STUDIES ON THE CIRRIPEDIA ACROTHORACICA

IV. MORPHOLOGY OF THE FEMALE OF *BALANODYTES TAIWANUS* UTINOMI[1)]

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With Plate I and 7 Text-figures

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Introduction

The following note, forming the fourth part of my serial studies on the Cirripedia Acrothoracica, is a detailed description of the morphology of the female of another peculiar type of the Acrothoracica *Balanodytes taiwanus* UTINOMI, its preliminary description having already been given (UTINOMI, 1950 a). Owing to the scantiness of the material, however, I could not extend into the detailed internal anatomy more extensively than I have made in the case of *Berndtia purpurea* UTINOMI (UTINOMI, 1957, 1960, 1961).

Habitat

During a collecting trip to Taiwan (Formosa) in the early summer of 1938,

1) Contributions from the Seto Marine Biological Laboratory, No. 395.

I collected many specimens of littoral cirripeds (HIRO, 1939). At that time of collecting, the occurrence of this curious boring animal was escaped from my notice, but when preparing the report on the thoracic cirripeds I re-examined a material of a common littoral cirriped *Balanus tintinnabulum tintinnabulum* (LINNÉ) obtained on the coast near Takao (Kaohsiung) and happened to find its occurrence, one in the perfect and the other in more imperfect condition. The two materials found there were preserved in formalin at that time. Hence, the following description of this curious acrothoracican is rather imperfect and even unsatisfactory to me, as compared with that of the previously reported *Berndtia purpurea* UTINOMI and no males were found. Accordingly, its detailed life habit and larval development are completely unknown for the present. Nevertheless, I have been able to elucidate the greater part of its structure. Besides, a smaller empty burrow was found in the same cirriped.

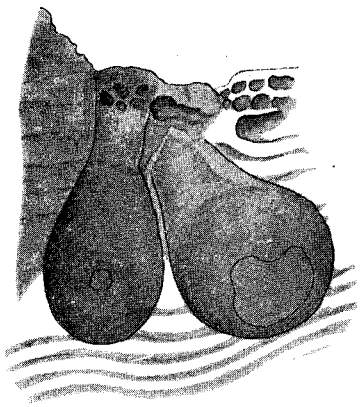

Fig. 1. Two burrows of *Balanodytes taiwanus* UTINOMI, formed on a calcareous basis of the littoral barnacle *Balanus tintinnabulum tintinnabclum* (LINNÉ). ×10

The specimens (females) were found bored into the calcareous basis of of the barnacle *Balanus tintinnabulum tintinnabulum* (LINNÉ). The burrow in which the animal is lodged is somewhat flask-shaped, consisting of a somewhat wide upper portion and an oval lower portion. The burrows examined measure as follows:

No.	Depth of burrow	Width of lower portion	Length of aperture
1	4.5 mm	2.2 mm	1.0 mm
2	4.5 mm	2.7 mm	?
3	2.0 mm	1.0 mm	0.8 mm (empty)

The bored holes (Fig. 1) are excavated almost vertically to the surface of the substratum and open to the outside by a slit-like aperture. The accurate

shape of the aperture could not be defined due to a careless treatment, when removed.

The burrow is laterally flattened and the lower portion is somewhat wider than the upper portion. The interior of the burrow is evenly smooth, and on one side the wall is more or less worn where a part of the tunic lining the internal mantle-sac is retained. However, there is found nowhere any trace of the hollowed attachment area on the internal surface.

In the mantle cavity of a perfect female, a number of fertilized eggs including nauplii before hatching were found. But, unfortunately the male was not discovered.

External Morphology of Female

A perfect female (holotype-SMBL Type 52 lost) is much compressed laterally, though a little wider towards the rostral and lower margins, so that it is oval in lateral outline (Fig. 2). The measurements of a perfect female are:

Total length 2.2 mm, greatest width 1.2 mm and length of orifice 0.8 mm.

Orifice

The orifice (Fig. 2, *or*) leading into the mantle cavity occupies almost one-third as long as the whole animal and lies on the upper rostral side and uppermost end. The whole edge is evenly arched; its upper one-third lying at the tip of the mantle-sac is fringed internally by the 'comb-collar' (*c. c*) formed of a comb-like row of long flattened setae and adorned externally with long hairs.

The lower two-thirds of the orifice on the rostral side is almost straight in parallel to the long axis of the mantle-sac, and its edges are moderately thickened, hardened, and bordered externally by a spiniferous ridge (Fig. 3, *e. r*), and also there is an almost naked, slight ridge (*i. r*) on its internal side, closing the orifice; these ridges do not form any unique operculum as seen in the genera *Berndtia* and *Lithoglyptes*. The external ridge is furnished with numerous forked chitinous spines (*sp*) which are mostly bifid at the tip, rarely simple or trifid, but not star-like.

Besides, in the middle of the orifice, lying slightly below the tip of the mantle-sac, there is on each side a peculiar spiniferous projection (*pr*) bearing one or two hanging hook-like spines on its lower side. This projection is about 0.22 mm long, sharply pointed and somewhat three-cornered. The lower two ribs continue from the outer and inner ridges bordering the lower half of the orifice and furnished with forked spines and long hairs (*hr*) as well. In the related *Kochlorine hamata* (NOLL, 1875), a similar but larger forked spine is

seated at the extremity of the paired projections. These forked spines are possibly specialized form of the chitinous spines for boring action common to all acrothoracicans.

At the lowest end of the orifice, inserting between both lips, there is a rounded small knob (Fig. 3, *k*) bearing a few simple spines and hairs. Pre-

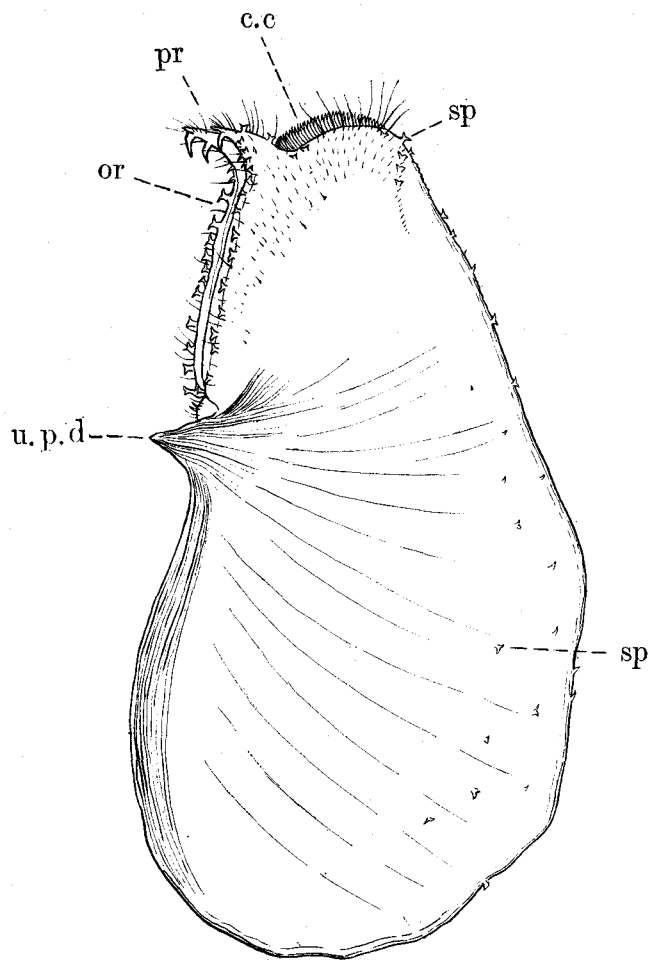

Fig. 2. *Balanodytes taiwanus* UTINOMI in lateral view. Legends are given at the end of the text. ×70

sumably it may correspond to the 'projecting bulb' found in a peculiar pedunculate cirriped *Koleolepas* (HIRO, 1933) and conical process at the lowest end of the orifice in *Trypetesa* (paired in this case); it may serve to facilitate the opening of the orifice.

Mantle

The mantle-sac is moderately thin in thickness, but somewhat elastic because of being lined within by the alternate layers of striated muscles, both longitudinal and transverse. In the uppermost part the surface of the mantle is finely hairy, but a little downwards naked. The majority of the lower surface particularly towards the carinal side is scattered with a number of simple

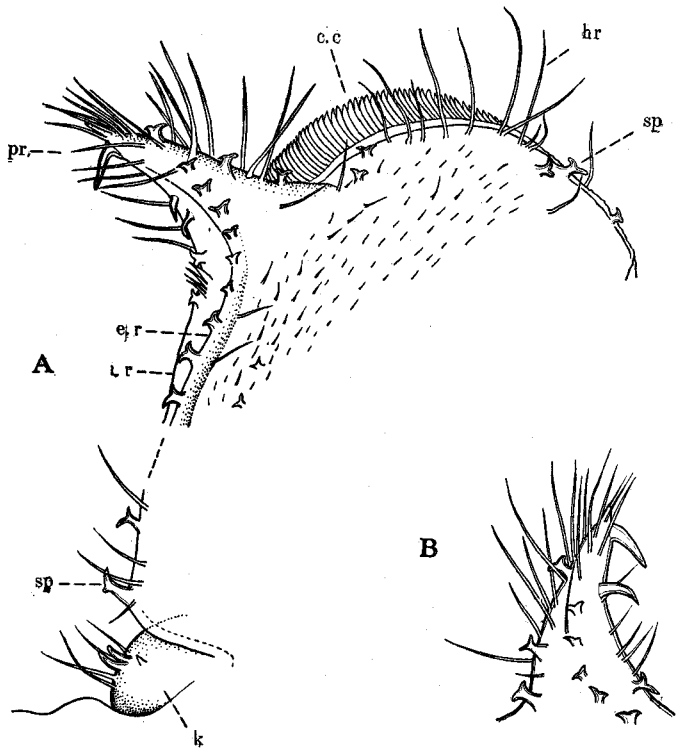

Fig. 3. A. Inside of the orifice of the female of *Balanodytes taiwanus* UTINOMI, showing the spinferous structure, prominent projection and comb-collar in outer view. B. Spinferous projection on the other side of the orificial edges.
Legends are given at the end of the text. A–B ×120

or bifid chitinous spines (Fig. 2, *sp.*). These boring spines occurring there are comparatively sparse and smaller than in those of other acrothoracicans, although much stronger around the orifice. Just beneath the rounded knob at the lower end of the orifice, there is prominent projection (Figs. 2 and 4, *u. p. d*) pointing upwards. This projection is naked, conical in outline, and

firmly adheres by its under side to the upper edge of the burrow within which the animal is lodged. This is evidently the same as the upper projection of the attachment-disc where the disk is much developed, or the 'horny knob' (as called by TOMLINSON). Also it corresponds to the so-called 'Unpaarer Fortsatz mit Haken' of *Kochlorine*, although lacking any hook.

Further downwards, the external surface towards the rostral side is apparently smooth, naked and not so strongly thickened as to form any broadened attachment-disc.

In this respect, the mode of attachment most closely resembles *Kochlorine hamata*. According to NOLL (1875), *Kochlorine* can keep itself freely within the cavity by hanging a hook-like spine on the unpaired process to the upper edge of ihe burrow, not forming any thickened attachment area below the attachment-process. In all probability it is NOLL's misunderstanding regarding the mode of attachment. In this *Balanodytes*, on the other hand, the corresponding projection does not bear such a prominent hook-like spine at its end and the texture is only muscular, as stated above.

Internal Morphology of Female

Body

The body proper contained in the mantle cavity (Fig. 4) is comparatively long and S-shaped in the contracted state. The upper part occupying the middle of the mantle cavity is the widest and tapers gradually to the lower or posterior part bearing four pairs of terminal cirri. The head portion, occupying almost an upper half of the whole body, is laterally compressed, and its upper or dorsal surface just beneath the orifice is slightly convex, sinuous in lateral aspect and devoid of any process.

At its upper ventral corner where the margin is rectangularly curved in lateral aspect, there is a greatly developed mouth and beneath it a pair of the mouth cirri (c_1). The boundary between the buccal region and the rest of the head is obscure. The prosomal portion is very large and devoid of segmentation. In the posterior crooked portion of the body bears three distinct joints, and at the terminal end there are four pairs of terminal cirri (c_{2-5}). The bodial surface is apparently smooth and not transversely wrinkled as drawn by NOLL (1875) for *Kochlorine hamata*. Hence the large part of the body may be the prolonged first thoracic segment united to the head totally.

Cirri

The cirri consist of five pairs of ordinary biramous type. In all the cirri, the protopodite is 2-jointed. In the mouth cirri, the lower segment is com-

paratively slender and long, while the upper segment is very short and wide. The two rami are also short, about one-fourth as long as the protopodite, and slightly directed anteriorly, though their tip slightly bent posteriorly. The anterior ramus is a little longer than the posterior one and 4-jointed, each

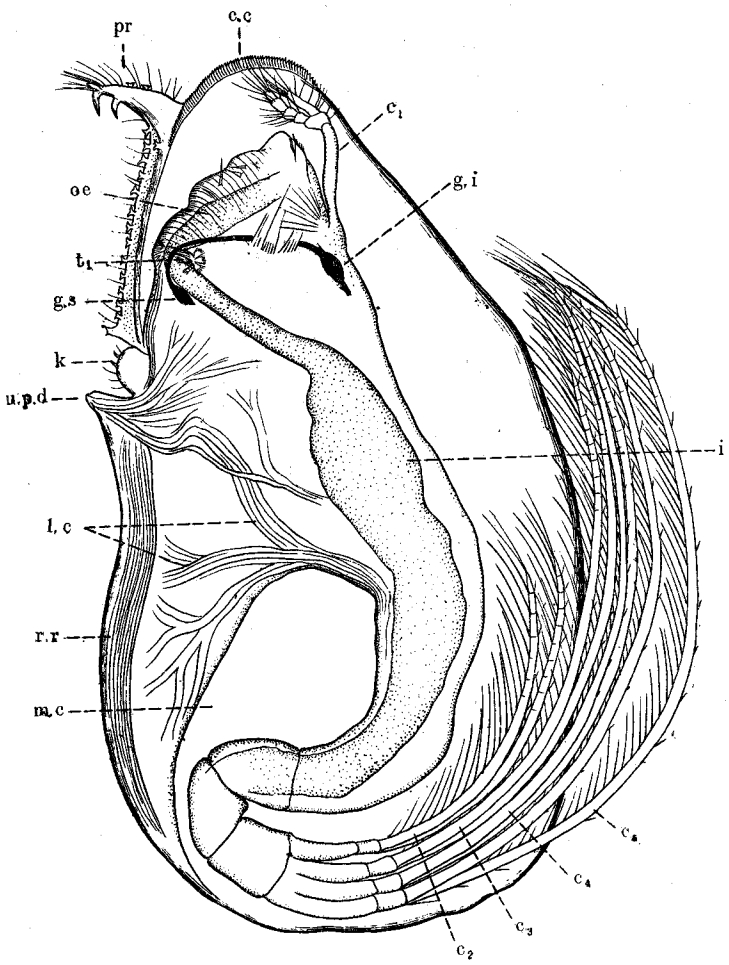

Fig. 4. Inside of the mantle-sac containing the body of the female of *Balanodytes taiwanus* UTINOMI, partially showing the internal structure of the body.
Legends are given at the end of the text. ×35

segment bearing long bristles at tip. The posterior ramus is unjointed, but bear long bristles posteriorly and terminally (Fig. 7).

The terminal cirri (c_2 to c_5) are almost alike, except that the second pair (c_2) is about two-thirds as long as the remaining posterior pairs. They form

together a nearly straight brush of considerable length at the end of the body, so that they may be wholly protractile out of the orifice. The protopodite in either of them is very elongate and 2-jointed, the upper segment being about one-third as long as the lower one. In all the rami, the articulation is nearly indistinct, except in the terminal portion. The bristles are, however, arranged in usual manner on both the margins. Each segment, when it is distinct, is armed with a pair of long bristles at the distal angle of the inner (ventral margin and rather rarely with a pair of additional short ones a little below

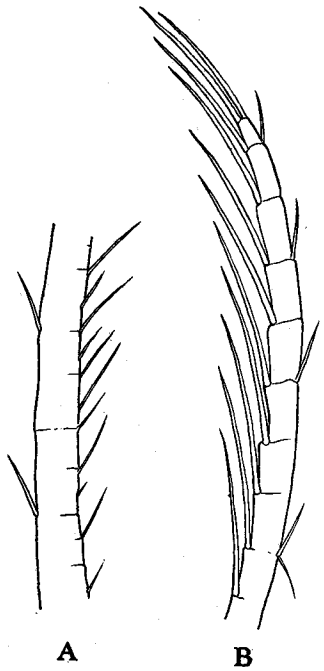

Fig. 5. A. Intermediate portion of the terminal cirri of *Balanodytes taiwanus* UTINOMI with obscure segmentation.
B. Terminal portion of the terminal cirri with distinct segmentation. ×140

the longer ones; its outer (dorsal) margin bears a short bristle or none at the distal angle (Fig. 5).

The caudal appendage is entirely lacking.

Mouth-parts

The mouth-parts are characteristic to the Acrothoracica, but comparatively rather simple (Fig. 6).

The labrum (Fig. 7, *lm*) which serves as the upper lip of the mouth is considerably large and bullate, but the manner is unlike that of *Berndtia* and *Cryptophialus*, not being produced forwards. The outer fold is a little swollen and furnished with a transverse row of short fine hairs. More forwards, there is a median elevation which is a little convex and bears a brush of long hairs on its summit. On each side of the median ridge there are 3 or 4 stiff spines.

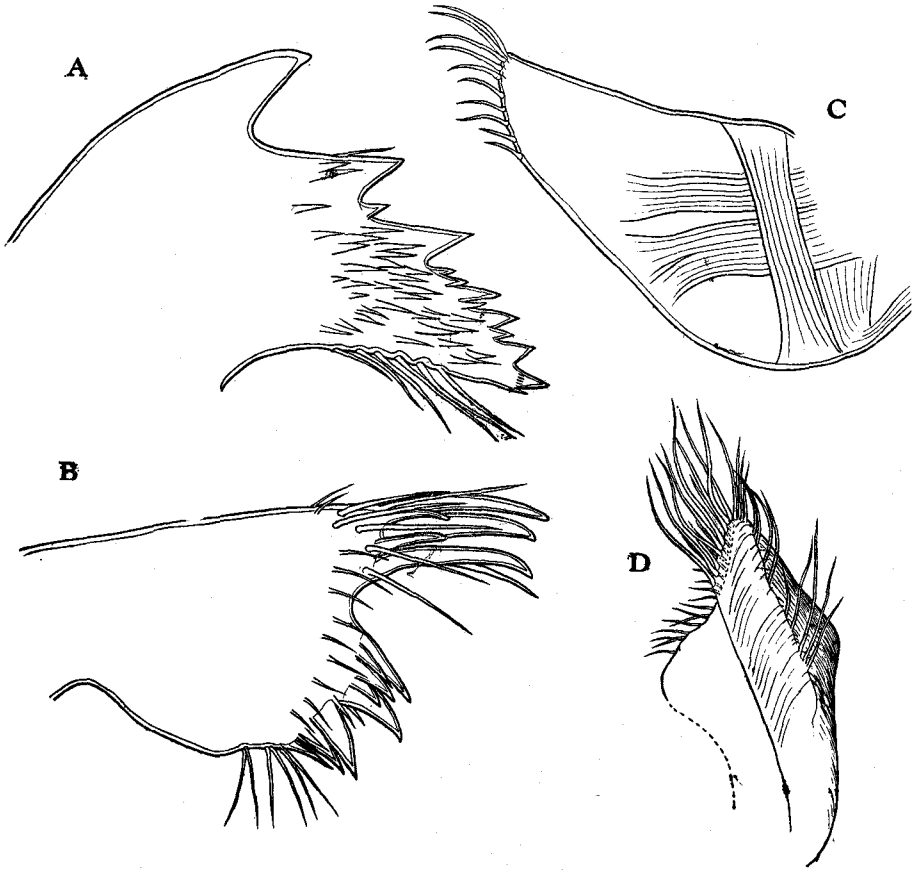

Fig. 6. Mouth-parts of the female of *Balanodytes taiwanus* UTINOMI. A. Mandible; B. Maxilla I; C. Manibular palp; D. Maxilla II. A–B ×446, C–D ×104

The cutting edge is deeply arched, and provided with many small teeth close together.

The palpi (Fig. 6 C and Fig. 7, *mp*) are widely flattened, shoe-shaped in outline and bear a few short hairs terminally.

The mandibles (Fig. 6 A) have three large main teeth and multipectinated lower angle along the frontal edge. The upper edge is hairless, but the lower

edge is fringed with a few long hairs. Both the lateral surfaces are densely hairy.

The first maxillae (Fig. 6 B) bear a very broad notch in the middle of the frontal edge. At its upper part there is a tuft of long spines, and at its lower part there are shorter spines, two of which are particularly large. The upper edge is hairless, but the lower edge and both the lateral surfaces near the frontal edge are densely hairy.

The second maxillae (Fig. 6 D and Fig. 7, mx_2) are considerably large and soft; those of both sides are fused in the lower part, forming together a lower lip below the labrum. They are roughly rhomboidal in outline, when viewed from the outsides, and have numerous flexible bristles distributed along their outer longitudinal ridge and outer and inner edges. The boundary between the upper and lower segments is indistinct, as in *Berndtia* and *Kochlorine*.

Digestive System

Owing to the scarcity of the material as well as the bad preservation, the detailed anatomy of the body could not be elucidated. Nevertheless, the important main organization could be detected from the outsides. So the internal structure is imperfectly described.

As is shown in Fig. 4, the digestive organ is represented only by a simple canal of considerable length. The oesophagus (*oe*) runs backwards from the mouth parallel to and just below the upper surface of the head facing the carinal side of the orifice. It is surrounded by the ring muscles (Fig. 7, *r. m*) and accompanied on each side by two parallel muscles i. e., the adductor capitis superior (*a. c. s*) and adductor capitis inferior (*a. c. i*), as in *Berndtia purpurea*.

At the point where a weak transverse muscle (Fig. 4, *t*) runs across the head, the oesophagus rectangularly bent and runs for some way obliquely downwards till entering into the expanded intestine; the stomachal part is not discernible from the outsides. The digestive glands are absent. The intestine (*i*) is broadly expanded, about three times as wide as the oesophagus at the beginning and gradually tapers down to the posterior end of the body; it is more than twice as long as the oesophagus. The terminal portion of the intestine could not be traced, but probably the anus is present at its end.

Nervous System

The nervous system could be partially traced. The cerebral or supra-oesophageal ganglion (Fig. 4, *g. s*) is situated close to the curved part of the oesophagus, and from it the nerve commissure runs forwards around the oesophagus to the infra-oesophageal ganglion (Fig. 4 and Fig. 7, *g. i*) which lie below the mouth-cirrus; the former ganglion is about one-half as large as

the latter ganglion. The succeeding ventral nerve cord running downwards could not be traced from the outsides. However, it seems certain that such a terminal ganglion as shown in *Berndtia purpurea* may occur near the base of the terminal cirri.

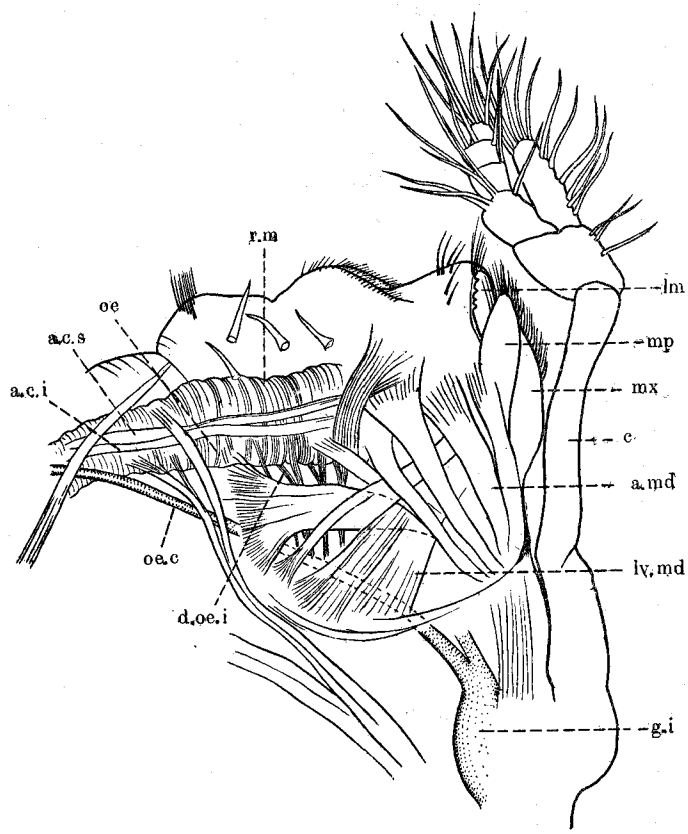

Fig. 7. Buccal region of the female of *Balanodytes taiwanus* UTINOMI, showing the muscular and nervous systems, and the mouth-cirrus.
Legends are given at the end of the text. ×140

Muscular System

As far as I have examined, the muscular system of this *Balanodytes* exhibits some remarkable differences from that of other acrothoracicans such as *Berndtia*, *Lithoglyptes*, *Cryptophialus* and *Trypetesa*, well studied. It shows a closer resemblance to that of *Kochlorine hamata* which has been described and figured only by NOLL (1875) very briefly.

Of all the peculiarities could be detected, the occurrence of a pair of unusually powerful longitudinal muscles (Fig. 4, *r. r*) running downwards from the attachment-process on the rostral side of the mantle is most noticeable. This muscle seems to correspond to the powerful muscle found on the rostral side of the mantle. Judging from the point of its attachment on the mantle-sac, it seems to be a specialized transverse (or radial) muscle lying close to the rostral side, namely the dorsal wall of the thickened mantle, where the attachment-disc is usually formed. All other transverse muscles of the mantle run obliquely to the rostral side of the mantle, but this powerful muscle only runs downwards perpendicularly. Such modification of this muscle can probably be attributed to the weak development of the disc for attachment. This supposition may be more strengthened by the fact that the corresponding muscle is quite lacking in any other acrothoracicans having a well-developed attachment-disc. Therefore, I propose to call it the rostral retractor muscle of the mantle (Plate I and Fig. 4, *r. r*).

MUSCLES OF MANTLE. As is shown in Plate I, the longitudinal muscles (*l. m*) run parallel to one another around the mantle-sac and are crossed by the transverse muscles (*t. m*). The transverse muscles run inside the longitudinal muscles in the rostral half, while outside the longitudinal muscles in the carinal half, by turning their way in the middle portion. The longitudinal muscles become much longer and stronger towards the carinal side; some of them lying on the carinal side extend further upwards the uppermost end of the orifice, while the remainder on both sides do not further extend and blindly end. The lower ends of all these longitudinal muscles are, as usual in other acrothoracicans, attached to the rostral side from both sides, where the rostral retractor muscle runs perpendicularly and internally. Thus, the whole animal is able to contract considerably and then to enlarge its own mantle cavity in co-operation of the extending action of the transverse muscles.

The transverse muscles, which are probably homologous with the ring muscles of the peduncle in the pedunculate cirripeds, are nearly uniform in strength. They run transversely or almost radially on both sides from the attachment-process (or 'horny knob') and then below it from the rostral margin of the mantle-sac where the wall is somewhat thickened, forming a compact network with the longitudinal muscles. Some of them lying upwards are arisen from the attachment-process are shorter, blindly ending, while more downwards they are attached on both sides the powerful retracter muscle along the rostral medial line. Their distal ends towards the carinal margin are generally expanded respectively and gradually obliterated. One of the transverse muscles directly arising from the attachment-process (*t. m'*) is particularly powerful and terminates at the middle portion and expands widely.

At a short distance below the lower end of the orifice, there is a fan of

short transverse muscles arising from the lower end of the orifice near a rounded knob, These muscles are never lined outsides by any muscle layer. Inside these muscles there is a short slender muscle-fibre (*l. b*) running vertically ; this is independent, so that it may correspond to the lateral bar. From its position it is probably homologous with the 'punctirte Chitinleiste' occurring on the corresponding part of *Kochlorine hamata* (cf. NOLL, 1875, Pl. 6, fig. 2, *c*), and also with the lateral bar ('Verstärkungsleiste' in all other acrothoracicans, although present externally in the other acrothoracicans as chitinous thickenings.

Alongside this bar, there is a large, flattened strong muscle attached with their expanded end to the short transverse muscles. This muscle runs across the head passing just behind the mouth, and thus it agrees with the second transverse muscle (t_2) of the body. In the middle portion between this muscle and the edge of the orifice, there is another bundle of smaller muscles, radially attached to the mantle; this bundle is evidently the first bodial transverse muscle (Plate I and Fig. 4, t_1). This muscle runs across the body just beneath the winding point of the oesophagus. The remainder of the mantle is naked, membranous, and thus devoid of muscles.

MUSCLES OF BODY. The constitution of muscles in the body proper differs markedly from that of aforementioned *Berndtia purpurea.*

A large bundle of strong longitudinal muscles originating from the attachment process passes on the dorsal side of the body. Some of them are widely divergent in the commencement and cover the thickened part of the mantle which connects the body with the mantle-sac and contains within the ovarian mass, although the latter could not be detected from the outsides. Some shorter muscles run radially from the attachment-process on both sides of the body. These muscles are probably homologous with the 'retractor corporis' of ordinary cirripeds (NUSSBAUM, 1890) and also with the 'protractors' in *Trypetesa lampas* (GENTHE, 1905).

As stated above, the muscular system somewhat resembles that of *Trypetesa lampas*, but in other respects, especially the musculature of the mantle, it seems agree with that of *Kochlorine hamata.*

The 'retractor orificii' such as shown in *Berndtia, Lithoglyptes* and *Cryptophialus* is entirely lacking in this *Balanodytes* and *Kochlorine.* Instead, the peculiar 'retractor pallii rostralis' is present in *Balanodytes* and *Kochlorine.* Anyhow, as far as the muscular system is concerned, the Acrotharacica can be divided into two (or three) separate groups.

As to the muscular system of the remaining portion, I could not enter into details. Still, the general appearance of the buccal region may be roughly understandable in Fig. 7.

Affinity between *Balanodytes* and *Kochlorine*

As mentioned above, the group Acrothoracica is divisible into two (or three) separate groups with respect to the muscular system of the mantle and body.

The present *Balanodytes* is most closely allied to the genus *Kochlorine* which was originally described by NOLL (1875) from Cadiz on the Atlantic coast of Spain under the name *K. hamata*, as lodging in the bored hole of the ear shell *Haliotis tuberculata*. A second species *K. bihamata* NOLL was recorded from the Cape of Good Hope, S. Africa, as lodging in the same ear shell (NOLL, 1883; GRUVEL, 1905, p. 334; STEBBING, 1905, p. 575; BARNARD, 1924, p. 99).

In comparison, *Kochlorine* and *Balanodytes* resemble closely both externally and internally. First of all, the mantle-sac of both the forms are laterally compressed, oval in outline and bears a narrow slitlike orifice, of which the edge is evenly arched and not conspicuously thickened.

The attachment-disc is weakly developed or reduced, and thus the animal is only attached by a small conical process to the narrowed rostral end of the slitlike aperture of the burrow. The mantle-sac is mainly supported by a remarkably strong longitudinal muscle named here the 'retractor pallii rostralis' running perpendicularly from the attachment-process or 'horny knob' along the weakly thickened rostral side of the mantle. The radial muscles, namely the 'levator corporis' arising from the attachment-process support the body proper within the mantle cavity.

Next, the outer margin of the orifice is furnished with strong forked (bifid, trifid or simple) spines on both sides, which may be the specialized or developed form of boring spines scattered over the mantle-sac. Besides, a prominent projection bearing the similar spines or hook-like spines densely on each side of the orificial lips.

The lateral bar is present inside the mantle and rudimentary, so may be practically non-functional. This may be due to the weak mode of attachment. The 'comb-collar' at the tip of the orifice is comparatively well-developed as well.

The similarity in the mouth-parts in comparison with the other acrothoracicans is also remarkable.

In the cirri, the mouth-cirri seem to tend to degenerate and the terminal cirri are long but mostly non-articulate. The caudal appendage is present, only 2-jointed in *Kochlorine*, but it is entirely lacking in *Balanodytes*.

In classifying the members (genera or families) of the Acrothoracica, BERNDT (1907) and GRUVEL (1905) based mainly on the differences in the alimentary canal and the cirri with the caudal appendages. In my opinion, however, the presence or absence of the cirri and caudal appendages, and the number of their pairs, if present, is no more than of generic value taxonomically.

GRUVEL (1905) treated *Lithoglyptes* and *Kochlorine* as belonging to separate

families respectively, Lithoglyptidae AURIVILLIUS (1894) and Kochlorinidae GRUVEL (1905), while BERNDT (1907) united to one family Kochlorinidae on account of the presence of the mouth-cirri and caudal appendage, not considering upon the remarkable disparities in other characters. Afterwards, KRÜGER (1940, p. III, 454) also following BERNDT (1907), combined 4 genera such as *Kochlorine*, *Lithoglyptes*, *Berndtia* and *Weltneria* as well. UTINOMI (1950 a, b) established a new family Balanodytidae to accomodate *Balanodytes* and *Kochlorine* according to a new system of classification. However, at present, I consider more reasonable to emend the old definition of the family Kochlorinidae GRUVEL (1905), not in the sense of BERNDT (1907) and KRÜGER (1940).

In conclusion, I give herein an emended diagnosis of the family Kochlorinidae to include two genera *Kochlorine* and *Balanodytes* and to retain the oldest family name following the nomenclatural rule as follows:

Family Kochlorinidae GRUVEL (emend.)

Kochlorinidae GRUVEL, 1905, p. 328, 335.
Kochlorinidae BERNDT, 1907, p. 287.
Kochlorinidae CALMAN, 1909, p. 140.
Kochlorinidae BARNARD, 1924, p. 99.
Kochlorinidae KRÜGER, 1940, p. III, 454.
Balanodytidae UTINOMI, 1950 a, p. 99 (p. 5 in reprint).
Balanodytidae UTINOMI, 1950 b, p. 458.

Mantle-sac considerably compressed laterally, oval in lateral outline. Orifice broadly arched, slit-like, with prominent spiniferous projection(s) on each side. Attachment-disc weakly developed or reduced, and only a conical attachment process ('horny knob') present below orifice. Rudimentary lateral bar present inside of mantle. Mouth-cirri biramous, with short rami unjointed or jointed. Terminal cirri indistinctly jointed, 3 or 4 pairs. Caudal appendage present or absent. For supporting mantle to upper edge of burrow-aperture a strong retractor muscle ('retractor pallii rostralis') runs downwards from attachment process.

Summary

1. The details of the morphology of an Acrothoracican cirriped *Balanodytes taiwanus* UTINOMI (1950), as far as can be detected, are given.

2. The animal was found boring in the calcareous basis of the barnacle *Balanus tintinnabulum tintinnabulum* (LINNÉ), obtained at Takao (Kaohsiung) Taiwan (Formosa).

3. The mantle-sac is laterally compressed, oval in outline, and attached

to the narrowed rostral end of a slitlike burrow-aperture by a small conical process.

4. This attachment process is only muscular, lacking any hooks and further downwards any ordinary broad attachment-disc is not formed.

5. Below the orifice and above the attachment-process a peculiar rounded knob is situated, serving to facilitate the opening and closing the orifice.

6. The mantle-sac is supported only by a strong retractor muscle arising from the conical attachment-process.

7. The orifice is narrow, slitlike. Its edge on both sides is broadly arched and fringed with forked spines externally in the lower half and with flattened setae in comb-like row internally in the upper half. In the middle of that edge there is a prominent spiniferous projection.

8. The lateral bar is situated inside the mantle as a fibrous structure; thus it may be degenerated and non-functional.

9. The body proper is as usual winding, tapering posteriorly and distinctly 4-segmented, with prolonged prosoma.

10. The alimentary canal is ordinary, without any appendages.

11. The mouth-cirri are small, slender, biramous, but the anterior ramus is 4-jointed and the posterior one unjointed. The terminal cirri consist of 4 pairs of obscurely jointed long rami and 2-jointed broad protopodite. The caudal appendage is absent.

12. For many morphological similarities, it is evident that this *Balanodytes taiwanus* is most closely allied to the genus *Kochlorine* NOLL hitherto known only from the Atlantic coast of Spain and South Africa.

13. Based on a new system of clasification, therefore, an emended disgnosis of the family Kochlorinidae GRUVEL (1905) is herein proposed, discarding the family name Balanodytidae UTINOMI (1950 a, b).

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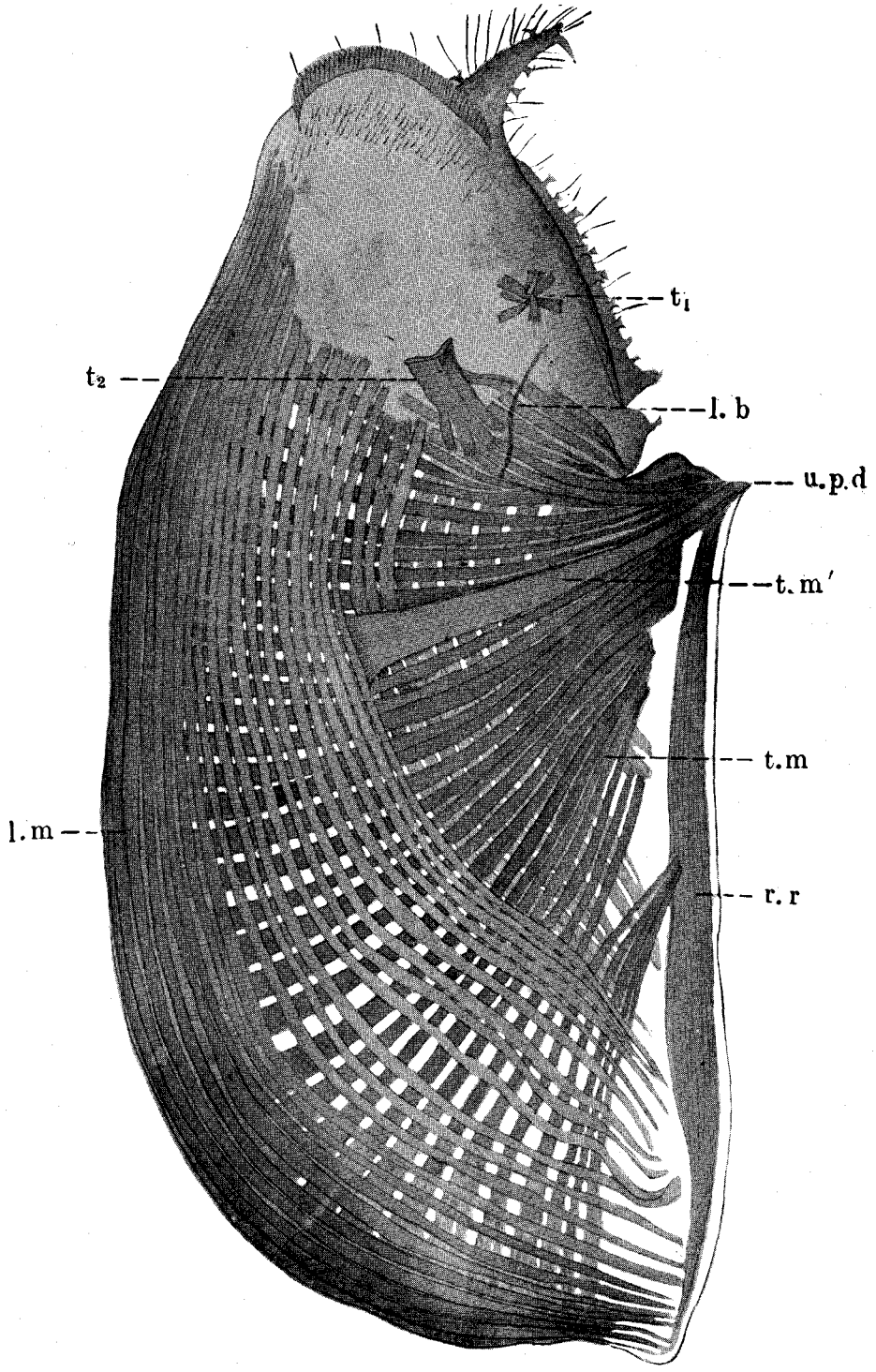
EXPLANATION OF PLATE I

Inner surface of the mantle of *Balanodytes taiwanus* UTINOMI (female), showing the muscular system. The body is removed. ×85

LIST OF ABBREVIATIONS USED IN FIGURES IN THE TEXT AND PLATE

a.c.i	Adductor capitis inferior.	lm	Labrum.
a.c.s	Adductor capitis superior.	lv.md	Levator mandiblae.
a.md	Adductor mandiblae.	m	Mouth.
c_{1-6}	Cirri I–VI.	m.c	Mantle-cavity.
c.c	Comb Collar.	mp	Mandibular palp.
d.oe.i	Dilatator oesophagi inferior.	mx_2	Maxilla II.
d.oe.s	Dilatator oesophagi superior.	or	Orifice.
e.r	External ridge of orificial edge.	pr	Orificial projection.
g.s	Supra-oesophageal ganglion.	r.m	Ring muscles of oesophagus.
g.i	Infra-oesophageal ganglion.	r.r	Retractor pallii rostralis.
hr	Hair.	sp	Chitinous spines (mostly forked).
i	Intestine.	t_{1-2}	Transversalis I–II.
i.r	Internal ridge of orificial edge.	t.m	Transverse muscles of mantle.
k	Lower knob of orifice.	t.m′	Specialized transverse muscle of mantle.
l.b	Lateral bar.	u.p.d.	Attachment-process ('horny knob')
l.c	Longissimus corporis. (Longitudinal muscles of body on dorsal side).		



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