1912. "Lamprophyre Dykes in Long Sleddale": *ibid.*, pp. 266-7.
 1914. "Fractional Crystallization the Prime Factor in the Differentiation of Rock-magmas": *Congr. Géol. Int. Comp.-Rend.*, xii, pp. 205-8.
 "The Sgùrr of Eigg: some Comments on Mr. Bailey's Paper": *GEOL. MAG.*, pp. 306-8.
 "Some Remarks on Geology in Relation to the Exact Sciences, with an Excursus on Geological Time" (Presidential Address to the Yorkshire Geological Society): *Proc. Yorks. Geol. Soc.*, vol. xix, pp. 1-13.
 1916. "Differentiation in Intercrustal Magma-Basins": *Journ. Geol.*, vol. xxiv, pp. 554-8.
 1917. Presidential Address to the Geological Society of London, delivered February 16 (see Reports and Proceedings, *GEOL. MAG.*, pp. 191-2, April, 1917).

II.—CRETACEOUS MOLLUSCA FROM NEW ZEALAND.

By C. T. TRECHMANN, M.Sc., F.G.S.

PLATES XIX AND XX.¹

INTRODUCTION.

OWING to incomplete palæontological knowledge, the true age and correlation of the various divisions of the great Mesozoic series of New Zealand, which, together with the Maitai Series, forms such an important element in the structure of the country, has long remained a matter of uncertainty. In consequence the idea has to some extent taken hold among New Zealand geologists that the Mesozoic faunas, owing to supposed conditions of isolation, show archaic features. It was explained that certain Permian forms occurred in the Trias and that Trias forms may have persisted into Jurassic times, and to a still greater extent that a Cretaceous fauna lived on in this portion of the earth into the Tertiary period.

On going further into these questions I find no support for the theory, and in the case of the Cretaceous, a comparison of the fauna of the Senonian with corresponding faunas of Australia and especially of South America shows that the isolated survival theory is untenable. The arguments adduced in its favour apply equally well to the Cretaceous of South America and other parts of the Indo-Pacific region as they do to New Zealand.

It must be remembered that the present isolation of New Zealand as a land mass is a phenomenon of late geological time. In the Permo-Carboniferous period there was as much or more land in the Southern Hemisphere as there now is in the Northern. The Cretaceous and Tertiary faunas of New Zealand point to a much closer connexion with South America than obtains at the present day. The number of species of recent Mollusca common to the coasts of New Zealand and Tierra del Fuego is now very slight.

In a paper recently published in this Magazine² I showed that the Maitai Series contains a fauna which agrees, so far as it goes, exactly with that of the marine Permo-Carboniferous of New South Wales

¹ Plate XXI will appear with the second part in the August Number.

² "The Age of the Maitai Series of New Zealand": *GEOL. MAG.*, N.S., Dec. VI, Vol. IV, pp. 53-64, Feb. 1917.

and Tasmania, but that the Maitai beds differ from the Permo-Carboniferous of Gondwanaland in being entirely marine.

I also showed in a recent communication to the Geological Society that the Kaihiku, the lowest known Mesozoic fossil-bearing horizon in New Zealand, contains fossils of late Middle or early Upper Trias, and is not as was formerly supposed of Permian age, and that the Carnic, Noric, and Rhætic horizons of the Upper Trias are well represented.

The Jurassic still remains the greatest *terra incognita* in New Zealand palæontology, and owing to the discontinuous nature of the outcrops, the scarcity and indifferent state of preservation of the fossils, its study will involve some difficulty. Several horizons seem to be represented by the fossils, of which I have a considerable collection. A knowledge of the Jurassic horizons which occur in New Zealand is an important matter, because the determination of the highest Jurassic and the lowest Cretaceous beds will indicate the time limits during which New Zealand first became a land surface.

It now seems to me quite clear that the New Zealand continent, and the present New Zealand is the relic of a former land mass both of continental dimensions and of continental faunal character, originated some time about the period of the final fragmentation of Gondwanaland. I am also inclined to think that its compression and uplift are among the phenomena of readjustment consequent upon that event.

The Cretaceous rocks form the basal portion of the newer or covering series, and where they occur they rest, as in Chili and the Californian coast ranges, with a most pronounced unconformity on the denuded edges of the folded and in part metamorphosed rocks beneath them. The lowest Cretaceous marine horizon present will afford us knowledge when the sea began once more to transgress upon the margins of the old peneplaned and lowered land mass which had arisen and been partly denuded during the period intervening, so far as we know at present, between very late Jurassic and Upper Cretaceous times.

The outcrops of the Upper Cretaceous beds in New Zealand are well shown by Professor J. Park on a small-scale map.¹

They occur in six or seven more or less isolated patches of greater or less extent. The relations of the Cretaceous to the overlying Tertiary series have given rise to much discussion, into which however I do not propose to enter in the present paper.

On the eastern side of the Alpine chain in the middle part of the South Island, in the Waimakariri and Waipara gorges, the marine Upper Senonian rests on the upturned edges of the older rocks. This condition of things obtains also at Quiriquina, on the coast of Chili. In the north-eastern part of the South Island and apparently also on the eastern side of the North Island some earlier Cretaceous beds with *Inoceramus* occur. In this connexion it is important to notice that in South Patagonia, between Lago Argentino and Last Hope Inlet, on the eastern side of the Cordillera, the Upper Senonian rests on beds containing *Inoceramus Steinmanni*,

¹ *The Geology of New Zealand*, 1910, sketch-map.

Wilckens, which are Upper Cretaceous but probably still of Senonian age.

The faunal and stratigraphical details in New Zealand still remain to be worked out, especially in the North Island, but the facts already known point to a north to south as well as to an east to west transgression of late Cretaceous beds, with a further overstep of the Upper Senonian to the south-west across the earlier upper Cretaceous beds beneath them. Mr. H. Woods has recently examined some Cretaceous fossils belonging to the New Zealand Survey collections and concludes that two distinct faunas occur.¹ The older of these occurs at Coverham, in the middle Clarence Valley in the north-east corner of the South Island, and is of approximately Upper Greensand or Gault age. The younger fauna of Upper Senonian age occurs at Amuri Bluff on the north-east coast of the South Island, at Selwyn Rapids, and other localities.

I understand that only the Lamellibranchs of Selwyn Rapids were examined by Mr. Woods. His work, however, is not published yet. Professor P. Marshall has recently investigated a very interesting and rather extensive fauna which occurs at Wangaloa, on the south-east coast of the South Island south of Dunedin. It is clearly newer than the Upper Senonian faunas above-mentioned, but must, on account of the presence of *Pugnellus*, in my opinion, still be referred to the Cretaceous. I should regard it as Danian or Maestrichtian.

The object of the present paper is to describe a series of fossils other than the groups already described by Mr. Woods or those at present under description by Professor Marshall, which throw further light on the age and correlation of some of the Cretaceous beds of the South Island of New Zealand.

All the specimens described were collected by myself, so I can guarantee the accuracy of the localities and horizons.

THE LOCALITIES.

Selwyn Rapids.

This locality is situated at the base of the eastern foothills of the Southern Alps about 36 miles west of Christchurch. The railway station is Glentunnel, and the outcrop forms a series of rapids in the Selwyn River about a mile from the station. The beds consist of a series of glauconitic greensands more or less concretionary. In the bed of a tributary creek a few hundred yards away there are several enormous spherical concretions² 5 or 6 feet in diameter

¹ *Nature*, March 22, 1917, p. 79.

² Similar concretions occur at Hampden, in North Otago, in beds apparently of the same age that crop out on the seashore. The concretions are surrounded by a casing of stony material in which the finest cone-in-cone structure I have ever seen is developed. The apices of the cones as a rule are directed towards the centre of the nodule, and the bases of the cones on the outside assume forms that suggest floral structures. The outer skin of the septaria is a few inches thick and is generally loose and detached from the concretion and is easily broken off. This together with the presence of yellow calcite veins which pass in all directions through the septaria suggests that the cone-in-cone structure is connected with a contraction of the inner portion of the septarian concretions. These large septarian nodules are rather sparingly distributed in

that show sections of *Conchothyra* and other fossils on the weathered surfaces. These concretions are extremely hard in places.

At the Rapids the fossils are very badly preserved in the softer rock, but the harder portions exhibit many sections of well-preserved fossils on the waterworn surface, but the rock is so hard that a hammer and chisel are of little use. On one visit, however, I employed a man to put some half-dozen shots of gelignite into the most likely-looking places, with the result that a large quantity of rock was broken up and became available for collecting.

The fossils show some unequal distribution in this bed, and *Conchothyra*, *Aplustrum*, and other forms occur in little clusters or nests. Lamellibranchs and Gasteropods are the chief fossils, but scales and bones of fish also occur, the former rather plentifully. I was fortunate in obtaining two Ammonites and a Belemnite, neither of which seems to have previously been recorded from this locality, and which establish the Mesozoic age of the beds beyond question. I collected a large number of Lamellibranchs, but as Mr. Woods has described those of the old Survey collection from this locality I await the appearance of his memoir before I describe them or record any new forms there may be among them.

Waipara Gorge.

In the Waipara Gorge, about 35 miles north of Christchurch, there is a glauconitic sandstone full of marine shells a very short distance above the local base of the Cretaceous and below the well-known concretionary greensands with Saurian bones. Some of the fossils are very much rolled, as though it had been an old shore-line, but unfortunately they are badly preserved. *Ostræa* is very plentiful, and there are many specimens of a shell I took to be *Conchothyra parasitica*, but which turns out to be an apparently undescribed form of *Pugnellus*. The Waipara Gorge affords the most important continuous section in New Zealand of the Cretaceous and Tertiary beds.

Waimakariri Gorge.

This locality is about 40 miles west-north-west of Christchurch. The station is Kowai Bush, and a section of Cretaceous beds resting unconformably on semi-metamorphic greywackes and argillites of uncertain age is exposed in a deep gorge of the river. The fossiliferous band is not far above the junction, and consists of some 3 feet of glauconitic greensand crowded with *Conchothyra parasitica*, the only other fossil being an occasional badly preserved valve of *Trigonia Hanetiana*.

Wangaloa.

This locality is on the coast about 35 miles south-west of Dunedin, and forms part of the Kaitangata Coalfield. Fossils occur in a calcareous sandstone with some glauconite. Professor Marshall has a bed of blackish-grey calcareous shale which shows no trace of cone-in-cone structure. I noticed in some places that where the concretions had been affected by subsequent pressure in the bed the action of the pressure tended to obliterate again the cone-in-cone structure in the outer layer of the nodules.

recently shown that the fauna here is distinct from the usual Cretaceous such as occurs at Selwyn Rapids, and that a shell which occurs here and was formerly supposed to be *Conchothyra parasitica* is really a new species of *Pugnellus*. Neither Ammonites nor Belemnites have yet been found in this bed. Marshall has recently published¹ a provisional list of fifty-two species of Mollusca from this locality which seems to include a considerable number of Tertiary Oamaru forms and even some recent species. He is at present investigating this fauna more closely. I made a fairly large collection one day at this locality, but I await Professor Marshall's work before reporting on them.

PALÆONTOLOGY.

TRIGONIA cf. HANETIANA, d'Orb. (Pl. XXI, Fig. 5.)

Voyage dans l'Amérique Paléontologie, 1842, p. 127, pl. xii, figs. 14-16.

Philippi, Die quaternären und tert. Versteinerungen Chiles, 1887, p. 199, pl. xlii, figs. 1-3.

Steinmann, "Die Gastropoden u. Bivalven der Quiriquina-Schichten": N.J. für Min., Beilage Bd. x, p. 101, pl. vii, figs. 8, 9, 1895.

Hector, Catalogue Ind. and Col. Exhibition, 1886, p. 64, fig. 5, *Trigonia sulcata*.

The only other shell I saw in the *Conchothyra* bed in the Waimakariri Gorge was a *Trigonia*, which occurred as single valves in a friable and fragmentary condition. I collected the pieces of one and succeeded in joining them together. It is undoubtedly the shell that Hector illustrates without any description under the name *Trigonia sulcata*. The curious double sculpture on the anterior part of the shell makes this quite certain. Steinmann notices Hector's figure, and compares it with *T. Hanetiana* from Quiriquina, in Chili, and remarks "that of all known forms of *Trigonia* the only one which compares with *T. Hanetiana* is one illustrated by Hector under the name *T. sulcata* from the lower (*sic*) Cretaceous of New Zealand. Both forms are obviously very closely related and represent a genuine Pacific form, for which it would be best to institute a special group". He goes on to say that it does not fall well into any of Lycett's *Trigonia* groups.

My specimen is a right valve, and unfortunately lacks the hinder part, but enough remains to give a fair description of it. The beak is rather anterior and the shell considerably elongated behind. The ridge which passes from the beak to the hinder part is bluntly angular, the sides making nearly a right angle with one another, and in front there is a wide shallow groove almost devoid of sculpture. Between this and the rounded anterior margin the surface is ornamented with broad and shallow concentric growth grooves which are crossed obliquely by a series of about six broad and low ridges, which are arranged parallel to the main posterior ridge and gradually diverge and increase in size as they pass from the upper anterior part of the shell backwards to the lower margin. Where they are strongest they tend to obliterate the concentric grooves of growth. The teeth cannot be seen. Height 50 mm.

¹ "Relations between Cretaceous and Tertiary Rocks": Trans. N.Z. Inst., vol. xlviii (new issue), p. 114, 1915.

I am inclined to think the New Zealand shell is identical with *T. Hanetiana*, but owing to the poor condition of the only specimen I collected I cannot be quite certain.

Wilckens¹ describes another form, *T. ecplecta*, from the Upper Cretaceous of Baguales in South Patagonia, which, though larger, is certainly related to *T. Hanetiana*, but on which the cross ribs are confined to the upper anterior portion of the shell, and the concentric furrows are much stronger.

T. Hanetiana belongs to the commonest fossils of the Chilean Upper Cretaceous, and together with *Cardium acuticostatum*, d'Orb., is regarded as a leading fossil of the Quiriquina Beds.

I found no Trigonias at Selwyn Rapids, but I believe they occur there.

DENTALIUM sp. (Pl. XXI, Fig. 10. $\times 2$ nat. size.)

Shell slightly curved, increasing slowly in size, rather thin, and almost circular in section. The surface is rather rough, and the growth-lines are well marked. A specimen I collected resembles *D. Chilensis*, d'Orb., which is common at Quiriquina, but is without the longitudinal striæ that occur on the thin end of that species. It is comparable also with *D. Cazadorianum*, Wilckens, from South Patagonia.

Locality.—Selwyn Rapids. Dentaliums of fairly large size are common, generally as casts in some parts of the rock.

TURRITELLA sp. (Pl. XIX, Fig. 11. $\times 2\frac{1}{2}$ nat. size.)

Shell small, consisting of seven whorls, which increase very gradually. The test is rather thin, the sutures are shallow, and each whorl is decorated with seven or eight very faint spiral raised ridges.

Locality.—Selwyn Rapids.

CHRYSTOMA SELWYNENSIS, sp. nov. (Pl. XXI, Figs. 4a, b.)

Shell very small, thick, and globose, consisting of five whorls. Surface smooth and rounded, sutures shallow. There is a faint umbilicus which is more or less covered by a reflected callus extension of the inner lip. The outer lip, though broken, seems to have been sharp. Height 5 mm. I can find no described form in the Indo-Pacific Cretaceous resembling this small and insignificant-looking shell, and so am constrained to give it a new specific name. The only living representative of the genus to which it certainly seems to belong is a beautiful shell, *C. paradoxum*, Born, found on the shores of New Caledonia.

Locality.—Selwyn Rapids, one specimen.

NATICA (EUSPIRA) VARIABILIS, Moore. (Pl. XIX, Figs. 8–10.)

Charles Moore, Quart. Journ. Geol. Soc., vol. xxvi, p. 256, pl. x, fig. 15, 1870. Jack & Etheridge, Geol. and Pal. Queensland, 1892, p. 485, pl. xxxi, figs. 2, 3. R. B. Newton, Proc. Malac. Soc., vol. xi, pt. iv, p. 232, pl. vi, figs. 21–3, 1915.

The New Zealand form of this Australian fossil is rather variable. One specimen (Fig. 8) has four volutions, is broader than it is high,

¹ Berichte der Naturf. Gesell. z. Freiburg, Bd. xv, p. 37, pl. vii, figs. 2, 3, 1907.

and is rather depressed. The body-whorl is large and globose and increases rapidly in size. The surface is rather eroded and bears closely spaced rather foliaceous growth-lines. The suture is somewhat deep and the whorls are not flattened below it, and there are no parallel striæ on the basal part of the body-whorl. It measures 16 mm. high and resembles a specimen figured by Jack & Etheridge, pl. xxxi, fig. 2. Another specimen (Fig. 9) differs in having a more elevated spire, the suture is not insunken and the whorls are flattened just below it, and the body-whorl is relatively smaller and less swollen. About six fine rounded concentric ridges occupy the base of the body-whorl near the umbilicus, and the growth-lines are much less strongly marked than in the first variety. It is smaller in size and resembles the specimen figured by Jack & Etheridge, pl. xxxi, fig. 3. Another smaller specimen (Fig. 10, $\times 1\frac{1}{2}$ nat. size) resembles the last, but the concentric ridges occupy the whole of the body-whorl.

This shell agrees in every way with the Australian form, and is the only Australian Cretaceous fossil I found in the New Zealand rocks. Mr. R. B. Newton has recently discussed the generic affinities of this shell in a paper quoted above dealing with the fossils of the opal deposits of the interior of New South Wales.

It occurs in the Rolling Downs Formation of the Lower Cretaceous, and also in the Desert Sandstone, Upper Cretaceous, in Australia. I have a specimen from the opal deposits of Whitecliffs, New South Wales.

Locality.—Selwyn Rapids, where it is not scarce. I did not find it in any other locality, and this is the first record of the occurrence of this typically Australian form in New Zealand and forms the sole connecting link among my specimens with the Australian Cretaceous.

NERITOPSIS (?) *SPEIGHTI*, sp. nov. (Pl. XIX, Figs. 12–15.¹)

The shell consists of four or five whorls, and in young specimens is thin and oval in shape. In the adult state it is more rounded owing to flattening of the spire and rapid enlargement of the body-whorl. The spire in immature specimens is pointed and rather elevated, but in the adult specimen it is flattened through erosion or wear. In the largest example there is a faint umbilicus, the peristome is entire, and the inner lip is somewhat detached from the body-whorl. The lip is thickened for some distance back from the margin, but ends in a sharp rim. The body-whorl is decorated with about fifteen raised concentric parallel rounded ridges, alternating with furrows of about the same width and depth. On the earlier whorls the furrows are less strongly marked. The growth-lines are rather faint, but are interrupted here and there on the body-whorl by a strong furrow.

In the absence of knowledge of the operculum or of the animal it is impossible to fix with certainty the genus of this shell, as many genera quite unallied to one another develop parallel concentric furrows, such as *Cinulia*, *Dolium*, *Pyrula*, *Fossarus*, and many others.

The moderate thickness of the shell and increasing thickness of the adult lip and sharpness of the aperture point to *Neritopsis*

¹ Fig. 15 is $\times 2$ nat. size.

as being the most likely genus. It also resembles *Vanikoro*, but the shell seems too thick and the inner lip too strongly developed. The partial detachment of the inner lip from the body-whorl and the complete peristome suggests the genus *Fossarus*, which together with *Vanikoro* has a horny operculum, whereas that of *Neritopsis* is thick and stony. There is no trace of columellar folds nor of a reflected lip which might connect it with *Cinulia* or *Eriptycha*.

The erosion or battering which the spire has suffered in the adult specimen points to its being some shore-loving form, but whether of the Littorinidæ or Neritopsidæ is uncertain, but I think the genus *Neritopsis* is the more likely one.

Locality.—Selwyn Rapids.

The only species I can trace which at all resembles the present form is *Vanikoro Kiliani*, Wilckens,¹ which occurs at Snow Hill and Seymour Island in Antarctica. But this is a very small shell and consists only of three to four whorls and has fourteen spiral ribs, the spaces between which are not always equal and the ribs are preserved only on the last whorl. I take the opportunity of naming this shell after my friend Dr. R. Speight, director of the Christchurch Museum, who has published many papers on New Zealand Geology, and who assisted me to collect several of the Cretaceous fossils.

CONCHOTHYRA PARASITICA, McCoy. (Pl. XX, Figs. 4, 5.)

Hector, Cat. Ind. and Col. Exhib., 1886, p. 58, fig. 4.

Park, Geol. New Zealand, 1910, p. 90, pl. v (after Hutton).

This extraordinary Gasteropod is the most abnormal of the curious group of the Pugnelliids. The smooth callosity of the inner lip is more exaggerated than in any other species of the group, and in some specimens it extends beyond the apex and sometimes almost buries the spire. The thickened claw-like outer lip is very large and heavy, and the growth-lines and ridges on the body-whorl are very exaggerated.

If the genus *Conchothyra* is to be retained—and in view of its frequent mention in New Zealand geological literature and the great specialization of the shell in question I think it should be—it may be re-defined as follows:—

Shell as in *Pugnellus*, but the early whorls are smooth and devoid of nodes or ribs. Spire short and in fully grown specimens almost buried by the labial callosity, and often scarcely visible owing to erosion. The lines and ridges of growth are coarse and prominent on the last whorl. The anterior channel of the mouth is deep and narrow, the posterior channel is shallower and more or less semi-circular in shape. The outer lip is much thickened and often greatly prolonged.

I think this curious mollusc may have been of a sluggish character and have lain partly buried in sand. Both the great weight of the shell and its frequent erosion suggest this mode of life. That part of the body-whorl on the back below the spire is generally very thin,

¹ "Die Anneliden, Bivalven, u. Gasteropoden der antarktischen Kreide, 1910": Wissensch. Ergebnisse der Schwed. Sudpolar Exped., p. 77, pl. iii, figs. 28a, b.

apparently by absorption or erosion. In one of my specimens there is a small *Anomia* attached to the surface near the inner lip which suggests that the shell may have lain mouth upwards in the sand.

Locality.—In the Upper Waimakariri Gorge there is a bed about 3 feet thick not far above the local base of the Cretaceous almost made up of thousands of these shells, some perfect and others broken. They show considerable variation in the degree of growth of the shelly callosity and the extension of the lip. The only other fossil that I found associated with them in this locality were a few valves of *Trigonia Hanetiana*, d'Orb. At Selwyn Rapids the shell is less plentiful, and is better preserved in the harder parts of the rock, but is in all respects similar to the specimens at Waimakariri.

It seems, as one might expect in so specialized a shell, to have a restricted vertical range, and may be regarded as a characteristic fossil of the Upper Senonian.

This form is apparently quite absent from the higher Wangaloa Beds, where it is replaced by a beautiful shell recently described by Professor Marshall as *Pugnellus australis*.

PUGNELLUS MARSHALLI, sp. nov. (Pl. XIX, Figs. 1-4.)

The shell consists of six whorls, the last one large and inflated. Above the middle of each whorl there is a row of blunt nodes, and below these on the last whorl a row of smaller and less prominent nodes which in some specimens coalesce into a raised ridge. The sutures are shallow. The outer layer of the shell bears very fine concentric raised lines.

The lip is not developed to the exaggerated extent it is in some forms of *Pugnellus*. The outer lip is extended and swollen, and ends in a rounded claw-like protuberance which is very easily broken off. Anteriorly there is a channel, but the shell is not drawn out. Posteriorly there is a wide semicircular channel formed by the swollen lip of the shell. The callosity of the inner lip reaches in most specimens to the top of the third whorl from the mouth, and in one or two examples it extends above this nearly to the apex. It is a shell of moderate size, the height being about 26 mm.

This shell was formerly erroneously supposed to be a *Struthiolaria* or *Pellicaria*, and a specimen was recently identified as such by Mr. Suter, and Prof. Marshall¹ remarks that it is the first occurrence of the essentially Tertiary form *Struthiolaria* in Cretaceous rocks.

I obtained, however, nine or ten perfect examples with entire lips and can definitely say that it is a true *Pugnellus*. It often happens that the specimen is immature or the lip is missing when the sculpture on the earlier whorls of the shell certainly recalls that on the recent *Pellicaria*. However, in no *Struthiolaria* that I have seen does the labial callosity extend to beyond the lower half of the penultimate whorl. The same remark applies to *Pellicaria*, which has in addition a thin smooth shelly deposit covering the back of the last and penultimate whorl. Neither *Struthiolaria* nor *Pellicaria* has the thickened and swollen outer lip characteristic of *Pugnellus* which is so conspicuous in the present shell.

¹ Trans. N.Z. Inst., vol. xlviii, p. 118, 1915.

Locality.—Selwyn Rapids, where it is rather common.

I name this species after Professor P. Marshall, who has done so much in elucidating the geology of New Zealand and in calling attention to the problems of the Cretaceo-Tertiary question in the South Pacific region.

PUGNELLUS WAIPARENSIS, sp. nov. (Pl. XX, Figs. 1a, b.)

The spire is moderately elevated and the shell consists of six whorls. The shell is almost completely overgrown up to the summit of the spire with a platy extension of the lip, and only when this is broken away is the spire visible and the nodes and ornamentation of the whorls seen. The earlier whorls are decorated with folds which develop into elevated and rather sharp nodes. These are placed in a diagonal position on the shell rather above the suture on the penultimate whorl, and are faintly visible on the body-whorl where they occur above the median line. Below these nodes on the last whorl there is a blunt faintly raised ridge.

A series of fine, rather wavy, spiral, raised lines occur on the penultimate whorl and are faintly seen on the body-whorl below the ridge. They run somewhat irregularly and are not exactly parallel to one another, but approach and recede again, a peculiarity already noticed by Wilckens in the case of *Pugnellus Hauthali*,¹ which he describes from South Patagonia. The anterior channel of the lip is not produced, and the outer margin of the lip is not swollen to an unusual extent for a *Pugnellus*.

This shell approaches *P. Hauthali* in having the spire completely covered with a leafy shell growth and in the diagonal arrangement of the elongated and sharp nodes and in the curious non-parallel arrangement of the spiral lines. It differs in the spire being more elevated and the anterior channel not being elongated and the outer lip being less swollen and extended.

Locality.—Waipara Gorge, in beds with *Ostrea* near the local base of the Cretaceous and well below the Saurian concretionary beds. It occurs plentifully, but often rolled and poorly preserved. It has hitherto been mistaken for *Conchothyra parasitica*, and I thought it was a small variety of that shell, but I find on developing my specimens that it is a *Pugnellus* that I cannot identify with any described form. I found no *Conchothyra* in the bed in which it occurs.

PUGNELLUS AUSTRALIS, Marshall; variety. (Pl. XX, Figs. 2a, b.)

Trans. N.Z. Inst., vol. xlviii, p. 120, pl. xi, figs. 1-3, 1915.

Professor Marshall has recently described a highly decorated shell which occurs rather commonly at Wangaloa. When I visited that locality in his company I collected several examples of the shell, two of which, when developed, prove to be excellently preserved. One of them closely resembles his type-specimen, Fig. 2, but the other differs in having a much more exaggerated development of the lip than any of his three figured examples and is apparently an aged specimen.

¹ Berichte der Naturf. Gesell. z. Freiburg, Bd. xv, p. 18, pl. iv, figs. 2a, b, 1907.

The spire is almost concealed, and the callosity extends far beyond it and is produced into a finger-like process which is bent away from the spire. The outer lip is much thickened and produced upwards, and the interior portion of the lip is provided with a second channel through excessive growth of the callous margin. I think this variety, Figs. 2*a*, *b*, is sufficiently distinct to warrant its illustration for comparison with the more normal type, Figs. 3*a*, *b*, and to complete the illustration of the Pugnelliid shells which have so far been found in New Zealand.

Locality.—Wangaloa. Maestrichtian (?).

ALARIA SUTERI, sp. nov. (Pl. XIX, Fig. 5. $\times 1\frac{1}{2}$ nat. size.)

The shell consists of eight whorls which increase gradually in size. The lip of the last whorl is moderately expanded to a simple curved outline and is not digitate. It ends anteriorly in a blunt termination beneath which there is a shallow channel. The posterior margin of the lip does not seem to be channelled, and the labial expansion extends about half-way up the penultimate whorl. The whorls are decorated with rather widely spaced curved ribs, recalling those of *Scalardia* or of the recent *Aporrhais occidentalis*, Beck. On the last whorl these ribs reach from the suture to rather beyond the middle line, where they meet a blunt ridge. The whole surface of the outer layer of the shell is covered with very fine parallel raised concentric lines which continue over the ribs. Length about 35 mm.

The earlier whorls of this shell strongly recall those of a *Scalardia*, and resemble a fragment of six whorls from Quiriquina that Wilckens illustrates¹ under the name *S. araucana*, Phil., only that the varices are rather closer together than they are on the New Zealand shell.

Locality.—Selwyn Rapids. I name this species, which I cannot identify with any described form, after Mr. H. Suter, of Christchurch, the leading authority on the recent Mollusca of New Zealand.

APORRH AIS GREGARIA, Wilckens. (Pl. XIX, Figs. 6, 7.)

Berichte der Naturf. Gesell. z. Freiburg, Bd. xv, p. 16, pl. iii, figs. 10-13; pl. iv, fig. 1, 1907.

The shell consists of seven or eight whorls, the last one of which is swollen and expanded. The margin is channelled anteriorly and is not digitate, but extends to a rather sharp projection, which is produced backwards in a direction almost parallel with the spire. Between this projection and the body of the shell the lip has a broad shallow posterior channel. The shell is ornamented with a line of nodes which occur rather above the median line of the last whorl. Beneath them on the last whorl there is a series of much smaller and more numerous nodes that tend to coalesce into a raised ridge. The surface is decorated with a series of more or less continuous parallel raised ridges which are most apparent above the nodes on the penultimate whorl and on the lip. Growth-lines are rather prominent and irregular especially on the last whorl.

¹ N.J. für Min., Beil. Bd. xviii, pl. xviii, fig. 1, 1904.

Dr. M. Woodward, del.

Boile & Sons, imp.

UPPER CRET. EOUS GASTEROPODA, NEW ZEALAND.

G. M. Woodward, del.

Bale & Sons, imp.

UPPER CRETACEOUS GASTEROPODA, NEW ZEALAND.

I am fortunately able to identify this form with certainty with the above shell, which Wilckens describes from Cazador, Sierra Contreras, and other places in South Patagonia between Lago Argentino and Last Hope Inlet. He illustrates several examples and says that the species is one that does not compare closely with any other *Aporrhais* known to him.

Locality.—Selwyn Rapids. I collected two specimens with spire and lip, one of them in fine condition which required to be laboriously chipped out and pieced together again. The spire in the better specimen (Fig. 6) is rather higher and more tapering than in the other. The shell that Hector¹ figures under the name *Rostellaria Waiparensis* is probably intended to represent this species.

EXPLANATION OF PLATES XIX AND XX.

All figures natural size unless otherwise indicated. All except *Pugnellus australis* are of Upper Senonian age.

PLATE XIX.

FIGS.

- 1-4. *Pugnellus Marshalli*, sp. nov. Selwyn Rapids.
5. *Alaria Suteri*, sp. nov. Selwyn Rapids. $\times 1\frac{1}{2}$ nat. size.
6. *Aporrhais gregaria*, Wilckens. Selwyn Rapids.
7. Ditto, another specimen showing upward extension of the lip. Selwyn Rapids.
- 8-10. *Natica (Euspira) variabilis*, C. Moore. Selwyn Rapids. Fig. 10 is $\times 1\frac{1}{2}$ nat. size.
11. *Turritella* sp. Selwyn Rapids. $\times 2\frac{1}{2}$ nat. size.
- 12-15. *Neritopsis* (?) *Speighti*, sp. nov. Selwyn Rapids. Fig. 15 is $\times 2$ nat. size.

PLATE XX.

- 1a, b. *Pugnellus Waiparensis*, sp. nov. Waipara Gorge.
- 2a, b. *Pugnellus australis*, Marshall, variety. Maestrichtian (?). Wangaloa.
- 3a, b. *Pugnellus australis*, Marshall, normal form. Wangaloa.
4. *Conchothyra parasitica*, McCoy. Waimakariri Gorge.
5. Ditto, same locality. Another specimen.

(To be concluded in the August Number.)

III.—SOME TERTIARY DYKES OF THE CLYDE AREA.

By G. W. TYRRELL, A.R.C.Sc., F.G.S., Lecturer in Mineralogy and Petrology, Glasgow University.

INTRODUCTION.

THE very numerous Tertiary dykes of the Clyde islands (Arran, Bute, and the Cumbraes), and of the adjacent mainland and peninsulas, have been little studied either from the geological or petrographical point of view; but they are of great interest, not only in themselves, but as providing a link between the dykes of the better known areas of the North of England, and of Skye and Mull. The material is not yet gathered on which could be based a complete account of the series. The present paper is designed to present a full description of a hitherto unrecognized type of Tertiary dyke, typically exposed in the Great Cumbrae, and to indicate its relationships to other types already described from Mull and the North of England. Furthermore, a few other dykes from the Clyde area, all of basaltic composition, will be briefly described.

¹ Cat. Ind. and Col. Exhibition, 1886, p. 58, fig. 3.