

## Three interesting Cyprididae (Ostracoda) from Western Australia

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**Abstract** – The paper contributes to the systematics of the family Cyprididae and to a description of the general ostracod biodiversity in Australia. *Riocypris hinzeae* sp. nov., is described from wells in the Murchison region (Western Australia). This is the second species described in the genus, previously known from South America. Another two species are transferred into this genus: *Riocypris fitzroyi* (McKenzie, 1966) comb. nov. and *R. fontana* (Graf, 1931) comb. nov. *Cyprinotus cingalensis* Brady, 1886, collected from wells in the Pilbara Region (Western Australia), is redescribed. Populations of some other described *Cyprinotus* species show extreme variability in morphology and length of the carapace and the following species are thus synonymized with *C. cingalensis*: *C. dahli* Sars, 1896; *C. uenoi* Brehm, 1936; *C. kimberleyensis* McKenzie, 1966 and *C. edwardi* McKenzie, 1978. The morphological variability in carapace shape and uniformity of the internal morphology of the species *Bennelongia australis* s. l. (Brady, 1886), here reported from the Murchison Region, confirms the need for a revision of the genus *Bennelongia* because correct identification of many representatives of this genus is almost impossible.

### INTRODUCTION

In Australia, the family Cyprididae Baird, 1845, is represented by 11 subfamilies, 32 genera and 110 species. King (1855) first recorded this ostracod group in Australia but the most significant contributions to our recent knowledge of the living Cyprididae from this continent have been made by the late Dr Ken McKenzie and Professor Patrick De Deckker (McKenzie 1966a, 1966b, 1978; De Deckker 1974, 1976, 1979a, 1979b, 1981a, 1981b, 1981c, 1982a, 1982b, 1982c). Most recently Halse and McRae (2004), Martens *et al.* (2004) and Karanovic (2005a) described some new Cyprididae taxa, breaking an hiatus of more than 20 years since the last Cyprididae ostracod description from Australia.

The most diverse Cyprididae subfamily in Australia is Eucypridinae Bronstein, 1947 with eight genera and 26 species, followed by Herpetocypridinae Kaufmann, 1900 with five genera and 19 species. The rest of the nine Cyprididae subfamilies in Australia are represented as follows: Cypretinae Hartmann, 1963 with two genera and eight species; Cypricercinae McKenzie, 1971 with two genera and five species; Cypridinae Baird, 1845 with two genera and 11 species; Cypridopsinae Kaufmann, 1900 with three genera and five species; Cyprinotinae Bronstein, 1947 with four genera and 14 species; Diacypridinae McKenzie, 1978 with two genera and 16 species; Ngarawinae De Deckker, 1979 with one

genus and one species; and Scottiinae Bronstein, 1947 with two genera and four species. The subfamilies Diacypridinae and Ngarawinae are endemic to Australia.

According to Halse (2002) there are about 121 Cyprididae species recognized in Western Australia, of which only 55 have been described. In the present paper I report on three species collected from northwestern Western Australia during various investigations of the subterranean waters of the Murchison and Pilbara regions. They often occur in great numbers in wells although they are all surface water species. A new species of the genus *Riocypris* Klie, 1935 is described, a genus until now known only from the type species described from Uruguay (Klie 1935). Beside the new species, two other species already known from Australia, are transferred to the genus *Riocypris*. The second species dealing with in this paper is *Cyprinotus cingalensis* Brady, 1886, described from Southeast Asia (Brady 1886a), but latter found in Queensland (Sars 1889). After finding great variability in populations collected from the Pilbara region, the following species are synonymized with it: *C. dahli* Sars, 1897; *C. kimberleyensis* McKenzie, 1966 and *C. uenoi* Brehm, 1936. The last species presented in this paper is identified as *Bennelongia australis* s. l. (Brady, 1886). While a detail revision of the genus *Bennelongia* De Deckker and McKenzie, 1981 is in progress (Martens and Halse,

in preparation), the present record deals with the status of the genus in the subfamily Cypridinae. In general, this paper contributes to a better understanding of the entire family Cyprididae, both in Australia and globally. This family is in urgent need of revision. When Hartmann and Puri (1974) published their work on the classification of the Recent and Fossil ostracods, there were 21 subfamilies recognized in the family Cyprididae (the subfamily Cypridopsinae was given family status). This was, and still is by far the greatest number of subfamilies in any of the families of the superfamily Cypridoidea. According to Martens (1990) today about 30 subfamilies are recognized within the family Cyprididae, many of them hard to distinguish. Some of the subfamilies have been revised in the last 20 years (Martens 1986, 1989, 1990, 1992) but there is still much work to be done to resolve the systematics of the family. This paper contributes to the systematics of the family with one new description and two redescriptions, a consideration of the taxonomy of the subfamily Eucypridinae, and by proposing some rearrangements of the genera within some other Cyprididae subfamilies.

#### MATERIAL AND METHODS

Samples were collected with haul-nets (mesh size 50, 250 or 350 micrometers) from wells. Samples were sorted under a dissecting microscope, either while alive (sample prefix BES) or after fixation in 70% or 100% ethyl-alcohol (PSS).

Ostracods were dissected in a mixture of distilled water and glycerol (1 : 1) with fine entomological needles (size 000). Dissected appendages and valves of some specimens were mounted in Faure's medium. The appendages of some specimens were mounted on slides in glycerol, while their valves are kept on micropalaeontological slides or in glass test-tubes in 70% alcohol. All non-dissected material is preserved in 70% ethyl-alcohol in glass test-tubes. Drawings have been prepared using a drawing tube attachment on Leica-DMLS microscope, with C-PLAN achromatic objectives. All the material is deposited in the Western Australian Museum (WAM).

In the systematic part of this paper the length of all segments was measured in the middle of the segments, and length ratios are presented beginning with the proximal end. The terminology of the appendages follows Martens (1998), while chaetotaxy of all limbs follows the model proposed by Broodbakker & Danielopol (1982), revised for the antenna by Martens (1987). Terminology of the second and third thoracopods follow Meisch (1996), while setae on the antennula are labeled according to Karanovic (2005b). No abbreviations are used in the text.

## SYSTEMATICS

### Family Cyprididae Baird, 1845

### Subfamily Eucypridinae Bronstein, 1947

### Genus *Riocypris* Klie, 1935

*Riocypris* Klie 1935: 289.

#### Type species

*Riocypris uruguayensis* Klie, 1935, by original designation.

#### Other species

*Riocypris fitzroyi* (McKenzie, 1966) comb. nov.; *Riocypris hinzeae* sp. nov.; and *Riocypris fontana* (Graf, 1931) comb. nov.

#### Amended diagnosis

Right valve with inwardly displaced selvage at least anteriorly. Selvage on left valve, if present, usually peripheral. Inner list prominent, especially on left valve. Maxillular palp cylindrical. First endopodal segment on antennula elongated. Prehensile palps asymmetrical, seta "c" absent on protopod of first thoracopod. Proximal basal seta on walking leg considerably longer than distal one (usually three times), penultimate segment on the same leg clearly divided. Penultimate segment on cleaning leg with only one seta. Caudal ramus thin and elongated, both claws and setae present, posterior seta not transformed into claw. Attachment simple.

#### Remarks

The genus *Riocypris* Klie, 1935, was described from Uruguay (Klie 1935), and was previously known from only the type species, *R. uruguayensis* Klie, 1935. The new species differs from the type species by the shape of the carapace which is highly arched in the type species, giving a triangular appearance to the carapace. The dorsal margin in the new species is slightly rounded, almost flat. In addition, the selvage is more inwardly placed in *R. uruguayensis*. In the diagnosis of the genus, Klie (1935) pointed out the internal morphology of the valves as one of the most important features, especially the asymmetry of the valves, where the right one has selvage inwardly placed. The internal morphology of the valves distinguishes the genus *Riocypris* from the closely related genus *Eucypris* Vávra, 1891, where selvage (if present) is always marginally situated (Martens 1989). The internal morphology of the genus *Riocypris* resembles that of the genera *Prionocypris* Brady and Norman, 1896, *Tonnacypris* Diebel and Pietrzeniuk, 1975, *Trajancypris* Martens, 1989 and *Koencypris* Meisch, 2000. All three genera are known only from the Palearctic, while the genus *Eucypris* has a

Cosmopolitan distribution. From the genera *Prionocypris*, *Tonnacypris* and *Trajanocypris*, the genus *Riocypris* differs by the cylindrical shape of the terminal segment of the maxillular palp. This segment is spatulate (distally enlarged) in the three genera. On the other hand, this segment is also cylindrical in the genus *Koencypris*, which is known only from the type species *K. ornata* (Müller, 1776), transferred from the genus *Eucypris* by Meisch (2000). The similarity between *Koencypris* and *Riocypris* is indeed large, but the caudal ramus in the former genus is much shorter than in the genus *Riocypris*. Unfortunately, *Koencypris* is known only from females. Beside the new species, I propose here to include the following two species in the genus *Riocypris*: *Candonocypris fitzroyi* McKenzie, 1966 and *Eucypris fontana* Graf, 1931. The first species was collected from the Fitzroy River in Western Australia (McKenzie, 1966b). The reason why McKenzie (1966b) included this species into the genus *Candonocypris* Sars, 1896, is not clear, as the main diagnostic character of the genus is the presence of two setae on the penultimate segment of the cleaning leg, but this was not described for *C. fitzroyi*. I believe that this species could not possibly belong to the genus *Candonocypris* because of the shape of the terminal segment of the maxillular palp, which is spatulate in all species, while in *C. fitzroyi* it is cylindrical. Also, species of the genus *Candonocypris* have more claw-like appearance of the posterior seta on the caudal ramus, while it is clearly seta like in *C. fitzroyi*. *Riocypris fitzroyi* (McKenzie, 1966) **comb. nov.** is in fact very similar to *R. hinzeae* sp. nov. having an almost identical valve shape and also the internal morphology of the valves. They differ in the length of the anterior seta on the caudal ramus, which is much longer in *R. fitzroyi*. Also, this species has a longer posterior claw, compared with the anterior one, than the new species. *Riocypris fitzroyi* is known only from females, and possible finding of males may eventually reveal even greater proximity of the two species. *Eucypris fontana* (Graf, 1931) was described from South Georgia, and later recorded from Signy Island, both in the sub-Antarctic (De Deckker 1981c). In this species, the selvage is clearly inwardly displaced anteriorly on the right valve, while it is peripheral on the left one. However, De Deckker (1981c) claimed that the position of selvage is typical for *Eucypris* species, which obviously is not correct. The presence of the knobs on the outside of the shell near the anterior margin (best observed in dorsal view) visible on the *E. fontana*, and common in the genus *Eucypris* led De Deckker (1981c) to the wrong conclusion. *Riocypris fontana* (Graf, 1931) **comb. nov.**, also known only from females, differs from the other species of the genus by its ornamented shell.

*Eucypris oblonga* (Sars, 1896) should tentatively

be included in the genus *Riocypris*. It seems to have selvage inwardly displaced on the right valve, but many other details of its morphology are obscure owing to the brief description. This new arrangement leaves the genus *Eucypris* with only one representative in Australia, *Eucypris virens* (Jurine, 1820). This is a cosmopolitan species, recorded from Australian inland waters by De Deckker (1982c). For the future investigation, it must be pointed out that many species described from South Africa, and assigned to the genus *Eucypris* by Sars (1924) obviously cannot belong there. This genus is in urgent need of revision and this may lead to the conclusion that at least *Riocypris* and *Koencypris* are its junior synonyms, because the morphology of the maxillular palp and length ratio between basal setae on the walking leg are the same in these genera. Also, the morphology of the male reproductive organs and prehensile palps are identical in *Eucypris* and *Riocypris*. Another genus, which has the same appearance of the maxillular palps and male sexual features, is the Australian genus *Alboa* described by De Deckker (1981a) from South Australia. This genus was erroneously placed in the subfamily Cyprinotinae by De Deckker (1981a), and should instead be in the subfamily Eucypridinae. In contrast to both *Eucypris* and *Riocypris*, the left valve in the genus *Alboa* has inwardly displaced selvage, while it is peripheral on the right valve. Therefore, the subfamily Eucypridinae has the following genera: *Alboa*, *Eucypris*, *Prionocypris*, *Riocypris*, *Tonnacypris*, and *Trajanocypris*. In my opinion the tribe Mytilocypridini, formed and placed in the Eucypridinae by De Deckker (1974) should be removed from the subfamily because the species of the tribe have a very different morphology of the male reproductive organs, including Zenker's organs with more than 60 rosettes and symmetrical prehensile palps. The position of Mytilocypridini is uncertain, but it is more closely related to the gigantic ostracod genera of the subfamily Megalocypridinae Rome, 1965, than to the subfamily Eucypridinae.

### *Riocypris hinzeae* sp. nov.

Figures 1–5

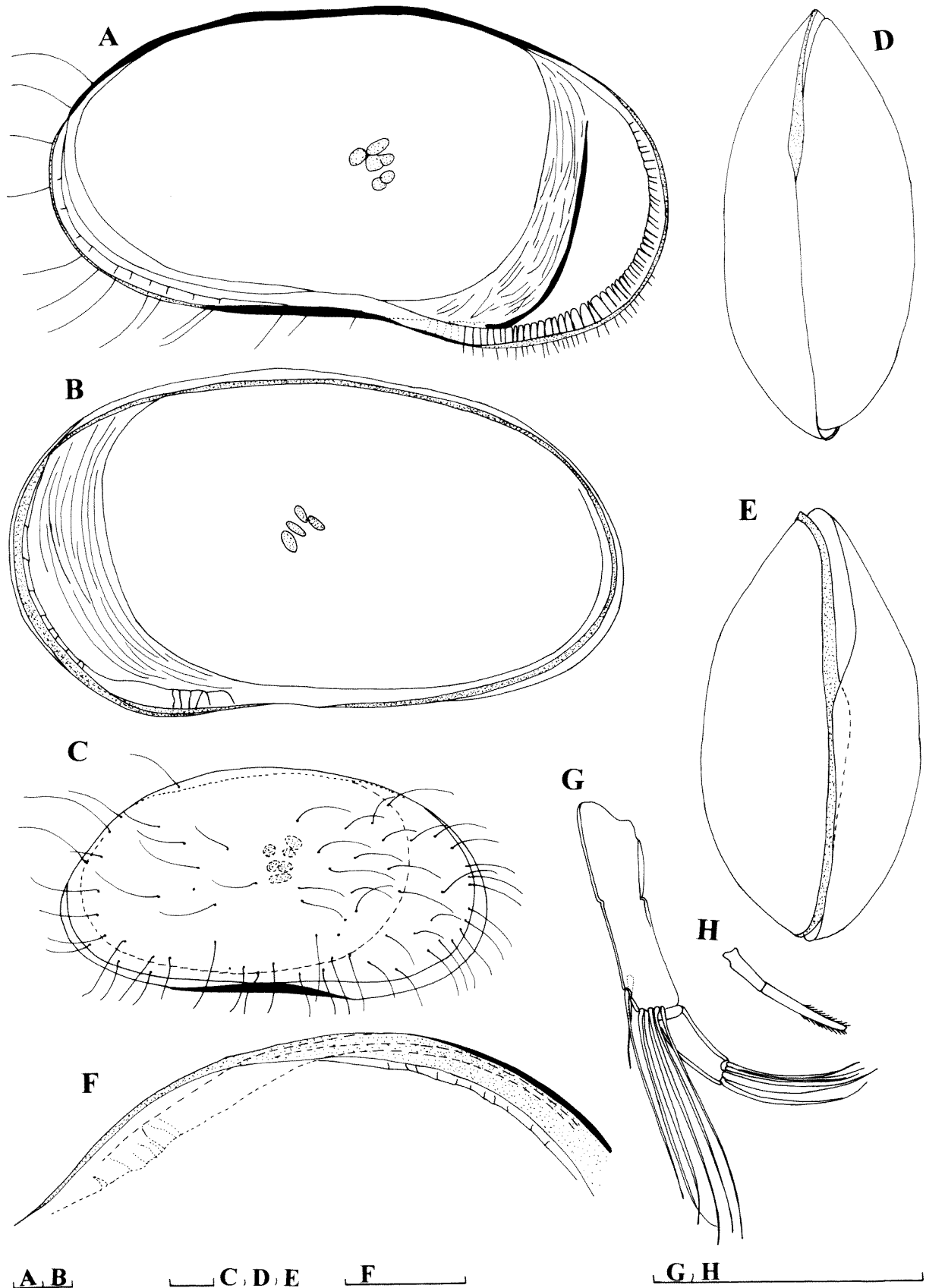
#### Material examined

##### *Holotype*

**Australia: Western Australia:** ♂, Friday Well, Depot Springs, Murchison region, 28°04'S, 120°04'E, 28 June 2000, W.F. Humphreys, S. Hinze (BES: 8410) (WAM C35693, slide).

##### *Allotype*

**Australia: Western Australia:** ♀, collected with holotype (WAM C36694, slide).



**Figure 1** *Riocypris hinzei* sp. nov., holotype male: A, left valve, internal view; B, right valve, internal view; C, carapace, lateral view from left side; D, carapace, dorsal view; E, carapace, ventral view; F, right valve, anterior margin; G, maxillular palp; H, tooth on the third endite of maxillula. Scales = 0.1 mm.

*Paratypes*

**Australia: Western Australia:** 5 ♂, 18 ♀, 10 juveniles, collected with holotype (WAM C35695, in alcohol)

*Other material*

**Australia: Western Australia:** 2 ♂, Puncture Well, Depot Springs, Murchison region, 28°07'S, 120°05'E, 28 June 2000, W.F. Humphreys, S. Hinze (BES: 8417) (WAM C35696, in alcohol); 1 ♀, New Well, Murchison region, 28°54'S, 119°10'E 15 May 2001, W.F. Humphreys, C.H.S. Watts, S. Cooper (BES: 7280) (WAM C35697, in alcohol); 14 ♂, 11 ♀, 2 juveniles, Friday Well, Depot Spring Station, Murchison region, 28°03'S, 120°04'E, 14 May 2001, W.F. Humphreys, C.H.S. Watts and S. Cooper (BES: 6649) (WAM C35698, in alcohol).

**Diagnosis**

The new species differs from all its congeners by the following combination of characters: dorsal margin of the carapace evenly rounded, almost flat; carapace surface smooth; anterior seta on the caudal ramus very short, not reaching 1/3 of length of anterior claw.

**Description***Male (holotype)*

Length 1.04 mm. Greatest height in front of middle, equalling 51% of length (Figure 1A–C). Greatest width around middle, equalling 44% of length (Figure 1D). Carapace elliptical in lateral view. Anterior margin wider than posterior one; dorsal margin slightly rounded; ventral margin straight. Left valve (Figure 1A), with small dorsal flange; selvage peripheral all around margins, inner list well developed anteriorly, much lesser posteriorly. Inner calcified lamella equalling 22% of length anteriorly, and only 5% posteriorly. Marginal pore canals straight and longer around mouth region. Right valve (Figure 1B) without well developed inner list. Salvage displaced internally all around free margins (Figure 1F). Right valve smaller than left one (Figure 1C). Left valve overlaps right one on all free margins (Figure 1C–E). Carapace surface covered with hairs and surface not ornamented.

Antennula (Figure 3B, C) 7-segmented. Protopod with both exopodal setae developed. Proximal coxobasal seta missing, while distal one well developed. First endopodal segment with one anterior seta, not reaching middle of following segment. Second segment with one posterior and one anterior seta, both very short. Third endopodal segment with two short posterior and two long anterior setae. Fourth and fifth segments with four long swimming setae. Terminal segment with one aesthetasc, two long swimming setae and one half

as long as aesthetasc. Aesthetasc eight times longer than terminal segment. Length ratios between five terminal segments: 4.6 : 2 : 1.4 : 1.7 : 1. Swimming setae extending far beyond terminal segment (Figure 3C).

Antenna (Figure 3A) with swimming setae reaching tip of terminal claws. Shortest seta among them not reaching middle of penultimate segment. Penultimate segment medially with two setae on exterior side and four setae on interior side. Setae z1 and z2 transformed into long claws, as long as first endopodal segment, z3 seta like and reaching middle of terminal claws. Claw G2 as long as transformed z setae, while claws G1 and G3 transformed into setae, former one reaching 2/3 of terminal claws, later one two times longer than terminal segment. Terminal segment with claw Gm well developed and almost reaching tip of other claws, while Gm less than half as long as Gm. Aesthetasc Y 0.5 times as long as first endopodal segment, y2 reaching distal end of terminal segment, while y3 three times longer than same segment. Length ratios between endopodal segments equalling 7 : 5 : 1.

Mandibula (Figure 4A, C, E) with strong coxa bearing eight strong teeth (Figure 4A, E). Palp with both S setae well developed. Alpha seta bare and short. Second segment with 3+2 setae in bunch, and three setae on external side. Gamma seta on penultimate segment short, stout and covered with short settulae. Terminal segment with one strong claw.

Rake like organ (Figure 4B) with 11 and 12 teeth.

Maxillular palp (Figure 1G) with six long and one short seta (situated on opposite side from long ones) on penultimate segment. Terminal segment elongated 3 times longer than wide. Teeth on first endite slightly serrated (Figure 1H).

First thoracopod (Figure 2B, C), with two "a" setae, and "b" and "d" seta on protopod. Endopod transformed into palps: right one (Figure 2B) with much stronger finger than left one (Figure 2C). Exopod with six rays.

Second thoracopod (Figure 2F) with two setae on basal segment: proximal one (d1) more than three times longer than distal one (d2). Seta on first endopodal segment not reaching distal end of following segment, seta on following segment exceeding distal end of terminal segment. Both setae on penultimate segment short. Terminal claw 1.3 times longer than three endopodal segments combined.

Third thoracopod (Figure 4D) with all three basal setae present. Generally, this appendage typical for entire family.

Caudal ramus (Figure 2D, H) with long and thin ramus, with row of setae on posterior margin. Anterior seta very short, posterior one situated low on ramus and slightly exceeding its tip. Anterior



**Figure 2** *Riocypris hinzei* sp. nov., holotype male: A, hemipenis; B, right prehensile palp; C, left prehensile palp; D, distal part of the caudal ramus; E, Zenker's organ; F, second thoracopod; G, attachment of the caudal ramus; H, caudal ramus. Scales = 0.1 mm.

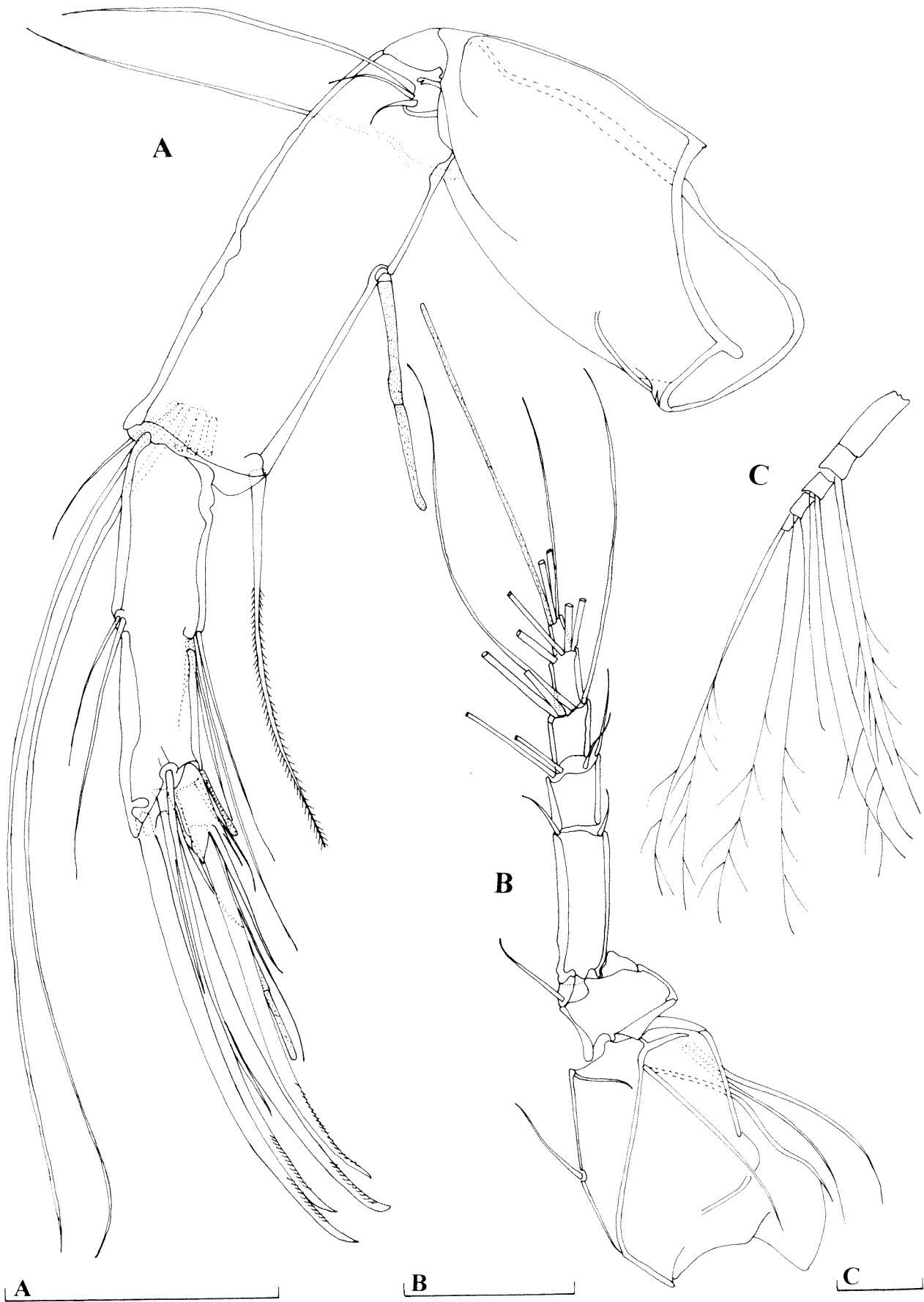


Figure 3 *Riocypris hinzei* sp. nov., holotype male: A, antenna; B, C, antennula. Scales = 0.1 mm.



**Figure 4** *Riocypris hinzei* sp. nov., holotype male: A, mandibular coxa, B, forehead and rake-like organ; C, mandibular palp; D, third thoracopod; E, distal part of the mandibular coxa. Scales = 0.1 mm.



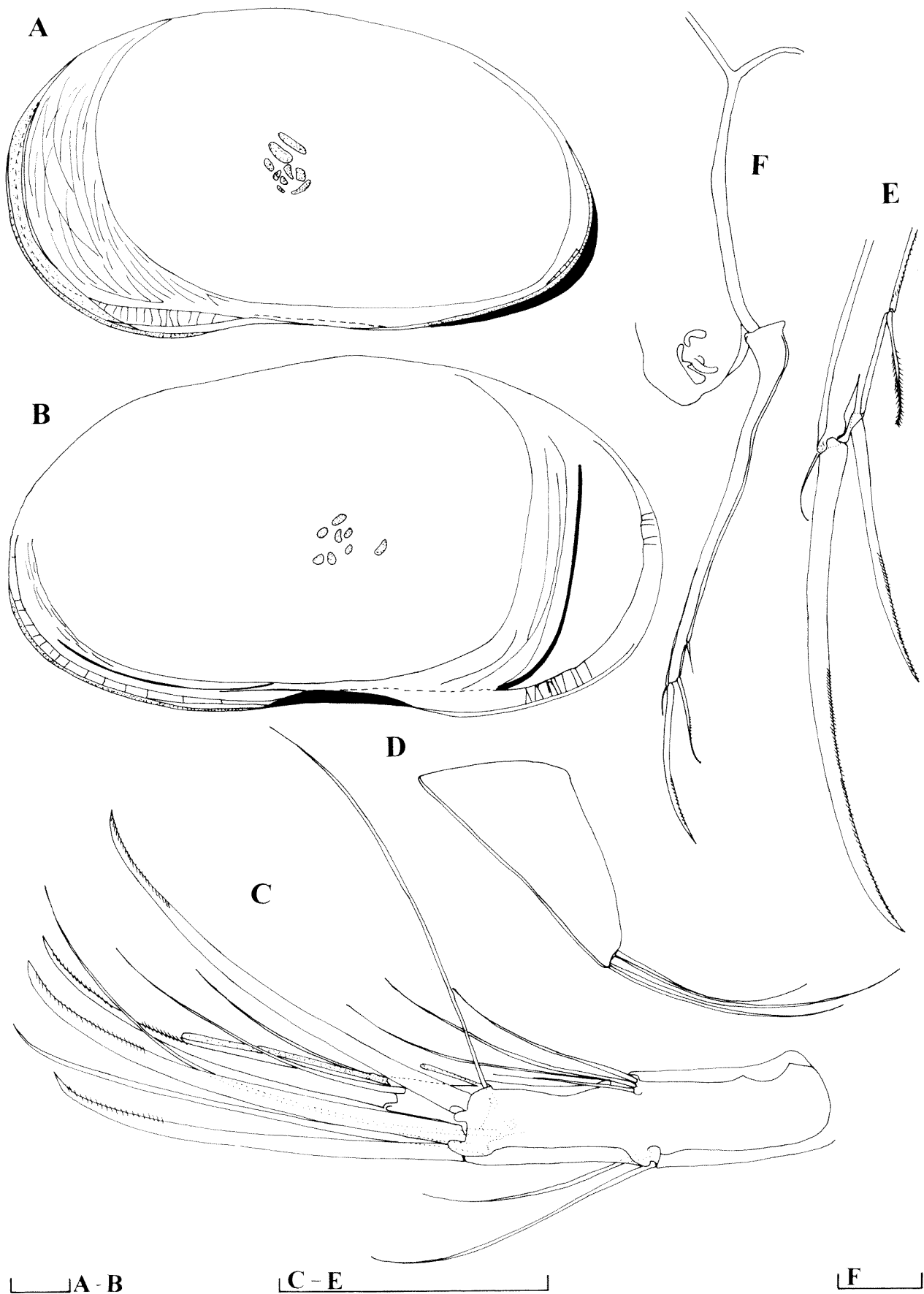


Figure 5 *Riocypris hinzei* sp. nov., allotype female: A, right valve, internal view; B, left valve, internal view; C, antenna, D, protodop of the first thoracopod; E, caudal ramus distal part; F, caudal ramus. Scales = 0.1 mm.

claw almost two times longer than posterior one. Length ratio of anterior margin and anterior claw equalling 2.3 : 1. Attachment of ramus (Figure 2G) simple.

Hemipenis (Figure 2A) with coiled internal canals. Lobe "a" higher than lobe "b", both lobes being bluntly pointed. Zenker's organ (Figure 2E) with numerous rows of spines.

#### *Female (allotype)*

Length of carapace 1.09 mm. Shape and other features same as in male.

Antenna (Figure 5C) with all three z setae long and all claws well developed and subequally long.

First thoracopod (Figure 5D) with three setae on tip of endopod.

Caudal ramus and genital field (Figure 5E, F). Length ratio between anterior margin and anterior claw equalling 2.2 : 1. Genital field rounded.

All other appendages similar to one in male.

#### **Etymology**

The new species is named after Ms Susan Hinze, one of the collectors of the material. The name is to be treated as a noun in the genitive singular.

### **Subfamily Cyprinotinae Bronstein, 1947**

#### **Genus *Cyprinotus* Brady, 1886**

*Cyprinotus* Brady, 1886a: 302.

#### **Type species**

*Cyprinotus cingalensis* Brady, 1886, by original designation.

#### **Remarks**

The genus *Cyprinotus* Brady, 1886 belongs to the subfamily Cyprinotinae, together with the genera *Heterocypris* Claus, 1892, *Hemicypris* Sars, 1903 and *Homocypris* Sars, 1924. The similarity between the genera *Cyprinotus* and *Heterocypris* has been discussed extensively in the literature (Meisch 2000). The only difference between the two genera is the presence of a hump-like dorsal extension on the right valve in the former genus, which can be traced through the geological record (Malz 1976). There are about 12 Recent species that can be assigned to *Cyprinotus* with certainty and many more Fossil ones. The genus is presently distributed in Africa, Southeast Asia and Australia. Pinto and Purper (1965) described *Cyprinotus trispinosus* Pinto and Purper, 1965 from Brazil, but this species can hardly belong to the genus *Cyprinotus*, because of the appearance of the caudal ramus and the terminal segment of the maxillula. Its long caudal ramus with very short setae suggests the species is more closely related to the genus *Strandesia* Stuhlmann, 1888 than to the genus *Cyprinotus*. In fact, the Triebel loop on

the attachment of the caudal ramus, characteristic of the genus *Strandesia*, seems to be present in the species *C. trispinosus* (see plate 6, figure 5 in Pinto and Purper 1965). Where Australia is concerned, the following six species of the genus *Cyprinotus* have been recorded so far: *C. carinatus* (King, 1855), *C. cingalensis* Brady, 1889; *C. dahli* Sars, 1897; *C. fuscus* Henry, 1919; *C. kimberleyensis* McKenzie, 1966 and *C. edwardi* McKenzie, 1978). *Cyprinotus carinatus* and *C. fuscus* were described from south-eastern Australia (King 1855; Henry, 1919); *C. cingalensis* was originally described from Sri Lanka by Brady (1886a) but later recorded throughout Southeast Asia and found by Sars (1889) in Queensland. *Cyprinotus kimberleyensis* and *C. dahli* were both described from north-western Australia (Sars 1896; McKenzie 1966b). *Cyprinotus kimberleyensis* was also recorded from Japan (Okubo 1974). The species *C. edwardi* was described from Lake Wagin in Western Australia, but it is widely distributed in southern Australian lakes (McKenzie 1978). When McKenzie (1966b) described the species, he pointed out that it is closely related to *C. cingalensis* and *C. dahli* from which it differs by the smaller size and the shape of the hump. However, I have examined populations from the Pilbara in which both size (lengths from 1.05 mm to 1.4 mm) and the appearance of the dorsal hump are very variable. Similar variation was observed in the northern Kimberley (Halse *et al.* 1996; S. Halse, pers. comm.). Therefore, I consider *C. dahli* and *C. kimberleyensis* to be junior synonyms of *C. cingalensis*. Their soft parts are almost identical, as are those of *C. uenoi* which was described from China (Brehm 1936) but was subsequently found both in Southeast Asia (Victor and Fernando 1981) and Japan (Okubo 1974). Thus *C. uenoi* is here also synonymized with *C. cingalensis*; this species is now seen to be widely distributed throughout Southeast Asia and north-western Australia. The same case is also with *C. edwardi*. McKenzie (1978) mentioned only a slightly more flexuous appearance of the carapace in dorsal view, as the only difference between his newly described species and both *C. dahli* and *C. kimberleyensis*. So, I consider *C. edwardi* a junior synonym of *C. cingalensis*. The two species recorded from the southeastern Australia differ from *C. cingalensis* by the pronounced ventral extension of the right valve.

#### ***Cyprinotus cingalensis* Brady, 1886**

Figures 6–9

*Cyprinotus cingalensis* Brady 1886a: 302, plate 38, figures 28–30; Sars 1889: 25, plate 1, figures 5–6, plate 3, figure 12; Victor and Fernando, 1979: 180, figures 125–126.

*Cyprinotus dahli* Sars 1896: 24, plate 4, figures 1–5.

**New synonymy.**

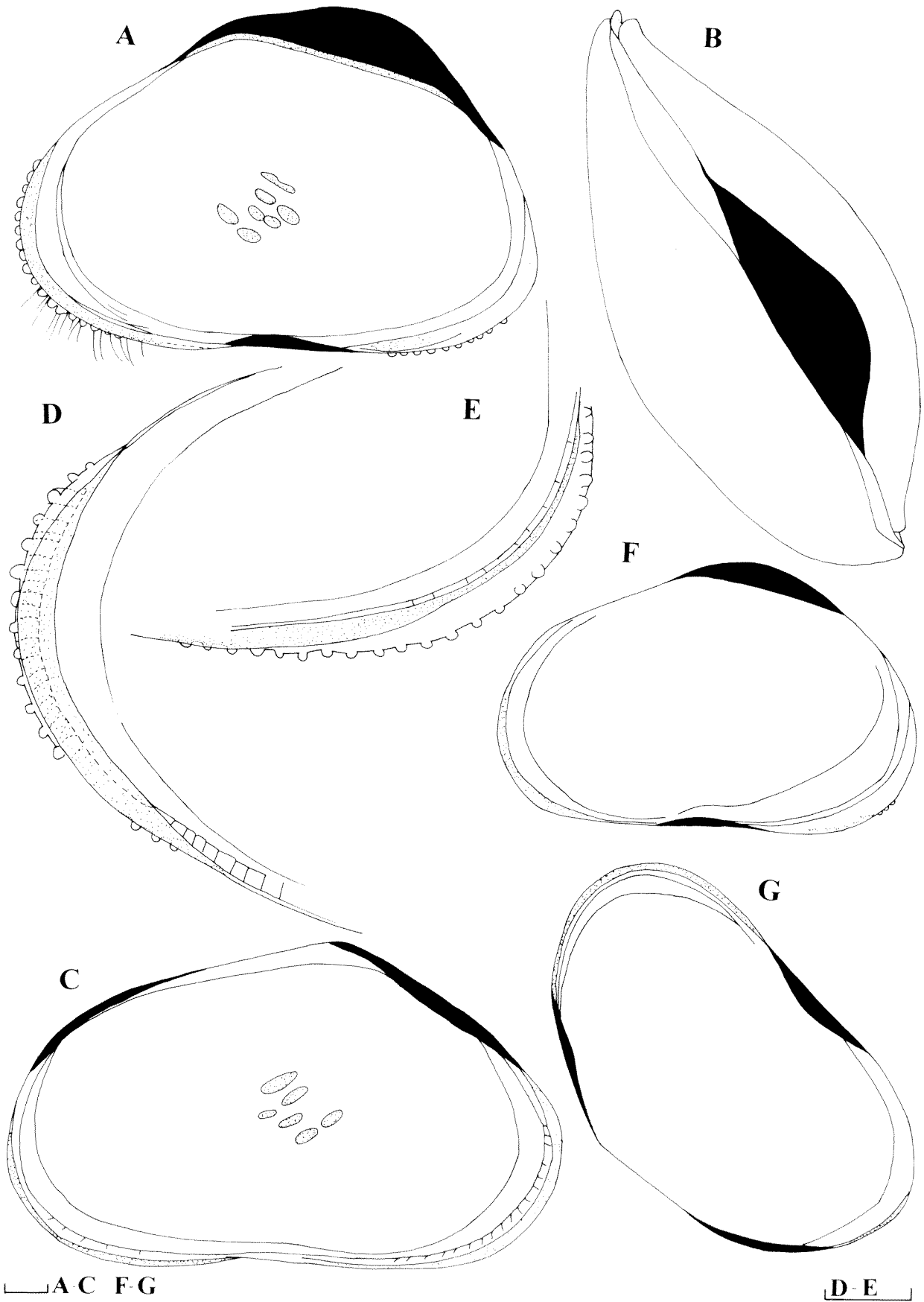
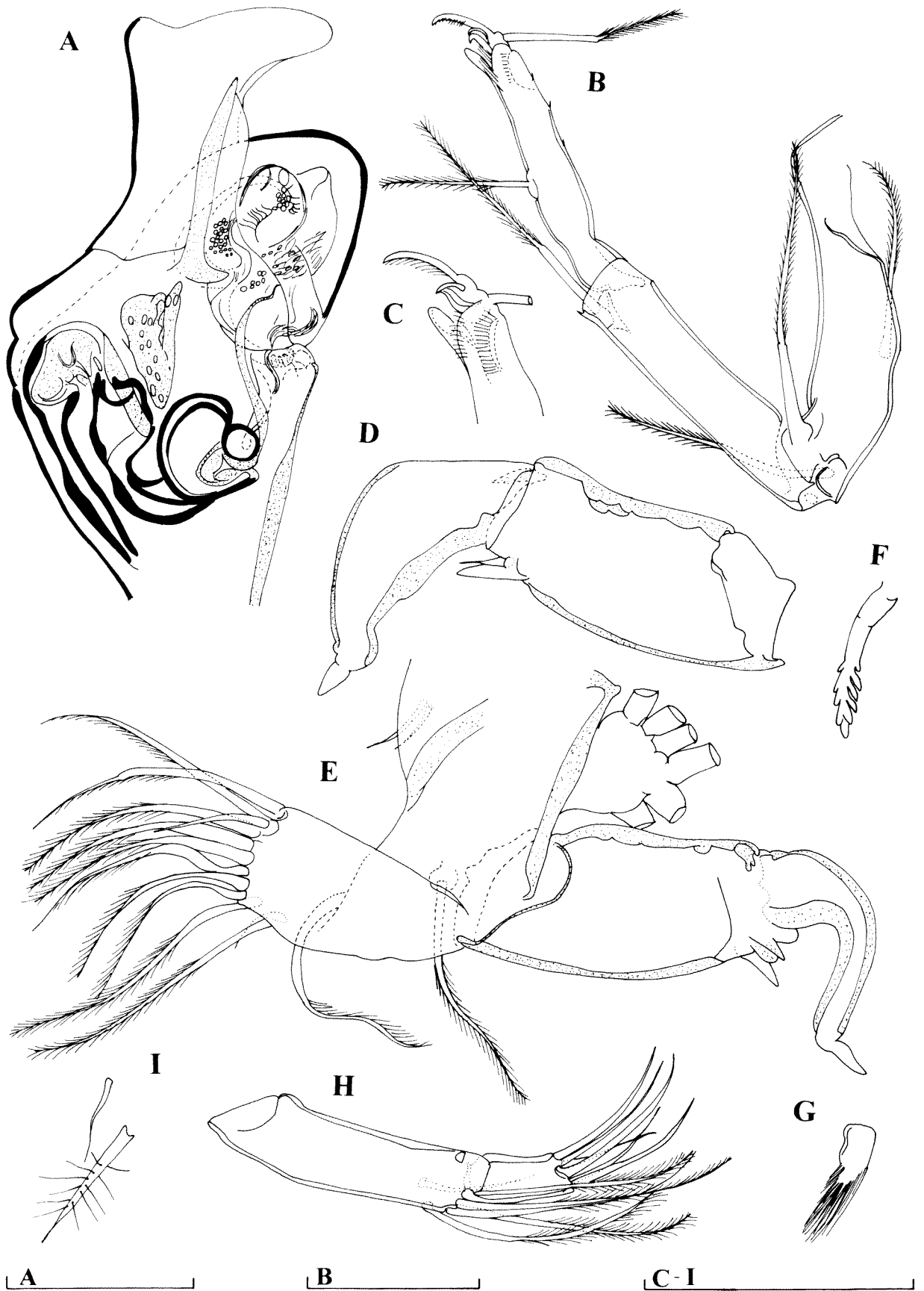


Figure 6 *Cyprinotus cingalensis* Brady, 1889, A-E, male (length, 1.3 mm) from Government Well #40; F-G, male (length, 1.05 mm) from Ten Mile Well: A, right valve, internal view; B, carapace, dorsal view; C, left valve, internal view; D, right valve, anterior margin; E, right valve, posterior margin; F, right valve, internal view; G, left valve, internal view. Scales = 0.1 mm.



**Figure 7** *Cyprinotus cingalensis* Brady, 1889, male (length, 1.3 mm) from Government Well #40: A, hemipenis; B, third thoracopod; C, third thoracopod, distal part; D, right prehensile palp; E, left prehensile palp; F, tooth on the third thoracopod endite of the maxillular palp; G, gamma seta on the mandibular palp; H, maxillular palp; I, alpha and beta setae on the mandibular palp. Scales = 0.1 mm.

*Cyprinotus uenoi* Brehm 1936: 374, figures 1–4; Okubo, 1974: 63, figure 3; Victor and Fernando, 1981: 13, figures 1–17. **New synonymy.**

*Cyprinotus kimberleyensis* McKenzie 1966b: 262, figures 2A–F; Okubo, 1974: 66, figures 2, 4. **New synonymy.**

*Cyprinotus edwardi* McKenzie 1978: 182, figures 8–10, 29, 52–57. **New synonymy.**

#### Material examined

**Australia: Western Australia:** 1 ♂, 2 ♀, Government Well #40, Savory 2, Pilbara Region, 23°51'49"S, 120°09'02.4"E, 21 June 2004, M. Scanlon, J. Cocking (PSS 280) (WAM C35699-35701, on slides); 1 ♀, 1 empty shell, 6 half shells, Helen's Well, Pilbara Region, 20°52'13.1"S, 120°20'44.2"E, 12 September 2004, M. Scanlon, J. Cocking (PSS 404) (WAM C35702, in alcohol); 46 ♀, 22 juveniles and 100 half and empty shells, Ten Mile Well, WAR 11, Pilbara Region, 20°51'34.2"S, 120°32'45"E, 11 September 2004, M. Scanlon, J. Cocking (PSS 401) (WAM C35703, in alcohol); numerous whole animals, half and empty shells, Ten Mile Well, WAR 11, Pilbara Region, 20°51'34.2"S, 120°32'45"E, 7 May 2005, M. Scanlon, J. Cocking (PSS 401) (WAM C35704, in alcohol).

#### Redescription

##### Male

Length of left valve around 1.3 mm. Greatest height in front of middle, equalling 62% of length (Figure 6C). Right valve smaller than left one and 1.2 mm long; greatest height situated behind middle and equalling 68% of length (Figure 6A). Greatest width behind middle, equalling 45% of length (Figure 6B). Carapace subtriangular in lateral view. Anterior and posterior margins equally wide; dorsal margin highly arched; ventral margin straight. Left valve (Figure 6C), with small dorsal flange; selvage peripheral all around margins. Inner calcified lamella equalling only 8% of length both anteriorly and posteriorly. Marginal pore canals straight and short. Right valve (Figure 6A) with well developed dorsal flange which overlaps left valve. Salvage displaced internally on both anterior and posterior margins (Figure 6D, E); both free margins carrying row of blunt teeth. Left valve overlaps right one on all free margins, except dorsally. Carapace surface covered with hairs and surface ornamented with small pits (Figure 9A).

Antennula (Figure 9E) 7-segmented. Protopod with both exopodal setae developed. Proximal coxobasal seta transformed into sensory organ, while distal one well developed. First endopodal segment with one anterior seta, not reaching middle of following segment. Second segment with one posterior and one anterior seta, both very short. Third endopodal segment with two short posterior

and two long anterior setae. Fourth and fifth segments with four long swimming setae each. Terminal segment with one aesthetasc, two long swimming setae and one half as long as aesthetasc. Length ratios between five terminal segments: 2.9 : 1.9 : 1 : 1 : 1. Swimming setae extending far beyond terminal segment.

Antenna (Figure 8A, E) with swimming setae exceeding tip of terminal claws. Shortest seta among them reaching middle of penultimate segment. Penultimate segment medially with two setae on exterior side and four setae on interior side. Setae z1 and z2 transformed into long claws, z3 seta like. Claw G2 long, G1 short but seta like, G3 transformed into seta. Terminal segment with claw Gm well developed and almost reaching tip of other claws, while Gm less than half as long as Gm. Aesthetasc Y 0.3 times as long as first endopodal segment, y3 as long as terminal segment. Length ratios between endopodal segments equalling 4 : 3.5 : 1.

Mandibular seta alpha tiny, beta seta better developed (Figure 7I), while gamma seta conical, short and strong (Figure 7G).

Maxillular palp (Figure 7H) with six long and one short seta (situated on opposite side from long ones) on penultimate segment. Terminal segment elongated two times longer than wide. Teeth on first endite strongly serrated (Figure 7F).

First thoracopod (Figure 7D, E), with two "a" setae, and "b" and "d" seta on protopod. Endopod transformed into palps: right one (Figure 7D) with much stronger finger than left one (Figure 7E). Exopod with six rays.

Second thoracopod (Figure 9D) with one seta on basal segment. Seta on first endopodal segment not reaching distal end of following segment, seta on following segment exceeding distal end of terminal segment. Terminal claw 1.3 times longer than three endopodal segments combined.

Third thoracopod (Figure 7B, C) with all three basal setae present. Generally, this appendage typical for entire family.

Caudal ramus (Figure 8C) with long and thin ramus, with row of setae on posterior margin. Anterior seta reaching 1/3 of anterior claw, posterior one situated low on ramus and almost reaching tip of posterior claw. Anterior claw more than two times longer than posterior one. Length ratio of anterior margin and anterior claw equalling 1.4 : 1. Attachment of ramus (Figure 8B) simple.

Hemipenis (Figure 7A) with coiled internal canals. Lobe "a" higher than lobe "b" and foot-like; lobe "b" rounded. One well-chitinised lobe present between lobes "a" and "b".

##### Female

Length of carapace 1.3 mm. Shape and other features same as in male (Figure 9A, B).



**Figure 8** *Cyprinotus cingalensis* Brady, 1889, A-C, E male (length, 1.3 mm) from Government Well #40; D, F female (length, 1.3 mm) from Government Well #40: A, antenna; B, attachment of the caudal ramus; C, caudal ramus; D, attachment of the caudal ramus; E, F, antenna, detail. Scales = 0.1 mm.

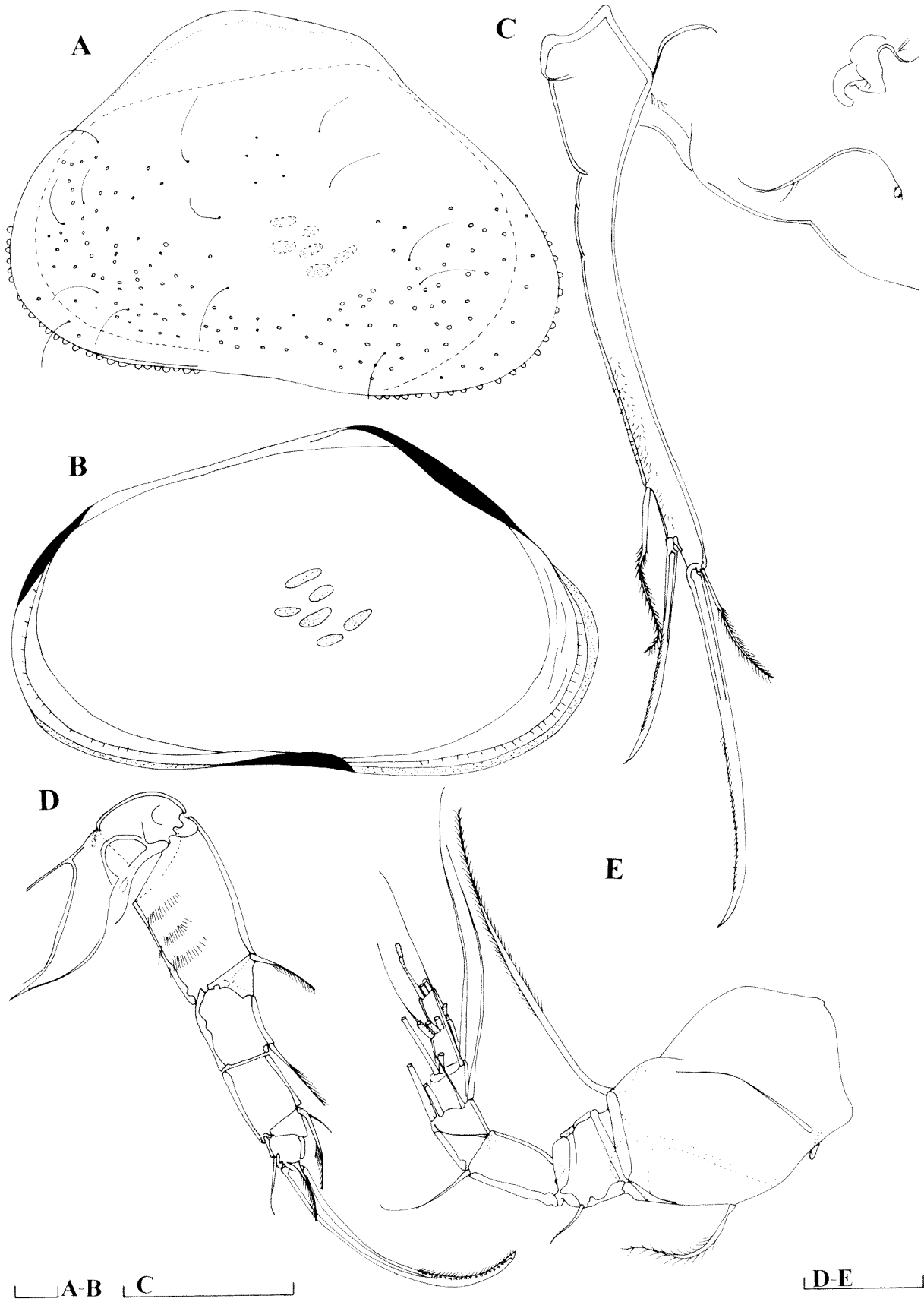


Figure 9 *Cyprinotus cingalensis* Brady, 1889, female (length, 1.3 mm) from Government Well #40: A, carapace, lateral view from right side; B, left valve, internal view; C, caudal ramus and the genital field; D, second thoracopod; E, antennula. Scales = 0.1 mm.

Antenna (Figure 8F) with all three z setae long, claw G2 being much shorter than other long claws.

Caudal ramus and genital field (Figure 9C). Length ratio between anterior margin and anterior claw equalling 1.4 : 1. Genital field rounded.

All other appendages similar to those in male.

#### Subfamily ?Cypridinae Baird, 1845

#### Genus *Bennelongia* De Deckker and McKenzie, 1981

*Bennelongia* De Deckker and McKenzie 1981: 53.

#### Type species

*Bennelongia harpago* DeDeckker & McKenzie, 198, by original designation.

#### Remarks

The genus *Bennelongia* DeDeckker and McKenzie, 1981, was described and is so far only known from Australia. Today, it contains six recent species (DeDeckker and McKenzie 1981; DeDeckker 1981a, 1982b): *B. australis* (Brady, 1886), *B. barangaroo* De Deckker, 1981, *B. harpago* De Deckker and McKenzie, 1981, *B. nimala* De Deckker, 1981, *B. pinpi* De Deckker, 1981, and *B. tunta* De Deckker, 1982. The genus was erected to distinguish the Australian group of species that are closely related to the genus *Chlamydotheca* Saussure, 1858, from those in South America, where most members occur. The Australian genus differs from *Chlamydotheca* mainly in having asymmetrical prehensile palps. Both genera were placed in the subfamily Cypridinae, but cannot remain there following the new diagnosis consequent on the revision of this subfamily (Martens 1990, 1992). The subfamily Cypridinae is characterized by "8"-shaped loops in the inner spermiducts but this is not present in either *Bennelongia* or *Chlamydotheca*. A revision of the genus *Bennelongia* is in progress (K. Martens and S. Halse, in preparation). The species presented in this paper is identified as *B. australis* (Brady, 1886) originally described in the genus *Chlamydotheca* by Brady (1886b), and it has a wide distribution in Australia. Unfortunately, the identity of most *Bennelongia* species is difficult to establish due to the variability in the carapace shape within one species and uniformity of the internal morphology. Therefore, the present identification remains uncertain until further revision of the genus.

#### *Bennelongia australis* s. l. (Brady, 1886)

Figures 10–12

*Chlamydotheca australis* Brady 1886b: 91, plate 9, figures 408.

*Bennelongia australis* (Brady, 1886): DeDeckker 1981a: 95, figures 3–6.

#### Material examined

**Australia: Western Australia:** 3 ♂, 19 ♀, Irwin Well, Millstream Aquifer, Pilbara Region, 21°40'S, 117°09'E, 20 October 1996, W.F. Humphreys (BES: 4564) (2 ♂, 1 ♀, WAM C35705-35707, on slides; the remainder, WAM C35708, in alcohol); 124 ♀ 29 ♂, Irwin Well (net over outlet for two days), Pilbara Region, 21°40'S, 117°09'E, 20 October 1996, W.F. Humphreys (BES: 4013) (WAM C35709, in alcohol); 2 ♀ CP 3 11/81, Chinderwariner (Crystal) pool, Millstream, Pilbara Region, 20°33'S, 118°14'E, 20 October 1996, W.F. Humphreys (BES: 4468) (WAM C35710, in alcohol).

#### Additional description

##### Male

Length around 1.7 mm. Greatest height in mid-anterior, equal to 50% of length (Figure 10C, D). Greatest width around middle, equalling 62% of length (Figure 10A, B). Carapace elliptical in lateral view. Anterior and posterior margins equally wide; dorsal margin slightly rounded; ventral margin straight or slightly concave. Left valve (Figure 10C), with small dorsal flange; selvage peripheral all around margins, inner list well developed anteriorly, much lesser posteriorly. Inner calcified lamella equalling 12% of length anteriorly, and only 6% posteriorly. Marginal pore canals straight. Right valve (Figure 10D) without well developed inner list. Selvage displaced internally on front margin. Antero-ventral "beak" better developed on right valve than left valve. Left valve overlaps right one on all free margins (Figure 10A, B, E). Carapace surface covered with hairs and ornamented with shallow pits.

Antenna (Figure 11C) with swimming setae exceeding tip of terminal claws. Penultimate segment medially with two setae on exterior side and four setae on interior side. Setae z1 and z2 transformed into long claws, z3 seta like and reaching tip of terminal claws. Claw G2 as long as transformed z setae, while claws G1 and G3 transformed. Terminal segment with claw Gm well developed and almost reaching tip of other claws, while Gm less than half as long as Gm.

Rake like organ (Figure 11I) with 7 teeth.

Maxillular palp (Figure 11EG) with six long and one short seta (situated on opposite side from long ones) on penultimate segment. Terminal segment elongated 3 times longer than wide. Teeth on first endite smooth (Figure 11F).

First thoracopod with two "a" setae, and "b" and "d" seta on protopod. Endopod transformed into palps: right one (Figure 10G) with much stronger finger than left one (Figure 10F). Exopod with six rays.



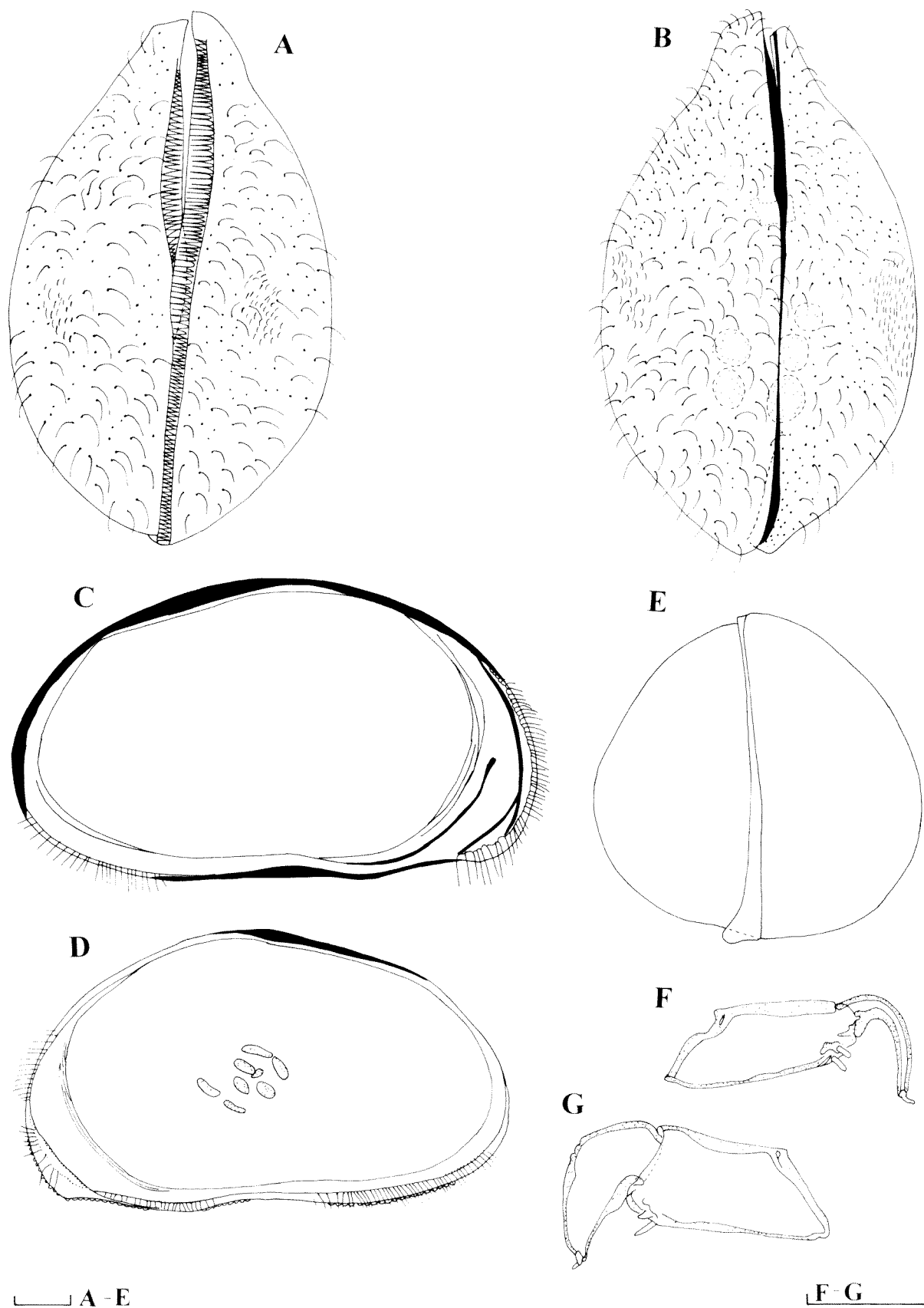
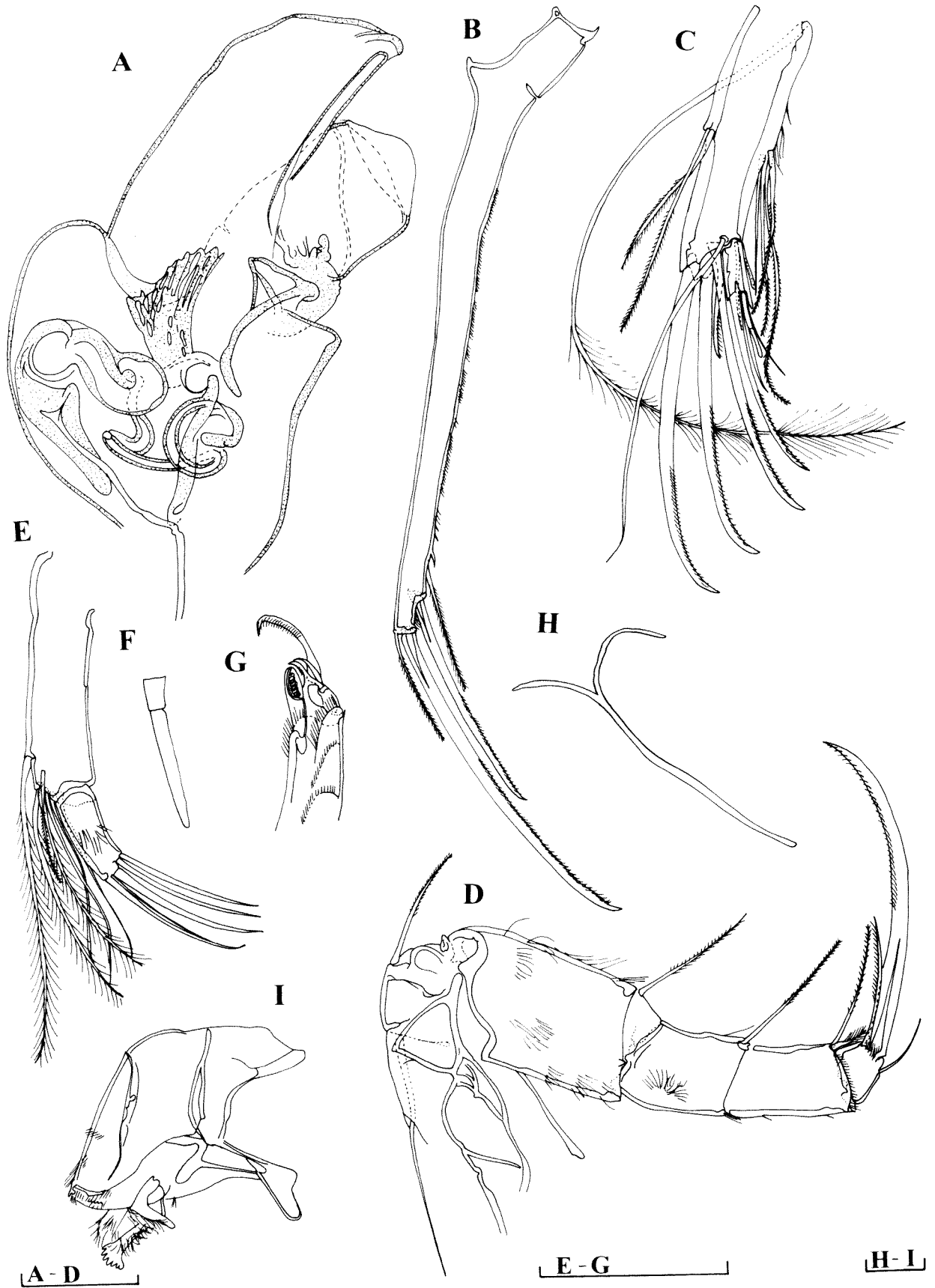


Figure 10 *Bennelongia australis* s. l. (Brady, 1886), male (length, 1.7 mm) from Irwin Well: A, carapace, ventral view; B, carapace, dorsal view; C, left valve, internal view; D, right valve, internal view; E, carapace, frontal view; F, left prehensile palp; G, right prehensile palp. Scales = 0.1 mm.



**Figure 11** *Bennelongia australis* s. l. (Brady, 1886), male (length, 1.7 mm) from Irwin Well: A, hemipenis; B, caudal ramus; C, antenna; D, second thoracopod; E, maxillular palp; F, tooth on the third endite of the maxillula; G, distal part of the third thoracopod; H, attachment of the caudal ramus; I, forehead and rake-like organ. Scales = 0.1 mm.

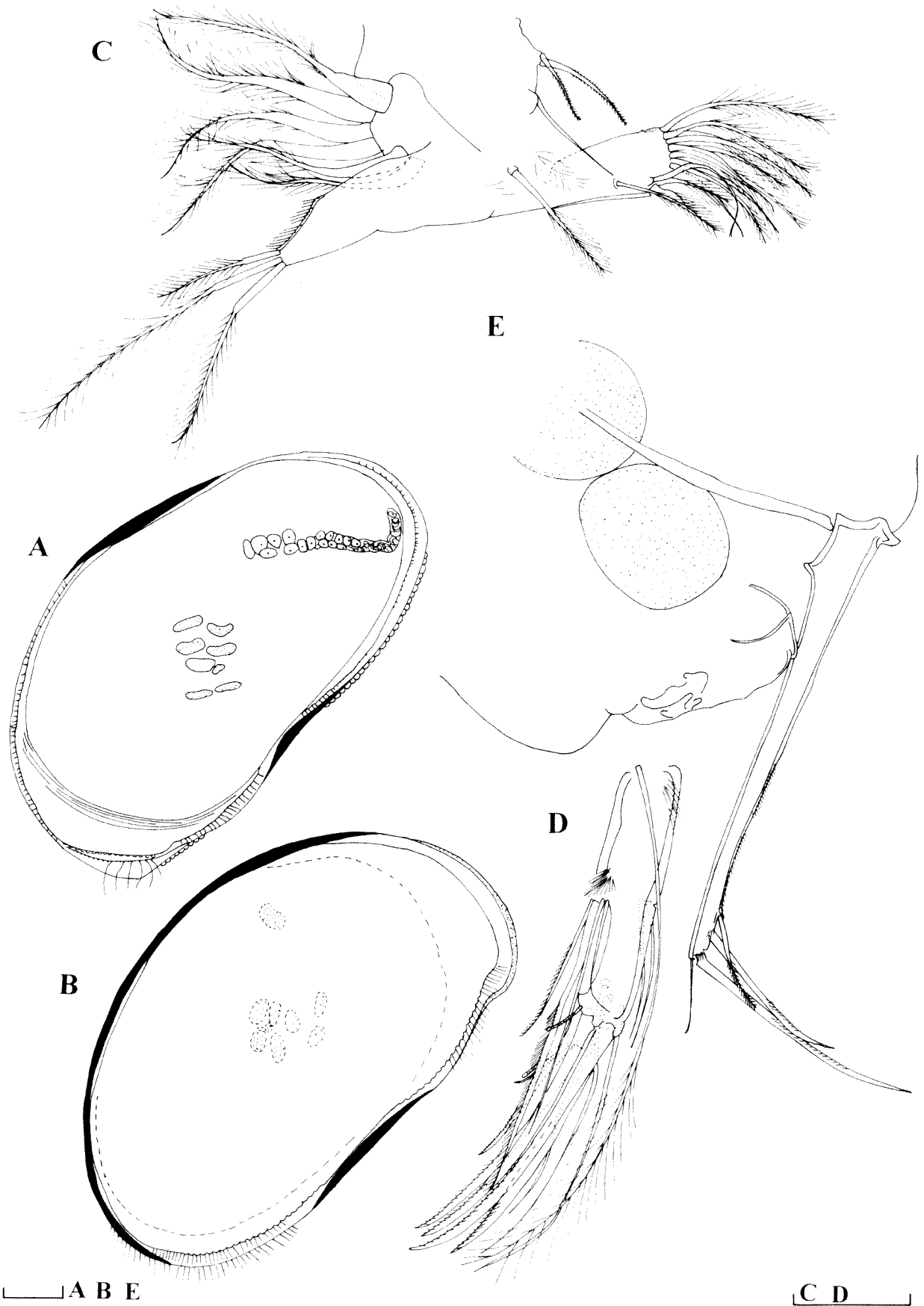


Figure 12 *Bennelongia australis* s. l. (Brady, 1886), female (length, 1.7 mm) from Irwin Well: A, right valve, internal view; B, left valve, internal view; C, first thoracopod; D, antenna; E, caudal ramus and the genital segment. Scale = 0.1 mm.

Second thoracopod (Figure 11D) with two setae on basal segment: proximal one (d1) more about two times longer than distal one (d2).

Third thoracopod (Figure 11G) with all three basal setae present. Generally, this appendage typical for entire family.

Caudal ramus (Figure 11B) with long and thin ramus, with row of small spines on posterior margin. Anterior seta short and equally long as posterior one. Anterior claw almost two times longer than posterior one. Length ratio of anterior margin and anterior claw equalling 1.6 : 1. Attachment of ramus (Figure 11H) simple.

Hemipenis (Figure 2A) with coiled internal canals. Lobe "a" higher than lobe "b", both lobes being bluntly pointed.

#### Female

Length of carapace about 1.7 mm. Shape and other features same as in male (Figure 12A–B).

Antenna (Figure 12D) with all three z setae long and all claws well developed and subequally long.

First thoracopod (Figure 12D) with three setae on tip of endopod.

Caudal ramus and genital field (Figure 12E). Length ratio between anterior margin and anterior claw equalling 1.6 : 1. Genital field rounded.

All other appendages similar to one in male.

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