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Georg DŽUKIĆ:
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TAXONOMIC AND BIOGEOGRAPHIC CHARACTERISTICS OF THE SLOW-WORM (*ANGUIS FRAGILIS* LINNAEUS 1758) IN YUGOSLAVIA AND ON THE BALCAN PENINSULA

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IZVLEČEK – TAKSONOMSKE IN BIOGEOGRAFSKE ZNAČILNOSTI SLEPCA (ANGUIS FRAGILIS LINNAEUS 1758) V JUGOSLAVIJI IN NA BALKANSKEM POLOTOKU – Proučevana je variabilnost zunanjih morfoloških značilnosti vrste *Anguis fragilis* LINNAEUS 1758 v Jugoslaviji in na os bvbvBalkanskem polotoku. Dokazana je prisotnost nominantne (*A.f.fragilis*) in kolhidske (*A.f.colchicus*) podvrste slepca ter kontaktne cone med njima. Določeni so areali v Jugoslaviji za vrsto *Anguis fragilis* ter obe njeni podvrsti.

ABSTRACT – The object of study is the variability of external morphological characteristics of the species *Anguis fragilis* LINNAEUS 1758 in Yugoslavia and the rest of the Balcan Peninsula. Proved is the presence of the typical (*A.f. fragilis*) and the Colchidic (*A.f. colchicus*) subspecies of slow-worm and a contact zone between them. Determined are the ranges of the species *Anguis fragilis* and both of its subspecies in Yugoslavia.

Introduction

After WERMUTH'S introduction of variational statistics (1950) which set the basis for the solution of the majority of the problems concerning intraspecific and secondary sex variability, the lizard *Anguis fragilis* became an object of intensive taxonomic investigations in the countries covered by its range. A number of works were published dealing with the material from the authors' countries or elsewhere (VOIPIO 1956, 1962, FUHN 1961, STUGREN, FUHN, POPOVICI 1962, LUKINA 1965, BEŠKOV 1966, LÁC 1967, PETZOLD 1971, DELY 1972, 1974, 1981, MUSTERS, BOSCH in den 1982). Most of the authors adopted the standpoint of WERMUTH (1950) and MERTENS & WERMUTH (1960), namely, that the slow-worm is a polytypic species represented in its vast range by three subspecies: a typical – *Anguis fragilis fragilis* L., a Colchidic – *A.f. colchicus* (NORDMANN) 1840, and a Peloponnesian – *A.f. peloponnesiacus* STÉPANEK 1937. Thus, they determined the intraspecific appurtenance of the slow-worm populations of their own national territories, and where several subspecies were present, also their interrelations and delimitations. Though not denying the polytypic character of the species Soviet authors consider the identification of the Colchidic subspecies unfounded (NIKOLJSKI 1913, 1915, TERENTJEV & ČERNOV 1936, 1949, LUKINA 1965) or suspicious (BANNIKOV, DAREVSKIJ & RUSTAMOV 1971, BANNIKOV, DAREVSKIJ, IŠČENKO, RUSTAMOV & ŠČERBAK 1977).

Due to its central position in the general range of the species, as well as the central position it occupies on the Balcan Peninsula – the only territory in which all three species meet – Yugoslavia could be neglected in no paper on the origin of the species and the subspecies, the history of the formation of the present range, the intraspecific variability, the distribution and the comparison of single populations in geographic relationships etc. However, with reference to our contry the conclusions presented in the works referring to the above mentioned problems are, to say the least of it, quite generalized. A lack of the evidential material led the authors to speculate and proceed on the basis of analogy with the surrounding regions so that in the majority of cases the opinions are definitely divided. Thus, some authors (WERMUTH 1950, MERTENS & WERMUTH 1960) believe that exclusively *Anguis f. colchicus* lives in our country, others (VOIPIO 1962, FUHN & VANCEA 1966, POZZI 1966) state, beside the typical one, also the Colchidic subspecies, with arbitrary delimitations between them, while some of them (MUSTERS & BOSCH in den 1982, HENLE 1985) have taken no definite standpoint yet.

Considerable disparities to be noticed among the characters of the populations of *A. fragilis* from the territory of Yugoslavia make the solution of the microtaxonomy and the zoogeography of the species and the research thereof quite difficult. Trying to moderate this conflict I decided upon researching the intraspecific variability of the slow-worm in our country. By means of a complex analysis of the external morphological characters on a larger number of specimmens I wished to obtain such results as to eliminate any arbitrariness from the interpretation of the taxonomic and biogeographic characteristics of this species in Yugoslavia. These results would represent also the missing link, making it possible to speak more reliantly on the geographic delimitation of the taxa within the species *Anguis fragilis.*

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1. Survey of the past investigations dedicated to the intraspecific variability of the species A. fragilis from Yugoslavia

The principal herpetological works dating back to the end of the 19th century i.e. »Herpetologia Europaea« (SCHREIBER 1875) and »Die Reptilien und Amphibien Österreich-Ungarns und der Occupationsländer« (WERNER 1897) abound with imprecisions with respect to the denominations and the distribution of the Colchidic subspecies, so it is not surprising to find a similar state of the matter reflected also in our herpetological literature of that time and the beginning of the 20th century. Even though fine experts in our herpetofauna, SCHREIBER and WERNER could state nothing definite nor generalized on this subspecies in our country. The reasons therefore could be found in the absence of the Austro-Hungarian domination over the eastern parts of Yugoslavia (cf. DŽUKIĆ 1979) and a lack of the material from this region, respectively.

The first confirmation of the presence of the subspecies *A.f. colchicus* in Yugoslavia can be found in the monography »Amphibians and Reptiles of Serbia« (DJORDJEVIĆ 1900).

DJORDJEVIĆ clearly distinguishes between the Colchidic and the typical subspecies, stating: »Some specimens of this variety make part of our collection.«[1] He does not enter into considerations on the intraspecific variability and the geographic distribution of single »varieties« but merely states the presence of the typical and the Colchidic subspecies in Serbia.

Published in 1916 was another Yugoslav work on the Colchidic subspecies i.e. SELIŠKAR's paper »Blue-Spotted Slow-Worm (*Anguis fragilis* L. var *incerta* KRYN)«. In this work SELIŠKAR specifically pointed out an interesting fact, namely, that the above-mentioned »variety« had been found at Kamniška Bistrica, far from all localities known by then, however, he made no attempt to explain it but dedicated all his attention to the description of external morphology and the problems of dependence of such a morphological type upon various factors.

In the period between the Wars, the time which saw the work of three of our greatest herpetologists (BOLKAY, KARAMAN, RADOVANOVIĆ) no special importance was attributed to the species *Anguis fragilis* and the problems connected to its intraspecific variability. Whenever discussing the slow-worm they consider it a monotypic species. It is interesting to note that not even CYRÉN (1941) who dedicates a detailed study to the relationships within the species *A. fragilis* on the Balcan Peninsula considers the Colchidic subspecies valid. As evident from his work »Beiträge zur Herpetologie der Balkanhalbinsel« (»Contributions to the herpetology of the Balcan Peninsula«) no material from Yugoslavia was at his disposal.

After the World War II the slow-worm continues to be neglected by our authors whereas elsewhere in Europe this species becomes an object of unusually intensive studies. Thus, as late as the seventies we can only speak of such investigation results concerning the problems of the intraspecific differentiation of the Yugoslav population of slow-worms as presented by foreign authors.

As pointed out before, the scientific zeal in the research of the species *A. fragilis* was initiated by WERMUTH (1950). In his principal work for the understanding of intraspecific variability he included also a material from Yugoslavia. Yugoslavia could then be found together with parts of Italy and Austria, Hungary, the major part of Rumania, Bulgaria, Albania, Greece and the European part of Turkey in the 4th region – southeastern Europe. The population of *A. fragilis* from this region was treated as unique and having been subject to a statistical analysis it revealed a series of characteristics in comparison with other regions that WERMUTH singled out from the slow-worm range.

Published in 1951 was a monography »The British Amphibians and Reptiles« (M. SMITH) the subject matter of which reaches far beyond the limits indicated by the title. In the chapter dealing with the slow-worm i.e. that part of the monography in which SMITH discusses intraspecific categories, he analyses also a material from Yugoslavia. At the time Smith was undoubtedly not familiar with WERMUTH's work so he was confronted with the same kind of problems as numerous authors before him i.e. the problems of ascertaining discontinuity in a seemingly continuous series of morphological variants so that he supported the idea of the non-existence of the Colchidic subspecies. He nonetheless devoted much attention to the blue-spotted »variety«. However, like TERENTJEV and ČERNOV (1936, 1949, 1965) he connected this phenomenon exclusively with sexually mature males. In the part in which he discusses the distribution of the blue-spotted »variety« he states that among the slow-worms from different countries he researched also a material from Yugoslavia.

MERTENS and WERMUTH (1960) generalized WERMUTH's conclusion (1950) on the microtaxonomy of slow-worms and the distribution of single subspecific taxa, consequently, there prevailed a belief that in Yugoslavia the species *Anguis fragilis* was represented by

[1] Collection of the Zoological Institute of High schod in Belgrade

the Colchidic subspecies. As also according to WERMUTH the delimitation with respect to the typical subspecies is fairly approximative it is drawn rather arbitrarily in a series of works by different authors (FUHN & VANCEA 1960, VOIPIO 1962, STUGREN, FUHN & POPOVICI 1962, PAVLETIĆ 1964, POZZI 1966, BEŠKOV 1966, LÁC 1967, DELY 1972, 1974, 1981, MUSTERS & BOSCH in den 1982).

VOIPIO (1962) makes an interesting remark, namely, that even though SMITH (1951) stated specimens with blue spots in Yugoslavia, they did not make part of the six specimens from our country as available to WERMUTH. On the basic of these facts VOIPIO drew an important conclusion i.e. that in the region of »southeastern Europe« the geographical distribution was not homogeneous. He believed that the »colchicus« characters were concentrated in the extreme southeast of this region (Rumania, Bulgaria, and Greece).

In her notes at the end of the index of amphibians and reptiles figuring in the collection of the Croatian Zoological Museum in Zagreb Jela PAVLETIĆ (1964) says that FUHN and VANCEA (1961) state the Colchidic subspecies for the eastern parts of Yugoslavia, so she considers it necessary to verify the subspecific appurtenance of the material from the localities in the region of Slavonia.

An extensive study on the zoogeography and taxonomy of Yugoslav amphibians and reptiles by the Italian author POZZI (1966) represents another example of a subjective delimitation of the intraspecific slow-worm taxa in our country. According to POZZI the typical subspecies is associated with the territory of Slovenia, Croatia and some islands whereas the Colchidic one with the central and the southern part of Yugoslavia: Bosna, Herzegovina, Montenegro, Serbia and Macedonia.

Published on the basic of preliminary investigations were the first native results on the intraspecific differentiation and distribution of *A. fragilis* in Yugoslavia (BRELIH & DŽUKIĆ 1974). We then established the presence of both subspecies, whereas *A. fragilis fragilis* is characteristic of the west of our country whereas in the east it appears only on highlands, while *A. f. colchicus* is associated with the eastern and southeastern parts of Yugoslavia, appearing merely locally in the west. We were not quite sure about the demarcation line between the subspecies, which was duly pointed out also in the paper.

A detailed analysis of slow-worms in Yugoslavia was presented by DŽUKIĆ in his Master's Thesis the results of which are incorporated in the present work.

Subjective views on the microtaxonomy, the status and delimitations of single intraspecific taxa are disclosed in the works of DELY (1981), MUSTERS and BOSCH in den 1982, and HENLE (1985), while the presence of slow-worms revealing the caracteristics of the Colchidic subspecies on the coast under the Velebit Mts. is mentioned by BANK, KRUYNTJENS & PAULISSEN (1982).

2. Material and methods

In determining the intraspecific differentiation and horizontal and vertical distribution of subspecific categories of *A. fragilis* in Yugoslavia I made use of a material from the entire territory of our country. In total I analysed 310 specimens from 135 localities. For the purposes of a comparison with populations from other territories I dealt with, in addition to the references from the literature, also with 12 specimens from Greece, Albania, and Spain.

Of totally 310 specimens 91 specimens make part of my own collection stored at the »Siniša Stanković« Institute for Biological Research (IBIS) in Belgrade, 66 specimens belong to the Natural History Museum of Slovenia (PMS) in Ljubljana, 41 to the Croatian Zoological Museum (HNZM) in Zagreb, 34 to the State Museum of Bosnia and Herzegovina (ZMBH) in Sarajevo, 23 to the herpetological collection of the late Prof. Dr. Milutin Radovanović (MR), 21 to the Natural History Museum (PMB) in Belgrade, 20 to the collection of Prof. Dr. Gojko Pasuljević (GP), 12 to the herpetological collection of the Young Researchers

»Vladimir Mandioć – Manda« (VMM) in Valjevo, 3 to the collection of Boban Zečević (BZ) from Zaječar, and 2 specimens are studied on the basis of the data presented by Dr. G. Dely.

A survey of localitiers is given in Table I and their geographical position in Fig. 1. The reference number of a locality corresponds to its number in the map.

Most of the material is preserved in 75 % alcohol and a smaller part in 4 % formalin. The specimens from the collection of B. Zečević are dermoplastic preparations.

Considerable difficulties presented themselves in the case of museum exhibits kept in sealed cylinders, as well as the material fixed in spiral form. I was not in position to study such specimens in detail. In the former case I took into consideration only the characters visible through the glass walls of the vessels whereas in the latter exact linear measures could not be taken.

In selecting morphological characters to be analysed I decided on those that proved most reliable in the course of the past studies dedicated to the problem of intraspecific differentiation of the slow-worm. In the first place the characters concerned are qualitative morphological characters, namely: 1. presence or absence of clear ear openings; 2. relation between the horny plates of the pileus; 3. colour and appearance of blue spots.

With respect to quantitative morphological characters I took into account their meaning as already ascertained and primarily made use of the number of scales in an average series around the body. Other quantitative characters are less significant than those mentioned above, that is why they are less frequently applied in analyses. I nonetheless took the following measures: 1. length of the head and the trunk (measured from snout to vent); 2. length of the tail (measured from vent to the tip of the tail); 3. length of the pileus (measured from the snout to the back margin of the occipital plate).

Statistical methods were also applied in describing and analysing the results, as well as drawing conclusions. Taken as basic parameters are the values of the above–mentioned measures (X), the number of specimens in a sample (N), and the frequency of single qualitative characters in different populations of slow-worms. Calculated by means of these parameters are arithmetic mean ($\bar{X}$) and standard error of the difference between two arithmetic means ($Sx_1 - x_2$).

The T-test was applied to define the statistic meaning of differences between two populations.

Taking into account the fact that the analysis of qualitative morphological characters yielded incomparably better results than the analysis of quantitative morphological characters, when comparing populations of *A. fragilis* from different parts of its range I considered mainly the comparison of the first characters, applying the method of hi-square test (x^2).

When testing two independent samples I entered the results into a 2×2 and calculated x^2 – test by applying the so called Yates's correction.

3. Results

3.1. Variability of basic differential characters

In the chapter on the material and the methods applied I explained in detail which morphological characters would be analysed and in what way. In presenting the results of researching the morphological characteristics of every single specimen, I made use of modified DELY's tables (1972, 1974). By adopting this manner of presenting the results one gets an insight into group as well as individual variability of slow-worms in Yugoslavia. Besides, other authors are offered a possibility of comparing the results and getting into closer contact with the material I treated. In the appendix of tables roman numbers are used to designate the following characteristics: I – running number of the specimen; II – number of the specimen in the corresponding collection; III – sex; IV – length of the head and the trunk; V – length of the tail; VI – length of the pileus; VII – presence of ear openings; VIII – pileus

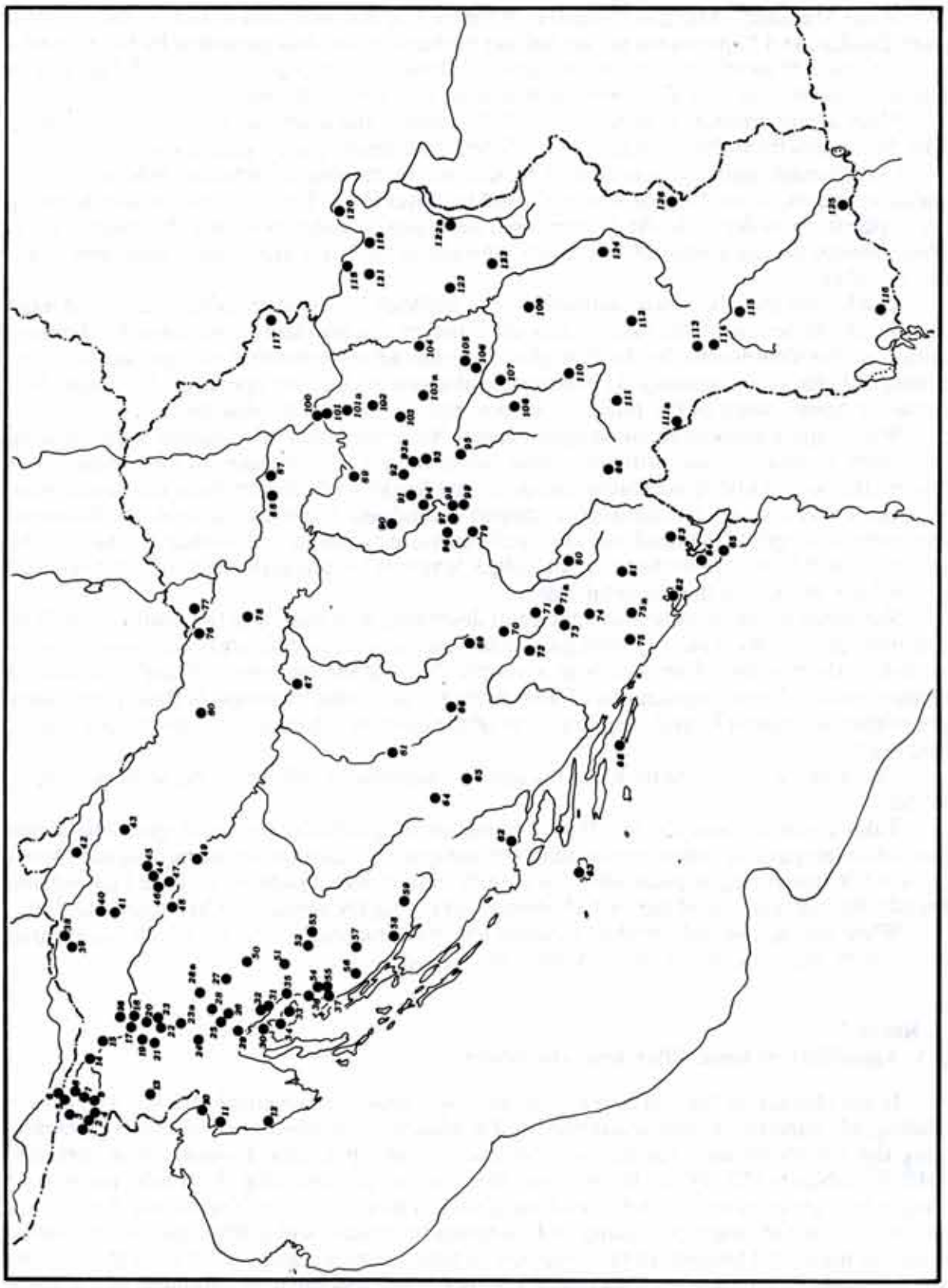

Fig. 1. Survey of the localities from which the material analysed in the present paper originates.
Slika 1. Pregled lokalitet, na katerih je bil zbran analizirani material.

Table I: Survey of localities. Tabela I: Pregled lokalitet

Locality No.	Locality
1	Slovenia: the Julian Alps: Rombon (1200–1300 m a.s.l.)
2	Slovenia: the Julian Alps: Polovnik
3	Slovenia: the Julian Alps: Mangart: Planina (highland) below Mangart
4	Slovenia: the Julian Alps: Krnsko jezero (Lake of Krn)
5	Slovenia: Kranjska gora: Martuljek: Srednji vrh
6	Slovenia: Karavanken Mts. above Gozd Martuljek: behind Lepi vrh
7	Slovenia: the Julian Alps: Triglav group: Krma (900 m a.s.l.)
8	Slovenia: the Julian Alps: Komarča
9	Slovenia: the Julian Alps: Bohinj: Ukanc
10	Slovenia: Koper
11	Croatia: Istria: Buje
12	Croatia: Istria: Rovinj
13	Slovenia: Ajdovščina
14	Slovenia: Radovljica
15	Slovenia: Kranj
16	Slovenia: Domžale
17	Slovenia: Ljubljana: Bežigrad (300 m a.s.l.)
18	Slovenia: Javor
19	Slovenia: Preserje
20	Slovenia: vicinity of Ig: Kremenica
21	Slovenia: Vrhnika: Borovnica: Kopitov grič
22	Slovenia: Mokrec
23	Slovenia: Rašica
23 a	Slovenia: Travna gora
24	Slovenia: Snežnik (highland)
25	Croatia: Gorski Kotar: Risnjak National Park: Crni Lug: Markov brlog and Velika voda
26	Croatia: Gorski Kotar: Delnice: Rogozno
27	Croatia: Gorski Kotar: Vrbovsko: Zapeć
28	Croatia: Gorski Kotar: Plešce
28 a	Slovenia: Kočevje
29	Croatia: Bakar
30	Croatia: Krk (island): Soline
31	Croatia: Novi Vinodol
32	Croatia: Crikvenica–Vinodol: Kotor
33	Croatia: Krk (island): Baška Draga
34	Croatia: Krk (island): Krk
35	Croatia: Senj
36	Croatia: Croatian seaside: Draga
37	Croatia: Jablanac
38	Slovenia: Pohorje
39	Slovenia: Pohorje: Pungert (1500 m a.s.l.)
40	Slovenia: Boč (highland): Poljčane (850 m a.s.l.)
41	Slovenia: Podčetrtek

Locality No.	Locality
42	Slovenia: Slovenske Gorice: Miklavž
43	Croatia: Mali Kalnik
44	Croatia: Medvednica (highland): Medvedgrad
45	Croatia: Medvednica (highland): Kraljičin zdenac
46	Croatia: Medvednica (highland):
47	Croatia: Zagreb
48	Croatia: Samobor
49	Croatia: Turopolje: Peščenica
50	Croatia: Ogulin
51	Croatia: Velika kapela (highland): Razvala
52	Croatia: Vrhovine: Doljani: Topoluša (800–1000 m a.s.l.)
53	Croatia: Vrhovine: Donji Babin Potok: Borića Borik (850 m a.s.l.)
54	Croatia: Velebit (highland): Zavižan
55	Croatia: Velebit (highland): Golić (1450 m a.s.l.)
56	Croatia: Velebit (highland): Oštarije
57	Croatia: Lika: Gospić
58	Croatia: Velebit (highland): Paklenica
59	Croatia: Velebit (highland): Predzid (660–750 m a.s.l.)
60	Croatia: Slavonia: Voćin
61	Bosnia and Herzegovina: vicinity of Jajce
62	Croatia: Split: Marjan (locality under justified suspicion)
63	Croatia: Vis (island)
64	Bosnia and Herzegovina: Glamoč
65	Bosnia and Herzegovina: Livno
66	Bosnia and Herzegovina: Vranica (highland)
67	Bosnia and Herzegovina: Derventa
68	Croatia: Mljet (island): Govedjari
69	Bosnia and Herzegovina: Igman (highland): Donja Grka–Veliko polje
70	Bosnia and Herzegovina: Treskavica (highland)
71	Bosnia and Herzegovina: Zelengora (highland): Gornje bare
71 a	Bosnia and Herzegovina: Čemerno
72	Bosnia and Herzegovina: Crvanj (highland)
73	Bosnia and Herzegovina: Bjelašica
74	Bosnia and Herzegovina: Korito
75	Bosnia and Herzegovina: Trebinje
75 a	Montenegro: Vilusi
76	Croatia: Slavonia: Valpovo
77	Croatia: Baranja: Haljevo (forest)
78	Croatia: Slavonia: Djurdjanci
79	Bosnia and Herzegovina: vicinity of Višegrad
80	Montenegro: Durmitor (highland): Zminje jezero (lake)
81	Montenegro: Nikšić
82	Montenegro: Donja Lastva (locality under justified suspicion)
83	Montenegro: Podgorica–Titograd
84	Montenegro: Crmnica: Brčeli
85	Montenegro: Novi Bar
86	Montenegro: Ivangrad: Rovca
87	Serbia: Voivodina: Fruška gora (highland)

Locality No.	Locality
88	Serbia: Voivodina: Fruška gora (highland): Andrevlje
89	Serbia: Debrc: Vlasanica
90	Serbia: Sokolske planine: Šljivova
91	Serbia: foot of Jablanik (highland): Poćuta: Bebića Luka
92	Serbia: Valjevo: Ribnička klisura
93	Serbia: Maljen (highland): Divčibare
93 a	Serbia: Osečenica: Bunčevica
94	Serbia: Ljubovija: Gornja Trešnjica
95	Serbia: vicinity of Užička Požega: Glumač, Bakionica, Zdravčići
96	Serbia: Tara (highland): Vidikovac
97	Serbia: Tara (highland): Tarabića brdo
98	Serbia: Tara (highland): Djurdjevo brdo
99	Serbia: Tara (highland): Vežanja
100	Serbia: Belgrade: Topčider
101	Serbia: Belgrade: Košutnjak
101 a	Serbia: Avala (highland)
102	Serbia: Kosmaj (highland)
103	Serbia: Bukulja (highland)
103 a	Serbia: Rudnik (highland): eastern slopes
104	Serbia: Batočina: Rogot (forest) (129 m a.s.l.)
105	Serbia: Gledničke planine
106	Serbia: Vitanovac
107	Serbia: Goč (highland): Brezjanska kosa
108	Serbia: Studenica: Savovo
109	Serbia: Jastrebac: Prokopačka kosa
110	Serbia: Kosovo: Leposavić: Gnje, dani
111	Serbia: Kosovo: the East
111 a	Serbia: Kosovo: Babaj Boks
112	Serbia: Kosovo: Priština: Grmija
113	Serbia: Kosovo: Šara: Brezovica
114	Serbia: Kosovo: Šara: Piribeg
115	Macedonia: the Treska Canyon
116	Macedonia: Pelister (highland): Begova česma
117	Serbia: Voivodina: Vršački breg
118	Serbia: Djerdap: Dobra
119	Serbia: Donji Milanovac
120	Serbia: Tekija: the Kašljinska reka (river)
121	Serbia: Majdanpek: Blagojev Kamen
122	Serbia: Sisevac
122 a	Serbia: vicinity of Zaječar
123	Serbia: Ozren (highland)
124	Serbia: Vučje: canyon of the Vučjanka river
125	Macedonia: Kožuf (highland)
126	Serbia: Bistar
Slov.	Slovenia without a precisely stated locality
Hrv.	Croatia without a precisely stated locality
Srb.	Serbia without a precisely stated locality
Kos.	Kosovo without a precisely stated locality
E	Spain: Mont Serrat

Locality No.	Locality
GR 1	Greece: Olympia: Kladeos (valley)
GR 2	Greece: Akarnanien
AL 1	Albania: Kanina
AL 2	Albania: Valona: Parha Liman
AL 3	Albania: Velipoja
AL 4	Albania (northern part)

type; IX – number of scales in an average series around the body; X – presence of blue spots; XI – date of the finding; and XII – number of the locality. Presence and absence of a qualitative morphological character is designated as + and –, respectively. Only in the case of the existence of a depression in the place of an ear opening the sign = (according to DELY 1974) is used. The abbreviations reg. and def. accompanying the linear measures in the tail length column indicate whether the tail is regenerated or defective.

As ensuing from the table, the number of localities and their geographic position are directly interdependent. Already in identifying the localities by means of numbers I decided upon a succession from lower to higher numbers, starting from the northwest towards the southeast. My decision was based on WERMUTH's conclusions (1950), namely, that from a global point of view morphological characters of the slow-worm, especially those taxonomically important, vary in the function of longitude. In my belief such an approach was methodologically the most appropriate as it provides answers to the fundamental questions of morphological variability and geographical distribution of single variants in the territory of Yugoslavia.

With respect to the frequency of positively linked intraspecific characters the material investigated was divided in three groups.

3.1.1. Groups of individuals with dominant characters of the typical subspecies

Gathered in the first group (Table 2) are all individuals characterized by the domination of the characters of the typical subspecies, as well as some specimens with a more marked presence of the »colchicus« characters originating from localities in the region of *A. fragilis fragilis*. The majority of slow-worms, no less than 215 specimens (72 %) proved to belong to this group. Not only does this population dominate in number but it also covers more or less the entire territory of our country. The region includes the whole of Slovenia, almost all of Croatia, Bosnia and Herzegovina, a large part of Montenegro and western Serbia with Kosovo (Fig. 2).

Table II: Results of investigating the typical subspecies of the slow-worm (*Anguis fragilis*) from Yugoslavia.
Tabla II: Rezultati raziskav nominantne podvrste slepca *(Anguis fragilis)* iz Jugoslavije.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	PMS s.n.	♂	/	/	/	/	/	/	/	30. 10. 1955	1
2.	PMS s.n.	♀	/	/	/	/	/	/	/	30. 10. 1955	1
3.	PMS 135	juv	39	36	/	/	/	/	/	2. 11. 1955	1
4.	PMS 134	juv	/	/	/	/	/	/	/	2. 11. 1955	1
5.	PMS 135	juv	/	/	/	/	/	/	/	2. 11. 1955	1
6.	PMS 136	juv	/	/	/	/	/	/	/	2. 11. 1955	1
7.	PMS 137	juv	39,5	36	/	/	/	/	/	3. 11. 1955	1
8.	PMS 138	juv	41,5	40,5	/	/	/	/	/	3. 11. 1955	1
9.	PMS 139	juv	42	41	/	/	/	/	/	3. 11. 1955	1
10.	PMS 140	juv	39	34	/	/	/	/	/	4. 11. 1955	1
11.	PMS 141	juv	42	38	/	/	/	/	/	4. 11. 1955	1
12.	PMS 142	juv	41	40	/	/	/	/	/	4. 11. 1955	1
13.	PMS 143	juv	43	35,5	/	/	/	/	/	4. 11. 1955	1
14.	PMS 4368	♂	175	128 d.	15	--	C	24	+	11. 07. 1974	2
15.	PMS 3217	♂	171	208	15	--	C	26	-	28. 07. 1973	3
16.	IBIS 610/L	♀	203	216	14,4	==	B	25	-	4. 07. 1975	4
17.	PMS 4241	♀	203	36 d.	14,3	==	A	26	-	11. 08. 1973	5
18.	PMS 4400	♀	156	196	12	--	C	25	-	23. 08. 1974	5
19.	PMS 4056	♂	238	305	18,9	==	B	26	+	19. 03. 1971	6
20.	PMS 4218	♀	188	42 d.	14,6	==	C	26	-	27. 07. 1973	6
21.	PMS 3420	juv	80	85	6	--	A	26	-	18. 08. 1967	7
22.	PMS 3486	juv	93	107	6,7	--	A	26	-	11. 06. 1968	7
23.	PMS 4386	o	193	230	14,5	==	B	26	+	juli 1974	8
24.	PMS 332	/	/	/	/	/	/	/	/	1956	9
25.	IBIS 611/L	♂	179	90 r.	16	==	A	28	-	10. 07. 1975	10

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
26.	IBIS 612/L	♀	127	141	11	−−	B	26	−	10. 07. 1975	10
27.	IBIS 614/L	juv	85	89	8,3	−−	B	25	−	10. 07. 1975	10
28.	IBIS 317/L	♀	240	135 r.	13,4	−−	A	27	−	1973	11
29.	IBIS 318/L	♂	235	77 r.	18,3	==	A	26	−	1973	11
30.	PMS 3446	♀	/	/	/	/	/	/	−	17. 04. 1968	12
31.	IBIS 584/L	juv	/	/	/	/	/	/	/	maj 1976	12
32.	IBIS 606/L	♂	225	180 r.	18,4	=−	A	26	−	23. 06. 1976	12
33.	PMS 3541	♂	222	132 r.	18,6	−−	C	24	+	maj 1968	13
34.	PMS 3906	♂	128	100 r.	11,0	==	C	24	−	4. 05. 1970	14
35.	PMS 3705	♀	175	106 r.	13,7	−−	A	27	−	sept. 1968	15
36.	PMS 3787	?	196	216	12,8	=−	A	25	−	9. 05. 1969	15
37.	PMS 3794	?	161	192	11,5	+=	A	28	−	16. 05. 1969	15
38.	PMS 3417	♂	202	95 r.	16,6	++	B	28	+	april 1967	16
39.	PMS 3539	♀	172	198	12,2	−−	A	25	−	1. 06. 1968	17
40.	PMS 3934	♀	210	73 r.	14,4	−−	B	24	−	15. 08. 1970	17
41.	PMS 3683	♀	199	128 r.	/	−−	A	/	−	1968	18
42.	PMS 3684	♂	129	153	16	−−	A	26	−	1968	18
43.	PMS 3685	♂	210	234	16,9	−−	A	24	−	1968	18
44.	PMS 3905	♂	220	170 r.	17,4	−−	B	26	+	9. 05. 1970	19
45.	PMS 3808	♂	166	129 r.	15	==	C	24	+	15. 05. 1970	20
46.	PMS 3914	♂	187	80 r.	15,8	−−	B	24	−	19. 06. 1970	20
47.	PMS 3923	♂	191	74 r.	15,8	−−	A	25	+	24. 07. 1970	20
48.	PMS 4086	♀	170	150 r.	13	−−	A	24	−	4. 07. 1972	20
49.	PMS 4160	♂	171	109 r.	15,7	−−	A	24	−	1972/73	20
50.	PMS 4161	♀	137	164	10,9	−−	A	23	−	1972/73	20
51.	IBIS 315/L	♂	233	164 r.	17,4	−−	A	25	+	1. 08. 1973	20
52.	PMS 3951	♂	231	270	17,8	−−	B	26	−	22. 06. 1971	21
53.	PMS 3952	♀	192	138 r.	14,5	−−	A	24	−	22. 06. 1971	21

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
54.	PMS s.n.	♂	230	250	17,3	--	A	28	+	16. 05. 1966	22
55.	PMS s.n.	♂	180	240	15,9	--	A	24	+	14. 05. 1966	23
56.	PMS 4158	♀	215	213 r.	14,2	--	B	25	-	1972	24
57.	MR 1	♀	140	150	11	--	A	26	-	28. 08. 1963	25
58.	MR 2	♂	115	165	10	==	C	24	-	19. 09. 1963	25
59.	IBIS 204/L	♀	175	195	12,1	--	A	24	-	19. 05. 1971	26
60.	IBIS 286/L	♂	212	85 r.	15,3	--	B	25	-	19. 05. 1971	26
61.	HNZM 2023	♀	145	145 r.	11,9	--	A	26	-	15. 07. 1933	27
62.	HNZM 717	♀	240	40 d.	14,8	--	A	24	-	20. 08. 1905	28
63.	HNZM 698	♀	190	200	13,1	--	B	27	-	3. 10. 1903	29
64.	HNZM 700	♂	100	120	11	--	B	26	-	5. 10. 1903	29
65.	HNZM 701	♀	190	150 r.	13,7	--	A	26	-	18. 10. 1904	29
66.	HNZM 703	♂	160	40 d.	14,3	=-	B	26	-	12. 09. 1903	29
67.	HNZM 706	♂	170	30 d.	14,9	==	A	27	+	30. 05. 1905	29
68.	HNZM 729	juv	/	/	/	/	/	/	/	22. 04. 1905	29
69.	HNZM 730	juv	/	/	/	/	/	/	/	22. 04. 1905	29
70.	MR 3	♀	130	190	12	--	A	24	-	22. 08. 1964	30
71.	HNZM 721	♀	200	130 r.	13,6	--	A	25	-	sept. 1902	31
72.	MR 11	♂	200	90 r.	16,5	--	A	26	-	20. 04. 1964	32
73.	PMS 3540	♀	191	182 r.	13,9	--	A	26	-	1968	33
74.	IBIS 486/L	♀	128	81 r.	10,8	==	A	25	-	17. 07. 1975	34
75.	HNZM 710	juv	/	/	/	/	/	/	/	1. 03. 1911	35
76.	HNZM 694	♀	190	100 r.	14	--	A	25	-	1908	36
77.	HNZM 724	♀	125	115 r.	10,7	==	A	26	-	21. 1. 1909	37
78.	HNZM 725	♂	/	/	/	--	C	/	-	21. 01. 1909	37
79.	HNZM 726	♂	/	/	/	==	B	/	-	21. 01. 1909	37
80.	PMS 3870	♀	155	189	12,1	=-	A	26	-	20. 07. 1969	38
81.	PMS 4268	♀	156	175	11,1	--	A	24	-	4. 09. 1973	39

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
82.	PMS 40	?	/	/	/	/	/	/	/	1954	40
83.	PMS 4387	♀	169	195	12,5	==	B	24	–	juli 1974	41
84.	PMS 3421	♀	180	60 d.	12,5	––	C	24	–	12. 08. 1967	42
85.	HNZM 705	♂	265	85 r.	19,3	=–	B	26	+	3. 09. 1902	43
86.	HNZM 702	♂	/	/	/	/	A	/	–	8. 06. 1905	44
87.	HNZM 720	♀	215	115 r.	13,7	––	A	24	–	8. 08. 1902	45
88.	IBIS 508/L	♀	220	280	12,3	––	A	25	–	1976	46
89.	IBIS 516/L	♀	188	225	13,6	––	A	26	–	1976	46
90.	HNZM 699	♂	220	170 r.	16,5	==	B	26	+	8. 06. 1905	47
91.	HNZM 704	♀	160	190	12,1	––	C	24	–	31. 10. 1902	47
92.	HNZM 695	♀	210	200 r.	13	==	B	25	–	23. 05. 1904	47
93.	HNZM 708	♂	80	80	7,4	––	B	26	–	15. 07. 1905	47
94.	HNZM 716	♂	/	d.	17	––	B	27	+	15. 07. 1905	47
95.	HNZM 719	♂	175	95 r.	16,3	==	A	27	–	12. 04. 1903	47
96.	HNZM 727	juv	/	/	/	/	/	/	/	1929	47
97.	IBIS 203/L	♂	235	115 r.	16,5	––	A	25	+	20. 05. 1971	47
98.	IBIS 379/L	♂	150	170	13,4	––	A	24	+	april 1975	47
99.	IBIS 402/L	♂	160	122 r.	13,2	––	A	24	–	15. 05. 1979	47
100.	IBIS 517/L	♂	210	266	15,6	==	B	25	–	4. 07. 1976	47
101.	IBIS 518/L	♀	201	98 r.	14,2	==	B	26	–	4. 07. 1976	47
102.	HNZM 722	♀	165	115 r.	13	==	A	24	–	26. 07. 1915	48
103.	IBIS 403/L	♂	212	274	16,4	––	B	26	+	11. 05. 1975	48
104.	IBIS 478/L	♂	243	245 r.	16,7	==	B	26	+	mart 1975	49
105.	HNZM 697	♀	199	136 r.	14	––	A	25	–	5. 06. 1912	50
106.	PMS 3657	♂	172	84 r.	13,5	––	B	26	–	juli 1968	51
107.	PMS 3664	♀	188	200	13,3	––	A	24	–	juli 1968	51
108.	MR 24	♀	120	120	8	––	B	26	–	18. 10. 1961	52
109.	MR 23	juv	/	/	/	/	A	/	/	11. 05. 1962	53

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
110.	PMS 4194	♀	178	202	13,5	−−	A	26	−	3. 07. 1973	54
111.	PMS 4195	♀	186	194	12,5	−−	A	24	−	5. 07. 1973	54
112.	PMS 4196	♀	179	195	12,4	−−	A	25	−	4. 07. 1973	54
113.	IBIS 519/L	♀	188	210	12	−−	A	26	−	31. 08. 1976	55
114.	HNZM 709	♂	115	150	10,4	−−	C	26	−	27. 07. 1903	56
115.	PMS 3660	♂	137	168	/	−−	C	/	/	1968	56
116.	HNZM 723	♂	195	145 r.	15,7	==	C	26	+	1915	57
117.	IBIS 507/L	♀	147	d.	11,4	−−	A	24	−	30. 05. 1976	58
118.	IBIS 489/L	♂	218	265	15,3	==	B	25	−	5. 07. 1975	59
119.	IBIS 487/L	♀	190	220	12,7	==	A	25	−	7. 07. 1975	59
120.	MR 5	juv	40	50	/	/	/	/	/	23. 08. 1957	61
121.	PMB 162 a	♂	187	127 r.	15,2	−−	A	25	−	25. 05. 1949	62
122.	PMB 162 b	♀	165	224	9	==	A	25	−	25. 05. 1949	62
123.	PMB 162 c	♀	120	151	10,6	−−	A	25	−	25. 05. 1949	62
124.	MR 7	juv	55	60	6	−−	C	26	−	18. 04. 1949	63
125.	ZMBH 9	♂	165	133 r.	14,5	++	C	26	+	1898	64
126.	ZMBH 10	♀	160	170	12,6	==	B	26	−	1898	64
127.	ZMBH 15	♀	235	235 r.	14,2	−−	A	26	−	avg. 1913	65
128.	ZMBH 16	♀	240	82 r.	15,1	−−	A	26	−	avg. 1913	65
129.	ZMBH s.n.	♂	195	250	16,6	−−	A	26	−	18. 07. 1953	66
130.	ZBMH s.n.	♀	225	210 r.	16	−−	A	25	−	18. 07. 1953	66
131.	ZBMH s.n.	♀	170	94 r.	12,1	−−	B	24	−	18. 07. 1953	66
132.	ZMBH s.n.	♂	130	160	10,7	−−	A	26	−	18. 07. 1953	66
133.	ZMBH s.n.	♂	100	110	8,6	−−	A	24	−	18. 07. 1953	66
134.	ZMBH 21	♀	210	180 r.	14	−−	A	26	−	26. 12. 1894	67
135.	VMM 9	♂	75	130	9,2	−−	B	27	−	8. 07. 1970	68
136.	ZMBH s.n.	♀	235	253	15,6	−−	A	24	−	21. 07. 1950	69
137.	IBIS 365/L	♂	165	195	12,7	−−	A	24	−	1. 08. 1974	69

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
138.	IBIS 366/L	♀	173	55 r.	12,3	--	B	24	-	1. 08. 1974	69
139.	ZMBH 28	♀	173	180	12,2	--	A	24	-	5. 08. 1912	70
140.	PMS 3880	♂	165	185	12,6	--	A	26	-	23. 07. 1969	70
141.	IBIS 615/L	juv	90	115	7,8	--	B	25	-	2. 09. 1977	71
142.	ZMBH 20	♀	203	195 r.	15	==	A	26	-	juli 1913	72
143.	ZMBH 21	♀	210	180 r.	14	--	A	26	-	juli 1913	72
144.	PMB 33 a	♂	201	80 r.	16	--	A	25	-	30. 04. 1937	79
145.	PMB 33 b	♂	160	72 d.	12,5	==	A	25	-	3. 05. 1937	79
146.	Dely	♀	/	/	/	--	A	24	-	1. 07. 1958	80
147.	Dely	♀	/	/	/	--	A	24	-	1. 07. 1958	80
148.	GP 20	♀	188	137 r.	13,2	--	B	24	-	avg. 1975	82
149.	GP 4	♀	160	182	12,5	--	A	25	-	7. 07. 1975	86
150.	GP 5	♀	135	130 d.	11,3	--	A	25	-	7. 07. 1975	86
151.	IBIS 505/L	♀	190	220	12,3	--	A	24	-	20.06.1976	89
152.	IBIS 506/L	♀	190	80 r.	13,5	--	A	24	-	26.06.1976	89
153.	VMM 144	♀	125	195 r.	/	--	A	24	-	22.07.1976	90
154.	VMM 145	♀	240	285 d.	/	--	A	25	-	22.07.1976	90
155.	VMM 3	♀	155	190	12	--	A	26	-	8.07.1975	91
156.	VMM 4	♀	178	212	13,2	--	B	24	-	4.07.1975	91
157.	VMM 5	♀	163	47 d.	12,6	--	A	25	-	juli 1975	91
158.	VMM 28	♀	139	205	12,9	--	A	25	-	24.08.1975	91
159.	VMM 2	♂	185	80 r.	15,7	--	A	24	-	5.05.1974	92
160.	PMB 173	♀	223	185 r.	15	==	A	24	-	14.08.1959	93
161.	VMM 1	♂	225	75 d.	16,5	==	A	24	+	juli 1972	94
162.	VMM 7	♀	143	182	11,7	--	A	25	-	21.07.1972	94
163.	MR 12	♀	160	160 r.	11	==	B	26	-	6.04.s.a.	95
164.	PMB 110 a	♀	120	140	10,4	--	B	24	-	13.07.1965	96
165.	PMB 110 b	♀	130	165	10,3	==	B	25	-	13.07.1965	96

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
166.	PMB 189	♀	125	153	9,6	==	A	25	–	23.07.1963	96
167.	PMB 184	♀	115	120	9,6	––	A	26	–	4.08.1962	97
168.	IBIS 99/L	juv	86	98	8,8	==	B	25	–	11.06.1969	98
169.	IBIS 100/L	juv	100	121	9	=+	A	25	–	11.06.1969	98
170.	VMM 6	♀	180	220	9,4	––	A	26	–	16.07.1973	99
171.	GP 7	♀	155	80 d.	11,5	––	A	25	–	1–15.05.1973	110
172.	GP 8	♀	250	130 r.	17	–=	B	26	–	5.06.1973	110
173.	GP 9	♀	260	100 r.	16,2	––	A	26	–	6.05.1973	110
174.	GP 10	♂	240	250	16,1	==	B	24	–	6.05.1973	110
175.	GP 11	♀	190	220	13,7	==	A	25	–	6.05.1973	110
176.	GP 12	♀	140	180	11	––	A	26	–	5.06.1973	110
177.	GP 2	♀	183	35 d.	13,2	––	A	26	–	27.11.1970	111
178.	GP 13	♂	200	270 d.	18	––	B	24	–	9.05.1970	112
179.	GP 1	♀	162	168	12,6	––	A	24	–	10.05.1970	113
180.	GP 18	♂	260	70 d.	17	––	A	24	–	s.a.	113
181.	GP 19	♂	240	170 r.	17	––	A	24	–	s.a.	113
182.	GP 6	♀	240	170 r.	17	––	A	24	–	6.06.1973	114
183.	PMS 3149	♀	/	/	11,1	––	C	26	–	s.a.	Slov.
184.	PMS 3150	♂	/	/	11,2	––	A	24	–	s.a.	Slov.
185.	HNZM 711	♂	155	265	14,4	==	C	26	–	s.a.	Hrv.
186.	HNZM 712	♂	/	/	/	/	B	/	–	s.a.	Hrv.
187.	HNZM 713	♂	95	125	8,7	––	C	24	–	s.a.	Hrv.
188.	HNZM 714	♂	80	90	8,8	––	B	26	–	s.a.	Hrv.
189.	HNZM 715	♂	145	145 r.	14,2	=–	A	25	–	s.a.	Hrv.
190.	IBIS 490/L	♀	145	202	12,2	==	B	26	–	leto 1970	Hrv.
191.	MR 13	♂	250	190 r.	17	==	A	23	–	s.a.	Srb.
192.	MR 14	♀	189	83 r.	14	==	A	26	–	s.a.	Srb.
193.	MR 15	♂	215	237	16	==	B	26	–	s.a.	Srb.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
194.	MR 17	♀	150	80 r.	11	==	B	25	–	s.a.	Srb.
195.	MR 17	♀	158	142 r.	11	==	A	25	–	s.a.	Srb.
196.	MR 18	♀	160	120 r.	12	––	B	24	–	s.a.	Srb.
197.	MR 19	♀	190	40 d.	12	==	A	26	–	s.a.	Srb.
198.	MR 20	♂	152	130 r.	12	==	B	24	–	s.a.	Srb.
199.	MR 21	♀	170	170 r.	11	==	B	26	–	s.a.	Srb.
200.	MR 22	♀	145	,, d.	10	==	B	24	–	s.a.	Srb.
201.	GP 14	♂	140	195	11,6	––	A	25	–	s.a.	Kos.
202.	GP 15	♂	260	60 d.	18,1	==	B	26	–	s.a.	Kos.
203.	GP 16	♀	200	80 d.	13,3	––	A	26	–	s.a.	Kos.
204.	GP 17	♀	150	30 d.	11,9	––	A	25	–	s.a.	Kos.
205.	PMS 3423	♀	125	145	10	––	A	25	–	s.a.	28 a
206.	IBIS 613/L	♂	163	180	13,3	––	A	24	–	10.07.1975	23 a
207.	IBIS 608/L	♀	204	138 r.	14,8	––	A	25	–	juni 1975	23 a
208.	IBIS 609/L	♂	199	246	14,9	––	A	25	–	6.07.1975	40
209.	IBIS 205/L	juv	/	/	/	/	A	/	/	juli 1971	47/26
210.	IBIS 206/L	juv	/	/	/	/	A	/	/	juli 1971	47/26
211.	IBIS 207/L	juv	/	/	/	/	A	/	/	juli 1971	47/26
212.	IBIS 208/L	juv	/	/	/	/	A	/	/	juli 1971	47/26
213.	PMB 149	♀	147	185	12,3	==	A	24	–	25.07.1965	97
214.	PMS 4159	♀	222	85 d.	16	––	A	24	–	1972	24
215.	PMS 3634	♂	/	/	16,2	––	B	26	–	s.a.	23

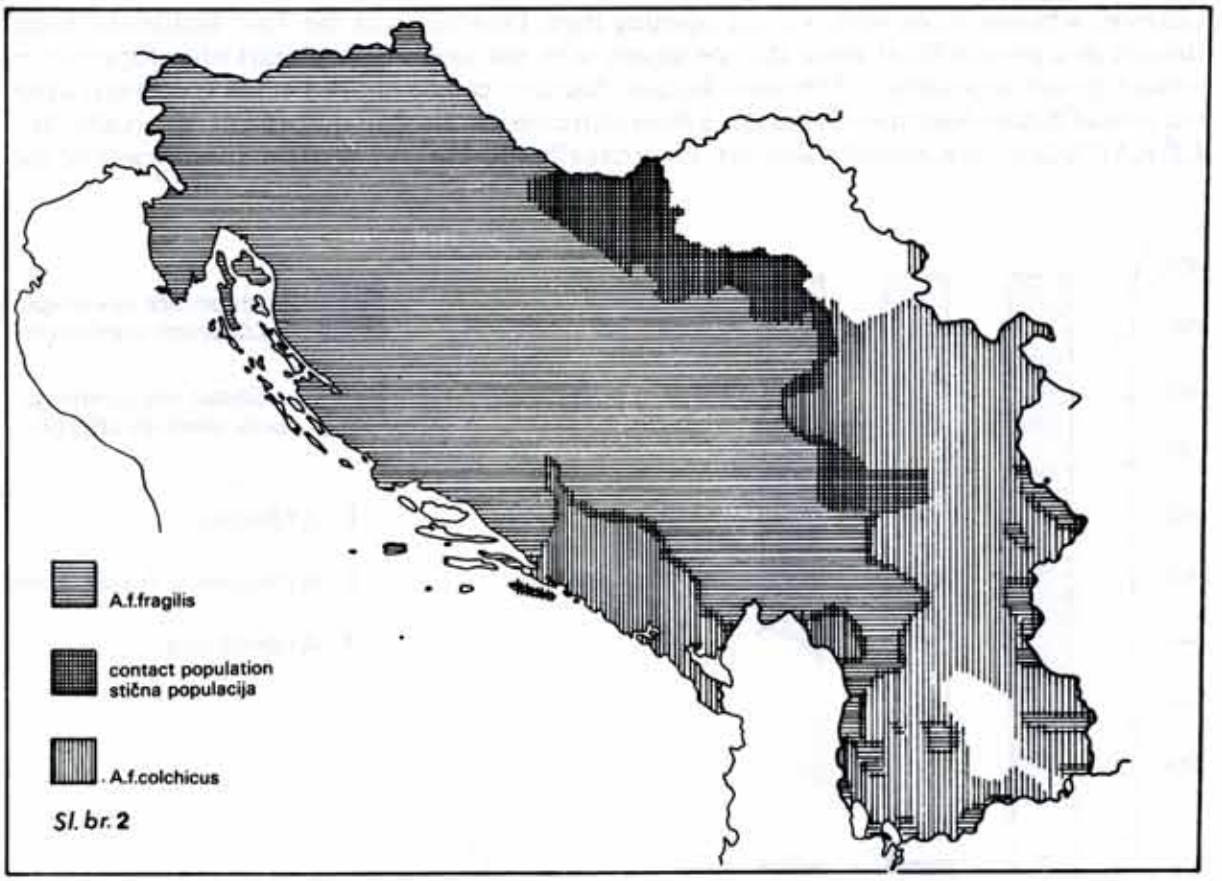

Fig. 2. Distribution and delimitation of the typical and the Colchidic subspecies of the slow-worm in Yugoslavia.

Slika 2. Razširjenost nominantne in kolhidske podvrste slepca v Jugoslaviji.

Due to the reasons explained in the chapter on the material and the methods applied as well as the inadequacy of juvenile specimens, it was impossible to subject every single specimen to the analysis of all basic differential characters. An analysis of presence or absence, respectively, of clear ear openings was performed on 186 specimens of this population, furthermore, an analysis of the relation among horny pileus plates on 192 specimens, and the presence of blue spots on all of 215 specimens. The presence of blue spots could only be ascertained in males so that for further treatment and comparisons calculations were prepared only on 76 males of this population. The number of scales in an average series around the body was established in 182 specimens.

3.1.1.1. Ear openings

With respect to the existence of clear ear openings in slow-worms making part of the first group the situation is as follows:

++	+=	==	=−	−−	n
1.1 %	1.1 %	27.4 %	4.3 %	66.1 %	2+2+51+8+123 = 186

Only four specimens had ear openings two of which had an ear depression on one side of the head only. The specimens with symmetrical ear openings originate from Kranj and

Glamoč, whereas those with one ear opening from Domžale and the Tara highlands. Even though in a geographical sense the specimens with ear openings are markedly dispersed, a certain grouping tendency of the »colchicus« character can be noticed in the specimens from the area of Kranj–Kamnik–Domžale. Taken into consideration in the present case is also SELIŠKAR's date on Kamniška Bistrica. Procentually speaking 2.2 % of the specimens had ear

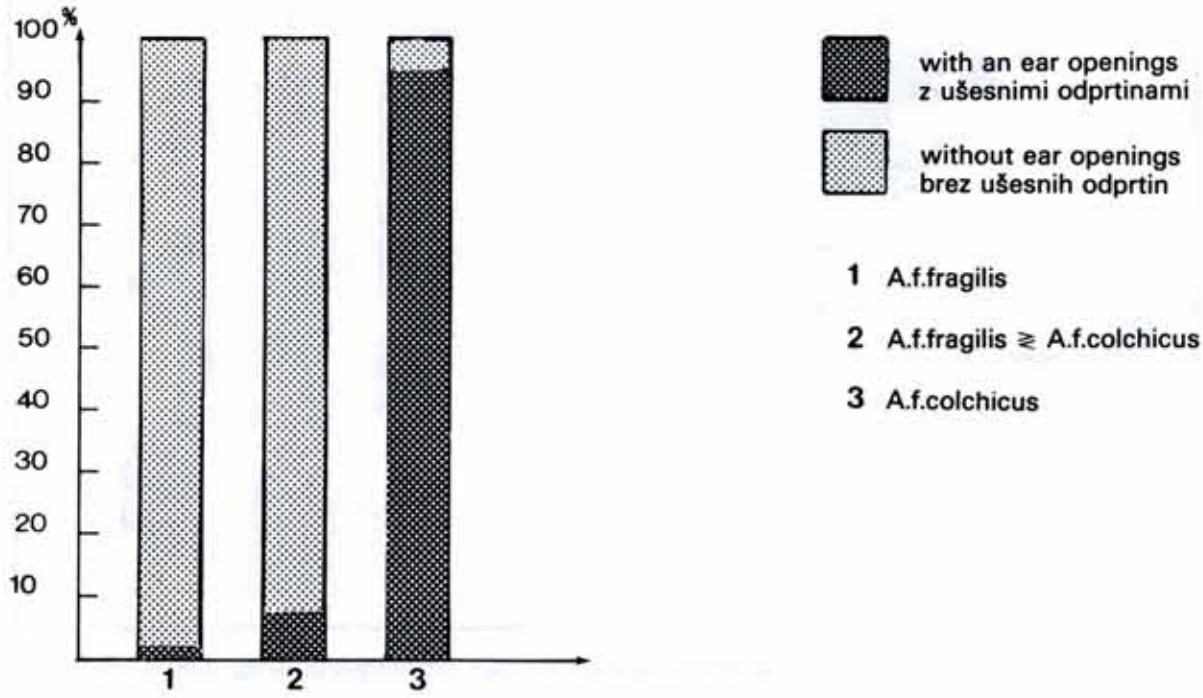

Fig. 3. Procentual frequency of the occurrence of ear openings within three slow-worm populations in Yugoslavia.

Slika 3. Odstotna zastopanost pojavljanja ušesnih odprtin znotraj treh populacij slepca v Jugoslaviji.

openings whereas in 97.8 % (Fig. 3) the ear openings were perfectly covered. A marked feature of this population of slow-worms in Yugoslavia is the absence of ear openings.

3.1.1.2. Pileus

Various possibilities of the position of prefrontal plates are shown in Fig. 4 and the following table:

Pileus Type A	Pileus Type B	Pileus Type C	n
62.0 %	29.2 %	8.8 %	119 + 56 + 17 = 192

As evident from the above, in the majority of specimens the prefrontal plates come into contact at considerable lenght, in one third thereof they touch one another in one point, whereas the number of specimens in which the prefrontal plates are separated from one another by the inter nasal shield and the frontal shield is very small.

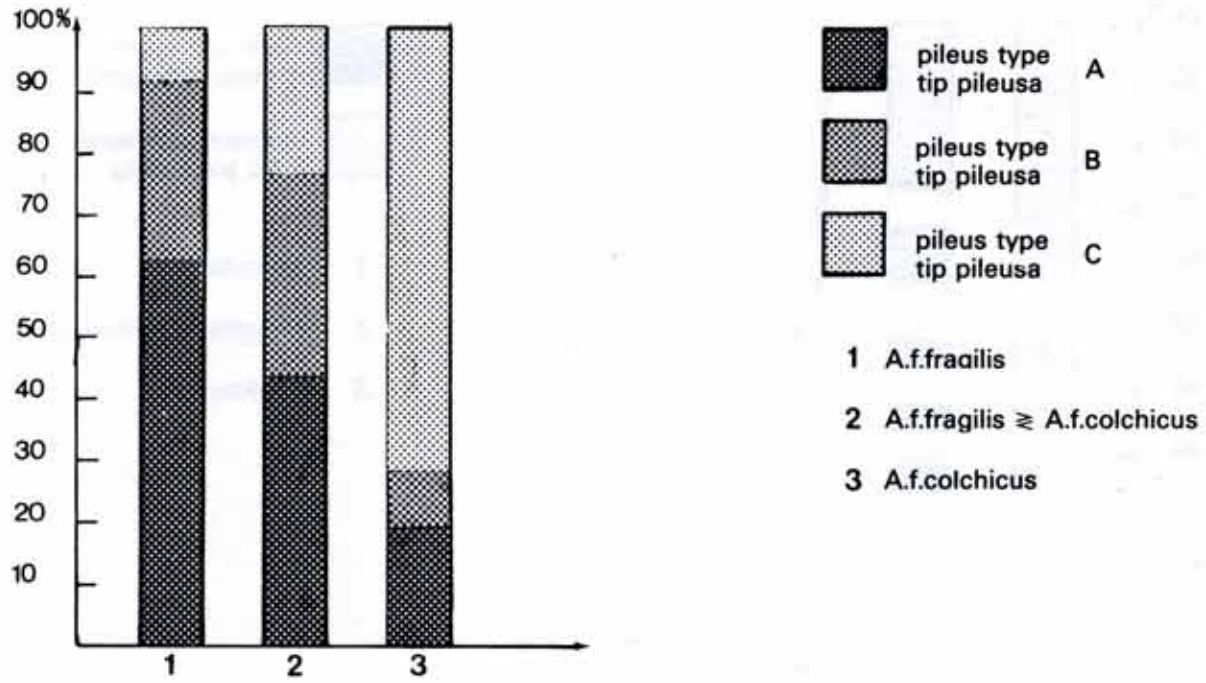

Fig. 4. Procentual frequency of the occurrence of single pileus types within three slow-worm populations in Yugoslavia.

Slika 4. Odstotna zastopanost pojavljanja posameznih tipov pileusa znotraj treh populacij slepca v Jugoslaviji.

3.1.1.3. Blue spots

Blue spots represent the third variable character important to the microtaxonomy of slow-worms. Relative frequency of this character within the first group of individuals is as follows:

+	−	n
30.3 %	69.7 %	23 + 53 = 76

A graphical illustration of the result is shown in Fig. 5. The appearance of spots in the specimens making part of the slow-worm group with dominant characters of the typical subspecies is quite frequent, taking into account the fact that it is characteristic of one third of the males.

3.1.1.4. Number of scales

The number of scales in an average series around the body represents one of the most important as well as stable differential characters of slow-worms. In the first population the frequency of specimens with a definite number of scales around the body is evident from the table and Fig. 6.

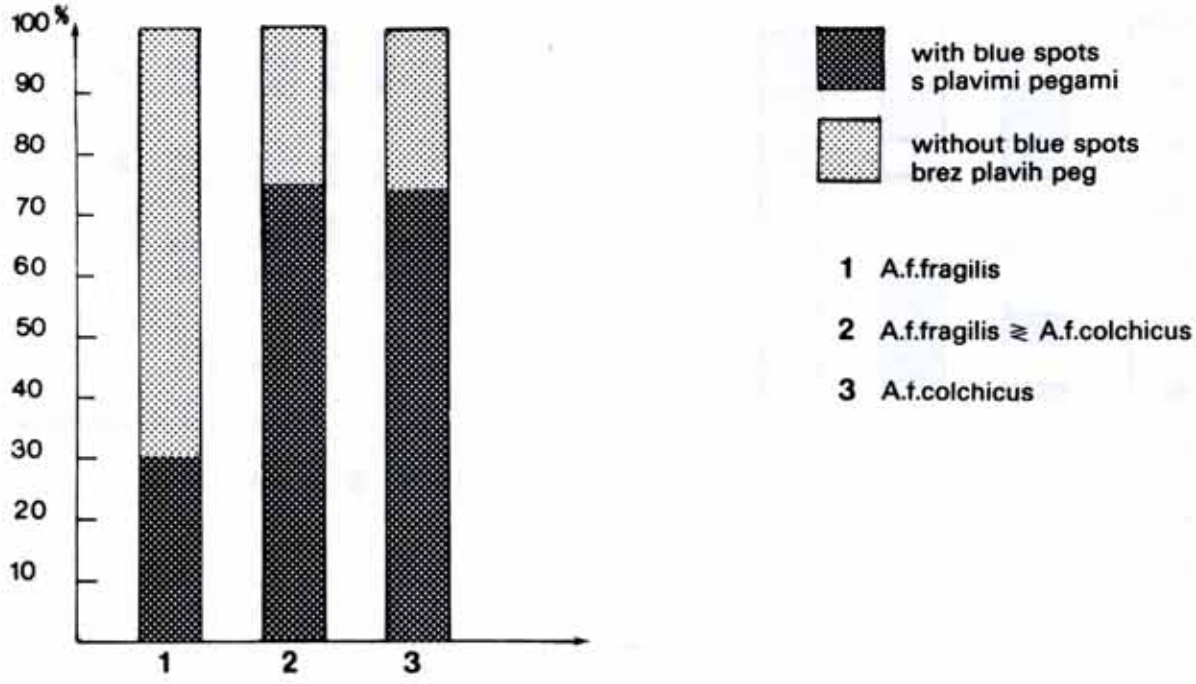

Fig. 5. Procentual frequency of the occurrence of blue spots within three slow-worm populations in Yugoslavia.

Slika 5. Odstotna zastopanost pojavljanja plavih peg znotraj treh populacij slepca v Jugoslaviji.

23	24	25	26	27	28	n
1.1 %	32.4 %	25.8 %	34.6 %	3.9 %	2.2 %	2 + 59 + 47 + 63 + 7 + 4 = 182

The number of scales varies from 23, in fact the lowest number of scales in a slow-worm recorded in Yugoslavia, to 28. The mean value of this character for the entire population amounts to:
$\bar{X} = 25.1$.

3.1.2. Group of animals from the contact zone of the typical and the Colchidic subspecies

Another group (Table 3) is represented by the animals from the contact zone of the typical and the Colchidic subspecies, which endows this population with a »mixed« character. Of 303 specimens of slow-worms from Yugoslavia 43 (14 %) belong to this group. Contrary to the previous case, one cannot speak of a range of boundaries of the range of this population but much more appropriately of a zone in which the two subspecies contact each other without clearly drawn border lines. Its position is presented in Fig. 2 and a detailed description in the following chapter.

Not all of the specimens of this group of animals could be subject to the analysis.

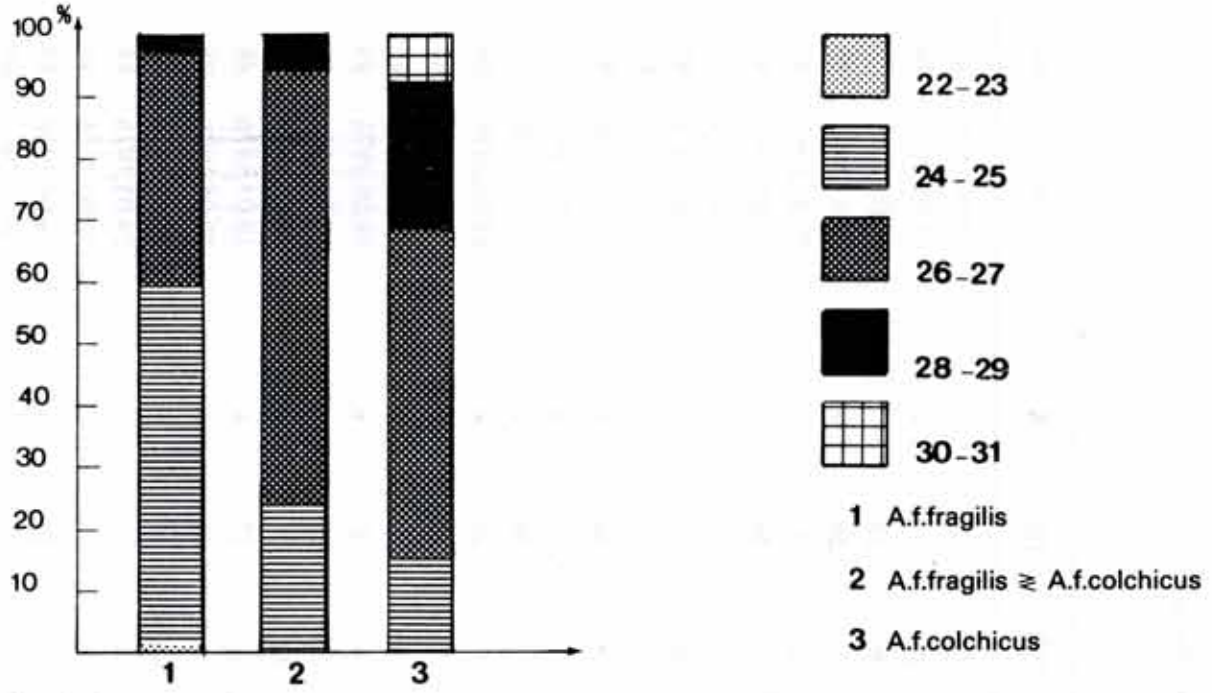

Fig. 6. Procentual frequency of the number of scales (in an average series) within three slow-worm populations in Yugoslavia.

Slika 6. Odstotna zastopanost števila lusk (v povprečnem nizu) znotraj treh populacij slepca v Jugoslaviji.

3.1.2.1. Ear openings

42 specimens were analysed to determine procentual frequency of ear openings in the contact population.

++	+=	==	−−	
2.4 %	7.1 %	47.6 %	42.8 %	1 + 3 + 20 + 18 = 42

In one specimen symmetrical ear openings were stated whereas three specimens had ear openings on one side of the head only. There exist indications of an increasing number of specimens with an asymmetrical ear opening in the contact population. Totally, 4 specimens (9.5 %) had ear openings and 38 specimens (90.4 %) had none. The results of the analysis are summarized in Histogram 1. With respect to the previous populations one notices a negligeable increase in the frequency of ear openings.

3.1.2.2. Pileus

Relative frequency of this character was calculated for 43 specimens. The relation among the prefrontal shields does not depend on sex and age.

Pileus Type A	Pileus Type B	Pileus Type C	n
41.9 %	34.9 %	23.2 %	18 + 15 + 10 = 43

Table III: Results of investigating the contact population of the slow-worms from Yugoslavia.
Tabela III: Rezultati raziskav stičnih populacij slepca iz Jugoslavije.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	HNZM 696	♀	200	40 d.	14,5	==	B	26	–	7.09.1910	60
2.	HNZM 728	♂	/	/	/	/	A	/	–	27.07.1905	76
3.	IBIS 275/L	♀	213	190 r.	14	++	B	25	–	4.05.1971	77
4.	HNZM 707	♂	157	190	12	– –	C	26	+	7.05.1903	78
5.	MR 8	♀	255	205 r.	15	– –	A	/	–	23.05.1965	87
6.	MR 9	♀	250	75 r.	14	– –	B	26	–	23.05.1965	87
7.	IBIS 400/L	?	/	/	10	– –	C	/	–	may 1974	87
8.	IBIS 401/L	?	/	/	11,7	– –	B	/	–	may 1974	87
9.	IBIS 384/L	♂	213	252	17,6	– –	C	26	+	12.05.1976	88
10.	IBIS 385/L	♂	202	249	16,6	– –	C	26	+	12.05.1976	88
11.	IBIS 386/L	♂	236	274	16,8	– –	A	25	+	12.05.1976	88
12.	IBIS 387/L	♂	198	229	16,8	– –	C	26	+	14.05.1976	88
13.	IBIS 388/L	♂	211	141 d.	/	==	C	26	+	14.05.1976	88
14.	IBIS 389/L	♂	213	162 r.	16	==	A	26	+	15.05.1976	88
15.	IBIS 390/L	♂	200	107 r.	16,5	==	B	26	–	16.05.1976	88
16.	IBIS 391/L	♂	200	140 r.	15,8	==	A	/	+	18.05.1976	88
17.	IBIS 329/L	♂	190	260	15,9	+=	B	26	+	18.05.1976	88
18.	IBIS 393/L	♂	185	226	14	==	C	/	+	18.05.1976	88
19.	IBIS 394/L	♂	188	82 d.	15,2	==	A	27	+	19.05.1976	88
20.	IBIS 395/L	♂	175	81 d.	13,3	==	A	28	+	20.05.1976	88
21.	IBIS 396/L	♀	164	218	12,6	– –	A	25	–	24.05.1976	88
22.	IBIS 397/L	♀	204	199 r.	13,6	– –	A	/	–	24.05.1976	88
23.	IBIS 398/L	♂	155	105 d.	12,9	==	A	26	+	24.05.1976	88
24.	IBIS 399/L	♀	160	107 r.	12,3	– –	C	26	–	24.05.1976	88
25.	PMB 46	♂	165	153 r.	13,8	==	A	25	–	20.03.1905	100

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
26.	IBIS 87/L	juv	100	126	8,8	==	C	26	–	9.05.1969	101
27.	IBIS 88/L	juv	128	96 r.	11,4	==	B	26	–	9.05.1969	101
28.	IBIS 80/L	juv	116	159	11,5	==	B	26	–	9.05.1969	101
29.	IBIS 139/L	♀	155	88 r.	12	==	B	26	–	22.04.1970	101
30.	IBIS 140/L	♂	180	140 r.	18,8	=+	A	26	–	22.04.1970	101
31.	MR 10	♀	220	300	16	==	A	28	–	22.08.1954	102
32.	MR 6	juv	90	110	9	==	A	/	–	16.04.1950	103
33.	PMB 89 a	♀	151	195	11,4	==	B	24	–	11.06.1963	107
34.	PMB 89 b	♀	113	117	10,1	==	B	25	–	11.06.1963	107
35.	IBIS 605/L	♀	198	82 r.	14,4	−−	B	25	–	13.07.1977	108
36.	PMB 185	juv	67	79	7,1	==	A	27	–	20.08.1962	109
37.	IBIS 617/L	♂	158	207	12,1	+=	A	26	–	19.05.1978	126
38.	IBIS 665/L	♂	222	130 r.	19,6	−−	B	27	+	1.06.1980	101 a
39.	IBIS 666/L	♂	212	258 d.	16	−−	C	25	+	1.06.1980	101 a
40.	IBIS 698/L	♂	200	50 d.	15	==	B	25	–	12.05.1980	71 a
41.	IBIS 788/L	♂	240	95 d.	18,3	−−	A	27	+	29.05.1980	93 a
42.	IBIS 789/L	♂	190	50 d.	12,4	−−	B	26	+	29.05.1980	93 a
43.	IBIS 790/L	♀	230	100 r.	13,2	−−	A	26	–	9.07.1980	87

The results are summarized in Fig. 4. Noticeable with respect to the previous group is a procentual increase of the number of specimens with the C type pileus. Even though the type A pileus is the most common one, it does not prevail over the others since the other two are represented by a large number of specimens.

3.1.2.3. Blue spots

Relative frequency of the occurrence of blue spots was calculated on 23 males, by taking into account the same reasons as in the previous group of individuals.

+	−	n
74.0 %	26.0 %	17 + 6 = 23

In addition to the table the results are presented also in Fig. 5. Already in conncection with the previous group attention was called to a relatively high frequency of the occurrence of blues spots in comparison with west-European populations. An increase in frequency is even more markedly expressed in the contact population where no less than 74 % of males have blue spots.

3.1.2.4. Number of scales

In the contact population the number of scales ranged between 24 and 28. The frequency of the specimens with a definite number of scales ensues from Fig. 6 and the folowing table:

24	25	26	27	28	n
2.9 %	22.9 %	57.1 %	11.4 %	5.7 %	1 + 8 + 20 + 4 + 2 = 35

With regard to the previous group the variation range is somewhat narrower. One can notice the prevailing of the specimens with 26 scales around the body. The arithmetic mean of the number of scales in this population amounts to $\overline{X} = 26$.

3.1.3. Group of individuals with dominant characters of the Colchidic subspecies

The individuals characterized by the domination of the »colchicus« characters are classified into the third group (Table 4). Of the total number of the specimens as studied 45 (14 %) make part of this group. The range of this population comprises the eastern and the southeastern part of our country. The contact zone separates it from the range of the typical subspecies (Fig. 2).

Due to the reasons as already stated it was impossible to attend to a detailed treatment of all slow-worm specimens from this group.

3.1.3.1. Ear openings

The variability of this character within the population with the domination of »colchicus« characters was analysed on 42 specimens. The frequency of single variants is shown in Fig. 3 and ensues from the table below:

Table IV: Results of investigating the Colchidic subspecies of the slow-worm (*A. fragilis*) from Yugoslavia.

Tabela IV: Rezultati raziskav kolhidske podvrste slepca *(Anguis fragilis)* iz Jugoslavije.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	ZMBH 17	♂	255	90 d.	19,4	++	C	26	+	juli 1913	73
2.	ZMBH 18	♂	180	200	13,2	++	C	26	–	juli 1913	73
3.	ZMBH 19	♀	210	260	15,9	++	A	24	–	juli 1913	74
4.	ZMBH 11	♂	205	250	15,9	++	C	26	+	1910/1911	75
5.	ZMBH 12	♀	220	163 r.	15,3	++	C	26	–	1910/1911	75
6.	ZMBH 13	♂	220	115 r.	15,6	++	C	28	+	1910/1911	75
7.	ZMBH 14	♀	205	160 r.	14,5	++	C	26	–	1910/1911	75
8.	ZMBH 3	♂	210	210 d.	17,6	+=	C	28	+	1895	81
9.	ZMBH 26	♀	215	235 r.	13,1	++	C	26	–	1896	83
10.	VMM 8	♀	140	160	11,4	++	C	26	–	17.07.1974	84
11.	HNZM 2076	♀	145	145 r.	11,3	++	C	25	–	27.05.1940	85
12.	HNZM 2077	♀	220	80 d.	14,8	++	C	28	–	27.05.1940	85
13.	HNZM 2083	♀	140	125 r.	9,9	++	C	27	–	12.06.1940	85
14.	HNZM 2084	♀	198	122 r.	13,7	++	C	26	–	12.06.1940	85
15.	PMB 34	♂	240	123 d.	18,6	++	A	26	–	s.a.	104
16.	PMB 45	♂	202	222	17,5	++	A	26	+	28.04.1940	105
17.	PMB 171	♀	195	230	13,6	++	B	26	–	6.07.1934	106
18.	PMS 3522	♀	169	202	12,7	==	C	26	–	1968	115
19.	IBIS 404/L	♂	150	147 r.	15,8	++	A	27	+	10.05.1975	116
20.	IBIS 15/S	♂	231	70 d.	17,5	++	C	30	+	9.06.1970	117
21.	IBIS 16/S	♂	232	120 d.	19,6	++	C	30	+	11.06.1970	117
22.	IBIS 17/S	♂	220	251	17,8	++	C	29	+	11.06.1970	117
23.	PMB 136	♀	220	235	15	++	A	27	–	16.05.1976	118
24.	PMB 121	♀	135	116 r.	11,7	++	A	28	–	sept. 1965	119
25.	PMB 146	♀	245	85 d.	15,2	==	A	27	–	22.08.1967	120

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
26.	IBIS 268/L	♀	105	138	9,6	++	C	28	–	7.06.1962	121
27.	IBIS 504/L	♀	380	130 r.	16	++	B	29	–	juni 1976	122
28.	IBIS 314/L	♀	226	d	16	/	A	26	–	30.06.1976	123
29.	IBIS 607/L	♂	210	265	17,1	++	B	26	–	20.05.1977	124
30.	IBIS 616/L	♀	110	150	10,3	++	C	26	–	s.a.	125
31.	ZMBH 4	♀	162	97 r.	11,3	++	C	25	–	26.04.1900	AL 1
32.	ZMBH 5	juv	138	/	/	/	C	/	–	14.05.1900	AL 2
33.	ZMBH 6	♂	132	150 r.	11,9	++	C	24	–	1897	AL 3
34.	ZMBH 7	♀	170	84 r.	12,9	++	C	24	–	1897	AL 4
35.	ZMBH 8	♀	75	93	/	/	C	/	–	1897	AL 4
36.	IBIS 629/L	♂	270	270 r.	18,3	++	C	31	+	27.06.1968	103 a
37.	IBIS 782/L	♂	155	185	12,0	++	C	27	+	18.07.1980	111 a
38.	IBIS 783/L	♂	151	205	12,9	++	C	28	+	VII–IX 1980	75 a
39.	IBIS 784/L	♂	170	162	13,4	++	C	28	+	VII–IX 1980	75 a
40.	IBIS 785/L	♀	193	122 r.	13,2	++	C	28	–	VII–IX 1980	75 a
41.	IBIS 786/L	♀	182	78 r.	13,1	++	C	27	–	VII–IX 1980	75 a
42.	IBIS 787/L	♂	132	120	11,2	++	C	27	+	VII–IX 1980	75 a
43.	BZ 1	♂	180	220	/	++	C	28	+	1979	122 a
44.	BZ 2	♀	200	205 r.	/	++	B	29	–	1979	122 a
45.	BZ 3	♂	250	300	/	++	C	28	+	1979	122 a

++	+=	==	n
92.9 %	2.9 %	4.7 %	39 + 1 + 2 = 42

Dominating in this group are individuals with clearly visible symmetrical ear openings. The number of animals with an ear opening on one side of the head only or those without ear openings is quite small.

3.1.3.2. Pileus

Procentual frequency of single types of pilei in this population is established on 45 specimens.

Pileus Type A	Pileus Type B	Pileus Type C	n
17.8 %	8.9 %	73.3 %	8 + 4 + 33 = 45

Prevailing in this group of slow-worms are individuals with separated prefrontal plates. The percentage of the animals with the B pileus type is surprisingly low, whereas the number of the specimens with the pileus characteristic of the western subspecies is somewhat higher. A graphic presentation of the results is revealed in Fig. 4.

3.1.3.3. Blue spots

Relative frequency of the occurrence of blue spots was calculated for 20 specimens.

+	−	n
80.0 %	20.0 %	16 + 4 = 20

A tendency to an increasing frequency of blue spots in connection with the Yugoslav populations of slow-worms is most obviously expressed in the group with dominant characters of the Colchidic subspecies. By the presence of blue spots (80 %) our population, together with the Slovakian one (80.3 %, LÁC 1967), distinguishes itself from the populations of this subspecies in other countries e. g. Bulgaria (68.7 %, BEŠKOV 1966) and Finland (73 %, VOIPIO 1962). Relative frequency is presented in Fig. 5.

3.1.3.4. Number of scales

In the population with dominant »colchicus« characters the procentual frequency of the occurrence of a definite number of scales around the body was calculated on 43 specimens. The results of calculation are shown in the table below and Fig. 6.

24	25	26	27	28	29	30	31	
7.0 %	4.6 %	34.9 %	16.3 %	23.3 %	7.0 %	4.6 %	2.3 %	
3 +	2 +	15 +	7 +	10 +	3 +	2 +	1 =	43

This population proved to have the widest variation range of the number of scales. The diapason of variation corresponds to the situation in Slovakia (LÁC 1967) and Rumania

(STUGREN, FUHN, POPOVICI 1962). It is interesting to note that in Hungary the variation range is narrower (DELY 1972, 1974). VOIPIO (1962) and BEŠKOV (1966) did not analyse this character. A specimen from the eastern slopes of the Rudnik highlands possessed a maximal number of scales (31) stated for Yugoslavia. The arithmetic mean of this character amounts to $\overline{X} = 26{,}909$.

3.2. Comparative analysis

As pointed out already in the chapter on the material and methods, I applied the method of hi-square test with Yates's correction to establish the differences among the populations identified on the basis of the calculated frequency of single characteristics as observed. Subject to comparison were all three qualitative differential characters. Analysed were three existing possibilities of combining the populations.

The t-test was used to test the differences between the arithmetic means of the number of scales within the populations identified. I preliminarily calculated the standard error of the difference between two arithmetic means.

3.2.1. Comparison of a group of individuals with the domination of »fragilis« characters with the popularion from the contact zone

The first comparison was made between the population of slow-worms with the domination of the characters of the typical subspecies with the population from the contact zone. The results ought to give a response to the question on the type of delimitation between two »great« subspecies of slow-worms, and to confirm or else refute whether the identification of the contact population was justified or not.

3.2.1.1. Ear openings

With respect to previous results (DELY 1972, 1974, BEŠKOV 1966 etc.) the existence of clear ear openings represents the stablest differential character in the microtaxonomy of slow-worms, therefore, a comparative analysis was introduced on the basis of this property.

A. f. fragilis	**A. f. fragilis ≷ colchicus**
$N_1 = 186$	$N_2 = 42$
Without ear. op. = 182	Without ear op. = 38
With ear op. = 4	With ear op. = 4

$\chi^2 = 2.382$

As ensuing from the hi-square table, the limit value of χ^2 at one degree of freedom attains a level of significance from 0.05 (5 %), $\chi^2 = 3.841$. As our hi-squre is smaller, no significant difference exists between these two populations with respect to the presence of clear ear openings.

3.2.1.2. Pileus

A. f. fragilis	**A. f. fragilis ≷ A. f. colchicus**
$N_1 = 192$	$N_2 = 43$
A = 119	A = 18
B + C = 73	B + C = 25

$\chi^2 = 5.076$

Table V: Result of investigating the species *Anguis fragilis* from Spain and Greece.

Tabela V: Rezultati raziskav vrste Anguis fragilis iz Španije in Grčije.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	PMS 3708	♀	/	/	13,08	−−	A	26	−	1968	ŠP
2.	ZMBH 1	♀	227	262	15,2	+=	C	31	−	juni 1898	GR 1
3.	ZMBH 2	♂	242	280	17	++	C	27	+	1894	GR 2
4.	ZMBH 22	juv	/	/	/	/	/	/	/	1894	GR 2
5.	ZMBH 23	juv	/	/	/	/	/	/	/	1894	GR 2
6.	ZMBH 24	juv	/	/	/	/	/	/	/	1894	GR 2
7.	ZMBH 25	juv	/	/	/	/	/	/	/	1894	GR 2

As in this case hi-squre exceeds the level of significance, the typical population markedly differs in this character from the contact population.

3.2.1.3. Blue spots

A. f. fragilis	A. f. fragilis ≷ A. f. colchicus
$N_1 = 76$	$N_2 = 23$
Without bl. sp. = 53	Without bl. sp. = 6
With bl. sp. = 23	with bl. sp. = 17

$\chi^2 = 12.555$

Taking into account the fact that the hi-square value is much above the limit value, the populations as compared essentially differ from each other in this property.

3.2.1.4. Comparison of artithmetic means of the number of scales and test of the difference between them

A. f. fragilis	A. f. fragilis ≷ A. f. colchicus
$\bar{x}_1 = 25.41 = 25$	$\bar{x}_2 = 25.940 = 26$
$s_1 = 7.2 = 7$	$s_2 = 1.604 = 2$
$N_1 = 182$	$N_2 = 34$

$s_{x_1 - x_2} = 0.621$

$t = 1.610$

On the threshold of significance of 0.05 (1.96) the difference between the populations is not statistically significant. Not even on the threshold of significance of 0.01 (2.58) does the difference between the populations become important.

3.2.2. Comparison of the contact and the Colchidic population

3.2.2.1. Ear openings

A. f. colchicus	A. f. fragilis ≷ A. f. colchicus
$N_1 = 42$	$N_2 = 42$
Without ear. op. = 2	Without ear op. = 38
With ear. op. = 40	With ear. op. = 4

$\chi^2 = 58.46$

The hi-squre value points to significant differences between the two populations when the most important character for identifying the typical subspecies is in question.

3.2.2.2. Pileus

A. f. colchicus	A. f. fragilis ≷ A. f. colchicus
$N_1 = 45$	$N_2 = 43$
A = 8	A = 18
B + C = 37	B + C = 25

$\chi^2 = 5.024$

The contact population importantly differs from the Colchidic one also with respect to definite pileus types as represented in this case. Though the difference does not attain the difference level of the previous character, it is nevertheless significant.

3.2.2.3. Blue spots

A. f. colchicus		**A. f. fragilis** ≷ **A. f. colchicus**
$N_1 = 20$		$N_2 = 23$
Without bl. sp. = 4		Without bl. sp. = 6
With bl. sp. = 16		with bl. sp. = 17
	$\chi^2 = 0.010$	

The hi-square as obtained is considerably lower than the significance threshold, which means that with regard to the frequency of the occurrence of blue spots no statistically significant difference exists between the populations compared.

3.2.2.4. Comparison of arithmetic means of the number of scales and testing of the difference between them

A. f. colchicus		**A. f. fragilis** ≷ **A. f. colchicus**
$\bar{x}_1 = 26.909 = 27$		$\bar{x}_2 = 25.940 = 26$
$s_1 = 3.444 = 3$		$s_2 = 1.604 = 2$
$N_1 = 41$		$N_2 = 24$
	$S_{\bar{x}_1 - \bar{x}_2} = 0.579$	
	$t = 1.727$	

At the threshold of significance of 0.05 (1.96) the difference between the populations is not significant, which is true also of the significance threshold of 0.01 (2.58).

3.2.3. Comparison of the typical and the Colchidic population

We are finally going to compare two populations of slow-worms, one of which is spread more to the northwest and the other to the southeast of Yugoslavia.

3.2.3.1. Ear openings

A. f. fragilis		**A. f. colchicus**
$N_1 = 186$		$N_2 = 42$
Without ear. op. = 182		Without ear op. = 2
With ear. op. = 4		With ear op. = 40
	$\chi^2 = 184.711$	

The limit value of hi-square at one degree of freedom on the significance level of 0.05 (5 %), $\chi^2 = 3.841$. The hi-square value is exceptionally high, which indicates that with respect to the existence of ear opening the differences between the typical and the Colchidic subspecies in Yugoslavia are most important.

3.2.3.2. Pileus

A. f. fragilis		A. f. colchicus
$N_1 = 192$		$N_2 = 45$
$A = 119$		$A = 8$
$B + C = 73$		$B + C = 37$
	$\chi^2 = 26.89$	

Also in this character a marked difference is to be observed between these two populations, since the hi-square value considerably exceeds the significance threshold.

3.2.3.3. Blue spots

A. f. fragilis		A. f. colchicus
$N_1 = 76$		$N_2 = 20$
Without bl. sp. = 53		Without bl. sp. = 4
With bl. sp. = 23		With bl. sp. = 16
	$\chi^2 = 14.240$	

The typical and the Colchidic subspecies differ least in the existence of blue spots in males, even though also in this case the difference between them is statistically most significant.

3.2.3.4. Comparison of the arithmetic means of the number of scales and testing of the difference between them

A. f. fragilis		A. f. colchicus
$\bar{x}_1 = 25.41 = 25$		$\bar{x}_2 = 26.909 = 27$
$s_1 = 7.2 = 7$		$s_2 = 3.444 = 3$
$N_1 = 182$		$N_2 = 41$
	$S_{\bar{x}_1} - \bar{x}_2 = 0.698$	
	$t = 2.865$	

The t-test value indicates that the difference between the populations compared is statistically significant, both on the trhreshold of significance of 0.05 (1.96) and that of 0.01 (2.58).

3.2.4. Comparison of the typical subspecies of slow-worms of Central Europe and Yugoslavia

In addition to testing the differences between the identified slow-worm groups from Yugoslavia I checked possible digressions of the populations thus identified from those that undoubtedly make part of the typical and the Colchidic subspecies, respectively. The material to be compared with the typical subspecies was taken from DELY's works (1972, 1974). The specimens originate from Central Europe (Austria and Hungary).

A comparison of the typical subspecies *A. fragilis* with our slow-worms classified into this group was made for all three differential characters and the number of scales around the body in one series.

3.2.4.1. Ear openings

A. f. fragilis Yugoslavia		**A. f. fragilis** Central Europe
$N_1 = 186$		$N_2 = 52$
Without ear op. = 182		Without ear op. = 51
With ear op. = 4		With ear op. = 1
	$\chi^2 = 0.188$	

These two populations do not differ from each other with respect to the existence of ear openings.

3.2.4.2. Pileus

A. f. fragilis Yugoslavia		**A. f. Fragilis** Central Europe
$N_1 = 192$		$N_2 = 46$
A = 119		A = 32
B + C = 73		B + C = 14
	$\chi^2 = 0.613$	

From a statistic point of view, the Yugoslav population of slow-worms, classified into the typical subspecies, does not differ from the typical subspecies from Central Europe.

3.2.4.3. Blue spots

A. f. fragilis Yugoslavia		**A. f. fragilis** Central Europe
$N_1 = 76$		$N_2 = 23$
Without bl. sp. = 53		Without bl. sp. = 15
With bl. sp. = 23		With. bl. sp. = 8
	$\chi^2 = 0.021$	

Not even in the third qualitative differential character do the populations compared differ from each other.

Due to negligible differences in the arithmetic means of the number of scales and an identical standard error between the arithmetic means in the case of the Yugoslav slow-worms classified into the first group and the indubitable *A. f. fragilis* from Central Europe, the t-test value amounted to t = 0.

3.2.5. Comparison of the Colchidic subspecies of slow-worms from Eastern Europe and Yugoslavia

Analysed in the above-mentioned works by Dely is also a material on *A. f. colchicus* from Eastern Europe (Rumania, Bulgaria, Ukraine, Poland, Russia, Gruziya, and Azerbaijan). With respect to the existence of blue spots I was not in position to attend to a comparison since Dely's material did not include a sufficient number of male slow-worms from these countries.

3.2.5.1. Ear openings

A. f. colchicus Yugoslavia		**A. f. colchicus** Eastern Europe
$N_1 = 42$		$N_2 = 36$
Without ear op. = 2		Without ear op. = 3
With ear op. = 20		With ear op. = 33
	$\chi^2 = 0.0316$	

The hi-square value does not attain the significance level (3.841 for one degree of freedom) so that no differences in the presence of ear openings exist between the slow-worm population from eastern Europe, making part of the Colchidic subspecies, and the slow-worm population from our country that I classified into this subspecies.

3.2.5.2. Pileus

A. f. colchicus Yugoslavia		**A. f. colchicus** Eastern Europe
$N_1 = 45$		$N_2 = 60$
A = 8		A = 23
B + C = 37		B + C = 37
	$\chi^2 = 4.278$	

In this character the slow-worm population from Yugoslavia that I classified into the Colchidic subspecies differs from the population of *A. f. colchicus* from eastern Europe.

For these two populations the results of calculating the arithmetic means of the number of scales and the standard error between them were perfectly identical. No further calculation was necessary as the samples obviously do not differ in this feature. The t-value was nevertheles calculated and proved to be equal to 0.

4. Discussion

The basic prerequisite in giving any sort of judgement on the taxonomy and biogeographic characteristics of the species *Anguis fragilis* in Yugoslavia was to possess a sufficient number of specimens for the purpose of analysis. In my opinion the treatment of the Yugoslav population of slow-worms was carried out on a material satisfying the above prerequisite. For the sake of comparison I am stating the material which served as a basis for solving the problem of systematics and distribution of this species in the countries where these problems have been an objects of intensive studies. Of the neighbouring countries, the sample for an analysis of *A. fragilis* from Bulgaria comprised 120 specimens (BEŠKOV 1966), from Rumania 55 specimens (STUGREN, FUHN & POPOVICI 1962), and from Hungary 126 specimens (DELY 1972, 1974). In Slovakia the study was done on 105 specimens (LÁC 1967), in Finland on 61 (VOIPIO 1962), in Norway on 12 (VOIPIO 1962), in Sweden on 101 (VOIPIO 1962), in Holland on 138 (MUSTERS & BOSCH in den 1984) and in the Soviet Union on 46 specimens (LUKINA 1965).

The material as treated and the data from the literature render it possible to get an insight into the present range of slow-worms in Yugoslavia, to respond to the question on the intraspecific differentiation of the species in our country, and to deliver a judgement on the geographic delimitation of the taxa within the species *A. fragilis*.

When discussing the distribution of the species in Yugoslavia, the authors most usually present generalized conclusions wherefrom it follows that it is spread everywhere with the ex-

ception of the islands. This probably results from a poor knowledge on the recent range of one of the most common species of reptiles in Yugoslavia, as well as a too tepid an interest in the problems connected with its distribution.

The results I obtained, as well as the latest results of other authors (BRUNO 1980) reveal a number of new facts on the distribution of slow-worms in Yugoslavia. First, *A. fragilis* does not live in certain parts of our country. The question is of larger areas of Voivodina: the major part of Bačka and the whole of Banat where the cultured steppe offers no conditions for the life of slow-worms. However, two data refer to this area, namely: Kovilj and Titel (MOJSISOVICS 1897). In my opinion the localities in question might be connected with Fruška Gora (Mt.), a great dispersion center of slow-worms, and a possibility of survival of this lizard in gallery forests (DŽUKIĆ 1980) – a possibility in which Mojsisovics, author of the afore mentioned data, did not believe. DŽUKIĆ's presumption was confirmed by finding slow-worms in forests on the alluvium at Doroslov in Bačka in May 1985. It is highly probable that slow-worms are likewise absent from those areas that from a biogeographic point of view make part of the province of Aegean-Anatolian semideserts (MATVEJEV 1961) which in our country are restricted mainly to some parts of Macedonia.

It used to be believed that *A. fragilis* does not inhabit the islands of the Adriatic Sea, with the exception of Isle of Košljun (WERNER 1891). After POZZI's (1966) generalized statement that it can be found on certain islands, BRUNO's work (1980) was published in which a series of localities is stated referring to the islands Cres and Krk. It is interesting to note that the localities on Krk from which our material originates do not coincide with BRUNO's data. This points to the fact that on Krk the slow-worm is rather wide-spread. Included in this group of data is also one most kindly communicated to me by Konrad KLEMMER from the Natur-Museum Senckenberg. It refers to a male from the Brioni Islands which is kept in the museum collection. In my belief a much greater meaning should be ascribed to an unexpected occurrence of slow-worms on the south-Dalmatian islands. The first finding is connected with Govedjari on Island of Mljet and the second on Island of Vis. But the following datum is in fact unexpected and, I think, not perfectly proved. Namely: working on the collection of Prof. RADOVANOVIĆ I found, in a pot, a juvenile specimen of *A. fragilis* with a designation »Vis«. Signed on the label as collector is Anaf, and beside the slow-worm itself there was also a tail of *Hemidactylus turcicus*. In any case this means that the Dalmatian islands shoudl not be excluded from the Yugoslav range of slow-worms before it is proved that, as a matter of fact, on one of them this lizard does not live. The above corrections of the slow-worm range in Yugoslavia represent a contribution to a better knowledge of the actual distribution of the species, as well as a signpost to future investigations dedicated to the range and eventual changes in it.

In order to realize the foremost objective of this work and to solve the problem of the intraspecific differentiation of the species *Anguis fragilis* and the horology of the intraspecific taxa, an extensive analysis of external morphological characters was performed for the first time on a material which made it possible to obtain valid results.

In accordance with my previous results as well as those of other authors the material available from the territory of Yugoslavia was divided into three groups. The first group consists of individuals characterized by the domination of the characters of the typical subspecies (*A. f. fragilis*). The second group is characterized by mixed characters with an indication that it originates from a contact zone between two subspecies, whereas the specimens marked by the domination of »Colchidic« characters were classified into the third group.

For every group in question I ascertained the variability of those qualitative and quantitative characters in the case of which differential nature has been proved in the history of investigating the microtaxonomic problems of the species. The procentual frequency of the occurrence of definite differential characters is graphically presented in Figs. 3, 4, 5, and 6. The results obtained by calculating the frequencies of definite qualitative and quantitative characteristics of the groups as identified reveal differences among them. The most marked

difference among the above-mentioned group is expressed in the existence of clear ear-openings. Thus, in the group of individuals with the domination of the characters of the typical subspecies only 2.2 % of animals had ear openings whereas in that with the domination of the features of the other »great« subspecies (*A. f. colchicus*) ear openings appear in as many as 92.5 % of the specimens. Somewhat less pronounced differences reveal themselves in the presence of a certain type of pileus and the number of scales in a series around the body, and the least important differences in the occurrence of blue spots. In order to find out whether the differences observed among the groups identified are statistically significant, the method of hi-square test was applied in the case of qualitative features and the t-test method in that of quantitative characters. In the first case I had to applly YATES's correction due to an unequal sample. I first compared the groups characterized by the domination of the characters of the »great« subspecies with the contact population, and then the two of them with each other.

As proved by the analysis, no statistically important differences present themselves between the groups of individuals with dominant characteristics of *A. f. fragilis* and the contact population in the existence of ear openings and the number of scales around the body. The populations differ essentially from each other in the pileus type and the presence of blue spots in males.

Comparing the individuals characterized by the domination of the Colchidic characters with the group of the contact population one can take note of a great difference between these two groups in the existence of ear openings or the presence of a certain pileus type, as well as the fact that the differences in the presence of blue spots and the number of scales are not statistically significant.

The results of comparing all differential characters revealed important statistical differences between the groups of individuals which with respect to their characteristics make part of one or the other »great« subspecies.

Beside testing the differences between the groups of identified slow-worms from Yugoslavia I also checked eventual deviations of the populations thus identified, with respect to the populations which undoubtedly belong to the typical and the Colchidic subspecies, respectively. The results show that there exist no statistically significant differences between the typical subspecies of slow-worms from Central Europe and the Yugoslav population with the domination of the characters of *A. f. fragilis*, that on the contrary, the differences are in fact negligible. A similar result was obtained also in the case of comparing *A. f. colchicus* of Eastern Europe with a group of individuals from Yugoslavia with prevailing characters of the eastern subspecies. The only difference between them was disclosed in different types of pilei. Namely, in the populations from the above-mentioned east-European countries the A type of pileus is more common than in the corresponding group of individuals from Yugoslavia. These differences are believed to result from the heterogeneity of the material from Eastern Europe, because no differences made themselves evident in comparing our data with the literature data from Bulgaria, Slovakia and Hungary.

The above results lead to a conclusion that in Yugoslavia the species *Anguis fragilis* is differentiated as two subspecies: the typical – *A. fragilis fragilis*, and the Colchidic – *A. fragilis colchicus*. Existing in the zone of a secondary contact between the said populations is a population marked by hybrid characteristics, however, it comes somewhat closer to the typical subspecies.

The subspecies *A. fragilis fragilis* is much more widely distributed in our country; its range includes Slovenia, almost all of Croatia and Bosnia, a large part of Herzegovina and Montenegro, as well as western Serbia and most of Kosovo (Fig. 2). Outside this compact part of the range the subspecies appears also on the highlands of Serbia and Macedonia. A contact zone of uneven width, without clearly drawn limits (Fig. 2), lies between the typical and the Colchidic subspecies.

The contact zone is narrower in the highland part of our country and broader in the lowlands, as well as the hilly region. It is widest in Šumadija, Srem and Slavonia. Due to a lack of the material from the western parts of Slavonia and Podravina I was not in position to precisely define the said zone in this region. Narrow contact zones take the form of strips on highlands whose roots and environs are populated by the Colchidic subspecies. Our knowledge on the vertical differention of slow-worms in the eastern part of Yugoslavia has not as yet attained a level of definitive conclusions. However, the fact is that in the mountains the typical subspecies appears in the range of *A. fragilis colchicus*. A fine example thereof is to be observed on Šar planina (highlands) where the Colchidic subspecies lives in the lowlands on the Macedonian and the Metohija side, while the typical on the mountain ridge: Brezovica and Piribeg (our data), and Karanikola and Lukovo polje (KRIVOKAPIĆ 1969). A similar situation is to be found in the region of northern Albania. However, the material available to me from Albania (see Table 1) leads to a different conclusion. This apparent contradiction results from the fact that DELY's material origites from highlands (Lura) and mine from lower sites of Albania. BEŠKOV's data (1966), as well as mine, referring to Stara planina may serve as another proof to this height differentiation. Here, on the peaks along the Yugoslav frontier appears the typical subspecies while the Colchidic subspecies populates the valleys of the Lom river and the environs of Zaječar.

The subspecies *Anguis fragilis colchicus* has a narrower but a most interesting distribution in Yugoslavia (Fig. 2). Its range includes the major part of Serbia, almost all of Macedonia, and a part of Montenegro and Herzegovina. The populations of slow-worms from parts of the ranges of the Colchidic subspecies in Herzegovina, Montenegro, and Metohija establish contact with the compact part of the range through the Albanian and the Greek populations (Table 5). The western delimitation of the range of the Colchidic subspecies *A. f. colchicus* in the mediterranean zone runs along the known turn of the Neretva river setting also a limit to the distribution of some east-mediterranean elements of our herpetofauna (*Mauremys caspica*) and terriofauna (*Talpa caeca, Pitymys thomasi* and others, PETROV 1979), while transitional forms of this zone were stated also by MATVEJEV (1969) – birds, MIKŠIĆ, S. (1971) – Orthoptera, DROVENIK (1973) – Coleoptera, and SIJARIĆ (1974) – Rhopalocera.

This subspecies has no disjunct parts of the range in the west of Yugoslavia, even though single occurrences of specimens (SELIŠKAR 1916; BRUNO 1976; BANK et al. 1982) have been recorded bearing the characteristics of *A. f. colchicus*. Such appearance of the characteristics of the eastern subspecies can be obtained by a »relay« passing-over of the genic material, by the appearance of ancestral characters in a determined genic combination or as a result of periodic pulsations of the range of the subspecies in the post-glacial epoch.

Single occurrences of specimens phenotypically belonging to a subspecies in the range of another cause confusion among the authors (BANK et al. 1982; MUSTERS & BOSCH in den 1982; HENLE 1985) who derived their herpetological experiences from biogeographically simpler areas so they tend to a complete simplification of the biogeographic situation, there at abstracting an exceptional biogeographic, geological, and orographic composition of the Balcan Peninsula, as well as the historical past of the herpetofauna. As a result of this tendency their conclusions on the problem of delimitation of the intraspecific taxa of *A. fragilis* on the Balcan Peninsula do not repose on forcible arguments. In addition to the above, the lack of a representative sample induces MUSTERS & BOSCH in den (1982) to seek the arguments for their conclusions by disputing undoubtedly unreliable consideration of these problems (POZZI 1966) or by questioning the validity of the data which geographically do not make part of the Balcan Peninsula (LÁC 1967) or are rather distant from it, as in the case of Finland (VOIPIO 1962). It is not clear why in their analysis they do not discuss the results of BEŠKOV (1966), FUHN (1961), FUHN & VANCEA (1961), STUGREN et al. (1962). Not even the results of DELY (1972, 1974) to which they refer are interpreted quite correctly

as they overlook the existence of a »mixed« population between the typical and the Colchidic subspecies on the Dunazug highlands.

Unacceptable is also their rigid attitude to the »purity« of the subspecies where in spite of a generally accepted belief no broader diapason of variability is acknowledged within the populations making part of one subspecies.

The results thus interpreted were summarized by MUSTERS & BOSCH in den (1982) in a map which, they believe, represents »the real state of affairs« but which, in an extremely schematized representation where precise geographic positions and even less so their altitudes, as well as animals with »mixed« characteristics are not duly taken into account, instead of classifying things leads to complete confusion. Generally speaking, their conclusions abound with presumptions which should not serve to identify the subspecies *A. f. colchicus*, which collides also with the essence of their remarks on the previous results.

The crucial remark of MUSTERS & BOSCH in den (1982) is that the authors opted for different characters, which represents an insurmountable obstacle to the drawing of concrete conclusions. As this remark is not supported by suitable arguments, it is our belief that in the previous analyses there are not concerned options for different characters but merely single instances of the omission of one of the characters which, if duly studied, would undoubtedly contribute to a greater importance of the analyses. I am convinced that in spite of the absence of absolutely identical analyses we are witnessing a positive trend in solving the problems of microtaxonomy and biogeography of slow-worms through a series of successive, complementary phases bringing us closer to ultimate solutions.

In principle, the explanation of the range of the two subspecies of slow-worms in Yugoslavia such as disclosed in this work, reposes on the theory put forward by VOIPIO (1962), irrespectively of certain inconsistencies and isolated beliefs (MUSTERS & BOSCH in den 1982) that the theory is precocious. VOIPIO (1962) presumed that in the period od glaciations a unique population of slow-worms from Central Europe divided itself into a »western« population (A) finding a refuge on the Pyrenean Peninsula, and an »eastern« population (B) that withdrew to Persia and Asia Minor (Fig. 7). In the time of glaciations the species was divided into subspecies two »great« of which established a secondary contact with Central Europe at the end of the glacial period. Taking into account the results of this work it is important to note that Voipio, as well as the majority of other authors, believes that the contact of the subspecies was brought about on the eastern slopes of the Alps and that it is there that *A. f. fragilis* is delimited from *A. f. colchicus*. A certain progress of the contact zone in the direction of the east can be observed in LÁC (1967), whereas a considerable, though a speculative one in DELY (1981). An obvious contribution to the perfection of VOIPIO's theory (1962) was presented by BEŠKOV (1966). He was the first to show that with regard to the results of slow-worm investigations in Bulgaria and Rumania, during one of the glaciations, the typical subspecies must have populated almost all of the territory of Central Europe and the Balcan Peninsula, but that as a result of a later penetration of the Colchidic subspecies, assisted by a global moderation of the climate, the typical subspecies retreated on one side towards the west, and on the other to the mountains. At the same time BEŠKOV (1966) was the first to raise the question of autochthonous populations originating from the Tertiary ones (BOLKAY 1913, MLYNARSKI 1962), and their influence upon the recent phenotype of slow-worms on the Balcan Peninsula.

My results of 1980, as well as those disclosed in the present work, largely support BEŠKOV's amendment of VOIPIO's hypothesis in addition to geographically defining the border between the typical and the Colchidic subspecies which, with respect to the material available to him, BEŠKOV was not in position to do. Likewise substantiated are indications that the delimitation of the typical and the Colchidic subspecies in Albania and Greece might be similar. Though as yet not possessing concrete proofs, we believe that on the highlands of northern Greece, more precisely, in the habitats populated by *Lacerta agilis* and *Vipera berus*

(CHONDROPOULOS 1986, ONDIRAS 1968) slow-worms make part of the typical subspecies.

There remains an insufficiently elucidated origin of the Peloponnesian subspecies (*A. f. peloponnesiacus*) and its link, originally, with the autochthonous populations which undoubtedly had absolute chances to survive on the Greek land, and secondarily, with the arriver i.e. the Colchidic subspecies, taking into aaccount a broad contact zone between Peloponnesus and the Greek mainland which existed several times for relatively long periods, thus also in the period of the last glaciation in the Valdai epoch (GERASIMOV & VELICHKO 1982).

5. Conclusions

The study of the Yugoslav population od *Anguis fragilis* was carried out on 307 specimens, a sample that made it possible to obtain valid results. Researched is the distribution of this species and its intraspecific differentiation in our country and on the Balcan Peninsula, as well as the biogeographic characteristics of the intraspecific taxa.

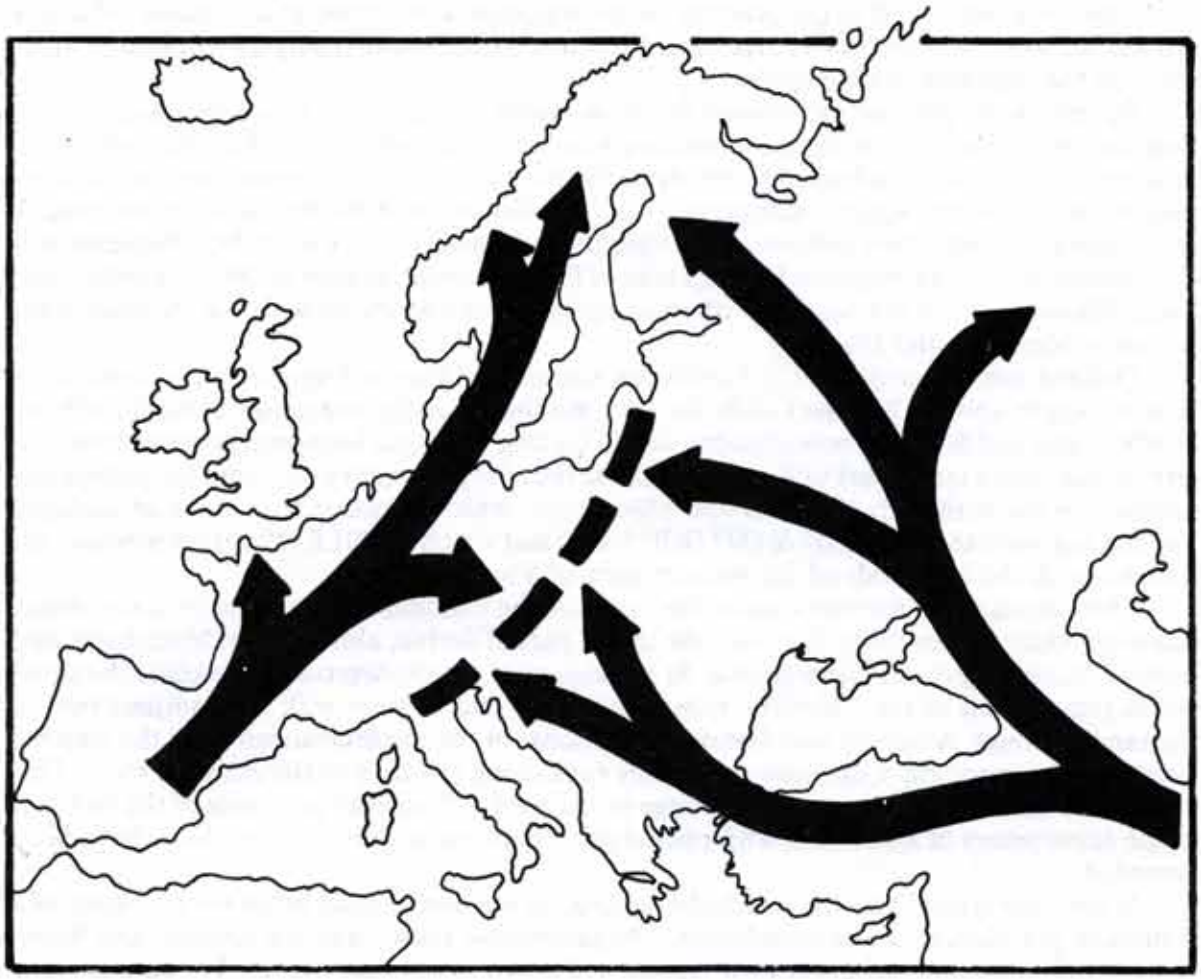

Fig. 7. Penetration of the typical and the Colchidic subspecies of the slow-worm (*Anguis fragilis L.*) to the north after the glacial period. According to VOIPIO (1962).

Slika 7. Smeri prodiranja nominantne in kolhidske podvrste slepca (*Anguis fragilis L.*) na sever po ledeni dobi (po Voipiu 1962).

Defined is the present slow–worm range in Yugoslavia, a range that does not cover the entire territory but includes larger areas in the cultured steppe of Voivodina from which this species is absent, in addition to a strong probability that *A. fragilis* does not populates such provinces that biogeographically make part of the subprovince of Aegean–Anatolian semi-deserts (MATVEJEV 1961) which in Yugoslavia are limited to single parts of Macedonia. Slow–worms, in some cases in large numbers, were proved to be present on single islands of the northern Adriatic, whereas the first mention of *Anguis fragilis* is connected with the south–Dalmatian islands Mljet and Vis.

On the basis of the frequency of positively linked intraspecific characters the Yugoslav population of slow–worms is divided into three groups. The first group consists of individuals with dominant characters of the typical subspecies (*A. f. fragilis*), the second of individuals of the contact population, and the third of specimens of the Colchidic subspecies.

By analysing qualitative and selected quantitative characteristics we established their variability within each group as indentified while the hi-square and t–test methods were applied to determine the statistical significances of the differences observed among single groups. It can now be stated that both the typical and the Colchidic species exist in Yugoslavia. A dominant difference between them expresses itself in Yugoslavia. A dominant difference between them expresses itself in the presence of ear openings, a lesser one in the number of scales around the body and the pileus type, and the least, though statistically an important difference in the presence of blue spots.

By testing the differences between the slow–worm groups from Yugoslavia and the population of *A. fragilis* from the neighbouring countries, undoubtedly making part of the typical and the Colchidic subspecies, respectively, we proved that our popuations wholly belong to one of the two »great« subspecies. The sole difference in the frequency of the type A of the pileus was observed between the Yugoslav specimens of the Colchidic subspecies and the specimens of this subspecies from an area of Estern Europe as kept in DELY's collection. Such differences were not recorded when comparing our specimens with the material from Bulgaria, Slovakia, and Hungary.

Defined was the range of *A. f. fragilis*; we also proved that in Yugoslavia this subspecies is more widely spread than the Colchidic one, and that its range comprises Slovenia, almost all of Croatia and Bosnia, a considerable part of Herzegovina and Montenegro, as well as western Serbia with a larger part of Kosovo. Outside the compact part of the range the subspecies appears on the highlands of Serbia and Macedonia, which is stated also in the »Catalogus Faunae Jugoslaviae« (BRELIH & DŽUKIĆ 1974) and which HENLE (1985) erroneously associates with the highlands of the western part of Yugoslavia.

Even though of a narrower span, the range of the Colchidic subspecies (*A. f. colchisuc*) has more indented contours. It covers the major part of Serbia, almost all of Macedonia and parts of Montenegro and Herzegovina. In Herzegovina, Montenegro and Metohija the slow-worm populations of the Colchidic subspecies come into contact with the compact part of the range through Albanian and Greek populations. In the mediterranean zone the western border of the range the Colchidic subspecies runs along the turn of the Neretva river. This subspecies has no disjunct part of the range in the west of Yugoslavia in spite of the fact that single occurrences of specimens with phenotypic characteristics of *A. f. colchicus* have been recorded.

Where the typical and the Colchidic subspecies encounter each other the existence of a »contact« population can be established. The geographic position of the contact zone forms also the delimitation line between the typical and the Colchidic subspecies. The contact zone is narrower in the mountainous part of Yugoslavia and broader in the lowlands and the highlands. Narrow contact zones take the form of strips on the highlands whose roots and larger environment are populated by the Colchidic subspecies.

The delimitation among the subspecies such as evidenced for Yugoslavia and Bulgaria (BEŠKOV 1966) is valid for the entire southeastern part of the Balcan Peninsula.

At present the most acceptable to the explanation of the intraspecific differentiation of the species *Anguis fragilis* and the horology of the intraspecific taxa in Yugoslavia and on the Balcan Peninsula are VOIPIO's hypothesis and an amended division of the Balcan Peninsula by BEŠKOV (1966), respectively.

Summary

The object of our study is the variability of morphological characters of the species *Anguis fragilis* LINNAEUS 1758 (Reptilia: Sauria: Anguidae) in Yugoslavia nad on the Balcan Peninsula. Included in the research were 307 specimens. It was found that the geographic distribution of external morpholigical characters of slow–worms was not homogeneous. A detailed study of the variability of outer ear openings, the number of scales in a series around the body, the pileus type, and the existence of blue spots served to prove the presence of the typical (*A. f. fragilis*) and the Colchidic (*A. f. colchicus*) subspecies of slow-worms in Yugoslavia, with a contact zone between them. Described are characteristics of these populations, in addition to a comparative analysis, both with respect to the identified groups of populations in Yugoslavia and the populations from different parts of Europe which undoubtedly belong to the typical or the Colchidic subspecies of slow–worms.

More closely determined are ranges of the subspecies in our country, and defined is also the contact zone. The typical subspecies was found to cover a larger range in our territory including Slovenia, almost all of Croatia and Bosnia, the major part of Herzegovina and Montenegro, as well as western Serbia and Kosovo. In addition to the compact part of the range the said subspecies appears also on the highlands of Serbia and Macedonia. The range of the Colchidic subspecies encompasses the eastern and the southeastern part of Yugoslavia, while from Greece and Albania a part extends to Montenegro, Herzegovina and southern Dalmatia. Extending between these populations i.e. subspecies is a contact zone of an uneven breadth and without sharp outlines. It is broader in the highland parts and the lowlands of Šumadija, Srem and Slavonia. The contact zone takes also the form of narrow strips on the highlands with isolated parts of the range of the typical subspecies.

Beside the ranges of the subspecies this works offers also an insight into the present range of the species *Anguis fragilis* in Yugoslavia. The species was found to be absent from larger spans of the cultured steppe in Voivodina and it is presumed that it likewise does not live in the provinces of Aegean–Anatolian semi–deserts in Macedonia. The species was stated for the first time on the south–Dalmatian islands.

The most acceptable to the explanation of such a type of the slow–worm range in Yugoslavia and the Balcan Peninsula, as well as its historical formation is VOIPIO's s hypothesis (1966) amended by BEŠKOV (1966).

Povzetek

Proučevana je variabilnost zunanjih morfoloških značilnosti vrste *Anguis fragilis* LINNAEUS 1758 (Reptilia: Sauria: Anguidae) v Jugoslaviji in na Balkanskem polotoku. Proučevanje je zajelo 307 primerkov. Ugotovljeno je, da ni homogene geografske distribucije zunanjih morfoloških značilnosti. Natančna obdelava spremenljivosti zunanjih ušesnih odprtin, števila lusk v enem nizu okoli telesa, tipa pileusa in plavih peg je dokazala nominantno (*A.f. fragilis*) in kolhidsko (*A.f. colchicus*) podvrsto slepca v Jugoslaviji in njuno medsebojno stično območje. Opisane so značilnosti teh dveh populacij, narejena je komparativna analiza med tema skupinama populacij kot tudi med populacijami iz različnih delov Evrope, ki nedvomno pripadajo nominantni ali kolhidski podvrsti.

Bolj natančno so določeni areali podvrst v naši deželi in njihovo stično območje. Ugotovljeno je, da ima nominantna podvrsta širši areal na našem ozemlju, ki zajema Slovenijo, skoraj celo Hrvatsko in Bosno, večji del Hercegovine in Črne gore, zahodno Srbijo ter Kosovo. Razen na tem strnjenem območju se ta podvrsta pojavlja na visokih planinah Srbije in Makedonije. Areal kolhidske podvrste zajema vzhodni in jugovzhodni del Jugoslavije. En del areala kolhidske podvrste zahaja preko Grčije in Albanije v Črno goro, Hercegovino in južno Dalmacijo. Med temi populacijami, pravzaprav podvrstami, je stično območje brez ostrih meja in neenake širine. Širše je v hribovitih in nižinskih predelih Šumadije, Srema in Slavonije. Stično območje se pojavi kot ozek višinski pas na planinah, kjer so izolirani deli areala nominantne podvrste.

Razen areala podvrst je v delu podana tudi analiza areala vrste *Anguis fragilis* v Jugoslaviji. Ugotovljeno je, da vrste na širšem prostoru kulturne stepe v Vojvodini ni in domneva se, da je ni na območju egejsko-anatolskih polpuščav v Makedoniji. Vrsta je prvič ugotovljena na južnodalmatinskih otokih.

Za obrazložitev takšnega tipa areala slepca v Jugoslaviji in na Balkanu kot tudi njegovega zgodovinskega nastanka je sprejemljiva Beškovljeva (1966) dopolnitev hipoteze Voipia (1962).

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