ART. 2.—The Genus Glycymeris in the Tertiary of New Zealand.


[Read, by permission of the Director of the N.Z. Geological Survey, before the Wellington Philosophical Society, 12th October, 1921; received by Editor, 2nd December, 1921; issued separately, 1st February, 1923.]

Plates 1–7.

GLYCYMERAES Da Costa, 1778 (=PECTUNCULUS Lamarck, 1799).

The genus Glycymeris, appearing first in the Cretaceous, is widely spread throughout the Tertiary strata of the world, and exists in the Recent seas of the West Indies, Britain, India, New Zealand, Australia, and western America. It is a shallow-water shell, ranging, according to Woodward, from 8 to 60 fathoms, and rarely to 120 fathoms. Consequently the fossil occurrence is generally in fine conglomerates, sandstones, or shell-beds.

Suter seems to have had an erroneous idea as to which is the anterior of the shell. Thus in his description of both G. laticostata and G. modesta (1913, pp. 851 and 852) he says the beaks curve "forward." This is not the case. The curvature, though generally slight, is towards the rear. It will not be out of place to quote Fischer (1887, p. 978): "The impression of the anterior adductor is subtrapezoidal, that of the posterior adductor is subtrapezoidal, and limited in front by a projection or ridge which is directed towards the umbones and more elevated than the ridge limiting the rear of the anterior adductor; the paellial line at its junction with the impression of the posterior adductor forms a small sinus; the beaks are slightly inclined to the rear."

Other noteworthy features are—

(1.) Worm-borings and malformation are very common on the posterior.

(2.) The ribs are narrower on the posterior.

(3.) In the huttoni group the anterior adductor impression is larger than the posterior.

(4.) In oblique shells the axis slopes downwards to the rear.

The earliest known occurrence in the New Zealand area is in the Upper Senonian. Mr. H. Woods (1917, p. 20) has recorded two species from this formation—Pectunculus sp. from the calcareous conglomerate of Amuri Bluff, and P. selwynensis from a slightly higher horizon at Selwyn Rapids. Another species, perhaps of Cretaceous age, is Glycymeris concava Marshall, from Wangaloa, a shell very like the Selwyn Rapids one, as noted by Dr. Marshall (1917, p. 459), but distinguishable by its much shallower anal depression. Then, too, the ribs of G. selwynensis are more strongly raised than those of G. concava, a feature seen only in well-preserved specimens. These early forms belong to the huttoni group (see below), differing only in their strongly-raised ribs and wide interstices. In this respect they approach the laticostata group, and may represent the ancestor.
of those shells; but it seems more probable that the separation took place at an earlier stage than that of *G. selwynensis*.

The Tertiary species fall into three well-defined groups:

I. The *laticostata* group, characterized by—
(a.) Raised rounded ribs (a few exceptions).
(b.) An equilateral outline, circular to dorso-ventrally oval.
(c.) Closely set ligamental grooves on a highly inclined area.
(d.) Valves little inflated, beaks low (exceptions).
(e.) Teeth small and numerous until invaded by the area.

II. The *huttoni* group, characterized by—
(a.) Linear interstices between low, flat ribs (exceptions).
(b.) An inequilateral outline, subquadrates to obliquely ovate.
(c.) Well-spaced ligamental grooves on a moderately inclined area.
(d.) Valves inflated, beaks prominent.
(e.) Teeth large and strong.

Some specimens of this group present an external resemblance to *Cucullaea*, but they can always be recognized by their rounded shoulders.

III. The *Axinea* group, characterized by—
(a.) Almost smooth surface, under a lens showing very fine radial riblets over the whole disc, superimposed upon a system of narrow obsolete ribs corresponding to the fine crenulations on the inner margin. Sometimes these ribs are shown only on weathering.
(b.) Outline circular to ovate.
(c.) Many closely set ligamental grooves on a highly inclined area.
(d.) Valves inflated, beaks moderate.
(e.) Teeth numerous and fine.

The fine secondary riblets so well developed in this group often appear in other groups, but then only on a small portion of the disc.

This group corresponds to *Axinea* of Poli, 1791, used as a separate genus by Cossmann, Angas, and others; as a section of *Glycymeris* by Fischer and Adams, and as a synonym of it by Zittel, Dall, and Suter.

The three divisions of the New Zealand species are probably of sub-generic value, the first being *Glycymeris* s. str., the second a new subgenus, and the third *Axinea*. The definite classification into subgenera has not been carried out in this paper, as no specimens from abroad were available for comparison.

**Description of Species.**

I. The *laticostata* Group.

*Glycymeris laticostata* (Quoy and Gaimard). (Plate 1, fig. 1.)

For synonymy and description see Suter’s *Manual*, 1913, p. 351.

A noteworthy feature that has not been remarked upon previously is the difference of the ribbing between the anterior and posterior halves of the shell. The ribs on the latter are narrower and more rounded, and the interstices are wider than those of the former.
Laticostata Group.

Fig. 1.—Glycymeris laticostata (Q. & G.), right valve.
Figs. 2, 3.—Glycymeris sp. A. (Uruti.)
Figs. 4, 9.—Glycymeris lornensis n. sp. Holotype.
Figs. 5, 6.—Glycymeris sp. B. (Pakaurangi.)
Fig. 7.—Glycymeris chambersi Marshall. Holotype.
Fig. 8.—Glycymeris traversi (Hutton). Lectotype.

Face p. 64.
Huttoni Group.

Figs. 1, 6.—Glycymeris cordata (Hutt.).  Lectotype.
Figs. 2, 3.—Glycymeris knawenensis n. sp.  Holotype.
Figs. 4, 5.—Glycymeris hutoriensis n. sp.  Holotype.
**Huttoni Group.**

Fig. 1.—*Glycymeris rapanuiensis* n. sp. Holotype.
Fig. 2.—*Glycymeris huttoni* Marwick. Lectotype.
Fig. 3.—*Glycymeris subglobosa* Suter. Holotype.
Fig. 4.—*Glycymeris manaicaensis* n. sp. Holotype.
Fig. 5.—*Glycymeris robusta* n. sp. Holotype.
Huttoni Group.

Fig. 1.—Glycymeris rapauiensis n. sp. Holotype.
Fig. 2.—Glycymeris huttoni (Hutt.) Marwick. Lectotype.
Fig. 3.—Glycymeris subglobosa Suter. Holotype.
Fig. 4.—Glycymeris manaiaensis n. sp. Holotype.
Fig. 5.—Glycymeris robusta n. sp. Holotype.
Axine Group.

Fig. 1.—Glycymeris callaghami n. sp. Holotype.
Fig. 2.—Glycymeris waiataiensis n. sp. Holotype.
Fig. 3.—Glycymeris shrimptoni n. sp. Holotype.
Fig. 4.—Glycymeris trellisickensis n. sp. Holotype.
Fig. 5.—Glycymeris waipipiensis n. sp. Holotype.
Fig. 6.—Glycymeris modesta (Angas). Left valve.
Axina Group.

Fig. 1.—Glycymeris collaghani n. sp. Holotype.
Fig. 2.—Glycymeris waitakiensis n. sp. Holotype.
Fig. 3.—Glycymeris shrimptoni n. sp. Holotype.
Fig. 4.—Glycymeris treissickensis n. sp. Holotype.
Fig. 5.—Glycymeris waipipiensis n. sp. Holotype.
Fig. 6.—Glycymeris modesta (Angas). Left valve.
Huttoni Group.

Figs. 1, 4.—Glycymeris concava Marshall var. (Wangaloa.)
Fig. 2.—Glycymeris huttoni Marwick. (White Rock River.)
Fig. 3.—Glycymeris sp. (Akuaku.)
Localities:

Holotype, Recent.
206—Shakespeare Cliff, Wanganui.
Castlecliff, Wanganui (Marshall).
Waihi, near Hawera (Marshall and Murdoch).
749 (in part)—Mouth of Ruamahanga River, Palliser Bay.
(Fragment.)
81—Castle Point. (Shell slightly more globose, ribs more regular.)
231—McLean’s, Ngaruroro River, Hawke’s Bay. (An old, heavy
shell, with beak and ribs like the Castle Point shells.)
Tokomaru (Marshall). (A very worn specimen, but similar to those
from Castle Point.)
? 649—Paparoa Rapids, Wanganui River. (One imperfect specimen.)
? 786—Mount Donald, Weka Pass. (An imperfect specimen, more
inflated than usual: Pal. Bull. No. 8, p. 42, last list.) This
specimen resembles that from loc. 231.
? 246—Cape Rodney, Auckland. (A distorted specimen.)

The locality-numbers are those of the New Zealand Geological Survey

It will be noted that positive identification could not be made in the
last three localities. The shells are undoubtedly of this group, but may
represent different species.

McCoy (1875, p. 26, pl. xix, figs. 9–13) has described and figured
specimens attributed to this species from the “Lower Tertiary” of Bird
Rock, Geelong; Mount Eliza and Mount Martha, at Schnapper Point.
With reference to this, Tate (1885, p. 137) says, “The identification of the
fossil and the living species has been disputed by Mr. R. M. Johnston.
The material at my command is not sufficient to permit me to express an
opinion, though I have little hesitation in accepting Professor McCoy’s
determination in respect to the fossil represented by fig. 10.”

Unfortunately, no material from Australia was available for this paper,
and opinions based upon figures and descriptions are not so reliable as
those based on the actual specimens. However, the excellent figures of
the Prodomus show no difference between the anterior and posterior
ribbing, so the specific identity of the two shells is open to doubt.

Records to be eliminated from N.Z. Geol. Surv. Pal. Bull. No. 8:

Page 25. Manaia Beach. These shells belong to the huttoni group,
and are here placed as a new species = G. manaiensis.

Page 30. Lower Awatere, loc. 126 = G. manaiensis.
Page 31. Starborough Creek = G. manaiensis.
Page 40. Moonlight Creek = G. manaiensis.
Page 44. Motunau beds, Weka Pass = G. manaiensis.
Page 46. Motunau beds, Mid-Waipara = G. manaiensis.
Page 57. Pareora, loc. 458 = G. huttoni (worn).
(common in this locality).

3—Trans.
In the cases cited above, as well as in the rest of this paper, the specimens have actually been handled. In the case of many other occurrences noted by Suter the specimens are missing from the Geological Survey collections: in fact, no undoubted specimen of _G. laticostata_ has been seen from strata older than Wanganuan.

**Cardium brachytonum** Suter.


The holotype on examination proves to be the cast of a _Glycymeris_, probably _laticostata_. In the plate reproduced in _Bulletin No. 5_ the extremities of the hinge-area have been blocked out by a black background.

**Glycymeris traversi** (Hutton). (Plate 1, fig. 8.)

1873. _Pectunculus traversi_ Hutton, _Cat. Tert. Moll._, p. 28.

In his description Suter gives the locality of the lectotype as Chatham Islands. The actual specimen in the Dominion Museum is labelled "Loc. ?". However, the shell is almost certainly from Chatham, so Suter's statement may stand.

Buchanan's drawing of this shell, reproduced by Suter (see above), does not represent accurately the wide interstices between the ribs. From the drawing one would take the shell to be inseparable from _G. laticostata_; this, however, is not so. The interstices are equal in width to the ribs, even at the margin of a 2 3/4 in. shell; thus the ribs in _G. traversi_ are noticeably narrower than in _G. laticostata_. As to Suter's statement that the former is less inflated than the latter, the present examination does not bear out the observation. The inflation is practically the same in shells of equal size. There is very little difference in width between the anterior and posterior ribs.

The shell from loc. 736, Mount Donald, in this paper provisionally placed under _G. laticostata_, may be the same as the one from Weka Pass placed under _G. traversi_ by Hutton (1873, p. 28). If so, Hutton's record of this species from that locality must be deleted, as the specimen in question has broadly rounded ribs, and so is nearer _G. laticostata_. No specimen of _G. traversi_ from New Zealand rocks has been seen during this examination, nor can I find a record of its having been identified by Suter.

**Glycymeris lornensis** n. sp. (Plate 1, figs. 4, 9.)

Shell, medium-sized, suborbicular, to longitudinally oval, equilateral; beaks only moderately raised above the dorsal margin, which is short, anterior end convex, the dorsal margin sloping; posterior end similar; sculpture consisting of 25 to 30 rounded, radiating ribs which reach the margin but become obscured in some specimens by strong growth-lines, the interstices rounded and narrower than the ribs; margins weakly crenate; hinge-plate deeply encroached on by the ligamental area, even in small individuals, leaving three or four teeth on each side; ligamental area relatively large, steeply inclined, and very closely grooved by about 12 well-incised lines.


Height, 40 mm.; length, 40 mm.; thickness, 14 mm. (one valve).
Material.—Six specimens, none of which is perfect.

Locality.—Conglomerate band in Waiarekan tufts about 50 ft. below the diatomaceous ooze, 400 yards west of Lorne Railway-station, North Otago. (J. Marwick.)

The actual specimens are from an outcrop above the road near the base of the hill, apparently a slip from above.

This shell has a more prominent beak than G. laticostata; it is also much smaller; so that young individuals of the latter may be distinguished by their little-developed ligamental area. In most specimens there is an inclination towards a subtriangular shape, and very little difference of width between the posterior and anterior ribs.

Glycymeris chambersi Marshall. (Plate 1, fig. 7.)


Suter thought that this shell was the ovate form of G. laticostata, but several features are displayed which seem to warrant the preservation of Marshall's specific name. The most important is that the area is more densely striated than that of G. laticostata, there being 13 striae in an area 7 mm. wide, while an equal area of G. laticostata has only about 7. In addition, the rib-interstices on the middle of the disc are deeper, and the shoulders are inclined to be narrower and more rounded.

The type-material consists of a pair of valves (one of which is incomplete), enclosing a larger right valve; the heights are 56 mm. and 62 mm. respectively. From the great encroachment of the area on the teeth, the latter appears to be a fully-grown shell.

This species seems to be intermediate between G. lornensis and G. laticostata; it is nearer to these than to G. traversi.

Locality.—Campbell Island.

Holotype in School of Mines collection, Otago University.

*Species not good enough for Full Description.*

Glycymeris sp. A. (Plate 1, figs. 2, 3.)

From loc. 1041, Uruti, North Taranaki.

Mr. L. I. Grange collected a shell of this group which, from its trigonal shape, wide ribs, and great inflation, especially towards the beaks, must be classed as a new species. The imperfect state of the specimen, however, makes it advisable to withhold full specific designation.

Glycymeris sp. B. (Plate 1, figs. 5, 6.)

From Pakaurangi Point, Kaipara (Bartram).

This very small shell, of only 8 mm. height, has a thickness (one valve) of 3 mm., and so is much too inflated to be the young of any of the named species. It is not necessarily a young shell. Until this point is settled by the collecting of more specimens, specific description and naming had better be held over.
Glycymeris sp. C.

In the Otago University Mining School collection there is a double-valved specimen, 60 mm. high and 55 mm. long, from an unknown locality. It is dorso-ventrally oval, equilateral, and has a closely-lined area. The sculpture, consisting of 40 flat obsolete ribs with linear interstices, is unusual for this group. The beaks are only moderately raised above the dorsal margin, but they are broad and prominent, the whole shell being considerably inflated. In the absence of a locality it would be unwise to give the shell a specific name.

From a shell-bed about the horizon of the Wairarapa limestone, Pukenui, south of Martinborough, the author collected the top half of a valve some- similar to sp. C, but larger and flatter.

II. The huttoni Group.

Glycymeris huttoni nom. mut. (Plate 3, fig. 2; Plate 4, fig. 2; Plate 7, fig. 2.)

1873. Pectunculus globosus Hutton, Cat. Tert. Moll., p. 28 (not of Sowerby).

"Globosa" is preoccupied by J. Sowerby in Dixon's Geol. of Sussex, p. 170, t. 3, fig. 20, 1850, so, unfortunately, this well-known name must go.

Hutton gives as the localities of his species "Hicks Bay; Kokohu; Wairoa, Nelson; Kanieri; Motunau (L); Broken River (U); Callaghan's Creek; Kawau; Oamaru." Unfortunately, the lectotype fixed by Suter is the only specimen available from Kanieri, so there are no means of finding out what variations existed in that locality. Nor are there any other of Hutton's types preserved. A consideration of the other localities does not help us very much:

(a.) There are now no specimens of Glycymeris from Hicks Bay, either in the Geological Survey collection or at the Dominion Museum. Harris (1897, p. 343) mentions "as immense double-valved specimen" from this locality. This description suits the shell (locality unknown) which was thought by Suter to be the type of Cucullaea ponderosa, and which is here classed as G. robusta (see below).

(b.) Kokohu (= Kakahu) : Suter separated these shells as G. subglobosa.

(c.) Wairoa, Nelson: Of a large number of specimens in the Geological Survey collection, all belong to G. cordata. Perhaps Hutton mistook a large specimen of this for his G. globosa.

(d.) Motunau (L): The exact locality is uncertain, but the few poor specimens in the Motunau collections (lots 218 and 219) are here referred to G. manaiaensis.

(e.) Broken River (U) affords good specimens, which are, however, more oblique than the type.

(f.) Callaghan's (= Callaghan's) Creek: The common shell of this locality belongs to the Acinea group, and is here called G. callaghani. There is another shell of the huttoni group, but from the equi-lateral and regularly-rounded shape in youth, and the absence of an anal sinus, it is considered to belong to a different species.
MARWICK.—Genus Glycymeris in Tertiary of New Zealand. 69

(g.) Kawau: No specimens very near the type were seen.
(h.) Oamaru: The many fossiliferous localities in this district and the various horizons represented give Hutton’s use of the name a very wide meaning. The Target Gully “shell-bed” was unknown to him, and, as he used “Awamoa” as a separate locality, it is hard to say from where his specimens came.

Thus it will be seen that there is room for considerable doubt as to the exact limits assignable to this species. The shells from the upper beds at Broken River, though more oblique than the Kanieri one, have the same strong anal sinus. Specimens similar to the Broken River ones are common at White Rock River, Pareora, and these, principally, were used in this paper for comparative purposes (see Plate 7, fig. 2).

Localities:

Kanieri. (Lectotype.)
165—White Rock River, Pareora. (Also a flat variety in Otago Museum collection.)
458—Lower Gorge, Pareora River.
237—“Upper part of Mount Brown limestone, Treliissick.”
451A—Pareora beds, Thomas and Porter Rivers.
Lower Gorge, Waipara (Marshall). (Shells more oblique and with sloping shoulders; perhaps a new species.)
Muddy Terrace, Waikaia (Marshall).
Opiki River, South Canterbury (north bank, two miles west of Pleasant Point) (Marwick).
Grey Marls, Mead Gorge, 25 ft. below conglomerate (Thomson).
Tutamore Ridge, Poverty Bay district (Ongley and Macpherson).
Shingly Creek, Lake Heron (Canterbury Museum collection: two specimens, one with a high, sharp beak).

Records to be eliminated from N.Z. Geol. Surv. Pal. Bull. No. 8:—
Page 49. Treliissick Basin, loc. 449 = G. treliissickensis.

Glycymeris subglobosa Suter. (Plate 3, fig. 3; Plate 4, fig. 3.)


For the description of this species Suter used, in addition to the Kakahu material from which he chose his holotype, a paratype from Target Gully. This latter shell belongs to a different species (G. robusta n. sp.), and has been responsible for such features as “more inflated than globosa” and “secondary ornamentation on the ribs” in Suter’s description.

The number of ribs on the holotype is 56, but other specimens have as few as 48. This species is distinguishable from G. huttoni by its somewhat rounded ribs and interstices. In this feature (seen only in well-preserved samples) it resembles the Cretaceous species—an interesting fact when its low stratigraphical position in the Tertiary is remembered. The angle of the beak is wider than that of G. huttoni, the anal depression is not so marked, and the outline is more nearly equilateral.

Localities:

164—Kakahu. (Holotype.) (Also in Dr. Marshall’s collection.)
176—Black Point. (Poor specimens.)
Transactions.

Although this shell has been recorded from many horizons—as high, indeed, as Wanganuiian—these determinations must be considered extremely doubtful. No specimens examined from other than the two localities given above can be placed in this species.

**Glycymeris robusta** n. sp. (Plate 3, fig. 5; Plate 4, fig. 5.)

Shell very large, heavy, much inflated, subquadrate; beaks very prominent; anterior dorsal margin long, curved, descending gradually; anterior end bluntly angled above; posterior dorsal margin shorter, more rapidly descending; posterior margin with a flattened curve; basal margin meeting the posterior in a blunt angle, but curving regularly to meet the anterior; anal depression moderate; sculpture consisting of about 43 ribs, broad on the anterior and middle part of the disc, but narrow on the posterior; interstices narrow, but widening slightly towards the margin; crenulations of the inner margin obsolete posteriorly; ligamental area long and fairly wide, with four well-spaced ligamental grooves; teeth long and strong, horizontal at the extremities of the hinge-line; anterior muscular impression large, triangular; posterior smaller, subquadrate.

Dimensions of holotype (right valve): Height, 74 mm.; length, 75 mm.; thickness, 30 mm.

**Localities:**

Target Gully (Park, 1916). (Holotype, in collection of N.Z. Geological Survey.) Specimens collected also by Marshall, Benson, and Finlay.)

649—Paparoa Rapids. (Collected also by Marshall and Murdoch.)

1017—Raekohua Valley, Tangarakau. (Specimen of 108 mm. height.)

Mead Gorge gravels (? from conglomerate). Collected by Dr. Thomson.

This specimen was (apparently accidentally) in the Geological Survey locality collection from Awatere Valley, loc. 126, and was accompanied by a label of Suter’s, “Cucullaea alta.” This record must therefore be deleted from *Pal. Bull. No. 8*, p. 30.

? Orari River. (Canterbury Museum collection, fragmentary specimen.)

Point Hill, Glenavy. (Otago University collection.)


483—McKay’s “Hutchinson’s Quarry greensands,” Wharekuri. (A fragment.)

**Remarks.**—The holotype was used by Suter as a paratype for his *G. subglobosa* from Kakahu. The excellence of its preservation makes one wonder why he did not make it the holotype of his species, instead of the matrix-filled specimen that he used. Perhaps he doubted the exact specific identity of the Target Gully and the Kakahu shells.

Although a large shell, the holotype is not quite full-grown, and so does not present all the characteristics of the old individuals, which are as much as 108 mm. in height. These are thicker and heavier, the shoulders are more rounded, while the area is broad and has encroached on the teeth, which are thick and irregular. The flattened posterior margin is extended ventrally, making the shell more inequilateral.

This species is larger and more tumid than *G. subglobosa*; the ribs, too, are wider. Young shells of *G. robusta* would be very like mature *G. subglobosa*, but the old shells present quite a different appearance, having more rounded shoulders and an inequilateral outline.
Very young shells of, say, 20 mm. height are difficult to separate from the young of *G. huttoni*. The teeth of *G. robusta*, however, are slightly thinner and more horizontal, the hinge-line is narrower, and the anal sinus somewhat shallower. The full-grown shell is more inflated than *G. huttoni*, the hinge-line is longer, the anal sinus much weaker, and the teeth are longer and more nearly horizontal. The flattening of the posterior margin and its extension downwards give the shell a suggestion of a shortened *Cuclulaea*, an effect strengthened by the horizontality of the outer teeth. Add to this the fact that the type of *Cuclulaea ponderosa* was lost, and we have a fine little pitfall for the palaeontologist. Fortunately, the missing shell has been found, so the error can be corrected. The specimen used by Suter (1914, p. 36) for his description of *G. ponderosa* (and now in the Dominion Museum) is a *Glycymeris robusta*. It measures 102 mm. high, 94 mm. long, and 80 mm. thick (both valves). The measurements and locality given by Suter are taken from Hutton's description, and it will be seen that, while the height of both is 102 mm., the length of the *Cuclulaea* is 109 mm., which can hardly be said to "answer very well" to that of the 94 mm. length of the *Glycymeris*. The locality of the shell is unknown, but it may be Hutton's *G. globosa* from Hicks Bay (1873, p. 28).

In an unpublished "List of Tertiary Mollusca in the Canterbury Museum" Hutton gives a photograph of a shell from Porter River which he identified as *Cuclulaea ponderosa*. It is almost certainly a *Glycymeris robusta*.

**Glycymeris cordata** (Hutton). (Plate 2, figs. 1, 6.)


Shell comparatively small, heavy, much inflated, roundly trigonal; beaks very broad and high; anterior end broadly curved, sloping steeply from the umbo; posterior end attenuated below; anal depression moderate; sculpture about 36 obscure ribs with linear interstices; ligamental area short and wide, with faint, spaced striae; teeth strong, steeply inclined, not greatly invaded by the area, 8 on each side.

Height (right valve), 34 mm.; length, 31 mm.; thickness, 15 mm.


Locality.—Wairoa River, Nelson, in large numbers in a brown sand at the mouth of the Wairoa Gorge.

This species is easily identified by its somewhat small size, and the very large, broad beak.


Page 69. Left bank, Waitaki River = *G. waitakiensis* n. sp.

None of the other specimens recorded by Suter could be found, so that no example of *G. cordata* was seen from other than the type-locality.

**Glycymeris hurupiensis** n. sp. (Plate 2, figs. 4, 5.)

Shell large, heavy, inflated, subquadrate when young but becoming obliquely subrhomboidal at maturity; beaks very prominent, anterior dorsal margin long, sloping gradually to the somewhat narrowly-convex anterior margin; posterior dorsal margin shorter, posterior margin broadly
convex; anal depression moderate; sculpture about 30 broad, flat radials with linear interstices generally obscured towards the edge of the adult by strong, waved growth-lines; inner margin coarsely crenate; ligamental area long and wide, with about 6 lightly-incised ligamental lines; teeth of variable strength, 10–12 on each side.

Height of holotype (right valve), 58 mm.; length, 63 mm.; thickness, 25 mm.

Localities.—
1037—Sandstone, Hurupi Creek, Palliser Bay.
1039—Basal grits, Whakapirihiaka, east shore, Palliser Bay.


This species may be distinguished from G. huttoni by its fewer and broader ribs, by its less-pronounced anal depression, and the ovate shape of the adult shell.

Glycymeris kaawaensis n. sp. (Plate 2, figs. 2, 3.)

Shell large, heavy, inflated, rounded, trigonal almost equilateral; beaks very prominent, anterior dorsal margin sloping fairly steeply to the convex anterior end; posterior dorsal margin short, posterior end broadly convex; anal depression very weak; sculpture 30–35 broad, flat ribs with linear interstices, crossed by strong waved growth-lines towards the margin; ligamental area moderately long and very wide, with 6 somewhat shallow ligamental grooves; teeth short and stout, posterior ones curved; the holotype has 17 in front and 13 behind, 5 at each end free of the area (this, however, seems an exceptionally large number, as paratypes have as few as 3 whole, teeth at each end and 2 or 3 rudimentary ones truncated by the area).

Height of holotype (right valve), 61 mm.; length, 65 mm.; thickness, 27 mm.

Locality.—996—Kaawa Creek.


Remarks.—This species can be distinguished from G. huttoni and G. hurupiensis by its much more sloping shoulders, and the short, curved posterior teeth; from the former also by its anal depression being practically absent, and from the latter by its slightly narrower ribs.

This is the shell identified by Suter as G. globosa (Hutton): J. A. Bartrum (1919, p. 104).

Although most of the large shells are thick and heavy, giving a strong resemblance to G. huttoni, this does not show the true nature of the species, which is much closer to G. manaiensis. This is shown not only by the shape of the growth-lines of youthful stages, but also by some large individuals which have not become thickened. One specimen, collected by Mr. Bartrum, has a low beak and is very like a large G. manaiensis. The area, however, is short and broad, as in other Kaawa shells. Viewed externally, the beak is seen to be somewhat narrower, the shoulders are more sloping, and the ribs fewer in number.

Glycymeris manaiensis n. sp. (Plate 3, fig. 4; Plate 4, fig. 4.)

Shell large, of moderate weight, obliquely ovate, inequilateral, moderately inflated; beaks small, not projecting much above the dorsal margin, anterior end practically a semicircle, posterior end somewhat attenuated ventrally; anal depression absent; sculpture 30–35 flat radials with linear
interstices, becoming obsolete towards the margin, where there are numerous waved growth-lines; ligamental area short and narrow, almost smooth, with three scarcely discernible ligamental grooves; teeth about 10 on each side, fairly short and stout, bent in the middle, where there is on each side a short striated facet with raised edges.

Height of holotype (complete individual), 49 mm.; length, 53 mm.; thickness of one valve, 16 mm.


Remarks.—This species may be distinguished from the three preceding ones by its ovate shape, very much lower beaks, moderate inflation, and small, almost smooth, area.

Localities:

875—Manaia beach. (Holotype.)
Whakino, Hawera (Marshall and Murdoch).
1018—Cliff half a mile north-west of mouth of Patea River.
? 720—"Upper band of Petane limestone." (Fragmentary specimen.)
? 736—"Petane and Scinde Island." (Fragmentary specimen.)
Lower end of Starborough Creek, Awatere Valley (Thomson).
218—Motunau. (Poor specimen.)
219—Motunau. (Poor specimen.)
126—Awatere Valley.
Motunau beds, Middle Waipara (Thomson).
Motunau beds, Lower Waipara (Thomson).
Motunau beds, Weka Pass (Thomson). (Fragment.)
? 41 (red)—Moonlight Creek, Waihero Survey District, Westland.

The shells from Whakino, Hawera, are somewhat stronger in the beak than the type, and in some cases have more sloping shoulders. In this respect they approach the variety of *G. kaawaensis* mentioned above. The general affinities are, however, with the Manaia shell.

Although the shells are not at all alike, this species has generally been identified as *G. laticostata*. This seems to have been brought about by an identification made by Zittel. The figure he published is that of an equilateral shell with flat ribs and wide shoulders. It is neither *G. laticostata* nor *manaiaensis*, but apparently belongs to *Glycymeris* sp. [see below, p. 74 (d)].

**Glycymeris rapanuensis** n. sp. (Plate 3, fig. 1; Plate 4, fig. 1.)

Shell fairly large, not heavily built, disc longitudinally oval, inequilateral; beaks fairly prominent; anterior dorsal margin almost horizontal, anterior end broadly convex; posterior end slightly sinuated above by the anal depression, which is bounded ventrally by a low ridge running from the umbo and making a blunt angle in the posterior margin; sculpture, about 26 very broad flat ribs with linear interstices obscured toward the margin by waved growth-lines; ligamental area small, with 4 lightly incised ligamental grooves; teeth short, curved, with short striated facets at the angle.

Height of holotype (right valve), 45 mm.; length, 52.5 mm.; thickness, 16 mm.


Locality.—895—Mouth of Rapanui River. (Collected also by Mr. L. Grange.)
Transactions.

Remarks.—This species is nearly related to *G. manuaensis*, as shown by the similar ligamental area and teeth; the beaks of the former, however, are noticeably more prominent, the outline is more oval, and the ribs fewer and wider. This latter characteristic is very marked in the crenulations of the inner margin, which in *G. manuaensis* are only about half the width of those in *G. rapanuiensis*. The outline and hinge-area distinguish it from the other species of the genus.

Suter classed this shell, as well as the *Manaia* one, as *G. laticostata*.

Species not good enough for Description.

There are several almost equilateral forms belonging to the *huttoni* group, but to none of the named species. The specimens are poorly preserved and few in number, so their separation and description have not been attempted. Three species, or subspecies, appear to be represented:—

1. A shell of moderate size and considerable inflation, with low beaks and about 30 ribs (see Plate 7, fig. 3):—
   (a) Loc. 70—Akuaku, Poverty Bay district (figured).
   (b) Between Blairich and Black Birch Creek, Awatere Valley (Thomson).
   (c) Loc. 154 (?)—Callaghan’s Creek, Goldsborough.
   (d) The shell figured by Zittel as *P. laticostatus* (1864, pl. xv, fig. 13a, 13b) from Awatere Valley.
   (e) Loc. 862—Near head of Waimata River, *N.Z. Geo. Surv.* Pal. Bull. No. 8, p. 10, listed as *G. subgloboza*. There is only a fragment of the beak and hinge, but it is not *subgloboza*.

2. A very large shell with wide flat shoulders and narrow beaks:—
   (a) Loc. 649—Paparoa Rapids (also Marshall).
   (b) Loc. 246—Cape Rodney, Auckland.

3. A large inflated shell with low rounded beaks and an almost smooth surface:—
   Loc. 866—Maungatokerau, Uawa, Gisborne District
   The hinge-line is not clearly shown, so the shell may not belong to this group. It is listed as *G. subgloboza* in *N.Z. Geol. Surv. Pal. Bull. No. 8*, p. 7.

III. The *Axinea* Group.

*Glycymeris trellissickensis* n. sp. (Plate 5, fig. 4; Plate 6, fig. 4.)

Shell of moderate size, very inflated, almost globular; beaks low, with a very wide angle; outline equilateral, roundly trigonal in youth, longitudinally oval in the adult; anal depression obsolete; sculpture, surface appearing almost smooth, but there are fine close radial ribs over the greater part of the disc, crossed by growth-lines; underneath these, and shown on weathering, is a system of narrow radial ribs; inner margin finely crenate, ligamental area small, closely striated by 4 or 5 grooves (a paratype of advanced age shows a wide area with 12 grooves); teeth small, numerous, about 6 on each side free of the area; muscular impressions subequal.

Height of holotype (right valve), 42 mm.; length, 45·5 mm.; thickness, 16 mm.

Holotype in collection of *N.Z. Geological Survey*. 
Localities:
239—"Fan coral bed, Porter and Thomas Rivers, Trelissick Basin" (McKay, 1879). (Holotype.)
237—"Upper part Mount Brown limestone," Trelissick.
238—"Mount Brown limestone, Coleridge Creek," Trelissick.
449—"Lower beds, Trelissick Basin" (Enys, 1880).

The matrix and preservation of this shell are similar to that of the holotype, so it is probably from the same horizon, and not from lower beds as stated in McKay's manuscript.

The species is distinguishable from the others of the group by its wider beaks and greater inflation towards the margins.

Glycymeris waipiensis n. sp. (Plate 5, fig. 5; Plate 6, fig. 5.)

Shell very large, regularly inflated, beaks wide and prominent, outline almost circular, anterior regularly rounded, posterior slightly straightened above; sculpture consisting of very fine radial riblets upon a system of obsolete narrow ribs, about 60 in number; waved growth-lines are prominent towards the margin; inner margin very finely crenate; ligamental area moderate, closely grooved: teeth small, 7 on each side free of the area; anterior muscular impression only slightly larger than the posterior.

Height of holotype (complete individual), 77 mm.; length, 79 mm.; thickness of one valve, 27 mm.

Holotype in the collection of Dr. Marshall.

Localities:
Waipi (Marshall). (Also collected by Murdoch.)
996—Kaaawa Creek (small specimens). (Also collected by Bartrum.)

This species is much larger than any of the others in the Axinea group, described in this paper. It is intermediate in character between G. trelissickensis and G. shrimptoni. Small specimens would be distinguishable from the former by their more prominent and narrower beaks, and from the latter by their slightly stronger beaks and higher shoulders.

Glycymeris shrimptoni n. sp. (Plate 5, fig. 3; Plate 6, fig. 3.)

Shell of moderate size, inflated, beaks low; outline almost circular; anal depression obsolete; sculpture—the whole disc is covered with fine closely-placed radial riblets, about 6 per millimetre, superimposed upon narrow obsolete ribs each bearing about 10 of the-lines at the margin, near which especially. There are concentric growth-lines; inner margin finely crenate; ligamental area moderate, closely striated by 8 grooves; teeth small, 7 on each side free of the area; muscular impressions subequal.

Height of holotype (left valve), 44 mm.; length, 43 mm.; thickness, 15 mm.


Localities:
191—Shrimpton's, Ngaruroro River, Hawke's Bay. (Holotype.)
?231—McLean's, Ngaruroro River. (Very much worn.)

This species is closely related to G. trelissickensis, but the beak is a shade higher and has a narrower angle; there is also less inflation towards the margins.

Some specimens develop a certain amount of obliquity, but they can always be separated from such species as G. callaghani and G. waitakiensis by their wider shoulders.

**Glycymeris waitakiensis** *n.* *sp.* (Plate 5, fig. 2; Plate 6, fig. 2.)

Shell of moderate size, fairly solid, roundly trigonal almost equilateral, inflated; beaks broad, prominent, but only moderately projecting above the hinge-margin; anterior end steeply sloping above, broadly rounded below; posterior end similar, slightly attenuated ventrally; sculpture—the surface is almost smooth but weathering shows very narrow radials corresponding to the fine crenulations of the inner margin; ligamental area short and broad, closely striated by 7–8 grooves; teeth small and fine, about 12 on each side, 6 of which are free of the area.

Height of holotype (left valve), 39 mm.; length, 40.5 mm.; thickness, 15 mm.


_**Locality**_—483—Hutchinson’s Quarry greensand, Wharekuri (McKay).

Material, one specimen, in very good preservation.

_**Remarks**_—This shell may be distinguished from *G. trellisickensis* by its trigonal shape, and from *G. callaghanii* by its approach to an equilateral disposition.


**Glycymeris callaghanii** *n.* *sp.* (Plate 5, fig. 1; Plate 6, fig. 1.)

Shell large, solid, inequilateral, obliquely ovate, inflated; beaks moderate, narrow; anterior end semicircular; posterior end attenuated ventrally; sculpture—surface covered with very fine radial riblets, underlain by obsolete primary ribbing, showing plainly on weathering, these ribs are about 50 in number; inner margin with crenulations of moderate size; ligamental area short but wide, closely striated by 8–10 well-incised grooves; teeth fairly strong; muscular impressions subequal, the posterior with a very strong ridge in front of it.


Height of holotype (right valve), 50 mm.; length, 51 mm.; thickness, 18 mm.

_Locality:_

154 (in part)—Greensand, Callaghan’s Creek, Kanieri district (*N.Z. Geol. Surv. Rep. No. 9, 1877, p. 84*). (Holotype.) (Collected also by Mr. Bartram.)

649—Paparoa Rapids, Wanganui River, (The beaks of these specimens are broader than those of the type.)

? 899—Taumatamaire, Awakino. (A small specimen filled with matrix.)

This species may be distinguished from others of the group by its obliquity. The outline is like that of *G. mameiensis* of the *globosa* group, but the fine ornamentation and closely grooved area easily distinguish it.

Dr. Henderson kindly procured some Callaghan’s Creek specimens from the Reefton School of Mines. These show the interior clearly. The ridge in front of the posterior muscular impression is stronger than in any other species of the genus.
Glycymeris modesta (Angas). (Plate 5, fig. 6; Plate 6, fig. 6.)

1873. Pectunculus striatulatis Lam.: Hutton, Cat. Ter. Moll., p. 28
   (not of Lamarck).
   pl. 30, figs. 1, 2.

For further synonymy and description see Suter’s Manual. It must be
remembered that Suter mistook the anterior for the posterior of the shell,
so his description of the beaks should read “slightly curved backwards,”
and so on.

Localities:

Holotype, Recent.
207, 208, 768—Shakespeare Cliff, &c., Wanganui.
720—Upper bank, Petane limestone.
191—Shrimpton’s, Ngaruroro River, Hawke’s Bay.
996—Kaaawa Creek, Auckland. (Small specimens.) (Also collected
   by Bartrum.)

The lowest horizon in the Wanganui district recorded for this shell by
Marshall and Murdoch is Nukumaru.

Beyond the characters of the “group,” this shell shows no close
affinities with any other New Zealand shell, and, as the original stock
apparently became established in this area about the commencement
of the Wanganui, it would be interesting to know from whence it came.
Suter mentions its occurrence at the Kermadec Islands; but it is omitted
by Oliver (1915, p. 567) in his list of molluscs from that locality.

Species to be eliminated from New Zealand Lists.

Glycymeris convexa (Tate).

1885. Pectunculus convexus Tate, Trans. Roy. Soc. S. Aust., vol. 8,
   p. 138, pl. xi, fig. 7 a, b.
   No. 8, p. 49.

The occurrence of this species in New Zealand strata is based on
a single record (Suter, 1921, p. 49) from locality 449, Trelissick Basin.
Strange to say, of the three shells in this collection, this particular speci-
men is missing, so that no definite statement can now be made as to its
identity, and until this specimen is found, or further material collected,
the Australian species cannot safely be said to occur in New Zealand.

Glycymeris striatulatis (Lamarck).


This is a Recent shell from King George Sound, Western Australia. It
has been recorded doubtfully by E. A. Smith (1885, p. 282) from Port
Jackson, but Hedley (1918) says the identification is erroneous.

Hutton (1873, p. 28) and others used the name for the Wanganui and
Recent shells now classed as G. modesta. Suter, while recognizing modesta
for these shells, has used striatulatis in three other cases: (a) For speci-
mens from Kaaawa Creek (Bartrum, 1919, p. 104) belonging to the Azineea

...
of *G. modesta* from Kaawa Creek; (e) for specimens from 191—Shrimpton's (Suter, 1921, p. 19).

This shell is also an *Axinea*, and is here classed as a new species, *G. shrimptoni*.

Note on *Glycymeris concava* Marshall var. (Plate 7, figs. 1, 4.)


As the Wangaloa beds from which this shell comes are probably Upper Cretaceous, this species has not been included with the Tertiary ones described above.

Dr. Marshall kindly sent some of the type-material of the species, including the holotype.

The paratype, 65 mm. high, 63 mm. long, here figured, is worthy of notice on account of its very strong beaks. It seems to be entitled to at last subspecific rank, a matter which can be cleared up when the Wangaloan fauna is being revised.

**Summary of Specific Characters.**

(These must be considered as only approximate.)

I. *Laticostata* group: Equilateral; circular or dorso-ventrally oval; low beaks; area steep, closely grooved.
(a.) *lorrensis*: Small, subtriangular, ribs broad, beaks moderate.
(b.) *traversi*: Ribs and interstices of equal width all over the disc.
(c.) *laticostata*: Interstices narrower and ribs broader on anterior half.
(d.) *chambersi*: Ligamental area very densely striated, ribbing fairly regular.

II. *Huttoni* group: Flat obsolete ribs, linear interstices, beaks generally strong, ligamental grooves widely spaced.
(a.) *subglobosa*: Equilateral, 55 ribs, beaks wide, shoulders high.
(b.) *huttoni*: Subquadrate, strong anal depression, 45 ribs, beaks high.
(c.) *robusta*: Subquadrate, shoulders rounded, 43 ribs, interstices widening towards the margin.
(d.) *cordata*: Beaks very high and broad, shell small.
(e.) *kurupiensis*: Obliquely rhomboidal, 30 ribs, beaks strong, shoulders rounded and sloping.
(f.) *kaawaensis*: Broadly trigonal, 35 ribs, beaks strong, shoulders sloping.
(g.) *rapanuiensis*: Longitudinally oval, ligamental area small and smooth, beaks moderate, 30 ribs.
(h.) *manaiacenisi*: Ovate, ligamental area small and smooth, beaks low, 35 ribs.

III. *Axinea* group: Circular to trigonal, smooth or with very fine surface radials, the primary ribs underneath are narrow, inner margin finely crenate, ligamental area steep, very closely grooved.
(a.) *trebickensisi*: Globular, beaks low but very wide.
(b.) *waitakiensis*: Subtrigonal, beaks strong.
(c.) *callaghanii*: Obliquely ovate, beaks narrow and prominent.
(d.) *waipipiensi*: Very large, circular, beaks prominent.
(e.) *shrimptonii*: Moderate size, circular to slightly oblique, beaks narrow and fairly prominent.
(f.) *modesta*: Very small, trigonal, beaks noticeably curved backwards.
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I am greatly indebted to the following gentlemen, who so kindly sent, or made available, material for examination: Drs. Benham, Benson, Cotton, Henderson, Marshall, and Messrs. Bartram, Morgan, Murdoch, Speight, and Finlay; also to Messrs. G. N. Sturtevant and J. McDonald for valuable advice in the preparation of the figures.

LIST OF PAPERS REFERRED TO.


HUTTON, F. W., 1873. *Cat. Tert. Möll. N.Z.*


ART. 3.—On the Discovery of the Liothyrella boehmi Greensand Band at Flume Creek, Waitaki Valley.

By Professor JAMES PARK, F.G.S., F.N.Z.Inst., Dean of the Faculty of Mining at Otago University.

[Read before the Otago Institute, 8th November, 1921; received by Editor, 12th November, 1921; issued separately, 1st February, 1923.]

At the lower end of Flume Gully, about a mile from Papakaio, the yellow-and-black speckled mineral tuffs which occupy the floor and lower sides of the valley are overlain conformably by a bed of compact yellowish-brown calcareous sandstone about 40 ft. thick. The lower part of this sandstone is highly glauconitic, and the upper part is intercalated with bands and lenses of hard impure limestone.

At the junction of the tuffs and overlying glauconitic layer there is an irregular streak of gritty, pebbly conglomerate, ranging from almost nothing to about 2 in. thick. The material in this grit-band is mainly flinty quartz and black minerals. In size it ranges from sand-grains to well-rounded pebbles 1/4 in. in diameter.

The dip of the tuffs and associated calcareous sandstone is towards the north at a low angle. The course of Flume Gully is almost at right angles to the strike, which coincides approximately with the trend of the Waitaki Valley.

On the west side of the gully, at a point about 100 yards above the big flume and 55 ft. above the floor of the valley, I discovered in the soft glauconitic band overlying the tuffs and in the pebbly band a rich marine fauna, containing prominently, among many other shells, a profusion of well-preserved examples of the large and beautiful *Liothyrella boehmi* (Thomson).