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Additions to the Ascothoracidan Fauna of Australia and South-east Asia (Crustacea, Maxillopoda): Synagogidae (part), Lauridae and Petrarcidae

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ABSTRACT. Previous Australian records of Ascothoracida are summarised. In the Synagogidae, three new species of *Gorgonolaureus* Utinomi are described from primnoid (*Pterostenella plumatilis* (Rousseau)), paramuriceid (unidentified), and gorgoniid (*Eunicella* sp.) gorgonacean hosts off Western Australia, Vietnam, and New Caledonia, respectively. The first two species are from unusually shallow depths, 80 to 100 m, the third from bathyal depths. *Flatsia* n.gen., with one species from 73 to 82 m depth off New South Wales, host unknown, is provisionally assigned to the Synagogidae. In the Lauridae, two new species of *Baccalaureus* Broch are described from the subtidal zoanthid *Isaurus tuberculatus* Gray on the Great Barrier Reef and the solitary zoanthid *Sphenopus marsupialis* Steenstrup at several shallow sites (40–86 m) off Queensland and Western Australia and in the Andaman Sea. In the Petrarcidae, morphological and ecological notes on *Petrarca okadai* Grygier infesting the coral *Heteropsammia cochlea* (Spengler) at Lizard Island, Queensland, are presented. Two new species of *Petrarca* Fowler are described infesting the solitary coral *Fungiacyathus* sp. off Moreton Bay, Queensland, and the hermatypic reef coral *Turbinaria reniformis* Bernard at Lizard Island. An unnamed species of *Petrarca* from the solitary coral *Anthemiphyllia dentata* Alcock collected between 110 and 350 m off Queensland is partly described. A list and some photographs of other new records of galls caused by petrarcid ascothoracidans in various Indo-Pacific scleractinians, especially *Turbinaria* spp. and other dendrophylliids, are presented.

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Contents

The superorder Ascothoracida encompasses a diversity of parasitic crustaceans, the hosts of which include members of the echinoderm classes Asteroidea, Crinoidea, Echinoidea and Ophiuroidea, and anthozoans belonging to the Scleractinia, Zoanthidea, Gorgonacea, Alcyonacea and Antipatharia. Wagin (1976) published the most recent comprehensive review of the group, although since then the number of described species has more than doubled to about 90. Grygier (1987c) published an updated classification of the Ascothoracida, with two orders and six families, and summarised some of the morphological characteristics of the different genera in tabular form. This superorder, together with the Cirripedia and Facetotecta, is considered part of the maxillopodan subclass Thecostraca (Grygier, 1987b).

By 1986, several varieties of Ascothoracida were already known from Australian waters. Bernard (1896) described apparent petrarcid galls in *Turbinaria edwardsi* Bernard from north-western Australia but did not recognise them as such (cited by Zibrowius & Grygier, 1985). Pyefinch (1937) described the laurid *Baccalaureus torrensis* infesting the zoanthid *Palythoa howesii* Haddon & Shackleton at Thursday Island in the Torres Straits. Hickman (1959) described in good detail the dendrogastrid *Dendrogaster tasmaniensis* infesting the asteroid *Allostichaster polyplax* Müller & Troschel in south-eastern Tasmania. Kenny (1959) briefly noted another *Dendrogaster*, identified by him as *Myriocladus ludwigi* (le Roi), from the asteroid *Nepanthia belcheri* (Perrier) in Moreton Bay, Queensland. Zann (1980) showed a photograph of an unidentified *Dendrogaster*, host unspecified, and stated that an ascothoracidan parasite was known in the crown-of-thorns starfish *Acanthaster planci* (Linnaeus). Dr L.R.G. Cannon of the Queensland Museum (personal communication), the supposed source of the latter information (Zann, personal communication), assures me that it is a mistake and no such parasite is known; the true provenance of Zann's illustrated *Dendrogaster* is unclear. Grygier (1981) described the petrarcid *Petrarca okadai* infesting the coral *Heteropsammia michelini* Milne Edwards & Haime (i.e., *H. cochlea* (Spengler)) from Lizard Island, Queensland, based on specimens collected by Fisk (1981). Fisk also reported what may be the same parasite from *Heterocyathus aequicostatus* Milne Edwards & Haime at Lizard Island, and from both corals at Wistari Reef near Heron Island, Queensland (cited by Zibrowius & Grygier, 1985). Lowry (1985) described the synagogid *Cardomanica andersoni* from the deep-water gorgonian *Chrysogorgia orientalis* Versluys in the Tasman Sea and Muirhead & Ryland (1985) reported a possible *Baccalaureus* infesting the zoanthid *Isaurus tuberculatus* Gray on the Great Barrier Reef near Townsville, Queensland.

In 1987 I had the opportunity to visit most of the natural history museums of Australia in order to work up previously culled ascothoracidans, to screen collections of echinoderms and anthozoans for previously unnoticed forms, and to collect ascothoracidans in the field at the Lizard Island Research Station. The present report concerns the representatives of the families Lauridae and Petrarcidae and part of the Synagogidae that were discovered during that visit, together with other representatives of these taxa from nearby regions that came to me from other sources. All are members of the order Laurida. A preliminary report on my new findings of Australian Ctenosculidae and Dendrogastridae (order Dendrogastrida) has already been published (Grygier, 1988a), and the crinoid-infesting synagogid genus *Waginella* has also been treated elsewhere (Grygier, 1990a). I intend to treat the remaining portion of the Synagogidae, comprising several new species provisionally but unsatisfactorily attributed to the genus *Thalassomembracis* Grygier, together with similar forms from various European museums, in the context of a cladistic revision of all the gorgonian-infesting Ascothoracida.

All tables referred to throughout the text are in Appendix 1.

Synagogidae Gruvel, 1905

Gorgonolaureus Utinomi, 1962

Gorgonolaureus decurvatus n.sp.

Figs 1, 2, Tables 1, 2

Type material. HOLOTYPE and 9 PARATYPE females (Western Australian Museum, WAM 93-87) occupying polyp-covered cysts (Fig. 1A) on single colony (1 of 3 in

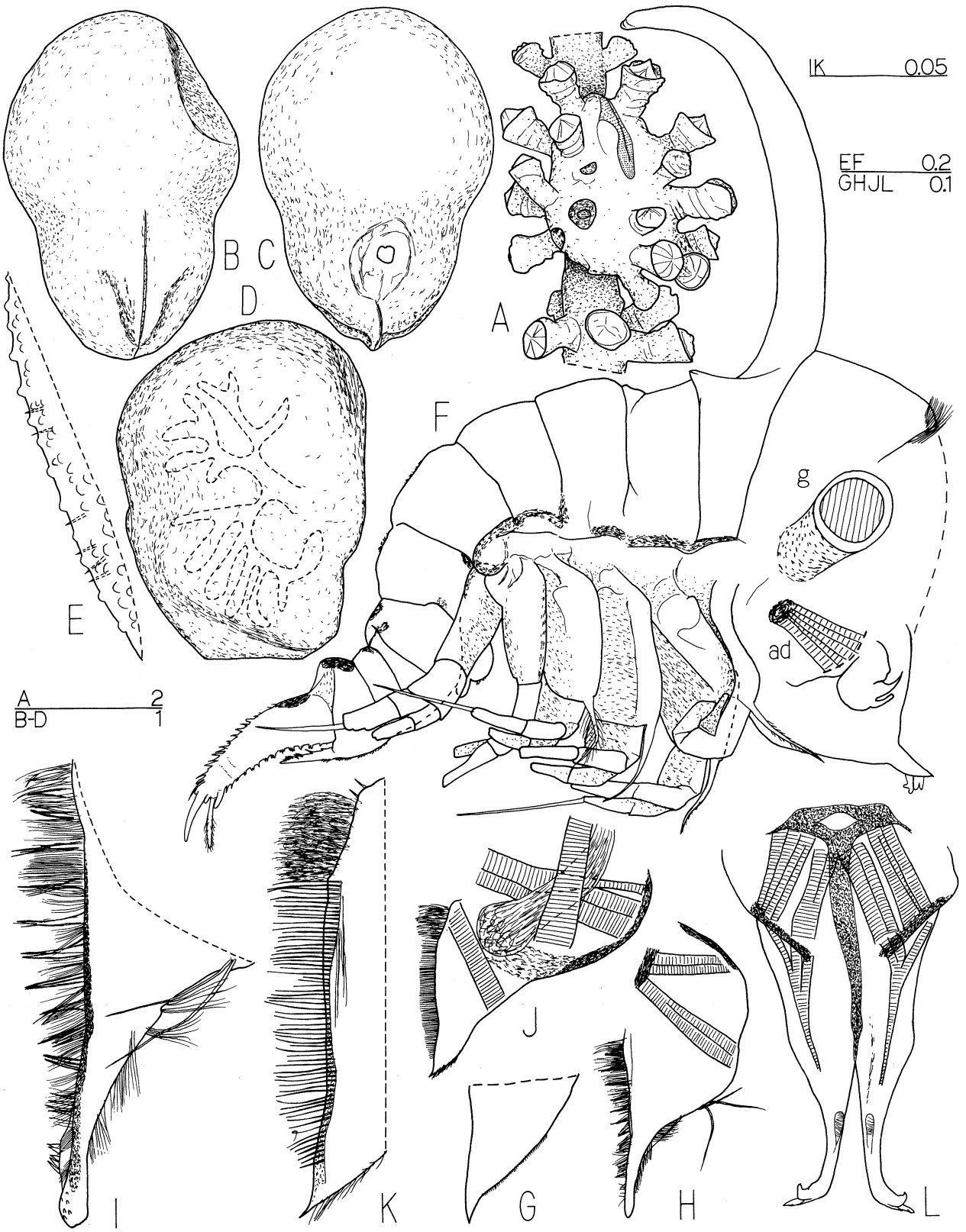

Fig.1. *Gorgonolaureus decurvatus* n.sp. (WAM 93-87). A, paratype #5 *in situ*. B, holotype, rear view. C–D, paratype #5, front and lateral views, latter with superimposed gut diverticulum of paratype #2 (dashed). E, lip of carapace aperture. F, body of paratype #1. G–L, mouthparts of paratype #1: G, medial languette; H–I, mandible and enlargement of its distal part; J–K, maxillule and enlargement of its medial edge; L, maxillae. Abbreviations: ad, adductor muscle; g, gut diverticulum. Scale bars in mm.

Fig.2. *Gorgonolaureus decurvatus* n.sp. (WAM 93-87). A, right antennule of paratype #1, medial view. B–F, thoracopods of paratype #2: B, composite of both thoracopods I; C, right II; D, left III; E, V (side uncertain); F, left VI; C–E with seminal receptacles in coxae, numbers in B,D,F corresponding to usage in Tables 2-5. G, abdomen of paratype #1 with penis, right telsonic spine, and right furcal ramus; H, furcal rami and right telsonic spine (left one absent) of paratype #2. Scale bars in mm.

jar) of gorgonian *Pterostenella plumatilis* (Rousseau) (WAM 12-87, determined by P. Alderslade), J. Marshall, F/V *Soela*, Stn SO 4B/82/64, 17 July 1982, 42.6 km east-north-east of Glomar Shoal, north-north-east of Dampier, WA, 19°25-26.6'S, 117°11-12.4'E, 98-90 m. 2 paratypes fully dissected, 2 others and holotype partly dissected to expose main body.

Diagnosis. Carapace of adult females less than 2.5 mm high, length 70-75% of height. Aperture margins lined with papillae, ventral half of carapace with external papillae and spinules; separate aperture for oral cone low on anterior side. Gut diverticulum on each side bifurcate, each branch with several side branches. Naked dorsal horn on thoracomere 2. Antennules very spinose, segment 5 with about 7 setae, segment 6 about as long as segment 5, with proximal sensory complex directly behind claw guard and aesthetasc of former standing separately. Thoracopods reaching farther ventrally than oral cone, with 7-9 setae on each distal exopod segment, 3-4 on each distal endopod segment, usually 2 ampoule-shaped seminal receptacles each in thoracopods II-V. Posteroventral telsonic spines over one third as long as furcal rami, latter tapered and strongly curved ventrally, with 3 short terminal setae, 1 subterminoventral seta, 7-11 short, thin, medial setae, and clusters of blunt spines along ventral margin.

Description of females (based principally on 2 paratypes). Dimensions of 5 specimens given in Table 1. Carapace univalved, with posteroventral, slit-like aperture along midline and separate small opening for oral cone near base of anterior midline (Fig.1B,C); rounded in front and rear view, with bulbous dorsal brood chamber atop narrower body chamber; oblong in side view, with nearly straight anterior side, rounded dorsum, and oblique posteroventral side surmounted by slight protrusion marking posterior end of aperture (Fig.1D). Aperture margins bearing small papillae and few short internal guard setae (Fig.1E); similar papillae on posteroventral outer surface, changing gradually into spinules farther dorsally and then disappearing. Lateral gut diverticulum in each half of carapace consisting of bifurcating dorsal branch and curved ventral branch with posteroventral side branches, ovary diverticulum relatively small, partly surrounding adductor muscle tentorium.

Main body (Fig.1F) attached anteroventrally within carapace and occupying its ventral third. Body of smaller dissected paratype 1.30 mm long from front of oral cone to tips of furcal rami. Body consisting of head with antennules and oral cone, 6-segmented thorax with dorsal horn on second segment and 6 pairs of biramous thoracopods reaching farther ventrally than oral cone, and 5-segmented abdomen with vestigial penis, posteroventral telsonic spines, and furcal rami. No eyes or frontal filament complexes observed. Thoracomeres nearly all of same length, transverse band of setae across front of slightly longer first segment; no filamentary appendages associated with first pair of thoracopods; dorsal horn naked, lightly curved posteriorly especially at tip, relative length of horn somewhat variable but generally slightly shorter than thoracic dorsum; pair of small, lateral epaulets on sixth segment. Abdominal segments all shorter than high, especially third and fourth.

Description of antennule based on right ones of 2 paratypes. Six-segmented, reaching to midlength of oral cone when folded (Figs 1F, 2A). First segment triangular, unarmed; second parallelogram-shaped with patches of long cuticular ctenae; third triangular, bearing numerous long, hair-like setae along anterior edge; fourth segment short, rectangular, with 2 short, spinulose setae and several spinules on anterior edge; fifth one nearly right triangular, with 6 or 7 short, spinulose setae along proximal two thirds of anterior edge and short cuticular ctenae posteriorly. Sixth segment little shorter than fifth, slightly curved and distally broadened to bear large, movable claw; surfaces heavily armed with spinules, 3 short setae clearly seen at base of claw in one specimen; robust claw guard with lateral flange and at least 2 apical setae (tip obscured in both preparations); short, cylindrical proximal sensory process with 3 setae directly behind claw guard, followed by separate short aesthetasc.

Oral cone triangular in cross section and in side view, tip produced into long, hypodermic needle-like point (Fig.1F). Labrum forming outer sheath of cone, lateral margins meeting and locked together behind other mouthparts. Medial languette triangular with minute hairs along anterior edge (Fig.1G). Mandible (Fig.1H,I) with broad, flat, muscular base narrowing to thin, bluntly pointed process; lateral edge with several long hairs and, farther distally, many shorter ones; medial edge with dense, fine hairs interspersed between regularly spaced clumps of thicker, spine-like hairs; tip with few minute, hook-like denticles. Maxillule (Fig.1J,K) with broad, muscular base containing nervous ganglion, and triangular distal part similar in shape and size to medial languette; lateral edge with few distal hairs, medial edge with mat of extremely fine hairs basally and about 63 comb setae along rest of edge, with web-like connection between setal bases. Maxillae fused basally, but distal 40% free, bifid tips bent laterally, ventral points somewhat hook-shaped (Fig.1L).

Thoracopods subequal in length, but second pair longest, others becoming slightly shorter towards rear (Fig.2B-F). Coxa longer than wide in thoracopods I and VI, trapezoidal and about as long as basal width in other pairs. Basis square or slightly shorter than wide except relatively longer in thoracopod I. Exopods 2-segmented with second segment slightly or moderately longer than first. Endopods shorter than exopods, 2-segmented in thoracopods I and VI, otherwise 3-segmented except aberrantly 2-segmented in one thoracopod III of paratype 2. Extensive lining of dense, fine hairs along margins of pairs II-IV, less on I and V, few on VI; cuticular ctenae also present, especially medially (mostly not illustrated). Setation of paratype 1 given in Table 2; terminal setae about as long as rami, and exopods of thoracopods II-VI with 3 apical setae, endopods with 2. Setation of paratype 2 similar except lateral coxal seta

unilaterally present on thoracopod V (position 1), 3-4 medial coxal setae present on thoracopods II and III (position 9), and no seta on proximal endopod segment of thoracopod I (position 6+7). All setae plumose except setules very short on thoracopod I. Two (occasionally 1) ampoule-shaped seminal receptacles each in thoracopods II-V, occupying lateral half of coxa, some of them empty (Fig.2C-E).

Abdominal segments 2-5 with many ventral cuticular ctenae (Fig.2G). Small penis rudiment on first segment reaching to end of second (Fig.2G); shaft with cuticular ctenae and in one specimen ending in small distal spine; rami short, unarmed. Telsonic spines with at least 2 rows of distally pointing spinules on dorsal side (Fig.2G,H). Furcal rami about as long as last 4 abdominal segments combined, basal height about half that of telson; rami curved downwards, tapering, about 2.5 times longer than basal height (Fig.2G,H). Three short terminal setae, naked middle one much shorter than spinulose others (one of latter missing on right side of paratype 2). Short, spinulose, subterminal seta on ventral edge. Row of short, very thin, simple setae along upper half of medial face, 10-11 in paratype 1, 7 in paratype 2. Ventral edge with about 15 clusters of short, rounded spines; dorsal margin, proximodorsal part of medial face, and distal part of lateral face set with cuticular ctenae; ventral half of medial face with small spinules proximally and pores more distally.

Nauplii. Four of 5 dissected specimens brooding eggs or nauplii, brood sizes about 20-50 (Table 1). Size and morphological details of nauplii difficult to determine due to larval retention of 2 unshed exuviae in one brood and at least 4 in another, but outermost cuticle averaging 442 µm long in those from paratype 2, living tissue averaging 384 µm (n = 25). Setation described following conventions of Grygier (1987a). On outermost cuticle of antennule, corresponding perhaps to instar I, proximal medial setae 'a' and 'b' not confirmed; of subapical setae, lateral 'd' longer than medial 'f', 'e' absent; most lateral of 3 apical 'g' setae a mere spine. Antennal exopod with 5 setae, mandibular exopod with 4 setae, endopodal setation of both limbs 0?-1-2, protopods obscured.

Remarks. *Gorgonolaureus decurvatus* n.sp. is quite similar to the type species, *G. bikiniensis* Utinomi, as redescribed by Grygier (1981c). Unfortunately, the mouthparts and some of the thoracopodal setation of the latter remain unknown. These species are the same size and have papillose margins of the carapace aperture and bifurcate gut diverticula (latter simpler in *G. bikiniensis*). Both have the fifth and sixth antennular segments nearly equally long, similar setation on the fifth segment, and the proximal sensory complex directly behind the claw guard. The setal counts of the distal segments of the thoracopodal rami usually differ by no more than 2, and both species have 2 seminal receptacles each in thoracopods II to V (interpreted as bilobed sacs in *G. bikiniensis*: Grygier, 1981c) and rather long, tapered furcal rami with a few distal setae and several medial ones, all setae short. In contrast, adult females of the other previously described species in this genus, *G. muzikae* Grygier (1981b), have a carapace over 5 mm high with distinctly scalloped aperture margins and highly branched gut diverticula. The sixth segment of the antennule is markedly shorter than the fifth, with about 12 setae on the fifth segment and the proximal sensory complex separated from the claw guard. *Gorgonolaureus muzikae* has about twice as many setae as *G. decurvatus* on the distal segments of the rami of thoracopods II to VI, clusters of 10 to 20 seminal receptacles in thoracopods II to V, and rectangular furcal rami with much more numerous, relatively longer setae.

Numerous differences from *G. bikiniensis* justify *G. decurvatus* as a new species. The former has spinules over the whole carapace, not just the ventral half, and its dorsal brood chamber is more spherical. The antennules of *G. bikiniensis* are not especially spinose, the claw is shorter and stouter, and the aesthetasc arises from the proximal sensory process proper. The dorsal horn has some long hairs and no band of setae was reported on the first thoracomere, although the latter may have been overlooked. The thoracopods and oral cone reach to about the same level in *G. bikiniensis*, the telsonic spines are small, and the furcal rami are straight, with the medial setae similar to the terminal ones.

The brooded nauplii of both previously described species of *Gorgonolaureus* are nearly twice as large as here (0.6-0.8 mm) but do retain a series of unshed exuviae like the present ones (Grygier, 1981c, 1987a). At least five instars could be demonstrated in *G. muzikae*, and that number also seems to be valid for *G. decurvatus*. Some short setae present in instar I nauplii of *G. muzikae* were not found here (cf. Grygier, 1981a: fig.2).

Gorgonolaureus bikiniensis was found on the paramuriceid gorgonian *Paracis squamata* (Nutting) at about 220 m at Bikini Atoll in the Marshall Islands, and *G. muzikae* infests an undescribed paramuriceid of uncertain generic affinity from about 366 m off Oahu, Hawaii. *Gorgonolaureus decurvatus* from north-western Australia represents a significant range extension of the genus into the Indian Ocean, and a much shallower depth of occurrence (90-98 m) than any reported until now for the four known genera of gorgonian-inhabiting ascothoracidans (previous records at 220 to 2000 m, but see *G. vietnamianus* n.sp. below). The host gorgonian, *Pterostenella plumatilis*, belongs to the Primnoidae, and is the first ascothoracidan host known in that family.

Etymology. Named for the decurved furcal rami.

Gorgonolaureus vietnamianus n.sp.

Figs 3–5, Table 3

Type material. HOLOTYPE female (Zoological Institute, Leningrad, ZIN 1/66583) and PARATYPE female (ZIN 2/66584), both brooding nauplii and dissected at least unilaterally. Encysted by numerous polyps at different sites on same 65 mm high and wide colony of

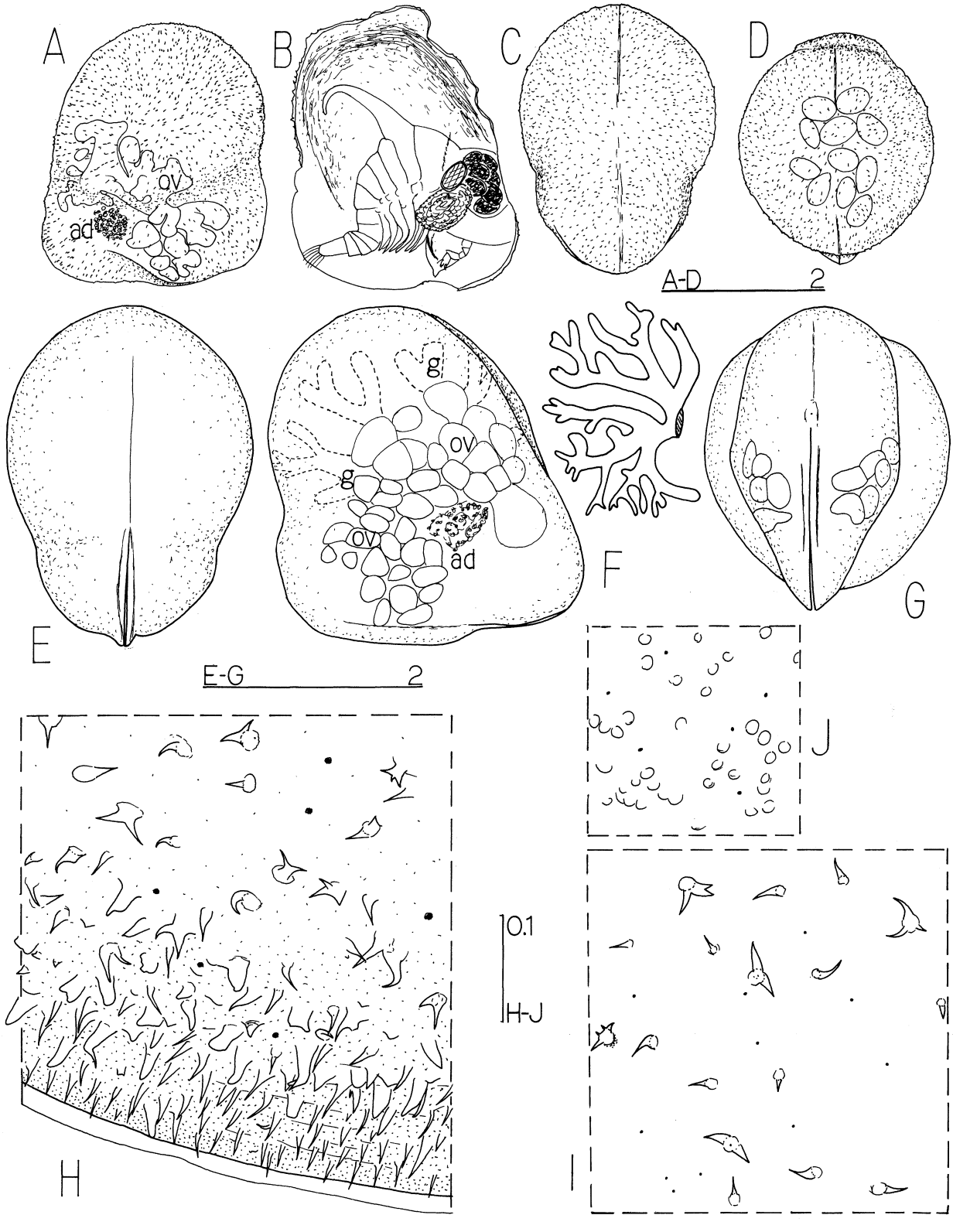

Fig.3. *Gorgonolaureus vietnamianus* n.sp. A–D, holotype female (ZIN 1/66583): A, lateral view; B, cutaway to expose main body; C, anterior view; D, dorsal view showing brooded nauplii. E–G, paratype female (ZIN 2/66584): E, rear view; F, lateral view showing organs within carapace and detail of gut diverticulum of opposite side; G, ventral view. H–I, carapace armament of holotype: H, along aperture; I, away from aperture; J, on inner lining. Abbreviations: ad, adductor muscle; g, gut diverticulum; ov, ovary diverticulum. Scale bars in mm.

Fig.4. *Gorgonolaureus vietnamianus* n.sp., holotype female (ZIN 1/66583). A, main body with most thoracopodal and furcal setae omitted. B, left antennule, lateral view. C, detail of right antennule, medial view. D–G, mouthparts: D, labrum, rear view with medial languette inside; E, distal part of mandible; F–G, distal parts of maxillules, G twisted to show setal origins along medial edge; H, maxillae. Abbreviations: ad, adductor muscle site; g, gut diverticulum; ov, ovary. Scale bars in mm.

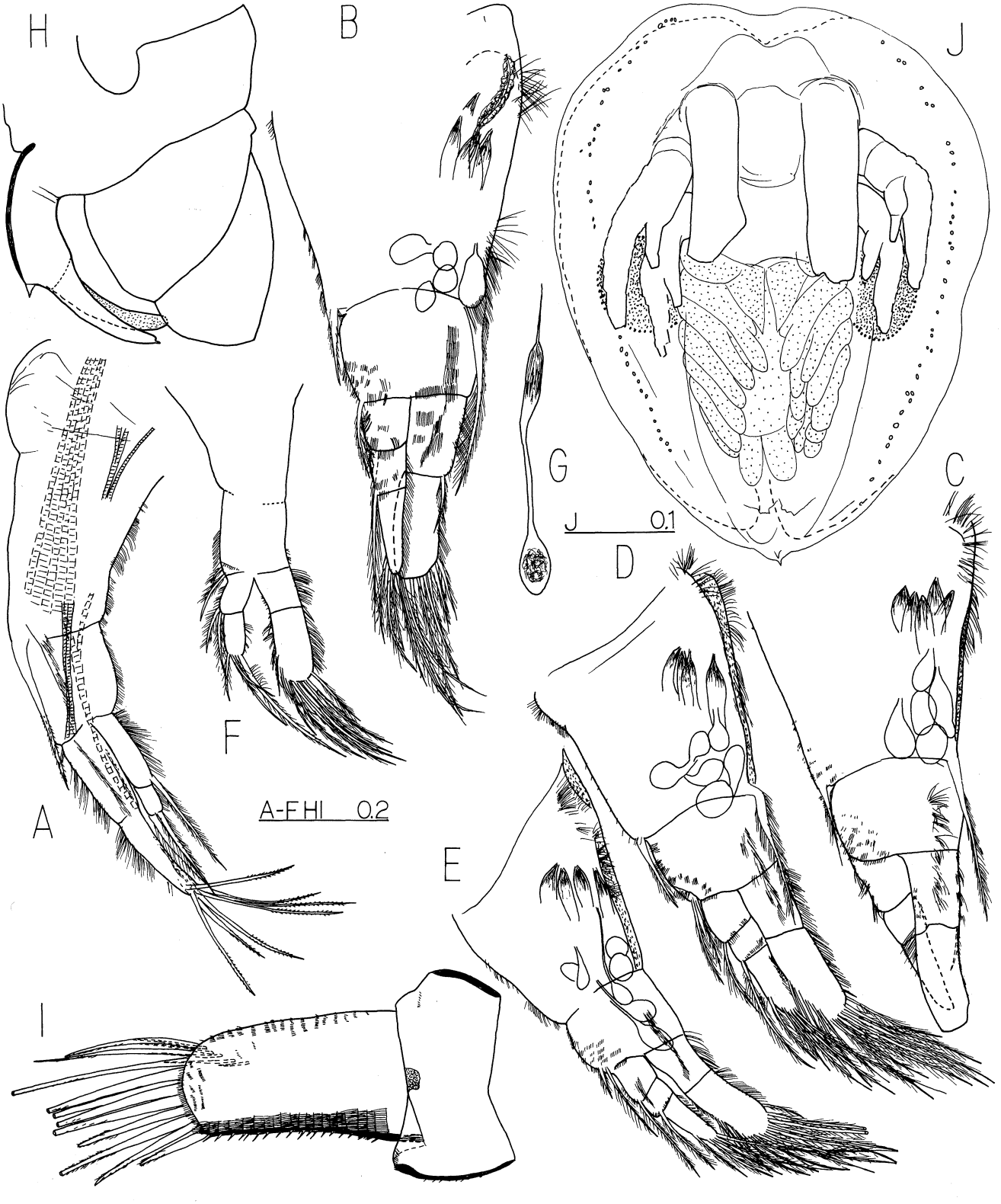

Fig.5. *Gorgonolaureus vietnamianus* n.sp. A–I, holotype female (ZIN 1/66583). A–F, left thoracopods I-VI respectively, all in front view except A. G, reconstruction of seminal receptacle (actual appearance shown in B–E). H, first 3 abdominal segments and penis. I, last abdominal segment and furcal ramus in lateral view. J, last-instar nauplius brooded by paratype (ZIN 2/66584) with developing ascothoracid larva (light stippling) and yolk masses (dark stippling) within, setae omitted. Scale bars in mm.

unidentified, uncatalogued paramuriceid gorgonian. E.F. Guryanova, *Pelamida* Stn 29, 27 July 1961, Vietnam, 10°01.6'N 108°35.6'E, 83 m, 34.60‰, 30.19°C, bottom of muddy sand, gravel and broken shells.

Diagnosis. Female carapace about 3 mm high, length 85-90% of height, aperture margins simple, external surface wholly covered with claw-like spinules. Gut diverticulum on each side with 3 main dorsal and 3 main ventral branches. Fifth antennular segment longer than sixth and with about 7 setae; proximal sensory process separated from claw guard, aesthetasc reduced to simple seta on latter. Dorsal horn on thoracomere 2 bearing minute spinule rows. Thoracopods reaching to midlength of oral cone. Distal segments of exopods and endopods of pairs II-V with 13-18 setae and 5-6 setae respectively; these limbs containing 5-9 seminal receptacles each, latter varying in diameter along length with round sacs at inner end. Telsonic spines absent; furcal rami broad, subrectangular, with many terminal and a few mediodistal setae.

Description. Holotype (Fig.3A-D) 3.3 mm high, 2.8 mm long ventrally, 2.0 mm wide dorsally; respective dimensions of paratype 3.2, 2.8, and 2.2 mm (Fig.3E-G). Carapace univalved, dorsal two thirds consisting of subglobular brood chamber, anterior side somewhat sloping, more so and with medial depression in paratype (Fig.3F). Rear half of somewhat narrower, ventral body chamber evenly tapered (Fig.3G), pair of ventrolateral bolsters in holotype only (Fig.3A). Aperture along posteroventral midline with simple margins, anterior end darkly pigmented; faint seam around most of rest of circumference except dorsally (Fig.3C-E,G). Outer surface covered with spinules and pierced by sparse pores; spinules most dense and diverse along aperture margins (needle-like to very thick and blunt; Fig.3H), with more widely scattered, mostly single and double, claw-like hooks elsewhere (Fig.3I). Delicate inner cuticle with abundant papillae and sparse pores (Fig.3J). Ripe oocytes visible within carapace wall (Fig.3A,F,G); gut diverticula of paratype consisting on each side of dorsal and ventral branch, each immediately dividing into 3, with little successive branching (Fig.3F), those of holotype similar but not clearly seen.

Body of holotype about 2.0 mm long from front of oral cone to tips of furcal rami, that of paratype about 1.8 mm, occupying ventral half of carapace with dorsal horn extending high into brood chamber (Figs 3B, 4A). Cephalic attachment zone vertical, attachment site low on anterior and anterolateral sides of carapace. Head with antennules and oral cone; no eyes or frontal filament complexes found. Extended antennules not reaching tip of oral cone. Adductor muscle tentoria and diverticula of gut and ovary leaving head dorsal to oral cone. Thorax 6-segmented, arched, first segment longest with anterior transverse row of short setae but no filamentary appendages; second segment with long, posteriorly curved horn bearing minute rows of short hairs or cuticular ctenae; sixth with pair of small epaulets. Six pairs of biramous thoracopods gradually decreasing in size posteriorly, tips reaching to midlength of oral cone. Abdomen 5-segmented, third and fourth segments shorter than others. Biramous penis on first segment, pair of furcal rami but no posteroventral spines on telson.

Description of antennules based mostly on holotype (Fig.4B,C). Six-segmented, Z-shaped; first segment short and triangular; second rhomboidal with hairs along part of anterior margin, third triangular with hairs along anterior margin; fourth very short with 2 setae; fifth long and tapered, with 7 anterior setae and some hairs along anterior margin and cuticular ctenae distally near posterior margin; border between third and fourth segments poorly evident in right antennule of holotype, borders between segments 3-5 obscure in paratype. Sixth segment shorter than fifth along anterior margins, narrow at both ends and heavily armed with cuticular ctenae; proximal sensory process at about midlength posteriorly with variably 4-5 setae (3-4 spinulose, apical ones; 1 simple, subapical one); cylindrical, non-flanged claw guard separated from and same size as sensory process, armed apically with 4 short, spinulose setae; weak apical claw with 3 setae anteriorly and to either side of its base.

Oral cone of holotype 0.62 mm long and deep, 0.88 mm wide including pair of lateral bulges (widest part of main body), edges of labrum meeting and joined by interlocking folds behind other mouthparts (Fig.4D). Medial languette 0.39 mm long, linguiform, with rounded tip and dense cover of fine hairs or cuticular ctenae (Fig.4D). Muscular bases of mandibles and maxillules not examined in detail due to damage in dissection; those of maxillules particularly large and occupying bulges in labrum. Distal part of mandible tapering to point (Fig.4E), with tufts of short hairs laterally and unruly short hairs densely placed along proximal two thirds of medial edge. Maxillules (Fig.4F,G) with short hairs at tip, at proximal end of medial side, and submarginally on anterior face; comb row of about 70 longer setae along most of medial margin, with 16 similar setae in groups of 1-6 forming very incomplete second row posterior to them. Maxillae tapered, basally fused, tips bifid with delicate anterior and posterior flanges and movable posterior hooks (Fig.4H).

First thoracopod about 1.7 times longer than sixth, with lateral swelling (genital papilla) at base (Fig.5A). Thoracopods (Fig.5A-F) paddle-like with long, tapered coxa, short rectangular basis (longer than wide in first pair, otherwise wider than long, protopod poorly segmented in sixth pair), 2-segmented exopod with long, equal segments in first pair, shorter ones with distal segment longer than basal in other thoracopods, and 3-segmented endopod (2-segmented in first and last pairs, unsegmented in left thoracopod I of paratype); endopod much shorter than exopod in first thoracopod due to minute proximal segment, in other thoracopods endopod at least three quarters as long as exopod, with first 2 segments together (or first alone in last pair) as long as first exopod segment. Thoracopod I lined with short, fine hairs medially, along lateral edge of exopod, and along medial edge of first exopod segment (Fig.5A).

Thoracopods II-V similarly lined laterally except on basis, with 2 distally converging rows on coxa; medial edges with shorter hairs and cuticular ctenae, latter also covering much of anterior side of medial part of basis and first 2 endopod segments (Fig.5B-E); other hairs fringing lateral side of distal endopod segment and medial side of distal exopod segment. Thoracopods I-V also with anterior field of longer hairs going from lateral part of basis onto first exopod segment. Thoracopod VI lined with fine hairs distal to midlength of basis (Fig.5F). Major setation of left thoracopods of both specimens compiled in Table 3, longest setae about as long as rami, paratype more setose. All setae plumose except for spinulose coxal and exopodal setae of first thoracopod. On endopods II-VI, lateralmost of 3 apical setae longest, but on exopods, longest of apical setae near middle of array, 5 apical setae in holotype, 6-7 in paratype, with no real distinction between apical and medial setae in last pair; usually 1-2 subapical lateral setae on exopods and large number of medial setae.

Seminal receptacles laterally within coxae of thoracopods II-V, about 5-7 per limb in holotype, 7-9 in paratype (Fig.5B-E). Shape not perfectly clear due to surrounding tissue; visible parts including round inner reservoir filled with amorphous substance and narrower, tapered, proximal end filled with longitudinally striated material (presumably sperm) and leading into fine duct surrounded by cord of cells (Fig.5B); proximal and distal parts assumed to be connected by unseen narrow tubes (Fig.5G).

Penis of holotype with short, curved, anteriorly thickened shaft ending in short spine and pair of curved, asetose rami (Fig.5H).

Furcal rami of holotype 0.41 mm long, 0.20 mm high basally, slightly tapered, tip slightly produced (Fig. 5I), those of paratype 0.35 mm long, 0.21 mm high basally and more tapered; lateral face with at least 20 ventral rows of long hairs and some short dorsal ctenae, medial face as seen in paratype largely covered with short ctenae. Holotype with 11 terminal setae on left ramus, longest ones almost as long as ramus, and 5 short, mediodistal setae; paratype with 13 terminal and 4 medial setae on left ramus; distal parts of setae biserially spinulose.

Nauplii (Fig.5J). Holotype brooding 112 nauplii (not illustrated) averaging 0.46 mm long, 0.36 mm wide (n = 9), with arrowhead-shaped yolk mass and 2 or maybe 3 unshed exuviae, at earliest stage of development of ascothoracid larva. Paratype brooding 95 late nauplii ready to molt to ascothoracid larva, averaging 0.47 mm long, 0.37 mm wide (n = 14), with 2 loose exuviae and smaller, bilobed yolk mass. More detailed information only available for paratype brood (Fig.5J). Frontal filaments and nauplius eye absent, dorsal pores present but pattern not discerned, equatorial pores present ventrally around rim, labrum very small, minute terminal papilla and bumpy furcal lobes present posteriorly. Antennules unsegmented, armed at a late instar (unclear which one, perhaps last) with 2 short medial setae ('a' and 'b'), small subapical claw rudiment, short subapical lateral seta ('f'), and 2 apical lobes, medial one bearing long and very short setae 'd' and 'e', lateral one bearing 1 very short and at least 1 long 'g' seta. Protopods of antennae and mandibles not clearly observed; exopods at third from last instar with 5 setae on antennae, 4 on mandibles, endopod with 2 apical setae on antennae, perhaps also on mandibles, proximal parts of apparently 2-segmented endopods not seen. Developing ascothoracid larva with short, rounded maxillules, pair of pointed maxillae, 6 pairs of biramous thoracopods, and furcal lobes.

Remarks. *Gorgonolaureus vietnamianus* n.sp. is about 50% larger than *G. bikiniensis* and has more highly branched gut diverticula, a relatively smaller sixth segment on the otherwise similar antennule, no long hairs on the thoracic horn, about twice as many setae on the distal segments of the thoracopodal exopods, multiple seminal receptacles instead of two per limb, no telsonic spines, much broader furcal rami with longer setae, and smaller metanauplii. Its overall appearance is somewhat more similar to *G. muzikae*, but the new species is about half as large as that one, with simple rather than interdigitating carapace aperture margins, less complicated gut diverticula, fewer setae on the fifth antennular segment (7 versus 11-12) and lacking two thin extensor muscles of the sixth segment that originate in the fourth segment in *G. muzikae* (cf. Grygier, 1987b), fewer setae on the distal endopod segments of thoracopods II-V (5-6 versus 7-11), differently shaped and fewer seminal receptacles, no posteroventral telsonic spines, and relatively longer furcal rami with slightly fewer setae. Some apparent differences from Grygier's (1981b) original description of *G. muzikae* are due to errors in the latter (Grygier, 1984b): wrong mouth position (before medial languette), missed transverse band of thoracic setae (present on first thoracomere), supposed partial medial fusion of thoracopodal coxae (medial margins simply shorter than lateral ones) – all actually as in *G. vietnamianus* n.sp.

The present nauplii are roughly comparable to those of *G. muzikae* (cf. Grygier, 1987a), though considerably smaller (0.46 mm versus 0.70 mm). However, while the present antennules have a claw rudiment and show more consolidation distally than instar III in *G. muzikae* (namely they are comparable to final instars of several other ascothoracidans; Grygier, 1987a, Grygier, in press, Itô & Grygier, 1990), the exopodal setae of the antennae and mandibles of the third from final instar are as few as in instar I of *G. muzikae*. Perhaps *G. vietnamianus* has only three naupliar instars, while *G. muzikae* is inferred to have at least five (Grygier, 1987a).

The present find is even more shallow, at 83 m, than *G. decurvatus* n.sp. reported above. In 1983 I examined an unidentified, *Gorgonolaureus*-infested, Indonesian gorgonian in the Copenhagen Zoological Museum from a similarly shallow depth, but it could not be located for detailed study a year later. The present host

gorgonian is a paramuriceid, and in older, obsolete classifications it would have been considered to belong to *Placogorgia* (F.M. Bayer, personal communication), but its poor condition and the lack of knowledge of South-east Asian gorgonians in general prevents a true identification.

Etymology. Named for the type locality, Vietnam.

Gorgonolaureus tricornutus n.sp.

Figs 6–8, Table 4

Type material. HOLOTYPE female (Muséum National d'Histoire Naturelle, Paris, MNHNP Ci2047) with carapace opened and trunk separated from head; 3 PARATYPES (Ci2048): dissected paratype female with brood, dissected male (right furcal ramus and frontal filament complex lost), and undissected specimen, sex uncertain; 2 old, empty cysts. Each specimen occupying separate cyst composed of several polyps on host gorgonian *Eunicella* sp., specimen HGP-46, ORSTOM New Caledonia, N/O *Vauban*, Campagne SMIB 1, Stn DW14, 7 Feb. 1986, 22°58.5'S 167°22.5'E, 640 m.

Diagnosis. Adult female carapace almost spherical, length and height equal, about 7 mm, outer surface with posteroventral spinules, giving way to sparse dorsal bumps, aperture margins simple. Naked dorsal horns on thoracomeres 1-3, third one shorter than others. Fourth antennular segment with 2 setae, fifth with about 5, sixth with claw guard only slightly separated from proximal sensory process (also in male). Mandible medially armed with hairs and few small, basal teeth. Maxillae trifid, lacking posterior hooks. Cluster of about 8-15 long seminal receptacles in coxae of thoracopods II-V. Coxa and basis of thoracopods II-IV each with 4-6 medial setae (also in male). Small posteroventral telsonic spines present. Furcal rami 4 times longer than basal width, somewhat tapered, with many short terminal and dorsomedial setae. Male lacking dorsal thoracic horns, fifth antennular segment tapering distally, 12-14 setae on second exopod segment of thoracopods II-V.

Description of females (based mostly on paratype) (Figs 6-7). Carapace univalved, that of holotype more or less spherical, 6.9 mm long and high, 6.0 mm wide, with pair of low anteroventral bolsters and laterally compressed posteroventral section bordering aperture (Fig.6A,B). Carapace of paratype female damaged and not measured. Aperture occupying about one sixth of circumference, faint seam visible along rest of midline. In paratype, dorsal brood chamber lined internally by long setae. Single row of widely spaced guard setae on each side posteroventrally just inside aperture. Externally, dorsal part of carapace with sparse bumps, anteroventral region smooth, and posteroventral region densely set with small, slightly curved spinules. Arrangement of internal organs of carapace not determined.

Main body (Fig.6C) attached by oblique attachment zone to anteroventral part of carapace. Body length of paratype 3.3 mm from front of oral cone to tips of furcal rami, height 3.3 mm from tip of oral cone to rear dorsal margin of thoracomere 1. Head with long free dorsal side, antennules, frontal filament complexes, and oral cone; no eyes observed. Thorax 6-segmented, each segment progressively shorter, first segment with anterior fringe of short setae broken at midline and no filamentary appendages, sixth with small lateral epaulets, each segment with pair of biramous thoracopods, their tips falling short of end of oral cone. First 3 thoracomeres each with naked dorsal horn, first two 4-5 mm long and curving backwards, third one short. Abdomen bent 90°, with 5 short, cylindrical segments, third and fourth especially short; small penis on first segment, posteroventral telsonic spines on fifth below blade-like furcal rami.

Antennules 6-segmented, reaching midlength of oral cone when folded, probably reaching tip when extended (Fig.6C,D). First 5 segments tending to become narrower distally: first segment broad, triangular; second parallelogram-shaped with hairs along anterior margin; third segment triangular with dense fringe of longer hairs anteriorly; fourth very short, with short hairs and 2 equal setae on anterior edge; fifth segment with sparse hairs and 5 short setae along anterior edge. Sixth segment about two thirds as long as fifth, broadening distally, with dense cuticular ctenae along margins and thin, movable, distal claw; 3 tiny setae at base of claw; claw guard as long as claw, with 2 setae behind and 1 before apical hood; proximal sensory process about half as long as claw guard, slightly separated from it, bearing 3 short, apical setae and slightly longer, subapical aesthetasc. Musculature of first segment unclear, but rest similar to that of *Gorgonolaureus muzikae* (cf. Grygier, 1987b), except no medial extensor muscles of sixth segment seen to originate in fourth, flexors of sixth segment forming narrow bundle in fifth, and flexor from medial side of third segment inserting on fourth instead of fifth segment.

Frontal filament complex consisting of blunt cone 180 μm long and 90 μm across and somewhat longer, thinner, digitiform piece (Fig.6E); correspondence to parts of homologous organs in other ascothoracidans unclear.

Oral cone triangular, slightly longer than deep in side view. Labrum not examined in detail. Medial languette pointed, trough along anterior edge lined on both sides by short hairs, posterior edge with fine distal hairs (Fig.6F). Mandible (Fig.6G,H) broad and flat basally with 3 muscles, distal part rapidly tapering to needle-like, minutely bifid or undivided tip; lateral edge with indentation and row of hairs, proximal ones longer; medial edge with dense, imprecisely arranged fine hairs flanked on each side submarginally by shorter cuticular ctenae; basal part of medial edge with few apically dissected teeth, also some simple spines on

Fig.6. *Gorgonolaureus tricornutus* n.sp., females. A–B, lateral and rear views of holotype (MNHNP Ci2047). C–J, paratype (Ci2048): C, main body; D, left antennule, lateral view, aberrantly placed muscle marked by arrow; E, frontal filament complex; F, medial languette; G, left mandible with detail of base; H, detail of base of right mandible, fine hairs omitted; I, right maxillule with detail of pores; J, maxillae with details of tips. Scale bars in mm.

right mandible of paratype. Maxillule (Fig.6I) broad basally but less flattened than mandible due to extensive musculature, distal part evenly tapered and shorter than that of mandible; lateral edge with few distal hairs; medial edge with patch of fine hairs at base, and comb-row of about 175 setae flanked on one side by row of spinules, on other side by more or less orderly arrays of short, fine hairs, and, farther from edge, by row of laterally directed hairs; basal part of latter side also bearing field of about 20 pores associated with nervous ganglion. Maxillae fused basally, stylet-like distal parts with trifid tips, apical structures neither hook-like nor movable (Fig.6J).

Thoracopods in form of tapered, biramous paddles, second pair longest, first pair a little shorter with weak segmentation, remainder decreasing in length posteriorly, last pair only two thirds as long as second (Fig.7A-E). Coxa making up half of length; basis shorter

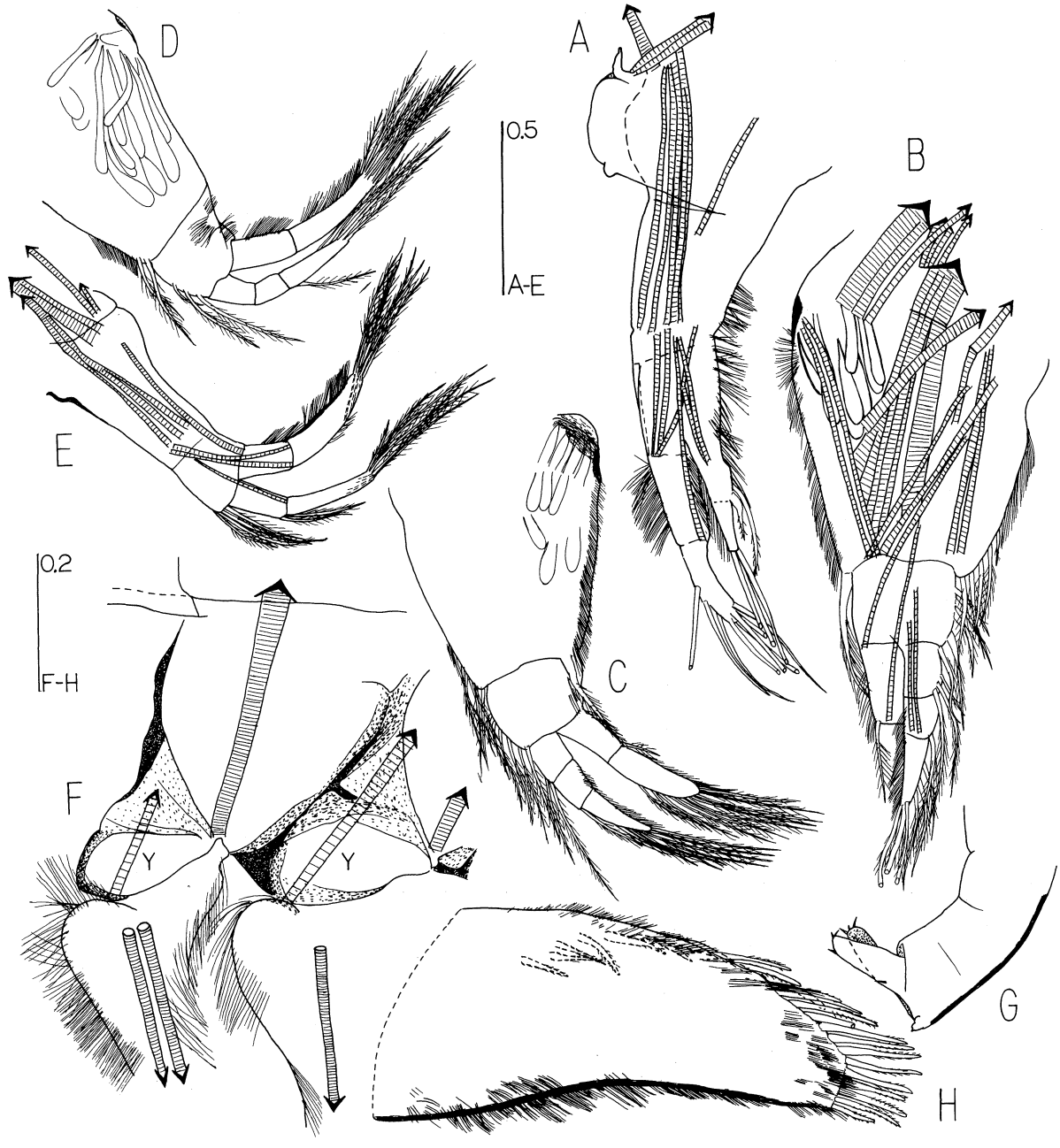

Fig.7. *Gorgonolaureus tricornutus* n.sp., paratype female (MNHNP Ci2048). A–E, left thoracopods I, II, IV, V, and VI, respectively, A and B in rear view, others in front view, seminal receptacles shown diagrammatically in B–D. F, lateral body wall at bases of thoracopods II (right) and III (left), showing seminal receptacle duct papillae (y). G, penis. H, left furcal ramus, lateral view. Scale bars in mm.

than wide; 2-segmented exopods slightly longer than endopods in thoracopods II-VI, endopods 3-segmented (2-segmented in thoracopod VI), exopod much longer than weakly 2-segmented endopod in thoracopod I. First thoracopod with large genital papilla at base (Fig.7A), bearing ventral bump and minute dorsal process (filamentary appendage?). Edges of thoracopods extensively lined with fringes of fine hairs. In thoracopods II-V (Fig.7F), row of hairs along both edges of narrow, triangular, lateral face of coxa; posterobasal part of coxa produced into round lobe, anterobasal part sclerotised as condyle for limb promotion and remotion; extrinsic muscles inserting on both lateral corners of coxa; posterior notch between condyle and pleural lobe containing oval swelling with openings of seminal receptacles, and deep, triangular depression. Major thoracopodal setae all plumose except on first pair, length half to two thirds that of rami. Left thoracopodal setation of paratype compiled in Table 4. On first thoracopod, usual lateral coxal seta shifted onto proximal quarter of basis. Distal exopod segments of thoracopods III-V with 3 apical setae and 2 subapical lateral setae (thoracopod VI with 4 and 1 setae, respectively), remaining setae medial.

Cluster of cylindrical seminal receptacles within proximolateral part of coxa of thoracopods II-V (Fig.7B-D), their number unclear, at least 6-8, maybe 15 or more per thoracopod. Illustrated musculature (Fig.7A,B,E) comparable to that of *G. muzikae* (cf. Grygier, 1984b, 1987b).

Penis stubby, slightly curved, with small, anterodistal spine and pair of short, stubby rami with several minute setae (Fig.7G). Telsonic spines very small, about 55 µm long, fully fused with telson, upper side hairy. Furcal rami (Fig.7H) about 0.63 mm long, twice as long as basal height, tapering distally and slightly downturned, right ramus with 24 short, spinulose setae extending along distal margin (6 setae), distal part of dorsal margin, and dorsal part of medial face; marginal and submarginal cuticular ctenae also present.

Description of male paratype (Fig.8). Carapace bivalved, 3.4 mm long, 2.6 mm high, 1.7 mm wide (Fig.8A,B). Lateral outline parallelogram-shaped with slightly convex anterior and ventral edges, fusiform in dorsal view. with broader anterior end. Valves separate except along dorsal hinge line, and exhibiting small anterior gape, posteroventral part exposed outside of host cyst. External surface smooth but with many pores, inner side of at least posteroventral margin bearing guard setae. Sperm-filled testes forming loop with about 6 posteriorly or ventrally directed, subdividing side branches.

Body somewhat shrivelled, with head, 6-segmented thorax apparently lacking dorsal horns and filamentary appendages, and 5-segmented abdomen. Abdominal segments 2 and 5 square in side view, equally long; segments 3 and 4 triangular, with short dorsum. All expected appendages present.

Antennule like that of female in most respects (Fig.8C), but relatively larger, about same length as oral cone when folded, segments 2, 5, and 6 somewhat longer relative to their widths, 2 setae on segment 4 unequal, about 10 long setae on fifth segment, and sixth segment longer relative to fifth due to extended distal half. Claw very slender with nearly straight portion at midlength, claw guard with lateral flange, almost all setae on this segment (also aesthetasc) relatively much longer than in female.

Frontal filament complex consisting of 2 long, slender, plumose parts (Fig.8D), ventral one 1.1 mm long and plumose to base, posterior one 1.6 mm long, only distal half plumose. No basal appendix observed on ventral part, but thick proximal aesthetasc present, shorter than filaments of plume (latter 300-550 µm long).

Oral cone 0.74 mm long, 0.44 mm deep, sharp spout comprising one quarter of length (not illustrated). Labrum surrounding other mouthparts, latter not dissected, exposed tips of maxillae bifid with small posterior hooks.

Six pairs of biramous, paddle-like thoracopods lacking seminal receptacles (Fig.8E-G). Thoracopodal segmentation as in female, including very short, poorly biarticulate endopod of first thoracopod; other endopods only a bit shorter than exopods. Thoracopods extensively fringed with fine hairs, but not on lateral side of basis. Setae of terminal segments of rami much longer than in female, about two thirds as long as rest of limb, but lateral and medial setae much shorter than these. All major setae plumose, except setules much shorter on first thoracopod. Setation very similar to that of female (Table 4), including numbers of apical and lateral setae on distal exopod segments.

Penis (Fig.8H) with long shaft slightly shorter than thoracopodal protopods, with double row of small, lateral setae and thickened anterior edge ending in small spine; pair of vermiform rami half as long as shaft, each with about 6 short, thin, distal setae. Posteroventral telsonic spines small and dorsally hairy (Fig.8I). Furcal rami as long as abdominal segments 4 and 5 combined, 0.69 mm long, one quarter that high at base, slightly tapered to truncate and slightly downturned end (Fig.8J). Closely set row of 22 long, medial setae up to 1.0 mm long (most proximal ones much shorter), 5 distal setae of varying lengths (longest 0.58 mm, ventral one shortest); all setae plumose and contributing to tail fan. Cuticular ctenae distally along dorsal margin and along most of ventral margin.

Eggs. Paratype brooding more than 215 subspherical eggs, many lost or crushed, major axis of eggs averaging 0.50 mm (n = 18).

Remarks. The assignment of *G. tricornutus* n.sp. to *Gorgonolaureus* is tentative. The presence of several dorsal horns suggests that this species ought to be assigned to either *Isidascus* Moyse or *Cardomanica* Lowry (cf. Moyse, 1983; Grygier, 1984; Lowry, 1985), but in those genera the three or four horns are on thoracomeres 2 to 4 or 2 to 5, while the present females have them on thoracomeres 1 to 3. Both of these other

Fig.8. *Gorgonolaureus tricornutus* n.sp., paratype male (MNHNP Ci2048). A, dorsal view. B, lateral view showing branched testes. C, right antennule, medial view. D, frontal filament complex. E–G, right thoracopods I, III, and VI, respectively. H, penis. I, posteroventral telsonic spine. J, right furcal ramus, lateral view, only bases of some setae shown. Scale bars in mm.

genera also have very long filamentary appendages associated with the first thoracopods, as well as more than one comb row of setae on the maxillules and prominent proximal teeth medially on the mandibles, and they have many more medial coxal setae on thoracopods II to IV; *Isidascus* has a uniramous penis in both sexes. Other species of *Gorgonolaureus* agree with *G. tricornutus* in lacking filamentary appendages, having only one maxillular comb-row, lacking mandibular teeth (details of mouthparts are unknown in the type species, however), and having a biramous penis (as does *Cardomanica*). *Isidascus* has a delicate outer cuticle except near the aperture and inhabits calcareous galls on an isidid gorgonian, and *Cardomanica* lives attached (usually by characteristic outgrowths of the carapace) to chrysogorgiid gorgonians, and may not always be covered by host tissue (Lowry, 1985; Grygier, 1990b), whereas the new species, like other species of *Gorgonolaureus*, is encapsulated by a number of host polyps.

Within *Gorgonolaureus*, the new species is most similar to *G. muzikae* in terms of size, appendage armament, and seminal receptacles (see Grygier, 1981b, 1987d). The principal differences in the females, besides the extra dorsal horns, are the more spherical carapace with simple rather than interlocking aperture margins, fewer setae on the fifth antennular segment, some basal teeth on the mandible, twice as many setae medially on the coxae of thoracopods II to IV (same distinction also valid in the males), and considerably longer furcal rami. The male also differs from those of *G. muzikae* ("protanders" of Grygier, 1981b) in lacking a dorsal horn, having a tapered sixth antennular segment with the claw guard and proximal sensory process only slightly separated, and in having fewer setae on the second exopod segment of thoracopods II-IV. The eggs are larger than those of other species parasitising gorgonians.

The host, *Eunicella* sp., has usually been classified in the Plexauridae, a family also said by Bayer (1981) to include the paramuriceid hosts of other species of *Gorgonolaureus*. However, Bayer (1981) transfered this genus to the Gorgoniidae, which makes *G. tricornutus* the first ascothoracidan parasite from that family of gorgonians.

Etymology. From the Latin *tri-* meaning three, and *cornu* meaning horn, referring to the three thoracic horns.

Flatsia n.gen.

Type species. *Flatsia walcoochorum* n.sp., by monotypy.

Diagnosis. Female carapace rounded, bivalved, with brood chamber in each valve and pore plates on concave ventral side. Cephalic attachment zone vertical, anterior. Setose, medial humps on thoracomeres 2-6, epaulets small. Antennules 6-segmented, proximal segments much bigger than distal ones, 1 strong and many weak setae on fourth segment; several short setae on fifth. Sixth segment much shorter than fifth; claw guard short with 4 setae, proximal sensory process directly behind it, bearing 3 setae and aesthetasc. Labrum with long, straight tip. Medial languette present. Mandibles with lateral setae, medial teeth, and toothed, needle-like tip. Maxillules with 2 medial setal combs. Maxillae bifid with posterior hooks. Conical filamentary appendage extending anteriorly from base of thoracopod I; heavily setose, laterodistal knob on coxa of that limb. Protopod of thoracopod VI undivided; thoracopodal endopods and exopods equal in length, endopods 3-segmented in thoracopods II-IV, 2-segmented in thoracopods I and V, undivided in thoracopod VI, exopods 2-segmented except undivided in thoracopod VI. Thoracopodal setae about as long as rami, lateral coxal seta often absent on thoracopods II-V, distal segments of endopods and exopods of these limbs with similar numbers of seta, seta found occasionally on medial corner of first exopod segment. Many elongate seminal receptacles in thoracopods II-V. Abdomen 5-segmented; first segment with biramous, setose penis; fifth with pair of telsonic spines and elongate, tapered, hairy furcal rami with many short, ventral setae and 2 apical ones. Host unknown. This detailed diagnosis may require changes if additional species are discovered.

Etymology. Named for Murray Ball's comic strip "Footrot Flats" ("Fæhunden" in Danish), which I greatly enjoyed while studying ascothoracidans for 16 months in Denmark and Australia. Gender feminine.

Flatsia walcoochorum n.sp.

Figs 9–11, Table 5

Type material. HOLOTYPE female with 295 brooded nauplii (AM P37803, vial and 6 slides of dissected appendages), J.C. Yaldwyn & D.J. McMichael, 22-23 June 1963, off Port Stephens, NSW, 73-82 m, muddy bottom. Host uncertain. Specimen found loose in vial with small, apparently normal actinian; pennatulacean from same haul also showing no obvious signs of infestation.

Diagnosis. As for genus.

Description of holotype. Carapace dull orange in preserved state, bivalved, 5.74 mm long, 5.57 mm high, 4.26 mm wide (Fig.9A-D). Rounded in side view except for shallow ventral indentation, oval in vertical view with anterior end more rounded. Ventral side with teardrop-shaped, slightly concave surface 3.7 mm long, 2.5 mm wide and spindle-shaped gap between valves exposing oral cone and anterior thoracopods. Valve edges free from mid-dorsum to anteroventral corner and distinct seam clearly visible on all but lowest part of

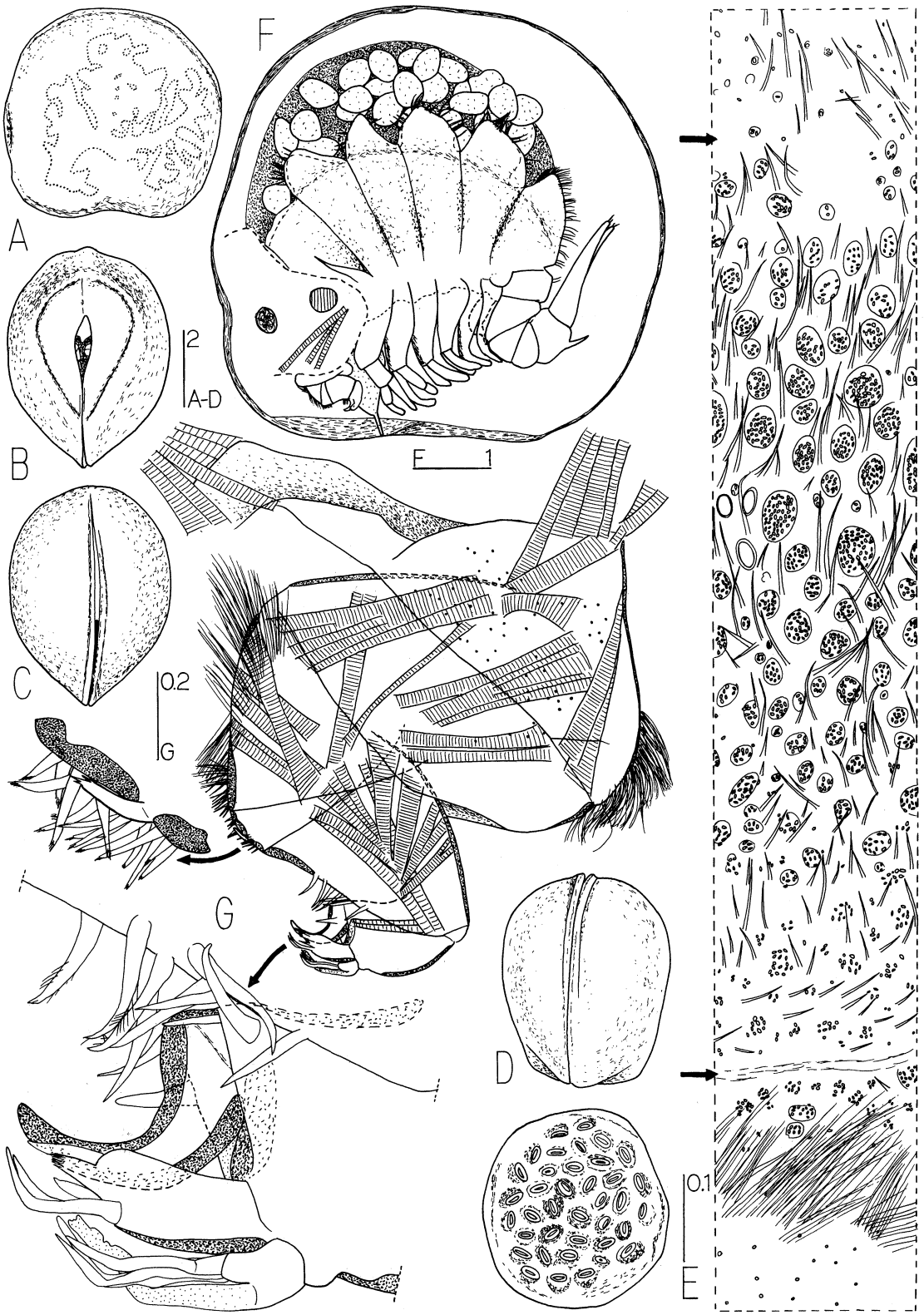

Fig.9. *Flatsia walcoochorum* n.gen. n.sp., holotype female (AM P37803). A–D, lateral, ventral, dorsal, and posterior views, respectively, A with dotted outline of organs within carapace. E, ornamentation of ventral surface of carapace (between arrows), lateral side above, medial side below, with detail of one pore-plate. F, left half of carapace removed, exposing main body and brood. G, left antennule, lateral view, with details of setal armament of segments 4-6. Scale bars in mm.

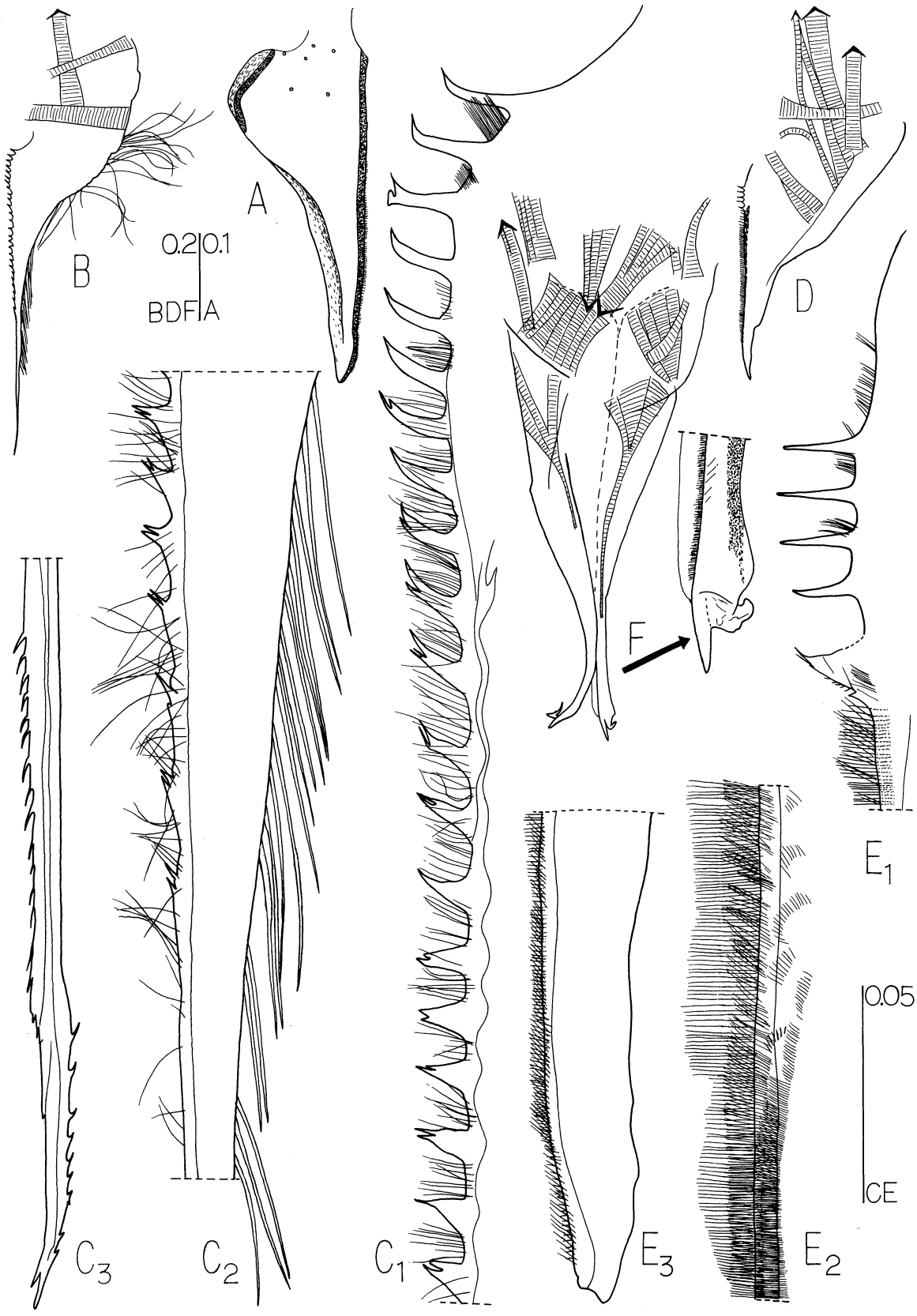

Fig.10. *Flatsia walcoochorum* n.gen. n.sp., holotype female (AM P37803), mouthparts. A, medial languette. B, left mandible and C_{1-3}, successively more distal details of its distal part. D, left maxillule and E_{1-3}, successively more distal details of its medial edge, submarginal short comb-row on far side omitted in E_2. F, maxillae with detail of tip. Scale bars in mm.

anterior side. Dorsal valve margins produced into low, narrow flanges, less pronounced anteriorly and posteriorly. Brood chamber anterodorsally in each valve, inner submarginal parts of valves flat and closely appressed (Fig.9F). Most of external surface dotted with pores and short setae, and inner surface with scattered pores, but valve margin more complicated, especially ventrally (Fig.9E): band of dense, fine hairs just submarginally on medial face; concave ventral surface with denser setae than elsewhere and with round or oval, possible slightly convex 'pore-plates' with up to 40 oval-rimmed, slit-like pores each, fewer pores per plate towards edges of this region. Internal organs of carapace (gut and ovary diverticula) with 3 main, subdivided branches, anterior, dorsal and posterior (Fig.9A).

Main body about 4.4 mm long and high, excluding thoracopodal setae (Fig.9F). Head attached to carapace anteriorly, bearing antennules and oral cone, and giving off gut and ovary diverticula and adductor muscle tentorium on each side; no eyes or frontal filaments seen. Thorax 6-segmented, arched, segments equally long and high except for laterally compressed, triangular or quadrangular humps on segments 2-6, last 2 of these pointing anterodorsally. Humps fringed with short, sparse setae, most abundant on thoracomere 6. Sixth segment also with pair of small lateral epaulets. Six pairs of biramous, paddle-like thoracopods, first pair accompanied by filamentary appendages at base. Abdomen small compared to thorax, J-shaped, third and fifth segments about as long as high, others shorter. First segment with short, biramous penis and few short, dorsal setae; fifth segment with medium-long pair of posteroventral spines situated side-by-side and pair of long, tapered furcal rami.

Antennules (Fig.9G) 6-segmented, somewhat prehensile, basal part massive, segments becoming much smaller distally. First segment right triangular, deeper than long, with scattered pores on lateral face and tuft of long, posterodistal hairs. Parallelogram-shaped second segment largest, about one third as deep as long. Third segment triangular, as long as deep, with hairs along anterior edge and anterior part of lateral face, distal hairs shorter and sturdier. Fourth segment very short, anterior edge with 1 strong seta laterally, about 15 weaker ones with frayed tips medially. Fifth segment quadrilateral, slightly curved and tapered, with about 9 short, setulate setae along middle part of anterior margin. Sixth segment about one third as large as fifth, with convex posterior margin and strong, retractable, distal claw with short seta to each side (anterior margin obscured, expected seta there unconfirmed); fixed claw guard just behind and about half as long as claw, with lateral flange, 2 medium-long and 2 short, distal setae and apical hood; proximal sensory process immediately behind claw guard with aesthetasc and 3 distal setae, all of same length. Antennular musculature generalised (cf. Grygier, 1987b), except only 1 claw retractor muscle, no thin extensor muscles connecting medial side of fourth segment to base of sixth, and no dorso-anterolateral muscle in segment 2.

Labrum forming conical sheath, posterior margins joined behind maxillae but not fused; straight, slender tip unusually long (Fig.9F). Languette 0.38 mm long, sharply pointed with several lateral pores at base (Fig.10A), straight anterior edge lined with extremely short, dense hairs, posterior surface trough-like. Mandible (Fig.10B,C_{1-3}) 0.94 mm long, basal width about 0.25 mm, 3 muscles in base, hairs along its lateral edge becoming shorter distally. Attenuated process making up two thirds of length of mandible, basal two thirds of medial edge with about 30 evenly spaced, slightly curved, simple or bifid teeth, distal ones shorter, with numerous interspersed fine setae; tip needle-like with distally pointing spinules along medial edge, retrorse spinules on lateral edge. Maxillules (Fig.10D,E_{1-3}) similar in form to mandibles, but distal part shorter and less attenuate, base more muscular; outer face with longitudinal trough for mandible, straight medial edge with 5 basal teeth and 2 combs of marginal and submarginal setae running along whole length and becoming shorter distally, accompanied by some submarginal ctenae on each side. Maxillae (Fig.10F) fused to level of midlength of languette, basal part massive with transverse grooves for muscle attachment, distal parts 0.8 mm long, becoming very slender, tips bifid with diaphanous flange and movable posterior hooks.

Thoracopods I-IV about 1.6 mm long without setae, measured along medial edge, thoracopod V about three quarters as long, thoracopod VI about one-half (Fig.11A,C-G). Protopods with relatively broad, distally tapering coxa and small, narrow basis longer than wide (protopod undivided in thoracopod VI). Exopods 2-segmented (undivided in thoracopod VI), first segment shortest. Endopod 2-segmented in thoracopods I, V, and VI (distal segment longer), and 3-segmented in thoracopods II-IV (second segment short, distal one longest). Rami equally long except endopod half as long as exopod in thoracopod VI. Lateral margins of thoracopods (only coxa in thoracopod I) typically profusely hirsute, medial part of coxa with rows of short hairs (but profuse long hairs on thoracopod I and distally on protopod in thoracopod VI), lateral edge of endopod and medial edge of first exopod segment also lined with hairs in thoracopods II-VI. Anteriorly directed, 1.0 mm long, conical filamentary appendage at base of thoracopod I (Fig.11B), this limb also with laterodistal coxal knob bearing many distally hirsute setae, one of them trifid (Fig.11A). Setal counts of left thoracopods given in Table 5. Thoracopodal setae typically about as long as rami, plumose except setules very short in thoracopod I. Highly unusual occurrence of medial seta on first exopod segment in thoracopods III and IV (Fig.11D,E). Coxae of thoracopods II-V containing laterobasal cluster of flask-like, long-necked seminal receptacles opening on dorsolateral swelling at base of limb (Fig.11D). In one case (thoracopod II), seta seen on lateral body wall above this swelling. Number of seminal receptacles estimated at 19 in thoracopod II,

Fig.11. *Flatsia walcoochorum* n.gen. n.sp., holotype female (AM P37803). A–G, left thoracopods, all except D in rear view: A, thoracopod I, omitting most of coxa (twisted) and with details of exopodal setal armament and B, of filamentary appendage; C, rami of thoracopod II, showing only bases of setae; D–E, thoracopods III and IV, respectively, with seminal receptacles shown in D (also present in thoracopods II, IV, V); F, rami of thoracopod V, showing only bases of setae; G, thoracopod VI with detail of exopodal setal armament (setal bases only shown). H, penis. I, left furcal ramus, medial view. Scale bars in mm.

at least 10 in thoracopod III, over 8 in thoracopods IV, 12 in thoracopod V. Penis (Fig.11H) about 0.6 mm long, shaft with curved anterior edge and about 12 short, thick, posterior setae, distal part short, posteriorly flexed, bearing 2 short, cylindrical rami with 8-9 short, slender setae each.

Furcal rami elongate (Fig.11I), 1.42 mm long, 0.34 mm high at base, 0.06 mm high at tip. Dorsal edge straight, unarmed; ventral edge slightly concave and rising, with abundant, spine-like setae; lateral and medial faces covered with short, thin hairs; 2 distal setae, dorsal one twice as long.

Nauplii (not illustrated). Typical brooded ascothoracidan nauplii (see Grygier, 1987a). Oval in dorsal view, averaging 0.48 mm long (n = 17), about 1.3 times longer than wide, more rounded in front than rear, yolk occupying rear half of body. Labrum small, ill-defined; 3 pairs of naupliar limbs and blunt terminal spine (small furcal lobes seen in minority of specimens). Antennule with long and short subterminal setae, medium and very long terminal setae; status of medial setae unclear. Antenna with probably unarmed protopod, weakly annulate exopod with 5 setae, and unsegmented endopod with tiny medial spine at midlength, subterminal seta, and apical spine and 2 apical setae. Mandible like antenna, but with only 4 setae on exopod.

Remarks. It is difficult to assign *Flatsia* n.gen. with certainty to any of the families recognised by Grygier (1987c). It is clearly advanced compared to the ectoparasitic, bivalved synagogids *Synagoga* Norman and *Waginella* Grygier, and it seems to have its greatest morphological affinities with the gorgonian-parasitising synagogid genera *Gorgonolaureus*, *Cardomanica*, *Isidascus*, and *Thalassomembracis* (see Grygier, 1981a, 1981b, 1984a; Moyse, 1983; Lowry, 1985).

The carapace is intermediate between the low, fully bivalved one of *Waginella metacrinicola* (Okada, 1926) and the ovoid one of *Cardomanica*, which is functionally univalved but still has a long, dorsally extending aperture. The ventral pore plates are unique to *F. walcoochorum* n.gen. n.sp., and they suggest that some kind of secretion is produced, perhaps for attachment to the unknown host like the cement pads of *Waginella* spp. living on crinoids (Grygier, 1983). The mid-dorsal humps on the thorax are reminiscent of those in several species *Thalassomembracis*, which, however, have transverse rows of setae, not longitudinal ones as here (Grygier, 1984a). The only other ascothoracidan with similar humps is the ctenosculid *Endaster hamatosculum* Grygier (1985c). The multiple thoracic horns in other ctenosculids, *Cardomanica*, and the dendrogastrid *Ulophysema*, which might be regarded as modifications of these humps, do not involve more than four segments, and never the sixth.

Six-segmented antennules are plesiomorphic in the Ascothoracida. The enlarged basal segments here are similar to those of females in various echinoderm-infesting genera of the order Dendrogastrida, but then in 4- or 5-segmented antennules; the pores on the first segment are unique. Possession of one instead of two strong setae on the fourth segment is typical of most species of *Thalassomembracis*; the similarity of that seta to its accompanying ones is unusual. Possession of an adjoining claw guard and proximal sensory process, both with the maximum setal armament, is typical of females of gorgonian-infesting genera (except *Thalassomembracis*), although these genera often have only three setae on the claw guard, not four.

Such a long labral tip is unique to *Flatsia*. The mandibular armament resembles that of *Synagoga*, but with a much finer distal process and the teeth more widely spaced (cf. Norman, 1913; Grygier, 1983). The maxillular armament, with two rows of setae, is typical of *Thalassomembracis*. The filamentary appendages resemble those of *Isidascus* and *Cardomanica*, but similar ones also occur in several diverse dendrogastridan species.

A two-segmented endopod in thoracopod V occurs very sporadically in the Synagogidae. No synagogid has more than a single lateral coxal seta on thoracopod I, and all of them do have such a seta on thoracopods II to IV but usually not on V and VI, the opposite of the present case. The number of major medial setae (positions 6–9) on thoracopods II to IV is higher than any synagogid, but is approached by females of *Cardomanica* and *Isidascus*. The relatively high number of terminal exopod setae (position 4) on the first thoracopod compared to other limbs is held in common with *Cardomanica*, *Synagoga mira* Norman, and the metacrinine crinoid-infesting species of *Waginella*. Such closeness in the setal counts of each limb's exopod and endopod is only approached by the same two species of *Waginella*, where the exopod usually has just two to three more setae than the endopod (Grygier,1983). Occasional possession of a medial seta on the first exopod segment is unique to *Flatsia*. The seminal receptacles are like those of *Gorgonolaureus muzikae* and *Cardomanica* spp. in form and number. The small, biramous penis is usual for females of *Gorgonolaureus*, while in related genera it is reduced to a uniramous nub. It is unusual for the telsonic spines not to be widely separated. The furcal rami are unlike those of other genera in detail.

All this suggests that *Flatsia* n.gen. might best be classified as an aberrant representative or perhaps the sister-group of the gorgonian-infesting group of genera within the Synagogidae. It has no clear synapomorphies with, for example, the higher families in the order Laurida, the Lauridae and Petrarcidae.

Etymology. Named for Wallace ("Wal") Footrot and Cooch Windgrass, protagonists of "Footrot Flats."

Lauridae Gruvel, 1905

Baccalaureus Broch, 1929

***Baccalaureus isauricola* n.sp.**

Figs 12, 13

Type material. HOLOTYPE female (AM P37808), 3 PARATYPE males (AM P37809) removed from single polyp of zoanthid *Isaurus tuberculatus* (AM G15233) [specimen mentioned by Muirhead & Ryland (1985)], R.A. Birtles & P.W. Arnold, 26 Mar. 1979, Great Barrier Reef off Townsville, Qld, Australia, James Cook Univ. Benthic Research Unit Square 6A, Stn 442, 18°48'S 146°55'E, 36 m. Holotype and largest paratype dissected; cephalic appendages of former and some thoracopods of latter lost in dissection.

Diagnosis. Female carapace oval in side view, lateral coils making 1.5 revolutions, medial face of coiled lobe armed with bispinose papillae. Thoracic horns short, straight, naked. First thoracopod short, filamentary appendage small; thoracopods V and VI absent; thoracopods II-IV with few distal setae, unsegmented but with short, seminal receptacle-free, distal part, about 10-12 seminal receptacles per thoracopod. Thoracic tergites separated by expanses of arthrodial membrane, no dorsal setae on thorax or abdomen. Furcal rami with 3-4 terminal setae and numerous dorsal or dorsomedial setae. Male lacking anteroventral pits on carapace, nauplius eye present, antennular claw denticulate, lobe-like penis short and setose, furcal rami with 3 terminal setae.

Relation to host. Female located within base of polyp, surrounded by thin coat of host tissue and with carapace aperture protruding through small hole in polyp wall. Polyp tissue firmly adhering to female aperture, and males partly embedded in polyp wall material externally (Fig.12A,B).

Description of female (Fig.12). Carapace oval in side view, 7.8 mm high, about 5.3 mm wide, 4.8 mm long without apertural protrusion, lateral lobes of carapace coiled, making just over 1.5 turns (Fig.12A-C). Coil edges and, to lesser extent, exposed faces finely wrinkled. Medial face of each lobe with arcuate field of papillae, each papilla bearing paired, opposed spines spanning 25 μm (mean of 16) (Fig.12D,E). Aperture protrusion just above midheight, 1.4 mm long. Aperture fringed with fine setae, margins separated posteriorly, joined but separable ventrally, with 3 sets of attached arcs of exuvial cuticle (Fig.12F).

Body 3.0 mm long from tip of thoracic horns to tips of furcal rami (Fig.12F,G). Most of head lost; large adductor muscle tentoria present. Thorax 6-segmented, thoracopods I-IV present. Anterior thoracic horns straight, naked, about 1.3 mm long along ventral edge, directed anteroventrally and tapering to rounded tips. Thoracic tergites 2-6 separated by long expanses of arthrodial membrane. Lateral chitinous ridge apparently formed of adjoining, thickened, ventral edges of tergites 2-4 and sinuous anterior extension reaching onto lateral part of horn base; ventral edges of tergites 5 and 6 thickened only at front and rear, so not part of chitinous ridge. Abdomen 4-segmented, bent 90° at triangular third segment. No dorsal setae on any thoracic or abdominal segments. First abdominal segment with penis, last with furcal rami.

Only right thoracopods examined in detail. Thoracopod I short, lobe-like with distal seta (Fig.12H); oval, basal swelling (filamentary appendage) 0.42 mm long, 0.35 mm wide when flattened, extending short distance over chitinous ridge (Fig.12G). Thoracopods II-IV long, uniramous, unsegmented (Fig.12I-K), tapering to point with uncertain but small number of setae in thoracopod II, 2 setae in thoracopod III, 1 apical and a few lateral setae in thoracopod IV. Seminal receptacles filling thoracopods II-IV except for short distal region, 9-12 elongate sacs with long, thin ducts seen per limb, emptying on prominent lateral papilla at limb base.

Penis vestigial, not reaching midlength of second abdominal segment. Furcal rami tapered (Fig.12L,M), 0.28 mm long along dorsal edge, 0.13 mm high at base, about one quarter as high distally, dorsal and ventral margins spinose, 3 hirsute distal setae on left ramus, 4 on right, 10 setae about half as long as distal one arising medially along distal half of left ramus (1 on dorsal margin, others inclined dorsally), 11 on right ramus, including many more on dorsal margin.

Description of male (based on largest paratype) (Fig.13). Elliptical in dorsal view (Fig.13A); in lateral view dorsum straight, posterodorsal margin oblique, rest of margin curved, possibly with very slight posteroventral scalloping (Fig.13B).Three specimens 0.51, 0.52, 0.57 mm long, smaller ones 0.34 and 0.37 mm wide, respectively, height slightly less than width. Weak external polygonal meshwork of chitinous ridges (Fig.13C), complete meshes about 14 μm across; scattered setae and pores at equal densities; no anteroventral pits. Large accumulations of sperm within valves. Body (Fig.13D) divided into head with large antennules compared to oral cone, short, 6-segmented thorax with 6 pairs of thoracopods, and 4-segmented abdomen bent sharply at third segment. Large, red nauplius eye within medial protrusion of 'forehead' anterior to labrum (Fig.13D,E). First 4 thoracomeres short and equal, last 2 elongated dorsally. Abdomen with penis on first segment, furcal rami and telsonic spines on last. Body length and height of dissected specimen 0.30 mm from front of oral cone to tips of furcal rami and from tip of oral cone to top of thorax.

Antennules 6-segmented, Z-shaped (Fig.13D), first bend occurring at triangular third and short fourth segments, latter with 2 short, equal setae on anterior margin. Fifth segment longest, with 2 unequal setae near base. Sixth segment oblong with movable, spinulose claw; frontal and lateral seta (at least) at base of claw; laterally flanged claw guard with 2 long distal setae and damaged tip

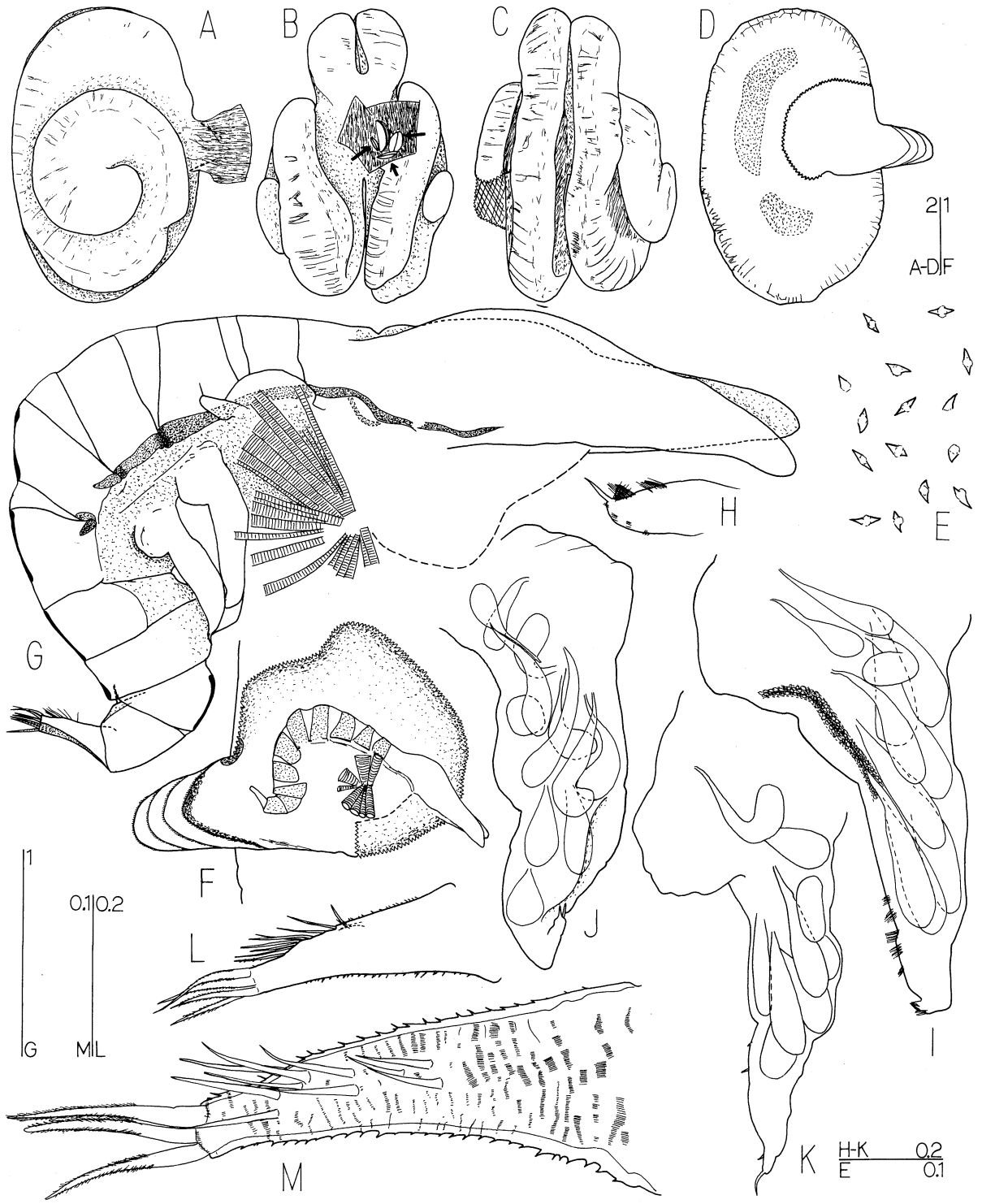

Fig.12. *Baccalaureus isauricola* n.sp., holotype female (AM P37808). A–C, lateral, rear, and front views of carapace, respectively, host tissue adhering to aperture in A and B, males indicated by arrows in B. D, right half of carapace, medial view, spinose areas stippled and E, enlarged. F, situation of body within carapace. G, body (head lost). H–K, right thoracopod I and left thoracopods II-IV, respectively, latter three showing seminal receptacles, and lining of duct shown for one in I. L–M, right and left furcal rami, respectively, in lateral and medial view. Scale bars in mm.

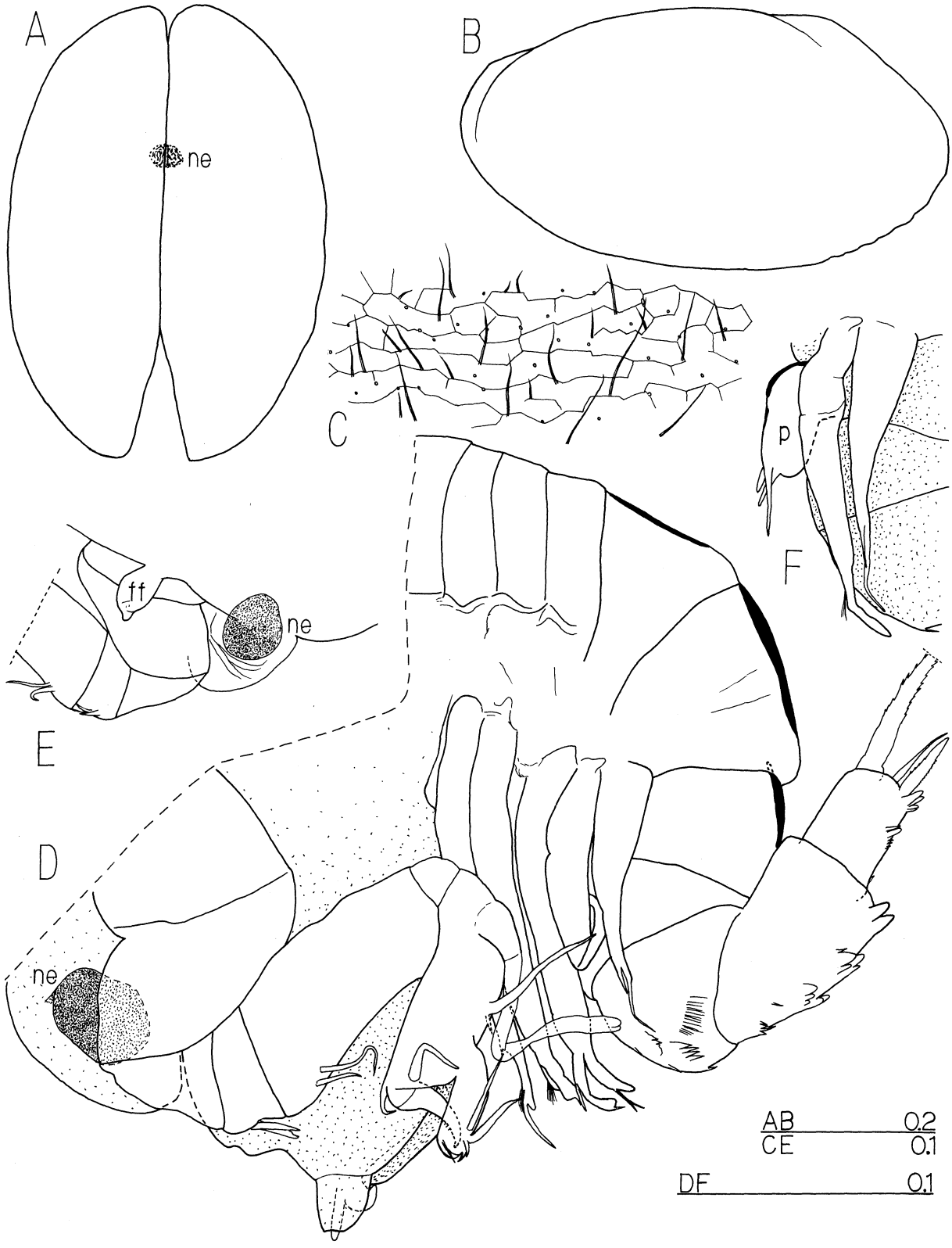

Fig.13. *Bacclaureus isauricola* n.sp., paratype male (AM P37809). A–B, dorsal and lateral views, respectively, showing nauplius eye (ne). C, external ornamentation of middle of lateral side. D, main body. E, "forehead" region seen from right side, with frontal filament (ff). F, penis (p) and last two left thoracopods. Scale bars in mm.

apparently bearing 2 setae behind and one in front of apical hood; long seta and short spine (latter only seen in right antennule) arising midway between claw guard and long, proximal aesthetasc, latter with bifid tip on left antennule. Small frontal filament seen lateral to base of right antennule (Fig.13E). Oral cone not dissected; labrum apparently with anterior crest and maxillae bifid with posterior hooks (Fig.13D).

All thoracopods long and slender (Fig.13D,F), but fifth and sixth successively shorter than rest, sixth half as long as first. Left thoracopods I-V: I with apical seta and short lobe, and subapical tuft of hairs; II biramous, endopod with tuft of hairs, exopod with minute seta; III hidden in this preparation; IV biramous, exopod with minute seta, endopod with 2 minute terminal setae; V uniramous with subapical tuft of hairs. Left and right thoracopods VI uniramous with subapical seta. Right thoracopod V biramous, endopod filiform with hairs, exopod half as long, with 2 tiny setae.

Penis very short with 3 unequal distal setae (Fig.13F). Third abdominal segment with ventral cuticular ctenae, some spiniform (Fig.13D); fourth segment with pair of basal ctenae, 2 sets of 2-3 blunt spines at half and three quarters length, and pair of short, blunt telsonic spines. Furcal rami rectangular, about 1.5 times as long as high, with 2 clusters of blunt, ventral spines at two thirds of length and terminally (Fig.13D); 3 terminal setae, dorsal one twice as long as others and spinulose, middle one simple and thin, ventral one intermediate in thickness, spinulose.

Remarks. The female of *Baccalaureus isauricola* n.sp. has many features that are unique or nearly so in the genus. Such a high oval carapace is only approached by *B. torrensis* among the species with coiled brood sacs, but there the aperture protrusion is much more dorsal (cf. Pyefinch, 1937). The bifid spines on the carapace are a new feature, other species having only simple papillae, or sometimes large papillae or simple spines; the present spines are smaller and simpler than the rosette papillae found in confamilial *Laura* spp. (cf. Grygier, 1985a). The clear division of the thorax into short tergites and large areas of arthrodial membrane is only otherwise known in a different laurid genus, *Zoanthoecus* (cf. Grygier, 1985a), but it is also evident by SEM (not light microscopy) in *Baccalaurus falsiramus* Itô & Grygier, 1990. Such short thoracic horns are only found in *B. verrucosus* Pyefinch (1939), where they are hairy, and in the new Japanese species, where they are naked but sometimes have upturned tips. The number of thoracopods can be variable within a species in this genus (Itô & Grygier, 1990; Grygier, unpublished data); this aside, *B. hexapus* Pyefinch (1936) is the only other species to lack thoracopods V and VI, but it has long, coiled thoracic horns and reportedly a peculiar sort of first thoracopod. In the new species, the furcal rami are relatively much shorter and also much more heavily armed with mediodorsal setae than any other in the genus, where there are at most a few small medial setae or sensilla. All the other species of *Baccalaureus* have dorsal setae at least on the last thoracomere and first abdominal segment, and most often on other segments as well. It is unfortunate that the antennules and mouthparts remain undescribed, but antennular morphology is known to be variable within a species (Itô & Grygier, 1990), and the mouthparts are essentially alike throughout the Lauridae (Grygier, 1985a; Grygier, 1990b; unpublished data). Even without the cephalic appendages, the present female has enough distinctive features to allow recognition in the future and separation from other species now.

In the Lauridae, males of *Baccalaureus japonicus* Broch (Yosii, 1931; Okada, 1938) and of two species of *Zoanthoecus* (Grygier, 1985a; Grygier, 1990b) have been well described. The present males are like *B. japonicus* in lacking anteroventral carapace pits, and in having a network-like ornamentation of the carapace. A possible male of *Baccalaureus falsiramus* also has cuticular reticulation (Itô & Grygier, 1990). Such reticulation is different from the spinule arrays covering males of *Zoanthoecus*, but is similar to, though less developed, than the reticulation on so-called Tessmann's larvae, as least one form of which is known to be the ascothoracid larva of *Baccalaureus* (Grygier, 1988b; Itô & Grygier, 1990). The antennules, thoracopods and abdomen are not substantially different from those of the other males, but the male of *B. isauricola* n.sp. is the only one with a spinulose antennular claw (as in Tessmann's larvae), its thoracopod VI is much better developed than in *B. japonicus*, and the three terminal setae on the furcal rami agree in number and form with *B. japonicus*, but not with the *Zoanthoecus* species, which have four. The anomalously high total of five setae on the claw guard, four being the normal maximum, may be an observational error in the present case. The other males have extremely long, uniramous penes, sometimes with a few minute distal setae. None of them have a nauplius eye; in fact, the present males represent the first record of adult ascothoracidans with a nauplius eye.

The only previously known Australian species of *Baccalaureus* is *B. torrensis* from *Palythoa howesi* at Thursday Island, Torres Straits (Pyefinch, 1937). *Baccalaureus isauricola* n.sp. is the first species of the Lauridae known to infest *Isaurus*, a genus of zoanthids with three currently recognised species (Muirhead & Ryland, 1985). *Isaurus tuberculatus*, the present host, is pantropical, so its ascothoracidan parasite may also be widely distributed.

Etymology. Named for the host genus, *Isaurus* and Latin *icola* (inhabitant).

Baccalaureus cannoni n.sp.

Figs 14, 15

Type material. HOLOTYPE female (AM P37807), CSIRO Cr. 0183, Stn B4S, 15 Feb. 1983, off WA, 19°5.3-5.1'S 118°54.0-53.4'E, 83 m; PARATYPE female (Queensland Museum W12661), QFS sample AQSIB/97,

north-east Qld, 16°46.0'S 146°3.8'E, 40 m; PARATYPE female and exuvia found within its carapace (Zoological Institute, Leningrad, ZIN 1/66585), NPS *Knipovich*, Stn 613, trawl 456, 12 Mar. 1966, Andaman Sea, 9°31.8'N 97°35.3'E, 83-86 m; PARATYPE female (Queensland Museum W12662), slightly damaged at aperture, L. Cannon, May 1973, Moreton Bay, Qld. First 3 specimens dissected, ZIN specimen brooding some eggs and harbouring a hyperparasitic, cryptoniscus-stage, cryptoniscid isopod.

Diagnosis. Female carapace oblong, with body chamber at one end and lateral brood chambers as

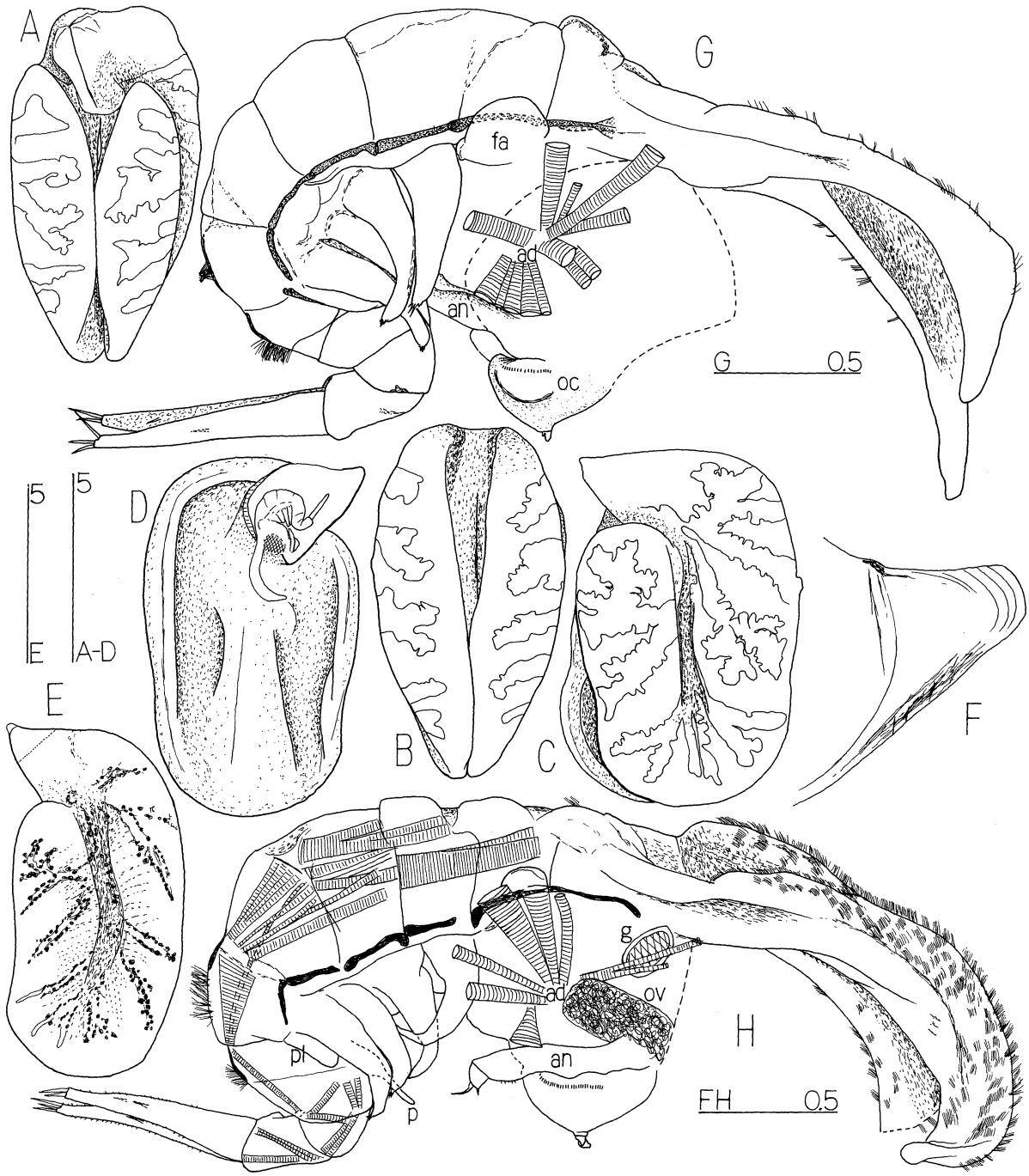

Fig.14. *Baccalaureus cannoni* n.sp., females. A–D, holotype (AM P37807): A–C, rear, front, and lateral views, respectively; D, left half of carapace removed to show situation of main body; E–F, paratype (ZIN 1/66585): E, lateral view; F, medial view of aperture protrusion. G–H, main bodies of holotype and ZIN paratype, respectively. Abbreviations: ad, adductor muscle; an, antennule; fa, filamentary appendage; g, gut diverticulum; oc, oral cone; ov, ovary; p, penis; pl, transverse plate. Scale bars in mm.

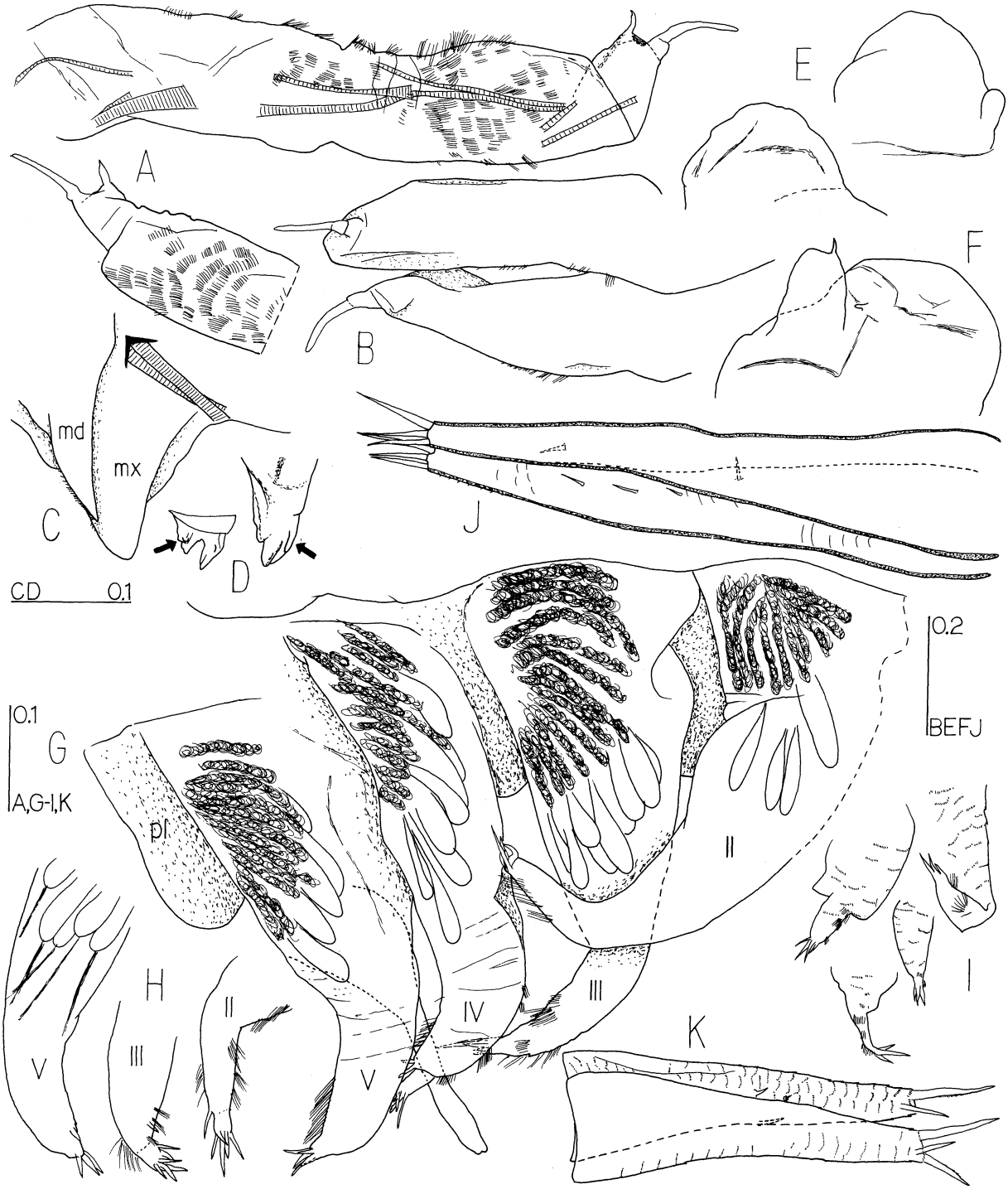

Fig.15. *Baccalaureus cannoni* n.sp., females. A, right and distal part of left antennules of ZIN paratype exuvia; B, antennules of W12661 (Qld). C, mandible (md) and distal part of maxillule (mx) of W12661; D, tips of one maxilla each of W12661 (right) and ZIN paratype exuvia (left), arrows pointing to ventral process. E, left (upper) and right (lower) filamentary appendage of holotype, with vestigial thoracopod I next to former; F, right thoracopod I and filamentary appendage of W128661. G–I, thoracopods of ZIN paratype; G, right thoracopods II-V and transverse plate (pl), showing seminal receptacles and ducts; H, distal parts of left thoracopods II, III, and V, showing tissue strands to seminal receptacles in last; I, tips of several thoracopods of exuvia. J,K, furcal rami of holotype and ZIN paratype exuvia, respectively. Scale bars in mm.

uncoiled, simple sacs 1.5-2 times longer than deep, each with lateral longitudinal furrow and 2 medial longitudinal furrows. Thoracic horns about as long as body proper, curving about 90°. Oral cone with row of spine-like striations internally on each side. Thoracopod I short or absent, with relatively small, oval, filamentary appendage at base. Thoracopods II-V usually vaguely 2-segmented, proximal portion of each largely filled with up to 40 or more seminal receptacles. No sixth thoracopods, but broad, apron-like, ventral lobe present on that segment. Dorsal setae on last (sometimes also second to last) thoracomere and first abdominal segment. Penis reaching end of second abdominal segment. Furcal rami straight, with 2-3 terminal and a few medial setae, cuticular ctenae weak and mostly limited to medial surface.

Host. All specimens were infesting *Sphenopus marsupialis* Steenstrup, large, solitary zoanthids from soft bottoms. First 3 specimens attached to inner wall of hosts' gastrovascular cavities, but uncertain whether host body wall penetrated by carapace aperture; last specimen previously removed from host. All parasites with thin, adhering layer of pink host tissue over the entire surface except aperture. One of 18 examined zoanthids from Moreton Bay infested, 1 of 37 from various Western Australian localities.

Description. Carapace with triangular body chamber and pair of elongate, anteroventrally extending brood sacs U-shaped in side view due to longitudinal furrow (Fig.14A-C,E). Holotype 9.5 mm long, 5.1 mm wide, 5.8 mm deep (from front to rear of brood sacs), W12661 6.8 *x* 4.7 *x* 3.6 mm, ZIN specimen 9.78 *x* 5.97 *x* 4.84 mm, W12662 11.38 mm long, 4.23 mm wide. Front and rear edges of each brood sac folded medially, forming 2 additional broad furrows on medial side (Fig.14D). Body chamber extending slightly beyond rear margin of brood sacs, slit-like aperture running from just dorsal of tip along entire ventral side; tip densely lined with hairs internally, possible growth bands visible externally, but no adhering arcs of exuvial cuticle (Fig.14F). Body chamber connected to lumina of brood sacs by anterolateral openings through which thoracic horns reach (Fig.14D). Outer cuticle thin, most delicate on medial faces of brood sacs, tougher near aperture, externally papillose except near aperture. Diverticula of gut and ovaries in each brood sac consisting of simple longitudinal branch along medial side and ramifying lateral branch along floor of lateral furrow (Fig.14C,E).

Main body of holotype 3.2 mm long from front edge of horns to tips of furcal rami, 1.4 mm high from tip of oral cone to top of thorax (Fig.15G). Body of W12661 4.4 *x* 2.2 mm (along same axes), that of ZIN specimen (Fig.14H) 3.4 *x* 1.5 mm, and 0.77 mm wide at thoracomere 4. Attachment zone of head to carapace slightly inverted, thorax extending somewhat anteriorly over head. Head bearing antennules and oral cone.

Thorax 6-segmented with pair of curved anterior horns on first segment and 4-5 pairs of uniramous thoracopods, sixth pair absent. Thoracic horns about 1.8 mm long in holotype, about 2.3 mm long in W12661, and 2.0 mm in ZIN specimen, length relative to body variable but making up half of body length in holotype (Fig.14G,H). Horns curved smoothly downward and outward about 90°, covered with tufts of thin, basally directed hairs, most abundant on proximodorsal margin. Rear of thorax bent downward, dorsal setae on last 2 thoracomeres in W12661 (shorter on segment 5) but only on sixth thoracomere in holotype and ZIN specimen. Ventrolateral edge of each thoracic tergite formed into thickened rod articulating with those of adjacent segments, together forming lateral chitinous ridge extending anteriorly onto base of horn.

Abdomen 4-segmented with sharp posterior bend at third segment. In W12661, boundary between first 2 segments unclear on right side and segment 4 partially divided dorsally; in ZIN specimen, first 2 segments poorly distinguished on both sides (Fig.14H), but clear in exuvia (second segment triangular, with extremely short dorsum and extensive arthrodial membrane). First 3 segments with cuticular ctenae and lateral pores, latter most abundant on first segment. Dorsal setae and posteroventral penis on first segment, furcal rami on fourth.

Antennules extending posteriorly from each side of base of oral cone, about equal in length to longest thoracopods and to furcal rami (Fig.14H). Segmentation usually obscure, possibly 4 segments in holotype, but distinct distal segment apparent in both antennules of ZIN specimen (Fig.15A). Apical spine and aesthetasc, latter on short process, in holotype and ZIN specimen, just aesthetasc on process in W12661 (Fig.15B). Cuticular ctenae present, especially dense on distal half.

Mouthparts based almost entirely on W12661, except ZIN exuvia useful for labrum. Labrum markedly deeper than long, laterally bulbous. Rear margins adjoining behind maxillae for short distance, terminal aperture with short spout. Basoposterior inner cuticle of labrum seeming to be produced into row of strong spines with about 8 setae between successive spines; however, this structure apparently actually a chitinous skirt with spiniform stays, perhaps involved in junction between labrum and bases of mouthparts. Mandibles narrow, with oblique medial edge bearing short, retrorse hairs (Fig.15C); maxillules with slightly longer and wider, blunt tips than mandibles and with broad, muscular bases. Maxillae massive, distal third of length free, tips bifid, anterior point bigger than posterior, latter not hook-like (Fig.15D).

In holotype, first right thoracopod short and stubby, left one absent (Fig.15E), both sides with oval swelling (filamentary appendage) reaching slightly dorsal of lateral chitinous ridge (Fig.14G). Short first thoracopods, each with a seta, and filamentary appendages also present in W12661 (Fig.15F), but only filamentary appendages found in ZIN specimen. Thoracopods II-V (Fig.15G-I) about equally long, uniramous, usually unsegmented, but with distinctly narrower distal region (latter lacking on right

thoracopod V of W12661); tiny but distinct apical segment seen on left thoracopod III and right thoracopod V of ZIN specimen. Distal part armed with fine hairs and ctenae and 3-9 short, apical setae (also 2 subapical setae on right thoracopod V of ZIN specimen). Proximal parts of thoracopods largely filled with seminal receptacles, minimum of 21, 51, 42, and 30 counted in right thoracopods II-V of W12661, appearing grouped into 2 clusters in most thoracopods in that individual, large but undetermined number also in thoracopods II-V of holotype and ZIN specimen (Fig.15G), but not in exuvia of latter. Fine, cell-lined ducts of seminal receptacles opening basolaterally with no distinct papilla; inner ends of receptacles attached to cuticle by tissue strands (Fig.15H). Thoracopods VI absent, but transverse ventral plate with square corners present instead in all specimens (Fig.15G).

Penis unarmed, uniramous (?absent in exuvia), little longer than ventral side of second abdominal segment, tip nozzle-like in W12661, long and narrow in ZIN specimen (Fig.15G).

Furcal rami straight and evenly tapered, 0.8 mm long in holotype, 1.0 mm in W12661, 0.70 mm in ZIN specimen, length 4.3-5.5 times basal height (furcal rami of ZIN exuvia only 0.33 mm long and 3.7 times longer than high). In holotype, right ramus with 3 apical setae, left with 2, dorsalmost seta slightly longer on both, 1 spine-like medial seta on each ramus; W12661 with 3 apical setae on each ramus, dorsal seta longest, 2 medial setae on left ramus, 3 on right (Fig.15J); ZIN specimen with terminal setation as in holotype (also in exuvia; Fig.15K) and 1-2 medial setae per ramus. Short cuticular ctenae covering medial surface, much weaker or absent on lateral face (only near ventral edge in exuvia).

Remarks. This new species is assigned to *Baccalaureus* despite several peculiarities because: it has a pair of lateral brood sacs unlike the other laurid genera; these sacs are not very different from those of the type species, *B. japonicus* Broch; a pair of thoracic horns is present (also found in one species of *Laura* Lacaze-Duthiers; Grygier, 1985a); there are continuous transverse bands of setae on some of the abdominal and rear thoracic segments (a newly recognised generic characteristic contradicted only by *B. isauricola* n.sp.); and the furcal rami are elongate (distinguishing it from *Laura*).

No other described species of *Baccalaureus* has a terminal body chamber; usually it is at about midheight posteriorly. A young specimen of *B. pyefinchi* Brattström illustrated by Pyefinch (1939: fig.1, as *B. japonicus*) is the most similar to the present form in this regard. Most species of this genus have coiled brood sacs; the least coiling until now, a slight posterior bend of the ventral parts, is exhibited by *B. japonicus*. Its brood sacs are simple, like those of *B. cannoni* n.sp., but they lack longitudinal furrows, and the body chamber is at midheight posteriorly. The short, hirsute, downturned thoracic horns of the new species are most similar to those of *B. verrucosus* Pyefinch (1939), where they are even shorter. All other species except *B. isauricola* n.sp. and *B. falsiramus* (see Itô & Grygier, 1990), in which the horns are short, naked, and straight or upturned, have very long, downwardly coiled horns. Variability in antennular morphology has been documented before by Itô & Grygier (1990). The mouthparts are poorly known in most other species of *Baccalaureus*, but the present ones are similar to those of other laurids (Grygier, 1985a; Itô & Grygier, 1990). The striated structure resembling a row of teeth or spines in the labrum has not been described before. No other described species of *Baccalaureus* has seminal receptacles in thoracopod V, although they are found there in most ascothoracidans, including some other laurids (Grygier, 1985a).

This is the first record of an ascothoracidan parasitising zoanthids of the monotypic genus *Sphenopus*. There is very little literature on this genus, and the only significant report on its biology (Nagabhushanam & Jothinayagam, 1982), which included a study of food and feeding, did not mention any parasites.

The wide geographic range of the present material (eastern and western Australia, Andaman Sea) is unusual in this genus, since most other species of *Baccalaureus* have been reliably reported only from their type locality. It is interesting that the species of *Baccalaureus* that parasitise *Sphenopus* (*B. cannoni* n.sp.), *Isaurus* (*B. isauricola* n.sp.), *Parazoanthus* (*B. japonicus*), and *Zoanthus* (*B. falsiramus*) are very distinct from each other and from the five described species infesting *Palythoa*. The latter are quite similar to each other except principally in thoracopod development, which is not a reliable specific character. Perhaps too many *Palythoa*-infesting species have been recognised. I am currently studying the variability within large populations of *Baccalaureus* in an attempt to answer this question.

Etymology. Named in honour of Dr Lester Cannon, Queensland Museum, who first discovered the species and brought it to my attention.

Petrarcidae Gruvel, 1905

Petrarcinae Gruvel, 1905

Petrarca Fowler, 1889

Petrarca okadai Grygier, 1981

Fig.16

Petrarca okadai Grygier, 1981a: 183–189, figs 1–3; Grygier, 1985b: 1031–1033, fig.2.

Material examined. Eight specimens out of 20 in lot (AM P37801): 2 pairs, 1 trio, 1 singleton; from internal galls (*sensu* Zibrowius & Grygier, 1985) in

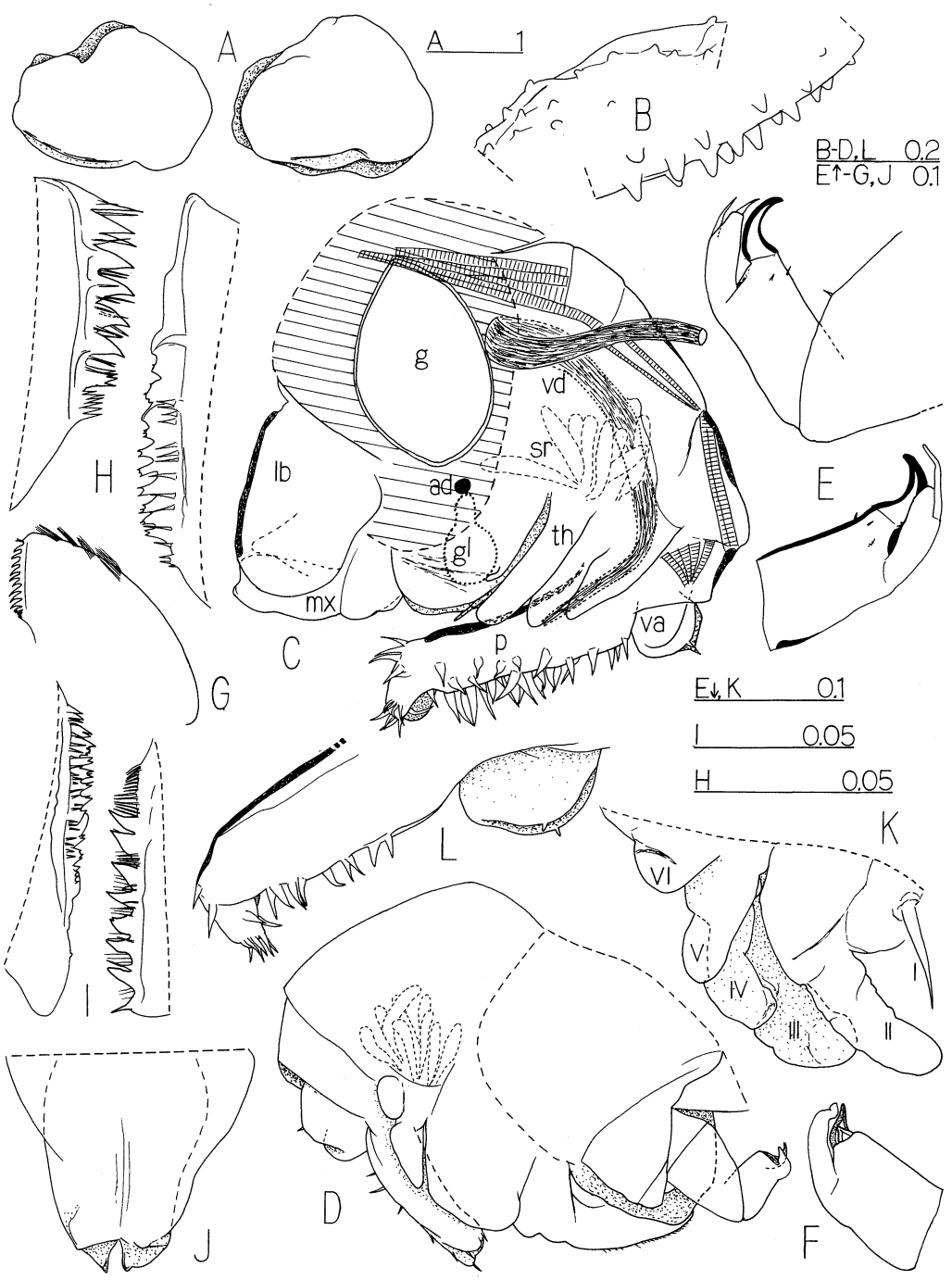

Fig.16. *Petrarca okadai* Grygier. A,B,D–I,K–L, Lizard Island, Qld (AM P37801); C,J, Straits of Macassar (MNHNP Ci2148). A, larger pair, lateral view, front ends left. B, posterodorsal (above) and anteroventral (below) carapace valve margins of left specimen in A. C, body removed from carapace, showing some internal organs and dorsal trunk musculature, antennules removed. D, body of aberrant specimen, anterior end right. E, distal segments of two typical antennules. F, double claw and abnormal claw guard on left antennule of specimen in D. G, mandible. H, medial edges of mandible (left) and maxillule (right) of one member of trio. I, medial edges of mandible (right) and maxillule (left) from two members of smaller pair. J, maxillae, frontal view. K, full set of thoracopods (cf. C–D). L, abdominal parts of left specimen in A. Abbreviations: ad, adductor muscle; g, gut diverticulum; gl, maxillary gland; lb, labrum; mx, maxillae; p, penis; sr, seminal receptacles; th, thoracopods; va, vestigial posterior abdomen; vd, vas deferens. Scale bars in mm.

Heteropsammia cochlea (AM G15229 and P37802), above commensal sipunculid burrows and mostly undetectable externally, J.K. Lowry & R. Springthorpe, 11 Feb. 1987, off Mrs Watson's Beach, Lizard Island, Qld, 12 m. Trio (MNHNP Ci2148) from internal gall in *Heteropsammia* sp., ORSTOM, Campagne CORINDON 2, Stn 293, 10 Nov. 1980, Straits of Macassar, 2°37.74'S 117°49.41'E, 45 m, gall visible externally as lump on one side of columella and extending towards neighbouring septa (Zibrowius, personal communication).

Morphological variability. Larger Lizard Island pair 2.0-2.1 mm long, with papillae over whole carapace surface and short but distinct ventral flanges, anteroventral papillae about 3 times longer than others (Fig.16A,B). Macassar specimens 1.3-1.5 mm long, similarly ornamented and with nubbly ventral flanges. Lizard Island trio 1.0-1.2 mm long, with few small to moderate anteroventral papillae on carapace, one specimen also with few tiny papillae along ventral valve margins; submarginal groove present in 2 specimens but no produced flanges. Singleton 1.4 mm long, with almost no papillae and no flanges.

Vestigial seta present on anterodistal corner of fourth antennular segment in some smaller specimens; up to 3 vestigial setae at base of claw, 1 marginal and 1 to each side (Fig.16E). Claw guard usually with 1-2 small, apical spines and with aesthetasc arising between midlength and beginning of distal third. Aesthetasc not accompanied by spinule and either not reaching end of claw guard or exceeding it, maximum length equal to that of claw-facing edge of claw guard. Both claw guards deformed in Lizard Island singleton, and one of its antennules bearing double claw (Fig.16F).

Lateral edge of mandible with several tufts of fine hairs (Fig.16G). Medial edge (Fig.16H,I), starting proximally, armed with 4-14 thin hairs, 6-10 strong, slightly curved teeth, most proximal tooth and sometimes another often bifid or otherwise apically split, and 1-2 more slender distal teeth. Typically 10-20 relatively strong hairs amongst teeth and along one side of tooth row, similar hairs or abundant, finer ones on other side. Medial armament of maxillules restricted to proximal half or two thirds (Fig.16H,I), consisting of thin lamella divided into about 10 weak, distally bifid or multidentate teeth flanked submarginally on one side by irregular row of 10-20 hairlike spinules. Maxillae completely fused into trapezoidal labium, end produced into 4 very short lobes representing ancestral bifid tips (Fig.16J).

Thorax with up to 2 dorsal thickenings in rear half, Macassar specimen and large Lizard Island specimen with 2 transverse dorsal wrinkles more anteriorly (Fig.16C). Pair of setiform first thoracopods of variable length observed in most examined specimens (not in Lizard Island singleton), but number of lobe-like thoracopods as seen in whole mounts of bodies apparently varying from 2-5 per side (Fig.16C,D,K), differing even on two sides of same specimen (lowest on left side of Lizard Island singleton). Cylindrical seminal receptacles within thorax, 5-10 on each side apparently principally associated with second thoracopods, i.e., first lobelike pair (Fig.16C,D).

Penis (Fig.16C,D,L) usually with 10-25 ventral setae along whole length or on distal two thirds of shaft (only 5 setae in Lizard Island singleton), and 7-14 smaller, thinner setae on each small, trapezoidal ramus (rami very weakly developed in Lizard Island singleton). Posterior, vestigial part of abdomen not exhibiting more than 2 segments; its armament, when visible, consisting of 2 spines (Fig.16C,L).

Remarks. My earlier concept of *Petrarca okadai* (see Grygier, 1981a, 1985b) included a carapace entirely covered with simple papillae and a thorax with 6 pairs of thoracopods, but according to the present observations, neither feature is actually true for all specimens. The variability recorded in the present specimens from Lizard Island, the type locality for *P. okadai*, in carapace morphology and armament, occurrence and size of antennular armament elements, number of thoracopods (although observations of the last are sometimes difficult in whole mounts), and penis setation provide a warning against giving such features much weight in diagnosing species of *Petrarca*. The most reliable discriminatory features seem to be gross aspects of the carapace armament and details of the mandibles and maxillules, the mouthparts perhaps being best. The singleton from Lizard Island differs most widely from the other specimens, but its bizarre distal antennular morphology allows us to recognise it as aberrant rather than a distinct species.

Demography of Lizard Island population. Of 358 *Heteropsammia* collected at Lizard Island as detailed above and split with a hammer and chisel, 14 were currently infested with *Petrarca okadai* and two had empty gall cavities (overall infestation 4.5%). Fisk (1981) previously reported only 0.5% infestation of *H. cochlea* by this parasite at Lizard Island. Of the 14 sets of parasites, two pairs and one set crushed by the chisel were brooding eggs. There were three apparent singletons, two of them notably small, and six pairs without brooded eggs. Two of these pairs were in separate galls in a single host; one other 'pair' may actually have been two singletons in separate galls, but this is quite uncertain. The number of individuals comprising three sets left *in situ* is unclear, but one of them was clearly at least a pair. There were no confirmed trios, and no singletons, with eggs. Two cases of cohabitation of *P. okadai* with the burrowing bivalve *Lithophaga lessepsiana* Vaillant were observed, one involving an empty gall with a tiny hole opening into the inner end of a bivalve burrow, the other involving one of the sets left *in situ*, with a tiny bivalve sitting within a slit at the sipunculid burrow aperture. Large and small bivalves or empty burrows occurred in 39 of 358 corals (10.9%), so the odds of finding even one such cohabitation in the present population are only $0.045 \times 0.109 = 0.0049$ (i.e., p less than 0.01). Two such occurrences in this sample may indicate a tendency for the ascothoracidans and bivalves to co-occur.

Petrarca sensoria n.sp.

Fig.17

Type material. HOLOTYPE (AM P37804) and 2 PARATYPES (AM P37805) occupying large internal gall (*sensu* Zibrowius & Grygier, 1985) of columella of undescribed species of *Fungiacyathus* G.O. Sars (determined by S.D. Cairns), another PARATYPE (AM P37806) occurring alone in small internal gall of columella of another specimen from same lot (AM G15230; also including 4 uninfested corals), W.F. Ponder, RANS *Kimbla* Stn 1, 29 Mar. 1969, off Moreton Bay, Qld, 27°31'S 153°40'E, 77-80.5 m. Holotype and singleton paratype dissected, latter referred to as "paratype" in description. Each gall evident as raised, spongy-appearing lump on columella.

Diagnosis. Carapace generally smooth and without distinct ventral flanges on valves; large, blunt papillae along middle half of ventral margins, small papillae elsewhere below midheight. Thorax not externally segmented, abdomen with pair of posterior spines. Distal aesthetasc on antennular claw guard about as long as claw guard itself. First pair of thoracopods setiform, others lobe-like, sixth pair extremely reduced. Penis relatively short and thick, rami broad, rounded and heavily setose. Mandible with 8-10 recurved teeth with row of spines on outer face alongside. Maxillule with about 9 delicate teeth, distal ones rounded, basal ones subdivided, row of tiny spinules on outer face alongside.

Description. Holotype 1.56 mm long, 1.36 mm wide, 1.28 mm high, its accompanying paratypes 1.30 *x* 1.20 *x* 1.03 mm (front end damaged) and 1.15 *x* 1.03 *x* 0.97 mm; singleton paratype 1.08 *x* 1.01 *x* 0.95 mm. Carapace bivalved but lacking distinct hinge, spheroidal with greatest girth well below midheight (Fig.17A,B); valves thick, completely enclosing main body. Brood chamber absent, one specimen with several spherical eggs 0.16-0.17 mm in diameter adhering to rear of carapace. Middle portion of ventral valve edge with large, blunt papillae, more in holotype than paratype (Fig.17C); similar but more widely spaced papillae dorsal and anterodorsal to these, and small, isolated papillae over entire ventral half of carapace in holotype, but rare in paratype.

Head comprising half of compact body (Fig.17D), with anterodorsal attachment zone, large, folding antennules, and oral cone. Thorax unsegmented externally, but in holotype, posterior segment indicated by dorsal cuticular thickening and musculature. Six pairs of thoracopods. Abdomen with large first segment bearing enormous, distally bifid penis; vestigial posterior part of abdomen consisting of perhaps 2 segments and bearing pair of small spines on projecting lobes, left spine in holotype much bigger than right (Fig.17K), both equally small in paratype.

Antennules large, strongly developed, 5-segmented (Fig.17E,F). First segment triangular with long base, heavily sclerotised but with much arthrodial membrane around partly recessed second segment, latter quadrilateral with thickened, transverse chitinous band mediobasally and much arthrodial membrane posterodistally. Third segment triangular, asymmetrical. Quadrilateral fourth segment also asymmetrical, longer posteriorly than anteriorly, with tiny seta at midpoint of short anterior margin in paratype. Fifth segment almost rectangular, distal edge bearing heavy, movable claw and trough-like claw guard. No more than 2 tiny, variably placed sensilla seen at base of claw, up to 2 more sensilla seen at tip of claw guard. Long, thin, subapical aesthetasc about as long as claw guard proper in holotype, slightly longer in paratype. Spinule at base of aesthetasc in 3 of 4 cases.

Labrum relatively large with pair of posterolateral flaps flanking maxillae, main part containing pharyngeal pump muscles. Mandibles and maxillules both with rounded lateral margin and short, toothed, medial edge, maxillules slightly broader. Toothed edge of mandible 87 µm in holotype, 53 µm in paratype; left one of holotype (Fig.17G) with 10 teeth, distal 8 simple and recurved, basal 2 divided; row of thin spines on outer face alongside teeth. Mandible of paratype with 9 teeth, 7 of them simple. Maxillules of holotype (Fig.17H) bare along distal third of medial edge, then 2 rounded teeth separated by bifid tooth, former with 1 basal spine each, and 6 more proximal teeth, most of them terminally subdivided into 2-5 spinules. Maxillular teeth much weaker than those of mandible; row of tiny spines on outer face alongside teeth. Maxillules of paratype with 2 teeth between rounded ones, 5 proximal teeth with no more than 3 apical spinules, and 2 isolated basal spines; 2 submarginal comb rows of spinules. Maxillae fused into massive, triangular labium except for distal medial notch, tips not subdivided. Very large, unpaired lobe for maxillary glands between oral cone and thoracopods.

First thoracopods longest, setiform, others lobe-like, decreasing in length but not thickness posteriorly, sixth pair reduced to indistinct bumps, especially in paratype (Fig.17I,J). Seminal receptacles in thorax, 8 seen on left side of holotype, seemingly associated with bases of second and third thoracopods (Fig.17D).

Penis phallus-shaped, curving upwards distally, reaching to base of maxillae in holotype, but only as far as maxillary gland swelling in paratype (Fig.17D,K). Rami short, broad, and rounded, extended in holotype, partly bent down in paratype, each ramus with about 16 short setae in holotype, perhaps 12 in paratype (half that number seen on left ramus). Shaft with few ventral setae distributed along whole length in holotype, only on distal half in paratype.

Remarks. This interspecific comparison is based primarily on Grygier (1985b). The new species differs from *P. morula* Grygier in having a smooth rather than macroscopically bumpy carapace. It differs from *P. azorica* Grygier in having only one third as many teeth on the mandibles and maxillules, in lacking a diversity of spines and papillae on the carapace, and having round rather than square furcal rami. *Petrarca*

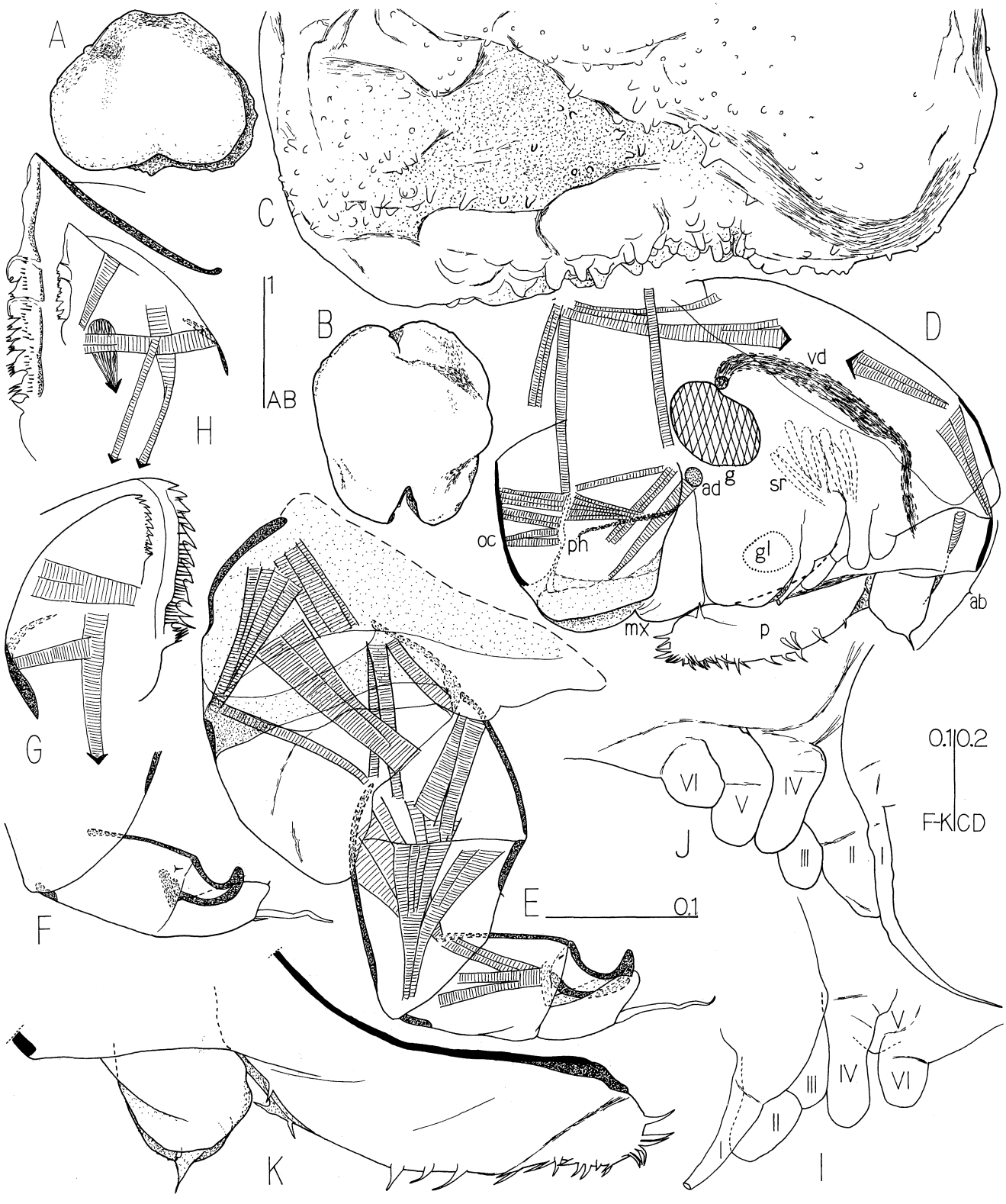

Fig.17. *Petrarca sensoria* n.sp., holotype (AM P37804) except for E, paratype (AM P37806). A–B, lateral and dorsal views of carapace. C, ventral half of left valve. D, main body, antennules omitted. E–F, left antennules in medial view. G–H, left mandible and maxillule, respectively, each with enlargement of medial armament (submarginal spinules in H actually on far side). I–J, left and right thoracopod clusters. K, abdomen and penis. Abbreviations as in Fig. 16, with ab, abdomen; oc, oral cone; ph, pharynx. Scale bars in mm.

indica Grygier has a long aesthetasc on the claw guard, but it has minutely denticulate medial edges on the paired mouthparts, a more slender penis, and much more massive ventrolateral carapace spines. Similarly, *P. bathyactidis* Fowler has massive ventrolateral carapace spines; it also has a short claw guard aesthetasc, a squared-off end of the penile shaft, and, at least in the holotype, apically bifid first thoracopods.

The differences between *P. sensoria* and *P. okadai* are rather subtle. Those that seem to be most trustworthy are large carapace papillae lying along the middle part of the ventral carapace margins instead of anteroventrally, taking the place of a nubbly ventral flange; hairs only in one row alongside of the mandibular teeth rather than on both sides and amongst them; much shorter spinules alongside the maxillular teeth; and much broader penile rami. The first thoracopods are usually shorter in *P. okadai*, and no spinule next to the claw guard's aesthetasc has been seen in that species.

Corals of the genus *Fungiacyathus* are well-known hosts of Petrarcidae worldwide (Zibrowius & Grygier, 1985), inhabiting internal galls that involve the columella, septa, and thecal wall, but the responsible crustaceans themselves have only rarely been found. Most records involve *F. marenzelleri* (Vaughan) from depths greater than 2000 m or not fully identified corals comparable to that species, such as the host of *P. bathyactidis* from off Japan. Previously recorded shallow *Fungiacyathus* with galls from which no parasites were recovered include *P. paliferus* (Alcock) in the Indian Ocean off Reunion at 280 to 375 m and an unidentified form off South Africa at 99 m (Zibrowius & Grygier, 1985; Cairns, 1989).

Etymology. From Latin *sensus* (sense), referring to the long sensory aesthetasc on the claw guard.

Petrarca goanna n.sp.

Figs 18,19,21A,B

Type material. Fifteen specimens (6 pairs, 1 trio), HOLOTYPE the larger of pair 3 (AM P37810), other 14 specimens PARATYPES (AM P37811-P37818), occupying 7 external galls (*sensu* Zibrowius & Grygier, 1985) in *Turbinaria reniformis* Bernard (AM G15234, including gall of holotype), J.K. Lowry, R. Springthorpe & M.J. Grygier, 14 Feb. 1987, near entrance to Blue Lagoon, Lizard Island, Qld, 2 m.

Other material. Three galls from same collection remain unopened, and 2 additional pairs of parasites were given to Drs J.M. Healy and D.T. Anderson (University of Sydney) for eventually unsuccessful spermatological study.

Diagnosis. Carapace with series of radially directed, dorsal and posterior ridges formed from partly or fully coalesced, lumpy surface irregularities; margins crenulated due to protruding outer ends of ridges. Irregular anterolateral lumps on carapace with prickly surface texture but no ventral papillae or spines present. Maxillae mostly exposed due to very short lateral extensions of labrum. Mandibles and maxillules with about 20 teeth, those of mandibles longer and stronger, those near base of maxillules tending to form 2 rows. First thoracopods setiform or absent, remaining 4 or usually 5 pairs of thoracopods long, slender, unsegmented, naked, arising in tight cluster, sixth pair markedly shorter than others when present. Penis with small, squarish rami bearing many short setae. Posterior part of abdomen extremely small, at least 2-segmented with variable number of tiny spines.

Host-parasite relations. Live host material on hand included several broken pieces and one whole colony; the latter had six galls, including two empty ones on a dead, overgrown part. Galls were detected by a SCUBA diver running his hand over the smooth, acalicular side of a *Turbinaria* colony, while feeling for rounded lumps. While fresh and presumably still alive, these lumps were partly cut in half with a rock saw, then split with a sharp blow to expose the contents. Some proved to be overgrown coral barnacles, but others contained ascothoracidans, usually a pair. Ascothoracidan galls were up to about 4 cm across and were evident on the calicular or acalicular side of the coral, or both (Fig.21A,B). The texture of the coenenchyme of such a gall is coarser than its surroundings, and no calices open upon a gall. No galls contained brooded eggs or larvae. Shrinkage of the parasites and loss of their pink colour after preservation were evident.

Description. Holotype 5.87 mm long, 5.14 mm high in preserved state. Other specimens of pairs 1-6 3.73-6.93 mm long, 3.75-6.35 mm high, measurements of width not comparable due to different degrees of valve splaying. Among all specimens, height 85-110% of length (mean percentage 94). In pairs 1-6, respectively, smaller specimen 90, 76, 75, 84, 83, and 88% as long as larger one. Carapace roughly spherical when valves not splayed, with lumpy external appearance and no distinct hinge (Fig.18A,B). Five to 8 radial ridges formed of partially to fully coalesced lumps in fan-like array encompassing anterodorsal to posteroventral regions, coalescence less pronounced anteroventrally along each ridge. In medial view (Fig.18C), valve margins appearing crenulated due to same ridges, latter barely protruding medially, and distinct only outside arc of dorsum of main body. Additional lateral swellings with prickly surface in anteroventral quadrant of valves. Ventral margin smooth, without papillae or spines.

Body enclosed between carapace valves except for tip of penis (Fig.18C,D). Body grub-like, consisting of anterodorsally attached head with antennules and oral cone, ovoid, apparently 2-segmented thorax with tight ventral cluster of slender thoracopods, and abdomen with massive, penis-bearing first segment and vestigial rear

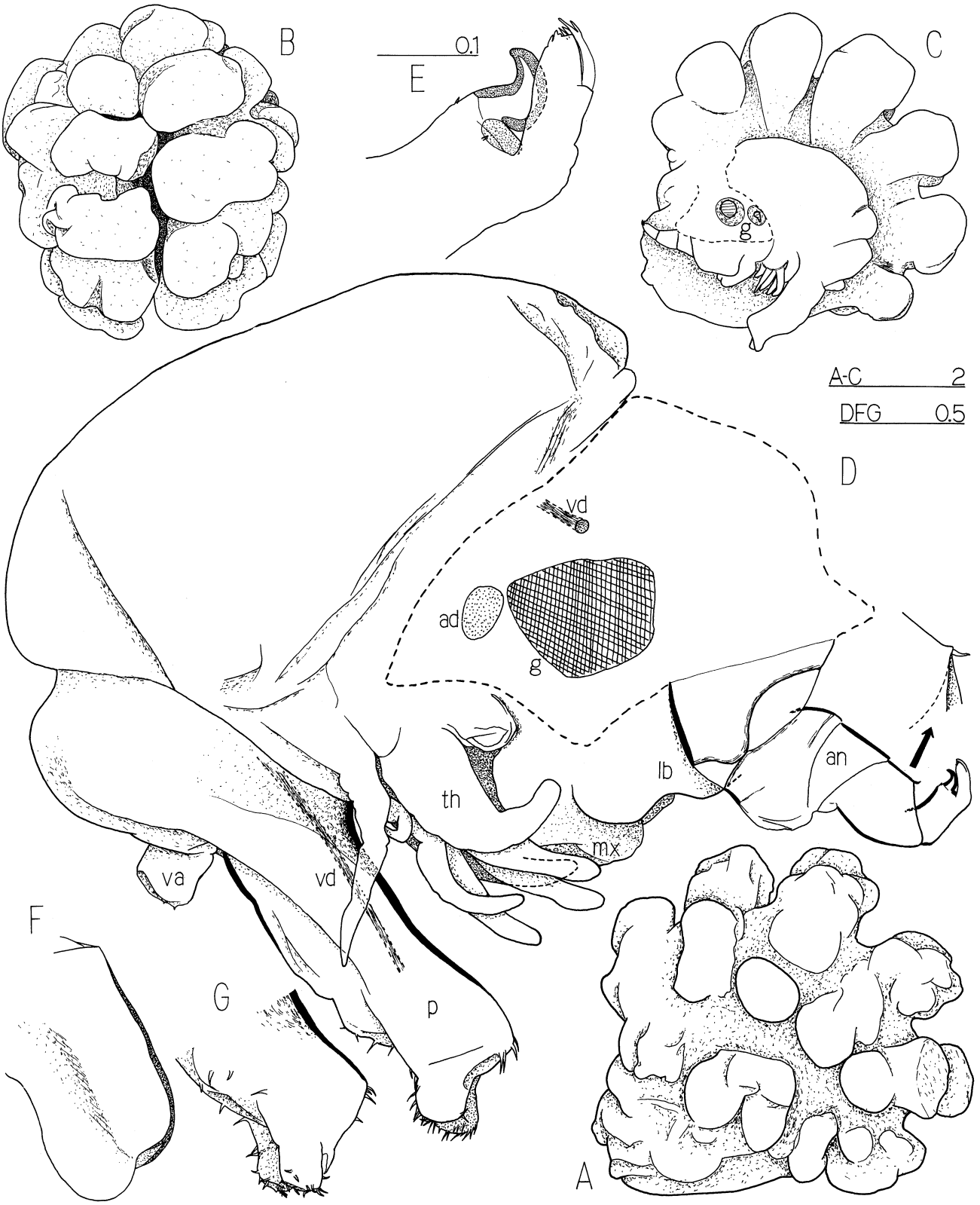

Fig.18. *Petrarca goanna* n.sp. A, holotype (AM P38810), left lateral view; B–C, paratype (AM P37811 or P37812), dorsal view and with left valve removed to expose body, respectively. D, body of holotype with details of antennular seta and E, of distal part of right antennule. F, labrum and G, tip of penis of two paratypes (AM P37811 and P37812). Abbreviations as in Fig. 16, with an, antennule. Scale bars in mm.

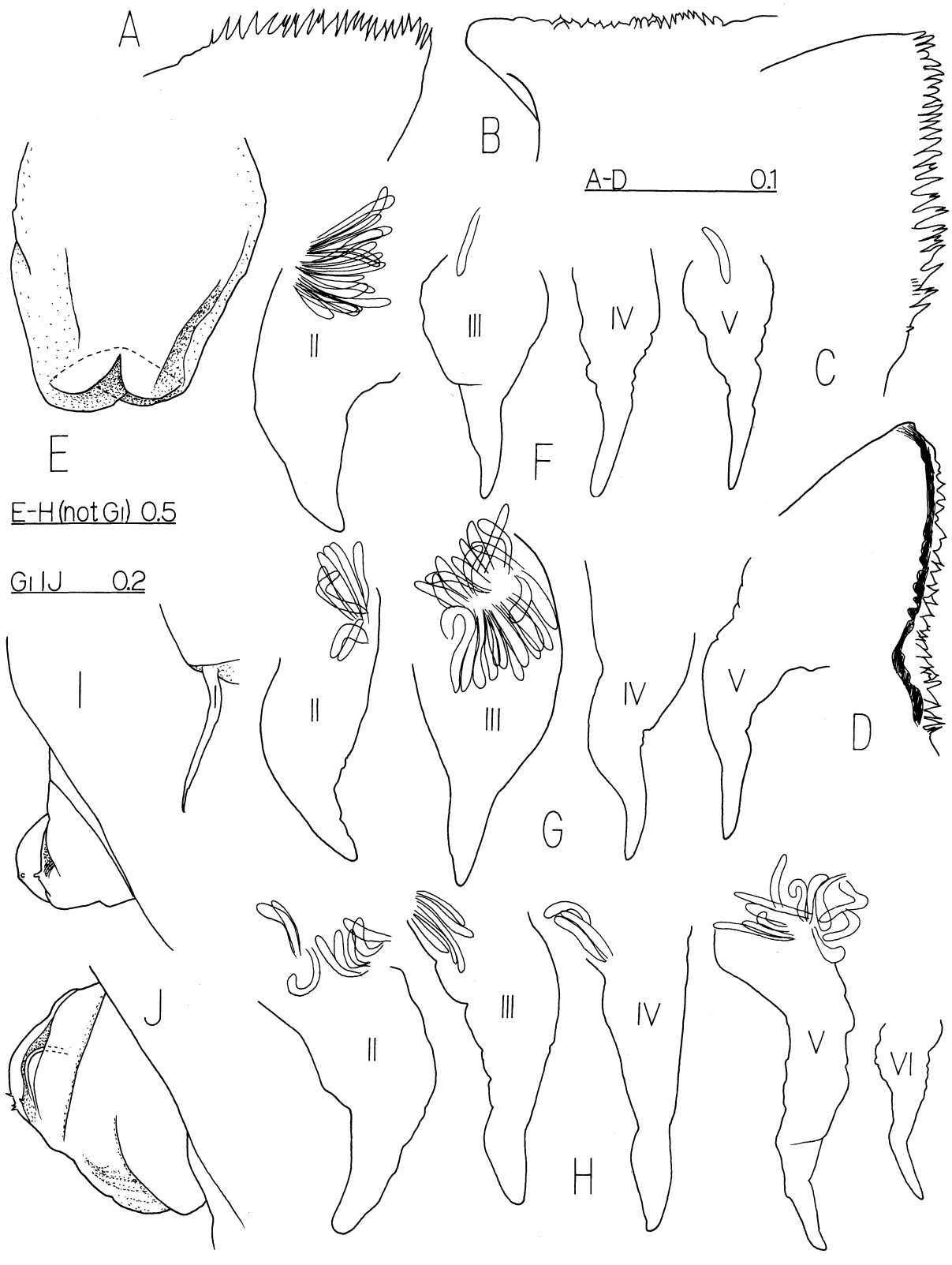

Fig.19. *Petrarca goanna* n.sp., paratype pair (AM P37811, AM P37812) except I, different paratype (AM P37812). A–B and C–D, two sets of medial edges of mandibles (A, C) and maxillules (B, D). E, maxillae. F–G, right and left thoracopods, respectively, from one specimen, and H, right thoracopods from other, all showing seminal receptacles. I–J, vestigial posterior abdomens. Scale bars in mm.

portion. In holotype, body length about 2.85 mm from front of oral cone to rear of first abdominal segment, this distance in 4 different specimens equal to 49-61% of carapace length.

Antennules 5-segmented with little armament, somewhat prehensile, segments becoming narrower distally (Fig.18D). First segment with lateral condyle and second with narrow, sclerotised medial strip; third segment triangular; fourth with curved posterior margin and short, straight, anterior margin, short seta at corner between anterior margin and oblique distal margin (seen in only 2 of 3 examined antennules). Fifth segment rectangular, with heavy, curved claw on anterodistal corner and longer, laterally flanged claw guard on posterodistal corner (Fig.18E). Probably 3 vestigial setae at base of claw and to each side. Claw guard with up to 4 vestigial, distal setae, subapical aesthetasc not over half as long as claw guard proper.

No eyes or frontal filaments present.

Oral cone short but very deep, consisting of massive labrum, massive labium formed from fused maxillae, and 2 sets of paired mouthparts. Labrum prow-shaped with thickened anterior surface and short posterolateral extensions leaving maxillae and bases of paired mouthparts largely uncovered (Fig.18D,F). Mandibles and maxillules based on pair 1 (Fig.19A-D). Both with rounded posterolateral margin and straight, toothed medial edge, maxillule more pointed distally. Mandibles with 20-25 straight, narrow teeth, some proximal ones bifid; a few additional, small spinules also present. Maxillules with about same number of teeth, but only about half as long; distal ones often rounded with terminal point, proximal ones tending to overlap as though formed into 2 irregular rows. Maxillae forming trapezoidal floor of oral cone, ending in 2 pairs of very short, rounded lobes perhaps representing bifid tips of generalised maxillae (Fig.19E).

Thorax unsegmented, but triangular region of thinner cuticle found at rear. Remainder of thorax somewhat bulbous, thoracopods in tight cluster below its rear half, female gonopore located in front of them (Fig.18D). Thoracopods not appearing to arise in orderly sequence in lateral view, but in ventral view seen to be paired but staggered; possibly thoracopods 3 and 4 usually positioned more medially than other pairs. Four to 6 thoracopods present on each side of body, varying among specimens (Fig.19F-H). Setiform thoracopod I rarely present, only on left side of 2 of 6 closely examined specimens, absent on both sides of holotype. Thoracopods II-V always present, as long, narrow, unsegmented, unarmed, distally blunt lobes. Thoracopod VI absent on both sides of smaller specimen of pair 1, but otherwise present at least as nub, generally similar in shape but shorter than other thoracopods. Numerous cylindrical seminal receptacles arranged in batteries in thorax above thoracopods, possibly some associated with each of thoracopods II-V.

First abdominal segment large, supporting long, thick, terminally bifid penis (Fig.18D). Shaft of penis slightly arcuate, narrowed at midlength, thickened anteriorly; cluster of short setae on squared-off tip, additional setae on distal half of ventral side; one penis seen with considerably larger seta below terminal cluster, between bases of rami (Fig.18G). Small, squarish rami arising posteroventrally from end of shaft, bearing numerous short setae (13-20) similar to or little shorter than those on shaft.

Rest of abdomen vestigial, apparently 2- or 3-segmented (only 2 segments clearly seen) generally sunken into posteroventral part of first segment, but occasionally protruding (Fig.19I,J). Second (or third?) segment possibly actually short, rounded, furcal rami. From 1-4 tiny terminal spines counted in different individuals, perhaps not all arising from same sites.

Remarks. The only described species of *Petrarca* comparable to *P. goanna* n.sp. is *P. morula*, which was discovered in external galls of *Turbinaria* sp. from the Banda Islands, Indonesia (cf. Grygier, 1985b). *Petrarca goanna* is larger, the largest type specimen of *P. morula* being 3.8 mm long. The carapace of the new species differs in having a much more regular pattern of external lumps, a crenulated valve margin, and no ventral papillae. It also has about twice as many teeth on the mandible and a clearer maxillular dentition. No first thoracopod was seen in *P. morula.*

The intermittent appearance of the first and sixth thoracopods in *P. goanna* confirms doubts raised above about the utility of the number of thoracopods in diagnosing species of Petrarcidae, as Grygier (1985b) did, for example. It also casts doubt on whether Grygier (1985b) correctly identified the thoracopods in different specimens of *P. azorica.* Supposedly that species has thoracopods II-VI only. A setiform first leg on one side of the holotype was identified as a shrivelled second thoracopod, but it is possible that that was actually thoracopod I, and that thoracopod VI was absent on that side.

Turbinaria spp. often serve as hosts of Petrarcidae. Numerous examples of petrarcid galls on dried specimens of this coral genus have been found in various museums (herein, below). They can be distinguished from galls formed by cryptochirid crabs since they have no external opening. Sometimes they resemble overgrown coral barnacles, but the latter are usually more conical, and plates of the barnacle wall are found inside when the "gall" is split. In contrast, petrarcid galls are normally rounded or oval, may penetrate all the way through the coral, and within them there are usually two linked cavities whose contours follow the parasites' carapaces.

Petrarca sp.

Figs 20, 21C

Material examined. 2 specimens (AM P39495-6) from dried *Anthemiphyllia dentata* Alcock (AM G15235), F. Rowe & P. Colman, *Kimbla* Stn 3, 17 Nov. 1977 (#2639), 33.8 km east of Lady Musgrave Island, Qld,

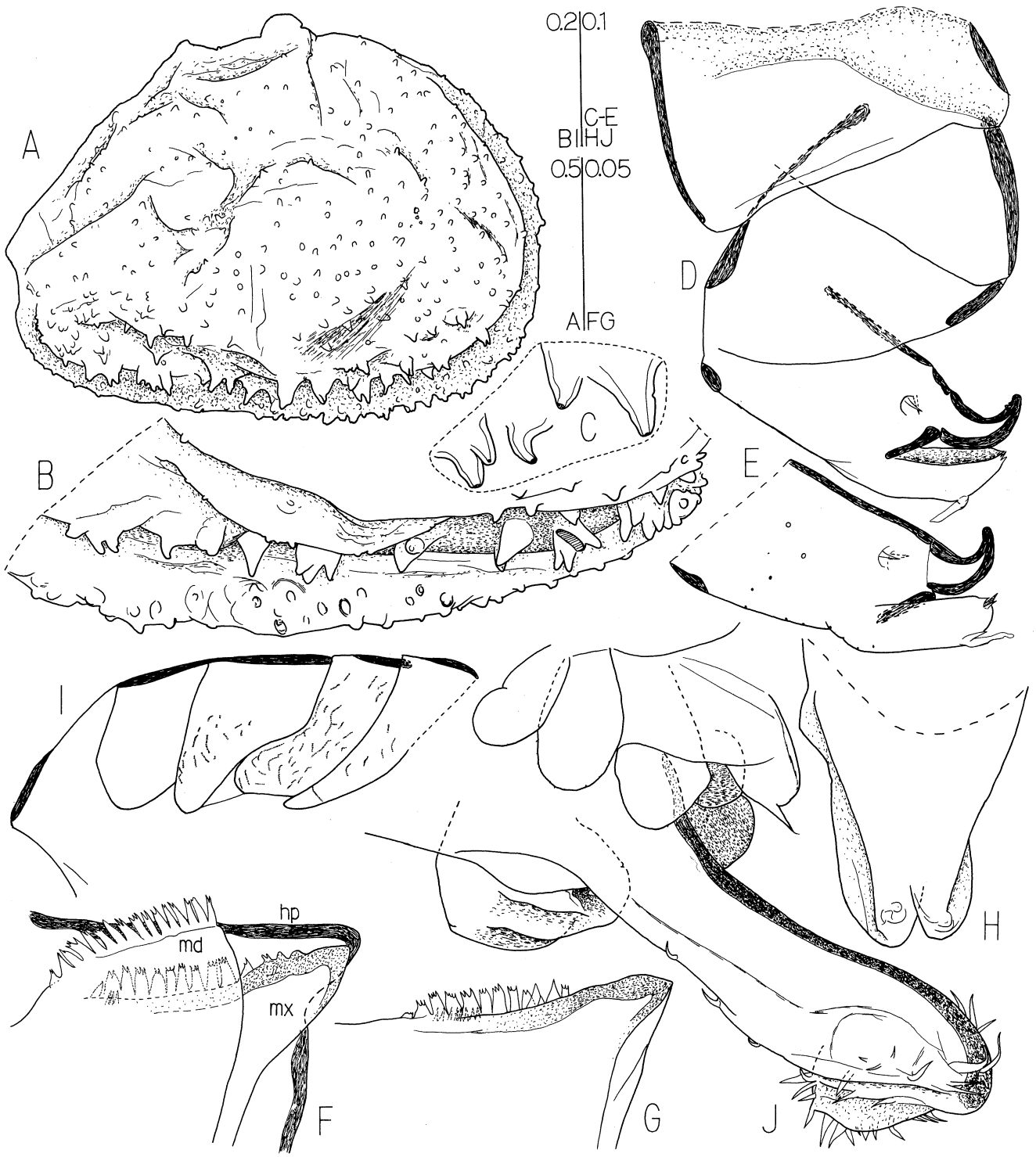

Fig.20. *Petrarca* sp. (mostly AM P39496, but B–C based on AM P39495) A–C, carapace: A, lateral view, front end left; B, armament of ventral valve margin; C, spines apparently with apical pores. D–E, antennules: D, left one, medial view; E, distal segment of right one, lateral view. F–H, mouthparts: F, hypopharynx (hp), mandible (md), and maxillule (mx); G, other maxillule; H, maxillae, frontal view. I, four thoracic tergites and first abdominal segment. J, thoracopods, abdomen, and penis. Scale bars in mm.

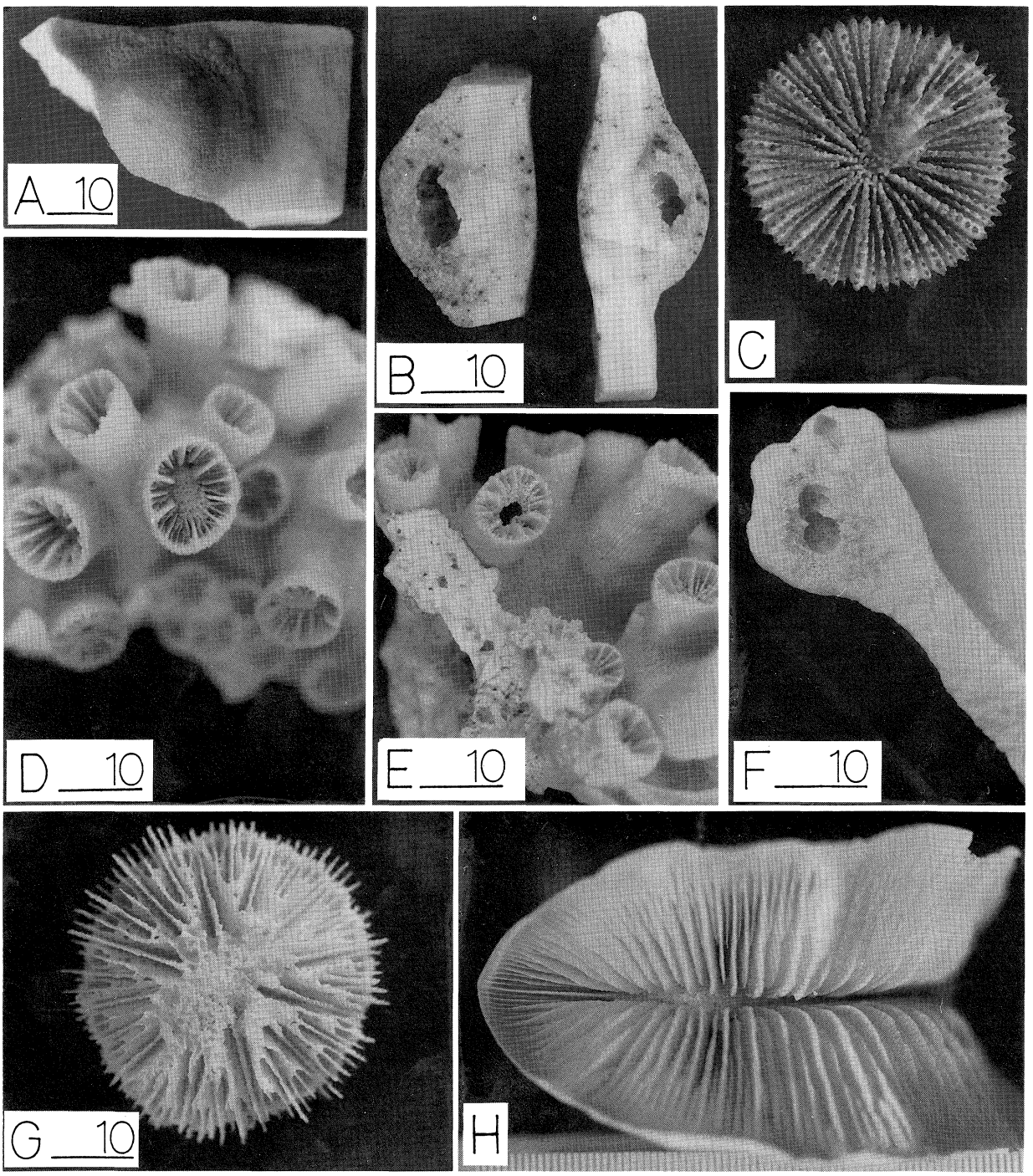

Fig.21. Australian Scleractinia with petrarcid galls. A–B, *Turbinaria reniformis* Bernard from Lizard Island, Qld (Australian Museum) with galls caused by *Petrarca goanna* n.sp. (AM P37810-18), those in B opened to show internal cavity. C, *Anthemiphyllia dentata* Alcock from off Qld (USNM 78611), unopened gall, photograph supplied by S.D. Cairns without scale. D–E, *Dendrophyllia* sp. from Dampier Arch., WA (National Museum of Victoria, uncatalogued): D, showing calice with enlarged columella; E, showing opened, infected calice. F, *Turbinaria conspicua* Bernard from Dampier Arch., WA (WAM 531-78) with open petrarcid gall combined with coral barnacle. G, *Deltocyathus magnificus* Moseley from north-west of Augustus Island, WA (WAM 524-81(1)) with greatly enlarged, irregular columella. H, *Flabellum magnificum* Marenzeller from off Cape Leveque, WA (WAM 580-84)) with gall in columella. Scale bars in mm.

23°33.7'S 152°37'E, 348-339 m; 3 specimens (AM P39497) from dried *A. dentata* (AM G15264), A.A. Racek, Night Challenge Trawl 318, 2 July 1959, east of Newcastle, NSW, 156-60 fms (285-110 m). Despite efforts to rehydrate the 5 dried ascothoracidan specimens in detergent, none found suitable for naming as holotype or as syntypes. This coral species ordinarily without columella and with dentate septa meeting in center, but infested ones with spongy internal gall (*sensu* Zibrowius & Grygier, 1985) close to center of calice (Zibrowius, personal communication).

Two dry specimens of *A. dentata* in National Museum of Natural History, Smithsonian Institution, with unopened, excentrically placed galls tentatively attributed to same parasite as above, gall on one specimen occupying about one third of radius (Fig.21C): USNM 78611, A.J. Bruce, Nimbus-12, off Qld, 27 July 1968, 26°32'S 153°50'E, 275 m; USNM 78609, A.J. Bruce, Nimbus-55, 5 Aug. 1968, off Qld, 26°27'S 153°50'E, 270-272 m.

Description. All 5 specimens shrivelled due to drying, with little improvement after soaking in detergent; P39495-6 in somewhat better condition, but no specimens with thoracopods, posterior part of abdomen, and distal end of penis well displayed.

Carapace probably subglobular in life, greatest girth at about 30% of height (Fig.20A). Length and height of P39495-6 1.28 *x* 0.87 mm and 1.54 *x* 1.11 mm, respectively; one specimen from P39497 2.27 *x* 1.91 mm, others similar; all specimens undoubtedly larger in fresh condition. Carapace bivalved but lacking distinct dorsal hinge. Free margins with distinct papillose flange most of way around, similar papillae scattered over dorsal two thirds of valve surfaces, giving way ventrolaterally to much larger, blunt, broad-based and often irregularly compound spines, at least some larger spines apparently with pore at tip (Fig.20B,C). Longest spines about 90 µm. Upper two thirds of carapaces of some specimens (P39497) filled with developing oocytes, but precise arrangement of internal organs not studied.

Main body semicircular with anterodorsal cephalic attachment zone. Head making up half of body of measured specimen from P39497, body measuring 1.45 mm long from front of oral cone, 1.38 mm high including penis. Head with massive, folding antennules and short, blunt oral cone. Thorax with at least 4, maybe 5, distinct tergites (Fig.20I), anterior ones narrower and with their ventral parts curving posteriorly, curved rows of minute cuticular ctenae laterally on tergites. Number of lobe-like thoracopods unclear (details below). Very large first abdominal segment bearing massive, distally swollen, more or less straight penis (Fig.20J). Rest of abdomen vestigial, sunken into rear of first segment, number of segments unknown.

Antennules of P39495-6 examined (Fig.20D,E), 5-segmented, with L-shaped, sclerotised part of first segment wider than long. Second segment quadrilateral with anterior margin about half as long as posterior; third segment more or less triangular. Fourth segment with extremely short anterior margin, oblique distal edge set at 45° angle to anterior side, and posterior edge about as long as other 2 margins combined; this segment apparently unarmed in one specimen, but with short seta proximally on lateral ridge of oblique distal side in other. Last segment parallelogram-shaped and slightly tapered, with several pores on lateral face; bearing heavy claw with or without 2 blunt denticles; 2 short setae lateral and medial to base of claw, no marginal one seen; claw guard about twice as long as claw, with lateral flange, 2-4 tiny apical setae, and short, subapical aesthetasc accompanied or not by short seta.

Labrum of P39496 about 0.30 mm long and deep, lateral edges flanking sides of maxillae, anterior face bent at obtuse angle about one third of distance from base. Mouthparts of same specimen dissected free (Fig.20F-H). Mandibles and maxillules both with short, broad, muscular base and short, dentate medial edge not extending beyond end of hypopharynx, medial edge of mandible half as long as that of maxillule. Mandible with 16 teeth, mostly bifid or trifid apically; maxillule with 12-14 teeth along middle half of medial edge, tips mostly truncate with 2-4 apical denticles. Maxillae forming massive, trapezoidal labium, rounded tips with anterodistal bump on each side.

Number of thoracopods unclear, 4 or 5 lobe-like ones per side, decreasing in size posteriorly (Fig.20J). Tip of apparent first right thoracopod of P39496 produced into short setiform process on lobelike base, but no setiform first thoracopods as known in other petrarcids observed.

Penis (Fig.20J) with short, ventral setae along shaft, only 1 distal ramus clearly seen in each of 2 specimens, ramus and rounded tip of shaft with numerous short setae, ramus capable of swinging nearly 180°, judging from different positions in various specimens. Posterior part of abdomen of P39495-6 examined closely, former with 4 short setae or spines, their precise positioning unclear, latter with no apparent armament (Fig.20J).

Remarks. The clearly segmented thorax distinguishes these specimens from all other species of *Petrarca*, in which the only evidence of thoracic segmentation is limited to dorsal cuticular thickenings, occasional dorsal wrinkles, and musculature (Okada, 1938; Grygier, 1985b, herein above). Clear segmentation has been considered a diagnostic feature of the other petrarcine genus, *Zibrowia* Grygier, but at least two of the other major distinctions between the two genera are still valid: the present specimens have no posterior lobes on the carapace and their abdomen does not end in a prominent single spine; the tip of the penis is not displayed well enough to be sure whether it is biramous or not.

Petrarca okadai is the only other species with papillae all over the carapace in some cases, but the papillae are not replaced by such large spines ventrolaterally. The outline of the fourth antennular segment, especially the short anterior margin, is most similar to that of *P. bathyactidis*, the type species of the genus, whose carapace has large, ventrolateral spines like the present ones, but the dorsal half of its carapace is bare of papillae, and the tip of its penis is squared off (Grygier, 1985b). The present mandibular dentition is so

far unique in the genus (mouthparts of *P. bathyactidis* unknown), but the maxillular dentition is similar to that of *P. okadai* and *P. sensoria* n.sp.

This is the second record of *Anthemiphyllia dentata* as a host of Petrarcidae. Zibrowius & Grygier (1985) reported empty internal galls in that species from 290 to 350 m off New Caledonia.

Other New Indo-Pacific Records of Petrarcid Galls in Scleractinian Corals

The following listing supplements the catalogue of petrarcid galls in scleractinians published by Zibrowius & Grygier (1985). Some of the entries were kindly provided by Dr H. Zibrowius, who has sent me the contents of galls discovered in the course of his recent studies of Indo-Pacific ahermatypic corals. The other entries are based on my own observations in various museums, mostly in Australia. In two cases (1 and 5), well preserved parasites were recovered from the galls but have not yet been studied in detail. *Turbinaria* always has external galls (*sensu* Zibrowius & Grygier, 1985), and the other corals have internal galls. To avoid damage to the hosts, most of the intact galls in dried museum specimens were not opened, and only the largest galls observed in *Turbinaria*, about whose etiology I have little doubt, are listed here.

1. (Zibrowius, personal communication) *Balanophyllia* sp. (i.e., solitary dendrophylliid), J. Vacelet, Gulf of Tadjoura, Obok, Djibouti, under small overhang, 15 m. Very distinct internal gall inside calice and independent of columella. Spongy proliferation extending up side from above columella to calicular edge, cavity involving septa only. After NaOCl treatment proliferation detached, leaving nearly normal columella. Gall very peripheral and visible from outside as modification of wall surface. Contained 2 unidentified specimens of *Petrarca*.

2. Dried colony labelled "*Dendrophyllia* sp.," National Museum of Victoria Acc. no. 78/9, uncatalogued (Australasian Marine Photographic Index Madro. 201)), N. Coleman, 1 Nov. 1971, Kendrew Island, Dampier Archipelago, Dampier, WA, reef, in cave, 8 m. At least 3 of about 50 calices with internal galls, visible externally as proliferation of columella upwards into septa, higher on one side of calice (Fig.21D). One opened gall (Fig.21E) with bilocular cavity and 2 dried specimens of *Zibrowia* sp. with eggs.

3. (Zibrowius, personal communication). Orange-pink *Dendrophyllia* sp., colonial but with spreading stolons as well as buds, H. Zibrowius, May 1985, small island (Manu-Manou) south of Capsalon Island, off Danlig village, in Dumaran Passage, north-east Palawan, Philippines, about 10°33'N 119°42.5'E, small overhangs at 3-5 m. Empty gall cavity deep down within or below columella, latter not markedly modified from above.

4. (Zibrowius, personal communication) *Tubastraea* sp. (perhaps young colony of *T. micranthus* (Ehrenberg) [= *T. nigrescens* (Dana)]), same locality as 3. Only parasite eggs recovered from within internal gall below one calice.

5. (Zibrowius, personal communication). Orange, plocoid to phaceloid *Tubastraea* sp., same locality as 3. Calices normally with reduced, deeply sunken columella, but 2 infested calices in one colony with large, spongy columella visible despite coral tissue, containing respectively 2 and 3 individuals of *Zibrowia* sp.

6. Dried *Enallopsammia rostrata* (Pourtalès) (i.e., *E. amphelioides* (Alcock)), Bernice P. Bishop Museum, uncatalogued, S. Ralston, HURL Dive 83-191, 30 Sept. 1983, Johnston Atoll, 16°41.4'N 169°24.9'W, 354 m on 30-45° slope. Four of 6 pieces in lot bearing numerous spongy and sealed external galls like those previously seen on this host genus in the Atlantic and Pacific (see Zibrowius & Grygier (1985) and references therein). Largest spongy gall 22.5 mm, largest sealed one 27 mm.

7. Dried *Turbinaria conspicua* Bernard (WAM 531-78), L.M. Marsh, 9 Aug. 1978, south-west corner of Dolphin Island, Dampier Archipelago, 4.5 m. Specimen bearing half of a split, bilocular gall combined with a coral barnacle (Fig.21F).

8. Dried *Turbinaria frondens* (Dana), WAM 12-83(1), J. Fromont, *Soela*, 30 July 1982, 15.7 km north-west of Port Hedland, WA, 20°12'S 118°29'E. One very large gall and maybe 2 small ones.

9. Dried *Turbinaria frondens*, Queensland Museum uncatalogued, I. Neuss, 18 Dec. 1971, Tryon Reef, MEQ, north-west side, outer slope, high tide, 3-9 m. Oval spongy region 21 *x* 10.5 mm, with about 6 mm wide raised knob in center.

10. Dried *Turbinaria danae* Bernard, Queensland Museum G7095, J. Veron *et al.*, 1972, Solitary Islands, 30°01-14'S. Three spongy petrarcid galls: one measuring 31 *x* 17.5 mm, low and involving both surfaces; another within a fold; third one irregular and near bottom of cup-shaped colony on calicular side.

11. Dried *Turbinaria peltata* (Esper), probably misidentified, Zoological Museum, Leningrad, no. 45 in public display case, no data. Opened bilocular gall on outer, acalicular side of conical colony.

12. Dried *Turbinaria* sp. (AM 13860), F.H. Talbot & M. Cameron, 4 Oct. 1967, outer north-west face of reef, One Tree Island, Capricorn Group, Qld, 3-12 m. Big gall principally in calicular side of broken slab, 2 linked cavities with bumpy walls and orange discolouration containing unidentifiable fragments of parasite (not *Zibrowia*).

13. Dried *Turbinaria* sp., South Australian Museum uncatalogued, no data. Stalked disc with 4 major and several minor vanes, one gall on rear near stalk, other on medial edge of vane.

14. Dried, chalice-shaped *Turbinaria* sp., South Australian Museum uncatalogued, Broome, WA, presented by J.C. Capper. Low and wide, spongy, large gall on upper side.

15. Large, dried, cup-shaped *Turbinaria* sp. (USNM uncatalogued), J.B. Steere, about 1900, Philippines. Large gall.

16. Dried *Turbinaria* sp., uncommon species different from 17 and 18 below, University of Guam Marine

Laboratory (UOG) 5193 (old number UOG 74B & C), R.H. Randall & Y.M. Cheg, 23 Jan. 1975, Stn 27, Nan Wan Bay at Ch'uan Fan-Shir, south coast of Taiwan, seaward side of offshore islet, 4 m. Single oval, external gall affecting both sides of coral, calicular side 14 *x* 12 mm with calices around edges, acalicular side 15 *x* 9 mm.

17. Dried *Turbinaria* sp., common species, UOG 13848, R.H. Randall, 30 July 1979, Lanyu Island (ie., Orchid Island), Taiwan, reef front slope on wall of large hole, unshaded, 4 m. Two spongy-textured, oval, external galls close together and affecting both sides of thin coral, calicular sides 12 *x* 9 mm and 13.5 *x* 10 mm, 3.5-4 mm high, acalicular sides respectively 16 *x* 11 mm and 16 *x* 8 mm.

18. Dried *Turbinaria* sp., same common species as 17, UOG 5422 (old number UOG 304), R.H. Randall & Y.M. Cheng, 26 Jan. 1975, Stn 30, Tan'tzu, south coast of Taiwan, edge of channel on reef front, unshaded, 3.5 m. Spherical gall 12.5 mm in diameter, affecting both sides of coral, with bilocular cavity containing shrivelled remains of two individuals of ?*Petrarca* sp.

19. Dried *Deltocyathus magnificus* Moseley (WAM 524-84(1)) (determined by S.D. Cairns from photo; Fig.21G)), S. Slack-Smith, *Soela*, 14 Feb. 1984, Stn SO 01/84/077, north-west of Augustus Island, WA, 13°33.3-34.3'S 122°54.5-52.3'E, 394-390 m. Enlarged, irregular and spongy, excentric columella.

20. Dried *Flabellum magnificum* Marenzeller (WAM 580-84) (determined by S.D. Cairns from photos; Fig.21H), S. Slack-Smith, *Soela*, 12 Feb. 1984, Stn SO 01/84/064, north-west of Cape Leveque, WA, 14°50.2-48.6'S 121°31.4-33.2'E, 356 m. Enlarged columella growing up into septa as lump on one side.

21. (Zibrowius, personal communication) *Flabellum* sp., MUSORSTOM 2, Stn 83, 2 Dec. 1980, Philippines, 13°55.2-55.6'N 12°30.5'E, 318-320 m. Empty internal gall, expressed externally as spongy proliferation of normally deep-seated columella, extending higher up in infested part.

These findings confirm that petrarcid ascothoracidans are widespread and reasonably abundant in the tropical Indo-Pacific, particularly in representatives of the Dendrophylliidae (Numbers 1–18), and are especially common and obvious on many species of the important hermatypic reef coral genus *Turbinaria*. In addition to those listed, several other specimens of *Turbinaria* in the Western Australian Museum have small lumps which may, at least in part, be due to petrarcid infestation, and underwater photographs of Australian *T. mesenterina* (Lamarck) (Veron, 1986: 567, fig.1) and *Turbinaria* sp. from Taiwan (Fang & Hwang, 1987: 30, fig.1) also seem to show petrarcid galls. All the other genera in the list have been recorded as petrarcid hosts before (Zibrowius & Grygier, 1985), but *Deltocyathus magnificus* and *Flabellum magnificum* are new host species records.

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APPENDIX 1

Table 1. *Gorgonolaureus decurvatus* n.sp., carapace size and brood of several type specimens (WAM 93-87), #1 and #2 dissected paratypes, #4 holotype.

Specimen	Height	Length	Width(top)	Width(bottom)	Brood
#1	2.30	1.68	1.64	1.17	23 nauplii
#2	2.07	1.52	?	?	>19 eggs
#3	2.11	1.57	1.43	1.15	–
#4	2.40	1.70	1.61	1.21	12 nauplii
#5	2.33	1.74	1.62	1.22	48 nauplii

Table 2. *Gorgonolaureus decurvatus* n.sp., thoracopodal setation of paratype #1 (WAM 93-87), ranges reflecting differences between left and right sides (only one each of pairs III and IV included), positions as marked in Fig.2C,D, parentheses used in case of 2-segmented endopods.

Leg/ Position	1	2	3	4	5	6	7	8	9
I	1	–	–	7	3	(1)		–	–
II	1	–	1	8-9	3	1	1	4	2
III	1	–	1	9	3	1	1	3?	2
IV	1	–	1	9	4	1	1	3	2
V	–	–	1	7-8	4	1	1	1	2
VI	–	–	–	7-8	4	(1)		1	–

Table 3. *Gorgonolaureus vietnamianus* n.sp., left thoracopodal setation, conventions as in Table 2, with parentheses used for 1- and 2-segmented endopods.

Leg/ Position	1	2	3	4	5	6	7	8	9
Holotype (ZIN 1/66583)									
I	1	–	–	7	2	(1)		–	–
II	1	–	1	13?	4?	1	1	2?	1
III	1	–	1	15	5	1	1	2?	1
IV	1	–	–	13	5	1	1	2	1
V	–	–	–	14	5	1	1	2	–
VI	–	–	–	11	4	(2)		2	–
Paratype (ZIN 2/66584)									
I	1	–	–	10		(2)		–	–
II	1	–	1	16	5	1	1	3	1
III	1	–	1	18	6	1	1	4	1
IV	1	–	1	16	6	1	1	3	1
V	–	–	–	15	6	1	1	2	–
VI	–	–	–	13	4	(2)		2	1

Table 4. *Gorgonolaureus tricornutus* n.sp., unilateral thoracopodal setation of two paratypes (MNHNP Ci2048), conventions as in Table 2, but ranges indicating uncertainty and, at position 4, a+b+c referring to numbers of medial, apical, and lateral setae, respectively.

Leg/ Position	1	2	3	4	5	6	7	8	9
Female									
I	–	1	–	8	3		(3)	–	–
II	1	–	1	?	6	1	3	5	5
III	1	–	1	6+3+2	7	1	2	6	5
IV	1	–	1	7+3+2	8	1	2	6	4-5
V	–	–	1	7+3+2	8	1	0?	3	2
VI	–	–	–	5+4+1	7		(2)	4	–
Male									
I	1	–	–	3+3+2	2		(5)	–	–
II	1	–	0-1?	7+3+2	6-7?	1	2	6	5
III	1	–	1	9+3+2	7	1	2?	6	4
IV	1	–	1	7+3+2	8?	1	2	4?	5
V	–	–	1	8+3+2	8	1	1	4	1
VI	–	–	?	6+4+2	8		(3)	6	–

Table 5. *Flatsia walcoochorum* n.g. n.sp., left thoracopodal setation of holotype female (AM P37803), conventions as in Table 2, but ranges indicating uncertainty and parentheses used in cases of reduced segmentation.

Leg/ Position	1	2	3	4	5	6	7	8	9
I	15	–	–	>23	>13		(–)	–	–
II	–	–	–	17	14	3	7	15?	>3
III	–	–	1*	19	16-17	3	5	15	3
IV	–	–	2*	18	19	4	7	18	8
V	1	–	–	11	>13		(4)	10	7
VI		(2)		(21)		(6)	–		(1)

*including 1 medial seta.