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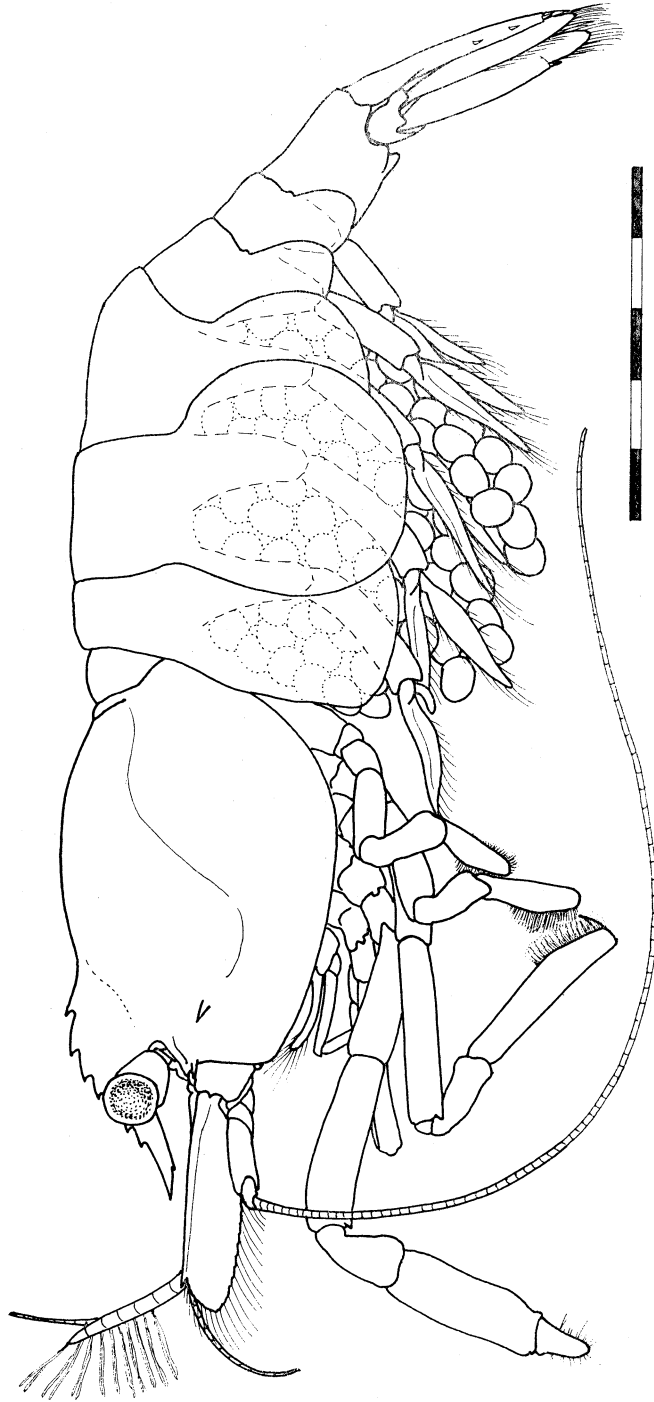


Fig. 1.—*Periclimenes colemani* sp. nov. Ovigerous female allotype.

Periclimenes colemani sp. nov., a new shrimp
associate of a rare sea urchin from Heron
Island, Queensland (Decapoda Natantia,
Pontoniinae)

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Figures 1-8.

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SUMMARY

Periclimenes colemani, a new species of pontoniinid shrimp, is described and illustrated. This species was found at Heron Island on the Australian Great Barrier Reef. It lives in pairs on the test of the sea urchin *Asthenosoma intermedium* H. L. Clark. The new species is considered to occupy a rather isolated systematic position, most closely related to another echinoid associate, *P. hirsutus* Bruce. It is also remarkable for its cryptic white, red spotted colour pattern. The associations between Indo-West Pacific *Periclimenes* spp. and echinoids are briefly reviewed.

INTRODUCTION

The association of echinoderms with many species of the large pontoniinid genus *Periclimenes* Costa, has been well established for many years but relatively few species have been found to occur in associations with echinoids. The first species to be reported as an echinoid associate was *Periclimenes maldivensis* Bruce, by Borradaile, (1915, as *P. (Cristiger) brocki*). Subsequently, Balss (1913, 1914) described *P. hertwigi*, which was also later recorded by Kubo (1940, as *P. gracilirostris*), a deep water species, that was found between the spines of an echinothuroid urchin. More recently several species have been reported from shallow water mainly in association with diadematid urchins, but also with a temnopleurid echinoid (Bruce, in press).

From Australian waters, only two species have so far been recorded. *Periclimenes hertwigi* Balss has been found on the echinothuroid *Areosoma thetidis* (H. L. Clark) in deep water off Mooloolaba, Queensland (Bruce, 1972), and *Periclimenes zanzibaricus* Bruce, has also been found on the diadematid urchin *Centrostephanus tenuispinus* (Clark) from Geraldton, Western Australia (Bruce, 1973). The discovery of a further species of echinoid associate is also of particular interest as the association is with a "venomous" urchin of the family Echinothuriidae.

I am most grateful to the collector, Neville Coleman, for the opportunity to examine this and the other interesting shrimps from his collections and for the additional information and photographs made available.

SYSTEMATICS

Periclimenes colemani sp. nov.

Material examined.—1 ♂ (holotype), 1 ovigerous ♀ (allotype), Wistari Reef, Heron Island, Capricorn Group, Queensland, Australia. 12 m. Coll. 18th July, 1973, N. Coleman, ref. No. 305.

Description.—Medium sized, robustly built pontonine shrimps. The female is distinctly larger and more swollen in appearance than the male, with smaller second pereiopods.

The carapace is smooth and moderately humped dorsally in the female. The rostrum is well developed and extends anteriorly to the level of the proximal end of the terminal segment of the antennular peduncle in both sexes. In the male the rostrum is almost horizontal and in the female, distinctly depressed. The lateral carina is broadened and continuous with the orbital margin posteriorly, but is feebly developed over the distal half of the rostrum. The dorsal lamina is strongly elevated posteriorly, with a convex upper border bearing seven acute teeth in the female and eight in the male and extending posteriorly well behind the posterior orbital margin. The most posterior tooth is situated behind the level of the posterior margin of the orbit. The dorsal teeth are generally similar but become slightly smaller and more closely spaced distally. The tip of the rostrum is slender and acute and devoid of teeth. The ventral border is almost straight in the male and moderately concave in the female. In both, a single small tooth is present distally. In the male, the ventral tooth is situated slightly posteriorly to the eighth dorsal tooth, and in the female, distinctly in advance of the seventh dorsal tooth. Supraorbital and epigastric spines are lacking. The orbit is feebly developed and the inferior orbital angle is slightly produced, and acute in lateral view. The antennal spine is distinct, slender and submarginal, situated immediately ventrally to the inferior orbital angle and directed horizontally. The hepatic spine is large and robust, situated at a lower level than the antennal spine and directed upwards. The antero-lateral angle of the branchiostegite is bluntly angled in the female and broadly rounded in the male.

The abdominal segments are smooth. The third abdominal segment is slightly posteriorly produced in the dorsal midline in the female but not in the male. The fifth abdominal segment is 0.7 times the length of the sixth segment which is 0.9 as deep as long in both sexes. The pleura of the first five abdominal segments are broadly rounded, with the first three expanded in the female, and the last two are feebly produced posteriorly. The posterior ventral angle of the sixth abdominal segment is subacute and the posterior lateral angle is also produced to a small acute point.

The telson is about 2.1 times the length of the sixth abdominal segment, and is 2.8 times longer than broad anteriorly. The lateral margins are feebly convergent over the anterior half and more strongly over the posterior half. The posterior margin is about one third of the anterior width and is feebly produced centrally. Two pairs of small dorsal spines are present, the anterior slightly larger than the posterior, both situated close to the lateral margins. The anterior

pair is at 0.6 of the telson length and the posterior pair at 0.8. The posterior margin bears a pair of small lateral spines, similar to the dorsal spines. The intermediate spines are large and stout, about 2.5 times longer than the lateral spines. The submedian spines are also well developed, about 0.7 of the length of the intermediate spines and devoid of setules.

The eyes present no special features. The cornea is large and hemispherical with a distinct accessory pigment spot. The podophthalmite is about 1.2 times longer than the distal width which is subequal to the corneal diameter, and is slightly expanded proximally.

The antennules are normal and the peduncle exceeds the tip of the rostrum by the distal segment in male and female. The proximal peduncular segment is twice as long as broad. The medial border is straight with a strong tooth ventrally. The lateral border is moderately convex. The stylocerite is well developed, acute distally and reaches to the level of the middle of the medial border. The antero-lateral margin is broadly produced and bears a stout disto-lateral tooth that reaches to the level of the proximal margin of the distal peduncular segment. The statocyst is normally developed and contains numerous discrete granules. The intermediate segment of the peduncle is obliquely articulated with the distal segment. The dorsal length is about 0.6 of the width. The lateral margin is laminar and setose and a smaller lamina is present on the medial side also. The distal segment is almost twice as long as wide, twice the dorsal length of the intermediate segment and the two segments together are equal to 0.4 of the median length of the proximal segment. The lower flagellum is slender and a little longer than the peduncle. The upper flagellum is biramous, with the first six segments of the rami fused. The shorter ramus consists of only two free segments and the longer of about fifteen. Ten groups of aesthetases are present.

The antenna has a robust basicerite with an acute lateral tooth. The merocerite and ischicerite are normal. The carpocerite is subcylindrical, slightly compressed, 2.2 times longer than broad and reaches nearly to the middle of the length of the scaphocerite. The scaphocerite is broad, about 2.5 times longer than wide, with the greatest width at about half the length. The lateral border is very feebly convex with a strong disto-lateral tooth. The lamina is broad distally and distinctly exceeds the tip of the disto-lateral tooth. The scaphocerite extends well beyond the end of the antennular peduncle. The flagellum is well developed, slender, extending posteriorly to the posterior margin of the third abdominal segment.

The epistome is normal and without horns. The labrum shows no special features. The sternite of the second thoracic segment shows a small median knob on a transverse ridge. The third sternite is unarmed. The fourth sternite is without a median process between the coxae of the pereopods but a distinct transverse ridge is present posteriorly, with a small median notch. A similar but rather larger ridge is also present on the fifth sternite posterior to the coxae of the second pereopods. The following sternite are unarmed.

The mouthparts are typical of the genus. The mandible is without a palp. The corpus is robust, with a small incisor process bearing three acute distal teeth. The molar process is stout, obliquely truncated distally. The ventral aspect bears a dense fringe of stout setae. The dorsal aspect bears two stout teeth, the anterior tooth with a tuft of stout setae and the posterior tooth with a group of fine short setae.

The maxillula has a distinctly bilobed palp. The upper lobe is small and rounded. The lower lobe is larger with a short hooked seta arising from a small ventral process. The anterior aspect bears a short simple seta. The upper lacinia is moderately narrow with numerous setae distally and six simple terminal spines. The lower lacinia is slender, with numerous long slender spiniform setae distally.

The maxilla has a moderately stout palp, bearing only a short simple seta near the middle of its median margin. The basal region bears an elongated slender bilobed endite. The terminal lobes are subequal, each bearing about ten short simple setae. The coxal portion is slightly produced medially but is without an endite. The scaphognathite is well developed, about 2.6 times longer than broad, with the antero-medial margin scarcely emarginated.

The first maxilliped has a subcylindrical palp, with a single short slender terminal seta and a longer stouter plumose preterminal seta. The basal endite is large and broad, with a straight medial and broadly rounded antero-lateral margin. The distal and medial borders are provided with numerous slender simple setae. The small rounded coxal endite is separated by a distinct notch. It is sparsely setose, but some long stout simple setae are present distally. The caridean lobe of the exopod is well developed but relatively narrow and slightly exceeds the tip of the palp. The flagellum of the exopod is normally developed with six plumose terminal setae. A large deeply bilobed epipod is also present.

The second maxilliped is of normal form. The dactylar segment is moderately broad, about 3.5 times longer than wide, with numerous finely dentate spines along the medial margin. The disto-medial border of the propodal segment is broadly rounded with long slender simple spines. The carpus, merus and ischio-basis are typical. The coxa bears a small medial protuberance, with a subrectangular epipod laterally, without a podobranch. The exopod is well developed, with six plumose setae distally.

The third maxilliped is slender, extending anteriorly to the proximal end of the carpocerite. The ischio-merus and basis are completely fused, with a small notch indicating the point of junction on the medial border. The combined segment is about six times longer than the central width. The ischiomerus part tapers slightly distally and is sparsely provided with slender simple setae along the medial border. The basal portion is slightly expanded medially and also feebly setose. On the proximal medial dorsal part of the ischiomerus is a submarginal row of about ten short feeble plumose setae. The penultimate segment is about four times longer than wide, scarcely tapering and equal to about half the length of the antepenultimate segment. The medial border is provided with about eight pairs of slender setae. The terminal segment is about 0.6 of the length of the penultimate segment and tapers strongly distally. The medial aspect bears 5-6 small groups of shorter stouter finely serrulate spines. The exopod is well developed with a broad flagellum bearing eleven plumose terminal setae. The coxa is not produced medially but bears a large rounded epipod laterally. A small arthrobranch, with six branchial lamellae, is present laterally.

The first pereiopods are moderately slender and extend beyond the carpocerite by the chela and carpus. The palm of the chela is subcylindrical, slightly broadened and compressed distally, about twice as long as the maximum width. The fingers are about 0.8 of the length of the palm, distinctly spatulate, with a finely pectinate lateral cutting edge. The pectinations are very close set, regular with truncated tips distally. Numerous groups of setae are also present on the fingers and the proximal end of the palm bears several rows of short

cleaning setae. The chela is about 0.9 of the length of the carpus, which is slightly expanded distally, and about 4.5 times longer than wide. The merus is 1.1 times the length of the carpus, of uniform width and 5.0 times longer than wide. The ischium and merus are subequal in length, slightly less than one third of the length of the merus, with sparsely setose medial borders. The coxa is short and stout, with a large setose medial lobe.

The second pereopods are slightly unequal and similar, larger in the male than in the female. The palm is subcylindrical, 3.9 times longer than wide in the male, in which it is slightly swollen proximally and 4.1 times longer in the female. The fingers are 3.7 times the palm length in the male and 3.4 in the female. The fingers are robust with distinctly hooked acute tips, and the length is a little more than three times longer than the breadth of the base. The distal two thirds of the cutting edges are entire. The dactylus bears a single small tooth at the end of the distal third of the cutting edge, larger and acute in the male, blunt in the female. On the fixed finger a small notch is situated opposite the dactylar tooth, with a single small tooth distally in the male and two smaller teeth in the female. Posteriorly an elevated row of three very small teeth is present. No fossa is present at the base of the dactylus. The carpus is short and stout, twice as long as wide distally, expanded distally and unarmed. The merus is robust, equal to 0.75 of the length of the palm in both sexes, about 3.5 times longer than wide. In the male the disto-ventral angle bears an acute tooth, but this is only feebly represented in the female. The ischium is about 0.75 of the meral length and tapers proximally. The basis and coxa are robust, without special features.

A number of the ambulatory pereopods are lacking. The third pereopod in the male exceeds the basicerite by the dactylus, propodus and carpus, and is relatively long and robust. The dactylus is small, with the carpus strongly compressed. The unguis is long, slender, slightly curved and very acutely pointed, subequal to the dorsal length of the corpus, and more than three times longer than the width at the base. The ventral border is carinate with the distal angle strongly produced and bearing a small acute accessory spine distally with a couple of rounded projections more proximally. Some sensory setae arise from pits adjacent to the base of the unguis. The propodus is seven times longer than the greatest width which occurs just distally to the midlength and slightly exceeds the length of the dactylus. The dorsal margin is straight but the proximal and distal parts of the ventral border are also straight but at a very obtuse angle to each other. The distal part of the ventral border bears two rather irregular longitudinal rows of spines, each with about 12–13 slender spines. A dense tuft of long simple setae arises on each side of these spines forming a dense brush and almost completely excluding the spines from view. The proximal half of the ventral border is without spines or setae. The carpus is 0.38 of the length of the propodus and is unarmed. The merus is 0.8 of the propodal length and 4.5 times longer than wide. There are no ventral spines present, but the disto-ventral angle bears an acute tooth. The ischium is unarmed and the basis and coxa present no special features.

The pleopods are normally developed. In the male the endopod of the first pleopod is about three times longer than the width, excluding the small lobe present on the distal part of the medial border. The distal border is rounded and sparsely setose. The central part of the lateral border bears five short plumose setae, and the proximal half of the medial border bears six short curved spines. On the male second pleopod, the appendix masculina slightly exceeds the appendix interna, and is about four times longer than wide distally. The distal end is slightly swollen and bears a row of about 12–13 slender spines

which extend down half the length of the lateral margin. Two short spines are also present disto-ventrally and a few more are present dorsally. The most medial spines are finely serrulate, but the rest are simple.

The uropods are without special features. The protopodite is rounded disto-laterally. The exopod is broad, about 2.5 times longer than wide, with an entire, slightly convex lateral margin ending in a small acute tooth with a large mobile spine medially. The endopod is about 2.8 times longer than wide and is slightly exceeded by the tip of the exopod, and both exceed the tips of the posterior telson spines.

Types.—The male specimen is designated as the holotype and the female, with mouthparts removed on the right side, as the allotype. Both specimens are deposited with the collections of the Australian Museum, registration numbers P. 20209 (Holotype), P. 20210 (Allotype).

Measurements.—(In millimetres)

			Holotype male	Allotype female
Total length, (approx.)	..	..	18.0	19.0
Carapace and rostrum	..	..	7.0	6.9
Post-orbital carapace length	..	..	4.3	4.8
Chela of second pereopod	..	..	5.9	4.4
Diameter of ova	..	..	—	0.68

Colouration.—The colour pattern is almost identical in male and female and consists of a dense white ground colour with large deep red spots and bands, in general relatively larger in the male than in the female. The carapace and rostrum are white with a large red patch over the gastric region and a transversely oval patch over the cardiac region. An extensive red patch covers the antero-lateral region and is almost in contact with the gastric patch. A circular patch covers the central part of the branchiostegite. The abdomen is similarly white with a large median transversely oval patch dorsally on the second segment, a smaller circular patch on the third and an oval patch on the fifth. The dorsal lateral parts of the first segment are red and the posterior parts of the second, third and fourth pleura are largely red. The fifth abdominal segment is red dorsally and also on the pleuron and the posterior half of the sixth segment is also red. A broad band of red crosses covers the whole of the central region of the caudal fan. The basicerite and proximal part of the first segment of the antennular peduncle and the whole of the distal end of the scaphocerite are white, the rest of the antennae being red, with transparent flagella. The eyestalks are white, with pinkish corneae. The fingers of the first and second pereopods are white, with the palm red except proximally. The carpus, merus and ischium are a similar red with a white zone distally. The ambulatory pereopods have the first and third fourths of the propodus red, with the merus similarly coloured. The carpus is white and the ischium is red with white distally.

Host.—*Asthenosoma intermedium* H. L. Clark (Echinothuriidae)

Habitat.—Coral reef at 12 m depth.

Remarks.—The collector observed pairs of shrimps on three separate host urchins. It was also observed that the shrimps are situated close together on the dorso-lateral aboral surface of the host in a small area of the shrimps, bare test devoid of spines, apparently caused by the presence of the shrimp.

Systematic Position of *Periclimenes colemani* sp. nov.

The new species *Periclimenes colemani* is most closely related to an other echinoid associate *P. hirsutus* Bruce, 1971. This species is found in association with the diademid urchin *Astropyga radiata* (Leske). The most noteworthy similarity between the two species is shown by the setal brushes on the propods of the ambulatory pereopods, similar features being lacking from all other species of the genus *Periclimenes*. The branchial formulae are similar and the morphology of the mouthparts show a very close resemblance although differing in some small details. The new shrimp does not show a close affinity to any other species of the genus *Periclimenes*.

Since the description of the original specimen of *Periclimenes hirsutus* Bruce, 1971, further specimens have become available for study. The original discussion overlooked the presence of spines along the ventral aspect of the ambulatory propods, which were completely obscured by the presence of the dense setal brush. Clearing with sodium hydroxide and staining with alizarin red S reveals that spines similar to those of *P. colemani* are also present in *P. hirsutus*. The spines are in two roughly longitudinal rows and are well developed posteriorly but decrease markedly in size distally along the propodus, so that the most distal spines are minute. Each spine is situated medially to the origin of one of the large groups of setae that arise along the ventro-lateral and ventro-medial aspects of the propodus. The differences between *P. colemani* and *P. hirsutus* are summarized in the following Table:

<i>Periclimenes Colemani</i> sp. nov.	<i>Periclimenes hirsutus</i> Bruce
1. Body glabrous.	Body generally hirsute.
2. Rostrum short and deep, distinctly shorter than the antennular peduncle.	Rostrum long and slender, distinctly exceeding the antennular peduncle.
3. Proximal part of dorsal lamina elevated to form a distinct crest.	No distinct rostral crest present.
4. Small ventral rostral tooth present.	No ventral rostral tooth present.
5. Hepatic spine large and robust, antennal spine slender.	Antennal spine robust, hepatic spine small and slender.
6. Scaphocerite broad, distally rounded.	Scaphocerite narrow, distally truncated.
7. First pereopod with fingers strongly spatulate with pectinate cutting edges.	First pereopod with fingers only moderately subs spatulate, cutting edges entire.
8. Second to fifth pereopods with well-developed disto-ventral meral tooth.	Second to fifth pereopods with feeble disto-ventral teeth.
9. Propod of ambulatory pereopods with well developed spines along whole length of the setal brush.	Propod of ambulatory pereopods with feebly developed spines ventrally, mainly along proximal part of setal brush.
10. Setose brush of ambulatory propods extending over distal half only.	Setose brush of ambulatory propods extending over whole length of propod.
11. Setae of propodal brush simple.	Setae of propodal brush plumose.

- | | |
|---|--|
| 12. Accessory tooth of dactyl very large and acute, much produced. | Accessory tooth of dactyl small and only feebly produced. |
| 13. Dorsal telson spines situated on posterior third, not very small. | Dorsal telson spines very small all situated on posterior fourth. |
| 14. Posterior telson spines normal. | Lateral spines minute, intermediate spines short and very stout with mobile tip. |

Apart from a relatively close relationship to *P. hirsutus*, *P. colemani* does not appear to be closely related systematically to any of the other species of the genus, although several of its characteristic features are also found in some of these. The propodal brushes of the ambulatory pereopods are to be found in a much less developed form in *P. curvirostris* Kubo. The disto-lateral meral teeth on the second to fifth pereopods are also found in *P. lanipes* Kemp and *P. noverca* Kemp, both of which are also echinoderm associates. The host of *P. curvirostris* has not been identified, but is probably also an echinoderm. *P. maldivensis* Bruce is also an associate of an unidentified echinoid and has the meral teeth present, but it is without the propodal brushes.

DISCUSSION

The associations between caridean shrimps and echinoids have been recently summarized by Bruce (in press). Including *P. colemani*, seven species are now known to associate with echinoids, and some hosts of six species have been identified. Four species have only been found in association with a single host species, *P. colemani*, *P. hirsutus*, *P. insolitus* and *P. cristimanus*. *P. hertwigi* has been found on two species of host, both belonging to the same family, the Echinothuridae. *P. zanzibaricus* has been found in association with five host species, of four different genera, but all belonging to the same family, the Diadematidae. *P. maldivensis* a shallow water species, was reported to have been collected from urchins, but the identity of the hosts was not established (Borradaile, 1915; Bruce, 1969). The relationships are illustrated in the following table.

Associate	Host
1. <i>P. hertwigi</i> Balss	——— <i>Phormosoma</i> sp. ——— <i>Areosoma thetidis</i> (H.L. Clark)
2. <i>P. hirsutus</i> Bruce	——— <i>Astropygia radiata</i> (Leske)
3. <i>P. cristimanus</i> Bruce	——— <i>Diadema setosum</i> (Leske) ——— <i>Diadema savignyi</i> Michelin
4. <i>P. zanzibaricus</i> Bruce	——— <i>Echinothrix calamaris</i> (Pallas) ——— <i>Centrostephanus tenuispinis</i> H. L. Clark
5. <i>P. insolitus</i> Bruce	——— <i>Pseudoboletiana indiana</i> Michelin
6. <i>P. colemani</i> sp. nov.	——— <i>Asthenosoma intermedium</i> H.L. Clark
7. <i>P. maldivensis</i> Bruce	——— Unidentified

One of the most striking characteristics of *P. colemani* is its unusual white and red colour pattern. Seen in isolation from its natural background, this colouration makes the shrimp extremely conspicuous. However, the pattern is cryptic and disruptive when on the host, so that the shrimps blend closely with their surrounding. The spines of the host are strongly ringed with red and white bands. None of the other species of *Periclimenes* found on echinoids have a similar colour pattern. They are in general uniformly coloured, matching the host, with a thin line of white along the side of the body.

The presence of only a single pair of shrimps on each of three separate hosts is unusual in echinoderm associated pontoniine shrimps, although normal in those found in molluscs.

In the case of other shrimp-echinoid associations, there have been no reports of any modifications or damage to the host. In the present association the activities of the shrimp appear to cause the development of a large area of test from which the spines have been lost. The shrimps are apparently permanently found on this bare area.

The *Periclimenes* species associated with echinoids appear also to fall into two natural groups—(i) occurring on the spines (*P. insolitus*, *P. cristimanus* and *P. zanzibaricus*) and (ii) occurring on the test (*P. colemani*, *P. hirsutus* and *P. hertwigi*). The position of *P. maldivensis* on the host is uncertain. *Asthenosoma intermedium* is said to be venomous, which may provide added protection for the shrimp and it may be noted here that in the course of examining numerous examples of the poisonous *Toxopneustes pileolus* from a wide variety of localities, no associated shrimps have so far been found.

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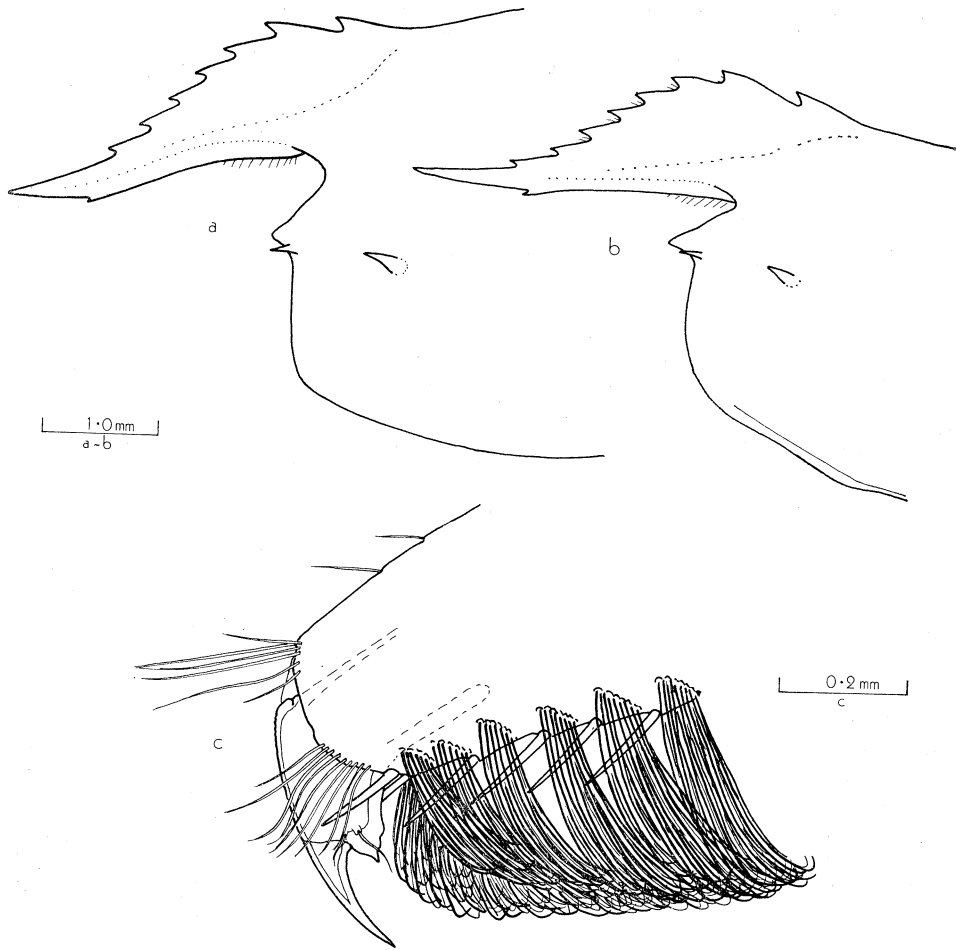


Fig. 2.—*Periclimenes colemani* sp. nov. Anterior carapace and rostrum. A, allotype female. B, holotype male. C, dactyl and distal propodus of third pereiopod of female.

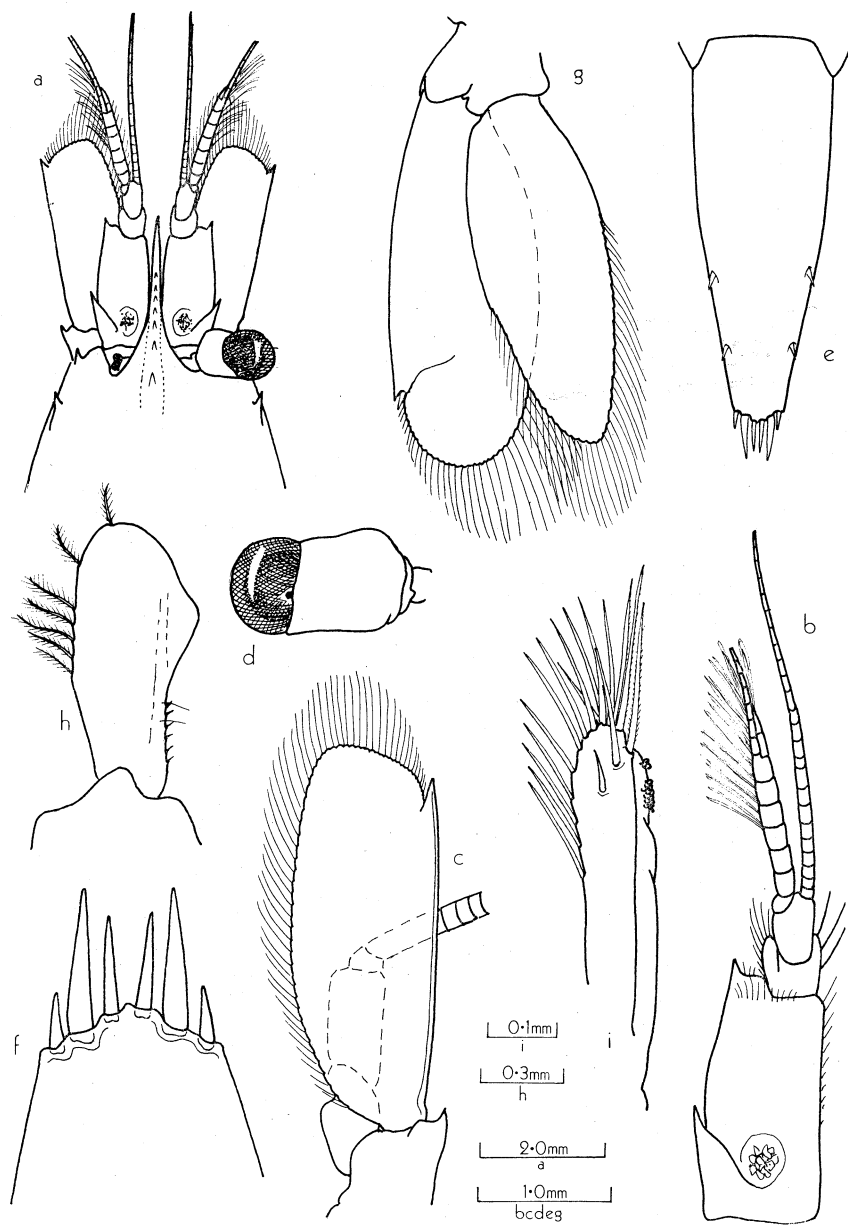


Fig. 3.—*Periclimenes colemani* sp. nov. A, anterior carapace, rostrum and antennae, dorsal view. B, antennule. C, antenna. D, eye, dorsal aspect. E, telson. F, posterior telson spines. G, uropod. H, endopod of first pleopod. I, appendix interna, appendix masculina of second pleopod. A-G, female allotype, H-I, male holotype.

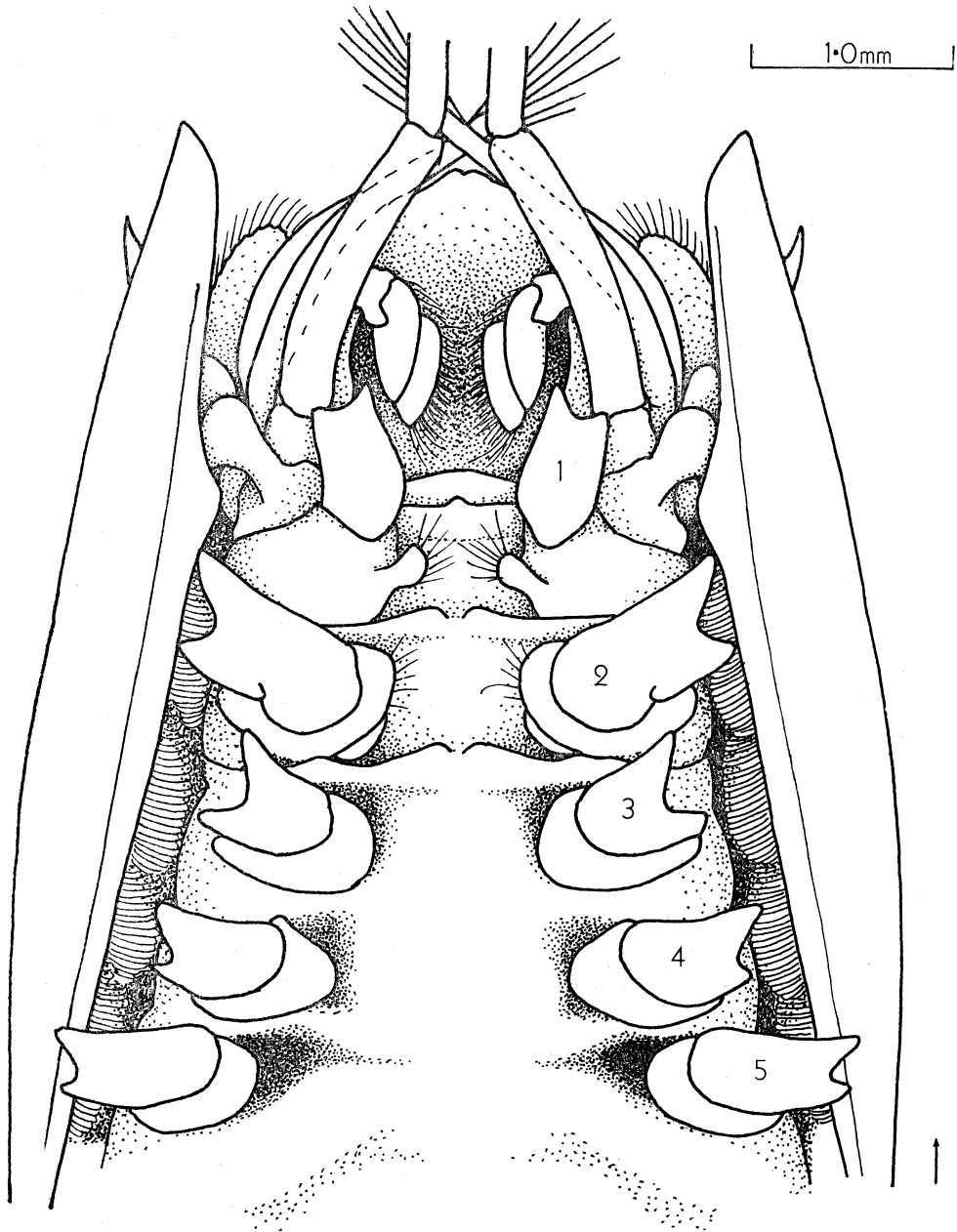


Fig. 4.—*Periclimenes colemani* sp. nov. Female allotype, thoracic sternites.

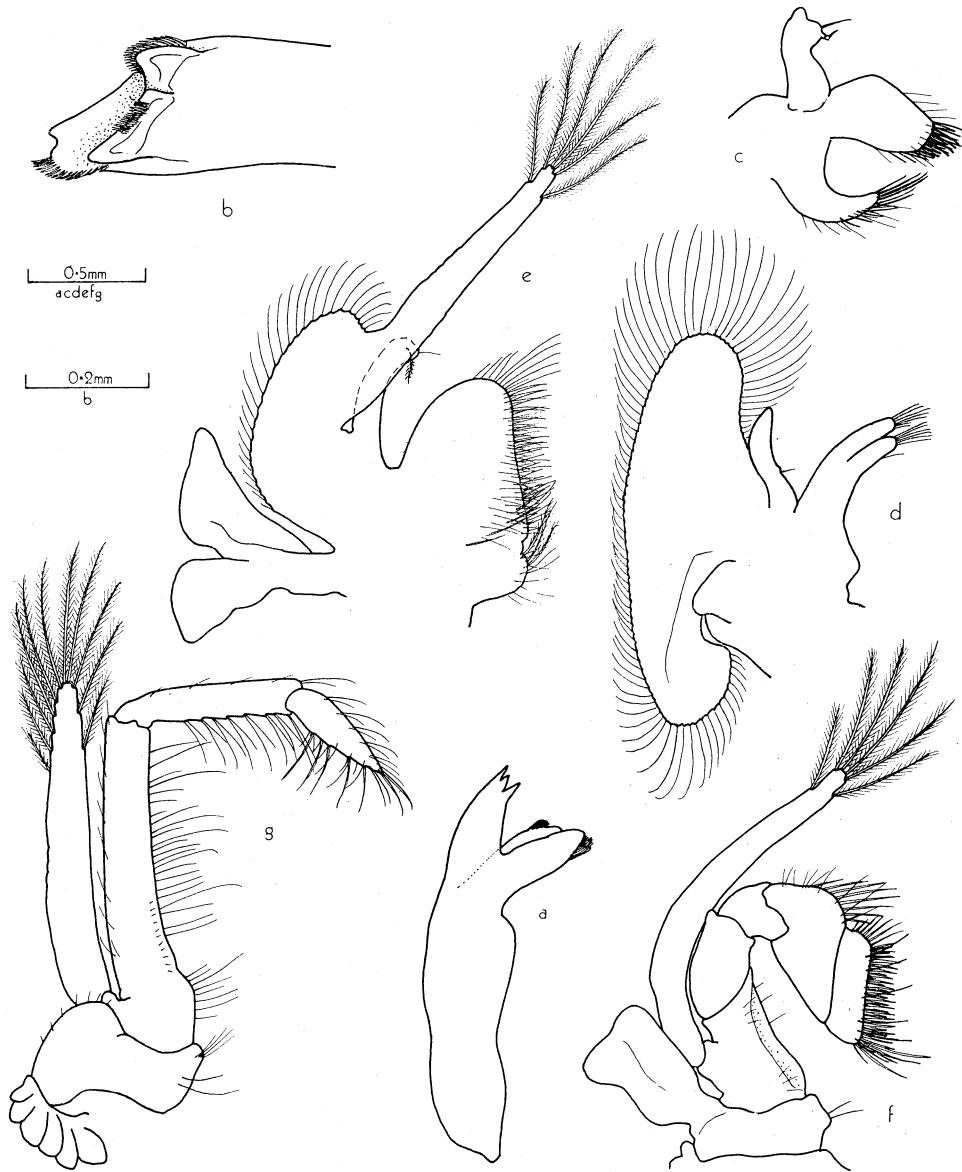


Fig. 5.—*Periclimenes colemani* sp. nov. Female allotype, mouthparts. A, mandible. B, molar process of mandible. C, maxillula. D, maxilla. E, first maxilliped. F, second maxilliped. G, third maxilliped.

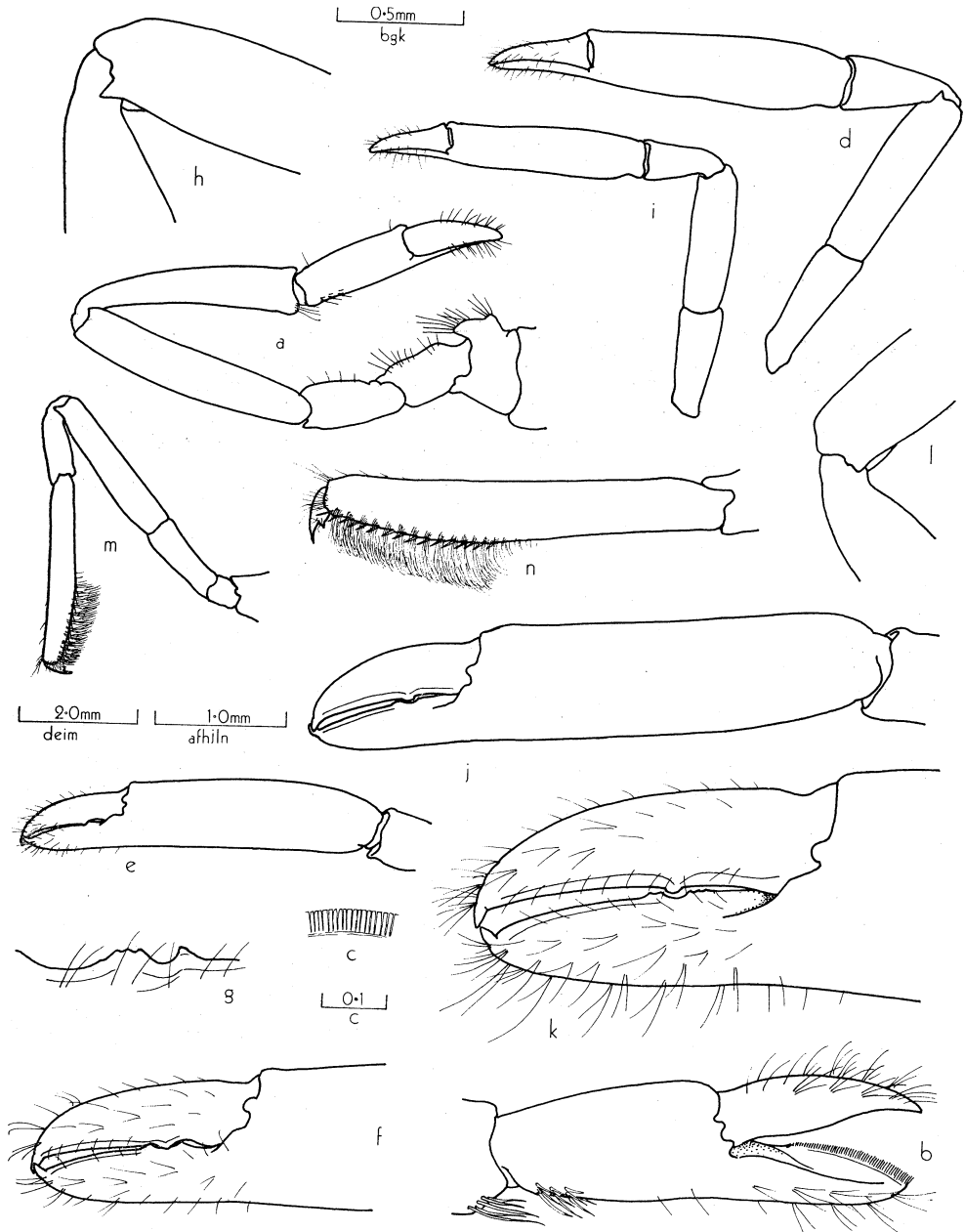


Fig. 6.—*Periclimenes colemani* sp. nov. A, first pereiopod. B, chela of first pereiopod. C, cutting edge of finger of first pereiopod. Male second pereiopod. D, major pereiopod. E, chela. F, fingers. G, teeth of fixed finger. H, carpo-meral joint. Female second pereiopod. I, major pereiopod. J, chela. K, fingers. L, carpomeral joint. M, third pereiopod of female. N, propodus and dactylus of third pereiopods.

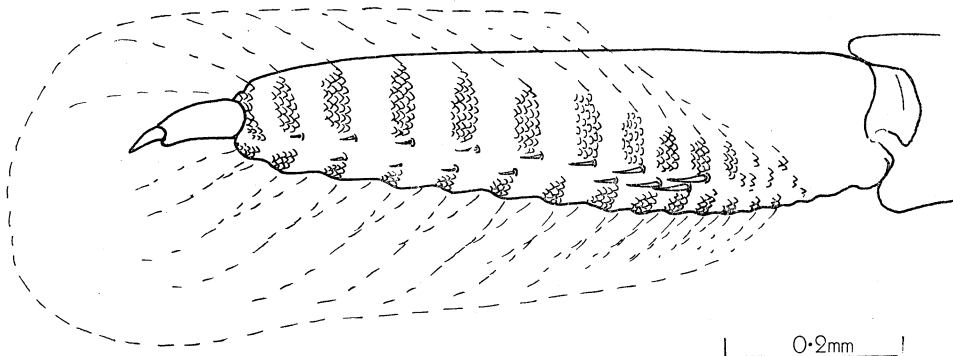
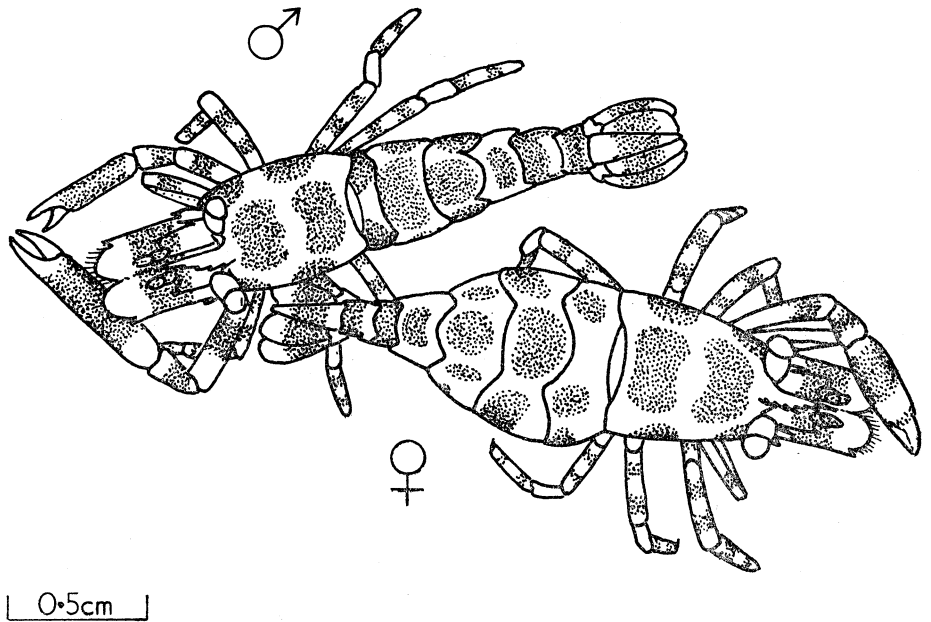


Fig. 7.—*Periclimenes colemani* Male and female. From colour photograph by N. Coleman.

Fig. 8.—*Periclimenes hirsutus* Bruce. Ventral aspect of third pereiopod of female.