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Revision of the isopod crustacean genus *Mothocya* Costa, in Hope, 1851 (Cymothoidae: Flabellifera), parasitic on marine fishes

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The genus *Mothocya* is fully revised. *Irona* Schioedte and Meinert is placed in synonymy with *Mothocya*. All named species but one, including 18 new species, are described and figured in detail. A further eight undescribed species are listed. With one exception *Mothocya* species are all gill parasites found principally on atherinomorph fishes of the families Hemiramphidae, Belonidae, and Atherinidae. Brief accounts are given of the biogeography, biology and host–parasite interaction of the species of *Mothocya*. Keys to the species are provided for the different major biogeographic regions.

Contents

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Introduction

The genus *Mothocya* (including *Irona*) is not large, and prior to this work contained only 12 named species. The genus was not considered problematic other than uncertainty over the validity of the genus *Irona* (Monod, 1923; Trilles, 1968 a; Monod, 1971). The appearance of simplicity in dealing with *Mothocya* was dispelled when it became evident that most earlier species' determinations were incorrect, and that the number of species was about three times that currently recognized.

Reference to type-specimens was essential to link new material to established names. Two of the types consisted of a polytypic series (*Mothocya melanosticta*, *Mothocya nana*), and designation of lectotypes was essential to stabilize future use of the names. Confirmation of many previous records helped remove ambiguities from the recorded data on distribution and host preferences, while also demonstrating the unreliability of older studies and identifications.

A large series of specimens allowed for full descriptions of species and it is now possible to give a restrictive diagnosis to the genus. It is also possible to offer a generic description that considers characters that are not diagnostic, but still typical of all species found in the genus. It is only in this way that the generic problems that exist at present within the Cymothoidae will begin to be resolved.

Materials and methods

Specimens were gathered from several sources, the major one being the isopods collected by Dr Bruce B. Collette during his studies of the fish families Belonidae and

Hemiramphidae. Additional material was obtained from the collections of the Queensland Museum (Brisbane), The Australian Museum (Sydney), the Bernice P. Bishop Museum (Honolulu), the Smithsonian Institution (Washington, DC), and the British Museum of Natural History (London), and other institutions. Attempts, almost entirely successful, were made to obtain all the type-specimens of previously described material, and all the specimens on which accounts had been published.

In identifying the abundant material reported on here, the approach used was purely morphological. Specimens were grouped according to locality (e.g., West Africa, Indian Ocean, etc.). Host identity was ignored, and the specimens sorted into 'look-alikes'. Many 'look-alikes' were later merged into single species (e.g., variations of *M. renardi*).

Data

Much of the material obtained by Dr Collette is from museum specimens of some antiquity. Many samples lacked precise data such as co-ordinates, date or collector. Many specimens obtained from biologists studying the effect of isopods on the host or the life-cycle of the isopods also lacked precise data. Only when a type-locality was involved was an attempt made to restrict the locality beyond that given on the specimen label.

In the case of host identifications, those of the families Belonidae and Hemiramphidae were made by Dr B. B. Collette. Determinations not made by him, and which are of species not represented in his collections, are listed as unconfirmed. Nomenclature for the Belonidae and Hemiramphidae can be found in Collette (1974), Parin (1967) and Parin *et al.* (1980). Names for the Australian Atherinidae were from determinations made and confirmed by Dr W. Ivantsoff, and follow Prince *et al.* (1982) and Whitehead and Ivantsoff (1983). Western Atlantic Apogonidae and Atherinidae species names were taken from Robins *et al.* (1980). Higher classification was taken from Norman and Greenwood (1975), Greenwood *et al.* (1966) and Collette *et al.* (1984).

Drawings

All drawings of pereopods, antennule and antenna, and pleopods are (respectively) drawn to the same scale except where indicated. Except for the smaller species (such as *M. epimerica*), all pereopods were drawn under the dissecting microscope. All pleopods were lightly flattened under a glass embryo dish cover and drawn under the dissecting microscope.

Measurements

Lengths were obtained along the median line from anterior margin of the cephalon to pereonite 5, and from pereonite 5 to the posterior margin of the pleotelson. Lengths must be regarded as approximate as the degree of twisting, contraction of segments due to preservation, and frequency of damage to the pleotelson render precise measurements meaningless.

The width of the pleon is given as the ratio of the width of the pleon at a line through pleonite 4, and the width of pereonite 5 between the lateral sutures (the suture that runs dorsally, from the middle of the suture that separates the coxal plate from the pereonite) and excluding the coxae. Pereonite 5 was used as the reference as it is commonly the widest; the coxae are excluded as they are commonly distorted, and vary in shape and in their angle to the body.

Terminology

The body of the mature female is frequently twisted to one side, with one side effectively being compressed, the other dilated or expanded. The two sides of animal will be referred to as straight (compressed side) and convex (dilated side).

Names

Names of new species were, where appropriate, derived from those of the commoner host species, or from the host genus. Classical names were developed using Brown (1956). The Australian Aboriginal names were taken from *Aboriginal Words of Australia* (Anon, 1965).

Abbreviations

AHF	Allan Hancock Foundation, University of Southern California, Los Angeles, USA
AIM	Auckland Institute and Museum, Auckland, New Zealand
AM	The Australian Museum, Sydney, New South Wales, Australia
ANSP	Academy of Natural Sciences, Philadelphia, Pennsylvania, USA
BBC	B. B. Collette
BMNH	British Museum (Natural History), London, UK
*LACM	Los Angeles County Museum, Los Angeles, California, USA
*MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA
MNHN	Muséum Nationale d'Histoire Naturelle, Paris, France
NMV	Museum of Victoria, Melbourne, Victoria, Australia
NRS	Naturhistoriska Riksmuseet, Stockholm, Sweden
NSW	New South Wales, Australia
NT	Northern Territory, Australia
NTM	The Northern Territory Museum, Darwin, Australia
QLD	Queensland, Australia
QM	The Queensland Museum, Brisbane, Queensland, Australia
RMNH	Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands
SA	South Australia
SAM	The South Australian Museum, Adelaide, South Australia
SAfM	The South African Museum, Durban, South Africa
TM	The Tasmanian Museum and Art Gallery, Hobart, Tasmania, Australia
TSM	Toyama Science Museum, Toyama, Japan
USNM	National Museum of Natural History, Smithsonian Institution, Washington, DC, USA
WA	Western Australia
WAM	Western Australian Museum, Perth, Western Australia
*ZMC	Zoologisk Museum, Copenhagen, Denmark

* These institutions do not or cannot give catalogue numbers.

Taxonomy

Family **CYMOTHOIDAE** Leach

Genus ***Mothocya*** Costa

Mothocya Costa, in Hope, 1851: 48; Trilles, 1968 a: 168; Monod, 1971: 174.

Irona Schioedte and Meinert, 1884: 381; Stebbing, 1905: 27; Richardson, 1905 b: 265; Hale, 1926: 281; Monod, 1971: 174; Kussakin, 1979: 307.

Diagnosis of female

Cephalon with rostrum; anterior margin of pereonite 1 never sinuate or lobed; coxae nearly as long as or longer than respective segment, broad and conspicuous in dorsal view. Pleon partly overlapped laterally by pereonite 7; pleonite 1 with lateral margin extended more on one side than on other. Antennule larger, more robust than antenna, bases of both widely separate. Maxilliped without oostegital lobe. Pereopods all robust, articles without carina, never flattened or swollen; pereopods all similar except 4 to 7 slightly longer than 1 to 3. Pleopods all lamellar; endopods of pleopods 3 to 5 with lamellar proximomedial lobe. Uropod exopod longer than endopod.

Additional characters. Body usually 2·0 to 2·5 times longer than wide, usually twisted to one side. Eyes dorsolateral. Pereonite 1 anterior margin recessed to accommodate cephalon; pleon broad, about 0·80 to 1·3 times width of pereonite 5, frequently wider than pereonite 7.

Antennule composed of seven or eight articles; antenna with seven to nine articles, usually nine. Mouthparts set strongly towards anterior of cephalon, distal apices sometimes almost between antennal bases. Mandible incisor narrow, acute; palp short without setae. Maxillule slender with one broad and three slender spines. Maxilla endopod with two recurved spines, lateral lobe with two to six recurved spines. Maxilliped 3-articled; article 3 with three to six recurved spines. Brood pouch made up of four pairs of oostegites arising from sternites near bases of pereopods 2, 3, 4 and 6; sternite 1 with reduced oostegite that never overlaps maxillipeds. Pleopod peduncles with distinct lateral lobe on pleopods 2 to 5, occasionally 1 to 5; exopod lateral margin with short suture present.

Male

Body not twisted, about 2·2 to 2·9 times longer than wide, pleon proportionally narrower than female. Appendages as for female, but buccal appendages set more posteriorly than in female and all males with appendix masculina on pleopod 2. Rostrum more strongly produced, eyes larger. Penes set on lobe on sternite 7, always short, not projecting posteriorly between pleopods.

Type-species

Mothocya epimerica Costa, in Hope, 1851, by designation. Costa (in Hope, 1851) described three species when he established the genus. Of these only *M. epimerica* has been utilized and is available as the type-species. The other two are unrecognizable.

Remarks

The genus *Mothocya* belongs with the group of genera that formed Schioedte and Meinert's (1884) Lironecinae. This group includes (amongst others) the genera *Cterissa* Schioedte and Meinert, 1884, *Pseudirona* Pillai, 1964, *Agarna* Schioedte and Meinert, 1884, and *Lironeca* Leach, 1818. *Agarna* and *Cterissa* are easily separated by their unusual coxal morphology and distorted body shapes (see Schioedte and Meinert, 1884; Trilles, 1981; Trilles and Paperna, 1980). *Pseudirona* is abundantly distinct from *Mothocya*, and in all respects except setosity and spination of the appendages agrees closely with *Lironeca*.

The genus *Lironeca* is a large one with about 45 described species at present, and the identity and validity of many of these are uncertain. While the number of species has

Table 1. Character differences between *Lironeca* and *Mothocya*.

Structure	Character differences	
	Lironeca	*Mothocya*
Cephalon	Posterior margin straight or sinuate	Posterior margin never sinuate
Antennule	Shorter than antenna	Larger than antenna
Antenna	Slender, 9+ articles	Short, 7–9 articles
Mandible	Palp often slender, article 3 often setose	Palp stout, article 3 never setose
Maxilliped	Ovig. ♀ with laminar oostegital lobe	Ovig. ♀ without laminar oostegital lobe
Pereopods	Slender, dactylus short; merus and carpus short, may be dilated; posterior pereopods may have carina or bosses	Robust, dactylus long; merus longer than carpus, never dilated; posterior pereopods without carina or bosses
Pleon	Usually largely free of pereonite 7	Deeply immersed in pereonite 7
Pleopods	Varied, lamellar, folded, or highly digitated	Always lamellar

increased over the years, only one study (Brusca, 1981) has made any attempt to delimit the genus, and fully describe the species being dealt with. Brusca described five species of *Lironeca*, and from even such a small selection of species it is apparent that a degree of morphological diversity exists that is inconsistent with that usually found within a single cymothoid genus. In order to assess the differences between *Mothocya* and *Lironeca* I examined specimens in the USNM crustacean collections of the species *L. californica* Schioedte and Meinert, 1884, *L. convexa* Richardson, 1905 a, *L. epimerias* Richardson, 1909, *L. redmani* Leach, 1818, *L. vulgaris* Stimpson, 1857 and a specimen tentatively identified (from Trilles, 1976 b) as *L. pomatoi*. From these specimens and Brusca's (1981) figures numerous differences can be discerned between the two genera. These differences are presented in Table 1. It must be remembered that most species of *Lironeca* are inadequately described, and that the characters listed in Table 1 for *Lironeca* are not necessarily found throughout the genus as it is currently composed.

The species *Lironeca californica* approaches the genus *Mothocya* in many ways. Unlike most *Lironeca* it lacks the laminar oostegital lobe on the maxilliped and has the antennule larger than the antenna, but in common with *Lironeca* it has a slender setose mandible palp, relatively narrow coxae, and has the pleon largely free of pereonite 7.

The characters which best serve to identify *Mothocya* are the usually twisted female body shape, the antennule always larger and stouter than the antenna, the maxilliped lacking a laminar oostegital lobe, the pereopods similar and robust, the pleopods all lamellar, and the pleon immersed in pereonite 7 to a greater or lesser degree.

Characters of taxonomic utility

This section relates only to the genus *Mothocya*, and is restricted to mature females. The most important characters in species identification are those of body morphology, and the morphology of the pleopods and uropods. Within the genus the antennules, antennae, mouthparts and pereopods are so uniform that they are usually of little assistance in making a species determination. Host identity may be useful in making a *Mothocya* identification.

(1) Body: shape, whether straight or twisted, narrow or broad; overall size can indicate species differences.
(2) Cephalon: eye size; rostrum shape, truncate or acute, short or produced.
(3) Pereon: coxal morphology is most important: length, posteriorly acute or rounded; which pereonite is widest; shape of posterior margin of pereonite 7.
(4) Pleon: yields important characters: relative width (compared to pereonite 5), lateral extension, degree to which it is overlapped by pereonite 7.
(5) Antenna and antennule: offer little in the way of species specific characters.
(6) Mouthparts: largely uniform throughout the genus, but maxilla and maxilliped may offer supportive characters in the number of spines they possess.
(7) Pereopods: extremely uniform throughout the genus.
(8) Brood pouch: relative depth and arrangement of oostegites (three or four pairs prominent in ventral view) may indicate to which group of species a specimen belongs.
(9) Pleopods: generally useful, development of peduncular lobes and proximomedial lobe on the endopods of pleopods 3 to 5, and presence or absence of the appendix masculina should be noted.
(10) Uropods: length; shape; relative lengths of rami; shape of peduncle.

Changes in taxonomic status of previously described Mothocya and Irona

Mothocya contracta Costa, in Hope, 1851. There are no types, figures, host indication, or locality for this species, and as the description is of a brevity that defies interpretation it is here designated *nomen dubium.*

Irona cypselurus Avdeev, 1978. Junior synonym of *Mothocya melanosticta.*

Mothocya detecta Costa, in Hope, 1851. Same comments as for *M. contracta;* also designated *nomen dubium.*

Irona far Nair, 1950. Junior synonym of *Mothocya plagulophora.*

Irona foveolata Hansen, 1897. Examination of Hansen's types (USNM 20729, 20730) shows that these belong to the genus *Lironeca*; the cephalic appendages, pleon morphology and shallow brood pouch all agree with the character states given for *Lironeca* in Table 1.

Irona nanoides Stebbing, 1905. The type of the species is apparently lost (J. Ellis and I. D. Wallace, personal communication), but Stebbing's (1905) figures strongly suggest that the species should be placed in *Lironeca.* Monod (1933) recorded this species from a variety of hosts in the Red Sea, and those specimens (MNHN No. 366, 379, 392, 463, 542, 543) are clearly *Lironeca.*

Irona philippinensis Avdeev, 1973. The description of this species is based on a single male. As species-specific characters are only present in adult females, and males cannot be reliably identified, *I. phillippinensis* is here regarded as *species inquirenda* (see remarks for *Mothocya arrosor*).

Irona robusta Nair, 1950. Junior synonym of *Mothocya renardi.*

Irona vatia Schioedte and Meinert, 1884. Junior synonym of *Mothocya plagulophora.*

Mothocya epimerica Costa

(Figs 1, 2)

Mothocya epimerica Costa, in Hope, 1851: 48; Carus, 1885; 444; Monod, 1923: 19, fig. 8; 1971: 175; Montalenti, 1948: 57, figs 22, 23, pl. 6; Delamare Deboutteville, 1951: 101; Tuzet, Manier and Ormières, 1959: 505, 518, 529; Trilles, 1962: 102, figs 3–5; 1964 a: 108, 114; 1964 b: 127; 1964 c:

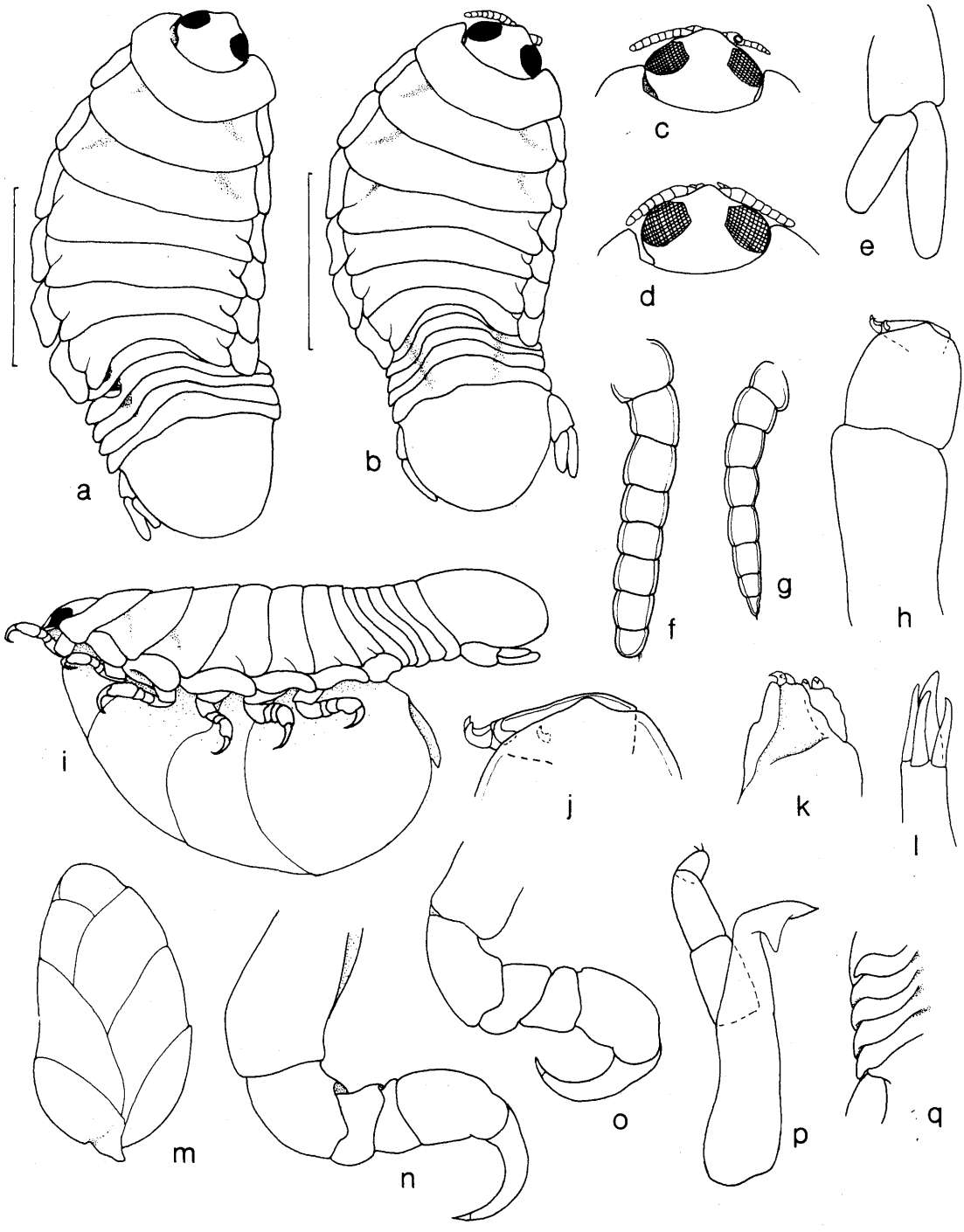

FIG. 1. *Mothocya epimerica*: b–d, i, m, ♀ 8·8 mm, remainder ♀ 9·3 mm, Murcia. a, dorsal view (dissected); b, dorsal view; c, cephalon; d, cephalon; e, uropod; f, antennule; g, antenna; h, maxilliped; i, lateral view; j, maxilliped apex; k, maxilla apex (lateral margin folded over); l, maxillule apex; m, brood pouch; n, pereopod 1; o, pereopod 7 (basis broken); p, mandible; q, right pleonites, ventral view. Scale bars = 3·0 mm.

365; 1964 d: 3; 1964 e: 128; 1968 a: 69, photos 13–17; 1968 b: 16; 1969: 434; 1973: 1271, 1275; 1976 a: 792, pl. 2, fig. 15; 1976 b: 801, figs 1–61, pl. 1, fig. 1; 1977: 15; Berner, 1969: 93; Boscolo, 1970: 72; 1977: 103, fig. 2; Romestand and Trilles, 1975: 2171.

Ceratothoa atherinae Gourret, 1892: 16, pl. 1, fig. 13, pl. 11, figs 1–6.

Livoneca sinuata Brian, 1912: 97, figs 1–4; Galati Mosella, 1920: 1 (part); Vasiliu, 1932: 177, fig. 8, pl. 1, figs 1, 2, pl. 2, figs 3, 4, pl. 3, figs 5–7. (Non *Lironeca sinuata* Koelbel, 1878.)

Mothocya epiremica. Brian, 1921: 21, figs 1–3 (lapus).

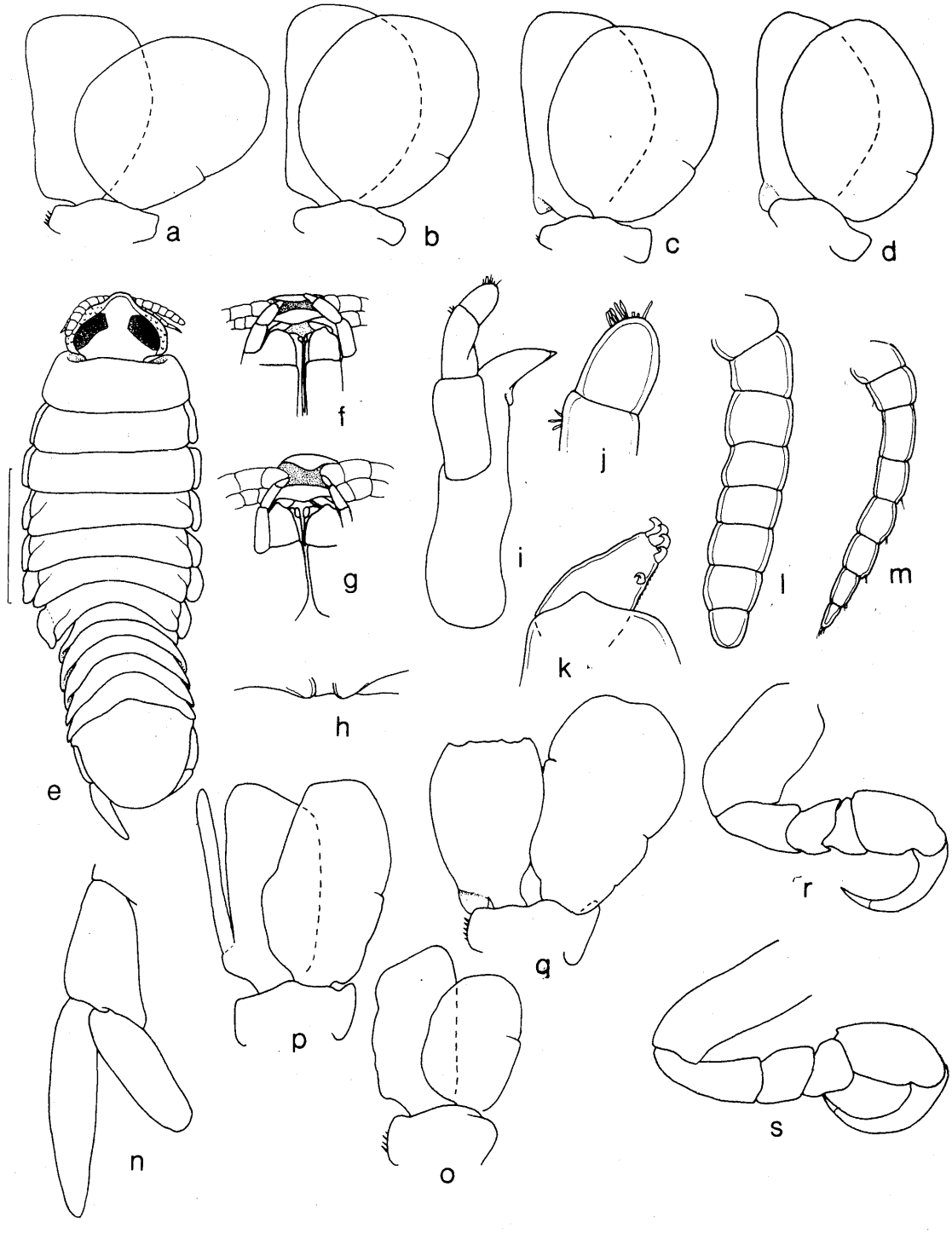

FIG. 2. *Mothocya epimerica*: a–d, f, ♀ 9·3 mm, remainder ♂ 7·8 mm, Murcia, a–d, pleopods 1–3, 5 respectively; e, dorsal view; f, buccal region ♀; g, buccal region ♂; h, penes; i, mandible; j, mandible palp article 3; k, maxilliped article 3; l, antennule; m, antenna; n, uropod; o–q, pleopods 1–3 respectively; r, pereopod 1; s, pereopod 7. Scale bar = 2·0 mm.

Material. Twelve ♀ (ovig. 9·3, 8·9, 8·8, 8·5, 6·9, 6·8, 6·8, 6·7, 6·6, 6·0, 5·5, imm. 6·2 mm), 2♂ (7·8, 6·8 mm), Mar Menor, Murcia coast of Spain (*c*, 37°45′N, 00°40′W), 3.xii.1967, ex *Atherina mochon* (RMNH 5493); 2♀ (ovig. 9·7, 9·6 mm), 2 imm. (3·0, 3·5 mm), Gulf of Naples, *c.* 1947 (Montalenti's (1948) specimens or part thereof); ♀ (ovig. 10·2 mm), Monaco, x.1922 (MNHN Is. 422); ♀ (ovig. 11·5 mm), no locality, 8.v.1930, ex *Atherina boyeri* Risso, coll. R. Dieuzeide (MNHM Is. 304); ♀ (ovig. 9·5 mm), Monaco, ex

Atherina, coll. Monod? (MNHM Is. 349); ♀ (non-ovig. 8·3 mm), Monaco, x.1922, ex *Atherina mochon*, coll. Monod? (BMNH 1924.5. 30.22); ♀ (ovig. 10·4, 9·1 mm), Naples, 1887, coll. A. H. Norman (BMNH 1911.11.8: 7732–7733).

Types. The whereabouts of the type-specimens are unknown, and it is uncertain if types were ever deposited for this species.

Type-locality. Costa (in Hope, 1851) gave no indication of the type-locality for *Mothocya epimerica.* All the isopods recorded in Hope (1851) are from Naples or Nizza, and the type-locality is here restricted to Naples, Italy, as the first detailed treatment of the species (Montalenti, 1948) was based on specimens from that area, and Costa's specimens were likely to have also come from the Naples area.

Description of female. Body weakly to moderately twisted, dorsal surface weakly convex. Rostrum with narrowly rounded point, or semi-truncated, weakly turned down. Eyes moderate to large, about 0·62 times width of cephalon. Coxae equal to or slightly longer than segment, narrow; posterolateral margins of posterior coxae rounded, lateral margins weakly sinuate. Pereonite 7 broadly recessed. Pleonites all visible in dorsal view, 2 to 5 or 3 to 5 not overlapped by pereonite 7; pleon 0·86–1·0 times width of pereonite 5. Pleotelson shorter than wide, posterior margin broadly rounded, apex may be very slightly narrowed. Antennule and antenna each composed of eight articles. Maxilla with two spines each on lateral lobe and medial lobe respectively; maxilliped article 3 with four recurved spines. Pereopod dactylus anteroproximal margin slightly flattened; pereopod 7 not much larger than pereopod 1. Pleopod peduncles with lateral lobe weakly developed; proximomedial lobe on pleopod 3 to 5 endopods weakly developed, that of pleopod 5 slightly larger than that of pleopod 4. Uropod short, not extending beyond apex of pleotelson; exopod slightly longer than endopod; both rami with broadly rounded apices.

Male. Body narrow, elongate; cephalon with rostral process bent posteriorly. Penes set clearly apart. Antenna with eight articles. Maxilliped article 3 with five spines. Pleopods not examined in detail. Uropods extending beyond posterior of pleotelson; exopod distinctly longer than endopod, apex narrowly rounded; endopod apex broadly rounded.

Variation. The degree of twisting of the body varies. Those with the body more strongly twisted have the coxal plate of pereonite 7 extending further down the concave side of the pleon than in weakly twisted specimens. The anterior margin of the cephalon may be narrowly rounded or indistinctly truncate.

Colour. Pale brown in alcohol, dorsum with brown chromatophores.

Size. Ovigerous females 5·5–11·5 mm; males 6·8–7·8 mm.

Remarks. This species, while having been relatively frequently recorded, was first figured in detail by Montalenti (1948) describing specimens from the Gulf of Naples. The type-specimens were not located, but Costa (in Hope, 1851) indicated the host species and, as no closely similar species have been recorded from the Mediterranean, there is little reason to doubt that specimens from *Atherina mochon* are *Mothocya epimerica.* Apart from some early confusion with *Lironeca sinuata* Koelbel (Brian, 1912; Vasiliu, 1932), determinations subsequent to Montalenti (1948) all appear to be correct.

Hosts. No recent confirmation of host species identities have been made, but literature records include *Atherina mochon*, *A. hepsetus* (Montalenti, 1948; Vasiliu, 1932), *A. boyeri* (Gourret, 1892; Boscolo, 1970) and *A. rissoi* (Berner, 1969; Trilles, 1962, 1964 a, 1968 a, b, 1976 a, b).

Distribution. Present material is from the Gulf of Naples, Italy, Monaco and the Murcia coast of Spain. Trilles (1976 b) reviewed the distribution and cited records from

Marseille, Banyuls in France, and also the Black Sea and the Adriatic Sea (Fig. 53:1).

Etymology. Presumably refers to the coxal plates, which at the time would have appeared larger than was common for cymothoid isopods.

Mothocya argenosa sp. nov.

(Fig. 3)

Irona nana. Richardson, 1905 b: 265, fig. 278 (part material from Bermuda); Linton, 1907: 120.

Material. From *Membras* (Atherinidae): 10♀ (ovig. 7·4 (HOLOTYPE, USNM 216252), 7·1 (no. 2), 7·0, 6·8, 6·4 (no. 1), non-ovig. 7·5, 7·4, imm. 6·6, 5·2, 4·9 mm), 3♂ (imm. 6·0, 5·9, 3·8 mm), marsh landing dock, Sapelo Island, Georgia, USA, 8.vi.1969, coll. R. W. Heard (USNM 216253, MCZ uncat.); ♀ (ovig. 9·8 mm), McKay Bay, Florida, USA, 9.v.1978 (ANSP CA4552); ♀ (ovig. 6·0 mm), McKay Bay, Florida, USA, 7.ix. 1977, coll. Dr W. Price (USNM 216254); 14♀ (9 ovig. 5·6–8·4 mm, 5 non-ovig. 5·5–7·0 mm), Bermuda, BB Stn. 1457, 15.vii. 1903, from mouth of 'Hogfish', coll. Dr E. Linton (USNM 40391) (reported on by Richardson, 1905). From *Hyporhamphus unifasciatus*: ♀ (non-ovig. 8·1 mm), Bahia Hondo anchorage, Cuba, 5.iv.1937, coll. Roebling Exped. (USNM 216255); 2♀ (non-ovig. 6·9, 6·3 mm), ♂ (4·5 mm), Santiago, Cuba, 7.iii.1884 (USNM 216356); ♀ (non-ovig. 6·3 mm), Road Harbour, Tortola Is., Virgin Islands, 17.v.1956 (USNM 216357); 2♀ (non-ovig. 7·1, 6·0 mm), locality uncertain, 3 labels in tube (USNM 216256).

Types. HOLOTYPE, ♀ 7·4 mm, USNM 216252; PARATYPES, USNM 40391, 216253, 216254; ANSP CA4552; MCZ uncatalogued.

Type-locality. Sapelo Island, Georgia, USA, *c.* 31°30′N, 81°20′W.

Description of female. Body weakly twisted to one side, about 2·0–2·2 times longer than wide; widest at pereonite 5. Rostrum narrow, turned down, apex acute. Eyes large, 0·69–0·80 times width of cephalon (occasionally 0·52). Coxae all narrow, not extending beyond posterior of segment; those of pereonites 5 to 7 with concave lateral margins. Posterior margin of pereonite 7 widely recessed. Pleon projecting clear of posterior coxae, 0·78–0·85 times width of pereonite 5. Pleotelson lateral margins converging slightly towards posterior, forming rounded posterior margin. Antennule and antenna bases set closer together than usual for genus. Maxilliped article 3 with three recurved spines. Pereopod 1 propodus shorter than usual for genus; pereopod 7 larger than pereopod 1. Brood pouch with anterior pair of oostegites smallest. Pleopod 1 peduncle lateral lobe scarcely developed, those of pleopods 4 and 5 moderately developed. Proximomedial lobe of pleopod 3 endopod small, only moderately developed on pleopods 4 and 5. Uropod extending beyond posterior margin of pleotelson; both rami broadly rounded, endopod about 0·66 times length of exopod.

Male. No mature males were present in the type-series. The material from Cuba differs in certain characters and at present it seems prudent to regard the male as unknown.

Colour. Pale tan to white in alcohol, liberally covered with black chromatophores; eyes black or brown in preserved material.

Size. Ovigerous females 5·6–9·8 mm, non-ovigerous females 5·5–8·1 mm.

Variation. All material from *Hyporhamphus unifasciatus* has smaller eyes and wider pleons than the atherinid material. The pleopods of the two host populations of isopods are identical, and at least two specimens from atherinid hosts have small eyes comparable to those of isopods from *H. unifasciatus*. At present there is insufficient

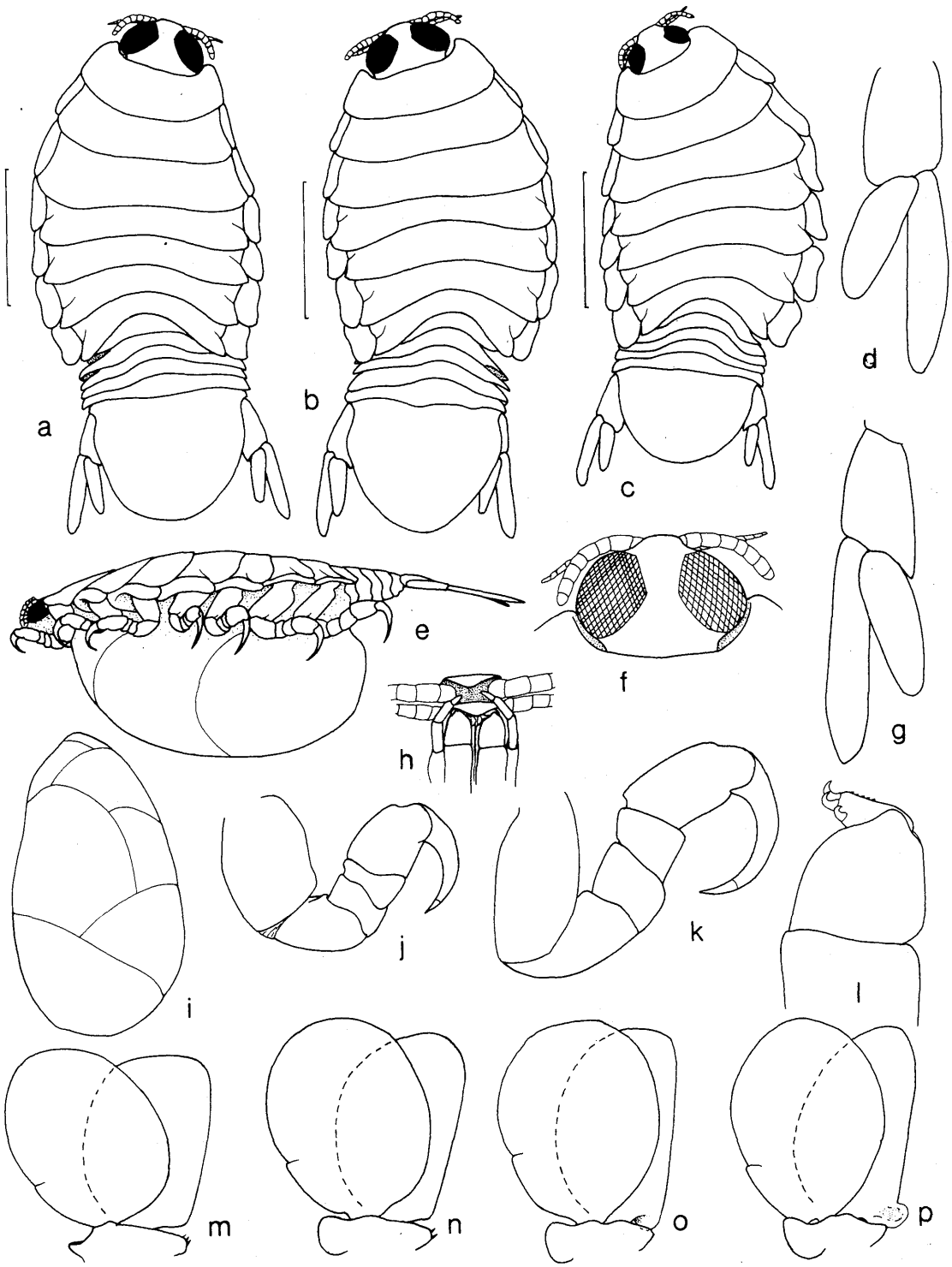

FIG. 3. *Mothocya argenosa* sp. nov.: a, e, f, i, j, HOLOTYPE; k–p, ♀ 7·1 mm; remainder as indicated. All from *Membras*, Sapelo Is., Georgia. a, dorsal view; b, ♀ no. 2, 7·1 mm; c, ♀ no. 1, 6·4 mm; d, uropod; e, lateral view; f, cephalon; g, uropod, ♀ no. 2, 7·1 mm; h, buccal region; i, brood pouch; j, pereopod 1; k, pereopod 7; l, maxilliped articles 2, 3; m–p, pleopods 1–3, 5 respectively. Scale bars = 2·0 mm.

material from *H. unifasciatus* to establish whether or not the two populations are separate species. Isopods from *H. unifasciatus* are not included in the type-series.

Remarks. This species is easily separated from all other western Atlantic species of the genus by its small size, narrow pleon, large eyes (when *Membras* is the host), and by the pleopod and uropod morphology. *Irona nana* is the most similar species but is substantially larger, has longer uropods and has larger proximomedial lobes on pleopods 3 to 5.

Hosts. The type-series were taken from '*Membras*'. As there is only one species known from the eastern USA (Robins *et al.*, 1980), the identity can be reasonably assumed to be *Membras martinica* (Valenciennes). Linton (1907) gave the host as *Atherina harringtonensis*, now *Hypoatherina harringtonensis* (Goode). This species is also recorded from *Hyporhamphus unifasciatus*.

Distribution. Georgia and Florida, USA, Bermuda, Cuba, and the Virgin Islands (Fig. 53:3).

Etymology. The name is derived from two Greek words argyros (silver) and kenos (flank) and alludes to 'silversides', the American popular name for the hosts.

Mothocya waminda sp. nov.

(Figs 4, 5)

Material. All specimens from Australia. From *Atherinosoma microstoma*: 2♀ (ovig. 6·8 (HOLOTYPE, USNM 216213), 7·5 mm), ♂ (7·0 mm), 1977 (USNM 216214); 4♀ (ovig. 5·4, non-ovig. 7·5, 5·6, 5·6 mm), ♂ (6·5 mm), 1977 (AM P35233–35235, QM W11733); 27 imm. specimens (2·7–9·0 mm), 27.xii.1977 (AM P35236); all from Lake Illawarra, NSW, coll. P. F. O'Connor. From *Atherinosoma presbyteroides*: ♀ (non-ovig. 7·1 mm), Lauderdale, Tasmania, xi–xii.1972 (AM P35232); ♀ (non-ovig. 8·9 mm), Granville Harbour, Tasmania, 41°49′S, 145°02′E, xii.1972 (TM G2834); ♀ (ovig. 5·8 mm), Margate Beach, Hobart, Tasmania, no date (USNM 216215); 2♀ (ovig. 5·8, 6·5 mm), Snug Beach, south of Hobart, Tasmania, 43°04′S, 147°16′E, no date (TM G2835); imm. (3·6 mm). Port Lincoln, SA, 13.v.1975 (SAM C4025). From *Atherinosoma elongata*: imm. (5·1 mm), Port Wakefield, SA, 15.v.1975 (SAM C4019); ♂ (6·6 mm), Ceduna, SA, no date (SAM C4020).

Types. HOLOTYPE, USNM 216213; PARATYPES, USNM 216214, 216215; AM P35232–35236; QM W11733; TM G2834, 2835.

Type-locality. Lake Illawarra, New South Wales, Australia, 34°32′S, 150°50′E.

Description of female. Body 2·07–2·38 times longer than wide, twisted to one side; dorsum moderately arched. Rostrum truncate or narrowly rounded, usually folded down; eyes moderate, 0·52–1·55 (mean 0·557) times width of cephalon. Coxae all narrow, those of pereonites 6 and 7 extending to or slightly beyond posterior of segment. Pereonite 7 posterior margin widely and shallowly recessed. Pleonites all visible; pleon 0·87–0·96 times width of pereonite 5. Pleotelson posterior margin evenly rounded. Antenna and antennule each composed of seven or eight articles. Maxilla with two spines each on medial and lateral lobes respectively; maxilliped article 3 with three stout recurved spines. Pereopod 1 short, robust; pereopod 7 more elongate than 1. Pleopods 1 and 2 peduncle lateral lobes not developed, pleopods 3 to 5 moderately developed. Pleopod 2 endopod with appendix masculina present. Proximomedial lobe of pleopod 3 scarcely developed, that of pleopod 4 moderately developed, and that of pleopod 5 slightly larger than that of pleopod 4. Rami of pleopod 1 rounded, those of pleopod 5 slightly elongate. Uropod rami extending beyond pleotelson posterior

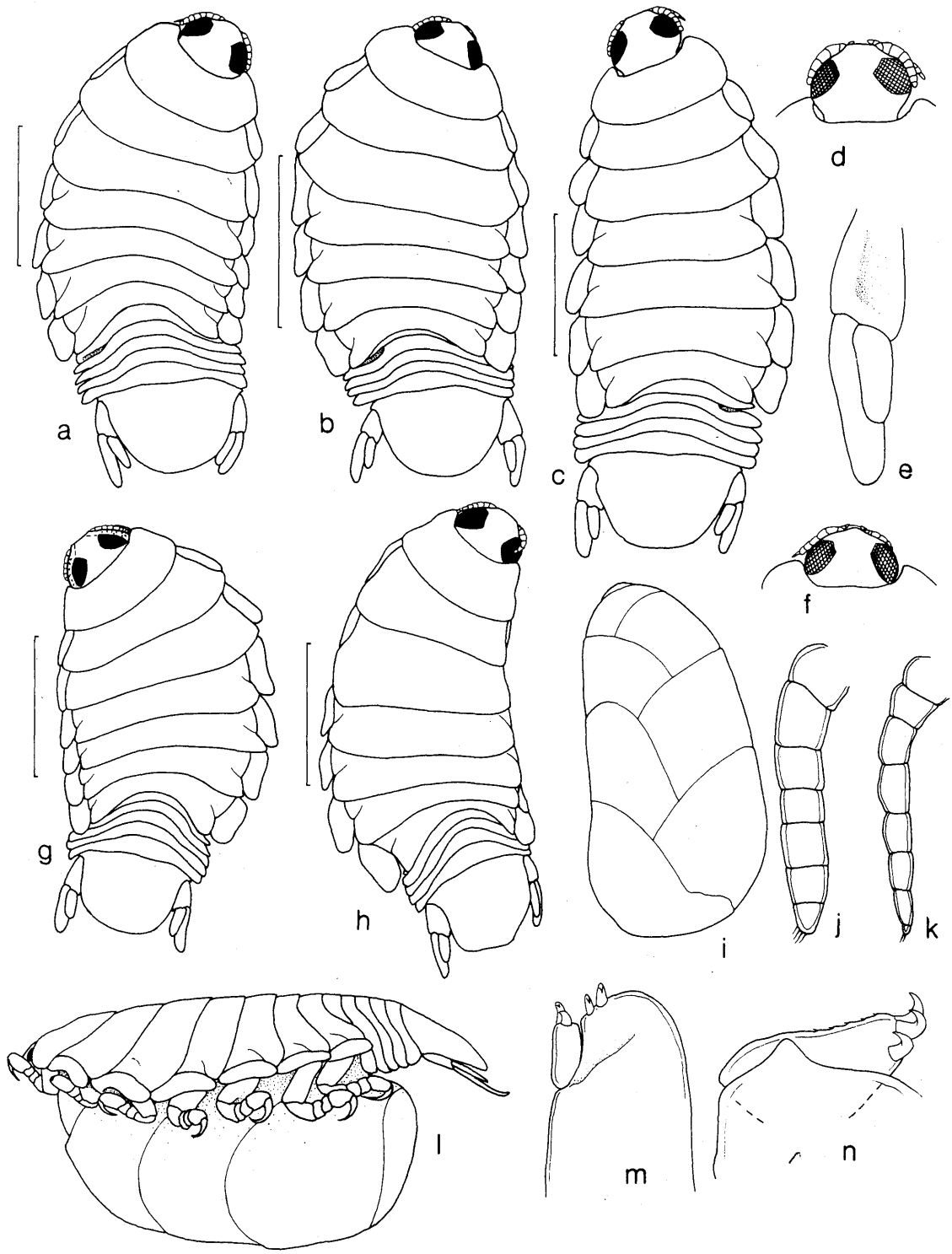

FIG. 4. *Mothocya waminda* sp. nov.: e, i–k, n, ♀ 7·5 mm, Lake Illawarra (USNM 216214). All figures from *Atherinosoma microstoma* except where indicated. a, HOLOTYPE; b, ♀ 5·4 mm (AM P35233); c, ♀ 7·5 mm (Am P35235); d, cephalon, ♀ 7·5 mm (AM P35235); e, uropod; f, cephalon, ♀ 5·4 mm; g, ♀ 5·8 mm, ex *A. presbyteroides*, Hobart; h, ♀ 6·5 mm; ex *A. presbyteroides*, Snug Beach; i, brood pouch; j, antennule; k, antenna; l, HOLOTYPE; m, maxilla apex; n, maxilliped article 3. Scale bars = 2·0 mm.

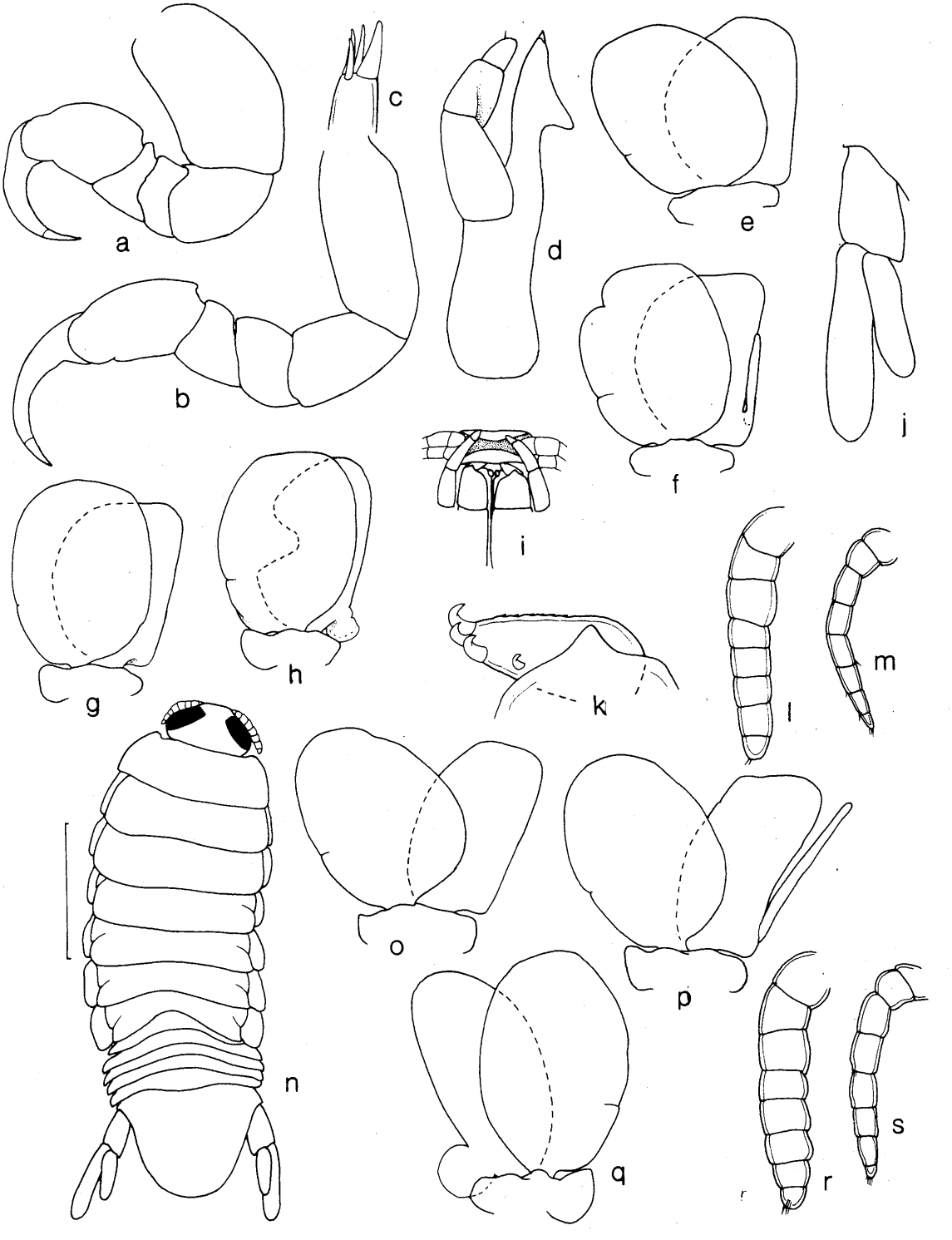

FIG. 5. *Mothocya waminda* sp. nov.: a–i, ♀ 7·5 mm, j–q, 7·0 mm, both ex *Atherinosoma microstoma* (USNM 216214), Lake Illawarra; remainder as indicated. a, pereopod 1; b, pereopod 7; c, maxillule apex; d, mandible; e–h, pleopods 1–3, 5 respectively; i, buccal region, Lake Illawarra (AM P35235); j, left uropod *in situ*; k, maxilliped article 3; l, antennule; m, antenna; n, dorsal view; o–q, pleopods 1, 2, 5 respectively; r, antenna, ♀ 5·6 mm, Hobart, ex *A. presbyteroides*; s, antennule, ♀ 5·6 mm, Hobart, ex *A. presbyteroides*. Scale bar = 2·0 mm.

margin; endopod about 0·62 times length of exopod, both rami with broadly rounded apices.

Male. Pleon as wide as pereonite 5; antenna and antennule each with eight articles. Pleopods similar to female, but pleopods 3 to 5 endopods with larger proximomedial lobes, especially pleopod 5. No specimens observed with developed penial processes.

Colour. White or brown in alcohol, with an abundance of black chromatophores.

Size. Ovigerous females 5·4–7·5 mm, non-ovigerous females 5·6–8·9 mm; males 6·6–7·0 mm.

Variation. The description is based on specimens from Lake Illawarra, taken from *Atherinosoma microstoma.* The specimens from south-eastern Australia taken from *Atherinosoma presbyteroides* show consistent slight difference in some characters, but are so similar that they are included under the one species.

Table 2 shows the variation in body proportions between the two populations. It can be seen that the specimens from *A. presbyteroides* have slightly larger eyes, narrower pleons, and a tendency to be wider than those from *A. microstoma.* All specimens from *A. presbyteroides* had an abruptly truncated rostrum. That character was less clearly expressed in specimens from *A. microstoma,* some of which had the rostrum rounded. In all other characters the two populations appear identical.

Remarks. This species was one of the three included under the name *Irona melanostricta* [sic] by O'Connor (1978, unpublished). The specimens examined here are from three estuarine species of Atherinidae, one from Lake Illawarra, NSW, and two from Tasmania and South Australia. O'Connor (1978) recorded isopods from rather more host species, including specimens from Western Australia (two localities) and Victoria (three localities). As no specimens from these additional localities were available their identity could not be confirmed and those records are not further considered.

Mothocya waminda is readily separated from other Australian species by its small size, relatively narrow body, and narrow coxae. *Mothocya waminda* bears a close resemblance to *Mothocya epimerica* which occurs on atherinid fishes in the Mediterranean, the morphology of the pleopods being nearly identical except that female *M. epimerica* do not retain the appendix masculina. In *M. epimerica* the rostrum is narrowly rounded, and does not project down as in *M. waminda.*

Hosts. Atherinosoma microstoma, Atherinosoma presbyteroides and *Atherinosoma elongata,* all estuarine species.

Distribution. Common in Lake Illawarra, New South Wales, also from Lauderdale, Granville Harbour, Hobart and Snug Beach, Tasmania; Port Lincoln, Port Wakefield, and Ceduna, South Australia (Fig. 55:6).

Etymology. Waminda is an Australian Aboriginal word meaning companion.

Table 2. Variation in body proportions between populations of *Mothocya waminda* from different *Atherinosoma* hosts from south-eastern Australia and Lake Illawarra, NSW.

	Variation in body proportions		
Atherinisoma host	Length/width	Pleon/pereonite 5	Eyes/cephalon
A. microstoma Lake Illawarra	2·07–2·38	0·87–0·96 mean 0·90	0·52–0·60 mean 0·55
A. presbyteroides South-eastern Australia	1·90–2·30	0·73–0·88 mean 0·81	*c.* 0·56–0·80 mean *c.* 0·56

Mothocya parvostis sp. nov.

(Figs 6, 7)

Irona melanosticta. Hatai and Yasumotu, 1980: 87 figs 1–4; 1981: 77; 1982 a: 75; 1982 b: 147.
Irona sp. Nunomura, 1981: 55, fig. 10.

Material. All material from Japan. Two ♀ (ovig. 11·5, 12·2 mm), ♂ (9·0 mm), Horioka, Sinminato City, Toyama Prefecture, 17.x.1983, ex *Hyporhamphus sajori*, coll. H. Kuroda (TSM Cr4122–4124). From cage-cultured fingerling *Seriola quinqueradiata*: 2♀ (ovig. 11·0, 11·2 mm), ♂ (imm. 8·5 mm), 11.vii.1979, no data, vicinity of Nagasaki (USNM 216296); 2♂ (imm. 11·0, 10·5 mm), 4 imm. (3·8, 4·0, 4·2, 4·5 mm), 29.v.1981 (TSM Cr4084–4089); ♀ (ovig, 15·0 mm, HOLOTYPE TSM Cr4083), off Nagasaki, *c*. 1977, Kyushu; 13 imm. ♀ and ♂ specimens, no data, vicinity of Nagasaki (TSM Cr4090–4102). From cage-cultured fingerling *Girella punctata*: ♀ (non-ovig. 10·9 mm), ♂ (8·4 mm), 16.vi.1980 (AM P35237); ♀ (ovig. 13·1 mm), 12.x.1980 (USNM 216286); 19 small imm. specimens, 4.vi.1980 (TSM Cr4103–4121). Series of small hosts (25–35 mm) with imm. specimens, no data, from the vicinity of Nagasaki (USNM 216270).

Types. HOLOTYPE, TSM Cr4083; PARATYPES, TSM Cr4084 4102, 4122 4124; USNM 216286, 216296; AM P35237.

Type-locality. Off Nagasaki, Kyushu, Japan, *c*. 33°10′N, 129°40′E.

Description of female. Body 1·97–2·15 times longer than wide, only weakly twisted to one side; convex margin not distorted. Rostrum not folded down. Eyes moderately large, 0·52–0·62 times width of cephalon. Coxae lateral margins straight or weakly convex, posterior margins rounded; coxae of pereonites 6 and 7 extending slightly beyond posterior of segment. Pereonite 7 posterior margin shallowly recessed. Pleon 0·88–0·98 times width of pereonite 5 (mean 0·91); pleonite 1 largely concealed by pereonite 7. Pleotelson broadly rounded, anterolateral margins indented prior to meeting pleon. Antennule and antenna both with eight articles. Maxilliped article 3 with three recurved spines, with or without fourth small recurved spine; maxilla with two spines each on medial and lateral lobes respectively. Pereopod 7 not significantly larger than pereopod 1. Pleopod 1 peduncle lateral lobe weakly developed, those of pleopods 2 to 5 moderately developed; peduncle medial margins of pleopods 1 to 3 may have coupling hooks. Pleopod 2 endopod with appendix masculina. Proximomedial lobe of endopods of pleopods 3 and 4 similar in size, that of pleopod 5 slightly larger. Uropod rami extending to or just beyond posterior margin of pleotelson; exopod about 0·33 longer than endopod; margins of both rami not tapering, apices bluntly rounded.

Male. Pereopods more slender, and pleotelson and uropods longer than female. Penes well separated on sternite 7. Pleopods 1 and 2 peduncle lateral lobe weak; pleopods 1 to 4 with coupling hooks on peduncle medial margin; pleopod 2 appendix masculina extending beyond distal margin of ramus; proximomedial lobe of pleopod 5 endopod prominent, much larger than that of pleopod 4.

Colour. Tan to white in alcohol, densely covered by black chromatophores.

Size. Ovigerous females 11·0–15·0 mm; males 8·0–9·0 mm.

Remarks. This species bears a marked resemblance to *Mothocya sajori*, but can at once be separated by (in *M. parvostis*) the straighter body shape, rounder coxae, and the posterior margin of pereonite 7 being weakly recessed. The size ranges of adults of the two species do not overlap.

Most of the material examined here was collected (and reported on) by Dr K. Hatai, who obtained them from immature or fingerling cage-cultured specimens of *Seriola*

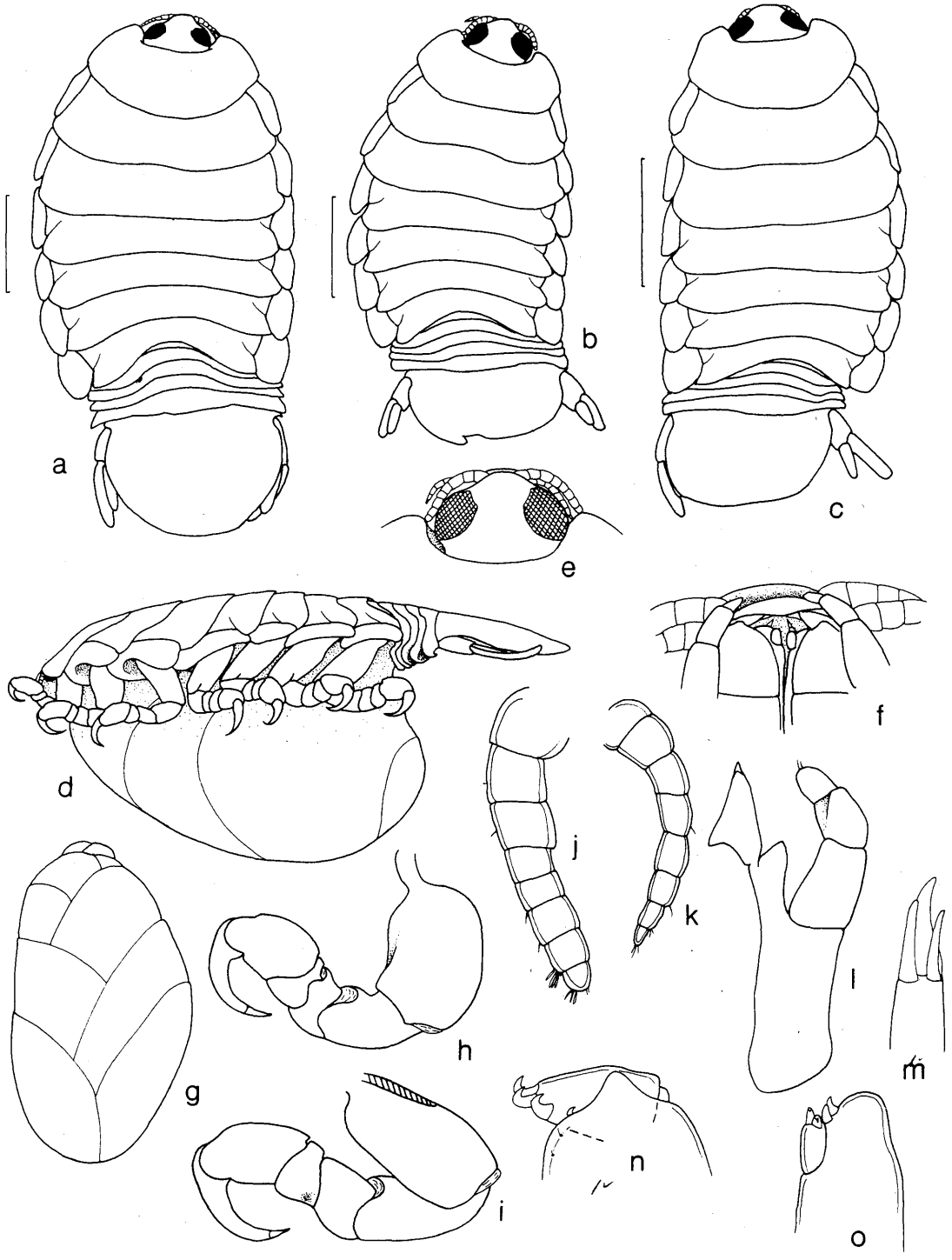

FIG. 6. *Mothocya parvostis* sp. nov.: b, e–g, ♀ 13·1 mm, ex *Girella punctata* (USNM 216268); h–o, ♀ 11·2 mm, ex *Seriola quinqueradiata* (USNM 216269); remainder as indicated. a, HOLOTYPE; b, dorsal view; c, ♀ 11·5 mm, ex *Hyporhamphus sajori*; d, HOLOTYPE; e, cephalon; f, buccal region; g, brood pouch; h, pereopod 1; i, pereopod 7; j, antennule; k, antenna; l, mandible (damaged); m, maxillule apex; n, maxilliped apex; o, maxilla apex. Scale bars = 3·0 mm.

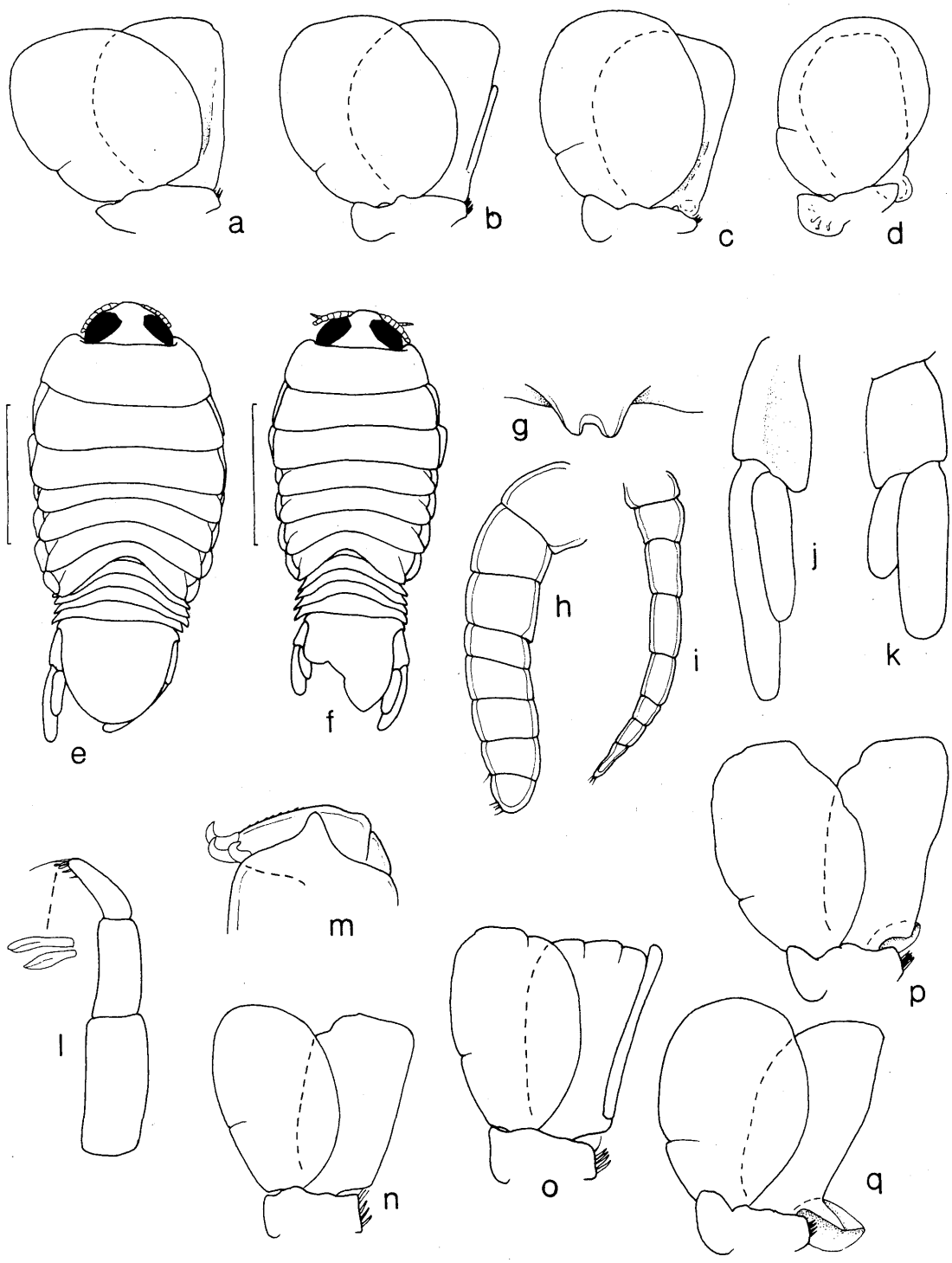

FIG. 7. *Mothocya parvostis* sp. nov.: a–d, k, ♀ 11·2 mm, ex *Seriola quinqueradiata* (USNM 216269); h, i, l–o, imm. ♂ 7·8 mm, ex *S. quinqueradiata*; remainder as indicated, a–d, pleopods 1–3, 5 respectively; e, ♂ 9·0 mm, ex *Hyporhamphus sajori*; f, ♂ 8·4 mm, ex *Girella punctata* (AM P35237); g, penes, ♂ 8·4 mm, ex *G. punctata* (AM P35237); h, antennule; i, antenna; j, uropod, ♂ 9·0 mm, ex *H. sajori*; k, uropod; l, mandible palp; m, maxilliped apex; n–q, pleopods 1, 2, 4, 5 respectively. Scale bars = 3·0 mm.

quinqueradiata and *Girella punctata* (Hatai and Yasumotu, 1980, 1981, 1982 a, 1982 b). Two females and a male were from 'wild' *Hyporhamphus sajori.*

Host. Cage-cultured *Seriola quinqueradiata* and *Girella punctata*; *Hyporhamphus sajori.*

Distribution. Coasts around Nagasaki, Kyushi Island and Toyama, Honshu Island, Japan (Fig. 54:6).

Entymology. The epithet is derived from two Latin words, parva (little or small) and hostis (enemy).

Mothocya bohlkeorum **Williams and Williams**

(Fig. 8)

Irona nana. Nierstrasz, 1918: 120 (non *Irona nana* Schioedte and Meinert, 1884).
Mothocya sp. Williams and Williams, 1977: 14.
Mothocya bohlkeorum Williams and Williams, 1982: 570, figs 1–26.

Material. Four ♀ (ovig. 8·5, non-ovig. 7·8, 8·0, imm. 6·7 mm), ♂ (3·7 mm), (HOLOTYPE and PARATYPES), shelf slope near Ensenada, off Salinas, Puerto Rico, 25.xii.1976, ex *Apogon lachneri*, coll. Williams and Colin; ♀ (ovig. 7·6 mm), Tortugas, Florida, USA, ex '*Apogon*' *conklini*, Longley's coll., (USNM 216216); ♀ (non-ovig. 8·0 mm), St Eustatius, ex *Apogonichthyes stellatus*, coll. J. Boeke (Instituut voor Taxonomische Zoölogie, Amsterdam reported on by Nierstrasz, 1918).

Types. HOLOTYPE USNM 190978, PARATYPES USNM 190079–190981.

Type-locality. Off Salinas Puerto Rico, Caribbean Sea, *c.* 17°55′N, 67°10′W.

Descriptive notes. Female pleopod peduncle lateral lobes not developed; appendix masculina retained; pleopods 3 to 5 endopod proximomedial lobe small.

Remarks. Williams and Williams (1982) gave detailed figures of this species as well as details of the host–isopod relationship.

This species differs in several characters from the genus diagnosis. The most significant of these are the narrow strongly produced rostrum, and the closely set antennule and antenna bases. The pleopod peduncles do not have the lateral lobe developed, and the proximomedial lobes of the endopods of pleopods 3 to 5 are only moderately developed, a feature commonly found in *Mothocya* species that are associated with atherinid fishes.

Hosts. Recorded only from Apogonidae: *Apogon lachneri*; *Phaeoptyx pigmentaria*; *P. conklini* (Williams and Williams, 1982); Nierstrasz (1918) recorded a specimen from *Astrapogon stellatus* (Cope).

Distribution. Williams and Williams (1982) recorded the species fromPuerto Rico; from Rose Island, Grand Island, Athol Island and Andros Island, Bahamas. Saint Eustatius Island, Leeward Islands (Nierstrasz, 1918); one specimen from Tortugas, Florida (Fig. 53:4).

Mothocya nana (Schioedte and Meinert)

(Figs 9, 10)

Irona nana Schioedte and Meinert, 1884: 390, pl. 17, figs 6–11; Richardson, 1901: 496; 1905 b: 265, fig. 278 (part); Stebbing, 1905: 29; Thielemann, 1910: 46; Montalenti, 1948: 63, 65; Nair, 1950: 70; Abraham, 1966: 38, 40; Schultz, 1969: 162, figs 218, 246; ?Trilles, 1976 b: 810, figs 110–139, pl. 1, figs 6, 7; 1981: 596, pl. 4, figs 23, 24; Williams and Williams, 1977: 14.

Non *Irona nana.* Nierstrasz, 1918: 120 (= *Mothocya bohlkeorum*); Trilles and Raibut, 1971: 79, fig. 9; 1973: 273, 274, 280 (= *Mothocya* sp.)

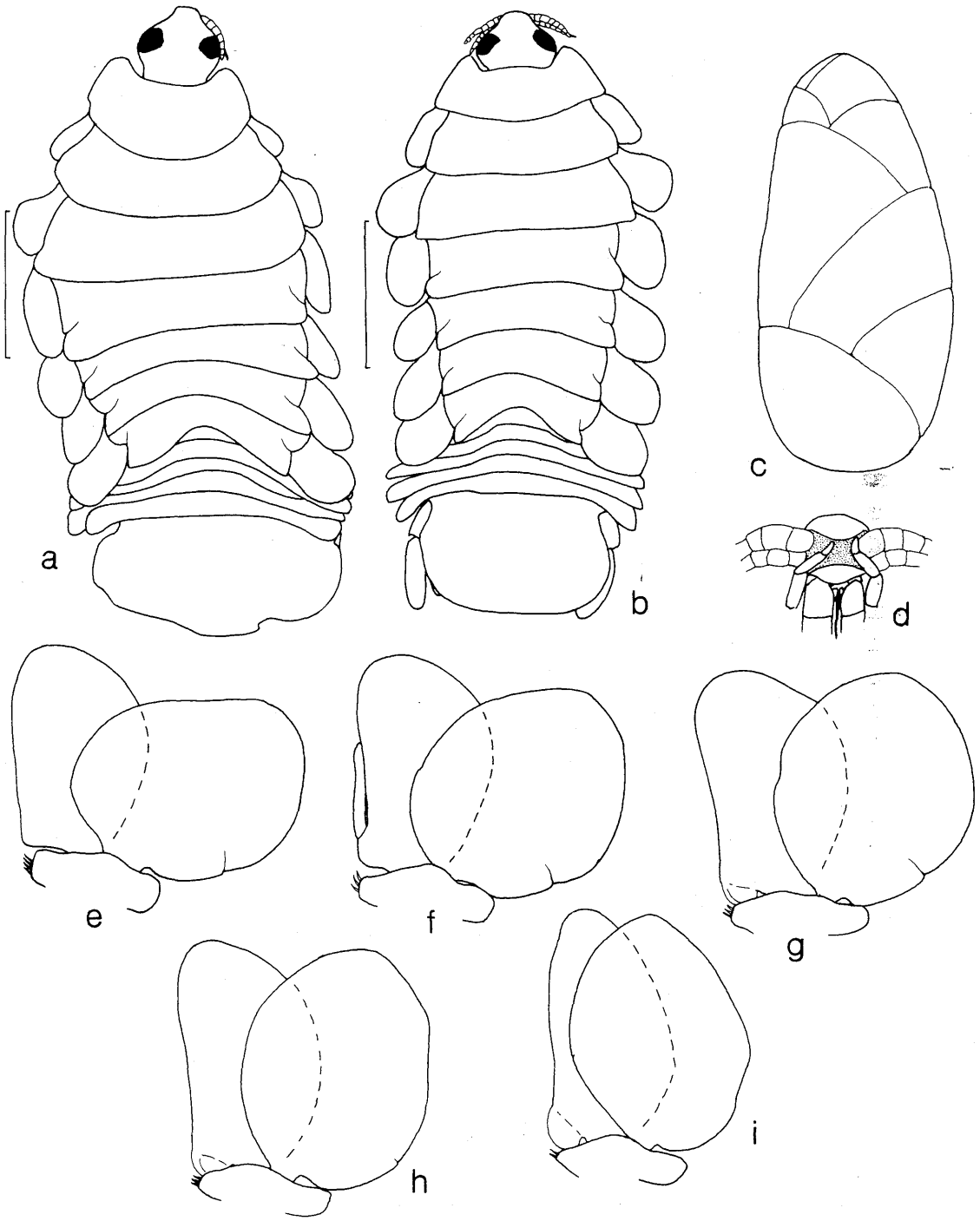

FIG. 8. *Mothocya bohlkeorum*: b, d–i, ♀ 8·0 mm (USNM 190980); remainder as indicated. a, HOLOTYPE, dorsal view; b, dorsal view; c, brood pouch, HOLOTYPE; d, buccal region; e–i, pleopods 1–5 respectively. Scale bars = 2·0 mm.

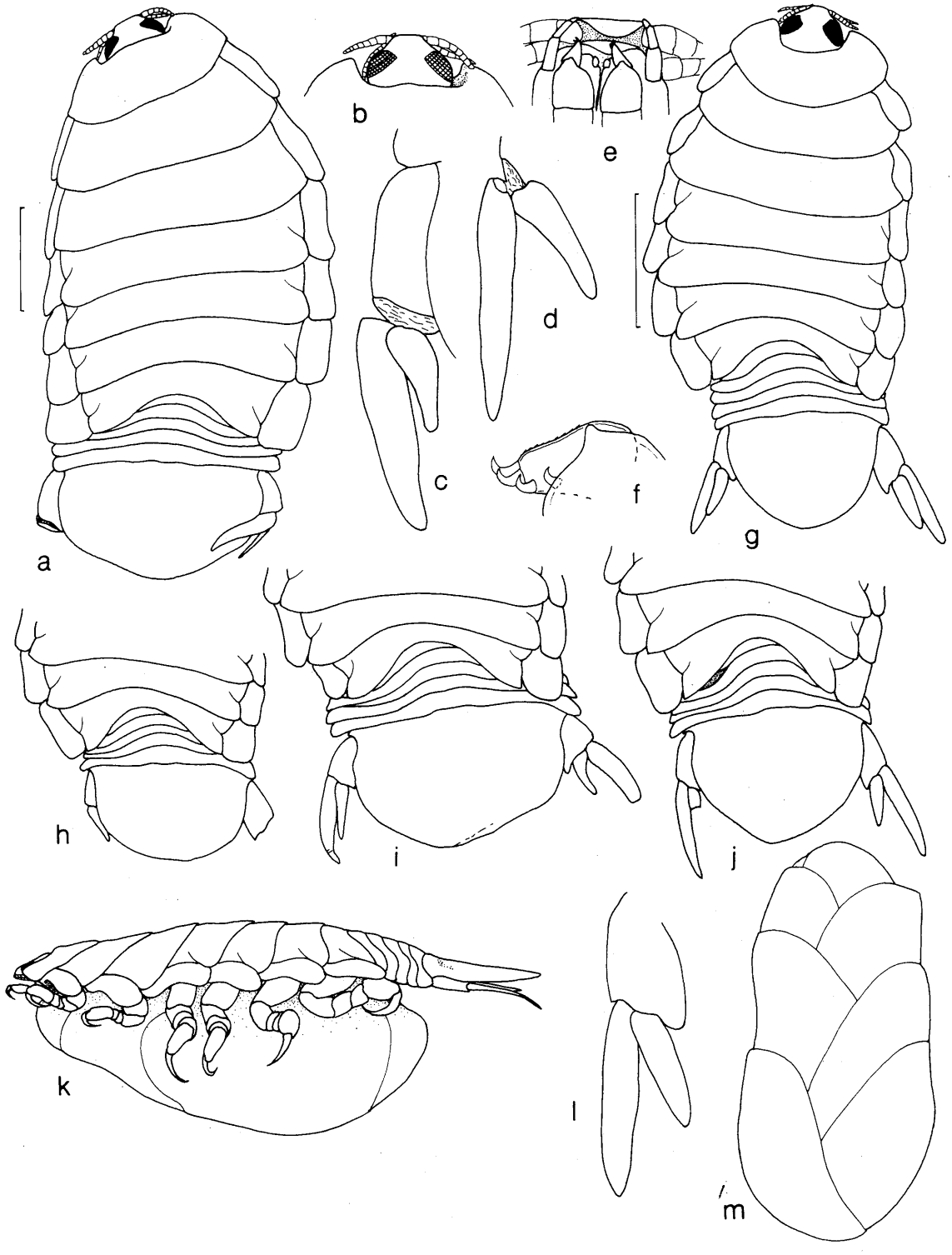

FIG. 9. *Mothocya nana*: a–d, ♀ 17·0 mm LECTOTYPE; e, g, k, m, ♀ no. 1, 12·0 mm, f, l, ♀ 12·5 mm, Duval Co.; remainder as indicated. All from *Hyporhamphus meeki* (USNM 216383) except LECTOTYPE and h. a, dorsal view; b, cephalon; c, left uropod *in situ*; d, right uropod *in situ*; e, buccal region; f, maxilliped article 3; g, dorsal view; h, ♀ 14·5 mm, Chesapeake Bay, ex *Hyporhamphus unifasciatus* (USNM 107775); i, ♀ no. 2, 13·0 mm; j, ♀ no. 3, 13·0 mm; k, lateral view; l, uropod; m, brood pouch. Scale bars = 3·0 mm.

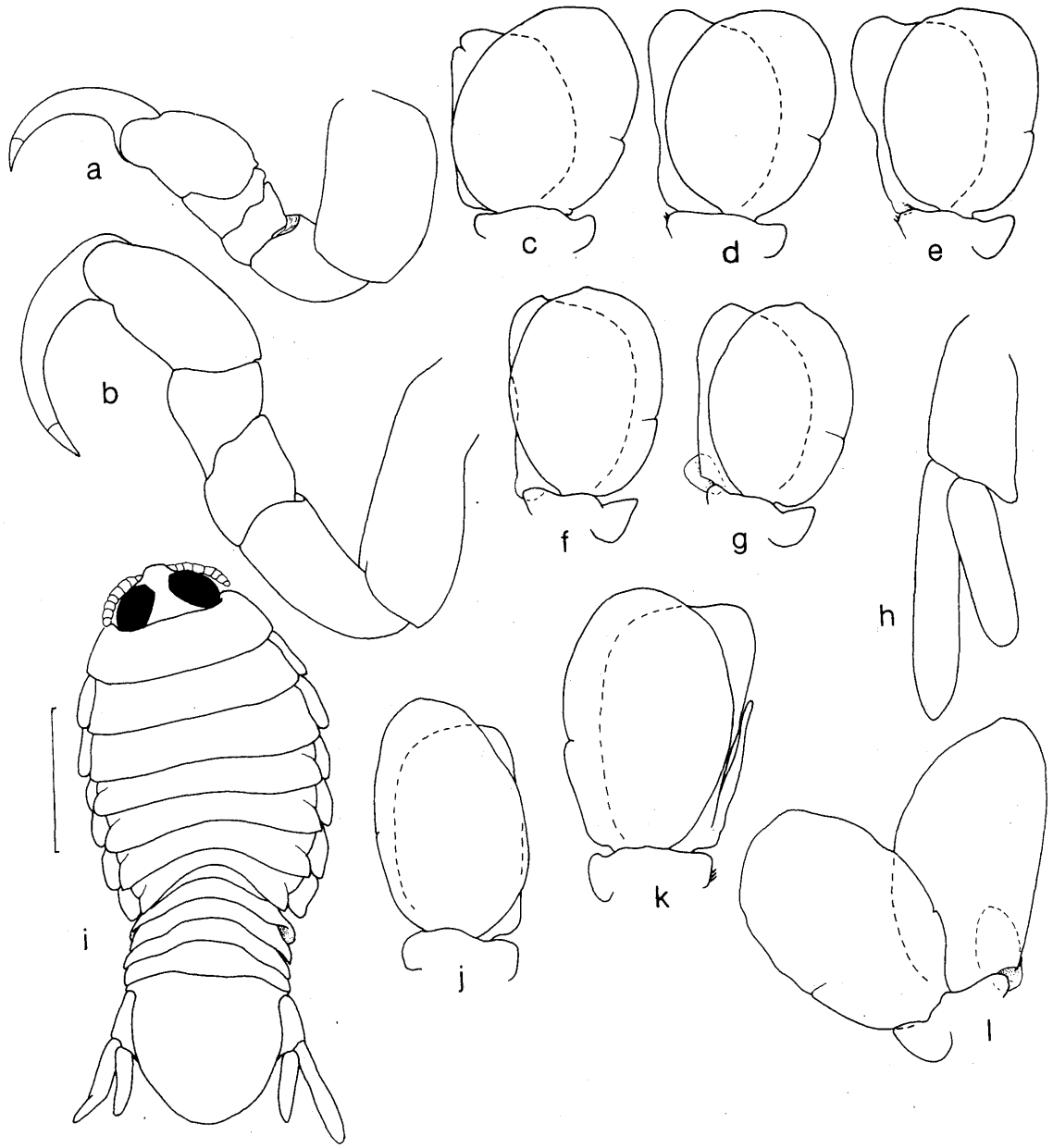

FIG. 10. *Mothocya nana*: a, b, ♀ 12·5 mm; c–g, ♀ no. 1, 12·0 mm; h, j–l, ♂ 7·9 mm. All Duval Co. Florida, ex *Hyporhamphus meeki* (USNM 216383) except i. a, pereopod 1; b, pereopod 7; c–g, pleopods 1–5 respectively; h, uropod; i, ♂ 7·9 mm, uncertain locality, ex *Hyporhamphus unifasciatus* (USNM 216267); j–l, pleopods 1, 2, 5, respectively. Scale bar = 2·0 mm.

Material. ♀ (ovig. 17·0 mm, LECTOTYPE NRS 3307), St Barthelemy, 2–6 f., alg. b. From *Hyporhamphus meeki*: 14 ♀ (ovig. 11·1, 11·8, 11·9. 12·0 (no. 1), 12·3, 12·5, 12·5, 13·0 (no. 3), non-ovig. 9·8, 10·5, 11·1, 12·2, 13·0 (no. 2), imm. 8·9, 10·5 mm), 2 ♂ (7·9, 7·9 mm), imm. specimens (7·0, 7·4, 9·5 mm), Duval County, Florida (USNM 216383); imm. (6·9 mm), Cedar Keys, Levy County, peninsula west coast, Florida, 3.iii.1951 (USNM 216381, 216382). From *Hyporhamphus unifasciatus*: ♀ (ovig. *c.* 11·0 mm), ♂ (imm. 7·9 mm), Fox Bay, Colon, Panama, 5.i.1911 (USNM 216358); ♀ (non-ovig. 11·0 mm), ♂ (7·9 mm), locality unknown—tube with three labels (USNM 216267); ♀ (ovig. 14·5 mm), Chesapeake Bay, Maryland, 18.viii.1961, coll. US Fish and Wildlife Service (USNM 107775); ♀ (non-ovig. 8·4 mm), Cove Point, Maryland (USNM 216377); ♀ (non-ovig. 10·5 mm), Saint Simons Is, Georgia, Brunns coll. (USNM 216378); ♂ (imm. 7·8 mm), Alligator Hole, Franklin County, Florida, (USNM 216380); ♂ (8·3 mm), nr Sebastian, Brevard County, Florida (USNM 216384); ♀ (non-ovig. 9·0 mm), Saint Simons Is., Georgia, (USNM 216379).

Types. The material studied by Schioedte and Meinert (1884) consisted of three lots and at least three species. All specimens are damaged, the female from Rio de Janeiro (MCZ 3717) and the specimen from St Joannius (ZMC uncatalogued) both lack pleons. The larger of the specimens from St Barthelemy (NRS 3307) is the one figured by Schioedte and Meinert (1884) and is here designated as the lectotype.

Type-locality. The locality data with the lectotype is 'St. Barthelemy, 6-8f., alg. b.' This is here fixed as Saint Barthelemy, Leeward Islands, Lesser Antilles, 17°54′N, 62°50′W.

Description of females. Body weakly twisted to one side, widest at pereonite 5; dorsum weakly convex. Rostrum truncate in dorsal view, folded down and posteriorly, apex narrowly rounded. Eyes moderate, 0·52–0·69 times width of cephalon. Coxae 2 to 4 shorter than segment, 5 and 6 as long as segment; coxae of pereonite 7 slightly longer than segment. Posterior margin of pereonite 7 deeply recessed. Pleonites all visible in dorsal view, lateral margins extending beyond coxal plate of pereonite 7 on concave side; pleon 0·80–0·98 times width of pereonite 5. Pleotelson lateral margins tapering to caudomedial point. Maxilla with two spines each on medial and lateral lobes respectively; maxilliped article 3 with four recurved spines. Pereopod 7 substantially larger than pereopod 1. Brood pouch deepest towards posterior, anterior pair of oostegites smallest. Pleopod peduncle lateral lobe weakly developed on pleopods 1 and 2, moderately developed on pleopods 3 to 5; proximomedial lobe of endopod small on pleopod 3, slightly larger in size on pleopod 4, largest on pleopod 5. Uropod extending clearly beyond posterior of pleotelson, in preserved specimens characteristically splayed out from body. Endopod about 0·66 times length of exopod, both rami tapering to narrowly rounded apex.

Male. Uropods longer, pereopods less robust, and rostrum narrower than in female. Proximomedial lobe on endopod of pleopods 3 to 5 larger than those of female.

Colour. Pale tan in alcohol, with scattered black chromatophores over dorsal surfaces.

Size. Ovigerous females 11·1–14·5 mm (lectotype 17·0 mm), non-ovigerous females, 8·4–13·0 mm; males 7·9–10·5 mm.

Variation. The extent to which the pleonites extend laterally varies. The pleonites of the lectotype do not extend beyond the coxal plates of pereonite 7, while in the other specimens they do on one or both sides. The coxae of pereonite 7 are posteriorly truncate in the lectotype and the female from Chesapeake Bay, but are more rounded on several of the Florida specimens.

Remarks. The characters by which the specimens were identified as *M. nana* include the pleotelson caudomedial point, long and attenuated uropods with the endopod about two-thirds as long as the exopod, morphology of the rostrum, and general body morphology. Five other species of *Mothocya* occur in the western Atlantic. Two of these, *M. xenobranchia* and *M. bermudensis*, are easily separated by their broad body shape, and by being longitudinally arched. *Mothocya omidaptria* is immediately separable by not having the rostrum turned down and truncate in dorsal view, and by the posterolateral angles of the coxae of pereonites 6 and 7 being acute rather than rounded or truncate. The other species, *Mothocya argenosa* and *M. bohlkeorum*, are far smaller, and *M. argenosa* has a rounded pleotelson and bluntly rounded uropods while *M. bohlkeorum* is altogether very different.

Resolving the identity of previous records has proved difficult as in many cases the specimens could not be located or obtained for study. Nierstrasz's (1918) specimen was easily identified as *Mothocya bohlkeorum.* Most of the entries in the synonymy are citations of the original record given by Schioedte and Meinert (1884). Those of Trilles (1976 b, 1981) are of uncertain identity as the photographs and figures given do not allow a specific assessment to be made. There are six western Atlantic species of *Mothocya*, and Trilles' photographs (1976 b, pl. 1, figs 6, 7) show both male and female with subequal uropodal rami, a character shown only by *Mothocya argenosa.* Of the other figures given by Trilles (1981, pl. 4, figs 23, 24), that of the male appears to be of the same specimen figured by Trilles (1976 b), while that of the female does not agree with the specimens of *Mothocya nana* examined here, but rather appears similar to the species *Mothocya* from Mediterranean *Belone belone* recorded by Trilles and Raibut (1971, 1973).

The record of Richardson (1905 b) repeated that of Schioedte and Meinert (1884) and added Linton's (1907) material from Bermuda which is *Mothocya argenosa.* The record of Williams and Williams (1977) is of an uncertain species from *Hyporhamphus*, but their material from *Tylosurus crocodilus* is almost certainly not *M. nana.*

Hosts. Most commonly recorded from *Hyporhamphus unifasciatus*, also on *Hyporhamphus meeki.*

Distribution. At present reliably recorded only from the Caribbean and eastern seaboard of the USA with specimens from Maryland, Georgia and Florida, and in the Caribbean from St. Barthelemy, and Colon, Panama (Fig. 53:5).

Etymology. Nana is a Latin word meaning small or dwarf; Schioedte and Meinert were probably referring to the relatively small size of this species.

Mothocya bermudensis sp. nov.
(Figs 11, 12)

Irona nana Schioedte and Meinert, 1884: 890 (part).

Material. ♀ (ovig. 11·5 mm), St Barthelemy, Leeward Islands, Caribbean Sea (syntype of *Irona nana*, NRS 5082). From *Hyporhamphus unifasciatus.* ♀ (ovig. 11·9 mm), Port au Prince, Haiti, purchased at fish market (USNM 216261). From Bermuda: ♀ (ovig. 9·8 mm, HOLOTYPE USNM 216344), ♂ (6·9 mm USNM 216345), no other data; ♀ (ovig. 9·8 mm), ♂ (6·8 mm), The Reach, 31.v.1951, coll. R. B. Manning (USNM 216258); ♀ (non-ovig. 9·2 mm), ♂ (6·8 mm), and ♀ (ovig. 9·1 mm), ♂ (6·2 mm), south-west tip of Georges Island, 8.vi.1951, coll. R. M. Bailey (USNM 216257); ♀ (non-ovig. 8·6 mm), and (imm. 8·1 mm), Somerset Is (ANSP CA4557); ♂ (6·0 mm), Ferry Beach, 14.iv.1957, coll. C. L. Smith (MCZ uncat); ♀ (8·2 mm), Swan Bridge, 1935, Beebe (USNM 216259).

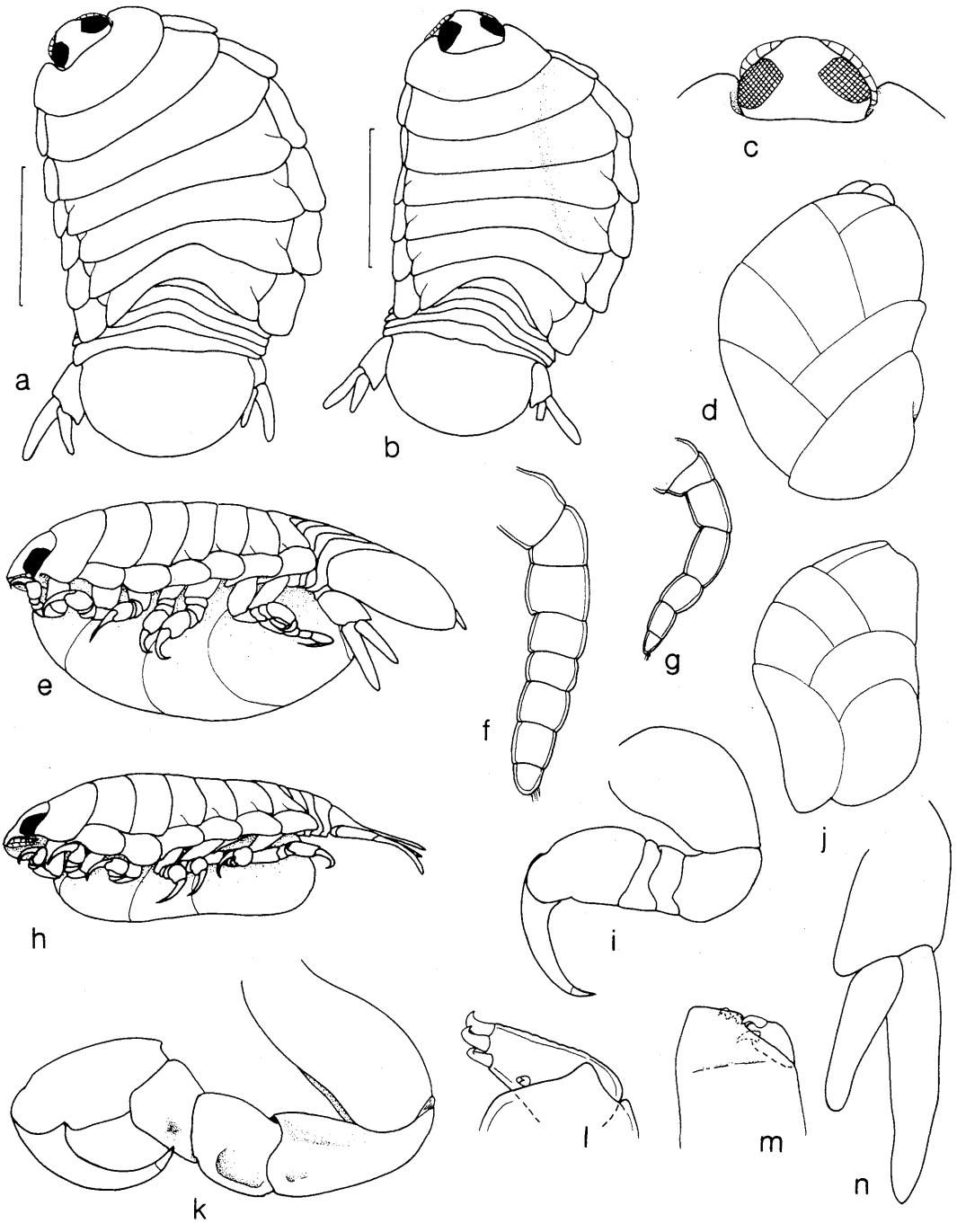

FIG. 11. *Mothocya bermudensis* sp. nov.: a, c–e, HOLOTYPE; b, h, j, ♀ 9·1 mm USNM 216257; remainder ♀ 9·8 mm (USNM 216258). a, dorsal view; b, dorsal view; c, cephalon; d, brood pouch; e, lateral view; f, antennule; g, antenna; h, lateral view; i, pereopod 1; j, brood pouch; k, pereopod 7; l, maxilliped article 3; m, maxilla apex; n, uropod. Scale bars = 3·0 mm.

Types. HOLOTYPE, USNM 216344; PARATYPES, USNM 216257–216260, 216345; ANSP CA4557; MCZ uncatalogued.

Type-locality. Bermuda, western Atlantic Ocean, *c.* 32°18′N, 64°45′W.

Description of female. Body about 1·8 times longer than wide, one margin very nearly straight, other laterally distorted; widest at pereonite 5; dorsum weakly convex, weakly arched anteroposteriorly. Rostrum moderately produced; eyes large, 0·66–0·73 times width of cephalon. Coxae all narrow, only those of pereonites 5 to 7 extending

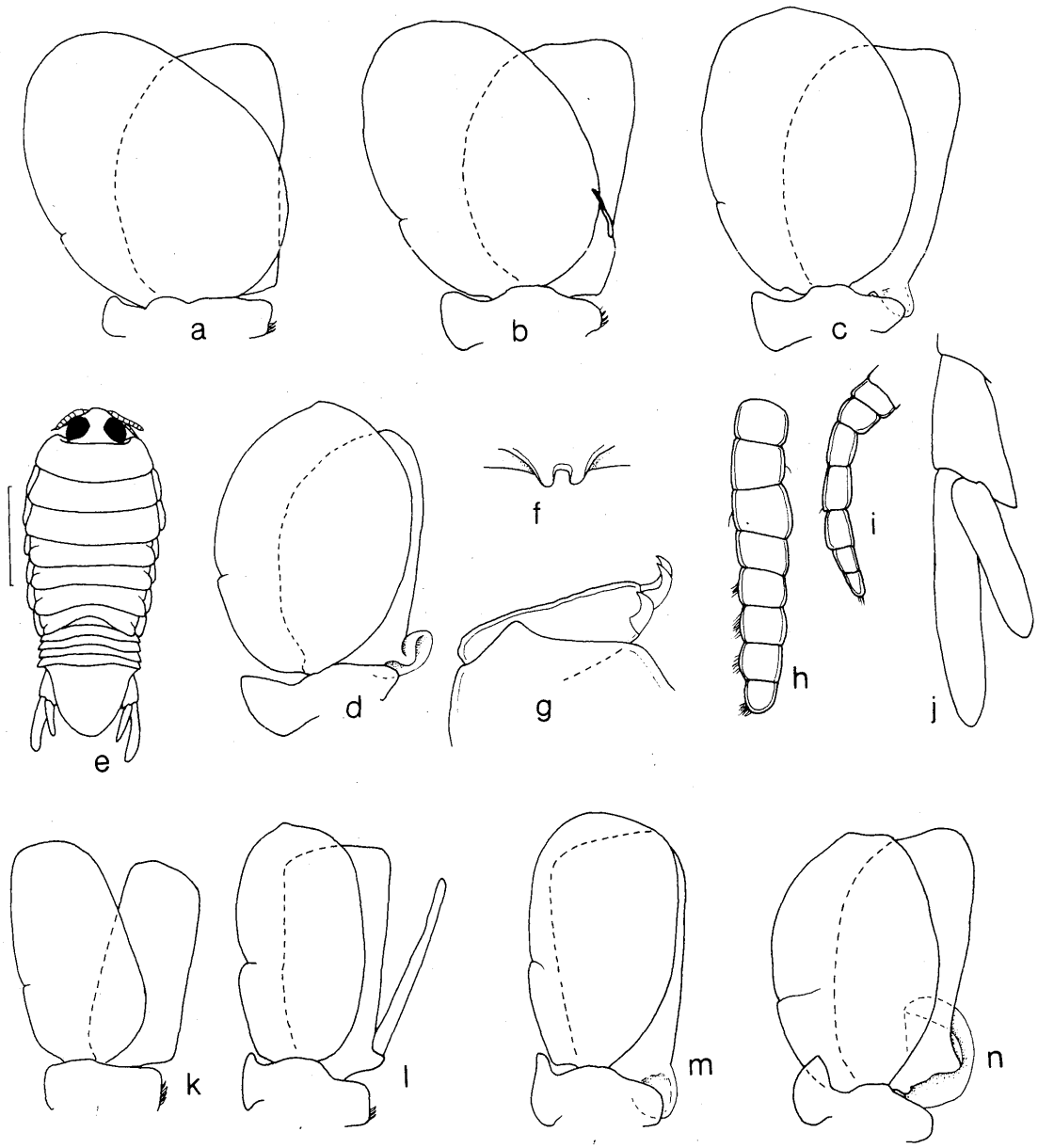

FIG. 12. *Mothocya bermudensis* sp. nov.: a–d, ♀ 9·8 mm (USNM 216258); e, f, ♂ 6·9 mm (USNM 216343); remainder ♂ 6·2 mm (USNM 216257). a–d, pleopods 1–3, 5 respectively; e, dorsal view; f, penes; g, maxilliped article 3; h, antennule; i, antenna; j, uropod; k–n, pleopods 1–3, 5 respectively. Scale bar = 2·0 mm.

beyond posterior of segment. Posterior margin of pereonite 7 deeply and widely recessed. Pleonites all visible; pleon 0·90 times width of pereonite 5. Lateral margins of pleonites 4 and 5 free on at least one side. Longitudinal axis of pleon skew to longitudinal axis of pereon. Pleotelson smoothly rounded, broadest just posterior to pleon. Antenna short, composed of seven articles, proximal two articles short, broader than remaining articles. Maxilla with two curved spines each on medial and lateral lobes respectively; maxilliped article 3 with three recurved terminal spines and fourth recurved spine on mediolateral surface. Pereopod 7 far longer than pereopod 1. Brood pouch made of three pairs of large overlapping oostegites, anterior small pair, not always visible in ventral view. Pleopod 1 peduncle lateral lobe small, medial margin with three coupling hooks, rami moderately elongate. Pleopod 2 with vestigial appendix masculina present on endopod; peduncle with four coupling hooks; pleopods 3 and 4

similar, pleopod 5 with large proximomedial lobe on endopod. Uropod extending slightly beyond apex of pleotelson, exopod straight or very slightly curved medially, endopod about 0·60 times length of exopod; both rami slightly tapered, apices rounded.

Male. Antenna shorter than antennule, with seven articles; maxilliped article 3 with three hooked spines, pereopod slightly less robust than female, penes set apart on sternite 7. Pleopod rami more elongate than female, distal margin subtruncate; proximomedial lobes of pleopods 3 and 4 larger than those of female; proximomedial lobe of pleopod 5 endopod much larger than that of pleopod 4, and also larger than that of female. Uropod rami extend clearly beyond apex of pleotelson.

Colour. Dark reddish brown.

Size. Ovigerous females 9·1–9·8 mm, non-ovigerous females 8·8–9·2 mm; males 6·2–6·9 mm.

Variation. The only variation noted other than in eye size is the degree by which the pleon is overlapped by the coxae of pereonite 7, which extend over pleonite 3 on the convex side and to pleonite 5 on the straight side. The specimen from Haiti, provisionally identified as this species, agrees in most respects but has a narrower body shape.

Remarks. This species resembles *Mothocya nana* Schioedte and Meinert, but is immediately separated by differences in brood pouch morphology. In *Mothocya bermudensis* the brood pouch is always shallow, and is made up of three pairs of large oostegites in ventral view, the fourth pair being scarcely visible. *Mothocya nana* has four visible pairs of oostegites. Other differences in *Mothocya bermudensis* are the laterally distorted pereon, the broadly rounded pleotelson and the longitudinally arched body.

The species *Mothocya bermudensis* most closely resembles is *Mothocya xenobranchia.* It differs from that species being much smaller in size, not as strongly arched, having larger eyes, less strongly produced coxal plates, and the anterior margin of the cephalon being less strongly produced.

Hosts. Recorded only from *Hyporhamphus unifasciatus.*

Distribution. Recorded from Bermuda and the Caribbean Sea, with one specimen from Haiti, and one from Saint Barthelemy, Leeward Isalnds (Fig. 53:6).

Etymology. The epithet is taken from the name of the type-locality.

Mothocya xenobranchia sp. nov.

(Figs 13, 14)

Material. ♀ (ovig. 14·0 mm), ♂ (10·5 mm), Key West, Florida, ex *Tylosurus crocodilus* (USNM 216371); ♀ (imm. 10·5 mm), 3♂ (6·8, 8·0, 9·0 mm), Everglade Park, Florida, ex *Strongylura marina* (USNM 216372); ♀ (non-ovig. 15·0 mm), Cape Haze Marine Laboratory, Cape Haze, Florida, USA, viii. 1967, probably from *Strongylura notata*, coll. R. F. Cressey (USNM 216278). From *Tylosurus crocodilus*, Venezuela: ♀ (ovig. 16·2 mm, HOLOTYPE USNM 216274); ♀ (ovig. 19·5 mm), ♂ (11·3 mm) (USNM 216277); ♀ (ovig. 23·0 mm), ♂ (14·0 mm) (ANSP CA4555); ♀ (non-ovig. 22·0 mm), ♂ (12·4 mm) (MCZ uncat); all Bahia Mochima, 4.iii.1962. ♀ (imm. 10·0 mm), ♂ (9·0 mm), Golfo de Santa Fe, 15.iii.1962 (USNM 216275). Two ♂ (7·5, 8·0 mm) (USNM 216276); ♀ (imm. 11·5 mm) (ANSP CA4556); both Golfo de Caraico e Juetep, 23.xii.1961.

Types. HOLOTYPE, USNM 216274; PARATYPES USNM 216275–216278; ANSP CA4555, 4556; MCZ uncatalogued.

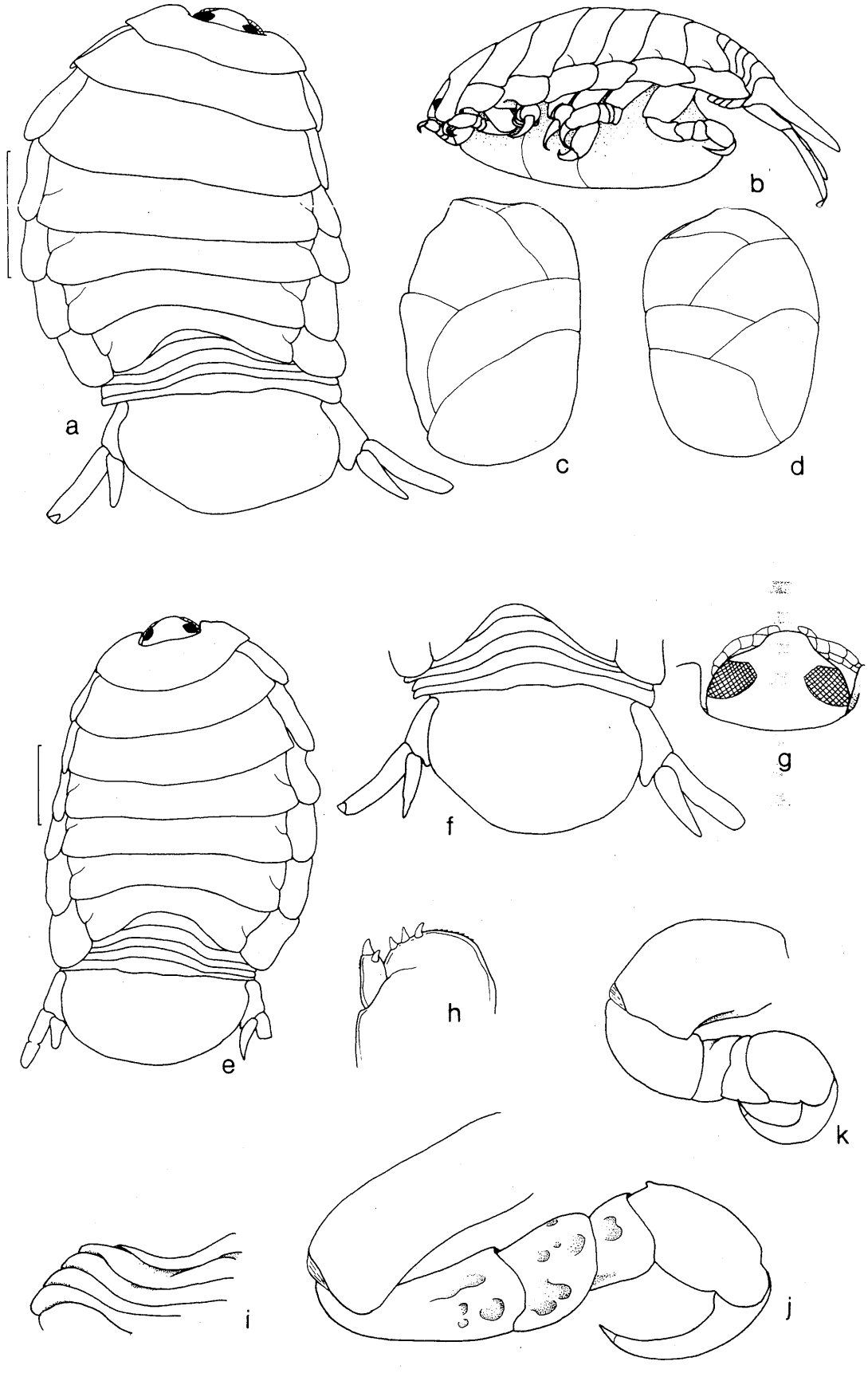

FIG. 13. *Mothocya xenobranchia* sp. nov.: q, f, g, HOLOTYPE; b, c, e, ♀ 23·0 mm (ANSP CA4555); d, h–k, ♀ 19·5 mm (USNM 216277). a, dorsal view; b, lateral view; c, brood pouch; d, brood pouch; e, dorsal view; f, pleon; g, cephalon; h, maxilla apex; i, right pleonites, ventral view; j, pereopod 7; k, pereopod 1. Scale bars = 4·0 mm.

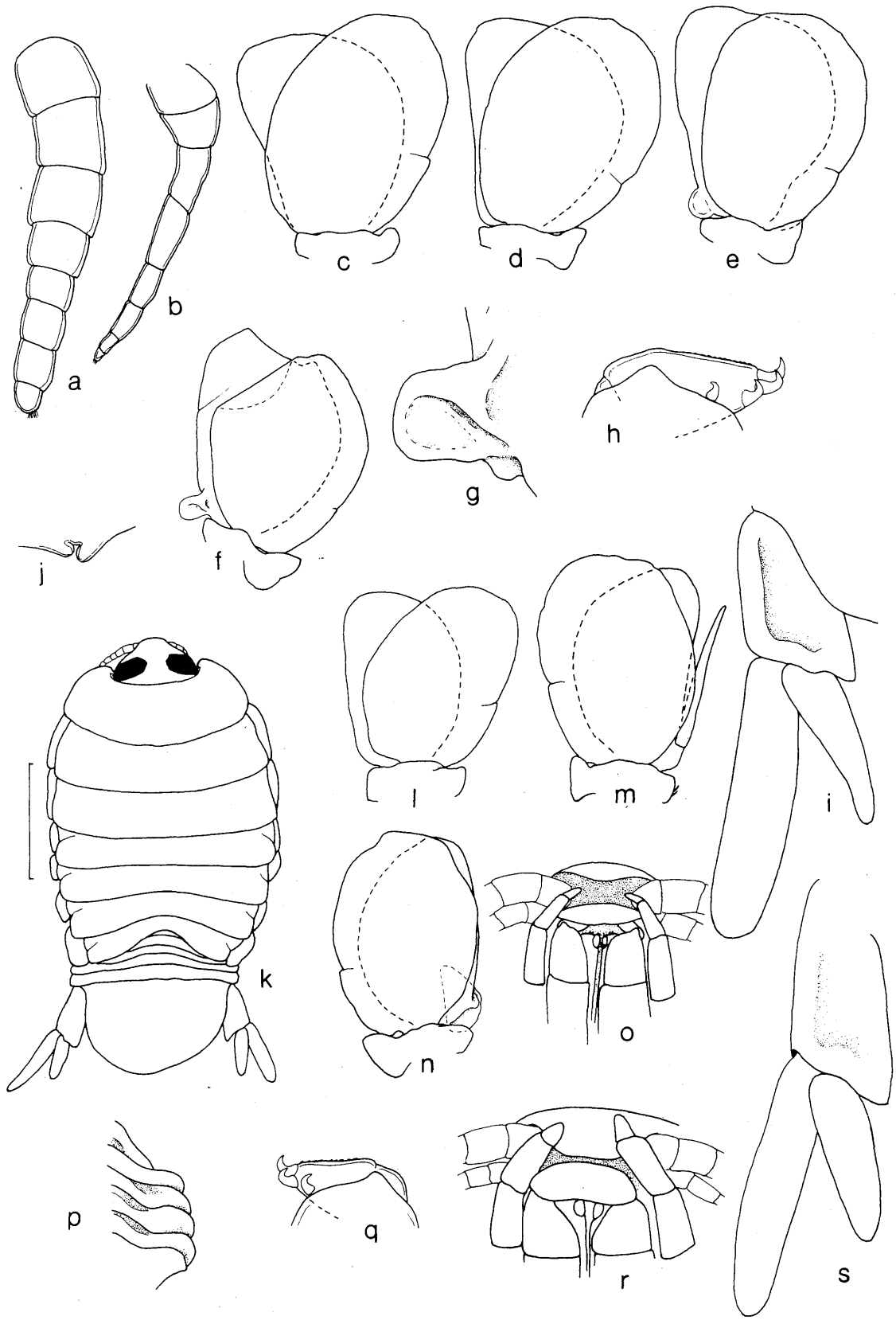

FIG. 14. *Mothocya xenobranchia* sp. nov.: a–h, ♀ 19·5 mm, j–q, s, ♂ 11·3 mm (USNM 216277); remainder as indicated. a, antennule; b, antenna; c–f, pleopods 1–3, 5 respectively; g, pleopod 5 endopod proximomedial lobe; h, maxilliped article 3; i, uropod, ♀ 10·0 mm (USNM 216275); j, penes; k, dorsal view; l–n, pleopods 1, 2, 5 respectively; o, buccal area; p, left pleonites, ventral view; q, maxilliped apex; r, buccal area, HOLOTYPE; s, uropod. Scale bar = 3·0 mm.

Type-locality. Bahia Mochima, Venezuela, *c*. 10°24'N, 64°21'W.

Description of female. Body about 1·6 times longer than wide, pereonites 3 to 5 widest; dorsum weakly convex but strongly arched longitudinally. Rostrum turned ventrally; eyes 0·47–0·60 times width of cephalon. Coxae narrow, not produced beyond posterior of segment except on one side of pereonites 6 and 7; coxae posterolateral margins rounded. Pereonite 7 posterior margin deeply recessed. Pleonites 1 to 5 at least partly visibile in dorsal view; lateral margins of pleonites 4 and 5 may be overlapped on one side by coxae of pereonite 7. Pleotelson anterolateral margins recessed; lateral margins widening slightly before curving to form broadly rounded posterior margin. Antennule composed of eight articles, antenna slender, composed of eight articles. Maxilla medial lobe slender, with two spines, lateral lobe with three hooked spines; maxilliped with four recurved spines on article 3. Pereopods 4 to 7 proportionally much longer than pereopods 1 to 3. Brood pouch formed by three large pairs of oostegites, anterior fourth pair being small, not prominent in ventral view. Pleopod 1 rami broad, lateral lobe of peduncle moderately developed. Pleopods 2 to 5 peduncle lateral lobe well developed; proximomedial lobe of pleopod 5 endopod larger than that of pleopod 4, but of same basic shape, not expanded distally. Uropod extending clearly beyond posterior margin of pleotelson; peduncle with mediodistal angle slightly produced; exopod a little less than twice length of endopod, apex broadly rounded; endopod margins converging rapidly to narrowly rounded apex.

Male. Anterior margin of cephalon more strongly produced than in female, eyes larger. Antennule with eight articles, antenna with seven or eight articles. Maxilla with two spines on lateral lobe; maxilliped article with three spines. Penes set close together on sternite 7. Pleopods narrower than in female, peduncles longer; otherwise differ only in male proximomedial lobe of pleopod 5 being large and distally produced. Uropod peduncle longer than in female, endopod not tapered.

Colour. All specimens dark brown, with scattered chromatophores.

Size. Ovigerous females 16·2–23·0 mm, males 7·5–14·0 mm; the single non-ovigerous female measured 21·9 mm.

Variation. Coxae of the concave side tend to be more produced than those of the convex side. In some specimens one coxal plate of pereonite 7 may extend to the posterior of pleonite 5.

Remarks. This species belongs to the group characterized by a very broad body, with the dorsum being arched anterior to posterior. Other distinctive characters include the posterior pereopods being notably larger than the anterior pereopods, the brood pouch being made up of three large pairs and one small pair of oostegites, and the antenna having seven or eight articles.

Mothocya longicopa, from the West Arican coast, is similar but immediately separated by its far longer uropods, and relatively shorter uropodal endopod. There are further differences in details of the pleopod morphology, pleon width and mouthpart spination. Another similar species is *Mothocya bermudensis* from Bermuda and the Caribbean. That species is separated by its smaller eyes, less strongly produced coxae, and is also much smaller in size. *Mothocya nana* is easily distinguished by the narrower body shape and the dorsum being flatter in lateral view.

Hosts. *Tylosurus crocodilus*; in Florida specimens were also from *Strongylura marina* and *S. notata*, but these are at present unconfirmed identifications.

Distribution. Only recorded from off the coast of Venezuela and Florida, USA (Fig. 53:7).

Entymology. The epithet is derived from the Greek words xenos (stranger, guest) and branchia (gills).

Mothocya longicopa sp. nov.
(Figs 15–17)

Material. All from West Africa. ♂ (6·1 mm), Fernando Po, date?, Pillsbury 258, ex *Tylosurus crocodilus* (USNM 216355). From *Ablennes hians*, Gulf of Guinea: ♀ (non-ovig. 11·1 (HOLOTYPE USNM 216350), 11·4, 11·6, imm. 9·2, 10·3 mm), ♂ (9·3 mm), 6°09′S, 20°30′E, 24.viii.1964, Geronimo Stn 4–112 (USNM 216351); ♀ (non-ovig. 12·2 mm), ♂ (11·0 mm), and 2♂ (7·0, imm. 5·0 mm), off Guinea, north of Conakry, 9°55′N, 15°56′W, 30.xi.1963 (USNM 216352, 216353); 2♀ (imm. 8·0, 8·9 mm), ♂ (7·0, 6·8 mm), off Sierra Leone, south of Freetown, 7°02′N, 11°57′W, 12.xi.1963 (USNM 216354, BMNH 1984: 402: 1).

Types. HOLOTYPE, USNM 216350; PARATYPES, USNM 216351–216354; BMNH 1984: 402: 1.

Type-locality. Gulf of Guinea, West Africa 6°09′S, 20°30′E.

Description of female. Body about two times longer than wide, twisted to one side; weakly arched anteroposteriorly, dorsum weakly convex. Rostrum moderately produced; eyes about 0·45 times width of cephalon (eyes all contracted away from exoskeleton making size assessment inexact). Coxae of pereonites 2 to 6 not produced beyond posterior of respective segments, those of pereonite 7 slightly produced. Pereonite 7 posterior margin widely and deeply recessed. Pleonites 1 to 2 at least partly visible; lateral margins of pleonites 3 to 5 or 4 and 5 not overlapped by coxae of pereonite 7; pleon same width as pereonite 5. Pleotelson widest just prior to meeting pleonite 5, lateral margins converging to broadly rounded apex. Antenna short, composed of eight articles. Maxilla with two spines on medial and lateral lobe respectively. Maxilliped article 3 with four or five recurved spines. Pereopod 7 distinctly larger than pereopod 1. Pleopod 1 rami broad, peduncle lateral lobe weakly developed. Pleopods 2 to 5 peduncle lateral lobe moderately developed; pleopods 3 to 5 endopod proximomedial lobe weakly developed, that of pleopod 5 only slightly larger than that of pleopod 4. Uropod rami long, extending well beyond posterior margin of pleotelson; exopod margins sub-parallel, apex rounded; endopod about 0·46 times length of exopod, margins converging smoothly to narrow apex.

Male. Cephalon anterior margin more strongly produced than in female. Antenna with nine articles; maxilliped article 3 with three recurved spines; mandible palp more slender than in female. Pleopods 1 to 4 with rami more rectangular and peduncle longer than in female; pleopods 3 to 5 endopod proximomedial lobe increasing in size towards posterior, that of pleopod 5 being very much larger than that of pleopod 4, as well as being very much larger than that of female. Uropod rami of similar proportions to female but longer; endopod may be proportionally longer.

Colour. Dorsal surfaces, pereopods, sternites with scattered chromatophores. Pale tan in alcohol.

Size. Females 11·1–12·2 mm; males 6·1–11·0 mm.

Variation. Specimens examined present a uniform appearance; the number of maxilliped spines may vary between four and five in the female.

Remarks. Although no ovigerous females are present in the material examined, males and females of these specimens show clear and consistent differences from any of the more closely related species. The most similar species are *Mothocya bermudensis* and *M. xenobranchia*; *M. longicopa* differs in having far longer uropodal rami, less strongly produced coxal plates and a weakly arched dorsum. Other differences are the maxilla lateral lobe having only two spines, females with a smaller proximomedial lobe

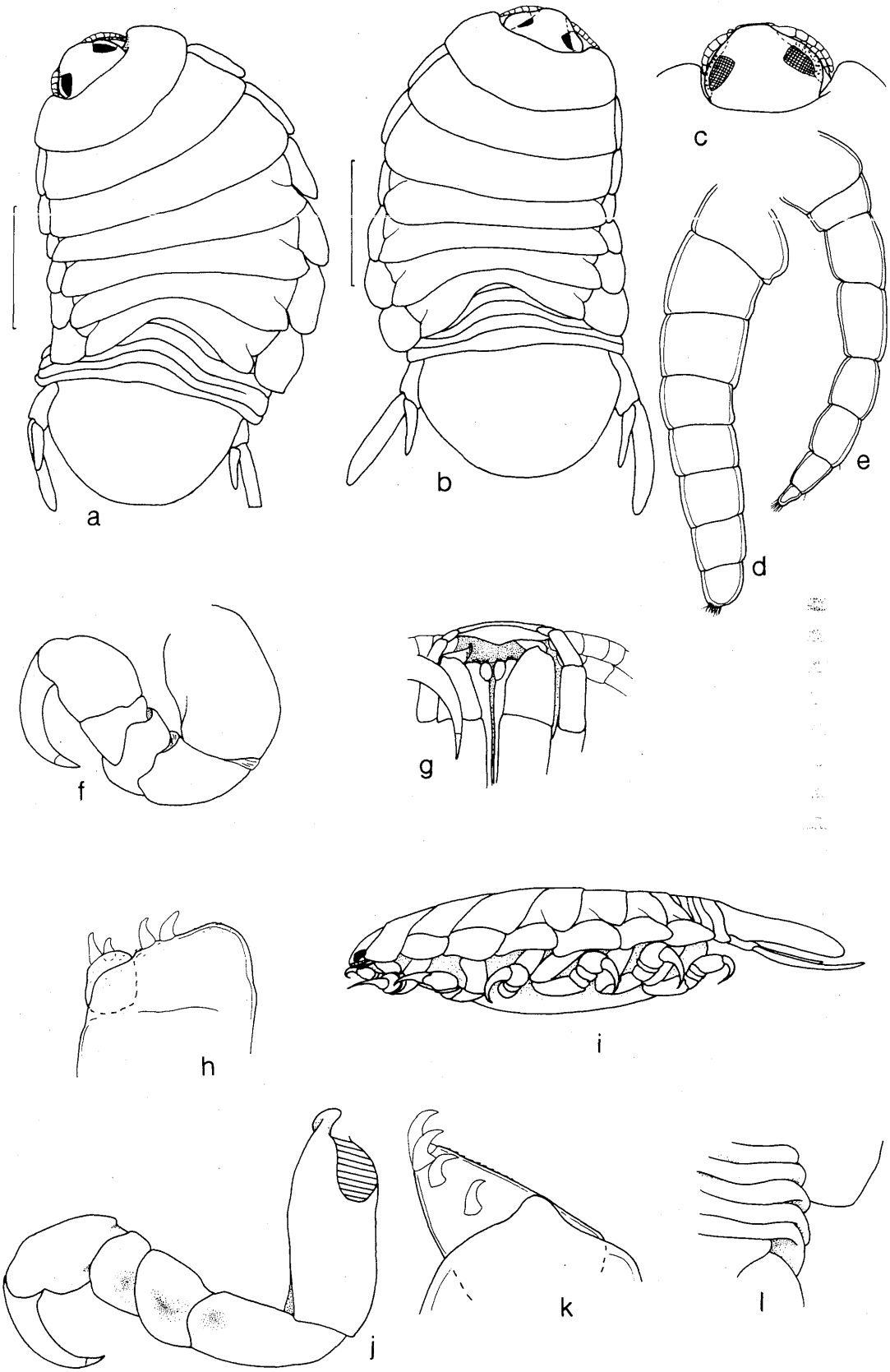

FIG. 15. *Mothocya longicopa* sp. nov.: a, c, g, i, HOLOTYPE; d–f, h, j, k, ♀ 11·6 mm, remainder as indicated. All Geronimo Stn. 4–112 (USNM 216351) except where indicated. a, dorsal view; b, ♀ 12·3 mm, (USNM 216352); c, cephalon; d, antennule; e, antenna; f, pereopod 1; g, buccal area, h, maxilla apex; i, lateral view; j, pereopod 7; k, maxilliped apex; l, left pleonites, ventral view, ♀ 11·4 mm. Scale bars = 3·0 mm.

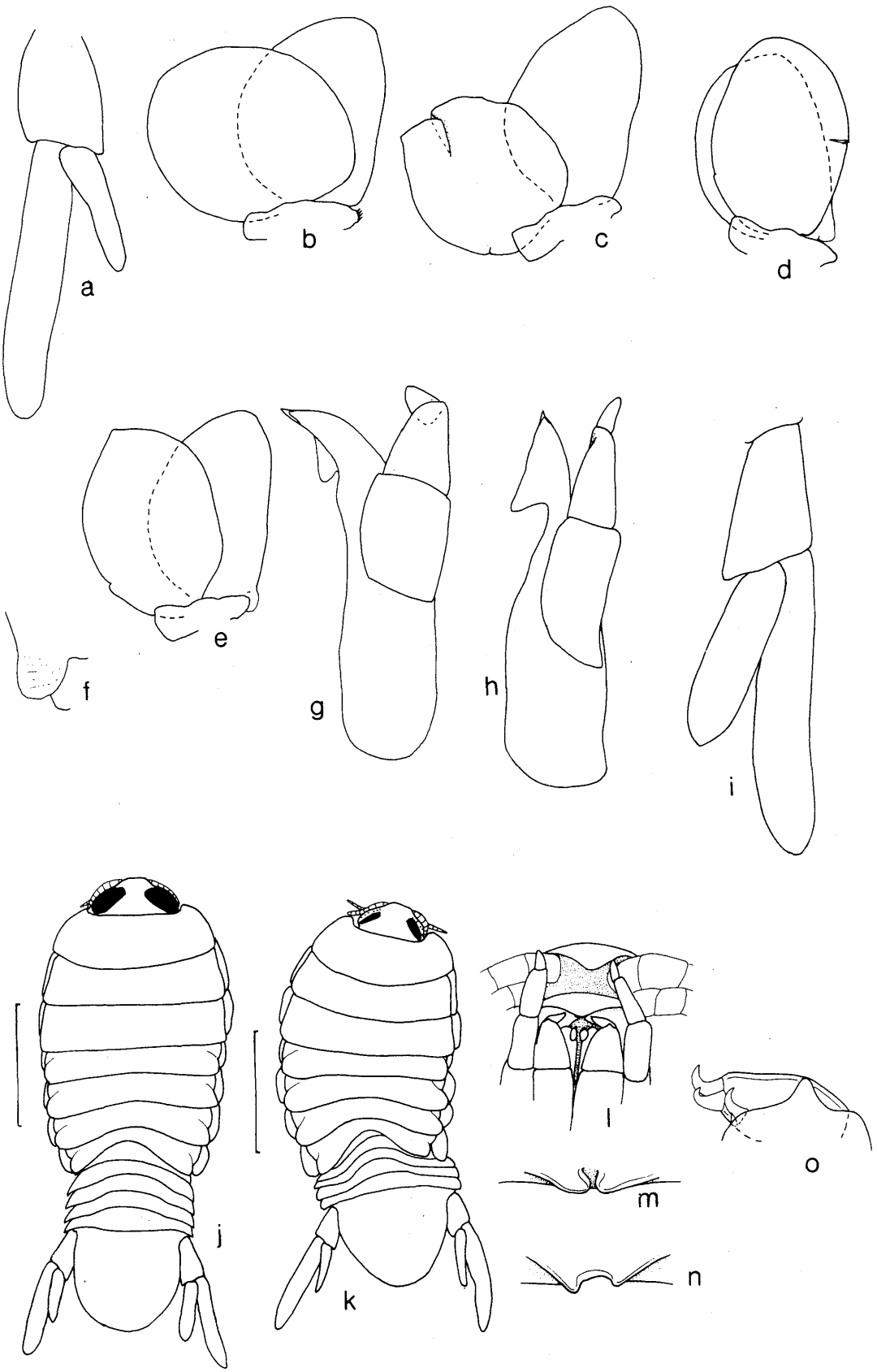

FIG. 16. *Mothocya longicopa* sp. nov.: a–g, ♀ 11·4 mm (USNM 216351); h–j, n, o, ♂11·0 mm (USNM 216252); remainder as indicated. a, uropod; b–e, pleopods 1–3, 5 respectively; f, pleopod 5 endopod proximomedial lobe; g, mandible ♀; h, mandible ♂; i, uropod; j, dorsal view; k, 9·3 mm (USNM 216351), dorsal view; l, cephalon, ♂ 9·3 mm; m, penes, ♂ 9·3 mm; n, penes; o, maxilliped articles 3. Scale bars = 3·0 mm.

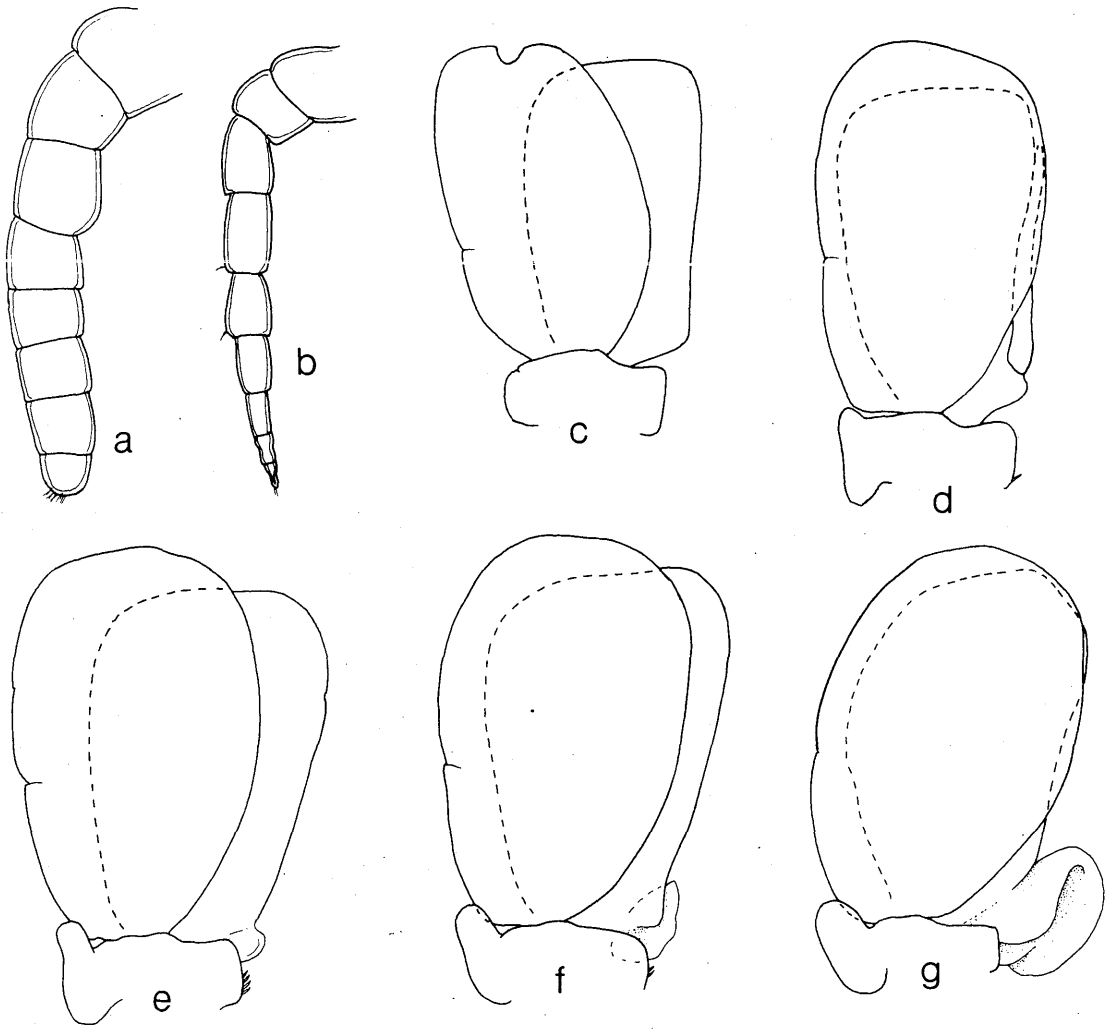

FIG. 17. *Mothocya longicopa* sp. nov.: a–g, ♂ 11·0 mm (USNM 216352). a, antennule; b, antenna; c–g, pleopods 1–5 respectively.

on the endopods of pleopods 3 to 5, and the male with an extremely large proximomedial lobe on the endopod of pleopod 5.

Hosts. Ablennes hians and *Tylosurus crocodilus.*

Distribution. Known only from the Gulf of Guinea, off Sierra Leone and off Guinea, West Africa (Fig. 53:8).

Etymology. Derived from the Latin words longus (long) and copis (a small knife), and alludes to the length of the uropods.

Mothocya belonae sp. nov.

(Figs 18, 19)

Material. From *Belone belone*: ♀ (non-ovig. 26·5 mm), Livorno, Italy, 14.xiii.1935 (USNM 216185); 2♂ (15·0, 15·5 mm), 5.xi.1945, 'Europe', Bonaparte collection (USNM 216186).

Types. HOLOTYPE ♀ USNM 216185.

Type-locality. Livorno, Italy, *c.* 4°13′N, 10°25′E.

Description of female. Body slightly twisted to one side, dorsum weakly convex. Rostrum apex narrow, bent downwards and posteriorly; eyes large, 0·62 times width of cephalon. Coxae not produced beyond posterior of respective segments, all narrow,

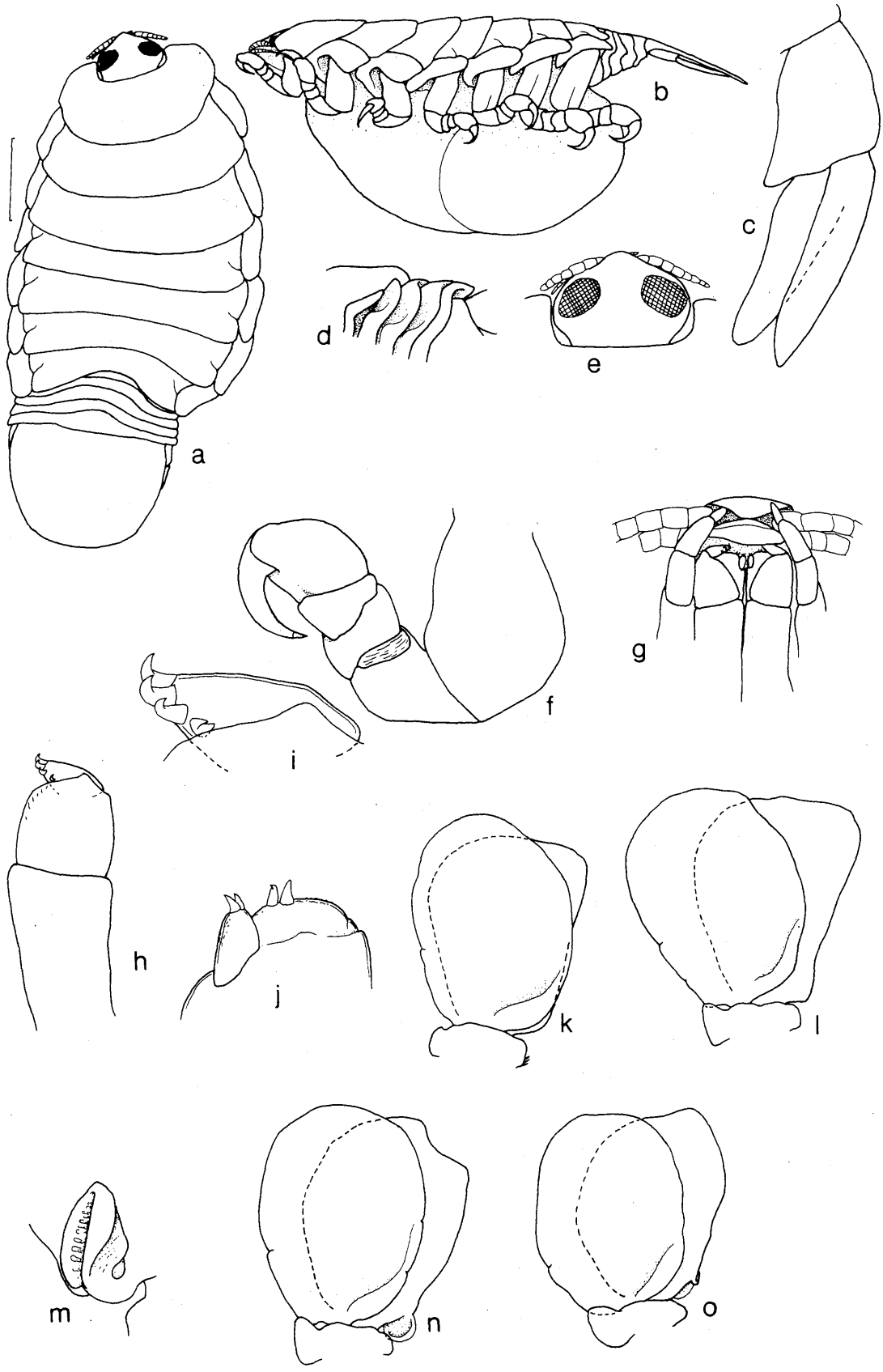

FIG. 18. *Mothocya belonae* sp. nov.: All HOLOTYPE. a, dorsal view; b, lateral view; c, left uropod, *in situ*, ventral view; d, left pleonites, ventral view; e, cephalon; f, pereopod 1, g, buccal region; h, maxilliped; i, maxilliped article 3; j, maxilla apex; k, l, n, o, pleopods 1–3, 5 respectively; m, pleopod 5 proximomedial lobe. Scale bar = 3·0 mm.

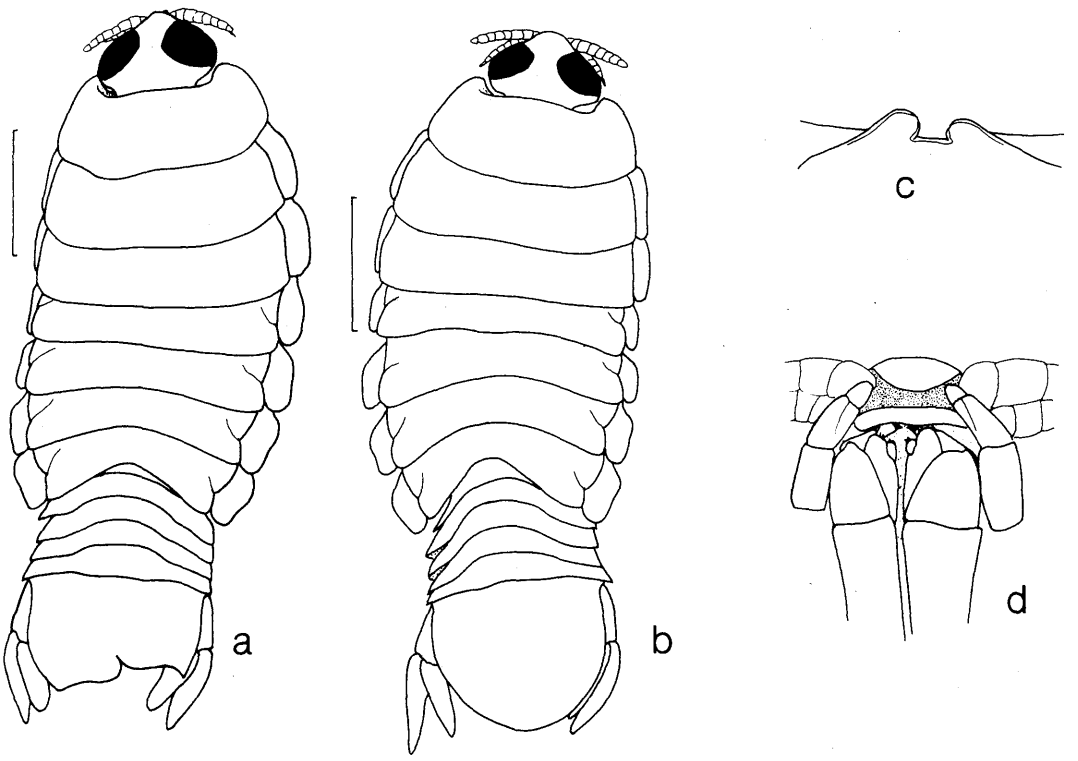

FIG. 19. *Mothocya belonae* sp. nov.: All USNM 216186. a, ♂ 15·0 mm; b–d, ♂ 15·5 mm: b, dorsal view, c, penes; d, buccal region. Scale bars = 3·0 mm.

about 1·8 (pereonite 2) to 3·6 (pereonite 6) times longer than wide. Posterior margin of pereonite 7 weakly and narrowly recessed. Pleon largely free of pereonite 7, pleonites all visible; about 0·77 times width of pereonite 5; pleonite 1 narrower than 2 on left side. Pleotelson smoothly rounded, 0·66 times as long as wide. Antennule composed of eight articles, antenna of nine; bases set closer together than in other species of genus. Maxilla with two recurved spines each on medial and lateral lobe respectively; maxilliped article 3 with four recurved spines. Pereopod propodus and dactylus relatively shorter than in other species; pereopods 4 to 7 distinctly longer than pereopods 1 to 3. Pleopod 1 peduncle lateral margin lobe scarcely developed; pleopod 3 endopod proximomedial lobe feebly developed, that of pleopod 5 well developed, much larger than that of pleopod 4. Peduncles of pleopods 1 and 2 each with three coupling hooks. Uropod not extending beyond posterior margin of pleotelson, peduncle distomedial lobe weakly produced, rami subequal in length; exopod lanceolate, endopod broad at base tapering to broadly rounded apex.

Male. Two specimens without precise locality data appear to belong to this species. Their pleopods are damaged and could not be compared to those of the holotype. Figures are given of the dorsal views, penes and buccal region. Until males positively associated with identified females are available, it seems best to regard them as undescribed.

Colour. Pale tan in alcohol, with scattered small chromatophores.

Size. Female 26·5 mm; males 15·0 and 15·5 mm.

Remarks. This species can be distinguished from others of the genus by the short subequal uropodal rami with a lanceolate endopod. It resembles somewhat the Indo-West Pacific species *Mothocya renardi*, but *M. renardi* has the pleon twisted, and has far longer uropodal rami with the exopod greatly exceeding the endopod in length.

Similarities between the two species include the proportions of the pereopods, the morphology of the pleopods and the maxilliped spination.

Lironeca taurica Czerniavsky, 1868, bears a close resemblance to *M. belonae* (see Kussakin, 1979) but is at present inadequately known. It can be distinguished from *M. belonae* by having much larger proximomedial lobes on the endopods of pleopods 3 to 5 and a much rounder pleotelson (see *Remarks* under *Mothocya taurica* for discussion of that species).

Hosts. Recorded only from *Belone belone.*

Distribution. Livorno, Italy; the range of this species within the Mediterranean is not even approximately known (Fig. 53:2).

Etymology. The name is taken from that of the host genus.

Mothocya taurica (Czerniavsky)

Restricted synonymy:
Lironeca pontica Borcea, 1933 a: 128; 1933 b: 481, figs 1–9, pls 2–4.
Lironeca punctata. Trilles, 1976 a: 782, pl. 2, fig. 6.
Lironeca taurica. Kussakin, 1979: 295, figs 160, 161.

Material. Two ♀ (ovig. 20·5, 22·3 mm), ♂ (10·5 mm), Agigea, Romania, Black Sea, 1959, ex *Alosa pontica*, coll. Aurelie Carausu (USNM 104130).

Remarks. Examination of these specimens shows that the species unequivocally belongs to the genus *Mothocya*, agreeing with all the generic characters given in the genus description and Table 1. Kussakin (1979) has given the most recent treatment of the species and the present material was identified from those figures. In appearance this species is very similar to *M. belonae*, from which it can be distinguished by having slightly wider coxae, a rounder pleotelson, and pleopods 3 to 5 endopods with much larger proximomedial lobes as well as a distolateral extension.

This species is being treated only briefly for several reasons. First, I have insufficient material at hand to assess the specific characters, and to confirm or negate previous records from different hosts. Secondly, the type-material of the different species listed in the synonymy was not available and the validity of these species could not be assessed. The descriptions given by Czerniavsky (1868) and Uljanin (1872) were without figures. Lastly, these species, synonymized under the name *taurica* by Kussakin (1979), are recorded from an array of hosts that is inconsistent with the pattern of host–parasite relationship shown by the rest of the genus. Trilles (1976 a) summarized the host records, and these can be summed up as nine species in nine genera belonging to the families Clupeidae, Engraulidae, Atherinidae, Pomatomidae, Carangidae, Scorpaenidae and Gobiidae. Trilles' (1976 a) photograph of the species does not agree with the figure given by Kussakin (1979) nor with the present material, being far broader in body shape. *Mothocya* species are far from indiscriminate in their host associations and it is extremely unlikely that all these records are of the one species.

I have given no figures as I do not wish identifications to be made from this account. Instead I prefer to draw attention to the need for re-evaluation of the Black Sea *Mothocya*, and a revision of the species currently synonymized with *M. taurica*, coupled with accurate host data.

Hosts. Trilles (1976 a) summarized previous records which suggest that the species is primarily associated with the families Clupeidae and Engraulidae.

Distribution. Restricted to the Black Sea (Fig. 53:10).

Mothocya omidaptria sp. nov.

(Figs 20–22)

Material. All specimens from *Hyporhamphus unifasciatus.* ♀ (ovig. 18·2 mm), HOLOTYPE USNM 216363; ♀ (ovig. 16·2 mm, no. 18), USNM 216365; ♀ (non-ovig. 16·8 mm, no. 14), USNM 216365; ♀ (non-ovig. 14·2 mm, no. 16), MCZ uncat; ♀ (pre-ovig. 16·0 mm), ♂ (9·5 mm, no. 17); ♂ (*c.* 9·1 mm), USNM 216364; ♂ (9·1 mm, no. 26), USNM 216365; ♀ (broken in two), USNM 216365; all Rio de Janeiro, Brazil; only data is Thayer-Agassiz, 1865. Two ♀ (ovig. 14·9, non-ovig. 15·0 mm), 4 ♂ (7·5, 7·8, 7·8, 8·4 mm), Curaçao, West Indies, 10–18.ii.1884, coll. US Fisheries *Albatross* (USNM 216366).

Types. HOLOTYPE, USNM 216363; PARATYPES, USNM 216364, 216365, MCZ uncatalogued.

Type-locality. Rio de Janeiro, Brazil, 22°53′S, 43°17′W.

Description of female. Body 2·13–2·30 times longer than wide, weakly to moderately twisted to one side, widest at pereonite 5. Rostrum strongly produced, apex narrow, scarcely turned down; eyes moderate, facets indistinct, about 0·54 times width of cephalon. Coxae all narrow, those of pereonites 6 and 7 extending beyond posterior of segment, those of pereonite 7 with posterolateral corner acute or subactue; lateral margins of most coxae weakly to moderately concave. Posterior margin of pereonite 7 strongly recessed. All pleonites at least partly visible in dorsal view, lateral margins extending beyond coxal plate of pereonite 7 one one side; pleon 0·90–1·01 times width of pereonite 5. Pleotelson 0·67–0·72 times longer than wide, widest at about midlength, posterior margin evenly rounded. Antennule composed of eight articles. Antenna composed of eight articles, first two of which are short and broad, remaining articles slender. Mandible palp robust, not extending beyond apex of incisor. Maxillule with one broad-based and three slender spines. Maxilla with two spines on medial lobe, three on lateral lobe. Maxilliped article 3 slender, with three terminal hooked spines and fourth hooked spine on proximomedial margin. Pereopods robust, pereopod 7 substantially larger than pereopod 1. Brood pouch with anterior pair of oostegites, smallest; deepest midlength to posterior. Pleopod 1 peduncle lateral lobe barely developed, those of pleopods 2 to 5 moderately developed. Proximomedial lobe of endopods 3 to 5 feebly developed, that of pleopod 5 slightly larger than that of pleopod 4. Uropod rami extending beyond posterior margin of pleotelson, apices of both rami narrow, subacute; endopod margins straight, converging rapidly to apex; exopod slightly sinuate, margins converging distally.

Male. Antennule similar to that of female, antenna with nine articles, first two not noticably broader. Maxilla lateral lobe with two spines. Maxilliped article 3 with three hooked spines. Penes set close, but not adjacent to each other. All males with damaged pleopods; proximomedial lobe on endopods 3 to 5 large, that of pleopod 5 conspicuously larger than that of pleopod 4. Uropod longer than in female, otherwise similar.

Colour. Pale tan in alcohol, females without conspicuous chromatophores on dorsal surface; males with chromatophores on dorsal surface and appendages.

Size. Ovigerous females 16·2–18·2 mm, non-ovigerous females 14·2–16·8 mm; males 9·1–9·5 mm.

Variation. The degree to which the posterior coxae are produced varies, as does the relative width of the uropodal endopod. The uropod exopod of some specimens is very nearly straight, in others it is weakly sinuate. Males and immature females have only

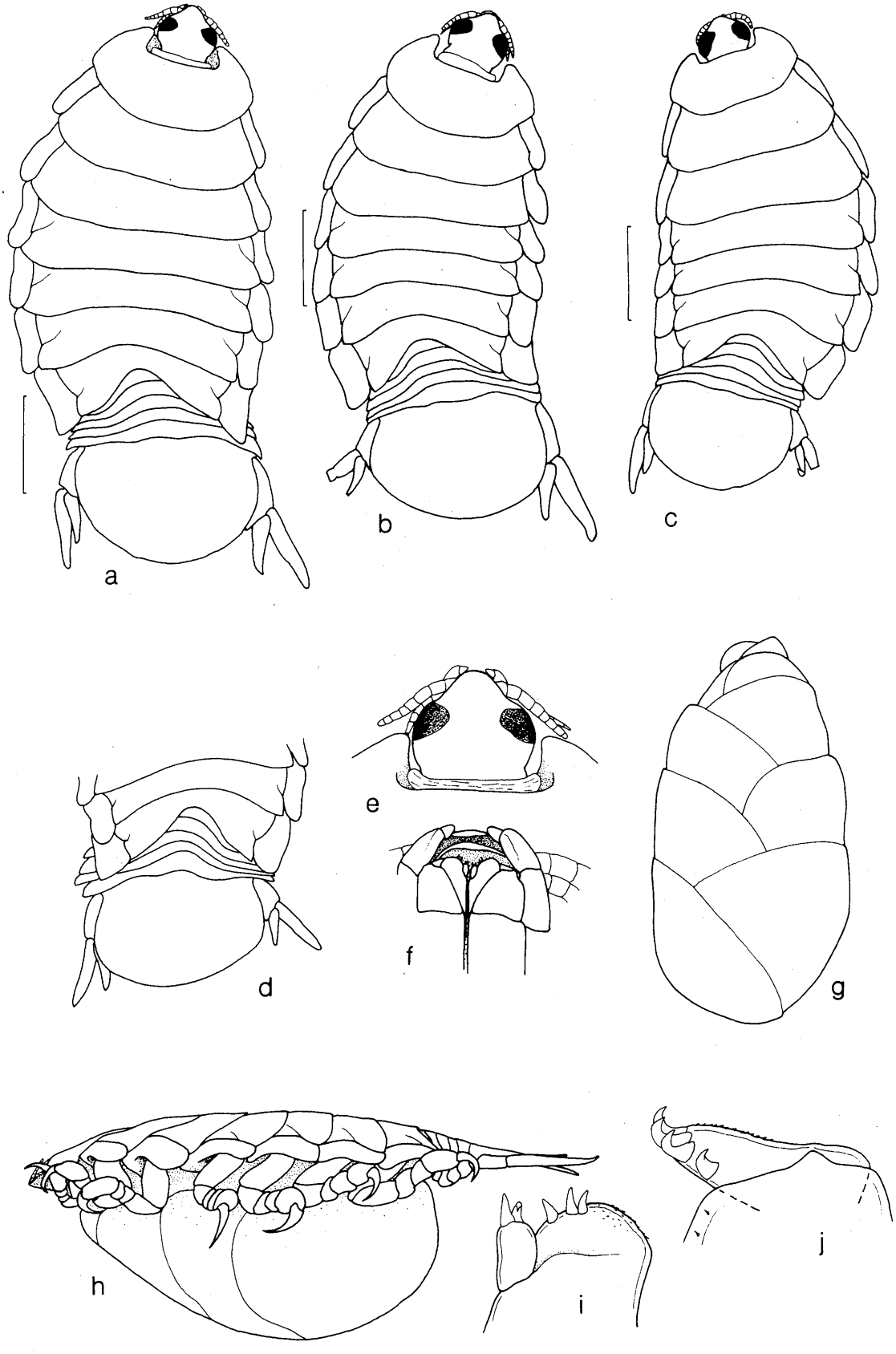

FIG. 20. *Mothocya omidaptria* sp. nov.: a, e–h, HOLOTYPE; i, j, ♀ 16·2 mm (USNM 216365), no. 18); remainder as indicated. a, dorsal view; b, ♀ 16·8 mm (USNM 216365 no. 14); c, ♀ 14·9 mm, Curaçao (USNM216366); d, ♀ 15·0 mm, Curaçao, pleon and pleotelson; e, cephalon; f, buccal area; g, brood pouch; h, lateral view; i, maxilla apex; j, maxilliped article 3. Scale bars = 3·0 mm.

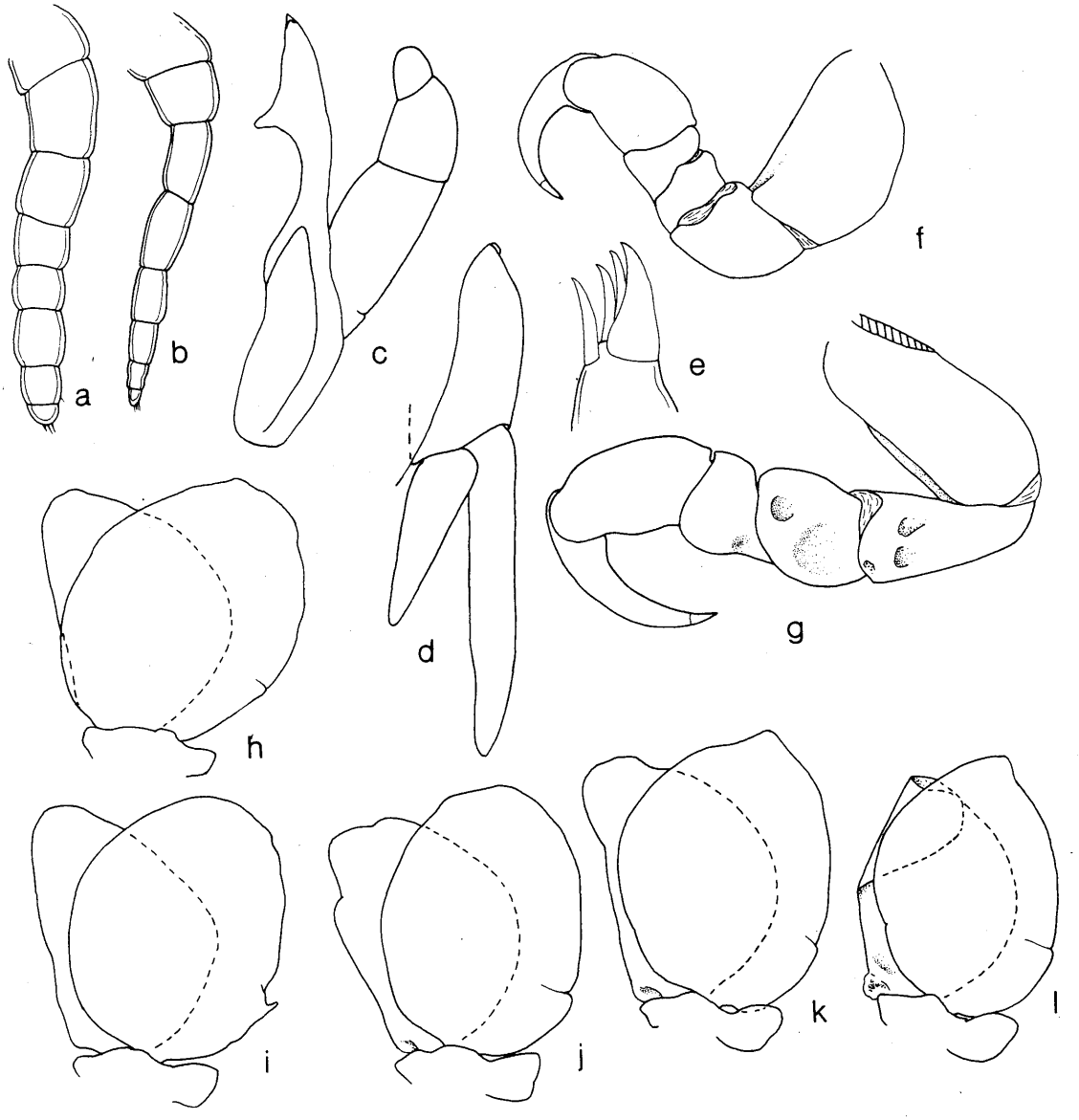

FIG. 21. *Mothocya omidaptria* sp. nov.; a–d, f–l, ♀ 16·2 mm (USNM 216365, no. 18); remainder as indicated. a, antennule; b, antenna; c, mandible; d, uropod; e, maxillule apex, ♀ 14·2 mm (MCZ, uncat.); f, pereopod 1; g, pereopod 7; h–l, pleopods 1–5 respectively.

two spines on the lateral lobe of the maxilla. The specimens from Curaçao have larger proximomedial lobes on the endopods of pleopods 3 to 5 than do specimens from Brazil.

Remarks. The most useful characters to identify this species are the narrowly produced rostrum, the acute coxae of pereonite 7, the pleon extending laterally beyond the coxae of pereonite 7 one one side, and relatively long uropodal rami with a narrow endopod and sinuate exopod.

Mothocya nana is separated by having the anterior margin of the rostrum truncate, shorter coxae, those of pereonite 7 with blunt posterior margins, and larger proximomedial lobes on the endopods of pleopods 3 to 5.

Hosts. Known only from *Hyporhamphus unifasciatus.*

Distribution. Known only from Rio de Janeiro, Brazil, and Curaçao, West Indies (Fig. 53:9).

Etymology. The epithet is derived from the Greek words omis (one of the many for fish) and daptria (eater).

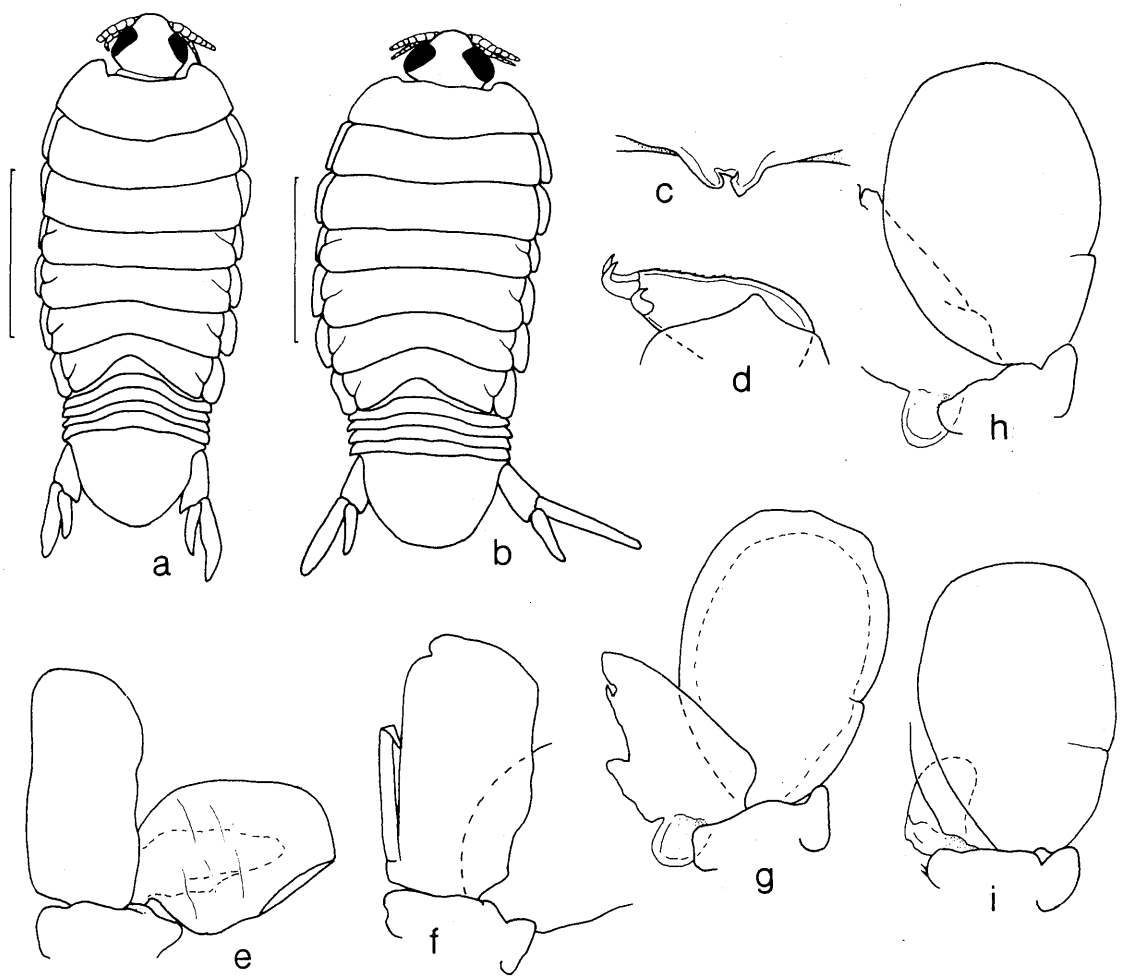

FIG. 22. *Mothocya omidaptria* sp. nov.: a, ♂ 9·1 mm (USNM 216365, no. 26); b, ♂ 9·5 mm (USNM 216365, no. 17); c–i, ♂ 9·1 mm: c, penes; d, maxilliped article 3; e–i, pleopods 1–5 respectively. Scale bars = 3·0 mm.

Mothocya melanosticta (Schioedte and Meinert)

(Figs 23, 24)

Irona melanosticta Schioedte and Meinert, 1884: 388, pl. 17, figs 3–5.
Irona cypselurus Avdeev, 1978: 33, fig. 3.
Non *Irona melanosticta* of all other authors (see Table 3).

Material. ♀ (ovig. 20·0 mm), LECTOTYPE, Sandwich Islands (= Hawaii), donated or collected by J. H. Barnard (MCZ 3714); ♀ (non-ovig. 18·8 mm), ♂ (9·0 mm), Nihoa Island, Hawaii, 22°55′N, 162°12′W, 5.vi.1967, ex *Cypselurus spilanoreptus* taken at night light, coll. R. V. T. Cromwell (BPBM S10474); ♀ (non-ovig. 16·0 mm), ♂ (8·0 mm), Poka Bay, Oahu, Hawaii, 5.ix.1970, ex *Cypselurus* sp., coll. P. M. Allen (BPBM S10473); ♀ (ovig. 16·3 mm), ♂ (9·5 mm), off Coiba Island, Pacific Panama, 08°07′N, 83°08′W, 7.v.1947, ex *Parexocoetus brachypterus* taken at night light (BPBM S10470); 3♀ (ovig. 19·5, 20·0, non-ovig. 18·5 mm), Keelung, Taiwan, 26.vi.1957, ex *Parexocoetus brachypterus*, coll. E. Teng (USNM 216218); ♀ (17·1 mm), Hawaiian Islands, no other data, ex *Parexocoetus brachypterus* (LACM uncat.); ♀ (17·8 mm), ♂ (10·1 mm), Naha, Okinawa, Japan, 1906, ex *Parexocoetus brachypterus* (USNM 216217); ♀ (ovig. 15·2 mm), north-east of Townsville, Qld, Australia, 18°02′S, 147°12′E, 27.ii.1979, ex *Cypselurus nigripinnis*, coll. AIMS, AM, QM (QM W11754).

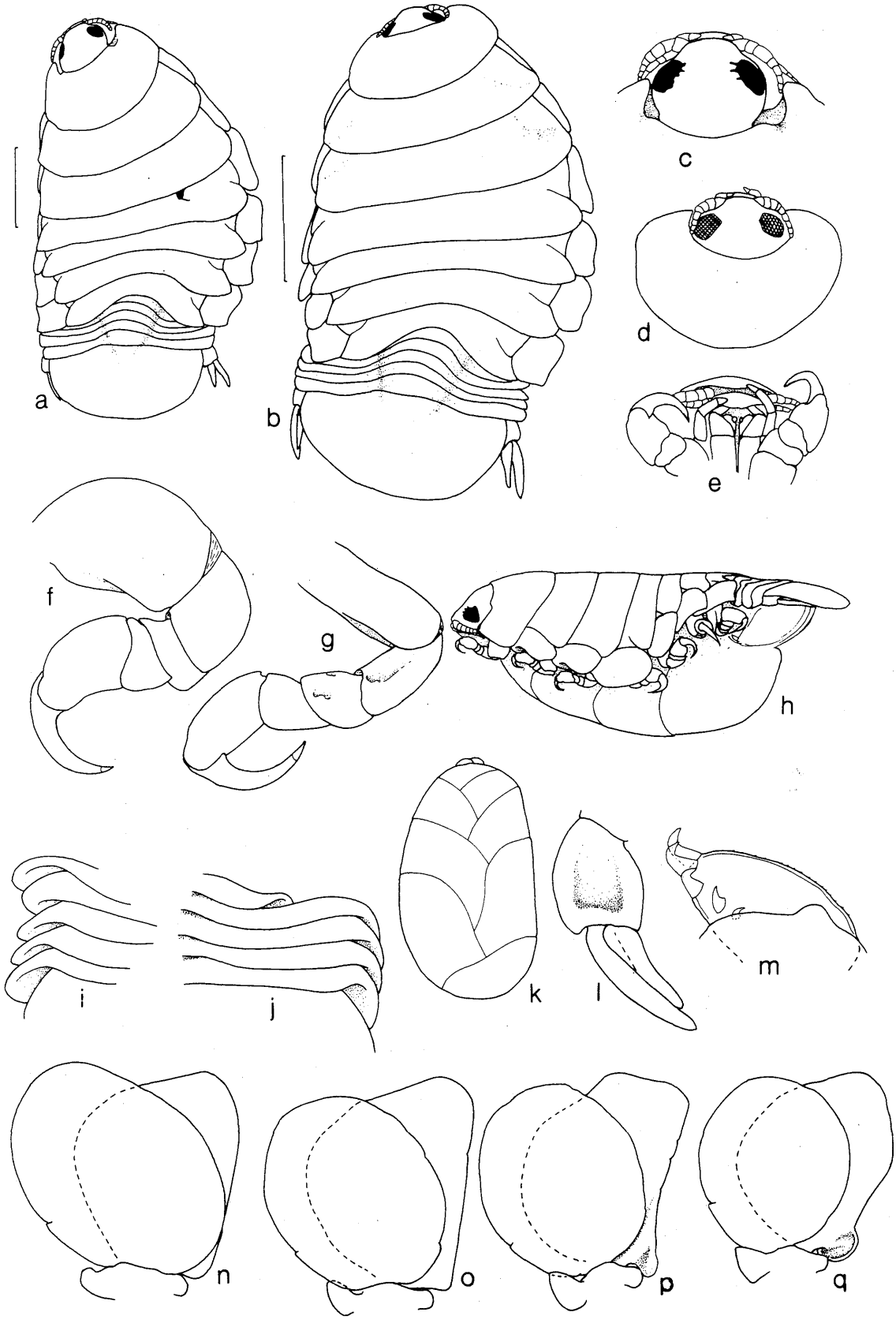

FIG. 23. *Mothocya melanosticta*: a, c, h, ♀ LECTOTYPE, remainder ♀ 16·3 mm, Coiba Is. (BPBM S10470). a, dorsal view, b, dorsal view; c, cephalon; d, cephalon and pereonite 1; e, buccal area; f, pereopod 1; g, pereopod 7 (pereopods 1 and 7 not to same scale); h, lateral view; i, right pleonites, ventral view; j, left pleonites, ventral view; k, brood pouch; l, uropod; m, maxilliped article 3; n–q, pleopods 1, 2, 4, 5 respectively. Scale bars = 4·0 mm.

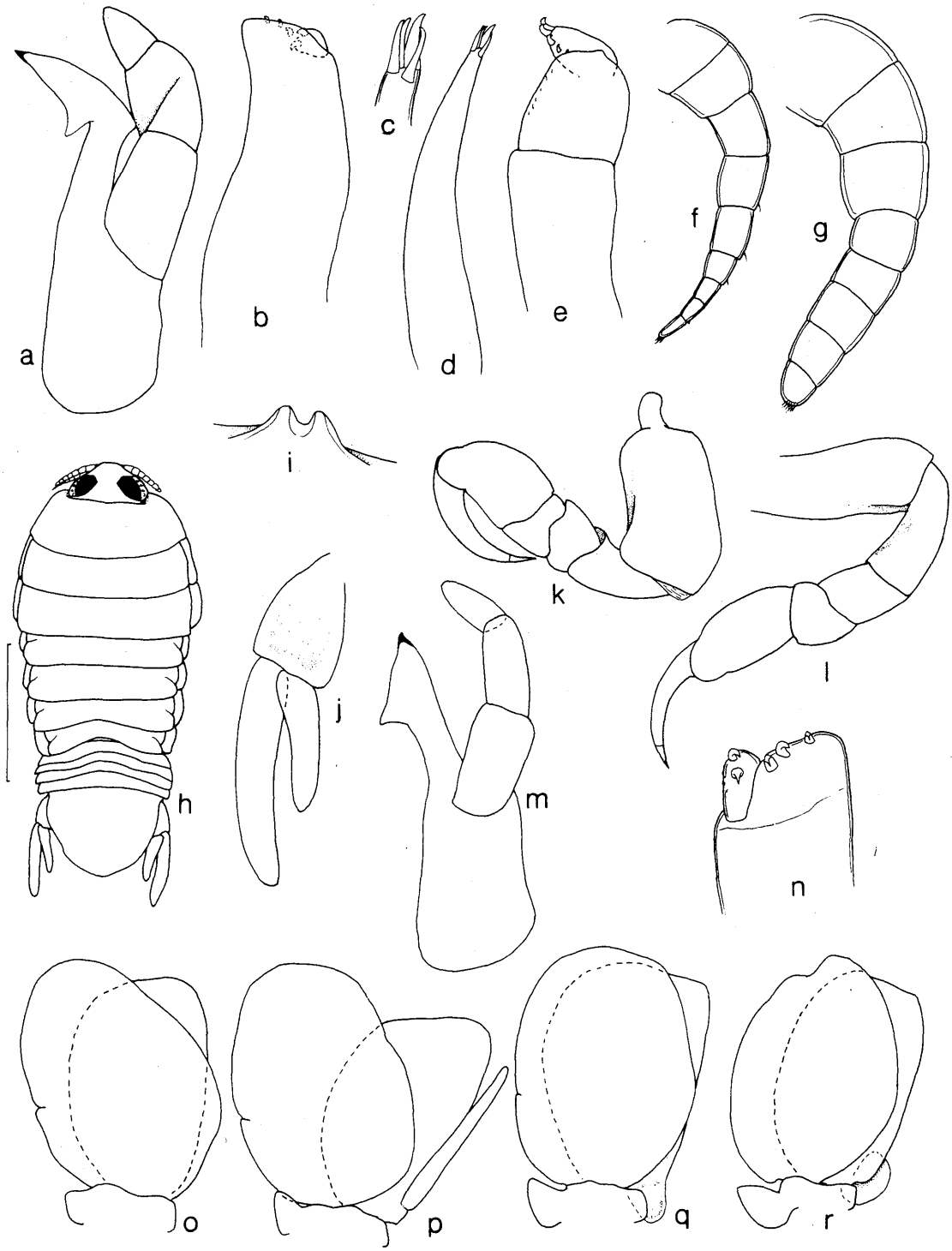

FIG. 24. *Mothocya melanosticta*: a–g, ♀ 16·3 mm, h, i, ♂ 9·5 mm, both Coiba Is. (BPBM S10470); remainder ♂ 9·0 mm, Nihoa Is. (BPBM S10474). a, mandible; b, maxilla, c, maxillule apex; d, maxillule; e, maxilliped; f, antenna, g, antennule; h, dorsal view; i, penes; j, uropod; k, pereopod 1; l, pereopod 7; m, mandible; n, maxilla apex; o–r, pleopods 1–3, 5 respectively. Scale bar = 3·0 mm.

Types. The material examined by Schioedte and Meinert (1884) consists of three species. The Museum of Comparative Zoology have the specimen that is recognizable as that figured by Schioedte and Meinert, and this specimen is here designated as the lectotype (MCZ 3714). Other syntypic material is not the same species and there are no paralectotypes. Material held by the Zoologisk Museum, Copenhagen includes one

specimen of *Mothocya sajori* and an undescribed species of *Mothocya* (see p. 1178). The four specimens at the Naturhistorisches Museum, Vienna are all *Mothocya sajori*.

Type-locality. Schioedte and Meinert (1884) refer to Asia, Pacific Ocean, Japan and the Sandwich Islands (Hawaii). The type-locality is here taken to be Hawaii, the locality of the lectotype.

Description of female. Body widest at pereonites 5 and 6, weakly twisted to one side. Rostrum moderately produced, truncate; eyes moderate, about 0·40–0·50 times width of cephalon. Coxae of pereonites 2 to 5 about 1·55–1·8 times longer than wide, not extending beyond posterior of respective segments; coxae of pereonite 7 about 1·2 times longer than wide, posterior margin straight, lateral margin concave, posterolateral angle acute. Posterior margin of pereonite 7 deeply recessed. Pleonites all visible, all medially indented; lateral margins of pleonite 1 entirely concealed by pereonite 7; lateral margins of pleonites 2 to 5 uncovered or only partly overlapped. Pleon about 0·90 times width of pereonite 5, slightly wider at pleonite 5 than at pleonite 4. Pleotelson short, about 0·5 times as long as wide; anterior margin narrower than pleonite 5, lateral margins curving in smoothly to meet pleonite 5. Mandible palp scarcely extending beyond incisor; maxilla with two spines on medial lobe, three on lateral lobe; maxilliped article 3 with five recurved spines. Pereopods all robust, 4 to 7 longer than 1 to 3. Pereopod 1 basis 1·7 times longer than wide, posterior margin convex; ischium about half as long as basis and longer than combined lengths of merus and carpus; propodus about 1·6 times longer than wide, palm straight; dactylus strongly curved, longer than propodus. Pereopods 2 and 3 similar to 1. Pereopod 7 basis slender, about 2·5 times longer than wide, margins subparallel; ischium 1·75 times length of merus, which is subequal in length to carpus; propodus nearly twice (1·9) as long as wide. Pleopods all with broadly rounded rami. Pleopod 1 peduncle lateral lobe weakly developed, only moderately developed on pleopods 2 to 5, pleopods 3 to 5 endopod with proximomedial lobes moderately developed, that of pleopod 5 distinctly larger than that of pleopod 4. Uropod peduncle short (1·23 times longer than wide), lateral margin distinctly convex; rami short, not extending beyond posterior of pleotelson; exopod longer than endopod, both rami tapering to narrow apex.

Male. Rostrum folded back; pleonites subequal in width, pleotelson shield-shaped, anterolateral margin slightly indented. Antennule, antenna, mouthparts and pereopods essentially similar to those of female. Pleopods differ from female in having longer peduncles on pleopods 1 and 2, and in pleopod 2 possessing an appendix masculina. Uropods longer than female, exopod proportionally longer, about 1·75 times length of endopod; both rami with bluntly rounded apices.

Colour. Tan in alcohol, chromatophores sparsely spread over dorsal surfaces, and on antennule and antenna; posterior of pereonites pale giving faintly banded appearance.

Size. Ovigerous females 16·0–20·0 mm, non-ovigerous females 16·0–18·8 mm; males 8·0–9·5 mm.

Variation. The specimens examined all present a uniform appearance with the exception of the female from Nihoa Is. (BPBM S10474). This specimen has a more pyriform body shape than the others, a feature also shown by the specimen figured by Avdeev (1978). In some specimens the eye facets are not distinct.

Remarks. *Mothocya melanosticta* has been the most widely applied name of the genus. The reported occurrence of the species in Japan (Schioedte and Meinert, 1884; Thielemann, 1910) encouraged workers in the belief that the species was widespread, and also unselective in its choice of host. All determinations subsequent to the original

Table 3. Determinations of *Irona melanosticta* and their current identity.

Author	Quoted host	Locality	Identity
Thielemann, 1910	*Belone* sp.	Okayama, Japan	*Mothocya* sp.
Thielemann, 1910	No host	Yokohama, Japan	*M. sajori*
Barnard, 1914	*Tylosaurus choram*	Zambesi River	**M. renardi*
Barnard, 1955	*Tylosaurus* sp.	South Africa	*Mothocya* sp.
Nierstrasz, 1915	No host	Indonesia	**M. plagulophora*
Nierstrasz, 1931	Citation of previous records		
Hale, 1926	*Hyporhamphus intermedius*	Australia	**M. halei*
Hale, 1926	*Tylosurus* sp.	Australia	**M. collettei*
Hale, 1929	Citation of previous record		
Hiraiwa, 1934	*Hyporhamphus sajori*	Japan	*M. sajori*
Inouye, 1941	*Hyporhamphus sajori*	Japan	*M. sajori*
Gurjanova, 1936	Repeat of Thielemann's record		
Shiino, 1951, 1965	*Hyporhamphus sajori*	Japan	*M. sajori*
Hattori and Seki, 1956	*Hemiramphus sajori*	Japan	*M. ?sajori*
Stephenson, 1969	*Hyporhamphus ihi*	New Zealand	**M. ihi*
Stephenson, 1976	*Hyporhamphus ihi*	New Zealand	**M. ihi*
Hewitt and Hine, 1971	*Hyporhamphus ihi*	New Zealand	*M. ihi*
Kensley, 1976	"Garfish"	South Africa	*M. renardi*
O'Connor, 1978	*Girella tricuspidata*	Australia	**M. halei*
			**M. girellae*
O'Connor, 1978	Atherinidae spp.		**M. waminda*
Kussakin, 1979	*Belone* sp.	?	*Mothocya* sp. ?
	Hemiramphus sajori	?	*M. ?sajori*
Hatai and Yasumotu, 1980	*Seriola quinqueradiata*	Japan	**M. parvostis*
Hatai and Yasumotu, 1981	*S. quinqueradiata*	Japan	**M. parvostis*
Hatai and Yasumotu, 1982 a	*Girella punctata*	Japan	**M. parvostis*
Hatai and Yasumotu, 1982 b		Japan	**M. parvostis*
Nunomura, 1981	*Hemiramphus sajori*	Japan	*M. sajori*

* Indicates specimens examined.

description of *Mothocya melanosticta* have been wrong (Table 3), and the species has only been recorded once since the original record by Avdeev (1978), who described it as a new species.

The morphology of the coxae, the extremely short pleotelson and uropods, and the details of the pleopods serve to identify this species.

Hosts. Recorded from *Cypselurus spilanoreptus, C. nigripinnis* and *Parexocoetus brachypterus*; also from an unidentified *Cypselurus* sp.

Distribution. Tropical East Pacific, Japan, Taiwan, and the tropical Indo-West Pacific from Hawaii, Australia and the Red Sea (Avdeev, 1978) (Fig. 54:4).

Etymology. The name means 'black spotted' and presumably refers to the chromatophores on the dorsum.

Mothocya plagulophora (Haller)

(Figs 25–27)

Livoneca plagulophora Haller, 1880: 380, pl. 18, figs 8, 9.
Irona vatia Schioedte and Meinert, 1884: 386, pl. 17, figs 1, 2; Nierstrasz, 1915: 104; 1931: 145; Monod, 1971: 169, 174, figs 18–42; Trilles, 1976 a: 784, pl. 1, fig. 9.
Irona vatica. Pfeffer, 1889: 36 (lapsus calami).

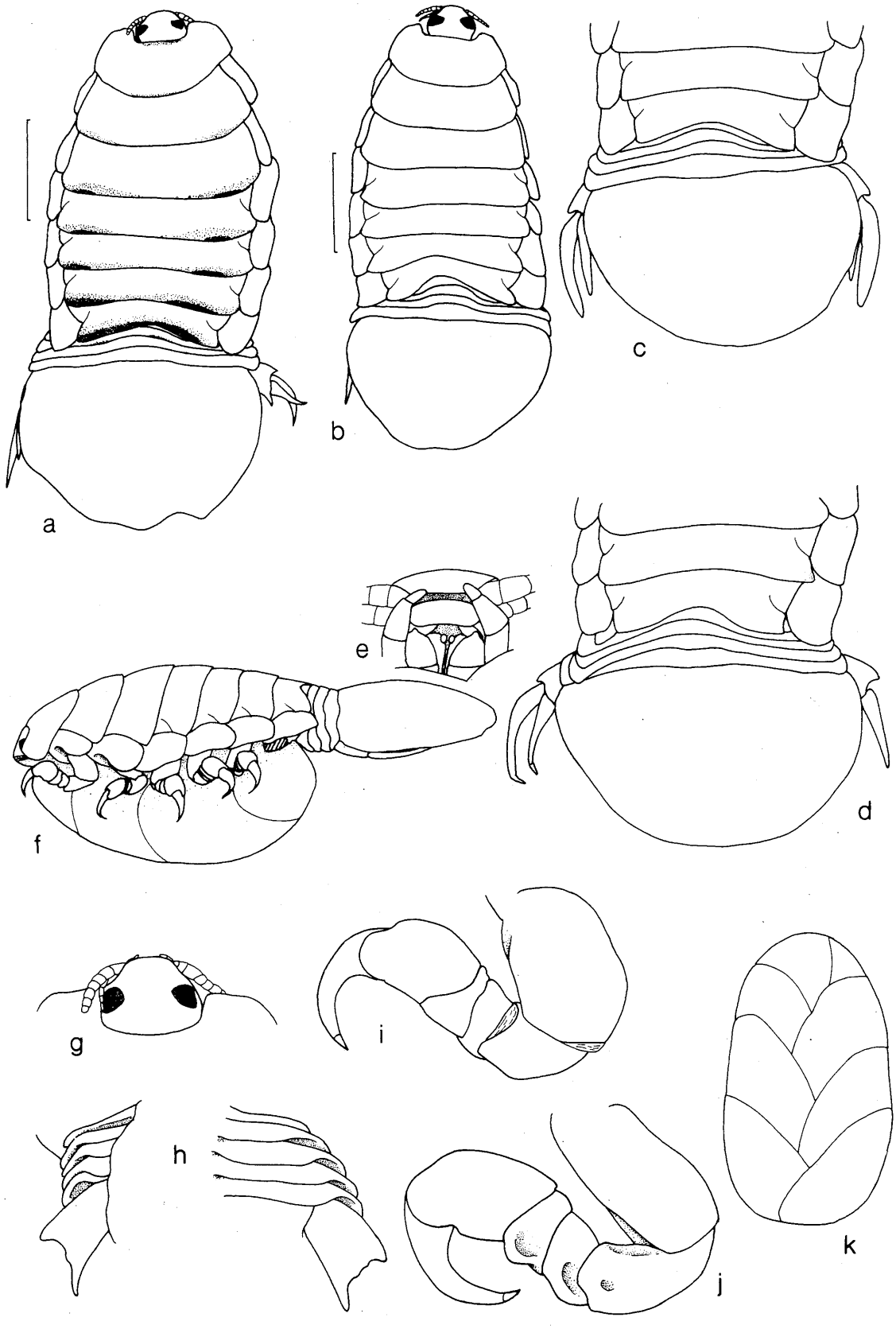

FIG. 25. *Mothocya plagulophora*: a, e–k, ♀ 24·0 mm, Mandapam (USNM 216271); remainder as indicated. a, dorsal view; b, ♀ 22·0 mm, Mauritius (USNM 10074); c, ♀ 21·0 mm, Ceylon (USNM 216376); d, ♀ 21·5 mm, Ceylon; e, buccal region; f, lateral view; g, cephalon; h, right and left pleonite, ventral view; i, pereopod 1; j, pereopod 7; k, brooch pouch. Scale bars = 5·0 mm.

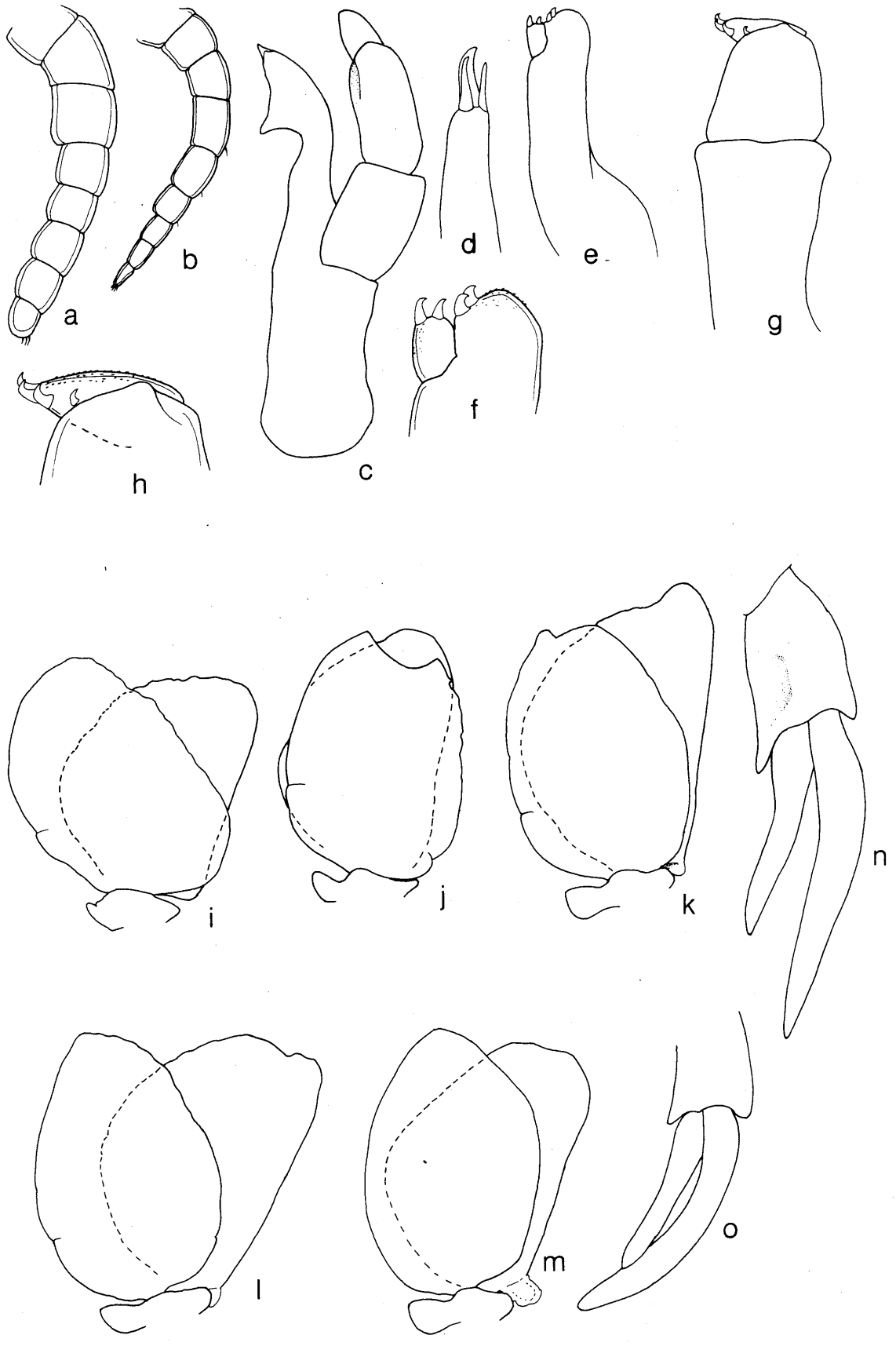

FIG. 26. *Mothocya plagulophora*: a–n, ♀ 24·0 mm, Mandapam (USNM 216271); remainder as indicated. a, antennule; b, antenna; c, mandible; d, maxillule; e, maxilla; f, maxilla apex; g, maxilliped; h, maxilliped article 3; i–m, pleopods 1–5 respectively; n, left uropod *in situ*; o, left uropod *in situ*, ♀ Bali (AM P35250).

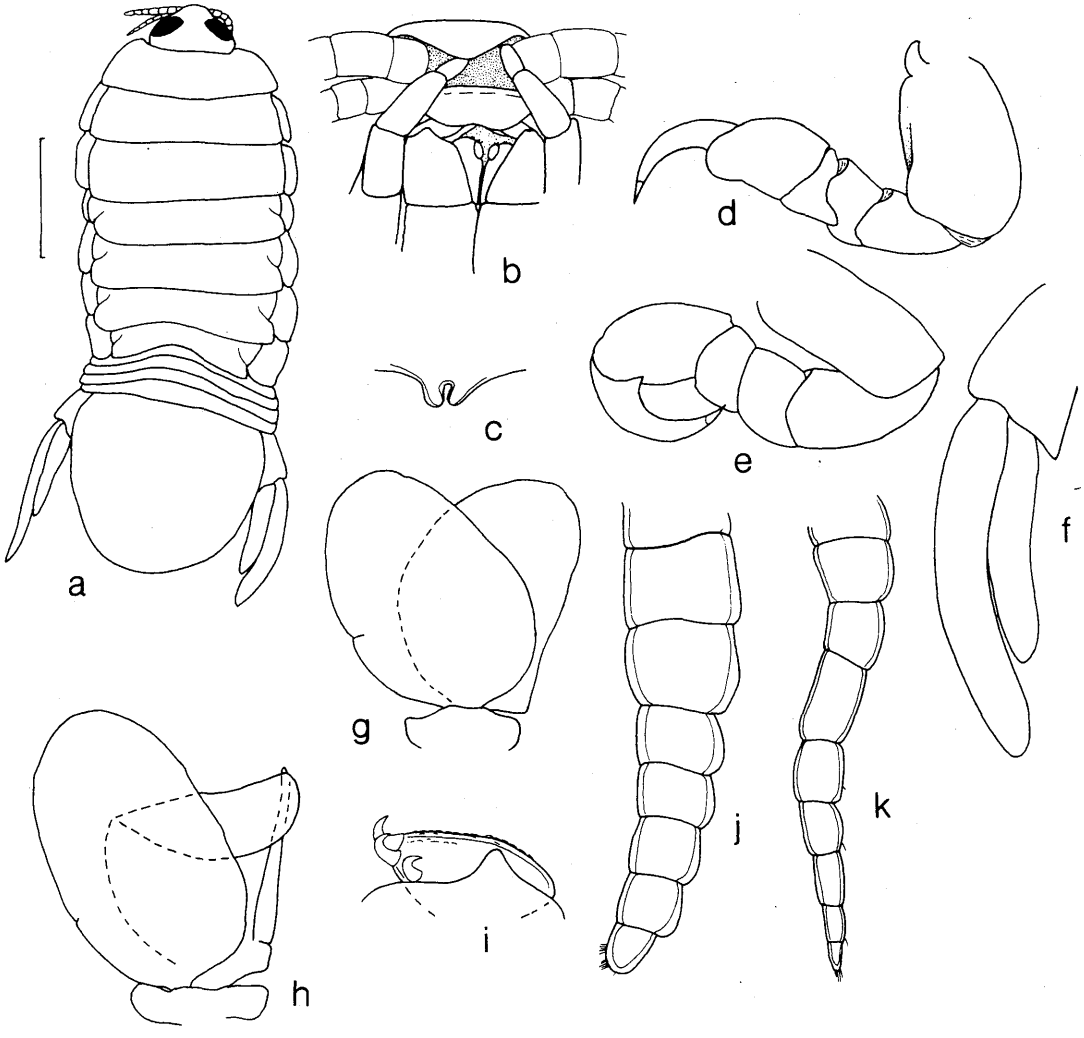

FIG. 27. *Mothocya plagulophora*: a–c, f, ♂ 14·2 mm, remainder ♂ *c.* 13·0 mm, Mandapam (USNM 216271). a, dorsal view; b, buccal area; c, penes; d, pereopod 1; e, pereopod 7; f, right uropod *in situ*; g, pleopod 1; h, pleopod 2; i, maxilliped article 3; j, antennule; k, antenna. Scale bar = 3·0 mm.

Irona melanosticta. Nierstrasz, 1915: 103 (non *Mothocya melanosticta* (Schioedte and Meinert)).
Lironeca plagulophora. Nierstrasz, 1931: 144.
Irona far. Nair, 1950: 70, pl. 2, figs 13–23; 1956: 25; Pillai, 1954: 17; Abraham, 1966: 24, figs 1–27; Monod, 1971: 173; Thampy and John, 1974: 574, figs 1–18.

Material. Three ♀ (ovig. 32·0, 26·8, 25·7 mm), syntypes, non-type ♀ (*c.* 27·0 mm), no data except 'Isles Maurice', examined by Haller (1880). From *Hemiramphus far* except where otherwise indicated: ♀ (non-ovig. 24·5 mm), ♂ (15·0 mm), Yeseva, Mogadiscio, Somalia (USNM 216375); 8♀ (ovig. 21.8, 22·0, 22·5, 23·0, 24·0, non-ovig. 18·0, 20·5 imm. 16·0 mm), Mombasa, Kenya, date?, purchased at fish market, coll. B. B. Collette (USNM 216374); ♀ (ovig. 19·2 mm), ♂ (*c.* 13·0 mm), Zanzibar Channel, East Africa, 25, 26.vi.1963, ex *Sardinella* sp., coll. G. Losse (BMNH uncatalogued); ♀ (non-ovig. 17·5 mm), Grande Comore, Comoro Islands, Indian Ocean (USNM 216373); ♀ (ovig. 22·0 mm), Mauritius, Indian Ocean, no host, no data, coll. Col. Ch. Pike (USNM 10074); ♀ (ovig. 24·0 mm). Madras, India, 1892(?), coll. J. R. Henderson (BMNH 1892.vii.15: 429–434); 2♀ (ovig. 22·0, 24·0 mm), 2♂ (13·5, *c.* 14 mm), Mandapam Camp, India, 29.ix.1966 (USNM 216271); 3♀ (ovig. 19·0, 21·0, 21·5 mm), 3♂ (11·5, 12·5, 13·6 mm), Hambutata Bay, Ceylon, 20.xii.1969, (USNM 216376); 6♀ (ovig. 17·0, *c.* 18·0,

18·5, 20·0, 20·0, non-ovig. 20·0 mm), Borneo, from Stebbing's collection (BMNH 1928. 12–1: 1576–83); ♀ (ovig. 22.5 mm), South-West Bali, Pacific Indonesia, ix. 1982 (AM P35240); ♀ (non-ovig. *c.* 26 mm), Great Barrier Reef, Australia (QM W11735).

Eight ♀, 6♂, Djibouti, Somalia (Red Sea coast), and 1♀, Tulear, Madagascar, reported on by Trilles (1976 a); 2♀ (ovig. 20·5, 20·7 mm), Reede van Semarang, x.1912 (RMNH 76. Nierstrasz, 1915; Monod, 1976); ♀ (ovig. 25·2 mm), Baai van Batavia, vii.1908 (RMNH 79), ♀ (25·6 mm), Java Zee (RMNH 80), both coll. P. Buitendijk.

Types. The three female syntypes are held at the Muséum d'Histoire Naturelle, Geneva, Switzerland (uncatalogued). Haller's specimens are all one species and a lectotype is not designated.

Type-locality. Haller (1880) states Mauritius as the locality from which his specimens originated.

Description of female. Body scarcely twisted, widest at pereonite 5. Rostrum moderately produced, turned down and posteriorly; eyes moderate, 0·41–0·44 times width of cephalon, facets indistinct. Coxae of pereonites 2 to 4 not extending beyond posterior of respective segments, those of pereonites 5 to 7 extending very slightly beyond segment; coxa 2 to 4 about 1·3–1·6 times longer than wide; coxae of pereonite 7 about 1·3 times longer than wide, distolateral angle gently rounded, lateral margin of one coxal plate may be concave. Posterior margin of pereonite 7 shallowly recessed. Pleon short, lateral margins extending beyond coxal plates on one or both sides between 1·21 and 1·33 times width of pereonite 5; pleonite 1, and most of 2, concealed by pereonite 7; pleonites appear to overlap (dorsoventrally) next pleonite; pleonite 5 widest; pleonite 1 only slightly shorter than pleonite 2. Pleotelson 0·7 times as long as wide, anterolateral margins dilating slightly, then tapering to broadly rounded apex; posterior part thin, foliaceous. Mandible palp not extending beyond incisor; maxilla with two spines on medial lobe, two on lateral lobe; maxilliped article 3 with four recurved spines. Pereopods robust. Pereopod 1 basis short, posterior margin with proximal two-thirds straight: ischium about half as long as basis, longer than combined lengths of merus and carpus; propodus about 1·3 times longer than wide, palm very slightly concave; dactylus robust, reaching to midlength of carpus. Pereopod 7 similar to 1, but basis and ischium markedly more elongate; dactylus also longer. Pleopod 1 peduncle lateral lobe scarcely developed, those of pleopods 3 to 5 only moderately developed; medial margin of exopod of pleopod 1 may be undulating; proximo distal lobe on endopods 3 to 5 all small, that of endopod 5 only slightly larger than that of endopod 4. Uropod peduncle distolateral angles produced, rami long, but not extending beyond apex of pleotelson, exopod smoothly curved, tapering from apex; endopod weakly curved, tapering from about two-thirds of length to narrowly rounded apex.

Male. Rostrum folded back; pleon wider than pereonite 7; pleonite 1 concealed by pereonite 7. Mouthparts similar to female except mandible palp less robust, and maxilliped article 3 with three curved spines. Pleopods same as in female, except pleopod 2 with appendix masculina. Uropod peduncle with distal angles scarcely produced; rami longer, extending beyond pleotelson, endopod proportionally longer than in female; both rami broader than in female.

Variation. The commonest variation is in the length of the uropods which are frequently very short on one side, occasionally on both. Variation is also seen in the shape of the uropod exopod, which may be smoothly curved (Fig. 26 o) or slightly sinuate (Fig. 26 n). The arrangement of the lateral margins of the pleonites is variable, but in all specimens pleonite 5 is widest (Figs 25 a–d).

Colour. *Mothocya plagulophora* is the only species of the genus showing a colour pattern of dark bands along the posterior margins of the pleonites and posterior pereonites. The distolateral extremity of the propodus is also pigmented. The banding is most developed on Indian and Sri Lankan specimens; in Australian and Indonesian material the pattern is present only on pereonites 6 and 7 and the pereopods: East African, Somali, Comoro and Mauritian specimens are without bands. Generally males have little pigmentation.

Size. Ovigerous females 17·0–24·0 mm, non-ovigerous females 17·5–26·0 mm; males 11·7–15·0 mm.

Remarks. This is one of the most distinctive species of the genus, the extremely wide pleon immediately separating it from all other species. It is one of the few species in which the male, by virtue of its wide pleon, can be confidently identified in the absence of female specimens. The colour pattern is characteristic, and in Indian and central Indo-West Pacific specimens immediately identifies the species.

This species has been described as *Irona far* by Nair (1950, and see Abraham, 1966), but the colour pattern and pleonal morphology identify their material as *Mothocya plagulophora.* This is further supported by *M. plagulophora* occurring only in association with *Hemiramphus far*, the host species from which *Irona far* was taken.

Irona vatia, by which name this species was better known, is easily recognized from Schioedte and Meinert's (1884) figures, the characteristic pleonal and pleotelson morphology clearly identifies their material as *Mothocya plagulophora.*

Hosts. Taken only from *Hemiramphus far*, the only *Mothocya* species recorded from that genus. The record of an East African specimen taken from a *Sardinella* species and the record from a belonid host (Monod, 1971) are regarded as unconfirmed; extensive collections made by B. B. Collette failed to obtain *M. plagulophora* from belonid fishes.

Distribution. Comoro Islands, Mauritius, Kenya, Somalia, India (Mandapam Camp, Madras), Sri Lanka, Indonesia and the Australian Great Barrier reef (Fig. 54:3).

Etymology. Haller (1880) gave the derivation of the epithet as from plagoule (a sheet of paper) and -phore (bearer or carrier), and was alluding to pleotelson.

Mothocya arrosor sp. nov.

(Figs 28, 29)

Material. All taken from *Euleptorhamphus viridis*, except where host data not recorded. ♀ (ovig. 26·5 mm, HOLOTYPE USNM 216335), ♂ (11·5 mm, USNM 216336), Ceralvo Island, Baja California, Mexico, 24°19′N, 109°55′W, 22.vi.1961, coll. Scripps; ♀ (ovig. 28·5 mm), ♂ (13·0 mm), Clipperton Is, East Pacific, 10°N, 109°W, 10.xii.1950, coll. Scripps (USNM 216337); ♀ (ovig. 24·0 mm), ♂ (12·3 mm), Clipperton Is., 10°N, 109°W, 1.xii.1950, coll. Scripps (LACM); ♀ (ovig. 22·5 mm), Coiba Is., Bahia de Las Damas, Gulf of Panama, 16.ix.1970, ex *Euleptorhamphus* sp., coll. J. E. McCosker (USNM 216338); ♀ (non-ovig. 25·0 mm), Galapagos Is. (USNM 216339); ♀ (ovig. 28·0 mm), ♂ (13·5 mm), 0·8 Km west of Hull Is., Phoenix Islands, *c.* 5°S, 173°W (BPBM S10471); ♀ (imm. 12·5 mm), off Mombasa, Kenya, 4°32′S, 41°26′E, 4.iii.1951, coll. Galathea (USNM 216340); 4♀ (ovig. *c.* 21, 22·2, 25·0, 26·5 mm), ♂ (12·8 mm), Sandakan, North Borneo, 6°30′N, 118°45′E, 27.i.1965, 'Te Vega' Cr. 6, stn TV 209, coll Cohen and Davis (AM P35230).

Non-type. ♀ (non-ovig. 18·5 mm), Japan?, (USNM 216343); ♀ (imm. 14·0 mm), Tuggerah Lakes, NSW (AM P35231); ♂ (11·0 mm), Straits of Malacca, 8°N, 96°E, xi–

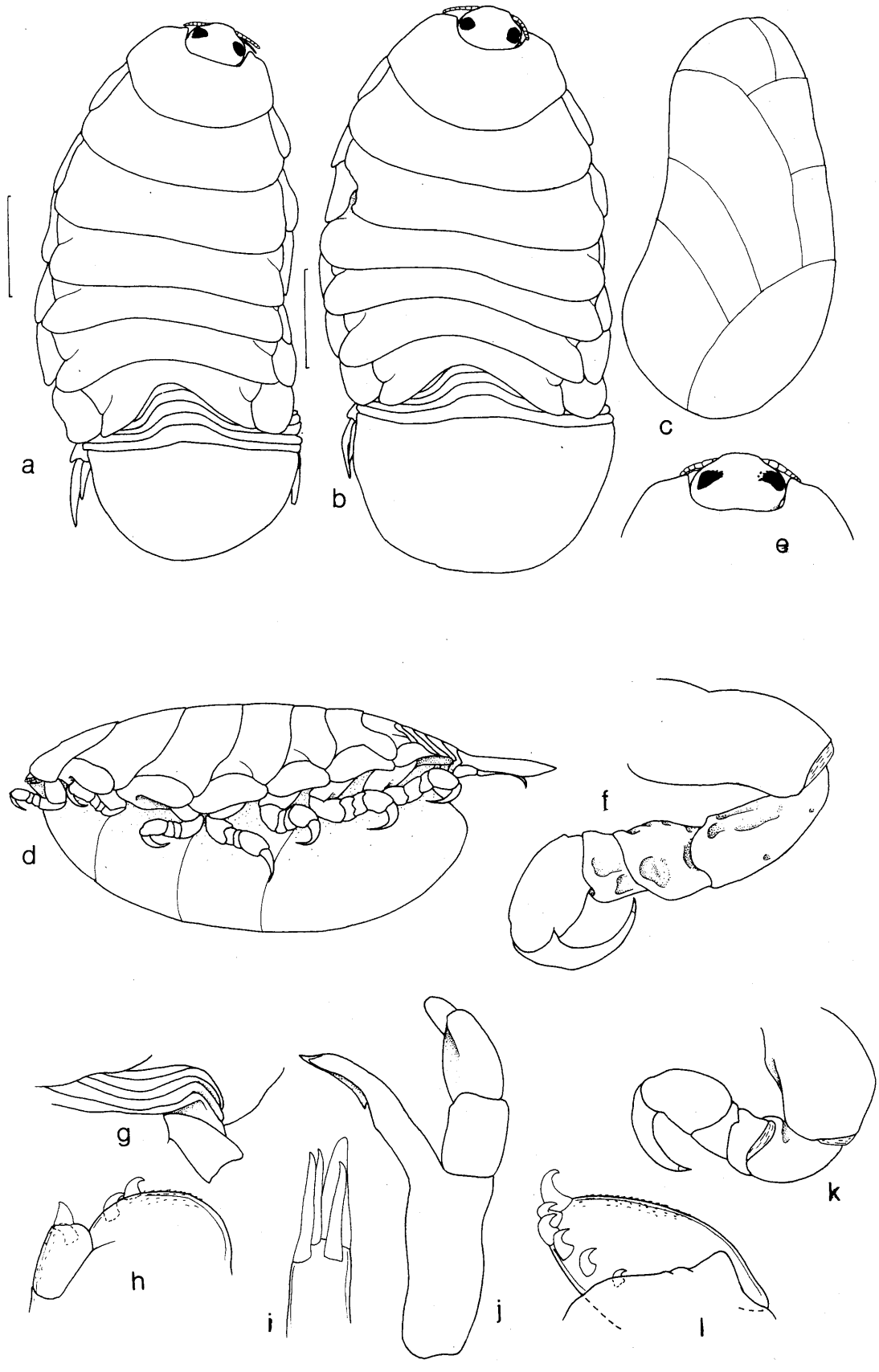

FIG. 28. *Mothocya arrosor* sp. nov.: a, c–e, HOLOTYPE; remainder ♀ 28·5 mm, Clipperton Is. (USNM 216337). a, dorsal view; b, dorsal view; c, brood pouch; d, lateral view; e, cephalon; f, pereopod 7; g, right pleonites, ventral view; h, maxilla apex; i, maxillule apex; j, mandible; k, pereopod 1; l, maxilliped article 3. Scale bars = 5·0 mm.

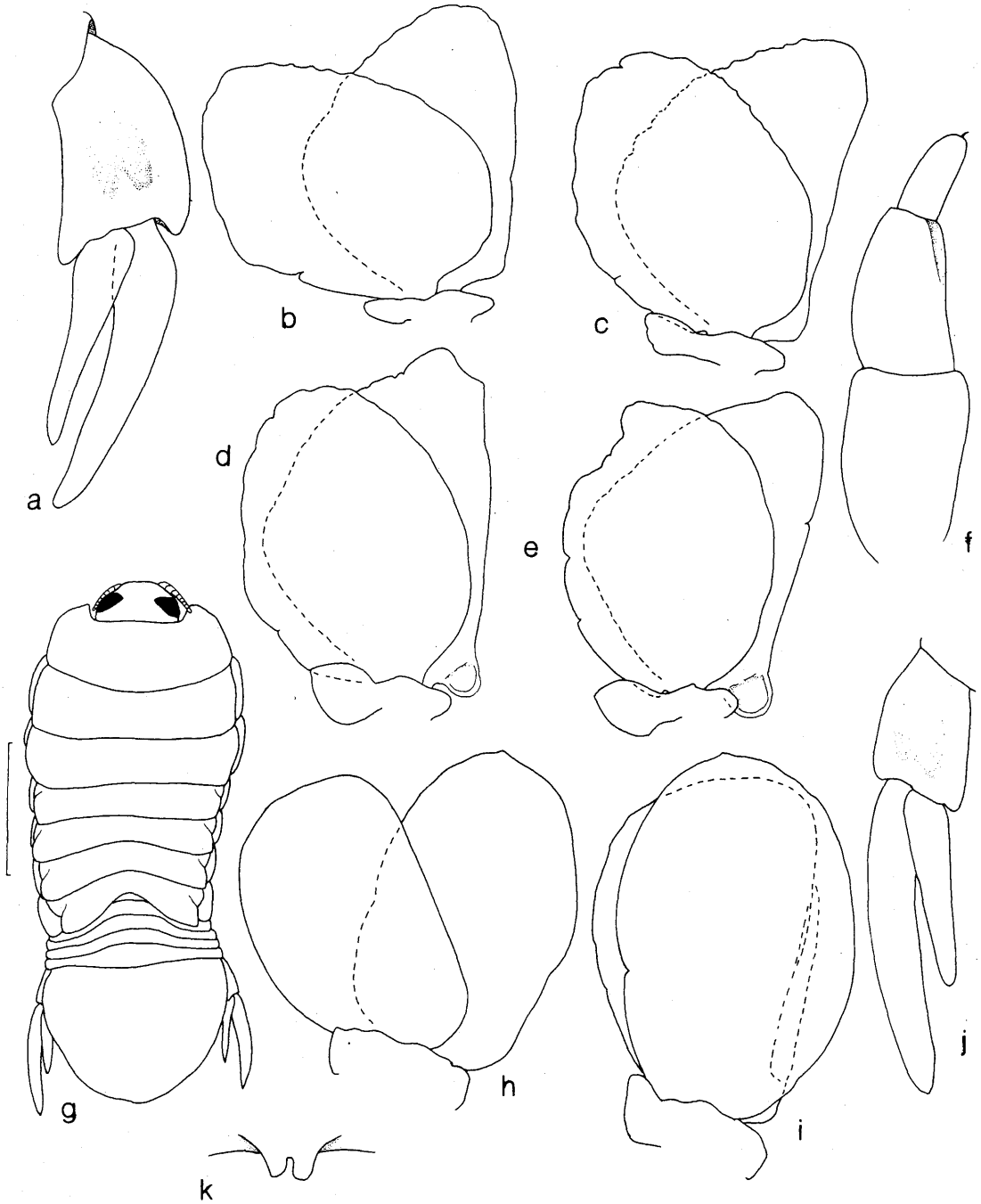

FIG. 29. *Mothocya arrosor* sp. nov.: a–e, ♀ 28·5 mm, f, h, i, k, ♂ 13·0 mm, both Clipperton Is. (USNM 216337); remainder ♂ 11·5 mm, Ceralvo Is. (USNM 216336). a, uropod; b–e, pleopods 1, 2, 4, 5 respectively; f, mandible palp; g, dorsal view; h, pleopod 1; i, pleopod 2; j, uropod; k, penes. Scale bar = 3·0 mm.

xii.1961, coll. Gladfelter (USNM 216342); ♀ (ovig. 15·5 mm), Straits of Malacca area, xi–xii.1961, no host data, coll. Wm. Gladfelter (USNM 216341).

Types. HOLOTYPE, USNM 216335; PARATYPES, USNM 216336–216340; BPBM S10471, AM P35230, LACM uncatalogued. → LACM 50-71.1

Type-locality. Ceralvo Island, southern Gulf of California, Mexico, 24°19′N, 109°55′W.

Description of female. Body slightly twisted to one side, dorsum weakly convex, widest at pereonite 5. Rostrum weakly produced; eyes small, 0·31–0·36 times width of cephalon, facets indistinct. Coxae 2 to 5 moderately narrow (1·8–2·3 times longer than

wide), coxae of pereonite 7 1·2–1·5 times longer than wide, about as long as segment; posterior margin of coxae of pereonites 6 and 7 round, lateral margin may be concave on one side. Posterior margin of pereonite 7 deeply recessed. Pleonite 1 largely concealed by pereonite 7; pleonites 2 to 4 overlapped laterally, at least in part, by pereonite 7; lateral margins of pleonites 2 to 5 may extend beyond coxae. Pleon 0·92–0·97 times width of pereonite 5. Pleotelson large, forming complete semicircle. Maxilla with two spines each on medial and lateral lobe; maxilliped article 3 with six recurved spines. Pereopods similar to *Mothocya melanosticta*, but dactyls more slender; pereopod 7 much larger than pereopod 1, with coarse pitting on ischium, merus, and carpus. Pleopod 1 peduncle very short, lateral lobe not developed; pleopods 2 to 5 peduncles with moderately developed lateral lobes; pleopods 1 to 3 margins may be scalloped, endopod lateral margin medially angled, exopod rounded. Pleopods 3 to 5 endopod proximomedial lobe prominent, that of pleopod 5 larger than that of pleopod 4. Uropod peduncle widest at distal extremity, about 1·3 times longer than wide. Exopod longer than endopod, curved medially, narrowing gradually to broadly rounded apex. Endopod narrowing rapidly to acute apex, medial and lateral margins weakly concave.

Male. Similar to male of *Mothocya melanosticta*, from which it differs principally in having a larger broader pleotelson, and more acute uropods. Maxilliped article 3 has four recurved spines, and mandible palp article 3 is more slender than female.

Variation. The body is generally evenly ovoid, but in one specimen (Phoenix Is., BPBM SI0471) it is more distinctly pyriform. In most specimens the lateral margins of pereonite 7 overlap pleonites 1 to 3 or 4. In immature females fewer pleonites are overlapped.

Colour. Tan in alcohol, with scattered chromatophores; pleon is characteristically darker than rest of body.

Size. Ovigerous females 22·5–28·5 mm, non-ovigerous females 18·5–25·0 mm; males 11·5–13·5 mm.

Remarks. This species resembles *Mothocya melanosticta* but can be distinguished by the following characters: coxae of pereonites 6 and 7 distinctly rounded; pleon more completely overlapped by pereonite 7; pleonite 1 scarcely visible in dorsal view; pleotelson longer; uropod peduncle longer, lacks strongly convex medial and lateral margins, while the endopod is more acutely narrowed.

Avdeev (1973) described *Irona philippinensis* from a single male specimen from an *Euleptorhamphus* sp. Males in the genus *Mothocya* are frequently impossible to separate by morphological characters alone, and identification of species is achieved primarily on the basis of the female morphology. Identification of present material as *M. philippinensis* would be only on the basis of having the same species of host. To make such an identification would be injudicious since at least half the *Mothocya* species are known to occur on more than one host, and several host species have more than one associated isopod. Furthermore, such an action could set a precedent for identifying the isopod species by its host rather than by the described morphology. The male described by Avdeev (1973) was not made available for study but there are numerous points of difference between Avdeev's (1973) figures and the material examined here (uropods, maxilla, maxilliped). As *I. philippinensis* could be one of several *Mothocya* species treated here (the body shape and uropods are effectively the same as those of *Mothocya karobran*) Avdeev's species is here regarded as *species inquirenda.*

Hosts. Recorded only from *Euleptorhampus viridis*, a wide-ranging pelagic species (Collette, 1974).

Distribution. Will probably occur in most areas where the host is to be found. Present material is from Kenya; New South Wales, Australia; Phoenix Islands in the West Pacific; North Borneo; Clipperton Is., Galapagos and Gulf of California in the East Pacific (Fig. 54:2).

Etymology. Arrosor is a Greek word that means nibble.

Mothocya sajori sp. nov.

(Fig. 30)

Irona melanosticta Schioedte and Meinert, 1884: 388 (part); Thielemann, 1910: 45, figs 28, 29; Hiraiwa, 1934: 382, fig. 2; Gurjanova, 1936: 94, fig. 50; Inouye, 1941: 219, figs 1–14, pls 1–3; Shiino, 1951: 87, fig. 1E, 1F; 1965: (from Nunomura, 1981); Hattori and Seki, 1956: 442; Kussakin, 1979: 308, figs 174, 175.

Irona melanostricta. Nunomura, 1981: 55 (lapsus).

(Non *Mothocya melanosticta* (Schioedte and Meinert, 1884); non *Irona melanosticta* of all other authors.)

Material. Specimens all from *Hyporhamphus sajori* taken in Japanese waters. Two ♀ (ovig. 22·5, HOLOTYPE BPBM S10472, 27·5 mm, BPBM S10604), Tokyo, Honshu Island, 1961, from Tokyo fish market, purchased J. Randall. ♀ (non-ovig. 27·0 mm) (TSM Cr4082); 2♀ (ovig. 22·2, 22·5 mm), Matsushima, Rikuzen (USNM 216369); 2♀ (non-ovig. 22·8, ovig. 20·5 mm), Tokyo, 1906, coll. *Albatross.* Expedition (USNM 216368); ♀ (non-ovig. 22·0 mm), Hakata Bay, Kyushu, 13.viii.1929, coll. Coll. C. H. Hubbs and H. Oshima (USNM 216370).

Types. HOLOTYPE, BPBM S10472; PARATYPES, BPBM S10604, USNM 216368–216370, TSM Cr4082.

Type-locality. Off Tokyo, Japan, *c.* 35°20′N, 139°40′E.

Description of female. Body moderately twisted to one side, 2·08–2·16 times longer than wide, dorsum convex; body widest at pereonite 4. Rostrum weakly produced, eyes moderate, about 0·5 times width of cephalon. Coxae narrow, especially on concave side, lateral margins usually concave; only coxae of pereonite 7 extending beyond posterior of segment. Pereonite 7 posterior margin deeply recessed. Pleonites all at least partly visible; pleon 0·96–1·04 times width of pereonite 5; lateral margins of pleonites 3 and 4 may be overlapped laterally by coxae of pereonite 7. Pleotelson with indistinct longitudinal median ridge; lateral margins abruptly indented prior to meeting pleonite 5; posterior margin broadly rounded. Maxilla with two spines each on medial and lateral lobe respectively; maxilliped article 3 with three large recurved terminal spines, and two recurved spines on proximal posterior surface. Pereopod 1 propodus relatively short; pereopod 7 distinctly longer than pereopod 1. Pleopod peduncles narrow; pleopod 1 peduncle lateral lobe weakly developed, those of pleopods 2 to 5 prominent. Pleopod 2 with appendix masculina. Endopod proximomedial lobes of pleopods 3 to 5 moderately developed, that of pleopod 5 only slightly larger than that of pleopod 4. Uropod with both rami broad, bluntly rounded, extending beyond posterior of pleotelson; endopod about 0·66 times length of exopod.

Male. No males were available for study.

Colour. Dark brown in alcohol, densely covered by chromatophores, including pereopods and pleopods.

Size. Ovigerous females 20·5–27·5 mm, non-ovigerous females 20·0–27·0 mm.

Variation. The coxal plate of pereonite 7 on the short side is posteriorly produced and may extend to pleonite 5, or just to pleonite 3. The lateral margins of pleonites 3 and 4 may be overlaid by the adjacent pleonites.

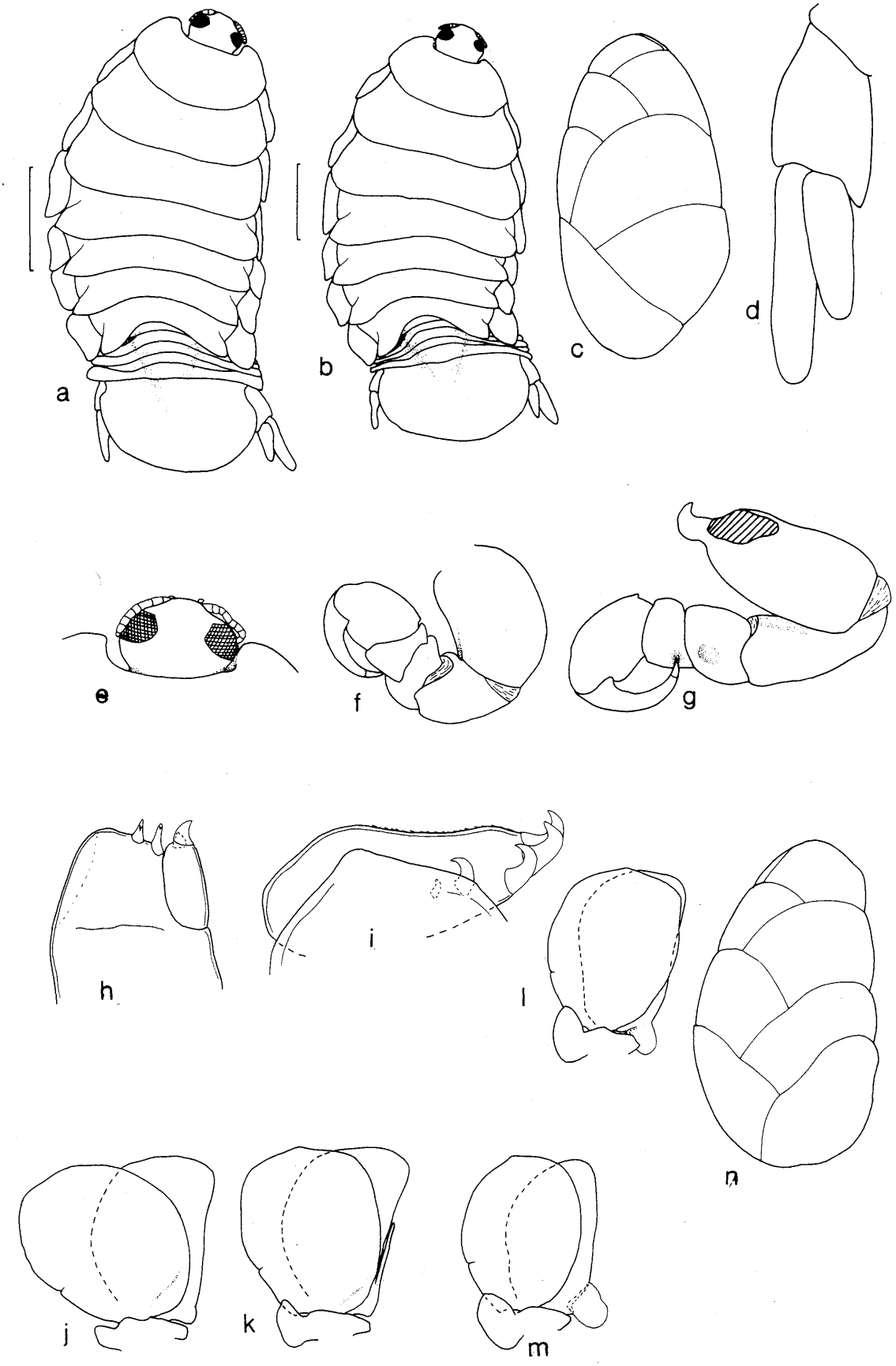

FIG. 30. *Mothocya sajori* sp. nov.: a, e, HOLOTYPE; b–d, ♀ 27·5 mm, Tokyo (BPBM S10472); remainder ♀ 22·5 mm (USNM 216369). a, dorsal view; b, dorsal view; c, brood pouch; d, uropod; e, cephalon; f, pereopod 1; g, pereopod 7; h, maxilla apex; i, maxilliped article 3; j–m, pleopods 1, 2, 4, 5 respectively; n, brood pouch. Scale bars = 5·0 mm.

Remarks. This species has been recorded frequently from Japanese waters under the name *Irona melanosticta*, a species initially recorded from Japan by Schioedte and Meinert (1884). Examination of Schioedte and Meinert's (1884) syntypes revealed them to be polyspecific and, although the bulk of their specimens were in fact *Mothocya sajori*, the specimen that they figured is *Mothocya melanosticta.*

Mothocya parvostis (identified as *Irona melanosticta* by Harai and Yasumotu, 1980, 1981, 1982a, b) also occurs on *Hyporhamphus sajori.* That species can be easily distinguished by its smaller body size, more symmetrical body shape, larger eyes, and pereonite 7 with the posterior margin shallowly recessed.

Mothocya sajori, endemic to Japan, is best separated from other similar species by the shape of the coxae, pleotelson, and the characteristically broad uropodal rami.

Hosts. Recorded only from *Hyporhamphus sajori.*

Distribution. Around the islands of Japan, probably wherever *Hyporhamphus sajori* occurs (Fig. 54:7).

Etymology. The epithet is taken from the specific name of the host.

Mothocya collettei sp. nov.

(Figs 31–33)

Material. ♀ (non-ovig. 13·8 mm), Port Pio, Camiguin Is., Philippines, 10.xi.1908, no host, coll. US Bureau of Fisheries, '*Albatross* Philippine Expedition' (USNM 216263); ♀ (ovig. 13·0 mm), Phuket, Thailand, ex *Toxotes* sp., coll. H. Smith (USNM 216360); ♀ (non-ovig. 15·5 mm), Yap Is., Caroline Islands, ex *T. punctulatus*, coll. Vanderbilt Foundation (USNM 216358). From *Tylosurus crocodilus*: ♀ (ovig. 15·8 mm), Shimoni, Kenya, 4°42′S, 38°23′E, 15.i.1966 (USNM 216265); ♀ (ovig. 23·8 mm), Hawaiian Is., Nov 1924 (LACM uncat); ♀ (ovig. 26·0 mm), ♂ (16·5 mm), Honolulu, Hawaii, 1901, coll. US Fisheries Commission (USNM 216262); 2♀ (ovig. 16·8, non-ovig. 14·5 mm), ♂ (10·0 mm), Cuhion, Philippine Is., 16.ix.1969, (AM P35225); ♀ (imm., 11·0 mm), Goh, Sindam Nug, Thailand, 9°25′N, 97°53′E, 5.xi.1968, coll. 'TeVega' (USNM 216264); ♀ (ovig. 18·2 mm, HOLOTYPE QM W11728), ♂ (10·0 mm QM W11729), Singapore, 28.ii.1937, coll. A. W. Herre Oriental Expedition; ♀ (imm. 13·5 mm), ♂ (imm. 5·8 mm), Papua New Guinea (USNM 216359); ♀ (ovig. 17·0 mm), Hayman Is., Qld, Australia coll. Embrery (AM P35226).

Non-type: ♀ (ovig. 23·3 mm), ♂ (12·5 mm), Magnetic Island, off Townsville, Qld, Australia, 24.viii.1949, ex *Tylosurus melanotus*, coll. G. Coates (QM W11490); ♀ (non-ovig. 25·0 mm), Tubuai Is., Austral Group, ii–iii.1902, ex *T. crocodilus*, coll. Alvin Seale (BPBM S10605); ♀ (non-ovig. 25·0 mm), Papeete, Tahiti, 31.v.1957, ex *Ablennes hians* (USNM 216266).

Types. HOLOTYPE, QM W11728; PARATYPES, QM W11729, AM P35225, 35226, USNM 216262–216265, 216358–216360, LACM uncatalogued. → LACM 24-1.1

Type-locality. Singapore, Straits of Malacca, *c.* 1°20′N, 127°48′E.

Description of female. Body only slightly twisted, dorsum weakly convex; lateral margins very nearly parallel. Rostrum weakly produced, eyes moderately large, about 0·50 times width of cephalon. Coxae strongly expressed laterally, very wide; coxae of pereonites 2 and 3 being 1·3 to 2·0 times longer than wide; coxae of pereonites 6 and 7 from 1·17 to 1·0 times longer than wide; coxae of pereonite 7 may be produced posteriorly as far as pleonite 5; posterior margin of pereonite 7 weakly recessed. Pleon 1·20–1·31 times width of pereonite 5; pleonite 1 entirely concealed by pereonite 7; lateral margins of pleonite 5 or 3 to 5 may be free on at least one side. Pleotelson lateral margin

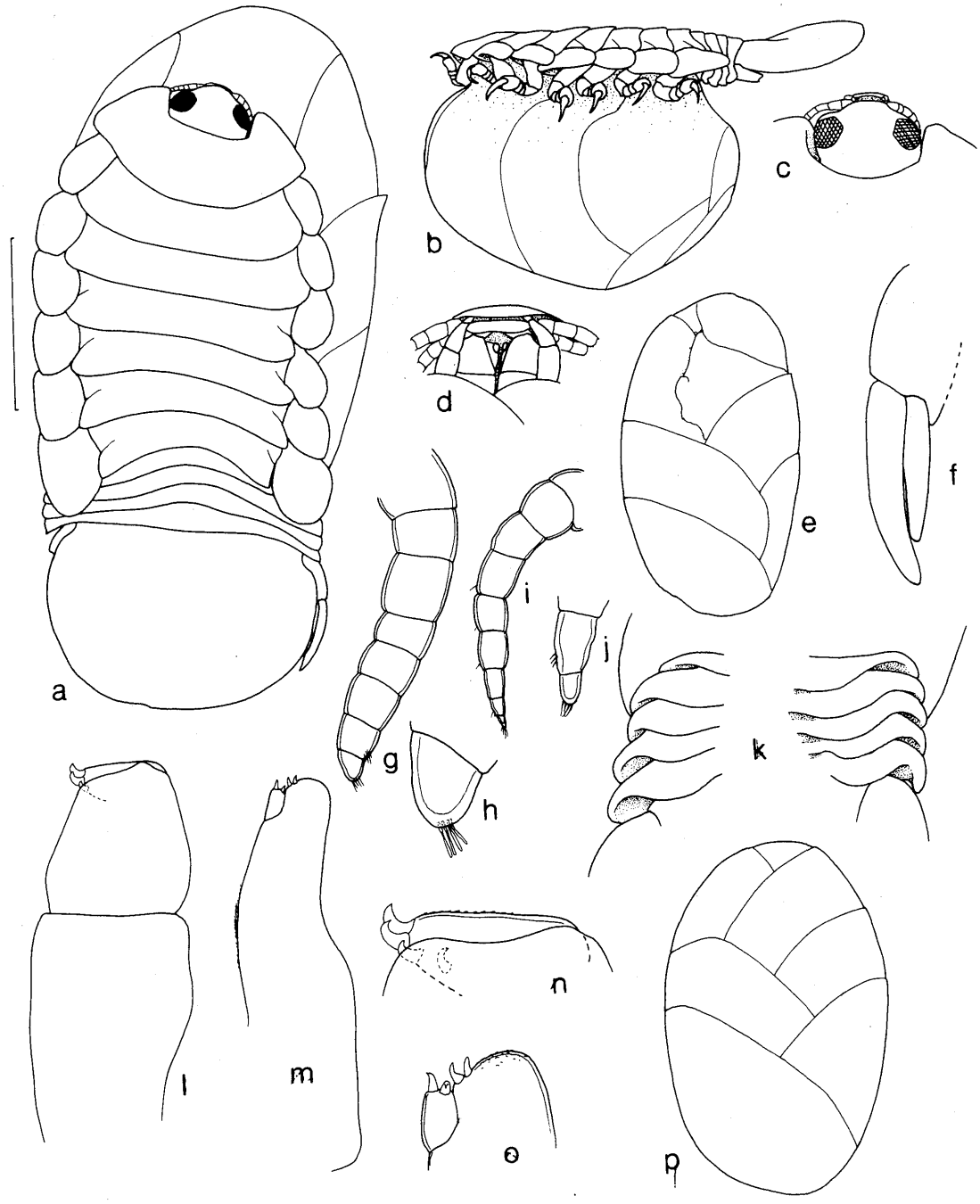

FIG. 31. *Mothocya collettei* sp. nov.: a–f, HOLOTYPE; g–o, ♀ 17·0 mm, Hayman Is. (AM P35226); remainder as indicated. a, dorsal view; b, lateral view; c, cephalon; d, buccal area; e, brood pouch; f, uropod *in situ*, ventral view; g, antennule; h, antennule, terminal article; i, antenna; j, antenna, terminal articles; k, right and left pleonites, ventral view; l, maxilliped; m, maxilla; n, maxilliped article 3; o, maxilla apex; p, brood pouch, ♀ 26·0 mm, Honolulu (USNM 216262). Scale bar = 5·0 mm.

indents slightly before pleonite 5, widest at about midlength; posterior margin widely rounded. Maxilla with two curved spines each on medial and lateral lobe respectively; maxilliped article 3 with four recurved spines. Pereopod 1 with basis only moderately stout, palm weakly convex; pereopod 7 with ischium, carpus and merus proportionally slightly longer than in pereopod 1, pereopods 4 to 7 not significantly larger than pereopods 1 to 3. Pleopod 1 peduncle with lateral lobe distinct; lateral lobe on penduncles of pleopods 2 to 5 prominent. Rami of pleopods 2 to 5 tending to converge

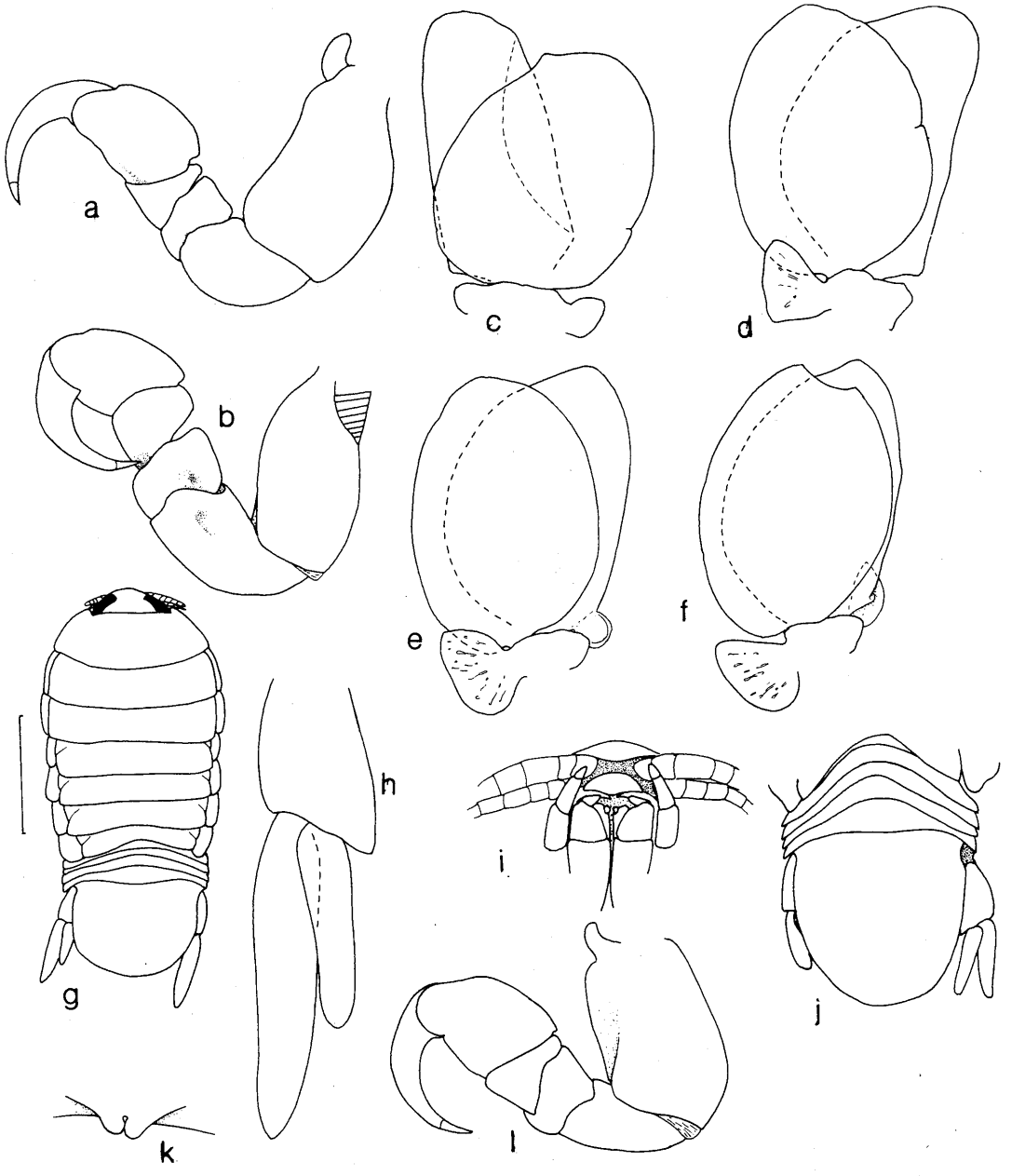

FIG. 32. *Mothocya collettei* sp. nov.: a–f, ♀ 17·0 mm, Hayman Is. (AM P35226); g–h, k, l, ♂ 10·0 mm, Singapore (QM W11729); a, pereopod 1; b, pereopod 7; c-f, pleopods 1, 2, 4, 5 respectively; g, dorsal view; h, uropod; i, buccal area, ♂ 16·5 mm, Honolulu (USNM 216262); j, pleon and pleotelson, ♂ 16·5 mm, Honolulu; k, penes; l, pereopod 1. Scale bar = 3·0 mm.

to distinct apex; distal margins of pleopod 1 rami more evently rounded. Pleopod 5 endopod apex acute; proximomedial lobe distinctly larger than that of pleopods 3 and 4. Uropod not extending to posterior of pleotelson, exopod longer than endopod, curved medially, endopod sharply tapered.

Male. Similar in most respects to males of *Mothocya karobran*, but uropod shorter, and uropod exopod proportionally not so long.

Variation. Considerable variation is shown by this species in the relative width of the coxal plates, uropod morphology, and size of the specimens. Females from the central Pacific (Hawaii, Tahiti and Tubuai) are all markedly longer (23·8–26·0 mm) than the West Pacific and Indian Ocean specimens (ovigerous females from 13·0–

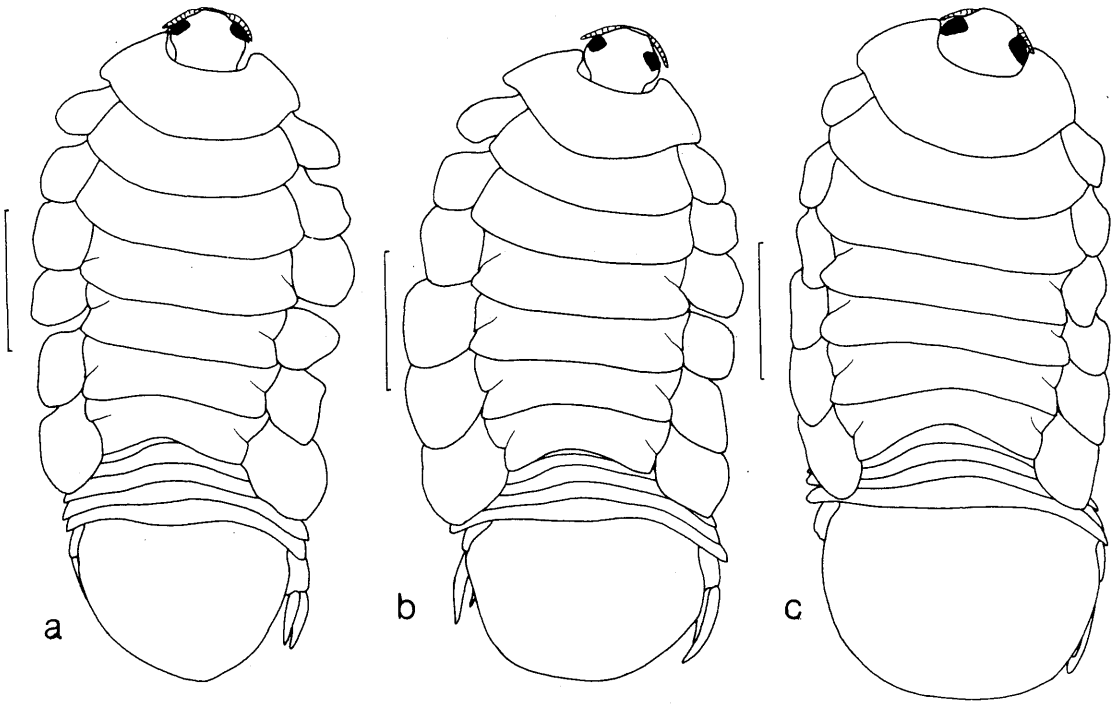

FIG. 33. *Mothocya collettei* sp. nov.: a, ♀ 25·0 mm, Tubuai Is. ex *T. crocodilus* (BPBM, S10605); b, ♀ 25·0 mm, Tahiti, ex *Ablennes hians* (USNM 216266); c, ♀ 26·0 mm, Honolulu, ex *T. annulatus* (USNM 216262). Scale bars = 5·0 mm.

18·2 mm). The morphology of the largest Hawaiian female accords totally with that of the holotype, but Tubuain and Tahitian specimens have coxae that are far wider than other specimens, and also have pleonite 1 visible in dorsal view.

Uropods from the two sides of the single specimens frequently vary, one uropod generally with distinctly shorter rami. The proportional length of the rami varies from subequal to the exopod being distinctly longer. The degree of narrowness of the endopod varies slightly, and when the exopod is shorter the apex tends to be blunt.

Colour. Pale tan to dark reddish brown in alcohol. Scattered chromatophores present.

Size. Ovigerous females 13·0–26·0 mm, non-ovigerous females 13·8–26·0 mm; males 10·0–16·5 mm.

Remarks. This species is characterized by a long, very wide pleotelson, pleon with subparallel sides (in contrast to *M. plagulophora* where pleonite 5 is widest), relatively straight body shape, wide rounded posterior coxal plates, and uropods that are relatively short with a slender endopod. Another character which will separate this species from nearly all others is the presence of a prominent lateral peduncular lobe on pleopod 1.

Mothocya karobran is the most similar species, but can be separated by a less evenly rounded pleotelson, narrower and almost subrectangular posterior coxal plates, and distinctly longer uropods, the rami of which reach the distal margin of pleotelson.

Material from Tubuai Island, Tahiti and Magnetic Island, Australia is excluded from the paratype material. The coxae are extremely wide, and with a larger series of specimens may prove to belong to a distinct species. They are included here since the range of this species extends to the Caroline Islands and Hawaii, and the coxal morphology of material from that area agrees closely to that from the West Pacific.

Hosts. Most specimens were from *Tylosurus crocodilus*; other hosts are *Ablennes hians*, *Tylosurus punctulatus* and *Toxotes* sp.

Distribution: Kenya, Singapore, Thailand, north-eastern Australia, Papua New Guinea, Philippines, Yap Is. in the Caroline Islands, Tubuai Is., in the Austral Group, Tahiti and Hawaii (Fig. 54:1).

Eytmology. Named in honour of Dr Bruce B. Collette, noted authority on the taxonomy of belonid and hemiramphid fishes, who was largely responsible for the accumulation of the specimens used in this study.

Mothocya karobran sp. nov.

(Figs 34–36)

Material. Two ♀ (non-ovig. 15·5, 18·1 mm), ♂ (13·5 mm), Pakistan, ex *Strongylura leiura* (USNM 216362). From Australia: 3♀ (pleotelsons all damaged: ovig. *c.* 29·0, non-ovig. *c.* 28·0, *c.* 25·5 mm), 3♂ (18·5, 16·5, 16·2 mm), Heron Island, Great Barrier Reef, Qld, 23°26·4′S, 151°43·4′E, 4.x.1980, ex 'Long Toms' (= *Tylosurus* sp.), coll. B. Kojis (QM W10275); ♀ (ovig. 18·5 mm), Port Bradshaw, NT. 25.vi.1948, ex *Strongylura* cf *groeneri*, coll. R. R. Miller (USNM 105880); 2♀ (32·0, 30·0 mm), Mannoning Park, Lake Macquarie, NSW, 6.x.1969, ex *Strongylura leiura*, coll. BBC (AM P35229); ♀ (non-ovig. 24·0 mm), ♂ (17·2 mm), no data, examined by Hale, 1926 (AM P9610). From *Tylosurus gavialoides*: 2♀ (non-ovig. 27·2, 25·5 mm), 2♂ (19·5, 17·2 mm), Great Barrier Reef, Qld, iv–v.1953, coll. Howard (USNM 101877); ♀ (non-ovig. 20·2 mm), ♂ (17·0 mm), Newcastle, NSW (USNM 216209); ♀ (ovig. 26·0 mm, HOLOTYPE QM W11726), ♂ (*c.* 17·5 mm QM W10413), Jumpinpin, Moreton Bay, south-eastern Qld, 7.xii.1981, coll. J. Fields; 2♀ (imm. 22·0, 21·2 mm), 2♂ (16·5, 15·0 mm), Botany Bay, Sydney, NSW, (NMV J10645); ♀ (19·0 mm), 2 (imm. 13·0, 11·0 mm), Mannoning Park, Lake Macquarie, NSW, 6.ix.1969, coll. BBC (USNM 216208); ♀ (ovig. 21·2, imm. 20·5 mm), Sydney fish market, from Lake Macquarie, NSW, 3 May 1976, BBC (AM P35228); ♀ (non-ovig. 22·0 mm), ♂ (18·0 mm), NSW, Australia (USNM 216361).

Types. HOLOTYPE, QM W11726; PARATYPES, QM W10413, 10275, USNM 101877, 105880, 216208, 216209, 216361, AM P35228, P35229, NMV J10645.

Type-locality. Jumpinpin, Moreton Bay, south-eastern Queensland, Australia, 27°50′S 153°24′E.

Description of female. Body broad, widest at pereonite 3. Cephalon deeply immersed in pereonite 1, margin rounded, eyes moderate, 0·42–0·46 times width of cephalon. Coxae strongly expressed laterally, coxae of pereonites 5 to 7 about 1·56–2·41 times longer than wide, distinctly rectangular in appearance, not produced posteriorly beyond respective segment. Posterior margin of pereonite 7 weakly recessed. Pleon wide, 1·01–1·05 times width of pereonite 5; pleonite 1 concealed by pereonite 7, not narrower than other pleonites, lateral margins of pleonites 2 to 5 acute. Pleotelson wide, lateral margins converging slightly to broadly rounded apex. Maxilla with two spines each on medial and lateral lobe respectively; maxilliped article 3 with four recurved spines. Pereopods robust; palm of pereopods 1 to 3 slightly produced straight; peropod 7 larger than pereopod 1. Brood pouch with fourth anterior pair of oostegites, not visible in ventral view. Pleopods with rami elongate. Pleopod 1 peduncle with distinct lateral lobe; lateral lobe large on peduncles of pleopods 2 to 5. Proximomedial lobe of pleopod 5 endopod distinctly larger than that of pleopod 4. Uropod extending to, or just short of posterior margin of pleotelson, peduncle about 1·5 times longer than wide, lateral margin weakly convex. Exopod longer than endopod, curved medially, apex broadly rounded; endopod narrows rapidly to acute apex.

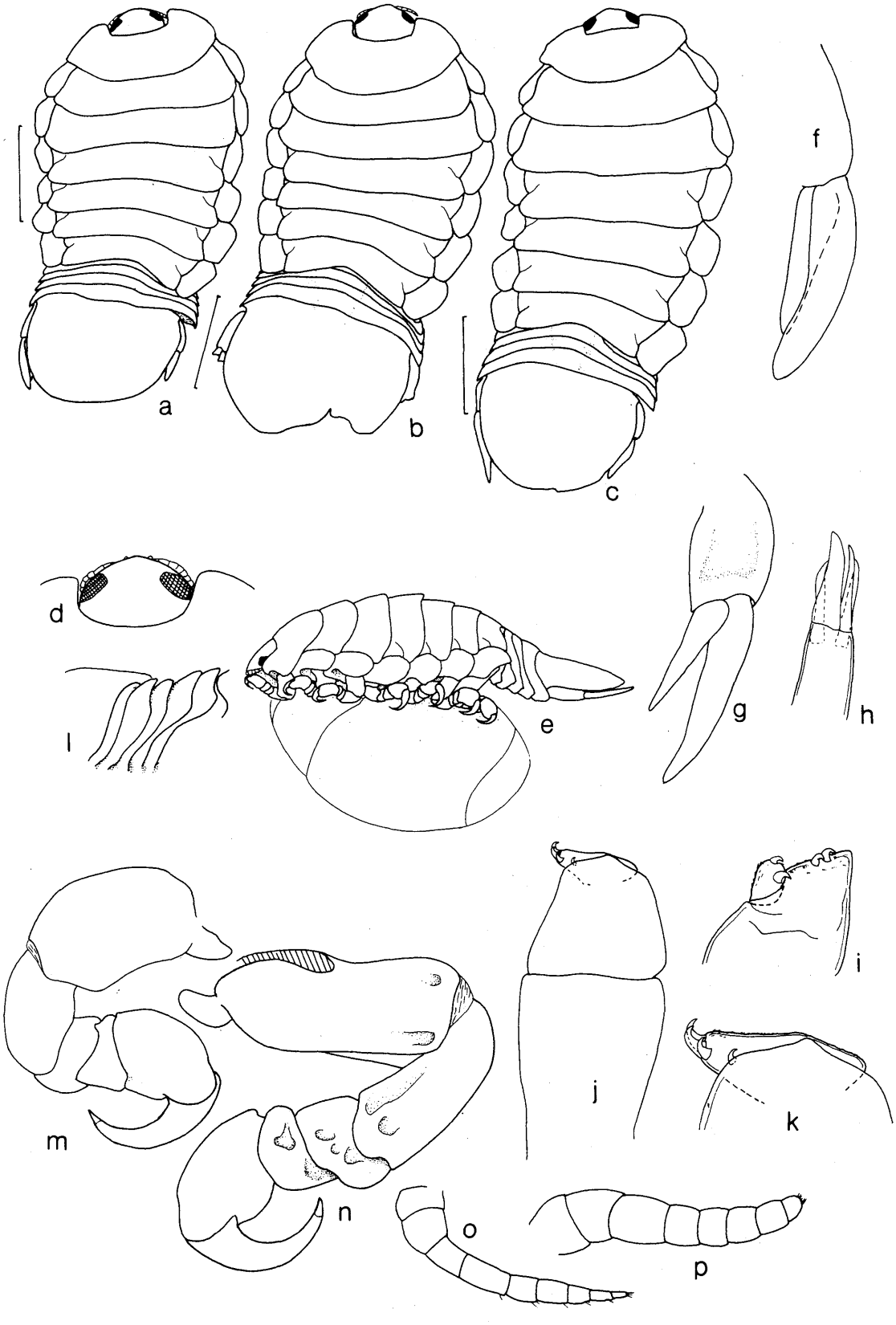

FIG. 34. *Mothocya karobran* sp. nov.: a, d, e. f, HOLOTYPE, others as indicated. a, dorsal view; b, ♀ 28·0 mm, Heron Is. (QM W10275); c, + 32·0 mm, Mannoning Park (AM P35229); d, cephalon; e, lateral view; f, left uropod, ventral view; g, uropod, ♀ 25·5 mm, Heron Is. (QM W10275); h, maxillule apex; i, maxilla apex; j, maxilliped; k, maxilliped apex; l, left pleonites, ventral view; m, pereopod 1; n, pereopod 7; o, antenna; p, antennule. Scale bars = 6·0 mm.

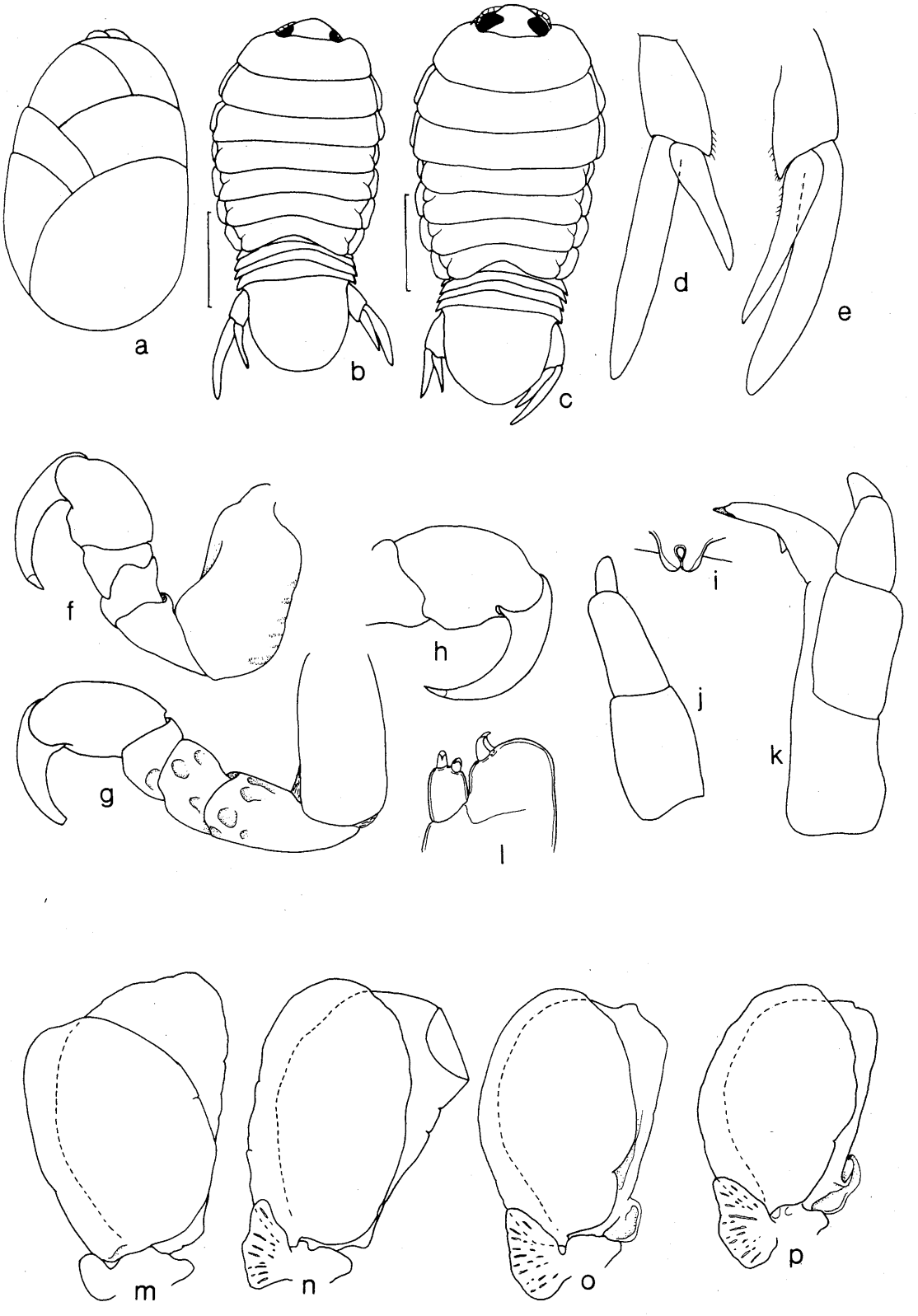

FIG. 35. *Mothocya karobran* sp. nov.: c–g, l, m, ♂ 16·5 mm, Heron Is., (QM W10275); remainder as indicated. a, brood pouch, ♀ 32·0 mm, Mannoning Park (AM P35229); b, ♂ 17·2 mm, Great Barrier Reef (USNM 101877); c, ♂ 17·5 mm, Jumpinpin (QM W10413); d, left uropod; e, right uropod; f, pereopod 1, g, pereopod 7; h, pereopod 1 propodus, ♂, Jumpinpin; i, penes, ♂, Jumpinpin; j, mandible palp; k, mandible, ♀ 27·2 mm, Heron Is. (QM W10275); l, maxilla apex; m–p, pleopods 1, 2, 4, 5 respectively, ♀ 30·0 mm, Mannoning Park (AM P35229). Scale bars = 5·0 mm.

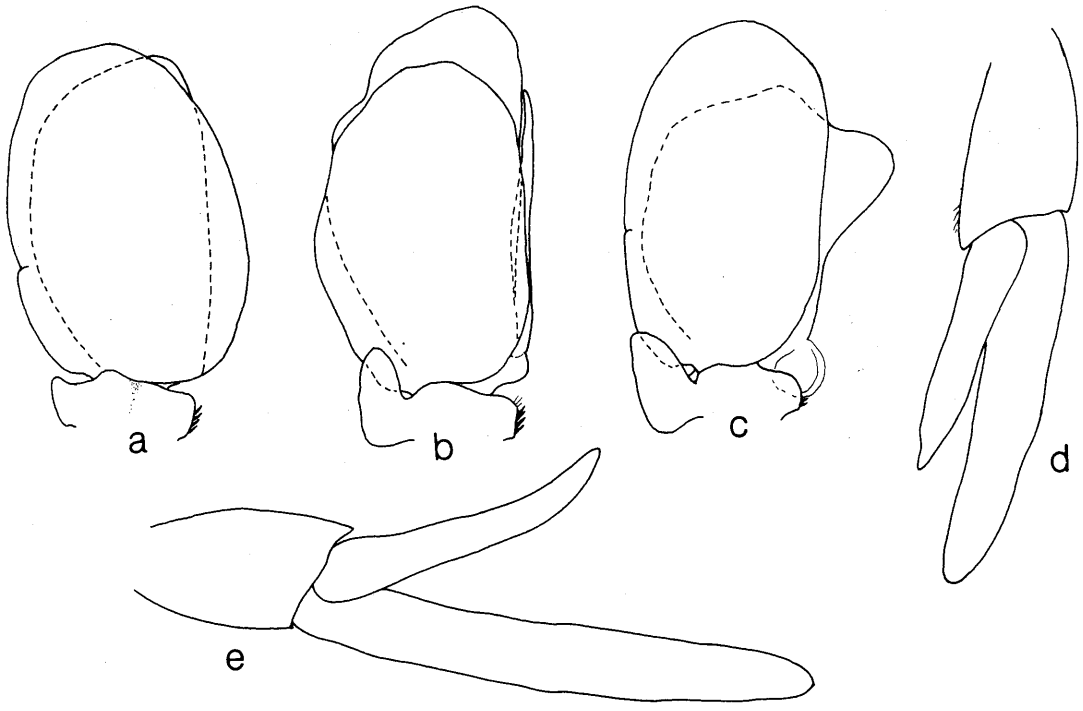

FIG. 36. *Mothocya karobran* sp. nov.: a–c, pleopods 1–3, ♂ Heron Island (QM W10275), ♂ Great Barrier Reef (USNM 101877); d, right uropod; e, left uropod.

Male. Uropod distinctly longer than pleotelson, both rami long, endopod shorter than exopod, narrows rapidly to acute apex. Pleopod 1 peduncle lateral lobe moderately large; lateral lobes on pleopod 2 to 5 peduncles prominent; proximomedial lobe on pleopods 3 to 5 endopods all large, that of pleopod 5 only slightly larger than that of pleopod 4; medial margins of all pleopod peduncles with coupling hooks, but absent in larger males. Penes prominent.

Colour. Females with few chromatophores on dorsal surface of cephalon, antennule and antenna, and at base of oostegites; males with scattered chromatophores over dorsum and sternum.

Size. Ovigerous females 18·5–32·0 mm, non-ovigerous females 20·0–30·0 mm; males 15·0–19·5 mm.

Variation. Specimens present a uniform appearance throughout their range. Small variations were seen in the morphology of the coxae, uropods and pleotelson.

Remarks. This species can be immediately recognized by the acute lateral margins of the pleonites, relatively long uropods with a slender endopod, and the rectangular appearance of the posterior coxal plates. The general appearance is of being broadest anteriorly (pereonite 3 is widest), with the cephalon deeply immersed into pereonite 1. Other characters are discussed under *Remarks* for *Mothocya collettei* to which this species is similar.

Hosts. Most specimens were taken from *Strongylura gavialoides.* Two specimens were taken from *Strongylura leiura*, these being amongst a series of about 60 *Mothocya renardi*, suggesting that *S. leiura* is not the normal host of *Mothocya karobran.*

Distribution. Eastern and northern Australia, from Lake Macquarie, NSW, along the Queensland coast (mainland and Great Barrier Reef) to the Northern Territory; one record from Pakistan, northern Indian Ocean (Fig. 55:7).

Etymology. Karobran is an Aboriginal word meaning together.

Mothocya halei sp. nov.

(Figs 37, 38)

Irona melanosticta. Hale, 1926: 220, figs 13, 14; 1929: 262, figs 260, 261.
Irona renardii. Lanzing and O'Connor, 1975: 355, fig. 1 c, d.

Material. All material from Australia. ♀ (imm. 8·0 mm), ♂ (imm. 5·5 mm), Gladstone Harbour, Qld, 11.xii.1969, ex *Hyporhamphus regularis ardelio*, coll. BBC (USNM 216203); (non-ovig. 8·9 mm), Mary River, Maryborough, Qld, 15.iv.1981, ex *Hyporhamphus regularis ardelio*, in mangroves, coll. E. J. Fields, N. L. Bruce (QM W10276); ♀ (ovig. 14·0 mm), ♂ (9·3 mm), 'Australia' in 1874 British Museum Register Book, from *Hyporhamphus regularis* (USNM 216205); 2♀ (ovig. 14·5, 14·8 mm) ♂ (10·0 mm). Deception Bay, Moreton Bay, Qld, 5.i.1983, ex *Hyporhamphus regularis ardelio*, coll Q.F.S. (QM W11734). ♀ (ovig. 13·0 mm), Pumicestone Passage, south-eastern Qld, 30.xii.1981, no host or collector, (QM W10424); 11♀ (ovig. 12·5, 14·5, 15·0, 15·0, 15·0, 15·5, 16·0, 16·8, 17·5, 18·5, 20·5, non-ovig. 15·5, 17·8 mm), 9♂ (7·5, 8·8, 9·5, 9·8, 10·0, 10·0, 10·0, 11·5, 12·0 mm), 6 imm. (7·2–8·5 mm), Lake Illawarra, NSW, 23.xii.1976, ex *Girella tricuspidata* coll. P. F. O'Connor (USNM 216202, AM P35238, 35239).

From *Hyporhamphus melanochir*: 6♀ (ovig. 16·4, 17·5, HOLOTYPE, 20·0, 20·5, 21·6, 25·8, imm. 16·5 mm), 8♂ (12·2, 12·2, 13·2, 13·5, 14·4, 14·5, 14·5, 14·6 mm), Adelaide, SA, i.1980, coll. K. Rhode (BMNH 1981: 446: 15); ♀ (ovig. 14·5 mm), St Stevens Bay, Kangaroo Is., SA, 25.iii–18.v.1952, coll J. K. Howard (USNM 219299); ♀ (ovig. 19·0 mm), Port Adelaide, SA, 3.ii.1970, purchased at fish market, coll. BBC (SAM C4017); ♀ (non-ovig. 12·7 mm), ♂ (8·6 mm), Adelaide anchorage, Adelaide, SA, 34°48′S, 138°25′E, 7.xii.1951, coll. Galathea (SAM C4018); 2♀ (imm. 9·5, 10·9 mm), 2♂ (9·4, 10·3 mm), Marion Bay jetty, Yorke Peninsula, SA, 18.iv.1981, coll. W. Zeidler (SAM C4021–2); ♀ (non-ovig. 18·5 mm), Agnes, Melbourne, Victoria, 1909, coll. F. Kenyon (ANSP CA4553); 2♂ (7·1, 7·3 mm), Queenscliffe, Victoria, xi.1905, coll. Edgar R. Waite (USNM 216204); 2♀ (ovig. 16·5, non-ovig. 16·0 mm), 4♂ (9·3, 10·4, 12·0, 12·6 mm), Mandurah, Perth, WA, 13.ii.1970, purchased, coll. BBC (USNM 216200); ♀ (ovig. 22·5 mm), ♂ (13·0 mm), Albany Harbour, WA, 10.x.1954, coll. CSIRO (USNM 216201).

Two ♀ (ovig. 19·5, 22·0 mm), 3♂ (12·5, 14·1, 15·0 mm), St Vincents Gulf, South Australia, *c.* 1924–25, parasites from *Hyporhamphus intermedius* (= *H. melanochir*), det. H.M. Hale (SAM E311). These were figured by Hale (1926): ♀ fig. 13 c–k, l, ♂ a, b. Hale (1926, p. 222) examined 18 specimens, but I have only seen those listed above.

Types. HOLOTYPE, PARATYPES, BMNH 1981. 446: 15: other PARATYPES, AM P35238, 35239 USNM 216199–216205, SAM C4017, 4018, ANSP CA4553.

Type-locality. Adelaide, St Vincents Gulf, South Australia, *c.* 34°56′S, 138°34′.

Description of female. Body widest at pereonites 5 and 6. Rostrum weakly produced; eyes moderate, 0·52–0·64 times width of cephalon. Pereonite 7 moderately recessed; coxal plates of pereonite 4 to 7 wide, those of pereonite 7 posteriorly produced, overlapping lateral margins pleonites 1 to 3 up to 5. Pleon moderately wide, 0·91–1·08 times width of pereonite 5, lateral margins extending beyond those of pleotelson. Anterolateral margins of pleotelson indented, lateral margins converging to broadly rounded apex. Maxilla with two spines each on medial and lateral lobe respectively; maxilliped article 3 with six recurved spines. Pereopods with dactylus slightly longer and more slender than in others of genus; pereopods 4 to 7 slightly longer than pereopods 1 to 3. Pleopod 1 peduncle lateral lobe weakly developed, those of pleopods 2 to 5 developed; pleopod 2 endopod with vestigial appendix masculina; proximomedial lobe of pleopod 5 endopod more prominent than that of pleopod 4. Uropod

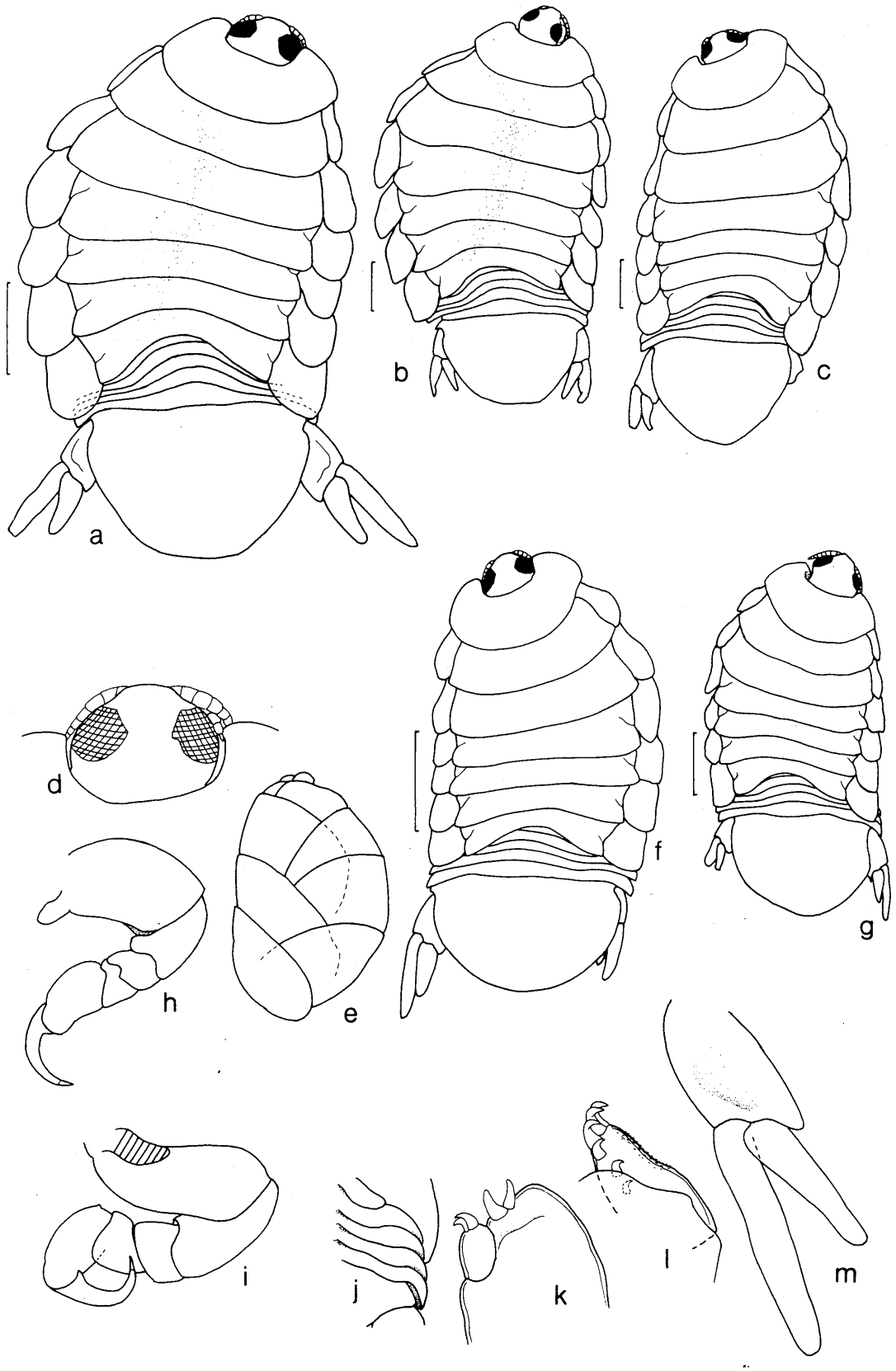

FIG. 37. *Mothocya halei* sp. nov.: a, d, e, HOLOTYPE; b, h, i, k, l, ♀ 19·0 mm, Adelaide (SAM C4017); remainder as indicated. a, dorsal view; b, dorsal view; c, ♀ 25·8 mm, Adelaide (BMNH); d, cephalon; e, brood pouch; f, ♀ 14·8 mm, Deception Bay (QM W11734); g, ♀ 18·0 mm, (AM P35239), Lake Illawarra; h, pereopod 1; i, pereopod 7; j, left pleonites, ventral view, ♀ 21·6 mm, Adelaide (BMNH); k, maxilla apex; l, maxilliped apex; m, uropod, ♀ 21·6 mm, Adelaide (BMNH). Scale bars = 3·0 mm.

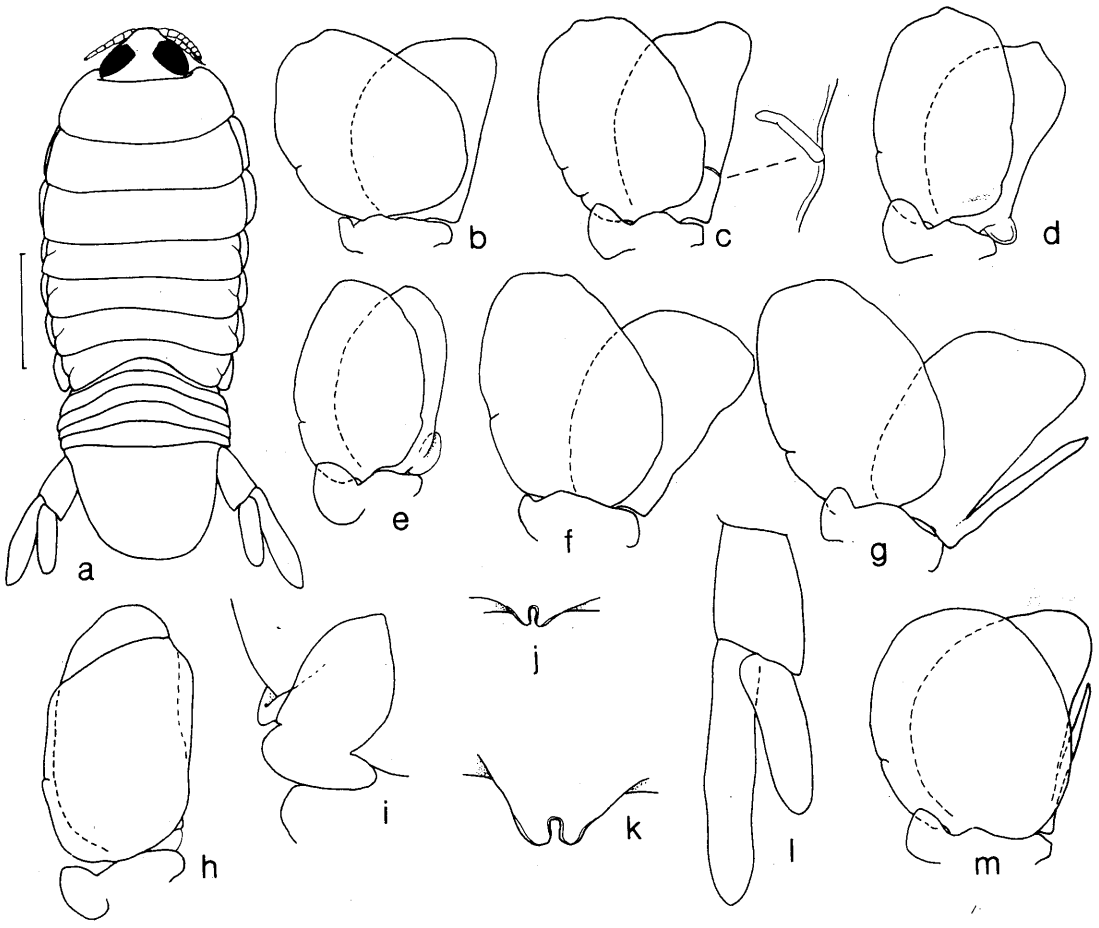

FIG. 38. *Mothocya halei* sp. nov.: b–e, ♀ 21·6 mm, Adelaide (BMNH); f–i, k, l, ♂ 14·0 mm, Adelaide (BMNH); remainder as indicated. a, ♂ 13·5 mm, Adelaide (BMNH); b–e, pleopods 1–3, 5 respectively; f–h, pleopods 1, 2, 5 respectively; i, pleopod 5 proximomedial lobe; j, penes, ♂ 13·5 mm, Adelaide (BMNH); k, penes; l, uropod; m, pleopod 2, ♀ 14·5 mm, Deception Bay (QM W11734). Scale bar = 3·0 mm.

peduncle mediodistal angle produced; lateral margin weakly convex; endopod distinctly shorter than exopod, tapering to broadly rounded apex, exopod weakly tapered; both rami extending to or beyond posterior margin of pleotelson.

Male. Uropod long, typically held at an angle out from pleotelson in preserved material. Maxilliped article 3 with four spines. Pleopod 5 endopod with enlarged accessory lobe. Penial processes set adjacent to one another, in contact distally.

Colour. Pale tan to brown in alcohol, with scattered chromatophores over dorsum, antennule and antenna. Posterolateral margins of posterior coxae often appearing transparent.

Size. Ovigerous females, 13·0–25·8 mm, non-ovigerous females 8·9–18·5 mm; males 10·0–15·0 mm.

Variation. A characteristic of those specimens from *Hyporhamphus melanochir* is one pereon margin being distorted. The animals are twisted to one side, as in most species, but there is a lateral expansion of the more convex margin which increases the assymmetry. The degree of prolongation of the coxal plates of pereonite 7 varies. In some specimens they do not extend beyond pleonite 4, in others they reach the pleotelson. Uropods may be shorter on one side, and are frequently malformed or damaged.

Table 4. Differences between the populations of *Mothocya halei* and *Mothocya girellae* (same means same as South Australian population).

	M. halei (S. Aust.)	*M. halei* (Qld)	*M. halei* (Illawarra)	*M. girellae*
Host	*Hyporhamphus melanochir*	*Hyporhamphus regularis ardelio*	*Girella tricuspidata*	*Girella tricuspidata*
Cephalon	Deeply immersed	Same	Same	Moderately immersed
Eyes	*c.* 0·52	Same	Same	0·44–0·54
Body	Twisted, broadest anteriorly	Same	Same	Weakly twisted broadest medially
Distortion	Present	Absent	Absent	Absent
Pereonite 7	Widely indented	Same	Same	Narrowly indented
Coxae	Posteriorly rounded	Same	Rounded to elongate	Elongate and acute
Uropods extend beyond pleotelson	Yes	Longer	Longer	No
Pleopod 5	Large lobe	Same	Same	Small lobe
Penes	Adjacent	Same	Same	Apart
Pleotelson	Rounded	Shorter	Rounded	Laterally tapered; subtruncate
Size (mm)				
Female	12·7–25·8 Mean = 17·60	13·0–14·8 Mean = 14·1	14·5–20·5 Mean = 16·3	22·5–29·0 Mean = 24·1
Male	9·3–15·0 Mean = 12·60	10·0	7·5–12·0 Mean = 9·9	12·5–17·9 Mean = 16·0
No. of specimens	34	4	22	34+

The material from Queensland includes mature females and one male, and females appear to differ only in having shorter coxae on pereonite 7 and a larger appendix masculina on pleopod 2. Otherwise the uropods and pleopods of the two populations correspond exactly. The Queensland specimens were all collected from *Hyporhamphus regularis ardelio*, a river-dwelling species (Collette, 1974), while southern specimens are from *Hyporhamphus melanochir*, a marine species. Because of slight differences in morphology, and as the populations appear to separate geographically, by habitat and host, the Queensland material is not included as part of the type-series.

Specimens have also been taken on *Girella tricuspidata* from Lake Illawarra, NSW, and these seem more variable than the specimens from *Hyporhamphus melanochir*. The material from *Girella* may have more pointed coxae, and lacks the lateral distortion of the southern specimens. The differences of these populations are summarized and presented in Table 4.

Remarks. Hale (1926) gave good figures of the South Australian specimens that he examined, all of which belong to this species except his fig. 13 o, which appears to differ by the strong indentation of pereonite 7. Hale (1926) also referred to specimens from Belonidae, but these are *Mothocya karobran.*

The characters by which this species is identified include long posterior coxal plates, lateral distortion of the pereonites, shape of the pleotelson and morphology of the uropods.

Hosts. In southern waters *Hyporhamphus melanochir* (Hale's (1926) record of *Hyporhamphus intermedius* is a misuse of the name—see Collette, 1974); in Queensland the host is *Hyporhamphus regularis ardelio*, and from *Girella tricuspidata* from Lake Illawarra, NSW.

Distribution. Melbourne, Victoria, several localities in South Australia to Albany and Mandurah in Western Australia; also Queensland from Gladstone to Moreton Bay and Lake Illawarra, NSW.

Etymology. This species is named in honour of Herbert M. Hale, in acknowledgement of his contribution to the taxonomy of Australian isopods.

Mothocya girellae sp. nov.

(Figs 39, 40)

Material. All from Lake Illawarra, NSW, ex *Girella tricuspidata*, coll. P. F. O'Connor. 19♀ (13 ovig. 22·5–27·0 mm (HOLOTYPE 27·0 mm, AM P35219), 6 non-ovig. 23·2–29·0 mm, mean 24·5 mm), 15♂ (12·5–17·9 mm, mean 16·0 mm), 26.1.1977 (AM P35220–35224, 35244–35247); 5♀ (ovig. 22·0, 26·0, non-ovig. 24·0, 24·5, 24·8 mm), 4♂ (15·5, 15·8, 16·0, 17·5 mm), 1977 (USNM 216193, NMV J10646, J10647, QM W11730); ♀ (ovig. 23·0 mm), ♂ (11·8 mm), 1.v.1975 (USNM 216194). ♀ (non-ovig. 22·5 mm), ♂ (16·8 mm), 5.vi.1975 (USNM 216198); 3♀ (non-ovig. 23·5, 24·5, 26·1 mm), 11.vii.1975 (USNM 216195–216197).

Types. HOLOTYPE, AM P35219; PARATYPES, AM P35220–35224, 35244–35247, NMV J10646, 10647, QM W11730, USNM 216193–216198.

Type-locality. Lake Illawarra, NSW, Australia, *c.* 34°32′S, 150°50′E.

Description of female. Body widest between pereonites 3 to 5, generally ovoid in outline; dorsum weakly convex. Cephalon moderately immersed in pereonite 1; eyes moderate in size, 0·44–0·54 times width of cephalon. Coxae of pereonites 2 to 4 as long as or slightly longer than respective segment; coxae of pereonites 5 to 7 becoming progressively more elongate, those of pereonite 7 with posterolateral margin acute. Posterior margin of pereonite 7 abruptly recessed. Pleon 0·98–1·31 times width of pereonite 5; lateral margin of pleonites 1 to 3 always, and 3 to 5 variably, overlapped by coxal plates of pereonite 7. Pleotelson 0·61 and 0·74 times as long as wide, lateral margin converging to subtruncate apex. Maxilla with two spines each on medial and lateral lobe respectively; maxilliped article 3 with four recurved spines. Pereopods all robust; pereopods 4 to 7 slightly larger than pereopods 1 to 3. Pleopod 1 with broadly rounded rami, peduncle lateral margin with moderate lobe. Pleopod 2 with prominent appendix masculina. Pleopods 3 to 5 essentially similar; proximomedial lobe on pleopod 5 endopod not larger than those of pleopods 3 and 4; pleopod 5 endopod lateral margin tapered, apex narrow. Uropod rami not extending beyond pleotelson; endopod shorter than exopod, weakly tapered.

Male. Uropod rami broadly rounded, exopod distinctly longer than endopod. Penial openings set distinctly apart. Pleopod 5 endopod proximomedial lobe not larger than that of pleopod 4.

Colour. Pale brown in alcohol, with sparse chromatophores.

Size. Ovigerous females 22·0–27·0 mm, non-ovigerous females 22·5–29·0 mm; males 12·5–17·9 mm.

Variation. Females vary in length and shape of the posterior coxae, shape of the posterior margin of the pleotelson, and also the degree by which the posterior margin of pereonite 7 is recessed. In many cases the uropods and pleotelson are damaged. The

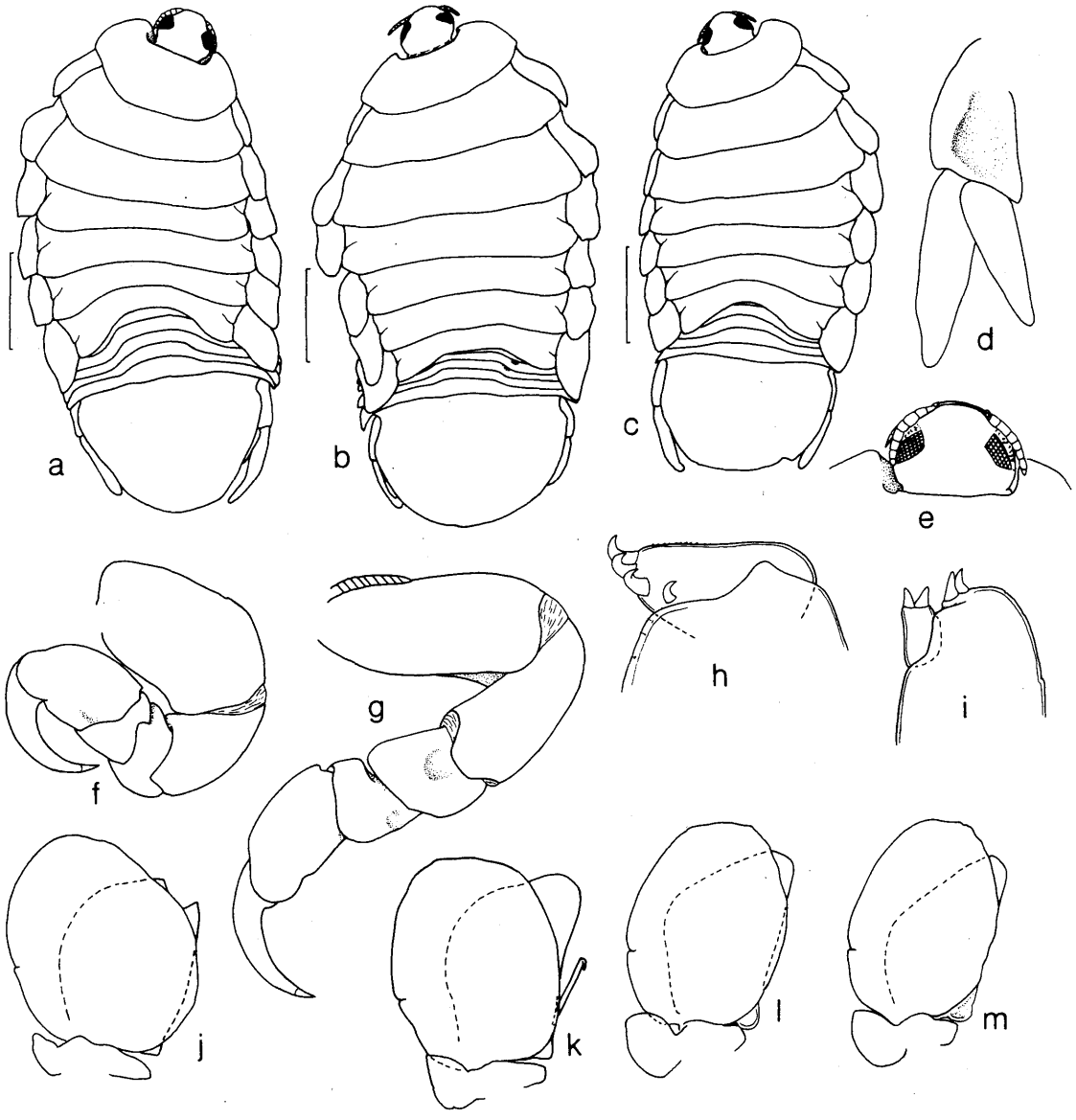

FIG. 39. *Mothocya girellae* sp. nov.: d, f–m, ♀ 28·5 mm (AM P35221); remainder as indicated. a, HOLOTYPE; b, ♀ 27·0 mm (P35224); c, ♀ 23·8 mm (P35222); d, uropod; e, cephalon, HOLOTYPE; f, pereopod 1; g, pereopod 7; h, maxilliped article 3; i, maxilla apex; j–m, pleopods 1, 2, 4, 5 respectively. Scale bars = 5·0 mm.

coxae of pereonite 7 nearly always extend to pleonite 4, and may extend beyond pleonite 5.

Remarks. This species is similar to *Mothocya halei*, especially individuals that have rounder or shorter coxae. Similarly, some specimens of *Mothocya halei* develop more pointed coxae, and again those individuals resemble *Mothocya girellae*. There are a number of characters which enable the two species to be separated. The shape of *Mothocya girellae* is clearly oval compared to *M. halei*, which is widest anteriorly. *Mothocya girellae* is much larger than *M. halei*, and has longer and more pointed coxae, and shorter uropods. Significantly the pleopods of the males and females, and the penial processes of the males of the two species differ. In *M. halei* the endopod of pleopod 5 has a large accessory lobe, while in *M. girellae* this lobe is small. The penial processes of *M. halei* are set adjacent to one another, while in *M. girellae* they are set distinctly apart. The differences between the populations of *M. halei* and *M. girellae* are summarized in Table 4.

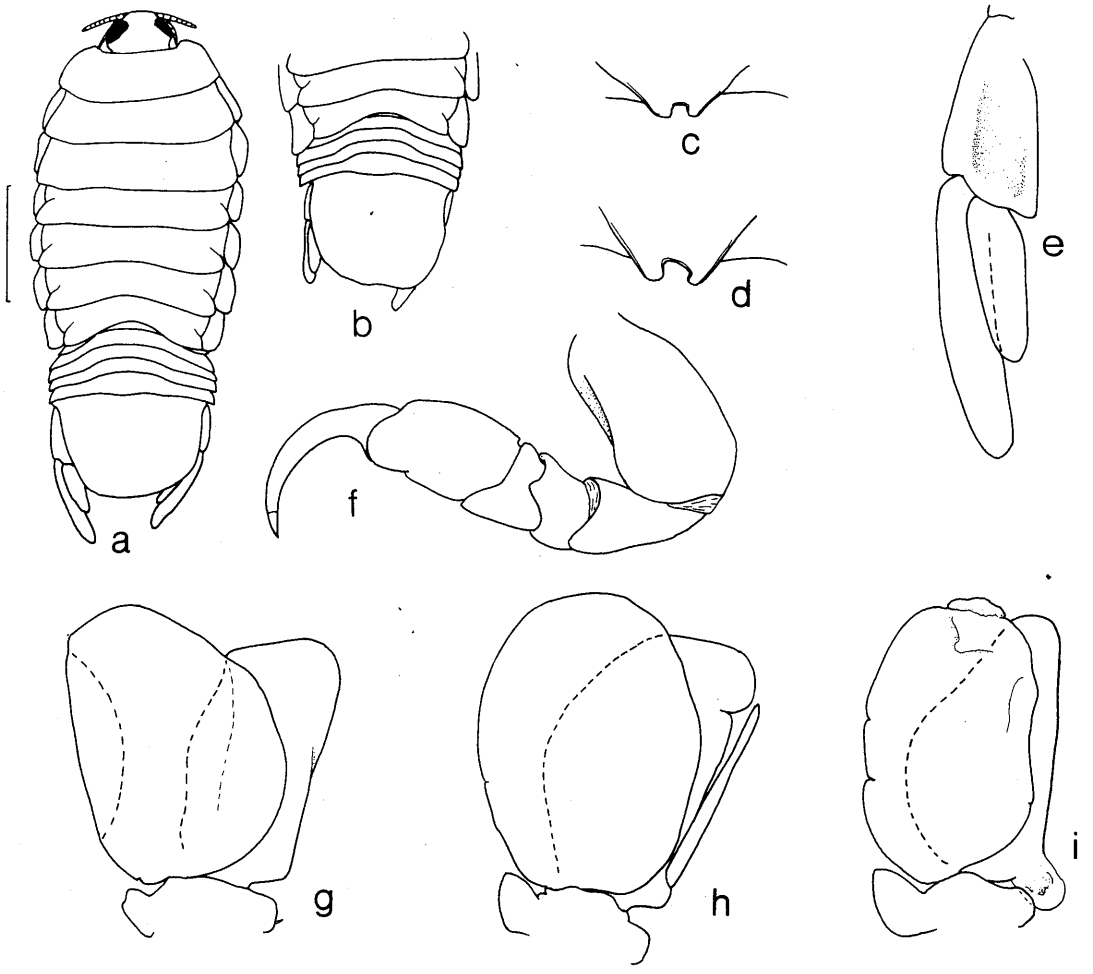

FIG. 40. *Mothocya girellae* sp. nov.: a, d–i, ♂ 16·7 mm (AM P35220); remainder as indicated. a, dorsal view; b, ♂ 16·5 mm; c, penes, ♂ 14·0 mm; d, penes; e, uropod; f, pereopod 1; g–i, pleopods 1, 2, 5 respectively. Scale bar = 4·0 mm.

Hosts. Recorded only from *Girella tricuspidata.*

Distribution. Known only from Lake Illawarra, NSW, Australia (Fig. 54:8).

Etymology. The specific name is taken from the host genus.

Mothocya gilli sp. nov.

(Figs 41, 42)

Materials. From *Hyporhamphus unifasciatus*: ♀ (ovig. 12·0 mm), Ensenada San Francisco, Guaymas, Sonoro, Mexico, 31.i.1952, coll. Boyd Walker (AHF 529); ♀ (ovig. 11·2 mm), ♂ (7·2 mm), Manzanilla Bay, Colima, Mexico, i.1970, coll. John Fitch (AHF 708); ♀ (ovig. 13·5 mm), ♂ (8·0 mm), May Bay, Baja California, Mexico, 23.viii.1960, (USNM 216190); ♀ (8·1 mm), St Maria Bay, Baja California, Mexico, 10.i.1957, (USNM 216189); 2♂ (7·5, 8·0 mm), Ascunsion Bay, Baja California, Mexico, 23.iii.1956, (USNM 216191). From *Hyporhamphus gilli*: ♀ (ovig. 11·0 mm, HOLOTYPE, USNM 216187), ♂ (8·6 mm, USNM 222664), Magdalena Bay, Baja California, Mexico, 14.vii.1956; ♀ (ovig. 6·5 mm), Almeja Bay, Mexico, 25.viii.1950 (USNM 216188).

→ LACM 52-40.1

→ LACM 70-157.1

Types. HOLOTYPE, USNM 216187; PARATYPES, USNM 216188–216191, 222664, AHF 529, 708.

Type-locality. Magdalena Bay, Baja California, Mexico, *c.* 24°40′N, 11°50′W.

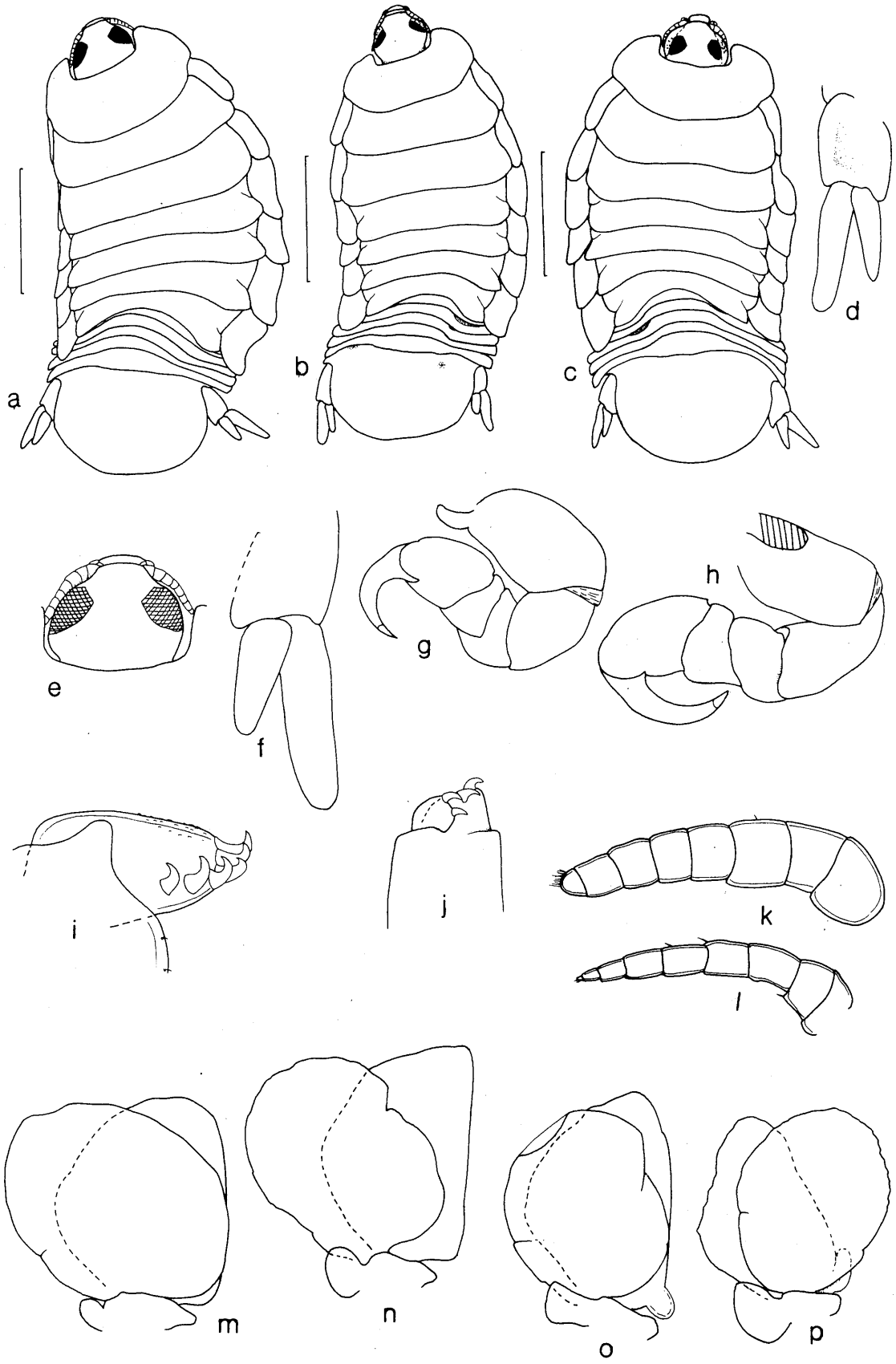

FIG. 41. *Mothocya gilli* sp. nov.: a, e, f, HOLOTYPE; d, g–o, ♀ 6·5 mm (USNM 216188); remainder as indicated. a, dorsal view; b, ♀ 11·2 mm, Manzanilla Bay (AHF 708); c, ♀ 13·5 mm, May Bay (USNM 216190); d, uropod; e, cephalon; f, uropod, *in situ*; g, pereopod 1; h, pereopod 7; i, maxilliped article 3; j, maxilla apex (creased); k, antennule; l, antenna; m–p, pleopods 1–3, 5 respectively. Scale bars = 3·0 mm.

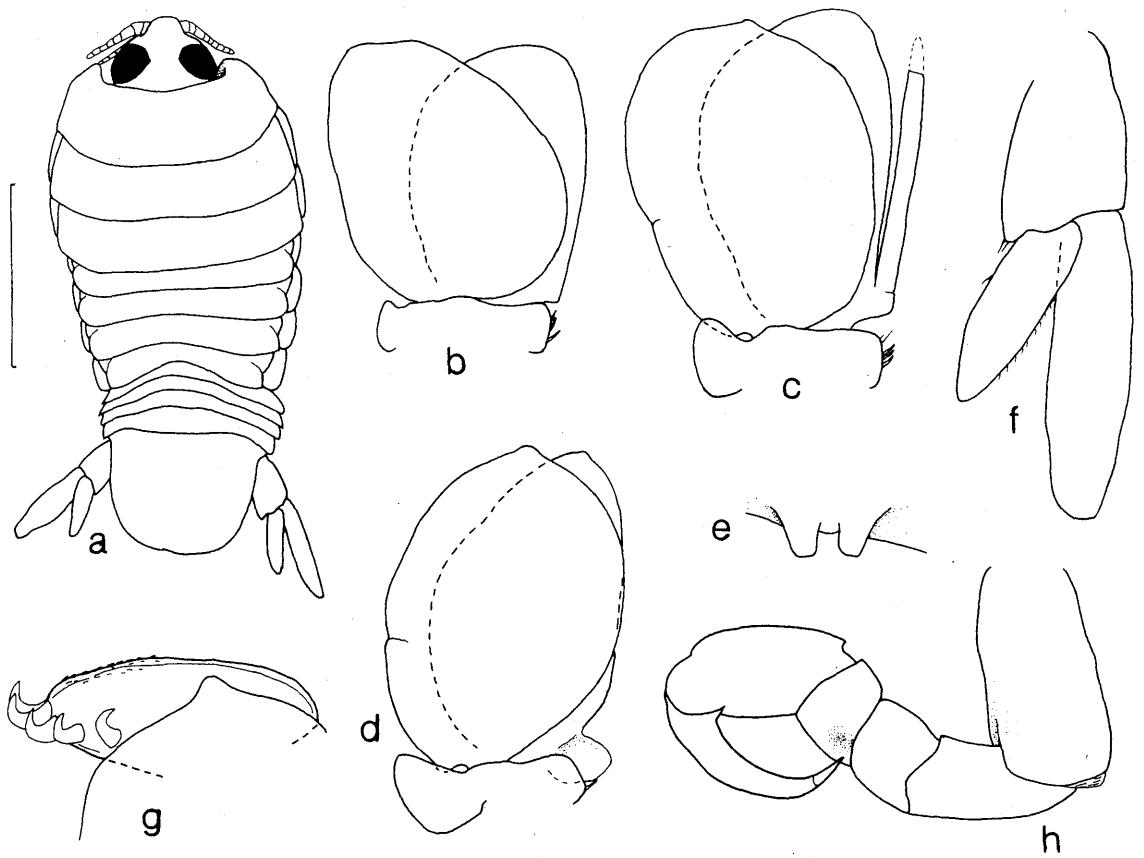

FIG. 42. *Mothocya gilli* sp. nov.: All ♂ 8·6 mm, Magdalene Bay (USNM 216187). a, Dorsal view; b–d, pleopods 1, 2, 5 respectively; e, penes; f, uropod; g, maxilliped article 3; h, pereopod 7. Scale bar = 3·0 mm.

Description of female. Body weakly twisted to one side, widest between pereonites 3 to 5. Cephalon moderately immersed in pereonite 1, rostrum feebly produced; labrum generally visible in dorsal view. Eyes moderate, 0·47 and 0·56 times width of cephalon. Coxae of pereonites 2 and 3 not extending beyond respective segment, those of pereonites 4 to 7 becoming progressively longer towards posterior; coxae on convex side tending to have concave lateral margins, those on straight side with straight lateral margins. Pereonite 7 posterior margin widely and shallowly recessed. Pleon 1·0–1·2 times width of pereonite 5; lateral margins of pleonites 1 to 3 overlapped by coxae of pereonite 7. Pleotelson short, posterior margin rounded, wide; anterolateral margins abruptly indented just before meeting pleonite 5. Maxilliped article 3 with six recurved spines. Pereopods short, robust; pereopod 7 not much larger than peropod 1. Pleopod 1 exopod broadly rounded; peduncle lateral margin lobe developed, medial margin narrow. Pleopods 2 to 5 with peduncle lateral margin lobes developed; pleopod 5 endopod proximomedial lobe larger than that of pleopod 4, which in turn is larger than that of pleopod 3. Uropod peduncle short, about 1·3 times longer than wide, lateral margin weakly convex; exopod broad with broadly rounded apex; endopod about 0·66 times length of exopod, tapering evenly to narrow rounded apex.

Male. Rostrum strongly produced; uropod extending well beyond posterior of pleotelson, medial margin of both rami tending to curve more than lateral margin; endopod tapering to narrow rounded apex. Penes set distinctly apart on sternite 7.

Colour. Brown to tan in alcohol. Chromatophores sparsely spread over dorsum, and also on antennules, antennae and pereopods.

Size. Ovigerous females 11·2–16·5 mm; males 7·2–8·6 mm.

Remarks. This species occurs along the Pacific coasts of Mexico, and is similar to *Mothocya rosea*, from which it can be separated by having smaller eyes, a wider pleon being larger in size, and having six large recurved spines on the maxilliped (compared to three in *M. rosea*).

The most similar species to *Mothocya gilli* is *Mothocya sajori* from the north-western Pacific. The two species can easily be separated by *M. sajori* having both uropod rami broad, and also by being about twice the size of *M. gilli.*

Host species. Hyporhamphus gilli and *Hyporhamphus unifasciatus* (East Pacific form).

Distribution. From the central Gulf of California to Manzanilla Bay, Colima, and the southern oceanic side of Baja California, Mexico.

Etymology. The species name is taken from the host species for the holotype.

Mothocya rosea sp. nov.

(Figs 43, 44)

Material. From *Hyporhamphus rosea*: ♀ (non-ovig. 6·8 mm), ♂ (imm. 6·5 mm), San Diego, California, 32°40′N, 117°12′W, 21.ii.1939 (LACM uncat); ♀ (ovig. 6·2 mm, HOLOTYPE), San Ignacio Lagoon, Baja California, Mexico, 11.ii.1950 (USNM 216272); ♀ (non-ovig. 8·4 mm), Magdalena Bay, Baja California, Mexico, 8.iv.1899, coll. 'Albatross' (USNM 216273). From *Hyporhamphus snyderi*: ♀ (ovig. 7·2 mm), ♂ (imm. 5·5 mm), Nicaragua, 1964, coll. Scripps (USNM 216367).

Types. HOLOTYPE, USNM 216272; PARATYPE, USNM 216273, 216367, LACM uncatalogued. → LACM 39-265.1

Type-locality. San Ignacio Lagoon, Baja California, Mexico, *c.* 26°25′N, 113°13′W.

Description of female. Body twisted to one side, widest at pereonites 3 and 4, dorsum weakly convex. Cephalon deeply immersed in pereonite 1, rostrum scarcely produced; eyes large, 0·52–0·76 times width of cephalon. Coxae of pereonites 2 and 3 not produced beyond posterior of segment; pereonites 4 to 7 with coxae more produced on concave side, those of convex side scarcely extending beyond posterior of segment, with lateral margin concave. Pleonites all visible; pleon 0·83–0·86 times width of pereonite 5. Pleotelson 0·75–0·83 times as long as wide, lateral margins converging slightly to broad posterior margin, almost parallel to anterior margin. Maxilla medial lobe narrow; maxilliped article 3 with three large recurved spines and fourth small spine at posteromedial surface. Pereopod 1 relatively slender; pereopods 4 to 7 not much larger than pereopods 1 to 3. Pleopod 1 peduncle lateral margin scarcely produced; exopod broad, rounded; endopod medial margin straight, apex truncate. Pleopods 2 to 4 similar to 1 but peduncle lateral lobe larger; endopods of pleopods 3 and 4 with proximomedial lobe developed, that of pleopod 5 much larger than that of pleopod 4, rami converging to narrow apex. Uropod peduncle short; both rami short, broadly rounded, not extending beyond pleotelson; endopod slightly shorter than exopod.

Male. Both specimens apparently immature males; larger specimen (ex *Hyporhamphus snyderi*) with penes set apart. One specimen with rostrum scarcely produced, other strongly produced. Pleon of both narrow. Uropod extending slightly beyond posterior of pleotelson.

Colour. Brown in alcohol, with scattered chromatophores.

Size. Females 6·2–8·4 mm; immature males 5·5–6·5 mm.

Variation. In most specimens the uropods are longer than those of the holotype and extend slightly beyond the posterior margin of the pleotelson. In some the endopod is

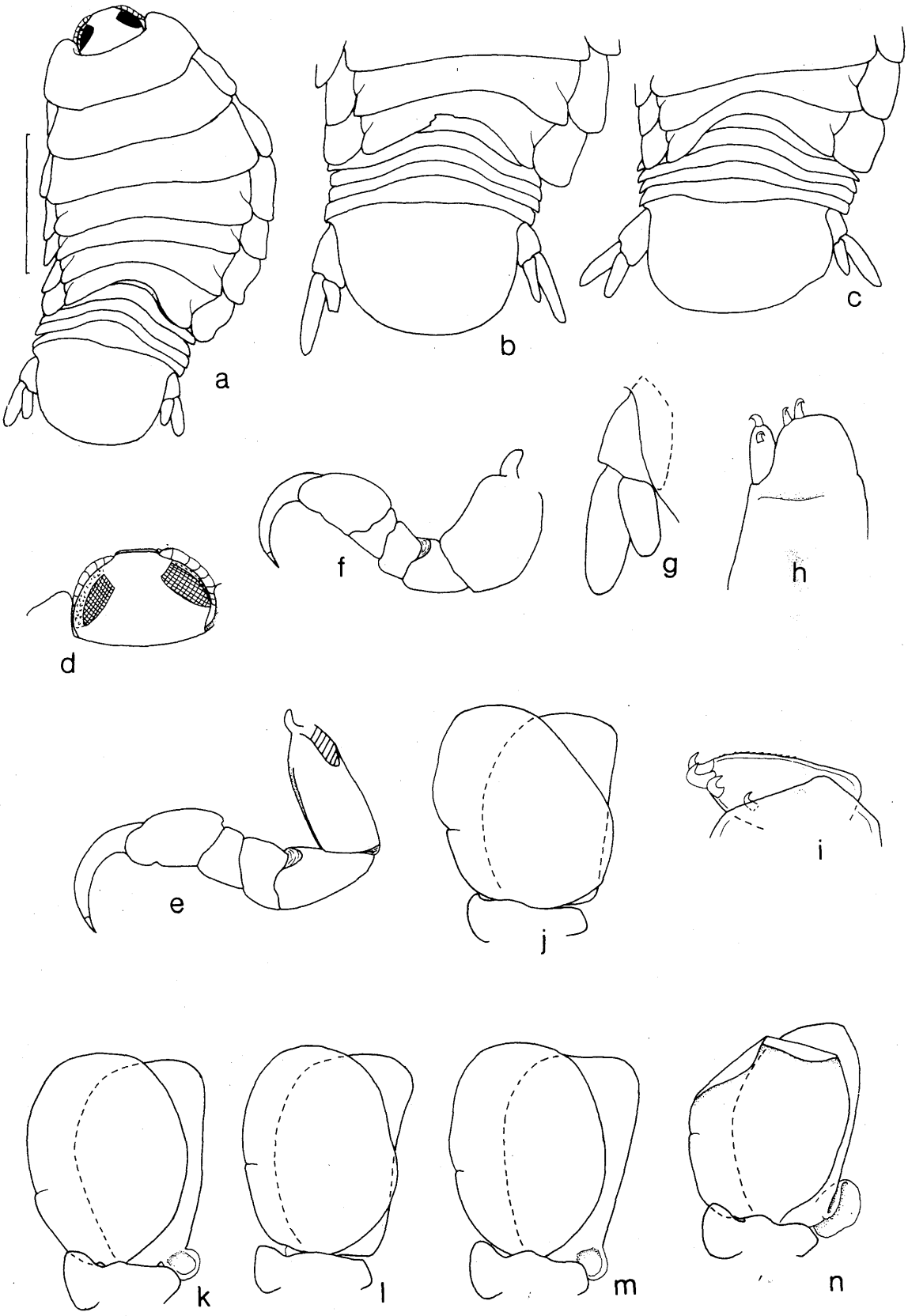

FIG. 43. *Mothocya rosea* sp. nov.: a, d, g, HOLOTYPE; c, ♀ 7·2 mm, ex *H. snyderi*, (USNM 216367); remainder ♀ 8·4 mm, Magdalene Bay (USNM 216273). a, dorsal view; b, pleon and pleotelson; c, pleon and pleotelson; d, cephalon; e, pereopod 7; f, pereopod 1; g, uropod, *in situ*; h, maxilla apex; i, maxilliped article 3; j–n, pleopods 1, 4, 2, 3, 5 respectively. Scale bar = 2·0 mm.

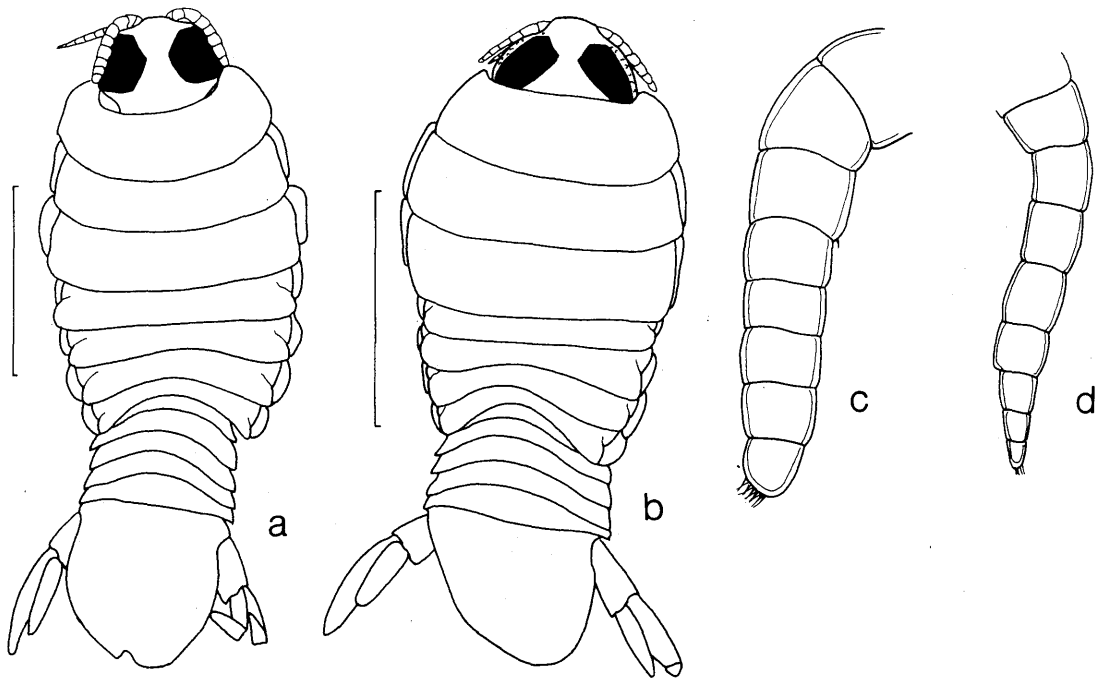

FIG. 44. *Mothocya rosea* sp. nov.: a, ♂ 6·5 mm (LACM uncat.); b, ♂ 5·5 mm, ex *H. snyderi* (USNM 216367); c, antennule, ♀ 8·4 mm (USNM 216273); d, antenna, ♀ 8·4 mm (USNM 216273). Scale bars = 2·0 mm.

more slender than in others. The specimens otherwise present a constant appearance.

Remarks. This species is similar in many ways to the sympatric *Mothocya gilli*, but is readily distinguished by its smaller size, narrower pleon, larger eyes and the morphology of pleopod 5. A further difference is that *Mothocya gilli* has six large recurved spines on maxilliped article 3 while *M. rosea* has only got three and a fourth small spine. The two species are also found on different host species.

Hosts. Recorded from *Hyporhamphus rosea* and *H. snyderi.*

Distribution. From Nicaragua, along the Mexican Coast and San Diego, California (Fig. 55:2).

Etymology. The epithet is taken from that of the commoner host.

Mothocya panamica sp. nov.

(Figs 45, 46)

Material. ♀ (non-ovig. 31·5 mm, HOLOTYPE, USNM 216211), Bay of Panama, Panama Canal Zone, Pacific coast, 10.viii.1973, ex *Tylosurus crocodilus*; ♂ (imm. 13·5 mm), Charles Point, Panama, no date, ex *Tylosurus crocodilus* (USNM 216212).

Types. HOLOTYPE, USNM 216211.

Type-locality. Bay of Panama, Panama, *c.* 8°40′N, 79°30′W.

Description of female. Body straight, about 2·5 time longer than wide. Rostrum scarcely produced, labrum visible in dorsal view; eyes very small, 0·15 times width of cephalon, facets not distinct. Pereonites 2 to 7 approximately equal in width; coxae all longer than wide, posterior margins rounded, only those of pereonite 7 extending beyond posterior of segment; posterior margin of pereonite 7 scarcely recessed. Pleon wide, 1·3 time width of pereonite 5; lateral margins extending beyond coxae of pereonite 7. Pleotelson widest at midlength, about 1·3 times longer than wide, lateral margins

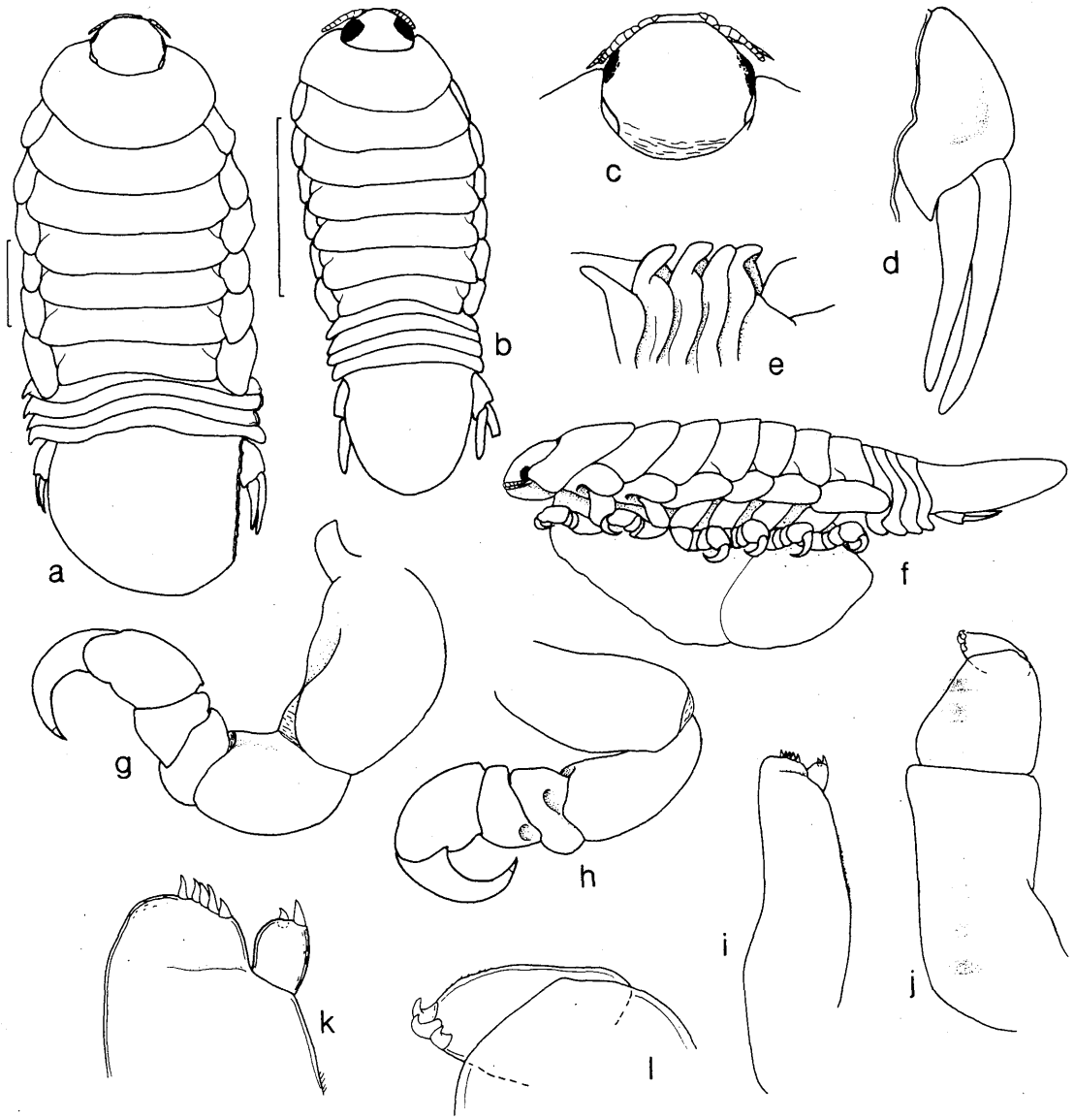

FIG. 45. *Mothocya panamica* sp. nov.: all HOLOTYPE, except b, ♂ (USNM 216212). a, dorsal view; b, dorsal view; c, cephalon; d, right uropod, *in situ*; e, left pleonites, ventral view; f, lateral view; g, pereopod 1; h, pereopod 7; i, maxilla; j, maxilliped; k, maxilla apex; l, maxilliped article 3. Scale bars = 5·0 mm.

curving gently to broadly rounded posterior margin. Maxilla with two spines on medial lobe, five spines on lateral lobe. Maxilliped article 3 broad, with three recurved spines. Pereopods robust, 1 to 5 of approximately equal size, pereopods 6 and 7 slightly larger, although less robust than anterior pereopods. Pereopod 1 posterior margins of ischium to carpus distinctly convex, propodal palm short. Pleopod peduncle lateral lobes large, that of pleopod 1 prominent, those of pleopods 3 to 5 with thickened ridges; pleopods 3 to 5 endopod proximomedial lobes moderate in size. Uropod peduncle short, both margins convex; uropod rami both slender, weakly curved medially, exopod slightly longer than endopod.

Male. The male examined here lacks penial processes, and is identified as belonging to this species by having well-developed lateral lobes on the pleopod peduncles and a relatively long pleotelson. The uropods are damaged. As the specimen is not associated with a female, and is damaged, it is not designated as a paratype.

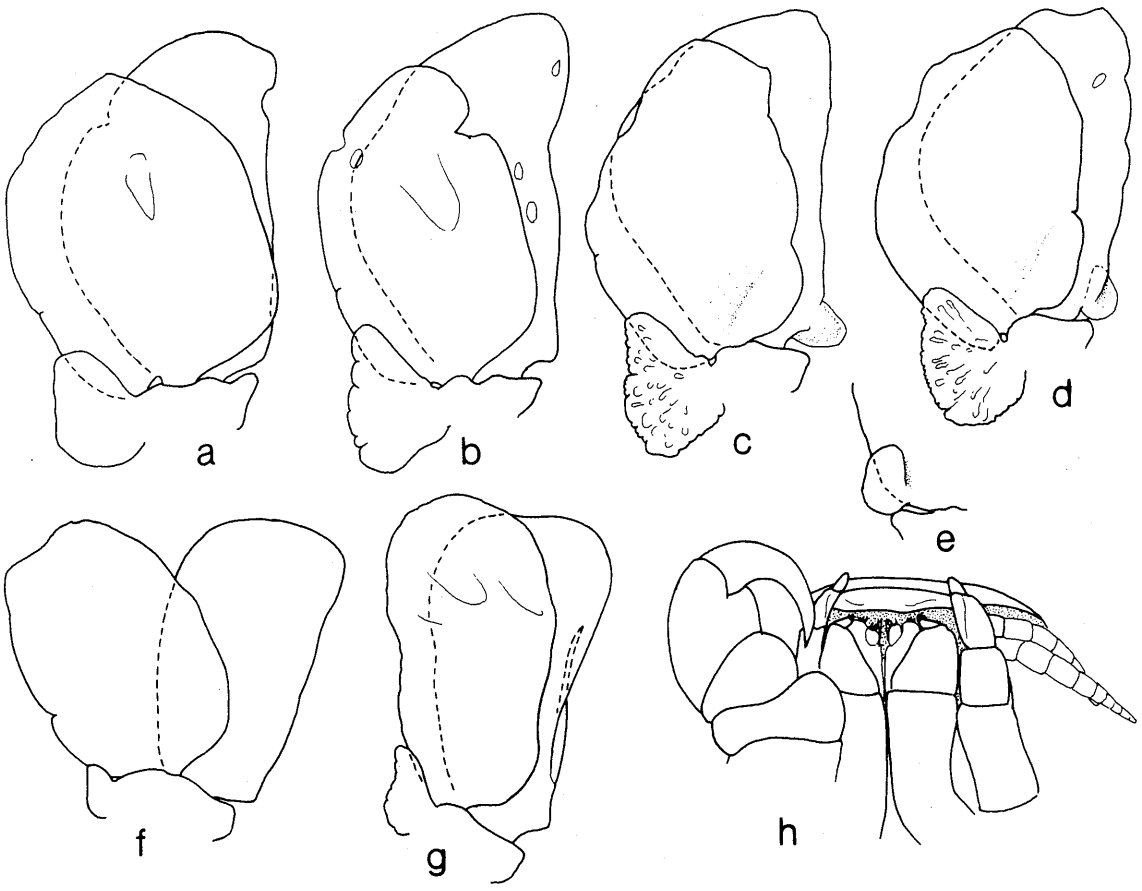

FIG. 46. *Mothocya panamica* sp. nov.: a–e, h, HOLOTYPE; remainder ♂ (USNM 216212). a–d, pleopods 1–3, 5 respectively; e, pleopod 5, proximomedial lobe; f, pleopod 1; g, pleopod 2; h, buccal area.

Colour. Pale tan in alcohol, with chromatophores scattered over dorsal surface.

Size. Non-ovigerous female 31·5 mm; male 13·5 mm.

Remarks. The female specimen differs from other *Mothocya* species in the morphology of the pleopod peduncles, being the only species with such large lateral lobes. The elongate body shape is also shown by *Mothocya ihi*, from which the present species otherwise differs in many respects.

Other unusual characters shown by *Mothocya panamica* are the small size of maxilliped article 3, the large number of spines on the lateral lobe of the maxilla (five versus the more usual two), the long pleotelson, and the small size of the posterior pereopods.

Hosts. Recorded only from *Tylosurus crocodilus.*

Distribution. Known only from the Pacific coast of Panama (Fig. 55:3).

Etymology. The name is taken from the type-locality.

Mothocya ihi sp. nov.

(Figs 47, 48)

Irona melanosticta. Stephenson, 1969: 427, figs 1–20; 1976: 167; Hewitt and Hine, 1971: 94, 108. (Non *Irona melanosticta* Schioedte and Meinert, 1884; non *Irona melanosticta* of all other authors.)

Material. All taken from *Hyporhamphus ihi*, taken in New Zealand waters: 13♀ (ovig. 16·5, 17·0, 21·0, 21·0, 21·5, 22·0, 22·5, 23·5 mm (HOLOTYPE AIM 5370); non-ovig.

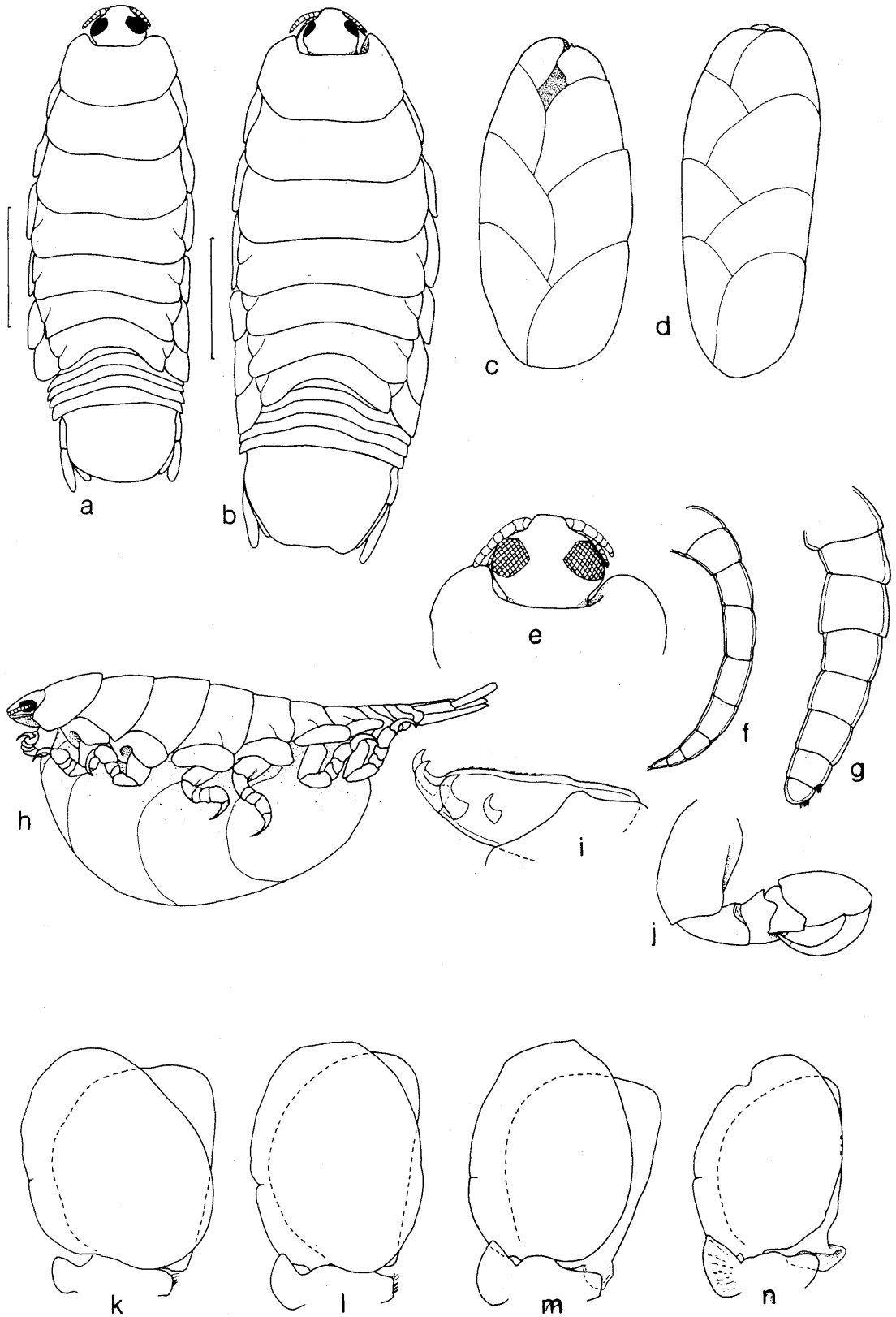

FIG. 47. *Mothocya ihi* sp. nov.: a, c, e, h, HOLOTYPE; f, g, i, ♀ 20·7 mm, Wellington (USNM 216437); k–n, ♀ 22·5 mm, Urapukapuka (AIM 5371); remainder as indicated. a, dorsal view; b, ♀ 26·0 mm (BMNH 1984: 401: 2); c, brood pouch; d, brood pouch, ♀ 22·2 mm (USNM 216437); e, cephalon; f, antenna; g, antennule; h, lateral view; i, maxilliped article 3; j, pereopod 1, ♂ 13·0 mm, Urapukapuka (AIM 5371); k–n, pleopods 1–3, 5 respectively. Scale bars = 6·0 mm.

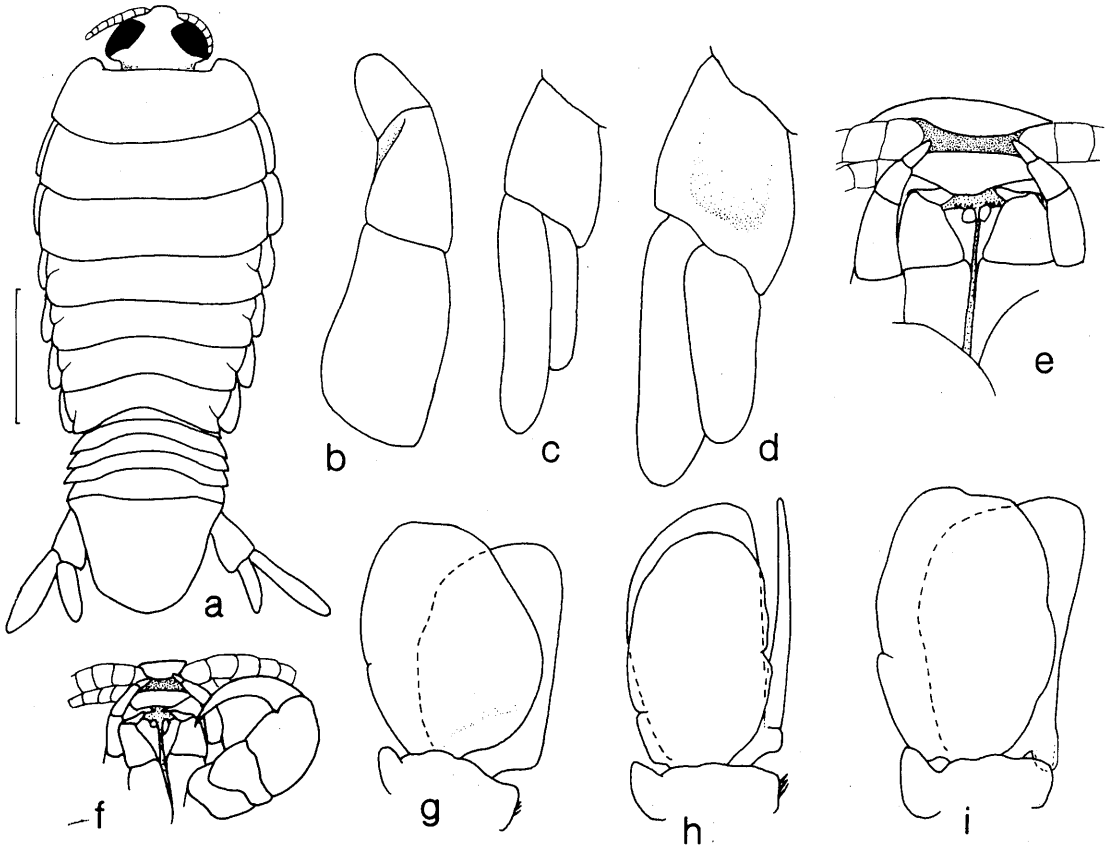

FIG. 48. *Mothocya ihi* sp. nov.: a, g–i, ♂ 13·0 mm, Urapukapuka (AIM 5371); remainder as indicated. a, dorsal view; b, mandible palp, ♀ 22·5 mm, Urapukapuka (AIM 5371); c, uropod, ventral view, ♀ Urapukapuka (AIM 5371); d, uropod, ♀ 22·2 mm, Wellington (USNM 216437); e, buccal area, ♀ 31·0 mm (USNM 216207); f, buccal area, ♂ 12·0 mm, Auckland (USNM 216207); g–i, pleopods 1–3 respectively. Scale bar = 3·0 mm.

17·0, 21·0, 21·8, 22·5, 24·5 mm), ♂ (13·0 mm), 4 imm. (4·0–6·0 mm), Urapukapuka Is., Bay of Islands, 17.i.1967, netted off sandy beach, coll. A. B. Stephenson (AIM 5371); ♀ (non-ovig. 24·0 mm), Cook Straits, no data, host depth 187 m, coll. CSIRO (AM P35227). ♀ (ovig. 19·0 mm), Auckland (LACM uncat.). 4 imm. (5·2, 5·5, 6·6, 7·2 mm), Queen Charlotte Sound, no other data (USNM 216349); ♂ (4·5, 4·9, 6·2, 6·5 mm), Port Charles, East coast, no other data (USNM 216348); ♀ (ovig. 31·0 mm), ♂ (11·2 mm), imm. (5·6 mm), Auckland, 6.i–1.ii.1953 (USNM 216207). ♀ (ovig. 20·7, 22·2 mm), Raumati Bay, Wellington, no other data (USNM 216347); ♀ (ovig. 26·4 mm), ♂ (19·1 mm), New Zealand, (BMNH 1984: 401: 2); 3♀ (ovig. 17·5, 18·5, 23·0 mm), Pukes Is., Urupuka, Bay of Islands, 29.ii.1960, coll. Sturchill (ANSP CA4554); ♂ (12·3 mm), Wellington Stream, 1951, Galathea stations 627, 52°23′S, 174°48′E (USNM 216206).

Types. HOLOTYPE, AIM 5370; PARATYPES, AIM 5371, AM P35227, USNM 216207, 216348, BMNH 1984: 401: 2, LACM uncatalogued, ANSP CA4554. no date

Tyep-locality. Urapukapuka Is., Bay of Islands, New Zealand, 35°13′S, 174°14′E.

Description of female. Body with dorsum strongly vaulted, about three times longer than wide; longitudinal apex of dorsum assymmetrical. Cephalon with distinct rostral process; eyes large, about 0·70 time width of cephalon, facets distinct. Coxae of pereonites 5 to 7 extending beyond posterior of segment, conspicuous and broad in dorsal view; coxae of pereonites 2 to 5 not prominent in dorsal view, 1·9 to 2·5 times longer than wide. Pleon largely free of pereonite 7, all pleonites visible, 0·92–1·00 times width of pereonite 5; lateral margins of pleonites 3 to 5 usually free. Pleotelson about 0·7

times as long as wide, lateral margins converging slightly to broad subtruncate apex. Maxilla with lateral angle abruptly rounded; two spines each on medial and lateral lobes respectively; maxilliped article 3 with four hooked spines. Pereopods with relatively slender dactylus; pereopod 7 distinctly larger than pereopod 1, without coarse pitting. Pleopod rami all broadly rounded. Pleopod 1 peduncle lateral lobe weakly developed; pleopods 2 to 5 endopods with well-developed proximomedial lobe, pleopods 3 to 5 endopod proximomedial lobes well developed, that of pleopod 5 distinctly larger than that of pleopod 4; pleopods 1 to 3 peduncle medial margin with coupling hooks and setae. Lateral margin of all exopods with trace of suture. Uropod extending slightly beyond pleotelson, both rami bluntly rounded, lateral margin slightly angled; exopod slightly longer than endopod.

Male. Pleotelson and uropods proportionally longer than in female, uropodal exopod nearly 2·0 times longer than endopod. Pereopod 7 markedly more slender than pereopod 1. Pleopods more elongate than in female; appendix masculina slightly longer than endopod.

Variation. One female (BMNH 1984: 401: 2) has the coxae of pereonites 5 to 7 more strongly produced, with the coxal plate of pereonite 7 extending to pleonite 4. The relative lengths of the uropodal rami varies, the endopod being from 0·66 to 0·72 times the length of the exopod.

Colour. Dark brown except on coxae and posterior two-thirds of pleotelson which is whitish. Chromatophores sparsely scattered over dorsum, dense on pereopods and oostegites.

Size. Ovigerous females 17·0–31·0 mm, non-ovigerous females 17·0–24·5 mm; males 12·0–13·0 mm.

Remarks. This species is unique in possessing a strongly vaulted dorsum, and an elongate body shape. *Mothocya panamica* is elongate, but does not have a strongly vaulted dorsum.

The relationship of *Mothocya ihi* to the host is also unique within the genus, this being the only species that is not a gill parasite. Stephenson (1969, fig. 1; 1976) shows clearly that females occupy the buccal cavity while males are located on the gills. The elongate shape shows convergence of body shape to those genera that regularly inhabit the buccal cavity (e.g., *Ceratothoa* Dana; *Glossobius* Schioedte and Meinert). Stephenson (1969) discusses the transition from male to female, and the effect of the isopod on the host (Stephenson, 1976).

Hosts. Known only from *Hyporhamphus ihi*, a species restricted to New Zealand waters (Collette, 1974).

Distribution. Around New Zealand with one record from further south (Fig. 55:4).

Etymology. The epithet is taken from that of the host species.

Mothocya renardi (Bleeker)

(Figs 49–52)

Livoneca Renardi Bleeker, 1857: 28, pl. 1, fig. 8.
Livoneca Renardi. Miers, 1880: 465.
Irona Renardi. Schioedte and Meinert, 1884: 383, pl. 16, figs 10–15.
Livoneca renardi. Gerstaecker, 1881: 261.
Irona melanosticta. Barnard, 1914: 373; ?1955: 6; Kensley, 1978: 80, fig. 33A. (Non *I. melanosticta* Schioedte and Meinert, 1884.)
Irona renardi. Nierstrasz, 1915: 104; 1931: 145; Hale, 1926: 218, fig. 12; 1929: 258, fig. 155; Holthuis, 1959: 97, photo. 11, figs 4–9; Monod, 1971: 173; 1976: 863, figs 30, 32; Trilles, 1976 a: 785, pl. 11, fig. 10; 1979: 266; Beumer *et al.*, 1982: 32.

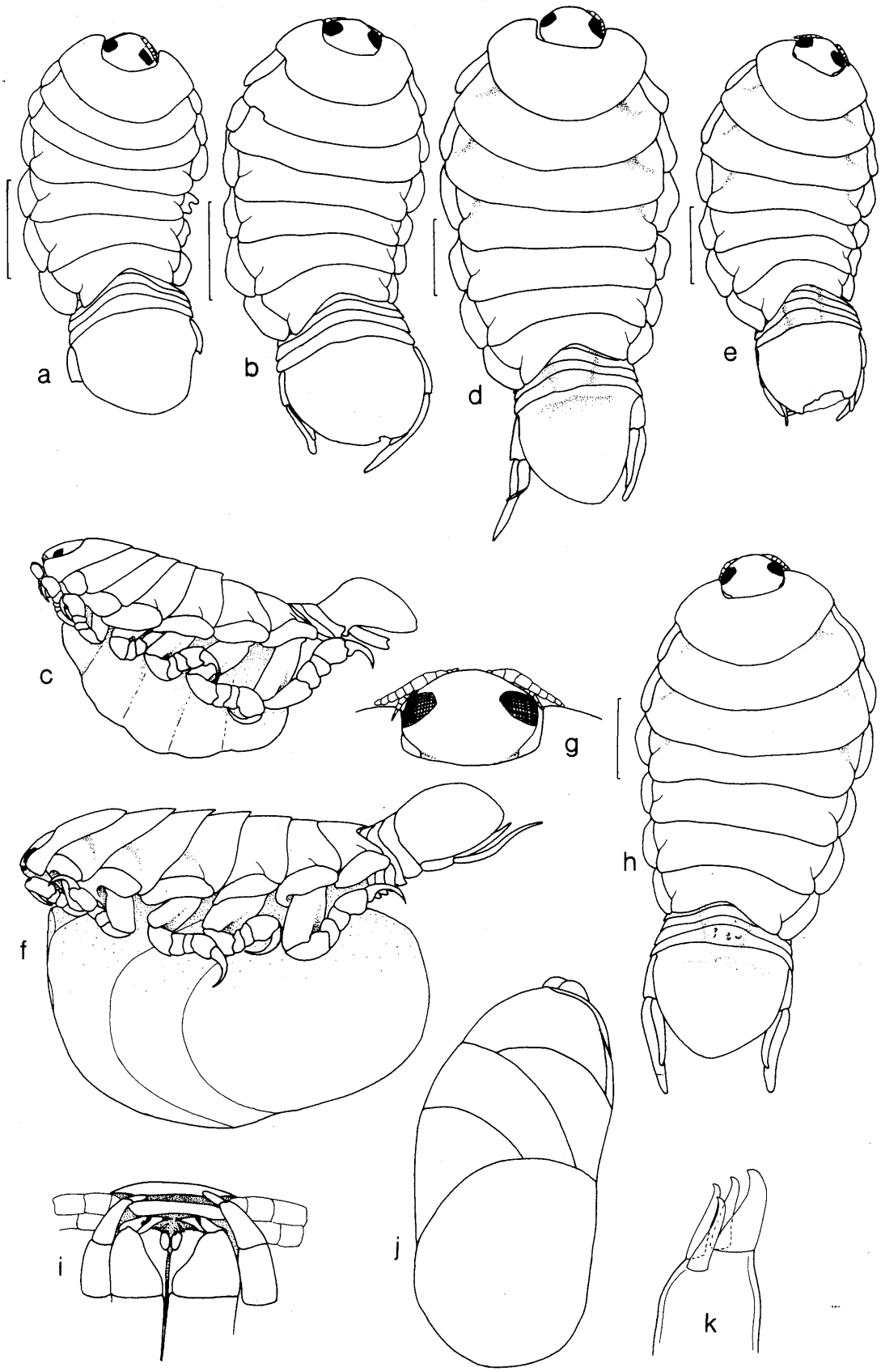

FIG. 49. *Mothocya renardi*: a, ♀ SYNTYPE RMNH 4611; b, ♀ SYNTYPE, RMNH 78; c, ♀ SYNTYPE RMNH 4611. Remainder from Mannoning Park, Lake Macquarie, NSW, (USNM 216221); d, ♀ 31·4 mm; e, ♀ 24·5 mm; f ♀ 31·4 mm; g, cephalon, ♀ 36·0 mm; h, ♀ 31·2 mm; i, buccal region, ♀ 36·0 mm; j, brood pouch, ♀ 36·0 mm; k, maxillule apex, ♀ 31·4 mm. Scale bars = 5·0 mm.

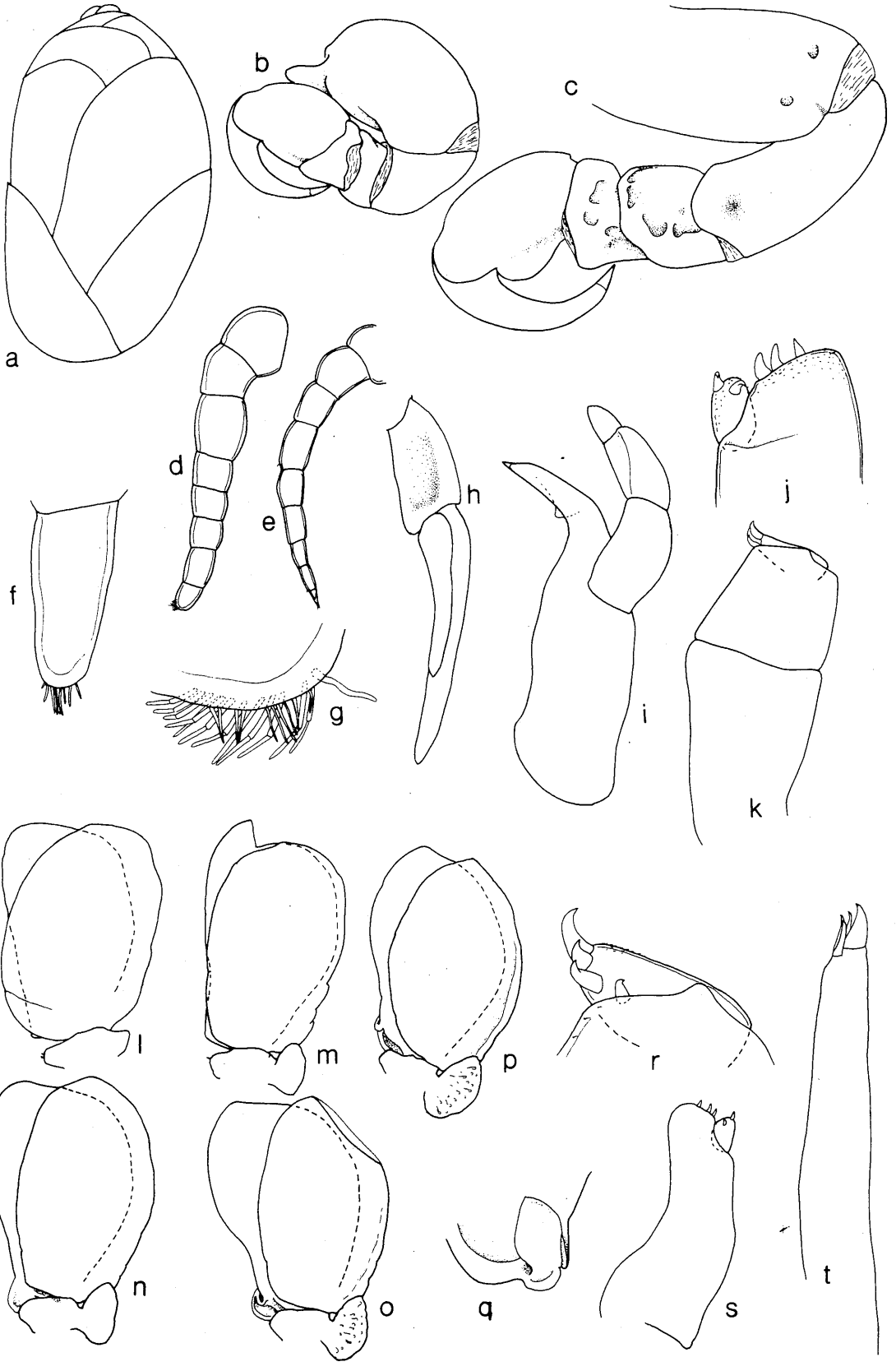

FIG. 50. *Mothocya renardi*: b, c, h–t, ♀ 31·4 mm, a, d–g, ♀ 29·0 mm, Mannoning Park, Lake Macquarie, NSW (USNM 216221). a, brood pouch, ♀ 29·0 mm; b, pereopod 1; c, pereopod 7; d, antennule; e, antenna; f, antenna, terminal article; g, antennule, apex of terminal article; h, uropod; i, mandible; j, maxilla apex; k, maxilliped; l–p, pleopods 1–5 respectively; q, proximomedial lobe, pleopod 5; r, maxilliped article 3; s, maxilla; t, maxillule.

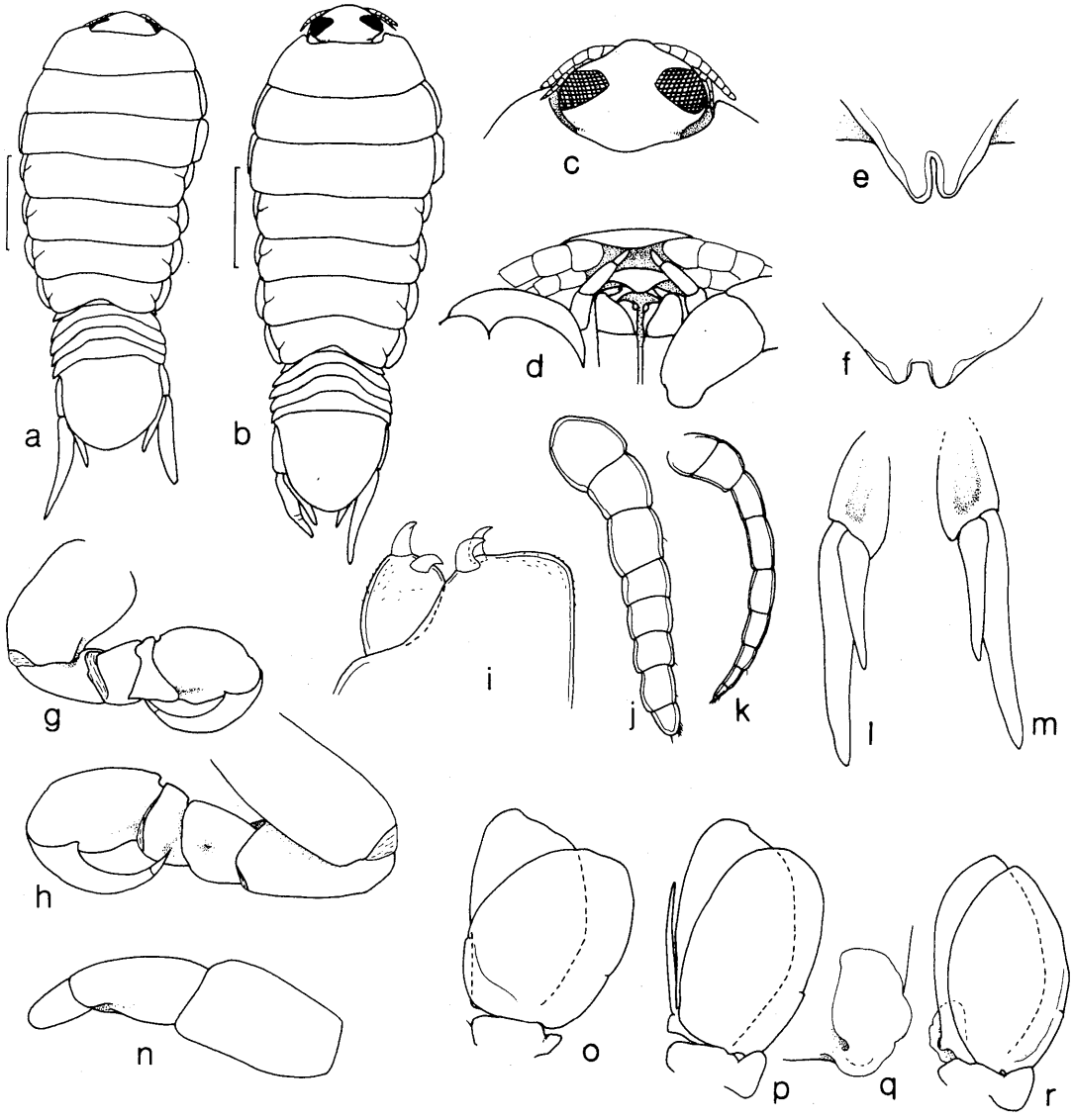

FIG. 51. *Mothocya renardi*: a, c–e, ♂ 17·8 mm, i–k, n–r, ♂ 17·2 mm, remainder as indicated; all from Mannoning Park, Lake Macquarie (USNM 216221). a, dorsal view; b, ♀ 20·0 mm; c, cephalon; d, buccal region; e, penes; f, penes ♂ 20·0 mm; g, pereopod 1, ♀ 18·2 mm; h, pereopod 7, ♂ 18·2 mm; i, maxilla apex; j, antennule; k, antenna; l, left uropod, ♂ 18·2 mm; m, right uropod, ♂ 18·2 mm; n, mandible palp; o, pleopod 1; p, pleopod 2; q, proximomedial lobe, pleopod 5; r, pleopod 5. Scale bars = 4·0 mm.

Irona robusta Nair, 1950: 66, figs 1–12; 1956: 2; Abraham, 1966: 32, figs 28–54, photos 5, 6; 1967: 10, figs 1–25; Monod, 1971: 174.
Mothocya species Bowman and Tareen, 1983: 25, fig. 19.
Non *Irona renardii*. Lanzing and O'Connor, 1975: 355, fig. 1 c, d (= *Mothocya halei*).

Material. Presumed syntypes: ♀ (ovig. 21·5 mm), Indische Archipel, P. Bleeker (RMNH No. 78); ♀ (non-ovig. 19·5 mm), Baai van Batavia, P. Bleeker (RMNH No. 4611). Eastern Australia, all from *Strongylura leiura*: 49♀ (24·0–36·0 mm), 23♂ (15·0–23·0 mm), Mannoning Park, Lake Macquarie, Sydney, NSW, 6.xi.1969, coll. BBC (USNM 216221, AM P35243); ♀ (non-ovig. *c.* 31·0 mm), ♂ (21·3 mm), Port Jackson, Sydney, NSW (AM P35241); ♂ (17·0 mm), Port Jackson, Sydney, NSW (USNM 216390); ♀ (ovig. 25·5 mm), ♂ (18·8 mm), Clarence River, northern NSW, coll. BBC (AM P35241); ♀ (non-ovig. 27·0 mm), NSW, vii.1929, coll. NSW Dept. of Fisheries (USNM 216391); ♀ (ovig. 22·0 mm), ♂ (18·1 mm), Queensland, (QM W11727). Western and

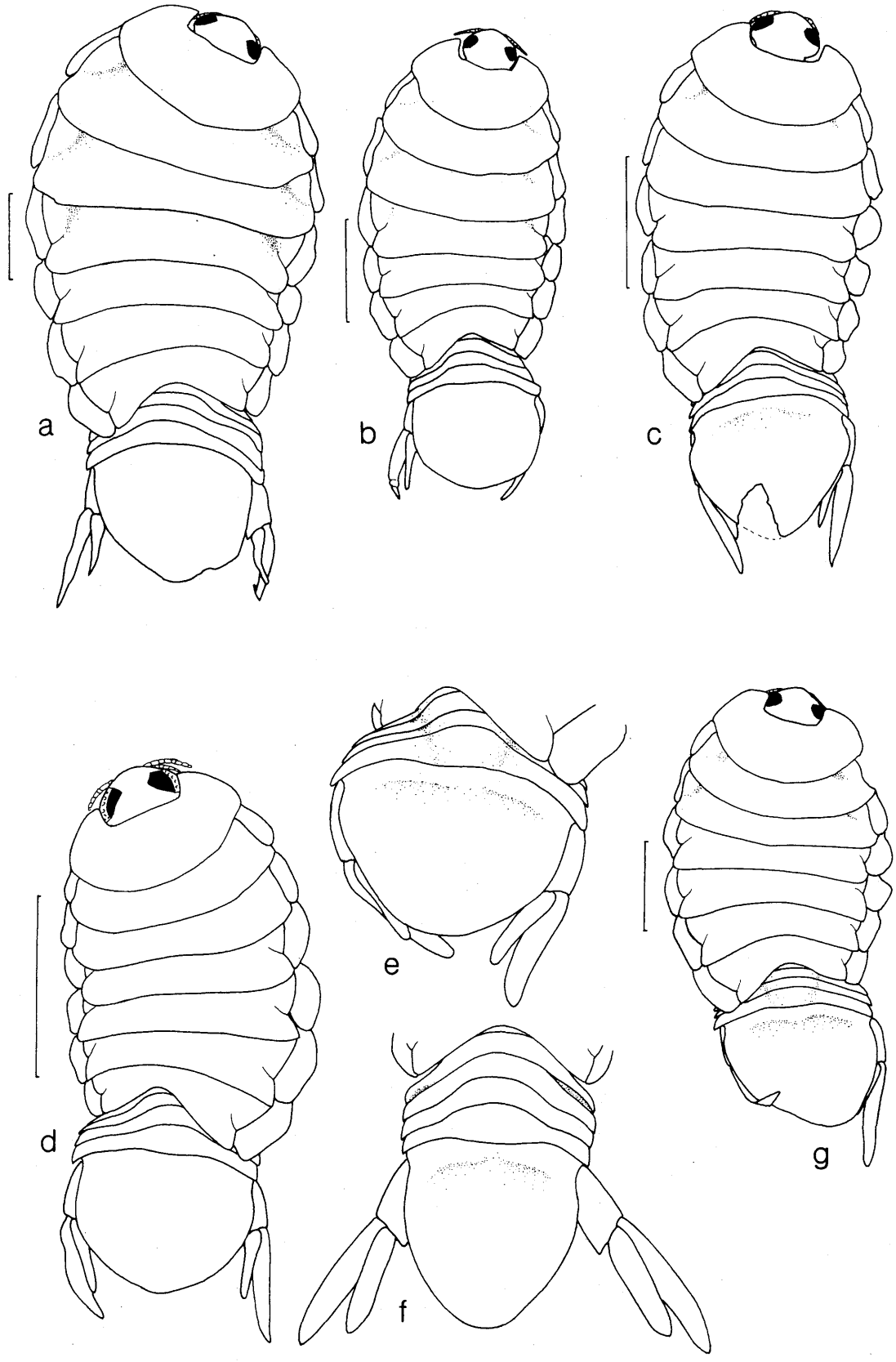

FIG. 52. *Mothocya renardi*: a, ♀ 31·1 mm, Mullaloo, WA (WAM 130–84); b, ♀ 24·2 mm, Mandurah, WA (WAM 131–84); c, ♀ 21·0 mm, Japan (TSM Cr.4081); d, ♀ non-ovig. 15·5 mm, Gulf of Carpentaria (NTM 002337); e, ♀ imm. 12·5 mm, Gulf of Carpentaria (NTM 002337); f, ♂ 15·0 mm, Wessel Islands, NT (NTM 002335); g, ♀ 24·5 mm, Aden, Saudi Arabian Peninsula (MCZ uncat.). Scale bars = 5·0 mm.

northern Australia, all from *S. leiura*: ♀ (ovig. 31·1 mm), Mullaloo, WA, 31°47′S, 115°44′E, 10.ii.1970, coll. J. Hastings (WAM 130–84)*; ♀ (ovig. 28·9 mm), Swanbourne, WA, 30.xii.1969, (USNM 216389); ♀ (ovig. 24·2 mm), ♂ (17·1 mm), Mandurah, WA, 32°32′S, 115°43′E, 30.i.1960, coll. Tomkinson (WAM 131–84)*; 4♀ (non-ovig. 15·5, imm. 13·5, 12·5, 10·2 mm), 3♂ (12·2, imm. 11·4, 10·0 mm), Sweers Is., Wellesley Islands, Gulf of Carpentaria; 9.xii.1963, coll. McMichael and Yaldwyn (NTM 002337); ♀ (non-ovig. 19·0 mm), ♂ (15·0 mm), Wessell Islands, NT, 20.i.1970, coll. CSIRO (NTM 002335).

Indo-Malaysia and North-west Pacific: ♀ (ovig. 23·2 mm), ♂ (16·0 mm), Gulf of Thailand, ex *Strongylura leiura* (USNM 216393); ♀ (ovig. 23·0 mm), ♂ (16·2 mm), 7 7.viii.1959, ex *S. leiura*, Naga Stn 42 (USNM 216392); ♀ (non-ovig. 24·5 mm), ♂ (18·0 mm), Pulau Roni, Teluk Kau, Halmahera Is., Indonesia, 1°00′N, 127°56′E, 1.ii.1983, ex *S. leiura*, coll. H. Singon (USNM 216396); ♀ (ovig. 18·8 mm), Jakarta, Java, Indonesia, 2.v.1909, ex *Strongylura incisa*, (USNM 216394); ♀ (non-ovig. 14·0 mm), 2 ♂ (9·5, 11·0 mm), Jakarta, Java, Indonesia, 15.v.1929, ex *S. leiura* purchased at fish market, coll. Hardenberg and Hubbs (USNM 216395); ♀ (ovig. 25·0 mm), Murik Lake, Sepik District, Papua New Guinea, 27.v.1972, on gill of 'marine fish', coll. F. T. Talbot (BMNH uncatalogued); ♀ (ovig. 21·0 mm), Shimoda, Kyushu, Japan, ex *Strongylura anastomella* (TSM Cr4081); ♀ (non-ovig. 19·5 mm), Iliolo, Panay Is., Philippines, ex *Strongylura leiura* (USNM 216399); ♀ (ovig. 18·2 mm), Philippines, ex *Strongylura ciconia* (USNM 216397); ♂ (13·6 mm), Philippines, ex *S. leiura* (USNM 216398).

Indian Ocean: ♀ (ovig. 26·0 mm), ♂ (16·5 mm), mouth of Sabaki River, Malindi, Kenya, 29.ix.1969, ex *S. leiura*, coll. G. Losse (USNM 216386); ♀ (ovig. 24·9 mm), 2♂ (15·5, 16·5 mm), Aden harbour, north-western Indian Ocean, 22.v.1958, ex *S. leiura*, coll. Riseborough and Woods (MCZ uncat); ♀ (ovig. 24·0 mm), Cochin, India, 1.ii.1980, ex *S. leiura* (USNM 216387); ♀ (ovig. 25·5 mm), Palk Bay, India, 19.iii.1962, ex *Tylosurus crocodilus* (non BBC det.), coll. Dr E. G. Silas (USNM 216219); ♀ (ovig. 19·9 mm), Pondichery, India, ex *S. leiura*, coll. E. Deschamps (USNM 216388).

Also examined. Four ♀ (ovig. 15·0, 16·8, 17·0, non-ovig. 12·5 mm), no data except 'Java Zee, *Belone leiurus*', Inst. voor Taxonomische Zoology, Amsterdam. ♀, ♂, SAfM A2675, *Strongylura crocodilus* (recorded as *S. choram*), Zambesi River estuary, (Barnard, 1914); ♀, RMNH No. 77, Java Zee, 1907, P. Buitendijk. (Nierstrasz, 1915; Monod, 1976). Material from Australia: AM P4905, 5822, 9608, 9617, 9626, examined by Hale (1926). ♀, ♂, ex *Strongylura strongylura*, Kuwait (Bowan and Tareen, 1983, USNM 216220).

Types. Two specimens believed to be Bleeker's (1857) material are held at the Rijksmuseum van Natuurlijke Historie, Cat. No. 78, 4611. Holthuis (in litt.) believes that the crustaceans identified and described by Bleeker were received by the Rijksmuseum before Bleeker's death (23.i.1878). Although the exact disposition of Bleeker's abundant material is not known, the correspondence of a damaged coxal plate in one of the specimens examined (Fig. 49 a) with that of Bleeker's figure (1857, fig. 8) suggests that these are the specimens examined by Bleeker.

Type-locality. Bleeker (1857) gives '... la mer de Batavia.' as the locality. The data on the oldest of the three labels with specimens 4611 gives 'Baai van Batavia, Java'. However, there is no label in Bleeker's own hand writing. The type-locality is here taken to be Jakarta Bay, Java, Indonesia.

* These specimens were posted to, but never received by the WAM.

Description of female. Body 2·09–2·45 times longer than wide, dorsum moderately convex; rostrum rounded, folded down, but not posteriorly directed; eyes about 0·47 times width of cephalon. Pereonite 1 deeply recessed to accommodate cephalon; pereonite 3 widest, pereonites 4 to 7 becoming increasingly narrow towards posterior; all coxae narrow, those of pereonites 2 to 4 generally shorter than segment, those of pereonites 5 to 7 as long as segment. Pereonite 7 widely recessed. Pleonite 1, most of pleonite 2 concealed by pereonite 7; pleonite 3, sometimes 4, overlapped by coxal plate of one side; pleon 0·68–0·78 times width of pereonite 5. Pleotelson about as long as wide to slightly shorter than wide, lateral margin converging to narrow rounded apex, or more or less rounded. Mandible palp extending beyond incisor. Maxilla with two spines on medial lobe, three on lateral lobe. Maxilliped article 3 with three large terminal recurved spines, fourth small spine on proximomedial surface. Pereopod 1 short, robust; pereopod 7 much larger than pereopod 1; propodal palm produced to form shallow lobe. Brood pouch with anterior pair of oostegites being scarcely visible in ventral view. Pleopod 1 peduncle narrow, lateral lobe not developed; pleopods 2 to 5 peduncles with lateral lobe well developed; pleopods 3 and 4 with endopod proximomedial lobe well developed, that of pleopod 4 longer than that of pleopod 3, pleopod 5 endopod with large proximomedial lobe, folded back. Uropod rami extending well beyond pleotelson, often weakly curved, both rami taper gradually to narrowly rounded apex. Peduncle about 1·6 times longer than wide, exopod about 1·6 times longer than endopod.

Male. Pereonites decreasing in width from pereonite 4 to pereonite 7; pleonite 1 largely concealed by pereonite 7. Mouthparts similar to female but maxilla with two spines on lateral lobe and mandible palp more slender. Penes prominent. Pleopod peduncles longer than in female, pleopod 2 with appendix masculina; rami narrower than those of female. Uropod long, rami extending well beyond posterior of pleotelson, exopod about 1·86 times longer than endopod.

Colour. In alcohol, colour varied from pale tan to dark red; chromatophores scattered over dorsum and present on most appendages.

Size. Sizes for the Mannoning Park sample were: ovigerous females 24·0–36·0 mm (mean 28·5 mm), non-ovigerous females 26·0–35·0 mm (mean 28·7 mm); males 15·0–23·0 mm (mean 19·1 mm). Western Australian females agree with this size range, but all the Indian Ocean, North Pacific, and Indo-Malaysian material is smaller, with Indian Ocean ovigerous females averaging 24·1 mm, and Indo-Malaysian and North Pacific ovigerous females averaging 26·8 mm.

Variation. This species shows a degree of variability not present in other species of *Mothocya.* Size difference has already been mentioned, material from south-western and south-eastern Australia being substantially larger both in range of sizes and in average size than material from elsewhere. There are also distinct morphological variations in different populations. The population from Queensland to south-eastern Australia is characterized by being elongate, widest at pereonite 3, with the posterior pereonites being markedly narrow. The pleotelson is as long as wide, with a narrow apex in most specimens. Pereopod 7 has a distinctly lobate propodal palm. The uropods are long and gently tapered. Material from Western Australia is of a similar size, but the body may be straighter, and less tapered posteriorly; the propodal palm of one pereopod 7 is lobate, the other not, and the pleotelson tends to be more rounded.

One female and male from Kenya correspond exactly to eastern Australian material. Other Indian Ocean material is broader, with wider posterior pereonites, and less tapered uropodal exopods. Specimens from Java and Japan are elongate but

straight, and again the posterior pereonites are proportionally wider than in eastern Australian material. The specimen from Japan has a pleotelson similar to specimens from Sydney, NSW. Finally, material from Wessel Island and the Gulf of Carpentaria is small, broad, and both males and females have far shorter uropod exopods (Fig. 52 d, e) than specimens from elsewhere.

Remarks. This species is easily separated from others of the genus by its large size, very narrow pleon and very long uropodal rami. It is further distinguished by having the plane of the pleon and pleotelson twisted in relation to the plane of the pereon.

Described by Bleeker (1857), this species has a longer synomymy than most. Most of the previous records have been verified, the material of Barnard (1914), Nierstrasz (1915), Hale (1926), and Bowman and Tareen (1983) having been compared to the syntypes and to the new material examined here. *Irona robusta* described by Nair (1950) and redescribed by Abraham (1966) agrees well with present material, as well as specimens from southern India.

Hosts. The commonest host is *Strongylura leiura*; other host species are *Strongylura incisa* and *Strongylura anastomella.* The records from *Tylosurus crocodilus* and *Strongylura strongylura* are at present unconfirmed.

Distribution. Indo-West Pacific from Mozambique and Kuwait in the West to the western and eastern coasts of Australia, and the Philippines and Japan in the East (Fig. 55:5).

Etymology. Bleeker (1857) named his species after Dr Renard who in 1718 mentioned the species as 'Zee Luys' (see Holthuis, 1959).

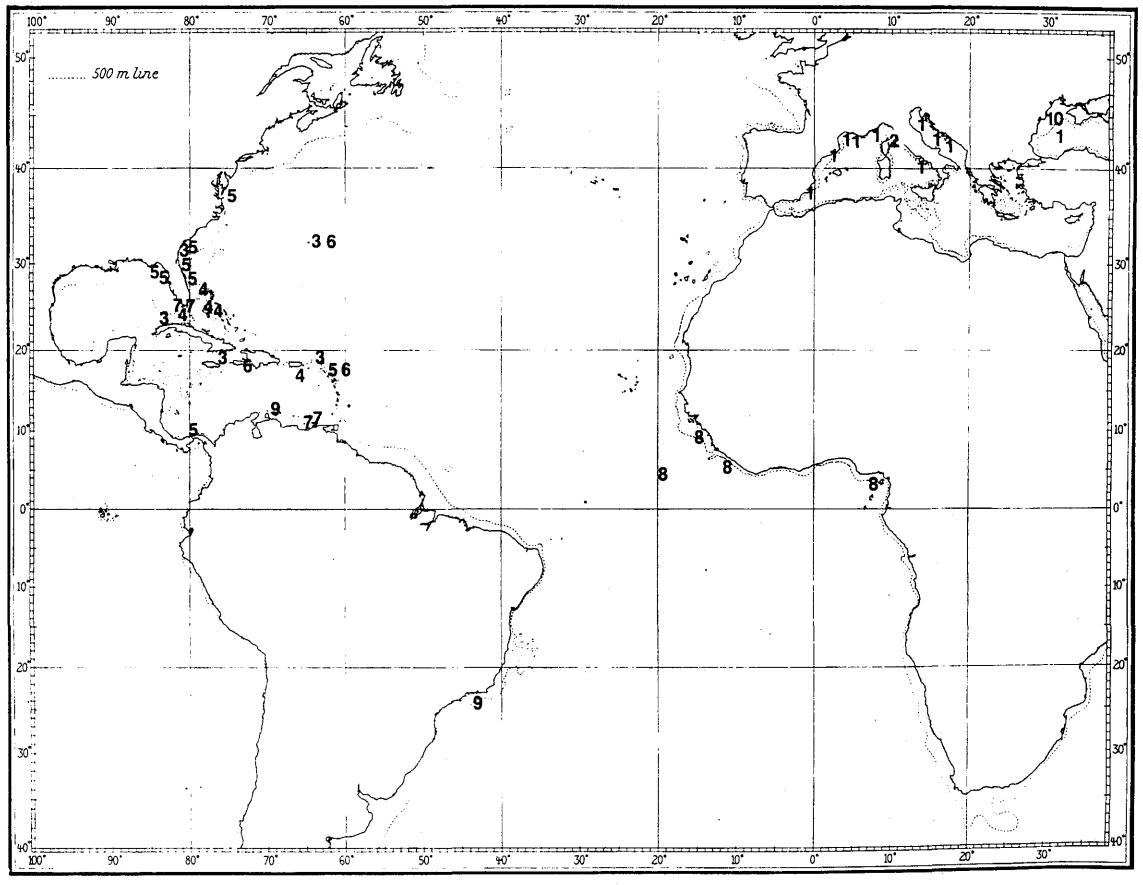

FIG. 53. The Atlantic species of *Mothocya.* 1, *M. epimerica*; 2, *M. belonae*; 3, *M. argenosa*; 4, *M. bohlkeorum*; 5, *M. nana*; 6, *M. bermudensis*; 7, *M. xenobranchia*; 8, *M. longicopa*; 9, *M. omidaptria*; 10, *M. taurica.*

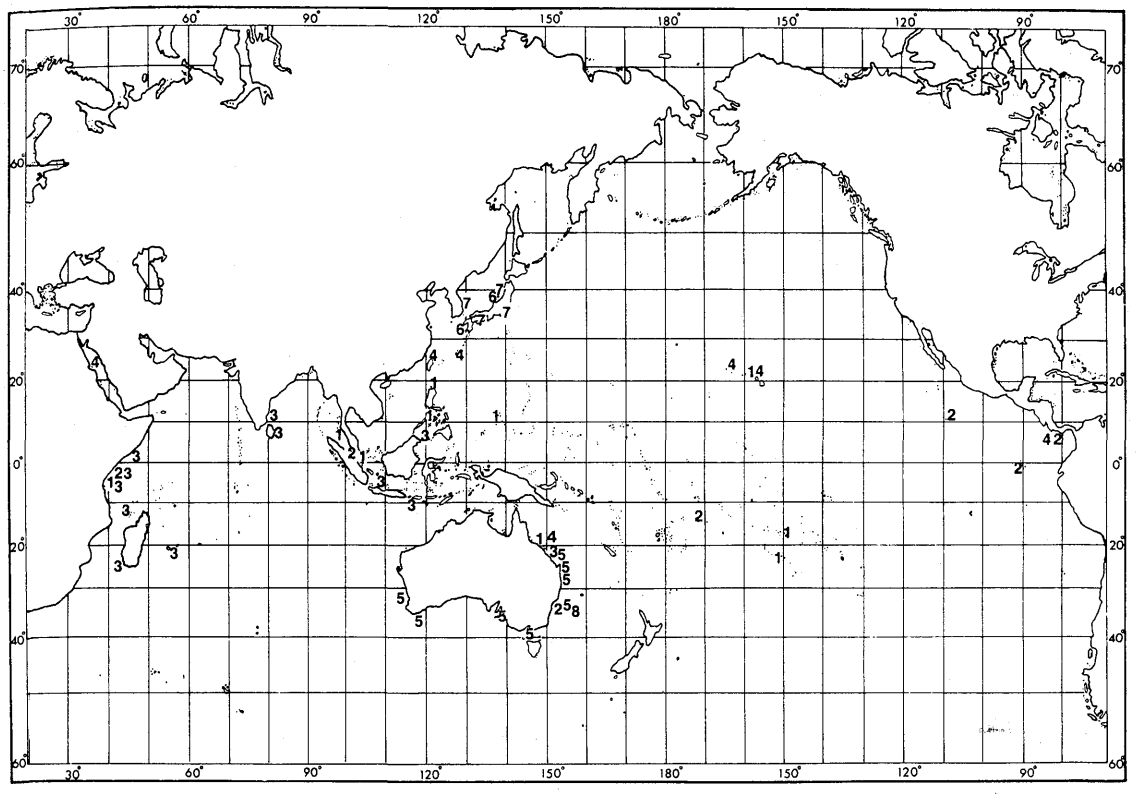

FIG. 54. The Indo-West and East Pacific species of *Mothocya*. 1, *M. collettei*; 2, *M. arrosor*; 3, *M. plagulophora*; 4, *M. melanosticta*; 5, *M. halei*; 6, *M. parvostis*; 7, *M. sajori*; 8, *M. girellae*.

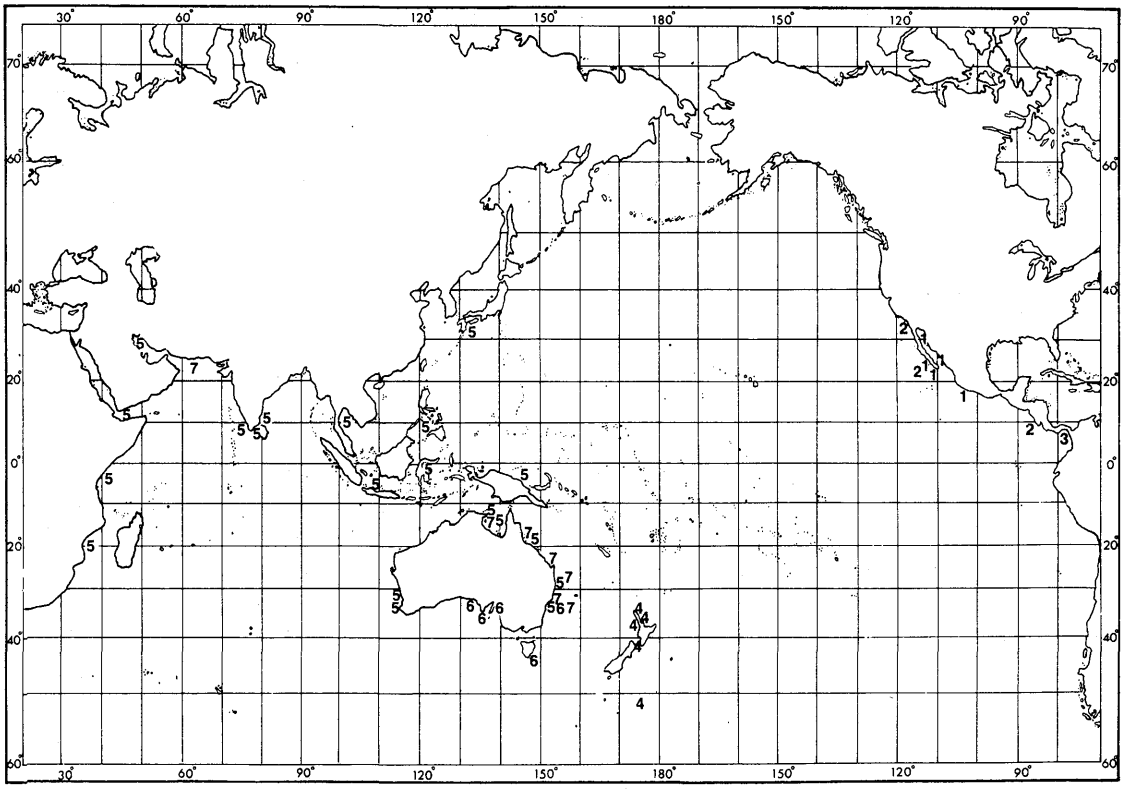

FIG. 55. The Indo-West and East Pacific species of *Mothocya*. 1. *M. gilli;* 2, *M. rosea*; 3, *M. panamica*; 4, *M. ihi*; 5, *M. renardi*; 6, *M. waminda*; 7, *M. karobran*.

Undescribed species

This section lists specimens that I have examined that are recognizable as distinct species but due to too few specimens, damaged specimens or inadequate data are being left undescribed. I include the locality, hosts and some remarks in the hope that this will encourage collection of these species. I also include species from the literature that I have not been able to associate with any of the species described in this work. Lastly I list host species that juveniles or totally unidentifiable specimens have been taken from so that a complete list of host species is available.

Mothcoya sp. Australia. One♂ and 1♀ (QM W11731, 11732), ex *Atherinomorus ogilbyi* from Moreton Bay, Queensland; 2♀ and 1♂ (USNM 216411), Sydney, NSW, ex *Myxus elongatus*. Specimens from the two host species may belong to distinct species.

Mothocya sp. Japan. ♀ syntype of *Irona melanosticta*, Zoologisk Museum, Copenhagen; ♀ (USNM 216406), ex *Strongylura anastomella*, Japan; ♂ (USNM 216405), ex *Tylosurus crocodilus* from Sendai Bay, Japan. An elongate species somewhat similar to *M. panamica* and *M. ihi*.

Mothocya sp. South Africa. Three ♀, 8♂ (USNM 216412). These are from *Hyporhamphus affinis*. They most closely resemble *Mothocya collettei*.

Mothocya sp. Pacific. ♀ and ♂ (USNM 216408), from *Hyporhamphus acutus acutus*, Gilbert Islands; ♀ (USNM 216407), from *Hyporhamphus acutus pacificus*, Hawaii. The uropods of this species are distinctive, and there are no other records of *Mothocya* from this host species.

Mothocya sp. Mediterranean. Two ♀ (USNM 216400, 216401), from *Belone belone*. These specimens appear to be the same species as that recorded by Trilles and Raibut (1971, 1973) from North Africa under the name *Irona nana*.

Irona sp. Monod, 1976; Monod and Sérène, 1976. From *Zenarchopterus buffonis* from Seram, Indonesia. No specimens were made available for study, and while the figures resemble that of *Mothocya collettei* they may be a separate species.

Irona sp. ♀ Semarang, Indonesia (RMNH 1338), from *Atherina temminckii*. This small species is similar to others found in association with atherinid hosts; Trilles' (1979) *Irona* sp. may be the same species.

Unidentifiable immature specimens

Mothocya sp.? From *Platybelone argalus*, Bermuda (USNM 216409, 216410).

Mothocya sp.? From *Strongylura urvilii*, Yap Island, Caroline Islands, tropical northern Pacific (USNM 216402).

Mothocya sp.? From *Hyporhamphus neglectissimus*, Jensen Bay, Wessel Islands, NT, Australia (USNM 216403).

Discussion

The identification of species and genera of the family Cymothoidae Leach, 1818, has long posed problems to isopod taxonomists and also to fish biologists and ecologists attempting to identify fish parasitic isopods. Brusca (1981) in his review of the East Pacific cymothoids discussed in some detail the taxonomic problems posed by this family, and I shall only outline the more important problems.

The major problems can be summarized as woefully inadequate descriptions that in the older literature frequently lacked figures and designated type-specimens, and the

variability of morphology that cymothoid species were reputed to show. Early descriptions often utilized only body characters and ignored appendages. Generic diagnoses were of a similar brevity, and in many cases their validity cannot be assessed. It seems that eventually most isopod taxonomists side-stepped the family, while those that recorded new species until very recently gave only abbreviated descriptions of species. Of the recent workers only Monod (1971), Bowman and Tareen (1983) and Brusca (1981) have addressed themselves to clarifying or giving restrictive diagnoses to genera. Essentially the family has not received specialist or revisionary treatment since the publication of Schioedte and Meinert's (1879–1884) monograph over a century ago.

Mothocya exemplifies the problems that many taxonomists and biologists have had in identifying cymothoids. Of the 18 new species described here, nine have synonymies. Of the five most recently described species only one is valid, the others being synonyms or unrecognizable. The most widely used name seems to have been '*Irona melanosticta*', identified in 22 records from Australia, Japan, New Zealand and South Africa. All of these determinations are incorrect (see Table 3), despite an accurate figure given by Schioedte and Meinert (1884), and despite the rather large morphological differences shown by the material recorded by Hale (1926) and Stephenson (1969) for example.

This chronic inability of workers to identify their material has led to a misleading representation of the biology, host specificity and distribution of these isopods. *Mothocya nana* for example was widely recorded in the Caribbean and also the Mediterranean from both hemiramphid and belonid hosts (see Trilles, 1976a). *Mothocya melanosticta* was recorded from a wide variety of Indo-Pacific localities and a diversity of hosts, but the evidence here is that it is restricted to flying fishes. The important point to make is that these problems are largely soluble. By obtaining all types it was possible to relate unidentified specimens to the actual specimens on which the name is based. It was possible to identify which specimen was figured in the original descriptions and to select a lectotype where necessary. With a confident determination a detailed description of the species could then be given. By examining a large series of specimens from accurately identified hosts and from restricted localities it was possible to assess and figure species characteristics and intraspecific variation. The species presented here, while frequently appearing similar, are all separated by a multiplicity of characters.

Recent studies on *Anilocra* (Williams and Williams, 1981; Bruce, in preparation), *Renocila* (Williams and Williams, 1980) and this present work have demonstrated that if discriminatory characters are identified, types critically studied, and detailed species description given, then closely related cymothoid species can be separated. This is abundantly illustrated by two species, *Mothocya melanosticta* (see Table 3) and *Anilocra laticauda* Milne-Edwards. The name *Anilocra laticauda* (most recently treated by Brusca, 1981) had been indiscriminately applied to Caribbean and eastern Pacific *Anilocra* species up to the revision of Williams and Williams (1981), who demonstrated that nine species were involved and that *A. laticauda* had to be regarded as nomen dubium.

The paradigm of cymothoid variability, most recently reiterated by Brusca (1981), must now be called into question. It is evident that the variability attributed to cymothoid species has been the result of uncritical acceptance of previous records and data that were based on inaccurate taxonomy. Rather than polymorphic, the 'species' are polyspecific. Clearly some cymothoid species are very variable (see Bowman, 1978), but the generalizations on character variability listed by Brusca (1981) can no longer be accepted as true for the entire family.

Relationships

Species within the genus can be divided into three broad groups. These groups are not greatly different, and in all cases intermediates between the groups occur. The group associated with atherinid fishes are characterized by relatively narrow pleons, narrow coxae, small pleopod peduncle and endopod lobes, short bluntly rounded uropods, and small body size. This group comprises *M. epimerica*, *M. argenosa*, *M. waminda* and *M. parvostis*. *Mothocya parvostis* has not been recorded from atherinid hosts, and has a wider pleon than the other three. *Mothocya bohlkeorum* has a very wide pleon, but the pleopods agree with those of the group. *Mothocya rosea* appears close to this group, but has dissimilar pleopods.

Four large species show some affinity to the *M. epimerica* group, these being *M. renardi*, *M. belonae*, *M. omidaptria* and *M. taurica*. In all of these the pleon is narrow, but they differ in having the pleon more deeply immersed in pereonite 7, larger pleopod lobes, and attenuated uropods which in two species are long.

The seond group comprises the Atlantic species *M. longicopa*, *M. bermudensis* and *M. xenobranchia* which have wide longitudinally arched bodies, wide pleons, shallow brood pouches made up of three visible pairs of oostegites, and tend to have a reduced number of articles on the antenna. *Mothocya nana* is similar to this group, but also shows affinities to *M. omidaptria*, both species having the brood pouch made up of four visible pairs of oostegites.

The majority of the Indo-Pacific species belong to the third group, that have wide short pleons, wide coxae, well-developed pleopod peduncle and endopod lobes and a generally broad body shape. Typical of this group are *M. collettei*, *M. karobran*, *M. halei* and *M. girellae*. Within this group there are recognizably related species: *M. melanosticta*, *M. arrosor* and *M. sajori* are all close; *M. halei* and *M. girellae* are close; *M. collettei* and *M. karobran* are also close.

Species that do not readily group include the two elongate species *M. ihi* and *M. panamica*. *Mothocya plagulophora* is the only species of the genus to occur on a *Hemiramphus* host, and shows no particular affinity to any other species.

Host–parasite relationship

The species of *Mothocya* listed here, including the undescribed ones, have been recorded from 48 host species. Hosts mainly belong to the superorder Atherinomorpha, the exceptions being the few species that occur on fishes of the perciform families Apogonidae, Kyphosidae, Mugilidae, Carangidae and Toxotidae. *Mothocya taurica*, recorded from seven fish families including the only records of *Mothocya* from clupeiomorph hosts, is excluded from this discussion as the identities of the specimens associated with different hosts are obscure.

There are now 25 named species of *Mothocya*, and of these 22 are associated with atheriniform fishes, 20 of them exclusively so. Of the 48 host species 39 or 81% belong to the Atherinomorpha. There are two orders, the Atheriniformes with the family Atherinidae (13 host species), and the Beloniformes with the families Belonidae (10 definite host species), Exocoetidae (2 host species) and Hemiramphidae (15 host species). There seems to be no morphological differentiation between isopod species associated with different families, but there is only one species within the atheriniform parasites, *Mothocya argenosa*, that also occurs on a beloniform host. Those species that occur on belonids are never found on hemiramphids and vice versa.

Belonidae

The family comprises 10 genera with 32 species. None of the purely freshwater genera and species have had *Mothocya* taken from them. Only the marine genus *Petalichthyes* has not been found to act as host to *Mothocya*. *Platybelone* has only had two juveniles recorded from the genus. The genera *Belone* and *Ablennes* each have a single associated *Mothocya* species.

The majority of records is from the two largest genera, *Strongylura* and *Tylosurus*. *Strongylura* has 14 species, three of which are freshwater, and has five marine species that are definite hosts and a further three that are unconfirmed as hosts. *Tylosurus* has five species, with only two known as hosts. The host–isopod interaction is not very specific at species or genus level. *Tylosurus crocodilus* acts as host for at least four species of *Mothocya*, but if the unconfirmed record of *M. renardi* is ignored then in any one area *T. crocodilus* has only one *Mothocya* species. *Mothocya renardi* occurs most commonly on *Strongylura leiura* but is reliably recorded from three other host species, and possibly occurs on a further two species. Similarly *M. collettei* occurs on three host species but is mainly found on *T. crocodilus*, and in the Indo-West Pacific is the only *Mothocya* found on that host. In contrast, *Strongylura leiura* acts as host to the symmpatric species *M. karobran* and *M. renardi*, although the preferred hosts of the two species are separate. The species of host and their associated isopods are listed in Table 5.

Hemiramphidae

The family Hemiramphidae consists of about 80 species in 12 genera, the largest genera being *Hyporhamphus*, *Hemiramphus* and *Zenarchopterus* (Parin *et al.*, 1980; Collette *et al.*, 1984).

The genus *Hemiramphus* has 10 species with only one, *H. far*, known as a host (to *M. plagulophora*). *Euleptorhamphus viridis* is the single representative of that genus in

Table 5. Species of Belonidae and their associated species of *Mothocya*.

Host	Isopod	Distribution
Ablennes hians	*M. collettei*	Tahiti, Pacific
	M. longicopa	Gulf of Guinea, Atlantic
Belone belone	*M. belonae*	Mediterranean
Platybelone argalus	*Mothocya* sp.	Bermuda, Atlantic
Strongylura anastomella	*M. renardi*	Japan
incisa	*M. renardi*	Indonesia
leiura	*M. karobran*	Australia, Indian Ocean
	M. renardi	Indo-Pacific
?marina	*M. xenobranchia*	Florida, USA
?notata	*M. xenobranchia*	Florida, USA
?strongylura	*M. renardi*	Kuwait
urvillii	*Mothocya* sp.	Yap Is., Caroline Is., Pacific
Tylosurus crocodilus	*M. collettei*	Indo-West Pacific
	M. longicopa	Gulf of Guinea, Atlantic
	M. panamica	Pacific Panama
	?M. renardi	South-eastern Africa
	M. xenobranchia	Venezuela; Florida, USA
gavialoides	*M. karobran*	Australia
punctulatus	*M. collettei*	Yap Is., Marianas, Pacific

Table 6. Species of Hemiramphidae and their associated species of *Mothocya*.

Host	Isopod	Distribution
Euleptorhamphus viridis	*M. arrossor*	Pacific and Indian Oceans
Hemiramphus far	*M. plagulophora*	Indo-West Pacific
Hyporhamphus acutus	*Mothocya* sp.	Gilbert Is., Hawaii, Pacific
affinis	*Mothocya* sp.	South Africa
gilli	*M. gilli*	Baja California, Mexico
ihi	*M. ihi*	New Zealand
melanochir	*M. halei*	Australia
neglectissimus	*Mothocya* sp.	Carpentaria, Australia
regularis	*M. halei*	Australia
rosea	*M. rosea*	Tropical East Pacific
sajori	*M. sajori*	Japan
	M. parvostis	Japan
snyderi	*M. rosea*	Tropical East Pacific
unifasciatus	*M. argenosa*	Caribbean
	M. bermudensis	Bermuda, Caribbean
	M. gilli	Baja California, Mexico
	M. omidaptria	Rio de Janeiro, Brazil
	M. nana	Caribbean, Atlantic US
Zenarchopterus buffonis	*Mothocya* sp.	Indonesia

the Indian and Pacific Oceans, and is host only to *Mothocya arrossor*. Atlantic *Euleptorhamphus* have not been found to have *Mothocya*. *Zenarchopterus*, an estuarine genus with 17 species, has one record as host for an unidentified species of *Mothocya* (Monod, 1976).

Hyporhamphus, the largest in the family with 34 species, has 11 species recorded as host for *Mothocya*. Of these 11 species, all but *H. unifasciatus* are hosts to only one *Mothocya* species. Not all *Mothocya* species are host specific. Three species of *Mothocya* (*M. arrossor*, *M. ihi* and *M. sajori*) are associated with a single host species. *Mothocya gilli*, *M. halei* and *M. rosea* are all associated with two host species.

The pattern of host–isopod association is disrupted by the taxonomic problems of the species *Hyporhamphus unifasciatus*. This host species strongly contradicts the trend shown by the rest of the family in the Indo-West Pacific of having only one species of *Mothocya* by appearing to have five associated species. Of those five species, two are recorded only from *H. unifasciatus*. B. B. Collette (personal communication) suggests that the name *H. unifasciatus* is currently being applied to what is a group of two or three allopatric sibling species, with separate East Pacific, Gulf of Mexico—Atlantic United States, and Caribbean—south-western Atlantic forms. Should this be so, the host–isopod pattern would not be very different to that of the Indo-West Pacific species. The hosts and their associated species are shown in Table 6.

Atherinidae

Owing to the small host size, *Mothocya* from atherinids are probably under recorded. Three species, *M. argenosa*, *M. epimerica* and *M. waminda*, are all associated with two to four host species. *Mothocya argenosa* is unique in also associating with a hemiramphid. The pattern shown by these small species is that in a particular area they occur on a variety of atherinid hosts. In Australia the atherinid hosts of *M. waminda* are all estuarine, while a second Australian species (undescribed at present) occurs on marine atherinids.

Table 7. Host species and their associated species of *Mothocya* (excluding Belonidae and Hemiramphidae).

Host	Isopod	Distribution
Apogonidae		
Apogon lachneri	*M. bohlkeorum*	Caribbean
Astrapogon stellatus	*M. bohlkeorum*	Caribbean
Phaeoptyx conklini	*M. bohlkeorum*	Caribbean
Phaeoptyx pigmentaria	*M. bohlkeorum*	Caribbean
Atherinidae		
Atherina boyeri	*M. epimerica*	Mediterranean
hepsetus	*M. epimerica*	Mediterranean
mochon	*M. epimerica*	Mediterranean
rissoi	*M. epimerica*	Mediterranean
temninckii	'*Irona* sp.'	Indonesia
Atherinomorus ogilbyi	*Mothocya* sp.	Eastern Australia
Atherinosoma elongata	*M. waminda*	South-eastern Australia
microstoma	*M. waminda*	South-eastern Australia
presbyteroides	*M. waminda*	South-eastern Australia
Hypoatherina harringtonensis	*M. argenosa*	Bermuda
Membras martinica	*M. argenosa*	Eastern USA
Carangidae		
Seriola quinqueradiata	*M. parvostis*	Japan
Clupeidae		
Alosa pontica	*M. taurica*	Black Sea
Engraulidae	*M. taurica*	Black Sea
Exocoetidae		
Cypselurus nigripinnis	*M. melanosticta*	Indo-Pacific
spilanoreptus	*M. melanosticta*	Indo-Pacific
Parexocoetus brachypterus	*M. melanosticta*	Indo-Pacific
Kyphosidae		
Girella punctata	*M. parvostis*	Japan
tricuspidata	*M. girellae*	South-eastern Australia
	M. halei	Eastern Australia
Mugilidae		
Myxus elongatus	*Mothocya* sp.	Eastern Australia
Toxotidae		
Toxotes sp.	*M. collettei*	Thailand

There are two other species, *Mothocya bohlkeorum* and *M. parvostis*, that show similarities to the atherinid isopods and these have a similar low degree of host specificity. The hosts and their associated isopods are shown in Table 7.

Exocoetidae and Perciformes

Mothocya melanosticta is associated exclusively with flying fishes, and is at present known only from two reliably identified host species.

Host species in several families of Perciformes are known. These are often hosts for species of *Mothocya* that are also associated with atherinomorph fishes. *Mothocya bohlkeorum* is only associated with the family Apogonidae, and is the only *Mothocya*

recorded from that family. *Mothocya girellae* is known only from *Girella tricuspidata*, while in Japan cage-cultured *Girella punctata* is one of the hosts for *Mothocya parvostis*. Other families are: carangidae, cage-cultured fingerling *Seriola quinquiradiata* acting as hosts for *Mothocya parvostis*; Toxotidae, there being one record from an archer-fish *Toxotes* sp.; Mugilidae, with *Mothocya* sp. recorded from *Myxus elongatus*. The hosts and their associated isopods are shown in Table 7.

Distribution

The area of maximum species diversity is the Indo-West Pacific Ocean, with 12 described and six undescribed species. Of those 12, two, *Mothocya melanosticta* and *M. arrossor*, occur on widespread pelagic hosts and have ranges that extend to the East Pacific and East Africa. The distribution of *Mothocya collettei* extends to Hawaii and Africa, while *M. renardi*, *M. plagulophora* and *M. karobran* are found in the western Pacific and western Indian Ocean. The remaining species have more limited distributions that in some cases reflect the distribution of the host. Japan has two endemic species, New Zealand one, and Australia with a total of nine species has three which are endemic.

The tropical East Pacific has five recorded species, three of which are endemic to the region. One is known only from Panama, the other two endemics occur one from Baja California and the Mexican coast, the third from San Diego to Nicaragua.

None of the Atlantic species have trans-oceanic ranges. Three species are endemic to the Mediterranean and one to West Africa. The remaining six species all have at least partly overlapping distributions in the Carribbean and off the eastern coast of the United States.

Biology

Isopods of the genus *Mothocya* have attracted the attention of biologists, from a wide variety of disciplines, although there have been few detailed studies. Unfortunately, the identity of the isopod is, in most cases, uncertain. Hatai and Yasumotu (1980, 1981, 1982 a, b) studied the effect of *Mothocya* on cage-cultured hosts and ways of eliminating *M. parvostis* from those hosts. Other studies have examined the immunological interaction of *M. epimerica* and the host (Romestand and Trilles, 1975), embryology of *M. plagulophora* (Nair, 1956), and egg development in *M. epimerica* (Trilles, 1964 e), reproduction (Trilles, 1964 b) and the digestive system (Tuzet *et al.*, 1959).

Effects of the isopods on their hosts have been recorded by several authors. Hattori and Seki (1956) found host gonad development to be inhibited. Stephenson (1976) provided evidence of damage to the gills, as did Williams and Williams (1982). Lanzing and O'Connor (1975) suggested that fishes of a given length were heavier if they were not infested with isopods.

Percentage infestation has been recorded by several authors. Lanzing and O'Connor (1975) recorded from 0% to 52·9% depending on the locality. They found that infested populations had from 20·3% to 52·9%, but they did not differentiate between mouth and gill parasites. Williams and Williams (1982) recorded between 6·7% and 66·7% (mean 36·6%) for the apogonid hosts they studied. Other figures are 60% (Delamare Deboutteville, 1951) for hosts of *Mothocya epimerica* and 80% (Thampy and John, 1975) for *Hemirhamphus far*.

The life-history biology has been little studied, with two brief accounts being given for *M. epimerica* by Boscolo (1970, 1977). The most comprehensive account is that of O'Connor (1978, unpublished) which deals with the isopods associated with *Girella tricuspidata* and Australian species of estuarine Atherinidae.

Keys to the species of Mothocya

Host family has been used in some couplets as the host families are easily recognized without specialist knowledge, and therefore some species appear in a key more than once. The lack of precise character states in the cymothoids means that a familiarity with the family has to be developed before the nuances of character differences can be appreciated. Qualitative descriptive terms have been used (such as longer than, rounded, etc.). Attempts to quantitatively restrict these would make the key inaccurate as the morphology of these species is variable. There are numerous undescribed species and all identifications need to be checked against the species description before being accepted.

Key to the eastern Atlantic and Mediterranean *Mothocya*

1 Occurring on Atherinidae . . . . . *M. epimerica*
– Not occurring on Atherinidae 2

2 Uropod rami extending beyond pleotelson, exopod much longer than endopod (on Belonidae) . . . . . *M. longicopa*
– Uropod rami not extending beyond pleotelson, rami subequal in length . . . 3

3 Pleopods 3 to 5 endopods with large proximomedial lobes, pleotelson evenly rounded (on Clupeimorpha). . . . . *M. taurica*
– Pleopods 3 to 5 endopods with moderately sized proximomedial lobes, pleotelson lateral margins straight (on Belonidae) . . . . . *M. belonae*

Key to the western Atlantic *Mothocya*

1 Occurring on Atherinidae . . . . . *M. argenosa*
– Not occurring on Atherinidae 2

2 Occurring on Apogonidae . . . . . *M. bohlkeorum*
– Not occurring on Apogonidae 3

3 Occurring on Belonidae . . . . . *M. xenobranchia*
– Occurring on Hemiramphidae 4

4 Rostrum narrowly rounded in dorsal view, posterior angles of coxae acute *M. omidaptria*
– Rostrum truncate in dorsal view, posterior angles of coxae rounded 5

5 Pleon narrow (0·78–0·85 times width of pereonite 5), uropod rami apices rounded *M. argenosa*
– Pleon wide (>0·85 times width of pereonite 5), uropod apices narrow . . . 6

6 Brood pouch deep, four prominently visible pairs of oostegites . . . . *M. nana*
– Brood pouch shallow, three prominently visible pairs of oostegites . *M. bermudensis*

Key to the East Pacific *Mothocya*

1 Occurring on Exocoetidae . . . . . *M. melanosticta*
– Not occurring on Exocoetidae 2

2 Occurring on Belonidae . . . . . *M. panamica*
– Occurring on Hemiramphidae 3

3 Uropod rami tapering, apices narrow . . . . . *M. arrosor*
– Uropod apices not tapering, apices bluntly rounded 4

4 Adult ♀ larger than 10·0 mm, pleon 1·00–1·14 times width of pereonite 5 . . *M. gilli*
– Adult ♀ shorter than 10·0 mm, pleon 0·75–0·82 times width of pereonite 5 . . *M. rosea*

Key to the Indo-Pacific *Mothocya*

1 Occurring on Exocoetidae . . . . . *M. melanosticta*
– Not occurring on Exocoetidae 2

2 Occurring on estuarine Atherinidae . . . . . *M. waminda*
– Not occurring on Atherinidae 3

3 Occurring on Kyphosidae (Perciformes) 4
– Not occurring on Kyphosidae 6

4 Pleotelson broadly rounded (endemic to Japan). . . . . *M. parvostis*
– Lateral margins of pleotelson convergent 5

5 Posterior angles of posterior coxae rounded; uropod rami extend beyond posterior of pleotelson, endopod apex rounded. . . . . *M. halei*
– Posterior angles of posterior coxae acute; uropod rami extending to or just short of posterior of pleotelson, endopod apex sub-acute . . . . . *M. girellae*

6 Occurring on Belonidae 7
– Occurring on Hemiramphidae 9

7 Uropod rami sinuate, extending clearly beyond posterior of pleotelson . *M. renardi*
– Uropod rami extending to, or just short of posterior of pleotelson 8

8 Coxae very large, rounded; uropod rami not extending to posterior of pleotelson, apices narrowly rounded . . . . . *M. collettei*
– Coxae subrectangular, uropod rami extending to or just short of posterior of pleotelson, endopod apex acute . . . . . *M. karobran*

9 Body elongate, strongly vaulted (New Zealand endemic) . . . . . *M. ihi*
– Body broad, dorsally flattened 10

10 Body straight, pleon and pleotelson very wide; posterior margins of pereonites banded *M. plagulophora*
– Body twisted to one side, not banded 11

11 Uropod rami short, apices acute . . . . . *M. arrosor*
– Uropod rami long or short, apices bluntly rounded 12

12 Uropod rami long, exopod about twice length of peduncle, endopod apex narrowly rounded (Australian endemic) . . . . . *M. halei*
– Uropod rami both bluntly rounded, exopod about 1·5 times longer than peduncle . 13

13 Body scarcely twisted to one side, posterior margin of pereonite 7 weakly recessed *M. parvostis*
– Body twisted to one side, posterior margin of pereonite 7 deeply recessed . *M. sajori*

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References

ABRAHAM, S. J. G., 1966, On a re-description of two species of *Irona*, *Irona far* and *I. robusta*. *Madras Journal of Fisheries*, **2,** 23–42.

ANON, 1965, *Aboriginal Words of Australia*. Sydney: A. H. and A. W. Reed, pp. 144.

AVDEEV, V. V., 1973, A new parasitic isopod *Irona philipinesis* sp. n. (Cymothoidae) from the fish *Euleptorhamphus* sp. *Parazitologiya (Leningrad)* **7,** 473–475.

AVDEEV, V. V., 1978, Parasitic isopods, family Cymothoidae from the Red Sea. *Biologiya Morya* **4,** 30–35.

BARNARD, K. H., 1914. Additions to the Marine Isopoda, with notes on some previously incompletely known species. *Annals of the South African Museum* **10,** 325a–440.

BARNARD, K. H., 1955. Additions to the fauna list of South African Crustacea and Pycnogonidae. *Annals of the South African Museum* **43,** 1–107.

BERNER, L., 1969. Les principaux Cymothoidés (Crustacés Isopodes) du Golfe de Marseille. *Bulletin du Muséum d'Histoire Naturelle de Marseille* **29,** 93–95.

BLEEKER, P., 1857, Recherches sur les Crustacés de L'Inde Archipélagique. II. Sur les Isopodes Cymothoadiens de L'Archipel Indien. *Acta de la Société Indo-Neerlandaise, Batavia* **2,** 20–40.

BEUMER, J. P., ASHBURNER, M. E., BURBERY, M. E., JETTÉ, E., and LATHAM, D. J., 1982, A checklist of the parasites of fishes from Australia and its adjacent Antarctic Territories. *Commonwealth Agricultural Bureaux, Technical Communication No. 48 of the Commonwealth Institute of Parasitology*. Slough: Commonwealth Agricultural Bureaux, pp. i–viii, 1–99.

BORCEA, I., 1933 a. *Livoneca pontica* n. sp. parasites des Aloses et sardines de la Mer Noire. *Bulletin du Muséum Nationale d'Historie Naturelle, Paris, 3^e série* **5,** 128–129.

BORCEA, I., 1933 b. *Livoneca pontica* nov. sp., Cymothoide parasite des Aloses et sardines de la Mer Noire. *Annales de Science de Jassy* **17,** 481–502.

BOSCOLO, L., 1970. Osservazioni sulla biologia e sulla pesca dell'*Atherina boyeri* Risso 1810 (Osteichthyes, Atherinidae) vivente nella acque dell'Alto Adriatico. *Bolletino di Pesca, Piscicultura, e Idrobiologia* **25,** 61–79.

BOSCOLO, L., 1977. *Mothocya epimerica* Costa (Isopoda, Cymothoidae), parasite of *Atherina boyeri* Risso (Osteichthyes, Atheriniformes) in the waters of the upper Adriatic. *Atti Societa Italiano Sciencia Nationali Museo Civica Stori Naturali, Milano* **118,** 103–108.

BOWMAN, T. E., 1978, Restoration of the subgenus *Emphylia* Koelbel for the parasitic isopod *Nerocila sundaica* Bleeker (Flabellifera, Cymothodaie). *Crustaceana* **34,** 33–44.

BOWMAN, T. E., and TAREEN, I. U., 1983. Cymothoidae from fishes of Kuwait (Arabian Gulf) (Crustacea: Isopoda). *Smithsonian Contributions to Zoology* **382,** 1–30.

BRIAN, A., 1912. Di un isopod parassiti dei pesci (*Livoneca sinuata KOELBEL*). *Revista mensile di Pesca e Hydrobiologia* **7,** 97–99.

BRIAN, A., 1912. A proposito di un Isopoda parassita dell'*Atherina mochon* Cuv. et Val. *Monitore Zoologica Italiano* **32,** 20–24.

BROWN, R. B., 1956. *Composition of Scientific Words.* Washington, DC: Smithsonian Institution Press, pp. 882.

BRUSCA, R. C., 1981. A monograph on the Isopoda Cymothoidae (Crustacea) of the eastern Pacific. *Zoological Journal of the Linnean Society* **73,** 117–199.

CARUS, J. V., 1885. *Coelenterata, Echinodermata, Vermes, Arthropoda. Prodromus faunae Mediterranae, sive descriptio animalium Maris Mediterrenei incolarum quam comparata silva rerum quatenus innotuit adiectis locis et nominubus vulgaribus eorumque auctoribus in commodum Zoologorum,* Vol. 1. Stuttgart: E. Schweizerbatsche, p. 525.

COLLETTE, B. B., 1974. The Garfishes (Hemiramphidae) of Australia and New Zealand. *Records of the Australian Museum* **29,** 11–105.

COLLETTE, B. B., MCGOWEN, G. E., PARIN, N. V. and MITO, S., 1984. Beloniformes: development and relationships. In *Ontogeny and Systematics of Fishes, Special publication, vol. 1,* Gainesville, Florida: American Society of Ichthyology and Herpetology, pp. 334–354.

COSTA, A., 1851, Caratteri di alcuni de'generi e specie nouve segnete nel presente catalogo. In *Catalogo dei crostacei Italiani e di molti altri de Mediterraneo, Napoli.* (F. W. Hope). Pp. 41–48. p. 48, plate 1.

CZERNIAVSKY, V., 1868, Materiala ad zoographiam Ponticam comparatum. *Transactions of the First Meeting of the Russian Naturalists in Saint Petersburg, 1868,* 19–136.

DELAMARE DEBOUTTEVILLE, C., 1951, Sur deux intéressants isopodes parasites de la région de Banyuls. *Archives de Zoologie Experimentale et Generale* **88,** 101–102.

GALATI MOSELLA, R., 1920, Sulla *Livoneca sinuata* Koelbel parassita di *Cepola rubescens* e di *Atherina mochon. Monitore Zoologica Italiano, Firenze* **31,** 1–10.

GERSTAECKER, A., 1881. Sechste Ordnung. Isopoda. -Asseln [part]. In Dr H. G. Bronn's *Die Klassen und Ordnungen des Thier-Reichs, wissenschaftlich dargestellt in Wort und Bild.* Fünfter Band II. Abteilung. Gleiderfussler: Arthropoda. Crustacea (Zweite Hälfte: Malacostraca). 1, 2, und 3, Lieferung, pp. 8–96.

GOURRET, P., 1892. Les lemipodes et les isopodes du Golfe de Marseille. *Annales du Musée d'Histoire Naturelle de Marseille* **6,** 1–44.

GREENWOOD, P. H., ROSEN, D. E., WEITZMAN, S. H. and MYERS, G. C., 1966. Phyletic studies of teleostean fishes, with a provisional classification of living forms. *Bulletin of the American Museum of Natural History* **131,** 339–455.

GURJANOVA, E. F., 1936, Faune de l'URRS. Crustacées. Vol. 7, no. 3. Isopodes des Mers Orientales. *Institute Zoologique de l'Academie des Sciences de l'URRS. Nouvelle Série* **6,** xii + 278.

HALE, H. M., 1926. Review of Australian isopods of the cymothoid group. Part II. *Transactions and Proceedings of the Royal Society of South Australia* **50,** 201–234.

HALE, H. M., 1929. *The Crustaceans of South Australia. Part 2. Handbooks of the Fauna and Flora of South Australia.* Adelaide: British Science Guild (South Australian Branch), pp. 201–380.

HALLER, G., 1880, Über einige neue Cymothionen. *Archiv fur Naturgeschichte, Berlin, Jahrsbuch* **46,** 375–395.

HANSEN, H. J., 1897. Reports on the dredging operations off the west coast of central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U.S. Fish Commission Steamer "Albatross", during 1891, Lieut. Commander Z. L. Tanner, U.S.N., commanding. *Bulletin of the Museum of Comparative Zoology at Harvard College* **31,** 95–129., pls 1–7.

HATAI, K. and YASUMOTU, S., 1980. A parasitic isopod *Irona melanosticta* isolated from the gill chamber of fingerlings of cultured Yellowtail, *Seriola quinqueradiata. Bulletin of the Nagasaki Prefectural Institute of Fisheries* **6,** 87–96 (in Japanese).

HATAI, K. and YASUMOTO, S., 1981. Some notes on the Ironasis of cultured young Yellowtail, *Seriola quinqueradiata*. *Bulletin of the Nagasaki Prefectural Institute of Fisheries* **7,** 77–81 (in Japanese).

HATAI, K and YASUMOTO, S., 1982 a. Effects of *Irona melanosticta* on the growth of young Rudderfish, *Girella punctata*. *Bulletin of the Nagasaki Institute of Fisheries* **8,** 75–79 (in Japanese).

HATAI, K. and YASUMOTO, S., 1982 b. The effects of Methyl isoxathion in eliminating the parasitic isopod *Irona melanosticta*. *Aquiculture, Japan* **30,** (3), 147–150 (in Japanese).

HATTORI, J. and SEKI, M., 1956. An isopod, *Irona melanosticta* parasitic on *Hemiramphus sajori* (T. & S.) and its influence on the hosts. *Dobutsugku Zasshi* (*Zoological Magazine*) **65,** 422–425.

HEWITT, G. C. and HINE, P. M., 1971. Checklist of parasites of New Zealand fishes and of the hosts. *New Zealand Journal of Marine and Freshwater Research* **6,** 69–114.

HIRAIWA, Y. K., 1934, Tainoe to Sayori-yadorimusi (*Rhexana verrucosa* and *Irona melanosticta*). *Syokubutu Oyobi Dobutu, Tokyo* **2,** 380–384. (Botany and Zoology, Scientific and Applied, in Japanese.)

HOLTHUIS, L. B., 1959. Notes on pre-Linnean carcinology (including the study of Xiphosura) of the Malay Archipelago. In *Rumphius Memorial Volume*. Hollandia: Baarn, Chap. 5, pp. 63–125.

INOUYE, M., 1941. On sexuality in Cymothoidae, Isopoda. II. *Irona melanosticta* Schioedte and Meinert parasitic in the branchial cavity of the halfbeak *Hyporhamphus sajori* (Temminck & Schegel). *Journal of Science of Hiroshima University, series B, Division 1 (Zoology)* **9,** 219–238.

KENSLEY, B., 1978, *Guide to the Marine Isopod Crustaceans of Southern Africa*. Cape Town: Trustees of the South African Museum, pp. 173.

KOELBEL, C. VON, 1878. Über einige neue Cymothoiden. *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Klasse der Kaiserlichen Akademie der Wissenschaften* **78,** 401–416.

KUSSAKIN, O. G., 1979, *Marine and Brackish Water Isopod Crustacea. Suborder Flabellifera*. Leningrad: Akademy of Science, USSR, pp. 470 (in Russian).

LANZING, W. J. R. and O'CONNOR, P. F., 1975, Infestation of luderick (*Girella tricuspidata*) populations with parasitic isopods. *Australian Journal of Marine and Freshwater Research* **26,** 355–361.

LEACH, W. E., 1818. Cymothoadées. *Dictionnaire des Sciences Naturelles* **12,** 338–354 (Paris).

LINTON, E., 1907. Notes on parasites of Bermuda fishes. *Proceedings of the United States National Museum* **33,** 85–126, pls 1–15.

MIERS, E. J., 1880. On a collection of Crustacea from the Malaysian region. Part IV. Penaeidae, Stomatopoda, Isopoda, Suctoria, and Xiphosura. *Annals and Magazine of Natural History, Series 5* **5,** 226–239, 304–317, 370–384, 457–472.

MONOD, T., 1923, Notes carcinologiques (parasites et commensaux). *Bulletin de l'Institute Océanographique de Monaco* **427,** 19–22.

MONOD. T., 1933. Mission Robert-Ph. Dollfus en Égypte (Decembre 1927–Mars 1929). Tanaidacea et Isopoda. *Mémoires de l'Institute d'Égypte* **22,** 162–264.

MONOD, T., 1971, Sur quelques crustacés de Tuléar (Madagascar). *Téthys* (Suppl. 1), 165–192.

MONOD, T., 1976. Expédition Rumphius II (1975). Crustacés parasites, commensaux, etc. (Th. Monod et R. Sérène, eds.) III. Crustacés isopodes (1ere partie Corallanidae, Anilocridae, Cymothoidae). *Bulletin du Muséum National d'Histoire Naturelle, séries 3, no. 391, Zoologie* **273,** 853–870.

MONOD, T. and SÉRÈNE, R., 1976, 8. Parasitic, commensal, and inquiline crustaceans collected during the Rumphius Expedition II. *Oceanology di Indonesia* **6,** 23–27.

MONTALENTI, G., 1948, Note sulla sistematica e la biologia di alcuni Cimotoidi del Golfo di Napoli (gen. *Emetha, Mothocya, Anilocra, Nerocila*). *Archivio di Oceanografia e Limnologia* **5,** 25–81.

NAIR, G. S., 1950, Two new species of *Irona* (Isopoda) parasitic on Madras fishes. *Journal of the Madras University* **20B,** 66–74.

NAIR, G. S., 1956. On the embryology of the isopod *Irona*. *Journal of Embryology and Experimental Morphology* **4,** 1–33.

NIERSTRASZ, H. F., 1915. Die Isopoden-sammlung im Naturhistorischen Reichsmuseum zu Leiden. I. Cymothoidae. *Zoologisch Mededelingen Rijksmuseum van Natuurlijke Historie, Leiden* **1,** 71–108.

NIERSTRASZ, H. F., 1918, VIII. Alte und neue Isopoden. *Zoologisch Mededelingen Rijksmuseum van Natuurlijke Historie, Leiden* **4,** 103–142.

NIERSTRASZ, H. F., 1931. Die Isopoden der Siboga-Expedition. 3. Isopoda Genuina. 2. Flabellifera. *Siboga Expeditie Monograph* **32C,** 123–232.

NORMAN, J. R. and GREENWOOD, P. H., 1975. *A History of Fishes*, 3rd edn. New York: John Wiley, pp. 467.

NUNOMURA, N., 1981, Isopod crustaceans in Sado Island, the Sea of Japan. *Annual Report of the Sado Marine Biological Station, Niigata University* **11,** 43–62.

O'CONNOR, P. F., 1978. The Biology, Life-cycle and Host-effects of Isopods (Cymothoidae) Found to Parasitise the Luderick, *Girella tricuspidata.* Masters thesis, University of Sydney, pp. 278.

PARIN, N. V., 1967. Review of the marine belonids of the Western Pacific and Indian Oceans. *Academia Nauk SSSR, Trudy Institute of Oceanography* **84,** 3–83 (in Russian).

PARIN, N. V., COLLETTE, B. B. and SHCHERBACHEV, Y. N., 1980. Preliminary review of the marine half beaks (Hemiramphidae, Beloniformes) of the tropical Indo-West Pacific. *Academia Nauk SSSR, Trudy Institute of Oceanography* **97,** 7–173 (in Russian).

PFEFFER, G., 1889. Ubersicht der von Herrn Dr. Franz Stuhlmann in Agypten, auf Sansibar und dem gegenuberliegenden Festlande gessammelten Reptilien, Amphibien, Fische, Mollusken und Krebse. *Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten* **6,** (1888), 1–36.

PILLAI, N. K., 1954. A preliminary note on the Tanaidacea and Isopoda of Travancore. *Bulletin of the Central Research Institute, University of Travancore, Trivandrum* **3C,** 1–21.

PILLAI, N. K., 1964. Parasitic isopods of the family Cymothoidae from South Indian fishes. *Parasitology* **54,** 211–223.

PRINCE, J. D., IVANTSOFF, W. and POTTER, I. C., 1982, *Atherinosoma wallacei*, a new species of estuarine and inland water silverside (Teleostei: Atherinidae) from the Swan-Avon and Murray Rivers, Western Australia. *Australian Zoologist* **21,** 63–74.

RICHARDSON, H., 1901, Key to the isopods of Atlantic coast of North America with descriptions of new and little known species. *Proceedings of the United States National Museum* **23,** 493–579.

RICHARDSON, H., 1905 a. Description of a new species of *Livoneca* from the coast of Panama. *Proceedings of the United States National Museum* **29,** 445–446.

RICHARDSON, H., 1905 b. A monograph on the isopods of North America. *Bulletin of the United States National Museum* **54,** i–Liii, 1–727.

RICHARDSON, H., 1909. Isopods collected in the northwestern Pacific by the U.S. Bureau of Fisheries Steamer "Albatross"in 1906. *Proceedings of the United States National Museum* **37,** 75–129.

ROBINS, C. R., BAILEY, R. M., BOND, C. E., BROOKER, J. R., LEA, R. N. and SCOTT, W. B., 1980. A list of common and scientific names of fishes from the United States and Canada (fourth edition). *American Fisheries Society, special publication* **12,** 1–174.

ROMESTAND, B. and TRILLES, J.-P., 1975. Les relations immunologiques "hote-parasitaire" chez les Cymothoidae (Isopoda, Flabellifera). *Comptes Rendus l'Academie des Sciences, Paris* **280(D),** (18), 2171–2173.

SCHIOEDTE, J. C. and MEINERT, F., 1879. Symbolae ad monographium Cymothoarum Crustaceorum Isopodum familiae. I. Aegidae. *Naturhistorisk Tidsskrift, series 3* **12,** 321–414, pls 7–13.

SCHIOEDTE, J. C. and MEINERT, F., 1881. Symbolae ad monographium Cymothoarum Crustaceorum Isopodum familiae. II. Anilocridae. *Naturhistorisk Tidsskrift, series 3* **13,** 1–166, pls 1–10.

SCHIOEDTE, J. C. and MEINERT, F., 1883, Symbolae ad monographium Cymothoarum Crustaceorum Isopodum familiae. III. Saophridae. IV. Ceratothoinae. *Naturhistorisk Tidsskrift, Series 3* **13,** 281–378, pls 11–16.

SCHIOEDTE, J. C. and MEINERT, F., 1884. Symbolae ad monographium Cymothoarum Crustaceorum Isopodum familiae. IV. Cymothoidae. Trib. II. Cymothoinae. Trib. III. Livonecinae. *Naturhistorisk Tidsskrift, series 3* **14,** 223–454, pls 6–18.

SCHULTZ, G. A., 1969. *How to know the Marine Isopod Crustaceans.* Dubuque, Iowa: Wm. C. Brown, pp. vii + 359.

SHIINO, S. M., 1951. On the cymothoid Isopoda parasitic on Japanese fishes. *Bulletin of the Japanese Society of Scientific Fisheries* **16,** 81–89.

SHIINO, S. M., 1965. *New Illustrated Encyclopedia of the Fauna of Japan.* Hokuryukan (cited from Nunomura, 1981).

STEBBING, T. R. R., 1905. Report on the Isopoda collected by Professor Herdman in Ceylon in 1902. In *Report to the Government of Ceylon on the Pearl Oyster Fishery in the Gulf of Manaar*, Part 4, supplementary report 13, (W. A. Herdman). London: Royal Society, pp. 64.

STEPHENSON, A. B., 1969, *Irona melanosticta* (Isopoda: Cymothoidae). A new record for New Zealand waters, with descriptions of male, female, and larval stages. *Records of the Auckland Institute and Museum* **6,** 427–434.

STEPHENSON, A. B., 1976, Gill damage in fish produced by buccal parasites. *Records of the Aukland Institute and Museum* **13,** 167–173.

STIMPSON, W., 1857. The Crustacea and Echinodermata of the Pacific shores of North America. *Boston Journal of Natural History* **6,** 503–513.

THAMPY, D. M. and JOHN, P. A., 1974. Sex-reversal and androgenic gland in the fish parasite *Irona far* (Cymothoidae: Isopoda: Crustacea). *International Journal for Parasitology* **4,** 575–583.

THIELEMANN, M., 1910, Beiträge zur Naturgeschichte Ostasiens. Herausgegeben von F. Doflein. Band II, No. 9. Beitrage zu Kenntnis der isopodenfauna Ostasiens. *Abhandlungen der Mathematisch-Naturwissenschaftlichen Klasse der K. Bayer. Akademia der Wissenschaften* (suppl.), vol. 2, Abhandlung 3, 1–109, pls 1, 2.

TRILLES, J.-P., 1962. Remarques morphologiques et biologiques sur les "Isopodes Cymothoidae" parasites des poissons, de l'Étang de Thau. *Naturalia monspelogia* **3,** 101–124.

TRILLES, J.-P., 1964 a. Spécificité parasitaire chez les isopodes Cymothoidae Méditerranéens. Note préliminaire. *Vie et Milieu* **15,** 105–116.

TRILLES, J.-P., 1964 b. Note préliminaire sur quelques aspects de la reproduction chez les isopodes Cymothoidae Mediterranéens. *Archives de Zoologie Experimentale et Générale* **104,** 127–134.

TRILLES, J.-P., 1964 c. A propos d'un fait particulaire d'éthologie parasitaire chez les isopodes Cymothoidae: Le relation de taille entre parasites et poissons. Note préliminaire. *Vie et Milieu* **15,** 365–369.

TRILLES, J.-P., 1964 d. Glandes androgenes, gonades et metamerisation chez les isopodes Cymothoidae. *Bulletin de l'Institute Océanogaphique de Monaco* **62,** (1293), 1–8.

TRILLES, J.-P., 1964 e. Sur differents aspects du developement de l'ovaire chez les isopodes Cymothoidae et l'existence d'une vitellegenese aberrante dans les oocytes de certains parasites. *Comptes Rendus de l'Academie des Sciences, Paris* **258,** 6545–6548.

TRILLES, J.-P., 1968 a. Recherches sur les Isopodes. Cymothoidae de côtes Françaises. I. Systématique et faunistique. II. Bionomie et parasitism. Thèse de Doctorat ès-sciences, Montpelier, CNRS, AO 2305: 1–181, pls 1–34, photos 1–56, pp. 1–307.

TRILLES, J.-P., 1968 b. Reference not located; cited in synonymy for *M. epimerica*, Trilles, 1976 b.

TRILLES, J.-P., 1969. Recherches sur les isopodes "Cymothoidae" des côtes françaises. Aperçu générale et comparatif sur la bionomie et la sexualité de ces Crustacés. *Bulletin de la Société Zoologique de France* **94,** 433–445.

TRILLES, J.-P., 1973. Sur la structure des pléopodes et de oostégites chez les Cymothoidae (Isopoda, Flabellifera) et ses rapports avec les characteristiques écologiques des espèces. *Bulletin du Muséum National d'Histoire Naturelle, Paris, 3^e série, no. 91, Zoologie* **70,** 1231–1268.

TRILLES, J.-P., 1976 a. Les Cymothoidae (Isopoda, Flabellifera) des collections du Muséum National d'Histoire Naturelle de Paris. IV. Les Lironecinae Schioedte et Meinert, 1884. *Bulletin du Muséum National d'Histoire Naturelle, Paris, 3^e série, no. 390, Zoologie* **272,** 773–800.

TRILLES, J.-P., 1976 b. Les Cymothoidae (Isopoda, Flabellifera) des côtes Francaises. III. Les Lironecinae Schioedte et Meinert, 1884. *Bulletin du Muséum National d'Histoire Naturelle, Paris, 3^e série, no. 392, Zoologie* **272,** 801–820.

TRILLES, J.-P., 1977. Les Cymothoidae (Isopoda, Flabellifera; parasites de poissons) du Rijksmuseum van Natuurlijke Histoire de Leiden. Méditerranée et Atlantique nord-orientale. *Zoologische Mededelingen, Leiden* **52,** 7–17.

TRILLES, J.-P., 1979. Les Cymothoidae (Isopoda, Flabellifera; parasites de poissons) du Rijksmuseum van Natuurlijke Histoire de Leiden II. Afrique, Amériques er régions Indo-Ouest-Pacifiques. *Zoologische Mededelingen, Leiden* **54,** 245–275.

TRILLES, J.-P., 1981. Les Cymothoidae (Isopoda, Flabellifera; parasites des poissions) des Antilles. *Bulletin du Muséum National d'Histoire Naturelle, Paris, 4^e série, section A,* **2,** 583–602.

TRILLES, J.-P. and PAPERNA, I., 1980. Sur quelques crustacés isopodes (Corallanidae, Lironecinae et Anilocridae) d'Israel. *Bulletin du Muséum National d'Histoire Naturelle, 4^e série, Section A* **2,** 445–454.

TRILLES, J.-P. and RAIBUT, A., 1971, Aegidae et Cymothoidae parasites de poissons de Mer Tunisiens: Premier résultats. *Bulletin, Institute National Scientifique et technique d'Océanographie et de Pêche, Salambo* **2,** 71–86.

TRILLES, J.-P. and RAIBUT, A., 1973, Sur les Cymothoidae (Isopoda, Flabellifera) parasites de poissions marins de Tunisie (2^e note). *Bulletin du Muséum National d'Histoire Naturelle, Paris 3^e série, no. 114, Zoologie* **88,** 273–281.

TUZET, O., MANIER, J.-F. and ORMIÈRES, R., 1959. Recherches sur l'appareil digestif du quelques isopodes (anatomie, histologie, cytologie). *Bulletin de la Societe Zoologique de France* **84,** 505–530.

ULJANIN, V. N., 1872. Data on the fauna of the Black Sea. *Izvestiya Moskovskogo Obshchestva Lyubitelei Estestvoznaniya, Antropoligii i Etnografii* **9,** 79–132.

VASILIU, G. D., 1932. *Livoneca sinuata* Koelb, ein kiemenparasit des fisches *Atherina hepsetus* L. *Publinile de Societe des Naturalistes de Roumanie* **11,** 177–180.

WHITEHEAD, P. J. P. and IVANTSOFF, W., 1983. *Atherina lacunosa* and the fishes described by J. R. Forster. *Japanese Journal of Ichthyology* **29,** 355–364.

WILLIAMS, JR, E. H. and WILLIAMS, L. B., 1977, Isopods of some marine fishes from Puerto Rico and adjacent areas. *Proceedings of the Association of Island Marine Laboratories of the Caribbean* **13,** 14.

WILLIAMS, JR, E. H. and WILLIAMS, L. B., 1980. Four new species of *Renocila* (Isopoda: Cymothodiae), the first from the New World. *Proceedings of the Biological Society of Washington* **93,** 573–592.

WILLIAMS, L. B. and WILLIAMS JR, E. H., 1981. Nine new species of *Anilocra* (Crustacea: Isopoda: Cymothoidae), the first from the New World. *Proceedings of the Biological Society of Biological Society of Washington* **94,** 1005–1047.

WILLIAMS, L. B. and WILLIAMS JR, E. H., 1982. *Mothocya bohlkeorum,* new species (Isopoda: Cymothoidae) external parasites of West Indian coral reef fishes. *Proceedings of the Biology* **2,** 570–577.