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A New Genus and Species of False Scorpion from Northern Vietnam (Arachnida, Chelonethi, Neobisiidae)

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ABSTRACT.– *Echinocreagris golovatchi* gen. n., sp. n. is being described from a montane subtropical forest in northern Vietnam. A characteristic feature of the new genus is sexual dimorphism, the male being armed with a large protuberance on the dorsal side of the fixed chelal finger which, in addition, carries numerous spines. In chelal structure, this genus resembles *Dentocreagris* Dashdamirov, 1997, another monobasic genus from Vietnam. A preliminary analysis is given of the structure of the male genital apparatus in some of the genera of the family Neobisiidae, with a discussion of its utility in the taxonomy of this group.

KEY WORDS: Chelonethi, Neobisiidae, male genital apparatus, taxonomy, new genus, new species, Vietnam

INTRODUCTION

Through the courtesy of Dr. Sergei Golovatch (Institute for Problems of Ecology and Evolution, Russian Academy of Sciences, Moscow), I have recently become privileged to study a small, but very important collection of false scorpions from a montane subtropical forest in northern Vietnam. Among other things, this material contained a highly unusual neobisiid representing an undescribed genus and species which shows a remarkable palpal conformation. Because the sample comprised both sexes, apparent sexual dimorphism could be seen. In particular, the male possesses a rather large protuberance on the dorsal side of the fixed chelal finger which, in addition, is armed with rather large modified setae in the form of thickened (in comparison with other chelal setae), slightly acuminate spines of complex structure. These spines are likely to represent some receptors, as each is equipped with a tiny, but clearly visible “sense pore” on the top, as well as with a dense network of thin channels at the base. This character alone makes the new genus very clearly isolated from the other genera of the "*Microcreagris*-complex". Although this complex of genera and species was first discussed by Ćurčić (1982), we follow the interpretation suggested later by Judson (1993).

In their outlines, the chelal palps in the new genus and species treated here somewhat resemble those of *Dentocreagris* Dashdamirov, 1997, still another monotypic genus described from central Vietnam. Its chelal palps are also armed with rather peculiar setae, thus allowing for a particular trend in this trait’s development to be suggested. Sexual dimorphism in the "*Microcreagris*-complex" has heretofore been documented for the species *Stenohya hamata* (Leclerc and Mahnert, 1988), in which the male palpal hand has a large conical spine on the ventral side. Possibly, *Dentocreagris vietnamensis* Dashdamirov, 1997 shows sexual dimorphism in the structure of the palps as well, but we still do not know the female of that species.

Special attention deserves the lack of a developed galea, namely, its retention as a reduced knob. The presence of a weakly developed galea is not typical of the "*Microcreagris*-complex", with only *Acanthocreagris obtusa* Mahnert, 1976 and some species of the genus *Roncocreagris* Mahnert, 1976 showing the galea on the chelicerae in the form of a small protuberance. A similar condition observed in the new genus and species is thus noteworthy.

A special comparative study has also been undertaken to detail the structure of the male genitalia in some of the genera of the family Neobisiidae Chamberlin, 1930 for their possible utility in the generic classification. However, since no clear-cut patterns have been revealed yet, this character can only be used as additional, but not the main one, in generic delimitations.

The situation concerning the new genus in the "*Microcreagris*-complex" is highly controversial. I deliberately avoid an in-depth diagnosis of the genus and restrict myself to its relatively vague definition within the "*Microcreagris*-complex". This is primarily due to unclear positions of many genera. Based on the available descriptions alone, the validity of *Orientocreagris* Ćurčić, 1985 remains unclear. The same holds true of some likely polyphyletic genera such as *Bisetocreagris* Ćurčić, 1983 and *Microcreagris* Balzan, 1892.

MATERIALS AND METHODS

All type material is deposited in the collection of the Zoological Museum of the Moscow State University (ZMMU). Comparative material was studied using the collections of Senckenberg Museum, Frankfurt am Main (SMF), Institute of Zoology, Baku (IZB) and ZMMU, as well as the personal collection of the author (SD + No.). Microscopic studies and measurements of objects were carried out using standard methods. The following abbreviations are applied across the text. Tactile setae: B = basal; SB = sub-basal; ST = subterminal; T = terminal; IB = interior basal; ISB = interior sub-basal; IST = interior subterminal; IT = interior terminal; EB = exterior basal; ESB = exterior sub-basal; EST = exterior subterminal; ET = exterior terminal. Cheliceral setae: GLS = galeal seta; ES = exterior seta; IS = interior seta; LS = lateral seta; SB = sub-basal seta; B = basal seta; AS = accessory seta.

SYSTEMATICS

Echinocreagris gen. n.

Diagnosis.– Microcreagrinae Balzan 1892 and the "*Microcreagris*-complex", with all of the characteristics of this subfamily and generic complex, respectively.

General coloration of body from light to dark brown, carapace brown, front edge a little more intensely so, pedipalps pale brown, fingers slightly darker. Tergites dark brown, sternites lighter, legs yellowish brown. Abdomen oblong, about twice as long as cephalothorax, with setae mostly acuminate, rather long, but quite vague because of being translucid; tergites and sternites completely smooth, pleural membranes whitish yellow and granular. Chaetotaxy of male genital area similar to that of *Bisetocreagris* due to two microsetae at anteromedian edge of sternite III (for which there is no V-like notch) and to two rows of longer setae at posterior margin;

sternite II with a cluster of several setae in the middle and with an irregular row at posterior margin. Border between sternites II and III of female genital area almost invisible; chaetotaxy represented by two clusters of several short setae on each side of posterior(?) edge of sternite II and by two rows of setae at posterior edge of sternite III, while those closest to edge of sternite consisting of a number of longer setae. Carapace subrectangular, usual in shape, as in most of Microcreagrinae (i.e. epistome present, albeit small; eyes well-developed, with lenses and well-visible eye lodges, without transverse furrows, but with a nearly straight caudal margin and a modest number of slender, pointed, vestitural setae), somewhat longer than breadth, anterior margin subtriangular, slightly compressed laterally in front of anterior pair of eyes.

Chelicera with six setae on hand, setae SB and IS longer than others; inner edges of both fingers with a few well-developed, sparse, flattened, saw-like teeth; movable finger with one seta located distal to the middle of finger. Movable finger with a knob-like, non-extended galea. Lamina exterior absent. Serrulae and rallum rather typical of the subfamily.

Pedipalps moderately robust, without granulations. Dorsal side of fixed chelal finger of male with a large protuberance, this being more intensely pigmented and showing a coarser (shagreened) surface resembling fine granulations. Chela densely setose, with two different types of setation. The above protuberance bearing thick, darkly pigmented spines strongly differing from remaining, usual setae of palps. Protuberance in female absent, fixed finger of a normal outline; setae more or less of the same type, while spines on dorsal side of fixed chelal finger absent. Dentition of chela of usual neobisiid facies.

Trichobothriotaxy rather typical of the subfamily: **IB-ISB-EB-ESB-IST** clustered in basal half of fixed finger; **IT** with **ET** and **EST** located in distal half of fixed finger. On movable finger, **B-SB** located in basal part, whereas **ST** at about midway of finger; **T** located in distal part, but closer to **ST** than to finger top. In fixed finger, both venom duct and venom tooth normally developed, complete and distinct (transmission light microscopy); venom duct very short, nodus ramosus (**nr**) located between venomous and first tooth. Venom duct of movable finger reduced.

Legs of typical facies; tibia, metatarsus and tarsus with one tactile seta each. Arolium simple and distinctly shorter than tarsal claws.

Type species.– *Echinocreagris golovatchi* sp. n.

Contents.– Only the type species.

Name.– The presence of spines grouped on a protuberance on the dorsal side of the fixed chelal finger in the male it to reflect the generic name which derives from the Greek εχινό (*echino*), meaning thorny (spiny), and *creagris*, a usual end suffix in genera of Neobisiidae.

Relations.– The new genus occupies an isolated position within the "*Microcreagris*-complex" because of its apparent sexual dimorphism and a unique combination of certain characters, such as the structure of the rallum, the shape of a reduced galea, the chaetotaxy of the genital area and the internal structure of the genitalia. This precludes inclusion of the new species into any known genus.

Only a few useful observations allow for a discussion of the position of the new genus within the Microcreagrinae to be made. First and foremost, heterogeneity of this subfamily is obvious, such that detailed revisions of the majority of its constituent genera are necessary. Sexual dimorphism here has only been documented for *Stenohya hamata* (Leclerc and Mahnert, 1988), in which the male shows a heavy spine on the ventral face of the chelal hand. The complex modifications of the fixed chelal finger in male *Dentocreagris vietnamensis* Dashdamirov, 1997 are likely to represent sexual dimorphism as well, but since the female of that species is still unknown, further speculations are superfluous. It is noteworthy, however, that there are no spines on the fixed chelal finger in *Dentocreagris*, whereas its chaetotaxy pattern is vastly different, like is the shape of the galea which unites the new genus with representatives of the subfamily Neobisiinae Chamberlin, 1930. Yet a similarly reduced galea in the form of a small tubercle is also found in a few species of the "*Microcreagris*-complex", such as *Acanthocreagris apulica* Callaini, 1986, *A. mahnerti* Dumitresco and Orghidan, 1986 or *A. obtusa* Mahnert, 1976, as well as some species of the genus *Roncocreagris* Mahnert, 1976.

By the way, *Trisetobisium fallax* (Chamberlin, 1962), a species originally described in Microcreagrinae and later, without clear arguments, transferred by Ćurčić (1982) to the Neobisiinae, has no developed galea either. The presence or absence of a galea has been discussed in the literature (Chamberlin, 1962; Murienne et al., 2008), so assuming only this character alone, the new genus is closer to Neobisiinae than to Microcreagrinae. However, this problem can be evaluated in a quite different way. In fact this feature seems to vary too strongly to be regarded as a character decisive for a secure subfamily allocation. Only the consideration of a combination of several generic characteristics (see above) allows for an accurate diagnosis of any genus within the family Neobisiidae to be formulated.

***Echinocreagris golovatchi* sp. n.**

(Figs 1, 2, 3A-C).

Holotype.– ♂ (ZMMU), northern Vietnam, Prov. Lao Cai, Hoang Lien National Park, W of Sapa, ca 2,000 m a.s.l., subtropical forest, 16-30 July 2007, leg. S. Golovatch.

Paratypes.– ♀ (ZMMU), 1T (ZMMU), same locality and date, together with holotype.

Description of the holotype (♂) (Figs 1A-H, L-O, R; 2B; 3A-C).– Body oblong, tegument smooth, not transparent. Tergites and sternites heavily pigmented, dark olive-brown, carapace slightly darker, palps dark yellow-brown, but slightly lighter than abdomen and cephalothorax (fingers of chela more intensely so). Carapace (Fig. 1E) completely smooth, without granulations, 1.38 times longer than broad. Anterior margin slightly produced forward in the form of an obtuse angle, epistome reduced to a small protuberance. Chaetotaxy of carapace: anterior margin with four setae, posterior margin with six setae (22 setae in total); formula of lyrifissures 4-2-1-2 (total nine); entire carapace more or less regularly beset with micropores, altogether totalling about 40. Tergites entire, uniseriate, with a large number of clearly visible micropores, lyrifissures amounting to an average of six per segment. Pleural membrane granular. Tergal chaetotaxy: 6:9:12:11:12:12:12:12:12:11(7+4 long pseudotactile setae):8(4+4 long pseudotactile setae):2. Chaetotaxy of

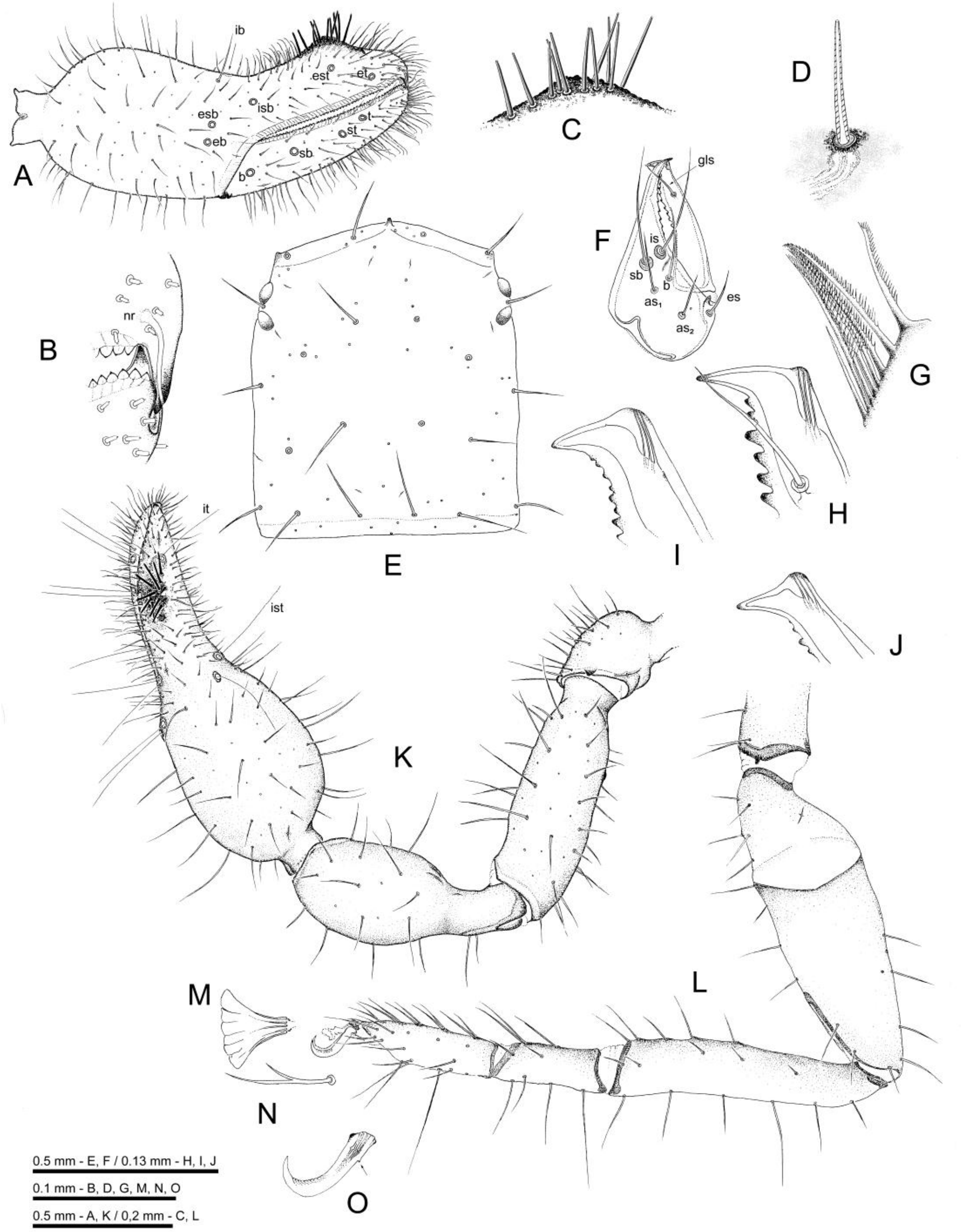

FIGURE 1. *Echinocreagris golovatchi* sp. n. (A-H and K-O – ♂ holotype; I – ♀, paratype, J – tritonymph paratype). **A:** Right chela, lateral view. **B:** Tip of movable finger of chela, lateral view. **C:** Protuberance on dorsal side of fixed finger of chela with setiform spikes, lateral view. **D:** Setiform spine. **E:** Carapace, dorsal view. **F:** Right chelicera, dorsal view. **G:** Rallum. **H-J:** Tip of cheliceral fixed finger, dorsal view. **K:** Left palp, dorsal view. **L:** Leg-IV, lateral view. **M:** Arolium. **N:** Subterminal seta. **O:** Claw, showing a dorsal denticle.

sternites: $\frac{6}{14}$:(3m)-$\begin{array}{c}2\\ \hline 6\\ \hline 6\end{array}$-(3m):(3m)-6-(3m): 13:12:13:12:12:12(8+4 long pseudotactile setae):8(4+4 long pseudotactile setae):2; pseudo glandular setae not observed. Chaetotaxy of genital area (Fig. 2B): sternite II with two clusters of caudally directed setae, with a median group consisting of six, posterior margin with 14 setae; sternite III with three clusters, anterior margin paramedially with two microsetae directed forward, a transverse midway row of six simple setae directed forward in the middle of segment, and six caudally directed setae at posterior margin.

Coxal chaetotaxy: P – 11, manducatory process rounded, with four apical and one very long subapical seta, the latter well separated from apical ones; suboral seta absent; I – 8; II – 5-6; III – 6; IV – 10. Chelicera (Fig. 1F) with six long acuminate setae in basal part, while IS and SB longer and their areoles showing thickened edges and each protruding over surface of chelicerae as a small broad cone, accessory setae located at base of chelicera. Movable finger (Fig. 1H) with one distal seta (gls); serrula exterior with 34-36 lamellae; serrula interna with 26-28 lamellae, distal seven clearly serrate unilaterally; rallum with eight unilaterally pinnate blades, only last blade without long spinules, slightly serrate. Galea present only as a small tubercle, with well-developed ducts of channels visible through tegument. Fixed finger with 12 slightly skewed serrate teeth. Movable finger with 11 larger teeth. Palp pattern and trichobothriotaxy as illustrated (Fig. 1A-C, K). Palp relatively robust, surface of femur and patella quite smooth, without slightest traces of granulation; chelal surface shagreened, vaguely reminiscent of minute granulations. Besides this, surface of palps rather regularly beset with numerous pores. Trichobothriotaxy typical of Microcreagrinae: IB-ISB-IST-EB-ESB clustered at base of fixed finger, IT-EST-ET solitary in distal position of finger, ST closer to T than to SB, the latter in its turn located exactly halfway between B and ST. Fingers rather thick in dorsal view, especially so closer to base; dorsal side of fixed finger (Fig. 1C) with a large, intensely pigmented protuberance armed with 11 stout setiform spikes, each of which supporting a micropore on top (Fig. 1D). Spines show a complex internal structure, namely, inside a hollow channel is being distinct, and at the base a dense network of delicate canals is visible. These spines are immobile and suggest a sensory function (chemoreceptors?). Other setae of chelal fingers more subtle, some almost transparent (especially closer to apex), and especially numerous on dorsal side of fixed and on ventral side of movable finger; distal part of ventral side of movable finger with setae being hamate and curved at apex. Proportions: trochanter 1.61 times as long as broad; femur 3.2 times as long as broad; patella 2.33 times as long as broad; chela with pedicel 2.86 times, without pedicel 2.6 times, as long as broad. Hand with pedicel 1.63 times, without pedicel 1.4 times, as long as broad. Hand with pedicel 1.16 times as long as movable finger; without pedicel almost same length as finger. Movable finger of chela with 55 teeth, fixed finger with 44 marginal teeth; in the middle of finger, teeth subquadrate. Some small setae located directly along dental ridge. Lamina defensor filamentary, present in both fingers, yet being larger on fixed finger and fitting closely to venomous tooth. A very short venom duct developed only in fixed finger, **nr** difficult to trace because of thick and pigmented tegument. Leg-IV of typical

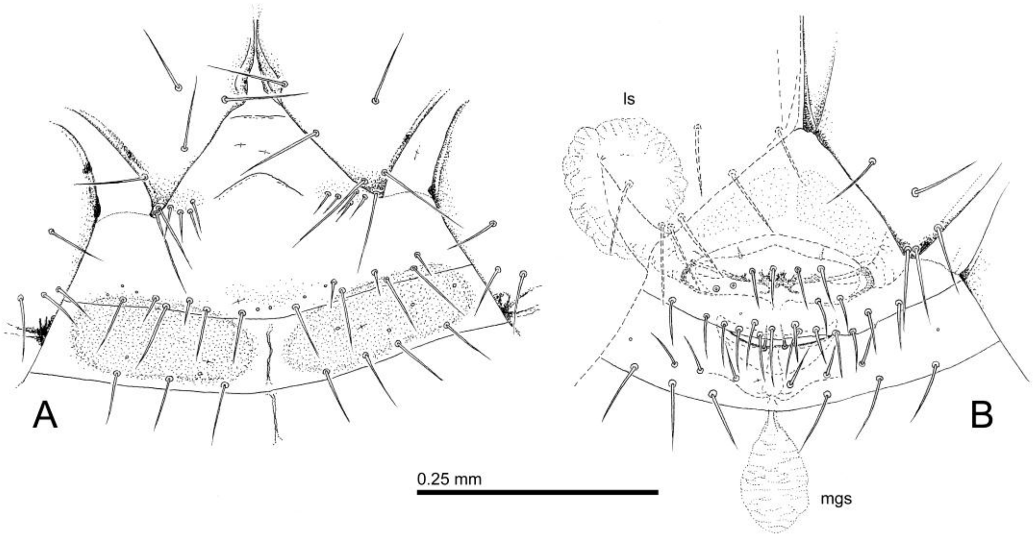

FIGURE 2. *Echinocreagris golovatchi* sp. n. (**A** – ♀ paratype; **B** – ♂ holotype). External chaetotaxy of genital opercula (segments II and III) with some details of internal structure (♂), abbreviations in text.

neobisiid facies (Fig. 2L, M, N, O), tibia, metatarsus and tarsus each with one tactile seta, as well as with numerous, long, prominently acuminate setae; proportions: femur+patella 3.15 times as long as deep; tibia 5 times as long as deep, TS=0.42; metatarsus 2.57 times as long as deep, TS=0.17; tarsus 3.32 times as long as deep, TS=0.39, tarsus 1.24 times as long as metatarsus. Arolium simple, with well-visible folded edges. Claws longer than arolium, at inner edge with an extremely finely serrate structure and on external side at base with a minute denticle. Subterminal seta deeply bifurcate.

Measurements (length/breadth or depth, in mm). Carapace 0.84/0.61. Palp: trochanter 0.45/0.28; femur 0.88/0.28; patella 0.84/0.36; chela with pedicel 1.43/0.5; length of chela without pedicel 1.3; length of hand with pedicel 0.81, without pedicel 0.7; length of movable finger 0.78. Leg IV: femur+patella 0.56/0.20; tibia 0.75/0.15; metatarsus 0.3/0.12; tarsus 0.37/0.11.

Name.– Honours Sergei Golovatch (Moscow, Russia), the collector of the new species.

Description of the paratype (♀) (Figs 1I and 2A).– Like holotype, but differs in the larger size, the lack of a protuberance with spines on the dorsal side of the fixed chelal finger and, of course, in a different chaetotaxy pattern of the genital area. In addition, coloration of tegument less intense than in male. Carapace 1.14 times longer than broad; chaetotaxy: anterior margin with four setae, posterior margin with seven setae (23 setae in total). Cheliceral galea represented only by a small tubercle. Tergal chaetotaxy: 6:11:12:14:11:12:13:12:10:10(6+4 long pseudotactile setae):8(4+4 long pseudotactile setae):2. Chaetotaxy of sternites: 4+5: (3m)-$\frac{5}{8}$-(3m):(3m)-7-(3m):10:12:12:12:10: 12(8+4 long pseudotactile setae):8(4+4 long pseudotactile setae):2. Genital area as in Fig. 2A, border between sternites II and III

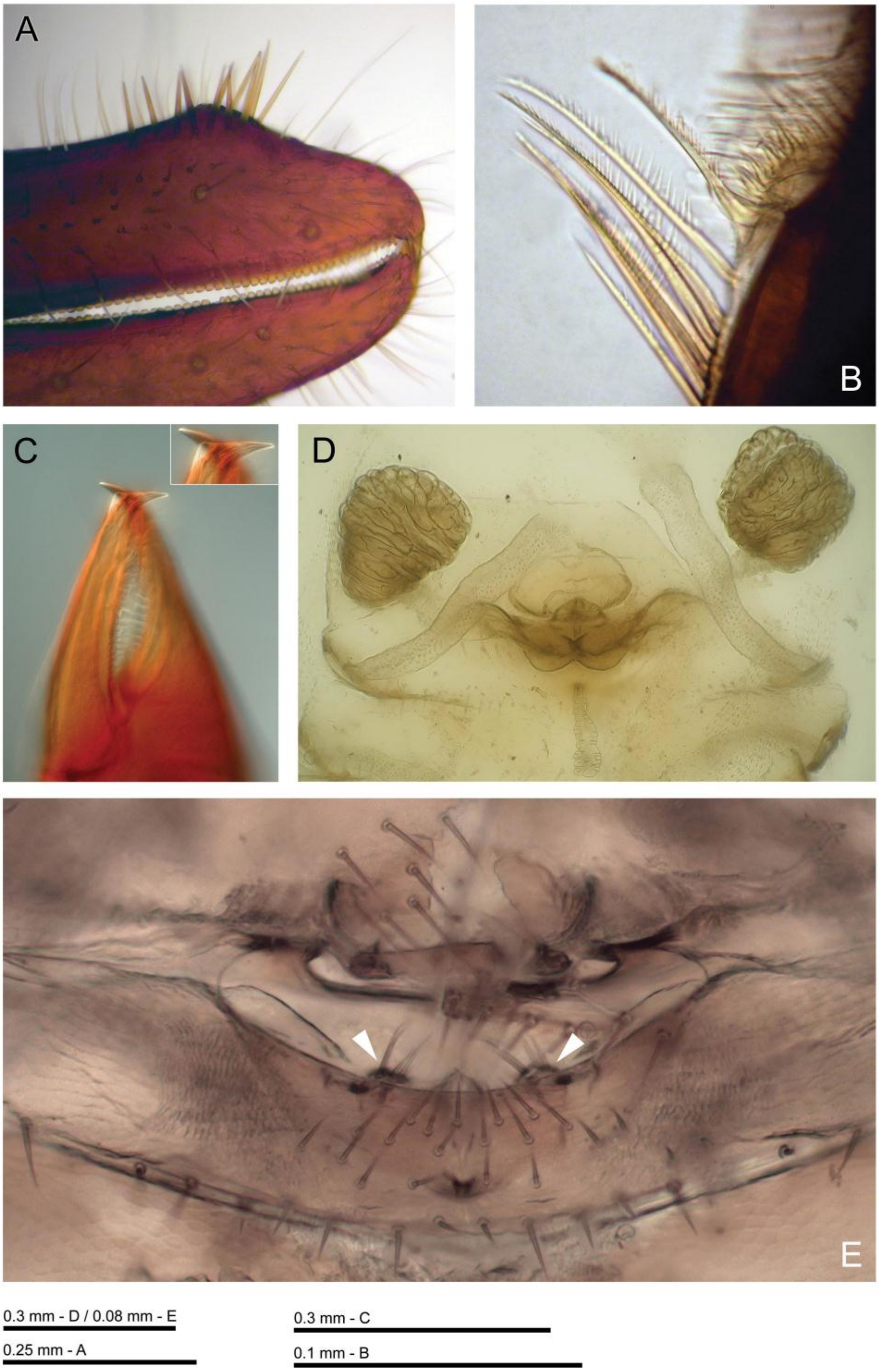

FIGURE 3. *Echinocreagris golovatchi* sp. n. (**A** – ♀ paratype; B – ♂ holotype). External chaetotaxy of genital opercula (segments II and III) with some details of internal structure (♂), abbreviations in text.

barely visible; chaetotaxy: sternum II showing a premarginal row of shorter setae and two groups of similarly short setae (4+5) located near posterior corners of bases of coxae; sternite III with two rows of setae closely adjacent to posterior margin (five short setae and, directly at edge, another eight, much longer, ca 2.5-3.0 times as long, setae).

Coxal chaetotaxy: P – 8-12, manducatory process rounded, with four apical and one long subapical seta; suboral seta absent; I – 8-9; II – 8; III – 6; IV – 10. Palp: trochanter 1.75 times as long as broad; femur 3.18 times as long as broad; patella 2.26 times as long as broad; chela with pedicel 2.61 times, without pedicel 2.43 times, as long as broad. Hand with pedicel 1.57 times, without pedicel 1.39 times, as long as broad. Hand with pedicel 1.41 times, without pedicel 1.25 times, as long as movable finger.

Measurements (length/breadth, in mm). Carapace 0.87/0.76. Palp: trochanter 0.49/ 0.28; femur 0.89/0.28; patella 0.79/ 0.35; chela with pedicel 1.48/0.57; length of chela without pedicel 1.38; length of hand with pedicel 0.89, without pedicel 0.79; length of movable finger 0.63.

Description of the tritonymph (Fig. 1J).– Apart from a considerably smaller size, the tritonymph closely resembles the adults. Coloration of tegument of cephalothorax, abdomen and pedipalps pale yellow-brown, legs lighter. Carapace 1.05 times longer than broad; chaetotaxy of carapace: anterior margin with four setae, posterior margin with six setae (20 setae in total). Tergal chaetotaxy: 6:8:8:9:10:11:11:10:9:9(5+4 long tactile setae):8(4+4 long tactile setae):2. Chaetotaxy of sternites: x:8:6:11: 12:10:10:10:10(6+4 long pseudo-tactile setae?):8(4+4 long pseudotactile setae?):2. Cheliceral galea like a small tubercle. Coxal chaetotaxy: P – 8-9, mandu-catory process rounded, with three apical and one long subapical seta; suboral seta absent; I – 5; II – 5-6; III – 4; IV – 7-8. Palp: fixed finger simple, without protuberance on dorsal side. Proportions: trochanter 1.8 times as long as broad; femur 2.67 times as long as broad; patella 2.16 times as long as broad; chela with pedicel 2.73 times, without pedicel 2.53 times, as long as broad. Hand with pedicel 1.61 times, without pedicel 1.42 times, as long as broad. Hand with pedicel 1.33 times, without pedicel 1.17 times, as long as movable finger.

Measurements (length/breadth, in mm). Carapace 0.63/0.6. Palp: trochanter 0.36/0.2; femur 0.56/0.21; patella 0.54/0.25; chela with pedicel 1.04/0.38; length of chela without pedicel 0.96; length of hand with pedicel 0.61, without pedicel 0.54; length of movable finger 0.46.

FIGURE 4. *Microcreagris gigas* Balzan, 1892, ♂ (**A-F, N**); *Bisetocreagris* sp. **A**, ♂ (**G-I**); *Bisetocreagris* sp. **B**, ♂ (**O**); *Bisetocreagris* aff. *annamensis* (Beier, 1951), ♂ (**J-M**); *Halobisium orientale* (Redikorzev, 1918), ♂ (**P-R**). Abbreviations in text. **A**: Genitalia, dorsal view. **B**: Fragment with lateral sac structure. **C**: Dorsal apodeme. **D**: Lateral apodeme frame with pores. **E**: Middle part of dorsal apodeme with micropores. **F**: Genital sternites. G: Genitalia, dorsal view. **H**: Pseudo glandular setae. **I**: Genital sternites. **J**: Genitalia, dorsal view. **K**: Central part of genitalia, enlarged. **L**: Genital sternites. **M**: Microsetae at anteromedian edge of sternite III. **N**: Caudomedian bulge, showing microsetae. **O**: Genital sternites. **P**: Genital sternites. **Q**: Genitalia, dorsal view. **R**: Pseudo glandular setae. Scale bar: 0.05 mm (**M**); 0.1 mm (**B, D, E, H, K, R**); 0.2 mm (**C, G, I, J, L, O, P, Q**); 0.5 mm (**A, F**).

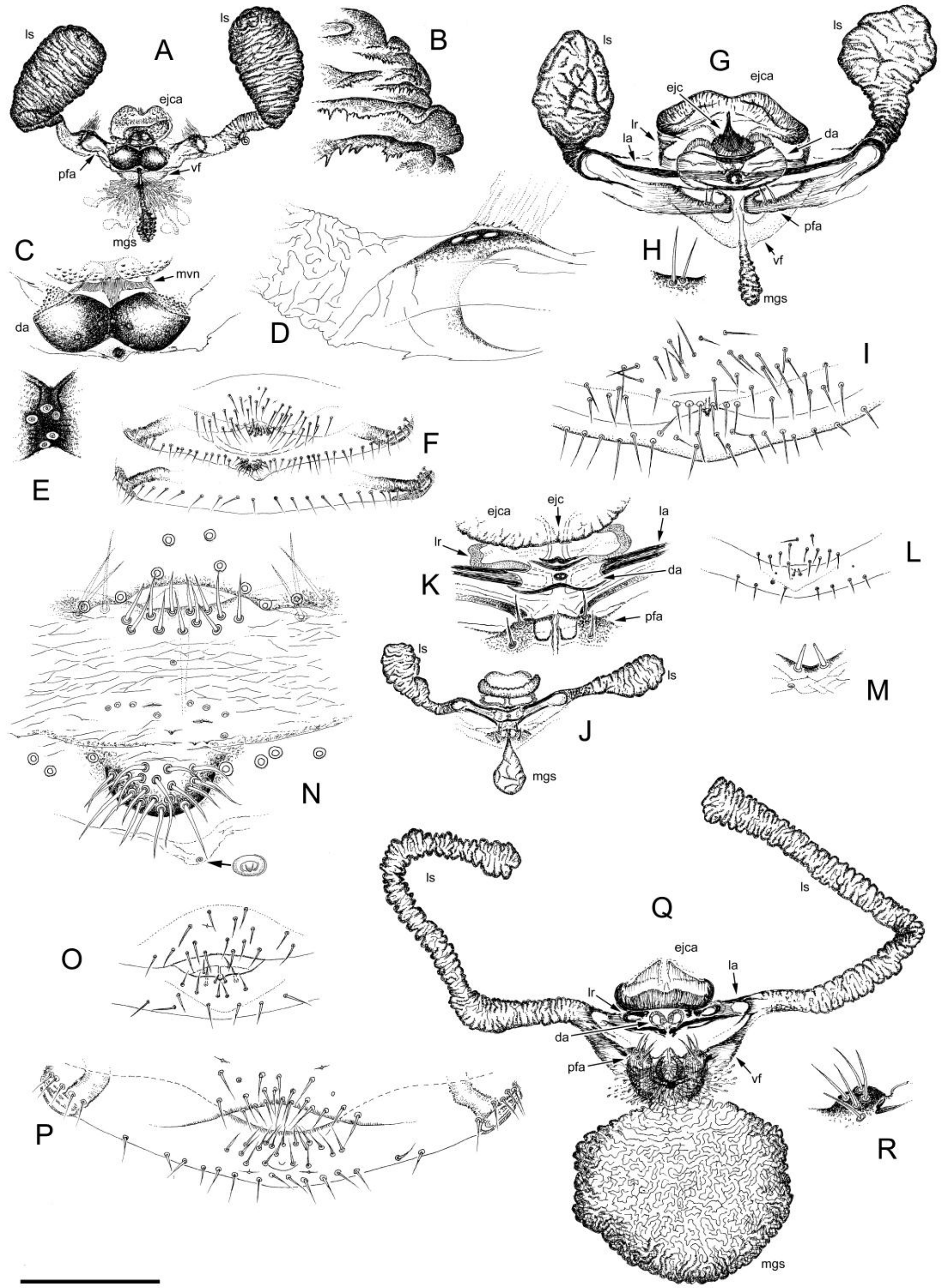

FIGURE 4. See page 105.

DISCUSSION

The following additional samples have been studied for the purpose of a more accurate assignment of *Echinocreagris* gen. n.

Microcreagris gigas Balzan, 1892, ♂ (SMF), China, N Yunnan, Zhongdian County, 27° 27.0’ N 99° 54.7’ E, creek valley, 46 km SSE Zhongdian, 3,050-3,100 m a.s.l., secondary mixed forest, bamboo, mushrooms, 17.08.2003, leg. D. W. Wrase (Figs 3D; 4A-F, N).

Bisetocreagris sp. A, ♂ (SD 299), Russia, southern Maritime Prov., 43° 55’ N 134° 23’ E, Pravaya Izvilinka River, 1-2.08.1998, leg. Yu. Marusik (Fig. 4G-I).

Bisetocreagris spec. B, ♂, (SD 124), Vietnam, Prov. Plei ku, 50 km N An Khe, forest, in rotten tree, 30.10.1979, leg. T. K. Sergeeva (Fig. 4O).

Bisetocreagris aff. *annamensis* (Beier, 1951), ♂ (ZMMU [300]), Vietnam, Dong nai Prov., Nam Cat Tien National Park, ca 150 m a.s.l., seasonal tropical forest, litter, 1.06.2005, leg. A.E. Anichkin (Fig. 4J-M).

Halobisium orientale (Redikorzev, 1918), ♂ (SD 037), Russia, Kurile Islands, Shikotan Isl., E coast, small bay opposite Greag Island, 43° 45.80’ N 146° 47.19’ E, on seashore rocks and cliffs, 16.071997, leg. Yu. Marusik (Figs 3E; 4P-R).

Neobisium labinskyi Beier, 1937, ♂ (IZB), Russia, Krasnodar Prov., Caucasian Nature Reserve, 20 km E of Krasnaya Polyana, Mt Aishkho-2, 1,900-2,000 m, light *Acer*-*Betula*-*Azalea* bushes and subalpine pads, 12.08.1986, leg. S. Golovatch (Fig. 5).

The type series of *Echinocreagris golovatchi* sp. n. containing only a single male has precluded the dissection of its abdomen for a more detailed study of its genital apparatus. So I had to confine myself solely to an examination of the external structure of sternites II and III, coupled with observations made using both transmission microscopy and a short-term immersion of the holotype in clove oil. Nevertheless, the abundant comparative material referred to above allows for some preliminary conclusions to be drawn.

Generally speaking, the male genitalia in Neobisiidae have rather rarely been studied and applied to the classification of this family. The only use hitherto made of the genital region of the male has been the number of setae in the genital area (= sternites) which can easily be seen on the ventral side. Ćurčić (1983 and later articles) developed much of his generic classification of the "*Microcreagris*-complex", based on this character alone. Unsurprisingly, this classifycation is fundamentally misleading in many ways and has not been adopted by most of the students (e.g. Leclerc and Mahnert, 1988; Judson, 1990; Dashdamirov and Schawaller, 1992; Harvey, 1999).

Perhaps the most important relevant studies accompanied by more or less detailed illustrations include those by Chamberlin (1931: figs 50, 51; 1952: fig. 3A, C; 1962: fig. 12), Vachon (1969: fig. 3, 1976: fig. 4), Harvey (1991: figs 11, 12; 2009: fig. 20), Heurtault-Rossi (1966: fig. 6), Heurtault (1968: fig. 10; 1969: fig. 15; 1977: fig. 16; 1979: fig. 5; 1980: fig.6), Legg (1975c: figs 8-12) and Judson (1993: fig. 1). In addition, there are some further papers (e.g. Dumitresco and Orghidan, 1986: fig. 3A; Cokendolpher and Krejca, 2010: fig. 13 or Muchmore 1995: fig. 7) with imperfect illustrations, limited to very crude outlines and lacking proper detail. Special mention deserves the great work of Vachon (1938), certainly one of the most important publications concerning the entire order Chelonethi (= Pseudoscorpiones). However, the illustrations presented in this

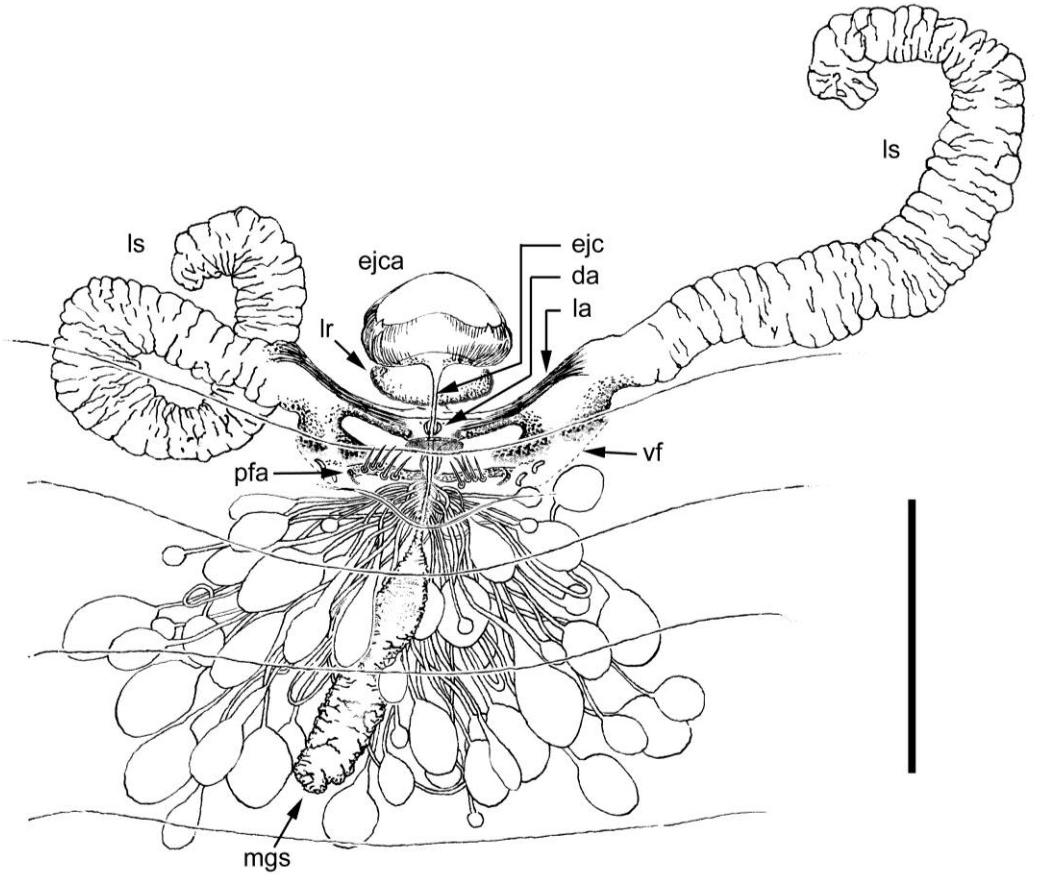

FIGURE 5. *Neobisium labinskyi* Beier, 1937, ♂ (after Dashdamirov and Schawaller, 1992b, with minor corrections). Male genitalia, ventral view. Abbreviations in text. Scale bar: 0.25 mm.

paper, with rare exceptions (e.g. fig. 36), are clearly too schematic in character as well.

Only rarely do descriptions of new genera and species refer to the number and location of the inner setae, the structures undoubtedly involved in the formation of the spermatophore. In particular, it is due to these setae that the sperm package is very likely to obtain its final characteristic shape. The same concerns a liquid drop which in many species is present in a variety of shapes and situated on the spermatophore stalk, obviously being released from the glands located at the base of setae (?), since at higher magnifications some of the these setae show apical pores or furrows along the entire extent.

Legg (1975b) showed the inner glandular setae to occur in the family Chthoniidae Daday, 1888, yet stating their absence in Neobisiidae (it is also noteworthy that Harvey (2009) has shown the presence of glandular setae [sic] in a representative of the family Garypinidae Daday, 1888). However, after having seen a draft of this article, he (personal communication) admits that probably the inner glandular setae and associated glands are present in some neobisiid genera as well. Thus, considering all available evidence, I suggest that internal setae located behind the anterior margin of sternite III, namely, on the paramedian front apophyses are best to be termed pseudo glandular setae (**pgs**) before they are proven as being truly glandular or simple. In any case, passive and/or active roles the setae located in the inner parts of the male genitalia might play in the formation of some elements of the spermatophore could well be assumed.

Much more instructive, however, appears to be the internal structure of the male genitalia which can only be scrutinized upon dissection. This structure is far more complex and mandates the development of a more advanced terminology to properly describe and designate the various components of the apparatus. It is noteworthy that only the elements have been used here which allow for a more or less clear separation of the taxa to be made, such as genital armature, setae, sacs etc. More detailed descriptions of the conformation of the male genitalia can be found in Legg (1975a, b, c, d).

Thus, when viewing the male genital apparatus in a number of presumably closely related genera, the most complex one appears to be found in *Microgreagris*. This genus shows the lateral genital sacs (**lgs**) subpyriform, but rather cylindrical, densely plicate and bearing a longer, tubiform base; the lateral apodeme frame (**laf**) is shortened, with a number of distofrontal pores; the median ventral node (**mvn**) is rather cross-shaped; the median genital sac (**mgs**) is club-shaped, but more coarsely papillate; the paramedian front apophyses (**pfa**) are far from evident and devoid of paramedian setae; the atrium of the ejaculatory canal (**ejca**) is rather mushroom-shaped, but evidently micropunctate; the dorsal apodeme (**da**) is clearly bean-shaped, heavily pigmented, with a few pores medially (in the shape of **da**, *Microgreagris* is very close to *Saetigerocreagris* Ćurčić, 1984, but the presence in the latter genus of paramedian setae and lateral genital sacs makes these two genera well distinguished (see Chamberlin, 1962: fig. 12 - G, F, I)); the ventral frame (**vf**) is far from evident, simple, lying entirely dorsally; the lateral rods (**lr**) are reduced and incomplete; the ejaculatory canal (**ejc**) is well-dveloped, completely covered with **ejca**. In ventral view, sterna II and III are beset with very numerous setae; the caudal edge of sternum II is clearly emarginate; sternum III is with a frontomedian group of rather numerous and short setae directed frontally, this group being flanked by 3+3 slightly longer setae; the caudal margin of sternum III, in addition to a single row of abundant, still longer setae at the caudal edge, carries a caudomedian bulge supporting abundant setae. In the immediate proximity to the bulge, a few pores and one or two microsetae are clearly visible.

In *Halobisium*, the lateral genital sacs (**lgs**) are extremely long and slender, deeply plicate; the lateral apodeme frame (**laf**) is short and well-sclerotized, a median ventral node (**mvn**) is missing; the median genital sac (**mgs**) is extremely large, subovate, very densely plicate, flanked only frontally by less obvious glands; the paramedian front apophyses (**pfa**) are heavily sclerotized, paramedially with 1+1 densely setose knobs (approximately with 5-7 pseudo glandular setae (**pgs**)); the atrium of the ejaculatory canal (**ejca**) is large and dome-shaped; the ventral frame (**vf**) is well-sclerotized and pigmented, an ejaculatory canal (**ejc**) is untraceable; the dorsal apodeme (**da**) is very small, almost transparent, in the form of two close bubbles. In ventral view, sterna II and III are also rather densely setose, the caudal edge of sternum II is less clearly emarginate than in *Microcreagris*; sternum III is with a row of small marginal setae and, unlike that observed in *Microcreagris*, with a scattered group of centrally located, frontally directed, short setae; a bare, median, relatively flat tubercle is present instead of the bulge observed in *Microcreagris*.

By the armament of the paramedian front apophyses (**pfa**) and the chaetotaxy of sterna II and III, *Halobisium* is very close to *Parobisium* Chamberlin, 1930, based on a photograph and a drawing presented by Cokendolpher and Krejca (2010). While there are no questions to the photo, the drawing depicting the structure of the internal armature, the **pfa** shape in particular, raises doubts. Of course, it would be useful to study the shape and size of the lateral genital sacs (**lgs**) and median genital sac (**mgs**) as well.

A different structure can be seen in *Neobisium labinskyi*. Namely, the lateral genital sacs (**lgs**) are extremely long and slender, deeply plicate and quite often rolled loop-like in the abdominal cavity; the lateral apodeme frame (**laf**) is long and well-sclerotized, a median ventral node (**mvn**) is present; the median genital sac (**mgs**) is thin and close in width to **lgs**, but highly variable in length (in some specimens the length of **mgs** can even exceed that of **lgs**), usually also more densely plicate, fully surrounded by numerous glands; the paramedian front apophyses (**pfa**) are weakly sclerotized and usually seen in fragments, paramedially on both sides with pseudo glandular setae (usually more than four) which are arranged in a row and never grouped into one tight knot; the atrium of the ejaculatory canal (**ejca**) is large and mushroom-shaped; the lateral rods (**lr**) are weakly-sclerotized and almost transparent, an ejaculatory canal (**ejc**) is clearly traced; the dorsal apodeme (**da**) is very small and sometimes highly modified.

I can also add that Ducháč (2004) illustrated the structure of the male genital apparatus in *Protoneobisium biocovense* (G. Müller, 1931), which shows a very close resemblance to many species of the genus *Neobisium* Chamberlin, 1930. A few of them Ducháč has also studied in due detail (2003: figs 1-15; 2004: figs 3, 4, 7, 8; 2005: fig. 8). Both **lgs** and **mgs** are especially similar in size and shape, as is the presence of numerous pseudo glandular setae on **pfa**: 4-5 such setae in *Neobisium* species, 9-10 in *Protoneobisium biocovense*. In the absence of reliable information concerning the variation range of the latter character in these taxa, the validity of the genus *Proton eobisium* Ćurčić, 1988 itself is questionable, as most likely it is just another junior subjective synonym of *Neobisium*.

Finally, there are variants of the structure most similar to the new genus. In *Bisetocreagris* sp. A. (from the Maritime Province of Russia), the lateral genital sacs (**lgs**) are subpyriform, slightly flattened dorsoventrally, plicate, also microspiculate on the internal surface; the lateral apodeme frame (**laf**) is more or less rod-shaped, attached to **lgs** laterally and meeting at a hoof-shaped node (**mvn**) centrally; the median genital sac (**mgs**) is clavate and evidently plicate, surrounded by numerous glands with their canals, together with the **mgs** orifice leading towards **mvn**; the paramedian front apophyses (**pfa**) are less heavily sclerotized than **laf**, closely approaching **lgs** laterally and supplied paramedially with 2+2 strong and short pseudo glandular setae, the distance between them not exceeding the diameter of the areola of setae; the ventral frame (**vf**), apparently holding the entire construction, is flattended dorsoventrally, translucid, but sufficiently well sclerotized;

the atrium of the ejaculatory canal (**ejca**) is subboletiform, lying on top of ventrally more considerably sclerotized and incomeplete lateral rods (**lr**), supported by an anterior apodeme (**aa**), the latter being very heavily sclerotized and densely spinulate; because of that, an ejaculatory canal (**ejca**) is not well visible; the dorsal apodeme (**da**) looks like a rounded, nearly completely translucid membrane only slightly more heavily sclerotized both frontally and caudally, sometimes folded dorsally into a bean-shaped tube enveloping the medial parts of **pfa**. In ventral view, sterna II and III are beset with numerous, largely caudally directed, simple setae, of which paramedian 1+1 are located at the front margin of sternum III and directed forward; the latter also shows a transverse midway row of simple setae directed forward.

In *Bisetocreagris* sp. B. (from Plei ku, Vietnam), the lateral genital sacs (**lgs**) are subpyriform, likewise plicate, but slightly more elongate than in *Bisetocreagris* sp. A.; the lateral apodeme frame (**laf**) is well-developed, rod-shaped, distinctly rounded at the lateral tips; a median ventral node (**mvn**) present centrally, like a very small plate with two evident micropores; a ventral frame (**vf**) is present, but translucid, its lateral parts are barely visible; the median genital sac (**mgs**) is also clavate, but far less evidently plicate; the paramedian front apophyses (**pfa**) are heavily sclerotized only frontally, supplied with 2+2 strong pseudo glandular setae, the distance between them being greater than two diameters of the areola of setae; the dorsal apodeme (**da**) is considerably modified into a transverse membrane showing trifid lateral parts and both front and caudal edges heavily sclerotized; the atrium of the ejaculatory canal (**ejca**) is also mushroom-shaped, surmounting an evident ejaculatory canal; the lateral rods (**lr**) are well-developed, complete. In ventral view, both sterna II and III are oligotrichous, 1+1 paramedian setae at the front edge of sternum III are directed frontally, apparently glandular because of microscopic orifices at their tips; similar structures can be found in other *Bisetocreagris*.

Considering the above variation range of the male genital apparatus in the "*Microcreagris*-complex" of Neobisiidae, the following evolutionary trends can be outlined. The basalmost structure seems to be the one observed in *Microcreagris,* where it is the most complex in the group, showing all of the main elements fully or almost fully developed, except for the absence of paramedian pseudo glandular setae on the paramedian front apophyses. In *Halobisium*, these setae are still numerous and grouped, while both in *Echinocreagris* gen. n. and two representatives of the genus *Bisetocreagris* they are already few, more definitively located to finally grow glandular/hollow in the latter genus. In addition, *Microcreagris* shows a remarkably complex and differentiated chaetome on male sterna II and III which grows simpler in *Halobisium* to finally become the simplest in the new genus and in both of the species of *Bisetocreagris* compared. To summarize, reduction of external setae and their simplification in the genital field, coupled with the development of especially complex inner parts of the genitalia, seem to represent a major trend in the evolution of the "*Microcreagris*-complex".

CONCLUSION

Thus, when allocating and comparing the types of male genitalia, it is necessary to focus on a fairly small group of characters, namely, the shape and size of the genital

TABLE 1. Comparing the types of male genitalia among four genera.

	***Microcreagris*-type**	***Neobisium*-type**	***Halobisium*-type**	***Bisetogreagris*-type**
Shape of **lgs** and **mgs**	**lgs** large and subpyriform; **mgs** small and club-shaped	**lgs** long and slender; **mgs** long and slender	**lgs** long and slender; **mgs** large and sobovate	**lgs** small and subpyriform; **mgs** small and clavate
pseudo glandular setae on **pfa**	absent	present; more than 4 on each side and in a row	present; more than 5-6 each side and in a node	present; no more than 2 on each side
chaetome of sterna II and III	numerous setae	oligotrichous	numerous setae	oligotrichous
paramedian setae at front edge of sternum III	absent	absent	absent	present

sacks, the presence or absence, as well as the number and location of pseudo glandular setae and, finally, the chaetotaxy of sterna II and III. All other characters seem to vary widely and, if still to be used, they first must be meticulously (re)checked using abundant material (Table 1).

In situations where only very subtle and variable characters, such as the shape of subterminal setae of leg-IV, are sometimes the sole grounds for distinguishing between genera, the above features of the male genital region ensure the reliability of separation or union. Of course, considerable material and efforts are in demand to reveal the degree of stability of a given combination of traits in each nominate genus. Only then could the division of the family into natural groups be achieved.

Last but not least, some further remarks concerning the structure of the galea, which is nearly absent from the new genus, more precisely, present as only a small protuberance. It would be useful to recall that the galea as a spinning organ is located terminally to open the channels of silk glands. Silk is used for the construction of molting and hibernation chambers. The character modality of a reduced galea has been treated by some authors as an apomorphy (Murienne et al., 2008), but this appears quentioned if one follows the well-known method of operational excellence (Rasnitsyn, 1996). This can be formalized, based on the following presumptions: "from two states of a character the one that corresponds to a more efficient adaptation is to be regarded as apomorphous, while and since there is no convincing evidence to the contrary." A galea armed with numerous and long branches seems to be more efficient (the maximum adapted) for carrying out the spinning function, hence apomorphous. As an additional argument to assuming its apomorphy can serve the presumption of complexity: “…a more complex structure requires additional costs of the organism, so it arises only because of its greater efficiency. Therefore, a complex structure is to be regarded as apomorphous to a relatively simple one, yet until there is nothing conclusive to assume otherwise”. The most “advanced” groups in the order Chelonethi show a very complex form of the galea supplied with numerous branches. Of course, secondary simplifications of the structure cannot be ruled out, but they must be documented as such. Sexual dimorphism seems to serve as still a reinforcing argument favouring the apomorphous modality of a more complex galea. Thus, in females the galea is usually more strongly developed than in males, apparently because during reproduction they build more spacious chambers usually supplied with thicker walls.

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