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The Genus *Pterynotus* Swainson (Gastropoda, Family Muri-  
cidae) in New Zealand and Norfolk Island.

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*Abstract*

THE Indo-Pacific genus *Pterynotus* (s. str.) first appears in the Lower Miocene of New Zealand (Otaian Stage) where it is represented by *P. kauparaensis* n.sp. and persisted in the Middle Miocene (*P. laetificus* Finlay). The subgenus *Pterochelus* also occurred for the first time in the Lower Miocene (*P. (Pterochelus) awamoanus* Finlay, Awamoan Stage). A south-east Australian species *P. (Pterochelus) angasi* (Crosse) colonised the North Island in interglacial periods of the Nukumaruan and Castleciffian (*P. (Pterochelus) angasi powelli* n. subsp.) and persists in the Recent fauna of Northland (*P. (Pterochelus) angasi eos* (Hutton)). Another species of *Pterochelus*, *P. (Pterochelus) zealandicus* (Hutton), superficially (but convergently) resembling African species classed in *Poropteron*, colonised New Zealand briefly during the Castleciffian interglacial and now persists at Norfolk Island (*P. (Pterochelus) zealandicus iredalei* n. subsp.), where it is accompanied by a further species of *Pterynotus*, *P. norfolkensis* n. sp. for which a new subgenus *Nothotyphis* is proposed, to include in addition *Murex robustus* Verco (South Australia) and *M. (Typhis) wenzelidesi* Hörmes (Vienna, Miocene). The New Zealand and Norfolk Island forms and type species of the genera and subgenera discussed are figured.

INTRODUCTION

THE Indo-Pacific warm water gastropod *Pterynotus* is rare as a Tertiary fossil in New Zealand, but its early Pleistocene representatives are not uncommon, and a single form persists in the fauna of North Auckland. The present study arose from the discovery that one of the early Pleistocene species, *P. zealandicus*, hitherto considered endemic, and lacking close relatives in the fossil and Recent faunas of Australia, persists as a subspecies (here described as new) at Norfolk Island, 500 miles north-west of New Zealand (Fleming, 1961). Description of this interesting novelty led to review of all available material from New Zealand and Norfolk Island.

I am grateful to Dr R. K. Dell, Dominion Museum, and to Mr W. Paul, Wellington, for making available New Zealand and overseas material, to Dr R. Tucker Abbott, Philadelphia Academy of Sciences, for a specimen of the type



species of *Pterynotus*, and to Dr A. W. B. Powell, Auckland War Memorial Museum, for lending the type of *P. laetificus* Finlay for figuring. Professor A. Myra Keen, Stanford University, California, kindly supplied data on American species of *Tripterotyphis*.

#### Genus PTERYNOTUS Swainson

1833. Zool. Illust. (2) 3, Pl. 100.

TYPE SPECIES (by monotypy): *Murex pinnatus* Swainson 1822 (see Fig. 20). Recent, China Seas.

The generic name *Pterynotus* (of which *Pteronotus* is a subsequent spelling, see Cox, 1948) has found general acceptance for Muricidae with 3 winged varices (e.g., Abbott, 1954; Keen, 1958; Hall, 1959). The type species (Fig. 20) is a specialised form with curved divergent siphonal canals corresponding to successive variceal stages, and with complicated spiral sculpture. The sectional or sub-generic names *Pteropurpura* Jousseaume (type: *Murex macropteron* Deshayes) and *Purpurellus* Jousseaume (type: *Murex gambiensis* Reeve) have therefore been used by some authors for shells more closely resembling the New Zealand fossil species here attributed to *Pterynotus* s. str. Finer supraspecific divisions are desirable in this large and diverse group, if they can be applied to give a consistent phylogenetic story, but the evidence presented below (under *Pterochelus*) suggests that some of the morphological characters used for recognition of such finer divisions have been developed independently in different lineages, so that a comprehensive study of fossil and living species is a pre-requisite for the recognition of related groups. Some progress along these lines has been made by recognition of the subgenera *Centrifuga* Grant and Gale and *Calcitrapessa* Berry, in the eastern Pacific, and of *Pterochelus* Jousseaume in the western Pacific. It has proved more difficult to confirm the use, for Australasian species, of *Poropteron* Jousseaume (type: *M. uncinarius* Lamarck).

#### Subgenus PTERYNOTUS s. str.

Muricidae with three winged or expanded varices, the outer lip and varix not interrupted by a spinous and deeply channelled adapical digitation.

Cossmann (1903: 18, 21) distinguished this group (under the name of *Pteropurpura* Jousseaume) from *Pterochelus* (under the name of *Alipurpura* Bayle) by its polygyrate, pointed conical protoconch, with a weakly deviated nucleus, in contrast with the paucispiral protoconch, with papillose nucleus, in the latter. This distinction has not been found consistent in the species examined by the writer.

#### *Pterynotus* (*Pterynotus*) *kaiparaensis* Fleming n. sp. (Plate 1, fig. 1)

1918. *Murex angasi* Crosse; Suter, in Marshall, Trans. N.Z. Inst. 49: 447 (also 1918, *Ibid.* 50: 274) (not of Crosse).

?1944. *Pteronotus* cf. *laetificus* Finlay; Laws, Trans. roy. Soc. N.Z. 73: 310.

Shell fairly small, narrowly fusiform, the three varices spaced and continuous from whorl to whorl, following a somewhat spiral course from apex to base. Protoconch damaged. Spire whorls weakly shouldered just below middle, with a smooth, rounded spiral thread at the periphery, two weaker spirals on the shoulder and another just above suture, body whorl with 3 additional spirals on base, spiral threads continuing on to backs of variceal frills. Axial sculpture of three spaced ribs between each pair of varices, nodulated where crossed by the spiral threads, dying out on upper shoulder and on base. Aperture narrowly oval, leading to a long, narrow, straight, open canal, apparently not denticulate, but with fine imbricate lamellae on front of varix.



HEIGHT: 28 mm, width across last two varices, 14 mm (holotype).

HOLOTYPE: New Zealand Geological Survey, TM 3079.

LOCALITY: Pakaurangi Point, Kaipara Harbour, coll. P. Marshall, 1916 (?).

AGE: Otaian Stage (Lower Miocene).

REMARKS: The holotype is accompanied by a label in Suter's handwriting. The fragmentary body whorl recorded by Laws (1944) from the same locality, has not been examined. *P. kaiparaensis* differs from *P. laetificus* in having three axial cords between varices instead of a single axial tubercle, in its smaller size and in its fewer spiral threads. Most species of *Pterynotus* (including species sometimes separated as *Pteropurpura*) have a single intervariceal axial tubercle; three axials have been noted in the species figured as *P. tortuosus* (Sowerby) from the Vienna Miocene (Hörnes, 1856, Pl. 25, fig. 12) which, however, is a much larger shell with a posterior channel interrupting the outer lip, and therefore classed in *Pterochelus* by Sieber (1958).

***Pterynotus* (*Pterynotus*) *laetificus* Finlay (Plate 1, figs. 2-8)**

1930. *Pteronotus* (s. str.) *laetificus* Finlay, Trans. N.Z. Inst. 61: 76.

1931. *Pteronotus* n. sp., Marwick, N.Z. geol. Surv. Palaeont. Bull. 13: 118, Pl. 12, fig. 226.

Finlay's holotype, recorded as from "Clifden, band 7 C, close to band 8" is a battered and fragmentary body whorl of a large specimen, filled with yellow-brown sandstone, and has not previously been figured. Finlay's label indicates that it was collected by Nissen from a bed designated "Nissen 7 CC", or "Clifden—37" of an unpublished scheme of Finlay's. Recent work at Clifden by Messrs B. L. Wood, N. de B. Hornibrook and the writer has led to recognition of the several horizons from which Mr K. I. Nissen collected mollusca for Finlay in 1927 or 1928, by lowering himself over the cliff by rope to a small ledge on a back-water of the Waiau River. At this point in the Clifden section, several shellbeds are exposed in the cliff, the lowest ("Nissen No. 1") containing the oldest Waiauan Foraminifera in the section. A fragmentary spire of *P. laetificus* (Fig. 4), from a silty sandstone immediately above the fourth shellbed, matches the holotype very precisely in preservation and matrix. The type horizon is thus low in the Waiauan Stage. Another topotype was collected by Dr C. R. Laws from Clifden Band 8 (AM 8033). An adult specimen, almost complete (Fig. 6), is available from the Waiauan of Alton Mill (GS 5623). A juvenile from "Clifden 7" (GS 2939) and an apex from the north bank of the Waiau River (GS 2155) show that a very similar if not identical form of *Pterynotus* ranges back into the Lillburnian and Clifdenian stages, and the spire figured by Marwick (1931) carries its upper limit into the Tongaporutuan. The following revised description is based on the above material. Shell very large, thick and solid, elongately fusiform, with three thick even varices giving a trigonal cross-section, the varices almost vertical and not spinous, but expanded into a broad projection at the periphery. Protoconch (Fig. 3) paucispiral, dome shaped, weakly deviated. Apical whorls with lamellate varices, about 6 per whorl on the second post larval whorl, three per whorl thereafter. A single stout blunt axial tubercle midway between varices, a further low axial bulging below and in front of each varix on the adult shell. Spiral sculpture of low spaced cords, prominent in young stages and persisting most conspicuously in the peripheral region, about 4 visible on spire whorls and up to 14 on body whorl, but their number difficult to count owing to abrasion of the shell surface. Aperture strongly callused and still pigmented in both adult specimens, suggesting an orange-yellow colour (as in the living *P. tripterus* (Born), Reeve, 1848, Fig. 55). External lip armed with 8 short stout tubercles. Parietal callus variable in development. Siphonal canal long, open, straight.



HEIGHT (estimated): 80 mm; width 42 mm (holotype). Height, 60 mm (TM 3080).

LOCALITIES: Clifden, Southland, north bank, Clifdenian (GS 2155), lower sand of Lillburnian (GS 2939), shellbed near base of Waiauan (holotype and GS 7704). Stream bank by road bend,  $\frac{1}{2}$  mile south of Alton Mill (GS 5624, S 167/594, Waiauan). Ormond Beds, Waitohu Survey District (GS 1332, Lower Tongaporutuan).

AGE: Clifdenian to Tongaporutuan (upper Lower Miocene to lower Upper Miocene).

REMARKS: As pointed out by Finlay (1930: 77), the closest Australian species is *P. calvus* (Tate) from the Miocene of South Australia and Victoria. This type of *Pterynotus*, with a single intervariceal tubercle, is not uncommon in the Eocene of Europe (*P. tripteroides* Lamarck, Lutetian) and persisted into the Miocene (*P. latilabris* Bellardi, *P. swainsoni* Michelotti, Vienna Basin) but does not seem to have been recorded in the western Pacific before the Miocene.

### *Pterynotus* (*Pterynotus*) cf. *laetificus* Finlay

Finlay (1930: 77) recorded fragments of a new species of the *laetificus* group from Target Gully. The only specimen available (Finlay Coll., Auckland Museum, AM 7970), is a damaged juvenile, originally about 7 mm high, that differs from *P. laetificus* of the same size in its more slender build and more prominent, narrowly elongated intervariceal tubercle. More material is needed to test the systematic significance of these differences.

LOCALITY: Target Gully, Oamaru, coll. C. R. Laws.

AGE: Awamoan.

### Subgenus *PTEROCHELUS* Jousseau

1879. *Rev. Mag. Zool.* (Ser. 3) 7: 335.

TYPE SPECIES (? by original designation, *fide* Iredale, 1913: 470): *Murex acanthopterus* Lamarck (see Fig. 22). Recent, Northern Australia.

*Pterynotus* in which the outer lip is interrupted by a spinous and deeply channelled adapical digitation, fringed by extensions of the fimbriated varix.

The type species represents a group of *Pterynotus* that can be recognised in such Eocene species as *P. contabulatus* Lamarck, is present in the Miocene of Australia and New Zealand, and persists in the Recent fauna of the latter countries (*P. acanthopterus* (Lamarck), *P. triformis* (Reeve), *P. angasi* (Crosse). In the Australasian species the siphonal canal and the apertural channelled spine are either open, (*triformis*, *awamoanus*), partly closed (*acanthopterus*, some forms of *angasi*), or completely closed to form tubes like those of *Typhis* (*zealandicus*). The extreme form, *P. zealandicus* (Hutton) in which the canals are closed and a false holostomatous aperture produced by the meeting of the lips, was therefore classed by Finlay in the subgenus *Poropteron* Jousseau, of which the type species *P. uncinarius* Lamarck, South Africa (see Fig. 21) also shares these characteristics. On the other hand, *P. zealandicus* is so similar in other features to the forms of *P. angasi* that link it with normal species of *Pterochelus* in the same area (compare Figs. 12, 13 and 16) that it must be derived from them. Its resemblance to *Poropteron*, which presumably developed in the same way in South African seas, is therefore considered due to convergence, and *Poropteron* is here restricted to two African species, *P. (Poropteron) uncinarius* and *P. (P.) mitriformis* (Sowerby). The siphonal canal has, in fact, become closed in several other independent lineages of Muricidae (*Ceratostoma*, *Pterynotus trialatus* (Sowerby), *Ocinebrellus*).



***Pterynotus* (*Pterochelus*) *awamoanus* Finlay (Plate 1, figs. 9, 10)**

1931. *Pteronotus* (*Pterochelus*) *awamoanus* Finlay, Trans. N.Z. Inst. 61: 77, Pl. 1, fig. 9.

A topotype is figured for comparison with other New Zealand species. The protoconch (Fig. 10) is more swollen and its nucleus larger than in *P. laetificus*, in which the adult shell is at least four times as tall as adult *awamoanus*. *P. awamoanus* has not been recorded away from the type locality, and there is a long time gap between this earliest New Zealand *Pterochelus* and the next occurrence in the Nukumaruan. An Australian Pliocene species (*P. (P.) trinodosus* (Tate)) is perhaps related (see Ludbrook, 1958, Pl. 2, fig. 14).

HEIGHT: 16.6 mm, width 8 mm (holotype, after Finlay).

LOCALITY: Target Gully, Oamaru (collected H. J. Finlay, J. Park, P. Marshall and J. Marwick).

AGE: Awamoan (Lower Miocene).

***Pterynotus* (*Pterochelus*) *angasi* (Crosse)**

1863. *Typhis angasi* Crosse, J. de Conch., 9: 86, Pl. 1, fig. 2.

This well-known Australian species was introduced into New Zealand lists by Hutton (1880) to include the living Northland population he had earlier separated as *Murex eos* (synonymy below). Suter (1913) recognised *eos* as a distinct variety of *angasi*, but recorded the latter on the basis of a beach specimen from Waikanae collected by Kirk. A specimen collected by Kirk is still in the Dominion Museum, labelled Wellington (M66), and is probably the original of Suter's illustration (Atlas, Plate 46, fig. 14) but it appears to be an Australian specimen and not a genuine New Zealand record. Other beachworn *Pterynotus* subsequently collected from west Wellington beaches are almost certainly fossils derived from the Castlecliffian of Wanganui Basin, washed down the coast. They include both *P. angasi* (*sensu lato*) and *P. zealandicus* (Hutton). Suter wrongly inferred that they are the same. By a strange coincidence the present study has shown that the genuine west Wellington (i.e., Castlecliff) form of *angasi* is more like Australian specimens in some characters than the living Northland *eos*. It is hard to understand Finlay's statement (1927: 419) that nothing like *angasi* occurs in New Zealand and that *eos* is more closely related to *P. (Pterochelus) triformis* (Reeve), a conclusion that led to subgeneric separation of *eos* (*Pterochelus*) from *angasi* (*Poropteron*). After comparison of *eos*, its early Pleistocene predecessor (*powelli* n. subsp.) and a range of specimens of the geographically variable *angasi* from Tasmania, South Australia and New South Wales, the writer confirms Hutton's and Suter's opinions on their close relationship and proposes to treat the New Zealand forms as subspecies of *angasi*. A Tasmanian specimen of *P. angasi angasi* is here figured for comparison. As noted above, the similarity of extreme forms in this series to *Poropteron* is believed to be due to convergence.

Rare well-preserved specimens of *P. a. angasi*, *P. a. powelli* and *P. a. eos* show a distinctive protoconch, flat-topped or weakly concave, with a strong upper peripheral angle or weak carina (Fig. 11) resembling that of the Columbariid genus *Coluzea* and contrasting with the mamillated protoconch of *P. awamoanus* and of the subgenera *Poropteron* and *Nothotyphis*. *P. zealandicus* has a similar protoconch (Fig. 15) which supports its close relationship with *angasi*. Possibly the peculiar protoconch of the *angasi* group originated like the Scaphellid proto-



conch of Volutidae, by the loss of an early horny embryonic envelope after formation of a scar at the time calcification began (Finlay, 1931: 8).

***Pterynotus (Pterochelus) angasi powelli* Fleming n. subsp. (Plate 1, figs. 11, 12)**

1953. *Pterochelus eos* (Hutton); Fleming, N.Z. geol. Surv. Bull. 52: 199, 205, 218; *P. aff. eos* (Hutton) *ibid.*: 203.

Shell similar to *angasi* but reaching a larger size and slightly broader in relation to height, mainly owing to a greater development of the variceal frill, which is strongly sculptured by imbricating fimbriated lamellae. Outer lip effuse and reflexed over the frill, not normal to it as in *angasi* and most *eos*. Spiral sculpture of low rounded cords, much stronger than in *angasi*, in which it is generally very weak, consisting of very fine close-spaced lirae. The three axial nodules between varices, normal in this species, are increased to five on fully adult whorls in *powelli*. The posterior apertural spine shows a backward—i.e., adapical, curvature, as in *angasi*, but is not as strongly curved as in some extreme Australian forms (which almost resemble African *mitriformis* in this respect).

HEIGHT: 29.5 mm, width including apertural varix 14.5 mm (holotype). Height, 28.5 mm, width 14 mm (paratype).

HOLOTYPE: TM 3115; figured paratype (apex), TM 3116, New Zealand Geological Survey.

LOCALITY: Castlecliff, Wanganui (holotype and paratype collected C. A. Fleming, 1931); GS 2186, "Windmill Gully", Castlecliff (3 paratypes, collected J. Marwick, 1936); GS 4041, 4042, 4050, gastropod shellbed, Kupe Formation, and GS 4057, Kaikokopu Shell Grit, Upper Westmere Siltstone, between Castlecliff and Kai Iwi; GS 4134, Kaikokopu Road, Aramoho (collected New Zealand Geological Survey, 1945).

AGE: Upper part of Okehuan and lower part of Putikian Substage, Castlecliffian Stage. (Early Pleistocene, equivalent to second interglacial age.)

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FIG. 1.—*Pterynotus (Pterynotus) kaiparaensis* Fleming n. sp. Holotype, TM 3079,  $\times 1$ .

FIGS. 2-8.—*Pterynotus (Pterynotus) laetificus* Finlay. Apex,  $\times 3.7$  (2) and protoconch (3)  $\times 15$ , TM 3082; topotype, TM 3081,  $\times 1$  (4); Tongaporutuan specimen, TM 3083, after Marwick, 1931,  $\times 1$  (5); hypotype, TM 3080,  $\times 1$  (6); holotype,  $\times 1$  (7, 8).

FIGS. 9, 10.—*Pterynotus (Pterochelus) awamoanus* Finlay. Topotype, TM 3084,  $\times 1$  (9); protoconch,  $\times 12$  (10).

FIGS. 11, 12.—*Pterynotus (Pterochelus) angasi powelli* Fleming n. subsp. Protoconch of paratype, TM 3116,  $\times 15$  (11); holotype, TM 3115,  $\times 1$  (12).

FIG. 13.—*Pterynotus (Pterochelus) angasi angasi* (Crosse). Tasmania, TM 3122  $\times 1$ .

FIG. 14.—*Pterynotus (Pterochelus) angasi eos* (Hutton). Topotype, TM 3163,  $\times 1$ .

FIGS. 15, 16.—*Pterynotus (Pterochelus) zealandicus zealandicus* (Hutton). Topotypes, protoconch, TM 3118,  $\times 15$  (15) and TM 3117,  $\times 1$  (16).

FIG. 17.—*Pterynotus (Pterochelus) zealandicus iredalei* Fleming n. subsp. Holotype, TM 3119,  $\times 1$ .

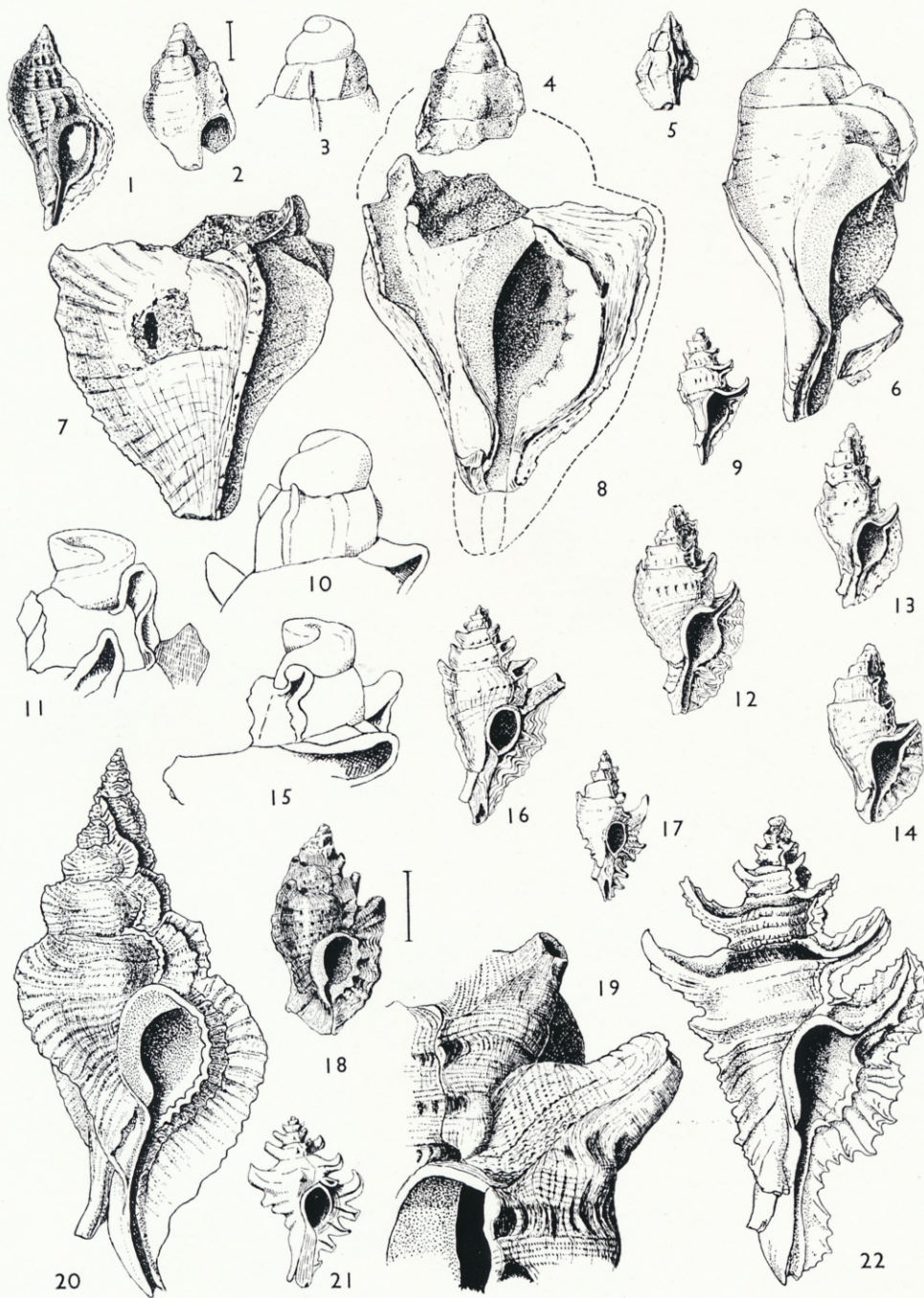
FIGS. 18, 19.—*Pterynotus (Nothotyphis) norfolkensis* Fleming n. sp. Holotype  $\times 3.1$ ; detail of variceal tube,  $\times 12$  approx. (19).

FIG. 20.—*Pterynotus (Pterynotus) pinnatus* (Swainson), type of *Pterynotus* Swainson (after Reeve, 1848).

FIG. 21.—*Pterynotus (Porofteron) uncinarius* (Lamarck), type of *Porofteron* Jousseaume (after Barnard, 1951).

FIG. 22.—*Pterynotus (Pterochelus) acanthopterus* (Lamarck), type of *Pterochelus* Jousseaume (after Reeve, 1848).





C. A. F. del



The holotype was collected by the writer in company with Dr A. W. B. Powell, after whom the subspecies is named, on a memorable field trip in January, 1931. Marwick's specimens from Windmill Gully (= The Pinnacles) are similar in preservation and show that the Putikian locality must be in the Lower Castlecliff Shellbed (as assumed by Fleming, 1953: 218), Pinnacle Sand, or Tainui Shellbed, but its horizon needs checking.

***Pterynotus (Pterochelus) angasi* subsp. indet.**

1953. *Pterochelus eos* (Hutton); Fleming, N.Z. geol. Surv. Bull. 52: 151.

LOCALITY: GS 4089, Great North-western Road, Okehu Valley (collected A. C. Beck and C. A. Fleming, 1945).

AGE: Marahauan Substage, Nukumaruan Stage (Early Pleistocene, equivalent to first interglacial age).

The only specimen from this horizon is not subspecifically determinable.

***Pterynotus (Pterochelus) angasi eos* (Hutton) (Plate 1, fig. 14)**

1873. *Murex eos* Hutton, Cat. Marine Moll. N.Z.: 8.

1880. *Murex (Pteronotus) angasi* Crosse; Hutton, Man. N.Z. Moll.: 47 (not of Crosse).

1913. *Murex (Pteropurpura) angasi* var. *eos* Hutton; Suter, Man. N.Z. Moll.: 404.

1915. *Pteronotus (Porofteron) angasi* var. *eos* (Hutton); Iredale Trans. N.Z. Inst. 47: 471.

1927. *Pteronotus (Pterochelus) eos* (Hutton); Finlay Trans. N.Z. Inst. 57: 419, Pl. 11, fig. 55.

1937. *Pteronotus (Pterochelus) eos* (Hutton); Powell, Shellfish N.Z.: 19.

This well-known rarity, which now lives only in Northland, differs from *P. a. angasi* in its solid shell, uniform pink colour, more open canal, stronger spiral sculpture on the body whorl, and in the course of the channelled apertural digitation, which runs straight out radially from the outer lip, and does not curve forward (compare Figs. 13, 14). This last character also distinguishes *eos* from *powelli* (Fig. 12).

***Pterynotus (Pterochelus) zealandicus* (Hutton).**

This species is here considered to be polytypic, with an extinct subspecies that lived in New Zealand during an interglacial of the early Pleistocene and another subspecies surviving at Norfolk Island (Fleming, 1961). *P. zealandicus* is similar and doubtless closely related to *P. angasi*, but is distinguished by the closure of the siphonal canal and of the adapical canal by the contact of shell lamellae from both sides of these structures. The inner and outer lips thus join to form a falsely holostomatous aperture of which the walls project forwards as a short cylindrical tube (as in *Typhis*). These features are fully developed in young shells only half the adult size. In protoconch, shell-form and texture, and in sculpture, *P. zealandicus* resembles *P. angasi* (particularly *P. a. powelli*) much more closely than the African species of *Porofteron*, with which it was grouped by Finlay.

***Pterynotus (Pterochelus) zealandicus zealandicus* (Hutton) (Plate 1, figs. 15, 16)**

1873. *Typhis zealandica* Hutton. Cat. Tert. Moll. Echinoderm. N.Z.: 2.

1886. *Murex zealandica*, Hector, Outline N.Z. Geol.: 50, Fig. 7 (4) (not *Murex zealandica* Quoy and Gaimard, 1833).

1913. *Murex angasi* (Crosse); Suter, Man. N.Z. Moll.: 404 (not of Crosse).

1914. *Murex (Alipurpura) angasi* (Crosse); Suter, N.Z. geol. Surv. Palaeont. Bull. 2: 2 (not of Crosse).



1927. *Pteronotus (Poropteron) zealandicus* (Hutton); Finlay Trans. N.Z. Inst. 57: 419, Pl. 11, fig. 56.

1961. *Pterynotus (Poropteron) zealandicus* (Hutton); Fleming, Bull. Conchol. Sect. Auckland Mus. 17: 13–15, fig.

FIGURED TOPOTYPES: TM 3117, TM 3118 (apex), N.Z. Geological Survey.

This striking form is known only from the 18ft Tainui Shellbed (Shakespeare Group) of Wanganui district, classed in the Putikian Substage of the Castlecliffian, in which it is common, and as worn derived fossils on the west Wellington beaches. For some years the Putikian has been interpreted as a warm-water interglacial fauna (Fleming, 1952, 1955) but the relationships and provenance of *P. zealandicus*, evidently an immigrant, were not known. Recognition of a close ally now living at Norfolk Island shows that *zealandicus* survived in the subtropical zone to the north after its extermination in New Zealand, presumably in the earliest Haweran glacial phase which followed the Putikian. Probably this is also the area from which it came south to New Zealand. Curiously enough, the New Zealand Pleistocene population was larger and more elaborately ornamented than the surviving Norfolk Island form.

***Pterynotus (Pterochelus) zealandicus iredalei* Fleming n. subsp. (Plate 1, fig. 17)**

1961. *Pterynotus (Poropteron) aff. zealandicus* (Hutton); Fleming, Bull. Conchol. Sect. Auckland Inst. 17: 13–15, fig.

Similar to *P. z. zealandicus* (Hutton), but distinguished by more slender shell, less continuous variceal frill and upward curve of adapical tube. Elements of spiral and axial sculpture, spacing of varices, the closure of both adapical and abapical canals, disposition of spines on varices, and oval tube-like apertural extension essentially the same as in the New Zealand fossil. Foliateous variceal frill, however, much less developed than in *zealandicus*, so that the spines project freely on outer lip of abapical canal. The long closed tube of the adapical canal curves regularly upwards in an apical direction, whereas in *zealandicus* it runs radially outward from the aperture and curves slightly backwards from the plane of the aperture. Colour white or faintly pink. Largest specimen two-thirds the normal height of *P. zealandicus*, but differences confirmed by examination of young of the latter species.

HEIGHT: 20 mm; width 10 mm (holotype TM 3119); height, 23 mm (largest paratype, TM 3120).

HOLOTYPE: TM 3119, paratype TM 3120, New Zealand Geological Survey.

LOCALITY: Norfolk Island (collected by Dr Hugh Marwick 1944, holotype and 4 paratypes); Norfolk Island (R. S. Bell and H. C. Quintal, 1913; Dom. Mus.).

The holotype and 4 paratypes are in the New Zealand Geological Survey, other paratypes in the Dominion Museum. Additional specimens have been examined in the Australian Museum, Sydney, where Mr T. Iredale had recognised their relationship with *P. zealandicus*.

#### Subgenus NOTHOTYPHIS nov.

TYPE SPECIES: *Pterynotus (Nothotyphis) norfolkensis* Fleming n. sp., Norfolk Island, Recent.

Small solid *Pterynotus* with closed siphonal and adapical canals, sculptured by broad rounded spiral cords on which are superposed fine intersecting spiral and radial threads, resulting in a trellised micro-texture. Siphonal canal short. Protoconch paucispiral with bulbous nucleus.



INCLUDED SPECIES: *P. (N.) norfolkensis*; *P. (N.) robustus* (Verco), Recent, South Australia; *P. (N.) wenzelidesi* (Hörnes), Miocene, Europe.

*Nothotyphis* differs from *Pterochelus* in its distinctive sculpture and texture, and in the complete closure of the adapical canal to form a curved tube even more like that of *Typhis* than in the most extreme forms of *Pterochelus*. *Poropteron* (Fig. 21) is strikingly different in sculpture, the shell surface being porcellanous, with axial sculpture (apart from growth lines) limited to a single intervariceal nodule (as in many *Pterynotus* s. str.). That these differences are of long standing is suggested by the conservative nature of *Pterochelus* sculpture from Eocene to Recent (spirals dominant, few axial nodules) and by the probable close relationship of a South Australian living shell and a Miocene species in Europe.

*Murex (Poropteron) robustus* Verco (1895) is similar in general form, in its closed siphons, dentate lip, and (judged by the figure) in its ornament of fine radial lirae intersecting the spirals, but differs in the extremely long, sinuous tubes of its posterior canals.

*Murex (Typhis) wenzelidesi* Hörnes 1856 (= *Typhis tripterus* Grateloup 1833, non *Murex tripterus* Born) from the Middle Miocene of Hungary and France, agrees even more closely with *norfolkensis* in shell form, and its surface is described as "mit erhabenen Querstreifen bedekt" suggesting similar ornament (Hörnes, 1856: 264). *M. wenzelidesi* was classed by Keen (1944) in *Tripterothyphis* Pilsbry and Lowe, 1932, as a subgenus of *Pterotyphis* Jousseaume, 1880, and by Sieber (1958: 145) in *Typhinellus* Jousseaume, 1880, but the evidence for its classification in the subfamily Typhinae has not been documented in detail, and it does not closely resemble the American species of *Tripterothyphis*.

The distinguishing feature of the Typhinae (see Keen, 1944; Vella, 1961) is the presence of tubes on the shoulder alternating with the varices. In some groups, the intervariceal tubes arise just behind the varices, and in *Tripterothyphis* they are enrolled in the varices so that the tube protrudes from the final varix which has enfolded it in the development of the variceal spine.\* Superficially similar tubes are produced in certain species of the subgenus *Pterochelus*, including *P. zealandicus* (Hutton), in the subgenus *Poropteron*, and in *Nothotyphis*, by the closure of opposing shelly lips over a canal on the front of the varix, leaving a suture to mark the line of closure (Fig. 19). That a "variceal origin of the tube separates it from all the species of" Typhinae was recognised by Verco (1895: 86) in his description of *M. robustus*. The tube in *P. (N.) norfolkensis* is also variceal, and that of the European *wenzelidesi* Hörnes is probably the same although Hörnes' illustrations do not show the suture on the spine to confirm this conclusion.

***Pterynotus (Nothotyphis) norfolkensis* Fleming n. sp. (Plate 1, figs. 18, 19)**

Shell small, solid, spire about four-sevenths height of body whorl. Protoconch papillate, smooth, paucispiral. Spire whorls weakly shouldered, gently convex. Sutures undulating. Varices three, almost continuous, each slightly behind that of previous whorl, thus with slightly spiral courses, each prolonged posteriorly in a stout tapering tube directed adapically and somewhat backwards, buttressed from the shoulder behind, and showing a sinuous suture in front. Sculpture of low rounded spiral cords, three on spire whorls, five more on base, separated by shallow grooves about half their width (marked in the holotype by irregular

\* Information kindly supplied by Professor A. Myra Keen, Stanford University, California, from examination of the Caribbean species *Tripterothyphis cancellatus* (Sowerby, 1841).



pits where the outer shell layer has broken down, but not in juvenile paratypes), the cords accentuated where they rise over the posterior surface of the varix and descending on its anterior surface to the peristome as stout radial pillars, separated by deep cavities corresponding to denticles of the outer lip. Fine ornament of intersecting radial and spiral lirae of equal strength trellised where they cross, the former strongly retrocurrent on shoulder, sinuously crossing the spiral cords at the periphery, and undulating across the radial pillars on the front of each varix. Aperture with thickened peristome, complete in adult shell, but continued as an open slit-like siphonal canal in immature paratype. Columella bent at lower third, the bend reflected in a prominent denticle in the parietal callus. Outer lip thick, crenulated, the crenulations thickened outwards to form five short peristomal digitations and inwards to form like number of labral denticles, the abapical one strongest. Siphonal canal twisted, formed anew at each growth stage, the space between filled by a broad outward growth of the adaxial lip of the succeeding canal.

HEIGHT: 9.5 mm, maximum diameter, 5 mm (holotype).

HOLOTYPE (NF 15142) and paratype in Dominion Museum, Wellington; another paratype (TM 3146) in New Zealand Geological Survey.

LOCALITY: Norfolk Island (collected Roy. S. Bell and H. C. Quintal, 1913). Apparently beach drift, together with *Pterynotus* (*Pterochelus*) *zealandicus iredalei* n. subsp.

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