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Observations on the Living Animal and Mode of Life of some  
New Zealand Erycinacean Bivalves

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Abstract

THE mode of life, locomotion, external morphology and functional morphology of the mantle cavity of *Borniola reniformis* (Suter), *Mysella unidentata* (Odhner), *Myllita* (*Zemyllita*) *stowei* (Hutton) and *Scintilla stevensoni* Powell are described.

INTRODUCTION

THOUGH the shells of the New Zealand Erycinacea are well known, there has been very little published on their morphology and habits. Odhner (1924) described the morphology of three New Zealand species, *Mysella tellinula* (Odhner), *Melliteryx parva* (Deshayes) and *Scintillona zelandicus* (Odhner), the latter being re-described, together with observations on its locomotion, ciliation of the mantle cavity and commensal habit, by Morton (1957). The commensal habit of species belonging to the genus *Arthritica*, the ciliation of the mantle cavity, external morphology and locomotion of *A. crassiformis* Powell were described by Ponder (1965), and Wear (1966) described the commensal habit of *Arthritica bifurca* (Webster).

This paper deals with the functional morphology of the mantle cavity, the external morphology, locomotion, and mode of life of four New Zealand species of erycinacean bivalves. The classification of the species described here will be more fully discussed elsewhere.

MATERIALS AND METHODS

Each species was examined alive to observe locomotion, external morphology and the ciliation of the mantle cavity. Ciliary currents were determined by using powdered carmine and carborundum powder.

*Borniola reniformis* (Suter)

1908. *Rocheportia reniformis* Suter: Trans. N.Z. Inst. 40: 351, Pl. 27, Fig. 12.

1926. *Rocheportula reniformis* (Suter), Finlay: Trans. N.Z. Inst. 57: 465.

*B. reniformis* is moderately common under stones in contact with shelly sand at low tide in clean, coastal situations. It occurs throughout New Zealand and extends to a depth well below a hundred fathoms.

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There is considerable variation in shape, and relative strength of sculpture and hinge. Short, inflated shells generally have strong growth lines, coarse radial sculpture and a heavy hinge, while compressed, more elongate specimens are delicately sculptured, have thinner shells and a weaker hinge. The latter type are usually found under stones embedded in sand while the crasser specimens generally occur on the undersides of stones encrusted with sponges, tunicates, etc. Shells intermediate between these extremes are also commonly encountered. The shell (Fig. 1) reaches about 7mm in length and 5mm in height. It is elongately oval, the anterior end longer, and moderately inflated. The prodissoconch is minute and the sculpture of the adult shell consists of regular close radial riblets and concentric growth lines. There is a large triangular internal ligament below the beaks. The right valve has two strong cardinals, and the left valve has two dorsal, narrow lamellae, the posterior one elevated.

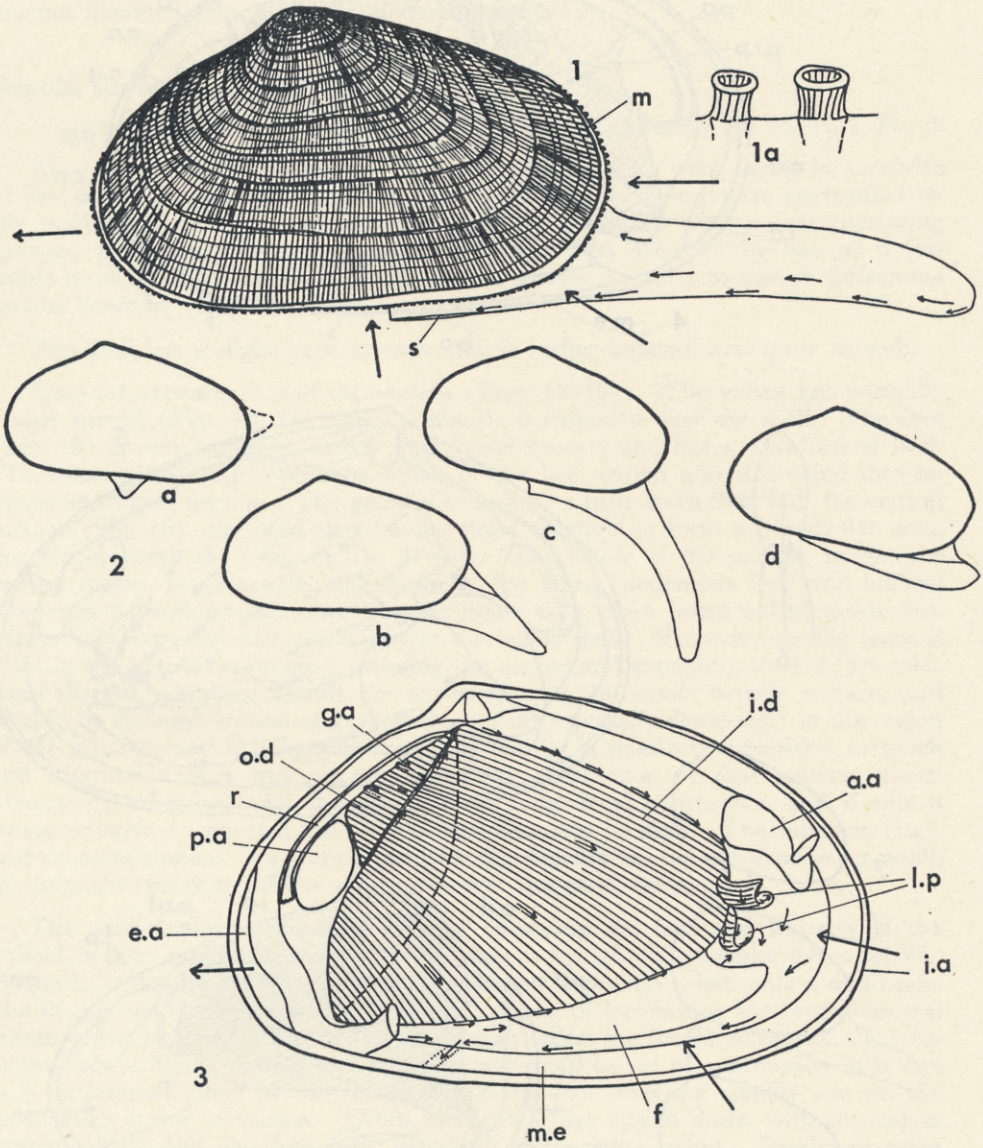
*External appearance and locomotion:* The animal (Figs. 1, 2), when fully extended, has no siphons and the mantle projects only slightly. There are small, blunt, hollow papillae (Fig. 1a) on the edge of the mantle which is extremely sensitive and rarely extended. The foot is large, flattened laterally and very mobile, broadening somewhat at the tip when crawling. The sole (s.) is narrow and there is a definite heel. Movement (Fig. 2, a-d) is achieved by the animal extending the foot, drawing the shell, which lies on its side, forward, and then re-extending the foot. The shell is flipped over from time to time during locomotion.

Normally it is attached by a byssus of one to a dozen or so threads emerging from the mid-ventral side of the shell which is slightly indented in some older shells.

*The mantle cavity and ciliary currents* (Figs. 3-5): There are two demibranchs present. The outer (o.d.) is much reduced and consists of only one lamella which is reflected posteriorly and bent inwards at its dorsal margin. The inner (i.d.) is larger, and has fully developed ascending and descending lamellae. The outer demibranch is weakly fused to the visceral mass at its dorsal edge but not to the mantle while the inner is fused to the visceral mass along its dorsal side and along the anterior half of the ascending lamella. There are two pallial openings, a large antero-ventral opening (inhalent-pedal aperture) and a moderately large exhalent aperture (e.a.) posteriorly.

Ciliation of the inner demibranch is normal, there being a well-formed food groove along the ventral edge with large guarding cilia on both sides. The frontal cilia of the reflected outer gill pass particles over the bent portion and so towards a narrow groove along the axis of the gill where some pass upwards to a ciliated track running anteriorly along the dorsal edge of the gill, but most sweep over the groove on to the inner demibranch. The labial palps (l.p.) are moderately large, mobile, and ciliation appears to be normal. The inner sides of the palps are ridged and cilia sweep food particles orally over these while waste is passed along the grooves between the ridges to the lower edges of the palps from where it is dropped on to the mantle. The foot (f.) and visceral mass are richly ciliated. Particles are carried by cilia towards the ventral anterior corner of the visceral mass, and posteriorly along the foot to be rejected at the heel. The narrow sole also has a backwardly directed current. There is a powerful ciliated tract just inside the mantle edge (m.e.), the very long cilia of which can easily be seen under the low power of a binocular microscope. Particles are passed posteriorly to a point just anterior to the end of the pedal opening where a ciliated rejection tract passes over the mantle edge. At this point an anteriorly moving current from the posterior end of the mantle edge also terminates. Above the rejection tract on the mantle edge, movement of cilia on the mantle is towards the region of the palps. The whole of the anterior portion of the mantle edge has outwardly beating cilia which reject heavy particles carried in by the inhalent water current. The adductor muscles (a.a., p.a.) are large, the anterior being slightly larger than the posterior. Some features of the gross anatomy are shown in Fig. 4.



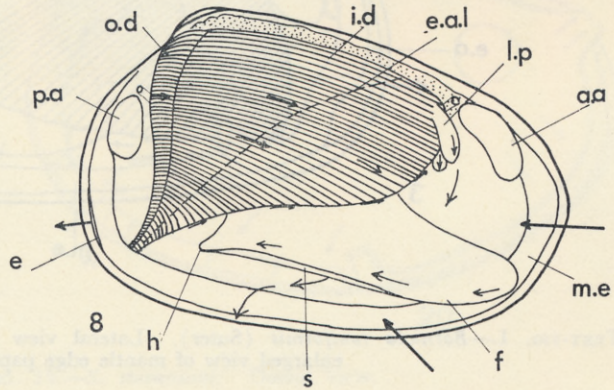
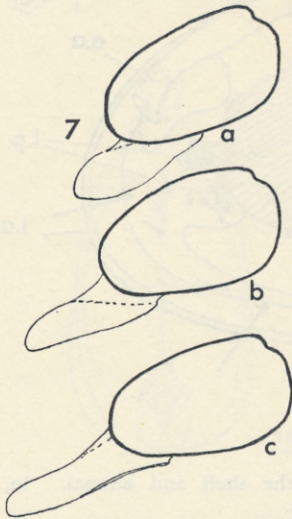
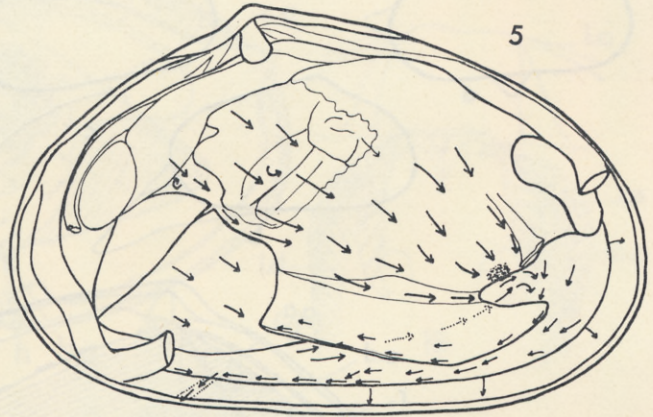
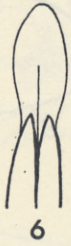
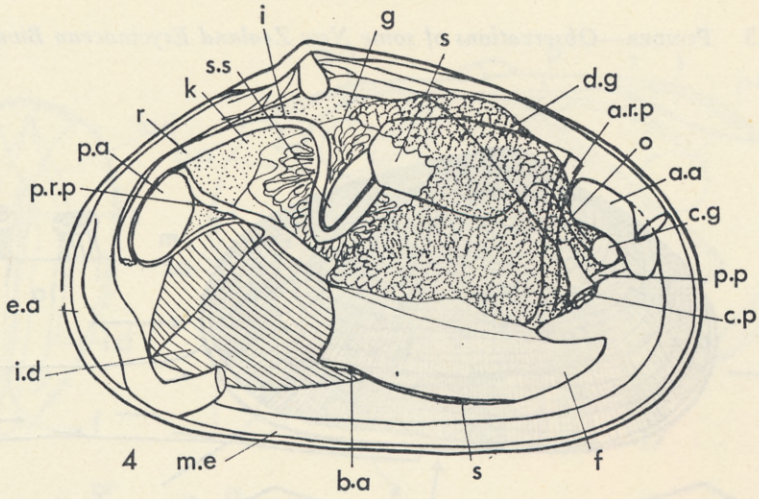


TEXT-FIG. 1.—*Borniola reniformis* (Suter). Lateral view of the shell and animal. 1a, enlarged view of mantle edge papillae.

TEXT-FIG. 2, a-d.—*B. reniformis*. Outline sketches showing the action of the foot.

TEXT-FIG 3.—*B. reniformis*. Right valve and mantle removed to show the ciliation and structure of the mantle cavity.





TEXT-FIG. 4.—*Borniola reniformis* (Suter). Right valve and right gill removed to show the structure of the visceral mass.

TEXT-FIG. 5.—*B. reniformis* as last, showing ciliation of the visceral mass and mantle.

TEXT-FIG. 6.—*Mysella unidentata* (Odhner). Dorsal view of the foot.

TEXT-FIG. 7, a-c.—*M. unidentata*. Outline sketches showing the action of the foot.

TEXT-FIG. 8.—*M. unidentata*. Right valve and mantle removed to show the ciliation and structure of the mantle cavity.



Occasionally specimens are found with their mantle cavities full of tiny veligers with a slightly asymmetrical shell, a large velum and a well developed foot. They closely resemble those of *Kellia* (Lebour, 1938) and like that species have a purplish colour en masse. They are packed into the pouch between the two lamellae of the inner demibranch and the visceral mass.

The larvae when placed in a dish of sea water swam quite strongly, rising rapidly to the surface in an open spiral. After a few seconds either swimming rapidly on the surface or gyrating moderately rapidly, they sank passively to, or near, the bottom. They then moved again to the surface or remained on the bottom either passively or moving. All movements were clockwise, the larvae swimming upside down. The eggs are slightly larger than the larvae.

### *Mysella unidentata* (Odhner)

1913. *Rochefortia donaciformis* Suter: Man. N.Z. Moll.: 931, Pl. 54, Figs. 5, a, b. (not of Angas, 1878).  
 1924. *Montacuta unidentata* Odhner: Pap. Mortensen's Pacific Exped. 19: 76, Pl. 2, Figs. 48-51.  
 1926. *Mysella unidentata* (Odhner), Finlay: Trans. N.Z. Inst. 57: 465.

Several specimens of *M. unidentata* were obtained by dredging in about one fathom off Quarantine Island, Dunedin Harbour. The substratum was of fine sandy mud. The bivalve did not appear to be associated with any "host" species, and in fact there was little in the sample apart from small molluscs.

The shell (Fig. 7) is rather thin, smooth, elongate, the anterior end considerably longer than the posterior and it attains a length of 2.8mm. The hinge line is narrow, that of right valve sharp-edged, with one broadly triangular lateral tooth that is strong and cardinal-like. The resilium is deep and short. The left valve has short anterior and posterior lamellae, the former gradually rising to form an elongate lateral tooth.

*External appearance and movement* (Figs. 6, 7): No siphons are visible in the living animal, but the powerful foot (f.) can be extended to a length equal to that of the shell or more. The foot is white, ciliated, rather broad, the anterior end bluntly rounded, with an ill-defined keel in the mid-dorsal position. The posterior-ventral part of the foot has a groove, but there is no sole. The posterior region of the foot is thin laterally, and distinct from the broad anterior part. Movements of the foot (Fig. 7, a-c) include rather limited digging thrusts during which blood moves into the thickened part of the foot causing it to elongate, swell and thus anchor, enabling the shell to be pulled forward. No byssus formation was observed.

*Mantle cavity and ciliary currents* (Fig. 8): There are two demibranchs present, but the outer (o.d.) is only a vestigial narrow strip reflected behind the almost vertical gill axis. The inner demibranch (i.d.) is triangular in shape, and attached to the mantle at the base of the small exhalent aperture (e.). The rest of the mantle edge is open and this aperture serves as both the pedal and inhalent opening. The gill filaments are orientated antero-ventrally, and the frontal cilia pass particles along these to the ventral edge of the gill where a food string is formed. This is passed anteriorly along the food groove to the small palps (l.p.). The ciliation of these structures was not studied in detail but the large particles were seen to be rejected along the length of the opposing faces of each pair. Material rejected from the palps falls on to the mantle where it is swept away by a powerful rejection tract running ventrally to the groove inside the first mantle lobe (m.e.). Waste material is then passed posteriorly for a short distance to a point about halfway along the ventral margin, whence it is rejected to the outside across the mantle lobes. There are no other obvious ciliary tracts on the surface of the mantle.

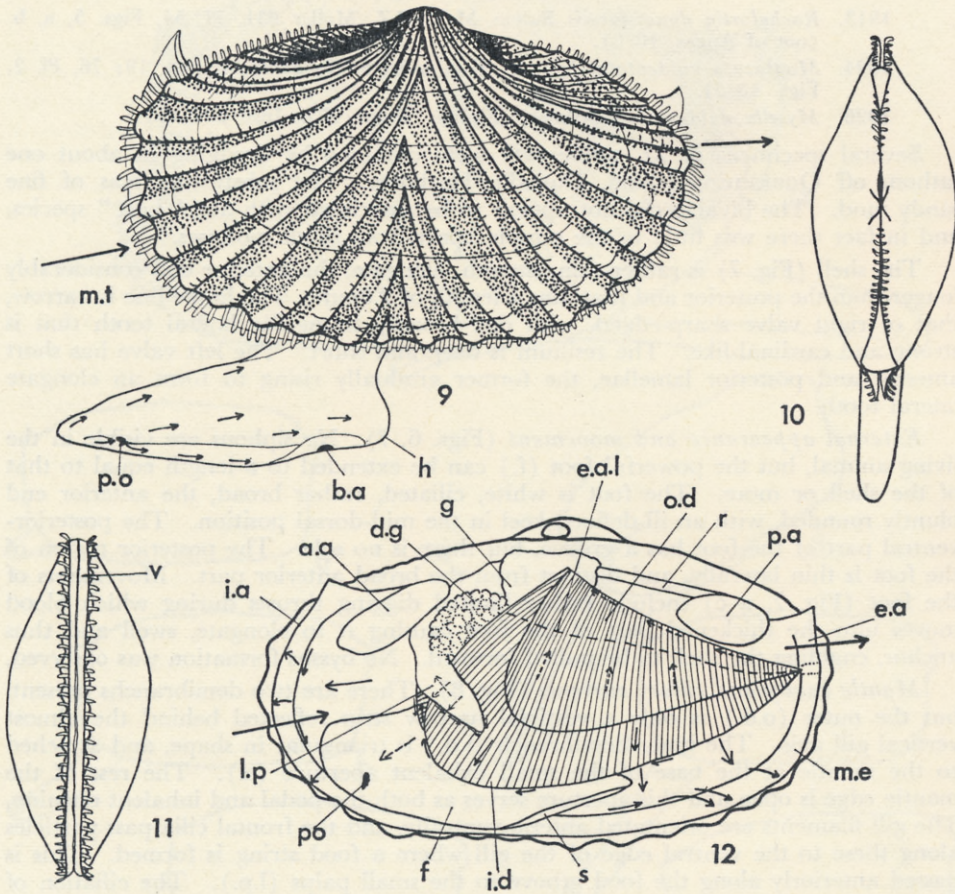
The adductor muscles are unequal in size, the anterior (a.a.) being the larger.



**Myllita (Zemyllita) stowei** (Hutton)1873. *Pythina stowei* Hutton: Cat. Mar. Moll. N.Z.: 76.1913. *Myllita stowei* (Hutton), Suter: Man. N.Z. Moll.: 929, Pl. 54, Fig. 2.1926. *Zemyllita stowei* (Hutton), Finlay: Trans. N.Z. Inst. 57: 464.

*Myllita stowei* is a small bivalve not uncommonly encountered as dead valves in debris on the shore. As a living animal, however, it is very rarely found. It is known from the coasts of both islands but is rather more typical of the North Island.

One living specimen was obtained at Takapuna, Auckland, under a large stone deeply embedded in black, anaerobic sand at low tide. It was attached to the bottom of the stone by a few thin byssal threads and was not closely associated with any other animals.



TEXT-FIG. 9.—*Myllita (Zemyllita) stowei* (Hutton). Lateral view of animal and shell from left side.

TEXT-FIG. 10.—*M. (Z.) stowei*. Dorsal view.

TEXT-FIG. 11.—*M. (Z.) stowei*. Ventral view showing velum.

TEXT-FIG. 12.—*M. (Z.) stowei*. Left valve and mantle removed to show the ciliation and structure of the mantle cavity.



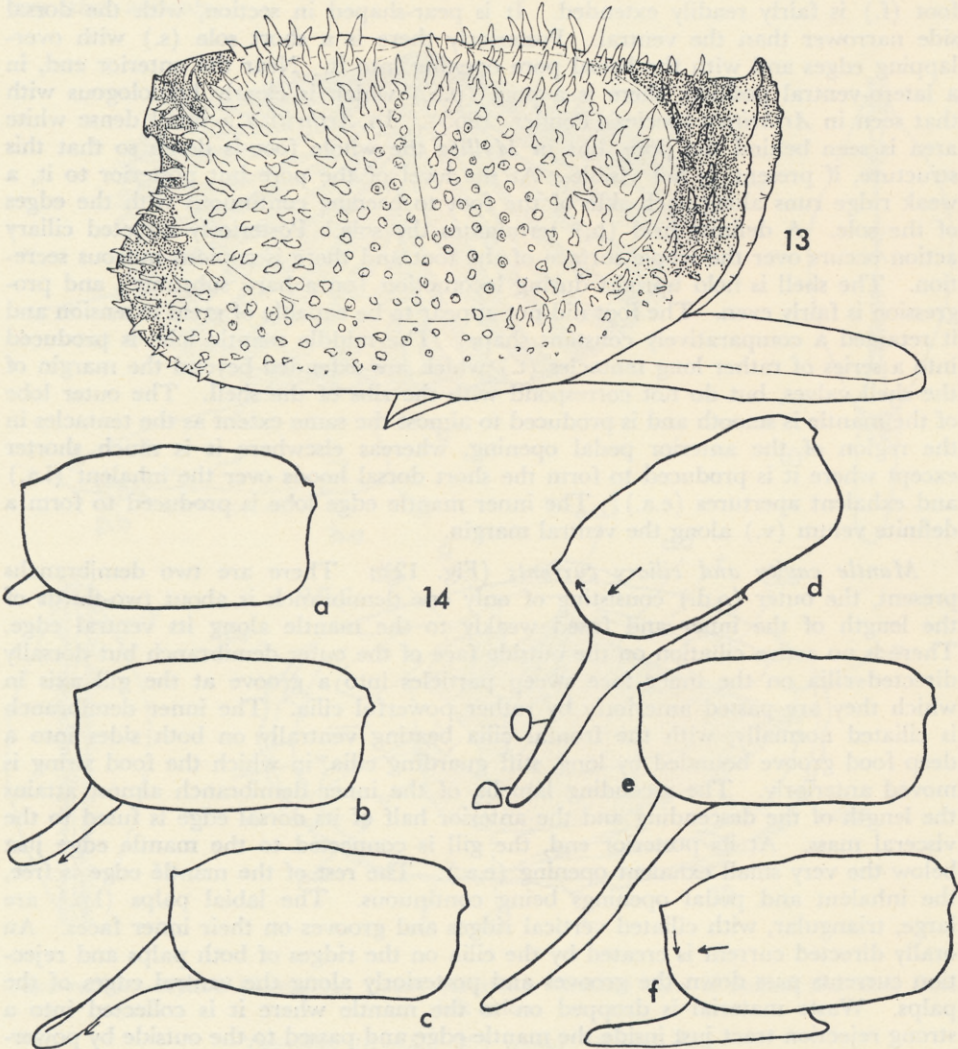
The shell (Fig. 9) is relatively large (up to 13mm long), oval, the anterior end about the same length as the posterior, rather inflated, with about 8–9 strong, divaricating ribs and many fine, radial ribs on the upper part of the shell, all of these crenulating the margin. The ribs are crossed by fine growth lines and the whole surface of the shell is densely punctate. The prodissoconch is very small and smooth. The rather strong hinge has, in front of the umbo in the right valve, a bilobed cardinal which is minutely hooked around a socket which lies just posterior to it. The two very short but strong anterior laterals and two longer posterior laterals both enclose a socket for the corresponding single laterals of the left valve. The cardinal of the left valve is rather thin, but strong. The resilium is strong, extending posteriorly beneath the hinge plate.

*External appearance and locomotion* (Figs. 9–11): The large, white, muscular foot (f.) is fairly readily extended. It is pear-shaped in section, with the dorsal side narrower than the ventral. Posteriorly there is a short sole (s.) with overlapping edges and with the byssal pore opening into it. Near the anterior end, in a latero-ventral position, there is a pore (p.o.) which is clearly homologous with that seen in *Arthritica* species (Ponder, 1965). In *Arthritica* a small dense white area is seen behind the pore, but in *Myllita* the whole foot is dense so that this structure, if present, is not visible. At the level of the pore but posterior to it, a weak ridge runs along each side of the foot to become continuous with the edges of the sole. A definite heel (h.) terminates the sole. Posteriorly directed ciliary action occurs over the whole surface of the foot and there is copious mucous secretion. The shell is held upright during locomotion (on a hard substrate) and progression is fairly even. The foot did not appear to be capable of great extension and it retained a comparatively constant shape. The middle mantle lobe is produced into a series of rather long tentacles (t.) which are extended beyond the margin of the shell valves, but do not correspond with the ribs of the shell. The outer lobe of the mantle is smooth and is produced to almost the same extent as the tentacles in the region of the anterior pedal opening, whereas elsewhere it is much shorter except where it is produced to form the short dorsal hoods over the inhalent (i.a.) and exhalent apertures (e.a.). The inner mantle edge lobe is produced to form a definite velum (v.) along the ventral margin.

*Mantle cavity and ciliary currents* (Fig. 12): There are two demibranchs present, the outer (o.d.) consisting of only one demibranch is about two-thirds of the length of the inner and fused weakly to the mantle along its ventral edge. There is no active ciliation on the outside face of the outer demibranch but dorsally directed cilia on the inner face sweep particles into a groove at the gill axis in which they are passed anteriorly by rather powerful cilia. The inner demibranch is ciliated normally, with the frontal cilia beating ventrally on both sides into a deep food groove bounded by long, stiff guarding cilia, in which the food string is moved anteriorly. The ascending lamella of the inner demibranch almost attains the length of the descending and the anterior half of its dorsal edge is fused to the visceral mass. At its posterior end, the gill is connected to the mantle edge just below the very small exhalent opening (e.a.). The rest of the mantle edge is free, the inhalent and pedal openings being continuous. The labial palps (l.p.) are large, triangular, with ciliated vertical ridges and grooves on their inner faces. An orally directed current is created by the cilia on the ridges of both palps and rejection currents pass down the grooves and posteriorly along the ventral edges of the palps. Waste material is dropped on to the mantle where it is collected into a strong rejection tract just inside the mantle edge and passed to the outside by powerful cilia near the posterior end of the ventral edge. A weaker outward rejection mechanism occurs across the mantle edge at the anterior end and presumably serves to carry away large particles brought in by the inhalent water current. Weak cilia on the mantle opposite the gills carry particles down into the ventral rejection tract.



The ciliation of the visceral mass was not properly observed but appeared to be mainly in a ventral direction. There is active posterior ciliation and mucous secretion over the whole foot (Fig. 9). A short tract of cilia wafts water into the pedal pore (p.o.). The wide, velum-like (v.) flap on the ventral part of the mantle edge probably serves to prevent particles clogging the mantle cavity unduly when the shell is gaping during feeding. Though the gape is not extensive, the velum serves to more or less completely close off the ventral part of the animal, leaving only the inhalent and exhalent openings and the region of rejection at the posterior end, open. Other species have achieved the same advantage by having a permanent gape in the anterior and posterior parts of the shell which means they are open to predation (e.g., *Scintilla*) but *Myllita* can close the shell completely if disturbed.



TEXT-FIG. 13.—*Scintilla stevensoni* Powell. Lateral view of animal from right side.

TEXT-FIG. 14, a-f.—*S. stevensoni*. Outline sketches showing the action of the foot.



The anatomy appears to be typical of other leptonaceans. The adductor muscles are subequal and rather large. The small prodissoconch suggests that the young are not liberated at a late stage in development.

### *Scintilla stevensoni* Powell

1932. *Scintilla stevensoni* Powell: Proc. Malac. Soc. (London) 20: 65, Pl. 6, Fig. 2.

About four dozen specimens of this rather rare species were found in a crevice at low water, Goat Island Beach, Leigh, in early June. They were aggregated on the upper surface of the horizontal, rather open crevice with a few encrusting sponges, polyzoans and tunicates. Each bivalve was attached by one or a few byssal threads. The habit and animal of this species is similar to that of *Galeomma turtoni* Sowerby (Popham, 1940).

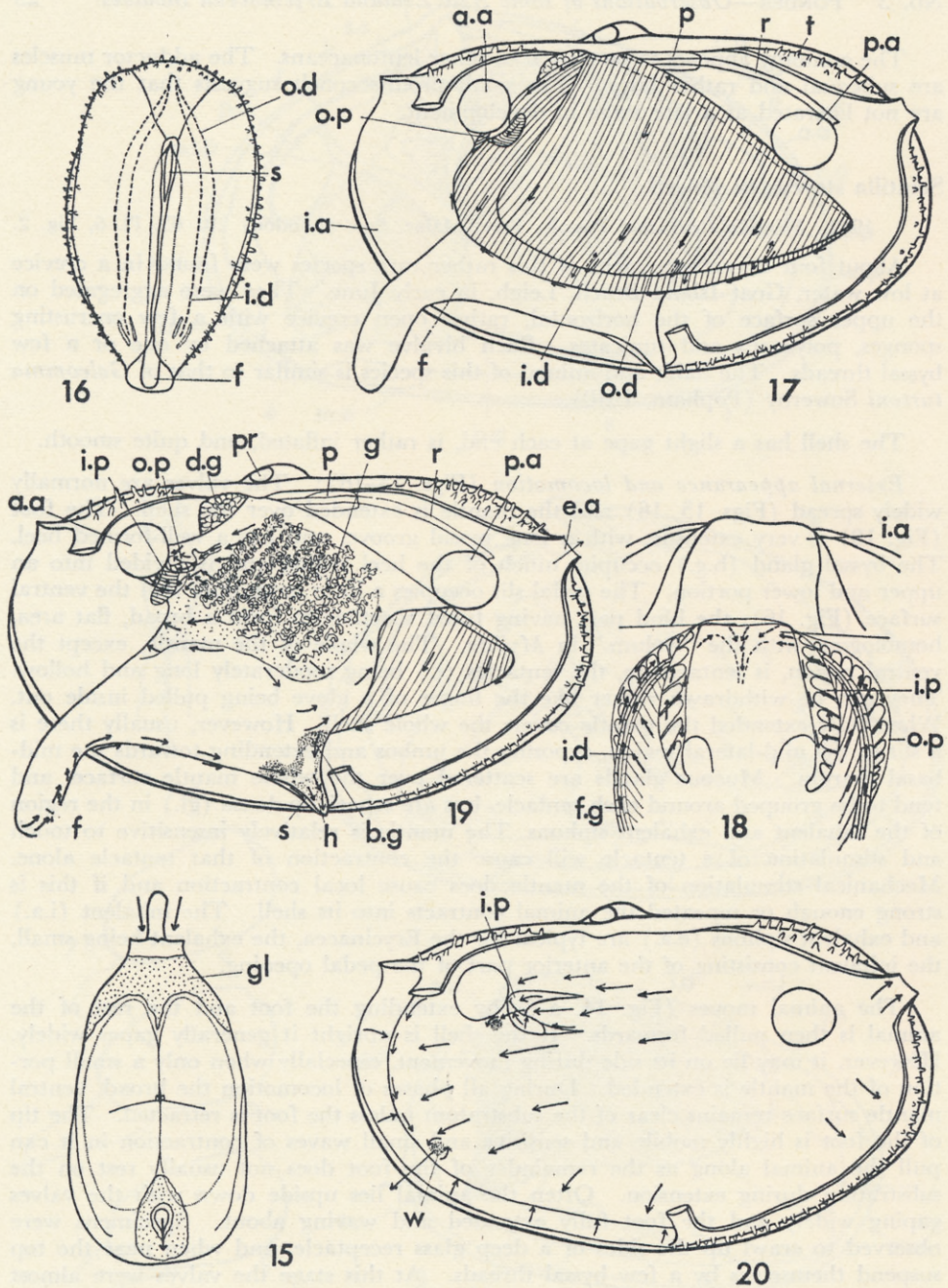
The shell has a slight gape at each end, is rather inflated, and quite smooth.

*External appearance and locomotion* (Figs. 13–16): The valves are normally widely spread (Figs. 15, 16) and the mantle is extended over the shell. The foot (Fig. 19) is very extensile, with a long byssal groove, and has a well-formed heel. The byssal gland (b.g.) occupies much of the heel region and is divided into an upper and lower portion. The pedal slit occupies a little more than half the ventral surface (Fig. 16), the hind part having fused together to form a broad, flat area, homologous with the "velum" in *Myllita*. The whole of the mantle, except the ventral region, is tentaculate, the tentacles (t.) being moderately long and hollow. They can be withdrawn rather like the finger of a glove being pulled inside out. When fully extended the mantle covers the whole shell. However, usually there is a slit in the mid-lateral region, exposing the umbos and extending towards the mid-basal margin. Mucous glands are scattered over the whole mantle surface, and tend to be grouped around each tentacle, but are especially dense (gl.) in the region of the inhalent and exhalent siphons. The mantle is relatively insensitive to touch and stimulation of a tentacle will cause the contraction of that tentacle alone. Mechanical stimulation of the mantle does cause local contraction and if this is strong enough or repeated the animal contracts into its shell. The inhalent (i.a.) and exhalent siphons (e.a.) are typical for the Erycinacea, the exhalent being small, the inhalent consisting of the anterior part of the pedal opening.

The animal moves (Fig. 14, a–f) by extending the foot and the rest of the animal is then pulled forwards. If the shell is upright it generally gapes widely. However, it may lie on its side during movement, especially when only a small portion of the mantle is extended. During all phases of locomotion the broad, ventral mantle surface remains clear of the substratum unless the foot is retracted. The tip of the foot is highly mobile and sensitive and small waves of contraction in it can pull the animal along as the remainder of the foot does not usually rest on the substratum during extension. Often the animal lies upside down with the valves gaping widely and the foot fully extended and waving about. Specimens were observed to crawl up the sides of a deep glass receptacle, and when near the top suspend themselves by a few byssal threads. At this stage the valves were almost closed, the mantle retracted to the border of the shell, and the foot withdrawn with the sides of the pedal opening overlapping. The siphons were still partially extended as feeding continued normally. An exactly similar situation was seen in *Galeomma* by Popham (1940). These molluscs move away from light and seem to prefer clumping together.

Juveniles look very similar, except that they have far fewer tentacles which are relatively larger. The mantle has strong retractor muscles which are clearly visible in juveniles.





TEXT-FIG. 15.—*S. stevensoni*. Dorsal view.

TEXT-FIG. 16.—*S. stevensoni*. Ventral view.

TEXT-FIG. 17.—*S. stevensoni*. Left valve and mantle removed to show the ciliation of the gills and the structure of the mantle cavity.

TEXT-FIG. 18.—*S. stevensoni*. Ventral view of the labial palps showing ciliary mechanisms.

TEXT-FIG. 19.—*S. stevensoni*. Left valve and gills removed to show the structure and ciliation of the visceral mass.

TEXT-FIG. 20.—*S. stevensoni*. Ciliation of the mantle.



*Mantle cavity and ciliary currents* (Figs. 17–20): Of the two demibranchs present (Fig. 17), the outer (o.d.) is a little smaller and both have two lamellae. Ciliation of the gills is typical of the Galeommatidae. Ciliary currents pass down the filaments to the ventral food groove on the inner demibranch, while on the outer they pass ventrally on the ascending lamella, under the free edge, and so dorsally to an orally directed current between the demibranchs. Long, stiff guarding cilia are present on the edges of the food groove of the inner demibranch. The palps (l.p.) have normal ciliation (Fig. 18), are moderate in size and relatively mobile, food passing across the ciliated ridges of their inner faces to the broad mouth where the closely adpressed lips prevent large particles from entering. The visceral mass (Fig. 19) is rather weakly ciliated, particles passing dorsally in the posterior region, and then anteriorly. An especially strong ventrally directed current occurs on the visceral mass just behind the inner palp. A ciliary tract along the ventral part of the foot passes material posteriorly to be rejected at the heel. The ciliation of the mantle (Fig. 20) is anteriorly directed, waste particles being collected in the lower part of the inhalent siphon. From here it is rejected forcibly from time to time by rapid closing of the valves. Some material was observed being expelled from the exhalent aperture, but this was probably faecal matter.

There was no rejection tract at the posterior end of the pedal aperture which is contrary to the condition seen in *Scintillona* (Morton, 1957) and *Galeomma* (Popham, 1940).

The adductor muscles (p.a., a.a.) are about equal in size, round and small.

#### DISCUSSION

The most detailed account of the functioning of the erycinacean mantle cavity is that of Popham (1940). The New Zealand species described here follow the general pattern of anterior water intake, efficient mobility, temporary byssus fixation and reduction of the outer demibranch. Efficient cleansing mechanisms are of vital importance to these small animals because of the danger of the food collecting ciliary currents clogging up.

The rudimentary outer demibranchs seen in *Borniola* and *Mysella* suggest that these species are intermediate between the Erycinidae and the Montacutidae of Pelseneer (1911) which are based on whether there are one or two demibranchs present. This question will be discussed in detail elsewhere, though there appears to be little reason for separating these two families. *Scintilla* and *Myllita* have certain features in common including the tentaculate mantle, and moderately large outer demibranch, but the shells are rather different. *Galeomma turtoni* Sowerby (Popham, 1940) is very like *Scintilla* while *Myllita* is anatomically like *Arthritica* (Ponder, 1965).

*Mysella bidentata* (Montagu) (Popham, 1940) is close to *M. unidentata* in general appearance and anatomy except that there is no trace of an outer demibranch in the British species. The short, blunt papillae on the mantle edge of this species recalls those of *Borniola* while the hinge and weak radial striae of *M. bidentata* are also reminiscent of *Borniola*.

#### ACKNOWLEDGMENTS

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## ABBREVIATIONS USED IN FIGURES

a.a., anterior adductor; a.p.r., anterior pedal retractor muscle; b.a., byssus aperture; b.g., byssus gland; c.g., cerebral ganglion; c.p., base of palp; d.g., digestive gland; e.a., exhalant aperture; e.a.l., edge of ascending lamella of inner demibranch; f., foot; f.g., food groove; g., gonad; g.a., gill axis; gl., glandular area; h., heel; i.a., inhalant aperture; i.d., inner demibranch; i.p., inner palp; k., renal organ; l., lip; m., mouth; m.e., mantle edge; o., oesophagus; o.p., outer palp; p., pericardium; l.p., labial palp; p.a., posterior adductor; p.o., pedal pore; p.p., pedis protractor muscle; p.r.p., posterior pedis retractor muscle; pr., prodissoconch; r., rectum; s., sole of foot; s.s., style sac; st., stomach; t., tentacle; w., waste material.

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