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Taxonomic and Biogeographic Characteristics of Horvath's Rock Lizard (*Lacerta horvathi* MEHELY, 1904, Lacertidae, Reptilia) in Yugoslavia

Taksonomske in biogeografske značilnosti velebitske kuščarice (*Lacerta horvathi* MEHELY, 1904, Lacertidae, Reptilia) v Jugoslaviji

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Taxonomic and Biogeographic Characteristics of Horvath's Rock Lizard *(Lacerta horvathi* MEHELY, 1904, Lacertidae, Reptilia) in Yugoslavia

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ABSTRACT - External morphology of Horvath's rock lizard *(Lacerta horvathi* MEHELY 1904) was examined. Variability was established in the biometric, meristic and qualitative characters, as well as differences between the adult and juvenile animals, males and females and between the samples of animals from the Slovenian and north Dinaric part of the area. New localities were stated and the known area of this species expanded.

IZVLEČEK - TAKSONOMSKE IN BIOGEOGRAFSKE ZNAČILNOSTI VELEBITSKE KUŠČARICE (*LACERTA HORVATHI* MEHELY, 1904, LACERTIDAE, REPTILIA) V JUGOSLAVIJI - Proučevana je zunanja morfologija velebitske kuščarice (*Lacerta horvathi* MEHELY, 1904). Ugotovljena je variabilnost biometrijskih, merističnih in kvalitativnih značilnosti in razlike med starimi in mladimi živalmi, med samci in samicami ter variabilnost med vzorci populacij iz Julijskih Alp in vzorci iz severnodinarske populacije. Ugotovljene so nove lokalitete ter razširjen do sedaj poznani areal te vrste.

Contents

1. Introduction

Although it is known as one of the representatives of the endemic herpetofauna of Yugoslavia, Horvath's rock lizard is one of the poorly investigated species. The newest compilation (BISCHOFF 1984a) points to a lack of biogeographic and taxonomic data. *Lacerta horvathi* is an endemic and relict species ranging throughout the eastern Alps and North Dinarid mountains. RADOVANOVIĆ (1964) considers it a Tertiary relict. The area is of a disjunct type and, as such, typical of the members of the subgenus *Archaeolacerta* in Europe and south-west Asia. At first this species was established only in the regions of Gorski Kotar and Velebit (MEHELY 1904a,b,c,1907a,b,c,1909). Later, KARAMAN (1921) found it in the region of Plitvice. Učka (MERTENS 1937) according to data as yet known, represents an exclave, separated from the main area. BRELIH (1954) was the first to catch Horvath's rock lizard in Slovenia while the first data from the Italian Julian Alps were given by DARSA (1972). The further discovery of new localities in the Carnic Alps in Italy (LAPINI and DOLCE 1983) and Austria (GRILLITSCH and TIEDEMANN, 1986) seems to indicate that the extent of the area has not been fully examined as yet.

The taxonomic status of this species was first discussed by MEHELY (1904 a,c, 1907, 1910) and BOULENGER (1910, 1920). Further descriptions of the species (KNAUER 1905; SCHREIBER 1912; RADOVANOVIĆ 1951; MERTENS and WERMUTH 1960; TORTONESE and LANZA 1968; BRUNO and MAUGERI 1977; ARNOLD and BURTON, 1978; ENGELMANN et al., 1986) are founded mostly on the first one done by MEHELY (1904a). BRELIH (1962) and LAPINI and DOLCE (1983) provide data on the external morphology for a larger number of specimens from the Julian Alps. The results of the Italian authors cause some doubt as to the validity of the diagnostic characters as established so far. The problem of the taxonomic status of this species has recently become more interesting due to the use of more advanced taxonomic methods (BÖHME 1971; ARNOLD 1973; MAYER and TIEDEMANN 1982; LUTZ and MAYER 1985).

This paper has been planned to contribute data on the geographical distribution and taxonomy of Horvath's rock lizard. A larger number of localities within and on the boundaries of the area was visited to collect as many specimens as possible and to complete the data on the distribution. By a complex analysis of a larger number of morphological characters on a hitherto largest animal sample, the constant of occurrences (meaning validity as well) of some diagnostic characters and eventual subspecific differences between the Alpine and the north Dinaric population were to be established, in order to present a description of external morphology of the species.

Taxonomic status of Horvath's rock lizard within the genus *Lacerta*

The taxonomic relationships of significantly varying and often very similar species among the lacertid lizards have not as yet been fully explained. SCHREIBER (1912), RADOVANOVIĆ (1951), BRELIH and DŽUKIĆ (1974) and MERTENS and WERMUTH (1960) consider the genus *Lacerta* monotypic, but already MEHELY (1907a,c, 1909, 1910) divides it, on the ground of the analysis of the external morphological characteristics and scull anatomy, into two groups: a phylogenetic older relict group *Archaeolacertae* (Horvath's rock lizard included) and a phylogenetic younger, more advanced group, *Neolacertae* (today the genus *Podarcis*). Already on the basis of the first description of *L. horvathi* MEHELY (1904a) concluded that this species developed directly from the Mosor rock lizard (*Lacerta mosorensis* KOLOMBATOVIĆ 1886) after migration of a part

of the northern population to the damper and colder northern habitats. The author considers the basic morphologic characteristics of both species as typical of the developing line of *Lacerta saxicola* EVERSMANN, 1834 from the Caucasus mountains (considered an origin species of many of the European species within the genus *Lacerta).* MEHELY (1904a) does not consider the morphological similarities of Horvath's rock lizard and the common wall lizard *(Lacerta muralis* LAURENTI, 1768) as taxonomically significant. BOULENGER (1910, 1920) points out that the high-mountainous relict *Archaeolacertae* are only a variety of the common wall lizard and labels Horvath's rock lizard as *Lacerta muralis* var. *horvathi.* KARAMAN (1939), on the other hand, considers it a valid species, more closely related, however, to the common wall lizard than the group of the endemic Balkan species *Lacerta oxycephala- mosorensis-graeca.* CYREN (1941) states Horvath's rock lizard to be a typical *Archaeolacerta,* which, however, renders it a relatively unique, independent species with no close relation to the others Balkan species. The group *Archaeolacertae* achieves the status of the subgenus *Archaeolacerta* MERTENS, 1921, which has been accepted by most authors (DAREVSKI 1967; TORTONESE and LANZA 1968; ORLOVA and ORLOV 1969; BÖHME 1971; MAYER and TIEDEMANN 1982; LAPINI and DOLCE 1983; LAPINI, 1984; LUTZ and MAYER 1985). KLEMMER (1957) considers this subgenus an artificial one, meaning that these species are of a polyphyletic origin, but being appropriate should be kept on. Some authors even think that a genus *Archaeolacerta* should be taken into consideration (LANZA et all. 1977; GUILLAUME and LANZA 1982). The taxonomic position of some species within the genus *Lacerta* has been interpreted differently. BÖHME (1971), on the ground of the similarity in the spiny epithelium of the hemipenis, included most species of the subgenus *Archaeolacerta* (also Horvath's rock lizard) into the previously established subgenus *Zootoca* WAGLER, 1830, together with the viviparous lizard *Lacerta (Zootoca) vivipara* JACQUIN, 1787. After a complex analysis of a larger number of the taxonomic characters of the European lacertids, ARNOLD (1973) establishes, among others, a *"Lacerta part II"* group which includes the subgenera *Archaeolacerta* and *Zootoca.* He also points out the polyphyletic character of this group and warns that the classification is partly based on ecologically conditioned and therefore unstable characters. The results of the electrophoretic analysis (MAYER and TIEDEMANN 1982; LUTZ and MAYER 1985) point to viviparous lizard's remoteness from the subgenus *Archaeolacerta.* Lizards from the family Lacertidae are characterized by an exeptional stability in chromosome number and morphology (GORMAN 1973; SMET 1981; CAPULA et al. 1982). The most recent taxonomic account of the European lacertids (BÖHME 1984) separates the genus *Podarcis* from the genus *Lacerta,* considering the subgenera within the genus *Lacerta* as follows: *Lacerta sensu stricto, Timon (monotypic with L.(T.) lepida)* and the polyphyletic *Lacerta incertae sedis* (includes all species from the subgenera *Archaeolacerta* and *Zootoca,* i.e. *"Lacerta part II"* group) thus leaving unexplained the status of Horvath's rock lizard, as well as other species within the subgenus *Lacerta inc. sed..*

2. **Acknowledgements**

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3. **Material and methods**

3.1. **Material and study area**

In this paper 208 specimens of Horvath's rock lizard (61 males, 109 females and 38 juvenile animals) have been examined. 123 adult animals were from the Croatian and 47 from the Slovenian part of the study area. For some morphological characters the number of the specimens examined varies because it was not possible to elaborate some of them exactly. The material examined was taken from the following collections:

- Croatian Museum of Natural History, Zagreb (designated as HPM, PAVLETIĆ 1964) - 33 specimens
- Museum of Natural History of Slovenia, Ljubljana (designated as PMS)- 31 specimens
- Museum of Natural History, Vienna (designated as NMW) - 52 specimens
- Institute for Biological Research "Siniša Stanković", Belgrade (Prof. M. Radovanović collection, designated as SS) - 3 specimens
- Institute of Zoology, Faculty of Natural Sciences and Mathematics, Zagreb, designated as ZZ) - 89 specimens.

I collected the material for the collection of the Institute of Zoology in the Julian Alps in Slovenia, Gorski Kotar, northern Velebit and Poštak in Croatia. For finding new localities, my research included also Nanos, Mt.Učka and Plitvice Lakes. I was collecting the material from 1984 - 1987.

The biometrical and some meristic characters of a certain number of specimens from the PMS collection have already been published (BRELIH 1954, 1962; MRŠIĆ 1978). Since the herpetological literature does not precisely state the standards of some of the characters (differences exist in the way of measuring some of the body dimensions or numbering the scales of pileus and pholidosis), the same specimens were re-examined. In that way some of the errors were corrected while the meristic characters were measured in the same way with all animals.

The material analysed was gathered from 44 localities, with collection notes ZZ, HPM, PMS and SS (Tab. 6. and Fig. 7.). The ordinal numbers of the localities on Table 6. correspond to those in the Figure 7. and the localities are arranged in a NW-SE direction. When owing to an insufficient data precision the exact UTM note could not be established, two neighbouring quadrants were labeled - so that the locality can be determined with certainty.

3.2. **Methods**

In this paper 37 morphologic characters were elaborated. The ordinal numbers of the characters, figures (except Figs.1.and 2.) and tables are identical throughout the text. The characters are grouped according to the statistical methods (SOKAL and ROHLF, 1973, 1981) in the following way:

I. **Biometrical characters**

Head and body dimensions were established according to TERENTJEV and ČERNOV (1949) and DAREVSKI (1967) (Figs. 1. and 2.):

1. Total length of the specimens (statistically noted only in animals with an undamaged and unregenerated tail)
2. Head- and trunk length (measured from the snout tip to the rear anal scale margin)
3. Tail length (measured from the rear anal scale margin to the tip of the tail, statistically noted only as in 1.)
4. Head length (measured from the snout tip to the rear margin of the ear opening)
5. Head width (measured in the widest head part)
6. Pileus length (measured from the tip of the snout to the rear margin of the occipital scale)
7. Pileus width (measured between the outward margins of the parietal scales on its widest part).

All measurements have been noted in milimeters and done on prepared animals.

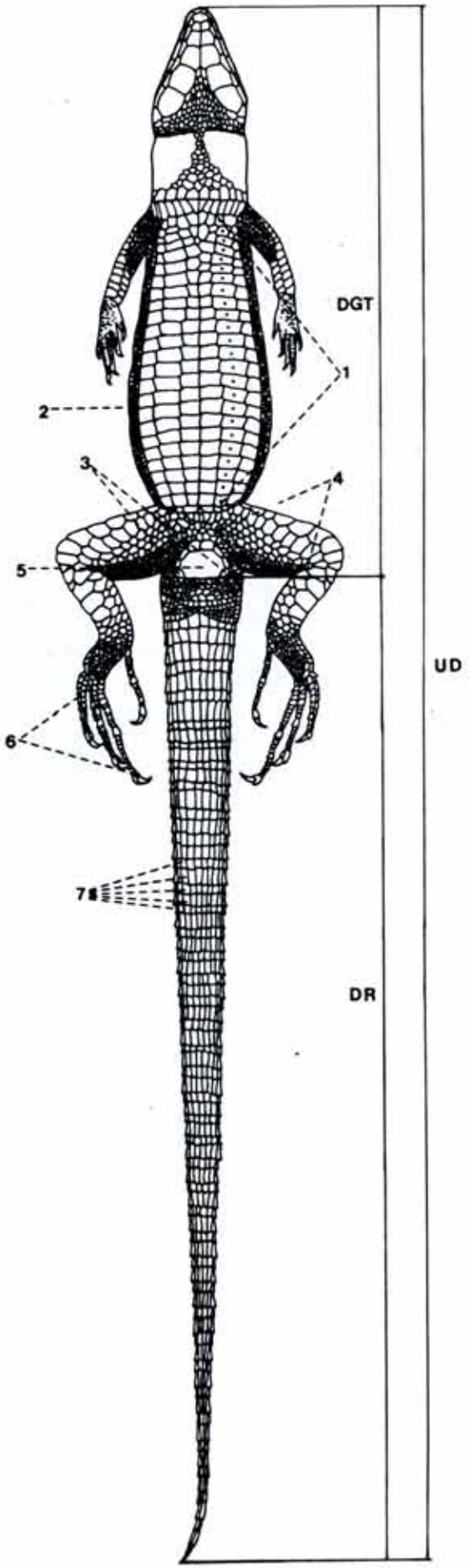
II. **Meristic characters**

Meristic characters referring to the number of pileus and pholidosis scales (Figs. 1. and 2.), were elaborated according to DAREVSKI (1967):

8. Number of supraciliar scales (supraciliaria, left and right)
9. Number of supraciliar granules (granulae supraciliariae, left and right)
10. Number of postocular scales (postocularia, left and right)
11. Number of temporal scales (temporalia, left and right)
12. Number of supratemporal scales (supratemporalia, left and right)
13. Number of upper labial scales (supralabialia, left and right)
14. Number of lower labial scales (sublabialia, left and right)
15. Number of chin shields (submaxillaria, left and right)
16. Number of collar shields (collare)
17. Number of guttural scales in the vertical order (gularia)
18. Number of ventral scales from the collar to the preanal scales in the vertical order (ventralia)
19. Number of dorsal scales in one horizontal order (dorsalia, counting from the left to right side of the ventral scales) in the trunk middle (in the spot reached by the longest toe of the front leg turned back and attached to the trunk)
20. Number of preanal scales (praeanalia)
21. Number of femoral pores (porii femorales , left and right)
22. Number of subdigital lamelles of the fourth rear leg finger (left and right).

Figure 1. Horvath's rock lizard (ventral view):

DGT – head – and trunk length
DR – tail-length
UD – total length of the specimens
1 – ventral scales
2 – dorsal scales
3 – praeanals scales
4 – femoral pores
5 – anal scale
6 – subdigital lamellas of the 4th rear leg finger
7 – rings of caudal scales



III. **Appearance and relation between the scales of pileus and pholidosis (qualitative characters)**

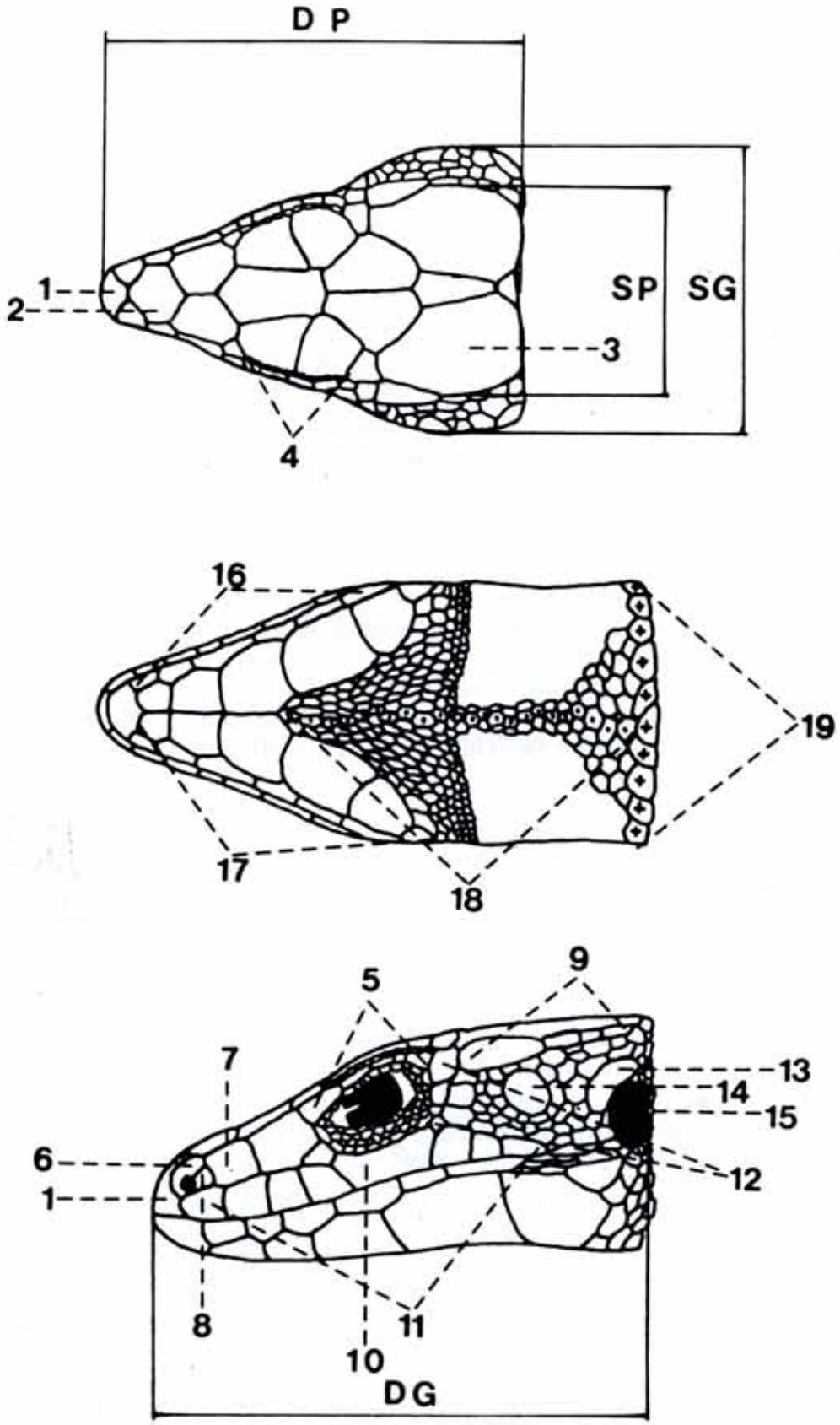
If the appearance or relation between the scales was found typical of Horvath's rock lizard (i.e. if corresponding to the data from the literature), it is labeled as "1", while the atypical ones as "0".

23. The supranasal scale touches the frenal scale ("1") or the postnasal scale touches the internasal scale ("0"), noted for the left and the right side of the head
24. The rostral scale touches the internasal scale ("1") or not ("0")
25. There exists one ("1") or two ("0") of the postnasal scales, noted for the left and the right side of the head
26. There exists one ("1") or two ("0") of the frenal scales (left and right)
27. The row of the supraciliary granules is unbroken ("1") or broken ("0")(left and right)
28. The first (upper) postocular scale touches ("1") or does not touch ("0") the parietal scale
29. The first supratemporal scale is distinctly larger than the rest in the row ("1") or not ("0"), (recorded for the left and right side of the head.)
30. The upper labial scales are typical ("1", i.e. there are four scales in front and three behind the subocular scale) or atypical arrangement ("0"), noted for the left and the right side of the head
31. The rear collar margin is smooth ("1") or slightly serrated ("0")
32. The dorsal scales are completely smooth (or flat) ("1") or slightly keeled ("0")
33. Two middle praeanal scales are enlarged ("1") or all praeanal scales are of the same size ("0")
34. On the unregenerated and undamaged tail wide whorls of caudal scales alternate with narrow ones ("1") or do not vary in width ("0")

Figure 2. Typical appearance of the pileus of Horvath's rock lizard (from above, from below and from left side)

DP – pileus-length
ŠP – pileus-width
DG – head-length
ŠG – head-width

1 – rostral scale
2 – internasal scale
3 – parietal scale
4 – supraciliar granules
5 – supraciliar scales
6 – supranasal scale
7 – frenal scale
8 – postnasal scale
9 – supratemporal scales
10 – subocular scale
11 – upper labial scales
12 – postocular scales
13 – tympanal scale
14 – massetericum
15 – ear opening
16 – lower labial scales
17 – chin shields
18 – guttural scales
19 – collar scales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35. The massetericum size: The size of the scale massetericum was ranged into categories from 1-4:

1 - massetericum does not vary in size from the temporal scales
2 - massetericum is small, scarcely revealed
3 - massetericum is prominent
4 - massetericum is markedly large

IV. **Colour and pattern**

The colour categories of each individual was established on a scale ranging from 1 - 6 (colour and pattern on the back) and from 1 - 3 (colour and pattern of the throat and belly), respectively. The scale range as well as the description of individual categories, was determined after the first survey of all specimens.

36. Head and back colouring and pattern (range 1 - 6):

1 - no dark spots or very few among the temporal stripes
2 - a small number of dark spots and a marked dark occipital line along the middle of the back, among the temporal stripes
3 - a medium number of dark spots with a marked dark occipital line
4 - a medium number of dark spots without a marked occipital line
5 - a large number of dark spots with a marked dark occipital line
6 - a large number of dark spots which join together in large irregular hues, the occipital line is scarcely marked or not visible at all, markedly colourful

37. Throat and belly colouring and pattern (range 1 - 3):

1 - very few (or no) dark spots on the sides of the throat and belly
2 - on the throat and belly a small number of dark spots appears on the sides (typical of Horvath's rock lizard)
3 - many dark spots on the sides of the throat and belly

3.2.1. **Statistical data elaboration**

The characters of the following samples were compared by statistical methods (SOKAL and ROHLF 1973, 1981; PETZ 1985):

1. adult animals - juvenile animals (only for meristic and qualitative characters)
2. adult males - adult females (for all characters)
3. sample from Croatia - sample from Slovenia (for all characters)

Quantitative characters (i.e. biometric and meristic) are described primarily by basic parameters of descriptive statistics: arithmetic mean ($\bar{X}$), standard deviation (S), variance (VAR or S^2), and minimal and maximal value.

The differences between the arithmetic means for the examined samples were tested by the t-test for little independent samples (SOKAL and ROHLF 1973, 1981; PETZ 1985) with the significance level of 5% ($p < 0.05$). The significance differences between the variances were previously tested by the F-test, and in some cases the Cochran-Cox correction (approximative method) was used (PETZ 1985).

The allotment of a typical and atypical label to the qualitative characters was expressed in percent. The statistical significance in the share of typical towards atypical marks of the character between samples was tested by the X^2-test. The so-called Yates-correction

(PETZ 1985) was used. The statistical significance of the differences amounted to 5% ($p < 0.05$).

The share of individual categories of the colouring and pattern, as well as the size of the massetericum was expresed in percent.

4. Results

4.1. External morphology

4.1.1. Biometric characters

The body dimensions were measured on 126 adult animals, 90 of which were females and 36 males. 86 animals were from the Croatian and 40 from the Slovenian area (Tab. 1., Fig. 3.). The total body length of all specimens measured was 164.18 mm (from 143.0-190.0 mm) on the average, the length of the head and the body 59.67 mm (50.0-70.5 mm), and the length of the unregenerated tail 105.61 mm (90.5-128.5 mm). The average dimensions of the head and the pileus are: head length 12.87 mm (11.02-14.96 mm), head width 8.80 mm (6.39-10.74 mm), pileus length 12.14 mm (10.34-14.14 mm), and pileus width 6.12 mm (5.17-7.21 mm).

The total length of females ($\bar{X} = 163.73$ mm, from 143.0-190.0 mm) is less than the total length of males ($\bar{X} = 165.78$ mm, from 151.0-175.0 mm), but this difference is not statistically significant ($t = 0.46$, $p < 0.05$). Females, however, have longer heads and bodies ($\bar{X} = 60.83$ mm, from 50.0- 70.5 mm) than males ($\bar{X} = 56.76$ mm, from 51.5-64.0 mm), and that is statistically significant ($t = 5.65$ at $p < 0.05$). The tail length of females ($\bar{X} = 104.48$ mm, from 90.5-128.5 mm) is lesser than that of males ($\bar{X} = 109.69$ mm, from 94.0-116.5 mm), but this difference is not significant ($t = 1.58$, $p < 0.05$).

The results indicate that males have a larger and wider head and pileus than females. The average head length of males is $\bar{X} = 13.465$ mm (from 12.51-14.96 mm) and that of females is $\bar{X} = 12.64$ mm (from 11.02-14.28 mm), this difference being statistically significant ($t = 5.92$, $p < 0.05$). Statistically the head width of males ($\bar{X} = 9.29$ mm, from 7.89-10.74 mm) is considerably larger ($t = 5.38$, $p < 0.05$) than the head width of females ($\bar{X} = 8.60$ mm, from 6.39-9.79 mm). The pileus of males ($\bar{X} = 12.75$ mm, from 11.56-14.14 mm) is also significantly longer ($t = 6.35$, $p < 0.05$) than that of females ($\bar{X} = 11.90$ mm, from 10.34-13.46 mm), the same as the pileus width ($t = 5.26$, $p < 0.05$) of males ($\bar{X} = 6.41$ mm, from 5.71-7.21 mm) in relation to that of females ($\bar{X} = 6.00$ mm, from 5.17-6.80 mm).

The results show especially important differences in the biometrical characters between the specimens from Croatia and those from Slovenia. The average total length of animals from Croatia is $\bar{X} = 166.71$ mm (from 150.0-190.0 mm), and of those from Slovenia $\bar{X} = 159.13$ mm (from 143.0-175.0 mm), and this difference is statistically significant ($t = 2.06$, $p < 0.05$), as well as the difference in the length of the head and body (Croatia: $\bar{X} = 61.13$ mm, from 54.5-70.5 mm; Slovenia: $\bar{X} = 56.52$ mm, from 50.0-65.5 mm; $t = 5.84$, $p < 0.05$), while differences in the tail length (Croatia: $\bar{X} = 106.78$ mm, from 94.0-128.5 mm); Slovenia: $\bar{X} = 103.17$ mm, from 90.5-116.5 mm) reveal no statistical significance ($t = 1.23$, $p < 0.05$).

The animals from Croatia have larger dimensions of the heads and pilei than those from Slovenia. The average head length of animals from Croatia is $\bar{X} = 13.06$ mm (from

Table 1. Biometric characters of Horvath's rock lizard

$\bar{X}$ – arithmetic mean	U. D. – total length
S – standard deviation	D. GLT – head – and trunk lenght
VAR – variance	D. R. – tail length
MIN – minimal value	D. GL. – head length
MAX – maximal value	Š. GL. – head width
(all values are presented in mm)	D. PIL. – pileus length
	Š. PIL. – pileus width

a) ALL ADULT SPECIMENS (N= 127)

	$\bar{X}$	S	VAR	MIN	MAX
U. D.	164.18	11.01	121.25	143.00	190.00
D. GLT.	59.67	4.65	21.60	50.00	70.50
D. R.	105.61	8.51	72.35	90.50	128.50
D. GL.	12.87	0.80	0.63	11.02	14.96
Š. GL.	8.80	0.69	0.48	6.39	10.74
D. PIL.	12.14	0.78	0.61	10.34	14.14
Š. PIL.	6.12	0.40	0.16	5.17	7.21

b) FEMALES (N = 90)

	$\bar{X}$	S	VAR	MIN	MAX
U. D.	163.73	11.74	137.94	143.00	190.00
D. GLT.	60.83	4.63	21.48	50.00	70.50
D. R.	104.48	8.53	72.84	90.50	128.50
D. GL.	12.64	0.72	0.52	11.02	14.28
Š. GL.	8.64	0.64	0.41	6.39	9.79
D. PIL.	11.90	0.68	0.47	10.34	13.46
Š. PIL.	6.00	0.35	0.12	5.17	6.80

c) MALES (N = 36)

	$\bar{X}$	S	VAR	MIN	MAX
U. D.	165.75	7.73	59.69	151.00	175.00
D. GLT.	56.76	3.18	10.09	51.50	64.00
D. R.	109.69	7.03	49.37	94.00	116.50
D. GL.	13.46	0.66	0.43	12.51	14.96
Š. GL.	9.29	0.57	0.33	7.89	10.74
D. PIL.	12.75	0.66	0.44	11.56	14.14
Š. PIL.	6.41	0.39	0.15	5.71	7.21

d) CROATIAN SAMPLE (N = 86)

	$\bar{X}$	S	VAR	MIN	MAX
U. D.	166.71	10.95	119.83	150.00	190.00
D. GLT.	61.13	4.23	17.93	54.50	70.50
D. R.	106.78	8.63	74.56	94.00	128.50
D. GL.	13.06	0.75	0.56	11.15	14.96
Š. GL.	8.95	0.65	0.43	6.39	10.34
D. PIL.	12.31	0.75	0.56	10.88	14.14
Š. PIL.	6.21	0.39	0.16	5.17	7.21

continued

e) SLOVENIAN SAMPLE (N = 40)

	$\bar{X}$	S	VAR	MIN	MAX
U. D.	159.13	9.26	85.76	143.00	175.00
D. GLT.	56.52	3.87	15.01	50.00	65.50
D. R.	103.17	7.68	58.93	90.50	116.50
D. GL.	12.80	0.54	0.29	11.02	14.01
Š. GL.	8.71	0.56	0.32	7.21	10.74
D. PIL.	12.08	0.54	0.29	10.34	13.19
Š. PIL.	6.07	0.28	0.08	5.17	6.80

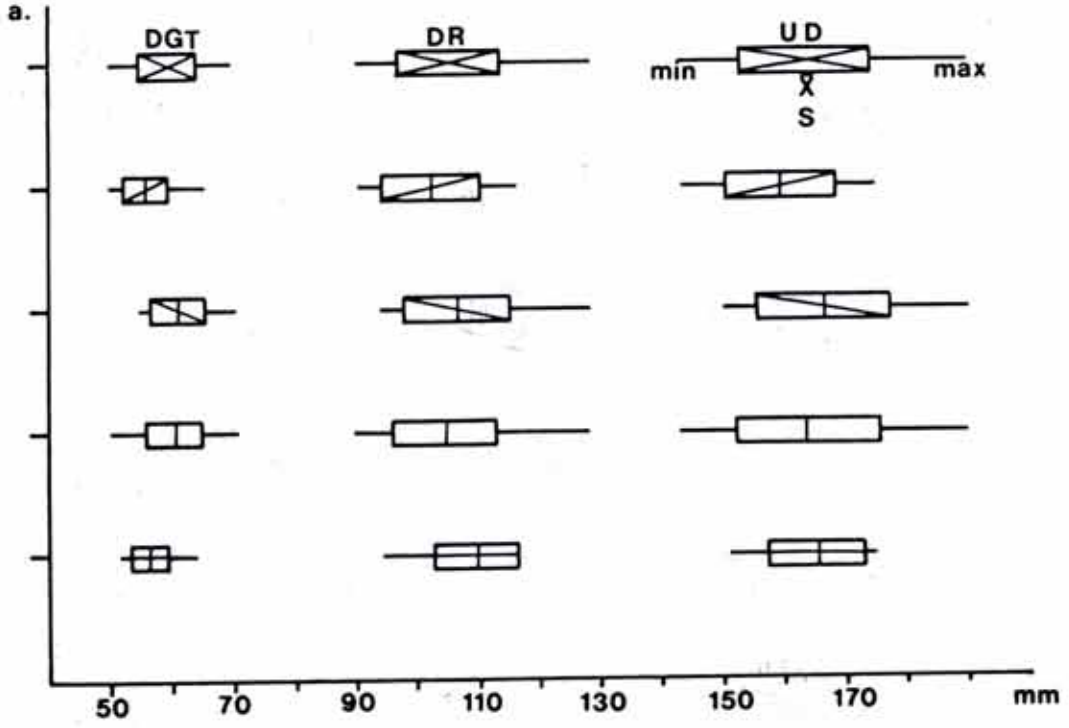
11.15-14.96 mm), while that of animals from Slovenia $\bar{X} = 12.80$ mm (from 11.02-14.01 mm). The difference is on the limit of statistical significance ($t = 1.97$, $p < 0.05$), i.e. it is significant when using Cochran-Cox's correction ($t = 3.44$). The difference in the head width shows statistical significance ($\bar{X}_{Croat.} = 8.95$ mm, from 6.39-10.34m; $\bar{X}_{Slov.} = 8.71$ mm, from 7.21-10.74 mm; $t = 2.00$, $p < 0.05$). Differences in the pileus length ($\bar{X}_{Croat.} = 12.31$ mm, from 10.88-14.14 mm; $\bar{X}_{Slov.} = 12.08$ mm, from 10.34-13.19 mm) show no statistical significance ($t = 1.75$) at the importance level of $p < 0.05$, but only at $p < 0.10$ and when using Cochran-Cox's correction ($t = 3.04$). The pileus width ($\bar{X}_{Croat.} = 6.21$ mm, from 5.17-7.21 mm, $\bar{X}_{Slov.} = 6.07$ mm, from 5.17-6.80 mm) is statistically of a significant difference ($t = 1.99$, $p < 0.05$).

4.1.2. **Meristic characters - numbers of scales of the pileus and the pholidosis**

Meristic characters of the pileus and the pholidosis were examined in 208 animals, i.e. 61 males, 109 females and 38 juvenile animals. 123 adult animals were from the Croatian and 47 adult animals from the Slovenian part of the area (Tab. 2.).

The number of supraciliaria for all animals examined was between 2-8, with the mean value of 5.62, while the average number of granulae supraciliariae was 9.48, ranging from 3-16. Behind the eye there were from 2 to 6 postocularia, the average amounting to 3.68. In the temporal region of the head, the number of temporal scales (temporalia) varied greatly between 13 and 70, the mean value being 31.50, while the number of upper temporal scales (supratemporalia) was 3.44 on the average, ranging from 1-7. The number of upper labial scales (supralabialia) ranged from 3-6, the mean value being 4.07, and that of lower labial scales (sublabialia) from 3-9, the mean value being 6.07. The number of submaxillary scales (submaxillaria) is the most stable meristic character - in all animals 6 scales were found both on the left and the right side. The number of the scales in the collar (collare) ranged from 6-14, with the mean value of 9.73, while the number of guttural scales (gularia) in the longitudinal row ranged from 19-30 with the mean value of 24.54. The average number of ventral scales (ventralia) in the longitudinal row was 24.66 (from 21-28) and that of the dorsal scales (dorsalia) in the cross row 43.91, ranging higher from 39-51. The number of anal scales (praeanalia) ranged from 6-11, its mean value amounting to 8.27. The number of femoral pores (porii femorales) on the rear legs varied from 14-36, its mean value being 18.67, while the number of subdigital lamellas of the fourth finger varied from 23-33, its mean value being 26.89.

For most meristic characters of the pileus and the pholidosis no statistically significant differences between males and females were determined. A significant difference was stated for three characters only. The guttural scales were much more numerous in females


a.
DGT
DR
UD
min
max
x̄
S
50
70
90
110
130
150
170
mm

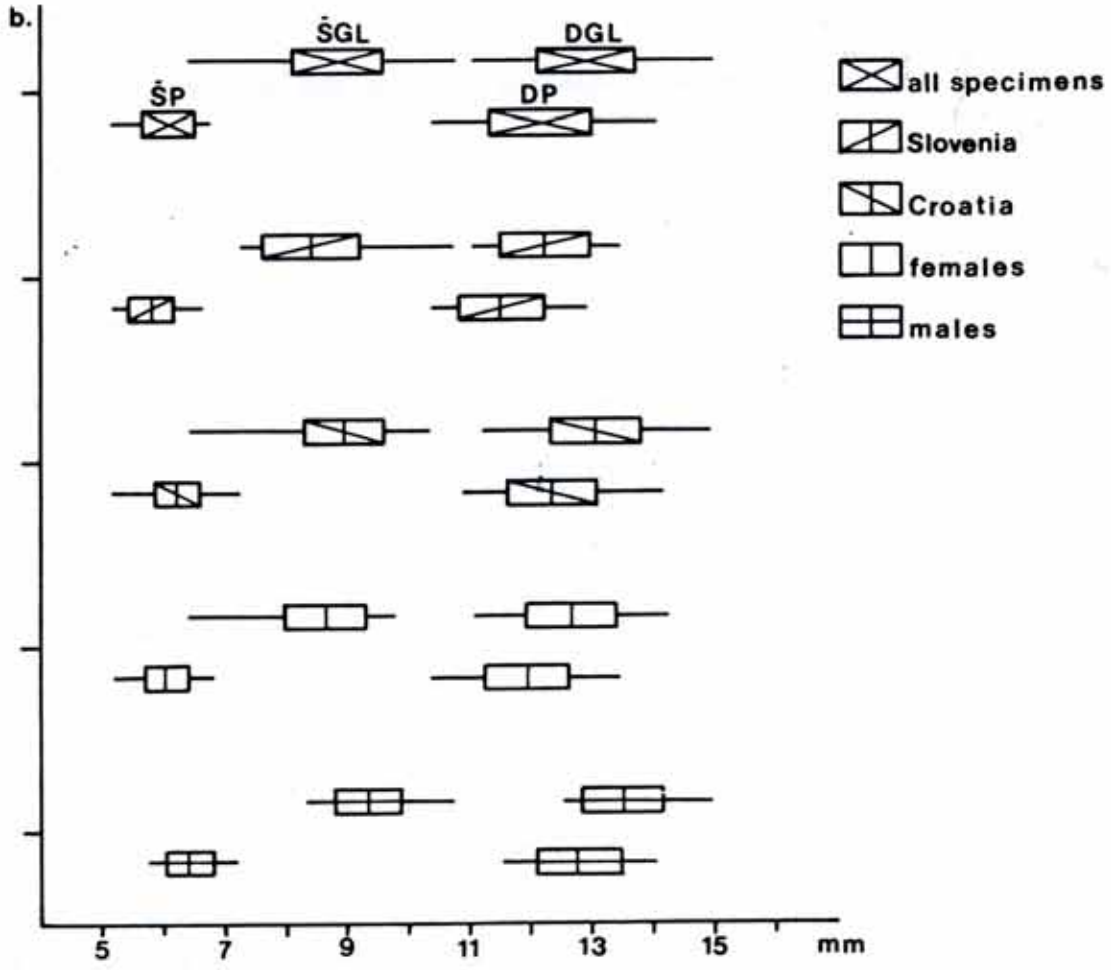

b.
ŠGL
DGL
ŠP
DP
all specimens
Slovenia
Croatia
females
males
5
7
9
11
13
15
mm

Figure 3. Survey of the biometric characters:

a)body dimensions

b)head– and pileus dimensions

DGT – head– and trunk length
DR – tail-length
UD – total length of the specimens
DGL – head-length
ŠGL – head-width
DP – pileus-length
ŠP – pileus-width
$\bar{X}$ – arithmetic mean
S – standard deviation
min.– minimum
max.– maximum

($\bar{X} = 24.74$, 20-30) than males ($\bar{X} = 23.92$, 19-29; $t = 2.31$, $p < 0.05$). The number of ventral scales was also higher in females ($\bar{X} = 25.47$, 23-28) than males ($\bar{X} = 23.21$, 21-26), and the difference in the arithmetic means was statistically significant ($t = 14.61$, $p < 0.05$). By the t-test and using Cochran-Cox's correction ($t = 3.79$, $p < 0.05$) the statistically important difference in number of femoral pores between males ($\bar{X} = 19.26$, 16-36) and females ($\bar{X} = 18.29$, 14-24) was demonstrated.

Adult animals differ significantly from the juvenile ones in 4 meristic characters. Thus, the number of supratemporalia is significantly lower ($t = 3.58$, $p < 0.05$) in adult animals ($\bar{X} = 3.38$), although much more variable (from 1-7). In juvenile animals the arithmetic mean of the number of upper temporals scales is $\bar{X} = 3.74$, with a less wide range from 2-5. The number of supralabialia is, on the average, higher in adults ($\bar{X} = 4.04$, from 3-6) than juveniles ($\bar{X} = 3.96$, from 3-5), this difference being statistically significant ($t = 1.58$, using Cochran-Cox's correction, $p < 0.05$). Statistically significant is that juveniles ($t = 1.51$, using Cochran-Cox's correction, $p < 0.05$) have a higher number of the lower labial scales with the mean value of $\bar{X} = 6.15$, but a lesser range of scales (from 5-7) than adult animals ($\bar{X} = 6.06$, from 3-9). The subdigital lamellas of the fourth finger on a rear leg are more numerous in juvenile ($\bar{X} = 27.38$, from 23-33) than adult animals ($\bar{X} = 26.77$, from 23-31). This difference is also statistically significant ($t = 3.03$, $p < 0.05$).

By comparison of adult animals from Croatia and Slovenia, statistically significant differences were found in 7 meristic characters. The number of supraciliaria is significantly higher ($t = 2.18$, $p < 0.05$) in the animals from Croatia ($\bar{X} = 5.71$, from 2-8) than in those from Slovenia ($\bar{X} = 5.49$) which also show a smaller range of the scale number (from 3-7). On the average, the temporal scales are more numerous ($\bar{X} = 32.0$) and with a wider range (from 13-58) in specimens from the Croatian part of the area that those from Slovenia ($\bar{X} = 29.75$, from 17-46). The difference is significant ($t = 3.02$, using Cochran-Cox's correction, $p < 0.05$). The number of supratemporalia is statistically significantly higher ($t = 3.49$, $p < 0.05$) in the animals from Croatia ($\bar{X} = 3.48$, from 2-7) than the values calculated for the specimens from Slovenia ($\bar{X} = 3.18$, 1-6). The same applies to the supralabialia: $\bar{X}_{Croat.} = 4.07$ (from 3-6), $\bar{X}_{Slov.} = 3.98$ (from 3-5), (Cochran-Cox's correction,

$t = 2.35$, $p < 0.05$). As for the number of scales in the collar, it is higher in the animals from Croatia ($\bar{X} = 9.96$, 7-14) than those from Slovenia ($\bar{X} = 9.30$, 6-1). The difference between the arithmetic means for this meristic character of both samples is statistically significant ($t = 3.55$, $p < 0.05$). By using Cochran-Cox's correction, the significant difference ($t = 1.15$, $p < 0.05$) in the number of femoral pores was demonstrated: $\bar{X}_{Croat.} = 18.70$ (14-36), $\bar{X}_{Slov.} = 18.47$ (15-23). The number of the subdigital lamellas on the fourth finger in the animals from Croatia is higher, too ($\bar{X}_{Croat.} = 26.90$, 23-31, $\bar{X}_{Slov.} = 26.50$, 23-30, $t = 2.28$, $p < 0.05$). Differences between arithmetical means of other meristic characters of the pileus and the pholidosis for specimens from Croatia and Slovenia reveal no statistical significance on the level of 5% ($p < 0.05$).

4.1.3. **Qualitative characters - appearance and relation of the scales of the pileus and the pholidosis**

The qualitative characters of the pileus and the pholidosis were examined in 208 animals, namely, 61 males, 109 females, and 38 juvenile specimens. 123 animals were from the Croatian and 47 animals from the Slovenian part of the area. The results are shown in Table 3 and Figure 4.

A typical relation between the scales supranasale and frenale (i.e. when these scales touch each other) is present in 66.99% cases, while these scales do not touch each other (i.e. they are separated by the postnasal scale) in 33.01%. In 119 animals (57.21%) the relation of these scales is typical on both sides of the head, in 44 animals (21.15%) the scales do not touch on one side of the head, while in as many as 45 animals (21.63%) an atypical relation between the scales supranasale and frenale was found on both sides of the head. The scales rostrale and internasale touch in 99.04% of animals while they are not touching each other in only 0.96% (i.e. in only two animals), which makes this character one of the most stable qualitative characters of the pileus. One postnasale (the typical character) was found in 88.07% of cases, while in 11.93% there were two postnasale. A similar relation was observed also in the scale frenale: one scale (the typical character) was stated in 89.23% of cases and two frenals connected with a postnasale in 10.77% cases. An uninterrupted row of granulae supraciliariae occurs with the frequency of 78.07%, while the frequency of an interrupted row of granules (the atypical character) is 21.93%. The contact between the first (the top) postoculare and parietale is considered a typical characteristic of the pileus in Horvath's rock lizard, but it is present only in 44.26% of cases while in 55.74% these scales do not touch each other, being separated by the supraciliary or upper temporal scales. The first supratemporale is larger than other scales in the row in 94.95% of cases, and only in 5.05% of cases it is of the same size as the others. Its upper edge always protrudes towards the parietal scale. A typical arrangement of the supralabialia (4 scales in front of, and 3 behind the suboculare) is present in 63.94% of cases and an atypical one in 36.06% of cases. A flat rear edge of the collar (collar "smooth") was found in 91.43% of animals and only in 8.57% the collar had a slightly indented ("serrated") edge. The appearance of the scales praeanalia was a typical one (two central scales larger than the others) in 65.38% and atypical in 34.62% of animals. The most stable qualitative characters were the appearance of the dorsalia (flat, ridgeless) which differed from the typical appearance in only 0.96% of the animals examined (i.e. in two animals), and the appearance of the caudalia (the alteration of narrow and wide whorls of the caudal scales): in all animals examined there was no deviation of this character from the typical appearance.

Table 2. Meristic characters of the pileus and the pholidosis

LEGEND: (number of character corresponds with that in 3.2.)
8. supraciliary scales
9. supraciliary granules
10. postocular scales
11. temporal scales
12. supratemporal scales
13. upper labial scales
14. lower labial scales
15. lower maxillar scales
16. collar scales
17. guttural scales
18. ventral scales
19. dorsal scales
20. praeanal scales
21. femoral pores
22. subdigital lamellas

a) ALL SPECIMENS (N = 208)

	$\bar{X}$	S	VAR	MIN	MAX
8.	5.62	0.87	0.76	2	8
9.	9.48	1.82	3.33	3	16
10.	3.68	0.60	0.36	2	6
11.	31.50	7.46	55.71	13	70
12.	3.44	0.77	0.60	1	7
13.	4.03	0.37	0.14	3	6
14.	6.07	0.56	0.31	3	9
15.	6.00	0.00	0.00	6	6
16.	9.73	1.20	1.44	6	14
17.	24.54	2.19	4.72	19	30
18.	24.66	1.47	2.15	21	28
19.	43.91	2.39	5.72	39	51
20.	8.27	1.11	1.23	6	11
21.	18.67	2.06	4.23	14	36
22.	26.89	1.58	2.51	23	33

b) MALES (N = 61)

	$\bar{X}$	S	VAR	MIN	MAX
8.	5.58	0.97	0.94	2	7
9.	9.67	1.84	3.39	4	16
10.	3.72	0.59	0.34	3	6
11.	30.54	6.67	44.50	13	47
12.	3.43	0.92	0.85	2	7
13.	4.07	0.38	0.14	3	5
14.	6.09	0.54	0.30	4	9
15.	6.00	0.00	0.00	6	6
16.	9.81	1.34	1.80	6	14
17.	23.92	2.29	5.24	19	29
18.	23.21	0.96	0.92	21	26.
19.	44.20	2.42	5.86	39	51
20.	19.26	2.49	6.22	16	36
21.	26.86	1.46	2.14	24	30
22.	26.86	1.46	2.14	24	30

continued

c) FEMALES (N = 109)

	$\bar{X}$	S	VAR	MIN	MAX
8.	5.67	0.85	0.72	3	8
9.	9.31	1.83	3.34	3	14
10.	3.68	0.60	0.36	3	5
11.	31.70	7.66	58.68	17	58
12.	3.35	0.66	0.44	1	5
13.	4.03	0.38	0.15	3	6
14.	6.04	0.60	0.36	3	8
15.	6.00	0.00	0.00	6	6
16.	9.73	1.14	1.30	7	12
17.	24.74	2.17	4.70	20	30
18.	25.47	0.97	0.95	23	28
19.	43.72	2.27	5.16	39	50
20.	8.34	1.09	1.18	6	11
21.	18.29	1.65	2.71	14	24
22.	26.73	1.59	2.43	23	31

d) ADULT SPECIMENS (N = 170)

	$\bar{X}$	S	VAR	MIN	MAX
8.	5.64	0.89	0.80	2	8
9.	9.44	1.84	3.39	3	16
10.	3.70	0.59	0.35	3	6
11.	31.29	7.35	53.95	13	58
12.	3.38	0.76	0.58	1	7
13.	4.04	0.38	0.15	3	6
14.	6.06	0.58	0.34	3	9
15.	6.00	0.00	0.00	6	6
16.	9.76	1.22	1.48	6	14
17.	24.45	2.25	5.05	19	30
18.	24.66	1.45	2.11	21	28
19.	43.89	2.34	5.46	39	51
20.	8.23	1.14	1.31	6	11
21.	18.63	2.04	4.15	14	36
22.	26.77	1.53	2.33	23	31

e) JUVENILE SPECIMENS (N = 38)

	$\bar{X}$	S	VAR	MIN	MAX
8.	5.57	0.77	0.54	3	7
9.	9.65	1.73	2.90	6	14
10.	3.58	0.62	0.33	2	5
11.	32.51	7.93	68.51	21	70
12.	3.74	0.75	0.64	2	5
13.	3.96	0.30	0.16	3	5
14.	6.15	0.42	0.19	5	7
15.	6.00	0.00	0.00	6	6
16.	9.61	1.11	1.24	7	11
17.	24.95	1.74	3.02	21	29
18.	24.68	1.52	2.32	22	28
19.	44.03	2.62	6.87	40	51
20.	8.43	0.92	0.84	6	11
21.	18.89	1.96	4.56	14	27
22.	27.38	1.79	2.95	23	33

continued

f) CROATIAN SAMPLE (N = 123)

	$\bar{X}$	S	VAR	MIN	MAX
8.	5.71	0.87	0.75	2	8
9.	9.45	1.95	3.82	3	16
10.	3.69	0.60	0.36	3	6
11.	32.00	7.67	58.58	13	58
12.	3.48	0.75	0.56	2	7
13.	4.07	0.40	0.16	3	6
14.	6.05	0.63	0.30	3	8
15.	6.00	0.00	0.00	6	6
16.	9.96	1.24	1.51	7	14
17.	24.31	2.22	4.94	19	30
18.	24.73	1.53	2.23	21	28
19.	43.76	2.44	5.83	39	51
20.	8.21	1.17	1.33	6	11
21.	18.70	2.19	4.79	14	36
22.	26.90	1.53	2.34	23	31

g) SLOVENIAN SAMPLE (N = 47)

	$\bar{X}$	S	VAR	MIN	MAX
8.	5.49	0.92	0.84	3	7
9.	9.44	1.51	2.28	6	13
10.	3.67	0.57	0.33	3	5
11.	29.75	5.94	35.24	17	46
12.	3.18	0.76	0.58	1	6
13.	3.98	0.30	0.09	3	5
14.	6.06	0.43	0.18	5	9
15.	6.00	0.00	0.00	6	6
16.	9.50	1.05	1.11	6	11
17.	24.88	2.16	4.68	19	29
18.	24.64	1.27	1.62	22	27
19.	44.34	2.04	4.15	40	50
20.	8.31	1.02	1.05	6	11
21.	18.47	1.49	2.23	15	23
22.	26.50	1.44	2.08	23	30

Statistically, no significant differences were determined between males and females by the X^2-test with regard to the frequency of typical and atypical characteristics of any of the qualitative characters studied of the pileus and the pholidosis.

However, statistically significant differences become evident from the frequency of the typical and atypical characteristics between adult and juvenile animals for three qualitative characters. Among adult animals there was a higher number of those with an interrupted row of the supraciliary granules (80.70%) than among juvenile animals (67.12%). This is a statistically significant difference ($X^2 = 5.756$, $p < 0.05$). In a considerably higher number of juvenile animals (78.38% to 64.53%) the scales supranasale and frenale touched ($X^2 = 4.670$, $p < 0.05$). In adult animals the first postocular scale touched the parietal scale in 39.66% of cases only and in juvenile animals in 56,25% of cases. The X^2-test shows that a significant difference is in question ($X^2 = 5.274$, $p < 0.05$).

Between the sample of the north Dinaric population and the one from the Slovenian part of the area statistically significant differences were determined for four qualitative characters. Significant is a higher frequency ($X^2 = 13.491$, $p < 0.05$) of the typically

uninterrupted row of the supraciliary granules in the animals from the Slovenian part of the area (92.86%) than those from Croatia (75.81%). Among specimens from Croatia the frequency of the typical relation between the supranasal and frenal scales was 71.54% and among Slovenian animals only 52.68%. This difference is statistically significant ($X^2 = 11.324$, $p < 0.05$) and especially important since it is one of the main differential characters enabling distinction from the morphologically similar species *Podarcis muralis*. A significant difference exists also in the frequency of the typical and atypical preanal scales ($X^2 = 8.068$, $p < 0.05$). In the sample from Croatia the proportion of the typical characteristics is much higher (72.35%) than in the one from Slovenia (49.09%). Besides, a significantly higher number of animals from Croatia (65.41%) in relation to the Slovenian sample (55.36%) have a typical arrangement of supralabialia ($X^2 = 5.057$, $p < 0.05$). No statistically significant differences were stated for other qualitative characters.

The size of the scale massetericum is ranged into categories from 1-4 (Tab. 5.). Most of the adult animals had a prominent massetericum (the 3rd category - 59.73%), in an equal number of animals the massetericum was either small (2nd category - 15.77%) or markedly large (4th category - 15.10%), while in 9.39% of animals the massetericum did not differ in size from other scales (1st category). No important differences were determined in the size of these scales between males and females. In juvenile animals, when compared with the adult ones, the proportions of the 1st (11.06%) and 2nd (21.88%) categories are higher and that of the 4th category (1.56%) is markedly lower; thus, it can said that the massetericum in juvenile animals is relatively smaller with regard to the surrouding scales than in adult animals. The animals from Slovenia have a markedly higher proportion of the 1st category (16.67%) than the animals from Croatia (7.78%), which applies also to the 2nd category (29.63% in animals from Slovenia to 12.70% in animals from Croatia). In the specimens from Slovenia the proportion of the 3rd (44.44%) and the 4th (9.26%) categories is lower than in specimens from the Croatian part of the area (the 3rd category - 63.93%, the 4th category - 15.57%), showing that by its size the massetericum is relatively smaller than other temporal scales in the animals from Slovenia.

4.1.4. **Colour and pattern**

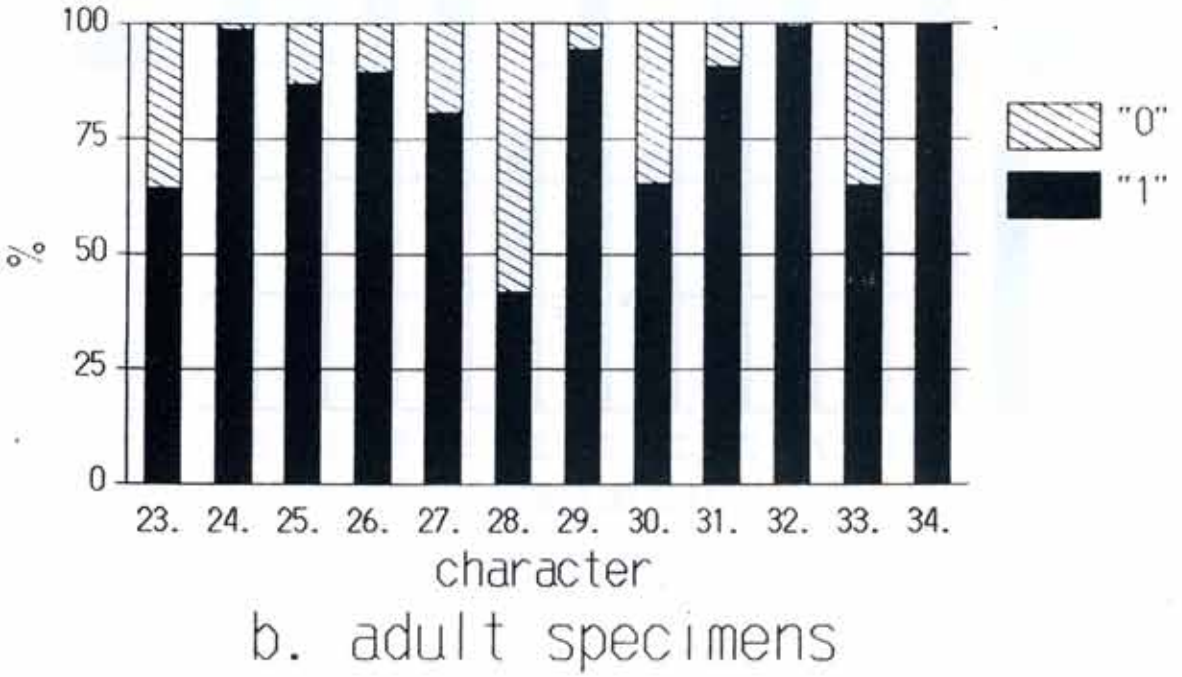
The frequency of particular categories in colour for Horvath's rock lizard (Tab.4.a,b, and Figs. 5. and 6.) was determined for 182 animals, i.e. 53 males, 97 females, and 32 juvenile animals. 123 adult animals belonged to the north Dinaric and 27 to the Slovenian population.

Most adult animals are classified in the 4th category of back colour (29.58%) although the number of animals classified in the 1st category is high, too (27.21%). The proportions of the 2nd and 3rd categories (20.12% and 15.98%, respectively) are somewhat lower, while outstandingly mottled animals are rare: animals without the occipital line in the middle of their back (6th category) represent 2.37% and those with a marked occipital line (5th category) 4.73%. This occipital line is present (in various categories) in 38.47% and absent in 61.52% of animals (Tab. 4a.). All animals examined had, along the entire back, two clearly marked brown temporal stripes which laterally continued into patches on the back and the flanks, and into separate rhombic stains on the tail. The basic colour on the back is light brown (beige) and particularly characteristic is an olive-green reflection noted in most adult animals.

In males the percentage of the 4th category (35.00%) is higher than in females (26.61%), but the percentage of the 1st category is lower (23.3% for males to 29.36% for

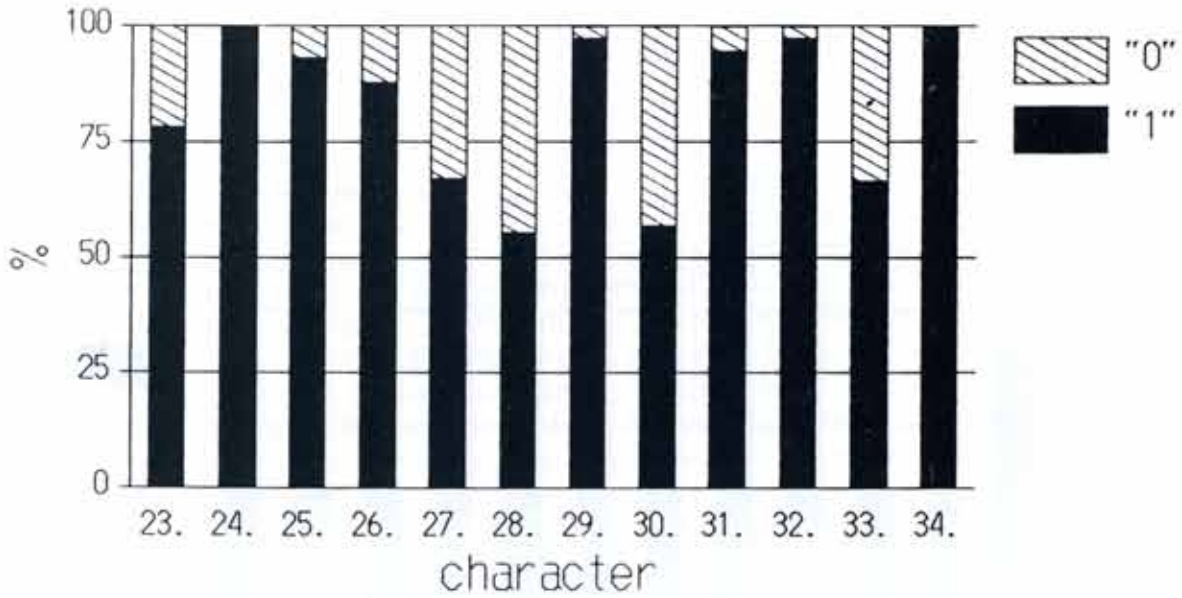
Figure 4.(a-g) Frequencies of the typical ("1") and atypical ("0") signs of the qualitative characters of the pileus and the pholidosis (for ordinal number of the character see Table 3.)

a. all specimens

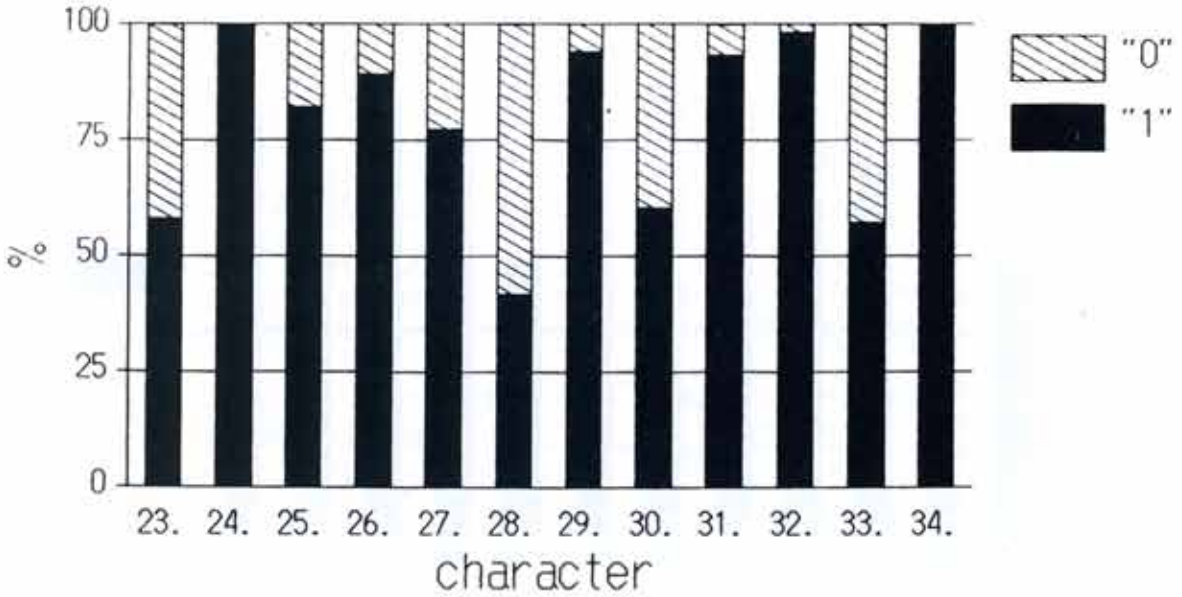


b. adult specimens

continued



c. juvenile specimens



d. males

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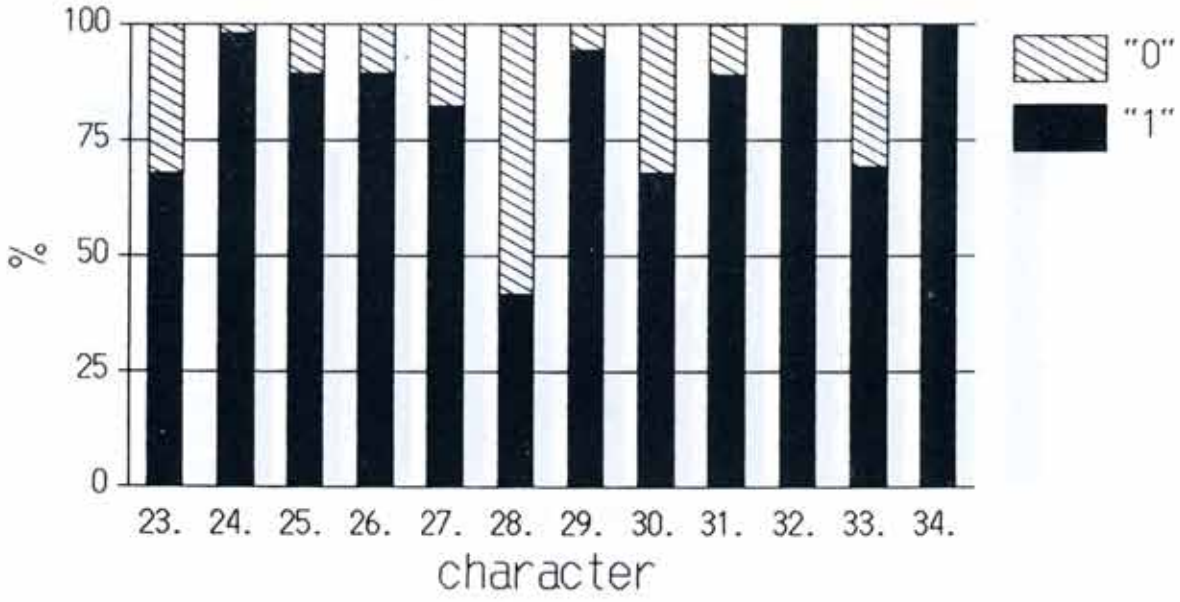
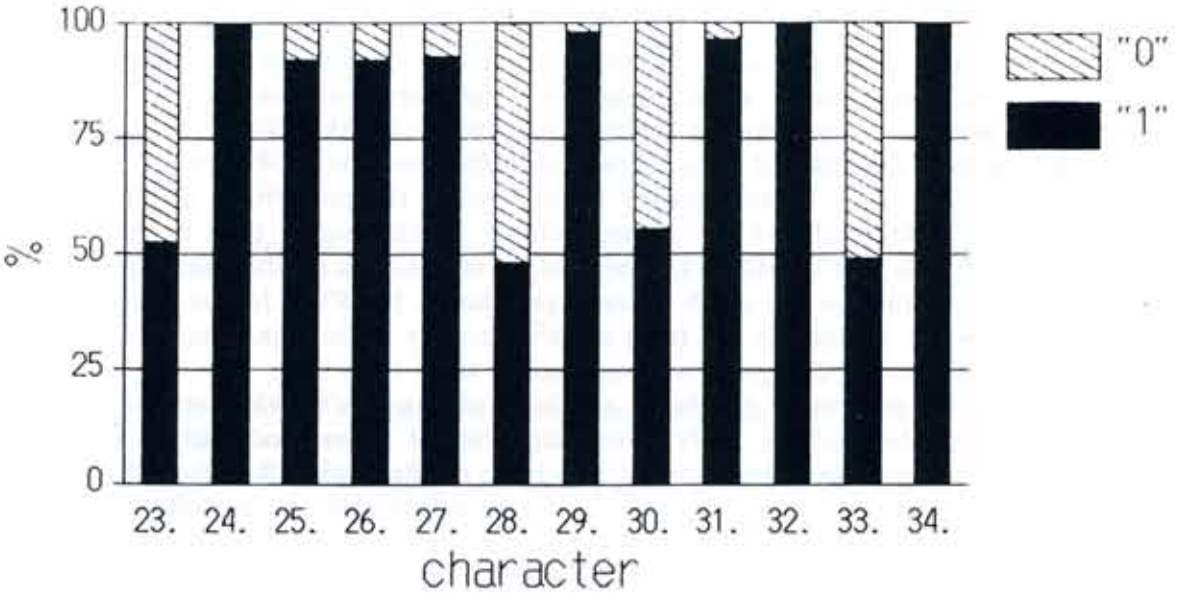
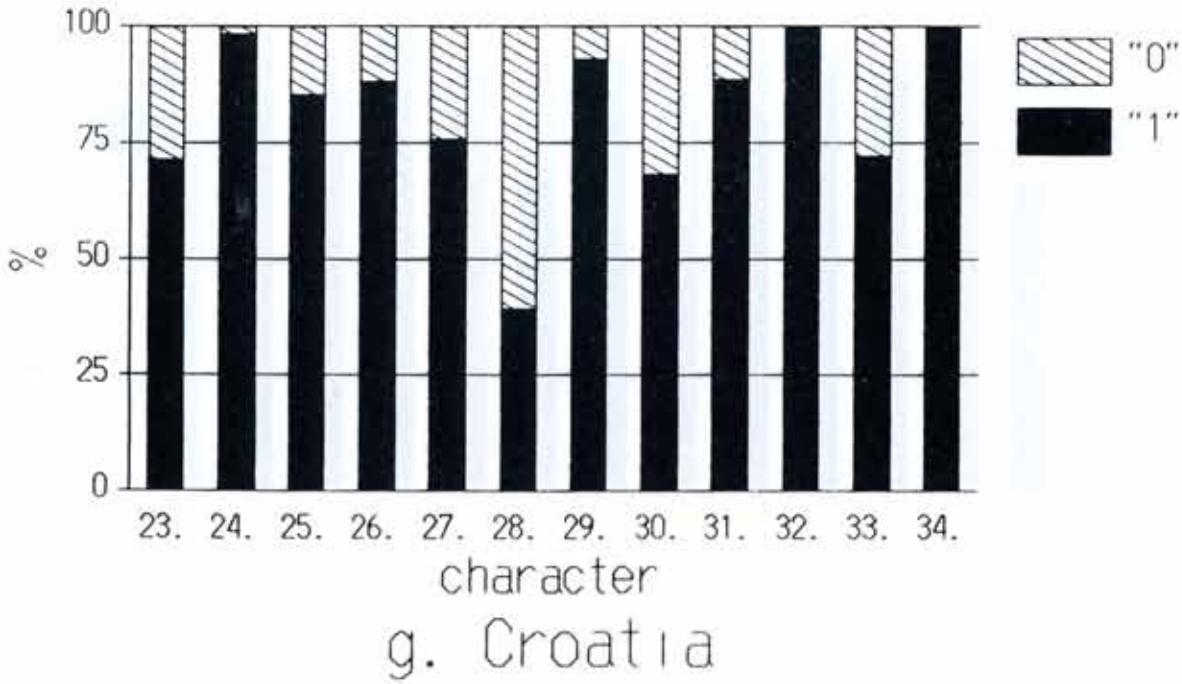


e. females



f. Slovenia

continued



females). A considerably higher number of males (10.00%) than females (1.83%) were very mottled (6th category). None of these highly mottled males had a marked occipital line (5th category), while 3.67% of females were in the said category (Fig. 5b). As evident from the results, the typical juvenile colour and pattern belong to the 1st category, i.e. there are either no dark patches or only a few dark patches on the back of the animal between the temporal stripes, since 82.86% of juvenile animals were in this category. Other categories appear rarely, while categories 5 and 6 are not present at all (Fig. 5a). Furthermore, juvenile animals have a strongly greenish or bluish tail end. In the sample of animals both from Croatia and Slovenia most animals belong to the 4th category (29.75% and 29.17%, respectively). In the animals from Slovenia the percentage of the 2nd and 3rd categories (25.00% and 20.83%, respectively) is slightly higher than in the sample from Croatia (18.18% and 14.04%). The percentage of the most mottled animals (5th and 6th categories) is higher in the north Dinaric population (9.08%). In the sample from Slovenia only 2.08% of animals are from the 6th category while highly mottled animals with the occipital line (5th category) were not noted at all (Fig. 5c.).

The colour and pattern of the throat and belly of Horvath's rock lizard show much less diversity than the back, so only three categories of colour and pattern could be determined. Black spots are rarely present in a large number (13.61%) of adult animals, but when so, they are distributed around the throat edges and on the belly marginally towards the flanks, respectively, on the outer longitudinal rows of the ventral scales. The basic colour of the belly and the throat is very lightly yellowish or greenish. Most animals are classified in the 2nd category with black spots which are not numerous (Tab. 4b.). Only among juvenile animals a somewhat higher number of animals of the 3rd category (25.71%) was noted, i.e. animals with a large number of black spots (Fig. 6a.). With regard to the colour and pattern of the belly and the throat there are no important differences either between males and females or between animals from Croatia and Slovenia (Figs. 6.b. and c.).

Table 3. Frequencies of the typical ("1") and atypical ("0") signs of the qualitative characters of the pileus and the pholidosis

	ALL SPECIMENS		ADULT SPECIMENS		JUV. SPECIMENS		MALES	
no.	(N = 208)		(N = 170)		(N = 38)		(N = 61)	
char.	"1" (%)	"0" (%)	"1" (%)	"0" (%)	"1" (%)	"0" (%)	"1" (%)	"0" (%)
23.	66.99	33.01	64.53	35.47	78.38	21.62	58.20	41.80
24.	99.04	0.96	98.84	1.16	100.00	0.00	100.00	0.00
25.	88.07	11.93	86.96	13.04	93.24	6.76	82.11	17.89
26.	89.23	10.77	89.53	10.47	87.84	12.16	89.34	10.66
27.	78.07	21.93	80.70	19.30	67.12	32.88	77.50	22.50
28.	44.26	55.74	41.86	58.14	55.41	44.59	41.80	58.20
29.	94.95	5.05	94.44	5.56	97.30	2.70	94.17	5.83
30.	63.94	36.06	65.41	34.59	56.94	43.06	60.66	39.34
31.	91.43	8.57	90.75	9.25	94.59	5.41	93.55	6.45
32.	99.04	0.96	99.42	0.58	97.30	2.70	98.36	1.64
33.	65.38	34.62	65.12	34.88	66.67	33.33	57.38	42.62
34.	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00

	FEMALES		CROATIA		SLOVENIA	
no.	(N = 109)		(N = 123)		(N = 47)	
char.	"1" (%)	"0" (%)	"1" (%)	"0" (%)	"1" (%)	"0" (%)
23.	68.02	31.98	71.54	28.45	52.68	47.32
24.	98.20	1.80	98.37	1.62	100.00	0.00
25.	89.64	10.36	85.36	14.63	91.96	8.04
26.	89.64	10.36	88.20	11.80	91.96	8.04
27.	82.43	17.57	75.81	24.18	92.86	7.14
28.	41.89	58.11	39.43	60.56	48.21	51.79
29.	94.59	5.41	93.03	6.96	98.21	1.79
30.	68.02	31.98	68.29	31.71	55.36	44.64
31.	89.19	10.81	88.61	11.38	96.43	3.57
32.	100.00	0.00	100.00	0.00	100.00	0.00
33.	69.37	30.63	72.35	27.64	49.09	50.91
34.	100.00	0.00	100.00	0.00	100.00	0.00

Legend: ordinal numbers of character correspond to those in 3.2.
23. supranasal touches frenal
24. rostrale touches internasale
25. appearance of the postnasal scale
26. appearance of the frenal scale
27. row of the supraciliary granules
28. postocular touches parietal
29. appearance of the first supratemporal
30. appearance of the supralabials
31. rear collar margin
32. appearance of the dorsal scales
33. appearance of the praeanal scales
34. ring of the caudal scales

Table 4. Procentual frequencies of the colour and pattern categories

a) HEAD AND BACK COLOUR AND PATTERN

category	% adult	% males	% females	% Croatia	% Slovenia	% juvenile
1	27.21	23.33	29.36	28.92	22.92	82.86
2	20.12	18.33	21.10	18.18	25.00	8.57
3	15.98	13.33	17.43	14.04	20.83	2.86
4	29.58	35.00	26.61	29.75	29.17	5.71
5	2.37	0.00	3.67	3.30	0.00	0.00
6	4.73	10.00	1.83	5.78	2.08	0.00

b) THROAT AND BELLY COLOUR AND PATTERN

category	% adult	% males	% females	% Croatia	% Slovenia	% juvenile
1	32.54	26.27	35.78	32.23	33.33	31.43
2	53.85	55.00	53.21	52.06	58.33	42.86
3	13.61	18.33	11.01	15.70	8.33	25.71

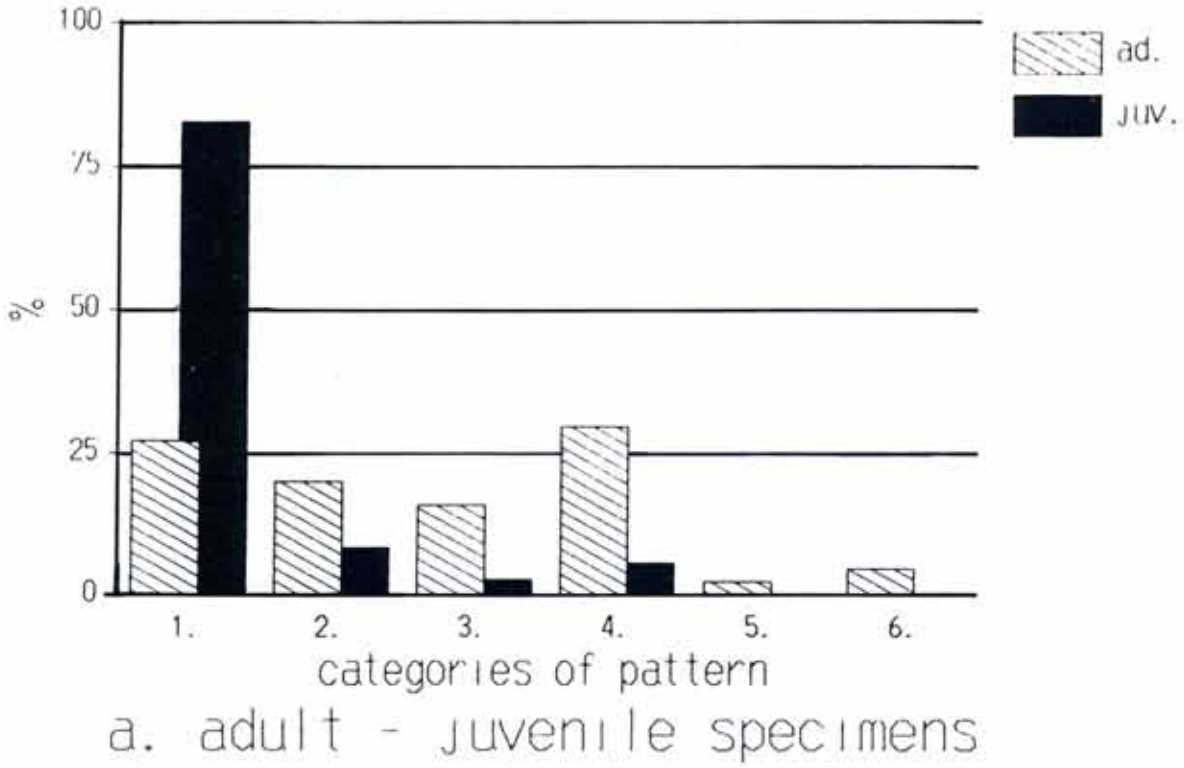
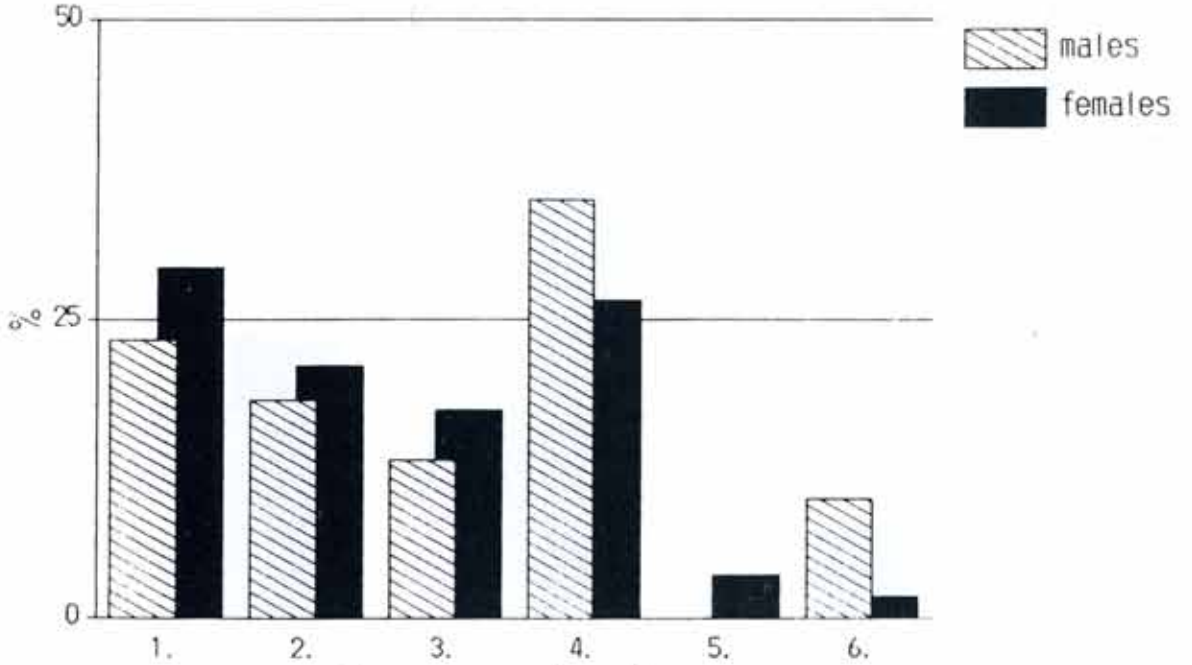


Figure 5. Procentual frequencies of the categories of the dorsal colour and pattern of Horvath's rock lizard

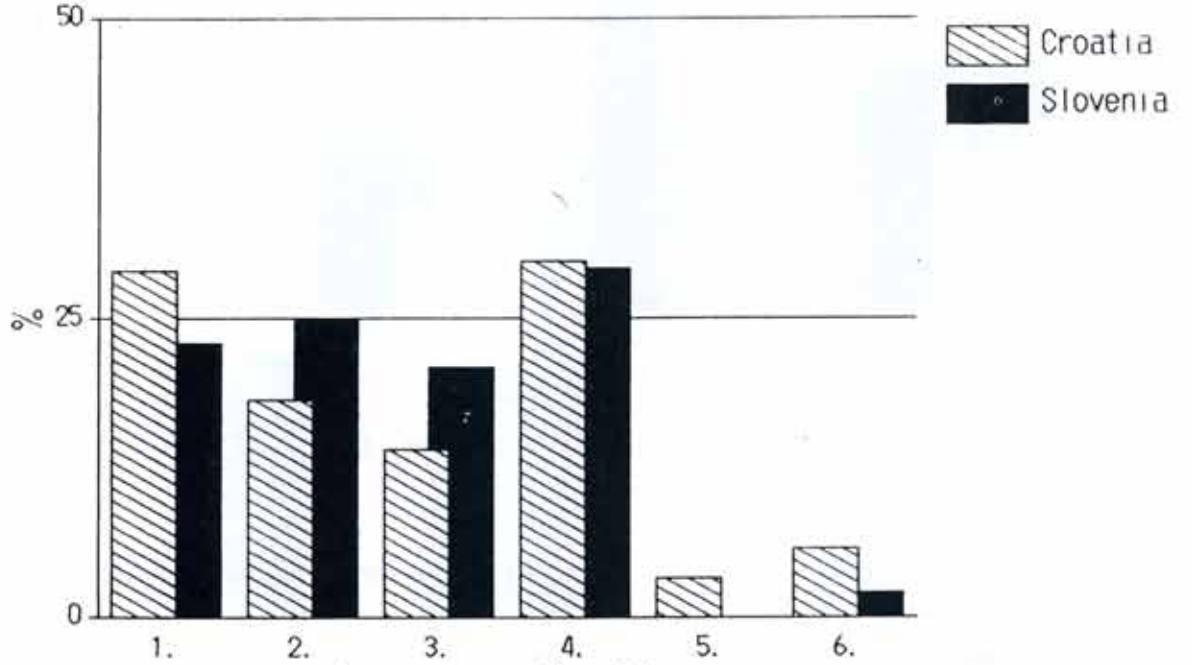
a) relation between adult and juvenile specimens

b) relation between males and females

c) relation between Croatian and Slovenian samples



b. adult specimens (males - females)



c. adult specimens (Croatia - Slovenia)

Table 5. Procentual frequencies of the categories of the masetericum size

category	% adult	% males	% females	% Croatia	% Slovenia	% juvenile
1	9.39	6.73	10.82	7.78	16.67	14.06
2	15.77	19.23	13.92	12.70	29.63	21.88
3	59.73	60.58	59.28	63.93	44.44	62.50
4	15.10	13.46	15.98	15.57	9.26	1.56

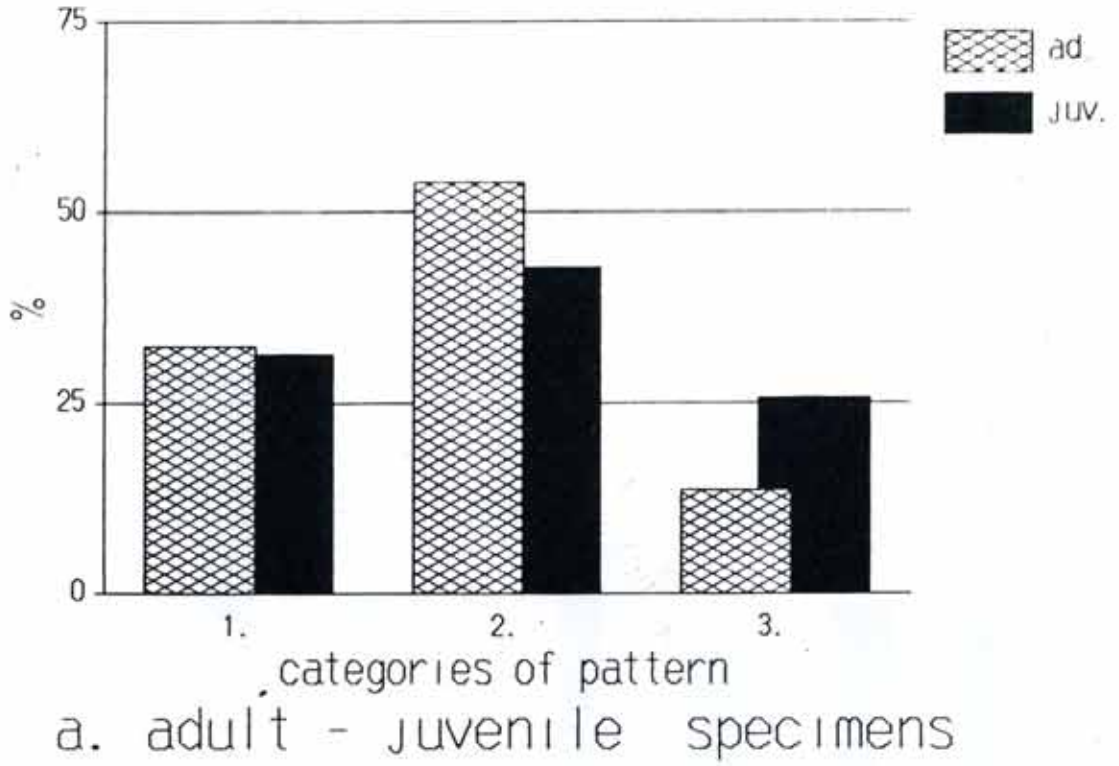
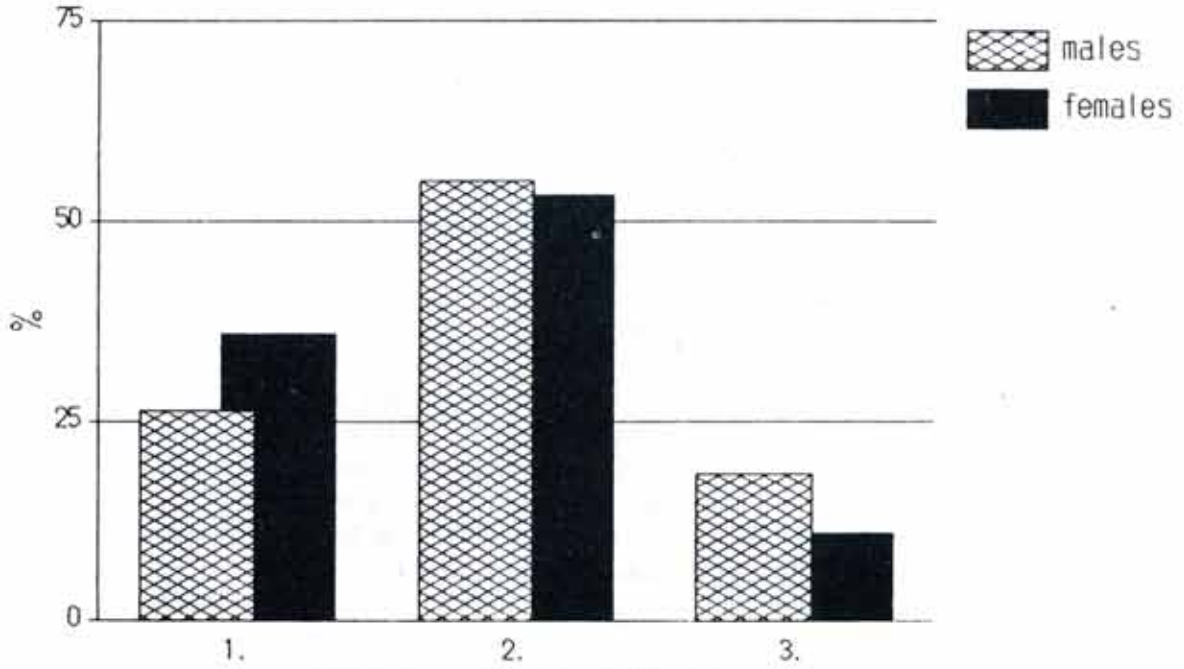


Figure 6. Procentual frequencies of the categories of the ventral colour and pattern of Horvath's rock lizard

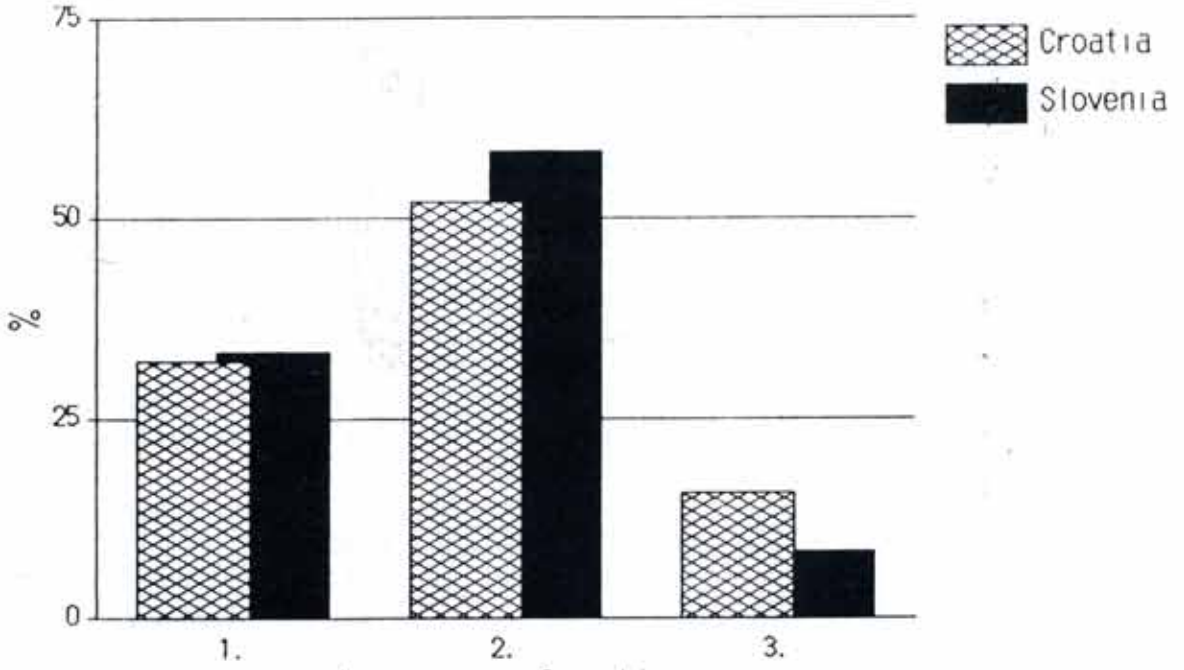
a) relation between adult and juvenile specimens

b) relation between males and females

c) relation between Croatian and Slovenian samples



b: adult specimens (males - females)



c. adult specimens (Croatia - Slovenia)

4.2. **Distribution of Horvath's rock lizard**

Geographical distribution of Horvath's rock lizard is shown in the map (Fig. 7.) while a list of all known localities with UTM marks is given in Table 6. The numbers of localities in the map correspond to those given in Table 6.

In the Julian and Carnic Alps 16 localities are known in the territories of Yugoslavia, Italy and Austria. Farthest in the west is Pierabech in the Carnic Alps in Italy and farthest in the east is Mrzli Studenec in the Julian Alps in Slovenia. Three animals caught in this locality make part of the collection of the HPM. They were collected by P. Postružin in 1932 and incorrectly determined as *Podarcis muralis*. The error occurred because at the time Horvath's rock lizard was not known to be spread in the Alps and also because of an outstanding morphological similarity between these two species. During my own research I found two extremely large populations of Horvath's rock lizard on Kanin and at the roots of Mangart. The southernmost and so far unreported locality in Slovenia is Trnovski gozd (leg. Brelih, collection PMS). This area does not pertain to the Alpine range, being located in Notranjsko and extending together with Nanos and other mountains of Slovenski Kras, towards the westernmost slopes of the mountains in the region of Gorski Kotar. On the mountain of Nanos (1299m above sea level) biotopes are favorable to Horvath's rock lizard, but during the one researching visit paid to this region this species was not found.

I could not determine the position of location No. 19 (Forte delle Chiuse di Plezzo) published in the catalogue of the Museum of Natural History from Udine (LAPINI 1984), so it is presently not clear whether it belongs to the Alpine or Dinaric part of the area.

Učka represents an exclave in the area of Horvath's rock lizard. During my one day tour through the region from the village of Vela Učka to the vicinity of the peak Vojak (1400m above sea level) I saw and caught only specimens of the wall lizard.

In Gorski Kotar Horvath's rock lizard has been found in 7 localities on Risnjak, Kapela and Klek. Risnjak represents the northernmost border of the area in the Dinarids. The new finding on Samarske stijene on Velika Kapela is within this part of the area.

In Croatia Horvath's rock lizard comes as far into the mainland as Plitvice. During my several visits to Plitvice Lakes I could not find the places inhabited by this species.

Most registered findings of *L. horvathi* are on Velebit. During these researches the littoral slope of northern Velebit, i.e. the region around Zavižan and Rožanski Kukovi, was investigated in detail. Another 12 localities within the already known area for this species were determined. Horvath's rock lizard is spread also on the entire central Velebit, as well as southern and south-eastern Velebit. In order to determine the southernmost border of the area I researched the mountain of Poštak extending from south-eastern Velebit and separated from it by the river Zrmanja. One animal was caught on Kučina Kosa (UTM:WJ99), and specimens of Horvath's rock lizard were seen above Ljubina Poljana. Kučina Kosa is so far the southernmost locality in the area of this species determined with certainly.

Based on proper researches, the data from the literature and the examination of collections of the HPM, PMS, SS and NMW, 63 localities were determined. For five of them the geographic position is not determined (No. 19, 58, 59, 62, 63), for four it is not quite precise (No. 5, 24, 27, 56) and for one (No. 61, Šibenik) no supporting material was found either in the collections or in the literature.

The places where Horvath's rock lizard has been found are indicated in 33 UTM squares in the region of the Julian and Carnic Alps, Trnovski Gozd, Učka, Gorski Kotar and Lika, as well as Velebit and Poštak. In the Julian Alps it lives in habitats on 650m

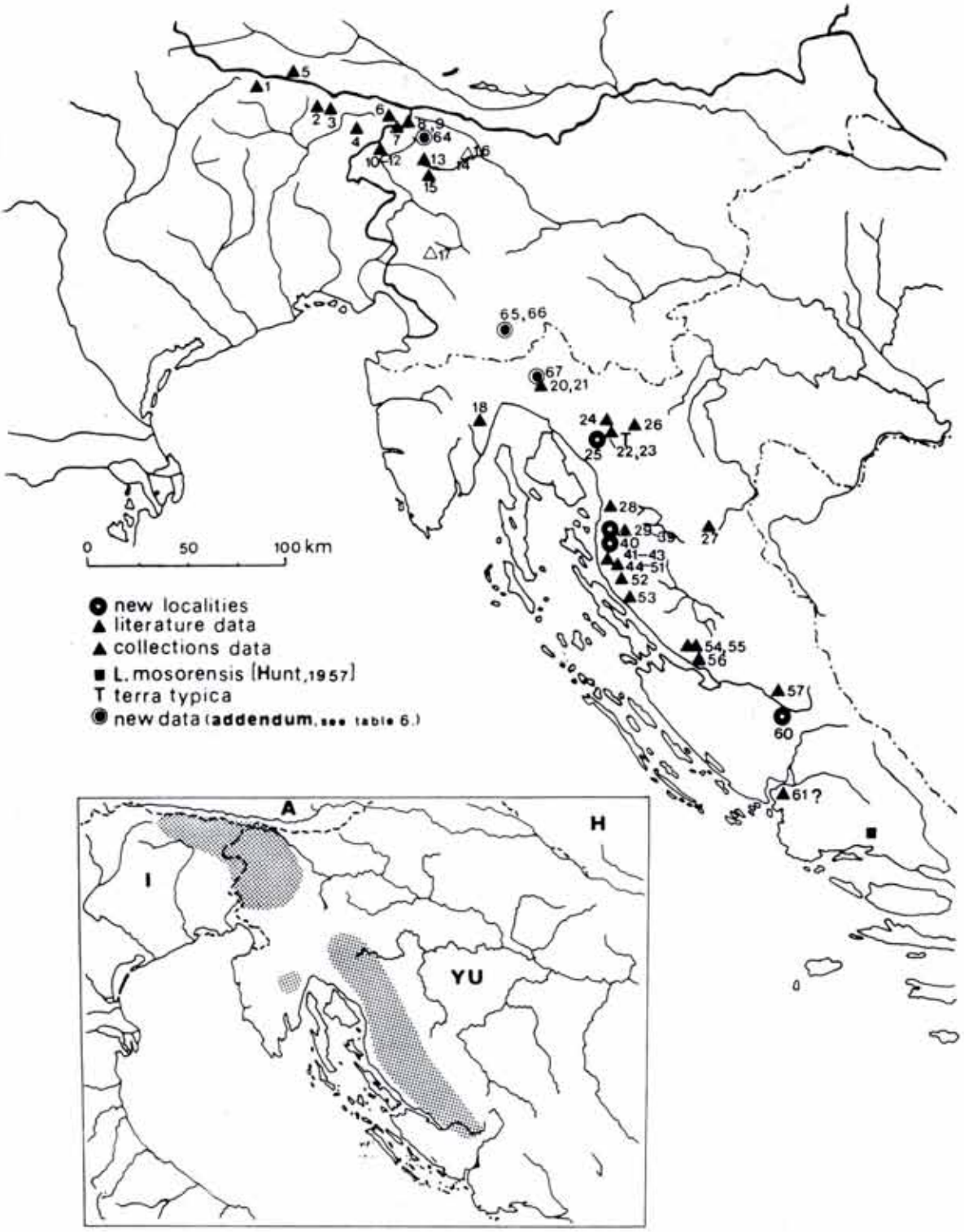


Figure 7. Distribution of Horvath's rock lizard (ordinal numbers of localities in the map correspond to those in Table 6.)

Table 6.: Survey of localities of Horvath's rock lizard according to the literature data, data from the collections and according to my own data

NO. LOCALITIES	Above sea level (m)	UTM	DATA SOURCE
Carnic Alps			
1. Pierabech (Forni Avoltri, Udine)	1100	UM26	Lapini and Dolce (1983)
2. Casera Pizzul (Paularo, Udine)	1500	UM55	Lapini and Dolce (1983)
3. Pontebba (Veneziana)	1000	UM65	Lapini and Dolce (1983)
4. Val Dogna (Dogna, Udine)	1080	UM64	Lapini and Dolce (1983)
5. Hubertuskapelle (Wolayertal, Austria)	1140		Grillitsch and Tiedemann (1986)
Julian Alps			
6. Raibl (Cave de Predil, Tarvisio, Udine)		UM84	Sochurek (1955)
7. Passo di Predil		UM84	NMW, unpublished
8. M. te Mangart	1800–1900	UM94	Darsa (1972)
Mangrt (Strmec)	1094–1160		ZZ
9. M. te Ponza	1650–2000	UM94	Darsa (1972)
10. Kanin (Bovec)	1100	UM83	Brelih (1962), PMS
	650–1050		ZZ
11. Svinjak (above Bovec)	1200	UM83	Brelih (1962)
12. Bala pod Morežom (Bavšica)		UM93	Brelih (1962)
13. Planina pod Skalo (Trenta)	1050	VM03	Brelih (1962), PMS
14. Crno jezero (Dolina Triglavskih jezera)	1340	VM03	Brelih (1954, 1962) PMS
15. Komarča (above Bohinj)	650	VM02	Brelih (1962)
16. Mrzli Studenec (Pokljuka)		VM23	HPM, unpublished
17. Trnovski gozd (Predmeja, Goljaki)	1200–1500	VL19	PMS, unpublished
18. Učka(Vela Učka)	1300	VL31	Mertens (1937)
	1250	VL31	Taddei (1950), Brelih (1962), PMS
19. Forte delle chiuse di Plezzo (Jugoslavia)		?	Lapini (1984) (geographic position not determined)
Gorski Kotar			
20. Risnjak		VL63/73	Fejervary-Langh, (1943), according to the collection Mehely
21a. Mali Risnjak (Risnjak)	1200	VL63/73	Rucner and Rucner (1971,SS)
21b. Markov Brlog (Risnjak)	1100	VL73	Rucner and Rucner (1971)
22. Jasenak (Velika Kapela) (TERRA TYPICA)	600–900	WL00	Mehely (1904a), NMW (Cyren, 1941), HPM (Karaman, 1921, 1939)
23. Jasenačka Kosa		WL00	Mehely (1904a)

continued

NO. LOCALITIES	Above sea level (m)	UTM	DATA SOURCE
24. Vrelo (Fiume, ? NW od Jasenka)		?WL00	Mehely (1909), NMW, (leg. Mehely, 1905)
25. Samarske stijene (Velika Kapela)	1302	VL90	ZZ, new locality
26. Klek		WL11	Mehely (1904a, 1909), HPM, SYNTYP (Karaman, 1921, 1939)
27. Plitvice (Lika)		WK46/47	Karaman (1921, 1939) (Cyren, 1941), HPM (Fejervary-Langh, 1943)
Velebit			
North Velebit			
28. Senjsko bilo Krivi Put		WK07	Mehely (1909)
29. Siča (Zavižan)	1300	VK96	ZZ, new locality
30. Lukin kuk (Babrovača)	925–1000	VK96	HPM, unpublished
31. Duplje (Zavižan)	1090	VK96	ZZ, new locality
32. Opaljenik (Zavižan)	1150	VK96	ZZ, new locality
33. Javorje (Zavižan)	1210	VK96	ZZ, new locality
34. Ciganište (Zavižan)	1230	VK96	ZZ, new locality
35. Šarinac (Zavižan)	1100–1200	VK96	HPM, unpublished
36. Žive Vodice (Zavižan)	1270	VK96	HPM, unpublished ZZ, new locality
37. Podstrana (Zavižan)	1350	VK96	ZZ, new locality
38. Vučjak (Zavižan)	1650	VK96	ZZ, new locality
39. Zavižanska Kosa	1620	VK96	HPM, unpublished
40. Rossijeva koliba (Rožanski Kukovi)	1600	VK95	ZZ, new locality
41. Alan		VK95	Mehely (1909); HPM, (Karaman, 1921, 1939)
	1100–1400		PMS, (Mršić, 1978)
Middle Velebit			
42. Jablanac		VK95	Karaman (1921, 1939) HPM
43. Mirevo	1100–1300	VK95	PMS (Mršić, 1978)
44. Krasno (Begovača)		WK05	Mehely (1909); NMW Wetstein (1928)
45. Kozjak (Hozjak, Velebit)		WK05	Mehely (1909); NMW
(Kozjak, Begovača)	1100		HPM (Karaman, 1921, 1939)
46. Grebalište		WK05	NMW, unpublished
47. Bilenski Padež		WK05	NMW, unpublished

continued

48. Mrkvište	1300	WK05	Karaman (1921, 1939) HPM; (Mršić, 1978,
	1100–1400		PMS); NMW
49. Štirovača		WK05	Mehely (1904a), NMW; (Cyren, 1941;
	1300		Mršić, 1978)
50. Položine	1100–1400	WK05	Mršić (1978), PMS
51. Šatorina		WK04	Mehely (1909)
52. Pazarište		WK14/24	Karaman (1921, 1939) HPM; NMW
53. Velinac (Karlobag)	965	WK03	Karaman (1921, 1939) HPM
South and south-east Velebit			
54. Vaganski vrh	1500–1750	WK41	Brelih (1962), PMS (Mršić, 1978)
55. Bunovac		WK41	leg. Pelić, HPM (not morphol. examined)
56. Paklenica		WK30/40	Karaman (1921, 1939) HPM
57. Zrmanja (UTM for the village Zrmanja)		?WJ89	Karaman (1921, 1939)
Velebit (unprecised)			
58. Ravni Padež		?	NMW, unpublished
59. Segocki (Segotski) Padež		?	NMW, unpublished
Poštak			
60. Kučina Kosa (Otrič, Zrmanja)		WJ99	ZZ, new locality
Locality without the material proofs			
61. Šibenik		?	Prozzi (1966)
Localities undetermined geographic position			
62. Stalak		?	Mehely (1909)
63. Vjetrenjak		?	Mehely (1909)

Addendum:

During the researches in 1989. Horvath's rock lizard was found in 4 new localities (leg. De Luca, Kletečki, Brelih):

64. Vršič (Kranjska Gora, Julian Alps)	1200	VM04	ZZ, new locality
65. Snežnik (Sviščaki–Leskova dolina)	1240	VL55	ZZ, new locality

continued

66. Snežnik (Sviščaki–Ilirska Bistrica)	1000–1050	VL44	ZZ, new locality
67. Snježnik (Gerovo–Gorski Kotar)	1200–1350	VL63	ZZ, new locality

Vršič is within the Slovenian part of the area in Julian Alps. Snježnik (Croatia) and two localities on Snežnik (Slovenia) are new localities in the Dinaric part of the area. With these findings the longest geographical distance between two localities (Trnovski Gozd and Snežnik) in the area of Horvath's rock lizard is reduced on about 55 km. As evident from the above, the distribution map (Fig. 7) indicates that the area is not disjunct, what essentially changes the present knowledge on zoogeography of this species. A special paper will be published on this problem.

(Kanin-Bovec) to 1900m above sea level (Mt Mangrt). Well known localities in Gorski Kotar are on altitudes from 600m to those of the highest peaks researched (Samarske stijene 1302m above sea level), while on the littoral slope of Velebit this species was found from 920m above sea level (Babrovača) up to the highest peaks (Vučjak - 1650m, Vaganjski vrh - 1750m above sea level).

5. **Discussion**

5.1. **External morphology**

5.1.1. **Biometric characters**

Details of the body dimensions of Horvath's rock lizard have so far been reported by MEHELY (1904a), MERTENS (1937), KRAMER et al. (1938), CYREN (1941), BRELIH (1962), MRŠIĆ (1978), LAPINI and DOLCE (1983) and BISCHOFF (1984a), but mostly for a rather small number of animals. The values of body dimensions presented in this work differ from those given by BISCHOFF (1984a). Thus, the head and the body of males on the average are shorter (56.76 mm to 58.5 mm) and of females are longer (60.83 mm to 59.3 mm). On the average the length of the tail in both males and females is shorter than the dimensions given by this author: 109.69 mm to 117.6 mm for males and 104.48 mm to 106.4 mm for females. The range from minimum to maximum values of these biometric characters is wider than the values given in the said work.

LAPINI and DOLCE (1983) give details on body dimensions of 25 animals (prepared in alcohol) from the Julian and Carnic Alps in Italy. Since the authors did not separate subadult animals from adult ones, the comparison is rather difficult, but the size of these animals obviously does not differ significantly from that of the animals from Slovenia (maximum overall length being 172.0 mm and that from the Slovenian Julian Alps

175.0 mm; length of the head and the body being 66.0 mm and for animals from Slovenia 65.0 mm). There in no considerable difference in the head dimensions either: the maximum head length for the animals from Italy is 14.0 mm and for those from Slovenia 13.46 mm. The maximum head width is 10.0 mm and in animals from Slovenia 10.74 mm. The sample from the Italian part of the area clearly shows smaller body dimensions than the sample of the north Dinaric population. LAPINI and DOLCE (1983) also give values for 14 fresh animals (unprepared). Among them, the maximum length of one male was no less than 192.5 mm, thus exceeding the maximum value registered for the animals from Croatia (190.0 mm). However, the comparison of these values is an ungrateful task, since by preparation animals are normally contracted for several millimeters. The values of body dimensions given by other authors (MEHELY 1904a; KRAMER et al.1938; CYREN 1941) do not differ significantly from the values recorded during this research. Minor differences may be attributed to the differences in the sample size. In this work a so far largest sample was processed, enabling a more accurate determination of the minimum and maximum values, as well as of arithmetic mean of biometric characters.

Females of Horvath's rock lizard have a markedly longer head and body, as well as a slightly shorter tail than males, which is typical of most other species of the genus *Lacerta* (BÖHME 1984). Significantly larger dimensions of the head and the pileus of males in relation to females are also typical of the species from the family Lacertidae (BÖHME 1984, 1986).

A t-test showed statistically significant differences in the size of animals from the Slovenian and the Croatian part of the area for all biometrical character examined except for the tail length. BRELIH (1962) already noted that animals from Croatia are bigger than those from Slovenia. Analysis of the reproduction cycle (DE LUCA 1988) showed that females from the Julian Alps become sexually mature at considerably smaller dimensions of the head and the body (minimum 49.0 mm) than females from the north Dinaric population (56.0 mm). Although the correlation between the age and body dimensions is as yet unknown it is evident that between the Alpine and north Dinaric population of Horvath's rock lizard there are significant differences in size, caused most likely by ecological, above all climatic factors, which can be considered as taxonomically unstable. For this reason, it cannot be asserted that these differences are on the subspecific level. Having in view the fact that the growth speed of ectothermic animals depends to some extent upon temperature, it is possible that this difference is caused by the more severe Alpine climate.

5.1.2. **Meristic characters**

The numbers of scales of the pileus and the pholidosis obtained by examining 208 specimens from the entire area in Yugoslavia do not differ essentially from the values stated by other authors (MEHELY 1904a; SCHREIBER 1912; CYREN 1941; RADOVANOVIĆ 1951; MERTENS and WERMUTH 1960; BRELIH 1962; ARNOLD and BURTON 1978; MRŠIĆ 1978; LAPINI and DOLCE 1983; BISCHOFF 1984a; ENGELMANN et al. 1986). BISCHOFF (1984a) presents the newest and more comprehensive review of his own data and data from literature. It should be mentioned that the methods of counting of particular scales (particularly temporal, postocular, collar, ventral and dorsal ones) are not standardized precisely, which may result in minor differences that do not result from a real difference between populations. My own results show considerably wider ranges between the minimum and maximum values for most characters in relation to the data given by

BISCHOFF (1984a). This analysis reveals that most meristic characters vary much more than known so far. The most stable character is the number of the submaxillaria (6 pairs of scales), as reported also by other authors (MEHELY 1904a; BISCHOFF 1984a). Some determination keys (ARNOLD and BURTON 1978; ENGELMANN et al. 1986) state 5 pairs of submaxillaria as the typical character of the pileus of *L.horvathi* to distinguish it from *L.mosorensis* having 6 pairs. It is possible that the authors did not count the last pair of smaller submaxillaria in the row in the case of Horvath's rock lizard while taking them into account for the Mosor rock lizard, which may cause a misunderstanding in determination. The number of the dorsalia in Horvath's rock lizard ($\bar{X} = 43.91$) is evidently higher than in the Mosor one ($\bar{X} = 40.2$, BISCHOFF 1984b). This difference was suggested already by MEHELY (1904a) who belived it to be taxonomically significant in the evolution of Horvath's rock lizard from the Mosor one. He thinks that in the more humide region where one part of the population of the Mosor rock lizard emigrated, the specimens with a higher number of the dorsalia (enabling faster evaporation) had a better chance to survive. ARNOLD (1973) confirms that the number of dorsalia is the usual parameter in the taxonomy of the family Lacertidae but also that the tendency towards an increased number of dorsal scales occurs in the species from more arid regions.

The difference in the number of ventral scales in the longitudinal row between males and females, which proved to be statistically important, is confirmed also by other authors, too (MEHELY 1904a; CYREN 1941; BISCHOFF 1984a). A longer head and body of females in relation to males are also statistically important, thus implying the conclusion that body length correlates with the number of ventralia. The gularia are more numerous in females, and as males have a longer head it is very likely that the guttural scales in females are smaller. The number of femoral pores is higher in males and, according to rather poor indications in the literature (MEHELY 1904a; CYREN 1941; LAPINI and DOLCE 1983), the same is true of the length of the rear leg, therefore, these two parameters are in mutual dependence.

In the literature no information has been provided on the differences in the meristic characters between juvenile and adult animals. Statistically significant differences for four characters indicate the possibility that the number of some scales changes during the growth. Since the sample of juvenile animals was considerably smaller than the sample of the adult ones, and as for three of these four characters, the approximative method of comparison had to be used, the final conclusion regarding this problem has not been drawn as yet.

Statistically important differences in 7 meristic characters between the samples from Croatia and Slovenia, together with the differences in the biometric characters, indicate the existence of an important intraspecific variability. Although the numeric values of these meristic characters do not differ considerably, these differences proved to be statistically important. In all cases, a higher number of scales was noted in the animals from the Croatian part of the area, and in three cases the approximative method had to be used to determine statistical significance. Bearing in mind that meristic characters may be very variable, for the moment it cannot be asserted that these differences are on the level of the subspecific ones.

5.1.3. **Qualitative characters of the pileus and the pholidosis**

Mutual relations and appearance of the scales have a higher taxonomic value than the meristic characters and are more frequently used in determination of the taxonomic

position and mutual relations, as well as in determination of species from the family Lacertidae (MEHELY 1909; SCHREIBER 1912; MERTENS and WERMUTH 1960; TORTONESE and LANZA 1968, ARNOLD 1973; BRUNO and MAUGERI 1977; ARNOLD and BURTON 1978; ENGELMANN et al. 1986).

Mutual relations of the scales around the nasal opening are particularly important (ARNOLD 1973). Contact of the scales supranasale and frenale is a very rare property and typical only of Horvath's rock lizard and the species *Lacerta monticola* from the Pyrenean Peninsula (ARNOLD and BURTON 1978; ENGELMANN et al. 1986). This character is mentioned in the above determination manuals as the principal distinctive character for distinguishing Horvath's rock lizard from other species, especially from the common wall lizard *(Podarcis muralis)*. The results show that it is extremely variable, i.e. it is typical on both sides of the head in only 57.21% of animals, consequently, it might be used only as an auxiliary and by no means the most important character in determination. The same conclusion was reached by LAPINI and DOLCE (1983) after examining 39 specimens from Italy in which this character appeared in its typical form in 51.3% animals only. In sympatric populations of the common wall lizard specimens can be found which on both sides or more frequently on one side of the head have a position of these scales as typical of *L.horvathi* (proper observations), thus further limiting the use of this character in determination.

Contact between the scales rostrale and internasale appears as a typical character in a large number of species: *Lacerta mosorensis, L.monticola, L.derjugini,* and as a more variable character in *L.bedriagae* and *L.caucasica* (ARNOLD and BURTON 1978), while DELY and STOHL (1982) indicate that it may be present, although rarely, in *P.muralis, L.rudis* and *L.vivipara.* In spite of that this character has by far bigger values in determination of Horvat's rock lizard, because it is very stable (it was atypical only in two animals examined), while in the sympatric species it is present very rarely or not at all.

By this research a significant variability of some qualitative characters of the pileus was determined, mentioned also by LAPINI and DOLCE (1983) - two scales each postnasale and frenale or these two scales joined together, and the absence of the contact between the first postoculare and parietale.

However, one must stress the stability of those characters of the pileus and pholidosis of Horvath's rock lizard that are considered important to the distinction between the genera *Podarcis* and *Lacerta* (BÖHME 1984): a markedly larger first supratemporal scale, its upper edge protruding towards the parietal scale, flat and ridgeless dorsal scales, as well as narrow and wide rings of tail scales. These characters, together with the contact between the scales rostrale and internasale, render it possible to distinguish Horvath's rock lizard from the common wall lizard without any doubt.

In the literature no details have so far been given on the differences in the frequency of typical and atypical signs of the qualitative characters between adult and juvenile animals. Statistically significant differences have been found in the characters that are in fact most variable. It is important to say that the stability of the characters essential for determination of a species does not differ considerably, so that juvenile animals can be distinguished from other species of lizards in the same way as the adult ones.

For three qualitative characters the sample from Slovenia shows a considerably higher frequency of the atypical sign, and a higher variability than the animals from Croatia, respectively; here it should be noted that a very high number of animals from the Slovenian sample reveals an atypical relation of the scales supranasale and frenale. For this reason this character should by no means be used in determination because it may easily lead to

an erroreous decision. Evidence in confirmation of the above statement ensue from the results given by LAPINI and DOLCE (1983).

The investigations have shown that in most animals the massetericum is prominent in relation to other temporal scales, as is confirmed by the results of other authors (MEHELY 1904a; SCHREIBER 1912), but also that it varies substantially in size. BISCHOFF (1984a) notes that in some animals this scale is so small that it cannot be distinguished from the surrouding scales of the temporal region, as evident also from the results of this work.

5.1.4. **Colour and pattern**

The colour and pattern such as described in this work do not differ much from the descriptions by other authors (MEHELY 1904a; KNAUER 1905; SCHREIBER 1912; BRUNO and MAUGERI 1977; ARNOLD and BURTON 1978; LAPINI and DOLCE 1983; BISCHOFF 1984a; ENGELMANN et al. 1986). MEHELY (1904a) and SCHREIBER (1912) indicate that the line of dark patches through the middle of the back (occipital line) is present in adult males. This research has demonstrated that this line is present also in females, even more often than in males, but males are mottled a little oftener. However, these differences are not expressed well enough to enable distinction between sexes by colour.

BRELIH (1962) notes, although on a small number of specimens, that compared to Slovenia, a higher number of the animals from Croatia are very mottled. The results of this work confirm that a lot of animals from Croatia are in the 5^{th} and 6^{th} categories, but the share of these two categories of very mottled animals in both samples is small in relation to other categories, thus reducing the importance of the said difference.

The greenish-blueish colour of the tail in juvenile animals noted during field research has been reported also by other authors (ARNOLD and BURTON 1978; LAPINI and DOLCE 1983). LAPINI and DOLCE (1983) indicate that such coloration of the tail is present only in animals up to 12cm long. Young animals belonging to other lacertid species (BÖHME 1984, 1986) possess a more coloured tail.

All investigations (MEHELY 1904a; KNAUER 1905; SCHREIBER 1912; BRUNO and MAUGERI 1977; ARNOLD and BURTON 1978; LAPINI and DOLCE 1983; BISCHOFF 1984a; ENGELMANN et al. 1986) point out the fact that the colour of Horvath's rock lizard is similar to that of the female of the *P.muralis*. Males of the common wall lizard are easily distinguishable by a large number of black spots on the throat and the belly which are of a vivid orange colour. The colour and pattern of the throat and the belly of *L.horvathi* do not show these characteristics either in males or females. LAPINI and DOLCE (1983) consider the colour and pattern as one of the least distinctive characters for the identification of these two species. Anyway, on living specimens of Horvath's rock lizard an olive-greenish reflection can be observed on the back that is never present in the sympatric populations of the common wall lizard.

5.1.5. **Discussion on the taxonomic status of Horvath's rock lizard**

ARNOLD (1973) considers the flat and ridgeless dorsal scales, the flat or smooth rear edge of the collar, and the square ventral scales which do not overlap as characters typical of the petrophyleous species from the sugenus *Archaeolacerta*. This features are typical

of and stable in Horvath's rock lizard. The question is of ecologically conditioned characters whose development resulted from the necessity to hide and move through narrow crevices in rocks where the scales shaped in this way do not present an obstacle. The species of the genus *Lacerta* which are linked with biotopes covered by vegetation *(Lacerta vivipara, L.derjugini, L.praticola)* have stronger and ridged dorsal scales, stronger ventral scales and serrated rear edge of the collar, i.e. such characters by which the danger of injuries when they move through the vegetation is reduced to a minimum (ARNOLD 1973). Although the small species of the genus *Lacerta* can be grouped with great precision according to these differences, ARNOLD (1973) considers these characters as taxonomically unstable, and unites all these species into group *"Lacerta part II"* . The electrophoretic investigations indicate a phylogenetic distance of the subgenus *Zootoca* with the species *Lacerta vivipara* from the subgenus *Archaeolacerta* with the species *L.horvathi, L.oxycephala, L.bedriagae* and *L.graeca* (MAYER and TIEDEMANN 1982; LUTZ and MAYER 1985). However, BÖHME (1971) draws attention to the similarity in the epithelium of the hemipenis in the viviparous lizard and the species *L.horvathi* and *L.oxycephala;* he believes that they must be united into a subgenus *Zootoca* leaving in the subgenus *Archaeolacerta* only the species *L.bedriagae* and *L.graeca.* The cytogenetic studies (DE LUCA and ĐULIĆ 1988) have shown the similarity of the karyotype of Horvath's rock and the viviparous lizard. From the data given in the literature and results of this work it is evident that the different taxonomic methods suggest various conclusions with regard to the taxonomic position of Horvath's rock lizard within the genus *Lacerta.* Formation of the polyphyletic association *Lacerta incertae sedis* (BÖHME 1984) into which all small species of the genus *Lacerta* from the sugenera *Archaeolacerta* and *Zootoca* have been classified represents just a temporary solution on this level of investigation. Many authors accept the existence of the subgenus *Archaeolacerta* (TORTONESE and LANZA 1968; ORLOVA and ORLOV 1969; MAYER and TIEDEMANN 1982; LAPINI and DOLCE 1983; LAPINI 1984; LUTZ and MAYER 1985). According to the results of the studies on the external morphology of *L.horvathi* in this work, showing the stability of the characters which distinguish this subgenus (shape of the first supratemporal scale, flat dorsal scales, smooth rear edge of the collar, square ventral scales and alteration of more and less wide whorls of the caudal scales), the classification of this species in the subgenus *Archaeolacerta* seems justified.

5.2. **Distribution of Horvath's rock lizard**

The distribution of Horvath's rock lizard in the Alpine part of the area is not known in detail. This is confirmed by the recent findings of this species in the Carnic Alps in Italy (LAPINI and DOLCE 1983) and Austria (GRILLITSCH and TIEDEMANN 1986). LAPINI and DOLCE (1983) are convinced that in this area *L.horvathi* is spread more than it seems from the data available, but its resemblance to the common wall lizard and the resulting confusion, as well as localization of the populations to the exclusively petrophylic habitats, are the reasons why so little information has so far been gathered on this problem. The proof of this are three incorrectly determined specimens from the locality Mrzli Studenec found in the HPM collection. In the locality Wolayertal in Austria, three specimens of Horvath's rock lizard were caught in 1926 by Werner who thought it to be the highest finding place of the common wall lizard in the Alps (WERNER 1926). Only by redetermination by GRILLITSCH and TIEDEMANN (1986) it was found Horvath's rock lizard was concerned; afterwards they confirmed their finding by discovering three new localities the exact position of which is not made known in order to protect this species

newly discovered for the fauna of Austria (GRILLITSCH and TIEDEMANN 1986; SOCHUREK 1986). These authors searched for the species also in the region of the Karawanken in Austria, but could not find it in any typical biotope. Future research in the Alps will have to cover the West Carnic Alps and East Tyrol so as to determine the western boundary, as well as the Karawanken and the Savinjske Alpe to fix the northern and eastern boundaries of the area. Some doubts occured whether *L.horvathi* was brought to the region of the Julian Alps at the beginning of this century (SOCHUREK 1955). BRELIH (1962) believes that the populations in the Julian Alps are autochthonous. A large number of localities discovered in the vast region of the Carnic and Julian Alps and Trnovski Gozd suggests that these are real autochthonous populations.

Another open question is that of the southern boundary of the area in Slovenia. Southward from Trnovski Gozd there extends Nanos where *L.horvathi* has not been found although considering the altitude (1299m above sea level) and the types of habitats it might be present there, too. An important question in the zoogeography of this species is whether the area is discontinous i.e. separated into three basic disjunct areas: the Alps, Učka and north Dinaric region (LAPINI and DOLCE 1983), or such image of the area simply results from a poor level of exploration. The region between Trnovski Gozd and Risnjak has not been explored in detail. On the mountains Snežnik (1798m above sea level) in Slovenia and Obruč (1377m), the westernmost mountain of the plate of Gorski Kotar (POLJAK 1981), there are rocky habitats suitable for Horvath's rock lizard. Obruč is in fact a little more thermophilous (POLJAK 1981), however, not as much as Učka where Horvath's rock lizard has been found. Between Obruč and Risnjak the massif of Snježnik extends with its peaks higher than 1400m above sea level and separated from Snežnik in Slovenia only by a mountain pass 1225m high (POLJAK 1981). Future explorations of these mountains should give an answer to the question concerning the disjunction of the area.

Učka represents an exclave in the area. Its only connection with the main area might eventually be through Ćićarija (1273m above sea level) which has not been explored yet.

The region around Jasenak and Klek includes the first known localities (MEHELY 1904a,b,c, 1907a,b,c), and Jasenak is indicated by MERTENS and WERMUTH (1960) as terra typica restricta. The locality on Risnjak was first made public by FEJERVARY-LANGH (1943) on the basis of the collection L. Mehely. The specimens from the locality Vrelo-Fiume were collected by Mehely in 1905. The locality concerned is most probably Vrelo in the north-west from Jasenak. The localities Stalak and Vjetrenjak (MEHELY 1909), too, probably belong to this part of the area. The new locality Samarske stijene on Velika Kapela is inside the already known area, so the number of localities in Gorski Kotar is likely to increase during further explorations.

Reliable proofs were provided on the localities of Horvath's rock lizard on Plitvice Lakes (KARAMAN 1921, 1939; CYREN 1941; FEJERVARY-LANGH 1943). In the course of my research, I succeeded neither to see nor to catch a single specimen, I only saw and caught specimens of the common wall lizard. The exact places and number of colonies, as well as the momentary situation of the population of this species with regard to the increasing anthropogenic influence within the National Park "Plitvice Lakes" are not known. A further exploration should prove whether Horvath's rock lizard is spread in the region of Lika even farther on the land than Plitvice Lakes.

The first specimen of Horvath's rock lizard ever caught comes from Štirovača (central Velebit) and MEHELY (1903, 1904a) first thought it to be a Mosor rock lizard. In further investigations a larger number of localities was discovered in the north (MEHELY 1909; KARAMAN 1921, 1939; TVRTKOVIĆ 1984), on central (MEHELY 1904a,b,c, 1909;

KARAMAN 1921, 1939; WETTSTEIN 1928; CYREN 1941; MRŠIĆ 1978) southern and south-eastern Velebit (KARAMAN 1921, 1939; BRELIH 1962). Although a part of southern Velebit has not been researched in detail (Fig. 7.), it is evident that *L.horvathi* is spread throughout its length. The research made by TVRTKOVIĆ (1984, unpublished) and within this work substantially increased the number of localities on northern Velebit. In the NMW collection, animals from unpublished localities were found: Grebalište and Bilenski Padež from central Velebit, as well as Ravni and Segotski Padež, the exact position of which on Velebit I was unable to determine. The first data about southern Velebit were given by KARAMAN (1921, 1939). These are the southernmost localities supported by evidence. The research done within this work showed that Horvath's rock lizard is spread farther in the south too, i.e. on the mountain Poštak. At the moment this locality represents the southernmost locality determined with certainly. On the distribution map made by BISCHOFF (1984a) Kozjak and Šibenik are marked more to the south. According to the data available, the locality Kozjak refers to Kozjak on Velebit (MEHELY 1909; KARAMAN 1921, 1939; the HPM and NMW collections), and not to the mountain Kozjak in Dalmatia. POZZI (1966) was the first to mention that Horvath's rock lizard is spread southward from Šibenik and BISCHOFF (1984a) introduced this data into the map. However, neither in the literature nor the collections examined evidence is provided for any localities of this species in the region around Šibenik; supposedly POZZI (1966) simply wanted to give an approximative southern boundary of the area. According to the present data *L.mosorensis,* which is considered by MEHELY (1904a) as the ancestor of *L.horvathi,* is not sympatric with the latter. HUNT (1957) indicates Kaštela as the northernmost locality of the Mosor rock lizard. The northern boundary of the area of this species has not as yet been completely explored, but so far the northernmost localities are the mountain Kozjak and Sinj (DŽUKIĆ 1987). The question of a possible overlapping of the areas of these two species from the subgenus *Archaeolacerta* will be of great importance in the future zoogeographical, taxonomic and ecologic investigations. The solution of this problem is to be sought on the slopes of the still unexplored mountains Ilica, Dinara and Svilaja.

Horvath's rock lizard is a mountainous species and according to the data in the literature and my own it does not descend to places lower than 600m above sea level in the Alpine part of the area and Gorski Kotar, while on the littoral side of Velebit it has not been found below 920m above sea level. Therefore, LAPINI and DOLCE (1983) speak about "the insular distribution" of this species. Connection with exclusively petrophilic habitats may lead to the conclusion that inside the area the populations make smaller isolated colonies in favourable habitats, separated from one another by regions without rocks and of lower altitudes (LAPINI and DOLCE 1983). In the region explored in detail around Zavižan I found animals on infinitely small sections of rocks (for example near the hunter's hut Siča on a rock of about 2X2m, surrounded completely by the forest, without any larger complexes of rocks nearby). Such places, not rare in our region on the rocky ground even inside rather large surfaces covered by forests, might represent "connections" between colonies that might seem isolated at first sight. One young animal found on Bunovac (leg. Pelić, HPM collection) in a dry rocky meadow indicates a possibility that these animals undertake limited migrations or that there are contacts between separate colonies, especially since Horvath's rock lizard, judging by the altitudes of the localities, is adapted to a relatively wide range of vegetational zones - from submediterranean to high mountainous forestal comunities (DE LUCA 1988).

The area may give an impression of disjunctive appearance, which may be due to a poor level of exploring, climatic changes in the past and in this connection of the migration

of the species and subspecies of the subgenus *Archaeolacerta.* DARSA (1972) thinks that in the Quarternary the subgenus was spread along south-western Asia and that the climatic changes in the Cenozoic era caused migrations based on "climatic preferences". Therefore, the species and subspecies scattered mainly over mountainous regions. RADOVANOVIĆ (1964) believes that *L.horvathi* is a tertiary relict. ARNOLD (1973) points out that most of the small species of the genus *Lacerta* (which he classified into the group *"Lacerta part II"*) have small and disjunctive areas that suggest relict distributions. In view of the fact that these are mostly mountainous species, this author believes that a certain role in the distribution may have been played by the postglacial rise of temperature. He presumes that the separation and speciation of *L.horvathi* and *L.mosorensis* are of a rather recent date, having in view their similarity in many characteristics. Since the actual state with regard to the distribution of these two species is not completely known, this question remains to be answered.

6. **Conclusions**

1. By a survey, as well as statistical elaboration, a significant variability of 37 biometric, meristic and qualitative characters of pileus and pholidosis in altogether 208 specimens of Horvath's rock lizard *(Lacerta horvathi* MEHELY, 1904) was established. The frequencies of the typical appearances of the qualitative characters, most often used as taxonomic and diagnostic characters, were checked. It was found that a diagnostic character i.e. the touching of the supranasal and the frenal scales, so far considered of 39 utmost importance, varies considerably not ensuring a certain determination of the species. A more reliable diagnostic character, showing a high constancy, is the contact of the rostral and internasal scales, appeareance of the supratemporal scales, and dorsal and caudal scales whose characteristics confirm the membership of Horvath's rock lizard in the subgenus *Archaeolacerta.*

2. Out of 7 biometric characters, specimens taken from the Slovenian part of the area reveal statistically significant differences from the north Dinaric sample in 6 characters, the animals from north Dinaric part of the area being bigger. Males differ from females in 5 biometric characters.

3. 15 meristic characters of the pileus and pholidosis were examined. The specimens from the Slovenian part of the area differ, in a statistically significant degree, in 7 characters from the animals found in the north Dinaric region, adult from the juvenile in four, and males from females in three meristic characters.

4. Out of 12 qualitative characters of the pileus and pholidosis statistically significant differences between adult and juvenile animals were established in three characters and between those from the Slovenian and north Dinaric region in four qualitative characters.

5. The size of the massetericum and the colouring show a considerable variability.

6. At the moment it cannot be asserted that the differences in 17 morphological characters between the Alpine and north Dinaric population are on the subspecific level. The differences in size are likely to have been caused ecologically (which means taxonomically unstable), the meristic characters showing a high variability.

7. Exploring the geographical distribution, a disjunction of the area was affirmed, although the data on the above sea level height of the localities suggest a need for further research. This work showed that Horvath's rock lizard is spread to the south of Poštak, which is, in this moment, the southernmost locality determined with certainty. This result

suggests that the southern boundary of the area of *L.horvathi* is closer to the northern one of the Mosor rock lizard, implicating a necessity for further research.

SUMMARY

Although endemic in Yugoslavia, Horvath's rock lizard (*Lacerta horvathi* MEHELY, 1904) is one of the insufficiently investigated species. Therefore, the task of this paper was to contribute to the knowledge of its morphology and distribution.

Examined and statistically processed were 37 external morphological characters on 208 specimens (61 males, 109 females and 38 juveniles) from the entire distribution area in Yugoslavia. 123 adult animals were from the north Dinaric and 47 from the Slovenian area. Considerable variability of meristic and qualitative characters of pileus and pholidosis was established. Furthermore, validity of some diagnostic characters was tested; established were also characters which enable a safe determination of species. The most reliable diagnostic characters, showing a high constancy, are the contact of the rostrale and internasale, appearance of the supratemporal scales and dorsal and caudal scales whose characteristics, at the same time, confirm the membership of Horvath's rock lizard in the subgenus *Archaeolacerta*. At the moment it cannot be asserted that significant differences as established in the 17 examined characters between the Alpine and north Dinaric population are on the subspecific level. The differences in size (animals from Croatia are bigger) probably result from ecological circumstances (which means they are taxonomically unstable) and the meristic characters show a high variability.

A greater number of new localities within the boundaries of the known area was presented for the first time. The disjunction of the area was affirmed, although the data on the above sea level height of the localities suggest a need for further research on the mountains between Trnovski Gozd and Risnjak. The area is now extended to include Poštak Mt. across the river Zrmanja, the southernmost locality determined with certainty. This finding brings the southern boundary of the area closer to the northernmost boundary of the Mosor rock lizard (*Lacerta mosorensis* KOLOMBATOVIĆ, 1886), implicating a necessity for further research of eventual sympatry of these two species from the subgenus *Archaeolacerta*.

POVZETEK

Čeprav je velebitska kuščarica (*Lacerta horvathi* MEHELY, 1904) v Jugoslaviji endemična, je ena od slabo raziskanih vrst pri nas. Zato je naš namen prispevati k poznavanju njene morfologije in razširjenosti.

Na 208 osebkih (61 samcev, 109 samic in 38 mladostnih osebkov) iz cele Jugoslavije je bilo pregledanih in statistično obdelanih 37 zunanjih morfoloških značilnosti. Od tega je bilo 123 odraslih živali iz severnih dinarskih predelov, 47 pa iz Slovenije. Ugotovljena je bila velika variabilnost merističnih in kvalitativnih značilnosti pileusa in folidoze. Preučevana je bila veljavnost nekaterih diagnostičnih znakov in ugotovljene značilnosti, ki omogočajo zanesljivo določevanje vrst. Najbolj zanesljivi diagnostični znaki, ki so zelo stalni, so stiki med rostralno in internazalno ploščico, videz supratemporalnih, dorzalnih in kavdalnih ploščic, katerih značilnosti obenem potrjujejo umestnost uvrščanja velebitske

kuščarice v podrod *Archaeolacerta*. Trenutno ni mogoče zanesljivo zagotoviti, da je mogoče na osnovi 17 proučenih značilnosti ugotoviti signifikantne razlike in obravnavati alpsko in severnodinarsko populacijo na nivoju podvrste. Razlike v velikosti (živali s Hrvaške so večje) so verjetno zaradi ekoloških razmer (kar pomeni, da so taksonomsko nestabilne), meristične značilnosti pa kažejo veliko variabilnost.

Prvič so predstavljene številne nove lokalitete znotraj meja poznanega areala velebitske kuščarice. Ugotovljena je disjunktnost areala, čeprav podatki, temelječi na nadmorski višini lokalitet, narekujejo nujnost nadaljnjega preiskovanja predelov med Trnovskim gozdom in Risnjakom. Znotraj areala sodi sedaj tudi gora Poštak z druge strani reke Zrmanje, kar je najjužnejša zanesljivo ugotovljena lokaliteta. Ta najdba pomika južno mejo areala bliže k najsevernejši meji razširjenosti mosorske kuščarice (Lacerta mosorensis KOLOMBATOVIĆ, 1886), kar narekuje nadaljnje raziskave možne simpatrije teh dveh vrst iz istega podrodu *Archaeolacerta*.

References

ARNOLD, E.N. (1973): Relationships of the Palearctic lizards assigned to the genera *Lacerta, Algyroides* and *Psammodromus* (Reptilia, Lacertidae). Bull. Brit. Mus. (Nat. Hist., Zoology), **25**(8): 289-366.

ARNOLD, E.N., BURTON, J.A. (1978): A field guide to the reptiles and amphibians of Britain and Europe. Collins, London, pp. 272.

BISCHOFF, W. (1984a):*Lacerta horvathi* Mehely 1904 - Kroatische Gebirgeidechse. In: Handbuch der Reptilien und Amphibien Europas, 2/I, Echsen II*(Lacerta)*. Ed. Böhme, W., AULA-Verlag, Wiesbaden, 265-289.

BISCHOFF, W. (1984b):*Lacerta mosorensis* Kolombatović 1886. - Mosor-Eidechse. In: Handbuch der Reptilien und Amphibien Europas, 2/I, Echsen II*(Lacerta)* . Ed.Böhme,W., AULA-Verlag,Wiesbaden, 290-300.

BÖHME, W. (1971): Über das Stachelepithel am Hemipenis lacertider Eidechsen und seine systematische Bedeutung. Z. f. zool. Systematik u. Evolutionsforschung, **9** (3): 187-223.

BÖHME, W. (1984): Handbuch der Reptilien und Amphibien Europas. Band 2/I, Echsen II *(Lacerta)* . AULA-Verlag, Wiesbaden, pp. 416.

BÖHME, W. (1986): Handbuch der Reptilien und Amphibien Europas. Band 2/II, Echsen III *(Podarcis)* . AULA-Verlag, pp. 434.

BOULENGER, G.A. (1910): Remarks on Prof. L.v.Mehely's recent contribution to the knowledge of the lizards allied to *Lacerta muralis*. Ann. and Magaz. Nat. Hist. (8), V: 247-256.

BOULENGER, G.A. (1920): Monograph of the Lacertidae, vol. 1. London (Trustees Brit. Mus.), pp. 352.

BRELIH, S. (1954): Prispevek k poznavanju favne plazilcev slovenskega ozemlja. Biol. Vestn. III, 128-131.

BRELIH, S. (1962): Plazilci Triglavskega narodnega parka in okolice. Varstvo narave I, Studijski prispevek k poznavanju Triglavskega narodnega parka **8**: 119-128.

BRELIH, S., DŽUKIĆ, G. (1974): Catalogus faunae Jugoslaviae IV/2 - Reptilia. Acad. Sci. Art. Slov., Ljubljana, pp.32.

BRUNO, S., MAUGERI, S. (1977): Rettili d'Italia. Tartarughe, Sauri, Serpenti. Giunti Martello, Firenze, pp.363.

CAPULA, M., NASCETTI, G., CAPANNA, E. (1982): Chromosome uniformity in Lacertidae: new data on four Italian species. Amphibia-Reptilia, **3**: 207-212.

CYREN, O. (1941): Beiträge zur Herpetologie der Balkanhalbinsel. Mitt. Konigl. Naturwiss. Inst., Sofia, **14** : 1-140 + 6 Tafeln.

DAREVSKI, I.S. (1967): Sistematičeskije priznaki i njekotorije metodičeskije ukazanija. In: Skaljnije jaščerici Kavkaza. Ed. Darevski, I. S. Nauka, Lenjingrad, 19-30.

DARSA, M. (1972): Anfibi e Rettili di Fusine. Hyla, U. E. I. **2** (1):3-13.

DELY, O.GY., STOHL, G. (1982): Pileusbeschilderung und phylogenetische Beziehungen innerhalb der Lacertiden. Vertebrata Hungarica, **21**: 85-109.

DE LUCA, Nina (1988): Morfološke i ekološke karakteristike velebitske gušterice *Lacerta horvathi* Mehely, 1904 (Lacertidae, Reptilia) u Jugoslaviji. Magistarski rad, Sveučilište u Zagrebu, pp. 176.

DE LUCA, Nina, ĐULIĆ, Beatrice (1988): Karyotype of Horvath's rock lizard *(Lacerta horvathi* Mehely, 1904, Lacertidae, Reptilia., Amphibia-Reptilia, **9**: 353-356.

DŽUKIĆ, G. (1987): Remarks on distribution and protection problems of the Mosor rock lizard *Lacerta mosorensis* Kolombatović 1886 (Reptilia, Lacertidae). 4thInt.Congress on Zoogeography and Ecol. of Greece and Adjac. Reg., 74, Kammena Vourla.

ENGELMANN, W.E., FRITZSCHE, J., GUNTHER, R., OBST, F. J.(1986): Lurche und Kriechtiere Europas. Ferdinand Enke Verlag, Stuttgart, pp. 420.

FEJERVARY-LANGH, A. (1943): Beiträge und Berichtungen zum Reptilien-Teil des ungarischen Faunenkataloges. Fragm. Faun. Hung., **6**(3): 81-98.

GORMAN, G.C. (1973): The chromosomes of the Reptilia, a cytotaxonomic interpretation. In: Cytotaxonomy and Vertebrate evolution. Ed. Chiareli, A. B., Capanna, E., Academic Press, London-New York, 349-424.

GRILLITSCH, H., TIEDEMANN, F. (1986): *Lacerta horvathi* Mehely 1904 - Erstnachweis für Österreich. Ann. Naturhist. Mus. Wien, 88/89(B): 357-359.

GUILLAUME, C.-P.,LANZA, B. (1982): Comparaison électrophorétique de quelques espèces de Lacertidés Mediterranéens, Genera *Podarcis* et *"Archaeolacerta"* . Amphibia-Reptilia, **4** : 361-375.

HUNT, T. (1957): Notes on the reptilian fauna of the Kastela, Dalmatia. Brit. Journ. Herpetol., **2**(4): 65-70.

KARAMAN, S. (1921): Beiträge zur Herpetologie von Jugoslawien. Glasn. Hrv. prir. društv., **33**: 194-209.

KARAMAN, S. (1939): Über die Verbreitung der Reptilien in Jugoslawien. Ann. Mus. Serb. Meridion., **1**(1): 1-20.

KLEMMER, K. (1957): Untersuchungen zur Osteologie und Taxonomie der europäischen Mauereidechsen. Abh. Senck. naturf. Ges., Frankfurt/M., **496**: 1-56.

KNAUER, F. (1905): *Lacerta horvathi* Mehely, eine neue europäische Eidechse. Blätter f. Aquar. u. Terrarkd., Magdeburg, **16**(4): 33-36.

KRAMER, G., NEAPEL, MERTENS, R. (1938): Zur Verbreitung und Systematik der festlandischen Mauer-Eidechsen Istriens. Senckenbergiana, **20**(1/2): 48-66.

LANZA, B., CEI, J.M., CRESPO, E.G. (1977): Immunological investigations on the taxonomic status of some mediterranean lizards (Reptilia, Lacertidae). Monitore Zool. Ital., **11**: 211-221.

LAPINI, L. (1984): Catalogo della collezione erpetologica del Museo di storia naturale. Ed. del Museo di Storia Naturale, Udine, 9-11, 26-27, **40**: 76-83.

LAPINI, L., DOLCE, S. (1983): *Lacerta (Archaeolacerta) horvathi* Mehely, 1904. in Italia; nuove per le Alpi Carniche e Giulie. Atti Mus. Friul. Storia Nat. Gortania, Udine, **4**: 213-225.

LUTZ, D., MAYER, W. (1985): Albumin evolution and its phylogenetic and taxonomic implications in several lacertid lizards. Amphibia-Reptilia, **6**: 53-61.

MACGREGOR, H.C., VARLEY, J.M. (1983): Working with animal chromosome. John Wiley & Sons, Chichester-New York, pp. 250.

MAYER, W., TIEDEMANN, F. (1982): Chemotaxonomical investigations in the collective genus *Lacerta* (Lacertidae, Reptilia) by means of protein electrophoresis. Amphibia-Reptilia, **2** : 349-355.

MEHELY, L. (1903): *Lacerta mosoriensis* Kolomb., a magyar kiralysag uy gyikja, szarmazastani kapcsolataban. Allattani Kozlemenyek (Budapest), 1903: 212-220.

MEHELY, L. (1904a): Eine neue *Lacerta* aus Ungarn. Ann. Mus. Nat. Hist. Hung. (Budapest) **2**: 362-377.

MEHELY, L. (1904b): Egy uj gyikja, szarmazastani kapcsolataban. Allattani Kozlemenyek(Budapest), **3**(4): 1-19.

MEHELY, L. (1904c): A Mecsek-hegyseg es a Kapela herpetologiai viszonyai.Allattani Kozlemenyek(Budapest), **3**: 241-289.

MEHELY, L. (1907a): Archaeo- und Neolacerten. Ann. Mus. Nat. Hist. Hung. (Budapest), **5**: 469-493.

MEHELY, L. (1907b): A "muralis kerdes" megoldasa. Allattani Kozlemenyek (Budapest), **6**: 58-62.

MEHELY, L. (1907c): Zur Lösung der "Muralis-Frage". Ann. Mus. Nat. Hist. Hung. (Budapest), **5**: 84-88.

MEHELY, L. (1909): Materialen zu einer Systematik und Phylogenie der *Muralis*-ähnlichen Lacerten. Ann. Hist. Nat. Mus. Natn. (Budapest), **7**: 409-621.

MEHELY, L. (1910): Weitere Beiträge zur Kenntniss der Archaeo- und Neolacerten. Ann. Mus. Nat. Hung. (Budapest), **8** : 217-230, tab.VI.

MERTENS, R. (1937): Neues ueber Eidechsen-Fauna Istriens. Zool. Anzeiger, **119**: 332-336.

MERTENS, R., WERMUTH, H. (1960): Die Amphibien und Reptilien Europas. (Dritte Liste). Verlag Waldemar Kramer, Frankfurt/M., pp. 264.

MRŠIĆ, N. (1978): Prispevek k poznavanju taksonomije, zoogeografije in ekologije plazilcev Velebita. SAZU,Razprave, Ljubljana, **21**(1): 1-43.

ORLOVA, V.F., ORLOV, V.N. (1969): Hromosomnije nabori i njekotorije voprosi sistematiki jaščerici roda *Lacerta*. Zool. Žurn., Moskva, **48**(7): 1056-1060.

PAVLETIĆ, J. (1964): Amphibia i Reptilia zbirke Hrvatskog narodnog zoološkog Muzeja u Zagrebu. HNZM, Zagreb, **4**: 1-37.

PETZ, B. (1985): Osnovne statističke metode za nematematičare. SNL, ZAGREB, pp. 409.

POLJAK, Ž. (1981): Planine Hrvatske. Planinarski savez Hrvatske, Zagreb, PP. 544.

POZZI, A. (1966): Geonemia e catalogo ragionato degli Anfibi e dei Rettili della Jugoslavia. Natura, Milano, **57**(1): 5-55.

RADOVANOVIĆ, M. (1951): Vodozemci i gmizavci naše zemlje. Naučna knjiga, Beograd, pp. 249.

RADOVANOVIĆ, M. (1964): Die Verbreitung der Amphibien und Reptilien in Jugoslawien. Senck. Biol., Frankfurt/M., **45** (3/5): 553-561.

RUCNER, D., RUCNER, R. (1971): Prilog poznavanju faune nekih šumskih zajednica u Hrvatskoj. Larus, **23**: 129-201.

SCHREIBER, E. (1912): Herpetologia Europaea. Verlag Gustav Fischer, Jena, pp. 960.

SMET, DE W.H.O. (1981): Description of the orcein stained karyotypes of 36 lizards species (Lacertilia, Reptilia) belonging to the families Teiidae, Scincidae, Lacertidae,

Cordylidae and Varanidae (Autarchoglossa). Acta Zool. Pathol. Antverpiensia, **76**: 73-118.

SOCHUREK, E. (1955): Über die Warscheinlichkeit eines Vorkommens von *Lacerta horvathi* in Kärnten. Carinthia II, **65** : 154.

SOCHUREK, E. (1986): Die Kroatische Gebirgeidechse an Kärntens Grenze. OGH-Nachrichten 8, Wien.

SOKAL, R.R., ROHLF, F.J. (1973): Introduction to biostatistics. W.H.Freeman and Comp., San Francisco, pp. 368.

SOKAL, R.R., ROHLF, F.J. (1981): Biometry. W.H.Freeman and Comp.,San Francisco, pp. 859.

TADDEI, A. (1950): Le Lacerte *(Archaeolacerte* e *Podarcis)* dell'Istria e della Dalmazia. Comment., Pont. Acad. Sci., **14** (3): 137-166.

TERENTJEV, P.V., ČERNOV, S.A. (1949): Opredeljitelj presmikajuščihsja i zemnovodnih. Gosudarstvenoe izdateljstvo "Sovjetskaja nauka", Moskva.

TORTONESE, E., LANZA, B. (1968): Piccola fauna Italiana. Pesci, anfibi e rettilli. Aldo Martello Editore, Milano, pp. 185.

TVRTKOVIĆ, N. (1984): Vertikalno rasprostranjenje vodozemaca, gmazova i sisavaca (Amphibia, Reptilia, Mammalia) na sjevernom Velebitu (Hrvatska, Jugoslavija). Bilten Društva ekologa BiH, III Kongres biologa Jugoslavije, Sarajevo, B, 2(knjga 1):403-407.

WERNER, F. (1926): Zweiter Beitrag zur Fauna des Lesachtales. Carinthia II, Klagenfurt, **34/35**: 58-70.

WETTSTEIN, O. (1928): Beiträge zur Wirbeltierfauna der kroatischen Gebirge. Annalen Naturhist. Mus., Wien, **42**: 1-45.