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On two new species of *Darwinula* BRADY & ROBERTSON, 1885 (Crustacea, Ostracoda) from South African dolomitic springs

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Abstract

Two new Recent darwinulid ostracods (*Darwinula molopoensis* spec. nov. and *D. inversa* spec. nov.) are described from dolomitic springs in the former North West Province (the former Transvaal), RSA. The two new taxa can be distinguished by both soft part and valve morphology. *Darwinula molopoensis* spec. nov. belongs to the *D. africana* lineage (with *D. inconspicua* KLIE as its closest relative), *D. inversa* spec. nov. belongs into the *D. serricaudata* group. The synonymy of *D. serricaudata espinosa* PINTO & KOTZIAN, 1961 with *D. serricaudata* KLIE, 1935 is discussed.
Key words: Ostracods, *Darwinula molopoensis* spec. nov., *Darwinula inversa* spec. nov., morphology, taxonomy, ancient asexuals, parthenogenesis, biodiversity.

Résumé

Deux nouvelles espèces d'ostracodes darwinulides Récents (*Darwinula molopoensis* spec.nov. et *D. inversa* spec.nov.) originaires des sources dolomitiques dans le North West Province (l'ancien Transvaal), RSA, sont décrites. Elles se distinguent par la morphologie des parties molles aussi bien que par celle de la valve. *Darwinula molopoensis* spec.nov. appartient à la lignée de *D. africana* (avec *D. inconspicua* KLIE comme espèce la plus étroitement apparentée, alors que *D. inversa* spec.nov. fait partie du groupe *D. serricaudata*. La synonymie des *D. serricaudata espinosa* PINTO & KOTZIAN, 1961 et *D. serricaudata* KLIE, 1935 est discutée.
Mots clefs: ostracodes, *Darwinula molopoensis* spec.nov., *Darwinula inversa* spec.nov., morphologie, taxonomie, anciens asexués, parthénogénèse, biodiversité.

Introduction

The Darwinulocopina are an ancient asexual group; no certain bisexual populations have been found at least since the end of the Cretaceous (70 million years - SOHN, 1988). Within this infraorder (see MARTENS 1992), one superfamily (the Darwinuloidea BRADY & NORMAN, 1889) and six families are recognized (MARTENS *et al.* in prep.); but the extant representatives belong to only one family, the Darwinulidae BRADY & NORMAN, 1889 and include two genera: *Microdarwinula* DANIELOPOL, 1968 (represented by only one extant species, *M. zimmeri*) and the nominate genus *Darwinula* BRADY & ROBERTSON, 1885. SOHN (1987) reported 23 living species and 2 subspecies for *Darwinula* (*D. dicastrii* LÖFFLER was missing from this list); among these species, only *D. stevensoni* can be considered truly ubiquitous.

Except for a few papers on *D. stevensoni* (MCGREGOR & WETZEL 1968, MCGREGOR 1969; RANTA, 1979), little is known on the biology and ecology of the Darwinuloidea. Also taxonomic relationships within this group remain unclear, in spite of valuable contributions by DANIELOPOL (1968, 1970, 1980). Indeed, the morphological uniformity of the Darwinuloidea makes it difficult to single out unequivocal characters suitable for discriminating species and genera. In addition, the minute size of the carapace in many species (L< 400 m) complicates dissection and subsequent analysis of soft parts.

Finally, extant taxonomic descriptions are often inadequate and sometimes faulty, which makes it impossible to establish the identity of existing nominal species.

The present contribution describes two new species from South Africa, but forms part of a wider investigation on the Darwinulidae, which aims to assess the extant diversity and morphological variability within this group (ROSSETTI *et al.*, 1996; ROSSETTI & MARTENS, 1996).

Abbreviations used in text and figures

Valves

Cp	carapace
H	height
L	length
LV	left valve
RV	right valve
ms	muscle scar(s)
dv	dorsal view
vv	ventral view
lv	lateral view
iv	internal view

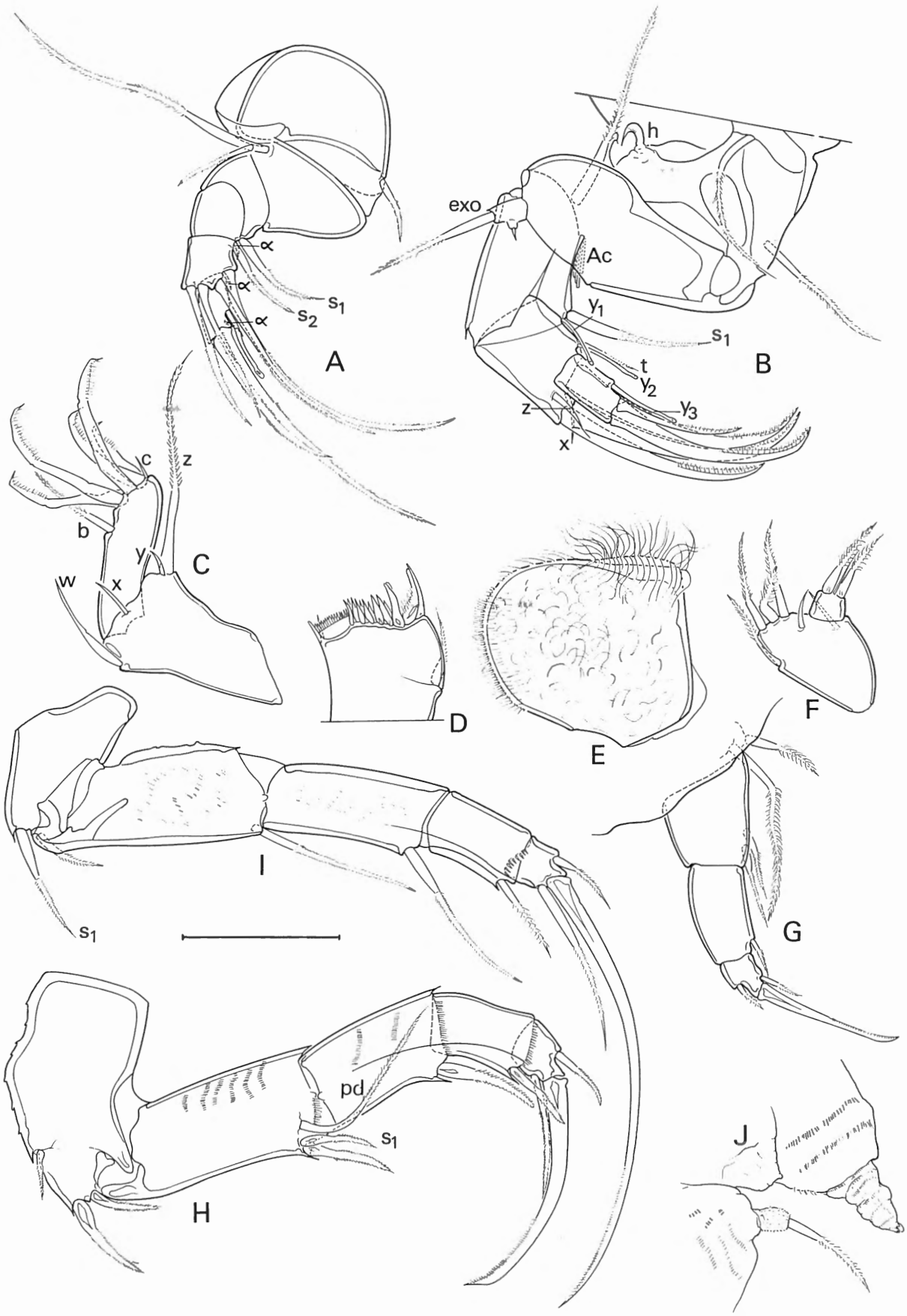

Fig. 1 – *Darwinula molopoensis* spec.nov. (Molopo, North West Province, RSA).
A. A1 (OC.2100). B. A2 (OC.2098). C. Md-palp (idem). D. Md, masticatory process (OC.2099). E. Labrum (OC.2098). F. Mx-palp (OC.2096). G. T1, endopodite (OC.2100). H. T2 (OC.2097). I. T3 (OC.2099). J. Fu and Abd (OC.2100). Scale = 49 µm for A-D, F-I; 42 µm for E, J.

Limbs and soft parts

A1	Antennula
A2	Antenna
Md	Mandibula
Mx	Maxillula
T1-3	thoracic limbs
Abd	(post-) abdomen
Fu	Furca
h	hook-like process on A2
exo	exopodite on A2
Ac	ventral aesthetasc clump A2
pd	'poil darwinuloïde'
s1,s2,t,w,x,y,z,alpha	specific setae on limbs
y1-3	aesthetascs

Nomenclature proposed by DANIELOPOL (1970), and adapted by ROSSETTI & MARTENS (1996) and ROSSETTI *et al.* (1996), is used in the description of chaetotaxy of soft parts. Recent evidence has shown that the maxilla is missing in Ostracoda and that there are three thoracopods (SMITH & MARTENS in prep., MEISCH in prep.). We will here adopt this view.

Taxonomic description

Class	Ostracoda LATREILLE, 1806
Subclass	Podocopa G.W. MÜLLER, 1894
Order	Podocopida SARS, 1866
Suborder	Podocopina SARS, 1866
Infraorder	Darwinulocopina SOHN, 1988
Superfamily	Darwinuloidea BRADY & NORMAN, 1889
Family	Darwinulidae BRADY & NORMAN, 1889

Remarks

The Darwinulocopina were described as a suborder by SOHN (1988), but lowered to the rank of infraorder, one of five within the suborder Podocopina, by MARTENS (1992). The taxonomic position of Darwinulocopina within Podocopina is discussed by ROSSETTI & MARTENS (1996).

Genus ***Darwinula*** (BRADY & ROBERTSON in JONES, 1885)
syn Polycheles BRADY & ROBERTSON, 1870
syn Darwinella BRADY & ROBERTSON, 1872

Darwinula molopoensis spec.nov.
(Figs. 1, 3H-N)

TYPE LOCALITY

Molopo Oog area, North West Province (former Transvaal), RSA. All specimens used for the present description were collected on 02.11.1993 by K. MARTENS from Marico River, near road to Groot- Marico, (station 216). Collected in riverine pools, amongst macrophytes and under rocks in strong rapids. Approximate coordinates: 25°46'40"S, 26°26'00"E; pH= 8.6, water temperature= 26°C, electrical conductivity (K25)= 250 S/cm.

TYPE MATERIAL

The holotype (with soft parts dissected in glycerine in a sealed slide and with valves stored dry) is lodged in the Albany Museum (Grahamstown, RSA)(no. AM-TDW-26A). The paratypes, including the figured specimens, are in the Ostracod Collection of the Royal Belgian Institute of Natural Sciences (Brussels) (nos. OC.2096-2109).

DERIVATION OF NAME

This species was named after the region where it occurs: the Molopo Oog area.

DIAGNOSIS

Medium-sized darwinulid. Cp enlarged in the posterior part (Figs. 3M,N). Valves short and quite high, LV overlapping RV on all sides; LV with a round anterior internal tooth (Fig. 3I), RV with a short posteroventral keel (Fig. 3J,K). A2 exopodite with one long seta and a short lateral spine; first segment of A2 endopodite carrying only one ventro-distal seta (Fig. 1B). Md-palp with seta *z* much longer than seta *y* (Fig. 1C). Fu and postabdomen present (Fig. 1J).

MEASUREMENTS

L= 478-519 µm (n=3); W= 240 µm (n=2); H= 240 µm (n=1).

ADDITIONAL DESCRIPTION

Shell with whitish, smooth surface covered with widely spaced setae. Cp egg-shaped, forming a brood chamber in the posterior part; seen dorsally, maximum width at about 4/5 of the length, posterior end broadly rounded, anterior more pointed; dorsal margin straight (Fig. 3I,J,L). In vv, margin of LV sinuous in anterior half (Fig. 3N). In lv, shell compressed and rather squarish; anterior end more narrowly rounded than posterior end and slightly sloping towards the ventral side; dorsal margin gently curved forward (Fig. 3L). Calcified inner lamellae absent. Hinge adont, but RV with a large groove, LV with corresponding smooth ridge (Figs. 3I,J). Central ms with 7-8 relatively large spots, arranged in a circular rosette (Fig. 3H). A1 (Fig. 1A). Uniramous, slender. Protopodite consisting of two segments, the first stout with one dorsal seta, the second bearing two unequal setae (one c. 3 times as long

as the other one) (= rudimentary exopodite ?). Endopodite four-jointed; first and second podomere with only one ventral seta each (s_1 and s_2); third podomere bearing four apical setae, two subequal, ventral setae and two longer ones in dorsal position; last podomere with a subapical aesthetasc and two long apical setae, the ventral one about half the length of the dorsal one; last three segments of endopodite with ventro-apical "alpha" setae.

A2 (Fig. 1B). Protopodite biarticulated, first segment with two setae and a ventral hook (*h*), second segment with one long seta. Exopodite (*exo*) with two setae, one apical and long, the other lateral and short, conical. Endopodite three-segmented; first podomere with a ventral aesthetasc clump (*Ac*) in proximal position and one seta (s_1) on the expanded ventro-apical corner; second podomere with two ventral aesthetascs (y_1 and y_2) and one short ventral seta (*t*), two subapical setae (*x* and *z*), and three distal claws; third endopodite short and slender, with one ventral aesthetasc (y_3) and two apical claws, one quite thin and about 2/3 of the length of the second one.

Md (Fig. 1C,D). Masticatory process typical of *Darwinula s.l.* Palp three-segmented, consisting of basis and two-segmented endopodite; basis typical of *Darwinula s.l.*, i.e. set with a fan of large respiratory (?) setae (not illustrated). First podomere of endopodite distally widened, with one external, subapical seta (*w*) and three apical setae: one median (*x*) about half the length of the external one, and two internal, one very short (*y*) and one long (*z*), the latter reaching tips of apical claws on the next segment; second podomere narrow, with five apically hirsute, unequal claws, one short internal seta (*c*), and a subapical external seta (*b*), length of the latter about 3/5 of the terminal segment.

Mx (Fig. 1F). Palp two-segmented; proximal segment with an external, subapical seta, three terminal setae (two straight and one curved, the latter shorter and plumose), and two short setae inserted on either side of the terminal segment; terminal segment small, with one thin median seta and two subequal, stout setae set with a double row of setulae.

T1 (Fig. 1G). Protopodite with two isolated, unequal setae close to the articulation with the endopodite. Three-jointed endopodite; first segment with two subapical setae; second segment with one subapical seta; third segment smaller, with two lateral, subequal setae and a strong terminal claw, the latter about four times the length of the last segment.

T2 (Fig. 1H). Protopodite one-segmented, rather stout, with three ventral setae, one short proximal and two long, unequal distal ones. Endopodite four-segmented; first segment with two unequal ventro-apical setae and one long seta (*pd*) slightly exceeding the tip of the next segment; second and third segment with one stout ventro-apical seta each; terminal segment short, with one strong apical claw, flanked by two subapical claws, the ventral longer than the dorsal one (length ratio c. 4:2:1).

T3 (Fig. 1I). Protopodite one-segmented, short, with two unequal ventro-apical setae (length ratio c. 5:3). Endopodite four-jointed; first segment with one distal seta approximately as long as the segment itself; second and third segments bearing one apical seta each, reaching beyond the tip of the next segment; fourth segment with a long, curved apical claw and two subapical setae, the ventral longer than the dorsal one (length ratio c. 13:5:2).

Fu (Fig. 1J) consisting of a broad, hirsute base, bearing a seta.

Abd (Fig. 1J) a conical, digitiform process (postabdomen).

DIFFERENTIAL DIAGNOSIS

Darwinula molopoensis spec.nov. belongs to the *D. pagliolii* lineage (ROSSETTI & MARTENS, in prep.) (not fully congruent with the *D. pagliolii* group in DANIELOPOL, 1980: 254) of the *D. africana* group; this lineage presently comprises the following extant species: *D. pagliolii* PINTO & KOTZIAN, 1961 (South America), *D. cuneata* KLIE, 1939 (East Africa), *D. inconspicua* KLIE, 1935 (West Africa), *D. marlieri* KISS, 1959 (East Africa) and *D. boteai* DANIELOPOL, 1970 (Europe), the latter found in interstitial waters.

The following main characteristics are shared by these species: small-medium size (0.42 - 0.52 mm); short and high valves; hinge adont, with large groove in RV, ridge in LV; LV > RV (mostly); RV with a short posteroventral keel and LV with one round internal anterior tooth (characters not recorded in type material of *D. cuneata*, probably due to valve decalcification); A2 exopodite with one long seta and one lateral spine; Md-palp with seta *z* much longer than seta *y* (seta *z* presumably broken in the original description of *D. inconspicua* (KLIE, 1935; fig. 52); furca and postabdomen present.

D. molopoensis spec.nov. can easily be distinguished from the above-mentioned species by both carapace shape and chaetotaxy of soft parts. The most remarkable differences are as follows: *D. pagliolii* has two setae at the ventro-distal corner of the first podomere of A2 endopodite (PINTO & KOTZIAN, 1961; pl. 4, fig. 3). *D. cuneata* has a ms rosette with many small spots, and short *b* and *z* setae on the Md-palp (KLIE, 1939; figs. 68, 71). *D. inconspicua* has relatively tapered valves in lv, A2 with long seta s_1, and Md-palp with long setae *x* and *y* (KLIE, 1935; figs. 49-52). *D. marlieri* is characterized by rather elongated valves in lv (KISS, 1959; figs. 1-2). Seen laterally, *D. boteai* has valves more slender than *D. molopoensis* spec.nov.; further differences can also be detected in the relative length of setae on the A1 (s_1 and s_2), A2 (s_1 and *z*), T2 (s_1) and T3 (s_1), Md-palp (*x* and *b*) and in the shape of Fu and Abd. Moreover, seta *t* of A2 appears to be wider in *D. boteai* (DANIELOPOL, 1970; figs. 1B-C, F; 2A, 2C-D, 3C-D).

Darwinula inversa spec.nov.
(Figs. 2,3A-G)

TYPE LOCALITY

Molopo Oog area, North West Province (former Transvaal), RSA. All specimens were collected by K. MARTENS on 01.11.93 from the dolomitic spring at Marico Oog (type

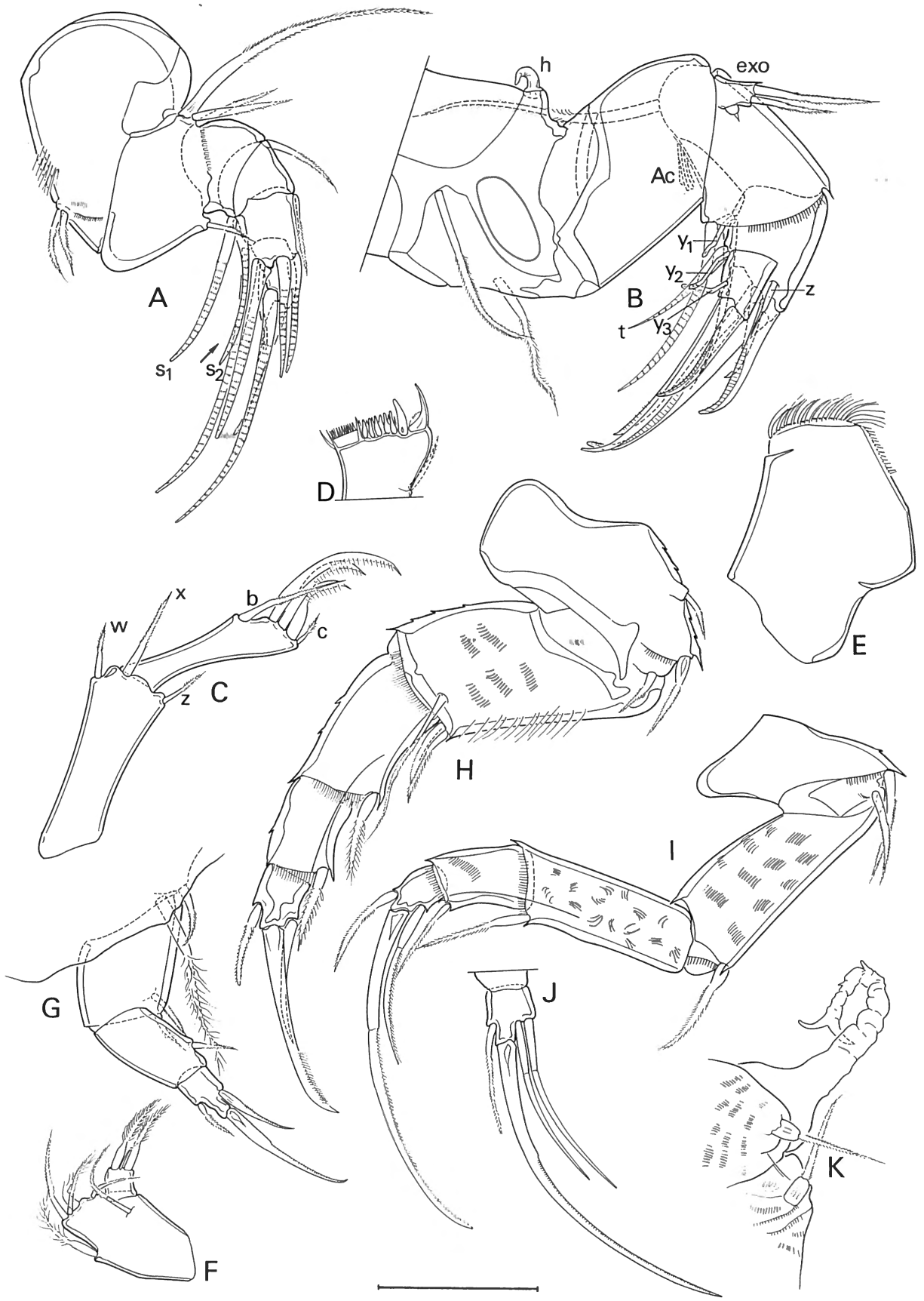

Fig. 2 – *Darwinula inversa* spec.nov. (Molopo, North West Province, RSA).
A. A1 (OC.2117). B. A2 (OC.2116). C. Md-palp (idem). D. Md, masticatory process (OC.2117). E. Labrum (idem). F. Mx-palp (OC.2116). G. T1, endopodite (OC.2117). H. T2 (idem). I. T3 (OC.2112). J. T3, aberrant form (OC.2116). K. Fu and Abd (OC.2112).
Scale = 49 µm for A-D, F-J; 42 µm for E, K.

locality), second eye (station 210) and on 10.11.1993 from Renoster Fontein (station 238). Station 210: approx. coordinates: 25°47'30"S 26°22'10"E, pH= 7.4, water temperature= 23°C, electrical conductivity (K25)= 240 S/cm. Station 238: approx. coordinates: 26°43'20"S 26°08'00"E, pH= 8.1, water temperature= 23°C, electrical conductivity (K25)= 514 S/cm.

TYPE MATERIAL

The holotype (with soft parts dissected in glycerine in a sealed slide and with valves stored dry) is lodged in the Albany Museum (Grahamstown, RSA) (no. AM-TDW-7A). The paratypes, including figured specimens, are in the Ostracod Collection of the Royal Belgian Institute of Natural Sciences (Brussels) (nos. OC.2110-2117).

DERIVATION OF NAME

The name derives from the latin word *inversus* (meaning "inverted", "turned to the opposite side"), and refers to the reversal of valve overlap with respect to *D. serricaudata* KLIE, 1935. For an assessment of the validity of this character, see discussion.

DIAGNOSIS

Medium-sized darwinulid. Cp elongate, with posterior part moderately enlarged. Valves unequal, with RV overlapping LV on all sides. Postero-ventral keel on RV and internal teeth in LV absent (Fig. 3A-C). A2 exopodite with two long setae and a short lateral spine (Fig. 2B). Md-palp with terminal segment bearing three distal claws and a small internal *c*-seta (Fig. 2D). Fu and postabdomen present (Fig. 2K).

MEASUREMENTS

L= 510-520 µm (n=3); W= 200-210 µm (n=2); H= 210 µm (n=1).

ADDITIONAL DESCRIPTION

Shell pearly white, smooth and covered with scattered, sparse setae. Cp slightly ovoid, posteriorly enlarged, forming a brooding chamber; in dv, maximum width 3/4 of the length, with pointed frontal side and broadly rounded posterior end (Fig. 3E); in vv, margin of RV sinuous in the first half (Fig. 3F); in lv, lanceolate in shape, anterior end more narrowly rounded than posterior end, ventral margin straight, dorsal margin gently sloping towards the front (Fig. 3D). Calcified inner lamellae absent. Hinge adont, groove in RV minute (Fig. 3B). Central ms with 6-7 spots arranged in a circular rosette (Fig. 3G).

A1 (Fig. 2A). Protopodite biarticulated; first segment with two dorsal setae; second segment with a distal, dorsal seta and, ventrally, with two short, subequal and one longer setae (= vestigal exopodite ?). Endopodite four-jointed; first and second segment wider than long, with one dorsal and one ventral seta each, the latter shorter; third segment with four distal setae, two ventral, subequal, and two dorsal, the latter longer; terminal segment narrow, with two apical setae, one about 5/8 the length of the other, and a long, subapical aesthetasc on the dorsal margin; all three "alpha" setae absent.
A2 (Fig. 2B). Protopodite biarticulated, proximal segment with two setae and a ventral hook, distal segment with a long seta. Exopodite with two apical setae, one 2/3 as long as the other one, and a short, lateral spine. Endopodite three-jointed; first podomere with a ventral group of aesthetascs (*Ac*) and two subequal setae on the expanded ventro-apical corner; second podomere bearing four distal claws of different length, one subapical seta (*z*) in dorsal position and, along the ventral margin, two aesthetascs (y_1 and y_2) and one seta (*t*); third endopodite with one ventral, subapical aesthetasc (y_3) and two terminal claws, one about 5/9 as long as the other one.
Md (Fig. 2C,D). Masticatory process typical of *Darwinula s.l.* Second segment of Md-palp with two short lateral setae (*w* and *z*) and one medial one (*x*), the latter twice as long as the former ones; setae *a* and *y* absent. Third segment with three apically hirsute, unequal claws, one short internal seta (*c*), and a subterminal external seta (*b*), the latter about 7/10 of the length of the segment.
Mx (Fig. 2F). Proximal segment of palp with an external, subapical seta, three terminal setae, two straight and one curved and plumose, and two setae inserted close to the articulation with the terminal segment, the distal one shorter than the proximal one. Terminal segment of palp with one thin median seta flanked by two stout setae distally provided with a double row of setulae, the latter more than twice as long as the former one.
T1 (Fig. 2G). Protopodite with two setae near the articulation with the endopodite, one short and one long, both plumose. Three-jointed endopodite; first segment with two subequal, subapical setae; second segment with one subapical seta; third segment with two lateral setae and a terminal claw (length ratio c. 3:6:10).
T2 (Fig. 2H). Strongly chitinized. One-segmented protopodite with a short, ventral seta and two subapical setae, one 3/5 as long as the other one. Endopodite four-articulated; first segment bearing two subequal, ventro-apical setae and a subapical seta (*pd*) slightly exceeding the next segment; second and third segments with one ventro-apical seta each; last segment provided with a strong terminal claw and two lateral setae, the ventral one longer than the dorsal one.
T3 (Fig. 2I). Strongly sclerotized, but more slender than T2. Protopodite one-segmented and short, with two ventro-apical setae. First three endopodial segments with one ventro-apical seta each; last segment bearing a long, curved terminal claw, and two subapical setae, one dorsal and one ventral, the latter longer.

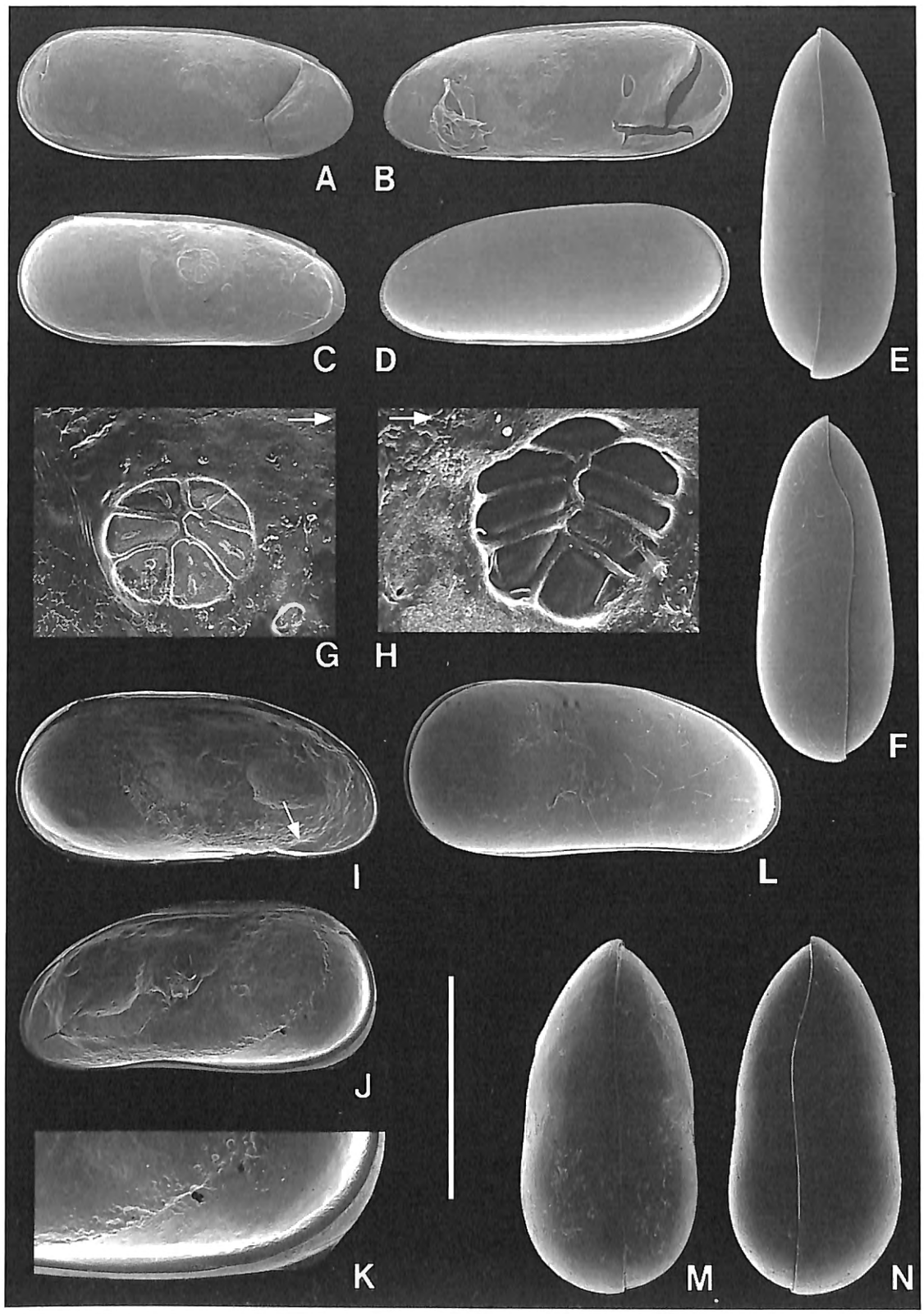

Fig. 3 – *Darwinula inversa* spec.nov. (A-G) and *D. molopoensis* spec.nov. (G-N). (Molopo, North West Province, RSA).
D. inversa. A. LV, iv (OC.2116). B. RV, iv (idem). C. LV, iv (OC.2117). D. Cp, left lv (OC.2115). E. Cp, dv (OC.2113). F. Cp, vv (OC.2114). G. LV, iv, detail central ms (OC.2117).
D. molopoensis. H. LV, iv, detail central ms (OC.2098). I. LV, iv (OC.2100). J. RV, iv (idem). K. RV, iv, detail ventro-caudal corner (idem). L. Cp, right lv (OC.2108). M. Cp, dv (OC.2105). N. Cp, vv (OC.2106).
Scale = 325 µm for A-F; 299 µm for I,J,L-N; 152 µm for K; 89 µm for G; 57 µm for H.

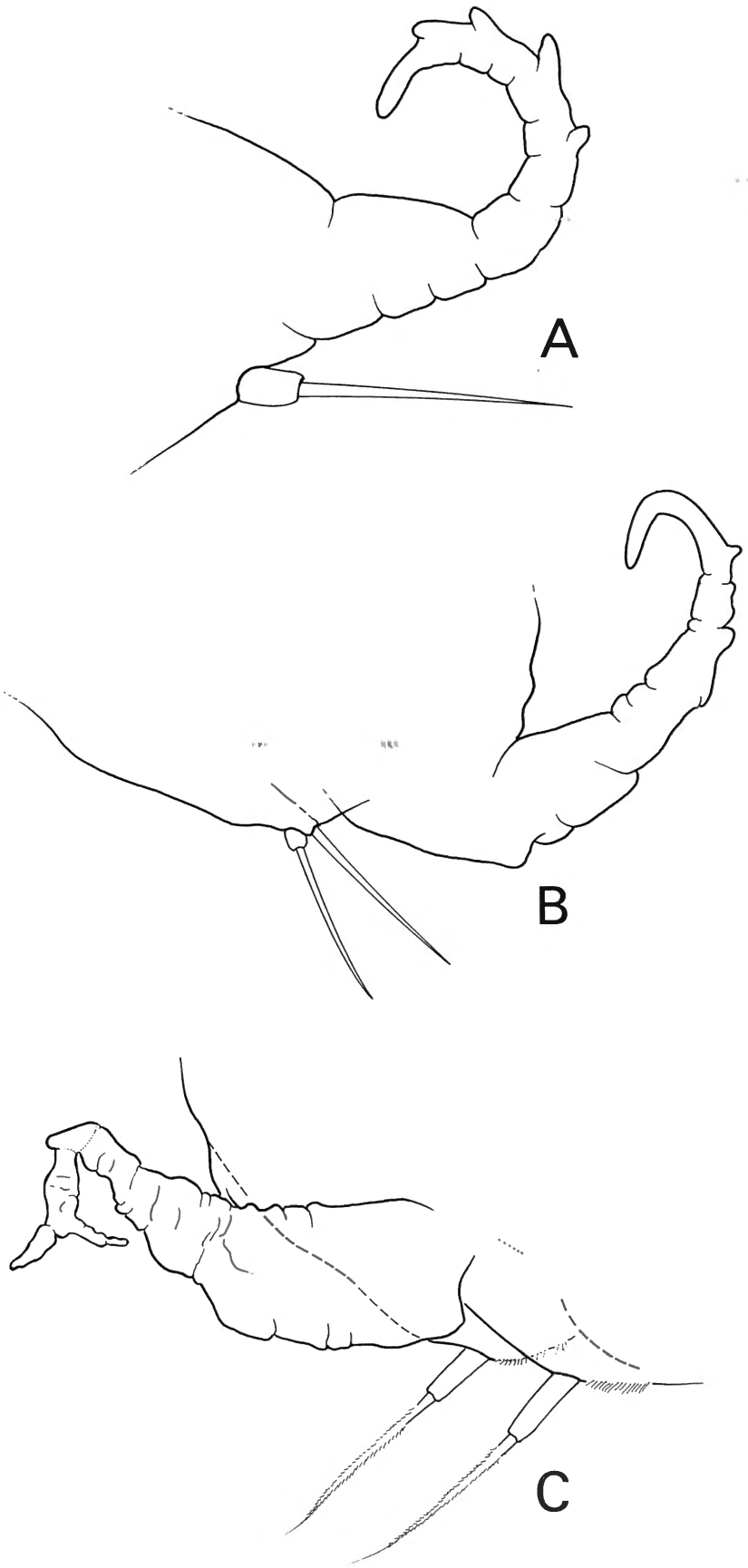

Fig. 4 – *Darwinula serricaudata* KLIE, 1935. Fu and Abd.
A. West Africa (redrawn after KLIE, 1935, fig. 44). B. Rio Grande do Sul, Brazil (redrawn after PINTO & KOTZIAN, 1961, plate 8, fig. 8). C. Paraibuna, RB, Brazil, 28.11.95 (original-GR227).
Drawings not to scale.

Postabdomen (Fig. 2K) long and elongate, curved and distally bifurcate, set with few (2-3) small spine-like expansions; furca with narrow base and elongate, hirsute distal seta.

REMARKS

One of the dissected adult females of *D. inversa* spec.nov. presented asymmetrical T3, one limb being normal and one aberrant, the latter with two subapical, ventral setae on the last endopodial segment (Fig. 2J). No differences from the normal form were observed in either remaining soft parts or valve shape.

Differential diagnosis and discussion

Characteristics of the D. serricaudata *lineage*

Darwinula inversa spec.nov. shows several analogies with other congeneric species which have been preliminarily grouped into the "*D. serricaudata* lineage" (ROSSETTI & MARTENS, in prep.). The new species shares the following features with *D. serricaudata* KLIE, 1935 (syn. *D. serricaudata espinosa* PINTO & KOTZIAN, 1961, see below) (West Africa, Brazil), *D. furcabdominis* KEYSER, 1975 (Florida, USA) and *D. lundi* NEALE & VICTOR, 1978 (Sri Lanka: small-medium size, 0.40 - 0.62 mm); generally elongate valves; penultimate segment of Md-palp without seta *y*; last segment with 3-4 terminal claws and one subapical seta (*b*); Fu present; postabdomen large and spinous.

Validity of reversed valve-overlap

Darwinula inversa spec. nov. can be distinguished from other species of the "*D. serricaudata* lineage" by the opposite valve overlap (LV > RV in other species of this group). The validity of valve overlap as a criterion for the delimitation of taxa in fossil and Recent Ostracoda is debatable. Occasional differences in symmetry of valve morphology (e.g. reversed presence of overlap and internal teeth) or in chaetotaxy of soft parts (see above) are not uncommon in individuals within darwinulid populations (ROSSETTI & MARTENS, 1996; ROSSETTI *et al.*, 1996). A good example is an aberrant specimen, amongst dozens of normal individuals, in a population of *D. brasiliensis* from Southern France, with reversed valve overlap AND with internal teeth, normally in LV, here in the RV (MARTENS *et al.* in prep.). Such occasional specimens with aberrant morphologies should generally not be allocated a taxonomic rank, as only genetically stable characters should be used as distinctive criteria for the identification of taxonomic categories. The observed variations could indeed also have an epigenetic basis (for instance, if a problem occurred during a moult) rather than being genetically induced. Note, however, that in obligate parthenogenetic lineages, such as the Darwinulidae (for an assessment of the occurrence of putative males in this group, see ROSSETTI & MARTENS (1996)), every individual represents an isolated *reproductive unit*, and genetically determined, non-disadvantageous morphological characters in a single individual can theoretically be transmitted to next generations. The consequences of such aberrant clonal individuals on the species concept in invertebrate asexual lineages and their nomenclature will be more extensively discussed elsewhere (MARTENS *et al.*, in prep.).
In other ostracod lineages, with both parthenogenetic and bisexual reproduction, this valve reversal is successfully used for delimitation of taxa, sometimes even at a generic level: the ostracod genera *Hemicypris* and *Heterocypris* in the subfamily Cyprinotinae are well-known examples in non-marine ostracods.
The taxonomic validity of valve reversals thus clearly depends on various factors and each situation should be assessed separately.

Taxonomic level of D. inversa

In the case of the new darwinulid specimens from Molopo Oog area, exclusively individuals with RV>LV have been found, and the reversed valve-overlap in these populations is thus a stable character, almost certainly genetically fixed and thus useful and sufficient to delimit a new taxon.
ENGHOFF (1976) argued against the use of the subspecific level in case of asexual lineages. The most relevant arguments for this are: (1) such lineages are fully reproductively isolated; (2) they do not comply with the requirements for geographical or ecological subspecies; (3) there are no (geographical or ecological) hybrid zones. The idea that many of these clonal lineages in Darwinulidae are geographically restricted is furthermore falsified. For example, there are no morphological differences between African and South American *D. serricaudata* (see below), and *D. africana brasiliensis* is now also found in Europe (as *D. brasiliensis* - MARTENS *et al.* in prep.).
Finally, an example similar to the present one, exists and can be taken as precedent. Whereas generally species in the *D. africana*-group have LV > RV overlap, LÖFFLER (1961) described *D. araucana* from Chile, with reversed valve overlap, as a separate species.
For the above reasons, we here allocate a specific rank to *Darwinula inversa* spec. nov.

Validity of D. serricaudata espinosa

Previous findings of *D. serricaudata* concern two regions, geographically distant from South Africa: West Africa (the type-locality of the nominate form - KLIE, 1935) and Brazil (as *D. serricaudata espinosa* - PINTO & KOTZIAN, 1961). The latter subspecies was distinguished from the nominate one on the basis of the following characters (PINTO & KOTZIAN, *loc. cit.*, p. 40): carapace smaller,

narrower and with a more tight curve at the anterior portion of both valves; without the ventral convexity on the RV; abdominal process more slender and with two or three spines (= furca?); only 3 so-called "teeth" on the external side of this process (KLIE 1935, fig. 44, described 4 such teeth).
Actually, the drawings of valves by KLIE (*loc. cit.*, figs. 40-42) seem quite approximate and this makes a decisive comparison with the valve outlines drawn by PINTO & KOTZIAN (*loc. cit.*, plate 4, figs. 1-4) difficult; moreover, the overall shape of valves is strikingly similar in both taxa. The so-called "teeth" are in fact small folds along the external margin of the postabdomen. These are thus quite variable and can therefore not be regarded as valid taxonomic characters (Fig. 2K, Fig. 4A-C).
In conclusion, there are no solid reasons to maintain *D. serricaudata espinosa* as a valid subspecies and it is here formally synonymized with *D. serricaudata s.s.*

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