

Anchialine Cyprididae (Ostracoda) from the Galapagos Islands, with a review of the subfamily Paracypridinae

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The five species of Cyprididae collected from anchialine habitats of the Galapagos Islands include *Paracypris crista*, previously described from marine caves and reefs on Bermuda, and the freshwater species *Strandesia stocki*, which is widely distributed in wells of the West Indies. Three new species, *Dolerocypris ensigera*, *Mungava recta* and *Hansacypris galapagosensis*, contribute to more precise understanding of these circumtropical genera. A review of known soft-anatomical characters for 68 species of Paracypridinae, five of which are transferred to different genera, reveals too many inconsistencies for a simple hypothesis. The current classification of Paracypridinae into three tribes and 18 genera may be overly subdivided, and elevation of Paracypridinae to family rank is not warranted.

KEY WORDS:—Anchialine – Cyprididae – Ostracoda – Galapagos – Paracypridinae.

CONTENTS

Introduction	1
Systematic descriptions.	3
Order Podocopida Sars, 1866	3
Superfamily Cypridacea Baird, 1845	3
Family Cyprididae Baird, 1845	3
Subfamily Paracypridinae Sars, 1923	3
Acknowledgements	25
References	26

INTRODUCTION

Thomas M. Iliffe's cave-diving expedition to the Galapagos Islands in 1987 yielded collections of 11 species of anchialine podocopid and platycopid Ostracoda, as well as myodocopid Ostracoda and many other interesting animals (Kornicker & Iliffe, 1989; Stock & Iliffe, 1990; Boxshall & Iliffe, 1990; Fosshagen & Iliffe, in press; Iliffe, in press). Anchialine habitats are "pools with no surface connection with the sea, containing salt or brackish water which fluctuates with the tides" (Holthuis, 1973). The faunal occurrences, descriptions of the habitats, and discussion of possible dispersal modes were presented in an earlier report (Maddocks & Iliffe, 1991), along with descriptions of the bairdiacean and cytheracean species. Two new species and genera of Pontocyprididae were analysed separately (Maddocks, 1991). Here the five

remaining species, belonging to the Family Cyprididae, are described. They include three new species of the tribes Thalassocypridini and Hansacypridini, which provide an occasion for re-evaluating relationships within the subfamily Paracypridinae.

Carapace structure, muscle-scar patterns, and appendage chaetotaxy show that there are three main branches of living Cypridacea: the families Macrocyprididae, Pontocyprididae and Cyprididae (Alm, 1916; Sars, 1923, 1925; Maddocks, 1969, 1979, 1990; Danielopol, 1976, 1978; Broodbakker, 1983). The extraordinary ecological adaptability of the Cyprididae, which have radiated into littoral, sublittoral, benthic reef, estuarine, fluvial, limnic, subterranean, and even terrestrial habitats, has encouraged some workers to elevate some of its members, such as the Paracypridinae, to family rank (Swain, 1961; Hartmann, 1964a; Hartmann & Puri, 1974, McKenzie, 1979, 1982). However, the three tribes (Paracypridini, Thalassocypridini, Renaudocypridini) of marine and brackish-water Paracypridinae are closely connected to the freshwater subfamilies Cyclocypridinae and Candoninae. Hartmann & Puri (1974) and Hartmann (1989) emphasized these affinities by uniting their subfamilies Candoninae, Cyclocypridinae, Paracypridinae, and Thalassocypridinae into one family Candonidae. Collectively, these five taxa span the freshwater-to-marine salinity gradient of the coastal zone, though from which direction the most recent invasion has come is not clear.

This 'Cyclocypridinae-Candoninae-Paracypridinae complex' (Danielopol, 1978: 26) displays patterns of mosaic and parallel evolution that defy analysis at present. Indeed, because until recently the number of well-described paracypridine species barely exceeded the number of generic names proposed (Maddocks, 1988: 55, table I), the existing genera have not been sufficiently well delineated to support a stable suprageneric classification. The controversy over taxonomic rank has been exacerbated by the tendency of ostracod workers to specialize ecologically, so that few workers have had the experience with both freshwater and marine faunas needed to evaluate the affinities of the Paracypridinae. World anchialine faunas, especially those targeted by Thomas M. Iliffe's expeditions, offer great taxonomic promise, but they are still very poorly known and will yet contribute many new paracypridine species. On the other hand, few fossil Paracypridinae other than *Paracypris* have been recognized, and there is some concern that the carapace characters on which fossil taxa must be recognized may be especially subject to iterative and convergent evolution (McKenzie, 1982).

A conservative strategy, for the present, is to forego new taxa until substantially more evidence is available and to make fuller use of such informal Linnaean categories as the tribe to portray relationships within the family. The three new anchialine species described here from the Galapagos Islands contribute important new information toward this goal, each helping to establish the integrity and scope of the genus to which it belongs.

In the following review, the existing three tribes and 18 genera of Paracypridinae are adopted provisionally, although the validity of a few is suspect. Table 1 is a compilation of selected anatomical information for 68 species of living Paracypridinae and revises the generic placement of five of these species. This reclassification produces five new combinations: *Aglaiella africana* (Scott), *Pontoparta eleotridis* (Harding), *Gerdocypris nipponica* (Okubo), *Hansacypris*

rara (Müller) and *Tasmanocypris westfordensis* (Benson & Maddocks). It also highlights numerous gaps and inconsistencies in our present knowledge, which must be resolved if we are to achieve a more satisfactory classification of Paracypridinae.

In Figs 1–5 homologous podomeres are numbered according to the scheme proposed by Maddocks (1976, 1979, 1988). Some minor discrepancies show that much additional analysis is needed.

SYSTEMATIC DESCRIPTIONS

Order Podocopida Sars, 1866

Superfamily Cypridacea Baird, 1845

Family Cyprididae Baird, 1845

Subfamily Paracypridinae Sars, 1923

1923 Group 1, Paracyprides, Sars: 69.

1958 Subfamily Paracypridinae Sars, Pokorný: 230; Morkhoven, 1926: 116; Hartmann & Puri, 1974: 59.

1961 Family Paracyprididae Sars, Swain: Q244; McKenzie, 1979: 32.

1964a Subfamily Candoninae Kaufmann, Hartmann: 561 (part); Hartmann, 1974: 354 (part).

1989 Tribe Paracypridini Sars, Hartmann: 799.

Discussion. Members of this subfamily share a compact, paracypridine adductor muscle-scar pattern, distinct yet homologous with the candonine and cyclocypridine scar patterns. Certain details and variations seem to typify smaller groups within the family, such as the divided cap-scar of Paracypridini or the k-shape of the thalassocypridine pattern. Although there are many inaccuracies in published scar patterns, this character complex may prove to be diagnostic of tribes and genus-groups and deserves more careful analysis.

Another character that has not been evaluated systematically is the fusion of podomeres in the antennule (see characters 9–11 of Table 1). Although most authors have described this as a seven-segmented limb, Müller (1894) and Maddocks (1976, 1979, 1988), on the basis of homologies with other Cypridacea and Podocopida, recognized eight podomeres. The first two are fused in diagonally overlapping, sleeve-like, stovepipe-angle fashion (see numbering of antennule podomeres on Figs 1–5). Podomere 3 may be articulated with podomere 2 at a flexible joint, or more often at an inflexible joint marked by a still-visible suture and setae. In a few cases, the suture grows obsolete, and then podomere 3 merges indistinguishably with the extension of podomere 2, or at least it seems so in some authors' drawings. The flexible elbow joint between podomeres 3 and 4 is regarded here as a fixed point of reference. Podomeres 4 and 5 are flexibly articulated originally, with a movable joint often represented as a double-line suture in drawings. In some lineages podomeres 4 and 5 fuse, giving an inflexible suture, which is often rendered as a single line in drawings. Finally the suture disappears and there is no line, but setae remain to mark its former position. In extreme cases, podomere 6 merges with the fused remnants of podomeres 4 and 5. In each instance these changes are associated with

TABLE 1. Selected anatomical characters of Paracypridinae

SPECIES:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
THALASSOCYPRIDINI:																							
Dol. bifurca	2	5	3	1	5	4	0	0	1	1	1	6	3	3	2	3	1	1	5	2	2	1	
Dol. elongata	4	5	3	1	5	4	0	0	1	1	1	5	3	3	2	2	1	1	5		2		
Dol. ensigera	3	4	3	1	5	3	0	0	1	1	1	4	3	3	1	2	1	1	5	2	2		
Dol. fastigata	3	5	3	2	5	4	0	0	1	1	1	5	3	3	1	1	1	1					
Dol. mukaishimensis				1	5	4	0	0	1	1	1	6	3	3	2	1	1	1				1	
Dol. taalensis*	4	5	3	2	5	4	1	1	1	1	1	6	3	3	1	3	1	1	5	2		1	
Mun. intermedia	2	2	1	1	3	3	4	0	1	1	1	6	1	3	1	2	1	1	5				
Mun. marthapuriae	2	1	1	1	5	4	5	0	1	1	1	6	2	3	1	1	2	1					
Mun. munda*	2	1	1	2	4	5	0	1	1	1	1	5	2	3	2	2	2	1	5	3			
Mun. papuensis	2	2	1	1	3	3	5	0	1	1	1	6	1	3	1	2	1	2	5				
Mun. recta	2	2	1	0	3	3	5	0	1	1	1	6	1	3	1	1	1	2	5	2	1	1	
Mun. riseri	1	2	1	2	4	3	5	0	1	1	1	6	1	3	1	1	1	2	5	2		1	
Pca. maryboroughensis	3	3	1	2	5	4	1	1				5	4	3	1	2	1	1					
Pca. minuta				3	4	4	0	0	1	1	1		2	2	1	3	1	1	5	3	2	1	
Pca. tenuis*	4	3	2	1	5	4	1	0	1	1	1	4	2	2	1	1	1	1	5	3	2	1	
Ppp. arcuata*	1	2	1	0	5	4	2	2	3	1	1	6	3	2	2	2	1	1	0	0	2	1	
Ppp. spicacarens	3	4	1	2	5	4	2	3	2	1	1	5	2	3	1	1	1	2	0	0	2	1	
Ppp. subcaerula	1	2	1	2	5	3	1	1	2	1	1	6	1	3	1	2	1	1					
Pon. eleotridis	1	2	1	2	5	4	1	0	1	1	1	6	2	3	2	1	1	1	5	3			
Pon. hartmanni	4	2	1	2	5	4	2	2	2	1	1	6	3	3	1	2	1	1					
Pon. rara*				1	5	4	1	1				6	3	2	2	1	1	1					
Pon. salina	1	1	1	1	5	4	1	1	3	1	1	6	4	3	1	1	1	1	5	3			
Tha. aestuarina*	4	3	2	1	5	4	0	0	3	1	1	6	2	3	1	3	1	1	5	3	2	1	
Tha. africana	0	0	0	0	5	4	0	0	3	1	1	6	3	3	2	3	1	1	5		2		
Tha. elongata	4	2	1	2	5	4	0	0	2	1	1	6	3	3	1	3	1	1	5		2	1	
Tha. gesinae	2	2	1	3	5	4	2	2	1	1	1	6	2	3	1	2	1	1				1	
Tha. inopinata	2	1	1	3	5	4	1	1				6	2	3	2	2	1	1	5		2	1	
Tha. inujimensis				2	5	4	1	1	1	1	1	5	2	3	1	2	1	1					
Tha. lacusola	4	2	1	3	5	4	3	3				5	4	3	2	3	1	1	5		1		
Tha. vavrai	2	2	1	2	5	4	2	2	1	1	1	6	2	3	2	3	1	1				1	
Tha. sp. YM	0	0	0	2	5	4	1	1	1	1	1	6	2	3	1	2	1	1	5	3	2		
RENAUDCYPRIDINI:																							
Han. aspera*	2	1	1	2	5	4	2	2	1	1	1	6	3	1	3	2	4	3	5				
Han. galapagosensis	1	1	1	3	5	4	2	2	1	1	1	6	2	2	3	1	4	1	5	3	2		
Han. glabra				3	5	4	2	2							2	2	4	3					
Han. natans				2	5	4	2	2	1	1	1	4	2	2	2	2	4	3					
Han. rara	1	1	1						2	2	1	5	5	2	3	1	5	1	5	3	1	1	
Han. sp. DB	2	1	1	2	5	4	1	1	1	1	1	6	3	2	2	2	4	3	5	3	1		
Han. sp. DL	0	0	0	2	5	5	2	2	1	3	1	4	4	2	3	1	5	1	5				
Ren. gorongae*	2	2	1	2	5	4	2	2	1	1	1	6	2	2	3	2	3	3	5	3		1	
Ren. luzonensis	1	1	1	3	5	4	3	2	1	1	1	6	3	2	2	2	3	3	5				
Ren. wolffi	1	1	1	3	5	4	3	2	1	1	1	4	3	2	2		3	3	5	3			
PARACYPRIDINI:																							
Agl. africana				3	5	4	0	0	2	1	1	6	4										
Agl. dietmarkeyseri	4	4	2	3	5	4	3	2	3	4	1	6	4	3	1	1	1	1					
Agl. kenmckenziei	4	3	1	2	5	4	0	0	3	3	1	6	4	3	1	1	1	1	6	3	2		
Agl. railbridgensis	4	3	2	3	5	4	1	1	2	1	1	4	4	3	1	2	1	1	7				
Agl. stagnalis*	3	1	2	2	5	4	2	2	3	1	1	6	4	3	2	2	1	1	5	3			
Agl. sp. DF	2	2	2	2	5	4	2	2	3	1	1	4	4	3	3	1	1	1	5	3	2		
Ags. pulchella*				3	5	4	3	3	1	1	1		5	3	2	2	1	1	7	2	1		
Ger. complanata	0	0	0	1	5	4	5	5	2	4	4		3	1	1	2	1				2		
Ger. eulitoralis				2	5	4	4	5	2	4	4	3	5	2	1	1	2	1					
Ger. muelleri*				2	5	4	3	3	1	3	1	3	5	2	2	1	3	1	5		1		
Ger. nipponica				2	5	4	3	5	2	4	4	5	5	2	2	1	2	1					
Ger. sp. VG	0	0	0	2	5	4	3	5	2	4	4	1	5	1	2	1	2	1	5	3			
Ger. sp. ZP	0	0	0	2	5	4	4	3	2	4	4	0	6	2	1	1	2	1	5	2			
Cor. corallicola*				2	4	5	1	1	1	4	4	2	4	2	2	2	5	1					
Cor. sp. DH				2	5	4	1	1	2	4	4	4	4	2	3	2	5	1					
Gha. mozambiquensis	1	1	2	0	5	4	1	1	2	3	1	5	4	2	2	2	1	1			1		
Gha. triebeli*	1	1	1	1	5	5	1	1	3	3	1	6	4	3	1	2	1	1	5	3	1		
Gha. sp. DD	1	1	3	2	5	4	2	2	3	3	1	5	4	3	1	2	1	1	7	3			
Pcs. bensoni	2	1	1	3	5	4	3	4	1	3	1	4	4	1	1	1	1	1	5	3	1		
Pcs. bradyi				2	5	5	1	1		3	1	1	4										
Pcs. crispa	0	0	0	1	5	4	1	1	2	2	1	5	4	2	3	1	5	1	5	2	1	1	
Pcs. polita*				3	5	4	4	4	2	2	1	3	4	2	3	1	5	1				1	
Phl. zealandica*				3	5	4	3	5	2	1	1	2	4	2	1	1	1	1	5	3			
Phl. cf. zealandica	1	1	2	0	5	4	1	1	3	2	1	4	4	2	1	2	1	1					
Tas. dartnalli*	3	3	2	3	5	4	3	1	2	3	1	5	4	3	2	2	2	1	5	3		1	
Tas. westfordensis	2	3	1	2	5	4	1	1	3	2	1	5	4	3	1	2	1	1	5	3			
Tri. laeva*	0	0	0	2	5	4	2	3	1	2	1	6	5	2	3	1	5	1	5	3			

Explanation of characters and character states for Table 1. For many species and characters, the evaluations of these characters are based on published illustrations and descriptions of varying levels of accuracy. Some judgements are subjective and might differ from those of the original author. Blanks indicate no information or insufficient information for a judgement, usually because the limb was not illustrated or because males have not been found.

Character 1, number of ray-setae on male fifth limb: 0 = none present; 1 = one ray; 2 = two rays, 3 = two rays on right limb and three rays on left limb; 4 = three rays.

Character 2, length of ray-setae on male fifth limb: 0 = absent; 1 = very short; 2 = short, just reaching terminal hook; 3 = medium length, reaching just past terminal hook; 4 = long, reaching beyond terminal hook; 5 = very long, reaching far beyond terminal hook.

Character 3, place of attachment of ray-setae on male fifth limb: 0 = rays are absent; 1 = at basal joint of hook; 2 = slightly behind basal joint of hook, or staggered so that margin is indented and setae arise at different points; 3 = set far back near base of podomere.

Character 4, length of seta 1 of furca: 0 = absent; 1 = very short, vestigial; 2 = short; 3 = short to medium length, 4 = long; 5 = very long.

Character 5, length of seta 2 (distal claw) of furca: as for character 4.

Character 6, length of seta 3 (proximal claw) of furca: as for character 4.

Character 7, length of seta 4 of furca: as for character 4.

Character 8, length of seta 5 of furca: as for character 4.

Character 9, antennule, podomeres 2 and 3: 1 = flexibly articulated; 2 = inflexibly articulated, with suture; 3 = fused, without suture, with seta, podomeres are distinguishable; 4 = fused, without suture, without seta, podomeres are indistinguishable.

Character 10, antennule, podomeres 4 and 5: as for character 9.

Character 11, antennule, podomeres 5 and 6: as for character 9.

Character 12, number of swimming setae on antenna (setae numbers 49–53 and 81 of Maddocks, 1976, 1979, 1988): 0 = none, 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 = 5, 6 = 6.

Character 13, length of longest swimming setae on antenna: 1 = very long, reaching far beyond tips of claws; 2 = fairly long, reaching beyond tips of claws; 3 = long, reaching to or almost to tips of claws; 4 = short; 5 = very short, present, vestigial; 6 = absent.

Character 14, podomeres 3 and 4 of seventh leg: 1 = flexibly articulated; 2 = inflexibly articulated, with suture and seta; 3 = fused, without suture, with seta.

Character 15, length of reflexed seta of seventh leg: 1 = very long, reaching almost to or beyond basal podomere; 2 = average length, reaching about to middle of podomere 2; 3 = short, reaching no farther than distal end of podomere 2.

Character 16, pectinate comb of reflexed seta of seventh leg: 1 = faintly pectinate, nearly smooth; 2 = average; 3 = coarsely pectinate with long or thick barbs.

Character 17, length of distal claw-seta of seventh leg: 1 = tiny, vestigial; 2 = short, thickened or slightly lengthened, distinct; 3 = medium length; 4 = long, approaching that of reflexed seta; 5 = very long, approaching that of sixth leg, exceeding that of reflexed seta.

Character 18, presence of scallops or bells on dorsal margin of podomeres 3 and 4 of seventh leg: 1 = absent, margin smooth; 2 = weakly developed; 3 = strongly developed.

Character 19, number of inner chitinous rosettes on Zenker's organ, not counting any terminal rosettes: 0 = none, no chitinous spikes present; 5 = 5 inner rosettes, not counting terminal rosettes of spikes if present; 6 = 6 (probably includes one terminal rosette); 7 = 7 (probably includes two terminal rosettes); 9 = whorls are too close together to count distinctly (probably 5 inner plus 2 terminal rosettes).

Character 20, length of chitinous spikes on Zenker's organ: 0 = absent; 1 = short; 2 = medium-sized; 3 = long.

Character 21, disposition of testes: 1 = looped in posterior region of body and in posterior vestibule, but not coiled; 2 = coiled in posterior vestibule.

Character 22, presence of fused eyes: 1 = present, 2 = absent.

List of species included in Table 1. In the table, 68 species of Paracypridinae are grouped into genera according to the character states shown. The inconsistencies suggest that no singular solution is possible at present. Type species of genera are designated by an asterisk (*). Abbreviations of generic names: Dol. = *Dolerocypris*, Mun. = *Mungava*, Pca = *Paracypris*, Ppp. = *Parapontoparta*, Pon. = *Pontoparta*, Tha. = *Thalassocypris*, Han. = *Hansacypris*, Ren. = *Renaudocypris*, Agl. = *Aglaiella*, Ags. = *Aglaiocypris*, Ger. = *Gerdocypris*, Cor. = *Coralliaglaia*, Gha. = *Ghardaglaia*, Pcs. = *Paracypris*, Phl. = *Phlyctenophora*, Tas. = *Tasmanocypris*, Tri. = *Triangulocypris*.

Below, these species are listed alphabetically by the trivial part of the species name, with original and subsequent generic assignments. In cases where authors have described conflicting characters for the species, the authority followed here is specified.

Thalassocypris aestuarina Hartmann, 1957; El Salvador.

Phlyctenophora africana T. Scott, 1894; transferred to *Paracypris* by Müller (1912); reclassified here in *Aglaiella*; Angola.

Thalassocypris africana Hartmann, 1974; Mozambique.

Parapontoparta arcuata Hartmann, 1955; Brazil.

- Hansacypris aspera* Wouters, 1984; Papua New Guinea.
Paracypris bensoni Maddocks, 1988; western Atlantic Ocean.
Dolerocypris bifurca Maddocks in Maddocks and Iliffe, 1986; Bermuda.
Paracypris bradyi McKenzie, 1967, as partially redescribed by Maddocks (1988); south-eastern Australia.
Aglaia complanata Brady and Robertson, 1869, as described by Müller (1894); transferred to *Paracypris* by Müller (1912); cited in *Aglaioocypris* by Reys (1961); may be a senior synonym of *Gerdocypris muelleri* McKenzie, 1983; transferred to *Gerdocypris* by McKenzie (1983); Gulf of Naples.
Coralliaglaia corallicola Hartmann, 1974; Tanzania.
Paracypris crispa Maddocks in Maddocks and Iliffe, 1986; partly redescribed by Maddocks (1988); Bermuda, Galapagos Islands.
Tasmanocypris dartinalli McKenzie, 1979; Tasmania.
Aglaiaella dietmarkeyseri Hartmann, 1979; south-western Australia.
Paracypris eleotridis Harding, 1962; reclassified here in *Pontoparta*: Solomon Islands.
Thalassocypris elongata Hartmann, 1957; El Salvador.
Thalassocypris elongata Hartmann, 1955; transferred to *Dolerocypris* by Keyser, 1975; Brazil.
Dolerocypris ensigera Maddocks, n. sp.; Galapagos Islands.
Aglaioocypris eulitoral Hartmann, 1974; transferred to *Gerdocypris* by McKenzie (1983); Angola.
Dolerocypris fastigata Keyser, 1975; Florida Everglades.
Hansacypris galapagosensis Maddocks sp. nov.; Galapagos Islands.
Thalassocypris gestnae Keyser, 1975; Florida Everglades.
Hansacypris glabra Wouters, 1894; Papua New Guinea.
Renaudocypris gorongae McKenzie, 1980; Gorong Island, Indonesia.
Pontoparta hartmanni Keyser, 1975; Florida Everglades.
Dolerocypris inopinata Klie, 1939a, as reinterpreted by Klie (1939b); Bonaire, Curacao, Aruba.
Mungava intermedia Wouters, 1987b; Papua New Guinea.
Thalassocypris inujimensis Okubo, 1980; Japan.
Aglaiaella kenmckenziei Hartmann, 1974; Angola.
Thalassocypris lacusola Hartmann, 1980; southeastern Australia.
Bythocypris laeva Puri, 1960; transferred to *Triangulocypris* by Tectter (1975), which was moved from Bairdiidae to Cyprididae-Paracypridinae by Maddocks and Kornicker (1986; see also Maddocks, 1988); Belize, Bermuda.
Renaudocypris luzonensis Wouters, 1986; Lake Taal, Luzon, Philippine Islands.
Mungava marthapuriae Keyser, 1975; Florida Everglades.
Paracypris maryboroughensis Hartmann, 1981; eastern Australia.
Paracypris minuta McKenzie, 1968; south-eastern Australia.
Ghardaglaia mozambiquensis Hartmann, 1974; Mozambique.
Dolerocypris mukaishimensis Okubo, 1980; Japan.
Gerdocypris muelleri McKenzie, 1983; may be a junior synonym of *Aglaia complanata* Brady and Robertson (according to McKenzie, 1983); Bay of Naples.
Mungava munda Harding, 1962; and as redescribed by Wouters (1987b); Solomon Islands, Comoros Islands.
Renaudocypris natans Hartmann, 1984; redescribed and transferred to *Hansacypris* by Wouters (1986); Tuamotu Islands.
Aglaioocypris nipponica Okubo, 1980; reclassified there in *Gerdocypris*; Japan.
Mungava papuensis Wouters, 1987b; Papua New Guinea.
Paracypris polita Sars, 1866, as redescribed by Sars (1923); North Sea and north-east Atlantic Ocean.
Aglaia pulchella Brady, 1868b; according to the description of *Aglaia* by Brady and Norman (1889: 94); transferred to *Paracypris* by Müller (1912); the type species of *Aglaioocypris* Sylvester-Bradley, 1947; Sicily. Comments by McKenzie (1979, 1982, 1983, and personal communications) indicate that he has seen the types and that this mysterious Mediterranean species is closely related to *Ghardaglaia triebeli*. Most other species referred to *Aglaioocypris* probably belong to other genera. It will be essential both to redescribe the type specimens of this species and to collect new living material for description of the soft parts, if *Aglaioocypris* is to be established as a valid genus. If this is not possible, or if such an analysis upholds the synonymy with *Ghardaglaia*, it would be preferable to set aside the species name as a *nomen oblitum* and the genus name as a *nomen dubium*, so that the more precisely defined junior names may be used.
Aglaiaella railbridgensis Benson and Maddocks, 1964, as redescribed by Hartmann, 1974; South Africa.
Aglaia rara Müller, 1894; transferred to *Paracypris* by Müller (1912); cited in *Aglaioocypris* by Reys (1961); reclassified here in *Hansacypris*: Bay of Naples.
Pontoparta rara Vávra, 1901; Bismark Archipelago.
Mungava recta Maddocks sp. nov.; Galapagos Islands.
Mungava riseri Maddocks, 1979; Panama.
Pontoparta salina Harding, 1955; Siwa Oasis of Libya.
Parapontoparta spicacarens Maddocks and Steineck, 1987; Gulf of Panama.
Aglaiaella stagnalis Daday, 1910; Egypt.
Parapontoparta subcaerulea Keyser, 1975; Florida Everglades.
Dolerocypris taalensis Tressler, 1937, as redescribed by Wouters (1987a); Philippines, Papua New Guinea, Solomon Islands.

- Paracypris tenuis* Sars, 1905; transferred to *Paracypria* by Sars (1910); and as redescribed by McKenzie (1979); Chatham Islands, also reported by Hartmann (1980) from south-eastern Australia.
- Ghardaglaia triebeli* Hartmann, 1964b; Red Sea, Gulf of Aqaba, Persian Gulf.
- Thalassocypris vavrai* Keyser, 1975; Florida Everglades.
- Paracypris westfordensis* Benson and Maddocks, 1964; rejected from *Paracypris* by Maddocks (1988); reclassified here in *Tasmanocypris*; South Africa.
- Pontoparta wolffi* Harding, 1962; and as redescribed and transferred to *Renaudocypris* by McKenzie (1980) and Wouters (1984); Solomon Islands and Papua New Guinea.
- Phylctenophora zealandica* Brady, 1880, as described by Brady; transferred to *Paracypris* by Müller (1912); New Zealand.
- Phylctenophora* cf. *zealandica* Brady, 1880, of Hartmann (1978); western Australia.
- Sp. DB of Maddocks, 1966; Nosy Be, Madagascar.
- Sp. DD of Maddocks, 1966; Nosy Be, Madagascar. This species is probably identifiable with or closely related to *Ghardaglaia triebeli*.
- Sp. DF of Maddocks, 1966; Nosy Be, Madagascar. This species is related to *Aglaiocypris* sp. of Babinot and Kouyoumontzakis (1986: 9) from Angola. It may also be related to the mysterious *Paracypris ovalis* Brady, 1868b, which Howe and McKenzie (1989, p. 8) indicated ought to be the type of a new genus.
- Sp. DH of Maddocks, 1966; Nosy Be, Madagascar.
- Sp. DL of Maddocks, unpublished; Nosy Be, Madagascar.
- Sp. VG of Maddocks, unpublished; reported as *Aglaiocypris* sp. by Maddocks (1974); Flower Gardens, Gulf of Mexico. The delicate reticulate microornament of this species (visible in transmitted light) resembles that described for some species of *Renaudocypridini* by Wouters (1984).
- Sp. YM of Maddocks, unpublished; reported as *Thalassocypris* sp. by Maddocks and Kornicker (1986); Bermuda.
- Sp. ZP of Maddocks, unpublished; Bermuda.

adaptation to benthic or interstitial life. Though subject to evolutionary parallelism, these trends are not likely to be reversible and may prove useful to reconstruct cladistic sequences.

The length of terminal setae on the antennule, which is sometimes emphasized in earlier descriptions, generally is correlated with the length of the antennal swimming setae and the mode of life. It is considered here not to have taxonomic significance above the species level, and is not included in Table 1.

Independently podomeres 3 and 4 of the seventh limb may fuse, and the disappearance of this joint, and of the suture marking its position, provides another useful character (character 14 of Table 1). It should be emphasized that the reflexed seta is invariably pectinate, with a comb of very fine to coarse barbs, although frequently these are too tiny to be represented in drawings of this limb.

Tribe Paracypridini Sars, 1923

1974 Tribe Paracypridini Sars, Hartmann: 355; Hartmann, 1989: 799.

1974 Subfamily Paracypridinae Sars, Hartmann & Puri: 59 (including tribes Aglaiellini and Paracypridini); McKenzie, 1979: 32; McKenzie, 1982: 416–418; Maddocks, 1988: 53–55, table 1.

Discussion. Paracypridini have elongate, well-calcified carapaces with broad marginal fused zones and more or less elaborate radial pore canals. These features reflect the benthic habit and near-normal marine salinities preferred. The soft anatomy is known at least in part for at least one species of each of the following genera: *Aglaiella* Daday, 1910; *Coralliaiglaia* Hartmann, 1974; *Gerdocypris* McKenzie, 1983; *Ghardaglaia* Hartmann, 1964b; *Paracypris* Sars, 1866; *Phylctenophora* Brady, 1880; and *Tasmanocypris* McKenzie, 1979. The genera *Aglaiocypris* Sylvester-Bradley, 1947, *Triangulocypris* Teeter, 1975, and *Novocypris*

Ducasse, 1967 (see Maddocks, 1990), which are defined on carapace features, belong here as well.

Paracypris Sars, 1866

1866 *Paracypris* Sars: 11; Brady, 1868; Sars, 1923: 69; Maddocks, 1988: 55.

Discussion. Maddocks (1988) reviewed 130 species referred to *Paracypris*, concluding that only seven living and eight fossil species are validly classified there. To that list should be added *Paracypris* sp. of Hartmann (1962: 176; Playa de Algarrhobo, near Valparaiso, Chile). The male anatomy is known as yet only for *P. bensoni* and *P. crispa*.

Paracypris crispa Maddocks & Iliffe, 1986

(Fig. 1A–F, 6A–B, 8J, 9)

1986 *Paracypris crispa* Maddocks & Iliffe: 67, fig. 17A–M; Maddocks, 1988: 62, fig. 4H, I.

Material. Twenty-three specimens in alcohol, including 19 females and four juveniles; USNM 193869–193870.

Occurrence. In sample 87–017, Cueva de la Cadena, Puerto Villamil, Isla Isabela, 31 May 1987; collected with 93 µm mesh plankton net from water column and surface sediments in 0 to 1 m in depths.

Distribution. *Paracypris crispa* is fairly common in anchialine caves and in lagoonal and reefal environments of the Bermuda platform. It has been searched for but not yet seen in reefal sediments of Florida, Belize, the West Indies, and the Gulf of Mexico. A somewhat similar species of about the same size is present in the Florida Keys, but that species is proportionally higher, with a more broadly rounded anterior margin and a more acutely pointed, down-turned posterior angle. A third, larger species, more closely related to *P. bensoni*, is living in the western Gulf of Mexico.

Dimensions. Illustrated female 3069F before dissection, L 0.71 mm, H 0.29 mm. See also Fig. 9.

Discussion. These specimens are identical with the Bermuda population, and some additional details may be added to the anatomical description of the species. The seta arising underneath the knee of podomere 1 of the seventh limb is smooth, lacking the fish-hook of *P. bensoni*. The furcal support is fairly straight with one triangular dorsal branch. In paragraph 2, line 4 of the original description of this species (Maddocks & Iliffe, 1986: 67), the sentence beginning ‘Recurved seta of sixth limb . . .’ should read ‘seventh limb’.

Paracypris sp. of Hartmann (1962) is much larger than *P. crispa* with more broadly rounded anterior margin, more acutely pointed posterior angle, more elaborately branching radial pore canals, and shallower anterior vestibule.

Tribe Thalassocypridini Hartmann & Puri, 1974

1974 Subfamily Thalassocypridinae Hartmann & Puri: 60; McKenzie, 1979: 32; Maddocks & Steineck, 1987: 347.

Discussion. McKenzie (1979: 33) suggested that Thalassocypridini “evolved from ‘Paracypridini’ and represent a continuing continental invasion by

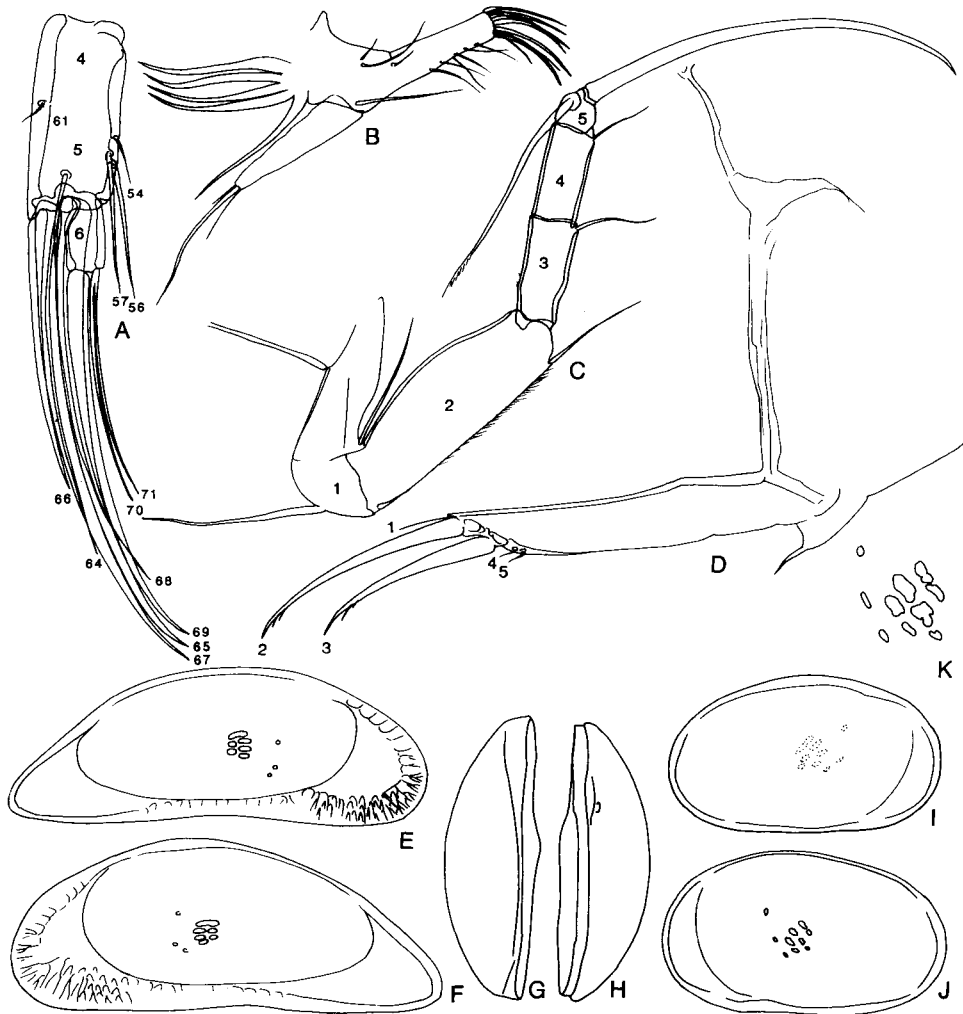


Figure 1. *Paracypris crispa* Maddocks, female specimen 3069F. A, Distal part of antenna; B, female fifth limb; C, seventh limb; D, posterior region of body with furca, furcal support, and postabdominal bristle (all $\times 320$); E, F, exteriors of right and left valves ($\times 77$) *Strandesia* (*Neocypris*) *stocki* Broodbakker, female specimen 3066F. G, H, Dorsal views of left and right valves; I, J, exteriors of right and left valves (all $\times 45$); K, left exterior adductor muscle-scar pattern, with one frontal and two mandibular scars ($\times 77$).

descendants of that older stock". Most Thalassocypridini live in oligohaline to polyhaline waters and can swim actively, in contrast to the mostly euhaline, bottom-crawling Paracypridini. The weakly calcified carapace with narrow marginal fused zone and simple, inconspicuous radial pore canals is responsive to this change of habit and, therefore, may not have much phyletic significance. Likewise, the missing fossil record of thalassocypridines is probably a result of the fragile carapace and does not necessarily imply recent origin.

At present the Thalassocypridini comprise six genera, whose mutual relationships remain somewhat unclear (Table 1): *Dolerocypris* Tressler, 1937;

Mungava Harding, 1962; *Paracypria* Sars, 1905; *Parapontoparta* Hartmann, 1955; *Pontoparta* Vávra, 1901; and *Thalassocypria* Hartmann, 1957 (Hartmann, 1974; Keyser, 1975; McKenzie, 1979). Of these, all except perhaps *Paracypria* and *Pontoparta* appear to be circumtropical. Keyser's placement of *Thalassocypris* Hartmann 1955, in synonymy with *Dolerocypria* seems well founded, although the type species, *Ts. elongata*, ought to be redescribed.

Dolerocypria Tressler, 1937

1937 *Dolerocypria* Tressler: 200.

1955 *Thalassocypris* Hartmann: 114 (*vide* Keyser, 1975).

Discussion. The stiff rays on the male fifth limb of *Dolerocypria* are homologous with the so-called pegs (clublike modified setae) that arise at the ventrodistal corner of the palp of other cypridaceans. Wouters (1987a: 131) claimed that "These structures are not real setae, but membrane-like appendages, covered with very fine and short setules. The true nature and function of those structures remain unexplained". This is an accurate description of their external appearance, but it misses an essential point: that an individual seta at any particular location may change its size, shape and function without thereby losing its identity for purposes of homology (Maddocks, 1976, 1979, 1988, 1990). Danielopol (1978), Schornikov (1980) and Maddocks (1990) have offered hypotheses showing how the female fifth limb of podocopid ostracods is transformed into the so-called male clasping apparatus and designating homologous podomeres and setae. Although these hypotheses differ in some details, they agree in identifying the sensory setae of the male limb as modified homologues of the simple setae of the female limb. The sensory seta of the tip of the male hook appears to be equivalent to the terminal claw of the female limb, and the three pegs and small setae at the ventrodistal corner of the penultimate segment appear to correspond to ventrodistal setae of podomeres 2–4 of the female limb. (These podomeres are fused and not separately recognizable in Cyprididae but are discernible in the more primitive Macrocyprididae.)

In one branch of Thalassocypridini (*Mungava*, *Parapontoparta*, *Pontoparta*, most *Thalassocypria*) these triangular pegs remain small or grow even smaller and may be reduced in number. In another branch (*Dolerocypria*, *Paracypria*, *Parapontoparta spicacarens*, *Thalassocypria aestuarina*) these pegs are modified into flat, stiff, triangular or ribbonlike, nearly transparent rays of varying length. Wouters (1987a) described them as "entirely covered by very short, minute spinules", which indicates a sensory function. A similar hirsute texture is found in the hypertrophied terminal sensory seta of *Paracypris bensoni*. In Fig. 2E the flared contours of one of these rays suggest a vestige of the division between basal shaft and terminal blade of a simple seta. Table 1 summarizes the number, relative length, and point of attachment of these rays in 30 species of Thalassocypridini. There is evidence for a continuous scale of development, even though the difficulty of studying this transparent structure and the differing artistic styles of published illustrations require caution in interpretation. It is logical to conclude (Wouters, 1987a) that these rays represent a synapomorphy uniting these genera into a closer unit within the Thalassocypridini; however, they are not confined to that tribe. Less elongate but equally hirsute rays have been illustrated for four

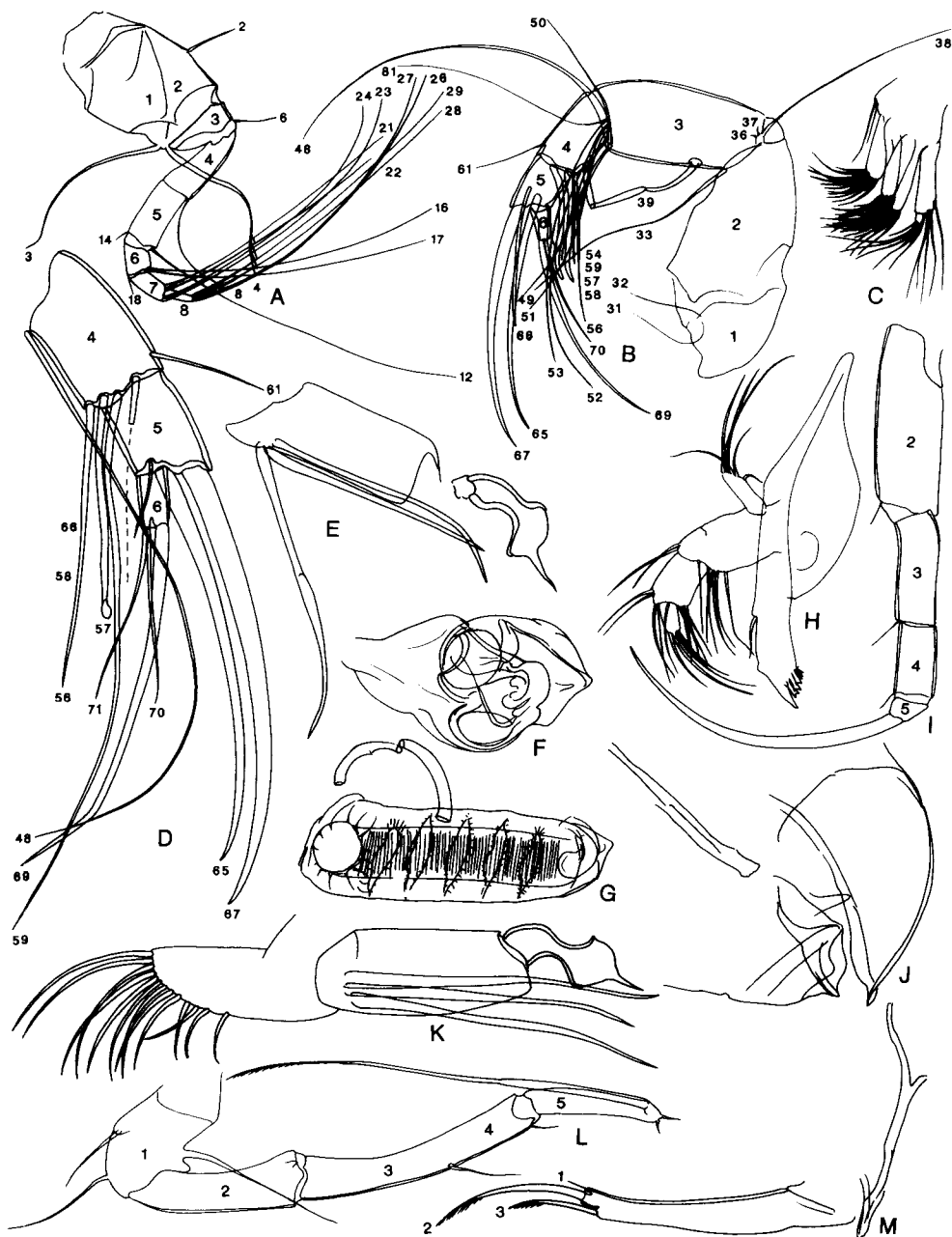


Figure 2. *Dolerocypria ensigera* Maddocks **sp. nov.** A–H, Male specimen 3077M; I, female specimen 3078F. A, Antennule; B, antenna; C, maxillule palp and masticatory processes (all $\times 320$); D, distal podomeres and setae of other antenna; E, palp of male fifth limb, with distal hook and three rays (all $\times 578$); F, hemipenis; G, Zenker's organ and part of vas deferens; H, mandible; I, sixth limb; J, mouth region, with hypostome and labrum (all $\times 320$); K, entire other male fifth limb, with three rays (vibratory plate not seen) ($\times 578$); L, seventh limb; M, furcal support and furca (all $\times 320$).

species of Paracypridini: *Aglaiella dietmarkeyseri*, *Aglaiella kenmckenziei*, *Aglaiella railbridgensis* and *Tasmanocypris dartnalli*.

The existence of proximal setae on the furca, which would be homologues of setae 4 and 5 of other Paracypridinae, has been the subject of debate. The conflicting statements by reliable authors show that these setae are vestigial structures, variable in their expression, that they are often too tiny to be drawn accurately to scale when present, and that they are missing entirely in many individuals, populations and species.

***Dolerocypris ensigera* sp. nov.**

(Figs 2, 6C–F, 8A–B, 9)

Derivation of name. Latin *ensiger*, sword-bearing; to describe the stiff rays on the fifth limb.

Material. Five specimens in alcohol, including one male, three females, and one juvenile.

Types. Holotype male 3077M USNM 193871, paratypes USNM 193872–193873.

Type locality. Grieta north of trail to Tortuga Bay, Puerto Ayora, Isla Santa Cruz; sample 87–021a, 18–19 June, 1987, specimens collected with 93 µm mesh plankton net from water column and root masses above halocline in 0 to 5 m depths.

Occurrence. In sample 87–021a, five specimens.

Dimensions. Holotype male 3077M, before dissection, L 0.59 mm, H 0.23 mm. The single male is slightly smaller than the females. See also Fig. 9.

Diagnosis. Carapace medium-sized, weakly calcified, translucent white; elongate-subtriangular in lateral view, with obscurely dorsal margin, narrowly and unequally rounded anterior margin, stepped ventral margin, and abruptly truncate posterior angle; elongate in dorsal view with narrowly tapering sides. Antennule fairly robustly proportioned, with most podomeres not more than half again as long as broad, with distal setae no longer than the ramus itself; antenna fairly slender, with short distal claws, swimming setae present but of only moderate length, not quite reaching tips of antennal claws; seventh limb with slender reflexed seta reaching almost to podomere 1, delicately pectinate at tip, other distal setae very tiny; furca with tiny distal seta, a long, slender, tapering claw and a shorter, tapering claw, both claws pectinate. Zenker's organ with five inner chitinous rings, the radial spokes of which are visible but short. Male hemipenis compact, fusiform in overall shape, with indented outline and angulate distal tip, with arched copulatory tube and short, blunt accessory lamella. Testes coiled against posterior valve surface and within posterior vestibule; strands of testes and seminal vesicle extending forward around anterior vestibule. Ovaries form a single loop against the posterior valve surface. Conspicuous reddish-brown eye.

Discussion. *Dolerocypris ensigera* is very similar to the type species, *D. taalensis*, recently redescribed by Wouters (1987a). The carapace is similar in dimensions and shape but may have a slightly more elongate posterior angle. The distal podomere of the antennule is smaller; the antennal podomeres are more elongate with longer terminal claws and shorter swimming setae; the sixth limb has less

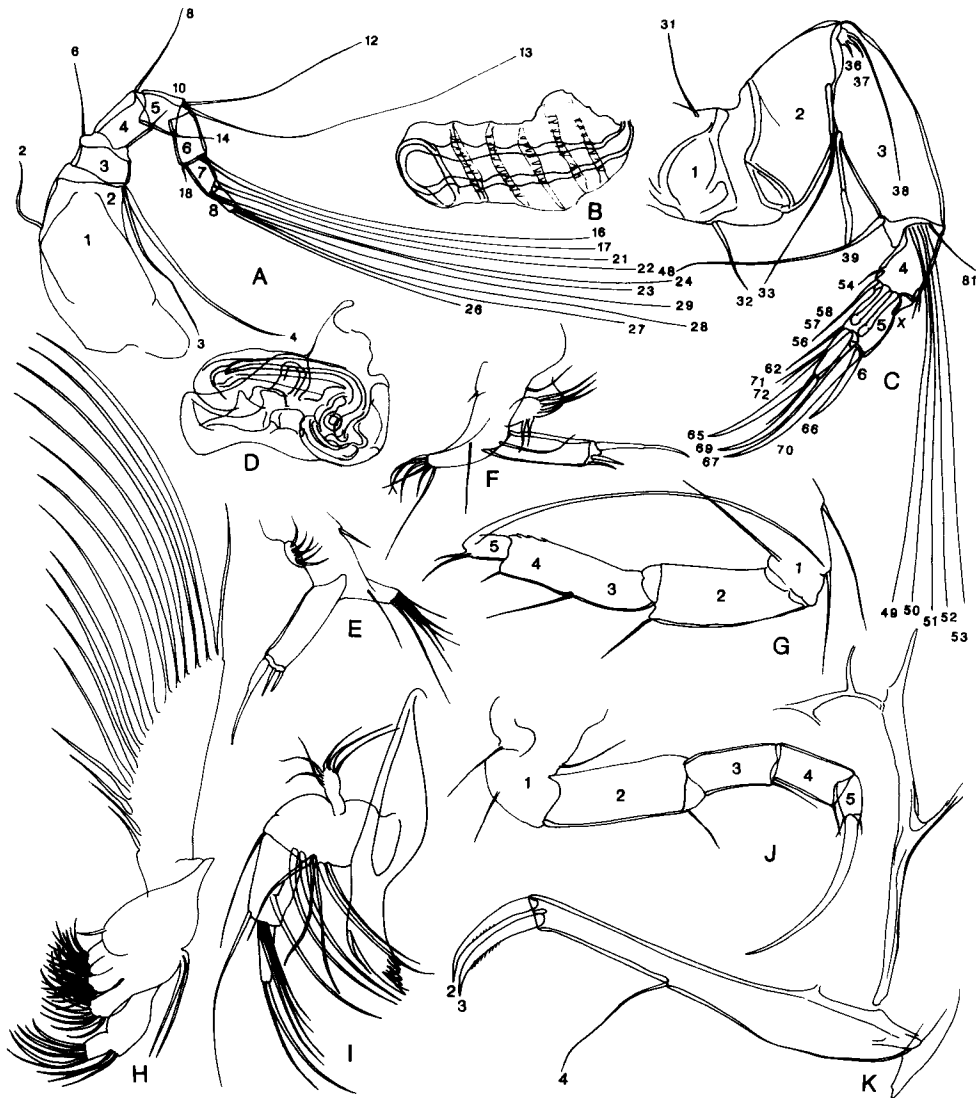


Figure 3. *Mungava recta* Maddocks **sp. nov.** A-F, H, J-K, Male specimen 3072M; G, I, female specimen 3071F. A, Antennule; B, Zenker's organ; C, antenna; D, hemipenis; E, F, both male fifth limbs; G, seventh limb; H, maxillule; I, mandible; J, sixth limb; K, furcal support and furca (all $\times 320$).

robust podomere proportions and a more elongate terminal claw; the seventh limb has more elongate proportions and much finer pectination on the reflexed seta; the distal claw of the furca is about twice as long as the proximal claw, both claws have profuse hairs, and no proximal setae are visible on the furca. The male fifth limb of *D. ensigera* is especially diagnostic, with its sinuous, pinched and swollen terminal hook, whereas *D. taalensis* apparently has a straight, tapering terminal segment rather like that of *Mungava*. The ventral rays of the male fifth limb of *D. ensigera* are thinner and perhaps slightly shorter than those of *D. taalensis*, though this may be an illusion caused by the larger size of the palp

and terminal hook. The hemipenis of *D. ensigera* is similar in structure to that of *D. taalensis* except more compact, with more irregular, lobate margins.

Dolerocypria differs from *D. fastigata* by the less elongate carapace, podomere proportions, and most setal proportions; by the hourglass, pinched-in shape of the terminal hook of the fifth limb, with three shorter rays on both right and left sides; and by the visible pectination of the recurved seta of the seventh limb. The hemipenis and furca are virtually identical, and it is apparent that these two species are very closely related. *Dolerocypria ensigera* shows few similarities to *D. bifurca*, which has a bluntly terminated hemipenis, a male fifth limb with compact hook and only two broad, bluntly rounded rays, and a less elongate carapace. *Dolerocypria mukaitshimensis* is higher in proportion to length, with more coarsely barbed furcae and reflexed seta of seventh limb, and no male has been described. *Dolerocypria elongata* has incurved terminal hooks and much longer ventral rays on the male fifth limb, and the carapace shape differs in many details, with the greatest height and thickness located closer to the anterior end than in *D. ensigera*.

Mungava Harding, 1962

1962 *Mungava* Harding: 53; Maddocks, 1979: 3; Wouters, 1987b: 171.

Discussion. The six known species of *Mungava* suggest a circumtropical distribution for this genus. Failure to mention *Mungava* in the few faunal monographs of tropical West Africa does not necessarily prove the genus is absent (Wouters, 1987b). The carapace of *Mungava* is fragile and nondescript, unlikely to be well represented in dry assemblages. To date, most species of Thalassocypridini have been described from live collections, while studies applying palaeontological methods to empty carapaces have tended to report Paracypridini, such as *Aglaioypris*. It is not yet certain whether thalassocypridine genera can be recognized consistently on carapace attributes alone.

***Mungava recta* sp. nov.**

(Figs 3, 6G–J, 7A–D, 8C–D, 9)

Derivation of name. Latin *rectus*, straight; to describe the furca and the palp of the male fifth limb.

Material. Five specimens in alcohol, including one male, three females, and one juvenile.

Types. Holotype male 3072M USNM 193874, paratypes USNM 193875–193877.

Type locality. Grieta north of trail to Tortuga Bay, Puerto Ayora, Isla Santa Cruz; sample 87–021a, 18–19 June 1987; specimens collected with 98 µm mesh plankton net from water column and root masses above halocline in 0 to 5 m depths. Also sample 87–021b at same locality, specimens collected with 93 µm mesh plankton net from water column and bottom sediments below halocline in 9 to 10 m depths.

Occurrence. In sample 87–021a, four specimens; in sample 87–021b, one specimen.

Dimensions. Holotype male 3072M before dissection, L 0.50 mm, H 0.25 mm. The single male is within the size range of the females. See also Fig. 9.

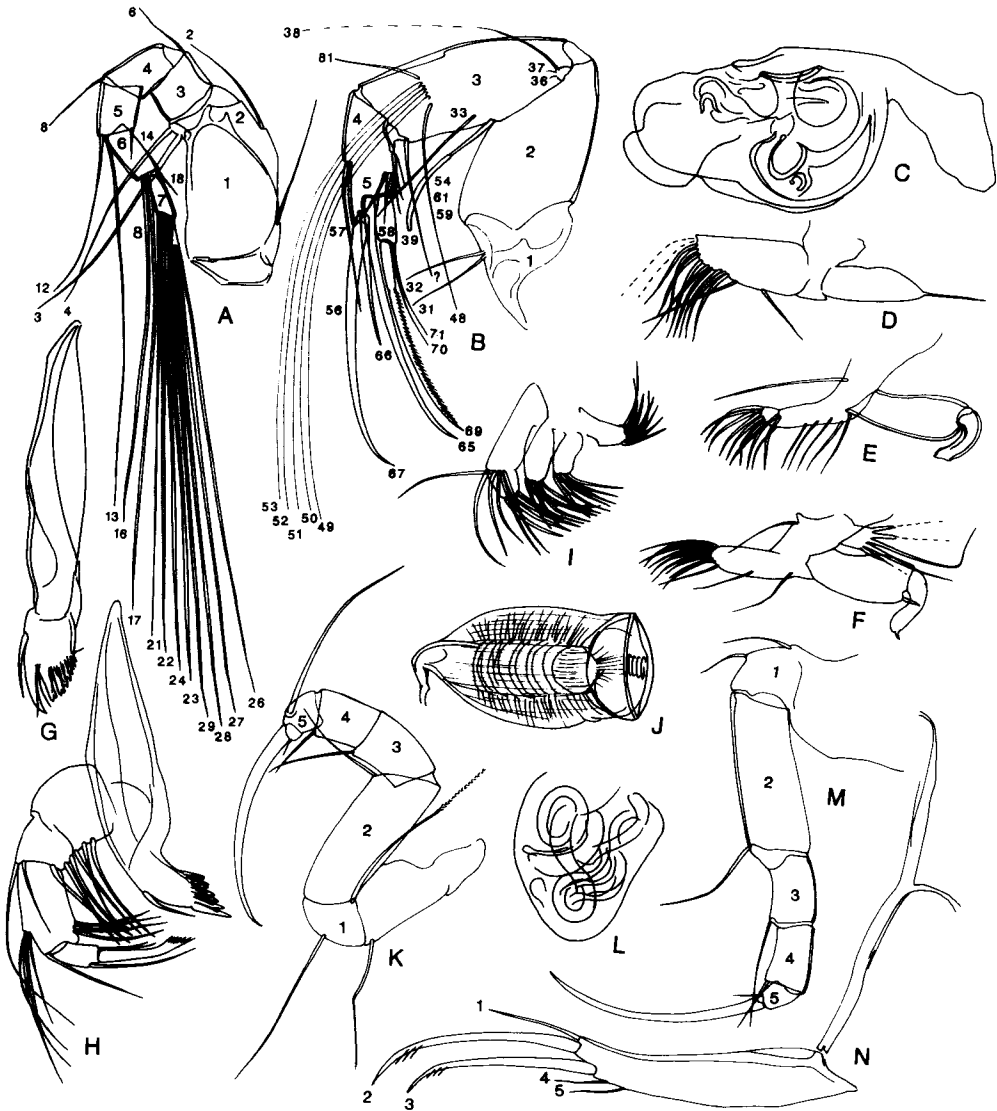


Figure 4. *Hansacypris galapagosensis* Maddocks **sp. nov.** A-C, E, G, I, K-N, Male specimen 3075M; D, L, female specimen 3073F; F, H, J, male specimen 3074M. A, Antennule; B, antenna; C, hemipenis; D, female fifth limb; E, F, male fifth limbs; G, base of mandible; H, entire mandible; I, palp and masticatory processes of maxillule; J, Zenker's organ; K, seventh limb; L, female genital lobe; M, sixth limb; N, furcal supports and furca (all $\times 320$).

Diagnosis. Carapace thin-walled, laterally compressed, nearly equivalve, translucent white to transparent; ovate-oblong in lateral outline, with evenly and nearly equally rounded anterior and posterior ends, broadly arching dorsal margin without angles, nearly straight ventral margin, and shallow ventral indentation; normal pore canals small, simple, scattered; zone of concrescence narrow all around free margin, with short, straight, inconspicuous radial pore canals; open, connected anterior and posterior vestibules; paracypridine

adductor muscle-scar pattern; dorsal outline elongate-oblong with gently tapering sides and rounded ends.

Antennule with podomeres 4 and 5 flexibly articulated, podomeres 4 through 8 only slightly longer than broad, with long terminal setae of nearly equal lengths. Antenna with short terminal claws, with short, thick male dimorphic setae and protuberance 'X' on podomere 4, with five swimming setae reaching beyond claws. Male fifth limbs nearly symmetrical, with rectilinear, elongate palp, bearing two small, slender ventrodistal pegs; terminal hook thin, straight, tapering. Sixth leg robustly proportioned with short, sharply tapering claw. Seventh limb with very long reflexed seta, which is so finely pectinate that the barbs cannot be drawn; with two small terminal setae of unequal lengths. Furca straight, slightly tapering, without any distal seta (seta 1), with two small, barbed claws of equal size (setae 2 and 3), and with one slightly longer proximal seta. Furcal support with two dorsal branches. Hemipenis oblong with broad, curved lamellar appendage. Zenker's organ thick, well muscled, with five rings of extremely short chitinous spikes. Testes lobes broad, swirled in fan shape against posterior valve surface and within posterior vestibule. Ovaries disposed in a broad loop through the posterior vestibule. Very large, red-brown eye.

Discussion. *Mungava recta* lacks the hirsute, spinulose texture of the Indo-Pacific species described by Wouters (1987b); most setae are smooth or very faintly barbed as compared with the vigorously barbed and pectinate setae of *M. munda*, *M. intermedia* and *M. papuensis*. *Mungava recta* is much smaller than all species except *M. papuensis* and has a more oval, less angular lateral outline than that species. It is most similar to *M. marthapuriae* but smaller, with more broadly rounded anterior and posterior ends in lateral outline, with mostly smooth podomeres and setae rather than the hirsute fringes and barbs of *M. marthapuriae*; it also has shorter antennal claws, a more elongate terminal hook-seta on the male fifth limb, a straight rather than curved furca, and a more compact hemipenis with less angular contours. It resembles *M. papuensis* in carapace shape and size as well as the straight furca, but it has longer antennal claws, a more elongate palp and terminal hook seta on the male fifth limb, a more oblong hemipenis with broader distal lamellar appendage, and lacks the conspicuous barbs and fringing hairs on many of these limbs. It is fairly similar to *M. intermedia* in carapace proportions, male fifth limb, and furca but is smaller, with longer antennal claws, more elongate podomere proportions of sixth and seventh limbs, and much more elongate hemipenis.

Tribe Renaudcypridini McKenzie, 1980

1980 Subfamily Renaudcyprinae McKenzie: 507; Wouters, 1984: 174; Wouters, 1986: 127.

Discussion: The original diagnosis (McKenzie, 1980) has many puzzling features that need clarification:

(1) The carapace is termed "spinose", but no spines are visible in the accompanying SEM photographs. It must be concluded that these "spines" are, in fact, the "spiky hairs" mentioned for the type species. Such sensilla arise at the normal pore canals in all cypridacean ostracodes, including Paracypridini and Thalassocypridini. Only the large size of these setae in some Renaudcypridini is



Figure 5. *Strandesia stocki* Broodbakker, female specimen 3066F. A, Antennule ($\times 130$); B, antenna; C, sixth limb; D, seventh limb (all $\times 320$); E, female fifth limb; F, mandible; G, mouth region with forehead, upper lip, and rake-shaped processes (all $\times 130$); H, palp and masticatory processes of maxillule ($\times 320$); I, furcal support; J, furca (all $\times 130$).

noteworthy. The tiny "comma-shaped pustules" illustrated by Wouters (1984) are merely epicuticular microornament and have little taxonomic value, as he recognized.

(2) Another passage—"The valves...are slightly depressed anterodorsally near the eye region"—refers to the lateral outline, a character of only species rank.

(3) The "subquadrate carapace" outline is common also in Thalassocypridini (*Mungava*, *Parapontoparta*, *Thalassocypris*) and Paracypridini (*Gerdocypris*, *Aglaiocypris*).

(4) The long swimming setae of the antenna (setae 49 through 53 plus 81 in the numbering scheme used by Maddocks (1976, 1979, 1988)) are supposed to distinguish Renaudocypridini unequivocally, but in Paracypridinae this character presents a continuous spectrum of variation (see characters 12 and 13 of Table 1). Swimming setae are well developed in most Thalassocypridini except *Parapontoparta spicacarens*. In Paracypridini, several swimming setae are present, but their number and relative lengths are variable. In *Aglaiella*, *Ghardaglaia* and *Coralliaiglaia* they are much reduced in number, and the remaining ones are easily confused with other setae of this podomere. Reduction of swimming setae appears to be an adaptation for benthic life, which, like any reduction, is liable to convergence. Its taxonomic value must be evaluated in context of other modifications. In fact, in Renaudocypridini the apparent length of the swimming setae is in part an illusion caused by the shorter terminal claws. Multivariate analysis of setal measurements may eventually be necessary to establish meaningful vectors of taxonomic change.

(5) The "elongate maxillule palp" is no different from that of Paracypridini and Thalassocypridini.

(6) The male fifth limb is twice described by McKenzie as "not dimorphic." It would be more exact to say that this limb shows sexual dimorphism, as usual in all Cypridacea, but does not show left-right asymmetry. Left-right asymmetry is usual but of slight magnitude in other Paracypridinae.

(7) The "stout end claw on the terminal segment of the third thoracic leg (P III)" is the "long and clawlike" "distal seta of the seventh limb" of Maddocks (1988), which is developed as a long or medium-sized claw in *Gerdocypris*, *Coralliaiglaia*, *Triangulocypris*, and some species of *Paracypris* in the Paracypridini (see character 17 of Table 1). In most Thalassocypridini this distal seta is very small, hardly any longer than the third distal seta, although *Mungava* shows a tendency for this seta to be enlarged. Enlargement of this seta seems to accompany shrinking antennal swimming setae in both Paracypridini and Hansacypridini and to be correlated with benthic life. At present, there is insufficient information to decide whether this is parallel evolution in two clades, or whether *Renaudocypris* and *Hansacypris* should be transferred to the Paracypridini.

(8) The two posterior bristles of the furca (characters 7 and 8 of Table 1) are long in many Paracypridini, while more or less reduced homologues are present in most Thalassocypridini.

(9) McKenzie's description of the male reproductive system—"in the hemipenes, the tubes of the testes form near circles which open dorsally—seems to confuse testes with hemipenes. These structures are at the two ends of the complex male reproductive system, between which the seminal vesicle, vas

deferens, Zenker's organ, and another length of vas deferens intervene (Hartmann, 1968). The complex architecture of the candonine hemipenis, which is shared by the Paracypridinae, has been elucidated by Danielopol (1969, 1978) and by McGregor and Kesling (1969). McKenzie's drawing (1980: fig. 15) shows two posteroventral circles, which probably represent the labyrinth and basal part of the copulatory tube (Danielopol) or sleeve and duct of the seminal tract (McGregor & Kesling), but the terminal course of the copulatory tube is not shown. Neither McKenzie (1980) nor Wouters (1984, 1986) illustrated the testes for any species of Renaudcypridini. In Paracypridini the testes are curved in an open V within the posterior vestibule, while in Thalassocypridini they form a closed coil. In *Hansacypris galapagosensis* the testes are coiled, while in two other species classified in *Hansacypris* (Table 1) they are not coiled.

(10) In all Paracypridinae (see Table 1) the Zenker's organ has "5 inner chitinrosettes" as described by McKenzie for Renaudcypridini. In addition, chitinous spikes may be developed at one or at both ends of the Zenker's organ, producing one or two additional rosettes that may be smaller, the same size as, or even larger than the five middle rosettes—hence the contradictory reports of six and seven rosettes by authors who have not specified which ones were being counted. Freshwater Candoninae and Cyclocypridinae, likewise, have five inner plus two terminal rosettes. The character appears to be homogeneous within this complex and, therefore, of little taxonomic value except for comparison with other branches of Cyprididae.

The Renaudcypridini seem to bridge the morphological gap between Paracypridini and Thalassocypridini as well as the marine to freshwater salinity gradient. The supposedly diagnostic characters are not unique and are related to environmental preferences. The validity of this tribe as a separate clade of Paracypridinae and the need for two genera must be re-evaluated at some future date, after more species have been described. For now, the Renaudcypridini show us that there are still too many gaps and inconsistencies in our knowledge of Paracypridinae to construct an optimal classification.

Distribution. McKenzie (1980) originally supposed *Renaudcypris* to be restricted to south-east Asia. Wouters (1984) predicted that it and its relatives would prove to be widely distributed through the Indo-Pacific region. There are now at least seven species known, which are characteristic of beaches, lagoons, mangroves swamps and other transitional environments with low or variable salinity.

Hansacypris Wouters, 1984

1984 *Hansacypris* Wouters: 169.

Discussion. Wouters distinguished *Hansacypris* from *Renaudcypris* by the very slightly more elongate proportions, the smooth rather than punctate carapace surface, the absence of pronounced angulation in the dorsal margin in lateral outline, and the absence of the external eye spot. It was not stated whether the eyes themselves are present or absent. Pigmented, fused naupliar eyes but not carapace eyespots are generally present in Paracypridini and Thalassocypridini. The other characters listed are variable and unlikely to be of phylogenetic significance. It may be doubted whether two genera are necessary on present evidence.

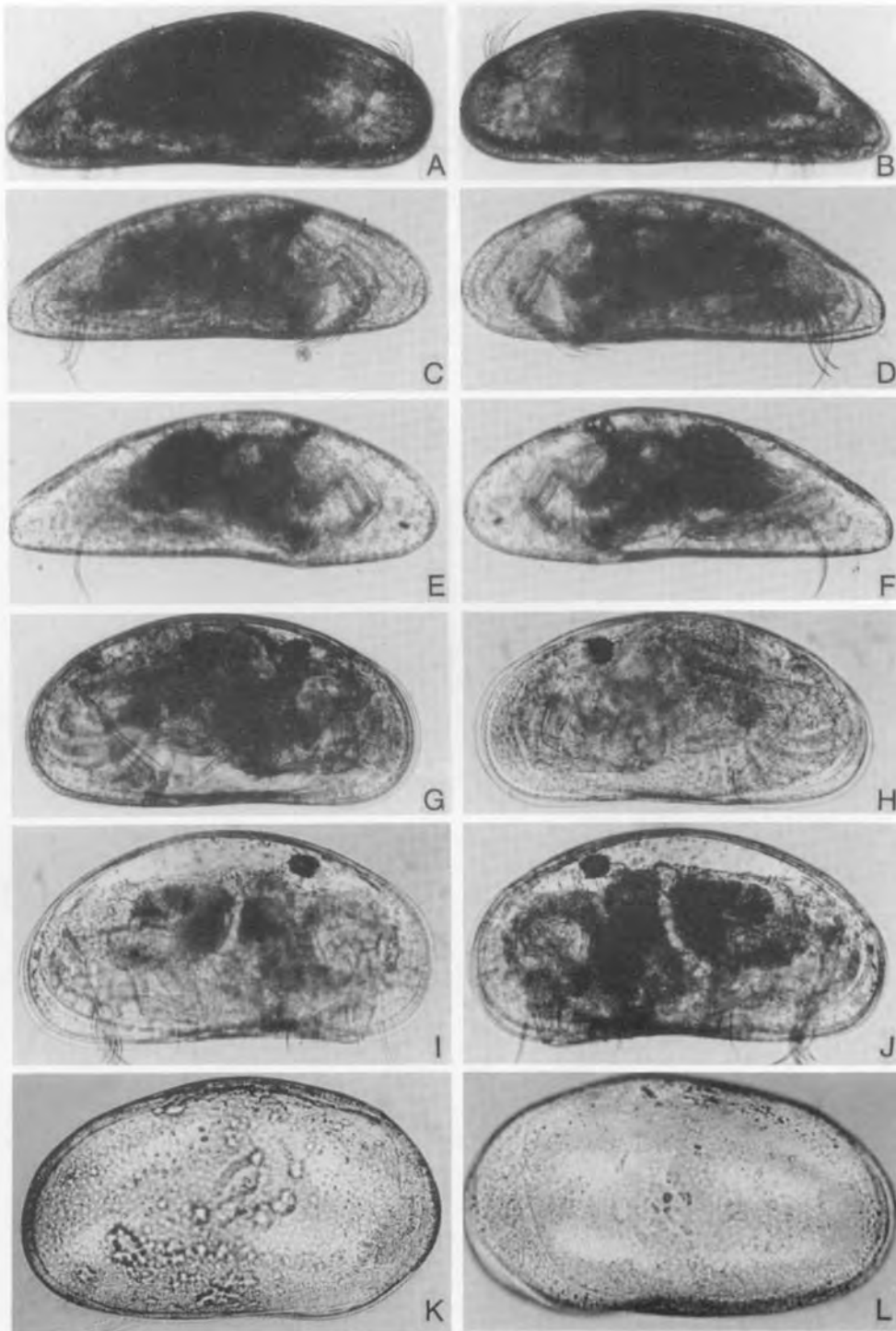


Figure 6. *Paracypris crispa* Maddocks, female specimen 3069F. A, B, Right and left sides of entire animal before dissection ($\times 85$). *Dolerocyprina ensigera* Maddocks **sp. nov.**, right and left exteriors of entire animals before dissection. C, D, Male specimen 3077M; E, F, female specimen 3078F (all $\times 100$). *Mungava recta* Maddocks **sp. nov.**, right and left exteriors of entire animals before dissection. G, H, Male specimen 3072M; I, J, female specimen 3071F (all $\times 110$). *Strandesia* (*Neocypris*) *stocki* Broodbakker, female specimen 3066F. K, L, Right and left valve exteriors ($\times 70$).

***Hansacypris galapagosensis* sp. nov.**

(Figs 4, 7E–J, 8E–I, 9)

Derivation of name. For the Galapagos Islands.

Material. 72 specimens in alcohol.

Types. Holotype male 3075M USNM 193878–193882.

Type locality. Grieta north of trail to Tortuga Bay, Puerto Ayora, Isla Santa Cruz; sample 87-021a, 18–19 June 1987, specimens collected with 93 μ m mesh plankton net from water column and root masses above halocline in 0 to 5 m depths. Also sample 87-021b at same locality, specimens collected with 93 μ m mesh plankton net from water column and bottom sediments below halocline in 9 to 10 m depths.

Occurrence. In sample 87-021a, 71 specimens; in sample 87-021b, 1 specimen.

Dimensions. Holotype male 3075M before dissection, L 0.54 mm, H 0.27 mm. Males appear to be as long as or perhaps slightly longer than females but proportionally not quite as high. See also Fig. 9.

Diagnosis. Carapace smooth, thin-walled, transparent, laterally compressed; oblong in lateral outline, with somewhat narrowly rounded anterior margin, distinct anterodorsal angle, sloping dorsal margin, in distinct posterodorsal angle, more broadly rounded posterior margin, and straight to slightly concave ventral margin; zone of concrescence very narrow with inconspicuous radial pore canals, vestibules open and continuous; adductor muscle-scar pattern paracypridine with divided dorsal cap-scar and anterodorsal scar; normal pore canals scattered, simple, conspicuous, with short, inconspicuous sensilla; no raised eyespot.

Antennules with flexibly articulated podomeres and long terminal setae. Antennae with five long and one short swimming setae and fairly short terminal claws. Male fifth limbs nearly symmetrical, with medium-sized, somewhat recurved terminal hook, with only one tiny ventrodistal peg on one limb and none visible on other limb. Sixth limb with robust proportions, rather long distal setae on podomeres 2 and 3, and fairly short terminal claw. Seventh limb with thick terminal claw and thin reflexed seta of about equal length; the seta arising beneath the knee is very long and distally serrate in symmetrical fashion with both edges bearing *en echelon* bells or saw-teeth, flaring distally. Furca with fairly long distal seta; slender, tapering, barbed claws, the distal one longer; and two small, close-spaced proximal setae; furcal support with one dorsal branch. Hemipenis hemi-oval, distally lobate with broad lamellar appendage. Zenker's organ short, with rings of chitinous spikes so closely spaced that they cannot be counted, probably five in number, with flaring, hemispherical, funnel-shaped terminal ball. Testes disposed in very broad coil against posterior valve surface and in posterior vestibule, continuing around anterior inner margin as narrow strand. Ovaries forming a single broad arc through posterior region. Eyes absent.

Discussion. Wouters (1984) emphasized the presence of a smooth, flat or raised eyespot on the carapace of *Renaudcypris* and the absence of this spot in *Hansacypris*, but he did not state whether the animals themselves have eyes. *Hansacypris galapagosensis* lacks eyes as well as eye spots.

Under the optical microscope, *H. galapagosensis* lacks the coarsely punctate valve surface of *H. aspera* and the pustulose microornament of *H. aspera* and *H. glabra*. It is quite similar in lateral outline to both species but slightly more

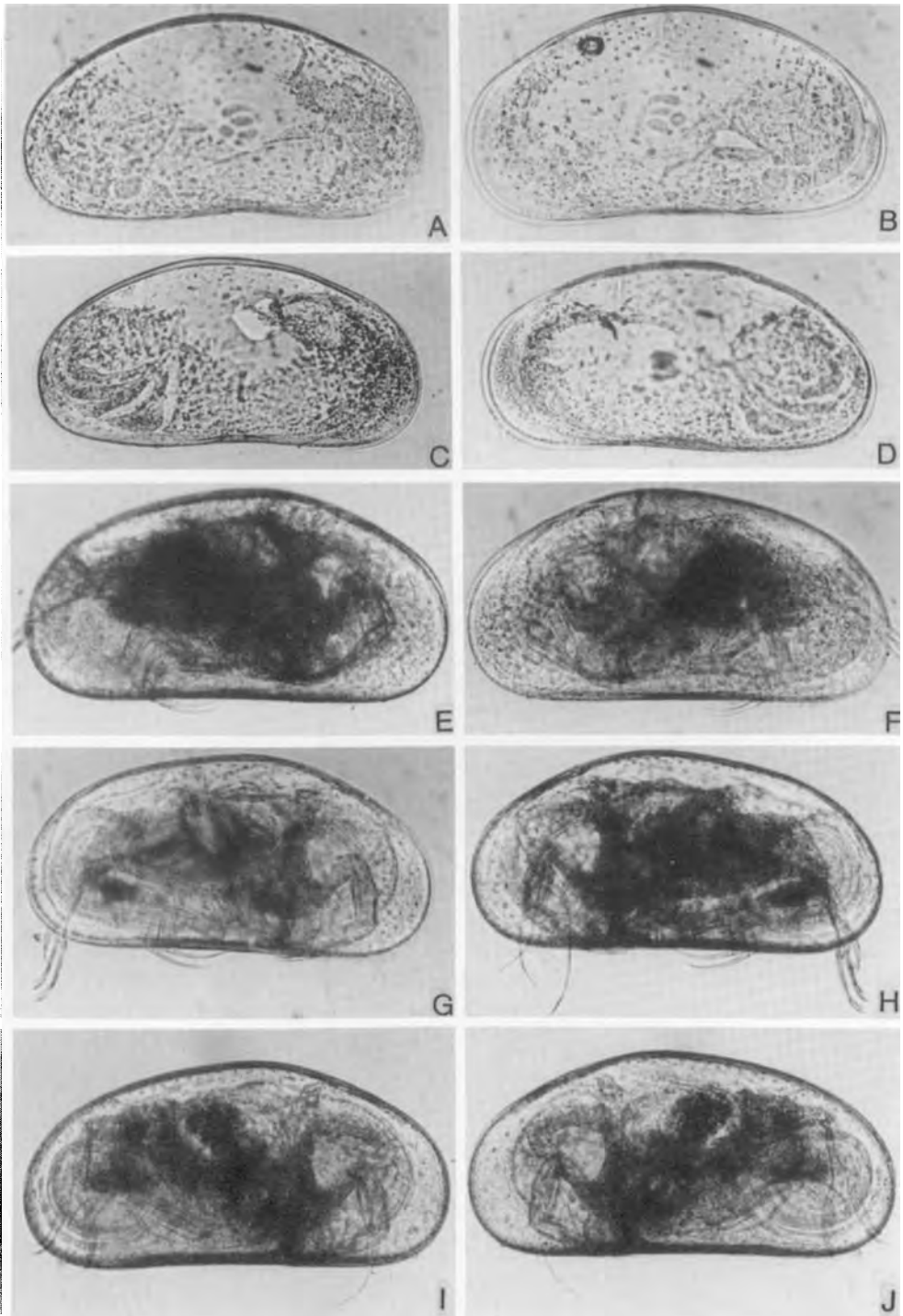


Figure 7. *Mungava recta* Maddocks **sp. nov.**, right and left valve exteriors, with ovaries and testes in vestibules. A, B, Female specimen 3071F; C, D, male specimen 3072M (all $\times 110$). *Hansacypris galapagosensis* Maddocks **sp. nov.**, right and left exteriors of entire animals before dissection. E, F, Female specimen 3073F; G, H, male specimen 3074M; I, J, male specimen 3075M (all $\times 110$).

elongate, with a more narrowly rounded anterior end and more sloping anterodorsal margin. It is less angular in lateral outline than *H. natans* and has longer antennal swimming setae and longer furcal claws. On the seventh leg of *H. galapagosensis*, the terminal claw is thicker and more regularly tapering, the reflexed seta is shorter and less coarsely pectinate, podomeres 3 and 4 lack the belled dorsal margins, the outer knee setae are smooth rather than arrow-barbed, and the inner knee-seta is symmetrically barbed rather than smooth, as compared with *H. natans*, *Hansacypris galapagosensis* is smaller than *R. gorongae*, with less conspicuous carapace sensillae and less hirsute appendages, with smooth rather than punctate carapace surface and distally rounded rather than angulate hemipenis, and lacks the flared ventrodiscal margin ("knoblike protuberance" of Wouters (1986: 127)) of the palp of the male fifth limb. *Renaudocypris luzonensis* and *R. wolffi* have more nearly subtriangular lateral outlines, more punctate carapace surfaces, angulate distal margins on the hemipenis, and less strongly recurved terminal hooks on the male fifth limb.

Subfamily Cypridinae Baird, 1845

Tribe Cypricercini McKenzie, 1971

Genus *Strandesia* Stuhlmann, 1888

Discussion. Broodbakker's (1983) concept of *Strandesia* is followed here. He stated that the subgenus *Neocypris* is worldwide but especially well represented in South America, Africa and Europe. Broodbakker further suggested that a *stocki* species-group could be recognized, to include this Caribbean species plus four Brazilian species with nearly symmetrical carapaces, as contrasted with the much more numerous and probably cosmopolitan *sphaeroidea* species-group having strongly asymmetrical carapaces [*S. (N.) sphaeroidea* Broodbakker, 1983]. Males are known for only 18 of the 95 species and subspecies of *Strandesia* reviewed by Broodbakker (1983, Appendix), including one Mexican species of *Neocypris* but none of the *stocki* species-group.

Subgenus *Strandesia (Neocypris)* Sars, 1901

1901 *Neocypris* Sars: 19.

1983 *Strandesia (Neocypris)* Sars, Broodbakker: 361.

Strandesia (Neocypris) stocki species-group

Strandesia (Neocypris) stocki Broodbakker, 1983

(Figs 1G–K, 5, 6K–L, 7D–G)

1983 *Strandesia stocki* Broodbakker: 339, figs 6, 7D–G.

Material. 64 specimens in alcohol; USNM 193883–193884.

Occurrence. In sample 87–008, lava rock pool, Puerto Villamil, Isla Isabella, 15 May 1987; 64 specimens collected with small bottle from algae in 20 cm depths.

Dimensions. Female specimen 3066F before dissection, L 0.94 mm, H 0.54 mm. See also Fig. 9.

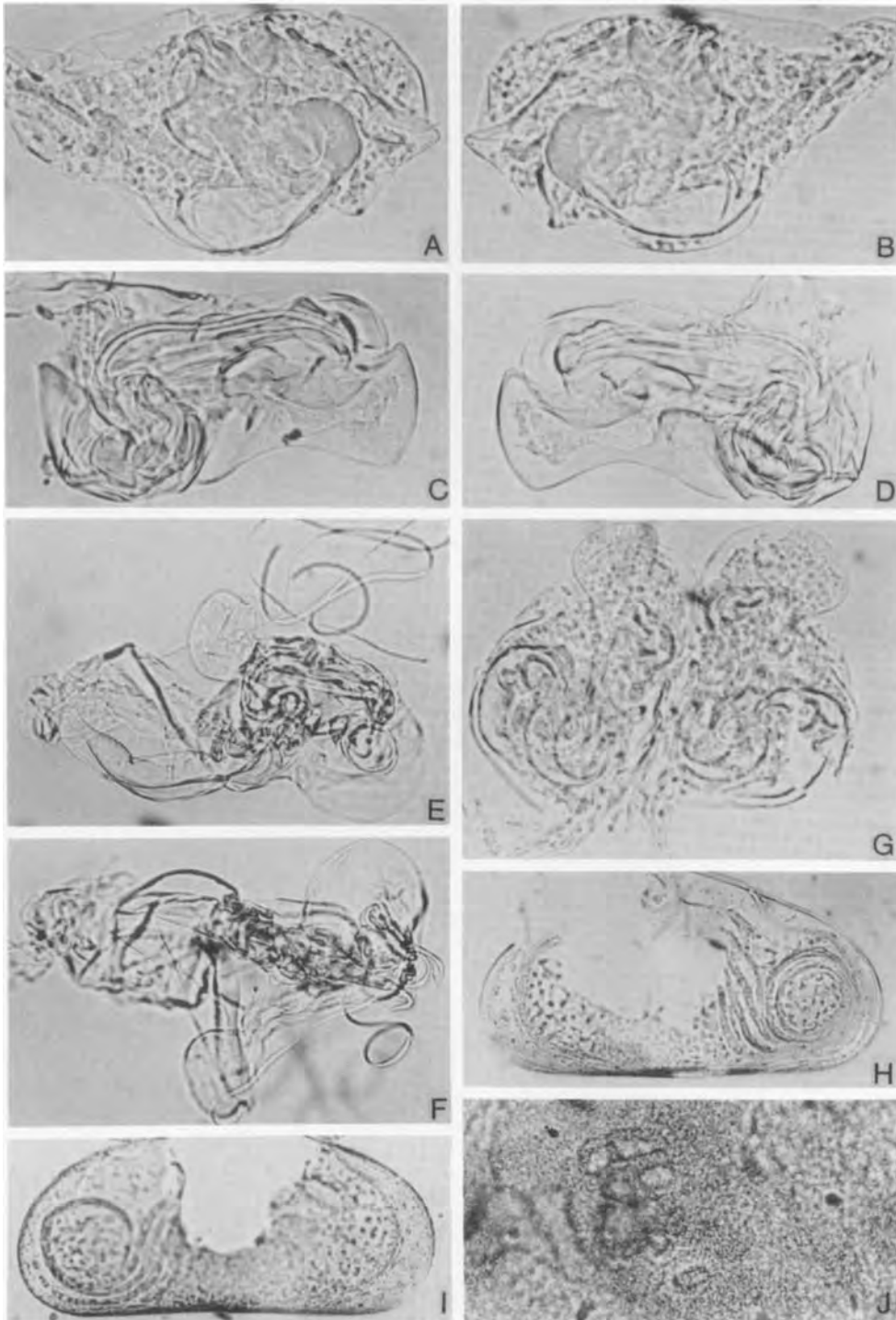


Figure 8. *Dolerocypris ensigera* Maddocks **sp. nov.** A, B, Both hemipenes, male specimen 3077M ($\times 600$). *Munghava recta* Maddocks **sp. nov.** C, D, Both hemipenes, male specimens 3072M ($\times 600$). *Hansacypris galapagosensis* Maddocks **sp. nov.** E, F, Both hemipenes in erection, male specimen 3074M; G, both hemipenes attached, male specimen 3075M (all $\times 400$); H, left valve exterior with testes, male specimen 3074M; I, right valve exterior with testes, male specimen 3075M (all $\times 110$). *Paracypris crista* Maddocks. H, Right exterior adductor muscle-scar pattern with frontal and mandibular scars, female specimen 3069F ($\times 350$).

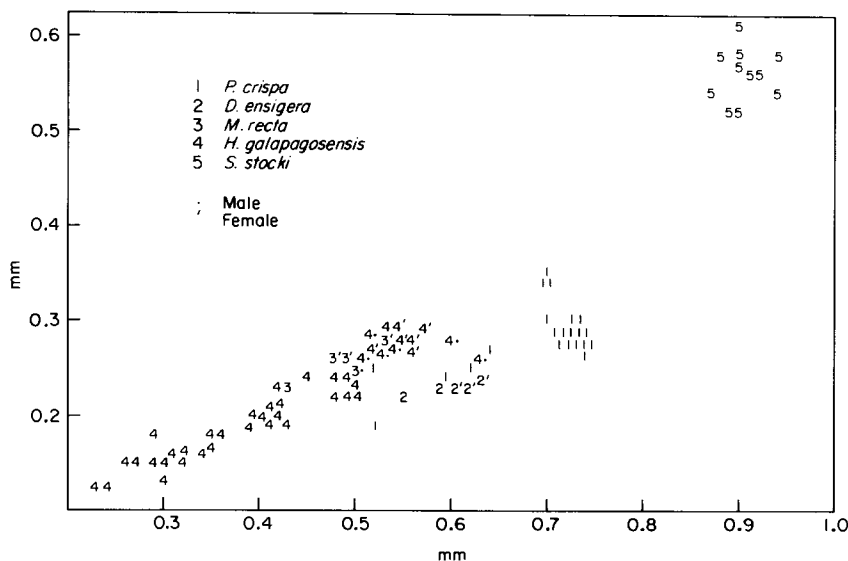


Figure 9. Carapace length (horizontal axis) and height (vertical axis). Explanation of symbols: 1 = *Paracypris crispa* Maddocks, 2 = *Dolerocypris ensigera* Maddocks **sp. nov.**, 3 = *Mungava recta* Maddocks **sp. nov.**, 4 = *Hansacypris galapagosensis* Maddocks **sp. nov.**, 5 = *Strandesia (Neocypris) stocki* Broodbakker, . = male, ' = female. Additional unplotted specimens for some species have dimensions that coincide with those plotted here.

Distribution. Broodbakker (1983, 1984a, b) collected *S. (N.) stocki* from wells, rivers, springs, and volcanic and limestone rock pools and reared it from dried mud from Cuba, Jamaica, Haiti, St. John (U.S. Virgin Islands), St. Martin, St. Kitts, Dominica and Martinique. He found it mostly in low chlorinities (400 mg l^{-1}) but stated that it could tolerate chlorinities as high as 3500 mg l^{-1} . No males are known. Broodbakker (1984b) concluded that the epigeic ostracodes of the central and southern Caribbean, including *S. (N.) stocki*, arrived by passive dispersal from South America, probably being transported by waterfowl or winds. Presumably the species reached the Galapagos Islands in the same way.

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Through years of musing on Paracypridinae, I have gained insight and encouragement from correspondence with Kenneth G. McKenzie (Riverina College of Advanced Education, New South Wales, Australia), though the conclusions presented here may differ from his. Conversations with Gerd

Hartmann (Zoologisches Institut und Museum, Universität Hamburg), Dietmar Keyser (same) and Karel Wouters (Institut Royal des Sciences Naturelles de Belgique, Brussels) have also been valuable.

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