and density of vegetation are concordant with the findings of other authors on lowland meadows (Schäffer, 1993; Flade, 1991).

The bird communities accompanying Corn Crakes in their upland habitat include grassland and alpine species as well as species favouring shrub and rocky habitats. The community of these birds, e.g. Corn Crake, Rock Partridge, Rock Trush and Whinchat, seems somewhat unusual but may occur throughout the mountains of southeastern Europe. Whinchat is typically accompanying Corn Crake also in its lowland breeding grounds. In the Alps, Whinchats were present at all sites frequented by Corn Crakes; a reciprocal relationship, however, was not noted. No Corn Crakes were noted in areas inhabited by Wheatears, which also holds for smaller patches within the areas.

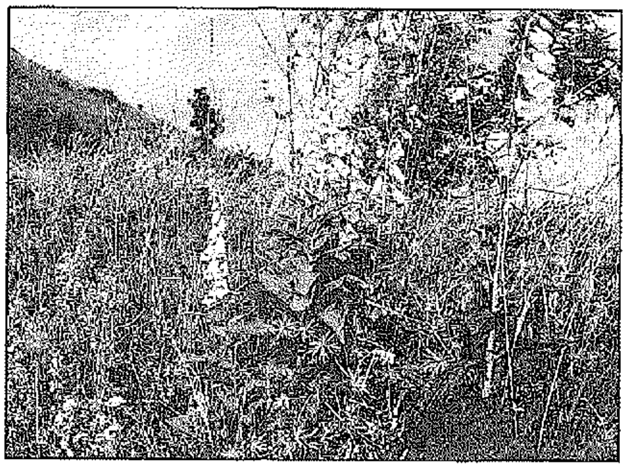

Fig. 4: A close view of the Corn Crake's alpine habitat on Kobariški Stol; June 17th 1993 (Photo: P. Trontelj)
Sl. 4: Pogled od blizu v koščev življenjski prostor na gorskih travnikih Kobariškega Stola; 17.06.1993. (foto P. Trontelj).

Open questions

1. Connection and comparison with breeding sites in NE Italy

The mountain-dwelling Corn Crakes in Slovenia probably belong to a subpopulation of the much larger Italian population inhabiting the Alps and the pre-Alpine country to the west (Farronato, 1994). For an assessment of the key factors for habitat selection, the conditions in Italy should be also compared.

2. Vertical migration

Recent investigations on radio-tagged Corn Crakes in Bulgaria have indicated vertical migration from valleys to higher lying mountain areas (Schäffer, *in litt.*). This shift is due to improved conditions (melting of snow, growth of vegetation) in the uplands in late spring. In the Upper Soča valley calling sites were also found at low altitude flatlands. From the nearest upland habitats they are four kilometers away. The question is, however, what is the role of these habitats early in the season, when the conditions higher on the mountains are still unfavourable. Do they serve as starting points for the birds to inhabit their upland breeding grounds? Parallel monitoring of the Corn Crake's in the valleys and higher up in the mountains could provide some answers to these questions.

3. Circadian calling pattern

During the first visits of Kobariški Stol (*e.g.* on June 17th 1993), Corn Crakes were intensively calling in the afternoon as well as in morning hours. In the evening and night time their activity was considerably reduced. At Mt. Krn, on June 16th and 17th 1993 a solitary Corn Crake was periodically calling through the entire day, and showed no increase in calling activity at night. Such circadian calling pattern deviates from the pattern known from low country: continuous calling at night and only occasional calls at daytime. A possible explanation was presented by Schäffer (1995) who determinated that paired males cease singing at night and begin to call at daytime. As far as the Upper Soča basin is concerned, this would mean that most recorded Corn Crakes were paired males. In view of the relatively high number of breeding records in the mountains, such assumption is not utterly unfounded. An answer could be found by regular monitoring of the circadian calling activity throughout the breeding season.

4. Breeding success

Factors reducing breeding success in the lowlands (early mowing, mechanical mowing, floods) are largely absent in the mountains. Moreover, the climate at the alpine grasslands above the Upper Soča valley is in spite of the high altitude relatively mild. Hence, a high breeding success with two clutches can theoretically be expected. Ideally, a single female could produce more offspring in the mountains than a whole group of females in a lowland meadow with an unfavourable mowing regime. Females breeding in the mountains may thus play in the reproduction of larger population a much greater role than is their actual proportion. A possible approach for elucidating this question would be radio tagging of females (for establishing the number of offspring and clutches) as well as banding of the pulli and netting in lowland breeding sites (to establish their dispersal).

Conservation

Since the Corn Crake is considered a globally threatened species, any newly discovered Corn Crake breeding site automatically raises the question of its conservation and protection. In those alpine breeding sites that support considerable numbers of Corn Crakes (Kobariški Stol, Lisec), it would be sufficient to freeze the state as existing at the moment. In the long run, however, this would be possible only by preserving the ecosystem at its early stage of succession. Potential mechanisms are three: grazing, mowing and burning. Grazing of cattle as well as sheep and goats is unsuitable, for the results of the research have shown that Corn Crakes do not inhabit active pastures. Summer mowing is an ideal way of habitat management but is, as far as steep mountain meadows are concerned, at many places unsuitable. These areas are inaccessible by ordinary agricultural mechanization, while scything in such vast areas cannot be even thought of today. Controlled burning as an alternative method for the maintenance of open habitats has become an important tool in conservation management (Gimingham, 1994; Blab, 1993; Calder *et al.*, 1992; Waldrop *et al.*, 1992). When carried out carefully (at the end of reproduction and vegetation period, in restricted areas, and not every year) it does not seriously affect plant and animal populations in open habitats.

The fire which raged in 1992 on the entire southern slope of Kobariški Stol can serve as a model case. The herb vegetation has been soon (mostly in the following year) completely renewed while shrubs and trees mostly died away. Corn Crakes inhabited this area prior and after the fire. Their abundance prior to it (Geister, 1985) is indeed not known, but in 1994 it nearly reached saturation. The established density (10 calling males/km^2) was among the highest in Slovenia (Trontelj, 1995). The species richness and abundance of other birds additionally speak in favour of a positive ecological effect of the fire.

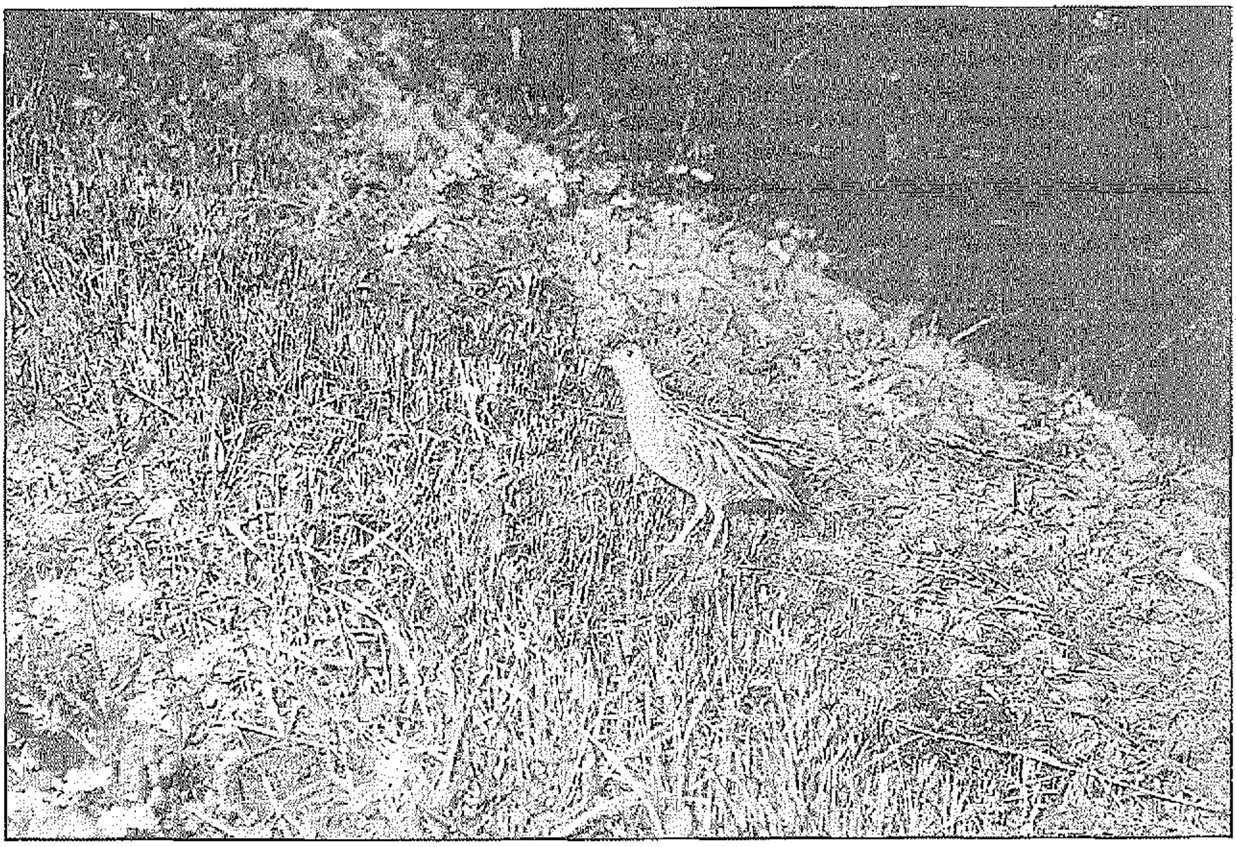

Fig. 5: Corn Crakes only exceptionally leave the cover of dense meadow vegetation. This bird was taken unawares by mowing (Photo: N. Schäffer).
Sl. 5: Kosec le izjemoma zapusti kritje visokega travniškega rastlinja. Ptico na sliki je presenetila košnja (foto N. Schäffer).

The main Corn Crake's upland nest sites lie outside the borders of Triglav National Park and should be therefore given an appropriate conservation status (e.g. nature monument), which will promote the implementation of management schemes and prevent possible negative human impact. The problem of disturbance is particularly pressing on the slope of Kobariški Stol which is accessible to motorized tourists. Cross country racing, hang gliding and paragliding are not compatible with the aims of nature conservation.

ACKNOWLEDGMENT

I thank following persons who helped elucidating the status of the Corn Crake in the Upper Soča river basin: Tomi Trilar contributed the data for the surroundings of Srpenica and Trnovo ob Soči; the Hunting Association of Slovenia, Viko Luskovec and a gamekeeper from Kneža participated with reports within the framework of the national Corn Crake census; Tomaž Jančar kept me informed about the data collected for the Triglav National Park ornithological atlas.

RAZŠIRJENOST IN ŽIVLJENJSKI PROSTOR KOSCA *(Crex crex)* V ZGORNJEM POSOČJU (JULIJSKE ALPE, SLOVENIJA)

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POVZETEK

Kosec je globalno ogrožena vrsta ptice, ki poleg nižinskih travnikov naseljuje tudi travnata pobočja gora v višjih legah. Dejavniki ogrožanja (uničevanje življenjskega prostora in intenzivno kmetijstvo) so v gorskih gnezdiščih neprimerno manj opazni kot v nižinah. Zato je na dlani vprašanje pomena gorskih gnezdišč za ohranitev koščevih populacij v Evropi. Gnezdišča v zgornjem Posočju, obravnavana v tem prispevku, so verjetno del večje populacije s težiščem v zahodno ležečih italijanskih Alpah in predalpah. V letih 1993-95 je bilo v zgornjem Posočju ugotovljenih devet lokalitet s skupaj 30 pojočimi samci. Tri lokalitete ležijo na dnu dolin in so primerljive z drugimi nižinskimi prebivališči. Pri drugih gre za večidel opuščene gorske travnike ali pašnike na nadm. višini med 700 in 1440 m, s srednjim naklonom 25-30 stopinj in prevladujočo južno do jugozahodno izpostavljenostjo. Srednja maksimalna višina vegetacije na mestih oglašanja samcev je bila pribl. 80 cm. Najizrazitejše zelnate rastline so bile: Laserpitium siler, L. latifolium, Thalictrum saxatile, Veratrum album, Polygonatum odoratum, Cynanchum vincetoxicum, Arrhenantherum elatius, Aconitum napellus, Digitalis grandiflora, Valeriana officinalis. *Okolico večine pevskih mest je poraščalo tudi grmovje, ki je zavzemalo do 20% površine. Značilne spremljajoče vrste ptic so bile npr. repaljščica, vriskarica in drevesna cipa, pa tudi kotorna, slegur in skalni strnad. Območja kosca in kupčarja, čeprav na pogled podobna, so se izključevala. Nekatera tačas odprta vprašanja se nanašajo na ključne dejavnike za izbiro habitata v gorah, morebitno vertikalno migracijo med dolinami in gorskimi gnezdišči, vzorec cirkadiane razporeditve petja ter gnezditveni uspeh in obstoj drugega legla. Glavni naravovarstveni problem je zaraščanje opuščenih travniških površin. Kot možni rešitvi se ponujata pozna košnja ter kontrolirano požiganje. Slednje je marsikje že uveljavljeno orodje naravovarstvenega managementa in ima modelno oporo v nedavnem velikem travniškem požaru na Kobariškem Stolu. Pašniška raba je neprimerna, saj kosci pašnikov ne naseljujejo.*

Ključne besede: kosec, gorski travniki, varstvo narave, management, požiganje

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izvirno znanstveno delo UDK 598.331.4(497.5 Srakane Vele)

PTICE OTOKA SRAKANE VELE V CREŠKO-LOŠINJSKEM ARHIPELAGU

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IZVLEČEK

Na kvarnerskem otoku Srakane Vele (Hrvaška) je bilo v letih 1994-96 popisanih 23 gnezdilk, 7 gnezdilk sosednjih otokov in v letih 1974-96 77 selivk. Naravovarstveno je najpomembnejše gnezdenje prilivke Burhinus oedicnemus.

Ključne besede: ptice, gnezdilke, selivke, prilivka, Srakane Vele, Hrvaška

UVOD

Na Cresu, Lošinju in sosednjih otokih so s favnističnimi raziskovanji začeli ob koncu devetnajstega stoletja avstroogrski ornitologi, vendar je nekaj naravoslovnih zapisov še starejših. Hrvaški ornitologi so začeli z bolj ali manj fragmentarnimi raziskovanji po drugi svetovni vojni, a kot je leta 1988 zapisal G. Sušić, *"do danas još ne postoji sustavni pregled faune ptica otoka Cresa i Lošinja"* (Sušić, 1988). Avtorjema pričujočega članka ni znano, da bi bilo po desetih letih kaj drugače, kar še posebno velja za otoka Srakane Vele in Male. V edinem znanem delu s tega območja, ki ima v naslovu navedena otoka Srakane (Igalffy, 1962), ni zanju nobenih konkretnih ornitoloških podatkov. Nekaj kratkih favnističnih zapisov s Srakan Velih je najti le v sodobni slovenski ornitološki literaturi (Ciglič, 1991; Geister, 1996; Štumberger, 1996), kjer je bil objavljen tudi spisek priložnostno na sosednjem otoku Susku opazovanih ptic (Škornik, 1988).

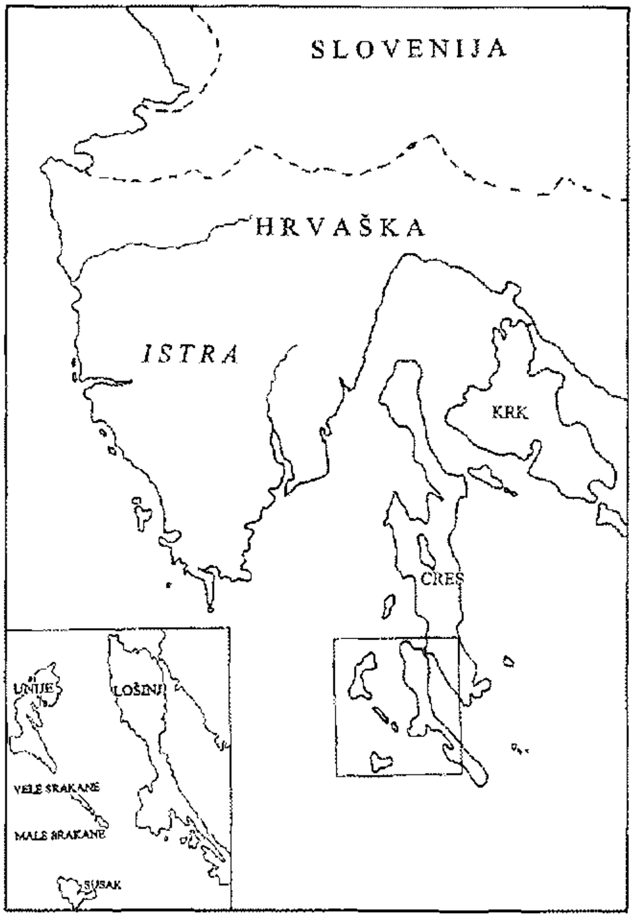
METODA

Na otoku Srakane Vele je ptice popisoval I. Geister v letih 1974 (28.9.-1.10), 1987 (26.4.-1.5.) in 1989 (14.4.-19.4), H. Ciglič pa priložnostno v obdobju od pomladi do jeseni v vseh nadaljnjih letih do leta 1997. Gnezditveno populacijo sva načrtno popisovala v letih 1994 (27.5.-2.6), 1995 (26.5.-3.6.) in 1996 (8.6.-12.6.). Priložnostno sva popisovala tudi na Srakanah Malih, obiskala pa sva tudi Susak in Karbarus.

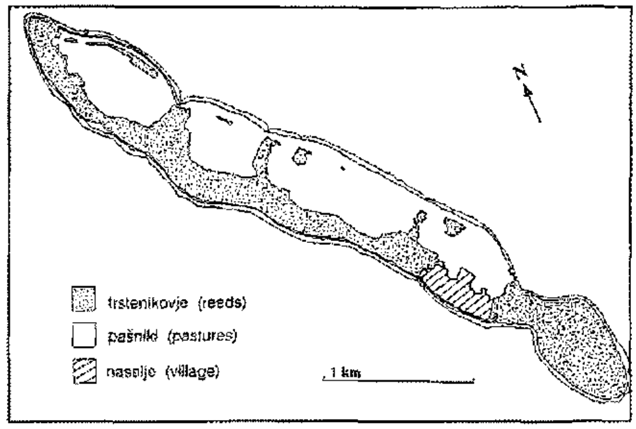
Popis Srakan Velih zajema gnezditveno obdobje ter spomladansko in jesensko pojavljanje ptic na tem otoku.

OPIS OBMOČJA

Otoki Susak, Srakane Vele in Srakane Male (sl. 1) so v geološkem pogledu prav gotovo med najbolj zanimivimi v creško-lošinjskem arhipelagu s starogrškim imenom Apsyrtides. Apneniško živoskalno osnovo prekrivajo - na Srakanah delno, na Susku pa v celoti - več metrov debele plasti puhlice (ilovnato peščene prsti), ki tem otokom daje svojsko rastlinsko odejo in tudi izjemen videz. O nastanku teh peščenih nanosov je več nasprotujočih si razlag: da so a) fluvialnega, b) termalnega, c) vulkanskega oziroma d) eolskega izvora. Mnenja si niso enotna niti o geološki podobnosti peska - medtem ko eni trdijo, da je podoben pesku padskih rek, drugi zatrjujejo, da je podoben pesku dinarskih tokav (Blašković, 1957). Rumenkasto rjava puhlica, ki je po gostoti podobna peščenjaku, na Srakanah Velih pokriva ves zahodni in južni del otoka, ravnico na severnem delu in dva prečna pasova na zgornjem delu otoka. Povsod drugod je opazna živoskalna osnova iz apnenca, vendar erozijski ostanki puhlice, raztreseni med tem skalnatim svetom, pričajo o nekdaj enotni ali vsaj obsežnejši pokritosti otoka z rečnimi naplavinami. Takšno prevladujočo pokritost s puhlico lahko vidimo še danes na Srakanah Malih in Susku.



Sl. 1: Zemljepisni položaj Srakan.
Fig. 1: Geographical position of the Srakane islands.



Sl. 2: Glavni habitatni tipi na otoku.
Fig. 2: The main habitat types on the island.

Srakane Vele so oddaljene kaki dve morski milji od rta Kurila na otoku Lošinju. Od Srakan Malih, ki so od rta oddaljene le nekaj čez miljo, jih loči dobrih sto metrov širok preliv. Otoka sta podolgovate oblike in se raztezata v smeri severozahod - jugovzhod. Srakane Vele merijo približno 1 km^2, Srakane Male kakih 0,7 km^2. Večji otok je dolg 3,3 km in širok največ 500 m, manjši 1,8 km in širok do 600 m. Medtem ko so Srakane Male visoke največ 24 m, pa se Srakane Vele s svojim stožčastim vrhom dvigajo 60 m nad morjem.

Edina obstoječa, italijanska katastrska mapa pozna za Srakane Vele (Canidole Grande) naslednja ledinska imena (zapisana v italijanščini): Sapallaz, Margar, Plotina, Artici, Garbizza, Progon, Basadura in Verh. Zadnje je ime vrha, ki se danes imenuje Varh.

Otok je bil naseljen že v prazgodovini, o čemer pričajo ostanki kamnite utrdbe iz bronaste dobe. Iz rimskih časov se je ohranil nagrobni spomenik. Vidni so tudi še ostanki utrdbe, kamor so se v srednjem veku zatekali prebivalci pred gusarskimi napadi (Fučić, 1991).

Največji gospodarski razcvet je otok doživel v obdobju avstroogrske vladavine. Pa tudi pozneje, vse do druge svetovne vojne, je bil otok žitnica za Lošinj. Obdelane so bile vse površine in tudi vinogradov ni manjkalo. Po drugi svetovni vojni, ko je usahnilo zanimanje za otoške pridelke, je bila otoška moška delovna sila vpoklicana v delovne brigade. Prej kultivirana pokrajina je začela propadati še zlasti po letu 1950, ko so se otočani začeli množično izseljevati v Ameriko. Na otoku je 27 hiš, vendar so danes naseljene z avtohtonim prebivalstvom le še štiri. Pred drugo svetovno vojno je na otoku živelo 148 prebivalcev, danes le še 10.

Podnebje je sredozemsko z vsemi značilnostmi otoške mikroklime. Pri opisu vremenskih razmer si smemo pomagati z opisom razmer, kakršne veljajo na sosednjem Susku: topla in vlažna pomlad, vroče in bolj ali manj suho poletje, deževna in vlažna jesen in blaga zima s pogostimi deževnimi padavinami. Srednja vrednost temperature zraka za januar je 7°C in za julij 24°C; povprečna letna temperatura se giblje okrog 15°C. Povprečno pade spomladi 179, poleti 129, jeseni 319 in pozimi 199 mm dežja (Blašković, 1957).

Posebno izrazito je menjavanje vetrov, ki je enako menjavanju vetrov na odprtem morju. Naj navedeva le dva primera. V tednu od 14. do 19. aprila 1989 se je veter na otoku menjaval takole: 14. šibka tramontana, 15. močna tramontana, 16. pulent, 17. jugo, pulent, oštro, 18. pulent, jugo, 19. jugo. V tednu od 27. maja do 2. junija 1994 pa takole: 27. maestral, tramontana, burja, 28. bonaca, 29. bonaca, 30. bonaca, burin, 31. burja, 1. maestral, 2. bonaca. V hudi burji, kakršna piha pozimi, nosi veter morsko peno prek otoka. Takrat so razmere na otoku podobne razmeram na morskih čereh.

Območje z opazno apnenčasto podlago je poraslo s travami in šaši, z redkimi grmiči brina, mirte in terebinta. Gospodarsko je to območje namenjeno paši drobnice. Območje s puhlico prekriva predvsem trstenika (sl. 2). Gospodarsko je namenjeno obdelovanju. Sadno drevje uspeva na otoku samo na puhlici. V bibavičnem pasu rastejo halofiti in obmorski sitec *(Scirpus maritimus)*. Ostanki prvobitnega gozda so vidni le še na zahodni strani Varha. Le tu namreč uspeva nekaj panjevih črnik. Zaradi paše (živali so tu spuščene) je tu vegetacijsko najbolj zanimiv predel otoka popolnoma degradiran.

Od prosto živečih sesalcev je treba omeniti predvsem od poznih 80ih umetno naseljene kunce *(Oryctolagus cuniculus)*. Zveri na otoku ne živijo.

SPISEK GNEZDILK S KOMENTARJEM

Navadna postovka *(Falco tinnunculus)*

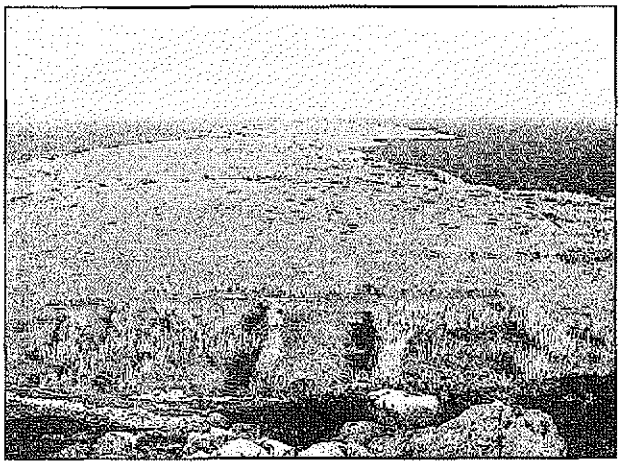
Iz leta v leto gnezdi na Srakanah Velih par navadnih postovk, najverjetneje v kakšnem opuščenem vranjem gnezdu. Največkrat poseda na več metrov visokih živomejnih grmiščih iz terebinta, mirte in trstenike, dodobra prepletenih s smilaksom. 12.6.1996 je navadna postovka zletela iz (vranjega) gnezda na drevesu na Srakanah Malih.

Prilivka *(Burhinus oedicnemus)*

Prilivka je bila prvič opažena leta 1993. Gnezditveno prebivališče naseli konec aprila, zapusti pa ga v septembru, kar je nepričakovano zgodaj. Leta 1994 je bilo gnezdo z 2 jajcema najdeno 28.5.; 2.6. sta ptici še vedno valili. Leta 1995 je bilo gnezdo z 2 jajcema najdeno 27.5. približno 600 m od lanskega. Mladiča sta bila obročkana 21.6. v starosti največ 2 dni (B. Štumberger, ustno). Potemtakem je prilivka začela valiti okrog 25. maja, kar je razmeroma pozno. 31.5. so bile ob gnezdu z dvema različno velikima in različno obarvanima jajcema tri prilivke, tako da je povsem mogoče, da sta jajci pripadali dvema samicama. Tudi na drugem gnezdišču so bili tega dne opazovani trije osebki, vendar gnezdo ni bilo najdeno. Leta 1996 je bilo gnezdo najdeno 9.6., spet oddaljeno približno 600 m od lanskoletnega gnezdišča. Že naslednjega dne se je izvalil prvi mladič, dan pozneje še drugi, kar pomeni, da sta se mladiča izvalila približno 10 dni prej kot prejšnje leto; prilivka je začela valiti sredi maja. Na Srakanah Velih sta v letih 1994-96 gnezdila največ 2 para. 12.6.96 je bil en osebek prvič opažen na Srakanah Malih.

Prilivka gnezdi na Srakanah Velih na prav posebno oblikovanih tleh, prstenih goličavah z nekaj večjimi kamni in zelo revnim rastlinstvom. Takšna erodirana tla so na prevladujoči apnenčasti kamnini pravzaprav zelo redka in so bila v preteklih treh letih uspešno uporabljena za gnezdišče. Na takšnih tleh je najti veliko kunčjih iztrebkov, nekaj kroglic vedno tudi v prilivkinem gnezdu.

Po končanem gnezdenju se otoške prilivke zberejo v jato. Tako je bilo avgusta leta 1995 opazovanih največ 8 (9.8.) in leta 1996 največ 10 (17.8.) prilivk. Glede na to, da je leta 1996 zanesljivo gnezdil en sam par, je jasno, da se na Srakanah Velih zbirajo tudi prilivke s sosednjih otokov. Zapoznela selivka je bila opazovana še 1.11.1994.



Sl. 3: Pogled na Srakane Vele z otoškega Varha, maj 1995 (Foto I. Geister).
Fig. 3: View of Srakane Vele from Varh, the island's highest point, May 1995 (Photo I. Geister).

Rumenonogi galeb *(Larus cachinnans)*

Rumenonogi galebi so začeli gnezditi na Srakanah Velih proti koncu osemdesetih let (prvi par je bil opazovan leta 1987). V letu 1994 je naselbina štela okrog 30 parov. Gnezdijo na vzhodnem travnatem pobočju 50 do 100 metrov od bibavičnega pasu v zavetju terebintovih, brinovih in mirtinih grmičev. Konec maja je bila v letih 1994-96 večina mladičev stara že teden ali dva. Rumenonogi galebi gnezdijo tudi na Srakanah Malih pa tudi na otočku Karbarus severno od rta Kurila. Kolonijski galebi s Srakan se prehranjujejo predvsem na Lošinju, najverjetneje na tamkajšnjih smetiščih.

Skalni golob *(Columba livia)*

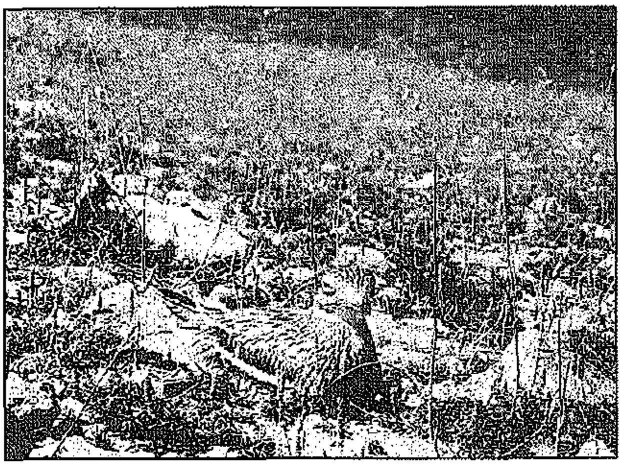
Dne 31.5.94 je bilo v grižah bibavičnega pasu pod Varhom odkrito gnezdišče skalnega goloba: iz zijavke, ki se je odpirala v brezno, sta zletela dva goloba. Par teh ptic je bil leto dni pozneje (11.6.96) opazovan v bližnjem vinogradu med krmljenjem. Dve leti prej (24.4.93) je bila opazovana jata 5 osebkov, najverjetneje otoška družina.

Turška grlica *(Streptopelia decaocto)*

Na severozahodnem obrobju vasi se zadržuje par turških grlic. Prvič sta bili opaženi leta 1994 (maj, junij).

Divja grlica *(Streptopelia turtur)*

Presenetljivo se v neposredni bližini turških grlic zadržuje tudi par divjih grlic. Sicer pa je bila divja grlica prvič opazovana že 27.4.87, vendar je bila takrat lahko le na preletu.



Sl. 4: ***Valeča prilivka*** *(Burhinus oedicnemus),* ***Srakane Vele, konec maja 1994.***
Fig. 4: Breeding Stone Curlew *Burhinus oedicnemus,* ***Srakane Vele, end of May 1994.***

Čuk ***(Athene noctua)***

Gnezdilec od leta 1989 do 1994, zadnji dve leti en sam osebek. Zadržuje se okrog cerkve, gnezdil pa je najverjetneje na podstrešju opuščene šole.

Čebelar ***(Merops apiaster)***

Čebelarji gnezdijo na Srakanah Velih od leta 1991 (Ciglič, 1991), na sosednjem Susku vsaj od leta 1987 (Škornik, 1988). Iz prezimovališč se vrnejo prve dni maja, otok pa zapustijo v prvi polovici avgusta. Gnezdilce z obeh srakanskih otokov (Velih in Malih) moramo obravnavati kot enotno populacijo, kar se jasno kaže v preletavanju ptic v jati, ki združuje prebivalce obeh otokov. Čebelarji se ne družijo le v pognezditvenem obdobju, temveč tudi med gnezdenjem, posebno v obdobju, ko eden od gnezdečih partnerjev vali.

Čebelarji gnezdijo v peščeno-ilovnatih stenah, ki so lahko naravnega ali antropogenega nastanka. Naravnega nastanka so erodirane stene na robu bibavičnega pasu, stene ob kulturnih terasah pa so delo človeških rok. Potem so tu še v puhlico vrezani prehodi, ki pa jih je na Srakanah Velih zelo malo, pa tudi na Srakanah Malih jih je veliko manj kot na Susku. Na Srakanah Velih je večina gnezdilnih rovov v obmorskih stenah, medtem ko jih je na Srakanah Malih več v stenah med terasastimi polji. Velikost in višina stene nista pomembni, pomembnejša sta odprt prostor pred steno in pristajalna steblika nad njo, največkrat je to steblika trstenike *(Arundo)*. Tako najdemo v nekaj pednjev visokih stenah gnezdilne rove tudi čisto pri tleh.

Nebesna stran pri izbiri gnezdilne stene ne igra nobene vloge. Na srakanskih otokih čebelarji gnezdijo posamično ali v majhnih skupinah (2-3 pari). Gnezdilni rov izkopljejo vsako leto na novo, valijo pa v juniju.

Žal na Srakanah Velih gnezdi iz leta v leto manj čebelarjev: leta 1994 je gnezdilo pet (5) parov, leta 1995 dva (2) para, leta 1996 in 1997 pa ni bil najden noben nov gnezdilni rov. Na upadanje gnezditvenega uspeha kaže tudi število pognezditvene jate: v začetku avgusta leta 1994 je jata štela 18, leta 1995 35 in 1996 le 9 osebkov. Jata združuje čebelarje z obeh otokov. Leta 1995 se je iz tropov vrnilo najmanj 12 osebkov, kar pomeni, da je iz največ 6 gnezd poletelo najmanj 23 mladičev ali malo manj kot 4 mladiči na gnezdo.

Srakanski čebelarji se prehranjujejo predvsem z modrimi lesnimi čebelami *(Xilocopa violeces)*, kar zagotovo velja za valeče ptice, saj so bili pred gnezdilnim rovom najdeni izključno hitinski ostanki te žuželke. Njihova gnezditvena uspešnost je potemtakem morda odvisna predvsem od te žuželke.

Poljski škrjanec ***(Alauda arvensis)***

En sam par poljskega škrjanca gnezdi na otoškem hrbtu za vasjo z ledinskim imenom Mergar.

Kmečka lastovka ***(Hirundo rustica)***

V naselju Srakane Vele gnezdi najmanj 30 parov kmečkih lastovk.

Rjava cipa ***(Anthus campestris)***

Ena najbolj stanovitnih gnezdilk na otoku je rjava cipa. Vseh 6 parov gnezdi vsako leto (1994-96) na istem mestu. 3.6.95 je bilo v gnezdu, najdenem v zavetju solinke *(Salsola sp.)* v bibavičnem pasu, 5 jajc. Vsa gnezditvena območja (teritoriji) so na vzhodni strani otoka, na kamnitem obrežju, poraslem s halofiti.

Bela pastirica ***(Motacilla alba)***

V vasi gnezdi en par belih pastiric.

Rumena pastirica ***(Motacilla flava)***

V rahlo depresivnem predelu z ledinskim imenom Plotina iz vasi proti Varhu prebiva par rumenih pastiric. (Več o rumeni pastirici glej v poglavju o selivkah.).

Repaljščica ***(Saxicola rubetra)***

Na otoku gnezdi en sam par repaljščic, in sicer na obrobju predela, imenovanega Basadura. Gnezditveno območje je bilo zasedeno vsa tri leta (1994-96), samec pa je pel že tudi 26.4.1987.

Kos *(Turdus merula)*

Nekaj parov gnezdi predvsem na južnem, poljedelsko opuščenem in z živomejnim grmovjem močno zaraščenem predelu otoka, imenovanem Sapallaz.

Svilnica *(Cettia cetti)*

Septembra 1974 svilnica ni bila ugotovljena, prav tako ne aprila 1987. Aprila 1989 pa je že prepevalo več parov. Škornik (1988) jo je na Susku popisal spomladi 1988. Leta 1994 so gnezdili 3 pari, vsi na južnem s trsteniko poraslem kultiviranem predelu otoka.

Bledi vrtnik *(Hippolais pallida)*

Leta 1994 sta na južnem delu otoka gnezdila dva bleda vrtnika, kot lahko sklepamo po petju dveh območnih samcev. V obeh območjih je nekaj oljčnih dreves, in po tem se njuno prebivališče nekoliko razlikuje od prevladujočega biotopa na otoku.

Kratkoperuti vrtnik *(Hippolais polyglotta)*

Leta 1994 so na otoku prepevali trije območni samci kratkoperutega vrtnika; eden na skrajnem južnem koncu, drugi na SZ obrobju vasi in tretji na vzhodnem znožju Varha. Naseljuje s trsteniko preraslo grmovje.

Taščična penica *(Sylvia cantillans)*

Pojoče samce taščične penice je bilo najti le ob znožju Varha, kjer naseljujejo mirtine in terebintove grmiče na pustem kamnitem svetu.

Žametna penica *(Sylvia melanocephala)*

Nasprotno pa je največ pojočih samcev žametne penice najti na južnem koncu otoka (Sapallaz), kjer prevladujoče robidovje ustvarja sekundarno divjino. Samo na tem predelu je bilo leta 1994 ugotovljenih 8 pojočih samcev.

Črnoglavka *(Sylvia atricapilla)*

Črnoglavka je bila kot gnezdilka odkrita šele leta 1995. Samec je prepeval v gosto zaraščenem trsteničevju na južnem obrobju vasi. Opazovana pa je bila tudi samica.

Siva vrana *(Corvus corone cornix)*

Na večer 2.6.1995 je bila opazovana jata 16 sivih vran, zato predvidevava, da je tačas gnezdilo 8 parov. Siva vrana gnezdi na srakanskih otokih na grmovju ali sicer redkem drevju. Svojevrstna umetnina so gnezda na trstenikah, prepletenih s smilaksom. Konec aprila 1995 so bila v gnezdih najdena jajca (v enem eno, v drugem pet), konec maja (1982) pa mladiči (vendar nikdar več kot dva!).

Temu se je čudil že Iggalfy (1962), ki je v gnezdih sivih vran na Susku našel samo po tri mladiče. Vsekakor najbolj zanimivo srakansko vranje gnezdo je tisto na brinovem grmiču sredi kolonije rumenonogih galebov. Očitno gre za sožitje, temelječe na medsebojnem obveščanju o potencialnih plenilcih, saj ni bilo nikdar zaznati niti najmanjše medsebojne napadalnosti.

Kljub škodi, ki jo vrane povzročajo na poljščinah (recimo na bobu), jih domačini pretirano ne preganjajo. Tako na primer ravno omenjeno vsem znano gnezdo ni bilo nikdar uničeno.

Domači vrabec *(Passer domesticus)*

Težko je reči, koliko parov domačih vrabcev gnezdi v vasi. Vsi gnezdeči osebki zagotovo pripadajo nominantni podvrsti.

GNEZDILKE SOSEDNJIH OTOKOV

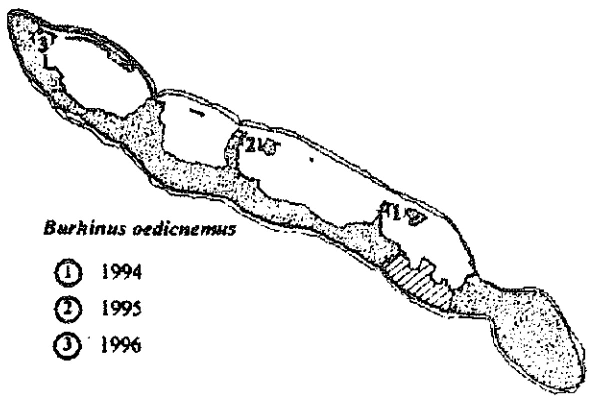
Posebno obravnavo si zaslužijo vrste, ki v obdobju popisa gnezdilk (1994-96) na Srakanah Velih niso gnezdile, pač pa so se v območju otoka v obdobju gnezdenja tako prej kot med popisom pojavljale.

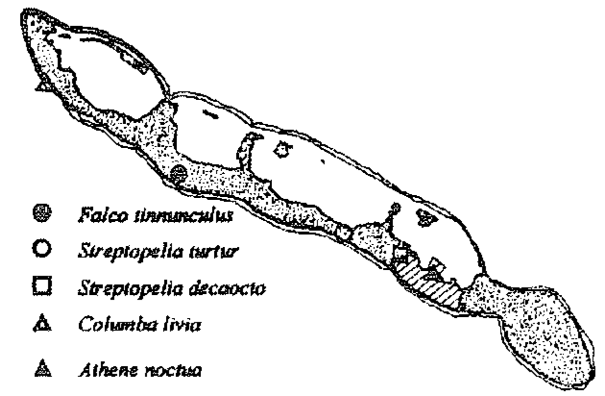
Vranjek *(Phalacrocorax aristotelis)*

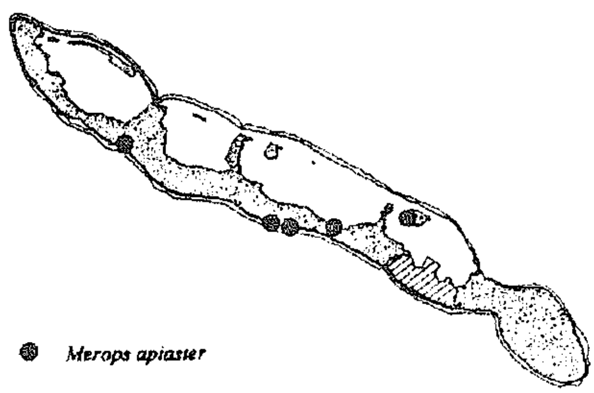
Gnezdo ni bilo najdeno; na Srakanah Velih tudi ni kakšnih visokih pečin, pač pa je v bibavičnem pasu v apnenčasto obrežje vrezanih nešteto žlebov, morda primernih za gnezdenje. Višje pečevje je najti ponekod na Srakanah Malih in na Susku. 31.5.94 sta bili na Šilu, svetilniških čereh v bližini južnega rta Malih Srakan, opazovani dve družini z mladiči (2 + 3, 3 + 1). Vranjeki začnejo gnezditi že v marcu, iz tega obdobja pa opazovanj tako rekoč ni. V drugi polovici maja in prvi polovici junija se družine s speljanimi mladiči (samostojnost dosežejo po 11 tednih) zbirajo v veliko skupno jato. 2.6.94 je takšna jata na vzhodnem obrežju Srakan Velih štela 36, 10.6.96 pa 68 osebkov. Povečanja ne gre pripisati večjemu gnezditvenemu uspehu, prej naraščanju skupne jate. Poleti je namreč v jati od 80 do 100 ptic.

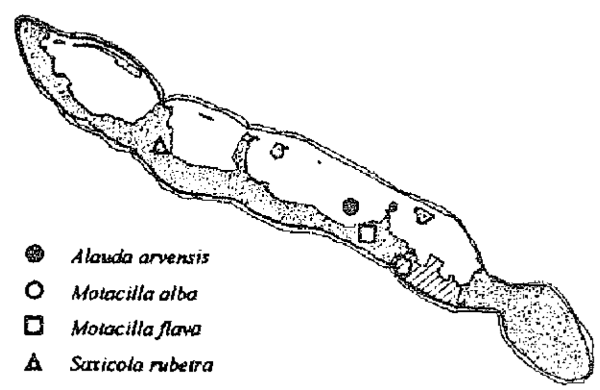
Beloglavi jastreb *(Gyps fulvus)*

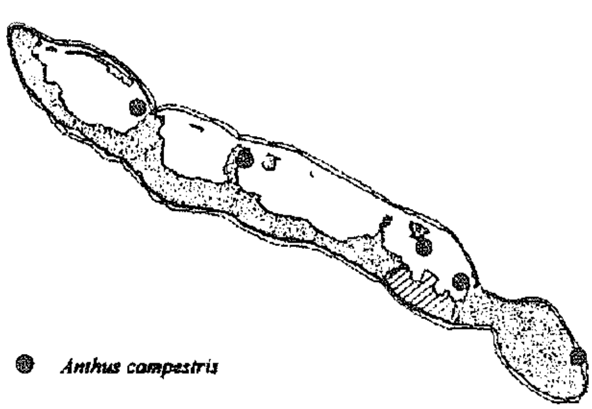
Beloglavi jastreb je bil nad Srakanami opažen le dvakrat: 2.5.92 in 16.8.96. Kot je splošno znano, gnezdi na Cresu.

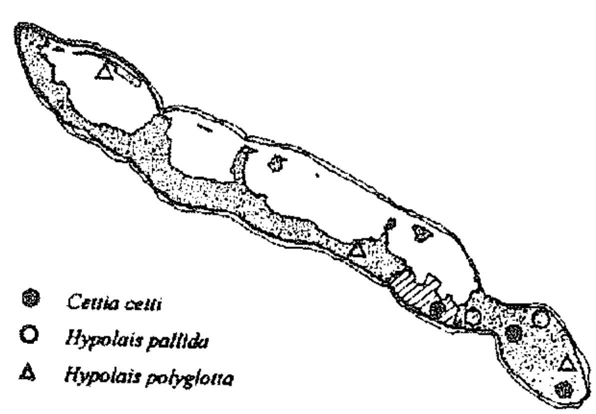

Burhinus oedicnemus
1 1994
2 1995
3 1996

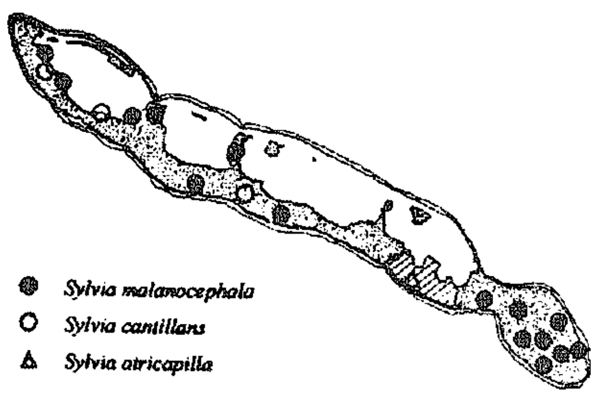

Falco tinnunculus
Streptopelia turtur
Streptopelia decaocto
Columba livia
Athene noctua

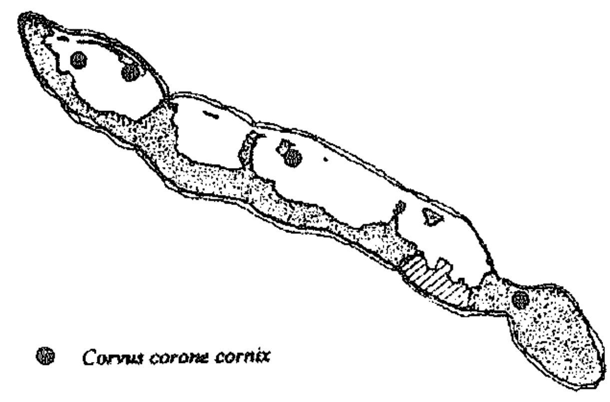

Merops apiaster


Alauda arvensis
Motacilla alba
Motacilla flava
Saxicola rubetra

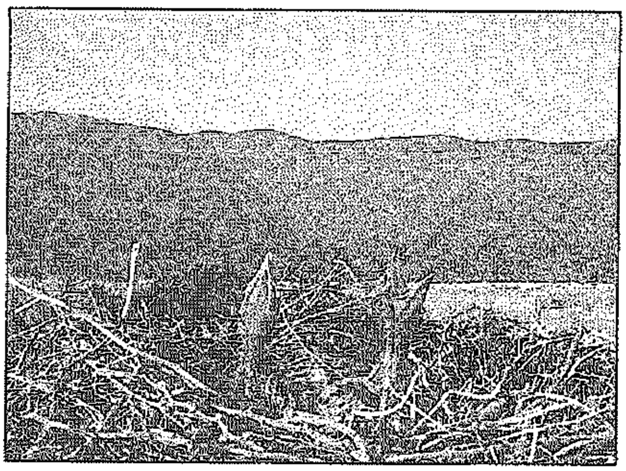

Anthus campestris


Cettia cetti
Hypolais pallida
Hypolais polyglotta

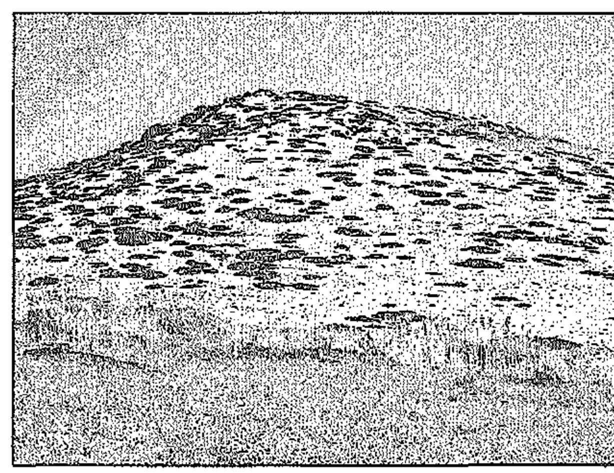




Sl. 5: Gnezditvena razširjenost ptic na Srakanah Velih leta 1994.
Fig. 5: Breeding distribution of birds on the island of Srakane Vele in 1994.



Sl. 6: "Letoviško" gnezdo sive vrane (Corvus cornix) v bližini gnezditvene naselbine rumenonogih galebov, Srakane Vele, maj 1995 (Foto: I. Geister).
Fig. 6: "Vacation" nest of the Hooded Crow (Corvus cornix) in the immediate vicinity of the Yellow-legged Gull's breeding colony, Srakane Vele, May 1995 (Photo: I. Geister).



Sl. 7: Vpliv paše na vegetacijo je opazen povsod po otoku, še najbolj na Varhu, kjer so ovce spuščene. Za vsakdanjo molžo je primernejša "rotacijska" paša (Foto: I. Geister).
Fig. 7: Grazing impact on the island's vegetation is clearly seen on the entire island, particularly around Varh, where the sheep have been let loose. The so-called "rotational" grazing seems much more convenient for the daily milking (Photo: I. Geister).

Navadna čigra *(Sterna hirundo)*

Čeprav par navadnih čiger vse leto poseda na privezu in po pomolu, je malo verjetno, da ta ptica gnezdi na Srakanah Velih. Nekaj bornih prodišč, raztegnjenih vzdolž jugovzhodnega obrežja, najbrž ne zadošča. Leta 1987 sta bili na Karbarusu, peščenem otočku pred lošinjskim obrežjem, najdeni dve gnezdi. Sicer pa na Srakanah tudi družine s speljanimi mladiči ni bilo nikdar opaziti.

Črni hudournik *(Apus apus)*

Osebki te vrste se spreletavajo tudi nad Srakanami.

Sivi hudournik *(Apus pallidus)*

Vrsta na Srakanah Velih zanesljivo ne gnezdi, pač pa gnezdi v pečinah na jugozahodnem obrežju otoka Susak. Naselbino teh ptic sva odkrila 27.5.1995, ko sva s čolnom obkrožila otok. Igalffy (1962) pravi, da črni hudourniki *(Apus apus)* (imenuje jih *Micropus apus)* gnezdijo v nizkih stenah južnega obrežja Suska. Na črno-beli fotografiji sta prikazana dva podora skalnatega obrežja, podobna podoru, kjer sva opazovala gnezdeče sive hudournike *(Apus pallidus)*. V zagrebški zbirki mehov ni primerkov s

Suska, pač pa je bil 30.5.1980 v Čunskem na Lošinju ustreljen sivi hudournik (Sušić *et al.*, 1988). Čunski je od gnezdišča oddaljen le nekaj kilometrov. Iztok Škornik pa je v družbi s še tremi ornitologi od 30.4 do 2.5.1988 opazoval na Susku "množično spreletavanje" sivih hudournikov. Iz literature sta nama znani na Hrvaškem le dve gnezditveni naselbini sivih hudournikov: na Dugem otoku (Rucner, 1968) in Kamenjaku v Istri (Šere, 1977).

Kratkoprsti škrjanec *(Calandrella brachydactyla)*

Območno spreletavanje kratkoprstega škrjanca je bilo zabeleženo v dneh od 26.4 do 1.5.1987. Kasneje vrsta ni bila več popisana, tako da jo lahko štejemo kvečjemu med občasne gnezdilke, kar pa se povsem ujema z njenim spreminjajočim se naseljevanjem, povezanim z začetnim stadijem vegetacijskega nasledstva. Sicer pa so v zagrebški zbirki iz gnezditvenega obdobja mehovi iz bližnjega Osorja in nekoliko bolj oddaljenega Beleja na Cresu (Sušić *et al.*, 1988).

Sredozemski kupčar *(Oenanthe hispanica)*

Proti pričakovanju gnezditev sredozemskega kupčarja na otoku do sedaj ni bila ugotovljena. Znana sta le dva podatka: 28.9.1974 je bil opazovan med navadnimi kupčarji na preletu, 29.5.1994 pa se je zadrževal v Basaduri nesparjen samec. V obeh primerih je bil opazovan kupčar v svetli, kontrastno črno-beli različici.

SEZNAM OPAZOVANIH SELIVK

V tabeli 1 navajava podatke o pticah, selivkah, opaženih na otoku.

vrsta	datumi opazovanj
polarni slapnik *(Gavia arctica)*	20.3.95 (7), 24.3.96 (1),31.3.97 (7), 2.4.97 (5)
čopasti ponirek *(Podiceps cristatus)*	24.3.96 (1)
črnogrli ponirek *(Podiceps nigricollis)*	24.5.93 (1), 2.4.97 (6)
črnokljuni viharnik *(Puffinus puffinus)*	13.7.95 (3), 14.7.95 (5), 17.8.97 (2)
veliki kormoran *(Phalacrocorax carbo)*	28.9.74 (1), 29.9.96 (3 prvoletni)
siva čaplja *(Ardea cinerea)*	4.5.96 (1), 29.9.96 (1), 15.8.97 (1)
rjava čaplja *(Ardea purpurea)*	5.5.95 (1)
mala bela čaplja *(Egretta garzetta)*	17.4.89 (1) 3.5.91 (1), 27.5.95 (1), 10.8.95 (1)
kvakač *(Nycticorax nycticorax)*	31.5.94, 4.5.96 (12, v letu)
žvižgavka *(Anas penelope)*	4.5.96 (1)
sivka *(Aythya ferina)*	24.3.96 (1)
srednji žagar *(Mergus serrator)*	24.3.96 (6), 2.4.97 (3)
kačar *(Circaetus gallicus)*	3.11.94 (2)
skobec *(Accipiter nisus)*	27.9.96 (1)
kragulj *(Accipiter gentilis)*	28.9.74 (1), 30.9.74 (1)
navadna kanja *(Buteo buteo)*	21.4.91 (1), 26.9.96 (1)
rjavi lunj *(Circus aeruginosus)*	28.9.96 (prvoletni)
pepelasti lunj *(Circus cyaneus)*	30.3.97 (samica), 2.4.97 (samica),28.4. do 3.5.97 (par)
rdečenoga postovka *(Falco vespertinus)*	30.5.87 (samec in samica)
prepelica *(Coturnix coturnix)*	26.9.96 (2)
žerjav *(Grus grus)*	10.3.96 (6, v letu)
školjkarica *(Haematopus ostralegus)*	28.4.94, 1.5.94 (2), 20.3.95 (1), 24.8.96 (2)
polojnik *(Himantopus himantopus)*	15.5.97 (4)
mali deževnik *(Charadrius dubius)*	4.5.96 (2)
črna prosenka *(Pluvialis squatarola)*	28.9.96 (2 v zim.perju), 2.4.97 (1 v zim. perju)
priba *(Vanellus vanellus)*	27.9.96 (13)
togotnik *(Philomachus pugnax)*	20.3.95 (3)
mali škurh *(Numenius phaeopus)*	redno pojavljanje (16 datumov v obdobju 1989-97)
rdečenogi martinec *(Tringa totanus)*	od 11. do 18.8.96 (več osebkov)
črni martinec *(Tringa erythropus)*	27.4.87 (1)
mali martinec *(Actitis hypoleucos)*	redno pojavljanje
čoketa *(Gallinago media)*	29.4.87 (1)
kozica *(Gallinago gallinago)*	17.8.95 (2)
sivi galeb *(Larus canus)*	18.4.89 (najden kadaver)
golob duplar *(Columba oenas)*	18.4.89 (11)
kukavica *(Cuculus canorus)*	18.8.95 (1), 21.8.95 (1), 2.5.97 (1)

vrsta	datumi opazovanj
podhujka *(Caprimulgus europaeus)*	datum izgubljen
planinski hudournik *(Apus melba)*	16.8.95 (najden kadaver), 18.8.95 (1 v jati *A. apus)*
smrdokavra *(Upupa epops)*	redno pojavljanje
čopasti škrjanec *(Galerida cristata)*	29.9.74 (3), 30.3.74 (2)
kmečka lastovka *(Hirundo rustica)*	28.9.74. (200), 29.9.74 (5), 20.3.95 (1), 26.9.96 (15)
mestna lastovka *(Delichon urbica)*	28.4.87 (2)
bela pastirica *(Motacilla alba)*	28.9.74 (21), 26.9.96 (min.15), 26.4. do 3.5.97 (ok. 20)
siva pastirica *(Motacilla cinerea)*	2.5.94 (velike jate),26.4. do 3.5.97
rumena pastirica *(Motacilla flava)*	30.9.74 (1 ujeta), 28.9.74 (16), 21.4. do 5.5.92 (v jatah, tudi podvrsta *M.f.feldegg)*, 26.9.96 (80), 29.9.96 (20)
stržek *(Troglodytes troglodytes)*	28.9.74 (1 ujet, 2 opazovana), 29.9.74 (1),
siva pevka *(Prunella modularis)*	3.5.95 (1)
taščica *(Erithacus rubecula)*	29.9.74 (1 ujeta), več osebkov zunaj gn. obdobja
pogorelček *(Phoenicurus phoenicurus)*	30.10.74 (1), 1.5.87 (1), 21.4. do 5.5.91 (v jatah), 5.5.95 (1), 29.4.97 (1), 2.5.97 (4)
šmarnica *(Phoenicurus ochruros)*	5.5.95 (1), 27.9.96 (1), 26.4. do 3.5.97 (nekaj osebkov)
repaljščica *(Saxicola rubetra)*	redno pojavljanje
prosnik *(Saxicola torquata)*	3.5.92 (1), 26.3.93 (1), 4.5.94 (1), 20.3.95 (1), 5.5.95 (1), 26.4. do 3.5.97 (več osebkov)
kupčar *(Oenanthe oenanthe)*	redno pojavljanje
slegur *(Monticola saxatilis)*	28.9.74 (2)
puščavec *(Monticola solitarius)*	1.11.94 (1), 29.9.96 (2 samca)
cikovt *(Turdus philomelos)*	27.3.93 (3)
brškinka *(Cisticola juncidis)*	27.9.96 (1)
vrtna penica *(Sylvia borin)*	28.9.74 (1 ujeta), 29.9.74 (1), 30.9.74 (1)
siva penica *(Sylvia communis)*	1.5.87 (1 ujeta)
grmovščica *(Phylloscopus sibilatrix)*	18.4.96 (2), 2.5.97 (1)
kovaček *(Phylloscopus trochilus)*	27.4.87 (1 ujet), 26.4. do 3.5.97 (večje število)
vrbja listnica *(Phylloscopus collybita)*	29.9.96 (5)
rumenoglavi kraljiček *(Regulus regulus)*	26.3.93 (1 ujet z roko)
črnoglavi muhar *(Ficedula hypoleuca)*	redno na preletu
belovrati muhar *(Ficedula albicollis)*	28.9.96 (min.6)
sivi muhar *(Muscicapa striata)*	4.5.96 (1), 16.8.96 (1), 29.9.96 (1), 26.4.-3.5.97 (večje št. osebkov)
rjavi srakoper *(Lanius collurio)*	29.9.96 (6), 1.5.97 (1)
rjavoglavi srakoper *(Lanius senator)*	2.5.97 (1)
škorec *(Sturnus vulgaris)*	4.10.74 (4), 26.3.93 (cca 50), 4.5.96 (40), 29.9.96 (15)
rožasti škorec *(Sturnus roseus)*	30.5.95 (2)
kobilar *(Oriolus oriolus)*	29.4.87 (1), 29.5.95 (1)
kavka *(Corvus monedula)*	24.4.93 (1)
brezovček *(Carduelis flammea)*	20.3.95 (večja jata)
repnik *(Carduelis cannabina)*	26.4.87 (30 osebkov, samci rdeče obarvani), 27.3.93 (5), 29.9.96 (3)
veliki strnad *(Miliaria calandra)*	27.3.93 (3)
rumeni strnad *(Emberiza citrinella)*	27.3.93 (1)
vrtni strnad *(Emberiza hortulana)*	27.3.93 (1)

Tab. 1: Seznam ptic - selivk na obravnavanem območju. V oklepaju podajava število opazovanih osebkov.
Tab. 1: The checklist of migratory bird species. In the brackets is the number of observed individuals.

RAZPRAVA

Zavoljo pomanjkanja podatkov iz preteklosti in pomanjkanja podatkov o ornitofavni sosednjih otokov, tako peščenih kot kamnitih, je nemogoče časovno in prostorsko primerjati ptičji svet Srakan Velih s stanjem iz časa, ko je bil otok temeljito kmetijsko obdelan. Primerjati ga ni mogoče niti s sosednjimi, danes prav tako poljedelsko opustelimi otoki.

Blašković (1957) za sosednji Susak navaja, sledeč ljudskemu pojmovanju, naslednje gnezdilke: vrabca, lastovko, slavca, škrjanca, liščka, pastirico, kosa, jerebico, ne pozabi pa dodati, da gnezdijo "še nekatere". Primerjava je zanimiva predvsem zaradi slavca in jerebice, ki ju na Srakanah Velih nisva popisala. Tudi na žitnih poljih Srakan je jerebica svojčas najbrž gnezdila, medtem ko pomanjkanje grmovja še do danes na otok ni privabilo sencoljubega slavca.

Sl. 8: En dan (levo) in nekaj ur (desno) stara mladiča prilivke (Burhinus oedicnemus) s še dobro vidnim jajčnim zobom na kljunu, Srakane Vele, 11.6.1996 (Foto: I. Geister).
Fig. 8: A day (left) and a few hours (right) old Stone Curlew's young with still well visible egg tooth on each bill, Srakane Vele, June 11th 1996 (Photo: I. Geister).

Na spisku priložnostnih opazovanj na Susku v dneh od 30.4 do 2.5.1988 (Škornik, 1988) je 12 vrst, ki na Srakanah Velih do danes niso bile opazovane: mala bobnarica *(Ixobrychus minutus)*, fazan *(Phasianus colchicus)*, močvirski martinec *(Tringa glareola)*, hribski škrjanec *(Lullula arborea)*, drevesna cipa *(Anthus trivialis)*, skalna lastovka *(Hirundo daurica)*, mali slavec *(Luscinia megarynchos)*, ščinkavec *(Fringilla coelebs)*, lišček *(Carduelis carduelis)*, zelenec *(Chloris chloris)*, poljski vrabec *(Passer montanus)* in šoja *(Garrulus glandarius)*. To opozarja na možno veliko pestrost in variabilnost ornitofavne creško-lošinjskega arhipelaga, tako v gnezditvenem kot selitvenem pogledu, kar je najbrž predvsem posledica majhnosti večine otokov.

Z vidika evropsko ogroženih gnezdilk je od srakanskih gnezdilk pomembna predvsem prilivka. Na Hrvaškem živi 100-200 parov (Tucker & Heath, 1994), in to predvsem na kvarnerskih otokih od Cresa do Paga. Potem ko je prilivka izginila z obrežij panonskih rek, je otoška populacija še toliko pomembnejša (Geister, v tisku). Na tako majhnem otoku prilivka presenetljivo lahko najde vse štiri sestavine biotske pestrosti, značilne za stepske predele (Bauer & Glutz von Blotzheim, 1987, jih navajata za Madžarsko): apnenčasta tla, nanose puhlice, slanišča v bibavičnem pasu in obrežna prodišča. Njeno gnezditveno prebivališče je dejansko kombinacija teh štirih segmentov, s skrbno izbranim položajem gnezdišča v njihovem stičišču. Tudi njihova ekološka vloga se zdi prepoznavna: bibavični pas z erozijo in slanimi penami preprečuje zaraščanje obrežja, le slanušam omogoča naselitev. Pod prodniki se skrivajo mnogi nevretenčarji obrežnega pasu; na sipinah puhlice skarabeji valijo kroglice kunčjega govna, na takšni goli zaplati je umeščeno tudi prilivkino gnezdo, in končno na prevladujoči živoskalni osnovi iz apnenca raste borno travišče, ki omogoča prehranjevanje v širokem spektru živalske hrane, od nižjih nevretenčarjev prek žuželk do glodalcev, počivališče za odrasle ptice in skrivališče za mladiče.

Navidez nepojasnjeno na teh otoških prebivališčih ostaja le vprašanje pitne vode. Znano je, da se prilivke na celinskih stepskih prebivališčih o mraku zbirajo ob napajališčih, če ne gnezdijo ravno ob kaki stoječi ali tekoči vodi. Domačini na teh otokih zbirajo deževnico v podzemnih cisternah, lokve so redke, večinoma zasute ali presahle (Geister, v tisku). Na Srakanah Velih je slaboten izvir sladke vode na vzhodnem obrežju.

K zanimivejšim redkostim za Kvarner štejeva postanek dveh rožastih škorcev *(Sturnus roseus)* na Srakanah Velih spomladi 1995 (Geister, 1996), čeprav je konec maja tipično obdobje za pojavljanja klateških osebkov te vagabundske vrste tudi drugod po Evropi. Presenetljivo je, da med selivkami nista bila popisana kos in črnoglavka, ki se prek Srakan očitno selita že pred 15. marcem, to je datumom najzgodnejšega opazovanja.

ZAHVALA

Za ljubeznivo pomoč pri iskanju hrvaške literature se zahvaljujeva Janezu Gregoriju in Daretu Šeretu iz Prirodoslovnega muzeja Slovenije in še posebno dr. Zvonimirju Devidéju, sodelavcu Zavoda za ornitologiju v Zagrebu.

BIRDS OF SRAKANE VELE IN THE CRES-LOŠINJ ARCHIPELAGO

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SUMMARY

From 1994 to 1996, 23 breeding birds were registered on the Quarnero island of Srakane Vele (Croatia), i.e. Common Kestrel, Stone-curlew, Yellow-legged Gull, Collared Dove, Turtle Dove, Rock Dove, Little Owl, European Bee-eater, Sky Lark, Barn Swallow, Tawny Pipit, Pied Wagtail, Yellow Wagtail, Whinchat, Blackbird, Cetti's Warbler, Olivaceous Warbler, Melodious Warbler, Subalpine Warbler, Sardinian Warbler, Blackcap, Hooded Crow and House Sparrow. During 1987-1996, 7 breeders of the neighbouring islands were registered, i.e. Shag, Griffon Vulture, Common Tern, Pallid Swift, Common Swift, Short-toed Lark and Black-eared Wheatear. During 1974-1996, 77 migratory species were recorded on the island.

Particularly interesting among the breeders of Srakane Vele are the European Bee-eater and Stone-curlew. European Bee-eater (Merops apiaster) *has bred on Srakane Vele since 1991, on the nearby Susak from at least 1987. These birds return from their wintering grounds in early May and leave the island in the first half of August. The breeders of the two Srakane islands (Srakane Vele and Srakane Male) must be dealt with as a single population, for they are frequently seen flying over Srakane Vele in a flock incorporating the inhabitants of both islands. These birds do not associate only in the post-breeding season but also during nesting, particularly in the period when one of the partners hatches the eggs.*

Bee-eaters nest in sandy-clayey banks of either natural or anthropogenous origin. The natural and well eroded banks are to be found on the edge of the intertidal belt, while the banks which are the work of man are situated at the bottom of cultivated terraces. There are also passages which have long ago been cut into the light soil; here they are scarcer than on Srakane Male, where they are still much scarcer than on the island of Susak. The majority of nest holes on Srakane Vele have been made in the banks of the intertidal belt, while on Srakane Male they are more common in the banks between terraced fields. The size and height of the banks are not significant; more important are the open spaces in front of the banks and the landing stalks above them, which are most often the stalks of reed (Arundo sp.). *In a few feet high banks the nest holes are thus found at the very foot of the banks and in any of the four main cardinal points.Bee-eaters of the Srakane islands breed individually or in small groups (2-3 pairs). They dig their nest holes each year anew and hatch the eggs in June. In the last few years, unfortunately, fewer and fewer Bee-eaters have bred on Srakane Vele: five (5) pairs in 1994, two (2) pairs in 1995, while in 1996 and 1997 not a single new nest hole was found. The decline in their breeding success is also reflected in the size of their post-breeding flock: in early August 1994 it included 18, in 1995 35 and in 1996 only 9 individuals. The flock incorporates the Bee-eaters of both islands. In 1995 at least 12 individuals returned from the tropics, which means that 6 nest at the most were left by at least 23 young or a little less than 4 young per nest.*

The Srakane Bee-eaters feed mainly on blue wood bees (Xilocopa violeces), *which certainly holds good for the brooding birds, as only chitinous remains of this insect were found in front of their nest holes. The Bee-eater's breeding success may therefore depend largely on this particular insect.*

The most important among the Srakane Vele breeding birds is, from the aspect of the endangered European breeding species, the Stone-curlew (Burhinus oedicnemus). *In Croatia breed some 100-200 pairs (Tucker & Heath, 1994), particularly on its Quarnero islands from Cres down to Pag. This population has become even more significant ever since it completely disappeared from the banks of Pannonian rivers. On Srakane Vele this bird was observed for the first time in 1993. In its breeding habitat it settles at the end of April; it leaves it in September, which is unexpectedly early. As far as the year 1994 is concerned, the nest containing 2 eggs was found on May 28th; on June 2nd the birds were still brooding. In 1995 the nest containing 2 eggs was found on May 27th, some 600 m away from the one in 1994. The young were ringed on June 21st when they could not be more than 2 days old. The Stone-curlew therefore began to brood on about May 25th, which is relatively late. On May 31st three Stone-curlews were seen beside the nest containing 2 unequally large and unequally coloured eggs. Thus it is quite possible that the eggs belonged to two females. Three individuals were on that day observed also on the other nesting ground, but the nest was not found.*

Regarding the year 1996, the nest was found on June 9th, again some 600 metres from the one in 1995. On the next day the first chick was hatched, and a day later the second, which means that the young hatched no less than 10 days earlier than in the previous year; the bird began to brood in mid-May. In the years 1994-1996, two pairs at the most bred on the island of Srakane Vele. On June 12th 1996 a single individual was observed for the first time on Srakane Male.

On Srakane Vele the Stone-curlew breeds on very specific ground - in barren earthy land with a few larger stones and very poor vegetation. Such eroded ground on the prevailing limestone rock is in effect very rare and has been in time gone by successfully used as a nesting ground. On such ground many rabbit droppings are found, some of them without fail in the Stone-curlew's nest.

After the breeding period the island's Stone-curlews gather in a flock. In 1995 (August 9th) 8 individuals at the most were observed, while in 1996 (August 17th) max. 10 were recorded.

Considering that in 1996 only a single pair reliably bred there, it is obvious that Stone-curlews from other islands gather on the Srakane Vele as well. A late migrant was observed also on November 1st 1994.

On such small island the Stone-curlew finds, with surprising ease, all of the four constituents of biodiversity typical of steppe (Bauer & Glutz von Blotzheim 1987 cite them for Hungary): limestone ground, alluvial deposits of light soil, saltmarshes in the intertidal belt and shingly shores. The Stone-curlew's breeding habitat is actually a combination of these four segments, with a carefully selected position of the nesting ground in their meeting-point. Their ecological role, too, seems evident: the intertidal belt prevents, due to the erosion and salty foam, the shore becoming overgrown with vegetation, except with halophilous plants. Under shingle there hide many invertebrate animals and insects of the intertidal belt; on soft soil dunes a number of scarabs roll their little balls made of rabbit droppings, and finally the prevailing limestone substratum is covered by miserable grassland which, however, has been providing sustenance to many animals, from invertebrates and insects to rodents, as well as resting grounds for adult birds and hideouts for their young.

Among the most interesting breeders of the neighbouring islands is the Pallid Swift (Apus pallidus). *This species does not breed on Srakane Vele but in the cliffs of the southwestern part of Susak. A colony of these birds was discovered there on May 27th 1995, when the island was encircled with a boat. Igalffy (1962) claims, however, that it is the Common Swift* (Apus apus) *(he calls it* (Micropus apus) *which breeds on the low rockwalls along the southern shore of Susak. On a black and white photograph two rockfalls can be seen, similar to those where the breeding Pallid Swifts were observed by us. In the Zagreb collection of skins there are no specimens from the islands of Susak, but there is a record about a Pallid Swift being shot on May 30th at Čunski on the island of Lošinj (Sušić* et al., *1988). Čunski is only a few miles away from the Pallid Swift's nesting ground at Susak. From April 30th to May 2nd 1988, however, "a mass flying around" by Pallid Swifts was witnessed by I. Škornik and three other Slovene ornithologists.*

As far as the observed migratory species are concerned, we found it very interesting to catch sight of two Rosy Starlings (Sturnus roseus) *on May 30th 1995. The birds which sat on reed stalks seemed very tired, as they squatted there for quite a while and later, when we got too near to them, moved for just a few metres away to a group of more isolated reeds. Considering that a few hours prior to this sighting the southwesterly wind began to blow across the island it was most probable that the birds had just crossed the Adriatic Sea, since it was obvious that the birds were particularly in need of rest. On the following morning the starlings could not be found anywhere on the island.*

Key words: birds, breeders, migrators, Stone Curlew, Srakane Vele, Croatia

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compendio

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LA COMUNITÀ DI STRIGIFORMI DELLA VAL ROSANDRA NEL CARSO TRIESTINO

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ESTRATTO

Il presente lavoro vuole approfondire le conoscenze sulla comunità di Strigiformi della Val Rosandra nel Carso triestino, riservando una particolare attenzione all'ecologia dell'Assiolo, una specie scarsamente studiata in Italia e negli altri paesi mediterranei. I rilevamenti in campagna hanno permesso di individuare la presenza nell'area di studio di 1 territorio marginale di Civetta, 2 territori di Gufo reale, 4 di Allocco e 15 territori di Assiolo (11 sicuramente stabili). I risultati confermano la nota preferenza del Assiolo per le stazioni collinari fortemente termofile ed i coltivi a conduzione tradizionale.

Parole chiave: Strigiformi, comunità, Carso triestino, ecologia, Assiolo

INTRODUZIONE

La presenza di una buona comunità di Strigiformi (rapaci notturni) in un'area costituisce sicuramente un indice attendibile del relativo livello di qualità ambientale; ciò in base alle caratteristiche eco-etologiche di queste specie, predatori posti ai vertici della piramide trofica. Nell'ambito del panorama italiano gli studi in merito sono molto scarsi (Benussi, 1997) e le specie più comuni (Civetta, Allocco, Barbagianni) risultano studiate soprattutto in ambienti antropizzati e comunque quasi sempre per singoli taxa e molto raramente come comunità negli ecosistemi naturali originari. Ciò anche per l'eccessiva difficoltà a rinvenire situazioni ambientali idonee alla presenza di una comunità di Strigiformi abbondante e diversificata.

Sotto questo aspetto il territorio del Carso triestino (Italia nord-orientale) presenta un comprensorio, la Val Rosandra, di notevole interesse anche per i peculiari aspetti ambientali che la caratterizzano.

La contemporanea presenza di quattro specie come l'Assiolo *(Otus scops)*, il Gufo reale *(Bubo bubo)*, la Civetta *(Athene noctua)* e l'Allocco *(Strix aluco)* ne fanno una zona molto importante nell'ambito del territorio italiano e quindi un'area di studio di estremo interesse per quanto riguarda la biologia dei rapaci notturni. Il presente lavoro vuole approfondire le conoscenze sulla comunità di Strigiformi ivi presente, riservando una particolare attenzione all'ecologia dell'Assiolo, una specie scarsamente studiata in Italia e negli altri paesi mediterranei.

CENNI SULLE METODOLOGIE DI CENSIMENTO

La valutazione numerica delle popolazioni di Strigiformi incontra numerose difficoltà riconducibili principalmente alle abitudini notturne e/o elusive della maggior parte delle specie, alle basse densità di popolazione, alla distribuzione cosmopolita ed euriecia, e alle variazioni stagionali nel comportamento e nell'utilizzo degli habitats.

Considerate queste premesse, le conseguenze pratiche per lo studio degli Strigiformi possono riassumersi nell'impossibilità di compiere censimenti a vista (eccetto per il Gufo comune, *Asio otus*), nella necessità di investire molto tempo nella ricerca e nell'opportunità di non limitare i rilevamenti ai soli siti ritenuti "idonei".

Per il conteggio delle popolazioni di rapaci notturni ci si avvale quasi esclusivamente di censimenti al canto, approfittando del rigido territorialismo e quindi l'intensa attività canora che caratterizza queste specie. Le metodologie più usate, messe a punto da diversi Autori, sono le seguenti:

1. Censimenti intensivi al canto spontaneo

Questo metodo, utilizzato da Baumgartner (1939), Southern (1954; 1970), Bell (1964), Hine (1969), Peterson (1979), consiste nel coprire simultaneamente al tramonto tutta l'area di studio, rilevando i canti spontanei dei maschi da punti d'ascolto prefissati; questo metodo, applicabile per zone campione non troppo vaste, molto omogenee dal punto di vista ambientale e caratterizzate da forti densità di popolazione, implica una perfetta conoscenza dell'area di studio e la presenza di numerosi esperti rilevatori. Questo tipo di censimento non garantisce tuttavia risultati assoluti, in quanto una frazione della popolazione non si manifesta mai, è molto dispendioso in termini di tempo e può essere effettuato con successo solo nei limitati periodi di intensa attività territoriale.

2. Censimenti al "play-back"

Consiste nello stimolare una risposta territoriale della specie che si vuole censire, simolando, mediante la riproduzione del canto con un registratore, la presenza di un conspecifico.

Tale metodo è stato utilizzato per la prima volta da Bhol (1956), ed in seguito è stato impiegato da molti ricercatori con buoni risultati (Braun *et al.*, 1973; Barbieri *et al.*, 1976; 1978; Falls, 1981; Johnson *et al.*, 1981; Fuller & Mosher, 1981; Mc Garigal & Fraser, 1984; Forsman *et al.*, 1984; Boldreghini *et al.*, 1987; Sarà, 1987; Cesaris, 1988; Galeotti, 1990; Benussi & Genero, 1995).

Il censimento con "play-back" presenta i seguenti vantaggi rispetto alle tecnica precedente:

a) impiego di un numero limitato di rilevatori (2-4);
b) possibilità di censire vaste superfici anche molto eterogenee;
c) applicabilità anche in presenza di basse densità;
d) rapidità ed alto rendimento dei censimenti in quanto incrementa in misura sensibile il tasso di canto anche di specie normalmente elusive e silenziose;
e) possibilità di censire facilmente le covate;
f) possibilità di censire il sito diurno tramite triangolazioni (Cignini *et al.*, 1989);
g) possibilità di una migliore definizione dei territori inquanto gli animali possono seguire il richiamo entro i propri confini;
h) attenuazione delle variazioni stagionali nell'attività di canto; questo permette di applicare il metodo anche in periodi in cui la specie è normalmente silenziosa;
i) possibilità di compiere osservazioni dirette sul comportamento in quanto molto spesso gli animali si rendono visibili a poca distanza;
l) possibilità di censire anche zone impraticabili.

Nell'utilizzo del "play-back" vanno tuttavie osservate alcune precauzioni di ordine sia tecnico che scientifico-conservazionistico:

m) i risultati migliori si ottengono, a seconda della specie, in ben determinati periodi dell'anno, del ciclo lunare, della notte e con condizioni climatiche specifiche; in genere l'attività canora è massima nel periodo precedente alla riproduzione, in luna crescente o piena, poco dopo il tramonto e poco prima dell'alba e con cielo parzialmente o totalmente coperto;
n) molti tipi di vocalizzazioni sono udibili solo da pochi metri (ad es. il canto territoriale del Gufo comune o il il canto di corteggiamento dell'Allocco); in questo caso occorre infittire le stazioni di emissione-ascolto per coprire esaustivamente l'area di studio;
o) in autunno la presenza di individui giovani non ancora stabili (es. Civetta) può falsare il risultato del conteggio;
p) in alcuni casi l'animale si avvicina al richiamo, ma non da risposta ("contatto visivo", ad es. l'Allocco degli Urali, *Strix uralensis*);
q) la potenziale presenza di "dialetti locali" impone scelte precise sul tipo di richiamo registrato da impiegare; in genere i migliori risultati sono ottenuti con richiami di individui "stranieri";
r) il tipo di equipaggiamento usato è di estrema importanza in relazione alla fedeltà della riproduzione e alla distanza cui il suono può venire trasmesso;
s) il rumore di fondo, gli ostacoli (struttura del terreno, della vegetazione, presenza di edifici ecc.), il vento e la pioggia interferiscono evidentemente con la trasmissione e la ricezione del suono;
t) secondo qualche Autore (Robbins, 1978) un'elevata frequenza di stimolazioni nello stesso territorio in un breve periodo di tempo può portare assuefazione al richiamo e quindi non suscitare più alcuna risposta o anche alterare il comportamento dell'animale in alcune situazioni o periodi dell'anno.

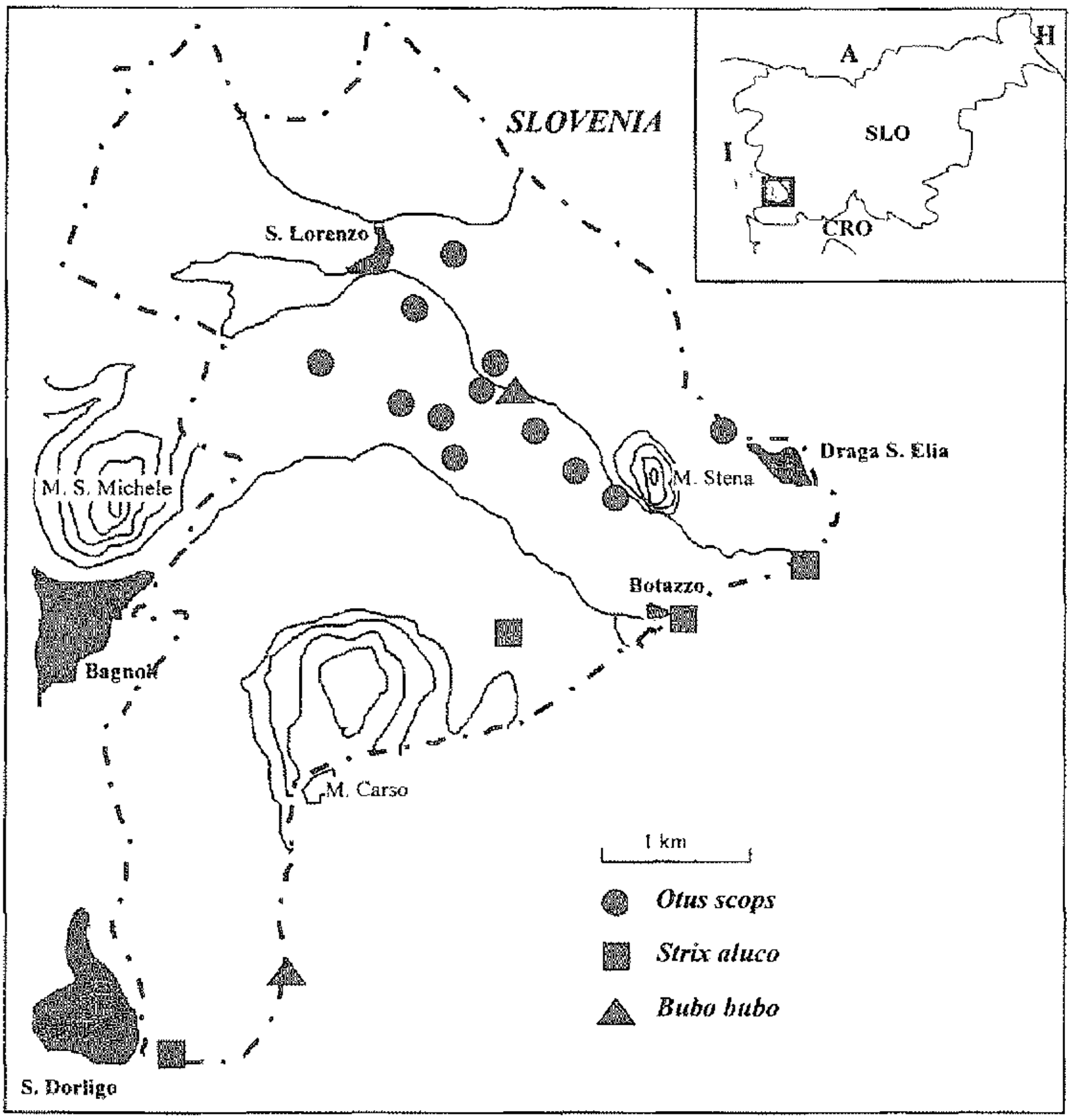

Fig. 1: Area di studio e localizzazione delle coppie di Strigiformi.
Sl. 1: Obravnavano območje in lokalitete, kjer so bili potrjeni pari sov.

AREA DI STUDIO

E'stata indagata un'area di circa 500 ha comprendente tutta la Val Rosandra (Carso triestino, provincia di Trieste) sino al confine con la Slovenia, il contiguo versante meridionale esterno alla valle, ma in diretta continuità con essa, sino all'abitato di S. Dorligo della Valle (Dolina) e una parte dell'altopiano carsico tra gli abitati di S. Lorenzo (Jezero) e Draga S. Elia (Draga) che sovrasta la valle a nord (Fig. 1).

Per le particolari caratteristiche climatiche, fisiche e geografiche la valle presenta aspetti ambientali e faunistico-floristici particolari e di grande interesse: accanto a specie illirico-balcaniche di provenienza orientale, si rinvengono infatti entità tipicamente mediterranee accanto a specie montano-alpine o centroeuropee. La valle per la sua posizione geografica rappresenta uno dei punti di penetrazione del vento freddo di Bora che soffia da E-NE, mentre d'altra parte risente dell'azione mitigatrice del Mare Adriatico, distante meno di 1 km in linea d'aria.

La composizione ambientale di tale territorio (Fig. 2) rivela uno scarso livello di antropizzazione, sia per le piccole dimensioni dei pochi centri abitati presenti sia per il limitato utilizzo agricolo. Circa il 15% della superficie è infatti occupato da vegetazione pioniera e da pareti rocciose, quest'ultime di origine calcarea eocenica. Nella parte più bassa della valle e sul versante meridionale predomina invece la boscaglia di latifoglie decidue composta da *Ostrya carpinifolia* e *Quercus pubescens* e, nello strato erbaceo, da *Sesleria autumnalis*. Sul M.te Carso e nei pressi della frazione di Botazzo (Botač) si trovano residui appezzamenti di boschi meno xerofili caratterizzati da esemplari, anche molto maturi, di *Quercus cerris* e *Quercus petrea*. La parte del versante più bassa, appena dopo l'abitato di S. Dorligo della Valle nonchè ampie zone dell'altopiano carsico sono invece occupate da impianti di *Pinus nigra*. Sull'altopiano, soprattutto intorno al M.te Stena, si sviluppa una formazione erbacea a gramineti tipica della landa carsica, mentre sulle rocce si insedia una particolare associazione vegetale detta di landa rupestre (Poldini *et al.*, 1978), caratterizzata dalla presenza di *Iris illyrica*. I macereti ed i brecciai, comuni sia sul versante settentrionale della valle sia su quello meridionale, sono colonizzati soprattutto da *Drypis spinosa* e da *Festuca carniolica*. Sul fondovalle scorre l'unico corso d'acqua epigeo della zona, il Torrente Rosandra, bordato da vegetazione igrofila (Fig. 3).

La presenza antropica saltuaria all'interno della valle, compresa tra gli ambiti di riserva di cui alla Legge Regionale n. 442, 1.6.1971, è tuttavia cospicua; soprattuto nei giorni festivi è infatti notevole l'afflusso di escursionisti ed alpinisti. Questi ultimi in particolare, utilizzano le numerose vie attrezzate lungo le pareti del versante nord (esposte a sud), che sono proprio quelle più frequentate dall'Assiolo e dal Gufo reale.

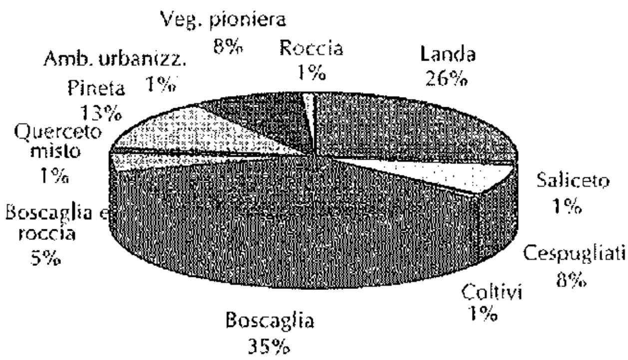

Fig. 2: Ambienti dell'area di studio.
Sl. 2: Tipi habitatov na obravnavanem območju.

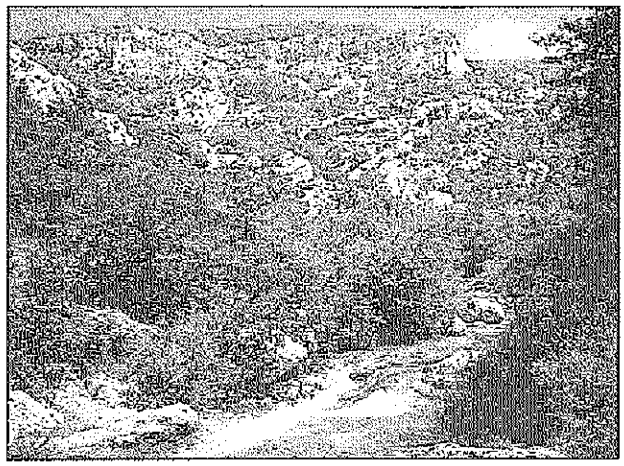

Fig. 3: Val Rosandra (Foto: E. Benussi).
Sl. 3: Glinščica (Foto: E. Benussi).

METODI

La ricerca sul campo si è svolta nel periodo 1991-1995, con periodiche uscite notturne quindicinali e numerosi sopralluoghi diurni. Nel periodo riproduttivo, aprile-giugno, sono stati compiuti controlli 2-3 volte alla settimana.

Per l'individuazione delle specie è stato utilizzato il metodo del "play-back", stimolando gli animali da 14 stazioni di ascolto precedentemente individuate (distanza media tra stazioni 300 m), per uno sviluppo complessivo di 11,5 km.

Per il Gufo reale e l'Assiolo, si è proceduto ad uno specifico approfondimento della ricerca, indagando il comportamento territoriale e le preferenze ambientali.

I territori di Assiolo e Allocco sono stati delimitati con il metodo del mappaggio (Blondel, 1969; Johnson *et al.*, 1981), tracciando i confini secondo il minimo poligono convesso (MacDonald *et al.*, 1980); sono stati considerati stabilmente occupati solo quei territori che hanno fornito almeno tre contatti positivi nell'arco di un mese. Per alcuni territori di Allocco, parzialmente esterni all'area di studio poiche sconfinanti in Slovenia, non è stato possibile definirne i confini e calcolarne la superficie.

Le osservazioni sono state riportate su apposite schede e cartografate utilizzando la Carta Tecnica Regionale (scala 1:5000). I rilevamenti ambientali per la definizione degli habitats selezionati sono stati eseguiti utilizzando una carta fitosociologica in scala 1:5000 (Poldini, 1985) ridotta a 1:1000, accorpando alcune categorie ambientali affini per loro più funzionale utilizzo a fini faunistici. Per l'individuazione delle preferenze ambientali dell'Assiolo abbiamo utilizzato il coefficiente di selettività di Chesson (1978), che fornisce una misura rigorosa ed attendibile dell'utilizzo selettivo dell'ambiente:

$$w = \frac{r_i / p_i}{\sum r_i / p_i}$$

dove r indica la proporzione d'uso relativa all'ambiente iesimo e p la proporzione disponibile dell'ambiente iesimo nell'area di studio.

RISULTATI

Distribuzione e densità

I rilevamenti in campagna hanno permesso di individuare la presenza nell'area di studio di 1 territorio marginale di Civetta, 2 territori di Gufo reale, per una densità di 0,43 terr./km², 4 di Allocco (D=0,87 terr./km²) e 15 territori di Assiolo (11 sicuramente stabili), per una densità variante dai 2,4 ai 3,25 terr./km². Questi ultimi valori sono confrontabili con i dati provenienti dalla Francia meridionale continentale (5 terr./km²) e dell'Isola di Port-Cros (1,8-2,3 terr./km²). Per l'Assiolo, ad esclusione di due territori posti sull'altopiano carsico nei presi dell'abitato di Draga S. Elia, tutti gli altri sono situati all'interno della Val Rosandra e sul versante orografico destro, quello esposto in prevalenza a sud-ovest. La loro distribuzione risulta di tipo aggregato, concentrata tra l'altro nello spazio di circa 1,5 km in linea d'aria; non sono state rilevate evidenti sovrapposizioni tra un territorio e l'altro.

Localizzati nella parte più interna della valle risultano invece i territori di Allocco, due dei quali posti in gran parte in Slovenia. La loro distribuzione non è limitata ad un unico versante e sembra soprattutto coincidere con i pochi boschi maturi di querce.

L' Assiolo e l'Allocco sembrano segregati spazialmente, con la specie più piccola che evita la zone frequentate da quella più grossa, mentre non sembrano sussistere problemi di competizione con il Gufo reale il cui territorio comprende quelli di entrambe le specie.

Territorialismo e preferenze ambientali nell'Assiolo

Nell'area di studio sono stati individuati 11 territori stabili di Assiolo (1991-1994), corrispondenti a coppie in fase riproduttiva, e altri 4 occasionalmente difesi da individui non accoppiati. Per dieci degli undici territori stabili è stato possibile tracciare dei confini e misurarne le relative superfici in quanto il numero dei punti di risposta era maggiore o almeno uguale a tre.

Le dimensioni dei territori misurati, la distanza media tra i territori e il valore dell'indice di ampiezza nicchia (Feisinger *et al.*, 19981) sono riportati in Tab. 1.

TERRITORI	ha	D	B
T1	0,5	204,86	0,26
T2	0,4	169,11 DS	
T3	1,56	12-472 range	
T4	0,89		
T5	0,79		
T6	0,17		
T7	0,39		
T8	0,47		
T9	0,29		
T10	0,51		
X	0,60		
DS	0,38		
range	0,17-1,56		

(D = distanza media tra i territori; B = ampiezza nicchia)
(D= povprečna razdalja med pos. teritoriji; B = širina ekološke niše)

Tab. 1: Superfici dei territori di Assiolo, *Otus scops.*
Tab. 1: Površine teritorijev velikega skovika, *Otus scops.*

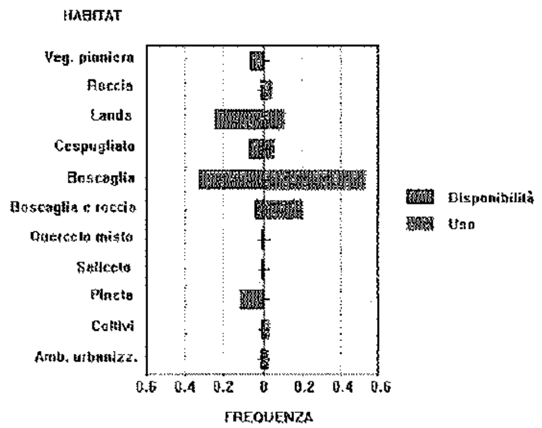

Fig. 4: Ambienti presenti nei territori di Assiolo, *Otus scops* ***(Rapporto uso / disponibilità).***
Sl. 4: Habitatni tipi na teritorijih velikih skovikov, *Otus scops* ***(razmerje med uporabljenimi in razpoložljivimi habitatnimi tipi).***

I risultati mostrano che generalmente gli assioli difendono con il loro canto monotono uno spazio di 0,6 ha, dove compiono per intero le loro attività trofiche e riproduttive.

Mediamente la distanza tra i territori è di 200 m, ma alcuni di loro possono essere separati anche da una sola decina di metri. Valori di questo tipo (8-10 m) sono stati trovati in Romania (Kalaber, 1971) e in Sud-Tirolo (Glutz & Bauer, 1980).

Il valore dell'indice di ampiezza di habitat è molto basso e indica una forte specializzazione da parte della specie nell'uso dei diversi ambienti presenti nella valle. I tipi ambientali percentualmente più scarsi sono infatti quelli maggiormente utilizzati dall'Assiolo (Fig. 4).

In effetti i territori non sono distribuiti omogeneamente nell'area di studio, ma sono tutti localizzati sul versante della valle a S-SW ad altezze comprese tra i 100 m e i 350 m s.l.m.

Questa distribuzione contagiosa indica una chiara preferenza per alcune situazioni ambientali evidentemente più idonee e favorevoli, che vengono con ogni probabilità rapidamente saturate all'inizio della stagione riproduttiva.

In modo particolare, in base ai valori dell'Indice di preferenza ambientale di Chesson (Tab. 2), risultano nettamente selezionati la boscaglia termofila di *Quercus pubescens* con ampia presenza di zone rocciose aperte, il vigneto ed i versanti rocciosi con scarsa o nulla copertura vegetale. Al contrario l'Assiolo evita la landa, i cespugliati, i boschi d'alto fusto ed i gramineti su ghiaie e breccie; la boscaglia carsica chiusa e gli ambienti urbanizzati sono infine usati secondo la loro relativa disponibilità.

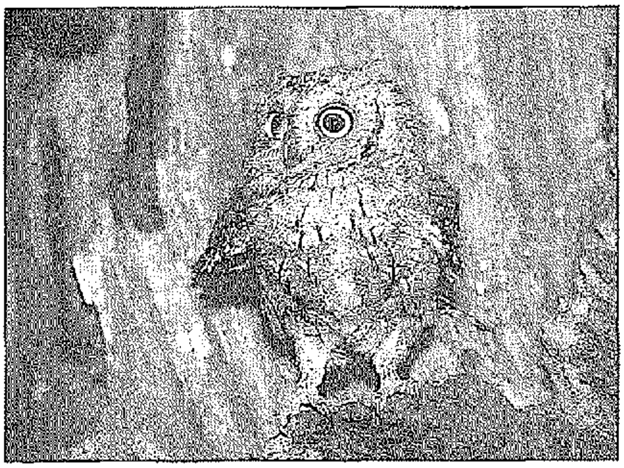

Fig. 5: L'Assiolo** (Otus scops)**(Foto: E. Benussi).
Sl. 5: Veliki skovik** (Otus scops)**(Foto: E. Benussi).

Questi risultati confermano la nota preferenza del piccolo strigide per le stazioni collinari fortemente termofile ed i coltivi a conduzione tradizionale. Il primo tipo di ambiente fornisce con ogni probabilità idonei siti riproduttivi, rappresentati da cavità e fessure tra le rocce, mentre il secondo assicura territori di caccia ancora remunerativi. Ricordiamo infatti che l'Assiolo (Fig. 5) è un predatore a dieta quasi esclusivamente insettivora ed è pertanto in declino nelle zone di pianura ad agricoltura intensiva.

La boscaglia chiusa e le zone urbanizzate rappresentano per il predatore habitats secondari, utilizzati tuttavia con una certa frequenza nel resto dell'altopiano carsico, dove evidentemente mancano situazioni più favorevoli.

I boschi maturi di latifoglie sono evitati sia per la loro maggiore umidità sia per la presenza di territori di Allocco, potenziale e temuto predatore in particolare di uccelli.

La pineta è invece evitata sia per la mancanza di idonee cavità di nidificazione, sia per la scarsa produttività di questo ambiente.

DISCUSSIONE

Lo studio ha rilevato la presenza e la nidificazione nella Val Rosandra di 4 specie di Strigiformi sulle 6 distribuite nel territorio della provincia di Trieste. Per la Civetta si ritiene che la nidificazione di una coppia avvenga in un territorio posto marginalmente all'area indagata.

La distribuzione delle altre tre specie presenti, Assiolo, Allocco e Gufo reale, mostra sia sovrapposizioni (Assiolo-Gufo reale) sia separazioni (Assiolo-Allocco, Gufo reale-Allocco) nell'utilizzo dei diversi ambienti della valle. Per interpretare queste situazioni possiamo avanzare le seguenti ipotesi:

a) Assiolo ed Allocco sono in prima analisi separati dalle differenti esigenze ambientali, in secondo luogo le interazioni aggressive tra le due specie, l'Allocco è un temibile predatore degli altri piccoli rapaci notturni (Mikkola, 1983), giocano un ruolo probabilmente importante nella segregazione.

b) Anche tra l'Allocco ed il Gufo reale è ipotizzabile un analogo rapporto preda-predatore, considerando l'abituale intolleranza della specie più grossa nei confronti della presenza di altri rapaci notturni di medie dimensioni. Intolleranza non presente, almeno nella nostra area di studio, nei confronti dell'Assiolo, i cui territori sono anzi concentrati soprattutto in prossimità delle pareti rocciose più frequentate dal Gufo reale (nido e posatoi diurni)(Fig. 6). Apparentemente la specie più piccola sembra avvantaggiarsi della vicinanza di un superpredatore come il Gufo reale, il quale d'altra parte non deve temere alcuna forma di competizione trofica (l'Assiolo è quasi esclusivamente insettivoro) nè possibili predazioni a carico dei propri piccoli, evento tutt'altro che raro qualora sia presente l'Allocco.

La netta preferenza dell'Assiolo per i versanti esposti a SW evidenzia la mediterraneità della specie che in queste zone è presente solo nel periodo riproduttivo primaverile-estivo (arrivi 15-25 marzo, partenze 20-30 settembre). L'altitudine media cui sono localizzati i territori conferma la spiccata termofilia di questa specie; infatti a queste quote durante le ore notturne, per il fenomeno dell'inversione termica, si hanno temperature dell'aria maggiori di alcuni gradi rispetto al fondovalle. Questo fenomeno influisce probabilmente anche sulla disponibilità delle principali prede dell'Assiolo, concentrandole nelle zone più calde della valle.

AMBIENTI	W
Vegetazione pioniera	0.00 -
Roccia	0.19 -
Landa	0.03 -
Cespugliati	0.05 -
Boscaglia	0.10 -
Boscaglia e roccia	0.29 +
Querceto misto	0.00 -
Saliceto	0.00 -
Pineta	0.00 -
Coltivi	0.26 +
Ambienti urbanizzati	0.08 -

Tab. 2: Valori dell'indice di preferenza ambientale W. (il segno + indica preferenza, il segno - controselezione)
Tab. 2: Vrednosti indeksa preferenčnega okolja (W). (znak + pomeni preferenco, znak - pomeni izogibanje takemu okolju)

Per quanto riguarda le densità riscontrate per le tre specie possiamo dire che l'Allocco è presente con valori medi, molto simili a quelli rilevati in ambienti urbani di pianura (Galeotti, 1990). L'Assiolo presenta densità medio-alte paragonabili a quelle rilevate ad analoghe latitudini nella Francia meridionale.

Infine per il Gufo reale non possiamo fornire indicazioni per la mancanza di vasti ambienti adatti, essendo la Val Rosandra limitata per estensione.

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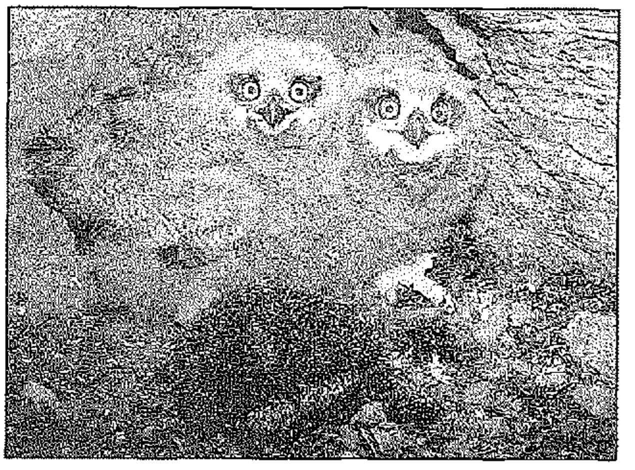

Fig. 6: Il nido del Gufo reale** (Bubo bubo)**(Foto: E. Benussi).
Sl. 6: Gnezdo velike uharice** (Bubo bubo)**(Foto: E. Benussi).

SOVE (STRIGIFORMES) V DOLINI GLINŠČICE (TRŽAŠKI KRAS)

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POVZETEK

V Glinščici (Val Rosandra) pri Trstu so avtorji odkrili pojavljanje in gnezdenje 4 vrst sov od 6 živečih v tržaški provinci. Na raziskanem območju so avtorji z uporabo metode "play-back" potrdili pojavljanje (in gnezdenje) 11 do 15 parov velikega skovika (Otus scops), *4 parov lesne sove* (Strix aluco), *2 parov velike uharice* (Bubo bubo) *in 1 para navadnega čuka* (Athene noctua). *Povprečne gnezditvene gostote znašajo 0,87 teritorijev/km^2 za lesno sovo, 0,43 teritorijev/km^2 za veliko uharico in 2,4-3,25 teritorijev/km^2 za velikega skovika. Topografski pregled razširjenosti treh vrst sov je pokazal, da se veliki skoviki izogibajo teritorijev, kjer živijo lesne sove, te pa teritorijev velikih uharic. Obenem se je izkazalo, da se teritoriji velikih skovikov prekrivajo s teritorijem velike uharice.*

Raziskava je pokazala, da so teritoriji velikih skovikov v večini primerov orientirani proti jugozahodu. Najraje si veliki skoviki izberejo termofilne gozdiče hrasta puhavca, vinograde in neporaščene skalnate niše. Avtorji domnevajo, da ima pri izboru teritorijev na južnih in jugozahodnih skalnatih pobočjih v Glinščici pomembno vlogo tudi toplotna inverzija. Temperatura je tedaj za nekaj stopinj višja kot v vznožju doline, to pa verjetno vpliva tudi na pojavljanje razpoložljive hrane - členonožcev, ki imajo v prehrani velikega skovika najpomembnejšo vlogo.

Ključne besede: sove, skupnost, Tržaški kras, ekologija, veliki skovik

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KRASOSLOVJE IN GEOLOGIJA

CARSOLOGIA E GEOLOGIA

KARSTOLOGY AND GEOLOGY

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KARSTOLOGY AND SPELEOLOGY IN SLOVENIA (FROM THE HISTORY OF KARST AND CAVE SCIENCE TO THEIR PERSPECTIVES)

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ABSTRACT

The article presents briefly the development of the term "karst", karstology and speleology in Slovenia, with an emphasis on the achievements of Slovene researchers and response to them elsewhere in the world. Since the second World War, the Slovene karstologists have played increasingly active part on the international karstologic scene. The author of the article believes that the future of a successful affirmation of our karstology lies in a detailed study of our karst in as close international cooperation as possible, in the publishing of our achievements, in introduction of karstology to higher education, and in active participation in the attempts to solve the issues concerning everyday life and economy on the karst.

Key words: karstology, speleology, history, Slovenia, "Kras"

INTRODUCTION

Although many parts of karst and karst phenomena, specially karst springs, swallow-holes and caves have been known since antiquity (we must not forget that in the Mediterranean, where most of the ancient cultures had flourished, karst is an important and even preponderant landscape), it was just the name of the country in the background of the Gulf of Trieste, Kras - Carso - Karst, which became, during the 19th century, the international scientific term "Karst". Where the term "karst" came from and how it has developed to its present-day form, has been written in this particular magazine (Gams and Kranjc, Annales 4, 1994).

From the topographical name "Kras (Karst)" to the technical term "karst"

From the term "karst", which means a special type of landscape developed on soluble (mainly carbonate) rocks, with all its surface and underground features, to the "birth" of a new branch of science called karstology (karst science) there has been a long way. In the middle of the 19th century the term karst as a general term was largely adopted by geologists and geographers in the Middle and in parts of the Southern and Western Europe. Yet, there were some researchers, for example well known French speleologist E.A. Martel, who even in the 20th century did not want to use the term karst and tried to persuade French scientists to use, instead of it, the "phenomènes calcaires, paysages calcaires, etc." (that is limestone phenomena, limestone landscapes). About karstology as a science one may not speak before the beginning of the 20th century. Even then, when karst science was already well used and well developed, the basic works upon it did not use directly the word karstology, but other terms containing the word karst (Cvijic's "Das Karstphänomen", Grund's "Karsthydrographie"). As the karst underground is the essential part of a karst landscape (although it is studied by a special branch of science, called speleology, often looked upon as a part of karstology), speleological works have to be treated as karstological also. Thus they are not only basic speleological works but at the same time basic works

Fig. 1: Up to the 1st World War the descending by rope into the shafts was a largely used technique (Photo by Pavel Kunaver).
Sl. 1: Do I. svetovne vojne je bilo spuščanje v brezna na vrvi običajna tehnika (foto Pavel Kunaver).

on karstology, such as Kraus's "Höhlenkunde" or Martel's "Les Abîmes ...".

THE BEGINNINGS OF THE "KARSTOLOGICAL" INVESTIGATIONS

Besides some geographical and historical advantages, one of the reasons why just the country Kras - Carso gave the name to the term, was also the popularisation, the studies and the publishing of karst phenomena in the Duchy of Carniola (Kranjska). Learned men of that time, later researchers and scientists living in Kranjska or visiting it with special intentions, contributed a lot. These studies started long before scientists began to talk about karst and karstology.

Specially important among them are the works of Valvasor (1689), Nagel (1748), Steinberg (1758), Hacquet (1778-1789) and Gruber (1781). We may call them the predecessors of karst and cave science in Slovenia. They studied and described numerous karst phenomena of Kranjska, but they were not aware of the fact that the karst is also a general phenomenon. It seemed that Hacquet thought already that karst is a special kind of landscape, general and typical for all the limestone terrain. So he marked down the general expression for karst terrain he presumably heard from native people, the "karoš". F. Hohenwart, 50 years later (1830), was the first of the scientists who began to write and to spread the idea that the "karst" is not only on the Kras - Carso, but everywhere where limestone country is. He was followed by distinguished geologists (Morlot, Lipold, Stur, Boué, Stache, Mojsisowicz) and geographers (Schmidl, Lorenz, Urbas) mostly. The terms "kras" or "kraševina" were suggested by Jesenko in his geography (1874) to be used in the Slovene language

In Kranjska it was soon generally adopted that the "real karst" was not only on the Kras but that this was the whole region between Vrhnika and Trieste. It is known, more like an anecdote, that at the beginning of this century at Vrhnika, where the road begins to climb up the karst plateau, there was a panel board with an inscription (or written on the rock) "Here begins the karst".

Knowledge of karst in Slovenia is closely connected to the knowledge of the karst underground. The predecessors of karstology, mentioned above, wrote more or less about the caves also. Caves are the karst features best known to the lay people. Regarding the development of cave tourism (if it is appropriate to use this expression of visiting the caves before the "invention" of modern tourism), for example mass in Sveta Jama near Socerb from the 3rd to 4th century onwards, the cave church at Landar mentioned in 888, and the Vilenica being a show cave in the 17th century, those people who crossed or voyaged through Kranjska, had enough opportunity to visit some cave. And at the beginning of the 19th century "the real cave tourism started", due to the fact that Postojnska and Škocjanske Jame were organised as show caves.

During the 19th century not only show caves, but also some other activities were very important for the popularisation of the karst underground. First the investigations for the Trieste water supply must be mentioned. A group led by Svetina tried to follow the underground Reka river course downstream into Škocjanske Jame; another group, headed by Lindner, tried to find the underground Reka beyond Trieste through deep shafts. In 1841 they discovered Labodnica (Abisso Trebiciano), 329 m deep, which held the world's deepest record for nearly 70 years (Shaw, 1961). The second achievement was the exploration of Schmidl: under an impulse and with the support of Southern Railways (the Vienna - Trieste railway reached the Carniolan karst in 1857) he published descriptions of his investigations. His book "Die Grotten und Höhlen von Adelsberg, Planina und Laas" (1854) had the greatest influence. In 1884 the caving section of Deutsche und Österreichische Alpenverein, Section Küstenland, was founded in Trieste and this is the beginning of successful explorations of Škocjanske Jame (Svetina penetrated few hundred meters only and Schmidl just little further). The main explorations ended with the discovery of Tiha Jama in 1904. Another important work of this section was exploration of Kačna Jama (1888) where later (1972) the underground Reka river was discovered. Nearly at the same time (1886) Putick came to Kranjska to make investigations in order to prevent floods on the karst poljes. At first he wanted to explore spring caves and ponor caves there and to find the underground channels connecting the poljes. In 1886 he explored the shaft Gradišnica, over 200 m deep (where Schmidl had failed) and his name is associated with most of the important water caves in the Ljubljanica river basin. His co-operation was essential for Martel's successful descent of the underground Pivka river, from Postojnska to Magdalena Jama (1893).

At the end of the 19th century a lot was already known about the caves of Kranjska, so that the data collected here could be used in the dispute between the followers of Grund's "karst underground water table conception" and Katzer's "underground streams".

The general situation at the beginning of the 20th century was as follows: karst as an international term and karstology (with speleology) as a special "karst & cave science" were widely recognised. The basic karstological and speleological works have been already published. There were several organisations dealing with karst research: speleological organisations at Trieste (3), Ljubljana and Postojna (all were amateurs). "Društvo za raziskovanje jam na Kranjskem" (DZRJ - Cave research society in Carniola) had even "scientific" and "hydrological" sections. Gratzy (1897) published a sort of Cave register of Kranjska, where the biographical data for more than 100 caves were gathered.

KARST SCIENCE AND SPELEOLOGY BETWEEN THE 1ST AND 2ND WORLD WAR

At the end of the 1st World War the situation changed. A great part of Kranjska karst became Italian and it was a core of their karstological and speleological activities. In 1926 the book "Duemila Grotte" (Two thousand caves) was published, financially supported by the money of Postojnska Jama, containing mostly caves from the Dinaric part of karst, although some data are doubtful. In 1929 "Istituto Speleologico Italiano" (Italian *speleological institute*") *was founded at Postojna*, and the next year the Biospeleological station was opened in a passage in Postojnska Jama. The institute published the review "Le grotte d'Italia" and started scientific work in caves (cave vegetation, sedimentological analyses, geophysical research).

In the Slovene part of the Kingdom of the Serbs, Croats and Slovenes, later called Yugoslavia, the leading organisation was DZRJ, dealing mostly with cave explorations in Notranjsko and Dolenjsko areas. Very important was the foundation of the Cave Register (Kataster jam) where the documentation of about 600 caves was gathered up to the beginning of the 2nd World War. Slowly other caving organisations were founded in other parts of Slovenia. Two events have to be mentioned: in 1927 Županova Jama was opened as a show cave, and in 1928 biospeleological station in Podpeška Jama (Dobrepolje), run by biologists of Ljubljana University, began to operate.

Maybe the most important change from the previous period was the absence of foreign researchers on our karst. Slovene specialists, mostly geographers, published a number of works about the karst in Slovenia. Among the first were K. Pick (1920) on karst hydrography and P. Kunaver (1922) on karst phenomena, later followed by Bohinec, Melik, Rus, *etc.* T he common ground is that

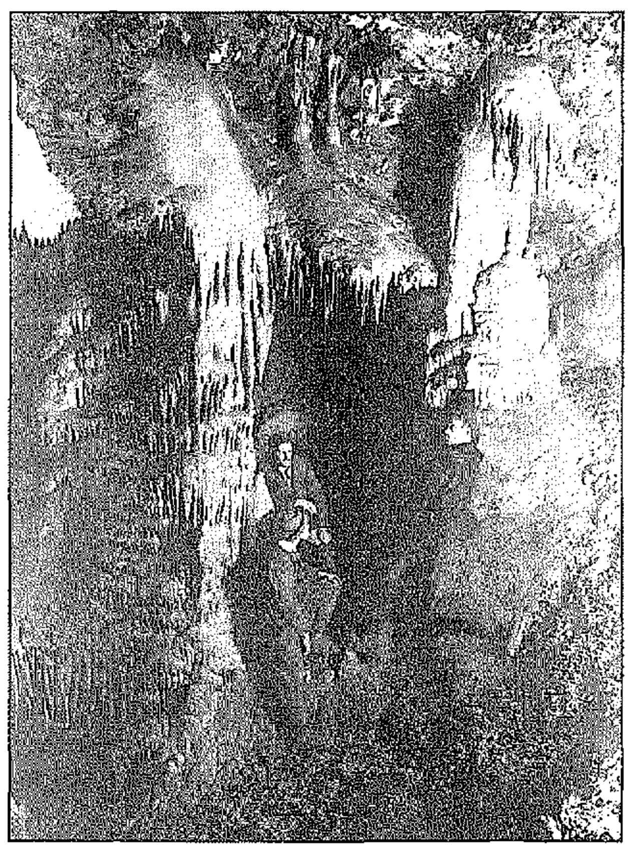

Fig. 2: Members of the Cave research society at the bottom of a shaft (Photo by Pavel Kunaver).
Sl. 2: Člani Društva za raziskovanje jam na dnu brezna (foto Pavel Kunaver).

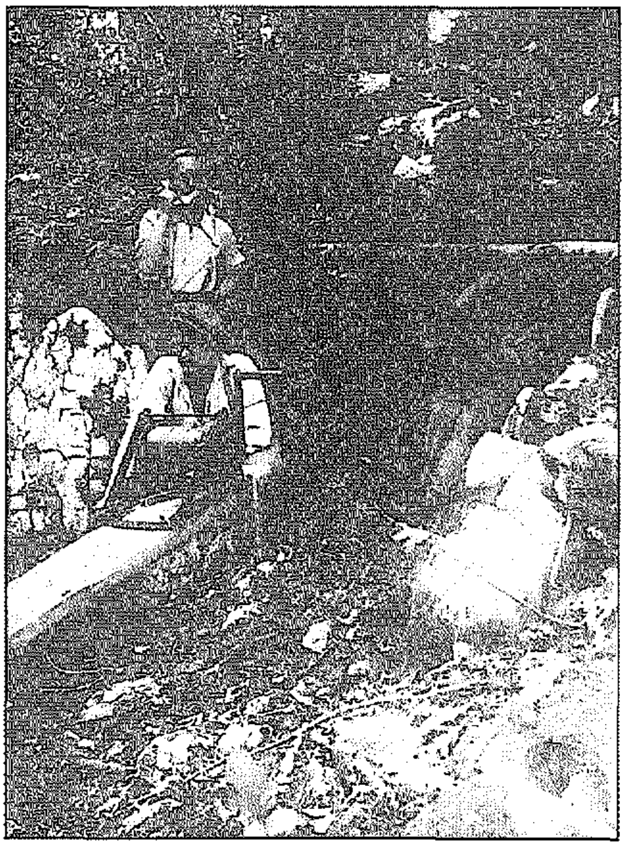

Fig. 3: Winch was used for deeper shafts - at the winch is Alfred Šerko, the first head of the Karst research institute at Postojna (Photo by Roman Kenk, 27th July 1932).
Sl. 3: Za globlja brezna so jamarji uporabljali vitel - ob njem Alfred Šerko, prvi direktor Inštituta za raziskovanje krasa v Postojni (foto Roman Kenk, 27.7.1932).

they studied Slovene karst (although in the 1930s they organised an "expedition" to Vjetrenica in Herzegovina) and published their results in mostly Slovene language. Their work was very important for the knowledge of the karst in Slovenia, regarding the popularisation of karst and cave science among the Slovenes, but it did not play an important role in international circles.

PROSPERITY AFTER THE 2ND WORLD WAR

After the 2nd World War both karstology and speleology got a new impetus. Caving organisations were founded in smaller places also, the DZRJS developed into an association and accordingly changed its name into Speleological Association of Slovenia. "Kataster jam" has complete documentation on some 7,000 caves, and in the Alps deep shafts (more than 1000 m) are being discovered and achieving world importance again.

Often the leading persons in caving activity were also the leading karstologists. Essential for karst research was the reopening or founding of the Karst Research Institute at Postojna by the Slovene Academy of Sciences and Arts. From one point of view this was the continuation of the Italian speleological institute but the staff changed completely and the research was oriented slowly from speleology to karstology. The Institute started to publish "Acta Carsologica" in 1955, and the caving organisation its journal "Naše jame" in 1959.

If it is necessary to compare the post-war research with that from before the war the main characteristic is the change (slow, of course) from describing karst phenomena to the investigation of karst processes. The second characteristic is the internationalisation of cave and karst science and international co-operation. It was symbolised by the foundation of the International Speleological Union during the 4th International speleological congress (Ljubljana - Postojna 1965). Cavers soon participated in foreign or international caving activities (in Teufelskessel, Austria, and in Tatras, Poland, both in 1959) and later organised expeditions to remote

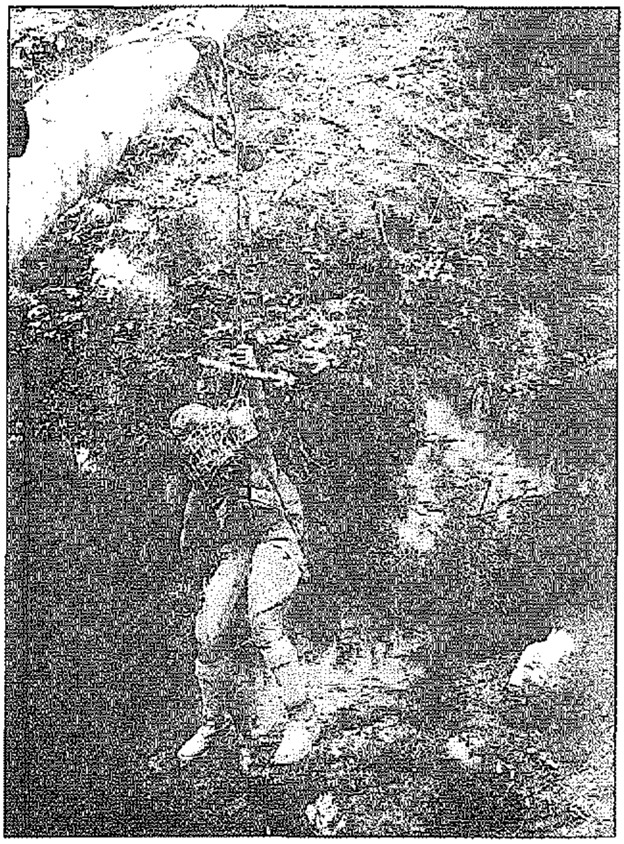

Fig. 4: The caver is lowered by the winch down the shaft, on 3rd September 1929 (Photo by Roman Kenk).
Sl. 4: Jamarja spuščajo z vitlom v brezno, 3.9.1929 (foto Roman Kenk).

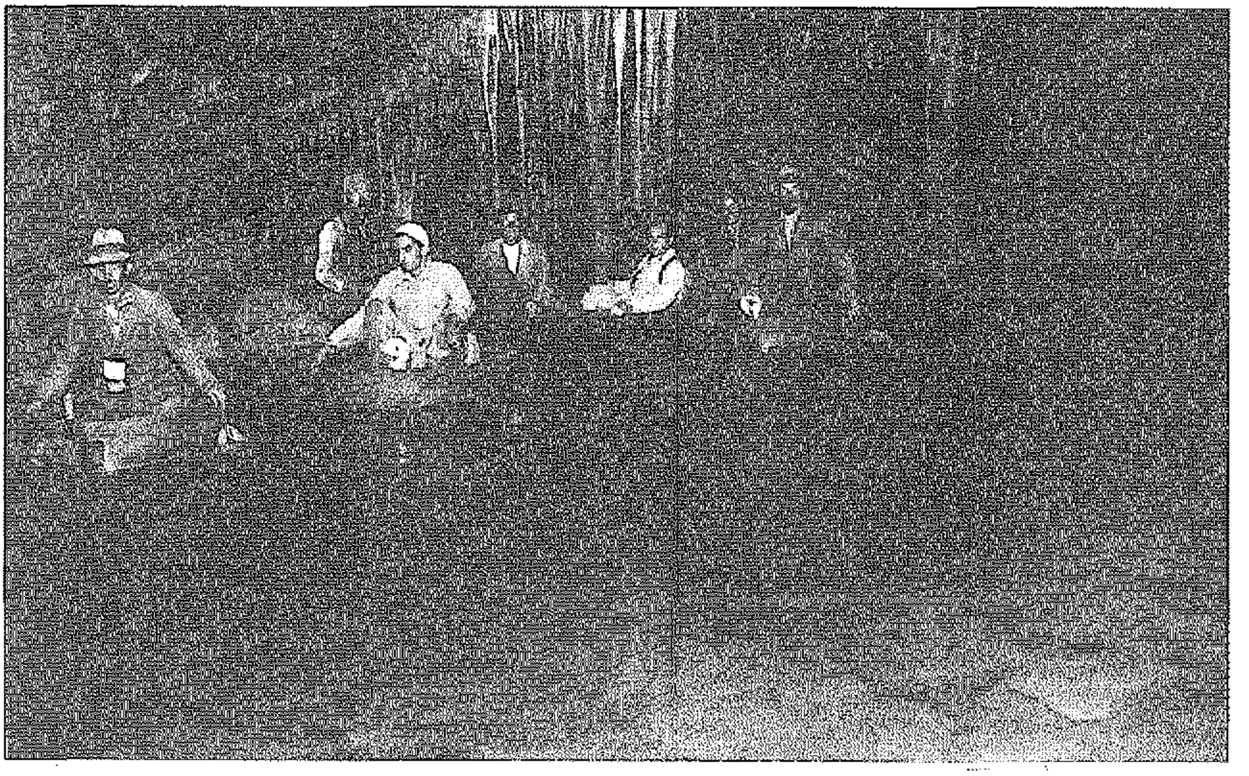

Fig. 5: "Caves' navy" in Križna jama cave on 18th July 1935 (Photo by L. Mandl?).
Sl. 5: "Jamska flota" v Križni jami 18.7.1935 (foto L. Mandl?).

karst terrains (South America, Philippines, China). Karstologists took part in and organised international professional meetings, study visits and inter-academic exchange which allowed them to introduce their work and to get acquainted with karst in foreign countries. Karstology was slowly becoming more and more important from an economic point of view. The research was incorporated in planning and implementation of different projects such as water supply, motorway construction, show cave displays, *etc.*

ROLE OF SLOVENIA IN THE INTERNATIONAL KARST SCIENCE

And what are the intentions of karst research in Slovenia?

Full, detailed studies in all the branches of karstology, but specially in:

- geomorphology (morphogenesis of "cone hills" and quantitative measurements of geomorphologic agents),
- tectonics, and the role of geological discontinuities in morphogenesis and speleogenesis,
- study of the epikarst from different points of view (CO_2, percolating water, transport of pollutants, flowstone deposition),
- detailed speleological studies supported by monitoring (microclimate, cave ecology, sediment datations),
- detailed local and regional karstological and speleological studies focused on the protection and safeguarding of karst phenomena and the karst environment.

More and more detailed study of wider topics demands changes in education too. In Slovenia, not long ago the karstologist were self-taught, while in recent years some karst topics have already been included in regular study, as for example lectures on karst geology or on karst geography in the geological and geographical departments of Ljubljana University. The number of universities and high schools is increasing and I hope that some of them will decide to include karstology in their regular programmes. This could be a speciality and appeal of the "third university" in the Slovene Littoral, and it could distinguish it from other high schools in Slovenia and elsewhere. Of course, "informal education" can be very important too, as it is proved by widely accepted "International karstological school Classical Karst". At the initiative and with the help of the Slovene National Commission for UNESCO, the first of these was organised in 1993, and the fifth in 1997. That it is successful has been proved by the wish of the Commission for Education of the International Speleological Union to take active part in the organisation.

Regarding karstology, Slovene researchers are involved in so many international project that they cannot be enumerated. And what are their trump cards?

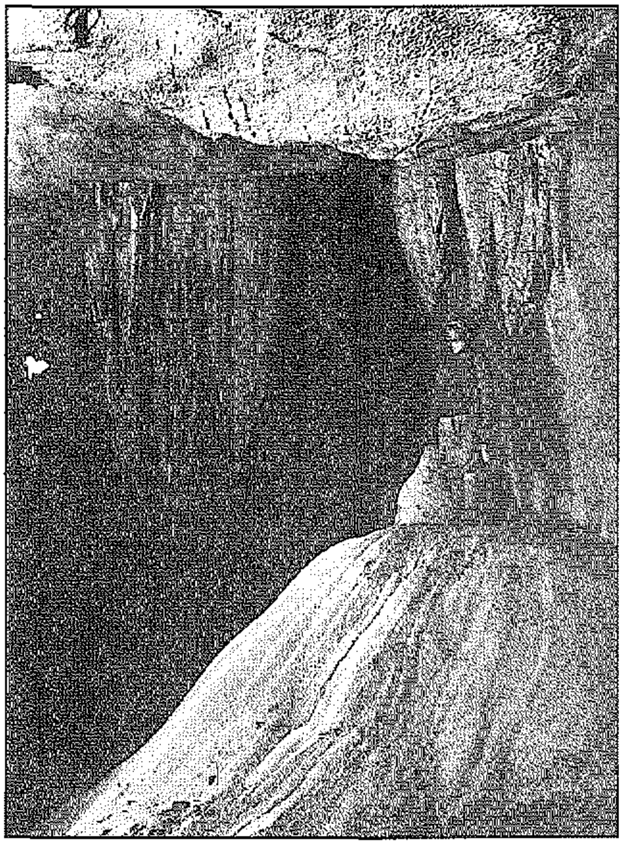

Fig. 6: Motif from the end of the cave Logarček (Photo by Ivan Michler).
Sl. 6: Motiv s konca jame Logarček (foto Ivan Michler).

The location on (or the possession of) the Classical Karst (the Kras itself), a part of "classical Dinaric karst" is without doubt very important, because every serious researcher is supposed to know it and visit it as well. And this can be best achieved in connection with Slovene researchers. Our advantage is also a great number of caverns appropriate for different observations and investigations taking into account their easy accessibility and equipment (electricity, doors). And last but not least there are also researchers of various specialisations speaking foreign languages who present the results of our investigations by attending international professional meetings, by publishing them in the form of articles and monographs and by being co-authors with foreign researchers. The organisation of international professional meetings - in Slovenia there is at least one per year - has to bear fruit sooner or later. A good example is the symposium "Classical Karst" at Lipica in 1997, being a pre-congress event of the International Congress of Geomorphology at Bologna (Italy). From the planned relatively humble symposium a top-level meeting of the world's leading karstologists developed, with the participation of over 70 members from all over the world including papers and discussions on a very high professional level.

The general trends of development of karstology in Slovenia should be a detailed knowledge about the karst in Slovenia, in order to acquaint international professional circles with our results, intensive international co-operation, publishing (a lot in foreign languages), initiation of karstology as a subject at university, co-operation in solving practical questions (water, constructions, tourism), and, of course, an adequate support of the state, moral, financial, and otherwise.

O KRASOSLOVJU IN SPELEOLOGIJI V SLOVENIJI (O ZGODOVINI VEDE O KRASU IN JAMAH TER O NJUNIH PERSPEKTIVAH)

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POVZETEK

Čeprav so bila številna kraška ozemlja znana že v antiki, je ravno iz imena pokrajine Kras v zaledju Tržaškega zaliva nastal mednarodni strokovni termin "kras" (karst), o čemer je bilo pisano tudi že na straneh te revije (Gams in Kranjc, Annales 4/94, 1994, 131-142).

Termin kras so v drugi polovici 19. stol. vpeljali predvsem avstrijski geologi in geografi, čeprav so se nekateri strokovnjaki (npr. E.-A. Martel) temu upirali. Kljub temu, da je bil izraz kras že splošno sprejet, pa se ime za vedo "krasoslovje" še ni pojavilo. Izraz kras je bil sprejet zahvaljujoč tudi opisom učenjakov in popotnikov med 17. -19. stoletjem. Med temi je treba omeniti Valvasorja (1689), Nagla (1748), Steinberga (1758), Hacqueta (1778-1789) in Gruberja (1781). Prvi, za katerega vemo, da je jasno povedal, da "kras ni le na Krasu", je bil Hohenwart (1830). Sledili so geologi (Morlot, Lipold, Stur, Boué, Stache, Mojsisowicz) in geografi (Schmidl, Lorenz, Urbas). Končno je J. Jesenko (1874) predlagal, naj slovenska terminologija sprejme izraza "kras" ali "kraševino".

Poznavanje krasa na Slovenskem je tesno povezano s poznavanjem kraškega podzemlja. Jame so obiskovali že od nekdaj, npr. Sveto jamo pri Socerbu po izročilu od 3. ali 4. stol. dalje, cerkev v Landarski jami je omenjena l. 888, Vilenica je bila že v 17. stol. prava turistična jama.

V 19. stol. so še nekatere druge dejavnosti pripomogle k poznavanju krasa tudi med laiki. Take so bile raziskave v zvezi z oskrbo Trsta z vodo (prodiranje v Škocjanske jame, odkritje 329 m globoke Labodnice), raziskovanje Škocjanskih jam ter njihovo urejanje za turistični obisk (1884-1904) ter Putickove raziskave (od 1886 dalje) v zvezi s preprečevanjem poplav na notranjskih kraških poljih.

Na začetku 20. stol. sta bila tako termin kras za posebno obliko zemeljskega površja in veda krasoslovje, ki se z njim ukvarja, splošno sprejeta. Izdana so bila temeljna krasoslovna in speleološka dela, več organizacij (v Trstu, Ljubljani in Postojni) se je ukvarjalo z raziskovanjem krasa in Gratzy (1897) je objavil zbrane bibliografske podatke o preko sto kranjskih jamah.

Med obema vojnama je bil razvoj v delu pod Italijo in v delu pod Jugoslavijo različen. Postojnska jama je postala državna, 1929 so v Postojni ustanovili Italijanski speleološki inštitut (ta je izdajal revijo Le Grotte d'Italia), 1930 pa Biospeleološko postajo. V Sloveniji je potrebno omeniti raziskave Društva za raziskovanje jam, odprtje Biospeleološke postaje 1928 v Podpeški jami in odprtje (1927) Županove jame za turizem. S krasoslovjem so se ukvarjali predvsem geografi, kot Bohinec, Kunaver, Melik in Rus.

Po II. vojni je iz Društva za raziskovanje jam nastala Jamarska zveza Slovenije, v njenem "Jamskem katastru" se je nabralo podatkov že o 7000 raziskanih jamah, med katerimi so tudi preko 1000 m globoka brezna, kar spet uvršča naše jame med prve na svetu. 1947 je bil v Postojni ustanovljen Inštitut za raziskovanje krasa, 1955 je pričel izdajati zbornik Acta carsologica, 1959 pa je začela izhajati jamarska revija Naše jame.

In kakšne naj bi bile bodoče naloge in perspektive slovenskega krasoslovja? Morali bi čim podrobneje preučevati in spoznavati kraške pojave na Slovenskem ter procese, ki jih oblikujejo, s svojimi dosežki seznanjati mednarodno strokovno javnost, skrbeti za čim tesnejše mednarodno sodelovanje, čim več in čim hitreje objavljati svoje izsledke in spoznanja (s poudarkom na objavah v tujih jezikih), skušati vpeljati poučevanja krasoslovja na univerzitetni študij, sodelovati pri reševanju vprašanj vsakdanjega življenja (oskrba z vodo, gradnje, turizem) in pridobivati zaupanje ter pomoč družbe oziroma države.

Ključne besede: krasoslovje, speleologija, zgodovina, Slovenija, Kras

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THE CAVE ROCKY RELIEF OF THE DIMNICE CAVE

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ABSTRACT

The rocky relief cave passage surfaces helps to explain a complex genesis of a ponor cave. In this cave traces of the oldest water flow that had shaped the passages are preserved, the traces of faster streams flowing above the gravel and the water which shaped the rock surfaces as it flowed above the fine-grained sediments that filled up the cave. Today the water flow is found in the lower passage and the cave is shaped by the water that trickles down the walls of the entrance shaft and by the humidity due to strong air circulation. Slight weathering of the rock surfaces and flowstone is due to well-pronounced microclimatic conditions in this cave.

Key words: cave rocky relief, shape and development of karst caverns, the karst of Istria, Slovenia

INTRODUCTION

Describing speleological characteristics, I focused my attention on the central part of the cave and studied cave rocky relief in this part, as the other parts are of difficult access because of siphons. In Dimnice the cave rocky relief reveals several important periods of the cave development. I attempt to point out the characteristics of single cave features in the passages where the development was diverse. The origin of these features are described in detail elsewhere (Slabe, 1995).

Location and cave description

On the southern slopes of the flysch Brkini hills bordering the Materija karst lowland in the north, the waters join into a superficial network and at the contact with limestone, where blind valleys developed (Gams, 1962), disappear underground. At the end of the blind valley near Velike Loče, where two major streams and their tributaries from the area near Slivje to the west, Kovčice to the east and Sv. Štefan to the north join, the water sinks through several swallow-holes into the Dimnice cave; so far this is the longest explored cave of this lowland.

In front of the swallow-holes the stream is incised into older fluvial sediments, covering the bottom of the blind valley to a depth of about 5 m. To the north the floodplain above the limestone base gradually rises to the flysch slopes. Here and there the limestone is exposed on the surface in a narrow belt between the floodplain and the flysch background. The surface above the cave is 525 m a.s.l. at the lowest point, near the actual swallow-holes on the southern border of the blind valley; from there the limestone overlaying the cave rises westwards to a doline-pitted plateau, at about 580 m a.s.l. The cave passages explored so far are in their entirety accessible only to cave divers and they extend from below the blind valley to the elevation called Na Grižcah, which lies to the west of the entrance shafts being about 500 m north from Markovščina. The swallow-hole leading to the cave is not accessible as it is filled by breakdown boulders.

The area of contact karst consists mostly of the Cretaceous limestones; only in parts of the ponor and below the alluvial plain are there Paleogene Kozina limestones. The rock layers strike northwards and northeastwards, dipping by 30-60°, and make a part of the recumbent Materija anticline which is Dinarically trending and developed after deposition of the Eocene flysch beds (Pleničar, 1961, 95).

The cave (Figs. 1a and 1b) may be entered by steps cut into the sides of a shaft, 40 m deep; the cave consists of two levels. It reaches the surface also by another shaft above Male Dimnice.

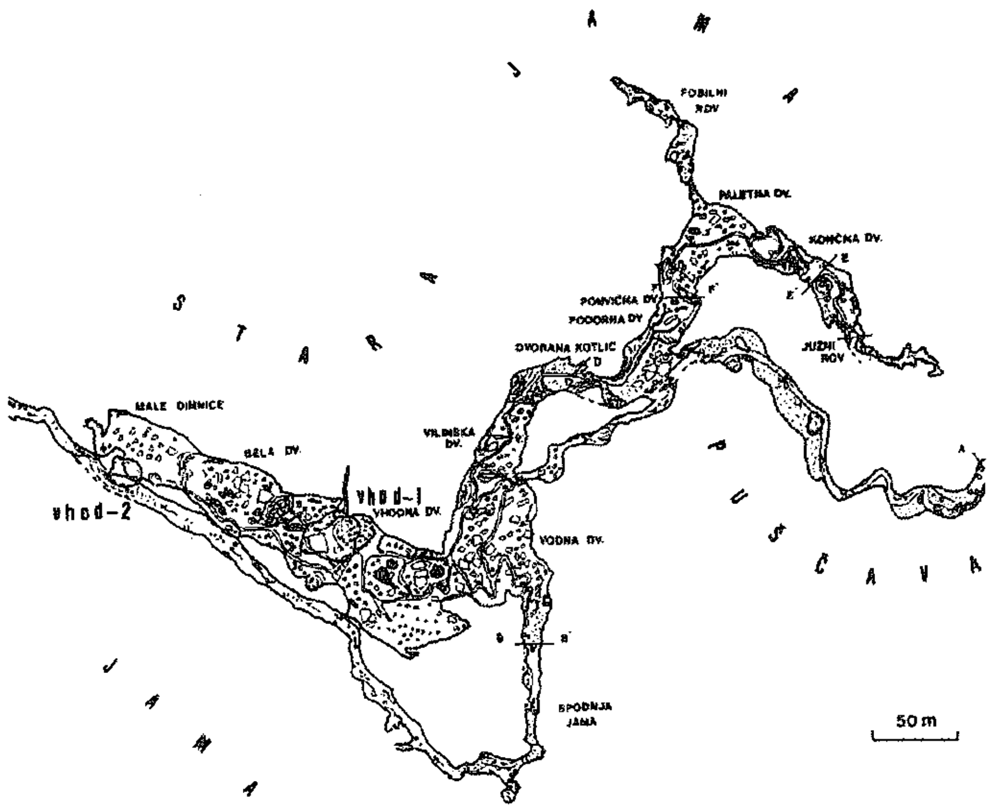

Fig 1a: The Dimnice cave plan.
Sl. 1a: Načrt Dimnic.

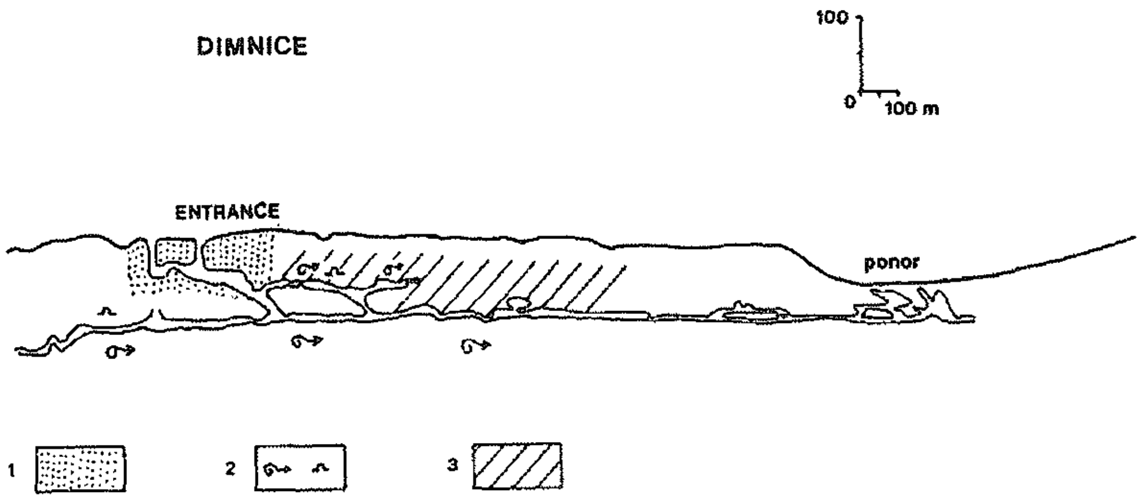

Fig. 1b: Longitudinal cross-section with rocky relief.
1. traces of water trickling down, moisture condensation and freezing,
2. traces of water flow,
3. along-sediment rocky features.
Sl. 1b: Vzdolžni prerez jame s skalnim reliefom.
1 sledi polzeče vode, kondenzacije vlage in zmrzali,
2 sledi vodnih tokov,
3 obnaplavinske skalne oblike.

Below the shaft, the upper dry passage opens. The biggest cave spaces are found just in the entrance part. Northwards the Vhodna Dvorana leads into Bela Dvorana, a 40 m wide and up to 20 m high chamber; it is separated from Male Dimnice only by speleothems; this is a 60 m long and 50 m wide passage from which the shaft leads to the surface. Eastwards the cave leads into the most spacious part of the upper level, Vodna Dvorana, 50 m wide and up to 30 m high; this chamber lowers eastwards to the contact of breakdown with the lower, active level. Northwards the passage is narrower and lower and it continues by Vilinska Dvorana, a 25 m wide and up to 15 m high chamber which lies 10 m above the level of the northern part of Vodna Dvorana. It is followed by Dvorana Kotlic, which is at first 15 m wide and of the same height and after an oxbow to the east it is only 3 m wide; the passage opens into Podorna Dvorana, a 30 m wide and 20 m high breakdown chamber; from there it lowers eastwards into a breakdown transverse where the lower level is reached for the second time. The chamber continues into Ponvična Dvorana and then Paletna Dvorana. Paletna Dvorana is 25 m wide and up to 10 m high. The main passage, 150 m long and 15 m high, runs south-eastwards, and is divided by flowstone into two chambers, called Kitajska Dvorana and Končna Dvorana, and from it branches off to Fosilni Rov, up to 10 m wide.

Through breakdown passages the lower level, where water flows, may be reached. Below Podorna Dvorana opens up the so-called Puščava, a passage 15 m wide and up to 20 m high that continues eastwards into a narrow passage called Thamesis; this one is separated by siphons into several parts. The right initial branch of the cave approaches the swallow-hole eastwards within 15 m, while the left branch collects water from several swallow-holes at the southern border of the blind valley. At the bottom of Vodna Dvorana lies Spodnja Jama; the water passage is 6 m wide and 2 m high downstream from the old water catchment. At first it leads southwards, and after 100 m it turns southwest. Between Puščava and Spodnja Jama there are collapse Dihalniki where water flows through breakdown boulders, and either stagnates or flows over cascades.

The upper level is about 500 m a.s.l. and is 2000 m long. In the entrance part of the cave the level of the larger chambers is some 10 to 20 m higher due to roof collapse and accumulation of breakdown boulders on the floor. The lower level, about 4000 m long, gradually descends westwards from the swallow-holes that are at 525 m a.s.l. to reach 430 m a.s.l. Particularly in the eastern part this level consists of two passages that are parallel at a vertical distance apart of 10 m and in several places connected by breakdowns. The upper passages of the cave below the swallow-holes are higher due to breakdowns.

The central part of the cave lies in the Upper Cretaceous Turonian and Cenomanian limestone. The beds dip towards northeast or north-northeast striking for 40-50°. The rock is densely fractured and fissured with prevailing NW-SE and NE-SW trends. The passages of the cave have the same direction. The levels connected by breakdown passages are parallel, indicating their origin along the same crushed zone of the rocks.

The rocky bottom is not seen as it is thickly covered by deposits transported into the cave and by breakdown boulders and rubble.

Loam covers the bottom and sometimes even gently sloping walls in Končna Dvorana, in Južni Rov that joins this chamber, and in Dvorana Kotlic on the upper level. Older loam may be traced also in cross-section of speleothems. At the lower level the loam is found on gently sloping walls in Puščava; at its bottom the stream flows over pebbles and they are found even 8 m above the actual river-bed. In Spodnja Jama also the stream flows over flysch pebbles, some of them are coated by carbonates and they are cemented into weakly consolidated conglomerate on the riverbank. Gravel is found in the upper level also. In Končna Dvorana it is seen in a hole at the north-west below the flood loam and in Južni Rov below the uncovered cross-section of fine-grained flood cover of the floor. Flysch pebbles are also along the flowstone that separates Končna Dvorana and Paletna Dvorana and on gently sloping walls of Fosilni Rov and Paletna Dvorana. Nadja Zupan Hajna (1994) studied the flood loams in Dimnice.

In the cave there are many flowstone cones and speleothems that divide otherwise uniform passage into several parts, large enough to be called chambers. In the lower level, old speleothems and flowstones are also preserved in a river-bed and now water flows through and above them.

A considerable part of the floor in the upper level, and in Dihalniki and Puščava of the lower level, is covered by breakdown blocks, in particular in sections that developed in more crushed rocks and are now higher due to breakdowns.

Due to distinctive breakdown, the rocky surface of the cave is also mostly shaped by collapses. Only the upper half of Južni Rov still bears a semicircular cross section with a distinctive corrosion notch below the ceiling. On the perimeter there are scallops. The rock surfaces shaped by water flow are also preserved in a part of the ceiling of Ponvična Dvorana and in Dvorana Kotlic. On the lower level there is a characteristic cross section due to water flow downcutting preserved in Vodni Rov and in the lower part of Puščava.

CAVE ROCKY RELIEF

Rocky features are to a large extent transformed by younger weathering and breakdown and partly covered by flowstone; the bottom of the cave is thickly covered by sediments, breakdown rubble and larger blocks thus offering only a partial insight into speleogenetic phases. By the shape of the rocky perimeter one may distinguish:

a. rocky features due to fast water flow,
b. rocky features along the sediment,
c. breakdown due to weathering and collapse of the rocky perimeter,
d. traces of condensation corrosion and thin weathering of the rocky perimeter due to cave microclimate,
e. features due to water trickling down the walls of entrance shafts.

Rocky features due to a fast water flow

Scallops and ceiling pockets in the lower passage

Features due to a fast water flow on the lower level are traces of the youngest period of the cave development. The only exception is the wall above the river-bed in Puščava dissected by semicircular longitudinal notches. To the north-eastern side of the passage, some

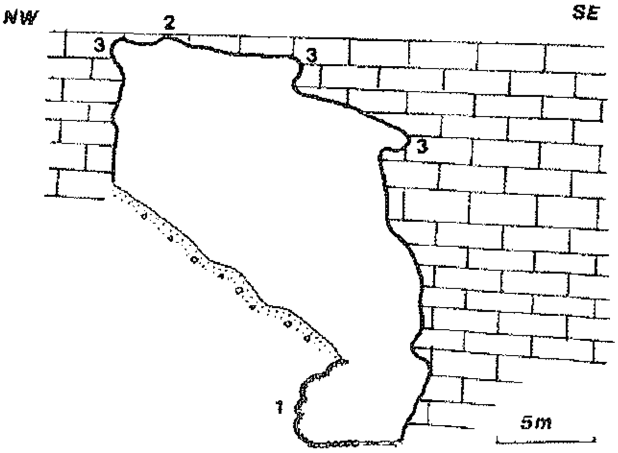

Fig. 2b: Cross-section of Puščava.
1. wall notches with scallops,
2. ceiling solution cup,
3. below-sediment wall notches.
Sl. 2b: Prečni prerez Puščave.
1. stenske zajede s fasetami,
2. stropna kotlica,
3. podnaplavinske stenske zajede.

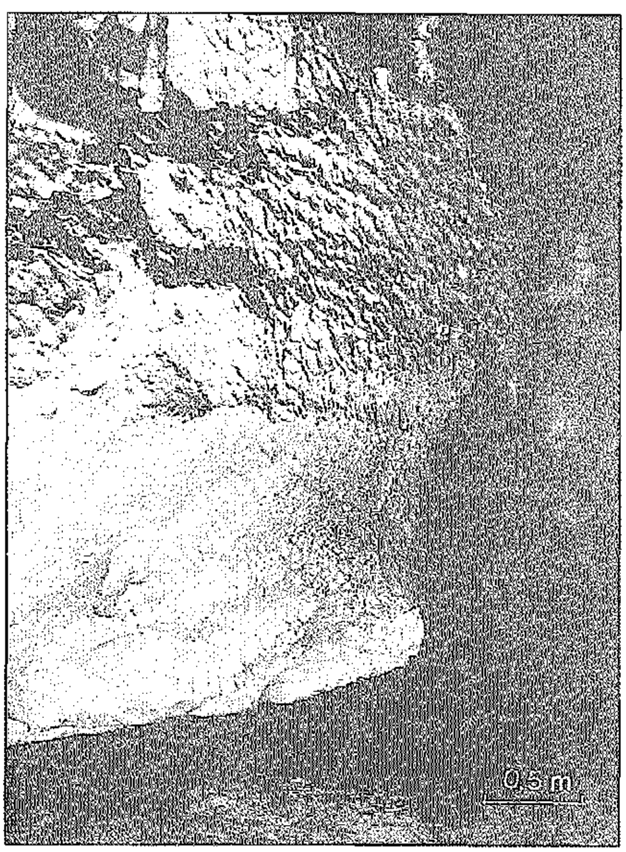

Fig. 2a: Scallops above the stream.
Sl. 2a: Fasete nad potokom.

20 m in front of the siphon, the river-bed is cut down deeper. The north-western perimeter of the river-bed is dissected into semicircular horizontal notches, about 1 m across, arranged in steps above the bed.

Scallops are on the walls of the river-bed. In the lower part they are smaller, from 30 to 50 mm across; higher up they are bigger, from 50 to 100 mm across. In narrow notches, about 0.15 m across, parallel to the water flow, wide flutes from 60 to 70 mm developed.

Similar distribution according to size is found everywhere in the river-bed of Puščava. In the middle of the passage there are scallops on the convex part of an oxbow (Figs. 2a, 2b) while on the other bank there is a gravel dam. Above the water flow of a medium discharge the scallops are 40 mm across, 2 m higher the diameter increases to 70 mm. About 0.1 m above the present water flow the longitudinal wall notch ends, and water flow shapes a new one. Water transports the gravel and deepens the river-bed.

Scallops are also on the rock perimeter and on rock blocks in the river-bed of Dihalniki. Above the water level of a medium water table their diameter is 50 mm; higher up, up to 5 m above the water level, the scallops are bigger, up to 100 mm across.

On the perimeter of Spodnja Jama (Fig. 3) the scallops are of the same size, being 50 mm across. The ceiling along the fissures is deepened into notches due to a typical turbulence of a slower water flow occurring when the passage is completely flooded. About 0.2 m above the level of the medium discharge the passage is indented into a new wall notch. There are potholes in

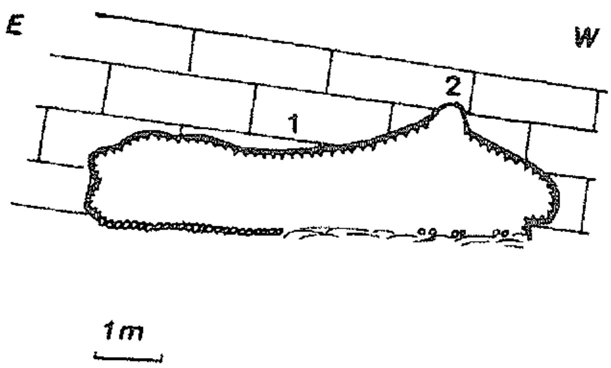

Fig. 3: Cross-section of Spodnja Jama.
1. scallops,
2. solution cup.
Sl. 3: Prečni prerez Spodnje jame.
1. fasete,
2. stropna kotlica.

the flowstone floor, 0.1 m across whirling small pebbles.

When flood water retreated from lower passages, water started to remove the loam and to cut into the older river-bed, covered by gravel.

The notches were uncovered due to changes in water level when the periods of downcutting into the rock bottom alternate with deposition and transport of gravel.

Bigger scallops preserved higher above the actual water level were excavated by a slower water flow. When there is a lot of water the passages are less permeable and the water flow consequently slower. Faster flows incise smaller scallops in the lower part of the river-bed. In Spodnja Jama the scallops are smaller over the whole perimeter due to smaller cross section of the passage; so the water flowed through the entire tube faster even when it was completely flooded.

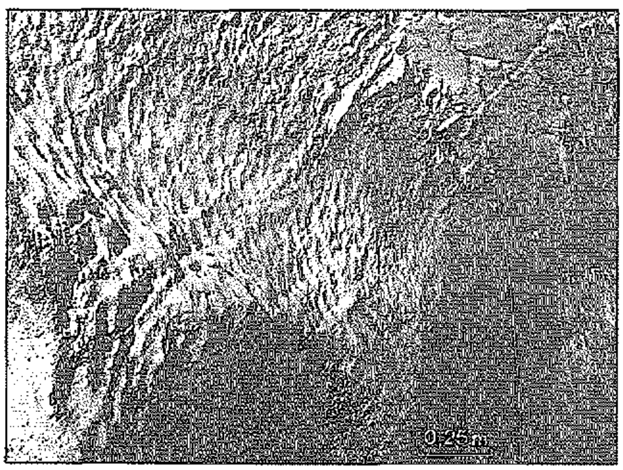

Fig. 4a: Old scallops in Južni Rov.
Sl. 4a: Stare fasete v Južnem rovu.

Today water is deepening its river-bed, removing gravel and downcutting into flowstone.

It is difficult to ascertain whether the flowstone in the river-bed had been deposited before the flood infill by fine-grained sediments or afterwards. The fact is that water pierced through the larger flowstone cones, and single speleothems are preserved in the middle of the water current; they were deposited at a time when the river-bed was dry.

Old rocky features due to water flow

On the perimeter of the upper old passages there are not many features left from the old water flow. Probably they are hidden below a thick cover of sediments; often they were removed by weathering of the rock perimeter or transformed by corrosion at the contact with flood loam.

Scallops, ceiling pockets and wall notches are the features due to fast water flow.

The scallops are best preserved (Figs. 4a, 4b) on the ceiling and on the eastern wall of Južni Rov where it joins Končna Dvorana. The size of scallops gets smaller upwards. The biggest, 50 or more mm across, are found at the lower part of the wall and also on a break-down block on the floor. In the central part of the wall the scallops are 30 mm across. The smallest are found in a semicircular notch on the upper part of the walls and on the roof; they are only 15 mm across.

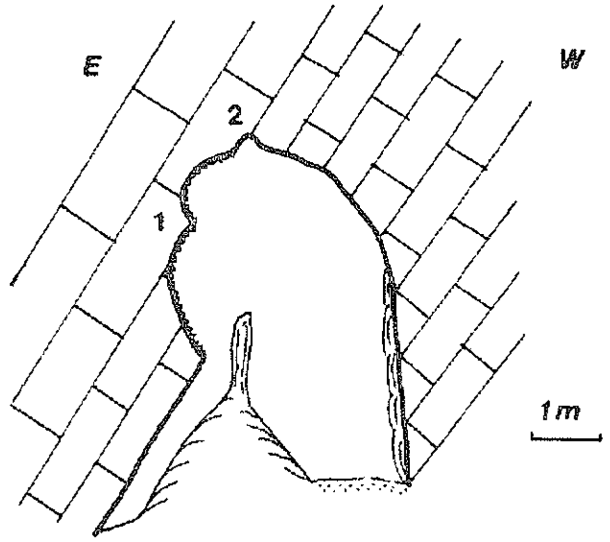

Fig. 4b: Cross-section of Južni Rov.
1. scallops,
2. above-sediment channel.
Sl. 4b: Prečni prerez Južnega rova.
1. fasete,
2. nadnaplavinski žleb.

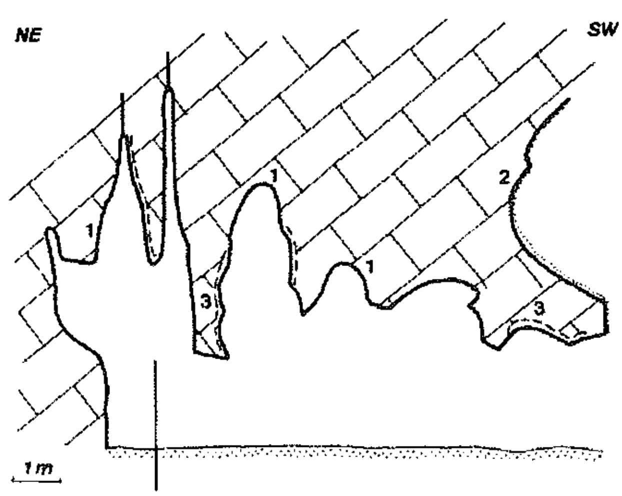

Fig. 5: Longitudinal section of Bar.
1. solution cups,
2. scallops,
3. above-sediment ceiling channels.
Sl. 5: Vzdolžni prerez Bara.
1. stropne kotlice,
2. fasete,
3. nadnaplavinski stropni žlebovi.

On the south-western wall of the Paletna Dvorana, close to the passage from Kitajska Dvorana, there are scallops in the wall of an overhang above the recent floor covered by flowstone. They are 30 mm across and partly blurred due to corrosion at the contact with loam infills in the passage. On the same wall the surface of a wall notch, which passes along the passage roof and has on the floor flysch pebbles coated by a thin layer of loam, is covered by scallops. These are 15 mm across; that is they are smaller than those at the lower part of the wall.

In the Fosilni Rov there is on part of the ceiling a network of not distinctive solution niches, 50 mm across. It seems that this is a part of the scalloped surface of a former water passage which was later reshaped due to corrosion above the loam infill and due to breakdowns. On the floor and even on the walls a small amount of flysch pebbles is preserved.

On the western side of Ponvična Dvorana there is a vault, about 2.5 m wide, incised into the roof. On the vaulted roof there are smaller scallops, 30 mm across.

A semicircular notch, about 3 m in diameter, in the south-western wall of Končna Dvorana, lying at the level of the southern passage, is probably a continuation of the same features due to the same water flow. But the surface of the wall notch was later transformed due to corrosion at the contact with loam.

In the lower part of the northern wall of Marmitna Dvorana is a relict of the best preserved water passage (Fig. 5) partly transformed below the loam deposits. The semicircular overhang Bar is 10 m long and 6 m wide, incised into the wall about 2 to 3 m above the passage floor; the whole north-eastern part of Marmitna Dvorana is covered by loam.

The upper parts of wall and roof of the overhang consist of big solution cups, up to 1 m wide and up to 2 m deep. Most of them developed along the fissures; the character of fissure influenced the shape of solution cup. Along distinctively vertical or only slightly inclined fissures, some deeper solution cups, narrowing downwards, developed. Along thinner fissures there are shallow solution cups of semicircular cross-section; some are composite, inside a larger one there is another one or several smaller ones. Solution cups that were not controlled by fissures are the most shallow. The solution cups are due to turbulent water flow in a leeward side of a wall notch where the rock was easily dissolved along a fissure. Due to the diversity of thin fractures the efficiency of downcutting was different and composite solution cups developed. It seems that the deepening and conical narrowing of deep solution cups was controlled by water disappearing through a fissure. On the outer surface of the overhang there are smaller scallops due to fast water flow, about 30 mm across.

There are two periods of old rocky features due to fast water flow. It may be concluded that different sizes of scallops on the upper part of the rim which are diminishing toward the ceiling are controlled by different water flow velocities. The rock type of the surface that also affects the size and shape of scallops, does not change in a cross-section of this passage. Such a case exists in Južni Rov of Končna Dvorana and in Paletna Dvorana. Also in the vaulted roof of Ponvična Dvorana there are small scallops preserved. Gravel remains in many places, also above older flowstone. One may suppose that water filled the passage with gravel and by diminishing its diameter the velocity of flow increased. This is a swallow-cave and water easily transported gravel into it. Horizontal wall notches in Južni Rov clearly mark the levels of gravel infill above which the water used to flow.

Solution cups and scallops in Bar and on the lower part of the wall in Paletna Dvorana are traces of older water flow that used to flow in lower parts of the passage which was at the time of formation of the upper part covered by gravel. The scallops and solution cups in Bar developed at the same time. The scallops are due to water flow strongly washing the exposed parts of the wall, and on the leeward side of a niche bigger local whirls developed, shaping solution cups.

Along-sediment rocky features

Prevailing traces in rock surface of the cave are due to water flow above the flood loam and to rock weathering at the contact with loam. They are found on both

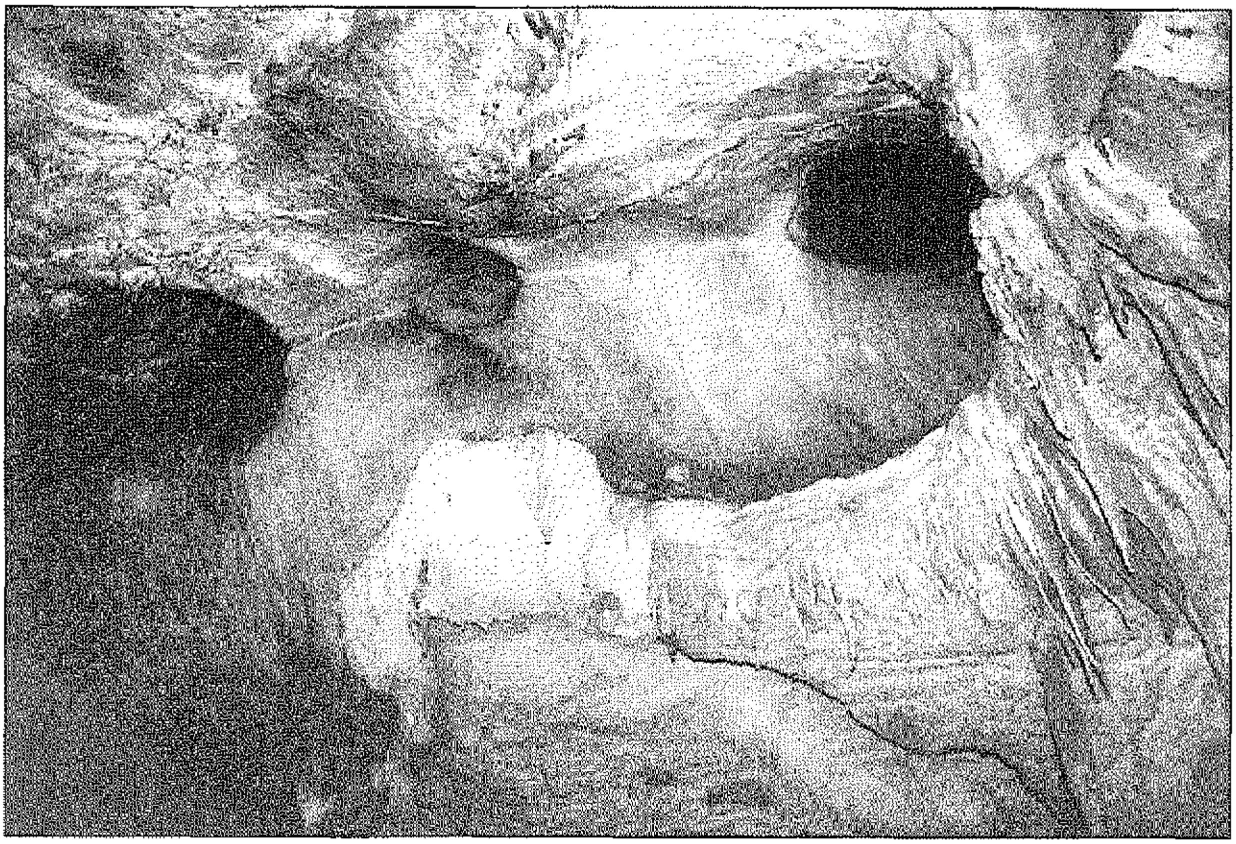

Fig. 6: Solution cups in Ponvična Dvorana.
Sl. 6: Stropne kotlice v Ponvični dvorani.

levels where walls and ceiling have not been transformed by later breakdowns and water flow.

Traces of slow water flow above the loam sediments in the passages

On the ceiling and upper parts of the walls above the loam sediments solution cups and large scallops, as well as water level horizons, are evidence for a slow water flow.

In the upper level of the cave solution cups are preserved in Končna Dvorana, in Paletna Dvorana near the passage from Kitajska Dvorana, in Ponvična Dvorana, in Dvorana Kotlic and in Vilinska Dvorana and also on the roof of the overhang in the south-western part of Male Dimnice. In the lower level they are found only in a high passage called Puščava.

Solution cups may be divided into two types:

1. semi-circular solution cups, 0.5 to 1 m across, are individual and developed along non-distinctive fissures. In relation to their diameter these solution cups are shallow. Some of them are composite. In a bigger solution cup there may be one or more smaller ones; this is controlled by the character of the fissure where they developed.

2. Solution cups of ellipsoidal openings (Fig. 6), narrowing downwards like a cone, developed along well-pronounced fissures. Their longer diameter is 0.5 to 1 m. It is typical that their depth is greater than the diameter of the opening. Often they appear in a series along a fissure or they are combined into acomposite solution cup of an undulatory cross-section. Ceiling cups developed in a water-filled passage with a slow water flow that dissolved and whirled along the fissures. It seems that they were deepened by a mixture corrosion as water may suck the water from fissures. The axes of cups are differently inclined depending on the fissure character and water turbulence.

At the place where Končni Rov joins Končna Dvorana there are big scallops, 0.3 m in diameter, incised into the roof and northern wall. Similar scallops are found on the roof of a narrower, the north-eastern part of Dvorana Kotlic. In the narrower part of the passage the water flow above the loam sediments was slightly faster and it shaped scallops.

Below-sediment notches (Fig. 7) along the wall developed at the time when the passage was for a longer period filled by loam and water flowed above it; they are preserved in Ponvična Dvorana where there are, in the south-eastern part of the passage, two parallel notches below the roof; in the north-western part of the passage there is a lower notch showing that the level of deposits changed. Also in Puščava there are two well-preserved wall notches 3 m below the ceiling on both sides of the passage.

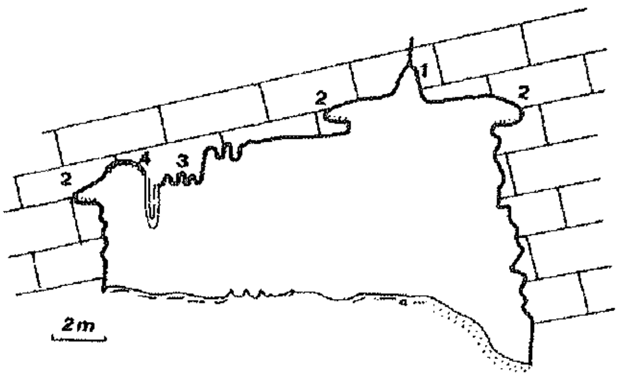

Fig. 7: Cross-section of Ponvična Dvorana.
1. solution cup,
2. below-sediment wall notch,
3. above-sediment ceiling channels,
4. scallops.
Sl. 7: Prečni prerez Ponvične dvorane.
1. stropna kotlica,
2. podnaplavinska stenska zajeda,
3. nadnaplavinski stropni žlebovi,
4. fasete.

Above-sediment ceiling and wall channels and anastomoses

About the anastomoses network in Paletna Dvorana (Fig. 8) I wrote in Acta Carsologica (Slabe, 1987).

In the north-eastern part of Ponvična Dvorana there are bigger ceiling channels, up to 1 m deep; most of them have omega-shaped cross-section. On flat bulge ends with square cross-section, 1 m across, lying between big channels, there are smaller channels, 20-30 mm across.

In the ceiling of a semi-circular notch in the south-south-western wall of Končna Dvorana there is two square meters of branching network with 50 to 100 mm wide channels with margin outflow channels directed downwards.

In Južni Rov near Končna Dvorana there are ceiling channels, 0.15 m wide and 50 mm deep, incised into scallops forming a smaller anastomosis network.

In Bar there are ceiling and wall channels, 50 mm across, even between the already mentioned solution cups and within them. This passage was filled by loam up to the roof and when flood water was flowing away it penetrated below the overhang and incised into the rock, outflow channels and flutes at the contact with loam. A part of water came through the fissures in solution cups at the final part of Bar; channels are seen in flanks of solution cups.

In the north-western part of Kitajska Dvorana there is in the north-north-eastern overhanging wall striking for 55°, a dense network of above-sediment wall channels. They are 20 to 50 mm wide and 0.1 m deep. Between the bends of incised channels there are conical wall pendants. A network of channels incised deeper into the overhanging wall is a transitional feature between the channels where water trickled down over vertical or inclined wall and ceiling channels and a branching network which develops in the overhanging of a local flood zone.

The features developing at the contact with loam infills are found on southern and north-western marginal parts of the Vodna Dvorana roof, on an overhang, close to the bottom at the northern part of Male Dimnice and also on walls and breakdown blocks in the passages between the levels.

Below-sediment channels are found on the walls of Puščava and Dihalniki in the lower level and they reach up to the river-bed where they are partly reshaped by a water flow.

In short, a branching network of anastomoses and channels are found on ceiling of lower passages and overhangs, and wall channels on gentle, vertical or overhanging walls of passages, but all of them below the level of a former loam infill.

The upper part of the wall which was in contact with loam is weathered.

In Južni Rov there are semicircular below-sediment notches on walls, 5-20 mm across. They are either independent or combined into a hollow of irregular shape. They too are due to corrosion below humid loam sediments.

On the south-eastern overhanging wall of Vodna Dvorana there are above-sediment solution cups along fissures which allowed the contact of fine-grained sediments and water.

In wet periods larger amounts of rain at the surface caused flooding underground and deposition of loam into passages. Water flowed through upper parts of the passages above the consolidated loam. When the floods retreated, water reached the contact of loam and rock. As shown by the shape of rocky surface in breakdown traverses, the levels were associated in a united system during floods. A similar vertical distribution of features as this appearing on the perimeter of passages of both levels is due to different flood and loam levels in the cave. Below the present lower passages there must be still lower passages; this is indicated by wall above-sediment channels preserved close to the present water flow.

Traces of weathering and breakdown of rock perimeter

The rock surface of the modern cave was mostly formed by weathering and breakdown; the only exception are rare traces of water flow.

In the cave one may observe breakdown according to shape - block, slab, chip, plate and roof-fall.

Stone and boulder falls, rubble and blocks remained on the floor of the passages. Below faults, as for example such as those between Paletna Dvorana and Fosilni Rov and below Vhodno Brezno, block piles are preserved.

The features on the rocky perimeter evidence the time sequence of weathering and breakdown processes. They are divided into a period before the flood filled the passages with loam and a younger period when the passages were mostly empty. More evidence for the first period exists. A good example of passage formation along the bedding-plane is the north-western overhanging wall between Končna and Paletna Dvorana. The wall is intersected with below-sediment channels. Next to traverse from Kitajska to Paletna Dvorana there are above-sediment anastomoses on a break-down block, fallen from the scalloped wall. At prominent faults there are two breakdown squeezes between the levels and entrance shafts.

The stable arched roofs of Vodna and Vhodna Dvorana and Male Dimnice are the results of younger weathering and breakdown of a rocky perimeter. On vaulted roofs there are no signs of loam fills.

Due to the accelerated weathering and breakdown of rock perimeter in all the periods of cave's genesis the spaces became larger, the passages were moved upwards due to breakdowns and entrance shafts appeared.

Rock features due to microclimatic properties of the cave

The Dimnice cave represents a special speleoclimatic type of cave. This is a system of two, unequally deep interconnected shafts and horizontal passages. When the air outside is cooler than inside, the cold air enters through a deeper shaft, warms up underground and rises through the nearby shaft together with the air from horizontal passages. When warmer air from the shaft reaches the surface, mist appears if the atmosphere is humid (Gams, 1972, 35).

Habič (1985) observed the results of dynamic microclimatic factors in the cave. Due to the abundant exchange of cave air with external air, the influence of condensation corrosion is strongly seen on weathered speleothems. During the winter the condensed moisture even freezes. Condensation zone may be recognised in typical changes on speleothems far inside the cave, even in parts where there is no freezing. In general the external climatic influences are felt only in the entrance parts of the cave.

Features due to microclimatic processes in the cave may be divided into traces of condensation moisture, and collapses as the rocky perimeter weathered because of moisture freezing on the walls.

I explained the conditions relating to condensation moisture on the walls and its effects in the case of

Fig. 8: Anastomoses in Paletna Dvorana.
Sl. 8: Anastomoze v Paletni dvorani.

Komarjev Rov in more detail elsewhere (Slabe, 1988). Condensation moisture also affects rocks and flowstone in some parts of perimeter in Vodna and Vhodna Dvorana and in Male Dimnice.

The intrusions of winter cold air through the entrance shaft may cause freezing of moisture in the entrance parts of the cave; most of the humidity is in fissures so the weathering of rock surface and flowstone is accelerated. The weathering is still a slow process and usually only smaller pieces of rocks are broken down.

Features due to water trickling down the walls of the entrance shafts

After percolating through the cave roof the saturated water may deposit flowstone when it reaches the cave, forming typical features. The best traces of aggressive trickling water are seen on the southern side of Vhodno Brezno where there are narrow and shallow flutes on vertical part of the wall and on the ceiling of the overhang some 10 mm long roof pendants from which water falls in small drops. Similar features exist also on the northern wall of Male Dimnice.

THE IMPORTANCE OF ROCK FEATURES IN STUDYING THE SPELEOGENESIS OF DIMNICE

The rock surface of Dimnice cave may explain the periods and factors that led to its present appearance.

In relatively diverse climatic and hydrologic conditions in the Pleistocene the water from the flysch recharge area was sinking underground, downcutting into flysch landscape and creating a cave system on several levels. The periods of water level lowering and karstification alternated with floods and sediment deposition.

The oldest preserved features in the rocky perimeter of the upper level are traces of a fast water flow. At first scallops and solution cups on the lower part of the perimeter appeared. Scallops on the upper part developed when water again started to flow above the gravel sediments. The lower levels were already developed at that time as there are remains of gravel in the traverse from Kitajska Dvorana into Paletna Dvorana preserved above the flowstone and breakdown rubble which cover the rock bottom of the passage. Caves are filled with sediments in cold climatic periods (Kranjc, 1981, 77) and in one such period the water started to flow again through passages transformed by breakdowns. The former passages could probably be compared with the present in the initial part of Spodnja Jama; the latter is, however, in the phase of the river-bed deepening and the gravel is already transported out of the cave.

Most of the rock perimeter was later transformed by weathering and break-down. I attribute the breakdown connections between Podorna Dvorana and Puščava, and Vodna Dvorana and Spodnja jama, and Dihalniki, and the origin of entrance shafts which connected the cave with the surface, to the period before the passages were flooded. Older weathering and breakdown of the rocky perimeter before the last prominent flood infill of the cave with fine-grained sediments belongs, it seems, to the last Würm stadial. A distinctive weathering at the surface and underground was mentioned also by Gospodarič (1985, 27) as a result of very low temperatures at that time when the entrance shafts probably opened.

Climatic changes caused several floods and the cave was filled up by loam, leaving only some space for water to flow below the roof. When the floods retreated, the lower passages were emptied of loam first and water that remained above the loam flowed downwards at the contact of rock and loam. According to the distribution of rocky features I infer that the two levels of the cave were already connected at the time of high floods. Water that flowed before the floods in the present low or even lower passage filled lower and upper parts of the cave during high floods. Traces of water flow above loam fill are seen in the lower and upper parts of the cave. Traces of water trickling down at the contact of loam and rock are seen in the present river-bed. It seems that above-sediment rocky features developed at the time of the Upper Würm and Postglacial flooding. Younger loam fills are mentioned by Gospodarič (1976, 100, 112; 1982, 191) as appearing in other parts of our karst also.

In the Holocene, sediments were removed and deposition of flowstone and breakdown of speleothems started (Gospodarič, 1976, 81; Table 2); in the first place the loam was transported out of the cave and water flow started to incise into the gravel and flowstone and breakdown blocks that cover the floor of the lower level.

Most prominent is the younger weathering and breakdown of the rock surface in Vodna, Vhodna and Bela Dvorana and in Male Dimnice. The roof in these biggest spaces of the cave system is dome vaulted.

Weathering of rock surfaces and flowstone due to condensation corrosion, weathering of the rock surface due to freezing and trickling of aggressive water down the walls of shafts are the youngest processes of cave formation in the upper level.

SKALNI RELIEF DIMNIC

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POVZETEK

Na južnem pobočju flišnih Brkinov, ki na severu obrobljajo kraško Matarsko podolje, se vode zbirajo v površinsko mrežo in na stiku z apnencem, kjer so nastale slepe doline, ponikajo v kraško podzemlje. Na koncu slepe doline pri Velikih Ločah, kamor se stekajo vode iz dveh večjih potokov s pritoki z območja med Slivjem na zahodu, Kovčicam na vzhodu in Sv. Štefanom na severu, skozi več ponorov ponikajo v jamo Dimnice, ki je doslej najdaljša raziskana jama v podolju.

Ponikalnica je pred ponori 5 metrov globoko vrezana v starejše rečne naplavine, ki prekrivajo dno slepe doline. Naplavinska ravnica, ki je na apnenčasti podlagi, se proti severu polagoma dviguje v flišna pobočja. Ponekod se apnenčasta podlaga pokaže na površju še v ozkem pasu med aluvialno naplavino in flišnim zaledjem. Površje nad jamo je torej najnižje s 525 metri nadmorske višine pri današnjih ponorih na južnem robu slepe doline, od koder se proti zahodu apnenčasti obod nad jamo dvigne na 580 metrov nadmorske višine v vrtačasti plato. Rovi doslej raziskane jame, ki so v celoti dostopni le potapljaško spretnim jamarjem, segajo izpod dna slepe doline do vzpetine Na grižcah, zahodno od vhodnih brezen, 500 metrov severno od Markovščine. Jamski ponor ni prehoden, saj ga zapolnjuje podorno skalovje.

Po skalnem reliefu Dimnic predpostavljam obdobja in njih dejavnike, ki so bili odločilni za današnjo jamsko podobo.

V razmeroma pestrih klimatskih in hidroloških razmerah v pleistocenu se je voda, ki se je stekala s flišnega zaledja in ponikala v apnenec, vrezovala v flišni rob in ustvarila večnadstropni jamski splet. Obdobja nižanja vodne gladine in zakrasevanja so se menjavala z obdobji poplavljanja in nanosov naplavin.

Najstarejše ohranjene oblike na skalnem obodu zgornjega nadstropja so sledi hitrega vodnega toka. Najprej so nastale fasete in kotlice na spodnjem delu oboda. Fasete na zgornjem delu oboda pa so nastale, ko se je nad prodno naplavino skozi rov ponovno začel pretakati vodni tok. Vodni tok si je pred tem že oblikoval spodnje rove, saj so ostanki prodnega nanosa na prehodu iz Kitajske v Paleino dvorano ohranjeni tudi nad sigo in podornim gruščem, ki prekrivata skalno dno rova. Zapolnjevanje jam z naplavinami je značilnost hladnih klimatskih obdobij (Kranjc 1981, 77) in v enem takih so skozi deloma že podorno preoblikovane rove zopet začeli teči vodni tokovi. Takratne rove bi verjetno lahko primerjali z današnjo podobo začetnega dela Spodnje jame, le da je slednja že v obdobju poglabljanja vodnega korita in tako odnašanja proda iz rova.

Večina skalnega oboda se je nato preoblikovala zaradi razpadanja in podiranja in zaobljene oblike vodnih rovov so le redki odseki med oglatimi površinami odlomov. Tudi podorne povezave med Podorno dvorano in Puščavo ter Vodno dvorano in Spodnjo jamo ter Dihalniki in nastanek vhodnih brezen, ki so jamo klimatsko povezala s površjem, pripisujem obdobju pred poplavnim zalivanjem rovov. Starejše razpadanje in podiranje skalnega oboda pred zadnjo izrazito poplavno zapolnitvijo jame z drobnozrnatim sedimentom je, kot kaže, iz obdobja zadnjega würmskega stadiala. Izrazito razpadanje tako na površju kot v podzemlju je omenjal tudi Gospodarič (1985, 27) kot posledice zelo nizkih temperatur tega obdobja. Takrat so se verjetno odprla tudi vhodna brezna.

Klimatske spremembe so povzročile večkratne poplave, ki so jamo zapolnile z ilovico, le pod stropom se je nad njo pretakala voda. V obdobjih umika poplav so se najprej izpraznili spodnji rovi, in voda, ki je obvisela nad ilovico, je odtekala navzdol ob stiku kamnine in ilovice. Po razporeditvi skalnih oblik sklepam o povezanosti jame v času poplav. Voda, ki se je pred poplavo pretakala v današnjem spodnjem ali celo nižjem rovu, je ob visokih poplavah z ilovico zapolnila spodnje in zgornje dele jame. Sledi pretakanja nad ilovnato zapolnitvijo jame se namreč ponovijo v obeh nadstropjih. Sledi polzenja vode ob stiku ilovice in kamnine pa segajo vse do današnjega vodnega korita. Nadnaplavinske skalne oblike so, kot kaže, nastale v času zgornjewürmskega in postglacialnega poplavljanja. Mlajše ilovnate zapolnitve omenja Gospodarič (1976, 100, 112; 1982, 191) tudi v drugih delih našega krasa.

V holocenu, za katerega je značilno izpiranje naplavin, odlaganje sige, podiranje kapnikov (Gospodarič 1976, 81; tabela 2), pa je bila najprej iz jame odnešena ilovica in vodni tok se je začel vrezovati v prodno nasipino in sigo ter podorne bloke, ki prekrivajo tla spodnjega nadstropja.

Najbolj izrazito je mlajše razpadanje in podiranje oboda v Vodni, Vhodni in Beli dvorani ter v Malih Dimnicah. Strop v teh največjih prostorih jamskega sistema se je kupolasto obokal.

Preperevanje skalne površine in sige zaradi kondenzne korozije, razpadanje skalnega oboda zaradi zmrzovanja vlage in polzenje korozijsko agresivne vode po stenah brezen so najmlajši procesi jamskega preoblikovanja v zgornjem nadstropju.

Ključne besede: jamski skalni relief, oblikovanje in razvoj kraških votlin, Istrski kras, Slovenija

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RUDISTI IZ LIPIŠKE FORMACIJE V KAMNOLOMU LIPICA I

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IZVLEČEK

V kamnolomih Lipica I in II pri Sežani izkoriščajo apnenec Lipiške formacije in sicer dva tipa arhitektonsko-gradbenega kamna, ki sta vezana na rudistne biostrome in bioherme. Prvi tip je "Lipica enotni" ("unito"), ki je svetlo olivno siv drobno do debelozrnat apnenec, v katerem so predvsem drobci lupin rudistov, veliki največ nekaj mm. Drugi tip je "Lipica rožasti" ("fiorito"). To je apnenec svetlo sive barve s številnimi lupinami rudistov iz osrednjega dela produktivne Lipiške formacije v kamnolomu Lipica I, v katerem se menjavajo okoli 1 m debeli pasovi "fiorita" in "unita". V njem smo določili 20 vrst rudistov iz rodov: Bournonia, Biradiolites, Radiolites, Sauvagesia, Medeella, Gorjanovicia, Praelapeirouseia, Katzeria, Vaccinites *in* Hippuritella. *Spremljajoča mikrofavna, zlasti foraminifera* Keramosphaerina tergestina *(Stache) kaže na zgornjesantonijsko in spodnjecampanijsko starost.*

Ključne besede: rudisti, zgornja kreda, Kras, Slovenija

UVOD

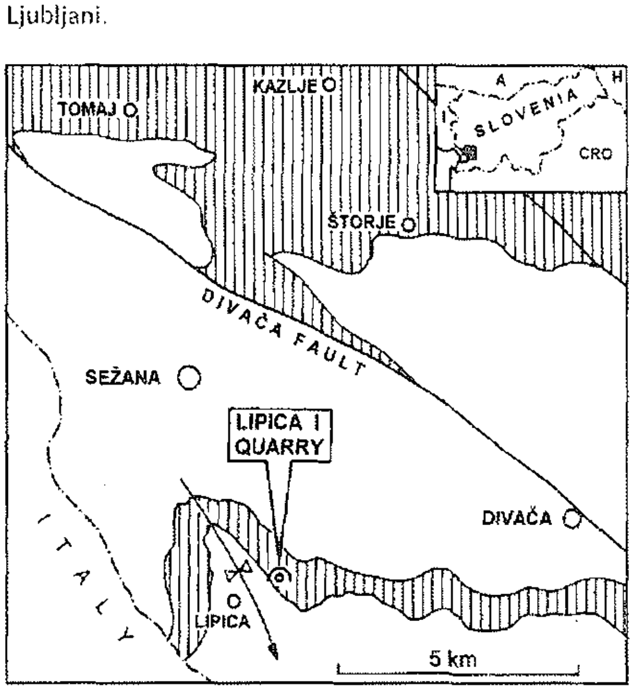
Ekonomsko najpomembnejši del karbonatnih kamnin na Krasu predstavlja Lipiška formacija s številnimi različki apnencev, ki se med seboj razlikujejo tako po strukturi kot po barvi. Vsi opuščeni in še delujoča kamnoloma arhitektonsko-gradbenega kamna v Lipiški formaciji so vezani na bližino rudistnih biostrom in bioherm. Čeprav so nekoč izkoriščali številne vrste apnencev, če so sestavljali dovolj debele sklade, je proizvodnja omejena le še na dva tipa, ki ju pridobivajo v kamnolomih Lipica I in II, severno oziroma severozahodno od Konjerejsko turističnega centra Lipica (slika 1). Prvi tip je "Lipica enotni" ("unito"), ki je svetlo olivno siv, homogen, kompakten, drobno do debelozrnat apnenec, v katerem so fosili ali njihovi drobci, ki niso večji od nekaj milimetrov. Drugi tip apnenca je "Lipica rožasti" ("fiorito"), ki je pretežno svetlo sive barve, v osnovi drobnozrnat, nekoliko porozen, vsebuje pa številne različno velike, ponekod neenakomerno razporejene fosilne ostanke, predvsem rudistne lupine (Soldat, 1987). Podobne tipe svetlih lipiških apnenecv so lomili v kamnolomih pri Lokvah, v obeh Čokovih kamnolomih, v enem celo "v galeriji". Manjši opuščeni kamnolom "unita" je tudi v zahodnem krilu Lipiške sinklinale.

Vsi drugi različki arhitektonsko-gradbenega kamna Lipiške formacije, ki ležijo severno od Divaškega preloma, so temnejši in nosijo različna lokalna imena (Vesel *et al.*, 1992; Jurkovšek *et al.*, 1996). Razlika v debelini in stratigrafskem razponu med apnenci Lipiške formacije severno in južno od Divaškega preloma je paleogeografsko pogojena in jo podrobneje obravnavamo v sklepnem poglavju.

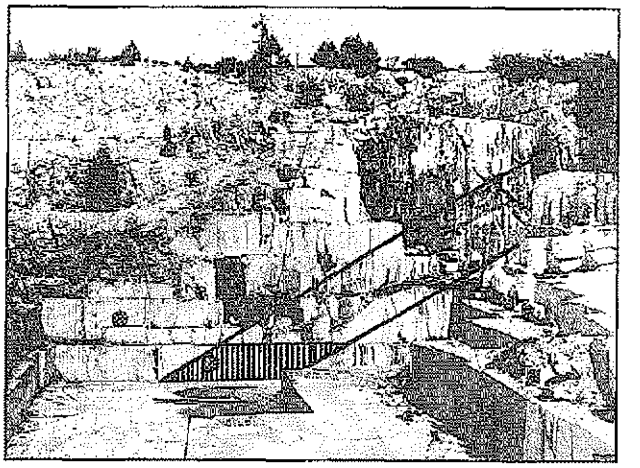
Z raziskavami smo zajeli osrednji del produktivne Lipiške formacije v trenutno mirujočem kamnolomu Lipica I, v katerem se menjavajo okoli 1 m debeli pasovi "fiorita" in "unita". Manjše število izoliranih in naravno prepariranih rudistnih lupin smo vzorčevali na preperelih površinah apnenčevih blokov (tab. 1, sl. 7), ki so bili odkopani v višje ležečih etažah kamnoloma, vendar so pripadali istemu horizontu kot osrednji del produktivne Lipiške formacije. Danes ti bloki ležijo na odvalu južno od kamnoloma Lipica I. Velik primerek desne lupine vrste *Vaccinites vredenburgi* Kühn so kamnoseki našli že pred letom 1989 v južnem delu kamnoloma. Preliminarno ga je tedaj določil dr. B. Korolija. Pleničar omenja v svoji razpravi iz leta 1975 najdbo vrste *Vaccinites oppeli* Douvillé, ki jo je tudi našel v kamnolomu Lipica I (Pleničar, 1975).

Rudistna favna v poliranih ploščah lipiškega apnenca pripada naslednjim vrstam: *Bournonia* cf. *retrolata* Astre, *B. wiontzeki* Pejović, *Bournonia* sp., *Biradiolites* cf. *zucchii* Caffau & Pleničar, *Radiolites* cf. *dario* (Catullo), *R. galloprovincialis* Matheron, *R. spinulatus* Parona, *R.* cf. *squamosus* d'Orbigny, *Sauvagesia tenuicostata* Polšak, *Sauvagesia* sp., *Medeella zignana* (Pirona), *Gorjanovicia* cf. *costata* Polšak, *Praelapeirouseia wiontzeki* Slišković, *Praelapeirouseia* sp., *Katzeria hercegovinaensis* Slišković, *Hippuritella castroi* Vidal, *H. sarthacensis* var. *peroni* (Douvillé), *H. sulcatissima* (Douvillé) in *H.* cf. *variabilis* (Munier-Chalmas). Nekaj je bilo tudi naravno izluženih lupin rudistov, ki pripadajo vrstam: *Radiolites* cf. *dario* (Catullo), *Sauvagesia tenuicostata* Polšak, *Gorjanovicia* cf. *costata* Polšak, *Medeella zignana* (Pirona), *Katzeria hercegovinaensis* Slišković in *Vaccinites* cf. *vredenburgi* Kühn. Slednji so bili zbrani na sekundarnih blokih v kamnolomu ali nad njim.

Vso dokumentacijo in fosile hrani Paleontološka zbirka dr. Bogdana Jurkovška, ki jo je Ministrstvo za kulturo začasno razglasilo za spomenik in je od leta 1985 registrirana pri Prirodoslovnem muzeju Slovenije v Ljubljani.



Sl. 1: Položajna skica kamnoloma Lipica I z označenimi plastmi Lipiške formacije.
Fig. 1: Location map of the Lipica I quarry with marked beds of the Lipica Formation.



Sl. 2: Položaj raziskanih vzorcev rudistnega apnenca iz najnižje etaže kamnoloma Lipica I. Vrisana sta dva nivoja pogostnega pojavljanja vrste** Keramosphaerina tergestina **(Stache).
Fig. 2: Position of studied samples of the rudist limestone from the lowest bench of the Lipica I quarry. Two levels of frequent appearance of species** Keramosphaerina tergestina **(Stache) are marked.

STRATIGRAFSKI DEL

Raziskani horizont apnenca z rudisti v kamnolomu Lipica I leži v osrednjem ekonomsko najbolj zanimivem delu Lipiške formacije v neposredni bližini Lipice, po kateri je dobila formacija ime. Strukturno ležijo raziskane plasti v severovzhodnem krilu Lipiške sinklinale, katere os rahlo tone proti jugovzhodu.

V talnini Lipiške formacije leži okoli 400 m plastnatega in skladnatega sivega do olivno sivega biomikritnega apnenca Sežanske formacije z razmeroma nizkim energijskim indeksom (1-2). Le mestoma, predvsem v vrhnjem delu, opazujemo nekoliko višji energijski indeks (2-3). V posameznih nivojih so v apnencu pogostne lupine rudistov, vendar so rudistne biostrome v prvotnem položaju v Sežanski formaciji redke.

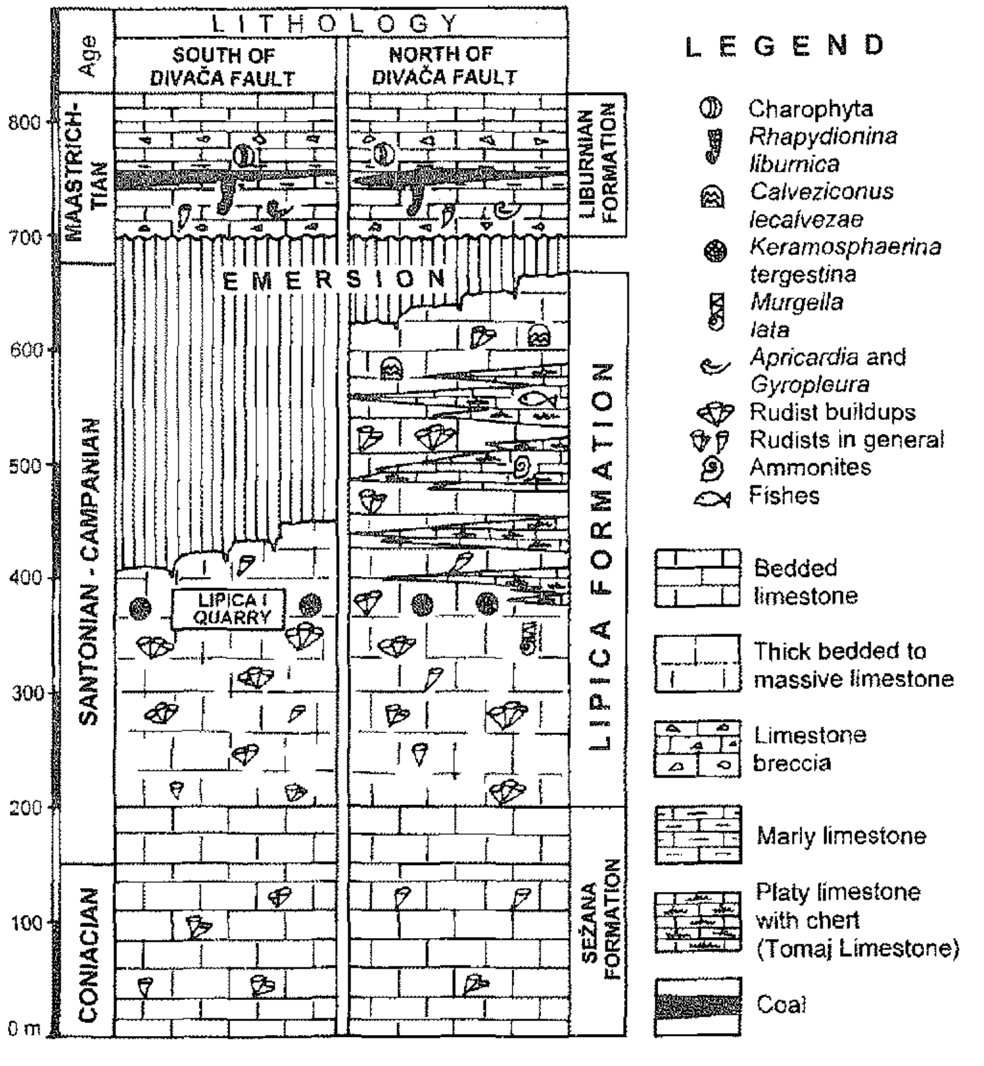
Lipiška formacija se od Sežanske razlikuje v prvi vrsti po razmeroma zelo debelih plasteh. Zaradi ugodne teksture in strukture kamna so v njej že v preteklosti izkoriščali kakovostne in pestre različke apnenca. Nastajala je na nekoliko bolj odprtem delu šelfa, za katerega so značilni različki zrnatega apnenca (grainstone do packstone) z vsemi prehodi v drobno zrnati biokalkarenit. Skelet kamnine sestavljajo največ lupine rudistnih školjk, ki so navadno močno endolitizirane. Te so lahko še popolnoma cele, lokalno pa opazujemo celo neporušene bioherme in biostrome (tab. 8, sl. 7). Večinoma pa so rudistne lupine zdrobljene, kar je značilno za večji del produktivne cone lipiških kamnolomov. Masivni apnenec kamnoloma Lipica I, ki je brez fizičnih meja med plastmi (brez lezik), daje zaradi menjavanja tako imenovanega enotnega ("unito") in rožastega ("fiorito") tipa apnenca občutek izrazite plastnatosti z nagnjenostjo 35° proti jugozahodu (slika 2).

Poleg rudistov so v apnencu prisotne še miliolide in druge foraminifere, med katerimi je razmeroma pogostna vrsta *Dicyclina schlumbergeri* Munier-Chalmas. V raziskanem rudistnem horizontu se lokalno pojavljajo posamezni gomolji stromatoporoidov in kolonijskih koral.

Čeprav pomembnejših vodilnih foraminifer v najdišču nismo našli, lahko sklepamo, da pripadajo zelo pogostni primerki vrste *Keramosphaerina tergestina* (Stache), ki se pojavljajo predvsem v pasovih biokalkarenitnega apnenca (tip "unito") med rudistnim apnencem (tip "fiorito") in v sedem metrov višjem nivoju, tako imenovanemu glavnemu keramosferinskemu horizontu (Jurkovšek *et al.*, 1996). Le-ta je verjetno sinhron in priča o zgornjesantonijski in spodnjecampanijski starosti teh plasti na prostoru južnega Krasa (slika 3).

Energijski indeks lipiškega apnenca je 3, izjemoma 4. Redke prevleke modro zelenih cepljivk okrog nekaterih fosilov in endolitizacija govore v prid zelo *plitvemu šelfu*.

V spodnjem campaniju je bil sedimentacijski prostor, v katerem so pred tem, t.j. v zgornjem santoniju, nastajali apnenci današnjih lipiških kamnolomov, že nizko kopno (slika 4). Šele v maastrichtiju se je morje vrnilo. Na Lipiški formaciji pa so se tedaj odložile plasti, ki kažejo značilnosti morskega, brakičnega in sladkovodnega okolja. Te plasti je že Stache (1889) združil v "liburnijsko stopnjo", danes pa jih uvrščamo v Liburnijsko formacijo.



Sl. 3: Primerjava razvojev Lipiške formacije na južnem delu Tržaško-komenske planote.
Fig. 3: Comparison of developments of the Lipica Formation in the southern part of the Trieste-Komen plateau.

PALEONTOLOŠKI DEL

Classis: Bivalvia
Ordo: Hippuritoida Newell, 1965
Superfamilia: Hippuritacea Gray, 1848
Familia: Radiolitidae Gray, 1848
Genus: *Bournonia* Fischer, 1887
Bournonia cf. *retrolata* (Astre, 1929)
Tab. 1, sl. 1

cf. 1965 *Bournonia retrolata* Astre - Torre, 9-10; tab. 1, sl. 6,7; sl. 2/5,6 med tekstom.

cf. 1972a *B. retrolata* (Astre) - Campobasso, sl. 1/4 med tekstom.

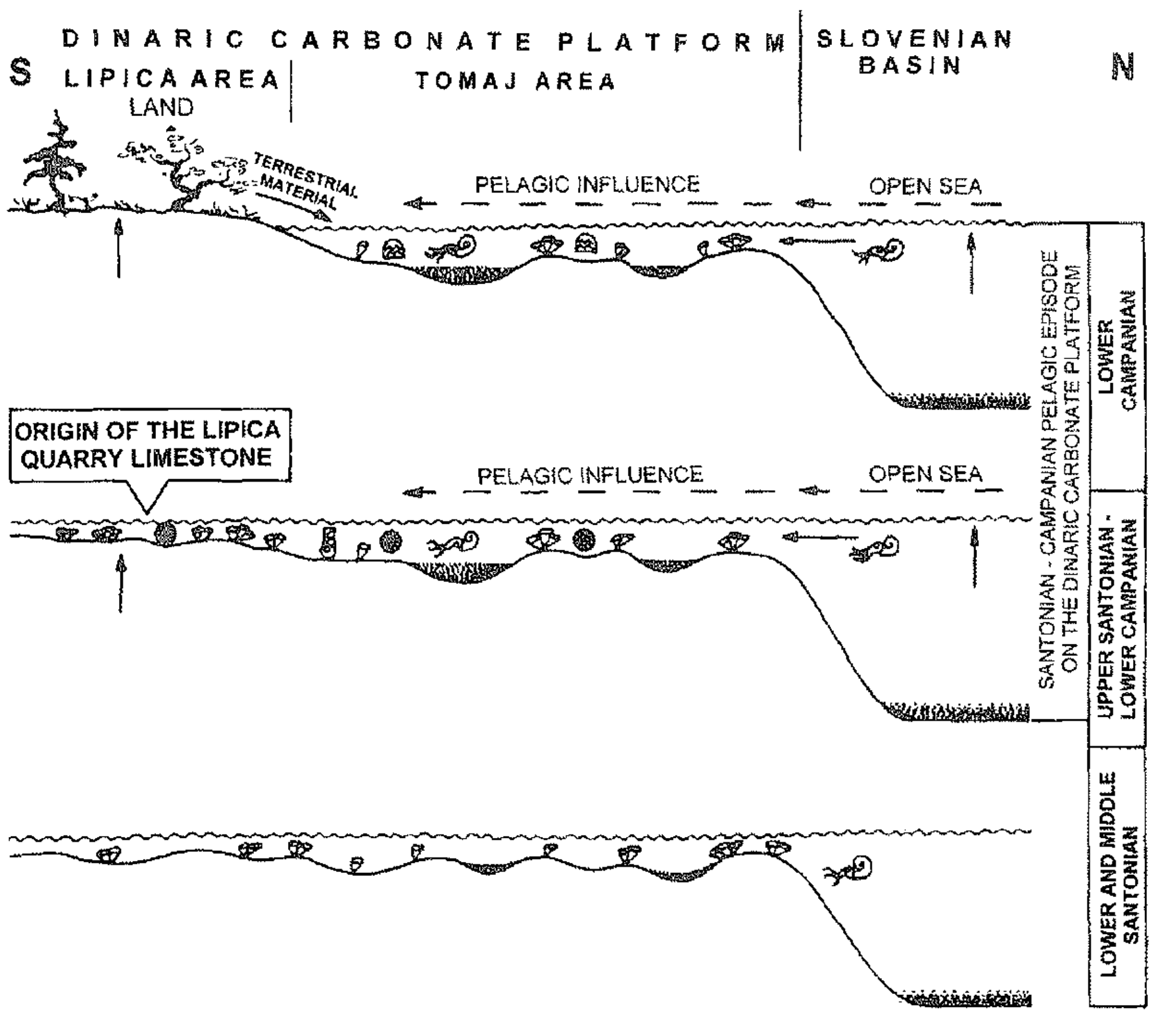
cf. 1978 *B. retrolata* (Astre) - Pejović, tab. 2, sl. 2b, 2c; tab. 3, sl. 1.

Material: Dva prečna preseka spodnjih lupin na polirani površini apnenca iz kamnoloma Lipica I; št. vzorca BJ 1696.

Opis: Lupini imata v preseku nekoliko ovalno obliko s premeroma 1,5 krat 1,8 cm in 2,7 krat 2 cm. Obe lupini sta precej nagrizeni od zajedalcev. Sifonalni brazdi predstavljata dve močnejši rebri, od katerih je anteriorna (E) manjša od posteriorne (S). Sicer pa je lupina okrašena s 5-7 zaobljenimi rebri, ki se v prečnem preseku le nejasno razločijo, posebno še zato, ker se obe lupini delno prekrivata. Torre (1965) navaja v svoji razpravi pri tej vrsti sedem reber, Astre (1929) pa celo devet. Ta vrsta je močno variabilna in število reber ni pri vseh primerkih enako. Medsifonalni prostor je konkavne oblike. Ker je lupina močno prekristaljena, ni mogoče videti njene strukture.

Podobnosti in razlike: Po obliki sifonalne cone se ta vrsta približuje vrsti *B. murensis* Pejović, precej pa tudi vrstama *B. gardonica* (Toucas) in *B. adriatica* Pejović.

Stratigrafski položaj in razširjenost: Vrsta *B. retrolata* je značilna za santonijske plasti v Španiji, Italiji in Srbiji.



Sl. 4: Predpostavljeni model sedimentacije Lipiške formacije.
Fig. 4: The presumed deposition model of the Lipica Formation.

Bournonia wiontzeki Pejović, 1968
Tab. 1, sl. 2, 3, 4

1968 *Bournonia wiontzeki* Pejović - Pejović, 168-169, tab. 1, sl. 1-2; tab. 2, sl. 1-3.
1983 *B. wiontzeki* Pejović - Slišković, tab. 2, sl. 2-4.
1985 *B. wiontzeki* Pejović - Pleničar, 252, tab. 1, sl. 5a.

Material: Prečni preseki treh spodnjih lupin na polirani površini apnenčevih plošč iz kamnoloma Lipica I; št. vzorcev BJ 1673, BJ 1675 in BJ 1686.

Opis: Prečni preseki spodnjih lupin so trikotni, rahlo zaokroženi s tremi močnejšimi rebri. Dve lupini sta precej deformirani (tab. 1, sl. 2, 4), medtem ko je tretja še dobro ohranjena, čeprav so pri vseh treh lupine prekristaljene. Lupine imajo prečni premer okoli 1,3 cm. V rebrih se vidi stik, ki je nastal pri vgubavanju lupine. Stena lupin je debela 2-3 mm. Kardinalni aparat ni viden in tudi sifonalna cona ni jasna. Bivalna komora je okrogla.

Stratigrafski položaj in razširjenost: Primerki te vrste se dobijo v Dalmaciji, na dalmatinskih otokih, v Črni gori, v Hercegovini in v Sloveniji (Kočevsko, Tržaško-komenska planota) v campanijskih in maastrichtijskih skladih.

Bournonia sp.
Tab. 1, sl. 5

Na poliranih površinah plošč apnenca v kamnolomu Lipica I opazujemo še nekaj presekov malih oblik burnonij, ki so deloma poševni, deloma prečni. Vrste tudi še niso dovolj jasno definirane. Tako imamo poševen presek burnonije na tab. 1, sl. 5 (vzorec št. BJ 1676), ki se po nekih elementih približuje vrsti *Bournonia triangulata* Pleničar & Zucchii. Drugi primerek ima poleg dveh zelo izraženih sifonalnih grebenov še dve ostri rebri. Primerek ima na ta način v prečnem preseku štirikotno obliko. Podobni primerki so v maastrichtijskih vremskih plasteh liburnijske formacije pri Dolenji vasi pri Senožečah in v Padričah na Tržaškem Krasu. Primerki so vsekakor značilni za zgornji senon.

Genus: *Biradiolites* d'Orbigny, 1847
Biradiolites cf. *zucchii* Caffau & Pleničar, 1990
Tab. 1, sl. 6

cf. 1990 *Biradiolites zucchii* Caffau & Pleničar - Caffau & Pleničar, 208-210, tab. 1, sl. 1; tab. 2, sl. 1; tab. 3, sl. 1; sl. 2 med tekstom.

Material: Prečni presek spodnje lupine na polirani plošči apnenca iz kamnoloma Lipica I; št. vzorca BJ 1672.

Opis: Prečni presek črne spodnje lupine s premerom približno 2 krat 3 cm. Lupina je zaradi močnih razvejanih reber videti neenakomerno debela. Ugotovimo lahko 7 močnejših, delno razvejanih reber. Večja rebra so na prečnem preseku videti lopatasta. Sifonalni brazdi sta v obliki ozkih jarkov med dvema močnima rebroma. Brazda S je nekoliko širša od brazde E. Medsifonalni prostor predstavlja močnejše rebro. Ligamentnega stebrička ni. Močnejša in razvejana rebra so dolga v prečnem prerezu lupine 0,8-1,4 cm. Struktura lupine se ne more ugotoviti, ker je ta popolnoma prekristaljena.

Podobnosti in razlike: Primerek je nekoliko podoben vrsti *Rajka spinosa*, vendar se po obliki sifonalnih brazd in manj razvejanih rebrih od nje loči. Nekoliko je podoben tudi vrsti *Biradiolites martelii*, ki pa sploh nima razvejanih reber.

Stratigrafski položaj in razširjenost: Vrsta *Biradiolites zucchii* je bila doslej najdena le na Tržaškem Krasu v nabrežinskih kamnolomih med Sesljanom in Nabrežino v plasteh zgornjega senona.

Genus: *Radiolites* Gray, 1848
Radiolites cf. *dario* (Catullo, 1834)
Tab. 3, sl. 1-3

cf. 1992a *Radiolites dario* (Catullo) - Cestari, tab. 1, 2.
cf. 1992b *R. dario* (Catullo) - Cestari, 27-44; Tab. 1, sl. v tekstu 1-11.

Material: Prečna preseka spodnjih lupin dveh primerkov na polirani plošči apnenca iz kamnoloma Lipica I; št. vzorcev BJ 1694 in BJ 1682 ter izluščena spodnja lupina iz istega kamnoloma; št. vzorca BJ 1801.

Opis: Spodnja ali desna lupina ima stožčasto obliko. Dolga je do 10 cm in ima premer 2,5-3 cm. Pripada tipu "elevatorjev". Ligament je kratek in trikoten. Lupina je prekrita s podolžnimi rebri, ki jih prekinjajo v spodnjem delu lupine razmeroma redke, v zgornjem pa gostejše prirastne linije. Sifonalna proga E je rahlo konkavna, prekrita z drobnimi rebrci in širša od proge S. Proga S se bistveno ne loči od ostalega dela lupine. Struktura zunanje plasti lupine je delno ali popolnoma celularna, deloma laminarna. Pri vzorcu št. BJ 1682 na tab. 3, sl. 1 se je celularna struktura v glavnem ohranila v sifonalni coni. Zgornja lupina ni bila najdena.

Podobnosti in razlike: Primerki te vrste so podobni vrstam iz rodu *Gorjanovicia*. Cestari (1992a, b) je na podlagi biometričnih analiz ugotovil, da pripada večina primerkov, ki so bili v literaturi določeni kot različne vrste rodu *Gorjanovicia*, vrsti *Radiolites dario* (Catullo). Ker niso ohranjeni pri naših primerkih elementi kardinalnega aparata in ker so precej prekristaljeni, smo jih določili kot *Radiolites* cf. *dario* (Catullo).

Stratigrafski položaj in razširjenost: Primerki te vrste so bili najdeni z ostalimi rudisti v plasti apnenca tipa "fiorito" in "unito" v kamnolomu Lipica I, ki jo štejemo v santonijske in campanijske plasti. Cestari (1992b) omenja, da je vrsta *Radiolites dario* (Catullo) značilna za zgornjekredne plasti območja Tetide.

Radiolites galloprovincialis Matheron, 1842
Tab. 2, sl. 2-5

1908 *Radiolites galloprovincialis* Matheron - Toucas, 76; tab. 15, sl. 1-5; slika v tekstu 47.
1954 *R. galloprovincialis* Matheron - Astre, 15, 44: tab. 4, sl. 6.
1957 *R. galloprovincialis* Matheron - Pejović, 90-91; tab. 29, sl. 1-2; tab. 30, sl. 1.
1967 *R. galloprovincialis* Matheron - Polšak, 71 (182); tab. 42, sl. 3.
1977 *R. galloprovincialis* Matheron - Pons, 70; tab. 55, sl. 1-3; tab. 56, sl. 1-4.

Material: Tri izlužene spodnje lupine iz separatnih blokov in prečni prerez spodnje lupine na polirani površini plošče apnenca, vse iz kamnoloma Lipica I; vzorca BJ 1783 in BJ 1684.

Opis: Premer prečnega preseka spodnje lupine je 1,7 krat 1,5 cm. Lupina je ornamentirana s številnimi zaobljenimi podolžnimi rebri, ki jih prekinjajo cikcakaste prirastne linije. Obe sifonalni brazdi sta konkavni in gladki. Sifonalna brazda E je še enkrat širša od brazde S. Medsifonalni prostor predstavljajo tri enaka rebra. Ob sifonalni brazdi E je močno rebro, ki je podobno nožnemu rebru pri rodu *Eoradiolites*. Struktura zunanje plasti lupine je celularna. V sifonalni coni (psevdostebričkih) so prizme večje in zato ta cona odstopa od ostale lupine. Ligamentni stebriček je droben in trikoten ter na notranjem obodu lupine komaj opazen. Ostali elementi kardinalnega aparata niso vidni zaradi prekristalizacije lupine.

Podobnosti in razlike: Prečni presek spodnje lupine je podoben kot pri vrsti *Radiolites angeoides*, ki pa ima spodnjo lupino znatno krajšo.

Stratigrafski položaj in razširjenost: *R. galloprovincialis* je razširjen v Španiji, Franciji, Srbiji, Italiji in na Hrvaškem (Istra) v santonijskih in campanijskih skladih.

Radiolites spinulatus Parona, 1912
Tab. 3, sl. 4-5

1869 (1868) *Sphaerulites ponsiana?* Pirona - Pirona, 414-415, tab. 17, sl. 8-9.
1912 *Radiolites spinulatus* Parona - Parona, 14-15; sl. 10 v tekstu.
1923 *R. spinulatus* Parona - Parona, 146.
1932b *R. spinulatus* Parona - Kühn, 156.
1965 *R. spinulatus* Parona - Paradisi & Sirna, 154; sl. 9 v tekstu.
1972b *R. spinulatus* Parona - Campobasso, 447-448; tab. 8, sl. 1.

Material: Dva prečna preseka spodnjih lupin na polirani plošči apnenca iz kamnoloma Lipica I; vzorca BJ št. 1674 in BJ 1681.

Opis: Prečni presek lupin je nekoliko ovalen s premeroma 3,1 krat 3,3 cm in 2 krat 2,8 cm. Lupini sta črni, prekristaljeni z dokaj zaobljenimi, pravilno razporejenimi rebri, ki segajo v samo zunanjo plast lupine in tvorijo radialno strukturo. Sifonalni brazdi sta konkavni; brazda E je širša od S. Medsifonalna cona je iz dveh reber. Ligamentni stebriček je ozek in precej podaljšan. Zunanja plast lupine je debela okoli 0,5 cm, srednja pa 0,1 cm in je v nasprotju z zunanjo plastjo, ki je črne in bele barve.

Stratigrafski položaj in razširjenost: V Italiji je bila ta vrsta najdena med Barijem in Brindisijem v turonijskih skladih, medtem ko jo dobimo v kamnolomu Lipica I v santonijsko-campanijskih plasteh.

Radiolites cf. *squamosus* d'Orbigny, 1842
Tab. 2, sl. 1

cf. 1907 *Radiolites squamosus* d'Orbigny - Toucas, 71; tab. 13, sl. 9-11.
cf. 1932b *R. squamosus* d'Orbigny - Kühn, 156-157.
cf. 1933 *R. squamosus* d'Orbigny - Milovanović, 96, 160-161; sl. 30-32 med tekstom.
cf. 1954 *R. squamosus* d'Orbigny - Astre, 43; tab. 4, sl. 3.
cf. 1958 *R. squamosus* d'Orbigny - Tavani, 172; tab. 27, sl. 4a, 4b.
cf. 1967 *R. cf. squamosus* d'Orbigny - Polšak, 67.
cf. 1977 *R. squamosus* d'Orbigny - Pons, 72; tab. 61, sl. 1-4.

Material: Prečni presek spodnje lupine na polirani plošči apnenca in kamnoloma Lipica I; vzorec št. BJ 1697.

Opis: Premera lupine sta 4 krat 3 cm. Zunanja plast lupine je okrašena z okoli 15 močnejšimi rebri. Sifonalna cona je iz dveh večjih brazd E in S. Brazda E je precej širša od brazde S. Medsifonalna cona je iz dveh močnejših reber. Ligamentni stebriček je trikoten in ob koncu odrezan. Radialno razporejena rebra se odražajo tudi v strukturi zunanje plasti lupine vse do sredje plasti lupine. Zunanja plast lupine je debela okoli 8 mm, srednja pa 1 mm. Lamele na površini spodnje lupine so prevrnjene proti njenemu bazalnemu delu, kar se odraža na prečnem prerezu s ponavljanjem, oziroma delnim prekrivanjem sledov reber.

Stratigrafski položaj in razširjenost: Vrsta *R. squamosus* je bila najdena v santonijskih skladih Francije, Španije in južne Italije in v santonijsko-campanijskih skladih Istre in Tržaško-komenske planote pri Lipici.

Genus: *Sauvagesia* Choffat, 1886
Sauvagesia tenuicostata Polšak, 1967
Tab. 4, sl. 1-6

1967 *Sauvagesia tenuicostata* Polšak - Polšak, 86-88

(189-191); tab. 50, sl. 1-5; tab. 51, sl. 1-4; tab. 52, sl. 1-7; tab. 53, sl. 1-11.

1973 *S. tenuicostata* Polšak - Pleničar, 192; tab. 3, sl. 1.

1975 *S. tenuicostata* Polšak - Civitelli & Mariotti, 96, sl. 9 v tekstu.

1976 *S. tenuicostata* Polšak - Lupu, 133; tab. 21, sl. 3a, 3b, 4.

1977 *S. tenuicostata* Polšak - Pons, 75; tab. 73, sl. 1-4.

1982 *S. tenuicostata* Polšak - Accordi, Carbone & Sirna, 772; tab. 4, sl. 1, 5.

1985 *S. tenuicostata* Polšak - Laviano, 332, tab. 8, sl. 2; tab. 10, sl. 1, 3; tab. 11, sl. 3; tab. 16, sl. 3-4.

1995 *S. tenuicostata* Polšak - Caffau & Pleničar, 238-239; tab. 11, sl. 1-3.

Material: Štiri nepopolno ohranjene spodnje lupine s številko BJ 1781 ter trije prečni preseki spodnjih lupin na polirani površini plošč apnenca s številkama BJ 1676 in BJ 1686.

Opis: Primerki stožčastih ali valjasto-stožčastih spodnjih lupin so dolgi 3-8,5 cm s prečnim premerom 1,5-3 cm. Lupine so prekrite s slabše izraženimi podolžnimi rebri, ki jih prekinjajo redke cikcakaste prirastne linije. Zunanja plast lupine je debela 0,5-0,8 cm. Struktura te plasti je celičasta, kar se vidi na slikah: tab. 4, sl. 1, 2a, 2b. Sifonalni progi sta konkavni in prekriti z drobnimi rebri. Proga E je široka 1,6 cm ter je dvakrat širša od proge S. Medsifonalni prostor prestavljata dve močnejši rebri. Ligamentni stebriček je trikoten, kratek in droben. Leva lupina ni ohranjena. Med primerki opazujemo male razlike, zlasti glede na jakost reber. Pri nekaterih so rebra zelo drobna in prirastnih linij skoraj ni videti (tab. 4, sl. 5), pri drugih so rebra močnejša, vidne pa so tudi cikcakaste prirastne linije.

Stratigrafski položaj in razširjenost: Ta vrsta je značilna za santonijske in spodnjecampanijske sklade zunanjih Dinaridov (zlasti hrvaške Istre), Apeninskega polotoka in Slovenskega Primorja.

Sauvagesia sp.
Tab. 3, sl. 6a, 6b

Material: Prečni presek spodnje lupine na polirani plošči apnenca iz kamnoloma Lipica I; št. vzorca BJ 1672.

Opis: Presek spodnje lupine ima nekoliko ovalno obliko s premerom 4,8 cm v smeri kardinalna cona - sifonalna cona in 5,5 cm pravokotno na to smer. Struktura zunanje plasti lupine je izrazito prizmatična s poligonalnimi prizmami kot jih imajo sovažezije. Na zunanji strani lupine potekajo podolžna rebra, ki so na vrhu nekoliko zaobljena. Vidna je široka oblika ploščaste sifonalne proge E in ozka konkavna proga S. Medsifonalni prostor predstavlja močnejše rebro, široko kot sifonalna proga S.

Posebnost tega primerka je ligamentni stebriček, ki je trikotne oblike in na vrhu izrazito razcepljen.

Podobnosti in razlike: Primerek kaže sorodnost z vrstami *S. meneghiniana* (Pirona), *S. raricostata* Polšak in njim podobnim vrstam, ki se dobijo po Polšaku (1967) v santonijskih in campanijskih plasteh južne Istre. Morda gre tudi za neko novo podvrsto ravno zaradi posebne oblike ligamentnega stebrička, ki je razcepljen.

Genus: *Medeella* Parona, 1923
Medeella zignana (Pirona, 1868)
Tab. 5, sl. 1-7

1869 (1868) *Radiolites zignana* Pirona - Pirona 419-421, tab. 22, sl. 1-11.

1907 *R. squamosus* var. *zignana* Toucas - Toucas, 72; tab. 13, sl. 12.

1923 (1924) *R. zignana* Pirona - Parona, 146-148; sl. 1-2 med tekstom.

1926 *Radiolites zignana* Pirona - Parona, 30; tab. 3, sl. 9.

1934 *R. (Medeella) zignana* (Pirona) - Wiontzek, 22.

1967 *Medeella zignana* (Pirona) - Polšak, 100-101 (199-200); tab. 24, sl. 1-4; tab. 68, sl. 1-10; tab. 70; sl. 3; tab. 71, sl. 1-2; sl. 27 med tekstom.

1981 *M. zignana* (Pirona) - Sánchez, 136.

1987 *M. zignana* (Pirona) - Cestari & Sirna; tab. 7, sl. 1-3.

1989 *M. zignana* (Pirona) - Sirna & Cestari, 715.

1990 *M. zignana* (Pirona) - Šribar & Pleničar, tab. 8, sl. 2-3.

1995 *M. zignana* (Pirona) - Caffau & Pleničar, 234-235; tab. 8, sl. 2.

Material: Pet odlomkov spodnjih lupin, številke vzorcev: BJ 1782 in dva prečna preseka spodnjih lupin na polirani površini plošče apnenca; številki vzorcev BJ 1684 in BJ 1688, vse iz kamnoloma Lipica I.

Opis: Desna lupina je cilindrična, vitka in podolgovata. Premeri posameznih lupin znašajo od 17 do 25 mm. Lupine so gladke in le mestoma opazimo nekaj šibkih vzdolžnih reber. Gladke lamele so obrnjene proti bazalnemu (spodnjemu) delu lupine in se tesno prilegajo lupini. Sifonalni progi sta v obliki dveh reber, na katerih pa so lamele obrnjene proti komisurnemu (zgornjemu) delu lupine. Medsifonalna cona je konkavni jarek, precej širši od obeh sifonalnih prog. Na prečnem preseku spodnjih lupin vidimo sledove zobnih jamic in obeh sifonalnih gub. Lupine imajo lamelozno strukturo. Bivalni prostor je okrogel. Ligamentni stebriček je kratek in okrogel. Leva lupina ni ohranjena.

Stratigrafski položaj in razširjenost: Vrsta *M. zignana* (Pirona) se pojavlja v turonijskih skladih Colle di Medea (Italija), Tržaškega Krasa, doline Soče, Tržaško-komenske planote in Nanosa ter v santonijsko-spodnjecampanijskih skladih južne Istre (Hrvaška).

Genus: *Gorjanovicia* Polšak, 1967
Gorjanovicia cf. *costata* Polšak, 1967
Tab. 5, sl. 8

cf. 1967 *Gorjanovicia costata* Polšak - Polšak, 103-105 (202-203); tab. 61-66; tab. 69, sl. 1-2; tab. 70, sl. 1, 2; slika 28 med tekstom.
cf. 1989 *G. costata* Polšak - Pieri & Laviano, 352.
cf. 1994 *G. costata* Polšak - Steuber, 55 cum syn.
cf. 1995 *G. costata* Polšak - Caffau & Pleničar, 232-233; tab. 4, sl. 1, 1a, 2, 2a.

Material: Del spodnje lupine; štev. vzorca BJ 1784; vzorec je bil najden na bloku apnenca v kamnolomu Lipica I.

Opis: Odlomek spodnje lupine je stožčaste oblike, nekoliko upognjen in dolg 5 cm. Na površini lupine so močna podolžna rebra brez prirastnih linij. Primerek je močno prekristaljen, zato notranjih elementov ni mogoče ugotoviti. Vrsta je bila določena pogojno kot cf. na podlagi primerjav slik v Polšakovem delu iz leta 1967.

Stratigrafski položaj in razširjenost: Ta vrsta je značilna za santonijsko-campanijske sklade južne Istre, Italije, Grčije in Tržaškega Krasa.

Genus: *Praelapeirouseia* Kühn, 1932
Praelapeirouseia wiontzeki Slišković, 1974
Tab. 6, sl. 1a, 1b

1974 *Praelapeirouseia wiontzeki* Slišković - Slišković, 25-27; tab. 1, sl. 1-6; tab. 5, sl. 1-2.
1984 *P. wiontzeki* Slišković - Pejović; tab. 6, sl. 1; tab. 7, sl. 1-2.
1993 *P. wiontzeki* Slišković - Pleničar, 56; tab. 8, sl. 1-2; tab. 9, sl. 1-2.

Material: Prečni presek spodnje lupine na polirani površini plošče apnenca iz kamnoloma Lipica I; štev. vzorca BJ 1675.

Opis: Prečni presek spodnje lupine je nekoliko ovalen s premeroma 35 in 40 mm. Na prečnem preseku je vidno, da potekajo na zunanji strani lupine dokaj številna podolžna rebra. Sifonalni progi sta dve izraziti rebri, medsifonalni prostor je konkaven z ozkim in ostrim rebrom v sredini. Prednja sifonalna proga E je trapezoidne oblike, zadnja sifonalna proga S pa je nekoliko bolj zaokrožena. Na prečnem preseku lupine je vidna prizmatična struktura zunanje plasti lupine, ki je na sifonalnem delu debela 7 mm, na kardinalnem delu pa do 12 mm. Srednja plast lupine je debela 0,5-1 mm. Ligamentni stebriček ni jasno razločen, vendar kaže, da je v bazalnem delu trikoten, proti vrhu pa se nenadno močno razširi. Prav ta razširjeni del stebrička ni jasno viden. Obe sifonalni progi sta zgrajeni iz poligonalnih prizem, ki so nekoliko manjše od prizem v ostalem delu lupine. Sifonalna proga E je iz prizem, ki so razvrščene v radialni smeri od srednje plasti lupine do zunanjega roba lupine. Prizme tega psevdostebrička so obdane z belo lamelasto plastjo. Druga sifonalna proga (psevdostebriček) S je okroglaste oblike. Sestavljajo jo prizme, ki so večje od prizem v progi E in krožno razvrščene. Tudi to sifonalno progo (psevdostebriček) obdaja lamelasta plast. Na prečnem preseku lupine je vidna tudi zunanja kortikalna plast, ki je posebno izrazita na medsifonalnem rebru.

Stratigrafski položaj in razširjenost: Vrsta *Praelapeirouseia wiontzeki* Slišković je bila ugotovljena v santonijsko-spodnjecampanijskih plasteh v Bosni vzhodno od Višegrada, pri Leposaviću na Kosovem in v Stranicah pri Slovenskih Konjicah v Sloveniji.

Praelapeirouseia sp.
Tabla 6, sl. 2-7

Material: Šest prečnih presekov spodnjih lupin na polirani površini plošče apnenca iz kamnoloma Lipica I. Štev. vzorcev BJ 1672, BJ 1673, BJ 1675, BJ 1682.

Opis: Premeri horizontalnih presekov spodnjih lupin znašajo 5,5-7 cm. Zunanja rebra so široka in dobro izražena. Sifonalne proge so iz dveh reber. Po medsifonalni coni potekajo tri podolgovata rebra. Sifonalni rebri sta zaobljeni. Struktura lupine je celičasta. V sifonalnih psevdostebričkih (progah) so prizme nekoliko močnejše in obdane z lamelasto plastjo. Te prizme so razporejene trapezasto ali radialno v obliki enakostraničnih trikotnikov z osnovno stranico ob srednji plasti lupine in vrhom usmerjenim proti zunanjemu robu. Pri psevdostebričku S sega vrh trikotnika navadno do zunanjega roba lupine, pri psevdostebričku E pa preneha že v sredini zunanje plasti lupine. Te strukture v sifonalnih psevdostebričkih odnosno progah niso pri vseh primerkih jasno vidne, ali pa je razločna le ena od obeh struktur psevdostebričkov. Ligamentni stebriček je kratek in trikoten, pri nekaterih primerkih na koncu betičasto razširjen. Pri nekaterih primerkih je vidno na prečnem preseku notranjega dela lupine konveksno vzbočenje na mestu psevdostebrička E.

Podobnosti in razlike: Primerki se približujejo oblikam rodu *Radiolites*, oziroma celo vrsti *Radiolites carsicus* Caffau & Pleničar, le da ima ta vrsta v strukturi sifonalnega psevdostebrička E izrazito dvojno gubo, ki je na naših primerkih ne opazimo (Caffau & Pleničar, 1994/95, 1995).

Stratigrafski položaj in razširjenost: Doslej so bile vrste tega rodu ugotovljene le v severnem delu Slovenije v okolici Stranic pri Slovenskih Konjicah, to je na območju "gosavske krede", ki sega iz Labotske doline v Avstriji na območje Pohorja in njegovega južnega obrobja v Sloveniji. Plasti, v katerih so tudi zastopniki rodu *Praelapeirouseia*, pripadajo santonijskim in campanijskim plastem.

Genus: *Katzeria* Slišković, 1966
Katzeria hercegovinaensis Slišković, 1966
Tab. 5, sl. 9-12

1966 *Katzeria hercegovinaensis* Slišković - Slišković, 176-177, sl. 1, 2 med tekstom.

1968 *K. hercegoviensis* Slišković - Pejović, tab. 6, sl. 3.

1973 *K. hercegovinaensis* Slišković - Pleničar, 214; tab. 10, sl. 1.

1974 *K. hercegovinaensis* Slišković - Pleničar, 178; sl. 64-66.

1985 *K. hercegovinaensis* Slišković - Pleničar, 254; tab. 2, sl. 5.

1992 *K. hercegovinaensis* Slišković - Caffau, Pirini-Radrizzani, Pleničar & Pugliese, tab. 2, sl. 1.

1995 *K. hercegovinaensis* Slišković - Caffau & Pleničar, 233-234; tab. 6, sl. 1, 1a, 2, 3, 4.

Material: Odlomek spodnje lupine, vzorec št. BJ 1780 in trije prečni preseki spodnjih lupin na poliranih površinah plošč, vzorci št. BJ 1697, BJ 1683, BJ 1681.

Opis: Odlomek spodnje lupine je valjaste oblike z dolžino 2 cm in premerom 1,2 cm. Lupina je okrašena s tankimi podolžnimi rebri. Prečni preseki spodnjih lupin imajo premere 1,7-2,8 cm. Struktura zunanje plasti lupine je sestavljena iz radialnih lamel izmenično svetle in temne barve. Zunanja plast lupine je debela okoli 0,5 cm. Srednja plast lupine je črna in debela 0,1-0,2 mm. Sifonalni progi E in S sta izraženi s posebno strukturo temne barve in trikotne oblike. Obe sifonalni progi sta skoraj enako veliki, le pri primerku št.1683 na tab. 5, sl. 9, je sifonalna proga S močnejša od proge E. Ligamentnega stebrička ta vrsta nima. Na prečnem preseku lupin ni videti elementov kardinalnega aparata zaradi prekristaljenosti notranjega dela lupin.

Stratigrafski položaj in razširjenost: Vrsta *Katzeria hercegovinaensis* Slišković je značilna za santonijsko-campanijske plasti Slovenije ter maastrichtijske plasti Hercegovine, Črne gore, Dalmacije z otoki, Italije ter Tržaškega Krasa.

Familia: Hippuritidae Gray, 1848
Genus: *Vaccinites* Fischer, 1887
Vaccinites cf. *vredenburgi* Kühn, 1932
Tab. 7, sl. 1a, 1b, 1c

cf. 1932a *Hippurites (Vaccinites) vredenburgi* Kühn - Kühn, 151-179; tab. 1, 2; sl. 1-5 med tekstom.

cf. 1934 *H. (Vaccinites) vredenburgi* Kühn - Milovanović, 218-225; sl. 17 med tekstom.

cf. 1957 *H. (Vaccinites) vredenburgi* Kühn - Pejović, 105-106; tab. 39, sl. 2; sl. 47 in 48 med tekstom.

cf. 1959 *H. vredenburgi* Kühn - Nazemi & Grubić, 950-952; sl. 4 med tekstom.

cf. 1962 *H. (Vaccinites) vredenburgi* (Kühn) - Grubić, 122; sl. 1-19 med tekstom.

cf. 1963 *H. (Vaccinites) vredenburgi* Kühn - Polšak, 440-441; sl. 2.

cf. 1967 *H. (Vaccinites) vredenburgi* Kühn - Polšak, 116-117 (210); tab. 74, sl. 4-5; tab. 75, sl. 1-3; sl. 38 med tekstom.

cf. 1975 *H. (Vaccinites) vredenburgi* Kühn - Pleničar, 97-98 (111); tab. 10, sl. 1-2; tab. 11, sl. 1-2; tab. 12, sl. 1-2.

cf. 1976 *Vaccinites vredenburgi* Kühn - Lupu, 11; tab. 7, sl. 1a, 1b; tab. 8, sl. 2.

cf. 1981 *V. vredenburgi* (Kühn) - Sánchez, 57.

cf. 1989 *V. vredenburgi* (Kühn) - Laviano & Guarnieri, 79-86; tab. 1, sl. 1-3, 6; sl. 2-6 med tekstom; tabela 1-2.

cf. 1990 *V. vredenburgi* Kühn - Guarnieri, Laviano & Pieri, tab. 3, sl. 4.

cf. 1996 *V. vredenburgi* (Kühn) - Pleničar & Jurkovšek, 43-46; tab. 3, sl. 1-2; tab. 4, sl. 1-2; tab. 5, sl. 1-3; tab. 6, sl. 2 in 4.

Material: Spodnja lupina iz kamnoloma Lipica I; št. vzorca BJ 1111.

Opis: Dolžina spodnje lupine znaša 19 cm, premer v zgornjem delu 10,7 krat 8,8 cm, v spodnjem delu pa 10 krat 8,3 cm. Na zunanji strani lupine potekajo podolžna rebra široka 5-8 mm. Prirastne linije so redke. Napravljena sta bila dva prečna preseka spodnje lupine. Debelina zunanje plasti lupine je 5-8 mm. Srednja plast lupine je debela 2-3 mm in je le delno ohranjena. Struktura zunanje plasti lupine je lamelarna. Zaradi napetosti v plasteh, v katerih je fosil ležal, je ta močno deformiran in prav zato določitev te vrste ni popolnoma zanesljiva. V obeh prečnih presekih spodnje lupine vidimo, da sta sifonalna stebrička delno ali popolnoma odtrgana od srednje plasti lupine, ali pa zasukana iz svoje prvotne lege. Ligamentni stebriček L leži le v nižjem preseku na prvotnem mestu. Sifonalni stebriček S je ovalne oblike z nitkastim pecljem. Podoben je stebriček E, ki ima tudi nitkast pecelj, je ohranjen le na višjem preseku lupine, vendar tudi tam pretrgan. Stebriček S je dolg okoli 2,5 cm, stebriček E pa nekaj čez 3 cm. Oba stebrička sta verjetno ležala prvotno precej vzporedno drug ob drugem. Ligamentni stebriček je dolg okoli 1,5 cm, širok 2-3 mm, na vrhu ravno odrezan in nagnjen proti sifonalnima stebričkoma. V zgornjem preseku lupine so ohranjeni tudi sledovi zobnih jamic in glavnega zoba, vendar očitno ne ležijo na primarnem mestu. Na zgornjem preseku je tudi vidna bivalna odprtina. Meja med srednjo plastjo lupine in notranjo plastjo je precej nagubana, kar je značilno za nekatere vrste rodu *Vaccinites* in njihovo tendenco k prehodu v rod *Pironea*.

Podobnosti in razlike: Primerek je precej podoben tudi vrsti *Vaccinites praegiganteus* Toucas, vendar zanesljiva določitev, kot smo že omenili, ni možna zaradi deformacije lupine.

Stratigrafski položaj in razširjenost: Vrsta *V. vredenburgi* Kühn je značilna za santonijske in spodnjecampanijske plasti Tržaško-komenske planote, Nanosa, Tržaškega Krasa, Istre, Dalmacije, Hercegovine, Medvednice pri Zagrebu, Italije, Francije, Španije, Romunije in Irana.

Genus: *Hippuritella* Douvillé, 1908
Hippuritella castroi Vidal, 1874
Tab. 8, sl. 1a, 1b, 2

1895 *Hippurites (Orbignya) castroi* Vidal - Douvillé, 171; tab. 25, sl. 3-5.
1932b *H. (O.) castroi* Vidal - Kühn, 41.
1961 *H. (O.) cf. castroi* Vidal - Devidé-Nedela & Polšak, 366-367; tab. 3, sl. 2; sl. 7 med tekstom.
1971 *H. (O.) castroi* Vidal - Pleničar, 249; tab. 7, sl. 1; sl. 21 med tekstom.
1976 *Hippurites castroi* Vidal - Lupu, tab. 12, sl. 3, 4.
1977 *H. (Hippuritella) castroi* Vidal - Pons, 58; tab. 10, sl. 1-3; tab. 11, sl. 1-5.

Material: Trije prečni preseki spodnjih lupin na polirani površini plošče apnenca iz kamnoloma Lipica I; št. vzorcev BJ 1689, BJ 1693.

Opis: Nekoliko ovalna prečna preseka lupin znašata 1,7 krat 1,8 cm in 3,1 krat 3,3 cm. Na presekih so vidni sledovi številnih ostrih reber. Sifonalni stebriček S je krajši in v bazi nekoliko širši od sifonalnega stebrička E. Ligamentni stebriček L je komaj opazen v obliki položne konveksne vzbokline na notranji strani lupin. Prav šibko sta vidni obe zobni jamici in glavni zob N (vzorec št. 1689, tab. 8, sl. 1a, 1b).

Podobnosti in razlike: Primerki se dobro ujemajo s slikami v Douvillé-jevem delu iz l. 1895 (tab. 25, sl. 1-3). Podobni so tudi vrsti *Hippurites colliciatus* Woodward, ki je podana v delu Sladić-Trifunovićeve iz leta 1978 na sl. 8/1, 2, pri Lupu (1976, tab. 12, sl. 1-2) ali *Hippuritella colliciata* Woodward pri Pleničar (1994, tab. 2, sl. 1, 2). Slednja ima le bolj razvita zunanja podolžna rebra.

Stratigrafski položaj in razširjenost: vrsta *H. castroi* Vidal je znana v maastrichtijskih skladih Španije, Romunije in Bosne (blizu Jajca) ter v santonijskih in campanijskih skladih severne Slovenije (Stranice pri Konjicah).

Hippuritella sarthacensis var. *peroni* (Douvillé, 1895)
Tab. 8, sl. 5

1895 *Hippurites peroni* Douvillé -Douvillé, 170; tab. 25, sl. 1, 2, 2a.
1976 *Hippuritella sarthacensis peroni* Douvillé - Lupu, 121; tab. 10, sl. 3a, 3b; tab. 11, sl. 7a, 7b.
1977 *Hippurites (Hippuritella) sarthacensis* var. *peroni* Douvillé - Pons, 63-64; tab. 32, sl. 1, 2.

Material: Prečni presek spodnje lupine na polirani plošči apnenca; vzorec št. BJ 1692.

Opis: Dva prečna preseka spodnjih lupin s precej okroglima premeroma 3,5 cm in 4 cm. Na presekih so vidna drobna, zaobljena rebra na zunanji strani lupin. Sifonalni stebriček S je precej širok, v bazalnem delu še dodatno razširjen in krajši od stebrička E. Stebriček E je ožji od S s precej vzporednima stranicama in v bazi prav neznatno razširjen. Ligamentni stebriček L je trikoten z odrezanim vrhom. Zobni jamici sta slabo vidni, ker sta lupini močno prekristaljeni.

Podobnosti in razlike: Varieteta *Hippuritella sarthacensis* var. *peroni* Douvillé je podobna turonijski vrsti *Hippuritella resecta* Defrance, s katero jo je prav lahko zamenjati, vendar ima slednja sifonalni stebriček S manj zaokrožen in bolj podoben stebričku E kot pri varieteti *H. sarthacensis* var. *peroni*.

Stratigrafski položaj in razširjenost: Ta varieteta je razširjena v spodnjesantonijskih in coniacijskih skladih Španije in v santonijskih skladih Francije in Romunije.

Hippuritella sulcatissima (Douvillé, 1894)
Tab. 8, sl. 3, 4

1894 *Hippurites sulcatissimus* Douvillé - Douvillé, 133-134; tab. 20, sl. 6-7.
1975 *H. (Orbignya) sulcatoides* Douvillé - Pleničar, 89 (108); tab. 1, sl. 3.
1975 *H. (Orbignya) sulcatissimus* Douvillé - Pleničar, 89 (108); tab. 1, sl. 4.
1977 *H. (Hippuritella) sulcatissimus* Douvillé - Pons, 65; tab. 37, sl. 1-3; tab. 38, sl. 1-2.

Material: Dva prečna preseka spodnjih lupin na polirani površini plošče apnenca in kamnoloma Lipica I; št. vzorcev BJ 1672 in BJ 1675.

Opis: Premera spodnjih lupin sta ovalna s premeroma 2 krat 2,5 cm. Debelina zunanje plasti lupine je 3 mm. Kardinalni aparat ni ohranjen. Analni stebriček S je čokat in v bazi razširjen ter ima zato skoraj trikotno obliko. Skržni stebriček E je podolgovat, vendar se tudi ta v bazi nekoliko razširi in je zasukan proti stebričku S. Ligamentni stebriček L je trikoten, v bazi zelo širok, sicer pa kratek s topo zaokroženim vrhom, oziroma celo topo prisekanim širokim vrhom. Zasukan je proti stebričku S. Razdalja L-S je enaka razdalji S-E.

Podobnosti in razlike: Primerka sta podobna vrstam *Hippuritella sulcatoides* Douvillé, *Hippuritella socialis* Toucas in *Hippuritella incisa* (Douvillé). Razlike so prav malenkostne in verjetno bi bilo potrebno napraviti podrobnejšo revizijo vseh teh vrst, da bi ugotovili, če ne gre morda za iste vrste z malimi varietetami.

Stratigrafski položaj in razširjenost: Vrsta *H. sulcatissima* (Douvillé) je značilna za campanijske sklade Slovenije (Tržaško-komenska planota), Španije in Francije.

Hippuritella cf. *variabilis* (Munier-Chalmas, 1867)
Tab. 8, sl. 6

cf. 1892 *Hippurites variabilis* Munier-Chalmas - Douvillé, 50; tab. 7, sl. 4-18;

cf. 1897 *H. variabilis* Munier-Chalmas - Douvillé, 187-188; sl. 68-70 med tekstom.

cf. 1910 *H. (Hippuritella) variabilis* Munier-Chalmas - Douvillé, 40-41; tab. 2, sl. 7-9; sl. 45a, 45b med tekstom.

cf. 1963 *H. (Hippuritella) variabilis* (Munier-Chalmas) - Slišković; tab. 5, sl. 3.

cf. 1961 *H. (Hippuritella) variabilis* Munier-Chalmas - Devidé-Nedela & Polšak, 367-368; sl. 8 med tekstom.

cf. 1963 *H. (Hippuritella) variabilis* Munier-Chalmas - Pamouktschief, 100; tab. 1, sl. 2, 3, 3a; sl. 1 med tekstom.

cf. 1970 *H. (Hippuritella) variabilis* Munier-Chalmas - Lupu, 75-76; tab. 1, sl. 7; sl. 4 med tekstom.

cf. 1977 *H. (Hippuritella) variabilis* Munier-Chalmas - Pons, 66; tab. 26, sl. 4.

cf. 1979 *H. (Hippuritella) variabilis* Munier-Chalmas - Polšak; tab. 10, sl. 3.

cf. 1981 *Hippuritella variabilis* (Munier-Chalmas) - Sánchez, 14.

Material: Prečni presek spodnje lupine na polirani površini plošče apnenca iz kamnoloma Lipica I; št. vzorca BJ 1684.

Opis: Premer lupine znaša 2,2 krat 3,3 cm. Na prečnem preseku lupine so sledovi drobnih, zaobljenih podolžnih reber na zunanji strani lupine. Sifonalni progi sta v obliki dveh zaobljenih reber. Sifonalna proga S je skoraj trikotna s širokim bazalnim delom, proga E je nekoliko šibkejša. Ligamentni stebriček L predstavlja rahlo izbočeni notranji del lupine. Na vsaki strani stebrička L je po en odtis zobne jamice. Ostali elementi kardinalnega aparata niso razpoznavni.

Podobnosti in razlike: Primerek je delno podoben tudi drugim vrstam rodu *Hippuritella,* od katerih ga le težko ločimo. Tudi v tem primeru velja pripomba, ki smo jo dali pri vrsti *Hippuritella sulcatissima.*

Stratigrafski položaj in razširjenost: Vrsta *Hippuritella variabilis* Munier-Chalmas se pojavlja v campanijskih skladih v Španiji, Franciji; Bolgariji, Srbiji, Romuniji in Alžiriji. V Bosni jo omenjajo v maastrichtijskih plasteh, medtem ko je bila najdena na Medvednici pri Zagrebu v santonijsko-campanijskih plasteh.

TABLE 1-8 - PLATES 1-8

Fotografije izdelal dr. Bogdan Jurkovšek.
Photographs were taken by Dr. Bogdan Jurkovšek.

TABLA - PLATE 1

Bournonia cf. retrolata ***(Astre).***
Sl. 1: Dva prečna preseka spodnjih lupin; vzorec št. BJ 1696; naravna velikost.
Fig. 1: Two cross sections of the lower valves; sample number BJ 1696; natural size.
Bournonia wiontzeki ***Pejović.***
Sl. 2, 3, 4: Prečni preseki spodnjih lupin; vzorci št. BJ 1686, BJ 1675, BJ 1673; naravna velikost.
Figs. 2, 3, 4: Cross sections of the lower valves; sample numbers BJ 1686, BJ 1675, BJ 1673; natural size.
Bournonia ***sp.***
Sl. 5: Prečni presek spodnje lupine; vzorec št. BJ 1676; naravna velikost.
Fig. 5: Cross section of the lower valve; sample number BJ 1676; natural size.
Biradiolites cf. zucchii ***Caffau & Pleničar.***
Sl. 6: Prečni presek spodnje lupine; vzorec št. BJ 1672; naravna velikost.
Fig. 6: Cross section of the lower valve; sample number BJ 1672; natural size.
Sl. 7: Površina apnenca Lipiške formacije z izluženimi lupinami rudistov v kamnolomu Lipica I.
Fig. 7: Limestone surface with rudist valves, Lipica Formation, Lipica I quarry.

TABLA - PLATE 2

Radiolites cf. squamosus ***d'Orbigny.***
Sl. 1: Prečni presek spodnje lupine; vzorec št. BJ 1697; naravna velikost.
Fig. 1: Cross section of the lower valve; sample number BJ 1697; natural size.
Radiolites galloprovincialis ***Matheron.***
Sl. 2: Prečni presek spodnje lupine; vzorec št. BJ 1684; x2.
Fig. 2: Cross section of the lower valve; sample number BJ 1684; x2.
Sl. 3, 4, 5: Odlomki spodnjih lupin; vzorec št. BJ 1783; x2.
Figs. 3, 4, 5: Fragments of the lower valves; sample number BJ 1783; x2.

TABLA - PLATE 3

Radiolites cf. dario ***(Catullo).***
Sl. 1, 2: Prečni presek spodnje lupine; vzorca št. BJ 1682, BJ 1694; sl. 1 - x1,5; sl. 2 - naravna velikost.
Figs. 1, 2: Cross section of the lower valve; sample numbers BJ 1682, BJ 1694; fig. 1 - x1.5; fig. 2 - natural size.
Sl. 3: Spodnja lupina, kardinalna stran; vzorec št. BJ 1801; x1,5.
Fig. 3: The lower valve, cardinal side; sample number BJ 1801; x1.5.
Radiolites spinulatus ***Parona.***
Sl. 4, 5: Prečna preseka spodnjih lupin; vzorca št. BJ 1674, BJ 1681; naravna velikost.

Figs. 4, 5: Cross sections of two lower valves; sample numbers BJ 1674, BJ 1681; natural size.
Sauvagesia sp.
Sl. 6a: Prečni presek spodnje lupine; vzorec št. BJ 1672; naravna velikost.
Fig. 6a: Cross section of the lower valve; sample number BJ 1672; natural size.
Sl. 6b: Prečni presek spodnje lupine, kardinalna regija; 3x povečan detajl iz slike 6a.
Fig. 6b: Cross section of the lower valve, cardinal side; 3x enlarged detail from the figure 6a.

TABLE - PLATE 4

Sauvagesia tenuicostata **Polšak.**
Sl. 1, 2a, 2b: Trije prečni preseki spodnjih lupin; vzorca št. BJ 1676 in BJ 1686; naravna velikost.
Figs. 1, 2a, 2b: Three cross sections of the lower valves; sample numbers BJ 1676 in BJ 1686; natural size.
Sl. 3, 5, 6: Odlomki treh spodnjih lupin; vzorec št. BJ 1781; x2.
Figs. 3, 5, 6: Fragments of three lower valves; sample number BJ 1781; x2.
Sl. 4: Spodnja lupina, sifonalna stran; vzorec št. BJ 1781; x1,5.
Figs. 4: The lower valve, siphonal side; sample number BJ 1781; x1.5.

TABLE - PLATE 5

Medeella zignana **(Pirona).**
Sl. 1, 2, 3, 4, 6: Odlomki spodnjih lupin; vzorec št. BJ 1782; x2.
Figs. 1, 2, 3, 4, 6: Fragments of the lower valves; sample number BJ 1782; x2.
Sl. 5, 7: Prečna preseka spodnjih lupin; vzorca št.BJ 1688 in BJ 1684; sl. 5 - naravna velikost; sl. 7 - x2.
Figs. 5, 7: Cross sections of the lower valves; sample numbers BJ 1688 and BJ 1684; fig. 5 - natural size; fig. 7 - x2.
Gorjanovicia cf. *costata* **Polšak.**
Sl. 8: Odlomek spodnje lupine; vzorec št. BJ 1784; x2.
Fig. 8: Fragment of the lower valve; sample number BJ 1784; x2.
Katzeria hercegovinaensis **Slišković.**
Sl. 9-11: Prečni preseki treh spodnjih lupin; vzorci št. BJ 1683, BJ 1681, BJ 1697; naravna velikost.
Figs. 9-11: Cross sections of three lower valves; sample numbers BJ 1683, BJ 1681, BJ 1697; natural size.
Sl. 12: Odlomek spodnje lupine; vzorec št. BJ 1780; x2.
Fig. 12: Fragment of the lower valve; sample number BJ 1780; x2.

TABLA - PLATE 6

Praelapeirouseia wiontzeki **Slišković.**
Sl. 1a: Prečni presek spodnje lupine; vzorec št. BJ 1675; naravna velikost.
Fig. 1a: Cross section of the lower valve; sample number BJ 1675; natural size.
Sl. 1b: Prečni presek spodnje lupine; 2x povečana slika 1a.
Fig. 1b: Cross section of the lower valve; 2x enlarged figure 1a.
Praelapeirouseia sp.
Sl. 2-7: Prečni preseki spodnjih lupin; vzorci št. BJ 1682, BJ 1675, BJ 1682, BJ 1673, BJ 1672, BJ 1673; naravna velikost.
Figs. 2-7: Cross sections of the lower valves; sample numbers BJ 1682, BJ 1675, BJ 1682, BJ 1673, BJ 1672, BJ 1673; natural size.

TABLA - PLATE 7

Vaccinites cf. *vredenburgi* **Kühn.**
Sl. 1a: Prečni presek spodnje lupine (4,5 cm od komisure); naravna velikost.
Fig. 1a: Cross section of the lower valve (4.5 cm from the commissure); natural size.
Sl. 1b: Prečni presek spodnje lupine (13,5 cm od komisure); naravna velikost.
Fig. 1b: Cross section of the lower valve (13.5 cm from the commissure); natural size.
Sl. 1c: Spodnja lupina; vzorec št. BJ 1111; merilo.
Fig. 1c: Lower valve; sample number BJ 1111; scale bar.

TABLA - PLATE 8

Hippuritella castroi **Vidal.**
Sl. 1a, 1b, 2: Prečni preseki spodnjih lupin; vzorci št. BJ 1689 in BJ 1693; sl. 1a - naravna velikost; sl. 1b,2 - x2.
Figs. 1a, 1b, 2: Cross sections of the lower valves; sample numbers BJ 1689 and BJ 1693; fig. 1a - natural size; figs. 1b, 2 - x2.
Hippuritella sulcatissima **(Douvillé).**
Sl. 3, 4: Prečna preseka spodnjih lupin; vzorci št. BJ 1672 in BJ 1675; x2.
Figs. 3, 4: Cross sections of the lower valves; sample numbers BJ 1672 and BJ 1675; x2.
Hippuritella sarthacensis var. *peroni* **(Douvillé).**
Sl. 5: Prečni presek spodnje lupine; vzorec št. BJ 1692; naravna velikost.
Fig. 5: Cross section of the lower valve; sample number BJ 1692; natural size.
Hippuritella cf. *variabilis* **(Munier-Chalmas).**
Sl. 6: Prečni presek spodnje lupine; vzorec št. BJ 1684; x2.
Fig. 6: Cross section of the lower valve; sample number BJ 1684; x2.
Sl. 7: Rudistna biostroma v kamnolomu Lipica I.
Fig. 7: Rudist biostrome in the Lipica I quarry.

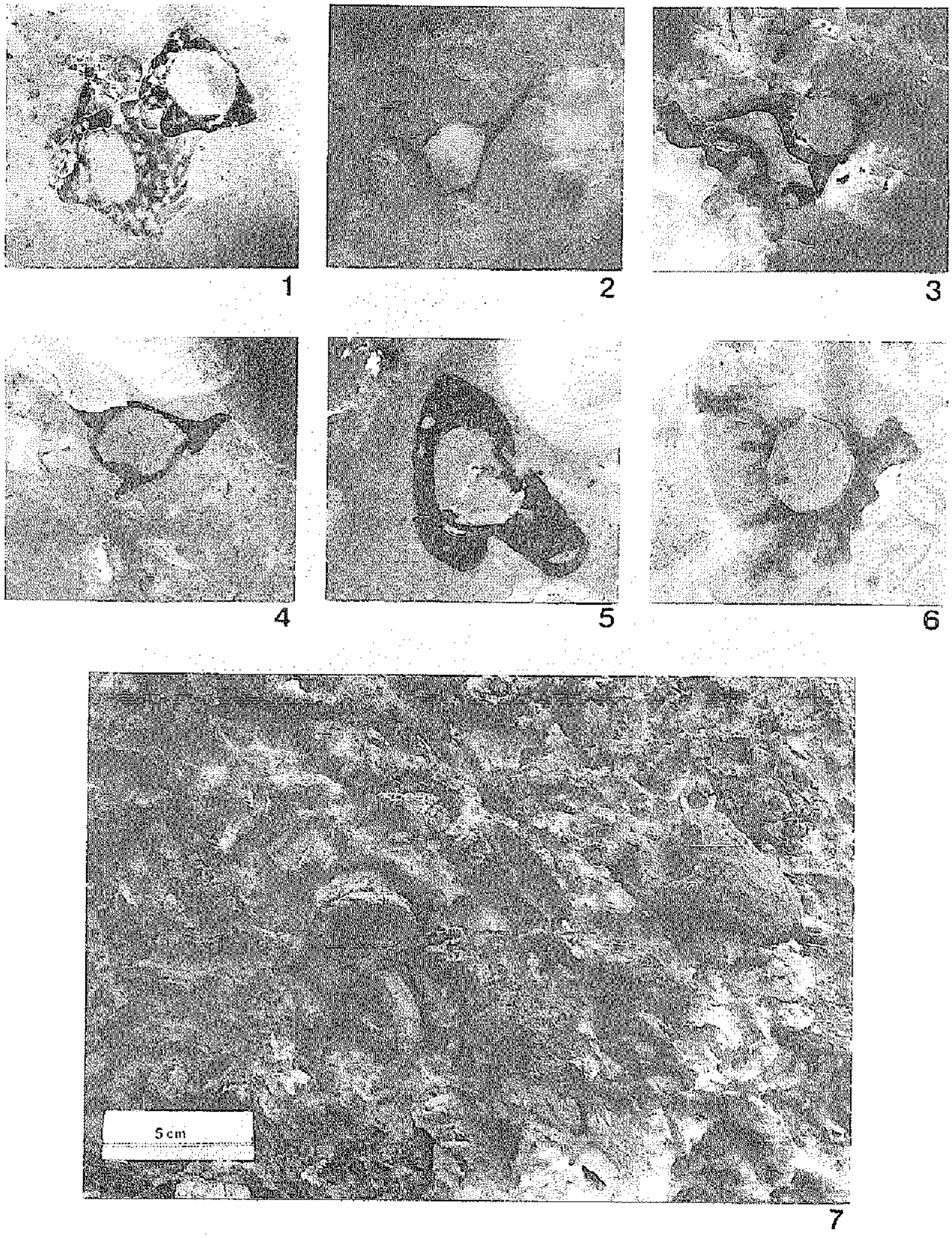


TABLA 1 - PLATE 1

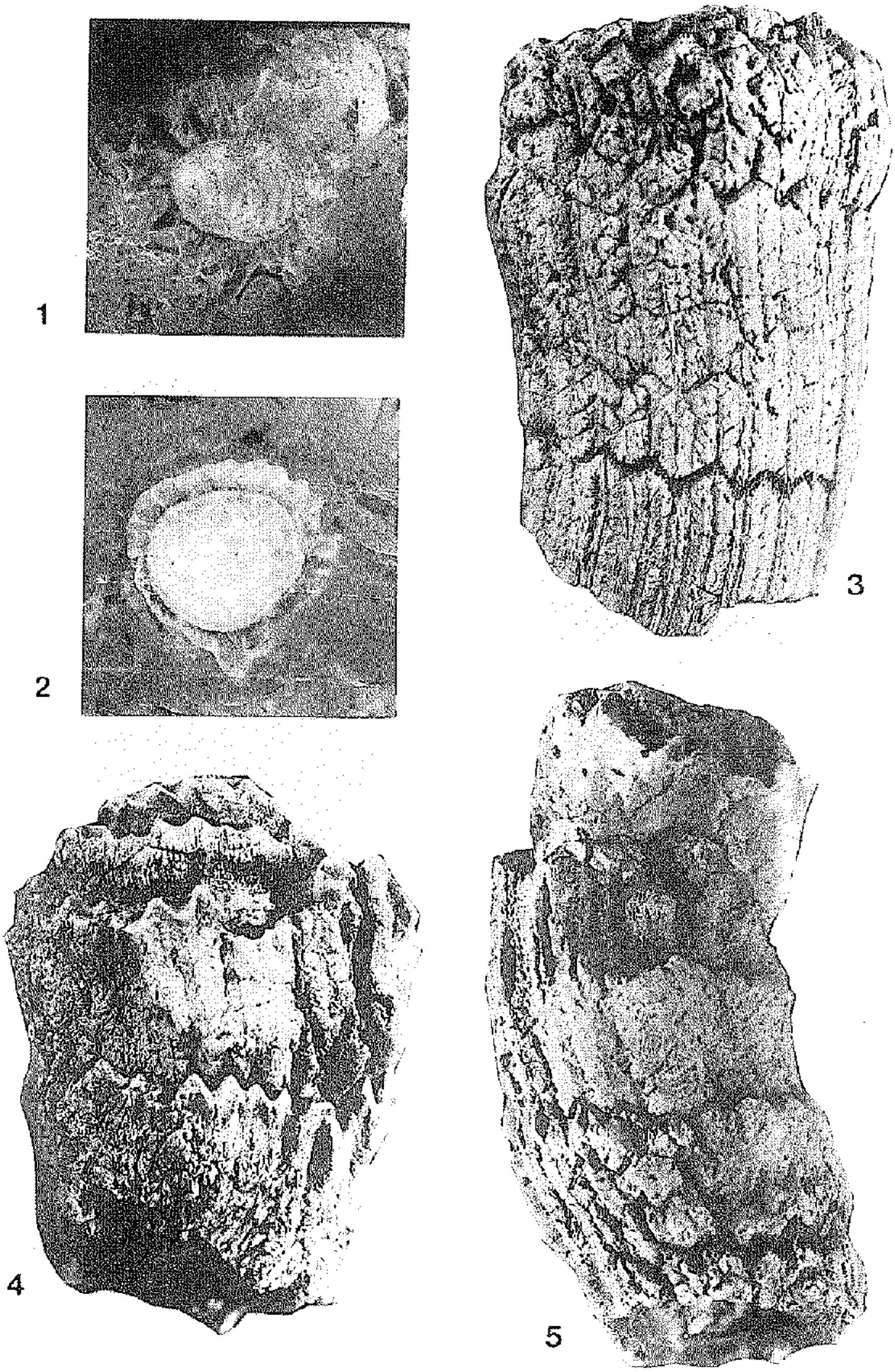


TABLA 2 - PLATE 2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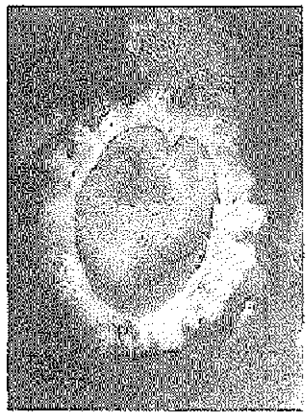
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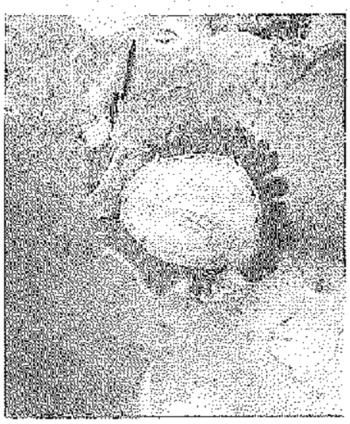
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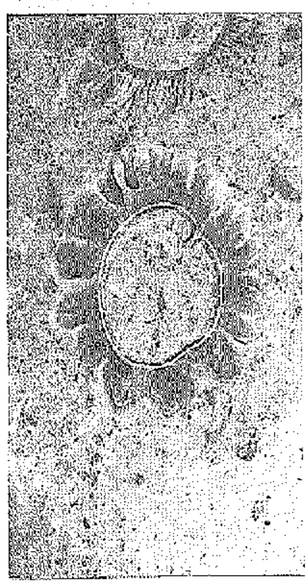
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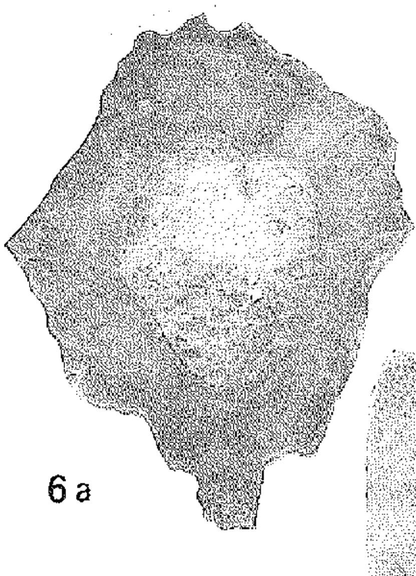
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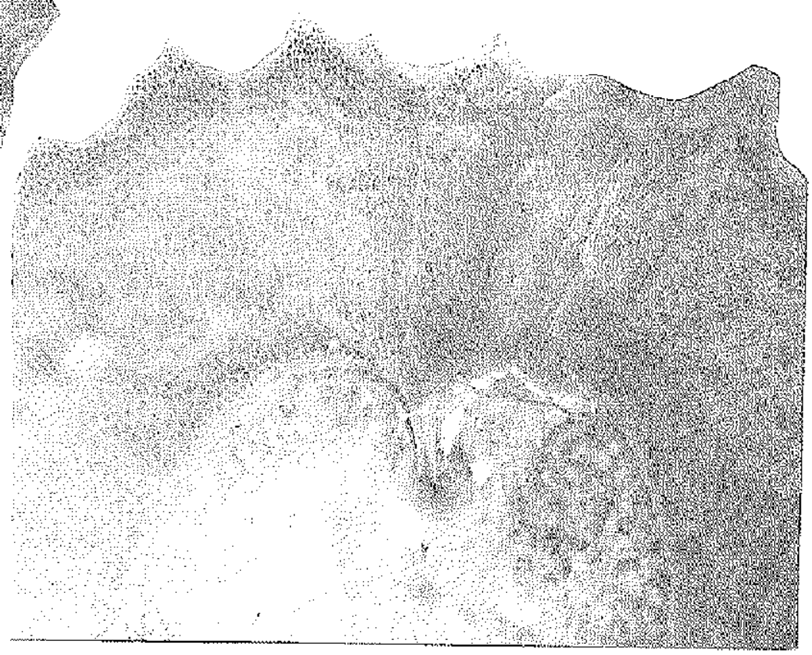
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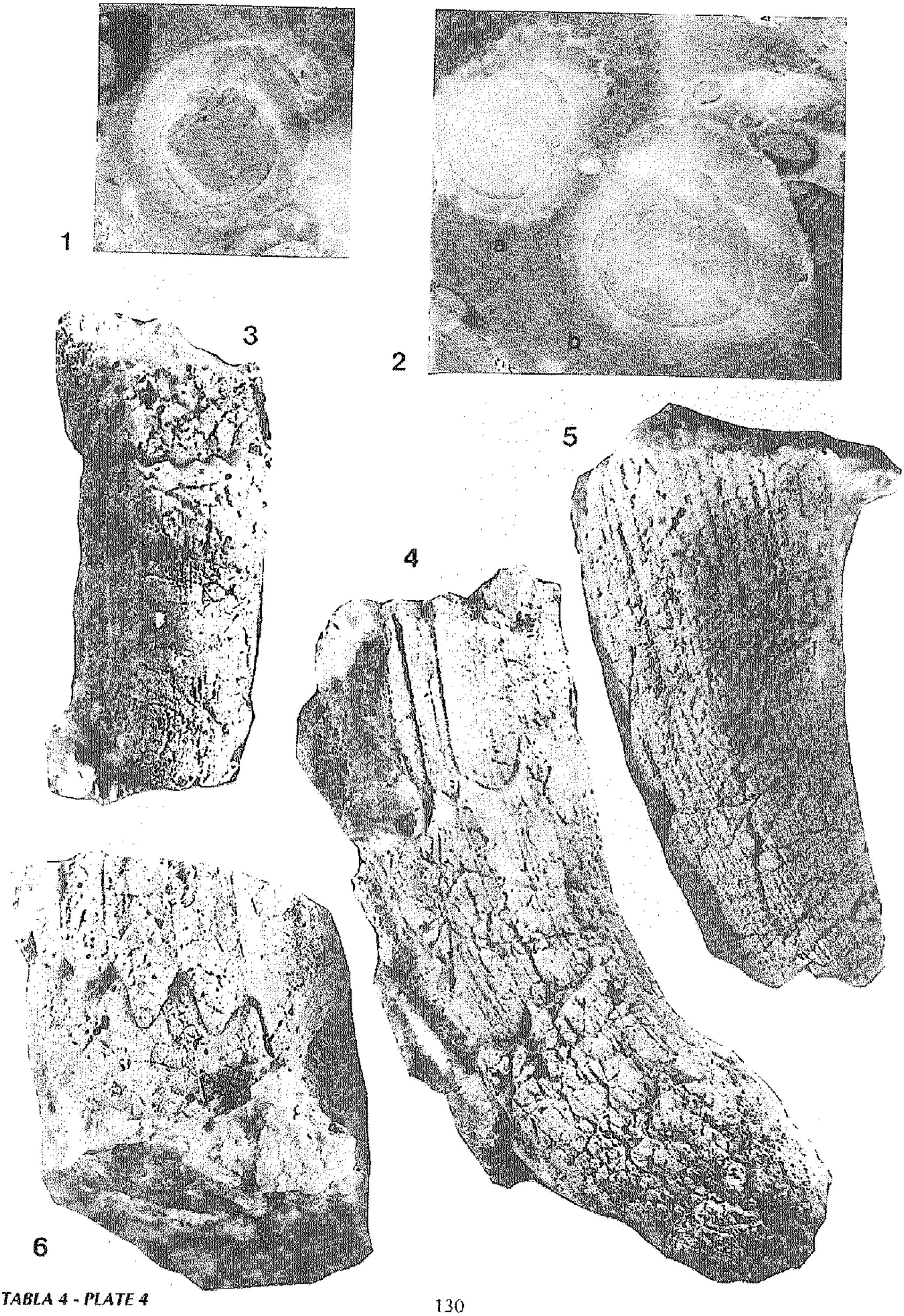
TABLA 3 - PLATE 3



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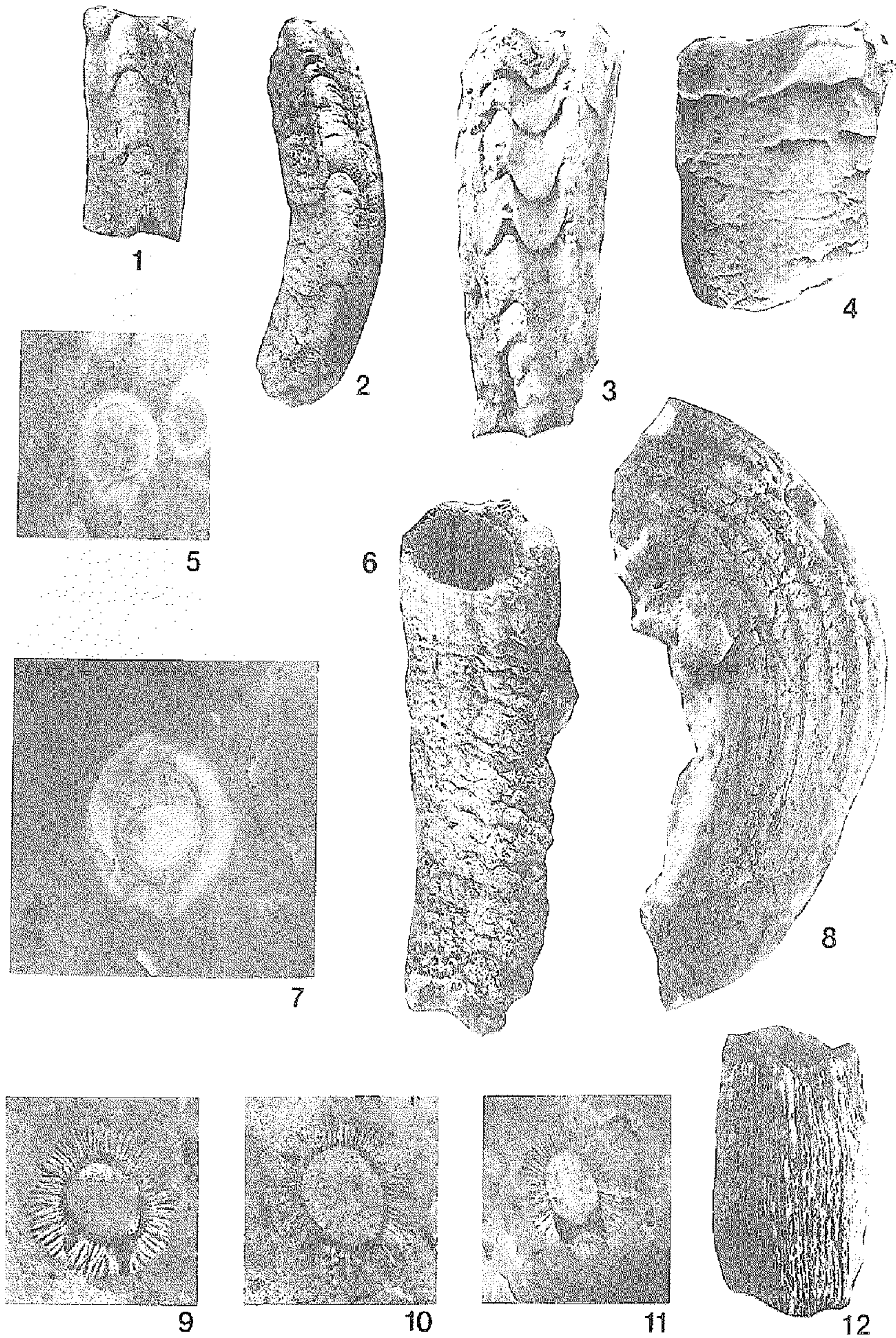

TABLA 5 - PLATE 5

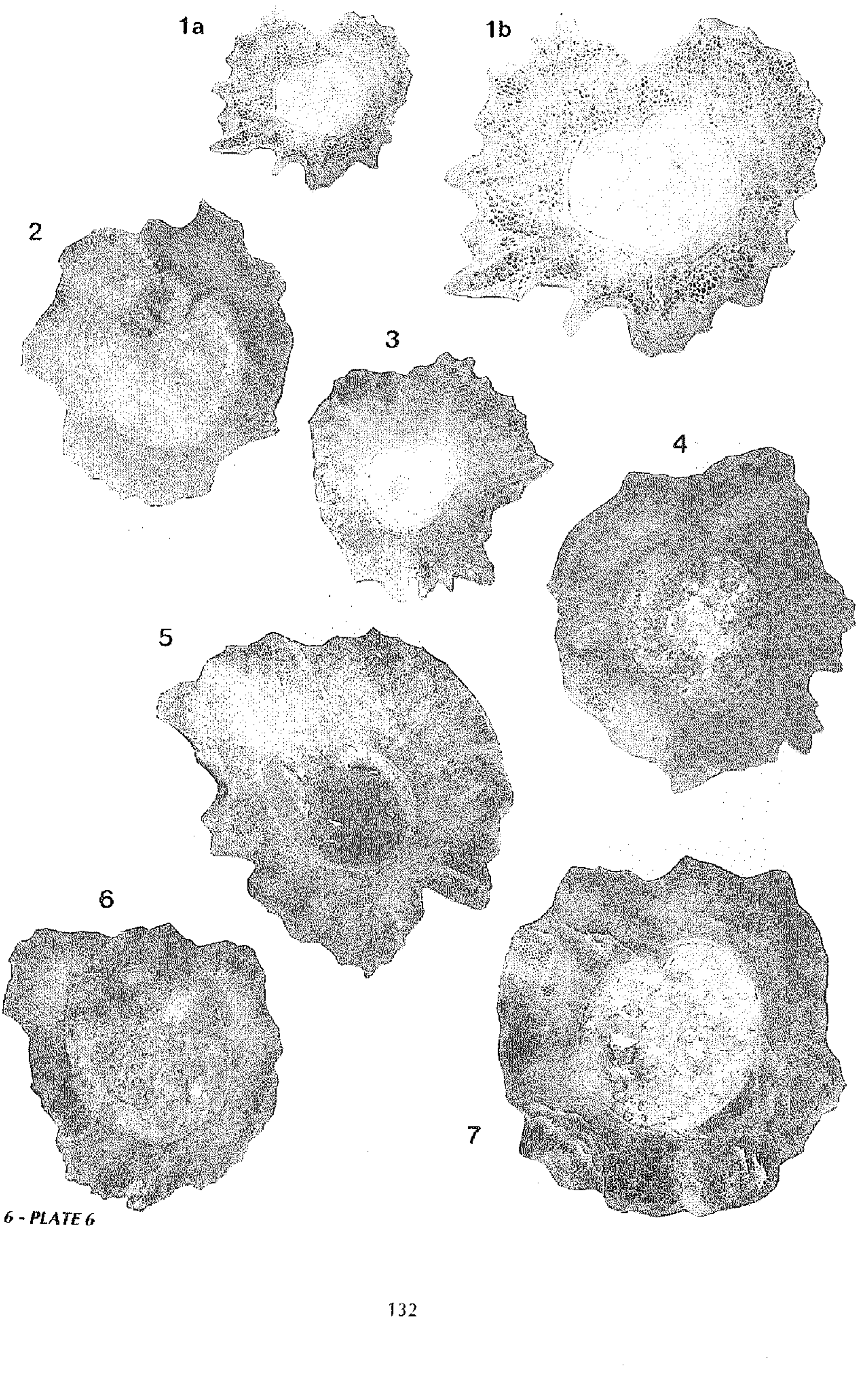

TABLA 6 - PLATE 6

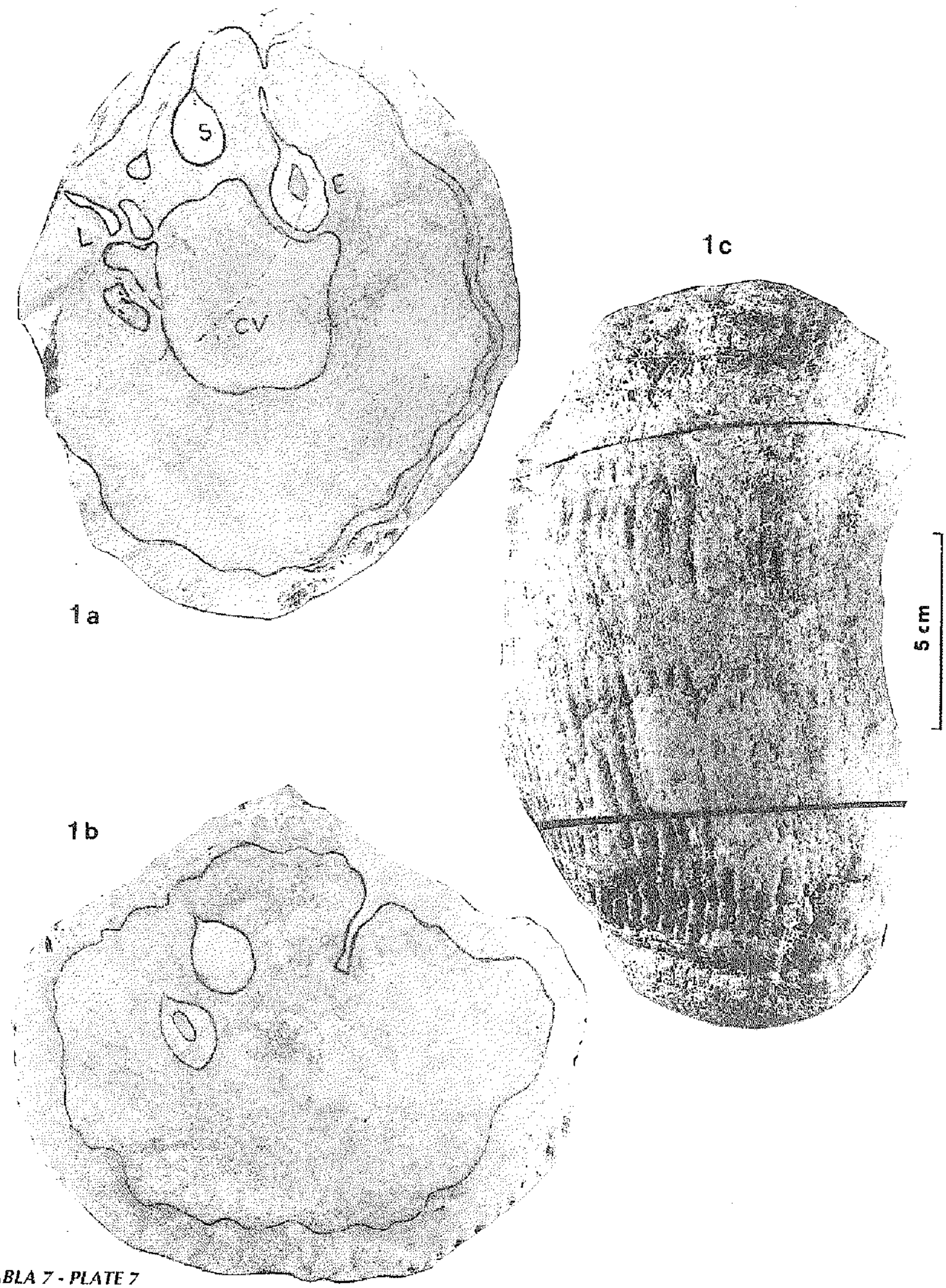

TABLA 7 - PLATE 7

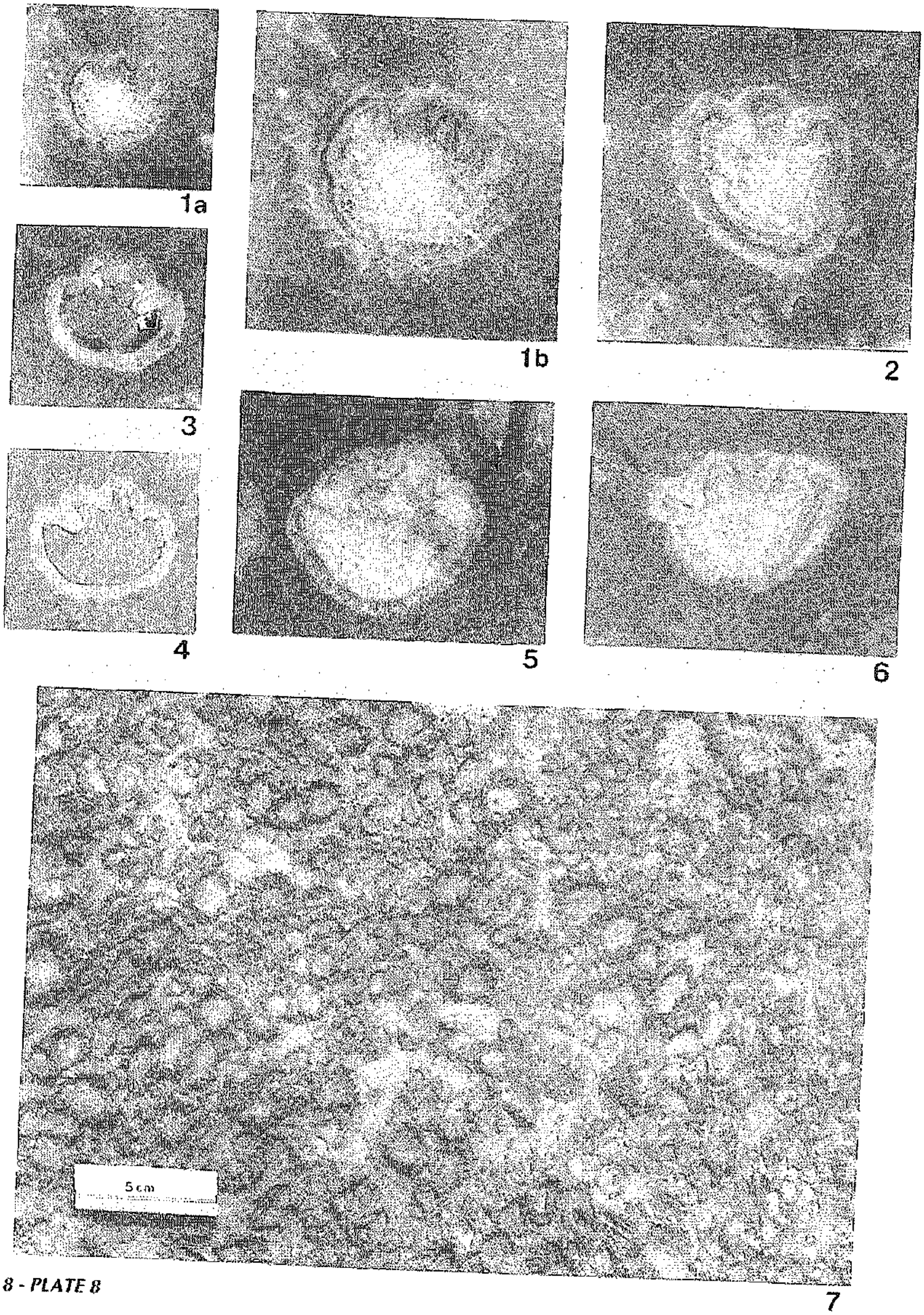

TABLA 8 - PLATE 8

SKLEP

Raziskani rudisti so značilni predstavniki santonijsko-campanijskih rudistnih biostrom na Dinarski karbonatni plošči.

Jurkovšek in sodelavci (1996) so na Formacijski geološki karti južnega dela Tržaško-komenske planote uvrstili v Lipiško formacijo velik del zgornjesantonijsko-campanijskih karbonatnih kamnin južnega Krasa. Kamnolom Lipica I z raziskano rudistno združbo leži južno od tektonske in predpostavljene paleogeografske ločnice, ki jo danes predstavlja Divaški prelom (slika 1). Razlika v barvi, debelini in stratigrafskem razponu med apnencem Lipiške formacije severno in južno od Divaškega preloma je nedvomno paleogeografsko pogojena (slika 4).

Najnovejše raziskave kažejo, da se je južno ležeče plitvo morsko območje, na katerem so nastajali tudi apnenci današnjega kamnoloma Lipica I v gornjem santoniju, postopno dvigovalo (Jurkovšek *et al.*, 1996), medtem ko je bil severni del ozemlja že pod vplivom santonijsko-campanijske t. im. druge pelagične epizode na Dinarski karbonatni plošči (Gušić & Jelaska, 1990; Jurkovšek *et al.*, 1996) in s tem dogodkom povezano povečano vsebnostjo organske substance v sedimentacijskem okolju (Pleničar & Jurkovšek, 1997). Vpliv pelagiala na območje, ki je danes severno od Divaškega preloma se je nedvomno širil iz severno oziroma severovzhodno ležečega Slovenskega jarka. O njem pričajo amoniti z aptihi, sakokomide in fosili nekaterih drugih prebivalcev odprtega morja (Jurkovšek & Kolar-Jurkovšek, 1995; Summesberger *et al.*, 1996; Kolar-Jurkovšek *et al.*, 1996; Pleničar & Jurkovšek, 1997).

O bližnjem kopnu pričajo številni fosilni ostanki kopenskih rastlin v Tomajskem apnencu Lipiške formacije. To kopno je že v spodnjem campaniju nastalo na območju, ki leži danes južno od Divaškega preloma. Naše razmišljanje potrjuje tudi dejstvo, da Lipiška formacija na tem prostoru nikjer ne vsebuje tanjših ali debelejših vložkov z ogljikom bogatega laminiranega santonijsko-campanijskega Tomajskega apnenca, manjka pa tudi tisti del formacije, ki vsebuje vrsto *Calveziconus lecalvezae* Caus & Cornella, ki je značilna za srednji del campanija (Gušić & Jelaska, 1990; Šribar, 1995). Razlika med severnim in južnim delom ozemlja je očitna tudi v debelini Lipiške formacije, ki znaša na severu do 450 m, na jugu pa le do 250 m. Kopno, ki je nastalo v zgornjem santoniju ali najkasneje v spodnjem campaniju, je obstajalo vse do maastrichtija, ko so se na zakraselo površino Lipiške formacije odložile brakične in morske plasti Liburnijske formacije (slika 3).

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RUDISTS FROM THE LIPICA FORMATION IN THE LIPICA I QUARRY

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SUMMARY

The economically most important part of carbonate rocks in the Kras region is represented by the Lipica Formation that contains numerous limestone varieties that differ in texture as well as in color. All abandoned and the two still producing quarries of architectonic-building stone in the Lipica Formation are associated to vicinity of rudist biostromes and bioherms. Although earlier numerous varieties of limestones were exploited, if only they occurred in sufficiently thick beds, the actual production is limited to the remaining two types that are being produced in the Lipica I and Lipica II quarries north and northwest of the Horse-breeding and touristic center of Lipica (fig. 1). The first type is "Lipica unified" ("unito") that is light olive grey, homogeneous, compact, fine to coarse grained limestone in which occur fossils and their fragments not larger than several millimeters. The second type of limestone is "Lipica rosy" ("fiorito") that is prevailingly light grey, of fine grained matrix, somewhat porose. It contains numerous fossil remains of various sizes and in places unregularly distributed, mostly consisting of rudist valves.

The investigations encompassed the central part of the productive Lipica Formation in the Lipica I quarry that is presently at rest; in it alternate about 1 m thick layers of "fiorito" and "unito". A minor number of isolated rudist valves sorted naturally out of rock were sampled by us on weathered surfaces of limestone blocks (pl. 1, fig. 7) that were quarried on the higher terraces of the quarry, but belonged to the same horizon as the central part of the productive Lipica Formation. At present these blocks lie on the dump south of the Lipica I quarry. A large specimen of right valve of species Vaccinites vredenburgi *Kühn was found by quarrymen before 1989 in the south part of the quarry. Then it was preliminarily determined by Dr. B. Korolija. Pleničar mentioned in his treatise from 1975 the species* Vaccinites oppeli *Douville that he also found in the Lipica I quarry (Pleničar, 1975).*

The rudist fauna in polished plates of the Lipica limestone belongs to the following species: Bournonia *cf.* retrolata *Astre,* B. wiontzeki *Pejović,* Bournonia *sp.,* Biradiolites *cf.* zucchii *Caffau & Pleničar,* Radiolites *cf.* dario *(Catullo),* R. galloprovincialis *Matheron,* R. spinulatus *Parona,* R. *cf.* squamosus *d'Orbigny,* Sauvagesia tenuicostata *Polšak,* Sauvagesia *sp.,* Medeella zignana *(Pirona),* Gorjanovicia *cf.* costata *Polšak,* Praelapeirouseia wiontzeki *Slišković,* Praelapeirouseia *sp.,* Katzeria hercegovinaensis *Slišković,* Hippuritella castroi *Vidal,* H. sarthacensis *var.* peroni *(Douvillé),* H. sulcatissima *(Douvillé) in* H. *cf.* variabilis *(Munier-Chalmas). There were also several naturally leached out rudist valves that belong to species:* Radiolites *cf.* dario *(Catullo),* Sauvagesia tenuicostata *Polšak,* Gorjanovicia *cf.* costata *Polšak,* Medeella zignana *(Pirona),* Katzeria hercegovinaensis *Slišković and* Vaccinites *cf.* vredenburgi *Kühn. The latter were collected on secondary blocks in the quarry or above it*

All documentation and fossils are stored in the Paleontological collection of Dr. Bogdan Jurkovšek that was declared temporarily a monument by the Ministry of Culture, and has been registered since 1985 at the Slovene Natural History Museum.

The investigated limestone horizon with rudists in the Lipica I quarry lies in the central, economically most interesting part of the Lipica Formation in the immediate vicinity of Lipica, the town that gave the name to the formation. Structurally the beds lie in the northeast flank of the Lipica syncline the axis of which is slightly plunging towards southeast.

The Lipica Formation is underlain by approximately 400 m of layered and bedded grey to olive grey biomicritic limestone of the Sežana Formation that has a relatively low energy index (1-2). Only in places, especially in its upper part, near to the Lipica Formation, a somewhat higher value of the energy index can be observed (2-3). In particular levels in the limestone occur abundant rudist valves, although the rudist biostromes in primary position are rare in the Sežana Formation.

The Lipica Formation differs from the Sežana Formation especially by comparatively very thick beds. Owing to favorable structure and texture of the stone it has been already in the past a favored source for quarrying high quality variegated limestones. The beds were deposited on a moderately open part of the shelf for which the varieties of grainstone to packstone with all passages to fine grained biocalcarenite were characteristic. The skeleton of rock consists mainly of valves of rudist lamellibranches that are as a rule intensely endolithified. The valves might be still complete, and locally even entire undamaged bioherms and biostromes could be observed (pl. 8, fig. 7). Predominantly, however, the rudist valves are fragmented which is typical for the major part of the productive zone

of the Lipica quarries. The massive limestone of the Lipica I quarry in which no physical boundaries between layers occur, gives owing to alternation of the so-called unified ("unito") and rosy ("fiorito") limestone types the appearance of a pronounced bedding with dip of 35° towards southwest (fig. 2).

Next to rudists in the limestone also miliolids and other foraminifers are present, among which the rather frequent species Dicyclina schlumbergeri *Munier-Chalmas. In the investigated rudist horizon locally isolated nodules of stromatoporoids and colonial corals occur.*

Although in the locality no important leading foraminifers were found, it can be presumed that the very frequent specimens of species Keramosphaerina tergestina *(Stache) that appear largely in bands of biocalcarenitic limestone ("unito" type) within the rudist limestone ("fiorito" type), and in a level seven meters higher, belong to the so-called main keramosphaerinic horizon (Jurkovšek* et al.*, 1996). The latter is probably synchronous, which indicates the Late Santonian and Early Campanian age of these beds in the region of southern Kras (fig. 3).*

The energy index of the Lipica limestone is 3, and exceptionally 4. Rare coatings of blue green algae on certain fossils and endolithization support the concept of a very shallow shelf.

During the Early Campanian the depositional environment in which earlier, i.e. in Late Santonian, the limestones of the present Lipica quarries deposited, was already low land (fig. 4). The sea returned in Maastrichtian only. On the Lipica Formation then deposited beds that show characteristics of marine, brackish and freshwater environment. These beds were united already by Stache (1889) into the "Liburnian stage", while today they are attributed to the Liburnian Formation.

The studied rudists are typical representatives of the Santonian-Campanian rudist biostromes on the Dinaric carbonate platform.

On the Formational geologic map of the southern part of Trieste-Komen plateau Jurkovšek and coworkers (1996) a large part of the Upper Santonian-Campanian carbonate rocks of the southern Kras attributed to the Lipica Formation. The Lipica I quarry with the studied rudist assemblage lies south of the tectonic and assumed paleogeographic divide which is represented today by the Divača fault (fig. 1). The differences in color, thickness and stratigraphic range between the limestone of the Lipica Formation north and south of the Divača fault are undeniably preconditioned by paleogeography (fig. 4).

The recent investigations indicate that the southerly lying shallow marine domain, on which also the limestones of the present Lipica I quarry were formed, in the Late Santonian was gradually uplifting (Jurkovšek et al.*, 1996), whereas the northern part of the territory was already under influence of the Santonian-Campanian so-called second pelagic episode on the Dinaric carbonate platform (Gušić & Jelaska, 1990; Jurkovšek* et al.*, 1996); with that event an increase of contents of organic matter in the depositional environment is associated (Pleničar & Jurkovšek, 1997). The influence of pelagial on the region that extends at present north of the Divača fault undubitably spread from the northerly and northeasterly lying Slovenian basin. This is supported by ammonites with aptychi, saccocomids and fossils of some other inhabitants of the open sea (Summesberger* et al.*, 1996; Kolar-Jurkovšek* et al.*, 1996; Jurkovšek & Kolar-Jurkovšek, 1996; Pleničar & Jurkovšek, 1997).*

The vicinity of land is indicated by numerous fossil remains of land plants in the Tomaj limestone of the Lipica Formation. This land was formed already in the Early Campanian in the region that extends presently south of the Divača fault. Our reasoning is supported also by the fact that the Lipica Formation in this region nowhere does contain thinner or thicker inclusions of carbon-rich laminated Santonian-Campanian Tomaj limestone, and absent is also that part of the formation that contains the species Calveziconus lecalvezae *Caus & Cornella characteristic for the middle part of Campanian (Gušić & Jelaska, 1990; Šribar, 1995). The difference between the north and south parts of the territory is obvious also in the thickness of the Lipica Formation that amounts in the north to 450 m, and in the south to 250 m only. The land that emerged in the Late Santonian, or at the latest in Early Campanian, persisted to the Maastrichtian, when on the karstified surface of the Lipica Formation brackish and marine beds of the Liburnian Formation were deposited (fig. 3).*

Key words: Rudists, Upper Cretaceous, Karst, Slovenia

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PALAEONTOLOGICAL AND STRATIGRAPHIC DESCRIPTION OF A RUDIST DEPOSIT OF THE UPPER TURONIAN IN SLIVIA, TRIESTE KARST, ITALY

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ABSTRACT

The study of the stratigraphic sequence located in the occidental area of the Trieste Karst, in the surroundings of Slivia, characterized by limestones with a highly rich rudist fauna brought to light an oncoidal limestone level for the first time in the Trieste Karst. This level is comparable with the Gračišće Oncolite of the Gornji Humac Formation (Gušić & Jelaska, 1990, 1993) on the island of Brač, Croatia, and with the Oncoidal limestone of the Sežana Formation, Slovenia (Jurkovšek et al., *1996). Both levels are attributed to the Upper Turonian and testify a rapid and global marine regression (Hancock & Kauffman, 1979 and Schlanger, 1986). Rudist association in the stratigraphic sequence of Slivia consists of species from the Upper Turonian:* Hippuritella resecta *(DEFRANCE),* Hippurites requieni *(MATHERON),* Hippurites requieni *var.* subpolygonia *DOUVILLÉ,* Vaccinites *cf.* inferus *(DOUVILLÉ),* Neoradiolites turoniensis *PAŠIĆ,* Distefanella ? robusta *CAFFAU & PLENIČAR* Distefanella kochanskae *SLIŠKOVIĆ and* Durania arnaudi *(CHOFFAT). Some of these species are described for the first time in the Trieste Karst. This association also includes gastropods, corals and incrusting algae.*

Key words: Rudists, Oncoids, Upper Turonian, Trieste Karst

INTRODUCTION

In the occidental area of the Trieste Karst (Fig. 1) near the small village of Slivia, a stratigraphic sequence of light gray to gray, very fossiliferous limestones was studied. These limestones belong to the lower part of the Borgo Grotta Gigante Member of the still informal Limestone Formation of the Trieste Karst (Cucchi *et al.*, 1987). Caffau and Pleničar (1992) reported the association of *Hippuritella resecta* (DEFRANCE), *Distefanella robusta* CAFFAU & PLENIČAR, *Neoradiolites turoniensis* PAŠIĆ and *Durania arnaudi* (CHOFFAT) from the Upper Turonian in the area of Slivia.

The aims of this work are: 1. the description and chronological attribution of the fossiliferous limestones sequence, 14 meters thick, in which 7 intervals that testify a carbonate platform environment are recognized; 2. the description of an oncoidal limestone level and its comparison with the Gračišće Oncolite level of the Gornji Humac Formation (Gušić & Jelaska, 1990, 1993) in the island of Brač, Croatia, and with the Sežana Formation, Slovenia (Jurkovšek *et al.*, 1996), both attributed to the Upper Turonian and 3. the systematic study of the rudist association that consists of *Hippuritella resecta* (DEFRANCE), *Hippurites requieni* (MATHERON), *Hippurites requieni* var. *subpolygonia* DOUVILLÉ, *Vaccinites* cf. *inferus* (DOUVILLÉ), *Neoradiolites turoniensis* PAŠIĆ, *Distefanella ? robusta* CAFFAU & PLENIČAR, *Distefanella* cf. *kochanskae* SLIŠKOVIĆ and *Durania arnaudi* (CHOFFAT).

STRATIGRAPHIC SEQUENCE

The studied deposit (fig. 2) belongs to the lower part of the Borgo Grotta Gigante Member. This member is located above the Zolla Member, which is characterized by limestones rich in radiolitids in the lower part and *Pithonella* (Cucchi *et al.*, 1987 and Caffau *et al.*, 1994) in the upper part. The lithology of the sequence of Slivia (Fig. 3) consists of ligth gray to gray, very fossiliferous limestones and sterile gray limestones.

The study of the rudist associations and the microfacies allowed to subdivide the sequence into 7 intervals:

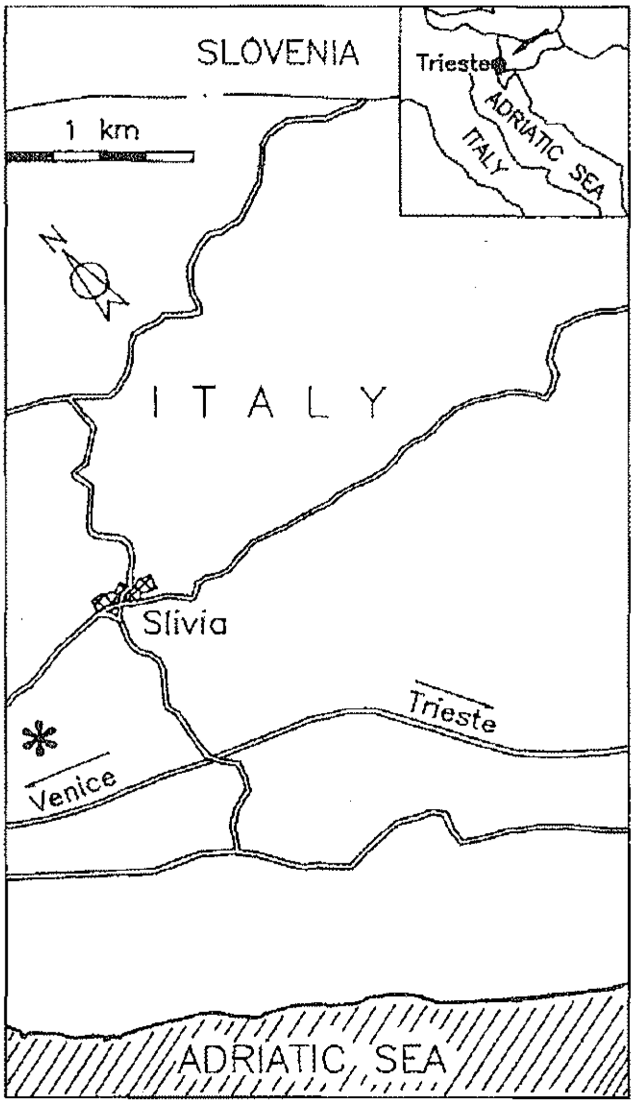


Fig. 1: Studied area and location of the stratigraphic sequence of Slivia, indicated by a star.
Sl. 1: Obravnavano območje z lokacijo stratigrafskega stolpca v Slivju, ki je označena z zvezdico.

Interval 1: this interval, 5 metres thick, consists of light gray, compact, bioclastic limestones. Fossils consist mainly of wavy lamellar fragments of upper valves of radiolitids, probably *Distefanella ? robusta* CAFFAU & PLENIČAR (tab. 6, fig. 1). The limestone microfacies is bioclastic grainstone, with rare Miliolids. This interval testifies a palaeoenvironment of inner carbonate platform with moderated bottom-energy that led to a selective transport mainly of fragments of radiolitid upper valves.

Interval 2: this 2.5 metres thick interval consists mainly of compact bioclastic limestones which are light gray towards the bottom and dark gray at the top. Bafflestone clusters of *Distefanella ? robusta* CAFFAU & PLENIČAR with *Neoradiolites turoniensis* PAŠIĆ, *Hippuritella resecta* (DEFRANCE), *Hippurites requieni* (MATHERON) and *Vaccinites* cf. *inferus* (DOUVILLÉ), occur in the middle-high part of this interval. Isolated individuals of *Hippurites requieni* var. *subpolygonia* DOUVILLÉ and *Distefanella* cf. *kochanskae* SLIŠKOVIĆ are found in the lower part. This association also includes calcareous algae. The microfacies consists of bioclastic-intraclastic grainstones where the bioconstructions occur and bioclastic-intraclastic wackestone-packestones in the lower part of this interval. Microfossils are represented by rare *Cuneolina* sp. and Miliolids. This is the only interval which presents aggregations of rudists, in addition to a large amount of chaotically disposed individuals around the bioconstructions.

Interval 3: this 20 centimetres thick interval consists of compact, dark gray limestones. The microfacies is mudstone-wackestone with fenestrae and includes rare microfossils such us *Cuneolina* sp. and Miliolids. This interval testifies a palaeoenvironment of inner carbonate platform which became adverse for the benthic life.

Interval 4: this interval, 1.2 metres thick, consists of gray, bioclastic, very fossiliferous limestones. Fossils are represented by chaotic accumulations of many fragments and complete individuals of *Hippuritella resecta* (DEFRANCE), *Hippurites requieni* (MATHERON), *Hippurites requieni* var. *subpolygonia* DOUVILLÉ, *Vaccinites* cf. *inferus* (DOUVILLÉ), *Neoradiolites turoniensis* PAŠIĆ, *Distefanella? robusta* CAFFAU & PLENIČAR and *Distefanella* cf. *kochanskae* SLIŠKOVIĆ. Gastropods and calcareous algae are also found. The microfacies is bioclastic-intraclastic grainstone with rare microfossils as *Cuneolina* sp. and Miliolids in the lower part and bioclastic wackestone-packestone with *Cuneolina* sp., *Moncharmontia apenninica* (DE CASTRO), Miliolids and the algae *Thaumatoporella parvovesiculifera* (RAINERI) in the upper part of this interval.

Interval 5: This interval is 1 metre thick and is characterized by the presence of different levels of light gray or gray bioclastic limestones. The dimension and selection of bioclasts varies from one level to the other, which testify different phases of transport of the bioclasts in this interval. In detail, the lower level of this interval, 30 cm thick, is characterized by chaotic accumulations (Fig. 4) of fragments and complete shells of *Hippuritella resecta* (DEFRANCE), *Hippurites requieni* (MATHERON), *Hippurites requieni* var. *subpolygonia* DOUVILLÉ, *Vaccinites* cf. *inferus* (DOUVILLÉ), *Neoradiolites turoniensis* PAŠIĆ, *Distefanella ? robusta* CAFFAU & PLENIČAR and *Distefanella* cf. *kochanskae* SLIŠKOVIĆ, frequently encrusted by blue-green algae. Gastropods encrusted by blue-green algae and calcareous algae are also found. The microphacies is bioclastic-intraclastic grainstone. The subsequent level, 25 cm thick, presents bioclastic beds with fragments of rudist shells that vary from few milimitres to one centimetre (Fig. 5). The

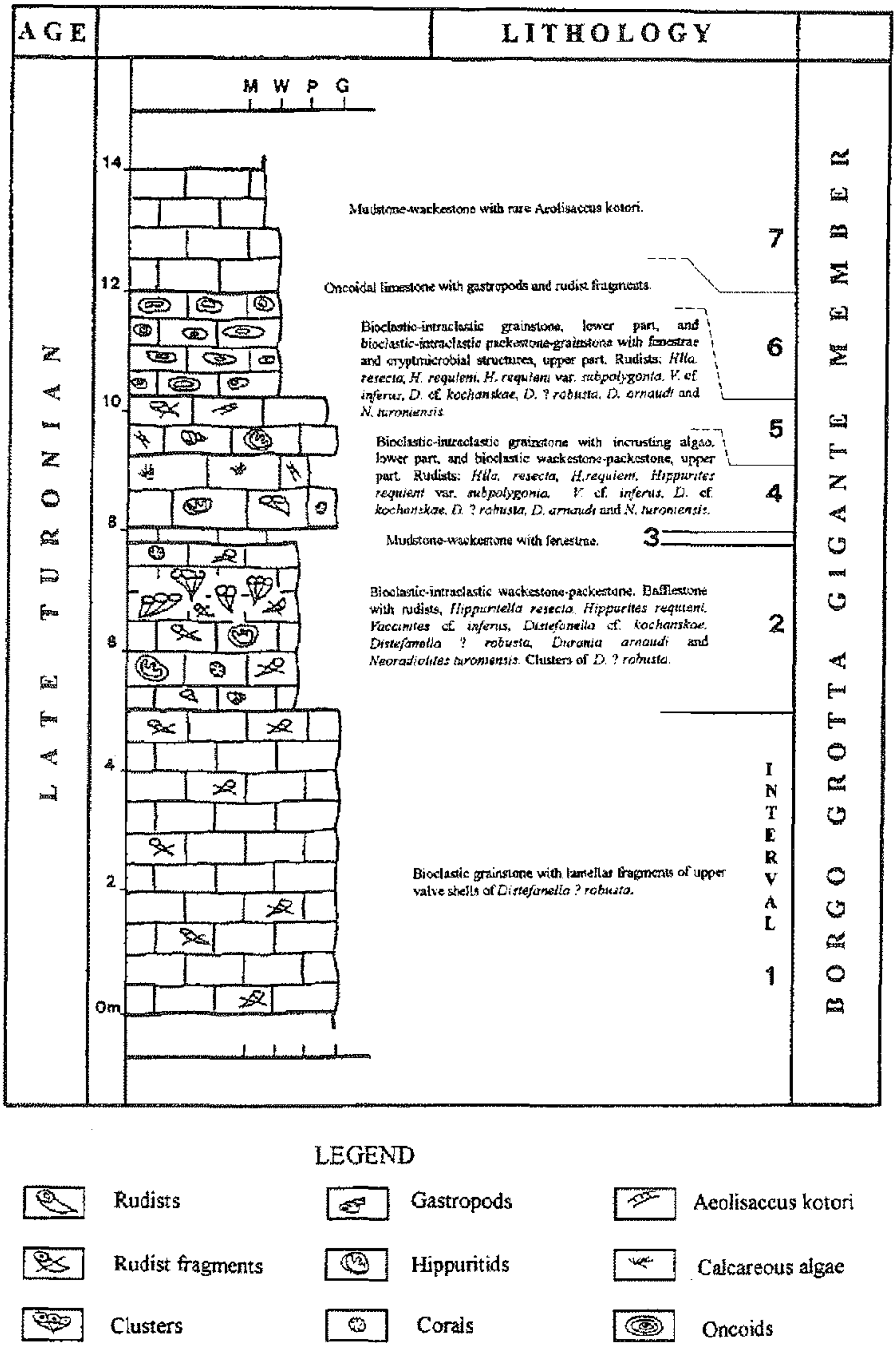


Fig. 2: Stratigraphic sequence of Slivia.
Sl. 2: Stratigrafski stolpec Slivja.

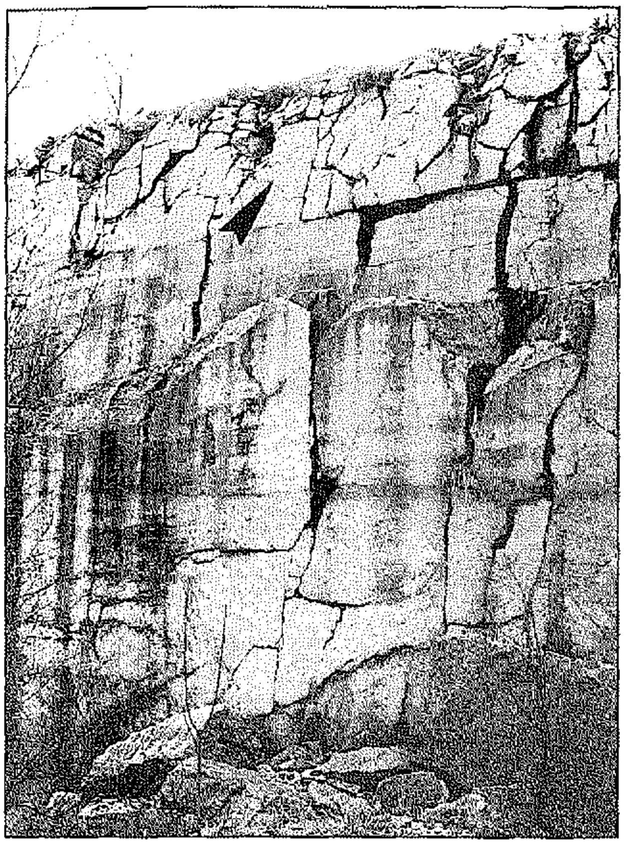


Fig. 3: View of the oncoidal level, indicated by an arrow.
Sl. 3: Posnetek onkoidnega nivoja, označenega s puščico.

Fig. 4: Bioclastic grainstones with fragments of rudist shells encrusted by blue-green algae. Interval 5, lower part. Scale bar: 1cm.
Sl. 4: Bioklastični "grainstones" s fragmenti lupin rudistov, ki so preraščene z modrozelenimi algami. Interval 5, spodnji del. Merilo: 1 cm.

microphacies is bioclastic-intraclastic grainstone. In the middle-high part of this interval, isolated individuals of *Hippuritella resecta* (DEFRANCE), *Hippurites requieni* (MATHERON), gastropods and large nodules of calcareous algae are present (Fig. 5). The thickness of this level is 30 cm. The uppermost level of this interval is characterized by fragments of hippuritids and radiolitids and a large amount of benthic foraminifers. The microfacies is bioclastic-intraclastic packestone-grainstone, very fossiliferous, including *Moncharmontia apenninica* (DE CASTRO) and the algae *Aeolisaccus kotori* RADOIČIĆ (pl. 7, fig. 3). In addition, cryptmicrobial structures (pl. 7, fig. 2) and fenestrae are found. This interval evidenciates a change from chaotic accumulations of rudists encrusted by blue-green algae at the lower part, to bioclastic levels of rudist fragments that are smaller than the previous ones at the upper part.

Interval 6: this interval, 1.8 metres thick, consists of very compact, gray limestones with oncoides of 10 to 45 mm in diameter (Fig. 6). The oncoid nucleus usually consists of gastropods of the Nerineidae family, either complete or in fragments, and rarely of fragments of shell rudists.

Interval 7: this 1.5 metres thick interval consists of very compact gray limestones, without fossils. The microfacies is mudstone-wackestone with rare *Aeolisaccus kotori* RADOIČIĆ.

Considerations: from the bottom up to interval 5, the lithology of the sequence of Slivia is characterized by bioclastic limestones. Rudist deposits are chaotic and traces of endolithization are usually found in rudist shells. In interval 2, rudists also form bafflestone clusters. The middle-upper part of interval 5 exhibits bioclastic levels that testify a selection of rudist fragments,

Fig. 5: Bioclastic grainstones with selected fragments of rudist shells. Scale bar: 1 cm.
Sl. 5: Bioklastični "grainstones" z izbranimi odlomki lupin rudistov. Merilo: 1 cm.

with shells that are frequently endolithized and encrusted by blue-green algae. A 10 cm thick level very rich in benthic foraminifers, mainly *Moncharmontia apenninica* (DE CASTRO), is evident at the top of interval 5. Subsequently, in interval 6, a level of oncoidal limestones associated to gray limestones with dissication pores evidenciates a clear lithological change. This level is similar to the Gračišće oncolite located in the lower part of the Gornji Humac Formation on the Brač island from the Upper Turonian (Gušić & Jelaska, 1990, 1993) where *Hippurites requieni* and the foraminifer *Moncharmontia apenninica* (DE CASTRO) make their first appearance. In addition, *Aeolisaccus kotori* RADOIČIĆ, gastropods of the Nerineidae family and cryptmicrobial structures are found. The oncolite horizon of the Sežana Formation, Slovenia, from the Upper Turonian (Jurkovšek *et al.*, 1996) is characterized by the presence of *Hippuritella sp.* and *Hippurites requieni* (Jurkovšek and Pleničar, *pers. comm.*) along with *Aeolisaccus kotori* RADOIČIĆ, *Taumatoporella parvovesiculifera* (RAINERI), gastropods of the Nerineidae family, while benthic foraminifers are extremely rare (Jurkovšek *et al.*, 1996).

Gušić & Jelaska (1990), Jurkovšek *et al.* (1996), Hancock & Kauffman (1979), Schlanger (1986), Flexer *et al.* (1986) and Haq *et al.* (1987, 1988) confirmed the occurrence of a rapid marine regression in the area of the Dinaric carbonate platform during the Late Turonian as testified by the Gračišće oncolite. This rapid eustatic drop of the sea level in the Late Turonian is also confirmed by the oncolite horizon of the Sežana Formation described by Jurkovšek *et al.* (1996). Therefore, the oncolite level of the stratigraphic sequence of Slivia provides additional evidence of the occurrence of this phenomenon in the studied area.

Fig. 6: Detail of the oncoidal limestone. Scale bar: one square= 0.5 cm.
Sl. 6: Detajl onkoidnega apnenca. Merilo: kvadrat = 0,5 cm.

SYSTEMATIC PALAEONTOLOGY

Familia Hippuritidae GRAY, 1848
Genus Hippuritella DOUVILLÉ 1908
Hippuritella resecta (DEFRANCE) 1821
Pl. 1; fig. 1, 2, 3.

1892 *Hippurites resectus* (Defrance) - DOUVILLÉ, 54, pl. fig. 9-12.

1904 *Orbignya requieni* var. *resecta* (Defrance) - TOUCAS, 20, pl. 1, fig. 4.

1961 *Hippurites (Hippuritella)* (Defrance) - PLENIČAR, 68, textfig. 22.

1970 *Hippurites (Hippuritella) resectus* (Defrance) - PEJOVIĆ, pl. 3, fig 1.

1993 *Hippuritella resecta* (Defrance) - STEUBER, 39, textfig. 3c-d.

Material: one lower valve and ten lower valves in the deposit.

Description: lower valves conical-elongated in shape, 50 to 65 mm long and 24 to 32 mm wide at the commisure. Shell traversed by wide rounded ribs separated by deep furrows. In transverse section, the *aréte cardinale* is wide, triangular in shape, truncated and slightly concave at the end. The values of the angles α (L-P2) and β (L-B1,B) are 90° and 79°, respectively. The first pillar (P1) is rounded while the second pillar (P2) is protruding and slightly pinched at the base.

It is noticeable that individuals of this species usually grew attached to shells of large individuals of *Distefanella ? robusta* CAFFAU & PLENIČAR and, less frequently, they lived as isolated individuals.

Geographic and stratigraphic distribution: Turonian in France and Spain. Middle-Upper Turonian in the Periadriatic area.

Genus Hippurites LAMARCK, 1801
Hippurites requieni (MATHERON), 1842
Pl. 2, fig. 1, 2, 3, 6

1890 *Hippurites requieni* Matheron - DOUVILLÉ, 58, pl. 8, fig. 1-5.

1903 *Orbignya requieni* Matheron - TOUCAS, 18, texfigs. 23-26, pl. 1, fig. 1-3.

1907 *Hippurites (Orbignya) requieni* Matheron - PARONA, 143, textfig. 1.

1932 *Hippurites (Orbignya) requieni* Matheron - KÜHN, 63

1984 *Hippurites (Hippurites) requieni* Matheron - BILOTTE, 342, pl. 38, fig. 3.

1992 *Hippurites requieni* Matheron - PONS & SIRNA, 344.

1996 *Hippurites (Hippurites) requieni* Matheron - BILOTTE & PLATEL, 23, pl. 3, fig. 3.

Material: forty lower valves in the deposit.

Description: cylindrical lower valve with a length that varies from 40 to 170 mm and a diameter of 10 to 30 mm at the commisure. Shell traversed by thin ribs. In transverse section, myocardinal elements are well preserved. The *aréte cardinale* (L) is protruding, triangular in shape and truncated at the end (Pl. 2, fig. 6). The first pillar (P1) is short with a wide base. The second pillar (P2) is slightly longer than the previous one and somewhat pinched at the base. The values of the angles α (L-P2) and β (L-B1, B) are 97° and 66°, respectively. The dorsal cavity (DC) lies between the anterior tooth socket (B1) and the shell inner layer. The posterior tooth socket (B) is smaller than B1. The posterior myophore (mp) located between B and P1, is oval in shape. The body cavity (BC) extends to about half of the lower valve cavity.

Remarks: Toucas (1903) described an evolution of the myocardinal elements of this species from the Lower to the Upper Turonian. The author indicated that most evident variations include the dimension and shape of the *aréte cardinale,* which is larger and protruding in more recent individuals, while its truncated end is a constant characteristic of this species. In addition, the dimension of the body cavity (BC) is also subjected to evolution, being smaller in more recent individuals than in ancient ones. The inner elements of the individuals studied in this work are similar to those of the individuals in figs. 25 and 26, p. 19, Toucas (1903).

Geographic and stratigraphic distribution: Upper Turonian in France, Spain and Periadriatic area.

Hippurites requieni var. *subpolygonia* DOUVILLÉ, 1892
Pl. 2, fig. 4, 5

1892 *Hippurites requieni* var. *subpolygonia* - DOUVILLÉ, 54, pl. 5, figs. 10-11

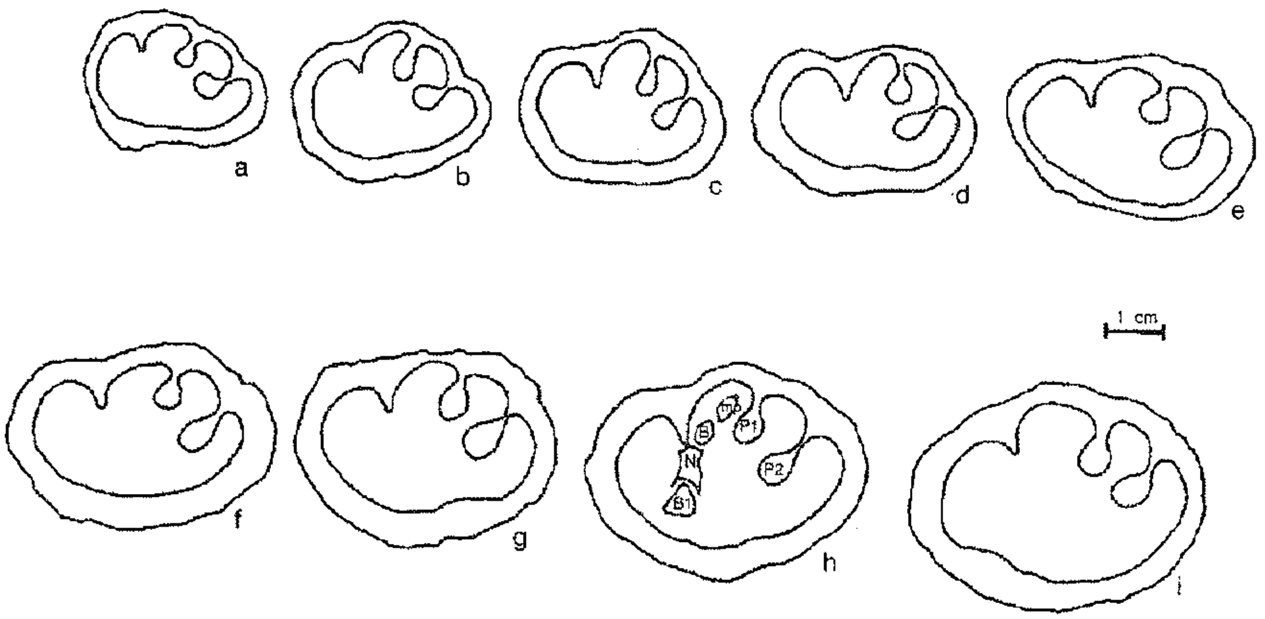
1903 *Orbignya requieni* var. *subpolygonia* Douvillé - TOUCAS, 22, figtext. 32, pl. 1, fig. 5

1932 *Hippurites (Orbignya) requieni* var. *subpolygonia* Douvillé - KÜHN,64

Material: twenty lower valves in the deposit.

Description: cylindrical lower valve, 35 to 160 mm long and 10 to 30 mm wide at the commisure.The shell is traversed by protruding ribs, 0.6 to 2 mm wide, with irregular and slightly rounded edges. The ribs are separated by well marked furrows. In transverse section, myocardinal elements are well preserved. The *aréte cardinale* (L) is protruding, triangular in shape and truncated at the end.The first pillar (P1) is short with a wide base while the second pillar (P2) is slightly longer than the previous one and somewhat pinched at the base. The values of the angles α (L-P2) and β (L-B1,B) are 91° and 89°, respectively. The anterior tooth socket (B1) is larger than the posterior tooth socket (B).

Remarks: morphological characters of rudist shells, such as ornamentation, shape and dimension should be taken into account as taxonomical characters only if they are unique for the species under consideration (Cestari, 1992). This is the case for the shell ornamentation taken as a taxonomical character to di-



Figs. 7a-i.:** Vaccinites cf. inferus **DOUVILLÉ. Successive transverse sections of the same lower valve. Scale bar: 1 cm. Fig. 7h: P1=first pillar; P2=second pillar; B1=anterior tooth socket; B=posterior tooth socket; mp=posterior myophore; N=lower valve tooth. Scale bar: 1cm.

Sl. 7a-i:** Vaccinites cf. inferus **DOUVILLÉ. Zaporedni prečni prerezi spodnje lupine. Merilo: 1 cm. Slika 7h: P1=prvi stebriček; P2=drugi stebriček; B1=anteriorna zobna jamica; B=posteriorna zobna jamica; mp=posteriorni mišični odtisek; N=zob v spodnji lupini. Merilo: 1 cm.

stinguish between *Hippurites requieni* (MATHERON) and *Hippurites requieni* var. *subpolygonia* DOUVILLÉ. The upper valve of the species *Hippurites requieni* var. *subpolygonia* DOUVILLÉ is characterized by polygonal pores regularly distributed, as described by Toucas (1903), and differs from the upper valve of *Hippurites requieni* (MATHERON) which presents pores that are slightly elongated and distributed in a linear manner.

These morphological differences that also imply functional differences allow to distinguish individuals that belong to two groups genetically different and therefore they assume taxonomical value.

Geographic and stratigraphic distribution: Upper Turonian in France.

Genus *Vaccinites* FISCHER 1887
Vaccinites cf. *inferus* (DOUVILLÉ) 1891
Pl. 1, fig. 4-8

1891 *Hippurites inferus* - (DOUVILLÉ), 23, pl. 2 fig. 6

1894 *Hippurites inferus* (Douvillé) - DOUVILLÉ, 115.

1904 *Vaccinites inferus* (Douvillé) - TOUCAS, 90, textfigs. 139-140; pl. 13, fig. 1.

1993 *Vaccinites inferus* (Douvillé) - STEUBER, 41, textfigs. 2a-i, 3a-f, 8; pl. 8, figs. 1-3.

Material: two lower valves and twenty valves in the deposit.

Description: cylindrical lower valve, 135 mm long and 45 mm wide at the commisure. The shell is traversed by protruding and rounded ribs, 1 mm wide. In transverse section, the first pillar (P1) is less developed than the second one (P2) and both are pinched at the base. Nine transverse sections (Textfig. 7), 15 mm equidistant one from the other, were obtained from the lower valve of a well conserved individual. The analysis of these transverse sections allowed to evidenciate morphological differences in the *aréte cardinale* (L) during the ontogenical development of the individual: from a truncated form in the lower part of the individual (Textfigs. 7 a-e) turns to be rounded in shape in the upper part (Textfigs. 7 f-i). Although the lower valve is slightly flattened at the dorsal side, the values of the angle α (L-P2) measured in the different transverse sections range from 56° to 71°, consistent with the range given by Steuber 1993 for *Vaccinites inferus* (DOUVILLÉ).

Geographic and stratigraphic distribution: Turonian in France. Middle-Upper Turonian in Greece.

Family *Radiolitidae* GRAY 1848
Genus *Distefanella* PARONA 1901
Distefanella cf. *kochanskae* POLŠAK 1968
Pl. 4, fig. 5, 6

1968 *Distefanella kochanskae* - POLŠAK, 183, text-figs. 8, 9.

Material: two transverse sections of a lower valve.

Description: small individuals, rarely larger than 10 mm with a thin shell, about 0.5 mm thick, traversed by triangular and very robust ribs. Four to six ribs are evident in the dorsal area. Radial bands lie between two very well developed ribs. The E radial band is twice as wide as the S band, flattened and traversed by 3 to 4 pronounced ribs. The S band is flattened and traversed by 3 ribs, less developed than those of the E band. The cardinal laminae or traverse saeptum is not visible.

Similarities and differences: as it was previously demonstrated for other rudist genera (Cestari, 1992; Caffau & Pleničar, 1996; Caffau *et al.*, 1997), the examined individuals of this species from Slivia are also characterized by a large morphological variability. For this reason, the number of ribs of the dorsal area and the radial bands are not significant for diagnosis. Further analysis may elucidate the range of variation of the morphological characters of these individuals.

The examined individuals from Slivia differ from those of *Distefanella kochanskae* POLŠAK by the lower number of ribs in the dorsal area and in the interband. Individuals of *Distefanella raricostata* SLIŠKOVIĆ differ from those of Slivia by the larger amount of ribs in the dorsal area and the smooth S radial band.

Geographic and stratigraphic distribution: Turonian in Istria.

Distefanella ? robusta CAFFAU & PLENIČAR 1992

Pl. 3, fig. 1-4; Tab. 4, fig. 1-4

1992 *Distefanella robusta* - CAFFAU & PLENIČAR, 191, pl. 1-3; textfigs. 2, 3.

Material: ten lower valves and four complete individuals.

Description: lower valve cylindro-conical in shape, with a length that varies from 40 to 210 mm and a diameter of 15 to 80 mm at the commisure. The shell is traversed by protruding and robust ribs interrupted by widely spaced megacycles. The siphonal area is represented by two wide, flattened and/or slightly concave bands, longitudinally traversed by thin ribs. The E radial band is crossed by 16 ribs while the S band exhibits 10 ribs. Both radial bands are separated by a very pronounced ridge that in some individuals devides into 3 ribs near the commisure (tab. 3, fig. 2). The upper valve is flat or slightly convex. In the inner part, the myocardinal apparatus consists of two teeth that form an angle of 50° between them and two large myophores. The dorsal cavity, oval in shape, is evident between both teeth. The shell structure is characterized by large polygonal cells. No ligamental ridge is present.

Discussion: Caffau & Pleničar (1992) described the species *Distefanella robusta*, identified as a new species of *Distefanella* because of the presence of a dorsal cavity delimited by a transverse saeptum or dorsal laminae (sensu Polšak, 1968), which is one of the most evident diagnostic characteristics of the genus *Distefanella* (Parona, 1901; 1912; 1926; Polšak, 1968 and Slišković, 1971). In this work, the analysis of several other individuals of this species allowed to verify that the dorsal cavity (DC), oval in shape and belonging to the lower valve, is not delimited by a dorsal laminae but by a wall formed by the inner layer of the lower valve shell. In addition, in some individuals this cavity is detached from the inner layer of the shell (tab. 4, figs. 1-4). Therefore, the morphology of the DC of *Distefanella ? robusta* CAFFAU & PLENIČAR differs from that of the DC of the genus *Distefanella* (sensu Polšak 1968) delimited by the dorsal laminae that separates the DC from the ventral cavity. Another observed difference is the angle formed by the teeth, which is 50° to 60° in *Distefanella? robusta* CAFFAU & PLENIČAR and about 180° in the genus *Distefanella* described by Polšak (1968). On the basis of these new observations, detailed analyses are in progress to confirm the validity of the systematic attribution of *Distefanella ? robusta* CAFFAU & PLENIČAR.

Geographic and stratigraphic distribution: Upper Turonian in the Trieste Karst.

Genus *Neoradiolites* MILOVANOVIĆ 1935

Neoradiolites turoniensis PAŠIĆ 1957

Pl. 5, fig. 2-5.

1957 *Neoradiolites turoniensis* PAŠIĆ - pl. 2, fig. 4; pl. 4, fig. 1, pl. 6, fig. 1, 2.

1976 *Neoradiolites turoniensis* CHARVET-DECROUEZ-POLŠAK - 248, pl. 2, fig. 2, 3; pl. 5, fig. 1, 2.

Material: two lower valves embedded in the limestone and one free lower valve.

Description: conical lower valve, 60 mm long and 40 mm wide at the commisure. The shell, 5 mm thick at the siphonal area and 10 mm at the dorsal area, is traversed by rounded and slightly concave ribs, about 1 mm wide. The inner structure is characterized by a dense mesh of small polygonal cells (tab. 5, fig. 5). The ligamental ridge of the myocardinal apparatus, hammer-shaped, is well developed. The angle formed between teeth is 60°. The anterior myophore (ma) is about twice as large as the posterior myophore (mp).

Geographic and stratigraphic distribution: Middle Turonian in Serbia and Greece.

Genus *Durania* DOUVILLÉ 1908

Durania arnaudi (CHOFFAT) 1891

Pl. 4, fig. 5, 6; tab. 5, fig. 1

1909 *Sauvagesia arnaudi* - TOUCAS, 93, pl. 18, figs. 3-7.

1910 *Durania arnaudi* - DOUVILLÉ, 50, pl. 3, fig 1.

1911 *Durania arnaudi* - PARONA, 290.

1926 *Durania arnaudi* - PARONA, 37, pl. 3, fig. 11.

1967 *Durania arnaudi* - POLŠAK, 90, pl. 7, fig. 3; pl. 55, figs. 1-7.

1968 *Durania arnaudi* - POLŠAK, 187, textfig. 11.

1973 *Durania arnaudi* - PLENIČAR, 221, pl. 4, fig. 1; pl. 12, fig. 3; pl. 13, fig. 1.

1982 *Durania arnaudi* - ACCORDI *et al.*, 772, pl. 4, fig. 9; pl. 5, fig. 4.

Material: two lower valves.

Description: cylindrical lower valve up to 120 mm long, with a shell thickness of 13 mm at the commisure. At the dorsal area, the shell is traversed by wide and robust ribs with a triangular profile, which turn to be thinner near the radial bands. The E radial band is concave and traversed by thin ribs. The S band is slightly smaller and less concave than the previous one and is also traversed by thin ribs. The shell is thin at the radial bands and wider at the interband. The latter is wide, very protruding and traversed by 2 to 3 ribs. The interband of the individual in table 5, fig. 1 seems greatly pronounced due to the slightly oblique transverse section. The inner structure of the shell is a mesh of large polygonal cells. The myocardinal apparatus consists of two myophores, being better developed the anterior than the posterior one. The teeth are equal in dimension and the angle formed between them is 62°.

Remarks: the individuals of *Durania arnaudi* (CHOFFAT) are externally similar to those of *Distefanella ? robusta* CAFFAU & PLENIČAR but differ from this species by the lack of the dorsal cavity. Comparative analysis of *Distefanella ? robusta* and *Durania arnaudi* (CHOFFAT) are in progress to verify if the presence of the dorsal cavity could be considered as a morphofunctional characteristic typical of one of these species.

Geographic and stratigraphic distribution: Turonian in France, Spain and Periadriatic area.

CONCLUSIONS

The study of the stratigraphic sequence of Slivia allowed to describe a rich rudist fauna of the Upper Turonian. The rudist association includes some species described for the first time in the Trieste Karst: *Hippurites requieni* (MATHERON), *Hippurites requieni* var. *subpolygonia* DOUVILLÉ, *Vaccinites* cf. *inferus* (DOUVILLÉ), *Neoradiolites turoniensis* PAŠIĆ and *Distefanella kochanskae* SLIŠKOVIĆ, along with *Hippuritella resecta* (DEFRANCE), *Distefanella? robusta* CAFFAU & PLENIČAR and *Durania arnaudi* (CHOFFAT). Rudists are found *in situ* only in interval 2, as testified by the presence of bouquets and clusters in physiological position in this interval. The poor development of the rudist fauna may have been due to the large production of bioclasts and their transport that prevented the formation of a rigid an stable substrate, required for rudist growth. Bioclastic accumulations consist mainly of fragments of rudist shells.

Moreover, an oncolite level is described for the first time in the Trieste Karst. This level is comparable with two oncolite horizons of the Upper Turonian: the Gračišće oncolite of the Gornji Humac Formation on the island of Brač in Croatia (Gušić & Jelaska, 1990; 1993) and the oncolite horizon of the Sežana Formation in Slovenia (Jurkovšek *et al.*, 1996). The oncolite horizons of both formations record the most evident phase of an important environmental change, with a rapid eustatic change of the marine level that characterized the Late Turonian (Haq *et al.*, 1987; Gušić & Jelaska, 1990). The oncoidal level of Slivia also testifies a regression of the marine level, although this change seems to have been more slow compared with that recorded in other areas of the Dinaric carbonate platform, *e.g.* on the Brač island and in Slovenia. In fact, in the Trieste Karst, the lithological transition from the limestones rich in *Phitonella*, in the upper part of the Zolla Member (Cucchi *et al.*, 1987; Caffau *et al.*, 1994) to the limestones rich in rudists and to the oncolite level of Slivia is gradual. The presence of an oncoidal level in the sequence of Slivia extends the area of the Dinaric carbonatic platform which has been described to be subjected to a global marine regression.

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PLATES - TABLE

PLATE 1 / TABLA 1

Figs. 1-3: *Hippuritella resecta* ***(DEFRANCE). Transverse sections of lower valves of three different individuals. Scale bar: 1 cm.***
Figs. 4 and 5: *Vaccinites* ***cf.*** *inferus* ***(DOUVILLÉ). Lower valve and transverse section of the same individual. Scale bar: 1 cm.***
Figs 6-8: *Vaccinites cf. inferus* ***(DOUVILLÉ). Transverse sections of three individuals. Scale bar: 1 cm.***

Sl. 1-3: *Hippuritella resecta* ***(DEFRANCE). Prečni prerezi spodnjih lupin treh različnih osebkov. Merilo: 1 cm.***
Sl. 4 in 5: *Vaccinites cf. inferus* ***(DOUVILLÉ). Spodnja lupina in prečni prerez istega osebka. Merilo: 1 cm.***
Sl. 6-8: *Vaccinites cf. inferus* ***(DOUVILLÉ). Prečni prerezi treh osebkov. Merilo: 1 cm.***

PLATE 2 / TABLA 2

Fig. 1: *Hippurites requieni* ***(MATHERON). Transverse section of two lower valves embedded in the limestone. Interval 2. Scale bar: 1 cm.***
Fig. 2: Polished transverse section with *Hippurites requieni* ***(MATHERON), fragments of rudist shells and incrusting blue-green algae. Interval 5. Scale bar: 1 cm.***
Fig. 3: *Hippurites requieni* ***(MATHERON). Transverse section of lower valve. Scale bar: 1 cm.***
Figs. 4 and 5: *Hippurites requieni var. subpolygonia* ***(DOUVILLÉ). Transverse sections of two lower valves. Scale bar: 1 cm.***
Fig. 6: *Hippurites requieni* ***(MATHERON). Transverse section, view of the truncated aréte cardinale. x 24.***

Sl. 1: *Hippurites requieni* ***(MATHERON). Prečni prerez dveh spodnjih lupin, vraščenih v apnenec. Interval 2. Merilo: 1 cm.***
Sl. 2: Poliran prečni prerez z vrsto *Hippurites requieni* ***(MATHERON), z odlomki rudistnih lupin in inkrustirane modrozelene alge. Interval 5. Merilo: 1 cm.***
Sl. 3: *Hippurites requieni* ***(MATHERON). Prečni prerez spodnje lupine. Merilo: 1 cm.***
Sl. 4 in 5: *Hippurites requieni var. subpolygonia* ***(DOUVILLÉ). Prečna prereza dveh spodnjih lupin. Merilo: 1 cm.***
Sl. 6: *Hippurites requieni* ***(MATHERON). Prečni prerez, pogled na odrezani ligamentni greben. x 24.***

PLATE 3 / TABLA 3

Figs. 1-2: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Lower valve, view of the radial bands E-S and detail of the interband with 3 thin ribs in the upper part. Scale bar: 1 cm.***
Fig. 3: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Polished transverse section of a lower valve. Scale bar: 1 cm.***
Fig. 4: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Transverse section of a lower valve. Scale bar: 1cm.***
Figs. 5 and 6: *Distefanella cf. kochanskae* ***POLŠAK. Polished transverse section of lower valves of two individuals. Scale bar: 1 cm.***
Fig. 7: Polished section with corals, rudists and calcareous algae. Scale bar: 1cm.

Sl. 1-2: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Spodnja lupina, pogled na radialni progi E-S in detajl medsifonalne proge s 3 šibkimi rebri v zgornjem delu. Merilo: 1 cm.***
Sl. 3: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Poliran prečni prerez spodnje lupine. Merilo: 1 cm.***
Sl. 4: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Prečni prerez spodnje lupine. Merilo: 1 cm.***
Sl. 5 in 6: *Distefanella cf. kochanskae* ***POLŠAK. Polirana prečna prereza spodnjih lupin dveh osebkov. Merilo: 1 cm.***
Sl. 7: Poliran presek s koralami, rudisti in kalcitnimi algami. Merilo: 1 cm.

PLATE 4 / TABLA 4

Figs.1-3: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Polished transverse sections of lower valves of three individuals. The dorsal cavity is clearly visible. Scale bar: 1 cm.***
Fig. 4: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Thin transverse section of lower valve. The structure of the dorsal cavity is clearly visible. x 1.5.***
Fig. 5: *Durania arnaudi* ***(CHOFFAT). Polished transverse section of lower valve with endolithized shell. Scale bar: 1 cm.***
Fig. 6: *Durania arnaudi* ***(CHOFFAT). Transverse section of lower valve with incomplete cardinal apparatus. Scale bar: 1 cm.***

Sl. 1-3: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Zbruski prečnih prerezov spodnjih lupin treh osebkov. Dorzalna votlina je dobro vidna. Merilo: 1 cm.***
Sl. 4: *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Zbrusek prečnega prereza spodnje lupine. Dobro je vidna struktura dorzalne votline. x 1,5.***
Sl. 5: *Durania arnaudi* ***(CHOFFAT). Polirani prečni prerez spodnje lupine z endolitizirano lupino. Merilo: 1 cm.***
Sl. 6: *Durania arnaudi* ***(CHOFFAT). Prečni prerez spodnje lupine z nepopolnim kardinalnim aparatom. Merilo: 1 cm.***

PLATE 5 / TABLA 5

Fig. 1: *Durania arnaudi* ***(CHOFFAT). Transverse section of lower valve embedded in the limestone. Scale bar: 1 cm.***
Figs. 2 and 3: *Neoradiolites turoniensis* ***PAŠIĆ. Lower valve and polished transverse section of the same individual. Scale bar: 1 cm.***
Fig. 4: *Neoradiolites turoniensis* ***PAŠIĆ. Polished transverse section of lower valve, view of the hammer-shaped ligamental ridge. Scale bar: 1 cm.***
Fig. 5: *Neoradiolites turoniensis* ***PAŠIĆ. Thin transverse section showing the myocardinal apparatus and the inner structure characterized by small cells. Scale bar: 1 cm.***

Sl. 1: *Durania arnaudi* ***(CHOFFAT). Prečni prerez spodnje lupine, vraščene v apnencu. Merilo: 1 cm.***
Sl. 2 in 3: *Neoradiolites turoniensis* ***PAŠIĆ. Spodnja lupina in polirani prečni prerez istega osebka. Merilo: 1 cm.***
Sl. 4: *Neoradiolites turoniensis* ***PAŠIĆ. Zbrusek prečnega prereza spodnje lupine; pogled na kladivasto oblikovan ligamentni rob. Merilo: 1 cm.***
Sl. 5: *Neoradiolites turoniensis* ***PAŠIĆ. Zbrusek prečnega prereza, ki prikazuje miokardinalni aparat in notranjo strukturo, za katero so značilne male celice. Merilo: 1 cm.***

PLATE 6 / TABLA 6

Fig. 1: Bioclastic grainstones with lamellar fragments of upper valves of *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Interval 1. Scale bar: 1 cm.***
Fig. 2: Oncoidal limestones with gastropods of the Nerineidae family. Interval 6. Scale bar: 1 cm.
Fig. 3: Detail of the oncoidal limestone with gastropods of the Nerineidae family. Interval 6. Scale bar: 1 cm.

Sl. 1: Bioklastični "grainstones" z lamelarnimi odlomki zgornjih lupin vrste *Distefanella ? robusta* ***CAFFAU & PLENIČAR. Interval 1. Merilo: 1 cm.***
Sl. 2: Onkoidni apnenec s polži iz družine Nerineidae. Interval 6. Merilo: 1 cm.
Sl. 3: Detajl onkoidnega apnenca s polži iz družine Nerineidae. Interval 6. Merilo: 1 cm.

PLATE 7 / TABLA 7

Fig. 1: Packestone-grainstones with *Moncharmontia apenninica* ***(DE CASTRO),*** *Aeolisaccus kotori* ***RADOIČIĆ and Miliolids. x 30. Interval 5, upper part.***
Fig. 2: Packestone-grainstones with cryptmicrobial structure, fragments of shell rudists, *Aeolisaccus kotori* ***RADOIČIĆ and Miliolids. x 30. Interval 5, upper part.***
Fig. 3: Packestone-grainstones with *Moncharmontia apenninica* ***(DE CASTRO),*** *Aeolisaccus kotori* ***RADOIČIĆ and Miliolids. x 30. Interval 5, upper part.***

Sl. 1: "Packestone-grainstones" z *Moncharmontia apenninica* ***(DE CASTRO),*** *Aeolisaccus kotori* ***RADOIČIĆ in miliolidami. x30. Interval 5, zgornji del.***
Sl. 2: "Packestone-grainstones" z kriptomikrobnimi strukturami, odlomki lupin rudistov, *Aeolisaccus kotori* ***RADOIČIĆ ter miliolida x 30. Interval 5, zgornji del.***
Sl. 3: "Packestone-grainstones" z vrstama *Moncharmontia apenninica* ***(DE CASTRO) in*** *Aeolisaccus kotori* ***RADOIČIĆ ter miliolida. x 30. Interval 5, zgornji del.***

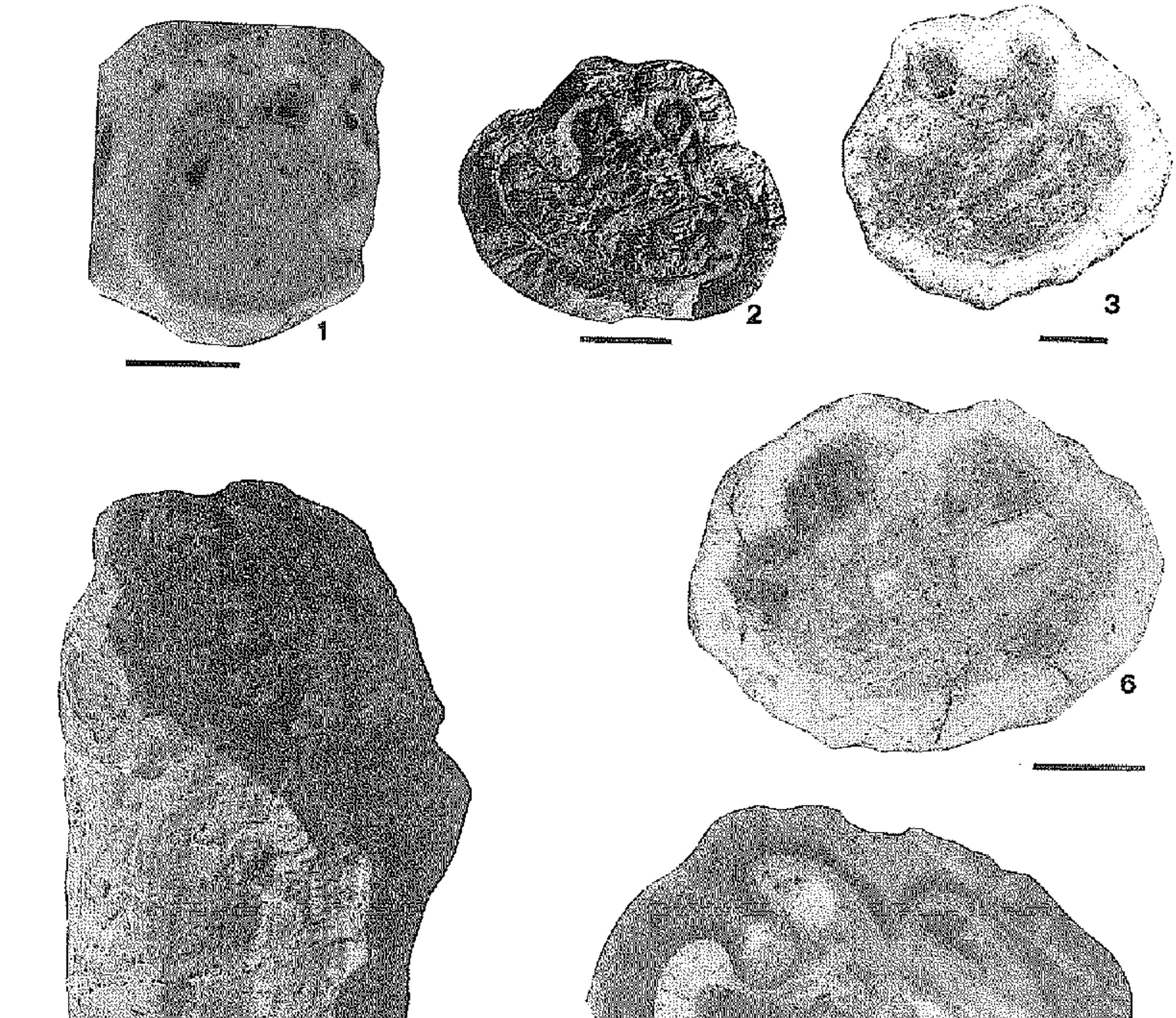
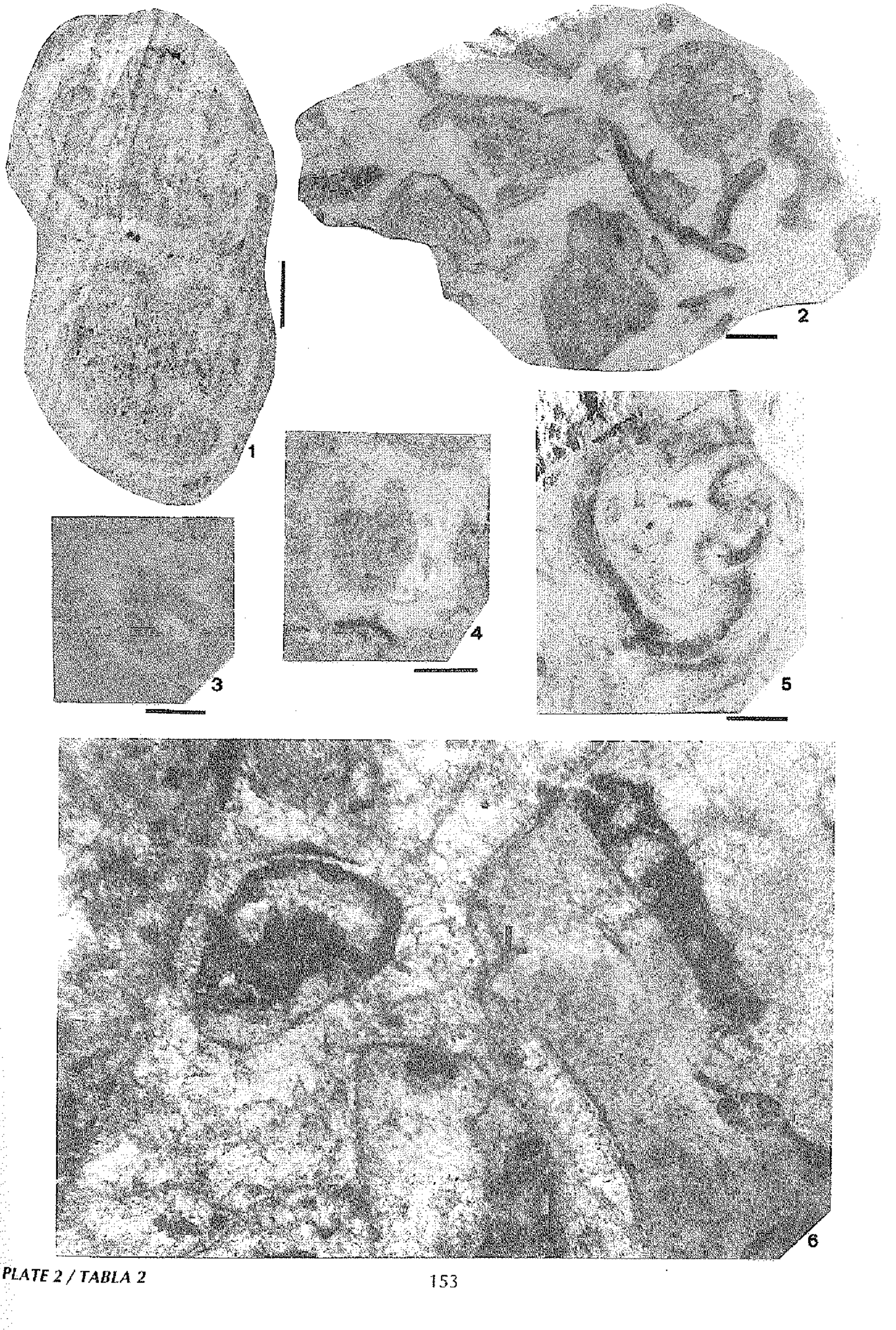


PLATE 1 / TABLA 1



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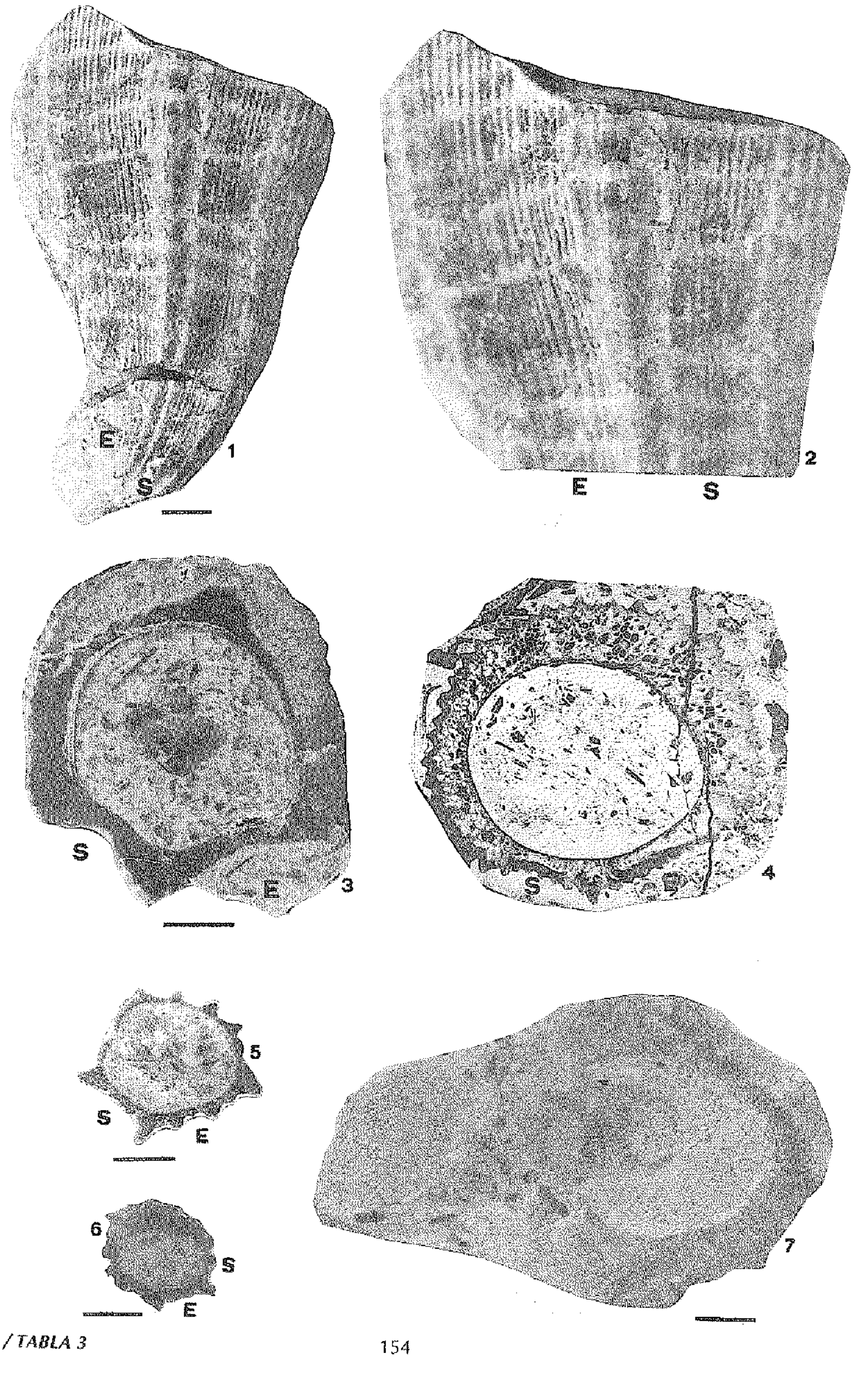
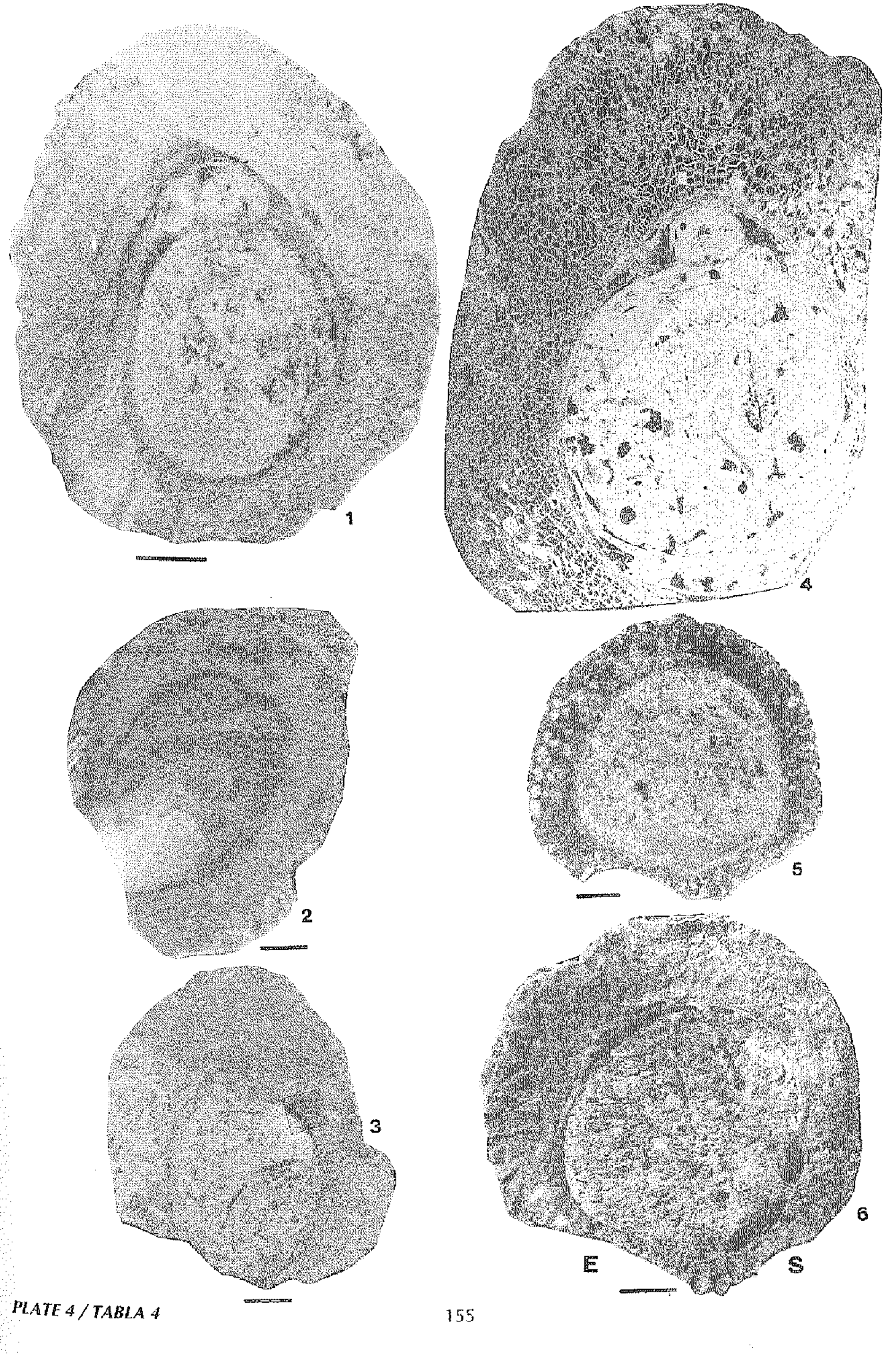


PLATE 3 / TABLA 3



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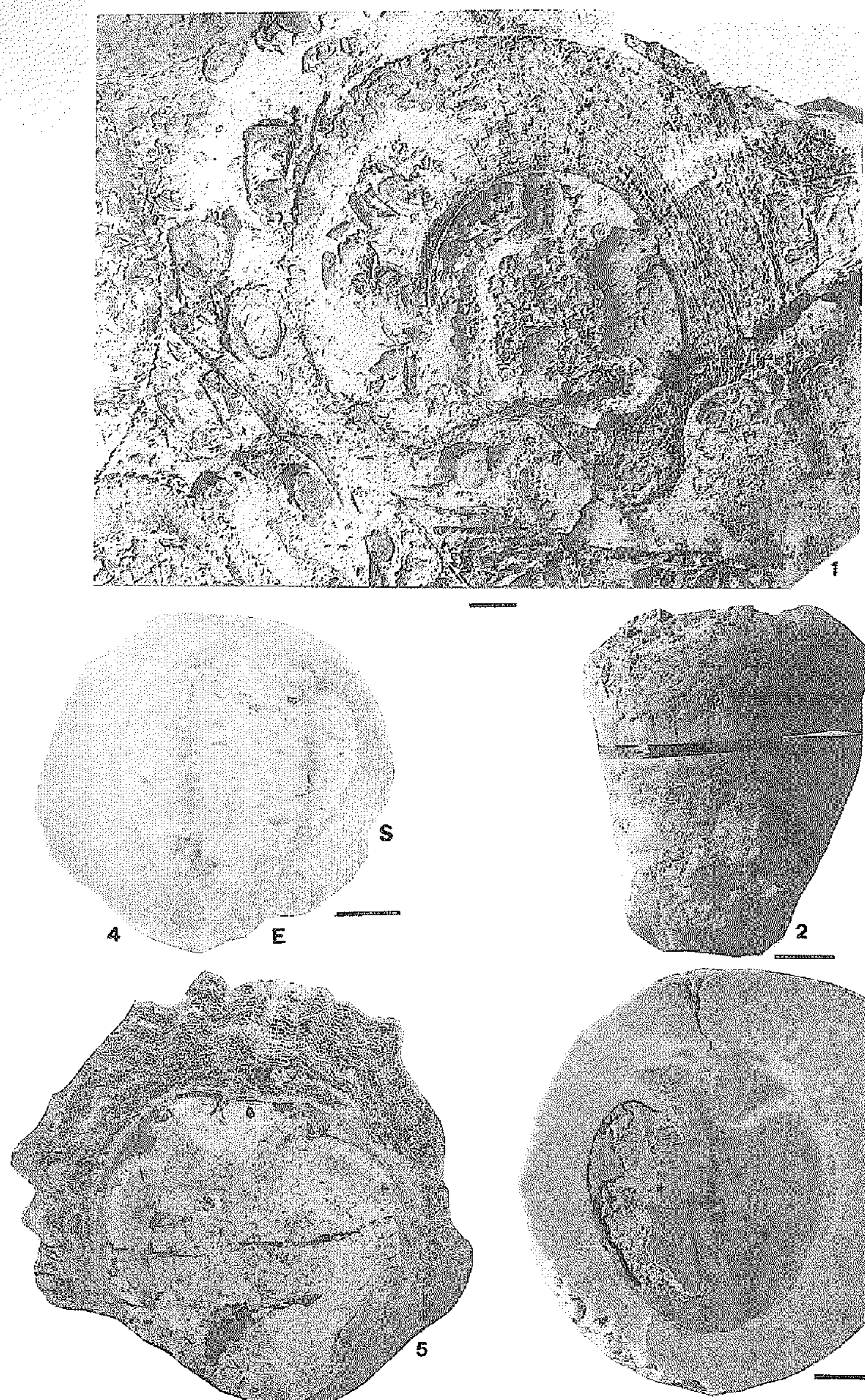

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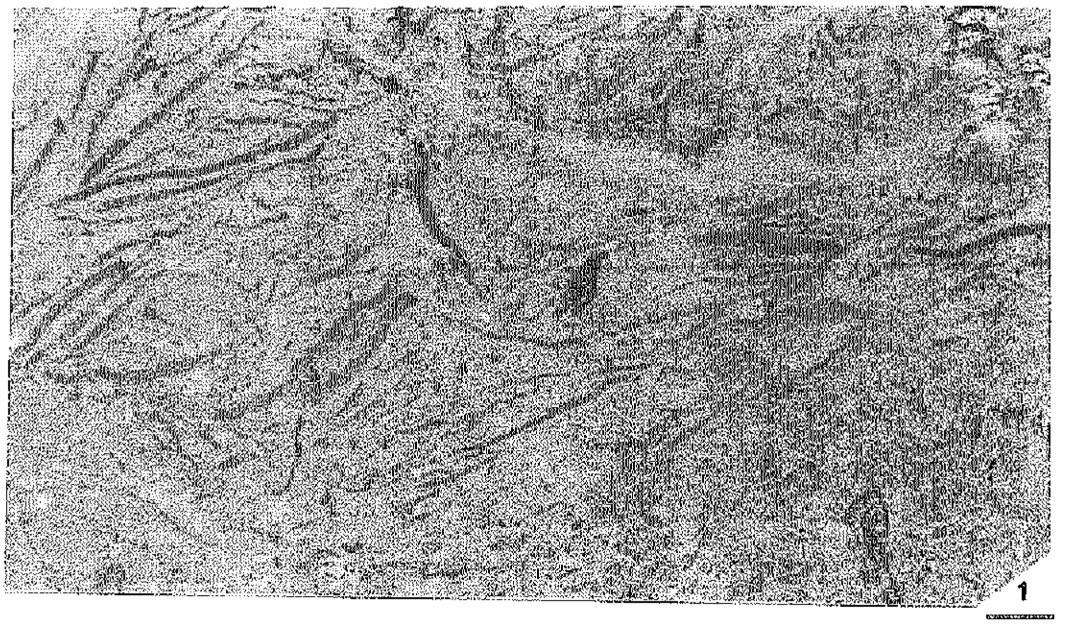

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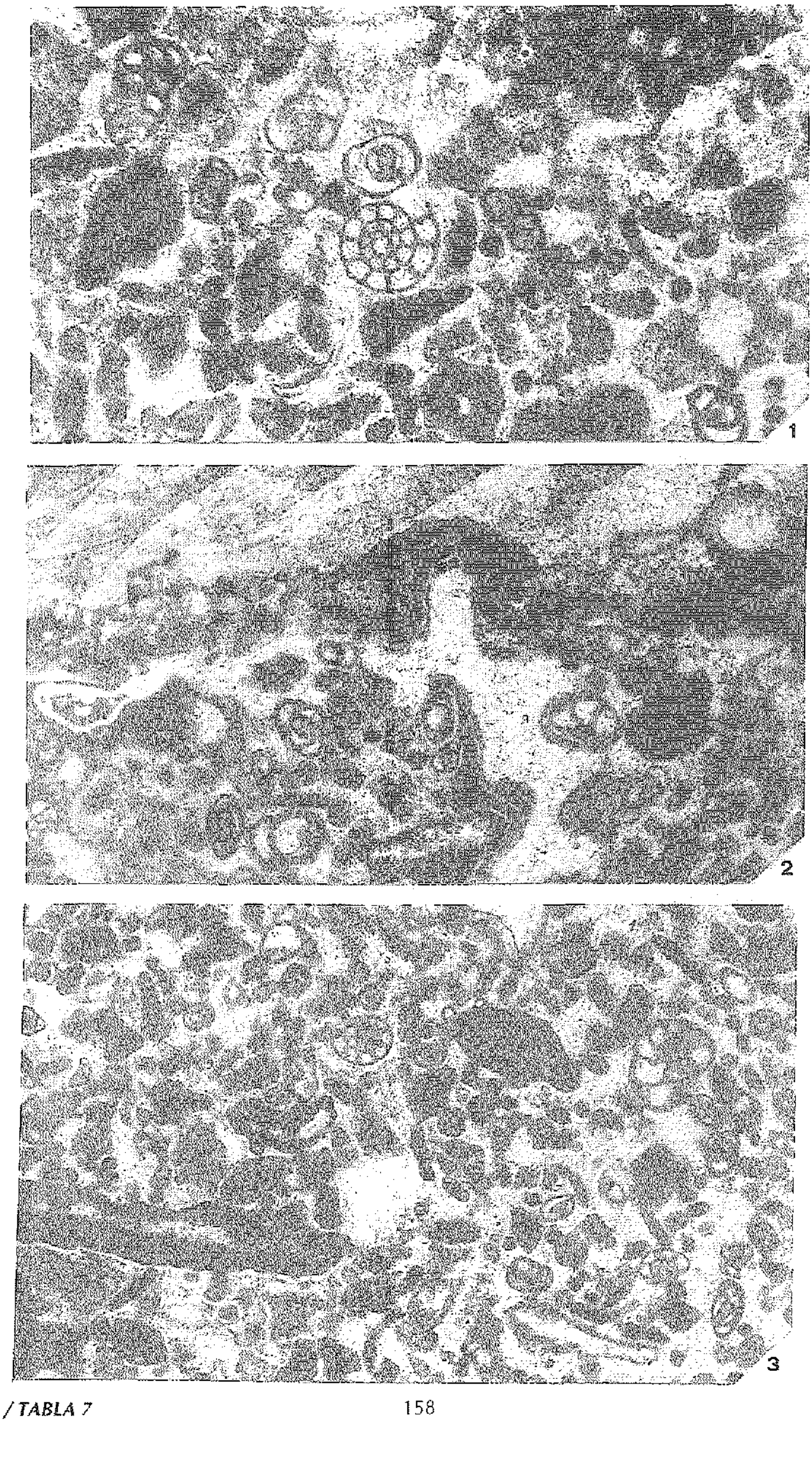

PLATE 7 / TABLA 7

PALEONTOLOŠKI IN STRATIGRAFSKI OPIS ZGORNJETURONIJSKIH PLASTI Z RUDISTI V SLIVJU, TRŽAŠKI KRAS, ITALIJA

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POVZETEK

Pri preučevanju stratigrafskega zaporedja apnencev z bogato rudistno favno na vzhodnem delu Tržaškega Krasa pri Slivju je bil prvič odkrit na Tržaške, Krasu horizont onkoidnega apnenca. Ta horizont lahko primerjamo z onkolitom v formaciji Gornji Humac pri Gračiću (Gušić & Jelaska, 1990, 1993) na otoku Braču (Hrvaška) ter z onkoidnim apnencem Sežanske formacije (Jurkovšek et al., *1996). Oba horizonta, ki ju prištevamo h zgornjemu turoniju, dokazujeta hitro in globalno morsko regresijo (Hancock & Kauffman, 1979 in Schlanger, 1986). Rudistno združbo v stratigrafskem zaporedju pri Slivju sestavljajo naslednje zgornjeturonijske vrste:* Hippuritella resecta *(Defrance),* Hippurites requieni *(Matheron),* H. requieni *var.* subpolygonia *Douvillé,* Vaccinites *cf.* inferus *(Douvillé),* Neoradiolites turoniensis *Pašić,* Distefanella? robusta *Caffau & Pleničar,* Distefanella kochanskae *Slišković,* Durania arnaudi *Choffat in* Biradiolites *sp. Nekatere od teh vrst so opisane prvič na Tržaškem Krasu. Asociacija obsega še polže, korale in kalcitne ter inkrustirane alge.*

Ključne besede: Rudisti, onkoidi, zgornji turonij, Tržaški Kras

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izvirno znanstveno delo

UDK 551.76/.78(497.4 Divača)
551.76/.78(497.4 Kozina)

GEOLOGIJA AVTOCESTNEGA ODSEKA DIVAČA - KOZINA

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IZVLEČEK

Ozemlje, po katerem poteka odsek avtoceste med Divačo in Kozino, spada med geološko bolj zanimive predele Krasa. Na njem se zvrstijo vse formacije, ki so nastajale med zgornjim santonijem in eocenom na severozahodnem delu Dinarske karbonatne plošče. Vzporedno z geološko spremljavo del na gradbišču avtoceste je bila izdelana podrobna geološka karta v merilu 1:5000. Namen članka je dopolniti poznavanje geološke zgradbe južnega Krasa in predstaviti primer znanstveno in naravovarstveno naravnane geološke spremljave enega od večjih gradbenih posegov v Sloveniji.

Ključne besede: geologija, zgornja kreda in paleogen, avtocesta Divača - Kozina, Kras, Slovenija

UVOD

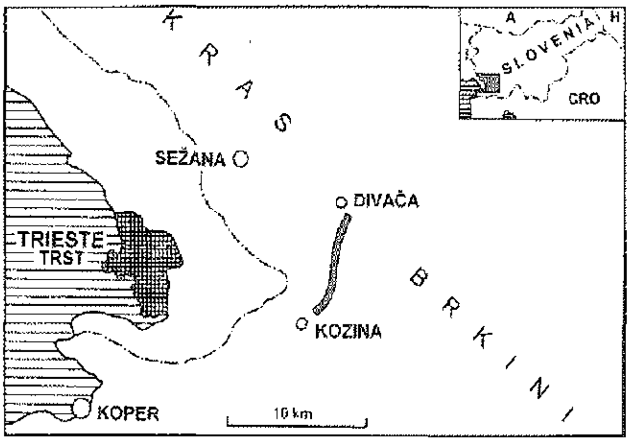
V članku so podani rezultati raziskav, ki so potekale vzporedno z geološko spremljavo avtocestnega odseka med Divačo in Kozino (sl. 1). Ob tem je bila za ožje območje avtoceste izdelana geološka karta v merilu 1:5.000. Terenske raziskave so potekale od začetka zemeljskih del v januarju do septembra 1997, ko so bila groba gradbena dela že v zaključni fazi.

Geološka karta (sl. 4-10) prikazuje v glavnem stanje na površini takoj po odstranitvi vegetacije, humusa in preperine. V zaključnih gradbenih fazah, predvsem po končanju cestnih usekov, so se pokazali nekateri novi geološki elementi, vendar jih je bilo v tej fazi mnogo več že zabrisanih zaradi izgradnje nasipov in finalizacije cestišča. Zato bi izdelava podrobne geološke karte morala postati obvezni sestavni del vseh geoloških spremljav ob večjih posegih na in pod zemeljsko površino.

Na geološki karti prikazano ozemlje je med prvimi podrobneje raziskoval že Stache (1889) in del rezultatov objavil v študiji *Die Liburnische Stufe und deren Grenzhorizonte*. V letih 1959 in 1960 je Hamrla napisal dve razpravi o premogiščih na Krasu, ki obravnavata tudi premogove plasti pri Rodiku. Kasneje je bilo celotno ozemlje geološko kartirano v okviru Osnovne geološke karte SFRJ 1:100.000 listov Gorica (Buser, 1968 in 1973) in Trst (Pleničar *et al.*, 1969 in 1973). Za potrebe Formacijske geološke karte južnega dela Tržaško-komenske planote 1:50.000 (Jurkovšek *et al.*, 1996) je bilo v merilu 1:10.000 kartirano širše ozemlje, po katerem poteka severni odsek avtoceste.

Od publiciranih del, ki se neposredno nanašajo na avtocesto, velja omeniti še članek o predhodnih krasoslovnih raziskavah trase avtoceste (Šebela, 1996) in poglavje Geološka zgradba Rodika z okolico (Jurkovšek, 1997) v knjigi Rodik med Brkini in Krasom, ki mu je priložena tudi geološka karta širšega prostora južnega odseka avtoceste med Divačo in Kozino.

Raziskani avtocestni odsek predstavlja enega od geološko bolj zanimivih predelov Krasa, saj se na njem zvrste vse formacije, ki so nastajale proti koncu sedi-



Sl. 1: Položajna skica avtocestnega odseka Divača - Kozina.
Fig. 1: Location of the Divača - Kozina motorway section.

mentacije na severozahodnem delu Dinarske karbonatne plošče (sl. 2). Nad Lipiško formacijo, ki jo označuje množica rudistnih ostankov, se je po razmeroma dolgi kopni fazi odložila Liburnijska formacija. Gradbišče avtoceste je plasti te formacije presekalo najbolj radikalno, saj je za vselej izbrisalo del erozijske meje, ki nakazuje kopno fazo med sedimentacijo Lipiške in Liburnijske formacije, izginili pa so tudi trije manjši rudniški rovi in izdanki premoških plasti. Ob teh je verjetno že Stache (1889) zbiral polže rodu *Stomatopsis* (tab. 4, sl. 2). V tem delu Liburnijske formacije je tudi znamenita meja med kredo in terciarjem, ki pa je žal na tem odseku avtoceste ne bo mogoče več proučevati.

V vrhnjem delu Liburnijske formacije sledi značilni, z miliolidami bogat Slivski apnenec. Zanimiv je krajši odsek blizu četrtega kilometra avtoceste, na katerem se je v osrednjem delu gradbišča pojavil manjši koralni greben, ki so ga spremljale številne spužve in trdoživnjaki.

Ob zaključni litostratigrafski enoti t.j. Alveolinsko-numulitnem apnencu velja zapisati, da je za razliko od zahodno ležečega ozemlja, na tem delu avtocestne trase jasno razvit Operkulinski apnenec, ki ga je izdvojil in imenoval že Pavlovec (1963). Vsekakor gre za pomemben litostratigrafski horizont, ki tudi na južnem delu Krasa tvori spodnji del formacije Alveolinsko-numulitnega apnenca in ga bo v bodoče potrebno bolj resno upoštevati pri izdelavi geoloških kart. Na Operkulinskem apnencu leži apnenec s številnimi alveolinidami in bolj redkimi numulitinami, ki je obenem najmlajša kamnina po kateri poteka avtocesta med Divačo in Kozino.

Na priloženi geološki karti so zaradi boljše preglednosti namenoma izpuščeni nekateri strukturno-tektonski elementi (prelomi, razpoke, zdrobljene cone itd.), razen v primerih, ko le-ti bistveno vplivajo na lego in medsebojne odnose litostratigrafskih enot.

Imena formacij in členov so v glavnem povzeta po Formacijski geološki karti južnega dela Tržaško-komenske planote 1:50.000 (Jurkovšek *et al.*, 1996), v katere tolmaču so podrobno opisane vse litostratigrafske enote južnega Krasa z interpretacijami okolja njihovega nastanka, fosili in starostjo. Zato v tem članku podajamo le najosnovnejše podatke o formacijah in členih, vse ostale informacije pa so zbrane in prikazane na geološki karti 1:5000 (sl. 4-10), na grafičnih prilogah (sl. 1-3), na terenskih fotografijah (sl. 11-17) ter na fotografijah vzorcev kamnin in mikroskopskih preparatov (tab. 1-8).

OPISI LITOSTRATIGRAFSKIH ENOT

Ozemlje avtocestnega odseka med Divačo in Kozino leži v jugovzhodnem podaljšku Tržaško-komenske planote v Komenski narivni grudi (Placer, 1981). Zgrajeno je iz karbonatnih kamnin, ki so se od zgornjega santonija do eocena z vmesnimi daljšimi ali krajšimi prekinitvami sedimentacije odlagale na severozahodnem delu nekdanje plitke Dinarske karbonatne plošče. Geološki dogodki in razlike v širšem in ožjem sedimentacijskem okolju so pogojevali nastanek različnih kamninskih enot, ki smo jih izdvojili na priloženi geološki karti.

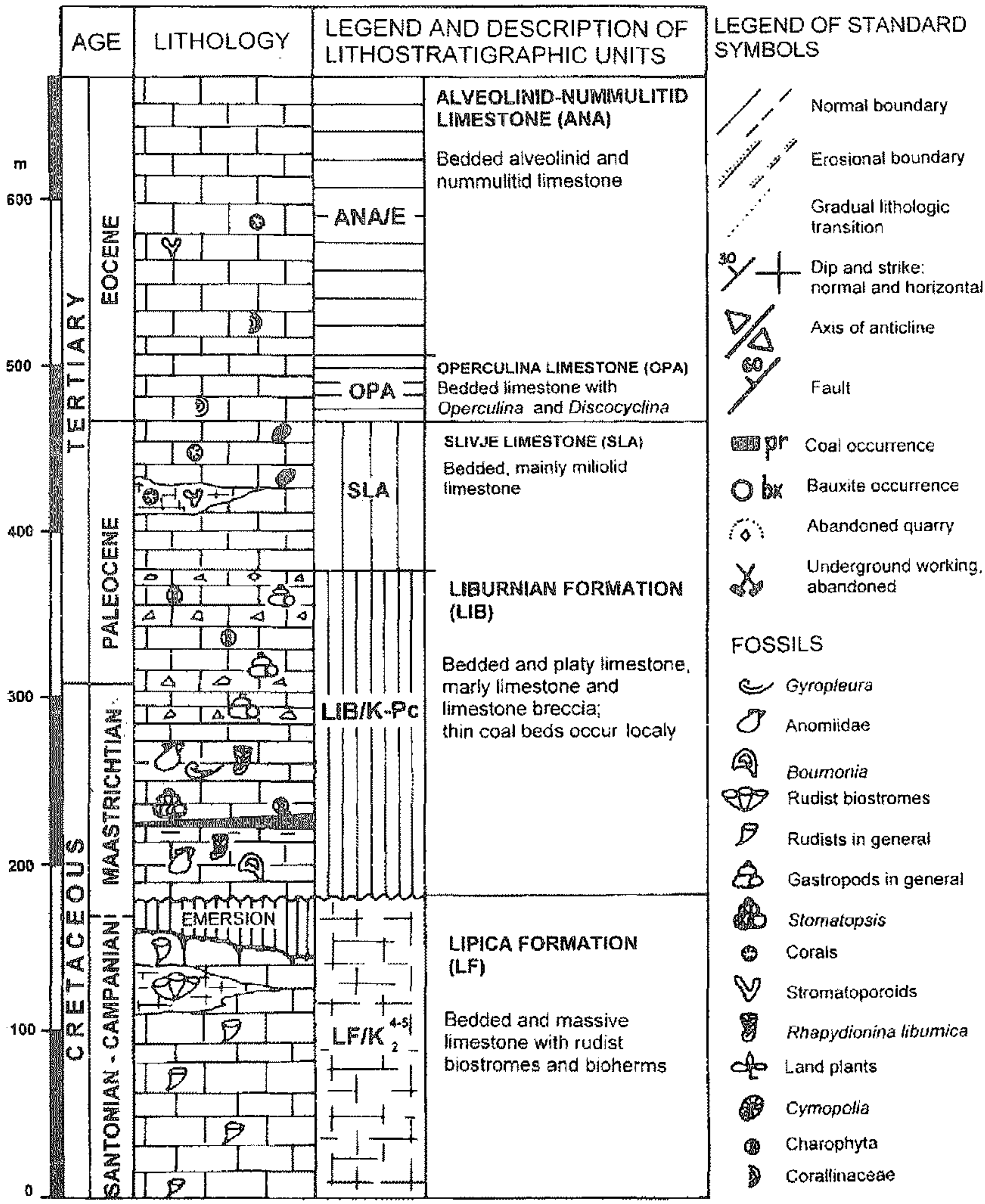
Osnovno naravno celoto predstavlja formacija, enote nižjega reda pa so členi. Formacije, ki smo jih kartirali, označujejo predvsem njihova litološka homogenost ter enotne sedimentološke in paleoekološke značilnosti. Pomemben kriterij je njihova jasna razpoznavnost na terenu. Meje formacij se v glavnem ne prekrivajo s kronostratigrafskimi mejami. Členi predstavljajo litološko homogeno zaporedje plasti, ki gradi vertikalni ali horizontalni del formacije.

Lipiška formacija (LF/K_2^{4-5})

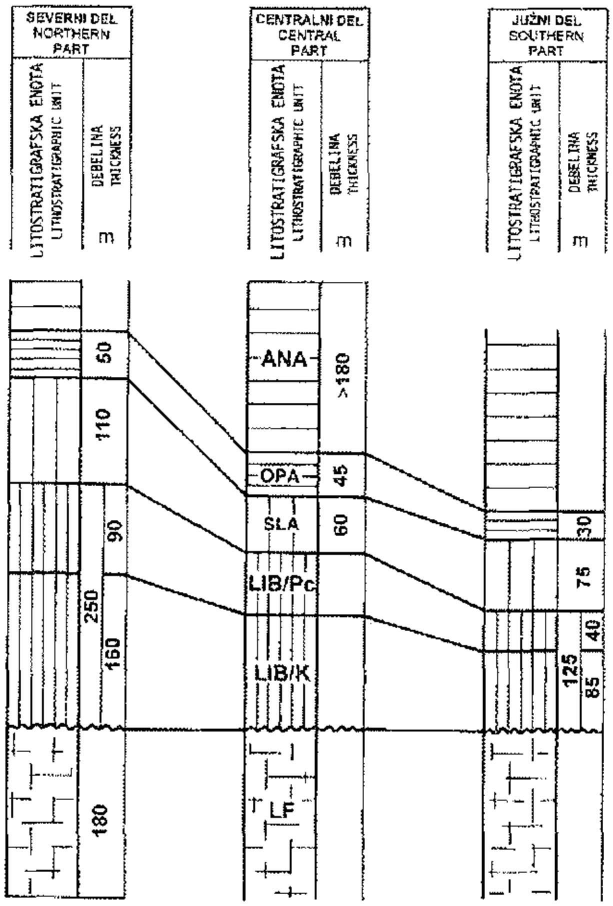
(Tab. 1, sl. 1-2; tab. 2, sl. 1)

Apnenec Lipiške formacije gradi pri Divači začetni del ozemlja avtocestnega odseka, na jugu sega na območje avtoceste v zahodnem krilu rodiške antiklinale, pri Kozini pa je ta formacija v tektonskem kontaktu z apnenci mlajših formacij.

Apnenec Lipiške formacije je večinoma debeloplastovit do masiven, svetlo sive do srednje sive barve. Skelet kamnine sestavljajo večji del lupine rudistov, ki jih je zajela intenzivna endolitizacija. Le redko opazujemo cele, še neporušene rudistne biostrome. Večinoma so rudistne lupine zdrobljene. Lokalno pojavljanje različkov zrnatega apnenca (grainstone do packstone) z vmesnimi prehodi v drobnozrnati biokalkarenit kaže na sedimentacijo na odprtem delu šelfa z dokaj visoko energijo vode (EI=3, izjemoma 4). Redke prevleke modrozelenih cepljivk okrog nekaterih fosilov in endolitizacija govore v prid zelo plitvemu šelfu.



Sl. 2: Litostratigrafsko zaporedje plasti na ozemlju avtocestnega odseka Divača - Kozina z legendo k stolpcu in geološki karti.
Fig. 2: Lithostratigraphic succession of the beds in the Divača - Kozina motorway section with legend to the column and geological map.



Sl. 3: Razmerja debelin litostratigrafskih enot vzdolž avtocestnega odseka Divača - Kozina.
Fig. 3: Relations of thicknesses of lithostratigraphic units along the Divača - Kozina motorway section.

Zaradi razmeroma debelih plasti, ugodne teksture in strukture so v Lipiški formaciji že v preteklosti izkoriščali pestre različke apnenca. Sledovi izkoriščanja ene od debelejših plasti biomikritnega apnenca z rudisti so bili vidni na začetku avtocestnega odseka pri Divači (sl. 4). Vzhodno od trase avtoceste (sl. 9), na ozemlju Male griže, so že v prejšnjem stoletju lomili apnenec Lipiške formacije za gradnjo. Med drugimi je iz njega deloma zgrajena tudi rodiška cerkev (Jurkovšek, 1997).

Apnenec Lipiške formacije na jugu blizu Kozine (sl. 10), ki s prelomom meji na kamnine mlajših formacij, se od prej opisanega razlikuje po barvi, strukturi in teksturi. Čeprav ga prav tako uvrščamo v Lipiško formacijo, gre za različek, ki se je odlagal v bolj zatišnih delih plitvega šelfa. Apnenec je srednje do temno sive barve, izrazito plastovit, lokalno celo laminiran. Po strukturi je to apnenec tipa "wackestone in packstone" z nizkim energijskin indeksom (1-2). Rudisti so v njem redkejši, prevladujejo predvsem drobne oblike. Med mikrofosili so zastopane predvsem številne bentoške foraminifere, med katerimi prevladujejo miliolide.

Lipiško formacijo uvrščamo v zgornji santonij in campanij. Na ozemlju avtocestnega odseka med Divačo in Kozino jo po primerjavah s širšim prostorom južnega Krasa postavljamo v bližino glavnega keramosferinskega horizonta, torej v zgornji santonij in morda še v spodnji campanij.

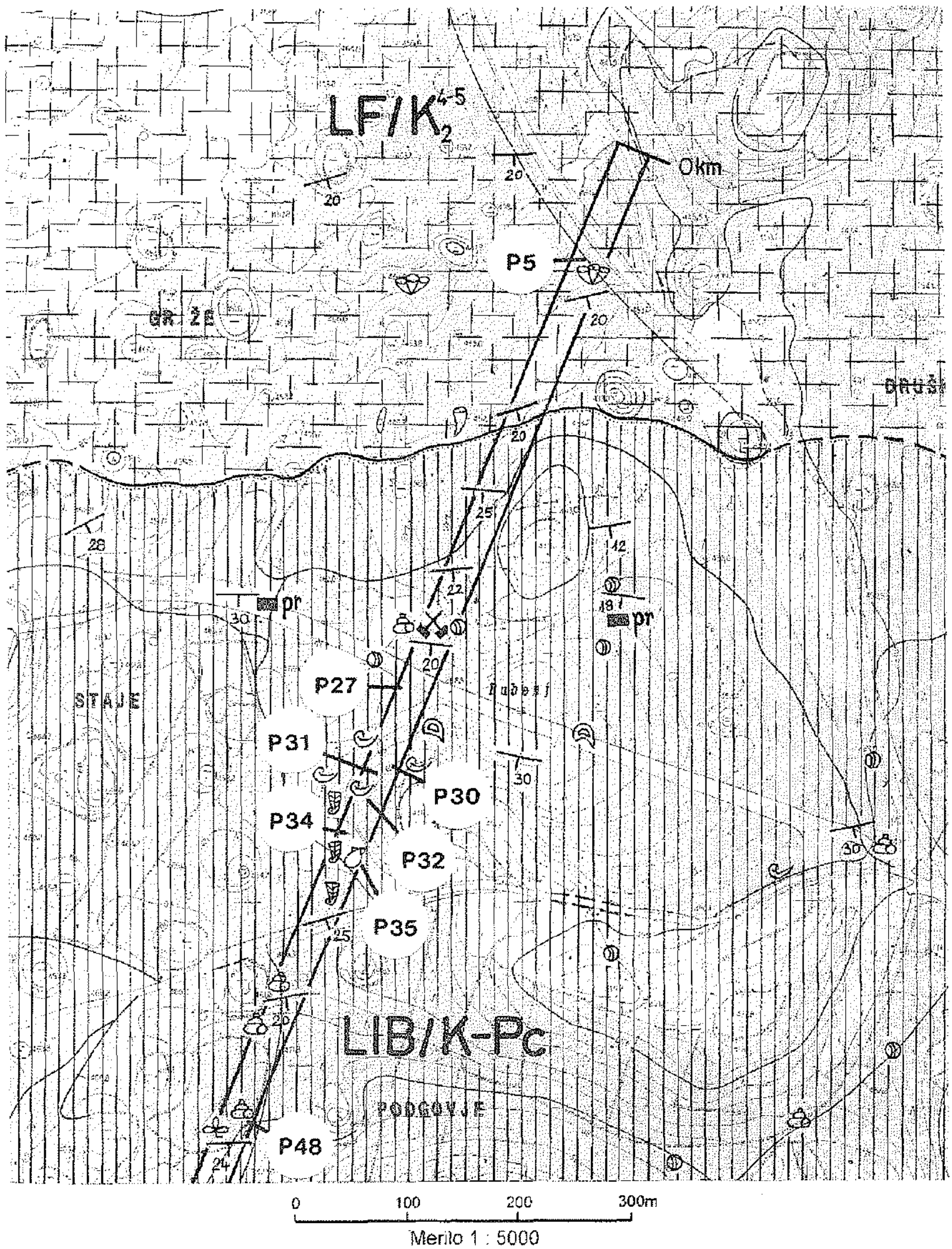
Liburnijska formacija (LIB/K-Pc)

(Tab. 2, sl. 2-6; tab. 3, sl. 1-3; tab. 4, sl. 1-5; tab. 5, sl. 1-2; tab. 6, sl. 1-4)

Kamnine Liburnijske formacije so zastopane tako na severnem kot na južnem delu ozemlja avtocestnega odseka med Divačo in Kozino. Na severu vpadajo plasti pod blagim kotom med 12° in 25° proti jugu (sl. 4-5), na južnem delu pa gradi Liburnijska formacija rodiško antiklinalo (sl. 8), v jedru katere leži rudistni apnenec Lipiške formacije.

Liburnijska formacija se je odložila po prekinitvi sedimentacije nad apnencem Lipiške formacije. V campaniju se je morje iz tega dela karbonatne plošče za nekaj časa umaknilo. Nastalo je kopno, o katerem pričajo pojavi paleokrasa in manjši ekonomsko nezanimivi žepi boksita v apnencu. Šele v maastrichtiju je morje ponovno preplavilo kopno in ustvarilo raznolike sedimentacijske sredine, v katerih so nastajale kamnine Liburnijske formacije. Le-te kažejo za razliko od Lipiške formacije značilnosti morskega, brakičnega in sladkovodnega sedimentacijskega okolja. Različni strukturni tipi apnencev se med seboj menjavajo tudi horizontalno. Tudi fosilna favna in flora se močno spreminjata.

Nedvomno gre za eno najbolj zapletenih formacij na Krasu, ki jo bo potrebno še temeljito raziskati in ob koncu izdelati model, v katerega bo mogoče vključiti na desetine velikih in malih različnosti med posameznimi lokalitetami in profili. Zato se pri opisu te litostratigrafske enote ne smemo izogniti kratkemu zgodovinskemu orisu raziskav Liburnijske formacije. Že Guido Stache (1889), ki je raziskoval tudi plasti v okolici Kozine, Rodika in Vremskega Britofa, je "liburnijsko stopnjo", ki jo je poimenoval po zgodovinski pokrajini Liburnija ob Jadranski obali med rekama Rašo in Krko, razdelil na tri dele: spodnji foraminiferni apnenec, zgornji foraminiferni apnenec in vmesne kozinske plasti, ki jih je imenoval po Kozini. Seveda med Stachejevimi raziskavami stratigrafska opredelitev liburnijskih plasti ni bila popolnoma določena predvsem zato, ker ni bila jasna vloga paleocena. Postavil jih je med zgornjekredne rudistne apnence in alveolinsko-numulitne apnence eocenske starosti. Za posamezne člene Liburnijske formacije so bila kasneje uvedena še druga imena. Pavlovec (1963) je spodnje foraminiferne apnence poimenoval vremske plasti po bližnjem Vremskem Britofu, zgornji foraminiferni apnenec pa sta Delvalle in Buser (1990) imenovala po vasi Slivje na jugozahodnih



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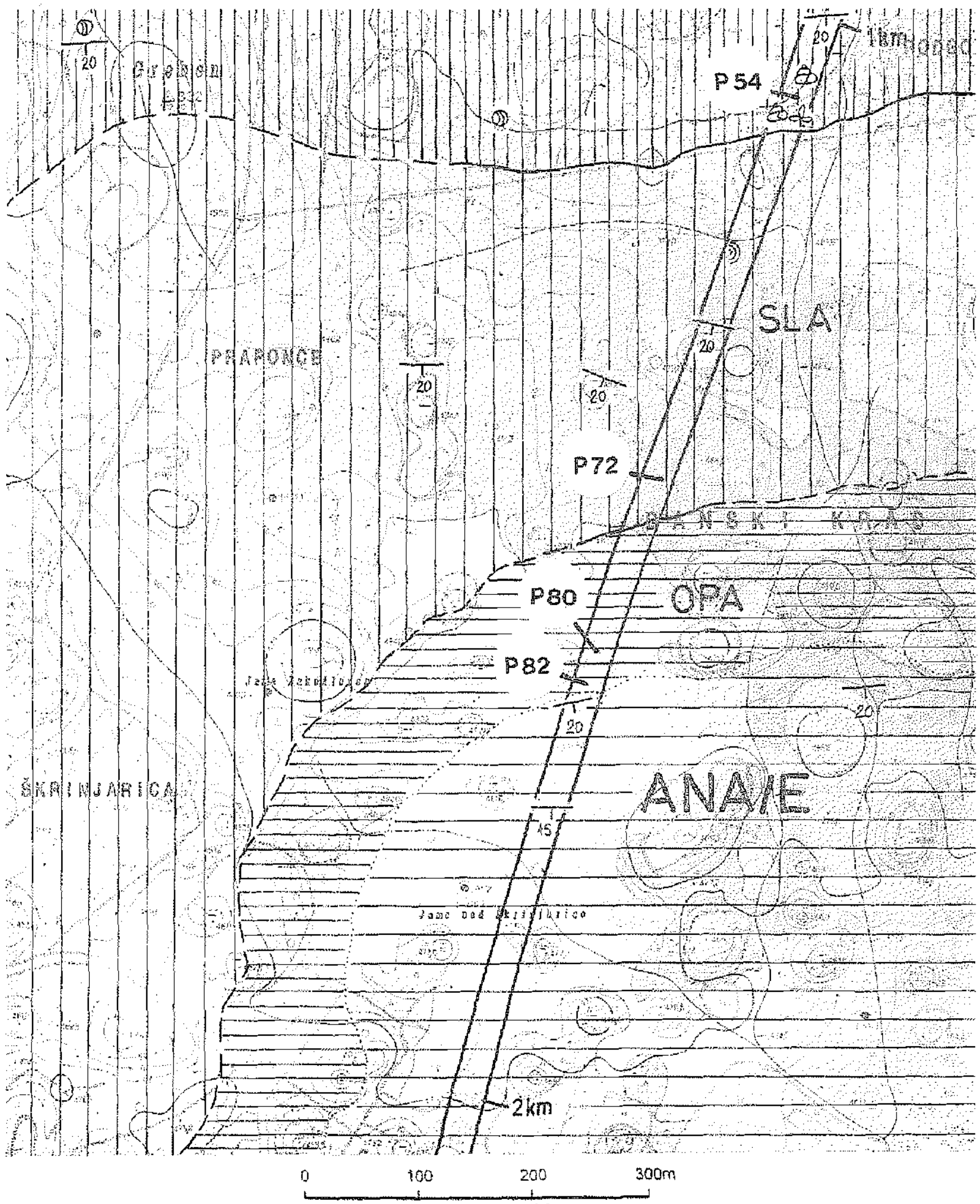
Sl. 4 - Fig. 4



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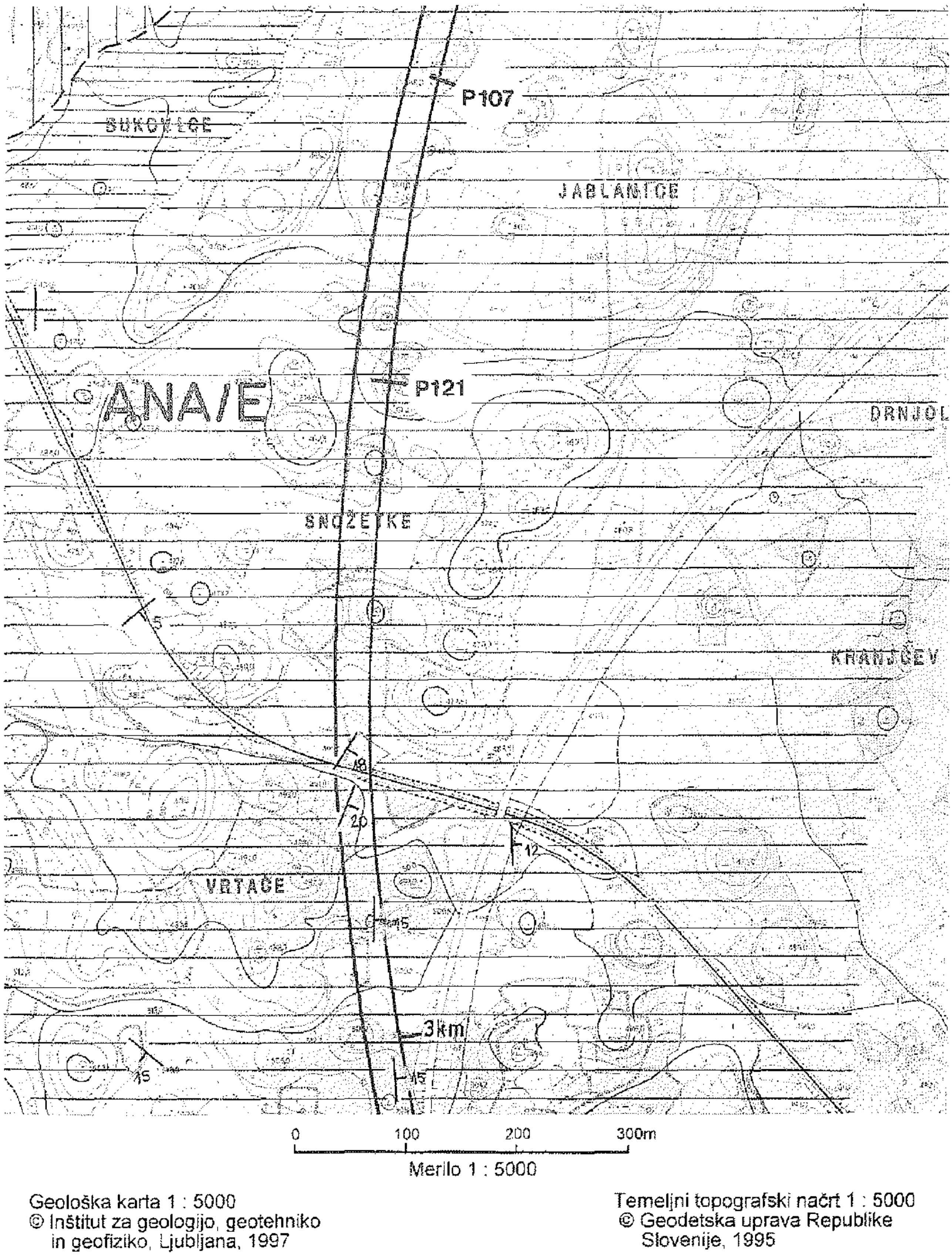
Sl. 5 - Fig. 5


P107
BUKOVLCE
JABLANICE
P121
ANAJE
DRNJOL
SNOŽETKE
KRANJČEV
VRTAČE
3km
0
100
200
300m
Merilo 1 : 5000
Geološka karta 1 : 5000
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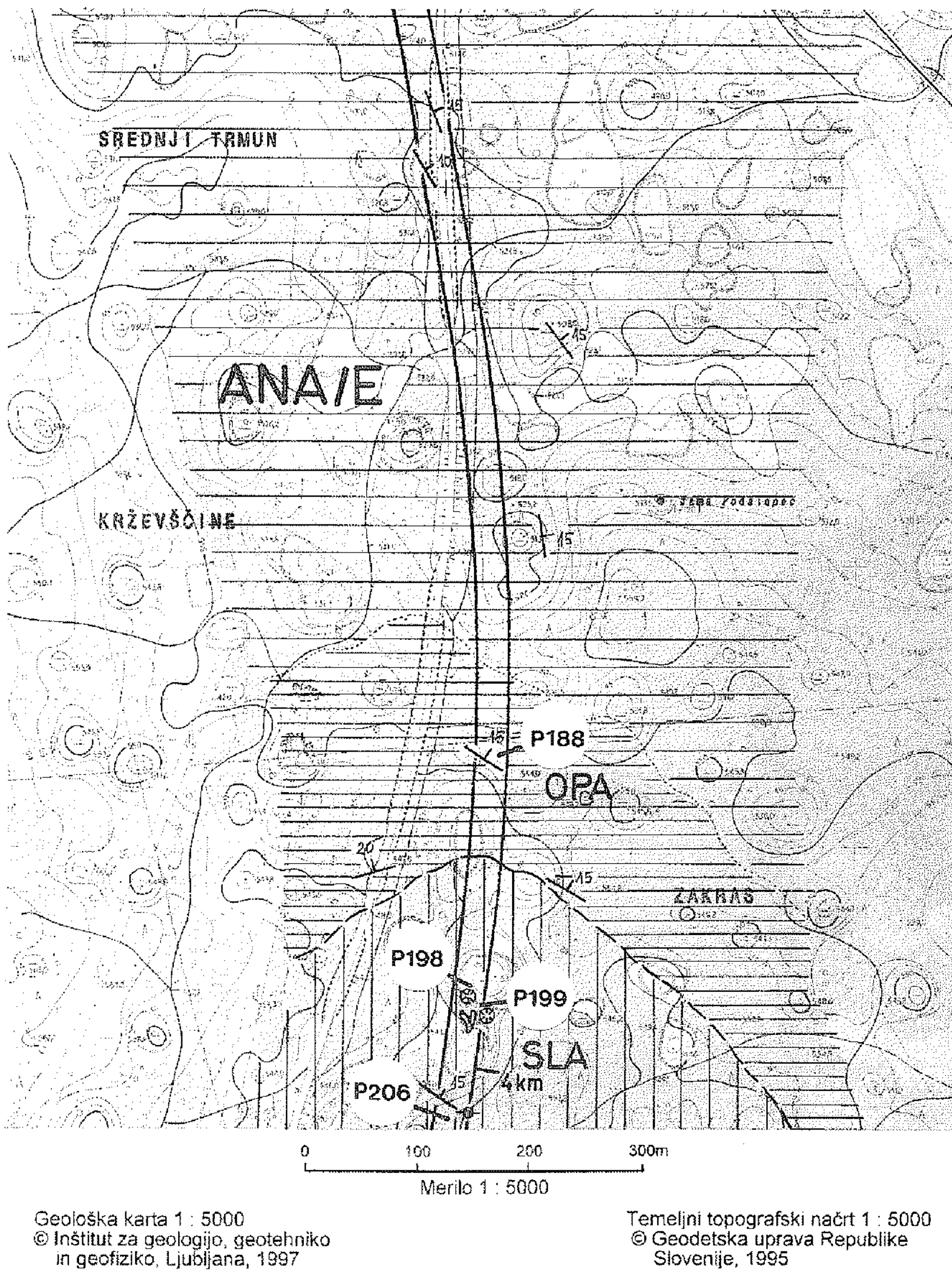
Sl. 6 - Fig. 6


SREDNJI TRMUN
ANA/E
KRŽEVŠČINE
P188
OPA
ZAKRAS
P198
P199
SLA
4km
P206
0
100
200
300m
Merilo 1 : 5000
Geološka karta 1 : 5000
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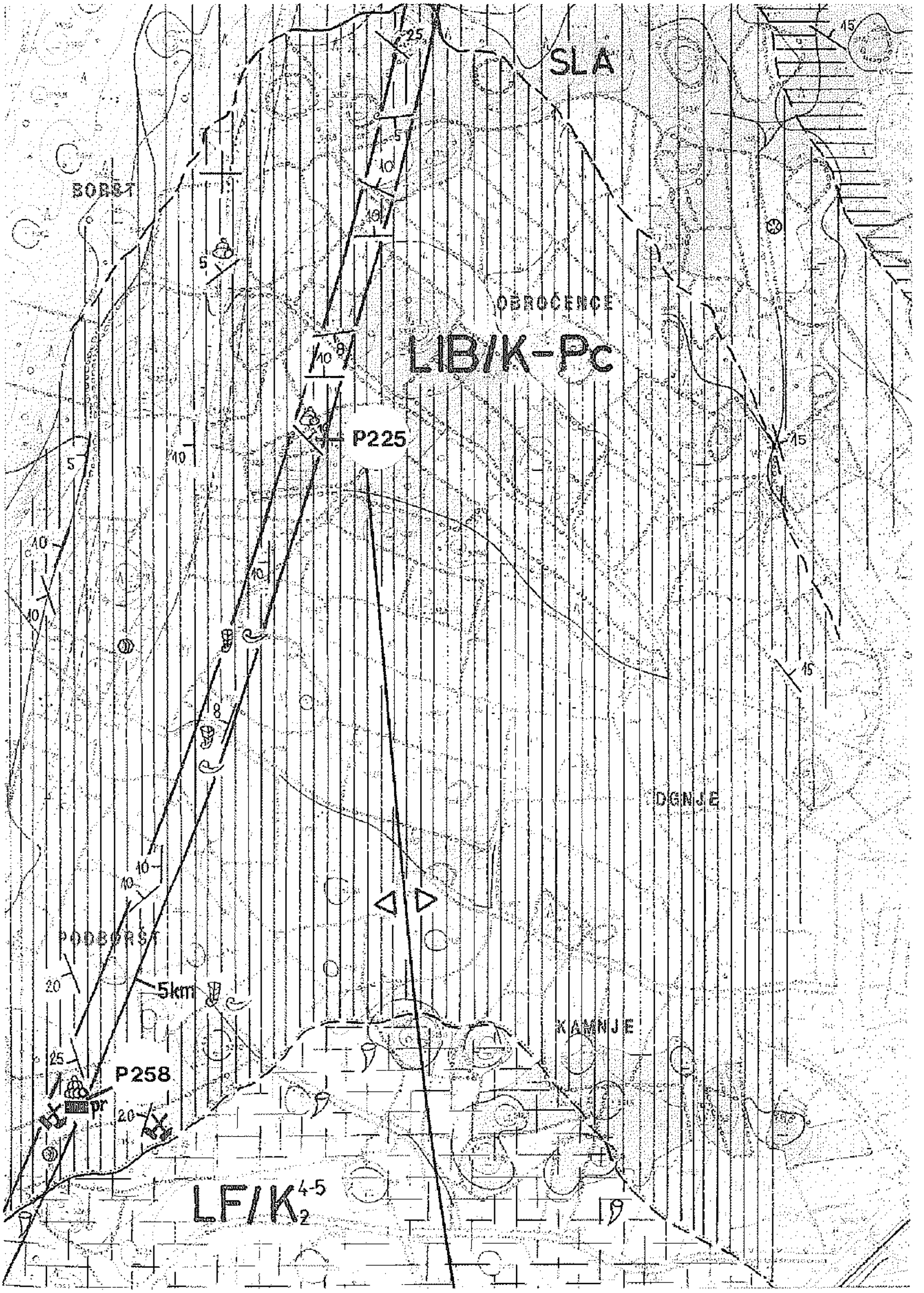
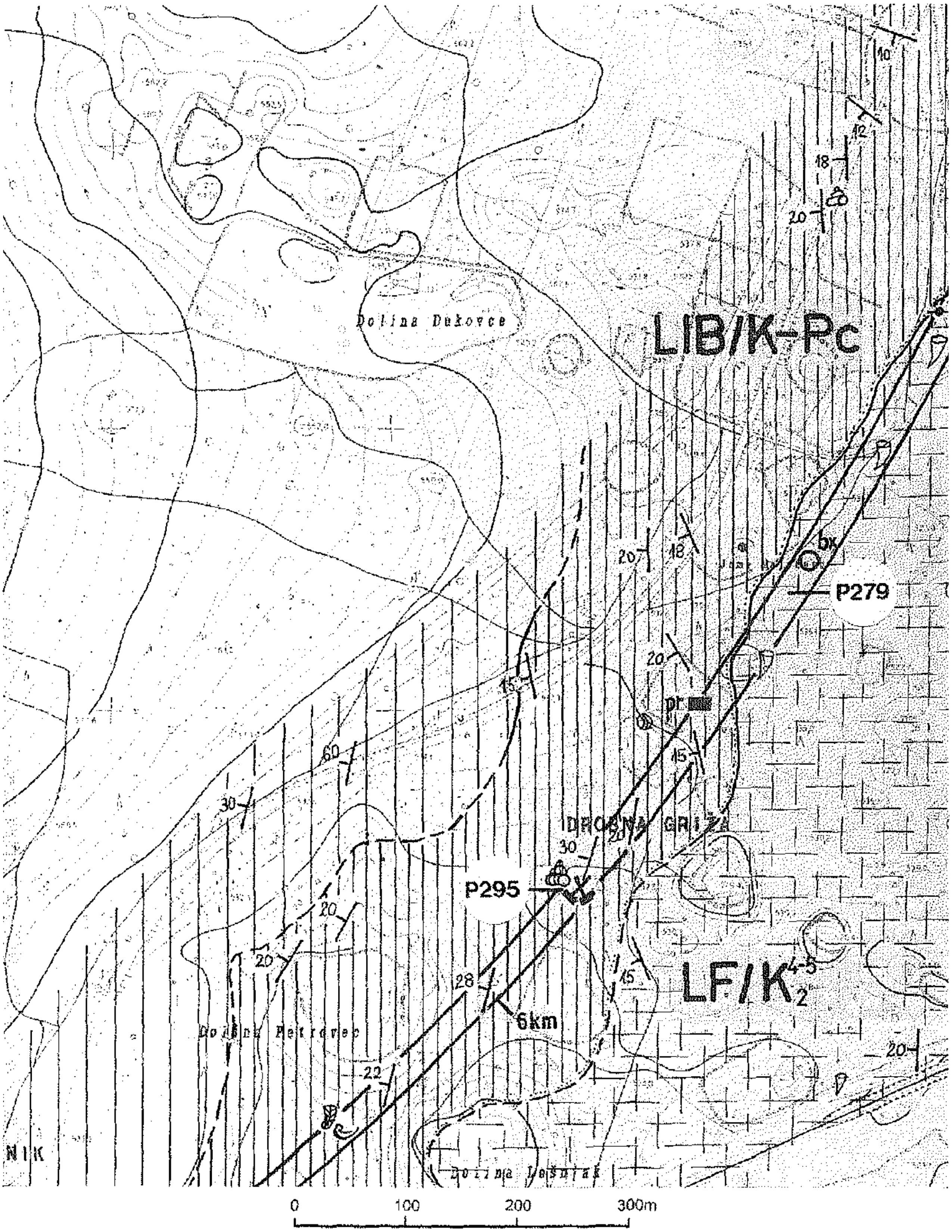
Sl. 7 - Fig. 7


SLA
BORŠT
OBROČENCE
LIB/K-Pc
P225
DGNJE
PODBORŠT
5km
KAMNJE
P258
pr
LF/K$_2^{4-5}$

Sl. 8 - Fig. 8



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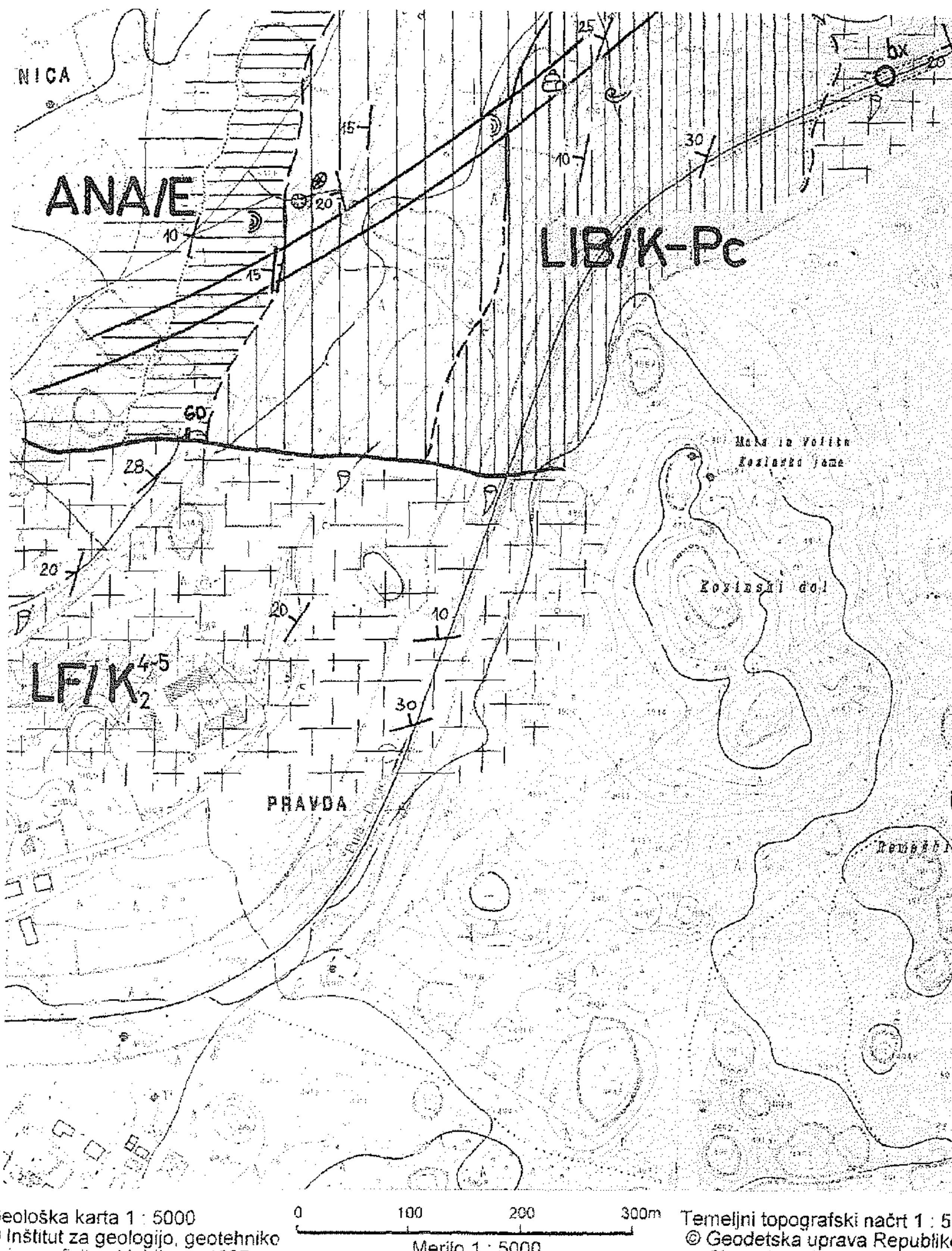
Sl. 9 - Fig. 9



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Sl. 10 - Fig. 10

Sl. 4-10: Geološka karta ozemlja avtocestnega odseka med Divačo in Kozino. Slike so razporejene od severa proti jugu.
Figs. 4-10: Geological map of the area of the Divača - Kozina motorway section, with sheets arranged from north to south.

obronkih Brkinov v slivsko formacijo, Jurkovšek in sodelavci (1996) te plasti obravnavajo kot člen v sklopu Liburnijske formacije.

Na severnem delu avtocestnega odseka pri Divači je kredni del Liburnijske formacije razvit v obliki srednjeplastovitega in lokalno laminiranega apnenca s pretežno pelmikritno strukturo. Vmes se pojavlja več različno debelih plasti intraformacijske emerzijske breče, ki ima ponavadi mikritno osnovo s primesjo organske snovi. Breče nakazujejo kratkotrajne okopnitvene faze predvsem v bližini meje med kredo in terciarjem. V nivoju črnega laminiranega apnenca s številnimi haracejami in polži se pojavlja tanka plast črnega premoga, ki so jo verjetno še v prejšnjem stoletju sledili s kratkim rudniškim vpadnikom z nagibom okoli 20° proti zahodu. Nad plastmi s premogom, ki so rezultat brakične sredine, sledi plastoviti povsem morski apnenec z giropleurami in bournonijami. Poleg njih se v nekaterih nivojih pojavljajo zelo številne do kamnotvorne miliolide, ki se jim v posameznih višjeležečih plasteh pridružijo še pogostne foraminifere vrste *Rhapydionina liburnica* (Stache). Za ta nivo apnenca je značilno tudi nekaj plasti s školjkami iz rodu *Anomia*. V bližini kredno-terciarne meje vsi zgornjekredni fosili postopoma izginejo, poveča pa se število plasti emerzijske breče.

V terciarnem delu profila, ki sledi v smeri proti jugu, se začne pogosteje pojavljati apnenec temnorjave do črne barve, ki je lokalno lahko tudi lapornat z rahlim vonjem po bitumnu in bi ga lahko primerjali s Stachejevimi kozinskimi plastmi. Po strukturi je biomikrit in biopelmikrit (mudstone do packstone) ter je bil odložen v zelo mirnem lagunskem okolju. Sem in tja ga prekinjajo tanjše stromatolitne lamine, ki kažejo na občasna medplimska stanja. Vmes nastopajo plasti temnosive breče, ki v vezivu in klastih pogosto vsebuje številne hišice polžev. V primerjavi s krednim delom Liburnijske formacije, ki ga lahko primerjamo s Pavlovčevimi (1963) vremskimi plastmi, je v terciarnem t. im. kozinskem delu prišlo do razmeroma hitre spremembe sedimentacijskega okolja oziroma faciesa. Bolj odprti del šelfa je postal naenkrat zaprt z lagunskim značajem in občasnimi znaki litorala. Fosili so značilni za mirno okolje z nizkim energijskim indeksom. Številne so tankolupinaste školjke, drobni polži, ostrakodi, haraceje in laginofore, bolj v zgornjem delu pa miliolide in druge foraminifere. V nekaterih plasteh so pogostne prizme paronipor. Nad temi plastmi leži Slivski apnenec, ki ga obravnavamo kot člen Liburnijske formacije.

Nekoliko drugačen razvoj Liburnijske formacije je na južnem delu, kjer v območje avtoceste seže z zahodnim delom rodiške antiklinale tudi velik del erozijske meje med Lipiško in Liburnijsko formacijo (sl. 9). Zato lahko med petim in šestim kilometrom avtocestnega odseka opazujemo na površini rudistnega apnenca Lipiške formacije znake paleozakrasevanja in manjše pojave boksita.

Sl. 11: Pogled iz Bubnja proti začetku gradbišča avtocestnega odseka. Tla v ospredju so zaradi premogovih plasti v Liburnijski formaciji temne barve, v ozadju pri avtodvigalu je svetlo siv rudistni apnenec Lipiške formacije. Foto: B. J., 3.9.1997.
Fig. 11: View from Bubanj towards the beginning of the motorway construction site. The soil in the forefront is dark due to coal seams in the Liburnian Formation; in the background, near crane, the light grey rudist limestone of the Lipica Formation can be seen. Photo: B. J., September 3rd 1997.

Sl. 12: Plasti Liburnijske formacije s premogom v useku izvoza za Divačo. Foto: B. J., 13.8.1997.
Fig. 12: Layers of the Liburnian Formation with coal in the cutting at the exit for Divača. Photo: B. J., August 13th 1997.

Sl. 13: Premogove plasti maastrichtijskega dela Liburnijske formacije v cestnem useku pri nekdanjem premogovniku (P 258). Foto: B. J., 6. 8. 1997.
Fig. 13: Coal beds of the Maastrichtian part of the Liburnian Formation in the road cut near the former coal mine (P 258). Photo: B. J., August 6th 1997.

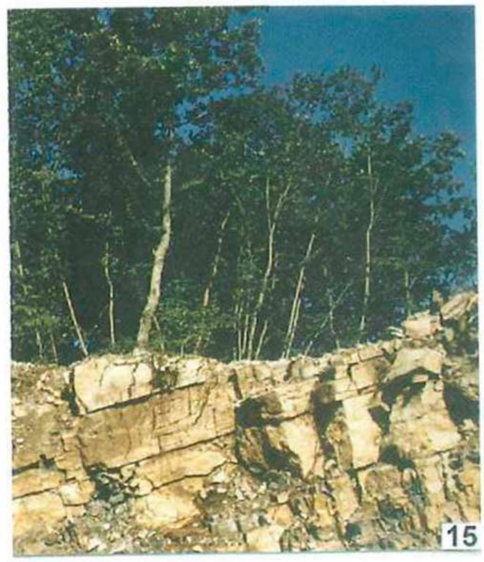
Sl. 14: Tektonski kontakt med svetlo sivim eocenskim Operkulinskim apnencem in temnejšim zgornjekrednim apnencem Lipiške formacije na južnem delu gradbišča pri Kozini. Foto: B. J., 6.8.1997.
Fig. 14: Tectonic contact between the light grey Eocene Operculina limestone and the darker Upper Cretaceous limestone of the Lipica Formation in the southern part of the motorway construction site near Kozina. Photo: B. J., August 6th 1997.

Sl. 15: Laminirani apnenec maastrichtijskega dela Liburnijske formacije (P 27). Foto: B. J., 3.9.1997.
Fig. 15: Laminated limestone of the Maastrichtian part of the Liburnian Formation (P 27). Photo: B. J., September 3rd 1997.

Sl. 16: Med 3. in 4. kilometrom se avtocesta prebija skozi tektonizirani Alveolinsko-numulitni apnenec. Foto: B. J., 14.5.1997.
Fig. 16: Between the 3rd and 4th kilometre the motorway passes through tectonized Alveolinid-nummulitid limestone. Photo: B. J., May 14th 1997.

Sl. 17: Gradbena mehanizacija na sedlu med dolinama Petrovec in Lešnjak pri Kozini. Pogled proti severovzhodu. Foto: B. J., 3.9.1997.
Fig. 17: Construction mechanization at the saddle between the Petrovec and Lešnjak valleys near Kozina. View to the northeast. Photo: B. J., September 3rd 1997.


11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12


16


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14


17

Zelo blizu erozijske meje zasledimo pojave črnega premoga. Pojavlja se ponavadi v tankih plasteh in lečah med črnim plastovitim in ploščastim apnencem, ki vključuje precej organske snovi. Plasti premoga so različno debele, vendar najdebelejša v rudniškem rovu blizu šestega kilometra avtocestnega odseka ne presega 40 cm. Podobne razmere so bile tudi v rudniškem rovu pri petem kilometru. Hamrla (1959, 1960) je premog iz Liburnijske formacije na Krasu, kamor uvrščamo tudi pojave premoga na trasi avtoceste, uvrstil med kakovostne vrste črnega premoga z visokim toplotnim efektom okoli 35.590 kJ/kg. Rudarjenje na Krasu je sicer staro že 200 let, vendar je zelo težko natančno določiti čas obratovanja obeh premogovnikov na trasi avtoceste. Po besedah domačinov naj bi zadnji rudaril na tem območju še po drugi svetovni vojni eden od lokalnih kovačev. Spremljevalci premogovnih plasti so haraceje, drobne školjčne lupine in številni razmeroma lepo ohranjeni polži iz rodu *Stomatopsis*. Slednji se pojavljajo v največjem številu v 3 do 5 cm debeli plasti črnega lapornatega apnenca tik nad najdebelejšo premogovno plastjo.

Nad plastmi s premogom leži, podobno kot na severnem delu avtocestnega odseka pri Divači, nekaj deset metrov sivega apnenca in apnenčeve breče, ki nakazuje več kratkotrajnih okopnitev znotraj sedimentacijskega prostora Liburnijske formacije. V nekaterih nivojih se pojavljajo številne giropleure in miliolide, ki se jim lokalno pridružijo še foraminifere vrste *Rhapydionina liburnica* (Stache).

Podobno kot na severu se tudi na tem delu avtocestnega odseka število brečastih plasti proti kredno-terciarni meji povečuje, apnenec pa začne kazati značilnosti bolj zaprtega lagunskega sedimentacijskega okolja značilnega za kozinski facies.

Skupna debelina Liburnijske formacije (brez Slivskega apnenca) znaša na severu do 250 m, od tega ocenjujemo debelino krednega dela na 160 m, paleocenskega pa na 90 m. Na južnem delu avtocestnega odseka pa je debelina Liburnijske formacije okoli 125 m, od tega je 85 m krednega in 40 m paleocenskega dela (sl. 3).

Slivski apnenec (SLA)

(Tab. 6, sl. 5-6; tab. 7, sl. 1-2; tab. 8, sl. 1-2)
Kot zaključni del Liburnijske formacije se povsod pojavlja Slivski apnenec (sl. 5, 7, 10), ki je v bistvu sinonim Stachejevega zgornjega miliolidnega apnenca. Spodnja meja ni povsod povsem jasna, zato podajamo primer meje na četrtem kilometru avtocestnega odseka, ki je bila lepo vidna v očiščeni vrtači na sredini gradbišča. V vrhnjem delu kozinskega faciesa se pojavi najprej 2 m miliolidnega apnenca, nad njim 2 m emerzijske breče s tankimi premogovimi vključki, sledi poldrugi meter srednje sivega sparitnega apnenca z redkimi polami miliolidnega apnenca in stromatolitnimi laminami, nato pa srednje siv miliolidni apnenec, ki se nadaljuje navzgor v svojem tipičnem razvoju.

Po strukturi kamnine prevladujeta v Slivskem apnencu tipa wackestone in packstone, oziroma izprani biopelmikrit, izjemoma intrabiosparit. Fosilna združba je pestra. Poleg foraminifer, med katerimi prevladujejo miliolide, se pogosto pojavljajo rdeče koralinacejske alge, dazikladicejske iz rodu *Cympopolia*, včasih pa še haraceje, ostrakodi, modrozelene cepljivke in osikli ehinodermov. Lokalno se v Slivskem apnencu pojavljajo manjše grebenske zaplate (patch reefs) s koralami in stromatoporoidami. Največji koralno-stromatoporoidni greben približne velikosti 5 x 15 m je bil odkrit v osrednjem delu gradbišča med profiloma P 198 in P 199, t. j. blizu četrtega kilometra avtocestnega odseka (sl. 7). Danes so v vzhodnem cestnem useku opazni le še obrobni ostanki verjetno enega najlepših grebenov v Slivskem apnencu na Krasu. Čeprav splošne značilnosti Slivskega apnenca kažejo na poglabljanje morskega dna in bolj odprto morsko okolje, nas tudi v tem členu redke plasti z izsušitvenimi porami, pojavi paronipor in intenzivno bioturbacijo opozarjajo na občasna, lokalna medplimska stanja.

Debelina Slivskega apnenca je na severnem delu avtocestnega odseka do 110 m, v osrednjem delu do 60 m, na jugu pa znaša okoli 75 m (sl. 3).

Alveolinsko-numulitni apnenec (ANA/E)

(Tab. 7, sl. 3-4; tab. 8, sl. 3-6)
Alveolinsko-numulitni apnenec s prevladujočo favno alveolin, numulitin in diskociklin predstavlja zaključno litostratigrafsko enoto karbonatnega razvoja Dinarske plošče. Plasti te formacije leže na Slivskem apnenecu in grade velik del ozemlja, po katerem poteka osrednji del avtocestnega odseka med Divačo in Kozino (sl. 5-7). Pojavlja se tudi na skrajnem južnem delu pri Kozini, kjer je v tektonskem kontaktu z Lipiško formacijo (sl. 10). Na trasi avtoceste so zastopani predvsem nižji deli formacije Alveolinsko-numulitnega apnenca, ki bi jih lahko podrobneje opredelili kot operkulinski in alveolinski apnenec. Operkulinski apnenec (OPA) je na geološki karti izdvojen kot najnižji člen formacije, medtem ko z alveolinami bogate plasti, ki leže na njem, niso posebej izdvojene.

Alveolinsko-numulitni apnenec je svetlosiv, v posameznih nivojih alveolinskega apnenca pa je lokalno temneje obarvan. Apnenec je srednje- do debeloplastovit, vendar je plastovitost večinoma šibko izražena. Po strukturi prevladujejo biomikritni ali biosparitni packstone s prehodi v wackestone in grainstone ter vsebuje številne fosile. Med temi je največ velikih foraminifer iz družine Alveolinidae in Nummulitidae, ki so povečini tako pogostne, da so kamnotvorne. Precej je tudi osiklov iglokožcev. V najnižjem delu so zelo pogostne do kamnotvorne operkuline in diskocikline, medtem ko je drugih foraminifer manj. V nekaterih nivojih Alveolinsko-numulitnega apnenca so številne litotamnije ter korale in hidrozoji.

Alveolinsko-numulitni apnenec se je večidel odlagal na odprtem, dobro prezračenem plitvem šelfu, kjer je bila večina mikrita odplaknjena z valovanjem in tokovi. Zato so fosilni skeleti zacementirani z drobnozrnatim kalcitom. Ponekod so bile sedimentacijske razmere bolj mirne. V teh primerih se je apnenec odlagal v zatišnih delih odprtega šelfa.

Na odseku avtoceste med Divačo in Kozino znaša vidna debelina eocenske formacije Alveolinsko-numulitnega apnenca več kot 180 m. Operkulinski apnenec v njeni talnini je na severu debel okoli 50 m, v osrednjem delu 45 m, na južnem delu avtocestnega odseka pa okoli 30 m (sl. 3).

ZAHVALA

Paleontološko-geološko spremljavo del na odseku avtoceste med Divačo in Kozino je naročilo Ministrstvo za okolje in prostor RS (Zavod za varstvo naravne in kulturne dediščine Gorica), financirala pa jo je Družba za avtoceste v Republiki Sloveniji. Za izvajalca spremljave je bil izbran Inštitut za geologijo, geotehniko in geofiziko v Ljubljani, ki je zaradi posebnega znanstvenega in naravovarstvenega pomena za ozemlje, po katerem poteka avtocestni odsek, v lastni organizaciji izvedel podrobno geološko kartiranje v merilu 1:5000. Vsi vzorci fosilov in kamnin so bili skupaj z dokumentacijo po pogodbi predani v hrambo in trajno last Prirodoslovnemu muzeju Slovenije.

Raziskovalci, ki smo skrbeli za paleontološko-geološko spremljavo izgradnje avtoceste, se zahvaljujemo ing. Sreču Konoblju (Družba za državne ceste - nadzor nad avtocesto) in vsem drugim, ki so nam po svojih močeh pomagali pri izvedbi naloge. Lepa hvala dr. Ladislavu Placerju za recenzijo rokopisa besedila in pregled geoloških kart, prof. dr. Simonu Pircu za pregled angleškega dela teksta in Andreju Stoparju za pomoč pri pripravi vzorcev. Prepariranje makrofosilov in fotodokumentiranje makroskopskih vzorcev je bilo opravljeno v Paleontološki zbirki dr. Bogdana Jurkovška, mikroskopski preparati pa so bili izdelani in fotografirani v laboratoriju Inštituta za geologijo, geotehniko in geofiziko v Ljubljani.

GEOLOGY OF THE DIVAČA - KOZINA MOTORWAY SECTION (KRAS, SLOVENIA)

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SUMMARY

The paper presents the results of the research carried out during the geological monitoring of the construction of the Divača - Kozina section motorway (Fig. 1). For this purpose a geological map 1:5,000 was made for the motorway route and its environs. The field research began in January 1997, when the initial diggings took place, and ended in September 1997, when the basic construction work was already in its concluding phase.

The geological map (Figs. 4-10) shows mainly the state of the surface of the route immediately after the vegetation, topsoil and weathered overburden were removed. During the concluding construction work, particularly after the completion of the road cuts, many new geological elements were exposed to view, while many more had already been obliterated due to the construction of embankments and finalization of the motorway. This is why elaboration of a detailed geological map should become an obligatory component part of any geological monitoring during major constructional interventions on the earth's surface as well as under it.

The territory shown on the geological map had been researched among the first by Stache (1889), who published a part of his results in the study entitled Die Liburnische Stufe und deren Grenzhorizonte (The Liburnian stage and its limiting horizons). In 1959 and 1960 Hamrla wrote two papers on coal deposits in the Kras region, in which the coal layers at Rodik were also dealt with. Later on the entire area was mapped for the Basic geological map of the SFRY

1:100,000, sheets Gorica (Buser, 1968 and 1973) and Trieste (Pleničar et al., *1969 and 1973). In the framework of the Geological map of the southern part of the Trieste-Komen plateau 1:50,000 (Jurkovšek* et al., *1996), a wider area through which runs the northern part of the motorway, was mapped on a scale of 1:10,000.*

Among the published works dealing directly with the motorway the paper on the preliminary karstological research into the course of the Divača - Kozina motorway (Šebela, 1996) should be mentioned, and the chapter The geologic structure of the Rodik surroundings (Jurkovšek, 1997) in the book entitled Rodik between Brkini and Kras, with attached geological map of the wider area of the southern section of the motorway between Divača and Kozina.

The examined motorway section represents one of geologically most interesting parts of Kras for the outcrops of the formations deposited in the northwestern part of the Dinaric carbonate platform (Fig. 2). Above the Lipica Formation, marked by abundance of rudists, the Liburnian Formation was deposited after a relatively long land phase. The motorway route has cut through the layers of this formation most radically, for once and for all it obliterated a part of the erosion boundary line which indicates a land phase between the sedimentation of the Lipica and Liburnian Formations. Three minor mine shafts and outcrops of coal seams, however, also disappeared. It is possible that Stache (1889) collected gastropods of the genus Stomatopsis along them (Pl. 4, Fig. 2). In this part of the Liburnian Formation is also present the prominent Cretaceous-Tertiary boundary which unfortunately, can not be studied any longer at this motorway section.

In the upper part of the Liburnian Formation there follows the typical Slivje limestone rich with miliolids. Very interesting is rather short section near the 4th kilometre of the motorway where a small coral reef accompanied by numerous sponges and hydrozoans appeared.

Concerning the terminal lithostratigraphic unit, i. e. the Alveolinid-nummulitid limestone, it should be noted that in a contrast to the western part of the area, the Operculina limestone is distinctly developed in this part of the motorway route. However, here we are dealing with an important lithostratigraphic horizon which in southern part of Kras also forms the lower part of the formation of the Alveolinid-nummulitid limestone; for this reason, in future it will have to be considered more in the geological mapping. The Operculina limestone is overlain by limestone with numerous alveolinids and rare nummulitids, which represents the youngest rock in the Divača - Kozina section of the motorway.

On the attached geological map certain structural elements (faults, fissures, crushed zones, etc.) have been deliberately left out for better visualization, except in the cases when they essentially affect the position and mutual relations between lithostratigraphic units.

The names of the formations and members are those used in the Geological map of the southern part of the Trieste-Komen plateau 1:50,000 (Jurkovšek et al., *1996); in its explanation all lithostratigraphic units of the southern part of Kras, together with suitable interpretations of their origin, fossils and age, are described in detail. Therefore only the basic data on the formations and members are given in this paper, while all other details are shown on the geological map 1:5,000 (Figs. 4-10), diagrammatic supplements (Figs. 1-3), field photographs (Figs. 11-17) and photos of rock samples and microscopic preparations (Pls. 1-8).*

Key words: geology, Upper Cretaceous and Paleogene, Divača - Kozina motorway, Kras, Slovenia

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TABLE - PLATES

TABLA - PLATE 1

Lipiška formacija - Lipica Formation
(Zgornji santonij - campanij; Upper Santonian - Campanian)

1. Del rudistne biostrome. Vzorec P 5, naravna velikost.
1. A part of rudist biostrome. Sample P 5, natural size.

2. Biomikritni apnenec z rudistnimi lupinami in sledovi paleozakrasevanja (temnejša barva). Vzorec P 279, naravna velikost.
2. Biomicritic limestone with rudist shells and traces of paleokarstification (darker colour). Sample P 279, natural size.

TABLA - PLATE 2

Lipiška formacija - Lipica Formation
(Zgornji santonij - campanij; Upper Santonian - Campanian)

1. Biomikritni apnenec z miliolidami in endolitizirano rudistno lupino (levo zgoraj).Vzorec P 279, 11 x.
1. Biomicritic limestone with miliolids and endolithified rudist shell (above left). Sample P 279, 11 x.

Liburnijska formacija - Liburnian Formation
(Maastrichtij; Maastrichtian)

2. Biomikritni apnenec z drobci školjčnih lupin in rapidioninami. Vzorec P 31, 11 x.
2. Biomicritic limestone with fragments of bivalve shells and *Rhapydionina*. ***Sample 31, 11 x.***

3. Biomikritni apnenec (wackestone) z vrsto *Rhapydionina liburnica* ***(Stache). Vzorec P 34, 24 x.***
3. Biomicritic limestone (wackestone) with *Rhapydionina liburnica* ***(Stache). Sample P 34, 24 x.***

4. Laminirani stromatolitni apnenec (biolitit). Vzorec P 35, 11 x.
4. Laminated stromatolithic limestone (biolithite). Sample P 35, 11 x.

(Paleocen; Paleocene)

5. Biomikritni apnenec (wackestone) s polži in haracejami iz rodu *Lagynophora*. ***Vzorec P 48, 11 x.***
5. Biomicritic limestone (wackestone) with gastropods and characeans *Lagynophora*. ***Sample P 48, 11 x.***

6. *Lagynophora* ***sp. Vzorec P 48, 24 x.***
6. *Lagynophora* ***sp. Sample P 48, 24 x.***

TABLA - PLATE 3

Liburnijska formacija - Liburnian Formation
(Maastrichtij; Maastrichtian)

1. Emerzijska nadplimska breča. Vzorec P 30/1, naravna velikost.
1. Emersed supratidal breccia. Sample P 30/1, natural size.

2. Odlomki lupin školjk rodu *Gyropleura* ***v biosparitnem apnencu s številnimi miliolidami in rapidioninami. Vzorec P 32, naravna velikost.***
2. Fragments of bivalve shells *Gyropleura* ***in biosparitic limestone with numerous miliolids and*** *Rhapydionina*. ***Sample P 32, natural size.***

3. *Anomia* ***sp. v biomikritnem apnencu z miliolidami. Vzorec P 35, naravna velikost.***
3. *Anomia* ***sp. in biomicritic limestone with miliolids. Sample P 35, natural size.***

TABLA - PLATE 4

Liburnijska formacija - Liburnian Formation
(Maastrichtij; Maastrichtian)

1. *Stomatopsis* ***sp. Vzorec P 258, naravna velikost.***
1. *Stomatopsis* ***sp. Sample P 258, natural size.***

2. Del table s polži rodov *Stomatopsis, Cosinia* ***in*** *Obbinula*, ***ki jih je Stache (1889) zbral ob premogovnih plasteh pri Kozini (verjetno tudi ob premogovnikih pri Podborštu in Drobni griži), pomanjšano.***
2. A part of the plate with gastropods of the genera *Stomatopsis, Cosinia* ***and*** *Obbinula*, ***collected by Stache (1889), along the coal beds near Kozina (also probably in coal pits near Podboršt and Drobna griža), diminished.***

3. Površina laminiranega apnenca. Vzorec P 27, naravna velikost.
3. Surface of laminated limestone. Sample P 27, natural size.

4. Površina apnenca z giropleurami. Vzorec P 30/2, naravna velikost.
4. Surface of limestone with *Gyropleura*. ***Sample P 30/2, natural size.***

5. Površina apnenca s preseki rudistov iz rodu *Bournonia*. ***Vzorec P 30/3, naravna velikost.***
5. Surface of limestone with cross sections of rudists *Bournonia*. ***Sample P 30/3, natural size.***

TABLA - PLATE 5

Liburnijska formacija - Liburnian Formation
(Paleocen; Paleocene)

1. Emerzijska nadplimska breča s klasti, ki so bili lokalno premeščeni v zgodnji fazi diageneze kot plastiklasti. Vzorec P 54, naravna velikost.
1. Emersed supratidal breccia with clasts which were in the early phase of diagenesis locally redeposited as plasticlasts. Sample P 54, natural size.

2. Emerzijska breča s polži in haracejami. Starejši biomikritni apnenec (temno) je bil v delu izlužen, kaverne pa zapolnjuje biomikritni apnenec mlajše generacije (svetlo). Vzorec P 225, naravna velikost.
2. Emersed breccia with gastropods and characeans. The older biomicritic limestone (dark) was partly leached out, while the caverns are filled by biomicritic limestone of a later generation (light). Sample P 225, natural size.

TABLA - PLATE 6

Liburnijska formacija - Liburnian Formation
(Paleocen; Paleocene)

1. Paronipora *sp. v mikritni osnovi. Vzorec P 225, 24 x.*
1. Paronipora *sp. in micritic matrix. Sample P 225, 24 x.*

2. Paronipora *sp. Vzorec P 206, 24 x.*
2. Paronipora *sp. Sample P 206, 24 x.*

3. Kalcitne prizme razpadle paronipore. Vzorec P 54, 24 x.
3. Calcite prisms of Paronipora. *Sample P 54, 24 x.*

4. Hišice polžev v biomikritnem apnencu (wackestone). Vzorec P 48, 24 x.
4. Gastropod shells in biomicritic limestone (wackestone). Sample P 48, 24 x.

Slivski apnenec - Slivje limestone
(Zgornji paleocen; Upper Paleocene)

5. Biomikritni apnenec z miliolidami (packstone). Vzorec P 72, 11 x.
5. Biomicritic limestone with miliolids (packstone). Sample P 72, 11 x.

6. Detajl biomikritnega apnenca z miliolidami. Vzorec P 72, 24 x.
6. Detail of biomicritic limestone with miliolids. Sample P 72, 24 x.

TABLA - PLATE 7

Liburnijska formacija - Liburnian Formation
Slivski apnenec - Slivje limestone
(Zgornji paleocen; Upper Paleocene)

1. Kolonijska korala. Vzorec P 198, naravna velikost.
1. Colonial coral. Sample P 198, natural size.

2. Korala in koralinacejska alga v biosparitnem apnencu (biolitit). Vzorec P 199, 11 x.
2. Coral and corallinacean alga in biosparitic limestone (biolithite). Sample P 199, 11 x.

Alveolinsko-numulitni apnenec - Alveolinid-nummulitid limestone
(Spodnji eocen; Lower Eocene)

3. Preperela površina apnenca s prevladujočimi foraminiferami rodov Operculina *in* Discocyclina *(Operkulinski apnenec). Vzorec P 188, naravna velikost.*
3. Weathered surface of limestone with prevailing foraminifers Operculina *and* Discocyclina *(Operculina limestone). Sample P 188, natural size.*

4. Apnenec z alveolinami - polirana površina. Vzorec P 107, naravna velikost.
4. Limestone with alveolinids - polished surface. Sample P 107, natural size.

TABLA - PLATE 8

Liburnijska formacija - Liburnian Formation
Slivski apnenec - Slivje limestone
(Zgornji paleocen; Upper Paleocene)

1. Biosparitni apnenec s koralami, hidrozoji, drobci litotamnij in presekom dazikladacejske alge (biolitit). Vzorec P 198, 11 x.
1. Biosparitic limestone with corals, hydrozoans, lithothamnian fragments and dasycladacean alga (biolithite). Sample P 198, 11 x.

2. Biosparitni apnenec s koralinacejsko algo in koralo. Vzorec P 198, 24 x.
2. Biosparitic limestone with corallinacean alga and coral. Sample P 198, 24 x.

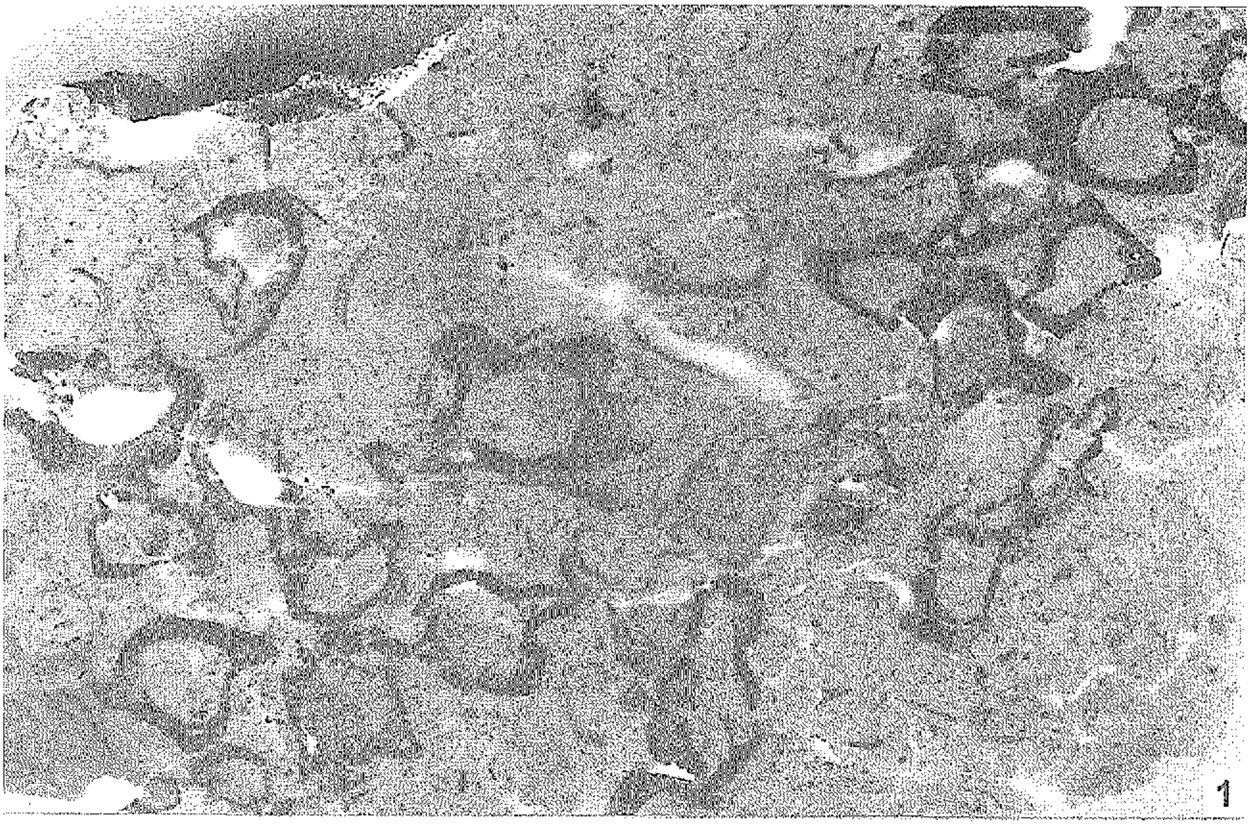
Alveolinsko-numulitni apnenec - Alveolinid-nummulitid limestone (Spodnji eocen; Lower Eocene)

3. Značilni preparat Operkulinskega apnenca z diskociklinami in numulitidami. Vzorec P 80, 24 x.
3. Typical view of Operculina limestone with discocyclinids and nummulitids. Sample P 80, 24 x.

4. Discosyclina *sp. v fosilni združbi numulitid Operkulinskega apnenca. Vzorec P 82, 11 x.*
4. Discosyclina *sp. in association with nummulitids in the Operculina limestone. Sample P 82, 11 x.*

5. Nummulites *sp. v biosparitnem apnencu z alveolinami (packstone). Vzorec P 121, 24 x.*
5. Nummulites *sp. in biosparitic limestone with alveolinids (packstone). Sample P 121, 24 x.*

6. Biosparitni apnenec s številnimi alveolinami (packstone). Vzorec P 121, 11 x.
6. Biosparitic limestone with numerous alveolinids (packstone). Sample P 121, 11 x.



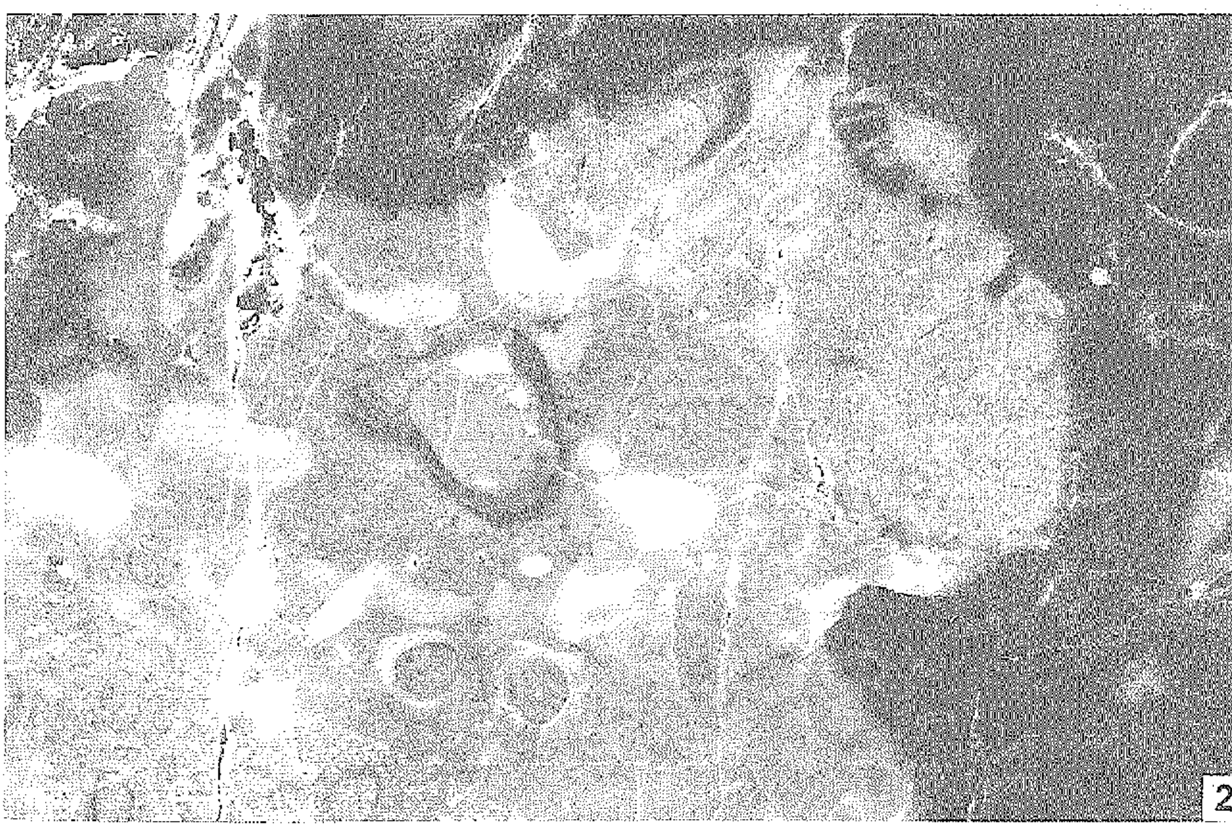


TABLA 1 - PLATE 1

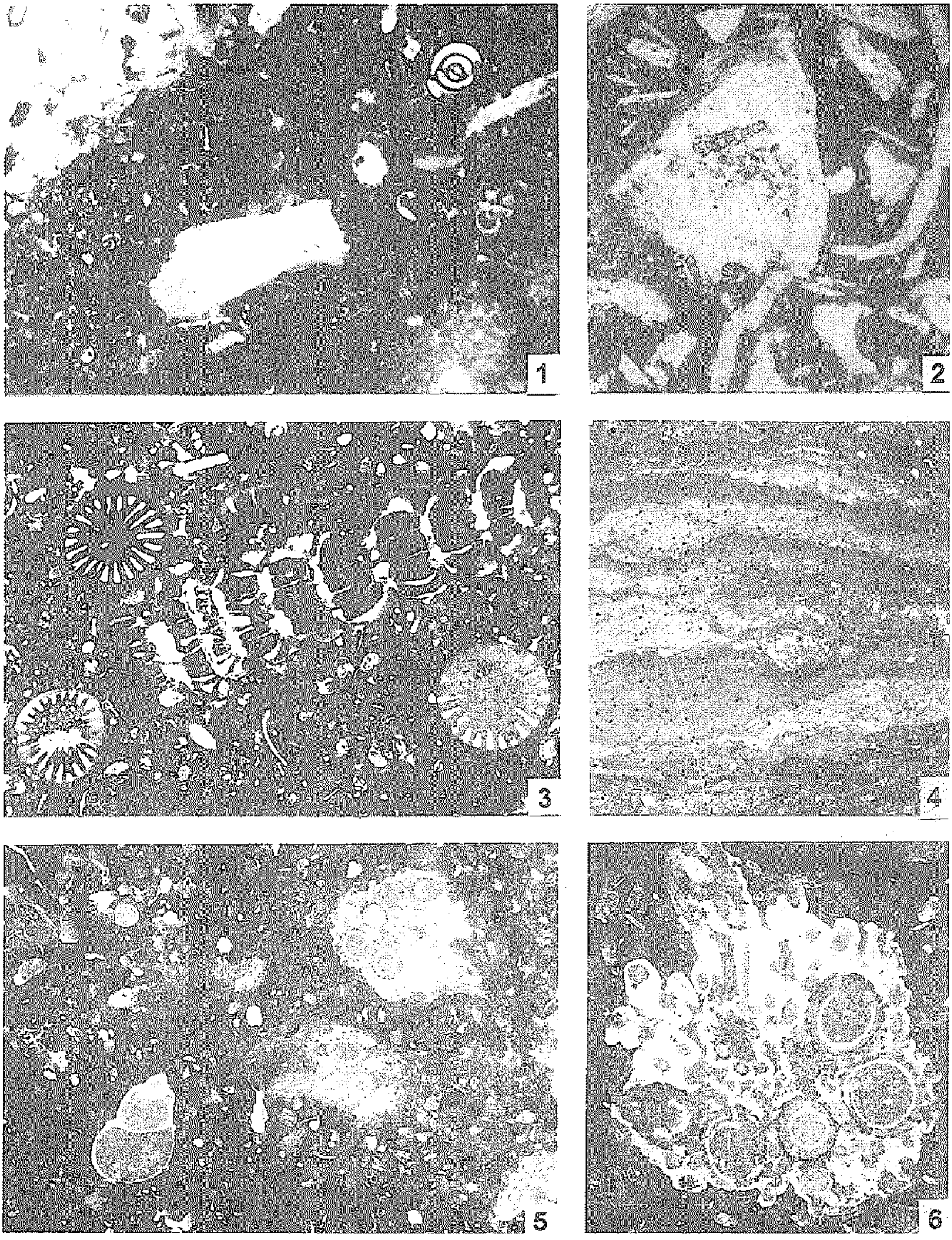


TABLA 2 - PLATE 2

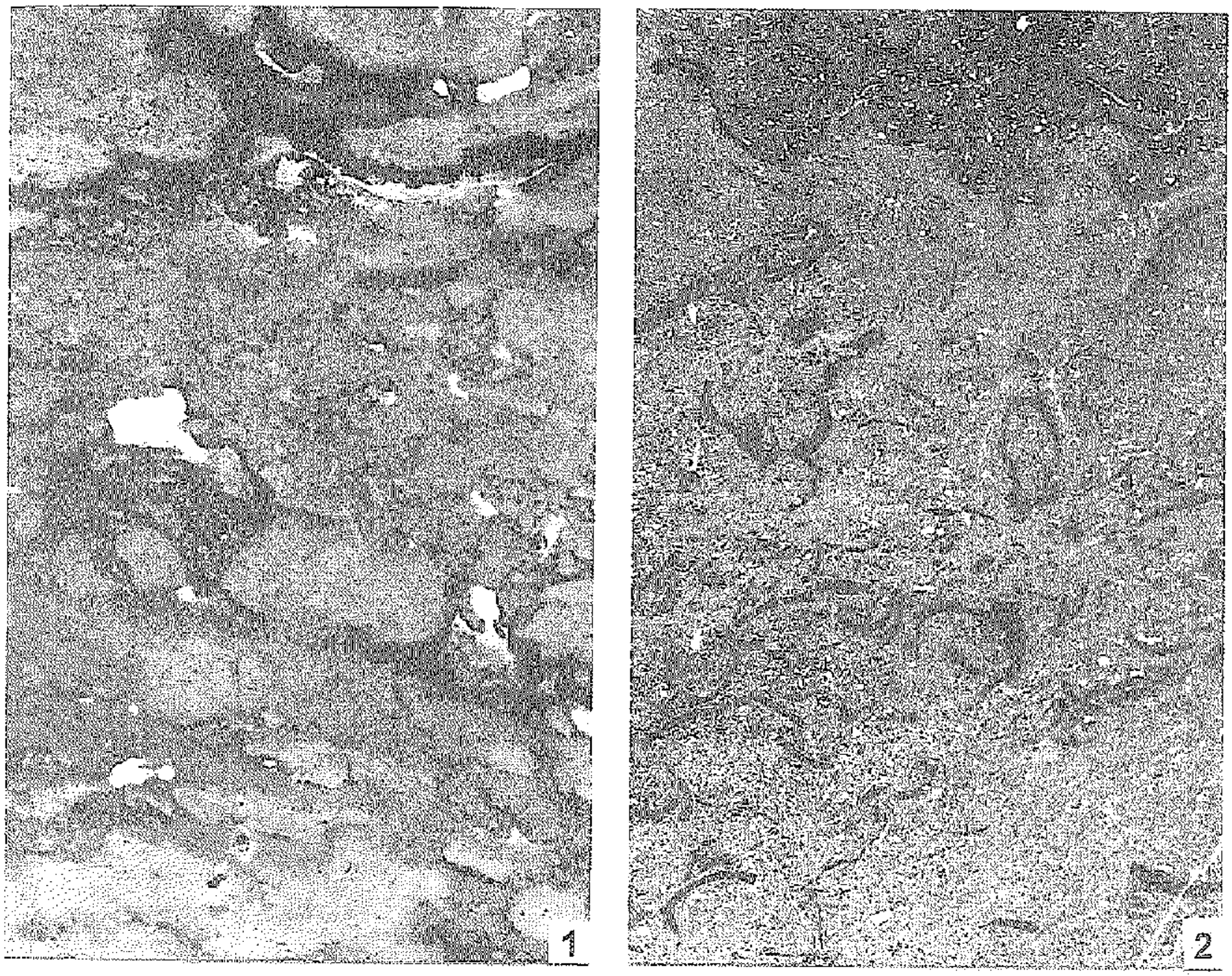
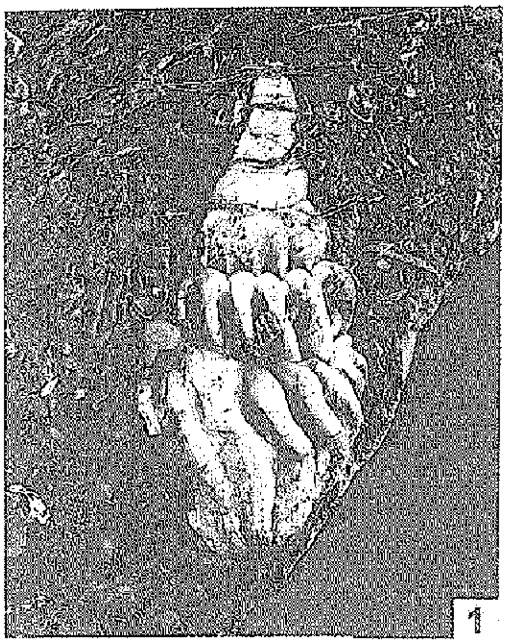
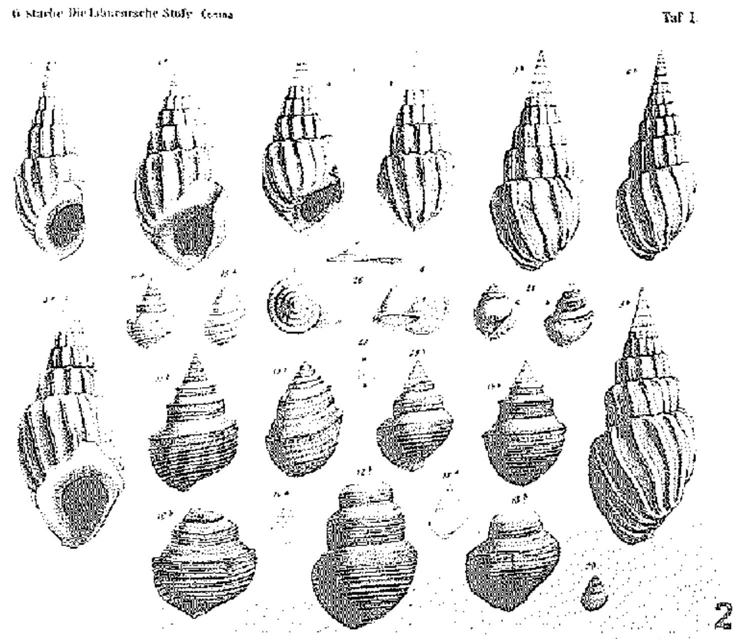


TABLA 3 - PLATE 3





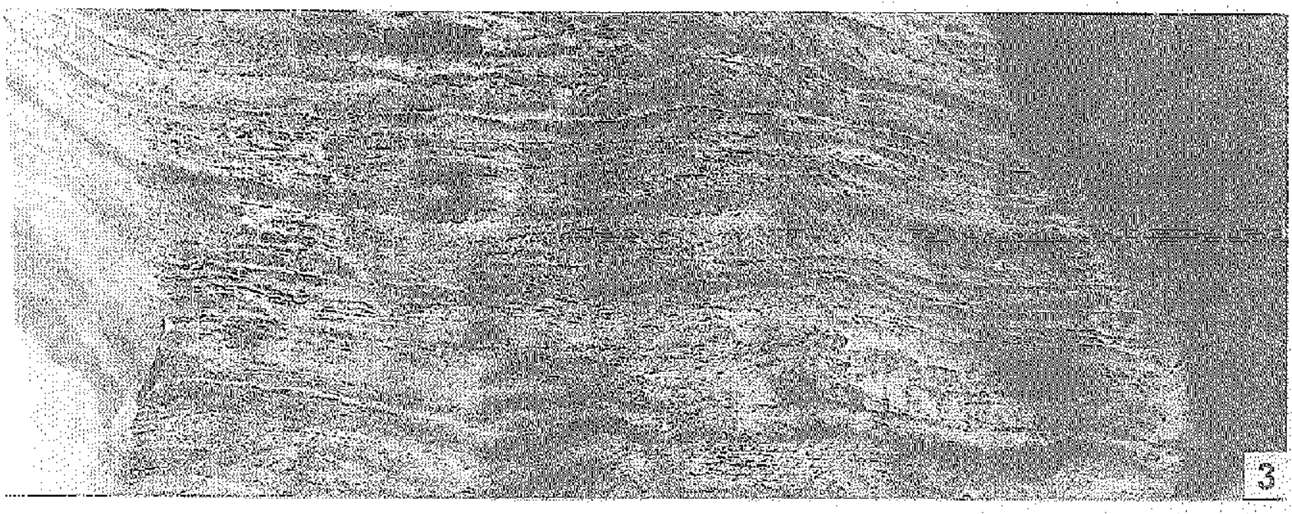


TABLA 4 - PLATE 4

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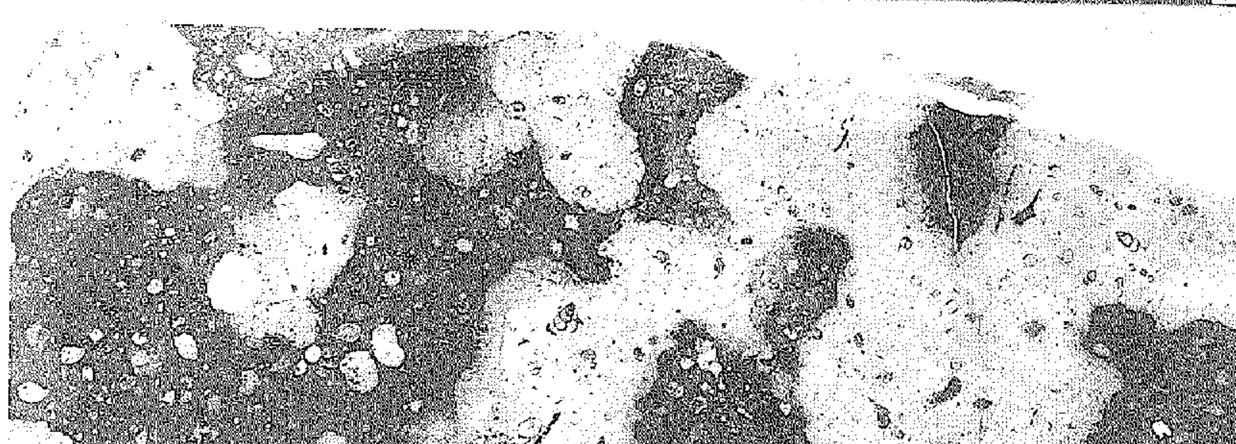

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TABLA 5 - PLATE 5

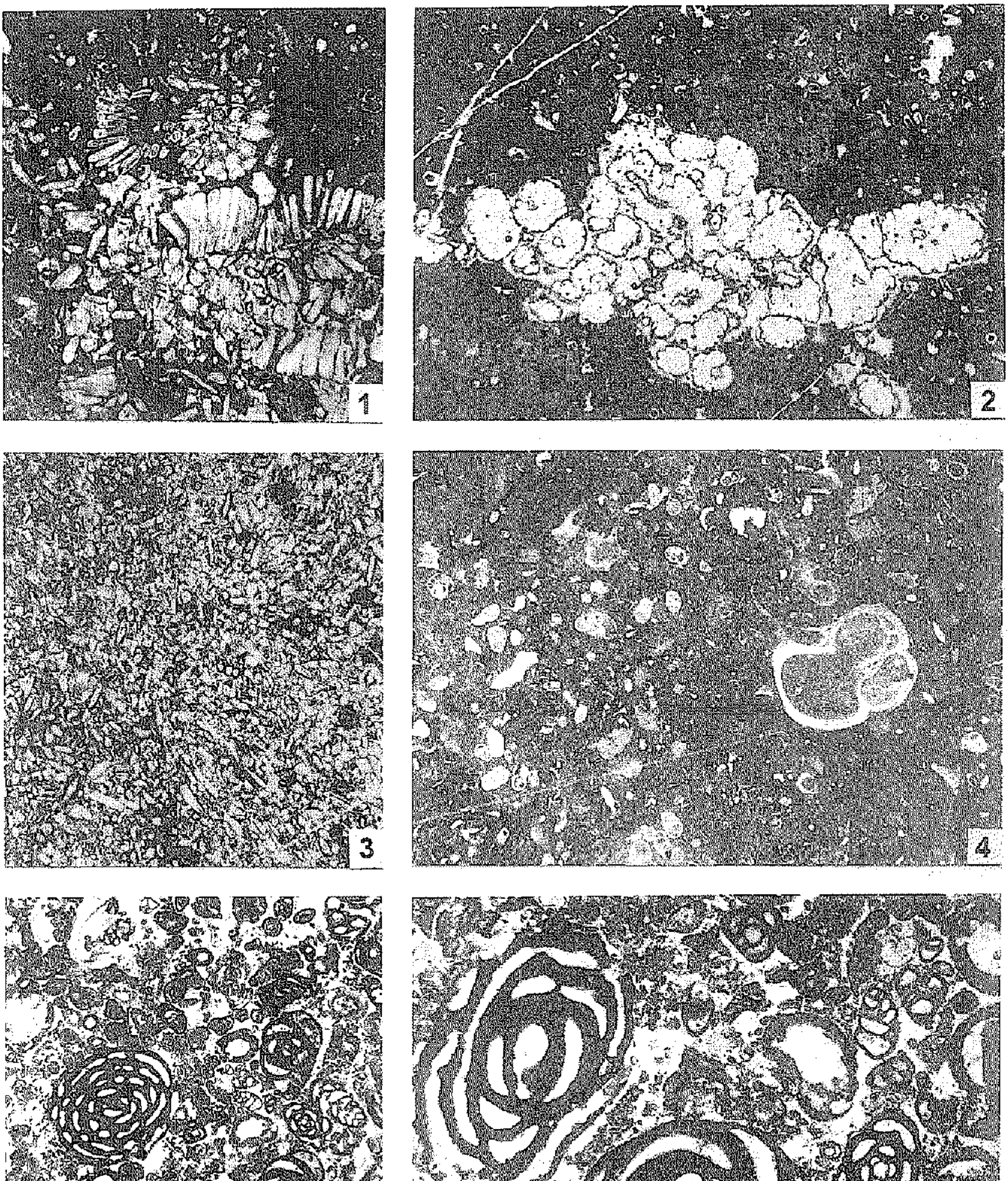

TABLA 6 - PLATE 6

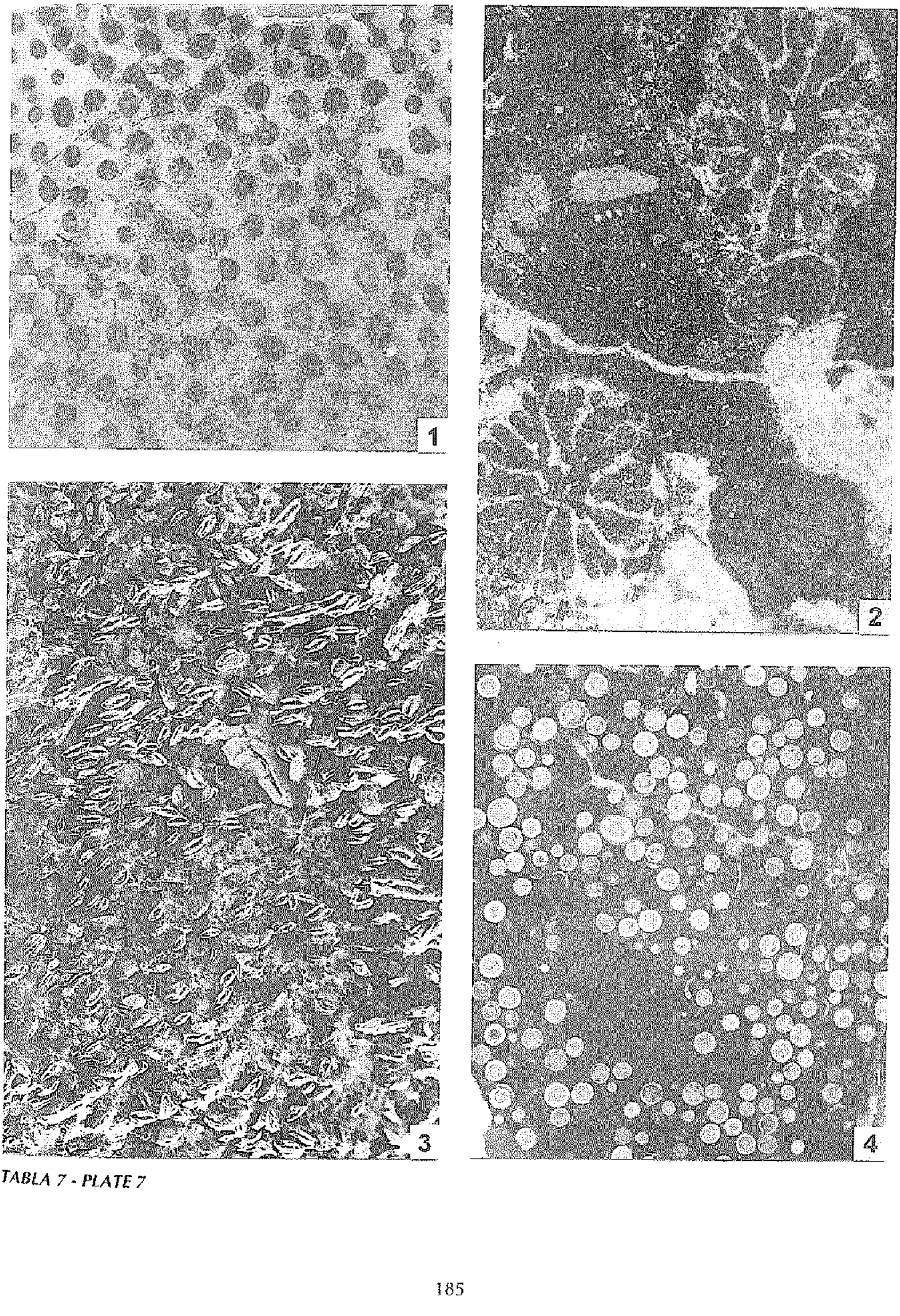

TABLA 7 - PLATE 7

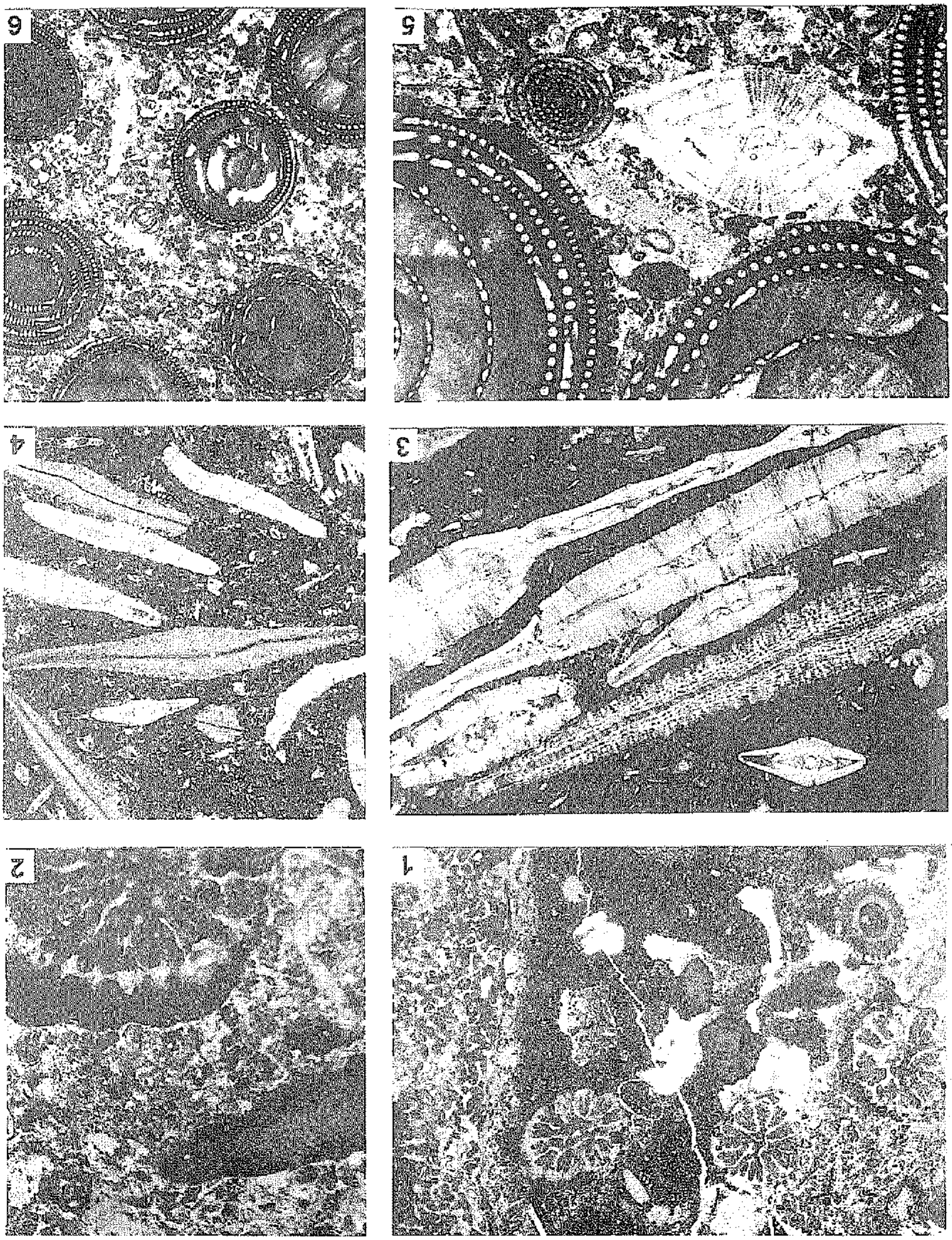

TABLA 8 - PLATE 8

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RECONSTRUCTION OF PALEOENVIRONMENT IN THE BAY OF KOPER (GULF OF TRIESTE, NORTHERN ADRIATIC)

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ABSTRACT

Geomorphologically, the Bay of Koper (Gulf of Trieste, northern Adriatic) is a wide submerged valley of the Rižana river. Five boreholes drilled in the inner part of the Bay of Koper were used to reconstruct the paleoenvironment of the Bay in the Holocene. These changes are clearly related to the global changes of sea level. The cross-section of the Holocene sediment in the Bay indicates that the early Holocene - late Glacial sediment, dated to about 10-11000 years BP, occurred in the southern part of the Bay when the sea started to enter the Rižana valley. When the southern part of the valley was submerged, the eastern part was still influenced by the Rižana fluvial deposits. Marine sedimentation prevailed over fluvial sedimentation at depth of 26 m during the most intensive sea transgression. Studied boreholes also indicate simultaneous sea level rise and sedimentation process in the Bay during the Holocene. These data are in accordance with the general of sea-level rise in the northern Adriatic in Holocene.

Key words: recent sediment, paleoenvironment, Bay of Koper, Gulf of Trieste, Adriatic Sea

INTRODUCTION

The Bay of Koper covers about 35 km^2 and is, as a component of the larger Gulf of Trieste, the northernmost part of the Mediterranean. Geomorphologically, it is a submerged Rižana valley. At present it is a wide submarine plateau up to 20 m deep which is, according to the data obtained from some boreholes in the Port of Koper and its vicinity, composed of a few tens of meters of Quaternary sediment (Ogorelec *et al.*, 1988). Towards the west, *i.e.* along the Izola - Debeli rtič line, the Bay grades towards the open part of the Gulf of Trieste (Fig. 1). There, recent Quaternary sediment reaches, according to the seismic data obtained by Italian researchers, thickness of up to 230 meters (Rossi *et al.*, 1968). In spite of the riverine inflows of the Rižana river and the Badaševica stream, the Bay of Koper is quite closed, with fairly limited water circulation. The boundary between oxidation and reduction sedimentary environments is located in surficial sediment a few millimeters below the surface. Study of the bottom relief has shown that Koper Bay has a fairly steep coast which, however, at depths between 5 and 10 meters quickly grades into a very gently sloping underwater plain. The coast is composed of Eocene flysch layers with characteristically alternating solid sandstone and soft marl. The flysch coast gives to the Bay its characteristic form, particularly between Izola and Koper, at Cape Ronek and between Valdoltra and Debeli rtič. The coast is gentle only between Koper and Ankaran.

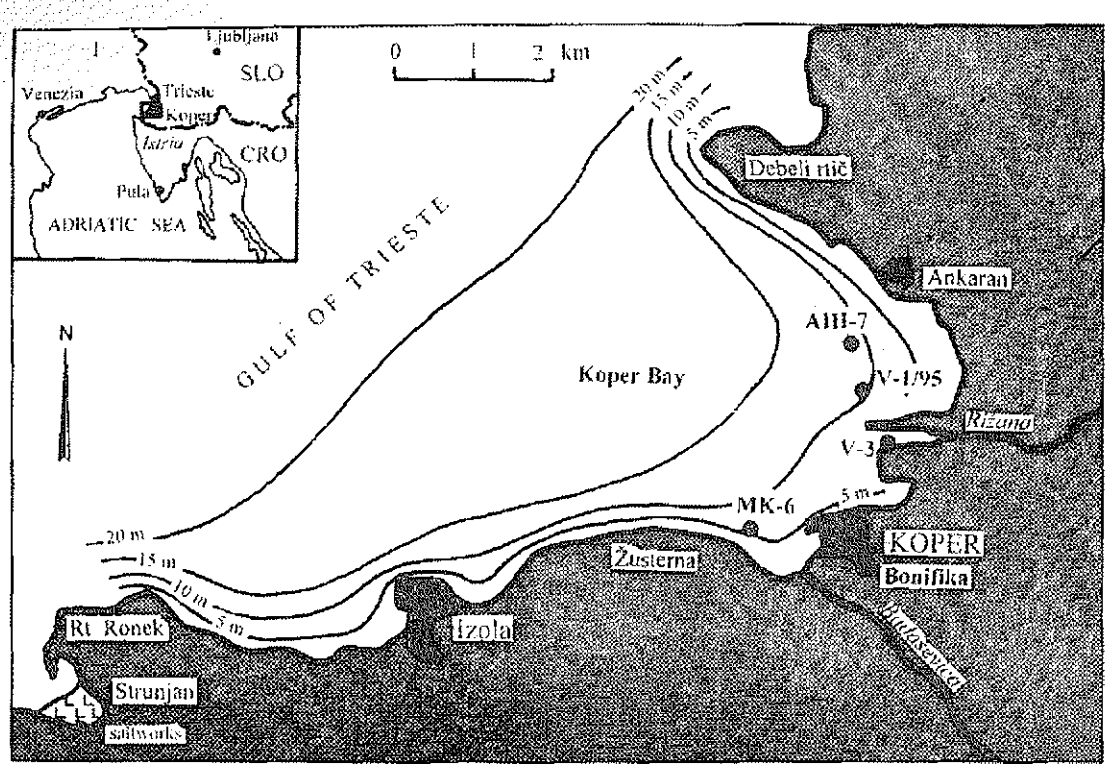

Fig. 1: Bathymetry and the position of studied boreholes in the Bay of Koper (Gulf of Trieste, northern Adriatic).
Sl. 1: Koprski zaliv: batimetrija in lokacije raziskanih vrtin.

Characteristic of the Bay are low winter (averaging 8 °C in February) and rather high summer water temperatures (averaging 24 °C in July). In late autumn and during winter, isothermia takes place. Shalowness, the mixing of water due to the strong winds (especially the so-called bora), and sediment resuspension caused by maritime traffic are the reasons for the high turbidity of these coastal waters. The concentration of suspended matter in the sea water column ranges between 1 and 18 mg/l and on average 60% is inorganic (Ogorelec *et al.*, 1991). Greater amount of suspended matter has been noted in the Rižana river mouth and this has been also confirmed by lower Secchi disc visibility. In the Rižana river mouth it reaches a depth of about 3 meters and in the central part of Koper Bay between 8 and 10 meters.

Recently, through multidisciplinary and systematic research carried out by geologists from the Geological Survey Ljubljana, chemists and biologists from the Marine Biological Station Piran and Jožef Stefan Institute Ljubljana, and paleontologists from the Research Center of the Slovene Academy of Sciences and Arts Ljubljana, we have obtained a fairly clear picture on the composition of the marine sediment in the southern (Slovene) part of the Gulf of Trieste (northern Adriatic). This study initially covered the Sečovlje saltwotks (Ogorelec *et al.*, 1981), successively the sediment of the Koper Bay (Ogorelec *et al.*, 1987), the open part of the Gulf of Trieste (Ogorelec *et al.*, 1991; Faganeli *et al.*, 1991), and a boreholes in Koper Bay (Ogorelec *et al.*, 1984; Faganeli *et al.*, 1987; Faganeli *et al.*, 1991). The sediment of Piran Bay was studied in detail by Ranke (1976) in the early 70's. These studies also implemented previous geographical and archaeological studies of the Slovene sea, its coast and Šavrinsko Primorje in the hinterland (Žumer, 1984; Kozličić, 1984; Župančič, 1986; Šegota & Filipčić, 1991).

The aim of this paper is to present a reconstruction of the paleoenvironment in the Bay of Koper through the latest geological period as well as the basic characteristic of marine sediment and the processes occurring in it. This description is particularly important for the appropriate study of sedimentary biogeochemical processes and pollution. Sampling and analytical methods are described elsewhere (Ogorelec *et al.*, 1987; 1991; Faganeli *et al.*, 1987; 1991).

SURFICIAL SEDIMENT OF THE BAY OF KOPER

Considering the grain size distribution, mineral composition and carbonate content the surficial sediment of the Bay of Koper can be divided into three distinct zones (Fig. 2): coastal sediment (zone A), sediment of the inner part (zone B), and sediment of the open part of the Bay (zone C). Along the coast there is a strip ranging from a few tens of meters to 300 meters large (zone A) com-

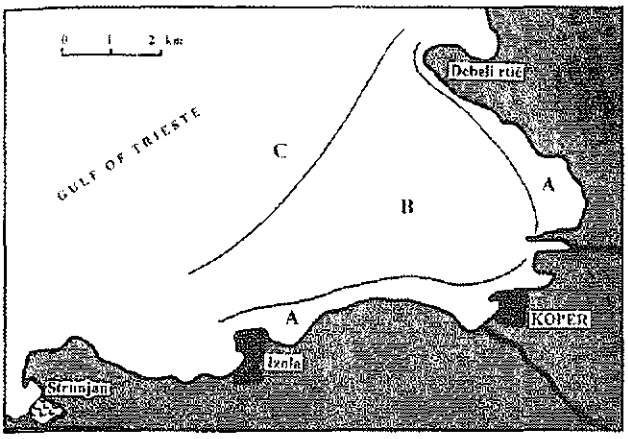

Fig. 2: Zonation of surficial sediment in the Bay of Koper. A - Coastal sediment, B - sediment of the inner part of the Bay, C - sediment of the open part of the Bay.
Sl. 2: Porazdelitev con površinskega sedimenta Koprskega zaliva: A - obrežni sediment, B - sediment notranjega dela zaliva, C - sediment odprtega dela zaliva.

posed of dark gray - green silt and sandy silt with up to 40% of sand and with less than 15% of clay (below 2 µm). The mean grain size ranges between 0.05 and 0.1 mm, while the contents of carbonates, composed of calcite, dolomite and shells of various organisms, are between 20 and 30%. The distribution of the clay in zone A is conditioned by the wave motion along the coast and its transportation to somewhat deeper and calmer parts of the Bay. Sand (above 63 µm) is composed of lithic fragments of coastal flysch rocks, shells of various organisms (shellfish, mollusks, foraminifers, sea urchins, and others), seagrass, wood, small tars of bitumen and, to a lesser extent, particles of anthropogenic origin (brick, glass, plastic, concrete, *etc.*).

In the inner part of the Bay (zone B, Fig. 2), including the majority of the Bay below the sea water depth of about 5 meters, the sediment becomes finer and more homogenous. The sediment is clayey silt with up to 40% of clay and up to 3% of sand. Its mean grain size is below 0.1 mm, while the carbonate content reaches about 30%. Towards the western part of the Bay the carbonate content increases. Here, in coarse fraction shells and skeletons of various organisms also prevail.

Towards the open part of the Bay (zone C, Fig. 2) the sediment is coarser (about 20% of sand with grains above 63 µm) because of lower contents of the clay component reaching less than 15%. Its mean grain size ranges between 10 and 40 µm, and the carbonate content between 30 and 45%. The high carbonate content is closely associated with numerous particles of organic skeletons. Clay is partially rewashed by the current flowing between Izola and Debeli rtič.

Mineralogically, the entire Koper Bay belongs to a uniform "mineral province", from where the minerals originate. This is the result of the input of particles originating from run-off mostly from the Rižana river, and erosion of the coast, built of flysch layers of Šavrinsko Primorje and Cretaceous-Paleogenic limestones of the Western Čičarija. The most abundant minerals in the recent sediment of Koper Bay are quartz and calcite. Quartz is present in all fractions, its content ranges from 20 to 35% and originates from flysch sandstones and marls. Also, calcite is mostly of terrigenous origin but its rather large part is associated with organic skeletons. Dolomite, as the second carbonate mineral, is much less common reaching only about 5%. Clay is composed of illite, chlorite and illite/montmorillonite, the latter as a mineral with mixed composition. In the central part of the Bay the total content of clay minerals reaches about 30%. Among authigenic minerals, pyrite should be mentioned together with calcite and organic skeletons. Pyrite is formed in the anoxic environment below the sediment-water interface by anoxic degradation of sedimentary organic matter. It occurs in up to 0.2 mm large framboids and its content is estimated at below 3%.

The organic carbon content in the surficial 5 cm sediment layer ranges between 0.5 and 2.7% averaging about 1.5%. Higher Corg. contents are found in fine clayey silt in the central part of the Bay, but lower (1.5%) in coarse sediment at the Bay entrance, and in the area along the shore (0.5%) influenced by tides and sediment resuspension. The sedimentary organic matter, deduced from the δ^{13}Corg. values, originates in the central part of the Bay from plankton and benthic microalgae ($\delta^{13}C$= -21‰., Faganeli*et al.*, 1991) while in the near shore area it has a significant imprint from macrophytes ($\delta^{13}C$= -18‰, Faganeli*et al.*, 1997).

The pollution of surficial sediment with heavy metals has been established using the results of geochemical analyses of samples from short cores at selected locations (Ogorelec *et al.*, 1987; Faganeli *et al.*, 1991). Concentrations of heavy metals in 30-40 cm long cores exhibit small variations and sometimes lower metal contents have been noted in the surficial 5 cm layer of sediment than below. This can be explained by the sediment resuspension, and homogenization as a result of the bioturbation processes mostly by polychaets and bivalves. The areal distribution of heavy metals is also more or less uniform. This is especially evident in copper, cobalt, arsenic and antimony distribution, while some small differences have been noted for zinc, lead and mercury. Zinc and lead, as pollution indicators, are slightly more concentrated in the inner part of the Bay, while mercury inversely shows increased concentrations towards the open part of the Bay. The higher mercury concentrations in the open part of the Bay are associated with the vicinity of the Soča river inflow which is the main source of mercury into the Gulf of Trieste, in spite of the fact that the Idrija mine has been closed for nearly 20 years. The average heavy metal contents in surficial sediments of the Bay of Koper are (Ogorelec *et al.*, 1987, Faganeli *et al.*, 1991): As 12 ppm, Hg 0.12 ppm, Cd 0.15 ppm, Mn 450 ppm, Co 10 ppm, Ni 100 ppm, Cr 160 ppm, Pb 45 ppm, Cu 30 ppm, Sb 0.3 ppm, Fe 3.15% and Zn 75 ppm. The heavy metal content in the surficial sediments of Koper Bay appears in general to be similar to that established in the unpolluted marine sediments. These values can be compared with the values from subsurficial layers of the 43 m deep borehole MK-6 in the Bay of Koper (Fig. 1, Faganeli *et al.*, 1991) and 40 m deep borehole V-6 in the Sečovlje saltworks (Ogorelec *et al.*, 1981), which could be considered as the natural geochemical background values for the eastern part of the Gulf of Trieste. Only the differences in the mercury content are noteworthy due to the greater distance from the Soča river outflow. The results show that the sediment of the Bay of Koper is not severely contaminated by heavy metals despite evident cultural impact. This would indicate that the sediment in the Bay is not a successful geochemical sink for pollutants as was also recently observed for areal distribution of PAH (Faganeli *et al.*, 1997).

THE STUDIED BOREHOLES

The sediment below the surface in the inner part of Koper Bay was studied using several boreholes (Ogorelec *et al.*, 1984, 1991; Faganeli *et al.*, 1987, 1991). These boreholes were located in the cargo port of Koper: (V-3, 41 m deep, at a depth of 4.5 m), in the ferry port (V-1/95, 45 deep, at a depth of 12 m), 200 metres off Žusterna (MK-6, 43 m deep, at a depth of 7 m), at Bonifika (24 m, on land), at the old Koper railway station (V-3/97, 28 deep, on land) and off Ankaran (A III-7, 20 m deep, at a depth of 13 m). The described locations are shown in Fig. 1. Boreholes Bonifika, V-1/95 and A III-7 are described in this paper for the first time.

Boreholes V-3 and V-1/95, drilled off port of Koper near the outflow of the Rižana river, reached the flysch basement at depths of approximately 40 and 50 meters, respectively. The cores can be divided into two parts (Figs. 3 and 8). The bottom 20 and 24 m, respectively, represent the alluvial deposit of the Rižana river with alternating layers of sand, silt and gravel. In borehole V-1/95 two thinner horizons of dark clayey silt with numerous organic particles appear at depths of 41 and 43 m below the present sea level, respectively, which are most probably the remains of a peat bog. They actually represent a paleomarsh environment at the former mouth of the Rižana river. A similar "peat" horizon was also noted in borehole V-6 drilled in the Sečovlje saltworks at a depth of 26.5 m (Ogorelec *et al.*, 1981). The upper 19 and 25 m of the sediment, respectively, which had been deposited in the marine environment consists of dark gray silt with uniform grain size and mineral composition. It contains many foraminifers, shells, mollusks and fragments of sea urchin remains. The mineral composition of marine deposit consists of quartz, calcite, illite, chlorite, illite/montmorillonite, feldspars, dolomite and pyrite while in fluvial deposit pyrite is absent. Vertical distribution of Corg. contents in the marine sequence of borehole V-3 exhibits higher values (1-1.6%) than in fluvial and brackish (<1%) probably because of lower biological productivity in these environments compared to marine, and lower sorption of organic matter on coarse fluvial particles (Hedges & Keil, 1995).

In borehole MK-6, drilled in the location of the planned Koper marina off Žusterna, no alluvial deposit has been noted. The sediment is approximately homogeneous composed of gray clayey silt with mean grain size below 10 μm, similar to that appearing in the surface of the central part of Koper Bay. It contains several fossil remains, particularly foraminifers, mollusks and ostracods. On the basis of foraminiferal species Cimerman *(pers. comm.)* concluded that the horizon between 26 and 36 m below the surface was deposited in a brackish environment (Fig. 8). The mineral composition is throughout rather uniform consisting predominantly of illite, chlorite, illite/montmorillonite, quartz, calcite, feldspars, dolomite and pyrite. Vertical distribution of Corg. contents showed higher values (1-2%) in the marine sequence, and lower (<1%) in the brackish sequence of the core. The δ^{13}Corg. values in the marine sequence varied between -20 and -24‰ while in the brackish sequence the δ^{13}Corg. values were lower (-26‰).

The borehole Bonifika (Fig. 4 and 8), drilled in the area between the new Koper commercial center and the sports center, reached a homogeneous orange-brown flysch mould at a depth of 12 m, and at a depth of 24 m a compact flysch basement. Down to the depth of 12 m the sediment is homogeneous dark gray silt containing remains of various shellfish, mollusks, echinoderms, foraminifers and ostracods. Occasionally, there are present various tiny mollusks of the species *Bittium reticulatum*, e.g. at a depth of 2 m where they represent up to 60% of the fraction above 63 μm, and *Barleeera rubba*, and a shellfish *Cardium* sp. On the basis of ostracod and foraminiferal species, Cimerman *(pers. comm.)* described the alternation of marine and brackish environments. In the marine deposit the clay minerals, e.g. illite, chlorite and illite/montmorillonite prevail over quartz, calcite, feldspars and dolomite. The authigenic mineral is pyrite. The residual clay is, on the other hand, composed of illite and illite/montmorillonite, chlorite, quartz, feldspars and calcite while dolomite and pyrite are absent. Vertical distribution of Corg. contents shows values around 1.5% (1-3%) in the marine sequence while in the alternating brackish and marine environment the Corg. contents varied between 0.5 and 1.8%, respectively.

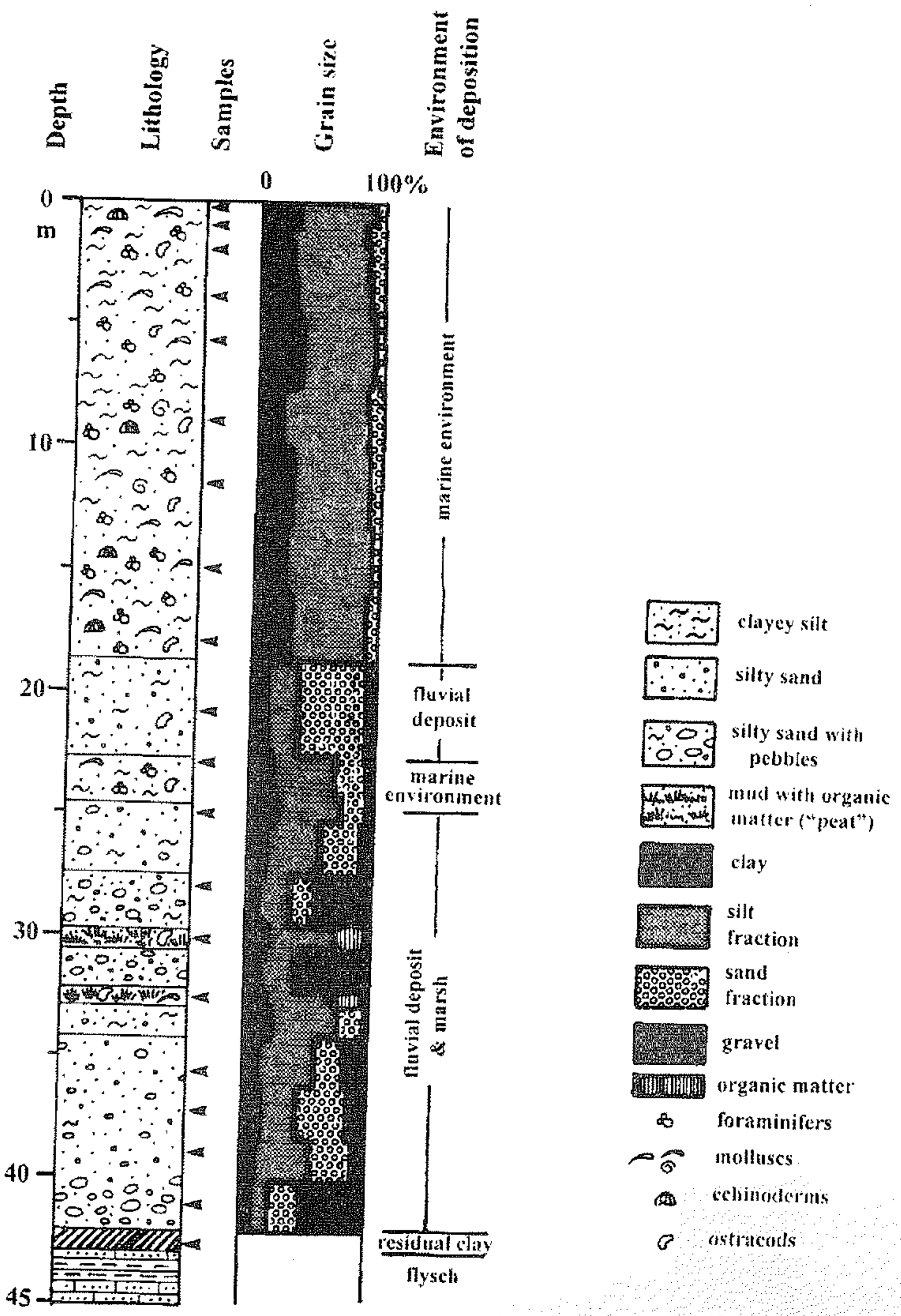

Fig. 3: Borehole V-1/95: lithological succession and grain size distribution.
Sl. 3: Litologija in zrnavost sedimenta vrtine V-1/95 v Koprski luki.

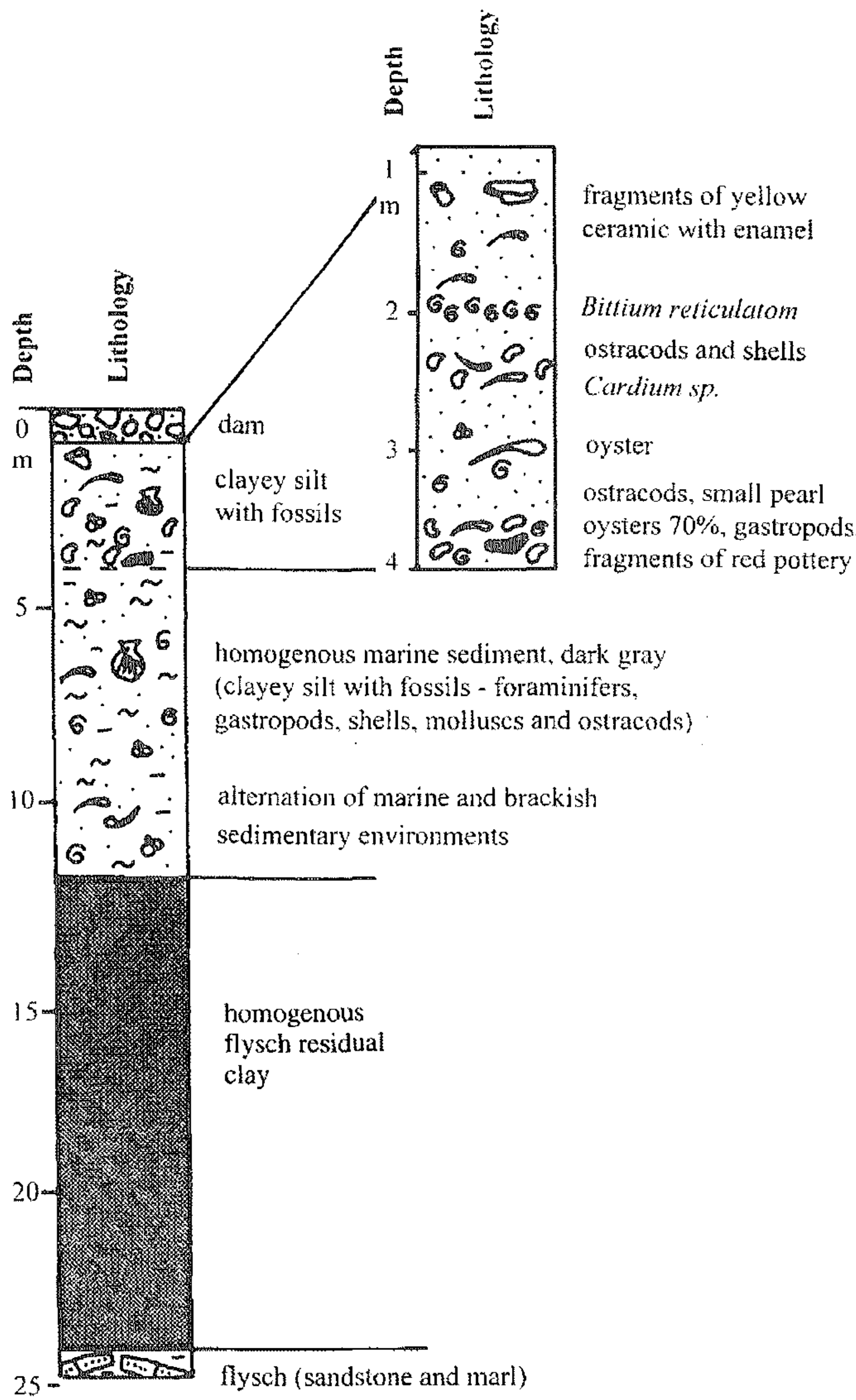

Fig. 4: Borehole Bonifika: lithological succession.
Sl. 4: Litologija vrtine Bonifika v Kopru.

In borehole A III-7 (Fig. 8), drilled in the sea bottom off Ankaran at a depth of 13 m for geomechanical purposes due to the planned expansion of the Port of Koper, the flysch mould was reached at a depth of 17 m. The sediment above the flysch mould is thoroughly homogeneous, *i.e.* dark gray silt with mean grain size around 10 µm. The clay content ranges between 24 and 38% and the content of the fraction above 63 µm ranges between 2 and 6.5%. This fraction consists mainly of mollusks and foraminifers. The mineral composition shows that the clay minerals, *e.g.* illite, illite/montmorillonite and chlorite, prevail over calcite, quartz and dolomite. Detrital grains of quartz and particles originating from coastal flysch layers are rare. Pyrite and part of calcite are authigenic minerals. The carbonate contents range between 25 and 36%.

RECONSTRUCTION OF PALEOENVIRONMENT OF THE BAY OF KOPER

Various historical sources clearly indicate that the coastline of Koper Bay was in the past very different than at present. The "embryo" of the town of Koper was the ancient settlement of Formio, in the Late Roman period known as Caprae (Šašel, 1989). At the end of the Middle Age it was a well formed town, densely populated, located on an islet and connected with the mainland by an artificial causeway (Fig. 5). At the edge of the eastern part of the Bay the Venetians constructed numerous small salt-pans in the 17th and 18th centuries, similar to those in Piran Bay near Sečovlje, and Strunjan (Fig. 6). In the mid-nineteenth century the salt-pans were abandoned as a result of the expansion of farmland.

Studying the described boreholes enable us to reconstruct the relief and sedimentation environment in Koper Bay through a longer geological history from the late Pleistocene to the Holocene. These conditions, however, are closely related to the relative global rise of the sea level. The most widely used dating method to establish the rate of sea level rise in the last postglacial period is ^{14}C analysis of samples and sediment from various depths. Especially appropriate for this purpose are the layers rich with organic matter (*e.g.* peat) and fossils. Peat layers were presumably formed in marshy plains at the mouths of former rivers and would therefore represent an approximate level of the sea in the past. The other, although less accurate but still widely used method in paleoenvironmental research, is the so-called palynological method based on the study of pollen. Studying the structure and association of pollen, a picture of vegetation and climate in a certain period can be deduced. Particularly important are the data from the pollen of agricultural plants, such as olive tree and grape in Istria, and maize in the most recent period, which could indicate the nature of human settlement in various places.

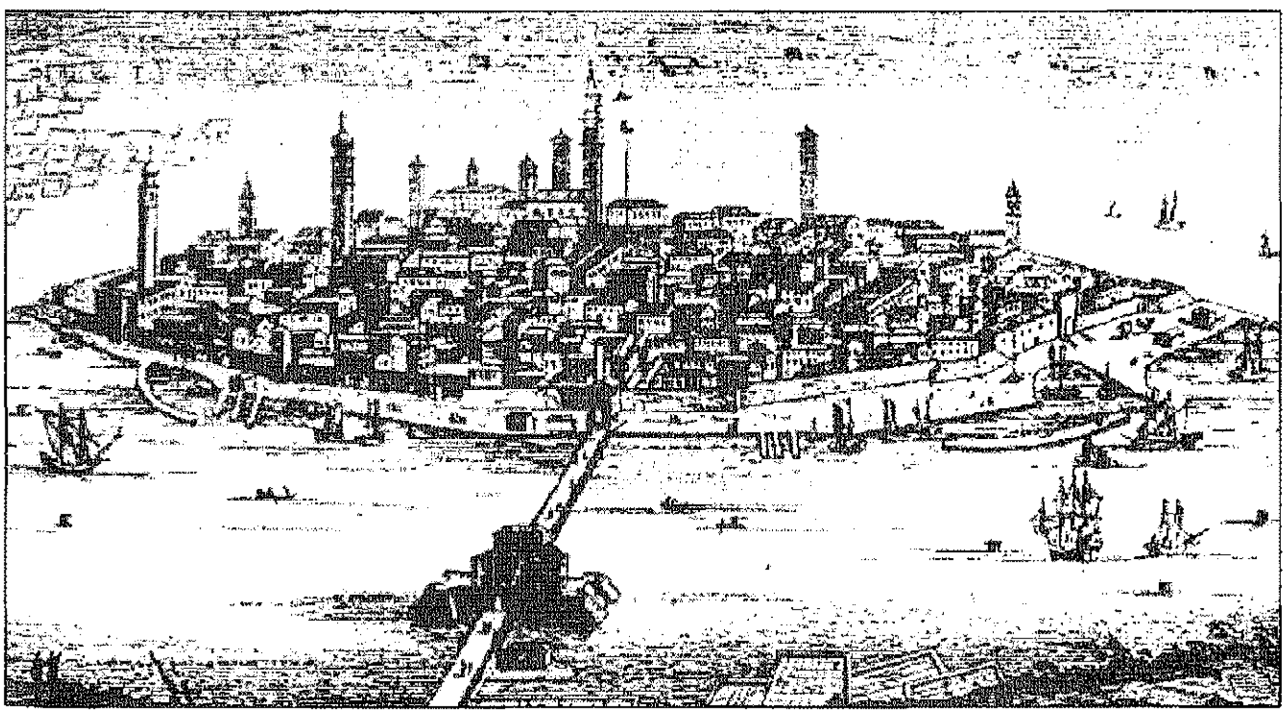

Fig. 5: View of the 18th century town of Koper.
Sl. 5: Panorama Kopra v 18. stoletju.

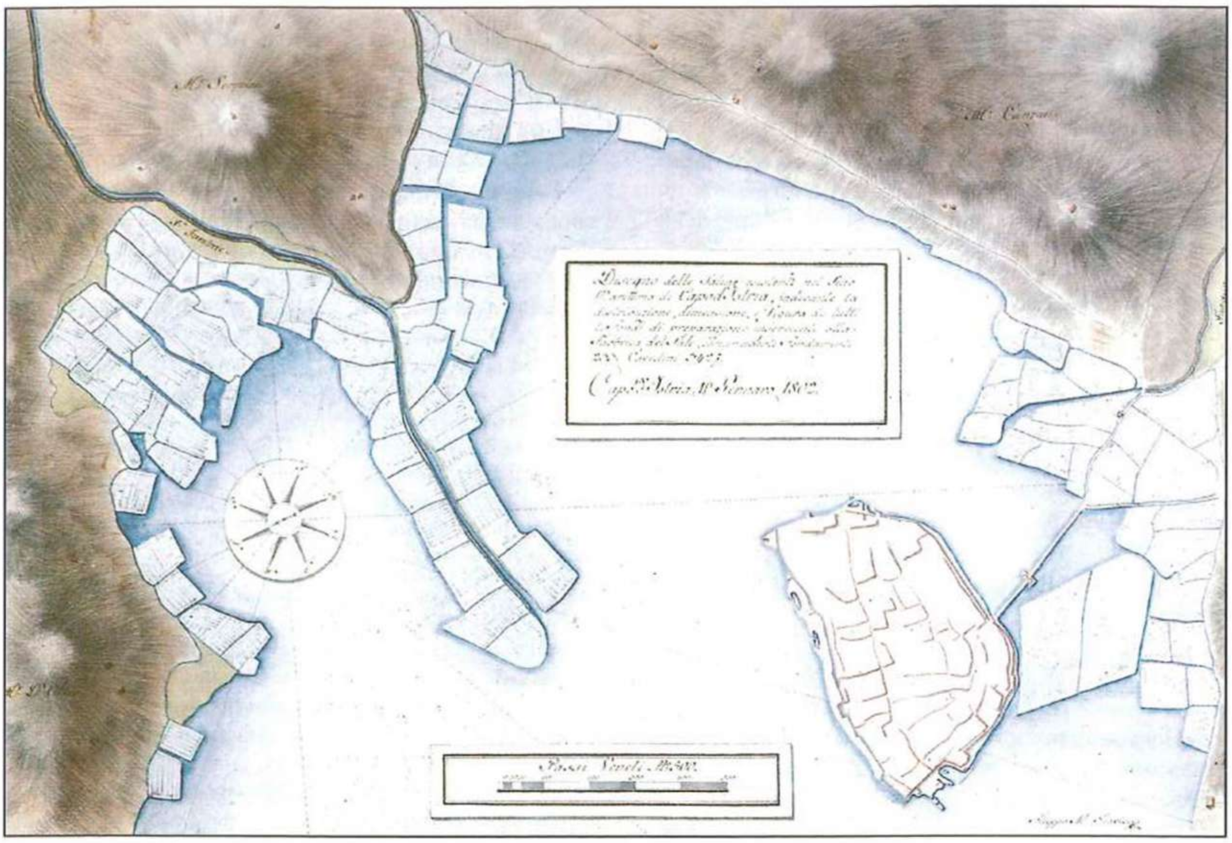

Fig. 6: Map of the inner part of the Bay of Koper with a view of saltworks from 1809 (Šašel, 1989).
Sl. 6: Zemljevid notranjega dela Koprskega zaliva iz leta 1809, na katerem so vidne številne soline (Šašel, 1989).

The problem of sea level changes in the Holocene has been intensively studied by a number of researchers: on the eastern Adriatic coast and Istria by Šegota (1968, 1973), Kozličić (1987), and Šegota & Filipčić (1991), on the Italian side of the northern Adriatic by Bortolami *et al.* (1977), Fontes & Bortolami (1973), Marocco (1989, 1991), Marocco *et al.* (1984), Tosi (1994) and recently by Correggiari *et al.* (1996), Marocco *et al.* (1996) and Bondesan *et al.* 1985). Their findings are consistent with the general curve of the global rising of the sea level, constructed on the basis of the ^{14}C dating and Th/U relations (Fairbanks, 1989, 1990). This curve (Fig. 7) indicates that 18000 years ago, during the sea transgression after the last glacial period, the relative sea level was about 120 m lower than at present. The Adriatic Sea located north of the Ancona - Zadar line was thus land (van Straaten, 1970). The rise of the sea level was initially relatively fast, the sea surface rose by 10 and even more meters in 1000 years. Some 5000 years ago, however, the rate of rise slowed considerably and in the last 2000 years the sea level has risen only another 2 meters, on average 1 mm yr^{-1}. The data obtained by Šegota & Filipčić (1991) and Kozličić (1987) are also quite consistent with the extrapolation of mareographical data from Pula (D'Ambrosi, 1951). The extension of the northern Adriatic Sea was the largest some 5000 years ago. In that time the Venice, Caorle and Grado lagoons were submerged by the sea (Marocco, 1991; Marocco *et al.*, 1996; Correggiari *et al.*, 1996).

Fig. 8 shows a cross-section of the Holocene sediment in the inner part of Koper Bay on the basis of five studied boreholes. The Bonifika borehole was drilled on land, the others at sea at different depths, ranging between 4.5 and 13 m. The sea level should be, therefore, taken into account to correctly correlate these boreholes. The MK-6 borehole is, however, not located south of the others, *e.g.* Bonifika (see the position of boreholes in Fig. 1), but westward in the open part of the Bay distorting the topographical view of the sea floor in the area around the town of Koper. The deepest and the oldest Holocene sediment in the inner part of Koper Bay was found in the borehole MK-6 off Žusterna at a depth of 48 m below the present sea level. This was expected since this borehole is the nearest to the open part of the Gulf of Trieste, from where the sea entered into the Bay. This occurred some 10 to 11 thousand years ago, when the sea began to advance quickly towards the Po plain and further north. This dating was per-

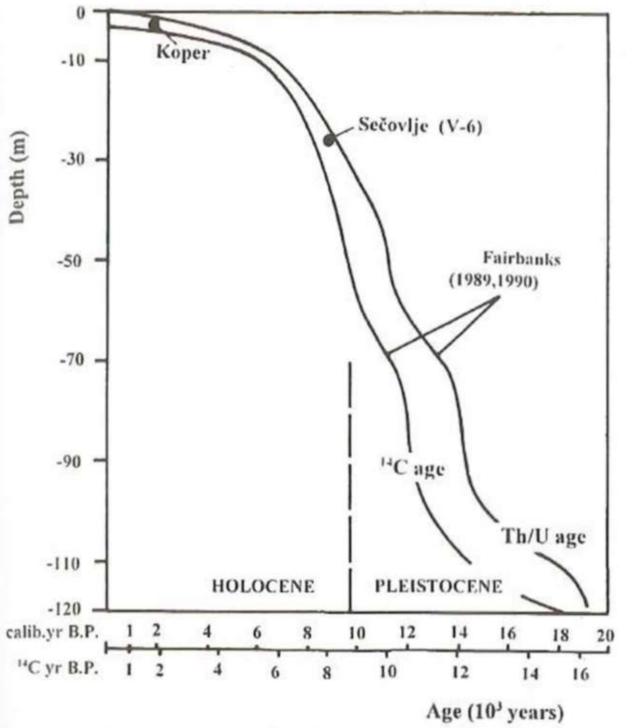

Fig. 7: Curve of sea level in the last 20000 years (Fairbanks, 1991; Correggiari** et al.**, 1996); ^{14}C of wood in peat layer from the borehole V-6 (Sečovlje saltworks) and pelecypods in Koper town wall are added for comparison.

Sl. 7: Krivulja gibanja morske gladine v zadnjih 20000 letih (Fairbanks, 1989, Correggiari** et al.**, 1996 1990); za primerjavo sta dodana vzorca lesa iz plasti šote iz vrtine V-6 v Sečoveljskih solinah in školjk pod mestnim obzidjem v Kopru izmerjena z metodo ^{14}C.

formed on the basis of the sea level curve movement (Fig. 7, Fairbanks, 1990) and the reconstruction of the movement of the Adriatic Sea in the late Quaternary (Correggiari *et al.*, 1996). In the period when the southern part of Koper Bay was already submerged by the sea, the inner (eastern) part of the Koper depression was filled up by fluvial sediments from the Rižana river inflow. This deposit is observable in layers of thick gravel (Fig. 3, borehole V-1/95, and Fig. 8), clayey sand and fine gravel. The thinner, some 0.5 m thick horizons of clayey silt rich in organic matter ("peat'), which in borehole V-1/95 occur at depths of 41 and 43 m below the present sea level, respectively, indicate the presence of episodical marshy areas in the Rižana river mouth

The most intensive sea transgression in the Bay was noted at a depth of 26 m. At that time the marine environment completely prevailed over the fluvial and brackish environment. This depth is completely in accordance with the "peat" layer in the V-6 borehole, which was, according to ^{14}C analysis, dated to 9180±120 years BP (Ogorelec *et al.*, 1981). In the same period, i.e. in the same sea level, when in the V-3 borehole, fluvial sedimentation changes into marine sedimentation, the sediment of the brackish environment in the MK-6 borehole also changes into marine environment. The area covered by Bonifika and Koper islet was at that time still a part of the land.

From a depth of 26 m upward, measured to the present sea level, only finely grained and homogenous clayey silt occurs over the entire Koper Bay. The numerous fossil skeletons, particularly shellfish and foraminifers indicate the marine sedimentation in this layer. This depth temporally corresponds to about 9000 years BP when the general sea transgression occurred during the transition from the late Glacial to Holocene. On the basis of sediment thickness and ^{14}C datings we can determine the approximate sedimentation rate in Koper Bay. For thicker sediments it ranges, on average, between 4 and 2.5 mm yr^{-1} and for upper meters of the sediment between 1.5 and 1 mm yr^{-1}. Assuming, in view of the general global rising of sea level (Fig. 7), that the sea transgression in the inner part of Koper Bay started on the flysch basement at a depth of 47 m (borehole MK-6) more than 10000 years ago, the sedimentation rate would then be approx. 4 mm yr^{-1}. For the upper 21 m of marine sediment the rate would be about 2.2 mm yr^{-1}. The rate from the borehole V-6 in the Sečovlje saltworks, measured on the basis of ^{14}C analysis of piece of wood in the "peat" layer, shows for the sediment depth of 26.5 m an average sedimentation rate of 3 mm yr^{-1}. The sedimentation rates calculated in the port of Koper (boreholes V-3 and V-1/95) range between 2.5 mm yr^{-1} for the upper marine part, and about 4 mm yr^{-1} for the whole (fluvial and marine) sediment. This difference is due to the faster sedimentation of the basin with more coarse riverine deposits than with pelitic marine sediment. The rate of 2.5 mm yr^{-1} is obtained if 22 m of the marine sediment is considered and the depth of the fluvial-marine sediment contact is located at a depth of 26 m below the present sea level and dated approximately to 9000 years BP. Similar accumulation rates, betwen 2 and 6 mm yr^{-1}, were reported by Marocco (1991) for sediments in the Tagliamento delta.

A somewhat slower sedimentation rate in the last 2000 years in the Bay of Koper is confirmed by isotopic datings and archaeological excavations. During the excavations performed at the so-called Great Gate in Koper, (Župančič, 1985) at a depth of 1.24 m, a layer of shells of the species *Cardium* sp. was found and they were ^{14}C dated to 1367±83 years BP, indicating that the sedimentation rate was about 1 mm yr^{-1}. This data is in accordance with the recent deposition rate in the Venice lagoon (Favero & Stefanon, 1980), lagoons of Marano, Grado and Caorle (Marocco, 1991, Marocco *et al.*, 1996) and with the average rise of the sea level in the last 2000 years, showing a synchronous rise of sea level with sedimentation.

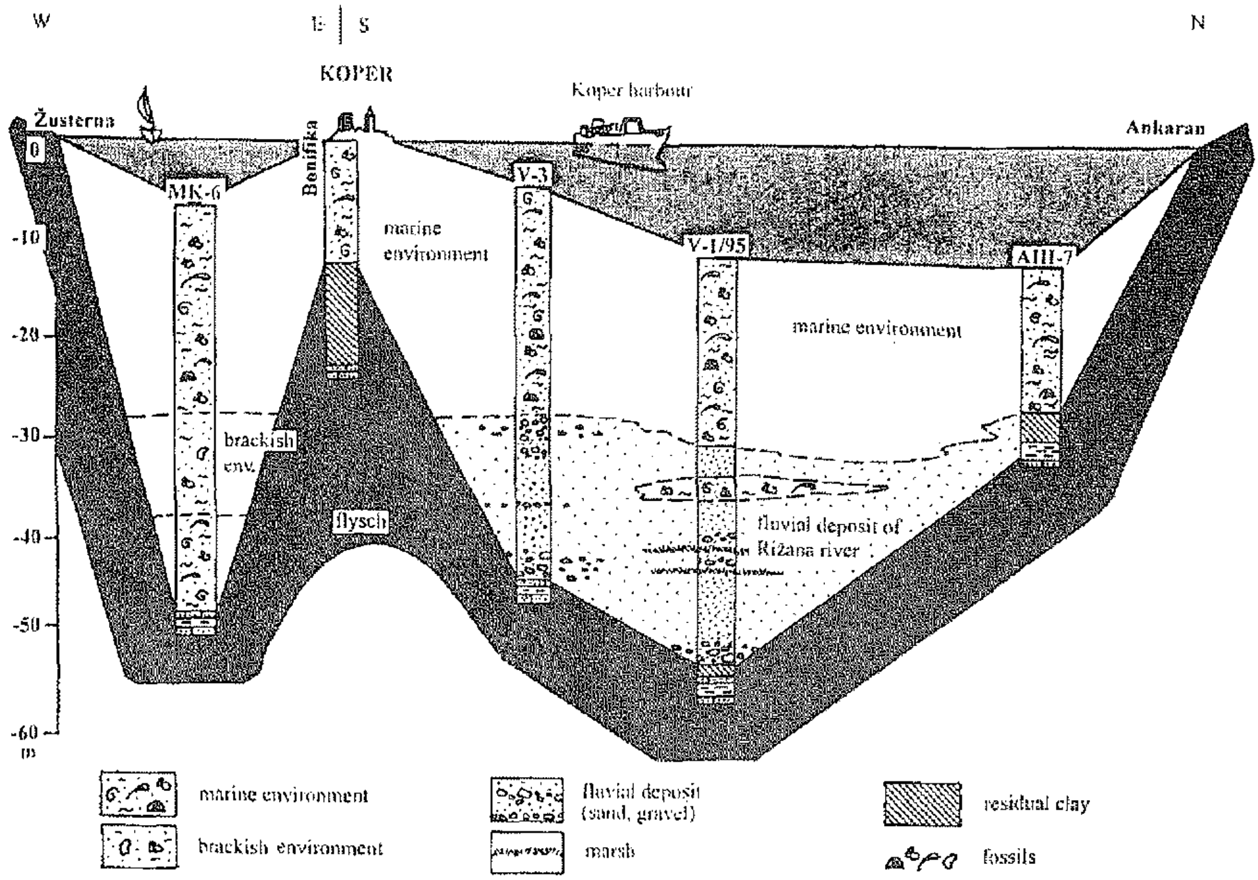

Fig. 8: Interpretation of Holocene sedimentary environment in the inner part of the Bay of Koper based on studied boreholes.
Sl. 8: Interpretacija sedimentacijskih okolij notranjega dela Koprskega zaliva v holocenskem obdobju po podatkih raziskanih vrtin.

A somewhat higher sedimentation rate, however, has been determined in various localities in the southern part of the Gulf of Trieste, and in Koper Bay, using ^{210}Pb analyses (Faganeli *et al.*, 1991). The recent sedimentation rate of about 5.5 mm yr^{-1} was estimated for the surficial layer of the borehole MK-6. This discrepancy should be attributed to the higher porosity of surficial sediment and that during diagenesis a compaction of the sediment occurs leading to lower sedimentation rate. Also, ^{210}Pb has a shorter half-life than ^{14}C and, hence, these nuclides are tracers of processes occurring in different time scales (tens vs. thousands of years).

The palynological investigations (Ogorelec *et al.*, 1984, Šercelj, *pers. comm.*) of sediment from boreholes V-3 and V-6/79 in the Sečovlje saltworks (Ogorelec *et al.*, 1981) divided the cores into three parts. In the sandy riverine deposits in the borehole V-3 from the depth interval between 43 and 26 meters pollen was not present. As a result of transgression the marine sediment at this depth contains oak and elm pollen as a characteristic vegetation of the early Holocene, Preboreal and Boreal. At depths of 18 and 16 m, the vegetation is already typical of the warmer period with its prevailing beech *(Fagus)* forest (boreal climate) and pine *(Pinus)* pollen. At a depth of 10.8 m the olive tree *(Olea)* and grape *(Vitis)* pollen occur, for the first time and in somewhat greater quantities. These are agricultural plants, which were introduced to Istria by man, most probably in the Early Roman period. At that time the forest vegetation greatly changed becoming poor, presumably as a result of deforestation and the introduction of pasture. The olive tree and grape pollen at a depth of 10.8 m indicate a high sedimentation rate, up to 5 mm yr^{-1}, in this part of the Bay, which is in accordance with the previously mentioned data from the borehole MK-6 (4 mm yr^{-1}) and recent sediment.

CONCLUSIONS

And finally, how will the Bay of Koper likely look in the future? An answer to this question depends on a number of factors, particularly on the trend and rate of the rise or fall of sea level, on tectonics and climate. In view of present predictions by climatologists, who claim even further global warming, we can expect a faster rate of rise of sea level. A warmer climate, on the other hand, enhances the general abrasion of the coast and denudation of land, a higher bioproduction of organic skeletons and, thus, a higher sedimentation rate. However, sedimentation will most probably still be balanced with the rise of sea level. In the eastern part of the Bay between Koper and Ankaran the expansion of the port will continue, which means that practically the entire coast will be urbanized. However, the steep flysch coast so characteristic of the Bay between Debeli rtič and Valdoltra as well as between Koper and Izola will probably remain intact.

REKONSTRUKCIJA PALEOOKOLJA V KOPRSKEM ZALIVU

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POVZETEK

Namen pričujočega članka je, da prikažemo rekonstrukcijo okolja v Koprskem zalivu (sl. 1) skozi najmlajše geološko obdobje ter osnovne značilnosti usedlin in procesov, ki se odvijajo v njih. Po zrnavosti, litologiji in geokemijskih lastnostih lahko površinski sediment Koprskega zaliva razdelimo v tri cone (sl. 2): obrežni sediment (cona A), sediment notranjega dela zaliva (cona B) in sediment odprtega dela zaliva (cona C). Opisane značilnosti sedimenta so pomembne za študij biogeokemijskih procesov in onesnaženja zaradi prisotnosti človekove dejavnosti.

Sediment pod površino smo v notranjem delu Koprskega zaliva raziskali z več vrtinami. Te so locirane v koprski tovorni luki: (V-3, globoka 41 m, na globini morja 4,5 m), tankerski luki (V-1/95, globoka 45 m, globina morja 12 m), dvesto metrov pred Žusterno (MK-6, globoka 43 m, globina morja 7 m), v Bonifiki pri Kopru (globoka 24 m, na kopnem) ter pred Ankaranom (A III-7, globoka 20 m, globina morja 13 m). Lokacije vseh teh vrtin so prikazane na sliki 1. Vrtine Bonifika, V-1/95 in A III-7 opisujemo v tem prispevku prvič.

Sediment vrtin V-3 in V-1/95, ki sta izvrtani na morju pred koprsko luko blizu izliva Rižane, sta na približno 40. in 50. metru prevrtali flišno podlago. Razdelimo ju lahko v dva dela (sl. 3 in 8). Spodnjih 20 in 24 metrov predstavlja rečni nanos Rižane. Menjavajo se plasti peska, mulja in proda. V vrtini V-1/95 se na 41. in 43. metru pojavljata dva tanjša horizonta temnega glinastega mulja s številnimi organskimi drobci, ki po vsej verjetnosti predstavljajo ostanke šotišča oziroma nakazujeta paleomočvirsko okolje ob nekdanjem ustju Rižane (sl. 3).

V vrtini MK-6, ki je bila izvrtana na predvideni lokaciji koprske marine pred Žusterno, rečnega nanosa ne opazujemo. Tu gre v celoti za precej homogen sediment, siv glinasti mulj s srednjo zrnavostjo pod 10 mm, kakršen nastopa na površini osrednjega dela Koprskega zaliva. V celotnem zaporedju se v večjem ali manjšem obsegu pojavljajo fosilni ostanki, predvsem foraminifere, moluski in ostrakodi. Po foraminifernih vrstah ugotavljamo, da je bilo v globini med 26. in 36. metrom pod morsko gladino v času nastanka sedimenta bolj brakično okolje (sl. 8).

Vrtina z oznako Bonifika, izvrtana na lokaciji med novim koprskim trgovskim centrom in športnim središčem, je v globini 12 m prešla v homogeno flišno preperino oranžno-rjave barve, na globini 24 m pa v kompakten fliš (sl. 4 in 8). Do globine 12 metrov je sediment zopet homogen temnosiv glinasti mulj z lupinami školjk, polžev, ehinodermov, foraminifer in ostrakodov. Mestoma so številni drobni polži vrste Bittium reticulatum, *nadalje polž* Barleera rubba *ter školjka* Cardium sp. *Tudi tu po ostrakodni in foraminiferni favni ugotavljamo menjavanje morskega in brakičnega okolja.*

Vrtina A III-7 (sl. 8), ki je bila izvrtana v morju pred Ankaranom v geomehanske namene zaradi širitve koprske luke, je na flišno preperino zadela na globini 17 metrov. Morje je tam globoko 13 metrov. Sediment nad flišno preperino je vseskozi homogen, temnosiv glinasti mulj s srednjo zrnavostjo okrog 10 µm. Glinasto frakcijo sestavljajo predvsem fosili - moluski in foraminifere, zelo redka pa so detritična zrna kremena in drobci flišnih plasti z obale.

Že iz zgodovinskih virov in slik lahko razberemo, da je obalna črta v Koprskem zalivu v preteklosti potekala drugače kot danes. Zametek Kopra je bila naselbina Formio iz antičnega obdobja, kasneje, v rimskem obdobju znana kot Caprae. Koncem srednjega veka je bil Koper že izoblikovano mesto, strnjeno na majhnem otočku in s kopnim povezano z umetnim nasipom (sl. 5). Ob robu vzhodnega dela zaliva so v 17. in 18. stoletju Benečani uredili številna manjša solna polja, kakršna so bila pri Sečovljah in Strunjanu (sl. 6). Sredi 19. stoletja so bila ta polja zaradi širitve kmetijskih površin opuščena.

Za ugotavljanje hitrosti dviga morske gladine v zadnji poledeni dobi so najbolj razširjene datacije z metodo izotopske sestave ^{14}C na vzorcih in sedimentu iz različnih globin. V ta namen so uporabne predvsem plasti, ki so bogate z organsko snovjo (npr. šota) in fosili. Šotne plasti naj bi nastajale na močvirskih ravnicah ob ustjih nekdanjih rek in bi torej predstavljale približni nivo morske gladine v preteklosti. Druga, sicer časovno manj natančna, a zelo razširjena metoda, s katero raziskujemo paleookolje, je palinološka, ki temelji na študiju peloda rastlin. Po sestavi in združbi peloda lahko sestavimo sliko o vegetaciji in klimi v nekem obdobju. Posebno pomembni so podatki o pojavih peloda kulturnih rastlin, kot so v Istri oljka in trta, v najmlajšem obdobju pa še koruza. Po njih lahko sklepamo na naselitve določenih prostorov. Za krivuljo dviga morske gladine v svetu konstruirane na osnovi starostnih datacij ^{14}C in razmerij Th/U (sl. 7) velja, da je bila morska gladina pred 18000 leti, v času würmske poledenitve, okrog 120 metrov nižja kot je danes. Tako je bil Jadran severno od linije Ancona-Zadar kopno. Dvig morja je bil sprva relativno hiter, saj se je morska gladina dvigovala povprečno za 10 in več metrov v 1000 letih. Pred približno 5000 leti pa se je to dvigovanje precej upočasnilo, tako da se je morje od rimskega obdobja dalje v zadnjih 2000 letih dvignilo le še za okrog 2 metra, kar pomeni v povprečju 1 mm/leto. Največji obseg morja v severnem Jadranu je bil pred približno 5000 leti, ko je to segalo še približno 50 km v notranjost delte Pada, pod vodo pa so bile tudi beneška laguna in laguni pri Maranu in Gradežu.

Na sliki 8 je prikazan presek skozi holocenske sedimente v notranjem delu Koprskega zaliva na osnovi petih vrtin. Vrtina Bonifika je bila izvrtana na kopnem, ostale vrtine pa na morju z različno globino vode, ki se giblje od 4,5 do 13 m. Zato moramo pri korelaciji teh vrtin upoštevati njihove prave položaje glede na današnjo gladino morja. Pri vrtini MK-6 moramo opozoriti tudi, da ta ni locirana južno od ostalih vrtin (npr. Bonifike, glej sl. 1), ampak zahodno proti odprtemu delu zaliva, kar popači topografijo morskega dna v predelu okrog Kopra.

Najglobji (najstarejši) holocenski sediment v notranjem delu Koprskega zaliva zasledimo v vrtini MK-6 pred Žusterno na globini 48 m pod sedanjo morsko gladino. To je bilo pričakovati, saj je ta vrtina najbližja proti odprtemu delu Tržaškega zaliva, od koder je prodiralo morje. Zato jo je tudi najpreje preplavilo. To je bilo pred približno 10 do 11000 leti, ko je morje hitro pričelo prodirati proti Padski nižini in naprej proti severu. To datacijo postavljamo na osnovi rekonstrukcije pomikanja Jadranskega morja v poznem kvartarnem obdobju.

V istem obdobju, ko je južni del Koprskega zaliva že zalilo morje, je notranji, vzhodni del takrat še koprske udorine zasipaval rečni nanos Rižane. Tega zastopajo sprva plasti debelega proda (sl. 3, vrtina V-1/95 in sl. 8), više navzgor pa zaglinjenega peska in drobnejšega proda. Tanjša, okrog 0,5 metra debela horizonta glinastega mulja oziroma "šote", ki se v vrtini V-1/95 pojavljata na globinah 41 in 43 m pod današnjim nivojem morske gladine, kažeta na občasne zamočvirjene predele ob ustju Rižane.

Najmočnejši morski transgresijski sunek v Koprskem zalivu zasledimo na globini 26 m pod sedanjo morsko gladino. Takrat je morski sediment popolnoma prevladal nad rečnim in brakičnim. Ta globina se popolnoma ujema s podatkom, da imamo v isti globini v vrtini V-6 v Sečoveljskih solinah plast "šote", ki je bila z izotopsko analizo ^{14}C datirana s starostjo pred 9180±120 leti. V istem obdobju oziroma nivoju, ko v vrtini V-3 rečna sedimentacija preide v morsko, preide tudi v vrtini MK-6 sediment brakičnega okolja v morskega. Prostor bonifike in koprskega otoka je bil v tem času še vedno del kopnega.

Od 26. metra navzgor, merjeno do današnje kote morske gladine, se v celotnem Koprskem zalivu javlja le še zelo drobnozrnat in homogen glinasti mulj. Številni fosilni skeleti, predvsem školjke in foraminifere kažejo na njegovo sedimentacijo v morskem okolju. Časovno ustreza ta nivo približno pred 9000 leti, kar ga uvršča v obdobje splošne morske transgresije na prehodu iz würma v holocen. Po debelini sedimenta in nekaterih njegovih starostnih datacijah z ^{14}C lahko sklepamo na približno hitrost sedimentacije v Koprskem zalivu. Ta se za debelejše morske pakete giblje med 4 in 2,5 mm/leto, za vrhnje metre sedimenta pa v poprečju med 1,5 in 1 mm/leto.

Če predpostavimo glede na splošno svetovno krivuljo dviga morske gladine (sl. 7), da je morska transgresija v notranjem delu Koprskega zaliva zajela flišno podlago na globini -48 m (vrtina MK-6) pred dobrimi 10000 leti, dobimo hitrost sedimentacije približno 4 mm/leto. Samo za vrhnjih 21 m sedimenta, ki je morskega izvora, pa znaša *ta hitrost okrog 2,2 mm/leto. Podatek iz vrtine V-6 v Sečoveljskih solinah, izmerjen na osnovi analize "šote" z metodo ^{14}C, nam daje za 26,5 m sedimenta povprečno hitrost sedimentacije 3 mm/leto.*

Izračuni hitrosti sedimentacije v koprski luki (vrtini V-3 in V-1/95) se gibljejo med 2,5 mm/leto za vrhnji morski sediment in okrog 4 mm/leto za skupni rečni in morski sediment. Ta razlika je lahko razložljiva zaradi hitrejšega zasipavanja bazena z bolj debelozrnatim rečnim nanosom kot pa pelitskim morskim sedimentom. Do podatka 2,5 mm/leto pridemo, če upoštevamo 22 m morskega sedimenta in datiramo globino kontakta rečni - morski sediment na globini 26 m v čas pred približno 9000 leti.

Počasnejšo sedimentacijo v zadnjih 2000 letih lahko v Koprskem zalivu zagovarjamo z izotopskimi datacijami in arheološkimi izkopavanji. Meritve ^{14}C školjk vrste Cardium sp., ki so jih izkopali pri velikih vratih v Kopru na globini 1,24 m, so pokazale starost 1367±83 let, kar kaže na približno hitrost sedimentacije 1 mm/leto. Ta podatek se ujema z enako hitrostjo zasipavanja Beneške lagune ter lagun Marano, Gradež in Caorle v zadnjem obdobju ter s povprečnim dvigom morske gladine v zadnjih 2000 letih, kar kaže na usklajeno dvigovanje morske gladine in sedimentacije.

Na večjo hitrost sedimentacije pa kažejo raziskave recentnega površinskega sedimenta, izmerjene na več lokacijah v južnem delu Tržaškega zaliva in tudi v Koprskem zalivu, analizirane z metodo ^{210}Pb. Te kažejo na hitrost usedanja približno 5 mm/leto. Upoštevati pa moramo, da je recentni sediment še zelo porozen in da pride v diagenezi do njegove kompakcije in s tem do vsaj polovico nižje hitrosti sedimentacije, pa tudi da sta ^{210}Pb in ^{14}C indikatorja procesov, ki potekajo v različnih časovnih skalah.

Palinološke raziskave v sedimentu iz vrtine V-3 in že prej iz vrtine V-6/79 v Sečoveljskih solinah so dale podlago za kronološko delitev sedimenta na tri dele. V peščenem rečnem nanosu vrtine V-3 od podlage na 43. metru do 26. metra sediment ne vsebuje peloda. S transgresijo se na tej globini že pojavi pelod hrasta in bresta kot značilna vegetacija zgodnjega holocena, preboreala in boreala. V globini 18 m in 16 m pa je vegetacija že toplodobna s prevladujočim bukovim gozdom (borealna klima) in s pelodom borovca. Na globini 10,8 m se prvič pojavita in sicer v večjih količinah oljka in vinska trta. To sta kulturni rastlini, ki jih je v Istro naselil človek, najverjetneje v zgodnjem rimskem obdobju. Gozdna vegetacija se je v tem času precej spremenila in osiromašila, verjetno zaradi krčenja gozda in uvajanja pašnih površin. Pelodi oljke in trte v globini 10,8 m kažejo na visoko hitrost sedimentacije, tudi do 5 mm/leto v tem delu zaliva, kar bi se nekako skladalo s preje omenjenimi podatki za vrtino MK-6 (4 mm/leto) in za recentni sediment.

In za zaključek, kako bo Koprski zaliv izgledal v prihodnosti? Odgovor na to vprašanje je odvisen od več dejavnikov, predvsem od trenda in hitrosti dvigovanja ali nižanja morske gladine, nadalje tektonike in klime. Glede na današnje prognoze klimatologov, ki napovedujejo še nadaljnjo otoplitev je pričakovati še pospešeno dvigovanje morja. Toplejša klima pa pospešuje splošno abrazijo obale in denudacijo zemlje v porečju, višjo bioprodukcijo organskih skeletov ter s tem višjo stopnjo sedimentacije. Po vsej verjetnosti pa bo zasipavanje še naprej uravnoteženo s porastom morske gladine. V vzhodnem delu zaliva med Koprom in Ankaranom se bo nadaljevalo širjenje luke, tako da bo praktično vsa obala z izlivom Rižane odvisna od človeka, še dolgo pa bodo ostale strme flišne stene, ki dajejo zalivu med Debelim rtičem in Valdoltro ter med Koprom in Izolo tako značilno podobo.

Ključne besede: recentni sediment, paleookolje, Koprski zaliv, Tržaški zaliv, Jadransko morje

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GENUS *MACRONEMURUS* COSTA, 1855 IN THE NORTHWESTERN PART OF THE BALKAN PENINSULA (NEUROPTERA: MYRMELEONTIDAE)*

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ABSTRACT

Distribution of two ant-lion species, Macronemurus appendiculatus *(Latreille) and* M. bilineatus *Brauer, in the northwestern part of the Balkan Peninsula is described and preliminary analysis of food supply of* M. appendiculatus *is carried out.*

Key words: *Macronemurus,* Neuroptera, distribution, Balkan, feeding

INTRODUCTION

The NW part of the Balkan Peninsula has a rich fauna of Myrmeleontidae (ant-lions), comprising about 20 species in 15 genera (Aspöck *et al.*, 1980; Tröger, 1988; Devetak, 1992a, 1992b). The genus *Macronemurus* Costa, 1855 is represented in the region with two species, *Macronemurus appendiculatus* (Latreille) (Fig. 1) and *M. bilineatus* Brauer. Both species can easily be distinguished (Hölzel, 1987). In *M. appendiculatus* the pronotum is characterized by a dark median stripe, which never occurs in *M. bilineatus,* but two lateral stripes are present in the latter species.

Macronemurus contains about 40 species, distributed all over Africa, southern Europe and SW Asia (Hölzel, 1986, 1987). Palearctic species of the genus are revised by Hölzel (1987).

Feeding habits of the pit-building ant-lion larvae have been described from different aspects (see Gepp & Hölzel, 1989), but information concerning adults is scarce. The intestinal content of adults was investigated by Stelzl & Gepp (1990), Stelzl (1991) and Devetak (1996).

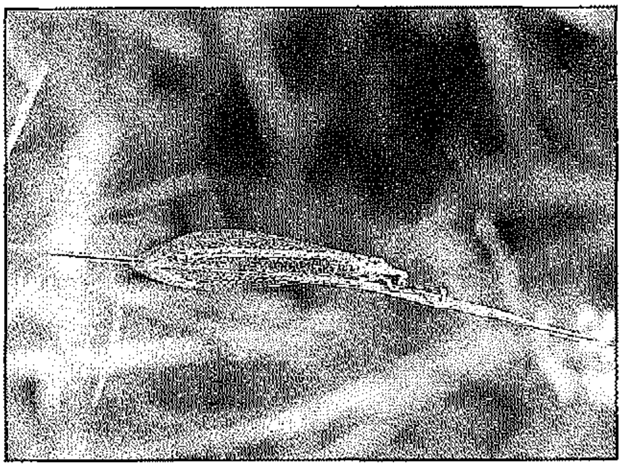
In this paper distribution of the genus *Macronemurus* in the northwestern part of the Balkan Peninsula and some information concerning food supply are presented.

MATERIAL AND METHODS

Specimens are deposited in the Natural History Museum, Zagreb (coll. Museum ZG), Insect Collection of the Slovene Academy of Sciences and Arts (coll. SAZU LJ) and the author's collection (Maribor). The ant-lions have been collected by the following entomologists (in order to save space, abbreviations of their names are used in the text): J. Carnelutti (JC), D. Devetak (DD), M. Devetak (MD), M. Filipović (MFI), M. Franković (MFR), P. Jakšić (PJ), F. Janžekovič (FJ), P. Prosenjak (PP), J. Staudacher (JS), T. Šoljan (TŠ) and F. Velkovrh (FV).

Six males and six females of *M. appendiculatus* originating from the island of Brač and preserved in 70% ethanol were dissected and the digestive tract was isolated. The partially digested food particles suspended in alcohol were examined microscopically. The best results were obtained without staining. The insects' activity was recorded in field with a Sony video camera recorder CCD-TR750E.

* Dedicated to the memory of Dr Narcis Mršić (1951-1997).



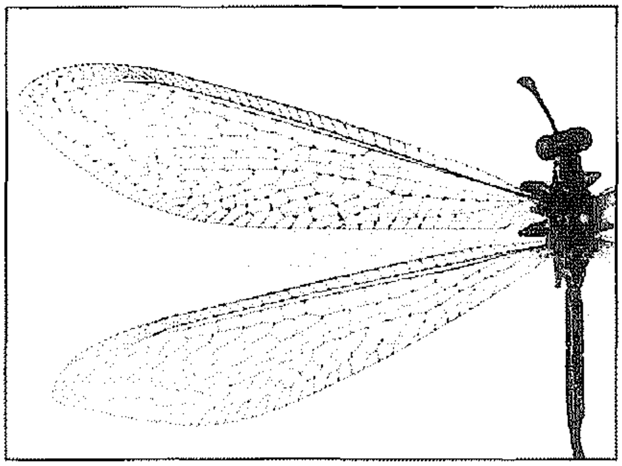


Fig. 1: *Macronemurus appendiculatus* **(Latreille, 1807) *(A) Male in resting position. (B) Right wings of a male. Fore wing length 23 mm.***

Sl. 1: *Macronemurus appendiculatus* **(Latreille, 1807) *(A) Samec med mirovanjem. (B) Desni krili samca. Dolžina sprednjega krila 23 mm.***

RESULTS

Distribution of *Macronemurus* in the northwestern part of the Balkan Peninsula

Macronemurus appendiculatus (Latreille, 1807)

Literature records:

Croatia: Novak (1891): Hvar; Klapálek (1906): Vis; Werner (1920): Gruž, Pula, Korčula, Brač: Supetar and Milna; Esben-Petersen (1925): Gruž; Hölzel (1987): Gruž, Vis, Split; Saure (1989): Zaostrog.

Bosnia and Hercegovina: Klapálek (1898, 1899, 1900): Hercegovina: Mostar; Spring of the Jasenica near Mostar

Doflein (1921) recorded the species in Macedonia without information on the locality.

Material examined (m, males; f, females):

Croatia:

Biograd na moru, 11.-19.VII.1973, 2m 5f, DD; Brač: Bol, 12.VII.1987, 1m 7f, 12.VII.1990, 1m 1f, VII.1997, 19m 51f, MD, DD; Cres: Belej, 27.VII.1997, 3f, MFI; Istria: Premantura, 18.VII.1986, 1f, DD; Istria: Pula: Stoja, 10.VIII.1983, 1f, DD; Istria: Rt Kamenjak, 13.VII.1986, 1f, 1.-4.VIII.1995, 2m 1f, DD; Kaštel Kambelovac, 4.VIII. 1986, 1m, PP; Korčula: Korčula, 29.VII.-2.VIII.1980, 5m 6f, DD; Kornati: Levrnaka, VI.1978, 2m 1f, FV; Lošinj: Nerezine, 22.-30.VII.1993, 4m, DD; Makarska, 25.VI. 1931, JS (coll. SAZU LJ); Mljet, VI.1980, 1m 1f, JC; 7.VIII. 1980, 1f, DD; Obrovac: Golubić, rijeka Krupa, 2.VIII. 1984, 1f, MF (coll. Museum ZG); Pag: Povljana, 3.VII. 1956, 1f, 30.VI.1960, 2f, 26.VII.1978, 3f (coll. Museum ZG); Planac, 1.VIII.1927, 1f, TŠ (coll. Museum ZG); Rab: Lopar, 21.VI.1976, 2f, DD; Unije, 7.VII.1964, 1f (coll. Museum ZG); Vele Srakane, 11.IX.1961, 1f (coll. Museum ZG); Zadar, 17.VIII.1937, 1f, JS (coll. SAZU LJ).

Habitats: grassland and garrigue. In southern Istria and Dalmatia, *M. appendiculatus* is one of the most abundant ant-lion species.

World distribution: Holomediterranean element.

Macronemurus bilineatus Brauer, 1868

Literature records:

Pongracz (1923): Kosovo: Morina; Dimitrova (1924) and Dimitrowa (1925): Macedonia: Bogdanci (Gevgelija) and Petrovska planina (Kavadarsko); Hölzel (1987): Macedonia: Drenovo-Kavadar, Ohrid, Petrina plan.

Brauer (1868) described the species from "Syra" in Dalmatia, but the meaning of this unnative (or fictive?) name and thus the position of this locality has not been solved. Pongracz (1923) refers to a female of *M. appendiculatus* from Morina, but from his illustration (p. 157) it obviously concerns *M. bilineatus*.

Material examined:

Macedonia: Dojransko Ezero: Dojran, 19.-24.VII. 1975, 1 m; Dojransko Ezero: Djopčeli, 20.-23.VII.1975, 1f; Prilep: Pletvar (1000 m a.s.l.), 16.VII.1980, 1m 1f, 20.VII.1983, 1f, PJ.

Yugoslavia: Serbia: Kosovo: Kosovo polje, Caravica, 24.VII.1979, 1m, DD; Ibarska klisura: Košutovac, 24.VII. 1987, 2m 2f, PJ.

Yugoslavia: Montenegro: Tuzi, 14.VIII.1982, 1f, 24. VIII.1982, 1f, FJ.

Habitats: grassland and garrigue.

World distribution: Pontomediterranean element.

The finding-places for both species in NW Balkan are shown in Fig. 2.

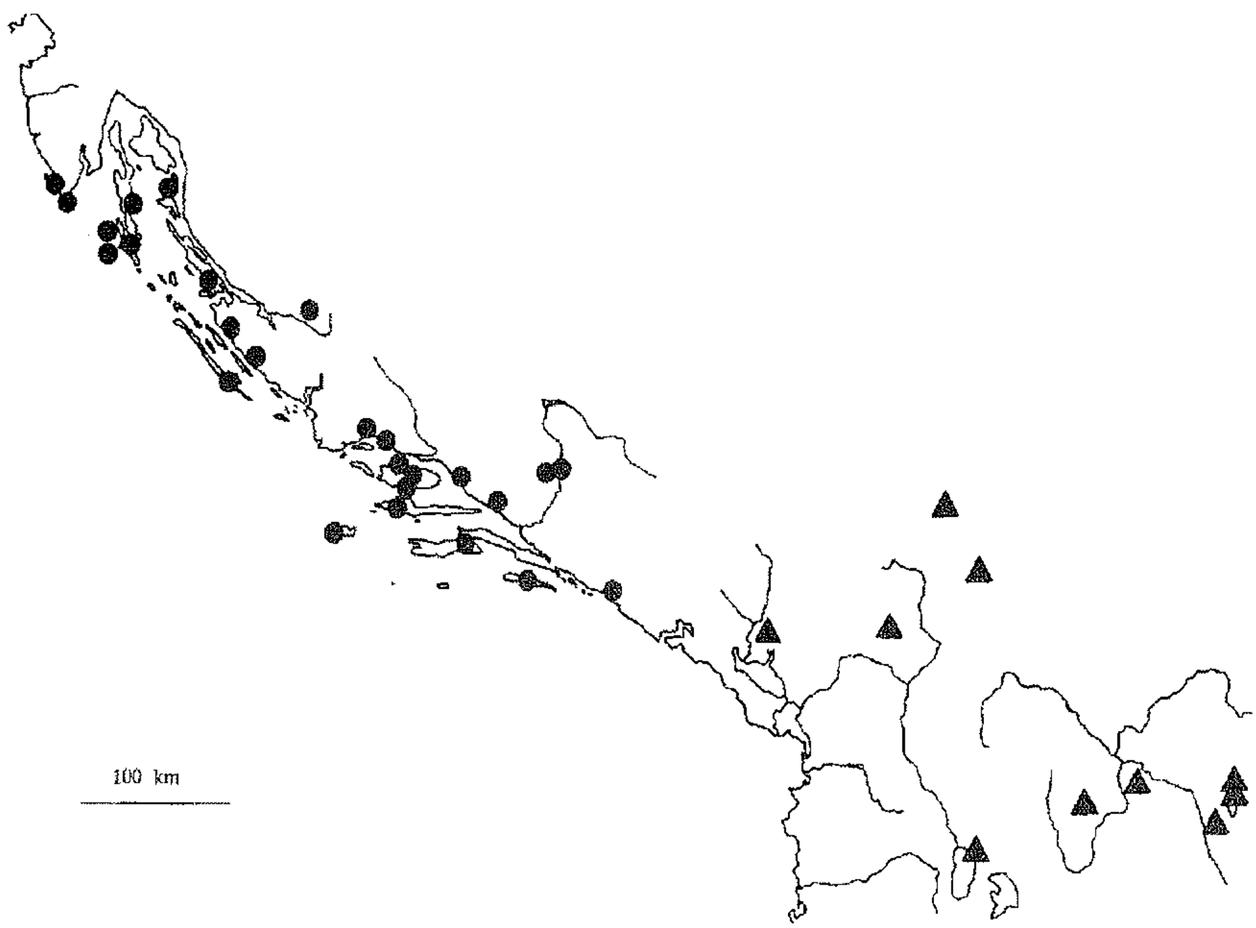


Fig. 2: Finding-places of** M. appendiculatus **(circles) and** M. bilineatus **(triangles) in the northwestern part of the Balkan Peninsula.
Sl. 2: Razširjenost volkcev** M. appendiculatus **(krogci) in** M. bilineatus **(trikotniki) v severozahodnem delu Balkanskega polotoka.

The food supply of *M. appendiculatus*

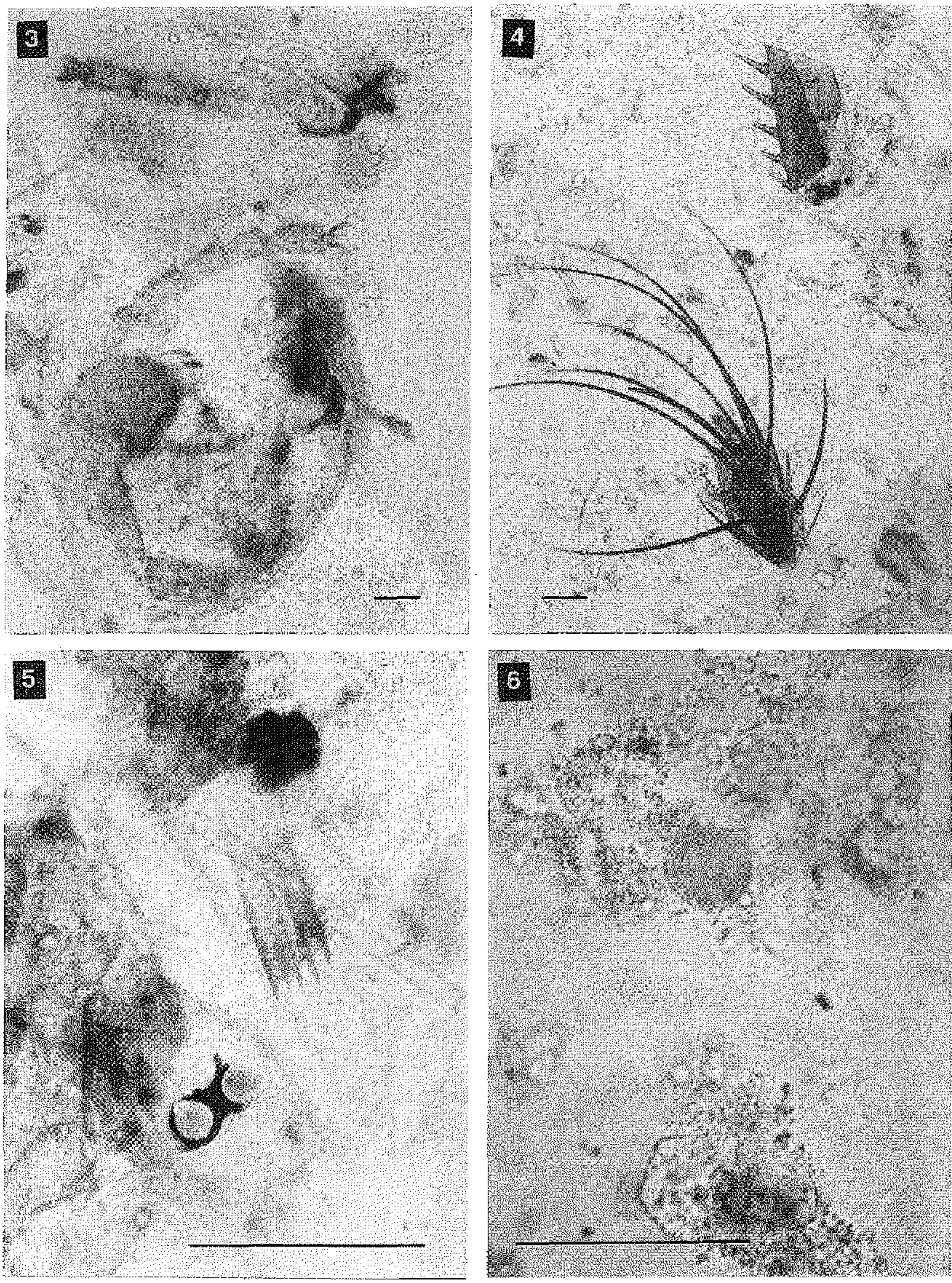
In the intestinal content of 3 males and 2 females arthropod fragments were found. One male consumed a large amount of pollen grains and in two individuals of both sexes fragments of plant tissue were recorded (Figs. 3-6). Only a few identifications of the arthropod fragments were possible, in other cases one can only speculate on the origin of these food remains. The following structures were recognized: compound eyes, antennal and leg segments, mandibles, cuticular fragments with bristles and lepidopteran scales. From the size of partially digested arthropod fragments and the size of the ant-lions it can be concluded that *M. appendiculatus* is able to consume smaller prey than the prey of *Palpares* (Devetak, 1996), which is the largest ant-lion species in the area.

These results are very similar to the investigated feeding habits in four central European ant-lion species (Stelzl & Gepp, 1990; Stelzl, 1991) and in *Palpares libelluloides* (Devetak, 1996). It is not clear whether the plant tissues in *Macronemurus* originated from the intestinal content of herbivorous prey (*e.g.* caterpillars) or had been digested directly. The ingestion of pollen has been also reported for some American species (Stange, 1970) and the European ant-lions (Stelzl & Gepp, 1990).

CONCLUSIONS

The ant-lions of the genus *Macronemurus* are common in the northwestern part of the Balkan. *M. appendiculatus* occurs in the coastal part of Croatia and in Hercegovina, and *M. bilineatus* inhabits Montenegro, Serbia (Kosovo) and Macedonia (Fig. 2).

M. appendiculatus feeds on insects, pollen and possibly on plant tissues (Figs. 3-6). Both species inhabit grassland and garrigue. In southern Istria and Dalmatia, *M. appendiculatus* is one of the most abundant ant-lion species.



Figures 3-6. *Slike 3-6.*

Figs. 3-6: Food remains from the digestive tract of *M. appendiculatus.* ***Bar 100 µm.***
Fig. 3: Insect tarsi and a fragment of compound eye.
Fig. 4: Two arthropod fragments of unknown origin.
Fig. 5: A lepidopteran scale and two ommatidia.
Fig. 6: Pollen grains.

Sl. 3-6: Ostanki hrane iz prebavil *M. appendiculatus.* ***Merilo: 100 µm.***
Sl. 3: Tarzi žuželk in del sestavljenega očesa.
Sl. 4: Fragmenta členonožcev neznanega izvora.
Sl. 5: Luska z metuljevih kril in dva omatidija.
Sl. 6: Pelodna zrna.

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ROD *MACRONEMURUS* COSTA, 1855 V SEVEROZAHODNEM DELU BALKANSKEGA POLOTOKA (NEUROPTERA: MYRMELEONTIDAE)*

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POVZETEK

Rod volkcev Macronemurus je splošno razširjen v severozahodnem delu Balkanskega polotoka. Vrsta M. appendiculatus *poseljuje obalno področje Hrvaške in Hercegovino, vrsta M. bilineatus pa Črno goro, Srbijo (Kosovo) in Makedonijo (sl. 2).*

Pri analizi prežvečenih in deloma prebavljenih ostankov hrane iz prebavila vrste M. appendiculatus *sem ugotovil, da se volkec hrani z žuželkami, cvetnim prahom in morda z rastlinskimi tkivi (sl. 3-6). Med ostanki žuželk so bili fragmenti nog, anten, sestavljenih oči, kutikularnih ploščic in lusk s kril metuljev.*

Obe vrsti poseljujeta travnate habitate in garigo. V južni Istri in Dalmaciji je M. appendiculatus *najpogostejši volkec.*

Ključne besede: *Macronemurus*, Neuroptera, razširjenost, Balkan, prehranjevanje

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* Posvečam spominu dr. Narcisa Mršića (1951-1997).

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CONTRIBUTION TO THE ANT FAUNA OF SLOVENIA WITH SPECIAL REFERENCE TO THE SUBMEDITERRANEAN AND EUDINARIC REGIONS

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ABSTRACT

In a preliminary study of the ant fauna of Slovenia, 45 species were recorded at 15 sites, 12 of which are situated in the southwestern part of the country.

Key words: Hymenoptera: Formicidae, fauna, Slovenia: Submediterranean and Eudinaric regions

INTRODUCTION

The basic faunistic research is especially important in those regions, which are threatened and/or represent biodiversity "hot spots". Both criteria are valid for Slovenia: the fast social and industrial development potentially influences the country's natural or quasi-natural landscapes, which represent a high biogeographical diversity from the high Alps to the Pannonic, the Dinaric and the Submediterranean regions, which means that there are several potential "hot spots" in this country.

In a careful analysis on the red wood ants, Titovšek (1994) recorded 8 species from the subgenera of *Formica, Coptoformica* and *Raptiformica*. Despite his paper, no other publications are known on the ants of Slovenia.

In this report, the results of the ant samples collected in the summer of 1996 are given as the first and preliminary list of ants from the southwestern part of Slovenia. The list of species is far from complete and final one, for which more intensive sampling effort should be made at many more sites.

METHODS AND COLLECTION SITES

The ants were collected between 9th and 19th July 1996 during a field trip with Slovene and Hungarian students. They were obtained at 15 sites by hand collecting, mostly based on the sampling of the colonies. 12 sites are situated in those (Submediterranean or Eudinaric) regions of Slovenia, from where Mediterranean elements were expected. For comparison, I included the ants from the remaining three sites, too, which are situated in the Alpine region (the zoogeographical division is after Novak *et al.*, 1995).

The individual collecting sites were as follows: (1) Kamniško-Savinjske Alpe: Logarski Kot (near the hostel, 10.07.1996); (2)-(3) Kamniško-Savinjske Alpe: Okrešelj (at two localities, 11-12.07.1996); (4) Trnovski Gozd: Mala Lazna (13.07.1996); (5) Trnovski Gozd: Paradana (in close and wider vicinity of the ice cave, 13.07.1996); (6) Trnovski Gozd: Smrekova Draga (in the dolina and the neighbouring forests, 13.07.1996); (7) Trnovski Gozd: Predmeja-Čaven, forest (different forests and forest edges by the path between the hostel at Predmeja and Čaven, 14.07.1996); (8) Trnovski Gozd: Predmeja, grassland (near the hostel at Predmeja, 14.07. 1996); (9) Trnovski Gozd: Čaven, Kucelj (mountain-sides at Kucelj, 14.07.1996); (10) Kozina: Camping (15.07.1996); (11) Podpeč (a slope by the seashore, 15.07.1996); (12) Podpeč: hill (15.07.1996); (13) Podpeč: roadside (16.07. 1996); (14) Strunjan: cliffs (17.07.1996); (15) Osp: limestone hill (19.07.1996) (Fig. 1).

Ants from different nests were treated separately and were preserved in 70% ethanol. 1094 ant individuals were collected as a sample.

As the majority of the collections were probably far from complete, it was necessary to compute the completeness of the sampling. I computed the completeness of the collections as follows. The sample number - species number relation was investigated by the means of linear, log-linear and log-log functions. Since the slopes of these functions (blin, blog-lin, and blog-log, respectively) depends on the sequence of the collections, I used

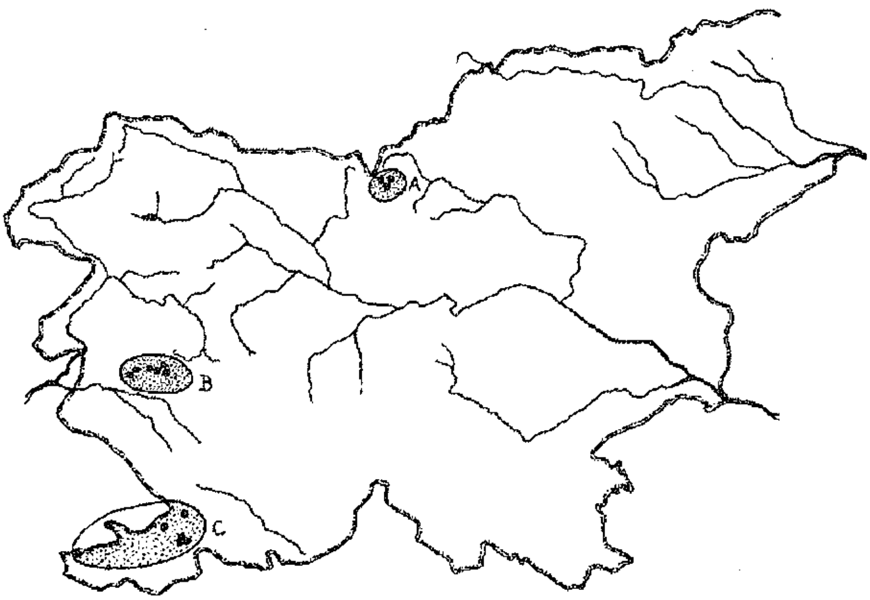

Fig. 1: Collection localities (see text for a detailed list of sites). A: sites 1-3, B: sites 4-9 and C: sites 10-15.
Sl. 1: Vzorčevalne lokalitete (natančen seznam lokalitet je v tekstu). A: lokalitete 1-3, B: lokalitete 4-9 in C: lokalitete 10-15.

the average of 50 repetition of random sequences of the original sample units for each site. The slopes of these functions can be considered useful tools in the assessment of the completeness of sampling (*i.e.* the sufficiency of the collection of the whole fauna), if they are in correlation with the number of sample units. In the cases of the linear and log-log transformed functions (blin and blog-log), the correlation coefficients were significant ($p<0.01$ in both cases), which means that these data can be taken into account for consecutive analyses. The completeness of the sampling is a negative function of the slopes mentioned above, therefore it is given as 1-blin and 1-blog-log. The products nblin and nblog-log (where *n* is the number of sample units) are obviously the measures of the diversity of the ant fauna in question.

RESULTS AND DISCUSSION

The ant species

Altogether 45 species were collected at the 15 sites. The list of species with their localities is as follows:

Fam. Formicidae

Subfam. Myrmicinae

Tribe Myrmicini

1. *Manica rubida* (Latreille 1802). Kamniško-Savinjske Alpe: Logarski kot; Trnovski Gozd: Paradana.

A well known species of high mountain regions. Its presence in Trnovski Gozd shows the alpine biogeographical influence on this region.

2. *Myrmica rubra* (Linnaeus 1758). Trnovski Gozd: Mala Lazna.

This species is known as euryfrequent and eurypotent one, typical to meadows of mesophilic and moist character.

3. *Myrmica ruginodis* Nylander 1846

Kamniško-Savinjske Alpe: Logarski kot; Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Paradana; Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Predmeja, grassland; Trnovski Gozd: Predmeja-Čaven, forest.

Being the least thermophilous *Myrmica* species in Europe (Seifert, 1988), its occurrence in the mountain areas meets the expectations.

4. *Myrmica scabrinodis* Nylander 1846. Trnovski Gozd: Mala Lazna.

This is a moderately thermophilous and hygrophilous species. Since its southern distribution boundaries are not exactly known, this occurrence in Slovenia is a contribution to the knowledge regarding the distribution of this species in Europe (see Seifert, 1988).

5. *Myrmica schencki* Emery 1895. Trnovski Gozd: Predmeja-Čaven, forest; Trnovski Gozd: Čaven, Kucelj.

A species of open areas with most thermophilous character among European *Myrmica* species. I collected it in Trnovski Gozd at a forest edge and in grassland.

6. *Myrmica lobicornis* Nylander 1846. Trnovski Gozd: Mala Lazna.

This is less thermophilous then the species above. I have found it in Hungary, mainly in mountain meadows and lowland grasslands of wet character.

Tribe Pheidolini

7. *Aphaenogaster (Attomyrma) subterranea* (Latreille 1798). Trnovski Gozd: Paradana; Podpeč: roadside; Strunjan: cliffs; Osp: limestone hill.

A species of Southern and Central Europe, Asia Minor and Caucasia, occurring at dry, warm Mediterranean and Submediterranean localities.

8. *Messor structor* (Latreille 1798). Strunjan: cliffs.

Widely distributed thermophilous species at Mediterranean and Submediterranean localities. In the southern part of Central Europe it is well associated with weedy habitats.

9. *Pheidole pallidula* (Nylander 1849). Podpeč: roadside.

A typical Mediterranean species in Europe, but can be also found in Central Asia. In South Europe it is also known as a house ant.

Tribe Crematogastrini

10. *Crematogaster (Acrocoelia) schmidti* (Mayr 1852). Podpeč: hill; Podpeč: roadside; Osp: limestone hill.

A typical ant of the Mediterranean and Submediterranean regions. Sometimes referred to as a synonimic species of *C. scutellaris* (Olivier 1791).

Tribe Solenopsidini

11. *Solenopsis (Diplorhoptrum) fugax* (Latreille 1798). Podpeč: hill; Osp: limestone hill.

Widely distributed species in North Africa, Europe and Asia to Japan. Very abundant in Central European grasslands. The collected material consists of typical *fugax* specimens according to Bernard (1968).

Tribe Leptothoracini

12. *Leptothorax (Mychotorax) acervorum* (Fabricius 1793). Kamniško-Savinjske Alpe: Logarski kot; Kamniško-Savinjske Alpe: Okrešelj.

A cold tolerant species, which is common in mountain habitats in Central and South Europe, and in lowlands of the northern regions. The only ant species in the open tundra habitats in Fennoscandia.

13. *Leptothorax (Mychotorax) muscorum* (Nylander 1846). Kamniško-Savinjske Alpe: Okrešelj.

Usually rarer species than *L. acervorum*, their habitat requirements are similar.

14. *Leptothorax (Myrafant) nigriceps* Mayr 1855. Trnovski Gozd: Čaven, Kucelj.

The only worker individual I collected at Kucelj most probably belongs to this taxon.

Tribe Tetramorinii

15. *Tetramorium caespitum* (Linnaeus 1758). Trnovski Gozd: Čaven, Kucelj; Podpeč; Strunjan: cliffs; Osp: limestone hill.

A thermophilous ant, which is very common in the majority of dry and weedy habitats in Europe, in Asia and also occurs in the northern parts of Africa.

16. *Tetramorium impurum* Förster 1850. Kamniško-Savinjske Alpe: Logarski kot; Kamniško-Savinjske Alpe: Okrešelj.

A species which is rather difficult to distinguish from *T. caespitum*. It occurs in high mountain habitats.

Tetramorium sp. Trnovski Gozd: Paradana

The only individual I collected could not be identified.

Subfam. Dolichoderinae

Tribe Tapinomini

17. *Tapinoma erraticum* (Latreille 1798). Podpeč: hill.

A thermophilous species commonly occurring in South and Central Europe to Central Asia.

Subfam. Formicinae

Tribe Plagiolepidini

18. *Plagiolepis pygmaea* (Latreille 1798). Podpeč: hill; Strunjan: cliffs.

The only *Plagiolepis* species collected during the trip. At least two other species of this genus are expected in the southern part of Slovenia.

Tribe Lasiini

19. *Lasius (L.) niger* (Linnaeus 1758). Trnovski Gozd: Mala Lazna; Trnovski Gozd: Predmeja, grassland.

On the basis of the PDCL (pilosity distance on the clypeus) values (between 13.3 and 16.1) and other traits, the individuals collected at the two localities belong to *niger* in the sense of Seifert (1992). Since in a recent revision Seifert (1992) split the European ant species, formerly classified as *niger*, into two species, the distribution and the ecology of this species should be revised.

20. *Lasius (L.) platythorax* Seifert 1991. Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Mala Lazna; Trnovski Gozd: Paradana.

Recently described species, its distribution and ecology not known. From the available data it seems that *platythorax* prefers woodland habitats.

21. *Lasius (L.) alienus* (Förster 1850). Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Čaven, Kucelj.

The individuals from Smrekova Draga have larger PDCL as given by Seifert (1992) for *alienus*. The specimens from Kucelj have a scape pilosity, which is more similar to *L. paralienus* Seifert 1992. The habitat is not typical of either species.

22. *Lasius (L.) psammophilus* Seifert 1992. Trnovski Gozd: Čaven, Kucelj.

On the basis of the five workers collected from Kucelj, it is the most probable species, although the soil in habitat is not sand.

23. *Lasius (L.) paralienus Seifert* 1992. Trnovski Gozd: Smrekova Draga; Podpeč: hill.

Typical specimens were collected from both localities.

24. *Lasius (L.) emarginatus* (Olivier 1791). Podpeč: hill; Strunjan: cliffs; Osp: limestone hill.

A thermophilous species with its northernmost distribution limits in Central Europe.

25. *Lasius (Cautolasius) flavus* (Fabricius 1781). Trnovski Gozd: Mala Lazna.

A common species in open habitats of Europe, with a distribution range from North America to Japan and from North Africa to Arctic (see Collingwood, 1979).

26. *Lasius (Chthonolasius) meridionalis* (Bondroit 1919)/ *balcanicus* Seifert 1988. Trnovski Gozd: Paradana.

The only female collected has a transitional character between the two species (six traits indicate *meridionalis* and six *balcanicus*). More individuals would have been necessary for positive identification.

27. *Lasius (Dendrolasius) fuliginosus* (Latreille 1798). Trnovski Gozd: Paradana.

A species with wide distribution range in Europe and Asia. In the majority of cases, this ant is nesting in trees.

Tribe Camponotini

28. *Camponotus (C.) herculeanus* (Linnaeus 1758). Kamniško-Savinjske Alpe: Logarski Kot; Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Predmeja-Čaven, forest; Trnovski Gozd: grassland.

This typical Central European mountain species occurs also in the lowlands of northern regions.

29. *Camponotus (C.) ligniperdus* (Latreille 1802). Trnovski Gozd: Predmeja-Čaven, forest.

This species has a more southern range than *C. herculeanus*. Fairly common in Central European mountain forests.

30. *Camponotus (C.) vagus* (Scopoli 1763). Podpeč: roadside; Strunjan: cliffs.

A South European species, common also in dry, lowland forests in Central Europe.

31. *Camponotus (Tanaemyrmex) aethiops* (Latreille 1798). Podpeč; Strunjan: cliffs; Osp: limestone hill.

A southern species, with the northernmost limits of its distribution in Hungary and in Slovakia.

32. *Camponotus (Myrmentoma) piceus* (Leach 1825). Kozina: Camping; Podpeč: hill; Strunjan: cliffs; Osp: limestone hill.

A thermophilous species, common in South Europe and in closed grasslands in Central Europe.

33. *Camponotus (Colobopsis) truncatus* (Spiniola 1808). Podpeč: hill.

A rather common species in South and Central Europe, but absent in Poland (Pisarski, 1975).

Tribe Formicini

34. *Formica (Serviformica) gagates* Latreille 1798. Trnovski Gozd: Smrekova Draga.

South and Central European species, its presence in Trnovski Gozd shows Mediterranean influence of the region's fauna.

35. *Formica (Serviformica) fusca* Linnaeus 1758. Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Predmeja-Čaven, forest; Trnovski Gozd: grassland.

A common ant in the whole of Europe, with its distribution range over the entire Palearctic region.

36. *Formica (Serviformica) lemani* Bondroit 1917. Kamniško-Savinjske Alpe: Okrešelj; Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Mala Lazna; Trnovski Gozd: Paradana; Trnovski Gozd: grassland.

This is a typical upland species, rare under 1000 m in Central and South Europe.

37. *Formica (Serviformica) cunicularia* Latreille 1798. Trnovski Gozd: Čaven, Kucelj; Kozina: campsite; Podpeč: roadside; Strunjan: cliffs; Osp: limestone hill.

One of the most common *Serviformica* species in Europe, occurring in open areas. More thermophilous than *F. rufibarbis*.

38. *Formica (Serviformica) rufibarbis* Fabricius 1793. Trnovski Gozd: Smrekova Draga; Kozina: campsite.

Similar species to *F. cunicularia*, but usually more common in wetter and urban habitats.

39. *Formica (Serviformica) balcanina* Petrov & Collingwood 1993. Kozina: campsite.

This species has been recently described from Deliblatska Peščara, near Belgrade, Yugoslavia (Petrov & Collingwood, 1993). Since then it has been found also in Rumania (Markó, 1997).

40. *Formica (F.) aquilonia* Yarrow 1955. Kamniško-Savinjske Alpe: Logarski kot; Kamniško-Savinjske Alpe: Okrešelj; Trnovski Gozd: Mala Lazna(?); Trnovski Gozd: Paradana; Trnovski Gozd: Smrekova Draga.

This is a common species in North Europe. In southern localities, however, it is restricted to high mountains. In the majority of cases, the collected specimens are typical *aquilonia*, but the Logarski kot material contains workers with poor pilosity on the eyes and gula, and in some cases the pilosity is too dense (*e.g.* Paradana collection). In Mala Lazna no nest was found, and as only one female was collected there is no proof that *F. aquilonia* is a constant member of the fauna. Titovšek (1994) found the species at several localities in the northern part of Slovenia.

41. *Formica (F.) pratensis* Retzius 1783. Trnovski Gozd: Smrekova Draga; Trnovski Gozd: Paradana; Trnovski Gozd: grassland; Kozina: campsite.

A typical species of woodland margins and open areas. It is the most thermophilous *rufa* group species. After Titovšek (1994) its distribution range is similar to that of *F. rufa L.* and *F. polyctena*, but its habitat requirements are different.

42. *Formica (F.) rufa* Linnaeus 1758. Trnovski Gozd: grassland.

A typical woodland species, which prefers open forests and is not common in very dense, closed woods.

43. *Formica (F.) truncorum* Fabricius 1804. Trnovski Gozd: Smrekova Draga; Trnovski Gozd: grassland.

In Central Europe it had been regarded as an ant of high mountains (see also Titovšek, 1994). Some recent data from very dry sandy forests in the Hungarian Great Plain (Gallé, 1986; Gallé & Szõnyi, 1988) modified our knowledge of its habitat requirements.

44. *Formica (Coptoformica) exsecta* Nylander 1846. Kamniško-Savinjske Alpe: Okrešelj.

This species has a distribution range from central Spain to North Europe and to Ural. More common in northern areas.

45. *Formica (Raptiformica) sanguinea* Latreille 1798. Trnovski Gozd: Predmeja-Čaven, forest.

Widely distributed species in Europe and Asia; expected from many more localities in Slovenia.

46. *Polyergus rufescens* (Latreille 1798). Kozina: campsite.

An obligate slave-making ant, with European distribution, but more common at southern localities.

Collection completeness and species diversity

The two measures ($1-b_{lin}$ and $1-b_{log-log}$) of the perfection of the ant inventory of the sampled localities (Table 1) are closely correlated ($r = 0.86$, $p< 0.001$). On the basis of the values in Table 1, the Okrešelj collection is the most complete, whereas Smrekova Draga and Predmeja-Čaven Forest are the least sufficiently sampled sites. The diversity metrics used in this study (nb_{lin} and $nb_{log-log}$) are loosely correlated ($r = 0.504$, $p<0.1$) and both of them are correlated with the number of recorded ant species ($r = 0.965$, $p<0.001$ and $r = 0.674$, $p<0.025$ respectively). On the basis of the linear ones (nb_{lin}), the ant species diversity is higher in those areas, which are under Mediterranean faunistical influence (Submediterranean sites and Trnovski Gozd), than in the Alps. The values of $nb_{log-log}$ are not so unequivocal.

Locality	s	n	b_{lin}	$1-b_{lin}$	nb_{lin}	$b_{log-log}$	$1-b_{log-log}$	$nb_{log-log}$
Logarski Kot	6	8	0.64	0.36	5.09	0.71	0.29	5.70
Okrešelj	9	26	0.26	0.73	6.89	0.54	0.46	14.12
Mala Lazna	5	6	0.81	0.19	4.85	0.90	0.1	5.42
Paradana	8	9	0.86	0.14	7.76	0.90	0.10	8.07
Smrekova Draga	9	9	0.96	0.04	8.67	0.90	0.01	8.11
Predmeja-Čaven forest	8	8	0.99	0.01	7.90	0.96	0.04	7.67
Predmeja:grassland	6	7	0.80	0.20	5.58	0.83	0.17	5.84
Kucelj	7	7	0.95	0.05	6.62	0.83	0.17	5.80
Podpeč (all habitats)	13	13	0.95	0.05	12.36	0.87	0.13	11.27
Strunjan: mountain	9	9	0.93	0.07	8.39	0.78	0.22	7.06
Osp: mountain	8	14	0.52	0.48	7.32	0.77	0.22	10.85

Tab. 1: The slope of the linear $s = f(n)$ regression function (b_{lin}), its log-log transformation ($b_{log-log}$) and two measures of the diversity (nb_{lin} and $nb_{log-log}$ respectively) of the local ant faunas. s = number of collected species, n = number of collections.
Tab. 1: Smerni koeficienti linearne regresije (b_{lin}), njihove logaritemske transformacije ($b_{log-log}$) in dva izračuna vrstne diverzitete (nb_{lin} and $nb_{log-log}$) lokalne mravljinčje favne. s = število vrst, n = število zbirk.

Comparison with surrounding areas

Comparing the collected Slovene ants species with the available data from the neighbouring countries and regions, this fauna seems to be most similar to the Balkan ants (Agosti & Collingwood, 1987), as more than 91% of the present collection is represented by the Balkan species. As Agosti & Collingwood (1987) could not consider the ants described since then, this similarity could be even greater. The similarity with Hungary is also great, since no less than 86% of the ants listed in this paper have been also found in Hungary (Somfai, 1959; Gallé, 1979; 1981; 1986; 1993 and unpublished data; Gallé & Szõnyi, 1988). The similarity with the Swiss fauna (Kutter, 1977) is at the same level. For Yugoslavia (80%, after Petrov, 1995) and Italy (84%, species list after Baroni Urbani, 1971) we have very similar results. It is interesting that there is an unexpectedly high similarity with North European ant fauna (Collingwood, 1979), 65%.

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PRISPEVEK K SLOVENSKI MRAVLJINČJI FAVNI S POSEBNIM POUDARKOM NA SUBMEDITERANSKEM IN EVDINARSKEM OBMOČJU

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POVZETEK

Preliminarna študija slovenske mravljinčje favne je temeljila na preučevanju mravelj julija 1996 na 15 lokalitetah, od katerih jih 12 leži v jugozahodni Sloveniji. Raziskave so bile opravljene v Kamniško-Savinjskih Alpah (3 lokalitete), Trnovskem gozdu (6 lokalitet), Kozini (1 lokaliteta), Podpeči (3 lokalitete), Strunjanu (1 lokaliteta) in Ospu (1 lokaliteta). Odkritih je bilo 45 vrst. Uporabljeni so bili posebni indeksi, da bi ocenili popolnost vzorcev in raznovrstnost favne. Na tej osnovi je bil najnatančneje raziskan Okrešelj (Kamniško-Savinjske Alpe), medtem ko je bila največja raznovrstnost mravljinčje favne zabeležena v Podpeči. Sicer pa je raznovrstnost mravljinčje favne za spoznanje večja v območjih s sredozemskim favnističnim vplivom.

Ključne besede: Hymenoptera, Formicidae, favna, Slovenija: submediteransko in evdinarsko območje

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UNEXPECTED RECORD OF A PYGMY WHITE-TOOTHED SHREW *SUNCUS ETRUSCUS* IN CENTRAL SLOVENIA (INSECTIVORA, MAMMALIA)

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ABSTRACT

A single Suncus etruscus *skull was found in an* Asio otus *pellet in Ljubljansko barje wetland, central Slovenia. The record is 60 km to the east of the actual range of* Suncus etruscus. *Since the pellet originates from the breeding season and includes also three* Microtus arvalis *skulls, it is unlikely to be of a migratory owl.*

Key words: *Suncus etruscus*, Slovenia, distribution

Pygmy white-toothed shrew *Suncus etruscus* (Savi, 1822), one of the smallest living mammals, populates an extensive area ranging from southern Europe and northern Africa as far east as Burma, Thailand and Yunnan (Hutterer, 1993). In Europe, it is strictly confined to the Mediterranean belt (Spitzenberger, 1990). Different authors found average temperatures to predict well the distribution of this species in various European regions: July 20°C isotherm in France (Fayard, 1984) and mean annual temperature above 12°C in Bulgaria (Popov & Nijagolov, 1991) as well as in the entire European range (Kahmann & Altner, 1956). Lipej & Kryštufek (1992) demonstrated close concordance of *S. etruscus'* distributional border with the 0°C isotherm of the coldest month, which further corresponds exactly to the 20°C isotherm of the warmest month.

During a long-term study on the long-eared owl *Asio otus* biology in the wetlands of Ljubljansko barje (central Slovenia), skull remnants of a single *S. etruscus* specimen were found in the owl pellet. Available are a rostral fragment and both mandibles (Fig. 1). Four unicuspids are clearly visible on the rostrum, which is diagnostic character of the genus *Suncus*. Coronoid height is 3.2 mm and thus within the range of *S. etruscus* from Slovenia (Kryštufek, 1991). The exact locality is Mah (9 km south, 2 km east of Ljubljana; 45°59'N, 14°33'E) and is situated at an altitude of 290 m above sea level. Ljubljansko barje is approximately 60 km (in a line) to the east of the eastern *S. etruscus'* distributional border as defined by Lipej & Kryštufek (1992), being further separated from it by the mountain chain of the Dinaric Alps. The habitats of Ljubljansko barje (fairly wet meadows and mixed/deciduous forests) as well as its climate (average annual temperature is around 9.5°C, average of the coldest month is -1.0°C, and annual precipitation averages approximately 1500 mm) strongly contradict the conditions reported from the *S. etruscus'* area elsewhere in Europe. All this speaks in favour of the introduction of the specimen by the migratory owl.

However, pellet samples were collected at regular intervals and the pellet with *S. etruscus* originates from the nesting period (May 1st, 1995). Furthermore, three common voles *Microtus arvalis* (Pallas, 1779) occurred in the same pellet. According to the present state of knowledge (Kryštufek, 1991; Lipej & Kryštufek, 1992) the distribution areas of the two species do not coincide (see also Fig. 2). Based on this evidence, introduction seems highly unlikely. On the other hand, this particular specimen is the only *S. etruscus* we found among 8422 small mammals extracted from the long-eared owl pellets from Ljubljansko barje between 1982 and 1996. Anyhow, shrews were rarely preyed by the long-eared

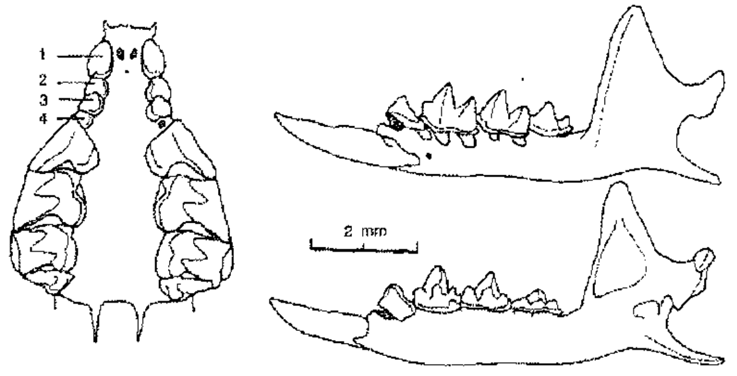

Fig. 1: Skull fragments of Suncus etruscus *which were extracted from a long-eared owl pellet from Ljubljansko barje. Rostral fragment (left) is in ventral view; numbers indicate unicuspids. On right side are left (above) and right (below) side of a mandible.*
Sl. 1: Lobanjski ostanki etruščanske rovke Suncus etruscus, *ki so bili najdeni v izbljuvku male uharice z Ljubljanskega barja. Od fragmenta rostruma (desno) je prikazana ventralna stran; številke označujejo enogrbičaste zobe. Desno sta leva (zgoraj) in desna (spodaj) spodnja čeljustnica.*

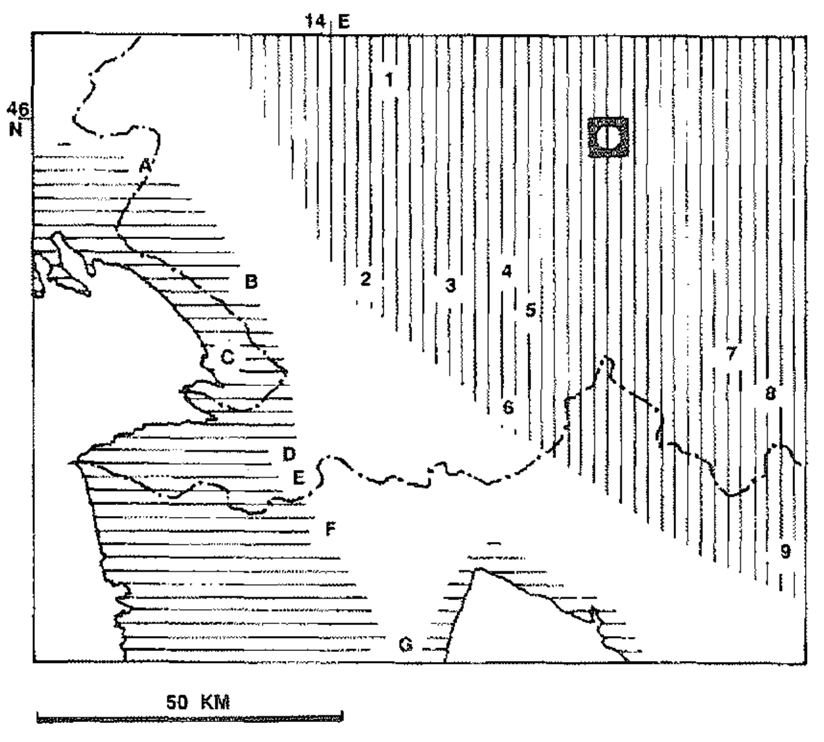

Fig. 2: South-western Slovenia with adjacent regions of Croatia and Italy. Position of the Suncus etruscus' *locality in Ljubljansko barje is indicated by a square. Tentative ranges are given for* Suncus etruscus *(horizontal stripes) and* Microtus arvalis *(vertical stripes), both with bordering records. See text for explanation.*
Sl. 2: Jugozahodna Slovenija s sosednjimi deli Hrvaške in Italije. Nahajališče etruščanske rovke na Ljubljanskem barju je označeno s kvadratom. Podana sta približna areala razširjenosti za etruščansko rovko Suncus etruscus *(ležeče črtano) in poljsko voluharico* Microtus arvalis *(pokončno črtano); za obe vrsti so vrisana mejna nahajališča. Razlaga je v besedilu.*
Localities. - Suncus etruscus: *A - Gorizia; B - Dutovlje; C - Trieste; D - Hrastovlje; E - Movraž; F - Čiritež; G - Lazarići.* Microtus arvalis: *1 - Žirovski vrh; 2 - Razdrto; 3 - Postojna, Jurišče; 4 - Cerknica; 5 - Otok; 6 - Mt. Snežnik, Sviščaki; 7 - Slovenska vas; 8 - Črni potok; 9 - Ravna gora. Corresponding references: Lapini* et al. *(1996): A; Lipej & Kryštufek (1992): B-G; Kryštufek (1987): 1, 3; Petrov (1992): 5, 6; Remžgar (1990): 7, 8; new records: 2, 4.*

owl and only 54 white-toothed shrews *(Crocidura suaveolens* and *C. leucodon)* were obtained so far *(i.e.* 0.6% of the total prey). In the 1995 sample (containing *S. etruscus)* we found only two *Crocidura* specimens among 788 small mammals.

Although we do not believe that this record alone provides sufficient evidence on the occurrence of *S. etruscus* in central Slovenia, we consider it worth publishing for two more reasons:

(1) Although *S. etruscus* is restricted in the western Palaearctic mainly to the coastal belt, there are several records also inland in Transcaucasia, Kazakhstan, Turkmenistan and Uzbekistan (Spitzenberger, 1970). Many of these bordering, if not even extralimital records, are also based on owl pellet remnants (Spitzenberger, 1970; Gromov & Baranova, 1981).

(2) Ljubljansko barje, which is a flat wetland area of 160 km^2, supports a rich shrew guild. Seven species were found so far in a ten hectare study plot, situated approximately 3 km away of the locality of *S. etruscus: Sorex araneus, S. minutus, S. alpinus, Neomys fodiens, N. anomalus, Crocidura leucodon,* and *C. suaveolens* (Kryštufek, 1982 and unpublished results). In the event that the pellet record proves to indicate actual occurrence of *S. etruscus* in Ljubljansko barje, this will raise the number of sympatric shrew species to eight. Eight shrews co-occurring in a fairly restricted area might be the highest number ever recorded for Europe.

NEPRIČAKOVANA NAJDBA ETRUŠČANSKE ROVKE *SUNCUS ETRUSCUS* V OSREDNJI SLOVENIJI (INSECTIVORA, MAMMALIA)

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POVZETEK

V izbljuvku male uharice Asio otus *z Ljubljanskega barja smo našli ostanke enega samega primerka etruščanske rovke* Suncus etruscus. *Nahajališče leži 60 km vzhodno od znanega areala vrste. Ker izbljuvek izvira iz gnezditvenega obdobja, v njem pa so bile prisotne tudi lobanje treh poljskih voluharic* Microtus arvalis, *je malo verjetno, da pripada sovi na migraciji.*

Ključne besede: *Suncus etruscus*, Slovenija, razširjeno

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NOTES ON THE WILD CAT *FELIS SILVESTRIS* IN TURKEY (MAMMALIA, CARNIVORA)

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ABSTRACT

There was no specimen report on wild cat from Turkey for approximately 20 years. We are providing information on two specimens, both obtained in 1990's from the north-western Anatolia: a subadult male from Aydinpinar (skin and skull) and an unsexed skin from the vicinity of Yenice. In both cases the habitat was mixed or deciduous forest. Based on skull dimensions, Aydinpinar male appears too small for the subspecies F. s. caucasica *but falls within the range of the nominate subspecies.*

Key words: *Felis silvestris*, Turkey, status

Of the eight cat species as occurred in Turkey within historical times, three of the largest species already became extinct. The lion *Panthera leo* and the cheetah *Acinonyx jubatus* survived until the 19th century (Danford & Alston, 1880; Harper, 1945) while the last reliable report for the tiger *Panthera tigris* dates back to early 1970's (Kock, 1990). Of the remaining five species, the wild cat *Felis silvestris* Schreber, 1777 is the smallest and also the most widespread. Besides, it is the only wild cat occurring in Asiatic, as well as European Turkey.

Very scanty data on the wild cat occurrence in Turkey are scattered through mammological literature (Blackler, 1916; Pocock, 1935; Çağlar, 1953; Haltenorth, 1953, 1957; Kumerloeve, 1955, 1975; Misonne, 1957; Bodenheimer, 1959; Alkan, 1965; Huş & Göksel, 1981); in addition, a tentative distribution map was provided by Turan (1984). Already Mursaloğlu (1964) warned against overhunting throughout the country which, in her opinion, was threatening the existence of the wild cat. Recently, a similar opinion was expressed also by Serez & Başkaya (1997). They found the wild cat population to be considerably below the estimated capacity of the environment which is said to include 11 million hectares of forested areas which are suitable for the wild cat. In spite of fairly high penalties (approximately 1400 German Marks) pouching is considered to be the main clue for such unfavourable condition. The species is under total protection since 1976, but the law is evidently not enforced (Serez & Başkaya, 1997).

In this communication we are reporting on two wild cat specimens recently obtained from north-western Anatolia. They seem to be the first specimen records after 20 years (compare Kumerloeve, 1975).

The first specimen (subadult male) entered a trap in April 1993 in the village of Aydinpinar near Düzce (district of Bolu). The trap, set near a poultry house, was intended for a marten. The village is situated at the foothills of a mountain covered by deciduous forests. The skin and skull are housed in the Mammal Collection at the Department of Biology, University of Ankara. The back of this specimen is dirty yellowish grey with vertical black stripes and the belly is dirty whitish yellow. The tail is bushy with a black tip and indistinct rings. The rhinarium is pinky. External measurements (in mm): head & body length 480; tail length 300; hind foot

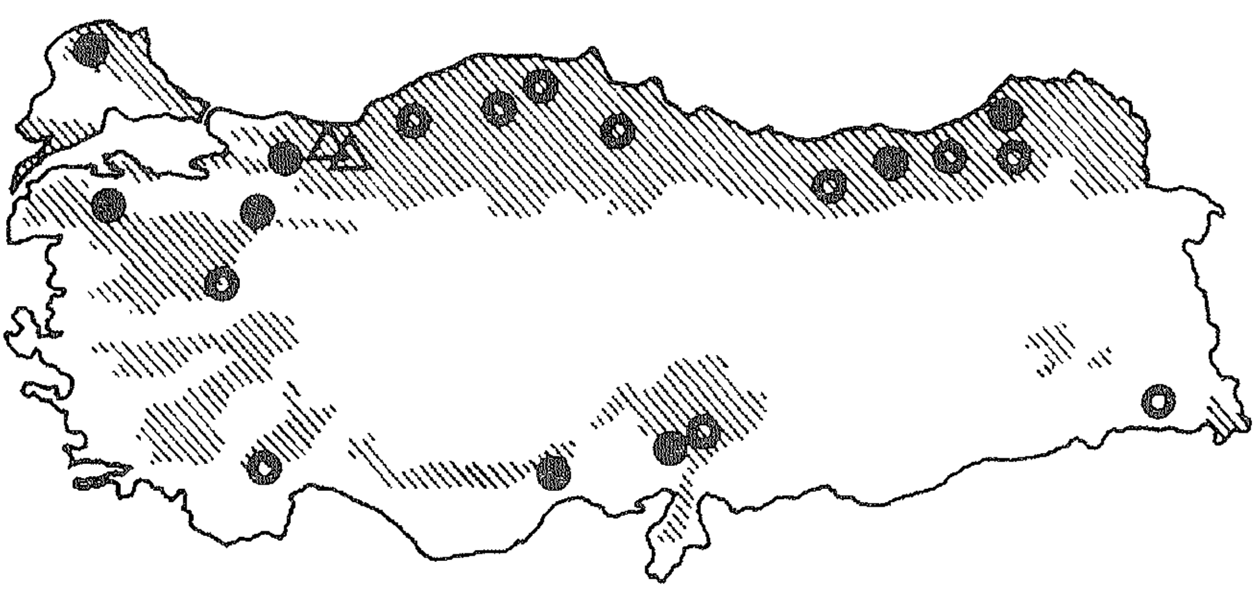

Fig. 1: Distribution of the wild cat* Felis silvestris *in Turkey. Tentative range, as proposed by Turan (1984), is shaded. Given are also published records (dots) as well as the localities obtained through inquiry (circles). The origin of the two specimens, reported in this communication, is indicated by triangles.
Sl. 1: Razširjenost divje mačke* Felis silvestris *v Turčiji. Približen areal (senčeno) je povzet po Turanu (Turan, 1984). Označeni so objavljeni podatki (pike), kot tudi nahajališča dobljena s pomočjo ankete (krožci). Izvor dveh primerkov, ki ju obravnava članek, je označen s trikotnikoma.

length 140; ear length 60; weight 2500 grams. Skull measurements (in mm): greatest length 89.7; condylobasal length 82.9; zygomatic breadth 61.2; interorbital constriction 16.0; braincase breadth 45.4; mastoid breadth 40.3; height of skull 46.0; maxillary tooth-row 30.3; mandibular tooth-row 31.3; mandible length 59.0.

Another specimens is a skin, which was purchased on July 2nd, 1994, from local people near Devrek, 8 km north-west of Yenice in the district of Zonguldak. It was said to originate from the vicinity of a village. The habitat there is comprised of well preserved deciduous forests (*Platanum* sp., *Fagus orientalis, Quercus* spp., and occasionally *Alnus* sp.) in a river valley. Simultaneous small mammal trapping revealed a high density population of rodents (mainly *Apodemus* spp.) and the presence of the bank vole *Clethrionomys glareolus* indicates fairly mesic conditions. The skin (now in the private collection of B.K.) is 74 cm long; length of the tail is 31 cm. A greyish back has a black longitudinal stripe, but no transverse stripes. The belly is dirty whitish with shades of yellowish. There are two broad and additionally two indistinct bands on the tail; its tip is black. The rhinarium is pinky.

Both localities are within the range as proposed by Turan (1984). The same applies to the records published so far (see references above), as well as for the new localities which I.A. obtained through the inquiry (Fig. 1). Populated are mainly wooded mountainous regions in Thrace, as well as in western, northern and southern Anatolia. On the other hand, the species is entirely absent from the deforested central Anatolian plateau.

Two subspecies of wild cat of the *"silvestris"* group are of interest when considering subspecific taxonomy of the Turkish wild cats. The nominate subspecies *F. s. silvestris* (Type locality is Germany) is reported for Europe, and the Caucasian subspecies *F. s. caucasica* Satunin, 1905 (Type locality is Borzhom in the Caucasus) is restricted to the Asiatic part of the *"silvestris"* range (e.g. Corbet, 1978; Heptner & Sludskij, 1980; Hemmer, 1993). As a matter of fact, differences between the two races seem to be scanty. According to Ognev (1962), who was unable to differentiate between them by pelage coloration, the nominate race is smaller. Heptner (1980) gave the following ranges for the condylobasal length in males: nominate subspecies 81.2 - 104 mm; the Caucasian subspecies 88.0 - 102.6 mm. The male from Aydinpinar seems to be referable to the nominate subspecies (condylobasal length amounts 82.9 mm). From the zoogeographical point this is not surprising, having in mind that northern Anatolia is populated also by other mammals of European origin. They presumably crossed the Bosporous land-bridge at one of the Pleistocene Black Sea low stages (Hosey, 1982). Anyhow, this conclusion is necessarily tentative and needs to be confirmed in a more representative sample as well as by other data sets.

ACKNOWLEDGEMENTS

Prof. M. Serez (Trabzon) kindly provided the manuscript of his unpublished oral presentation at the International Symposium on the biology and conservation of the wild cat *(Felis silvestris)*, hold on March 13-16, 1997, in Kyllburg near Cologne. I.A. wishes to express his gratitude to Mr. Osman Ilhan (Düzce, Turkey), who supplied a complete specimen used in this study, and to Dr. I. Tüzün for his help with the earlier draft of the manuscript.

ZAPISKI O DIVJI MAČKI *FELIS SILVESTRIS* V TURČIJI (MAMMALIA, CARNIVORA)

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POVZETEK

Zadnjih dvajset let ni iz Turčije novejših podatkov o divji mački, ki bi temeljili na primerkih. Avtorja poročata o dveh primerkih, dobljenih v 90-ih letih v severozahodni Anatoliji: nedorasel samec iz vasi Aydinpinar (koža in lobanja) in koža (spol ni znan) iz okolice mesta Yenice. Habitat je bil v obeh primerih listopaden oz. mešan gozd. Primerek iz Aydinpinarja je, sodeč po lobanjskih dimenzijah, premajhen za podvrsto F. s. caucasica, *vključuje pa se v variacijsko širino nominatne podvrste.*

Ključne besede: *Felis silvestris*, Turčija, status

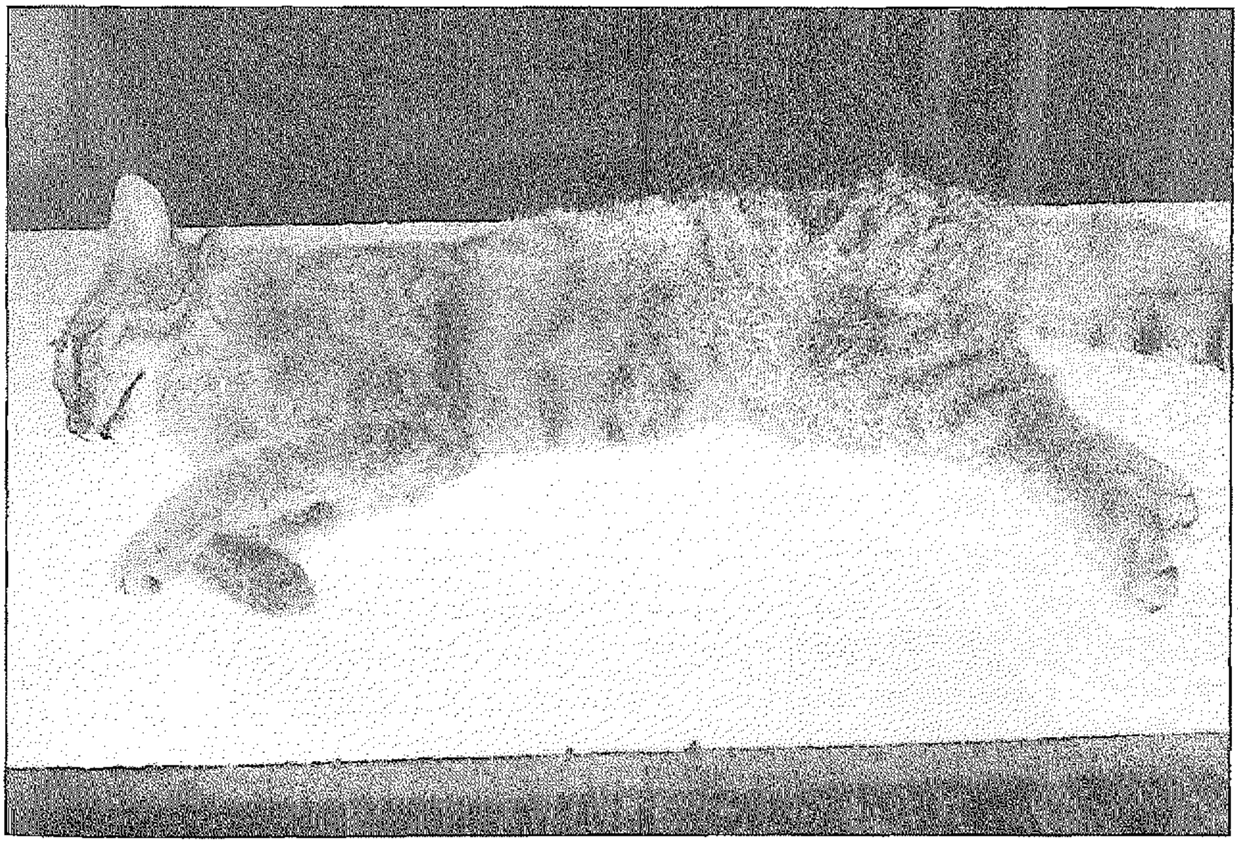

Fig. 2: Subadut male wild cat from Aydinpinar, reported in this contribution.
Sl. 2: Nedorasel samec divje mačke iz Aydinpinarja, ki ga obravnavamo v tem prispevku.

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TEMPORAL DISTRIBUTION OF *ALEXANDRIUM* SPP. IN THE GULF OF TRIESTE (NORTHERN ADRIATIC)

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ABSTRACT

A monitoring program was carried out in the Gulf of Trieste in order to check the quality of shellfish and seawater in which blue mussels (Mytilus galloprovincialis) *are cultivated. The occurrence and temporal distribution of dinoflagellate* Alexandrium *spp., together with environmental conditions in inshore waters, were reported monthly to biweekly from 1994 to 1996. No blooms occurred, but in May 1994 4200 cells l^{-1} of* Alexandrium *species were found along the southeastern side of the Gulf, while on the northwestern side densities up to 4000 cells l^{-1} peaked in July 1995. An unknown species for the area, presumably related to* A. acatenella, *was observed for the first time with the scanning electron microscope.*

Key words: dinoflagellates, *Alexandrium* spp., environmental factors, PSP toxicity, Gulf of Trieste

INTRODUCTION

The regular occurrence of toxic dinoflagellates is well documented in the Northern Adriatic Sea (Boni, 1983; Honsell *et al.*, 1992; Mozetič & Obal, 1995). Scientific attention increased particularly since the first DSP (diarrhetic shellfish poisoning) intoxication in 1989 (Boni *et al.*, 1992; Sedmak & Fanuko, 1991) to which *Dinophysis* (Dinophyceae) species were connected as the potentially causative organisms. Since then, monitoring programs were set up to identify potentially toxic dinoflagellates and their temporal occurrence as well as toxicity of blue mussels on shellfish farms of the Gulf of Trieste (Northern Adriatic).

Up to now no cases of PSP (paralytic shellfish poisoning) human intoxication have been recorded from the Northern Adriatic, although PSP toxins have been detected in blue mussels from the Emilia Romagna (Italy) coast (Honsell *et al.*, 1996). Since the first observation of the genus *Alexandrium* on the western side of the Northern Adriatic in 1982 (Boni *et al.*, 1983), five species of the genus have been identified (Honsell *et al.*, 1992, 1996). However, there is still a lack of information regarding their temporal distribution and dynamic on a yearly basis.

The aim of this work was to study the seasonality of *Alexandrium* species in the Gulf of Trieste, together with the main environmental factors.

MATERIALS AND METHODS

The Gulf of Trieste (Fig. 1) is a shallow, semi-enclosed embayment with a maximum depth of ca. 25 m in its central part. It is characterized by large temperature variations (6-26°C in the surface layer and 6-20°C above the bottom) and, following the seasonal freshets, surface salinity oscillations (<30-38.5). Along the northwestern (Italian) coast there are large mussel farms, while on the southeastern (Slovenian) part there are three shellfish farms. Six stations near the shellfish farms were included in the monitoring program.

On the Italian side, the sampling for temperature, salinity and *Alexandrium* abundance was carried out monthly from July 1994 to December 1996 at stations

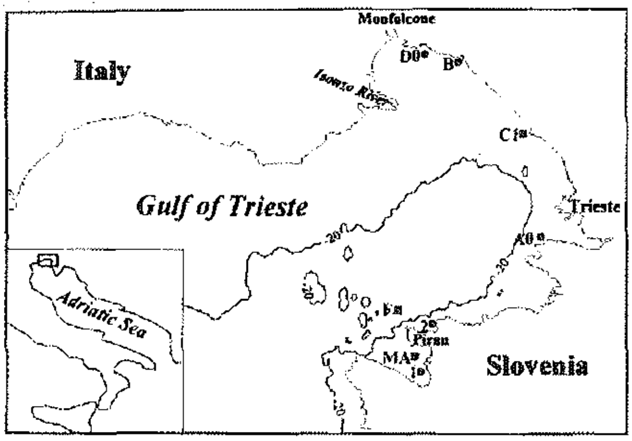

***Fig. 1:** Sampling locations in the Gulf of Trieste (Adriatic Sea): (●) stations close to the shellfish farms and (■) oceanographic stations.*
***Sl. 1:** Vzorčevalna mesta v Tržaškem zalivu (Jadransko morje): (●) postaje v bližini školjčnih nasadov in (■) oceanografske postaje.*

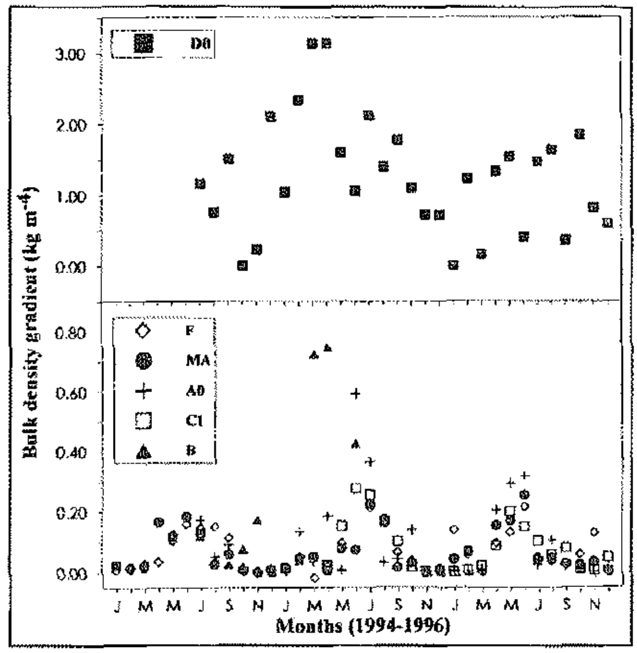

***Fig. 2:** "Bulk" density gradient at six stations in the period 1994-1996.*
***Sl. 2:** Vertikalni gostotni gradient na šestih postajah v obdobju 1994-1996.*

A0, D0 and B. Station B was from May 1995 to December 1996 replaced with station C1. Water samples (500 ml) for cell counts were collected at 0 m, 2 m, 5 m and above the bottom. Stations A0 and B are 10 m deep, while the depths of stations C1 and D0 are 17 and 5 m, respectively.

Samples for cell counts (800 ml) were collected biweekly at the subsurface (2.5 m) from April 1994 to November 1996 at stations 1 and 2 on the Slovenian side. From January 1994 to December 1996, temperature, salinity, phosphate and inorganic nitrogen (nitrate+nitrite+ammonium) concentrations were measured at two stations (F and MA) close to shellfish farms 1 and 2 (Fig. 1). Nutrients were measured at 0, 5, 10 m and above the bottom (21 and 16 m at stations F and MA, respectively), although, only mean concentrations from 0 and 5 m were used for this purpose.

Temperature and salinity profiles were recorded with a CTD probe, while nutrients were analyzed on unfiltered samples using standard colorimetric procedures (Grasshoff, 1976). Temperature and salinity data were used to calculate "bulk" density gradient (c) as follows

$$c = (\sigma_{Tb}-\sigma_{Ts})/H$$

where σ_{Ts} and σ_{Tb} are surface and bottom densities (kg m^{-3}), respectively, and H is water column depth (m).

Alexandrium species were identified in formaldehyde fixed subsamples and counted on the inverted microscope with a magnification of x200. Some samples with a high abundance of *Alexandrium* spp. were also prepared for scanning electron microscopy using a SEM Leica Cambridge Stereoscan 430i. Both microscopic methods, optical and electronic, are described in detail in Zingone *et al.* (1990).

RESULTS AND DISCUSSION

Hydrography and nutrients

During the investigated period the surface temperatures ranged from 7.3°C to 27.2°C. A decrease in surface salinity was observed in the periods of higher freshwater discharge, especially in late spring and autumn (from 27 to 34), while in other months higher salinity values were measured (>34 to 38). The exception was station D0, which is directly influenced by the Isonzo River, the largest freshwater source in the Gulf of Trieste. At this station extremely high salinity oscillations were observed in the surface layer (from 17 to 37). Stability of the water column is described with a "bulk" density gradient (Fig. 2). Generally, from April to October the water column was stratified (c>0.05), while during the other months it was mixed. Station D0 is shown separately on Figure 2, because the water column was most of the time density-stratified due to continuously diluted surface layer. In the period of thermohaline stratification, *Alexandrium* spp. was found in the seawater samples.

At the F and MA mean phosphate concentrations in the subsurface layer were most of the time below 0.10 or even 0.05 μmol l^{-1} (Fig. 3). The highest concentrations (from >0.20 up to 0.30 μmol l^{-1}) were measured in the summer periods of 1994, 1996, November 1994 and February 1996. Generally, mean phosphate concen-

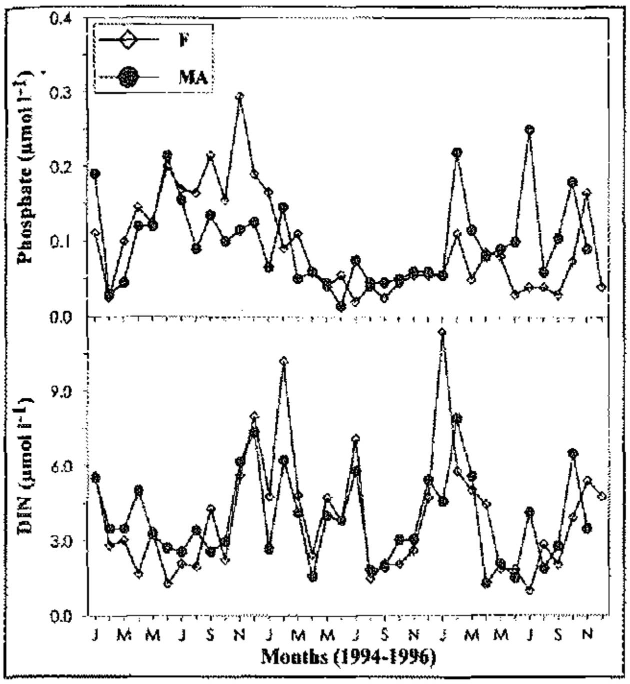

Fig. 3: Mean phosphate and DIN (dissolved inorganic nitrogen) concentrations at stations F and MA in the southeastern part of the Gulf (1994-1996).
Sl. 3: Povprečne koncentracije fosfata in raztopljenega anorganskega dušika (DIN) na postajah F in MA v jugovzhodnem delu zaliva (1994-1996).

trations increased from May to November in the years 1994 and 1996, whereas in 1995 the highest concentrations (>0.05 µmol l^{-1}) were measured in the first three months and July.

In the upper water column, nitrate was the predominant form of dissolved inorganic nitrogen. Highest mean concentrations (around 10 µmol l^{-1}) were found in the winter-spring and autumn periods (January-March, November), and only once in the summer period (July 1995) (Fig. 3). The peaks of inorganic nitrogen, especially nitrate, are connected to external nitrogen inputs from land during spring and autumn freshets of the Isonzo River, and occasionally with rain during the summer storms (Malej *et al.*, 1997). During late spring and summer, concentrations of dissolved nitrogen decreased and became the lowest in July 1996 (1.0 µmol l^{-1}). Besides low phosphate concentrations, calculated high N/P ratios (on average 58) reflect limited phosphate availability during almost the whole investigated period. Only during late spring-early summer in 1994 and 1996 the N/P was close to or below the Redfield ratio of 16.

Temporal and spatial dynamics of *Alexandrium* species

As the identification of *Alexandrium* species is very difficult with optical microscopy, we classified all the observed species as *Alexandrium* spp. *Alexandrium* species were present in the samples during almost each of the months of the 1994-1996 period, but their abundance increased from April to October each year (Fig. 4). In this period cell numbers ranged from undetectable to 4000 and 4200 cells l^{-1} in the northwestern and southeastern part, respectively. On both sides of the Gulf maximal densities were quite similar, but the months of peak abundances were different. The highest abundance was recorded in May-June in the southeastern part, while in the northwestern part abundance peaked later in the season (July-August). Following these peaks, abundance decreased significantly to increase slightly again in September and/or October at some stations. In the northwestern part cells counted at discrete depths were integrated in two layers: subsurface, low-salinity layer (from 0 to 5 m), and a deeper layer above the bottom. Generally, higher abundance was found in the subsurface layer, whereas at station B maximal densities were at 10 m.

Among *Alexandrium* species we identified *A. pseudogonyaulax* and *A. minutum*, two species already reported from the Gulf of Trieste (Honsell *et al.*, 1992). During the abundance maximum of genus *Alexandrium* in May 1994 new species for this area was found in the southeastern part. Based on scanning electronic observations it is presumably related to *A. acatenella* (Fig. 5; Fukuyo, *pers. comm.*). Interestingly, in 1996 a similar species appeared in the samples from the northwestern part and it was isolated. Although more detailed morphological study has to be done to ascertain the taxonomic position of *A.* cf. *acatenella*, it is likely that a new *Alexandrium* species did appear on both sides of the Gulf of Trieste. In our case the isolated species is now kept in cultures for morphological and possibly biochemical (HPLC analyses for PSP toxins) studies.

Environmental factors and *Alexandrium* abundance

The seasonality of *Alexandrium* spp. in the Gulf of Trieste is similar to those observed in other Mediterranean areas, with even higher maximal densities especially in the upper, less-saline layer and in connection with developed thermohaline stratification (Delgado *et al.*, 1990; Giacobbe *et al.*, 1996). In our study we observed that the increased cell numbers coincided with the decreased surface salinity in late spring-early summer at all stations. The exception was again station D0, where in a very diluted surface layer (salinity <20, April 1995) *Alexandrium* spp. was not found, but was present at 2 m (salinity >30). Although intense autumn freshets caused another surface-salinity decline, *Alexandrium* abundance did not increase. This is probably linked to the destratification of the water column and lower temperatures compared to the spring-summer period. Higher temperatures, a stratified water column and ab-

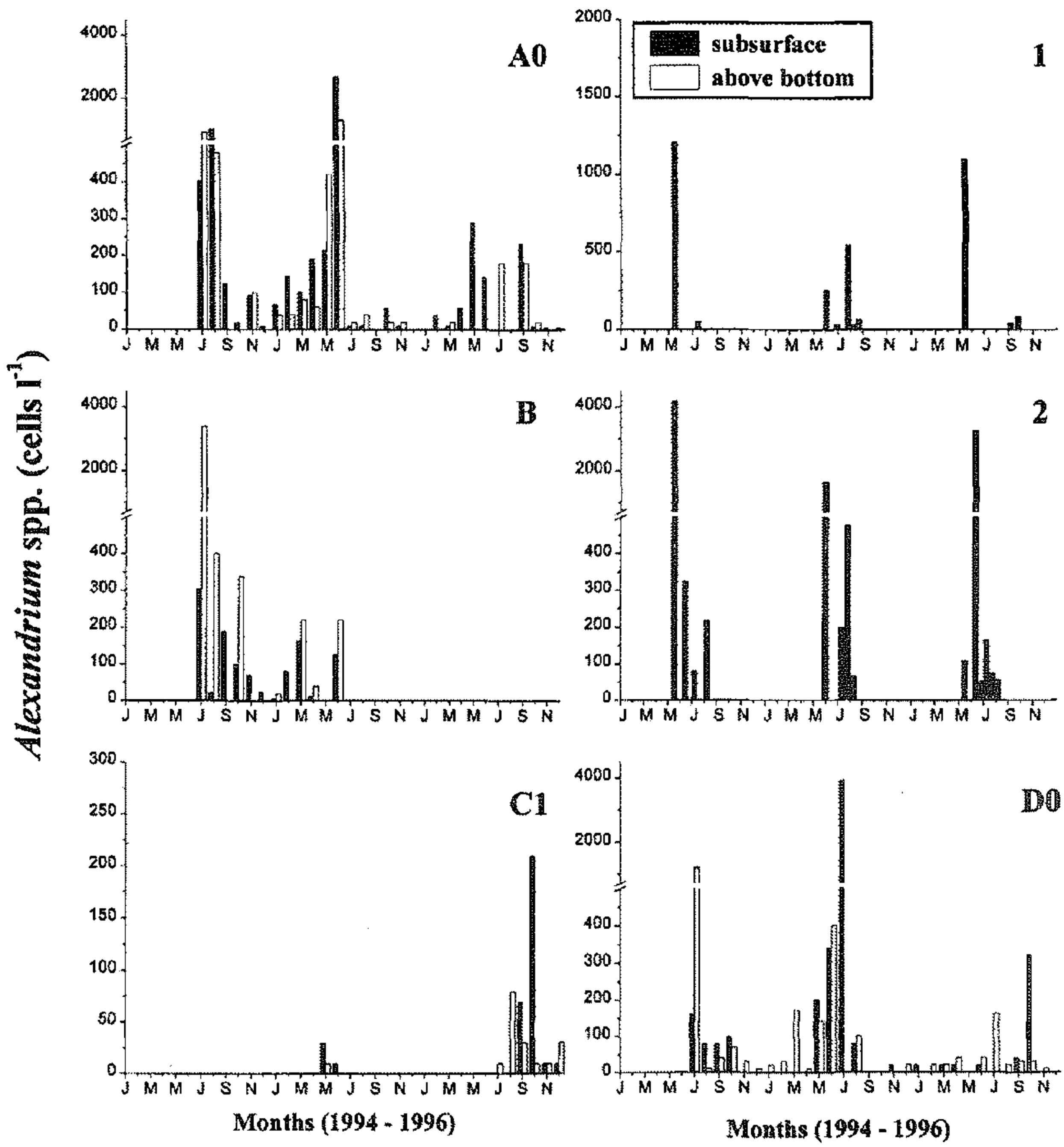

***Fig. 4:** Alexandrium* **spp. abundance at six stations in the period 1994-1996. (Note the different units on y axes.)**
***Sl. 4: Gostota vrst iz rodu** Alexandrium* **na šestih postajah v obdobju 1994-1996. (Upoštevaj različne enote na oseh y.)**

sence of turbulence seem to be favorable conditions not only for *Alexandrium* but for dinoflagellates as a group (Paerl, 1988). In mixed and nutrient enriched autumnal conditions diatoms prevail in the phytoplankton community of the Gulf of Trieste (Malej *et al.*, 1995; Cabrini *et al.*, 1994)

As mentioned above, mean phosphate concentrations increased from May to November in the years 1994 and 1996, and in July 1995. These periods coincide with the occurrence of *Alexandrium* species at the nearby stations 1 and 2. However, during the periods of favorable phosphate conditions *Alexandrium* abundance peaked (>1000 cells l^{-1}) only on few occasions (May 1994, 1995, 1996, June 1996), suggesting that factors other than phosphate availability control the *Alexandrium* dynamics. Coincidence of high temperature, low salinity, stability of water column, high phosphate concentration and low N/P ratio, with high density of *Alexandrium* spp., was also observed in the Sicily lagoon, Mediterranean Sea (Giacobbe *et al.*, 1996). Several studies have also shown strong relationship between phosphate limitation and toxin production in *Alexandrium* species (Boyer *et al.*, 1987; Anderson *et al.*, 1990). However, in our case the results should be interpreted with care for at least two important reasons. *Alexandrium* abundance and nutrient concentrations were not measured in the same water sample, but from two, although close, different locations. It means that nutrient data allow to give an idea of the general situation in the area. Secondly, an important ecophysiological characteristic that should be taken into consideration is the ability of many free-living dinoflagellates to perform diel vertical migrations through the water column (Eppley & Harrison, 1975). For example, in our case inorganic nitrogen concentrations were low during the period of *Alexandrium* occurrence, which might suggest that *Alexandrium* cells could utilize deep nitrogen sources through vertical migrations. This behavioral adaptation enables a population of toxic dinoflagellates to persist in many nitrogen-depleted, summer-stratified surface coastal waters (Koizumi *et al.*, 1996; MacIntyre *et al.*, 1997).

In conclusion, our study confirmed the presence of *Alexandrium* spp. in the Gulf of Trieste and its increased abundance from April to October. Maximal cell numbers were recorded during thermohaline stratification of the water column, in a less-saline subsurface layer. A more detailed study on the influence of other environmental factors, mainly nutrients, on *Alexandrium* seasonality in the Gulf of Trieste is to be carried out in the future.

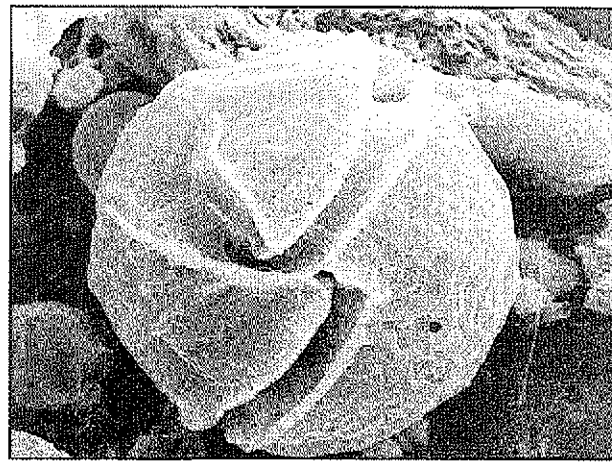

Fig. 5: Scanning electron micrograph of** Alexandrium **sp. (presumably related to** A. acatenella**) from the southeastern part of the Gulf of Trieste.
***Sl. 5: Posnetek (elektronski mikroskop) vrste** Alexandrium **sp. iz jugovzhodnega dela Tržaškega zaliva, ki je najverjetneje sorodna vrsti** A. acatenella.*

ČASOVNA PORAZDELITEV VRST IZ RODU *ALEXANDRIUM* V TRŽAŠKEM ZALIVU (SEVERNI JADRAN)

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POVZETEK

V prispevku avtorji podajajo rezultate triletnega spremljanja gostote toksičnih vrst dinoflagelatov na šestih postajah v bližini školjčnih nasadov užitne klapavice vzdolž italijanske in slovenske obale Tržaškega zaliva. Dinoflagelati iz rodu Alexandrium *so povzročitelji paralitične zastrupitve s školjkami (PSP) pri ljudeh, zato je že nekaj let na obeh straneh zaliva vpeljan program rednega spremljanja kakovosti morske vode in školjk. Poleg časovne in prostorske porazdelitve celic* Alexandrium *spp. v obdobju 1994-1996 so avtorji spremljali tudi nekatere fizikalno-kemijske parametre (temperatura, slanost, hranilne snovi).*

Vzorčevanje v mesečnih do dvotedenskih presledkih od leta 1994 do 1996 je pokazalo, da se Alexandrium *spp. pojavlja skoraj v vseh mesecih, vendar njegova gostota naraste v obdobju od aprila do oktobra vsako leto. V jugovzhodnem delu zaliva je bila največja gostota zabeležena v maju 1994 (4200 cel. l^{-1}), v severozahodnem delu pa julija 1995 (4000 cel. l^{-1}). Ti spomladansko-poletni viški so se ujemali z gostotno razslojenostjo vodnega stolpca,* *kot posledico povišanih temperatur in oslajevanja zgornjih slojev. V obdobju naraščajoče gostote vrst iz rodu* Alexandrium *so bile v jugovzhodnem delu zaliva izmerjene povečane koncentracije fosfata, vendar so bili viški števila celic (>1000 cel. l^{-1}) izmerjeni le štirikrat v daljšem obdobju ugodnejših fosfatnih razmer.*

Avtorji opozarjajo na previdnost pri razlagi sezonske dinamike roda Alexandrium *zlasti zaradi dveh pomembnih dejstev: 1. število celic in koncentracija hranilnih snovi so bili merjeni na dveh različnih, četudi blizu ležečih postajah, zatorej izmerjene koncentracije hranilnih snovi odsevajo zgolj splošne hranilne razmere na tem območju; 2. za dinoflagelate je značilna dnevna vertikalna migracija po vodnem stolpcu, kar jim omogoča izkoriščanje globljih, bogatejših virov hranil zlasti v plitvih, temperaturno razslojenih priobalnih vodah.*

V vzorcih morske vode je bila z elektronskim mikroskopom odkrita do sedaj nepoznana vrsta Alexandrium *sp. iz Tržaškega zaliva, ki je najverjetneje sorodna vrsti* A. acatenella. *Vendar so za pravilno taksonomsko določitev in morebitno toksičnost potrebne nadaljnje morfološke in biokemijske raziskave na monokulturi izolirane vrste.*

Ključne besede: dinoflagelati, *Alexandrium* spp., dejavniki okolja, PSP zastrupitev, Tržaški zaliv

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FIRST CONTRIBUTION TO THE KNOWLEDGE OF MICROBENTHIC PROTISTS FROM THE VENICE LAGOON

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ABSTRACT

The importance of protists, especially ciliates, in marine communities has been stressed by many authors; since these organisms feed at various trophic levels, e.g., bacteria, algae of various sizes, and other ciliates.

The protists living in the Lagoon of Venice have been poorly studied. It seemed particularly interesting to investigate their populations in this environment, the hydrological dynamics of which have been seriously modified and which is continuously subjected to large-scale anthropic modifications and polluted by waste from several different sources.

This paper presents preliminary data on microbenthic protists in sediment samples collected in May and September 1995 from six stations of the Venice Lagoon. Twenty-one genera of ciliates were found. The highest concentration recorded in station 1, also characterized by the highest concentration of fine sand, was about 100 cells. ml^{-1}, whereas that of flagellates was about 1000 cells. ml^{-1}, with a lower number of taxa in all stations sampled.

Key words: microbenthos, Protists, Ciliates, Flagellates, Venice Lagoon

INTRODUCTION

Since the earlier part of this century it has been recognized that protists form a diversified quota of the biota living within marine benthic habitats. Most work has been concentrated on ciliated protozoa, which appeared to be dominant consumers in some benthic habitats (Kahl, 1930-35; Czapik & Fyda, 1992; Dragesco, 1963a, b; Epstein *et al.*, 1992; Fauré-Fremiet, 1950; Fenchel 1967, 1968, 1969, 1987; Hartwig, 1980a, b) and in recent years also on other protists, such as heterotrophic flagellates, all involved in microbial food webs (Fenchel, 1986; Patterson *et al.*, 1989). Sediment particle size influences the organic content of sediments, water and oxygen penetration, oxygen content, and accessibility by protists or metazoan competitors, and granulometric characteristics have a marked effect on the composition of protist biota. Microbenthic organisms include sessile and vagile unicellular eukaryotic species living on the surface of, or within, sediments; in the former case, the organisms are defined as components of the microbiotecton or epipsammon, in the second as mesopsammon. Many protists cannot be included exclusively in either class (Patterson *et al.*, 1989).

Admittedly, many difficulties are encountered when examining microbenthic commmunities, *e.g.* species determination, collection of qualitative and quantitative data, and the almost complete uselessness of analysing fixed samples (Finlay & Guhl, 1992).

As already mentioned, the protists living in the Lagoon of Venice have been poorly studied: very old data are available in the literature (Kiesselbach, 1936) together with some recent data on a new *Euplotes* morphospecies, *E. margherensis* (Coppellotti & Cisotto, 1996), which has greater resistance to copper than other species of *Euplotes* (Coppellotti & De Gabrieli, 1995).

The Lagoon of Venice is a unique ecosystem which originated nearly 6000 years ago and now consists of a semi-enclosed body of water connected with the Adriatic Sea through three channels (Bendoricchio *et al.*, 1993). The hydrological dynamics of this environment have been modified by various anthropic activities. The Lagoon receives wastes from various sources, all of which are very numerous and complex, such as discharges of treated and untreated domestic sewage, treated industrial effluent, and cooling water from the industrial zone, and also pollutants, such as heavy metals, transported down the waterways flowing into the Lagoon. Particular attention was paid to sediments, because it is well known that heavy metals and organic micropollutants are closely associated with this fraction, from which they may be resuspended (Donazzolo *et al.*, 1984; Martin *et al.*, 1994). For all these reasons, this area may be highly selective. Some other types of organisms, such as macroalgae, have been used as biological indicators for the Lagoon of Venice (Favero *et al.*, 1996).

It seems particularly interesting to investigate protist populations in this peculiar environment, which is continuously subjected to large-scale anthropic modifications. The studied organisms belonged to the taxonomic group of Ciliophora and to the flagellate group, a heterogeneous assemblage of protists equipped with flagella.

MATERIALS AND METHODS

Samples were taken from the sediments of six stations in the Venice Lagoon, chosen for their different environmental characteristics (Fig. 1). Station 1 was located near the hydrobiological station of Chioggia, subject to pollution by urban waste; stations 2 and 3 were located at mussel-farming sites; station 4 was in an area polluted by industrial waste; station 5 lay between the industrial zone of Marghera and the city of Venice, and is polluted by both industrial and city waste; and station 6 was located in a "clean" site in the northern part of the Lagoon.

Samples were collected in May 1995 from all stations and in September 1995 from station 1 only.

Sampling was carried out by pressing a plexiglass tube 3.2 cm in diameter some 10 cm into the sediment and that part of sediment from 0 cm to 2 cm below the surface was collected. Samples thus consisted of 16 ml each, and were placed in plastic 500-ml bottles. A minimum of three samplings was made for each station. 100 ml of seawater, filtered through 0.22 μm Sterivex-GS mesh (Millipore) and having the same salinity as that of the collection site, were added to the sediment samples.

Samples were taken to the laboratory in a refrigerated container and were observed within 6 hours.

Three procedures were adopted for examination of samples:

1) Uhlig's "seawater ice" method (Uhlig, 1964) for extracting interstitial microfauna: sediments were filtered through nylon nets (200, 100, 60 and 45 μm meshes).

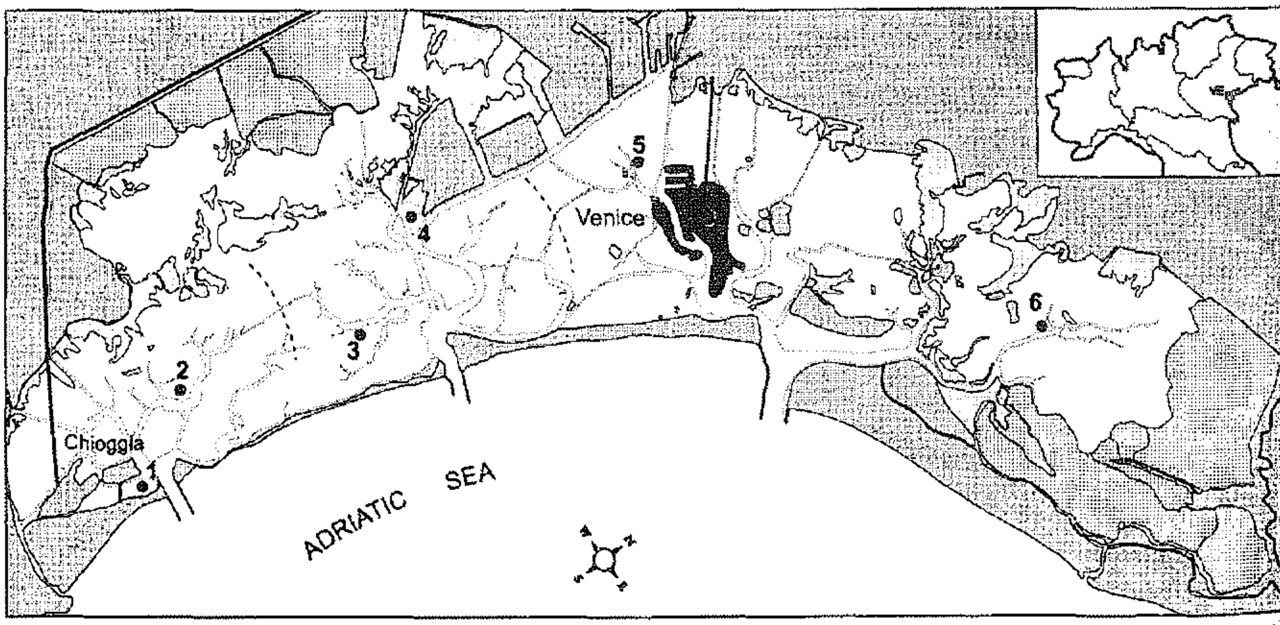

Fig. 1: Lagoon of Venice and location of sampling stations.
Sl. 1: Beneška laguna in lokacija vzorčnih postaj.

This method was only used for sediments composed of relatively large sand particles with low percentages of silt and clay, which are washed through with the protozoa.

2) Three sub-samples were prepared by withdrawing 10 ml of diluted sediment and adding 90 ml of filtered seawater. Ciliates and flagellates were counted in five 100-µl drops for each sub-sample under a Leitz Diaplan microscope at magnifications of 310x or 500x, following the indications of Finlay & Guhl (1992).

3) Six sub-samples were prepared from each bottle by withdrawing 5 ml, to which 45 ml of seawater were added. Quantitative observations and initial identification of ciliates were carried out on every sub-sample under a Wild M8 stereomicroscope. Living ciliates were removed by a Pasteur pipette and directly counted.

The data on protozoan densities reported in this work were obtained using method 2 for flagellates and method 3 for ciliates, after washing of all sediments by Uhlig's "seawater ice" method where possible.

In most cases, quantitative data refer to genera more than to species, due to the difficulty in collecting simultaneously both qualitative and quantitative data on ciliates. Impregnation by protargol or silver nitrate was used for correct identification of most ciliates, following respectively Wilbert or Chatton-Lwoff procedures as modified by Foissner (1991). Some particularly fragile ciliates, such as those belonging to Kinetofragminophorea, were fixed before impregnation with Raikov's (1978) fluid, normally used in electron microscopy. Drawings of protargol-impregnated specimens were made with the aid of a *camera lucida* under a Diaplan Leitz microscope. The taxonomic scheme by Levine *et al.* (1980) was used. Species descriptions by Kahl (1930-1935), Curds (1975), Curds & Wu (1983), Dragesco (1963a, b), and Carey (1992) were also used. Flagellates were identified with the aid of Prescott's (1962) and Schiller's (1933-1937) descriptions.

Salinity values were determined with a refractometer. Samples were analysed for organic matter content and for grain-size composition according to Buchanan (1984).

RESULTS AND DISCUSSION

Abiotic data

In May 1995 salinity was at a minimum value of 28‰ at station 1 and peaked at 35‰ at station 5. A value of 30‰ was measured at all other stations. In September 1995, salinity was 35‰ at station 1.

Water temperatures were respectively 16°C and 21°C at all stations.

Table 1 lists data referring to the May samplings. The sediments were characterized by compositions of differing percentages: the highest sand content was recovered at station 1 (97.39%) and the lowest at station 6 (14.92%). The highest contents of fine sand (250-125 µm) were measured at station 1 (54.61%) and of median sand (500-250 µm) at station 4 (49.49%). Very high contents of silt were found at stations 6 (68.39%) and 5 (49.55%). Very little organic matter was present at stations 1 (0.26%) and 4 (0.22%).

	Stations						
Grain-size fractions (µm)	1	2	3	4	5	6	
1000-500	0.38	3.07	1.90	10.73	13.57	0.49	
500-250	34.82	12.11	13.40	49.49	7.24	0.57	S
	97.39*	58.73*	63.72*	94.74*	45.00*	14.92*	A
250-125	54.61	26.58	32.31	28.93	4.95	1.55	N
125-63	7.58	16.96	16.11	5.58	19.24	12.30	D
							S
63-15.6	0.65	14.71	18.81	2.19	27.50	42.54	I
	1.24*	25.28*	26.58*	3.40*	49.55*	68.39*	L
15.6-3.9	0.59	10.57	7.77	1.21	22.05	25.85	T
							C
							L
<3.9	1.37	15.99	9.70	1.86	5.45	16.70	A
							Y
Organic matter	0.26	3.13	0.72	0.22	2.13	1.64	

Tab. 1: Grain-size percentage distribution and organic matter content of sediments examined in may 1995.
** Total percentage values refer to sand and silt, respectively.*
Data kindly supplied by Prof. R. Brunetti.
Tab. 1: Porazdelitev zrnavosti (v odstotkih) in vsebnost organske snovi v sedimentu, raziskanem v maju 1995 (v %).
** Skupne odstotkovne vrednosti se nanašajo na pesek in mulj.*
Podatki s prijaznim dovoljenjem prof. R. Brunettija.

Microfauna

Taxa found in the May samplings in all 6 stations are listed in Table 2. With our counting procedures, flagellates were the most numerous protists (approximately 1000 cells. ml^{-1}), although higher numbers of ciliate taxa were recorded at almost all stations. The highest number was recorded at station 1, where ciliates belonging to Kinetofragminophorea were represented by 9 genera, Polyhymenophorea by 6, and Oligohymenophorea by 4. The most frequent genera were *Remanella, Strombidium* and *Aspidisca. Remanella* is common in fine marine sand, its diet comprising diatoms and flagellates. *Strombidium* is generally found in the oxidized zone, where it feeds on diatoms and small phytoflagellates.

	Sampling stations					
Taxa	1	2	3	4	5	6
Flagellates						
Amphidinium sp.	++++					
Gymnodinium sp.	++					
Techadinium sp.	+++					
Oxyrrhis sp.	+++					
Anisonema sp.	++	+++	++	+++		+
Chlorogonium sp.	++	+++	+++	++	+	+
Bodo spp.	++++	++++	++++	++++	+++	+++
Other species	++	++	++	++	++	++
Ciliates						
Kinetofragminophorea						
Lacrymaria sp.	+		+		+	
Mesodinium pulex	+	+			+	
Litonotus sp.	+					+
Trachelocerca schultzei	+					
Trachelocerca sp.	+					
Tracheloraphis sp.	+					
Remanella spp.	+++					
Geleia sp.	+					
Conchostoma longissimum	+					
Colpoda cucullus	+					
Oligohymenophorea						
Frontonia sp.	+	+			+	+
Uronema sp.	+			+		
Pleuronema coronatum	+	+		+	+	+
Cyclidium sp.	++	+				+
Polyhymenophorea						
Condylostoma remanei	+					
Strombidium spp.	+++	+	+	+	+	+
Tintinnopsis sp.		+				
Holosticha spp.	+					
Aspidisca leptaspis	++					
Aspidisca sedigita	++					
Aspidisca spp.	+++		+	+		+
Diophrys appendiculata	+	+				
Euplotes bisulcatus	+					
Euplotes rariseta	+			+		
Euplotes vannus	++	+				++
Uronychia transfuga		+				

+,(<5 CELLS ml^{-1}); ++, (5-15 CELLS ml^{-1}); +++, 15-100 CELLS ml^{-1}); ++++, (>100 CELLS ml^{-1}).

Tab. 2: List of taxa in samplings of May 1995.
Tab. 2: Seznam taksonov v vzorcih iz maja 1995.

Taxa	May	September
Flagellates		
Amphidinium sp.	++++	
Gymnodinium sp.	++	
Techadinium sp.	+++	
Oxyrrhis sp.	+++	
Anisonema sp.	++	+++
Chlorogonium sp.	++	++
Bodo spp.	++++	++++
Other species	++	++
Ciliates		
Kinetofragminophorea		
Lacrymaria sp.	+	+
Dileptus sp.		+
Mesodinium pulex	+	+
Litonotus sp.	+	+
Trachelocerca binucleata		+++
Trachelocerca schultzei	+	++
Trachelocerca sp.	+	++
Trachelonema minima		++
Tracheloraphis sp.	+	+
Remanella spp.	+++	+
Geleia sp.	+	+
Conchostoma longissimum	+	+
Colpoda cucullus	+	
Oligohymenophorea		
Frontonia sp.	+	+
Uronema sp.	+	+
Pleuronema coronatum	+	+++
Cyclidium sp.	++	+
Polyhymenophorea		
Condylostoma remanei	+	
Strombidium spp.	+++	+
Holosticha spp.	+	+
Aspidisca leptaspis	++	+
Aspidisca sedigita	++	+
Aspidisca spp.	+++	++
Diophrys appendiculata	+	+
Euplotes bisulcatus	+	
Euplotes rariseta	+	
Euplotes vannus	++	++

+,(<5 CELLS ml^{-1}); ++, (5-15 CELLS ml^{-1}); +++, 15-100 CELLS ml^{-1}); ++++, (>100 CELLS ML^{-1}).

Tab. 3: List of taxa in samplings of station 1 in May and September 1995.
Tab. 3: Seznam taksonov v vzorcih s postaje 1 iz maja in septembra 1995.

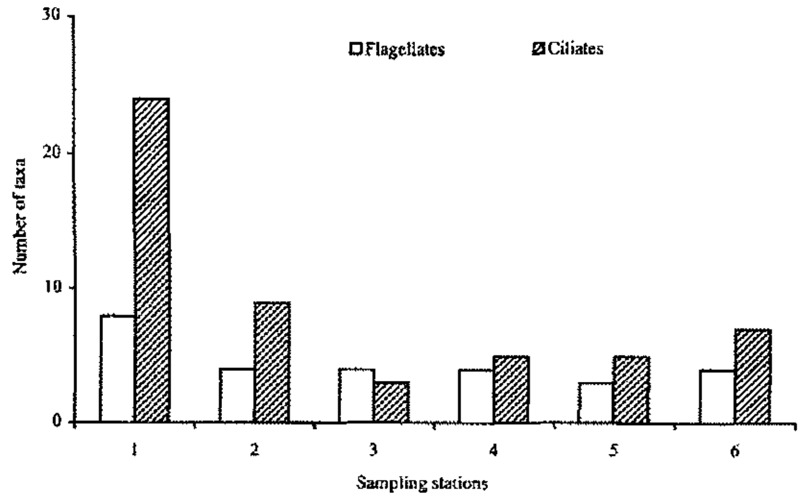

Fig. 2: Number of taxa of Ciliates and Flagellates in six sampling stations of Venice Lagoon in May 1995.
Sl. 2: Število taksonov migetalkarjev in bičkarjev na šestih vzorčnih postajah v Beneški laguni maja 1995.

Ciliate density was very low at the other stations, Oligohymenophorea and Polyhymenophorea being the main groups.The lowest number of genera was found at station 4, *i. e.* 3 genera, whereas 9 were recorded at station 3. *Strombidium* and *Pleuronema* were the most frequently observed genera at all stations.

As regards flagellates, *Anisonema, Chlorogonium* and *Bodo* could be observed at almost all stations, while Dinoflagellates such as *Amphidinium, Gymnodinium, Techadinium* and *Oxyrrhis* were identified only at station 1, where the most numerous genera were the bacterivorous *Bodo* and the phagotrophic *Amphidinium*. It must be noted that diatoms were very abundant in samples from all stations.

The richness of taxa in the May samplings at all stations is reported in Fig. 2. The highest numbers of both flagellate and ciliate taxa are clearly present at station 1. In particular, ciliate taxa numbered 24, and at all stations 26.

On the basis of the data obtained, it was decided to take samples only from station 1 in September 1995. The taxa of this station in May and September are listed in Table 3. Flagellate density was seen to have decreased, mainly because of the disappearance of Dinoflagellates from the September samplings. A remarkable increase in the density of some Karyorelictida, such as the predators *Trachelocerca* and *Tracheloraphis*, was also noted. Indeed, *Trachelocerca* was found to be represented by at least three species. *Trachelonema* also appeared at station 1 in the September sampling.

Direct counts of ciliates in the September samplings yielded the following data: about 70 cells. ml^{-1} of Kinetofragminophorea, especially Karyorelictida; 20 cells. ml^{-1} of Oligohymenophorea, especially *Pleuronema coronatum;* and about 15 cells. ml^{-1} of Polyhymenophorea, without any dominant genus. The morphological traits of some ciliate species after protargol impregnation are shown in Figs. 3, 4 and 5.

These preliminary data indicate that the studied stations of the Lagoon of Venice are characterized by relatively low densities of ciliates.

It is well known that ciliates are most frequent in fine sand (250-125 μm). In finer sand (125-63 μm) their numbers decrease drastically, and in coarser sands (500-250 μm) they also occur in smaller numbers (Fenchel,1969). Larger amounts of organic matter lead to a strongly reducing environment. The richness of station 1 with respect to the other stations may be explained by the composition of its sediments (see Table 1) and by the amount of organic matter. In fact, the highest percentage (54.61%) of fine sand was found at this station. As regards organic matter, a value of 0.26% was recorded at station 1 and a similarly low value (0.22%) at station 4. However, station 4 was located in the industrial zone of the Lagoon, which is known to be highly polluted by heavy metals (Donazzolo *et al.*, 1984; Basu & Molinaroli, 1994) which may thus strongly limit the biological characteristics of the environment and lead to the creation of a highly selective area for microfauna.

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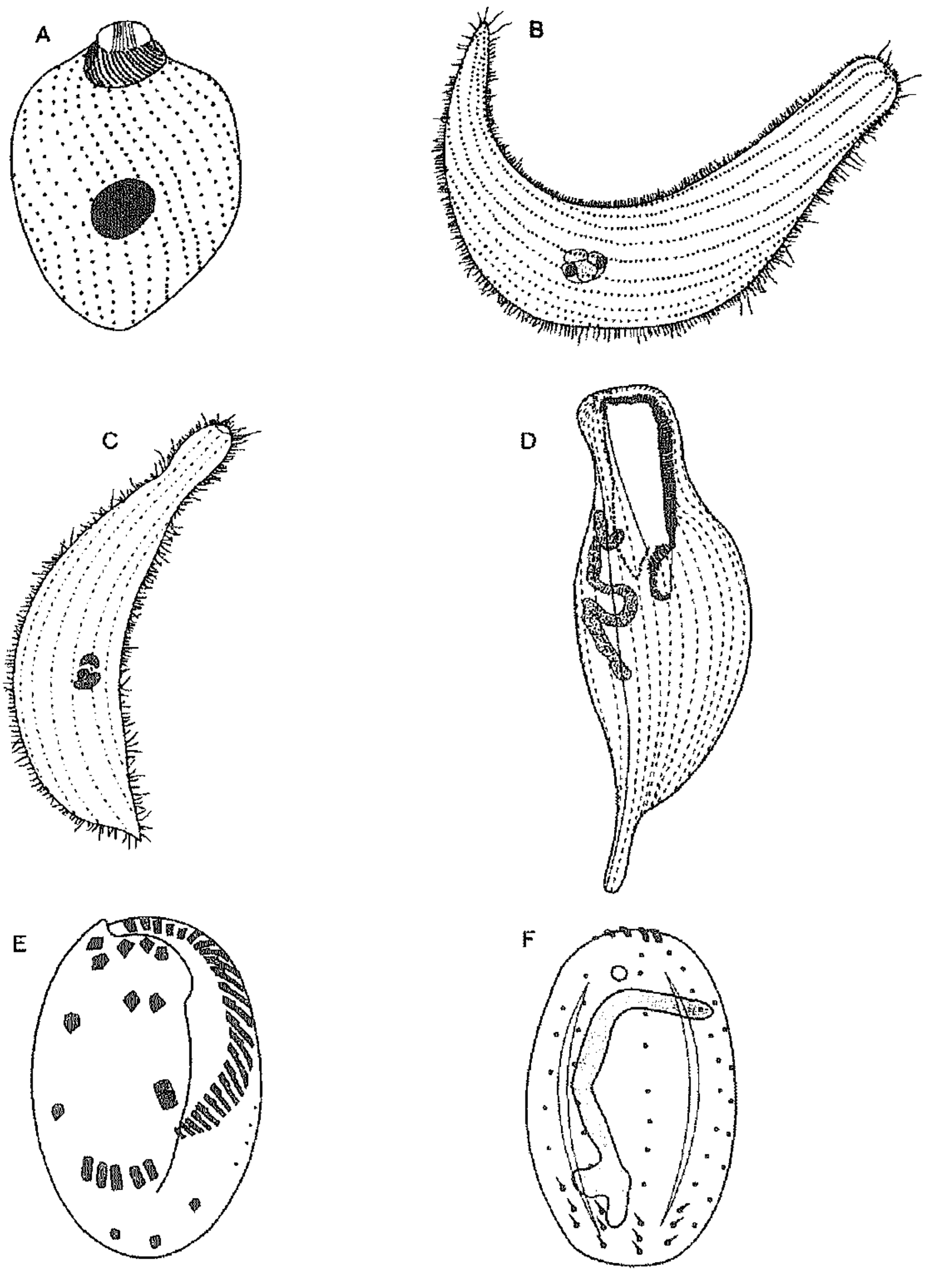

Fig. 3: ***Camera lucida*** ***drawings of protargol-impregnated ciliates. A:*** *Lacrymaria sp.,* ***700x; B:*** *Trachelocerca schultzei,* ***450x; C:*** *Trachelocerca binucleata,* ***450x; D:*** *Condylostoma remanei,* ***290x; E:*** *Euplotes bisulcatus,* ***ventral view, 1100x; F:*** *Euplotes bisulcatus,* ***dorsal view, 1100x.***

Sl. 3: Risbe migetalkarjev (napravljene ob pomoči tako imenovane camera lucida), prepojenih s protargolom. A: *Lacrymaria sp.,* ***700x; B:*** *Trachelocerca schultzei,* ***450x; C:*** *Trachelocerca binucleata,* ***450x; D:*** *Condylostoma remanei,* ***290x; E:*** *Euplotes bisulcatus,* ***pogled s trebušne strani, 1100x; F:*** *Euplotes bisulcatus,* ***pogled s hrbtne strani, 1100x.***

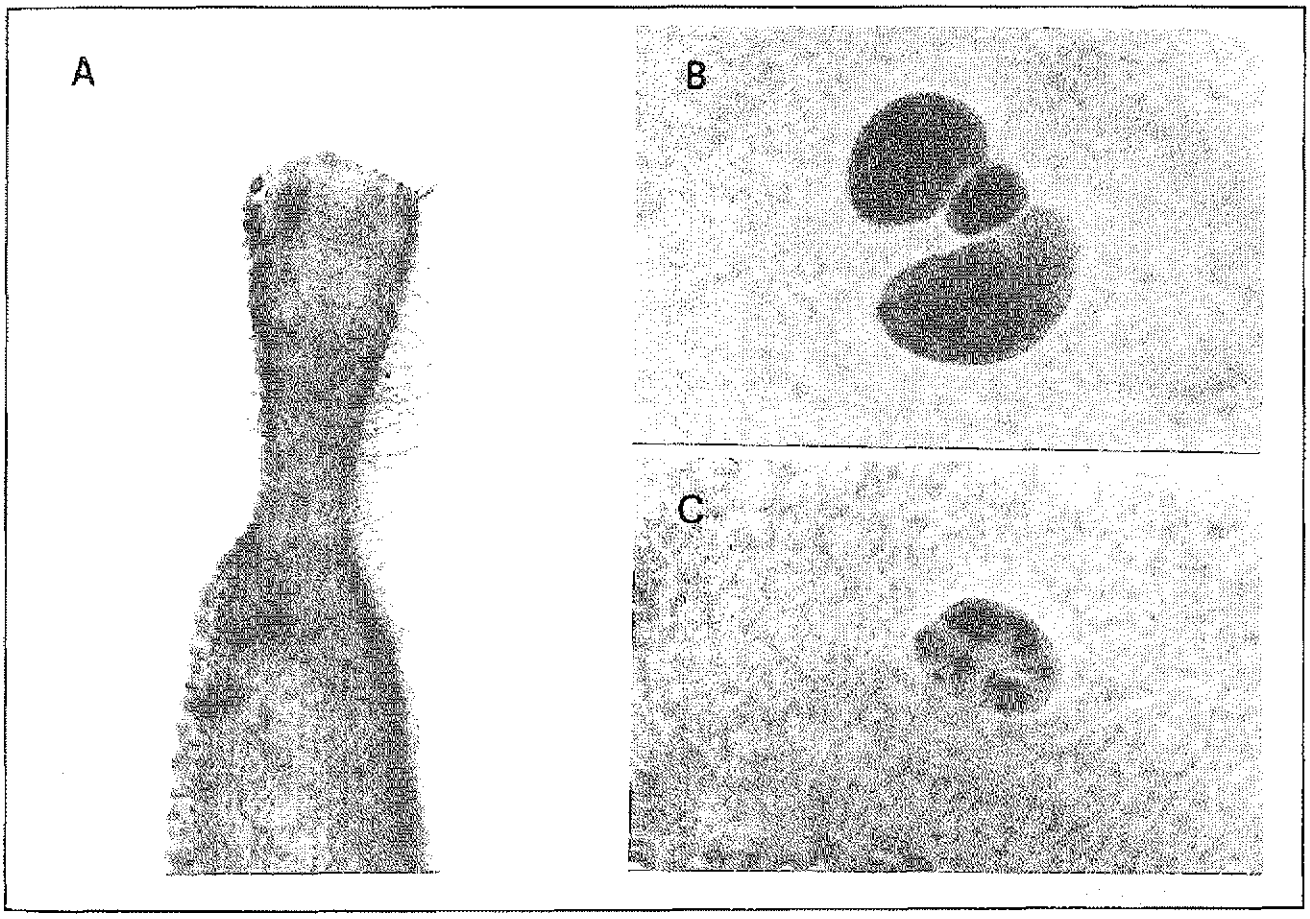

Fig 4: Micrographs of protargol-impregnated specimens. A:** Trachelocerca binucleata, **anterior part of cellular body, 960x; B:** Trachelocerca binucleata, **nuclear apparatus, 1280x; C:** Trachelocerca schultzei, **nuclear apparatus, 1280x.

Sl. 4: Mikrografi primerkov, prepojenih s protargolom. A:** Trachelocerca binucleata, **prednja stran celičnega telesa, 960x; B:** Trachelocerca binucleata, **jedrni aparat, 1280x; C** Trachelocerca schultzei, **jedrni aparat, 1280x.

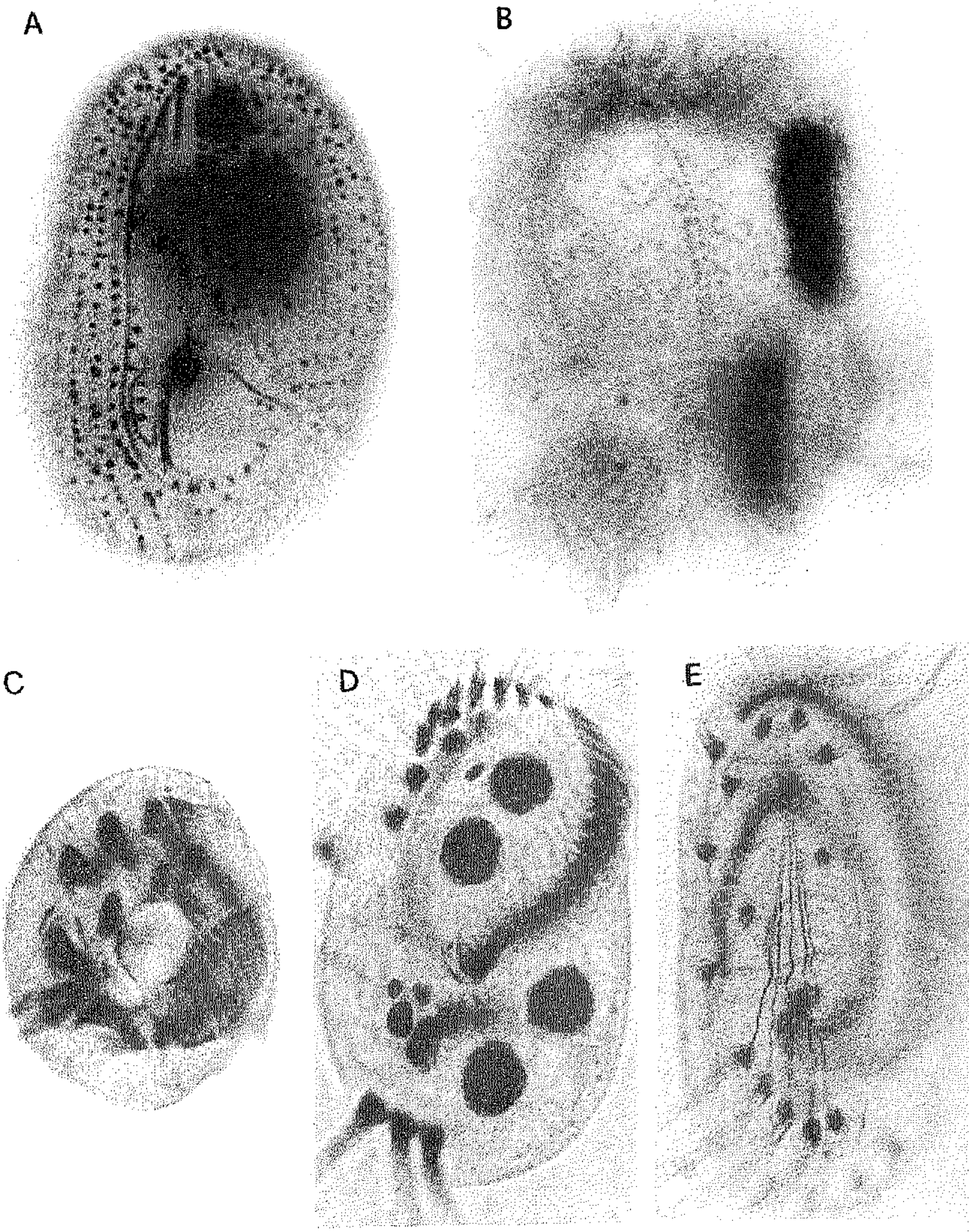

Fig. 5: Micrographs of protargol-impregnated specimens. A: *Pleuronema coronatum,* ***ventral view, 1120x; B:*** *Uronychia transfuga,* ***dorsal view, 1280x; C:*** *Aspidisca sedigita,* ***ventral view, 1280x; D:*** *Diophrys appendiculata,* ***ventral view, 1280x; E:*** *Euplotes vannus,* ***ventral view, 960x.***

Sl. 5: Mikrografi primerkov, prepojenih s protargolom. A: *Pleuronema coronatum,* ***pogled s trebušne strani, 1120x; B:*** *Uronychia transfuga,* ***pogled s hrbtne strani, 1280x; C:*** *Aspidisca sedigita,* ***pogled s trebušne strani, 1280x; D:*** *Diophrys appendiculata,* ***pogled s trebušne strani, 1280x; E:*** *Euplotes vannus,* ***pogled s trebušne strani, 960x.***

PRVI PRISPEVEK K POZNAVANJU MIKROBENTOŠKIH ENOCELIČARJEV V BENEŠKI LAGUNI

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POVZETEK

Na pomen enoceličarjev, posebno migetalkarjev, v morskih združbah so opozorili že mnogi avtorji, saj se ti organizmi hranijo na več trofičnih ravneh, npr. z bakterijami, algami različnih velikosti in drugimi migetalkarji. Enoceličarji, ki živijo v Beneški laguni, so slabo preučeni, zato se nam je zdelo še posebno zanimivo raziskati njihove populacije v tem okolju, katerega hidrološka dinamika se je do danes že temeljito spremenila. Nenehno je namreč izpostavljena velikim antropogenim vplivom in onesnaževanju z odpadki iz več različnih virov.

Pričujoči članek predstavlja preliminarne podatke o mikrobentoških enoceličarjih v vzorcih sedimenta, zbranih v maju in septembru 1995 na šestih postajah v Beneški laguni. Ugotovljenih je bilo 21 rodov migetalkarjev. Njihova največja koncentracija, ki je bila zabeležena na postaji 1 in katere značilnost je tudi največji delež mivke, je bila približno 100 celic. ml^{-1}, največja koncentracija bičkarjev pa okrog 1000 celic. ml^{-1}, z manjšim številom taksonov na vseh vzorčnih postajah.

Ključne besede: mikrobentos, enoceličarji, migetalkarji, bičkarji, Beneška laguna

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MOLLUSCHI CONCHIFERI DEL LITORALE SLOVENO

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RIASSUNTO

Nelle acque della Slovenia sono state identificate 393 specie di molluschi marini conchiferi e per 309 di queste viene indicata la biocenosi preferenziale. Tale numero risulta elevato rapportato alla limitata estensione del litorale sloveno, evidenzia la particolare ricchezza della malacofauna e sottolinea la varietà di biotopi presenti.

Parole chiavi: Mollusca, elenco, Alto Adriatico, Slovenia

INTRODUZIONE

La malacofauna marina dell'Alto Adriatico è stata fonte di studio sin dalla fine dell'800, infatti risale al 1865 la prima pubblicazione degna di nota: "*Enumerazione dei Molluschi del Golfo di Trieste*" di A. Stossich (1865). L'argomento verrà ripreso in alcuni lavori di Weinkauff (1868), M. Stossich (1879), Graeffe (1903), Stiasny (1908), Vatova (1928 e 1949), Coen (1933 e 1937), Matjašič & Štirn (1975) e Velkovrh (1975). Recentemente Bussani & Zuder (1986) forniscono un censimento dei Molluschi della Riserva Marina di Miramare, rielaborato da Vio & De Min (1994). Di Massa (1988-93) esamina dal punto di vista malacologico la Baia di Muggia e Vio & De Min (1996) presentano una lista di molluschi conchiferi rinvenuti nel tratto di mare compreso tra P.ta Tagliamento e P.ta Salvore corredandola con osservazioni biologiche ed ecologiche.

Per quel che riguarda il solo litorale sloveno, benchè dalle pubblicazioni sovra citate si possano ricavare alcuni dati inerenti la sua malacofauna, ad eccezione di De Min *et al.* (1997), sembra non risultare alcun lavoro, il più completo possibile per numero di specie rinvenibili e ben caratterizzato dal punto di vista sistematico. Dal momento che la tassonomia è la base per eventuali futuri studi di varia natura gli Autori hanno ritenuto utile presentare, con una nomenclatura attuale ed aggiornata, i molluschi che vivono nelle acque slovene e le conchiglie spiaggiate.

MATERIALI E METODI

Le osservazioni sui molluschi marini e sulla loro biologia si riferiscono a dati raccolti negli ultimi vent'anni nelle acque costiere della Slovenia sia nel corso di immersioni in apnea o con autorespiratore, sia durante escursioni lungo il litorale.

In questa sede viene presentata una lista dei soli molluschi dotati di conchiglia. Non tutti gli esemplari considerati risultano essere perfettamente integri in quanto, in moltissimi casi, il materiale esaminato proviene da detrito spiaggiato o raccolto tra le reti dei pescatori, ma non sono rovinati a tal punto da compromettere il riconoscimento.

I molluschi viventi sono stati identificati e quindi fissati in una soluzione al 5% di aldeide formica in acqua di mare il tempo necessario per eseguire eventuali ulteriori controlli.

La determinazione delle specie è stata resa possibile consultando numerosi testi ed i principali sono riportati in bibliografia; nel caso in cui si sia trattato di micromolluschi, oppure per visionare meglio alcuni parti-

Fig. 1: Il litorale sloveno con le stazioni di campionamento.
Sl. 1: Slovensko obalno morje z vzorčevalnimi postajami.

colari, ci siamo avvalsi di uno stereomicroscopio Olympus SZ 40, per mezzo del quale abbiamo effettuato anche le microfotografie.

Per quanto concerne la sistematica si fa riferimento al *"Catalogo Annotato dei Molluschi Marini del Mediterraneo"* (Sabelli *et al.*, 1990) pubblicato dalla Società Italiana di Malacologia; per le osservazioni ecologiche, ci si è affidati allo schema della suddivisione del dominio bentonico proposto da Peres & Picard (1964) e ripreso successivamente da Ghirardelli (1981); mentre per quanto concerne l'assegnazione delle biocenosi alle specie si è seguito il lavoro di Vio & De Min (1996). Riteniamo opportuno inoltre specificare che alcune specie sono state rinvenute in località diverse sia viventi sia nel detrito, in tal caso abbiamo considerato più importante riportare le prime provenienze.

RISULTATI

Il litorale

Il litorale sloveno, che comprende buona parte del lato meridionale del Golfo di Trieste, si estende dal confine di San Bartolomeo (Sv. Jernej) con l'Italia fino al fiume Dragogna (Dragonja) che segna la separazione con la Croazia. La costa appare molto frastagliata e notevolmente modificata nell'aspetto originale soprattutto in corrispondenza dei più importanti centri abitati dove sono sorti impianti portuali, industriali e turistici.

Procedendo nella descrizione del litorale da Nord verso Sud possiamo affermare che l'insenatura di San Bartolomeo presenta una costa bassa e caratterizzata da alcune risorgive d'acqua dolce. In corrispondenza di Punta Grossa (Debeli rtič), invece, incontriamo le prime alte formazioni rocciose di flysch (litotipi arenaceo-marnosi) con alla base grossi blocchi franati dalle falesie. Doppiando la Punta, verso Valdoltra (Valdoltra), il litorale si abbassa nuovamente, vi sono massi di dimensioni considerevoli di arenaria e procede in tal modo fino ad Ancarano (Ankaran), da dove iniziano l'area di bonifica presso la foce del Risano (Rižana) e la Valle dello Stagnone (Štanjonska draga) caratterizzata da molti acquitrini e vegetazione palustre. Continuando ci sono le installazioni portuali di Capodistria (Koper), e la massicciata che protegge la strada costiera nel tratto compreso tra Semedela (Semedela) ed il campeggio di

Isola (Izola). Quindi la costa risale caratterizzata da flysch, con affioramenti di "calcare principale ad alveoline" presso P.ta Gallo (Rt Korbat) e S. Simone (Simonov zaliv), che portano alla formazione di strette spiagge ciottolose; successivamente incontriamo rispettivamente la baia di Strugnano (Strunjanski zaliv), sede di un impianto per la produzione del sale marino, posto vicino ad una spiaggia di ghiaia, ed il promontorio di Pirano (Piran) dalle pareti di flysch scoscese, alla cui base riappaiono i massi di arenaria che vengono rimaneggiati dalle onde. Dopo gli impianti turistici di S. Bernardino (Sv. Bernardin), Portorose (Portorož), con il lungomare che si distingue per le spiagge di sabbia fine e Lucia (Lucija), doppiato il Promontorio della Sezza (Rt Seča), la costa si abbassa a formare il Golfo di Pirano, considerato geologicamente come la valle del paleo Dragogna. Tra P.ta Sezza e l'attuale bacino del Dragogna si estendono le saline di Sicciole (Sečoveljske soline), vasta area pianeggiante parzialmente allagata dal mare ora trasformata in Parco Naturale Regionale.

Il fondo marino

I fondali dell'Alto Adriatico sono relativamente bassi ed il Golfo di Trieste in particolare, non supera in media i 25 metri, soltanto in un canalone disposto parallelo alla costa, in prossimità del promontorio di Pirano, raggiunge la profondità di 30 metri.

I sedimenti che ricoprono il fondo marino hanno origine e natura diverse e possono essere sommariamente raggruppati in quattro tipi:

1) la "terra rossa" che proviene dal dilavamento della costa nordorientale, soprattutto durante le intense precipitazioni delle stagioni autunnale ed invernale (Meischner, 1973);

2) i frammenti calcarei derivanti sia dall'azione delle onde sul litorale sia soprattutto dallo scavo e dall'erosione degli organismi appartenenti ai piani superiori del dominio bentonico, attività che assume una notevole importanza lungo le coste dell'Istria (Torunski, 1979);

3) il materiale siliceo proveniente dal Po e dai suoi affluenti e quello delle acque dei fiumi che sfociano nell'Alto Adriatico prevalentemente ricco in carbonati e soprattutto dolomia (Meischner, *ibid.)*; a opinione degli Autori, parte del residuo siliceo può aver origine flyschoide sia per quanto riguarda il sedimento grossolano sia per quello più fine

4) le sabbie grossolane dolomitiche e silicee che ricoprono il fondo al largo dell'Istria di origine pleistocenica (Meischner, *ibid.)*: infatti, il livello del mare che nel Pleistocene era più basso di circa 100 metri, nell'Olocene si innalza ai valori attuali sommergendo in tal modo la piattaforma dell'Alto Adriatico.

La granulometria dei sedimenti permette una distinzione in quattro fasce parallele alla costa e indipendenti dalle isobate. La prima (Zona I), ampia 2-4 chilometri, è caratterizzata da sedimento con granulometria molto variabile (da pochi a circa 1.000 micron) e la componente più fine si accumula nelle depressioni del fondo. Allontanandosi dalla costa, dopo un'area ristretta (Zona II) in cui si depositano solo materiali molto fini, la percentuale sabbiosa aumenta (Zona III) e raggiunge i 160 micron. Più al largo (Zona IV) si arricchisce nuovamente in sedimenti a granulometria più fine (Futterer & Paul, 1976).

La sedimentazione è essenzialmente controllata dagli apporti fluviali e dalla morfologia del fondale, tuttavia anche le correnti marine rivestono un loro ruolo, seppur di minore importanza nella dispersione dei sedimenti; ad una corrente di gradiente, con andamento generale ascendente lungo la costa istriana, si sovrappongono sia le correnti di marea, sia soprattutto quelle di deriva determinate dai venti dominanti. Il moto ondoso, per quanto concerne i processi di sedimentazione, ha effetti locali e limitati date le condizioni di bassa energia che lo caratterizzano; infatti il vento dominante, la Bora, che spira da E-NE, ha un fetch trascurabile, lo Scirocco, che soffia da SE, pur avendo un fetch notevole, pari all'intera lunghezza dell'Adriatico, crea solamente onde rifratte, che perciò raggiungono il litorale sloveno con energia ridotta e lo Scirocco, proveniente da SW, risulta pertanto essere l'unico in grado di sollevare notevoli mareggiate.

Dal punto di vista bionomico, il piano sopralitorale da P.ta Grossa alla penisola di Sezza, è sostanzialmente caratterizzato dalla biocenosi della Roccia Sopralitorale (R.S.), ad eccezione dei tratti di costa bassa (S. Bartolomeo, foce del Risano, baia di Strugnano, Portorose), dove il substrato mobile ospita le biocenosi dei Residui a Rapida Dissecazione (R.R.D.) ed a Lenta Dissecazione (R.L.D.).

Nela zona intertidale vi sono le biocenosi della Roccia Mesolitorale Superiore (R.M.S.) ed Inferiore (R.M.I.). Il piano mediolitorale appare molto sviluppato, come del resto in tutto il Golfo di Trieste, a causa delle notevoli escursioni di marea ed è caratterizzato da un rigoglioso *Fucetum virsoides* Pignatti, 1962, associazione vegetale che si sviluppa in presenza d'acqua non inquinata e soggetta ad un discreto idrodinamismo.

Il piano infralitorale di substrato solido è rappresentato da diverse associazioni vegetali di cui la più diffusa è il *Cystoseiretum barbatae* Pignatti, 1962 presente su tutte le rocce sommerse ed i manufatti (moli, pali, dighe) sino alla profondità di 7-8 metri, mentre le associazioni sciafile si trovano per lo più alla base dei massi frangiflutto e come sottostrato del *Cystoseiretum*.

Il substrato mobile in prossimità della costa, costituito generalmente da sabbia o sabbia pelitica, si presenta in alcuni tratti ricoperto da prati di fanerogame marine. Le caratteristiche del sedimento e la penetrazione luminosa sono i fattori principali che limitano la distribuzione di *Cymodocea nodosa* (Ucria) Asch.; tale fanerogama si estende lungo una fascia che va da circa 1 metro a 7 metri di profondità davanti a quasi tutto il litorale sloveno, fatta eccezione per Capodistria, Isola e Pirano dove gli insediamenti portuali e l'inquinamento urbano hanno ridotto i prati fino alla totale scomparsa. Nel tratto tra Semedela ed Isola, a pochi metri di profondità, vivono dei raggruppamenti ridotti di *Posidonia oceanica* (L.) Delile, che in Slovenia si presenta con il tipico aspetto "a macchie di leopardo" e costituisce una delle poche testimonianze di quando la sua distribuzione era abbondante nelle acque del Golfo di Trieste (Vukovič & Turk, 1995).

Altre aree limitate di fondo mobile costiero sono popolate dalle fanerogame *Zostera marina* (L.) e *Zostera noltí* (Hornem.); la prima presente vicino a sorgenti d'acqua dolce (foci del Risano e Dragogna, Strugnano), mentre la seconda caratteristica dei bassifondi melmosi ricchi di sostanza organica in decomposizione (Baie di Strugnano e Pirano).

Le zone sabbiose costiere libere da fanerogame sono principalmente rappresentate dalla biocenosi delle Sabbie Fini Ben Calibrate (S.F.B.C.), ma nel caso in cui le sabbie siano più grossolane ed il fondo sia soggetto ad un forte idrodinamismo dovuto alle correnti di marea (per esempio nelle piccole insenature), questo popolamento si impoverisce e presenta alcune specie caratteristiche delle Sabbie Grossolane sottoposte a Correnti di Fondo (S.G.C.F.), quelle che Vatova (1949) definì "Sabbie ad Anfiosso".

I fondali al largo, soprattutto quelli del Golfo di Capodistria e della parte interna del Golfo di Pirano, sono caratterizzati da materiali fangoso argillosi di origine continentale e perciò quest'area ospita la biocenosi dei Fanghi Terrigeni Costieri (F.T.C.). Avvicinandosi al confine con le acque territoriali italiane a N-W ed a quelle croate a S-W, il fondale si arricchisce di detrito organico formando la biocenosi del Detritico Fangoso (D.F.) termine di transizione tra la biocenosi F.T.C. e quella del Detritico Costiero (D.C.) che è presente sui fondi sud-occidentali del Golfo di Trieste e sulle sabbie pleistoceniche della parte centrale dell'Alto Adriatico.

CATALOGO DEI MOLLUSCHI CONCHIFERI RINVENUTI SULLE COSTE DELLA SLOVENIA

Note

V = rinvenuto vivente	Frequenza:	r = raro
D = rinvenuto nel detrito		f = frequente
		c = comune

Biocenosi caratteristica o di preferenza:

a) Piano sopralitorale		
substrato solido:	RS	= Roccia Sopralitorale
substrato mobile:	RLD	= Residui Lenta Dissecazione
	RRD	= Residui Rapida Dissecazione
b) Piano mediolitorale		
substrato solido:	RMS	= Roccia Mediolitorale Superiore
	RMI	= Roccia Mediolitorale Inferiore
substrato mobile:	SM	= Sabbie Mediolitorali
c) Piano infralitorale		
sustrato solido:	AF	= Alghe Fotofile
substrato mobile:	GI	= Ghiaie Infralitorali
	SRPV	= Sabbie Relativamente Protette dalle Onde
	SFMC	= *Sabbie Fangose di Moda Calma*
	LEE	= *Lagune Euriterme ed Eurialine*
	SFBC	= Sabbie Fini Ben Calibrate
	SFS	= Sabbie Fini Superficiali
d) Piano circalitorale		
substrato mobile:	DC	= Detritico Costiero
	DF	= Detritico Fangoso
	FTC	= *Fanghi Terrigeni Costieri*
e) Biocenosi indipendenti dal piano:	SGCF	= Sabbie Grossolane con Correnti di Fondo
	MI	= Fondi Mobili Instabili
d) altre indicazioni	Ind.pol.	= specie indicatrice inquinamento
	Ind. dess.	= specie indicatrice di bassa salinità

Stazioni di raccolta dei molluschi riportate nella figura.

Località: 1 = S.Bartolomeo (Sv. Jernej), 2 = Valdoltra (Valdoltra), 3 = Foce Risano (Rižana),
4 = Giusterna (Žusterna), 5 = Isola (Izola), 6 = S. Simone (Simonov zaliv),
7 = Strugnano (Strunjan), 8 = Pirano (Piran), 9 = Punta Sezza (Rt Seča),
10 = Saline di Sicciole (Sečoveljske soline), 11 = Golfo di Capodistria (Koprski zaliv),
12 = Golfo di Pirano (Piranski zaliv).

Classis: **POLYPLACOPHORA** Gray J.E., 1821

Ordo: **LEPIDOPLEURIDA** Thiele, 1909

Famiglia: LEPTOCHITONIDAE Dall, 1889

Lepidopleurus (Lepidopleurus) cajetanus (Poli, 1791) **(V - 7 - 8 - 9 - AF - f)**
Lepidopleurus (Leptochiton) cancellatus (Sowerby G.B.II, 1840) **(V - 12 - DC - r)**

Famiglia: ISCHNOCHITONIDAE Dall, 1889

Ischnochiton (Ischnochiton) rissoi (Payraudeau, 1826) **(V - 7 - 8 - 9 - 10 - AF - f)**
Callochiton septemvalvis euplaeae (Costa O.G., 1829) **(V - 7 - 8 - DC - r)**
Lepidochitona corrugata (Reeve, 1848) **V - 4 - 6 - 7 - 8 - 9 - RMS, RMI - c)**

Famiglia: CHITONIDAE Rafinesque, 1815

Chiton (Rhyssoplax) corallinus (Risso, 1826) **(V - 9 -12 - DC - r)**
Chiton (Rhyssoplax) olivaceus Spengler, 1797 **(V - lungo tutto il litorale - AF - c)**

Famiglia: ACANTHOCHITONIDAE Pilsbry, 1893

Acanthochitona fascicularis (Linné, 1767) **(V - 4 - 5 - 6 - 9 - 12 - AF - c)**

Classis: **GASTROPODA** Cuvier, 1797

Ordo: **DOCOGLOSSA** Troschel, 1866

Famiglia: PATELLIDAE Rafinesque, 1815

Patella caerulea Linné, 1758 **(V - lungo t. il litorale -RMS - RMI - c)**
Patella rustica Linné, 1758 **(V - 8 - 9 - RMS - r)**
Patella ulyssiponensis Gmelin, 1791 **(V - 7 - 9 - RMS, RMI- r)**

Famiglia: ACMAEIDAE Carpenter, 1857

Acmaea (Tectura) virginea (Mueller O.F., 1776) **(D - 6 - 12 - DC - r)**

Ordo: **NERITOPSINA** Cox & Knight, 1960

Famiglia: NERITIDAE Rafinesque, 1815

Smaragdia viridis (Linné, 1758) **(D - 5 - 7 - 9 - AF -f)**

Ordo: **VETIGASTROPODA** Salvini-Plawen & Haszprunar, 1987

Famiglia: FISSURELLIDAE Fleming, 1822

Diodora gibberula (Lamarck, 1822) **(V - tutto il litorale - AF - c)**
Diodora graeca (Linné, 1758) **(V - tutto il litorale - AF - f)**
Diodora italica (Defrance, 1820) **(V - 8 - 9 - 12 - AF - c)**
Emarginula adriatica Costa O.G., 1829 **(D - 12 - r)**
Emarginula octaviana Coen, 1939 **(V - 5 - 6 - 7 - 8 - 12 -AF - f)**
Emarginula rosea Bell T., 1824 **(D - 12 - DC - r)**
Emarginella huzardii (Payraudeau, 1826) **(V - 5 - 7 - 9 - AF - f)**

Famiglia: SCISSURELLIDAE Gray J.E., 1847

Scissurella costata D'Orbigny, 1824 **(D - 6 - r)**
Anatoma crispata Fleming, 1828 **(D - 12 - r)**
Sinezona cingulata (Costa O.G., 1861) **(D - 7 -r)**

Famiglia: HALIOTIDAE Rafinesque, 1815

Haliotis tuberculata lamellosa Lamarck, 1822 **(V - tutto il litorale - AF - c)**

Famiglia: TROCHIDAE Rafinesque, 1815

Clanculus (Clanculopsis) cruciatus (Linné, 1758) **(V - tutto il litorale - AF - c)**
Clanculus (Clanculopsis) jussieui (Payraudeau, 1826) **(V - tutto il litorale - AF - c)**
Calliostoma (Calliostoma) conulus (Linné, 1758) **(V - tutto il litorale - AF- f)**
Calliostoma (Calliostoma) laugieri laugieri (Payraudeau, 1826) **(V - tutto il litorale - AF - f)**
Calliostoma (Calliostoma) zizyphinum (Linné, 1758) **(V - 5 - DC - f)**
Calliostoma (Ampullotrochus) granulatum (Von Born, 1778) **(D - 12 - r)**
Gibbula (Gibbula) albida (Gmelin, 1791) **(V - tutto il litorale - SFMC - c)**
Gibbula (Gibbula) ardens (Von Salis, 1793) **(V - 8 - 9 - AF- r)**
Gibbula (Gibbula) magus (Linné, 1758) **(V - 5 - DC - r)**
Gibbula (Colliculus) adansonii adansonii (Payraudeau, 1826) **(V - tutto il litorale - AF - c)**
Gibbula (Colliculus) adriatica (Philippi, 1844) **(V - 10 - LEE - c)**
Gibbula (Forskalena) fanulum (Gmelin, 1791) **(D - 1 - 5 - AF - r)**
Gibbula (Phorcus) leucophaea (Philippi, 1836) **(D - 10 - r)**
Gibbula (Phorcus) varia (Linné, 1758) **(V - tutto il litorale - GI - c)**
Gibbula (Steromphala) divaricata (Linné, 1758) **(V - tutto il litorale - AF - c)**
Gibbula (Steromphala) rarilineata (Michaud, 1829) **(D - 5 - 7 - AF -r)**
Gibbula (Tumulus) umbilicaris (Linné, 1758) **(D - 7 - r)**
Monodonta (Osilinus) articulata Lamarck, 1822 **(V - 8 - 9 - RMS - r)**
Monodonta (Osilinus) mutabilis (Philippi, 1846) **(V - tutto il litorale - RMS, RMI - c)**
Monodonta (Osilinus) turbinata (Von Born, 1778) **(V - tutto il litorale - RMS, RMI - c)**
Jujubinus exasperatus (Pennant, 1777) **(V - tutto il litorale - AF - c)**
Jujubinus montagui (Wood W., 1828) **(V - 12 - DC - r)**
Jujubinus striatus striatus (Linné, 1758) **(V - tutto il litorale - AF - c)**

Famiglia: TRICOLIIDAE Robertson, 1985

Tricolia pullus pullus (Linné, 1758) **(D - 1 - 3 - 5 - 6 - AF - c)**
Tricolia speciosa (Von Muehlfeldt, 1824) **(D - 3 - 6 - AF - r)**
Tricolia tenuis (Michaud, 1829) **(D - 1 - 6 - 9 - AF - f)**

Famiglia: TURBINIDAE Rafinesque, 1815

Bolma rugosa (Linné, 1767) **(V - 2 - 5 - 7 - 8 - 9 - AF - c)**

Ordo: **NEOTAENIOGLOSSA** Haller, 1882

Famiglia: CERITHIIDAE Férussac, 1819

Cerithium alucaster (Brocchi, 1814) **(V - 12 - DC - f)**
Cerithium rupestre Risso, 1826 **(V - tutto il litorale - AF - c)**
Cerithium vulgatum Bruguiere, 1792 **(V - tutto il litorale - SFMC - c)**
Bittium latreillii (Payraudeau, 1826) **(V - tutto il litorale - AF - c)**
Bittium reticulatum (Da Costa, 1778) **(V - tutto il litorale - AF - c)**
Bittium scabrum (Olivi, 1792) **(V - 1 - 2 - 3 - 9 - 10 - AF - c)**
Cerithidium submamillatum (De Rayneval & Ponzi, 1854) **(V - 11 - 12 - DC - c)**

Famiglia: FOSSARIDAE Troschel, 1861

Fossarus ambiguus (Linné, 1758) **(D - 7 - RMS, RMI - r)**

Famiglia: TURRITELLIDAE Lovén, 1847

Turritella communis Risso, 1826 **(V - 11 - 12 - FTC - c)**

Famiglia: LITTORINIDAE Gray J.E., 1840

Littorina (Melaraphe) neritoides (Linné, 1758) **(V - tutto il litorale - RS - c)**

Famiglia: CINGULOPSIDAE Fretter & Patil, 1958

Eatonina (Coriandria) cossurae (Calcara, 1841) **(V - tutto il litorale - AF - c)**
Eatonina (Coriandria) fulgida (Adams J., 1797) **(D - 7 - 9 - AF - r)**

Famiglia: RISSOIDAE Gray J.E., 1847

Rissoa auriscalpium (Linné, 1758) **(D - 6 - AF - r)**
Rissoa decorata (Philippi, 1846) **(V - tutto il litorale - AF - f)**
Rissoa fraunfeldiana Brusina, 1868 **(D - 8 - 9 - AF - r)**

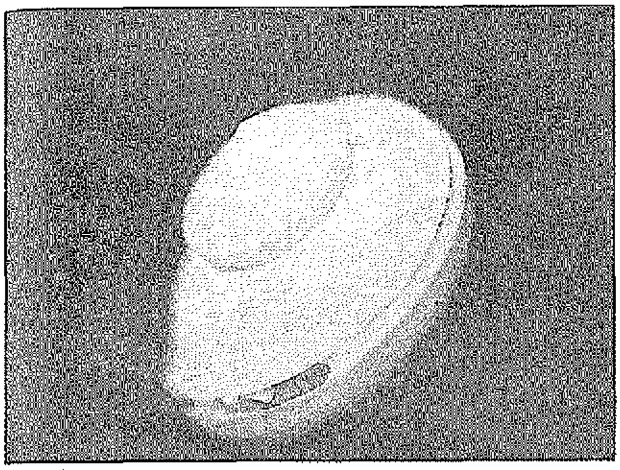

Fig. 2: Anatoma crispata **Fleming, 1828 (G. di Pirano, detrito).**
Sl. 2: Anatoma crispata **Fleming, 1828 (Piranski zaliv, detrit).**

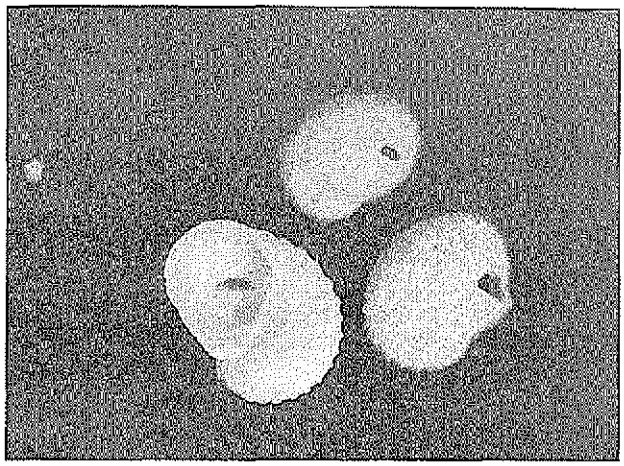

Fig. 3: Sinezona cingulata **(Costa O. G., 1861) (Strugnano, detrito).**
Sl. 3: Sinezona cingulata **(Costa O. G., 1861)(Strunjan, detrit).**

Rissoa guerinii Recluz, 1843	**(V - 8 - 9 - AF - f)**
Rissoa labiosa (Montagu, 1803)	**(V - 10 - SFMC - r)**
Rissoa lia (Monterosato, 1884 ex Benoit ms.)	**(D - 8 - AF - r)**
Rissoa monodonta Philippi, 1836	**(V - 10 - SFMC - r)**
Rissoa similis Scacchi, 1836	**(D - tutto il litorale - AF - c)**
Rissoa splendida Eichwald, 1830	**(V - tutto il litorale - AF - c)**
Rissoa variabilis (Von Muehlfeldt, 1824)	**(D - 7 - 8 - 9 - AF - f)**
Rissoa ventricosa Desmarest, 1814	**(V - tutto il litorale - SFMC - f)**
Rissoa violacea violacea Desmarest, 1814	**(D - 7 - AF - r)**
Alvania (Alvania) cancellata (Da Costa, 1778)	**(D - tutto il litorale - AF - c)**
Alvania (Alvania) cimex (Linnè, 1758)	**(D - tutto il litorale - AF - c)**
Alvania (Alvania) discors (Allan, 1818)	**(V - tutto il litorale - AF - c)**
Alvania (Alvania) geryonia (Nardo, 1847 ex Chiereghini ms.)	**(D - tutto il litorale - AF - f)**
Alvania (Alvania) lactea (Michaud, 1832)	**(D - tutto il litorale - AF - c)**
Alvania (Alvania) lanciae (Calcara, 1841)	**(D - tutto il litorale - AF - r)**
Alvania (Alvania) lineata Risso, 1826	**(V - tutto il litorale - AF - r)**
Alvania (Alvania) rudis (Philippi, 1844)	**(D - tutto il litorale - AF - f)**
Alvania (Crisilla) semistriata (Montagu, 1808)	**(V - tutto il litorale - AF - c)**
Alvania (Galeodina) carinata (Da Costa, 1778)	**(D - tutto il litorale - AF - f)**
Manzonia (Manzonia) crassa (Kanmacher, 1798)	**(D - tutto il litorale - AF - c)**
Obtusella intersecta (Wood S. W., 1857)	**(D - 3 - 7 - 8 - AF - r)**
Peringiella elegans (Locard, 1892)	**(D - tutto il litorale - f)**
Pusillina benzi (Aradas & Maggiore, 1844)	**(D - tutto il litorale - AF f)**
Pusillina incospicua (Alder, 1844)	**(D - tutto il litorale - AF - r)**
Pusillina marginata (Michaud, 1832)	**(D - tutto il litorale - AF - r)**
Pusillina parva (Da Costa, 1778)	**(V - tutto il litorale - AF - f)**
Pusillina philippi (Aradas & Maggiore, 1844)	**(V - tutto il litorale - AF - c)**
Pusillina radiata (Philippi, 1836)	**(V - tutto il litorale - AF - c)**
Setia (Setia) turriculata Monterosato, 1884	**(D - tutto il litorale - AF - c)**
Rissoina (Rissoina) bruguieri (Payraudeau, 1826)	**(D - tutto il litorale - AF - c)**

Famiglia: ADEORBIDAE Monterosato, 1884

Circulus striatus (Philippi, 1836)	**(D - 6 - 7 - 8 - AF - r)**

Famiglia: ASSIMINEIDAE Adams H. & A., 1856

Assiminea cfr. grayana Fleming, 1828	**(D - tutto il litorale - r)**
Paludinella littorina (Delle Chiaje, 1828)	**(V - 10 - S - RLD - r)**

Famiglia: BARLEEIDAE Gray J.E., 1857

Barleeia unifasciata (Montagu, 1803) **(D - tutto il litorale - r)**

Famiglia: CAECIDAE Gray M.E., 1850

Caecum auriculatum De Folin, 1868 **(D - tutto il litorale - f)**
Caecum subannulatum De Folin, 1870 **(D - tutto il litorale - r)**
Caecum trachea (Montagu, 1803) **(V - tutto il litorale - c)**

Famiglia: HYDROBIIDAE Troschel, 1857

Hydrobia acuta (Draparnaud, 1805) **(V - 10 - AF - c)**
Heleobia stagnorum (Gmelin, 1791) **(D - 3 - 10 - LEE - c)**

Famiglia: IRAVADIIDAE Thiele, 1928

Ceratia proxima (Forbes & Hanley, 1850 ex Alder ms.) **(D - 3 - 11 - 12 - r)**
Hyala vitrea (Montagu, 1803) **(D - 11 -12 - r)**

Famiglia: TORNIDAE Sacco, 1896

Tornus subcarinatus (Montagu, 1803) **(D - tutto il litorale - c)**

Famiglia: TRUNCATELLIDAE Gray J.E., 1840

Truncatella subcylindrica (Linné, 1767) **(V - tutto il litorale - RLD - c)**

Famiglia: APORRHAIIDAE Gray, 1850

Aporrhais pespelecani (Linné, 1758) **(V - 11 - 12 - MI - c)**

Famiglia: CALYPTRAEIDAE Lamarck, 1809

Calyptraea chinensis (Linné, 1758) **(V - 11 - 12 - DC - c)**
Crepidula gibbosa Defrance, 1818 **(V - 2 - 5 - 8 - 9 - AF - f)**
Crepidula unguiformis Lamarck, 1822 **(D - 11 - 12 - DF - r)**

Famiglia: CAPULIDAE Fleming, 1822

Capulus ungaricus (Linné, 1758) **(V - 11 - 12 - DC - f)**

Famiglia: VERMETIDAE Rafinesque, 1815

Vermetus (Vermetus) triquetrus Bivona Ant., 1832 **(V - tutto il litorale - AF - c)**
Vermetus (Thylácodus) semisurrectus Bivona Ant., 1832 **(V -12 - AF - f)**
Petaloconchus (Macrophragma) glomeratus (Linné, 1758) **(V - tutto il litorale - AF - c)**
Serpulorbis arenaria (Linnè, 1767) **(V - tutto il litorale - AF - f)**

Famiglia: CYPRAEIDAE Rafinesque, 1815

Luria lurida (Linnè, 1758) **(D - 11 - 12 - r)**

Famiglia: TRIVIIDAE Troschel, 1863

Trivia arctica (Pulteney, 1789) **(D - 11 - 12 - r)**
Trivia multilirata (Sowerby G.B. II, 1870) **(D - 12 - r)**

Famiglia: NATICIDAE Forbes, 1838

Natica (Naticarius) stercusmuscarum (Gmelin, 1791) **(D - 6 - SFBC - r)**
Euspira guillemini (Payraudeau, 1826) **(V - 5 - 11 - 12 - MI - r)**
Euspira nitida (Donovan, 1804) **(V - tutto il litorale - SFMC - c)**

Famiglia: CASSIDAE Latreille, 1825

Galeodea echinophora (Linné, 1758) **(V - 5 - 11 - 12 - DC - f)**

Famiglia: TRIPHORIDAE Gray J.E., 1847

Marshallora adversa (Montagu, 1803) **(V - tutto il litorale - AF - c)**
Monophorus perversus (Linné, 1758) **(V - tutto il litorale - AF - c)**

Famiglia: CERITHIOPSIDAE Adams H.& A., 1853

Cerithiopsis minima (Brusina, 1865) **(V - tutto il litorale - AF - f)**

Cerithiopsis tubercularis (Montagu, 1803)	**(D - tutto il litorale - AF - r)**
Famiglia: JANTHINIDAE Leach, 1823	
Janthina nitens Menke, 1828	**(D - 1 - pelagica - r)**
Famiglia: ACLIDIDAE Sars G.O., 1878	
Aclis attenuans Jeffreys, 1883	**(D - 12 - r)**
Aclis minor (Brown, 1827)	**(D - 12 - FTC - r)**
Famiglia: EPITONIIDAE Berry S.S., 1910	
Epitonium aculeatum (Allan, 1818)	**(D - 1 - 3 - 4 -6 - 9 - DF, SFMC - f)**
Epitonium commune (Lamarck, 1822)	**(V - tutto il litorale - SFMC - c)**
Epitonium turtoni (Turton, 1819)	**(D - 2 - 3 - SFMC - r)**
Famiglia: EULIMIDAE Adams H.& A., 1853	
Eulima glabra (Da Costa, 1778)	**(V -11 - 12 - MI - c)**
Crinophtheiros comaticula (Graff, 1875)	**(D - 8 - r)**
Melanella polita (Linné, 1758)	**(V - 12 - S - DC - f)**
Vitreolina antiflexa Monterosato, 1884	**(D - 3 - 8 - DC - r)**
Vitreolina incurva (B.D.D., 1883	**(D - 7 - 8 - 9 - r)**
Ordo: **NEOGASTROPODA** Thiele, 1929	
Famiglia: MURICIDAE Rafinesque, 1815	
Bolinus brandaris (Linné, 1758)	**(V - tutto il litorale - DF - c)**
Hadriania oretea (De Gregorio, 1885)	**(V - 5 - 12 - MI - f)**
Hexaplex trunculus (Linné, 1758)	**(V - tutto il litorale - SFMC - c)**
Muricopsis cristata (Brocchi, 1814)	**(V - tutto il litorale - AF - c)**
Ocenebra erinaceus (Linné, 1758)	**(V - tutto il litorale - AF - f)**
Ocinebrina aciculata (Lamarck, 1822)	**(V - tutto il litorale - AF - c)**
Ocinebrina edwardsii (Payraudeau, 1826)	**(V - 1 - 9 - AF - r)**
Trophon muricatus (Montagu, 1803)	**(V - 12 - DC - f)**
Typhinellus sowerbyi (Broderip, 1833)	**(D - 7 - SFMC - r)**
Buccinulum corneum (Linné, 1758)	**(V - 5 - 8 - AF - r)**
Chauvetia brunnea (Donovan, 1804)	**(D - tutto il litorale - AF - f)**
Engina leucozona Philippi, 1843)	**(V - tutto il litorale - AF - f)**
Pisania striata (Gmelin, 1791)	**(V - tutto il litorale - AF - c)**
Pollia dorbignyi (Payraudeau, 1826)	**(D - 7 - AF - r)**
Fasciolaria lignaria (Linné, 1758)	**(V - 5 - 8 - 9 - AF - r)**
Fusinus (Fusinus) rostratus (Olivi, 1792)	**(V - 1 - 5 - 11 - 12 - DC -c)**
Fusinus (Aptyxis) syracusanus (Linné, 1758)	**(V - 1 - 5 - 9 - SFMC - f)**
Nassarius (Gussonea) corniculus (Olivi, 1792)	**(V - tutto il litorale - AF - c)**
Nassarius (Hima) incrassatus (Stroem,1768)	**(V - tutto il litorale - AF - c)**
Nassarius (Hima) pygmaeus (Lamarck, 1822)	**(V - tutto il litorale - SFMC - c)**
Nassarius (Hinia) reticulatus (Linné, 1758)	**(V - tutto il litorale - SFMC - c)**
Nassarius (Sphaeronassa) mutabilis (Linnè, 1758)	**(V - 5 - 7 - SFBC - f)**
Nassarius (Telasco) costulatus cuvierii (Payraudeau, 1826)	**(D - 7 - 8 - 9 - f)**
Nassarius (Uzita) lima (Dillwin, 1817)	**(D - 12 - r)**
Cyclope (Cyclope) neritea (Linné, 1758)	**(V - 1 - 3 - 10 - LEE - Ind. pol. -f)**
Rapana venosa (Valenciennes, 1846)	**(V - 12 - DF - f)**
Famiglia: COLUMBELLIDAE Swainson, 1840	
Columbella rustica (Linné, 1758)	**(V - tutto il litorale - AF - c)**
Mitrella gervillii (Payraudeau, 1826)	**(V - 8 - 9 - AF - r)**
Mitrella minor (Scacchi, 1836)	**(V - 9 - AF - f)**
Mitrella scripta (Linné, 1758)	**(D - tutto il litorale - AF - c)**
Famiglia: COSTELLARIIDAE Mac Donald, 1860	
Vexillum (Pusia) ebenus (Lamarck, 1811)	**(V - 7 - 8 - 9 - AF - f)**
Vexillum (Pusia) littorale (Forbes, 1844)	**(D - 3 - 5 - r)**
Vexillum (Pusia) tricolor (Gmelin, 1790)	**(D - tutto il litorale - c)**

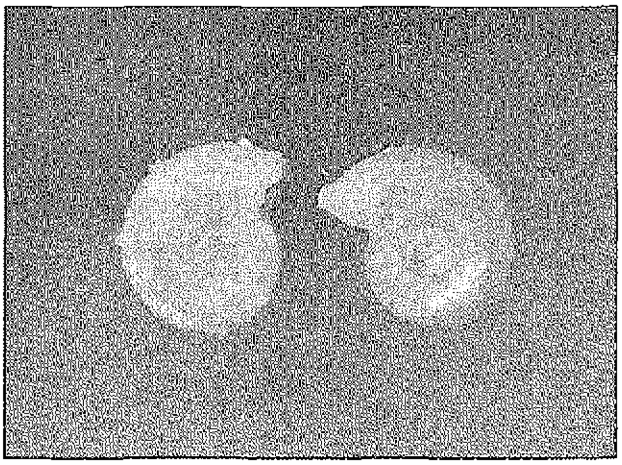

Fig. 4: *Ammonicera fischeriana* ***(Monterosato, 1869) (Sezza, detrito).***
Sl. 4: *Ammonicera fischeriana* ***(Monterosato, 1869) (Seča, detrit).***

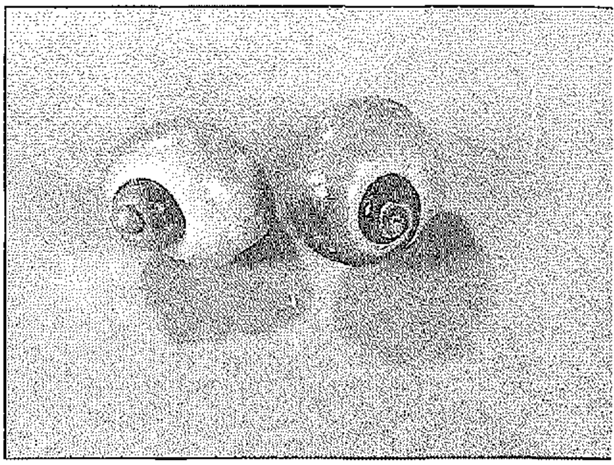

Fig. 5: *Janthina nitens* ***Menke, 1828.***
Sl. 5: *Janthina nitens* ***Menke, 1828.***

Famiglia: MARGINELLIDAE Fleming, 1828

Gibberula miliaria (Linné, 1758) **(D - 1 - 6 - 7 - 8 - 9 - AF - f)**
Granulina clandestina (Brocchi, 1814) **(V - tutto il litorale - AF - f)**

Famiglia: MITRIDAE Swainson, 1831

Mitra cornicula (Linné, 1758) **(V - tutto il litorale - AF -r)**
Mitra zonata Marryat, 1818 **(V - 12 - DF - r)**

Famiglia: CONIDAE Rafinesque, 1815

Conus mediterraneus Hwass in Bruguiere, 1792 **(V - 1 - 5 - 6 - 7 - 8 - 9 - AF - c)**

Famiglia: TURRIDAE Swainson, 1840

Bela brachystoma (Philippi, 1844) **(D - 3 - 11 - 12 - f)**
Bela nebula (Montagu, 1803) **(V - tutto il litorale - SFBC - c)**
Mangelia attenuata (Montagu, 1803) **(V - 11 - 12 - SFBC - c)**
Mangelia costulata (Blainville, 1829) **(V - 12 - DC - f)**
Mangelia scabrida Monterosato, 1890 **(D - 3 - 7 - 9 - f)**
Mangelia stossiciana Brusina, 1869 **(D - 7 - 9 - r)**
Mangelia vauquelini (Payraudeau, 1826) **(D - 1 - 5 - 6 - 7 - 8 - 9 -c)**
Mangiliella multilineolata (Deshayes, 1835) **(D - 7 - 9 - r)**
Raphitoma (Raphitoma) echinata (Brocchi, 1814) **(V - 9 - R - AF - r)**
Raphitoma (Raphitoma) laviae (Philippi, 1844) **(D - 7 - 8 - 9 - r)**
Comarmondia gracilis (Montagu, 1803) **(D - 3 - 11 - 12 - DF - f)**
Philbertia papillosa Pallary, 1904 **(D - 9 - r)**

Ordo: **HETEROSTROPHA** Fischer P., 1885

Famiglia: OMALOGYRIDAE Sars G.O., 1878

Omalogyra atomus (Philippi, 1841) **(D - tutto il litorale - AF -f)**
Ammonicera fischeriana (Monterosato, 1869) **(D - tutto il litorale - AF - r)**

Famiglia: PYRAMIDELLIDAE Gray J.E., 1840

Chrysallida delpretei (Sulliotti, 1889) **(D - tutto il litorale - AF - f)**
Chysallida doliolum (Philippi, 1844) **(D - 7 - 9 - r)**
Chrysallida emaciata (Brusina, 1866) **(D - tutto il litorale - AF - f)**
Chrysallida monozona (Brusina, 1869) **(D - 7 - 8 - 9 - f)**
Chrysallida obtusa (T. Brown, 1827) **(D - tutto il litorale - AF - c)**
Chrysallida suturalis (Philippi, 1844) **(D - tutto il litorale - f)**

Chrysallida terebellum (Philippi, 1844)	**(D - tutto il litorale - f)**
Euparthenia bulinea (Lowe, 1841)	**(D - 11 - 12 - r)**
Folinella excavata (Philippi, 1836)	**(D - tutto il litorale - c)**
Eulimella acicula (Philippi, 1836)	**(D - tutto il litorale - f)**
Eulimella turris (Forbes, 1844)	**(D - 3 - 9 - r)**
Anisocycla pointeli (Folin, 1867)	**(D - 3 - r)**
Odostomia (Odostomia) acuta Jeffreys, 1848	**(D - 7 - 9 - AF - f)**
Odostomia (Odostomia) carrozzai Van Aartsen, 1987	**(D -3 - r)**
Odostomia (Odostomia) eulimoides Hanley, 1844	**(D - 7 - 9 - r)**
Odostomia (Odostomia) lukisii Jeffreys, 1859	**(D - 6 - 7 - 9 - f)**
Odostomia (Odostomia) plicata (Montagu, 1803)	**(D - tutto il litorale - c)**
Odostomia (Odostomia) suboblonga Jeffreys, 1884	**(D - 1 - r)**
Odostomia (Megastomia) conoidea (Brocchi, 1814)	**(D - tutto il litorale - c)**
Odostomia (Megastomia) conspicua Alder, 1850	**(D -3 - r)**
Ondina crystallina Locard, 1892	**(D - 1 - r)**
Turbonilla lactea (Linné, 1758)	**(D - tutto il litorale - c)**
Turbonilla rufa (Philippi, 1836)	**(D - 6 - 7 - f)**

Ordo: **CEPHALASPIDEA** Fischer P., 1883

Famiglia: ACTEONIDAE D'Orbigny, 1835

Acteon tornatilis (Linné, 1758)	**(D - 3 - 5 -12 - SFBC - f)**

Famiglia: RETUSIDAE Thiele, 1931

Retusa mammillata (Philippi, 1836)	**(D - 1 - 3 - 11 - f)**
Retusa obtusa (Montagu, 1803)	**(D - 3 - 11 - r)**
Retusa truncatula (Bruguiere, 1792)	**(D - tutto il litorale - c)**
Cylichnina laevisculpta (Granata-Grillo, 1877)	**(D - 3 - r)**
Cylichnina multiquadrata (Oberling, 1970)	**(D - 3 - r)**
Cylichnina umbilicata (Montagu, 1803)	**(D - 3 - 11 - r)**
Volvulella acuminata (Bruguiere, 1792)	**(D - 3 - 11 - r)**

Famiglia: RINGICULIDAE Philippi, 1853

Ringicula auriculata (Ménard de la Groye, 1811)	**(D - 11 - DF - r)**

Famiglia: BULLIDAE Lamarck, 1801

Bulla striata Bruguiere, 1792	**(D - 5 - r)**

Famiglia: HAMINOEIDAE Pilsbry, 1895

Haminoea hydatis (Linné, 1758)	**(D - 1 - 10 - SFMC - r)**
Haminoea navicula (Da Costa, 1778)	**(V - tutto il litorale - AF, SFMC - f)**
Atys jeffreysi (Weinkauff, 1868)	**(D - 12 - r)**
Weinkauffia turgidula (Forbes, 1844)	**(D - 11 - 12 - r)**

Famiglia: PHILINIDAE Gray, 1850

Philine aperta (Linné, 1767)	**(V - 6 - 7 - SFBC - r)**
Philine catena (Montagu, 1803)	**(D - 12 - r)**

Famiglia: AKERIDAE Pilsbry, 1893

Akera bullata Mueller O.F., 1776	**(V - 3 - SFMC - f)**

Famiglia: CYLICHNIDAE Adams H. & A., 1854

Cylichna cylindracea (Pennant, 1777)	**(V - 1 - 4 - 6 - 7 - SFBC -f)**
Scaphander lignarius (Linné, 1758)	**(V - 12 - DC -r)**

Ordo: **THECOSOMATA** Blainville, 1824

Famiglia: CAVOLINIDAE Gray, 1850

Creseis acicula Rang, 1828	**(V - planctonica - r)**

Ordo: **ANASPIDEA** Fischer P., 1883

Famiglia: APLYSIIDAE Lamarck, 1809	
Aplysia (Aplysia) depilans Gmelin, 1791	**(V - 1 - 9 - AF - f)**
Aplysia (Varria) fasciata Poiret, 1789	**(V - tutto il litorale - AF - c)**
Famiglia: TRIMUSCULIDAE Zilch, 1959	
Trimusculus mammillaris (Linné, 1758)	**(D - 7 - r)**
Ordo: **BASOMMATOPHORA** Schmidt A., 1855	
Famiglia: ELLOBIIDAE Adams A., 1855	
Ovatella (Ovatella) firminii (Payraudeau, 1826)	**(D - 1 - 7 - 10 - RLD -r)**
Ovatella (Myosotella) myosotis (Draparnaud, 1801)	**(D - 3 - 7 - 10 - RLD - r)**
Classis: **BIVALVIA** Linné, 1758	
Ordo: **SOLEMYOIDA** Dall, 1889	
Famiglia: SOLEMYIDAE Gray J.E., 1857	
Solemya togata (Poli, 1795)	**(V - 1 - SFMC - r)**
Ordo: **NUCULOIDA** Dall, 1889	
Famiglia: NUCULIDAE Gray J.E., 1824	
Nucula nitidosa Winckworth, 1930	**(V - 11 - MI - f)**
Nucula nucleus (Linné, 1758)	**(V - 11- 12 - SFMC - c)**
Nucula sulcata Bronn, 1831	**(V - 12 - DF - f)**
Famiglia: NUCULANIDAE Adams H. & A., 1858	
Nuculana (Lembulus) pella (Linné, 1767)	**(V - 11 - 12 - MI - f)**
Nuculana (Jupiteria) commutata (Philippi, 1844)	**(V - 12 - DF - r)**
Ordo: **ARCOIDA** Stoliczka, 1871	
Famiglia: ARCIDAE Lamarck, 1818	
Arca noae Linné, 1758	**(V - tutto il litorale - AF - c)**
Barbatia (Barbatia) barbata (Linné, 1758)	**(V - tutto il litorale - AF - f)**
Scapharca inaequivalvis (Bruguiere, 1789)	**(V - 11 - 12 - SFBC, SFMC - f)**
Famiglia: NOETIDAE Stewart, 1930	
Striarca lactea (Linné, 1758)	**(V - tutto il litorale - AF - c)**
Famiglia: GLYCYMERIDIDAE Newton, 1922	
Glycymeris bimaculata (Poli, 1795)	**(V - 12 - SGCF - f)**
Glycymeris glycymeris (Linné, 1758)	**(V - 12 - SGCF - f)**
Glycymeris insubrica (Brocchi, 1814)	**(V - 4 - 5 - 7 - SFBC - f)**
Ordo: **MYTILOIDA** Férussac, 1822	
Famiglia: MYTILIDAE Rafinesque, 1815	
Mytilus galloprovincialis Lamarck, 1819	**(V - tutto il litorale - RMS, RMI - c)**
Mytilaster lineatus (Gmelin, 1791)	**(V - 1 - 9 - 10 - LEE - f)**
Mytilaster minimus (Poli, 1795)	**(V - tutto il litorale - RMS, RMI - c)**
Modiolarca subpicta (Cantraine, 1835)	**(V - tutto il litorale - DC, in Tunicati -f)**
Musculus costulatus (Risso, 1826)	**(V - tutto il litorale - A F - f)**
Musculus discors (Linné, 1767)	**(V - 12 - DC - r)**
Lithophaga lithophaga (Linné, 1758)	**(V - tutto il litorale - AF - c)**
Modiolus (Modiolus) barbatus (Linné, 1758)	**(V - tutto il litorale - AF - f)**
Modiolus (Gibbomodiola) adriaticus (Lamarck, 1819)	**(D - 12 - r)**
Modiolula phaseolina (Philippi, 1844)	**(V - 12 - DC - r)**
Famiglia: PINNIDAE Leach, 1819	
Pinna nobilis Linné, 1758	**(V - tutto il litorale - SFMC - c)**
Atrina pectinata (Linné, 1767)	**(V - 5 - 11 - 12 - DF - f)**

Ordo: **PTERIOIDA** Newell, 1965

Famiglia: PECTINIDAE Rafinesque, 1815

Pecten jacobeus (Linné, 1758) **(V - 12 - DC - f)**
Aequipecten (Aequipecten) opercularis (Linné, 1758) **(V - 12 - DC - c)**
Chlamys (Chlamys) multistriata (Poli, 1795) **(V - tutto il litorale - AF - r)**
Chlamys (Chlamys) varia (Linné, 1758) **(V - tutto il litorale - AF - c)**
Chlamys (Flexopecten) flexuosa (Poli, 1795) **(D - 2 - r)**
Chlamys (Manupecten) pesfelis (Linnè, 1758) **(D - 3 - 9 - AF - r)**
Chlamys (Proteopecten) glabra (Linné, 1758) **(V - tutto il litorale - SFMC - c)**
Chlamys (Proteopecten) proteus (Dillwyn, 1817 ex Solander ms.) **(V - tutto il litorale - SFMC - c)**

Famiglia: SPONDYLIDAE Gray J.E., 1826

Spondylus (Spondylus) gaederopus Linné, 1758 **(V - 9 - AF - r)**

Famiglia: ANOMIIDAE Rafinesque, 1815

Anomia ephippium Linné, 1758 **(V - tutto il litorale - AF - c)**
Pododesmus (Monia) patelliformis (Linné, 1761) **(V - 12 - DC - r)**

Famiglia: LIMIDAE Rafinesque, 1815

Lima (Lima) lima (Linné, 1758) **(V - 5 - 6 - 7 - 8 - 9 -AF - f)**
Lima (Limaria) exilis Wood S. V., 1839 **(V - 1 - 8 - 9 - AF - f)**
Lima (Limaria) hians (Gmelin, 1791) **(V - 9 - DC, AF - r)**
Limea loscombi (Sowerby G.B.I, 1823) **(V - 12 - DC - f)**

Ordo: **OSTREOIDA** Ferussac, 1822

Famiglia: OSTREIDAE Rafinesque, 1815

Ostrea edulis Linné, 1758
Crassostrea gigas (Thunberg, 1793) **(V - tutto il litorale - RMI - c)**
Ostreola stentina (Payraudeau, 1826) **(D - 1 - 5 - AF - f)**
Ostreola parenzani Settepassi, 1978 **(V - 1 - 9 - 10 - AF - c)**

Ordo: **VENEROIDA** Adams H. & A., 1857

Famiglia: LUCINIDAE Fleming, 1828

Ctena decussata (Costa O.G., 1829) **(V - tutto il litorale - SRPV - c)**
Loripes lacteus (Linné, 1758) **(V - tutto il litorale - SFMC - c)**
Lucinella divaricata (Linné, 1758) **(V - tutto il litorale - SFMC - c)**
Anodontia (Loripinus) fragilis (Philippi, 1836) **(V - tutto il litorale - SFMC - c)**
Myrtea spinifera (Montagu, 1803) **(V - 11 - 12 - DC - f)**

Famiglia: THYASIRIDAE Dall, 1901

Thyasira flexuosa (Montagu, 1803) **(V - 11 - 12 - FTC - f)**

Famiglia: UNGULINIDAE Adams H. & A., 1857

Diplodonta rotundata (Montagu, 1803) **(V - 11 - 12 - DF - f)**

Famiglia: CHAMIDAE Blainville, 1825

Chama gryphoides Linnè, 1758 **(V - tutto il litorale - AF - c)**
Pseudochama gryphina (Lamarck, 1819) **(V - tutto il litorale - AF - f)**

Famiglia: GALEOMMATIDAE Gray J.E., 1840

Galeomma (Galeomma) turtoni Turton, 1825 **(V - 8 - 9 - AF - r)**

Famiglia: KELLIDAE Forbes & Hanley, 1848

Kellia suborbicularis (Montagu, 1803) **(V - 12 - DF - r)**
Bornia sebetia (Costa O.G., 1829) **(V - tutto il litorale - SRPV - f)**

Famiglia: LASAEIDAE Gray J.E., 1842

Lasaea rubra (Montagu, 1803) **(V - tutto il litorale - RMI - c)**
Hemilepton nitidum (Turton, 1822) **(D - 11- 12 - SFMC - r)**

Famiglia: MONTACUTIDAE Clark W., 1852	
Montacuta substriata (Montagu, 1808)	**(D - 12 - r)**
Tellimya ferruginosa (Montagu, 1808)	**(V - 12 - SFBC - r)**
Mysella bidentata (Montagu, 1803)	**(V - 11 - 12 - FTC - f)**
Famiglia: NEOLEPTONIDAE Thiele, 1934	
Neolepton obliquatum Chaster, 1897	**(D - 3 - 12 - DC - r)**
Famiglia: CARDITIDAE Fleming, 1828	
Cardita calyculata (Linné, 1758)	**(V - tutto il litorale - AF - c)**
Venericardia antiquata (Linné, 1758)	**(V - 5 - 6 - 8 - 12 - DC - c)**
Familia: ASTARTIDAE D'Orbigny, 1844	
Astarte fusca (Poli, 1795)	**(D - 12 - r)**
Famiglia: CARDIIDAE Lamarck, 1809	
Acanthocardia (Acanthocardia) aculeata (Linné, 1758)	**(V - 5 - 7 - 8 - 12 - DC - f)**
Acanthocardia (Acanthocardia) deshayesi (Payraudeau, 1826)	**(V - 5 - 12 - DC -f)**
Acanthocardia (Acanthocardia) echinata (Linné, 1758)	**(V - 12 - DC - r)**
Acanthocardia (Acanthocardia) paucicostata (Sowerby G.B.II, 1841)	**(V - 8 -10 - 11 - 12 - FTC - f)**
Acanthocardia (Acanthocardia) spinosa (Solander, 1786)	**(V - 12 - DC - r)**
Acanthocardia (Rudicardium) tuberculata (Linnè, 1758)	**(V - tutto il litorale - SFBC - c)**
Parvicardium exiguum (Gmelin, 1791)	**(V - 1 - 3 - 10 - SFMC, ind.pol. - c)**
Parvicardium minimum (Philippi, 1836)	**(V - 12 - DF - f)**
Plagiocardium (Papillocardium) papillosum (Poli, 1795)	**(V - 5 - 6 - 7 - 8 - 9 - DC - c)**
Laevicardium oblongum (Gmelin, 1791)	**(V - 12 - DC - f)**
Cerastoderma edule (Linné, 1758)	**(V - 1 - 2 - 4 - SFMC - f)**
Cerastoderma glaucum (Poiret, 1789)	**(V - 1 -10 - LEE - c)**
Famiglia: MACTRIDAE Lamarck, 1809	
Mactra stultorum (Linné, 1758)	**(V - tutto il litorale - SFBC - c)**
Spisula subtruncata (Da Costa, 1778)	**(V - tutto il litorale - SFBC - c)**
Famiglia: SOLENIDAE Lamarck, 1809	
Solen marginatus Pulteney, 1799	**(D - 3 - 7 - 8 - SFBC - f)**
Famiglia: PHARELLIDAE Tryon, 1884	
Ensis ensis (Linné, 1758)	**(V - 12 - DC - r)**
Ensis minor (Chenu, 1843)	**(V - tutto il litorale - SFBC - f)**
Phaxas adriaticus (Coen, 1933)	**(V - 5 - 8 - 12 - SFMC - f)**
Famiglia: TELLINIDAE Blainville, 1814	
Tellina (Angulus) tenuis Da Costa, 1778	**(V - 1 - 3 - 7 - SFS - f)**
Tellina (Arcopagia) balaustina Linné, 1758	**(V - 1 - SFMC - r)**
Tellina (Arcopagia) crassa Pennant, 1777	**(V - 9 - SGCF - r)**
Tellina (Peronidia) nitida Poli, 1791	**(D - 3 - 6 - 7 - SFBC - f)**
Tellina (Serratina) serrata Brocchi, 1814	**(V - 11 - 12 - DF - r)**
Tellina (Tellinella) distorta Poli, 1791	**(V - 11 - 12 - MI - f)**
Gastrana fragilis (Linnè, 1758)	**(V - 1 - 3 - 7 - 8 - 10 - SFMC, Ind.dess. - f)**
Famiglia: DONACIDAE Fleming, 1828	
Donax (Donax) semistriatus Poli, 1795	**(V - tutto il litorale - SFBC - c)**
Donax (Serrula) trunculus Linné, 1758	**(V - tutto il litorale - SFS - c)**
Famiglia: PSAMMOBIIDAE Fleming, 1828	
Psammobia (Psammobia) fervensis (Gmelin, 1791)	**(V - 12 - DC - f)**
Psammobia (Gobraeus) depressa (Pennant, 1777)	**(V - tutto il litorale - SFMC - f)**
Famiglia: SCROBICULARIIDAE Adams H. & A., 1856	
Scrobicularia plana (Da Costa, 1778)	**(D - 3 - 10 - LEE - f)**

Famiglia: SEMELIDAE Stoliczka, 1870

Abra (Abra) nitida (Mueller O.F., 1776)	**(V - 11 - 12 - FTC - f)**
Abra (Abra) prismatica (Montagu, 1808)	**(V - 11- 12 - DC - f)**
Abra (Abra) segmentum (Récluz, 1843)	**(V - 3 - 10 - LEE - c)**
Abra (Syndosmya) alba (Wood W., 1802)	**(V - tutto il litorale - SFMC - c)**

Famiglia: SOLECURTIDAE D'Orbigny, 1846

Solecurtus scopula (Turton, 1822)	**(V - 11 - 12 - FTC - r)**
Solecurtus strigilatus (Linné, 1758)	**(V - 11 - 12 - DC - f)**
Azorinus chamasolen (Da Costa, 1778)	**(V - tutto il litorale - SFMC - f)**
Pharus legumen (Linné, 1758)	**(V - tutto il litorale - SFBC - c)**

Famiglia: TRAPEZIIDAE Lamy, 1920

Coralliophaga lithophagella (Lamarck, 1819)	**(D - 3 - 12 - r)**

Famiglia: GLOSSIDAE Gray J.E., 1847

Glossus humanus (Linné, 1758)	**(V - 12 - DF - r)**

Famiglia: VENERIDAE Rafinesque, 1815

Venus (Venus) verrucosa Linné, 1758	**(V - tutto il litorale - SFMC - c)**
Venus (Circomphalus) casina Linné, 1758	**(V - tutto il litorale - SGCF - r)**
Chamelea gallina (Linné, 1758)	**(V - tutto il litorale - SFBC - c)**
Clausinella brongniartii (Payraudeau, 1826)	**V - 12 - SGCF - r)**
Timoclea ovata (Pennant, 1777)	**(V - 12 - DC - c)**
Gouldia minima (Montagu, 1803)	**(V - tutto il litorale - DC - f)**
Dosinia (Dosinia) lupinus (Linné, 1758)	**(V - tutto il litorale - SFBC - c)**
Dosina (Pectunculus) exoleta (Linné, 1758)	**(V - 5 - 8 - 9 - SGCF - f)**
Pitar rudis (Poli, 1795)	**(V - tutto il litorale - DC - c)**
Callista chione (Linné, 1758)	**(V - 5 - 6 -12 - DC - c)**
Tapes (Ruditapes) decussatus (Linné, 1758)	**(V - tutto il litorale - LEE, SFMC - c)**
Irus irus (Linné, 1758)	**(V - tutto il litorale - AF - f)**
Paphia (Politapes) aurea (Gmelin, 1791)	**(V - tutto il litorale - SFMC - c)**
Paphia (Politapes) rhomboides (Pennant, 1777)	**(V - 12 - SGCF - r)**
Venerupis senegalensis (Gmelin, 1791)	**(D - 7 - r)**

Famiglia: PETRICOLIDAE Deshayes, 1839

Petricola (Petricola) lithophaga (Retzius, 1786)	**(V - tutto il litorale - AF - c)**
Petricola (Lajonkairia) lajonkairii (Payraudeau, 1826)	**(V - tutto il litorale - SFMC - f)**
Petricola (Lajonkairia) substriata (Montagu, 1808)	**(D - 9 - r)**
Mysia undata (Pennant, 1777)	**(V - tutto il litorale - SFMC - f)**

Ordo: **MYOIDA** Stoliczka, 1870

Famiglia: CORBULIDAE Lamarck, 1818

Corbula (Varicorbula) gibba (Olivi, 1792)	**(V - tutto il litorale - MI - c)**

Famiglia: GASTROCHAENIDAE Gray J.E., 1840

Gastrochaena dubia (Pennant, 1777)	**(V - tutto il litorale - AF - f)**

Famiglia: HIATELLIDAE Gray J.E., 1824

Hiatella arctica (Linné, 1767)	**(V - tutto il litorale - AF - c)**
Hiatella rugosa (Linné, 1767)	**(V - 5 - 9 - AF - r)**
Saxicavella jeffreysi Winckworth, 1930	**(D - 3 - 11 - 12 - DF - r)**

Ordo: **PHOLADINA** Adams H. & A., 1858

Famiglia: PHOLADIDAE Lamarck, 1809

Pholas dactylus Linné, 1758	**(V - 9 - AF - f)**
Barnea (Barnea) candida (Linné, 1758)	**(D - 3 - FTC - r)**

Ordo: **PHOLADOMYOIDA** Newell, 1965

Famiglia: THRACIIDAE Stoliczka, 1870

Thracia (Thracia) convexa (Wood W., 1815)	**(V - 11 - FTC - r)**
Thracia (Thracia) corbuloides Deshayes, 1830	**(D - 3 - 6 - 11 - 12 - DF - r)**
Thracia (Thracia) papyracea (Poli, 1791)	**(V - tutto il litorale - SFBC - c)**
Thracia (Thracia) pubescens (Pulteney, 1799)	**(V - 11 - 12 - DC - f)**
Thracia (Ixartia) distorta (Montagu, 1803)	**(V - 9 - AF - r)**

Famiglia: PANDORIDAE Rafinesque, 1815

Pandora pinna (Montagu, 1803) **(V - 11 - 12 - DF - f)**

Famiglia: LYONSIIDAE Fischer P., 1887

Lyonsia norwegica (Gmelin, 1791) **(V - 11 - 12 - DF - r)**

Famiglia: CUSPIDARIIDAE Dall, 1886

Cuspidaria (Cuspidaria) cuspidata (Olivi, 1792) **(D - 3 - 11 -12 - DF - r)**

Classis: **SCAPHOPODA** Bronn, 1862

Famiglia: DENTALIIDAE Gray J.E., 1834

Dentalium (Antalis) dentalis Linné, 1758	**(D - 3 - 6 - 7 - r)**
Dentalium (Antalis) inaequicostatum Dautzenberg, 1891	**(V - tutto il litorale - DC - c)**
Dentalium (Antalis) vulgare Da Costa, 1778	**(V - tutto il litorale - SGCF - f)**
Fustiaria rubescens (Deshayes, 1826)	**(D - 3 - 6 - 7 - MI - r)**

Classis: **CEPHALOPODA** Cuvier, 1798

Ordo: **SEPIOIDEA** Naef, 1916

Famiglia: SEPIIDAE Leach, 1817

Sepia elegans Blainville, 1827	**(V - tutto il litorale - f)**
Sepia officinalis Linné, 1758	**(V - tutto il litorale - c)**

Famiglia: SEPIOLIDAE Leach, 1817

Sepiola rondeletii Leach, 1817 **(V - tutto il litorale - r)**

Ordo: **TEUTHOIDEA** Naef, 1916

Famiglia: LOLIGINIDAE D'Orbigny, 1839

Loligo vulgaris Lamarck, 1798	**(V - tutto il litorale - c)**
Alloteuthis media (Linné, 1758)	**(V - tutto il litorale - f)**
Alloteuthis subulata (Lamarck, 1798)	**(V - tutto il litorale - r)**

Famiglia: OMMASTREPHIDAE Steenstrup, 1857

Todarodes sagittatus (Lamarck, 1798) **(V - tutto il litorale - r)**

Ordo: **OCTOPODA** Leach, 1818

Famiglia: OCTOPODIDAE D'Orbigny in Férussac & D'Orbigny, 1840

Octopus vulgaris Cuvier, 1798	**(V - tutto il litorale - f)**
Eledone cirrhosa (Lamarck, 1798)	**(V - tutto il litorale - f)**

CONCLUSIONI

Nelle acque della Slovenia sono state rinvenute 393 specie di molluschi conchiferi: 9 Polyplacophora, 232 Gastropoda, 139 Bivalvia, 4 Scaphopoda e 9 Cephalopoda. Di queste specie 253 sono state raccolte viventi (corrispondente al 64,4%). I Il totale dei molluschi (pari circa al 25% del Mediterraneo) (Sabelli *et al.*, 1990), è considerevole in rapporto alla limitata estensione del litorale sloveno.

In base ad osservazioni recenti ed ai dati bibliografici, si è potuta definire la biocenosi preferenziale per 309 specie e rilevare che quasi tutti i biotopi della piattaforma continentale, descritti da Peres e Picard (1964) per il Mediterraneo centro-orientale, sono presenti anche nelle acque della Slovenia.

L'elenco presentato non può essere confrontato dal punto di vista tassonomico con nessun altro, in quanto è il primo nel suo genere. Esistono comunque segnalazioni precedenti che abbiamo considerato, ma che presentano delle diversità nella determinazione di alcune specie (Rissoidae, Eulimidae, Pyramidellidae), probabilmente dovute ad una minor conoscenza sistematica.

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MEHKUŽCI LUPINARJI V SLOVENSKEM MORJU

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POVZETEK

Na podlagi vzorčevanj na dvanajstih lokalitetah v slovenskem obalnem morju je bilo določenih 393 vrst mehkužcev z lupino. Med temi je bilo 9 vrst bokoživčnikov (Polyplacophora), 232 vrst morskih polžev (Gastropoda), 139 vrst morskih školjk (Bivalvia), 4 vrste slonovih zobčkov (Scaphopoda) in 9 vrst glavonožcev (Cephalopoda). Skoraj dve tretjini (253) vseh mehkužcev je bilo najdenih živih. Glede na majhnost slovenskega obalnega morja je dobljeno število vrst veliko.

Na podlagi opazovanj in literaturnih podatkov sta avtorja navedla življenjsko združbo, v kateri vrsta živi. Obenem ugotavljata, da se skoraj vsi biotopi, ki jih navajata Peres & Picard za Sredozemlje, pojavljajo tudi v slovenskem obalnem morju.

Ključne besede: Mollusca, seznam, severni Jadran, Slovenija

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EFFECTS OF ENVIRONMENTAL CHANGES ON EARLY STAGES AND REPRODUCTION OF ANCHOVY *(ENGRAULIS ENCRASICOLUS* L.) IN THE ADRIATIC SEA

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ABSTRACT

Anchovy spawns in the Adriatic from (March) April to October (November). Egg production and the quantity of yolk-sac larvae follow the changes of primary production and zooplankton quantity during the spawning season, with the phase lag of about two months. Investigations of long-term fluctuations of egg production, quantity of larvae and postlarvae showed that increase of egg production was followed by increase of the quantity of postlarvae but also with the increase of their instantaneous mortality rates. These fluctuations were positively correlated with the fluctuations in temperature, salinity, primary production and zooplankton quantity, with the phase lag of one year. Since 1978 these "regular" fluctuations have been disturbed. The anchovy biomass decreased, while the temperature, salinity, contents of nutrients and primary production have been continuously increasing in the entire Adriatic. It seems that these changes were the consequence of a low frequency period of climatic change, probably amplified by the antropogenic eutrophication.

Key words: Anchovy, early-life history stages, environmental changes, reproduction, Adriatic Sea

INTRODUCTION

Early stages of the anchovy, *Engraulis encrasicolus* (Linnaeus, 1758), have been studied in the Adriatic for more than 100 years. Graeffe (1888) was the first who reported its eggs in the plankton of Northern Adriatic during the summer months. This report was published in the same year when the anchovy eggs were described for the first time by Raffaele (1888). Later on, numerous scientists studied various aspects of the early life stages of Adriatic anchovy up to nowadays. The number of studies related to the ecology of planktonic stages and to the adult anchovy is considerably higher than those related to other fishes. Therefore it follows that anchovy is the most intensively studied fish species in the Adriatic.

The attention paid to the studies of both early stages and adult anchovy is, to a large extent, the consequence of the anchovy's abundance in the catch of pelagic fish in the Adriatic. For example, during the period from 1962 to 1973 the catch of the anchovy made 47% of the mean annual catch of pelagic fish. However, since 1978 the decrease of anchovy biomass was observed. This caused decrease of the catch, and in the period from 1977 to 1989 anchovy catch was only 28.7% of the total pelagic fish catch in the Adriatic.

The aim of this paper is to review basic information about the early life stages of the Adriatic anchovy, and to provide an explanation of the causes of the recent biomass decrease of this fish.

ELEMENTARY DATA

A) Spawning season

Numerous authors (Steuer, 1910; Stiasny, 1910; Vatova, 1928; Gamulin, 1940, 1964; Varangolo, 1964a, b, 1965; Vučetić, 1957, 1964, 1975; Zavodnik, 1967, 1970; Štirn, 1969; Merker & Vujošević, 1972; Regner, 1972, 1979, 1985; Picinetti *et al.*, 1979, 1980; Regner *et al.*, 1985) found anchovy eggs in plankton during the April-October period, and sometimes also in March and November. It seems that the increased sea temperatures in January and February affect earlier occurrence of the anchovy eggs (Regner, 1972). The earliest record was of

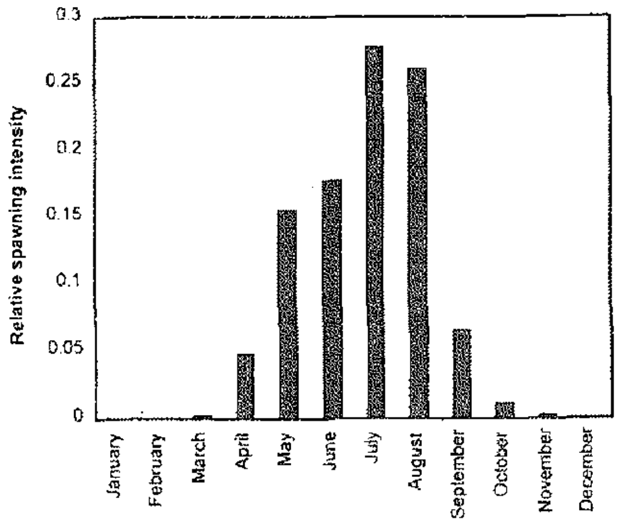


Fig. 1: Long-term means of relative spawning intensity of the Adriatic anchovy.
Sl. 1: Povprečne vrednosti relativne intenzivnosti drstenja jadranskega inćuna v daljšem časovnem obdobju.

a single egg found in the Gulf of Venice at the end of February 1967 (Zavodnik, 1970).

Maximum of eggs in plankton may appear, depending on characteristics of the spawning seasons and spawning areas, at any time during the period between May and September. Very often, curves of the spawning intensity are polymodal. Generally, maximum egg production occurs in open waters earlier than in coastal ones.

Long-term means, calculated from the data of different authors, show that about 85% of the anchovy eggs in the Adriatic are produced in the May-August period. The production of eggs is highest in July (Fig. 1).

The relationship with the temperature and salinity during the spawning season was studied by Vučetić (1957), Varangolo (1965), Štirn (1969), Zavodnik (1970), Merker & Vujošević (1972), Regner (1972, 1979, 1985). The results obtained show that anchovy spawns within temperature ranges of 11.6-27.5°C in the Northern Adriatic, and 13.12-27.32°C in the Central and Southern Adriatic, with the maximal egg production at temperatures between 17°C and 22°C. In the Northern Adriatic anchovy spawns within 9.1 and 38.5 ppt salinity ranges, and within 33.8 and 39.6 ppt in the Central and Southern Adriatic. Maximal egg production may occur at any of the aforementioned salinities (Regner, 1979, 1985).

Positive correlation was found between the quantity of anchovy eggs and the number of phytoplankton cells, as well as with the zooplankton dry weight (Vučetić, 1975). Analysis of long-term data (1962-1976 period) showed that production of anchovy eggs and the quantity of larvae followed primary production and the zooplankton spring peaks with the phase lag of about two months (Regner, 1979, 1985). This phase lag may be related to the intensive feeding of adult anchovy in the pre-spawning period. Such a correlation was not found for the quantity of postlarvae (stages after the yolk-sac resorption). It was assumed that their survival was connected to the quantity of microzooplankton which was found to be their main food in the Central Adriatic (Regner, 1971).

The catch of juveniles was analyzed in the Gulf of Manfredonia (Rizzoli, 1983). The largest quantities were observed in December, and again in April and May. So far there are no studies on the ecology of juveniles in the wider areas of Adriatic, except in the area of Novigradsko more (Sinovčić, 1992).

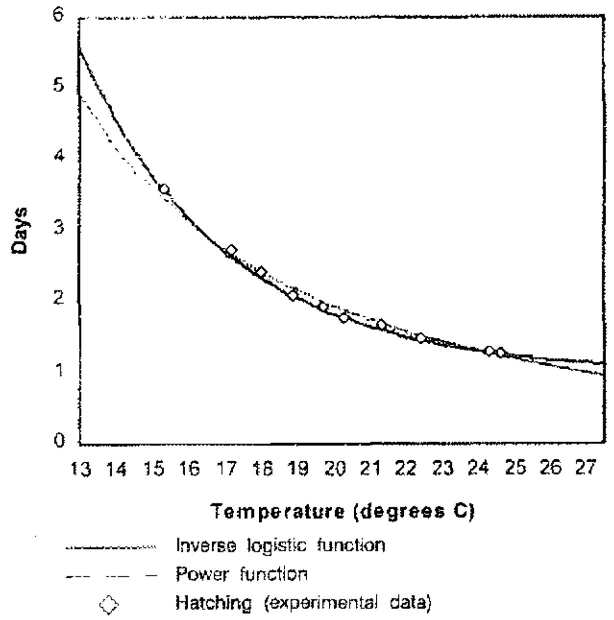


Fig. 2: Temperature-dependent development of anchovy eggs fitted with inverse logistic (---) and power (- -) functions.
Sl. 2: Temperaturna odvisnost razvoja inćunovih iker (inverzna in potenčna odvisnost).

B) Daily period of spawning

Anchovy spawns in the Central Adriatic in the evening, between 7 and 9 p.m. (Vučetić, 1957). According to Varangolo (1964a) maximum spawning in the Northern Adriatic takes place between 6 and 8 p.m.

C) Temperature-specific development times of eggs and larvae, growth of larvae and postlarvae

During the 1976 and 1977 spawning seasons, anchovy eggs, larvae, and postlarvae were reared under experimental conditions in order to estimate their temperature-developmental time relationship, and growth rates of larvae and postlarvae as influenced by temperature (Regner, 1979, 1985). The relationship between egg development and temperature was fitted with four different functions. The power function:

$D = 1788.4199 \times T^{-2.290236}$ (1),

where D is the developmental time in days, and T is the temperature in °C, was used for all estimates of anchovy developmental times. The best fit was obtained with inverse logistic function with the parameters:

$D = 1 / 1.012896 \times [1 + e^{4.914322 - (0.257451 \times T)}]$ (2),

(Regner, 1979, 1985), and therefore this function was used for all the estimates of developmental times of anchovy eggs since 1979. This function gives better estimates particularly at lower temperatures (Fig. 2).

For the estimates of instantaneous mortality rates of eggs, residence times and the mean ages of particular developmental stage have to be known. Thus, to obtain residence times and mean ages of stages (stages were described by Regner, 1979, 1985) the value of D obtained from equations (1) or (2) has to be corrected with the following factors:

Stage	Residence time correction	Mean time correction
I+II	0.1630	0.0815
III	0.0795	0.2028
IV	0.1506	0.3178
V	0.0837	0.4350
VI	0.1925	0.5731
VII	0.1173	0.7280
VIII	0.1046	0.8389
IX	0.0628	0.9226
X	0.0460	0.9770

Value of D has to be divided with the residence time correction factor, while for the estimate of the mean age it has to be multiplied with the correction for the mean time.

For the egg mortality estimates during biomass assessments the smaller number of stages has been used:

Stage	Residence time correction	Mean time correction
A (I-IV)	0.395	0.198
B (V-VII)	0.393	0.592
C (VIII-IX)	0.165	0.871
D (X)	0.046	0.977

Developmental time for larvae from hatching to yolk-sac resorption was fitted with the power function, the parameters of which were:

$D = 270065.2744 \times T^{-3.8079}$ (3),

where D is time in days, and T is temperature.

Larval growth up to the yolk-sac resorption was approximated with Farris (1960) and von Bertalanffy (1938) functions, while the growth of postlarvae was approximated with exponential functions (Regner, 1979, 1985). In 1980, data obtained on larval and postlarval growth were fitted again with Gompertz function, which gave better fit then previously used equations. The form of the Gompertz function used for the estimates of growth was:

$l_t = a \times e^{-be^{-ct}}$ (4),

where l_t is length of larva in the time t, a is the asymptote, while b and c are constants.

As far as larvae were concerned, the constants (b, c) of equation (4) were found to be temperature dependent. This relationship can be expressed as:

$a = 0.20466 + 0.369659 \times T - 0.00893519 \times T^2$
$b = 0.335907 + 0.001603 \times T$
$c = 7.87357 - 0.841969 \times T + 0.028809 \times T^2$,

where T is temperature in °C.

For the postlarvae, only the data obtained for the mean temperature of 21.30°C were consistent enough to be fitted with Gompertz function (Regner, 1980). The parameters of the Gompertz function obtained for the growth at this temperature level were:

$l_t = 27 \times e^{-2.532e^{-0.086t}}$ (5).

Growth of postlarvae was also estimated from the daily growth increments of the otoliths of the postlarvae collected during the cruises along the Eastern Adriatic coast in August 1989 (Regner & Dulčić, 1990) and July/August 1990 (Dulčić & Kraljević, 1996). The parameters of the Gompertz functions were:

Parameters	a	b	c
Regner & Dulčić (1990)	27.315	2.0517	0.0892
Dulčić & Kraljević (1996)	29.664	3.0311	0.1211

It is interesting that the parametes of the Gompertz functions obtained either from the measured lengths of postlarvae reared in experimental conditions, or from the counting otolith daily increments of postlarvae caught from the plankton after the twelve years, do not differ very much (Regner & Dulčić, 1990).

The age of anchovy larvae and postlarvae was estimated for the following standard length groups:

Larvae (SL, mm)
I - 2.38
II - 2.39 - 3.03
III - 3.04 - 3.68
Postlarvae (SL, mm)
I - 3.99
II - 4.00 - 5.99
III - 6.00 - 7.99
IV - 8.00 - 9.99
V - 10.00 - 11.99
VI - 12.00 - 13.99
VII - 14.00 -15.99

VIII - 16.00 - 17.99
IX - 18.00 - 19.99
X - 20.00 - 21.99

Residence time of length group can be estimated with the equation:

$$\Delta t = -1/c \ln [(1/b \ln a/l_{t(i+1)}) - \ln (1/b \ln a/l_{ti})] \quad (6),$$

where Δt is the residence time, while l_{ti} and l_{ti+1} are initial and final lengths of each length group, while *a*, *b*, and *c* are the parameters of the equation (4). For the estimate of mortality rates the number of larvae and postlarvae from each length group have to be divided with the residence time.

The mean age from hatching of n-th length group can be estimated with the equation:

$$t_n = \sum_{i=1}^{n-1} \Delta t_i + \Delta t_n/2 \quad (7),$$

where Δt_i are residence times of length groups, obtained from equation (6).

D) Length-weight relationship of anchovy larvae and postlarvae

The relationship between standard lengths and dry weights was studied on the artificially reared larvae and postlarvae (Regner, 1983). It was found that larvae showed initial increase of the W/L ratio, which decreased later during yolk-sac resorption. Length-weight relationship in postlarvae was approximated with the power function, the exponent of which was 3.32, indicating positive alometric relationship.

E) Feeding of postlarvae

The feeding of postlarvae of the size from 3.0 to 8.0 mm standard lengths was investigated during the 1968 and 1969 spawning seasons in the Central Adriatic (Regner, 1971). It was found that the food consisted mostly of copepod eggs, nauplii and copepodites. The mean percent of postlarvae with the food in the digestive tract was, depending on size, between 10 and 43%.

F) Horizontal and vertical distribution

Horizontal distribution of anchovy eggs during the spawning season in the Adriatic was studied by numerous authors either in local areas (Gamulin, 1940; Varangolo, 1965; Štirn, 1969; Vučetić, 1971; Regner, 1972; 1979, 1985; Casavola *et al.*, 1987) or on larger scale in the Northern, Central and Southern Adriatic (Steuer, 1913; Piccinetti *et al.*, 1979, 1980; Gamulin & Hure, 1983; Regner *et al.*, 1985).

According to the aforementioned authors, anchovy spawns in the Adriatic above the depths of about 200 m, which corresponds with the Adriatic shelf. Thus, its eggs

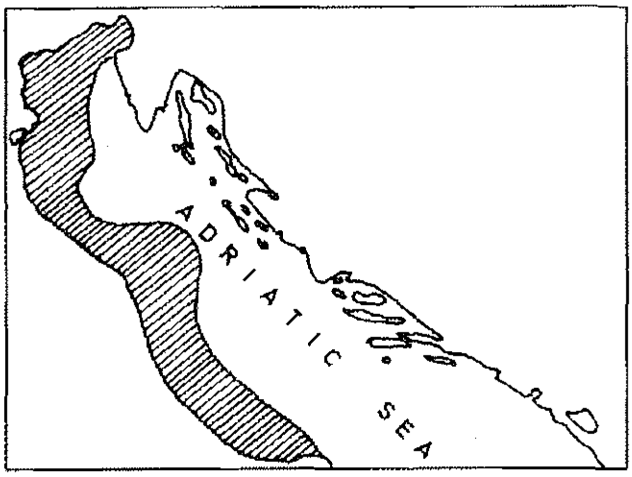


Fig. 3: The main spawning area (shaded) of the Adriatic anchovy.
Sl. 3: Glavno (osenčeno) drstišče jadranskega inčuna.

can not be found only in the areas deeper than 200 m - above the Jabuka pit in the Central Adriatic and above the Southern Adriatic pit.

Analysis of the long-term data shows that the main spawning area of the anchovy can be relatively clearly distinguished in the Adriatic (Regner *et al.*, 1985). In this area the probability that the mean daily egg production during the period of the maximum spawning intensity will be more than 100 eggs m^{-2} day^{-1} is higher than 90%. The area covers the shallow Northern Adriatic (with the exception of the zone along the western coast of the Istrian peninsula which is under the influence of relatively oligotrophic waters of the incoming Adriatic geostrophic current), and the zone along the western coast, to the Gargano peninsula (Fig. 3). Sometimes high production of anchovy eggs can be found around Palagruža island. In fact, this area is under the influence of the outflows of Italian rivers, especially of the river Po. In other areas, along the eastern Adriatic coast and in the channels between the islands along the eastern coast, as well as along the western coast from the Gargano peninsula to the Otranto straight, the intensity of spawning is substantially lower than in the main spawning area.

The anchovy egg and larvae surveys which covered almost the entire area of the Adriatic shelf were relatively numerous. For example, 11 cruises have been performed in the Northern, Central and a part of Southern Adriatic during the 1976-1990 period only for anchovy biomass estimates. However, most of the surveys have been carried out only once or twice during the spawning season. Therefore, little is known about the shifting of spawning centers during the spawning season, if the Adriatic is considered as a whole. The knowledge of transport and survival of larval stages is even more scarce. Only one analysis of the mortality rates of anchovy larvae and postlarvae in the entire area of the

Northern and Central, and a part of Southern Adriatic was carried out on the material collected in July 1978 (Piccinetti *et al.*, 1982).

The surveys throughout the spawning season were relatively scarce. They have been performed over relatively limited areas, mainly in the shallow Northern Adriatic. According to these surveys, centres of spawning within this part of the main anchovy spawning area move during the spawning season either in cyclonic (Vučetić, 1964; Varangolo, 1965) or in anticyclonic direction (Štirn, 1969).

These displacements are presumably affected by the specific water circulation in the Northern Adriatic. The circulation of surface waters in the Adriatic is basically cyclonic, with the northwest incoming flow along the eastern coast and southwest outgoing flow along the western coast (Zore, 1956). Owing to the bottom topography, this current forms four relatively permanent gyres with the northwesternmost one in the Northern Adriatic. The horizontal density gradients, combined with coastal river runoff of fresh water are capable of driving cyclonic circulation in the Northern Adriatic, which during the summer may be modified by two separate circulation cells (Malanotte-Rizzoli & Bergamasco, 1983). The wind stress (NE direction) may accelerate cyclonic circulation. On the contrary, if the wind direction is SE it can generate anticyclonic circulation along the west coast of the Northern Adriatic (Betello & Bergamasco, 1991; Rajar & Četina, 1991). This explains the differences in the direction of the moving of anchovy spawning centres found by different authors. Besides, the influence of these gyres on the rates of the mixing of oligotrophic waters of incoming geostrophic current and eutrophic waters of the river Po outflow is very important, because the rates of both horizontal and vertical mixing regulate the intensity of primary and secondary production. Together with the direction of currents is, no doubt, essential for the intensity of the spawning of anchovy in this area, as well as for the more or less successful survival of its planktonic stages. So far there were no detailed studies on the influence of the Northern Adriatic circulation on the transport and survival of anchovy larval stages. This should be one of the main tasks in the future investigations.

Along the Eastern Adriatic coast, where the anchovy spawning is not so intensive, some other geophysical factors may be of some importance for the reproduction of this fish. During the last two cruises, performed in July 1989 and August 1990 for the anchovy biomass assessment along the Eastern Adriatic coast, the distribution of daily egg production was compared with the vertical distribution of isotherms along the transects. This comparison showed that the egg production was most intensive in the areas of upwelling (Regner, *pers. comm.*)

Obvious influnce of the atmosphere - sea interaction on the distribution of anchovy spawning centre points out that both short and long-term climatic changes may be the principal factors that regulate reproduction of the Adriatic anchovy.

Vertical distribution of the anchovy planktonic stages was also studied in the Adriatic. Varangolo (1965) found maximal density of anchovy eggs 1 m below the surface, while Ghirardelli (1967) and Specchi (1968) reported maximum egg concentration in 7-27 cm layer. After Regner (1972), eggs were most abundant in the upper 10 m, while larvae and postlarvae were found in maximal densities in 10-20 m layer. The larger quantities of larvae and postlarvae found near the surface during the night indicated their diurnal vertical migrations.

G) Long-term fluctuations

Long-term fluctuations of the anchovy early stages were studied only in the eastern part of the Central Adriatic (Vučetić, 1971; Regner, 1974; Regner, 1979, 1985).

Considerably large fluctuations of total annual number of anchovy eggs through the period between 1959 and 1969 were accounted for the changes of amount of advection of the eastern Mediterranean water into the Adriatic (Vučetić, 1971). Later it was found that the fluctuations of the annual quantity of the anchovy eggs coincided with the fluctuations of primary production (Regner, 1974).

The more detailed studies on the relationships between annual means of egg production, number of postlarvae and their mean mortality rates with the annual means of abiotic and biotic factors (temperature, salinity, primary production and quantity of zooplankton) were carried out for the period of fifteen years (1962-1976) (Regner, 1979, 1985). It was found that the fluctuations of egg and postlarvae quantities were positively correlated with the fluctuations of temperature, salinity, primary production, with the phase lag of about 1 year. Mean instantaneous mortality rates of postlarvae were negatively correlated with the aforementioned factors. Thus, it may be supposed that survival of the postlarvae is more successful in the years of higher organic production, probably due to the decreased intraspecific competition. Spectral analysis of all long-term data showed periodicity of 2-3, 5-7, and 9-11 years. Since the similar periods were found out in annual variations of air pressure in Trieste and Venice (Polli, 1955), as well as in fluctuations of sardine catch (Regner & Gačić, 1974), it is possible that the reproduction of anchovy, regarding the long-term periods, is controlled by climatic changes, which affect the dynamics of the water masses and fluctuations of organic production in the Adriatic. The mechanism of this control seems to act through the changes of atmosphere - sea interactions. These changes depend on changes of air pressure gradients over the Mediterranean and on intensity of penetration of polar air towards the Mediterranean, *i.e.* on dis-

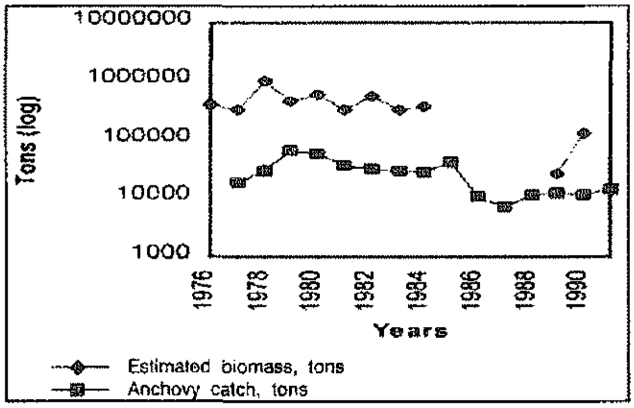


Fig. 4: Relationship between the estimated biomass and the catch during the period of decrease of the anchovy population in the Adriatic.
Sl. 4: Razmerje med ocenjeno biomaso in ulovom v obdobju upadanja inćunove populacije v Jadranskem morju.

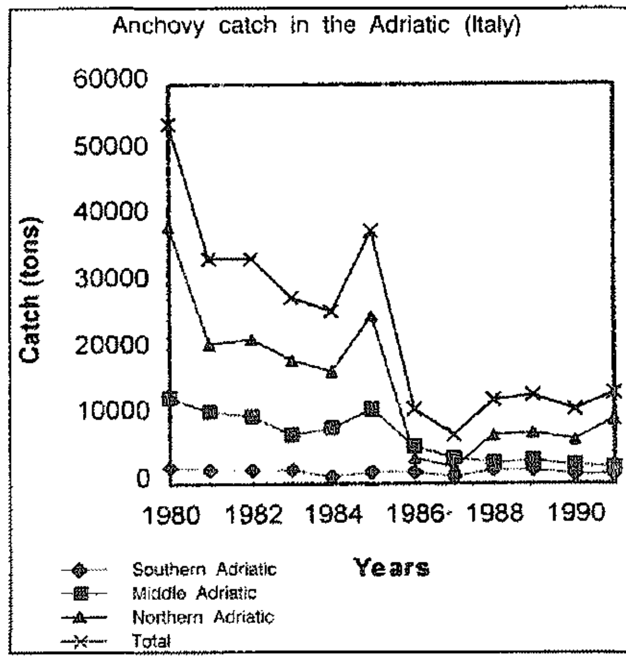


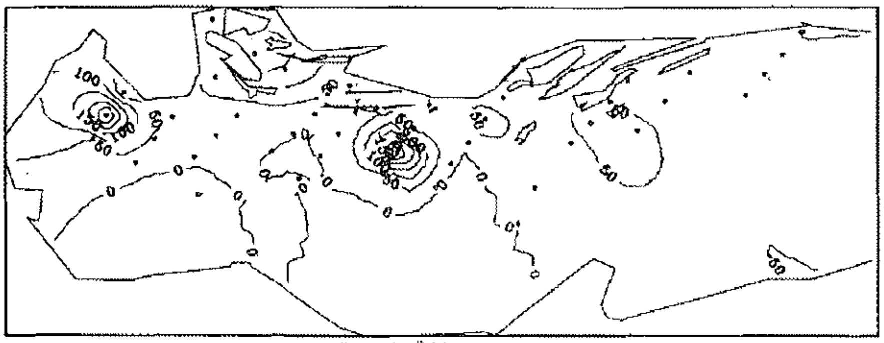
Fig. 5: Data on Italian catch in the Northern, Central, and Southern Adriatic during the period of anchovy population decrease.
Sl. 5: Podatki o italijanskem ulovu inćunov v severnem, srednjem in južnem Jadranu v obdobju upadanja inćunove populacije.

placements of large baric centres such as Icelandic cyclone and Syberian anticyclone (Zore-Armanda, 1969). Fluctuations of these climatic factors affect the intensity of penetration of the water masses of the Eastern Mediterranean intermediary layer (Buljan, 1963), which carry relatively large quantities of nutrients. They also intensify general water circulation, as well as the rates of mixing of water masses in the Adriatic (Zore-Armanda, 1991). In the years of intensified advections of the eastern Mediterranean waters, the primary and secondary productions increase (Pucher-Petković & Zore-Armanda, 1973). These changes of production may be assumed as the main factor which regulates the reproduction of anchovy in the Adriatic.

Further investigations have shown that after 1978 these "regular" fluctuations were disturbed. Long-term estimates of the anchovy biomass in the Adriatic, with both egg production (Regner *et al.*, 1985; Dulčić, 1993) and acoustic methods (Azzali *et al.*, 1990), showed a continuous decrease since 1978. Stock has almost collapsed during the years 1986-1987, and began to recover in the years 1989-1990 (Fig. 4). The catch of the anchovy in the Adriatic, which was 62,492 tons in 1979, fell down to only 7,055 tons in 1987.

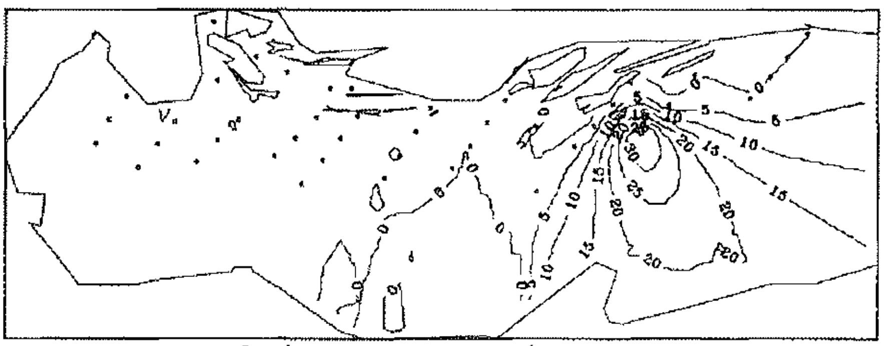
Since the biomass assessments by both methods applied showed that the anchovy stock was not overfished, some other explanations had to be found for this decrease.

From the mid-seventies onwards some changes, which may be the cause of the anchovy stock decrease, took place in the Adriatic. The constant increase of sea surface temperatures and salinity was observed, together with the decrease of sea water transparency and oxygen saturation in bottom layers (Zore-Armanda *et al.*, 1987; Zore-Armanda, 1991). These changes were followed by the increase of primary production (Pucher-Petković *et al.*, 1987), indicating that the Adriatic ecosystem went through a relatively long period of eutrophication. Just during this period some unusual changes in the distribution of some species took place in the Adriatic. For example, the large masses of gilt sardine *(Sardinella aurita)*, which was always present but not abundant in the Souhern Adriatic, spread since 1975 over the entire Adriatic, and in 1979 reached even the Gulf of Trieste (Gamulin, 1975; Kačić, 1975; Regner, 1977). The fish retreated to the Southern Adriatic in the second half of the eighties. As this fish spawns during the summer months, it can be a competitor to the anchovy postlarvae. A similar phenomenon happened with the population of jellyfish *Pelagia noctiluca* which exploded and covered large parts of the Adriatic during the period from 1977 to 1985 (Vučetić, 1982, 1985). This jellyfish is known as a predator of fish eggs and larvae. Since its quantities were the most numerous during the spawning season of anchovy, it may be assumed that this phenomenon also negatively influenced the recruitment of anchovy population. However, the anchovy stock decrease, although evident, was not so great during the period of the massive occurrence of *Pelagia noctiluca* (Vučetić & Alegria-Hernandez, 1987). On the contrary, the sharp decrease of the anchovy stock began just in 1985 (Figs. 4 and 5).

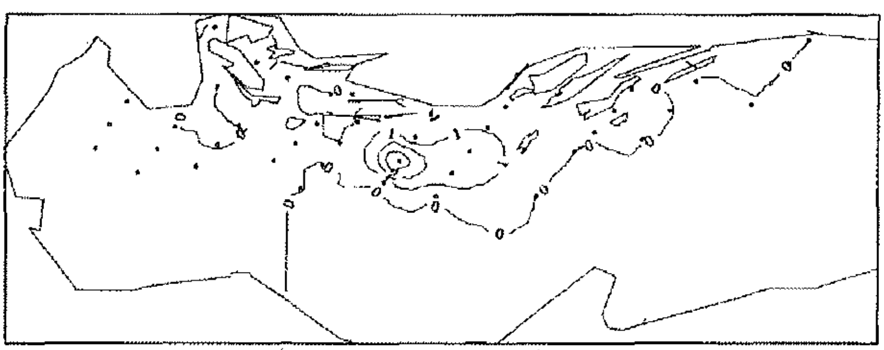


Eggs/m²/day, 1989

Larvae, mean age 2.9 days, 1989



Postlarvae, mean age 7.8 days, 1989



Postlarvae, mean age 12.3 days, 1989

Fig. 6: Horizontal distribution of anchovy eggs, larvae, and postlarvae (N/m²/day) along the Eastern Adriatic coast in August, 1989.

Sl. 6: Horizontalna razširjenost inćunovih iker, ličink in preobraženih ličink (N/m²/dan) vzdolž vzhodnojadranske obale v avgustu 1989.

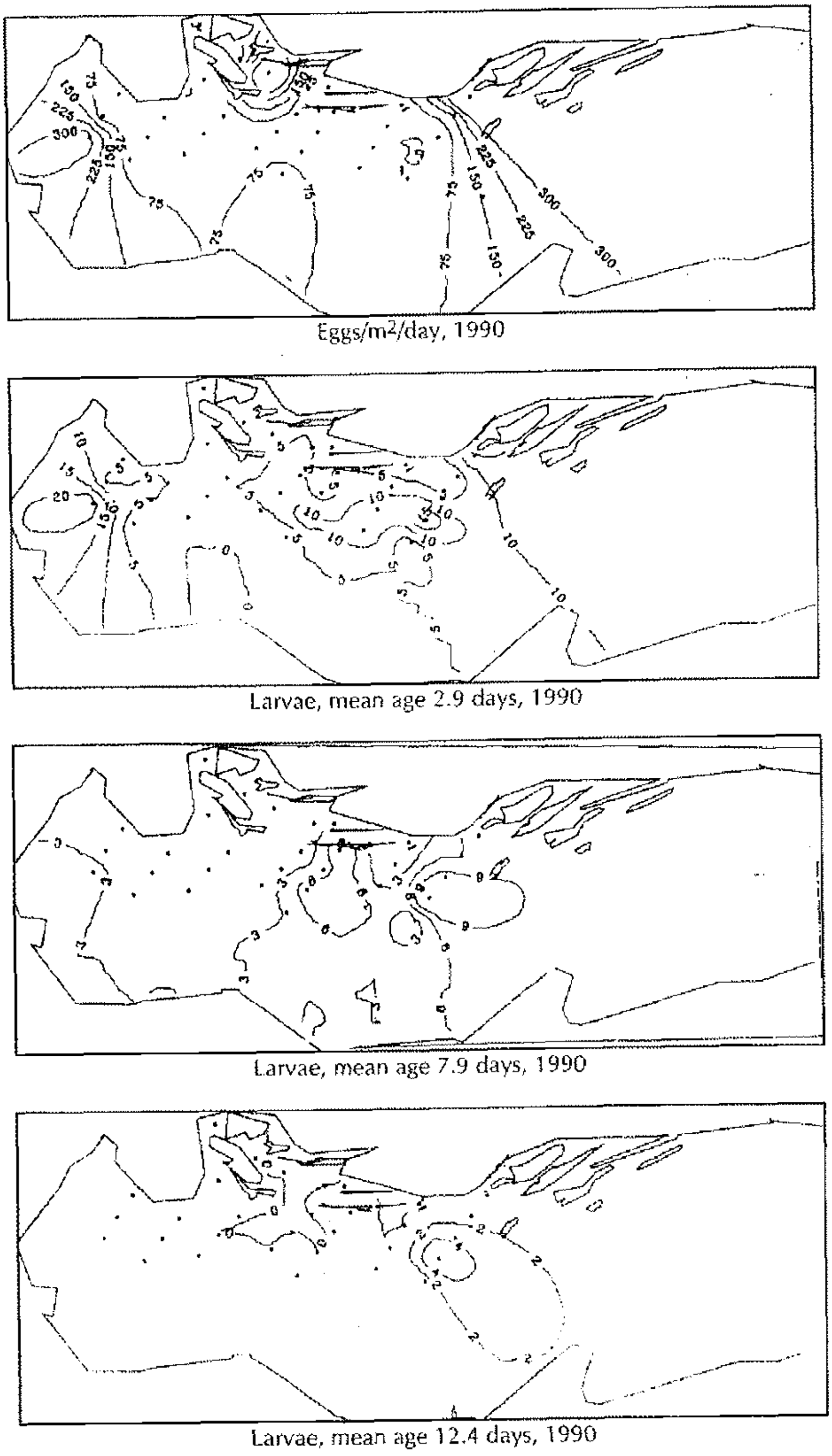


Fig. 7: Horizontal distribution of anchovy eggs, larvae, and postlarvae (N/m^2/day) along the Eastern Adriatic coast in July, 1990.
Sl. 7: Horizontalna razširjenost inčunovih iker, ličink in preobraženih ličink (N/m^2/dan) vzdolž vzhodnojadranske obale v juliju 1990.

At the same time, from the beginning of the eighties, the summer blooms of phytoplankton and benthic diatoms started to spread in the Adriatic Sea. Initially they were limited to smaller enclosed or semienclosed polluted areas, and they lasted for a relatively short time. The surface affected by the blooms increased from year to year, especially in the shallow Northern Adriatic, and along the western Adriatic coast, to the Gargano peninsula (Marasović & Pucher-Petković, 1987; Marchetti *et al.*, 1988; Todini & Bizzari, 1988; Marasović *et al.*, 1994). The period of blooms prolonged to the entire warmer season, coinciding with the spawning period of anchovy. Finally, during the period between 1986 and 1989, the blooming of plankton and benthic diatoms covered almost all the shallow parts of the Adriatic, particularly central and western parts of the Northern Adriatic, just the main spawning area of anchovy. In all the areas affected by the blooms, mucous matter released by diatoms was dispersed in dense patches, from the bottom to the surface. These blooms began to decrease in 1990. Time series of Italian catch of the anchovy (Fig. 5) show the sharpest decrease of the catch in the Northern Adriatic just in these years. This indicates that the anchovy was seriously affected by the blooms.

The spawning of the anchovy during the 1989 spawning season in the Northern Adriatic showed the lowest egg production in June, July and August, ever recorded in this area. Only one centre of more intensive spawning was detected in August in the area 10-20 miles off the western Istrian coast, in the zone of relatively oligotrophic waters of the incoming geostrophic current. The mortality rates of larvae were unusually high, while older postlarvae were not found in plankton (Dulčić, 1995). Moreover, during the anchovy egg surveys along the eastern Adriatic coast in 1989, it was found that anchovy postlarvae from the age classes of ~ 8 and 12 days were completely absent not only in the Northern Adriatic but also in the northern parts of the Central Adriatic (Fig. 6). The situation in 1990, when blooms began to decrease, was slightly different. Postlarvae from 8 days age class were found in large parts of the Northern Adriatic, but those 12 days old were still absent (Fig. 7).

This would mean that during the relatively long period of changes which caused eutrophication in the Adriatic, conditions for the reproduction of anchovy gradually deteriorated, using the permanent decrease of the population. Finally, during the 1986-1989 period of massive blooms, the population almost collapsed. Intensive blooms in the main spawning area of the Adriatic anchovy changed chemical properties of the water (Legović & Justić, 1994), qualitative and quantitative composition of phyto- (Marasović & Pucher-Petković, 1985; Fanuko, 1989) and zooplankton (Regner, 1987), which affected negatively both adult fish and larval stages. Besides all possible direct or indirect effects, it can be supposed that the patches of the mucous matter may irritate adult fish even physically, and act as a traps for larvae and postlarvae (Dulčić, 1995). Therefore, it seems that especially during the mentioned periods of massive blooms fish was forced to reproduce in relatively "clean" oligotrophic waters of the Central and Southern Adriatic, instead in its main spawning areas. It seems that during this period anchovy population recruited mostly from the waters of the eastern coast of Central and Southern Adriatic, and probably from waters of the western coast of the Southern Adriatic (in the area between the Gargano peninsula and Otranto). The conditions for the reproduction are not so favourable in these areas as they are in the traditional spawning area where the effects of eutrophication have been most pronounced. Since the temperature and salinity increased during this period, it seems that this eutrophication was the consequence of the period of low frequency climatic change, the effects of which could be intensified by the anthropogenic eutrophication. After all, it is known that this kind of phytoplankton blooms occurred from time to time in this area. These blooms were recorded, for example, in 1890-1891, 1903, 1905, 1921, 1927, 1931 (Fonda-Umani *et al.*, 1989; Regner, 1991), when anthropogenic influence was not so obviously intensive as it is nowadays. However, it seems that the reproductive potential of anchovy is considerably high, because stock began to increase immediately after decrease of the blooms intensity (Fig. 4).

CONCLUSIONS

It is evident from this review that numerous investigators studied various aspects of the early life history stages of the Adriatic anchovy. Together, their results give relatively comprehensive picture of the embryonic development and growth, seasonal and daily intensity of spawning, horizontal and vertical distribution and long-term fluctuations of anchovy planktonic stages in the Adriatic.

It is also evident that the results obtained were dispersed within the long period of time, and that the intensity of investigations, as well as the number of investigated parameters, varied from one area to another. Thus, the data obtained are not consistent enough, and it is not easy to compare them. On the other hand, some factors essential for the better understanding of reproduction and recruitment of this important species for the Adriatic fisheries have been studied only occasionally and in very restricted areas. Besides, very little is known about juvenile anchovy. The simultaneous targeted studies of both adult fish and early life stages were never performed in the Adriatic. The same situation is with the comparative studies of the influence of dynamics of water masses, as well of production, quantity and distribution of microzooplankton on the transport and survival of anchovy postlarvae. Those were, among the others, the main reasons that it was not possible to forecast the collapse of the anchovy population in the 1986-1989 period, although the decrease in the anchovy population has been observed on time.

Therefore, for the future projects some systematic multidisciplinary investigations have to be planned. Investigations have to be designed in a way which will enable a better understanding of the processes essential for the success of survival of the anchovy postlarvae and juveniles, *i.e.* for the success of recruitment. They should encompass physical oceanography, phyto- and zooplankton production with the emphasis on the studies of microzooplankton, together with studies of transport, condition and survival of postlarvae and juveniles, and the state of the adult part of population. They have to be performed throughout the year, and most intensively in the main spawning area. Since the basic period of fluctuation of anchovy population in Adriatic must be covered, they should last three years at least.

POSLEDICA SPREMEMB V MORSKEM OKOLJU NA ZAČETNE RAZVOJNE STOPNJE IN RAZMNOŽEVANJE INČUNA *ENGRAULIS ENCRASICOLUS* L. V JADRANSKEM MORJU

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POVZETEK

Začetni razvojni stadiji inčuna Engraulis encrasicolus *v Jadranskem morju so bile prvič preučevani že pred dobrim stoletjem. Graeffe (1888) je bil prvi, ki je poročal o ikrah, odkritih v poletnih mesecih v planktonu severnojadranskega morja. To poročilo je bilo objavljeno prav tistega leta, ko je inčunove ikre opisal Raffaele (1888). Pozneje so se raziskavam o začetnih razvojnih stadijih jadranskega inčuna posvetili še mnogi drugi znanstveniki, in treba je reči, da je število raziskav, povezanih z ekologijo planktonskih stadijev in z odraslimi inčuni, precej večje, kot jih je bilo opravljenih za druge vrste rib. Tako seveda lahko trdimo, da je inčun najintenzivneje preučevana riba v Jadranu.*

Avtor je v pričujočem članku želel napraviti pregled znanja o planktonskih stadijih inčuna v Jadranu. Razmnoževalno območje te vrste v Jadranu je zelo široko, saj se inčun drsti v globinah do 200 m, vendar je njegovo glavno drstišče v evtrofiziranih vodah zahodnega dela plitkega severnega Jadrana in ob italijanskem obrežju vse do Garganskega polotoka. Inčun se v Jadranu drsti od (marca) aprila do oktobra (novembra), in sicer v vodah s temperaturo med 11,6 in 27,6 °C in slanostjo med 9,1 in 39,6 ppt. Produkcija in število ličink z rumenjakovo vrečko sledita spremembam v primarni produkciji in biomasi zooplanktona med drstenjem, s približno dvomesečnim odmikom v razvojni stopnji.

Čas razvoja iker in ličink jadranskega inčuna kot tudi krivulje rasti ličink in preobraženih ličink je avtor izračunal v eksperimentalnih razmerah. Krivulje rasti preobraženih ličink so bile začrtane tudi na osnovi otolitnih določevanj starosti. Nadrobne raziskave o dolgoročnih nihanjih v produkciji inčunovih iker, številu ličink in preobraženih ličink kot tudi o stopnji takojšnje umrljivosti preobraženih ličink so bile opravljene v srednjem Jadranu med letoma 1962 in 1976. Pokazale so, da je povečani produkciji iker sledila povečana abundanca preobraženih ličink in hkrati povečana stopnja njihove takojšnje umrljivosti. Ugotovljeno je bilo, da so ta nihanja neposredno povezana z nihanji v temperaturi, slanosti, primarni produkciji in količini zooplanktona, z enoletnim odmikom v razvojni stopnji.

Že od leta 1978 so ta "redna" nihanja povsem porušena. Zmanjšala se je biomasa inčunov, medtem ko se temperatura, slanost, vsebnost nutrientov in primarna produkcija nenehno povečujejo v celotnem Jadranu. Videti je, da so bile te spremembe posledica nizkofrekvenčne periode podnebnih sprememb, na kar je bržkone vplivala tudi antropogena evtrofikacija. Ker je evtrofikacija prizadela predvsem plitki severni Jadran in pas ob italijanskem obrežju do Garganskega polotoka, se zdi, da je ta pojav negativno vplival na razmnoževanje inčuna v njegovih glavnih drstiščih.

Ključne besede: inčun, zgodnji razvojni stadiji, spremembe v morskem okolju, razmnoževanje, Jadransko morje

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OCCURRENCE OF FINGERLINGS OF GREY TRIGGERFISH, *BALISTES CAROLINENSIS* GMELIN, 1789 (PISCES: BALISTIDAE), IN THE EASTERN ADRIATIC

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ABSTRACT

Three fingerlings of Balistes carolinensis *Gmelin, 1789, found under a floating wreckage near the coast of the islet Gubavac (vicinity of the settlement Lumbarda, Korčula island), in September 1994, provided the first occurrence of the grey triggerfish fingerlings in the eastern Adriatic. This occurrence shows that this species spawns in the south-eastern Adriatic. The main morphometric and meristic data are given. The status of the grey triggerfish needs to be evaluated on a continuous basis as it is becoming increasingly apparent that uncommon species, and particularly those on the edge of their distribution, can be essential indicators of environmental change.*

Key words: *Balistes carolinensis,* fingerlings, Eastern Adriatic, first occurrence

INTRODUCTION

The grey triggerfish, *Balistes carolinensis* Gmelin, 1789, occurs on reefs and in open waters in tropical and subtropical seas, chiefly over rocky bottoms at 10-100 m. It is common in the Mediterranean Sea and on both sides of the Atlantic (from the North Sea to Angola and from Nova Scotia to Argentina) but rare in the Black Sea (Tortonese, 1986). This species also occurs in the Adriatic Sea, especially in its southern part (Jardas, 1983, 1996; Pallaoro, 1988), and in warmer years it may be found in the northern Adriatic (Pallaoro, 1988).

There is no published information on biology and ecology of the grey triggerfish in the eastern Adriatic. The aim of this paper is to provide first data on the occurrence of fingerlings of grey triggerfish in the eastern Adriatic and their morphometric and meristic characteristics.

MATERIAL AND METHODS

Three fingerlings were found under a floating wreckage near the coast of the islet of Gubavac in the vicinity of the settlement Lumbarda (Korčula island) in the southeastern Adriatic in September 1994 (Fig. 1).

The specimens were identified according to Šoljan (1975) and Tortonese (1986). They are deposited in the Ichthyological Collection of the Institute of Oceanography and Fisheries in Split.

Specimens were preserved in 4% buffered formalin immediately after capture, subsequently measured to the nearest 0.1 mm (Fig. 2) and weighed to the nearest 0.01 g. Reduction in length caused by preservation depends on the initial lengths of the specimens and duration of storage. Preservation in formalin causes an average 5% loss in total length of larvae and fingerlings (Mc Gurk, 1984). Meristic characteristics considered were dorsal, anal, pectoral, caudal fin rays and number of scales in the longitudinal line.

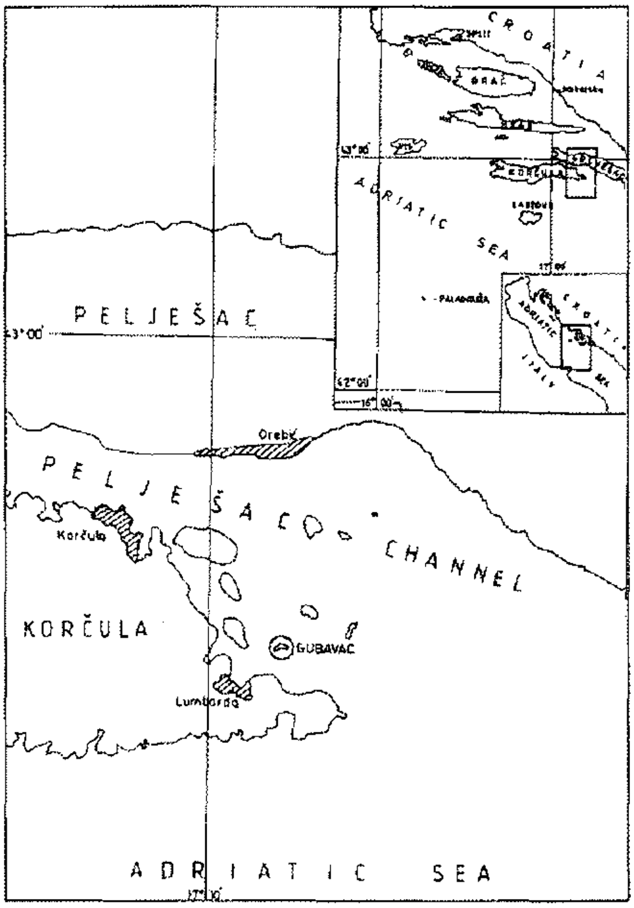

Fig. 1: Site where fingerlings of *Balistes carolinensis* ***were found (islet Gubavac).***
Sl. 1: Lokaliteta mladic balestre *Balistes carolinensis* ***(ob otočku Gubavac).***

RESULTS AND DISCUSSION

The grey triggerfish is relatively common in the south-eastern Adriatic and belongs to amphiatlantic biogeographical elements (Tortonese, 1964, 1970; Jardas, 1983, 1996). It is considered very rare in the northern areas, and only occurs in some years in the central Adriatic in the regions of Split and Zadar. The last occurrence was recorded in 1986/87 when several adult specimens were caught near the island of Ugljan and in Kornati Archipelago. Specimens occurred around the island of Lošinj in the northern Adriatic (Pallaoro, 1988); in 1969 and again in 1978, specimens were reported from the extreme north of the Adriatic in the Gulf of Venice (Boldrin & Rallo, 1980). Specimens were also recorded in Slovenian coastal waters (Piran Bay) and one is kept in the Piran Aquaria (Lipej, *pers. comm.*)

Studies on larval and juvenile stages of fish are of particular importance to population dynamics, especially to recruitment and biological models incorporating environmental parameters (Houde, 1986; Myers & Cadigan, 1993). There are no previous records of the grey triggerfish fingerlings in the eastern Adriatic although several studies and investigations on fish juvenile stages were carried out between 1975 and 1995 in the eastern Adriatic.

Fingerlings of the grey triggerfish has short and deep body. Eyes are near dorsal edge. Mouth are small and jaws short and strong with two rows of few incisor-like teeth (Randall, 1968; Tortonese, 1986). Specimens have two dorsal fins; the anterior fin is equipped with three spines (Tortonese, 1986). Pelvic fins are replaced by short spine at end of long and movable pelvic bone. Gill openings are very small. There were no blue stripes below the eye (a pair of blue side stripes below the eye is characteristics of *Balistes vetula* L., 1758). It is indicative that all specimens were found under a floating wreckage, which is in agreement with the findings of Tortonese (1986). All specimens are without elongated caudal rays, which are characteristics of adult species (Bini, 1968; Tortonese, 1986).

In Table 1 the main morphometric and meristic data of the three specimens are presented.

Specimens	1	2	3
Total length	40.0	46.9	48.6
Standard length	33.1	38.9	40.8
Predorsal length	10.0	12.5	13.3
Preanal length	23.1	25.5	27.3
Preventral length	21.1	22.3	22.5
First dorsal fin, length	7.6	8.4	9.0
Second dorsal fin, length	11.4	12.2	13.0
Anal fin, length	6.2	6.7	7.0
Pectoral fin, length	6.6	6.9	6.9
Body depth (max)	18.2	19.1	21.3
Body depth (min)	4.4	4.5	4.8
Head length	13.8	14.9	15.7
Ocular diameter	3.4	3.9	4.3
Preorbital length	7.5	8.0	8.2
Postorbital length	3.3	3.8	3.9
First dorsal fin rays (D_1)	III	III	III
Second dorsal fin rays (D_2)	27	27	27
Anal fin rays (A)	25	25	26
Pectoral fin rays (P)	14	14	14
Caudal fin rays (C)	11	11	11
Scales	54	54	55

Tab. 1: Morphometric and meristic data (in mm) of the grey triggerfish fingerlings in the south-eastern Adriatic (islet Gubavac).
Tab. 1: Morfometrični in meristični podatki (v mm) mladic balestre v jugovzodnem Jadranu (otoček Gubavac).

The meristic characteristics of fingerlings (Table 1) closely correspond with data by Bini (1968), *i.e.* D_1 III, D_2 27-28, A 25-27, P 14, C 10-12, but differ from data by Tortonese (1986) *i.e.* D III+2, 22-25, A 2-3, 22-23.

Even several adult stages were caught and since there are no previous records of larval and fingerling stages, the following question was raised: "Does the grey triggerfish spawn in the eastern Adriatic?" This September record shows that this species probably spawns in the southeastern Adriatic or even more the south, especially when we take into consideration that the grey triggerfish spawns in summer in the Mediterranean (Tortonese, 1986). We suppose that this specimens are about 3 or 4 months old according to the spawning time. Ofori-Danson (1990) defined the breeding season of the grey triggerfish as October to December (warmer months) in the Ghanaian coastal waters (Africa). The same author noted that the spawning of this species was characterized by relatively short preceding period of average minimum sea-surface temperature of 22.6°C. First time spawners were 13.3-15.7 cm in fork length (mean length L=14.4 cm, about 50.0-70.5 g in weight and one year of age) (Ofori-Danson, 1989, 1990). Wheeler (*pers. comm.*, after Quigley *et al.*, 1993), based on unsubstantiated reports on the occurrence of very small "young" triggerfish in Irish waters, speculated that the species may be "breeding quite close to Irish coasts (perhaps in Biscay)". It should be emphasized that in 1994 the eastern Adriatic was characterized by frequent records of larvae and juveniles, for example, larva of a mesopelagic species *Trachipterus trachypterus* (Dulčić, 1996) and juvenile of *Trachinotus ovatus* (Dulčić, *et al.*, 1997).

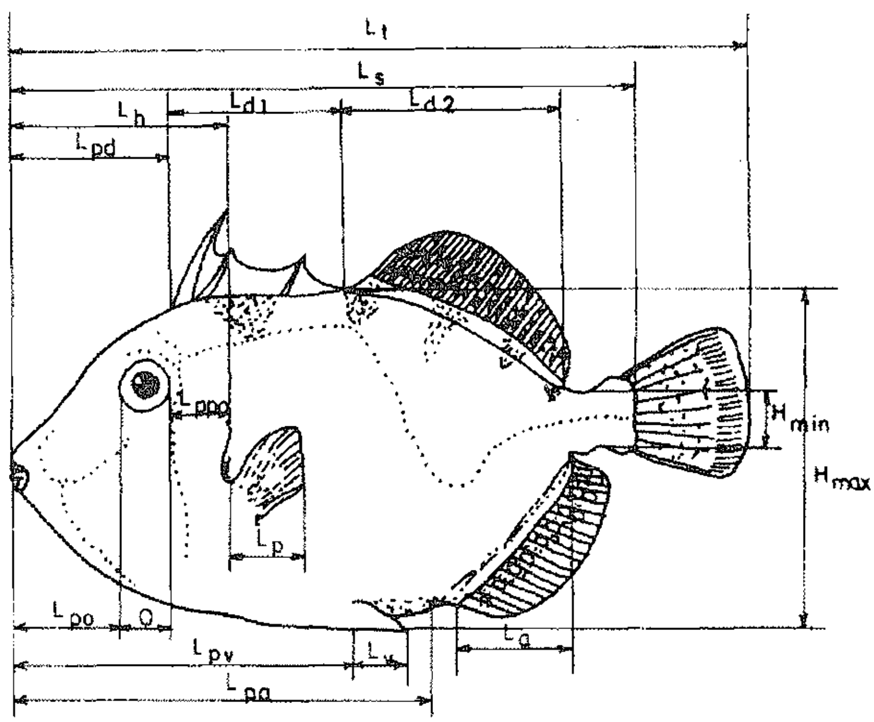

Fig. 2: Body measurements of** Balistes carolinensis **fingerlings. L_t - total length; L_s - standard length; L_{pd} - predorsal length; L_{pv} - preventral length; L_h - head length; O - eye diameter, L_{po} - preorbital length; L_{ppo} - postorbital length; L_{d1} - first dorsal fin length; L_{d2} - second dorsal fin length; L_p - pectoral fin length; L_v - ventral fin length; L_a - anal fin length; L_{pa} - preanal length; H_{min} - minimal body depth; H_{max} - maximal body depth at dorsal fin.

Sl. 2: Mere mladic balestre** Balistes carolinensis **: L_t - skupna dolžina; L_s - standardna dolžina; L_{pd} - predhrbtna dolžina; L_{pv} - predtrebušna dolžina; L_h - dolžina glave; O - premer očesa, L_{po} - predorbitalna dolžina; L_{ppo} - postorbitalna dolžina; L_{d1} - dolžina prve hrbtne plavuti; L_{d2} - dolžina druge hrbtne plavuti; L_p - dolžina prsne plavuti; L_v - dolžina trebušne plavuti; L_a - dolžina analne plavuti; L_{pa} - predanalna dolžina; H_{min} - najmanjša višina; H_{max} - največja višina pri hrbtni plavuti.

Quigley *et al.* (1993) noted, from the biogeographical review, that *B. carolinensis* has been extending its range and abundance on both sides of the North and South Atlantic during recent decades, especially for Irish waters. During the 1960's and 1970's the triggerfish increase in frequency and range in British waters (Wheeler *et al.*, 1975; Dobson, 1984). During the 1970's they occurred in numbers in the North Sea (Blacker, 1981) and penetrated even into the Thames estuary (Andrews & Wheeler, 1985). During the same period, it was recorded from the coasts of Denmark (Neilsen, *pers. comm.* from Quigley *et al.*, 1993), The Netherlands (de Groot, 1973), and Belgium (De Clerk, 1975). Wheeler (1978) considered that the triggerfish appeared to make regular annual migrations into northern European waters, where its relative abundance varied from year to year. During the 1980's and early 1990's triggerfish numbers appeared to increase further. In 1983, two specimens were recorded from the Dutch coast (de Groot, 1986), while in 1984 several specimens were recorded from as far north as Scotland (Dobson, 1984). Large numbers of triggerfish were also captured by anglers off the southwest coast of England in 1984 and 1989 (Cooling, 1989). During 1991, triggerfish appear to have occurred more frequently than usual in UK waters, paricularly in the west and northwest of Scotland (Gill, 1991). Wheeler (*pers. comm.* from Quigley *et al.*, 1993) remarked that "the triggerfish had become so common in English waters that it is probably the most striking change in the fauna of this century". In 1976, the triggerfish was regarded as rare north of the Gulf of Gascony in southwest France (Harambillet *et al.*, 1976). However, during the 1960's, 1970's and 1980's, the species was recorded with increasing frequency as far north as northwest France (Quéro *et al.*, 1986; Delmas *et al.*, 1986). The greater geographical range and general abundance of triggerfish may be related to the changes in climate and/or oceanographical conditions (Quigley, 1985). Global temperatures, for example, have risen by about 0.5°C in this century (Sweeney, 1989). Some changes in oceanographical conditions were noted for the central Adriatic (Marasović *et al.*, 1996). The penetration of the grey triggerfish in the central and northern Adriatic and, according to our data, probably for its spawning in the southeastern Adriatic might be connected with some special climatological and oceanographical conditions in 1994 and input of intermedian waters (50-100 m) in the central Adriatic which influenced the increase in salinity and temperature (Marasović *et al.*, 1996). Pallaoro (1988) also stated that the Adriatic ingressions caused more rare species (*Centracanthus cirrus, Aulopus filamentosus, Pseudocharanx dentex, Synodus saurus, Centrolophus niger*) to appear in the central Adriatic region in 1986-87 period. An unusual abundance of such rarely found fish species compared to the non-ingression periods gives indication of their interdependence. The moving of some southern Adriatic thermophile (*Balistes carolinensis*) and bathiphile (*Lepidopus caudatus*) species to a greater extent towards the North has been ascertained in 1986/87, which is a possible result of the effect of the ingression waters (Pallaoro, 1988). As quoted by Harmelin (1991), some species with southern affinities like *Seriola dumerili, Diplodus cervinus, Balistes carolinensis, Epinephelus alexandrinus* and *Epinephelus marginatus* are being found more commonly along the northwestern Mediterranean coasts. Juveniles of these species were observed at relatively high latitudes such as Calvi and Barcelona (Spain). Changes in the physical properties of the water and natural fluctuations in space and time are perhaps responsible for the mentioned occurrences (Saldanha, 1992). Sazonov and Galaktionova (1987) found that the quasi-synchronous increase in abundance of *Sardina pilchardus, Macroramphosus scolopax* and *Balistes carolinensis* in different climatic zones of the Central east Atlantic can more likely be attributed to global weather processes rather than to fishery impact since the exploitation rate of these species is quite different.

The status of the grey triggerfish needs to be evaluated on a continuous basis because it is becoming increasingly apparent that uncommon species, and particularly those on the edge of their distribution, can be essential indicators of environmental change (Swaby & Potts, 1990).

POJAVLJANJE MLADIC BALESTRE *BALISTES CAROLINENSIS* GMELIN, 1789 (PISCES: BALISTIDAE) V VZHODNEM JADRANSKEM MORJU

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POVZETEK

Balestra Balistes carolinensis *Gmelin, 1789 naseljuje grebene odprtih voda tropskih in subtropskih morij, predvsem kamnito dno v globinah med 10 in 100 metri. Pogosta je v Sredozemskem morju in na obeh straneh Atlantika (od Severnega morja do Angole in od Nove Škotske do Argentine); v Črnem morju je redka (Tortonese, 1986). Živi tudi v Jadranskem morju, predvsem v njegovem južnem delu (Jardas, 1983, 1996; Pallaoro, 1988); v toplejših letih jo utegnemo opaziti tudi v severnem Jadranu (Pallaoro, 1988). Tri balestrine mladice, odkrite septembra 1994 pod ladijskimi razbitinami ob obrežju otočka Gubavac (v bližini naselja Lumbarda na Korčuli), so prvi podatek o pojavljanju mladic te vrste v vzhodnem Jadranu. To odkritje potrjuje, da se balestra drsti v jugovzhodnem Jadranu; v članku so nanizani glavni morfometrični in meristični podatki, zbrani o tej vrsti. Sicer pa avtorji članka ugotavljajo, da je treba položaj balestre v Jadranu oceniti na osnovi trajnejšega raziskovanja, saj postaja vse bolj očitno, da so tako nenavadne vrste - in posebno vrste z roba svoje razširjenosti - pomemben kazalec sprememb v morskem okolju.*

Ključne besede: *Balistes carolinensis*, mladice, vzhodni Jadran, prvo pojavljanje

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DELO NAŠIH DRUŠTEV IN ZAVODOV

ATTIVITTÀ DEI NOSTRI ISTITUTI E DELLE NOSTRE SOCIETÀ

ACTIVITIES BY OUR INSTITUTIONS AND ASSOCIATIONS

OCENE IN POROČILA

RECENSIONI E RELAZIONI

REVIEWS AND REPORTS

IN MEMORIAM

N MEMORIAM

IN MEMORIAM

DELO NAŠIH ZAVODOV IN DRUŠTEV

ATTIVITÀ DEI NOSTRI ISTITUTI E DELLE NOSTRE SOCIETÀ

ACTIVITIES BY OUR INSTITUTIONS AND ASSOCIATIONS

Andrej Sovinc

'Towards a Pan-European Wetland Inventory' - report from the IUCN "Parks for Life"/RAMSAR Bureau workshop

Within the framework of the "*Parks for Life: Action for Protected Areas in Europe*", a workshop 'Towards a Pan-European Wetland Inventory' has been organized jointly by the IUCN "*Parks for Life*", Ramsar Bureau and Italian hosts (Centro Documentazione Internationale Parchi-CEDIP and the Pistoia authorities). The workshop took place in the Montecatini Terme in Italy between 22-23 January 1997. Experts from most important international wetland conservation and information management organisations and other institutions discussed the needs and opportunities to prepare the Pan-European Wetland Inventory.

Participants of the workshop agreed that there was an urgent need to bring together the currently diverse and dispersed data on European wetlands for the following reasons:

- to monitor the status and value of wetlands as a basis for promoting better protection;
- to assess the impact of proposed development projects;
- to provide information for effective implementation of global and regional Conventions, Directives, Strategies and other international initiatives;
- to promote public awareness of the values and importance of wetlands;
- to provide the basis for a coordinated approach to wetland conservation at the pan-European level.

The following objectives of the Pan-European Inventory have been agreed:

- Provision of information

(a) to provide information on wetlands relevant to the implementation of international legal instruments (*e.g.* Ramsar and other Conventions, EU Directives) and other initiatives (*e.g.* Pan-European Biological and Landscape Diversity Strategy);

(b) to provide information on wetlands relevant to the implementation of national policies, action plans and other initiatives;

(c) to provide information on wetlands relevant to planning and development processes.

- Promotion of information management

(a) to promote the adoption of common standards in order to integrate and exchange information with respect to national agencies, international legal instruments and Pan-European initiatives;

(b) to promote and strengthen capacities in information management.

Action strategy for the future is based on the following:

- Pan-European Inventory of Wetlands

Database management system by linking relevant existing databases

Spatial coverage of wetlands

It should be noted that this project could be undertaken under the auspices of BCIS (Biodiversity Conservation Information System), since most of the relevant agencies are members of this consortium.

- Meta-Database Framework

Design the structure of a wetlands meta-database and make it available on the Internet for agencies, institutions and other organisations to provide details of their data holdings

- Wetlands Information Network (WIN)

Establish a Wetlands Information Network on the Internet, modelled on the World Heritage Information Network (WHIN)

- Guidelines on Best Practice in Managing Wetlands Information

The Ramsar Bureau will, in cooperation with other international organisations, take the leading role in the preparation of the Pan-European Wetland Inventory.

Andrej Kranjc

7th SYMPOSIUM ON WATER TRACING
Portorož, May 26th - 31st, 1997

Many important meetings have been organised this year at Portorož, including the meeting of the Central European presidents. Among the professional meetings the 7th SWT was without doubt one of the most important. Under the simple name of symposium it was in fact the world's congress of specialists, using tracing techniques for water research. Already the fact that these symposia are held every fifth year confirms the importance of the event.

The five years which elapsed from the previous symposium (at Karlsruhe in 1992) were needed for the preparation of this one. First, it is necessary to say that the SWT symposia are not simple meetings where the specialists gather and discuss some topics. For the SWT a group of specialists belonging to the ATH (Association of Tracer Hydrology) choose appropriate karst terrain where they are trying different, if possible new, tracing techniques and methods. The results of these field experiments are the essential part of the symposium. Of course the report about the experiments has to be published, too, prior to the symposium, and the publication distributed to the participants. In 1992 at Karlsruhe the Slovene researchers, members of the ATH, offered to prepare the next, 7th SWT and to use Trnovsko-Banjška Planota karst plateau as a test area. Trnovsko-Banjška Planota is very important for Slovenia when drinking water reserves are taken into account. An ATH team came to Slovenia to visit the terrain and to discuss it with Slovene colleagues and according to the conclusions the organisation of the 7th SWT was assigned to Slovenia.

Here a special project *"Transport of pollutants in karst: tracers and models"* was launched, co-financed mainly by Ministries of Science & Technology and of Environment & Physical Planning. In the frame of the project over 50 researchers of different professions (hydrogeology, hydrology, geology, physics, chemistry, geography, meteorology, *etc.*) coming from 18 institutes (Austria, France, Germany, Switzerland and Slovenia) investigated the waters of Trnovsko-Banjška Planota and their underground connections.

In 1995 the project was concluded and 1996 was used for analysing and interpreting the results and for preparing the final report. This was published in a special number of *"Acta carsologica"* (edited by Karst Research Institute at Postojna), no. XXVI/1 under the title *"Karst Hydrogeological Investigations in south-western Slovenia"*, on 400 pages. The first part of the report presented basic data about Trnovsko-Banjška Planota (physical geography, hydrology, meteorology, geomorphology, speleology, geology, hydrology, water quality, karst springs' fauna, vegetation). These data were not just gathered but for some of them special research was needed (detailed geological mapping of the Vipava and Hubelj springs, precipitation, evapotranspiration). The essential part of the publication contains the results of the project investigations: water balance and hydrogeological and hydrochemical investigations. Special attention was focused on the so-called "short events" (water pulses after heavy rain or snow melt) which is a new approach and very important in studying the processes. Taking into account that isotopes are a sort of "natural tracer", a very appropriate one, these investigations played an important role in the project. The gist of the publication are the results of water tracing in the recharge area of important springs (Vipava, Hubelj, Lijak, Mrzlek). All the tracing experiments were combined, *i.e.* different tracers were injected simultaneously into the swallow-holes, sinkholes, and shafts on the Trnovsko-Banjška Planota. Besides the answers to scientific and methodological questions, the results are very important regarding underground water connections in the frame of the Trnovsko-Banjška Planota aquifer. The knowledge of the connections is essential for the protection of the aquifer.

The results of the project can be very useful for water managers and for water users, that means for all the inhabitants of the Trnovsko-Banjška Planota surroundings (Vipava valley, Nova Gorica and Idrija regions), as well as for the karst water specialists, who are using (or have to use) tracing techniques. At the same time the project and its publishing is a promotion of the Slovene research and science.

Publishing of the *"Karst Hydrogeological Investigations in south-western Slovenia"* was only one of the tasks the organiser, the Karst Research Institute, had to fulfill. Before the beginning of the symposium the proceedings had to be published, too. To enable the participants of the excursions to follow the routes more easily, a small (100 pages) *"Field Guide of Karst in Slovenia"* was prepared also. The symposium's proceedings *"Tracer Hydrology 97"* which contain 63 papers (grouped in 5 chapters) on 450 pages, were published by Balkema, Rotterdam.

When all this work was done (we found out that five years is not such a long time), the symposium could start. In the Convention Centre of the hotel Emona at Bernardin (Portorož) over 160 registered members gathered from 17 countries. Together with the occasional (non-registered) visitors, there were over 180 participants. Most of them came from all over Slovenia, from Germany and Austria. The rest were from European countries, from Malta to Ireland, from Spain to Slovakia. Specialists from other continents were present, too, from Brazil to China. It is necessary to mention that much more interest in attending the symposium was shown specially from the countries with economic problems

(India, Russia, Ukraine), but the organiser could not help them by other support than to exempt them the organisation fees. In the future such meetings should be organised with the help of an international organisation which can provide some money for such purposes (UNESCO or EU). Specialisation of the participants was very high, considering that more than half of them were doctors in science. Young researchers (young by age) formed quite a large proportion of the members, due also to the reduced fees. Despite the proximity of the sea and nice weather, all the lectures were attended by more than hundred listeners, which showed the quality of the papers and their interesting topics.

The symposium was opened on Monday afternoon, May 26th, by the state secretary of the Ministry of Science and Technology F. Demšar. Greetings were expressed by the organiser, representative of the Municipal Council, general sponsor, president of ATH, representative of the Ministry of Environment and Physical Planning, and by the president of the Karst Commission of the International Association of Hydrogeologists. On the first day only one paper (but lasting over one hour), the report on the Trnovsko-Banjška Planota project, was presented by P. Habič, the president of ATH. The next three days were fully occupied by professional papers, except one afternoon when the participants visited Kras (Classical Karst) and Škocjanske Jame caves. During three days, 42 papers and 23 posters were presented. Papers were grouped into six thematic sections: methods, surface water, unsaturated zone, aquifer, transport of pollutants and protection, aquifer characteristics, and modelling. It is impossible to mention all the papers and posters. Directly or indirectly all of them talked about water tracing, but were very different in details; from the papers which treated tracers to those which treated the study (by tracing methods) of waste water flow into the sea and pollution of groundwater by nuclear power plants.

About 30% of the participants (and 15% of the authors) were from Slovenia.

Their contributions were in the section on methods: Movement of bacteriophage and fluorescent tracers through underground river sediments (Bricelj & Mišič), Laboratory tracer experiments in carbonate porous media from Slovenia (Čenčur Curk, Obal, Kogovšek &Veselič); on the unsaturated zone : Water tracing tests in vadose zone (Kogovšek); on aquifers: Experiences in monitoring the Timavo river (Classical Karst) (Cucchi, Giorgetti, Marinetti & Kranjc), Properties of underground water flow in karst area near Lunan in Yunnan Province, China (Kogovšek, Liu & Petrič), Preliminary results of the submarine outfall survey near Piran (northern Adriatic Sea, (Malačič & Vukovič), Water balance investigations in the Bohinj region (Trišič, Bat, Polajnar & Pristov), Advanced methods of tracing in several Slovenian karst aquifers by using the natural light isotope characteristics (Pezdič), On the role of clay-carbonate reactions in the speleoinception - advanced theory of the earliest stage of karst channels formation (Pezdič & Šušteršič); on pollutant transport and protection: Agriculture - Potential polluter of waters in karst region in Slovenia (Matičič), Development of a tracer test in a flooded uranium mine using *Lycopodium clavatum* (Wolkersdorfer & Trebušak & Feldtner). The papers prepared by Italian, German and Chinese participants in co-operation with Slovene authors proved that Slovene researchers are involved intensely into the international research sphere.

The symposium was also an opportunity to acquaint foreign participants with karst in Slovenia, focused upon karst waters and the results of Slovene field research, which was achieved through the excursions. For the participants from Slovenia, the main topic of the excursions were problems of karst water protection. The highest interest was shown for the Trnovsko-Banjška Planota, where the test area of the project was shown and explained. On the way through Nova Gorica, the participants visited the headquarters of the general sponsor HIT. The second excursion was devoted to the upper Ljubljanica river basin focused upon karst poljes, the test area of the 3rd SWT (1976). The third excursion led the participants to the less known part of Slovene karst, to the karst of Dolenjsko in the basin of the river Krka.

Additional activities have to be mentioned, too: presentations, exhibitions, selling of literature and instruments, organisation meeting (10th ATH meeting), and the programme for accompanying persons. In the closure of the symposium, C. Leibundgut, the president of the International Committee on Tracers of the International Association of Hydrological Sciences, made a short summary of the expert part of the symposium, including the trends of the future activity of the ATH. The symposium was closed by R. Tavzes, the state secretary of the Ministry of Environment and Physical Planning.

For the moment it is too early to evaluate the success of the symposium; we have to wait for the remarks and published reports of the participants. Taking into account their number, the professional and organisation work done, the published material (1000 pages), the first responses of the participants and of the parent organisation - ATH - it is possible to say that the symposium succeeded as a professional event. Last but not least we must not forget the excellent technical assistance by the Meridiana agency and its specialist N. Zalar, as well as the Hotels Emona Convention Centre. The work and the money spent for the symposium must not be regretted. The question, however, how we will be able to make use of the new knowledge and the new perceptions is yet another problem.

Tadej Slabe

THE FIFTH KARSTOLOGICAL SCHOOL "THE CLASSICAL KARST": CAVE SYSTEMS. Postojna, June 30 - July 3, 1997

For a long time karstologists have been well aware that knowledge about karst must be deepened and widened. This is why we organise, every year, the karstological school, destined for karstologists, students, all those that plan life on karst and obviously for all those living on the karst. The lectures held during the school promote new knowledge about karst genesis and the impacts of human activity on this sensitive landscape.

The school of this year was dedicated to cave systems, that is to the origin and development of caves and to the cavernosity of aquifers.

The mornings lectures given by Slovene and foreign experts dealt with types of caves in the karst of Slovakia and Slovenia, with cave development in a part of the Czech karst, with flowstone formations, with origin and development of selected caves in Slovenia, Croatia and Italy, with the influence of bedding-planes and faults on the development of Postojnska jama, with cave sediments, with caves discovered during the motorway construction on karst, with caves that developed at the contact with impermeable rocks, and with the relation between caves and dolines. The discussion was open to everybody. The papers will be published in Acta Carsologica.

Afternoons and the entire last day were dedicated to field work. In the first afternoon we visited the non-tourist parts of Škocjanske Jame and had a look at some typical features in the Reka river-bed and in the higher level old passages. The origin and development of caves were presented. In Postojnska Jama special attention was paid to the features showing traces of the cave's development and that of its flowstones. A profile from Kraški Rob, from the higher old caves to the present springs at the contact with flysch, revealed the main periods of the development of this border aquifer. We visited a part of the aquifer, through which the waters from Cerkniško Polje flow into Planinska Jama; this is a part of the underground Ljubljanica flow. In Rakov Škocjan, caves are located between collapse dolines, and the Zelške Jame caves are a good example of periodically flooded passages with a typical rock surface relief.

Since the beginning of 1993 the Karstological School has been highly valued in Slovenia and abroad. In spite of some financial problems we believe that the external support will assure its successful promotion also in future.

The number of participants is growing from year to year. This time there were 67 participants from 8 countries.

We may conclude that the aim of such a school, *i.e.* to widen the understanding of this unique karst landscape, in this case particularly underground, was completely fulfilled and that the school was successful.

Staša Tome

3. SVETOVNI HERPETOLOŠKI KONGRES
Praga, Češka republika, 2.-10. avgust 1997

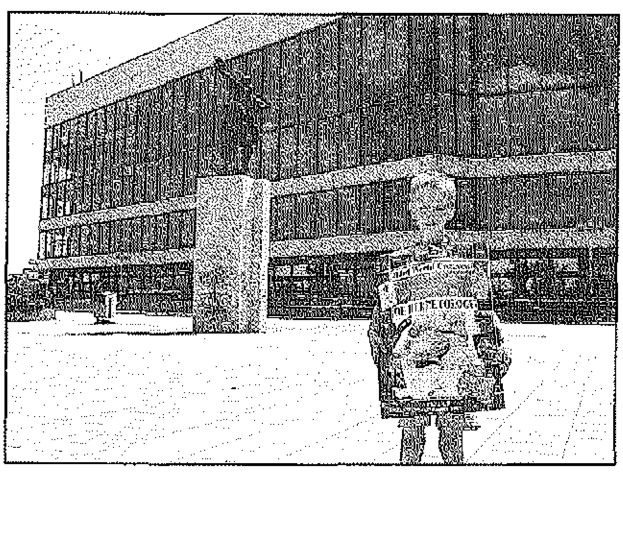
Poleti 1997 je prestolnica Češke republike gostila številne strokovnjake in amaterje, ki se znanstveno ali ljubiteljsko ukvarjajo z dvoživkami in plazilci. Prijavljenih je bilo 512 predavanj in 278 posterjev, sodeloval je 1121 avtorjev z vsega sveta. Predavanja so bila organizirana kot zasedanja in simpoziji, razdeljena pa so bila v več sklopov, ki pokrivajo vse vidike preučevanja dvoživk in plazilcev. Prispevki o ogroženosti herpetofavne so bili združeni v sklope: Herpetofavna in onesnaževalci okolja, Upadanje populacij dvoživk: geografija in možni vzroki, Vpliv človekove aktivnosti na populacije dvoživk, Upadanje populacij plazilcev in strategija njihove zaščite ter Strategija zaščite dvoživk in plazilcev. Paleontološko so bili obarvani naslednji sklopi: Dvoživke paleozoika, Zgodnji plazilci in Dvoživke in plazilci mezozoika. Z evolucijo so se ukvarjali sklopi: Evolucija kač, Evolucija in sistematika kač, Evolucija in sistematika plazilcev, Evolucija repatih krkonov ter Evolucija in sistematika brezrepcev. Fiziološki procesi, rast in razvoj so bili obravnavani v sklopih: Fiziologija dvoživk in plazilcev, Temperatura in določanje spola pri plazilcih, Razvoj pri dvoživkah, Rast in razvoj pri plazilcih, Neonatologija plazilcev. Obsežne celodnevne sklope so oblikovale vedno aktualne teme, s katerimi se ukvarja veliko število strokovnjakov: Ekologija dvoživk, Ekologija plazilcev, Zoogeografija dvoživk in plazilcev, Morfologija dvoživk, Morfologija plazilcev, Filogenija in sistematika družine gadov, Razmnoževanje dvoživk, Razmnoževanje plazilcev, Vedenje dvoživk, Vedenje plazilcev, Populacijska ekologija dvoživk, Populacijska biologija plazilcev in Biologija in biodiverziteta afriške herpetofavne. Manjši sklopi pa so bili: Zgodovina herpetologije: herpetološke ekspedicije in potovanja, Strupi dvoživk in plazilcev, Spreminjanje podnebja in njegov vpliv na herpetofavno, Razmnoževanje v ujetništvu, Oglašanje dvoživk, Kromosomske študije dvoživk in plazilcev, Parazitologija in Morske želve: biologija, ekologija, gospodarjenje.

Zaradi velikega števila prispevkov je bil čas posameznih predavanj omejen na 15 minut, 5 minut pa je bilo namenjenih diskusiji. Predavanja so potekala hkrati v šestih dvoranah praškega Kongresnega centra, tako da se je bilo večkrat težko odločiti med več zanimivimi temami. Vendar pa je nemalokrat sledilo razočaranje, saj je zaradi kvantitete trpela kvaliteta predavanj. Mnoga predavanja (žal tudi edino iz Slovenije) kljub obetajočemu naslovu ne bi vzdržala resne kritike. Seveda je bilo tudi veliko odličnih in zanimivih predavanj, med katerimi naj le kot primer omenim predavanje dr. R. C. Drewesa (California Academy of Sciences, USA), ki je na razumljiv in tu in tam hudomušen način predstavil problematiko herpetologije v Keniji in Ugandi. Predavanje je bilo namenjeno širokemu krogu poslušalcev, na sporedu pa so bila tudi mnoga odlična predavanja, namenjena specialistom na posameznih področjih herpetologije.

Predstavitev posterjev je potekala v dveh delih: prvi je obravnaval dvoživke, drugi pa plazilce. Skoraj tretjina panojev pa je ostala nezasedena. Zdi se, da je pri nekaterih raziskovalcih boj za točke, ki jih prinese objava izvlečka s kongresa, prevladal nad osnovno raziskovalsko etiko. Tako mnogi prijavijo posterje in celo predavanja, pošljejo izvlečke, kongresa pa se ne udeležijo. Poleg moralne spornosti se ob tem lahko vprašamo tudi o verodostojnosti in kvaliteti rezultatov. Takšno "taktiko" sem že prej opazila pri nekaterih sodelavcih v Sloveniji, tokrat pa sem ugotovila, da je precej pogosta tudi pri kolegih, ki prihajajo iz tako imenovanih držav v tranziciji.

Na programu je bilo tudi več delavnic, med katerimi je bilo največ pozornosti posvečene zaščiti ogroženih vrst plazilcev in dvoživk Evrope.

Kongresa se je udeležilo kar devet udeležencev iz Slovenije, med njimi sedem študentov. Čeprav vsi niso aktivno sodelovali, pa to kaže na razveseljivo dejstvo, da je zanimanje mladih za dvoživke in plazilce v Sloveniji veliko. Katja Poboljšaj (Prirodoslovni muzej Slovenije) je s posterjem predstavila pregled stanja populacije laške žabe *(Rana latastei)*, ki je v Sloveniji omejena le na majhno območje v bližini Nove Gorice, in izpostavila nujnost njene dejanske zaščite. V soavtorstvu s Tamaro Čelhar, Aleksandro Lešnik in Barbaro Skaberne (študentke BTF, oddelek za biologijo Univerze v Ljubljani) je predstavila tudi rezultate zasledovanja dinamike masovnih migracij sekulje *(Rana temporaria)* v prezimovališče Vranja jama. Poster je bil deležen velikega zanimanja. Nuša Vogrin (študentka Pedagoške fakultete v Mariboru) se je predstavila z dvema prispevkoma: posterjem o herpetofavni Dravskega polja in predavanjem o demografiji pozidne kuščarice *(Podarcis muralis)* na razvalinah gradu Žovnek. Sama sem, kot predstavnica Biološkega inštituta ZRC SAZU, s posterjem predstavila začetke kartiranja in razširjenost plazilcev v Sloveniji.



Poleg znanstvenega programa so v času kongresa potekale tri simultane videoprojekcije filmov s herpetološko vsebino. Ogledati si je bilo mogoče tudi razstavo živih dvoživk in plazilcev, ki jo je organiziralo Društvo teraristov iz Prage. Poleg 42 vrst predvsem tropskih dvoživk in plazilcev, ki jih sicer tu vzgajajo, so bile za to priložnost na ogled postavljene tudi vrste, ki živijo v Češki republiki, in nekatere vrste palearktične regije. V času kongresa so imeli udeleženci prost vstop v praški živalski vrt, 4. avgusta je bilo po njem organizirano tudi strokovno vodstvo.

V prostorih kongresnega centra so se predstavila številna večja evropska herpetološka društva, nekatere specializirane založbe pa so ponujale velik izbor herpetološke literature.

Udeleženci kongresa so lahko izbirali med dvanajstimi strokovnimi ekskurzijami po Češki republiki, ki so poleg strokovnih ponujale tudi nekaj turističnih užitkov.

Družabni del programa je ponujal zabavo za dobrodošlico ob prihodu in koncert Češkega komornega orkestra, ki je z deli Wolfganga Amadeusa Mozarta in njegovih sodobnikov v slovitem Rudolfinumu verjetno navdušil vse navzoče. Za doplačilo pa je bila organizirana pivska zabava "Pri Fleku", najstarejši in najznamenitejši praški pivnici in pivovarni, ter panoramski ogled Prage s parnika.

Čeprav se na prireditvi takšnih razsežnosti, kot je svetovni kongres herpetologov, včasih zazdi, da ni mogoče slediti vsemu, kar se dogaja, pa je to odlična priložnost za sicer bežen, a celosten vpogled na dogajanje v herpetologiji in navezovanje ter vzdrževanje stikov s strokovnjaki s področij, ki te zanimajo. Tu so namreč na enem mestu zbrani skoraj vsi, ki v tej veji znanosti kaj pomenijo.

Aleksander Vukovič

6. KONGRES BIOLOGOV HRVAŠKE
Opatija, 22. - 26. september, 1997

V Opatiji je potekal, že šesti po vrsti, Kongres biologov Hrvaške, ki se ga udeležujejo biologi in drugi strokovnjaki, ki se ukvarjajo z biološko ali sorodno problematiko in procesi, pa tudi pedagoški delavci s področja biologije. Zaradi takšne pestrosti različnih tem je bilo delo kongresa razdeljeno na več vzporedno potekajočih sekcij, tako da je bilo težko slediti celotnemu poteku in vsebini prispevkov. Sekcije so bile dokaj široke - Molekularna biologija, Genetika in evolucija, Mikrobiologija, Razvojna biologija in onkologija, Morfologija in fiziologija živali in človeka, Rastlinska citologija in fiziologija, Imunologija, Favna, sistematika in ekologija kopenskih biotopov, Flora, sistematika, fitoekologija in fitocenologija, Biologija kopenskih voda, Flora in favna, sistematika in ekologija morja, Toksikologija ter Pouk biologije - pa vendar je pri nekaterih prispevkih težko najti odgovarjajočo sekcijo. Vseh prispevkov je bilo 318, poleg tega pa še pet plenarnih predavanj in dve okrogli mizi na temo *"Stanje in perspektive pouka biologije na Hrvaškem"* ter *"Stanje in perspektive biološke znanosti na Hrvaškem"* Slednja je bila še posebno zanimiva, z uvodnim prispevkom dr. Maje Jokić z naslovom *"Scientometrijska evaluacija znanstvenih projektov s područja biologije v obdobju od 1991-1996"*, s katerim je prikazala uspešnost posameznih raziskovalcev, skupin in projektov, ki jih je financiralo ministrstvo za znanost.

V zvezi z morsko problematiko je zbujala pozornost dejavnost, usmerjena k zaščiti sredozemske medvedjice *(Monachus monachus)*, ki je glede na hitro upadanje števila osebkov najbolj ogrožena vrsta v Jadranskem morju. Veliko je bilo prispevkov o razmerah in življenju v NP Mljet in v Malostonskem zalivu, drugi prispevki pa so bili razpršeni tako po strokovnih kakor tudi po geografskih področjih.

Iz Slovenije se je kongresa udeležilo kar nekaj predstavnikov z Inštituta za biologijo, s prispevki v obliki predavanj in s posterskimi prikazi. Sodelovali so v sekcijah Toksikologija, Mikrobiologija ter Sistematika in ekologija morja. Poleg sodelavcev Inštituta za biologijo so se kongresa udeležili iz Slovenije še kolegi s Slovenske akademije znanosti in umetnosti iz Ljubljane.

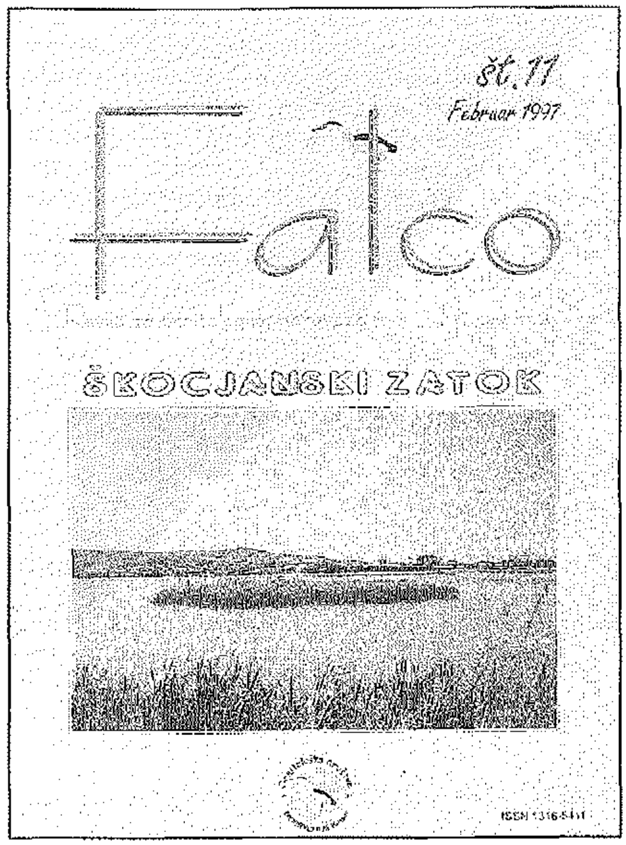
Kongres je organiziralo Društvo biologov Hrvaške, ki je ob tej priložnosti imelo tudi svoj občni zbor. V času trajanja kongresa so bili predvideni različni strokovni izleti, izmed katerih je bil po moji presoji najbolj zanimiv ogled rezervata beloglavih jastrebov na otoku Cresu.

OCENE IN POROČILA

RECENSIONI E RELAZIONI

REWIEWS AND REPORTS

FALCO, Revija za ornitologijo, naravoslovje in naravovarstvo, št. 11
Ornitološko društvo Ixobrychus Koper, 79 strani



Koprski ornitologi so tudi v letu 1997 izdali novo, 11. številko revije Falco in jo v celoti posvetili Škocjanskemu zatoku.

Novi obliki in novemu pristopu je tokrat sledilo še eno presenečenje... V uvodniku z naslovom Uvodnik v osušitev nam Iztok Geister predstavi zasutje Škocjanskega zatoka v nekoliko drugačni luči, ne le kot izgubo življenjskega prostora rastlin in živali, temveč tudi kot izgubo lastne identitete. Prepoznavno podobo svojega mesta mestni očetje prodajajo košček za koščkom. V nasprotju z njimi pa je uredništvo pokazalo širino svojega duha tudi s tem, ko je v reviji objavilo članke in prispevke v italijanskem, materinem jeziku manjšine tega narodnomešanega območja. V angleškem jeziku je poleg naslovov in povzetkov tudi eden izmed uvodnih prispevkov.

Vsebina revije je razdeljena na tematske sklope. V prvem sklopu z uvodnimi prispevki na temo Škocjanski zatok - izgubljena stvar? nam Iztok Škornik na kratko predstavi pomen sredozemskih mokrišč, njihovo hitro izginjanje in možnosti ohranitve. Martina Gamboz je v italijanskem jeziku pisala o nastanku in spreminjanju Škocjanskega zatoka zaradi degradacijskih posegov. O konfliktih, ki se pojavljajo zaradi različnih interesov na tem svojstvenem naravnem območju, je J.P. Hesselink pisala v angleškem jeziku. Mitja Kaligarič je naštel in opisal halofitne vrste, ki jih lahko srečamo na ožjem območju Škocjanskega zatoka. Kar je bilo do leta 1994 napisanega in storjenega v povezavi s Škocjanskim zatokom, je Tihomir Makovec zbral in kronološko zapisal v prispevku Škocjanski zatok na papirju.

Drugi sklop je posvečen člankom in razpravam z različnih področij. Iztok Škornik je opazoval gnezdenje črne liske v Škocjanskem zatoku. Lovrenc Lipej je s prehrano pegaste sove predstavil male sesalce Škocjanskega zatoka, v drugem članku pa je pisal o gnezdenju navadne postovke na robu Škocjanskega zatoka. Ali Šalamun je preučil in opisal kačje pastirje Škocjanskega zatoka in okolice. Številne mehkužce, ki so nekoč živeli v Tržaškem zalivu, so avtorji Raffaella De Min, Ennio Vio in Valter Žiža prepoznali v nanosu, ki je nastal s poglabljanjem morja v pristaniške namene. Rastišče krhke hrbtorese, ki je hkrati tudi prva potrditev uspevanja te vrste na območju Slovenske Istre, je odkril Nejc Jogan. Manca Plazar Mlakar je predstavila ureditev Škocjanskega zatoka tako, kot si ga želimo ljubitelji narave.

V naslednjem sklopu sta predstavljeni mladinski raziskovalni nalogi, ki so ju pod skrbnim mentorstvom prof. Luise Angelini Ličen, Tihomirja Makovca in Iztoka Škornika pripravili dijaki italijanske gimnazije Gian Rinaldo Carli iz Kopra. Zanimivo je poročilo Tihomirja Makovca o opazovanju malega deževnika v Škocjanskem zatoku.

Vitez za okroglo mizo je bil tokrat Iztok Geister. Glede na njegov obsežni opus vam zagotavljam, da pogovor ni potekal le o Škocjanskem zatoku, ampak še o marsičem.

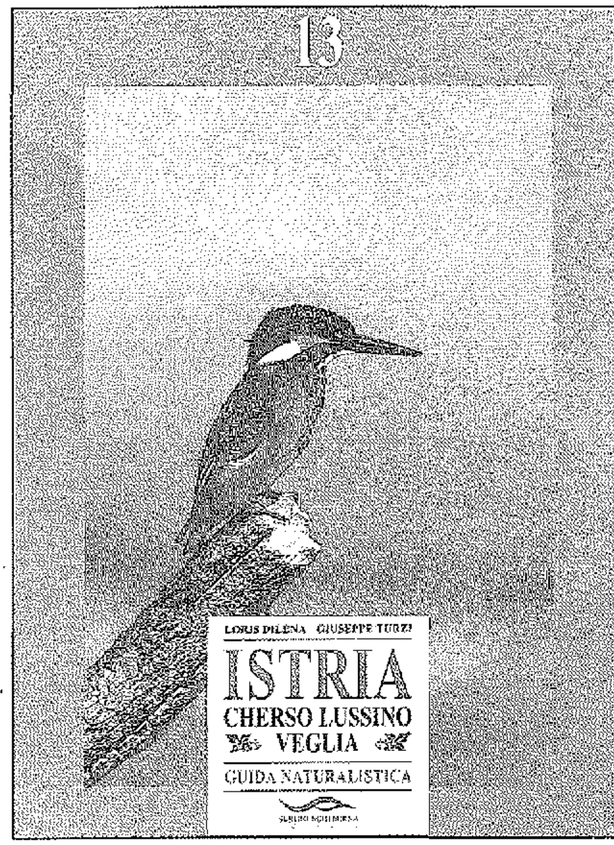
Revijo zaključujejo krajši zapisi o različnih ekskurzijah, prireditvah, zanimivostih, ocenah novih knjig, pisma bralcev in navodila avtorjem za pripravo člankov. Barbara Švagelj je pripravila poročilo o občnem zboru Ornitološkega društva Ixobrychus Koper. Ornitološki izlet k izlivu reke Soče v Maransko laguno je na svojstven način opisal Boris Švagelj. Uredništvo je omenilo žalostno najdbo kmečke lastovke v Južni Afrki, ki je v letu 1989 odletela iz Škocjanskega zatoka. Deveti zvezek naravoslovne revije Annales, Anali za istrske in mediteranske študije, ki jo izdaja Zgodovinsko društvo za južno Primorsko, je predstavila Barbara Švagelj.

Uredništvo je prejelo tudi dve zanimivi pismi bralcev. Prvo je poslal osnovnošolec, kar kaže, da ima ornitološko društvo svoje privržence tudi med mladimi. Drugo pismo, v italijanskem jeziku, nam odkriva stare načine ribarjenja v Škocjanskem zatoku. Za popestritev revije z risbami je poskrbela Martina Trani.

Izdajo 11. številke Falca je tokrat sofinanciralo Ministrstvo za znanost in tehnologijo Republike Slovenije. Revijo je mogoče listati na internetu, kamor lahko tudi sami prispevate svoje zamisli.

S prispevki v 11. številki revije Falco so koprski ornitologi in drugi ljubitelji narave še enkrat opozorili na Škocjanski zatok kot pomembno naravno dediščino, ki bi jo bilo vredno zaščititi. Ker vemo, kako počasi se odzivajo naše institucije, lahko samo upamo, da ne bo 11. tematska številka revije Falco o Škocjanskem zatoku postala eden redkih virov o zatoku in njegovih prebivalcih.

Danijela Kleva Švagelj



Loris Dilena, Giuseppe Turzi: Istria - Cherso - Lussino - Veglia, Guida naturalistica. Založba Sergio Schiberna editore, Trst 1997, 21 zvezkov, 252 str.

V poletnih mesecih sem v Miljah pri Trstu v izložbi naletel na prva ravno izšla dva zvezka naravoslovnega vodnika po Istri. Ker sta oba zvezka name naredila dober vtis, sem se odločil, da bom zvezke tega vodnika, ki so izhajali v tedenskih presledkih, redno kupoval. Na podlagi prebranih 15 zvezkov, ki sem jih doslej kupil, sem lahko strnil pričujočo oceno o tej reviji.

Naravoslovni vodnik krasijo izjemne fotografije živalskega in rastlinskega sveta Istre in Kvarnerskih otokov ter odlični krajinski posnetki življenjskih okolij tega območja. Revija je velikega formata, z zeleno uokvirjeno naslovnico in domiselno oblikovano notranjostjo. Poleg značilnih motivov istrske in kvarnerske favne in flore sta avtorja postregla tudi s fotografijami nekaterih redkih in/ali fotografsko izredno zahtevnih vrst ptic in sesalcev. Zvezki obravnavajo zanimive kotičke Istre, začenši z naravnimi posebnostmi doline Rižane, Kraškega roba in Sečoveljskih solin, nadaljujejo z obravnavo dolin reke Mirne in Raše, predstavijo nam Brionsko otočje ter nadaljujejo s posebnostmi Čičarije vse do Učke. Vsako zanimivo območje je zaključena celota, razdeljena v posamezna poglavja. V uvodnem delu nam avtorja predstavita osnovne podatke (lega, osnovne značilnosti, geografske in geološke posebnosti) o obravnavanem območju. Sledi poglavje o flori in favni (ki je običajno tudi najdaljše), v katerem nam predstavita posebnosti iz istrskega živalskega in rastlinskega sveta. V naslednjem poglavju nas avtorja seznanita s potmi *(Percorsi)*, ki si jih bralci lahko izberejo za izlet. V kratkem poglavju *(Consigli)* nas avtorja opozorita na najprimernejši čas obiska teh predelov (npr. barvitost pokrajine) ter dasta še kakšen namig o potrebni opremi.

Sledi poglavje *(Vitto e Alloggio)* o znanih restavracijah in gostilnah v bližini in o istrskih specialitetah. V stavku ali dveh, ki tvori(ta) poglavje *Clima ed epoca delle escursioni*, nam avtorja spregovorita o podnebnih razmerah in o najprimernejšem času za obisk danega območja. V zadnjem poglavju pa lahko zvemo kaj več o jamah, gradovih, razvalinah, cerkvah in drugih zanimivih razglednih točkah, ki jih najdemo v okolici obravnavanega predela.

Več kot očitno je, da sta avtorja v prvi vrsti pri bralcih želela vzbuditi željo po obisku Istre in Kvarnerja. Z izborom izjemnih fotografij sta to prav gotovo dosegla. S tega vidika je smislu naravoslovnih vodnikov prav gotovo zadoščeno. Žal pa je to tudi vse. Če odmislimo fotografski del revije in oblikovno plat, od vodnika ostane bore malo. Besedilo je skromno in strokovno siromašno, poleg tega pa se je v tekst prikradlo kar nekaj napak. Pri tem ne mislim na tiskarske škrate, ki jih je pri latinskih imenih in na zemljevidih veliko preveč, ampak na zamenjave vrst. Tako avtorja npr. pod fotografijo kukavičnice *Serapias lingua* (ki jo v tekstu tudi omenjata) navajata vrsto *S. vomeracea*. Ali ni npr. fotografija osočnika *(Salicornia)* v resnici fotografija obrežne lobodke *(Suaeda maritima)*? Velika nedoslednost postane očitna že kar na začetku, pri navedbi avtorjev. Na naslovnici namreč piše, da sta avtorja dva, na notranji strani, kjer se avtorja zahvaljujeta svojim kolegom, ravno tako. V kataloškem zapisu pa je kot avtorica zapisana tudi znana tržaška astronominja prof. Margherita Hack, kar je v bistvu pošteno, saj je napisala uvodnik in astronomski del v tej reviji. Kot avtorico jo omenja tudi pisec predgovora, sloviti italijanski biolog prof. Giorgio Celli.

Najbolj pa me v tej reviji moti dejstvo, da sta avtorja (ta del krivde nočem naprtiti prof. Hackovi, ker ni ornitologinja) natančno navedla lokaliteto 4 gnezd redke vrste ujede (navedba vrste se mi zdi odveč). Zdi se mi nedopustno, za ornitologe pa celo profano, da sta avtorja, italijanska pisca, v svojem besedilu navedla kraje, kjer lahko bralci opazujejo gnezda te ujede v Hrvaški Istri. Precej nenavadno za nekoga, ki je zaljubljen v istrske lepote.

Pred kratkim je ugledala luč sveta tudi istoimenska knjiga. Za zaključek bi rad še zapisal, da bo knjiga kljub vsem slabostim, ki sem jih navedel in ki so očitno posledica dejstva, da je avtorjem iz zvezka v zvezek začelo zmanjkovati sape, knjiga našla širok krog bralcev, ljubiteljev istrske in kvarnerske narave.

Lovrenc Lipej

IN MEMORIAM

JACQUES - YVES COUSTEAU (1910-1997)

Pred nedavnim je umrl Jacques - Yves Cousteau, človek, ki je vse svoje življenje posvetil morju. Njegovo ime pozna danes vsak človek po številnih knjigah, dokumentarnih filmih o podmorskem življenju, o življenju velikih morskih prebivalcev, kot so morski psi, kiti in delfini, morski levi in tjulnji. Bil je vsestranski prebivalec svetovnih oceanov. Bolj kot katerikoli drug znanstvenik nam je približal ocean, prodrl je v naše okolje, v okolje vsega človeštva, v okolje, ki je planetarnega pomena, in z neverjetnimi izumi, kot so akvalunga, podmorski skuter, mala raziskovalna podmornica, potapljaški krožnik in podobno. Opozoril je na nevarnost, da izgubljamo bogato dediščino, ki jo človek s svojo vse večjo in naravi tujo aktivnostjo počasi ubija.

In kdo je bil veliki Cousteau?

Rodil se je v Franciji v Saint Andre-de-Cubzac leta 1910, absolviral je pomorsko akademijo in se že zelo zgodaj posvetil svojemu življenjskemu elementu, morju. Leta 1943 je z Emilom Gagnanom razvil akvalungo, ki je človeku prvič omogočila, da se je potopil globlje in ostal tam dalj časa. Leta 1957 je zapustil mornarico v rangu kapetana korvete in sprejel mesto direktorja Oceanografskega muzeja v Monacu. Leta 1959 je z inženirjem Jeanom Mollardom razvil podmornico za dva človeka z zmožnostjo potapljanja do 350 m. Sledilo je veliko organizirano podmorsko snemanje, ki ni prenehalo vse do njegove smrti, in seveda izdajanje mednarodno znanih dobrih knjig o morju in njegovih prebivalcih. Tako je za svoje filme prejel dva oskarja, zlato palmo v Cannesu, veliki grand prix francoskega filma za mladino in še marsikatero nagrado.

Glavno raziskovalno ladjo Calypso je tehnično izredno opremil, tako da je bila morda med najboljšimi raziskovalnimi oceanografskimi plovili na svetu. Prekrižarila je tako rekoč vsa morja. Njegovo ekipo so sestavljali biologi, tehniki, fiziki, oceanografi, drugi raziskovalci in poklicni potapljači. Na ladji je imel velik, dobro opremljen znanstveni laboratorij. Pozneje je imel na svojem drugem raziskovalnem plovilu, ki se je prav tako imenoval Calypso, še helikopter in malo podmornico. Na križarjenjih po svetovnih oceanih se je tako srečal na morju in pod njim z nenavadnimi in malo raziskanimi morskimi prebivalci. S svojo ekipo je raziskoval njihov način življenja, hkrati pa opozarjal na nevarnost izumiranja ogroženih vrst. Snemal je npr. rojstvo kitovega mladiča in sesanje mleka pa tudi spočetje oziroma spolne navade kitov. V njegovih filmih so posnetki napadov nevarnih vrst morsih psov na potapljače v kletkah. Bil je velik prijatelj narave, posebno rad je imel delfine in tjulnje. Dva tjulnja, Pepito in Christobalda, so imeli celo v bazenih na ladji. Ko so ju po nekaj mesecih spustili nazaj v morje, sta še dolgo plavala za ladjo.

Izjemna so njegova raziskovanja orjaških hobotnic v severovzhodnem Pacifiku, ob kanadski obali severno od Seattla. Prav tako so znani filmi o koralah, korališčih in koralnih otokih, še bolj kot to pa so pomembna njegova opozorila o izumiranju koral v Rdečem morju in Indijskem oceanu. Korališča v Rdečem morju je njegova ekipa raziskovala vrsto let zapovrstjo in ugotovila vzroke za propad. Iz leta v leto so zaradi polucije in turističnega vandalizma spreminjala svoj videz in lepoto. Morda se je prav tu vkoreninila njegova izjemna upornost in aktivnost za ohranjanje narave.

Jacques Yves Cousteau se je že zgodaj v svoji oceanografski karieri opredelil kot naravovarstvenik. Pri tem delu je postal tudi načelnik Sveta za pravice prihodnjih generacij, ustanovljenega pod varstvom predsednika francoske republike leta 1993. Vendar je že po letu dni odstopil zaradi nadaljevanja francoskih jedrskih poskusov na otokih Tihega oceana, ki jih je ukazal francoski predsednik Chirac.

Bil je izreden organizator in koordinator dela med znanstveniki na Calypsu, hkrati pa je znal pridobiti sponzorje, ki so financirali njegove odprave, filmanje in opremo na ladji. Med sponzorji je bilo čedalje več takih, ki so bili zainteresirani za njegovo naravovarstveno delo.

Hkrati s postavitvijo za direktorja Oceanografskega muzeja v Monacu je Jacques Yves Cousteau postal tudi generalni tajnik raziskovalne organizacije za Sredozemlje *(Commission Internationale pour l'Exploration Scientifique de la mer Mediterranée - CIESM)*, ki je imela v dveletnih presledkih sestanke vseh raziskovalcev morja tega območja. Tako sva s kolegom dr. Miljenkom Buljanom tudi prišla v stik s Cousteaujem. Jadransko morje je Cousteauja zelo zanimalo in tedanja jugoslovanska oceanografska raziskovanja na Jadranskem morju so občutno prekašala italijanska. Izrazil je željo, da bi tudi sam prišel na Jadran na podobna raziskovanja. Obisk so mu dovolili v začetku osemdesetih let, da v okviru svetovne študije primerjalno pokaže, v kolikšni meri je Jadransko morje onesnaženo. Vendar pa je bilo s strani prejšnjega režima v Jugoslaviji njegovo delovanje tu omejeno. Raziskave je smel opraviti le na treh točkah v Jadranskem morju, pri tem mu je bil dodeljen še nekakšen spremljevalec, da ne rečem kontrolor. Vsaj na teh treh točkah je Cousteau ugotovil, da je Jadran razmeroma čisto morje v primerjavi z drugimi.

V svoji najplodnejši morski ekspediciji, lahko bi rekli odisejadi, je Calypso preplula 140.000 morskih milj po vseh morjih od Beringovih vrat do Antarktike. Tedaj je nastalo osem zvezkov obsežno delo z naslovom Tajnosti in uganke oceanov. Calypso je imela vmesne postanke v Argentini, Patagoniji, na Falklandskih otokih in Ognjeni zemlji, od koder je prodrla tudi do Antarktike. V teh oceanih je šlo predvsem za študij uničevanja narave, to je prelov v ribištvu in preveliko izkoriščanje drugih morskih virov pa tudi negativni vpliv industrije, ki se kaže predvsem v kemijskem zastrupljanju morja in živega sveta.

Zavzemal se je za varovanje ravnotežja v naravi, govoril je o tem, da bi moralo vsaj obrežno morje postati nekakšna plodna površina, enaka kopenski plodni zemlji. Ljudje se sicer strinjajo z njim, da je morje treba gojiti, v njem ribe in rake, po drugi strani pa z industrijsko aktivnostjo, s polucijo, uničujejo morsko naravno in umetno produkcijo.

Jacques Yves Cousteau je vedno trdil, da je na svetu premalo zavesti, da znanost raziskuje in pokaže na probleme, ljudje pa se na to ne odzivajo in še naprej uničujejo naravo, ki ni neizčrpna.

Pomembnejša dela:

Naši prijatelji kiti (1972)
Cousteaujeva enciklopedija: Svet oceanov (1974)
Cousteaujev almanah okolja (1981)
Cousteaujeva ekspedicija v Amazoniji (1985)
Ranjeno morje (1987)
Cortesovo morje (1988)

Miroslav ZEI

NARCIS MRŠIĆ (1951-1997)

O sodelavcih, znancih in prijateljih običajno pišemo ob dogodkih dveh vrst: ob njihovih življenjskih jubilejih in delovnih uspehih ali ob njihovem (vselej) prezgodnjem slovesu. Povod za tokratno pisanje je, žal, te, druge vrste. Kakor je pisanje ob prvih priložnostih prijetno, tako gredo vrstice, ki jih prijatelj in sodelavec nikoli ne bo bral, težko na papir.

Sredi septembra 1997 je na vrhu znanstvene ustvarjalnosti, poln življenjskih načrtov nenadno umrl doc. dr. Narcis Mršić, znanstveni svetnik na Biološkem inštitutu Jovana Hadžija Znanstvenoraziskovalnega centra SAZU.

V pojasnilo, da - sama zgodovinarka - posvečam te spominske vrstice biologu, naj omenim, da sta Narcisova in moja službena pot dobrih dvajset let v "naši hiši", Znanstvenoraziskovalnem centru Slovenske akademije znanosti in umetnosti, in zunaj nje potekali na nek način usklajeno in se pogosto križali. Po opravljeni gimnaziji, ki jo je obiskoval na Reki, se je Narcis - leto mlajši od mene - leto kasneje kot jaz na zgodovino vpisal na biologijo v (isti) stavbi Filozofske fakultete Univerze v Ljubljani.

Na biološkem inštitutu se je kot stažist-asistent zaposlil 1975, medtem ko sem sama postala stažistka-asistentka na zgodovinskem inštitutu leto prej. Narcis je bil izjemno delaven in sistematičen raziskovalec. Doktoriral je v rekordnih sedmih letih (1982) in me pri tem prehitel za eno leto, pri izvolitvi v naziv znanstvenega sodelavca (v istem letu) pa za dve. Višji znanstveni sodelavec je postal leta 1988, znanstveni svetnik pa 1993, obakrat sem mu sledila z zamikom enega leta. Leta 1988 je (tokrat dve leti za menoj) prejel raziskovalno nagrado sklada Borisa Kidriča.

Kot vrhunskega strokovnjaka so ga pritegnili tudi k sodelovanju na Oddelku za biologijo Biotehniške fakultete v Ljubljani, njegova izjemna ustvarjalnost pa ga je v letu 1997 uvrstila med redke dobitnike laskavega priznanja Zlati znak Znanstvenoraziskovalnega centra SAZU za leto 1996.

Preteklih dobrih dvajset let sva se z Narcisom pogosto srečevala in si vselej ukradla minuto časa za besedo ali dve. Skozi razgovore, v katerih je bil izjemno odkrit in odprt, sem spoznavala njegov značaj, njegovo delo, a tudi njegove hobije in njegovo družino - ženo in sina, mamo in brata. Slovel je kot "tisti, ki ima doma živega krokodila". Ko sva odkrila, da nama je obema pri srcu jadranje, sva si po poletnih dopustih pogosto izmenjala izkušnje. Seveda pa on na morju ni užival le rekreativnega, aktivnega počitka, ampak je z družino obiskoval dalmatinske otoke in na njih iskal primerke za svoje raziskave, ki jim je bil povsem predan. Podredil jim je svoj življenjski ritem in jim prilagodil svoje družinsko življenje. V tihih nočnih urah, ko drugi ljudje ležemo k počitku, se je začel njegov raziskovalni in ustvarjalni "delovni dan" ob skodelici kave, cigareti in živalicah, ki jih je proučeval in risal.

Ko je po osamosvojitvi prišlo do reorganizacije financiranja raziskovalnega dela po projektih, so se najini interesi vnovič srečali. Vsak za svojo stroko sva skušala dokazati pomen nacionalnih ved, ki raziskujejo slovenski prostor in slovenskega človeka. Prizadevanja so naju z ramo ob rami popeljala do položajev sodelavcev - svetovalcev Ministrstva za znanost in tehnologijo. Skupaj sva na Narcisovo pobudo in pod njegovim vodstvom pripravila osnutek programa za sklop raziskav Narava in kultura, kjer me je pritegnil kot svojo namestnico. Ker sva pri tem oba zakoračila na področje, ki nama je bilo novo, sva nekolikokrat iskala nasveta, pomoči in opore drug drugega.

Narcis je bil oseba, ki je vzbujala vedro zaupanje. Tudi ob neprijetnih dejstvih se je znal pošaliti in svet je postal svetlejši. S svojim živahnim temperamentom je osvojil tudi najbolj zadrte resnobneže. Izžareval je nalezljiv optimizem in brez zadrege opisoval svoje življenjske in delovne načrte, za katere ni bilo videti ovir.

Prijatelji, znanci in sodelavci smo poleg njegove družine med tistimi redkimi srečneži, ki smo imeli priložnost in možnost, da smo doživljali Narcisovo prisotnost, čutili njegov hudomušni šarm, ustvarjalno energijo in delovno vnemo. Kdor ga je poznal, ne more ostati ravnodušen ob izgubi, ki nas je doletela z njegovim odhodom. Drugim pa bo ostal v zavesti predvsem s svojim delom, ki mu je bil predan z vsem srcem in pri katerem je izgorel svoje življenje. V kratko odmerjenem ustvarjalnem obdobju je objavil prek 130 bibliografskih enot, med njimi enajst monografij, od katerih je bila v svetu opažena zlasti znanstvena monografija o deževnikih Balkana in sosednjih območij. V letu 1997 je objavil kar dve knjigi: Plazilci Slovenije in Biotska raznovrstnost v Sloveniji, Slovenija - "vroča točka" Evrope. Znanstvene študije je pospremil z objavami prek 2000 lastnoročno izrisanih izvirnih risb živalstva Slovenije.

Ob izgubi, ki je z Narcisovo smrtjo doletela njegove bližnje in stroko, nudi drobno iskrico tolažbe misel, da je svoje kratko življenje živel natanko tako, kot je želel: v razdajanju raziskovalnemu in pedagoškemu delu ter svojim bližnjim.

Darja Mihelič

KAZALO K SLIKAM NA OVITKU

SLIKA NA NASLOVNICI: Kraške gmajne se zaraščajo z rujem, ki je pionirska vrsta med grmi. (Foto: D. Podgornik)

1. Na jesen, ko listje ruja *Cotinus coggygria* dobiva rdeč nadih, se kraške gmajne odenejo v tople, rdeče barve. (Foto: D. Podgornik)
2. *Carlina acanthifolia* subsp. *utzka*, upodobljena na brakrorezu iz Hacquetove monografije. (Foto: M. Kaligarič)
3. Morski polž *Janthina nitens* je bil najden tudi v slovenskem obalnem morju. (Foto: R. De Min)
4. Lesna sova *Strix aluco* iz gozdov okoli Glinščice. (Foto: E. Benussi)
5. Kamnolomi na Krasu so zanimivi za krasosolovce, geologe in paleontologe. (Foto: D. Podgornik)
6. Nobena rastlinska vrsta ne obeleži jeseni na kraških gmajnah tako kot ruj *Cotinus coggygria.* (Foto: D. Podgornik)
7. Zaraščanje kraških vrtač v Čičariji nad Rakitovcem. Modrino prispeva kojniška perunika *Iris sybirica* var. *errerhiza*. (Foto: M. Kaligarič)
8. Navadna čigra *(Sterna hirundo)* na srakanskem privezu proti koncu pomladi 1995. (Foto: I. Geister)
9. Kraški rob ni le golo skalovje, marveč zatočišče specifičnih vrst in združb ilirsko-mediteranskega značaja (rumeno-svilnata košeničica Genista sericea). (Foto: M. Kaligarič)
10. Progasti žafran *Crocus reticulatus* je prvi znanilec pomladi na kraških traviščih. (Foto: M. Lipovšek)

FRONT COVER: Karst commons are overgrown with the wig tree, which is a pioneer species among the bushes of the karst. (Photo: D. Podgornik)

1. In autumn, when the leaves of the wig tree *Cotinus coggygria* are beginning to acquire a redish tint, the thickly overgrown karst commons dress themselves in warm, red colours. (Photo: D. Podgornik)
2. *Carlina acanthifolia* subsp. *utzka,* as depicted on the copper engraving in Hacquet's monograph. (Photo: M. Kaligarič)
3. The marine gastropod *Janthina nitens* has been also found in Slovene coastal waters. (Photo: R. De Min)
4. Tawny Owl *Strix aluco* from the forests around Val Rosandra. (Photo: E. Benussi)
5. Quarries in the karst country are of great interest not only for karstologists but also for geologists and palaeontologists. (Photo: D. Podgornik)
6. There is no plant species that would mark the arrival of the autumn to the karst commons as eloquently as the wig tree *Cotinus coggygria.* (Photo: D. Podgornik)
7. Overgrown karst sinkholes in Čičarija above Rakitovec. The blueness has been contributed by *Iris sybirica* var. *errerhiza.* (Photo: M. Kaligarič)
8. Common Tern *(Sterna hirundo)* on the island of Srakane Vele eastern quay towards the end of spring 1995. (Photo: I. Geister)
9. The so-called Karst edge is not merely a bare rocky mass but also a shelter for some specific plant species and communities of the Illyrian-Mediterranean character (yellow-silky broom *Genista sericea).* (Photo: M. Kaligarič)
10. Reticulated saffron *Crocus reticulatus* is the first harbinger of spring in karst grassland. (Photo: M. Lipovšek)

NAVODILA AVTORJEM

1. *ANNALES: Anali za istrske in mediteranske študije - Annali di Studi istriani e mediterranei* (do 5. številke: *Anali Koprskega primorja in bližnjih krajev - Annali del Litorale capodistriano e delle regioni vicine)* je znanstvena in strokovna interdisciplinarna revija humanističnih, družboslovnih in naravoslovnih vsebin v podnaslovu opredeljenega geografskega območja.

2. Sprejemamo prispevke v slovenskem, italijanskem, hrvaškem in angleškem jeziku. Uredništvo ima pravico prispevke jezikovno lektorirati.

3. Prispevki naj obsegajo največ 24 enostransko tipkanih strani s po 30 vrsticami. Na levi pustite 3 do 4 cm širok rob. Zaželjeno je tudi (originalno) slikovno gradivo, še posebno pa oddaja prispevka na računalniški disketi v programih za PC (osebne) računalnike. V tem primeru avtorji najprej pošljejo besedilo izpisano na papirju, uredništvo pa nato avtorju vrne besedilo v vnos *lektorskih* in *recenzentskih* popravkov. Tako pripravljen tekst avtor pošlje uredništvu na računalniški disketi.

4. Naslovna stran tipkopisa naj vsebuje naslov in podnaslov prispevka, ime in priimek avtorja, avtorjeve nazive in akademske naslove, ime in naslov inštitucije, kjer je zaposlen. Pripišite tudi svoj poštni naslov.

Navedite kategorijo prispevka!

Uredništvo razvršča prispevke v naslednje kategorije:

IZVIRNA ZNANSTVENA DELA vsebujejo izvirne rezultate lastnih raziskav, ki še niso bili objavljeni. Dela pošlje uredništvo v recenzijo. Avtor se obvezuje, da prispevka ne bo objavil drugje.

STROKOVNA DELA prikazujejo rezultate strokovnih raziskav. Tudi te prispevke uredništvo pošlje v recenzijo in avtor se obveže, da prispevka ne bo objavil drugje.

PREGLEDNI ČLANKI imajo značaj izvirnih del. To so natančni in kritični pregledi literature iz posameznih zanimivih strokovnih področij (review article).

GRADIVA imajo ravno tako značaj izvirnih del.

POROČILA vsebujejo krajše znanstvene informacije o zaključenih raziskovanjih ali kratek opis strokovnih in znanstvenih knjig ali srečanj. Taki prispevki ne smejo presegati 5 strani.

MLADINSKE RAZISKOVALNE NALOGE morajo biti urejene kot strokovna dela.

KOMENTARJI so namenjeni aktualnostim s strokovnega področja. Ne smejo presegati 2 strani.

OBVESTILA so namenjena družbenemu življenju. Obsegajo 1 stran.

5. Izvirna znanstvena dela in strokovna dela naj vsebujejo **povzetek** in **izvleček**. Izvleček je krajši od povzetka in v nasprotju s povzetkom tudi ne vsebuje komentarjev in priporočil.

V *izvlečku* na kratko opišemo namen, metode dela in rezultate. Navedemo, čemu smo delo opravili ali napisali dokument. Na že objavljeno gradivo se sklicujemo le, če je to glavni motiv dela. Metode: na kratko opišemo metode in tehnike dela - kolikor je potrebno za razumevanje. Nove tehnike opišemo le, kjer se razlikujejo od že znanih. Če v delu ne opisujemo eksperimentalnega ali praktičnega dela, opišemo vire informacij. Rezultate in zaključke lahko združimo. Kar se da informativno navedemo le, kaj smo ugotovili oziroma odkrili. Izvleček vsebuje do 60 besed.

Povzetke vsebujejo tudi pregledni članki. Povzetek je en sam odstavek. Začnemo ga s stavkom, ki vsebuje glavno sporočilo dela. Stavki naj bodo popolni in ne predolgi. Pišemo v tretji osebi, le izjemoma uporabimo glagole v neosebni obliki. Uporabljamo pravilni strokovni jezik in se izogibamo slabše znanim kraticam. Ohraniti moramo osnovno informacijo in poudarke iz glavnega besedila. V povzetku ne sme biti ničesar, česar glavno besedilo ne vsebuje.

Povzetki znanstvenih besedil smejo vsebovati 200, strokovnih 150, preglednih člankov pa 50 besed.

6. Avtorji so dolžni definirati in pripisati ustrezne ključne besede (pod izvlečkom) članka. Zaželjeni so tudi angleški prevodi podnapisov k slikovnemu in tabelarnemu gradivu. Priporočamo se še za angleški prevod izvlečka, sicer bo za to poskrbelo uredništvo.

7. V besedilu se po možnosti držimo naslednjih poglavij:

1. Uvod.
2. Pregled dosedanjih objav.
3. Materiali in metode (Dokazni postopek).
4. Rezultati.
5. Razprava ali diskusija.
6. Zaključek (Sklepi).
7. Zahvala - če avtor želi.
8. Priloge - če je potrebno.
9. Literatura (Viri, Bibliografija).
10. Povzetek (Summary).
11. Izvleček.

8. Ločimo vsebinske in bibliografske *opombe*. Vsebinske opombe besedilo še podrobneje razlagajo ali pojasnjujejo, postavimo jih pod črto. Z bibliografsko opombo pa mislimo na citat - torej sklicevanje na točno določeni del besedila iz neke druge publikacije (navedemo tudi točno stran, kjer je citat objavljen) ali na publikacijo (članek) kot celoto (točne strani, kjer smo besedilo prevzeli, ne navajamo).

Bibliografsko opombo sestavljajo naslednji podatki: avtor, leto izida in - le če citiramo točno določeni del besedila - tudi navedba strani. Celotni bibliografski podatki citiranih in uporabljenih virov so navedeni v poglavju *Literatura* (Viri, Bibliografija). Primer citata med besedilom: *(Grafenauer, 1993, 11)*. Primer navajanja vira kot celote, brez citiranja: *(Grafenauer, 1993)*. Popolni podatki o tem viru v poglavju Literatura pa se glasijo: *Grafenauer, B. (1993): Miti o "Istri" in resnica* *istrskega polotoka. V: Acta Histriae I. Koper, Zgodovinsko društvo za južno Primorsko, 9-52.*

Če citiramo več del *istega avtorja iz istega leta*, poleg priimka in kratice imena napišemo še črke po abecednem vrstnem redu, toliko, da se viri med seboj razlikujejo. Primer: *(Grafenauer, 1993a); (Grafenauer, 1993b).*

V primeru, kjer je *avtorjev več kot dva*, je korekten citat: (*Verginella et al., 1995*).

Bibliografska opomba je lahko tudi del vsebinske opombe in jo zapisujemo na enak način.

Posamezna dela ali navedbe virov v isti opombi ločimo s podpičjem, opombo pa zaključimo s piko in vezajem. Primer: *Lane (1978); Grafenauer, sup.*-

9. Pri citiranju arhivskih virov navedemo najprej arhiv, nato ime fonda ali zbirke in signaturo. Če navajamo isti arhiv oziroma fond večkrat, navadno uporabljamo kratico, ki smo jo navedli na začetku opomb. Primer: *Pokrajinski arhiv Koper (PAK). Rodbinski arhiv Gravisi, arhivska enota (a.e.) 1. Accademia di Belluno: Dissertazione di Bernardo Bernardi sopra il simbolo della Società Accademica.*

10. Poglavje o literaturi in virih je obvezno. Bibliografske podatke navajamo takole:

- Opis zaključene publikacije kot celote - knjige: avtor (leto izida): naslov, izdaja, kraj, založba, npr.:

Verginella, M., Volk, A. & Colja, K. (1995): Ljudje v vojni. Druga svetovna vojna v Trstu in na Primorskem. Knjižnica Annales 9. Koper, Zgodovinsko društvo za južno Primorsko.

- Če navajamo določeni del iz zaključene publikacije, zgornjemu opisu dodamo še številke strani, od koder smo navedbo prevzeli.

- Opis prispevka v zaključeni publikaciji - npr. prispevka v zborniku:

avtor prispevka (leto izida): naslov prispevka. V: avtor knjige. naslov knjige, izdaja, strani od-do

Verginella, M. (1995): Poraženi zmagovalci. Slovenska pričevanja o osvobodilnem gibanju na Tržaškem. V: Verginella, M. et al.: Ljudje v vojni. Druga svetovna vojna v Trstu in na Primorskem. Knjižnica Annales 9. Koper, Zgodovinsko društvo za južno Primorsko, 13-51.

- Opis tekoče publikacije - revije kot celote:

naslov periodike, kraj izdaje

Annales, Koper

- Pri opisu posamezne številke revije zgornjemu opisu dodamo (leto izida), številko letnika in številko zvezka

Annales (1995), Koper, 5, 7.

- Opis članka v reviji:

avtor članka (leto izida): naslov članka naslov revije, kraj izdaje, letnik, številka, strani od-do

Forlani, F. (1994): Dinosauri in Istria. Annales, Koper, 4, 4, 209-214.

Članki so razvrščeni po abecednem redu priimkov avtorjev ter po letu izdaje, v primeru, da gre za več citatov istega-istih avtorjev.

11. Tiskarski znaki za poudarke naj bodo:

podčrtano za **polkrepko**

valovito podčrtano za *ležeče*.

Računalniški zapis naj vključuje ustrezne oznake za **bold** in *italics*.

12. Kratice v besedilu moramo razrešiti v oklepaju, ko se prvič pojavijo.

13. Pri ocenah publikacij navedemo v naslovu prispevka avtorja publikacije, naslov, kraj, založbo, leto izida in število strani (oziroma ustrezen opis iz točke 10).

14. Prvi odtis prispevkov uredništvo pošlje avtorjem v korekturo. Avtorji so dolžni popravljeno gradivo vrniti v treh (3) dneh. Besedilo popravljamo s korekturnimi znamenji, ki jih najdemo na koncu Slovenskega pravopisa, Ljubljana, 1962 ali v: Slovenski pravopis 1. Pravila. Ljubljana, SAZU-DZS, 1990, 13-14.

Širjenje obsega besedila ob korekturah ni dovoljeno. Druge korekture opravi uredništvo.

15. Uredništvo prosi avtorje, naj navodila vedno upoštevajo. Ob vseh nejasnostih je uredništvo na voljo za vsa pojasnila.

Uredništvo

INSTRUCTIONS TO AUTHORS

1. *ANNALES: Annals for Istrian and Mediterranean Studies - Annali di Studi istriani e mediterranei (formerly: Annals of the Koper Littoral and Neighbouring Regions - Annali del Litorale capodistriano e delle regioni vicine)* is a scientific and specialist interdisciplinary review with humanistic, sociological and naturalistic contents covering the area as stated in the review's subtitle.

2. Articles (papers) written in Slovene, Italian, Croatian and English languages are accepted. The Editorial Board reserves the right to have them linguistically revised and corrected.

3. Articles should be written on max. 24 pages with double spacing and on one side of the sheet only. On the left side of each page, a 3-4 cm wide margin is to be left. Original photographs, drawings and tables are welcomed, as well as diskettes containing the texts, together with reference to the programme used. In such cases, only printed texts are to be sent initially to us, and once returned to the authors with eventual *linguistic, editorial or reviewer's* corrections, the suitably processed texts (on diskettes) are to be sent back to the Editorial Board.

4. Title page of typescript is to include title and subtitle of the article (paper), author's name, any (academic) titles and name of institution by which employed. Personal address is to be added as well.

Please state the category of your article. Articles are arranged in the following eight categories:

ORIGINAL SCIENTIFIC WORKS containing not yet published results of the author's own research. Such works are reviewed by scientists chosen by the Editorial Board. Authors oblige themselves that the material is not being offered to any other journal or magazine.

SPECIALIST WORKS presenting results obtained by specialist research. They too are reviewed, and authors oblige themselves not to publish them elsewhere.

REVIEW ARTICLES bearing the character of original works. These are critical and detailed reviews of literature from various interesting specialist fields.

MATERIALS AND SOURCES also with the character of original works.

REPORTS include short scientific information on integral research work or a short description of scientific or specialist books or meetings of experts. Such articles are not to exceed 5 pages.

YOUTH RESEARCH COMPOSITIONS are to be arranged the same as specialist works.

EXPLANATORY COMMENTS include topical issues from various specialist fields and are not to exceed 2 pages.

NOTICES include news from various associations and should not exceed 1 page.

5. Each of the original scientific and specialist works is to include both **summary** and **abstract.** *Abstract* is the shorter of the two and does not include, in contrast to summary, explanatory comments and recommendations. Abstract is to contain a short description of the purpose and methods of work and its results. Author should also state why the work has been carried out and why a document has been written about it. References to the already published material are made only if this is the main purpose of the work. Methods: if necessary, work methods and techniques are to be briefly described (new techniques are to be stated only if differing from the already known ones). If no experimental or practical work is described, sources of information are to be given. Results and conclusions may be incorporated. Findings are to be presented as briefly as possible. Abstract is to include up to 60 words.

Summary is to accompany review articles also and is to contain one chapter only. First of all, the essential points of the carried out work are to be presented. Sentences should be concise and not too long. The text is to be written in the third person; verbs may be used in impersonal form only exceptionally. The not so well known abbreviations are to be avoided. Summary is to retain the basic information from the main part of the text, and should not contain anything that does not appear in the main text itself.

Summary of scientific text may contain 200 words, summary of specialist text 150 words, summary of review article 50 words.

6. Authors are obliged to define and state the **key words** (below abstract) in their articles. English translation of texts accompanying figures and tables are welcomed, as well as English translation of abstracts; if this is not convenient, the Board of Editors will provide for it.

7. Texts should include, if at all possible, the following chapters:

1. Introduction
2. Works published to date
3. Material and methods
4. Results
5. Discussion
6. Conclusions
7. Acknowledgements (if desired by author)
8. Supplements (if necessary)
9. References (Sources, Bibliography)
10. Summary
11. Abstract

8. Two kinds of *notes* are distinguished: those regarding **contents** of the text, and **bibliographical** ones. The first elucidate the text in even greater detail and are to appear at the bottom of the page (under line). Bibliographical notes, however, deal with quotations and refer to a precisely stipulated part of the text from some other publication (the page on which quotation appears is to be therefore stated as well) or to a publication (article) as a whole (in this case no page from which the text has been taken is to be stated).

Bibliographical notes are made up of the following details: author, year when published, and page (but only if a precisely stipulated part of the text is quoted). The entire bibliographical data of the quoted and used sources are to be stated under *References* (Sources, Bibliography). Example of quotation in the text: *(Grafenauer, 1993, 11)*. Example of source quotation as a whole, with no citation: *(Grafenauer, 1993)*. Complete data about the source under *References* are to read as follows:

(Grafenauer, B. (1993): Miti o "Istri" in resnica istrskega polotoka. In: Acta Histriae I. Koper, Zgodovinsko društvo za južno Primorsko, 9-52.

If a number of works *by the same author from the same year* are quoted, letters in alphabetical order are to be stated apart from the author's surname and abbreviation of his first name, so that sources are clearly divided between each other. Example:

Grafenauer, 1993a); (Grafenauer, 1993b).

If there are more than two authors, the work can be also cited as: (Verginella et al., 1995).

Bibliographical note can also be a part of the note referring to the contents and is to be written in the same way.

Separate works or source quotations under the same note are to be separated with semicolon; the note is to be ended with full stop or hyphen. Example: *Lane (1978); Grafenauer, B., sup.-*

9. When quoting archive sources, the archive is to be stated first, then the name of the fund or collection and shelfmark. If the same archive or fund is stated a number of times, the appropriate abbreviation as shown above is to be used. Example: *Pokrajinski arhiv Koper (PAK). Rodbinski arhiv Gravisi, arhivska enota (a.e.) 1. Accademia di Belluno: Dissertazione di Bernardo Bernardi sopra il simbolo della Società Accademica.*

10. The chapter of references and sources is compulsory. Bibliographical data are to be stated as follows:

- Description of integral publication: author (year when published), title, published by, volume and place of publication, e.g.:

Verginella, M., Volk, A. & Colja, K. (1995): Ljudje v vojni. Druga svetovna vojna v Trstu in na Primorskem, Knjižnica Annales 9. Koper, Zgodovinsko društvo za južno Primorsko.

- If a specific part from an integral publication is quoted, the page numbers from which the quotation has been taken are to be added to the above description.

- Description of the article (paper) in integral publication - e.g. text in a collection of scientific papers:

author of the paper (year of its publication): title of the paper. In: author of the book, title of the book, published by, volume and place of publication, pages from - to

Verginella, M. (1995), Poraženi zmagovalci, Slovenska pričevanja o osvobodilnem gibanju na Tržaškem. In: Verginella, M. et al.: Ljudje v vojni. Druga svetovna vojna v Trstu in na Primorskem. Knjižnica Annales 9. Koper. Zgodovinsko društvo za južno Primorsko, 13-51.

- Description of current publication - review as a whole:

title of periodical, place of publication

Annales, Koper

- When describing separate number of review, its volume, year of publication and number are to be added to the above description

Annales (1995), Koper, 5, 7.

- Description of the article in review:

author of the article, name of review, volume, year, number, pages from - to

Forlani, F. (1994): Dinosauri in Istria. Annales 4, 209-214.

If the same author(s) is (are) cited a number of times, the articles are to appear in alphabetical order of the authors' surnames and year of publication.

11. On diskettes, the following printer's marks are to be used:

underlined for **bold**

undulatory line for italics.

12. Abbreviations in the texts are to be explained in brackets when appearing for the first time.

13. When assessing a publication, its author, address, place, publishing house, year of publication and page numbers (or appropriate description from Item 10) are to be stated in the title of the article.

14. First copies of printed articles will be sent to authors for proof-reading. Authors are obliged to return them in three (3) days. No new sentences are allowed to be added during proof-reading. The second (printing) proofs are read by the Editorial Board.

15. Authors are kindly requested to consider these instructions at all times. In case of any indistinctness, please do not hesitate to contact the review's Editorial Board.

Editorial board

UDC 016:58(497.4 Kras)
016:58(497.4/.5 Istra)

Livio POLDINI, Department of Biology, IT-34127 Trieste University, L. Giorgieri 10

Bibliographical survey of the research on the flora and vegetation of the Karst and Istria with emphasis on the present state

Annales: Annals for Istrian and Mediterranean Studies, 11, 1997, p.p. 9-24

The treatise presents the main phases of the botanical research on the Karst, including the northwestern slope of Trnovski gozd and Hrušica, as well as Istria with its Quarnero islands of Cres, Krk and Lošinj.

UDC 82.632(497.4 Snežnik)

Lojze MARINČEK, Istituto di Biologia, CRS presso ASSA, SI-1000 Lubiana, Novi trg 5
Urban ŠILC, Istituto di Biologia, CRS presso ASSA, SI-1000 Lubiana, Novi trg 5

Nuova subassociazione di boschi di faggio alto montano *Ranunculo platanifolii-Fagetum* Marinček *et al.* 1993 var. geogr. *Calamintha grandiflora* Marinček 1996 seslerietosum autumnalis sul Monte Nevoso (Snežnik)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 25-32

Gli autori descrivono la nuova subassociazione *Ranunculo platanifolii-Fagetum* Marinček *et al.* 1993 var. geogr. *Calamintha grandiflora* Marinček 1996 *seslerietosum autumnalis* sul Monte Nevoso (Snežnik). Specie differenziali della subassociazione sono la *Sesleria autumnalis*, il *Cirsium erisithales*, il *Carex alba* e il *Sorbus aria*.

UDC 582.542(497.4 Rakitovec)
582.998(497.4 Rakitovec)

Mitja KALIGARIČ, Dipartimento di Biologia, Facoltà di Pedagogia, Università di Maribor, SI-2000 Maribor, Koroška 160

L'importanza dal punto di vista botanico e della tutela ambientale dei prati dell'associazione *Danthonio-Scorzoneretum villosae* Ht. & H-ić (56)58 a Rakitovec, nella Ciceria (Slovenia sud occidentale)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 33-38

Vengono qui presentati gli elenchi delle fitocenosi di *Danthonio-Scorzoneretum villosae* Ht. & H-ić (56)58 dei prati normalmente falciati nella fascia montana sovrastante Rakitovec. Viene constatato come questi elementi diano vita ad una sub associazione indipendente, che *forma il nucleo e le componenti più ricche* dell'associazione e che, contemporaneamente, rappresenta il passaggio fra la razza carsica e quella istro-quarnerina dell'associazione stessa. Nello studio vengono presentate anche le specificità floristiche della zona e i problemi legati alla tutela dell'ambiente.

UDC 582.542(497.4-14)

Andraž ČARNI, Istituto di Biologia, CRS presso ASSA, SI-1000 Lubiana, Gosposka 13

Le associazioni *Hordeetum murini* e *Lepidio drabae-Agropyretum* nell'area costiera della Slovenia

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 39-42

L'autore presenta le associazioni *Hordeetum murini* Libbert 1993 *(Stellarietea mediae)* e *Lepidio drabae-Agropyretum repentis* T. Müller et Görs 1966 *(Artemisietea vulgaris)*, presenti tra la vegetazione rudelare nell'area costiera della Slovenia.

UDC 582.998(497.4-16)

Mitja KALIGARIČ, Dipartimento di Biologia, Facoltà di Pedagogia, Università di Maribor, SI-2000 Maribor, Koroška 160

***Carlina acanthifolia* subsp. *utzka* (Hacq.) Meusel & Kästner in Slovenia**

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 43-46

L'autore presenta la storia della scoperta e l'attuale distribuzione della specie *Carlina acanthifolia subsp. utzka* (Hacq.) Meusel & Kästner al margine estremo della parte nord-occidentale del proprio areale.

UDC 582.263(262.3-17)

Claudio BATTELLI, Ginnasio A. Sema, SI-6320 Portorose, Tra gli orti 8 e Facoltà per l' Educazione di Lubiana, unita di Capodistria, SI-6000 Capodistria, Via Cankar 5

Contributo alla conoscenza delle alghe macrobentoniche del mare costiero della Slovenia: genere *Cladophora* (Chlorophyta)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 47-56

Nell' articolo vengono trattate 8 specie del genere *Cladophora* Kützing (1843) che vivono nelle acque costiere della Slovenia. Vengono descritte le caratteristiche generali fondamentali delle singole specie ed indicati i luoghi di presenza. Viene presentata una chiave per la determinazione delle specie trattate che si basa prevalentemente sulle caratteristiche morfologiche delle alghe. Vengono descritte pure due nuove specie del genere *Cladophora* per il mare costiero sloveno. Si presentano inoltre le proposte per i nomi in lingua slovena delle specie descritte.

UDC 598.2(497.4)
502.74(497.4)

Iztok GEISTER, SI-6276 Pobeghi, Kocjančiči 18

L'ornitologia slovena alle soglie del terzo millennio

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 59-64

L'autore fa una comparazione tra due modi di vedere il mondo avifaunistico basati su scale di valori diversi, quello qualitativo di Reiser dell'inizio e quello quantitativo di Tucker della fine di questo secolo. Entrambi i punti di vista sono oberati dai loro valori *prioritari*. *Come ha saputo superare la visione di Reiser*, la Slovenia dovrà in futuro andare oltre anche alla visione globale sulla tutela degli uccelli di Tucker, che trascura i margini del loro areale. In ciò le sia di sostegno la consapevolezza dell'importanza della varietà della sua ornitofauna.

UDK 582.998(497.4-16)

Mitja KALIGARIČ, Abteilung für Biologie der Universität Maribor, SI-2000 Maribor, Koroška 160

Carlina acanthifolia subsp. _utzka_ (Hacq.) Meusel & Kästner in Slowenien

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 43-46

Die Autor behandelt die Geschichte der Entdeckung und die heutige Verbreitung der Art *Carlina acanthifolia* subsp. *utzka* (Hacq.) Meusel & Kästner im ausserst nordöstlichen Teil ihres Verbreitungsgebietes.

UDK 582.263(262.3-17)

Claudio BATTELLI, Gymnasium A. Sema, SI-6320 Portorož, Med vrtovi 8 und an der Pädagogischen Fakultät, Abteilung Koper, SI-6000 Koper, Cankarjeva 5

Einige der häufigsten Arten der Gattung _Cladophora_ (Chlorophyta) in den slowenischen Küstengewässern

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 47-56

In diesem beitrag werden acht Arten der gattung *Cladophora* Kützing 1843, die in den slowenischen Küstengewässern leben, behandelt. Dazu wird eine allgemeine Beschreibung dieser Arten mit deren wesentlichen Characteristika und deren Verbreitungsgebiet gegeben. Es wird auch ein Schlüssel zur Bestimmung der hier behandelt Algen vorgelegt. Zitiert werden die Angaben zu zwei Arten, die bisher in den slowenischen Küstengewässern nicht vermerkt wurden. Ausserdem wird ein Worschlag zur slowenischer Benennung der betreffenden Arten gemacht.

UDK 598.2(497.4)
502.74(497.4)

Iztok GEISTER, SI-6276 Pobegi, Kocjančiči 18

Die slowenische Ornithologie an der Schwelle zum dritter Jahrtausend

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 59-64

Der Autor vergleicht zwei verschiedene Standpunkte inder Beurteilung der Vogelwelt, nämlich Reisers von der Qualität ausgehenden Standpunkt zu Beginn und Tuckers von der Quantität bestimmten Sichtweise am Ende diesen Jahrhunderts. Beide Standpunkte sind von der bewertung einer Priorität belastet. So wie Slowenien bereits die Reisersche Sichtweise überwunden hat, so wird es in Zukunft auch Tuckers globale Einstellung zum Vogelschutz, die am Rand stehende Populationen vernachlässigt, hinterschlassen müssen. Dabei sollte das, Bewusstsein, wie wichtig die Vielfalt der Vogelwelt Sloweniens ist helfen.

UDK 016:58(497.4 Kras)
016:58(497.4/.5 Istra)

Livio POLDINI, Abteilung für Biologie, IT-34127 Triest, Via L. Giorgieri 10

Abriss zur Bubliografie der Flora und Vegetation des Kartses und Istriens unter besonderer Berücksichtingung der gegenwärtiger Situation

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 9-24

Die wichtigsten Phasen der botanischen Erforschung des Karstes werden einschliesslich der nordöstlichen Abhänge des Trnovski gozd, der Hrušica, Istriens und der Kvarnerinseln Cres, Krk und Lošinj im Überblick dargestellt.

UDK 82.632(497.4 Snežnik)

Lojze MARINČEK, Institut für Biologie ZRC SAZU (Slowenische Akademie für Wissenschaften und Kunste), SI-1000 Ljubljana, Novi trg 5
Urban ŠILC, Institut für Biologie ZRC SAZU (Slowenische Akademie für Wissenschaften und Kunste), SI-1000-Ljubljana, Novi trg 5

Diese neue Subassoziation des dinarischen Hochgebirgswald _Ranunculo platanifolii-Fagetum_ Marinček _et al._ 1993 var. geogr. _Calamintha grandiflora_ Marinček 1996 _seslerietosum autumnalis_ auf dem Snežnik

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 25-32

Die Autoren haben die thermophilste Subassoziation *Ranunculo platanifolii-Fagetum* Marinček *et al.* 1993 var. geogr. *Calamintha grandiflora* Marinček 1996 *seslerietosum autumnalis* subass. nova beschrieben. Die Trennarten dieser Subassoziation sind: *Sesleria autumnalis*, *Carex alba, Cirsium erisithales* und *Sorbus aria*.

UDK 582.542(497.4 Rakitovec)
582.998(497.4 Rakitovec)

Mitja KALIGARIČ, Abteilung für Biologie der Universität Maribor, SI-2000 Maribor, Koroška 160

Die Bedeutung der Wiesen mit Vergesellschaftung von _Danthonio-Scorzoneretum villosae_ Ht. & H-ić (56)58 in Rakitovec am Tschitschenboden (Südwestslowenien) für Botanik und Naturschutz

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 33-38

Es wird eine Beschreibung der Vergesellschaftung von *Danthonio-Scorzoneretum villosae* Ht. & H-ić (56)58, die auf den traditionell zur Mahd verwendeten Wiesen Berggürtel über Rakitovec vorkommt, gegeben. Es wird festgestellt, dass diese Bestände selbstständige Subassoziationen bilden, die im Rahmen der Assoziation Kern und reichste Bestände, gleichzeitig aber auch den Übergang vom Karst- zum Istrokvarner typ dieser Assoziation darstellen. Floristische Besonderheiten dieser Gegend und Probleme des naturschutzes werden ebefalls angesprochen.

UDK 582.542(497.4-14)

Andraž ČARNI, Institut für Biologie ZRC SAZU (Slowenische Akademie für Wissenschaften und Kunste), SI-1000 Ljubljana, Gosposka 13

Die Gesellschaftten _Hordeetum murini_ und _Lepidio drabae-Agropyretum_ im Küstengebiet Sloweniens

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 39-42

Der Autor behandelt die Gesellschaftten *Hordeetum murini* Libbert 1935 *(Stellarietea mediae)* und *Lepidio drabae-Agropyretum repentis* T. Müller et Göre 1966 *(Artemisietea vulgaris)*, die sich auf stickstoffreichen Sohotterböden des slowenischen im Küstengebiete entwickeln.

UDC 598.322(234.323.6-11)
598.322(497.4-15)

Peter TRONTELJ, Dipartimento di Biologia, Facoltà di Biologia dell'Università di Lubiana, SI-1001 Lubiana, P.P. 2995

Distribuzione e spazio vitale del Re di quaglie *(Crex crex)* nell'alto Posočje (Alpi Giulie, Slovenia)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 65-72

Negli anni 1993-1995 sono state individuate dieci aree dell'alto Posočje con 30 esemplari canterini. In maggioranza si tratta di prati e pascoli montani abbandonati, ad un'altitudine tra i 700 e i 1440 metri sopra il livello del mare, con digradazione media di 25-30 gradi, esposti in prevalenza a sud e sudovest. Per arrestare l'inselvamento, che costituisce la principale minaccia, si raccomanda una falciatura tarda o l'incenerimento controllato, mentre si sconsiglia il pascolo.

UDC 598.331.4(497.5 Srakane Vele)

Iztok GEISTER, SI-6276 Pobeghi, Kocjančiči 18
Henrik CIGLIČ, traduttore e ornitologo, SI-4000 Kranj, Likozarjeva 7

Gli uccelli dell'isola di Srakane Vele, nell'arcipelago di Cherso - Lussino

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 73-84

Nel 1974-1996, nell'isola quarnerina di Srakane Vele (Croazia) sono stati censiti 23 uccelli nidificanti e 72 migratori. Altri 7 uccelli nidificanti sono stati scoperti nelle isole vicine. Dal punto di vista della tutela ambientale, quella dell'occhione *Burhinus oedicnemus* è ritenuta la nidificazione più importante.

UDC 598.88(450.361 Glinščica)

Enrico BENUSSI, Osservatorio Faunistico del Friuli-Venezia Giulia, IT-34138 Trieste, Via A. Grego 35
Paolo GALEOTTI, Dipartimento di Biologia Animale, Università di Pavia, IT-27100 Pavia, Piazza Botta 9
Armando GARIBOLDI, Dipartimento di Biologia Animale, Università di Pavia, IT-27100 Pavia, Piazza Botta 9

The Owl community (Strigiformes) from Val Rosandra (Carso triestino)

Annales: Annals for Istrian and Mediterranean Studies, 11, 1997, p.p. 85-92

The authors discovered that out of 6 Owl species living in the Trieste province, 4 occur and breed in Val Rosandra near Trieste. With the aid of play-back they were able to confirm that in the researched area there occur (and breed) from 11 to 15 pairs of Eurasian Scops Owl *(Otus scops)*, 4 pairs of Tawny Owl *(Strix aluco)*, 2 pairs of Eagle Owl *(Bubo bubo)* and 1 pair of Little Owl *(Athene noctua)*. Average breeding densities were 0.87 territory/km^2 for Tawny Owl, 0.43 terr./km^2 for Eagle Owl, and from 2.4 to 3.25 terr./km^2 for Eurasian Scops Owl. A topographic survey of their distribution has shown that Eurasian Scops Owls avoid the territories inhabited by Tawny Owls, and that the latter avoid the territories inhabited by Eagle Owls. At the same time it was established that the territories of Eurasian Scops Owls overlap the territories of Eagle Owls.
The research has shown that the Scops Owls' territories are in most cases orientated towards the southwest. Their favourite biotopes are thermophilous pubescent oak *(Quercus pubescens)* groves, vineyards and bare rocky niches. The authors presume that heat inversion plays an important role in the selection of territories on Val Rosandra's southern and southwestern rocky slopes. The temperature is then for a few degrees higher than at the bottom of the valley, which probably has a strong effect on the availability of food, i.e. arthropods that play the most important part in the diet of Eurasian Scops Owl.

UDC 551.44(497.4)(091)

Andrej KRANJC, Istituto per la ricerca del Carso, CRS presso ASSA, SI-6230 Postojna, Titov trg 2

Sulla carsologia e speleologia in Slovenia (Sulla storia delle scienze che studiano il Carso e le grotte, nonché sulle loro prospettive)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 95-102

Il contributo presenta in breve lo sviluppo del termine "carso", della carsologia e della speleologia in Slovenia, con particolare accento ai risultati raggiunti dai ricercatori sloveni e agli echi che essi hanno avuto nel mondo. Dopo la II guerra mondiale, la loro partecipazione in campo internazionale è aumentata. L'autore è dell'opinione che il successo e l'affermazione futuri della nostra carsologia dipendano dallo studio particolareggiato del nostro carso nell'ambito di uno stretta collaborazione internazionale, dalla pubblicazione dei risultati, dall'introduzione della carsologia tra gli studi universitari e dalla partecipazione alle soluzioni dei problemi della vita quotidiana e dell'economia del Carso.

UDC 551.442(497.4 Dimnice)

Tadej SLABE, Istituto per la ricerca del Carso, CRS presso ASSA, SI-Postojna, Titov trg 2

La conformazione rocciosa della Grotta del fumo (Dimnice)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 103-114

La conformazione rocciosa delle rocce della Grotta del fumo (Dimnice) ci aiuta a chiarire il variegato sviluppo delle grotte carsiche. Si sono conservate le tracce delle più antiche correnti idriche che hanno formato le gallerie, e delle correnti idriche più rapide che scorrevano sulla ghiaia, acque che hanno formato la volta rocciosa scorrendo sui sedimenti sabbiosi che riempivano la grotta. Ora la corrente circola nella galleria inferiore, mentre a creare la conformazione della grotta sono l'acqua che scorre sulle pareti degli abissi orientali e l'umidità che si condensa grazie a forti correnti d'aria. Anche il disfacimento minuto della volta rocciosa e delle stalattiti è dovuto agli agenti microclimatici interni.

UDC 56:591(497.4 Sežana)
553.5:56(497.4 Sežana)

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Bogdan JURKOVŠEK, Isituto di geologia, geotecnica e geofisica, SI-1000 Lubiana, Dimičeva 14

Rudiste delle formazioni di Lipizza nella cava di Lipica I

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 115-140

Nelle cave di Lipica I e Lipica II, presso Sesana, viene estratto la roccia calcarea delle formazioni di Lipizza e più precisamente due tipi di pietra per uso architettonico e edile. Si tratta di biostrome e di bioherme originate dalle rudiste. Il primo tipo è il "Lipica unito", di colore verde oliva chiaro; un calcare con frammenti da minuti a grossi, che contiene soprattutto resti di valve di rudiste, grandi al massimo qualche millimetro. Il secondo tipo è costituito dal "Lipica fiorito". Un calcare di colore grigio chiaro con numerose valve di rudiste situate nella parte centrale produttiva della formazione di Lipizza, nella cava di Lipica I, dove si alternano strati di circa un metro di "fiorita" e di "unito". Qui sono state individuate 20 specie delle famiglie *Bournonia, Biradiolites, Radiolites, Sauvagesia, Medeella, Gorjanovicia, Praelapeirouseia, Katzeria, Vaccinites* e *Hippuritella*. La microfauna presente, soprattutto il foraminifero *Keramosphaerina tergestina* (Stache), fa risalire l'età delle rocce al Santoniano superiore e al tardo Campaniano.

UDK 551.44(497.4)(091)

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Zur Karstforschung und Speläologie in Slowenien (zur Geschichte der Karst- und Höhlenforschung und deren Perspektiven)

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 95-102

Der Beitrag gibt eine kurze Darstellung über die Entwicklung des terminus "Kras" sowie der Karstforschung und Speleologie in Slowenien, wobei der Schwerpunkt auf die Resultate der slowenischen Forscher und deren internationale Geschehen. Der Autor vertritt die Meinung, dass in Zukunft ein erfolgreiches Hervortreten der slowenischen Karstforschung mit dem eingehanden Studium des slowenischen Karstes, noch engeren internationalen Verbindungen, der Veröffentlichung der Forschungs resultate, der Einbindung der karstforschung in die Hochschulstudien und dem Heranziehen dieser Disziplin zur Losung von Fragen aus der Wirtschaft und dem alltäglichen Leben auf dem Karst selbst einhergehen muss.

UDK 551.442(497.4 Dimnice)

Tadej SLABE, Institut für Karstforschung ZRC SAZU, SI-6320 Postojna, Titov trg 2

Das Felsrelief der Dimnice-Höhle

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 103-114

Das Felsrelief der Dimnice-Höhle erleichtert uns die Erklärung der bunten Entwicklung von Ponorhöhlen. Hier sind die Spuren der ältesten Wasserläufe, die Schächte ausgebildet haben, aber auch von schnelleren Wasserläufen, die sich über den Schotter ergossen haben, sowie von Wasser, das das Felsrelief durch Ausschwemmen des feinkörnigen Sedimentes mit dem die Höhle erfüllt war, formte, erhalten. Heute ergießt sich der Wasserlauf über den unteren Teil des Felsprofils. Die Höhle wurde durch das Wasser, das über die Felsen des Eingangsbereiches flicht und durch die Feuchtigkeit, die sich aus den verschiedenen Wasserläufen kondensiert, umgestaltet. Auch die leichte Abtragung des Felsreliefs und der Sinterbildungen ist die Folge verschiedener mikroklimatischer Vorgänge in der Höhle.

UDK 56:591(497.4 Sežana)
553.5:56(497.4 Sežana)

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Bogdan JURKOVŠEK, Institut für Geologie, Geotechnik und Geophysik, SI-1000 Ljubljana

Rudisten aus der Formation von Lipica im Steinbruch Lipica I

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 115-140

In den Steinbrüchen Lipica I und Lipica II bei Sežana werden zwei Kalktypen der Formation von Lipica, die als Baumaterial dienen und Rudisten (Biostrom und Bioherm) aufweisen, gebrochen. Der erste Typ wird "Lipica unito" gennant. Es handelt sich einem hellolivgrauen fein bis grobkörnigen Kalk, in dem sichvor allem Bruchstücke von Rudistenschalen, die höchstens einige Milimeter groß sind, finden. Der zweite Typ; "Lipica fiorito" gennant, ist ein hollgrauer Kalk mit zahlreichen Rudistenschalen aus dem zentralen Bereich der produktiven Formation von Lipica im Steinbruch Lipica I, wo sich etwa 1 m diche Schichten von "fiorito" und "unito" abwechseln. Hier konnten 20 Rudistenarten der Gattungen: *Bournonia, Biradiolites, Radiolites, Sauvagesia, Medeella, Gorjanovicia, Praelapeirousea, Katzeria, Vaccinites* und *Hippuritella* festgestellt werden. Die begleitende Mikrofauna, insbesondere die Foraminiferen Keramosphaerina tergestina (Stache) sprechen für eine Datierung in das Ober Santonium und das Unter Campanium.

UDK 598.322(234.323.6-11)
598.322(497.4-15)

Peter TRONTELJ, Abteilung für Biologie, Biotechnische Fakultät der Universität Ljubljana, SI-1001 Ljubljana, p.p. 2995

Verbreitung und Lebensraum des Wachtelkönig *(Crex crex)* im oberen Isonzobereich (Julische Alpen, Slowenien)

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 65-72

In den jahren 1993 bis 1995 wurden im oberen Isonzobereich neun Lokalitäten mit insgesamt 30 singender Mänchen festgestellt. Es handelt sich grosstenteils um Lokalitäten wie aufgelassene Bergwiesen und Weiden in 700 bis 1440 m Seehöhe in überwiegender Süd- bis Südwestlage mit einer durchscnittlichen Hangneigung von 25 bis 30%. Die grosste Gefährdung diesesLebensraumes liegt in der beseitigung des Grases. Es wird daher empfohlen, die Wiesen spät zu mähen oder auch kontrolliert abzubrennen. Vom Abweiden hingegen wird abgeraten.

UDK 598.331.4(497.5 Srakane Vele)

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Die Vögel von Vele Srakane in der Inselgruppe von Cres und Lošinj

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 73-84

Auf der Kvarnerinsel Vele Srakane (Kroatien) wurden in den Jahren 1994 bis 1996 23 brütende und in 1974-1996 77 nichtbrütende Vögel beschrieben. Weitere 7 Brutvögel wurden auf den Nachbarinseln entdeckt.
In Hinblick auf den Naturschutz ist den Nisten von *Burhinus oedicnemus* von ganz besonderer Bedeutung.

UDK 598.88(450.361 Glinščica)

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Die Eulenvögel im Val Rosandra im Triester Karst

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 85-92

Die vorliegende Arbeit möchte zur Vertiefung der Kenntnisse über die Eulenvögel im Val Rosandra im Karst von Triest beitragen. Besonderer Berücksichtigung gilt der Ökologie der Zwergohreule, einer bisher in Italien and anderen Ländern des Mediterrans wenig untersuchten Art. Die Erhebungen im Gelände ermöglichten die Unterscheidung verschiedener Territorien: 1 Randterritorium des Steinkauzes, 2 Territorien des Uhu, 4 Territorien des Waldkauzes und 15 Territorien der Zwergohreule (11 sicher ständige). Die Ergebnisse bestätigen die benannte Vorliebe der Zwergohreule für hügelige, äusserst thermophile Gelände und Traditionelle Anbaugebiete.

UDC 56"61/62"(450.361 Slivje)
55.763.32(450.361 Slivje)
551.763.32(450.361 Kras)

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Descrizione paleontologica e stratigrafica di un affioramento a Turioniano superiore a Slivia, Carso triestino, Italia

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 141-160

Lo studio di una successione stratigrafica del Turoniano superiore ubicata nelle vicinanze del paese di Slivia nel Carso triestino, ha permesso di descrivere a livello a oncoliti e una fauna a rudiste quali: *Hippuritella resecta* (Defrance), *Hippurites requieni* (Matheron), *H. requieni var. subpolygonia* Douvillé, *Vaccinites cf. inferus* (Douvillé), *Neoradiolites turoniensis* Pašić, *Distefanella? robusta* Caffau & Pleničar, *Distefanella kochanskae* Slišković e *Durania arnaudi* (Choffat). Completano l'associazione, gasteropodi, coralli e alghe calcaree. Il livello a oncoliti della successione di Slivia è confrontato con l'orizzonte a oncoliti della Gornji Humac Formation dell'Isola di Brač (Croazia) e con l'orizzonte a oncoliti della Sežana Formation (Slovenia). Gli orizzonti a oncoliti delle due formazioni, testimoniano la fase piu evidente di un importante cambio ambientale, cvon una regressione marina che ha caratterizzato il Turoniano superiore della Piattaforma carbonatica dinarica. Anche il livello a oncoliti della successione di Slivia testimonia una regressione del livello marino, sebbene questo cambiamento sembra essere stato più graduale comparato con quello registrato in altre aree della Piattaforma carbonatica dinarica, per esempio nell'isola di Brač e in Slovenia.

UDC 551.76/.78(497.4 Divača)
551.76/.78(497.4 Kozina)

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I risultati dell'osservazione geologica dei lavori edili nel tratto autostradale fra Divaccia e Cosina

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 161-186

Il terreno sul quale corre il tratto autostradale fra Divaccia e Cosina fa parte di una delle zone più interessanti di tutto il Carso. Vi compaiono tutte le formazioni che hanno avuto origine nel Sentoniano superiore e nell'Eocene nella parte nord occidentale di quella che era la piattaforma carbonatica dinarica. Contemporaneamente all'osservazione dei lavori nel cantiere è stata preparata una carta geologica in scala 1:5.000. Intenzione dello studio è contribuire a migliorare la conoscenza geologica della struttura del Carso meridionale e presentare un esempio di osservazione geologica scientifica e di tutela dell'ambiente in uno dei maggiori cantieri edili della Slovenia.

UDC 551.8(262.3-17)

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Miha MIŠIČ, Instituto di Geologia, Geotechnica e Geofisica, SI-1000 Lubiana, Dimičeva 14
Branko ČERMELJ, Stazione di Biologia Marina, SI-6330 Piran, Fornače 41

Ricostruzione paleoambitale della baia di Capodistria bolfo di Trieste, Adriatico settentrionale)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 187-200

La Baia di Capodistria (Golfo di Trieste, Adriatico settentrionale) è, dal punto di vista geomorfologico, l'ampia valle sommersa del fiume Risano. Cinque sondaggi, effettuati nel settore interno della Baia di Capodistria, sono stati utilizzati per una ricostruzione paleoambientale olocenica di questo tratto di mare del Golfo di Trieste. Le variazioni riscontrate sono chiaramente relazionate ai cambiamenti del livello marino su scala globale. La sequenza stratigrafica olocenica della baia indica che i più antichi sedimenti olocenici, datati 10-11000 anni fa, si depositarono nel settore meridionale della baia quando il mare iniziò la sua ingressione nella valle del fiume Risano. Nel momento in cui il settore più meridionale della valle venne sommerso, l'area orientale era ancora influenzata dai depositi fluviali del Risano. La sedimentazione marina fu prevalente su quella fluviale alla profondità di 26 metri durante la fase più intensa della trasgressione marina. Lo studio dei sondaggi ha evidenziato pure la sincronia tra l'innalzamento del livello marino ed i processi di sedimentazione nella Baia di Capodistria durante l'Olocene. Questi risultati sono in accordo con l'innalzamento generale del livello marino riscontrato nell'Adriatico settentrionale.

UDC 595.74(263.35)

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Il genere *Macronemurus* Costa 1885 nella parte nord-occidentale della penisola balcanica (Neuroptera: Myrmeleontidae)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 203-208

L'autore descrive la diffusione di due specie di formicaleone - *Macronemurus appendiculatus* (Latreille) e *M. bilineatus* Brauer - nella parte nord-occidentale della penisola balcanica e presenta un'analisi preliminare dell'alimentazione del formicaleone *Macronemurus appendiculatus*.

UDK 551.8(262.3-17)

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Rekonstruktion der Ablagerungsgeschichte in der Bucht von Koper (Golf von Triest, Nord-Adria)

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 187-200

Aus geomorphologischer Sicht stellt die Bucht von Koper im Golf von Triest das uberflutete breite Tal des Flusses Rižana in die Adria dar. Das Studium mehrerer Kernbohrungen, die in zentralen Teil der Bucht von Koper niedergebracht wurden, ermöglicht eine Rekonstruktion der Sedimentationsgeschichte während des Holozäns. Es zeigt sich eindrucksvoll, daß die Faziesänderungen mit globalen Meeresspiegelschwankungen einhergehen. Eine dreidimensionale Rekonstruktion zeigt, daß die früheste marine Transgression vor 10-11000 Jahren vom Süden her das Rižana-Tal überflutete, während gleichzeitig in nördlichen Bereich der Bucht von Koper noch die fluviatilen Sedimente der Rižana abgelagert wurden. Die flächenmäßig ausgedehnteste marine Transgression ist in einer Teufe von 26 m nachweisbar. Die Bohrkerne belegen weiters eine gleichmäßig verlaufende Meeresspiegel-Hebung während des Holozäns, bei gleichzeitiger mariner Sedimentation. Diese Daten sind in guter Übereinstimmung mit der Sedimentationsgeschichte in der nördlichen Adria.

UDK 595.74(263.35)

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Die Gattung *Macronemurus* Costa, 1855 im nordwestlichen Teil der Balkanhalbinsel (Neuroptera: Myrmeleontidae)

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 203-208

Es werden die Verbreitung zweier Ameisenlöwen-Arten, *Macronemurus appendiculatus* (Latreille) und *M. bilineatus* Brauer im nordwestlichen Teil der Balkanhalbinsel beschrieben und die vorläufigen Ergebnisse einer Analyse der Ernährungsgewohnheiten von *M. appendiculatus* vorgelegt.

UDK 56"61/62"(450.361 Slivje)
55.763.32(450.361 Slivje)
551.763.32(450.361 Kras)

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Paläografische und stratigrafische Beschreibung eines Rudistendepots aus dem Ober Turonium in Slivia, Karst von Triest, Italien

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 141-160

Die Untersuchung der stratigrafischen Abfolge im östlichen Bereich des Triester Karstes in der Umgebung von Slivia, die durch Kalk mit einer überaus reichen Rudistenfauna charakterisiert wird, brachte erstmals eine Onkoid-Kalkschichte im Triester Karst and Licht. Diese schicht wird mit dem Onkolith von Gračišće aus der Gornji Humac Formation (Gušić & Jelaska, 1990, 1993) auf der Insel Brač in Kroatien und mit dem Onkoid-Kalk der Sežana Formation in Slowenien (Jurkovšek *et al.*, 1996) verglichen, die beide dem Ober Turonium zugeschrieben werden und eine rasche und globale Regression des meeres bezeugen (Hancock & Kauffman, 1979 und Schlanger, 1986). Die Rudisten-Assoziation in der stratigrafischen Abfolge von Slivia besteht aus Arten aus dem Ober Turonium: *Hippuritella resecta* (Defrance), *Hippurites requieni* (Matheron), *H. requieni* var. *subpolygonia* Douvillé, *Vaccinites cf. inferus* (Douvillé), *Neoradiolites turoniensis* Pašić, *Distefanella? robusta* Caffau & Pleničar, *Distefanella kochanskae* Slišković und *Durania arnaudi* (Choffat). Einige dieser Arten werden im Triester Karst zum ersten Mal beschrieben. Diese Assoziation beinhaltet auch Gastropoden, Korallen und Algen mit Inkrustationen.

UDK 551.76/.78(497.4 Divača)
551.76/.78(497.4 Kozina)

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Die Geologie des Autobahnschnittes Divača-Kozina

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 161-186

Das Gelände, durch das das Autobahnstück Divača-Kozina führt, gehöhrt zu den geologisch interessanten Teilen des karstes. Hier vereinen sich alle Formationen, die zwischen dem Ober Santonium und dem Eozän im nordwestlichen Teil der Dinarischen Karbonatplatte entstanden sind. Parallel zur geologischen Überwachung der Arbeiten an der Autobahnstelle wurde eine genaue geologische Karte im Maßstab 1:5000 erstellt. Die Absicht dieses Artikels ist es, die Kenntnise des geologischen Aufbaus des südlichen Karstes zu vervollständigen und ein Beispiel für eine wissenschaftlich und naturschützerisch orientierte geologische Überwachung von größeren baulichen Eingriffen in Slowenien zu geben.

UDC 595.796(497.4-14)
595.79(497.4 Podpeč)

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Contributo alla fauna slovena degli Imenotteri Formicidi con particolare riguardo all'area submediterranea ed eudinarica

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 209-214

Nel corso di uno studio preliminare sulla fauna slovena delle formiche sono state scoperte 45 specie in 15 aree, 12 delle quali situate nella parte sud-occidentale della Slovenia.

UDC 599.33(497.4)

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Ritrovamento casuale di mustio *Suncus etruscus* nella Slovenia centrale (insectivora, mammalia)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 215-218

Nella borra di gufo comune *Asio otus* della zona paludosa di Lubiana abbiamo trovato i resti di un solo esemplare di mustiolo *Suncus etruscus*. La zona del ritrovamento è situata 60 chilometri ad est dell'areale di questa specie. Poiché la borra risale al periodo della nidificazione, e in essa sono state ritrovate anche tre crani di arvicola campestre *Microtus arvalis*, è poco probabile che appartenga ad un gufo in migrazione.

UDC 599.74(560)

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Annotazioni sul gatto selvatico *Felis Silvestris* in Turchia (Mammalia, Carnivora)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 219-222

Negli ultimi venti anni non sono giunti dalla Turchia nuovi dati relativi al gatto selvatico che si basassero su esemplari. Gli autori riferiscono di due esemplari trovati negli anni Novanta nell'Anatolia nord occidentale: un maschio non adulto del villaggio di Aydinpinar (pelle e cranio) e una pelle (sesso sconosciuto) dei dintorni di Yenice. In entrambi i casi l'habitat era costituito dai boschi a foglia caduca o misti. L'esemplare di Aydinpinar, stando alle dimensioni del cranio, è troppo piccolo per appartenere alla sottospecie *F. s. caucasica*, ma è compreso nella gamma della medesima sottospecie.

UDC 593.16(262.3-17)

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Presenza temporale delle specie del genere *Alexandrium* nel golfo di Trieste (alto adriatico)

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 225-230

Nell'ambito dell'osservazione regolare della qualità dell'acqua costiera del Golfo di Trieste abbiamo riscontrato la presenza di specie tossiche di dinoflagellati nelle coltivazioni di molluschi commestibili *(Mytilus galloprovincialis)*. Fra gli anni 1994 e 1996 abbiamo misurato a intervalli mensili, o quindicinali, la densità dei dinoflagellati del genere *Alexandrium* e abbiamo notato alcuni parametri fisico-chimici. La maggior densità delle specie del genere *Alexandrium*, nella parte sud orientale del golfo, é stata registrata nel maggio del 1994 (4200 cel. l^{-1}), in quella nord occidentale invece nel luglio del 1995 (4000 cel. l^{-1}). Con l'impiego del microscopio elettronico abbiamo evidenziato una specie sinora sconosciuta nel Golfo di Trieste, molto probabilmente simile alla *A. acatenella*.

UDC 593.17(450 Beneška laguna)"1995"

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Un primo contributo alla conoscenza dei Protisti microbentonici presenti nella laguna veneta

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 231-240

In maggio e settembre del 1995, in sei stazioni della laguna veneta situate in ambienti molto diversi, è stato effettuato uno studio preliminare sui Protisti microbentonici, con particolare riguardo ai Ciliati. Sono stati scoperti 21 generi di Ciliati. La loro maggiore concentrazione era rappresentata da circa 100 cellule per ml, mentre per i Flagellati era rappresentata da 1000 cellule per ml, con un piccolo numero di taxon presenti in tutte le stazioni scelte come campione.

UDK 593.16(262.3-17)

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Die temporäre Verbreitung von *Alexandrium* spp. im Golf von Triest (Nördliche Adria)

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 225-230

Im Golf von Triest wurde ein Monitoringsprogramm zur Untersuchung der Wasserqualität in Bereichen mit Miesmuschelkulturen *(Mytilus galloprovincialis)* durchgeführt. Vorkommen und temporäre Verbreitung der Dinoflagellata-Art *Alexandrium* spp. wurden gemeinsam mit daten über die Umweltbedingungen in den Küstengewässern monatlich und wöchentlich von 1994 bis 1996 aufgezeichnet. Es gab keine Algenblüten, nur im Mai 1994 wurden an der südöstlichen Seite des Golfes 4200 Zellen l^{-1} der Art *Alexandrium* festgestellt, während die Dichte an der nordwestseite mit einem Höhepunkt im Juli 1995 bis zu 4000 Zellen l^{-1} betrug. Unter dem Elektronenmikroskop wurde erstmalig eine in diesem Bereich bisher unbekannte Art, die vermutlich mit *A. acatenella* verwandt ist, beobachtet.

UDK 593.17(450 Beneška laguna)"1995"

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Ein erster Beitrag zur Kenntnis der mikrobenthischen Einzeller in der lagune von Venedig

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 231-240

Eine vorläufige Studie über die mikrobenthischen Einzeller, insbesondere die Ciliata, wurde anhand von Sedimentproben, die im Mai und September 1995 an sechs Stellen mit untershiedlichen Milinucharacteristika in der Lagune der Venedig entnommen wurden. Es konnten 21 Ciliatagattungen festgestellt werden. Die hochste Ciliata Konzentration betrug etwa 100 Zellen ml^{-1}, die hochste Flagellata-Konzentration um 1000 Zellen ml^{-1} mit einer geringeren Anzahl von taxa in sämtlichen entnommenen Proben.

UDK 595.796(497.4-14)
595.79(497.4 Podpeč)

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Ein Beitrag zur Ameisenfauna mit besonderen Schwerpunkt auf den submediterranen und eudinarischen Bereich

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 209-214

Die vorläufigen Ergebnisse einer Studie über die slowenische Ameisenfauna basiert auf Untersuchungen von Ameisen, die im Juli 1996 an 15 lokalitäten, von velchen sich 12 im südwestlichen Slowenien befinden, durchgeführt wurden. Die Untersuchungen wurden in den Steiner Alpen (3 lokalitäten), im Trnovski gozd (6 lokalitäten), in Kozina (1 Lokalität), Podpeč (3 lokalitäten), Strunjan (1 Lokalität) und Osp (1 Lokalität) durchgeführt. 45 Arten wurden entdeckt. Zur Auswertung der Proben und der Vielfalt der Arten wurden spezielle Indices verwendet. Auf dieser Basis wurde die Lokalität Okrešelj (Steiner Alpen) eingehend untersucht. Die grosste Vielfalt der Ameisenfauna aber wurde in Podpeč verzeichnet. Die Vielfalt der Ameisenfauna ist jedoch in Gebieten mit Einfluss der mediterranen Fauna immer grösser.

UDK 599.33(497.4)

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Ein unerwartetes Autrefen von *Suncus etruscus* in Zentralslowenien (Insectivora, Mammalia)

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 215-218

In einem Gewölle von *Asio otus* wurde im Laibacher Moor (Ljubljansko barje) ein einzelner Schädel von *Suncus etruscus* gefunden. Dieser Fund wurde 60 km östlich des aktuellen Verbreitungsgebietes von *Suncus etruscus* verzeichnet. Da das Gewölle aus der Brutzeit stammt, und auch drei Schädel von *Microtus arvalis* enthält, ist es unwahrscheinlich, dass es sich um eine Waldohreule auf Wanderung handelt.

UDK 599.74(560)

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Bemerkungen zur Wildkatze *Felis silvestris* in der Türkei (Mammalia, Carnivora)

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 215-218

Ungefähr 20 Jahre gab es aus der Türkei keine Angaben über die Wildkatze. Die Autoren legen Material zu zwei Exemplaren vor, die in den Neunzigerjahren in Nordwestanatolien aufgefunden wurden. Es handelt sich um ein subadultes Männchen aus Aydinpinar (Fell und Schädel) und ein Exemplar aus der Nähe von Yenice, dessen Geschlecht nicht mehr bestimmt werden konnte. In beiden Fällen bestand der Lebesnraum aus Wald oder Mischgebiet. Aufgrund der Schädeldimensionen erscheint das männliche Exemplar für die Subspecies *F. c. caucasica* zu klein, fällt jedoch in das Verbreitungsgebiet der gennanten Subspecies.

UDC 594(262.3-17)

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Mollusca shellfish in Slovene coastal waters

Annales: Annals for Istrian and Mediterranean Studies, 11, 1997, p.p. 241-258

Through sampling carried out on twelve sites in Slovene coastal waters. 393 Mollusca shellfish were identified. 9 of these were Polyplacophora, 232 Gastropoda, 139 Bivalvia, 4 Scaphopoda and 9 Cephalopoda. Almost two thirds (253) of the found molluscs were alive. and in view of the smallness of Slovene coastal waters, the obtained number of the species is certainly high. On the basis of the observations and data from literature the authors were able to state the association in which a species lives. At the same time they ascertained that almost all of the biotopes stated by Peres & Picard for the Mediterranean occur also in Slovene coastal waters.

UDC 597.5:591.5(262.3)

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Inifluenza dei cambiamenti dell'ambiente marino sulla crescita iniziale e sulla moltiplicazione dell'acciuga *Engraulis encrasicolus* L. nel mare Adriatico

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 259-270

Nell'Adriatico, l'acciuga va in fregola da (marzo) aprile a ottobre (novembre), in acque con temperatura tra gli 11,6 e i 27,6°C e grado di salinità tra i 9,1 e i 39,6 ppt. La produzione ed il numero delle larve dipendono dai cambiamenti nella produzione primaria e nella biomassa dello zooplancton durante il periodo della fregola, con una scansione dello stadio di sviluppo di circa due mesi. Il periodo di sviluppo delle uova e delle larve dell'acciuga adriatica, come pure la curva di crescita delle larve e delle post-larve, è stata studiata dall'autore in condizioni sperimentali. Ricerche accurate hanno dimostrato che ad un aumento della produzione di uova ha fatto seguito una maggiore abbondanza di post-larve e contemporaneamente un maggior grado di mortalità delle stesse. Queste oscillazioni sono direttamente connesse a quelle della temperatura, della salinità, della produzione primaria e della quantità di zooplancton, con una scansione dello stadio di sviluppo di un anno.
Già dal 1978 queste "regolari" oscillazioni non reggono più. La biomassa delle acciughe è diminuita, mentre la temperatura, la salinità, le sostanze nutritive e la produzione primaria aumentano di continuo in tutto l'Adriatico. Sembra che questi cambiamenti siano dovuti ai periodi di bassa frequenza dei mutamenti climatici, influenzati probabilmente anche dalla eutrofizzazione antropogena.

UDC 597.5(262.3-11)

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Presenza di larve di pesce balestra *Balistes carolinensis* Gmelin, 1789 (Pisces: Balistidae) nell'Adriatico orientale

Annales: Annali di Studi istriani e mediterranei, 11, 1997, p.p. 271-276

Tre larve di pesce balestra, scoperte nel settembre del 1994 tra i rottami di una imbarcazione lungo la riva dell'isolotto di Gubavac (nelle vicinanze della località di Lumbarda, sull'isola di Curzola) sono il primo dato sulla presenza di piccoli di questa specie nell'Adriatico orientale. La scoperta conferma che il pesce balestra va in fregola nell'Adriatico orientale. L'articolo presenta i principali dati morfometrici raccolti su questa specie. Gli autori ritengono altresì che la posizione del pesce balestra nell'Adriatico vada giudicata sulla base di una ricerca più duratura, in quanto risulta sempre più evidente che pesci di specie così inconsuete - e particolarmente di specie provenienti dai margini delle loro aree di diffusione - sono un importante indicatore di cambiamenti nell'ambiente marino.

UDK 597.5(262.3-11)

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Das Vorkommen von Postlarven des Drückerfisches, *Balistes carolinensis* Gmelin, 1789 (Pisces: Balistidae) in der östlichen Adria

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 271-276

Drei Postlarven von *Balistes carolinensis* Gmelin, 1789, die unter einem treibenden Wrackteil unweit der Küste der Insel Gubavac (in der Nähe der Ansiedlung Lumbarda auf der Insel Korčula) im September 1994 gefunden wurden, stellen das erste Vorkommen des Drückerfisches in der östlichen Adria dar. Das Vorkommen zeigt, dass diese Art in der südöstlichen Adria laicht. Es werden die wichtigsten Angaben zu Form und Massen angeführt. Der Status des Drückerfisches sollte anhand einer kontinuierlichen Basis ausgewertet werden. Es wird nämlich immer deutlicher, dass sich Arten, deren Vorkommen ungewöhnlich ist und speziell jene, die sich am Rande ihres Verbreitungsgebietes befinden, als wichtige Indikatoren für Umweltveränderungen erweisen können.

UDK 594(262.3-17)

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Mollusken in den slowenischen Küstengewässern

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 241-258

Anhand von Proben, die in den slowenischen Küstengewässern an zwölf Stellen entnommen wurden, konnten 393 Molluskenarten bestimmt werden. Darunter befanden sich 9 Polyplacophora-Arten, 232 Gastropoda-Arten, 139 Bivalvia-Arten, 4 Scaphopoda-Arten und 9 Cephalopoda-Arten. Fast zwei Drittel (253) aller Mollusken wurden leben angetroffen. In Hinblick auf Sloweniens geringen Anteill am Meer stellt das Untersuchungsergebniss eine grosse Anzahl von Arten dar. Aufgrund dieser Beobachtungen und der Angaben aus der Literatur weisen die Autoren auf eine Vergesellschaftung von Arten, in der auch die Art lebt, hin. Zugleich stellen sie fest, dass nahezu alle Biotope, die Peres & Picard für die Niederlande anführen, auch in den slowenischen Küstengewässern vorkommen.

UDK 597.5:591.5(262.3)

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Die Auswirkungen von Umweltveränderungen auf frühe Lebenstadien und Vermehrung der Anchovis *(Engraulis encrasicolus)* in der Adria

Annales: Annalen für istrische und mediterrane Studien, 11, 1997, S. 259-270

Die Anchovis laicht in der Adria von (Marz) April bis Oktober (November). Die Laichproduktion und die Quantität an Prälarven mit Dottersack reagiert auf Veränderungen der Primärproduktion und Quantität von Zooplankton während derlaichperiode mit einer Verzögerung von etwa zwei Monaten. Untersuchungen von Langzeitschwankungen der Laichproduktion, der Quantität an Präelarven und Larven zeigte, daß auf die Zunahme der Laichproduktion eine Zunahme der Larven folgte, die gleichzeitic aber auch mit der Zunahme deren augenblicklichen Mortalitätsrate verbunden war. Diese Schwankungen standen mit den Temperatureschwankungen, der Schwankungen der Salinität, Primärproduktion und Zooplanktonmenge mit einer Verzögerungsphase von einem Jahr in positiver Wechselwirkung. Seit 1978 sind diese "regulären" Schwankungen gestört. Die Anchovis-Biomasse nahm ab, wahrend Temperatur, Salinität, Nährstoffgehalt und Primärproduktion in der gesamten Adria kontinuierlich zunahmen. Es scheint, daß diese Veränderungen auf Klimaveränderungen, die wahrescheinlich durch die vom Menschen verursachte Eutrophierung verstärkt werden, zurückzuführen sind.

ZRS