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On the distribution of *Cyprideis torosa* (JONES)(Crustacea, Ostracoda) in Africa, with the discussion of a new record from the Seychelles

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Abstract

Newly acquired material of *Cyprideis torosa* (JONES, 1850) from Silhouette Island (the Seychelles) is compared with material from The Netherlands, Belgium, southern France and Egypt. Several taxonomically relevant features are discussed, such as the shape of the valves, the presence of a postero-ventral spine on the right valve, the morphology of the hemipenis, of the medial seta of the antennule, and of the male right first leg. It is shown that the two hemipenes of *C. torosa* are asymmetrical. The differences between specimens from the Seychelles and other *C. torosa* populations are discussed and the distribution of the species in Africa is illustrated. It is concluded that *C. torosa* is a very variable and widely distributed species. Although *C. torosa* is considered to be a well-known ostracod spcies, many questions regarding intraspecific variability, distribution etc. remain unanswered.

Key-words: Ostracoda, *Cyprideis torosa*, Africa, zoogeography, Seychelles.

Introduction

Cyprideis torosa (JONES, 1850) is a common brackish water species, occurring in Europe, west and central Asia, and in Africa. Information on the occurrence of the species in Africa, with exception of the Mediterranean zone, however, is limited. New records of the species in Africa are therefore of particular importance. In July 2001 Dr. Justin GERLACH collected brackish water ostracods on Silhouette Island (the Seychelles). The sample contained one single species, which in this study is identified, with some reserve, as *Cyprideis torosa*. Because of the geographical position of Silhouette Island (4°35' S, 50°40' E) this new record would be the first of the species south of the equator. To check the identification, the material of the Seychelles was compared with material of the same species from other localities. Furthermore, the general distribution of *Cyprideis torosa* was reviewed. Especially the distribution of the species in Africa is documented in detail.

Material and methods

The following material of *Cyprideis torosa* was used in this study.

1. Texel (The Netherlands), "Zandkes" claypit. Leg. K. WOUTERS, 1st May 1977.
2. Knokke-Heist (Belgium), creek "Hazegraspolder". Leg. F. FIERS & M. ESPEEL, 1st June 1981.
3. Camargue (S. France), Etang de Malagroy. Leg. K. WOUTERS, 26th July 1976.
4. Lake Qarun, Fayum (Egypt), SE tip of the lake. Leg. L. TRIEST, 23th May 1986.
5. Silhouette Island (the Seychelles), Dauban Marsh. Leg. J. GERLACH, 11th July 2001.

All material studied is deposited in the Ostracod Collection (numbers O.C. 2496-2529) of the Royal Belgian Institute of Natural Sciences, Brussels (Belgium).

Distribution of *Cyprideis torosa*

The euryhaline ostracod *Cyprideis torosa* first appeared in the Late Miocene (VAN HARTEN, 2000). It is the only survivor of a large number of fossil species and subspecies that have been recorded from the Neogene of the Mediterranean area, the Paratethys in particular. It may well be a daughter species of the ubiquitous species in the "Lago Mare" of the Mediterranean Messinian, *Cyprideis agrigentina* DECIMA, 1964 (VAN HARTEN, 1990).

The Recent *C. torosa* is a common species in shallow anomohaline waters in western and southern Europe, i.e. Mediterranean coasts, including Mediterranean Isles, and the Atlantic coasts of W and NW Europe. The species is also known from Eurasia, Central Asia and SW Asia, for example in the Black Sea, Caspian Sea, Lake Aral and Lake Issyk-Kul, and in China. ZHAO & WANG (1988) comment on the presence of *Cyprideis torosa* in China. They emphasized that the species is conspicuously absent along the Chinese coast, and that it is probably replaced by the endemic species *Sinocytheridea latiovata* HOU & CHEN. In 1993 the same authors reconsidered the distribution of *Cyprideis torosa* in China, and concluded that (p.674) this species "has been widely encountered in W. China, such as in he Miocene of the Tarim Basin, and in the Pleistocene of the Qaidam basin, but never in East China. The eastern boundary of its distribution probably lies near Yunchen and Yuxian, where both *Sinocytheridea impressa* and *Cyprideis torosa* can occur in deposits, but rarely together in the same assemblage".

The northernmost locality of the species is Dalnye Zelenski (E. of Murmansk), Kola Peninsula, Barentz Sea (ALADIN, 1989). The easternmost record is the Qinghai Plateau (N.W. China)(YANG, 1988). The southernmost locality in Asia is Loharwada, 9 km east of Charki Dadri (28°26'N, 76°16'E), District Mahendragarh, N. India, where the species occurs abundantly in subrecent deposits (BHATIA & KHOSLA, 1977). The most western locality is Iceland, where the species was found living in waters associated with hot springs by KLIE (1938).
The species also occurs in Africa (see further). Along the western coast, the southernmost locality is Joal Beach, 100 km S. of Dakar, Senegal (WITTE, 1993), and in eastern Africa, the species has repeatedly been reported from Lake Turkana, Kenya. The new record from the Seychelles constitutes an additional locality situated in the Indian Ocean, at 4°35' south of the equator.
It is generally accepted that *Cyprideis torosa* does not occur in the Americas (SANDBERG, 1964, KILENYI & WHITTAKER, 1974).

Cyprideis torosa in Africa

The species is common to very common in northern Africa in a large number of Mediterranean and in some inland localities, in Morocco, Algeria, Tunisia, Libya and Egypt. A special locality is Lake Qarun (Fayum, Egypt) from which BASSIOUNI *et al.* (1985, 1986) reported *Cyprideis sohni* BASSIOUNI, 1979. The material studied in the present paper, however, shows that the *Cyprideis* species in Lake Qarun is *C. torosa*.
Along the western coast, *C. torosa* occurs on the Canary Islands (BALTANAS & GARCIA-AVILES, 1993, BEYER *et al.*, 1997). Further to the south, the species has been recorded from Senegal and Gambia. (CARBONNEL, 1982, CARBONEL *et al.*, 1984, WITTE, 1993). The southernmost record in continental Africa is Lake Turkana, Kenya (KLIE, 1939a, LINDROTH, 1956, KILENYI & WHITTAKER, 1974 and COHEN, 1986). KILENYI & WHITTAKER (1974, p.31) restudied a male specimen, with soft parts, from Lake Turkana and confirmed the identification as *Cyprideis torosa*.
Apart from these recent occurrences there are some records of the species in Quaternary deposits. GRAMANN (1971) mentions *Cyprideis torosa pertorosa* and *Cyprideis torosa* subsp.? from the Danakil depression in Ethiopia (1). Further African Quaternary records are (2) Monastir in Tunisia, in Tyrrhenian marine sediments (WOUTERS, 1973), (3) Wadi Shaw, NW Sudan (KEMPF, 1986), (4) the N.E. Nile Delta in Egypt (PUGLIESE & STANLEY, 1995), (5) Lake Manzala, Nile Delta, Egypt (SLACK *et al.*, 1995), (6) ancient lake deposits (Lake Paleomoeris), SW of Lake Qarun, Fayum, Egypt (BOUKHARI & GUERNET, 1985), (7) the Sudan (SCHÖNING, 1996) and (8) the region of Hodh, SE Mauritania, in lacustrine deposits, in an archaeological context (FERRÉ *et al.*, 2001).
There are other *Cyprideis*-species in Africa, namely *Cyprideis remanei* KLIE, 1940, *Cyprideis nigeriensis* OMATSOLA, 1970 and *Cyprideis limbocostata* HARTMANN, 1974, occurring along the western coast of the African continent. HARTMANN (1974) considers these three species to be closely related.
The genus *Cyprideis* is completely absent along the eastern coast of southern Africa, because, as HARTMANN stated (1974, p. 269), the genus *Cyprideis* is replaced here by the genus *Sulcostocythere*.
Furthermore the genus *Cyprideis* occurs also in Lake Tanganyika. During the last decade a number of species, belonging to the *Cyprideis* species flock, have been described, namely *C. mastai* WOUTERS & MARTENS, 1994, *C. rumongensis* WOUTERS & MARTENS, 1994, *C. spatula* WOUTERS & MARTENS, 1999, *C. profunda* WOUTERS & MARTENS, 1999 and *C. loricata* WOUTERS & MARTENS, 2001.

The Seychelles record and discussion

The material from Silhouette Island (the Seychelles) was compared with material from the Netherlands, Belgium, southern France and Egypt.
The valves of *Cyprideis torosa* from Silhouette Island differ in some respect from other *C. torosa* populations. First, the valves are somewhat more oblong (especially the males), and have parallel dorsal and ventral margins (Pl. 3, figs 4a-d). In the Belgian and French material (Pl. 3, figs 1a-d, 2a-d) the dorsal margin is tapering towards the posterior. The Egyptian material (Pl. 3, figs 3a-d), however, takes a somewhat intermediate position, in having nearly parallel dorsal and ventral margins. Some specimens of *C. torosa*, figured by previous authors, have valve shapes which are more or less similar to that of *C. torosa* from Silhouette Island, such as those figured by SLACK *et al.* (1995) from the Nile Delta in Egypt, by BASHA (1987) from Quaternary deposits in the Jordan Rift Valley, by BOUKHARI & GUERNET (1985) from Pleistocene deposits in the Fayum, Egypt, and by PUGLIESE & STANLEY (1991), from Late Quaternary deposits in the Nile Valley. The West-African *Cyprideis torosa*, as figured by CARBONNEL (1982, as *C.* cf. *mandviensis*), CARBONEL *et al.* (1984) and WITTE (1993) apparently show more resemblance to "European" *C. torosa*. In this respect, the valve shape of *C. torosa* from Silhouette Island could be interpreted as unusual or unknown, within a highly variable species.
All specimens from the Seychelles lack the postero-ventral spine in the right valve. When studying numerous valves of the species from Italy, DECIMA (1964) noticed that all right valves possessed a postero-ventral spine. Analysis of specimens from Lake Qarun (Egypt) by the present author, however, revealed that on 25 specimens (with soft parts), 3 specimens completely lacked a postero-ventral spine. Careful observation under the microscope showed that in these three cases the spine is really absent, and not broken or worn off. The other 22 specimens have a more or less developed spine. This indicates that in a single population there may be specimens with and without a spine, illustrating that the presence of such a spine is perhaps not as important a diagnostic feature of *C. torosa* as is generally accepted.
Three soft part characters have been compared, namely the morphology of the hemipenis, the medial seta of the fourth segment of the antennule, and the morphology of the male

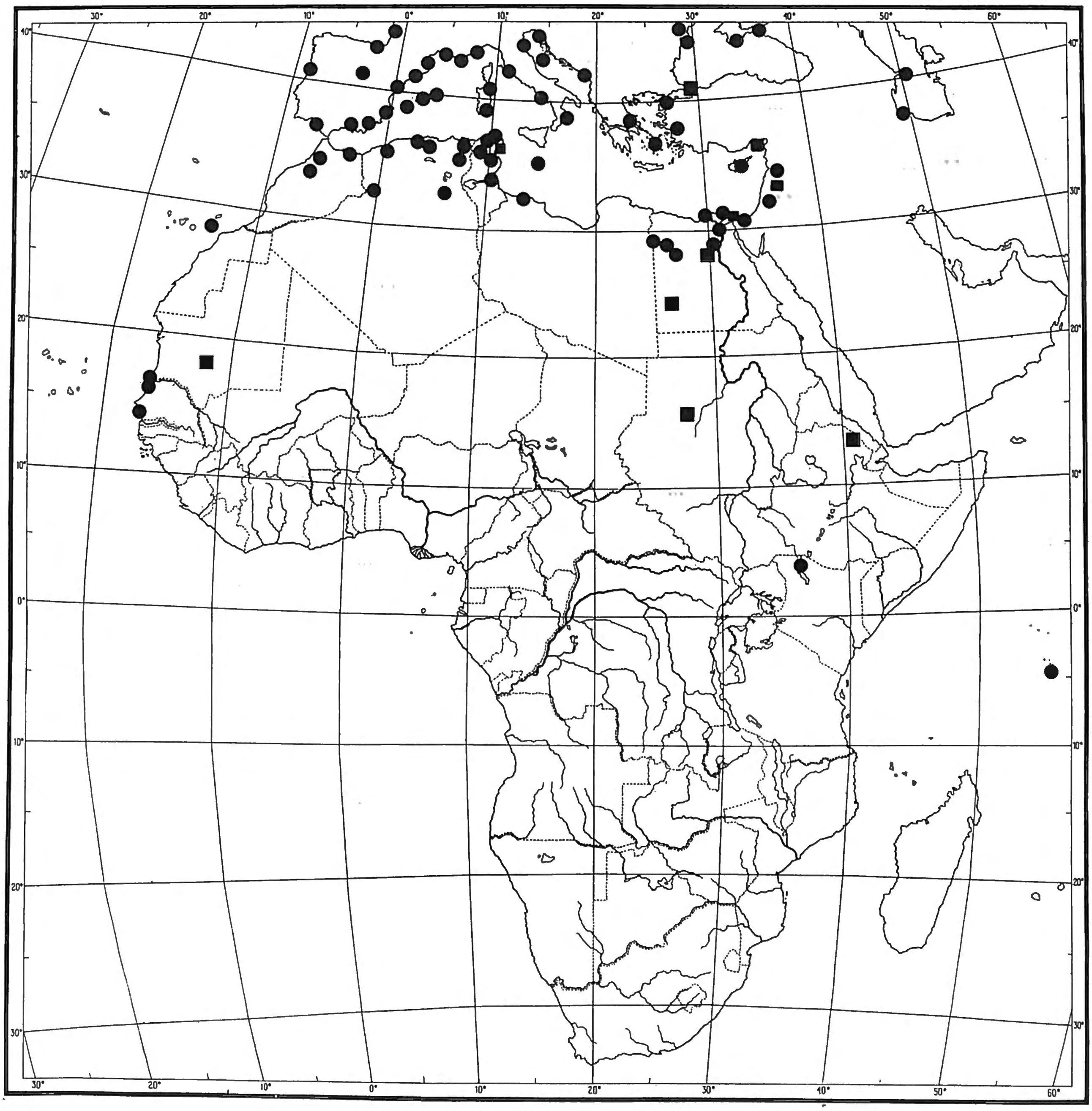

Fig. 1. Distribution of *Cyprideis torosa* (JONES, 1850) in Africa (and in S. Europe and SW Asia). Circles: Recent, squares: Quaternary. The localities on this map are borrowed from the following publications (in alphabetical order).

African localities: BALTANAS & GARCIA-AVILES (1993), BARRA (1997), BASSIOUNI (1985, 1986), BEYER *et al.* (1997), BONADUCE & MASOLI (1968), BONADUCE & PUGLIESE (1975), BOUKHARI & GUERNET (1985) CARBONEL & PUJOS (1981, 1982), CARBONEL *et al.* (1984), COHEN (1986), DADAY (1910), FERRÉ *et al.* (2001), GAUTHIER (1928, 1932) GRAMANN (1971), HARTMANN (1964a), KEMPF (1986), KLIE (1935, 1939), LINDROTH (1956), MANSOURI *et al.* (1985), MARTENS (1984), PUGLIESE & STANLEY (1991), RAMDANI (1982), RAMDANI *et al.* (2001), SCHÖNING (1996), SLACK *et al.* (1995), WITTE (1993), WOUTERS (1973),

The non-African localities on the map are mostly from LACHENAL (1989), MEISCH *et al.* (1991), and the NODE database of the University of Greenwich (by courtesy of D. HORNE), but also from ALADIN (1989), ARBULLA *et al.* (2001), ATHERSUCH (1979), BALTANAS *et al.* (1996), BARBEITO-GONZALEZ (1971), BASHA (1987), BONADUCE & MASOLI (1970), BRONSTEIN (1947), CARAION (1965), CARBONNEL (1983), GÜLEN (1985), HARTMANN (1964b), MASALA (1968), MERIC *et al.* (2000), MONTENEGRO & PUGLIESE (1995), NAZIK *et al.* (1999), PAULO & MOUTINHO (1983), ROSENFELD & VESPER (1977), RUIZ *et al.* (1997), SAFAK (1999), SOHN (1965), TZIAVOS (1979), SCHORNIKOV (1961, 1967), YASSINI & GHAHREMAN (1976).

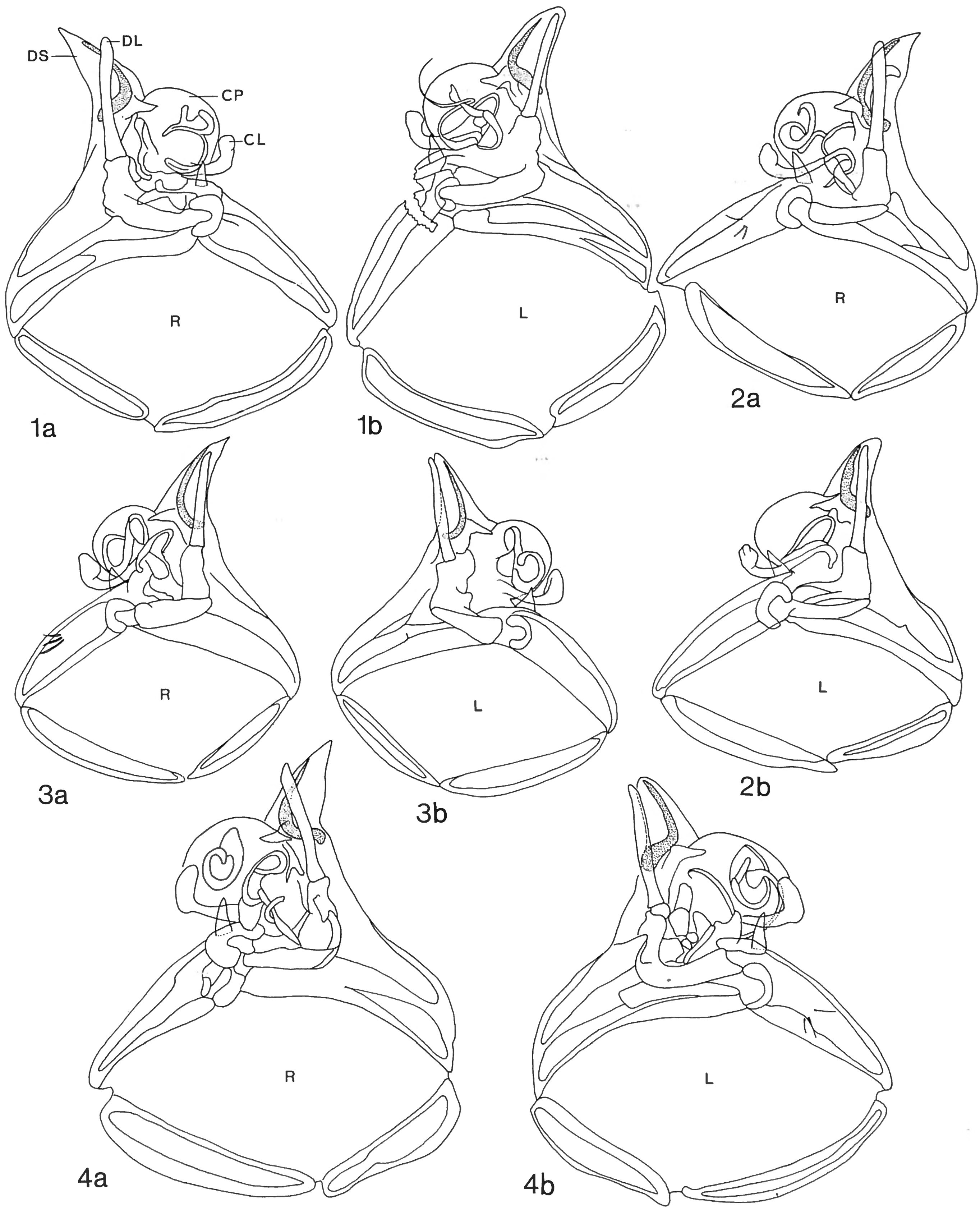

Plate 1. Right and left hemipenes of *Cyprideis torosa* (JONES, 1850)(R = right, L = left). Figs 1 a-b. Texel (the Netherlands), O.C. 2515. Figs 2 a-b. Lake Quarun (Fayum, Egypt), O.C. 2506. Figs 3 a-b. Silhouette Island (the Seychelles), O.C. 2499. Fig. 4. Knokke-Heist (Belgium), O.C. 2526.

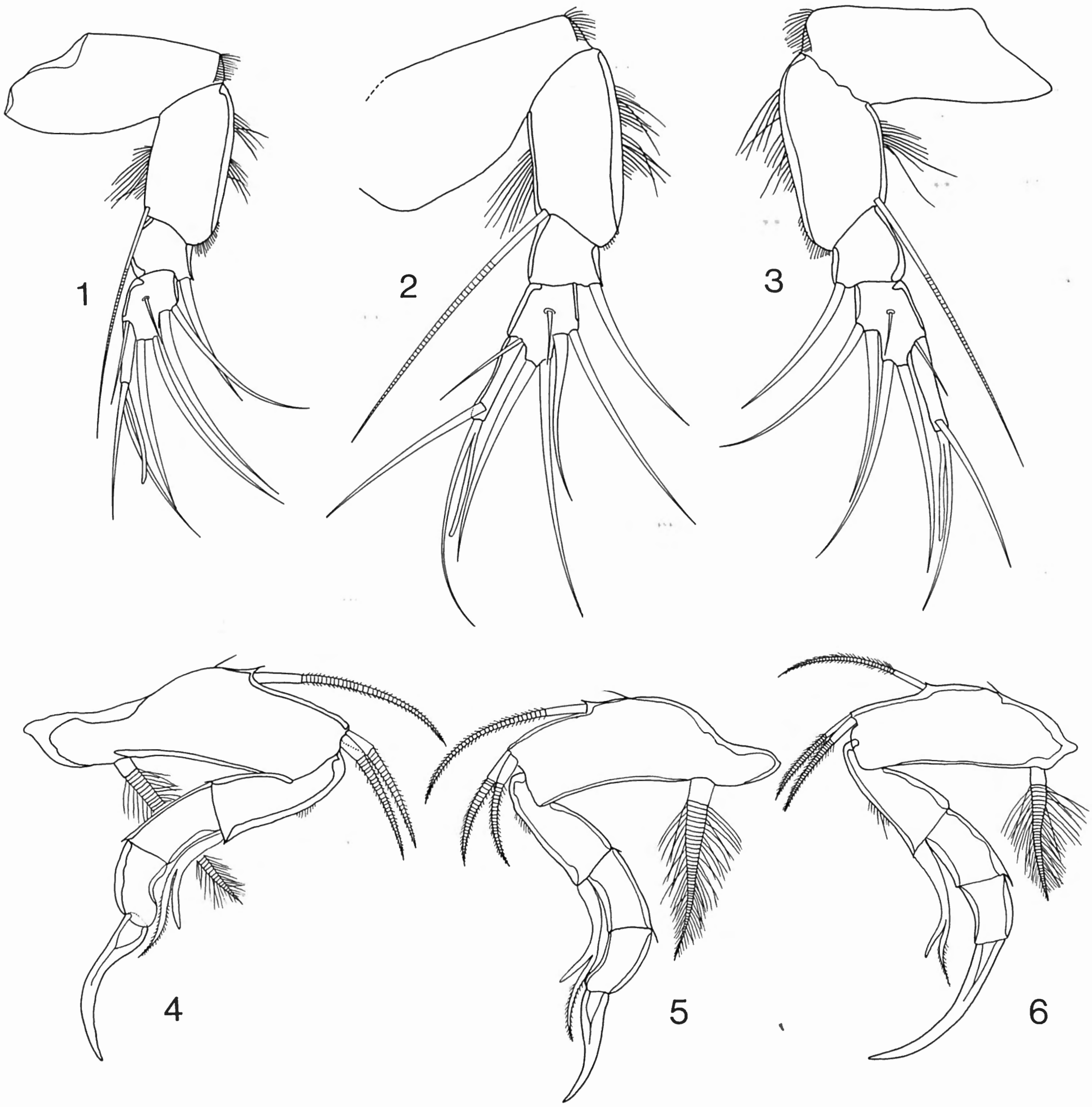

Plate 2. Male antennules (figs 1-3) and male right first legs (figs 4-6) of *Cyprideis torosa* (JONES, 1850). Fig. 1. Texel (The Netherlands), O.C. 2515. 2. Lake Qarun (Fayum, Egypt), O.C. 2504. 3. Silhouette Island (the Seychelles), O.C. 2496. Fig. 4. Knokke-Heist (Belgium), O.C. 2526. Fig. 5. Lake Qarun (Fayum, Egypt), O.C. 2504. Fig. 6. Silhouette Island (the Seychelles), O.C. 2497.

right first leg, more particularly the length of the terminal claw. The morphology of the hemipenis is generally accepted to be a good discriminating character between *Cyprideis* species. The importance of hemipenis morphology was already underlined by SANDBERG & PLUSQUELLEC (1974, p. 14), stating that "it allows rapid determination of specific placement of any given *Cyprideis* male". The significance of hemipenis morphology for species discrimination was also experienced when describing species of the *Cyprideis* species flock in Lake Tanganyika (WOUTERS & MARTENS, 1994, 1999, 2001). The most important elements of the hemipenis are the dorsal shield (DS), dorsal lobe (DL), copulatory process (CP) and copulatory lobe (CL)(Pl. 1, fig. 1a) (WOUTERS & MARTENS, 1994).

In the present species the two hemipenes are asymmetrical. The dorsal shield is distally rounded in the left hemipenis, and pointed in the right one. The dorsal lobe is long, and straight or nearly straight, with parallel lateral margins, and with rounded or bluntly pointed distal extremity. The copulatory process is a large, broadly rounded lobe, and the copulatory lobe has a hammer-like appearance, with a slightly curved shaft. When comparing each of these elements in specimens from different localities (The Netherlands, Plate 1, figs 1a-b, Egypt, Pl. 1, figs 2a-b, the Seychelles, Pl.1, figs

3a-b and Belgium, Pl. 1, figs 4a-b) it appears that there are no significant differences between them.

In relation to the left-right asymmetry of the dorsal shield, it must be emphasized that this feature is difficult to compare with other populations or with other species, because this asymmetry is not mentioned in the descriptions of *C. torosa* or of any other *Cyprideis* species. Some available material was re-examined in the present study. None the five *Cyprideis* species hitherto descibed from Lake Tanganyika exhibits left-right asymmetry in the hemipenis. It remains uncertain whether this asymmetry occurs also in other *Cyprideis* species, or whether it is typical of *C. torosa*.

The length of the medial seta of the fourth segment on the antennule is another interesting character. It proved to be useful and discriminating when studying the *Cyprideis* species flock of Lake Tanganyika (WOUTERS & MARTENS, 1992, 1994, 1999, 2000, 2001), and it is, among other features, used to distinguish between the genera *Cytherissa* (seta absent) and *Cyprideis* (seta present) (DANIELOPOL & TETART, 1990).

In the material studied here this seta seems to show some variation in length. It is longest in specimens from The Netherlands (Pl. 2, fig. 1), and shortest in specimens from Silhouette Island (Pl. 2, fig. 3). Specimens from Lake Qarun (Pl. 2, fig. 2) take an intermediate position. The material from Belgium and southern France (not figured) resembles that of the Netherlands, but because there is apparently some variation in the length of this seta, some specimens are closer to the Egyptian material. From this it can be concluded that the differences in the length of the medial seta are very small and not significant.

The morphology of the male right first leg and especially the length of the terminal claw is another useful feature in *Cyprideis* taxonomy. In the studied material the length of the claw shows a large variability. The percentages used here represent the length of the claw versus the combined lengths of the second, third and fourth segments of the leg. The shortest claw can be found in specimens from Lake Qarun (50 %)(Pl. 2, fig. 5), then follows the material from the Netherlands (51 %)(not figured), the material from Belgium (54 %)(Pl. 2, fig. 4) and finally the material from the Seychelles (from 67.8 to 70.5 %)(Pl. 2, fig, 6). The specimens from Silhouette Island clearly have the longest claws. It is surprising, however, to see that the specimens from Lake Qarun, geographically intermediate between Europe and the Seychelles, have the shortest claws of all.

The male right first leg shows another interesting feature, namely a "split seta" on the antero-distal margin of the second segment (Pl. 2, figs 4-6). This split seta also occurs in some other *Cyprideis* species, such as *Cyprideis edentata* KLIE, 1939b. The latter author interpreted this split seta as (p. 13) a large claw-like seta on which a sensory hair is inserted. This remarkable seta can also be seen in *Cyprideis stenopora* TRIEBEL, 1956, *Cyprideis gelica* SANDBERG & PLUSQUELLEC, 1974, and *Cyprideis americana* (SHARPE, 1908) *fide* SANDBERG & PLUSQUELLEC (1984). In none of these species is this split seta as strongly developed as in *C. torosa*. There is one other species, however, in which the split seta very much resembles that of *C. torosa*, namely *Cyprideis australiensis* HARTMANN, 1978. Apart from this feature, there are a number of other valve and soft part characters of *C. australiensis* that are very similar to those of *C. torosa*. This close resemblance between the two species can be interpreted in two ways: either both species are very closely related, or the species are synonymous. It is not the aim of this paper to elaborate on this, but given the zoogeographical implications, the morphological similarity between these two species needs further research, preferentially on the basis of newly acquired material.

JAIN (1978) described *Cyprideis mandviensis* from the west coast of India. As far as the valve shape is concerned this species is very similar to the specimens of *C. torosa* from the Seychelles. *C. mandviensis* has elongate valves, and it lacks a postero-ventral spine in the right valve. JAIN (1978) emphasized that the difference between *C. torosa* and *C. mandviensis* is not only in the shape of the valves, but also in the number of anterior marginal pore canals. *C. mandviensis* has fewer anterior pore canals, namely 25-30, whereas *C. torosa* has 33-40 (according to DECIMA, 1964). The specimens from the Seychelles have 32 to 39 marginal pore canals. Unfortunately, the appendages of *C. mandviensis* remain unknown.

When comparing *C. torora*, from different localities, with the *Cyprideis* species flock of Lake Tanganyika, it can be observed that, among other differences, the Tanganyikan species of the genera *Cyprideis, Tanganyikacythere, Mesocyprideis, Romecytheridea, Archeocyprideis* and *Kavalacythereis* all lack the left-right asymmetry in the dorsal shield of the copulatory appendage, and the split seta on the male right first leg. This leads to the conclusion that species of the Tanganyikan *Cyprideis* species flock are not closely related with *Cyprideis torosa*. The ancestry of this flock must be sought for elsewhere, maybe in one of the numerous fossil *Cyprideis* species and subspecies described from Neogene deposits from the Mediteranean area and the Paratethys.

In a recent publication on the genetic differentiation in *C. torosa* SYWULA *et al.* (1995) concluded that the studied European populations of *C. torosa* are genetically similar to each other to such a degree that they should be treated as sets of subpopulations, rather than as separate units. One can wonder if the same conclusion could be reached when studying populations from a much wider geographical area, including far eastern and southern localities. According to SYWULA *et al.* (1995), this similarity is largely due to the passive dispersal of *C. torosa* by aquatic birds. Passive dispersal is frequently cited in the literature to explain the distribution of *C. torosa* (KLIE, 1939a, SANDBERG & PLUSQUELLEC, 1974, VAN HARTEN, 1990, and many others), and is probably also an acceptable explanation for the presence of *C. torosa* in the Seychelles.

In a remarkable paper on the effects of genotype and environment on phenotypic variability in *Limnocythere inopinata*, YIN *et al.* (1999) threw a new light on this widely distributed species. They concluded that both valve shape and the absolute and relative length of limb setae can be affected by environmental factors and by genotype, and this in parthenogenetic as well as in bisexual populations.

The final conclusion of this fine article is (p. 111) that it is impossible to single out population(s) as separate and recognizable clusters. All specimens investigated are therefore

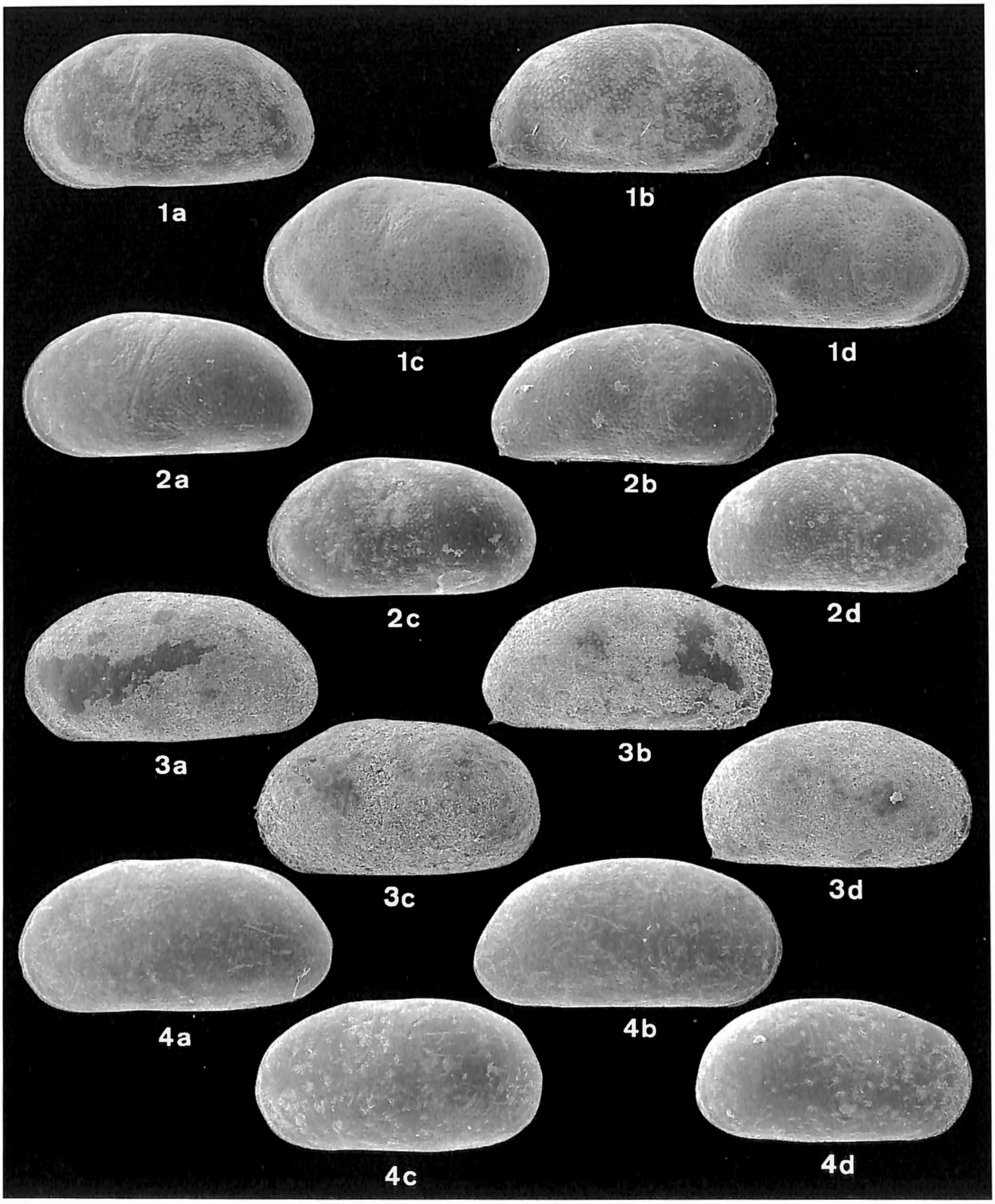

Plate 3. *Cyprideis torosa* (JONES, 1850). **Fig. 1**. Knokke-Heist, Belgium, O.C. 2527 and 2529 (a: LV male, L 1.18 mm, b: RV male, L 1.16 mm, c: LV female, L 1.04 mm, d: RV female, L 1.01 mm). **Fig. 2**. Etang de Malagroy, Camargue, S. France, O.C. 2524 and 2520 (a: LV male, L 0.99 mm, b: RV male, L 0.97 mm, c: LV female, L 0.94 mm, d: RV female, L 0.92 mm). **Fig. 3**. Lake Qarun, Fayum, Egypt, O.C. 2505 and 2510 (a: LV male, L 1.06 mm, b: RV valve male, L 1.04 mm, c: LV female, L 1.00 mm, d: RV female, L 0.96 mm). **Fig. 4**. Silhouette Island, Seychelles, O.C. 2496 and 2501 (a: LV male, L 0.98 mm, b: RV male, L 0.97 mm, c: LV female, L 0.88 mm, d: RV female, L 0.87 mm). RV = right valve, LV = left valve, L = length.

maintained within *L. inopinata*, which can thus be considered a very variable species.
Having studied and compared *Cyprideis torosa* from different localities, the present author assumes that for this species the situation may well be comparable to that of *L. inopinata*, namely that it is a very variable and widely distributed species. The new approach adopted by YIN *et al.* (1999) is a milestone in ostracod research, which will compel us to review some old ideas. *Cyprideis torosa*, considered to be one of the best-known ostracod species, is maybe not so well-known as we would like to believe. The simple discovery of new material in the Seychelles, which in this study is identified, with some reserve, as *C. torosa*, raises several new questions, which cannot or only partially be answered in the present paper. It is hoped that the morphological data presented here, and the questions raised, will be useful for further research.

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References

ALADIN, N., 1989. Osmoregulation in *Cyprideis torosa* from various seas of the USSR. *Zoologicheskii Żhurnal*, 68(7): 40-50.

ARBULLA, D., PUGLIESE, N. & RUSSO, A., 2001. Ostracodi del Golfo Saline (Sardegna nord-orientale). *Studi Trentini di Scienze Naturali, Acta Geologica*, 77: 25-35.

ATHERSUCH, J., 1979. The ecology and distribution of the littoral ostracods of Cyprus. *Journal of Natural History*, 13(2): 135-160.

BALTANÁS, A., BEROIZ, B. & LÓPEZ, A., 1996. Lista faunística y bibliográfica de los ostrácodos no-marinos (Crustacea, Ostracoda) de la Península Ibérica, Islas Baleares e Islas Canarias. *Listas de la Flora y Fauna de las Aguas continentales de la Península Ibérica*, 12: 1-71.

BALTANÁS, A. & GARCÍA-AVILÉS, J., 1993. New records of freshwater Ostracoda (Crustacea) from the Canary Islands. *Bulletin de la Société des Naturalistes luxembourgeois*, 94: 219-232.

BARBEITO-GONZÀLEZ, P., 1971. Die Ostracoden des Küstenbereiches von Naxos (Griechenland) und ihre Lebensbereiche. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut*, 67: 255-326.

BARRA, D., 1997. The shallow-water marine ostracods of Tripoli (Libya) and their geographical distribution in the Mediterranean. *Revista Española de Micropaleontologia*, 29(3): 71-107.

BASHA, S.H., 1987. Contribution to the Quaternary Ostracoda of the Jordan Rift Valley. *Revista Española de Micropaleontologia*, 19(1): 99-111.

BASSIOUNI, M.A., 1979. Brackische und marine Ostracoden (Cytherideinae, Hemicytherinae, Trachyleberidinae) aus dem Oligozän und Neogen der Türkei. *Geologisches Jahrbuch*, B31: 3-195.

BASSIOUNI, M.A., BOUKHARY, M., ANAN, H. & BAHR, S., 1985. Distribution of *Cyprideis (Cyprideis) sohni* in Lake Qarun, Fayum, Egypt. *Revue de Paléobiologie*, 4(1): 15-34.

BASSIOUNI, M.A., ANAN, H., BOUKHARY, M. & BAHR, S., 1986. Ostracodes from modern Lake Qarun (Fayum, Egypt). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, 172(1): 107-120.

BEYER, G., MEISCH, C. & WOUTERS, K., 1997. New records of freshwater Ostracoda (Crustacea) from La Gomera, El Hierro, Fuerteventura and Tenerife (Canary Islands). *Bulletin de la Société des Naturalistes luxembourgeois*, 98: 239-259.

BHATIA, S.B. & KHOSLA, S.C., 1977. Sub-recent ostracodes from Teshil Charkhi Dadri, District Mahendragarh, southern Haryana. *Journal of the Palaeontological Society of India*, 20: 333-338.

BONADUCE, G. & MASOLI, M., 1968. Marine Ostracoda of Tunisia. *Pubblicazione della Stazione zoologica di Napoli*, 36: 458-470.

BONADUCE, G. & MASOLI, M., 1970. Benthic marine Ostracoda from Malta. *Pubblicazione della Stazione Zoologica di Napoli*, 38: 47-56.

BONADUCE, G. & PUGLIESE, N., 1975. Ostracoda from Lybia. *Pubblicazione della Stazione zoologica di Napoli*, 39: 129-135.

BOUKHARI, M. & GUERNET, C., 1985. Ostracodes du Pléistocène de Fayoum (Egypte): aperçu systématique et observations nouvelles sur les caractéristiques d'un ancien lac. *Revue de Micropaléontologie*, 28(1): 32-40.

BRONSTEIN, Z.S., 1947. Fresh-water Ostracoda. *Fauna of the USSR, Crustaceans*, 2(1): 1-470. Translated and published (1988) for the U.S. Department of the Interior, National Science Foundation, Washington D.C.

CARAION, F.E., 1976. Family Cytheridae (Ostracode marine si salmastricole). *Fauna Republicii Socialiste România, Crustacea (Ostracoda)*, 4(10): 1-164.

CARBONEL, P., PINSON, J., RIFFAULT, A., PEYPOUQUET, J.-P. & TASSET, J.-P., 1984. Les ostracodes du plateau continental sénégalais: témoins des environnements actuels et quaternaires. *Bulletin de l'Association sénégalaise pour l'Etude du Quaternaire (ASEQUA)*, 70/71: 15-42.

CARBONEL, P. & PUJOS, M., 1981. Comportement des microfaunes benthiques en milieu lagunaire. Actes du Premier Congrès National des Sciences de la Terre (Tunis): 127-139.

CARBONEL, P. & PUJOS, M., 1982. Les variations architecturales des microfaunes du Lac de Tunis: relations avec l'environnement. *Oceanologica Acta*, 1982, special volume: 79-85.

CARBONNEL, G., 1983. Morphométrie et hypersalinité chez *Cyprideis torosa* (Jones)(Ostracoda, Actuel) dans les salines de Santa-Pola (Alicante, Espagne). *Sciences Géologiques, Bulletin*: 36(4): 211-219.

CARBONNEL, G., 1982. Microfaune (Ostracodes) dans les estuaires à mangroves du Sénégal. *Bulletin de l'Institut Fondamental d'Afrique Noire*, 44A(3-4): 326-340.

COHEN, A., S., 1986. Distribution and faunal associations of benthic invertebrates at Lake Turkana. *Hydrobiologia*, 141: 179-197.

DADAY, E. VON, 1910. Beiträge zur Kenntnis der Mikrofauna des Nils. *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse*, 119(6): 537-589.

DANIELOPOL, D.L. & TETART, J., 1990. Morphology of *Cytherissa* and *Cyprideis*: supplementary data on the appendages and the caryotype. *Bulletin de l'Institut de Géologie du Bassin d'Aquitaine*, 47-48: 55-67.

DECIMA, A., 1964. Ostracodi del Gen. *Cyprideis* Jones del Neogene e del Quaternario italiani. *Palaeontographica Italica*, 57: 81-133.

FERRÉ, B., PERSON, A. & AMBLARD-PISON, S., 2001. Ostracodic evidence of a neolithic food crop practice on Dhar Oualata (SE-Mauritania). *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte*, 2001(3): 129-141.

GAUTHIER, H., 1928. Recherches sur la faune des eaux continentales de l'Algérie et de la Tunisie. Imprimerie Minerva, Alger, 419 pp.

GAUTHIER, H., 1932. Remarques sur la faune aquatique de la "Fontaine Chaude" au nord de Batna en Algérie. *Bulletin de la Société d'Histoire naturelle de l'Afrique du Nord*, 23: 105-108.

GRAMANN, F., 1971. Ostracoda aus Neogen und Quartär der Danakil-Senke (Nordost-Äthiopien). *Beihefte Geologisches Jahrbuch*, 106: 109-142.

GÜLEN, D., 1985. Bisexual Ostracoda (Crustacea) populations in Anatolia. *Instanbul Üniversitesi Fen Fakültesi Mecmuasi*, Seri B, 50: 81-86.

HARTMANN, G., 1964a. Zur Kenntnis der Ostracoden des Roten Meeres. *Kieler Meeresforschungen*, 20 Sonderheft: 35-127.

HARTMANN, G., 1964b. Asiatische Ostracoden, systematische und zoogeographische Untersuchungen. *Internationale Revue der gesamten Hydrobiologie, Systematische Beihefte*, 3: 1-154.

HARTMANN, 1974. Zur Kenntnis des Eulitorals der afrikanischen Westküste zwischen Angola und Kap der Guten Hoffnung und der afrikanischen Ostküste von Südafrika und Mocambique unter besonderer Berücksichtigung der Polychaeten und Ostracoden. Die Ostracoden des Untersuchungsgebiets. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut*, Erganzungsband 69: 229-520.

HARTMANN, G., 1978. Die Ostracoden der Ordnung Podocopida G.W. Müller, 1894 der tropisch-subtropischen Westküste Australiens (zwischen Derby in norden und Perth im Süden). *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut*, 75: 64-219.

KEMPF, E. K., 1986. Late Quaternary environmental changes in the eastern Sahara (Libyan Desert) documented by an ostracode diagram. Inqua-Asequa Symposium International, Dakar. *Travaux et Documents de l'Institut Français de Recherche scientifique pour le Développement et Coopération*, 197: 235-238.

KILENYI, T.I. & WHITTAKER, J.E., 1974. On *Cyprideis torosa* (JONES). *Stereo-Atlas of Ostracod Shells*, 2(1): 21-32.

KLIE, W., 1935. Die Fischereigruende vor Alexandrien. V.-Ostracoda. *Notes and Memoirs Fisheries Research Directorate*, 12: 1-9.

KLIE, W., 1938. Ostracoda, Muschelkrebse. *Die Tierwelt Deutschlands*, 34(3): 1-230.

KLIE, W., 1939a. Ostracoden aus dem Kenia-Gebiet, vornehmlich von dessen Hochgebirgen. *Internationale Revue der gesamten Hydrobiologie und Hydrographie*, 39: 99-161.

KLIE, W., 1939b. Ostracoden aus den marinen Salinen von Bonaire, Curaçao und Aruba. *Capita Zoologica*, 8(4): 1-19.

KLIE, W., 1940. Ostracoden von der Küste Deutsch-Südwest-Afrikas. *Kieler Meeresforschungen*, 3: 404-448.

LACHENAL, A.M., 1989. Ecologie des ostracodes du domaine méditerranéen: application au Golfe de Gabès (Tunisie orientale). *Documents des Laboratoires de Géologie Lyon*, 108: 1-239.

LINDROTH, S., 1956. Taxonomic and zoogeographical studies of the ostracod fauna in the inland waters of East Africa. *Zoologiska Bidrag från Uppsala*, 30: 43-156.

MANSOURI, R., BOBIER, C., CARBONEL, P. & TASTET, J.-P., 1985. Contribution à la connaissance des systèmes lagunaires en domaine méditerranéen: les milieux actuels et les paléoenvironnements du Lac de Ghar el Melh et de la Sebka de l'Ariana (Tunisie). *Bollettino di Oceanologia teorica ed applicata*, 3(3): 167-195.

MARTENS, K., 1984. Annotated checklist of non-marine ostracods (Crustacea, Ostracoda) from African inland waters. *Documentation zoologique Musée royal de l'Afrique centrale*, 20: 1-51.

MASALA, M.L., 1968. Inquinamento ed ostracodofauna in un ambiente mesoalino (canale delle saline di Cagliari). *Rendiconti del Seminario della Facoltà di Scienze della Università di Cagliari*, 38(3-4) suppl.: 1-12.

MEISCH, C., WOUTERS, K. & MARTENS, K., 1990. Liste annotée des ostracodes actuels non-marins trouvés en France (Crustacea: Ostracoda). *Travaux scientifiques du Musée national d'Histoire naturelle de Luxembourg*, 15: 1-62.

MERIÇ, E., KEREY, I.E., AVSAR, N., TUNOGLU, C., TANER, G., KAPAN-YESILYURT, S. & ROSSO, A., 2000. Geç Kuvaterner (Holosen)'de Istanbul Boğazi Yolu ile Marmara Denizi-Karadeniz Bağlantisi Hakkinda Yeni. *Türkyie Jeoloji Bülteni*, 43(1): 73-118.

MONTENEGRO, M.E. & PUGLIESE, N., 1995. Ostracodi della laguna di Orbetello: tolleranza ed opportunismo. *Atti del Museo Geologico e Paleontologico di Monfalcone*, quaderno speciale 3: 71-80.

NAZIK, A., EVANS, G. & GÜRBÜZ, K., 1999. Sedimentology and paleontology with special reference to the Ostracoda fauna of Akyatan lagoon (Adana-SE Turkey). *Yerbilimleri*, 35 special issue, 127-147.

OMATSOLA, M.E., 1970. Podocopid Ostracoda from the Lagos Lagoon, Nigeria. *Micropaleontology*, 16(4): 407-445.

PASCUAL, A., 1990. Los ostracodos actuales de la Ria de Lekeito. *Kobie (Serie Ciencias Naturales) Bilbao*, 19: 45-51.

PASCUAL, A., 1991. Ostracodes in Biscayan Estuaries (Spain): their relationship with the environment. *Cahiers de Micropaléontologie*, N.S., 6(2): 5-16.

PAULO, L.F. & MOUTINHO, M., 1983. Systématique et distribution des ostracodes au Portugal. *Publicações do Instituto de Zoologia "Dr. Augusto Nobre", Faculdade de Ciências do Porto*, 173: 1-32.

PUGLIESE, N. & STANLEY, D.J., 1991. Ostracoda, depositional environments and the Late Quaternary evolution of the eastern Nile delta, Egypt. *Il Quaternario*, 4(2): 275-303.

RAMDANI, M., 1982. Les entomostracés de la Merja Sidi Bou Ghaba. *Bulletin de l'Institut Scientifique*, 6: 105-117.

RAMDANI, M., FLOWER, R.J., ELKHIATI, N., BIRKS, H.H., KRAÏEM, M.M. & FATHI, A.A., 2001. Zooplankton (Cladocera, Ostracoda), Chironomidae and other benthic faunal remains in sediment cores from nine North African wetland lakes: the CASSARINA project. *Aquatic Ecology*, 35: 389-403.

ROSENFELD, A. & VESPER, B., 1977. The variability of the sieve-pores in recent and fossil species of *Cyprideis torosa* (Jones, 1850) as an indicator for salinity and paleosalinity. In: LÖFFLER, H. & DANIELOPOL, D. (Eds), Aspects of ecology and zoogeography of recent and fossil Ostracoda, Junk Publishers, The Hague: 55-67.

RUIZ, F., GONZALEZ-REGALADO, M.L. & MUÑOZ, J.M., 1997. Multivariate analysis applied to total and living fauna: seasonal ecology of recent benthic Ostracoda off the North Cadiz Gulf coast (southwestern Spain). *Marine Micropaleontology*, 31: 183-203.

SAFAK, Ü., 1999. Recent Ostracoda assemblage of the Gökçeada-Bozcaada-Canakkale region. *Yerbilimleri*, 35 special issue, 149-172.

SANDBERG, P.A., 1964. The ostracod genus *Cyprideis* in the Americas. *Stockholm Contributions to Geology*, 12: 1-178.

SANDBERG, P.A. & PLUSQUELLEC, P.L., 1974. Notes on the anatomy and passive dispersal of *Cyprideis* (Cytheracea, Ostracoda). *Geoscience and Man*, 6: 1-26.

SCHÖNING, C., 1996. Subrecent Ostracoda (Crustacea) from the Sudan, with a description of the juvenile stages of *Oncocypris muelleri* (Daday, 1910). *Mitteilungen aus dem Hamburgischen zoologischen Museum und Institut*, 93: 39-56.

SCHORNIKOV, E.I., 1961. To the study of the ostracods from the waters of the Kuban Delta. *Trudy Azovskogo Nauchno-Issledovatelskogo Instituta Rybnogo Khozyastva (Azniirkh)*, 4: 131-141.

SCHORNIKOV, E.I., 1967. Fauna chernomorsko-azovskich ostrakod v ekologicheskom i zoogeograficheskom aspektach. Donnie biocenozi i biologia bentosnikh organismov Chernogo Moria, Seria Biologia Moria, Kiev: 122-143.

SLACK, J.M., KONTROVITZ, M. & STANLEY, D.J., 1995. Ostracoda from Lake Manzala, Nile Delta, Egypt. In: RIHA, J. (Ed.), Ostracoda and Biostratigraphy, Proceedings of the 12th International Symposium on Ostracoda: 333-342, Balkema, Rotterdam.

SOHN, I.G., 1965. Late Quaternary ostracodes from the southern part of the Dead Sea, Israel. *Marine Technology Society and American Society Limnology and Oceanography, Transactions, Ocean Science and Ocean Engineering*, 1: 82-94.

TRIEBEL, E., 1956. Brackwasser-Ostracoden von den Galapagos-Inseln. *Senckenbergiana biologica*, 37(5/6): 447-467.

SYWULA, T., GLAZEWSKA, I., WHATLEY, R.C. & MOGUILEVSKY, A., 1995. Genetic differentiation in the brackish-water ostracod *Cyprideis torosa. Marine Biology*, 121: 647-653.

TZIAVOS, C.C., 1979. Distribution of recent Ostracoda from the Sperchios River delta and Maliakos Gulf, Greece. In: KRSTIC, N.(Ed.), Proceedings of the VIIth International Symposium on Ostracodes, Belgrade: 219-222.

VAN HARTEN, D., 1990. The Neogene evolutionary radiation of *Cyprideis* Jones (Ostracoda: Cytheracea) in the Mediterranean area and the Paratethys. *Courier Forschungsinstitut Senckenberg*, 123: 191-198.

VAN HARTEN, D., 2000. Variable noding in *Cyprideis torosa* (Ostracoda, Crustacea): an overview, experimental results and a model from catastrophe theory. In: HORNE, D.J. & MARTENS, K. (Eds), Evolutionary Biology and Ecology of Ostracoda, *Hydrobiologia*, 419: 131-139.

WITTE, L., 1993. Taxonomy and biogeography of West African beach ostracods. *Verhandelingen van de Koninklijke Nederlandse Akademie van Wetenschappen, Afdeling Natuurkunde, Eerste Reeks*, 39: 1-84.

WOUTERS, K., 1973. Quelques ostracodes du Tyrrhénien de Monastir (Tunisie). *Annales des Mines et de la Géologie*, 26: 379-399.

WOUTERS, K. & MARTENS, K. 1992. Contribution to the knowledge of Tanganyikan cytheraceans, with the description of *Mesocyprideis* nom. nov. (Crustacea, Ostracoda). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Biologie*, 62: 159-166.

WOUTERS, K. & MARTENS, K., 1994. Contribution to the knowledge of the *Cyprideis* species flock (Crustacea: Ostracoda) of Lake Tanganyika, with the description of three new species. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Biologie*, 64: 111-128.

WOUTERS, K. & MARTENS, K., 1999. Four new species of the *Cyprideis* species flock (Crustacea: Ostracoda) of Lake Tanganyika. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Biologie*, 69: 67-82.

WOUTERS, K. & MARTENS, K., 2000. On the taxonomic position of the genera *Archeocyprideis* and *Kavalacythereis* of the *Cyprideis* species flock (Crustacea, Ostracoda) in Lake Tanganyika (East Africa), with the description of the appendages. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Biologie*, 70: 207-216.

WOUTERS, K. & MARTENS, K., 2001. On the *Cyprideis* species flock (Crustacea, Ostracoda) in Lake Tanganyika, with the description of four new species. *Hydrobiologia*, 450: 111-127.

YANG, Fan, 1988. Distribution of the brackish-salt water ostracods in northwestern Qinghai Plateau and its geological significance. In: HANAI, T., IKEYA, N. & ISHIZAKI, K. (Eds), Evolutionary biology of Ostracoda. *Developments in Palaeontology and Stratigraphy*, 11: 519-530.

YASSINI, I. & GHAHREMAN, A., 1976. Récapitulation de la distribution des ostracodes et des foraminifères du Lagon de Pahlavi, Province de Gilan, Iran du Nord. *Revue de Micropaléontologie*, 19(3): 172-190.

YIN, Yu, GEIGER, W. & MARTENS, K., 1999. Effects of genotype and environment on phenotypic variability in *Limnocythere inopinata* (Crustacea: Ostracoda). *Hydrobiologia*, 400: 85-114.

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