Bijdragen tot de Dierkunde, 57 (2): 207-260 — 1987

FRESHWATER *GAMMARUS* SPECIES FROM EUROPE, NORTH AFRICA AND ADJACENT REGIONS OF ASIA (CRUSTACEA-AMPHIPODA)

PART III. *GAMMARUS BALCANICUS*-GROUP AND RELATED SPECIES

by

GORDAN S. KARAMAN

Biological Institute, Titograd, Yugoslavia

&

SJOUK PINKSTER

Institute of Taxonomic Zoology, University of Amsterdam, The Netherlands

ABSTRACT

1) This third part of the revision of the freshwater *Gammarus* species deals with the *G. balcanicus*-group. Members of this artificial group are characterized by poorly setose pereiopods 3 and 4 and uropod 3 and by the absence of dorsal carinae (processes) on the metasome segments.

2) The morphological characters used in this work are identical to those used in the first part, the revision of the *Gammarus pulex*-group (Karaman & Pinkster, 1977a).

3) The type material or topotypic material of all studied taxa was reexamined and compared with many (several hundreds) of newly collected samples and material from many European museums.

4) Complete descriptions and many illustrations are given of the males of all species from Europe and Asia Minor. The variability of the various characters is discussed and a key is given of the species of the *Gammarus balcanicus*-group. If necessary, the characters of the females, in case they are different, are likewise figured.

5) It is established that many taxa described from the Balkans must be considered synonyms of *G. balcanicus*.

6) In numerous localities, members of the *G. balcanicus*-group have been found together with members of the *G. pulex*- and /or *G. roeseli*-group and/or with members of the genus *Echinogammarus*.

7) Two new taxa are described, *G. longipedis* n. sp. and *G. pseudanatoliensis* n. sp., both from Asia Minor.

8) Three taxa of this group are limited to cave-streams: *G. halilicae*, *G. albimanus*, and *G. longipedis* n. sp. Seven species are limited to Lake Ohrid between Yugoslavia and Albany: *G. ochridensis*, *G. stankokaramani*, *G. parechiniformis*, *G. macedonicus*, *G. solidus*, *G. lychnidensis* and *G. salemaai*.

9) The species from Lake Ohrid not only differ from the other species within this group in morphology but likewise in karyology. All common freshwater gammarids have a haploid chromosome number of 26. In the species from Lake Ohrid this number varies from 12 in *G. salemaai* to 34 in *G. lychnidensis*. From these chromosomal numbers we assume that polyploidy is the evolutionary mechanism of speciation within this lake, and that *G. salemaai* is the ancestral form.

10) From zoogeographical data it can be concluded that this group originates from southeastern Europe and Asia Minor. The only species of this group that invaded a more extended area is *G. balcanicus*.

11) In *G. balcanicus* isolated populations are found which are more or less distinct in morphology. Since these populations are interfertile and since a geographical isolation mechanism does not exist, these populations should be considered as mere variations.

12) For all species complete lists of all studied material are given (except for *G. balcanicus*, for graphical space economy).

RÉSUMÉ

1) Cette troisième partie de la révision des Gammares d'eau douce est dédiée au groupe *Gammarus balcanicus*. Ce groupe artificiel est caractérisé par l'absence des carènes dorsales sur les segments du métasome et par l'absence d'une sétation, ou par une sétation peu développée, sur les péreiopodes 3 et 4 et sur l'uropode 3.

2) Les caractères morphologiques utilisés dans cette étude sont les mêmes que dans la révision antérieure du groupe *pulex* (Karaman & Pinkster, 1977a).

3) Le matériel-type, ou au moins du matériel non-type, de tous les taxa à été (ré)examiné et comparé avec des centaines d'échantillons récemment collectés et avec du matériel provenant de nombreux musées d'Europe.

4) Des descriptions complètes et de nombreuses illustrations sont données pour les mâles de toutes les espèces

d'Europe et d'Asie Mineure. Elles sont accompagnées d'une clé de détermination. La variabilité des divers caractères est discutée. Si nécessaire, les caractères des femelles, lorsqu'ils sont distincts, ont été figurés.

5) On démontre que plusieurs espèces décrites du Balkan doivent être considérées comme synonymes de *G. balcanicus*.

6) Dans plusieurs localités, des populations mixtes, composées de membres du groupe *balcanicus* et des groupes *pulex*, *roeseli* ou du genre *Echinogammarus*, ont été trouvées.

7) Dans la présente étude deux nouvelles espèces ont été décrites: *Gammarus longipedis* n. sp. et *Gammarus pseudanatoliensis* n. sp., toutes les deux d'Asie Mineure.

8) Trois espèces ne sont trouvées que dans les eaux souterraines: *G. halilicae*, *G. albimanus* et *G. longipedis* n. sp. Sept espèces sont limitées au Lac Ohrid entre la Yougoslavie et l'Albanie: *G. ochridensis*, *G. stankokaramani*, *G. parechiniformis*, *G. macedonicus*, *G. solidus*, *G. lychnidensis* et *G. salemaai*.

9) Les espèces du Lac Ohrid ne se distinguent des autres espèces de ce groupe seulement par leur morphologie, mais également par leur karyologie. En général, chez les Gammares d'eau douce, le nombre haploïde de chromosomes est 26. Parmi les espèces du Lac Ohrid ce nombre varie de 12 chez *G. salemaai* à 34 chez *G. lychnidensis*. En nous basant sur le nombre des chromosomes nous supposons que la polyploïdie est le mécanisme évolutif dans ce lac et que *G. salemaai* représente la forme ancestrale.

10) En se basant sur des données zoogéographiques, on peut conclure que ce groupe est originaire d'Europe du sud-est et d'Asie Mineure. Le seul membre de ce groupe ayant envahi une aire plus vaste est *G. balcanicus*.

11) *G. balcanicus* comprend des populations isolées qui sont morphologiquement plus ou moins différentes. Puisque ces populations sont interfécondes, et un mécanisme d'isolation géographique n'existant pas, l'on doit considérer ces populations comme étant de simples variations.

12) Pour toutes les espèces (abstraction faite de *G. balcanicus* pour des raisons d'économie d'espace graphique) des listes complètes du matériel étudié sont données.

INTRODUCTION

In the first part of the revision of the freshwater taxa belonging to the genus *Gammarus*, Karaman & Pinkster (1977a) subdivided them into three artificial groups, as is shown in the key below:

KEY TO THE SPECIES-GROUPS IN THE GENUS *GAMMARUS*

1a) Metasome segments with middorsal process (carina), laterally compressed ..... *G. roeseli*-group
b) Metasome segments without middorsal process 2
2a) Pereiopods 3 and 4 and uropod 3 bearing numerous long setae ..... *G. pulex*-group
b) Pereiopods 3 and 4 and uropod 3 poorly setose .... *G. balcanicus*-group

This subdivision is merely a practical one, based on morphological characters only and it does not follow the evolutionary way.

The first described species of the *G. balcanicus*-group was *G. balcanicus* Schäferna, 1922, described by the author from Kolašin (Crna Gora, southern Yugoslavia). Later many other taxa of this group were described by different authors from localities all over southern and middle Europe and Asia.

Schäferna's types of *G. balcanicus* are supposed to have been deposited in the Zoological Museum of Prague, but all our attempts to study this material were without success. So we collected new material from the type locality (Kolašin) which was used as a basis for the present study. We reexamined the type material of all other described taxa with the exception of *G. bosniacus*. For this species new topotypic material was collected by the first author. Likewise we studied the material of the major European museums and the rich material collected by both authors.

The *balcanicus*-group of species is distributed over a wide area in southeastern Europe, Asia Minor and Asia. So far the group is not known from northern Africa. Because of the inaccessibility of the Asian material we limited our study to taxa from Europe and Asia Minor.

In the present paper 18 taxa of this group have been studied, described and figured. We used the same taxonomic character terminology and abbreviations as in our previous revisions of the *pulex*- and *roeseli*-group (Karaman & Pinkster, 1977a & b).

It became clear that this group of species has its main distribution area in southeastern Europe and Asia Minor. All species described here, with the exception of *G. balcanicus*, are confined to this part of the world. *G. balcanicus* has a much wider distribution area. It invaded Italy and eastern Europe as far north as southern Poland. From these zoogeographical data we may conclude that this group originates from southeastern Europe and/or Asia Minor.

ACKNOWLEDGEMENTS AND RESPONSIBILITIES

The authors are indebted to Dr. Sandro Ruffo and Dr. G. Osella of the Museo Civico di Storia Naturale, Verona, Italy; to Dr. G. Hartmann and Dr. C. Kosswig of the Zoologisches Museum und Institut of the University of Hamburg, G.F.R.; to Dr. K. Jażdżewski of the University of Łodz and Dr. A. Skalski of the University of Częstochowa, Poland; to Dr. L. B. Holthuis of the Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands; to Dr. J. Forest of the Muséum National d'Histoire Naturelle, Paris, France; to Dr. R. Lincoln of the British Museum (Natural History), London, U.K.; to Dr. A. Koçatas of the Université d'Egée, Izmir, Turkey; to Dr. S. Andreev of the Museum of Natural History, Sofia, Bulgaria; to Dr. B. Karaman of the University of Skopje, Dr. M. Karaman of the University of Kragujevac and Dr. T. Petkovski of the Museum of Natural History, Skopje (all Yugoslavia) for providing us with the material used in this study.

Special thanks are due to Mrs. Irene de Graaf, Dr. Annemarie Goedmakers, Drs. J. Dieleman, and Mr. J. van Veen for their assistance to the second author during his fieldwork in many parts of the area studied.

During the work on the present paper, the authors started to study their material separately. Later, during meetings in Titograd, May 1977 and October 1986, the authors compared each other's material and discussed the results. Therefore, both authors agree with the results presented here and share the full responsibility for the total work.

ABBREVIATIONS USED

KC = Collection of S. & G. Karaman, Titograd, Yugoslavia.
MCSN = Museo Civico di Storia Naturale, Verona, Italy.
ZMA = Zoölogisch Museum Amsterdam, Amsterdam, The Netherlands.
ZMH = Zoologisches Museum und Institut, Hamburg, G.F.R.

SEXUAL DIMORPHISM

In general the sexual dimorphism is identical to that observed in the *Gammarus roeseli*-group, although a few exceptions remain to be noted. So, unlike in other species, females of *G. stankokaramani* have calceoli and medial palmar spines like the males. In some other species (*G. salemaai, G. lychnidensis*) the setation of pereiopods 5 to 7, which is usually longer in females, is identical in both sexes. In *G. albimanus* no difference can be observed in the setation of pereiopods 3 and 4 in males and females.

VARIABILITY OF CHARACTERS

Each of the 18 taxa presented here can be quite stable in some characters, but not in others. As in the *pulex*-group and the *roeseli*-group the most characteristic features are found in the setation of the antennae, the pereiopods and uropod 3 as well as in the armature of both metasome and urosome. Since all characters change during development, all our remarks concerning specific characters and their variability are valid for adults only.

Occasionally the presence or absence of C-setae on the mandibular palp (G. Karaman, 1973) as well as the presence of a spine in between the medial palmar spine and the palmar angle spine proved to be variable (in *G. pljakici*). The setation on pereiopods 3 to 7 in females is much more variable than in males, especially within populations of *G. balcanicus* s. str.

A. Stable characters proved to be:
(1) The structure of the mandibular palp (except in *G. pljakici*).
(2) The shape and armature of antenna 1.
(3) The shape and armature of peduncle and flagellum of antenna 2.
(4) The presence of a medial palmar spine in gnathopods 1 and 2 in males.
(5) The length of the setation along the posterior margin of pereiopods 3 and 4 in males.
(6) The shape and armature of pereiopods 5 to 7 in males, especially the presence or absence of setae along the anterior margin of articles 3 to 6 and on the inner surface of the basis.
(7) The presence of setae on the dorsal surface (not dorsoposterior margin) of the metasome segments.

(8) The armature of the second epimeral plate (presence or absence of setae).

B. Variable characters proved to be:
(1) The height and armature of the metasome and urosome segments (elevated or not elevated).
(2) The shape of the eyes and the epimeral plates.
(3) The shape of the lateral cephalic lobes (especially in *G. balcanicus*).
(4) The armature of telson and uropod 3.

Some characters which are stable in one species can be quite variable in other species, like the presence or absence of calceoli (stable in *G. lychnidensis*, instable in *G. balcanicus*), and the length of the inner ramus of uropod 3 (stable in most species, very variable in *G. balcanicus*).

KEY FOR THE IDENTIFICATION OF THE SPECIES OF THE *GAMMARUS BALCANICUS*-GROUP (based on adult specimens only)

1a. Eyes absent. Spines on outer lobe of maxilla 1 densely pectinate (see fig. 14E) .... *G. albimanus* G. Karaman, 1968a
b. Eyes present. Spines on outer lobe of maxilla 1 poorly pectinate 2
2a. Peduncle segment 3 of antenna 1 as long as or longer than peduncle segment 1 .... *G. lychnidensis* Schellenberg, 1943
b. Peduncle segment 3 of antenna 1 shorter than peduncle segment 1 3
3a. Peduncle of antenna 1 in males densely setose 4
b. Peduncle of antenna 1 in males sparsely setose, setae shorter than diameter of segments 5
4a. Posterior margin of pereiopods 3 and 4 in males almost without setae. Inner ramus of uropod 3 exceeding half of first segment of outer ramus. First metasome segment without dorsal spines .... *G. salemaai* G. Karaman, 1985
b. Posterior margin of pereiopods 3 and 4 with distinct short setae. Inner ramus of uropod 3 up to half of first segment of outer ramus. First metasome segment with dorsal spines .... *G. ochridensis* (Schäferna, 1926)
5a. Metasome segments 1-3 with spines on dorsal surface 6
b. Metasome segments 1-3 smooth or with (several) setae on dorsal surface only 10
6a. Segment 3 of mandibular palp with C-setae. Flagellum of antenna 2 short, swollen, with brush of many short setae at the inner margin (calceoli absent in males) .... *G. macedonicus* G. Karaman, 1976b
b. Segment 3 of mandibular palp without C-setae. Flagellum of antenna 2 slender, without brush of setae 7
7a. Antenna 2 in females with calceoli. Palm of gnathopods 1 and 2 in females with medial palmar spine ..... *G. stankokaramani* G. Karaman, 1976a
b. Antenna 2 in females without calceoli. Palm of gnathopods 1 and 2 in females without medial palmar spine 8
8a. Antenna 2 in males without calceoli. Epimeral plates 2 and 3 sharply produced .... *G. accolae* G. Karaman, 1973
b. Antenna 2 in males with calceoli. Epimeral plates 2 and 3 rectangular to moderately pointed (Lake Ohrid species) 9
9a. Inner surface of segment 2 (basis) of pereiopods 6 and 7 in males with setae. Epimeral plates 2 and 3 with numerous setae. Anterior margin of segments 3-6 of pereiopods 5-7 with spines intermixed with numerous long setae .... *G. solidus* G. Karaman, 1977b
b. Inner surface of segment 2 (basis) of pereiopods 6 and 7 in males without setae. Epimeral plates 2 and 3 with spines, sometimes intermixed with 1 or 2 setae only. Anterior margins of segments 3-6 of pereiopods 5-7 with spines only .... *G. parechiniformis* G. Karaman, 1977b
10a. Inner surface of basal segment of pereiopod 7 with setae 11
b. Inner surface of basal segment of pereiopod 7 without setae 13
11a. Accessory flagellum of antenna 1 one-segmented. Epimeral plates 2 and 3 with setae only .... *G. bosniacus* Schäferna, 1922
b. Accessory flagellum of antenna 1 with 2 or more segments. Epimeral plates 2 and 3 with spines, often intermixed with setae 12
12a. Epimeral plate 2 with setae only. Dorsoposterior margin of metasome segments 1-3 low, smooth, bearing a small number of marginal setae .... *G. dulensis* S. Karaman, 1929
b. Epimeral plate 2 with spines intermixed with setae. Dorsoposterior margin of metasome segments crenulated, often elevated and bearing many marginal setae *G. anatoliensis* Schellenberg, 1937b
13a. Metasome segments 1-3 with many dorsal setae each ..... *G. abscisus* G. Karaman, 1973
b. Metasome segments 1-3 dorsally unarmed 14
14a. Pereiopods 3-7 very elongated, basis of pereiopod 7 at least twice longer than wide (cave species) 15
b. Pereiopods 3-7 normal, basis of pereiopod 7 usually less than twice longer than wide (epigean species) 16
15a. Outer ramus of uropod 3 narrow, poorly setose along inner margin. Calceoli absent in males .... *G. halilicae* G. Karaman, 1969
b. Outer ramus of uropod 3 wider, with many setae

along inner margin. Calceoli present in males .... *G. longipedis* n. sp.

16a. Uropod 3 very short, poorly setose, not or hardly overreaching the tip of uropod 1; inner margin of exopodite unarmed or with 1 or 2 setae only (C-setae often present in mandibular palp) .... *G. pljakici* G. Karaman, 1964

b. Uropod 3 more setose, easily overreaching the tip of uropod 1; inner margin of exopodite with many setae (C-setae always absent in mandibular palp) 17

17a. Metasome segments 1-3 with crenulated and often elevated dorsoposterior margin .... *G. pseudanatoliensis* n. sp.

b. Metasome segments 1-3 with low, smooth non-crenulated dorsoposterior margin .... *G. balcanicus* Schäferna, 1922

DESCRIPTIVE PART

Gammarus balcanicus Schäferna, 1922 (Figs. 1-3)

Refs. — *Gammarus pulex* (non Linnaeus); Schäferna, 1908: 126; 1922: 14.

Gammarus balcanicus Schäferna, 1922: 3, text-figs. 1-2, pl. I fig. 7; Spandl, 1924: 442; Schäferna, 1926: 2; Birstein, 1963: 127; G. Karaman, 1977b: 37, figs. I-VII; 1978: 2581; Pinkster, 1978: 245; G. Karaman & Ruffo, 1979: 78, figs. I-VI; Barnard & Barnard, 1983: 464.

Rivulogammarus balcanicus; S. Karaman, 1931a: 51; Cărăuşu, Dobreanu & Manolache, 1955: 93, figs. 54-56.

Gammarus (*Rivulogammarus*) *balcanicus*; Schellenberg, 1937b: 508; Straškraba, 1957: 256; 1959: 199, fig. 2; Dedyu, 1961: 11; 1962: 34; Pljakić, 1962: 51; Dedyu, 1966: 36; 1967: 42.

Gammarus (*Rivulogammarus*) *balcanicus balcanicus*; G. Karaman, 1966: 111, figs. 1-10, 13, 14, 16; Dedyu, 1967: 43, figs. 1-2.

Gammarus balcanicus balcanicus; G. Karaman, 1974: 9.

Rivulogammarus balcanicus orientalis S. Karaman, 1934: 131.

Rivulogammarus balcanicus occidentalis S. Karaman, 1935: 126.

Rivulogammarus balcanicus pannonicus S. Karaman, 1935: 125.

Rivulogammarus balcanicus panonicus; Dobreanu & Manolache, 1936: 30, fig. 6.

Gammarus balcanicus alarodius Derzhavin, 1938: 172, fig. II, 2.

Gammarus balcanicus talyschensis Derzhavin, 1939: 48, pl. I fig. 2.

Rivulogammarus balcanicus dacicus Dobreanu & Manolache, 1942: 294, figs. 1-5; Cărăuşu, Dobreanu & Manolache, 1955: 97, figs. 57-60.

Gammarus (*Rivulogammarus*) *balcanicus dacicus*; Dedyu, 1961: 11; 1962: 35; G. Karaman, 1966: 122, fig. 27; Dedyu, 1967: 46.

Gammarus balcanicus dacicus; G. Karaman, 1974: 10.

Gammarus (*Rivulogammarus*) *balcanicus turcomanicus* Birstein, 1945: 155, fig. 3.

Gammarus balcanicus burduri S. Karaman & G. Karaman, 1959: 186.

Gammarus (*Rivulogammarus*) *balcanicus bilečanus* G. Karaman, 1964: 2, fig. 5; 1966: 122, figs. 17-20.

Gammarus balcanicus bilečanus; G. Karaman, 1974: 10.

Gammarus konjicensis Schäferna, 1922: 17, figs. 7-8; S. Karaman, 1931a: 31; Pinkster, 1978: 247.

Gammarus (*Rivulogammarus*) *konjicensis*; G. Karaman, 1966: 123, figs. 11, 12, 15.

Gammarus konjicensis plančići S. Karaman, 1931a: 34; G. Karaman, 1974: 11.

Gammarus konjicensis istrianus S. Karaman, 1931b: 104; G. Karaman, 1974: 11.

Rivulogammarus konjicensis istrianus; S. Karaman, 1959: 18.

Gammarus spinicaudatus Schäferna, 1922: 14, fig. 6; 1926: 2; S. Karaman, 1929: 98; G. Karaman, 1974: 13; Pinkster, 1978: 248.

Rivulogammarus spinicaudatus; S. Karaman, 1931a: 56.

Gammarus pavlovići pavlovići S. Karaman, 1929: 95, figs 9a, d; G. Karaman, 1974: 12.

Rivulogammarus pavlovići pavlovići; S. Karaman, 1931a: 51, fig. 9.

Gammarus (*Rivulogammarus*) *balcanicus pavlovići*; G. Karaman, 1966: 117, figs. 21, 23-26.

Gammarus pavlovici stankoi G. Karaman, 1974: 12.

Gammarus pavlovići montanus S. Karaman, 1929: 97.

Rivulogammarus montanus; S. Karaman, 1931a: 52, fig. 10; 1935: 127.

Rivulogammarus (*Gammarus*) *montanus*; Dobreanu & Manolache, 1936: 29, figs. 5a-c.

Rivulogammarus balcanicus montanus; Cărăuşu, Dobreanu & Manolache, 1955: 98, figs. 61-63.

Gammarus (*Rivulogammarus*) *balcanicus montanus*; G. Karaman, 1966: 120, figs. 22, 28-32.

? *Gammarus angustatus* Martynov, 1930: 109, figs. 20-25.

? *Gammarus angustatus* forma *obensis* Martynov, 1930: 113.

? *Gammarus nudus* Martynov, 1931: 580, figs. 11-17.

? *Gammarus tauricus* Martynov, 1931: 574, figs. 1-10.

Gammarus klisanus S. Karaman, 1931a: 42, fig. 5.

Rivulogammarus neretvanus S. Karaman, 1931a: 41; Ruffo, 1937: 46.

Rivulogammarus tatrensis S. Karaman, 1931b: 97.

Gammarus (*Rivulogammarus*) *balcanicus tatrensis*; Straškraba, 1953: 218, fig. 4; 1962: 122.

Rivulogammarus spinulatus Martynov, 1935: 456, figs. 48-54.

Gammarus gr. *balcanicus*; Ruffo & Vigna Taglianti, 1967: 5, fig. 2.

Gammarus cf. *balcanicus*; Goedmakers & Pinkster, 1977: 16.

Diagnosis. — Small to medium large species, making a rather robust impression. Body smooth. Antenna 2 slender, poorly setose. Pereiopods 3 and 4 with few, short setae.

Pereiopods 5 to 7 almost without setae. Epimeral plates moderately pointed, armed with spines only. Uropod 3 poorly setose.

Description of topotypic material (Kolašin, Crna Gora, Yugoslavia). — Male: Body length up to 12.5 mm. Body dorsally smooth, urosomites low without a distinct saddle. The dorsal armature usually consists of two middorsal groups of setae on urosomite 1 and a middorsal and two dorsolateral groups of spines and setae on urosomites 2 and 3 (fig. 1N).

The lateral lobes of the head (fig. 1A) are more or less rounded. The eyes are rather small, less than twice as long as wide, the upper margin being widely separated from the middorsal line.

The first antenna (fig. 1B) is about 3/5 of the total body length. The length of the peduncle segments gradually decreases, the third being about half as long as the first. The number of segments in the flagellum and accessory flagellum is variable, up to 29 and 3 or 4, respectively. The armature of both peduncle and flagellum is poor.

The second antenna (fig. 1C) is slender, poorly setose. The antennal gland cone is short.The flagellum has up to 14 segments, armed with setae that are shorter than the diameter of the segments. Calceoli are present.

The mouthparts are identical to those in the *Gammarus pulex*-group (Karaman & Pinkster, 1977a: figs. 5A-F). The mandibular palp (fig. 1D) has an unarmed first segment; the second segment bears 4 to 6 setae in its proximal part and 6 to 9 setae in its distal part. The third segment is armed with 24-27 D-setae, 4-5 long E-setae, 1 or 2 groups of A-setae and one group of B-setae. (For terminology see G. Karaman, 1973.)

Coxal plates 1 to 4 are well developed, with more or less rounded inferior corners. The lower margins are sparsely armed. Gnathopods 1 and 2 (figs. 1E-H) are armed with a limited number of straight setae. Segment 6 of gnathopod 1 is longer than segment 5, pyriform. The palm is concave, armed with a medial palmar spine and 2 palmar angle spines. Additionally many small spines can be found along the inner surface and along the posterior margin. The propodus of gnathopod 2 is about as long as that of gnathopod 1. It is armed with a strong medial palmar spine and a varying number of smaller spines near the palmar angle.

Pereiopods 3 and 4 (figs. 1-I, J) are moderately slender, poorly setose. In segment 4 of P3 the setae can be about as long as the diameter of the segments on which they are implanted, in segments 5 and 6 they are always shorter. Pereiopod 4 resembles P3, although the setation is less dense and shorter.

The fifth pereiopod (fig. 1K) has a subrectangular basis with a more or less backward protruding lobe near its distal end, always set with a spinule. In P6 and P7 (figs. 1L, M) the aspect of the basis gradually changes from almost quadrangular into more elongate. The armature of the distal segments of P5 to P7 usually consists exclusively of a varying number of spines. If setae are found, they are always short. In all pereiopods the relative length of the segments increases with age.

The pleopods have two retinacula each. The posteroinferior corners of the second and third epimeral plates vary from almost rectangular to moderately pointed. The lower margins of the epimeral plates are armed with spines only (fig. 1N).

The peduncle of uropod 3 (fig. 1-O) is shorter than the rami. The inner ramus is 3/5 to 2/3 as long as the outer ramus, provided with groups of spines and setae (longer than the spines) along both margins. The 2-segmented exopodite bears moderately long setae along the inner margin; the outer margin is armed with 4 or 5 groups of rather short simple setae, intermixed with some spines.

The telson lobes (fig. 1P) are twice as long as wide, each lobe set with two distal spines and several setae. On the dorsal surface of each lobe 1 to 3 setae are implanted as well as a pair of short plumose (sensory) setae.

Female: Antenna 1, urosome, epimeral plates and telson (fig. 2L) are as in males. Antenna 2 (fig. 2A) bears longer setae on both peduncle

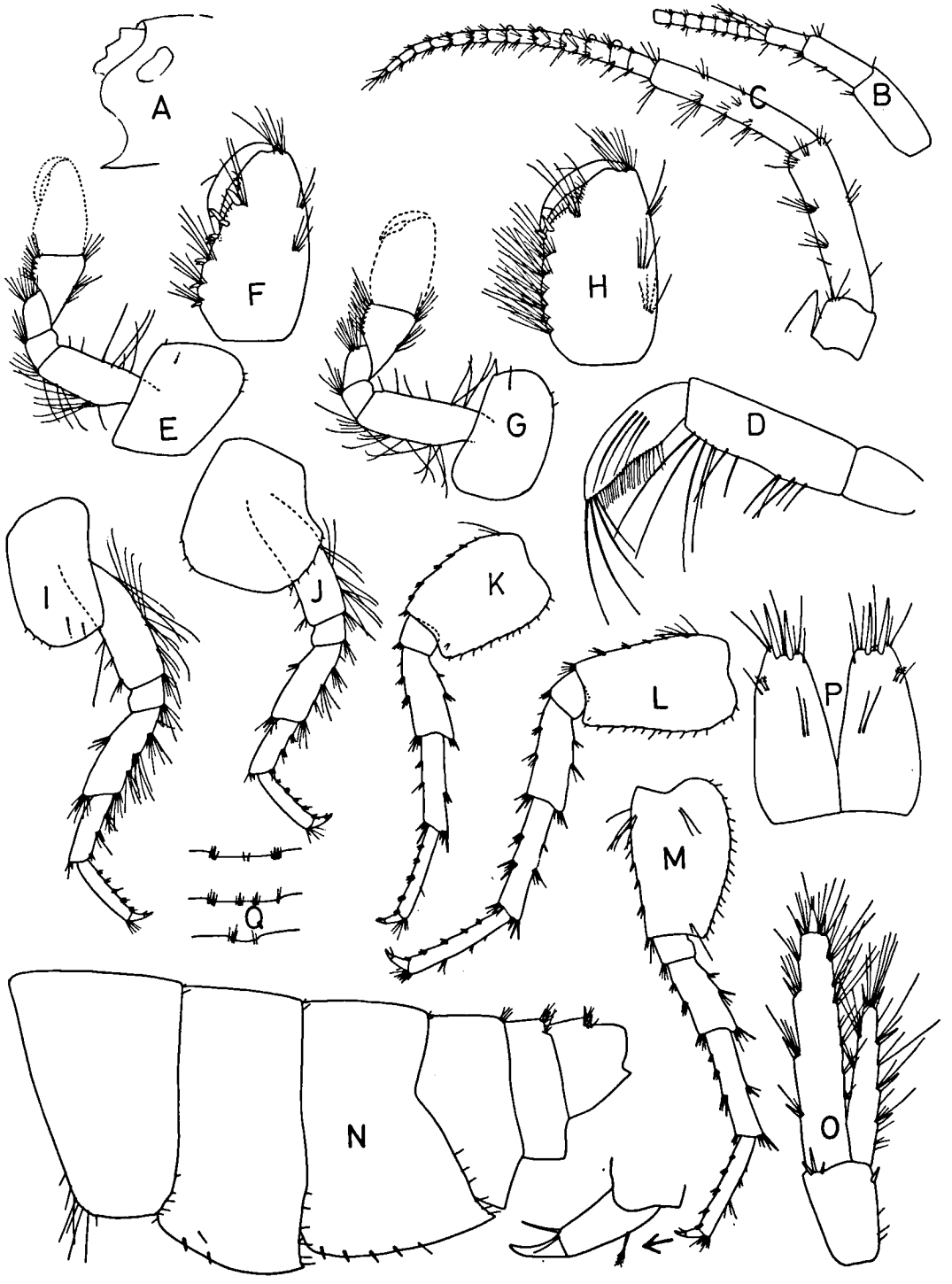

Fig. 1. *Gammarus balcanicus* Schäferna, 1922. A-Q, ♂, 12 mm, from Kolašin, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, mandibular palp; E, gnathopod 1; F, propodus of gnathopod 1; G, gnathopod 2; H, propodus of gnathopod 2; I, pereiopod 3; J, pereiopod 4; K, pereiopod 5; L, pereiopod 6; M, pereiopod 7 and detail of dactylus; N, meta- + urosome + epimeres; O, uropod 3; P, telson; Q, dorsal view of urosome.

and flagellum. Calceoli are absent. Gnathopods 1 and 2 (figs. 2B-E) are smaller than those in males. Medial palmar spines are absent and the number of palmar angle spines is reduced as compared to males. The setation is more densely implanted and longer. Pereiopods 3 to 7 (figs. 2F-J) are less slender than in males. The setation of P5 to P7 is almost identical to that in males. Uropod 3 (fig. 2K) is relatively short. The inner ramus varies from 1/2 to 3/5 of the outer ramus.

The colour of live specimens is very variable, from yellowish to yellow-red, red-brown, or yellow-green.

Variability. — *Gammarus balcanicus* is a very variable species and it has been a source of confusion for many decades as can be seen from the long list of synonyms. A review of the variability of this species in Yugoslavia is given by G. Karaman (1977b). He distinguishes (a) variability within populations, (b) regional variability and (c) variability of different taxonomic characters. Although it is not always possible to separate these different types of variability, we will try to give some of the essentials:

(a) Intrapopulational variability: Within one locality often subpopulations are found that show important differences in morphological characters, like the number of setae on the antennae, the shape of the eyes, the relative length of the inner ramus of the third uropod, the armature of the urosome and telson, and presence or absence of calceoli in males; as a rule all kinds of transitive forms can be found. Often in such cases we are dealing with some sort of seasonal variability in which overwintering specimens from the autumn generation show differences from the specimens born in early spring or summer.

(b) Regional variability: In Yugoslavia the populations from mountainous regions are usually smaller than those from the plains. Often the inner ramus of the third uropod of these populations is reduced in length. Populations from the lower parts of large rivers often grow very large and develop relatively large reniform eyes like in the genus *Echinogammarus*. In other countries the patterns observed can be quite different.

In cross-breed experiments by the second author between several morphologically distinct populations, these populations proved to be interfertile. Since geographical isolation mechanisms do not exist, these populations must be considered as mere variations of the same species *G. balcanicus*.

(c) Variability is observed in the following taxonomic characters:

1. Populations living in lowland streams and large karstic springs attain much greater lengths than those in small springs and upper reaches of streams.
2. Dorsal armature: the number of groups of dorsomedian and dorsolateral armature is variable on all three urosome segments (figs. 1Q, 3F-I).
3. The setation of the peduncle in antenna 1 can be more or less setose (figs. 1B, 3Q).
4. Antenna 2 can be more or less setose (figs. 3L-N), calceoli can be present or absent.
5. The lateral lobes of the head are usually rounded but can be almost angular (fig. 2N); the eyes vary from small ovoid to large reniform (figs. 2M-P).
6. The number of spines on gnathopods 1 and 2.
7. The setation of the pereiopods can be moderately long to almost absent (figs. 1-I, 3-O, P).
8. The basal segments of pereiopods 5 to 7 can have very short or longer setae along the posterior margin.
9. The epimeral plates 2 and 3 can be almost rectangular to moderately pointed (figs. 3J, K).
10. The relative length of the endopodite of uropod 3 is very variable, from 1/3 to 5/6 times the length of the first segment of the exopodite; the outer margin of the exopodite is always armed with some groups of spines, but the number and length of accompanying setae (which are always simple) can vary considerably (figs. 3A-E).

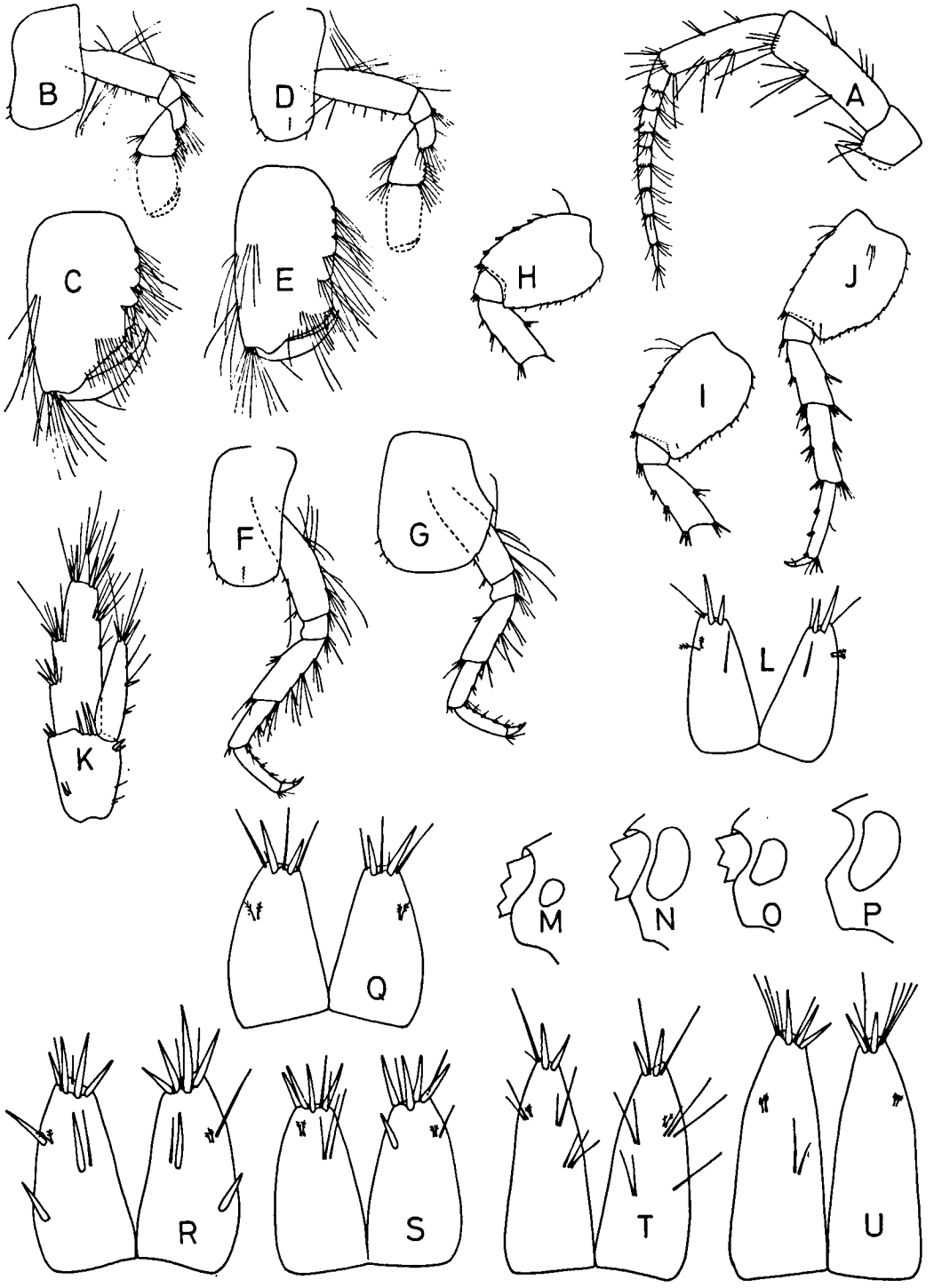

Fig. 2. *Gammarus balcanicus* Schäferna, 1922. A-L, ♀, 9 mm, from Kolašin, Yugoslavia. A, antenna 2; B, gnathopod 1; C, propodus of gnathopod 1; D, gnathopod 2; E, propodus of gnathopod 2; F, pereiopod 3; G, pereiopod 4; H, pereiopod 5 (part); I, pereiopod 6 (part); J, pereiopod 7; K, uropod 3; L, telson, M, ♂, 8 mm, from Kajmakčalan, Yugoslavia, head; N, ♂, 8 mm, from Knin, Yugoslavia, head; O, ♂, 7.8 mm, from Jadro River near Split, Yugoslavia, head; P, ♂, 13 mm, from Norino, Yugoslavia, head; Q, ♂, 9 mm, from Mt. Ljuboten, alt. 1850 m, Yugoslavia, telson; R, ♂, 9 mm, from Kičevo, Yugoslavia, telson; S, ♂, 11 mm, from Rasce, Yugoslavia, telson; T, ♂, 11.5 mm, from Ilidza, Yugoslavia, telson; U, ♂, 12 mm, from Plitvice Lakes, Yugoslavia, telson.

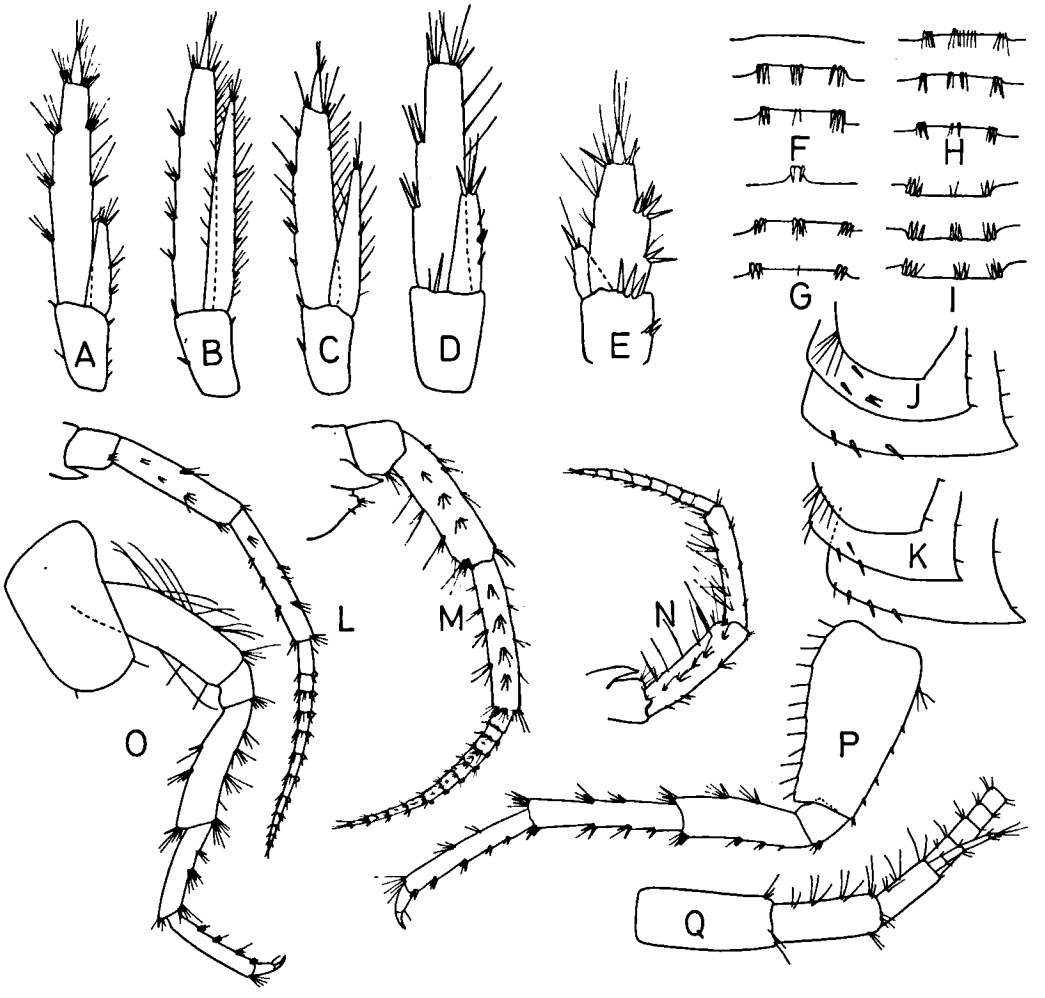

Fig. 3. *Gammarus balcanicus* Schäferna, 1922. A, ♂, 11.9 mm, from G. Bijela, Yugoslavia, uropod 3; B, ♂, 11.9 mm, from Bošavica, Yugoslavia, uropod 3; C, ♂, 8 mm, from Bošavica, Yugoslavia, uropod 3; D, ♂, 9 mm, from Mt. Ljuboten, Yugoslavia, uropod 3; E, ♀, 9 mm, from Keklik near Erzurum, Turkey, uropod 3; F, ♂, 9 mm, from Bileća, Yugoslavia, dorsal armature; G, ♂, 11 mm, from Konjic, Yugoslavia, dorsal armature; H, ♂, 9 mm, from Perister, Yugoslavia, dorsal armature; I, ♂, 10 mm, from Skopje, Yugoslavia, dorsal armature; J, ♂, 8 mm, from Mavrovo, Yugoslavia, epimeral plates; K, ♂, 11 mm, from Norino, Yugoslavia, epimeral plates; L, ♂, 12 mm, from Norino, Yugoslavia, antenna 2; M, ♂, 13 mm, from Lesko, Poland, antenna 2; N, ♂, 11 mm, from Smolnik, Poland, antenna 2; O, ♂, 11.9 mm, from G. Bijela, Yugoslavia, pereiopod 3; P, ♂, 11.9 mm, from G. Bijela, Yugoslavia, pereiopod 7; Q, ♂, 10 mm, from G. Bijela, Yugoslavia, antenna 1.

11. The telson lobes in larger males are much more elongate than in smaller specimens; the armature always consists of at least one or two distal spines, but often more spines and setae are present, both on the dorsal surface and along the lateral margins (figs. 2Q-U).

In females both the length and number of setae on pereiopods 3 to 7 is very variable.

Material examined. — More than 1000 samples from all over the distribution area, including type specimens and/or topotypic material from all formerly described (sub)species that are presently synonymized with *G. balcanicus* (except of *G. b. alarodius*, *G. b. talyschensis*, *G. angustatus*, *G. angustatus* forma *obensis*, *G. nudus*, *G. tauricus*, and *R. spinulatus*, mentioned under "Refs.").

Loc. typ. — Springs in Kolašin, prov. Crna Gora, Yugoslavia. The holotype and paratypes are supposed to be deposited in the Museum of Natural History in

Prague, Czechoslovakia. Topotypic material is deposited in Karaman's collection in Titograd.

Distribution. — The species is with certainty known from Yugoslavia, Bulgaria, Roumania, eastern part of Czechoslovakia, S.E. part of Poland, northern Italy, Albania, Turkey, Greece, S.W. part of the U.S.S.R., and Turkestan. Most probably the species can also be found in adjacent areas.

Ecology. — *Gammarus balcanicus* is a rather tolerant species, which can possibly explain its wide distributional area. It can thrive in all kinds of surface waters as long as they contain enough oxygen (like karstic springs, brooks, rivers and lakes) and salinities are not too high. They are absent in areas with direct influence of seawater, although they can certainly stand a high ion content.

Gammarus bosniacus Schäferna, 1922
(Fig. 4)

Refs. — *Gammarus bosniacus* Schäferna, 1922: 8, figs. 3-4, pl. I fig. 9; G. Karaman, 1974: 10; 1975a: 297, figs. I-III; Pinkster, 1978: 247; Barnard & Barnard, 1983: 465.
Rivulogammarus bosniacus; S. Karaman, 1935: 128.
Fontogammarus bosniacus; S. Karaman, 1931a: 37.
Gammarus (Rivulogammarus) bosniacus; Schellenberg, 1937a 270; G. Karaman, 1965: 86.

Diagnosis. — Small species with one-segmented accessory flagellum of antenna 1. Epimeral plates and inner surface of the basal segments of pereiopods 5 to 7 setiferous.

Description. — Male: Maximum length observed 10 mm. Body smooth, urosomites 1 to 3 flat, slightly laterally compressed. Urosomites 1 and 2 with one dorsomedian and 2 dorsolateral groups of 1 to 3 spines and 1 or 2 setae each. The dorsomedian group of the third urosomite only consists of setae (fig. 4L).

The lateral lobes of the head (fig. 4A) are rounded, the eyes vary from small, ovoid, to reniform.

The first antenna (fig. 4B) is shorter than half the body length, poorly setose. The main flagellum has up to 18 segments; the accessory flagellum always has but one segment.

The second antenna (fig. 4C) is also short, slender and armed with few tufts of short setae only. The (maximum 9) flagellar segments never bear calceoli.

The first segment of the mandibular palp is unarmed, the second segment bears 1 to 4 setae in its proximal part and 6 to 8 setae in its distal part. The third segment has 23 to 26 D-setae, 4 to 6 long E-setae, one group of A-setae and one group of B-setae.

Coxal plates 1 to 4 have rounded ventral corners, they are poorly setose. The propodus of gnathopod 1 (fig. 4D) is very poorly setose. It is armed with a strong medial palmar spine, 3 or 4 palmar angle spines and a varying number of smaller spines along the posterior margin. The dactylus is slender, set with one seta at the superior margin. The propodus of the second gnathopod (fig. 4E) is armed with many groups of rather short setae near the anterior margins. Apart from the usual medial palmar spine and the 3 to 4 palmar angle spines, a transverse row of three submarginal spines is found.

Pereiopods 3 and 4 (figs. 4F, G) are poorly setose, the setae being shorter than the segments on which they are implanted.

Pereiopods 5 to 7 (figs. 4H-J) are moderately slender. Setae are practically absent on segments 3 to 6. The basal segments of P6 and P7 are always set with (a variable number of) setae. The dactyli are relatively short, stout.

Epimeral plates 2 and 3 (fig. 4K) have moderately pointed posteroinferior corners. Setae are implanted along the ventral margin and on the surface of the second plate.

The inner ramus of the third uropod (fig. 4M) is slightly shorter than half the outer ramus. The outer margin of the exopodite is armed with few spines and some short setae only, the second segment is relatively long.

The telson lobes (fig. 4N) are more than twice as long as wide, armed with 1 or 2 distal spines, 1 to 3 short distal setae and a reduced number of spines and/or setae on the dorsal surface.

Female: Apart from the "normal" sexual dimorphism like the absence of medial palmar spines in the gnathopods and the smaller size,

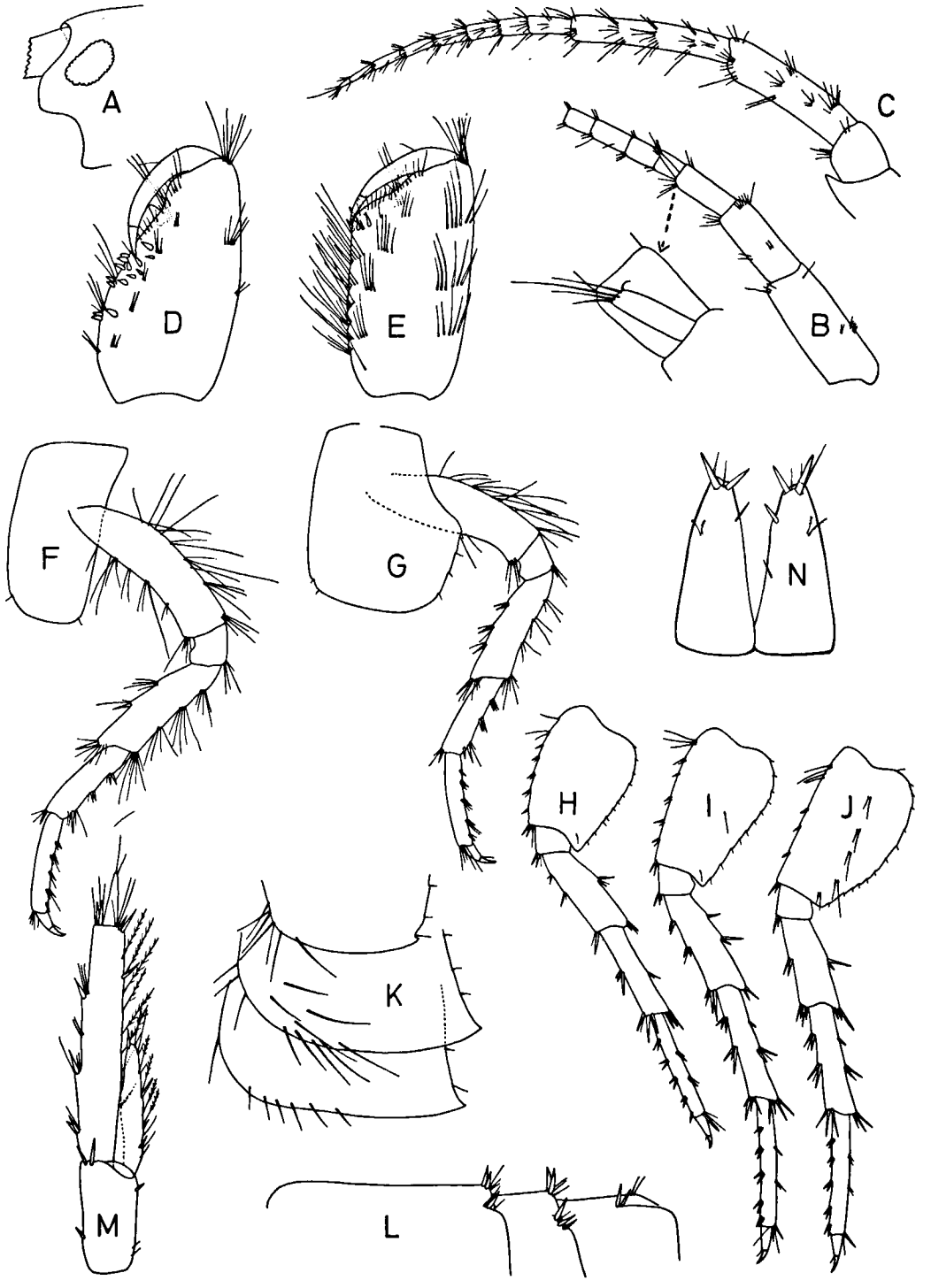

Fig. 4. *Gammarus bosniacus* Schäferna, 1922. A-N, ♂, 10 mm, from spring of Bosna River, Yugoslavia. A, head; B antenna 1 + detail; C, antenna 2; D, propodus of gnathopod 1; E, propodus of gnathopod 2; F, pereiopod 3; G pereiopod 4; H, pereiopod 5; I, pereiopod 6; J, pereiopod 7; K, epimeres; L, urosome; M, uropod 3; N, telson.

females of this species show all the characters of the males.

The colour of live specimens is yellowish with red dots on the coxal and epimeral plates.

Variability. — Shows the usual pattern.

Material examined. —
Yugoslavia: Spring of Bosna River, Ilidza, near Sarajevo, many specimens accompanied by *Gammarus balcanicus*, and *Niphargus ilidzensis* Schäferna, 1922 (KC).
— Ibid., many samples collected by several people from the same locality between 1969 and 1973 (KC).

Loc. typ. — Schäferna described this species from the same locality and the holotype and paratypes are supposed to be deposited in the Museum of Natural History in Prague, Czechoslovakia.

Remarks and affinities. — This species is the only known *Gammarus* species in Europe with a one-segmented accessory flagellum and can therefore easily be distinguished.

Distribution and ecology. — The species is known from the type locality only, a large rheocrene spring near Sarajevo, central Yugoslavia.

Gammarus anatoliensis Schellenberg, 1937
(Figs. 5-6)

Refs. — *Gammarus* (*Rivulogammarus*) *balcanicus anatoliensis* Schellenberg 1937b: 509, fig. 8.
Gammarus anatoliensis; Pinkster, 1978: 245; Barnard & Barnard, 1983: 464.

Diagnosis. — Medium large species. It is readily recognizable within this group of species because of the incisions of the dorsoposterior margins of all metasome segments, each incision bearing a setule, and the presence of setae on the inner surface of the basal segment of pereiopod 7.

Description. — Male: Maximum length observed 15 mm. The metasome segments are characteristic because of crenulations of the dorsoposterior margins (fig. 5P). In each incision a short to medium long setule is implanted. These segments are broadly elevated in the dorsoposterior part, but never laterally compressed or forming a tooth-like projection like in the *Gammarus roeseli*-group (Karaman & Pinkster, 1977b). The urosome segments 1 to 3 are flat or moderately elevated, not compressed laterally. The dorsal armature of the urosome consists of 1 middorsal and 2 dorsolateral groups of 1-3 spines and 1 to 4 setae on each segment.

The lateral lobes of the head (fig. 5A) are more or less rounded, the eyes ovoid to reniform, about as long as or shorter than the diameter of the first peduncle segment of the first antenna.

The first antenna (fig. 5B) is poorly setose, nearly half as long as the total body length. The main and accessory flagellum have 26 to 32 and 3 to 4 segments, respectively.

The second antenna (fig. 5C) is moderately slender. The 4th peduncle segment is slightly longer than the 5th. They are armed with 3 to 4 and 5 or 6 groups of setae along the ventral margin. The flagellum is up to 13-segmented, set with a row of short brushlike setae along the inferior margin. Calceoli can be present or absent.

The second segment of the mandibular palp (fig. 5D) bears 5 or 6 setae in its proximal part and 12 to 14 setae in its distal part. The third segment is armed with 22 to 25 D-setae, 4 or 5 E-setae, one group of A-setae and one group of B-setae. C-setae are absent.

Coxal plates 1 to 4 have rounded inferior corners. Gnathopods 1 and 2 (figs. 5E-H) are poorly to moderately setose, bearing straight setae only. In both gnathopods a strong medial palmar spine and 2 to 3 palmar angle spines are present; a variable number of smaller spines can be found along the posterior margin of the propodus in P1.

Pereiopods 3 and 4 (figs. 5-I, J) are poorly setose. The setae implanted on segments 4 are sometimes as long as the diameter of these segments; in all other segments these setae are shorter. P4 is less setose than P3.

Segments 3 to 6 of pereiopods 5 to 7 (figs. 5K-M) are armed with spines along the anterior margins; setae are practically absent. The basal segment of P7 is always armed with 1 to 8 setae on the inner surface. The dactyli of all pereiopods are moderately slender, normal.

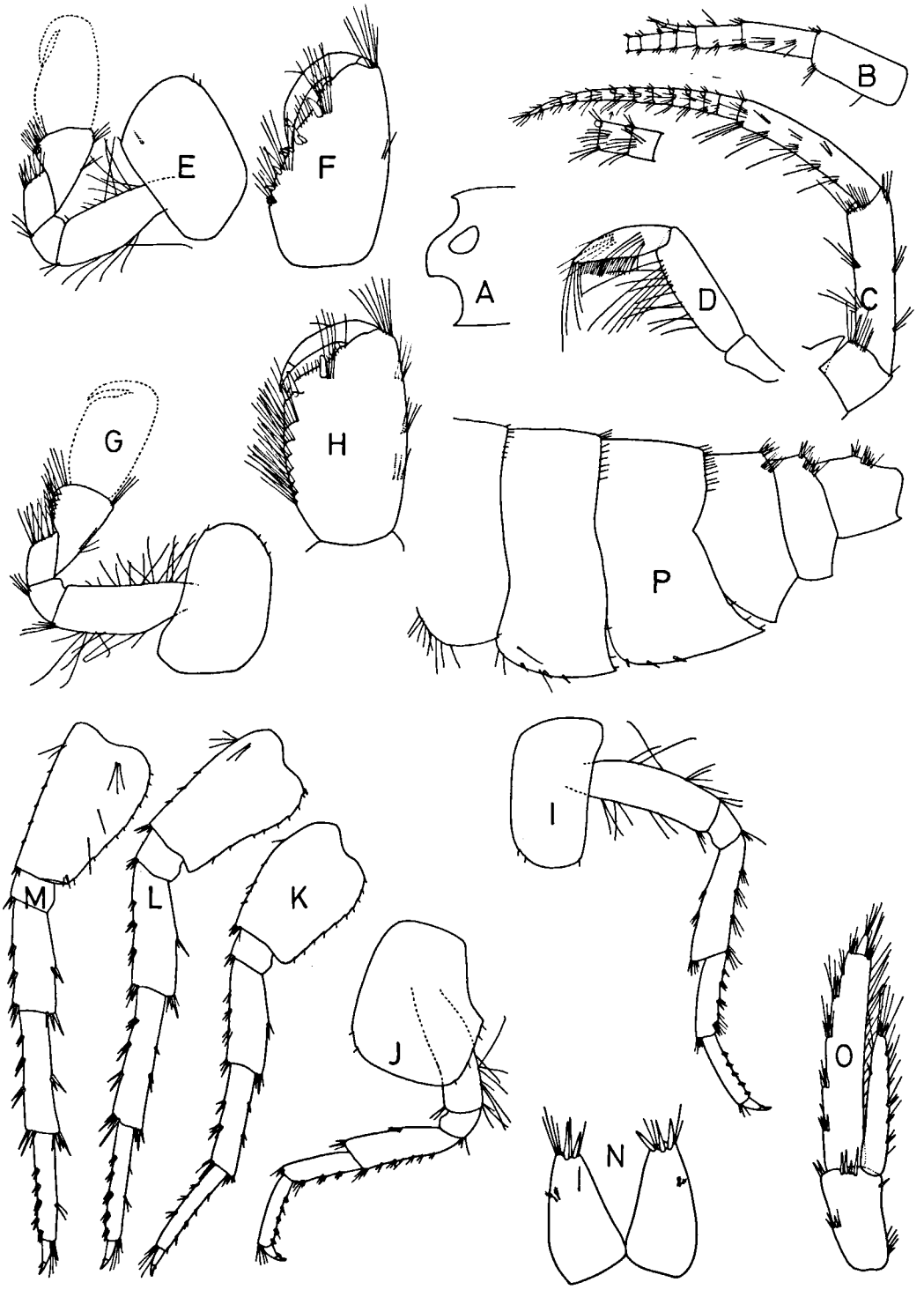

Fig. 5. *Gammarus anatoliensis* Schellenberg, 1937. A-P, ♂, 10.5 mm, from Akschehir, Turkey. A, head; B, antenna 1; C, antenna 2 + detail; D, mandibular palp; E, gnathopod 1; F, propodus of gnathopod 1; G, gnathopod 2; H, propodus of gnathopod 2; I, pereiopod 3; J, pereiopod 4; K, pereiopod 5; L, pereiopod 6; M, pereiopod 7; N, telson; O, uropod 3; P, meta- + urosome.

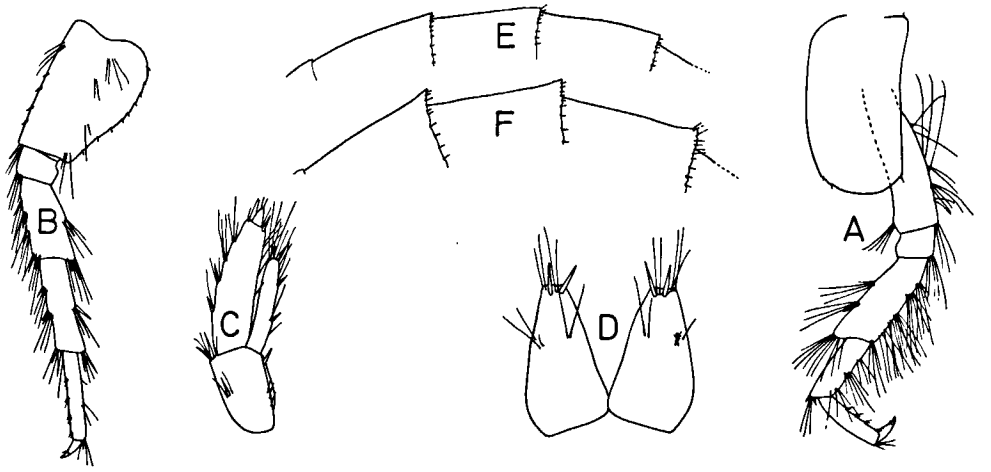

Fig. 6. *Gammarus anatoliensis* Schellenberg, 1937. A-D, ♀, 7.8 mm, from Akschehir, Turkey. A, pereiopod 3; B pereiopod 7; C, uropod 3; D, telson; E, ♂, 9 mm, from Sarkikaraagac, Isparta, Turkey, metasome; F, ♂, 11 mm from same locality, metasome.

The posteroinferior corners of epimeral plates 2 and 3 (fig. 5P) are moderately to sharply pointed.

The third uropod (fig. 5-O) is moderately long. Its endopodite is 1/2 to 3/4 times as long as the exopodite. Both rami are moderately setose. The setae along the outer margin of the exopodite are never plumose.

The telson lobes (fig. 5N) are more than twice as long as wide, set with 2 or 3 distal spines and some long distal setae. Usually one or two groups of longer setae are implanted on the dorsal surface of the lobes.

Female: Apart from the usual sexual dimorphism encountered in this group, like the absence of medial palmar spines and calceoli, females of this species differ from the males in the longer setation of the second antenna, the presence of numerous setae along the posterior margins of pereiopods 3 and 4 and both margins of segments 3 to 6 of pereiopods 5 to 7 (figs. 6A, B), shorter rami in uropod 3 (fig. 6C), and longer setae on telson (fig. 6D).

The colour of life specimens is brownish to grey.

Variability. — The shape of the eyes varies from ovoid to reniform; calceoli are usually present but not always.

The number and length of the setae along the posterior margin of P3 and P4 is rather variable, especially in females.

The metasome segments can be more or less elevated, with a varying number of crenulations in which the setules are implanted. Specimens from Sarkikaraagac, near Isparta, Turkey have very elevated metasome segments and many crenulations (figs. 6E-F); however, those from a spring at Ilgin, near Kaplica, are almost flat.

The number and length of the setae on segments 3 to 6 of pereiopods 5 to 7 in females is very variable and increasing with age. The number of setae on the interior surface of pereiopod 7 in males is variable too, as well as the relative length of the endopodite in uropod 3.

Material examined. —

Turkey: Akschehir torrent, alt. 1500 m in Sultan Dagh mountains, 11-VI-1934, many specimens, paratypes. Museum of Natural History, Berlin, G.D.R.

— Aksehir, 29-VIII-1971, 8 specimens (MCSN).

— Bozüyük, near Eskisehir, 17-VIII-1967, 15 specimens accompanied by *G. balcanicus* and *G. p. pulex* (Linnaeus, 1758) (MCSN).

— Çamlik Dalayman, Cave near Körükini, near Konya, alt. 1200 m, 24-IV-1973, 2 specimens (MCSN).

— Cave of Korükün, near Konya, 11-VIII-1969, 2 ♀♀ (MCSN).

— Torrent at Sarkikaraagac, near Isparta, alt. 900 m, 10-7-1973, many specimens (MCSN).
— Spring at Ilgin, near Kaplica, 10-V-1959, many specimens, accompanied by *G. agrarius* G. Karaman, 1973 (ZMH).
— Tavsanli, 6-IX-1968, several specimens (MCSN).
— Prov. Ankara, small brooklet 20 km N.W. of Kirikkale along road E23, 6-VI-1973, 5 specimens (ZMA).
— Prov. Afyon, small brooklet 5 km W. of Afyon, 16-VI-1973, many specimens (ZMA).
— Prov. Eskişehir, affluent of Parsuk çayi, 35 km S.E. of Eskişehir, 16-VI-1973, many specimens (ZMA).
— Prov. Isparta, affluent of Egridir Golü, crossing road from Aglasen to Isparta, 8-VIII-1969, many specimens (ZMA).

Loc. typ. — Turkey, torrent at Akschehir, alt. 1500 m, in Sultan Dagh Mountains. The ♂ holotype and many paratypes are still present in the Museum of Natural History, Berlin, G.D.R., cat. no. 24672. One paratype is deposited in the collections of G. Karaman, Titograd, Yugoslavia.

Remarks and affinities. — *G. anatoliensis* differs from the other species within this group in the presence of both the crenulations with setae along the posterior margins of the metasomites, and setae on the inner surface of the basal segment of P7.

Distribution and ecology. — Asia Minor, in torrents, springs, cave waters, and brooklets, at altitudes up to 1500 m; sometimes accompanied by *G. balcanicus*, *G. p. pulex*, and *G. agrarius*.

Gammarus pseudanatoliensis n. sp.
(Figs. 7-8)

Diagnosis. — Medium large species. Metasome segments elevated posteriorly, crenulated, set with many setules. Inner surface of basal segments of pereiopods 5 to 7 unarmed.

Description. — Male: Maximum length observed 14 mm. The metasome segments, like in *G. anatoliensis*, have numerous crenulations along the dorsoposterior margins, each set with a setule (fig. 7F). These segments are more or less elevated in the dorsoposterior part. Urosome segments 1 to 3 are flat, not compressed laterally. A middorsal group and two dorsolateral groups of elements (spines and setae) are always present.

The lateral lobes of the head are rounded, the eyes are ovoid to reniform, as long as or longer than the diameter of the peduncle of the first antenna.

The first antenna (fig. 7A) is poorly setose, about half as long as the total body length. The main and accessory flagellum have 25 to 30 and 2 or 3 segments, respectively.

The second antenna (fig. 7B) is sparsely armed, both in its peduncle and flagellum. Calceoli are always present.

The second segment of the mandibular palp (fig. 7C) bears 3 or 4 setae in its proximal part and 7 to 9 setae in its distal part. The third segment is armed with 22 to 27 D-setae, 4 or 5 E-setae, one group of A-setae and one group of B-setae.

Coxal plates 1 to 4 have more or less rounded inferior corners. Gnathopods 1 and 2 are poorly setose. They do not show important differences with those described for *G. anatoliensis* (figs. 5E-H).

Pereiopods 3 and 4 (figs. 8A, B) are poorly setose. In P3 the longest setae are never as long as the diameter of the segments on which they are implanted.

Pereiopods 5 to 7 (figs. 7D, E) have wide basal segments with a backward protruding lobe. The inner surface is unarmed. Segments 3 to 6 are armed with groups of spines along the anterior and posterior margin; setae are almost absent.

The posteroinferior corners of epimeral plates 2 and 3 are sharply pointed (fig. 7F). The armature is scarce, only consisting of 1 or 2 spines along the inferior margin.

The third uropod (figs. 8C, D) is rather variable; its endopodite can vary from 1/2 to 3/4 of the length of the exopodite. Along the outer margin of the exopodite 3 or 4 groups of spines and setae can be found. These setae are never plumose.

The telson lobes (fig. 7G) are more than twice as long as wide, armed with one or two distal spines and a few short setae. The dorsal surface of the lobes is unarmed.

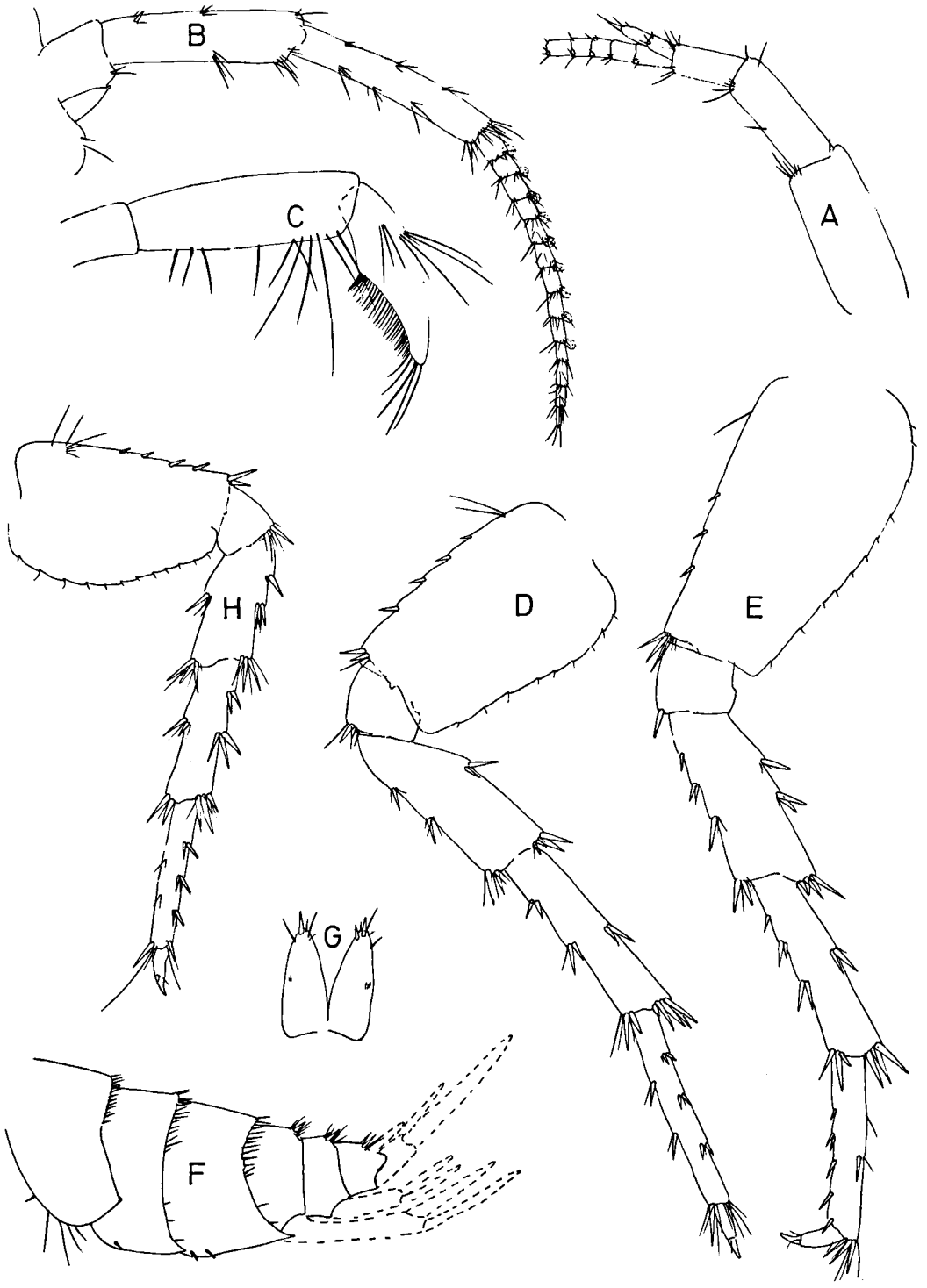

Fig. 7. *Gammarus pseudanatoliensis* n. sp. A-G, ♂, 14 mm, from Malatya, Turkey. A, antenna 1; B, antenna 2; C, mandibular palp; D, pereiopod 5; E, pereiopod 7; F, meta- + urosome + epimeres; G, telson; H, ♀, 11 mm, from same locality, pereiopod 7.

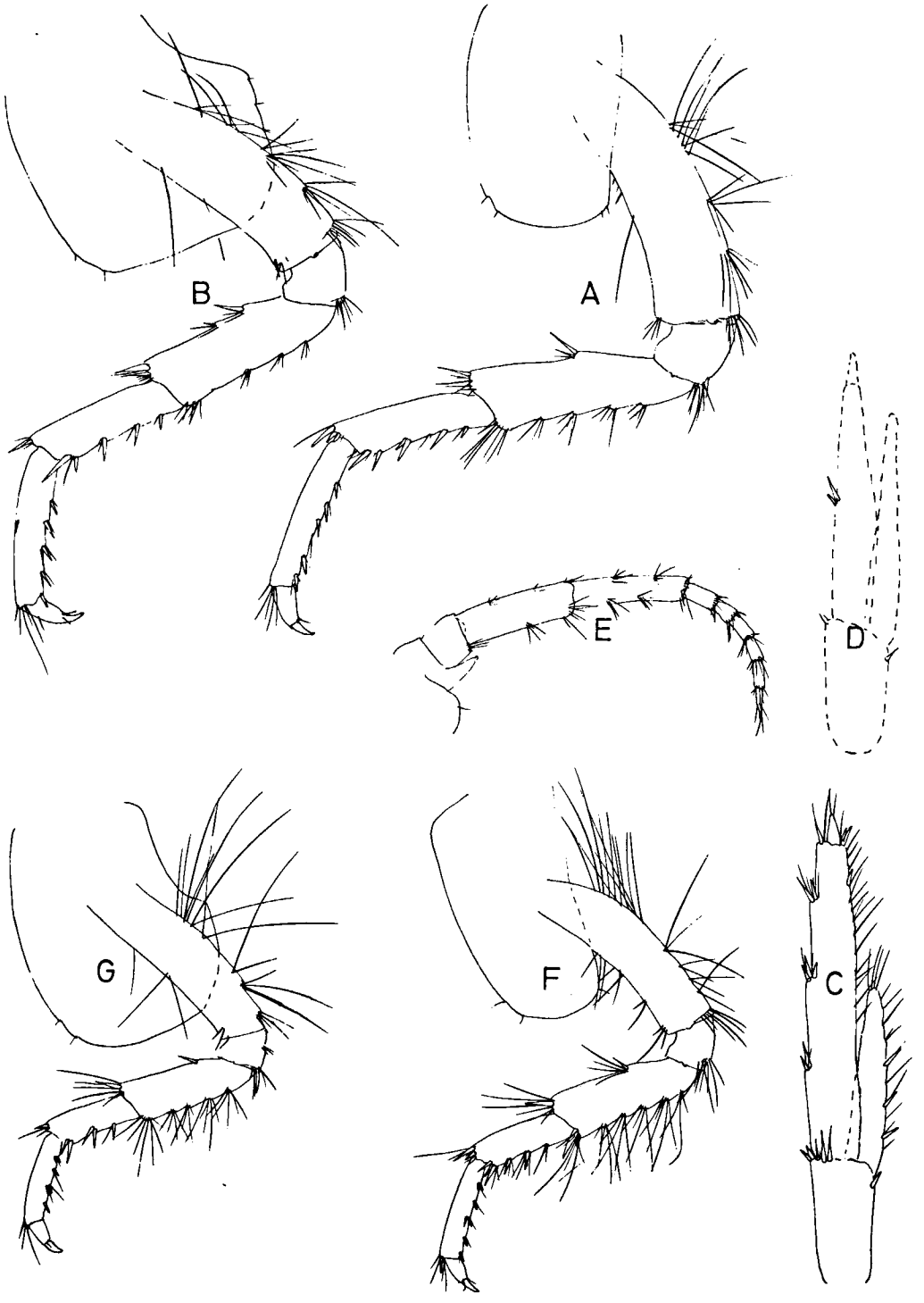

Fig. 8. *Gammarus pseudanatoliensis* n. sp. A-D, ♂, 14 mm, from Malatya, Turkey. A, pereiopod 3; B, pereiopod 4; C, uropod 3; D, uropod 3 of another ♂ of equal size. E-G, ♀, 11 mm, from same locality. E, antenna 2; F, pereiopod 3; G, pereiopod 4.

Female: Like in the male the setation of the antennae is very poor (fig. 8E). The setation of pereiopods 3 and 4 is little longer than in the male, but never as long as in female *G. anatoliensis* (figs. 8F, G). In pereiopods 5 to 7 (fig. 7H) some short setae are found in between the groups of spines.

The colour of live specimens is grayish brown.

Variability. — Apart from the "normal" variability in this group, variation can be found in the number of crenulations of the metasome segments. These segments can be more or less elevated.

Material examined. —

Turkey: Prov. Sivas, confluent of Tohma Suyu, 30 km W. of Gürün, 3 m wide, 20 cm deep, 12-VI-1973, many specimens, many in precopulation. The ♂ holotype and many paratypes have been deposited in the Zoölogisch Museum Amsterdam, cat. no. ZMA Amph. 106.189 a & b.

— Prov. Nevşehir, confluent of Kizilarmak in village Göre, 1 to 3 m wide, 10 to 20 cm deep, 14-VI-1973, 20 specimens (ZMA).

— Prov. Konya, small brook at Meram, 8 km W.S.W. of Konya, ± 3 m wide, 3-VIII-1969, many specimens (ZMA).

— "East Anatolia", Fenike, 4-IX-1971, ± 20 specimens (ZMH).

— Prov. Elbistan, cave Gueuzeu at village Maraş, near Afsin, alt. 1300 m, 27-VI-1968, 10 specimens (MCSN).

— Prov. Elbistan, Elbistan, 30-VI-1950, several specimens (MCSN).

— Prov. Ankara, Gölbasi, 5-X-1949, 3 specimens (ZMH).

Remarks and affinities. — In general appearance this new species closely resembles *G. anatoliensis*. However, it differs from it in the absence of setae on the interior surface of the basal segments of pereiopods 5 to 7 in both males and females, and the shorter setation of pereiopods 3 to 7 in females. Another species with crenulated metasome segments, *G. abscisus* (vide infra), differs from *G. pseudanatoliensis* in the possession of setae on the dorsal surface of the metasome segments. The last species with which this new species could eventually be confused is *G. accolae* G. Karaman, 1973; in this species however, spines are implanted in between the setae in the indentations along the posterior margins of the metasome segments.

Distribution and ecology. — Asia Minor, in brooklets and cave waters, at altitudes up to 1300 m.

Gammarus abscisus G. Karaman, 1973
(Fig. 9)

Refs. — *Gammarus abscisus* G. Karaman, 1973: 6, figs. 1-3; Pinkster, 1978: 247; Barnard & Barnard, 1983: 464.

Diagnosis. — Metasome segments 1 to 3 with numerous short setae on the dorsal surface. Epimeral plates 2 and 3 with spines and setae. Basal segments of pereiopods 6 and 7 without setae on inner surface. Antenna 2 poorly setose, with calceoli.

Description. — Male: Maximum length observed 11.5 mm. The metasome (fig. 9M) is very characteristic since it bears many short setae on its dorsal surface. The urosome segments (fig. 9L) are slightly elevated, each provided with a middorsal and two dorsolateral groups of elements (spines and setae).

The lateral cephalic lobes (fig. 9A) are rounded, the eye is small, round to ovoid, but always smaller than the diameter of the peduncle of the first antenna.

The first antenna (fig. 9B) is short, hardly as long as half the body length, poorly setose. The main and accessory flagellum have a maximum of 21 and 3 segments, respectively.

The peduncle segments of the second antenna (fig. 9C) bear some groups of short setae. The flagellum is slender, poorly setose, calceoli are present.

The first segment of the mandibular palp is sometimes set with a seta. The second segment bears 4 to 6 setae in its proximal portion and 7 to 9 setae in its distal portion. The last segment of the palp bears 19 to 22 marginal D-setae and 4 or 5 longer E-setae. On the outer surface one group of A-setae and on the inner surface one group of B-setae are found.

Coxal plates 1 to 4 have rounded inferior corners, sometimes set with one or two setae on the inner surface. The propodus of gnathopod 1 is

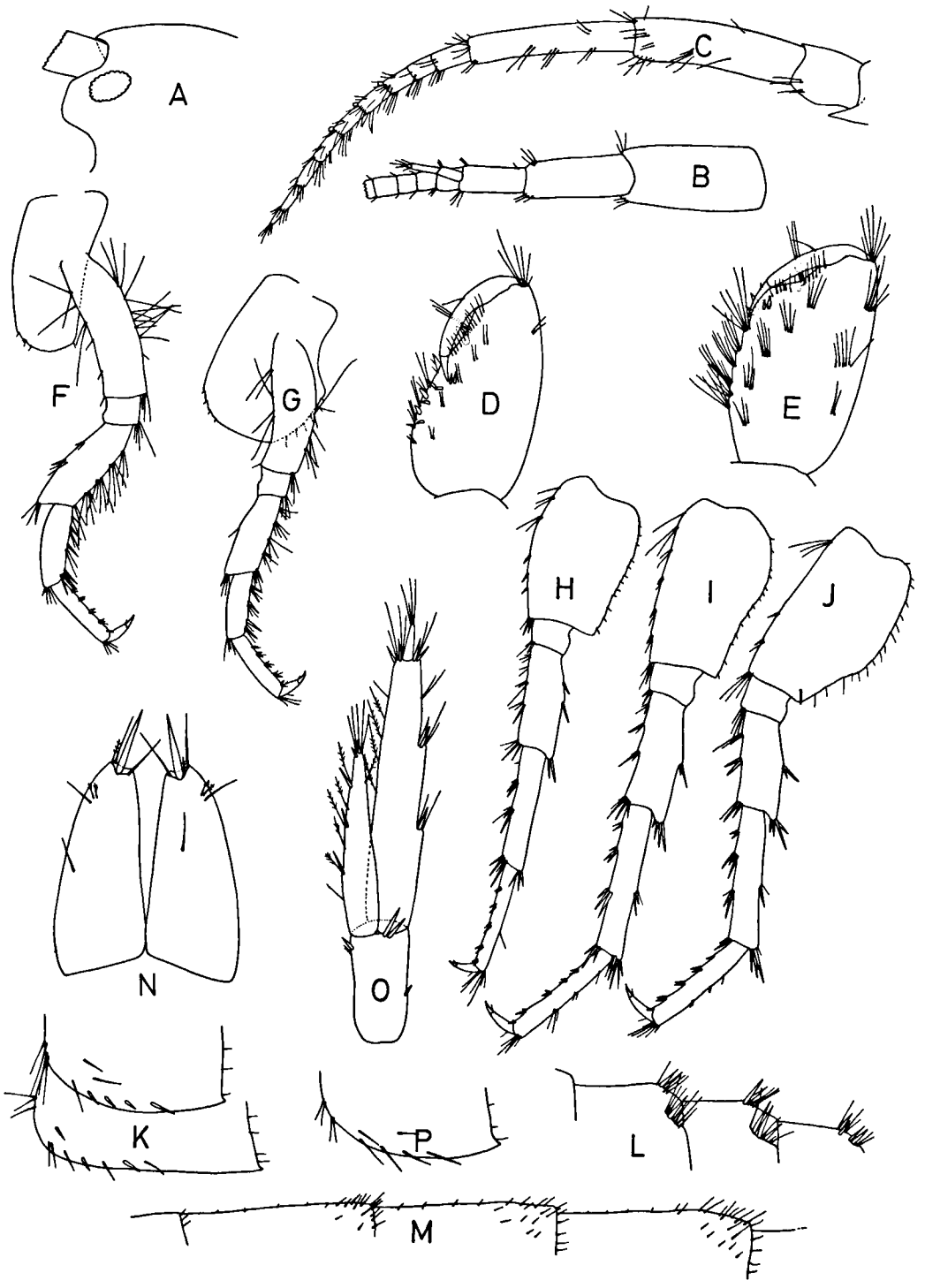

Fig. 9. *Gammarus abscisus* G. Karaman, 1973. A-O, ♂, 11 mm, from Kirsehir, Turkey. A, head; B, antenna 1; C, antenna 2; D, propodus of gnathopod 1; E, propodus of gnathopod 2; F, pereiopod 3; G, pereiopod 4; H, pereiopod 5; I, pereiopod 6; J, pereiopod 7; K, epimeres 2 and 3; L, urosome; M, metasome; N, telson; O, uropod 3; P, ♂, 10.9 mm, from same locality, epimere 3.

pyriform (fig. 9D). It is armed with a medial palmar spine, 1 or 2 palmar angle spines and a whole series of short spines along the posterior margin. The propodus of gnathopod 2 (fig. 9E) is armed with the usual medial palmar spine, 3 palmar angle spines, and 2 or 3 spines at the inner surface. The setation of both gnathopods is relatively short.

Pereiopod 3 (fig. 9F) is moderately setose, the setae being about as long as or shorter than the diameter of the segments on which they are implanted. The setation of pereiopod 4 (fig. 9G) is shorter than that of pereiopod 3. The dactyli of P3 and P4 are slender.

The basal segment of pereiopod 5 (fig. 9H) has a distinct backward protruding lobe. In P6 and P7 (figs. 9-I, J) the basal segments gradually become more elongate and slender, narrowing distally. In P7 the backward protruding lobe has almost disappeared. The armature is poor, consisting of some groups of spines and short setae.

Epimeral plates 2 and 3 (figs. 9K, P) have almost rectangular to slightly pointed posterior corners. The armature consists of some spines and setae.

The inner ramus of uropod 3 (fig. 9-O) is about 2/3 of the outer ramus. The outer margin of the exopodite is armed with three groups of elements in which the setae are longer than the spines.

The telson lobes (fig. 9N) are more than twice as long as wide. Each lobe is armed with one (occasionally 2) distal spines accompanied by some setae. Usually 1 to 3 setae or one spine occur on the dorsal surface.

Female: Shows the same sexual dimorphism as described for *G. balcanicus*. Because of the setiferous metasome segments, females of *G. abscisus* are easily recognizable.

The colour of live specimens is unknown.

Variability. — As far as can be seen from three samples only, the variability pattern is of the normal type for this group. The number of setae on the dorsal segments increases with age.

Material examined. —

Turkey: Prov. Kirsehir, spring near Kirsehir, 19-V-1959, 15 specimens. The ♂ holotype and 10 paratypes have been deposited in the collections of the Zoologisches Museum Hamburg (G.F.R.); 4 paratypes are deposited in the collections of G. Karaman, Titograd.

— Prov. Kirsehir, Kurugöl near Mucur, alt. 1000 m, 12-VII-1973, several specimens intermixed with *G. balcanicus* (MCSN).

— Prov. Antalya, Borabay Golü at village Amasia, 4-VI-1969, several specimens (MCSN).

Remarks and affinities. — *G. abscisus* is easily recognizable within this group because of the setae implanted on the dorsal surface of the metasome segments.

Distribution and ecology. — So far this species is known from a limited area in Asia Minor only, occurring in springs, sometimes accompanied by *G. balcanicus*.

Gammarus accolae G. Karaman, 1973
(Fig. 10)

Refs. — *Gammarus accolae* G. Karaman, 1973: 8-13, figs IV-VI; Pinkster, 1978: 247; Barnard & Barnard, 1983 464.

Diagnosis. — Metasome segments slightly bulging, crenulated and provided with a row of spines and setae along the dorsoposterior margins. Epimeral plates sharply produced, armed with spines only. Antenna 2 long and slender, in both sexes without calceoli.

Description. — Male: Maximum length observed 12.5 mm. Mesosome segments smooth, metasome segments (figs. 10L, M) slightly bulging, crenulated and provided with a row of short spines and setae. Urosome segments slightly elevated, laterally compressed, armed with a dorsomedian and two dorsolateral groups of strong spines, accompanied by several short setae.

The lateral lobes of the head (fig. 10A) are rounded, the eyes small and ovoid.

The first antenna (fig. 10B) is very long, 2/3 to 3/4 of the total body length. The main flagellum has up to 44 segments, all poorly armed and provided with an aesthetask each. The accessory flagellum has 3 or 4 segments.

The second antenna (fig. 10C) is slender, poorly armed, with some groups of short setae.

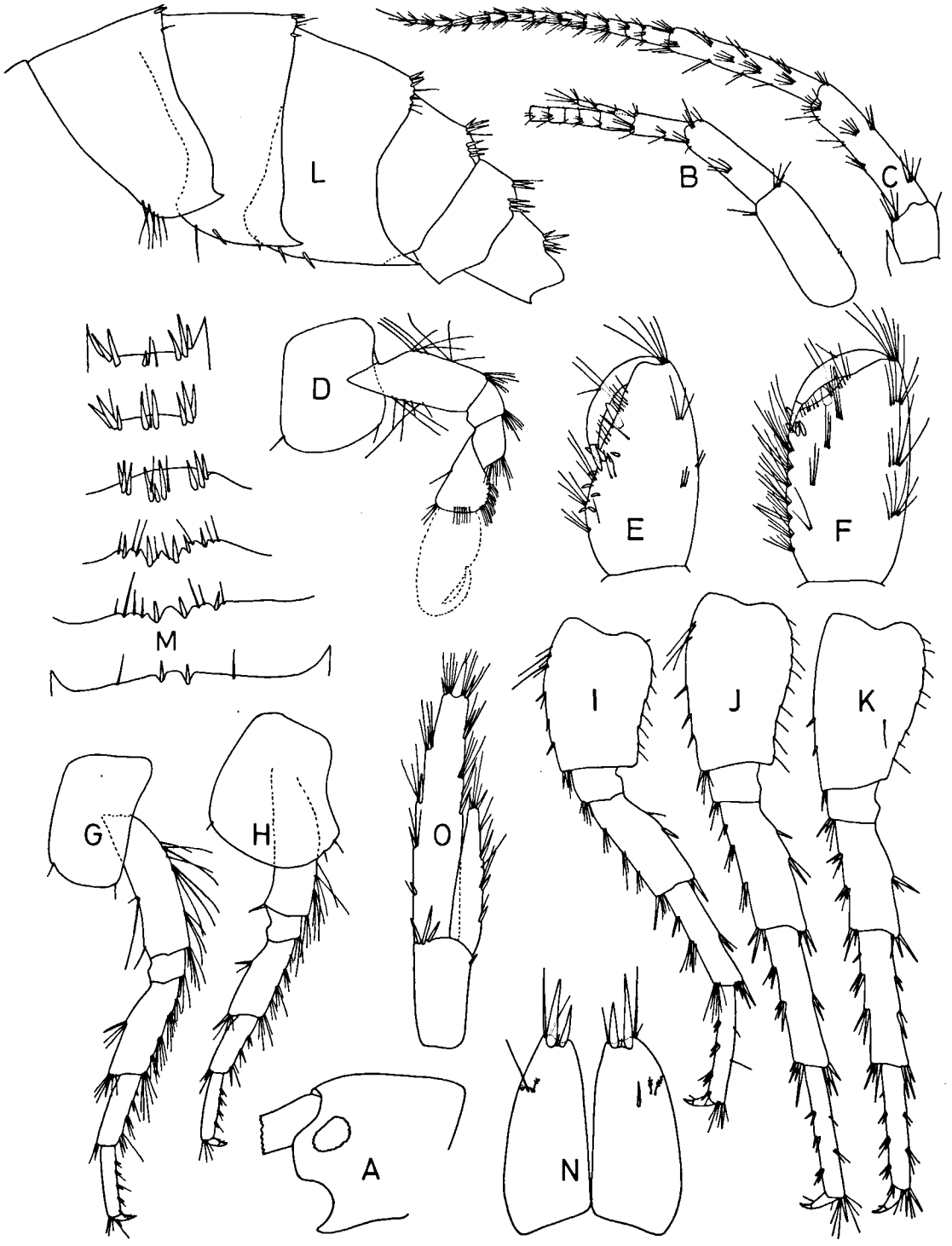

Fig. 10. *Gammarus accolae* G. Karaman, 1973. A-O, ♂, 11.5 mm, from Kirgöz, near Antalya, Turkey. A, head; B, antenna 1; C, antenna 2; D, gnathopod 1; E, propodus of gnathopod 1; F, propodus of gnathopod 2; G, pereiopod 3; H, pereiopod 4; I, pereiopod 5; J, pereiopod 6; K, pereiopod 7; L, meta- + urosome + epimeres; M, dorsal armature of meta- and urosome; N, telson; O, uropod 3.

Calceoli are never found. The gland cone is slender.

The first segment of the mandibular palp is unarmed. The second segment has 4 to 6 setae in its proximal part and 6 to 9 setae in its distal part. The third segment has one group of A-setae, one group of B-setae, 23 to 27 D-setae, and 4 to 6 long E-setae. C-setae are absent.

The coxal plates have rounded inferior corners; their setation is scarce. Gnathopods 1 and 2 (figs. 10D-F) are basically the same as in *G. balcanicus*. The carpus and propodus are poorly setose, making a rather bald impression. The dactyli are slender and provided with one seta at the superior margin.

Pereiopod 3 (fig. 10G) has long and slender segments. The setae along the posterior margins are shorter or as long as the diameter of the segments on which they are implanted. The segments of pereiopod 4 (fig. 10H) are shorter than those of P3, bearing less setae along the posterior margin.

The basal segments of pereiopods 5 to 7 (figs. 10-I, J, K) change from almost rectangular with a well-developed distoposterior corner (P5) into a more elongate one (P7) without this distoposterior lobe. The armature of segments 3 to 6 mainly consists of spines.

Epimeres (fig. 10L) with sharply produced posteroinferior corners. The armature is scarce.

The inner ramus of uropod 3 (fig. 10-O) is half as long as the outer ramus; its outer margin is unarmed. The inner margin of the endopodite and both margins of the exopodite are armed with groups of spines and a limited number of setae.

Telson (fig. 10N) longer than wide, each lobe with 1 or 2 distal spines accompanied by some setae. The dorsal surface of the lobes usually bears a seta or spine.

Female: Resembles the male in the dorsal armature of the meta- and urosome segments. The antennae as well as the pereiopods are much more setose than those in males.

The colour of live specimens is unknown.

Variability. — Apart from the usual variability in this group, extreme variability was observed in the length and number of flagellar segments in the first antenna, as well as in the number of spines and setae of the dorsal armature of metasome segments 1 to 3.

Material examined. —
Turkey: Prov. Antalya, small brook near Kirgöz, 30-III-1959, many specimens accompanied by *Echinogammarus antalyae* G. Karaman, 1973, and *Gammarus agrarius* G. Karaman, 1973. The ♂ holotype, 11.5 mm long, and many paratypes are deposited in the Zoologisches Museum, Hamburg (G.F.R.). Several paratypes are deposited in the collection of G. Karaman, Titograd, Yugoslavia.

Remarks and affinities. — This species is very characteristic because of its dorsomarginal spines on all metasome segments, its very long antenna 1 and its sharply produced epimeres. Dorsomarginal spines are equally found in the species-complex from Lake Ohrid, but these species all differ clearly in the shape of the epimeral plates and the length and/or setation of the antennae.

Martynov, 1935, described *G. caucasicus* from the mountainous river Reproa near Gagry in the western part of the Caucasus. The second and third segment of the metasome each possess about 8 minute spinules, but on the first segment these spinules are almost invisible according to Martynov. This species differs from *G. accolae* in its much shorter antenna 1, its short endopodite of uropod 3, and the presence of calceoli in antenna 2 of the male.

Distribution and ecology. — Up to now *G. accolae* is known only from the type locality near Kirgöz, Turkey, living in fresh water, accompanied by *Echinogammarus antalyae* and *G. agrarius*.

Gammarus dulensis S. Karaman, 1929
(Fig. 11)

Refs. — *Gammarus pavlovići dulensis* (part.) S. Karaman, 1929: 96, fig. 9b.
Gammarus dulensis; G. Karaman, 1973: 26, figs. 13-15; 1974: 10; Pinkster, 1978: 247; Barnard & Barnard, 1983: 466.
Gammarus balcanicus (part.); G. Karaman, 1966: 119.
? *Gammarus spinicaudatus* (part.) Schäferna, 1926: 2, 13.

Diagnosis. — Body smooth, metasome

segments poorly setose, smooth. Antenna 2 poorly setose, basis of pereiopods 6 and 7 with setae on inner surface.

Description. — Male: Body length up to 12 mm. Metasome segments 1 to 3 smooth, only set with some short setae along the posterior margin. Urosome segments (fig. 11M) not elevated, armed with one dorsomedian and two dorsolateral groups of spines and setae; the setae are as long as or longer than the spines.

The lateral lobes of the head (fig. 11A) are rounded, the eyes round or ovoid, as long as or smaller than the diameter of the peduncle of the first antenna.

The first antenna (fig. 11B) hardly reaches half the body length, it is poorly setose. The main and accessory flagellum have up to 25 and 3 to 5 segments, respectively.

Peduncle segments 4 and 5 of the second antenna (fig. 11C) are set with 3 to 5 groups of short setae along the inferior margin. The flagellum is slender, somewhat dorsoventrally compressed, armed with setae which are shorter than the diameter of the flagellar segments on which they are implanted. Calceoli are present.

The second segment of the mandibular palp has 4 to 6 setae in its proximal part and 6 to 9 setae in its distal part. The last segment is armed with 18 to 22 D-setae, 4 to 6 E-setae, one group of A-setae, and 1 or 2 groups of B-setae.

Gnathopods 1 (fig. 11D) and 2 are moderately setose, bearing straight setae only. The propodus of gnathopod 1 (fig. 11E) has a medial palmar spine and several (groups of) spines along the posterior margin. The propodus of the second gnathopod (fig. 11F) has a medial palmar spine, 2 palmar angle spines and 3 or 4 smaller spines on the inner surface near the palmar angle.

Pereiopod 3 (fig. 11G) is poorly to moderately setose, the setae being sometimes as long as the diameter of the segments on which they are implanted. The setation of pereiopod 4 (fig. 11H) is little shorter than that of pereiopod 3.

The basal segments of pereiopods 5 to 7 (figs. 11-I, J, K) gradually change from almost rectangular with a distinct posterodistal corner (in P5) into a more elongate one (in P7) in which this protrusion is almost invisible. In P6 and especially in P7 these basal segments are set with a number of setae on the inner surface. The armature of the other segments almost exclusively consists of spines.

The epimeral plates 2 and 3 (fig. 11L) have almost rectangular to moderately pointed posteroinferior corners. The lower surface of epimere 2 is set with setae only; in epimere 3 spines and some setae are found.

The inner ramus of uropod 3 (fig. 11-O) is nearly half as long as the first segment of the outer ramus. The second segment of the outer ramus is longer than the distal spines. The armature is of the normal *balcanicus* type; the setae along the outer margin (if present) are always simple.

The telson lobes (figs. 11N, P) are more than twice as long as wide. Usually the armature consists of one or two distal spines accompanied by several longer setae; sometimes (fig. 11P) setae or spines are found on the dorsal surface of the lobes.

Female: Pereiopods 3 and 4 densely setose, the setae being longer than the diameter of the segments on which they are implanted. Both antennae 1 and 2 are slightly more setose than in the male. Pereiopods 5 to 7 resemble those in the other sex.

The colour of live specimens is yellowish.

Variability. — The armature of epimeres 2 and 3 can be more or less dense (epimere 2) or varying in composition of the elements partitioning in it (epimere 3). The number of setae on the inner surface of the basal segments in pereiopods 6 and 7 can vary considerably, but some setae are always present.

Material examined. —

Yugoslavia: Macedonia, Skopska Crna Gora, Dulo spring near village Banjani, X-1927, many specimens. The ♂ holotype, 11 mm long, and many paratypes are deposited in the collection of G. Karaman, Titograd, Yugoslavia.

— do., 27-VII-1969, many specimens accompanied by *G. balcanicus* (KC).

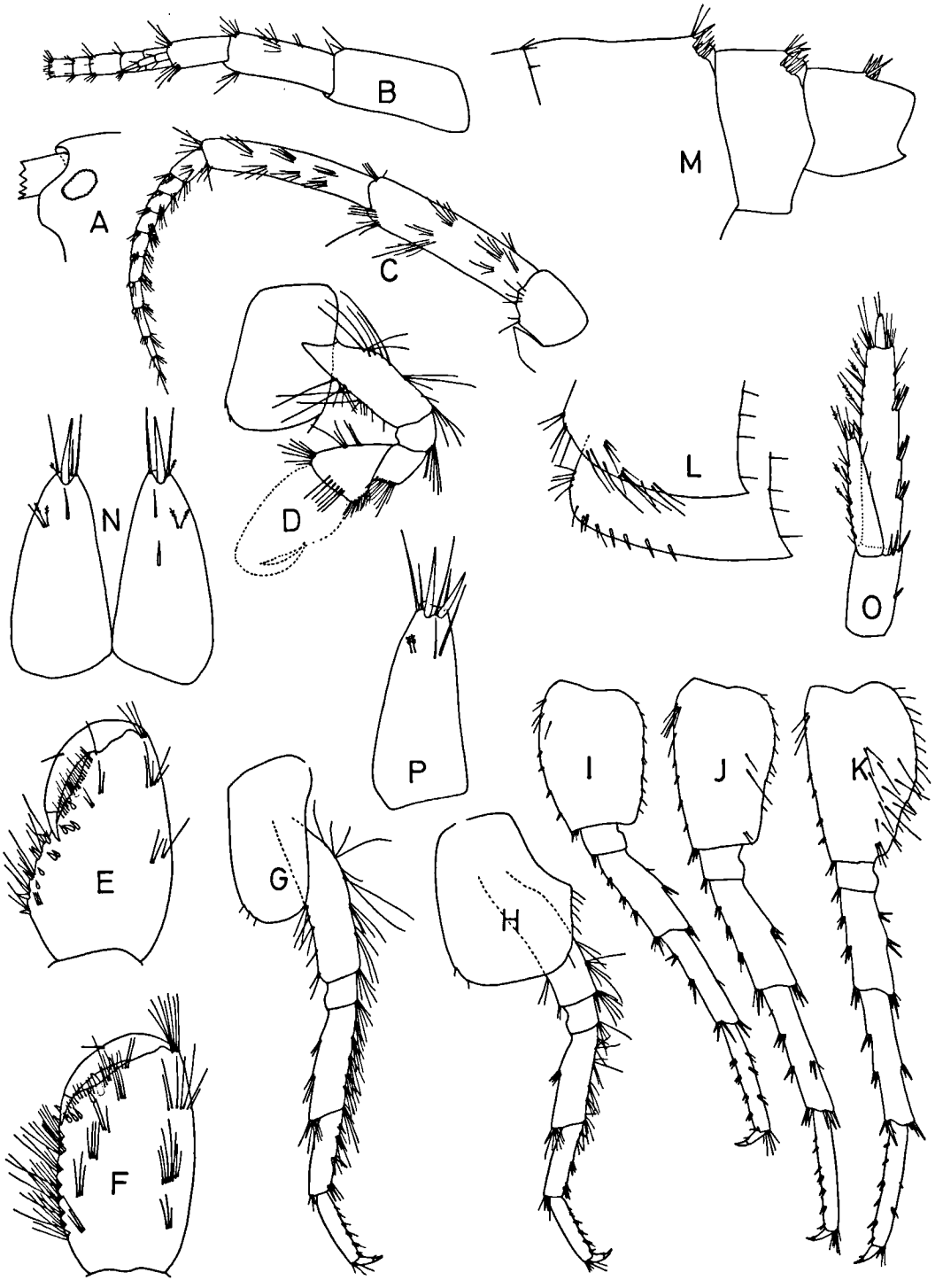

Fig. 11. *Gammarus dulensis* S. Karaman, 1929. A-O, ♂, 11 mm, from Dulo spring, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, gnathopod 1; E, propodus of gnathopod 1; F, propodus of gnathopod 2; G, pereiopod 3; H, pereiopod 4; I, pereiopod 5; J, pereiopod 6; K, pereiopod 7; L, epimeres 2 and 3; M, urosome; N, telson; O, uropod 3; P, ♂, 10.5 mm, from Monastery St. Ilija, Yugoslavia, telson lobe.

— Macedonia, Skopska Crna Gora, brook uphill of Monastery St. Ilija, near Banjani, 27-VII-1969, several specimens (KC).
— Macedonia, Skopska Crna Gora, brook uphill of village Pobožje, 27-VII-1969, many specimens (KC).
— Macedonia, Skopje, spring near village Butelj, 1960, several specimens (KC).
— Macedonia, Skopje, spring Belbanunar near Saraj, 29-VII-1969, many specimens, accompanied by *G. balcanicus* (KC).
— Macedonia, brook Banjički Potok near Gostivar, 10-V-1963, several specimens, accompanied by *G. balcanicus* (KC).
— Crna Gora, brook in town of Ivangrad, 19-VI-1969, many specimens (KC).
— Crna Gora, spring of tributary of river Lim at Tvrdaš, 9-VI-1966, several specimens accompanied by *G. balcanicus* (KC).

Remarks and affinities. — *G. dulensis*, although it has many characters in common with *G. balcanicus*, clearly differs from this species by the possession of setae on the inner surface of pereiopods 6 and 7, and the setose epimeral plates 2 (and 3). Other species with the same "pilosity" on the inner side of the basal segments in pereiopods 6 and 7 show remarkable differences in the structure of the second antenna, armature and structure of the metasome, etc.

Distribution and ecology. — Southern Yugoslavia, in brooks and springs, often accompanied by *G. balcanicus*.

Gammarus pljakici G. Karaman, 1964
(Fig. 12)

Refs. — *Gammarus (Rivulogammarus) pljakići* G. Karaman, 1964: 1, figs. 1-4.
Gammarus pljakici; G. Karaman, 1974: 12; Pinkster, 1978 248; Barnard & Barnard, 1983: 468.

Diagnosis. — A small species with partially reduced dorsal armature of the urosome. Antenna 2 without calceoli in males. Armature of pereiopods very poor. Uropod 3 very short, reduced.

Description. — Male: Maximum length observed 9 mm. Metasome segments 1 to 3 smooth, unarmed. Urosome segments 1 and 2 without dorsolateral groups of elements (fig. 12L); urosome segment 3 with 2 dorsolateral groups of spines and setae and 2 groups of dorsomedian setae (2 setae in each group) (fig. 12L).

The lateral lobes of the head (fig. 12A) are rounded, the eyes almost round to ovoid, as long as or shorter than the diameter of the peduncle of antenna 1.

The first antenna (fig. 12B) is almost half the body length, poorly setose. The main flagellum has up to 28 articles; the accessory flagellum 2 or 3.

The second antenna (fig. 12C) is relatively slender; its peduncle segments 4 and 5 bear 5 or 6 groups of long setae. The flagellum is short, moderately setose, without calceoli.

The mandibular palp has an unarmed first segment. The second segment bears 5 to 6 setae in its proximal part and 11 to 13 in its distal part. The last segment (fig. 12D) is armed with 2 groups of A-setae, 1 group of B-setae, 1 or 2 C-setae, 17-20 D-setae and 4 or 5 E-setae.

Gnathopods 1 (fig. 12E) and 2 are moderately setose, all setae being straight. The propodus of gnathopod 1 (fig. 12F) has a medial palmar spine and several spines along the posterior margin. The dactylus is slender. The propodus of gnathopod 2 (fig. 12G) likewise has a medial palmar spine, as well as 3 palmar angle spines, and some smaller spines on the inner surface.

Pereiopods 3 (fig. 12H) and 4 are poorly setose, like those in *G. balcanicus*.

The basal segments of pereiopods 5 to 7 (figs. 12-I, J, K) each have a sharply protruding lobe, their inner surface is unarmed. The other segments are sparsely armed with short spines and even shorter setae.

Epimeral plates 2 and 3 (fig. 12N) are almost rectangular to slightly pointed. The armature is scarce.

Uropods 1 and 2 normal. Uropod 3 is short, hardly exceeding the tip of uropod 1 (fig. 12M). The inner ramus is about half as long as the outer ramus (fig. 12P), sparsely armed along the inner margin and tip; the second segment of the outer ramus is very short, reduced, much shorter than the spines. The armature on the

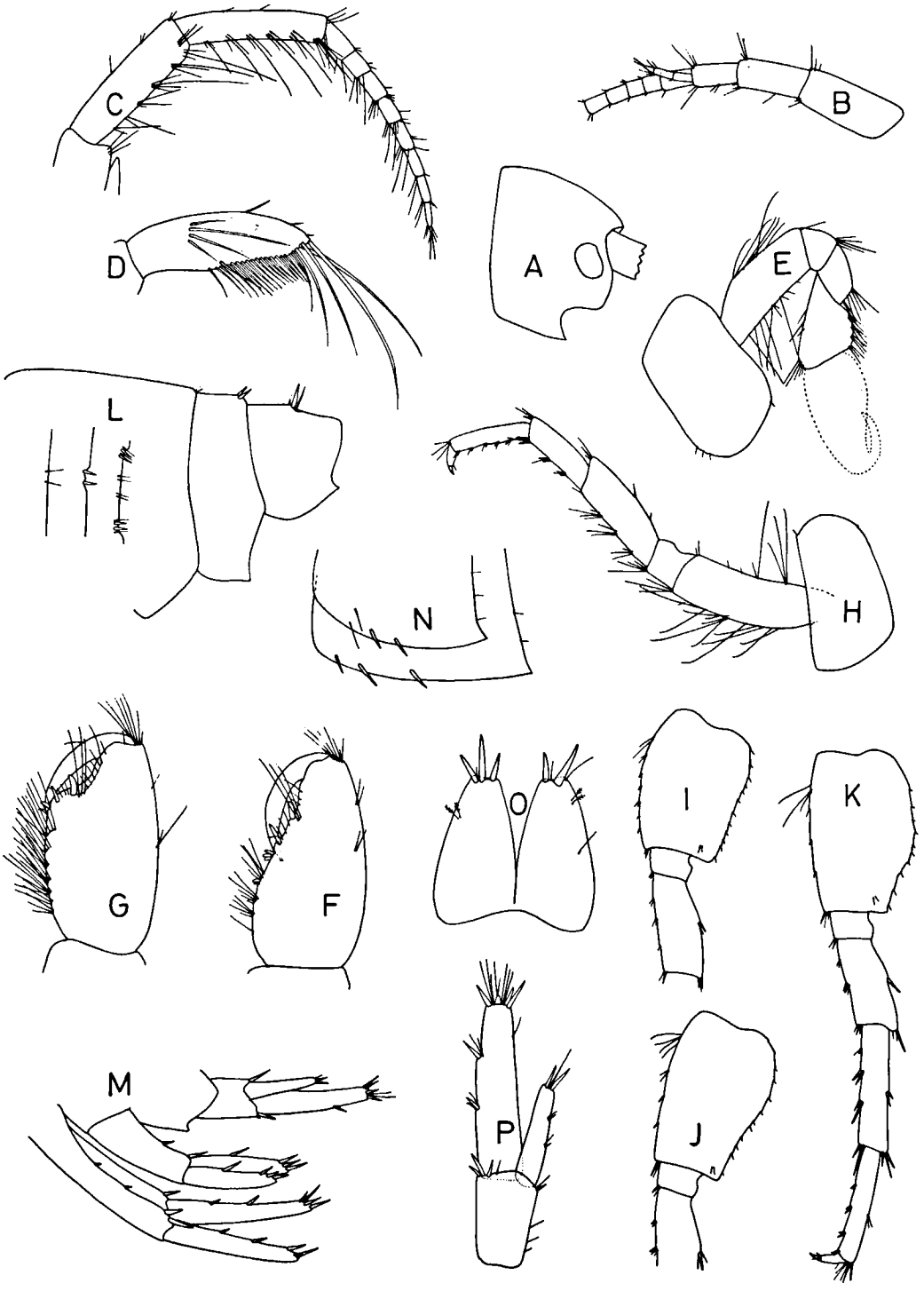

Fig. 12. *Gammarus pljakici* G. Karaman, 1964. A-P, ♂, 8.7 mm, from a spring near Andrijevica, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, last segment of mandibular palp; E, gnathopod 1; F, propodus of gnathopod 1; G, propodus of gnathopod 2; H, pereiopod 3; I, pereiopod 5 (part); J, pereiopod 6 (part); K, pereiopod 7; L, urosome + detail of dorsal armature; M, uropods 1 to 3; N, epimeres 2 and 3; O, telson; P, uropod 3.

outer margin of the exopodite is scarce, with a maximum of 3 groups of spines and setae; the inner margin is either unarmed or armed with 1 seta only.

The telson (fig. 12-O) is normal, armed with a distal group of 2 or 3 spines and 1 or 2 additional short setae. Sometimes a seta is found on the dorsal surface.

Female: Apart from the usual differences between the sexes, like the absence of medial palmar spines in gnathopods 1 and 2, females differ from males in more setose pereiopods 3 and 4 and more setose antennae. Pereiopods 5 to 7, epimeral plates, telson and uropod 3 are like those in males.

The colour of live specimens is unknown.

Variability. — Considerable variability was observed in the armature of the epimeral plates, especially in plate 3. Usually only 2 or 3 spines are found, but sometimes a much higher number is found, intermixed with some setae.

Material examined. —

Yugoslavia: Crna Gora, Andrijevica, VIII-1933, many specimens. The ♂ holotype and many paratypes have been deposited in G. Karaman's collection, Titograd.

— Crna Gora, Ivangrad, VIII-1933, many specimens (KC).

— Crna Gora, spring near road to Andrijevica, 14-VIII-1968, many specimens accompanied by *Synurella ambulans* Fr. Müller, 1846 (KC).

Remarks and affinities. — In most of its characters this species resembles *G. balcanicus*. It differs from the latter in the very reduced uropod 3 and armature of the urosome segments.

Distribution and ecology. — So far this species is known from a limited area in the northern part of Crna Gora, Yugoslavia, only, once occurring in a spring together with *Synurella ambulans*.

Gammarus halilicae G. Karaman, 1969 (Fig. 13)

Refs. — *Gammarus balcanicus halilicae* G. Karaman, 1969 45, figs. 1-16.
Gammarus halilicae; G. Karaman, 1974: 11; Barnard & Barnard, 1983: 466.

Diagnosis. — Pereiopods 3 to 7 elongate, with very slender segments, poorly setose. Metasome smooth, urosome low. Antenna 2 slender, poorly setose, without calceoli. Uropod 3 poorly setose.

Description. — Male: Maximum length observed 13 mm. Body smooth, urosome (fig. 13K) non-elevated, urosomites each with one dorsomedian and two dorsolateral groups of spines and short setae.

Lateral cephalic lobes obtuse to slightly rounded (fig. 13A). Eyes rounded to slightly ovoid, smaller than the diameter of the peduncle of antenna 1.

The first antenna (fig. 13B) is long, reaching 2/3 of the body length; it is very poorly setose. The main flagellum and accessory flagellum have up to 32 and 3 or 4 segments, respectively.

The second antenna (fig. 13C) is also slender. Peduncle segments 4 and 5 each bear 6 or 7 groups of short setae along the ventral margin. The flagellum has up to 11 segments, is sparsely armed and does not bear calceoli.

The mouthparts are like those in *G. balcanicus*. The second segment of the mandibular palp has 5 to 6 setae in its proximal part and 7 to 9 setae in its distal part. The last segment bears 32 to 35 D-setae, 5 or 6 E-setae, one group of A-setae and one group of B-setae.

Coxae 1 to 4 longer than wide, with rounded inferior corners. Gnathopods 1 and 2 moderately setose, with straight setae only. The propodus of gnathopod 1 (fig. 13D) has a medial palmar spine and many spines along the posterior margin. The dactylus is slender. The propodus of gnathopod 2 (fig. 13E) likewise has a medial palmar spine as well as 3 palmar angle spines and 2 smaller spines on the inner surface. The dactylus is slender.

Pereiopods 3 and 4 (figs. 13F, G) are long and slender, poorly setose; the dactyli are short.

Pereiopods 5 to 7 (figs. 13H, I, N) are also long and slender. In P6 and P7 the basal segments are more than twice as long as wide, without setae on the inner surface. Segments 3 to 6 are sparsely armed with some spines and some single short setae. The dactyli are short.

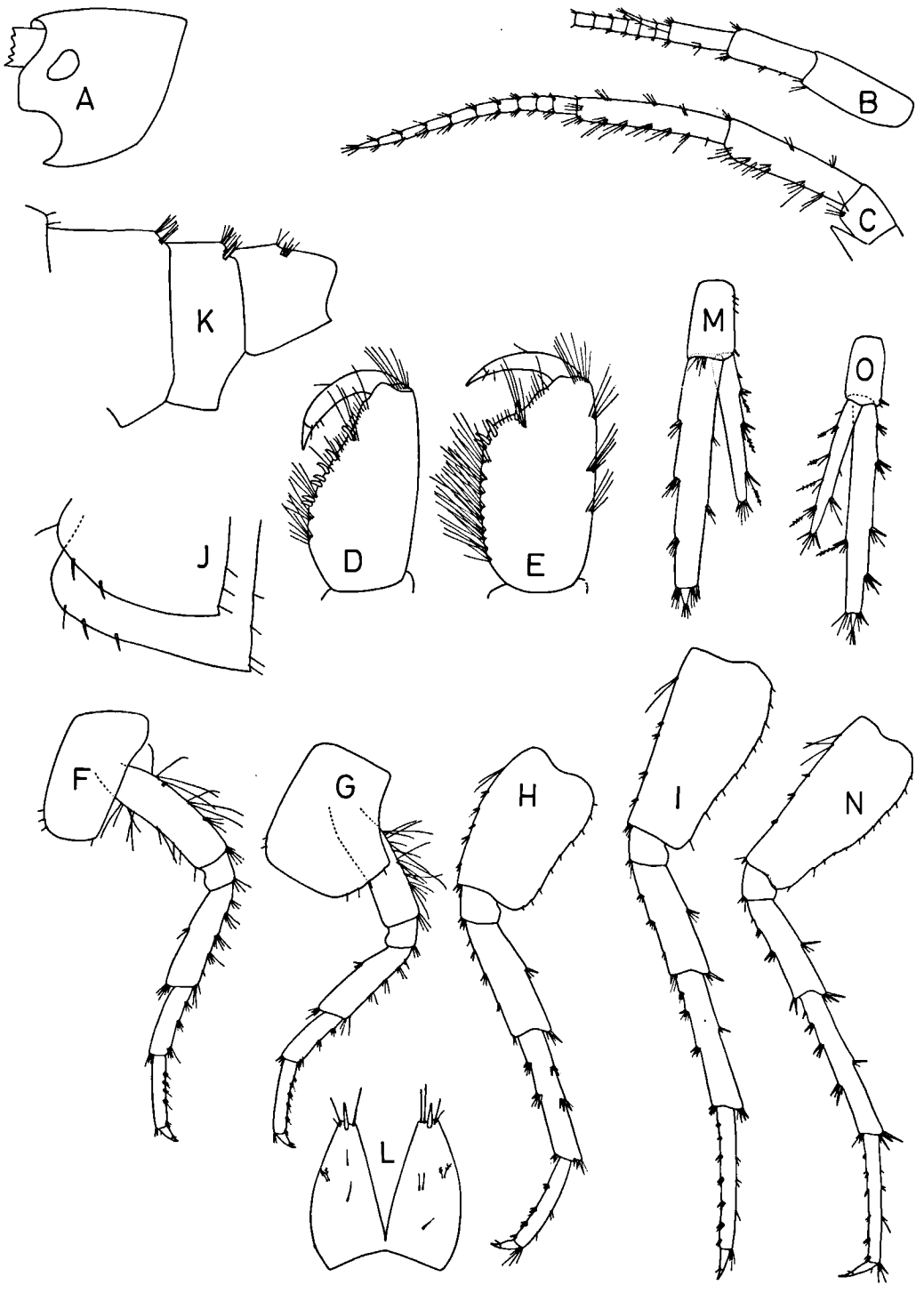

Fig. 13. *Gammarus halilicae* G. Karaman, 1969. A-M, ♂, 11.8 mm, from Donja Halilica Cave, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, propodus of gnathopod 1; E, propodus of gnathopod 2; F, pereiopod 3; G, pereiopod 4; H, pereiopod 5; I, pereiopod 7; J, epimeres 2 and 3; K, urosome; L, telson; M, uropod 3. N-O, ♂, 12.5 mm, from same locality. N, pereiopod 7; O, uropod 3.

Epimeral plates 2 and 3 (fig. 13J) are almost rectangular to slightly pointed, armed with some spines only.

Uropod 3 (figs. 13M, O) is elongate with narrow slender rami. The endopodite is slightly longer than half the exopodite. Both rami are poorly setose, bearing a limited number of (groups of) spines, intermixed with short setae. The setae on the outer margin of the exopodite are never setose. The second segment of the exopodite is short.

The telson lobes (fig. 13L) are tapering distally, each lobe bearing one distal spine and 2 to 4 setae. Some short setae occur on the dorsal surface of each lobe.

Female: Shows the same long and slender pereiopods as the male.

The colour of live specimens is milky white (body pigments absent).

Variability. — See *G. balcanicus*.

Material examined. —

Yugoslavia: Macedonia, Donja Halilica Cave near village Tresonče, 28-IX-1967, many specimens. The ♂ holotype and many paratypes have been deposited in the collections of G. Karaman, Titograd.

— Macedonia, small cave near Donja Halilica Cave, 28-IX-1967, 3 specimens accompanied by *G. balcanicus* (KC).

Remarks and affinities. — *G. halilicae* is closely related to *G. balcanicus* but differs from this species in the shape and armature of uropod 3 and pereiopods 3 to 7. Moreover, the coexistence of both forms in the entrance of the same cave shows that *G. halilicae* must be a distinct species.

Distribution and ecology. — Known from two nearby caves in Macedonia (Yugoslavia) only, accompanied by *G. balcanicus*.

Gammarus albimanus G. Karaman, 1968 (Fig. 14)

Refs. — *Gammarus* (*Rivulogammarus*) *balcanicus albimanus* G. Karaman, 1968a: 149, figs. 1-14.
Gammarus albimanus; G. Karaman, 1974: 9; Barnard & Barnard, 1983: 464.

Diagnosis. — Eyes absent, body smooth, urosomites low, not elevated. Outer lobe of maxilla 1 with densely pectinate spines. Second antenna poorly setose, calceoli present in males. Pereiopods 5 to 7 without setae on the interior surface of the basis. Epimeres 2 and 3 with spines.

Description. — Male: Body length up to 10 mm; body pigments absent. Mesosome and metasome segments unarmed. Urosomites 1 to 3 (fig. 14N) low, with one dorsomedian group of 2 or 3 setae and two dorsolateral groups of spines and setae.

The lateral cephalic lobes are rounded; eyes are absent (fig. 14A).

The first antenna (fig. 14B) is slightly longer than half the body length. Both peduncle and flagellar segments are poorly setose. The main flagellum has up to 26 segments, the accessory flagellum 3.

The second antenna (fig. 14C) is slender; peduncle segments 4 and 5 are provided with 3 or 4 groups of setae of about the same length as the diameter of the segments. The up to 13-segmented flagellum is poorly setose. Calceoli are always present.

The mouthparts are of the *balcanicus* type except for maxilla 1 (fig. 14E), which has an outer lobe with densely pectinate spines (against poorly pectinate in all other members of this group). The second segment of the mandibular palp (fig. 14D) has 3 or 4 setae in its proximal part and 4 or 5 setae in its distal part. The third segment is armed with 16 to 20 D-setae, 2 groups of A-setae and one group of B-setae.

Coxae 1 to 4 normal, with rounded ventral corners. Gnathopods 1 and 2 moderately setose with straight setae only. The propodus of gnathopod 1 (fig. 14F) has a row of spines and setae along the posterior margin. A medial palmar spine is present. The propodus of gnathopod 2 (fig. 14G) has a concave palm with a well-developed medial palmar spine, 2 or 3 palmar angle spines and 1 or 2 spines on the inner surface near the palmar angle.

Pereiopods 3 and 4 (figs. 14H, I) strong with slightly recurved articles, poorly setose. In both the dactylus is short.

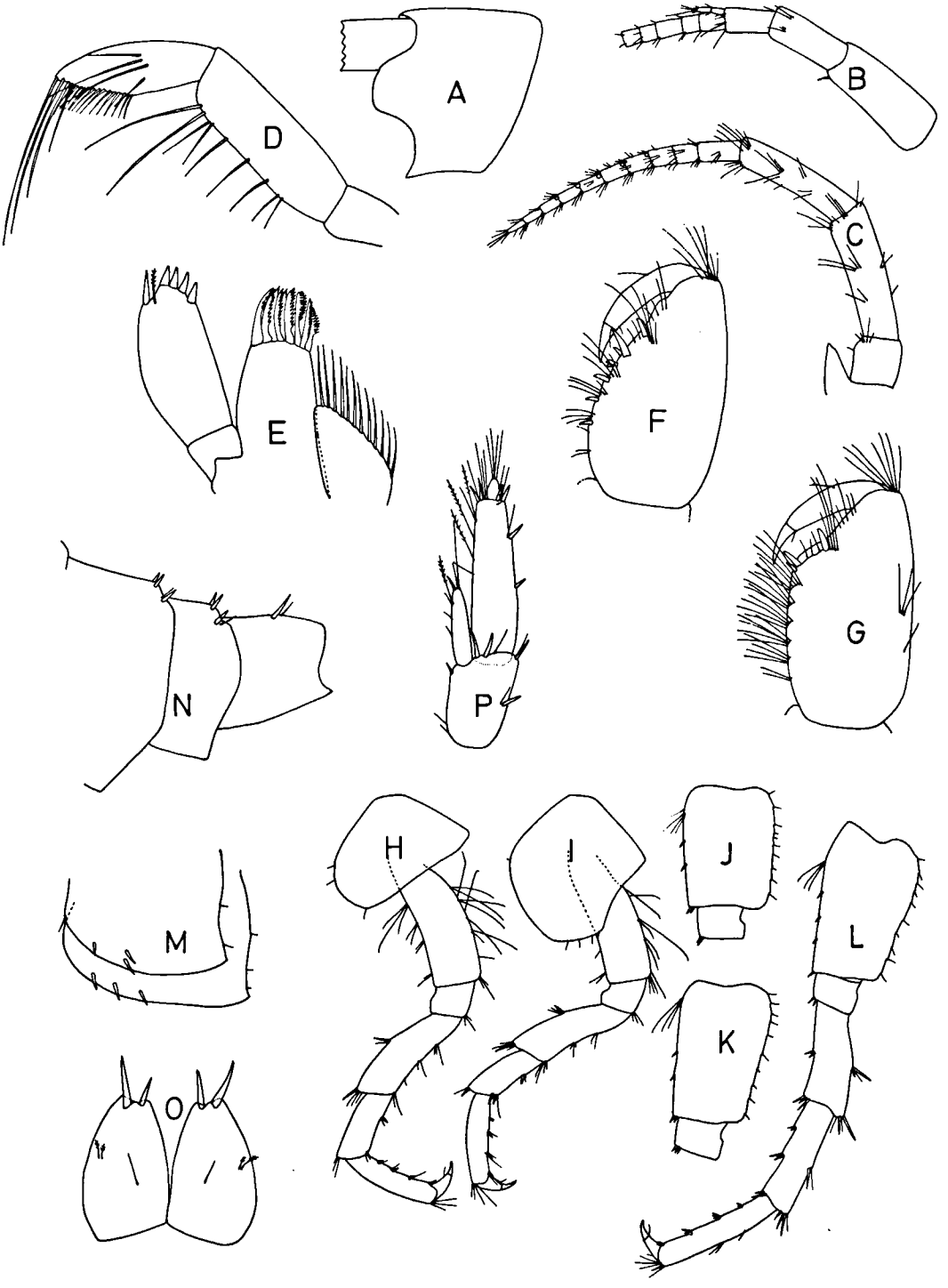

Fig. 14. *Gammarus albimanus* G. Karaman, 1968. A-P, ♂, 8.9 mm, from Golema peštera Cave, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, mandibular palp; E, maxilla 1; F, propodus of gnathopod 1; G, propodus of gnathopod 2; H, pereiopod 3; I, pereiopod 4; J, pereiopod 5 (part); K, pereiopod 6 (part); L, pereiopod 7; M, epimeres 2 and 3; N, urosome; O, telson; P, uropod 3.

Pereiopods 5 to 7 (figs. 14J-L) moderately long, their basis provided with a ventro-posterior rounded tooth (not lobe); no setae are found on the interior surface of the basal segments. Segments 3 to 6 of P5 to P7 provided with spines, setae are almost absent, the dactyli are short.

Epimeral plates 2 and 3 (fig. 14M) are rectangular to slightly pointed, armed with spines only.

Uropod 3 (fig. 14P) is moderately setose, its endopodite nearly half as long as its exopodite. Outer margin of exopodite without plumose setae.

Telson (fig. 14-O) short, each lobe with 2 distal spines, often mixed with 1 or 2 short setae; 1 or 2 setae are present on the dorsal surface of each lobe.

Female: Antenna 2 with longer setae than in the male, calceoli absent. Pereiopods 3 to 7 poorly setose, like in males. Oostegites broad.

The colour of live specimens is milky white (body pigments absent).

Variability. — The shape of the epimeral plates is variable. Sometimes a supplementary spine is found in between the medial palmar spine and the palmar angle spines.

Material examined. —
Yugoslavia: Macedonia, Golema Peštera Cave near village Gornja Džonovica (Gostivar), 2-I-1968. The ♂ holotype and several paratypes have been deposited in the collections of G. Karaman, Titograd.

Remarks and affinities. — *G. albimanus* belongs to the *balcanicus*-group because of the structure of its pereiopods 3 and 4 and its uropod 3. Within this group it is the only blind species without body pigments. Its maxilla 1 is slightly modified (densely pectinate spines on the outer lobe) for a better filtration of the food. All other mouthparts are like those in the other members of the group.

Distribution and ecology. — Known from the type locality, a cave in Macedonia (Yugoslavia) only, living in the subterranean stream of the cave.

Gammarus longipedis n. sp.
(Fig. 15)

Diagnosis. — Medium large species with smooth meso- and metasome and low, not elevated urosome; armature of urosomite 1 partially reduced. Eyes very small, pereiopods 3 to 7 elongate, poorly setose. Females with poorly setose pereiopods 3 and 4.

Description. — Male: Maximum length observed 15 mm. Metasome segments unarmed, urosome segments 1 to 3 (fig. 15L) not elevated; dorsal armature of urosome segment 1 (often) partially reduced, consisting of 1 or 2 middorsal and 0 to 2 lateral setae only. Urosomites 2 and 3 with one middorsal and two dorsolateral groups of elements (spines and/or setae).

The lateral cephalic lobes are rounded, the eyes very small, almost round, always smaller than the diameter of the peduncle of antenna 1 (fig. 15A).

The first antenna (fig. 15B) is relatively short, hardly reaching half the body length. Both peduncle and flagellum are poorly setose. The main and accessory flagellum have 21 to 25 and 2 or 3 segments, respectively.

The second antenna (fig. 15C) is slender, with a short gland cone. Peduncle segments 4 and 5 are moderately setose with 3 to 4 and 4 to 5 groups of short setae, respectively. The slender flagellum is also poorly setose, calceoli are present.

The second segment of the mandibular palp (fig. 15D) has 4 to 5 setae in its proximal part and 6 to 7 setae in its distal part. Segment 3 is armed with 21 to 24 D-setae, 4-5 E-setae, one group of A-setae and 2 groups of B-setae.

The ventral corners of coxal plates 1 to 4 are rounded. Gnathopods 1 and 2 (figs. 15E, F) are moderately setose, bearing straight setae only. In both gnathopods the propodus is provided with a medial palmar spine and 2 or 3 palmar angle spines. Moreover, in gnathopod 1 a series of smaller spines is found along the posterior margin. The dactyli are slender, narrow.

Pereiopods 3 and 4 (figs. 15G, H) are elongate and slender, both poorly armed with

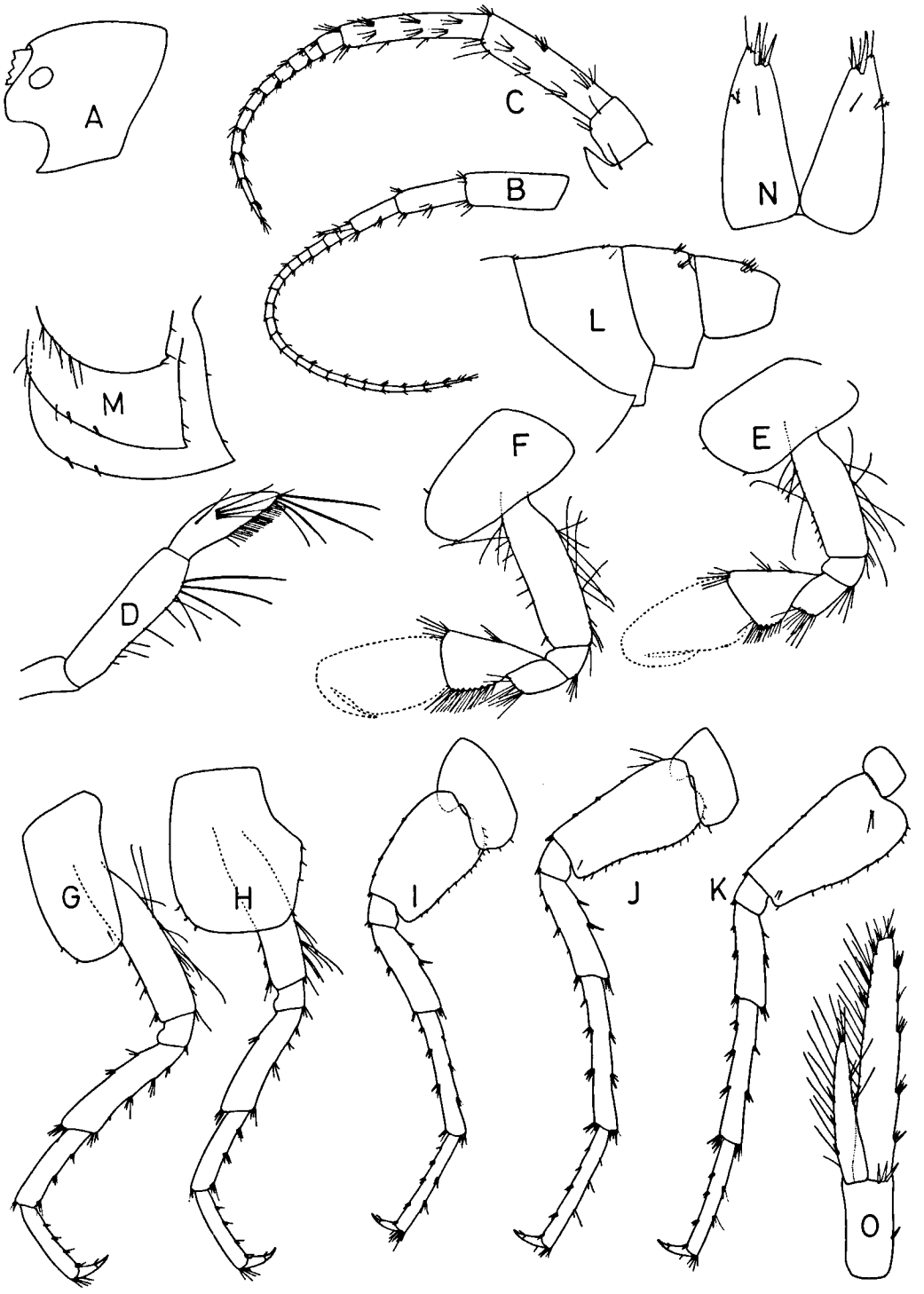

Fig. 15. *Gammarus longipedis* n. sp. A-O, ♂, 14 mm, from Su Ciktigi Cave, Hadim, Turkey. A, head; B, antenna 1; C, antenna 2; D, mandibular palp; E, gnathopod 1; F, gnathopod 2; G, pereiopod 3; H, pereiopod 4; I, pereiopod 5; J, pereiopod 6; K, pereiopod 7; L, urosome; M, epimeres; N, telson; O, uropod 3.

very short setae along the posterior margins. The dactyli are moderately slender.

Pereiopods 5 to 7 (figs. 15-I, J, K) are likewise elongate and slender. The basal segments are long and narrow (in P6 and P7 more than twice as long as wide) and have no setae on their inner surface. The distal part of the basal segments is always wider than the proximal part of the ischium, thus forming a backward protruding lobe. Segments 3 to 6 are poorly armed with small groups of spines and short setae. The dactyli are moderately slender.

Epimeral plates 2 and 3 (fig. 15M) bear a limited number of spines along the ventral margin, occasionally intermixed with some short setae.

Uropod 3 (fig. 15-O) is moderately long, with an inner ramus about 1/2 to 3/5 as long as the outer ramus. The armature does not show much differences with that encountered in *G. balcanicus*.

The telson lobes (fig. 15N) are elongate, each lobe bearing two distal spines and a limited number of short setae. On the dorsal surface of the lobes 1 or 2 setae may be present.

Female: Differs from the male in a slightly longer setation of antenna 2, the absence of calceoli and medial palmar spines, and a shorter uropod 3. The setation of pereiopods 3 and 4 is like in males.

The colour of live specimens is unknown.

Variability. — Variability was observed in the armature of the first urosome segment (more or less reduced) and the size of the eye.

Material examined. —

Turkey: Prov. Konya, Hadim, Su Ciktigi Cave, alt. 1700 m, 24/25-IV-1973, 15 specimens. The ♂ holotype and 12 paratypes have been deposited in the collections of the Museo Civico di Storia Naturale, Verona; 2 paratypes have been deposited in the collections of G. Karaman, Titograd.

— Prov. Isparta, Zindam Magarasi Cave (Anamas), 11-VIII-1967, 4 specimens (MCSN).

— Do., 17-IV-1973, 2 specimens (MCSN).

Remarks and affinities. — *G. longipedis* n. sp. resembles *G. balcanicus* in many aspects. The most important differences are found in the elongation of the pereiopods, a phenomenon that is often observed in cave-dwelling *Gammarus* species (see also Karaman & Pinkster, 1977a & b). Within this group the same was found in *G. halilicae*. This last species, however, differs from *G. longipedis* in the reduction of the third uropod.

Distribution and ecology. — So far *G. longipedis* n. sp. is known from cave waters in the southern part of Asia Minor only, at altitudes up to 1700 m.

Gammarus ochridensis (Schäferna, 1926)
(Fig. 16)

Refs. — *Echinogammarus ochridensis* Schäferna, 1926: 3, figs. 1-8.
Gammarus echiniformis S. Karaman, 1929: 94, fig. 8.
Gammarus ohridensis ohridensis; S. Karaman, 1931a: 53, figs. 11b, d, f.
Gammarus (Rivulogammarus) ochridensis; Schellenberg, 1937a: 270; Stanković & Pljakić, 1962: 68, fig. 1a; (part.) Schellenberg, 1943: 97.
Rivulogammarus ochridensis; Straškraba, 1967: 208.
Gammarus ochridensis ochridensis; G. Karaman, 1974: 11.
Gammarus ochridensis; G. Karaman, 1977a: 54; Pinkster, 1978: 248; Barnard & Barnard, 1983: 468.
Rivulogammarus ochridensis ochridensis; G. Karaman, 1968b: 55.

Diagnosis. — Large species with spines and setae on dorsal surface of all metasome segments. Antennae 1 and 2 slender with long setae. Calceoli present. Epimeral plates with some spines only.

Description. — Male: Maximum length observed 18 mm. Dorsal surface of metasome segments not elevated, provided with several spines each. Urosome segments slightly elevated, armed with one dorsomedian and two dorsolateral groups of 2 or 3 spines and 1 to 3 setae (fig. 16N).

The lateral lobes of the head (fig. 16A) are rounded, the eyes slightly reniform, as long as or little longer than the diameter of the peduncle of antenna 1.

The first antenna (fig. 16B) is about 3/5 of the total body length. Peduncle segment 3 is always shorter than peduncle segments 1 or 2. The peduncle segments as well as the proximal

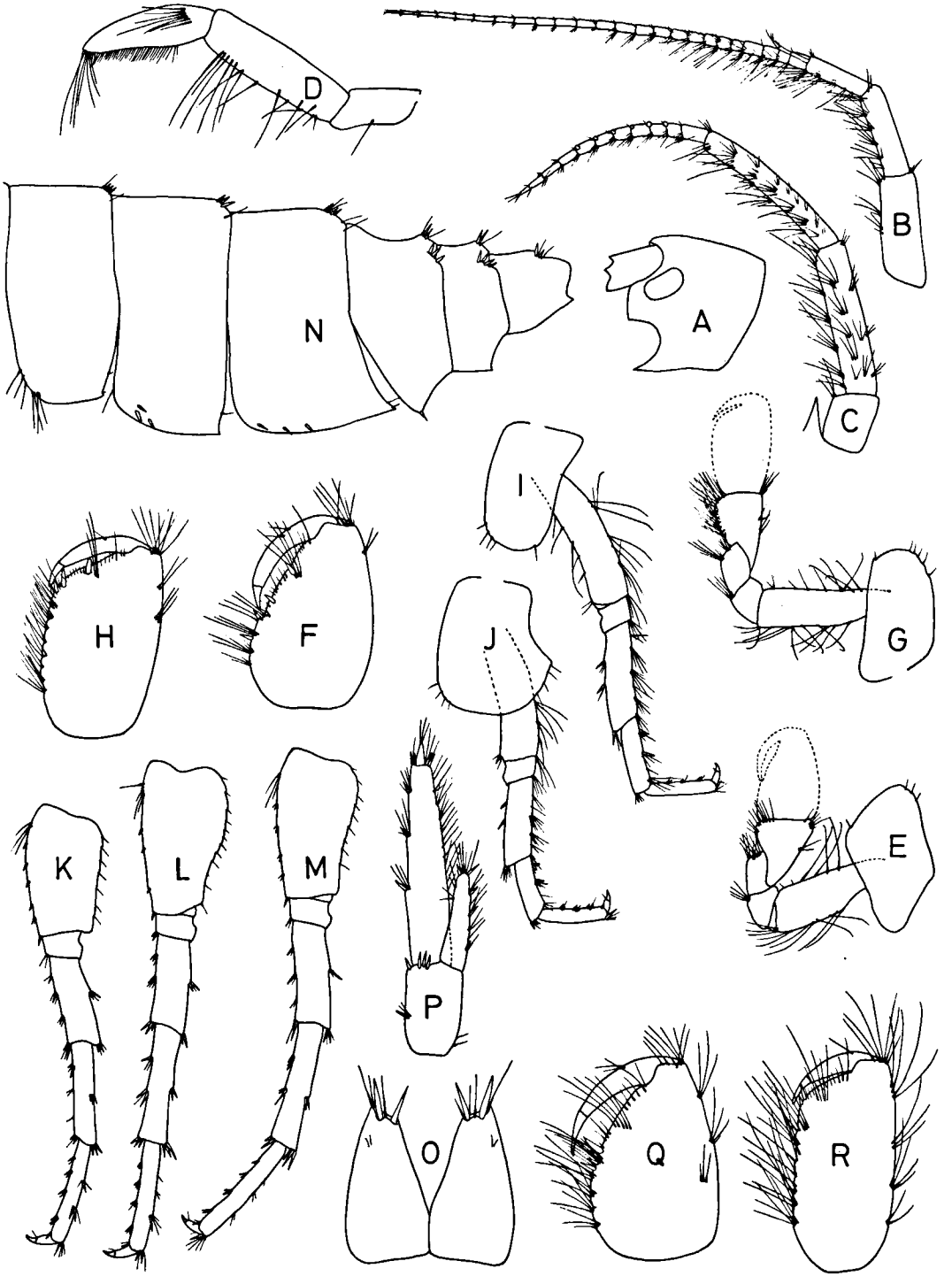

Fig. 16. *Gammarus ochridensis* Schäferna, 1926. A-P, ♂, 15 mm, from the coast of Lake Ohrid, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, mandibular palp; E, gnathopod 1; F, propodus of gnathopod 1; G, gnathopod 2; H, propodus of gnathopod 2; I, pereiopod 3; J, pereiopod 4; K, pereiopod 5; L, pereiopod 6; M, pereiopod 7; N, meta- + urosome + epimeres; O, telson; P, uropod 3. Q-R, ♀, 9.5 mm, from same locality. Q, propodus of gnathopod 1; R, propodus of gnathopod 2.

10 to 15 flagellar segments are armed with many groups of relatively long setae, longer (up to 2.5 times) than the diameter of the segments on which they are implanted. The main and accessory flagellum have up to 26 and 3 or 4 segments, respectively.

The second antenna (fig. 16C) is slender, set with many groups of setae on both its peduncle and flagellar segments. These setae are as long as or longer than the diameter of the segments on which they are implanted. Calceoli are always present.

The first segment of the mandibular palp (fig. 16D) bears one seta; the second is provided with 6 to 8 setae in its proximal part and 6 to 9 setae in its distal part. The third segment bears 32 to 38 D-setae, 5 or 6 E-setae and one group of A-setae. C-setae are absent.

Coxal plate 1 with slightly concave anterior margin (fig. 16E), coxae 2 to 4 normal. Gnathopods 1 and 2 (figs. 16E-H) moderately setose, bearing straight setae only. Propodus of gnathopod 1 pyriform with 3 to 5 groups of setae and 2 or 3 pairs of short spines at the posterior margin. Palm with medial palmar spine, 2 palmar angle spines and some smaller spines on the inner surface. Dactylus moderately slender, occasionally with 2 setae on the dorsal surface. The propodus of gnathopod 2 is nearly as long as that of gnathopod 1 with 8 to 10 groups of setae along the posterior margin. Palm slightly concave, with one medial palmar spine, 3 palmar angle spines and 2 smaller spines on the inner surface. Dactylus as in gnathopod 1.

Pereiopods 3 and 4 (figs. 16-I, J) moderately long, sparsely armed with spines and some setae. The dactyli are short and stout.

Pereiopods 5 to 7 (figs. 16K-M) are also moderately long, sparsely armed with spines and some short setae. The inner surface of the basal segments is unarmed. The dactyli are short and stout.

Epimeres 1 and 2 are almost rectangular, epimere 3 moderately to sharply pointed. The armature is very poor (fig. 16N).

Uropod 3 (fig. 16P) is moderately long, poorly setose. The endopodite is 2/5 to 1/2 times as long as the exopodite. The exopodite has plumose setae at the inner margin and simple setae, intermixed with single spines, at the outer margin.

The telson (fig. 16-O) is short, slightly wider than long, each lobe with 2 distal spines, intermixed with 2 or 3 short setae.

Female: Setosity of antennae 1 and 2, uropod 3, epimeres, and pereiopods 5 to 7 like in the male. Calceoli absent. Gnathopods 1 and 2 have no medial palmar spine (figs. 16Q, R). Pereiopods 3 and 4 have remarkably longer setae than in males, being as long as (in P4) or longer than (in P3) the diameter of the segments on which they are implanted.

The colour of live specimens is yellowish to yellow-brown.

Variability. — Apart from the usual variability within this group, the length and the number of setae in antennae 1 and 2 is rather variable.

Material examined. —

Yugoslavia, Lake Ohrid: W. of Ohrid town, under stones, near the shore of the lake, 13-VII-1939, many specimens (KC).
— Coast of Lake Ohrid, 1924, 10 specimens (KC).
— Coast of Lake Ohrid near Sv. Jovan, 17-VI-1939, 6 specimens (KC).
— Spring near Ohrid town, 1934, 20 specimens (KC).
— Beach of Lake Ohrid between Ohrid and Sv. Naum, under stones, VI-1969, many specimens (KC).
— Lake Ohrid, 30-VII-1970, many juvenile specimens, accompanied by *G. lychnidensis* Schellenberg, 1943 (KC).
— Lake Ohrid, bottom sample with dredge near Struga, depth 4.5 fathoms, in vegetation of *Chara* sp., 26-IV-1954, 5 specimens (ZMA).
— Shore of Lake Ohrid, 5 km S. of Ohrid, substrate of *Chara*, boulders and sand, 26-V-1954, many specimens (ZMA).
— Beach springs along Lake Ohrid near Sv. Naum, under stones, 10 specimens (ZMA).

Loc. typ. — Coast of Lake Ohrid, under stones. The ♂ holotype and paratypes are most probably deposited in the Zoological Museum, Prague, Czechoslovakia.

Remarks and affinities. — *G. ochridensis*, because of its scarce setation of pereiopods 3 and 4 and uropod 3, belongs to the *Gammarus balcanicus*-group. It is characterized by the dorsal armature of all three metasome segments, all

three provided with several spines and setae. In this respect it resembles *G. accolae* from Kirgöz (prov. Antalya, Turkey). It differs from this species in its more setose antenna 2, the presence of calceoli in males, and in the shape of the epimeres which are less pointed. (See also: General remarks on the species of the *G. ochridensis*-complex.)

Distribution and ecology. — *G. ochridensis* lives in coastal waters of Lake Ohrid. It was found together with *G. lychnidensis* and *G. salemaai.*

Gammarus macedonicus G. Karaman, 1976 (Fig. 17)

Refs. — *Gammarus macedonicus* G. Karaman, 1976b: 71, figs. 1-5; 1977a: 77, figs. XIII-XIV; Barnard & Barnard, 1983: 467.

Diagnosis. — Medium large species with spines and setae on the dorsal surface of all metasome segments. Antenna 2 short with short inflated flagellum bearing numerous, short brushlike setae. Calceoli always absent in both sexes. Basal segments of pereiopods 5 to 7 without setae on inner surface.

Description. — Male: Maximum length observed 14.4 mm. Mesosome dorsally smooth, unarmed; metasome segments 1 to 3 with dorsal spines intermixed with some single setae, like in *G. ochridensis.* Urosomites 1 to 3 slightly elevated, with one dorsomedian and 2 dorsolateral groups of spines (fig. 17N).

The eyes are ovoid to slightly reniform, slightly longer than the diameter of the first peduncle segment of antenna 1.

The armature of both peduncle and flagellum of the first antenna is poorly developed. The main and accessory flagellum are up to 24-, and 3- or 4-segmented, respectively (fig. 17A).

The second antenna is short. The setae on peduncle segments 4 and 5 are implanted in groups, being shorter than the diameter of the peduncle segments. The flagellum is short, slightly inflated and dorsoventrally compressed. Each segment is armed with a transverse row of setae at the inferior margin, forming a short brush. Calceoli are absent (fig. 17B).

The first segment of the mandibular palp (fig. 17C) is unarmed; the second segment bears 18 to 22 setae. The third segment (fig. 17D) is armed with 8 to 10 E-setae, 38 to 40 D-setae, 2 groups of A-setae, 2 groups of B-setae and 3 to 4 (sometimes 2) C-setae.

The coxal plate of gnathopod 1 (fig. 17E) has a slightly concave anterior margin. The propodus (fig. 17F) is pyriform, its palm armed with a medial palmar spine and 2 palmar angle spines on the outer surface and 3 or 4 smaller subcorner spines on the inner surface. The dactylus is moderately slender with one seta on the dorsal margin.

The propodus (fig. 17H) of the second gnathopod (fig. 17G) is slightly longer than that of gnathopod 1. A strong medial palmar spine is present together with 3 palmar angle spines and 3 smaller spines. The setation of both gnathopods is scarce.

The setation of pereiopods 3 and 4 is scarce and short (figs. 17-I, J).

Pereiopods 5 to 7 (figs. 17K-M) are moderately long and slender, their segments 3 to 6 armed with spines and very short setae only. The basal segments have unarmed inner surfaces. The dactyli are relatively long, moderately slender.

The epimeral plates change from almost rectangular in the first to moderately pointed in the third. The armature is scanty (fig. 17N).

Uropod 3 (fig. 17P) is rather short and poorly setose. The inner ramus is never longer than half the outer ramus. The outer margin of the exopodite bears a few groups of spines and some short, simple setae.

The telson lobes (fig. 17-O) are little more than twice as long as wide, armed with 2 distal spines and 1 or 2 setules.

Female: Like in *G. stankokaramani* (vide infra) females of this species have gnathopods with a well-developed medial palmar spine. However, calceoli are absent, like in the males. The other setation of the antennae, pereiopods and uropods does not show remarkable differences with the other sex. The broad oostegites are found on thoracic segments 2 to 5.

The colour of live specimens is unknown.

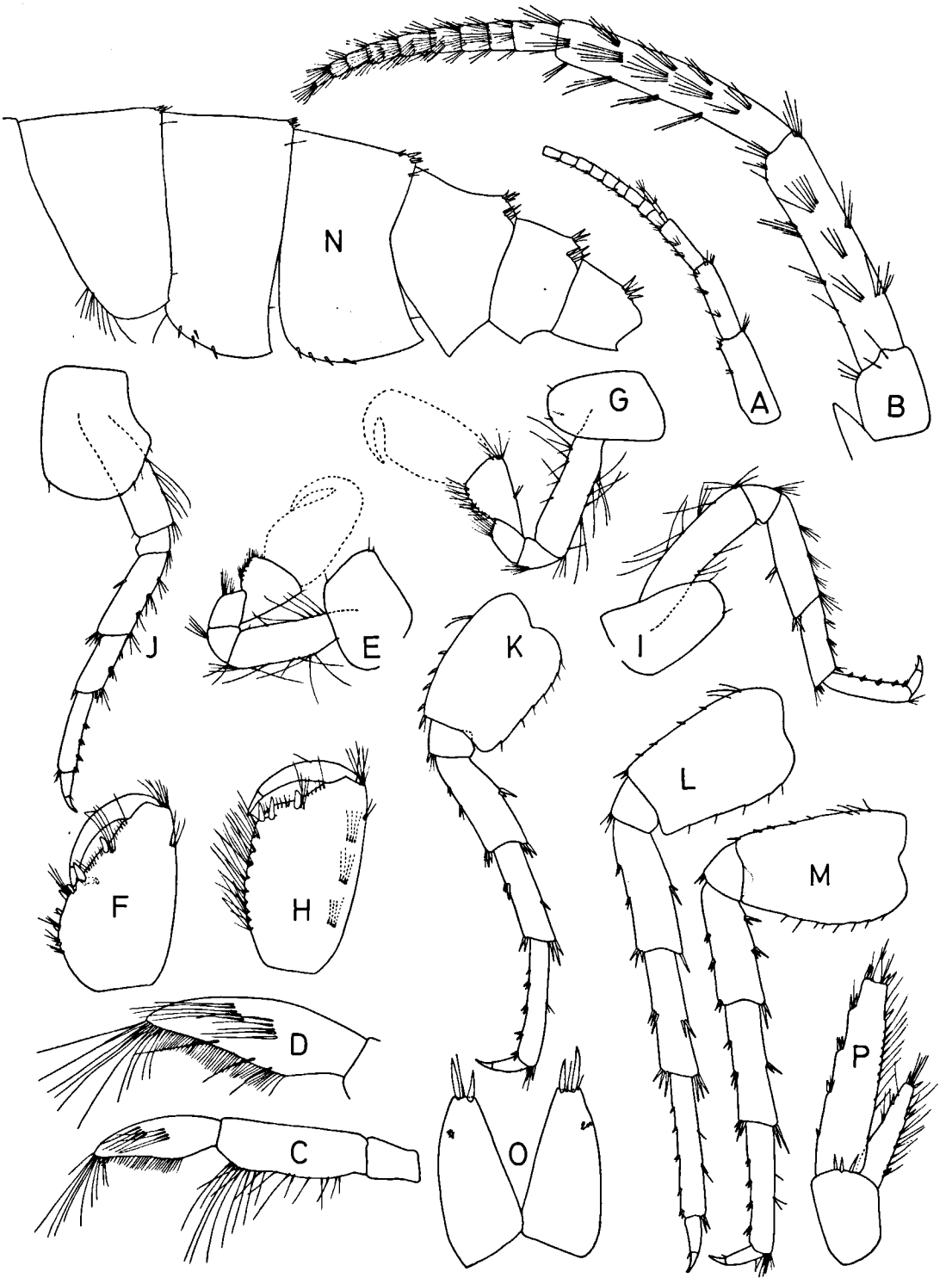

Fig. 17. *Gammarus macedonicus* G. Karaman, 1976. A-P, ♂, 14.4 mm, from Lake Ohrid, depth 40 m, Yugoslavia. A, antenna 1; B, antenna 2; C, mandibular palp; D, detail of mandibular palp; E, gnathopod 1; F, propodus of gnathopod 1; G, gnathopod 2; H, propodus of gnathopod 2; I, pereiopod 3; J, pereiopod 4; K, pereiopod 5; L, pereiopod 6; M, pereiopod 7; N, meta- + urosome + epimeres; O, telson; P, uropod 3.

Variability. — Apart from the usual pattern no striking variability was observed. This of course can be due to the low number of specimens examined.

Material examined. —
Yugoslavia, Lake Ohrid: Depth 40 m, 14-IX-1934, 8 specimens accompanied by *G. stankokaramani* G. Karaman, 1976. The ♂ holotype and 7 paratypes have been deposited in the collection of G. Karaman, Titograd.
— Depth 160 to 240 m, 1934, 1 specimen accompanied by *G. stankokaramani* (KC).

Remarks and affinities. — *G. macedonicus* seems to be related to *G. stankokaramani* because of the presence of a medial palmar spine in the gnathopods of both sexes. However, it differs from this species by the absence of calceoli in both sexes, the smooth last mesosome segment and the presence of C-setae on the third segment of the mandibular palp.

Distribution and ecology. — *G. macedonicus* lives in the deeper parts of Lake Ohrid. It was found together with *G. stankokaramani.*

Gammarus stankokaramani G. Karaman, 1976
(Fig. 18)

Refs. — *Gammarus stankokaramani* G. Karaman, 1976a: 87, figs. I-V; 1977a: 81, figs. XIV-XV; Barnard & Barnard, 1983: 469.

Diagnosis. — Last mesosome and all metasome segments with spines and setae on the dorsal surface. Antenna 2 in both sexes with calceoli. Palm of gnathopods 1 and 2 with medial palmar spine in male and female. Basis of pereiopods 5 to 7 without setae at the inner surface.

Description. — Male: Maximum length observed 19 mm. The last mesosome segment and all three metasome segments are armed with groups of elements on the dorsal surface, each consisting of several spines and a single seta. The urosome is identical to that of *G. ochridensis* (fig. 18J).

The lateral lobes of the head (fig. 18A) are more or less rounded, the eyes are small, 1.5 times as long as wide and widely separated from the middorsal line.

The first antenna (fig. 18B) is 1/2 to 3/5 of the total body length, sparsely setose; the setae on the peduncle segments and the flagellum are shorter than the diameter of the segments on which they are implanted.

The second antenna (fig. 18C) is moderately setose. The peduncle segments each bear 5 to 6 groups of setae along their ventral margin as well as some lateral groups. The setae are as long as or slightly longer than the diameter of the peduncle segments. The flagellum is strong, slightly inflated and sparsely setose. Calceoli are always present.

The first segment of the mandibular palp has one seta near its distal end. The second segment bears 20 to 26 setae; the third segment 32 to 39 D-setae, 6 to 8 E-setae, one group of A-setae and 3 groups of B-setae.

The coxal plate of gnathopod 1 (fig. 18D) is slightly concave. The propodus (fig. 18E) is pyriform, and armed with a medial palmar spine, two palmar angle spines, and a pair of smaller spines in between them. On the inner surface three more spines are found. The dactylus is long and slender, bearing 2 or 3 setae at the superior surface.

The propodus of gnathopod 2 (figs. 18F, G) is slightly longer than that of P1. Its palm is armed with a medial palmar spine, 3 palmar angle spines as well as one spine in between them. Two or three smaller spines occur on the inner surface of the propodus. The dactylus is also slender and bears 2 or 3 (sometimes 4) setae at the superior margin.

Pereiopods 3 (fig. 18H) and 4 are long, slender, the setation is short and scarce.

Pereiopods 5 to 7 (fig. 18-I) are long and slender, their segments 3 to 6 are armed with spines and some very short setae only. The inner surface of the basal segments is unarmed. The dactyli are moderately slender.

Epimeral plates 2 and 3 are moderately pointed, armed with some spines (and often some setae) along the inferior margin (fig. 18J).

Uropod 3 (fig. 18L) is moderately long. The inner ramus is moderately setose, 3/5 to 2/3 as long as the outer ramus. The outer margin of the exopodite is sparsely armed with a few spines and some short simple setae.

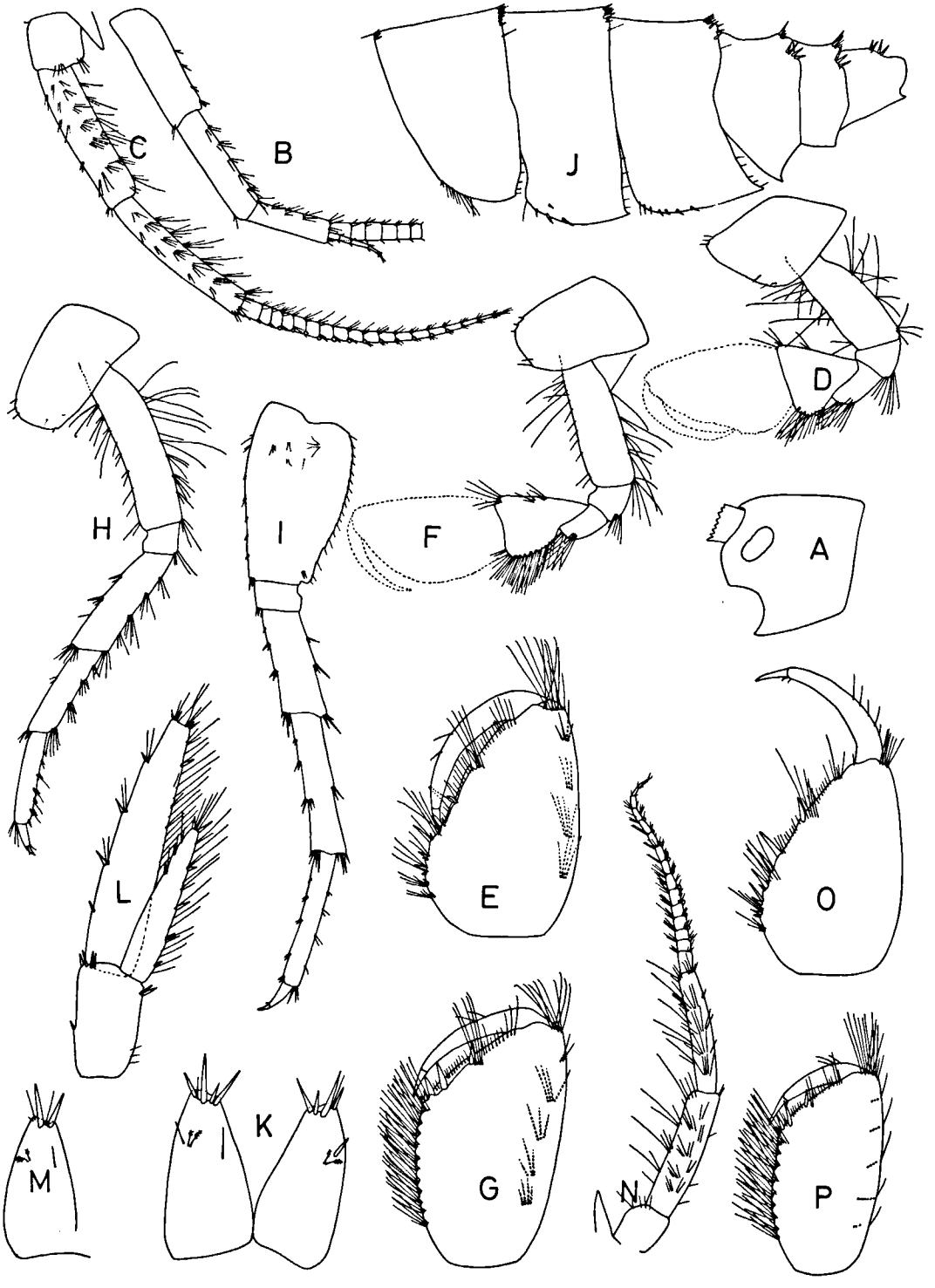

Fig. 18. *Gammarus stankokaramani* G. Karaman, 1976. A-L, ♂, 17 mm, from Lake Ohrid, depth 100 m, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, gnathopod 1; E, propodus of gnathopod 1; F, gnathopod 2; G, propodus of gnathopod 2; H, pereiopod 3; I, pereiopod 7; J, meta- + urosome + epimeres; K, telson; L, uropod 3; M, ♂, 14.5 mm, same locality, telson. N-P, ♀, 10 mm, same locality. N, second antenna; O, propodus of gnathopod 1; P, propodus of gnathopod 2.

The telson lobes (figs. 18K, M) are twice as long as wide, each with 2 to 4 distal spines and 1 or 2 short setae. The dorsal surface of each lobe is provided with 1 or 2 small setae or one spine.

Female: Unlike in most other species, females have a medial palmar spine on gnathopods 1 and 2 (figs. 18-O, P) and calceoli on the flagellum of the second antenna (fig. 18N). The setation on the peduncle of antenna 2 and of pereiopods 3 and 4 is slightly longer than in males. In all other characters both sexes closely resemble each other. The gills are ovoid, the oostegites very large.

The colour of live specimens is yellow to yellow-red.

Variability. — In this species most characters are very stable, like the presence of calceoli and medial palmar spines in females and males. Of course some age-dependent variability can be observed in the armature of the various appendages.

Material examined. —
Yugoslavia, Lake Ohrid: Depth 100 m, VIII-1934, many specimens. The ♂ holotype, 17 mm long, and many paratypes have been deposited in the collection of G. Karaman, Titograd.
— Depth 80 m, VIII-1934, 15 specimens (KC).
— Depth 40 m, IX-1934, many specimens (KC).
— Depth 160-240 m, 1934, 30 specimens, accompanied by *G. macedonicus* (KC).
— Depth 65-70 m, 1934, 7 specimens (KC).
— Depth 100 m, 1939, 1 specimen accompanied by *G. solidus* G. Karaman, 1977a and *G. lychnidensis* Schellenberg, 1943 (KC).

Remarks and affinities. — *Gammarus stankokaramani* differs from all other *Gammarus* species from Lake Ohrid by the presence of calceoli on the flagellum of the second antenna and of medial palmar spines in both gnathopods in females. The dorsal armature of meso- and metasome is very similar to that of *G. accolae* from Kirgöz, near Antalya, Turkey. However, this species has very sharp epimeral plates, and calceoli and medial palmar spines are lacking in females.

Distribution and ecology. — Living in deeper waters of Lake Ohrid. It is found together with *G. solidus*, *G. macedonicus* and *G. lychnidensis*.

Gammarus parechiniformis G. Karaman, 1977
(Fig. 19)

Refs. — *Gammarus parechiniformis* G. Karaman, 1977a: 59, figs. IV-VI.
Gammarus (Rivulogammarus) ochridensis (part.); Schellenberg, 1943: 97.
Gammarus ochridensis ochridensis (part.); G. Karaman, 1974: 11.

Diagnosis. — Metasome segments 1 to 3 with spines and setae on the dorsal surface. Antennae 1 and 2 poorly setose, epimeral plates 2 and 3 with spines along the lower margin. Basal segments of P6 and P7 without elements on the inner surface.

Description. — Male: Maximum length observed 16.7 mm. Mesosome segments dorsally unarmed. Metasome segments 1 to 3 all armed with 5 to 15 spines and 4 to 6 setae (fig. 19K). The urosome segments are slightly elevated, not compressed, armed with a dorsomedian and a dorsolateral group of 2 to 4 spines and 0-2 setae.

The lateral lobes of the head (fig. 19A) are rounded, the eyes weakly reniform, as long as or slightly longer than the diameter of the peduncle of antenna 1.

The first antenna (fig. 19B) is about 3/5 times as long as the total body length. It is poorly setose; the main and accessory flagellum have up to 30 and 3 to 4 segments, respectively.

The second antenna (fig. 19C) is also poorly setose. The antennal gland is short. The flagellum is slender, up to 13-segmented, set with few short setae, never forming a brush. Calceoli are always present.

The first segment of the mandibular palp is unarmed, the second segment has 7 to 10 setae in its proximal part and 8 to 10 setae in its distal part. The third segment is armed with 28 to 32 D-setae, 6 or 7 E-setae, one group of A-setae and 2 groups of B-setae; C-setae are absent.

Coxal plate 1 has a slightly concave anterior margin; coxal plates 2 to 4 are normal. The propodus of gnathopod 1 (fig. 19D) is pyriform,

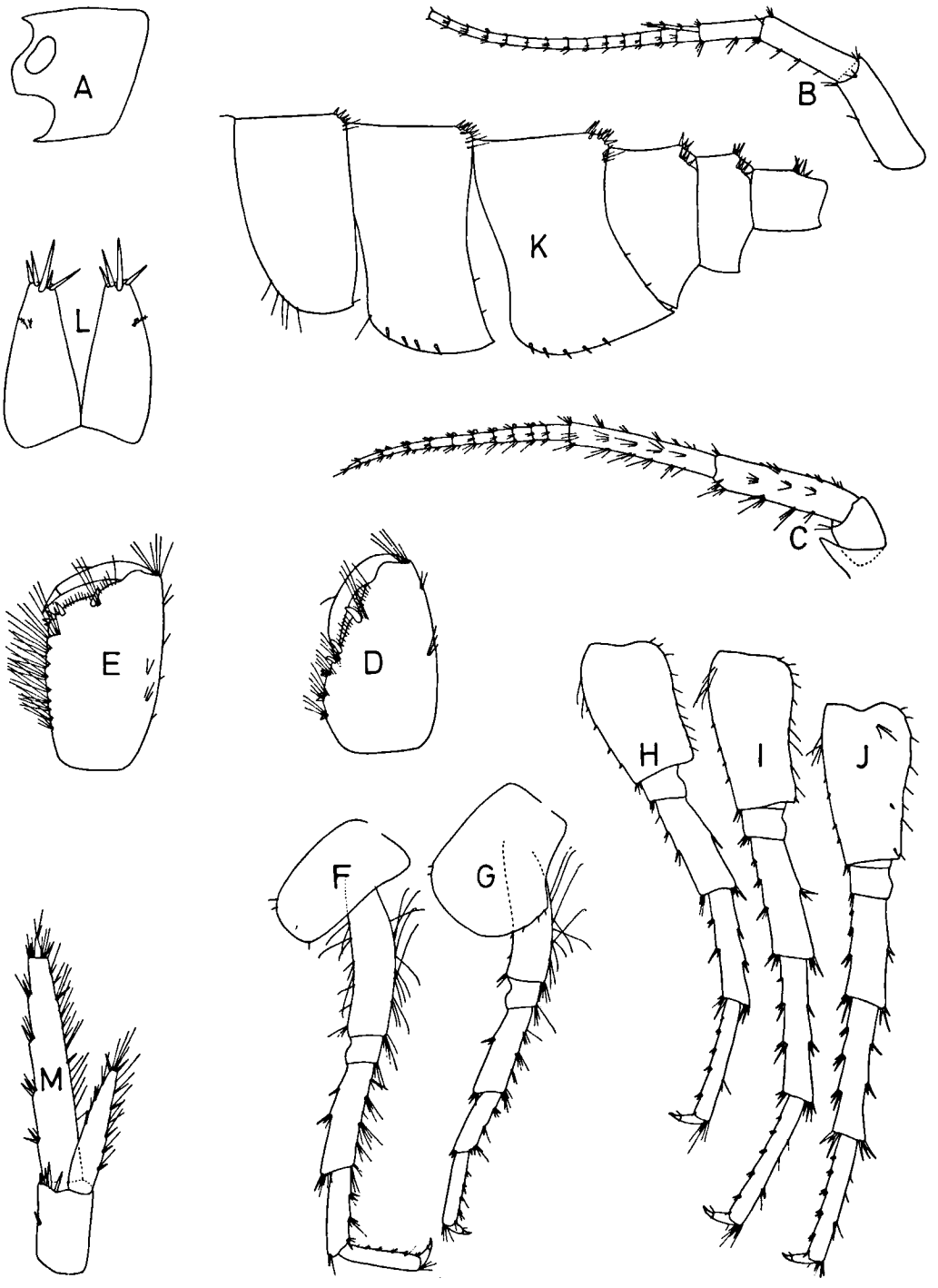

Fig. 19. *Gammarus parechiniformis* G. Karaman, 1977. A-M, ♂, 14.3 mm, from a spring near Sv. Naum, Lake Ohrid, Yugoslavia. A, head; b, antenna 1; C, antenna 2; D, propodus of gnathopod 1; E, propodus of gnathopod 2; F, pereiopod 3; G, pereiopod 4; H, pereiopod 5; I, pereiopod 6; J, pereiopod 7; K, meta- + urosome + epimeres; L, telson; M, uropod 3.

poorly setose, armed with 3 to 4 groups of small spines along the posterior margin and the usual medial palmar spine and group of palmar angle and subcorner spines. The moderately slender dactylus bears one seta on its dorsal margin. The propodus of the second gnathopod (fig. 19E) is little longer than that of the first, very poorly setose. A medial palmar spine, 3 to 4 palmar angle spines and 2 subcorner spines can be found. The dactylus is like in the first gnathopod.

Pereiopods 3 and 4 (figs. 19F, G) are poorly setose, the setae being as long as or shorter than the diameter of the segments on which they are implanted.

Pereiopods 5 to 7 (figs. 19H-J) are moderately long, their segments 3 to 6 bearing groups of spines along both margins. Setae are almost absent. The setae along the posterior margin of the basal segments are slightly longer than in *G. balcanicus*; the inner surface of these basal segments is unarmed. The dactyli are short, stout.

The posteroinferior corners of the epimeral plates change from almost rectangular in the first to sharply pointed in the third (fig. 19K). Some spines are found along the ventral margins of epimeres 2 and 3, setae are absent.

Uropod 3 (fig. 19M) is moderately long, poorly setose. The endopodite is 2/5 to 1/2 times as long as the exopodite. Few groups of spines and some short setae are found along the outer margin of the exopodite.

The telson lobes (fig. 19L) are more than twice as long as wide, each set with a group of 2 to 5 distal spines, sometimes accompanied by 1 or 2 short setae. No spines or setae are found on the dorsal surface.

Female: Apart from the normal sexual dimorphism, females differ from the males in (a) a longer setation of antenna 2, (b) a distinctly longer and denser setation of pereiopods 3 and 4, and (c) the presence of setae on the inner surface of the basal segments in pereiopods 5 to 7. All other characters are like those in males.

The colour of live specimens is yellow-brown to yellow-grey.

Variability. — *Gammarus parechiniformis* shows the normal pattern within this group of species.

Material examined. —

Yugoslavia, Lake Ohrid: Spring near Sv. Naum Monastery, IX-1934, many specimens. The ♂ holotype, 14.3 mm long, and many paratypes have been deposited in the collection of G. Karaman, Titograd.
— Ibid., 21-VII-1969, many specimens, accompanied by *G. roeseli* Gervais, 1835 (KC).
— Sv. Naum - Kolibarci, 3-VIII-1930, 6 specimens (KC).
— Biljanini Izvori, springs, 21-VII-1969, many specimens accompanied by *G. roeseli* (KC).
— Lake at depth of 20-25 m, 1-IX-1939, 30 specimens accompanied by *G. lychnidensis* (KC).
— Lake at depth of 0.20 m, 4-IX-1939, 20 specimens (KC).
— Lake at depth up to 40 m near Sv. Jovan, 18-VII-1939, 15 specimens accompanied by *G. lychnidensis* (KC).
— Lake at depth of 40 m, IX-1934, 15 specimens accompanied by *G. solidus* G. Karaman, 1977 (KC).
— Ohrid town, spring near public pump, 26-VII-1939, 20 juvs. (KC).

Localities cited. — Spring near Sv. Naum, Bej Bunar spring and spring near Studenčište (= Biljanini Izvori springs), Schellenberg, 1943 sub *G. ochridensis*.

Remarks and affinities. — *G. parechiniformis* has a lot of characters in common with *G. ochridensis*, like the armature of the body and shape and setation of all pereiopods (except the basal segments of pereiopods 5 to 7 in females), epimeres, uropods, and telson. It is clearly different in the setation of both antennae 1 and 2 which are poorly setose, against moderately to very setose in *G. ochridensis*.

Distribution and ecology. — This species is known from the coastal zone of Lake Ohrid only. Although it prevails in springs, often accompanied by *G. roeseli*, it can also be found in the lake up to a depth of 40 m, where it is found together with *G. lychnidensis* and *G. solidus*.

Gammarus solidus G. Karaman, 1977
(Fig. 20)

Refs. — *Gammarus solidus* G. Karaman, 1977a: 71, figs X-XIII; Barnard & Barnard, 1983: 469.
Gammarus ohridensis abyssalis S. Karaman, 1931a: 53, figs. 11a, c, e.

Gammarus (Rivulogammarus) ochridensis abyssalis; Schellenberg, 1943: 99; Stanković & Pljakić, 1962: 68.
Rivulogammarus ochridensis abyssalis; G. Karaman, 1968b: 55.
Gammarus ochridensis abyssalis; G. Karaman, 1974: 12.

Diagnosis. — A medium large species with spines and setae on all metasome segments. Basal segments of pereiopods 6 and 7 with setae on the interior surface. Antennae 1 and 2 poorly setose, calceoli present. Epimeral plates 1 to 3 with many long setae.

Description. — Male: Maximum length observed 15 mm. The metasome segments are armed with groups of spines intermixed with single setae, like in *Gammarus ochridensis* (fig. 20K). Urosome slightly elevated, each urosomite armed with a dorsomedian and two dorsolateral groups of 2-5 spines and 1 or 2 setae.

The lateral lobes of the head (fig. 20A) are more or less rounded, the eyes being ovoid to reniform, nearly as long as or slightly longer than the diameter of peduncle segment 1 of antenna 1.

The first antenna (fig. 20B) is poorly setose, up to 3/5 times as long as the total body length. The main and accessory flagellum are up to 33-segmented and 3- to 4-segmented, respectively.

The second antenna (fig. 20C) has a short gland cone and is slender, poorly setose. The setae on the peduncle segments and flagellum are short, the longest are about as long as the diameter of the segments on which they are implanted. Calceoli are present.

The first segment of the mandibular palp is unarmed; the second bears 14 to 17 setae. The third segment is armed with 30 to 32 D-setae, 8 to 10 E-setae, 2 groups of B-setae and one group of A-setae.

The propodus of the first gnathopod (fig. 20D) is pyriform, bearing 3 or 4 pairs of short spines along the posterior margin, intermixed with groups of setae, as well as two groups of spines on the inner surface. In between the medial palmar spine and the two palmar angle spines an additional pair of spines can be found. Three subcorner spines can be equally found. The dactylus is slender.

The propodus of the second gnathopod (fig. 20E) is slightly longer than that of the first, bearing 8 to 10 groups of setae along the posterior margin. Like in the first gnathopod, an additional spine is implanted in between the medial palmar spine and the palmar angle spines. The dactylus is slender.

Pereiopods 3 and 4 (figs. 20F, G) are moderately setose, the setae along the posterior margin of segments 2 to 5 being as long as or slightly longer than the diameter of the segments.

Pereiopods 5 to 7 (figs. 20H-J) are relatively long and slender. In P6 and P7 the basal segments bear moderately long setae along the posterior margin. In P5 the interior surface of the basis is naked, in P6 and P7 several groups of rather long setae can be found. Segments 3 to 5 are armed with groups of spines and setae along the anterior margin; the setae are usually longer than the spines.

Epimeral plates 2 and 3 are moderately pointed, bearing long setae at their distal margin, occasionally intermixed with one spine. The lateral surface of these epimeres is also provided with several groups of setae (fig. 20K).

Uropod 3 (fig. 20M) is moderately long and slender. The endopodite is about 3/5 times as long as the first segment of the exopodite, bearing plumose setae along the margins. The exopodite is armed with spines and simple setae along the outer margin and plumose setae at the inner margin.

The telson lobes (fig. 20L) are about twice as long as wide; each lobe is armed with 2 distal spines intermixed with several short setae. Sometimes 1 or 2 setae are found on the dorsal surface of the lobes.

Female: The armature and setation of pereiopods 3 to 7, epimeres, uropods, first antenna and telson closely resemble those in males. The setation of the peduncle segments 4 and 5 of the second antenna can be slightly longer. Calceoli are absent.

The colour of live specimens is unknown.

Variability. — The number of spines and setae

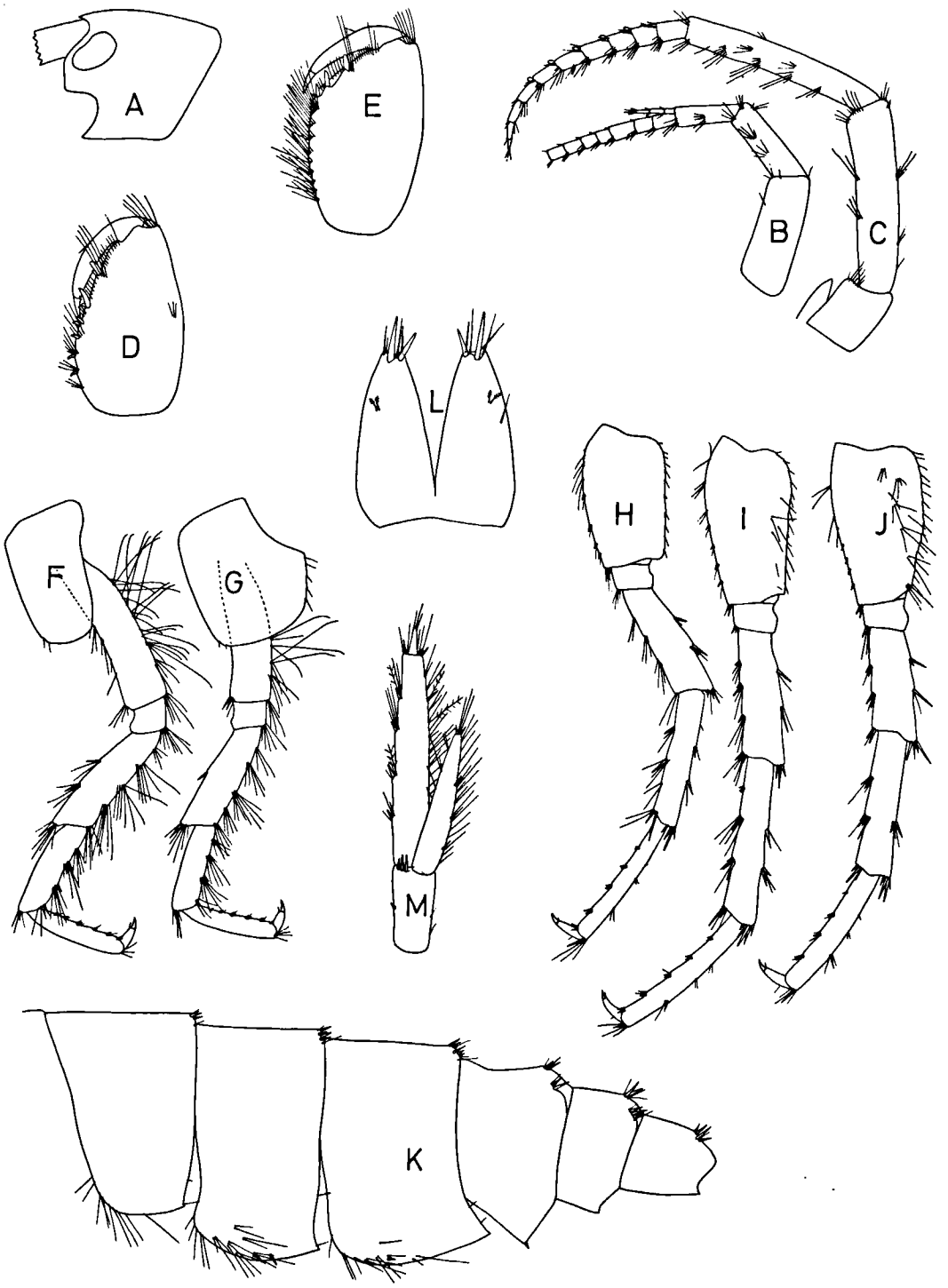

Fig. 20. *Gammarus solidus* G. Karaman, 1977. A-M, ♂, 13 mm, from Lake Ohrid near St. Jovan, depth 30 to 40 m, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, propodus of gnathopod 1; E, propodus of gnathopod 2; F, pereiopod 3; G, pereiopod 4; H, pereiopod 5; I, pereiopod 6; J, pereiopod 7; K, meta- + urosome + epimeres; L, telson; M, uropod 3.

on the dorsal surface of the metasome segments as well as the number of setae on the inner surface of the basis in pereiopods 6 and 7 are variable.

Material examined. —
Yugoslavia, Lake Ohrid: Depth 160-240 m, 1934, 3 specimens. The ♂ holotype, 13 mm long, and 2 paratypes have been deposited in the collection of G. Karaman, Titograd.
— Depth 100 m, 1939, 1 specimen accompanied by *G. lychnidensis* and *G. stankokaramani* (KC).
— Depth 40 m, IX-1934, 10 specimens accompanied by *G. parechiniformis* (KC).
— Depth unknown, 1934, 6 specimens accompanied by *G. ochridensis* (KC).
— Depth 20-25 m, 1-IX-1934, 1 specimen accompanied by *G. lychnidensis* (KC).

Remarks and affinities. — Although this species has some characters in common with other species from Lake Ohrid, it differs from all of them by the presence of rather long setae on the basal segments of pereiopods 6 and 7 and on the epimeres in males and females.

Distribution and ecology. — *G. solidus* lives in the deeper parts of Lake Ohrid. It was found intermixed with *G. parechiniformis*, *G. stankokaramani*, *G. lychnidensis* and *G. ochridensis*.

Gammarus lychnidensis Schellenberg, 1943
(Fig. 21)

Refs. — *Gammarus* (*Rivulogammarus*) *ochridensis* f. *lychnidensis* Schellenberg, 1943: 98, fig. 1.
Gammarus lychnidensis; G. Karaman, 1977a: 65, figs VI-IX.

Diagnosis. — Medium large species with variable dorsal armature of meso- and metasome. Segment 3 of antenna 1 about as long as or longer than segments 1 and 2. Both antennae 1 and 2 provided with many long setae. Calceoli absent in males.

Description. — Male: Maximum length observed 14 mm. The dorsal surface of mesosome segment 3 and metasome segments 1 to 3 can be smooth, unarmed or set with a varying number of spines and/or setae (fig. 21K). All kinds of transitive forms exist between these two extremes. The urosomites are hardly elevated, armed with a middorsal and two dorsolateral groups of 2-3 spines. Setae are usually absent.

The lateral lobes of the head (fig. 21A) are rounded, the eyes slightly reniform, shorter than the diameter of the peduncle of antenna 1.

The first antenna (fig. 21B) is long and slender, 3/5 to 2/3 times as long as the body length. Unlike in most other species the third peduncle segment is about as long as or longer than peduncle segments 2 and 3. The distal part of the first peduncle segment and peduncle segments 2 and 3 are armed with many groups of long setae, usually longer than the diameter of the peduncle segments. The main and accessory flagellum have up to 29 and 3 segments, respectively. The setation on the proximal 10 to 15 segments is longer than the diameter of the flagellar segments.

The second antenna (fig. 21C) is also slender. Both its peduncle and flagellar segments are armed with groups of long setae along the ventral margin, being up to twice as long as the diameter of the segments on which they are implanted. Calceoli are absent.

The first segment of the mandibular palp bears 2 setae, the second has 5 to 7 setae in its proximal and 8 to 11 setae in its distal part; the third segment is armed with 1 group of A-setae, 2 or 3 groups of B-setae, 8 or 9 E-setae and 28 to 31 D-setae; C-setae are absent.

Gnathopods 1 and 2 are moderately setose. The propodus of the first (fig. 21D) is pyriform, armed with 2 pairs of small spines along the posterior margin, a medial palmar spine, 2 palmar angle spines and 3 subcorner spines on the inner surface. The dactylus is slender, bearing one seta on the superior margin.

The propodus of the second gnathopod (fig. 21E) is little longer than that of gnathopod 1. Apart from the medial palmar spine, 2 palmar angle spines and 2 subcorner spines can be found. The dactylus is also slender, bearing one seta at the superior margin.

Pereiopods 3 and 4 (figs. 21F, G) are poorly setose, the setae on segments 3 to 6 being shorter than the diameter of the segments. The dactyli are short and stout.

Pereiopods 5 to 7 (figs. 21H-J) are not very

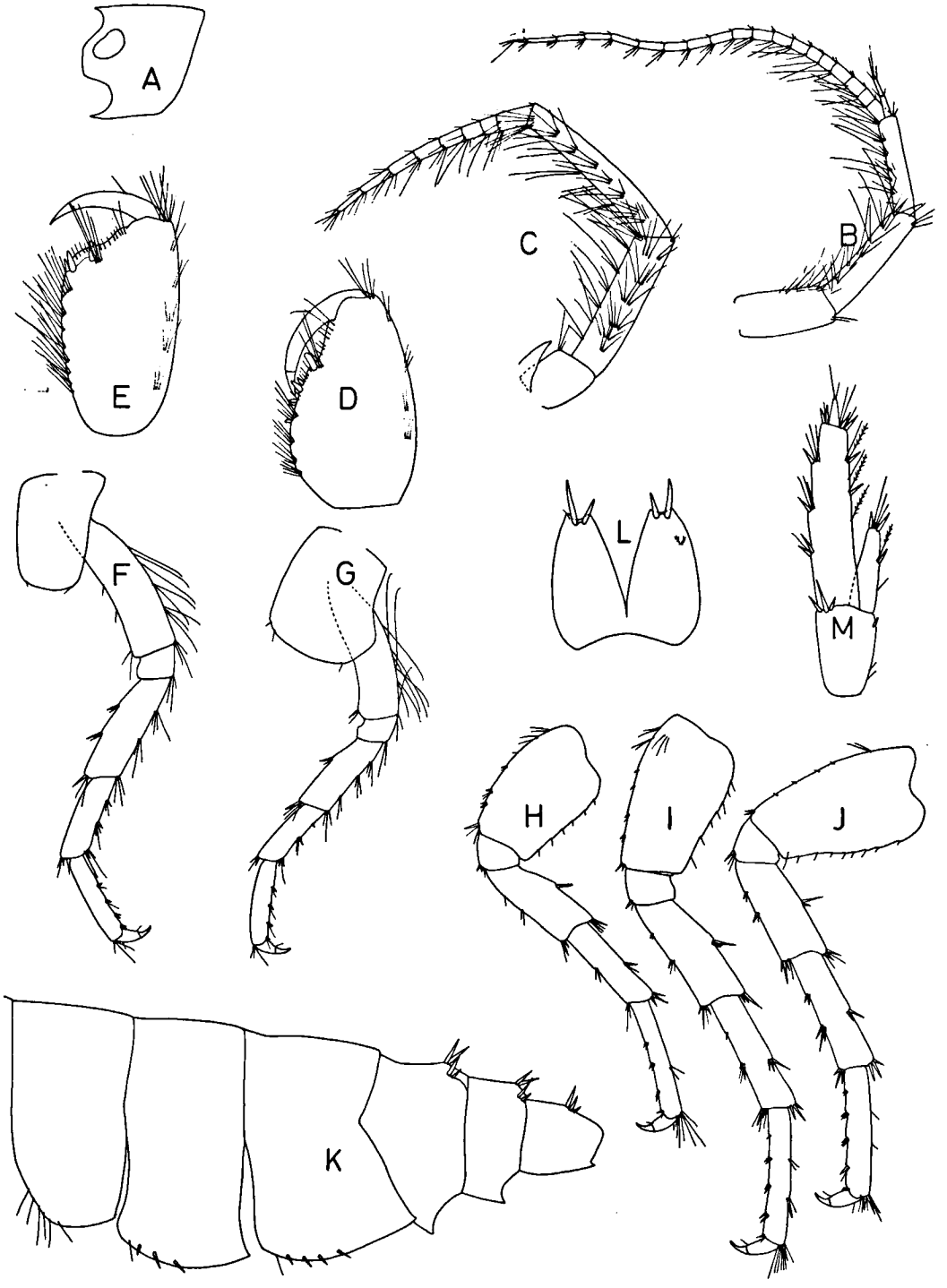

Fig. 21. *Gammarus lychnidensis* Schellenberg, 1943. A-M, ♂, 12.7 mm, from Lake Ohrid near Sv. Jovan, depth 30 to 40 m, Yugoslavia. A, head; B, antenna 1; C, antenna 2; D, propodus of gnathopod 1; E, propodus of gnathopod 2; F, pereiopod 3; G, pereiopod 4; H, pereiopod 5; I, pereiopod 6; J, pereiopod 7; K, meta- + urosome + epimeres; L, telson; M, uropod 3.

special, almost exclusively armed with spines. The basal segments never have setae on their inner surface. The dactyli are short.

Epimeral plates 2 and 3 are moderately pointed, armed with a limited number of small spines and 1 seta along their inferior margin (fig. 21K).

Uropod 3 (fig. 21M) is moderately long. The endopodite is 2/5 to 1/2 times as long as the exopodite. The outer ramus is armed with 3 or 4 groups of spines, intermixed with some (slightly longer) setae along the outer margin.

The telson lobes (fig. 21L) are less than twice as long as wide, armed with two distal spines only.

Female: Apart from the "normal" sexual dimorphism, females differ from the males in (a) a longer setation of peduncle and flagellum of antenna 2, (b) a longer setation in pereiopods 3 and 4, and (c) a relatively shorter, and more setose uropod 3. All other characters are basically the same as in males.

The colour of live specimens is unknown.

Variability. — The armature of the last mesosome and metasome segments, which is always very stable in other species of this group, is very variable. In between the extremes of completely unarmed to an armature with 15 spines and many setae per segment, all intermediate combinations can be found. The length of the third peduncle segment of antenna 1 is variable, but always longer than the length of the first segment. All other characters seem to be stable (within the usual limits).

Material examined. —

Yugoslavia, Lake Ohrid: Ohrid town, near bridge, depth 10 to 26 m, 13-IX-1934, 10 topotypes (KC).
- — Depth 100 m, 1939, 4 specimens accompanied by *G. solidus* and *G. stankokaramani* (KC).
- — Depth 160-240 m, 1934, 3 specimens (KC).
- — Lake near Sv. Jovan, depth 30 to 40 m, 16-VII-1939, many specimens accompanied by *G. parechiniformis* (KC).
- — Depth 20 to 25 m, 1-IX-1939, 4 specimens accompanied by *G. parechiniformis* (KC).
- — Lake W. of Ohrid town, 13-VII-1939, 4 specimens intermixed with *G. ochridensis* (KC).

Loc. typ. — Lake Ohrid, depth 17 to 22 m, in front of Ohrid town (Schellenberg, 1943). The ♂ holotype and an unknown number of paratypes are deposited in the Museum of Natural History in Berlin, G.D.R. Many topotypes are deposited in the collections of G. Karaman, Titograd.

Remarks and affinities. — *G. lychnidensis* differs from all other species within this group in the extremely long third peduncle segment of antenna 1 which is always longer than peduncle segment 1. In some characters like the long setation of antennae 1 and 2 it does resemble *E. ochridensis*, but unlike in this species calceoli are lacking in males.

Distribution and ecology. — The species is exclusively known from the deeper parts of Lake Ohrid, Yugoslavia. Its ecology is unknown. It has been found together with *G. solidus*, *G. stankokaramani*, *G. parechiniformis*, *G. ochridensis*, and *G. salemaai*.

Gammarus salemaai G. Karaman, 1985 (Fig. 22)

Refs. — *Gammarus salemaai* G. Karaman, 1985: 155, figs I-IV.
Gammarus ochridensis ochridensis (part.); G. Karaman, 1974: 11.
Gammarus ochridensis (part.); G. Karaman, 1977a: 54; Barnard & Barnard, 1983: 468.

Diagnosis. — Medium large species with or without spines and setae on the dorsal surface of all metasome segments. Peduncle of antenna 1 with long setae. Calceoli present in males. Basal segments of pereiopods 5 to 7 without setae on inner surface, segments 3 to 6 with spines only (setae practically absent).

Description. — Male: Maximum length observed 11 mm. Mesosome dorsally smooth, unarmed. Usually metasome segments 2 and 3 are armed with 2 middorsal spines, but sometimes these spines can be absent. All metasome segments have several setae along the posterior margin. Urosomites 1 and 2 elevated and slightly compressed laterally, each with one dorsomedian and 2 dorsolateral groups of elements. In urosomite 3 the dorsomedian group of elements is absent (fig. 22K).

Lateral lobes of the head almost rounded, eyes large, reniform.

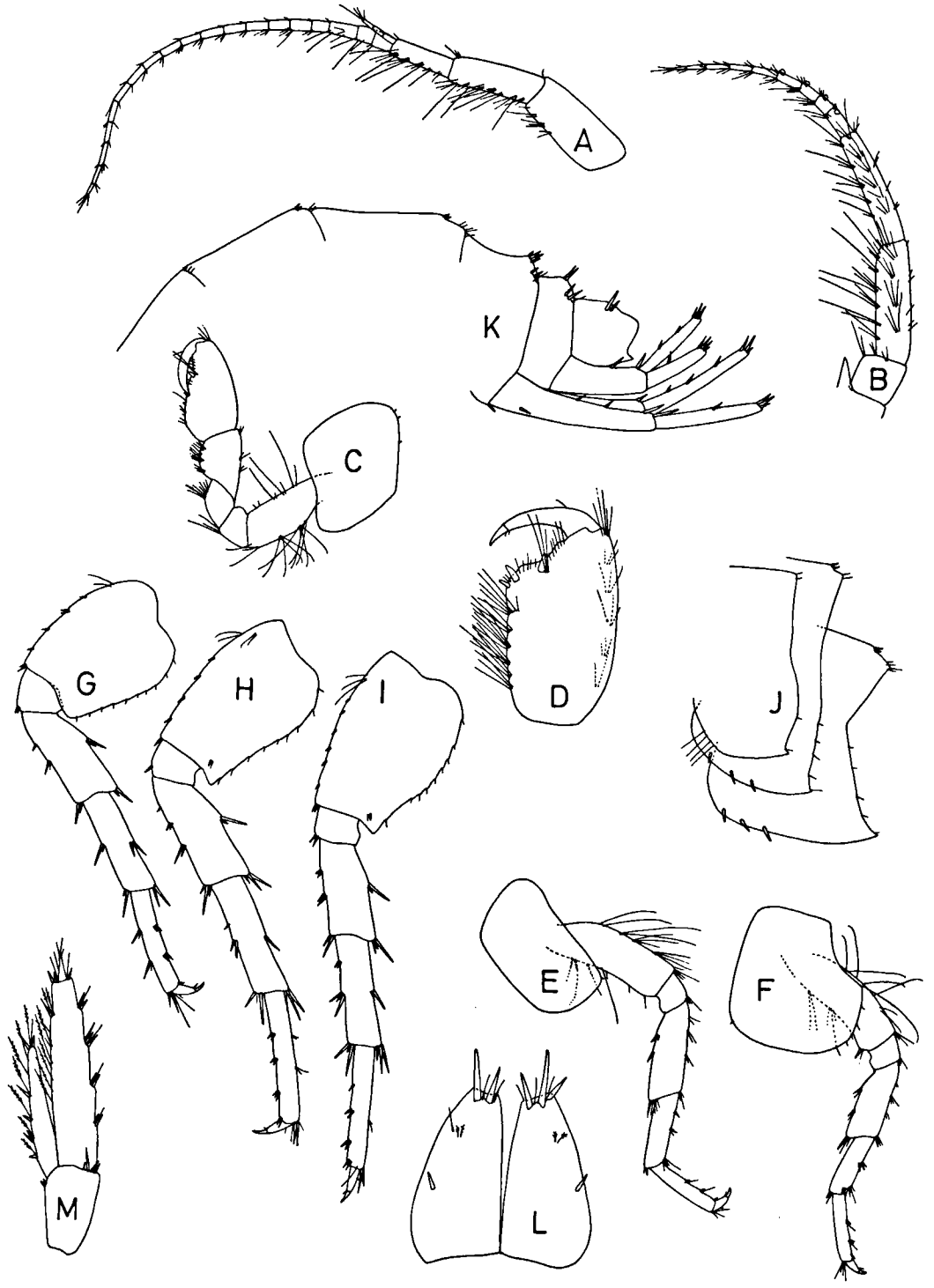

Fig. 22. *Gammarus salemaai* G. Karaman, 1985. A-M, ♂, 11 mm, from the coast of Lake Ohrid, Yugoslavia. A, antenna 1; B, antenna 2; C, gnathopod 1; D, propodus of gnathopod 2; E, pereiopod 3; F, pereiopod 4; G, pereiopod 5; H, pereiopod 6; I, pereiopod 7; J, metasome + epimeres; K, meta- + urosome; L, telson; M, uropod 3.

The first antenna (fig. 22A) reaches half the body length, its peduncle segments 1 to 3 progressively diminish in length. Segments 2 and 3 and the first flagellar segments are armed with relatively long setae, longer than the diameter of the segments on which they are implanted. The main and accessory flagellum have up to 20 and 3 or 4 segments, respectively.

Segments 4 and 5 of antenna 2 (fig. 22B) are set with 5 to 7 groups of ventral setae, longer than the diameter of the segments on which they are implanted. The flagellum is slender, up to 9-segmented, provided with calceoli.

The first segment of the mandibular palp can be either unarmed or set with one seta; the second is provided with up to 26 setae, the third with 2 groups of A-setae, 2 or 3 groups of B-setae, up to 20 D-setae and 5 or 6 E-setae.

Gnathopod 1 (fig. 22C) is a little smaller than gnathopod 2 (fig. 22D); both are poorly setose, provided with the usual medial palmar spine and palmar angle spines.

Pereiopods 3 and 4 (figs. 22E, F) are moderately slender, poorly setose; the dactyli are short and stout.

Pereiopods 5 to 7 (figs. G-I) are relatively short; the basal segments are unarmed at the inner surface; the armature of segments 3 to 6 is poor, setae are practically absent. The dactyli are moderately slender.

Epimeres 1 and 2 almost rectangular, epimere 3 moderately to sharply pointed (fig. 22J). The armature is poor, only consisting of some spines in epimeres 2 and 3.

The inner ramus of uropod 3 (fig. 22M) is about 2/3 of the outer ramus. The armature is poorly developed. The exopodite has short plumose setae at the inner margin and short spines intermixed with a simple seta at the outer margin.

The telson lobes (fig. 22L) are about twice as long as wide, armed with 2 or 3 apical spines intermixed with 2 or 3 short setae and a single subbasal spine. Occasionally a short seta is found on the dorsal surface of the lobes.

Female: Ovigerous specimens up to 8 mm long. Apart from the usual sexual dimorphism, the following characters differ from those in males: (1) antennae 1 and 2 are relatively shorter; (2) gnathopods 1 and 2 and pereiopods 3 and 4 are more setose; (3) inner ramus of uropod 3 relatively shorter, hardly reaching half the length of the outer ramus.

Colour of live specimens unknown.

Variability. — Variability was observed in the presence or absence of middorsal spines on mesosome segments 2 and 3 and in the presence or absence of a seta on the first segment of the mandibular palp.

Material examined. —

Yugoslavia, Lake Ohrid: Coast of Lake Ohrid, near Sv. Naum, under stones near the shore, 14-VI-1972, many specimens accompanied by *G. ochridensis*. The ♂ holotype and many paratypes are deposited in the collection of G. Karaman, Titograd, cat. no. 1610.

— Coast of Lake Ohrid near monastery Sv. Jovan, 1972, 3 specimens accompanied by *G. ochridensis* (KC).

— Beach of the lake, W. of Ohrid town, in shallow water under stones, 13-VI-1939, 1 specimen accompanied by *G. ochridensis* and *G. lychnidensis* (KC).

— Coast of Lake Ohrid near village Peštani, 1984, 3 specimens accompanied by *G. ochridensis* (KC).

Remarks and affinities. — *G. salemaai* is a species which is difficult to identify within the *G. ochridensis*-complex. It can be easily confused with juveniles of *G. ochridensis* and *G. lychnidensis*. It differs from *G. ochridensis* in less setiferous pereiopods 3 and 4, less spiniferous and less setose metasome segments, and in a longer inner ramus in uropod 3. It differs from *G. lychnidensis* in the presence of calceoli in antenna 2, shorter setation in pereiopods 3 and 4, and a shorter third peduncle segment of antenna 1.

The most important differences, however, can be found when doing karyological studies. Salemaa, 1986, studied all gammarid species from Lake Ohrid and found that the haploid chromosome number for this species is 12, while all other species have a haploid chromosome number of at least 21. This was the reason for G. Karaman to describe a new species which he kindly dedicated to Salemaa (G. Karaman, 1985). (See also General remarks on the species of the *G. ochridensis*-complex.)

Distribution and ecology. — *G. salemaai* is known from shallow water on the beach and from coastal waters of Lake Ohrid where it is found together with *G. ochridensis* and *G. lychnidensis*; its ecology is practically unknown.

GENERAL REMARKS ON THE SPECIES OF THE *G. OCHRIDENSIS*-COMPLEX

The dorsal armature of all seven species within this group is characteristic because of the presence of spines on the (meso- and) metasome segments. This is possibly the reason that for a long time these species have been considered as one (*G. ochridensis*), or two after the description of *G. lychnidensis*. Nevertheless, constant differences can be observed.

So *G. ochridensis*, *G. parechiniformis*, *G. solidus* and *G. macedonicus* have dorsal armature (consisting of spines and setae) on all three metasome segments only. In *G. stankokaramani* the last mesosome segment is armed as well. In *G. lychnidensis* the dorsal armature is extremely variable: it can be present on the last mesosome and all urosome segments, but it can also be absent; all stadia in between these extremes can be found. In *G. salemaai* a constant pattern is absent.

Calceoli on antenna 2 are present in males of *G. ochridensis, G. parechiniformis, G. solidus, G. stankokaramani* and *G. salemaai*, but absent in *G. lychnidensis* and *G. macedonicus*. In *G. stankokaramani* calceoli are found in females as well, a character which is rarely encountered in the genus *Gammarus*.

Distinctly setose epimeral plates and a setose basal segment in pereiopod 7 are only found in *G. solidus*. *G. macedonicus* is the only species with C-setae in the third segment of the mandibular palp.

Females of *G. stankokaramani* and *G. macedonicus* differ from females of the other four species in having medial palmar spines in both gnathopods.

In *G. lychnidensis*, *G. ochridensis* and *G. salemaai* the proximal part of antenna 1 is set with long setae; in the other four species only short setae are found.

It will be clear that the amphipod fauna of Lake Ohrid is a very rich one. Three different genera are found, all belonging to the family Gammaridae: *Gammarus*, *Synurella* and *Niphargus*. Each of these genera has endemic species in the lake (G. Karaman, 1977a).

Within the genus *Gammarus*, the *G. ochridensis*-complex with its seven species is a very interesting one. Although the distribution of the different species is still poorly known, since so far only a few samples could be studied, some interesting observations on the ecology were made. So, *G. ochridensis*, *G. parechiniformis* and *G. salemaai* are prevalently found in the littoral zone of the lake, usually at depths from 0 to 20 m, occasionally up to 40 m. Within this zone *G. ochridensis* and *G. salemaai* prefer the shallow coastal water where they live under stones, whereas *G. parechiniformis* inhabits the springs along the coast of the lake. The other four species *G. lychnidensis*, *G. stankokaramani*, *G. macedonicus*, and *G. solidus* live in deeper parts of the lake, from 20 to 240 m. Often these species were collected in mixed populations of 2 or 3 species. In spite of these observations, the ecology of any of the species is still practically unknown.

Because of the poor setation of pereiopods 3 and 4 and uropod 3 we consider this species-complex as members of the *G. balcanicus*-group in which, however, they occupy a special place because of the characteristic dorsal armature.

Interesting karyological studies were done by Salemaa (1986), who studied the chromosomes of all known *Gammarus* species from Lake Ohrid, viz. the seven from the *G. ochridensis*-complex which are endemic to the lake, and *G. roeseli* and *G. balcanicus*, two species with a much wider distribution. His results are striking: within the *G. ochridensis*-complex *G. salemaai* has the lowest haploid chromosome number of 12; *G. macedonicus* has 21; *G. ochridensis*, *G. parechiniformis*, *G. stankokaramani* and *G. solidus* each have 25, whereas *G. lychnidensis* has 34. Both *G. roeseli* and *G. balcanicus* have 26 chromosomes, a number established for most marine and freshwater *Gammarus* species (Le Calvez & Certain, 1951).

From these chromosomal features in the endemic *Gammarus* species of Lake Ohrid we must assume that polyploidy is the evolutionary mechanism of intralacustrine speciation in this group of Crustacea. Consequently, *G. salemaai* seems to be a palaeoendemic relict, extinct in other European waters.

REFERENCES

BARNARD, J. L. & C. M. BARNARD, 1983. Freshwater Amphipoda of the world, I & II: 1-830 (Hayfield Associates, Mt. Vernon, Virginia, U.S.A.).

BIRSTEIN, J. A., 1945. Zametka o presnovodnykh vysshikh rakoobraznykh Turkmenii i Irana. Uchen. Zap. mosk. gos. Univ., **83**: 151-164.

——, 1963. Nekotorye itogi izucheniia podzemnoi fauni Kryma. Trudy Eksped. Akad. Nauk Ukrain SSR, **1**: 123-136.

LE CALVEZ, J. & P. CERTAIN, 1951. Gammarus chevreuxi Sext. et la caryologie des Gammariens. Archs. Zool. exp. Gén., **88**: 131-141.

CĂRĂUȘU, S., E. DOBREANU & C. MANOLACHE, 1955. Crustacea Amphipoda, forme salmastre si de apa dulce. Fauna Repub. pop. rom., **4** (4): 1-409.

DEDYU, I. I., 1961. K voprosu o sostave i rasprostranenii amfipod Moldavii. In: Voprosy gidrobiol. i ikhtiol. vodoemov Moldavii, Kishinev: 10-18.

——, 1962. O rasprostranenii podroda Rivulogammarus St. Karaman v basseĭnakh rek Dnestr i Prut. In: Biologicheskie Resursy vodoemov Moldavii, Akademia Nauk Moldavskoi SSR, Institut Zoologii, Kishinev: 33-39.

——, 1966. Znachenie amfipod i mizid v pitanii ryb vodoemov Moldavii. Gidrobiol. Zh., **24** (4): 32-37.

——, 1967. Amfipody i mizidy basseĭnov rek Dnestra i Pruta: 1-172 (Izd. Nauka, Moskva).

DERZHAVIN, A. N., 1938. Bokoplavy Nakhichevanskoi ASSR. Trudy zool. Inst. Baku, **8** (42): 163-184.

——, 1939. Presnovodnie Perakaridi Talisha. Trudy zool. Inst. Baku, **10**: 43-57.

DOBREANU, E. & C. MANOLACHE, 1936. Zur Kenntnis der Amphipodenfauna Rumäniens (zweiter Beitrag). Bull. Sect. scient. Acad. roum., **18** (1-2): 24-30.

—— & ——, 1942. Nouvelles contributions à l'étude des Amphipodes de Roumanie. Bull. Sect. scient. Acad. roum., **25** (5): 293-304.

GOEDMAKERS, A. & S. PINKSTER, 1977. The Gammarus pulex-group in Italy (Crustacea, Amphipoda). Bull. zool. Mus. Univ. Amsterdam, **6** (2): 11-20.

KARAMAN, G., 1964. Über einige Gammarus (Rivulogammarus) Arten aus Jugoslawien. Arh. biol. Nauka, Beograd, **16** (1-2): 1-2.

——, 1965. Über die Gattung Fontogammarus S. Karaman in Jugoslawien. Fragm. balcan., **5** (13): 81-89.

——, 1966. Beitrag zur Kenntnis der Gammarus (Rivulogammarus) Arten Jugoslaviens. Acta Mus. maced. Sci. nat., **10** (5): 111-127.

——, 1968a. XVI Beitrag zur Kenntnis der Amphipoden (Crustacea, Malacostraca). Fragm. balcan., **6** (16): 149-155.

——, 1968b. Quelques aspects de la faune des Amphipodes de l'eau douce en Yougoslavie. Trav. Mus. Hist. nat. "Gr. Antipa", Cent. G. Antipa 1867-1967, București, **8**: 49-58.

——, 1969. XVIII. Beitrag zur Kenntnis der Amphipoden. Gammarus balcanicus halilicae n. ssp. aus Mazedonien. Fragm. balcan., **7** (6): 45-52.

——, 1973. 53. Contribution to the knowledge of the Amphipoda. Some new or very interesting Gammarus species from southern Europe and Asia Minor. Poljoprivreda i Šumarstvo, Titograd, **19** (3): 1-42.

——, 1974. Crustacea Amphipoda. Catalogus Faunae Jugoslaviae, Ljubljana, **3** (3): 1-42.

——, 1975a. Two very interesting species of Gammarus (Fam. Gammaridae) from Euro-Asia, Gammarus bosniacus Schäf. 1922 and G. brachyurus Birst. 1935 (55. Contribution to the knowledge of the Amphipoda). Boll. Mus. civ. Stor. nat. Verona, **1** "1974": 295-310.

——, 1975b. Gammarus species from Asia Minor (Fam. Gammaridae). (56. Contribution to the knowledge of the Amphipoda). Boll. Mus. civ. Stor. nat. Verona, **1** "1974": 311-343.

——, 1976a. Contribution to the knowledge of the Amphipoda 75. Description of one new species of the genus Gammarus (family Gammaridae) from the Ohrid Lake, G. stankokaramani n. sp. Poljoprivreda i Šumarstvo, Titograd, **22** (1): 87-96.

——, 1976b. Contribution to the knowledge of the Amphipoda 76. Gammarus macedonicus n. sp., one new species from Ohrid Lake. Posebno Izd. prirod. Muz. Skopje, **7**: 71-79.

——, 1977a. Contribution to the knowledge of the Amphipoda 77. Gammarus ochridensis Schäf. species complex of Ohrid Lake. Glasn. Odjeljenja Prir. Nauka, Crnogorska Akad. Nauka, Titograd, **2**: 49-89.

——, 1977b. Contribution to the knowledge of the Amphipoda 90. Revision of Gammarus balcanicus Schäf. 1922 in Yugoslavia (fam. Gammaridae). Poljoprivreda i Šumarstvo, Titograd, **23** (4): 37-60.

——, 1978. Amphipoda from Skadar Lake and its drainage system. Verh. int. Verein. Limnol., **20**: 2579-2583.

——, 1985. Contribution to the knowledge of the Amphipoda 151. Gammarus salemaai, new species from Lake Ohrid (fam. Gammaridae). Fragm. balcan., **12** (14): 155-168.

KARAMAN, G. & S. PINKSTER, 1977a. Freshwater Gammarus species from Europe, North Africa and adja-

cent regions of Asia (Crustacea-Amphipoda). Part I. Gammarus pulex-group and related species. Bijdr. Dierk., **47** (1): 1-97.

—— & ——, 1977b. Freshwater Gammarus species from Europe, North Africa and adjacent regions of Asia (Crustacea-Amphipoda). Part II. Gammarus roeseli-group and related species. Bijdr. Dierk., **47** (2): 165-196.

KARAMAN, G. & S. RUFFO, 1979. Il Gammarus balcanicus Schäferna nella fauna Italiana (Crustacea, Amphipoda). Atti Memorie Accad. Agric. Sci. Lett. Verona, (6) **29**: 77-90.

KARAMAN, S., 1929. II. Beitrag zur Kenntnis der Amphipoden Jugoslaviens. Glasn. zemalj. Mus. Bosni Herceg., **41** (1): 83-100.

——, 1931a. III. Beitrag zur Kenntnis der Amphipoden Jugoslaviens, sowie einiger Arten aus Griechenland. Prirodosl. Razpr., **1**: 31-66.

——, 1931b. 4. Beitrag zur Kenntnis der Süsswasseramphipoden. Glasn. skops. nauc. Drust., **9** (3): 93-107.

——, 1934. Über asiatische Süsswassergammariden. Zool. Anz., **106** (5-6): 127-134.

——, 1935. VII. Beitrag zur Kenntnis der Süsswasseramphipoden. Zool. Anz., **110** (1-6): 125-130.

——, 1958. Weitere Beiträge zur Kenntnis der Amphipoden und Isopoden Jugoslawiens und Griechenland. Biol. Glasn., Zagreb, **11**: 11-22.

KARAMAN, S. & G. KARAMAN, 1959. Gammarus (Fluviogammarus) triacanthus Schäferna, argaeus Vavra und roeselii Gervais am Balkan. Izd. Zav. Ribarst. N.R. Maked., Skopje, **2** (9): 183-211.

MARTYNOV, A. V., 1930. Fauna Amphipoda Teletskogo ozera i ee proiskhozhdenie. Izv. gosud. Gidrob. Inst., **29**: 95-128.

——, 1931. Zur Kenntnis der Amphipoden der Krim. Zool. Jb., (Syst.) **60** (5-6): 573-606.

——, 1935. K poznaniyu Amphipoda tekuchikh vod Turkestana. Trudy zool. Inst. Akad. Nauk SSSR, Leningrad, **2** (2-3): 411-508.

PINKSTER, S., 1978. Amphipoda. In: J. ILLIES ed., Limnofauna Europaea (2nd ed.): 244-253 (Gustav Fischer, Stuttgart/New York; Swets & Zeitlinger, Amsterdam).

PLJAKIĆ, M. A., 1962. A contribution to the knowledge of the structure of mixed populations of the amphipods Gammarus (R.) balcanicus and Gammarus (R.) pulex fossarum. Arh. biol. Nauka, Beogr., **14** (1-2): 69-76.

RUFFO, S., 1937. Studi sui Crostacei Anfipodi. III. Gammaridi delle acque superficiali del Veneto, della Venezia Tridentina e della Lombardia. Memorie Mus. Stor. nat. Venezia trident., **4** (1): 35-61.

RUFFO, S. & A. VIGNA-TAGLIANTI, 1967. Sulla presenza di Gammaridi (Crustacea Amphipoda) a distribuzione orientale nelle acque dolci dell'Italia centro meridionale. Archo. bot. biogeogr. ital., **43**: 3-12.

SALEMAA, H., 1986. Karyological studies in Gammarus and Asellus species from Lake Ohrid. In: Station Hydrobiologique-Ohrid, Édition jubilaire, I: 245-254.

SCHÄFERNA, K., 1908. Die zoologische Reise des naturwissenschaftlichen Vereines nach Dalmatien im April 1906. B. Specieller Teil. Bearbeitung des gesammelten Materiales. 12. Amphipoda. Mitt. naturw. Ver. Univ. Wien, **6** (9-10): 126.

——, 1920. A contribution to the knowledge of the Gammarida of the Adriatic region and their geographical distribution. Bull. int. Acad. Sci. Prague, **23**: 38-43.

——, 1922. Amphipoda balcanica, spolu s poznámkami o jiných sladkovodních Amphipodech. Mém. Soc. r. Sci. Bohème, (Cl. Sci.) **1921-1922** (12): 1-111, pls. I-II.

——, 1926. Gammaridea ze sběrù prof. Dra Julia Komárka v Makedonii. Mém. Soc. r. Sci. Bohème, (Cl. Sci.) **1925** (10): 1-15.

SCHELLENBERG, A., 1937a. Schlüssel und Diagnosen der dem Süsswasser-Gammarus nahestehenden Einheiten ausschliesslich der Arten des Baikalsees und Australiens. Zool. Anz., **117** (11-12): 267-280.

——, 1937b. Kritische Bemerkungen zur Systematik der Süsswassergammariden. Zool. Jb., (Syst.) **69** (5-6): 469-516.

——, 1938. Tschechoslowakische Amphipoden. Zool. Anz., **121** (9-10): 239-244.

——, 1943. Die Amphipoden des Ochridasees. Zool. Anz., **143** (3-4): 97-103.

SPANDL, H., 1924. Studien über Süsswasseramphipoden I. Sber. Akad. Wiss. Wien, math.-naturw. Kl., (I) **133** (9): 431-525.

STANKOVIĆ, S. & M. PLJAKIĆ, 1962. Variabilité intraspécifique des Amphipodes et des Isopodes endémiques du lac d'Ohrid. Izdanija, Mus. macedon. Sci., Zbornik na Dr. S. Karaman, **3** (2): 67-97.

STRAŠKRABA, M., 1953. Předběžná zpráva o rozšíření rodu Gammarus v ČSR. Věst. čsl. zool. Spol., **17** (3): 212-227.

——, 1957. Beitrag zur Kenntnis der Amphipodenfauna Karpatenrusslands (USSR). Věst. čsl. zool. Spol., **21** (3): 256-272.

——, 1959. Beitrag zur Kenntnis der Verbreitung der Amphipoden in der Tschechoslowakei aus dem zoogeographischen Gesichtspunkt. Acta Univ. Carol., (Biol.), **1958** (2): 197-208.

——, 1962. Amphipoden der Tschechoslowakei nach den Sammlungen von Prof. Hrabe. I. Vest. čsl. zool. Spol., **26** (2): 117-145.

——, 1967. Amphipoda. In: J. ILLIES ed., Limnofauna Europaea: 202-209 (Gustav Fischer, Stuttgart).

LIST OF (SUB)SPECIFIC NAMES USED IN THIS PAPER

(names in current use are printed in italics, synonyms in roman characters)

Received: 9 December 1986