

A reassessment of *Paralimnocythere* CARBONNEL, 1965 (Crustacea, Ostracoda, Limnocytherinae), with a description of a new genus and two new species

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Abstract

The Recent and Fossil species of *Paralimnocythere* are reassessed and the genus is characterized using both soft part and valve morphology. Seventeen species, of which eleven have living representatives, are here retained. *Relictocytherina* NEGADAIEV-NIKONOV, 1968 is confirmed as a synonym of *Paralimnocythere*; *R. originalis* (NEGADAIEV-NIKONOV, 1965), the type species, is furthermore synonymous with *P. relictata* (LILLJEBORG, 1863). *Paralimnocythere psammophila* (FLÖSSNER, 1965) and *P. compressa* (BRADY & NORMAN, 1889) are both reinstated as valid species, quite different from *P. relictata*. All Recent Balkan species are retained as valid and *P. ochridense* (KLIE, 1934) is here re-described as an example of the Balkan endemics. *Paralimnocythere messanai* nov. spec. is described from interstitial habitats in an Italian river and as such constitutes the first subterranean representative of the genus.

There are seven Fossil species, the oldest ones being found in Miocene deposits. *Paralimnocythere* WANG WEN-SHENG, 1989 is a junior homonym and the three *Cytherissa*-like species require a new generic name. A new genus, *Kiwicythere* nov. gen., is erected to comprise a new species from the Chatham Islands (*K. anneari* nov. spec.) and *P. vulgaris* MCKENZIE & SWANSON, 1981 from New Zealand. It is here postulated that this genus does not belong to the same phyletic lineage as *Paralimnocythere* s.s.; it is more closely related to other southern hemisphere limnocytherids. *Paralimnocythere* s.s. itself has a Palaearctic distribution.

Key words: *Limnocythere*, Palaearctic, Italy, New Zealand, interstitial fauna, Macedonia.

Résumé

Les espèces actuelles et fossiles de *Paralimnocythere* sont réévaluées et les caractéristiques génériques établies en fonction des parties molles et de la morphologie des valves. Dix-sept espèces, dont onze ont des représentants vivants, sont ici retenues. *Relictocytherina* NEGADAIEV-NIKONOV, 1968 est confirmée comme synonyme de *Paralimnocythere*; *R. originalis* (NEGADAIEV-NIKONOV, 1965) l'espèce type, est en outre synonyme de *P. relictata* (LILLJEBORG, 1863). *Paralimnocythere psammophila* (FLÖSSNER, 1965) et *P. compressa* (BRADY & NORMAN, 1889) sont rétablies en tant qu'espèces à part, complètement distinctes de *P. relictata*. Toutes les espèces balkaniques actuelles sont validées et *P. ochridense* (KLIE, 1934) est ici redécrite comme un exemple d'espèce balkanique endémique.

Paralimnocythere messanai nov. spec. est décrite dans un habitat interstitiel d'une rivière italienne et devient de ce fait le premier représentant endogé du genre. Il existe sept espèces fossiles dont les plus anciennes ont été trouvées dans les dépôts du Miocène. *Paralimnocythere* WANG WEN-SHENG, 1989 est l'homonyme le plus récent et il est nécessaire de donner un nouveau nom générique aux trois espèces ressemblant à *Cytherissa*. Un nouveau genre, *Kiwicythere* nov. gen., est érigé pour contenir une nouvelle espèce originaire des îles Chatham (*K. anneari* nov. spec.) et *P. vulgaris* MCKENZIE & SWANSON, 1981 de Nouvelle Zélande. Il est postulé que ce genre n'appartient pas à la même lignée phylétique que *Paralimnocythere* s.s.; il est en effet plus proche des autres Limnocytherides de l'hémisphère sud, alors que *Paralimnocythere* s.s. a une distribution paléarctique.

Mots-clés: *Limnocythere*, Paléarctique, Italie, Nouvelle Zélande, faune interstitielle, Macédoine.

Introduction

KLIE (1934) was the first to introduce some order into the rather heterogenous group of *Limnocythere*-species, when he distinguished three different types of male copulatory appendages: the *aethiopica*, the *sanctipatricii* and the *relictata*-type. In the meantime, names have become available for these three groups. The *aethiopica*-type was shown to also occur in *L. inopinata*, the type species of *Limnocythere*, hence this group has to be *Limnocythere* s.s. (see MARTENS, 1990). According to DANIELOPOL *et al.* (1990), *L. sanctipatricii*, together with a great number of North American species, forms the subgenus *Limnocytherina* NEGADAIEV-NIKONOV, 1968 of *Limnocythere*. CARBONNEL (1965) erected the genus *Paralimnocythere* for the *relictata*-group. PETKOVSKI (1969) considered both *Limnocytherina* and *Paralimno-*

cythere as subgenera of *Limnocythere* and furthermore synonymized the fossil genus *Relictocytherina* NEGA-DAEV-NIKONOV, 1968 with *Paralimnocythere*. Lateron, DIEBEL & PIETRZENIUK (1978) reconfirmed the generic status of *Paralimnocythere* and also synonymized the type species of *Relictocytherina* (*R. originalis*) with *P. relictata*, the most common Recent species of *Paralimnocythere*.

Since then, a substantial amount of new species, both fossil and Recent, has been described (see below for a full literature review). Most of the Recent taxa were described from two lakes in Macedonia. For a long time, *Paralimnocythere* was thought to have a strictly European distribution (PETKOVSKI, 1969). Since then, species have been reported from northern America (DIEBEL, 1968), eastern Siberia (PIETRZENIUK, 1977) and New Zealand (MCKENZIE & SWANSON, 1981). These presumed range extensions caused problems with regard to exact zoogeographical distribution, phylogenetic position and age of the lineage. A second problem hampering identification in *Paralimnocythere*, is the identity and status of a number of species in relation to *P. relictata*. In order to investigate these problems, all records in the literature (including those of Fossil taxa) are here re-assessed, a number of taxa is redescribed using type materials and a new genus is erected to accommodate the southern hemisphere limnocytherids with branching marginal pore canals. Two new species are also described, one belonging to *Paralimnocythere* s.s., the other one being the type species of the new genus.

Abbreviations used in text and figures

Part of the terminology of the hemipenis is similar to the one developed in MARTENS (1990) and in DANIELOPOL *et al.* (1990).

Hemipenis.

cp	copulatory process
cp ₁	basal part of cp
cp ₂	ascending part of cp
cp ₃	distal part of cp

cs	caudal seta
dej	ductus ejaculatorius
dl ₁ -dl ₃	distal lobes
f ₁ -f ₃	furcal setae
fu	furca
pcp	protuberance on cp ₂
ur	upper ramus of clasping organ

Other soft parts.

A1	antennula
A2	antenna
geo	genital operculum
Md	mandibula
Mx1	maxillula
P(1-3)	walking limbs
Y and Ya	aesthetascs

Valves.

cr	intercardinal ridge
cso	cardinal socket
ct	cardinal tooth
H	height of valves
im	inner margin
L	length of valves
lc	line of conrescence
ms	muscle scars
rpc	radial pore canals
RV	right valve
LV	left valve

Museums.

BM(NH)	The Natural History Museum (formerly the British Museum) (England, London).
MF	Museo Civico di Storia Naturale di Firenze (Italy, Firenze).
NZGS	New Zealand Geological Survey (New Zealand, Lower Hut).
OC	Ostracod collection of the Royal Belgian Institute of Natural Sciences (Belgium, Brussels).
UPPS	Uppsala Universitet, Zoologiska Muset (Sweden, Uppsala).

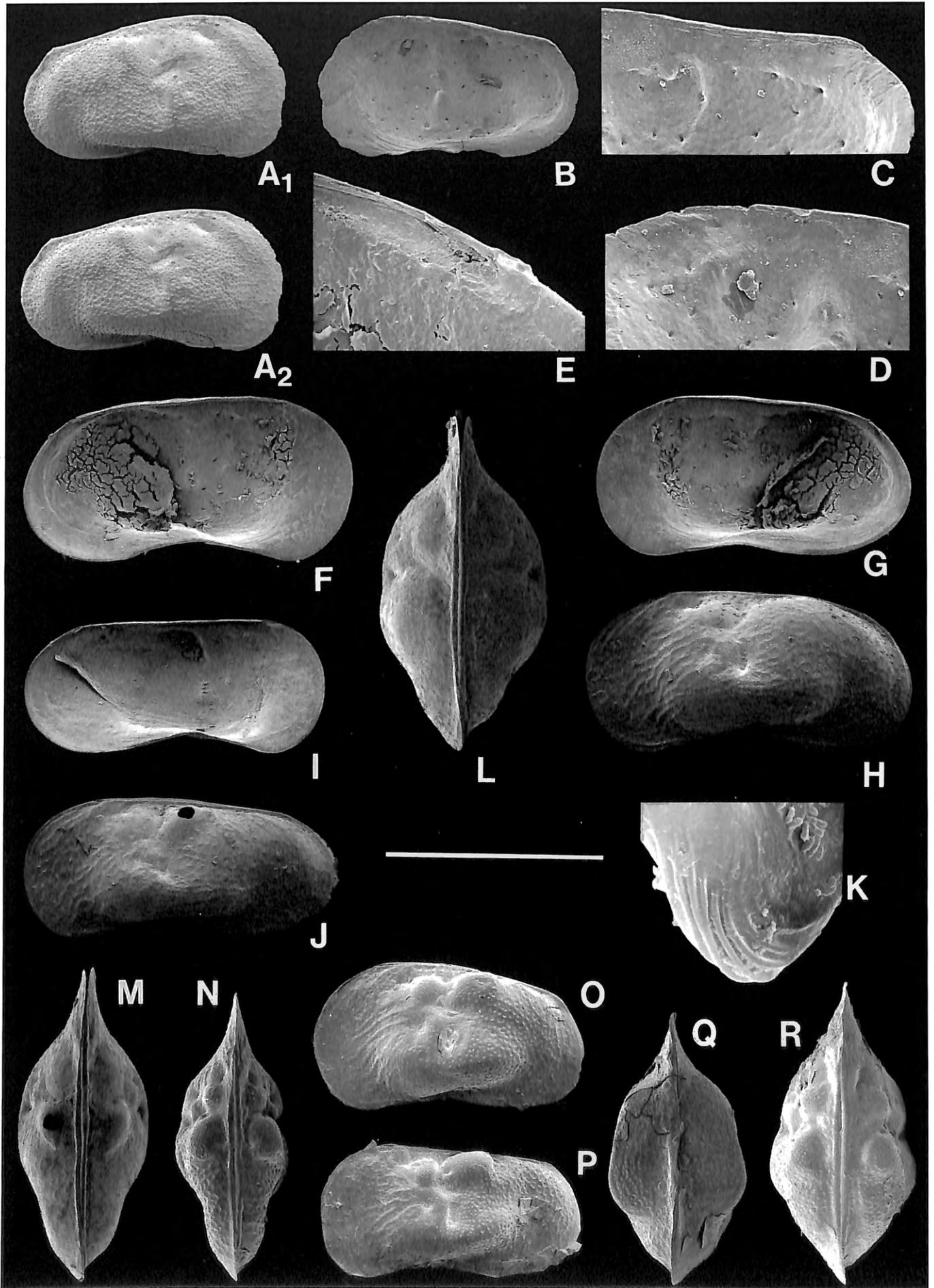
Fig. 1 – *Paralimnocythere bouleigensis* CARBONNEL, (A-D); *P. relictata* (LILLJEBORG) (E-M) & *P. compressa* (BRADY & NORMAN) (N-R).

P. bouleigensis: A. ♀ (A-1), RV, external view, stereo-pair (no. OC.1628). B. ♀, RV, internal view (OC.1629). C. *Idem*, detail of posterior part of hinge. D. *Idem*, detail of anterior part of hinge.

P. relictata: E. ♀, RV, internal view, detail of posterior cardinal tooth (UPPS-LILLJEBORG.3387 : 3). F. ♀, LV, internal view (UPPS-LILLJEBORG.3387 : 3). G. ♀, RV, internal view (UPPS-LILLJEBORG.3387 : 3). H. ♀, LV, external view (UPPS-LILLJEBORG.3387 : 3). I. ♂, LV, internal view (temp. code KM.1432 — specimen lost). J. ♂, Cp, left lateral view (UPPS-LILLJEBORG.3387 : 4). K. ♂, hemipenis, detail of protuberance on copulatory process. L. ♀, Cp, dorsal view (UPPS-LILLJEBORG.3387 : 112). M. ♂, Cp, dorsal view (UPPS-LILLJEBORG.3387 : 4).

P. compressa: N. ♂, Cp, dorsal view (BM(NH).1992.61). O. ♀, Cp, left lateral view (BM(NH).1992.64). P. ♂, Cp, left lateral view (BM(NH).1992.65 — specimen afterwards used for line drawings of soft parts, valves lost). Q. ♀, Cp, ventral view (BM(NH).1992.63). R. ♀, Cp, dorsal view (BM(NH).1992.62).

Scale = 556 µm for B; 455 µm for F-J, L-R; 446 µm for A; 222 µm for C,D; 80 µm for E; 10 µm for K.



Taxonomic Descriptions

Subclass	Ostracoda LATREILLE, 1806
Order	Podocopa G.W. MÜLLER, 1894
Suborder	Podocopa SARS, 1866
Infraorder	Cytherocopina GRÜNDEL, 1967
Superfamily	Cytheroidea BAIRD, 1850
Family	Limnocytheridae KLIE, 1938
Subfamily	Limnocytherinae KLIE, 1938
Tribe	Limnocytherini KLIE, 1939

REMARK

For a diagnosis of the subfamily, see COLIN & DANIELOPOL (1978, 1980). The four tribes in the Limnocytherinae (Limnocytherini, Leucocytherini, Cytheridellini, Dinacytherini) were characterized by DANIELOPOL *et al.* (1990). For a discussion on the use of infraorders, see MARTENS (1992).

Genus *Paralimnocythere* CARBONNEL, 1965

Paralimnocythere CARBONNEL, 1965.

syn. *Relictocytherina* NEGADAIEV-NIKONOV, 1968 synonym *sensu* PETKOVSKI, 1969).

non *Paralimnocythere* WANG WEN-SHENG, 1989 (= junior homonym).

non *Paralimnocythere sensu* MCKENZIE & SWANSON, 1981 (= *Kiwicythere* nov. gen. - see below).

TYPE SPECIES

Paralimnocythere bouleigensis CARBONNEL, 1965.

DIAGNOSIS

Limnocytherids with branched pore canals, and with inner margins running regularly. RV with both anterior and posterior cardinal teeth present (either short and rounded (e.g. *P. ochridense*), or more elongated (e.g. *P. relictica*)) or with hinge completely adont (e.g. *P. bouleigensis* - see remark).

A1 with an apical seta on the second segment. Respiratory plate on Mx1 semi-circular. P(1), P(2) and P(3) all with ventral setae on basal segments minute or absent; ♂ furca with a short base. Hemipenis with one or two additional lobes near dl, the latter relatively small; furcal seta f_1 long; copulatory process pc short, curved and inserted in the distal 2/3 of hemipenis.

ADDITIONAL GENERIC FEATURES

Carapace in dorsal view with a rostrum-like (convex) anterior and a squarish posterior margin. Surface of valves with prominent ridges, tubercles and ala. Sieve pores of normal size, shape and abundance. Mx1-palp with a rectangular terminal segment.

SEXUAL DIMORPHISM

♂ valves somewhat longer and narrower in dorsal view, ♀ valves in lateral view with dorsal margin sloping towards the caudal side. A2 with claws not strikingly different in both sexes; aesthetasc Y in ♀ shorter than both accompanying setae, in ♂ shorter than one of these setae only.

REMARK

CARBONNEL (1965) wrote that the hinge of *P. bouleigensis* is adont and this could be confirmed after re-examination of some paratypes with S.E.M. (Figs. 1A-D). The Recent West-Palaeartic species, on the other hand, appear to have two cardinal teeth on the RV. However, as I only had limited Miocene material, this difference is not deemed of sufficient importance to provoke the creation of a new taxon for the Recent species to date.

OTHER RECENT SPECIES

Paralimnocythere relictica (LILLJEBORG, 1863) KRSTIC, 1984 (syn.: *Relictocytherina originalis* (NEGADAIEV-NIKONOV, 1965) *sensu* DIEBEL & PIETRZENIUK, 1978); *P. compressa* (BRADY & NORMAN, 1889) DIEBEL & PIETRZENIUK, 1969; *P. psammophila* (FLÖSSNER, 1965) nov. comb.; *P. diebeli* (PETKOVSKI, 1969) DIEBEL & PIETRZENIUK, 1978; *P. ochridense* (KLIE, 1934) nov. comb.; *P. umbonata* (KLIE, 1939) nov. comb.; *P. alata* (KLIE, 1939) nov. comb.; *P. karamani* (PETKOVSKI, 1960) nov. comb.; *P. georgevitschi* (PETKOVSKI, 1960) nov. comb.; *P. slavei* (PETKOVSKI, 1969) nov. comb.

OTHER FOSSIL SPECIES

P. rostrata (STRAUB, 1952), *P. cretensis* MOSTAFAWI, 1989, *P. dalmatica* SOKAC, 1970; *P. tenera* SOKAC, 1970; *P. njaravajensis* ZUBOVITCH, 1976, *P. bicornis* FÜHRMANN, 1991.

REMARKS

1. A number of species have previously been referred to *Paralimnocythere*, but do not belong there.

Limnocythere posterolimba DELORME, 1967 (redescribed in DELORME, 1971) was placed in *Paralimnocythere* by DIEBEL (1968). For this decision, DIEBEL (loc. cit.) relied on the description of the marginal zone, with: "... radial pore canals bifurcate ..." (DELORME 1967 : 362, 1971 : 52). However, a close examination of the morphology of the hemipenis of this species as described by DELORME (1971) illustrates that *L. posterolimba* rather belongs to the subgenus *Limnocytherina*, and not to the *Paralimnocythere* lineage within the Limnocytherini. No genuine *Paralimnocythere* species are therefore known from the Nearctic.

Paralimnocythere vulgaris MCKENZIE & SWANSON, 1981 is here referred to *Kiwicythere* nov. gen. (see below).

WANG WEN-SHENG (1989) described a new genus from the early Cretaceous of Nei Mongol and named it *Paralimnocythere*, thus clearly creating a junior homonym. The genus comprised the following three species: *P. impolita* WANG WEN-SHENG, 1989; *P. erenhotensis* WANG WEN-SHENG, 1989 and *P. spinisalata* WANG WEN-SHENG, 1989 and should receive a new name. The three taxa are however much more closely related to *Cytherissa* SARS, 1925 than to *Limnocythere*.

Limnocythere esphigmenia SIEBER, 1905 is closely related to *Paralimnocythere rostrata* according to STRAUB (1952) and one might therefore assume that the species could belong in this genus. However, the brief redescription offered by LUTZ (1966: 307) already shows that this species does not belong here. JANZ (1992), relying on extensive fossil material from the Miocene of southern Germany, offered many new figures and referred this species to *Leucocythere*, thus substantially widening the concept of this genus, which was recently redefined by DANIELOPOL *et al.* (1990).

Finally, *P. dinarica* SOKAC, 1970 and *P. originalis thuringica* DIEBEL & PIETRZENIUK, 1978 both constitute a *nomen nudum*.

2. Most Recent species have hemipenes with a solid lobe dl₂. This structure has not been illustrated for a number of other Balkan taxa, but there it might have been overlooked and these hemipenes should be reinvestigated. It is here postulated that this elongated lobe dl₂ is homologous with the moveable trabecule in species of *Limnocythere* s.s. and *Ovambocythere* MARTENS.

***Paralimnocythere bouleigensis* CARBONNEL, 1965**
(Figs. 1(A-D))

Paralimnocythere bouleigensis CARBONNEL, 1965: 147-150, pls. 1-2.

TYPE LOCALITY

Valley of Bouleigue, Nyons (Drome, South East France).

TYPE HORIZON

Tortonian (fluvio-lacustre) (Miocene).

TYPE MATERIAL STUDIED

2 paratypes: 1 RV (A-1) juvenile ♀ (no. OC.1628) and 1 RV of an adult ♀ (no. OC.1629 - partly broken after use for S.E.M.).

DIAGNOSIS OF ♀

Relatively elongated, with nearly straight dorsal margin, broadly rounded anterior margin and narrow, but evenly rounded posterior margin, evenly passing into the ventral margin, but forming a blunt angle with the dorsal margin, the carapace there building a keel. External valve surface weakly pitted, with a ventral, weakly formed ridge, a shallow vertical sulcus (medially inserted) and an antero-dorsal depression. Internally with adont hinge, RV with a weak intercardinal ridge. Measurements: RV ♀ (paratype): L = 680 µm.

***Paralimnocythere relictata* (LILLJEBORG, 1863)**
(Figs. 1(E-M), 3, 4(A-E))

Cythere relictata LILLJEBORG, 1863: 391-394, plt 1(1-17).

Limnocythere relictata LILLJEBORG, 1883: 8.

Paralimnocythere relictata (LILLJEBORG), KRSTIC, 1981.

Relictocytherina originalis (NEGADAEV-NIKONOV, 1965). DIEBEL & PIETRZENIUK, 1978: 212.

TYPE MATERIAL INVESTIGATED

UPPS-3384: ("Limnocythere relictata, Ultuna, d. 19/6 88, LILLJ."). 22 ♂ and ♀, all decalcified, but with soft parts in good condition. One ♂ (UPPS-Lilljeborg.3384:1/2) from this collection dissected, with valves stored dry and soft parts kept in glycerine in a sealed slide.

UPPS-3386: (= Typesamlungen no. 5430 Crustacea) ("Limnocythere relictata, Upsala, d. 12/5 58, LILLJ.") 1 unidentifiable (crushed and decalcified) specimen.

UPPS-3387: ("Limnocythere relictata, Malma, d. 17/5 95, LILLJ."). 6 ♀ + 5 ♂, some crushed, most in good condition. Some of these specimens used for S.E.M.: 1 ♀ (no. UPPS-Lilljeborg.3387:3); 1 ♂ (no. UPPS-Lilljeborg.3387:4); 1 ♀ (no. UPPS-Lilljeborg.3387:1/2) dissected with valves stored dry and soft parts kept in glycerine in a sealed slide.

BM(NH)-M.3401 (NORMAN collection 1911.11.8). 'Limnocythere relictata' LILLJEBORG, Upsala, Sweden, coll. 10/5/1882. TYPES. 2 ♀ stored dry in a micropalaeontological slide. Specimens in good condition.

LECTOTYPE

Only no. UPPS.3386 of the Uppsala collection is indicated as typematerial and this specimen cannot be used. A lectotype is therefore not designated here. If no further material is present in the Uppsala museum, then the specimens from the BM(NH), obviously sent by LILLJEBORG to NORMAN, are good candidates to be designated as lectotype.

DIAGNOSIS

Carapace in dorsal view (Figs. 1L,M) with beak-like anterior; LV largely overlapping RV posteriorly and with nearly parallel lateral margins, evenly sloping towards both anterior and posterior edges; four dorsal semi-globular lobes not very pronounced; $W/L = c. 1/2$ in ♀, $c. 5/12$ in ♂.

Male in lateral view (1I,J) with valves elongated, with straight dorsal margin and with anterior and posterior margins subequally rounded. Female (Figs. 1F-H) with dorsal margin slightly sloping towards the posterior side, and with the latter margin consequently less broadly rounded than the anterior margin. RV with a small, but clear elongated posterior cardinal tooth (Fig. 1E), fitting into a cardinal socket on the LV. A1 in both sexes with terminal segment strikingly elongated (Figs. 3D,4A).

P(1) with kneesetae on first segment subequal (Figs. 3A, 4C). Hemipenis (Fig. 3F) with lobe dl_1 small and in an oblique position; lobe dl_2 broad and stout; a subrectangular lobe dl_3 also present; copulatory process (Fig. 3G) compact, with a broad base (cp_1), but without an additional protuberance pcp on cp_2 , this corner however set with ribs (Fig. 1K); part cp_1 and cp_3 situated close together, running nearly parallel, subequal in length; furcal seta f_1 relatively small and f_2 relatively large (length ratio = $c. 3:2$).

MEASUREMENTS

(All in μm): ♀ : LV : L = 692, H = 337; RV : L = 664, H = 328; carapace : L = 701, W = 355, $W/L = 0.51$. ♂ : LV : L = 628, H = 282; carapace : L = 655, H = 291, W = 273, $W/L = 0.42$.

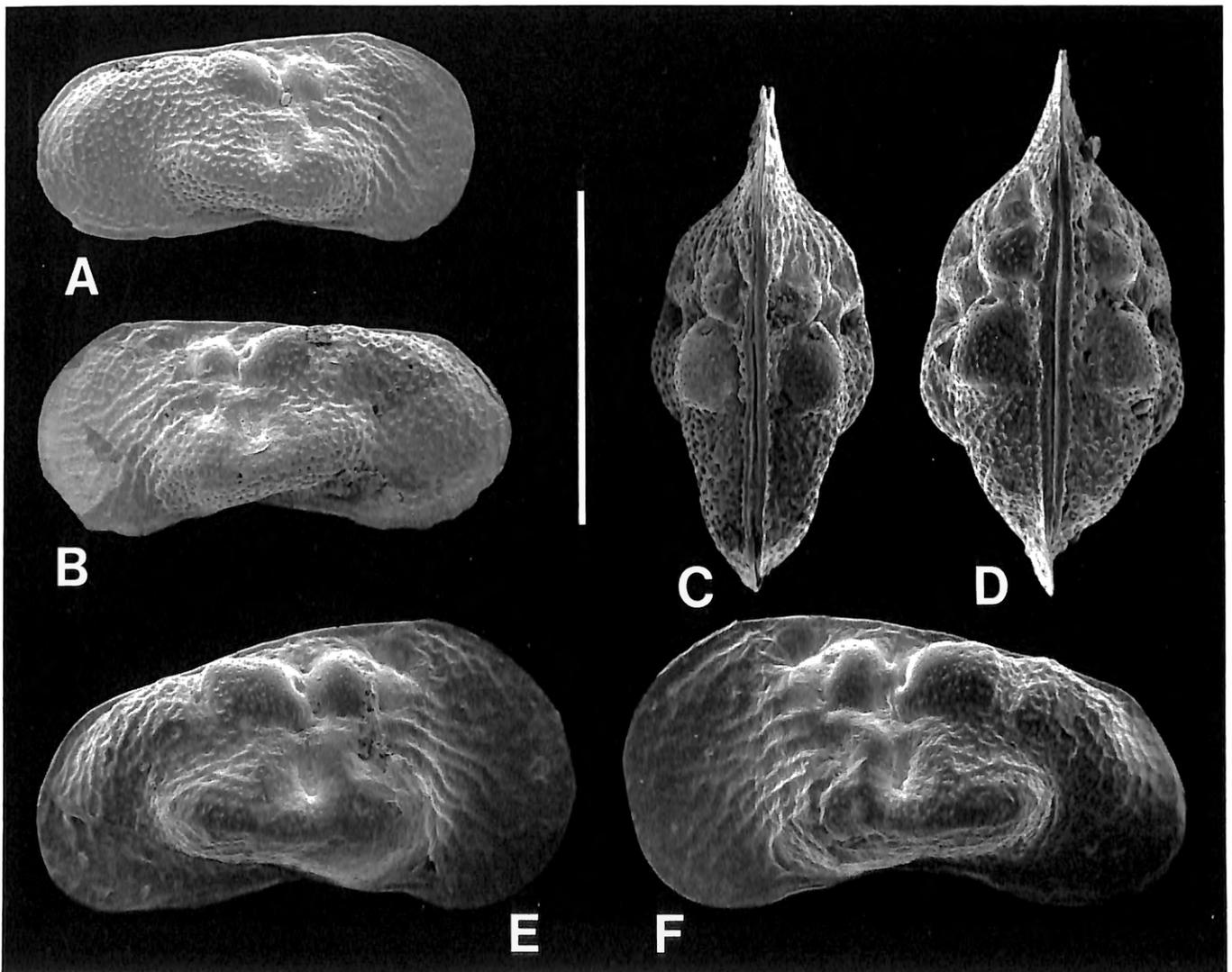
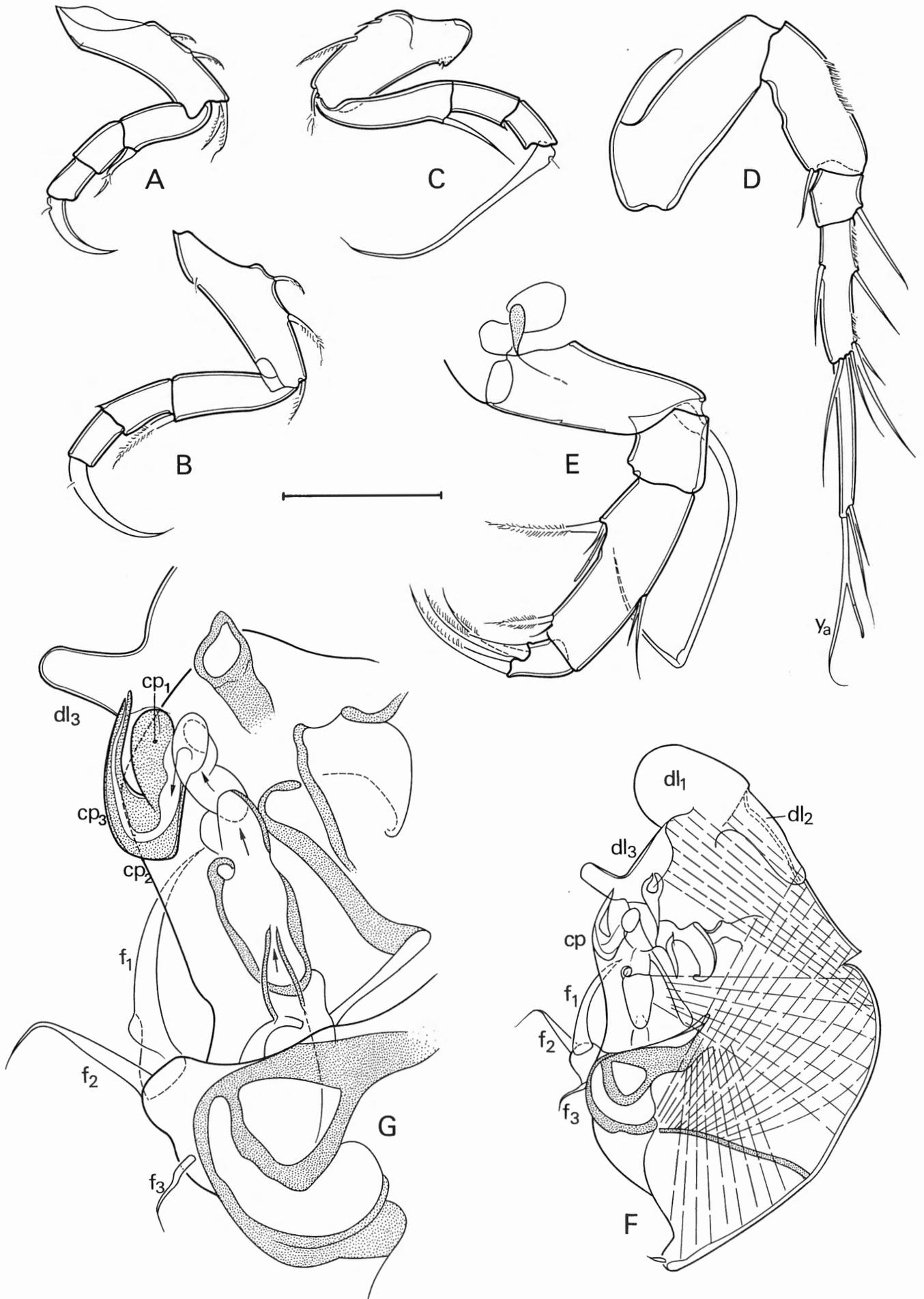


Fig. 2 – *Paralimnocythere psammophila* (FLÖSSNER) (all in slide no. OC.1691). A. ♂, RV, external view (no. KM.1490). B. ♂, LV, external view (no. KM.1491). C. ♂, Cp, dorsal view (no. KM.1488). D. ♀, Cp, dorsal view (no. KM.1489). E. ♀, RV, external view (KM.1492). F. ♀, LV, external view (no. KM.1493). Scale = 424 μm for A-F.

Fig. 3 – *Paralimnocythere relicta* (LILLJEBORG) (♂, no. UPPS-LILLJEBORG.3384 : 112). A. P(1). B. P(2). C. P(3). D. A1. E. A2. F. Hemipenis. G. Hemipenis, detail of copulatory complex. Scale = 78 μm for A-F; 29 μm for G.



DISTRIBUTION

(See also Fig. 18) : Sweden (LILLJEBORG 1863, 1883; ALM (1915), Germany (G.W. MÜLLER 1900, 1912; KLIÉ 1938), Switzerland (KAUFMANN 1892, 1896), Poland (SYWULA 1965, 1974), Russia (BRONSHTEIN 1947; SEMENOVA 1977, 1985; PIETRZENIUK 1977 (as *P. cf. diebeli*)), England (HENDERSON 1990), France (PARIS 1917, 1920, 1928 - see also MEISCH *et. al* 1990), Turkey (GÜLEN 1985).

REMARKS

1. There is a lot of confusion in the literature about the identity of this species. For the present redescription, we used type material of LILLJEBORG. At least KAUFMANN was dealing with the same species, as he could compare his specimens from Switzerland with some of LILLJEBORG's types (1896 : 361).

2. PETKOVSKI (1969) described *Paralimnocythere diebeli* and illustrated the hemipenis of both *P. diebeli* and *P. relicta* (1969 : figs. 19 & 20 resp.). However, the illustration of the hemipenis of *P. diebeli* conforms to the general morphology observed in the types of *P. relicta*. PETKOVSKI's *P. relicta*, on the other hand, is very different from true *P. relicta* (it lacks the asymmetrical lobe dl₁ and the elongated lobe dl₃, present in *P. relicta*, and has a pointed protuberance pcp on cp₂, which is completely missing in *P. relicta*), but incidentally shows great similarity with *P. messanai* nov. spec., described below. The specimens of *P. relicta sensu* PETKOVSKI originated from Germany (pers. comm. 30/3/1991). PETKOVSKI (1969) stressed that *P. diebeli* is very closely related to *P. relicta*, but also correctly pointed out that important differences exist in valve morphology, *P. diebeli* being much higher and shorter than *P. relicta*. Finally, whereas all Balkan endemics are restricted to the large lakes Ohrid and Prespa, *P. diebeli* occurs in smaller waterbodies as does *P. relicta*.

Since then, DIEBEL & PIETRZENIUK (1978) and PIETRZENIUK (1977) reported a species which they named *P. cf. diebeli*. DIEBEL & PIETRZENIUK (loc. cit.) also included ABSOLON's (1976) record of *P. originalis thuringica* (to be considered a *nomen nudum* according to PIETRZENIUK, pers. comm. 19/4/1991) as *P. cf. diebeli*. I have compared all these records and reached the following conclusions :

(a) The Recent population reported from Jakutsk (Eastern Siberia) by PIETRZENIUK (1977) should probably be referred to *P. relicta*. A close examination of

the hemipenis morphology will yield conclusive evidence.

(b) *P. cf. diebeli* in DIEBEL & PIETRZENIUK (1978) is indeed a species with valve morphology intermediate between *P. relicta* and *P. diebeli*.

(c) The taxon reported by ABSOLON (1976) is very different from both taxa and is here referred to as *Paralimnocythere* uncertain species. (Fig. 18).

(d) *P. relicta* and *P. diebeli* should be treated as separate species. The main differences between both taxa are cited in the keys given below.

3. The specimens from Anatolia (GÜLEN, 1985) should be reinvestigated to check whether this author was indeed dealing with *P. relicta*, as no figures or descriptions were given.

Paralimnocythere psammophila

(FLÖSSNER, 1965) nov.comb.

(Fig. 2)

Limnocythere psammophila FLÖSSNER, 1965 : 466-470.
SYWULA, 1970 : 666-667.

TYPE MATERIAL

Numerous attempts were made to obtain type material of *P. psammophila*, which is believed to be lodged either in the Akademie der Wissenschaften at Jena (H. PETERSEN, pers. comm. 2/4/1991) or in the personal collection of Dr FLÖSSNER (Dr E. PIETRZENIUK, pers. comm. 19/4/1991), but I have been unsuccessful.

MATERIAL INVESTIGATED

1 RV, 1 LV, 1 empty Cp of both ♂ and ♀ from subrecent sediments of Lake Wumm (Grosse Wumm-See), Germany, situated at c. 15 km from Lake Stechlin, the type locality. Material collected by Dr E. PIETRZENIUK (Berlin), date unknown. Material presently stored in the Ostracod Collection of the K.B.I.N. (no. OC.1691).

DIAGNOSIS

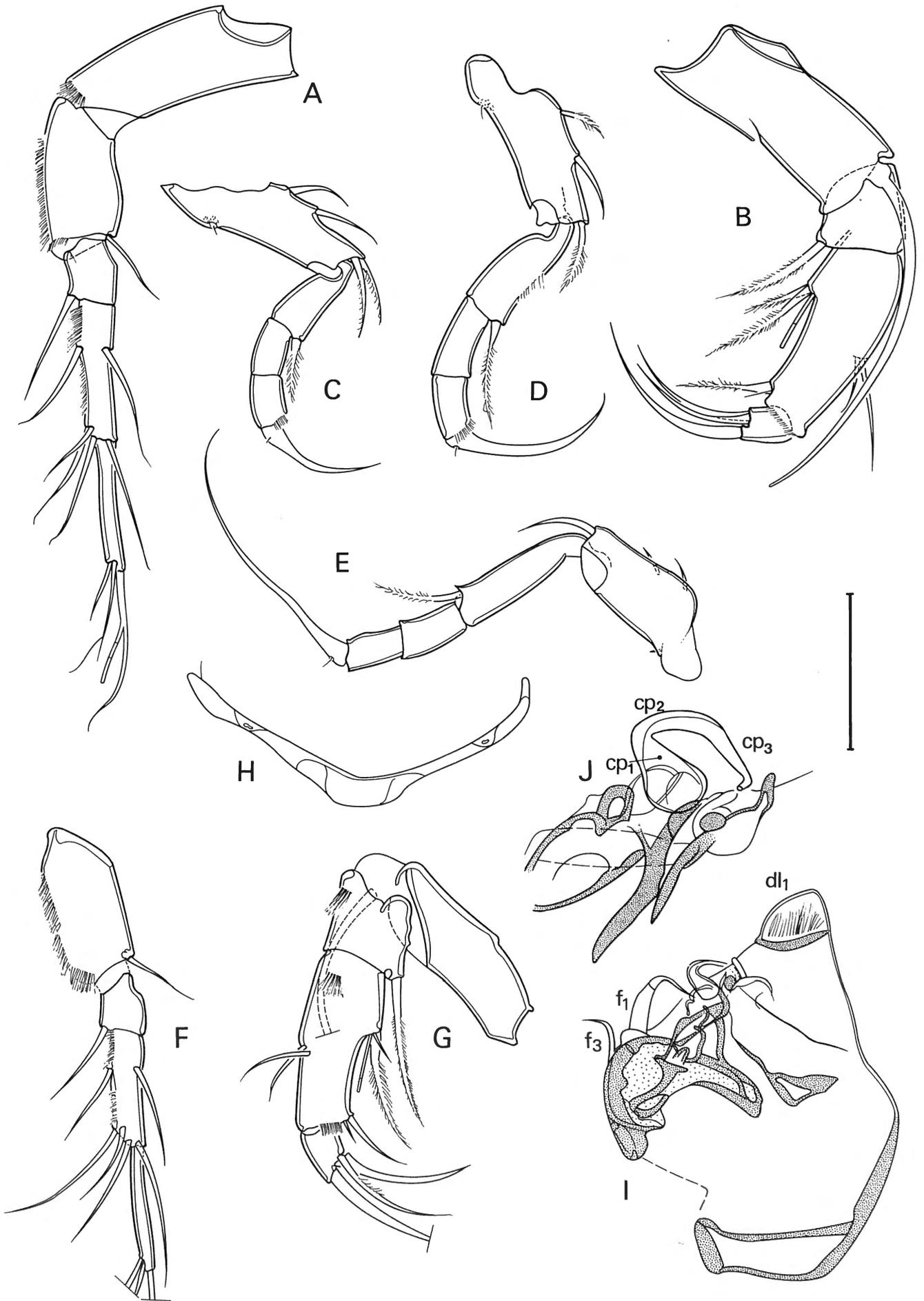
Valves large and relatively elongated in lateral view, with prominent surface sculpture. Female valves with slightly rounded dorsal margin, sloping towards a strikingly narrow caudal margin. Ventral margin sinuous. Male valves elongated, especially the LV, with nearly

Fig. 4 - *Paralimnocythere relicta* (LILLJEBORG) (♀, no. UPPS-LILLJEBORG.3387 : 1/2) & *P. compressa* (♂, no. BM(NH).1992.65).

P. relicta : A. A(1). B. A(2). C. P(1). D. P(2). E. P(3).

P. compressa : F. A1. G. A2. H. sternum. I. Hemipenis, somewhat damaged, lobe dl₂ and furcal seta f₂ not visible. J. Hemipenis, (other half of same specimen) detail of copulatory process.

Scale = 78 µm for A-I; 29 µm for J.



straight dorsal margin, the latter passing into anterior and posterior margins with a blunt angle (without such angles in *P. relictata*). In dorsal view very wide, lateral sides straight over c. 2/3 of total length, sloping towards the anterior margin (parallel in *P. relictata*); this anterior margin acutely pointed.

Soft parts (based on original description) : terminal segment of A1 as long as penultimate segment. Hemipenis with lobe dl₁ symmetrical, rounded, lobe dl₂ not illustrated, lobe dl₃ minute, pointed; copulatory process sickle-shaped; three furcal setae large.

MEASUREMENTS (in μm)

δ : RV, L = 560, H = 263; LV : L = 602, H = 271; Cp : L = 645, W = 288 (L/W = 2.24). ♀ : RV : L = 687, H = 365; LV : L = 721, H = 365; Cp : L = 687, W = 339 (W/L = 2.03).

RECENT DISTRIBUTION

Germany (FLÖSSNER 1965), France (STEGER 1979 - see also MEISCH *et al.* 1990), Russia (GOLUBNICHAYA 1967).

REMARKS

SYWULA (1970) synonymized *P. psammophila* with *P. compressa* and at first I was inclined to agree with this opinion. However, a comparison between the types of *P. compressa* and the subrecent material from Germany, kindly sent to me by Dr PIETRZENIUK, without any doubt proved that both taxa are valid and distinct species.

Paralimnocythere compressa

(BRADY & NORMAN, 1889)

(Figs. 1(N-R), 4(F-J))

Limnocythere inopinata compressa BRADY & NORMAN, 1889.

Limnocythere compressa BRADY & NORMAN, 1896.

Paralimnocythere compressa (BRADY & NORMAN) : DIEBEL & PIETRZENIUK, 1969 : 483.

TYPE MATERIAL INVESTIGATED

All material is lodged in the BM(NH) and is contained in two micropalaeontological slides. All carapaces are kept dry.

BM(NH) M.3396 (NORMAN collection 1911.11.8/171) TYPES. Whitefield Lock, Wigtonshire, July 3 1885. A micropal slide, containing 22 dried carapaces (3 δ + 19 ♀). The following specimens were illustrated : 3 ♀

(nos. BM(NH).1992.62-64) and 2 δ (nos. BM(NH).1992.61 and 65). Lectotype : the δ no. BM(NH).1992.61 (Fig. 1N) is here designated the lectotype. All other syntypes become paralectotypes.

BM(NH) M.3397 (NORMAN collection 1911.11.8/175). Loch Aber, Kircudbright Shire, June 30 1885. A micropal slide, containing 6 dried ♀ carapaces.

REMARK

As was said above, all type material of *P. compressa* was stored dried in micropalaeontological slides. From one slide, a number of specimens were removed, subsequently used for S.E.M. and are now kept in separate slides. One male (no. BM(NH).1992.65) was submerged in a phosphate-rich detergent, which destroyed the valves through decalcification (not kept), but which also efficiently re-soaked the appendages. These had been dry for more than one hundred years, but after one week in the detergent, they could be dissected and illustrated.

DIAGNOSIS

Valves relatively small; both δ and ♀ (Figs. 1(O-P)) relatively short and high in lateral view, with pronounced surface sculptures. In both sexes caudal margin in lateral view more squarish than in the preceding species. In dorsal view (Figs. 1(N,R)) lateral sides not parallel, but obliquely tapering towards the anterior, the lateral edge beak-like, but with valves closed, not open; on the posterior side, LV largely overlapping RV.

A1 (Fig. 4F) with terminal segment very elongated. Hemipenis (Fig. 4I) with lobe dl₁ almost symmetrical, lobe dl₃ minute or absent, lobe dl₂ not observed; furcal seta f₁ relatively short. Copulatory process (Fig. 4J) nearly evenly curved, with distal tube (cp₃) slightly tapering, but generally narrow, idem for cp₁; no pcp on cp₂.

MEASUREMENTS (all in μm)

♀ : carapace (1) : L = 619, W = 309, W/L = 0.50; carapace (2) : L = 564, H = 300. δ : carapace (1) : L = 592, W = 237, W/L = 0.40; carapace (2) : L = 546, H = 273.

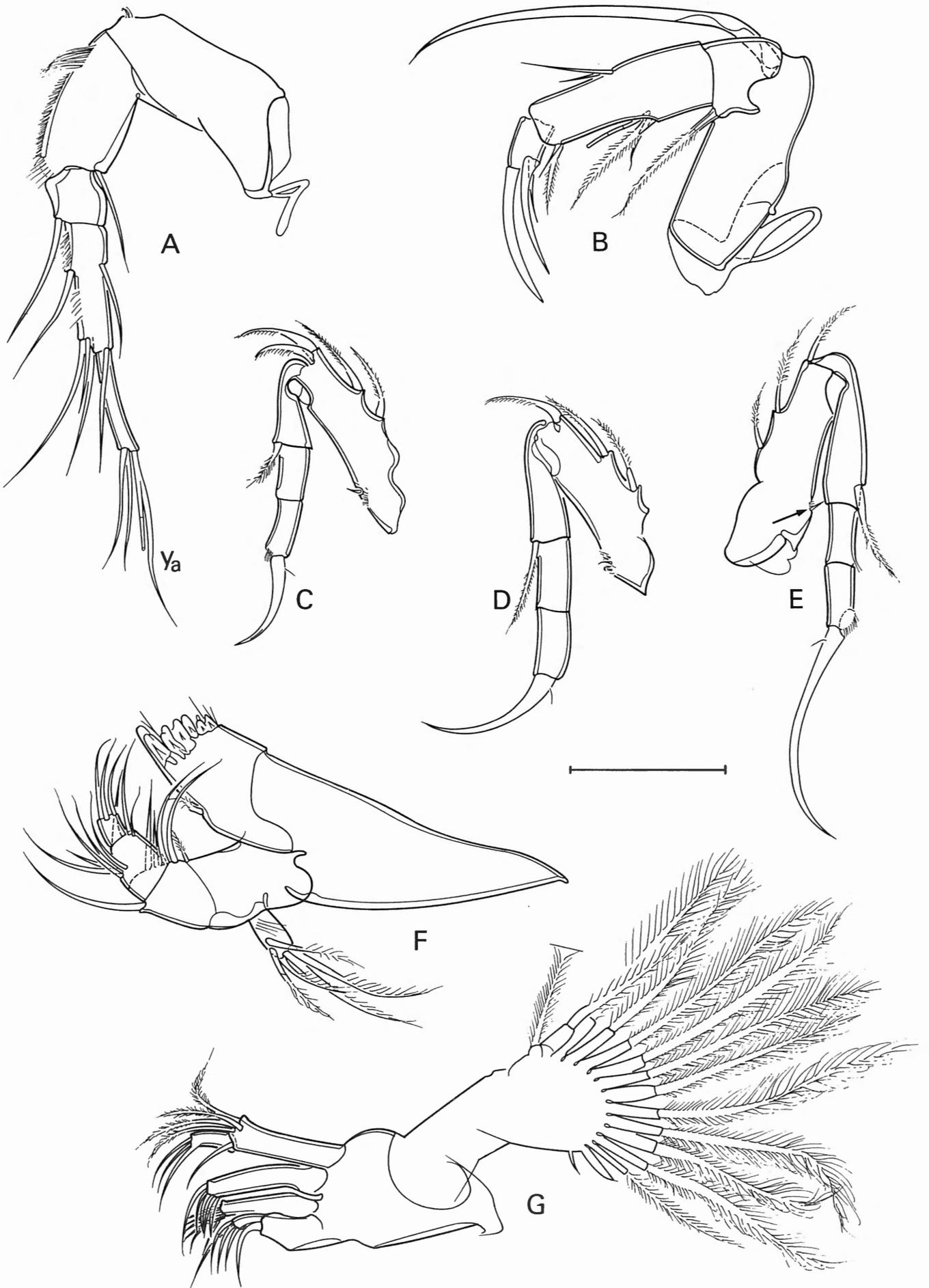
REMARKS

1. SOKAC (1980) synonymized *P. rostrata* (STRAUB) with *P. compressa* (BRADY & NORMAN) and this might actually very well be true. However, there are minor morphological differences between both species : dorsal

Fig. 5 – *Paralimnocythere ochridense* (KLIE), (δ , no. OC.1617).

A. P(1). B. P(2). C. P(3). D. A1. E. A2. F. Hemipenis, detail of furca and copulatory process. G. Hemipenis. Scale = 78 μm for A-E,G; 29 μm for F.





margin shorter, but more straight and caudal margin more rounded in *P. rostrata* (compare illustrations in STRAUB (1952) and those of the type material of *P. compressa* in the present paper). Size (c. 550 µm) and L/H ration (c. 1.88 for ♀) are similar in both taxa. Because this synonymy could have important implications (one and the same species could have existed in Western Europe at least since the Miocene) and because of the differences in shape cited above, I suggest to keep both taxa as separate species. *P. rostrata* is a Miocene species, while *P. compressa* occurs at least since the Pleistocene.

2. DE DECKKER (in GASSE *et al.*, 1987) reported *P. rostrata* from the Holocene of North Africa, but the illustration provided shows closer similarity to *P. compressa*, as redefined here. If SOKAC' synonymy is valid, then this correction of course becomes superfluous.

RECENT DISTRIBUTION

England (BRADY & NORMAN 1889, 1896, HENDERSON 1990).

Paralimnocythere ochridense (KLIE, 1934) nov. comb. (Figs. 5-7)

Limnocythere ochridense KLIE, 1934 : 36-37, figs. 1,3,7,8-11; 1939 : 635-637, fig. 13. PETKOVSKI 1960A : 118.

TYPE LOCALITY

Lake Ohrid (Macedonia). Distribution : Lake Ohrid (KLIE 1934, 1939); Lake Prespa (PETKOVSKI, 1960A).

MATERIAL STUDIED

Topotypes, kindly sent to me by Professor Dr T.K. PETKOVSKI and collected by him from Lake Ohrid (date of collection unknown). One ♂ (no. OC.1617) and 1 ♀ (no. OC.1619) with valves stored dry and with dissected soft parts kept in glycerine in a sealed slide. One ♂ carapace (no. OC.1618) and 1 ♀ carapace (no. OC.1620) stored dry after use for S.E.M.. One ♀ carapace (temp. code KM.1327) lost after use for S.E.M.. Fourteen specimens (♂, ♀, larvae and empty carapaces) kept in spirit (no. OC.1621).

DIAGNOSIS

Valves in lateral view elongated, in ♂ (Figs. 7A,B) more so than in ♀ (Figs. 7C-F), in the latter the dorsal margin

more tapering towards the caudal side. In dorsal view (Figs. 7G,I), valves wide (W/L = c. 0.5 in ♂, c. 0.6 in ♀) with large ventral ala; medio-dorsally with one large posterior and one smaller anterior rounded lobe. Ventral side (Fig. 7H) set with a pattern of ridges. All valves generally much more heavily calcified than in the preceding species. RV with prominent anterior and posterior cardinal teeth (Figs. 7K,L). Limbs typical of the genus, with terminal segment of A1 in both sexes intermediately elongated (Figs. 5D, 6A). Hemipenis with cp hook-like, pcp large and blunt, cp₃ with an internal tooth; seta f₁ long and stout, f₂ minute (length ratio = c. 5 : 1); f₃ absent (?); lobe dl₁ evenly rounded; dl₂ c. twice as long as basal width, evenly tapering; dl₃ a pointed lobe (Figs. 5F,G).

MEASUREMENTS (all in µm)

♀ : LV : L = 651, H = 330; RV : L = 633, H = 340; carapace (1) : L = 651, W = 378, W/L = 0.58; carapace (2) : L = 642, W = 359, W/L = 0.56. ♂ : LV : L = 661, H = 302; RV : L = 699, H = 321; carapace : L = 680, W = 340, W/L = 0.50.

REMARKS

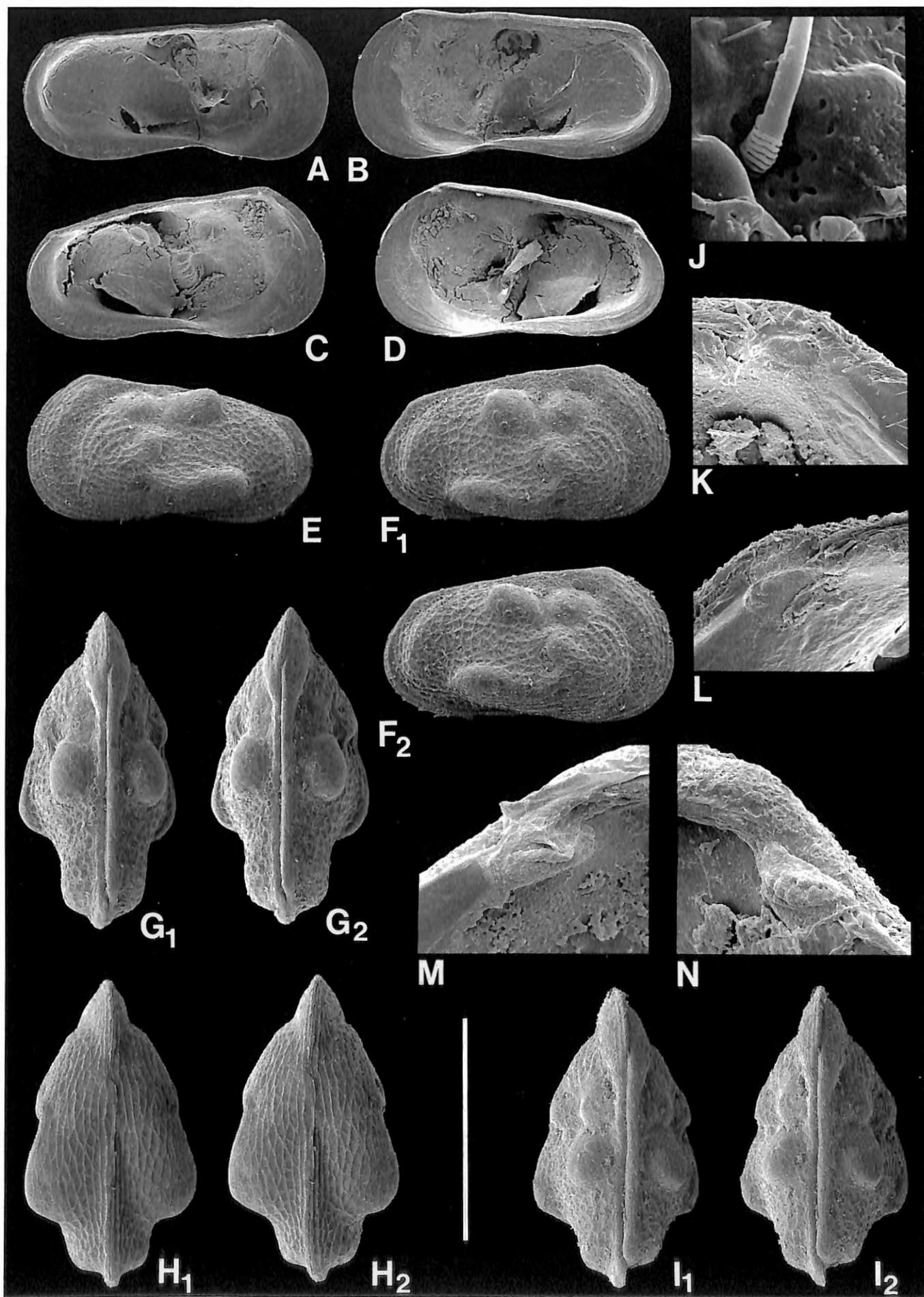
P. ochridense has here been rather extensively illustrated. This was done for two reasons. Firstly, it was thought necessary to present at least one example of the endemic species of the Ohrid-Prespa area, which as a whole, will be more extensively revised elsewhere (PETKOVSKI, pers. comm. 30/3/1991). Secondly, the hemipenis of *P. ochridense* at first glance resembles that of *P. messanai* nov. spec. (see below), although the valves are very different. The present detailed re-examination revealed important differences in the anatomy of the hemipenes of both species.

Paralimnocythere messanai nov. spec. (Figs. 8-11, 12(A-I))

TYPE LOCALITY

River sediments (70 cm depth) in Torrente Mugnone, an affluent of the River Arno, NNE of the city of Firenze (Italy). All specimens were collected on 23/12/88 from station 5, with a pump (10 liter sample); the tube was inserted to a depth of 33 cm. Station 5 is situated near Querciola, upstream from the confluence with the tributary coming from Pratolino. There is an alternation of waterfalls and puddles and the surrounding forest is

◁ Fig. 6 – *Paralimnocythere ochridense* (KLIE) (♀, no. OC.1619).
A. A1. B. A2. C. P(1). D. P(2). E. P(3). F. Md + palp. E. Mx1, including respiratory plate.
Scale = 78 µm for A-G.



moderately dense. It is interesting to note that the river has run dry between August and November 1986. Altitude = 220 m; approximate coordinates are 43°48'N, 11°15'E. Accompanying ostracod fauna: *Pseudolimnocythere* nov. spec., *Pseudocandona* nov. spec. and *Psychrodromus* cf. *fontinalis* (these identifications by Dr D. DANIELOPOL).

TYPE MATERIAL

Holotype: a male, with soft parts dissected in glycerine in a sealed slide and with valves stored dry (no. MF.1307). Allotype: a female, dissected and stored as the holotype (no. OC.1624). Paratypes: 1 ♂ (no. OC.1623) and 1 (A-1) ♀ (no. OC.1622).

Deposition: the holotype is lodged in the collections of the Museo Civico di Storia Naturale (Firenze). The allotype and the paratypes are lodged in the Ostracod Collection of the Royal Belgian Institute of Natural Sciences (Brussels).

DERIVATION OF NAME

The species is named after Dr G. MESSANA (Firenze, Italy), who collected the present material.

DIAGNOSIS

Valves atypical; in dorsal view narrow and without ala; ♂ valves in lateral view shorter and higher than usual, with nearly equally rounded anterior and posterior margins. Sexual dimorphism in shape of valves limited. Terminal segment of A1 in both sexes relatively short. Hemipenis with lobe dl_1 asymmetrically rounded towards the internal side; dl_2 long and recurving towards the external side; dl_3 absent; cp hook-like, with a large pcp; length ratio of furcal setae f_1 and $f_2 = c. 5 : 2$; f_3 also present.

MEASUREMENTS (all in μm)

♀ : LV : L = 576, H = 330. ♂ : LV = 604, H = 312; RV : L = 595, H = 312.

ADDITIONAL DESCRIPTION OF ♂

Valves (Figs. 8B,C, 12A,B,E,F) with straight dorsal

margin and with anterior margin more broadly rounded than posterior one; the latter asymmetrically produced towards the dorsal side, especially so in the LV. In dorsal view, carapace narrow, with pointed frontal and rounded posterior side. No lateral protuberances or ridges. LV slightly overlapping RV caudally. Fused zone, pore-canal, muscle scars and hinge as typical for the genus. A1 (Fig. 9A) with penultimate segment carrying 2 lateral, 2 apical and 2 subapical setae; terminal segment straight (c. 5.5 x as long as its basal width), with 2 subapical setae and 1 apical, bifurcated aesthetasc (Ya), the latter fused with the longer flagellum over c. half its length, and its hyaline part being about 2/5 of its total length.

A2 (Fig. 8A) with a large exopodite (shown in Fig. 9E), penultimate segment with a ventro-lateral group of hairs, consisting of 1 long and 1 short hair and 1 long aesthetasc (Y), with hyaline part being c. 40 % of its total length; 2 unequal, dorso-lateral setae and 2 unequal apical setae; terminal segment with 3 unequal claws.

Mandibular coxa (Fig. 9B) without special features. First segment of mandibular palp (Fig. 9C) with a respiratory plate (not shown) and 1 apical hirsute seta; second segment externally (dorsally) with 1 very long hair, internally (ventrally) with 2 long and 2 shorter hairs; penultimate (third) segment with a lateral group of 5 setae and apically with 1 long and 2 shorter setae; terminal segment with 4 claw-like setae.

Mx1 (Fig. 9D) with 3 endites and a 2-segmented palp. First endite with 1 huge medio-lateral seta, inserted in the middle of the endite, and 4 apical setae. Second and third endites without special features. First palp segment with 5 apical setae; second palp segment with 1 large, non-articulating and 2 normal setae. First segment of P(1) (Fig. 10A) with 2 dorsal setae, 2 unequal apical knee-setae and a minute ventral seta; second segment with one relatively stout seta, reaching about halfway the terminal segment; apical claw short and curved.

P(2) (Fig. 10B) of aberrant morphology, with all segments relatively more elongated than in the other limbs: basal segment without ventral setae and bearing 2 dorsal and 1 apical knee-seta; second segment extremely elongated and with a very stout subapical seta, nearly reaching to the tip of the terminal segment; apical claw somewhat longer than in P(1).

P(3) (Fig. 10C) with one very small ventral, 2 dorsal and one apical knee-seta; apical seta on second segment

◁ Fig. 7 – *Paralimnocythere ochridense* (KLE).

A. ♂, LV, internal view (OC.1617). B. ♂, RV, internal view (OC.1617). C. ♀, LV, internal view (OC.1619). D. ♀, RV, internal view (OC.1619). E. ♀, LV, external view (OC.1619). F. ♀, RV, external view (stereo-pair — OC.1619). G. ♂, carapace, dorsal view (stereo-pair — OC.1618). H. ♀, carapace, ventral view (stereo-pair — OC.1620). I. ♀, carapace, dorsal view (stereo-pair — temp. code KM.1327, specimen lost). J. ♀, LV, external view, detail sieve pore (OC.1619). K. ♀, LV, internal view (OC.1619), detail of anterior cardinal socket. L. Idem, detail of posterior cardinal socket. M. ♀, RV, internal view (OC.1619), detail of anterior cardinal tooth. N. Idem, detail of posterior cardinal tooth.

Scale = 472 μm for A-I; 58 μm for K,L; 43 μm for M,N; 7 μm for J.

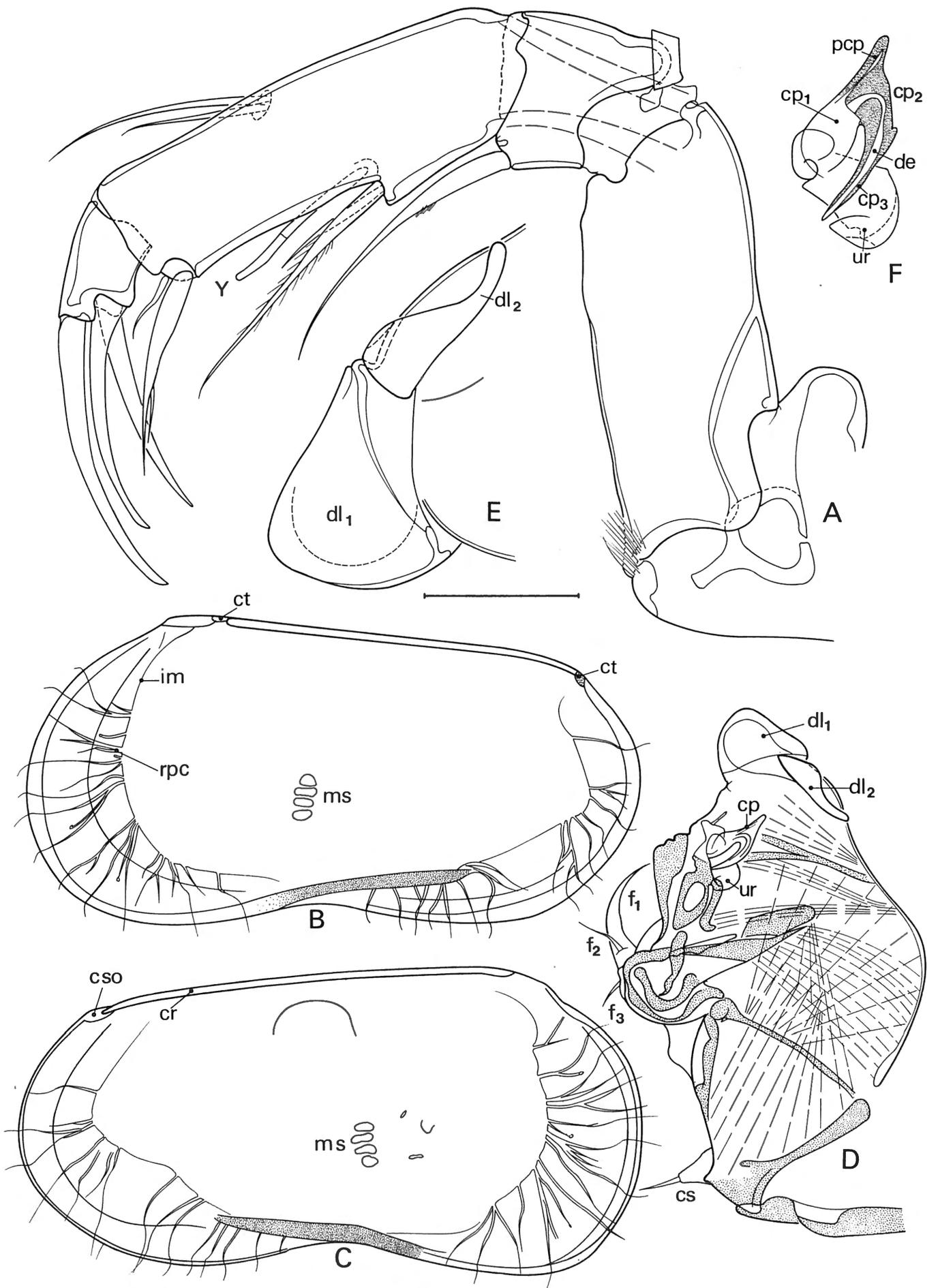


Fig. 8 – *Paralimnocythere messanai* nov. spec. (♂, holotype no. MF.1307).

A. A2. B. RV, internal view. C. LV, internal view. D. Hemipenis. E. Idem, detail of dl. F. Idem, detail of copulatory complex.

Scale = 146 μm for B,C; 78 μm for D; 29 μm for A,E,F.



Fig. 9 - *Paralimnocythere messanai* nov. spec. (♂, holotype no. MF.1307).
 A. A1. B. Md, coxa. C. Md, palp. D. Mx1 (respiratory plate not shown). E. A2, detail of epipodite.
 Scale = 29 μm for A-E.

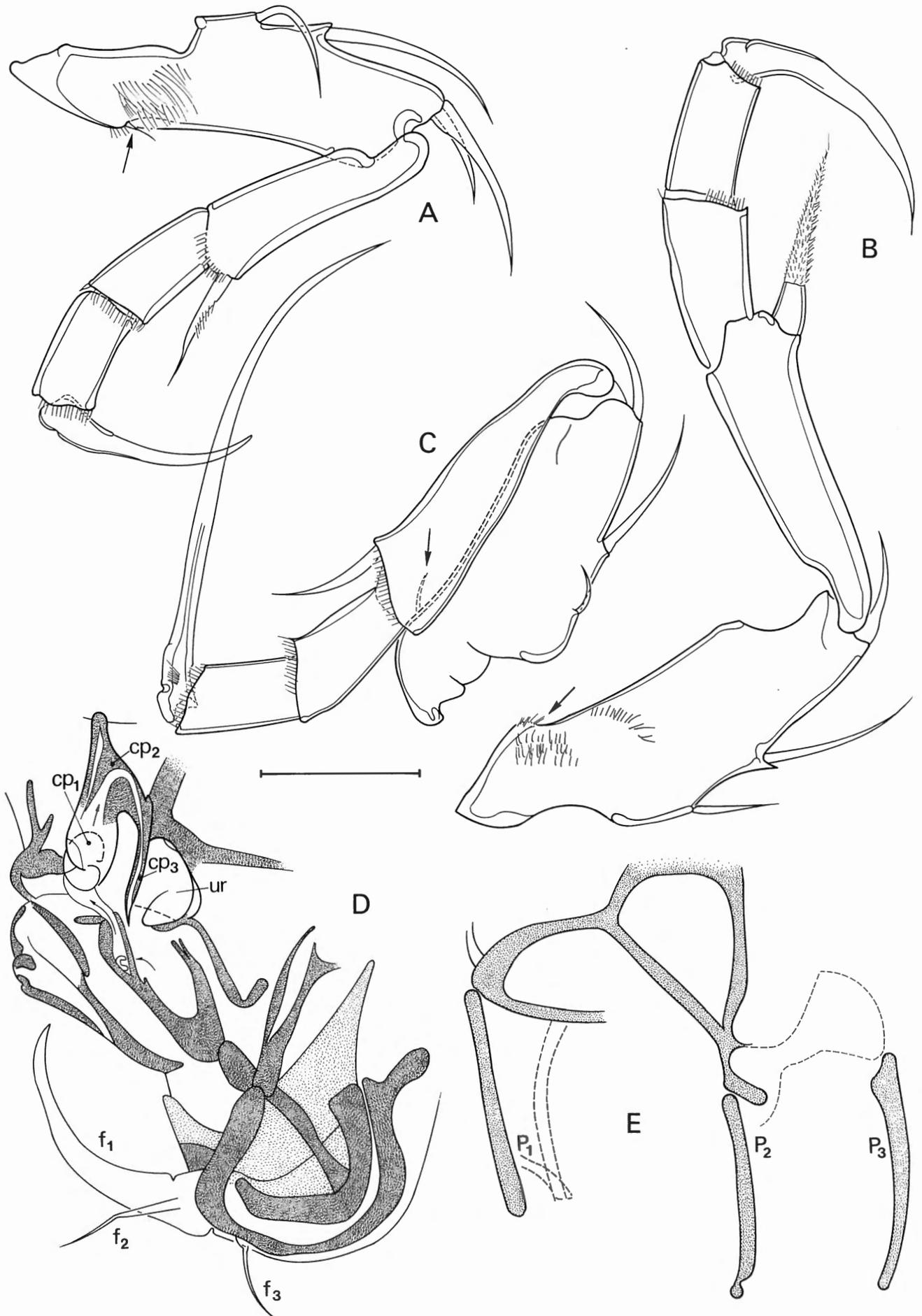


Fig. 10 – *Paralimnocythere messanai* nov. spec. (♂, holotype no. MF.1307).

A. P(1). B. P(2). C. P(3). D. Hemipenis, detail of inner anatomy. E. Attachments of P(1)-P(3).
 Scale = 29 μ m for A-E.

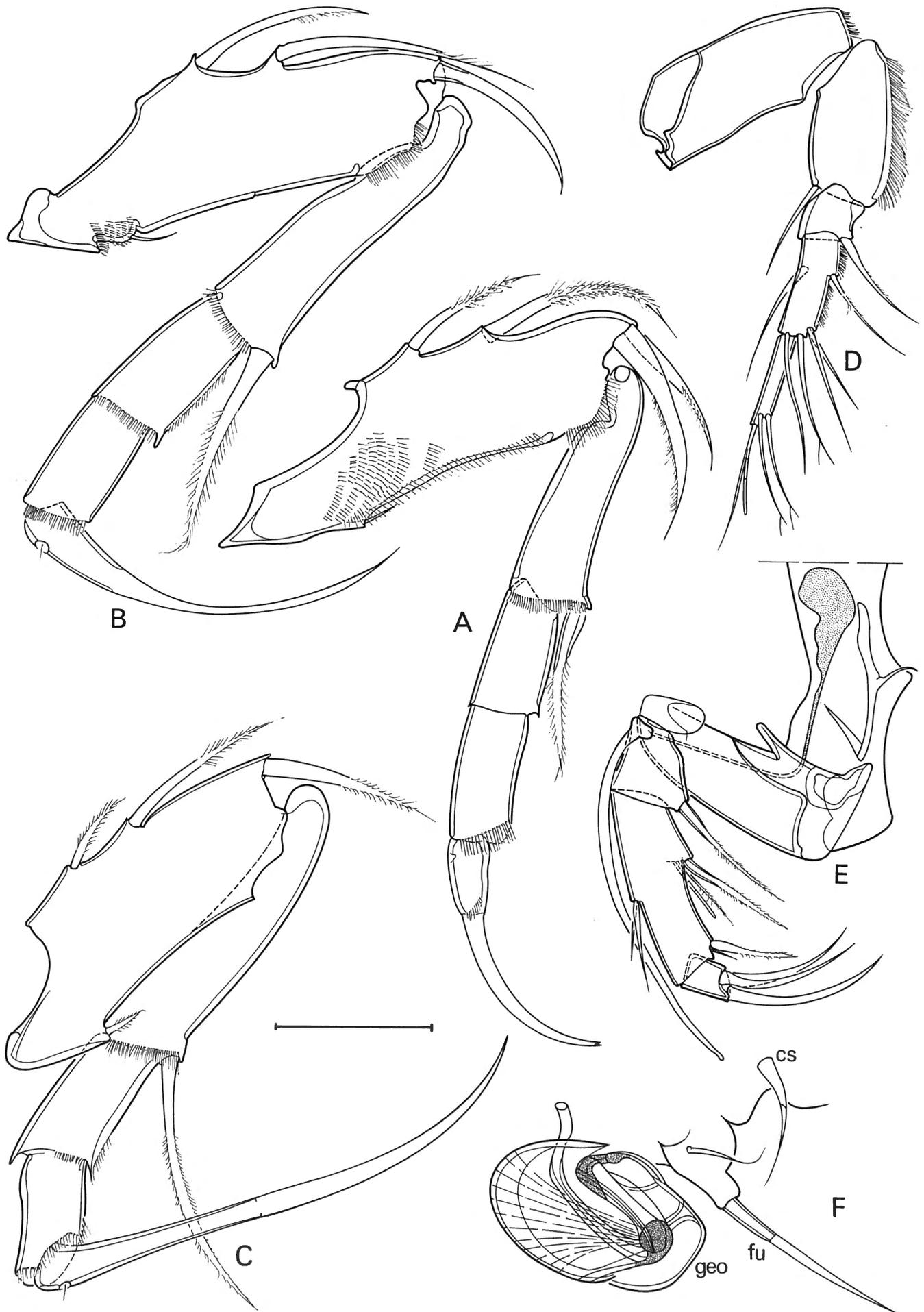
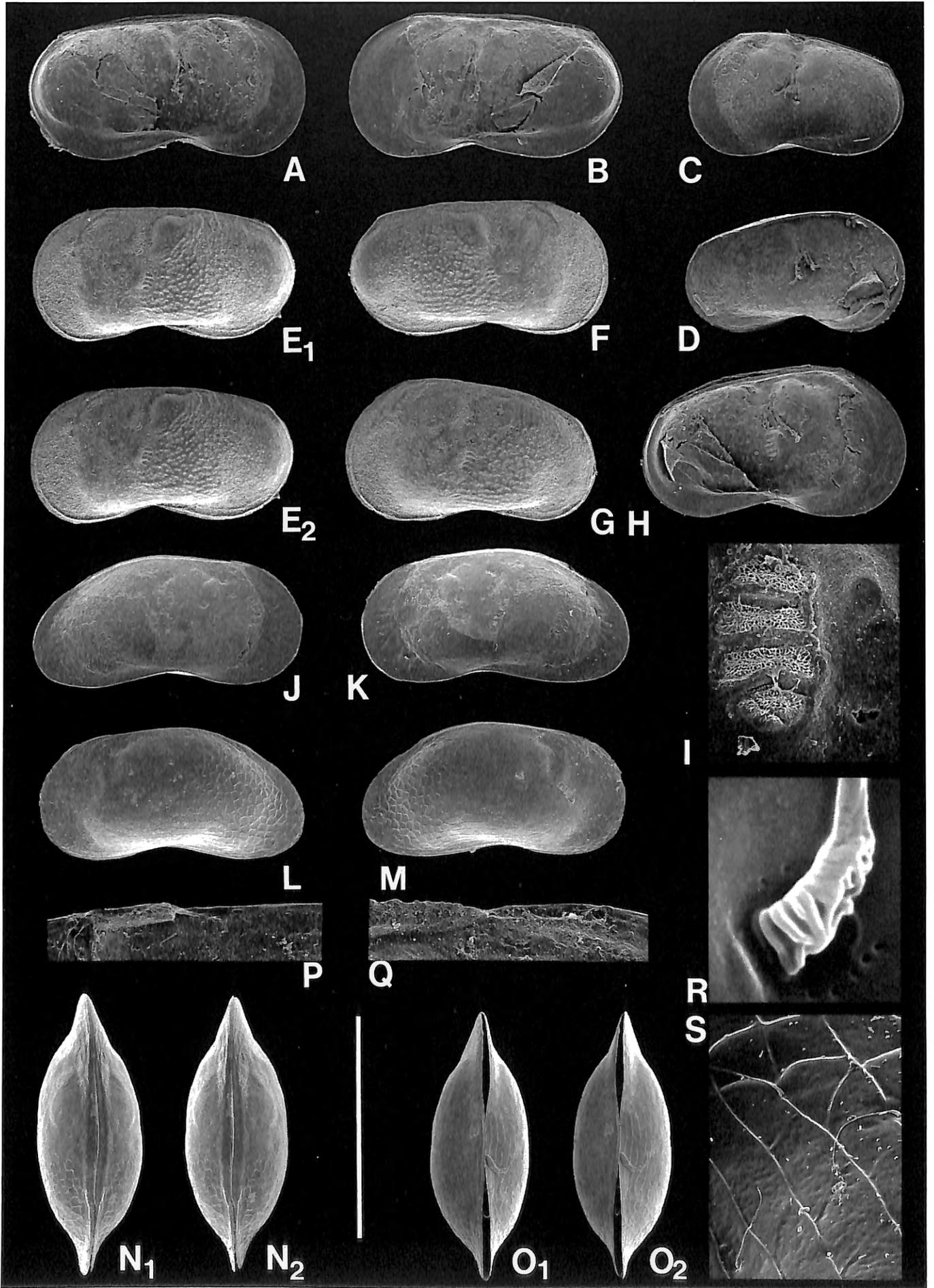


Fig. 11 – *Paralimnocythere messanai* nov. spec. (♀, allotype no. OC.1624).

A. P(1). B. P(2). C. P(3). D. A1. E. A2. F. Genital corner, showing furca, genital operculum and caudal seta.
Scale = 78 μm for D,E; 29 μm for A-C,F.



of normal shape, reaching somewhat beyond the tip of the penultimate segment; apical claw very long and narrow.

Attachments of walking limbs (Fig. 10E) consisting of simple trabeculae.

Hemipenis (Figs. 8D-F, 10D) with copulatory complex simple: upper ramus (?) a small and simple plate, copulatory process short, beak-like and with a pointed dorsal protuberance on part cp₂, part cp₃ relatively wide, curved and with an exterior tooth situated in the middle; furcal seta f₁ large, setae f₂ and f₃ small, one apical, asymmetrically rounded distal lobe (dl₁) and one elongated recurved lobe dl₂; inner anatomy relatively complex.

ADDITIONAL DESCRIPTION OF ♀

Valves (Figs. 12C,D, 9H) slightly shorter than in the ♂ and with dorsal margin more sloping towards the caudal side.

Aesthetasc Y on A2 (Fig. 11E) shorter than both accompanying setae (shorter than one seta in ♂). Dorsal setae on basal segment and apical claw of P(2) (Fig. 11B) shorter than in the ♂. Furca (Fig. 11F) with a short base; a short lateral seta and a longer apical seta.

DIFFERENTIAL DIAGNOSIS

The new species can be distinguished from its congeners by the narrow carapace in dorsal view, by the short and high valves in lateral view (this is most atypical of this genus, especially in ♂) and by the general shape of the cp (including the large pcp) of the hemipenis. With regard to the latter feature, *P. messanai* nov. spec. appears to have its closest congeners in *P. diebeli*, *P. relicta* and *P. ochridense*.

ADAPTATIONS TO INTERSTITIAL ENVIRONMENT

The reduced sexual dimorphism in the shape of the valves, normally rather pronounced in the genus, is very typical of this species. Both males and females have short, high and narrow valves, with little surface ornamentation. Especially the latter is here deemed of importance as a possible adaptation to subterranean life. The

short male valves and the relatively small hemipenis are furthermore related features. No other morphological peculiarities are present in this species. It is furthermore highly significant that a large eye is still present. Such limited adaptations in an animal clearly collected from interstitial habitats, either indicate that the species invaded this environment only recently, or that its habitat is not exclusively interstitial.

In this context, it should be noted that CARBONNEL *et al.* (1985: 235) reported the first freshwater interstitial ostracod from the Tortonian; *Darwinula flandrini* CARBONNEL, 1985. *Paralimnocythere rostrata* is associated with this species, so that *P. rostrata* itself could also be, at least facultatively, a hypogean taxon.

Brief description of the other Recent species

P. alata (KLIE, 1939): Valves relatively smooth, with weak ventral ala and without obvious dorsal protuberances. Dorsal margin strongly sloping towards the caudal margin; the latter very narrowly rounded. In dorsal view, LV not overlapping RV. Hemipenis elongated, especially the distal lobe; cp long and narrow, sickle-shaped. L: ♀ = c 680 µm, ♂ = c. 620 µm. Lake Ohrid.

P. diebeli (PETKOVSKI, 1969): species very similar to *P. relicta* (see above), but with valves shorter and higher and with dorsal margin somewhat more curved; in dorsal view posterior part of carapace wider than in *P. relicta*. Copulatory process of hemipenis with part cp₃ long and straight, extending with nearly half its length beyond edge of cp₁. L: ♀ = 670-690 µm. Small waterbody at Skopje (Macedonia).

P. georgevitschi (PETKOVSKI, 1960): Valves moderately sculptured, in dorsal view with both anterior and posterior margin bluntly pointed; dorsal margin in lateral view straight over most of its length, strongly sloping in the ♀, and with posterior margin consequently narrow, in ♂ dorsal margin slightly sinuous, posterior margin only slightly narrower than anterior one. Hemipenis with lobe dl₁ subrectangular, lobe dl₃ blunt; cp hook-like, with irregular and highly specific shape: cp₁ with a basal spine, cp₂ with a blunt pcp, cp₃ apically slightly and irregularly dilated. Lake Ohrid.

P. karamani (PETKOVSKI, 1960): Valves well sculp-

Fig. 12 – *Paralimnocythere messanai* nov. spec. (A-I) & *Kiwicythere anneari* nov. gen. nov. spec., ♀ (J-S).

P. messanai: A. ♂, LV, internal view (OC.1623). B. ♂, RV, internal view (OC.1623). C. ♀ (A-1), RV, internal view (OC.1622). D. ♀ (A-1), LV, internal view (OC.1622). E. ♂, LV, external view (stereo-pair — OC.1623). F. ♂, RV, external view (OC.1623). G. ♀, LV, external view (OC.1624). H. ♀, LV, internal view (OC.1624). I. *Idem*, detail central muscle scars.

K. anneari: J. LV, internal view (NZGS.1169/3-4). K. RV, internal view (NZGS.1169/3-4). L. LV, external view (NZGS.1169/3-4). M. RV, external view (NZGS.1169/3-4). N. carapace, dorsal view (stereo-pair — OC.1626). O. carapace, ventral view (stereo-pair — OC.1626). P. RV, internal view, detail of anterior cardinal tooth (NZGS.1169/3-4). Q. LV, internal view, detail of anterior cardinal socket (NZGS.1169/3-4). R. carapace, dorsal view, detail of sieve pore (OC.1626). S. *Idem*, detail of external surface.

Scale = 472 µm for A-H, J-O; 66 µm for P, Q, S; 58 µm for I; 4 µm for R.

tured, elongated in lateral view, with dorsal margin straight over 2/3-3/4 of total length, in both sexes sloping towards the caudal margin. Hemipenis with lobe dl₁ sub-squarish, lobe dl₂ short and wide; cp with a long and narrow pcp on cp₂, cp₃ developed into a long and narrow flagellum, the latter feature being the most typical of this species. L: ♀ = c. 630 µm; ♂ = c. 620-650 µm. Lakes Ohrid and Prespa (PETKOVSKI, 1960A,B).

P. slavei (PETKOVSKI, 1969): carapace very narrow in dorsal view, with surface sculpture limited; in lateral view with dorsal margins straight over 2/3-3/4 of the total length; in ♂ dorsal and ventral margins nearly parallel. Fused zone relatively narrow, with few pore canals branching. Hemipenis with lobe dl₁ large and squarish, dl₃ triangular with a broad base; cp hook-like, cp₂ with pcp, cp₃ with an internal tooth. L: ♀ and ♂ = 660-690 µm. Lake Ohrid.

P. umbonata (KLIE, 1939): Valves elongated, with pronounced dorsal and ventral protuberances, the posterior protuberances being the largest. Dorsal margin straight over at least 3/4 of length, but sloping towards the caudal margin. Hemipenis with dl₁ large and rounded, dl₃ triangular and with a wide base; cp sickle-shaped, with cp₃ long, curved and tapering. L: ♀ = c. 800 µm; ♂ = c. 700 µm (= measurement of (A-1)?). Lake Ohrid.

The fossil record

The following fossil species have been reported from the literature. Their stratigraphical position is here indicated; geographical distribution is represented in Fig. 18.

P. bicornis: FÜHRMANN (1991) (Pleistocene); (as *P. compressa*): DIEBEL & PIETRZENIUK (1969) (Pleistocene).

P. bouleigensis: CARBONNEL (1965) (Tortonian); CARBONNEL (1969) (Upper Miocene).

P. compressa: (as *P. rostrata*): GASSE *et al.* (1987) (Pleistocene).

P. cretensis: MOSTAFAWI (1989) (Neogene).

P. dalmatica: SOKAC (1970) (Pleistocene).

P. cf. diebeli: DIEBEL & PIETRZENIUK (1978) (Pleistocene).

P. njaravaniensis: ZUBOVICH (1976) (Quaternary).

P. ochridense: PETKOVSKI (1969) (Miocene).

P. relicta (as *R. originalis*): NEGADAEV-NIKONOV (1965, 1969) (Pleistocene).

P. rostrata: STRAUB (1952) (Miocene), LUTZ (1966) (Neogene), CARBONNEL *et al.* (1985) (Tortonian).

P. tenera: SOKAC (1972) (Neogene).

Paralimnocythere uncertain species: identified as *P. rostrata*: DEVOTO (1965) (Pleistocene); as *P. originalis thuringica nomen nudum*: ABSOLON (1976) (Pleistocene).

REMARKS

The oldest citation is from the Miocene; after that there is a semi-continuous record of species of this genus. It is questionable, however, if all fossil taxa are really valid and independent species. For example, the recently

described *P. bicornis* FÜHRMANN is very similar to *P. compressa* (see redescription above), and only has slightly wider and more pointed lateral ala in dorsal view. A reappraisal of all fossil species, using original type material, is urgently required.

Keys to the West European species

MALES

1. a. Small species (L = < 600 µm), with short valves (L/H ratio of LV = < 2.00) *P. compressa*
- b. Larger species (L ≥ 610 µm), with valves elongated (L/H ratio of LV ≥ 2.20) 2
2. a. Surface sculptures prominent, lateral sides in dorsal view straight and sloping towards the front. Lobe dl₁ on hemipenis symmetrical (see Fig. 4I) *P. psammophila*
- b. Surface sculptures less prominent, lateral sides in dorsal view rounded and/or parallel. Lobe dl₁ on hemipenis asymmetrically rounded (see Fig. 3F) 3
3. a. Carapace in dorsal view with posterior end blunt, both valves subequal. Hemipenis with lobe dl₃ large and swollen, copulatory process hook-like *P. diebeli*
- b. Carapace in dorsal view with posterior end more pointed, LV extending substantially beyond RV. Hemipenis with lobe dl₃ long and subrectangular, copulatory process swollen *P. relicta*

FEMALES

1. a. Small species (L = < 620 µm), with short valves (L/H ratio of LV < 2.00) *P. compressa*
- b. Larger species (L ≥ 660 µm), with valves short or long 2
2. a. Surface sculpture prominent, lateral sides in dorsal view straight and sloping towards the front *P. psammophila*
- b. Surface sculpture less prominent, lateral sides in dorsal view rounded or parallel 3
3. a. Carapace in dorsal view with posterior end blunt, both valves subequal. L/H ratio of LV = < 2.00 *P. diebeli*
- b. Carapace in dorsal view more pointed at the posterior end, with LV largely surpassing RV. L/H ratio ≥ 2.20 *P. relicta*

Genus **Kiwicythere** nov. gen.

TYPE SPECIES (here designated)

Kiwicythere anneari nov. gen. nov. spec.

OTHER SPECIES

Paralimnocythere vulgaris MCKENZIE & SWANSON, 1981.

DERIVATION OF NAME

The genus is named after the most commonly known representatives of New Zealand: the fruit and the bird. Gender is feminine.

DIAGNOSIS

Species with branched pore canals and with anterior inner margin irregular, about halfway forming a recurving pouch. RV with one (anterior) cardinal tooth, the latter elongated and narrow. A1 without apical seta on second segment. Respiratory plate of Mx1 elongated, not semi-circular. Ventral seta on basal segment of P(2) and P(3) minute, large and of normal shape in P(1) in both sexes, the latter limb furthermore generally very small. Hemipenis without additional lobes near dl; the latter huge, constituting half of the entire hemipenis; furca extremely long, with a separated top on f₁; upper ramus (ur) an elongated lobe; copulatory process (cp) small, inserted about halfway the hemipenis.

ADDITIONAL GENERIC FEATURES

Carapace in dorsal view with concavely pointed anterior and posterior tips. External surface of valves set with a fine network of delicate ridges; no ala or tubercles; sieve pores scarce and small. Mx1 with squarish second palp segment. ♀ furca with an elongated base.

REMARKS

The above diagnosis must also be valid for *K. vulgaris* (MCKENZIE & SWANSON) nov. comb. There are, however, a few features from the (very brief) original description which appear to be different. (1) According to MCKENZIE & SWANSON (1981), the basal segment of P(1) does not show the long ventral seta. However, this could easily have been missed, as this seta is inserted very near to the attachment point of the limb. Also, this segment was illustrated with only one dorsal seta, which is erroneous according to me. (2) The female furca is illustrated with a more normal base in *K. vulgaris*. As the elongated furcal ramus in *K. anneari* could indeed be a specific feature, this aspect is not incorporated in the actual generic diagnosis. (3) There are differences

in aspects of the chaetotaxy in for example the A2, but these should be re-examined on the types of *K. vulgaris*.

With regard to the same *K. vulgaris*, it should be noted that there are important differences in the shape of the ♀ valves in the line drawings and in the Scanning Electron Micrographs in MCKENZIE & SWANSON (1981): the valves in the S.E.M. plates are indeed more elongated than the RV in the line drawing. It would thus seem that either two species are involved, or that the photographs give aberrant images. For the comparison between *K. anneari* and *K. vulgaris*, only the line-drawing of the latter is therefore used.

RELATIONSHIPS

Kiwicythere nov. gen. differs from *Paralimnocythere* in the external morphology of the valves (general absence of conspicuous sculptures, different dorsal view), in the anatomy of the anterior inner margin (presence of recurving pouch), in the absence of an apical seta on the second segment of the A1, in the shape of the respiratory plate of the Mx1 (elongated), in the presence of a large ventral seta on the basal segment of the P(1) and in important aspects of the hemipenis-anatomy (large lobe dl, huge furca).

***Kiwicythere anneari* nov. spec.**

(Figs. 12J-S, 13-16)

TYPE LOCALITY

Lake Tenants (locs 1,2,15 of Mr E. ANNEAR) on Chatham Island (approx. coord.: 43°50'S, 175°26'E). Abbreviated description: relatively shallow waters (samples taken at c. 60 cm of depth), with a hard and tight sand under c. 1 cm of detritus. Small fish apparently present. Sample taken amongst short weeds. No information available on pH, salinity, etc.

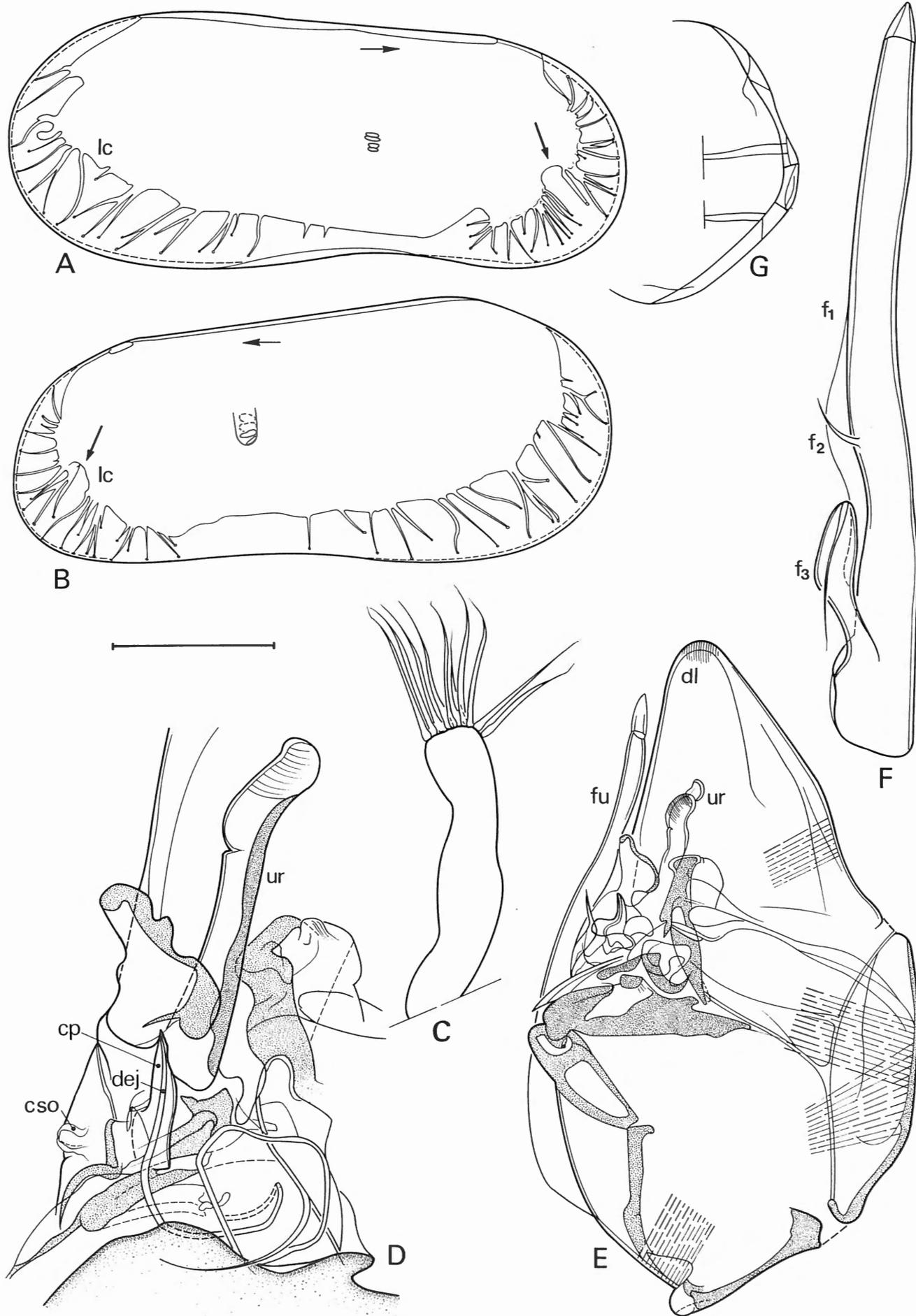
TYPE MATERIAL

Holotype: a ♂, with valves stored dry and with soft parts dissected in glycerine on a sealed slide (no. NZGS.1169/1-2).

Allotype: a ♀, dissected and stored as the ♂ (RV lost after use for S.E.M.) (no. NZGS.1169/3-4).

Paratypes: a ♀, dissected and stored as the holotype (RV lost — no. OC.1625); 1 ♀ carapace stored dry (no. OC.1626), 4 ♀ and 2 larvae kept in spirit (some damaged) (no. OC.1627).

Deposition: the holotype and the allotype are stored in the New Zealand Geological Survey (New Zealand), the paratypes are stored in the Ostracod Collection of the K.B.I.N. (Belgium).



DERIVATION OF NAME

The species was named after Mr Ernie ANNEAR, who collected the present material.

DESCRIPTION OF ♂

Valves (Figs. 13A,B) elongated, with posterior margin more broadly rounded than anterior one; dorsal margin straight over c. 2/3 of total length, sloping towards the front. Four central muscle scars in a vertical row situated well in front of the middle. Anterior pore canals consisting of 2-3 distinct groups, branching, between 20 and 30 in all. Anterior inner margin with a recurving pouch about halfway this margin. External surface devoid of tubercles and ala, set with a delicate pattern of narrow ridges, except for a weakly elevated anterodorsal region, situated c. 1/3 from the front. In internal view, calcified inner lamellae relatively wide.

Second segment of A1 (Fig. 14C) without dorsal seta; terminal segment elongated, with 2 short subapical setae and one bifurcated apical aesthetasc.

A2 (Fig. 14D) with 3 stout, short apical claws on terminal segment; aesthetasc Y shorter than one, longer than the other accompanying seta.

Md-coxa (Fig. 15D) without special features. Palp (Fig. 15E) with typical setation (Remark: as this palp was badly orientated in the holotype slide, this limb will be described in detail for the ♀, because there seems to be no sexual dimorphism in the chaetotaxy).

Mx1 (Fig. 14B) with second palp segment nearly squarish. One large, non-articulating claw and two smaller, articulating claws forming the chaetotaxy of this segment. Penultimate segment with 4 unequal, apical setae. Three endites without special features. Respiratory plate (Fig. 14A) elongated and narrow, with c. 10 plumose rays.

P(1) (Fig. 15A) small, less than half the size of P(3) and with a short claw. Second segment c. twice as long as apical width and with 1 apical seta, reaching about halfway the terminal segment. Basal segment with two dorsal setae, subequal and inserted very closely to one another; one long ventral seta and two unequal knee-setae. Terminal claw about as long as terminal segment. P(2) (Fig. 15B) much larger, with basal segment carrying 1 knee-seta, two dorsal setae (proximal one only half the length of distal one) and a minute ventral seta. Second segment c. 3 times as long as its apical width and with an apical seta, reaching beyond the tip of the terminal segment. Terminal claw with a row of prominent spinulae, this claw about as long as both terminal segments combined.

P(3) (Fig. 15C) huge; chaetotaxy of basal segment as in

the preceding limb. Second segment c. 4x as long as its apical width; apical seta as long as penultimate segment. Terminal claw about 3x as long as terminal segments, carrying a row of setulae.

Hemipenis (Fig. 13E) with distal lobe (dl) subtriangular, about half the size of the entire hemipenis. Furca (Fig. 13F) an elongated shaft, almost reaching tip of dl; f_1 with a segmented tip; seta f_2 short, inserted about halfway f_1 ; f_3 large, with a broad base. Copulatory process rectangular, hook-like, inserted halfway the hemipenis. Ur an elongated lobe (Fig. 13D).

Sternum (Fig. 13G) and brush-like organs (Fig. 13C) without special features.

DESCRIPTION OF ♀

Valves (Figs. 12J-M, 16A) of a completely different shape, with dorsal margin curved, nearly straight over a short distance only and with anterior margin more broadly rounded than posterior one, the latter elongated. In dorsal view (Fig. 12N), both anterior and posterior extremities pointed; LV reaching slightly beyond RV anteriorly and posteriorly; ventrally (Fig. 12(O)), RV weakly overlapping LV. Anatomical details as in the ♂, but with pouch on anterior inner margin less pronounced. RV with one elongated anterior cardinal tooth (Fig. 12P), fitting in a socket on the LV (Fig. 12Q).

A1 (Fig. 16B) as in the ♂.

A2 (Fig. 16C) with aesthetasc Y shorter than both accompanying setae; 3 apical claws of normal shape and length. Md-palp (Fig. 16(I) — see remark above) with a respiratory plate and one short apical seta on the first segment. Second segment narrow and not completely separated from the third segment. The latter large, with various distinct brushes of setae: medio-laterally on the inner margin with one short, stout and plumose seta (equivalent of Cypridoidean beta-seta?), accompanied by 2 long and 1 stout and shorter setae; on external side with 1 long and 1 short seta; apically on the internal margin with a group of 1 long and 1 short seta and next to this, medio-apically, a short and stout seta (homologous to the gamma-seta?); subapically on the external side with a brush of 5 subequal setae. Apical segment minute, with 2 long and 2 short claws.

P(1) (Fig. 16E) very small. Basal segment with 1 short and 1 long dorsal seta, two unequal knee-setae and a long ventral seta.

P(2) (Fig. 16F) with two subequal short dorsal setae on basal segment. Apical seta on second segment not reaching apical margin of terminal segment.

P(3) (Fig. 16G) with proximal dorsal seta on basal segment less than half the length of distal one. Second

Fig. 13 — *Kiwicythere anneari* nov. gen. nov. spec. (♂ holotype, no. NZGS.1169/1-2).

A. LV, internal view. B. RV, internal view. C. Brush-like organ. D. Hemipenis, detail of copulatory complex. E. Hemipenis. F. Idem, detail of furca. G. Sternum.

Scale = 146 μ m for A,B; 78 μ m for E,F; 29 μ m for C,D,F.

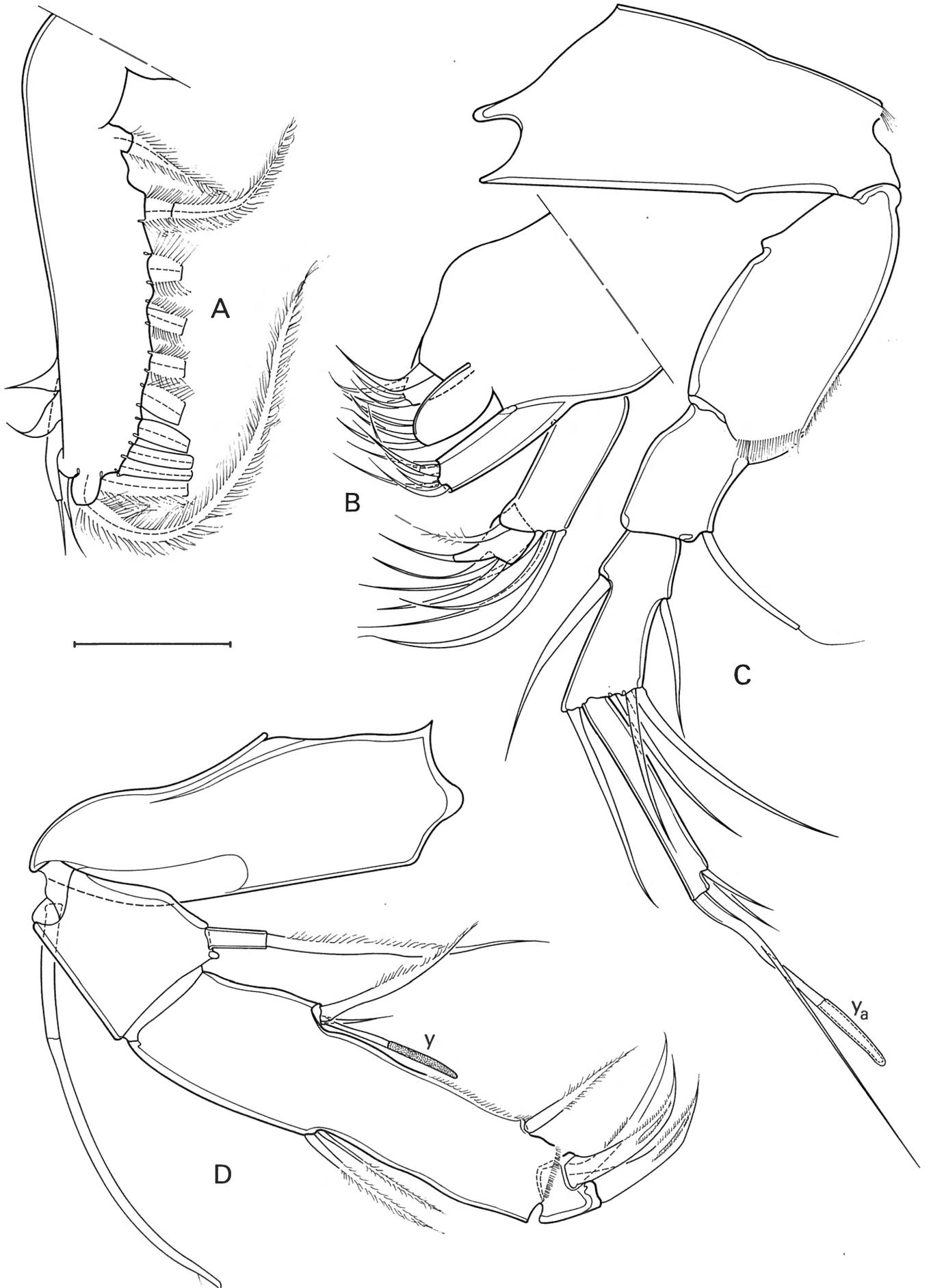


Fig. 14 – *Kiwicythere anneari* nov. gen. nov. spec. (δ holotype, no. NZGS.1169/1-2).
 A. Mx1, detail of respiratory plate. B. Mx1, detail of palp and three endites. C. A1. D. A2.
 Scale = 29 μ m for A-D.

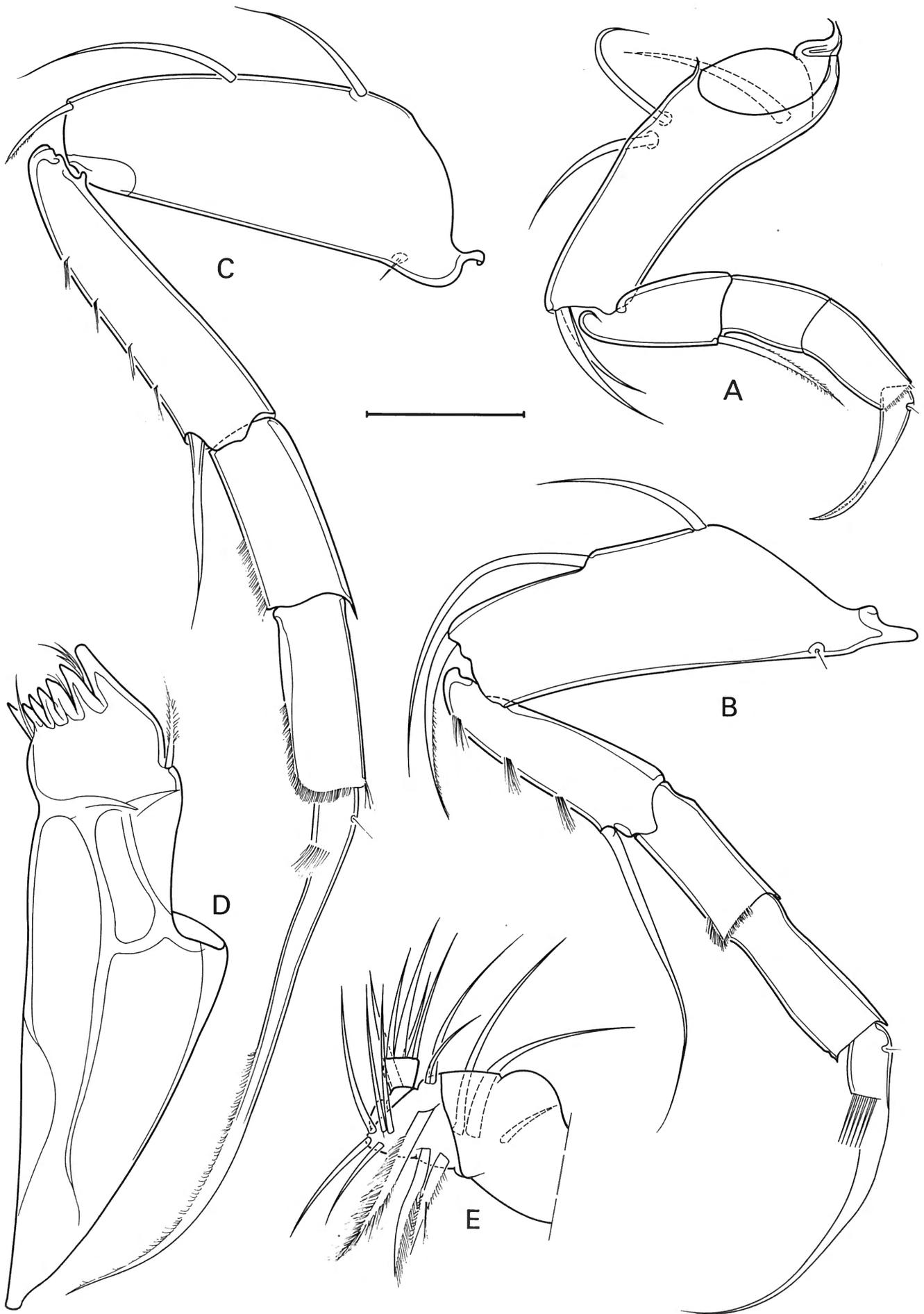


Fig. 15 – *Kiwicythere anneari* nov. gen. nov. spec. (♂ holotype, no. NZGS.1169/1-2).

A. P(1). B. P(2). C. P(3). D. Md, coxa. E. Md, palp (somewhat contorted in the slide).
Scale = 29 μm for A-E.

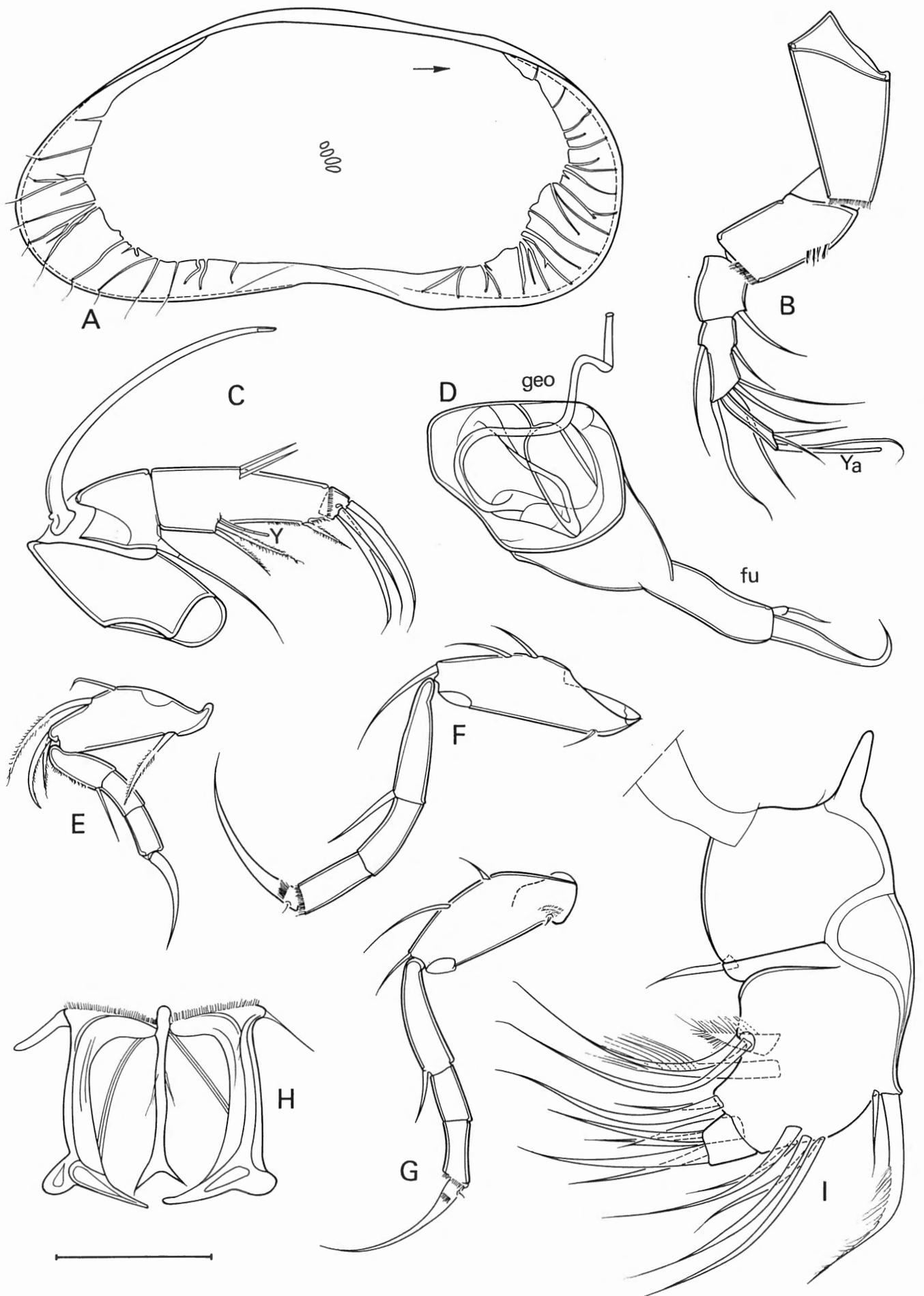


Fig. 16 - *Kiwicythere anneari* nov. gen. nov. spec. (♀ : A,E-H = OC.1625, B-D,I = NZGS.1169/3-4).
 A. LV, internal view. B. AI. C. A2. D. Furca and genital operculum. E. P(1). F. P(2). G. P(3). H. Rake-like organs.
 I. Md-palp.
 Scale = 156 μ m for A; 78 μ m for B,C,E-G; 29 μ m for D,H,I.

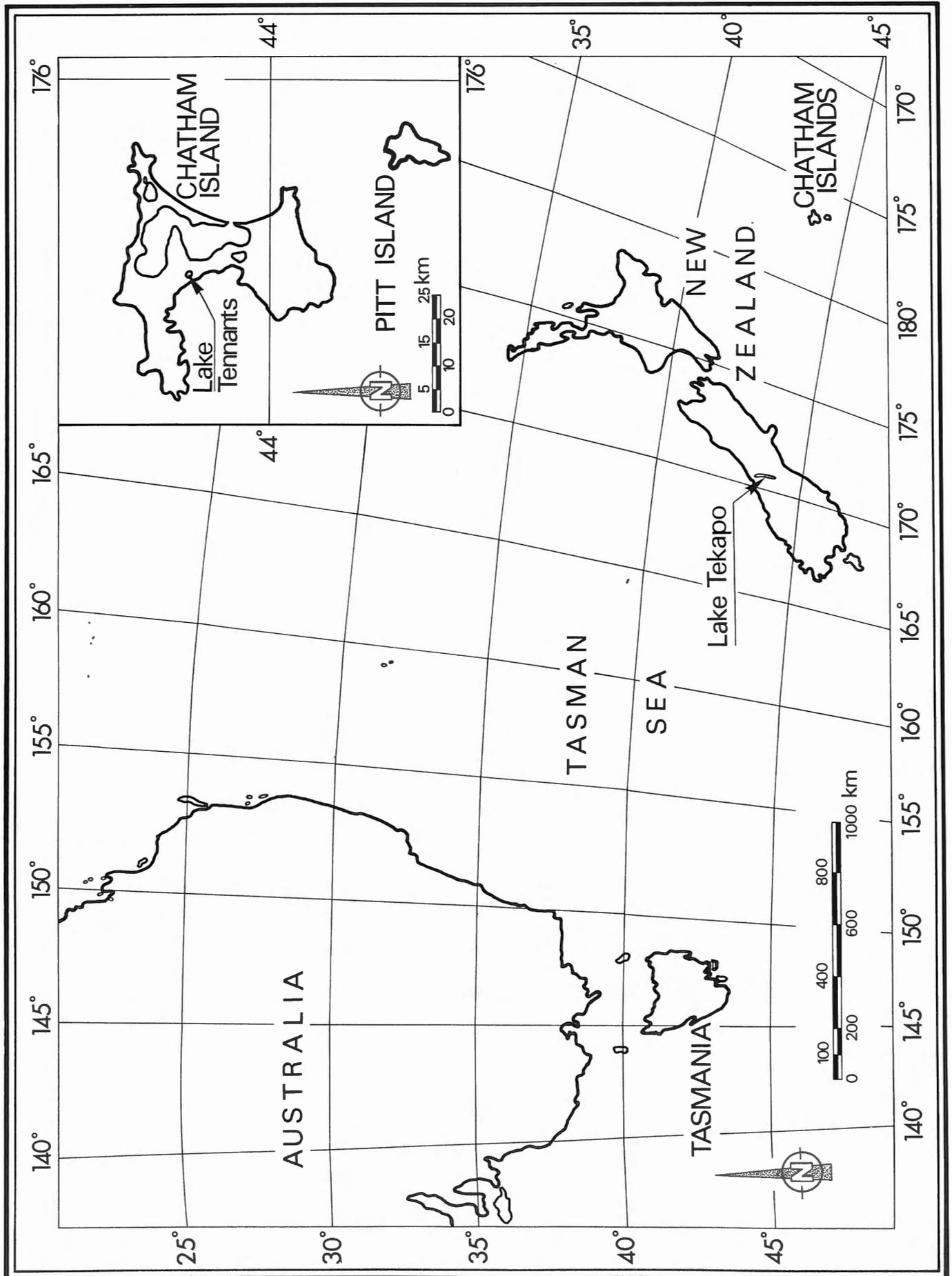


Fig. 17 – Type localities of the two species of *Kiwicythere* nov. gen. : pools near Lake Tekapo (New Zealand) for *K. vulgaris*; Lake Tennants on Chatham Islands for *K. anneari* nov. spec.

segment large, with a short apical seta. Terminal claw shorter than in the ♂.

Furca (Fig. 16D) with an elongated base, a minute lateral and a short but stout apical seta. Rake-like organs (Fig. 16H) stout, with a multitude of apical minute teeth.

MEASUREMENTS (all in μm)

♀ : LV : L = 585, H = 264; RV : L = 585, H = 274, carapace : L = 604, W = 227, W/L = 0.38. ♂ : LV : L = 562, H = 239; RV : L = 544, H = 239.

RELATIONSHIPS

The present species differs from *K. vulgaris*, the only known congener, by a different shape of the valves : anterior margin more broadly rounded, dorsal margin asymmetrically arched (see remarks on the morphology of *K. vulgaris* above).

SEXUAL DIMORPHISM

There are a number of interesting sexual dimorphisms in this species, which can briefly be discussed here. Firstly, ♂ and ♀ differ considerably in the shape of the valves. ♀ have a narrow posterior part of the valves, whereas ♂ are much higher there. This difference is almost certainly related to the accommodation of the huge hemipenes, to which end various Limnocytherid groups have chosen different solutions. In *Kiwicythere* nov. gen., such a difference is more obvious than in *Paralimnocythere* s.s., as the distal lobe in the former is much larger than in the latter.

A second set of dimorphic features can be found in the A2 (short and stout claws in ♂, different length ratio's between Y and accompanying setae) and in the three walking limbs (different relative lengths of setae and a much longer claw of the P(3) in ♂). Following the discussion in DANIELOPOL *et al.* (1990), these differences are considered to be related to copulatory behaviour (more specifically : pre-copulatory mate recognition) as the four limbs are known to form part of the 'copulation'-module.

ECOLOGY

K. anneari nov. gen. nov. sp. is known from its type locality only (Lake Tenants), where it was collected amongst weeds in relatively shallow waters. Judging

from the climatic conditions on Chatham Islands, the species is probably cold-stenothermic and can tolerate fluctuating salinities. Nothing is known about the ecology of *K. vulgaris*.

SARS (1905) already reported on some brackish water ostracods from the Chatham Islands, but his collections did not contain the present species.

Discussion

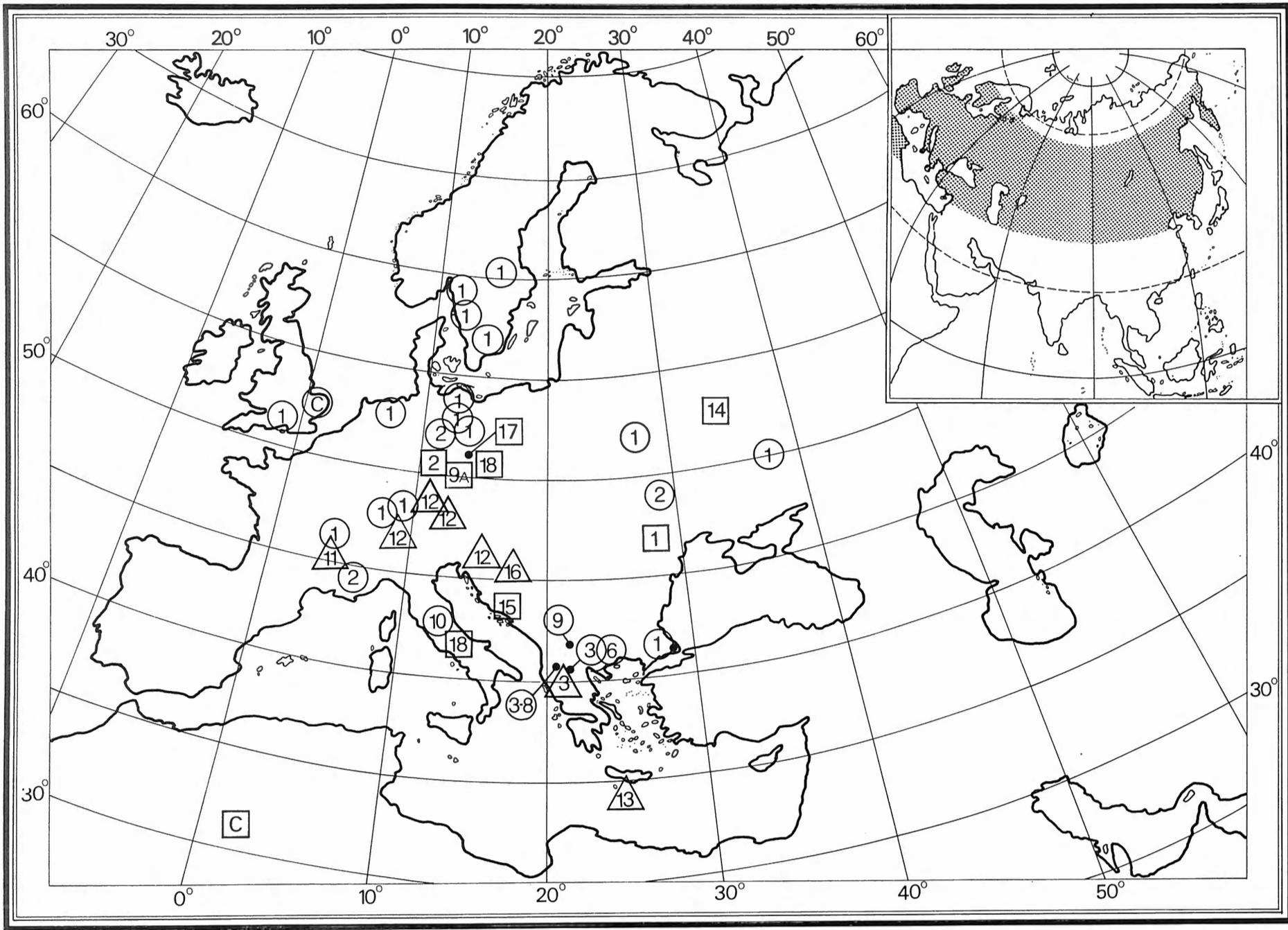
The genus *Paralimnocythere* s.s. has been reported with certainty from the Miocene onwards. Morphological differences between Neogene and Quaternary species on the one hand and the Recent taxa on the other hand are minimal. *Paralimnocythere bouleigensis* appears to have an adont hinge, while some of the Recent taxa have clear anterior and posterior cardinal teeth on the RV. However, there are also Recent species with only one minute cardinal tooth, hence a certain degree of intrageneric variability in the structure of the hinge must be accepted.

SOKAC (1980) suggested that *P. rostrata* is a synonym of *P. compressa*, thus implying that one and the same species survived in Europe since the Miocene. Differences in the shape of the valves of both nominal taxa are indeed minimal, clearly reflecting the stability of morphologies over time in the genus. Nevertheless, as was discussed above, I still suggest to maintain both taxa as independent species. PETKOVSKI (1969) reported the Recent *P. ochridense* from the Miocene in Macedonia. This is the second species, which is suspected to have survived in Europe since the Tertiary.

Limnocythere nodosa LI Y.P & LAI X.R., 1978 (formerly BOJIE, 1978 — see good redescription in HOU YOU-TANG & ZHAO YU-HONG, 1986), shows features of *Paralimnocythere* and might belong to this genus. However, none of the illustrations allows us to see if the marginal pore canals are indeed also branched. This feature should be checked as soon as possible. If *L. nodosa* is a true *Paralimnocythere*, than this has important implications with regard to the age of the genus, because this species was described from early Cretaceous deposits in China.

No truly Fossil records of *Kiwicythere* are known, as valves of *K. vulgaris* were recovered from subrecent sediments. This could be due to the scarcity of palaeontological work on ostracods in the southern hemisphere, but also to the fact that *Kiwicythere* species have very

Fig. 18 — Large map : localities of Recent and Fossil *Paralimnocythere* s.s. 1 = *P. relicta* (= *R. originalis*), c = *P. compressa*, 2 = *P. psammophila*, 3 = *P. ochridense*, 4 = *P. umbonata*, 5 = *P. alata*, 6 = *P. karamani*, 7 = *P. georgevitschi*, 8 = *P. slavei*, 9 = *P. diebeli*, 9A = *P. cf. diebeli*, 10 = *P. messanai*, 11 = *P. bouleigensis*, 12 = *P. rostrata*, 13 = *P. cretensis*, 14 = *P. njaravaniensis*, 15 = *P. dalmatica*, 16 = *P. tenera*, 17 = *P. bicornis*, 18 = *Paralimnocythere uncertain species*. Circles = Recent localities; squares = Quaternary; triangles = Neogene. Small map : extrapolated Palaearctic distribution of Recent *Paralimnocythere* s.s., relying on locality of *P. relicta* in Jakutsk (PIETRZENIUK, 1977).



fragile valves. Such valves will break easily and few will fossilize intact.

As was mentioned above, *Paralimnocythere* s.s. has a Palaearctic distribution. According to PETKOVSKI (1969), the genus was exclusively European in its distribution. PIETRZENIUK (1977) reported *P. relictata* (as *P. cf. diebeli*) from Jakutsk in northeastern Siberia, together with a significant number of other species, previously thought to be confined to (Western) Europe, and thus greatly extended our knowledge of Palaearctic ostracods. The extrapolated distribution of *Paralimnocythere* is presented on Fig. 18 (small map); northern and southern boundaries are based on the most northern (Jakutsk, Malmö) and the most southern (Algeria) localities thus far known. Future findings may still extend the areal in either direction.

With regard to the present day fauna, at least *P. relictata*, *P. compressa* and *P. psammophila* have a relatively wide distribution. *P. diebeli* might also be found outside Macedonia, but this needs confirmation based upon hemipenis morphology. All other Recent species are presently considered to be endemic to the Balkan lakes, primarily to Lake Ohrid and to a lesser degree also to Lake Prespa. It cannot be said with certainty whether or not these species also evolved in these lakes, or if they should be considered relicts of a larger areal, pushed towards southern localities by subsequent glaciations. The fact that PETKOVSKI (1969) reported *P. ochridense* (KLIE) from the Miocene of Macedonia nevertheless provides a first clue: Lakes Ohrid and Prespa were not yet formed in their present condition, when at least one of the present day endemics already existed. According to STANKOVIC (1960), Lake Ohrid most likely originated in the middle-Pliocene, i.e. c. 3 million years BP. If both Miocene and Recent populations indeed belong to the same taxon (no illustration or description of the fossils were offered), then at least this taxon did not evolve in Lake Ohrid.

To draw phylogenetic relationships within the genus is difficult, even when restricting the analysis to Recent forms. All species are closely related to one another, and especially *P. relictata* and *P. diebeli* are very similar to each other. *Paralimnocythere alata* and *P. umbonata* have aberrant valves, with very narrowly rounded caudal margins, while *P. karamani* has an aberrant copulatory process on the hemipenis. But in general, soft part morphology is strikingly uniform in the genus. In this context, it should be noted that *P. alata* reportedly has only one lateral seta on the penultimate segment of the A1 (KLIE 1939, PETKOVSKI 1960A), but this is almost certainly erroneous and the feature should be rechecked. As animals are small and setae nearly completely smooth and transparent, it is indeed very easy to miss a seta in this genus.

Large differences in the surface ornamentation of the valves occur between certain species. For example, *P. messanai* nov. spec. is nearly devoid of such protuberan-

ces, while *P. ochridense* is extremely tuberculate. However, it is known that tuberculate and atuberculate forms of the same species can exist in various ostracod groups. Although no such apparent variability has thus far been shown to exist in *Paralimnocythere*, this feature should still always be treated with caution. One can never rely on such differences in morphology alone to distinguish between taxa. For this reason, I doubt the validity of *P. bicornis* (see above).

Paralimnocythere s.s. belongs to the Limnocytherini and is directly related to *Limnocythere* s.s. The relationship with *Kiwicythere* nov. gen. is less obvious. Both genera share common features, but many morphological characteristics are different. Both have branched marginal pore canals and reduced ventral setae on the first segment of the P(2) and the P(3) (in *Paralimnocythere* also on the P(1)). The around shape of the valves and the surface ornamentation, the chaetotaxy of the A1 and of the P(1) and the morphology of the hemipenis, however, are different. Especially in the latter feature (size of furca, shape of cp and ur, size and shape (only 1 lobe) of dl), *Kiwicythere* appears to be related to the other southern hemisphere Limnocytherids (see *Neolimnocythere* and *Paracythereis* in DELACHAUX, 1928). A revision of the anatomy of the latter taxa in comparison to *Kiwicythere* and *Paralimnocythere* will show if the branched marginal pore canals are a synapomorphy of the *Paralimnocythere-Kiwicythere* lineage, or if it constitutes a homeomorphic feature, which developed at least twice in limnocytherid evolution. In the former case, a paralimnocytherid ancestor should have had a nearly worldwide distribution and the fossil record, although admittedly limited outside Europe, offers no evidence for this. Based on all data available to date, I here postulate that *Paralimnocythere* and *Kiwicythere* are not adelphotaxa and that the marginal pore canals in both genera are homeomorphies.

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References

- ABSOLON, A., 1976. Neue Daten zur Evolution der Süßwasser-Ostracoden im Pleistozän. *Abhandlungen und Verhandlungen des naturwissenschaftlichen Vereins Hamburg (NF)*, 18/19 (Suppl.): 229-237.
- ALM, G.C., 1915. Monographie der Schwedischen Süßwasser-Ostracoden nebst systematischen Besprechungen der Tribus Podocopa. *Zoologiska Bidrag fran Uppasala*, 4 (1): 1-248.
- BRADY, G.S. & NORMAN, A.M., 1889. A monograph of the marine and freshwater Ostracoda of the North Atlantic and of Northwestern Europe. Section I. Podocopa. *Scientific Transactions of the Royal Dublin Society, Series 2*, 4 (2): 63-270, pls 8-23.
- BRADY, G.S. & NORMAN, A.M., 1896. A monograph of the marine and freshwater Ostracoda of the North Atlantic and of Northwestern Europe. Section II-V. Mydocopa, Cladocopa, Platycopa. *Scientific Transactions of the Royal Dublin Society, Series 2*, 5: 621-784, pls. 50-68.
- BRONSHTEIN, Z.S., 1947. Ostracoda Presnykh Vod. - *Akademiya Nauk SSSR, Akademiya Nauk SSSR, Zoologicheskii Institut (N.S. no. 31), Fauna SSSR Rakoobraznye*, 2/1 (3) (Moscow): 339 pp + 14 plates. (English translation of this work 1988: 'Freshwater Ostracoda', Amerind Publishing company Pvt. Ltd. New Delhi: 470 pp).
- CARBONNEL, G., 1965. Sur un nouveau genre (*Paralimnocythere*) et une nouvelle espèce (*P. bouleigensis*) d'ostracodes du Tortonien. *Archives des Sciences*, 18 (1): 146-150, Plts. I-II.
- CARBONNEL, G., 1969. Les Ostracodes du Miocène Rhodanien. Systématique, biostratigraphie, écologie, paléobiologie. *Documents des laboratoires de Géologie de la Faculté des Sciences de Lyon*, 32 (1): 1-228, pls. 1-16, tabs. 1-4.
- CARBONNEL, G., WEIDMAN, M. & BERGER, J.-P., 1985. Les ostracodes lacustres et saumâtres de la Molasse de Suisse Occidentale. *Revue de Paléobiologie*, 4 (2): 215-251.
- COLIN, J. & DANIELOPOL, D.L., 1978. New data on the systematics of the Limnocytheridae. *Geobios*, 11: 563-567.
- COLIN, J. & DANIELOPOL, D.L., 1980. Sur la morphologie, la systématique, la biogéographie et l'évolution des ostracodes Timiriaseviinae (Limnocytheridae). *Paléobiologie continentale*, 11: 1-51.
- DANIELOPOL, D.L., MARTENS, K. & CASALE, L.M., 1990. Revision of the genus *Leucocythere* KAUFMANN, 1892 (Crustacea, Ostracoda, Limnocytheridae), with the description of a new species and two new tribes. *Bulletin van het Koninklijk Belgisch Instituut voor Natuurwetenschappen, Biologie*, 59 (1989): 63-94.
- DELACHAUX, T., 1928. Faune invertébrée d'eau douce des hauts plateaux du Pérou. *Bulletin de la Société de Neuchâtel des Sciences naturelles*, 52: 45-77.
- DELORME, D.L., 1967. New freshwater Ostracoda from Saskatchewan, Canada. *Canadian Journal of Zoology*, 45: 357-363.
- DELORME, L.D., 1971. Freshwater ostracodes of Canada. Part V. Families Limnocytheridae, Loxoconchidae. *Canadian Journal of Zoology*, 49 (1): 43-64, pls. I-XIX.
- DEVOTO, G., 1965. Lacustrine pleistocene in the lower Liri Valley. *Geologica Romana* 4: 291-368.
- DIEBEL, K., 1968. Neue Limnocythere-Arten aus dem Deutschen Pleistozän. *Monatesberichte der Deutschen Akademie der Wissenschaften zu Berlin*, 10 (7): 519-538.
- DIEBEL, K. & PIETRZENIUK, E., 1969. Ostracoden aus dem Mittelpleistozän von Süssenborn bei Weimar. *Paläontologische Abhandlungen, Abteilung A., Paläozoologie*, 3 (3/4): 463-488, Plts VII-X.
- DIEBEL, K. & PIETRZENIUK, E., 1978. Die Ostrakodenfauna aus dem jungpleistozänen (weichselkaltzeitlichen) Dekschichten von Burgtonna in Thüringen. *Quartärpaläontologie*, 3: 207-221.
- FLÖSSNER, D., 1965. *Limnocythere psammophila* n. sp., ein neuer Muschelkrebs (Crustacea, Ostracoda) den deutschen Fauna. *Zoologischer Anzeiger*, 175: 466-470.
- FÜHRMANN, R., 1991. Ostrakoden aus dem Holstein-Interglazialbecken Wildschütz und Dahlen (Sachsen). *Zeitschrift für geologische Wissenschaften*, 19 (3): 269-288.
- GASSE, F., FONTES, J.C., PLAZIAT, J.C., CARBONNEL, P., KACZMARSKA, I., DE DECKKER, P., SOULIE-MARSCHÉ, I., CALLOT, Y. & DUPEUBLE, P.A., 1987. Biological remains, geochemistry and stable isotopes for the reconstruction of environmental and hydrological changes in the Holocene lakes from North Sahara. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 60: 1-46.
- GOLUBNICHAYA, L.V., 1967. The finding of Limnocythere psammophila FLÖSSNER, 1965 (Crustacea, Ostracoda) in the Soviet Union. *Vestnik Zoologii, organ Instituta zoologii Akademii nauk Ukrainsoy SSR*, 2 (1968): 83-84.
- GÜLEN, D., 1985. The species and distribution of the group Podocopa (Ostracoda, Crustacea) in the fresh waters of Western Anatolia. *Istanbul Üniversitesi Fen Fakültesi Mecmuası, Seri B (Sciences naturelles)*, 50: 65-80.
- HENDERSON, P., 1990. Freshwater Ostracods. *Synopsis of the British Fauna (New Series)*, 42: 1-226.
- HOU YOU-TANG & ZHAO YU-HONG, 1986. CLASSIFICATION AND SIGNIFICANCE OF ORNAMENTATIONS AND NORMAL PORES IN MESOZOIC AND CENOZOIC OSTRACODS FROM CHINA. *Acta Micropalaeontologica Sinica*, 3 (3): 223-238, Plts. I-IX.
- JANZ, H., 1992. Die miozänen Süßwasserosttrakoden des Steinheimer Beckens (Schwäbische Alb, Süddeutschland). *Stuttgarter Beiträge zur Naturkunde. Serie B (Geologie und Paläontologie)*, 183: 1-117.
- KAUFMANN, A., 1892. Über die Gattung *Acanthopus* Vernet und eine neue Süßwassercytheride. *Zoologischer Anzeiger*, 15 (381-408): 393-395.
- KAUFMANN, A., 1896. Die Schweizerischen Cytheriden. *Revue Suisse de Zoologie et Annales du Musée d'Histoire naturelle de Genève*, 4 (2): 313-384, pls. XII-XV.
- KLIE, W., 1934. Zur Kenntnis der Ostracoden-Gattung Limnocythere. *Archiv für Naturgeschichte*, 3: 534-544.
- KLIE, W., 1938. Ostracoda, Muschelkrebse. In: Dahl, F. (Ed.) *Die Tierwelt Deutschlands und der angrenzenden Meeresteile*, 34. Teil Krebstiere oder Crustacea (III): 230 pp.

- KLIE, W., 1939. Studien über Ostracoden aus dem Ohridsee : II. Limnocytherinae und Cytherinae. *Archiv für Hydrobiologie*, 35 : 631-646.
- LILLJEBORG, W., 1863. Beskrifningoefver tva arter Crustaceer af ordningarna Ostracoda och Copepoda. *Oefversigt af Kungliga Vetenskaps-Akademiens Foerhandlingar*, 19 (1862) (6) : 391-398.
- LILLJEBORG, W., 1883. Collection of chiefly freshwater Crustacea from Sweden. In : *Great International Fisheries Exhibition, London, special catalogue*, Sweden, Division 50, no. 265 : 140-150.
- LUTZ, A., 1966. Jungtertiäre Süßwasser-Ostracoden aus Süd-deutschland. *Geologisches Jahrbuch*, 82 : 271-330.
- MARTENS, K., 1990. Revision of African *Limnocythere* s.s. BRADY, 1867 (Crustacea, Ostracoda) with special reference to the Eastern Rift Valley Lakes : morphology, taxonomy, evolution and (palaeo) ecology. *Archiv für Hydrobiologie, Supplements*, 83 (4) : 453-524.
- MARTENS, K., (1992). On *Namibcypris costata* n. gen. n. sp. (Crustacea, Ostracoda, Candoninae) from a spring in northern Namibia, with the description of a new tribe and a discussion on the classification of the Podocopina. *Stylogia*, 7 (1) : 27-42.
- McKENZIE, K.G. & SWANSON, K., 1981. On *Paralimnocythere vulgaris* McKENZIE & SWANSON. *A Stereo-Atlas of Ostracod Shells*, 8 (9) : 45-50.
- MEISCH, C., WOUTERS, K. & MARTENS, K. 1990. Liste annotée des ostracodes non-marins trouvés en France (Crustacea, Ostracoda). *Travaux scientifiques du Musée d'Histoire naturelle de Luxembourg*, 15 : 62 pp.
- MOSTAFAWI, N., 1989. Neogene Ostracoden von Chersonisos und Vrysses (Kreta, Griechenland). *Neues Jahrbücher für Geologischen und Paläontologischen Abhandlungen*, 178 (2) : 183-201.
- MÜLLER, G.W., 1900. Deutschlands Süßwasser-Ostracoden. *Zoologica*, 30 : 1-112, pls 1-21.
- MÜLLER, G.W., 1912. Ostracoda. In : SCHULTZE, F.E. (Ed.), *Das Tierreich*, 31. Lieferung. Verlag von R. Friedländer und Sohn, Berlin : 434 pp.
- NEGADAEV-NIKONOV, K.N., 1968. On the phylogenetical development of species of the genus *Limnocythere*. *Izvestiya Akademii Nauk Moldavskoy SSR, Ser. Biologicheskikh i Khimicheskikh Nauk*, 1968 (3) : 3-9.
- PARIS, P., 1917. Note sur quelques Entomostracés récoltés dans le département de la Côte-d'Or. *Bulletin de la Société zoologique de France*, 41 (1916) : 112-117.
- PARIS, P., 1920. Notes sur les Cladocères et les Ostracodes du département de la Côte-d'Or. *Bulletin de la Société zoologique de France*, 64 (1919) : 251-266.
- PARIS, P., 1928. Quelques caractéristiques de la faune du département de la Côte-d'Or. *Comptes-rendus du Congrès de l'Association Française pour l'Avancement des Sciences, La Rochelle* (1928) : 662-664.
- PETKOVSKI, T.K., 1960A. Zur Kenntnis der Crustaceen des Prespasees. *Fragmenta Balcanica, Musei Macedonici Scientiarum Naturalium* 3, 15 (74) : 117-131.
- PETKOVSKI, T.K., 1960B. Zwei neue Ostracoden aus dem Ohrid- und Prespasee. *Izdanija Institut de Pisciculture de la R.P. Macedoine*, 3 (2) : 57-66.
- PETKOVSKI, T.K., 1961. Zur Kenntnis der Crustaceen des Skadar (Scutari) Sees. *Acta Musei Macedonici Scientiarum Naturalium* 8, 2 (70) : 29-52.
- PETKOVSKI, T.K., 1969. Zwei neue Limnocythere-Arten aus Mazedonien (Crustacea, Ostracoda). *Acta Musei Macedonici Scientiarum Naturalium* 12, 1 (102) : 1-18.
- PIETRZENIUK, E., 1977. Ostracoden aus Thermokarstseen und Altwässern in Zentral-Jakutien. *Mitteilungen aus dem Zoologischen Museum in Berlin*, 53 (2) : 331-364, pls. VII-XIII.
- SARS, G.O., 1905. Pacifische Plankton-Crustaceen. 2. Brackwasser-Crustaceen von den Chatham-Inseln. *Zoologische Jahrbücher, Abteilung für Systematik, Geographie und Biologie der Tiere*, 21 (4) : 371-414.
- SEMEANOVA, L.M., 1977. Material on ostracod fauna in the Ivanovski Reservoir. *U.S.S.R. Academy of Sciences, Biology of internal waters, Information Bulletin*, 35 : 41-44 (Leningrad, 1977). (In Russian).
- SEMEANOVA, L.M., 1985. Specific structure and distribution of ostracods in reservoirs of Upper Volga. *U.S.S.R. Academy of Sciences, Institute of Biology of Internal Waters, Proceedings*, 52 (55) : 105-118 (Leningrad, 1985). (In Russian).
- SOKAC, A., 1970. Die neue Art *Paralimnocythere dalmatica* (Crustacea, Ostracoda) aus dem Pleistozän der Kniner Feldes. *Zbornik Rudarsko-Geološko-Naftnog Fakulteta Sveučilišta U Zagrebu U Povodu*, 30 Godina Rada (1939-1969) : 161-164.
- SOKAC, A., 1972. Pannonian and Pontian Ostracode fauna of Mt. Medvednica. *Palaeontologia Jugoslavica*, 1972 (11) : 1-140.
- SOKAC, A., 1980. Miocenski ostrakodi Sinjskog polja. *Geoloski Vjesnik*, 31 : 137-144.
- STANKOVIC, S., 1960. The Balkan Lake Ohrid and its living world. *Monographiae, Biologicae*, 9 : 357 pp.
- STEGER, Ch., 1979. Contribution à l'étude des Ostracodes en Camargue. *Rapports et Procès-Verbaux des Réunions de la Commission internationale pour l'Exploration scientifique de la Mer Méditerranée*, 25/26 (3) : 165-166.
- STRAUB, 1952. Mikropaläontologische Untersuchungen im Tertiär zwischen Ehingen und Ulm a.d. Donau. *Geologisches Jahrbuch* 66 : 433-523.
- SYWULA, T., 1965. Notes on Ostracoda I. On some Polish species. *Bulletin de l'Académie Polonaise des Sciences, Cl. II*, 13 (11/12) : 647-652.
- SYWULA, T., 1970. Notes on Ostracoda. IV. Some Limnetic Cytheridae from Europe. *Bulletin de l'Académie Polonaise des Sciences, Cl. II*, 17 (11/12) : 665-668.
- SYWULA, T., 1974. Malzorzaczki (Ostracoda). *Fauna Slodkowodna Polski*, 24 : 1-315.
- WANG, WEN-SHENG, 1989. Early Cretaceous Ostracoda from the Western Eren Basin, Nei Mongol. *Acta Micropalaeontologica Sinica*, 6 (4) : 373-387, Pls. I-IV.
- ZUBOVICH, S.F., 1976. New species of Ostracoda from Aleksandrian (Likhvinian) deposits of Belorussia. In : *New species of fossil animals and plants from Belorussia*, Minsk : 91-99.

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