

New Zealand Tertiary Rissoids.

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RISSOIDS are not usually plentiful as fossils in New Zealand. In the latest list of our Tertiary Mollusca (Suter, 1918) nine species of *Rissoa* and *Rissoina* are recorded; five of these are also Recent species, and only one of the other four is from the Miocene. In the present paper the number of Rissoids recorded as fossil from New Zealand is raised to twenty-five, fifteen of these being described as new, most of them being from Miocene beds.

Hutton (1873, 1885, 1893) was the first to describe members of this family from the New Zealand Tertiary; five of the nine species above mentioned were originally described from the Pliocene beds of Petane or Castlecliff, one from Awamoa (Miocene), and the remaining three were discovered fossil subsequent to their description as Recent species. The only addition made to this number in recent years is *Rissoina* (?) *obliquocostata* M. & M., described by Marshall and Murdoch (1920A) from Hampden.

Although these small shells are termed Rissoids, Iredale (1915) has shown that the type name, *Rissoa*, should not be applied to any Neozelanic shells, and has provided a series of generic names to cover austral forms. His scheme marks a decided advance in their treatment, and by it New Zealand Recent Rissoids can be reduced to some semblance of order. Strong support for his action is given by the ease with which practically all the fossil Rissoids so far discovered fall into his groups. Iredale might, however, have been more generally explicit in defining his genera. It may be legally correct to define a new genus—e.g., *Merelina*—by “proposing it for shells grouped around *Rissoa cheilostoma* Ten.-Woods,” but this is extremely unsatisfactory for workers who have not access to large suites of actual specimens, and have to rely mostly on literature. To ensure immediate appreciation and acceptance of new genera a *résumé* of diagnostic characters is imperative. From Iredale’s treatment of the Rissoids it was almost inevitable that when his names did come into use some of them should be misapplied, and this has already occurred. The genus *Estea*, in particular, seems to have given trouble—the writer has seen one of the spirally lirate species determined as a *Subonoba*; and, further, Marshall and Murdoch (1920B) have listed *Rissoa semiscalcata* Hutt. as a *Lironoba*, to which genus it bears little resemblance. As far as the writer can see, the following diagnostic notes (compiled after study of New Zealand Recent and fossil species) represent Iredale’s ideas fairly correctly; he would, however, have saved Neozelanic workers much trouble had he given a similar table when his genera were proposed.

(A.) "RISSOA" GROUP.

Aperture generally suboval and entire; basal lip hardly channelled or effuse.

1. Shell thin; axial sculpture prominent (broad low ribs, interstices rather wide and either smooth or with slight spiral sculpture); protoconch smooth, globose, whorls convex; aperture rotund and subvertical, peristome continuous.
Haurakia. Type, *H. hamiltoni* (Sut.).
2. Shell moderately solid, clathrate (distant fine spiral ribs, crossing and rendering nodulous the axial ribs, which are also rather distant, wide but with a sharp edge, base generally with a few smooth spirals); protoconch papillate, spirally striate; whorls convex; aperture oval, oblique, heavily variced, peristome continuous, internally duplicated.
Merelina. Type, *M. cheilostoma* (Ten.-Woods).
3. Shell similar to *Merelina*; protoconch smooth and glossy, dome-shaped; aperture thin-edged, rather simple, with or without varix behind, rim not duplicated.
Linemera n. gen. Type, *L. interrupta* Finlay (nom. nov. for *R. gradata* Hutt., preoco.).
4. Shell thin, semitransparent; fine and weak axial and spiral sculpture visible through the aperture; protoconch smooth, dome-shaped; whorls lightly convex; aperture ovate-pyriform, the peristome discontinuous, thin and sharp.
Onoba. Type, *O. striata* (Montague).
5. Shell thin, translucent; cut up into weak spirals by grooves, no axials; protoconch smooth, papillate, whorls slightly convex; aperture subvertical, ovate-pyriform, peristome continuous, thin and sharp.
Subonoba. Type, *S. fumata* (Sut.).
6. Shell very solid; very heavily lirately sculptured (spiral ribs much raised and flatly rounded, continuing over the whole surface, interstices deep and broad); protoconch smooth (or spirally lirate?); whorls convex; aperture oval, heavily thickened, peristome continuous, internally duplicated.
Lironoba. Type, *L. euteri* (Hedley).
7. Shell solid; strong spiral keels, the intervening spaces with dense axial foliations; protoconch spirally striate; whorls strongly shouldered; aperture rounded; peristome continuous, thick and blunt.
Anabathron. Type, *A. contabulatum* Frfld.
8. Shell solid; sculpture not prominent, and when present generally confined to the lower whorls. (The whole surface may be smooth, or traces of spiral grooves may be present; there may be flattish oblique axials on the lower whorls; there may be a subobsolete sculpture of axial ribs crossed by spiral cords; or there may be a few spiral cords only. Both axial and spiral ribs, when present, are low and flatly rounded, and often almost obsolete.) Protoconch small, conical, smooth; whorls almost flat; aperture highly distinctive, perpendicular, subcircular, with a narrow, rather sharp, and often reflected edge, but much thickened internally, no exterior varix; peristome generally continuous, often reflected all round.
Estea. Type, *E. zosterophila* (Webster).
9. Shell thin; sculpture generally absent (when present confined to microscopic spiral grooves); protoconch small, globose, smooth; whorls convex, suture often margined below; aperture subcircular, peristome generally discontinuous, thin and sharp.
Notosetia. Type, *N. neozelanica* (Sut.).
10. Shell moderately thick, pupoidal; sculpture inconspicuous (smooth, spirally lirate, or ridged); protoconch large and globose; whorls slightly convex, elongate; aperture semilunar, extended beyond the body-whorl, peristome duplicated, the inner lip produced forward with a sunken space behind it.
Amphithalamus. Type, *A. inclusa* Carp.
11. Shell rather thin, tall and cylindrical; sculpture obsolete (but strong growth-lines often present); protoconch large and globose, often protuberant, whorls slightly convex, very elongate; aperture similar to that of *Amphithalamus* but narrower and more appressed.
Epigrus. Type, *E. ischna* (Tate).

(B.) "RISSOINA" GROUP.

Aperture semilunar, anteriorly effuse, or channelled.

12. Shell solid, elongate, with strong sculpture (generally strong axial riblets crossed by fine spirals, but the latter may be absent); protoconch small, dome-shaped; whorls convex; aperture obliquely oval, channelled below and above, peristome continuous, thickened.

Rissoina. Type, *R. inca* D'Orb.

13. Shell thin, white and highly polished; shell apparently smooth, sculpture very inconspicuous (very fine spiral grooves only, sometimes over the whole surface, sometimes only a few prominent grooves on the base); protoconch minute, flattened; whorls nearly flat; aperture pear-shaped, often truncated below, peristome continuous, outer lip moderately thin, blunt, but reinforced by an external varix.

Nozoba. Type, *N. emarginata* (Hutt.).

14. Shell thin or solid; smooth (rarely with microscopic spiral grooves); protoconch minute, globose; whorls flattened to convex; aperture pyriform or ovate, peristome continuous, hardly thickened.

Dardanula. Type, *D. olivacea* (Hutt.).

(C.) SKENELLA.

Shell depressed, orbicular, umbilicated.

15. Shell depressed, umbilicated; smooth; protoconch flatly convex, rather large; whorls convex; aperture large, subcircular.

Skenella. Type, *S. georgiana* Pfr.

Of the above genera, *Merelina*, *Onoba*, *Subonoba*, *Anabathron*, *Amphithalamus*, and *Skenella* are as yet unrepresented in the New Zealand Tertiary, while *Haurakia*, *Lironoba*, *Notosetia*, and *Epigrus* are here recorded for the first time. The best-represented genus is *Estea*, with five species; then *Linemera*, with four.

Descriptions of the new species are appended, also notes on the other recorded species; to facilitate identification a key to the fossil genera and species is also appended. The thanks of the author are due to Mr. J. Marwick, of the New Zealand Geological Survey, for the drawing of the figure for *Estea polysulcata*.

Haurakia mixta n. sp. (Fig. 1.)

Shell minute, ovate, axially costate. Protoconch blunt, of about $1\frac{1}{2}$ smooth conical whorls; shell-whorls 2, flattish; body-whorl subangled at periphery, base rounded. About 19 flatly rounded axial ribs on last whorl, interstices generally narrower; ribs pass from suture to suture on spire-whorls but suddenly diminish on reaching periphery of body-whorl and rapidly die out just below it. A strong spiral groove crosses ribs just below suture, but otherwise there is apparently no spiral sculpture in interstices or on base. Spire conical, a little higher than aperture, outlines almost straight. Suture inconspicuous. Aperture squarely ovate, subangled above, flattened below. Peristome nearly continuous, sharp. Columella vertical, subtruncate at base. Imperforate.

Height, 1.2 mm.; diameter, 0.7 mm.; height of aperture, 0.5 mm.

Type, from Castlecliff, in the author's collection.

The species has analogy with *H. hamiltoni* (Sut.) and *H. huttoni* (Sut.), being in some respects intermediate between them. It is probably juvenile, but is distinctly characterized by its flattish whorls, squat form, and infra-sutural groove.

Haurakia oamarutica n. sp. (Fig. 2.)

Shell small, oval, imperforate, axially costate. Protoconch of $1\frac{1}{2}$ smooth globose whorls, pullus large. Shell-whorls about 3, convex, body-whorl regularly rounded. Narrow unequally-spaced axial ribs cross whorls, about 30 on body-whorl, fading out on base; interstices generally a little wider than ribs and bearing fine spiral striae. A varix marks outer lip. Both spirals and axials often quite worn off. Spire conical, higher than aperture, outlines almost straight. Suture well impressed. Aperture ovate, angled above. Peristome continuous, slightly thickened, basal lip somewhat expanded. Columella arcuate, hardly expanded. Umbilical area with a small narrow impression.

Type: Height, 1.4 mm.; diameter, 0.8 mm.; height of aperture, 0.5 mm.

Largest paratype: Height, 1.9 mm.; diameter, 1.1 mm.; height of aperture, 0.7 mm.

Type and many paratypes, from Target Gully, in the author's collection.

Very close to *H. huttoni* (Sut.), but separable by its thinner and irregular ribs with spirally-striate interstices, and its constantly much smaller size. The figure shows the shell in a sloping position, hence the spire is somewhat foreshortened.

Linemera n. gen.

Shell superficially similar to *Merelina*—i.e., with clathrate sculpture—but protoconch adpressed, smooth, glossy, and dome-shaped, with inconspicuous sutures, instead of being projecting, spirally grooved, dull, and paucispiral, with deep sutures, as in *Merelina*. Aperture with thin edge, sometimes thickened behind with simple varix, without a second projecting rim inside, rather effuse at base. Chink-like umbilicus generally present.

Type, *L. interrupta* nom. nov. (*Rissoa gradata* Hutt.; Philippi's usage of the same name for an Italian fossil has many years' priority).

Iredale has already indicated the presence of this group in Australian waters (1915, p. 448); here undoubtedly belong *Rissoa filocincta* Hedley and Petterd, *Merelina sculptilis* May, and perhaps *Alvania thoinnensis* and *A. suprasculpta*, both of May. The axial sculpture is often reminiscent of *Haurakia*, and a common feature is a slight indentation and a stronger spiral rib near the upper suture. True *Merelina* occurs only in the Recent fauna of New Zealand, and, though like *Linemera* in sculpture, is probably more closely allied to *Anabathron* and *Attenuata*, which have similar lirate embryos. *Rissoa pingue* Webster is the only Recent representative of *Linemera* in New Zealand.

Linemera minuta n. sp. (Fig. 3.)

Shell minute, oval, clathrate, imperforate. Protoconch of 2 globose glossy whorls, nucleus minute, rapidly enlarging. Shell-whorls about 2, indistinctly shouldered just below suture, then flatly convex; body-whorl bluntly angled, base almost flat. Axial sculpture commencing first, consisting of strong bluntly-rounded ribs, sloping forwards and reaching from suture to suture, interstices narrower; they number about 19, and cease just below line of suture on body-whorl. Axials crossed by much weaker spirals, indistinct on early whorls, 4 on penultimate whorl; broad and flatly rounded (interstices sublinear) and cutting up axials into blunt

laterally-elongate tubercles. A fifth spiral emerges from suture-line on to base and is slightly crenulated by ends of axials; below this are 2 smooth and much fainter ribs, the rest of base smooth. Spire a little higher than aperture. Suture much impressed. Aperture slightly oblique, sub-ovate, angled above, effuse below. Peristome discontinuous. Outer lip thin, but does not appear to be finished. Columella slightly oblique, arcuate.

Height, 1.5 mm.; diameter, 0.9 mm.; height of aperture, 0.7 mm.

Type and two paratypes, from Pukeuri, in the author's collection.

Very close to *L. pingue* (Webster). No specimens of this species have been available for comparison, and Webster does not state the number of axials per whorl, but from the description and figure his species would seem to have weaker axials and a rounder body-whorl than the fossil shells. The specimens are not adult, but, in view of the slight differences noted, it is probable that actual comparison of adult shells of the two species would show wider divergence; till then the fossil species is best treated as distinct.

Linemera interrupta (Finlay).

Rissoa gradata Hutt. (not of Phil.).

This species has also considerable analogy with *L. pingue* (Webster), but is characterized by its irregularly-placed spiral ribs, these being crowded anteriorly, but almost absent posteriorly, so that spire-whorls have only two distinct ribs close to suture below. There are, however, traces of faint flattish ribs with linear interstices between these and suture above, and a distinct groove crosses ribs just below suture. *L. filocincta* (H. & P.) is a very similar shell, but has more regular spiral ribs.

Linemera pukeuriensis n. sp. (Fig. 4.)

Shell moderately large for the genus, elongated, clathrately sculptured, rather thin, imperforate. Protoconch of 2 smooth and shining lowly-convex whorls, nucleus minute, swelling rapidly, sharply marked off from the sculptured whorls. Shell-whorls nearly 4, convex, body-whorl regularly and gently rounded. Four thin spirals per whorl, interstices many times their width; spirals equidistant, but a wider concave space between the first one and suture above. Another strong spiral emerges on base from suture-line, and 4 weaker but similar spirals cross remainder of base, the lowest often obsolete. Axials begin at same time as spirals and are narrow, sharp, and distant, interstices variable but about two to three times their width; axials about 18 on body-whorl, very soon dying out below fifth spiral, so that remaining basal spirals are much less crenulated than the others; points of intersection on higher spirals slightly raised into elongated and rather sharp tubercles. Spire about twice height of aperture, outlines nearly straight, but body-whorl turns slightly upwards near aperture which is thus thrown forward basally and axis of shell seems curved. Suture well impressed. Aperture ovate, oblique, projecting basally. Peristome continuous; outer lip with sharp edge but considerably thickened just previously by a strong varix. Columella slightly oblique, arcuate. Inner lip projects prominently as a sharp edge, producing a shallow umbilical chink, surrounded by a very blunt and low basal carina.

Height, 2.5 mm.; diameter, 1.2 mm.; height of aperture, 0.8 mm.

Type and many paratypes, from Pukeuri, in the author's collection. Also from Mount Harris.

This shell has only superficial analogy with the Recent *M. cheilostoma* (Ten.-Woods), though resembling it in appearance.

Linemera awamoensis n. sp. (Fig. 5.)

Shell small, elongated, finely clathrately sculptured, rather thin, imperforate. Protoconch as in *L. pukeuriensis*. Shell-whorls nearly 3, lowly convex, body-whorl regularly rounded. Six very fine spirals per whorl; uppermost relatively distant from suture above, leaving a concave shoulder between; lowest nearly masked by suture below; interstices several times their width. Four more similar and equally-spaced spirals on base, and sometimes traces of a fifth. Axials commence at same time as spirals, are very fine and numerous, bluntly convex, interstices subequal to them or a little wider. Axials number about 36 on body-whorl, but are less numerous on earliest whorls; they die out just below suture-line on base. Axials stronger than spirals and but little nodulous at points of intersection. Spire about $1\frac{1}{2}$ times height of aperture, outlines faintly convex, body-whorl turning up as in *L. pukeuriensis*. Suture well impressed. Aperture ovate, a little oblique, projecting basally, larger than in *L. pukeuriensis*, and the continuous peristome not so much thickened inside the sharp edge, though an apertural varix is distinct. Columella slightly oblique, arcuate. Inner lip as in *L. pukeuriensis*.

Height, 2.1 mm.; diameter, 1.1 mm.; height of aperture, 0.8 mm.

Type and four paratypes, from Awamo, in the author's collection.

Easily distinguished from its near relative *M. pukeuriensis* by shorter spire and much finer sculpture.

Lironoba polyvincta n. sp. (Fig. 6.)

Shell small, conical, imperforate, solid, staged. Protoconch of 2 finely but strongly lirate lowly-convex whorls, interstices between lirae linear. Shell-whorls 3, not shouldered, lightly convex, body-whorl regularly rounded. The shell proper, which is abruptly marked off from embryonic whorls, has 5 narrowly-rounded strongly-projecting spiral ribs per whorl, lowest two subequal and strongest, next two weaker, and uppermost one inconspicuous, margining suture above. On later whorls a faint rib margins lower suture, this emerges on base as a rib as strong as upper ones; 3 more equidistant and gradually weakening ribs extend over rest of base. Interstices between ribs about three times their width but become a little narrower on base; they are crossed by regular fine growth-lines, but no dense axial foliations are present. Spire gradate, about $1\frac{1}{2}$ times height of aperture, outlines straight. Suture well impressed, margined below and above. Aperture very little oblique, ovato-polygonal, peristome continuous, much thickened by a strong exterior varix, internally duplicated by small raised rim. Columella arcuate, inner lip raised, but no umbilical chink, encircled by a slight basal ridge.

Height, 2.3 mm.; diameter, 1.2 mm.; height of aperture, 0.9 mm.

Type and several paratypes, from Pukeuri, in the author's collection. Also from Target Gully.

The genus is new as a fossil in New Zealand. It has much narrower and more numerous ribs than the Recent *L. suteri* (Hedley); though the protoconch is spirally lirate, it is here referred to *Lironoba* rather than to

Anabathron, as there is no trace of dense axial foliation, the whorls are not strongly keeled, and the peristome is duplicated in the same manner as in *L. suteri* (Hedley). Target Gully specimens are smaller, slightly more compressed vertically, and the two lowest spirals are more strongly marked on emergence from the protoconch than in Pukeuri shells; but as there are only two examples from Target Gully in the author's collection the slight differences observed may not be constant and hardly justify the creation of even a variety.

Lironoba charassa n. sp. (Fig. 7.)

Shell small, conical, imperforate, solid, staged. Only a small portion of protoconch remains; it has strong spiral ribs with linear interstices, and is sharply marked off from shell proper. Shell-whorls 3, not shouldered, lightly convex, body-whorl regularly rounded. Three moderately-wide flattened strongly-projecting spiral ribs per whorl, lower two subequal and stronger, upper one still fairly strong and margining suture above. On later whorls a faint rib margins lower suture and emerges on base as a rib weaker than other three; four more equidistant and subequal ribs extend over rest of base. Interstices between ribs about twice their width, but narrower on base; they are crossed by regular fine growth-lines. Spire gradate, about $1\frac{1}{2}$ times height of aperture, outlines straight. Suture well impressed, margined above, and, later, below. Aperture very little oblique, more pyriform than polygonal, peristome continuous, much thickened by a strong external varix, internally duplicated by a small raised rim. Columella arcuate, inner lip raised and thickened, distinctly marked off from body-sculpture by a narrow groove, the encircling basal ridge very faint.

Height, 2.5 mm.; diameter, 1.2 mm.; height of aperture, 1 mm.

Holotype (unique), from Nukumarū, in the author's collection.

Very close to preceding species; probably an evolutionary product. From its ancestor it is distinguished by its fewer but thicker ribs, while the Recent *L. suteri* (Hedley) has still fewer. In its aperture, basal sculpture, and apex *L. charassa* is much nearer the Miocene species.

In addition to these last two species, the Australian *L. wilsonensis* G. & G. and a few other forms have spirally-lirate apices; but these shells correspond so closely to other forms with smooth embryos that, though the difference may eventually prove radical, it would seem unwise on present knowledge to make any separation.

Estea polysulcata n. sp. (Fig. 8.)

Shell of moderate size, pupiform, imperforate, solid, with several spiral sulci. Protoconch dome-shaped, of about 2 slightly convex whorls. Shell-whorls about $4\frac{1}{2}$, almost flat, base regularly rounded. Early whorls apparently quite smooth, indications of spiral ribs seen on third whorl, and on following whorls low and flat spiral sulci well developed. On penultimate whorl, between suture and periphery, are about 7 spirals, but the downward turn taken by body-whorl causes about 2 more to be exposed below periphery. About 11 ribs visible on body-whorl, but anteriorly base is smooth. Uppermost spiral margins suture above, and is followed by a wide flat space; then 4 spirals with linear interstices, next 2 spirals separated from each other and from adjacent spirals by shallow grooves as wide as ribs; spaces between the remaining basal spirals linear. In

early whorls periphery is apparently subangled, but becomes convex later; each whorl clasps the one above rather closely but leaves margining sutural cord prominent; these two facts render the suture subcanaliculate. Spire high, about twice height of aperture, outlines pupiform. Aperture ovate, laterally compressed, decidedly oblique. Outer lip broken, but apparently thin and sharp; peristome nearly continuous. Columella very oblique. Inner lip very slightly reflected, spread as a callus over columella and parietal wall.

Height, 3.7 mm.; diameter, 1.4 mm.; height of aperture, 1.2 mm.

Holotype, from Maraekakaho Creek (three miles above junction with Ngaruroro River, Geol. Surv. loc. 1102; horizon Nukumaruan), in the collection of the New Zealand Geological Survey. Collected by Mr. J. Marwick. Also one paratype from Nukumarau, in the author's collection, collected by Mr. R. S. Allan.

Paratype reproduces sculpture of holotype exactly except that second-lowest rib on base is unduly accentuated, forming almost a blunt carina, and faint traces of longitudinal ribs are present. The species is related to *E. semisulcata* (Hutt.), but has far more numerous and more persistent spirals, and a taller and thinner shell; it is still closer to the following species, which, from Hutton's description, seems to be well distinguished by its stronger axial ribs, relatively greater width, and lack of spiral ornament on base.

Estea rugosa (Hutt.).

Only one juvenile specimen of this species has been available for examination, so that it is not generically placed with absolute confidence, but the figure and description seem fairly definitely to indicate this genus. The species combines the types of sculpture shown by *E. impressa* (Hutt.) and *E. polysulcata* Finlay.

Locality: Petane, Nukumarau.

Estea impressa (Hutt.).

Characterized by the stout sloping axial riblets on the lower whorls, the infrasutural groove, and the minute size of the shell. Related to such Australian forms as *E. kerskawi* Ten.-Woods.

Localities: Castlecliff, Petane, Waikopiro, Nukumarau.

The Recent *E. minor* (Sut.)—which Suter reduced to a variety of *E. zosterophila* (Webster), but which is certainly worthy of specific rank—is a totally unsculptured relative of this species.

Estea semisulcata (Hutt.).

Distinguished by having about 4 spiral cords, with linear interstices, on the last $1\frac{1}{2}$ whorls only; otherwise very similar to *E. zosterophila* (Webster), to which it bears somewhat the same relation as *E. impressa* does to *E. minor*.

Localities: Castlecliff, Nukumarau.

Estea zosterophila (Webster).

Locality: Castlecliff (*vide* Suter, *Man. Moll.*, p. 211).

This record needs confirmation; it probably is based on a worn *E. impressa* (Hutt.).

Notosetia prisca n. sp. (Fig. 9.)

Shell minute, ovate, body-whorl large in proportion to rest of shell. Sculpture of faint growth-lines; at somewhat regular distances some appear more prominent, but are not raised; a faint furrow emerges from suture on body-whorl and marks periphery. Spire very little higher than aperture. Protoconch of $1\frac{1}{2}$ smooth and polished whorls, marked off by a groove from whorls proper, of which there are 3, lightly convex, body-whorl very slightly subangled for a short distance in front of suture, which is deep and channelled. Aperture oval, oblique, angled above. Peristome discontinuous, outer lip with prominent varix behind, but sharp edge; slightly effuse basally, and angulated medially. Columella short, arcuate, rounded. Inner lip distinctly callous but not covering the narrow elongated umbilical chink.

Height, 1.5 mm.; diameter, 0.9 mm.; height of aperture, 0.7 mm.

Type and several paratypes, from Pourakino, Riverton (Awamoan ?), in the author's collection.

Very close to *N. vulgaris* (Webster); separable only by its consistently smaller size and more tightly clasping spire-whorls. The Recent species has not been found fossil, and it is curious to find a form so closely similar in beds of at least Awamoan age. The outer lip of the holotype is rather more rounded than in the other specimens, most of which have a prominent angulation at about the middle. The holotype, too, on account of its fine preservation, is almost the only specimen that shows the axial markings and median furrow.

Subsp. paroeca n. subsp.

Differs from the species only in slightly higher spire and more regularly curved outer lip, which slants downwards from suture without any medial angulation. Both adult specimens show these differences, but otherwise are so like *N. prisca* that full specific rank does not seem justified.

Height, 1.4 mm.; diameter, 0.8 mm.; height of aperture, 0.6 mm.

Type and two paratypes, from Clifden, Southland (bands 6A and 6C Ototaran ?), in the author's collection.

Notosetia sp.

In the author's collection is a single worn specimen of a species from the Kakanui tuffs which somewhat resembles *N. micans* (Webster). Apart from the foregoing species, it is the only one of this genus yet known from pre-Pliocene beds in New Zealand; it is certainly new, but description is withheld till better specimens are obtained.

Notosetia sp. cf. *subflavescens* Iredale.

Rissoa atomus Suter; not of Smith (Iredale, 1915).

Specimens of a shell very close to, if not identical with, this species are not uncommon at Castlecliff; they are rather variable, the body-whorl being often subangled with traces of microscopic spirals on some specimens. They agree with the diagnosis in every point except that of translucent test; opacity may be due to fossilization, but in the absence of authentic specimens of the Recent form identification is deferred. *Notosetia* is the most difficult and unsatisfactory genus in the New Zealand Rissoidae.

The name *Notosetia pupa* nov. is suggested in place of *Rissoa lubrica* Suter, 1898; preoccupied by *R. lubrica* Verrill, 1885.

Epigrus fossilis n. sp. (Fig. 10.)

Shell minute, elongate-oval, smooth and polished. Apex and first whorl lost. Whorls very slightly convex, long in proportion to width, loosely coiled, regularly rounded and not shouldered, base convex. No sculpture except fine flexuous and rather conspicuous growth-lines. Spire elongate-conic, evidently considerably higher than aperture. Suture canaliculate. Aperture oblique, ovato-semilunar, extended beyond body-whorl and separated from it by a rather narrow white sunken callosity. Peristome very thick and rounded. Columella short.

Height, at least 1.8 mm.; diameter, 0.75 mm.; height of aperture, 0.7 mm.

Holotype, from Pukeuri, in the author's collection.

The material consists of a single fragmentary specimen, but as the species is evidently rare, and the genus has not previously been recorded from New Zealand, it has been described. The Recent *E. dissimilis* (Wats.) and *E. vercomis* (Tate) of Australia seem to be related forms.

Rissoina perplexa n. sp. (Fig. 11.)

Shell minute, rather short, stout, almost imperforate, opaque, but slightly shining. Protoconch of about 2 convex whorls, apex minute, volutions very regular, forming a low but wide dome, sharply marked off from shell proper. Three post-embryonic convex whorls, base regularly rounded. Distant broadly-convex axial ribs cross whorls from suture to suture, 11 on body-whorl, faint at extremities, but gradually swelling at middle of whorls; they rapidly diminish in strength near periphery and are absent on base, which is quite smooth; interstices are 2-3 times width of ribs. Spiral sculpture absent except for faint swelling margining suture above, and fairly strong, blunt angulation at upper three-quarters of whorls; between these is a small concave shoulder. Spire bluntly conical, about $1\frac{1}{2}$ times height of aperture, outlines lightly convex. Suture impressed, submarginated below. Aperture suboval, oblique, both from left to right and from front to back, projecting farthest anteriorly. Peristome complete, sharp, but considerably thickened on upper part of outer lip, though not much elsewhere. A strong basal channel, marked by a semicircular curve in peristome; also a distinct posterior notch in outer lip. Inner lip not much thickened, encircled by a tiny umbilical chink.

Height, 2.1 mm.; diameter, 1 mm.; height of aperture, 0.8 mm.

Holotype (unique), from Clifden, Southland (horizon 6, of Park*), in the author's collection.

The channelled basal lip seems to indicate that this species is a *Rissoina*, otherwise it has considerable superficial resemblance to *Haurakia*. It is much smaller than any of the Recent species, and the aperture, too, is not quite in accord, being perhaps most like that of *R. chathamensis* (Hutt.), but the basal channel is less lateral; however, a somewhat similar type of notch is shown by *Nozeba*. *Rissoo nana* (Lamk.), and especially *R. misera* Desh., from the Paris Basin (Bartonian and Cuisian respectively) have considerable likeness to the new species, but it cannot be said from figures alone if they are generically related. It is a question, however, whether Iredale's "Gordian-knot solution" of abandoning almost all northern genera in favour of new austral ones will not rather hinder than help when Tertiary

* J. PARK, Geology and Mineral Resources of Western Southland, *N.Z. Geol. Surv. Bull. No. 23* (n.s.), p. 52, 1921.

species are under consideration. The convenient excuse that "the particular forms that conchologically agree are known, in the few cases that animal or opercular features have been studied, to disagree" is unfortunately not available for the palaeontologist, and it will not be the easiest of matters to decide at what stage of the Tertiary the line of separation should be drawn.

Rissoina chathamensis (Hutt.).

R. rugulosa (Hutt.) (see Iredale, *loc. cit.*, p. 453).

Locality: Castlecliff.

Rissoina (?) *obliquecostata* M. & M.

This shell is, as its describers remark, "very different from any other of our Recent or fossil *Rissoids*." It does not look adult, though this cannot well be judged from a figure, and is quite probably not a member of this family at all. The "narrow subperforation at the side of the columella, bounded by a small funicular ridge which curves round to the basal lip," is not reminiscent of any *Rissoid*.

Locality: Hampden.

Nozeba candida n. sp. (Fig. 12.)

Rissoina emarginata (Hutt.): Suter, *N.Z. Geol. Surv. Pal. Bull. No. 8*, p. 82 (not of Hutt.).

Shell small, trapezoidal, imperforate, polished, milk-white, loosely coiled, base truncate, with a few spirals. Protoconch minute, smooth, and shining, subhelicoid, nucleus globular. Shell-whorls 5, flatly convex, very glossy, the last large, occupying about three-quarters total height, slightly flattened below suture. Shell at first sight smooth, but close examination shows traces of linear spiral grooves on whorls, more distinct on upper ones just below suture; one or sometimes two on periphery, rather more prominent, those on base much more prominent; these vary in number from 4 to about 7, fairly equally spaced, but those near columella closer and fainter. A very shallow sulcus runs parallel with suture just below it, giving it an indistinctly margined appearance. Suture distinct but not impressed, also very faintly submargined above. Spire conical, not much higher than aperture. Aperture subvertical, subtriangular, the almost flat basal margin extending nearly whole width of aperture, outer lip descending to meet it in a gentle curve, union of the two much produced outwards. A strong lowly-convex and rather wide varix encircles outer lip, which has a bluntly-rounded edge. Peristome continuous, of irregular shape, heavily calloused along parietal wall; a narrow posterior channel in aperture, basal lip somewhat effuse and hollowed out, forming a very wide indistinct canal. Columella oblique, covered by the well-marked callus of inner lip, meeting basal lip in a bluntly rounded acute angle.

Height, 2.7 mm.; diameter, 1.4 mm.; height of aperture, 1.2 mm.

Type and many paratypes, from Pukeuri, in the author's collection. Also found at Ardgowan and Target Gully.

This shell has previously been recorded in lists from Awamoan localities as *Rissoina emarginata* (Hutt.). It is easily distinguished from this Recent and Pliocene species by the absence of the regular close grooves and the

differently shaped aperture. In the prominence of the basal grooves and almost smooth whorls it resembles *N. coulthardi* (Webster), but differs in its aperture. It is perhaps ancestral to these two Recent species. In the type specimen figured the basal margin is not so long and flat as in most specimens.

Var. effusa n. var.

Differs from the species only in its aperture, which is more effuse and projecting below and lacks the strong angulation at junction of basal and outer lips. This variety makes a still nearer approach to *N. coulthardi* (Webster), but the aperture remains a little truncate below, basal lip meeting columella in an acute angle as in the species.

Holotype and one paratype, from Pukeuri, in the author's collection.

Dardanula olivacea (Hutt.).

A rather solid, totally smooth shell, with flattish whorls.
Localities: Castlecliff, Nukumaru.

Dardanula rivertonensis n. sp. (Fig. 13.)

Shell minute, elongate oval, smooth. Protoconch obtusely marked off, blunt, of about 2 smooth flatly-convex whorls. Whorls about 5, flat, periphery bluntly angled. Surface quite smooth. Suture rather well impressed, especially in later whorls; body-whorl takes a downward curve near aperture, and becomes a little separated from penultimate whorl, so that suture becomes much deeper anteriorly. Spire conical, nearly twice height of aperture, which is subcircular, oblique, angled above. Peristome not quite continuous, but ends united by parietal callus. Columella short, arcuate, callous.

Height, 2 mm.; diameter, 1 mm.; height of aperture, 0.7 mm.

Holotype and many paratypes, from Pourakino, Riverton (horizon probably near Awamoan), in the author's collection.

Closely related to *D. olivacea* (Hutt.) and *D. limbata* (Hutt.), but smaller more slender, and with the aperture more oblique (both from left to right and from front to back) and relatively smaller. This is the only pre-Pliocene *Dardanula*. It is interesting that a form so close to the Recent species should be abundant in a locality of this age, when up till now it has been found nowhere else. The type and a few other specimens show traces of zigzag colour-bands most prominent on the periphery, as in the Recent shells.

Rissoa vana Hutt.

This name must be omitted from Rissoid lists, as it is a synonym of *Potamopyrgus badia* Gould. The specimens clearly came not from the Miocene clays at Awamoan, but from the Holocene river-gravels overlying these. Every flood of the Awamoan Stream lays a fresh coating of silt over the exposed parts of the beds, and, as *Melanopsis*, *Isidora*, *Lymnoea*, *Sphaerium*, and species of *Potamopyrgus* (especially *P. badia*) are plentiful in the stream, it is only to be expected that these should be found, as they all are, in a subfossil condition in the surface soils. The occurrence with them of numerous small land-shells is further proof of this origin; also, all these specimens are in a different state of preservation from the true Miocene



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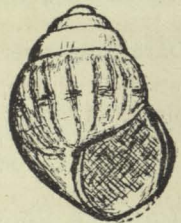
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FIG. 1.—*Haurakia mixta* n. sp. $\times 30$.
 FIG. 2.—*Haurakia oamarutica* n. sp. $\times 30$.
 FIG. 3.—*Linemera minuta* n. sp. $\times 18$.
 FIG. 4.—*Linemera pukeuriensis* n. sp. $\times 14$.
 FIG. 5.—*Linemera awamoensis* n. sp. $\times 20$.
 FIG. 6.—*Lironoba polyvineta* n. sp. $\times 12$.
 FIG. 7.—*Lironoba charassa* n. sp. $\times 12$.

FIG. 8.—*Estea polysulcata* n. sp. $\times 8$.
 FIG. 9.—*Notosetia prisca* n. sp. $\times 20$.
 FIG. 10.—*Epigrus fossilis* n. sp. $\times 19$.
 FIG. 11.—*Rissoina perplexa* n. sp. $\times 19$.
 FIG. 12.—*Nozeba candida* n. sp. $\times 12$.
 FIG. 13.—*Dardanula rivertonensis* n. sp. $\times 14$.

species, and frequently retain their colour-bands. One or two juvenile shells in the author's collection, which had been doubtfully named "*R. vana* Hutt.," proved to have exactly the same protoconch as specimens of *P. badia* gathered both living from the stream itself and subfossil from the silt. Suspicion of the identity of the two species was confirmed by examination of the type (kindly lent, through Mr. Marwick, by Miss Mestayer), so that the name *R. vana* Hutt. must be dismissed from faunal lists. *Potamopyrgus speleus* (Frauenfeld) has been found by the author in exactly similar circumstances, occurring with Pliocene fossils from Castlecliff.

KEY TO GENERA.

- Aperture suboval, edge thin, often reflected, much thickened internally,
no exterior varix *Estea*.
- Aperture with the edge either thin or thickened by means of an external
varix.
- (1.) Very strong spiral cords *Lironoba*.
- (2.) Clathrate sculpture.
- (A.) Protoconch spirally lirated, dull *Merelina*.
- (B.) Protoconch smooth, glossy *Linemera*.
- (3.) Axial ribs most prominent.
- (A.) Aperture rotund, simple; spirals rarely present *Haurakia*.
- (B.) Aperture obliquely ovate, channelled below, spirals
generally present *Rissoina*.
- (4.) Surface almost smooth.
- (A.) Shell white, highly polished, aperture channelled below *Nozeba*.
- (B.) Shell white, smooth, tall and cylindrical, aperture separated from the body-whorl by a groove *Epigrus*.
- (C.) Shell smooth or faintly spirally lirated, whorls convex, aperture simple, rotund *Notosetia*.
- (D.) Shell smooth, whorls flattish or convex, aperture ovato-pyriform, slightly channelled below *Dardanula*.

KEY TO SPECIES.

Genus *Haurakia*.

1. About 20 axial ribs per whorl, with an infrasutural groove, whorls flattish *H. miata* Finlay.
2. About 30 axial ribs per whorl, with faint spirals between, whorls convex *H. oamarutica* Finlay.

Genus *Linemera*.

1. Two distinct spiral ribs close to the lower suture, with a smooth band between, also an infrasutural groove *L. interrupta* Finlay.
2. Four weak and broad spirals per whorl, interstices linear *L. minuta* Finlay.
3. Four distinct but thin spirals per whorl, interstices much wider; axials about 18 per whorl *L. pukeuriensis* Finlay.
4. Six very fine spirals per whorl, interstices much wider; axials about 36 per whorl *L. awamoensis* Finlay.

Genus *Lironoba*.

1. Five spiral ribs per whorl, with 4 more on the base, interstices about three times their width *L. polyvincta* Finlay.
2. Three spiral ribs per whorl, with 5 more on base, interstices about twice their width *L. charassa* Finlay.

Genus *Estea*.

1. Shell without sculpture *E. zosterophila* (Webster).
2. Shell with spiral sculpture only.
 - (a.) Five spiral cords with linear interstices on the last $1\frac{1}{2}$ whorls *E. semisulcata* (Hutt.).
 - (b.) Seven spiral cords on the last 2 whorls, about 11 on base *E. polysulcata* Finlay.
3. Shell with axial riblets, about 20 per whorl, interstices narrower, and an infrasutural groove *E. impressa* (Hutt.).
4. Shell with subobsolete axials, about 22 per whorl, and 5 spirals on the spire-whorls, 3 more on base *E. rugosa* (Hutt.).

Genus *Notosetia*.

1. Aperture pear-shaped, spire noticeably higher than aperture *N. cf. subflavescens* Iredale.
2. Aperture subcircular, spire almost equal to aperture *N. paroeoa* Finlay.
3. Aperture subrhomboidal, spire subequal to aperture but rather immersed, last whorl very large *N. prisca* Finlay.

Genus *Epigrus*.

1. Shell with elongate spire and regularly flatly convex whorls and deeply channelled suture *E. fossilis* Finlay.

Genus *Rissoina*.

1. Shell elongate, about 16 axials per whorl *R. chathamensis* (Hutt.).
2. Shell oval, about 30 axials per whorl *R. obliquecostata* M. & M.
3. Shell minute, short, about 11 axials per whorl *R. perplexa* Finlay.

Genus *Nozeba*.

1. Spiral grooves present over the whole surface, aperture pyriform, truncated *N. emarginata* (Hutt.).
2. A few prominent spiral grooves on base only, aperture subtriangular, very broadly truncated *N. candida* Finlay.
3. Ditto, but aperture effuse and produced *N. candida* var. *effusa* Finlay.

Genus *Dardanula*.

1. Height of shell about $1\frac{1}{2}$ times the width, shell reaching a height of 3 mm. *D. olivacea* (Hutt.).
2. Height of shell about twice the width, shell reaching a height of 2 mm. *D. rivertonensis* Finlay.

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