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## Contribution to the Knowledge of the Amphipoda 90. Revision of *Gammarus balcanicus* Schäf. 1922 in Yugoslavia (fam. Gammaridae).

### ABSTRACT

Study of taxonomy and variability of *Gammarus balcanicus* Schäf. 1922 from Yugoslavia is provided and this species is redescribed and figured. The taxons: *Gammarus spinicaudatus* Schäferna 1922, *Gamm. konjicensis* Schäf. 1922, *Gamm. pavlovići* S. Karaman 1929, *G. pavlovići montanus* S. Kar. 1929, *G. konjicensis plančići* S. Kar. 1931a, *Rivulogammarus neretvanus* S. Kar. 1931a, *G. klisanus* S. Kar. 1931a, *G. konjicensis istrianus* S. Kar. 1931b, *Rivulogammarus balcanicus pannonicus* S. Kar. 1935, *Riv. balcanicus occidentalis* S. Kar. 1935, *Gammarus (Rivulogammarus) balcanicus bilećanus* G. Kar. 1964 and *G. balcanicus stankoi* G. Kar. 1974 are synonymized with *Gammarus balcanicus* Schäferna 1922. The distribution of *G. balcanicus* in Yugoslavia is presented and the list of all known *Gammarus* species from Yugoslavia is given.

### INTRODUCTION

The specimens of the genus *Gammarus* are very common and numerous in the fresh continental waters in Yugoslavia, among them also the specimens of *Gammarus balcanicus* Schäf. 1922. Because of very large variability of this species, many different populations of this species were described as a distinct species or subspecies.

During the study of a very large number of samples of *G. balcanicus* (several hundreds samples) from different parts of Yugoslavia, it was evident that many of former described taxons belong to *G. balcanicus* s. str. as synonyms. After the end of this study, 12 taxons known from Yugoslavia must be consider as synonyms of *G. balcanicus*.

#### SURVEY OF DESCRIBED GAMMARUS SPECIES FROM YUGOSLAV CONTINENTAL WATERS

Genus *Gammarus* was studied in Yugoslavia by several authors and many species and subspecies were described.

Schäferna (1922) described several species: *Gammarus balcanicus* n. sp. from several localities in Crna Gora, Herzegovina and Bulgaria; *G. spinicaudatus* n. sp. from Crna Gora, Dalmatia, Bosnia and Herzegovina, Bulgaria; *G. bosniacus* n. sp. from Bosna River (Ilidža) in Bosnia; *G. konjicensis* n. sp. from Konjic in Herzegovina; *Carinogammarus triacanthus* n. sp. from Skadar Lake; he mentioned also *G. lacustris* Sars (sub. *G. pulex* L.) from Bukumir — and Pošćen- Lakes in Crna Gora.

Schäferna (1925) described *Echinogammarus ochridensis* n. sp. from Ohrid Lake.

Karaman, S. (1929) described several new taxons from Yugoslavia also: *Gammarus echiniformis* n. sp. from Ohrid Lake, *Carinogammarus roeselii meridionalis* n. ssp. from Ohrid Lake, *Car. vardarensis* n. sp. from Rašče spring in Macedonia, *Car. vardarensis semiarmatus* n. ssp. from springs in Valandovo (Macedonia), *Car. argaeus stojičevići* n. ssp. from springs in Bela Palanka (Serbia), *Gammarus pavlovići* n. sp. from several localities in Macedonia, *G. pavlovići dulensis* n. ssp. from spring Dulo near Skoplje (Macedonia) and *G. pavlovići montanus* n. ssp. from Skopska Crna Gora (Macedonia).

Karaman, S. (1931a) described *Gammarus konjicensis plančići* n. ssp. from Plitvice Lakes (Croatia), *Rivulogammarus neretvanus* n. sp. from Buna River (Herzegovina), *Gammarus klisanus* n. sp. from Jadro River and Klis near Split (Dalmatia), *G. ohridensis abyssalis* n. ssp. from deeper parts of Ohrid Lake.

In the same work, Karaman S. created a new genus *Rivulogammarus* for the freshwater *Gammarus* species from Europe, leaving the name *Gammarus* for the marine members of *Gammarus* genus (locista group etc.).

Karaman, S. (1931b) described *Rivulogammarus pulex danubialis* n. ssp. from some localities of Central Europe and Yugoslavia, *Riv. pulex danubialis* f. *subterranea* n. f. from some localities on jugoslav-italian borger (Monfalcone, Divlja Jama near Plavo), *Riv.*

*pulex rambouseki* n. ssp. from Macedonia, and *Gammarus konjicensis istrianius* n. ssp. from Istra peninsula (Boljune, Osipo).

Karaman, S. (1934) described *Rivulogammarus bolkayi* n. sp. from Treskavica Mt. near Sarajevo (Bosnia).

Karaman, S. (1935) described *Rivulogammarus balcanicus panonicus* n. ssp. from Avala Mt. near Beograd and Fruška Gora Mt. near Novi Sad (Serbia) and *Riv. balcanicus occidentalis* n. ssp. from Crna Gora Andrijevića, Ivangrad, Titograd).

Schellenberg, A. (1943) described *Gammarus (Riv.) ochridensis f. lychnidensis* n. f. from Ohrid Lake.

Karaman, S. and G. (1959) described *Riv. triacanthus f. montenegrinus* n. f. from Crna Gora (Plav), *Riv. triacanthus prespensis* n. ssp. from Prespa Lake, *Riv. triacanthus strumicae* n. ssp. from Strumica, creating for *Riv. roeselii* group a new genus *Fluviogammarus* (considered later nom. preocc. because of former existing genus *Fluviogammarus* Dorogost. 1917 from Baikal Lake).

Karaman, G. (1964) described *Gammarus (Riv.) pljakići* n. sp. from Andrijevića (Crna Gora) and *Gammarus (Riv.) balcanicus bilećanus* n. ssp. from Herzegovina (Bileća, Trebinje).

Karaman, G. (1968) described *Gammarus (Riv.) balcanicus albimanus* n. ssp. from Golema Peštera-cave near Gostivar (Macedonia) and later (1969) *Gammarus balcanicus halilicae* n. ssp. from Donja Halilica-cave near Lazaropole (Macedonia).

Karaman, G. (1974) showed that the name *G. pavlovici montanus* Kar. S. 1929 is nom. preocc. and he established a new name for it, *Gammarus balcanicus stankoi* n. ssp.

From Ohrid Lake, Karaman, G. described (1976a, 1976b) two new species, *Gammarus stankokaramani* n. sp. and *Gammarus macedonicus* n. sp., and recently (1977, in press) the species *Gammarus parechiniiformis* n. sp. and *G. solidus* n. sp., removing taxon *G. ochridensis f. lychnidensis* Schell. 1943 to the specific rank.

Recently (1977b, in press) Karaman, G. et Pinkster, S. synonymized *Riv. pulex danubialis f. subterranea* with *G. fossarum* Koch; the same authors (1977c, in press), within their revision of *roeselii* group, synonymized species *Carinogammarus roeselii meridionalis*, *Car. vardar. vardarensis*, *Car. vard. semiarmatus*, *G. triacanthus*, *Riv. triac. strumicae*, *Riv. triacanthus f. montenegrinus* and *Riv. triacanthus prespensis* with *Gammarus roeselii* Gerv.

#### DISTRIBUTION OF GAMMARUS SPECIES IN YUGOSLAVIA

Based on all recent studies, including the results mentioned in this work, the fauna of *Gammarus* Genus living in the continental fresh waters of Yugoslavia is presented by following 16 species:

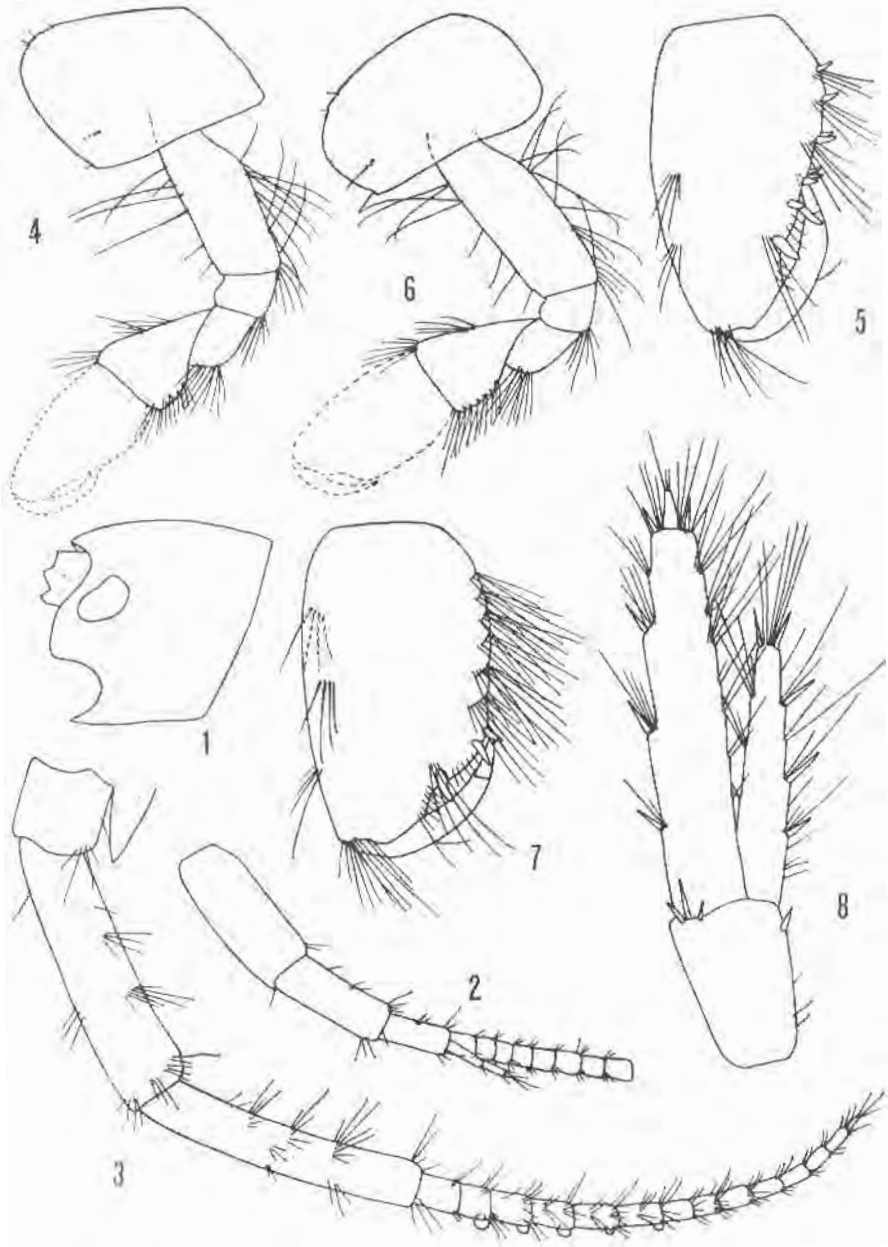


Fig. 1. *Gammarus balcanicus* Schäf., Kolašin, male 12 mm: 1 = head; 2 = antenna 1; 3 = antenna 2; 4-5 = gnathopod 1; 6-7 = gnathopod 2; 8 = uropod 3.

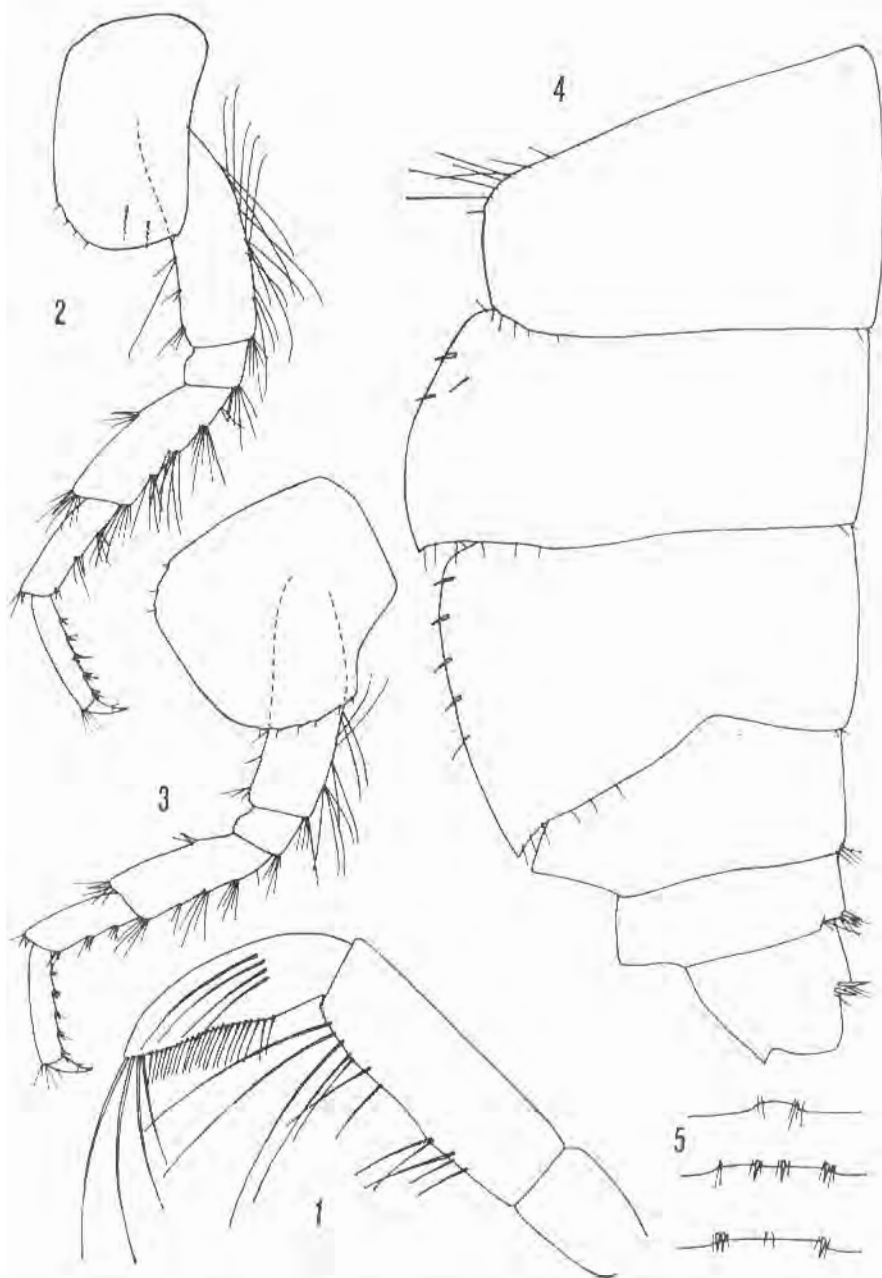


Fig. II. *Gammarus balcanicus* Schäf., Kolašin, male 12 mm: 1 = mandible palp; 2 = pereopod 3; 3 = pereopod 4; 4 = metasome and urosome, lateral projection; 5 = urosome, dorsal projection.

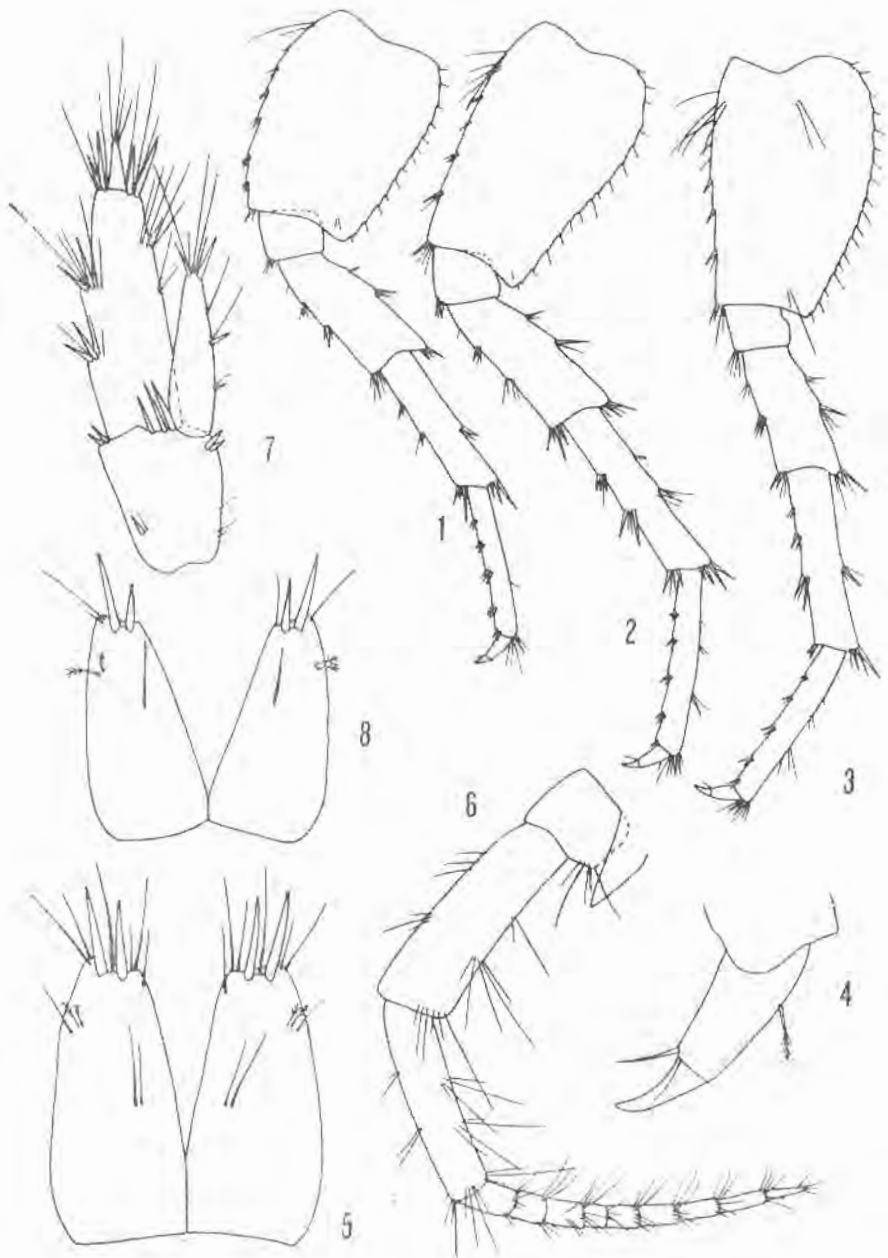


Fig. 111. *Gammarus balcanicus* Schäf., Kolašin, male 12 mm: 1 = pereopod 5; 2 = pereopod 6; 3-4 = pereopod 7; 5 = telson. Female 9 mm: 6 = antenna 2; 7 = uropod 3; 8 = telson.

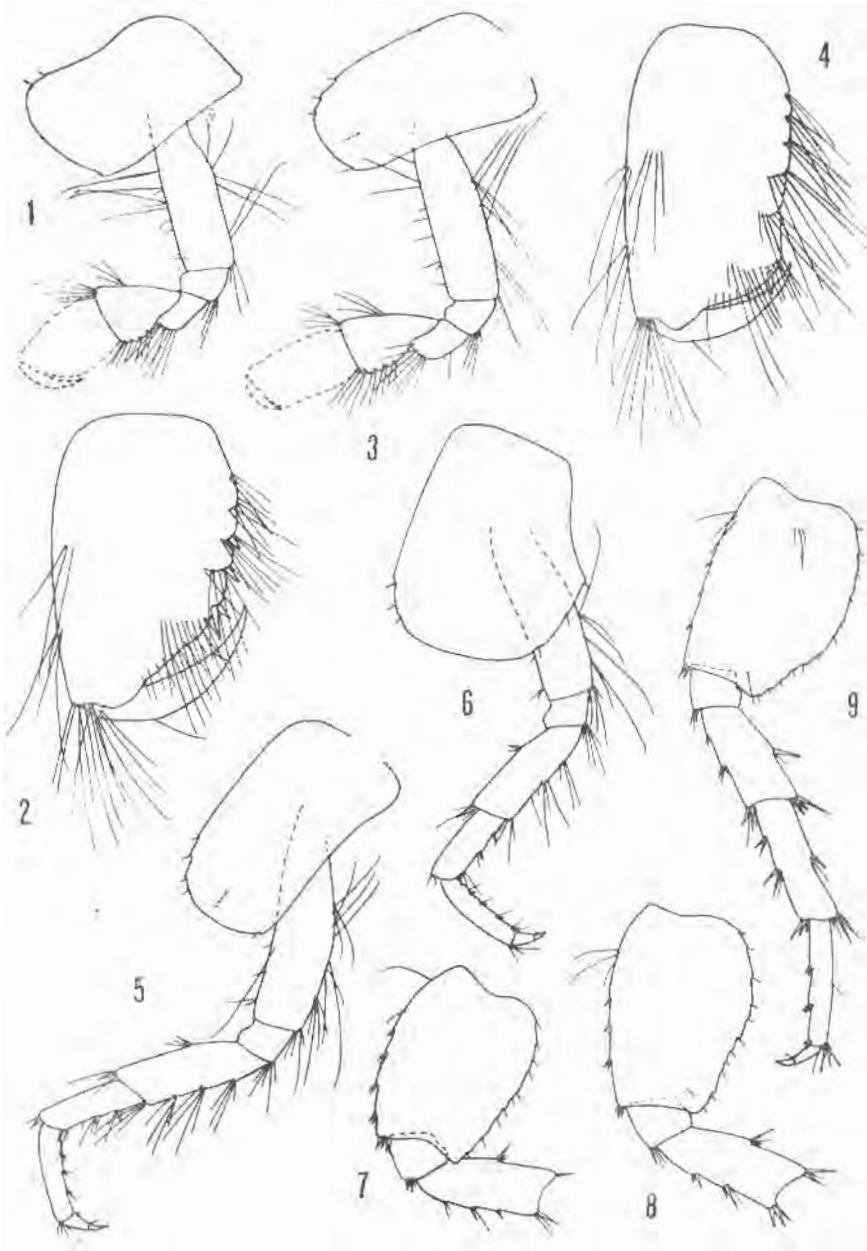


Fig. IV. *Gammarus balcanicus* Schäf., Kolašin, female 9 mm: 1-2 gnathopod 1; 3-4 = gnathopod 2; 5 = pereopod 3; 6 = pereopod 4; 7-9 = pereopods 5-7.

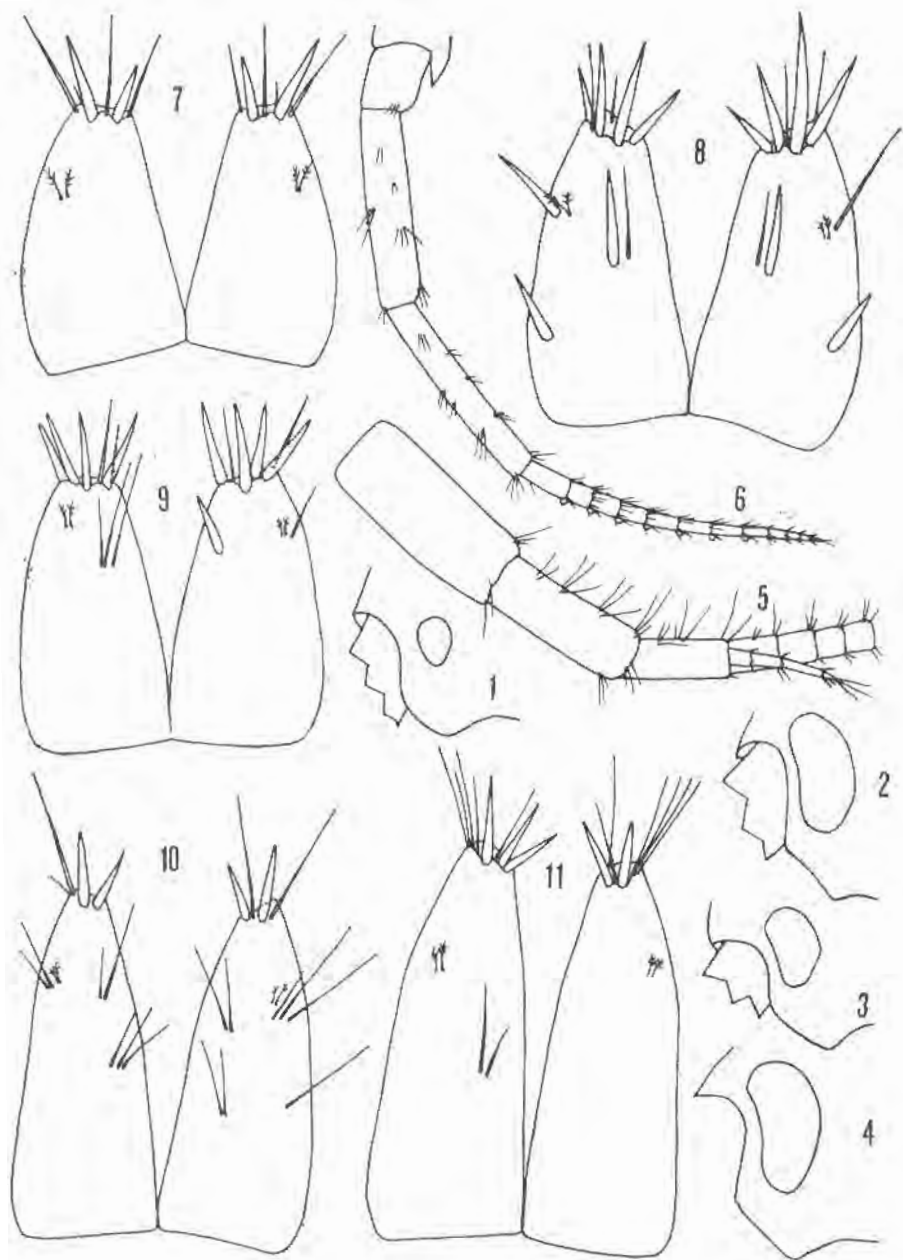


Fig. V. *Gammarus balcanicus* Schäf., males: 1 = head, Kajmakčalan, 8 mm; 2 = head, Knin, 8 mm; 3 = head, Jadro near Split, 7.8 mm; 4 = head, Norino, 13 mm; 5 = antenna 1, G. Bijela, 10 mm; 6 = antenna 2, Norino, 12 mm; 7 = telson, Ljuboten 1850 m, 9 mm; 8 = telson, Kičevo, 9 mm; 9 = telson, Rašče, 11 mm; 10 = telson, Iliđža, 11.5 mm; 11 = telson, Plitvice Lakes, 12 mm.



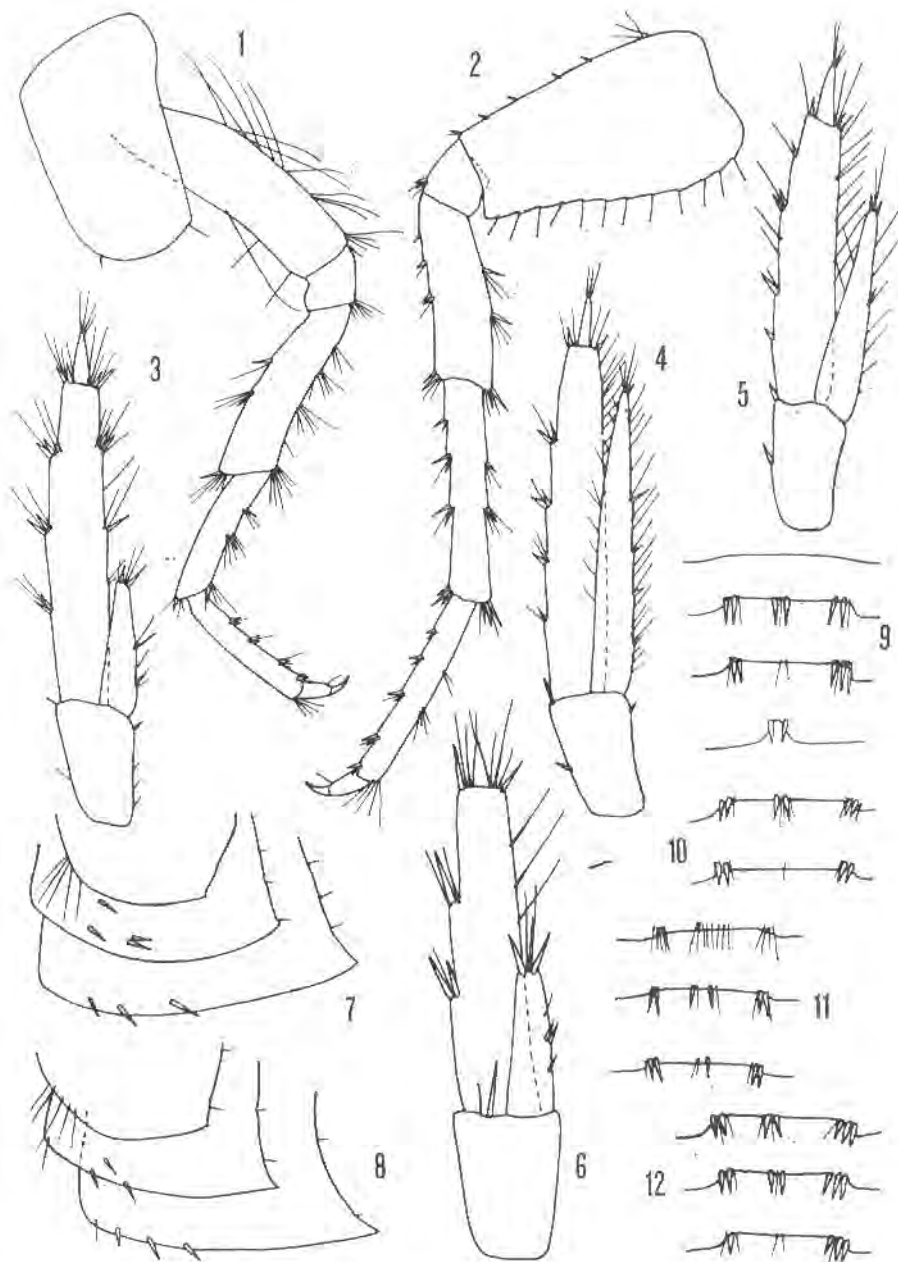
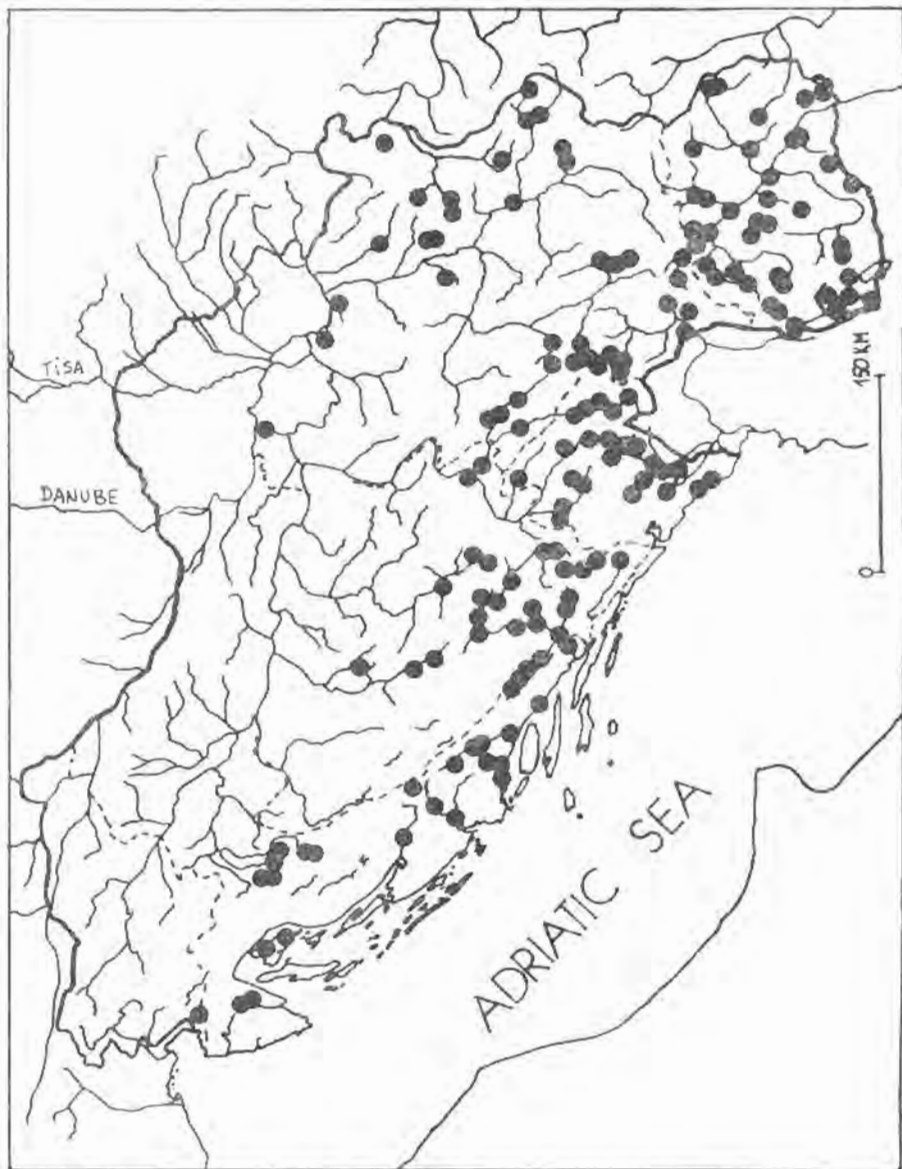


Fig. VI. *Gammarus balcanicus* Schäf., males: 1 = pereopod 3, G. Bijela, 11.9 mm; 2 = pereopod 7, G. Bijela, 11.9 mm; 3 = uropod 3, Bregava, 12 mm; 4 = uropod 3, Bošavica, 11 mm; 5 = uropod 3, Bošavica, 8.9 mm; 6 = uropod 3, Ljuboten 1850 m, 9 mm; 7 = epimeral plates, Mavrovo, 8 mm; 8 = epimeral plates, Norino, 13 mm; 9 = urosome, Bileča, 9 mm; 10 = urosome, Konjic, 11 mm; 11 = urosome, Perister, 9 mm; 12 = urosome, Skopje, 10 mm.



Distribution of *Gammarus balcanicus*  
Schäf. in Yugoslavia.

*Gammarus albimanus* (G. Karaman 1968), *G. balcanicus* Schäferna 1922, *G. bosniacus* Schäferna 1922, *G. dulensis* (S. Karaman 1929), *G. fossarum* Koch 1835, *G. halilicae* (G. Karaman 1969), *G. lacustris* Sars 1863, *G. lychnidensis* (Schellenberg 1943), *G. macedonicus* G. Karaman 1976, *G. ochridensis* (Schäferna 1925), *G. parechiniformis* G. Karaman 1977, *G. pljakici* G. Karaman (1964), *G. rambouseki* (S. Karaman 1931), *G. roeselii* Gerv. 1835, *G. solidus* G. Karaman 1977 and *G. stankokaramani* G. Karaman 1976.

The species *G. albimanus* and *G. halilicae* are known only from the caves of Macedonia. Species *G. lychnidensis*, *G. macedonicus*, *G. ochridensis*, *G. parechiniformis*, *G. solidus* and *G. stankokaramani* are limited to the Ohrid Lake.

*G. lacustris* lives in the mountain's lakes. *G. pljakici* is known from the very small area near Andrijevica and the origin of this species is going from some *G. balcanicus* populations. I can not exclude the possibility that *G. pljakici* is only one aberrant population of *G. balcanicus*, but until now, we have not any clear proofs for it. At the other hand, the breeding experiments can show the exact taxonomic relations between *G. ochridensis* and *G. parechiniformis*, both species living in Ohrid Lake.

#### *Gammarus balcanicus* Schäferna 1922

fig. I-VII

Syn.: (yugoslav records only); *Gammarus balcanicus* Schäferna 1922, p. 1, pl. 1, fig. 7, text fig. 1-2; Schäferna 1925, p. 2.

*Gammarus balcanicus balcanicus* Karaman, G. 1974, p. 9.  
*Gammarus (Rivulogammarus) balcanicus* Pljakić 1962, p. 51.

*Gammarus (Rivulogammarus) balcanicus balcanicus* Karaman, G. 1966, p. 111, fig. 1-10, 13, 14, 16.

*Rivulogammarus balcanicus* Karaman, S. 1931a, p. 51.

*Rivulogammarus balcanicus pannonicus* Karaman, S. 1935, p. 125.

*Rivulogammarus balcanicus occidentalis* Karaman, S. 1935, p. 126.

*Gammarus (Rivulogammarus) balcanicus bilecanus* Karaman, G. 1964, p. 2P, fig. 5; Karaman, G. 1966, p. 122, fig. 17-20.

*Gammarus balcanicus bilecanus* Karaman, G. 1974, p. 10.

*Gammarus (Rivulogammarus) balcanicus dacicus* Karaman, G. 1966, p. 122, fig. 27.

*Gammarus balcanicus dacicus* Karaman, G. 1974, p. 10.

*Gammarus klisanus* Karaman, S. 1931a, p. 42, fig. 5.

- Gammarus pavlovići pavlovići* Karaman, S. 1929, p. 95, fig. 9a; d; Karaman, G. 1974, p. 12.
- Rivulogammarus pavlovići pavlovići* Karaman, S. 1931a, p. 51, fig. 9.
- Gammarus (Rivulogammarus) balcanicus pavlovići* Karaman, G. 1966, p. 117, fig. 21, 23-26.
- Gammarus pavlovići montanus* Karaman, S. 1929, p. 97.
- Rivulogammarus montanus* Karaman, S. 1931a, p. 52, fig. 10; Karaman, S. 1935, p. 127.
- Gammarus (Rivulogammarus) balcanicus montanus* Karaman, G. 1966, p. 120, fig. 22, 28-32.
- Gammarus pavlovići stankoi* nov. nom. Karaman, G. 1974, p. 12.
- Rivulogammarus neretvanus* Karaman, S. 1931a, p. 41.
- Gammarus konjicensis* Schäferna 1922, p. 17, fig. 7, 8; Karaman, S. 1931a, p. 31, fig. 1.
- Gammarus konjicensis konjicensis* Karaman, S. 1931b, p. 104; Karaman, G. 1974, p. 11.
- Gammarus (Rivulogammarus) konjicensis* Karaman, G. 1966, p. 123, fig. 11, 12, 15.
- Gammarus konjicensis istrianus* Karaman, S. 1931b, p. 104; Karaman, G. 1974, p. 11.
- Rivulogammarus konjicensis istrianus* Karaman, S. 1958, p. 18.
- Gammarus konjicensis plančići* Karaman, S. 1931a, p. 34; Karaman, G. 1974, p. 11.
- Gammarus pulex* (non L.) Schäferna 1908, p. 126; Schäferna 1922, p. 14.
- Gammarus spinicaudatus* Schäferna 1922, p. 14; Schäferna 1925, p. 2; Karaman, S. 1929, p. 98; Karaman, G. 1974, p. 13.
- Rivulogammarus spinicaudatus* Karaman, S. 1931a, p. 56.

Description of topotypic material (Kolašin):  
 Male: Body length up to 12.5 mm. Body dorsally smooth, urosome low (fig. II, 4). Urosomite 1 with two dorsal groups of setae, without dorsolateral groups of elements (fig. II, 5); urosomites 2 and 3 with one dorsomedian and two dorsolateral groups of elements (spines and/or setae) each (fig. II, 5).

Lateral cephalic lobes subrounded; eyes weakly reniform, nearly as long as the diameter of peduncle of antenna 1 (fig. I, 1).

Antenna 1 reaching 3/5 of body, its peduncle segments progressively shorter, poorly setose (segment 1 with one ventral group

of setae, segment 2 with 2-3 groups, and segment 3 with 2 groups of setae at ventral margin) (fig. I, 2). Principal flagellum up to 29-segmented, poorly setose; setae are as long as or shorter than the diameter of the segments; aesthetascs short, one on each flagellar segment. Accessory flagellum 3-4 segmented.

Antenna 2 slender, poorly setose. Peduncle segments 4 and 5 with 4-5 groups of short setae at ventral margin each (setae are almost as long as the diameter of the segments). Flagellum up to 14-segmented, poorly setose, slender, slightly dorsoventrally compressed (fig. I, 3); flagellar segments with setae nearly as long as the diameter of the segments, calceola present. Antennal gland cone short.

Mouthparts normal. Mandible palp: first segment smooth, second segment with 4-6 setae in proximal and 6-9 setae in distal part (fig. II, 1); third segment with 24-27 D-setae, 4-5 long E-setae, 1-2 group of A-setae and one group of B-setae (fig. II, 1).

Coxa 1 normal, with straight anterior margin (fig. I, 4), coxae 2-4 normal (fig. I, 6; II, 2, 3). Gnathopods 1 and 2 moderately setose, with all straight setae. Gnathopod 1: segment 5 shorter than segment 6 (fig. I, 4). Segment 6 pyriform, bearing 3-4 groups of spines at posterior margin, intermixed with groups of long setae (fig. I, 5). Palm concave, with 2 corner and one median palmar spine on outer face and with 3-4 subcorner spines and several dorsal spines on inner face. Dactyl with one dorsal seta, moderately slender.

Gnathopod 2: segment 5 shorter than 6. Segment 6 almost as long as than of gnathopod 1, with parallel lateral margins, bearing 6-8 groups of setae at posterior margin. Palm concave, with on median and 2 corner spines on outer face and with 3-4 subcorner spines on inner face. Dactyl with one dorsal seta (fig. I, 6, 7).

Pereopods 3 and 4 moderately slender, poorly setose (fig. II, 2, 3). Pereopod 3: posterior margin of segment 4 with 4-5 groups of longer straight setae as long as or weakly longer than the diameter of the segment (fig. II, 2), posterior margin of segment 5 with 3 groups of spines intermixed with several setae nearly as long as the diameter of segment; segment 6 with 4-5 groups of short spines at posterior margin intermixed with single short setae, dactyl short.

Pereopod 4 like pereopod 3 but slightly shorter and provided with shorter setae (fig. II, 3).

Pereopods 5-7 moderately long: their segment 2 with short setae at posterior margin, without setae on inner surface (fig. III, 1-3); both margins of segments 3-6 of pereopods 5-7 with groups of spines. Dactyl short and stout (fig. III, 4).

Pleopods with 2 retinaculas each. Epimeral plates 2-3 moderately pointed (fig. II, 4): epimera 2 sometimes with 1-2 submargi-

nal spines and with 2-4 distal spines; epimeral plate 3 with 3-5 distal spines, setae are absent. Posterior margin of epimere 1-3 with short setae.

Uropods 1-2 normal. Uropod 3 moderately long and moderately setose (fig. I, 8). Peduncle much shorter than rami: inner ramus reaching  $\frac{3}{5}$  to  $\frac{2}{3}$  of first segment of outer ramus, provided with spines and longer setae at both margins. Outer ramus 2-segmented, bearing moderately long simple setae at both margins, intermixed with spines at outer margin. The setae at inner margin are longer than these at outer margin. Setae at inner ramus are simple or pectinate (fig. I, 8).

Telson nearly as long as broad, lobes with 2 distal spines intermixed with several setae; dorsal surface of each lobe with 1-3 setae and with one pair of short plumose setae (fig. III, 5).

Gills occur on thorocal segments 2-7, simple.

Female: Antenna 1, urosome, epimeral plates, telson and gills like these in males. Antenna 2 bearing longer setae on peduncle and flagellum, calceolas absent (fig. III, 6).

Gnathopods 1-2 smaller than these in males. Gnathopod 1: segment 6 pyriform, with several spines at posterior margin, intermixed with groups of straight setae (fig. IV, 1-2). Palm without median spine, but with 2 corner and 1-2 subcorner spines. Dactyl with one dorsal seta (fig. IV, 2).

Gnathopod 2: segment 6 weakly longer than that of gnathopod 1 (fig. IV, 3, 4), provided with 5-7 groups of setae at posterior margin. Palm without median spine, but with one corner and 2 subcorner spines (fig. IV, 4).

The pilosity of pereopods 3 and 4 like that in males (fig. IV, 5, 6). Pereopods 5-7 stout, their pilosity like that in males (fig. IV, 7-9). Uropod 3 short (fig. III, 7), bearing simple setae intermixed with spines at both margins of outer ramus as well as at outer margin of inner ramus. Inner ramus reaching up to  $\frac{3}{5}$  of first segment of outer ramus. All setae of uropod 3 are simple. Gills simple, oostegys moderately broad, occur on thorocal segments 2-5.

#### DESCRIPTION OF OTHER POPULATIONS AND THEIR VARIABILITY

##### a) Presence of mixed populations

*Gammarus balcanicus* is very variable species and he create numerous different populations in Yugoslavia. Distribution of all these populations is mosaic, without any geographical area of distribution. On the other hand, often without one locality we found two or more different populations together, with transitive specimens among them.

So, in the spring of Bijela River (near Konjic), exist two different populations together: one population with specimens having longer setae at posterior margin of segment 2 of pereopods 5-7, slightly longer inner ramus of uropod 3, urosomite 1 without dorsolateral groups of elements (described as *G. konjicensis* by Schäferna 1922); other population with specimens having short setae at posterior margin of segment 2 of pereopods 5-7, slightly shorter inner ramus of uropod 3, urosomite 1 with or without dorsolateral groups of elements. First population is dominant in the spring, second population is dominant in the upper part of the river. But, on the mouth of Bijela River (affluent of Neretva), intermixed specimens, having some new characters (absence of calceola, etc.) were observed.

In the spring of Buna River near Mostar, three different populations were observed: first population with specimens having elevated number of setae on peduncle of antenna 1 (fig. V, 5), antenna 2 with calceola, short inner ramus of uropod 3, etc.; second and third population with small number of setae on peduncle of antenna 1 (fig. I, 2), but second population with calceola, and third population without calceola on antenna 2 in males. All differences among these 3 populations disappear in lower part of Buna River.

Two different populations of *G. balcanicus* exist in the Jadro River near Split also: one population without lateral groups of elements on urosomite 1, another population with lateral groups of elements on urosomite 1. First population is dominant in the spring, and both populations are present in the other part of the river. But in numerous other localities not far from Jadro River, live the specimens with characters combined of both populations.

The presence of two or three different populations of *G. balcanicus* in one river was observed in many other localities also: Krka River near Knin, Bosna River near Sarajevo, Bjelica River near Kičevo, Komadinovo spring near Jablanica, etc.

In the spring of Bele Vode (Skopska Crna Gora) we found mixed population consisting of specimens with more setose peduncle of antenna 1 and the specimens with less setose peduncle of antenna 1; these differences disappear in lower part of this torrent.

In the torrent in Žuglići live two population together also: one population with specimens having lateral groups of elements on urosomite 1, shorter inner ramus of uropod 3 and non elevated urosome; second population with specimens having longer inner ramus of uropod 3, urosomite 1 without lateral groups of elements and elevated urosome, both populations have short setae at posterior margin of segment 2 of pereopods 5-7.

All our intentions to separate all these different populations from many localities into a distinct species remain without success,

because the morphological differences existing between these populations disappear in the other localities. Some populations have some of combined characters belonging to one or more different populations, combined with several new characters. For this reason, because of absence of distinct characters between different populations, we consider them as members of the same species, *G. balcanicus* Schäf.

Unfortunately, the cause of existing of different population of *G. balcanicus* into one torrent or river are still unknown, although we can not be sure that the morphological characters are always enough to recognize the different species. For this reason, each next study on ecology and on breeding problems of these micropopulations within one mixed population of one torrent or spring, will be wellcome.

#### b) Regional variability

The populations from Dalmatia, Lika, Herzegovina, Istra have often more or less reduced lateral groups of elements on urosomite 1. Some populations (near the mouth of Neretva River and Krka River) near the Sea are consisting of very large specimens, having often angular lateral cephalic lobes and large reniform eyes, almost like these in *Echinogammarus* species (fig. V, 2-4).

The populations from mountains are consisting usually of specimens having smaller body-size, smaller eyes, stouter and shorter extremities and uropod 3, reduced number of spines on urosome, larger gills, shorter inner ramus of uropod 3, reduced number or absence of plumose setae on uropod 3. But, often in the vallys there are the specimens with short inner ramus of uropod also (some population of Demir Kapija, Skopje, Plitvice Lakes, etc.).

#### c) Variability of different taxonomic characters

The very large variability of taxonomic characters within the specimens of one population as well as within the specimens of different populations was observed.

Body-length: The specimens living in large carstic springs, are much larger than specimens living in small streams and small springs, especially in the mountains (body-size of males 6-19 mm, of females ovig. 4.5-15 mm).

Urosomite 1: The specimens are usually with one dorsomedian and 2 dorsolateral groups of elements (spines and setae) on urosomite 1, but sometimes two dorsomedian groups of elements are present. Dorsolateral groups of elements can be often absent (Konjić, Plitvice Lakes) or all groups of elements on urosomite 1 can be absent (Bileća) (fig. VI; 9-12, II, 1).



Antenna 1: peduncle segments have more or less setose ventral margin, sometimes within one population (Skopska Crna Gora, Neretva) (fig. I, 2; V, 5).

Antenna 2: It is very poorly to moderately setose, calceola present or absent in males (fig. I, 3; V, 6).

Lateral cephalic lobes are usually subrounded (fig. I, 1), rather angular (fig. V, 1-4), eyes ovoid to reniform.

Coxa 4 with more or less convex distal margin and with larger or shorter distoposterior lobe.

Gnathopod 1 is as long or shorter than gnathopod 2, both with variable number of corner and subcorner spines.

Pereopods 3-4 poorly setose (fig. II, 3; VI, 1). Pereopods 5-7 larger or shorter; segment 2 with or without distoposterior tooth (not lobe), posterior margin of segment 2 with short or long setae (fig. III, 1-3; VI, 2), always without bunches of setae on inferior face; segments 3-6 always with spines at both margins (if exist, setae are shorter than spines); posterior margin of segment 4 with 2-3 groups of setae at posterior margin.

Epimeral plates weakly to sharply pointed (fig. II, 4, VI, 7, 8), with spines along ventral margin.

Uropod 3 in males is longer or shorter, poorly to moderately setose (fig. I, 8; VI, 3-6), with inner ramus reaching 1/3 to 5/6 of first segment of outer ramus. Outer margin of outer ramus is always with simple setae intermixed with spines, other margins of outer and inner ramus are provided with simple and or plumose setae with or without spines.

Telson as long as broad or longer than broad (fig. V, 7-11), each lobe with 2-5 distal spines intermixed with longer or shorter setae; dorsal surface of lobes with or without spines and setae.

The length of setae on pereopods 3-7 in females is variable.

**Material examined:** It as examined more than 500 samples of *G. balcanicus* from almost whole Yugoslavia. For this reason, it was impossible to cite all samples, but only the different drainage systems with more important localities are mentioned here:

**CROATIA:** Plitvička Jezera-Lakes (Glibovita Draga; spring near Mirič-Štopine; Labudovac; Prošćansko Jezero-Lake; Burget; Okrugljak);

Zrmanja River (springs near Žegar);

Krka River (brook near Knin; springs on Šareno Jezero-Lake near Knin; Krka River below Krčić; Roški Slap; Skradinski Buk; Miljacka River; Tiškovac);

Cetina River (brook in Hrvace near Sinj; Han near Sinj; spring Kosinac; spring in Vrlika; Podosje near Vrlika; springs Kalašće and Studena near Omiš);

Neretva River (Vrlika River; spring near Imotski);

Other localities: spring of Mrežnica River, spring of Slunjčica River; Sv. Rok in Lika; Vrlika near Plaški; spring near Klis; spring in Kaštel Stari; Žrnovica, spring near Split; Jadro River near Solin; spring near Tučepi (Makarska);

BOSNIA AND HERZEGOVINA: Vrbas River: spring Dugoš (Skender Vakuf); Vranica Lake, spring (Vakuf); spring Ibrahimovac (G. Vakuf);

Drina River: Sutjeska River (springs near Tjentište; spring N. of Čemerno; Višegrad; Stolac near Višegrad; Dobrun;

Bosna River (spring of Bosna River near Ilidža; brook Večerca near Ilidža); Treskavica Mt. (spring Srebrenik below Turovo; spring near Barice; spring near Veliko Jezero-Lake; Kozja Luka below Iljaš; Platno Jezero-Lake); Skakavica, Jahorina Mt.

Neretva River with tributaries: Ostrožac (Falino Brdo; spring near Ostrožac; spring Beroje); Konjic (Bijela brook; springs in Gornja Bijela and Donja Bijela; Špiljani; Boračko Jezero-Lake; spring Vruljak near Boračko Jezero); Lisin (Breze; Duboki Potok; Klinac; Čelava; Čobansko Vrelo; Crevin Potok; Topla Bukva); Komadinovo Vrelo-spring near Jablanica; Mostar (Bačevići, brook; Radobolje torrent); Buna River from spring to the mouth in Neretva River; Bregava River (spring of Bregava; Stolac); Čapljina; Počitelj, springs; Aleksin Han; Metković (springs near Metković, Norino spring; Doljani; Glušci; Šibanice); Ljubuški (Vrtošnica; spring Studenac; Vrioštica-Vitina).

Other localities: Lukavac (spring Čatrnja; spring Vitak, Donji Lukavac, NE of Stolac); Gacko (spring in Gacko; Stepen); Vrijeka, Dabarsko Polje; spring Knežev Izvor in Lukničko Polje; spring Jastrebnjak in Fatničko Polje; Trebišnjica River (springs near Bileća; spring Oko; springs near Trebinje); Višnjevica-Gaj; Bijelo Vrelo; spring in Polje; Kuhija; Žuglići; spring in Jelovo Polje, Lisičići;

SERBIA: Lim River: cave in Čedovo, Sjenica; Prijepolje; Murtenica (E. of Priboj);

Drina River (brook near Kokin Brod); Ibar River: Priština (Grimija; brook Čiovo near Janjevo); Batlava River; Novi Pazar (spring of Raška River near Sopočani; Raška River near Novi Pazar); spring in Ribarići; springs on road Ribarići-Rožaj;

Bijeli Drim River: spring of Bijeli Drim near Peć; Pečka Bistrica River; springs in Rugovska Klisura; spring near Suha Reka;

spring near Nova Šumadija (Prizren); Istok; Kruma spring on Paštrik Mt.; Vrbnica near Prizren;

Morava River: Niš (Jalovik); Vlasina, spring; brook near Vlasina Lake; Pirot (spring on Vzganica; spring in Slavinja; spring in Brlog); Motino Brdo (Kragujevac); Brezovački Potok (Kučaj);

Vardar River (spring near Strpci on road Uroševac-Prizren; springs near Kačanik); Mlava River (Gornjačka Klisura near Gornjak);

Timok River: spring of Zlotska Reka River; Rtanj, spring; spring of Crni Timok; spring and course of Radovanska Reka; Mirovštica; spring Rumenjok (Svrljig);

Other localities: Avala near Beograd; Vrdnik (Fruška Gora); spring in Đurđevica Voda (Pešter); Provalija (Smederevo); Rđanska Pećina-cave; spring in Salakovo; Turica; Megara, spring; Ljubišnica; spring Lozice; Gosevska Reka near Bare.

CRNA GORA: Drina and Lim Rivers: Čehotina River near Gradac; Dobrakovo; Bijelo Polje; spring on road Bijelo Polje-Ivangrad; Ivangrad; Plav Lake;

Tara River (Biograd Lake; spring in Mratinje); Piva River near mouth of Komarnica River; spring in Šavnik; springs in Donja Bukovica (Durmitor); Kolašin;

Ibar River (brook near tunnel Lokve on road Rožaj-Ivangrad); Morača River: spring near Morača Monastery; Mala Rijeka, spring near Lijeva Rijeka; springs in Platije; spring of Zeta River; springs along river banks of Zeta River (Vrelo in Vranjičke Njive; Milojevićka Vrela near Tunjevo); spring Bašina Voda near Ostrog; Marezja spring near Titograd; spring of Ribnica River (Titograd) Rijeka Crnojevića (Obodska Rijeka); springs along the coast of Skadar Lake;

Other localities: spring near Pečurice (Bar); spring Dobra Voda (Bar); spring Škurca near Dobra Voda (Bar);

MACEDONIA: Vardar River with tributaries: spring of Vardar River (Vrutok); Skoplje (spring Rašče; spring in Nerezi; spring on Treska River; spring Belbunar; Aržiničane; Glumovo; Kapeštica; Matka; Saraj; Kisela Voda); Gostivar: Šar Mt. (Gotovište; Ljuboten, 1400-1850 m; Kobilica; Vratnica); brook below Golema Peštera-cave near Gostivar; Skopska Crna Gora Mt. (Bele Vode, 1200 m; monastery Sv. Ilija; monastery Sv. Nikita; monast. Mala Bogorodica in Pobožje; cave in Banjani); Mavrovo (Torbeški Most; Korijska; Trnica; Gališka Reka; Tresonče); Kičevo (Belica River; Brzdani; Krušino; Drugovo; Boškovo Most); Perister Mt.; Karaorman Mt.; Jakupica Mt. 1000-1800 m; Titov Veles (Radobil); Gradmanci (Katlanovo); Štip; Radoviš; Osovgovo Mt.; Delčevo (Golak Mt.; Grad); Carev Dab (Crna Reka River); Kumanovo (Romanovci; Bedin Voda); Prilep (Raštani; Zrze Monastery); Kožuh Mt.; Demir Kapija (Bošavica River; Došnica River);

Markova Česma); spring on road Bitola-Resen; Bele Vode (Resen); Rašavec on road Ohrid-Prespa; springs in Stari Dojran; Valandovo;

Crni Drim River: spring in Djepište near Debar; spring in Sv. Naum near Ohrid (springs of C. Drim); Studenčište springs (Ohrid); Svinjiški izvori-springs (Ohrid); Jablanica and Žepin near Struga (Ohrid); Sateska Reka on road Ohrid-Prespa.

Localities cited:

Schäferna (1908) mentioned *G. balcanicus* for Klis (sub *G. pulex*).

Schäferna (1922) mentioned it for Kolašin, Šavnik, Grabovice, Komadina (sub *balcanicus*), Podgorica (=Titograd), Krka River, Buna River, Radobolje brook (Mostar), Bosna River (Ilidža), Kožljak and Bogljušnica on Čepić Lake (Istra) (sub *G. spinicaudatus*), Klis (sub *G. pulex*), Bijela brook near Konjic (sub *G. konjicensis*).

Schäferna (1925) mentioned it for Skoplje (Vardar) (sub *G. spinicaudatus*), Kajmakčalan, Babuna (between Gradsko and Bitolj), Perister (sub *G. balcanicus*).

Karaman, S. (1929) mentioned it for Neretva River near Metković (sub *G. spinicaudatus*), Bele Vode (Skopska Crna Gora, 1100 m), Jakupica Mt. 1400-1600 m (sub *G. pavlovići montanus*), Rašče spring (Skopje), tributary of Radika, 1000 m (sub *G. pavlovići pavlovići*).

Karaman, S. (1931a) mentioned *balcanicus* for Plitvice Lakes (Crna Rijeka, Leskovac, Ciginovac) (sub *G. konjicensis plančići*), Han, Vrlika, spring of Krka River, Knin, spring near Zrmanja vil. (Žegar), Sv. Rok (sub *G. konjicensis konjicensis*), Buna River (sub *G. neretvanus*), Jadro River and Klis near Split (sub *G. klisanus*), Stolac (sub *G. balcanicus*), Krurna spring, Vranište, spring of Drim and Hodža near Prizren, Rudo (Lim), Dobrunj-Biqelo Brdo, Rumenjak, Šiševac (sub *G. pavlovići pavlovići*) and Jakupica Mt. (spring of Babuna, 1800-2300 m) (sub *G. montanus*).

Karaman, S. (1931b) mentioned *balcanicus* for Plaško (sub *G. konjicensis konjicensis*), Boljun (N. of Čepić Lake), Risan and Reka near Ospos (near jugoslav-italian borger) sub *G. konjicensis istrianus*).

Karaman, S. (1935) mentioned *balcanicus* for Avala and Vrdnik (sub *G. balc. pannonicus*), Andrijevića, Ivangrad (=Berane), Titograd (=Podgorica) (sub *G. balc. occidentalis*), vicinity of Andrijevića (sub *G. montanus*), Studenčište (Ohrid), Sv. Naum (Ohrid) (sub *G. dalmatinus*).

Karaman, S. (1958) mentioned it for Baška Draga and Dobrinj (sub *G. konjicensis istrianus*).

Pljakić (1962) mentioned *balcanicus* for Kosmaj (S. of Beograd).

Karaman, G. (1964) mentioned it for Bileća and Trebinje (sub *G. balc. bilećanus*), and (1966) for Bukovo near Negotin (sub *G. balc. dacicus*).

Loc. typ.: springs in Kolašin (Crna Gora).

Holotype: Holotype and paratypes are deposited in Museum of Natural History in Praha (Czechoslovakia). The topotypic material is deposited in Karaman's collection in Titograd (Yugoslavia).

Distribution: Central and SE part of Europe, Asia Minor, URSS.

Ecology. *G. balcanicus* live in all clean continental surfacial waters having enough oxygen (rivers, lakes, brooks, springs), under the stones or among the vegetation. Often, it was found intermixed with other *Gammarus* species (*roeselii*, *dulensis*, *bosniacus*, *fossarum*, *ochridensis*, *parechiniformis*, *halilicae*, *rambouseki*) as well as with some *Echinogammarus* species (*veneris*, *acarinatus*, *scutarensis*, *thoni*). In all these cases, *G. balcanicus* live in the spring of brooks or rivers, and mixed populations consisting of *G. balcanicus* + some of former mentioned species live in other part of brooks or rivers (springs along bank of Vardar River, Morača River, Neretva River etc.).

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## Rezime

### 90. PRILOG POZNAVANJU AMPHIPODA. REVIZIJA GAMMARUS BALCANICUS SCHÄF. 1922 U JUGOSLAVIJI (FAM. GAMMARIDAE)

Vrstu *Gammarus balcanicus* je opisao Schäferna 1922. iz nekoliko lokaliteta na Balkanskom poluostrvu, a Karaman, G. je (1966) odredio lokalitet Kolašin kao loc. typ.

*G. balcanicus* je vrlo varijabilna vrsta koja u svakom vodenom bazenu formira različite populacije. Zbog toga su mnoge populacije ove vrste iz raznih dijelova Jugoslavije bile opisane kao zasebne vrste ili podvrste. Čak je i sam Schäferna (1922) u radu gdje opisuje novu vrstu *G. balcanicus*, istovremeno opisao dvije druge populacije iste vrste kao zasebne vrste (*konjicensis* i *spinicaudatus*).

Nakon višegodišnjeg sakupljanja materijala *G. balcanicus* iz cijele Jugoslavije i detaljne obrade istog, utvrdili smo da 12 različitih vrsta i podvrsta opisanih iz Jugoslavije pripadaju ustvari jednoj istoj vrsti, *G. balcanicus* Schäf. 1922: *Gammarus spinicaudatus*, *Gammarus konjicensis*, *Gammarus pavlovići*, *Gammarus pavlovići montanus*, *Gammarus konjicensis plančići*, *Rivulogammarus neretvanus*, *Gammarus klisanus*, *Gammarus konjicensis istrianus*, *Rivulogammarus balcanicus pannonicus*, *Rivulogammarus balcanicus occidentalis*, *Gammarus (Rivulogammarus) balcanicus bilećanus* i *Gammarus balcanicus stankoi*.

Glavne odlike vrste *Gammarus balcanicus* su slijedeće: Tijelo srednje dužine, urozomit I. sa srednjom leđnom i dvije bočne grupe trnova i dlaka ili bez ikakvih grupa trnova i dlaka. Bočne glavene ploče zaobljene, rjeđe uglaste, oči okruglaste ili bubrežaste. I. antena sa većim ili manjim brojem dlaka na donjem rubu drške. II. antena tanka, slabo do srednje dlakava, bič tanak, sa ili bez kalceola. Usni aparat normalan.

Koksa IV uža ili šira, sa ravnim ili konveksnim donjim rubom. I. i II. gnatopodi slabo dlakavi, sa svim dlakama pravim. III. i IV. pereopodi slabo dlakavi. V-VII. pereopodi kraći ili duži, sa bazisom izduženim, bez stražnjeg lobusa i bez dlaka na unutrašnjoj površini; zadnji rub bazisa sa kraćim ili dužim dlakama. Segmenti III-VI. sa trnovima sa obje strane, dok dlaka praktički i nema, ili su samo pojedinačne i uvijek kraće od trnova. Pleopodi sa po 2 retinakule.

Epimere slabo do jako zašiljene, samo sa trnovima na donjem rubu. Uropod III. kraći ili duži, slabo do srednje dlakav. Njegova unutrašnja grana dostiže 1/3 do 5/6 dužine segmenta vanjske grane. Vanjski rub vanjske grane nema nikad peraste dlake, dok oba ruba unutrašnje grane kao i unutrašnji rub vanjske grane nosi peraste ili obične dlake uz trnove. Telzon je četvrtast ili dosta izdužen, usje-

čen do dna; svaki njegov lobus nosi po nekoliko trnova na vrhu uz pojedine kraće dlake, a na leđnoj površini lobusa dolaze trnovi, dlake ili je površina potpuno gola.

Ženke imaju nešto jače dlakave III-VII. pereopode i II. antenu, dok kalceola nema, a gnatopodi I. i II. su manji.

*G. balcanicus* formira u raznim vodama različite populacije, a ponekad se u istom izvoru ili vodotoku može naći 2-3 razne populacije iste vrste, što je i zbunjivalo dosadašnje istraživače, navodeći ih na pogrešak zaključak da su to razne vrste.

*G. balcanicus* naseljava skoro cijelu Jugoslaviju, ali pretežno njen južni i zapadni dio, kao što se vidi iz priložene mape.

U mnogim vodenim tokovima je *G. balcanicus* naden u mješovitim populacijama sa drugim vrstama rodova *Gammarus* i *Echinogammarus*, pri čemu je uvijek vrsta *G. balcanicus* naseljavala izvore, dok su u donjim tokovima tih vodotoka bile druge vrste pomiješane sa *G. balcanicus*. Te vrste su *G. roeselii* Gerv., *G. dulensis* S. Kar., *G. bosniacus* Schäf., *G. fossarum* Koch, *G. ochridensis* Schäf., *G. parechiniformis* G. Kar., *G. halilicae* G. Kar., *G. rambouseki* S. Kar., *E. veneris* Heller, *E. acarinatus* S. Kar., *E. scutarensis* Schäf. i *E. thoni* Schäf.