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Anatomical Notes on Two Species of the Colubrariidae  
(Mollusca, Prosobranchia)

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*Abstract*

THE anatomy of *Ratifusus mestayerae* (Iredale) and *Iredalula striata* (Hutton) indicates that the Colubrariidae is a distinctive family belonging to the Buccinacea. Unusual features of the alimentary canal are a very long stomach, a large non-introvertible proboscis sac in which lies the long, slender, coiled proboscis and the swollen mid-oesophagus with very glandular walls. The radula is relatively minute and rachiglossan.

INTRODUCTION

THE systematic position and status of the Colubrariidae Dall, 1904 has never been satisfactorily settled. Cernohorsky (1967, p. 326) has outlined some of the taxonomic history of the genus *Colubraria* Schumacher, 1817 as follows: "Schepman (1913) and Demond (1957) assigned it to the Buccinacea, Iredale (1929) to the Fusidae (synonym of the Colubrariidae), Kuroda and Habe (1952) retained the genus in the Cymatiidae and Thiele (1929) assigned *Colubraria* as a section of *Charonia* Gistel, 1848 with a query" (see Cernohorsky for references). In addition Wenz (1941) places the genus in the Cymatiidae and Dall (1904) suggests rachiglossate affinity.

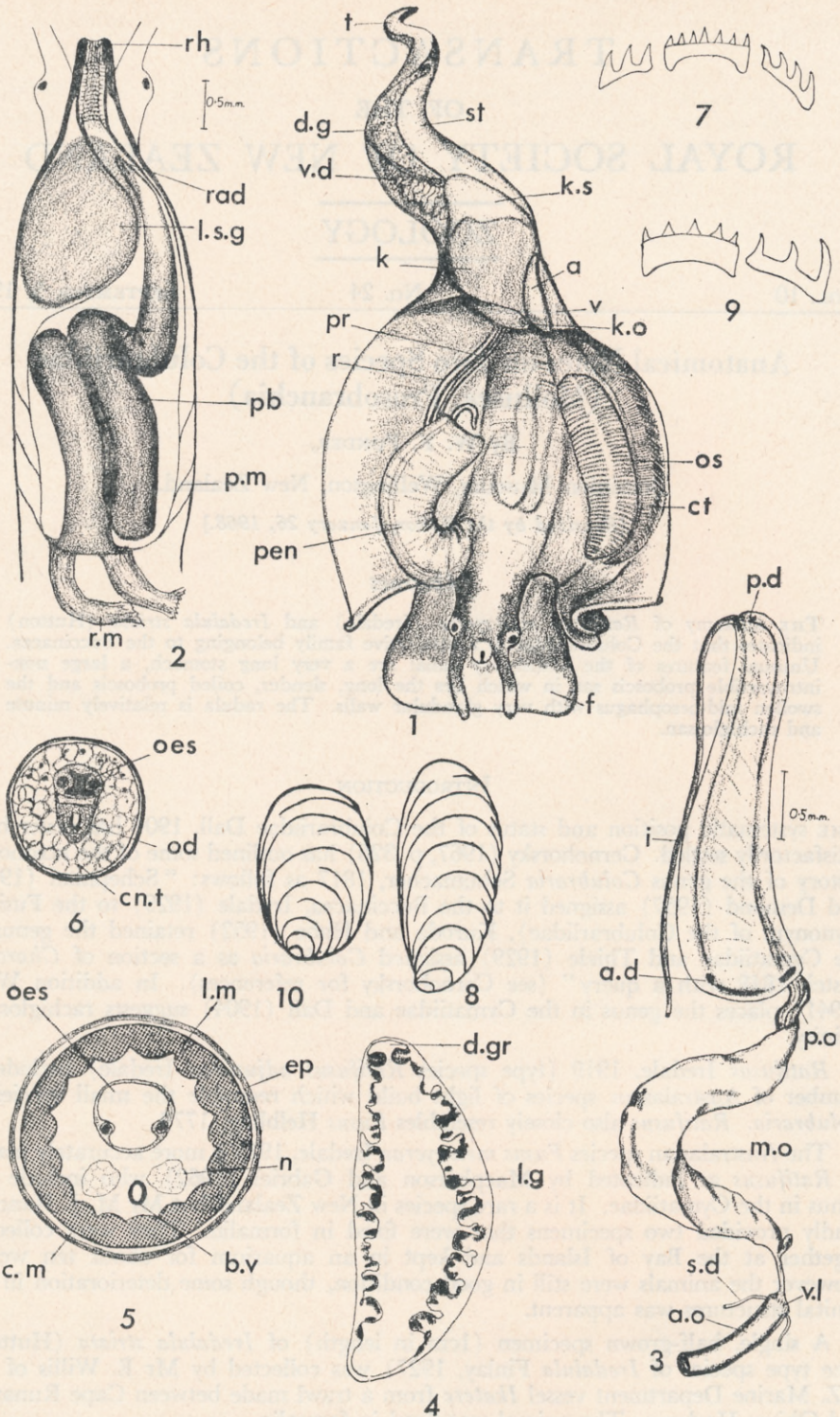
*Ratifusus* Iredale, 1919 (type species *Ratifusus adjunctus* Iredale) includes a number of Australasian species of light build which resemble the small species of *Colubraria*. *Ratifusus* also closely resembles *Fusus* Helbling, 1779.

The Australasian species *Fusus mestayerae* Iredale, 1915 is more accurately placed in *Ratifusus* as indicated by Macpherson and Gabriel (1962) who include the genus in the Cymatiidae. It is a rare species in New Zealand but Mr M. J. Hancock kindly provided two specimens that were fixed in formalin. They were collected together at the Bay of Islands and kept in an aquarium for about ten weeks. However the animals were still in good condition, though some deterioration in the genital structures was apparent.

A single, half-grown specimen (1cm in length) of *Iredalula striata* (Hutton) (the type species of *Iredalula* Finlay, 1927) was collected by Mr E. Willis of the N.Z. Marine Department vessel *Ikatere* from a trawl made between Cape Runaway and Ohiwa Harbour. The animal was fixed in formalin.

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*Ratifusus mestayerae* (Iredale)—Fig. 1.—Male with mantle cavity opened; Fig. 2.—Diagrammatic dorsal view of retracted proboscis and proboscis sac; Fig. 3.—The oesophagus, stomach and intestine. The stomach is shown opened along the mid-dorsal line; Fig. 4.—Transverse section through the mid-oesophagus; Fig. 5.—Transverse section of the middle region of the proboscis; Fig. 6.—Transverse section near the distal end of the proboscis; Fig. 7.—Radula; Fig. 8.—Operculum.

*Iredalula striata* (Hutton)—Fig. 9.—Radula; Fig. 10.—Operculum.

ABBREVIATIONS USED IN FIGURES—a.—auricle; a.d.—anterior digestive gland opening; a.o.—anterior oesophagus; b.v.—blood vessel; c.m.—circular muscle layer; cn.t.—connective tissue; ct.—ctenidium; d.gr.—dorsal groove; d.g.—digestive gland; ep.—epithelium; f.—foot; i.—intestine; k.—renal organ; k.o.—renal opening; k.s.—renal sac; l.g.—lateral glandular area; l.m.—longitudinal muscle; l.s.g.—left salivary gland; m.o.—mid-oesophagus; od.—odontophore; oes.—oesophagus; os.—osphradium; pb.—proboscis; p.d.—posterior digestive gland opening; p.m.—protractor muscle; p.o.—posterior oesophagus; pr.—prostate; r.—radula; rh.—rhynchostome; r.m.—retractor muscle; s.—siphon; s.d.—salivary duct; st.—stomach; t.—testis; v.—ventricle; v.d.—vas deferens; v.l.—valve of Leiblein.

With the small amount of material available no complete anatomical investigation could be made. The proboscis, oesophagus and salivary glands of *Ratifusus mestayerae* were sectioned and stained with Mallory's triple stain.

### *Ratifusus mestayerae* (Iredale)

- 1855. *Pisania reticulatus* A. Adams Proc. Zool. Soc., 1854: 138.
- 1913. *Pisania reticulatus* A. Adams: Suter Man. N.Z. Moll., 392, Pl. 45, fig. 12.
- 1915. *Fusus mestayerae* Iredale; Trans. N.Z. Inst., 47: 466 (new name for *Fusus reticulatus* A. Adams not of Blainville).
- 1962. *Ratifusus mestayerae* (Iredale) Macpherson and Gabriel, Marine Molluscs of Victoria, 158, fig. 189.

### GENERAL APPEARANCE

The short snout, large foot and rather long tentacles are reddish-brown on their upper surfaces, while the rest of the animal is white. The small, yellow operculum (Fig. 8) has a terminal nucleus and would not be fully functional in closing the shell aperture.

The animal removed from its shell (Fig. 1) shows the usual stenoglossan pallial organs. A large, brown osphradium (os.) below, and to the left of, the somewhat larger ctenidium (ct.) is readily seen through the roof of the mantle cavity. No conspicuous hypobranchial gland is present, though this is probably due to the condition of the material. Behind the large mantle cavity, and on the left, is the white heart (a. v.) while on the right is the pale brown renal organ divided into an anterior glandular half (k.) and a posterior thin-walled sac (k.s.). The conspicuous, long stomach (st.) dominates the next portion of the visceral mass. Alongside the stomach, and continuing above it is the brown digestive gland (d.g.) which, together with the gonad (t.), make up the uppermost portion of the visceral coil.

### THE ALIMENTARY CANAL

The reddish-brown proboscis (pb.) lies coiled up in the proboscis sac (Fig. 2) when retracted and is visible through the thin roof of the body cavity. It is elongate and tapers only gradually to an almost pointed tip. There is a short, white anterior portion which lies, when retracted, in the narrow, weakly muscular anterior part of the proboscis sac. This is pushed to the right by the left salivary gland (l.s.g.). Behind the salivary glands the proboscis sac is spacious and has membranous walls. Only a narrow strip of pigmented, muscular wall surrounding the base of the proboscis could possibly be introverted. Over most of its length (Fig. 5) the proboscis wall is composed of a very loose inner layer of longitudinal fibres (l.m.) and a very narrow, elastic, circular muscle layer (c.m.) beneath the cuboidal, pigmented epithelium. The proboscis cavity contains the oesophagus (oes.), which is not connected to the proboscis wall, a pair of large ventral nerves (n.) and, below these, a median artery (b.v.) with relatively thick, muscular walls. Near the distal end of the proboscis (Fig. 6) the proboscis cavity contains a mass of connective tissue (cn.t.) and, while the outer wall has only a few longitudinal

fibres, the circular layer is unchanged. The tiny odontophore, with a single thickness of cartilage cells on each side, is surrounded by a thin muscular sheath. The minute radula, no longer than the odontophore protrudes into the oral cavity which is barely distinguishable from the rest of the oesophagus. A radular protractor muscle lies in front of the odontophore and a retractor behind. The salivary ducts, lying in the wall of the oesophagus, become swollen and slightly convolute just before they terminate in front of the odontophoral aperture.

The radula (Fig. 7) is very minute, being only 0.3mm in length, but is of the typical rachiglossan pattern. The radula mounted had four cusps on one lateral and three on the other. The broad central tooth is  $10\mu$  in width and has a pair of basal flanges and seven cusps of nearly even height, the median one slightly larger.

The proboscis sac opens at a slit-like rhynchostome (rh.) situated on a short snout. The rhynchostome is surrounded by a sphincter muscle and is longitudinally ridged internally. Immediately behind the sphincter there are thick annular folds but these terminate just behind the eyes where the proboscis sac wall becomes thinner. A pair of powerful retractor muscles (r.m.) is situated at the base of the proboscis sac just above the end of the introvert. A few, weak, protractor muscle (p.m.) strands lie along the sides of the proboscis sac, but they can be of little functional significance apart from attaching it to the body wall against which it is closely applied on both sides.

The left salivary gland lies above the proboscis sac and the right is below. The glands are compact, white bodies in which islands of purple staining cells lie in an otherwise uniform mass of weakly staining cells; both types having granular contents. The salivary ducts (s.d.) are very narrow, ciliated, a short portion being free before they enter the wall of the anterior oesophagus in front of the nerve ring. The anterior oesophagus (a.o.) is a transparent tube with a pair of lateral internal ridges containing the salivary ducts. These ridges (the dorsal folds) are covered with a non-ciliated pavement epithelium unlike the short columnar cells lining the rest of the oesophageal wall. A very thin circular muscle coat surrounds the oesophagus externally. Immediately behind the point of entry of the salivary ducts a slight swelling with a transverse band of columnar gland cells indicates the valve of Leiblein (Fig. 3, v.l.) and marks the beginning of the mid-oesophagus. The very narrow portion of the mid-oesophagus which passes through the nerve ring is internally ridged and slightly glandular but it expands behind into a wide, somewhat flattened, white, glandular structure (m.o.). A minute caecum-like portion of this glandular section is cut off where the visceral nerve passes over the oesophagus. In section (Fig. 4) the glandular portion of the mid-oesophagus is almost oval, flattened on the inner side, and has a dorsal, non-glandular groove (d.gr.) lined with a non-ciliated cuboidal epithelium. This groove is bordered by a pair of inconspicuous ridges, the remnants of the dorsal folds. At the point where the glandular region commences the dorsal groove appears to be ventral in position, but it swings dorsally a little further posteriorly where it remains through the remainder of the mid-oesophagus. However, it is not possible to be entirely certain of this observation as some of the sectioned material was cut obliquely. There is in addition a broad, ciliated, mostly non-glandular channel ventrally. The lateral walls (l.g.) are lined with irregular folds and these bear short, red staining and mucoid gland cells and ciliated cells. There is no trace of a gland of Leiblein. The anterior portion of the glandular part of the mid-oesophagus lies beneath the proboscis sac but it is displaced to the left by the right salivary gland. It then curves to the right and emerges behind the proboscis sac where it passes dorsally to the left side. At this point the longitudinally ridged, non-glandular posterior oesophagus (p.o.) begins. This section of the oesophagus is broad and short and connects with the left side of the anterior end of the stomach.

The long, thin-walled stomach tapers slightly towards its posterior end where the very narrow intestine emerges. The stomach walls are not conspicuously ridged internally, though an ill-defined groove emerges from the oesophagus. Opposite the oesophageal opening, also at the anterior end of the stomach, is the tiny anterior digestive gland opening (a.d.), while the posterior opening (p.d.) lies just in front of the intestinal sphincter. The rest of the stomach is simple in structure, though around the intestinal aperture the walls thicken and presumably form a sphincter. The very narrow intestine (i.) runs beneath the upper edge of the stomach and then below the kidney to the right mantle wall. There is no anal gland. Lying beneath the stomach are the two lobes of the digestive gland. The anterior lobe lies beneath the majority of the stomach while the posterior lobe is below the gonad on the rest of the visceral coil and the posterior end of the stomach. They are connected to the stomach by small, simple apertures, there being no indication of the tubular ducts usually found in the *Rachiglossa*.

#### REPRODUCTIVE ORGANS

The female has a short ovary containing large, yolky eggs and the oviduct is a delicate, straight tube which runs down the columellar side of the visceral coil. This joins with the pallial oviduct on which no posterior accessory structures could be determined. The glandular pallial duct is long and uniform, but rather narrow for most of its length. At its distal end a bulb-like bursa-copulatrix with a vagina passing beneath it can be discerned. The oviduct opens beneath a flap of tissue and encloses a groove between itself and the pallial wall, which runs to the mantle edge.

The testis (Fig. 1, t.) lies above the digestive gland and commences just behind the stomach. A convoluted, swollen, white tube, the vas deferens (v.d.) which functions as a seminal receptacle, lies on the columellar side of the visceral mass. The renal portion of the vas deferens is a muscular tube which separates the upper and pallial portions of the male duct. There is no prostate gland, only a narrow duct (pr.). The large penis (pen.) is attached behind the right eye; it is flattened, parallel-sided and has a terminal filamentous portion.

#### *Iredalula striata* (Hutton)

1873. *Bela striata* Hutton; Cat. Tert. Moll.: 5.

1913. *Mitromorpha striata* (Hutton); Suter; Man. N.Z. Moll.: 488, Pl. 46, fig. 27.

1926. *Iredalula striata* (Hutton), Finlay; Trans. N.Z. Inst., 56: 231.

The general appearance and anatomy of the alimentary canal are essentially like that of *Ratifusus*. The proboscis sac is a little more elongate and narrower with the mid-oesophagus visible alongside it on the left for most of its length. The protractor muscles occur about halfway along, the posterior half of the sac being more muscular and presumably forming part of the introvert. The radula (Fig. 9) resembles closely that of *Ratifusus*, the lateral has three cusps and the broad central has five. Unlike *Ratifusus* the stomach wall is thickened, with internal, transverse ridges above and below. However, the other features of the stomach are nearly identical to those of *Ratifusus*.

The stomach lumen contained a dark greenish-brown mass of amorphous material which possibly represented coagulated liquid food. There was little faecal material and this was not compacted into firm pellets. A white hypobranchial gland covered the pallial cavity roof. The operculum (Fig. 10) is relatively broader than that of *Ratifusus* but otherwise is similar.

## DISCUSSION

The shells of *Ratifusus mestayerae* and typical *Colubraria* species are so similar that there can be little doubt that they are closely allied. Common features are: the fusiform shape with the spire higher than the aperture and with numerous convex whorls; discontinuous varices; sculpture of close spiral and axial ridges becoming granular at their points of intersection; the rather small aperture which is denticulate within (only outer lip denticulate in *Ratifusus*); the short, open, recurved canal, and the minute protoconch of two smooth, rather depressed whorls.

*Iredalula* has a similar shell outline, protoconch and build, but has no varices, the aperture has no denticles and spiral ornament is the only sculpture.

The protoconch of the Colubrariidae is a type not encountered in the Cymatiidae but like that family it is of a size and form that could be associated with a free swimming larval stage. All Buccinidae, as far as is known, have a direct development.

Essential buccinacean features shown by *Ratifusus* and *Iredalula* are: the simple salivary glands with the ducts not passing through the nerve ring; the long proboscis; multicusped lateral radular teeth; a simple prostate with no massive glandular development, and poorly developed valve of Leiblein.

On the other hand several anatomical features separate the Colubrariidae from the rest of the Buccinacea. These include: a thin, non-invaginate proboscis sac in which the retracted proboscis is convolute; a vestigial radula; a glandular mid-oesophagus with no separate gland of Leiblein; a very long stomach with no caecum and the opening of the very narrow intestine posterior to the oesophagus.

The reticulate sculpture and varices on the shell of typical members of the group (*Colubraria*, *Ratifusus*, *Fusus*, etc.) are also distinctive features of the family. Genera such as *Iredalula*, however, resemble the other members of the family in general appearance only, there being no varices nor reticulate sculpture. It is these non-distinctive members of the family that will prove difficult to place without anatomical evidence.

The absence of a gland of Leiblein may be compensated for by the excessive glandular development of the mid-oesophagus. This region of the oesophagus is normally well supplied with gland cells in the Rachiglossa so that the hyperdevelopment of this structure in *Ratifusus* is a change in degree rather than kind. Only one other buccinacean, *Melongena melongena* Linné (Vanstone, 1894), is known to have lost the gland of Leiblein.

Very little is known about the biology of the Colubrariidae. They are rarely collected alive so that they would be a difficult group on which to make field observations. The minute radula and tiny mouth suggest some form of suctorial feeding, with the muscular proboscis wall presumably used as a pump. The amorphous food material observed in the gut of *Iredalula* supports this conception. The absence of a gland of Leiblein may possibly be correlated with a semi-liquid diet as the enzymes of that gland generally cause the initial breakdown of solid food.

The determination of further members of the Colubrariidae will be difficult as the radula is not particularly distinctive apart from its relatively minute size.

The shell features of the Colubrariidae and Buccinidae appear to intergrade though this is probably only superficial. Clearly anatomical information on more species and genera is required before a detailed analysis of the generic composition of the family can be undertaken.

## ACKNOWLEDGMENTS

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