# *The Struthiolariidae.*

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Plates 11–15.

## Family STRUTHIOLARIIDAE Fischer, 1884.

### PART I.—GENERIC CLASSIFICATION.

IN his invaluable *Essais de Paléoconchologie comparée*, Cossmann (1904, p. 106) tabulates the family as follows :—

| Genus. | Subgenus. | Section. |
|---|---|---|
| *Struthiolaria.* Beak short, adjacent to the basal sinuosity. | *Struthiolaria.* Columellar margin thin and wide. | *Struthiolaria.* Lip bisinuous. |
| | | *Struthiolariopsis.* Lip unknown. |
| | *Pelicaria.* Thick layer of enamel on the spire. | *Pelicaria.* Sutural excavation. |

In addition there is *Struthiolarella* Steinmann and Wilckens, separated as a subgenus in 1908.

*Zemira* H. and A. Adams was placed in the family by Hedley (1899, p. 118) because of the curved columella and the presence of a spur on the outer lip, but the nature of the latter is quite different from that of the projection on the lip of *Struthiolaria*. The little spur on the lip of *Zemira* owes its origin to the spiral channel on the anterior portion of the body-whorl, as in *Ancilla* and *Pseudoliva;* but in *Struthiolaria* there is no spiral channel, the two projections on the outer lip not being dependent on the spiral sculpture. In addition the opercula are different, so it does not seem advisable to include this genus in the Struthiolariidae.

### STRUTHIOLARIOPSIS Wilckens, 1904.

Genotype: *Fusus ferrieri* Philippi.

The value and systematic position of this genus are by no means established. It was placed in this family because of the strong spirals on the base, thus resembling the South American members. Cossmann rightly considered the creation of the genus on the material available "premature," as the aperture was unknown. The excellent figure (Wilckens, 1904, pl. 18, fig. 5), however, shows that the course of the growth-lines of the outer lip is the same as that of *Belophos*, which has many Tertiary representatives in New Zealand. Other features of agreement are the concave shoulder, with fine spirals, much stronger spirals below, and the presence of axial sculpture. A figure of the New Zealand *Belophos*

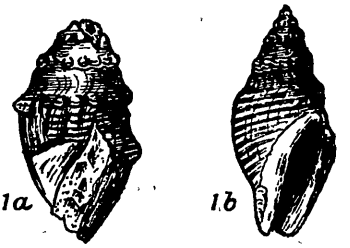



FIG. 1.—*a. Struthiolariopsis ferrieri* (Phil.). (After Wilckens.)
*b. Belophos sulcata* (Hutton).

cf. *sulcata* (Hutton) is given (text-fig. 1*b*) for comparison with the type of *Struthiolariopsis*. The chief differences observable are the longer axials and the higher whorls of the former.

Another species attributed to this genus is *Struthiolariopsis similis* Wilckens (1922, p. 17), from the Upper Senonian of Amuri Bluff, New Zealand; but unfortunately this shell does not in any way improve the position. Wilckens was not sure whether there was an anterior canal, but the aperture of the type and only specimen has now to some extent been cleared of the hard matrix (see text-fig. 2). The columella is quite straight, and, where broken, the canal shows little taper, so it was originally much longer. This, with the strong biangulation of the body-whorl, the nodules on the shoulder-angle, the course of the growth-lines, and the disposition of the spiral ornamentation, indicates generic, perhaps even specific, agreement with *Tudicula alta* Wilckens, figured by him on the same plate, and occurring at the same locality.

FIG. 2.
*"Struthiolariopsis" similis* Wilckens (holotype).

*Struthiolariopsis* should therefore be removed from the Struthiolariidae and put near *Belophos*. The latter genus was placed by Cossmann (1901, p. 37) in the Buccinidae, but its shape, aperture, and ornamentation show relations with *Pseudotoma*, the only difference being the deeper anterior notch of the canal.

* * * * * * *

The shells hitherto classed under *Struthiolaria* sensu lato present a considerable diversity of appearance, and several well-defined divisions can be made :—

1. *Monalaria* n. g. Outer lip with broad sinus above sweeping round to a convex wing below, columella straight.
   - *a*. Whorls convex, sculpture of equal strong spaced spiral cords. Ex. cf. *S. lirata* Tate.
   - *b*. Whorls with curved axials, crossed by spaced spiral cords. Ex. *S. minor* Marshall.
   - *c*. Early whorls as in *b*, later whorls with fine regular spiral striae, and axials abbreviated to sharp tubercles. Ex. *S. concinna* Suter.
2. *Struthiolarella* Steinmann and Wilckens. Outer lip as in 1, columella slightly bent in youth, curvature increasing with age; whorls subangled, early sculpture of curved axials, later abbreviated to rounded tubercles, fine spirals above, strong cinguli below. Ex. *S. ameghinoi* von Ihering.
3. *Struthiolaria* Lamarck. Outer lip bisinuous, columella bent well to right.
   - *a*. Whorls angled, often tuberculate, sculpture of fine spiral lirae. Ex. *S. papulosa* (Martyn).
   - *b*. An enormous development of callus on inner lip, otherwise as *a*. Ex. *S. callosa* n. sp.
   - *c*. Spire-whorls bicarinate or tricarinate, body-whorl with four principal spiral cinguli and several weaker ones below, cinguli sometimes moniliform. Ex. *S. vermis* Martyn.
4. *Tylospira* Harris. Outer lip bisinuous, columella well bent, lightly calloused at an early stage, but continuing to grow forward so that no sculpture is formed on the body-whorl. Ex. *B. scutulatum* Martyn.

The four main divisions, based on the formation of the aperture, are here given generic rank, and that these genera have sprung from a common stock appears on a study of their ornamentation.

Grabau (1902) was the first to apply the theory of recapitulation to the development of gasteropod sculpture, notably for *Fusus* (1904). Additional groups have been worked out by Miss McDonald, Dr. Trueman (1921), and others.

The following is an attempt to discover the phylogeny of the family by following the ontogeny of some characteristic species.

Well-preserved examples of the Recent and Pliocene *S. papulosa* and *S. vermis* show, in most cases, a small almost planorbid apex of one or two smooth volutions. This has always been considered as the protoconch; but a surprising condition was revealed by some specimens of *S. vermis* from the Wanganuian Pliocene. In these the protoconch is a smooth, bulbous, capuliform structure, with its long axis at right angles to that of the shell (a particularly large and projecting example is figured in text-fig. 3, *a–c*). That this is the true protoconch is shown by the

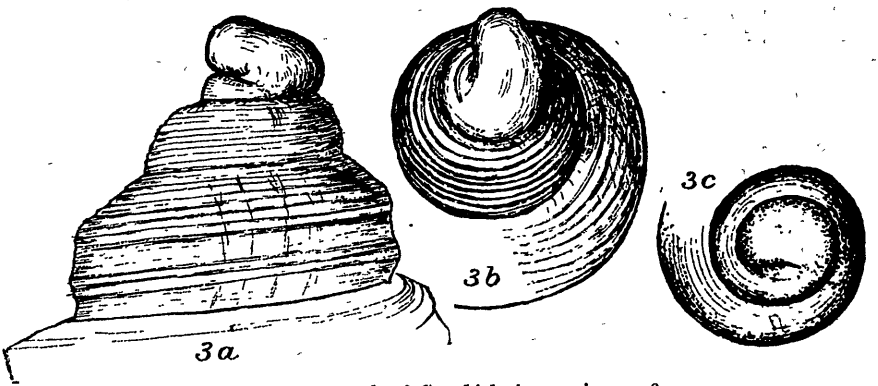



FIG. 3.—Protoconch of *Struthiolaria vermis*. × 6.

appearance of the same feature on specimens of *S. convexa* n. sp. from the Pliocene of the Ngaruroro River. In withdrawing from the embryonic shell the animal constructs numerous septa, so that, the hollow bulb being easily broken off, a planorbid apex is the result. It is probable that this type of protoconch prevails throughout the genus, for the smooth planorbid tip, generally seen in all well-preserved shells, is followed by a convex, striated conch-whorl similar to that following the deviated protoconch of the examples cited above.

### 1. Genus MONALARIA n. g.

Genotype: *Struthiolaria tuberculata concinna* Suter.

(*a.*) *S. lirata* Tate. The first volution of the conch in all species of New Zealand Struthiolariidae is a convex whorl with about six regular spiral threads separated by interspaces of slightly greater width, and, as far as seen, all starting at practically the same time. This indicates that the primitive type from which the various species are descended was a round-whorled shell with strong regular-spaced spirals, a condition well represented by *Struthiolaria lirata* Tate from the Gippsland Lakes (Tate, 1889, p. 169, pl. x, fig. 11). (See text-fig. 4.)

FIG. 4. "*Struthiolaria*" *lirata* Tate. (After Tate's figure.)

The figure shows that this species has a straight columella, and little callus on the inner lip, though the outer lip is thickened. That a certain advance has been made on the primitive type is indicated by Tate's description of secondary spirals in the interspaces of the body-whorl. The growth-lines are stated to be "sigmoidal," which

suggests agreement* with *Monalaria* n. g. (see below) rather than with *Struthiolaria.*

(*b.*) *M. minor* (Marshall). The only apex seen is tectiform, consisting of about two smooth rounded whorls, the top one small and depressed; the nucleus, however, is broken off. The first conch-whorl is convex and has eight spirals appearing simultaneously, but the shell is somewhat weathered at this point. Later the whorl becomes subangled and short, curved axial ribs appear on the upper part of the whorl, not reaching the suture below, while the spirals increase in number. The body-whorl is weakly biangulate, the lower keel having two more prominent cords, the upper of which is moniliform. The outer lip is reflexed and thickened with a broad sinus above, sweeping forward to a prominent rounded wing opposite the lower keel, and then retreating in a shallow sinus to the columella. No specimen showing a complete aperture has yet been found, but, while the columella is twisted, it does not appear to have been bent inwards at the base. (See Plate 11, figs. 5, 6, 7.)

(*c.*) *M. concinna* (Suter). The first two conch-whorls are the typical convex spirally-striated ones common to the apices of the family, and the next two show a fine development of the curved axial ribs crossed by the primary spirals with secondaries appearing in the interstices; that is stage (*b*) as typified by *M. minor.*

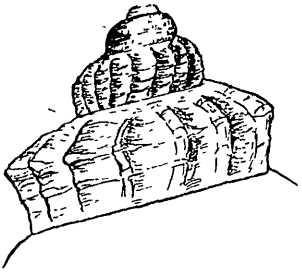


FIG. 5.—Apex of *Monalaria concinna* (Suter). × 3.

On succeeding whorls the axials are much abbreviated, forming strong sharp tubercles on a well-developed shoulder-angle. The body-whorl has, in addition, a double lower keel armed with more closely set tubercles, while the spirals have become numerous fine regular threads. The columella is straight and comparatively little calloused, while the contour of the outer lip is exactly the same as that of *S. minor—i.e.*, it is unisinuous.

2. Genus STRUTHIOLARELLA Steinmann and Wilckens, 1908.

Genotype: *Struthiolaria ameghinoi* von Ihering.

This group was separated from *Struthiolaria* as a subgenus (Steinmann and Wilckens, 1908, p. 53) for the reception of the South American species, on the grounds that they differed from the typical New Zealand shells as follows: (1) "On the older whorls spiral sculpture does not predominate, but axial ribs, which are, it is true, crossed by fine spirals"; (2) "there is no continuous spiral angle formed on the upper part of the whorls." Other important features justify the separation. Ortmann's figure of *S. ornata* (1901, pl. 33, fig. 12*a*), reproduced below (text-fig. 6, *a*), shows convex whorls with the curved axial ribs crossed by spirals as in *Monalaria*,

* A new genus seems to be required for *S. lirata* because of the different sculpture from *Monalaria.*

while on the base are two strong spiral cords. Other and more developed species of the group show the axials abbreviated to rounded tubercles with many strong spirals below. The columella is in most cases only slightly bent; but in *S. nordenskjoldi* Wilckens the curvature is marked, and the callus is well developed, showing that a gerontic stage has been reached. In all cases the outer lip has the same contour as that of *Monalaria—i.e.*, there is one prominent sinuosity.

The development of strong spirals on the base shows that this group branched off from *Monalaria* sensu lato before the development of such as *M. concinna*, but it may have come through *M. minor*. The age of these two species cannot definitely be placed on the European time-scale, but the probabilities are that the latter is about Palaeocene and the former Oligocene. The curvature of the columella and the spread of the callus in mature

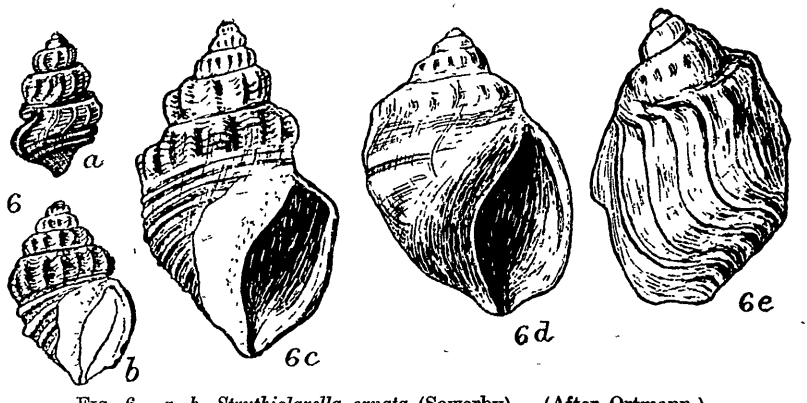



FIG. 6.—*a, b. Struthiolarella ornata* (Sowerby). (After Ortmann.)
*c. S. ameghinoi* von Ihering. (After Ortmann.)
*d, e. S. nordenskjoldi* Wilckens. (After Wilckens.)

individuals—see Steinmann and Wilckens, 1908, figures of *S. ameghinoi*, pl. 6, fig. 7, and *S. nordenskjoldi* Wilckens, 1911, pl. 1, figs. 26, *a*, *b*—in addition to the strong basal spirals, justify the generic separation of *Struthiolarella* from *Monalaria*, while the contour of the outer lip and the ornamentation separate it from *Struthiolaria*. Wilckens later (1922, p. 17) tentatively suggested that *S. nordenskjoldi* was wrongly classed with *S. ameghinoi*, and was more closely related to *Conchothyra parasitica*. The writer does not agree with this, and considers *S. nordenskjoldi* to be a gerontic development of *Struthiolarella*.

Under *Struthiolarella*, Steinmann and Wilckens included *Tylospira coronata* (Tate) from the Lower Tertiary of Victoria, and the living *Struthiolaria mirabilis* Smith from Kerguelen Land, not granting generic recognition to *Tylospira* as based on *B. scutulatum*. Previously Tate (1889, p. 170) had included the Kerguelen shell with *T. coronata* and *T. scutulata* in his interpretation of the genus *Pelicaria* (*i.e.*, *Tylospira*).

FIG. 7.
*Struthiolarella mirabilis* (Smith).
(After Tryon.)

Though the apertural callus is lacking, *S. mirabilis* certainly is similar to *S. ameghinoi*, and is perhaps rightly associated with *Struthiolarella*; but

the case for the inclusion of *T. coronata* is not so good, because it involves the separation of that species from *T. scutulata* and *T. clathrata.*

It is necessary, before going further, to determine what relative importance should be conceded to the various shell-characters. Roughly, the order of importance may be stated as—first, the formation of the aperture; second, the ornamentation; third, the disposition of the callus. (The protoconch is, of course, very important in classification, but the material available does not allow of its use in the present case.) Naturally, the rule cannot be applied absolutely, because a small difference in the aperture might not carry the same weight as a considerable difference in sculpture; also, the possibility of parallelism and convergence must be taken into account. Still, there is a broad relative value attached to the features mentioned.

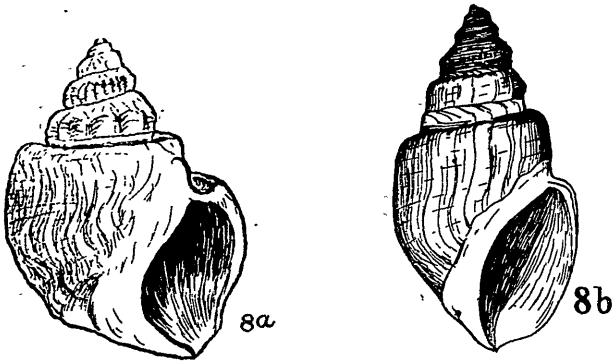



FIG. 8.—*a. Tylospira coronata* (Tate). (After Tate.)
*b. Tylospira scutulata* (Martyn).

As regards the generic position of *T. coronata*, an examination of actual specimens shows that it cannot be separated generically from *T. scutulata*, the type of *Tylospira*. Both species have a bisinuous outer lip which is not reflexed in the adult. In late youth this lip acquires a shining callus which, continuing across the suture, ascends the wall of the preceding whorl. Unlike Struthiolaria, growth continues for a considerable time after the formation of this callus, so that no ornamentation except growth-lines and a few obsolete spirals is developed on the body-whorls. If Steinmann and Wilckens were correct in classing *T. coronata* as *Struthiolarella*, then *T. scutulata* would also have to be included, and *Tylospira* would supersede *Struthiolarella*. The former genus, however, has a bisinuous outer lip, while the latter has a unisinuous one, so that the two generic terms should stand, *Tylospira* for the Australian and *Struthiolarella* for the South American species.

### 3. Genus STRUTHIOLARIA Lamarck, 1812.

Genotype: *Buccinum papulosum* Martyn.

#### (*a.*) *S. papulosa* Group.

The apex consists of about two smooth whorls, the first planorbid; but, as pointed out above, these may not represent the true protoconch.

The first conch-volution of the type species is the usual convex one with five or six spirals. Three finer exogeneous spirals (Grabau, 1902) then appear, while at the posterior primary spiral the whorl shows a slight

angulation that gradually becomes stronger and bears nodules formed by the intersection of the growth-lines. On later whorls these nodules become more prominent and farther apart, finally developing into prominent tubercles, and numerous secondary endogeneous spirals appear. The stage of curved axial ribs so characteristic of *Monalaria* is not represented, so this is probably a case of lipopalingenesis, or the dropping of an ancestral stage in the ontogeny of a specialized group (Grabau, 1904, p. 3; Trueman, 1922, p. 141).

About the third conch-whorl of *S. subspinosa*, *S. cincta*, and some others of the group, a faint spiral cingulum appears half-way between the shoulder and the suture. This disappears after one or two volutions, but, together with the angled shoulder, it may represent the stage at which

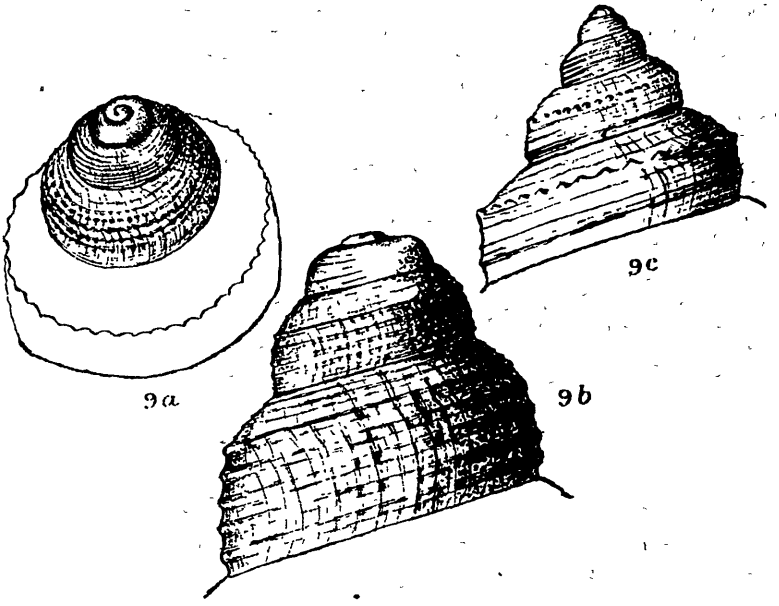



FIG. 9.—*a*. Apex of *Struthiolaria papulosa*; × 6. *b*. Same; × 12. *c*. *Struthiolaria subspinosa*; × 3.

diverged the *S. vermis* group, with its bicarinate spire-whorls. This bicarination has practically disappeared from the early whorls of *S. papulosa*, but some specimens have a suggestion of it.

Traces of the double lower keel of *M. concinna* linger in some specimens of *S. subspinosa*, but in the other Miocene species, such as *S. spinosa*, this keel is single, while in the Pliocene and Recent *S. papulosa* it has disappeared, leaving only one angulation—*i.e.*, at the shoulder of the body-whorl.

More profound changes from the *Monalaria* stage are to be seen in the curved columella, and the appearance of a second angulation on the outer lip, opposite the posterior keel (or shoulder-angle). Indeed, these features may indicate that *Struthiolaria* s. str. did not descend through *Monalaria*, but that the two are independent branches of an earlier convex-whorled ancestor. This would mean that the body-whorls of *M. concinna* and *S. subspinosa* are parallel developments, but their close agreement in details of sculpture points rather to direct descent of the latter from the former.

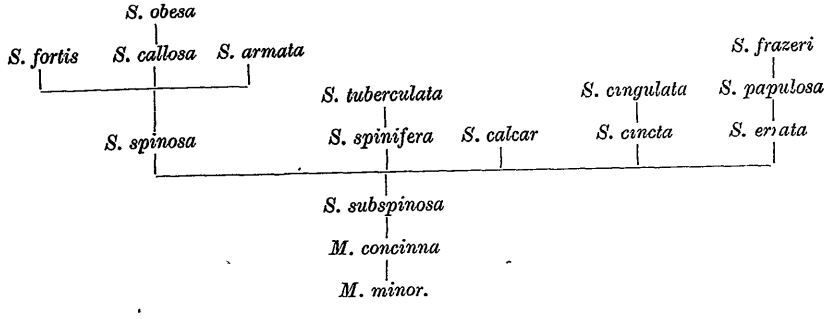
This resemblance is so close that Suter granted only varietal rank to *M. concinna*, though why he considered it a variety of *S. tuberculata* is hard to understand.

(*b.*) *S. callosa* Group.

At different localities in the rocks of Upper Miocene and perhaps Lower Pliocene age there are several species of *Struthiolaria* which have a somewhat strange appearance. These shells agree with *Struthiolaria* s. str. in all essential features, but there is a huge development of the rather flat pad on the inner lip. This callus-pad surmounts the shoulder, even burying the long tubercles, generally reaching the posterior suture, but rarely adhering to the whorl above. On the outer part of the base the pad protrudes and has a vertical face exteriorly; but between this knob and the anterior beak is a deep smooth channel with only a thin layer of enamel. The pad is rounded off somewhat abruptly at its upper junction with the outer lip, forming another channel on the shoulder. The outer lip is thickened and reflexed, but no more so than in the typical *Struthiolaria*. In the sutures on the later spire-whorls a layer of enamel is generally showing, sometimes ascending to the row of tubercles on the shoulder (see Plate 14).

At least four species are represented, but they may not form a natural group distinct from the *S. papulosa* group; for, while *S. callosa*, apart from the callus, agrees closely with *S. spinosa*, *S. armata* appears to be just as closely related to *S. spinifera*. This might mean that the great callus is produced by a parallel development of different species.

The following table gives a suggested ancestry of the species belonging to the two foregoing groups :—




(*c.*) *S. vermis* Group.

The shells belonging to this group form a well-defined series attaining considerable development in the Wanganuian (Pliocene) of New Zealand. Only one specimen has been seen from a lower horizon, the Tawhiti series, East Cape, which may be of Upper Miocene age. This shell is much distorted, but there is no doubt that it belongs to the group, being closely allied to *S. acuminata* n. sp.

A study of the neanic shell of *S. vermis* shows that the first conch-volution is regularly convex, with the usual five or six spirals. On the succeeding volutions these become grouped into two cinguli forming a biangulation in the spire-whorls, with numerous secondary spirals (see text-fig. 3). On later spire-whorls in some species (ex. *S. canaliculata*) a third cingulus appears posteriorly.

*S. convexa* n. sp. has rounded whorls throughout, but there are numerous fine spirals of secondary and higher orders arranged in groups as obsolete cinguli, corresponding to those of related species. It is therefore not so primitive a type as at first might appear.

The characteristic feature of this group is the presence of spiral cinguli which make the spire-whorls bicarinate or even tricarinate; but the cinguli are sometimes obsolete, especially on the body. The spirals are occasionally nodular or moniliform, but are generally smooth, and there are never axial ribs. The aperture differs from most of the *S. papulosa* group in having a definitely limited inner lip of regular width, while the callus of the outer lip is thick and rounded in cross-section. The sinuation of the outer lip is shallow, sometimes obsolete, but the posterior edge of the callus generally shows its bisinuate character, which, with the curved columella, indicates a relationship closer to *Struthiolaria* s. str. than to any of the other groups. If a sectional or subgeneric name is required it will be *Pelicaria* Gray, 1857, with *Buccinum vermis* Martyn as type (see remarks below under *Tylospira*).

As already pointed out, the bicarinate spire is foreshadowed in the third conch-volution of *S. subspinosa* and *S. cincta*.

The canaliculate suture of such species as *S. canaliculata*, *S. fossa*, and *S. zelandiae* must be considered as a gerontic feature parallelling a similar development in *Tylospira coronata* (Tate).

It is possible that exception may be taken to the specific recognition of some of the forms described below. No subspecific, mutational, or varietal divisions are used in this paper; but it must be understood that the relations between some of the species in a group are much closer than those between others. After all, a species is a purely artificial division, and in palaeontology especially a grading is found between different forms, so that in a good series one can trace the gradual change which produces what is commonly termed a "new species." The placing of the specific boundary must always be a difficulty, and the better the collection the harder it is to decide; but that two different shells can be connected by a series is no reason why the extremes should not be separated specifically, especially if the change goes on throughout a considerable lapse of time.

Although the arrangement proposed in this paper is by no means final, it will be of much more use to the stratigrapher than the previous one.

### 4. Genus TYLOSPIRA Harris, 1897.

Genotype: *Buccinum scutulatum* Martyn.

*Pelicaria* was proposed by Gray (1857, p. 97), who gave as the single example, and therefore the genotype, *S. vernis*, for shells with a callus spreading over the body. The division was recognized sectionally by Tryon (1885, p. 134) and subgenerically by Fischer (1887, p. 677), but these authors cited *B. scutulatum* Martyn as an example, and did not mention *S. vernis*. Harris (1897, p. 218) noticed the anomaly, and thought *S. vernis* to be a misprint for *S. vermis* (Martyn). Consequently *Pelicaria* became synonymous with *Struthiolaria*, so he proposed *Tylospira* with genotype *B. scutulatum* Martyn for the calloused species. This proceeding was not approved by Cossmann (1904, p. 106), who argued that Gray, "who knew perfectly well *S. vermis* and *B. scutulatum*," would not have created a new genus for the former, which is nearer to the true *Struthiolaria* than is the latter.

In support of this he states that "all authors (Tyron, Zittel, Fischer) have admitted, till now, *S. scutulata* as the type of *Pelicaria*." The latter

argument does not apply, for the mere citing of an example by subsequent writers is not a legal fixation of a genotype (Jukes-Browne, 1909, p. 238), which, in any case, must be one of the original species given by the author. The only way, therefore, in which *Pelicaria* can be accepted for this group is to prove that *S. vernis* is synonymous with *B. scutulatum*.

This synonymity appears to be unlikely; for if Gray was "familiar with both *B. vermis* and *B. scutulatum*," and intended it for the latter, why (1) did he propose a new specific name for it? why (2) did he use a name so likely to be confused with *vermis?* what (3) is the derivation and meaning of *vernis?* It does not appear to be a Latin word.

On the other hand, *S. vermis* does not possess a spreading callus, as stated by Gray, but has a more limited one than *Struthiolaria* s. str., so it seems likely that he was handling a specimen of *T. scutulata* wrongly identified as *S. vermis*. This, however, cannot alter the fact that the only example cited by the author of *Pelicaria*, and therefore the type of that genus, is *S. vermis*. This is confirmed by at least one of the figures that he cited. The original reads, "*P. vernis*, t 5, f 3, t 91, f 6: Adams, *Gen. Moll.* t 27, f 7." The former reference is to *Figures of Molluscous Animals*, by Maria E. Gray (1850–54), a work which unfortunately was not available for this revision. The figure referred to in Adams's work is labelled "*Struthiolaria vermis*," and is a copy of Kiener's figure of that species; *vernis* is therefore a misprint for *vermis*, and *Pelicaria* is synonymous with *Struthiolaria*, as Harris stated. *Tylospira* must be used for the group of calloused shells typified by *Buccinum scutulatum* Martyn, and including the fossils *T. coronata* (Tate) and *T. clathrata* (Tate). (See text-fig. 8 and remarks above under *Struthiolarella*.)

Both Tryon and Cossmann give only New Zealand as the locality for *T. scutulata*, and consequently cite *Pelicaria* (= *Tylospira*) as a New Zealand genus. This is not correct. *T. scutulata* is a New South Wales shell (Tate, 1889, p. 170), and does not occur in this country, so that the genus *Tylospira* must be considered as exclusively Australian. The peculiar formation of the body-whorl by continued growth of the outer-lip callus, as well as the arched columella and sharp beak, justify generic distinction from *Struthiolaria*.

## Phylogeny of the Family.

From the foregoing it will be seen that all the members of this family have descended from a convex-whorled ancestor with fairly strong, spaced spirals, probably of Cretaceous age. "*Struthiolaria*" *lirata* Tate, which has been cited above as an example, is probably far in advance of the primitive form, but gives a general idea of what its appearance must have been.

In the next stage, that illustrated by *M. minor*, there are strong axial ribs which curve forward anteriorly, following the shape of the outer lip. This species presents a remarkable similarity to the young uncalloused stage of the Upper Senonian *Pugnellus marshalli* Trechmann (1917, p. 302, pl. xix, figs. 1–4), which Wilckens (1922, p. 14) considers conspecific with *Conchothyra parasitica* Hutton. The specimen of *P. marshalli* figured below (text-fig. 10), a paratype, shows by growth-lines that the contour of the outer lip of early stages was almost identical with that of *Monalaria*, the wing being a little narrower (see text-fig. 10). The other features also correspond, for the columella is straight, and the ornamentation consists of axially-elongated tubercles on the shoulder and

two weak cinguli below, fine spirals covering the whole surface. Later in life the shell is heavily calloused (*C. parasitica* is completely covered), the wing is more prominent, and the columella curved. This condition shows that a gerontic stage has been reached, so that it is unlikely that *Monalaria* is a direct descendant of *Conchothyra*. The ontogeny shows, rather, that both had a common origin, but that *Conchothyra* became much more specialized and soon died out, while the *Monalaria* stock persisted.

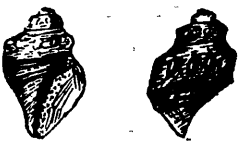


FIG. 10.
*Conchothyra marshalli* Trechmann (juv.); Selwyn Rapids. Compare with *Monalaria minor* (Plate 11, figs. 5, 6, 7).

The next development was a shortening of the axial ribs into tubercles, accompanied by evolution of the spiral sculpture along two different lines—(1) fine equal spiral lirae on a bicarinate body, (2) strong cords below a tubercled shoulder.

The former retains the straight columella and is the typical *Monalaria* (in which the previous stage is here included generically); but in the latter, *Struthiolarella*, the columella becomes curved, and a considerable callus forms in some species.

In *Struthiolaria* s. str., which seems to date from the early Miocene or late Oligocene, there is a change in the outer lip, which becomes bisinuous, the columella is well curved, and the callus generally well developed. Sometimes it is enormously so, but these highly specialized forms did not last long. The history of the *S. vermis* group is somewhat uncertain; the apertural characters are the same as those of *Struthiolaria* s. str. (*i.e.*, the *S. papulosa* group), but the ornamentation is of a very different nature, and in the course of its development shows none of the preceding stages except the first convex one. The appearance of a somewhat similar bicarination is, however, seen in young whorls of some of the Miocene *Struthiolaria* s. str., so it is possible that the *S. vermis* group diverged during early Miocene or late Oligocene times. As its appearance before the Pliocene is very brief, it is possible that the divergence was caused by isolation, which ended towards the close of the Miocene.

*Tylospira*, with its much-curved columella and peculiar callus, is evidently an advanced genus. The bisinuous outer lip would seem to connect it with *Struthiolaria*, though its early appearance in the Tertiary shows that it is not descended from that group. Perhaps both sprang from an earlier common ancestor, slightly in advance of *Monalaria*. A study of the ontogeny of the Australian species might throw some light on this point.

* * * * * * *

An analysis of the published lists of New Zealand Tertiary Mollusca, with a view to finding the stratigraphical range of the different species, gives a result quite disheartening to the stratigrapher. According to these lists, many species range from the bottom to the top of Oamaruian, and even into Wanganuian and Recent times. As accurate correlations with European stages or even systems cannot yet be made, such results are liable to force all New Zealand Tertiary strata into one horizon. There is already a tendency in this direction, for several geologists have put the whole of the Oamaruian into the Miocene.

## Stratigraphical Distribution.

| Palaeocene | Oamaruian. Oligocene (perhaps Upper Eocene)—Miocene. | | | | Wanganuian. Pliocene. | | | Recent. |
|---|---|---|---|---|---|---|---|---|
| Wangaloan. | Bortonian. | Upper Waiarekan, Ototaran, and Hutchinsonian. | Awamoan. | Mokau Series, &c. | Waipipian. | Nukumaruian. | Castlecliffian. | |
| *M. minor* | *M. concinna* | *M. concinna* (?)<br>*S. subspinosa* (?) | *S. subspinosa* | *S. subspinosa* | *S. cincta*<br>*S. cingulata*<br>*S. errata* | *S. frazeri* | | |
| | | | | | *S. papulosa* | *S. papulosa* | *S. papulosa* | *S. papulosa* |
| | | | *S. spinosa* | *S. callosa*<br>*S. fortis* | | | | |
| | | | *S. tuberculata*<br>*S. calcar*<br>*S. spinifera* | *S. armata*<br>*S. obesa* | | | | |
| | | | | | *S. canaliculata* | *S. acuminata* | *S. tricarinata* | *S. tricarinata* |
| | | | | *S.* cf. *acuminata* (Tawhiti Series) | *S. monilifera*<br>*S. zelandiae* | *S. vermis* (?)<br>*S. parva* (?) | *S. vermis* | *S. vermis* |
| | | | | | *S. rugosa* | *S. fossa*<br>*S. convexa*<br>*S. media* | | |

The position is by no means so confused as the fossil-lists would show, but it is a difficult matter to supply an absolute proof, especially as the evidence is largely negative. It is impossible, for instance, to take all the records of *S. papulosa*, and to establish the correctness or incorrectness of each identification. But since, in the extensive collections examined from many localities during the course of this revision, a very definite sequence of species was observed, it is a fair inference that such stratigraphical limits prevail throughout the country.

Previous to the appearance of Suter's bulletins the identification of Tertiary Mollusca from Hutton's catalogue was pure guesswork, and the greatest credit must be given to Mr. Suter for the improvement he effected in the status of New Zealand Tertiary palaeontology. It must, however, be recognized that, owing to the great amount of ground covered, many of his specific usages were applied too widely, while in some cases, through bad material, altogether wrong identifications were made.

The table giving stratigraphical ranges of species of *Struthiolaria* on page 172 is therefore based on identifications made during the course of this revision only, and, except where correlations of South Island Pliocene localities are concerned, is claimed to give fairly accurately the stratigraphical limits of the different species.

For valuable help in the preparation of this paper by the loan of specimens, &c., my thanks are due to the following: Miss M. K. Mestayer, Dr. J. Henderson, Professor R. Speight, Messrs. H. J. Finlay, the late R. Murdoch, and W. R. B. Oliver; also to Mr. P. G. Morgan, Director of the Geological Survey, for his permission to publish.

## PART II.—SPECIFIC CLASSIFICATION.

### 1. Genus MONALARIA n. g.

Genotype: *Struthiolaria tuberculata* subsp. *concinna* Suter, 1917.

Shell somewhat small, ovate, umbilicus closed in the adult, conch-whorls at first spirally lirate, later with curved axial ribs, and finally keeled and tuberculate; outer lip reflexed, thickened, concave above, then produced in a sweeping curve into a broad rounded wing opposite the lower keel, columella straight, aperture produced into a short widely-open canal.

This genus differs from *Struthiolaria* in the contour of the outer lip, and the presence of a straight columella.

**Monalaria concinna** (Suter), 1917. (Plate 11, figs. 1, 2, 3.)

1917. *Struthiolaria tuberculata* Hutton subsp. *concinna* Suter, *N.Z. Geol. Surv. Pal. Bull. No. 5*, p. 9, pl. ii, fig. 9.

Shell rather small, ovate; spire broad, gradate, a little over half the height of aperture; whorls 6, later ones strongly shouldered; sculpture, first 2 conch-whorls convex, with 5 strong but narrow spiral ridges with wide interspaces, on third whorl they are reticulated by curved axials slightly stronger and wider apart than spirals, 3 posterior spirals much finer than other 5; fourth whorl strongly angled with wide shoulder, a fairly strong spiral thread on angle, 3 above and 2 below of equal strength, and, between these, 2 finer spirals with wide interstices in all cases; there are 13 strong rounded axials which commence a short distance from suture and are arched, anterior end being slightly in advance, they are not so

strongly curved as axials of earlier whorl, but are much more prominent; on the penultimate whorl spirals are same as before, but axials have rather the appearance of tubercles on angle of shoulder; body-whorl is spiralled by fine regular threads with wider interstices, the row of tubercles seen on the penultimate whorl continues with unabated strength, and below this is a double keel consisting of 2 rows of low tubercles which do not correspond to those of shoulder nor with each other; suture impressed; aperture inclined, ovate with a short truncated canal below; outer lip reflexed, thickened, concave above, but well produced at lower keel, retreating somewhat rapidly in a shallow sinus to anterior canal; inner lip very moderately calloused; columella straight, ending in a short beak.

Holotype in the collection of New Zealand Geological Survey.

Height, 31 mm.; diameter, 23 mm.

*Localities.*—Waihao greensands (holotype, J. A. Thomson); 176, 933, Black Point, Waitaki Valley; 164, greensands above coal-beds, Kakahu; 487, above coal-beds, Ngapara; 27, roof of upper coal-seam, Ten-mile Creek, north of Grey River.

The last two identifications are based on casts, and so may be of shells slightly different from *concinna*, but as far as can be seen they are specifically identical. It will be observed that the beds at all these localities are of a uniformly low horizon, so that this species will be of great value for zoning purposes because of its wide distribution.

For the subspecific relationship with *Struthiolaria tuberculata* nothing can be put forward as evidence. The shells are far apart; indeed, the apertures are so different that the distinction is of generic importance.

Several specimens show an earlier lip, after the formation of which the animal continued building its shell in the usual way. One such lip on the holotype is a complete whorl behind the present aperture, while a specimen from Black Point has a quite complete thickened lip one-third of a turn behind the final one.

Suter (1917, p. 9) mentions the cast of another specimen showing a fourth row of nodules, and concludes therefrom that *S. tuberculata* may have two, three, or four keels. This quite ignores other and much more important characters, for the cast with the four nodules is that of a *Galeodea* cf. *senex* (Hutton).

**Monalaria minor** (Marshall). (Plate 11, figs. 5, 6, 7.)

1917. *Struthiolaria minor* Marshall, *Trans. N.Z. Inst.*, vol. 49, p. 451, pl. 34, figs. 12, 13.

*Localities.*—Wangaloa (type); Boulder Hill, near Dunedin (H. E. Fyfe).

The exact horizon with reference to the European time-scale has not yet been worked out, but it is probably lowest Tertiary. (For description of the sculpture, see above, p. 164.)

### 2. Genus Struthiolaria Lamarck, 1812.

Genotype: *Buccinum papulosum* Martyn.

Shell ovate, umbilicus closed in adults; spire about same height as aperture which is oval, with slight posterior channel and very short truncated anterior canal; columella bent to right, ending in a beak; outer lip bisinuous, reflexed and thickened; inner lip with well-developed callus; protoconch probably bulbous, at right angles to axis, but generally destroyed, leaving a smooth planorbid apex.

In previous descriptions *Struthiolaria* has always been described as imperforate. A section of the columella, however, shows that it is hollow, and therefore the genus must be considered as umbilicate, but with the umbilicus closed in adults by the callus of the inner lip.

### (*a.*) *S. papulosa* Group.

**Struthiolaria subspinosa** n. sp. (Plate 11, figs. 4, 9, 10.)

Shell of moderate size, ovate, with gradate spire about equal in height to aperture; whorls 8, including protoconch, sharply angled above middle, with a somewhat flat shoulder, whorls immediately after protoconch convex, body-whorl bicarinate, concave between shoulder and lower keel, base very rapidly contracted; apex conoidal, of 2 smooth whorls, nucleus minute, planorbid; sculpture, angle of shoulder furnished with small sharply-pointed laterally-elongated tubercles, 14–20 on body-whorl, 18–25 on the penultimate, and about 30 on each spire-volution; keel of body-whorl obsoletely nodular, and base often with weak cinguli, of which the one nearest keel is sometimes stronger, giving the shell the suggestion of a double keel; the whole surface covered with fine, sharp, spiral threads, with wide interstices, 8 on first two convex whorls, 10 on third, the sixth thread from top being moniliform and marking the subangled shoulder, 7 above the finely-tuberculated shoulder of fourth whorl and 9 below, 9 above and 10 below on fifth, 10 above and 17 below on penultimate, the growth-lines very fine; on early whorls a strong spiral cord midway between angle and anterior suture, making whorl bicarinate; suture linear, not impressed; aperture ovate, angled above, produced below into very short canal; outer lip reflexed, thickened, wedge-shaped in cross-section, sinuous, not greatly produced at shoulder, more so opposite lower keel; inner lip with moderate regular callus, barely surmounting keel, and little wider than outer lip; columella concave, bent to right below, ending in beak.

Type in collection of the New Zealand Geological Survey.

Height, 40 mm.; diameter, 27·5 mm.

*Localities.*—165, White Rock River, Pareora (type); 170, Awamoa; 475, Mount Harris; 458, Lower Gorge, Pareora; 44, Brewery Creek, Mokihinui River; 577, Pareora beds, Kakahu; Target Gully shell-bed, Oamaru; Pukeuri, Oamaru; Hurupi Creek, Palliser Bay (J. A. Thomson), (two incomplete specimens); shell-bed above upper limestone, junction of Porter and Thomas Rivers, Trelissick Basin (J. A. Thomson); 952, Target Gully; Waikaia (H. J. Finlay).

*Remarks.*—This is the commonest and most widely spread *Struthiolaria* in the Tertiary. The specimens from higher horizons seem to have a smooth lower keel on the body-whorl.

Poor specimens and casts from the following localities resemble this species, but certain identification cannot be made: 98, brown sandstone, Whangaroa Harbour; 70, Akuaku, East Cape district; 649, Paparoa Rapids; 919, mudstone below upper limestone, Awakino Valley; 1043, grit band, McGovern's Stream, Ohura; 1048, Okahukura tunnel.

Distinguished from *S. spinosa* by the more numerous and finer spines, and the narrow callus of the inner lip. The description was compiled from paratypes as well as from the holotype, which is somewhat worn on the spire.

Many of the Target Gully specimens have an appearance somewhat different from the typical *S. subspinosa*. They have very small low

tubercles, are of a slender shape and small size, and have a sloping shoulder. It is quite possible that they can be separated as a distinct species. (See Plate 11, fig. 10.)

**Struthiolaria calcar** Hutton. (Plate 11, figs. 8, 11, 13.)

1873. *Struthiolaria cincta* var. C Hutton, *Cat. Tert. Moll.*, p. 11.
1886. *Struthiolaria calcar* Hutton, *Trans. N.Z. Inst.*, vol. 18, p. 335.
1887. *Struthiolaria calcar* Hutton, *Proc. Linn. Soc. N.S.W.*, ser. 2, vol. 1, p. 216.
1914. *Struthiolaria calcar* Hutton: Suter, *N.Z. Geol. Surv. Pal. Bull. No. 2*, p. 17, pl. 1, fig. 8.

*Localities.*—Shell-bed, Ardgowan, Oamaru (H. J. Finlay); Ashburton River, Canterbury (H. J. Finlay); Tengawai Cliffs, South Canterbury (Canterbury Museum).

Hutton gives as the original locality "Oamaru"; and, although the horizon cannot be stated definitely, it was probably Awamoan. Mr. Finlay has some fine specimens from the Ardgowan shell-bed and from the Ashburton River.

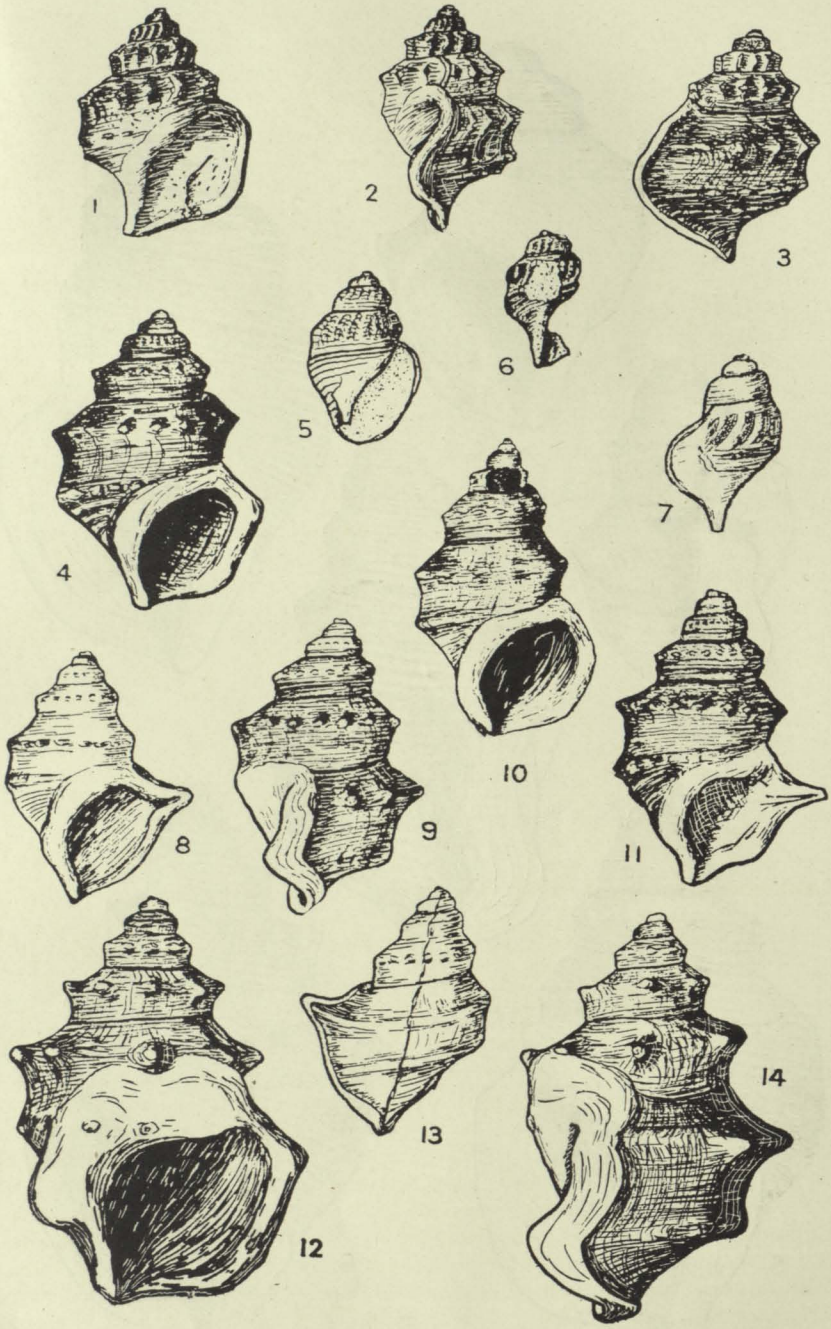
In all respects except the spur on the outer lip these shells are identical in appearance with *S. subspinosa*. Further, just as there are two forms of that species, a broad and a slender, so there are two similar forms of *S. calcar*. It is unlikely, however, that such a development should not have specific value.

The specimen described by Suter as Hutton's type is an artificial, plaster cast, and no trace of the original material now remains. Suter did not notice the nature of the "holotype," for he says (1914, p. 17), "protoconch and all the whorls covered by a white calcareous layer obscuring the sculpture." In view of this, Mr. Finlay's specimen from Ardgowan shell-bed (Plate 11, fig. 11) is here named "neotype." If, as seems probable, the plaster cast mentioned above was prepared directly from the original material it is a plastotype (Schuchert, 1905, p. 15); but there is no way of proving this.

**Struthiolaria spinosa** Hector. (Plate 11, figs. 12, 14.)

1886. *Struthiolaria spinosa* Hector, *Outline N.Z. Geol.*, p. 51, fig. 9, No. 13.
1886. *Struthiolaria tuberculata* Hutton, *Trans. N.Z. Inst.*, vol. 18, p. 335, in part (not of 1873).
1887. *Struthiolaria tuberculata* Hutton, *Proc. Linn. Soc. N.S.W.*, ser. 2, vol. 1, p. 216, in part (not of 1873).

Shell moderately large, ovate, turreted; whorls 7, strongly shouldered, body-whorl bicarinate; sculpture, the whole surface finely regularly spirally lirate, about 10 lirae on shoulder and 10 between angle of shoulder and suture below, on shoulder-angle is row of long, strong tubercles, 8 per whorl on neotype but 10 on some specimens, generally more numerous on earliest whorls; body-whorl provided with tubercled keel, just below level of suture, in this case tubercles are smaller and closer together than those of shoulder; suture linear, not impressed; aperture oblique, ovate, with shallow channel above and very short canal below; outer lip reflexed, thickened, sinuous, little produced at shoulder but well produced at keel, then retreating rapidly to canal; columella concave, ending in beak directed towards right and front; inner lip with very thick pad of callus which extends up to angle of shoulder, filling in spaces between tubercles and extending over part of base where it presents prominent protuberance with vertical face towards outside and wide smooth channel between it and beak.




FIGS. 1, 2, 3.—*Monalaria concinna* (Sut.). Type.
FIGS. 4, 9.—*Struthiolaria subspinosa* n. sp. Type.
FIGS. 5, 6, 7.—*Monalaria minor* (Marshall).
FIGS. 8, 13.—*Struthiolaria calcar* Hutton's plastotype.
FIG. 10.—*Struthiolaria subspinosa* n. sp. Target Gully.
FIG. 11.—*Struthiolaria calcar* Hutton. Neotype.
FIGS. 12, 14.—*Struthiolaria spinosa* Hector. Neotype.

*Face p. 176.*]


FIGS. 1, 3.—*Struthiolaria errata* n. sp. Type.
FIGS. 2, 5, 6.—*Struthiolaria papulosa* (Martyn). Recent.
FIG. 4.—*Struthiolaria papulosa* (Martyn). Mangatahi River.


FIG. 1.—*Struthiolaria cingulata* Zitt. (After Zitt.)
FIG. 2.—*Struthiolaria rugosa* n. sp. Type.
FIG. 3.—*Struthiolaria spinifera* n. sp. Type.
FIGS. 4, 5.—*Struthiolaria cincta* Hutt.
FIG. 6.—*Struthiolaria tuberculata* Hutt.
FIG. 7.—*Struthiolaria monilifera* Sut. Type.
FIGS. 8, 10. — *Struthiolaria frazeri* Hutt. Maraekakaho.
FIG. 9.—*Struthiolaria cingulata* Zitt. (usual form).


FIGS. 1, 2, 3.—*Struthiolaria fortis* n. sp. Type.
FIG. 4.—*Struthiolaria armata* n. sp. Type.
FIGS. 5, 6.—*Struthiolaria obesa* Hutt. Type.
FIGS. 7, 8, 9.—*Struthiolaria callosa* n. sp. (Fig. 7 is type.)

Neotype in collection of New Zealand Geological Survey.

Height, 55 mm.; diameter, 40 mm.

*Localities.*—165, White Rock River, Pareora (type); Ardgowan shell-bed (H. J. Finlay).

As pointed out by Thomson (1913, p. 25), Hutton illegally introduced *S. spinosa* (1886) as being more appropriate for his *S. tuberculata* (1873). Thus *S. spinosa* Hutton (1886) is an absolute synonym of *S. tuberculata* Hutton (1873). But in the same year (1886) Hector published a figure labelled "*S. spinosa.*" No locality is given, but the drawing (text-fig. 11) is a very fair representation of the common White Rock River species, which is quite different from Hutton's *S. tuberculata* var. B, the shell to which *tuberculata* proper was transferred by that author in 1886.

FIG. 11.
*Struthiolaria spinosa* Hector.
(After Hector's figure.)

The validity of Hector's specific name and the application of it depend upon whether his publication was prior to Hutton's, which was issued in May. Hector's *Outline* shows only the year of issue, but as the Indian and Colonial Exhibition, for which it was prepared, commenced in May it is safe to assume that the publication of the catalogue was earlier in the year than that of the *Transactions.*

Suter's usage of *S. tuberculata* for the Broken River species is correct; but he made a serious mistake in connection with the type of *S. spinosa.* Hutton (1873) listed *S. tuberculata* var. B, giving the localities "Palliser Bay; Waikari; Lower Gorge of Waipara." The specimen in the show-cases, and therefore the one to be taken as type of *S. tuberculata* var. B, is from Waikari. Both Hutton and Suter thought the White Rock River shell was specifically the same as this one, but their opinions must have been formed without a close examination of the shells, for the body-whorl of the former has a second row of prominent tubercles. A comparison of the figures here published will show the difference at once. *Struthiolaria spinosa* must be based upon the shell that Hector figured—*i.e.*, the White Rock River species; while a new name must be applied to the Waikari one. (See below, *S. errata* n. sp.)

**Struthiolaria spinifera** n. sp. (Plate 13, fig. 3.)

Shell moderately large, conoidal, with high turreted spire, 1½ times height of aperture; whorls 8, angled above middle with concave shoulder and sloping sides, body-whorl bicarinate, keel of greater diameter than shoulder-angle, base rapidly contracted; apex conoidal, nucleus minute, planorbid; sculpture, first whorls after apex are faintly shouldered, the shoulder-angle of fourth has numerous nodules, while on each of remaining whorls it bears 9 long strong spines, keel of body-whorl also has strong spines, more closely placed but hardly so long as those of shoulder-angle, fine spiral ornamentation is obsolete but growth-lines are strong; suture somewhat undulating, bulging over spines of concealed keel and with narrow strip of callus peeping over it here and there; aperture ovate, subangled above, produced into short canal below; outer lip reflexed, thickened, edge wedge-shaped, sinuous, with fairly prominent projection opposite shoulder-angle and more prominent one opposite keel, inner lip with

moderately wide and regular callus just surmounting keel where it joins outer lip; columella concave, bent to right below and ending in beak.

Holotype in collection of New Zealand Geological Survey.

Height, 55 mm.; diameter, 39·5 mm.

*Locality.*—475, Mount Harris (= *S. tuberculata* of *Pal. Bull. No.* 8, p. 64).

*Remarks.*—The long sharp spines show that this shell is closely related to *S. tuberculata*, from which it differs in its greater size and higher spire.

**Struthiolaria tuberculata** Hutton. (Plate 13, fig. 6.)

1873. *Struthiolaria tuberculata* Hutton, *Cat. Tert. Moll.*, p. 11.
1886. *Struthiolaria tuberculata* Hector, *Outline Geol. N.Z.*, p. 51, fig. 9, No. 4.
1886. *Struthiolaria spinosa* Hutton, *Trans. N.Z. Inst.*, p. 335 (not of Hector).
1887. *Struthiolaria spinosa* Hutton, *Proc. Linn. Soc. N.S.W.*, ser. 2, vol. 1, p. 217.
1914. *Struthiolaria tuberculata* Hutton: Suter, *N.Z. Geol. Sur. Pal. Bull. No. 2*, p. 19, pl. 1, fig. 12.

Hutton's localities are: "East coast, Wellington; Upokororo Stream, Te Anau Lake; Kawau; Broken Hill (U)." Probably several species were represented; the Broken River shell has become the type because it was represented as the example of the species in Hutton's type collection at the Dominion Museum. Thomson and Speight collected this fossil from the shell-bed immediately above the limestone of Trelissick Basin (Speight, 1917, p. 348); also "in the small tributary of White Water Creek coming in from the north, in what may be called the *Struthiolaria* bed from the number of remains of this genus occurring. The same bed is met with in a similar stratigraphical position in the Porter River between the gorges in the Thomas River." The horizon seems, then, to be low Awamoan. No specimens from elsewhere than the Trelissick Basin have been seen during this revision.

**Struthiolaria cincta** Hutton. (Plate 13, figs. 4, 5.)

1873. *Struthiolaria cincta* Hutton, *Cat. Tert. Moll.*, p. 11.
1887. *Struthiolaria cincta* Hutton, *Proc. Linn. Soc. N.S.W.*, ser. 2, vol. 1, p. 216.
1897. *Struthiolaria cincta* Hutton: Harris, *Cat. Tert. Moll. Brit. Mus.*, vol. 1, p. 221.
1914. *Struthiolaria cincta* Hutton: Suter, *N.Z. Geol. Surv. Pal. Bull. No. 2*, p. 16, pl. 1, fig. 7.

The type of *S. cincta* is from "Awatere," but the exact horizon was not stated by Hutton. Dr. Thomson's collection from Lower Awatere (*Pal. Bull. No. 8*, p. 30) contains *S. cincta*, so this may be the type locality. The species has been recorded from many horizons — *e.g.*, Kakanui; Waihao greensands; Target Gully; Pakaurangi; Duncan's, Tolaga Bay. These are based either on poor specimens or on a very wide interpretation of the species. The true *S. cincta* has very coarse spirals of irregular appearance, and during the course of this revision has been seen only from 126, Awatere Valley, and 218, Motunau.

The shell most often mistaken for it is *S. subspinosa* n. sp., which has much the same outline, but sculpture consisting of numerous very fine regular spiral lirae, whereas in *S. cincta* the spirals are strong and very irregular. The shoulder-angle of *S. cincta* is sometimes smooth and sometimes ornamented with blunt nodules, 15 to 18 per whorl; in *S. subspinosa* the tubercles are about the same in number, but they are fairly strong and sharply pointed, and are always present.

**Struthiolaria cingulata** Zittel. (Plate 13, figs. 1, 9.)

1864. *Struthiolaria cingulata* Zittel, *Reise der "Novara,"* 1 Bd., 2 Abt., p. 35, pl. 15, fig. 2.
1873. *Struthiolaria cingulata* Zittel: Hutton, *Cat. Tert. Moll.*, p. 11.
1887. *Struthiolaria cingulata* Zittel: Hutton, *Proc. Linn. Soc. N.S.W.*, ser. 2, vol. 1, p. 217.
1893. *Struthiolaria cingulata* Zittel, *Macleay Mem. Vol.*, p. 61.
1914. *Struthiolaria cingulata* Zittel: Suter, *N.Z. Geol. Surv. Pal. Bull. No. 2*, p. 18 (not the specimen figured pl. 1, fig. 9).

The figure published by Suter was drawn by Buchanan from Hutton's plesiotype from Patea. This shell belongs to the *S. vermis* group, and so is widely separated from Zittel's species. The latter's figure represents an individual with whorls much more convex than usual, but the angulation is described in the text. The more common outline is shown in Plate 13, fig. 9. An examination of the aperture with its spreading callus on the body-whorl, and of the arrangement of the spirals, will show that the species is closely related to the convex variety of *S. papulosa.*

Zittel gives Awatere Valley as the locality, but in this extensive district more than one horizon is represented. The specimens here placed under this species come from Starborough Creek, where the rocks are of Pliocene age.

Suter quotes in his synonymy (1914, p. 18) the *S. cingulata* figured in Hector's *Outline of New Zealand Geology.* This figure was drawn from the type of *S. monilifera* Suter, which was Hutton's variety B of *S. cingulata,* but which belongs to a group different from Zittel's species. It should therefore appear in the synonymy of *S. monilifera,* not of *S. cingulata.* A comparison of Zittel's figure of this species with that published by Suter (drawn by Buchanan from Hutton's specimen) shows that there are important differences. The true *cingulata* has the inner-lip callus wide-spreading and thin on the parietal wall, then tapering rapidly below, with a protuberance about half-way down on the outside. The outer lip is quite thin near the junction with the body. This is the typical *S. papulosa* aperture, and the shell certainly falls under that group. The aperture of Hutton's specimen, on the other hand, has a thick callus of regular width surrounding the aperture; the whorls, too, are convex without the suggestion of carination, and consequently this shell is of the *S. vermis* group. It is described below as *S. rugosa* n. sp.

Although Zittel's figure shows a shell with convex spire-whorls, the body-whorl is obsoletely bicarinate, while in his description (1864, p. 35) he says, "Die Embryonalwinddungen sind glatt, die ubrigen dagegen stumpfkantig . . . die letzte Windung . . . . ist mit zwei stumpfen Kanten versehen."

No well-preserved replicas of Zittel's figure have been seen, but there is a common *Struthiolaria* from Awatere which corresponds with the description except that the angles are not blunt (see Plate 13, fig. 9). Perhaps the specimen handled by Zittel's artist was one with exceptionally convex whorls, such as sometimes occur in *S. papulosa,* figured in Plate 12, fig. 2.

According to this interpretation, *S. cingulata* is closely related to *S. cincta,* differing in the presence of regular strong spiral cords, and the absence of tubercles on the shoulder.

**Struthiolaria errata** n. sp. (Plate 12, figs. 1, 3.)

1873. *Struthiolaria tuberculata* var. B Hutton, *Cat. Tert. Moll.*, p. 11.
1886. *Struthiolaria tuberculata* Hutton, *Trans. N.Z. Inst.*, vol. 18, p. 335 (in part, but not of 1873).
1887. *Struthiolaria tuberculata* Hutton, *Proc. Linn. Soc., N.S.W.*, ser. 2, vol. 1, p. 216 (in part, but not of 1873).
1914. *Struthiolaria spinosa* Hector: Suter, *N.Z. Geol. Surv. Pal. Bull. No. 2*, p. 18, pl. 1, fig. 11 (not of Hector).

Suter has given a full description and figure of this shell, which he wrongfully took to be the type of Hector's *spinosa* (see above, p. 177). The large planorbid protoconch mentioned by him is not the true protoconch of the shell, but is one of the many septa built by the animal in retreating from the summit, which was afterwards broken off.

The species is closely related to *S. papulosa*, but it differs in having a straighter columella and more wide-spreading callus on the body-whorl, which also has larger tubercles, placed farther apart. There is a fairly strong spur at the junction of the shoulder with the outer lip.

*Locality.*—Waikari.

**Struthiolaria papulosa** (Martyn). (Plate 12, figs. 2, 4, 5, 6.)

1786. *Buccinum papulosum* Martyn, *Univ. Conch.*, vol. 2, f. 54.
1786. *Buccinum coronarium* Solander, *Cat. Port. Mus.*
1788. *Murex pes-struthiocameli* Chemnitz, *Conch. Cab.*, vol. 10, figs. 1520, 1521.
1790. *Murex stramineus* Gmelin: Linn., *Syst. Nat.*, ed. 13, t. 1, pt. 6, 3542.
1822. *Struthiolaria nodulosa* Lamarck, *Anim. s. Vert.*, vol. 7, p. 147.
1835. *Struthiolaria nodosa* Gray, in Yate's *New Zealand*, p. 308.
? 1839. *Struthiolaria sulcata* Jonas, *Arch. f. Nat.*, i. 342, pl. 9, fig. 5.
1842. *Struthiolaria gigas* Sowerby, *Thes. Conch.*, 1, pl. 5, f. 17.
1843. *Struthiolaria papillosa* Martyn: Gray in Dieff. *New Zealand*, vol. 2, p. 231.
1849. *Struthiolaria papulosa* Martyn: Reeve, *Conch. Icon.*, vol. 6, pl. 1.
1849. *Struthiolaria straminea* Gmelin: Reeve, *Conch. Icon.*, vol. 6, f. 3.
1857. *Struthiolaria papillaria* Gray, *Guide Moll. Brit. Mus.*, p. 76.
1858. *Struthiolaria papulosa* Martyn: Adams, *Gen. Rec. Moll.*, pl. 27, f. 6, *b*.
1859. *Struthiolaria papulosa* Martyn: Chenu, *Man. Conch.*, vol. 1, p. 263, f. 1649.
1868. *Struthiolaria stramineus* Woodward, *Man. Moll.*, pl. 4, f. 6.
1873. *Struthiolaria gigas* Sowerby: Hutton, *Cat. Mar. Moll. N.Z.*, p. 24.
1873. *Struthiolaria nodulosa* Lamarck: Hutton, *Cat. Mar. Moll. N.Z.*, p. 24.
1873. *Struthiolaria nodulosa* Lamarck: Hutton, *Cat. Tert. Moll. N.Z.*, p. 10.
1873. *Struthiolaria papulosa* Martyn: von Martens, *Crit. List*, p. 25.
1876. *Struthiolaria papulosa* Martyn: Paulucci, *Bull. Soc. Malac. Ital.*, ser. 2, vol. 2, p. 225.
1880. *Struthiolaria papulosa* Martyn: Hutton, *Man. N.Z. Moll.*, p. 67.
1885. *Struthiolaria papulosa* Martyn: Tryon, *Man. Conch.* (1), vol. 7, 133, pl. 12, f. 34.
1885. *Struthiolaria gigas* Sowerby: Tryon, *Man. Conch.* (1), vol. 7, 133, pl. 12, f. 37.
1885. *Struthiolaria sulcata* Jonas: Tryon, *Man. Conch.* (1), vol. 7, 134, pl. 12, f. 38.
1887. *Struthiolaria nodulosa* Lamarck: Fischer, *Man. Conch.*, p. 877, pl. 4, f. 6.
1893. *Struthiolaria papulosa* Martyn: Hutton, *Macleay Mem. Vol.*, p. 60.
1897. *Struthiolaria papulosa* Martyn: Harris, *Cat. Tert. Moll. Brit. Mus.*, i, p. 219.
1904. *Struthiolaria papulosa* Martyn: Cossmann, *Ess. Paléo. Comp.*, vol. 6, p. 104
1913. *Struthiolaria papulosa* Martyn: Suter, *Man. N.Z. Moll.*, p. 274, pl. 40, fig. 1.

Among Recent specimens there is a considerable variation of form and sculpture. In some the spines on the shoulder are large, strong, and sharply pointed, while in others the shoulder bears only small, spaced nodules. The former may be regarded as the typical *papulosa*, while the

latter represent Sowerby's *gigas*. In a card of five Stewart Island specimens in the Dominion Museum, two are typically nodulous; two have the nodules becoming obsolete on the later whorls, with a corresponding rounding of the shoulder; while the fifth has almost regularly convex whorls throughout, with the merest traces of the nodules on the rounded shoulder—it has, in fact, somewhat the appearance of Tryon's figure of *S. sulcata* Jonas.

It does not at present seem advisable to give any of these aberrant forms specific recognition. The one with rounded whorls and obsolete tubercles can, however, be distinguished easily, and it is possible that a separate species is represented.

*Localities.*—Recent, Castlecliff and Kai Iwi, Wanganui; 1094, Mangatahi River, Hawke's Bay (very strong spirals—Plate 12, fig. 4); 875, Manaia Beach, Taranaki (M. Ongley); 858, below waterfall, Starborough Creek.

The specimens from the last three localities are by no means typical. Those from Manaia and Starborough resemble a tumid form of the nodular variety, and have the nodules very closely placed.

The only shell closely resembling *S. papulosa* from a possibly lower horizon than Pliocene is one from Kanieri. This is Hutton's *S. cincta* var. B of 1873. The specimen has very much the aspect of the Stewart Island shell with rounded whorls, mentioned above, and was thought by Suter to be *S. papulosa*. Another specimen in the Geological Survey collection from the same district (154, Kanieri) has whorls more angled, but also only traces of nodules. Both are fragmentary, and the second has the suggestion of a keel on the body-whorl. So until better specimens are found it does not seem justifiable to extend the range of *S. papulosa* back to the Miocene. Several fossils from Kanieri have Wanganuian affinities, and may be from Pliocene strata in the neighbourhood.

**Struthiolaria frazeri** Hutton. (Plate 13, figs. 8, 10.)

1885. *Struthiolaria frazeri* (Hector MS.): Hutton, *Trans. N.Z. Inst.*, vol. 17, p. 329.
1886. *Struthiolaria fraseri* Hector, *Outline N.Z. Geol.*, p. 48, fig. 5, No. 1.
1893. *Struthiolaria frazeri* Hutton, *Macleay Mem. Vol.*, p. 61.
1897. *Struthiolaria frazeri* Hutton: Harris, *Cat. Tert. Moll. Brit. Mus.*, i, p. 220, pl. vi, figs. 10, *a*, *b*.
1910. *Struthiolaria frazeri* Park, *Geol. N.Z.*, p. 162, fig. 81.
1913. *Struthiolaria frazeri* Hutton: Speight, *Rec. Cant. Mus.*, No. 2, pt. 1, p. 31.
1921. *Struthiolaria frazeri* Hutton: Suter, *N.Z. Geol. Surv. Pal. Bull. No. 8*, p. 19.

In revising Hutton's types, Suter did not find that of *S. frazeri*, which Hutton described while he was in Christchurch. Professor Speight informed me in a private communication that it is not in Canterbury Museum, and thinks that the fine specimen in the Geological Survey collection at the Dominion Museum is probably the original type. Consequently this shell becomes the type of the species.

Most of the specimens, including the type, have small blunt tubercles on the shoulder, but others have only the strong, regular, smooth, spiral ribs; of the former variety Harris's figure is an excellent representation, while Hector's figure is equally characteristic of the latter.

As regards the localities, several obscure names have been given, so that it may be well to list and explain them here: Hutton (1885), Kikiwheru Creek; Hutton (1886), Matapiro (found also in the Pareora system);

Hutton (1893), Matapiro; Harris (1897), McLean's station, Napier; Hutton (MS.) (1904), Ngaruroro Station and Motunau; Park (1910), McLean's station, Napier; Speight (1913), Motunau; Suter (1921), Shrimpton's, Ngaruroro River; Marshall and Murdoch (1920), Nukumaru, Wanganui district.

Most of these refer to the same place. "Shrimpton's" was a station on the Kikowhero Creek, which is a tributary coming in on the north side of the Ngaruroro River, and forming the eastern boundary of the Matapiro Plain. McLean's was a station on the south side of the Ngaruroro River, opposite Shrimpton's. (*Rep. Geol. Explor.*, x, xii, xviii.)

The statement that this species is "found also in the Pareora system" refers, no doubt, to the specimen recorded from Motunau. I have not seen the specimen, so cannot confirm the identification. In any case, the Motunau beds are now recognized as belonging to a much higher horizon than the Pareora. The Blue Clays of the Ngaruroro River, the type locality of this fossil, are equivalent to the Nukumaru stage of the Wanganuian, so the record of *S. frazeri* by Marshall and Murdoch from Nukumaru is most interesting. Unfortunately, the specimen was broken to pieces in transmission from Mr. Suter.

The identification of *S. frazeri* in the Wangaloa beds (Marshall, 1917, p. 451) is surely a mistake.

Four excellent specimens were collected by Dr. Uttley and the writer in a sandy pocket of the clays not far below the Scinde Island limestone at Maraekakaho, Ngaruroro River.

**Struthiolaria** sp. Zittel.

1864. *Struthiolaria* sp. Zittel, *Reise der "Novara,"* Geol. Theil, 1 Band, 2 Abt., *Palaontologie von Neu Seeland*, p. 35, pl. xv, fig. 3.

In the Geological Survey collection from locality 126, Awatere Valley, are fragments which should probably be placed here; but their condition is no better than Zittel's material, so no good purpose would be served by attempting specific description.

A similar shell, but with sharper spines, occurs at Kaawa Creek, but here again only fragments are available. In both cases there is a strong callus on the inner lip, recalling that of *S. spinosa*, but the spire is flatter than in the Pareora shell, and the keel is weaker.

### (*b.*) *Struthiolaria callosa* Group.

**Struthiolaria callosa** n. sp. (Plate 14, figs. 7, 8, 9.)

Shell large, ovate, with gradate spire, about same height as aperture; whorls five, angled about middle with wide slightly-inclined shoulder, body-whorl bicarinate; sculpture, fine regular spiral threads on upper whorls, becoming obsolete on lower, the shoulder-angle furnished with about 8 distant strong tubercles, lower keel also has tubercles but smaller and more numerous; suture slightly undulating, filled with layer of enamel which towards aperture reaches to tubercles above; aperture inclined, ovate; outer lip reflexed, moderately thickened, wedge-shaped, sinuous, projecting slightly at shoulder but more so at lower keel, bent then in wide shallow sinus to anterior canal; columella concave, bent to right below and ending in rounded beak; inner lip with enormous callus-pad reaching suture above, ending below about middle of base with rounded knob which

is separated from beak by deep rounded lightly-calloused channel; similarly at its junction with outer lip above, pad ends in rounded knob, causing a channel on shoulder.

Holotype in collection of the New Zealand Geological Survey.

Height, 70 mm.; diameter, 50 mm.

*Localities.*—1037, Hurupi Creek, Palliser Bay, 300 yards above mouth, at base of Tertiary beds (holotype) (also collected by Dr. J. A. Thomson); 1065, grit band, Kururau Road, Piopiotea West Survey District (L. I. Grange).

The following localities have provided fragmentary specimens belonging either to this species or to one closely related: 649, Paparoa Rapids, Wanganui River; 832, below crossing, Mohaka River; 859, Deadman's Creek, Marlborough (Dr. J. A. Thomson); 904, quarter-mile south of saddle, Okaroa Road, Rangi Survey District (Dr. J. Henderson); 1047, 1049, grit band east of mouth of Okahukura Tunnel, Rangi Survey District (L. I. Grange); 1052, 25 chains along road east side of Okahukura saddle, Rangi Survey District (L. I. Grange); Lower Awatere beds, Tachell's Creek, Marlborough (= *S. tuberculata* of Suter, *N.Z. Geol. Surv. Pal. Bull. No. 8*, p. 31).

**Struthiolaria fortis** n. sp. (Plate 14, figs. 1, 2, 3.)

Shell small, ovate, with gradate spire shorter than aperture; whorls 5 remaining, angled about middle with sloping shoulder, body-whorl bicarinate; sculpture, shoulder with few obsolete spiral threads, angle armed with 7 or 8 strong tubercles, and keel with smaller and closer ones, growth-lines very strong, suture undulating and showing layer of enamel getting higher towards aperture; aperture inclined, semilunar, produced into very short canal below; outer lip reflexed, thickened, wedge-shaped in cross-section, bisinuous, more projecting at lower keel than at shoulder-angle; inner lip with enormous pad, not surmounting shoulder, but very thick and with strong projecting ends, forming channel between beak and basal end of pad, and another on shoulder; columella concave, strongly bent to right below.

Holotype in collection of the New Zealand Geological Survey.

Height, 33 mm.; diameter, 24 mm.

*Localities.*—1035 (holotype), Shelton's Whare traverse, Block XI, Tutamoe Survey District, Raukumara Division (E. O. Macpherson); 1044, Motumati Waterfall, Waingaromia Survey District, Raukumara Division (= *S. calcar* Hutton of Marshall, 1910, *N.Z. Geol. Surv. Bull. No. 9* (n.s.), p. 22).

This species differs from *S. callosa* in its much smaller size, and narrower pad projecting sharply at both ends and forming deeper channels. The columella is also more bent to the right, and the whorls are lower.

**Struthiolaria armata** n. sp. (Plate 14, fig. 4.)

This species resembles *S. spinifera* just as *S. callosa* resembles *S. spinosa*. It has a high spire with very sloping shoulders and long strong spines on the shoulder-angle, 7 to 8 on the body-whorl and 6 on each of the spire-whorls.

The suture is filled with a layer of callus which ascends to the tubercles above, while the inner-lip pad extends to about half-way between the tubercles and the suture, but does not quite bury the spines. The growth-lines are very strong, but there is no spiral ornamentation.

As only spires of three specimens are available, full specific description cannot be given, but the characteristic and easily identified spire justifies the application of a specific name.

*Localities.* — Muddy Creek, Tutamoe Survey District, Raukumara (M. Ongley and E. O. Macpherson); 1034, lowest band, Shelton's Whare traverse, Block XI, Tutamoe Survey District.

**Struthiolaria obesa** Hutton. (Plate 14, figs. 5, 6.)

1885. *Struthiolaria obesa* Hutton, *Trans. N.Z. Inst.*, vol. 17, p. 329.
1887. *Struthiolaria obesa* Hutton, *Proc. Linn. Soc. N.S.W.*, ser. 2, vol. 1, p. 217.
1913. *Struthiolaria (Pelicaria) obesa* Hutton: Speight, *Rec. Cant. Mus.*, No. 2, pt. 1, p. 32.
1915. *Struthiolaria (Pelicaria) obesa* Hutton: Suter, *N.Z. Geol. Sur. Pal. Bull. No. 3*, p. 7, pl. iv, fig. 3.

The aperture of this species is very like that of *S. callosa*. The calloused pad surmounts the shoulder, passes the suture, and adheres to the whorl above. Anteriorly the pad ends in a raised knob separated by a smooth channel from the beak. The columella is only moderately bent, ending in a strong beak, and the outer-lip callus does not form the body-whorl. The shell is consequently not a *Tylospira* (= *Pelicaria*), as Suter thought, but a *Struthiolaria* of the *callosa* group.

The spire-whorls are convex, the body-whorl obsoletely bicarinate, and there are traces of fine spiral striae. As the tendency of the genus seems, in the main, to have been towards a loss of tubercles in the more advanced forms, this species appears to have reached a gerontic stage.

*Localities.*—Shepherd's Hut, Waipara; Porter River, Trelissick Basin.

These specimens are in the Canterbury Museum, and were kindly lent by Professor Speight.

? Awamoa. A fragmentary specimen in Mr. Finlay's collection. The aperture and callus are broken off, so the identity is not quite certain.

The Porter River specimens are identical in state of preservation and appearance with the Shepherd's Hut ones; even the scattered grains of sand adhering in both cases are similar, suggesting that they are from the same locality—*i.e.*, Waipara.

(*c.*) *Struthiolaria vermis* Group.

**Struthiolaria** sp.

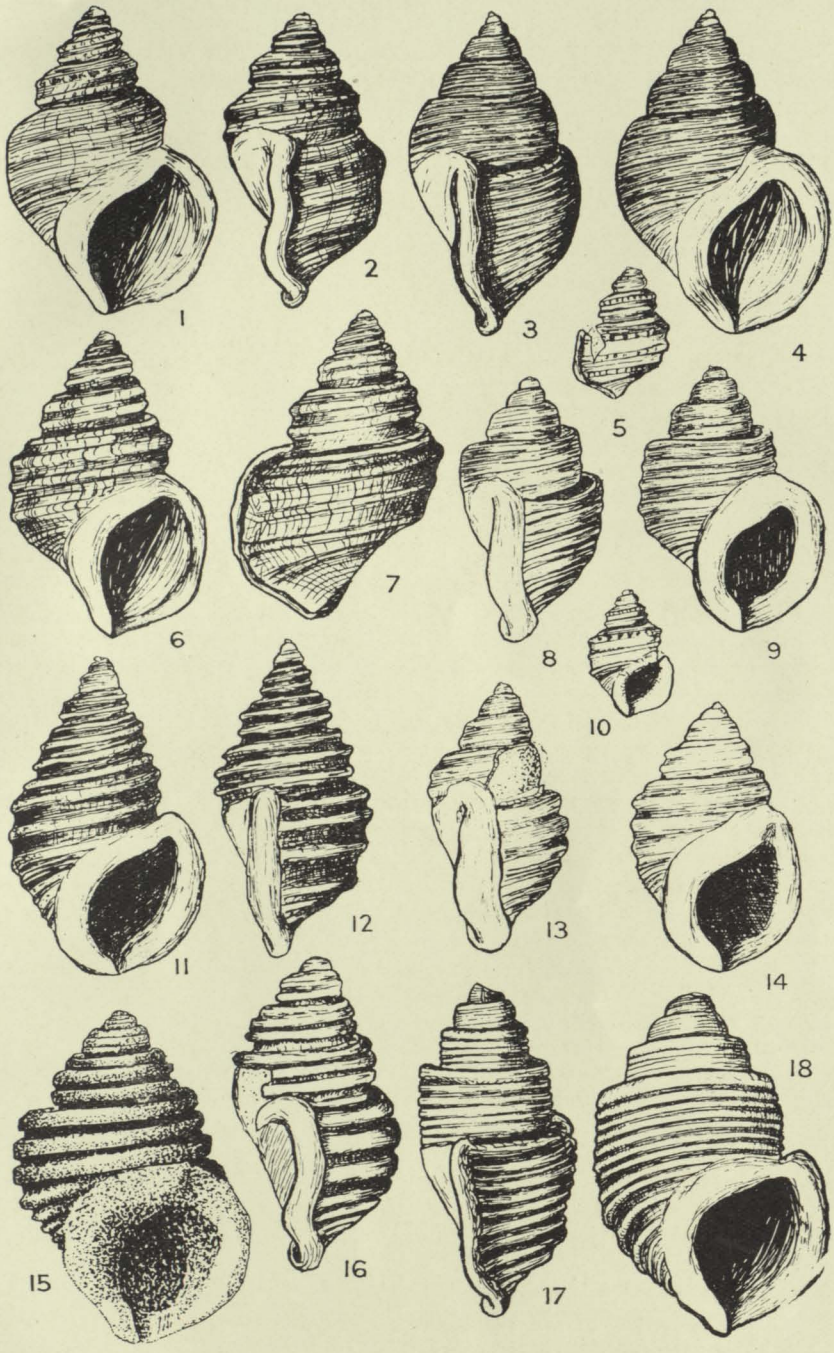
A single distorted shell from the Tawhiti beds, probably of Upper Miocene age, is of great interest, for it marks the first known appearance of this group in the Tertiary sequence. The ornamentation consists of 2 and later 3 spiral cinguli on the spire-whorls, and so resembles that of *S. tricarinata*. The base has but 3 or 4 strong cords, a condition found only in the Lower Pliocene forms *S. canaliculata*, *S. acuminata*, and *S. monilifera*.

*Locality.*—1091, base of sandstone, three miles south-east of Trig. S. 45, north border Waiapu Survey District (Dr. J. Henderson).

**Struthiolaria canaliculata** Zittel. (Plate 15, figs. 15, 16.)

1864. *Struthiolaria canaliculata* Zittel, *Reise der "Novara,"* 1 Bd., 2 Abt., p. 34, pl. xv, figs. 1, *a*, *b*.
1873. *Struthiolaria sulcata* Hutton, *Cat. Tert. Moll.*, p. 10 (not of Jonas, 1829).
1887. *Struthiolaria sulcata* Hutton, *Proc. Linn. Soc. N.S.W.*, ser. 2, vol. 1, p. 217.
1914. *Struthiolaria canaliculata* Zittel: Suter, *N.Z. Geol. Surv. Pal. Bull. No. 2*, p. 17, pl. xvii, figs. 8, *a*, *b*.

Suter quotes, in the synonymy, Hector's figure of 1886. This, from its elongated outline, must have been drawn from a specimen of *S. acuminata*




FIGS. 1, 2.—*Struthiolaria vermis* (Mart.). Recent.
FIGS. 3, 4.—*Struthiolaria convexa* n. sp. Type.
FIGS. 5, 10.—*Struthiolaria parva* Sut. Type.
FIGS. 6, 7.—*Struthiolaria tricarinata* Less. Recent.
FIGS. 8, 9.—*Struthiolaria fossa* n. sp. Type.
FIGS. 11, 12.—*Struthiolaria acuminata* n. sp. Type.
FIGS. 13, 14.—*Struthiolaria media* n. sp. Type.
FIGS. 15, 16. — *Struthiolaria canalicalata* Zitt. (Fig. 15 after Zitt.)
FIGS. 17, 18.—*Struthiolaria zelandiae* Marsh. & Murd. Waipipi.

*Face p. 184.*]

n. sp., which Hutton did not separate from Zittel's *S. canaliculata*. The latter is easily distinguished by its robust form, strong square spiral cords, and deep flat interstices. The suture is situated in a wide canal, and in some cases a fourth rib appears low down on the penultimate whorl.

*Locality.*—Zittel gives as the locality "Awatere Valley," which is somewhat indefinite, but Dr. J. A. Thomson collected two typical specimens from 858, "below waterfall, Starborough Creek, lower end Awatere Valley." This is probably the type locality, and the species must be considered as a Pliocene one.

**Struthiolaria zelandiae** Marshall and Murdoch, 1920. (Plate 15, figs. 17, 18.)

1920. *Struthiolaria zelandiae* Marshall and Murdoch, *Trans. N.Z. Inst.*, vol. 52, p. 130, pl. vii, figs. 11, 11*a*.

In this species an advance from such types as *S. canaliculata* and *S. acuminata* is marked by the appearance of a strong secondary spiral cord in each of the interstices between the 4 primary spirals. There is also a tendency for the second and third primaries to divide, and when this happens each part is often weaker than the secondaries. Thus the 4 spirals of *S. canaliculata* may be represented by 7, 8, or 9 spirals in *S. zelandiae*. The holotype figured by Marshall and Murdoch belongs to the last kind. As most of the specimens are flattened by pressure, the figures of Marshall and Murdoch make this shell appear too broad; a side as well as a front view is therefore given on Plate 15, figs. 17, 18. The deep canaliculate suture shows that this species has reached a gerontic stage.

*Localities.*—Waipipi Beach, west of Wairoa Stream, Waverley (type); 876, mouth of Waihi Stream, Hawera (M. Ongley) (first form = *S. canaliculata* of Suter, *N.Z. Geol. Surv. Pal. Bull. No. 8*, p. 25); mouth of Waingongoro River, Taranaki (Dr. G. H. Uttley and J. Marwick).

**Struthiolaria acuminata** n. sp. (Plate 15, figs. 11, 12.)

1886. *Struthiolaria sulcata* Hector, *Outline of N.Z. Geol.*, p. 50, fig. 6, No. 7 (not of Hutton, 1873).

1914. *Struthiolaria sulcata* Hutton: Chapman, *Australasian Fossils*, p. 200, fig. 103, F (not of Hutton or Jonas).

Shell somewhat small, ovate, with acute turreted spire longer than aperture. Whorls 6, gradually increasing; sculpture, whorls immediately below apex convex and with spiral cords, third whorl bicarinate, keels being marked by 2 strong cinguli, on fourth and fifth whorls these become much stronger, raised and rounded, angle of shoulder has now developed strong raised band so whorls are tricarinate, interstices being rounded and a little wider than spiral ribs; on body-whorl are 5 strong raised rounded cinguli, the lowest near fourth and slightly weaker than the others; on base are 4 strong spiral threads with wide interstices; the whole surface spiralled with fine obsolete threads, crossed by sinuous growth-lines; suture situated in channel formed by strong spirals, whorl being slightly depressed between top spiral and suture; aperture ovate, channelled above and produced below into very short canal; outer lip reflexed, thickened, edge rounded, sinuosity very shallow; columella concave, ending in truncated beak, bent to right, inner lip with moderate regular callus equal in width to that of outer lip, and not ascending on body-whorl above outer llip.

Holotype in collection of the New Zealand Geological Survey.

Height, 43 mm.; diameter, 26 mm.

*Localities.*—1040, greensand below Wairarapa limestone, at Twaite's cutting, five miles south of Martinborough (holotype); coast half-mile east of Ruamahanga River mouth, Palliser Bay (Dr. J. A. Thomson).

*Remarks.*—This shell is intermediate in appearance between *S. canaliculata* and *S. tricarinata;* it is higher in the spire than either, more slender than the former, with rounded ribs and wider interstices; it may be distinguished from the latter by its 5 regular, strong, rounded ribs on body-whorl, and only 4 cords on the base.

Hutton collected this species from "east coast, Wellington," but did not separate it from *S. canaliculata.* The figure so labelled in Hector's *Outline* must have been drawn from a specimen of *S. acuminata,* for it shows the high spire.

**Struthiolaria monilifera** Suter. (Plate 13, fig. 7.)

1873. *Struthiolaria cingulata* Zittel var. B Hutton, *Cat. Tert. Moll.,* p. 11.
1886. *Struthiolaria cingulata* Hector, *Outline of N.Z. Geol.,* p. 51, fig. 9, No. 17 (not of Zittel).
1914. *Struthiolaria cingulata* subsp. *monilifera* Suter, *N.Z. Geol. Surv. Pal. Bull. No. 2,* p. 18, pl. 1, fig. 10.

As has been stated above (p. 179), *S. cingulata* belongs to the *S. papulosa* group, but *S. monilifera* has the characteristic outline, aperture, and typical arrangement of cinguli shown by the *S. vermis* group; it must therefore be granted at least specific distinction from *S. cingulata.* These features, together with the strong spirals on the base, show that the closest relationship is to *S. acuminata.* The mistake of coupling *S. monilifera* with *S. cingulata* was caused by Hutton's wrongful identification of a shell from Patea as the latter species. This shell, also an undoubted member of the *vermis* group, was Hutton's plesiotype of *S. cingulata,* and was figured by Suter (1914). It is here described and named as a new species, *S. rugosa* (see p. 189).

No good specimens of *S. cingulata* were available for the figure of this species in Hector's *Outline,* so one was drawn from Hutton's variety B—*i.e., S. monilifera.*

**Struthiolaria tricarinata** Lesson. (Plate 15, figs. 6, 7.)

1830. *Struthiolaria tricarinata* Lesson, *Ann. Sci. Nat.,* ser. 2, vol. 16, p. 256.
1880. *Struthiolaria vermis tricarinata* Lesson: Hutton, *Man. N.Z. Moll.,* p. 68.
1913. *Struthiolaria vermis tricarinata* Lesson: Suter, *Man. N.Z. Moll.,* p. 276.

The strong spiral cinguli of this shell show that it is a more primitive form than *S. vermis,* and on that account it is deemed advisable to grant it full specific recognition. No doubt intermediate forms occur, but the extremes are well separated.

On the base are about 7 fine spiral lines, showing an advance from *S. acuminata,* which has only 4 strong cords.

The specimen here figured is in the Dominion Museum collection, and comes from Farewell Spit, Nelson.

*Fossil Locality.*—Languard Bluff, Wanganui (R. Murdoch).

Suter (1913) wrongly quotes in his synonymy of *S. tricarinata* Gray's record of *S. scutulata* Martyn, in Dieffenbach's *New Zealand.* Gray merely lists *S. scutulata* as recorded from New Zealand by Martyn, the author of the species. The mistake originated in Martyn's statement that *B. scutulatum* was a New Zealand shell. In the same synonymy (Suter, 1913) Hutton's use of *S. scutulata* as of Deshayes is given as being intended for

*S. tricarinata.* This also appears to be a mistake, for in his *Manual* (1880, p. 219) Hutton used *S. australis* Gmel. as the equivalent of his *S. scutulata* Desh., and listed *S. tricarinata* as a different species.

**Struthiolaria parva** Suter. (Plate 15, figs. 5, 10.)

1915. *Struthiolaria parva* (Hutton MS.): Suter, *N.Z. Geol. Surv. Pal. Bull. No. 3*, p. 7, pl. iv, fig. 4.

As the locality of the holotype is unknown, it is a pity that this shell was described. In appearance it resembles young *S. vermis*, particularly those forms which have the tubercles well developed. If the specimen represents the normal adult it is a valid species, closely related to *S. tricarinata* and *S. vermis*.

**Struthiolaria vermis** (Martyn). (Plate 15, figs. 1, 2.)

1786. *Buccinum vermis* Martyn, *Univ. Conch.*, vol. 2, fig. 53.
1790. *Murex australis* Gmelin: Linn., *Syst. Nat.*, ed. 13, 1, 3542.
1822. *Struthiolaria crenulata* Lamarck, *Anim. s. Vert.*, vol. 7, p. 148.
1835. *Struthiolaria crenulata* Lamarck: Q. & G., "*Astrolabe*," vol. 2, p. 430, pl. 31, figs. 7–9.
1835. *Struthiolaria crenulata* Lamarck: Gray in Yate's *New Zealand*, p. 308.
1842. *Struthiolaria inermis* Sowerby, *Thes. Conch.*, vol. 1, p. 23, pl. 5, figs. 12, 13, 19.
1849. *Struthiolaria australis* Reeve, *Conch. Icon.*, vol. 6, fig. 1.
1858. *Struthiolaria vermis* Martyn: Adams, *Gen. Rec. Moll.*, pl. 27, fig. 6.
1859. *Struthiolaria vermis* Martyn: Chenu, *Man. Conch.*, vol. 1, p. 263, fig. 1653.
1873. *Struthiolaria scutulata* Desh.: Hutton, *Cat. Mar. Moll. N.Z.*, p. 24 (wrongly attributed to Desh., not of Martyn).
1873. *Struthiolaria vermis* Martyn: Hutton, *Cat. Mar. Moll. N.Z.*, p. 24.
1873. *Struthiolaria vermis* Martyn: Hutton, *Cat. Tert. Moll. N.Z.*, p. 10.
1873. *Struthiolaria australis* Gmelin: von Martens, *Crit. List*, p. 26.
1876. *Struthiolaria vermis* Martyn: Paulucci, *Bull. Soc. Malac. Ital.*, ser. 2, vol. 2, p. 229.
1880. *Struthiolaria australis* Gmelin: Hutton, *Man. N.Z. Moll.*, p. 68.
1880. *Struthiolaria inermis* Sowerby: Hutton, *Man. N.Z. Moll.*, p. 68.
1885. *Struthiolaria vermis* Martyn: Tryon, *Man. Conch.*, ser. 1, vol. 7, p. 133, pl. 12, figs. 35, 36.
1893. *Struthiolaria vermis* Martyn: Hutton, *Macleay Mem. Vol.*, p. 61.
1894. *Struthiolaria vermis* Martyn: Harris, *Cat. Tert. Moll. Brit. Mus.* (Aust.), p. 219.
1904. *Struthiolaria vermis* Martyn: Cossman, *Ess. Paleo. Comp.*, vol. 6, pl. 8, fig. 2.
1913. *Struthiolaria vermis* Martyn: Suter, *Man. N.Z. Moll.*, p. 276, pl. 40, fig. 2.

There is a considerable amount of variation in living specimens of this shell, and when one goes back to the Pliocene the variations are still more considerable. All the Recent examples appear to have the same very fine spiral striae of somewhat irregular strength. The prominence of the spiral cinguli, and the presence on them of tubercles, are the most variable features. The arrangement of these cinguli corresponds to that of *S. canaliculata*, and, indeed, to that of the whole group.

*Localities.*—Castlecliff; ? Petane.

**Struthiolaria media** n. sp. (Plate 15, figs. 13, 14.)

Shell somewhat small, ovate, with turreted spire about equal in height to aperture; whorls 6, regularly increasing; sculpture, the first two whorls convex with from 6 to 8 spiral threads, with slightly wider interstices, third whorl with about 12 spiral threads, two very weak cinguli beginning to appear, fourth and fifth whorls with 2 strong cinguli, the

whole surface with about 12 spiral threads some of which are more prominent than others, body-whorl with 4 strong rounded spiral cinguli, and a fifth rudimentary on base, which has 6 stronger threads and 4 or 5 weak ones, the fine spirals of spire continue on body-whorl, but in interstices of cinguli there is generally one more prominent than others; suture bounded below by narrow flat surface; aperture ovate, channelled above, produced below into very short canal; outer lip reflexed, thickened, edge rounded, sinuosity very shallow. Columella concave, ending in truncated beak bent to right, inner lip with regular callus, about equal in width to outer lip.

Holotype in collection of the New Zealand Geological Survey.

Height, 36 mm.; diameter, 23 mm.

*Localities.*—81, Castle Point, east Wellington; 1040, Twaite's Cutting, Martinborough.

*Remarks.*—This species differs from *S. acuminata* in its shorter spire and weaker cinguli; from *S. parva* in its greater size, wide cinguli, and many more spirals on base. The nearest relationship is to *S. fossa* and to *S. convexa.* The former has weaker cinguli, flat sides, and canaliculate suture, while the latter may be distinguished by its very much weaker cinguli and convex outline. The systematic position is probably between *S. acuminata* and *S. convexa,* development being along the lines of a weakening of the spiral cinguli and an increase in the number and decrease in strength of spirals on the base.

**Struthiolaria convexa** n. sp. (Plate 15, figs. 3, 4.)

Shell ovate, plump; spire acute, about same height as aperture; protoconch an elongated bulbous nucleus, at right angles to axis of shell; whorls 6, increasing rather rapidly, convex in outline; sculpture, first three conch-whorls have 11 regular spirals, with interstices of slightly greater width, on fourth whorl a single thread in most of interstices, on fifth and sixth whorls secondary threads rapidly increase in number, generally 1 on each side of and close to primaries, with 1 or more in wide interspaces; suture with a flattened border on first four whorls and in shallow channel on last two; aperture ovate, channelled above, produced below into very short widely-open canal; outer lip reflexed, thickened, edge rounded, sinuosity very shallow; columella concave, ending in beak bent to right; inner lip with fairly regular callus, equal in width to and hardly ascending above junction with outer lip.

Holotype in collection of the New Zealand Geological Survey.

Height, 43 mm.; diameter, 28 mm.

*Localities.*—1089, blue clays, Okauawa Creek, Ngaruroro River; 184, blue clay west of limestone scarp, Porangahau Creek, Ruataniwha Plain (holotype); 231, McLean's station, south side of Ngaruroro River, Hawke's Bay; blue clays below Napier limestone at many localities in the Ngaruroro and Matapiro Survey Districts, Hawke's Bay.

*Remarks.*—Distinguished from *S. vermis* by convex outline and more regular sculpture. Many of the larger specimens show a definite grouping of the spiral striae corresponding to the cinguli on other members of the group. The species is closely related to *S. fossa,* but it seems to have diverged along a line of increasing convexity instead of increasing flatness of the whorls. Some of the specimens are difficult to separate from *S. vermis,* but in the latter species the spiral striae are always finer and more irregular.

**Struthiolaria fossa** n. sp. (Plate 15, figs. 8, 9.)

Shell small, ovate; spire gradate, about equal in height to aperture; whorls 5, but apex broken, early whorls convex, later ones with high shoulder and sides inclined to be flat; sculpture, first three whorls regularly spiralled by 12 fine cords with equal interstices, on penultimate whorl these become narrow ridges with wide interstices, there are also 2 obscure but wide cinguli, the raised shoulder has now 3 fine spiral threads; body-whorl with 5 spirals on shoulder, and 21 narrow spiral ridges with wide interstices below, the 6 on base being slightly stronger; 5 obscure cinguli with equal interspaces; suture in deep channel, 2 mm. wide; aperture ovate, channelled above, produced below into very short open canal; outer lip thickened, reflexed, only slightly sinuous, edge rounded, columella concave, ending in beak bent forwards and to right; inner lip regularly calloused, equal in width to outer lip, not ascending on body-whorl.

Holotype in collection of the New Zealand Geological Survey.

Height, 36 mm.; diameter, 25 mm.

Locality.—191, Shrimpton's, Kikowhero Creek, Ngaruroro River, Hawke's Bay.

*Remarks.*—This species is characterized by the deeply excavated channel round the shoulder of the whorls. In ornamentation it resembles some varieties of *S. vermis*, but may be distinguished by the much stronger and more regular spiral ridges, as well as by the even, though weak, cinguli. It further differs from *S. parva* in having weaker cinguli and flatter sides.

A close connection exists between *S. fossa* and *S. convexa;* both occur in the same district and in the same formation. The two shells are easily separated, however, by means of the canaliculate suture and flat sides of the former. These features show that the species is not only more advanced than *S. convexa,* but is also a phylogerontic development.

**Struthiolaria rugosa** n. sp. (Plate 13, fig. 2.)

1914. *Struthiolaria cingulata* Zittel: Suter, *N.Z. Geol. Surv. Pal. Bull. No. 2,* pl. 1, fig. 9 (not of Zittel).

Shell ovate, spire about same height as aperture; whorls 6, convex; sculpture, spire-whorls with 5–6 strong cords with narrow interstices, lowest cord being wide and having secondary spirals on it and on wide interspace below it, body-whorl with 15 equal cords, with interstices of almost same width and generally containing fine secondary spiral, growth-lines very strong over whole shell, giving spiral cords a moniliform appearance; aperture ovate, channelled above, with very short wide canal below; outer lip thickened, reflexed, bisinuous; inner lip with strong regular callus equal in width to outer lip; columella concave, strongly bent to right below.

Holotype in collection of the New Zealand Geological Survey.

Height, 40 mm.; diameter, 27 mm.

*Locality.*—Patea.

*Remarks.*—As stated on page 179, this shell was Hutton's plesiotype of *S. cingulata* Zittel. This mistake arose from Zittel's figure representing a specimen with unusually convex whorls; but the characteristics features, obsolete bicarination of the body-whorl, and the disposition of the inner lip-callus show that *S. cingulata* belongs to the *papulosa* group, whereas there can be no doubt that this specimen falls under the *vermis* group. In outline it is very near *S. convexa,* but is easily distinguished by the strong spiral cords, which are rendered moniliform by the prominent growth-lines.

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