

# ON THREE NEW CAVE PSEUDOSCORPION SPECIES (PSEUDOSCORPIONES, NEOBISIIDAE) FROM MT. MOSOR, DALMATIA (CROATIA)

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**Abstract.** – Most subterranean pseudoscorpions are concentrated in regions with a Mediterranean climate. Although data on the abundance of pseudoscorpion species in the humid tropics are lacking, preliminary observations suggest that the number of species is greater in the Mediterranean area than in tropical rain forests.

Speciation in pseudoscorpions has not been studied in great detail. New taxa are constantly being described. Exact data on the different niche preferences which are a prerequisite for evolutionary studies are available for only a few cases. The pseudoscorpions are not particularly suitable for genetic investigations due to their extended generation times.

The cave-dwelling forms of the genus *Neobisium* L. Koch comprise many phyletic lines, some less specialized and others highly adapted to cave life. To trace their origin, biogeography and evolution, it is necessary to compare the evidence about troglotic species with that of the epigean forms from different European habitats, especially in the Mediterranean or Dinaric regions.

To the south of the river Zrmanja, up to the lower Neretva valley, a massive Holokarst region rises to a considerably height. Many summits attain between 1800 and 2000 m, and Mt. Dinara gave its name to both the Dinaric region and the Dinaric Karst. The karst of Mt. Mosor (and Mts. Kozjak and Biokovo), is quite different from that previously discussed. This is a zone of younger, intensively folded mountains. Their karst, although young, appears to be deep and almost fully developed.

In this study, descriptions of *Neobisium montdori* n. sp., *N. mosorensis* n. sp., and *N. dalmatinum* Beier, 1939, all from caves on Mt. Mosor, Dalmatia (Croatia), have been presented, with some details on the comparative morphology of both sexes and tritonymph.

**Keywords:** Pseudoscorpiones, Neobisiidae, *Neobisium montdori* n. sp., *N. mosorensis* n. sp., and *N. dalmatinum* evolution, biogeography, biospeleology, development, Mt. Mosor, Dalmatia, Croatia.

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## INTRODUCTION

The Dinaric Karst is closely associated to the great range of the Rhodope Mountains (of the old Balkan Crystalline nucleus), which occupies the central part of the Balkan Peninsula. In the 19<sup>th</sup> and first half of the 20<sup>th</sup> centuries a number of zoologists visited this remote region and made the first unexpected discoveries. They found endemic

arachnids, especially pseudoscorpion taxa (most of them described later by Beier: 1929, 1931, 1932, 1939, 1963). The biogeographical importance of these findings was soon recognized by the Serbian zoologist Hadži (1928, 1930, 1931, 1933, 1937, 1940, 1941, 1957, 1961, 1965). However, the organized biospeleological study of the Dinaric caves and their inhabitants only started mid-century (from the 1960s onwards), uncovering an extraordinary

wealth of endemic pseudoscorpions, greater than in any other European region. This abundance is unique in Europe and comparable only to that of tropical rain forests (Ćurčić, 1974, 1977, 1984, 1988, 2002, 2010; Ćurčić and Dimitrijević 1984, 1986; Ćurčić et al., 2004).

Two fundamental features are characteristic of underground karst relief: the "ephemeral" existence of the majority of the caves and their scattered and isolated distribution. Caves are formed and disappear within a geologically short time. Thus, the majority of Alpine (and Dinaric) caves are of quite recent origin. Life-times have been estimated for a few of them as being roughly from 40,000 to 80,000 years. Caves and other forms of the underground karst relief are therefore transitory incidents in the history of the Earth, spasmodic phenomena in time and space.

#### DESCRIPTIVE PART

NEOBISIIDAE J. C. CHAMBERLIN, 1930

*NEOBISIUM* J. C. CHAMBERLIN, 1930

*NEOBISIUM MONTDORI*, NEW SPECIES

*Etymology.* – According to some explanations, the name of Mt. Mosor is derived from "mont d'or" (or the Golden Mountain).

*Material examined.* – Holotype female, from the Kravska Jama Cave, Bradarića Staje, cca 700 m a. s. l., northern slope of Mt. Mosor, Dalmatia, Croatia; collected by Branko Jalžić (no collecting date enclosed).

*Description.* – Carapace reticulate throughout; epistome small, triangular and apically rounded (Figs. 1 and 2). Neither eyes nor eyespots are developed (Fig. 2). No preocular microsetae present. Setal carapacial formula: 4+6+6+6=22.

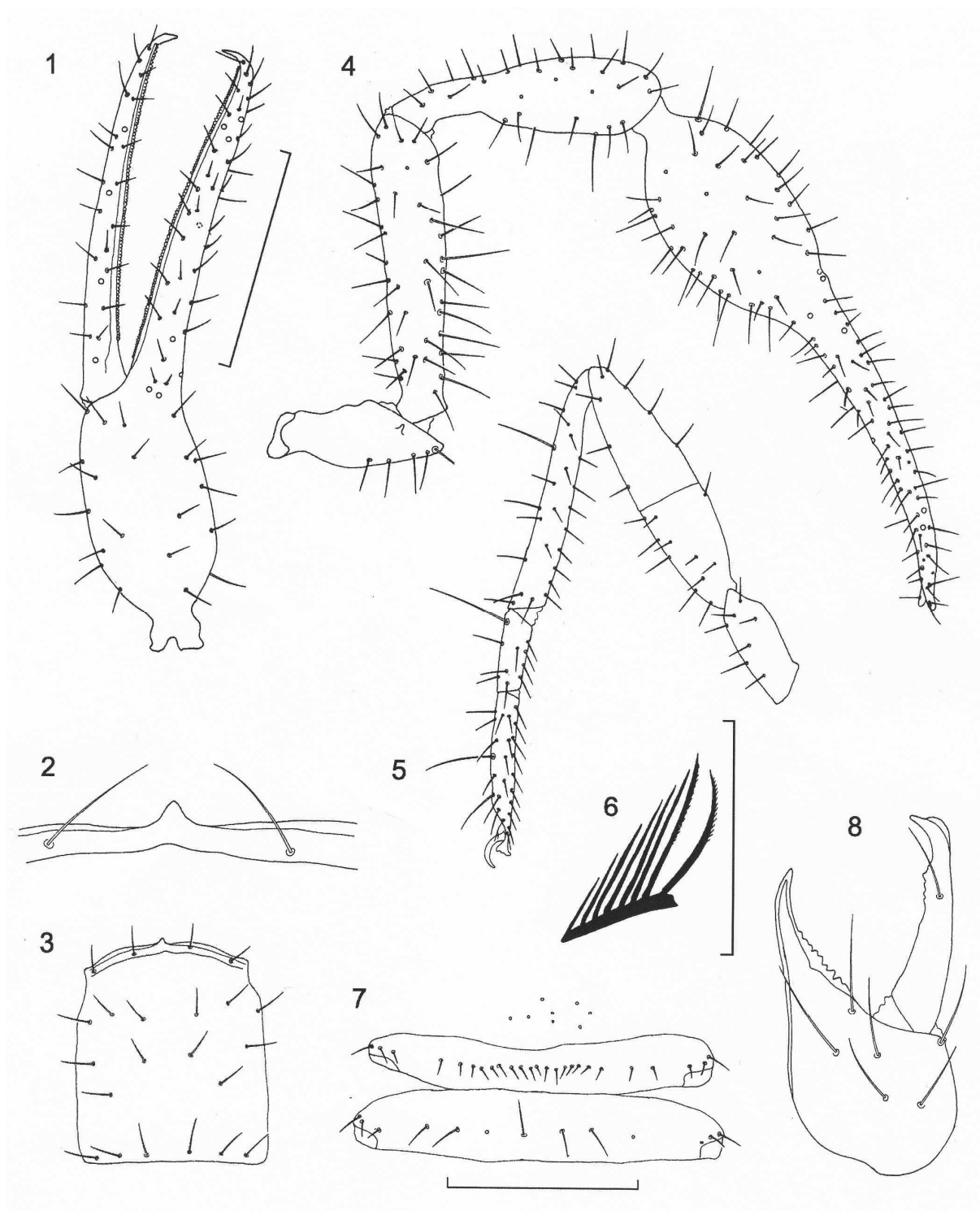
Tergites I-X and sternites IV-X uniseriate, smooth, and entire. Setal formula of tergites I-X is 6-6-6-7-9-8-9-9-9-8; setation of posterior carapacial row equal to the number of setae on either of the

tergites I-III. Male genital area: unknown. Female genital area (Fig. 1): sternite II with 8 small median and posterior setae, sternite III with 17 posterior setae and 3 suprastigmatic setae on either side, sternite IV with 7 posterior setae and 3 small setae along each stigma. Sternites V-X with 12-10-13-12-12-10 posterior setae. Twelfth abdominal segment with two pairs of small setae. Pleural membranes granulostriate.

Cheliceral spinneret (galea) low and rounded (Fig. 8). Movable cheliceral finger with one, cheliceral palm with six setae (Fig. 8). Galeal seta inserted almost at the upper third of the movable finger, just below the galeal seta (*gl*). Fixed cheliceral finger with a row of 10-12 small and close-set teeth which are irregularly shaped and of unequal size. Movable cheliceral finger with one larger tooth distally, followed by 4-5 small teeth which merge into a distal lamella (Fig. 8). Flagellum eight-bladed; only two distal blades are pinnate anteriorly. Other blades are smooth and acute and diminish proximally (Fig. 6).

Manducatory process (apex of pedipalpal coxa) bears 5 long setae. Trochanter with one small tubercle, pedipalpal articles smooth and attenuated, femur and tibia somewhat dilated distally (Figs. 1 and 4). Chelal palm ovate (Figs. 1 and 4). Fixed chelal finger with 103 small and contiguous teeth which are triangular and apically pointed. Only basal teeth are smaller, narrower and lower. The teeth of the fixed finger reach the level of the trichobothrium *ib* (Fig. 1). Movable chelal finger with 90 small teeth; distal members are triangular and low; basal to *t* the teeth gradually become retroconical, wider and lower, but not reaching the level of *b*. Chelal fingers longer than chelal palm; pedipalpal femur shorter than chelal femur (Fig. 4 and Table 1).

Disposition of trichobothria: *eb*, *esb*, *ib* and *isb* on the finger base, *et*, *it* and *est* on the top of the finger (Fig. 1); *ist* closer to *est* than to *isb*. Setae *b* and *sb* in the proximal, and *st* and *t* in the distal finger half. Distance *sb-st* less than twice as long as *b-sb* and less than twice as long as *t-st* (Fig. 1).



**Figs. 1-8.** *Neobisium montdori* n. sp., from Dalmatia. Holotype female: 1 – pedipalpal chela, 2 – epistome, 3 – carapace, 4 – pedipalpal chela, 5 – leg IV, 6 – flagellum, 7 – female genital area, 8 – chelicera. Scales = 0.50 mm (Figs. 1, 3, 4, 5 and 8) and 0.25 mm (Figs. 2, 6, 7 and 8).

**Table 1.** Linear measurements (in millimetres) and morphometric ratios in *Neobisium montdori* n. sp., *N. mosorense* n. sp. and *N. dalmatinum* Beier from some caves in Dalmatia. Abbreviations: M = male(s), F = female, T = tritonymph.

Species	<i>N. montdori</i>	<i>N. mosorense</i>	<i>N. dalmatinum</i>			
	F	M	F	M	F	T
Body						
Length (1)	4.45	3.26	3.82	3.35-3.90	3.79-3.99	2.86
Cephalothorax						
Length (2)	1.05	1.06	1.19	1.07-1.26	1.10-1.28	0.79
Breadth (2a)	0.79	0.91	0.88	0.855-1.05	0.90-1.05	0.63
Ratio 2/2a	1.33	1.16	1.35	1.20-1.25	1.21-1.27	1.25
Abdomen						
Length	3.40	2.20	2.63	2.09-2.83	2.51-2.89	2.07
Chelicerae						
Length (3)	0.69	0.67	0.76	0.72-0.87	0.67-0.73	0.51
Breadth (4)	0.37	0.35	0.41	0.36-0.41	0.36-0.38	0.275
Length of movable finger (5)	0.50	0.45	0.52	0.46-0.55	0.46-0.50	0.34
Ratio 3/5	1.38	1.49	1.46	1.565-1.58	1.46-1.50	1.50
Ratio 3/4	1.86	1.91	1.85	2.00-2.12	1.86-2.00	1.85
Pedipalps						
Length with coxa (6)	7.23	6.965	7.34	8.395-9.79	7.30-7.51	4.655
Ratio 6/1	1.62	2.14	1.91	2.15-2.92	1.84-1.98	1.63
Length of coxa	0.90	0.845	0.89	0.88-1.05	0.91-0.94	0.63
Length of trochanter	0.75	0.75	0.79	0.78-1.03	0.77-0.79	0.51
Length of femur (7)	1.56	1.54	1.54	1.59-2.13	1.56-1.61	1.03
Breadth of femur (8)	0.295	0.28	0.315	0.275-0.37	0.285-0.295	0.20
Ratio 7/8	5.29	5.50	4.89	5.76-5.78	5.29-5.65	5.15
Ratio 7/2	1.485	1.45	1.29	1.485-1.69	1.26-1.42	1.30
Length of patella (tibia) (9)	1.26	1.21	1.29	1.365-1.78	1.24-1.29	0.815
Breadth of patella (tibia) (10)	0.36	0.34	0.38	0.39-0.46	0.34-0.37	0.25
Ratio 9/10	3.50	3.56	3.39	3.87-4.14	3.405-3.65	3.26
Length of chela (11)	2.76	2.62	2.83	3.78-3.80	2.71-2.98	1.67
Breadth of chela (12)	0.59	0.48	0.59	0.52-0.73	0.57-0.59	0.39
Ratio 11/12	4.68	5.46	4.80	5.205-7.27	4.75-5.05	4.28
Length of chelal palm (13)	1.14	1.25	1.33	1.20-1.70	1.22-1.32	0.805
Ratio 13/12	1.93	2.60	2.25	2.31-2.33	2.14-2.24	2.06
Length of chelal finger (14)	1.62	1.365	1.50	1.56-2.10	1.49-1.66	0.87
Ratio 14/13	1.42	1.08	1.13	1.235-1.30	1.19-1.26	1.08
Leg IV						
Total length	4.62	4.585	5.01	4.885-6.035	4.71-4.98	3.04
Length of coxa	0.53	0.50	0.57	0.60-0.73	0.57-0.63	0.42
Length of trochanter (15)	0.55	0.52	0.60	0.54-0.63	0.54-0.58	0.36
Breadth of trochanter (16)	0.20	0.19	0.22	0.21-0.305	0.19-0.22	0.16
Ratio 15/16	2.75	2.74	2.73	2.065-2.57	2.50-2.90	2.25
Length of femur + patella (17)	1.31	1.355	1.40	1.385-1.70	1.33-1.42	0.835
Breadth of femur + patella (18)	0.305	0.25	0.295	0.285-0.39	0.25-0.275	0.20
Ratio 17/18	4.295	5.42	4.745	4.36-4.79	4.84-5.60	4.175
Length of tibia (19)	1.20	1.12	1.23	1.26-1.59	1.14-1.21	0.71
Breadth of tibia (20)	0.14	0.14	0.16	0.15-0.22	0.15-0.16	0.12
Ratio 19/20	8.57	8.00	7.69	7.23-8.40	7.44-8.07	5.92
Length of metatarsus (21)	0.40	0.46	0.47	0.42-0.57	0.43-0.47	0.285
Breadth of metatarsus (22)	0.12	0.12	0.13	0.12-0.17	0.12	0.10
Ratio 21/22	3.33	3.83	3.615	3.35-3.50	3.58-3.92	2.85
Length of tarsus (23)	0.63	0.63	0.74	0.70-0.815	0.64-0.67	0.43
Breadth of tarsus (24)	0.10	0.10	0.12	0.11-0.15	0.10-0.11	0.10
Ratio 23/24	6.30	6.30	6.17	5.43-6.36	5.82-6.70	4.30
TS ratio - tibia IV	0.35	0.44	0.41	0.34-0.43	0.39-0.45	0.31
TS ratio - metatarsus IV	0.13	0.155	0.13	0.14-0.15	0.12-0.14	0.14
				0.43-0.59	0.46-0.61	
				0.77-0.83	0.74-0.81	
TS ratio - tarsus IV	0.435	0.40	0.34	0.12-0.18	0.16-0.19	0.38



Anterior and median rim of coxa I with numerous small chitinous points; trochanteral foramen elongate and apically transparent. Tibia IV, basitarsus IV, and telotarsus IV each with a single sensitive seta (Fig. 5). Subterminal tarsal setae furcated, each branch with few spinules. Morphometric ratios and measurements are presented in Table 1.

*Remarks.* – From its phenetically close congener, *Neobisium usudi* Čurčić, 1988, from Middle Dalmatia, *N. montdori* n. sp., is easily distinguished by the absence/presence of preocular microsetae (present vs. absent), by the setation of tergites I-IV (6-6-6-7 vs. 4-8-10-13), by the number of setae on sternites II and III of the female (8 and 17 vs. 15 and 28), by the number of teeth on fixed (103 vs. 84) and movable fixed finger (90 vs. 67), by the body length (4.45 mm vs. 3.74 mm), by the pedipalpal femur length-to-breadth ratio (5.29 vs. 5.10), leg IV tibia length-to-breadth ratio (8.57 vs. 5.32), and by the leg IV femur length-to-breadth ratio (4.295 vs. 4.925).

*Distribution.* – Dalmatia, Croatia: Mt. Mosor, in caves.

*Remarks.* – This species seems to be endemic and confined to the Dalmatian region (Mt. Mosor) of the Dinaric Karst only.

#### NEOBISIUM MOSORENSE, NEW SPECIES

*Etymology.* – After its terra typical, Mt. Mosor, Dalmatia.

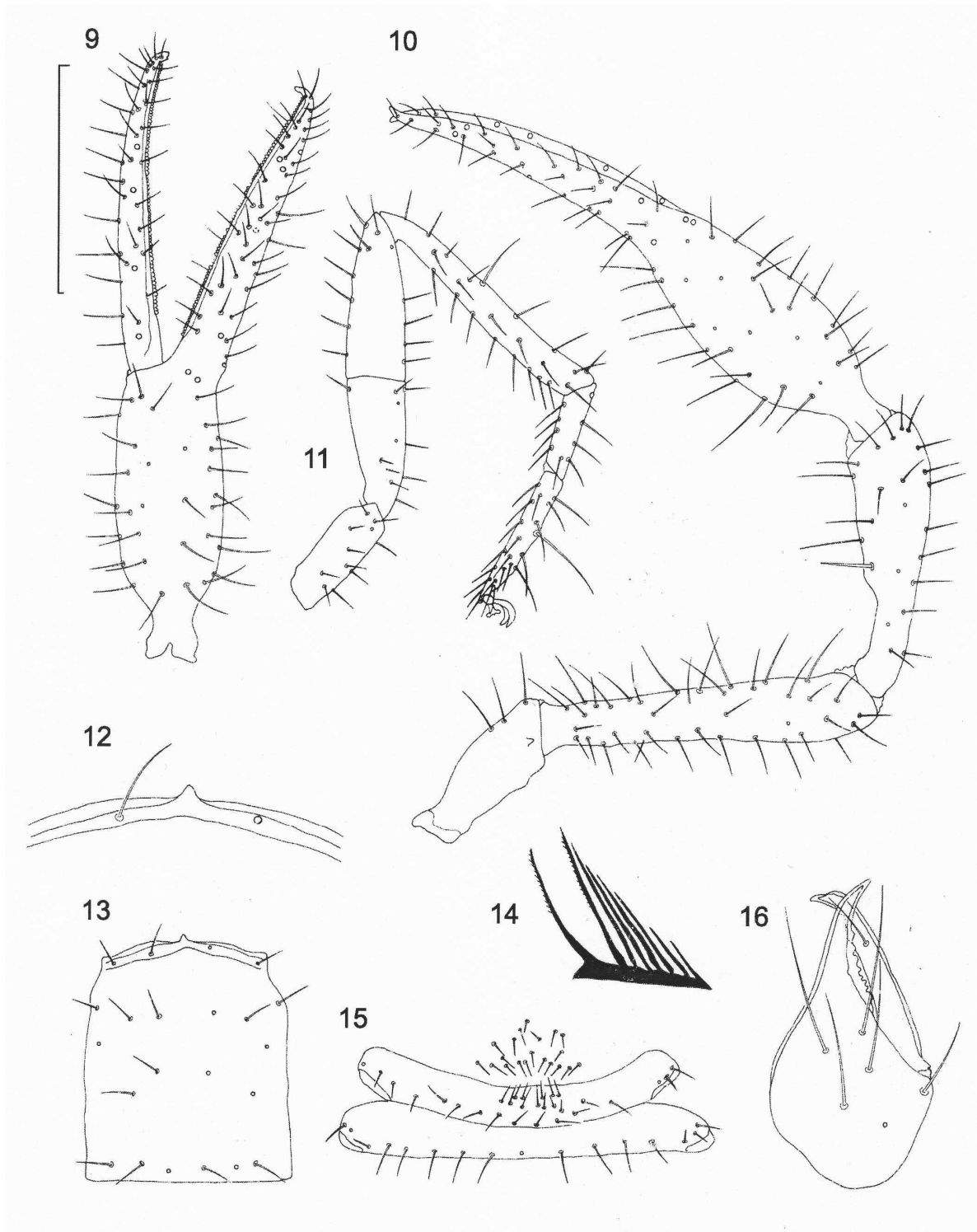
*Material examined.* – Holotype male, from the Koraljna Jama Cave, northern side of Mt. Mosor, Bradarića Staje, Dalmatia; collected by Branko Jalžić (no collecting date available); allotype female, from the same locality, collected by Branko Jalžić.

*Description.* – Carapace reticulate throughout; epistome triangular, but apically rounded (Figs. 12, 13, 21 and 22). Anterior carapacial margin only slightly convex medially (Figs. 13 and 22). Neither eyes nor eyespots are present (Figs. 13 and 22). Setal formula 4+6+6+6=22 (male) and 4+6+4+5=19 (female). Preocular microsetae absent.

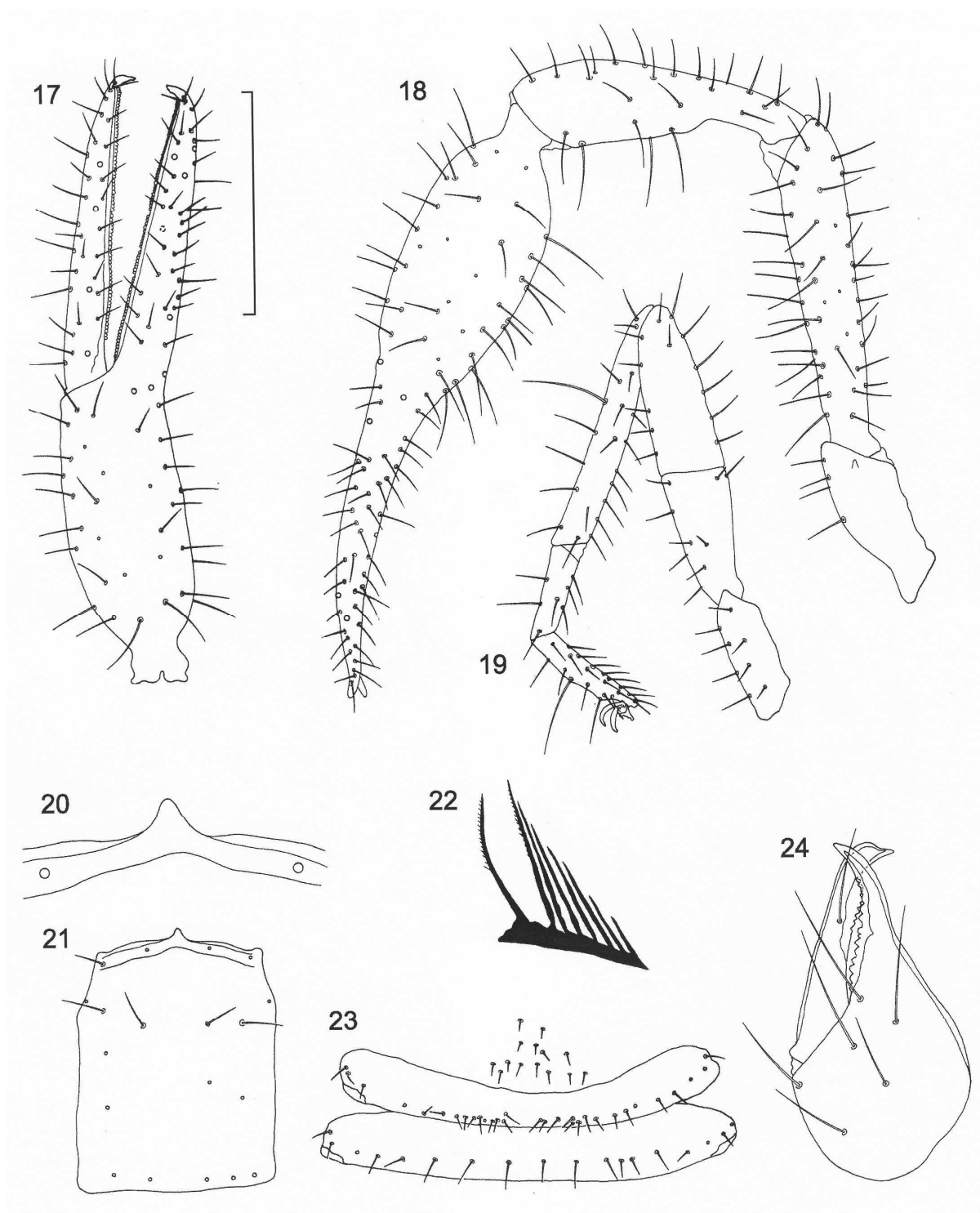
Abdominal tergites entire, smooth and uniseriate. Tergites I, II and III somewhat more sclerotized than others. Setation of tergites: 6-7-9-9-9-10-10-10-10-9 (male) and 5-6-8-9-9-9-10-10-10-9 (female). Male genital area (Fig. 16): sternite II with 20 small setae, chelate medially and posteriorly; sternite III with 12 median and anterior setae, 11 posterior setae and 3 small setae on either side. Sternite III with 10 posterior setae and 3 microsetae along each of the stigma. Sternites V-X uniseriate and smooth, with 15-15-14-15-14-13 posterior setae. Female genital area (Fig. 24): sternite II with 14 small median and posterior setae; sternite III with 25 posterior setae and 3 microsetae along each stigma; sternite IV with 13 posterior setae. Sternites V-X with 16-15-15-14-14-13 setae; sternites IV-X uniseriate and smooth. Pleural membranes granulostrate. Twelfth abdominal segment with two pairs of small setae.

Galea of a hyaline convexity, somewhat more prominent in the female (Figs. 17 and 25). Cheliceral palm with six, movable finger with one seta (Fig. 17 and 25). Fixed cheliceral finger with 11 (male) and fifteen teeth (female), movable cheliceral finger with 4-8 small distal teeth, which diminish from distal to proximal ending in a dental lamella. Galeal seta inserted slightly above the level of the large tooth on the movable finger. Flagellum of eight blades; only two distalmost blades pinnate anteriorly (Figs. 15 and 23). The remaining blades decrease in size from distal to proximal. The two most proximal flagellar blades are the smallest.

Manducatory process (or apex of pedipalpal coxa) bears 5 acuminate setae. Pedipalpal trochanter elongated with one or two low tubercles, femur with an exterior and lateral tubercle, other pedipalpal articles smooth and slender (Figs. 9, 10, 18 and 19). Chelal palm elongated (not ovate) and slightly shorter than chelal fingers (Figs. 9 and 18; Table 1). Fixed chelal finger with 83 (male) or 89 (female) small, contiguous and asymmetrically pointed teeth which reach the level of *ib*. Movable chelal finger with 75 (male) or 72 (female) close-set teeth; only a few distal members are asymmetrically pointed and the remainder belong to the square-cusped or rounded teeth which do not reach as far as the level of *b* (Figs. 9 and 18).



**Figs. 9-17.** *Neobisium mosorense* n. sp., from Dalmatia. Holotype male: 9 – pedipalpal chela, 10 – pedipalp, 11 – Leg IV, 12 – epistome, 13 – carapace, 14 – pedipalp, 15 – flagellum, 16 – male genital area, 17 – chelicerae. Scales = 0.50 mm (Figs. 9, 10, 11, 13 and 14) and 0.25 mm (Figs. 12, 15, 16 and 17).



**Figs. 18-25.** *Neobisium mosorense* n. sp., from Dalmatia. Allotype female: 18 – pedipalpal chela, 19 – pedipalp, 20 – Leg IV, 21 – epistome, 22 – carapace, 23 – flagellum, 24 – female genital area, 25 – chelicera. Scales = 0.50 mm (Figs. 18, 19, 20 and 22) and 0.25 mm (Figs. 21, 23, 24 and 25).

Trichobothriotaxy (Figs. 9 and 18): *et*, *est*, *it* and *ist* are in the distal half of the fixed chelal finger, the remainder are found on the finger base. Seta *ist* closer to *est* than to *isb*. Seta *sb* closer to *b* than to *st*, *b-sb* slightly shorter than *sb-st*, *st* closer to *t* than to *sb*. Chelal fingers longer than chelal palm, and somewhat shorter than pedipalpal femur (Table 1).

Coxa I: anterior and median rim with few transparent chitinous points, trochanteral foramen acute. Tibia IV, basitarsus IV and tarsus IV each with a single sensitive seta (Figs. 11 and 20). Subterminal tarsal setae furcated, each ramus with few spinules.

Morphometric ratios and linear measurements are presented in Table 1.

*Differential diagnosis.* – The new species is easily distinguished from its phonetically close congener *Neobisium usudi* Ćurčić, 1988 (from Middle Dalmatia) by many important aspects such as: the presence/absence of preocular microsetae (absent vs. present), the tergite setation I-X of the female (5-6-8-9-9-9-10-10-10-9 vs. 4-8-10-13-13-11-12-12-11-12), the sternite IV-X setation of the female (13-16-15-15-14-14-13 vs. 21-16-18-18-16-17-17), the number of teeth on the movable chelal finger of the female (72-75 vs. 67), the pedipalpal tibia length-to-breadth ratio of the female (3.39 vs. 3.71), the leg IV length of the female (5.01 mm vs. 4.40 mm), the leg tibia IV length-to-breadth ratio in the female (7.69 vs. 5.32 mm), and by the leg tarsus length-to-breadth ratio in the female (6.17 vs. 4.64).

*Distribution.* – Middle Dalmatia, Mt. Mosor, in a cave. Probably endemic to the Balkan Peninsula, and relict to the Dinaric Karst in Croatia.

#### *NEOBISIUM DALMATINUM* BEIER, 1939

Synonyms: *N. dalmatinum dalmatinum* Beier, 1939  
*N. dalmatinum aberrans* Beier, 1939

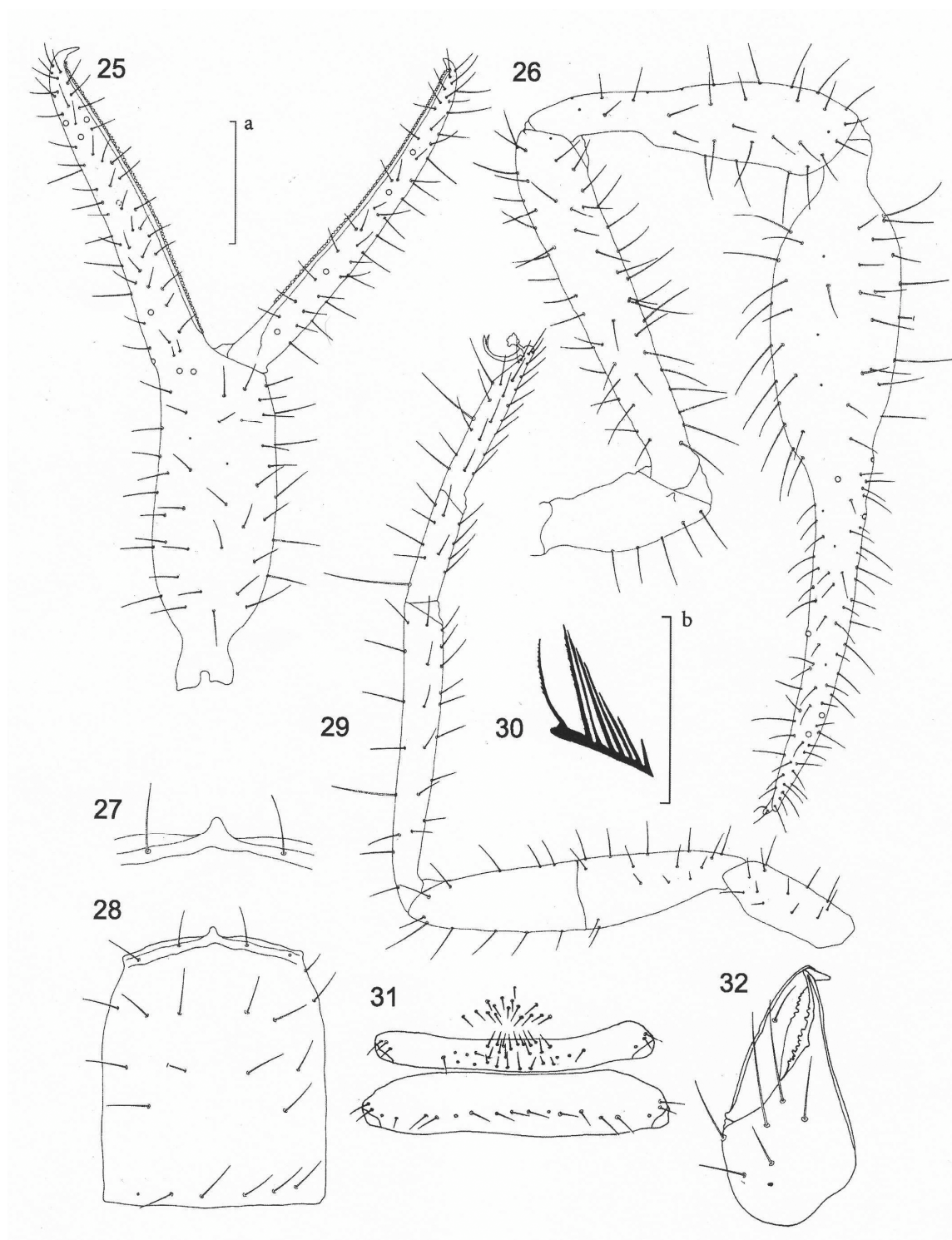
*Material examined.* – One male from the Kraljeva Peć Cave, Mt. Mosor, Dalmatia, April 1980, collected by Tonći Rađa; one male, from the Trojama Pit, Mt. Mosor, Dalmatia, 6 August 1935,

collected by Guido Nonveiller; two females, from the Kraljeva Peć Cave, Mt. Mosor, Dugo Polje, Dalmatia (no collecting data); one male, from Jama I Pit za Strumicom, Mt. Mosor, Dalmatia, 24 July 2009, collected by Tonći Rađa; and one tritonymph, from the Kraljeva Peć, Mt. Mosor, Dalmatia, April 1980, collected by Tonći Rađa.

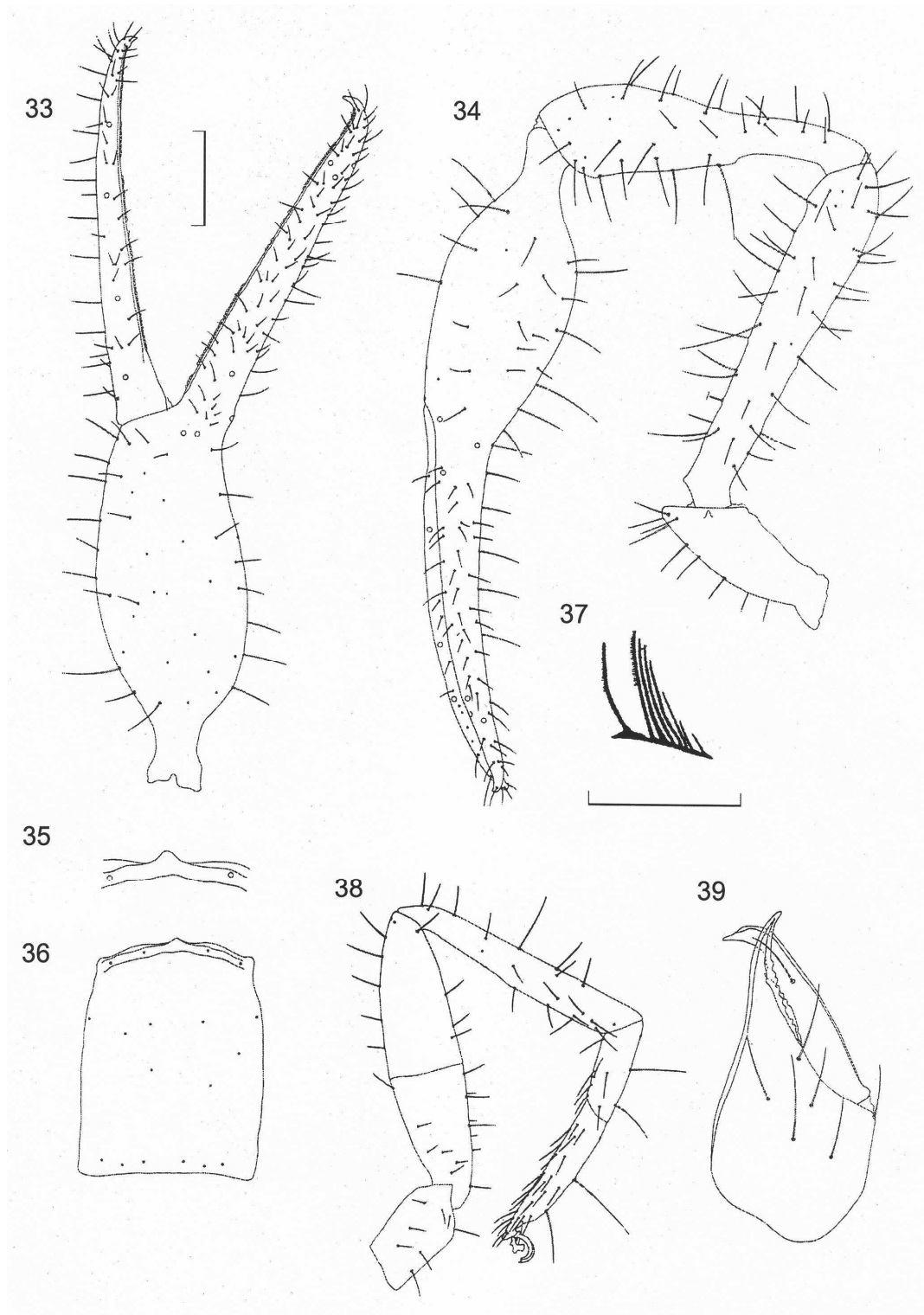
*Description.* – Carapace longer than broad (Figs. 29, 37, 46 and 55; Table 1) and reticulate throughout. Epistome triangular and apically rounded. Anterior carapacial margin slightly convex medially. Neither eyes nor eyespots are developed. Setal formulae: 4+6+6+6=22, 4+6+2+6= 18 (male), 4+6+6+6=22, 4+6+6+5=21 (female), and 4+6+7+6=23 (tritonymph). Preocular microsetae 0-0 or 0-1 or 1-0 on either side of the carapace (Figs. 29 and 37).

Abdominal tergites uniseriate, smooth and entire. Tergites I and II more heavily sclerotized than others. Setation of tergites I-X: 6-6-7-9-9-9-9-11-10-10, 6-7-8-9-8-9-7-10-10-9 (male), 6-6-7-10-9-9-9-9-10-9, 6-6-6-8-9-9-9-9-9-9, 6-6-6-8-9-9-9-10-10-8 (female) and 5-6-6-8-9-8-9-9-9-8 (tritonymph). Male genital area: sternite II with 11-6 median and posterior setae, sternite III with 8-17 anterior and 10-13 posterior setae and 3 suprastigmatic microsetae on either side, sternite IV with 8-13 posterior setae and 2 or 3 microsetae along each of the stigma; sternites V-X with 15-13-13-13-13-12 and 8-11-11-9-9-8 posterior setae. Female genital area: sternite II with 10-15 small median and posterior setae, sternite III with 16-19 posterior setae and 3 (rarely 4) small setae on either side, sternite IV with 8-11 posterior setae, and 3 microsetae along each of the stigma; sternites V-X with 12-15-13-14-14-13, 14-12-12-13-12-14, and 13-12-12-12-12-11 setae. Tritonymph: sternite II with 2 median and posterior setae, sternite III with 8 posterior setae and 2 microsetae on either side, sternite IV with 10 posterior setae and 2 suprastigmatic microsetae on either side. Sternites V-X with 11-12-11-11-13-11 posterior setae. Pleural membranes granulostriate. Twelfth abdominal segment with two pairs of small setae (in both adults and tritonymph).

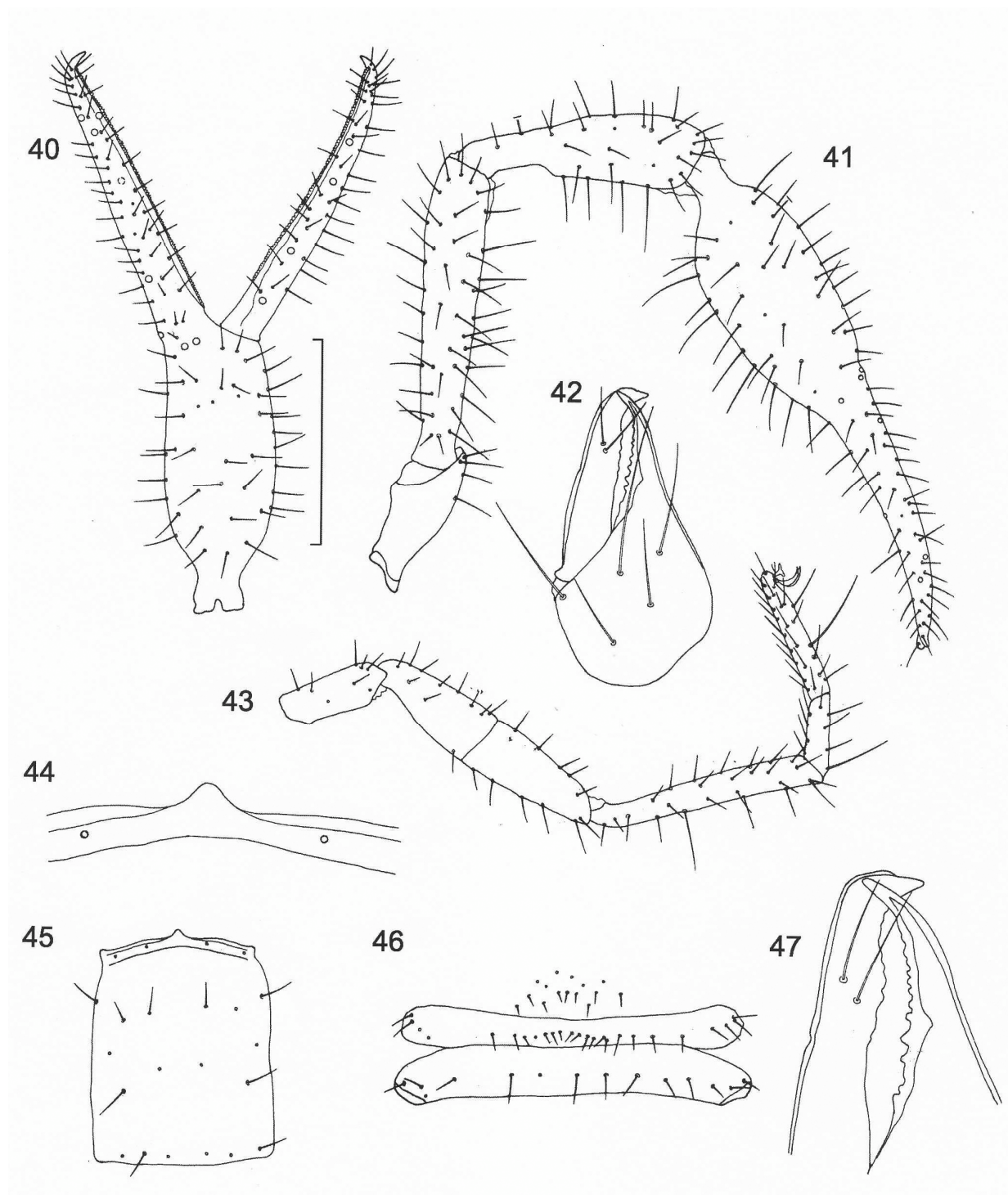




**Figs. 26-33.** *Neobisium dalmatinum* Beier, from Dalmatia. Male I: 26 – pedipalpal chela, 27 – pedipalp, 28 – epistome, 29 – carapace, 30 – Leg IV, 31 – flagellum, 32 – male genital area, 33 – chelicerae. Scales = 0.50 mm (Figs. 26, 27, 29, 30 and 32) and 0.25 mm (Figs. 28, 31 and 33).

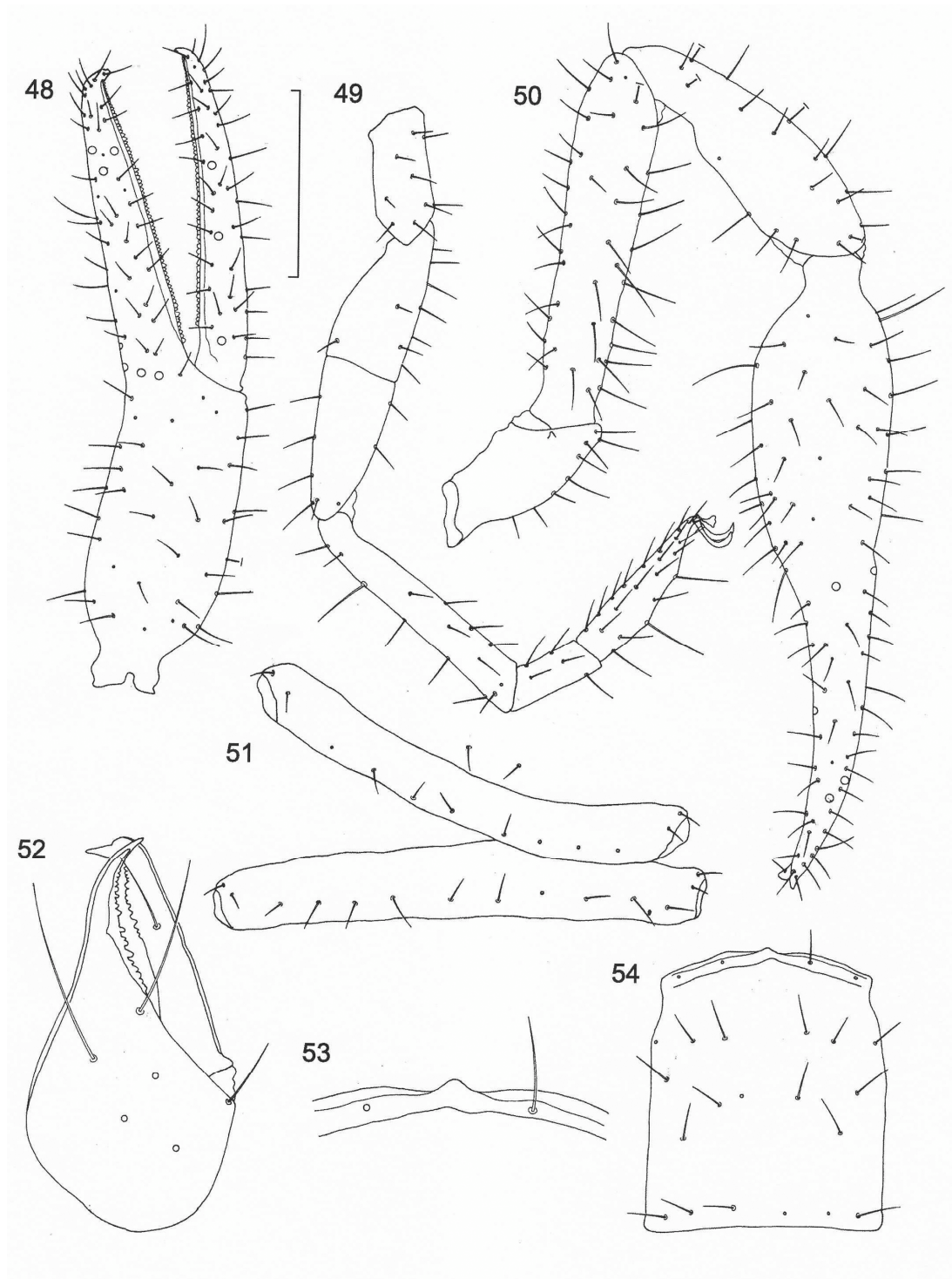


**Figs. 34-40.** *Neobisium dalmatinum* Beier, from Dalmatia. Male II: 34 – pedipalpal chela, 35 – pedipalp, 36 – epistome, 37 – carapace, 38 – flagellum, 39 – leg IV, 40 – chelicerae. Scales = 0.50 mm (Figs. 34, 35, 37, and 39) and 0.25 mm (Figs. 36, 38 and 40).



**Figs. 41-48.** *Neobisium dalmatinum* Beier, from Dalmatia. Female: 41 – pedipalpal chela, 42 – pedipalp, 43 – chelicera, 44 – Leg IV, 45 – epistome, 46 – carapace, 47 – female genital area, 48 – cheliceral tips. Scales = 0.50 mm (Figs. 41, 42, 44 and 46) and 0.25 mm (Figs. 43, 45, 47 and 48).





**Figs. 49-55.** *Neobisium dalmatinum* Beier, from Dalmatia. Tritonymph: 49 – pedipalpal chela, 50 – leg IV, 51 – pedipalp, 52 – sternites II-IV, 53 – chelicera, 54 – epistome, 55 – carapace. Scales = 0.50 mm (Figs. 49, 50, 51 and 55) and 0.25 mm (Figs. 52, 53 and 54).

Galea present, somewhat more prominent in females and tritonymph than in male (Figs. 33, 48 and 53). Cheliceral palm with six, movable finger with one seta (adults, tritonymph). Fixed cheliceral finger with 9-11 (adults) or 18 (tritonymph) small teeth, which merge into a distal dental lamella; movable cheliceral finger with 6-7 (adults) or 13 small rounded and irregularly shaped teeth which merge into a distal lamella (Figs. 33, 40, 48, and 53). Galeal seta inserted basal to the level of large tooth on the movable finger; in a single female from the Kraljeva Peć Cave, the left chelicerae carries two (instead of one!) galeal seta, while its right complement is normal (Fig. 43). Flagellum of 8 blades; only the two distalmost blades are pinnate anteriorly and the remaining smooth blades decrease in size from distal to proximal. The two most proximal flagellar blades are the shortest.

Apex of pedipalpal coxa (manducatory process) carries 5 (adults) and 4 long and acuminate setae (tritonymph). Pedipalpal trochanter with one or two small tubercles, femur with an anterior and lateral, other pedipalpal articles smooth and slender (Figs. 21, 27, 34, 35, 41, 42, 49 and 51). Chelal palm thinly ovate and slightly shorter than chelal fingers (Table 1). Fixed chelal finger with 101-116 (male), 98-116 (female) and 73 (tritonymph) small contiguous and asymmetrically pointed teeth which reach almost as far as the level of *ib* (in adults). Movable chelal finger with 92-101 (male), 84-93 (female) and 62 (tritonymph) small, close-set teeth; only a few distal members are asymmetrically pointed and the remainder belong to the square cusped or rounded teeth which do not reach the level of *b*.

Trichobothriotaxy (in adults): *et*, *est*, *it* and *ist* in the distal finger part, *eb*, *esb*, *ib* and *isb* on the finger base; *et* slightly closer to *it* than to *esb*, *est* closer to *it* than to *et* or *it*; *ist* nearer to *est* than to *isb*, on the middle between *isb* and finger top. Seta *sb* closer to *b* than to *st*, *st* closer to *t* than to *sb*. Distance *b-sb* slightly shorter than *st-t*, *t-st* less than twice as long as the distance *st-sb*. Chelal fingers slightly shorter than pedipalpal femur (Table 1).

Tritonymph: setae *eb* and *esb* on the finger base, *et* slightly nearer to *est* than to *et*, *its* closer to *est* than to *it*, *ist* closer to *est* than to *isb*. Seta *sb* closer to *t* than to *b*. Distance *b-sb* longer than *sb-t*.

Coxa I: anterior and median rim with few transparent chitinous points, trochanteral foramen acute. In adults, tibia IV with one sensitive seta, basitarsus with 3 sensitive setae, and tarsus IV with two such setae. Subterminal basal setae furcated, each ramus with few spinules. In tritonymph, tibia IV, basitarsus IV, and tarsus IV each carry a single tactile setae (Figs. 31, 39, 44 and 50).

Morphometric ratios and linear measurements are presented in Table 1.

*Distribution.* – Middle Dalmatia, Mt. Mosor, Croatia.

*Remarks.* – Endemic to the Balkan Peninsula, and endemic and relict to the Dinaric Karst in Middle Dalmatia.

It should be also noted that Čurčić (1988) has described this species from a number of localities in Middle Dalmatia and has also synonymized the subspecies *Neobisium dalmatinum aberrans* with *N. dalmatinum dalmatinum*.

## IN LIEU OF A CONCLUSION

Cave pseudoscorpions are usually descendants of the tropical epigean fauna living in Europe and North America at the beginning of the Tertiary period. The tropical fauna has subsequently disappeared from these regions. The species changed, were destroyed, or emigrated towards the present-day tropics. Only in caves have the same species survived. Simultaneous karstification provided a wide variety of niches underground, resulting in a huge refuge for originally epigean species (Čurčić, 1988; Čurčić et al., 2004).

Edaphism, or euedaphism (strict adaptation) to life in deep soil, is not characteristic of a single morphological or taxonomical group, but rather an

adaptive response of the epigeal or humicolous species of many pseudoscorpion groups for survival in Mediterranean climates. This shows the fundamental importance of humidity in the environment in the phenomenon of euedaphism, and reveals the changes resulting from adaptation to life in deep soil as well as a more cryptic way of life in caves. The more arid the (Mediterranean) climate, the greater the degree of edaphism adopted by the hypogean forms living there. Euedaphism is therefore the result of historical (climatic and vegetational changes) and contemporary factors (Mediterranean climate, topography).

Biogeographically, the pseudoscorpion genus *Neobisium* from the family Neobisiidae is characterized by extreme diversity, especially in southern Europe. This genus is distributed over a wide area from most of Europe to the south-western Russia and northern Iran and from northern Europe to the North African coast, including the Mediterranean islands (Ćurčić, 1988; Ćurčić et al., 2004). The nominal subgenus covers the whole distribution area of the genus, but is particularly well-represented in the Dinaric area, where the majority of its genus inhabits caves.

Since the distribution center of *Neobisium* is southern Europe, it is likely that it evolved there. This assumption is supported by the discovery of several *Neobisium*-related genera in the caves of the Iberian, Apennine and Dinaric Alps which have more primitive characteristics when compared to *Neobisium*. This fact therefore justified the assumption of the great age and autochthonous origin of the neobisiid stock and its species complexes in the Dinaric region. In addition, it is probable that the majority of *Neobisium* species originated during the Tertiary period, while the discoveries of some primitive proto-neobisiid taxa point to their even greater age and relict characteristics (Ćurčić, 1988; Vachrameev, 1960). The most intensive radiation of at least some of these archaic forms into species probably took place either during the Alpine Orogeny or later during the karstification which affected much of the northern hemisphere. Interestingly, the development of new, lower taxa has

taken place mainly on the periphery of the original area of distribution of the "protoneobisiid" or "neobisiid" stock.

The analysis of pseudoscorpions examined here helps in the interpretation of the origin and history of the Dinaric troglobitic pseudoscorpions. The primordial population is believed to have colonized the Proto-Balkans at the beginning of its existence. Subsequently, it gave birth to a number of phyletic lineages. First come the stem forms which had inhabited the leaf-litter and humus of Dinaric forests during or even before the Tertiary period. Evidently, there existed rich epigeal Paleogene and Neogene faunas in Eurasia and their disappearance from some parts is due not only to unfavorable changes in climate, but also to the lack of ways of migration or possibilities of attaining shelters (Stanković, 1932; Vitali-DiCastri, 1973).

It is not easy to analyze the origin and history of the endemic pseudoscorpions studied because they represent an adaptive and selected fauna. The colonization of the Dinaric subterranean habitats (including those on Mt. Mosor in Dalmatia) must have begun a long time ago and has passed through successive stages during different geological times, together with the development of karstic phenomena (Jeannel, 1943; Guéorguiev, 1977; Ćurčić, 1988). Among the main causes which have affected the history of the cave-dwelling Dinaric pseudoscorpions, one should emphasize the effects of the karstification process. Very little is known about this process as yet, hence its interpretation would be more or less hypothetical. It is evident, however, that the Dinaric Karst was not developed at the time, and therefore its colonization must have occurred progressively throughout its life span.

However, the question of the direct provenance of the Dinaric cave pseudoscorpions still remains open. We have every reason to assume that the fauna evolved from the ancient circum-Mediterranean fauna, its origin to be sought in the Dinaric area. The survival of numerous relict pseudoscorpions has been sustained by the continuity of the continental phase, by the relative constancy of life conditions in caves, as

well as by the isolation of underground habitats (Beier, 1963; Ćurčić et al., 2004).

This study of the cave pseudoscorpions inhabiting Dalmatia (which belong to the Dinaric Karst) has offered further proofs of their great age and probably different origin. These species (and higher taxa as well) represent the last vestiges of an old fauna, which found their shelter in the underground domain of the Balkan Peninsula and elsewhere.

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