

**ON THE TAXONOMY AND ZOOGEOGRAPHY
OF THE GENUS *GOMPHOCY THERE* SARS, 1924
(CRUSTACEA, OSTRACODA), WITH THE DESCRIPTION
OF A NEW SPECIES FROM THE NAHAL DAN (ISRAEL)**

by

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SUMMARY

Gomphocythere ortali n.sp. is described from the Nahal Dan, one of the three main sources of the River Jordan. This area is well known as one of the southernmost Palaearctic enclaves in the Levant. The occurrence of an endemic species of an otherwise purely Ethiopian genus in such an area is therefore of interest. The present locality furthermore constitutes an important range extension for the genus, as the most northern locality of *Gomphocythere* thus far was Addis Ababa (Ethiopia).

Gomphocythere ortali n.sp. can easily be distinguished from all its congeners by the large, elongated valves in both sexes, by the relatively narrow female carapace in dorsal view and by the shape and anatomy of the hemipenis. New diagnoses for the tribe Cytheridellini and for the genus *Gomphocythere* are given; a number of morphological features and the validity of some species are reassessed. The origin and zoogeography of the genus and species are discussed.

Keywords : taxonomy, morphology, zoogeography, ecology, Ostracoda, Levant, *Gomphocythere*, Afro-Syrian Rift.

INTRODUCTION

MARTENS *et al.* (1992) published a preliminary checklist of non-marine ostracods reported from Israeli inland water and retained 25 species in 18 genera. Meanwhile, DIMENTMAN *et al.* (1992) and MARTENS (1993) added 6 genera and 8 species to this list. This total of 33 species still constitutes considerably less than half of the number of species present and/or expected in this country (MARTENS, unpublished records). Especially temporary pools, springs and subterranean habitats continuously prove to hold a very rich and diverse ostracod fauna. The present con-

tribution reports on a new species of an Ethiopian genus, *Gomphocythere* SARS, 1924.

Nahal (River) Dan is one of the three main headstreams of the River Jordan. The Dan spring emerges on the northern frontier at the foot of Mount Hermon from a powerful karstic exsurgence (POR *et al.*, 1986), where it forms a crystal-clear pond. Its waters, originating from melting mountain snow, are cold (15-16°C), even in mid-summer. The average flow of Nahal Dan is estimated at c. 252 million m³ (ORNI and EFRAT, 1980) or at c. 8 m³.s⁻¹ (ALLAN *et al.*, 1988). Both discharge and water temperature are unusually constant and there are no visible seasonal effects. Nahal Dan flows south in a series of small waterfalls, over a stretch of c. 6 km, very uniform from a faunal point of view, after which it unites with the Nahal Hermon and later on with the Nahal Senir to form the Upper Jordan River.

Our samples were collected near the actual spring of the Nahal Dan, i.e. near station 1 of ALLAN *et al.* (loc.cit.).

The new species, *G. ortali* n.sp., is here described and some problems with regard to taxonomy and morphology of the genus in general, as well as to origin and zoogeography of the new species in particular, are discussed.

ABBREVIATIONS USED IN TEXT AND FIGURES

With regard to the nomenclature of the chaetotaxy of the various limbs, we follow the model proposed by BROODBAKKER and DANIELOPOL (1982). Part of the terminology of the hemipenis is similar to the one developed in DANIELOPOL *et al.* (1990) and in MARTENS (1990a).

Soft parts

A1	antennula
A2	antenna
cop	copulatory processus of hemipenis
cs	caudal seta
dl	distal lobe of hemipenis
fs (1-2)	furcal setae 1-2
fl (1-3)	furcal lobes 1-3
fo	forked organ («organe fourchu»)
fu	furca
GeO	genital orifice
hlo	hypostomeal lobes
lb	labium
Md	mandibula
Mx1	maxillula
P(1-3)	walking limbs
ro	rake-like organs
ur	upper ramus of clasping organ of hemipenis
Ya	aesthetasc on A1
Y	aesthetasc on A2

Valves

H	height of valves
L	length of valves
RV	right valve
LV	leftvalve

TAXONOMIC DESCRIPTIONS

Subfamily Limnocytherinae KLIE, 1938

Tribe Cytheridellini DANIELOPOL and MARTENS, 1990

Amended diagnosis. Carapace with important sexual dimorphism, i.e. ♀ caudally with widely dilated valves in dorsal view, forming brooding pouches for eggs and first (2?) instars. Valves with or without additional longitudinal ridges and crests on the external surface. Hinge adont to weakly lophodont. Mx1 with palp weakly sclerified, mostly undivided and with reduced number of apical and lateral setae. P(3) the largest walking limb (*Gomphocythere* and *Gomphodella*) or reduced to a short and curved cleaning limb (*Cytheridella*).

Genus *Gomphocythere* SARS, 1924

Type species : *Limnocythere obtusata* SARS, 1910

Amended diagnosis. Females with a brooding pouch. Hinge lophodont, with posterior cardinal tooth on LV (always?) larger than anterior one. Ventral side in some species set with ridges.

A1 with penultimate segment set with 7 claw-like setae and weakly or not at all divided. P(3) the largest walking limb. Posterior part of female abdomen with one furca, bearing two furcal setae and three hirsute furcal lobes. Hemipenis with large, articulating distal lobe, without a lateral seta (present in *Cytheridella*).

Gomphocythere ortali sp.n.

Type locality. Nahal Dan, spring and river, northern Israel. Approximate coordinates: 35°37'33" N, 33°15'29" E (Israel Grid: 2110/2950). For description of the area: see introduction.

Type material. The following collections have been used for the present descriptions :

ISR/84/27 (no. IG.27401) : sample collected amongst littoral vegetation, at c. 200 m from actual spring, by MARTENS and ORTAL on 5/3/1984. Measurements at time of collection: Ph = 8.2, T° = 15.3°C. All illustrated specimens originate from this sample. Accompanying ostracod fauna : *Psychrodromus* n.sp., « *Stenocypris* » *subterranea*, *Ilyocypris* gr. *inermis*.

ISR/91/54 (no. IG.27757): sample collected amongst *Potamogeton* stands, c. 200 m from spring, by MARTENS and ORTAL on 13.6.1991. Accompanying ostracod fauna : *Psychrodromus* n.sp., « *Stenocypris* » *subterranea*, *Heterocypris rotundata*.

Holotype : a ♂, with soft parts dissected in glycerine in a sealed slide and with valves stored dry (no. OC.1698)).

Allotype : a ♀, dissected and stored as the holotype (no. OC.1699)).

Paratypes : 3 ♂ + 3 ♀ stored dry after use for SEM (nos. OC.1692-1697), 2 tubes which c. 50 specimens (♂, ♀, juv.) each (nos. OC.1700-1701).

Repository : all types, both dissected and in spirit, are stored in the Ostracod Collection of the R.B.I.N.Sc.

Derivation of name : this species is named after Dr Reuven ORTAL (The Hebrew University, Dept of Zoology and The Nature Reserves Authority, Jerusalem), in appreciation of his contribution to the research on and the conservation of aquatic environments in the Levant. This is also to thank him for the warm friendship that we have shared over the years.

Diagnosis. Large and elongated species, with straight dorsal margin sloping towards the caudal side, especially in the male. Posterior part of carapace in female relatively narrow and rounded in dorsal view. Mx1-palp weakly sclerified and undivided. Hemipenis with dl sub-triangular, with squarish base, blunt tip set with comb-like structure, medio-lateral indentation without a protuberance; ur relatively short, cop short and curved in its distal half.

Additional description of ♂. Valves (Figs. 1E, F) strongly sclerified and externally reticulated, but without ridges or crests. Anterior margin broadly rounded, posterior margin more narrow, but still evenly rounded. Greatest height situated at about one fourth from the anterior, from there the straight dorsal margin sloping towards the caudal side. Ventral margin weakly sinuous. Hinge (Fig. 1L) lophodont, with prominent and elongated, but simple cardinal teeth on LV fitting in cardinal sockets on RV; intercardinal bar on RV smooth. Both valves (Figs. 1G, H) with prominent selvage; calcified inner lamellae narrow on both anterior and posterior sides. Ventro-caudal flanges irregularly serrated (Fig. 1M). Carapace in dorsal and ventral (Fig. 1K) views narrow, with nearly parallel sides.

A1 (Fig. 2D) with 4-segmented endopodite, penultimate segment undivided. First segment of endopodite c. twice as long as wide, with one long, medio-ventral seta. Second segment short and squarish, with one long apical seta. Third segment with one medio-ventral and two medio-dorsal setae and four apical (one ventral, three dorsal) setae. Terminal segment elongated, with two sub-apical setae and one apical aesthetasc, slightly fused at the base with a seta, this seta longer than the actual sensorial club.

A2 (Fig. 3E) with endopodite three-segmented. First segment short, bearing one long apical seta. Second segment long, with medio-ventrally two setae and one long aesthetasc (the latter reaching to tip of segment); medio-dorsally two unequal setae and apically one stout, claw-like seta. Terminal segment with three stout and short claws, one subapically and two apically inserted.

Md (Fig. 3D) without special features. Palp four-segmented. First segment with respiratory plate consisting of three rays only (two long, one short) and with two subequal ventral setae. Second segment short and squarish, bearing three apical setae. Third segment of similar shape, with 5 apical setae, three dorsally and two ventrally inserted. Terminal segment pyramidal, with two claws.

Mx1 (Fig. 2E) with three endites of normal shape and chaetotaxy; palp weakly sclerotized and unsegmented, set with three lateral and two apical setae.

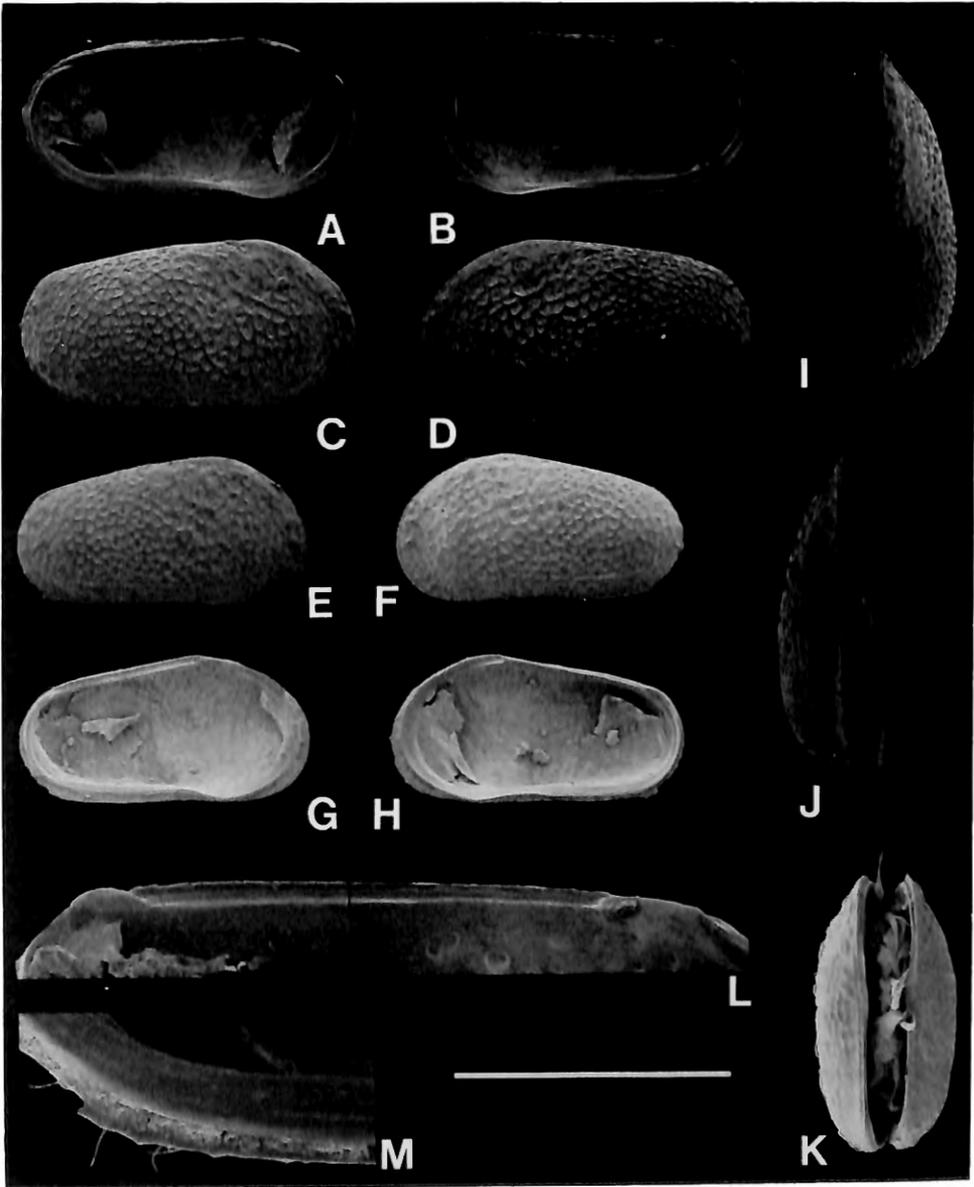


Fig. 1. *Gomphocythere ortalii* n. sp.: SE micrographs of the valves. — A. ♀, LV, internal view (no. OC.1694). - B. ♀, RV, internal view (no. OC.1694). - C. ♀, RV, external view (no. OC.1693). - D. ♀, LV, external view (no. OC.1693). - E. ♂, RV, external view (no. OC.1697). - F. ♂, LV, external view (no. OC.1697). - G. ♂, LV, internal view (no. OC.1696). - H. ♂, RV, internal view (no. OC.1696). - I. ♀, Cp, dorsal view (specimen lost). - J. ♀, Cp, ventral view (no. OC.1692). - K. ♂, Cp, ventral view (no. OC.1695). - L. ♀, LV, internal view, detail of hinge (no. OC.1694). - M. ♀, LV, internal view, detail of posterior part (no. OC.1694). (Scale = 556 μ m for A-K; 217 μ m for L; 139 μ m for M.).

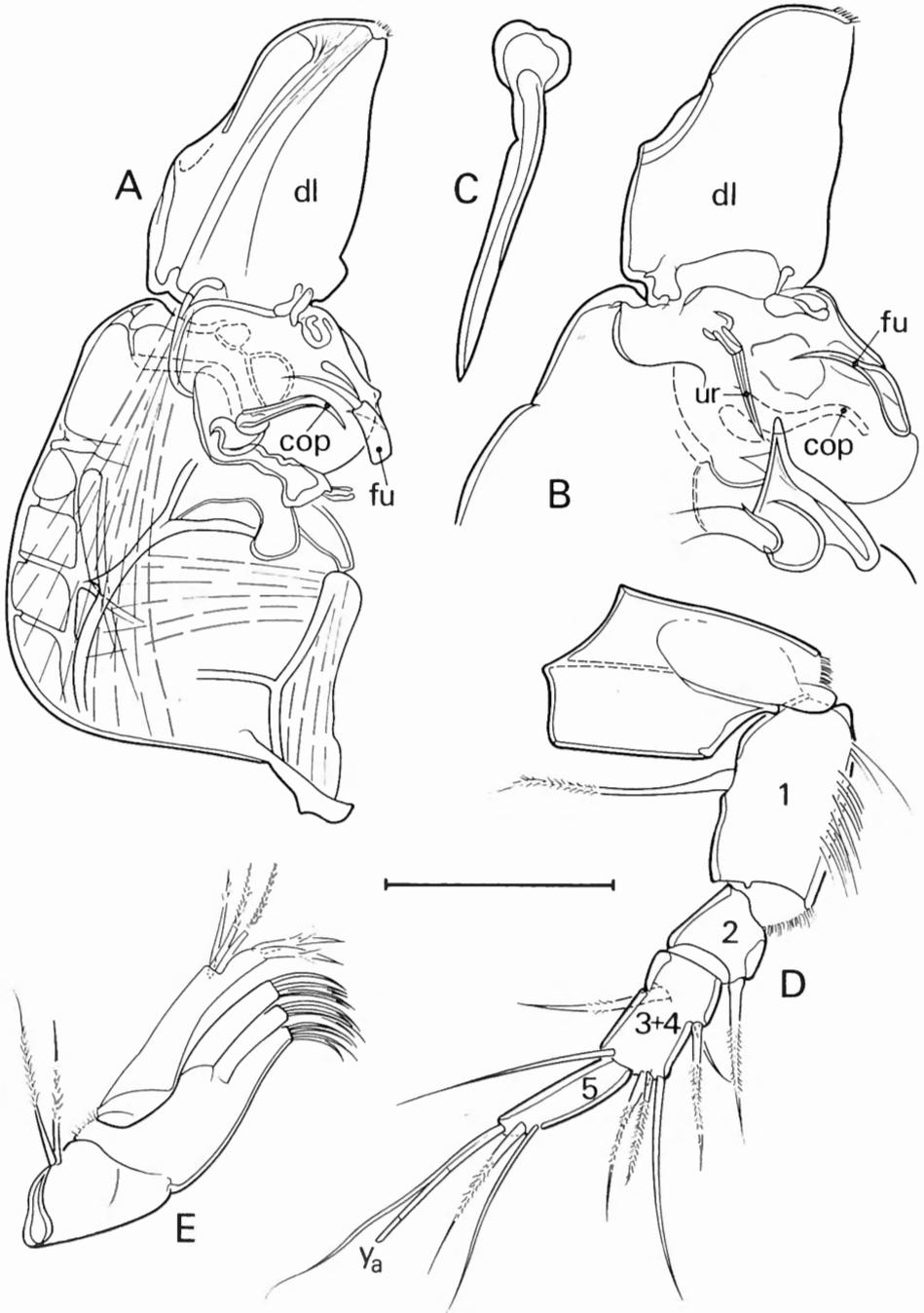


Fig. 2. *Gomphocythere ortali* n.sp. (♂, no. OC.1698). — A. Hemipenis, medial view. — B. Hemipenis, detail, medial view. — C. Hemipenis, detail of ur. — D. A1. — E. Mx1, respiratory plate not shown.

(Scale = 78 μ m for A-E).

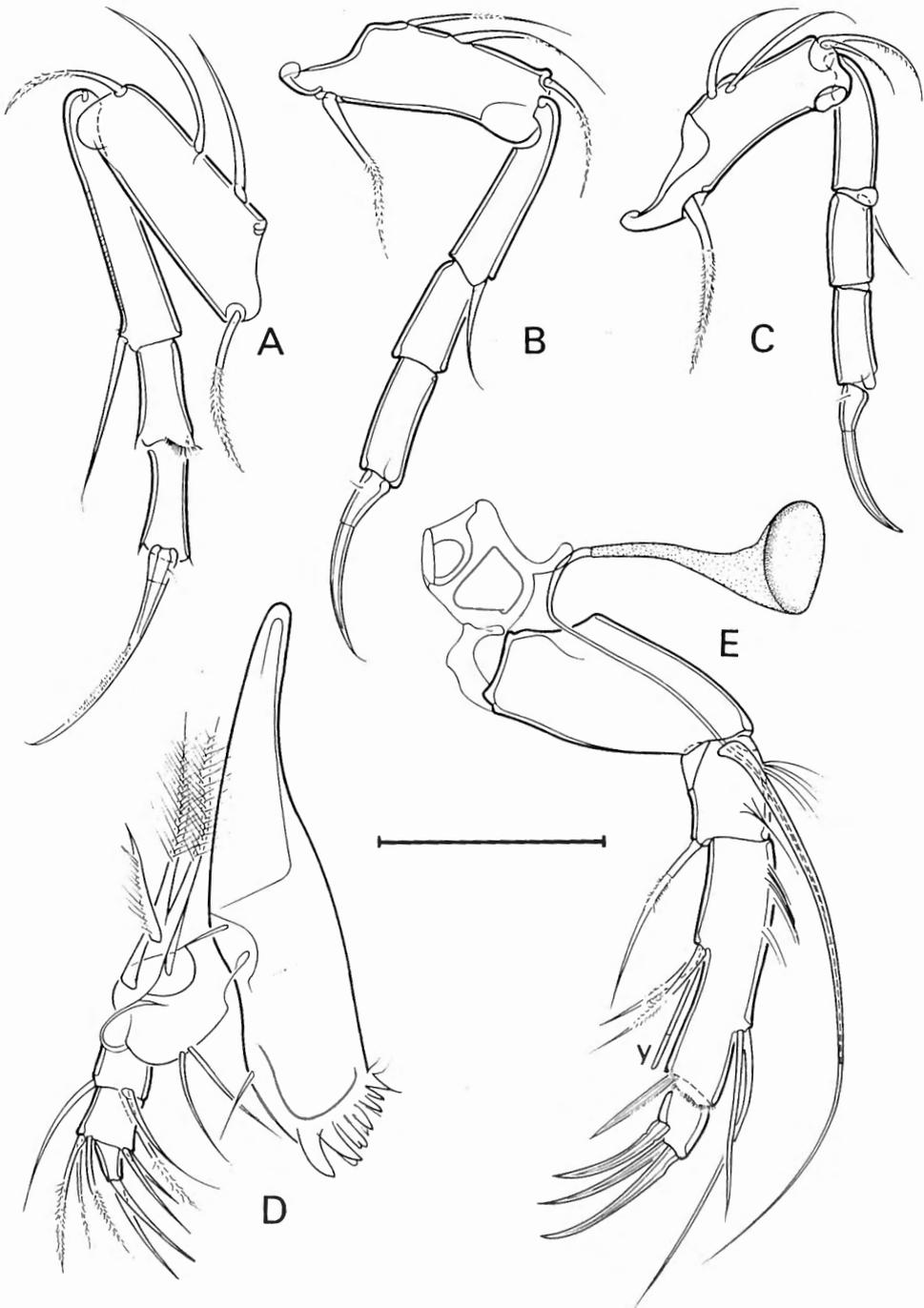


Fig. 3. *Gomphocythere ortali* n.sp. (♂, no. OC.1698). — A. P(3). - B. P(2). - C. P(1). - D. Md and mandibular palp. - E. A2. (Scale = 78 μ m for A-E).

P(1-3) (Figs. 3A-C) all walking limbs; P(1) the shortest and P(3) the longest and with the longest claw. First segment in these limbs with 2 long dorsal and one long and hirsute ventral seta (the latter proximally inserted) and with one (on P(2) and P(3)) or two (on P(1)) knee-setae as is typical of the subfamily.

Hemipenis (Figs. 2A-C) of the typical *Gomphocythere*-type, i.e. with a large, muscular body and a prominent, articulating distal lobe (dl), devoid of setae. Shape of the dl in this species broadly subtriangular, with a squarish base, a blunt tip set with a comb-like structure and with a sinuous dorsal margin devoid of protuberances. On main body, ur relatively short and straight, well sclerotized; cop short and distally curved.

Additional description of ♀. Valves (Figs. 1A-D) generally as in the ♂, but larger and with straight dorsal margin only slightly sloping towards the caudal side; anterior margin still more broadly rounded than posterior one. Structure of hinge and valve margin as in the ♂. Carapace in dorsal (Fig. 1I) and ventral (Fig. 1J) view with posterior part more swollen than in the ♂, but considerably less so than in most other species of this genus. Anterior tip in dorsal view bluntly pointed, posterior edge rounded.

All appendages (Figs. 4A-C, 5A-C) generally as in the ♂; aesthetasc Y on A2 (Fig. 4B) slightly shorter than the accompanying setae. Two pairs of « hypostomeal lobes » present posterior to labium (Fig. 5E), anterior lobes approximately twice as long as posterior ones. Sternum as illustrated in Fig. 4D. Posterior part of abdomen (Fig. 5D) with one furca bearing two furcal setae and three hirsute furcal lobes, one (caudal ?) seta and one forked organ (see discussion for homology). Genital orifice small and rounded.

Measurements

♀ : L = 667-578 (n = 6); H = 334-345 (n = 4), W = 311 (n = 1)

♂ : L = 578-589 (n = 5); H = 300 (n = 4).

Differential diagnosis. The new species can easily be distinguished from almost all of its congeners by the elongated valves and by the shape of the hemipenis.

DISCUSSION

Taxonomy of the genus *Gomphocythere*

Although most of the descriptions of the species in this genus are sufficient to allow identification, there are still a number of problematic taxa.

1. SARS (1910) described *Limnocythere* (sic) *obtusata* from Lake Victoria. Later on (1924), he designated this taxon as the type species of the genus *Gomphocythere*, offering a redescription of what he claimed to be *G. obtusata* from South Africa.

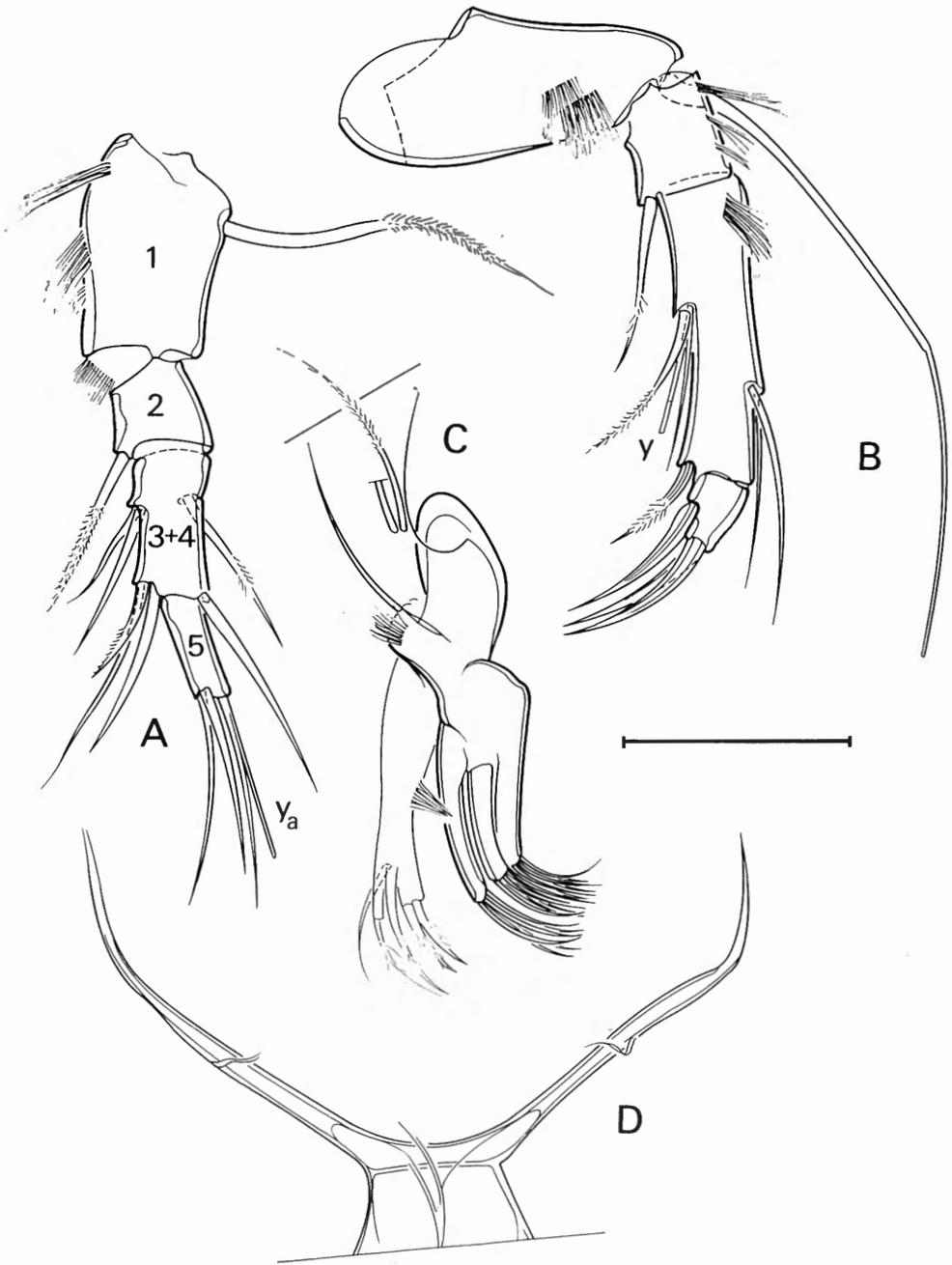


Fig. 4. *Gomphocythere ortali* n.sp. (♀, no. OC.1699). — A. A1. — B. A2. — C. Mx1, respiratory plate not shown. — D. Sternum.
 (Scale = 78 μ m for A-D).

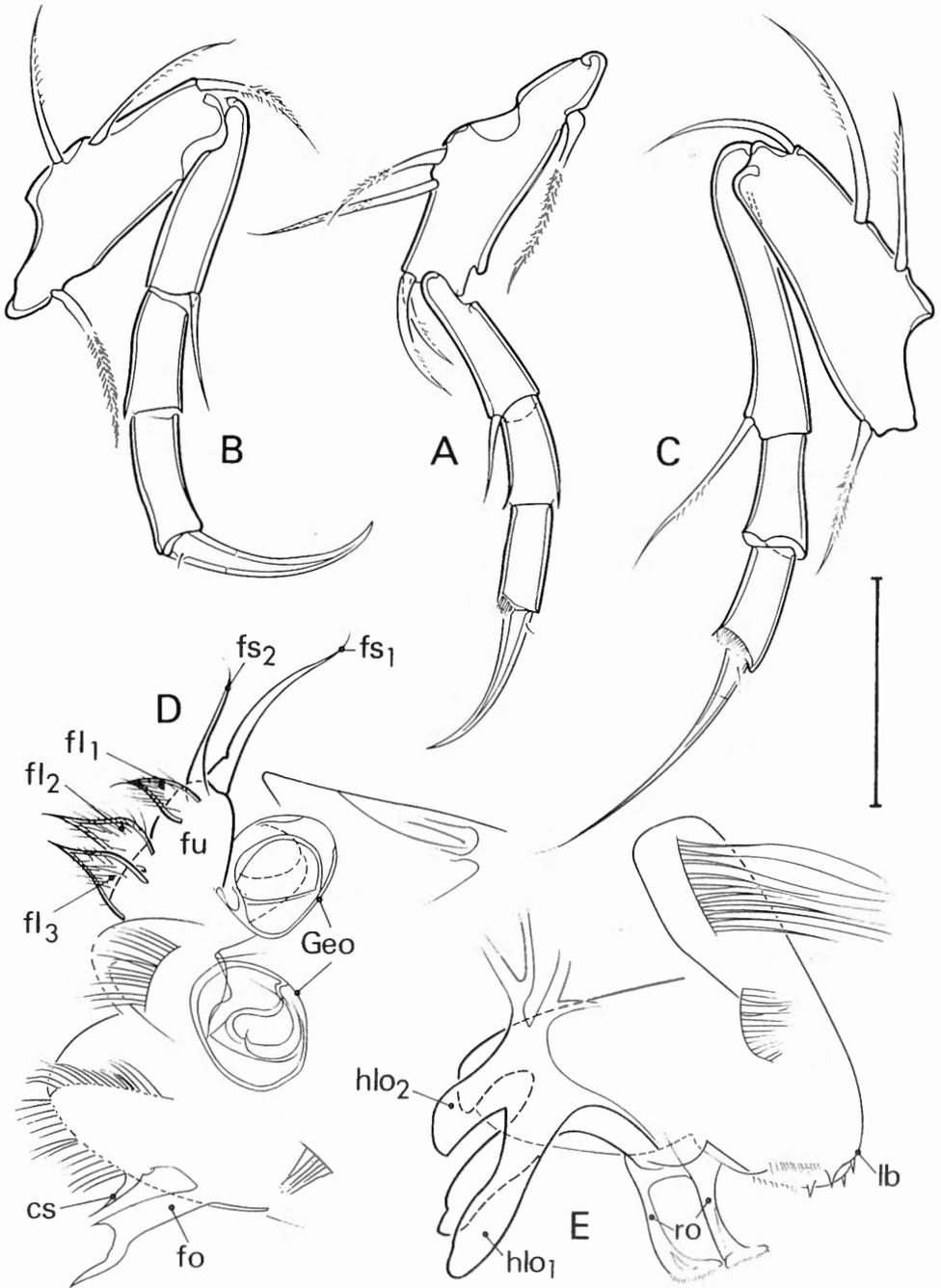


Fig. 5. *Gomphocythere ortali* n.sp. (♀, no. OC.1699). — A. P(1). - B. P(2). - C. P(3). - D. Furca and posterior part of abdomen. - E. Labium, rake-like organs and hypostomeal lobes. (Scale = 78 μ m for A-E).

In the same paper he described *G. expansa*, which was later identified from East Africa by LOWNDES (1932) and LÖFFLER (1978). I have doubts with regard to the conspecificity of populations from East and South Africa, especially with regard to *G. obtusata* of which illustrations from both populations exist: the specimens from South Africa have a pronounced dorso-caudal corner on the valves, whereas this corner in Lake Victoria specimens is perfectly rounded. This is an important feature in this group. Unfortunately, no males are known from East Africa. Male specimens of both populations must be compared in order to solve this problem.

2. I have doubts with regard to the validity of *G. expansa* and *G. capensis*, the latter described as *Cytheridella capensis* by MÜLLER (1914) and characterized mainly by the complete absence of a brooding pouch in the ♀. From the same locality, MÜLLER identified females of *Cytheridella obtusata*, which actually belong to *Gomphocythere expansa* (fide KLIE 1939 and ROME and DE DECKKER 1977). The male valves and hemipenis of *G. capensis* are identical to those of *G. expansa*, whereas the ♀ supposedly belonging to *G. capensis* and illustrated by MÜLLER (*loc. cit.*) is similar to juvenile (A-1) ♀ of *G. expansa*. It would thus seem that *G. capensis* and *G. expansa* are synonyms, with the name *capensis* (described in 1914) then having priority over *expansa* (described in 1924). I have attempted to obtain the type material of *G. capensis* to check this assumption, but was thus far unsuccessful. Various new collections from the surroundings of Cape Town and the Cape Flats furthermore yielded several new populations of both *G. expansa* and *G. obtusata*, but never from *G. capensis*. Solutions to both of these problems will be described elsewhere (MARTENS, in prep.).

Morphology

There are a number of aspects of the morphology of this genus which need to be discussed here.

1. According to KLIE (1939), segments 3 + 4 of the A1 are fused in some species of this genus, separated in others. This is also described by ROME (1962, 1970) and ROME and DE DECKKER (1977). I have checked material of several species and it appears that a separation between these segments, if at all present, is always very superficial and never pronounced.

2. Ventral ridges and lateral crests were thought to be typical of *Gomphocythere*, until KLIE (1939) described *G. angusta*, which is completely devoid of both. This author also explicitly stated that these features should be lifted from the generic diagnosis, a fact which was ignored by DE DECKKER (1981) when he described the Australian genus *Gomphodella*. The ventral ridges were indeed cited by him as the main difference between *Gomphodella* and *Gomphocythere*. The other features from the diagnosis clearly separate *Gomphodella* from *Cytheridella*, but not from *Gomphocythere*. The Australian species should be re-investigated and new generic characteristics need to be defined.

3. The undivided and weakly sclerotized Mx1-palp with very reduced chaetotaxy is characteristic of the tribe Cytheridellini, as it occurs in all three genera belonging to this group. Nevertheless, for some species a two-segmented palp (e.g.

G. obtusata) or even a completely normal Mx1 (e.g. *G. expansa*) are described. At least for these two species I have been able to check new material from South Africa, and both species have the reduced Mx1-palp. The illustration of this appendage for *G. expansa* by Sars (1924) is completely erroneous. The degree to which the chaetotaxy is reduced (number of setae) does seem to show some inter-specific variability. Some species (e.g. *G. obtusata* from South Africa) furthermore have a large lateral seta on the first endite of this limb. This seta was missing in all investigated specimens of *G. ortali* n.sp.

4. Some of Rome's species are described and illustrated with two endclaws on the A2, while all species examined by me clearly show 3 endclaws. ROME's material should be re-investigated in order to see if these observations are correct or not.

5. The forked organ was described by ROME and DE DECKKER (1977) as «organe fourchu», and occurs on the posterior part of the abdomen of females of both *Gomphocythere* and *Cytheridella*. In most species (including *G. ortali* n.sp.) it is indeed an undivided fork-like structure, but in *G. curta* ROME, 1962 it is illustrated as a solid base on which a small seta is inserted. Females of *Gomphocythere* and *Cytheridella* reportedly have only one furca (with furcal setae and furcal lobes), and the forked organ therefore in all probability represents the reduced second furca.

6. Fig. 5E shows part of the hypostomium (following nomenclature in SCHULTZ 1976), with lower lip (labium), rake-like organs and a pair of unsegmented lobes posterior to the labium. I have not found a homologue of these «hypostomeal lobes» in the literature.

Zoogeography

The extant (recent) species of the genus *Gomphocythere* are restricted to the Ethiopian Realm. A number of species outside Africa have been referred to this genus, but these are now lodged in other genera: the species from South America are in *Cytheridella*, while DE DECKKER (1981) created the genus *Gomphodella* for the Australian species. Including *Gomphocythere ortali* n.sp., there are 13 extant species (MARTENS, 1984). The distribution of this genus (Fig. 6) in Africa is very similar to that of the genus *Limnocythere* (see MARTENS, 1990a), with three exceptions: (1) *Limnocythere* is not exclusively Ethiopian, whereas *Gomphocythere* clearly is, (2) there are no *Limnocythere* species in the Cape Province (2-3 species of *Gomphocythere*) and (3) there are no *Gomphocythere* species in Namibia and Botswana (*Limnocythere tudoranceai* in both countries). The latter two observations, if at all valid and not due to an insufficiently dense sampling grid, are problematic, as they cannot be correlated with any physical or chemical environmental factor: *Limnocythere* and *Gomphocythere* both occur in large to very large lakes and in smaller (although permanent) water bodies, while also their tolerance ranges for conductivity/salinity, temperature etc. are very similar (see below).

The distribution pattern of *Gomphocythere* shows a clear affinity between the faunas of eastern and southern Africa, in this case including the Cape Province, as was already amply shown for other ostracod groups, such as *Limnocythere* (see

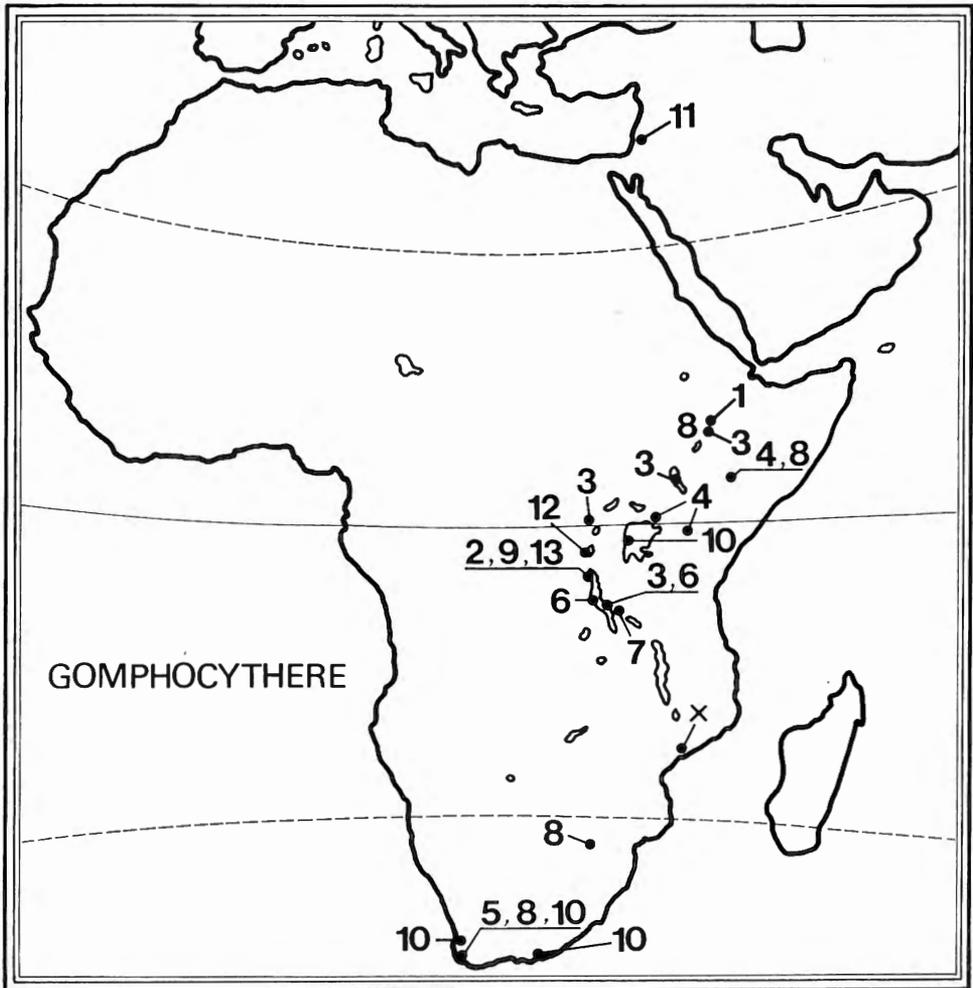


Fig. 6. — Distribution of *Gomphocythere* species.

1 = *G. aethiopis* ROME, 1970. 2 = *G. alata* ROME, 1962.. 3 = *G. angulata* LOWNDES, 1932. 4 = *G. angusta* KLIE, 1939. 5 = *G. capensis* (G. W. MÜLLER, 1914). 6 = *G. cristata* ROME, 1962. 7 = *G. curta* ROME, 1962. 8 = *G. expansa* SARS, 1924. 9 = *G. lenis* ROME, 1962. 10 = *G. obtusata* (SARS, 1910). 11 = *G. ortali* n.sp. 12 = *G. parcedilatata* ROME, 1977. 13 = *G. simplex* ROME, 1962. x = *G. spec. indet.*

MARTENS, 1990a), the Megalocypridinae (MARTENS and COOMANS, 1990) and the Cypridini (Martens, 1990b, 1992). These generalized patterns of the distribution of African ostracods again prove that East and South Africa indeed belong to the same zoogeographical province (TAYLOR, 1978 and others).

The presence of *Gomphocythere ortali* n.sp. in Nahal Dan is surprising and this mainly for two reasons. Firstly, the number of aquatic species of truly Ethiopian

origin in the Levant in general is rather limited and «... whatever Ethiopian influence is felt in the inland waterfauna of the Levant, this is mostly limited to the south, i.e. to the Jordan Valley and the coastal plain of Israel». (POR, 1989 : 137). The Nahal Dan and its spring belong, together with the Golan heights, to an area which is believed to be the southernmost limit of the Palaeartic, and the southern border of this region is termed the « Nehring-line » (POR, 1975 and others). Of the 156 taxa of aquatic animals, reported from the River Dan by ALLAN *et al.* (1988), the major part is Palaeartic in character. Only 7 of the identified species have an Ethiopian origin. All of these belong to the Hemiptera and the Chironomidae and are furthermore widely distributed in central and southern Israel. *Darwinula africana* KLIE, 1935 (MARTENS, unpublished data) and *Klieopsis horai* (KLIE) (in MARTENS *et al.*, 1991) are Ethiopian ostracods reported from Israel, but these species were found in springs around the Dead Sea, and this is the area where Ethiopian species can be expected.

Most of the other ostracods identified from the Nahal Dan (see above) are indeed also cold-stenothermal (even partly rheophylic) Palaeartic elements: *Psychrodromus* n.sp. (a second new (sub) species occurs in streams on the Golan heights) and a representative of the *Ilyocypris inermis*-group. « *Stenocypris* » *subterranea* HARTMANN is a cold-stenothermal species, typical of springs, rivers and subterranean aquatic habitats in the Eastern part of the Mediterranean.

There is also a second reason why the presence of *G. ortali* n.sp. in this area is surprising: the habitat itself, a cold water spring and river, is unusual for species of *Gomphocythere*. So even if we accept that *G. ortali* n.sp. is an endemic relict of a much wider ancient distribution of *Gomphocythere*, comprising the entire Afro-Syrian Rift valley — and this indeed seems to be the most logical explanation — then it is still not clear why this species survived in the cold running waters of the Nahal Dan and not, for example, in Lake Tiberias (LERNER-SEGGEV, 1968) or in Lake Hula (MARTENS 1993, DIMENTMAN *et al.* 1992), which would constitute more logical habitats. It should also be mentioned that the species does not occur in either Nahal Senir or Nahal Hermon, the other two main headwaters of the river Jordan.

Finally, to further complicate matters, Nahal Dan is in all probability not the original and/or only refuge of the species in this area, as this spring and river are supposed to be of postglacial origin (POR *et al.*, 1986). Other localities might for example be found in the Lebanon Mountains (POR, 1989).

Ecology

As was outlined above, species of *Gomphocythere* are generally confined to permanent lakes (large or small), where they can survive in a wide variety of ecological conditions, e.g. for pH (5.6 for *G. expansa* in Black Bosvlei, W. Cape — MARTENS, unpublished — and 9.5-10 for the Tanganyika species), conductivity (a range of 0-30,000 $\mu\text{S}\cdot\text{cm}^{-1}$ for *G. angulata* — MARTENS, 1990a), etc. Most East African lakes have semi-permanent water temperatures of 20-25°C, but both the Ethiopian crater lakes and some of the vleis of the Cape Flats have considerably colder waters.

A number of *Gomphocythere* species have a maze of ridges on the ventral side of the carapace and this hinted towards a hyponeustic mode of life, in analogy with, for example, *Notodromas* and *Oncocypris*. However, several species of *Gomphocythere* (including *G. ortali* n.sp.) lack these ridges, and these taxa are certainly benthic species.

It is not impossible that certain species of this genus live in the subsurface (interstitially), but this would need further substantiation. It should finally be noted that Cytheridellini in all probability do not have dry resistant stages, which is the main reason why they are confined to permanent waterbodies. Of the Limnocytherinae, only some Leucocytherini are thus far known to have such dry resistant stages.

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