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AUSTRALIAN SPECIES OF *HALIOPHASMA* (CRUSTACEA: ISOPODA: ANTHURIDAE)

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Figures 1–16

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SUMMARY

Haliophasma purpureum Haswell, 1881, types species of the genus, and nine new species of *Haliophasma* (*H. canale, H. cribensis, H. cycneum, H. falcatum, H. pugnatum* and *H. yarra* from Port Phillip and Western Port Bays in Victoria; *H. elongatum* and *H. pinnatum* from the New South Wales shelf; and *H. syrtis* from Moreton Bay, Queensland) are described and figured. A key to these species is presented and their relationships discussed. The genus *Haliophasma* is redefined and the status of some of its previously included species is questioned.

INTRODUCTION

The family Anthuridae is at present known to be represented in Australia by 15 species in 9 genera. However, examination of material from recent surveys of the soft-bottom benthos in bays and coastal waters near major population centres in the southeast of the country has revealed the existence of many more species. This paper is the first of what I hope to be a series describing this group.

The genus *Haliophasma* was erected by Haswell (1881) for two species of anthurid isopod, *H. purpureum* and *H. maculatum* from Port Jackson, Australia. Barnard (1925a) placed *H. maculatum* in *Mesanthura,* leaving *H. purpureum* as type species. Twelve additional species of *Haliophasma* have subsequently been described from South Africa, West Africa, southern California, the Mediterranean Sea and Venezuela.

In this paper the type species and nine new species from Australia are described. The generic diagnosis is rewritten and a key to Australian species presented. The status of the non-Australian species is discussed.

Nomenclature used differs little from that used in Barnard's (1925a) review of the family. The maxilliped in *Haliophasma* is of 4 articles (the fused basal one not figured), the last two being equivalent to the palp in other isopods. The maxilla, as used here, is probably the outer lobe of maxilla 1 but the homology of this structure seems in doubt. All illustrations are of left mouthparts or limbs. The generic name is considered neuter.

Material of new species for this paper has come from the following surveys and institutions: Port Phillip Bay Environmental Study (PPBES) and Crib Point Benthic Survey (CPBS), Fisheries and Wildlife Division, Melbourne, Victoria; Shelf Benthic Survey (SBS), the Australian Museum, Sydney, New South Wales; Moreton Bay Benthic Survey (MBBS), Department of Zoology, University of Queensland, Brisbane, Queensland. Type material has been lodged in the museums indicated and series of *H. canale, H. cribensis, H. falcatum, H. pugnatum,* and *H. yarra* have been placed in the Australian Museum, and series of *H. elongatum* and *H. pinnatum* placed in the National Museum of Victoria.

Family **ANTHURIDAE**

Genus **Haliophasma** Haswell, 1881

Haliophasma Haswell, 1881: 476.—Barnard, 1925a: 131.—Barnard, 1940: 382.—Menzies and Barnard, 1959: 17.

Diagnosis. Anthuridae with normal, non-piercing mouthparts. Eyes well developed. Pereon with dorsolateral grooves and sometimes with additional pitting or sculpture; pereonites 4–6 with dorsal pits. Pleonites 1–5 fused, 6 distinct but not aways distinct from telson dorsally. Telson thick, more or less indurated and usually dorsally sculptured; pair of statocysts present (but not always obvious). Uropod with endopod shorter than telson, exopod folding alongside or over telson. Antenna 1 with flagellum 2-articulate, article 2 minute. Antenna 2 with flagellum of 4–7 articles. Mandible with 3-articulate palp, article 3 with 1 seta or transverse or oblique row of 2 to many setae. Maxilliped 4–articulate, article 4 smaller than 3. Pereopod 1 stout, palm entire but sometimes strongly curved. Pereopods 2, 3 with article 6 rectangular. Pereopods 4–7 with article 5 rectangular not underriding 6, dorsal margin about half as long as 6. Pleopod 1 more or less indurated, operculiform. Adult male characterized by more elongate form, less pronounced sculpture, multiarticulate setose flagellum on antenna 1, larger eye, more elongate pereopods, telson and uropods, simple appendix masculinis on pleopod 2. (Females bearing oostegites have not been reported.)

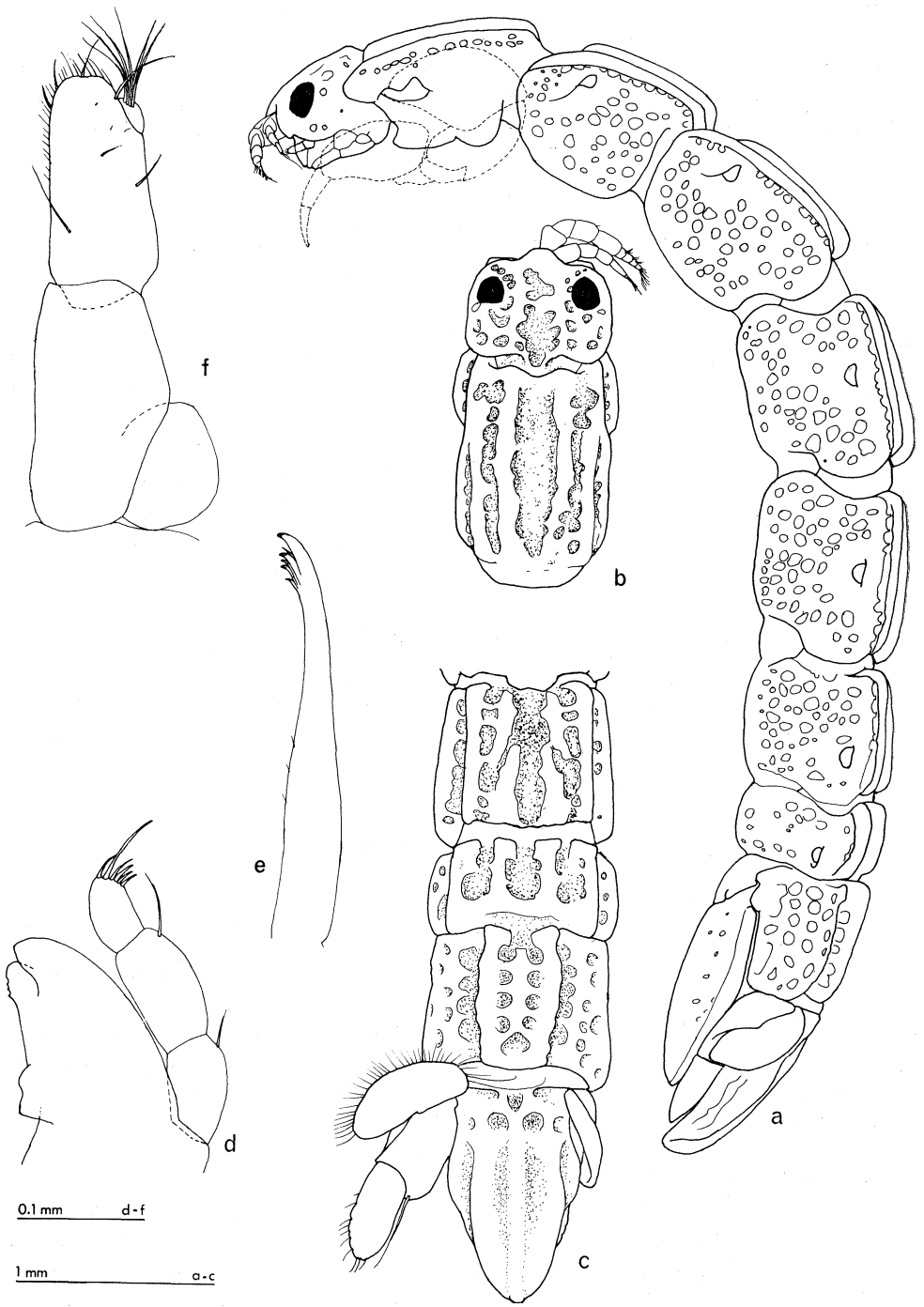

Fig. 1.—*Haliophasma canale* n. sp. Holotype: a, whole specimen, pereopods removed, left aspect; b, anterior end, dorsal aspect; c, posterior end, dorsal aspect; d, mandible; e, maxilla; f, maxilliped.

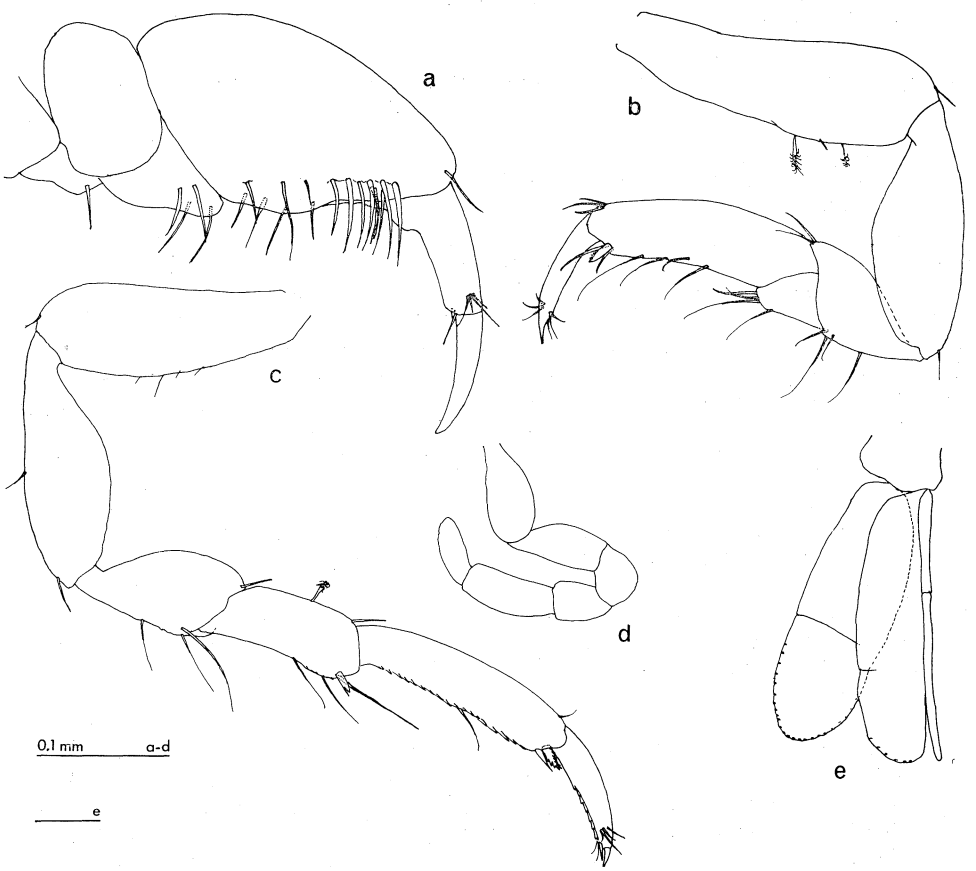

Fig. 2.—*Haliophasma canale* n. sp. Holotype: a–c, pereopods 1, 2, 7. Juvenile (5.4 mm long): d, pereopod 7. Allotype (male): e, pleopod 2.

Haliophasma canale, new species

Figures 1, 2

Description. Head wider than long, strongly pitted dorsally and laterally; prominent, broad, truncate rostrum greatly exceeding anterolateral lobes; cheek with strongly convex ventral margin; eyes dark. Pereon with strong doroslateral grooves complicated by large pits; 2 pairs of low dorsal carinae separated by a deep median groove; strongly pitted laterally. Pereonite 1 with distinctly bilobed ventral keel, produced anteriorly. Pereonites 4–6 with large, circular dorsal pits obscured by median groove. Pleonites 1–5 without epimera; laterally pitted; dorsally the medial pair of pereon carinae run on to pleon where they are separated by a short central ridge and intervening pits, lateral pair of pereon carinae obsolete. Pleonite 6 not distinct from telson mid-dorsally. Telson thick

with broad ventrolateral flanges proximally, median dorsal carina and 2 low dorsolateral ridges meeting anteriorly behind a pair of large pits; broadly rounded terminally. Uropod peduncle medially lobed; endopod not reaching to end of telson, unevenly scalloped lateral edge, medial margin convex; exopod dorsal margin evenly curved, folding alongside telson and not exceeding it dorsally, shorter than peduncle.

Antenna 2, article 2 short, dorsal flange triangular, much less than half width of front of head; flagellum of 5 articles, subequal to peduncle article 5. Mandible with a short, blunt bilobed molar; palp reaching to about end of incisor, article 2 the longest with a single long subterminal seta, article 3 broad, curved with oblique row of 6 setae. Maxilla elongate, almost straight; 5 hooks, 1 spine. Maxilliped articles 2, 3 narrow, scarcely produced laterally; article 3 truncate terminally, 3 long setae and many fine hairs on medial margin, ventral face with 1 proximal seta, 2 in the mid-area and 1 on distal suture; article 4 small, quite lateral being about its own length from distal end of article 3, bearing 6 setae. Pereopod 1 with slightly sinuous, blade-like palm on axis of limb, few medial setae and few lateral setae near palm edge; unguis 0.5 length of dactylus.

Male. Differs from above description in: less pronounced dorsal sculpture; antenna 1 setose, 17 articles, reaching back to end of pereonite 1; eye larger; pereopod 1, article 6 more elongate, palm densely setose medially; pereopods more elongate; pleopod 1 less indurated; pleopod 2 with appendix masculinis simple, more than half length of inner ramus and reaching to its end; telson flatter, more elongate; endopod of uropod longer.

Development. Ovigerous females were not found but adult males were found on 10th June, 1971, in Port Phillip Bay (stn 921), and on 6th July, 1970, at Crib Point (stn 32N). One of the males at stn 32N had a small eye, lacked setae on the otherwise male-type antenna 1, did not have a flattened telson and lacked the appendix masculinis. Juveniles up to a length of about 5 mm lack pereopod 7; pereopod 7 is reflexed forwards and has paddle-like article 7 on individuals up to about 6 mm and normal at greater lengths. Maximum size about 10 mm.

Types. National Museum of Victoria. Holotype, No. J.250, subadult 9.0 mm long. Allotype, No. J.264, male 8.7 mm long. Paratype series, No. J.266, 10 specimens.

Type locality. Port Phillip Bay, near Martha Cliff, PPBES stn 978, 19 m, clayey-silt sediment, 12th October, 1971.

Material. Port Phillip Bay, PPBES stns: 908 (1 specimen), 921 (10), 932 (1), 978 (1); Western Port Bay, Crib Point, CPBS stns: C2 (1), C3 (2), 11N (1), 22N (1), 22S (1), 26N (1), 300 (1), 31N (3), 31S (2), 32N (7), 33N (1), 34N (2), 40E (2), 51N (1), 51S (1), 61N (2).

Distribution. Port Phillip and Western Port Bays, Victoria; 3–19 m; clayey-silt to coarse sand sediments.

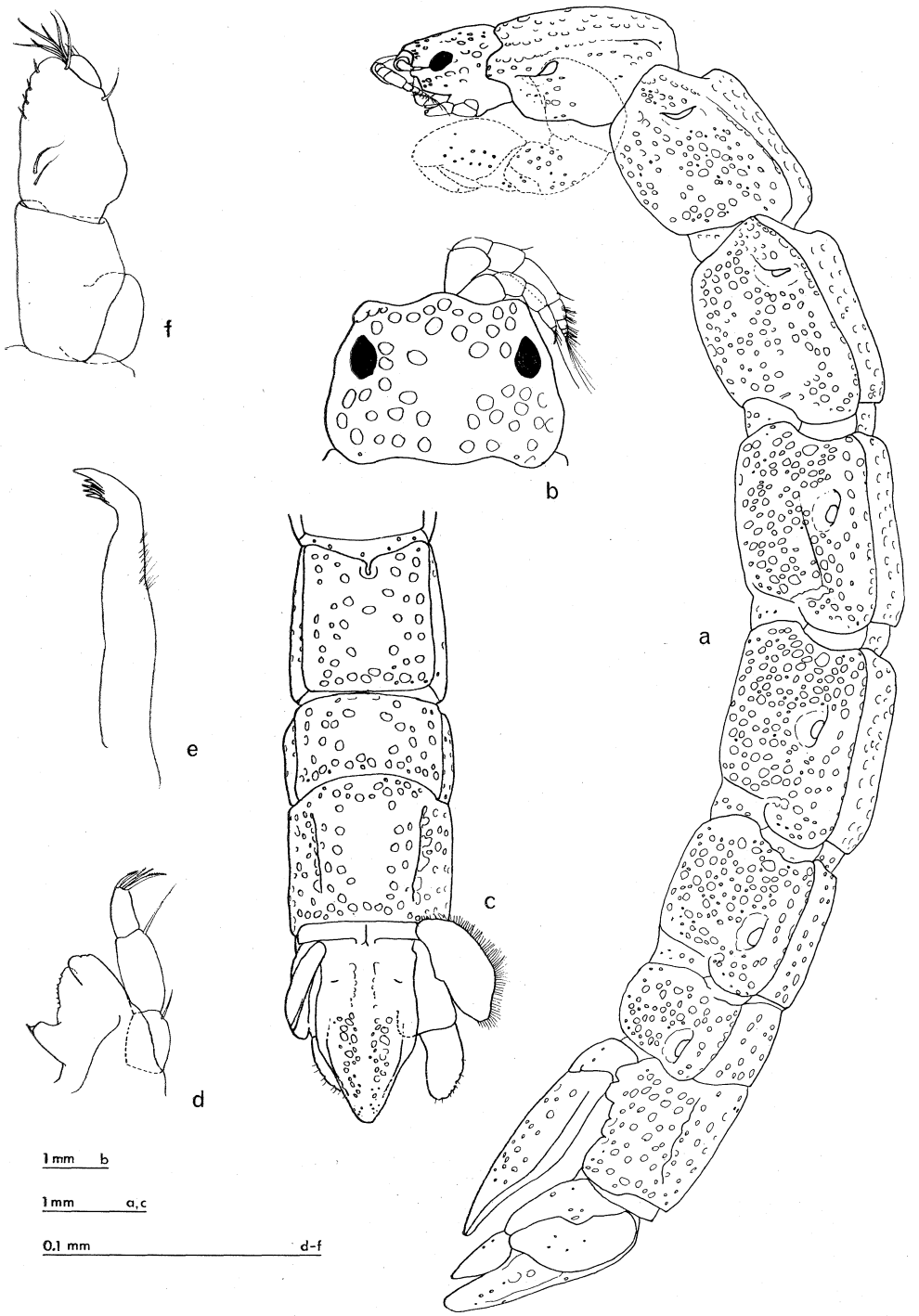

Fig. 3.—*Haliophasma cribensis* n. sp. Holotype: a, whole specimen, pereopods removed, left aspect; b, head, dorsal aspect; c, posterior end, dorsal aspect; d, mandible; e, maxilla, f, maxilliped.

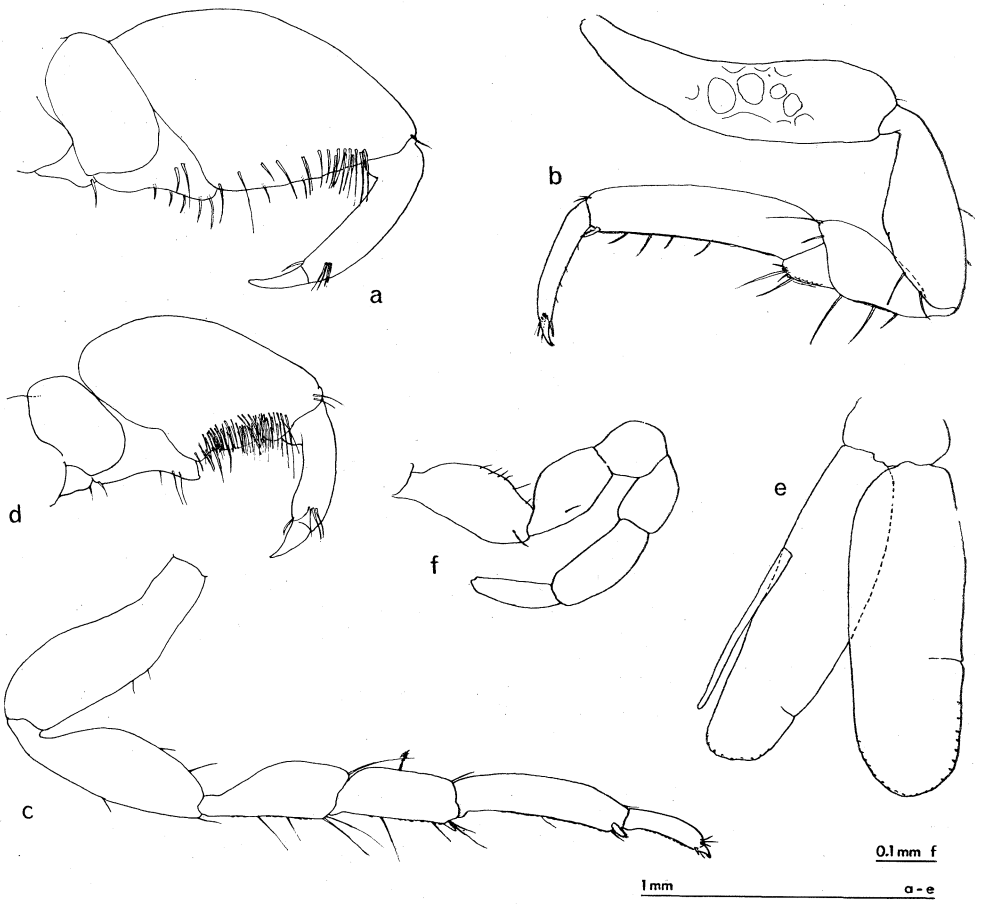

Fig. 4.—*Haliophasma cribensis* n. sp. Holotype: a–c, pereopods 1, 2, 7. Allotype (male): d, pereopod 1; e, pleopod 2. Juvenile (6.1 mm long): f, pereopod 7.

Haliophasma cribensis, new species

Figures 3, 4

Description. Head wider than long, narrowing anteriorly, strongly pitted dorsally and laterally; rostrum very broad, bluntly rounded, little longer than anterolateral lobes; cheek definitely angular anteriorly; eyes dark. Pereon with strong dorsolateral grooves complicated by some small pits, extensively pitted dorsally and laterally. Pereonite 1 with obsoletely biblobed ventral keel, not produced anteriorly. Pereonites 4–6 with transverse step between major part of dorsal surface and lower anterior area; dorsal pit reduced to a small keyhole-shaped notch at midpoint of this step. Pleonites 1–5 with small epimera, dorsolateral groove distinct, complicated by pits and not extending back to posterior margin; pitted laterally but free of pits mid-dorsally. Pleonite 6 fused with telson at midpoint.

Telson thick; a low median carina along whole length but most prominent proximally, and smooth dorsolateral ridges on distal half, pitted dorsally between the 3 ridges and laterally; narrowly rounded terminally. Uropod peduncle with medial lobe square posteriorly; endopod not reaching to end of telson, bluntly rounded with scalloped lateral margin and concave medial margin; exopod with sinuous margin, folding alongside telson and not exceeding it dorsally, little longer than peduncle.

Antenna 2, article 2 short, dorsal flange subtriangular, much less than half width of front of head; flagellum of 6 articles, shorter than peduncle article 5. Mandible with prominent molar bearing sharp accessory tooth; palp reaching beyond incisor, article 2 the longest with a single long subterminal seta, article 3 narrow, curved, with transverse row of 4 setae. Maxilla narrow, sharply curved end; 5 hooks and 2 spines. Maxilliped articles 2, 3 broad, laterally produced; article 3 rounded terminally, 4 short setae on medial margin, ventral face with 2 proximal setae, near distal suture and 1 near outer distal edge; article 4 small, ovoid, subterminal, scarcely exceeding end of 3, with 6 setae. Pereopod 1 with straight, blade-like palm on axis of limb, few medial setae and 1–2 laterally near palm edge; unguis 0.25 length of dactylus.

Male. Differs from above description in: dorsal pits less pronounced; ocelli of eye (about 30) separate; antenna 1 setose, about 16 articles reaching back to midpoint of pereonite 1; pereopod 1 palm more densely setose medially and with slight notch proximally, article 5 produced distally as a tooth opposing the dactylus; other pereopods a little more elongate; pleopod 1 less indurated; pleopod 2 with appendix masculinis simple, more than half length of inner ramus but not reaching to its end; telson flatter and more pointed, median ridge indistinct; uropod with narrower endopod, less indurated.

Development. Ovigerous females were not found but adult males were found on 24th March, 1965, (stn 21N), 1st and 8th April, 1965, (stns 400, 31S), and 28th August, 1964 (stns A6). Juveniles up to a length of about 5 mm lack pereopod; up to about 7 mm pereopod is reflexed forwards and had a paddle-shaped article 7 and pereopod 7 is normal at greater lengths. Maximum length about 16 mm.

Types. National Museum of Victoria. Holotype, No. J.251, subadult 16.0 mm long. Allotype, No. J.265, male 12.7 mm long. Paratype series, No. J.267, 13 specimens.

Type locality. Western Port Bay, Crib Point, CPBS stn 21N, 7 m, fine sand-mud sediment, 24th March, 1965.

Material. Western Port Bay, Crib Point, CPBS stns: A6 (1 specimen), B6 (2), 21N (2), 21S (1), 22N (1), 22S (1), 25S (2), 26N (1), 300 (3), 31N (3), 31S (7), 34N (7), 400 (1), 42N (4), 42S (2).

Distribution. Western Port Bay, Victoria; 7–15 m; fine to fairly coarse sand sediments.

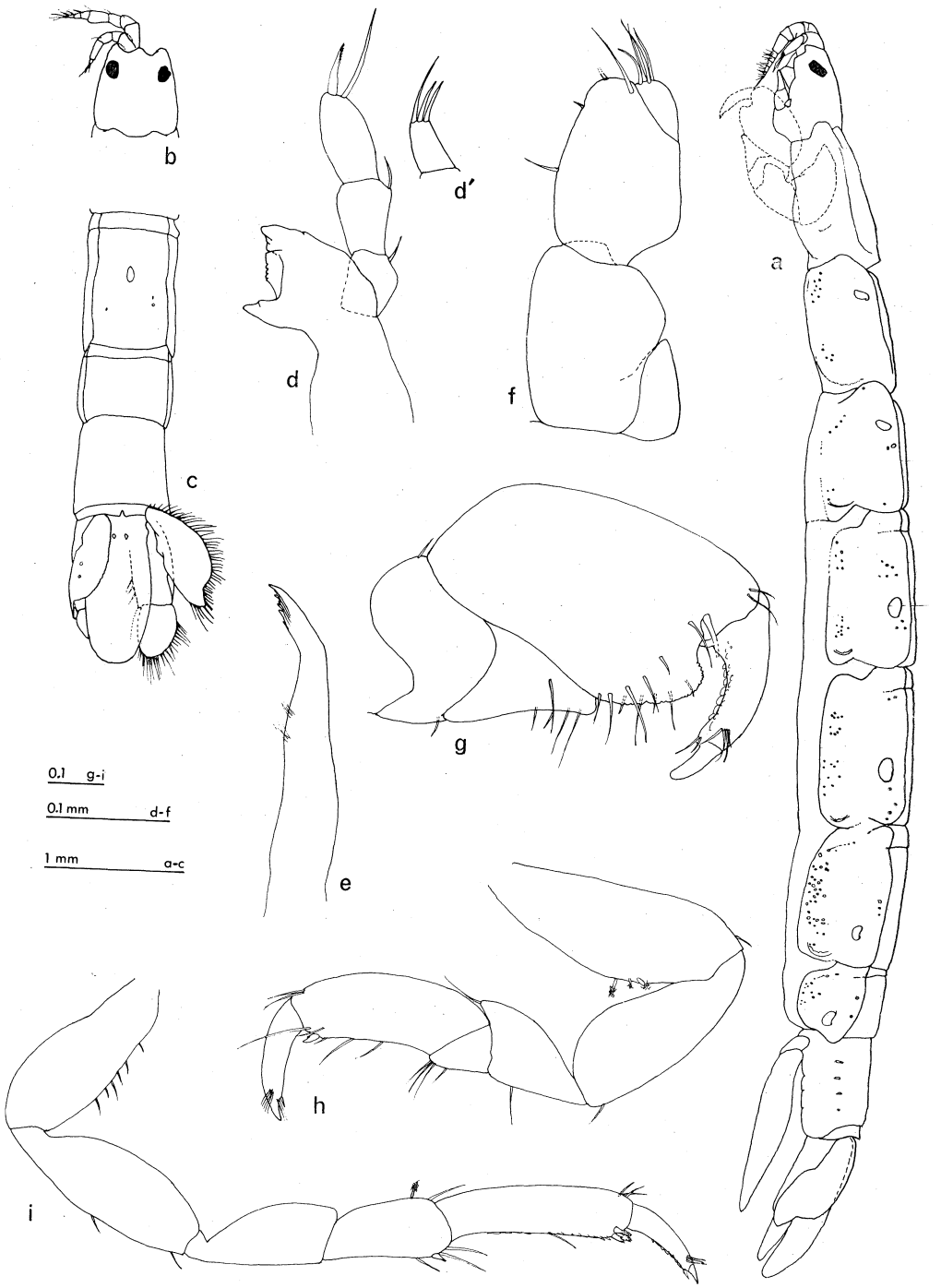

Fig. 5.—*Haliophasma cycneum* n. sp. Holotype: a, whole specimen, pereopods removed, left aspect; b, head, dorsal aspect; c, posterior end, dorsal aspect; d, left mandible; d′, right mandibular palp, article 3; e, maxilla; f, maxilliped; g–i, pereopods 1, 2, 7.

Haliophasma cycneum, new species

Figure 5

Description. Head a little longer than wide, narrowing anteriorly, without pits; rostrum short, rounded, about equal to prominent anterolateral lobes; cheek deep, square anterior corner; eyes dark. Pereon with distinct, simple dorsolateral grooves, smooth except for few small pits laterally. Pereonite 1 without a ventral keel, 2 acute corners on posterior margin of dorsum. Pereonites 4–7 with a strong transverse groove anteriorly and oval dorsal pit on 4–6. Pleonites 1–5 with minute epimera, smooth except for a few pits in place of dorsolateral grooves. Pleonite 6 distinct from telson. Telson thick; smoothly curved dorsally, gently tapering to a broadly rounded end. Uropod peduncle not lobed medially but produced mediodistally; endopod as wide as peduncle, ovate not reaching to end of telson; exopods folding over telson to almost meet, produced to an acute point beyond end of peduncle.

Antenna 2, article 2 long, dorsal flange narrow, less than half width of front of head; flagellum of 5 articles, longer than peduncle article 5. Mandible with prominent molar, dominated by a large accessory tooth; palp reaching well beyond incisor, article 2 with 1 subterminal seta, article 3 narrow, curved with 3 terminal setae. (Left mandibular palp of holotype malformed—Fig. 5d.) Maxilla narrow, gently curved end; 5 hooks and 2 spines. Maxilliped articles 2, 3 broad, laterally produced; article 3 end rounded medially, 3 setae on medial margin, ventral face with 1 seta near distal suture; article 4 subterminal, reaching as far as end of 3, with 4 setae. Pereopod 1 with strongly convex blade-like palm, very few medial or lateral setae; unguis 0.25 length of dactylus.

Male. Unknown.

Holotype. National Museum of Victoria, No. J. 252, subadult 9.3 mm long.

Type locality. Port Phillip Bay, Swan Bay, PPBES stn 966, 1 m, clayey-sand sediment, 23rd January, 1973.

Material. Port Phillip Bay, Swan Bay, PPBES stn 966 (1 specimen), Western Port Bay, mudflats N. of French Island, stns M7(1), M9(1).

Distribution. Port Phillip and Western Port Bays, Victoria; shallow mudflats.

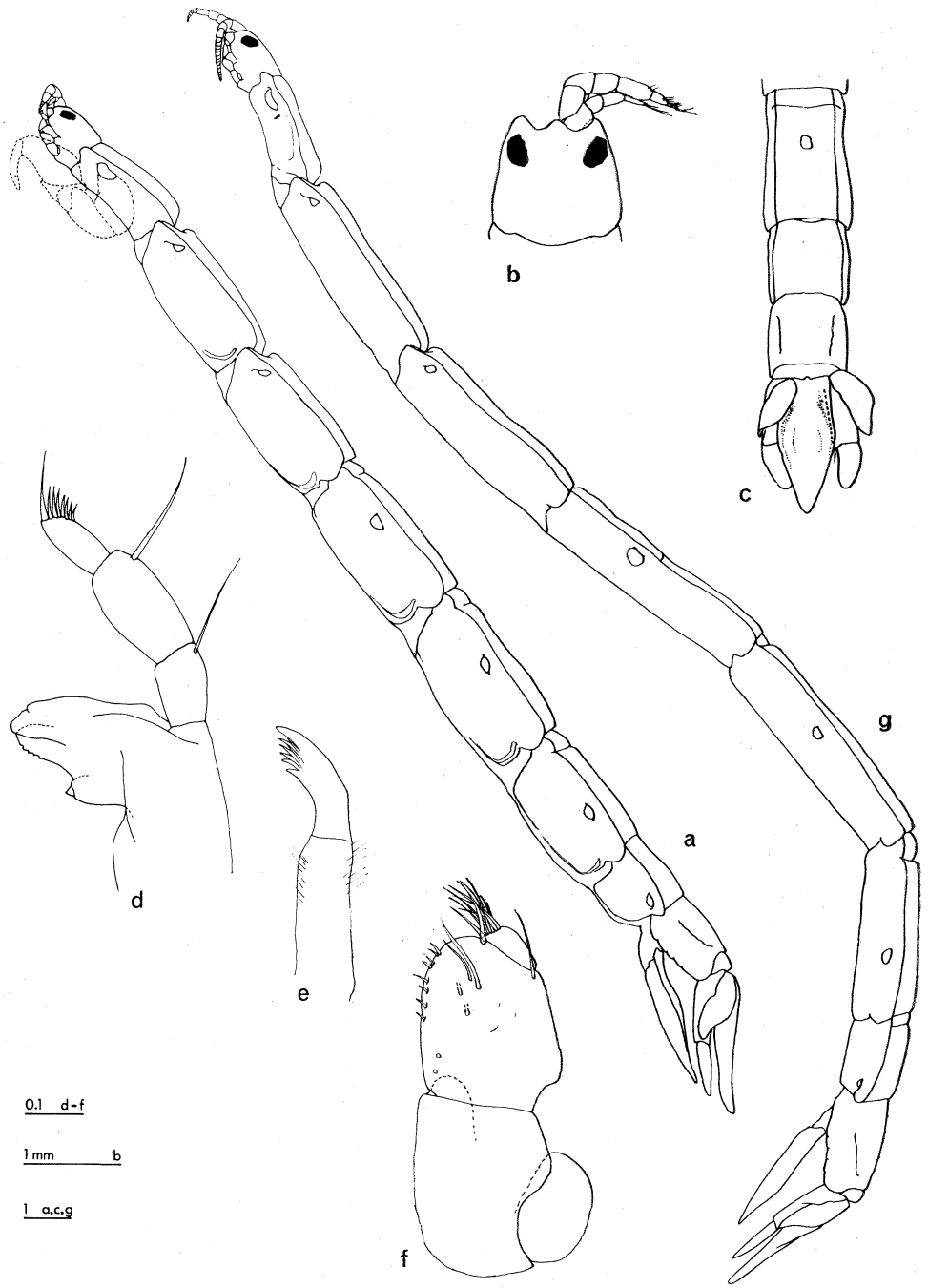

Fig. 6.—*Haliophasma elongatum* n. sp. Holotype: a, whole specimen, pereopods removed, left aspect; b, head, dorsal aspect; c, posterior end, dorsal aspect; d, mandible; e, maxilla; f, maxilliped. Allotype (male): g, whole specimen, pereopods removed, left aspect.

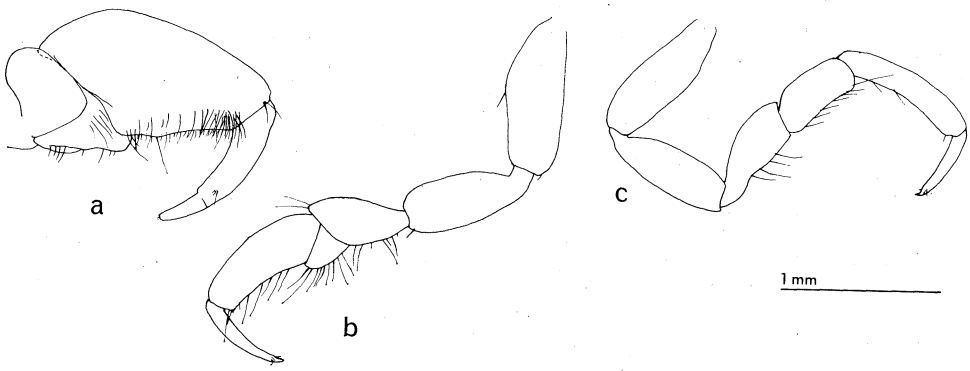

Fig. 7.—*Haliophasma elongatum* n. sp. Holotype: a–c, pereopods 1, 2, 7.

Haliophasma elongatum, new species

Figures 6, 7

Description. Head as long as maximum width, narrowing anteriorly, without pits; rostrum narrow, acute, shorter than anterolateral lobes; cheek deep, without sharp anterior corner; eyes dark. Pereon with clear, simple dorsolateral grooves, generally smooth, pitting obsolete. Pereonite 1 without ventral keel. Pereonites 4–7 with strong transverse groove anteriorly and oval dorsal pit on 4–6. Pleonites 1–5 with minute epimera, distinct dorsolateral groove, not reaching to posterior margin, otherwise smooth. Pleonite 6 distinct from telson. Telson low; sharply narrowed from midpoint to slightly upturned end; dorsal surface flat but for obsolete medial and lateral ridges vanishing posteriorly and narrowing to a broad rounded ridge anteriorly. Uropod peduncle with medial edge straight and produced a little; endopod much shorter than telson, medially concave and laterally convex; exopods not meeting over telson, strongly produced to an acute point but shorter than peduncle.

Antenna 2, article 2 long, dorsal flange broad for most of length, less than half width of front of head; flagellum of 5 articles, shorter than peduncle article 5. Mandible with a short molar bearing a small, acute accessory tooth; palp reaching well beyond incisor, article 2 the longest with a single long subterminal seta, article 3 narrow with an oblique row of 8 setae. Maxilla broad, gently curved, toothed end large; 6 hooks and 2 spines. Maxilliped articles 2, 3 broad, produced laterally; article 3 broadly rounded mediodistally, 8 short setae on medial margin, ventral face with 2 proximal setae (insertions only shown in fig. 6f), 4 in the mid-area and 3 on distal suture; article 4 subterminal but exceeding end of 3, with 9 setae. Pereopod 1 with blade-like palm on axis of limb, slight proximal convexity, densely setose medially and on lateral margin of palm; unguis 0.3 length of dactylus.

Male. Differs from above description in: antenna 1 setose, multiarticulate, reaching back to end of head; pereopod 1 palm more setose medially; pereonites 2–7, pleon, telson, uropods grossly elongate; appendix masculinis not reaching to end of pleopod 2 inner ramus.

Development. Ovigerous females were not found but adult males were found in samples taken on 23rd, 26th Jan., 22nd Feb., 26th Mar., 23rd May, 26th June, 1973. (No specimens were collected from the second half of the year). Specimens ranged from 11 mm in length to 26 mm for juveniles and females. The largest male obtained was a probable 58 mm long, as estimated from length of head plus first three segments (22 mm).

Types. Australian Museum. Holotype, No. P.20436, subadult 26 mm long. Allotype, No. P.20437, male 33 mm long. Paratype series, No. P.20438, 14 specimens.

Type locality. New South Wales shelf, off Malabar, SBS stn IV, 66 m, slightly muddy sand sediment; 24 April, 1973.

Material. New South Wales shelf, off North Head, SBS stns: 22 (2 specimens), 34 (1); off Malabar, SBS stns: 25 (5), 31 (2), 36 (1), 41 (1), III (10), IV (2), V (1), E2S4 (1).

Distribution. New South Wales shelf; 21–72 m; muddy sand to gravelly sand sediments.

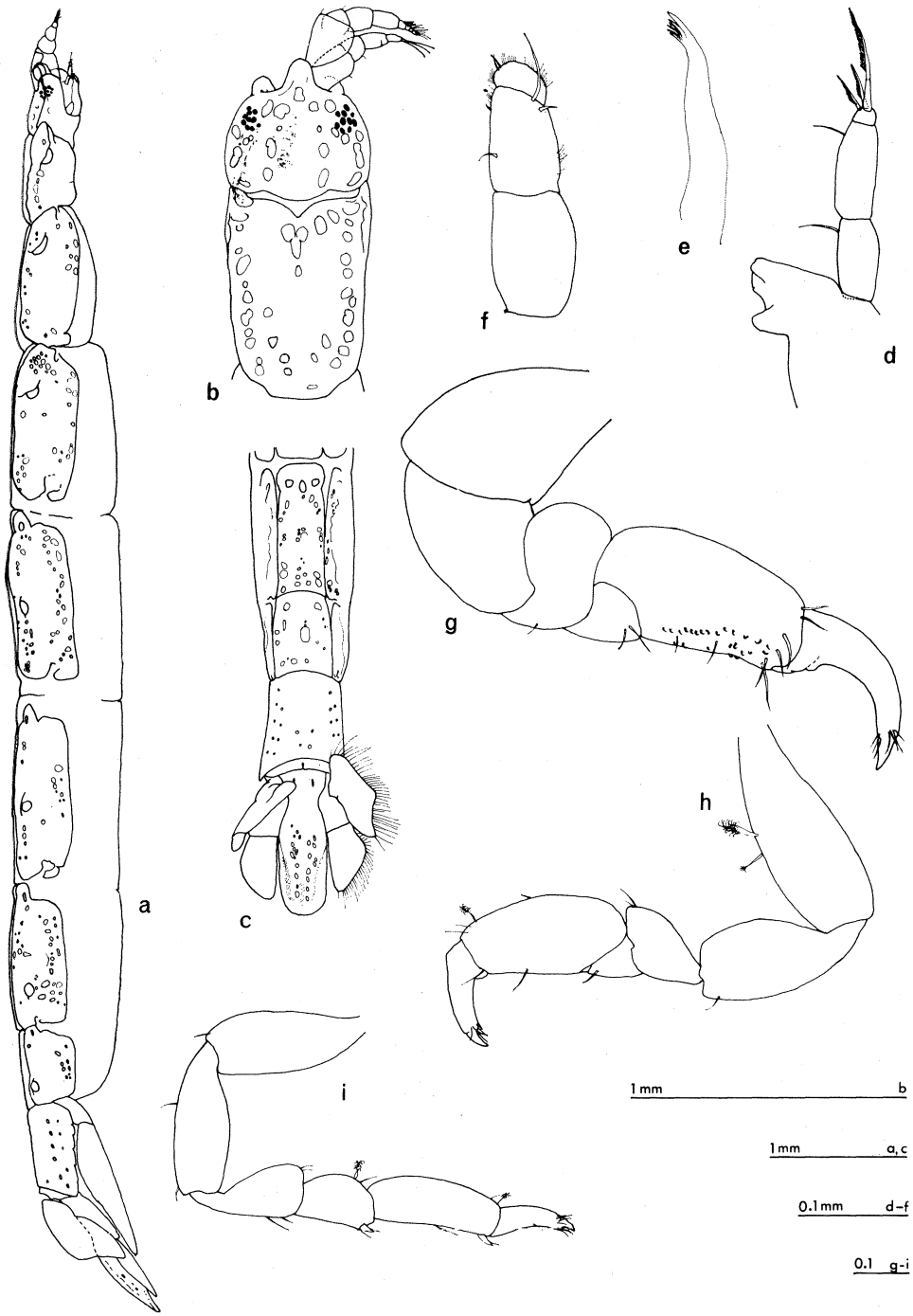

Fig. 8.—*Haliophasma falcatum* n. sp. Holotype: a, whole specimen, pereopods removed, right aspect; b, head, dorsal aspect; c, posterior end, dorsal aspect; d, mandible; e, maxilla; f, maxilliped; g–i, pereopods 1, 2, 7.

Haliophasma falcatum, new species

Figure 8

Description. Head as wide as long, convex laterally; strongly pitted laterally and dorsally; rostrum comparatively long (0.2 of total head length), gradually tapering to round end, distinctively longer than prominent anterolateral lobes; cheek with angled ventral margin; eyes with ocelli separate. Pereon with strong, simple dorsolateral grooves, pitted dorsally and laterally; dorsum flat. Pereonite 1 with a vestigial ventral keel. Pereonites 4–6 with 3 large pits in a very shallow transverse groove near anterior of dorsum. Pleonites 1–5 with minute epimera, dorsolateral groove absent except as a lateral row of pits. Pleonite 6 separate from telson. Telson dorsally convex with two longitudinal irregular rows of pits on distal two-thirds; waisted proximal third, parallel-sided distally with semicircular end. Uropod peduncle without medial lobe; endopod as long as peduncle, not reaching to end of telson, medial margin straight, widest at about midpoint and abruptly narrowing to subacute end; exopod with dorsal margin excavate posteriorly, much exceeding telson dorsally, acute posterior corner reaching well beyond end of peduncle.

Antenna 2, article 2 with a broad dorsal flange less than half width of head; flagellum of 6 articles, shorter than peduncle article 5. Mandible with a prominent blunt molar lacking accessory tooth; palp reaching beyond incisor, article 2 longest with 1 subterminal seta, article 3 minute, bearing 3 terminal setae. Maxilla narrow, gently curved; 5 hooks and 1 spine. Maxilliped articles 2, 3 narrow, not laterally produced; article 3 not produced mediodistally, single seta on medial margin, ventral face with 1 proximal seta and 2 near distal suture; article 4 terminal, its suture oblique, large, about one third length of article 3, with 2 setae and many fine hairs. Pereopod 1 with cylindrical article 6, palm straight, a convex surface, not blade-like, on axis of limb, few medial setae, 1–2 lateral setae and many small palmar hooked setae; dactylus stout, strongly curved, unguis 0.15 its length.

Male. A single specimen (length 7.7 mm) was found with male-type antenna 1 but the antenna lacked setae; the appendix masculinis was absent.

Development. Mature specimens were not found. Juveniles of length 5–6 mm had pereopod 7 reflexed. More indurated specimens differed from the holotype only in the strongly serrate margin of the uropod exopod and more pointed endopod. Maximum length recorded 9.5 mm.

Types. National Museum of Victoria. Holotype, No. J.255, subadult 9.5 mm long. Paratype series, No. J.270, 22 specimens.

Type locality. Western Port Bay, Crib Point, CPBS stn 32N, 11 m, sandy gravel sediment, 23rd March, 1965.

Material. Western Port Bay, Crib Point, CPBS stns: C2 (1 specimen), C3 (1), 21N (1), 31N (2), 31S (1), 32N (17), 32S (2), 33N (1), 51N (1), 52N (2).

Distribution. Western Port Bay, Victoria; 7–18 m; fine sand-mud sediments.

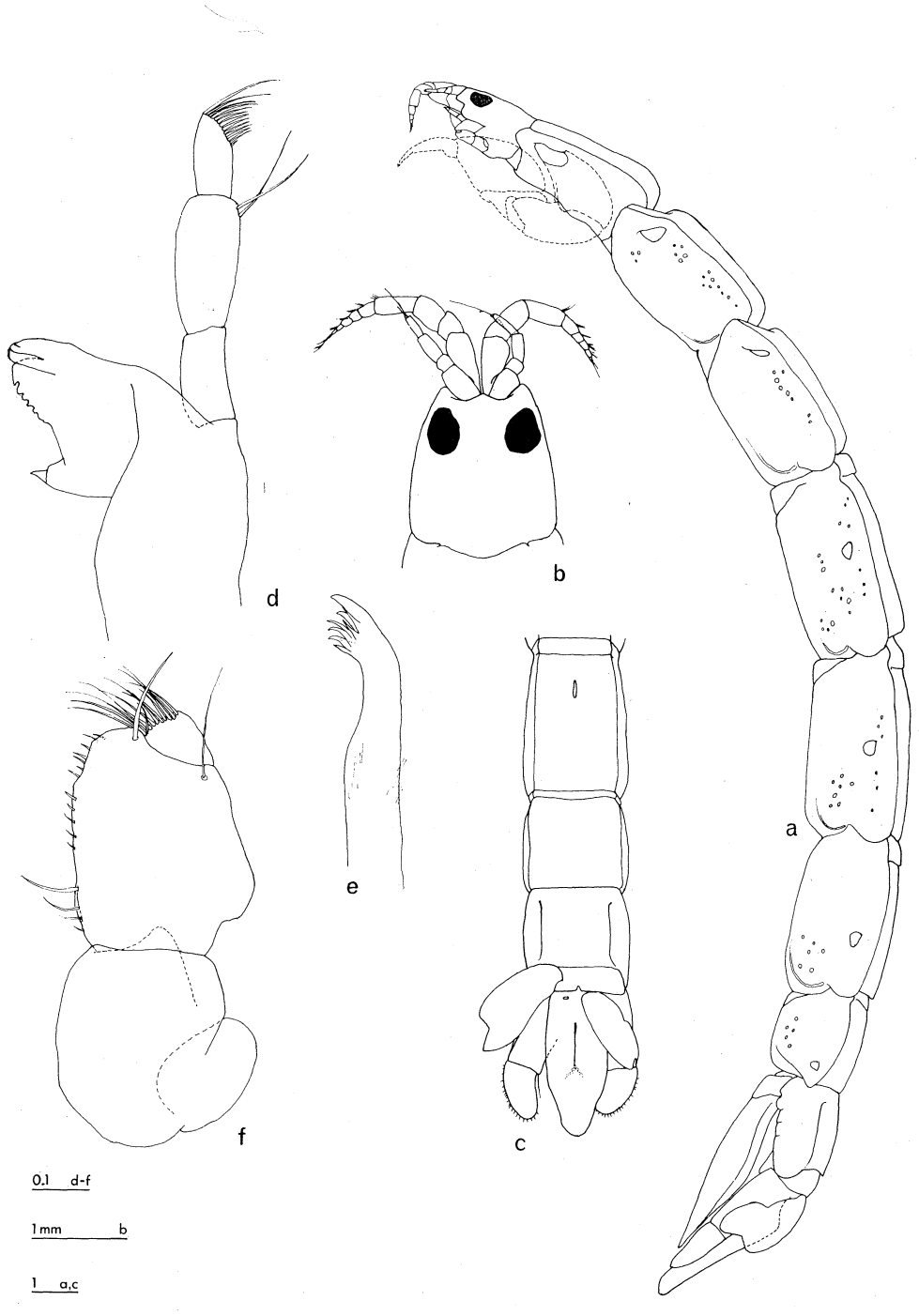

Fig. 9—*Haliophasma pinnatum* n. sp. Holotype: a, whole specimen, pereopods removed, left aspect; b, head, dorsal aspect; c, posterior end, dorsal aspect; d, mandible; e, maxilla; f, maxilliped.

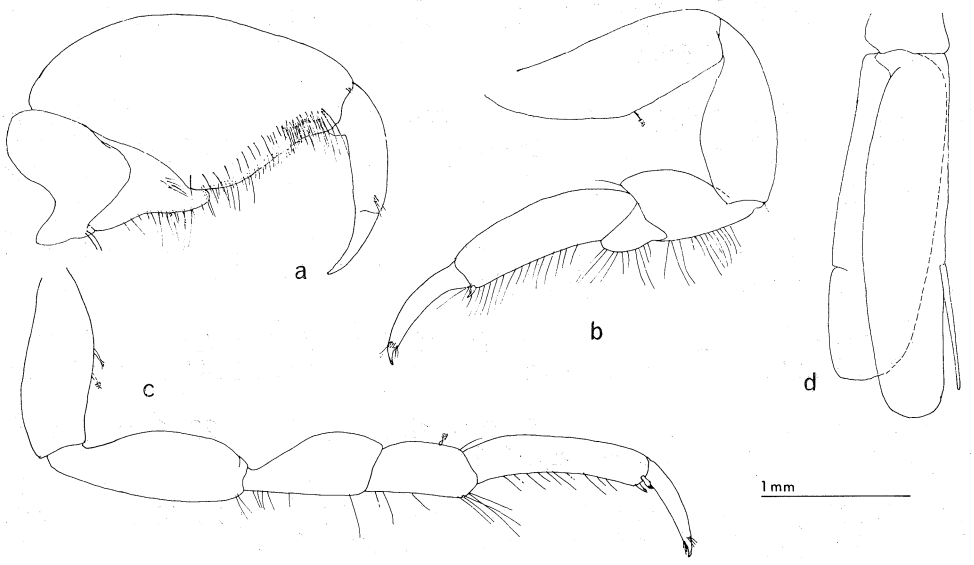

Fig. 10.—*Haliophasma pinnatum* n. sp. Holotype: a–c, pereopods 1, 2, 7. Allotype (male): d, pleopod 2.

Haliophasma pinnatum, new species

Figures 9, 10

Description. Head longer than wide, much narrower anteriorly; rostrum broad, much shorter than anterolateral lobes; cheek deep, rounded anterior margin; eyes dark. Pereon scarcely pitted, dorsolateral grooves distinct and simple. Pereonite 1 without ventral keel. Pereonites 4–7 with strong, transverse groove delineating an elevated anterior part of dorsal surface; elongate dorsal pits on 4–6. Pleonites 1–5 with small epimera, dorsolateral groove simple, extending to posterior margin. Pleonite 6 long, about 0.25 length of pleon, distinct from telson. Telson with a high narrow median crest sloping gradually posteriorly but with a steep anterior edge; narrowing to a broad, slightly upturned end. Uropod peduncle without medial lobe; endopod not reaching to end of telson, concave medial and convex lateral margins; exopods meeting dorsally over telson, basal part divided from dorsal by sharp angle on margin and produced to end of peduncle.

Antenna 2, article 2 very long, dorsal flange narrow, less than half width of front of head; flagellum of 5 articles, longer than peduncle article 5. Mandible with prominent molar bearing sharp accessory tooth; palp much longer than incisor, article 2 the longest bearing 2 long subterminal setae, article 3 narrow with an oblique row of 13 setae. Maxilla broad, large end with 6 hooks and 2 spines. Maxilliped articles 2, 3 very broad, much produced laterally; article 3

angular terminally, medial margin with 12 short setae distally and 4 longer setae proximally, ventral face with 2 setae near distal suture; article 4 triangular, subterminal, exceeding end of 3, with 11 setae. Pereopod 1 with sinuous, blade-like palm on axis of limb, densely setose medially and laterally near palm edge; unguis 0.35 length of dactylus.

Male. Differs from above description in: multiarticulate antenna 1 (broken in single specimen available), setose palm on pereopod 1; longer, flatter telson, appendix masculinis 0.35 length of inner ramus of pleopod 2 and not reaching to its end.

Development. A single male specimen, 30 mm long, was taken from stn 34 on 27th February, 1973; maximum size of non-males 28 mm.

Types. Australian Museum. Holotype, No. P.20439, subadult 22 mm long. Allotype, No. P.20440, male 30 mm long. Paratype series, No. P.20441, 5 specimens.

Type locality. New South Wales shelf, off North Head, SBS stn 22, 66 m, medium coarse sand sediment, 23rd January, 1973.

Material. New South Wales shelf, off North Head, SBS stns: 20 (4 specimens), 21 (1), 22 (1), 34 (1); off Malabar, SBS stn D2S4 (1).

Distribution. New South Wales shelf; 46–66 m; medium fine to medium coarse sand sediments.

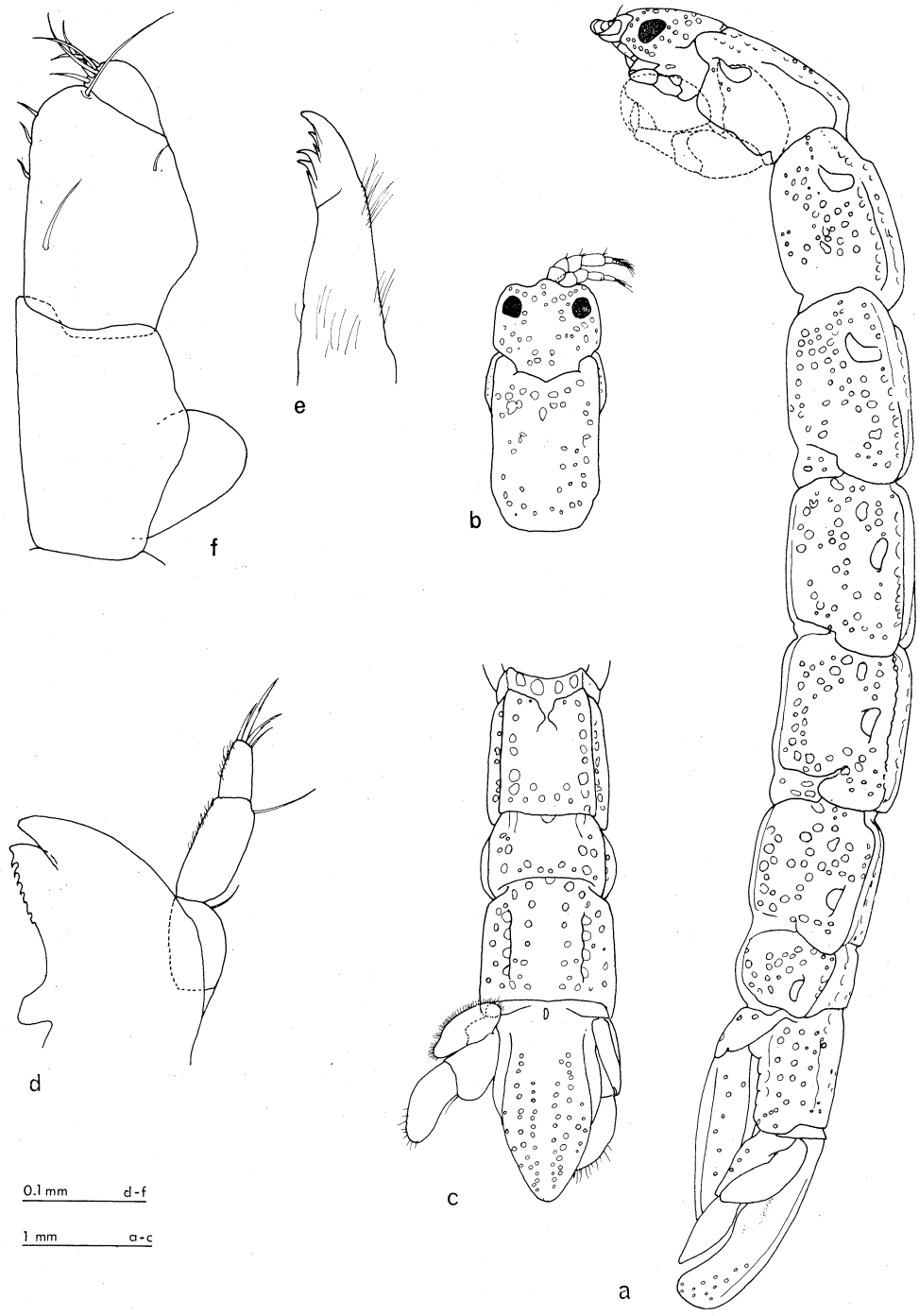

Fig. 11.—*Haliophasma pugnatum* n. sp. Holotype: a, whole specimen, pereopods removed, left aspect; b, anterior end, dorsal aspect; c, posterior end, dorsal aspect; d, mandible; e, maxilla; f, maxilliped.

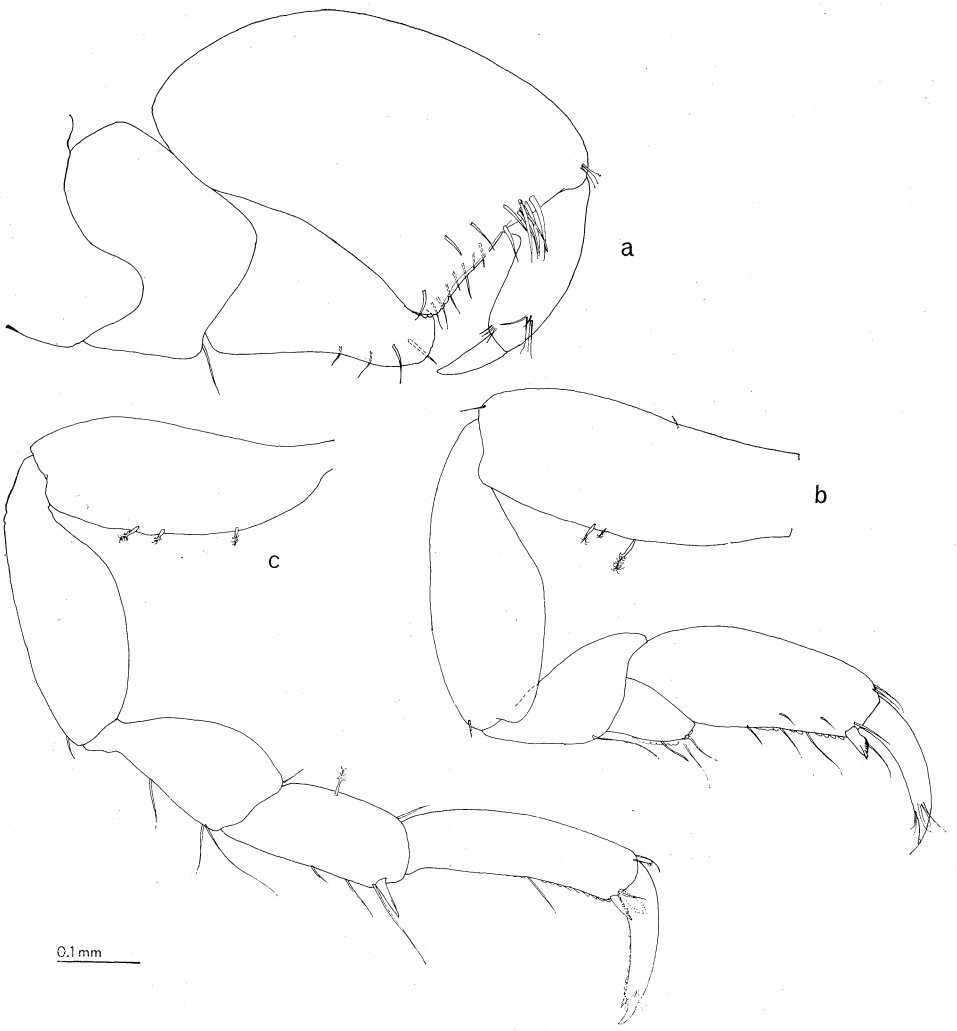

Fig. 12.—*Haliophasma pugnatum* n. sp. Holotype: a–c, pereopods 1, 2, 7.

Haliophasma pugnatum, new species

Figures 11, 12

Description. Head wider than long, strongly pitted dorsally and laterally; rostrum broad, rounded-truncate, longer than anterolateral lobes; cheek not distinct from lobes, shallowly curved ventral margin; eyes dark. Pereon with strong dorsolateral grooves complicated by pitting, extensively pitted dorsally and laterally. Pereonite 1 with obsoletely bilobed ventral keel, not produced anteriorly. Pereonites 4–6 with transverse step between major part of dorsal surface and the anterior depressed area which bears 4 large pits; dorsal pit a large keyhole-shaped notch

at midpoint of this step. Pleonites 1–5 with small epimera, dorsolateral groove distinct, complicated by pits and not reaching back to posterior margin; pitted laterally but free of pits mid-dorsally. Pleonite 6 not separate from telson mid-dorsally. Telson thick, especially terminally; 3 similar, low, smooth ridges (1 median, 2 lateral) separated by wide shallow, pitted depressions along most of length of telson and meeting anteriorly on a smooth plane; deep, elongate slit at base of this plane near fusion with pleonite 6; narrowly rounded terminally. Uropod peduncle with a rounded medial lobe, endopod not reaching to end of telson, elongate, sharply rounded terminally, concave medial margin; exopods much exceeded by telson dorsally and widely separate, dorsal margin sinuous, rounded posteriorly, little longer than peduncle.

Antenna 2, article 2 very short, dorsal flange rounded, much less than half width of front of head; flagellum of 6 articles, shorter than peduncle article 5. Mandible with a prominent, blunt molar lacking accessory tooth; palp reaching to about end of incisor, article 2 the longest with a single subterminal seta, article 3 narrow with a transverse row of 4 setae. Maxilla very stout, tapering to an almost straight, large toothed end; 5 hooks and 2 spines. Maxilliped articles 2, 3 broad, laterally produced; article 3 rounded terminally, 3 setae on medial margin, ventral face with 1 proximal seta, 1 on distal suture and 1 near outer distal corner; article 4 large, oval, subterminal, well exceeding 3, with 5 setae. Pereopod 1 with straight, blade-like palm, strongly inclined to axis of limb, few medial setae and lateral setae near palm edge; dactylus stout, unguis 0.25 its lenth.

Male. Unknown.

Development. Mature specimens were not found. A single juvenile (length 5 mm) lacking pereopod 7 was found at stn 41N. Maximum size recorded 11.4 mm.

Types. National Museum of Victoria, Holotype No. J.253, subadult, 11.4 mm long. Paratype series, No. J.268, 2 specimens.

Type locality. Western Port Bay, Crib Point, CPBS stn 25S, 8 m, muddy sand sediment, 25th February, 1965.

Material. Western Port Bay, Crib Point, CPBS stns: 03S (3 specimens), 25S (1), 41N (1), 51S (1).

Distribution. Western Port Bay, Victoria; 0–16 m; muddy to coarse sand sediments.

Fig. 13.—*Haliophasma purpurem* Haswell, 1881. Holotype: a, whole specimen, pereopods removed, left aspect; b, head, dorsal aspect; c, posterior end, dorsal aspect; d–f, pereopods 1, 2, 7; g, mandible; h, maxilla; i, maxilliped.

Haliophasma purpureum Haswell, 1881

Figure 13

Haliophasma purpurea Haswell, 1881: 447; Pl. 18, fig. 3 (not fig. 2).—Haswell, 1882: 305–6.—Barnard, 1925a: 132; Pl. 4, fig. 3.

H. purpureum.—Haswell, 1884: 1012; Pl. 53, figs 6, 7.

Description. (Queries in this description result from the age of the material.) Head much longer than wide, lateral margins curving, narrower anteriorly, smooth; rostrum short, broad, a rounded point shorter than anterolateral lobes; cheek deep, angled anteriorly; eyes? Pereon with distinct, simple dorsolateral grooves, few lateral pits, Pereonite 1 without ventral keel. Pereonites 4–6 with a shallow, wide transverse groove delimiting an elevated anterior part of the dorsal surface; dorsal pit elongate, waisted. Pleonites 1–5 with clear epimera, dorsolateral groove present but not reaching to posterior margin. Pleonite 6 separate from telson. Telson thick, wih broad ventrolateral flanges proximally; 3 (1 median, 2 lateral)narrow, close ridges separated by narrow grooves, coalescing anteriorly; narrowing abruptly distally to an obtuse end. Uropod peduncle without medial lobe but medial margin produced distally; endopod not reaching to end of telson, convex on both medial and lateral margins, sharply rounded end; exopod scarcely exceeds telson dorsally, cleft posteriorly, little longer than peduncle.

Antenna 2, article 2 very long, dorsal flange little narrower than half width of front of head; flagellum of 7 articles, about as long as peduncle article 5. Mandible with a short, blunt molar with no accessory tooth; palp reaching well beyond incisor, article 2 the longest, bearing 1 subterminal and 1 lateral setae, article 3 lanceolate, with an almost-axial row of 13 setate. Maxilla narrow, gently curved; 6 hooks and ? 1 spine. Maxilliped articles 2, 3 broad produced laterally; article 3 with subacute end, ? 11 short setae on medial margin, ventral face with 2 setae in mid-area (insertions only shown in fig. 13i) and 1 terminally near distal suture; article 4 very large, ovoid-triangular, subterminal, greatly exceeding 3, with ? 8 setae. Pereopod 1 with an almost-straight, blade-like palm on axis of limb, densely setose medially and a few lateral setae near palm; unguis 0.25 length of dactylus.

Male. Unknown.

Development. Largest specimen 29 mm long.

Holotype. Australian Museum No. 526, subadult 25 mm long.

Type locality. Port Jackson (Sydney Harbour).

Material. Australian Museum Collection: holotype; P. 3314 (3 specimens).

Distribution. Port Jackson, New South Wales.

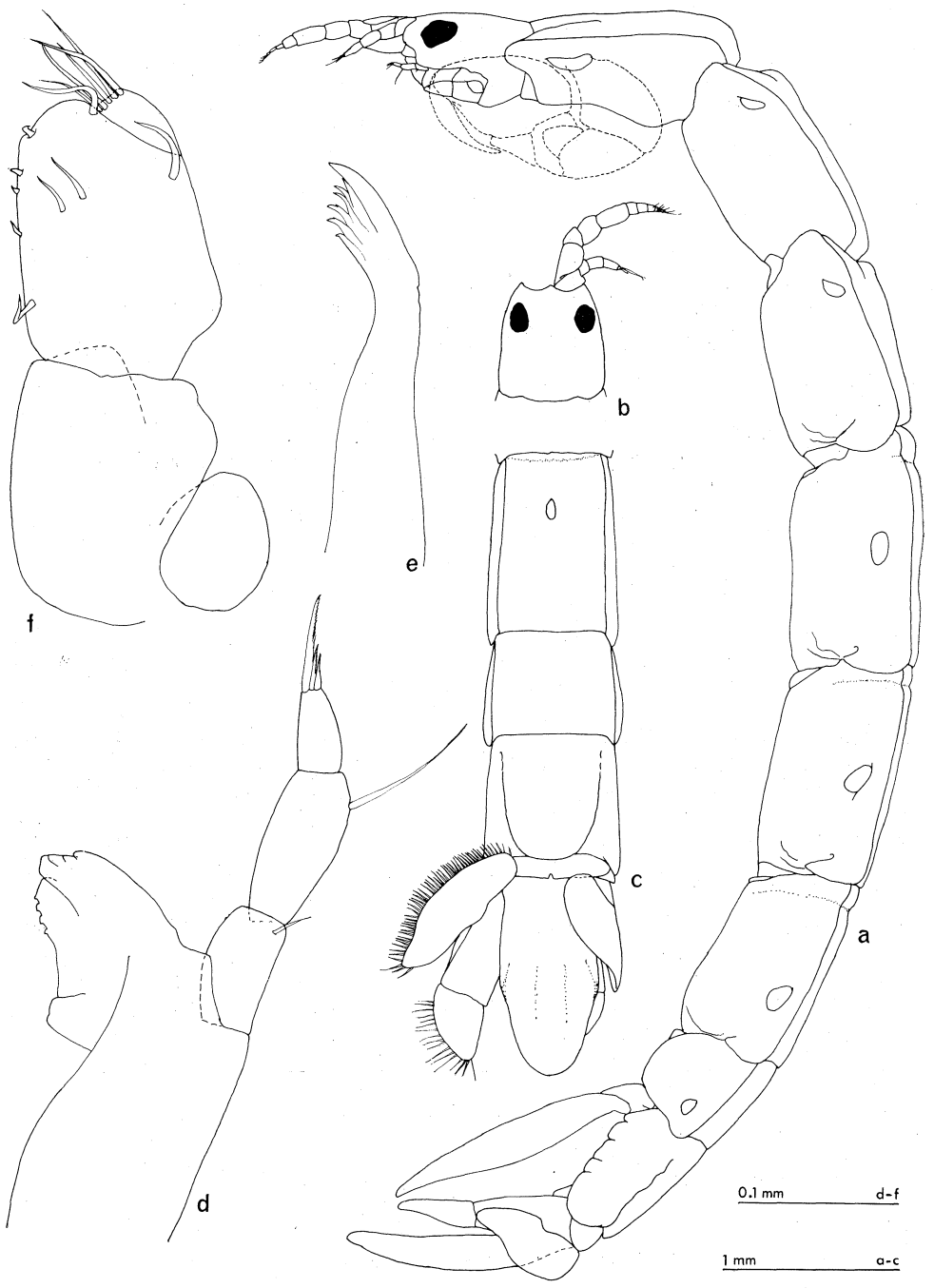

Fig. 14.—*Haliophasma syrtis* n. sp. Holotype: a, whole specimen, pereopods removed, left aspect; b, head, dorsal aspect; c, posterior end, dorsal aspect; d, mandible; e, maxilla; f, maxilliped.

Haliophasma syrtis, new species

Figures 14, 15

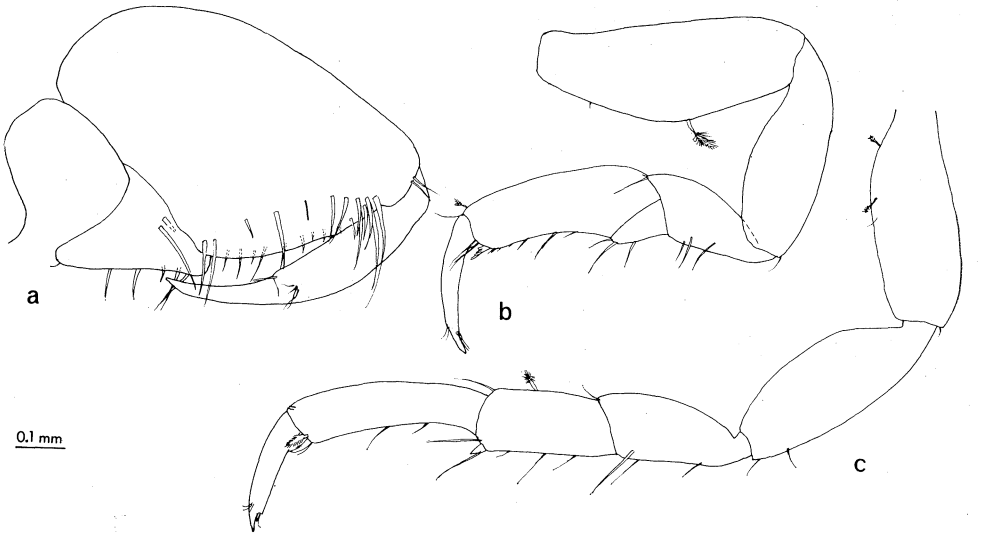

Fig. 15.—*Haliophasma syrtis* n. sp. Holotype: a–c, pereopods 1, 2, 7.

Description. Head little longer than wide, scarcely tapering except anteriorly; rostrum broad, acute subequal to anterolateral lobes; cheek deep, rounded anterior margin; eyes dark. Pereon with clear, simple dorsolateral grooves, not pitted but surface uneven. Pereonite 1 without ventral keel. Pereonites 4–6 with a shallow, anterior transverse groove and separate oval dorsal pit. Pleonites 1–5 with distinct dorsolateral groove running into the posterior margin. Pleonite 6 separate from the telson. Telson with 2 obsolete depressions dorsally, separating very low median and lateral ridges near the midpoint, these not distinct on proximal half and coalescing distally; tapering to a broadly rounded end. Uropod peduncle without a medial lobe; endopod not reaching to end of telson, medial margin straight, lateral margin convex; exopods with sinuous dorsal margins meeting dorsally over telson, reaching to end of peduncle.

Antenna 2, article 2 long, dorsal flange broadly curved, less than half width of front of head; flagellum of 7 articles, subequal to peduncle article 5. Mandible short, lacking accessory tooth, palp extending well beyond incisor, article 2 the longest, with 1 long subterminal seta, article 3 narrow, with 3 terminal setae. Maxilla broad, gently curved to large toothed end; 6 hooks and 1 spine. Maxilliped articles 2, 3 broad, laterally produced; article 3 with rounded end, medial margin with 4 short setae and 1 long seta proximally, ventral face with 2 setae in mid-area and 2 near distal suture; article 4 small, subterminal, scarcely exceeding 3, with 5 setae. Pereopod 1 with a slightly convex, blade-like palm, few medial setae and some laterally near palm edge; unguis 0.4 length of dactylus.

Male. Unknown.

Holotype. Australian Museum No. P.20442; subadult 9.5 mm long.

Type locality. Moreton Bay, Middle Banks off Tangalooma, MBBS stn 37, 12.5 m, clean sand, 9th December, 1972.

Material. The holotype.

Distribution. Moreton Bay, Queensland; shallow sandy sediments.

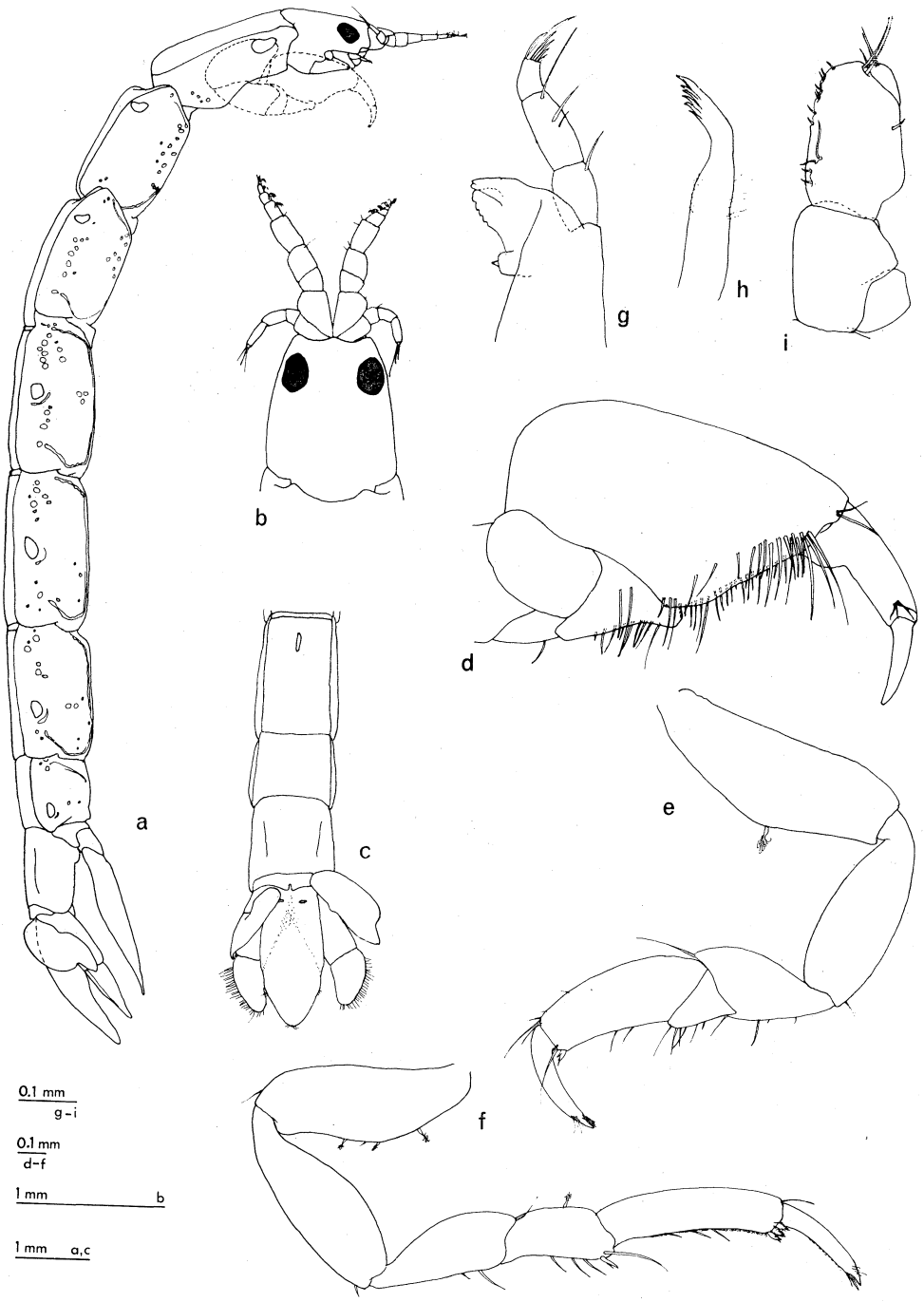

Fig. 16.—*Haliophasma yarra* n. sp. Holotype: a, whole specimen, pereopods removed, right aspect; b, head, dorsal aspect; c, posterior end, dorsal aspect; d–f, pereopods 1, 2, 7; g, mandible; h, maxilla; i, maxilliped.

Haliophasma yarra, new species

Figure 16

Description. Head much longer than wide, narrowing anteriorly, not pitted; rostrum very broad and short, as long as anterolateral lobes; cheek with a straight ventral margin, sharp anterior corner; eyes dark. Pereon with distinct simple dorsolateral grooves, with few lateral pits. Pereonite 1 without ventral keel. Pereonites 4–6 with an anterior transverse groove close to preceding segment; elongate dorsal pit. Pleonites 1–5 with shallow dorsolateral groove not extending back to posterior margin. Pleonite 6 distinct from telson and elevated from it. Telson with a smooth dome on the distal half flattening posteriorly and tapering to a bluntly rounded medial ridge anteriorly. Uropod peduncle without a medial lobe; endopod not reaching to end of telson, medial margin straight, convex lateral margin; exopods meeting mid-dorsally over telson, produced to an acute apex separated from dorsal part by a sharp angle, longer than peduncle.

Antenna 2, article 2 long, dorsal flange little narrower than half width of front of head; flagellum of 5 articles, about as long as peduncle article 5. Mandible with a short molar bearing a small accessory tooth; palp much longer than incisor, article 2 longest bearing 1 long subterminal seta and 2 lateral setae, article 3 narrow, curved, with a transverse row of 6 setae. Maxilla narrow, sharply curved; 6 hooks and 1 spine. Maxilliped articles 2, 3 broad, produced laterally; article 3 almost truncate terminally, medial margin with 10 short setae, ventral face with 2 proximal setae and pair + 1 near distal suture; article 4 small, ovoid, subterminal, level with end of 3, with 3 setae. Pereopod 1 with an almost-straight, blade-like palm on axis of limb, densely setose medially and a few setae on lateral edge of palm; unguis 0.4 length of dactylus.

Male. Unknown.

Development. Pereopod 7 was absent on specimens 5 mm long. Maximum length about 22 mm.

Types. National Museum of Victoria. Holotype, No. J. 254, subadult 15 mm long. Paratype series, J. 269, 4 specimens.

Type locality. Port Phillip Bay, Prince George Bank, PPBES stn 945, 4 m, silty sand sediment, 16th November, 1971.

Material. Port Phillip Bay, PPBES stns: 945 (7 specimens), 953 (1), 230 (1).

Distribution. Port Phillip Bay, Victoria; 3–8 m; silty sand to sandy sediments.

Key to Australian Species of **Haliophasma**

1 Rostrum prominent, about one-fifth length of head; dactylus of pereopod 1 strongly curved, article 6 cylindrical; maxilliped article 4 terminal, about one-third length of article 3 ..... *H. falcatum*
— Rostrum small; dactylus of pereopod 1 curvilinear, palm blade-like, maxilliped article 4 subterminal, less than one third length of article 3 2

2 Head wider than long; rostrum broad, rounded-truncate, longer than anterolateral lobes; pereon and pleon strongly pitted or scultpured dorsally and laterally 3
— Head as long as or longer than wide; rostrum acute to subacute, as short as or shorter than anterolateral lobes; pereon and pleon weakly or not pitted laterally and dorsally 5

3 Pereopod 1 palm strongly oblique ..... *H. pugnatum*
Pereopod 1 palm on axis of limb 4

4 Pereon with 2 pairs of low carinae dorsally, separated by deep pitted grooves ..... *H. canale*
— Pereon with dorsolateral grooves and few pits dorsally ..... *H. cribensis*

5 Exopod of uropod cleft; maxilliped article 4 extending well beyond mediodistal corner of article 3 ..... *H. purpureum*
— Exopod of uropod with sinuous dorsal margin, not cleft; maxilliped article 4 level with or exceeded by mediodistal corner of article 3 6

6 Telson not sculptured or ridged dorsally, a simple dome 7
— Telson with crest, ridges or pits dorsally 8

7 Pereopod 1 with straight palm on axis of limb ..... *H. yarra*
— Pereopod 1 palm strongly convex ..... *H. cycneum*

8 Telson with a high, narrow dorsal crest ..... *H. pinnatum*
— Telson without a crest 9

9 Telson with broadly rounded end ..... *H. syrtis*
— Telson with acute, upturned end ..... *H. elongatum*

Non-Australian Species of **Haliophasma**

H. alaticaudum Amar, 1966
H. alaticauda Amar, 1966: 193–9; figs 1, 2.
Canon de Cassidaigne, Mediterranean coast of France; 470–500 m.

H. coronicaudum Barnard, 1925
H. coronicauda Barnard, 1925a: 132.—Barnard, 1925b: 386–7.—Barnard 1940: fig. 3d.
Off Saladanha Bay, South Africa; 157 m.

H. curri Paul and Menzies, 1971
H. curri Paul and Menzies, 1971: 39–40; figs 16, 17,
Off Venezuela; 11° 03′ N, 64° 37.5′ W; 95 m.

H. dakarensis Barnard, 1925
H. dakarensis Barnard, 1925a: 133; Pl. 4, fig. 4.
Dakar, West Africa; 21–25 m.

H. foveolatum Barnard, 1940
H. foveolata Barnard, 1940: 384–5; fig. 2.—Barnard, 1955: 50–1; fig. 24.
False Bay, Port Elizabeth, South Africa; amongst corallines, worm-tubes, etc., under stones.

H. geminatum Menzies and Barnard, 1959
H. geminata Menzies and Barnard, 1959: 17–19; figs 11–12.—Menzies, 1962: 339.—Schultz, 1964: 312.—Schultz, 1966: 13.—Schultz, 1969: 103; fig. 141.
South California and northern Mexico, coastal shelves, slopes and submarine canyons, Santa Catalina Island, Santa Rosa Island, Coronada Canyon; 9–510 m.

H. hermani Barnard, 1940
H. hermani Barnard, 1940: 383–4; fig. 1.
Hermanus, South Africa; from cavity in *Allopora* coral.

H. irmae Paul and Menzies, 1971
H. irmae Paul and Menzies, 1971: 38–39; figs 14, 15.
Off Venezuela; 11° 03′ N, 64° 37.5′ W; 95 m.

H. ornatum Barnard, 1957
H. ornatum Barnard, 1957: 3; fig. 2.
Sea Point, South Africa; intertidal.

H. pseudocarinatum Barnard, 1940
H. pseudocarinata Barnard, 1940: 385–7; fig. 3.—Barnard, 1955: 5.
Port Elizabeth, False Bay, Algoa Bay, South Africa; under stones.

H. tricarinatum Barnard, 1925
H. tricarinata Barnard, 1925a: 132, Pl. 4, fig. 2.—Barnard, 1925b: 385.
Agulhas Bank, Cape St Blaize, South Africa; 73 m.

H. valeriae Paul and Menzies, 1971
H. valeriae Paul and Menzies, 1971: 37–38; figs 12, 13.
Off Venezuela; 11° 03′ N, 64° 37.5′ W; 95 m.

DISCUSSION

The diagnosis of the genus *Haliophasma* given here differs from that of Barnard (1925a) in two important aspects: (1) the maxilliped is of only 4 articles (never 5), and (2) the flagellum of antenna 1 is of 2 articles, the second minute (never multiarticulate except in adult males). The structure of the maxilliped

was the major character used by Barnard to distinguish genera in the Anthuridae and only *Haliophasma* was ambiguous in this respect. Four of Barnard's species are described as having 5-articulate maxillipeds and a multiarticulate (5–8 articles) flagellum on antenna 1 (*H. coronicaudum, H. dakarensis, H. foveolatum* and *H. pseudocarinatum*). These features and others, e.g., distinguishable pleon sutures in *H. coronicaudum,* form of the uropod endopod in *H. dakarensis* and *H. pseudocarinatum,* and the toothed pereopod 1 palm in the male *H. foveolatum,* suggest that these species should be moved to other genera. *H. hermani* also has a 5-articulate maxilliped but the antenna 1 is of the *Haliophasma* form. The description of *H. ornatum* is inadequate to place it with certainty and Barnard was undecided as to the number of maxilliped articles in *H. tricarinatum.* All of these seven species differ from the related genera *Malacanthura* Barnard, 1925, and *Apanthuroides* Menzies and Glynn, 1968, in a number of important aspects. It is not possible at this stage to place these species in other defined genera without examination of the original material.

The four American species (*Haliophasma geminatum, H. curri, H. irmae* and *H. valeriae*) are all described as lacking dorsal grooves and pits which excludes them from the genus as defined here. In addition *H. curri* posesses a 5-articulate maxilliped but is otherwise similar to *H. geminatum.* Paul and Menzies (1971) suggested that the remaining two species could be placed in a separate related genus on the basis of the teeth on the inferior margin of the dactyl of pereopod 1.

Haliophasma as diagnosed in this paper is most closely related to *Exanthura* Barnard, 1914, from which it differs mainly in the non-segmented pleon, and to *Notanthura* Monod, 1972, distinguished, among other features, by the absence of eyes.

The Australian species of *Haliophasma* can be divided into three groups as is done in the first two couplets of the key.

(1) *H. falcatum* is distinguished from all other species by the form of the rostrum, eyes, mandibular palp, maxilliped and pereopod 1.

(2) The three other species from Western Port Bay, *H. canale, H. cribensis* and *H. pugnatum,* differ from the remaining species in the shape of the head, peduncle of antenna 2, and extensive sculpture. They share the stepped transverse groove on the dorsal surface of pereonites 4–7 and modified dorsal pit, ventral keel on pereonite 1, reduced uropod exopod and medially lobed uropod peduncle.

(3) The remaining six species have in common the minute rostrum, tapering head, long antenna 2 and obsolete pitting. *H. purpureum* is separate from others in this group in having a strongly cleft uropod exopod and is also distinguished by the large article 4 of the maxilliped, approaching *H. falcatum* in this character. The species in this group differ most obviously in the form of the telson but are otherwise similar in, e.g., the shape of the maxilliped, mandibular palp and pereonal dorsal sculpture.

Only one non-Australian species of *Haliophasma* falls within the generic diagnosis used here. *H. alaticaudum* Amar is most closely allied to *H. cribensis* and related species on the basis of the shape of the head and uropods, and sculpture of the pereon, pleon and telson.

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