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*Berndtia nodosa* sp. nov. (Cirripedia, Acrothoracica),  
a new burrowing barnacle from Singapore

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## INTRODUCTION

Acrothoracican cirripeds burrow into almost anything calcareous, including corals. The genus *Berndtia*, previously known from the single species *B. purpurea* Utinomi, is noted for burrowing into coral which is living. The University of Singapore collection of the local coral *Psammocora contigua* (Esper) contained several dozen dried specimens of a new species of this genus. I obtained them through the courtesy of Dr. D. S. Johnson. The coral identification was confirmed by Prof. J. Wyatt Durham.

## DESCRIPTION

Genus *Berndtia*

One pair of mouth cirri and 5 pairs of terminal cirri present; caudal appendage absent; optic nerve and well-developed eye may be present in adult. Type species, *B. purpurea* Utinomi (1950).

*Berndtia nodosa* sp. nov.

Female mantle apertural plates studded over their outer surfaces with numerous blunt, heavy, nodular teeth; margins of apertural lips bearing over 30 simple teeth; no well-developed conical body processes. Males adhere to female exuviae of the attachment disk as well as the wall of the burrow.

*Type material*.—Holotype United States National Museum No. 113310. Paratypes at the National Museum of Singapore No. 1305; British Museum (Natural History); San Francisco State College; California Academy of Sciences; Seto Marine Biological Laboratory; and U.S. National Museum.

Holotype 3.04 × 1.5 mm. Average of 6 arbitrarily sampled females 2.88 mm. long, 1.44 mm. wide, and with an aperture 1.08 mm. long.

*Female*.—The mantle is composed of a typical bag-like covering of the body, with a narrow but heavy horny attachment disk representing cemented exuviae where the animal is cemented to the burrow. The exterior of the mantle is studded with many fine teeth used in abrading the burrow in the coral. These may have from one to four points, unlike *B. purpurea*, which does not have four-pointed teeth. Around the aperture of the mantle these fine teeth are interspersed with small hairs and scale-like ridges common in the order. Muscle bands are conspicuous, particularly the longitudinal bands on the ventral lateral surface (fig. 1a).

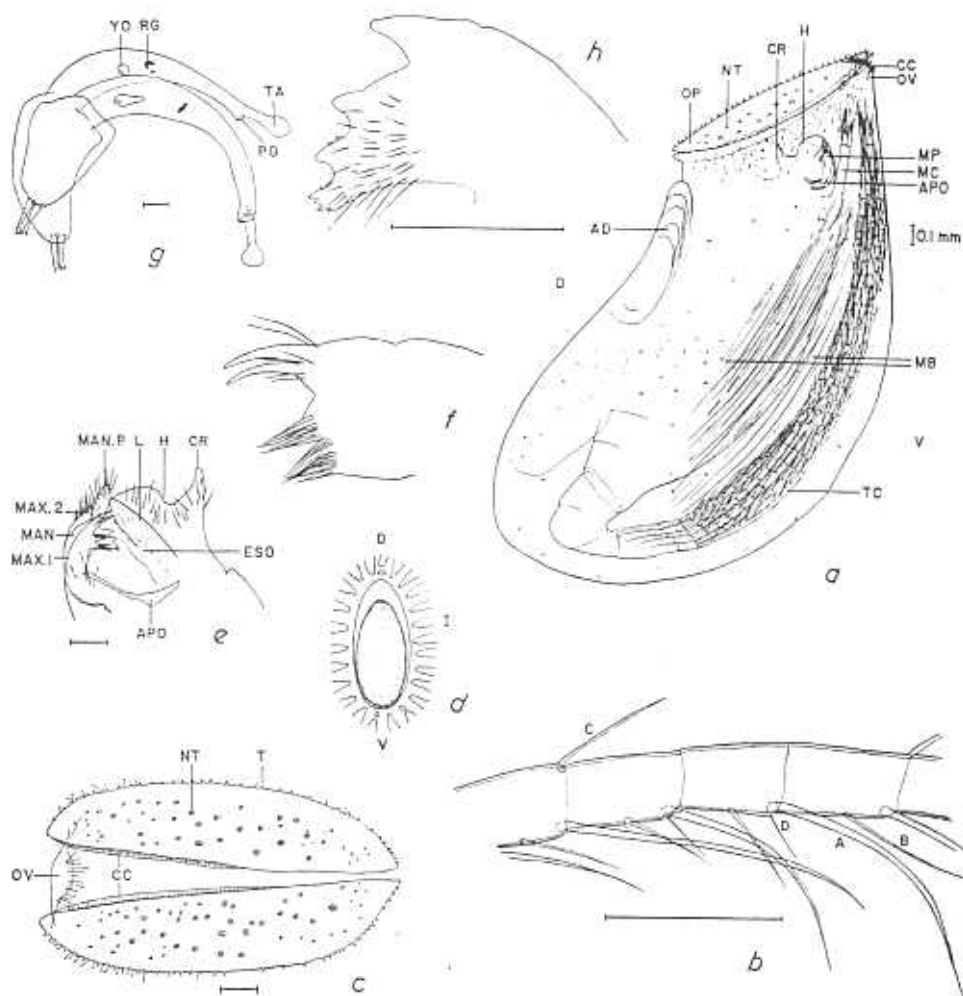


Figure 1. *Berndtia nodosa* sp. nov. *a* female, composite drawing of KOH-cleared specimens, *b* portion from middle of female sixth cirrus, setae A & B paired, C & D unpaired, *c* female operculum somewhat opened, showing nodular teeth in end-view, *d* burrow aperture of female in *P. contigua*, external vertical view (stippled area is interior of burrow, coral septal skeleton shown by wavy lines, clear area is accreted lip of burrow "shell"), *e* female head and mouthparts, *f* female first maxilla, *g* two males, *h* female mandible. AD = attachment disc, APO = apodeme, CC = comb collar, CR = crest, D = dorsal (rostral) sides, ESO = oesophagus, H = head, L = labrum, MAN = mandible, MAN, P = mandibular palp, MAX. 1, 2 = first, second maxilla, MB = mantle muscle bands, MC = mouth (first) cirrus, MP = mouth parts, NT = nodular teeth, OP = operculum, OV = orificial velum, PO = penis aperture, RG = reflecting granules, T = tooth, TA = terminal ampulla, TC = terminal cirrus, V = ventral (carinal) side, YO = yellow organ Scale 0.1 mm,

The aperture of the mantle bears two heavy plates or lips, analogous to the operculum of thoracican cirripeds, uniquely studded over the external surfaces with evenly-distributed heavy teeth which appear superficially blunt, but may have a very fine rosette of extremely small nodules around the outer margin.

The typical comb-collar on the inner ventral margins of the aperture extend into the "orificial velum" described by Utinomi in *Berndtia purpurea*, although the velum in this species does not appear to be as well developed as that in *B. purpurea*. The brush of fine hairs within the ventral apertural area of the mantle sac is found much as it is in *B. purpurea*.

No orificial knob is seen in this genus.

The coloration cannot be relied on in dried specimens, but it is suspected that the apertural areas may have been purplish colored, although not as prominently as other species of the order I have checked in the dried condition.

The mouth parts, consisting of the mandibles with palps and 2 pairs of maxillæ, are typical for the group. The palps and second maxillæ (not illustrated separately, see fig. 1e) are very similar to those of other species of the order.

The labrum, representing the anterior margin of the mouth field, is heavy, slightly rounded, and equipped with a few knobs of heavy chitin. Very fine dots are arranged in characteristic rows on the labrum, but their function is not known.

The head is rounded, sparsely set with small bristles not in distinguishable rows, and leads dorsally into a very pointed anteriorly-projecting conical "crest", but without the back-up fold or secondary crest shown in *B. purpurea*.

The mandible (fig. 1h) bears 3 major teeth, which diminish in size slightly toward the inner or inferior angle; the inferior angle bears a cluster of 4 or more teeth with subsidiary teeth on the sides. The 3 major teeth may also have smaller subsidiary teeth. Hairs set along the outer lateral surface do not appear to be as heavy as in *B. purpurea*.

The first maxilla (fig. 1f) has 2 major teeth on the upper or superior angle, a conspicuous notch without teeth or hairs, and an area of heavy bristles or fine teeth often divided into 2 distinct clumps or tufts along the inner or inferior edge. The auxiliary hairs along the lateral surfaces again do not appear as heavy as in *B. purpurea*. The apodemes are typical, with a heavy keel for muscle attachment.

Segmentation of the mouth cirri tends to be so obscure or vestigial that no attempt will be made to describe it. This segmentation is subject to variation in other species where it can be counted with some confidence, so I tend to discount the value of the characteristic at best. The anterior ramus is longer than the posterior ramus, and both are set on a pedicle with a short distal segment and a long proximal segment, the latter being slightly indented near the base, suggesting a possible further articulation.

There are 5 pairs of biramous, multi-segmented terminal cirri. The lesser curvature of each segment supports a distal pair of long setæ and a central, shorter pair. In addition, a very short unpaired bristle extends from between the bases of the distal pair. The distal end of every second to sixth segment along the greater curvature supports a single setæ. None of these bristles are plumose. The pedicles are 2-segmented, with the proximal segment not quite 3 times as long as the distal segment. The pedicle of the 1st pair of terminal cirri (cirrus 2) tends to be about one-third as thick as those of the other cirri, but may be over twice as wide.

The cirral segment count of the terminal cirri seems to be much more differentiating than the count of the segments of the mouth cirri. The count of a specimen of *Berndtia nodosa*, as compared with *B. purpurea*, is given in table 1.

TABLE 1  
Cirral segment count of the two species of *Berndtia*

Cirrus number	<i>B. purpurea</i>					<i>B. nodosa</i>				
	2	3	4	5	6	2	3	4	5	6
Segment count:										
Anterior ramus	26	36	47	56	59	16	19	29	32	33
Posterior ramus	16	46	56	57	61	19	20	31	33	30
Length (mm.):										
Anterior ramus	3.45	4.1	5.35	5.55	5.65	1.3	1.8	2.5	2.65	2.65
Posterior ramus	2.5	4.65	5.65	5.63	5.68	—	—	—	—	—

The body segmentation is similar to *B. purpurea*, but no conical body processes have been seen.

*Male*.—The dwarf male resembles those of *B. purpurea* insofar as can be ascertained from dried specimens (fig. 1g). They are found primarily on the exuvia of the female, and come out of the burrow with the female when the coral is decalcified. This is opposed to *B. purpurea*, where the males are invariably found attached to the wall of the burrow. *B. nodosa* males have been found singly (three times on the female) and in sets of two (once on the female, once on the burrow wall).

The shape of the male in this genus is unique in the order. It is considerably elongated, tadpole-shaped, and bears a terminal ampulla of unknown function at the posterior end. There appears to be a penis and the common "yellow organ" present. In addition, a scattering of opaque, reflecting, reddish-purple granules are found near the middle of the elongated body. These could be remnants of eye pigment, although no direct evidence is available.

*Burrow*.—The burrow is deeper than long in mature specimens. The aperture, viewed from outside, looks much like a typed apostrophe: a slit tapered slightly at the attachment end (fig. 1d). The average dimensions of this external aperture, for ten specimens arbitrarily circled on a piece of coral, is  $1.1 \times 0.5$  mm. There might be a reaction to the burrowing action on the part of the coral, because a white shell of calcareous material surrounds the burrow, becoming especially prominent around the external aperture. Perhaps this is a product of the abrading action of the barnacle, forming fine granules which accrete and fill in the interstices of the coral's skeleton.

Two burrows without acrothoracican specimens were discovered on the dead arms of *Acropora tubicinaria* (Dana) from Pulau Kapas, Trengganu, Malaya, from the collection of the National Museum of Singapore, through the courtesy of Mr. Eric R. Alfred. They measured  $1.2 \times 0.39$  mm. in apertural length and width of the undamaged specimen, and  $1.4 \times 0.39$  mm. in the slightly broken specimen. The shape of the aperture was similar to that of *B. nodosa*, but inasmuch as penetration was made through algæ on the dead coral, the details of the calcareous shell was not apparent.

Many empty burrows were found on the under (dead) side of *Montipora efflorescens* in the collection of the University of Singapore. Measurements of three representative burrow apertures are  $2.0 \times 0.70$ ,  $1.2 \times 0.39$ , and  $0.85 \times 0.31$  mm., with an average of  $1.35 \times 0.47$  mm. in length and breadth. One could hardly discern which end was more pointed, a trait common in *Berndtia*.

These two sets of burrows could have been made by *Berndtia nodosa*, judging from their size and shape, but they were definitely in the dead coral area, whereas the recovered specimens were apparently in living coral. Another set of burrows in the dead areas of *Favia speciosa* (Dana) from Pulau Kapas, Trengganu, Malaya, from the collection of the National Museum of Singapore, were much thinner and definitely pointed, measuring  $0.81 \times 0.15$  mm. These empty burrows were probably not made by *Berndtia*.

An acrothoracican in the Fungiid coral *Podabacia crustacea* (Pallas) from Singapore, is illustrated in Plate 67, fig. 1, by Ma (1937). The under surface of the colony is heavily infested, probably by *Berndtia*, as suggested by Utinomi (1957), but more likely by *B. nodosa* than his *B. purpurea*.

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