original scientific article
received: 2003-01-25

UDK 582.26(282.24 Dragonja)

ALGAE IN DRAGONJA RIVER

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ABSTRACT

Between 1998 and 2000, peryphytic algal communities were sampled and analysed at five sampling sites on the Dragonja river and at a single site on the tributary Pinjevec. Altogether, 238 algal taxa were registered, with prevailing Bacillariophyceae (170), while 38 taxa belonged to Cyanophyceae and 17 to Chlorophyceae. Of all 238 taxa, 65 were recorded for the first time in Slovenia, 13 belonging to Cyanophyceae and 52 to Bacillariophyceae. Most of these 65 taxa were recorded in the Dragonja estuary.

Key words: algae, streams, springs, brackish waters, southwestern Slovenia

ALGHE NEL FIUME DRAGOGNA

SINTESI

Tra il 1998 ed il 2000 sono state campionate ed analizzate comunità perifitiche algali in cinque stazioni di campionamento nel fiume Dragogna ed una stazione nel tributario Pinjevec. Sono stati trovati 238 taxa algali. Il contributo maggiore proviene dalla famiglia delle Bacillariophyceae (170 specie); 38 taxa appartengono alle Cyanophyceae mentre 17 alle Chlorophyceae. Tra i 238 taxa, 65 sono nuove segnalazioni per la Slovenia, tra le quali 13 Cyanophyceae e 52 Bacillariophyceae. La maggioranza di questi taxa è stato campionata nell'estuario del fiume Dragogna.

Parole chiave: alghe, corsi d'acqua, sorgenti, acque salmastre, Slovenia sud-occidentale

INTRODUCTION

The biodiversity of algae in Slovenia is relatively high, as more than 2000 different algae species have been recorded so far (Kosi & Vrhovšek, 1996). The issue of the endangered algal species, threatened by the endangered water ecosystems, has not been clarified as yet due to the lack of investigations. Drastic changes usually occur during the regulation of rivers and streams, when the fundamental ecological conditions are changed (the substrate, water current, light); the consequences are of course reflected in the species' reduced diversity. Similar results can be seen in polluted waters, where the number of species decreases from the sources towards estuaries of the water courses (Vrhovšek *et al.*, 1983). Most of the Slovenian water-streams are already polluted (Vrhovšek *et al.*, 1983, 1994; Krivograd, 1997; Krivograd Klemenčič, 2001; Smolar, 1997). The Dragonja is one of the very few unpolluted Slovenian rivers. The water at its estuary is brackish. The algae occurring in Slovenian brackish waters have not been studied so far. With a view to protect its natural ecosystems with all its constituent parts, including algae, the Dragonja river valley is planned to be given the status of a landscape park. It is necessary to conserve the high diversity of algal species, and the rare species, which cannot be found in other Slovenian rivers due to the Dragonja's very special ecological conditions (flysch landscape, brackish water).

The purpose of this research was to determine the species composition of algal communities in the Dragonja river, from its source to estuary and in its tributary Pinjevec. The only data on the algal species concerned the lower part of the river at Kaštel (in *"The research of the quality of surface waters in Slovenia in 1992"*, Zupan (ed., 1994)), where the sampling site of the Hydro-Meteorological Institute of Slovenia is situated. However, no research has been carried out concerning the algae of the upper part of the Dragonja river and its tributaries. At the sampling site in the Dragonja estuary, the water is brackish. On this occasion let us add that no investigations concerning the brackish waters of Slovenia had been carried out prior to this research.

MATERIALS AND METHODS

Description of sampling sites

The sampling sites are presented in figure 1 and their description given in Table 1. The sampling sites C, D and E are located close to each other. They differ mainly in the speed of the water current. The sampling site B is located in the tributary Pinjevec, just before it joins the Dragonja river.

Tab. 1: Description of sampling sites on Dragonja river and its tributary Pinjevec.
Tab. 1: Opis vzorčnih mest na reki Dragonji in pritoku Pinjevcu.

Sampling sites	Shading of the riverbed	Speed of water-current	Riverbed width (m)	Co-ordinates (after Gaus-Krüger)
A-source	shaded	fast	1	X=5039250 Y=5412000
B-Škrline	partly shaded	changing	15	X=5037125 Y=5402750
C-pool	partly shaded	very slow	10	X=5396825 Y=5034175
D-slow current	shaded	slow	12	X=5034000 Y=5396750
E-strong current	not shaded	fast	7	X=5396825 Y=5034175
F-estuary	not shaded	slow	20	X=5390625 Y=5037250

The samples were collected seasonally during the years 1998, 1999 and 2000 (10. 7. 1998, 18. 7. 1998, 23. 8. 1998, 20. 3. 1999, 29. 7. 1999, 18. 10. 1999, 17. 1. 2000) at all sampling sites. Five periphyton samples were taken at each sampling site for qualitative analysis by scratching the surface of gravel, rocks, macrophytes, wood and other submersed materials (glass and plastic bottles, iron sticks, *etc.)* The phytoplankton was sampled using the plankton net with mesh size 25 µm at the estuary. The fixation of the samples was done *in situ* with 4% formalin concentration. For diatom determination, samples were pre-treated with saturated HNO_3 (APHA, 1985).

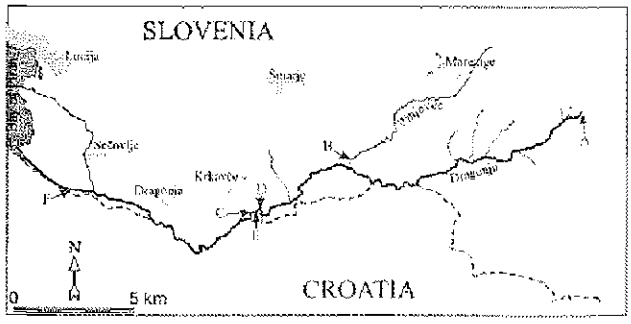

Fig. 1: Map of the river Dragonja and its tributary Pinjevec. Legend: A – source, B – Škrline, C – pool, D – slow current, E – strong current, F – estuary.
Sl. 1: Zemljevid reke Dragonje in pritoka Pinjevca. Legenda: A – izvir, B – Škrline, C – tolmun, D – počasi tekoča, E – brzica, F – izliv.

The algal samples were determined in the laboratory using the light microscope (magnification 1000×). The relative frequency of most common species was evaluated using the numbers from 1 – single, 2 – rare, 3 – common, 4 – frequent and 5 – dominant. The algae were determined using the following identification monographs: Lazar, 1960; Starmach, 1966, 1972; Hindak *et al.*, 1978; Krammer & Lange-Bertalot, 1986, 1988, 1991a, 1991b; Popovsky & Pfiester, 1990; Cvijan & Blaženčić, 1996; Hindak, 1996.

RESULTS AND DISCUSSION

At the five sampling sites on the Dragonja river and at the single site on its tributary Pinjevec, 238 (Tab. 2) algal taxa were established (with their composition presented in figure 2). In view of the number of species, Bacillariophyceae dominated at all sampling sites, followed by Cyanophyceae. A similar situation was recorded in the river Branica flowing on flysch ground (Smolar, 1997). Cyanophyceae were followed by Chlorophyceae at sampling sites A, C, D and F, and by Zygnematophyceae at sampling sites B and E. Zygnematophyceae were not found at sampling site A. *Euglena* sp. was recorded at sampling site D. The species *Peridinium umbonatum* was found at sampling site B, and *Peridinium bipes* at sampling site F. The species *Dinobryon sertularia* was found at sampling sites B, C, D and E. All four species are planktonic. The species *Batrachospermum vagum* was registered at sampling site E, and *Audouinella chalybea* at sampling site F.

The total number of different taxa at sampling site A was 62 (Tab. 2). In all five periphyton samples taken at sampling site A, the following species were found: *Achnanthes minutissima, Amphora ovalis, Diploneis elliptica, D. oblongella, Gomphonema angustatum, G. angustum* and *Nitzschia linearis* var. *linearis*. The most common species were *Achnanthes minutissima* and *Gomphonema angustatum*. *Achnanthes flexella, Cymbella amphicephala* var. *amphicephala, Diploneis elliptica, Gomphonema angustum* and *Cymbella descripta* are characteristic oligotrophic water species. *Surirella spiralis* is a widespread species, characteristic of the river springs and lakes with limestone ground, containing mid- to high- levels of electrolytes (Krammer & Lange-Bertalot, 1988). The species *Caloneis alpestris, Cymbella ehrenbergii, C. tumidula* and *Nitzschia angustatula* are widespread and characteristic of karst waters rich in calcium (Krammer & Lange-Bertalot, 1986, 1988).

At sampling site B, the total number of different taxa was 116, at sampling site C 105, at sampling site D 89, and at sampling site E 94 (Tab. 2). Although the water current was quite different between the individual sampling points, the composition of the algal species did not differ much.

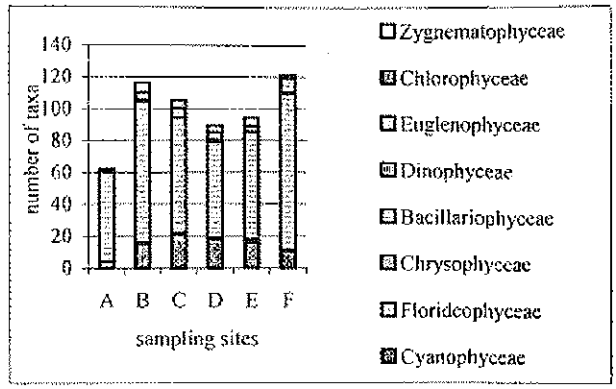

Fig. 2: Algal community structure in the river Dragonja and its tributary Pinjevec during the years 1998, 1999 and 2000 (A – source, B – Škrline, C – pool, D – slow current, E – strong current, F – estuary).
Sl. 2: Sestava algne združbe v reki Dragonji in v pritoku Pinjevcu v letih 1998, 1999 in 2000 (A – izvir, B – Škrline, C – tolmun, D – počasi tekoča, E – brzica, F – izliv).

The changes in biomass along the current occurred mainly because of the differences in the pH values, temperature, water level and the nitrate concentration (Szarek, 1994). Light has a greater impact on the composition of periphyton than the water current, level and nitrate concentration (DeNicola & McIntire, 1990).

In all five periphyton samples taken at sampling sites B, C, D and E, the following species were found: *Achnanthes flexella, A. minutissima, Anomoeoneis vitera, Cymbella affinis, C. cymbiformis, C. microcephala, Denticula kuetzingii, Eunotia arcus, Fragilaria biceps* and *Gomphonema angustum*. The most abundant species were *Achnanthes minutissima, Cymbella affinis* and *C. microcephala*. The species *Rivularia haematites*, which can be found in stagnant and running waters on limestone (Starmach, 1966), was present at sampling sites B, C and E. On the same substrate, *Amphipleura pellucida, Caloneis alpestris, Cymbella laevis* and *Tolypothrix cacullata* are also widespread (Starmach, 1966; Krammer & Lange-Bertalot, 1986, 1991a). *Batrachospermum vagum*, a characteristic oligotrophic water species (Hindak *et al.*, 1978), was found at sampling site E during the summer 1998. At sampling sites B, C, D and E, *Dinobryon sertularia* was present, while at sampling site B *Peridinium umbonatum* was established. Both species are characteristic of plankton (Hindak *et al.*, 1978). The presence of plankton species in the rivers depends on the water retention time in stagnant places.

The high species diversity was found at sampling site F – the Dragonja river estuary. The total number of different planktonic and periphyton species was 121 (Tab. 2). By their nature, estuaries are generally eutrophic and dynamic systems. Consequently, the number of species

Tab. 2: List of algal species occurring in the river Dragonja and its tributary Pinjevec during the years 1998, 1999 and 2000. Legend: 1 – single, 2 – rare, 3 – common, 4 – frequent, 5 – dominant species; A – source, B – Škrline, C – pool, D – slow current, E – strong current, F – estuary.

Tab. 2: Vrstna sestava alg v reki Dragonji in v pritoku Pinjevcu v letih 1998, 1999 in 2000. Legenda: 1 – posamična, 2 – redka, 3 – običajna, 4 – pogosta, 5 – dominantna vrsta; A – izvir, B – Škrline, C – tolmun, D – počasi tekoča, E – brzica, F – izliv.

Taxon	Sampling site					
	A	B	C	D	E	F
PROKARYOTA						
CYANOPHYTA						
CYANOPHYCEAE						
**Borzia trilocularis* Cohn		1	1	1	1	
Calothrix parietina (Naegeli) Thuret					1	
Calothrix sp.			1	1		
Dactylococcopsis rhaphidioides Hansg.			1			
**Gloeocapsa bituminosa* (Bory) Kuetz.		1		1		
Gloeocapsa montana Kuetz.				1		
Gloeocapsa turgida (Kuetz.) Holler.			1	1	1	1
Lyngbya cryptovaginata Schkorbatoff						1
**Lyngbya perelegans* Lemm.			1			
Merismopedia glauca (Ehren.) Naegeli		1	1	1	1	
Merismopedia punctata Meyen		1	1		1	
Nostoc paludosum Kuetz.			1	1	1	
Nostoc sp.				1		
**Oscillatoria laetevirens* (Crouan) Gomont						1
Oscillatoria okenii Agardh			1			
Oscillatoria subcapitata Ponomarenko						2
Phormidium ambiguum Gomont				1		
**Phormidium angustissimum* W. & G.S. West		1	3	3	2	
Phormidium autumnale (Agardh) Gomont	1	2	1	2	1	1
**Phormidium dimorphum* Lemm.	1					
Phormidium foveolarum (Mont.) Gomont						2
Phormidium fragile (Menegh.) Gomont						2
Phormidium retzii (Agardh) Gomont		1	1	1	1	
Phormidium sp.	1	1	1	1	1	1
Plectonema sp.			1			
**Pseudanabaena papillaterminata* (Kiss.) Kukk		3	3	1	3	1
**Pseudospirulina amoena* Pankow & Jahnke			1			
Rhabdoderma lineare Schmidle & Lauter.			1			
Rivularia haematites (D.C.) Agardh		2		3	3	
**Schizothrix friesii* (Agardh) Gomont				1	2	
Schizothrix lateritia (Kuetz.) Gomont		2	1		1	
Schizothrix sp.		1				
Spirulina maior Kuetz.		1				
Spirulina sp.	1					
**Spirulina tenuissima* Kuetz.						1
Synechococcus cedrorum Sauvageau		2	2	1	1	
**Synechocystis septentrionalis* Skuja			1			
**Tolypothrix cucullata* Jaag		3	1	3	2	
EUKARYOTA						
RHODOPHYTA						
FLORIDEOPHYCEAE						
Audouinella chalybea (Lyngbe) Fries						1
Batrachospermum vagum (Roth.) Agardh					1	
HETEROKONTOPHYTA						
CHRYSOPHYCEAE						
Dinobryon sertularia Ehren.		1	1	1	1	
BACILLARIOPHYCEAE						
Achnanthes delicatula (Kuetz.) Grun.						1
Achnanthes flexella (Kuetz.) Brun	1	3	3	2	2	1
Achnanthes laevis Oestrup			1	1		
Achnanthes lanceolata ssp.*lanceolata* var.*lanceolata* (Breb.) Grun.						1
Achnanthes minutissima Kuetz.	5	5	5	5	4	3
**Achnanthes septata* A. Cleve						5
Achnanthes sp.	1				1	1
Amphipleura pellucida (Kuetz.) Kuetz.			1		1	
**Amphora angusta* (Greg.) Cleve						3
Amphora coffeaeformis (Agardh) Kuetz.	1					3
Amphora libyca Ehren.		1				1
Amphora montana Krass.		1	1			1
Amphora ovalis (Kuetz.) Kuetz.	1		1	1	1	1
Amphora pediculus (Kuetz.) Grunow						1
Anomoeoneis vitrea (Grun.) Ross		2	3	3	3	1
Aulacoseira granulata (Ehren.) Simon.				1		
**Bacillaria paradoxa* Gmelin	1					1
Caloneis alpestris (Grun.) Cleve	1	1	1	1	1	1
Caloneis bacillum (Grun.) Cleve		1				
**Caloneis molaris* (Grun.) Kramm.			1		1	
Caloneis pulchra Messik.			1			
Caloneis schumanniana (Grun.) Cleve				1		
Caloneis silicula f. *silicula* (Ehren.) Cleve		1				
Caloneis tenuis Greg.					1	
Cocconeis pediculus Ehren.						2
Cocconeis placentula Ehren.	1					3
Cyclotella ocellata Panto.		1				1
Cyclotella sp.		1	1	1	1	1
**Cymatopleura solea* var. *apiculata* (W.Smith) Ralfs			1			1
Cymbella affinis Kuetz.	1	4	5	5	5	1
Cymbella amphicephala var. *amphicephala* Naegeli	1	2	1	1	1	1
**Cymbella caespitosa* (Kuetz.) Brun		1				
Cymbella cesatii (Raben.) Grun.		2	3	3	2	
Cymbella cistula (Ehren.) Kirch.		2	1	1	1	
Cymbella cymbiformis Agardh		2	2	1	1	
Cymbella delicatula Kuetz.		3	1	1	1	
**Cymbella descripta* (Hust.) Kramm. & Lan.-Bert.	1	1	2	2	1	
Cymbella ehrenbergii Kuetz.	1					
Cymbella helvetica Kuetz.			1		1	
Cymbella incerta (Grun.) Cleve			1			
Cymbella laevis Naegeli		2	1		1	
Cymbella microcephala Grun.	3	3	3	4	3	1
Cymbella prostrata (Berk.) Cleve		1	1	1	1	
**Cymbella pusilla* Grun.	1	1	1	1		3

Cymbella rupicola Grun.	2	1	1	1	1	
Cymbella silesiaca Bleisch	1	2	2	2	2	1
Cymbella sinuata Greg.	1				1	1
Cymbella subaequalis Grun.	4	1	1		3	1
Cymbella tumida (Breb.) Van Heurck	1					
**Cymbella tumidula* var. *lancettula* Kramm.	1		3	3	3	2
Cymbella tumidula var. *tumidula* Grun.	3	2	3	3	2	
**Denticula kuetzingii* Grun.		3	3	3	2	1
**Denticula subtilis* Grun.						2
Denticula tenuis Kuetz.	3	1	1	1	1	
**Diatoma ehrenbergii* Kuetz.					1	1
Diatoma tenuis Agardh		3	1	3	3	
Diploneis elliptica (Kuetz.) Cleve	1		1	1	1	1
Diploneis oblongella (Naegeli) Cleve-Euler	1	1	2	1	2	2
Eunotia arcus Ehren.	1	2	2	2	2	1
Eunotia exigua (Breb.) Raben.						1
**Fragilaria biceps* (Kuetz.) Lan.-Bert.	1	3	3	3	2	2
Fragilaria capucina Desm.	1	1	1		1	1
Fragilaria construens Ehren.						1
Fragilaria fasciculata (Agardh) Lan.-Bert.		3	1	3	3	1
**Fragilaria montana* (Krass.) Lan.-Bert.			1			
Fragilaria tenera (W.Smith) Lan.-Bert.		4	4	5	3	1
Fragilaria ulna var. *acus* (Kuetz.) Lan.-Bert.		1				
Fragilaria ulna var. *ulna* (Nitzsch) Lan.-Bert.					1	1
Frustulia rhomboides (Ehren.) De Toni						1
**Frustulia spicula* Amosse	3					1
Frustulia vulgaris (Thwait.) De Toni			1	1	1	
Gomphonema acuminatum Ehren.		1				1
Gomphonema angustatum (Kuetz.) Raben.	4	2	3	2	1	1
Gomphonema angustum Agardh	3	3	3	3	3	1
Gomphonema clavatum Ehren.	1	1	1	1		1
Gomphonema olivaceum (Horn.) Breb.			1		1	1
Gomphonema parvulum Kuetz.	1	1		1		1
Gomphonema truncatum Ehren.		1	1			
Gyrosigma acuminatum (Kuetz.) Raben.		1	1			1
Gyrosigma attenuatum (Kuetz.) Raben.		1	1	1		1
**Gyrosigma nodiferum* (Grun.) Reimer				1		
**Gyrosigma tenuissimum* (W.Smith) Cleve						1
**Gyrosigma wansbeckii* (Dankin) Cleve						1
Hantzschia amphioxys (Ehren.) Grun.	1	1		1		
Mastogloia smithii Thwait.		1	2	3	2	
**Melosira moniliformis* (Muell.) Agardh						1
**Melosira nummuloides* (Dillwyn) Agardh						2
Melosira varians Agardh						1
Meridion circulare (Grev.) Agardh	1					1
**Navicula accomoda* Hust.			1	1	1	
Navicula bacillum Ehren.	1	2				
**Navicula bryophila* Pet.	1		1	2	1	
Navicula capitatoradiata Germ.	1	1	2	2	2	
Navicula contenta Grun.	1					
Navicula cryptocephala Kuetz.	2	1	1		1	1
Navicula cryptotenella Lan.-Bert.	1	1			1	1
Navicula cuspidata Kuetz.		1				
**Navicula duerrenbergiana* Hust.						3
Navicula elginensis (Greg.) Ralfs		1				
**Navicula gregaria* Donkin		1		2		1
Navicula halophila (Grun.) Cleve						4
**Navicula incertata* Lan.-Bert.						2
**Navicula libonensis* Schoeman		1				
**Navicula margalithii* Lan.-Bert.						2
Navicula mutica var. *mutica* Kuetz.						3
Navicula oblonga Kuetz.		1				
**Navicula oppugnata* Hust.		1				
**Navicula pseudokotschyi* Grun.		1				
Navicula pupula var. *pupula* Kuetz.	2	2	1	2	2	
Navicula radiosa Kuetz.	1	2	1	2	3	1
**Navicula recens* Lan.-Bert.						1
Navicula rhynchocephala Kuetz.		1				1
**Navicula salinarum* Grun.						1
Navicula sp.	1	1	1		1	
Navicula tripunctata (Muell.) Bory						1
Navicula trivialis Lan.-Bert.		2				
Navicula veneta Kuetz.	1	2	2	1	2	1
Navicula vitiosa Schiman.					1	
Neidium affine var. *affine* (Ehren.) Pfitzer		1				
**Neidium bisulcatum* (Lagerst.) Cleve		1				
**Neidium ladogensis* (Cleve) Foged		1				
Neidium productum (W.Smith) Cleve		1				
Nitzschia amphibia f. *amphibia* Grun.			1			1
Nitzschia angustata (W.Smith) Grun.	1	2	1	1	1	
**Nitzschia angustatula* Lan.-Bert.	2		1			
Nitzschia brevissima Grun.						1
**Nitzschia compressa* var. *compressa* (Bailey) Boyer						1
**Nitzschia constricta* (Kuetz.) Ralfs	1	1		1		4
Nitzschia dissipata (Kuetz.) Grun.	1	1	1	1	1	1
Nitzschia dubia W. Smith						1
Nitzschia fonticola Grun.	1	1	1	1	1	
Nitzschia frustulum (Kuetz.) Grun.	1					5
**Nitzschia granulata* Grun.						1
**Nitzschia levidensis* var. *salinarum* Grun.						1
Nitzschia linearis (Agardh) W.Smith		1				
Nitzschia linearis var. *linearis* (Agardh) W. Smith	1	1	1	1	1	1
**Nitzschia longissima* var. *genuina* A. Cleve						1
**Nitzschia lorenziana* Grun.						1
Nitzschia microcephala Grun.						1
**Nitzschia navicularis* (Breb.) Grun.						1
Nitzschia palea (Kuetz.) W. Smith	1	5	5	1	1	1
Nitzschia parvula Lewis		1				
Nitzschia recta Hant.			1		1	
Nitzschia recta var. *recta* Hant.				1		
**Nitzschia scalpelliformis* Grun.						1
**Nitzschia sigma* (Kuetz.) W. Smith						2
Nitzschia sp.						1
**Pinnularia divergens* W.Smith		1				
Pinnularia interrupta W. Smith		1				
Pinnularia maior (Kuetz.) Raben.		1	1	1	1	1
Pinnularia microstauron var. *microstauron* (Ehren.) Cleve		1	2	1	1	1
**Pinnularia rupestris* Hant.	1				1	

**Pinnularia subcapitata* var. *hilseana* (Jan.) Muell.		1	1	1	1	
Pinnularia subcapitata var. *subcapitata* Greg.					1	
Pinnularia viridis (Nitzsch) Ehren.			1		1	
**Pleurosigma salinarum* Grun.						3
**Pleurosigma strigosum* W. Smith						1
Rhoicosphenia abbreviata (Agardh) Lan.-Bert.	1	1	1			1
**Rhopalodia brebissonii* Krammer				1		
**Rhopalodia constricta* (W. Smith) Kramm.						1
Rhopalodia gibba (Ehren.) O. Muell.		1	1	1	1	
Stauroneis anceps Ehren.		1				
Stauroneis phoenicenteron (Nitzsch) Ehren.		1				
Stauroneis smithii var. *smithii* Grun.		1				
Surirella angusta Kuetz.		1				
Surirella bifrons Ehren.		1				
Surirella biseriata Breb.						1
**Surirella brebissonii* Kramm. & Lan.-Bert.	1					3
**Surirella constricta* W. Smith		1				
Surirella spiralis Kuetz.	1					1
DINOPHYTA						
DINOPHYCEAE						
Peridinium bipes Stein						3
Peridinium umbonatum Stein		2				
EUGLENOPHYTA						
EUGLENOPHYCEAE						
Euglena sp.				1		
CHLOROPHYTA						
CHLOROPHYCEAE						
Bulbochaete sp.			1	1		
Cladophora fracta Kuetz.			1		1	1
Cladophora sp.				1		
Coelastrum reticulatum (Dang.) Senn.						1
Enteromorpha sp.						4
Microspora amoena (Kuetz.) Raben.						1
Microspora pachyderma (Wille) Lagerh.						1
Oedogonium sp.	3	1	1	1	1	1
Oocystis pusilla Hansg.		1				
Oocystis sp.			1		1	1
Pediastrum integrum Naegeli			1			
Scenedesmus brasiliensis Bohl.		1	1			
Scenedesmus serratus (Corda) Bohl.				1		
Trentepohlia aurea (L.) Martius	2	1		1	1	
Ulothrix tenerrima Kuetz.						1
Ulothrix zonata (Web. & Mohr.) Kuetz.		1				
Uronema confervicolum Lagerh.						1
ZYGNEMATOPHYCEAE						
Closterium cornu Ehren.			1	1		
Cosmarium ochtodes Nordst.		1	1	1	1	
Cosmarium sp.		1	1		1	1
Mougeotia parvula Hassal.		1				
Mougeotia sp.		1	1	1	1	1
Spirogyra sp.		1			1	
Zygnema sp.		2	1	3	1	
Total No. of species	62	116	105	89	94	121

* Algae first recorded in Slovenia

in the flora is variable and sometimes high (Kilham & Mavuti, 1990). However, Remane & Schlieper (1971; in Kies, 1997) discovered just the opposite, that the lowest number of species occurs in brackish waters. The number of species increases with the distance from brackish water towards fresh and salty water. Planktonic algae entering the estuary from upstream reach their upper limit of salt tolerance at approximately 5 ‰, while marine planktonic algae entering the estuary from the sea approach their lower limit in the salinity gradient at about the same point. Fresh-water, brackish and marine algal species were present in the Dragonja river estuary. In the Warri/Forcados estuary in Nigeria, the phytoplankton community was composed of fresh-water, brackish and marine species as well. Fresh water species mainly belonged to Chlorophyceae, Bacillariophyceae and Cyanophyceae, brackish species mainly to Bacillariophyceae, and marine species mainly to Bacillariophyceae and Dinophyceae (Kilham & Mavuti, 1990). Chindah & Pudo (1991) found similar results during their research on algal communities in the estuary of the Bonny river in Nigeria, where Bacillariophyta constituted more than 50% of fresh water and brackish species. Euglenophyceae and Chlorophyceae occurred mainly in those parts of the river estuary, were fresh water was predominant. In the Dragonja river estuary, the marine and brackish algae were almost exclusively diatoms as well. In the Dragonja estuary, the following marine species were present: *Achnanthes septata, Amphora angusta, Gyrosigma tenuissimum, G. wansbeckii, Nitzschia longissima* var. *genuina, Pleurosigma strigosum and Enteromorpha* sp., and the following brackish species: *Melosira moniliformis, Denticula subtilis, Navicula duerrenbergiana, N. halophila, N. incertata, N. recens, Pleurosigma salinarum, Nitzschia compressa* var. *compressa, N. granulata, N. lorenziana, N. levidensis* var. *salinarum, N. navicularis, N. sigma* and *Rhopaladia constricta*. Very similar brackish and marine species were found in the estuaries of other rivers around the world (Freese, 1952; Hendey, 1958; Wood, 1968; Kilham & Mavuti, 1990). This indicates a cosmopolitan nature of the majority of the above listed algal species. Diatoms predominated in the estuary of Dragonja river, which is similar to the findings by other authors from rivers' estuaries (Chindah & Pudo, 1991; Kies, 1997).

In all five periphyton and phytoplankton samples taken at sampling site F, the following species were present: *Achnanthes septata, Cocconeis pediculus, Gyrosigma acuminatum, Navicula mutica* var. *mutica* and *Nitzschia frustulum*. *Achnanthes septata* and *Nitzschia frustulum* were the most frequent species.

65 algal taxa recorded for the first time in Slovenia

were determined in the Dragonja river and its affluent Pinjevec (Tab. 2). 13 taxa belonged to Cyanophyceae and 52 to Bacillariophyceae. The highest number of the taxa recorded for the first time (38) was determined in the Dragonja river estuary (sampling site F), belonging mainly to the genus *Nitzschia* (9) and *Navicula* (6). Marine and brackish species were predominant, which did not occur at other sampling sites.

CONCLUSIONS

At the five sampling sites on the Dragonja river (A, C, D, E, F) and at the single site on its tributary Pinjevec (B), the total number of algal taxa was 238. 170 taxa belonged to Bacillariophyceae, 38 to Cyanophyceae, 17 to Chlorophyceae, 7 to Zygnematophyceae, 2 to Florideophyceae, 2 to Dinophyceae, 2 to Chrysophyceae, and 1 to Euglenophyceae. 20 taxa were present at all sampling sites: *Phormidium autumnale*, *P.* sp., *Achnanthes flexella*, *A. minutissima*, *Caloneis alpestris*, *Cymbella affinis*, *C. amphicephala* var. *amphicephala*, *C. microcephala*, *C. silesiaca*, *Diploneis oblongella*, *Eunotia arcus*, *Fragilaria biceps*, *Gomphonema angustatum*, *G. angustum*, *Navicula radiosa*, *N. veneta*, *Nitzschia dissipata*, *N. linearis* var. *linearis*, *N. palea* and *Oedogonium* sp.

Among 238 taxa, 65 were recorded for the very first time in Slovenia. 13 taxa belonged to Cyanophyceae and 52 taxa to Bacillariophyceae. The highest number of the taxa recorded for the first time was determined in the Dragonja estuary. Marine and brackish species, which did not occur at other sampling sites, were predominating. As the algal species composition between sampling sites C, D and E (which differed mainly due to their water currents) did not vary a great deal, it can be concluded that the speed of the water current did not have a significant influence on the composition of the species of algal communities.

ALGE V REKI DRAGONJI

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POVZETEK

V obdobju med letoma 1998 in 2000 smo v različnih letnih časih vzorčevali perifitonske in planktonske alge v reki Dragonji, pritoku Pinjevcu in v brakičnem predelu izliva Dragonje. Namen raziskave je bil ugotoviti vrstno sestavo in relativno abundanco algnih združb na območju, ki je predvideno za regijski krajinski park. Identificirali smo 238 taksonov alg. Prevladovale so kremenaste alge (170 taksonov), sledile so cianobakterije (38 taksonov) in zelene alge (17 taksonov). Druge skupine alg so bile zastopane le s posameznimi predstavniki. Zasledili smo večje število v Sloveniji prvič opaženih taksonov, ki so vezani predvsem na brakični del izliva Dragonje. Med 65 v Sloveniji prvič opaženimi taksoni je 13 taksonov pripadalo skupini cianobakterij in 52 kremenastim algam. Visoko število teh taksonov je posledica neraziskanosti brakičnih algnih združb v Sloveniji. Primerjava združb v različnih predelih reke Dragonje (tolmun, brzica, počasi tekoči predel) ne kaže bistvenih razlik v vrstnem sestavu algnih združb.

Ključne besede: alge, reke, izviri, brakične vode, jugozahodna Slovenija

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