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A contribution to the taxonomy and ecology of the Ostracoda (Crustacea) from Verlorenvlei (Western Cape, South Africa)

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Two preliminary surveys (one during the dry season and one during the wet season) of the ostracod fauna of Verlorenvlei (Western Cape) are presented. Fifteen species were found; two are reported for the first time from Africa. Various species are indicative of slightly saline to even hypersaline conditions. The morphology and ecology of the various species are briefly discussed, in order to allow future palaeo-environmental reconstructions based on ostracod fossils from this locality.

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Introduction

Musselshrimps, or Ostracoda, are small, bivalved Crustacea. Their calcified carapaces have an average length of *ca* 1 mm and completely envelop the reduced body. Ostracods are very common in most of the African inland waters, where they abound in the benthic and periphytic animal communities. They are also abundant in marine, interstitial and even (semi-) terrestrial environments. Their valves readily fossilize, frequently providing numerous micro-fossils in cores from lake sediments, and most species are easily identifiable from these micro-fossils. This, combined with the fact that various species occur in specific ecological conditions, makes the group useful as guide fossils to reconstruct palaeo-environments and, by inference, palaeo-climates.

There are very few permanent, natural lentic waters with a palaeontological record in southern Africa (e.g. Davies & Day 1986; Allanson, Hart, O'Keeffe & Robarts 1990), as most standing waters are either temporary or man-made. Typical lakes, with a Quaternary or even Holocene history, are rare. As such, Verlorenvlei (Western Cape) has assumed great importance as a palaeo-ecological research site, and a concerted, multidisciplinary research project on the Holocene history of the system has been initiated, in order to reveal the climatic, floristic and hydrological history of the lowland fynbos area within which Verlorenvlei is situated (Meadows, Baxter & Adams 1994; Baxter & Meadows 1994; Baxter & Davies 1994). To date, this study has included a detailed palynological investigation which has demonstrated major floristic changes both for the area surrounding the vlei and within the vlei itself (Baxter & Davies 1994; Meadows *et al.* 1994).

The present paper reports on the extant ostracod communities of Verlorenvlei in relation to their salinity and habitat preferences and tolerances. It is anticipated that, by providing ecological data on present ostracod communities of the system, this study will allow clearer interpretation of past ecological conditions, as indicated by different fossil ostracod communities preserved within the sedimentary record of the lake. In addition, however, the present paper also contributes to the knowledge of Recent non-marine ostracods of southern Africa, as no fewer than three species are here reported for the first time from southern Africa, while two species are new for the fauna of the entire continent.

The study site: Verlorenvlei

Verlorenvlei is a shallow, semi-estuarine coastal lake, river and swamp system, located some 200 km north of Cape Town along the Atlantic coast near Elands Bay (latitudes 32°19' and 32°23'S and longitudes 18°20' and 18°28'E). The lake extends inland for approximately 13 km and reaches a maximum width of 1.5 km. The river, and the swamp system which feeds the lake, has its origins in the Piketberg and Olifantsberg mountains to the south and east. The catchment occupies an area of some 1890 km^2 and drains across extensive low-lying sandy flats or Sandveld. The geology comprises quartzitic sandstones of the Table Mountain Group, Tertiary to Recent sands and fine-grained rocks (mainly shales) of the Malmesbury Group (Sinclair, Lane & Grindley 1986). Extensive low-lying sand flats occur to the north and the west of the lake, while the southern shore is formed by a range of low sandstone hills, whose highest point is at 300 m AMSL (Sinclair et al. 1986). A rocky barrier, covered by up to 2 m of marine sands, currently separates the lake from the open sea, although occasional exchanges with the sea occur during winter storms. The rainfall of the Verlorenvlei area is 250–300 mm yr^{-1}, most of which (80%) falls during winter (April–September). As such, the climate is considered Mediterranean, although in essence it could be classified as semi- to sub-arid, with characteristically hot and dry summers (Noble & Hemens 1978).

Towards the riverine/lacustrine transition, Verlorenvlei tends to be overgrown by extensive stands of *Typha capensis* and *Phragmites australis*. Submerged stands of *Myriophyllum* occur throughout the entire length of the lake, while *Potamogeton* appears to be restricted to the eastern part (e.g. Baxter & Davies 1994). The northern shore is characterized by exposed patches, with turbid water and bare sandy sedi-

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ments. The major part of the lake has a low salinity (measured as E.C.), with a K_{25} between 2000 and 4500 µS cm^{-1}. Close to the sea, however, the salinity is highly variable, and waters can even become hypersaline (see Table 1). Sinclair *et al.* (1986) referred to a decline in the salinity with increasing distance from the sea, but this is a simplification of the situation as in certain parts of the lake, isolated by extensive stands of macrophytes, salinity increases (presumably through evaporation) more rapidly than in the open water.

During the current investigation, the daytime pH varied between 6.9 and 8.8, agreeing well with the figures recorded by Sinclair *et al.* (1986; between 6.7 and 9.6). Although Sinclair *et al.* (1986) reported little or no photosynthetic activity in the open water (determined from changes in oxygen content), this wide variation in pH must at least partly be due to photosynthesis. Surface temperatures were invariably high (20°C and higher) at the time of our collecting.

Material and methods

All ostracod material used for the present paper was collected on 15 April 1993 (dry season) and on 19 October 1994 (wet season) by the present authors. Seven stations along the W-E gradient were sampled during the dry season; an additional two stations were investigated during the wet season survey (Figure 1). All samples were taken with a rectangular handnet (mesh size 160 µm), between 10 cm and 1.5 m deep and were preserved in buffered formalin. Samples were washed in the laboratory over a 250 µm sieve and stored in 80% ethanol, buffered with borax. Ostracods were sorted under a stereo-binocular microscope. All samples are stored in the collections of the Royal Belgian Institute of Natural Sciences (RBINSc: Brussels, Belgium) (no. I.G. 27.958); all illustrated specimens are included in the Ostracod Collection of the RBINSc (nos OC.1704-1723, OC.1774–1778). Measurements of electrical conductivity, pH and temperature were effected *in situ* with a portable CONSORT (C531) pH/EC-meter.

Brief description of stations

Station 1: mouth of vlei, within *ca* 10 m from sea, separated by a narrow, sandy barrier. Seawater occasionally washes in. Sample taken amongst weeds and algae. Co-ordinates, 32°19'05"S; 18°20'02"E.

Station 2: near mouth, immediately upstream of an illegal causeway, amongst *Sarcocornia* stands. Co-ordinates, 32°19' 02"S; 18°20'11"E.

Station 3: 'Verlorenvlei Farm' embayment, *ca* 500 m upstream of main causeway, amongst large beds of *Myriophyllum*. Co-ordinates, 32°19'12"S; 18°21'38"E.

Station 4: *ca* halfway along the vlei on the northern side, on the major open water embayment; a highly exposed zone, amongst very large *Juncus* and few *Myriophyllum* stands, on bare, fine sand. Co-ordinates, 32°19'54"S; 18°25'42"E.

Station 5: at culvert on the road to Grootdrift, amongst *Typha* and *Nymphea*. Co-ordinates, 32°23'40"S; 18°28'26"E.

Station 6: at coring site, Grootdrift, amongst *Potamogeton* and detritus, on sand. Co-ordinates, 32°23'12"S; 18°27'30"E.

Station 7: *ca* halfway along the south side, sheltered weed-beds, near Muishoekberg, inland of large *Phragmites* stands. Co-ordinates, 32°22'08"S; 18°26'52"E.

Station 8: at corner of road to Grootdrift, between Stations 5 and 6. This area is dry during the dry season, inundated during the wet season and covered with extensive growths of *Cotula coronopifolia* L. (Asteraceae). Co-ordinates, 32°23'42"S; 18°28'18"E.

Station 9: temporary vlei near the Verlorenvlei River, *ca* 2 km from the entrance of the vlei itself, and *ca* 3–4 km W of Redelinghuys. This area is dry during dry season, inundated during the wet season. Co-ordinates, 32°24'50"S; 18°31'15"E.

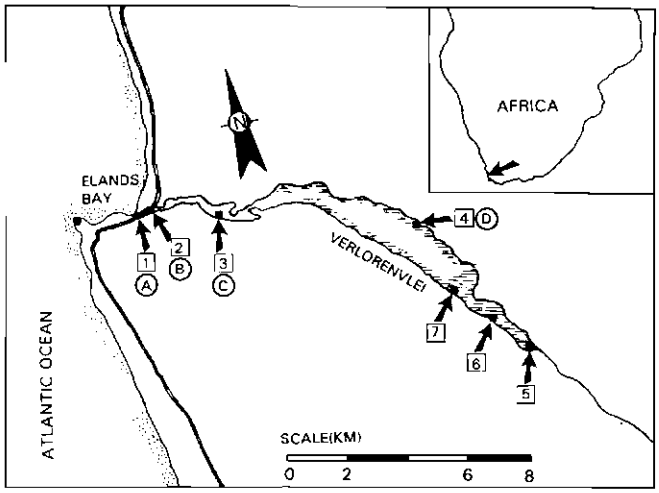

Figure 1 Map of Verlorenvlei, indicating positions of the seven sampling stations.

Table 1 *In situ* measurements of pH, temperature and electrical conductivity (K_{25}) for seven stations in Verlorenvlei (see Figure 1). DS, Dry season (15. 4. 1993); WS, Wet season (19. 10. 1994); – = no measurements

	pH		Temp. (°C)		K_{25} (µS/cm)	
Station	DS	WS	DS	WS	DS	WS
1	8.6	7.8	20.5	23.0	76 000	2 430
2	8.8	7.3	21.0	21.5	11 600	2 410
3	8.8	7.7	23.0	21.0	4 340	2 000
4	8.3	7.7	26.5	23.0	2 250	1 830
5	7.7	6.9	22.0	22.0	4 200	2 050
6	7.7	–	20.0	26.0	3 870	2 379
7	8.5	–	22.0	23.0	3 230	2 420
8	–	–	–	24.5	–	2 140
9	–	–	–	27.0	–	2 890

Abbreviations used in text and figures

act = anterior cardinal tooth; cop = copulatory process on hemipenis; Cp = carapace; d1,d2 = setae on T1; dl = distal lobe of hemipenis; fu = furca; L = length; ls = lateral shield of hemipenis; ms = medial shield of hemipenis; Mx1 = maxillula; pct = posterior cardinal tooth; rp = respiratory plate on maxilla; T1 = first thoracopod; UR = upper ramus of clasping organ on hemipenis; Y and Ya = aesthetascs on A2 and A1 respectively.

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Taxonomy and ecology of the Verlorenvlei ostracods

The present account includes fifteen species found during the present survey in the dry season (DS) or wet season (WS) collections, and four species reported by Sinclair *et al.* (1986) (SI) that were not found during our survey (see Discussion). We will not give a full description of each taxonomic level of the species encountered. However, as no comprehensive fauna of southern African ostracods, with both generic and specific keys, is at present available, abbreviated diagnoses are included for all species. These might include both generic and specific features and should allow identification of the 19 species thus far found in Verlorenvlei.

The first three species belong to the Cytheroidea, mainly characterized by four central muscle scars in a vertical row on both valves and by the presence of three pairs of symmetrical walking limbs. All other species are Cypridoidea, with a scattered pattern of central muscle scars and with the last three pairs of appendages having a different morphology (only one pair of walking limbs).

Limnocythere inopinata (Baird, 1843) (Figures 3 K–O)

Verlorenvlei: DS.
Additional references: Martens (1990).
Abbreviated diagnosis: smallish species, with relatively high, generally reticulated valves; at least LV with small postero-ventral marginal spines. In dorsal view, anterior part beak-like, posteriorly with LV largely overlapping RV. RV with large pct; act absent.
Measurements: L = *ca* 0.5 mm, which is slightly smaller than the European populations (0.58–0.64 mm — Klie, 1938).
Other South African species: L. tudoranceai Martens, 1990 (Namibia, Botswana); *L. aethiopica* Klie 1934 (Lake Chrissie area, Transvaal, RSA).
Ecology: species of this genus are often considered to be indicators of waters with moderate to high salinity and alkalinity (Cohen, Dussinger & Richardson 1983), but it should be stressed that *Limnocythere* can also be found in freshwater conditions (Martens & Tudorancea, 1991). *Limnocythere inopinata* is a benthic species, devoid of all swimming powers. The population in Verlorenvlei is parthenogenetic, as is usually the case in this species (Martens 1994b).
Remarks: this is the first certain record of this species in Africa, although *L.* cf. *gibbosa* from Sudan (Martens 1990) might also be *L. inopinata*. It is suspected that this species is a relatively recent (European) introduction.

Gomphocythere obtusata (Sars, 1910) (Figures 2F, G, J, K; 6A)

Verlorenvlei: DS, WS.
Additional references: Martens (1993), Sars (1924).
Abbreviated diagnosis: (valid for southern African specimens only) species with reticulated valves and conspicuous sexual dimorphism. Female valves swollen in dorsal view, with wide posterior brooding cavity; posterior margin in dorsal view rounded. In lateral view ventro-lateral crests minute or absent; both antero- and dorso-caudal corners with an obtuse angle, ventro-caudal corner not pronounced. Both this and the preceding species with act and pct well developed on LV, absent on RV. Hemipenis (Figure 6A) with dl squarish.
Measurements: female: L = *ca* 0.75 mm; male: L = *ca* 0.6 mm.
Other South African species: G. capensis (G.W. Müller, 1914) (see below).
Ecology: G. obtusata generally occurs in freshwater conditions, but is here reported from a slightly saline environment. As the preceding species, it is purely benthic and devoid of all swimming powers.
Remarks: note that the difference in shape of carapaces in dorsal view between this and the next species is less pronounced than is indicated in the illustrations in Sars (1924).

Gomphocythere capensis (G.W. Müller, 1914) (Figures 2A–E, H, I, L, M; 6B–D; 7A–E)

syn.: *Gomphocythere expansa* Sars, 1924 **nov.syn.**

Verlorenvlei: DS.
Additional references: Martens (1993), Müller (1914), Sars (1924).
Abbreviated diagnosis: female carapace in dorsal view wider and with a more squarish caudal part and with ventro-caudal corner more pronounced than in the preceding species. Ventro-lateral crests more conspicuous in both sexes than in the preceding species. Hemipenis with dl pointed (Figures 6B–D).
Measurements: slightly smaller than preceding species: female: L = *ca* 0.7 mm; male: L= *ca* 0.6 mm.
Ecology: this species is generally associated with slightly saline conditions, and is often found together with *S. aculeata.*
Remarks: (i) Martens (1993) provides the arguments behind the synonymy between *G. capensis* and *G. expansa.*
(ii) there are a number of morphological differences between the populations from the Cape Flats on the one hand and the specimens from Verlorenvlei on the other: the ventro-lateral crests in both males and females are unusually small in the specimens from Verlorenvlei, whereas the males from this locality also have a slightly aberrant hemipenis (compare Figures 6B and 6C, D: the difference in size between the dorsal process on the dl). However, large populations from the Western Transvaal (Martens 1994a) have a similar hemipenis morphology and carapaces with large and conspicuous crests. This species thus appears to be quite variable, both in valve and in soft-part morphology.

Physocypria capensis (Sars, 1895) (Figures 3E, F)

syn.: *Cypria armata* G.W. Müller, 1914

Verlorenvlei: DS, WS.
Abbreviated diagnosis: Physocypria is a small cyclocypridinid genus, with high and narrow valves and with LV overlapping RV on anterior and posterior side, RV with rows of anterior and posterior marginal tubercles, as is typical of this genus. *Physocypria capensis* has a rounded dorsal margin, a variable, but usually limited dorsal overlap of the LV by the RV and no conspicuous ventral overlap. The external surface of the valves has a microscopic striation. For illustrations of soft parts, see Sars (1924).
Measurements: female: L = 0.6–0.7 mm, males are slightly smaller.
Other South African species: in *P. bullata* (Vavra, 1897), the

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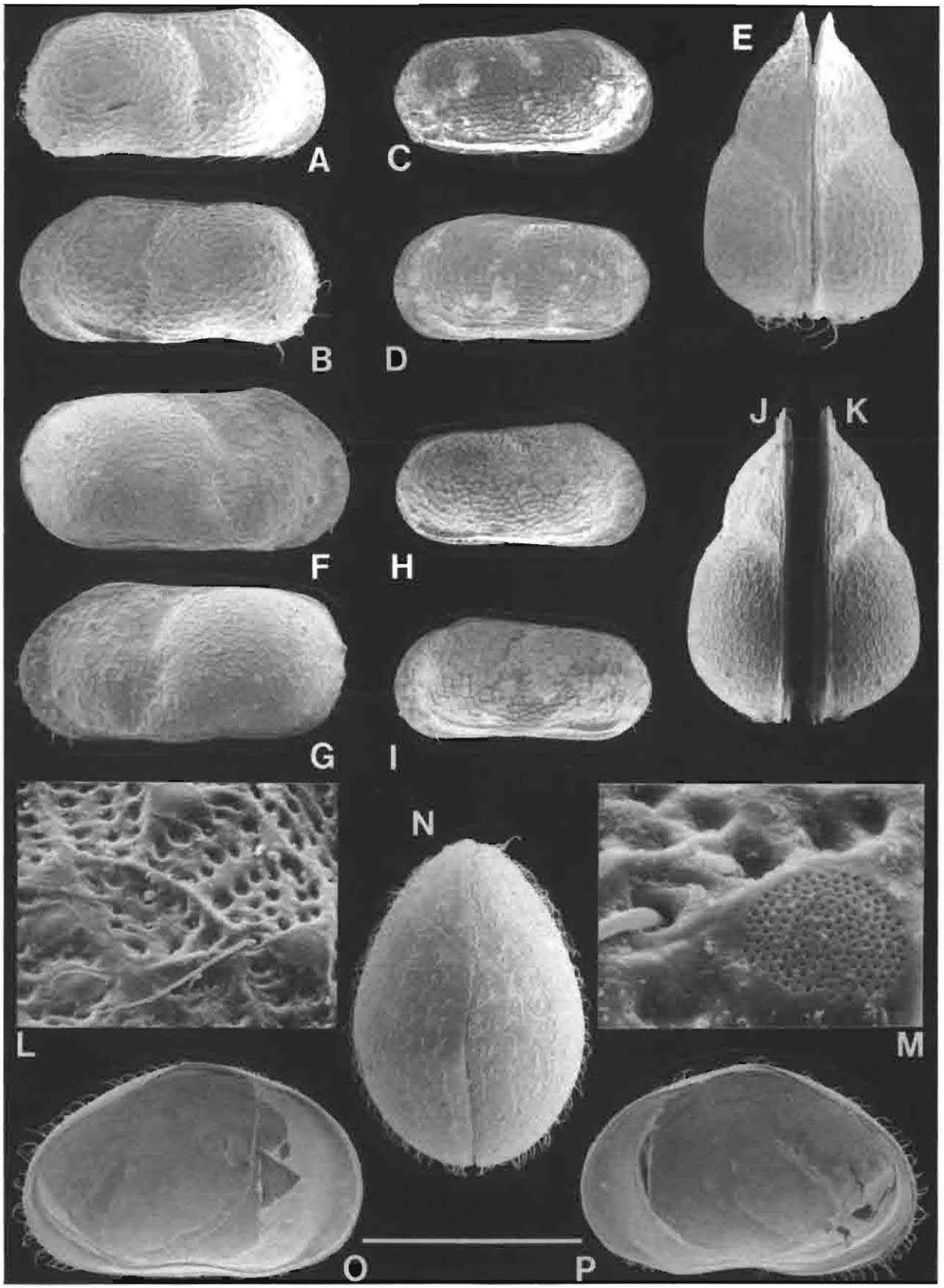

Figure 2 *Gomphocythere capensis* (A–E, H, I, L, M); *G. obtusata* (F, G, J, K) & *Cypridopsis vidua* (N–P). ***G. capensis:*** A. female, RV, external view (no. OC.1711). B. female, LV, external view (*idem*). C. male, RV, external view (no. OC.1710). D. male, LV, external view (*idem*). E. female, Cp, dorsal view (no. OC.1711). H. male, RV, external view (no. OC.1719). I. male, LV, external view (no. OC.1720). L. female, Cp, dorsal view, detail of surface (no. OC.1711). M. *Idem*, detail of sieve pore (*idem*). ***G. obtusata:*** F. female, RV, external view (no. OC.1704). G. female, LV, external view (*idem*). J. female, LV, dorsal view (no. OC.1704). K. female, RV, dorsal view (*idem*). ***C. vidua:*** N. female, Cp, dorsal view (specimen lost). O. female, LV, internal view (no. OC.1723). P. female, RV, internal view (*idem*). Scale = 521 μm for A–K; 424 μm for N–P; 52 μm for L; 15 μm for M.

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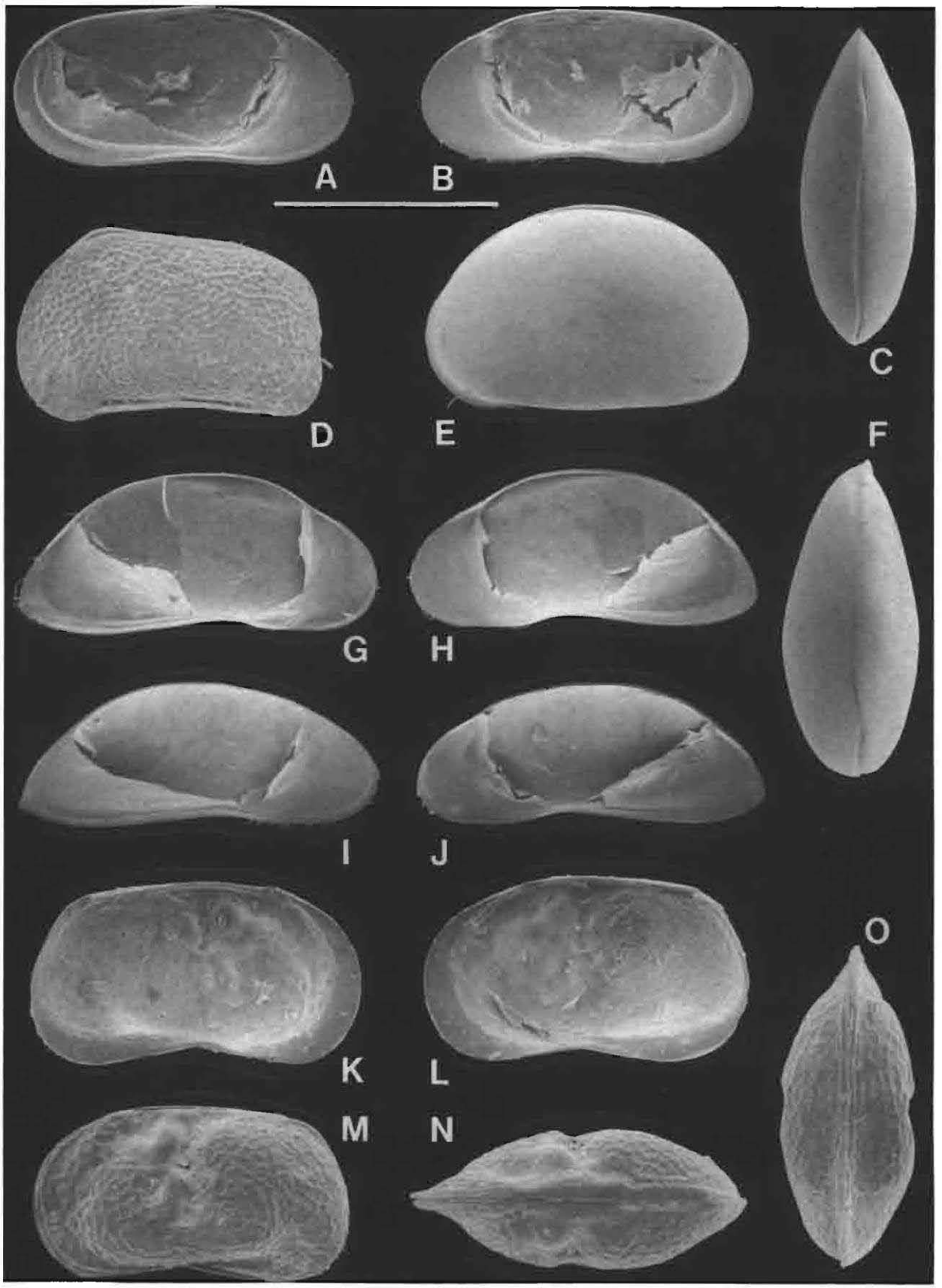

Figure 3 *Ilyodromus viridulus* (A–C); *Cyprilla humilis* (D); *Physocypria capensis* (E, F); *Parastenocypris hodgsoni* (G–J) & *Limnocythere inopinata* (K–O). ***I. viridulus:*** A. female, LV, internal view (specimen lost). B. female, R., internal view (*idem*). C. female, Cp, dorsal view (no. OC.1708). ***C. humilis:*** D. female, Cp, left lateral view (no. OC.1716). ***P. capensis:*** E. female, Cp, left lateral view (no. OC.1709). F. female, Cp, dorsal view (no. OC.1709). ***P. hodgsoni:*** G. female, LV, internal view (specimen lost). H. female, RV, internal view (*idem*). I. male, LV, internal view (no. OC.1705). J. male, RV, internal view (*idem*). ***L. inopinata:*** K. female, LV, internal view (no. OC.1717). L. female, RV, internal view (*idem*). M. female, Cp, left lateral view (no. OC.1717). N. female, Cp, dorsal view (no. OC.1717). O. female, Cp, ventral view (specimen lost). Scale = 1409 µm for G–J; 746 µm for A–C; 424 µm for E, F; 343 µm for D, K–O.

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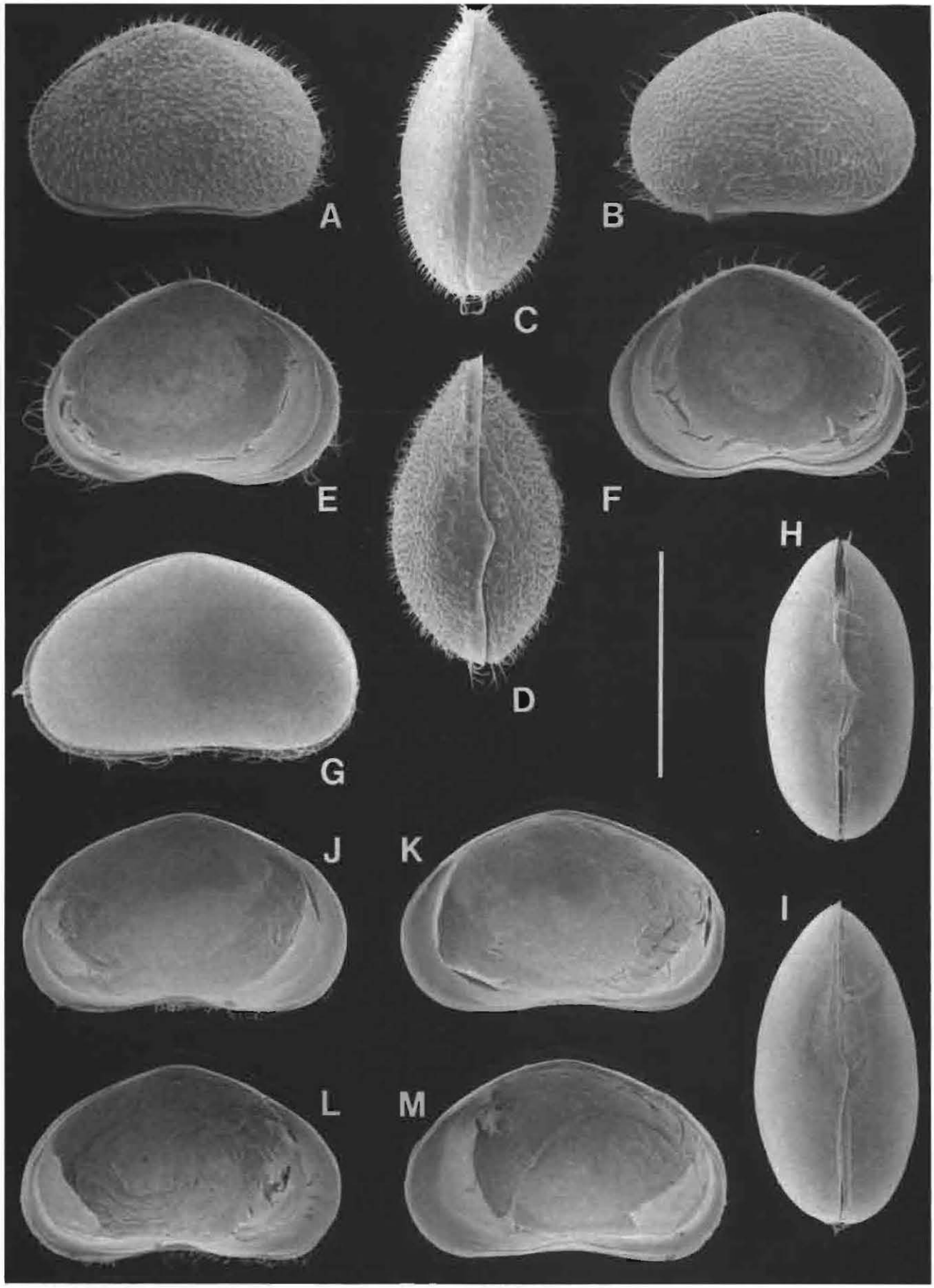

Figure 4 *Sarscypridopsis aculeata* (A–F) & *S. glabrata* (G–M). ***S. aculeata:*** A. female, Cp, left lateral view (no. OC.1707). B. female, Cp, right lateral view (no. OC.1707). C. female, Cp, dorsal view (no. OC.1707). D. *Idem*, ventral view (no. OC.1707). E. female, LV, internal view (no. OC.1706). F. female, RV, internal view (no. OC.1706). ***S. glabrata:*** G. female, Cp, left lateral view (no. OC.1715). H. male, Cp, ventral view (no. OC.1712). I. female, Cp, ventral view (no. OC.1712). J. female, LV, internal view (no. OC.1713). K. female, RV, internal view (*idem*). L. male, LV, internal view (no. OC.1714). M. male, RV, internal view (*idem*). Scale = 500 μm for A–F; 424 μm for G–I.

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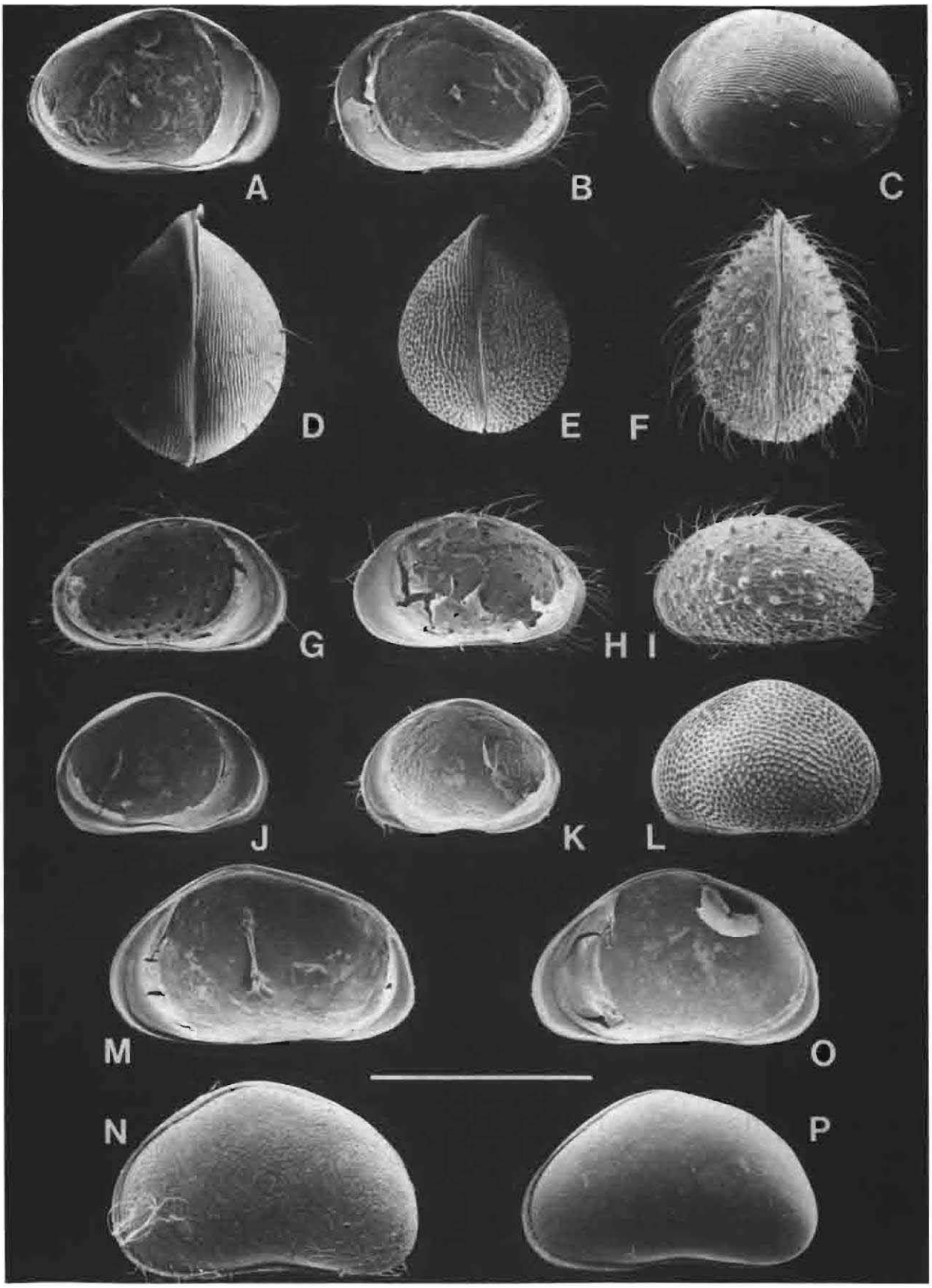

Figure 5 *Paracypretta acanthifera* (A–D), *Zonocypris cordata* (E, J–L), *Z. tuberosa* (F–I), *Sarscypridopsis ochracea* (M, N) & *S. trigonella* (O, P). ***P. acanthifera*** (no. OC. 1776) : A. female, LV, internal view. B. female, RV, internal view. C. female, LV, external view. D. female, Cp, dorsal view. ***Z. cordata*** (no. OC.1778) : E. female, Cp, dorsal view. J. female, LV, internal view. K. female, RV, internal view. L. female, LV, external view. ***Z. tuberosa*** (no. OC.1777) : F. female, Cp, dorsal view. G. female, LV, internal view. H. female, RV, internal view. I. female, LV, external view. ***S. ochracea:*** M. female, RV, internal view (specimen lost). N. female, Cp, left lateral view (no. OC.1774). ***S. trigonella:*** O. female, RV, internal view (specimen lost). P. female, Cp, left lateral view (no. OC. 1775). Scale = 1000 μm for A–D; 676 μm for F–I; 595 μm for E, J–L; 463 μm for M–P.

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Figure 6 *Gomphocythere*, male, Hemipenes (A–D). A. ***G. obtusata*** (no. OC.1721), in medial view, from Verlorenvlei. B. ***G. capensis*** (no. KM. 249), in medial view, from Sirkelsvlei, Cape Flats. C. Detail of distal part in lateral view (no. OC.1710), from Verlorenvlei. D. *Idem*, complete hemipenis in medial view, (no. OC.1720), from Verlorenvlei. Scale = 78 μm for A–D.

RV overlaps the LV largely and conspicuously on both dorsal and ventral sides. *P. castanea* (Brady, 1904) is an uncertain species from Natal and Free State and is probably a synonym of *P. capensis*.

Ecology: one of the most common species in southern Africa, occurring in both fresh and slightly saline conditions and in both permanent and temporary water bodies.

Ilyodromus viridulus (Brady, 1886) (Figures 3A–C)

Verlorenvlei: DS.

Additional references: Danielopol & McKenzie (1977); De Deckker (1981a).

Abbreviated diagnosis: a large elongated species, with broadly rounded posterior and protruding anterior margins in lateral view, pointed anterior and posterior extremities in dorsal view. External surface of valves with microscopic striations. Dorsal margin in lateral view nearly straight. Calcified anterior inner lamella wide.

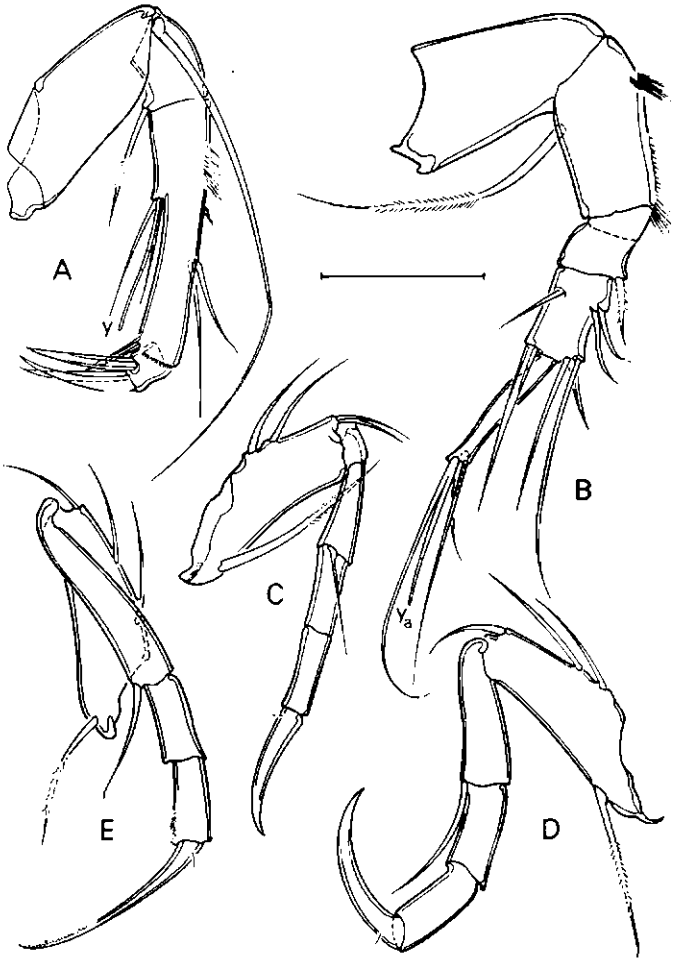

Figure 7 *Gomphocythere capensis*, male (A–E). A. A2 (no. OC.1710). B. A1 (no. OC.1720). C. P(1) (no. OC.1710). D. P(2) (no. OC.1710). E. P(3) (no. OC.1710). Scale = 78 μm for A–E.

Measurements: L = *ca* 1 mm.

Other South African species: none.

Ecology: in South Africa thus far found in temporary to semi-permanent freshwater pools and dams in the Eastern Cape. Verlorenvlei is the first slightly saline locality.

Remarks: the genus *Ilyodromus* has an Australasian distribution and frequently occurs in bisexual populations. All South African populations are parthenogenetic, which offers proof to the hypothesis that it constitutes an introduced alien species. In some of the Eastern Cape localities, this species occurs together with another Australian introduced species, *Candonocypris novaezelandiae* (Baird) (Martens, unpubl.)

Ramotha purcelli (Sars, 1924)

Verlorenvlei: SI.

Additional references: Martens (1992).

Abbreviated diagnosis: Ramotha is a eucypridinid genus, with mostly globular and large (2–3 mm) species. RV with frontal and caudal selvage inwardly displaced over a large distance, but with anterior valve margin ventrally not lip-like produced. LV without inwardly displaced selvage, but with a large inner list, situated in the centre of a wide anterior calcified inner lamella and on the posterior inner margin; ventrally

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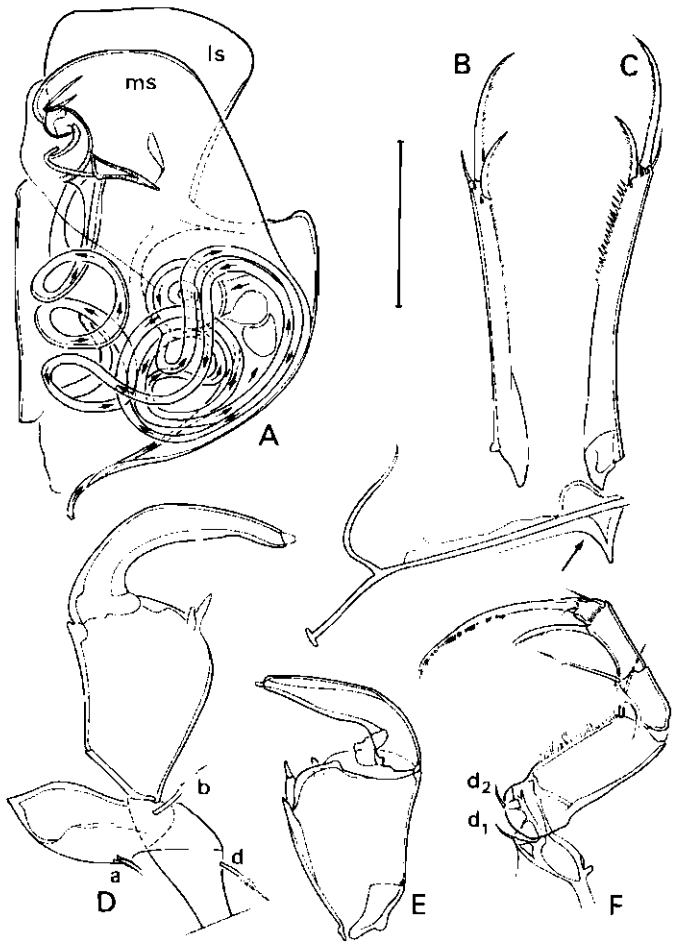

Figure 8 *Parastenocypris hodgsoni*, male, (no. OC.1705), (A–F). A. Hemipenis. B. Left furca. C. Right furca and furcal attachment. D. Right maxilla. E. Left prehensile palp. F. T1. Scale = 298 µm for B, C, F; 146 µm for A, D, E.

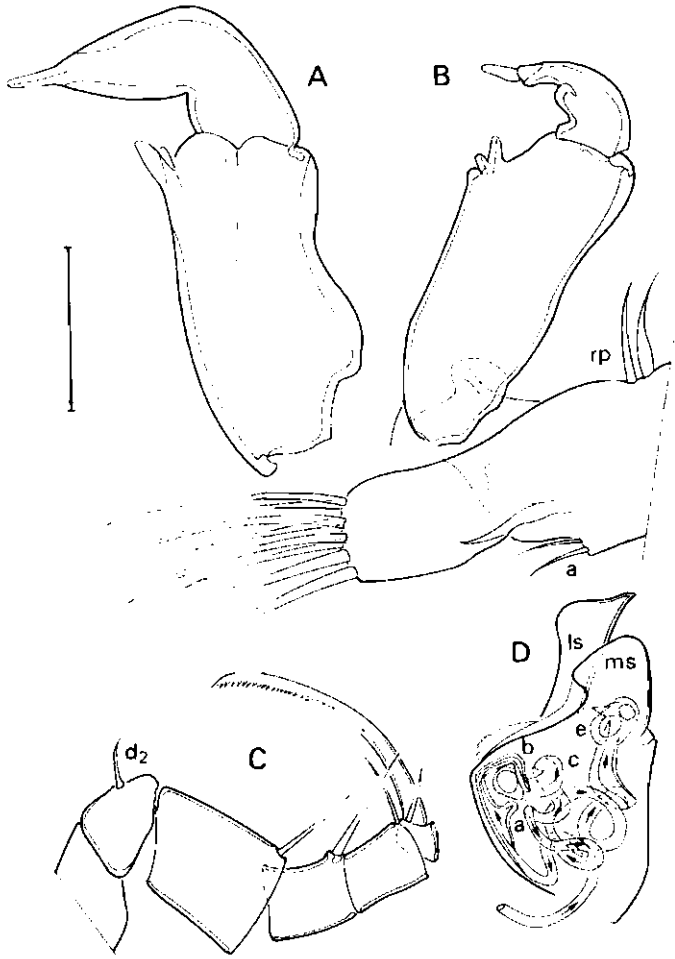

Figure 9 *Sarscypridopsis glabrata*, male, (no. OC.1722), (A–D). A. Right prehensile palp. B. Left maxilla. C. T1. D. Hemipenis. Scale = 78 µm for C, D; 29 µm for A, B.

with a conspicuous outer list.

In *R. purcelli*, both valves are elongate in lateral view, with frontal margin broadly rounded, passing into the dorsal margin almost without an angle, the latter margin passing into the caudal margin with a blunt angle; caudal margin not evenly rounded but showing an additional blunt angle; ventral margin weakly sinuous. Greatest height situated slightly in front of the middle. Ventral outer list on LV weak; dorsal outer list on this valve prominent. Cp in dorsal view with RV anteriorly clearly reaching beyond LV, and with greatest width situated at about $^1/_3$ from the front.

Measurements: female: L = 1.9–2.2 mm.

Other South African species: there are at present eight species recognized in southern Africa (Martens 1992).

Ecology: the only other locality thus far is the type locality: a freshwater pond near Ashton. Normally, these species are restricted to occurrences in temporary habitats. It is thus possible that this taxon was found in one of the pools associated with the feeding river of Verlorenvlei and not in Verlorenvlei itself.

Remarks: whereas the generic assignment of the specimens is to all probability correct, the specific identification of the Verlorenvlei material needs confirmation. As this species was not found in either of our surveys (so that it cannot be illustrated from Verlorenvlei), and as all species in the genus have rather similar shapes, a rather extensive description of the valves is here provided.

Parastenocypris hodgsoni (Sars, 1924) (Figures 3G–J; 8A–F)

Verlorenvlei: DS, WS.

Abbreviated diagnosis: the largest species in this locality, elongated in lateral view and very narrow in dorsal view; female somewhat larger and higher than male. LV in both sexes variable, with spines possible on both anterior margin and ventro-caudal extremity; anterior calcified inner lamella wide. No special marginal structures on valves.

Natatory setae on A2 reaching end of claws. Second segment of Mx1-palp more than twice as long as wide; 'zahnborsten' on third endite serrate. Furcae asymmetrical, with right furcal ramus set with a semi-continuous row of spines, getting gradually longer towards the distal side. Hemipenis with distal margins of ls and ms running nearly parallel (not so in other species in this genus — see Sars, 1924).

Measurements: L = *ca* 2.7 mm.

Other South African species: there are at present 13 nominal species, belonging to at least two natural groups (Martens

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1984 and Martens, in press).
Ecology: found in salinities of up to 25 g l^{-1} (Martens, unpubl.). This species is an indicator of (even highly) saline conditions; it often lives periphytically on submerged macrophytes such as *Myriophyllum*, etc. Very good swimmers.
Remarks: the taxonomy of this genus needs urgent revision, but *P. hodgsoni* is a relatively easily identifiable species. Valves of these species are nearly always very thin and fragile, which makes preservation as fossils hazardous.

Isocypris priomena G . W . Müller, 1908

Verlorenvlei: SI.
Additional references: Sars (1924).
Abbreviated diagnosis: the genus as such is easily recognizable, owing to the very hairy aspect of the thin and fragile valves (which decalcify rapidly, even in buffered formalin), rounded in lateral view, with long T1 and furcae always sticking out of the carapace. The main character is the absence of a posterior calcified inner lamella. *Isocypris priomena* is rather highly arched, and relatively small (see below).
Measurements: L = *ca* 1.5 mm.
Other South African species: I. perangusta G.W. Müller, 1908 has a maximal length of 1.2 mm and is more elongate than *I. priomena*; *I. africana* (Brady, 1913) (L = *ca* 1.4 mm) from the Free State is probably a synonym of *I. priomena*. '*Isocypris*' *nivea* Sars, 1924 is an altogether different species, easily recognizable and *ca* 2 mm long (see illustrations in Sars 1924).
Ecology: species of *Isocypris* are very good swimmers, and mostly occur in weed beds; there are no indications that they should be linked to saline conditions.

Paracypretta acanthifera Sars, 1924 (Figures 5A–D)

Verlorenvlei: DS, WS.
Abbreviated diagnosis: all species in this genus are globular with longitudinally striated valve surface and septa-like marginal structures in the RV only. For *P. acanthifera*, the width in dorsal view is between 0.75 and 0.85 times the length, while the surface of the valves is set with long hairs and stout spines.
Measurements: L = *ca* 1.1 mm.
Other South African species: Martens (in press) distinguishes four other species in southern Africa, but *P. acanthifera* is the only species set with spines.
Ecology: the species has thus far nearly always been found in slightly saline to saline environments (Martens, unpubl.).

Paracypretta minor (G.W. Müller, 1914)

syn.: Paracypretta syngramma minor (G.W. Müller, 1914)
syn.: Paracypretta rubra Sars, 1924

Verlorenvlei: SI.
Additional references: Martens (in press).
Abbreviated diagnosis: all species are globular with striated valve surface and septa-like marginal structures in the RV only. For *P. minor*, the width in dorsal view is between 0.75 and 0.85 times the length, while the surface of the valves is densely set with long hairs but no spines; colour of living animals brown to reddish.
Measurements: L = *ca* 0.95 mm.
Other South African species: see above.
Ecology: unknown, probably primarily a freshwater species. Species of this genus occur in both temporary and (semi-) permanent habitats.
Remarks: P. rubra Sars, 1924 is a junior synonym of *P. syngramma minor* (G.W. Müller, 1914), which is elevated to the rank of species .

All the following species belong to the subfamily Cypridopsinae (Cyprididae), which is characterized by the presence of a whip-like furca in females (males lack a furca) and a reduced number (mostly 4–5) of central muscle scars. All are small, mostly compact species, some have striking valve sculptures and ornamentation.

Sarscypridopsis glabrata (Sars, 1924) (Figures 4G-M; 9A–D)

Verlorenvlei: DS, WS.
Abbreviated diagnosis: species of this genus are medium-sized, with RV overlapping LV at least on anterior, posterior and ventral side; they have a rectangular second Mx2-palp segment. *Sarscypridopsis glabrata* has a sub-triangular shape in lateral view, with greatest height situated almost exactly in the middle, and with nearly evenly rounded anterior and posterior margins. External surface of valves smooth, not pitted and with few hairs. Both valves without anterior inner lists. Sexual dimorphism minimal, except in dorsal view where lateral margins are evenly rounded in females, sub-parallel in males; both sexes relatively narrow, with anterior and posterior margins pointed and subequal in dorsal view. Hemipenis with beak-like lobe ls, as typical of the genus.
Measurements: L of present specimens = *ca* 0.65 mm, which is considerably smaller than the 0.87 mm indicated by Sars (1924) for the type specimens.
Other South African species: to date this genus comprises at least 20 ill-defined South-African nominal taxa. Soft-part morphology remains unknown for most species and identifications down to species level are nearly always uncertain. Urgent revision is necessary, as this group constitutes an important part of the athalassic fauna of South Africa.
Ecology: S. glabrata is the only ostracod occurring in the hyper-saline part of Verlorenvlei. The type locality consists of pools near the whaling station at Saldhana Bay, which are almost certainly saline and probably also of marine origin. Hartmann (1974) found the species in saline lakes and pools near Swakopmund, Namibia. The species should thus be considered a good indicator of highly saline conditions.

Sarscypridopsis gregaria (Sars, 1895)

syn.: S. triquetra (G.W. Müller, 1908)

Verlorenvlei: SI.
Additional references: Sars (1924), Martens (in press).
Abbreviated diagnosis: shape variable, but mostly relatively highly arched and subtriangular in lateral view; in dorsal view with pointed anterior and rounded posterior margin, relatively wide. Surface of valves pitted, set with short hairs but no

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spines. Both valves with large anterior inner lists.
Measurements: female: L = *ca* 0.8 mm.
Other South African species: see above.
Ecology: largely unknown, it most likely prefers freshwater conditions, although it was also recorded from the (possibly saline) pools near the whaling station in Saldanha Bay.
Remarks: some authors consider this species to be the spineless and sexually reproducing form of *S. aculeata*.

Sarscypridopsis aculeata (Costa, 1847)

(Figures 4A-F)

syn.: Cypridopsis spinifera Sars, 1924

Verlorenvlei: DS, WS.
Additional references: McKenzie (1977), De Deckker (1981a), Hollwedel & Scharf (1988).
Abbreviated diagnosis: valves very variable in shape, mostly highly arched and subtriangular in lateral view; in dorsal view with pointed anterior and posterior margins, relatively wide in the middle. Surface of valves pitted and set with long hairs and stout spines. Shape of carapace in lateral view variable (all specimens of *Sarscypridopsis* spec. in Hollwedel & Scharf (1988) belong to *S. aculeata*).
Measurements: L = *ca* 0.65 mm.
Other South African species: see above.
Ecology: this cosmopolitan species is universally regarded as an indicator of slightly saline (*ca* 3 g l^{-1}) conditions, be they of marine or of non-marine origin.
Remarks: the common *S. spinifera* is without any doubt a synonym of this species. Note, however, that *S. echinata* (G.W. Müller, 1908), on the other hand, is a good and distinct species.

Sarscypridopsis ochracea (Sars, 1924) (Figures 5M,N)

Verlorenvlei: WS.
Additional references: Sars (1924).
Abbreviated diagnosis: valves subtriangular in lateral view, with anterior margin pointed and posterior margin nearly straight. LV without marginal tubercles; RV with pronounced inner list, not running parallel to valve margin, ventrally more closely positioned to it than dorsally. LV with widely inwardly displaced caudal selvage (visible without separating the valves).
Measurements: L = *ca* 0.8 mm.
Other South African species: see above.
Ecology: one of the most common species in southern Africa in both temporary and permanent conditions; nearly always present, together with the next species, in muddy man-made dams. Probably resistant to even very eutrophic conditions.
Remarks: this species is very closely related to the following one and, owing to variability in carapace might easily be confused with it (Figures 5M–P indeed only show the typical forms). Good structural features to separate these taxa are the position of the anterior inner list in the RV and the presence of marginal tubercles on the LV in *S. trigonella*, absent in *S. ochracea*.

Sarscypridopsis trigonella (Sars, 1924)

(Figures 5O, P)

Verlorenvlei: WS.
Additional references: Sars (1924).
Abbreviated diagnosis: valves (sub-) triangular in lateral view, generally more highly arched than in the preceding species, with anterior margin even more pointed than in the preceding species and with posterior margin nearly straight. LV with anterior and posterior rows of small marginal tubercles (use highest magnification); RV with pronounced inner list, relatively far inwardly displaced and running parallel to valve margin. LV with widely inwardly displaced caudal selvage (visible without separating the valves).
Measurements: L = *ca* 0.8 mm.
Other South African species: see above.
Ecology: see previous species.
Remarks: see previous species.

Cyprilla humilis Sars, 1924 (Figure 3D)

Verlorenvlei: DS.
Additional references: Meisch (1985).
Abbreviated diagnosis: species of *Potamocypris* and *Cyprilla* have trapezoid distal segment on the Mx1; *Cyprilla* is different from *Potamocypris* s.s. by the presence of relatively large hyaline flanges on the LV (less conspicuous in *C. humilis*). The present species has a conspicuous pitted surface, a straight dorsal margin where the RV does not or only slightly overlaps the LV and a nearly straight (not rounded) caudal margin in lateral view.
Measurements: L = *ca* 0.5 mm in Verlorenvlei; Meisch (1985) cited a length of 0.54–0.60 mm.
Other South African species: there are five species of *Cyprilla* presently recognized in southern Africa.
Ecology: nothing is known about the salinity of the type locality on the Cape Flats, but the Finnish locality of this species consisted of a slightly saline rock pool (Purasjoki 1948 in Meisch 1985).
Remarks: Cyprilla can be considered a synonym (Gauthier 1939; Meisch 1985) or a subgenus (Martens, in press) of *Potamocypris*, or can be maintained as an independent genus (McKenzie 1977). *Cyprilla humilis* also occurs in other parts of Africa and has even been reported from Finland.

Cypridopsis vidua (O. F. Müller, 1776) (Figures 2N–P)

Verlorenvlei: DS, WS.
Abbreviated diagnosis: a genus with globular species, with LV overlapping RV in dorsal view, and with both anterior and posterior margins in the same view obtusely rounded. In lateral view, *C. vidua* has valves with subtriangular shape, with greatest height in the middle, but anterior margin far more broadly rounded than the obtusely pointed caudal margin. External surface of valves weakly pitted and densely set with hairs. Living specimens often with dorsal pigmented patches.
Measurements: L = *ca* 0.65 mm; Klie (1938) cited 0.7 mm for the European populations.

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Other South African species: there are 3–4 other nominal species in this genus reported from southern Africa, but at least one or two of these will turn out to be parthenogenetic clones of *C. vidua* with slightly different shapes and surface ornamentation.

Ecology: C. vidua is considered a ubiquist and an opportunist, although it mostly occurs periphytically on submerged macrophytes. There are no indications that it can be used as an indicator of saline conditions. The species is cosmopolitan.

Zonocypris cordata Sars, 1924 (Figures 5E, J–L)

Verlorenvlei: WS.

Abbreviated diagnosis: species of *Zonocypris* s.s. are generally small, globular, with rounded posterior and pointed anterior margins in dorsal view and with LV overlapping RV at least anteriorly in this view; most species have clearly ornamented valve surfaces. *Zonocypris cordata* is a relatively highly arched species in lateral view, with sinuous ventral margin, and especially with strongly pitted external valve surface. No spines and only few, short hairs.

Measurements: L = *ca* 0.6 mm.

Other South African species: Z. tuberosa (see below) and *Z. costata* (Vavra).

Ecology: a Western Cape species, which occurs in both temporary and permanent water bodies; it is not especially indicative of saline conditions.

Remarks: the taxonomy of this genus is confused. As one of the main features, a comb-like claw on the A2, is often cited and this has led to the inclusion of narrow, smooth species into this genus. However, none of these species has thus far been found in southern Africa and we consider *Zonocypris* s.s. to comprise only the ornamented, globular taxa.

Zonocypris tuberosa G.W. Müller, 1908 (Figures 5F–I)

Verlorenvlei: WS, SI.

Additional references: Sars (1924).

Abbreviated diagnosis: species in this genus are sub-globular and have sculptured valves. *Zonocypris tuberosa* G.W. Müller, 1908 is about half as wide as long, and thus relatively elongate in lateral view, and carries very striking large and stout spines on the valves; the external valve surface is furthermore reticulated and some of the spine-like hairs originated from large cone-like tubercles. An easily recognizable species.

Measurements: L = 0.7–0.8 mm.

Other South African species: see above.

Ecology: nothing is known about its ecology, although it has already been found from a purely freshwater locality near Port Alfred (Martens *et al.*, unpubl.).

Remarks: see above.

Discussion

Fifteen species were found during our present survey (Table 2). Two species are reported from the African continent for the first time (Martens 1984), viz.: *Ilyodromus viridulus*, an Australian species, and the Holarctic *Limnocythere inopinata*.

Table 2 Occurrence of the ostracod species at the various sampling stations in Verlorenvlei (1993–1994) and species reported by Sinclair *et al.* (1986) not found in the present survey. Dry season collection, 15. 4. 1993; wet season collection: 19. 10. 1994

	Dry season							Wet season								
Species / Station	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9
Limnocythere inopinata		x	x													
Gomphocythere obtusata			x							x						
Gomphocythere capensis					x	x										
Physocypria capensis		x	x		x	x	x		x	x		x	x	x	x	x
Ilyodromus viridulus					x	x										
Parastenocypris hodgsoni			x	x				x	x	x	x	x	x	x	x	x
Paracypretta acanthifera			x					x				x	x		x	x
Sarscypridopsis glabrata	x	x						x	x							
Sarscypridopsis aculeata		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sarscypridopsis ochracea											x					
Sarscypridopsis trigonella														x		
Cyprilla humilis		x														
Cypridopsis vidua					x									x		
Zonocypris cordata										x		x	x	x	x	x
Zonocypris tuberosa												x	x		x	x
Isocypris priomena																
Ramotha purcelli																
Paracypretta minor																
Sarscypridopsis gregaria																

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Many of the species reported in this paper are to some extent indicative of saline or alkaline conditions, as exemplified by *S. aculeata, G. capensis* and especially *S. glabrata.* However, *Physocypria capensis, Cypridopsis vidua* and *Limnocythere inopinata* also occur in freshwater, while *Gomphocythere obtusata* was up to now thought to occur only in freshwater. It is also noteworthy that no marine species occur in the highly hypersaline parts of the lake, which is strong evidence for the fact that these parts are not permanent and occasionally dry out completely. Marine (thalassic) ostracods indeed lack the ability to produce desiccation-resistant stages.

Sarscypridopsis glabrata, collected from Sites 1 and 2, was especially abundant during the dry season. It is, furthermore, the only cypridinid ostracod thus far found in African hypersaline waters. Saline to highly saline lakes in Africa generally have a cytherid fauna (*Cyprideis, Limnocythere*), unlike Australian inland saline lakes which have several cypridinid endemics adapted to hypersaline conditions (De Deckker 1981b).

Sinclair *et al.* (1986) reported five different ostracod species from this lake, collected during the late 1970s, only one of which, *Zonocypris tuberosa*, was found in the present survey. All five species are typical of freshwater conditions. It is possible, of course, that some of the identifications of Sinclair *et al.* (1986) were erroneous, i.e. *Sarscypridopsis gregaria* might have been *S. aculeata* while *Paracypretta rubra* might have been *P. acanthifera. Sarscypridopsis aculeata* and *Paracypretta acanthifera*, both found during the present survey are, indeed, indicators of more saline conditions, whereas *S. gregaria* and *P. rubra* are freshwater species. If the identifications of Sinclair *et al.* (1986) are correct, then the ostracod fauna of Verlorenvlei indicates that conditions during the 1970s collections were far less saline than during the present study. Unfortunately, examination of the Sinclair *et al.* (1986) data provides no clue as to the time of year in which their collection was made. Accordingly, we cannot speculate as to whether or not there have been major changes in salinities in the main lake of Verlorenvlei during the intervening period. It is hoped that analysis of the fossil ostracod assemblages in the lake sediments will be able to elucidate the problem.

Dingle & Honigstein (1994) reported on Quaternary ostracods from the surroundings of Verlorenvlei. They found three non-marine species, though not from Verlorenvlei itself: *Heterocypris capensis, Sarscypridopsis brevis* (erroneously identified as *S. ?aculeata*) and *Sarscypridopsis glabrata* (erroneously identified as *S. ?reniformis*). The excellent valve illustrations in this paper allow correct identification.

Data from Grindley, Lane & Robertson (1982), presented in Figure 10 show that there are significant seasonal salinity fluctuations in the stations located closest to the mouth, whereas the salinity of the major body of the lake remains rather more stable around 2–3 g l^{-1} all through the year. The significant salinity fluctuations near the mouth are further reflected by the ostracod fauna from Station 1 during the present survey: this consists of only *S. glabrata* in the hypersaline conditions that develop during the dry season, while species tolerant of more moderate salinities also occur there during the wet season (Table 2).

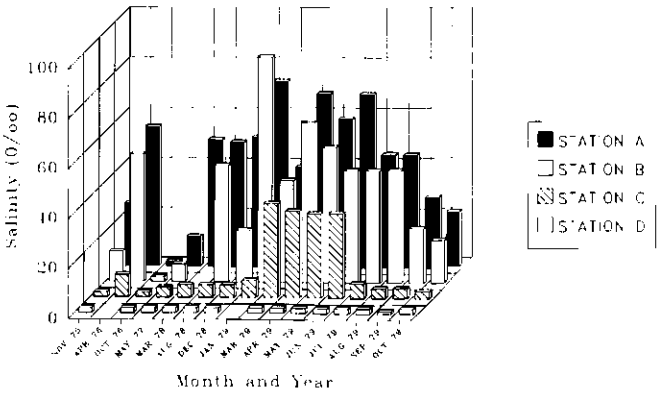

Figure 10 Patterns of salinity fluctuations at Verlorenvlei, recorded between November 1975 and October 1979, adapted from Table 5 in Grindley *et al.* (1982). See Figure 1 for site locations of Stations A–D.

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References

ALLANSON, B.R., HART, R.C., O'KEEFFE, J.H. & ROBARTS, R.D. 1990. Inland waters of southern Africa: an ecological perspective. Kluwer Academic Publ., Dordrecht. *Mongr. Biol.* 64, 458 pp.

BAXTER, A.J. & DAVIES, B.R. 1994. Palaeoecological insights for the conservation of aquatic ecosystems in dryland environments: A case study of the Verlorenvlei system, South Africa. *Aquat. Conserv.: Mar. Freshwat. Ecosys.* 4: 225–271.

BAXTER, A.J. & MEADOWS, M.E. 1994. Palynological evidence for the impact of colonial settlement within lowland fynbos: A high-resolution study from the Verlorenvlei, Southwestern Cape Province, South Africa. *Histor. Biol.* 9: 61–70.

COHEN, A.C., DUSSINGER, R. & RICHARDSON, J. 1983. Lacustrine paleochemical interpretations based on Eastern and Southern African ostracods. *Palaeogeogr., Palaeoclimatol., Palaeoecol.* 43: 129–151.

DANIELOPOL, D.L. & MCKENZIE, K.G. 1977. *Psychrodromus* gen. n. (Crustacea, Ostracoda), with redescription of the Cypridid genera *Prionocypris* and *Ilyodromus. Zool. Scr.* 6: 301–322.

DAVIES, B.R. & DAY, J.A. 1986. The biology and conservation of South Africa's vanishing waters. Department of Extra-mural Studies, University of Cape Town & Western Cape Branch of the Wildlife Society of Southern Africa. 186 pp.

DE DECKKER, P. 1981a. Ostracoda from Australian inland waters — notes on taxonomy and ecology. *Proc. r. Soc. Victoria.* 93(1): 43–85.

DE DECKKER, P. 1981b. Ostracods of athalassic saline lakes. *Hydrobiologia* 81: 131–144.

DINGLE, R.V. & HONIGSTEIN, A. 1994. Ostracoda from

Reproduced by Sabinet Gateway under licence granted by the Publisher (dated 2009).

Quaternary coastal sequences in the South-western Cape. *Ann. S. Afr. Mus.* 104(5): 63–114.

GAUTHIER, H. 1939. Sur la structure de la coquille chez quelques cypridopsines à furca réduite et sur la validité du genre *Cyprilla* (Ostracodes). *Bull. Soc. zool. France* 64: 203–228.

GRINDLEY, J.R., LANE, S.B. & ROBERTSON, H.N. 1982. The environment and ecology of Verlorenvlei. In: Verlorenvlei: a challenge to conservation. University of Cape Town Publ., 40 pp.

HARTMANN, G. 1974. Zur Kenntnis des Eulitorals der afrikanischen Westküste zwischen Angola und Kap der Guten Hoffnung und der afrikanischen Ostküste von Südafrika und Moçambique unter besonderer Berücksichtigung der Polychaeten und Ostracoden. Teil III. Die Ostracoden des Untersuchungsgebietes. *Mitt. Hamb. zool. Mus. Inst.* 69: 229–520.

HOLLWEDEL, W. & SCHARF, B. 1988. Süsswassercladoceren und Ostracoden (Crustacea) auf den niedersächsischen Nordseeinseln Mellum und Memmert. *Drosera* 88(1/2): 341–369.

KLIE, W. 1938. Die Tierwelt Deutschlands. 34. Krebstiere oder Crustacea. II. Ostracoda, Muschelkrebse. Verlag von Gustav Fischer, Jena, 230 pp.

MARTENS, K. 1984. Annotated checklist of non-marine ostracods (Ostracoda, Crustacea) from African inland waters. *Zool. Bijdr. K. Mus. mid. Afr., Tervuren* 20: 51 pp.

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. *Arch. Hydrobiol., Suppl.* 83(4): 453–524.

MARTENS, K. 1992. Taxonomic revision of African Cypridini. Part II. Description of *Ramotha* gen. nov. *Ann. S. Afr. Mus.* 102(2): 91–130.

MARTENS, K. 1993. On the taxonomy and zoogeography of the genus *Gomphocythere* Sars, 1924 (Crustacea, Ostracoda), with the description of a new species from the Nahal Dan (Israel). *Belg. J. Zool.* 123(1): 39–54.

MARTENS, K. 1994a. The ostracods from the Molopo Oog-area (Western Transvaal, RSA). In: Conservation of Dolomitic ecosystems — Final Report, Appendix D. *Publ. J.L.B. Smith Inst. Ichthyol.* 30 pp.

MARTENS, K. 1994b. Summary of the morphology, taxonomy and distribution of *Limnocythere inopinata* (Baird, 1843) (Ostracoda, Limnocytherinae). In: The evolutionary ecology of reproductive modes in non-marine Ostracoda. (Eds) Horne, D.J. & Martens, K. Greenwich University Press. pp. 17–22.

MARTENS, K. (in press). Ostracoda. In: A guide to the freshwater crustaceans of southern Africa. (Eds) Day, J.A. Stewart, B.A. & Louw, E. South African Museum, Cape Town.

MARTENS, K. & TUDORANCEA, C. 1991. Seasonality and microdistribution of the non-marine ostracods of Lake Zwai (Ethiopia) (Crustacea, Ostracoda). *Freshwat. Biol.* 25: 233–241.

MCKENZIE, K.G. 1977. Illustrated generic key to South African Continental Ostracoda. *Ann. S. Afr. Mus.* 74(3): 45–103.

MEADOWS, M.E., BAXTER, A.J. & ADAMS, T. 1994. The Late Holocene vegetation history of lowland fynbos, Verlorenvlei, Southwestern Cape Province, South Africa. *Histor. Biol.* 9: 47–59.

MEISCH, C. 1985. Revision of the Recent West European species of the genus *Potamocypris* (Crustacea, Ostracoda). Part II. Species with long swimming setae on the second antennae. *Trav. sci. Mus. Hist. nat. Luxemb.* 6: 95 pp.

MÜLLER, G.W. 1914. Süsswasserostracoden der Deutschen Südpolarexpedition 1901–1903. Nachtrag. In: Deutsche Südpolarexpedition 16 (zool. 8): pp. 67-78 (2nd Ed. 1921), (Ed.) Drygalski, E.V.

NOBLE, R.G. & HEMENS, J. 1978. Inland water ecosystems in South Africa — A review of research needs. South African National Scientific Programmes, Council for Scientific and Industrial Research, Pretoria, Report 34, 150 pp.

SARS, G.O. 1924. The freshwater Entomostraca of the Cape Province (Union of South Africa). Ostracoda. *Ann. S. Afr. Mus.* 20: 105–193.

SINCLAIR, S.A., LANE, S.B. & GRINDLEY, J.R. 1986. Estuaries of the Cape. Part II. Synopses of available information on individual systems. Report 32. Verlorenvlei (CW 13). Council for Scientific and Industrial Research, Pretoria, Research Report 431, 96 pp.

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