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7. *The* Trias *of* New Zealand.

By Charles Taylor Trechmann, D.Sc., F.G.S. (Read February 7th, 1917.)

[Plates XVII–XXV—Fossils.]

Contents.

I. Introduction.

New Zealand occupies the most isolated and, so far as the palæontology is concerned, one of the lesser-known links in the great chain of folded marine Triassic sedimentary rocks which surrounds the Pacific Ocean.

The presence of Triassic rocks of the Alpine type in New Zealand was first made known as a result of the visit of the Austrian frigate 'Novara' in 1858 & 1859 and the researches of F. von Hochstetter. Four species of Triassic fossils found on that occasion were described and figured by Zittel in 1864.[1] These were *Monotis salinaria* var. *richmondiana* Zittel, *Spirigera wreyi* Suess, *Mytilus problematicus* Zittel, and *Halobia lommeli* Wissmann.

The Nelson province was the only district where Hochstetter obtained Trias fossils. He collected several Jurassic forms at Kawhia Harbour on the western coast of the North Island, but the Triassic deposits south of the harbour were discovered at a later date.

Since Hochstetter's visit the detailed geological survey of New

[1] Bibliography, 51, p. 26–29.

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used this substance during my work on the Triassic fossils, which are often unsatisfactorily preserved.

In the present paper forty-six genera of mollusca and brachiopoda are described, of which three seem to be hitherto undescribed and are regarded as new, and seventy-eight species, of which forty-one seem to be new, together with five or six new or local varieties of species already known. This certainly falls considerably short of the total which must exist in the New Zealand Trias. There are several conspicuous fossils which are too badly preserved, or otherwise unsuitable, for adequate illustration or description; but I hope that in the future better-preserved specimens of these and other forms may be found.

For the zonal divisions I have relied primarily on my own collecting; but, where better specimens than those that I found existed in the Survey collections, I have made use of these for description, though in most cases only where the recorded localities are confirmed by my own collecting.

II. Nomenclature and Correlation.

Great divergence of opinion has existed among New Zealand geologists concerning the classification of the rock series intermediate between the Reefton and Baton-River Series, which contain a marine Silurian or Devonian fauna, and the beds commencing with the Bastion Series which yield a lower Jurassic marine fauna. Hector classified them as follows in 1886 in his 'Handbook of New Zealand Geology.' In the right-hand column I add the equivalents which I suppose these divisions to represent, after my examination of the faunas.

Jurassic.	8 *a*. Matauia Series. 8 *b*. Putataka Series. 8 *c*. Flag-Hill Series.	Higher Jurassic series, with marine faunas as high as the Tithonian.
Lias.	9 *a*. Catlin's-River Series. 9 *b*. Bastion Series.	Lower Jurassic beds, with marine faunas of Liassic, and probably also of Bajocian age.
Trias.	10 *a*. Otapiri Series.	=Rhætic and Upper Noric beds.
	10 *b*. Wairoa Series.	=Lower Noric and Higher Carnic beds.
Permian.	11 *a*. Oreti Series.	=Lower Carnic beds.
	11 *b*. Kaihiku Series.	=Beds with a Ladino-Carnic marine fossil horizon near the top, and a great thickness of unfossiliferous beds below, representing Middle and possibly Lower Trias.
Carboniferous.	12 *a*. Maitai Series.	=Maitai Argillites, with *Aphanaia* De Koninck.
	12 *b*. Maitai Limestones.	=Maitai Limestone, with brachiopods, etc.
		Permo-Carboniferous.
Devonian.	13 *a*. Te Anau Series. 13 *b*. Kakanui Series.	Probably in part metamorphosed Maitai Beds.
Upper Silurian.	14 *a*. Baton-River Series. 14 *b* & *c*. Limestones and serpentine.	Silurian or Devonian, horizon not yet determined. Limestones with marine fauna.

F. W. Hutton[1] in 1885 included the Te Anau and the Maitai

[1] Q. J. G. S. vol. xli (1885) pp. 191–220.

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in his Maitai Series as Carboniferous and the Kaihiku, Oreti, Wairoa, and Otapiri in the lower part of his Hokonui System as Triassic.

Prof. James Park[1] in 1903 classed Hutton's Maitai Series as Jurassic. However, in 1910[2] he changed his opinion, and said that the evidence of the separation of the Te Anau from the Maitai was far from satisfactory, classing the Maitai limestone as Carboniferous. He also identified the Kaihiku as Permian and the Wairoa and Otapiri as Triassic, and included all the rocks from the upper part of the Maitai to the top of the Jurassic in his Hokonui System.

Prof. Patrick Marshall[3] in 1911 included all the beds, from Hutton's Maitai Series inclusive to the top of the Jurassic, in his Maitai System, and called them Trias-Jura, regarding them as a conformable series. The inclusion in recent years of the Maitai Series in the Trias-Jura or Jurassic is due to the fact that, since the survey of the Nelson area in 1878, no one had succeeded in finding either the Palæozoic fossils which occur in the Maitai Limestone of the Wairoa Gorge, or the large prismatic *Inoceramus*-like bivalves which exist in the Maitai Argillites at Wooded Peak, 5 miles east of Nelson and elsewhere. Fragments of this prismatic shell occur also in the Maitai Limestone, and led to the assumption that the rocks containing it were Jurassic. In the Nelson area the Trias is evidently separated from the Maitai Series which bounds it on the east and south-east by a strike-fault or series of faults, and the Maitai Series is undoubtedly of late Palæozoic age, as the early surveyors concluded.[4]

Hector's identification of many of the New Zealand Triassic fossils with English Permian Zechstein forms led him to place the Kaihiku and Oreti Series in the Permian, a conclusion which was naturally followed by his field-workers on the Survey. He identified three English Permian species out of a total of seventeen in the Kaihiku, three out of seven in the Oreti, one out of fourteen in the Wairoa, and four out of nineteen in the Otapiri. However, in the Wairoa and Otapiri Series he records, in addition to his supposed Permian forms, a number of Alpine Triassic fossils. The following reasons seem to have caused Hector to class the Kaihiku beds as Permian:—

[1] Bibliography, 40, p. 431. [2] Bibliography, 37, p. 51.

[3] Bibliography, 22, p. 22.

[4] C. T. Trechmann, Geol. Mag. dec. 6, vol. iv (1917) pp. 53–64. Dr. J. A. Thomson and I were so fortunate as to rediscover in 1915 the fossils in the Maitai Limestone, and to obtain a few additional unrecorded forms from it: they are undoubtedly of Permo-Carboniferous age. I also found the large prismatic bivalves in the Maitai Argillites at Wooded Peak, and have shown from examination of the hinges that they are not *Inoceramus*, but are apparently identical with *Aphanaia* De Koninck of the Australian Permo-Carboniferous. The Permo-Carboniferous of New Zealand differs from that of Australia in being apparently entirely marine, and in lacking a *Glossopteris* flora and glacial beds.

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A. A *Dielasma* closely resembling the Permian *D. elongata* occurs in them.

B. He identified the Rhynchonellids of the *Halorella* group with the Permian genus *Camarophoria*.

C. He compared the alate *Spiriferinæ* with the Permian *Spirifer alatus*, which is not a *Spiriferina*, but a true *Spirifer* devoid of punctate shell or median dorsal septum. Even Prof. C. Diener was not certain on this point, and speaks of *Spiriferina alata*.[1] The error is due to King, but was corrected by Davidson.

D. The *Spiriferinæ* of the group of *Sp. fragilis* bear a certain resemblance to the Permian *Spiriferina cristata*.

E. The flat dorsal valve of a spiny *Mentzelia*, to which I have given the generic name *Mentzeliopsis*, seems to have suggested to Hector the genus *Streptorhynchus*, which appears in his list of Kaihiku fossils. I myself thought when I collected it that it was some Palæozoic survival, until, after I had ground down a specimen with both valves conjoined, the spiralia in it became apparent.

Hector and others sometimes speak of the whole or part of the Otapiri Series as Rhætic. As there is apparently a perfectly conformable passage from the Wairoa to the Bastion Series, the intermediate beds may by analogy be called Rhætic. But, on an examination of the fossils, the correlation seems to be valid also on palæontological grounds. The large specialized Spirigerid to which I have given the new generic name *Hectoria* shows decided affinities with the Alpine Rhætic form *Spirigera oxycolpos* Emmrich, the largest and latest of the Alpine Spirigerids.

Briefly stated, the following are the points in which the results of my work contrast with the previous views on these beds:—

a. The great unfossiliferous series beneath the lowest fossiliferous horizon in the Kaihiku represents the Middle and possibly part of the Lower Trias. It is possible, though very unlikely, that some fossils will in future be found in the Kaihiku Series below the above-mentioned horizon.

b. The Kaihiku fauna, the lowest fossiliferous Mesozoic horizon in New Zealand, is either Upper Ladinic or Lower Carnic—that is, late Middle or early Upper Trias, and not Permian, as was hitherto supposed.

c. The higher fossiliferous horizons, which are always separated in clear sections by several hundred feet from that of the Kaihiku, are all Upper Trias. The Oreti and lower part of the Wairoa are Carnic, and yield a prolific fauna. The upper part of the Wairoa and lower part of the Otapiri are Noric, and contain *Pseudomonotis* in great abundance. The remainder of the Otapiri is Rhætic.

d. The only forms that seem to survive the Trias, and may be identical with Triassic species, are a form of the Spirigerid genus *Hectoria* and some of the belemnites of the *Atractites* group, the large phragmocones of which occur in the Jurassic beds.

e. I found no fossil in the New Zealand Trias that could be identified with any English Permian species, so many of which occur in Hector's lists.

f. I can see no reason why any of the New Zealand Triassic forms should be regarded as local isolated survivals from Palæozoic times, as has sometimes been suggested.[2] The fauna is a normal Upper Triassic one,

[1] Bibliography, 11, p. 2.

[2] Bibliography, 37, p. 69.

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comparable in every way with faunas of similar age in the great circum-Pacific region. It is now well established that *Trigonia* and belemnites of the *Atractites* and *Aulacoceras* group are normal associates in the marine Triassic beds with such Palæozoic survivors as *Orthoceras* and *Dielasma*. It is the association of Palæozoic survivals with the Mesozoic forerunners which gives a special interest to the Trias. Such archaic survivors at the present day as exist in New Zealand are chiefly found in the terrestrial fauna and flora owing to its long isolation as a land-mass.

g. There is no premature appearance of truly Jurassic forms in the New Zealand Trias. The supposed *Gryphæa*[1] which has been mentioned in this connexion is a shell allied to that called *Mytilus problematicus*.

III. Lithology, Thickness, and Tectonics.

The Trias consists of a great series of coarse or fine felspathic sandstones, grey or dark shales, and argillites—some very hard, others, when weathered, of a splintery or crumbling nature, frequently enclosing concretions. Thick beds of coarse conglomerate, more or less discontinuous and lenticular, appear at various horizons. Thin bands of pebbles also occur in the felspathic sandstones and greywackes. Prof. Marshall[2] has examined the pebbles composing some of the conglomerates, and notes the absence of schistose rocks. They are made up of granitic or porphyritic fragments with felspar- and quartz-pebbles.

The Rhætic beds become more pebbly and glauconitic and less felspathic, approaching in character the overlying Jurassic series. In some beds the quantity of felspar is so great that the rock weathers along the joint-planes in large spheroidal masses, and has given rise to the term 'cannon-ball sandstone.' Iron-stained beds containing plant-remains occur interbedded with the marine series at several places.

No definite assertion can yet be made as to the source whence the material of the Trias was derived, but there was evidently some large land-mass not far away. The series seems to agree closely with the littoral facies of the Trias on the south-western coast of New Caledonia. The littoral nature of the sediments explains the absence or rarity of certain fossils, such as ammonites and corals. Except in the Okuku district, where diabasic ash-beds are reported to occur (but these, if re-examined, would probably turn out to be felspathic sediments), no contemporaneous igneous rocks are known in the Trias. A dyke occurs at Nugget Point,[3] and a hypabyssal intrusion at Kawhia[4]; but these are probably of post-Jurassic age.

No natural base of the Trias is seen in any of the localities described, although in the Takitimu Mountains, west of the Hokonuis, the Kaihiku is said to rest unconformably upon the Maitai Series.[5]

[1] Bibliography, 22, p. 22.
[2] Bibliography, 23.
[3] Bibliography, 45.
[4] Bibliography, 30.
[5] Bibliography, 15, Introduction, p. xii.

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Prof. Marshall estimates the thickness of the rocks from the top of the Baton-River Series to the top of the Jurassic, his Maitai System, at 53,200 feet. This includes the Upper Palæozoic, Triassic, and Jurassic strata. Prof. Park reckons the thickness of the Trias and Jura at 18,000 feet. When I was at Nugget Point I stepped out the series of the fossiliferous Trias exposed there, from the Rhætic beds northwards to the road leading to the lighthouse where the Kaihiku fauna is said to occur. The beds are tilted on end, and the section is clear; but the Noric *Pseudomonotis* Beds are missing. I estimated the thickness at well over 3000 feet. Prof. Park's diagram of the Nugget-Point section includes a part of the unfossiliferous Kaihiku and all the fossiliferous Trias, and the thickness is about a mile. At Kawhia the Rhætic alone is over 3000 feet thick.

All rocks in New Zealand older than the Cretaceous are affected by the great orogenic pressure which occurred between the uppermost Jurassic and the Middle Cretaceous.[1] The Trias, except on the west side of the Hokonui Hills and immediately south of Kawhia, stands everywhere nearly or quite vertical. The Jurassic beds, as a rule, dip much less steeply. The schistosity of much of the metamorphic rock of the Southern Alps appears to have been produced during this period. Some of these metamorphic and semi-metamorphic rocks are undoubtedly Mesozoic, others are Maitai or pre-Maitai. Greywackes associated with the Trias pass gradually into phyllites and schists. The change has been described by Prof. Marshall,[2] who states further that the schists pass gradually into the gneisses of Westland. The semi-metamorphic slaty argillites at Mount St. Mary, which are full of crushed and distorted Triassic fossils of Kaihiku or Ladino-Carnic age, contain secondary macroscopic flakes of white mica parallel to the foliation.

[1] The history of New Zealand as a land-surface dates from about the time of the final break-up of Gondwanaland, and its uplift may be connected with that event. In connexion with the age of the Maitai Series, I have shown that the New Zealand area was under water during the Permo-Carboniferous Period. The Jura-Cretaceous uplift is not connected with the present configuration of New Zealand, except that the rocks then hardened and metamorphosed resist weathering better, and now form the Alpine Ranges. It was probably reduced to a low elevation before late Cretaceous times. No part of the present New Zealand can be said with certainty to have remained land during Tertiary times. The present uplift dates from the Middle or late Tertiary, and was more of an epeirogenic nature accompanied by block-fracture. Tertiary strata are deeply involved in faults, overthrusts, and downthrows in the Alpine and other areas, but in no case are they much crushed or metamorphosed.

[2] Bibliography, 21, p. 21.

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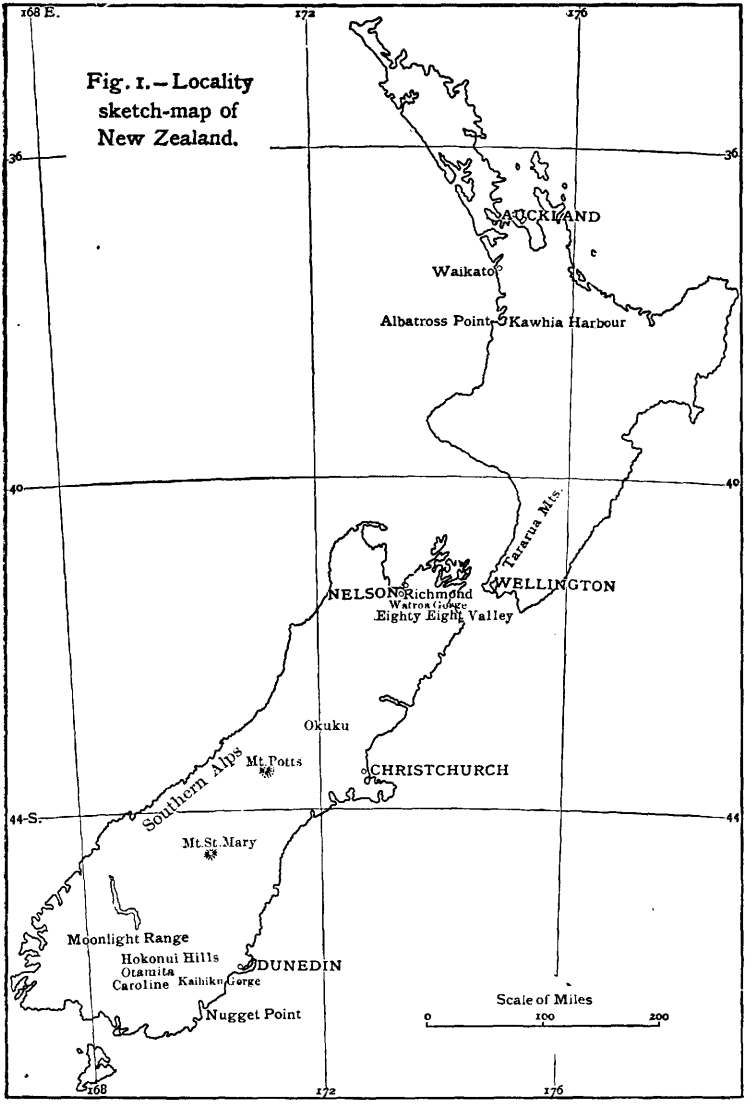

Fig. 1.—Locality sketch-map of New Zealand.

At Kawhia, on the western coast of the North Island, folded Triassic and Jurassic rocks are exposed beneath horizontal Tertiary covering deposits. At Waikato Jurassic of undetermined age occurs. Only the Rhætic and Noric beds of the Trias are known as yet in the North Island.

In the South Island, in the Nelson district, the Trias is much faulted and folded, and strikes more or less north-north-eastwards and south-south-westwards—parallel to the main structural axis. In the far south it is much less faulted and disturbed, and the strike of the Trias and Jura from the Hokonui Hills past Kaihiku Gorge to the coast at Nugget Point is approximately west and east to west and south-east, at right angles to the strike in

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IV. Typical Areas of Triassic Rocks.

Fossiliferous Triassic beds are exposed at intervals, from Kawhia on the western coast of the North Island to Nugget Point on the south-eastern coast of the South Island, a distance of 620 miles or nearly 9° along the meridian. The most important localities are briefly described in the following order:—

District.	*Chief fossiliferous localities and the horizons represented.*
North Island.	
Kawhia.	Coast-section south and south-west of Kawhia Harbour, towards Albatross Point (Noric and Rhætic).
South Island.	
Nelson area.	Richmond (Noric); Wairoa Gorge (Carnic); Garden Gully (Carnic and Noric); Mount Heslington (Carnic); Eighty-Eight Valley (Kaihiku or Ladino-Carnic and Carnic).
Okuku.	Carnic, Noric (?).
Mount Potts.	Kaihiku or Ladino-Carnic, and Lower Carnic.
Mount St. Mary.	Kaihiku or Ladino-Carnic, and possibly Lower Carnic.
Hokonui Hills: North side.	Gore (Carnic, Noric); Otamita (Carnic, Noric); East Peak (Kaihiku or Ladino-Carnic).
South-west side.	Caroline railway-cutting (Kaihiku or Ladino-Carnic); Benmore Cutting (Rhætic).
Kaihiku Gorge.	Kaihiku or Ladino-Carnic, Carnic, Noric.
Nugget Point.	Kaihiku or Ladino-Carnic, Carnic, Rhætic.
Moonlight Range.	Carnic, Noric.

The localities in the South Island are probably connected along the structural axis by others where the fossils are still undiscovered, or have been more or less obliterated through metamorphism.

North Island.

Kawhia.

The Jurassic strata are well exposed round the shores of Kawhia Harbour, where they lie unconformably beneath a horizontal cover of Tertiary limestones, and Kawhia is the most important locality in the North Island for Jurassic fossils. Outside the harbour in

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the Nelson district. At Mount Potts and Mount St. Mary the Triassic beds form part of the eastern fringe of the complex of the Alpine Range, and are crushed and partly metamorphosed. Except immediately south-west of Kawhia Harbour, and on the southern and western side of the Hokonui Hills, the Triassic beds stand everywhere practically vertical.

At Kawhia, and in the far south, the Trias is succeeded conformably by Jurassic rocks. At Nelson and in the Alpine Region no Jurassic is known. In the Nelson district fossiliferous Trias, from the Ladino-Carnic to the Noric inclusive, occurs. The Triassic limestones at Okuku are of uncertain age, but probably Carnic. At Mount Potts and Mount St. Mary the Ladino-Carnic (Kaihiku) and possibly Lower Carnic occur. In the ranges extending from the Hokonui Hills to Nugget Point all divisions, from the Kaihiku to the Rhætic inclusive, are fossiliferous, and the overlying Jurassic is also highly fossiliferous.

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the coast-section extending southwards and south-westwards the Jurassic deposits pass conformably down into a thick series of grey felspathic sandstones with bands of pebbles and conglomerate-beds. These beds gradually become increasingly inclined until Tarawai Point, north of Albatross Point, is reached. Fossils are scarce, but quite high up in these beds Prof. Marshall and I found a specimen of *Arcestes* cf. *rhæticus*, and a little lower down another similar but indeterminable *Arcestes*. Brachiopods occur sparingly, generally in little clusters throughout a great thickness of these rocks. The commonest form is *Hectoria bisulcata*, and rather high up (but below the *Arcestes*) I found two specimens of *Mentzelia*. These beds are presumably Rhætic.

At Tarawai Point, some miles south of Kawhia Harbour, there is a large intrusion of a hypabyssal porphyry of the syenite group, and the sedimentary rocks are here nearly or quite vertical. A black argillite full of *Pseudomonotis ochotica* and its varieties occurs in very close association with this intrusion, and seems in places to underlie and become involved in it. Great masses of this dark shale are found mixed up with blocks of porphyry lying on the shore. These beds are Noric, and are the lowest Trias that I saw in this locality. McKay,[1] in a sketch-map appended to his report of the district, shows a repetition of the Wairoa, Otapiri, and Bastion Series south of the igneous intrusion, but says that the rocks were not examined. Prof. Marshall, who on a previous occasion visited that very rugged portion of the coast in a boat, tells me that he saw no fossils there.

South Island.

Nelson Area.

The strip of fossiliferous Trias in this district extends in a north-easterly and south-westerly direction from near Richmond to Eighty-Eight Valley, a distance of about 12 miles. Its greatest width is about three-quarters of a mile, near the Wairoa Gorge. The beds are steeply inclined. Various sections have been drawn to show the arrangement of the beds, but the structure is complicated and involved. Great divergence of opinion exists regarding the presence or absence of faults, and the relation of the Trias of the foothills to the Maitai Limestones and Argillites which form the higher peaks that bound it on the south-east. In the Wairoa Gorge the Maitai Limestone contains an Upper Palæozoic fauna, and closely adjoins the dark greywackes full of *Mytilus problematicus*. At Richmond the felspathic sandstones containing *Pseudomonotis richmondiana* are sharply cut off on the east by unfossiliferous red and green slaty argillites of the Maitai Series.

The Kaihiku Beds appear only in Eighty-Eight Valley at the south-western end of the Triassic outcrop. Here they are wedged in between Maitai Limestone on the south-east and the Upper

[1] Bibliography, 30.

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Trias on the north-west. The strip of Kaihiku Beds is half a mile long and a quarter of a mile wide, and the strata dip south-south-eastwards at 55° to 65°.

In the Wairoa Gorge the *Mytilus-problematicus* Bed occurs near the entrance, and again on the east close to the Maitai Limestone. The intervening space is occupied by the higher beds of the Carnic.

In the hills south of the gorge the *Pseudomonotis-richmondiana* Beds occur in full thickness, but are not seen in the gorge itself. At Garden Gully, about a mile south-west of the Wairoa Gorge, I found a bed of fine-grained greywacke containing many varieties of the Asiatic Noric fossil *Pseudomonotis ochotica*. It seems to occupy the limb of a syncline, possibly a faulted syncline, and I believe the Noric *Pseudomonotis-ochotica* Beds to be the highest that occur in the Nelson area.

No Jurassic fossils have been found in this part of the South Island. All the evidence that I saw led me to conclude, in opposition to recent Survey results,[1] that there is a series of strike-faults parallel to the structural axis and that the Trias is partly overthrust to the north-west by the Maitai Series. The Tertiary deposits of the Waimea Plains, which bound the Trias on the north-west, are tilted up along their junction, and are probably overthrust to some extent in their turn by the Trias.

Okuku (Ashley County).

The geology of this very mountainous district is little known. McKay studied and described it in 1879,[2] and states that the whole of the northern end of the Mount-Torlesse range is occupied by Trias and younger formations, which form the higher peaks of Mount Torlesse. The rocks consist of a great thickness of conglomerates, sandstones, red and green so-called 'diabasic ash' (by which one may probably understand coarse greywacke), and limestones. *Mytilus problematicus* and *Monotis salinaria* are said to occur in the limestones and in the 'diabasic ash.' These fossils are found in immense numbers in the Upper Okuku Valley, in a limestone associated with cherts. I had no opportunity of visiting this locality, and McKay's report is not quite clear as to whether the *Monotis* and *Mytilus* occur together or in separate strata. I examined a series of the *Monotis*-like shells in the limestone from this district belonging to the New Zealand Geological Survey, and selected several examples to be sent to England. These pieces of limestone contain *Monotis*, but no *Mytilus*. I could find no trace of the anterior byssal notch characteristic of *Pseudomonotis* in any of these shells, and therefore am compelled to regard them as really the Alpine *Monotis salinaria*. If this be the case, their reported association with *Mytilus problematicus* may be explicable, as *Monotis salinaria* is recorded from Carnic horizons in Europe. Perhaps future research in the district may clear up these points.

[1] Bibliography, 22, pp. 20–22. [2] Bibliography, 29.

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Mount Potts.

The chief interest of this locality centres in the plant-beds discovered by McKay in 1877. Great uncertainty has arisen over the age of these beds and the associated marine fossils, owing to Hector's determination of *Glossopteris* among the flora. The district, which is extremely mountainous, was described by McKay,[1] who states that the plant-beds of Tank Gully underlie the marine '*Spirifer*' Beds. Later, however, he says that plant-remains overlie the Kaihiku in the district between the Rangitata and Ashburton Rivers.[2] The fossils in the marine beds have been variously determined as Permian, Lower Carboniferous, or Upper Devonian; but my examination of the Geological Survey Collection and of a series collected by Prof. Marshall convinced me that they are all Triassic. They occur in black, compressed and fractured, slaty argillites. The following forms are present:—

A Nautilid.
Small gasteropods with angular whorls.
Daonella indica Bittner.
Pinna sp.
Anodontophora sp.
Spirigera kaihikuana, sp. nov.
Spiriferina (Cyrtina?) carolinæ, sp. nov.
Spiriferina sp.
Halorella sp.
Dielasma sp.
Mentzeliopsis sp.
Crinoid-stems.

Mr. McKay told me that *Mytilus problematicus* occurs there, but there is no trace of *Monotis* or *Pseudomonotis*.

The great majority of the fossils are those of the Kaihiku and are of early Upper or late Middle Trias. The only forms that indicate a Carnic horizon are *Nautilus* and *Pinna*. Reptilian remains occur in some of the beds, the large narrow amphicœlous vertebræ of which suggest some form of *Ichthyosaurus*.

The late Dr. E. A. N. Arber[3] examined a series of the plants which Mr. D. G. Lillie collected here in 1911, with the result that the supposed *Glossopteris* turned out to be a new form, to which he gave the generic name *Linguifolium*, and the whole flora proved to be either late Triassic, Rhætic, or early Jurassic. Dr. Arber, however, informed me that, at present, it is impossible to distinguish between late Triassic and early Jurassic floras. From the evidence, both of the flora and of the associated marine fauna, it seems perfectly justifiable to attribute an Upper Triassic age to the plant-beds of Mount Potts; but the question as to the position of the plant-beds relatively to the marine horizon is one on which further evidence is needed.

Mount St. Mary.

The fossiliferous outcrop at Mount St. Mary occurs at an altitude of 5160 feet. Fossils occur in three zones in a thickness of 50 feet: the two lower zones are slaty shales and the upper a

[1] Bibliography, 28, p. 92.
[2] Bibliography, 28, p. 95.
[3] Bibliography, 2.

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conglomerate. The fossiliferous rocks are associated with altered sandstones, and follow the phyllites, quartzites, etc. (known as the Kurow Schists) in direct stratigraphical succession. At the foot of the mountain the dip is very high, and at the fossiliferous outcrop it is about 60°. Prof. Park [1] says that the thickness of the strata exposed in the section is not less than 10,000 feet, and he gives a careful enumeration of these metamorphic and semi-metamorphic rocks. His attribution, however, of a Permo-Carboniferous age to the fossils is erroneous, as they are all Triassic, and the majority belong (as do those at Mount Potts) to the Kaihiku Series. I examined the series in the Geological Survey Collection, and also a collection which Prof. Marshall made. Many of the forms attain an unusually large size, but are much crushed and distorted: they occur in a fissile slaty argillite or greywacke. I identified the following forms:—

A crushed Nautilid.
Patella (?), crushed.
Pleurotomaria sp. and another small gasteropod.
Lima sp.
Part of a large indeterminate bivalve.
Many small specimens of *Megalodon* cf. *globularis*, sp. nov. in a coarse, gritty felspathic sandstone.
Spirigera resembling *Sp. kaihikuana*, sp. nov.
Mentzeliopsis sp. of unusually large size.
Large alate *Spiriferinæ* and a small form resembling *Spiriferina fragilis* Schlotheim.
Large *Dielasma*.

There is no trace in this fauna of *Hectoria*, *Halobia*, *Mytilus*, or *Pseudomonotis*.

It is quite certain that the slaty shales contain the Kaihiku fauna, and are of late Middle or early Upper Triassic age, while the *Megalodon*-like bivalves in the higher conglomerate-bed suggest the presence of part of the Carnic horizon below the *Mytilus-problematicus* Bed.

Hokonui Hills.

The Hokonui Ranges consist of a series of conformable Triassic and Jurassic rocks. On the north-east they are bounded by the Waimea Plains and the Waimea River, a tributary of the Mataura, and on the south-west and south-east by the Makerewa Flats and the Oreti River. Their structure was investigated by S. H. Cox [2] and A. McKay [3] in 1878. The hills rise to a height of about 2500 feet, and are part of a range extending from the Takitimu Mountains to Nugget Point on the south-eastern coast of Otago. The Government surveyors estimated the thickness of the strata at 21,000 feet or more. The structure is roughly that of a trough, of which only the northern and western edges are exposed. The axis follows roughly a south-easterly trend at its western end and a nearly easterly trend at the eastern end. The beds along the northern and north-eastern fringe of the hills stand nearly vertical, while on the southern and western side the dip rapidly decreases

[1] Bibliography, 38. [2] Bibliography, 9. [3] Bibliography, 27.

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till they form a flat syncline with an axis oriented north-west and south-east. The result is that the outcrop of the beds bends round, and becomes much wider on the south-western side. In consequence, the Triassic rocks occupy the northern and western fringes of the hills; while the inner and less accessible part of the range, together with the southern and south-western portion, is occupied by the much less strongly inclined Jurassic deposits.

The great mass of greywackes and conglomerates, called the Kaihiku Series, estimated as 6600 feet thick, occupies the northern fringe. The thin fossiliferous band, which occurs 4000 feet above the lowest beds seen in the district, crops out at various points as a continuous bed. It is seen in a railway-cutting a mile south of Caroline Station, and at East Peak, whence it extends eastwards in the direction of the Kaihiku Gorge, from which it takes its name, and finally reaches the coast at Nugget Point.

I visited various localities in the Hokonuis in company with Prof. Marshall, but most of our collecting was done at a spot, previously known to Prof. Marshall, in the valley of the Otamita Stream some distance west of East Peak. This stream, according to the map published by Cox & McKay, flows eastwards in the first part of its course approximately down the junction of the Otapiri and Upper Wairoa Series. It then turns northwards and cuts across the strike of the Lower Wairoa and Kaihiku Series, ultimately joining the Mataura. The section that we observed on both banks of the Otamita Stream is as follows:—

Beds.	*Approximate thickness in feet.*	*Fossils.*	*Age.*
a. Massive felspathic grits and sandstones.	20	Fragment of *Pinacoceras*, alate *Spiriferinæ*.	? NORIC.
b. Felspathic sandstones interbedded with shaly bands.	20	*Nautili*, *Arcestes*, *Discophyllites*, *Halobia hochstetteri*, etc.	CARNIC.
c. A massive bed of dark, hard, but fissile crumbling shale, with concretionary nodules in its lower part.	25	*Halobia hochstetteri* and many other well-preserved fossils, *Nautili*, *Discophyllites*.	
d. Felspathic sandstones and argillites.	?	*Pleurophorus*, *Spiriferina*, etc., badly preserved.	
e. Dark-grey rusty shales with small rounded pyrite nodules, and bands of felspathic sandstone weathering in spheroidal masses.	100	*Halobia zitteli* var. *zealandica*, *Spirigera manzavinioides*, *Spiriferinæ*, *Conularia*, and many other fossils.	
f. Dark slaty shales.	?	Full of *Mytilus problematicus*.	

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Fossils are unusually well preserved in beds *c* and *e*. The Geological Survey reports make no mention of the occurrence of *Mytilus problematicus* in the Hokonui Hills, and so it would appear that this section was overlooked by the Government surveyors in 1878.

Kaihiku Gorge.

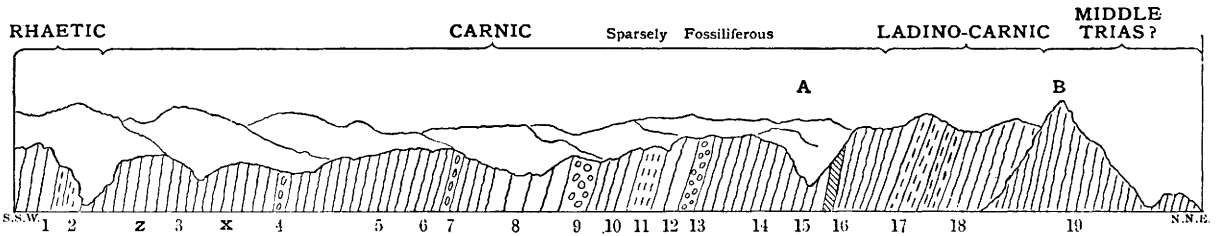
This gorge cuts across the strike of the Triassic range between the Hokonui Hills and Nugget Point. At the entrance of the gorge several blocks fallen from the rock that crops out on the grassy hillside, but is not well exposed, contain the fauna which takes its name from the locality. The fauna, a very constant one, corresponds exactly to that found at various points in the Hokonuis and at Eighty-Eight Valley, near Nelson. Some distance above this a thick coarse conglomerate occurs, overlain by a hard greywacke full of indeterminable plant-remains. A thick series of spheroidal felspathic sandstones represent the Wairoa and Otapiri Beds, but fossils are very scanty. In the stream I found a piece of a *Pinacoceras*, evidently washed down from the higher Triassic beds.

Nugget Point.

This is one of the clearest sections of the Trias in New Zealand. In Roaring Bay or Shaw Bay, south of Nugget Point Lighthouse, the beds are ranged almost vertically for a distance of nearly a mile. It is possible to obtain a good idea of the thickness and succession of the fossiliferous Trias. Here, however, although the Carnic with the *Mytilus-problematicus* Bed is well developed, the *Pseudomonotis* Beds of the Noric are missing. The series commences with hard unfossiliferous greywackes and felspathic sandstones, upon which the lighthouse stands. Slightly south of this, Prof. Park tells me that fossiliferous bands in the Kaihiku Series occur, although I did not succeed in finding them. The Carnic Series is excellently developed, and yields many fossils, showing several recognizable zones. About 195 feet above the *Mytilus-problematicus* Bed is a band of ferruginous sandstone with fragmentary plant-remains, where I collected a fragment of a frond which I identified as *Thinnfeldia* cf. *odontopteroides* Morris.[1] The late Dr. E. A. N. Arber kindly confirmed this identification, and informed me that this species is commonest in the Upper Trias, although not confined to that horizon. The Noric is not recognizable here; but Prof. Marshall has recently traced it at Glenomaru, about 10 miles inland from Nugget Point. A fragment of the rock that he sent me is full apparently of the small rounded and arched variety of *Pseudomonotis richmondiana*. The Triassic System comes to an end, about a mile south of the lighthouse, with a hard, resistant, pebbly and glauconitic or chloritic felspathic conglomerate, full of *Hectoria* (*Clavigera*) *bisulcata*

[1] Now in the Sedgwick Museum, Cambridge.

Fig. 2.—*Diagrammatic section of Triassic deposits from South Head, Shaw Bay to Nugget Point.*



1. Claystones and sandstones.
2. Pebbly sandstones, with *Hectoria bisulcata* and *Spiriferina diomedea*.
3. Coarse sandstones.
4. *Mytilus-problematicus* Bed.
5. Claystones and sandstones.
6. So-called '*Trigonia*' Bed.
7. Granite conglomerate.
8. Sandstones and claystones.
9. Conglomerate.
10. Greywackes and sandstones.
11. Greywacke.
12. Indurated claystones.
13. Conglomerate.
14. Greywackes and sandstones.
15. Claystones and greywackes.
16. Dyke of porphyrite.
17. Greywacke and sandstone.
18. Black *Spiriferina* claystones (Kaihiku fossiliferous band).
19. Claystones (plant-beds, according to Prof. Park).

z. Position of *Halobia zitteli* var. *zealandica* and *Palæocardita*; slightly north of this a bed containing *Clydonautilus*, *Pleurophorus*, and other fossils occurs.

x. Ferruginous sandstone with *Thinnfeldia odontopteroides*.

A. Track to Roaring Bay.

B. Nugget-Point Lighthouse.

[The Noric *Pseudomonotis* Beds are missing in this section, which is about a mile long.]

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and the very alate *Spiriferina diomedea*. The section was described by McKay, and later by Park. I confirmed the lithological sequence as Prof. Park [1] represents it, and have added in fig. 2 (p. 180) my interpretation of the zones represented after examining the fossils collected there.

Moorlight Range.

This lies more or less on the westward continuation of the Hokonui Hills, but the geology of the district is very little known. A considerable series of Triassic rocks is probably present there. In the Geological Survey Collection from this locality I identified the following forms: *Pseudomonotis richmondiana* Zittel, and a large flat form like *Ps. ochotica* Teller, var. *densistriata*, *Halorella* sp., and a small bivalve.

V. Palæontology.

CEPHALOPODA.

The Cephalopods of the New Zealand Trias belong to the genera *Orthoceras*, *Clydonautilus*, and *Grypoceras* among the Nautilids; *Aulacoceras*, among the Belemnoids; and among the Ammonites, *Arcestes*, *Cladiscites*, *Pinacoceras*, and *Discophyllites*. The last is the only ammonite sufficiently well preserved to afford any real zonal information. No cephalopods have been found in the Kaihiku Beds, and the Trias of New Zealand shares with that of New Caledonia and the Malay Archipelago the absence of ammonites of the Ceratitic type, or of the profuse Upper Triassic ammonite fauna which occurs in Western America and in the Himalayas.

Orthoceras sp. (Pl. XVII, fig. 6.)

Surface of the shell smooth; growth-lines straight, not sinuous. The septa are rather strongly convex towards the apex, and the siphuncle is slightly excentric. Length originally = about 40 mm.; diameter of aperture = 6 mm.; and length of living chamber = about 11 mm. The aperture of the latter is preserved, and is circular in outline, quite horizontal; the rim is slightly thickened. In the angle of emergence and other features it resembles *O. triadicum* Mojsisovics.

Locality and horizon.—The only locality that I know where this dwarfed *Orthoceras* occurs is Bed *c*, Otamita, Hokonui Hills, Carnic. Previous records of *Orthoceras* seem to have been based on parts of the phragmocones of large Atractitid belemnites.

Grypoceras cf. mesodiscum Hauer.

1902 E. von Mojsisovics, 'Cephalopoden der Hallstätter Kalke' vol. i, Supplem. p. 229.
1910. G. Böhm, Centralblatt f. Min. &c. p. 635.

The name of *Nautilus mesodiscus* appears in Hector's list of

[1] Bibliography, 39, p. 382 & pl. xxix.

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fossils of the Otapiri Series, and this attribution is confirmed by Diener on the strength of a specimen which Prof. Marshall sent to Bœhm. Several specimens of this shell that I collected confirm Diener's observations on the external ornamentation, which consists of longitudinal lines crossed by fine transverse lines. The sutures show a very shallow ventral lobe and similar, but rather deeper, lateral lobes, and a small, well-marked, annular lobe. The siphuncle in a specimen of three whorls occurs about midway between the centre and the ventral margin.

Locality and horizon.—Bed *c*, Otomita, Hokonui Hills; Nugget Point, and other localities. Carnic.

CLYDONAUTILUS (PROCLYDONAUTILUS) cf. SPIROLOBUS Dittmar. (Pl. XVII, fig. 3.)

1902. E. von Mojsisovics, 'Cephalopoden der Hallstätter Kalke' vol. i, Supplem. p. 211 & pl. x, fig. 3, pl. xi, fig. 1.
1910. G. Bœhm, Centralblatt f. Min. &c. p. 634.

A Nautilid with angular sutures was sent by Prof. Marshall to Bœhm, and handed on to Diener, who identified it as near the above species. In specimens that I collected the lobes are angular and the saddles rounded, strongly recalling those of a nearly-allied species *Pr. goniatites* Hauer. The siphuncle of a specimen of three whorls is dorsad of the centre. The surface of the shell slopes more towards the venter, and is less rounded than in either *Pr. spirolobus* or *Pr. goniatites*; while the venter itself is narrow and gently rounded.

Locality and horizon.—It is common in Bed *c*, Otamita (Hokonui Hills), and occurs also at Nugget Point and other localities.

ARCESTES sp.

1909. *Arcestes hokonui* P. Marshall, Trans. N.Z. Inst. vol. xli, p. 144.
1910. G. Bœhm, Centralblatt f. Min. &c. p. 634.

Arcestids are fairly common in the Carnic beds, especially in Bed *c* at Otamita. Prof. Marshall sent a specimen from this locality to Bœhm, who submitted it to Diener. As the living chamber was missing, he could not say whether it was *Arcestes* or *Proarcestes*, and considered it better not to give any specific name. No specimen that I saw or found had the living chamber, and so I cannot add anything to Diener's observations. If more complete specimens could be obtained, it would probably be found that several species of *Arcestes* are present in the New Zealand Trias.

ARCESTES cf. RHÆTICUS W. B. Clark. (Pl. XVII, fig. 1.)

1888. Am. Journ. Sci. ser. 3, vol. xxxv, p. 119.
1895. J. E. Pompeckj, 'Ammoniten des Rhät' Neues Jahrb. vol. ii, pt. 1, p. 3.

Shell smooth, sides and venter rounded, umbilicus wide and deep; the umbilical shoulders are rounded, and slope towards the

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umbilicus. The living chamber is wanting; but on the last whorl two slightly-sinuous channels cross the venter and sides nearly opposite one another, and represent former contractions of the aperture.

This specimen agrees in outer shape with *Arcestes rhæticus*, a form for which Hyatt has proposed the new generic name *Rhætites*, but seems to differ in the sutures. Five saddles are seen between the siphuncular saddle and the umbilical shoulders, the fourth being higher up though not larger than the rest. The saddles are deeply cut on each side into four auxiliary saddles, and the siphonal lobe is divided by a saddle into two points which are not deeper than the lateral lobes. In *Arcestes rhæticus* the sutures are said to form a series of lobes and saddles which gradually decrease in size from the siphuncle, and the two siphuncular lobes are deeper than the lateral lobes.

Mojsisovics says that Pompeckj considered *Arcestes rhæticus* to be merely part of the inner whorl of an *Arcestes* of the Galeati group.

Locality and horizon.—The specimen illustrated in Pl. XVII was collected by Prof. Marshall and myself high up in the Rhætic between Kawhia Harbour and Albatross Point, 3000 feet or more above the Noric *Pseudomonotis* Beds. It is probably the highest Triassic fossil that we obtained in New Zealand: it is entirely distinct from the Arcestids in the Carnic, which are much smaller, more involute, and lack the deep funnel-shaped umbilicus.

Cladiscites sp. (Pl. XVII, fig. 2.)

Sides flat, sloping gently towards the small shallow umbilicus; venter gently rounded. The living chamber is missing and the shell destroyed, and consequently it is impossible to see whether there was any surface decoration. No specific name can, therefore, be given.

Locality and horizon.—The only specimen of this genus known to me comes from the *Nautilus* Bed at Mount Heslington, Nelson. Carnic.

Pinacoceras sp.

All the specimens of *Pinacoceras* that I saw are fragments of air-chambers, and no satisfactorily-preserved example has come to light. One cannot, therefore, say more than that this genus, or some similar large and flat phylogerontic form with very complicated sutures, occurs in the higher Triassic deposits.

Locality and horizon.—I found a fragment in a bed at Otamita, in the Hokonui Hills, which is probably Lower Noric; and in the Geological Survey Collection is a piece of a very large flat *Pinacoceras*, but with greatly eroded sutures, from beds on the eastern side of Mount Heslington, near Nelson, which may also be Lower Noric.

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DISCOPHYLLITES cf. EBNERI Mojsisovics. (Pl. XVII, fig. 7.)

1896. *Phylloceras* (*Mojsvarites*) *ebneri* 'Obertriadische Cephalopodenfauna des Himalaya' Denkschr. k. Akad. Wissensch. Wien, vol. lxiii, p. 668 (96) & pl. xix, fig. 6.

1906. C. Diener, 'Fauna of the *Tropites* Limestone of Byans' Pal. Ind. ser. 15, vol. v, Mem. 1, p. 173 & pl. v, fig. 5.

Shell smooth or exhibiting faint growth-lines; whorls gently rounded, increasing rather rapidly; the umbilicus wide and open, each whorl embracing about half the previous one. Umbilical shoulders in the more adult shell are rounded and rather overhanging. The earlier whorls are much flatter than the later, which in very large specimens become much rounded.

Locality and horizon.—Bed *c*, Otamita (Hokonui Hills). The fragment illustrated occurred near the *Mytilus-problematicus* Bed, south of the Wairoa Gorge, Nelson. In the Geological Survey Collection is a magnificent specimen from Nugget Point, measuring 18 inches in diameter. Carnic. Large *Discophyllites* are recorded from New Caledonia.

Remarks.—*Discophyllites* is a sub-generic name proposed by Hyatt for a group of forms connecting *Monophyllites* and *Rhacophyllites*. The peculiarities of the suture are said to be that the siphonal lobe is deep and narrow, and divided by a high median prominence, and the siphonal saddle is diphyllic. Three species have been described: *D. patens* Mojsisovics, from Europe; *D. ebneri* Mojsisovics, from the Himalayas; and *D. insignis* Gemmellaro, from Sicily. Prof. Diener remarks that all three form a well-defined and closely-allied group ranging from Middle Carnic into Lower Noric strata. The New Zealand form seems to agree closely with the Himalayan *D. ebneri*.

AULACOCERAS sp. (Pl. XVII, figs. 4 & 5.)

1878. *Belemnites otapiriensis* Hector, Trans. N.Z. Inst. vol. x, p. 485.

In one example the end of the guard and the anterior part of the phragmocone are both missing. The guard is soft and friable, and there are one or more longitudinal grooves on it. The phragmocone is nearly twice as long as the guard, and has eleven or twelve air-chambers remaining. The septa are irregularly spaced, and the siphuncle is marginal. A label attached to this specimen (which is figured in Pl. XVII, fig. 4) states that it is the holotype of Hector's *Belemnites otapiriensis*. A highly-idealized illustration of this specimen, which Hector caused to be printed, has recently been issued.[1] It is 150 mm. long.

Another specimen consists of a fragment of a guard in very hard greywacke, which, when dissolved out with acid, yielded a gutta-percha squeeze (illustrated in Pl. XVII, fig. 5). About half the surface is seen, and has three longitudinal ribs separated by two, sharp and deep furrows. The surface of the ribs is gently rounded,

[1] Bibliography, 47, pl. v, fig. 1.

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and one of them bears five longitudinal parallel cuts. A very sharp and faint rib passes down the bottom of each of the furrows.

Locality and horizon.—Hector's specimen comes from Oreti railway-cutting (Hokonui Hills), and is probably Noric; the fragment of guard is from the *Spiriferina* Beds at Eighty-Eight Valley, Nelson, and is probably Carnic. Both specimens belong to the New Zealand Geological Survey Collection.

Remarks.—The first specimen is contained in a large piece of decomposed felspathic sandstone, and seems to be specifically indeterminable. The fragment of guard agrees well with a similar fragment of *Aulacoceras sulcatum* Hauer, illustrated by Mojsisovics.[1]

The New Zealand Geological Survey possesses fragments of phragmocones of belemnites of the *Atractites* group which are of large size; but most of them seem to be from Jurassic deposits.

GASTEROPODA.

PATELLA (?) NELSONENSIS, sp. nov. (Pl. XVIII, figs. 8 *a* & 8 *b*.)

Shell patelliform, the apex directed forwards and situated about the anterior third portion of the shell. The shape is not always symmetrical: in one example the apex is slightly inclined to the left, and in another the left anterior position of the shell slopes more steeply than the rest of the surface. The decoration consists of fine rounded ribs, which radiate from just below the apex to the margin. Between the primary ribs three or four smaller ones commence at various distances below the apex, but do not attain the strength of the primary ribs. The ribs are crossed by a regular series of faint, close-set, concentric growth-lines, giving the surface a latticed appearance. The shell is fairly thick, and the muscle-scar in the interior is broad, but not very distinct, and in one specimen seems to continue round the inside of the shell, while in another it appears to be interrupted on the left anterior side. The largest specimen that I examined was 71 mm. long, 65 mm. wide, and 36 mm. high.

Locality and horizon.—It has only been found in the Kaihiku Beds at Eighty-Eight Valley (Nelson district). Ladino-Carnic.

The New Zealand Geological Survey possesses several large examples, of which, except in one instance, the interior casts alone have been preserved. From this one I made a gutta-percha impression showing the outer surface, which I have taken as the holotype. It has a small mass (apparently of stromatoporoid coral) attached to its outer side.

Remarks.—It is possible that this shell may be a Capulid or perhaps a *Siphonaria*, in which case the apex would be posteriorly directed. The apparent interruption of the muscle-scar on one side rather suggests the latter genus as being the correct one.

[1] Bibliography, 32, pl. xiii, fig. 4.

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PLEUROTOMARIA (SISENNA) HECTORI, sp. nov. (Pl. XVIII, figs. 5 *a*–5 *c*.)

Shell consisting of about seven whorls; the spire is depressed; the upper surface of the first three whorls is nearly flat, but in the later whorls it is rather concave and slopes towards the line of nodes. The slit-band occurs about two-thirds of the distance above the base of the body-whorl and nearly half the distance above the suture of the penultimate whorl. The earliest whorls seem to be smooth. A row of heavy rounded nodes occurs both above and below the slit-band; those below it project beyond the slit-band, and form the keel of the shell. The nodes above and below the slit-band are of about equal size, are rather irregularly spaced, and occasionally tend to coalesce one with the other. The slit-band has a faint furrow above and below it, and between it and the nodes. Below the keel the surface of the shell is slightly concave; it then becomes convex, and then again concave towards the umbilicus, which is partly covered and obscured by a thin callosity of the inner lip. Below the keel the growth-lines bend sharply backwards, and then curve forwards again and pass to the umbilicus. This forward curving produces a tongue-like projection of the lip below the notch. The notch of the lip is about 10 mm. deep, the diameter of the shell is 34 mm., its height 20 mm., and the height of the spire 15 mm.

Locality and horizon.—Bed *c*, Otamita (Hokonui Hills). Carnic. I collected two or three very fine specimens here. I also found casts of it in the Carnic beds in the river-section of the Wairoa Gorge, and a cast of this (or of a very similar shell) in the Noric beds, with *Pseudomonotis ochotica*, at Garden Gully, in the Nelson district.

Remarks.—This shell may be placed in Koken's Pleurotomarid group *Sisenna*, which includes several Upper Triassic forms having a depressed spire, step-like whorls, and the slit-band situated between two ridges on the upper and outer side of the whorl. The tongue-like projection of the lip below the notch is also characteristic of this group. Koken says, however, that in *Sisenna* the umbilicus is open, whereas in the form here described it is partly or completely covered. It bears a rather remote resemblance to a shell from the Upper Trias of Bear Island in the Arctic Ocean, called by J. Bœhm *Sisenna conwentzi*,[1] in which the umbilicus is also, as in the present shell, covered by a thin labial callosity.

PLEUROTOMARIA HOKONUIENSIS, sp. nov. (Pl. XVIII, figs. 6 *a*–6 *c*.)

Shell small, consisting of seven whorls increasing rather rapidly. The apex is pointed, and the earliest whorls are angular. About the fourth whorl a row of vertically-elongate nodes appears below the suture, together with five or six spiral thread-like lines, one of which crosses the centre of the line of nodes. The ornamentation

[1] Bibliography, 8, p. 51 & pl. vi, figs. 1, 9, 10, 16

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almost disappears on the last whorl of some specimens, which in consequence become nearly smooth above the slit-band. The latter is rather broad, and occurs above the keel in the last whorl. The keel is decorated with a line of blunt nodes, and there are a number of parallel threads between it and the slit-band. Beneath the keel are about eight concentric spiral lines, which are crossed by the growth-lines. The umbilicus is covered by a callosity of the inner lip. The slit-band seems to correspond to a rather deep notch in the lip. Diameter=18 mm.; height=10 mm.

Locality and horizon.—Bed *c*, Otamita (Hokonui Hills), where it is common. Also on Mount Heslington, Nelson. Carnic.

TROCHUS (TECTUS) MARSHALLI, sp. nov. (Pl. XVIII, fig. 7.)

Shell trochiform, consisting of eight whorls, which are sharply keeled, and each one slightly overhangs the suture below it. The whorls are slightly concave above the keel. Below the keel the base is hollowed out and concave. The keel is decorated with a line of forward-pointing nodes, which rather resemble the teeth of a saw. The lower part of each whorl above the keel is decorated with five or six parallel thread-lines, and beneath it are several still fainter lines.

The columella is strong and twisted, and folded near the inner lip. The aperture was not preserved. Diameter=15 mm.; height =18 mm.

Locality and horizon.—Bed *c*, Otamita (Hokonui Hills), where Prof. Marshall collected it during one of our visits. Carnic.

Remarks.—Several species of Trochoid shells with a twisted inner lip occur in the Alpine Hallstatt Limestone, and are figured by Koken under the generic name *Tectus*; but none of them resemble the form here described. It may seriously be questioned whether these Mesozoic Trochoids are congeneric with the Tertiary and recent genus *Tectus*.

CORONARIA SPECTABILIS, sp. nov. (Pl. XVIII, fig. 4.)

The shell consists of fifteen or more whorls which increase slowly in size; the test is fairly thick, the nodes being but faintly visible on the internal cast. The decoration consists of a series of prominent rounded nodes of elongate outline, arranged with their longer axes upright. The nodes occupy most of the surface of each whorl, but above them, and just below the suture, is a flat band which bears three or four raised spiral lines with shallow grooves between them. A series of fainter raised spiral lines passes round that part of the whorl which is occupied by the nodes, and across the depressions between them. The umbilicus seems to have been shallow; but the shape of the aperture or lip could not be ascertained. The earliest whorls appear to have been devoid of ornamentation. The holotype is 96 mm. long, and has an apical angle of 14°.

Locality and horizon.—Western slopes of Mount Heslington,

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south of the Wairoa Gorge (Nelson), where fragments, often of large specimens, are not rare. It is also found at Nugget Point. Carnic.

The holotype is a mould belonging to the Geological Survey Collection, and comes from Mount Heslington. After preparing it, I was able to make a gutta-percha squeeze (fig. 4). The Survey also possesses a poorly-preserved fragment, consisting of several whorls, of a specimen from Nugget Point, which must have measured nearly a foot in length. I have several fragments from Mount Heslington.

Remarks.—This handsome shell seems to agree generically with Koken's genus *Coronaria*, of which several species occur in the Hallstatt Limestone. The genus resembles in some ways the *Zygopleura* group of the Loxonematidæ.

BOURGUETIA (?) ARATA, sp. nov. (Pl. XVIII, fig. 3.)

This shell consists of six or seven whorls, which increase rather rapidly in size; the body-whorl is large and rounded, and occupies rather more than half the length of the shell. The sutures are rather deep, and the whorls form a narrow platform below them. The decoration consists of spiral, rounded, parallel, raised, equidistant ridges, between which are furrows of about the same width as the ridges. There are about fifteen ridges on the body-whorl. A shallow umbilicus seems to be present, but the shape of the aperture could not be seen. Height=32 mm.; width of body-whorl=24 mm.

Locality and horizon.—Mount Heslington (Nelson). The holotype from which I made a gutta-percha impression belongs, together with several fragments from the same locality, to the Geological Survey Collection. I found a cast of a smaller specimen, 20 mm. high, in hard greywacke at Nugget Point. Carnic.

Remarks.—Owing to the poor state of preservation of the material, the generic position of this shell cannot be determined with certainty, and its attribution to *Bourguetia* is somewhat conjectural.

DENTALIUM sp. (Pl. XVIII, fig. 2.)

Length=originally about 37 mm. Greatest breadth=7 mm. at the anterior end; the posterior end is missing. The shell is gently curved: it is oval in section at the anterior, and nearly circular towards the posterior, end. The shell is rather thick, smooth, and ivory-like, with fine concentric growth-lines. The edge of the aperture is sharp and oblique, the margin being high and convex on the concave side, and concave on the ventral or convex side of the shell. The surface towards the aperture is rounded on the concave, flatter on the convex side. The growth-lines correspond to the obliquity of the aperture.

Locality and horizon.—Bed *c*, Otamita (Hokonui Hills). Carnic.

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CONULARIA sp. (Pl. XVIII, fig. 1.)

Length=originally about 27 mm.; width at the aperture=9 mm. The section seems to be more or less square or rectangular. In most of its features this *Conularia* resembles *C. lævigata* Morris from the Permo-Carboniferous of Australia, which also occurs in beds of similar age in the Salt Range. In the fineness of its striæ it recalls also *C. tenuistriata* McCoy.

Locality and horizon.—Bed *e*, Otamita (Hokonui Hills); also in the *Mytilus-problematicus* Bed at Eighty-Eight Valley, near Nelson, and in the *Pseudomonotis-richmondiana* Bed on the south side of the Hokonui Hills. Carnic and Noric. It seems to be widely distributed, but is scarce and, as a rule, poorly preserved.

LAMELLIBRANCHIATA.

The New Zealand Triassic Lamellibranchs are of considerable interest. An edentulous shell with a general resemblance to *Cardiomorpha* I place, for want of contrary evidence, among the Palæoconchs. Taxodonts are represented by *Palæoneilo*, *Leda*, and *Macrodon*. Forms of great zonal value occur among the Anisomyarians, of which *Daonella indica* fixes the Ladino-Carnic horizon, several forms of *Halobia* the Carnic, while great masses of *Pseudomonotis* indicate the Noric horizon. The Alpine form, *Monotis salinaria*, also seems to occur; but the exact horizon which it occupies in New Zealand is not yet determined. *Mytilus* (?) *problematicus* is an important fossil in the Carnic beds, hitherto found only in the South Island, but it recurs in New Caledonia. Forms of *Cassianella*, *Pinna*, *Pecten*, *Limatula*, etc., also occur. A series of curious and very variable more or less *Lima*-like Myalinidæ is common in the Carnic. These forms show affinities with *Pergamidia*, *Mysidia*, and *Mysidioptera* of the Upper Trias of Asia Minor and the Alps, and I have applied to them the new generic name *Hokonuia*.

The Schizodonts include *Megalodon* and several species of *Myophoria*, one of which has hitherto been mistaken by New Zealand geologists for a *Trigonia*. The genus *Anodontophora*, of which at least three species occur, seems to be a Schizodont, the dentition of which has become obscure or obsolete. The Eulamellibranchiata are represented by *Palæocardita*, *Pleurophorus*, and possibly *Anisocardia*.

CARDIOMORPHA (?) NUGGETENSIS, sp. nov. (Pl. XXI, fig. 7.)

Shell thin and platy in structure. Valves apparently equal in size, edentulous; beaks very anterior, pointed, close together, and incurved. Hinge-area long and slightly arched. Beneath the beaks there is a sunken false lunular depression. The valves are closed all round, except in the depression below the beak, where they gape to a slight extent for a short distance, apparently in order to allow the passage of a byssus. The surface is decorated with broad

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irregular growth-ripples, especially towards the beaks, but is otherwise smooth. Anterior margin nearly straight, lower margin gently rounded, and hinder margin below the hinge-line rounded.

An adult shell is 49 mm. long, 36 mm. high, and the two valves are 24 mm. thick.

A young specimen is shorter relatively to the height than the adult, measuring 18 mm. in length and 15 mm. in height.

Locality and horizon.—Nugget Point, in a loose block washed out of Carnic beds in the cliff-section. I collected four or five specimens.

Remarks.—It is with considerable reserve that I refer this edentulous shell to the Palæoconch genus *Cardiomorpha*. The shape of the young shell, however, suggests this genus. The gape below the beak apparently precludes it from belonging to the group of *Anodontophora*; while the laminar structure of the shell and the byssal gape suggest that it may be a Myalinid.

PALÆONEILO OTAMITENSIS, sp. nov. (Pl. XXI, fig. 21.)

The shell is rather thick; anteriorly the valves are somewhat strongly inflated, but they tend to flatten out posteriorly. The beaks are rather prominent, anteriorly situated, and directed forwards. The margin is well rounded in front, gently curved below, and is produced, narrowing gradually behind. There is no trace of a posterior ridge on the shell, the surface of which is gently rounded and smooth. The concentric growth-lines are fine, evenly spaced, and very regular. When the hinge-line is scraped away, a row of many teeth is seen behind the beak, with about six much larger teeth in front of it. Length=17 mm.; height=9 mm.; depth of right valve=3 mm.

Locality and horizon.—Bed *c*, Otamita. Carnic. I collected several specimens with the shell on them.

Remarks.—The comparatively-smooth surface of this shell suggests that of *P. elliptica* Goldfuss, from St. Cassian; but the beaks are more anterior, and the shell more inflated beneath them.

PALÆONEILO cf. PRÆACUTA Klipstein. (Pl. XXI, fig. 22.)

1895. A. Bittner, 'Lamellibranchiaten der Alpinen Trias' p. 143 & pl. xvi, figs. 32–35.

The shell is fairly thick, the beaks situated well forward. The anterior margin is well rounded, the lower margin gently curved; the posterior portion of the shell is produced, and tapers rather rapidly. The anterior portion of the valves is considerably inflated, but they flatten out posteriorly. An appreciable blunt ridge passes from behind the beaks to the lower posterior margin. The concentric growth-ridges are well marked and fairly regular; a few of the furrows between them are wider than the rest. Length=18 mm.; height=10 mm.

Locality and horizon.—Bed *c*, Otamita (Hokonui Hills). Carnic. I collected two or three fine specimens with the shell on them.

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Remarks.—This form agrees fairly well with *P. præacuta* from St. Cassian, but differs in having the beaks rather more anterior. It comes nearest to Bittner's fig. 34, yet the differences hardly seem to warrant a new specific name for it.

LEDA SEMICRENULATA, sp. nov. (Pl. XXI, fig. 20.)

Shell rather thick; beaks broad and low, situated about the middle of the shell, and directed slightly backwards. The anterior margin is well rounded, the outline forming almost a semicircle; the lower posterior margin of the shell is produced upwards, and the hinder part is rostrate. The decoration consists of about forty-five rather sharp concentric ridges which are fairly regular on the anterior portion; but near the beaks and on the posterior half, though remaining constant in width, they become curiously wavy and broken, producing a crenulated appearance. A blunt ridge passes from the beaks to the lower end of the rostrate hinder margin. Length=18 mm.; height=13 mm.

Locality and horizon.—Bed *c*, Otamita (Hokonui Hills). I collected two or three specimens with the shell on, but all rather crushed.

MACRODON cf. CURIONII Bittner. (Pl. XXI, figs. 12 & 13.)

1895. 'Lamellibranchiaten der Alpinen Trias' p. 121 & pl. xv, fig. 16.

Shell fairly thick. The hinge-margin is straight, and is produced in front of the beak, terminating rather sharply where it joins the gently-curved and retreating anterior margin. About the middle of the lower margin, which is nearly straight, the shell is contracted by a shallow sulcation extending almost to the beak. The concentric growth-lines are well marked, but irregular. Behind the beaks there is a faint trace of radial ribs interrupted by the growth-lines. Length=about 33 mm.; height=13 mm.

Locality and horizon.—Bed *c*, Otamita (Hokonui Hills). I collected a left valve there with the shell preserved, but damaged at both ends. The New Zealand Geological Survey possesses the internal casts of two specimens from Mount Heslington (Nelson), showing the characteristic dentition; but they are not specifically determinable, though probably belonging to the same species. Carnic.

Remarks.—At least one species of *Macrodon* occurs in the New Zealand Trias, but the shells are scarce. My specimen resembles rather closely the above-named species from the Raibl Beds of Lake Iseo (Lombardy). It recalls also a closely-related form, *M. esinensis* Stoppani, from the Esino Limestone, which Bittner figures on the same plate, figs. 17 & 18.

PSEUDOMONOTIS AND MONOTIS.

The *Monotis*-like shells, which Hochstetter brought from Richmond, near Nelson, were identified by Zittel as a variety of *Monotis salinaria* and called var. *richmondiana*. The fact that

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they possess an anterior byssal notch in the right valve, which is wanting in the true *M. salinaria*, was pointed out by Teller,[1] who consequently placed them in the genus *Pseudomonotis*.

I have found this byssal ear and notch in all the New Zealand specimens that I examined, except in those that occur in limestone at Okuku. In some cases the rock must be carefully cut away to show it; but it is always present, except in the case just mentioned. In the large flat varieties of *Pseudomonotis ochotica* the ear and notch are reduced to the smallest possible size.

F. Frech[2] thinks that the three circum-Pacific species of *Pseudomonotis*: namely, *Ps. ochotica*, *Ps. richmondiana*, and *Ps. subcircularis*, are varieties of one and the same shell. He believes that *Ps. richmondiana* occurs in two forms, and figures and describes a new form as var. *truncata*, pointing out its resemblance to *Ps. ochotica* var. *sparsicostata*. He also considers *Ps. subcircularis* identical with *Ps. ochotica* var. *sparsicostata*.

Ps. richmondiana has been recorded only from New Zealand and New Caledonia. *Ps. subcircularis* is a British Columbian, Californian, and South American Cordilleran form, and characterizes the Noric Beds. *Ps. ochotica* was first discovered at Verkhoyansk in Arctic Siberia, in beds of Noric age. It was found later in Japan,[3] where it occurs in beds very near the top of the Trias and a very short distance below the overlying Jurassic. It is also recorded from Central Timor, where a specimen of *Ps. ochotica* var. *densistriata* was found in a pebble in the Talau River.[4]

I now record *Ps. ochotica*, as defined by Teller, for the first time in New Zealand. It is a very variable species, but an even greater range of varieties is present among my specimens than among those from Arctic Siberia figured by Teller and Mojsisovics.

Near the head of Garden Gully, on its western slope a mile south-west of the Wairoa Gorge, in the Nelson area, I was fortunate in finding a bed of fine-grained dark greywacke-mudstone, containing a large series of forms which undoubtedly belong to the Asiatic fossil *Ps. ochotica*. The beds seem to occupy the middle limb of a syncline, or possibly a faulted syncline of the Trias, and are, I think, the highest Triassic rocks exposed in the Nelson district. In this district the varieties of *Ps. ochotica* occur in the bed in Garden Gully to the exclusion of *Ps. richmondiana*. The typical *Ps. richmondiana* occurs in vast numbers in a bed exposed some distance away on the opposite slope of the valley to the east; but the two forms are clearly separated, and I have little doubt that *Ps. richmondiana* occurs at a lower horizon than *Ps. ochotica*.

The felspathic sandstone at Richmond, 5 miles north-east of

[1] Bibliography, 35, p. 104. It is clear that the genus *Pseudomonotis* does not represent a natural group. The *Pseudomonotis* forms of the Upper Trias are much more closely related to *Monotis salinaria* than they are to shells called *Pseudomonotis* in the Permian or Jurassic, such as *Ps. speluncaria* or *Ps. echinata*.

[2] Bibliography, 13, pl. lxviii.

[3] Bibliography, 33, p. 175.

[4] Bibliography, 49, p. 189.

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Garden Gully, contains only *Pseudomonotis richmondiana*. Near Albatross Point, in the Kawhia district, the dark shales underlying the Rhætic Series, close to an igneous intrusion, contain the large flat *Ps. ochotica* var. *densistriata* and a form approaching var. *pachypleura*, while *Ps. richmondiana* seems to be absent, a fact which further goes to indicate the higher position of the *Ps.-ochotica* horizon. I have seen no *Ps. ochotica* from the Hokonui Hills, but *Ps. richmondiana* occurs at various places in that district. Okuku is the only locality in New Zealand where the *Monotis*-like shells form a limestone. Though it seemed unlikely to me that the Alpine *Monotis salinaria* should occur in New Zealand, yet it is not an impossible contingency. Wanner,[1] who paid great attention to the differences between this shell and the large flat forms of *Ps. ochotica*, records its occurrence in the island of Serang.

I have already stated, in discussing the Okuku locality, that I am compelled to regard the shell which occurs there as belonging to the Alpine form *Monotis salinaria*.

PSEUDOMONOTIS OCHOTICA Teller. (Pl. XIX, figs. 1–8.)

1886. E. von Mojsisovics, 'Arktische Triasfaunen' p. 116 & pl. xvii, figs. 1–15, pl. xviii, figs. 1–11.
1907. J. Wanner, 'Triaspetrefakten der Molukken' p. 189 & pl. viii, fig. 9.

This is a very variable species, and Mojsisovics and Teller have carefully described and illustrated from the original locality at Verkhoyansk in Arctic Siberia five varieties, in addition to the form which they regard as the normal type. These they have called vars. *densistriata*, *eurhachis*, *ambigua*, *pachypleura*, and *sparsicostata*.

In the one bed at Garden Gully, near the Wairoa Gorge, I collected specimens more or less closely comparable with all these varieties, and, in addition, a form still more strongly arched and ribbed than any that are recorded from the original locality, which I have ventured to institute as a new variety under the name *acutecostata*. All the varieties occur indiscriminately mingled together in one and the same rock.

It is not necessary here to recapitulate the description of the different varieties as given by Teller; but I may say that the large flat *Salinaria*-like variety *densistriata* (fig. 1) occurs in very characteristic form, and that some of the specimens approach the North American form *Pseudomonotis subcircularis* in the expansion and rounded outline of the anterior margin.

The posteriorly elongate and expanded, coarsely-ribbed variety *pachypleura* (fig. 3) occurs together with a form presenting a more or less quadrilateral margin, which Teller calls var. *eurhachis* (fig. 5). The variety *sparsicostata*, approaching in character the large and nodosely-ribbed form of *Ps. richmondiana*, which

[1] Bibliography, 49, p. 190.

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Frech calls var. *truncata*, can also be identified among the New Zealand shells (fig. 4).

A small, dwarfed, and strongly-ribbed form, in which the right valve is often strongly arched and bent downwards towards the margin, very similar to the variety that Teller calls *ambigua* (fig. 2), also occurs in association with all the other varieties.

It may here be emphasized that I regard these different forms as representing individual variants in one very variable species, since some confusion or misuse of terms may arise in calling them varieties. However, in describing the following form as var. *acutecostata* nov., I am merely following the plan adopted by Mojsisovics and Teller, who describe the specimens of different shape from Verkhoyansk and Japan as varieties.

Var. ACUTECOSTATA, nov. (Pl. XIX, fig. 7.)

The left valve is strongly arched, the beak is pointed, tapers rapidly, and is acutely bent over the hinge-area. The outline of the shell is angular, and there are about fourteen primary ribs, some of them very acute and prominent, others lower and more rounded. Other very much smaller secondary ribs appear about halfway between the beak and the margin.

Locality and horizon.—Garden Gully, south of the Wairoa Gorge (Nelson), on the western slope of the valley, where all the varieties occur. On the coast, south of Kawhia, towards Albatross Point, where the varieties *densistriata* and *pachypleura* occur. Upper Noric.

I collected a large series of examples at Garden Gully and several at Kawhia. The Geological Survey possesses several specimens of the different varieties from the Nelson district, but the exact bed whence they came is not identified.

Remarks.—The geographical distribution of this form has already been discussed. It has not yet been recorded from New Caledonia.

PSEUDOMONOTIS RICHMONDIANA Zittel. (Pl. XIX, figs. 9*a* & 9*b*.)

1864. 'Paläontologie von Neu-Seeland' p. 26 & pl. vi, figs. 1 *a*–1 *e*.

This species has an oval and gently rounded outline, and the margin is never angular as it is in some of the forms of *Ps. ochotica*, nor does the shell show the extremes of variation exhibited by the individuals of that species. The byssal notch and ear in the right valve are small, but well developed; the left valve is gently arched and rounded, the right nearly flat. The ribs are regular on both valves, being straight or slightly curved. Fainter secondary ribs occur between the primary ribs, and commence a short distance from the beak. There are about twenty-eight ribs on the left valve.

Frech[1] describes a form under the name var. *truncata*, and

[1] Bibliography, 13, p. 506 & pl. lxviii, figs. 4 *c*–4 *d*.

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remarks that it approaches very closely to *Pseudomonotis ochotica* var. *sparsicostata*. I have a mass of felspathic sandstone from Richmond, with a specimen on it which seems to agree with Frech's variety. It certainly resembles the variety of *Ps. ochotica*, but it seems to me to be merely a more fully-grown example of *Ps. richmondiana*, in which the ribs have become nodose towards the margins, where they are interrupted by coarse growth-lines. It retains, however, the characteristic rounded outline of this species: it measures 81 mm. in length and 65 mm. in height.

The more common form, however, is smaller. The Geological Survey possesses a very fine specimen with the two valves together, which is illustrated (figs. 9*a* & 9*b*). It is 45 mm. long, 37 mm. high, and 11 mm. thick, and comes from the eastern slopes of Mount Heslington, near Garden Gully.

Locality and horizon.—Richmond, and the eastern slope of Garden Gully in the Nelson district; also in the Hokonui Hills. It is wanting in the coast-section at Nugget Point. It occurs in enormous quantities in more or less decomposed felspathic sandstone, and marks a Noric horizon apparently below that of *Ps. ochotica*. In only one case did I see any other fossil associated with it, whereas I found several gasteropods and brachiopods in the *Pseudomonotis-ochotica* Bed in Garden Gully. It is recorded from New Caledonia.

Monotis salinaria Bronn. (Pl. XIX, fig. 10, & Pl. XX, figs. 1–3.)

1830. Leonhard & Bronn, Jahrb. f. Min. &c. p. 284 & pl. iv, fig. 1.
1907. J. Wanner, 'Triaspetrefakten der Molukken' p. 190 & pl. ix, figs. 2–4.

Among the *Monotis*-like shells that occur at Okuku the right valves are nearly as convex as the left, whereas in most specimens of *Pseudomonotis* in New Zealand the right valve is nearly flat or even slightly concave. Also, as already stated, no trace can be seen of the anterior byssal notch and ear which occur in the right valve of *Pseudomonotis*.

For some unapparent reason the shells in this limestone-bed tend to vary in a manner analogous, though to a less extreme degree, to the variation in those of *Pseudomonotis ochotica*. The word 'variety,' therefore, is to be understood in the same sense as that in which I have used it in discussing the last-named species.

The variation tends to produce a reduction in size from the large flat form which may be regarded as the normal form, accompanied by a progressively strong arching of the valves, especially of the left valve, without, however, any increase in the size of the ribs.

Monotis salinaria. (Pl. XIX, fig. 10.)

The largest specimen that I examined is a left valve 70 mm. long and 57 mm. high. It has twenty very regular, equidistant, straight, or slightly-curved primary ribs, which radiate from the beak; between these occasional fainter secondary ribs appear at

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various distances from the beak, and near the margin they attain almost the strength of the primary ribs. This form seems to resemble in every way the typical Alpine *Monotis salinaria*.

Var. INTERMEDIA, nov. (Pl. XX, fig. 1.)

This seems to be a fairly-constant variety: the left valve is rather strongly arched, and has sixteen narrow and very regular primary ribs, between each of which in one specimen that I examined fainter secondary ribs occur at various distances from the beak. In another left valve the primary ribs are rather broader, and become nodose towards the lower margin, owing to interruption by the growth-lines; and very faint, in some cases scarcely perceptible, secondary ribs occur between the primary ribs, commencing about halfway between the beak and the lower margin. Length=46 mm.; height=37 mm.; depth of left valve=14 mm.

Var. HEMISPHERICA, nov. (Pl. XX, figs. 2 & 3.)

Shell small, the left valve very strongly arched and rounded; the beak is inflated, and projects beyond the hinge-line, which is very short. The margin is rounded and contracted in front, but rather produced behind. There are about seventeen regular, low, rounded primary ribs, more or less equal in size, between which an occasional very faint secondary rib occurs towards the lower margin. A right valve is rather strongly arched, but much less so than the left; the beak is pointed and not inflated; and the hinge-line is short, with a faint posterior wing. There are about fifteen primary ribs, more or less equal in size, but rather irregularly spaced; and in the two widest spaces about the middle of the shell a very faint secondary rib occurs. A left valve is 22 mm. long, 22 mm. high, and 12 mm. deep. A right valve is 23 mm. long, 19 mm. high, and 9 mm. deep.

Locality and horizon.—Okuku (Ashley County), in the Canterbury Alps, in limestone. Horizon uncertain, Carnic or Noric. All the specimens that I examined belong to the New Zealand Geological Survey, and were collected by Mr. McKay in 1879.

Remarks.—*Monotis salinaria* is generally a Noric fossil, but occurs in Europe also in Carnic beds. It ranges from the Alps and Sicily through Afghanistan, Baluchistan, the Pamirs, Himalayas, and Borneo to the Moluccan Islands, and is now recorded for the first time from New Zealand as distinct from the genus *Pseudomonotis*.

DAONELLA INDICA Bittner. (Pl. XX, fig. 7, & Pl. XXI, fig. 5.)

1899. 'Trias Brachiopoda & Lamellibranchiata' Pal. Ind. ser. 15, vol. iii, pt. 2, p. 39 & pl. vii, figs. 4–11.
1907. J. Wanner, 'Triaspetrefakten der Molukken' p. 202 & pl. ix, figs. 8–9, pl. x, figs. 2–3.

The outline is rounded so far as one can ascertain, since most of the specimens are broken prior to fossilization. The hinge-margin is straight: the beak projects slightly above it, and is situated about

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the middle of the hinge-margin. There is no anterior ear as in *Halobia*, and consequently there can be no doubt that this shell belongs to the genus *Daonella*. The ribs commence near the beak, only a small area of which is free from them, and sweep regularly down to the margins. Secondary furrows commence some distance from the beak, but do not reach the depth of the primary furrows, and it is only occasionally that a rib is divided by two furrows. Concentric ripples are confined to the umbonal regions, and growth-lines are scarcely seen. There is a very narrow triangular space extending along the posterior hinge-margin, which is free of ribs. It attains a considerable size: a fragment of a large specimen in my collection (Pl. XX, fig. 7) shows that it must have been about 70 mm. long and 60 mm. high.

Locality and horizon.—In New Zealand this form is confined to the Kaihiku Beds, and affords very strong evidence that these are of Ladinic or Lower Carnic age. It seems to occur in all the localities where the Kaihiku Beds are found. I collected several specimens in the Caroline Cutting on the south side of the Hokonui Hills, and on looking over the Geological Survey Collection I identified many specimens from the Nelson district, Mount Potts, and other localities.

Remarks.—This is the only member of the *Daonella*[1] and *Halobia* group that occurs in the Kaihiku Beds, and seems to be in every way identical with the Himalayan form. It belongs to the group of *D. tyrolensis* of the classification of Mojsisovics, from which it differs in details well defined by Bittner. It resembles also in some ways *D. sakawana* Mojsisovics, a Japanese fossil. It is widely distributed in the Himalayan Trias, and in the Shal-Shal section and other localities, occurs in a bed which Diener took to be the top of the Muschelkalk complex, but later attributed to the *Aonoides* Beds. Wanner[2] records it, figuring specimens from the southern coast of Timor, and regards it as marking the base of the Upper Trias. This form has not been recorded from New Caledonia. In the Spiti district of the Himalayas[3] it is associated with *D. lommeli*, a well-known Alpine Ladinic fossil.

HALOBIA ZITTELI Lindström, var. ZEALANDICA, nov. (Pl. XX, fig. 6, & Pl. XXI, figs. 1–2.)

Beak rather prominent, somewhat inflated, directed forwards, and situated rather in front of the middle of the straight hinge-line. The anterior ear is broad and well marked, triangular in outline; it widens out rapidly, and is strongly arched and rounded. This ear is marked off from the rest of the shell by a broad shallow sulcus. The radial ribs begin just below the beak as a series of closely-set,

[1] The fossils which Zittel identified as *Halobia lommeli* were later described by Mojsisovics as *Halobia hochstetteri*. *H. lommeli* is really a *Daonella*. The true *D. lommeli*, a Ladinic fossil, does not seem to occur in New Zealand, the Kaihiku horizon being apparently too high for it.

[2] Bibliography, 49, p. 202. [3] Bibliography, 10, p. 11 & pp. 143–45.

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very faint, raised, rounded lines, which are produced regularly downwards and backwards with a slight anteriorly-concave bend. Some distance below the beak they widen out, become wavy, and bend suddenly forwards, continue thus for a short distance and then bend downwards again less abruptly, passing towards the lower and anterior margins. In some specimens the hinder portion of the shell is almost smooth, in others the ribs continue in fairly-straight though wavy lines, between which a series of shallow furrows of very irregular width are produced. On the anterior ear the faint radial ribs are sometimes seen on the portion bordering the hinge-line. Concentric growth-ripples are well marked in the region of the beak, but are broad, shallow, and irregular in width. They are also developed on the anterior ear, but to a less extent. Secondary ribs appear intercalated between the primary ribs on the posterior portion of fully-grown shells. The marginal outline is difficult to construct, as the shells are nearly always imperfect; but the anterior ear projects beyond the lower anterior margin and is well rounded, and the margin retreats below it, at least in the right valve. Under the ear the margin is well rounded, the lower margin seems fairly straight or gently rounded, and the posterior margin broadly rounded.

This species attains a large size; the biggest example that I collected, when perfect, must have measured about 65 mm. in length and 42 mm. in height.

Locality and horizon.—Large specimens are rather common in brown, decomposed, fine-grained greywackes on the crest and saddle of Mount Heslington, south of the Wairoa Gorge, Nelson. It occurs also in Bed *e* in the Otamita section, Hokonui Hills, and I found some small examples in hard greywackes at Nugget Point, above the *Mytilus-problematicus* Bed. I collected specimens in various stages of growth in all these localities. Carnic.

Remarks.—This large and variable *Halobia* falls into the group of *H. fallax* of the classification of Mojsisovics. The New Zealand form seems to partake of the characters, both of *H. zitteli* Lindström and of *H. superba* Mojsisovics. The sudden forward bending of the ribs occurs nearer the beak than in *H. superba*, but somewhat farther away than in *H. zitteli*. The ribs are less numerous than in *H. superba*, but they become wavy in the anterior portion of the shell, which seems not to be the case in *H. zitteli*. However, the form here described seems to be nearer to *H. zitteli* than to *H. superba*, and I am inclined to regard it as a local variety of the former species.

H. zitteli comes from the Trias of Spitsbergen, where it occurs in rather high Carnic beds with *Pinacoceras* cf. *floridum*. It also occurs in the Upper Trias of Bear Island, and some forms figured as young examples from both these localities closely resemble some of the Halobias from New Zealand. *H. superba* occurs in the Carnic of the Austrian Alps.

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HALOBIA HOCHSTETTERI Mojsisovics. (Pl. XXI, fig. 3.)

1874. 'Ueber die Triadischen Pelecypodengattungen *Daonella* & *Halobia*' p. 32 & pl. iii, figs. 7–9.

Hinge-line straight, the beak directed forwards, not very prominent, and situated rather in front of the median line. The anterior ear is triangular in shape and widens rapidly, is not inflated or rounded, and is marked off from the rest of the shell by a narrow and somewhat angular sulcus. The primary radial ribs begin below the beak, and consist of a series of rather broad flattened ribs of irregular width, separated by well-marked and rather deeply cut grooves. On these ribs two or three very much fainter secondary grooves occur some distance from the beak. At some distance below the beak (the distance seems to vary in different specimens), the ribs become wavy and bend very strongly forwards, continue thus for a short space, and then curve gently downwards again towards the lower and anterior margin. The hinder portion of the shell below the hinge-margin is devoid of ribs and almost smooth, and the ribs become very feeble towards the lower posterior margin in fully-grown shells. The anterior ear bears a shallow radial furrow not far below the hinge-margin.

Broad concentric growth-ripples occur on the young shell, but they are faint and rather irregular, and they tend to occur also on the anterior ear. Since specimens of any size are almost invariably broken, I cannot describe the marginal outline with any certainty, but it seems to have been similar to that of *H. zitteli* var. *zealandica*. This shell also attains a large size: for instance, a fragmentary specimen in my collection must have been 65 mm. long and 40 mm. high.

Locality and horizon.—Crest and saddle of Mount Heslington, Nelson. Bed *e*, Otamita, Hokonui Hills. It occurs in the same bed as the last-described form, and I collected several specimens of it.

Remarks.—Mojsisovics figures three specimens of *H. hochstetteri*, all of small size, which were apparently brought to Europe by Hochstetter and had been identified by Zittel as *Halobia lommeli*.[1] Mojsisovics gives a long and clear description of this form, of which the following are the main points:—

It is a rather high form, unstriated towards the hinder hinge-margin, with a wide anterior ear, on which beneath the margin a rather strongly-arched fold occurs, split at some distance from the beak by a sunken groove. Primary radial grooves are not numerous, and the ribs that they form are divided at varying distances, by further single or double grooves, into secondary ribs of dissimilar width. Near the forward and hinder part smaller ribs occur. Anteriorly the ribs reach to the ear. The ribs do not run straight, but undergo several bendings to and fro similarly, as is generally the case in the group of *H. fallax*. The wavy breaking of the ribs does not take place in all examples at the same age, and he remarks that it would be interesting to know whether this corresponds to any difference in geological age. Concentric ripples are very apparent on the upper half of the shell. Length=13 mm.; height=10 mm.

[1] Bibliography, 51, p. 27 & pl. vi, figs. 2 *a*–2 *c*.

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From the description it is clear that Mojsisovics only had shells in the young stage. Some of those that I obtained, and apparently identified correctly with *Halobia hochstetteri*, reach a much more adult stage, and show the sudden forward bending of the ribs.

He goes on to say that Lindström rightly considered this form to be distinct from *Daonella lommeli*, but erred in identifying it (though under reserve) with the Spitsbergen form *H. zitteli*, from which it is easily distinguished by its less numerous, wider, and more often wavy ribs. He compares it with *H. rugosa*, a form which attains a wide horizontal range in the European Alps. Bittner[1] regards *H. hochstetteri* as more closely related to *H. zitteli* than to *H. rugosa*, an opinion with which I thoroughly agree.

The specimens illustrated by Mojsisovics were said to come from the *Monotis-richmondiana* Beds at Richmond, near Nelson. By analogy with the Alpine and Spitsbergen Halobias he places this form high in the Carnic, in which case it should not occur with *Pseudomonotis richmondiana*, a Noric fossil. I never saw any Halobias in the *Pseudomonotis* Beds in New Zealand, and *Ps. richmondiana* generally occurs entirely by itself. I think, therefore, that the specimens that Hochstetter obtained must be from some other locality, possibly the Wairoa Gorge. Arthaber[2] attributes *Halobia hochstetteri* to a Noric horizon, probably because of its supposed occurrence in the same bed as *Pseudomonotis richmondiana*.

HALOBIA cf. AUSTRIACA Mojsisovics. (Pl. XXI, fig. 4.)

1874. 'Ueber die Triadischen Pelecypodengattungen *Daonella* & *Halobia*' p. 26 & pl. iv, figs. 12–13, pl. v, fig. 14.

The shell is about as long as it is high; the beak is slightly directed forwards; the ribs are not very numerous, flattened, irregular in width, and separated by rather sharply-cut furrows, some of which are deeper than others. The ribs are finer and more closely set on the posterior portion of the shell. Near the hinder hinge-margin a considerable portion of the shell is smooth. The primary ribs are split at various distances below the beak into two or four secondary ribs. The anterior ear is rather wide; it bears one or two faint radiai ribs, and is not sharply differentiated from the rest of the shell. Concentric ripples are most prominent on the umbonal region, and pass across the anterior ear as well as over the rest of the shell. A specimen in my collection, which has the margins somewhat broken, measures about 26 mm. in length and 24 mm. in height.

Locality and horizon.—Bed *e*, Otamita, Hokonui Hills, where I collected three or four specimens, none of them very well preserved. Carnic.

Remarks.—This shell apparently belongs to the group of *Halobia rarestriata* of the classification of Mojsisovics; it comes

[1] Bibliography, 6, xlv, p. 254.
[2] Bibliography, 13, p. 241.

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nearest to *H. austriaca*, which is a Carnic fossil and, in the Austrian Alps, builds up banks in the limestones with *Bucephalus subbullatus*. The flattened ribs of irregular width and the sharply-cut furrows of the present form recall those of the young shell of *H. hochstetteri*; but the beak in *H. austriaca* is less strongly inclined forwards, also the ribs show no waviness and do not bend forwards.

HALOBIA spp.

In addition to the three forms of *Halobia* already described, the Carnic beds of the New Zealand Trias contain at least two other smaller and less conspicuous forms, which appear to be distinctive and probably new species, although from the rather scanty nature of the material obtained by me I hardly feel inclined at present to record them as such. As they occur in the same bed at Otamita and Mount Heslington as the forms just described, and as they appear to be undescribed species, a description of them cannot add any further information regarding the horizon of these beds than that yielded by the forms which closely resemble *H. zitteli* and *H. austriaca*. I may remark, however, that a small *Halobia*, very common in Bed *c* at Otamita, strongly resembles a shell which Bittner illustrates under the appellation '*Halobia*, n. sp., aff. *neumayri* Bittner,' from the Upper Trias of Balia in Asia Minor. I do not recollect finding the forms allied to *H. zitteli* or *H. hochstetteri* in Bed *c* at Otamita, and so the small Halobias mentioned above may characterize a rather higher horizon. *Halobia neumayri*, which occurs at Balia, is a species of the group to which *H. zitteli* and *H. hochstetteri* belong. A careful and prolonged zonal collecting of the Carnic Halobias of the New Zealand Trias would probably yield further interesting results.

MYTILUS (?) PROBLEMATICUS Zittel. (Pl. XX, fig. 8.)

1864. 'Paläontologie von Neu-Seeland' p. 28 & pl. viii, figs. *a–b*.

Shell thin, mytiliform, the beaks anteriorly situated, terminal, the upper posterior margin bluntly alate.

Area straight or slightly curved; behind the beak is a concave ligament-groove bearing faint parallel striæ. I saw no trace of hinge-teeth nor of muscle-scars. Some specimens seem to have a small, narrow, byssal sinus below the beak. There is a small plate or septum inside the beak. A typical specimen measures 109 mm. in length. The specimen illustrated is a small left valve.

Locality and horizon.—The *Mytilus-problematicus* Bed forms a very constant horizon about the middle of the Carnic in all the principal sections in the South Island. It has not been traced in the North Island, but reappears in New Caledonia. The bed is made up of incredible quantities of separated valves, among which an occasional valve of *Hokonuia*, or of the form next to be

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described, occurs. The bed is specially well seen at Nugget Point, where it is about 10 feet thick.

Remarks.—The specific name that Zittel gave to this shell seems to imply some doubt as to its real affinities. I never found the two valves together, but the New Zealand Geological Survey Collection includes one or two examples in this condition, though not well enough preserved to show whether it is an exactly equivalve shell or not. This, as also the absence of muscle-scar impressions, makes a certain attribution impossible at present, but I strongly suspect that the form here described may be related to the Myalinidæ rather than to *Mytilus*.

MYTILUS (?) MIRABILIS, sp. nov. (Pl. XX, figs. 9 *a* & 9 *b*.)

Shell inflated, very strongly arched; the valves are nearly twice as deep as they are long, very much compressed antero-posteriorly. Beak small, anteriorly situated or terminal; area very short with a ligament-groove behind it, bearing faint parallel striæ. There is a small apical septum in the interior of the beak. In one specimen I detected a posterior muscle-scar of fair size, but saw no trace of an anterior scar. The hinge is edentulous.

Length=52 mm.; height=108 mm.; depth of valve=100 mm.

Locality and horizon.—It occurs rather commonly in the *Mytilus-problematicus* Bed at Eighty-Eight Valley, south of the Wairoa Gorge, Nelson. Carnic.

Remarks.—This shell has been called *Gryphæa* in New Zealand Geological Survey reports. The valves are always separated, but I have no doubt that it is an approximately or completely equivalve shell, as I collected both left and right valves. I feel sure also, after examining the shell-structure, which is of a laminar nature, that it is related to *Mytilus problematicus*, with which it occurs in intimate association and with which it seems to be connected by a series of intermediate forms that may be young specimens. It suggests, in fact, an enormously overgrown specimen of *Mytilus problematicus* in which the valves have become strongly arched. Fully-grown examples with the two valves together must have presented an extraordinary appearance, quite unlike that generally associated with *Mytilus*, a fact which causes me to question the generic attribution both of this and of *Mytilus problematicus*. The holotype is a right valve in my collection. The New Zealand Geological Survey possesses several specimens from Eighty-Eight Valley. This form generally occurs in a poor state of preservation, with the shell more or less completely dissolved away.

HOKONUIA, gen. nov. (Pl. XX, figs. 4–5 *b*; Pl. XXII, figs. 1–5.)

The shells belonging to this genus show very considerable diversity in size, shape, degree of inflation, thickness of shell, and situation of the beak. Some recall *Lima* in general shape, others *Myalina* or *Avicula*.

The shell-structure is more or less platy and foliaceous, recalling

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in this respect that of the Australian Permo-Carboniferous genus *Eurydesma*. The hinge seems to be quite edentulous, and the articulation was so feeble that the two valves are always disconnected; but I have a few specimens in which the valves are only displaced slightly, and they obviously belonged together. From these it is evident that the valves were approximately equal in size and degree of inflation, although whether the valves were exactly equal or not is not clear. I am inclined to think that the left valve may have been slightly smaller than the right.

The hinge-line is straight or very slightly curved, and is less than the greatest width of the shell. Behind the beak in both valves is a longitudinal, concave, areal furrow, which extends for about two-thirds the length of the hinge-margin, and seems to have accommodated a partly sunken ligament. There is a small, blunt, thickened septum in the interior of the apex of each valve, recalling that in *Myalina* or *Dreissensia*. Behind the beaks is a flattened, obtusely-angular, posterior wing, which in some examples is but slightly differentiated from the hinder margin of the shell.

The anterior portion of the shell in front of, or below, the beak differs markedly in the right and left valves, and shows features which are common to all the species of the genus whatever may be their shape or degree of inflation.

The right valve immediately below the beak bears a strong curved or semicircular truncation, which is bounded on the posterior side by a rounded, raised or thickened ridge of shell. In front of this truncation, and just below the apex, is a rather long tongue-shaped projection (Pl. XXII, figs. 1, 2 *a*, & 2 *b*), and immediately below this is a conspicuous retreat of the shell-margin forming a deep and marked sinus. The upper edge of the anterior tongue-like shelly process carries a raised or thickened ridge.

In the left valve no concave truncation is seen in front of the beak as in the right valve; but below the beak the shell-margin is arched and thickened, and retreats so as to produce a narrow byssal opening similar to that of *Mytilus* or *Myalina* (Pl. XX, fig. 5 *b*).

The tongue-like process of the right valve projects beyond the plane of junction of the valves, and must have covered the upper part of the opening produced by the retreat of the margin of the opposing left valve. The opening which remained beneath the process when the two valves were together seems to have allowed the passage of a byssus.

In one example (Pl. XXII, fig. 2 *a*) a fairly-large posterior muscle-scar is observed rather more than halfway down the shell between the median line and the posterior margin; but I could see no trace of an anterior scar, and in nearly all the specimens the muscle-impressions are quite obscure. One cannot therefore say with certainty whether the genus is monomyarian or dimyarian.

Dimensions.—The specimens are extremely variable in size, and this feature, together with the shape, will be noticed in the specific descriptions.

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Material.—I collected some twenty-five specimens, several of which bear a portion of the shell. The New Zealand Geological Survey has many specimens, mostly in the form of casts. They generally occur in a very unsatisfactory state of preservation, with most or all of the shell dissolved away.

Locality and horizon.—The genus seems to be confined to the Carnic beds and occurs in all localities, such as the Nelson district, the Hokonui Hills, Nugget Point, etc. Separated valves are found in the *Mytilus-problematicus* Bed.

Affinities.—I found considerable difficulty in attempting to determine the relationship of these curious bivalves. The anterior tongue-like projection of the right valve appears to be homologous with the anterior auricle of the Myalinidæ, to which group the genus seems to belong. The anterior retreat or thickening of the margin of the left valve below the beak resembles that of *Pergamidia* Bittner,[1] a genus which occurs in the Upper Trias of Balia in Asia Minor; but in *Hokonuia* it extends over a less distance of the anterior margin than it does in *Pergamidia*.

The genus *Mysidia* Bittner[2] occurs also in the Upper Trias of Balia; but only right valves were known to Bittner, and they have a prominent tooth beneath the beak.

Hokonuia also recalls the genus *Mysidioptera* Salomon, a group of bivalves described as Mytiloid Limidæ, which occur in the Upper Trias of the Alps and other regions. In these, however, according to Bittner's illustrations, the byssal opening is similar in both valves. As a result of later research, however, Bittner shows that in *Mysidioptera* the area of the right valve is higher than that of the left.

The anterior ear of the right valve in *Hokonuia* recalls in some ways that which characterizes the left valve of *Eurydesma*, a form occurring in the Permo-Carboniferous marine beds of Australia and other regions of Gondwanaland.

As I can find no genus closely comparable with these New Zealand shells, I am compelled to institute a new generic name for them, and to regard them as having affinities with *Pergamidia*, *Mysidia*, and *Mysidioptera*, three *Lima*-like Myalinidæ of the Upper Trias of the Alps and Asia Minor.

It seems that a considerable number of species occur in New Zealand; but, owing to the poor state of preservation of the material, it is very difficult to separate these, or accurately to diagnose them. I offer descriptions of two species which seem to be the commonest and most distinctive.

HOKONUIA LIMÆFORMIS, sp. nov. (Pl. XXII, figs. 2 *a*, 2 *b*, & 5; Pl. XX, fig. 4.)

Shell rather higher than long, hinge-line straight, measuring about two-thirds of the length of the shell. Beak rather pointed,

[1] Bibliography, 6, xli. p. 103 & pl. iii, figs. 1–4.
[2] *Ibid.* p. 113 & pl. ii, fig. 10.

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anteriorly situated and directed forwards, not projecting above the hinge-line. There is a curved truncation in front of and below the beak of the right valve, which extends for about a third of the length of the anterior margin and is bounded posteriorly by a raised ridge, on and behind which three or four faint radial ridges occur. The tongue-like projection of the right valve is directed towards the opposite valve at about a right angle from the plane of the right valve. The posterior wing is angular and flattened. The hinder margin is gently curved, the anterior margin more rounded, and the lower margin is well rounded. The growth-lines are prominent and irregular, and the surface of the shell towards the lower margin tends to become wavy and irregular.

Height = 75 mm.; length = 58 mm.; length of the hinge-area = 27 mm.; depth of right valve = 18 mm.

Locality and horizon.—Bed *c*, Otamita, Hokonui Hills. Carnic.

Remarks.—This is the most *Lima*-like of these shells, and recalls in general outline the recent *Lima excavata*. I have three right valves, all with portions of the shell; one of them with the left valve attached but lacking the beak; and a separated left valve.

HOKONUIA ROTUNDATA, sp. nov. (Pl. XX, figs. 5 *a* & 5 *b*; Pl. XXII, figs. 1, 3, & (?) 4 *a*, 4 *b*.)

Shell fairly thick, valves rather inflated and gently rounded, about as high as wide. Hinge-line considerably less than the width of the shell. The beak projects somewhat above the hinge-line, and is situated about the median line or rather in front of it. The posterior wing is rounded in outline, and is scarcely differentiated from the hinder margin of the shell, which is gently rounded. The anterior margin is rounded and rather produced, and the lower margin is gently rounded. There is a short, anterior, semicircular truncation below the beak of the right valve.

Growth-lines are well marked, and irregular ripples of growth occur especially towards the margin.

The anterior tongue-like process of the right valve is directed forwards, rather than directly downwards, away from the right valve.

A specimen with both valves measures 89 mm. in height and 84 mm. in length; the right valve is 21 mm. deep, and the hinge-line is 35 mm. long.

Locality and horizon.—Hokonui Hills. I have casts of two left valves, and another cast in which both valves are slightly displaced. I collected a left valve with the shell on it in the *Mytilus-problematicus* Bed at Nugget Point. The New Zealand Geological Survey possesses a cast of the anterior part of a right valve, from which I made a gutta-percha squeeze. Carnic.

Remarks.—This species is more rounded in outline than the last; the anterior truncation of the right valve is less extensive and more curved; and the tongue-like process is directed more forwards from the plane of the valve.

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PINNA sp. (Pl. XXII, fig. 11.)

Shell thin, hinge-line straight, marginal outline broadly rounded behind. A bluntly-angular median ridge passes from the beak to the lower posterior margin. The concentric growth-ripples are well marked and closely set. Length = 80 mm.; height near posterior margin = 47 mm.

Locality and horizon.—Eighty-Eight Valley, Nelson. Carnic. The New Zealand Geological Survey Collection possesses two or three specimens.

Remarks.—This *Pinna* rather resembles *P. heeri*, J. Bœhm,[1] from the Upper Trias of Bear Island.

PECTEN sp. (Pl. XXI, fig. 18.)

Shell thin, with comparatively large ears. A great number of fine, sharp, radial, slightly-wavy ribs start some distance below the beak, and pass to the margins; between these a number of exactly similar secondary ribs are developed lower down. Towards the lateral margins the ribs are somewhat more closely set. About five rather coarse ribs are present on the ear. The concentric growth-lines are numerous and closely set, but are fainter than the ribs. Length = 30 mm.; height = 28 mm.

Locality and horizon.—*Palæocardita* Bed, Nugget Point. Carnic. A single cast, from which I made a gutta-percha squeeze.

Remarks.—I am uncertain whether this is a left or a right valve; only one ear is well shown, and it seems different from the other one. The shell may possibly be an *Aviculopecten*. The absence of ribs on the umbonal portion may be due to erosion during life, or to conditions of fossilization. It recalls in some respects a *Pecten* from the *Pseudomonotis* Beds of Japan figured by Mojsisovics.[2]

LIMA (LIMATULA) cf. PICHLERI Bittner. (Pl. XXI, fig. 16.)

1895. 'Lamellibranchiaten der Alpinen Trias' p. 192 & pl. xxii, fig. 21.

Outline oval and rather narrow, hinge-line wide, posterior and anterior ears about equally developed. Area not visible. It is decorated with fine, somewhat sharp, and wavy ribs, which pass from the beak to the margins. This shell agrees with the above-named species, but is less oblique in outline and the ribs are rather more wavy.

Locality and horizon.—Western slope of Mount Heslington, south of the Wairoa Gorge, Nelson. Carnic.

CASSIANELLA sp. (Pl. XXI, fig. 19.)

Shell fairly thick, the beak arched and rolled, projecting above and rather over the hinge-line. The posterior wing is somewhat

[1] Bibliography, 8, p. 38 & pl. v, figs. 4–6.
[2] Bibliography, 33, p. 176 & pl. ii, fig. 9.

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produced and pointed. The lower posterior margin is rounded and slightly produced; the upper anterior margin is apparently well rounded. The surface-decoration consists of fine, closely-set, rather foliaceous, concentric growth-lines.

Locality and horizon.—Bed *c*, Otamita, Hokonui Hills. Carnic. I collected a single left valve; unfortunately, the margins are somewhat damaged.

Remarks.—This specimen is too imperfect for a specific determination, but is undoubtedly a *Cassianella*.

Anodontophora. (Pl. XXI, figs. 8–10.)

The three bivalves which will now be described appear to belong to the genus *Anoplophora* of Sandberger: this is a preoccupied name, which Cossmann has replaced by that of *Anodontophora*, although, owing to the somewhat uncertain characters of the genus, the identification is not entirely beyond doubt.

Zittel[1] says of *Anoplophora* that the hinge-teeth are wanting, and that the hinge-margin is somewhat thickened in front of and behind the beak; the anterior muscular depression is heart-shaped and wide, the posterior one slightly sunken, and the pallial line is marginal and linear.

Dr. W. H. Dall[2] includes *Anoplophora* in the Cardiniidæ, and says that in the right valve there is a blunt, thick, cardinal tooth fitting into a socket in the opposite valve, and beside the socket a long posterior lateral tooth.

Bittner[3] says of the Himalayan form *Anodontophora griesbachi* that the test is thin near the umbones, and a slight filing was sufficient to prove that a strong hinge-plate with tooth-structure did not exist. He goes on to say that muscular impressions are tolerably distinct for the thin shell, and that a pallial sinus is not perceptible.

In my New Zealand examples, which I am able to group into three species, the shell is completely closed all round; in two of them it is very thin, but in the third rather thicker. I could detect no impressions, either of the muscle-scars or of the pallial line. As regards the dentition, a close examination of all the casts in my possession showed no trace of hinge-teeth; but there was evidence of a thickening of the hinge-margin below and behind the beak.

Locality and horizon.—They seem to be confined to the Carnic beds in New Zealand. I succeeded in collecting several specimens with the shell; but they generally occur as casts, and are often more or less distorted and crushed. Sir James Hector's identification of *Edmondia* in these beds seems to have been based on shells of this group.

[1] 'Handbuch der Paläontologie' vol. i, pt. 2, p. 62.

[2] Zittel's 'Textbook of Palæontology' [transl. Eastman] vol. i (1913) p. 452.

[3] Bibliography, 5, p. 60.

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ANODONTOPHORA ANGULATA, sp. nov. (Pl. XXI, fig. 10.)

Shell thin, elongated; the beaks anterior or terminal, projecting considerably above the hinge-area, strongly directed forwards, tapering and rolled, enclosing a deep false lunular depression beneath them, divided by the sharp margin of the valves. The anterior margin below the beak is well rounded, the lower margin very gently rounded, and the posterior lower margin rather angulated. The upper posterior margin is bluntly angular. A rather prominent angular ridge merging gradually into the surface of the shell passes from behind the beak to the lower posterior margin, causing the valves to be somewhat inflated. Growth-lines are fine and closely set, but rather irregular: otherwise the surface is smooth. Length = 31 mm.; height = 20 mm.; thickness of both valves = 17 mm.

Locality and horizon.—Bed *c*, Otamita, Hokonui Hills, where I collected several specimens, both as casts and with the shell preserved. Carnic.

Remarks.—This form is easily recognized by its elongate shape, nearly terminal beaks, and the strong ridge on the posterior portion of the valves.

ANODONTOPHORA OVALIS, sp. nov. (Pl. XXI, fig. 9.)

Shell very thin; beaks rather anteriorly situated, rounded, broad, low, anteriorly directed and rolled, enclosing beneath them a deep, false, lunular depression. The anterior margin below the beaks is well rounded and rather produced; the posterior margin is broadly rounded. The valves are not inflated; the surface is gently rounded, and shows no ridge in the posterior portion.

The surface of the shell is fairly smooth with fine, but rather irregular, raised growth-lines, which become more strongly developed towards the margin. Length = 35 mm.; height = 25 mm.; thickness = 15 mm.

Locality and horizon.—Bed *c*, Otamita, Hokonui Hills. Carnic. I collected three specimens with the shell wholly or partly preserved.

Remarks.—This species resembles rather closely *Anodontophora griesbachi* Bittner,[1] which occurs in the *Tropites* Beds of the Bambanag and Shal-Shal sections of the Himalayan Upper Trias; but in the New Zealand shell the beak seems wider, blunter, and more anteriorly situated, and the growth-lines are coarser and less regular.

ANODONTOPHORA EDMONDIIFORMIS, sp. nov. (Pl. XXI, fig. 8.)

The shell is fairly thick, but seems to have been thinner in the umbonal region. The beak is rather anteriorly situated, broad and blunt, anteriorly directed and inrolled, enclosing a small lunular depression. The margin is well rounded in front, slightly

[1] Bibliography, 5, p. 60 & pl. viii, figs. 14–16.

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curved below, and broadly rounded behind. The surface of the shell is gently rounded, with fine, closely-set growth-lines, interrupted in places, especially towards the margin, by a larger growth-furrow. There is no radial sculpture or ridge. Length = 42 mm.; height = 29 mm.; depth of the left valve = 11 mm.

Locality and horizon.—Bed *c*, Otamita, Hokonui Hills. I collected a fine left valve and a smaller double-valved specimen, both with the shell preserved. Carnic.

Remarks.—This form differs from *A. ovalis* in its much thicker shell, more elongated shape, and larger size. The fine concentric growth-lines recall those on a specimen of *A. griesbachi* illustrated by Bittner; but the beaks are more anteriorly situated, and the shell is apparently thicker. I could not ascertain the characters of the hinge-area in my specimens.

MEGALODON GLOBULARIS, sp. nov. (Pl. XXI, fig. 17.)

Shell thick, rounded, tumid, and inflated, especially towards the hinder margin; the two valves together form a rather globular shell. The beaks are anteriorly situated, strongly directed forwards, produced to a point, and nearly touch one another. Below them is a deep, false, lunular depression. The shell-margin is gently rounded behind and below, but is slightly produced anteriorly below the lunule. The growth-lines are closely set and coarsely marked, and the growth of the shell is somewhat interrupted and irregular. The anterior muscle-scar is fairly strongly marked.

One specimen is 23 mm. long, 27 mm. high, and each valve is 15 mm. deep. A rather smaller right valve is 20 mm. long, 18 mm. high, and 8 mm. deep.

Locality and horizon.—I collected the casts and impressions of two specimens (one with both valves together and part of the shell remaining) on the north side of the entrance of the Wairoa Gorge in greywackes below the *Mytilus-problematicus* Bed. The other, a right valve, occurred a little way up the Gorge in the *Mytilus-problematicus* Bed. Lower Carnic. From both of these gutta-percha squeezes were made.

Remarks.—There seems to be no doubt that this shell is a *Megalodon*, the hinge-plate is thick and heavy; but I could not see the disposition of the teeth, neither could I ascertain whether the valves were quite equal or not.

PSEUDOPLACUNOPSIS PLACENTOIDES, sp. nov. (Pl. XXI, figs. 14 & 15.)

Bittner uses this generic or subgeneric name for shells outwardly resembling *Placunopsis*, but wherein the hinge-apparatus partakes of the character of that of *Spondylus* or *Plicatula*, and is formed by two ridges or auricular crura which diverge below the beak.

The shell here described comes under this generic definition.

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It occurs fixed to the surface of other shells, but seems to have a partiality for attaching itself to the large Nautilids. The free or upper valve reproduces the sculpture of the shell to which it is attached. The lower sessile valve is very thin, and is closely attached by the whole of its surface. The crura diverge at about a right angle, and the margin of the valve is marked by a row of fine radiating furrows. The free or left valve is convex, and the growth-lines are irregularly spaced and well marked. The hinge-line is straight, and occupies almost the greatest width of the shell; but the area is obscure or absent.

Locality and horizon.—Bed *c*, Otamita, Hokonui Hills. Carnic. Prof. P. Marshall collected a large crushed *Grypoceras*, which had a great part of its surface covered with these shells.

MYOPHORIA NUGGETENSIS, sp. nov. (Pl. XXII, fig. 10.)

The shell is sub-triangular in outline. The beaks are situated slightly forward of the median line, are pointed, close together, and turned very slightly but perceptibly backwards.

The anterior margin is rounded, the posterior lower margin somewhat prolonged and angular. The keel, which passes from the beaks to the lower posterior margin, is prominent, and the two parts of the shell separated by it make a rather sharp angle one with the other. The groove in front of and adjoining the keel is very slightly wider, but no deeper, than the other radial grooves, and a line of very small nodes passes down the middle of it. About eight ridges, broken by the growth-lines into nodes, pass from the beaks to the lower and anterior margin. Behind the keel the shell is almost flat, and is covered with fine growth-lines and small irregular pimples, which vary in size. A shallow furrow passes down the middle of the flat posterior portion. The posterior muscle-scar is suboval and deep on the side nearest the beak, but shallower towards its lower margin. The pallial impression is well marked.

The left valve has one very strong central triangular tooth, not perceptibly divided, but strongly grooved on both sides, eight grooves on the posterior and six on the anterior side; there is a very feeble anterior tooth, strongly grooved on its inner side, and a very thin posterior tooth scarcely differentiated from the shell-margin, not grooved. Length = 53 mm.; height = 47 mm.

Locality and horizon.—About ten specimens, from which the above diagnosis was drawn up, were obtained from a bed at Nugget Point, known to New Zealand geologists as the '*Trigonia*' Bed. It comprises about 15 feet of a very hard fine-grained greywacke rather low in the Carnic, about 700 feet below the *Mytilus-problematicus* Bed, and immediately above a thick bed of granitic conglomerate. The shells occur somewhat plentifully as single valves, or often with the two valves open or slightly displaced. They are difficult to collect, owing to the hardness of the rock; but, by preparation of the material and dissolution of the shell, satisfactory gutta-percha impressions were obtained.

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Remarks.—I was undecided at times whether to regard this shell as a *Trigonia* or a *Myophoria*, but have finally come to the conclusion that it is a *Myophoria*. The striation of the hinge-teeth alone does not apparently make it a *Trigonia*, although the very slight but definite posterior inclination of the beaks in some, if not all, of the specimens is suggestive of *Trigonia*.

Two Triassic *Trigoniæ* have been recorded. Bittner in 1895 described *Tr. gaytani* (Klipstein) from the St. Cassian Beds, and placed it in the group of Costatæ; and J. Bœhm in 1903 described a very small form (*Tr. margaritifera*) from the Upper Trias of Bear Island in the Arctic Circle.

MYOPHORIA OTAMITENSIS, sp. nov. (Pl. XXII, fig. 8.)

Shell rather small, beaks situated slightly behind the median line, medially directed. Margin rounded in front and below, slightly angulated behind, but not produced. A raised keel, bearing seven or eight coarse nodes, passes from behind the beak to the lower posterior margin. Behind this keel a shallow sulcus passes down the flank of the shell, rather more than halfway towards its posterior margin. The flank is decorated with raised tubercles of irregular size. In front of the keel, and almost adjoining it, is a fine raised ridge; in front of this are six very much more prominent ridges, which are cut by the concentric growth-furrows into a series of prominent rounded nodes. The young shell bears a series of concentric wavy ridges. Length = 18 mm.; height = 15 mm.

Locality and horizon.—The holotype is an excellently preserved specimen (with both valves and the test preserved) that I collected in Bed *c* at Otamita, Hokonui Hills. Carnic.

Fragments of casts, apparently of this shell, are common in the decomposed felspathic sandstones of the Carnic, near Gore, in the Hokonui Hills, and other localities. A form which may be identical occurs also in Noric beds, but is generally very badly preserved.

MYOPHORIA HESLINGTONENSIS, sp. nov. (Pl. XXII, fig. 9.)

Shell small and finely sculptured, rounded in front, gently rounded below, but angulated at the lower posterior portion where the ridge joins the margin. An acute raised ridge passes from behind the beak to the lower posterior margin, in front of which there is a wide sulcus. The middle part of the shell bears six or seven faint radial ridges, which become progressively fainter as they approach the anterior margin. These are crossed by a series of very regular concentric ridges and furrows forming a series of raised points. Behind the ridge the flank is decorated with fine raised points. Length = 7 mm.; height = 6 mm.

Locality and horizon.—Mount Heslington, south of the Wairoa Gorge. Carnic. The holotype consists of a piece of hard felspathic sandstone belonging to the New Zealand Geological Survey, having three or four casts on its surface, from which I made a gutta-percha squeeze.

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PALÆOCARDITA QUADRATA, sp. nov. (Pl. XXI, fig. 11.)

Shell thick, strongly arched, with a high rounded ridge passing from the beaks to the lower or hinder margin and merging into the rounded surface of the shell. Beaks prominent, rather anteriorly situated, tapering, and rolled. Shell-margin rounded in front, bluntly angulate behind, and rather less sharply angulate below where the ridge joins the lower margin. The marginal outline and the position of the beaks vary somewhat in different examples. The upper posterior margin is not alate.

Sixteen or seventeen sharp, raised, radial ribs pass from the beak to the margins, the shallow sunken furrow between them in well-preserved specimens is marked with very fine, sharp, regular, closely-set, concentric growth-lines which also cross the ribs. The anterior muscle-scar is deep and well marked, and is situated closely adjoining the upper anterior margin.

A left valve from Nugget Point is 20 mm. long, 18 mm. high. A right valve from Otamitais 18 mm. long, 16 mm. high, and 8 mm. deep.

Locality and horizon.—I collected many specimens with badly-preserved test in a loose block of very hard, coarse, felspathic sandstone on the shore at Nugget Point; but I traced the bed in the cliff where it occurs above the *Mytilus-problematicus* Bed. Valves of *Hokonuia* sp., gasteropods, etc., occur also in the same deposit. I found a right valve in Bed *c* at Otamita with part of the shell very well preserved. Carnic.

Remarks.—*Palæocardita* is now regarded as connected with the Pleurophoridæ rather than with the Tertiary and recent *Carditæ*. The form now described is related to the Alpine forms of which Bittner records four species in the St. Cassian Beds. It is as strongly arched as *P. beneckî* Bittner, but is much shorter and more quadrate in outline. It is more strongly arched than the common *P. crenata* Goldfuss, and the upper posterior portion of the shell is less expanded than in the Alpine species. In the Alps the *Palæocardita* Beds mark a horizon in the Carnic, and in New Zealand the genus seems to occupy an analogous position.

PLEUROPHORUS ZEALANDICUS, sp. nov. (Pl. XXI, fig. 6.)

Shell thick and solid, oblong and produced behind; the hinge-line is arched, and the surface of the shell is rounded. The beaks are very small and anterior, in some specimens terminal, and scarcely project from the regularly-rounded anterior outline of the shell. A broadly-rounded ridge passes from the beaks to the lower posterior margin, and between this and the hinge-margin occur two or three faintly-marked ridges. The lunule is obscure, but there is a long concave escutcheon behind the beaks. The concentric growth-lines are prominent, closely set, and regular. The anterior muscle-scar is deep and rounded, and the pallial impression is well marked. Length = 63 mm.; height = 25 mm.

Locality and horizon.—Bed *c*, Otomita, Hokonui Hills,

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where it is common and very well preserved. It also occurs at Nugget Point and in the Nelson district. Carnic.

Remarks.—This large form recalls somewhat the Permian *Pleurophorus costatus*, but is larger, more rounded, and the hinge-line is more arched.

ANISOCARDIA PARVULA, sp. nov. (Pl. XXII, figs. 6 & 7.)

Shell thick, sub-circular, with rounded margins. Beak slightly in front of the median line, not very prominent, but there is a well-marked lunule in front of it. Five or six irregularly spaced growth-furrows occur, and about seventeen faint, slightly-arched ribs pass from the beak to the margin. The ribs are wanting on the hinder part, and become very faint on the front part, of the shell. A squeeze of the interior of a right valve shows a strong cardinal tooth and apparently another tooth in front of this one, and sockets about equally distant from the beak for an anterior and a posterior tooth. These sockets occur just above the muscle-scars; the anterior scar is deep and bounded by a ridge, the posterior scar is less strongly marked. The lower interior margin of the valve is crenulated. Length = 5·5 mm.; height = 5 mm.

This little shell seems to belong to the Cypricardiaceæ, and, with *Palæocardita* and *Pleurophorus*, forms the third representative of that group in the New Zealand Trias.

Locality and horizon.—Bed *c*, Otamita, Hokonui Hills. I also saw traces of it in the *Halobia-zitteli* Beds at Mount Heslington, near Nelson. It is a scarce form.

BRACHIOPODA.

The Brachiopoda of the New Zealand Trias afford an interesting and suggestive study. The Rhynchonellids seem all to belong to the essentially Upper Triassic group *Halorella* of Bittner, which have a more or less pronounced median sulcus in both valves. One species, apparently new, is very common in the Kaihiku Beds, but becomes much scarcer in the Lower Carnic. I have described only two forms of *Halorella*, but probably more of them occur. Among the Terebratulids the Palæozoic genus *Dielasma* occurs, apparently to the exclusion of all others, in the Kaihiku Beds, and seems to be represented by two species. It persists into the Carnic, but becomes much less conspicuous there. In the Carnic beds the Terebratulids of Mesozoic aspect, devoid of hinge-plate and median dorsal septum, become conspicuous.[1] There are several species, one of which is much thickened in the umbonal region and bears very thick hinge-teeth. Others seem to belong to more normal Mesozoic types; but, as the nature of the brachidia could not easily be seen, it is impossible to make any certain generic determination of them.

[1] W. Waagen mentions that, in the Upper Triassic Kœssen Beds of India, *Dielasma* is replaced by the genera *Rhætina* and *Zugmayeria*.

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No true Spirifers occur in the New Zealand Trias: the spire-bearing forms are all referable to the genera *Spiriferina*, *Cyrtina*, *Mentzelia*, *Mentzeliopsis*, gen. nov., *Retzia*, *Spirigera*, and *Hectoria*, gen. nov. *Spiriferina* begins in the Kaihiku Beds with a small form belonging to the group of *Sp. fragilis* Schlotheim, which occurs in the German, Alpine, and Himalayan Muschelkalk. Both *Sp. fragilis* and a large and rather alate form are confined to these beds. In the Carnic a series of conspicuous sharply-alate forms occur, but in the Rhætic beds an extremely long-winged form, *Sp. diomedea*, sp. nov., occurs in association with the Spirigerid genus *Hectoria*. Bittner expressed his surprise on finding in the Himalayan Trias a *Spiriferina* so alate as *Sp. stracheyi* Salter, which he compares in this respect with the Permian *Spirifer alatus*. The New Zealand Trias is characterized by some very much more sharply-alate forms, which represent a morphic equivalent of the long-winged Spirifers of the Palæozoic. Some, however, are more acutely winged than even the most alate of the true Spirifers.

Various *Spiriferinæ* occur, in which the ventral septum and the dental plate assume the Cyrtiniform arrangement. These include the *Psioidea* group of Hector, and some of them resemble certain forms of the Alpine Rhætic.

A *Retzia* of the group of *R. schwageri* Bittner, a rather widespread form in the Alps and Himalayas, occurs in the Carnic. Other *Retziæ* also seem to be present, but my specimens are not well enough preserved for description. *Mentzelia* is intermediate in some ways between *Martinia* and *Spiriferina*. The shell is silky and fibrous, and at the same time faintly punctate; a sharp median septum and dental plates are found in the ventral valve. I collected two species of *Mentzelia* high up in the Rhætic at Kawhia: one with a smooth *Martinia*-like shell, and the other faintly ribbed. They should be searched for at lower horizons and in other localities in New Zealand.

One of the commonest brachiopods in the Kaihiku Beds is a *Mentzelia*-like form having both valves covered with tubular spines. It seems to be quite new, and so I have instituted a new genus for it, and have called it *Mentzeliopsis*. It apparently occurs only in the Kaihiku Beds.

The representatives of the Athyrid or Spirigerid group are especially interesting. *Spirigera kaihikuana*, sp. nov., is confined to the Kaihiku Beds, and belongs to the group of *Sp. wreyi* already described by Zittel, but occurring on a Carnic horizon. In the Carnic a form occurs, which is related, as regards the thickening of the hinge-region and cardinal process, to *Spirigera oxycolpos* Emmrich, the largest and latest of the Alpine Athyrids confined to the Rhætic Kœssen Beds.

A still more specialized group, to which I have given the name *Hectoria* (subgenus *Clavigera* of Hector), begins in the Carnic, and becomes exceedingly common in the Rhætic. They are related to *Spirigera oxycolpos*; but they are bisulcate, and have a still more

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exaggerated development of shelly matter in the hinge-area and cardinal process. The group persists into Jurassic times, the first instance known to me of a Spirigerid in the Jurassic.

The appearance in New Zealand, on so low a horizon as the Carnic, of brachiopods presenting a decidedly Rhætic aspect, such as the group of *Spirigera oxycolpos* (including the new genus *Hectoria*), and *Spiriferinæ* of the group of *Sp. suessi* and *Sp. austriaca* and others with the Cyrtiniform septal structure, impresses the Upper Triassic Brachiopod fauna of New Zealand with Rhætic affinities. It suggests that some of the European Rhætic forms may have originated in the Southern Hemisphere or round the shores of Gondwanaland. On the other hand, a *Mentzelia* very like the European Muschelkalk form *M. mentzeli* occurs high in the Rhætic in New Zealand. The value of the Brachiopoda for zonal purposes in the New Zealand Trias seems to be limited.

It is significant to find in the New Zealand Trias certain phyla of the Brachiopoda towards the last stages of their existence developing an excess of shelly matter in the following respects:—

(*a*) In the *Spiriferinæ*, in the form of extremely-alate shells and correspondingly lengthened spiralia.
(*b*) In the *Mentzeliæ*, as a covering of tubular spines.
(*c*) In the *Spirigeræ*, as an enormously-enlarged cardinal process and a greatly-thickened hinge-area.

Rastelligera, Psioidea, and Clavigera.

A few remarks dealing with these subgenera of Hector[1] are necessary in discussing the Brachiopoda of the New Zealand Trias.

Rastelligera embraced a group of alate *Spiriferinæ*, having a row of vertical rake-like teeth arranged along the hinge-area. The comb-tooth structure is certainly very apparent in many of the New Zealand *Spiriferinæ*, but especially so in the very alate form that I have called *Spiriferina diomedea*. Since, however, it is visible also in many true *Spiriferæ* of the Palæozoic, as well as in *Spiriferina*, it cannot be regarded as of generic significance. In some at least of the specimens that I examined I concluded that the shell-surface had been partly decomposed and the outer layer destroyed previous to fossilization. This surface-erosion seems to have taken place readily in the coarser sediments. In one specimen the central part of the area showed the comb-like structure; while towards the wings the outer surface remained, and was longitudinally striate as in an ordinary Spirifer. The structure certainly does not appear on the alate *Spiriferina kaihikuana* of the Kaihiku Series, and in consequence Hector concluded that *Rastelligera* was absent from those beds; but I am inclined to think that the greater fineness, or more rapid deposition, of sediment in those beds prevented the surface-decomposition of the shell.

Psioidea designates, according to Hector, *Spiriferinæ*, varying

[1] Bibliography, 16.

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greatly in width of the hinge-line, in which the dental plates join the median septum. Zugmayer[1] describes several such *Spiriferinæ* from the Alpine Rhætic, and includes them in his group of Dimidiatæ, separating them from the genus *Cyrtina*, in which this septal and dental peculiarity also occurs, apparently on account of their concave and uncovered delthyrium. The Cyrtiniform septal arrangement is apparently a phylogerontic feature, and seems to have arisen independently in several phyla of *Spiriferinæ* Hector's subgenus includes forms which closely resemble the Alpine Rhætic *Spiriferina suessi* and *Sp. austriaca*, and new forms which I have named *Sp. nelsonensis* and *Sp. otamitensis*. The early appearance of these forms in the New Zealand Trias is a remarkable feature.

Clavigera represents a group of specialized bisulcate Spirigerids the affinities of which are discussed later on. I have considered it advisable to rename this group, and have called it *Hectoria*. Hector's description was published without any illustrations, and his subgeneric name closely resembles that of *Claviger* given to a group of the Melanias.

HALORELLA ZEALANDICA, sp. nov. (Pl. XXIII, figs. 1*a*–3.)

Beak prominent, the hinge-line sloping rapidly away from it on each side, giving the shell a subtriangular outline. The delthyrium is triangular and insunken. In the ventral valve is a broad median sulcus with a flattened floor, on which two (or, in some specimens, four) small rounded folds occur, and continue from about a third to half of the distance to the beak. The sulcus is bounded on each side by a broad rounded fold, which continues about halfway to the beak, and two similarly rounded, but much shorter, lateral folds on each side. The dorsal valve has a broad median depression, but it is rather flattened than sunken, and bears two (or, in some specimens, three) narrow rounded folds on it, which continue for only about a third, or rather more, of the length of the shell from the anterior margin. The median depression is bounded by two broad, rounded, lateral folds which reach about halfway to the beak, and there are two more rounded but shorter lateral folds.

Dental plates are well developed in the ventral valve, and in the dorsal valve there is a sharp median septum which extends from the beak about halfway to the anterior margin. Growth-ridges are well marked, but widely spaced.

This species varies somewhat in shape and dimensions, and in the number of secondary ribs on the median sulcus; some specimens are wider, and have a less prominent beak than others. One example is 16 mm. long and 15 mm. wide; another is 13 mm. long and 13 mm. wide; a third is 13 mm. long and 15 mm. wide.

Locality and horizon.—It is common in the Kaihiku Beds at all localities. I collected many casts and impressions at

[1] Bibliography, 52.

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Caroline Cutting in the Hokonui Hills. It persists into the Carnic beds, but becomes much scarcer.

Remarks.—I think that this shell should be placed in Bittner's group *Halorella*, although the dorsal median sulcus is rather flattened than sunken. In outline it recalls *H. pedata* var. *coarctata* Bittner of the Alpine Trias, but in that form the ribs continue from the anterior margin to the beak.

HALORELLA sp. (Pl. XXIII, fig. 4.)

A single fragmentary dorsal valve has a very faint median sulcus and about twenty very regular ribs, all of about equal height. The sulci between the ribs are of equal depth. The lateral ribs become curved as they approach the anterior lateral margins, and all ribs extend to the beak region. There is a short median dorsal septum.

Locality and horizon.—Eighty-Eight Valley, Nelson. Apparently from the *Mytilus-problematicus* Bed. New Zealand Geological Survey Collection. Carnic.

Remarks.—This *Halorella* belongs to the group of *H. pedata* Bronn and *H. amphitoma* Bronn. It seems to agree best with *H. pedata* var. *multicostata*, which has twenty or twenty-four ribs. These forms occur in the Alps in the Hallstatt and Dachstein Beds. J. Wanner[1] records a very similar variety of *H. amphitoma*, with about eighteen ribs, from North-Eastern Serang in the Malay Archipelago.

DIELASMA cf. HIMALAYANA Bittner.

1899. 'Trias Brach. & Lamellibranch.' Pal. Ind. ser. 15, vol. iii, pt. 2, p. 25 & pl. v, figs. 1–8, 10, 11.

Small forms of rounded or oval outline occur plentifully as casts in the lower strata of the New Zealand fossiliferous Trias. The shell bears none or only a very faint plication, and gutta-percha squeezes show that the growth-lines are closely set and well marked. The dental plates of the ventral valve and the median septum of the dorsal valve are well developed.

They are generally of small size, and are not strongly inflated: one specimen is 11 mm. long and 10 mm. wide.

Locality and horizon.—This form is plentiful in the Kaihiku Beds at Caroline Cutting and other localities; and I found casts of this or a very similar small *Dielasma* in the *Halobia* Beds at Mount Heslington, but they become very scarce in the Carnic.

Remarks.—This form recalls the Permian *D. elongata* Schlotheim, but I think that it is identical with *D. himalayana* Bittner, which occurs in the main complex of the Muschelkalk and in the beds with *Spiriferina stracheyi* Salter in the Himalayas.

DIELASMA ZEALANDICA, sp. nov. (Pl. XXIII, fig. 5.)

Shell elongated, the outline tapering gradually towards the beak, but expanding towards the anterior margin, which is well rounded.

[1] Bibliography, 49, p. 187 & pl. vii, fig. 8.

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Valves somewhat flattened. The beak is prominent, but receding; the foramen is large and rather diagonally situated, having encroached on the beak through absorption or wear. The delthyrium seems to have been partly covered by the dorsal beak. The dorsal valve bears near its anterior margin a very faint, broad, mesial fold and lateral sulci. Owing to the extremely-slight plication, the junction of the valves is nearly straight. The growth-lines are well marked on the cast.

Dental plates are well developed in the ventral beak. In the dorsal valve a strong median septum extends for more than a third of the length of the shell, and supports a prominent shield-like hinge-plate.

Length = 46 mm.; width = 33 mm.; thickness = 16 mm.

Locality and horizon.—Kaihiku Beds, Caroline Cutting, Hokonui Hills. Two casts were collected, one of them crushed.

Remarks.—This form differs from the numerous small Dielasmas in the Kaihiku Beds, in its very much larger size and more prominent beak. I could not ascertain either the structure of the crura, or the nature of the shell. Although it is only a cast, its distinctive characters justify the attribution to it of a specific name.

CŒNOTHYRIS sp. (Pl. XXIII, fig. 7.)

Shell subpentagonal in outline, rather inflated; the beak tapering slowly, fairly prominent, and bent over so that the area and part of the foramen are hidden by the dorsal beak. The dorsal valve has a broad and high median fold, bounded on each side by a broad and shallow sulcus, which merges into the rounded surface of the shell. Near the anterior margin the median fold has a faint sulcus on it.

The internal cast shows that dental plates are well developed, but apparently in part calloused. There is a slight median septum in the dorsal valve, but nothing of the loops could be seen.

Length = 30 mm.; width = 28 mm.; thickness = 17 mm.

Locality and horizon.—A single specimen in my collection occurred in the *Pseudomonotis-richmondiana* Beds at Richmond, near Nelson. Noric. A gutta-percha squeeze of the beak and dorsal valve was obtained from the mould.

Remarks.—This large plicated Terebratulid is the only fossil that I ever saw associated with *Pseudomonotis richmondiana*, and is the only deeply-plicated Terebratulid that I obtained in the New Zealand Trias.

'TEREBRATULA' PACHYDENTATA, sp. nov. (Pl. XXIII, fig. 6.)

Shell oval and gently rounded in outline; the valves are somewhat flattened and not inflated, and show no plication. The beak projects but very slightly above the hinge-area, and the foramen is very small. The growth-lines are fairly well marked. The shell is remarkably thickened in the umbonal region of the ventral valve,

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the dental plates being massive and calloused. The hinge-teeth are large and broad, and become very conspicuous in the crushed specimens. The dorsal valve appears to have had a large cardinal process and wide dental sockets. The loops seem fairly long, but nothing definite of their structure could be seen.

Locality and horizon.—Bed *c*, at Otamita, Hokonui Hills, where I collected three or four well-preserved specimens with the shell on. One specimen is 27 mm. long and 23 mm. wide; another is 21 mm. long and 18 mm. wide.

Remarks.—The shelly thickening of the hinge-region of this shell points to its being some phylogerontic form, but of which generic stock I could not determine. The shell has a fibrous structure, and bears dark closely-set punctations.

TEREBRATULA cf. HUNGARICA Bittner. (Pl. XXIII, fig. 8.)

1890. 'Brachiopoden der Alpinen Trias' p. 278 & pl. xxvi, figs. 2–3.

A single specimen is oval in outline, rather inflated, but not plicate. The area and beak are rather prominent, and the foramen is small. The surface is smooth, with occasional regular growth-furrows. Length=12 mm.; width=11 mm.; thickness=6 mm.

Locality and horizon.—Bed *c*, Otamita, Hokonui Hills. Carnic. One specimen in my collection.

Remarks.—This specimen could not be sacrificed in order to investigate the internal structure; but in outward appearance it resembles the above-named species, which occurs at high Triassic horizons in the Eastern Alps.

SPIRIFERINA FRAGILIS Schlotheim. (Pl. XXIV, figs. 10–12.)

1890. A. Bittner, 'Brachiopoden der Alpinen Trias' p. 29 & pl. xxxv, figs. 2–4.

The hinge-line in most examples represents the greatest width of the shell. In the ventral valve the area is high, wide, and triangular, flat or slightly concave, and the beak is but slightly bent over the area. The median sulcus is deep and angular, and is bounded by more or less angular folds, on each side of which are three lateral folds, the last one often very small. The area of the dorsal valve is obscure; the beak is small, and projects but slightly above the area. The median fold is appreciably higher and wider than the lateral folds, of which there are three or four on each side of it, the last one being very small. Concentric growth-lamellæ are prominent, and become foliaceous towards the anterior margin. Length = 16 mm.; width = 19 mm.

In another dorsal valve of a slightly-different variety (fig. 12) the outline contracts very slightly below the hinge-line and then widens out again, becoming somewhat wider than at the hinge-line. At the hinge-line the shell is 17 mm. wide, but widens out to 18 mm. below that, and is 15 mm. long.

Locality and horizon.—This form is confined to the Kaihiku Beds, in which it occurs commonly in most localities. I collected

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a series of casts at Caroline Cutting, from which I made gutta-percha squeezes.

Remarks.—It closely resembles *Spiriferina fragilis*, except that the beak seems rather less bent over the area than in the typical European form. Bittner describes a form called *Spiriferina lilangensis* Stol. from the Muschelkalk of the Spiti district of the Himalayas, and remarks on its similarity to *Sp. fragilis*; but the New Zealand specimens seem to resemble the European rather than the Himalayan form. *Sp. fragilis* was first described from the German Muschelkalk. In the Alps it occurs at Wengen in Upper Ladinic beds, according to Bittner. Piroutet records it from New Caledonia.

SPIRIFERINA KAIHIKUANA, sp. nov. (Pl. XXIV, fig. 15.)

The area is broad, and extends the whole length of the wings. Some specimens are more sharply alate than others; but in all of them the hinge-line represents the greatest width of the shell, and the margin contracts rapidly in front of the wings. The ventral valve has a broad, concave, median, rapidly-widening, dorsal furrow with about six low rounded folds on each side of it. The dorsal valve has a broad, rounded, median fold with five (in another specimen seven) low rounded folds on each side, which gradually diminish in size. The folds occupy the surface of the shell nearly to the hinge-area. The growth-lines are rather coarse. Casts show that the posterior part of the inside of the ventral valve was much filled in with shelly matter, and that there was a sharp median septum.

One specimen measures 72 mm. across the wings and 41 mm. in length; another less alate example is 46 mm. across the wings and 30 mm. long.

Locality and horizon.—This is the only large and alate *Spiriferina* that occurs in the Kaihiku Beds, to which it seems to be confined. The Geological Survey possesses some very fine specimens, of which, unfortunately, only the internal casts have been preserved. Hector illustrates one of these casts as *Trigonotreta alata*,[1] the English Permian form. It comes from the Crinoid Beds at Cowan's Railway Station, Oreti Valley.[2] From another specimen found at Eighty-Eight Valley, Nelson, I was able to make a gutta-percha impression of the exterior of the dorsal valve. I collected some smaller examples at Caroline Cutting.

Remarks.—This shell occurs in a rather fragmentary condition in the Kaihiku Beds; but, so far as I can ascertain from the material, the fragments all represent one species, despite variation in the length of the wings and in the number of the lateral folds. It shows some affinity with the small *Spiriferina fragilis* which accompanies it, in the width of the area and in the continuation of the ribs up to the area-margin. The only described form

[1] Catal. Ind. & Col. Exhibition (1886) p. 76, fig. 3.

[2] Prof. P. Marshall and I think that this is the same locality as Caroline Cutting, the name of the station having apparently been changed since the early survey was made.

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with which I can compare it is *Spiriferina stracheyi* Salter from the Himalayan Muschelkalk, which Bittner says is rather closely related to the European *Sp. fragilis*; but the form here described is much larger, and is more strongly ribbed.

SPIRIFERINA GYPAËTUS, sp. nov. (Pl. XXIV, fig. 4.)

Shell extremely alate, the wings towards their apices tapering rapidly to sharp points. The ventral area is very long, concave, and narrow, and is faintly striate. The beak of the ventral valve is very small, and projects but slightly above the hinge-area; it practically touches that of the dorsal valve, which is broad and projects slightly above the dorsal area.

The dorsal valve has a broad, median, triangular, rapidly-widening fold, with a fairly-deep angular sinus on each side of it. The first lateral folds on each side are lower and rather narrower than the median one, and on either side of these are three much smaller and fainter lateral folds which gradually decrease in size. All the folds continue to the beak. The wings towards the apices are free from folds. The anterior outline of the shell is gently rounded, and narrows rapidly towards the wings, which continue very narrow for some distance, ending in sharp points. The growth-lines are prominent, irregularly spaced, and rather foliaceous.

Length = 22 mm.; width = 75 mm.

Locality and horizon.—A very fine cast of the ventral beak and dorsal valve, from which I made a gutta-percha squeeze, comes from the slopes of South Peak (Benmore), in the Hokonui Hills, and belongs to the New Zealand Geological Survey. The horizon is probably Noric.

SPIRIFERINA ACUTISSIMA, sp. nov. (Pl. XXIV, fig. 3.)

Shell extremely alate; the wings are produced into very acute points. The hinge-area extends the whole length of the wings, is very narrow, concave, and faintly striate parallel to the margin. The ventral beak is very small, and projects but slightly above the hinge-area; that of the dorsal valve is also small, and scarcely projects above the dorsal area, and the two almost touch one another.

In the dorsal valve the median fold is high, narrow, and triangular, and has a very faint median sulcus on its anterior portion. On each side of it are six similar folds gradually decreasing in size and height, the last being very faint. The folds continue to the dorsal beak, and are divided by rather deep and angular sulci. The anterior margin is very narrow in proportion to the width of the shell, the lateral margins narrowing gradually to the wings, which are considerably produced and end in very fine points. The growth-lines are not very prominent.

Length = 21 mm.; width = 83 mm.

Locality and horizon.—The New Zealand Geological Survey possesses a very fine mould of the ventral beak and dorsal valve in hard dark greywacke, from which I took a gutta-percha squeeze.

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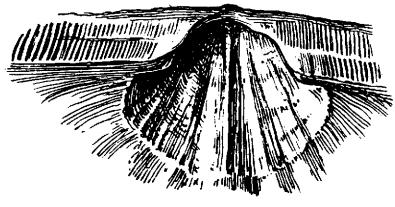
It comes from the east side of Mount Heslington, south of the Wairoa Gorge, but there is no other fossil on the piece of rock to indicate its horizon, which is probably Upper Carnic or Noric. I collected a rather weathered cast of a smaller dorsal valve in felspathic sandstone in Bed *a*, Otamita, Hokonui Hills, which is probably Lower Noric.

Remarks.—Both this and the last species are remarkable for the very narrow ventral area, the slight prominence of the ventral beak, and the fact that the apices of the wings end in acute points.

SPIRIFERINA DIOMEDEA, sp. nov. (Pl. XXIV, figs. 1 & 2.)

Shell extremely alate, about five times as wide as it is long, the wings narrowing gradually to the apices. The area extends the whole length of the wings: it is broad and high, and shows the comb-tooth structure along its whole length; but whether the serrated structure was exposed in the living shell, or whether during life it was covered with an easily decomposable layer of shell, I am not able to say with certainty. The ventral beak is blunt, wide, and rather prominent; that of the dorsal valve is broad, and projects very faintly above the hinge-line. The ventral valve has a rather broad, shallow, median sulcus, and on each side three or four lateral sulci, only slightly smaller and no deeper than the median one. The dorsal valve has a wide and low, triangular, rapidly-widening fold, which extends to the beak, and bears a slight median depression towards the anterior margin. On each side are four narrower rounded folds of equal height, which gradually decrease in size. The wings are free from folds towards the apices. The delthyrium is wide, open, and triangular. The median septum of the ventral valve is sharp but low, and extends for about three-quarters of the distance to the anterior margin; it lies in a well-marked hollowed-out depression which accommodates the muscle-scars, but these are not strongly marked.

Fig. 3.—*Gutta-percha squeeze of the interior apex of the ventral valve of* Spiriferina diomedea, *sp. nov. Rhætic. South Hillend, Otago.*



[This shows the sunken pit occupied by the pedicle and muscle-scars and median septum, also the area bearing the 'comb-tooth' structure upon which the subgenus *Rastelligera* was founded.]

Length = 26 mm.; width = 127 mm.

Locality and horizon.—The New Zealand Geological Survey possesses a cast of a ventral valve in coarse felspathic grit, from the north-western branch of Taylor's Creek, in the Hokonui Hills. This form occurs plentifully in the highest Trias with *Hectoria bisulcata* at the southern end of Roaring Bay, Nugget Point, in

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a hard pebbly sandstone, which stands out as a stack in the coast-section; but specimens are very difficult to collect, the rock being so hard. The Survey, however, possesses a fairly-good specimen from this locality (Pl. XXIV, fig. 2). Prof. P. Marshall has recently sent me a piece of felspathic sandstone from South Hillend, 12 miles south of Benmore railway-cutting, on the south side of the Hokonui Hills, with several casts of this shell, from which I was able to make gutta-percha squeezes (fig. 1). It seems to be the same bed as that in the Benmore cutting, and contains casts of a large *Hectoria*. Rhætic.

Remarks.—This is the largest and latest, as well as by far the most alate, of the New Zealand Triassic *Spiriferinæ*. It differs from the two previously-described species in its larger size and in the wings narrowing very gradually to the points. The folds are lower and more rounded, and decrease gradually in size, the area also is broader, the ventral beak higher, and it occurs on a higher horizon than the two previously-described forms, which are of Carnic and Noric age.

SPIRIFERINA NELSONENSIS, sp. nov. (Pl. XXIV, figs. 6–8.)

Shell alate, valves rather inflated, the anterior margin is gently rounded in outline. The ventral valve has a broad median sulcus, which extends to the beak, and is bounded on each side by four rounded slightly-raised ribs, which decrease gradually in size. The dorsal valve has a triangular median fold, which increases rapidly in width, and on each side of it four fainter rounded ribs which are continued nearly to the beak.

The area of the ventral valve is wide, high, and concave; it is longitudinally striate, and represents the greatest width of the shell, the margin of the valves converging rapidly in front of the area. The delthyrium is triangular, wide, and open, bounded on each side by dental plates, which converge together inwards and meet the median septum: this latter is visible at the bottom of the open delthyrium as a thin plate projecting slightly above the line of junction of the dental plates. The surface of the dental plates is faintly furrowed. On both sides of the delthyrium another slightly-sunken triangular area is separated off, and is ornamented with faintly-impressed vertical furrows. The dorsal area is narrow, and a 'comb-tooth' structure is seen for a short distance on each side of the dorsal beak. The growth-lines are fairly well marked.

Length=23 mm.; width=45 mm.

Locality and horizon.—I collected three or four specimens in the *Halobia* Beds on the western slope and crest of Mount Heslington in the Nelson district. The New Zealand Geological Survey possesses a specimen from the same locality. Carnic.

Remarks.—Zugmayer divides his group of Rhætic 'Dimidiatæ' into two 'form groups' (Formenkreise): namely, the group of *Spiriferina uncinata* and that of *Sp. suessi*, the latter including only the single species. The species here described apparently

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belongs to the first group, which comprises forms with vertical striæ on the dental plates and on the adjacent areal portion on each side of them: these, Zugmayer thinks, may have assisted in attaching a ligament or external muscle. He illustrates three species that show this peculiarity: namely, *Sp. uncinata*, *Sp. kœssenensis*, and *Sp. austriaca*; but they are all non-alate forms with a very high ventral area.

SPIRIFERINA cf. AUSTRIACA Suess. (Pl. XXIV, fig. 5.)

1882. H. Zugmayer, 'Untersuchungen über Rhätische Brachiopoden' p. 28 & pl. iii, figs. 6 *a*-6 *c*.

Shell about as long as it is wide. Ventral area high and triangular, slightly concave, and coarsely striate parallel to the hinge-margin, which represents very nearly the greatest width of the shell. The delthyrium is triangular and deeply sunken, the septal arrangement is cyrtiniform, and the thin median septum is seen towards the apex projecting above the floor of the delthyrium. The ventral beak is bent slightly over the areal region; the dorsal beak is rounded, rather inflated, and projects slightly above the hinge-area.

The dorsal valve is semicircular in outline, and has a raised, rather narrow, median fold, and three or four much fainter lateral folds, which cover the shell nearly to the hinge-margin. The ventral valve has a broad and shallow triangular median sulcus, which extends to the apex and is bounded by two raised narrow folds, on each side of which are two or three much fainter lateral folds.

Length = 38 mm.; width = 38 mm.

Locality and horizon.—The New Zealand Geological Survey possesses a specimen from Mount Potts, from which the above description was made. The shell is well preserved; but the delthyrium is nearly filled up with rock, and part of the dorsal valve is concealed. I am not sure whether it comes from the Kaihiku Series or from the Lower Carnic, but it is probably from the latter. I have three or four smaller, separated, single dorsal valves apparently belonging to this species, some of which have a faint fourth lateral fold. I collected them in low Carnic beds on the north side of the entrance of the Wairoa Gorge.

Remarks.—The attribution of this brachiopod to the above Alpine species is conjectural, but it evidently belongs to the group of *Sp. uncinata* and *Sp. austriaca*; the former, however, has a series of vertical striæ on the area next to the delthyrium, which is wanting in the present form and in *Sp. austriaca*, but is found in the form last described, *Sp. nelsonensis*. In general shape it resembles *Spiriferina austriaca*, which occurs in the Starheimberg Beds of the Alpine Rhætic.

Hector[1] illustrated a drawing of the specimen from Mount Potts under the title of '*Spiriferina (cristata?)*,' the small English Permian fossil, a very different species: this gave rise to

[1] Catal. Ind. & Col. Exhibition (1886) p. 76, fig. 6.

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the idea that the Mount-Potts Beds were of Permian age, an idea further supported by the supposed occurrence of *Glossopteris* in these beds.

SPIRIFERINA OTAMITENSIS, sp. nov. (Pl. XXIV, figs. 9*a* & 9*b*.)

Both valves are about equally convex and slightly inflated. The hinge-line represents in some examples the greatest, in others nearly the greatest, width of the shell. The ventral beak projects but slightly above the hinge-area. The ventral area extends the whole length of the hinge-line, is moderately high, concave, and faintly striate parallel to the margin. The delthyrium is open and sunken, and the arrangement of dental plates and median septum is cyrtiniform. In one specimen the apex of the ventral valve is considerably thickened by a deposit of shelly matter.

The anterior and lateral margins are gently rounded, the outline forming more or less a semicircle. The dorsal valve has a rounded, gradually-widening, median fold, with four lateral folds on each side decreasing gradually in size. The median and the first two lateral folds extend to the beak, but the last two lateral folds die away before reaching it. The ventral valve has a rounded, fairly-deep median sulcus, bounded on each side by five rounded narrow folds gradually decreasing in size, the last two of which are very faint and do not reach the beak. The growth-lines are well marked.

Length = 20 mm.; width = 27 mm.

Locality and horizon.—Bed *e*, Otamita, Hokonui Hills, with *Halobiæ* of the group of *H. zitteli*. I collected several specimens bearing the shell, but they are more or less crushed or flattened in the shale.

Remarks.—This species belongs to the *Sp.-uncinata* group of the Dimidiatæ, but differs from *Sp. nelsonensis* and *Sp.* cf. *austriaca* in having a much narrower hinge-area and a less prominent ventral beak, and also from the former in the absence of a vertically-sulcate areal portion on each side of the delthyrium.

SPIRIFERINA SUESSI var. AUSTRALIS, nov. (Pl. XXIV, figs. 13*a*–14.)

1882. H. Zugmayer, 'Untersuchungen über Rhätische Brachiopoden' p. 29 & pl. iii, figs. 14–19.

The ventral valve is semipyramidal in shape, and more or less semicircular in outline. The ventral area is almost vertical, triangular, wider than it is high, flat or very slightly concave, and faintly striate parallel to the hinge-area. The ventral beak scarcely projects above the area; the delthyrium is triangular and deeply sunken; on each side of it a very narrow triangular area is marked off and slightly sunken, and is faintly furrowed longitudinally. In casts of the ventral beak the single incision of the median septum is seen extending forwards for about a third of the length of the valve.

The surface of the ventral valve bears a deep, angular, rapidly-

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widening sulcus, which extends to the apex and is bounded on each side by a slight, rounded, raised fold. The dorsal valve has a strong, raised, roof-like, rapidly-widening, triangular fold, which extends to the beak and is bounded on both sides by a narrow sulcus. The growth-lines are faint, but well marked.

Length=18 mm.; width=20 mm.

Locality and horizon.—The crest of Mount Heslington, south of the Wairoa Gorge, in fine, brown, decomposed greywackes, with *Halobiæ* of the group of *Halobia zitelli*. I collected several specimens, both casts and moulds; but it is not a common form. Carnic.

Remarks.—This species forms the second group of Zugmayer's Dimidiatæ, in which the dental plates do not reach the back of the ventral beak, but join the edge of the median septum where it passes towards the area, forming a triangular sunken trough in the areal region. This arrangement obtains also in the Palæozoic genus *Cyrtina*, from which Zugmayer separates his Dimidiatæ, apparently on account of differences in the delthyrium. He gives a detailed description of *Spiriferina suessi*, which in the Alps seems to be confined to the Kœssen facies of the Rhætic. The New Zealand form appears to be slightly different in shape, the sides meeting the hinge-area at almost a right angle; but the differences do not seem to warrant a new specific name for it. A slight difference, however, is the presence on each side of the delthyrium of a very narrow, triangular, vertically-sulcate area, which Zugmayer says is absent in the Alpine *Sp. suessi*, but occurs in *Sp. uncinata*. I regard the present form as a local variety of *Spiriferina suessi*.

A drawing which Hector[1] published under the name of '*Psioidea* sp.' appears to represent this species.

SPIRIFERINA (?) CAROLINÆ, sp. nov. (Pl. XXIII, figs. 19 *a*–20.)

Ventral valve semi-pyramidal in shape, dorsal valve almost flat. The hinge-line is straight, and represents the greatest width of the shell; the hinge-area is flat and vertical. The ventral beak is conical and blunt, and does not project above the hinge-area. The delthyrium is conical and apparently open. The hinge-area of the dorsal valve is narrow; the dorsal beak is broad and blunt, and projects but very slightly above the area.

The ventral valve has a faint, shallow, rapidly-widening, median sulcus, which extends from the anterior margin to near the apex, and on each side two very faint, shallow and broad, lateral sulci. Otherwise the surface is gently rounded, and the outline of the anterior margin is nearly semicircular. The dorsal valve, which is nearly flat, bears a very faint, broad, low, median fold bounded by scarcely perceptible lateral sulci.

The interior of the ventral valve (fig. 19 *a*) shows two thick and strong dental plates, which converge rapidly together and partly

[1] Catal. Ind. & Col. Exhibition (1886) p. 73, fig. 1.

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fuse; they then become thinner and diverge again, the space between and in front of them bearing the adductor-scars. Immediately in front of their point of divergence a strong median septum is developed, which extends beyond the dental plates. The dorsal valve has a faint cardinal process with dental sockets on each side, and small, but well-marked, adductor and diductor scars. Ovarian pittings are well marked in both valves. The shell-structure is punctate, and the growth-lines become rather foliaceous towards the anterior margin.

Length=23 mm.; width=40 mm.; height of area of ventral valve=10 mm.

Locality and horizon.—It occurs in the Kaihiku Beds at Caroline Cutting, but seems to be scarce. I collected specimens, from which gutta-percha squeezes of the interior and exterior of both valves were made. Prof. Marshall possesses a specimen from the splintery argillites of Mount Potts (where it occurs in association with the Kaihiku fauna), which I recognized as the interior of a ventral valve of this species.

Remarks.—This brachiopod is peculiar as to shape, and as to form of the dental plates and septum, and I am unable to refer it definitely either to *Spiriferina* or to *Cyrtina*. The smoothness of its valves and the height of the hinge-area recall in some ways the very abnormal form *Cyrtina zitteli* Bittner from St. Cassian, but in that species the area of the ventral valve is enormously extended. The appearance of the dental plates in the casts at the back of the ventral beak, however, prevents its union with the genus *Cyrtina* as usually defined.

RETZIA SCHWAGERI Bittner. (Pl. XXIII, fig. 21.)

1890. 'Brachiopoden der Alpinen Trias' p. 21 & pl. xxxvi, figs. 1–4.
1899. 'Himalayan Trias Brach. & Lamellibranchs' p. 42 & pl. viii, figs. 1–3; p. 54 & pl. x, figs. 16–20.

Shell considerably longer than it is wide, beak prominent and pointed, lateral margins gently rounded, anterior margin rounded. The dorsal valve has a median rib, which is rather less prominent than the ribs on each side of it. There are seven rounded lateral ribs on each side of the median one; the last five of these are distinctly curved outwards, and all of them extend to the beak. The ventral valve has a median furrow no deeper than the next lateral furrows and seven lateral ribs.

Length=14 mm.; width=11 mm.

Locality and horizon.—Western slope of Mount Heslington, Nelson, in the *Halobia* Beds, where it is rather scarce. I have two or three casts and impressions, from one of which a gutta-percha squeeze of the outside of the shell was made. Carnic.

Remarks.—This shell resembles the Himalayan *R. schwageri* var. *asiatica* Bittner, but bears rather more numerous lateral ribs. *R. schwageri* is a species of wide vertical distribution, ranging from the Muschelkalk to the Dachsteinkalk in the Alps. In the Himalayas it occurs with *Halobiæ* of the group of *H. rugosa*.

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Piroutet records three Alpine species of *Retzia* from the Trias of New Caledonia, of which *R.* aff. *superbescens* is the only one that resembles the present form.

MENTZELIA cf. AMPLA Bittner. (Pl. XXIII, fig. 9.)

1890. ' Brachiopoden der Alpinen Trias ' p. 165 & pl. xli, figs. 10-11.

Ventral valve inflated, the dorsal rather less so, area triangular, rather high, less than the width of the shell, the ventral beak somewhat bent over it. The ventral valve has a broad and shallow rounded sulcus, which does not continue to the apex. The dorsal valve bears a rather broad, rounded, triangular fold, which does not reach the beak and is bordered on both sides by steep slopes. In the ventral beak there is a sharp median septum with sharp dental plates on each side of it. The shell-structure is fibrous, and at the same time faintly punctate.

Length = 31 mm.; width = 42 mm.; thickness = 20 mm.

Locality and horizon.—I collected a single specimen in pebbly sandstones, with *Arcestes* cf. *rhæticus* and *Hectoria bisulcata*, several hundred feet above the *Pseudomonotis-ochotica* Beds, north of Albatross Point, Kawhia. The wings of this specimen are damaged, and the ventral beak is slightly eroded. Rhætic.

Remarks.—This smooth *Mentzelia* seems to agree closely with the above-named species, which Bittner thinks may be a variant of the Muschelkalk form *M. mentzeli*. In the Alps *M. ampla* occurs at a horizon corresponding to that of the St. Cassian Beds; while the typical *M. mentzeli* is predominantly a Muschelkalk form, but has been found also in the Carnic of Spiti in the Himalayas.

MENTZELIA KAWHIANA, sp. nov. (Pl. XXIII, figs. 10 *a* & 10 *b*.)

Shell rather wider than long, the anterior margin gently rounded. The ventral valve is somewhat swollen and arched, the beak tapering gradually, the dorsal valve is almost flat, and the margin of the valves lies nearly in one plane. The area is less than the width of the shell, and seems to have been rather high. The ventral valve has a shallow, rounded, rather broad, median sulcus, with about seven very faint and narrow, lateral, rounded ribs on each side of it: these do not continue to the beak, and are absent from the lateral portions of the shell. The dorsal valve bears a very faint, flattened, triangular, median fold and about seven very faint, narrow ribs on each side of it which do not reach the beak. The lateral portions of the shell towards the hinge-area are smooth.

Length = 25 mm.; width = 31 mm.

Locality and horizon.—I collected a single specimen not far from the last-described form in the *Arcestes* and *Hectoria* Beds, in the cliff-section south of Kawhia Harbour. Rhætic.

Remarks.—The shell-structure is fibrous and faintly punctate. This form rather closely resembles *M. palæotypus* Loretz, from the Alpine Muschelkalk, but has fewer radial ribs, a weaker dorsal fold and ventral sulcus, a more prominent beak, and a less inflated shell.

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MENTZELIOPSIS, gen. nov. (Pl. XXIII, figs. 11–18.)

Shell thin, the growth-lines being visible on the inner surface. Beak of the ventral valve prominent, arched, and tapering rapidly. Hinge-line straight and rather shorter than the greatest width of the shell. Area triangular, concave, striated parallel to the margin, with an open triangular delthyrium. The hinge-teeth situated on each side of the delthyrium are somewhat prominent, and are supported by two sharp plates. A sharp and prominent median septum extends for nearly half the length of the ventral valve. The dorsal valve is flatter than the ventral. Dental sockets are present, and between them is a short, blunt, cardinal process. An obscure cardinal area is present in the dorsal valve, and there is a faint median dorsal septum. Muscular and vascular impressions are obscure. The outer surface of both valves bears prominent, fairly-equidistant, more or less foliaceous growth-lamellæ, and is covered with tubular spines measuring up to 3 or 4 mm. in length. The spines generally occur on the surface between the growth-lamellæ, but occasionally the latter are prolonged into spines. There is a more or less prominent dorsal median fold and ventral sinus, and fainter lateral ridges. Owing to the feeble articulation the valves are generally found separated.

A specimen which I ground down showed the spiralia directly connected with the crural processes, and two discrete jugal processes, a condition which obtains in the true Spirifers and in *Mentzelia*.

The following points show that the brachiopod is really a thin-shelled spiny *Mentzelia* :—

(*a*) The outline, area, and sulcation are that of *Mentzelia*.

(*b*) There is a strong ventral median septum with sharp dental plates on each side of it, well seen in every cast of the ventral beak.

(*c*) The only specimen that I had available to grind down showed that the junction of spirals and crura was simple, and the juga apparently discrete.

(*d*) The shell-structure is fibrous and silky, but on the only specimen that I have which shows any of the test no punctation could be seen; if present, it is very faint.

The founding of a new genus or subgenus for this shell requires some explanation. *Mentzelia* is generally a perfectly-smooth shell, but Bittner mentions the fact that von Schauroth found a specimen of *Mentzelia mentzeli* in the German Muschelkalk with a covering of hair-like spines. The New Zealand form, at least two species of which seem to occur, has the surface of both valves covered with comparatively long tubular spines. It bears a similar relation to *Mentzelia* as *Acanthothyris* does to *Rhynchonella*. I adopt the commoner species *M. spinosa* as the genotype.

Locality and horizon.—It seems to be confined to the Kaihiku Beds, Ladino-Carnic. The only true *Mentzeliæ* that I found in New Zealand were in the Rhætic. On looking over the material that I collected at Mount Heslington, in the Nelson district, I find some dorsal valves of a small spiny brachiopod,

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which, though scarcely adequate for a specific description, appear to represent a dwarfed species of *Mentzeliopsis*. These occur in the Carnic with *Halobia zitteli* var. *zealandica*.

MENTZELIOPSIS SPINOSA, sp. nov. (Pl. XXIII, figs. 11–16.)

The shell is slightly wider than it is long; the area is rather concave, less than the greatest width of the shell, and striated parallel to the hinge-margin. The ventral valve is inflated and arched; the beak is prominent, tapers rapidly, and is rather bent over the area. The delthyrium is triangular and deeply sunken. The ventral valve has a feeble, wide, median sulcus and very feeble lateral dorsal folds.

The dorsal valve is much flatter than the ventral, and has a broad, rapidly-widening, triangular, slightly-raised fold, on each side of which are about five very feeble, narrow, lateral folds. The growth-lines are rather widely spaced and foliaceous, and are sometimes produced into tubular spines. The latter also occupy the spaces between the growth-lines, but are not very closely set. They attain a length of 3 or 4 millimetres.

A ventral valve measures 19 mm. in length and 32 mm. in width; another 25 mm. and 30 mm.; two dorsal valves are respectively 20 mm. long and 31 mm. wide, and 20 mm. long and 26 mm. wide.

Locality and horizon.—Kaihiku Beds at Caroline Cutting; Kaihiku Gorge; Eighty-Eight Valley, in the Nelson district; and other localities, where it is common. Ladino-Carnic.

Remarks.—I collected most of my specimens at Caroline Cutting, and made several gutta-percha squeezes of the exterior and interior surfaces of both valves.

MENTZELIOPSIS HORRIDA, sp. nov. (Pl. XXIII, figs. 17 & 18.)

Valves rather inflated, both about equally so. Shell slightly wider than it is long; the ventral beak is broad, and tapers slowly. The ventral valve has a broad, shallow, median sulcus which reaches to the beak, and on each side of it about six rather faint, but well-marked, rounded, narrow lateral folds, which also reach nearly to the beak.

The dorsal valve bears a rounded, triangular, rapidly-widening, median fold, with a smaller fold passing down the middle of it, and four or five rather faint, lateral, rounded folds, all of which reach to the beak. The spines are short, and small and closely set. Growth-ridges are widely set and well marked, but not foliaceous.

Length = 22 mm.; width = 26 mm.

Locality and horizon.—Kaihiku Beds at Caroline Cutting and elsewhere, where it seems to be scarce; but I collected casts from which gutta-percha squeezes of both valves were made. Ladino-Carnic.

Remarks.—This form differs from *M. spinosa* in having a broader beak and a more inflated dorsal valve. The ribs are better marked and reach to the beak, and the spines are more numerous, smaller, and more closely set.

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SPIRIGERA WREYI Zittel. (Pl. XXV, figs. 6 *a* & 6 *b*.)

1864. 'Paläontologie von Neu-Seeland' p. 28 & pl. viii, figs. 3 *a*–3 *d*.

Zittel, when he described it, had only casts of this species, which Hochstetter collected in the Nelson district. I therefore take the opportunity of describing and illustrating a fine uncrushed testiferous example, which I found in a pebbly felspathic grit on the western slope of Mount Heslington. It is rather wider than long, the ventral valve is rather inflated, the dorsal less so. The ventral beak is comparatively small; the area is narrow and faintly striate parallel to the hinge-margin; the delthyrium is triangular and deeply sunken, and only slightly hidden by the dorsal beak. The apex is perforated by a pedicular foramen of moderate size. The ventral valve has a broad, shallow, median sulcus which dies away about halfway to the beak, and two faint lateral sulci which only appear near the anterior lateral margins. The dorsal valve bears near its anterior margin a broad median fold, which is bordered by steep slopes. It measures 28 mm. in length, 31 mm. in width, and 16 mm. in thickness. The growth-lines are well marked.

Locality and horizon.—This is a common Carnic fossil in New Zealand: it occurs at Mount Heslington and in the Wairoa Gorge; in the Hokonui Hills; at Nugget Point and other places in the South Island. It is also reported to occur in New Caledonia.

Remarks.—Zittel mentions the large cardinal process, and Bittner remarks upon the resemblance of this shell to the Alpine Rhætic *Spirigera oxycolpos*.

I have employed the generic name *Spirigera* (A. d'Orbigny, 1847) in preference to *Athyris* (McCoy, 1844) for the Triassic forms of this group, in conformity with the writings of Zittel, Bittner, Diener, and others, by whom it is used so largely. The name *Spirigera* seems to be coming into use to designate the Mesozoic Athyrids.

SPIRIGERA KAIHIKUANA, sp. nov. (Pl. XXV, fig. 5.)

Shell rather inflated, the ventral valve slightly more than the dorsal. Outline elongate-oval or subtriangular, often widening out towards the anterior margin, which is gently rounded. The ventral beak is prominent, and tapers gradually. The delthyrial cavity is more or less entirely concealed by the dorsal beak. The foramen was wide and remained open during life, as the casts are always attached to the interior of the cavity by rock which filled up the foraminal passage: this, in some examples, is extended forward, and encroaches on the delthyrium.

There is a faint broad fold on the anterior part of the dorsal valve, and a very faint corresponding median depression on the ventral valve: consequently, the junction of the valves lies almost in one plane. The ventral apical region is much thickened at the sides with shelly material, but a passage for the pedicle-muscle always remains.

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One specimen measures 41 mm. in length and 31 mm. in width; another, of more triangular outline, is 46 mm. long and 52 mm. wide.

Locality and horizon.—It is confined to the Kaihiku Beds, and casts are very common at Caroline Cutting, Kaihiku Gorge, and other localities. I have a few specimens with the shell preserved, as also a large number of casts. Ladino-Carnic.

Remarks.—This species belongs to the group of *Spirigera wreyi*, but is larger, has a more oval or elongate outline, the delthyrial region is more hidden by the dorsal beak, the pedicle-passage remained wide and open, the fold and sinus are much feebler, and the shell-structure is more coarsely fibrous. It occurs on a lower horizon than *Sp. wreyi*, which is a Carnic fossil.

SPIRIGERA MANZAVINIOIDES, sp. nov. (Pl. XXV, figs. 7 *a* & 7 *b*.)

Shell wider than long; valves only slightly convex near the beaks, the ventral rather more so than the dorsal, becoming flattened towards the margins. Near the anterior margin there is a broad but feeble ventral sulcus, and a low and broad rounded dorsal ridge bounded by wide, feebly-marked, lateral sulci. The area is small, and less than the width of the shell; the beak is very small and pointed, and projects but very slightly over the hinge-line. The pedicle-passage is minute. The growth-interruptions are prominent, foliaceous, irregular, and widely spaced, and the interspaces are marked with very faint, regular, parallel, concentric striæ. The shell-structure is coarsely fibrous, the fibres directed towards the median line. A typical, somewhat flattened, specimen is 30 mm. long and 40 mm. wide.

The internal structure is as follows: it has a thickened ventral hinge-region and a large cardinal process, beneath which a cavity projects backwards into the beak region, and is divided by a short, blunt, median septum. The end of the cardinal process carries a triangular depression, and there are prominent ventral hinge-teeth supported by plates.

Locality and horizon.—I collected six or seven specimens in dark shales along with *Halobia zitteli* var. *zealandica* in Bed *e*, Otamita, Hokonui Hills. They have the shell preserved, but are somewhat flattened or laterally distorted. Carnic.

Remarks.—This shell belongs to the group of *Spirigera oxycolpos* Emmrich, of the Rhætic Kœssen Beds, the latest and largest of the European Spirigerids; but it differs in being much flatter, whereas the full-grown *Sp. oxycolpos* is a swollen and rounded shell. It comes very near in shape and outline to *Sp. manzavinii* Bittner[1] of the Upper Trias of Balia in Asia Minor, a form which (as Bittner remarks) bears comparison with the New Zealand species *Sp. wreyi*. In *Sp. manzavinii*, however, the foramen is large, whereas in the present form it is quite minute.

[1] Bibliography, 6, xli, p. 107 & pl. i, figs. 9–11.

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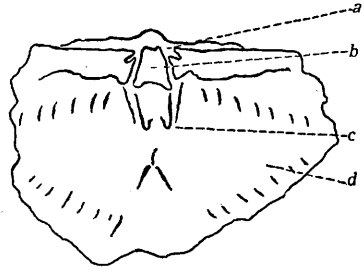
Spirigera eurycolpos Bittner,[1] of the Alpine Dachsteinkalk, also belongs to this group, but differs from the present form in shell-outline and other details. The internal structure is essentially similar to that of *Sp. oxycolpos*, which Zugmayer has described in detail, a structure which exists in a more exaggerated form in the group next to be described.

I have very strong reasons to think that the New Zealand Trias, if thoroughly searched, would yield more and different forms of the group of *Spirigeræ*, to which *Sp. wreyi*, *Sp. kaihikuana*, and *Sp. manzavinioides* belong. The New Zealand Geological Survey possesses another such form, and I have fragments of others; but the rather doubtful locality-record of the former, as also the poor condition of my material, makes it unadvisable to found further new species at present.

Hectoria, gen. nov. (Pl. XXV, figs, 1 *a*–4 *b*.)

The hinge-line slopes very slightly away from the beaks, and represents the greatest, or nearly the greatest, width of the shell. The ventral area extends for nearly the whole length of the hinge-line: it is narrow, but conspicuous, and has faint parallel striations; the area of the dorsal valve is nearly obsolete. The ventral beak projects but very slightly above the hinge-line; the dorsal beak is rather less prominent. The valves are almost equally convex; the ventral sometimes slightly more so than the dorsal. Both valves have a more or less pronounced, median, rapidly-widening sinus, bounded on each side by rounded lateral folds which diverge from the beak and pass to the anterior margin, where they meet similar folds of the opposite valve. The junction of the valves lies almost in one plane, or is very slightly sinuous. The shell-structure is silky and fibrous, the fibres being mostly directed towards the median line. In a cast that I collected in Carnic beds near Gore, in the Hokonui district, the beak has been pierced by a narrow and long arched tubular foramen, but in others, and especially in the larger and more fully grown specimens, the foramen is filled up and obliterated by the shelly thickening of the beak. The delthyrium is triangular and sunken, and in the larger specimens at least is closed.

Fig. 4.—*Specimen of* Hectoria *sp. from Carnic shales at Otamita, partly ground down.*



a = Dental sockets.
b = Cardinal process of the dorsal valve.
c = The recurving of the primary lamellæ.
d = The medio-laterally directed spiralia.

[1] Bibliography, 4, p. 273 & pl. xxix, figs. 7–13.

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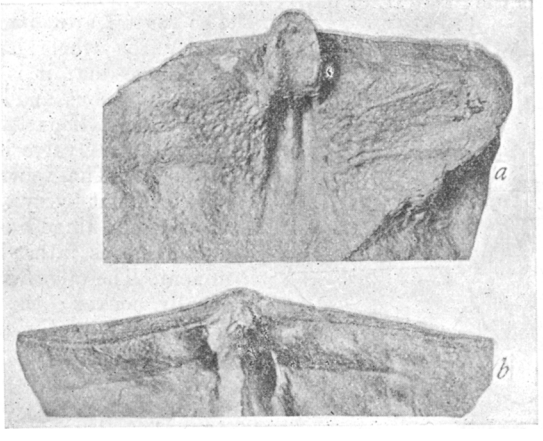
The following account of the internal structure is based chiefly on large specimens of *Hectoria tumida*, from the Rhætic of Benmore Cutting, where fine moulds and casts occur, from which I obtained gutta-percha impressions. The interior of the ventral valve is considerably thickened posteriorly by deposition of shelly matter; the hinge-teeth are prominent, are supported by short dental plates, and there is a short median septum.

In the dorsal valve the hinge-region is still more thickened; the cardinal process is very large and prominent, and consists of a blunt tongue-shaped mass of shell, which projects backwards beneath the delthyrial region of the ventral valve. The cardinal process has a shallow depression on its surface. In front of the cardinal process a deepened cavity projects backwards beneath it,

Fig. 5.—*Gutta-percha squeezes of interior of apices of valves of* Hectoria tumida, *gen. et sp. nov. (Natural size.) Rhætic. Benmore Cutting.*



a=Dorsal valve, showing the large tongue-like cardinal process with the hollowed-out space in front of and below it divided by a median septum. Slight dental sockets occur on each side of the cardinal process.

b=Ventral valve, showing the concave slightly-striated area, the small hinge-teeth and plates supporting them, and the small median septum.

and is divided by a rather high, blunt, median septum which separates the two adductor-scars. On each side of the cardinal process is a fairly-deep dental socket. The ovarian pittings, vascular impressions, and muscle-scars are well marked in both valves, the diductor-scars of the ventral valve being flabellate. The spiral cones are laterally directed. The arrangement of the juga and junction of the spiralia with the crura could not easily be seen; but, on grinding down a specimen from the Carnic shales at Otamita, I concluded that it was similar to that which obtains in other Spirigerids.

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This genus comprises a well-defined group of specialized bisulcate Spirigerids, which shows close relationship to *Sp. oxycolpos* of the Alpine Rhætic in the structure of the cardinal process and the deepened pit beneath it. They differ, however, in features sufficiently marked to justify their attribution to a new genus or subgenus, such as the equal convexity and equal median sulcation in both valves, the greater internal posterior thickening of the valves, and the relatively-larger size of the cardinal process.

Locality and horizon.—Two species appear to occur in the Trias, and one in the Jurassic, of New Zealand. They are rather scarce in the Carnic of the Hokonui district; but they occur in great abundance in some beds of Rhætic age, and a single rather dwarfed form survives into the Jurassic.

Remarks.—Hector proposed the generic name *Clavigera* for this group, in a paper read before the Wellington Philosophical Society in 1878. An abstract of this paper was published the following year, but it never appeared in full. Some plates which he caused to be printed about that time have recently been issued with a palæontological bulletin already mentioned.[1] Pl. i is occupied by illustrations of the genus *Clavigera*. Some years ago Mr. McKay collated these plates, and labelled the species so far as he could from memory: he gave the species on pl. i as follows: *Clavigera bisulcata*, *Cl. cuneiformis*, *Cl. gracilis*, *Cl. tumida*, and *Cl.* 'sp. innom.' I have adopted the specific names *bisulcata*, *tumida*, and *cuneiformis* for the forms for which Hector apparently intended them—the last name referring to the Jurassic shell. *Clavigera gracilis* is a cast from Benmore Cutting, apparently identical with *Cl. tumida*. Hector gave drawings of *Cl. cuneiformis* and of a cast of *Cl. tumida*, but without any specific names, in a work issued in 1886.[2] For reasons already stated, I considered it advisable to discard Hector's name *Clavigera* and to institute that of *Hectoria* instead.

HECTORIA BISULCATA, sp. nov. (Pl. XXV, figs. 1 *a* & 1 *b*.)

Shell rather wider than long, moderately inflated, the valves almost equally convex. The hinge-line is nearly straight, and represents the greatest width of the shell. The area is narrow and faintly striate parallel to the margin, and the ventral beak projects slightly above the area. The delthyrium is triangular and insunken. The growth-lines show that the outline of the young shell was rather strongly alate; but towards maturity it becomes less so, and is more or less produced anteriorly. The outline maintains the same width at the sides for some distance from the hinge-line, and then narrows to the anterior margin, which is gently rounded. In both valves two raised rounded ridges diverge from the beaks, and proceed towards the anterior margin meeting the similar ridges of the opposite valve. They enclose a shallow,

[1] Bibliography, 47.
[2] Catal. Ind. & Col. Exhib. (1886) p. 72, figs. 2 & 3.

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rapidly-widening, triangular sulcus; but towards the anterior margin both ridges and sulcus become weaker, and merge into the rounded surface of the shell. The junction of the shell is but slightly sinuous.

The type-specimen is 51 mm. long, 63 mm. wide, and the two valves are 23 mm. deep.

Locality and horizon.—Casts apparently of this species occur in Carnic and Noric strata at Otamita, Hokonui Hills. At Nugget Point it is extremely abundant, together with *Spiriferina diomedea*, at the southern end of Roaring Bay, in a bed of very hard pebbly sandstone of Rhætic age, which here closes the Triassic sequence. It is less common at Kawhia, where it occurs sporadically through a very thick series of grey sandy Rhætic deposits overlying the Noric *Pseudomonotis* shales. I obtained one very fine example there and several less perfect ones, also several specimens at Nugget Point. The New Zealand Geological Survey possesses a specimen from blue sandstones and chert at the main branch of Taylor's Creek, on the south side of the Hokonui Hills, in beds apparently of Rhætic age.

HECTORIA TUMIDA, sp. nov. (Pl. XXV, fig. 2.)

Shell very slightly wider than long; valves inflated, the ventral often rather more so than the dorsal. The hinge-line slopes gently from the beaks, and represents rather less than the greatest width of the shell; the area is concave, and striated parallel to the margin. The ventral beak is broad, and projects slightly above the hinge-area. The delthyrium is triangular and insunken, and closed internally by shelly matter; it is partly concealed by the dorsal beak. The outline is gently rounded at the sides, but is somewhat prolonged and rounded anteriorly. Rounded ridges diverge in both valves from the beak, and extend to the anterior lateral margins; but in this species they become somewhat indistinct, and tend to merge into the swollen and rounded outline of the shell, and on the dorsal valve they form a more or less flattened or gently rounded, raised, median, triangular fold rather than a sulcus. The growth-lines are well marked towards the anterior margin.

A typical specimen is 60 mm. long and 63 mm. wide.

Locality and horizon.—Benmore Cutting, on the south side of the Hokonui Hills, in a coarse, decomposed, pebbly, felspathic sandstone. Many casts of this large shell occur here. I collected and brought home several internal casts, and a mould from which I was able to obtain a gutta-percha impression of the ventral beak and area and dorsal valve; but the surface of the shell is damaged and pitted by the quartz-grains in the rock. The description of the internal structure of the hinge-region given in the diagnosis of the genus is based on moulds of the separated ventral and dorsal valves, which I obtained in this locality and brought home with me. Rhætic.

Remarks.—This is a distinctive form, and seems to occur in high Rhætic beds. It differs from *H. bisulcata* in its larger size

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and more inflated shell, its relatively narrower hinge-line, and much less clearly-marked folds and sulcus. In its general rounded outline and swollen surface it somewhat recalls full-grown specimens of the Alpine *Spirigera oxycolpos*.

HECTORIA CUNEIFORMIS, sp. nov. (Pl. XXV, figs. 4*a* & 4*b*.)

Valves about equally convex, compressed, and but slightly inflated. The junction of the valves is nearly straight. The hinge-margin slopes very gently away from the beak, and represents the greatest width of the shell. The ventral beak is very small, and projects but slightly above the hinge-margin; the ventral area is extremely narrow. In front of the hinge-line the lateral margins converge together rather rapidly, and the anterior margin is strongly hollowed out between the ridges. The median sulcus and the rounded ridges on each side of it are well marked in both valves; they continue in full strength from the beak to the anterior margin. Ridges of growth are rounded and fairly prominent, and the structure of the shell is coarsely fibrous.

The type-specimen, from Taylor's Creek, is 25 mm. long, 37 mm. wide, and 11 mm. thick.

Locality and horizon.—A fine specimen in the New Zealand Geological Survey Collection was obtained in the lowest part of the lower Ammonite Bed at Taylor's Creek, in the Hokonui Hills. Prof. P. Marshall lent me a fragment of a valve that he collected at Totara Point, in the harbour of Kawhia. I am at present uncertain about the exact horizon of the Jurassic at Totara Point; but I think, from an examination of the associated fossils, that it is Bajocian.

Remarks.—This form is smaller than *H. bisulcata*, the sulcus and ridges are better marked, and the beaks relatively smaller. It is a dwarfed Jurassic survival of an essentially Upper Triassic group.

VII. RELATION OF THE NEW ZEALAND TRIAS TO THAT OF NEW CALEDONIA AND THE MALAY ARCHIPELAGO.

New Caledonia lies on the north-westerly continuation of the Australian festoon or submarine ridge which connects the Auckland Peninsula with Norfolk Island and the Malay region.

On the south-western side of New Caledonia the Trias shows a close agreement with that of New Zealand. The points of similarity and difference seem to be as follows:—

(*a*) At the base occurs a thick detrital series devoid of fossils. Piroutet supposes this to represent probably the Permian and the lower divisions of the Trias, and it evidently corresponds with the Kaihiku Series below the lowest fossiliferous horizon in New Zealand.

(*b*) Above this comes a series of shales, greywackes, tuffs, andesitic breccias, and conglomerates, which represent the

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Ladinic, Carnic, and Noric horizons, and pass conformably upwards into the Lias.

(*c*) Piroutet regards the lowest fossiliferous beds, which contain *Halobia zitteli*, as of Upper Ladinic age. I can find no mention of the occurrence of any equivalent in New Caledonia of the Kaihiku fossiliferous beds with *Daonella indica*, which form a lower horizon than the *Halobia-zitteli* Bed in New Zealand. *Spiriferina fragilis*, however, figures in Piroutet's list of fossils, and so some members or survivals of the Muschelkalk fauna seem to be present. I prefer to regard *Halobia zitteli* as a Carnic fossil and the bed below it as Ladino-Carnic.

(*d*) The Carnic Series in New Caledonia has the beds with *Mytilus problematicus* as its base, and includes among its fossils *Halobia superba*, *H. austriaca*, several indeterminate species of *Arcestes*, *Discophyllites*, *Spirigera*, *Spiriferina*, etc.

(*e*) The Noric attains a thickness of at least 4920 feet, and contains *Pseudomonotis richmondiana* in great abundance. There is no record yet of *Ps. ochotica* or *Monotis salinaria* in New Caledonia.

(*f*) No mention is made of any definite Rhætic fauna, nor can any reference to the bisulcate Spirigerids of the *Hectoria* group be found. Piroutet, however, records fossils which present affinities with those of the Alpine Dachstein in his lists.

(*g*) The *Mytilus-problematicus* Beds are said to be transgressive, and to begin in the coastal region with a conspicuous conglomerate, which rests upon the trachytic tuffs of the middle portion of the underlying series. The *Pseudomonotis* Beds are again transgressive, and rest upon beds increasingly older as they extend westwards.

The presence in New Zealand of thick and coarse conglomerates at various horizons, together with the local absence of the Noric *Pseudomonotis* Beds, points to local transgression and retrogression. This is notably the case at Nugget Point, where a thick coarse conglomerate appears rather low in the Carnic, and where the *Pseudomonotis* Beds are entirely wanting. The Trias in New Zealand, however, is too much disturbed, and the outcrops are too discontinuous to enable one to make definite assertions as to the extent or direction of such transgressions.

The Triassic deposits in the eastern part of the Malay Archipelago belong, with one exception, to the Upper Trias. The exception is that of a piece of rock containing a Ceratitic ammonite of the genus *Dinarites*, which was ejected by a mud-volcano on the southern coast of Timor. Upper Trias has been found on seven distinct islands spread over the whole East Indian Archipelago. The beds discovered by Volz in Sumatra, and those in Borneo described by Vogel, are also of Upper Triassic age.

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The faunal transgression which began over a wide area of the Malay Archipelago at the end of the Middle Trias, or the beginning of the Upper Trias, extended also to the regions now occupied by New Caledonia and New Zealand.

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EXPLANATION OF PLATES XVII–XXV.

Plate XVII.

Fig. 1. *Arcestes* cf. *rhæticus* W. B. Clark. Rhætic: north-east of Albatross Point, Kawhia. Two-thirds of the natural size. Marshall Coll. (P. 182.)
2. *Cladiscites* sp. Carnic; Mount Heslington, Nelson. Natural size. N.Z. Geol. Surv. Collection. (P. 183.)
3. *Clydonautilus (Proclydonautilus)* cf. *spirolobus* Dittmar. Carnic; Nugget Point. One-third of the natural size. N.Z. Geol. Surv. Coll. (P. 182.)
4. *Aulacoceras* sp. Noric (?); Oreti Cutting, Hokonui Hills. Two-thirds of the natural size. N.Z. Geol. Surv. Coll. (P. 184.)
5. *Aulacoceras* cf. *sulcatum* Hauer. Natural size. Carnic (?); Eighty-Eight Valley, Nelson. N.Z. Geol. Surv. Coll. Gutta-percha squeeze. (P. 184.)
6. *Orthoceras* cf. *triadicum* Mojsisovics. Carnic; Otamita, Hokonui Hills. Natural size. Trechmann Coll. (P. 181.)
7. *Discophyllites* cf. *ebneri* Mojsisovics. Carnic; Mount Heslington, Nelson. One-third of the natural size. Trechmann Coll. (P. 184.)

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Plate XVIII.

Fig. 1. *Conularia* cf. *lævigata* Morris. Carnic; Otamita, Hokonui Hills. Natural size. Trechmann Coll. (P. 189.)

2. *Dentalium* sp. Carnic; Otamita, Hokonui Hills. Natural size. Trechmann Coll. (P. 188.)

3. *Bourguetia (?) arata*, sp. nov. Carnic; Mount Heslington, Nelson. Natural size. Gutta-percha squeeze. N.Z. Geol. Surv. Coll. (P. 188.)

4. *Coronaria spectabilis*, sp. nov. Carnic; Mount Heslington, Nelson. Natural size. Gutta-percha squeeze. N.Z. Geol. Surv. Coll. (P. 187.)

Figs. 5 *a*–5 *c*. *Pleurotomaria (Sisenna) hectori*, sp. nov. Carnic; Otamita, Hokonui Hills. Natural size. Trechmann Coll. (P. 186.)

6 *a*–6 *c*. *Pleurotomaria (Sisenna) hokonuiensis*, sp. nov. Carnic; Otamita, Hokonui Hills. Natural size. Trechmann Coll. (P. 186.)

Fig. 7. *Trochus (Tectus) marshalli*, sp. nov. Natural size. Carnic; Otamita, Hokonui Hills. Marshall Coll. (P. 187.)

Figs. 8 *a* & 8 *b*. *Patella (Capulus ?) nelsonensis*, sp. nov. Ladino-Carnic; Eighty-Eight Valley, Nelson. Natural size. Gutta-percha squeeze. N.Z. Geol. Surv. Coll. (P. 185.)

Plate XIX.

Fig. 1. *Pseudomonotis ochotica* var. *densistriata* Teller. Upper Noric; Garden Gully, near Wairoa Gorge, Nelson. Right valve. Seven-eighths of the natural size. Trechmann Coll. (P. 193.)

2. Ditto, var. *ambigua* Teller. Same locality. Right valve. Natural size. Gutta-percha squeeze. Trechmann Coll. (P. 193.)

3. Ditto, cf. var. *pachypleura* Teller. Same locality. Left valve. Seven-eighths of the natural size. Trechmann Coll. (P. 193.)

4. Ditto, cf. var. *sparsicostata* Teller. Same locality. Left valve. Seven-eighths of the natural size. Trechmann Coll. (P. 193.)

5. Ditto, var. *eurhachis* Teller. Same locality. Right valve. Slightly reduced. Trechmann Coll. (P. 193.)

6. Ditto, var. *acutecostata* nov. Same locality. Right valve. Seven-eighths of the natural size. Gutta-percha squeeze. Trechmann Coll. (P. 194.)

7. Ditto, var. *acutecostata* nov. Same locality. Left valve. Seven-eighths of the natural size. Trechmann Coll. (P. 194.)

8. Ditto, very small, cf. var. *pachypleura* Teller. Same locality. Left valve. Seven-eighths of the natural size. Trechmann Coll. (P. 193.)

Figs. 9 *a* & 9 *b*. *Pseudomonotis richmondiana* Zittel. Noric; eastern slopes of Mount Heslington, Nelson. *a* = right valve; *b* = left valve. Seven-eighths of the natural size. N.Z. Geol. Surv. Coll. (P. 194.)

Fig. 10. *Monotis salinaria* Bronn. Noric (?); Okuku, Canterbury. Seven-eighths of the natural size. Left valve. N.Z. Geol. Surv. Coll. (P. 195.)

Plate XX.

Fig. 1. *Monotis salinaria* Bronn, var. *intermedia* nov. Noric (?); Okuku, Canterbury. Left valve. Natural size. N.Z. Geol. Surv. Coll. (P. 196.)

2. *Monotis salinaria* Bronn, var. *hemispherica* nov. Noric (?); Okuku, Canterbury. Left valve. Natural size. N.Z. Geol. Surv. Coll. (P. 196.)

3. Ditto, same locality. Right valve. Natural size. N.Z. Geol. Surv. Coll. (P. 196.)

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Fig. 4. *Hokonuia limæformis*, gen. et sp. nov. Carnic; Otamita, Hokonui Hills. Right valve. Natural size. Trechmann Coll. (P. 204.)

Figs. 5 *a* & 5 *b*. *Hokonuia* cf. *rotundata*, sp. nov. Carnic; *Mytilus-problematicus* Bed, Nugget Point, Otago. *a* = left valve; *b* = anterior portion of beak-region of the same specimen. Natural size. Trechmann Coll. (P. 205.)

Fig. 6. *Halobia zitteli* Lindström, var. *zealandica* nov. Carnic; Mount Heslington, Nelson. Right valve. Two-thirds of the natural size. Trechmann Coll. (P. 197.)

7. *Daonella indica* Bittner. Ladino-Carnic; Caroline Cutting, Hokonui Hills. Portion of a large right valve. Natural size. Trechmann Coll. (P. 196.)

8. *Mytilus (?) problematicus* Zittel. Carnic; Eighty-Eight Valley, near Nelson. Left valve of a small specimen. Natural size. Trechmann Coll. (P. 201.)

Figs. 9 *a* & 9 *b*. *Mytilus (?) mirabilis*, sp. nov. Carnic; *Mytilus-problematicus* Bed, Eighty-Eight Valley, near Nelson. Right valve: *a* = anterior; *b* = posterior view. Half of the natural size. Trechmann Coll. (P. 202.)

Plate XXI.

Fig. 1. *Halobia zitteli* Lindström, var. *zealandica* nov. Carnic; Otamita, Hokonui Hills. Seven-eighths of the natural size. Right valve. Trechmann Coll. (P. 197.)

2. Ditto. Same locality. Seven-eighths of the natural size. Left valve. Trechmann Coll. (P. 197.)

3. *Halobia hochstetteri* Mojsisovics. Carnic; Mount Heslington, Nelson. Natural size. Right valve. Trechmann Coll. (P. 199.)

4. *Halobia* cf. *austriaca* Mojsisovics. Carnic; Otamita, Hokonui Hills. Seven-eighths of the natural size. Right valve. Trechmann Coll. (P. 200.)

5. *Daonella indica* Bittner. Ladino-Carnic; Caroline Cutting, Hokonui Hills. Seven-eighths of the natural size. Trechmann Coll. (P. 196.)

6. *Pleurophorus zealandicus*, sp. nov. Carnic; Otamita, Hokonui Hills. Somewhat reduced. Left valve. Marshall Coll. (P. 212.)

7. *Cardiomorpha (?) nuggetensis*, sp. nov. Carnic; Nugget Point, Otago. Somewhat reduced. Trechmann Coll. (P. 189.)

8. *Anodontophora edmondiiformis*, sp. nov. Carnic; Otamita, Hokonui Hills. Somewhat reduced. Left valve. Trechmann Coll. (P. 208.)

9. *Anodontophora ovalis*, sp. nov. Carnic; Otamita, Hokonui Hills. Somewhat reduced. Trechmann Coll. (P. 208.)

10. *Anodontophora angulata*, sp. nov. Carnic; Otamita, Hokonui Hills. Somewhat reduced. Trechmann Coll. (P. 208.)

11. *Palæocardita quadrata*, sp. nov. Carnic; Nugget Point, Otago. Natural size. Left valve. Trechmann Coll. (P. 212.)

12. *Macrodon* cf. *curionii* Bittner. Carnic; Otamita, Hokonui Hills. Natural size. Left valve. Trechmann Coll. (P. 191.)

13. *Macrodon* sp. Carnic; Mount Heslington, Nelson. Natural size. Gutta-percha squeeze. Interior of right valve. N.Z. Geol. Surv. Coll. (P. 191.)

14. *Pseudoplacunopsis placentoides*, sp. nov. Carnic; Otamita, Hokonui Hills. Natural size. Attached valve. Trechmann Coll. (P. 209.)

15. Ditto. Carnic; Otamita, Hokonui Hills. Natural size. Upper valve. Trechmann Coll. (P. 209.)

16. *Lima (Limatula)* cf. *pichleri* Bittner. Carnic; Mount Heslington, Nelson. Natural size. Gutta-percha squeeze. Left valve. Trechmann Coll. (P. 206.)

17. *Megalodon globularis*, sp. nov. Carnic; north side of entrance of Wairoa Gorge, Nelson. Natural size. Gutta-percha squeeze. Trechmann Coll. (P. 209.)

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Fig. 18. *Pecten* sp. Carnic; Nugget Point, Otago. Natural size. Gutta-percha squeeze. Left valve (?). Trechmann Coll. (P. 206.)
19. *Cassianella* sp. Carnic; Otamita, Hokonui Hills. Natural size. Left valve. Trechmann Coll. (P. 206.)
20. *Leda semicrenulata*, sp. nov. Carnic; Otamita, Hokonui Hills. Natural size. Trechmann Coll. (P. 191.)
21. *Palæoneilo otamitensis*, sp. nov. Carnic; Otamita, Hokonui Hills. Natural size. Right valve. Trechmann Coll. (P. 190.)
22. *Palæoneilo* cf. *præacuta* Klipstein. Carnic; Otamita, Hokonui Hills. Natural size. Trechmann Coll. (P. 190.)

Plate XXII.

Fig. 1. *Hokonuia rotundata*, gen. et sp. nov. Carnic. Mount Heslington, Nelson. Natural size. Gutta-percha squeeze. Right valve. N.Z. Geol. Surv. Coll. (P. 205.)
2 *a*. *Hokonuia limæformis*, sp. nov. Carnic; Otamita, Hokonui Hills. Two-thirds of the natural size. Right valve. Trechmann Coll. (P. 204.)
2 *b*. Same specimen. Anterior portion of hinge showing tongue-like shelly process. Natural size. (P. 204.)
3. *Hokonuia* cf. *rotundata*, sp. nov. Carnic; Eighty-Eight Valley, Nelson. Natural size. Gutta-percha squeeze. Interior of left valve. Trechmann Coll. (P. 205.)
Figs. 4 *a* & 4 *b*. *Hokonuia* cf. *rotundata*, sp. nov. Carnic; Wairoa Gorge, Nelson. Three-quarters of the natural size. Left valve; *b*= anterior view. N.Z. Geol. Surv. Coll. (P. 205.)
Fig. 5. *Hokonuia limæformis*, sp. nov. Carnic; Otamita, Hokonui Hills. Right valve. Natural size. Trechmann Coll. (P. 204.)
6. *Anisocardia parvula*, sp. nov. Carnic; Otamita, Hokonui Hills. Thrice the natural size. Gutta-percha squeeze. Right valve. Trechmann Coll. (P. 213.)
7. Ditto. Same locality. Thrice the natural size. Gutta-percha squeeze. Left valve. Trechmann Coll. (P. 213.)
8. *Myophoria otamitensis*, sp. nov. Carnic; Otamita, Hokonui Hills. Natural size. Trechmann Coll. (P. 211.)
9. *Myophoria heslingtonensis*, sp. nov. Carnic; Mount Heslington, Nelson. Thrice the natural size. Gutta-percha squeeze. Right valve. N.Z. Geol. Surv. Coll. (P. 211.)
10. *Myophoria nuggetensis*, sp. nov. Carnic; Nugget Point, Otago. Natural size. Gutta-percha squeeze. Trechmann Coll. (P. 210.)
11. *Pinna* sp. Carnic; Eighty-Eight Valley, Nelson. Natural size. Left valve. N.Z. Geol. Surv. Coll. (P. 206.)

Plate XXIII.

Figs. 1 *a* & 1 *b*. *Halorella zealandica*, sp. nov. Ladino-Carnic; Caroline Cutting, Hokonui Hills. Natural size. Cast of ventral and dorsal valves. Trechmann Coll. (P. 216.)
Fig. 2. Ditto. Same locality. Natural size. Gutta-percha squeeze of ventral valve. Trechmann Coll.
3. Ditto. Same locality. Natural size. Gutta-percha squeeze of ventral beak and dorsal valve. Trechmann Coll.
4. *Halorella* sp. cf. *pedata* var. *multicostata* Bittner. Carnic; Eighty-Eight Valley, Nelson. Natural size. Dorsal valve. N.Z. Geol. Surv. Coll. (P. 217.)
5. *Dielasma zealandica*, sp. nov. Ladino-Carnic; Caroline Cutting, Hokonui Hills. Three-quarters of the natural size. Cast, dorsal aspect. Trechmann Coll. (P. 217.)
6. '*Terebratula*' *pachydentata*, sp. nov. Carnic; Otamita, Hokonui Hills. Natural size. Dorsal aspect. Trechmann Coll. (P. 218.)

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Fig. 7. *Terebratula (Cœnothyris?)* sp. Noric, *Pseudomonotis* Bed; Richmond, Nelson. Natural size. Gutta-percha squeeze. Dorsal aspect. Trechmann Coll. (P. 218.)

8. *Terebratula* cf. *hungarica* Bittner. Carnic; Otamita, Hokonui Hills. Natural size. Dorsal aspect. Trechmann Coll. (P. 219.)

9. *Mentzelia* cf. *ampla* Bittner. Rhætic; Kawhia. Natural size. Dorsal aspect. Trechmann Coll. (P. 228.)

Figs. 10 *a* & 10 *b*. *Mentzelia kawhiana*, sp. nov. Rhætic; Kawhia. Natural size. *a*=ventral; *b*=dorsal aspect. Trechmann Coll. (P. 228.)

Fig. 11. *Mentzeliopsis spinosa*, gen. et sp. nov. Kaihiku Beds, Ladino-Carnic; Caroline Cutting, Hokonui Hills. Natural size. Gutta-percha squeeze of dorsal valve. Trechmann Coll. (P. 230.)

12. Ditto. Same locality. Natural size. Gutta-percha squeeze of another dorsal valve. Trechmann Coll.

13. Ditto. Same locality. Natural size. Gutta-percha squeeze of a ventral valve. Trechmann Coll.

14. Ditto. Same locality. Natural size. Gutta-percha squeeze of another ventral valve. Trechmann Coll.

15. Ditto. Same locality. Natural size. Gutta-percha squeeze of the interior of a ventral valve showing the median septum and the external spines. Trechmann Coll.

16. Ditto. Kaihiku Beds; North Peak, Hokonui Hills. Cast, the spines destroyed, showing the ventral median septum and dental plates. Natural size. N.Z. Geol. Surv. Coll.

17. *Mentzeliopsis horrida*, sp. nov. Kaihiku Beds, Ladino-Carnic; Caroline Cutting, Hokonui Hills. Gutta-percha squeeze of dorsal valve. Natural size. Trechmann Coll. (P. 230.)

18. Ditto. Same locality. Gutta-percha squeeze of the ventral valve of another specimen. Natural size. Trechmann Coll.

Figs. 19 *a* & 19 *b*. *Spiriferina (?) carolinæ*, sp. nov. Kaihiku Beds, Ladino-Carnic; Caroline Cutting, Hokonui Hills. Natural size. Gutta-percha squeeze: *a*=the interior; *b*=the exterior of a ventral valve. Trechmann Coll. (P. 236.)

Fig. 20. Ditto. Same locality. Natural size. Gutta-percha squeeze of the exterior of a dorsal valve. Trechmann Coll.

21. *Retzia schwageri* Bittner. Carnic; Mount Heslington, Nelson. Gutta-percha squeeze. Dorsal aspect. Natural size. Trechmann Coll. (P. 227.)

PLATE XXIV.

Fig. 1. *Spiriferina diomedea*, sp. nov. Rhætic. South Hillend, near the Hokonui Hills. Gutta-percha squeeze of a dorsal valve and part of the ventral area. Natural size. Marshall Coll. (P. 222.)

2. Ditto. Rhætic: Nugget Point, Otago. Natural size. Dorsal aspect, the wings broken. N.Z. Geol. Surv. Coll. (P. 222.)

3. *Spiriferina acutissima*, sp. nov. Noric (?); east side of Mount Heslington, Nelson. Gutta-percha squeeze, dorsal aspect. Natural size. N.Z. Geol. Surv. Coll. (P. 221.)

4. *Spiriferina gypaetus*, sp. nov. Noric (?); South Peak, Benmore, Hokonui Hills. Gutta-percha squeeze, dorsal aspect. Natural size. N.Z. Geol. Surv. Coll. (P. 221.)

5. *Spiriferina* cf. *austriaca* Suess. Lower Carnic (?); Mount Potts. Dorsal aspect. Natural size. N.Z. Geol. Surv. Coll. (P. 224.)

Figs. 6–8. *Spiriferina nelsonensis*, sp. nov. Carnic; western slopes of Mount Heslington, Nelson. Natural size. Gutta-percha squeezes: 6=a dorsal valve and ventral area; 7=exterior of a ventral valve; 8=ventral area; of three different examples. Trechmann Coll. (P. 223.)

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Figs. 9 *a* & 9 *b*. *Spiriferina otamitensis*, sp. nov. Carnic; Otamita, Hokonui Hills. *a*=dorsal; *b*=ventral valve of a rather crushed example. Natural size. Trechmann Coll. (P. 225.)

10–12. *Spiriferina fragilis* Schlotheim. Kaihiku Beds, Ladino-Carnic; Caroline Cutting, Hokonui Hills. Natural size. Gutta-percha squeezes: 10=ventral; 11 & 12=dorsal valves. Natural size. Trechmann Coll. (P. 219.)

13 *a* & 13 *b*. *Spiriferina suessi* Winkler, var. *australis* nov. Carnic, *Halobia* Beds; Mount Heslington, Nelson. Natural size. *a*=dorsal; *b*=ventral aspects of the same example, a cast. Trechmann Coll. (P. 225.)

Fig. 14. Ditto. Same locality. Gutta-percha squeeze of the exterior of a ventral valve. Natural size. Trechmann Coll.

15. *Spiriferina kaihikuana*, sp. nov. Kaihiku Beds, Ladino-Carnic; Eighty-Eight Valley, Nelson. Gutta-percha squeeze of the exterior of a dorsal valve. Natural size. N.Z. Geol. Surv. Coll. (P. 220.)

Plate XXV.

Figs. 1 *a* & 1 *b*. *Hectoria bisulcata*, gen. et sp. nov. (Hector). Rhætic; Kawhia. Natural size. *a*=dorsal; *b*=ventral aspect. Trechmann Coll. (P. 225.)

Fig. 2. *Hectoria tumida*, sp. nov. Rhætic; Benmore, Hokonui Hills. Natural size. Gutta-percha squeeze of a ventral beak and a dorsal valve. Trechmann Coll. (P. 236.)

3. *Hectoria* sp. Taylor's Creek, Hokonui Hills. Natural size. Weathered cast showing the spiralia. Ventral aspect. N.Z. Geol. Surv. Coll. (P. 233.)

Figs. 4 *a* & 4 *b*. *Hectoria cuneiformis*, sp. nov. Jurassic, Taylor's Creek, Hokonui Hills. Natural size. *a*=ventral aspect; *b*=section. N.Z. Geol. Surv. Coll. (P. 237.)

Fig. 5. *Spirigera kaihikuana*, sp. nov. Ladino-Carnic; Cowan's Railway-station, Hokonui Hills. Natural size. Dorsal aspect. N.Z. Geol. Surv. Coll. (P. 231.)

Figs. 6 *a* & 6 *b*. *Spirigera wreyi* Zittel. Carnic; western slope of Mount Heslington, Nelson. Natural size. *a*=dorsal aspect; *b*=section. Trechmann Coll. (P. 231.)

Figs. 7 *a* & 7 *b*. *Spirigera manzavinioides*, sp. nov. Carnic; Otamita, Hokonui Hills. Natural size. *a*=dorsal; *b*=ventral aspect. Trechmann Coll. (P. 232.)

Discussion.

Dr. F. A. Bather was glad to find a British geologist and palæontologist tackling these complicated problems of New Zealand geology with such success. Ever since he himself had described *Torlessia*, he had wished to know the age of the supposed Maitai Beds near Mount Torlesse, where this presumed annelid was found. Did the Author include them in those which he now referred to the Permo-Carboniferous, or would he parallel them with the Yakutat Slates of Liassic age, or would he leave them in the Trias?

The Author, in reply, stated that the true relationship of the Mount-Torlesse Annelid Beds was still one of the unsolved problems of New Zealand geology. The question of their stratigraphy is discussed by McKay and others, and the evidence seems to show

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that they form the upper part of the Maitai Series. The Annelid Beds have not been traced in the Nelson district, the classical area of the Maitai Series; but he had himself found a piece of annelid-like tube in the Maitai Limestone of the Wairoa Gorge, accompanied by *Zaphrentis* and Permo-Carboniferous brachiopods.

He did not think the Mount-Torlesse Annelid Beds in any way equivalent to the Yakutat Slates of Alaska, as he had shown that the large bivalve in the Maitai Argillites overlying the Limestone near Nelson, formerly supposed to be *Inoceramus*, is apparently identical with *Aphanaia* L. G. de Koninck, of the Permo-Carboniferous of New South Wales.

Inoceramya Ulrich, of the Yakutat Slates, is a shell of the *Inoceramus* group, and bears a row of areal ligament-pits. The Lias, or at least the Lower Jurassic, is a well-defined formation in New Zealand, where it overlies the Trias, and in no way resembles the Annelid Beds.

He felt much interest in the fact that Dr. Bather had determined the scanty crinoid remains that he collected in the Kaihiku Beds as rather of Upper than of Middle Triassic age. All evidence that these deposits were Permian or Lower Trias seemed now entirely removed.

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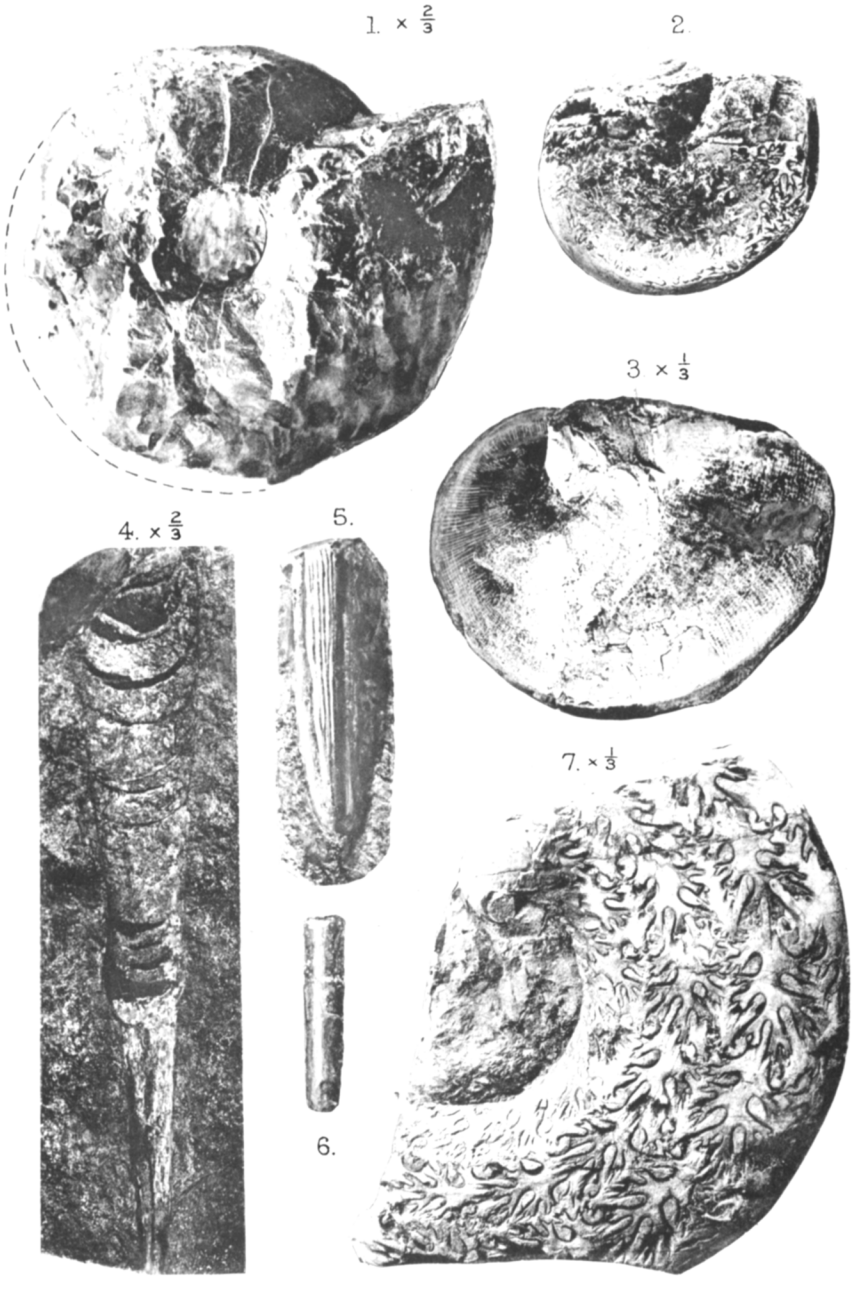

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TRIASSIC CEPHALOPODA FROM NEW ZEALAND.

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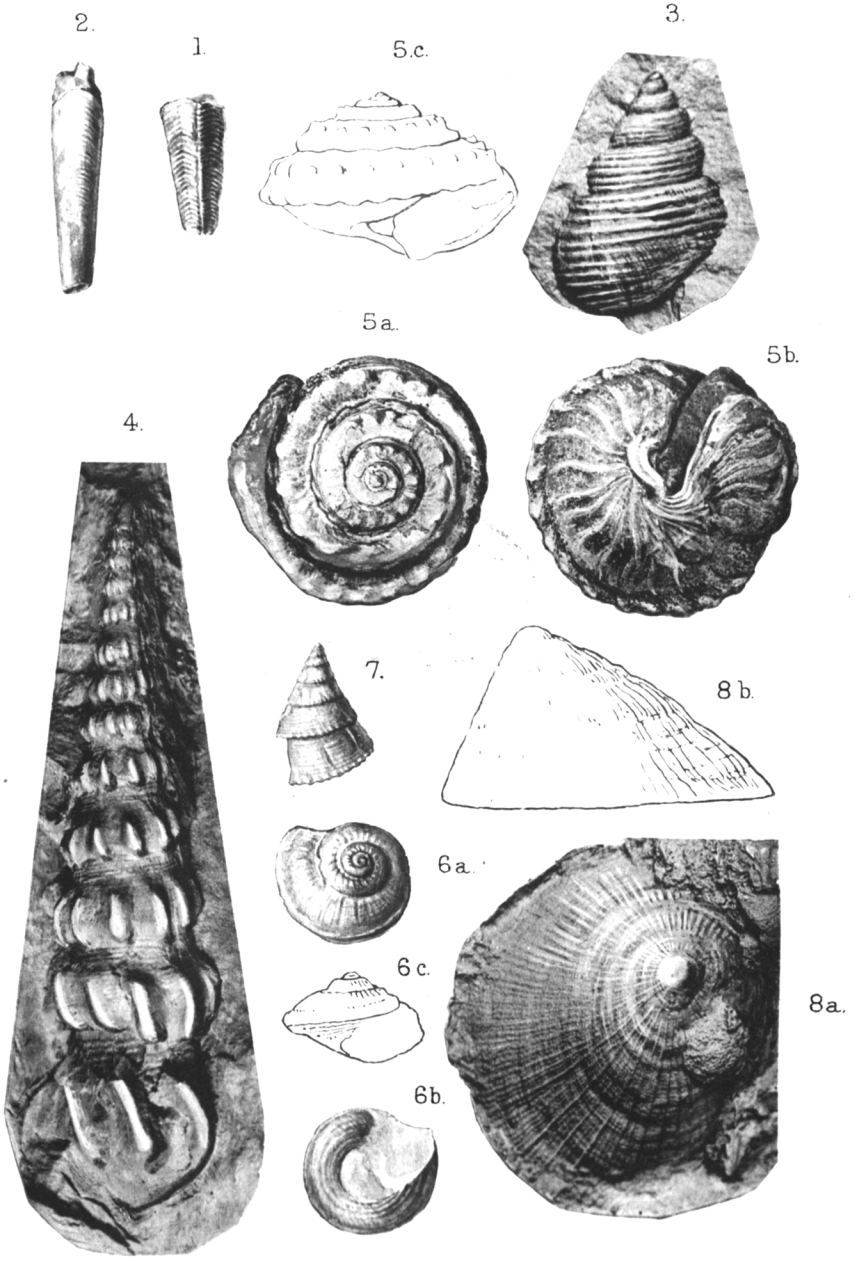

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TRIASSIC GASTEROPODA, ETC., FROM NEW ZEALAND.

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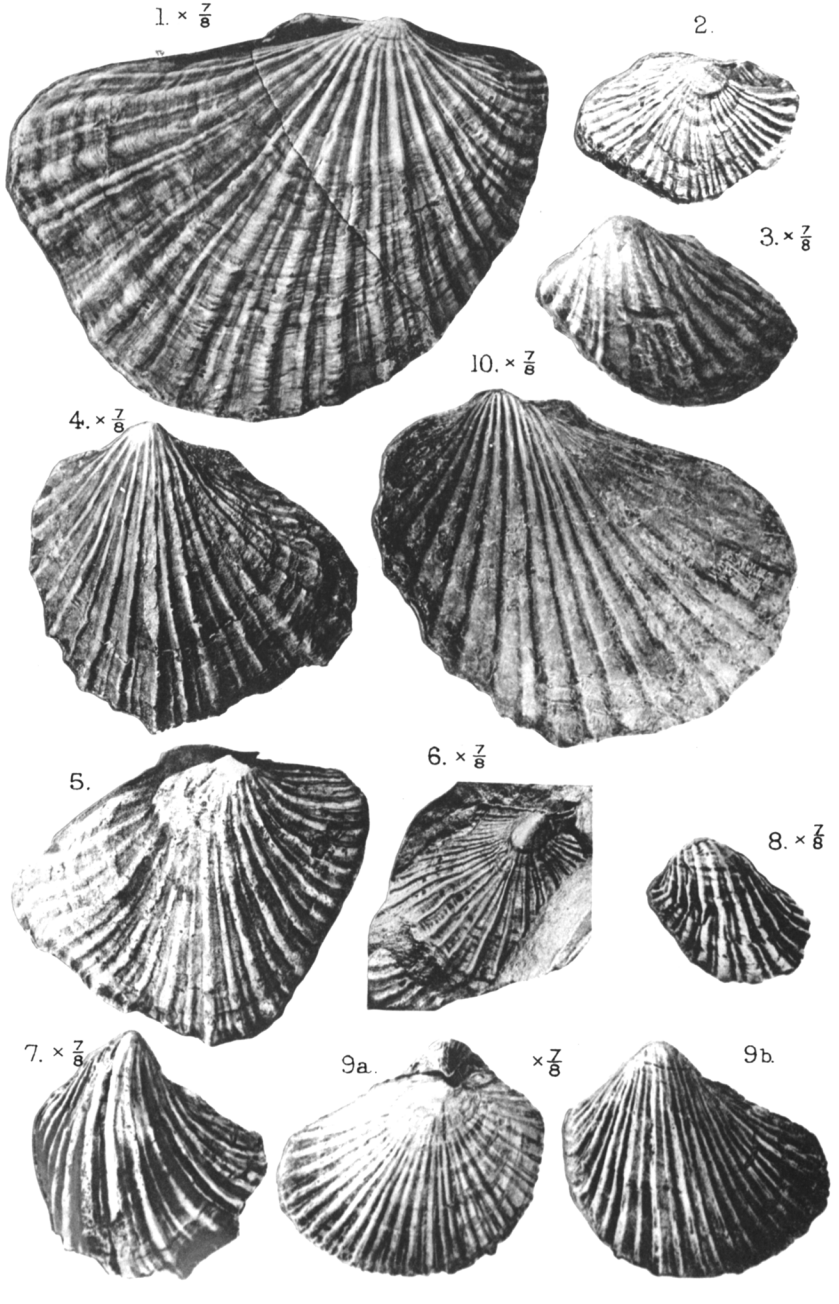

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PSEUDOMONOTIS AND MONOTIS.

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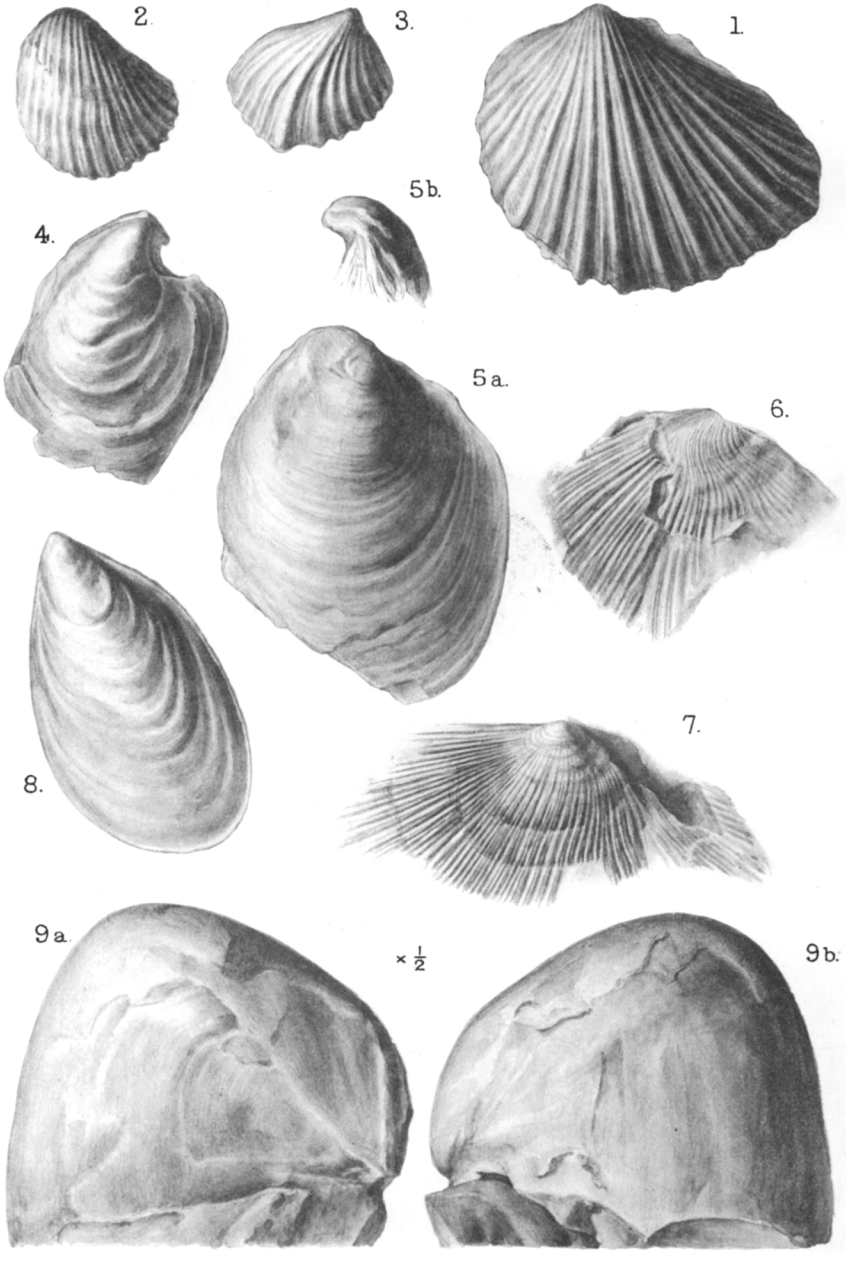

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TRIASSIC LAMELLIBRANCHS FROM NEW ZEALAND.

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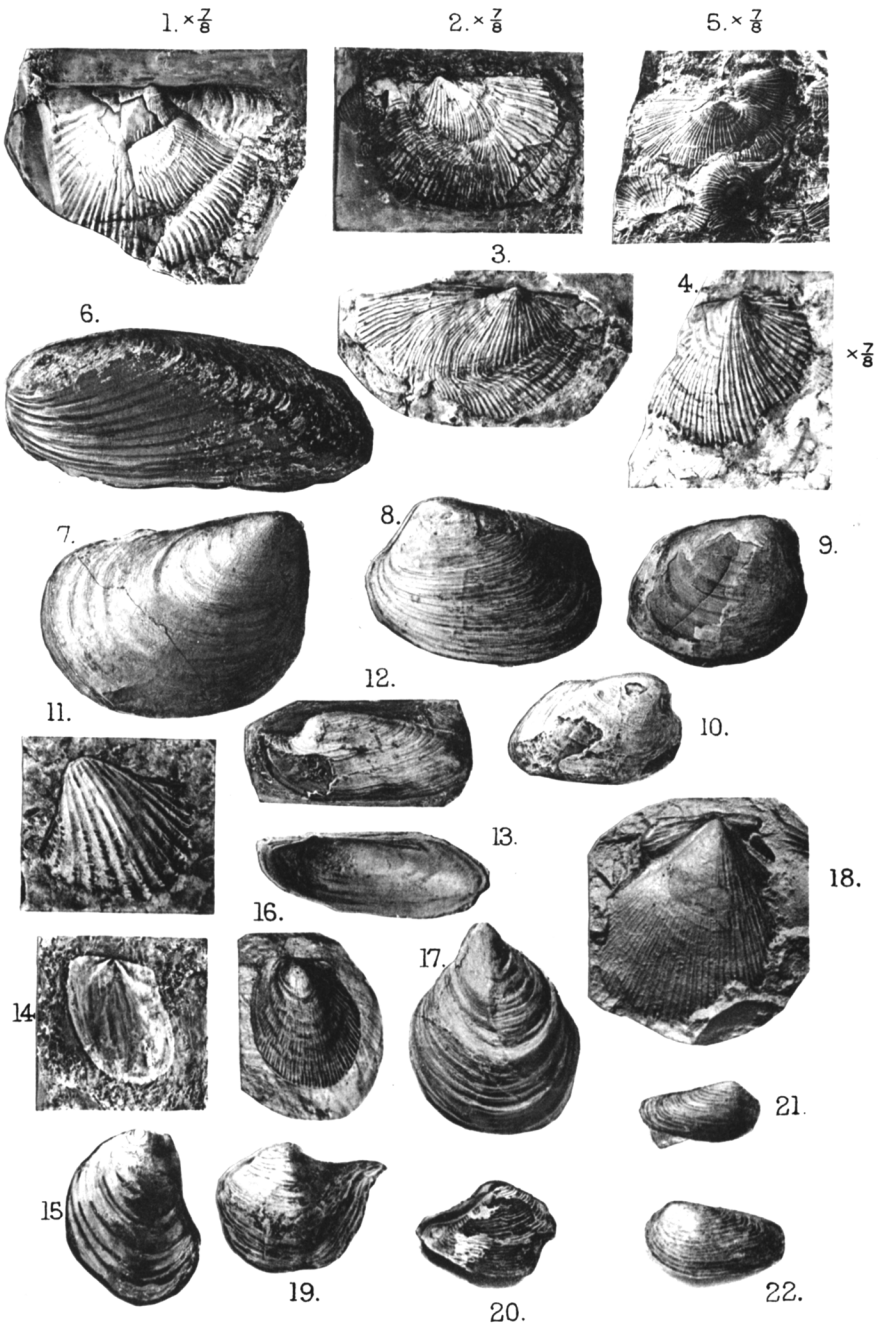

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TRIASSIC LAMELLIBRANCHS FROM NEW ZEALAND.

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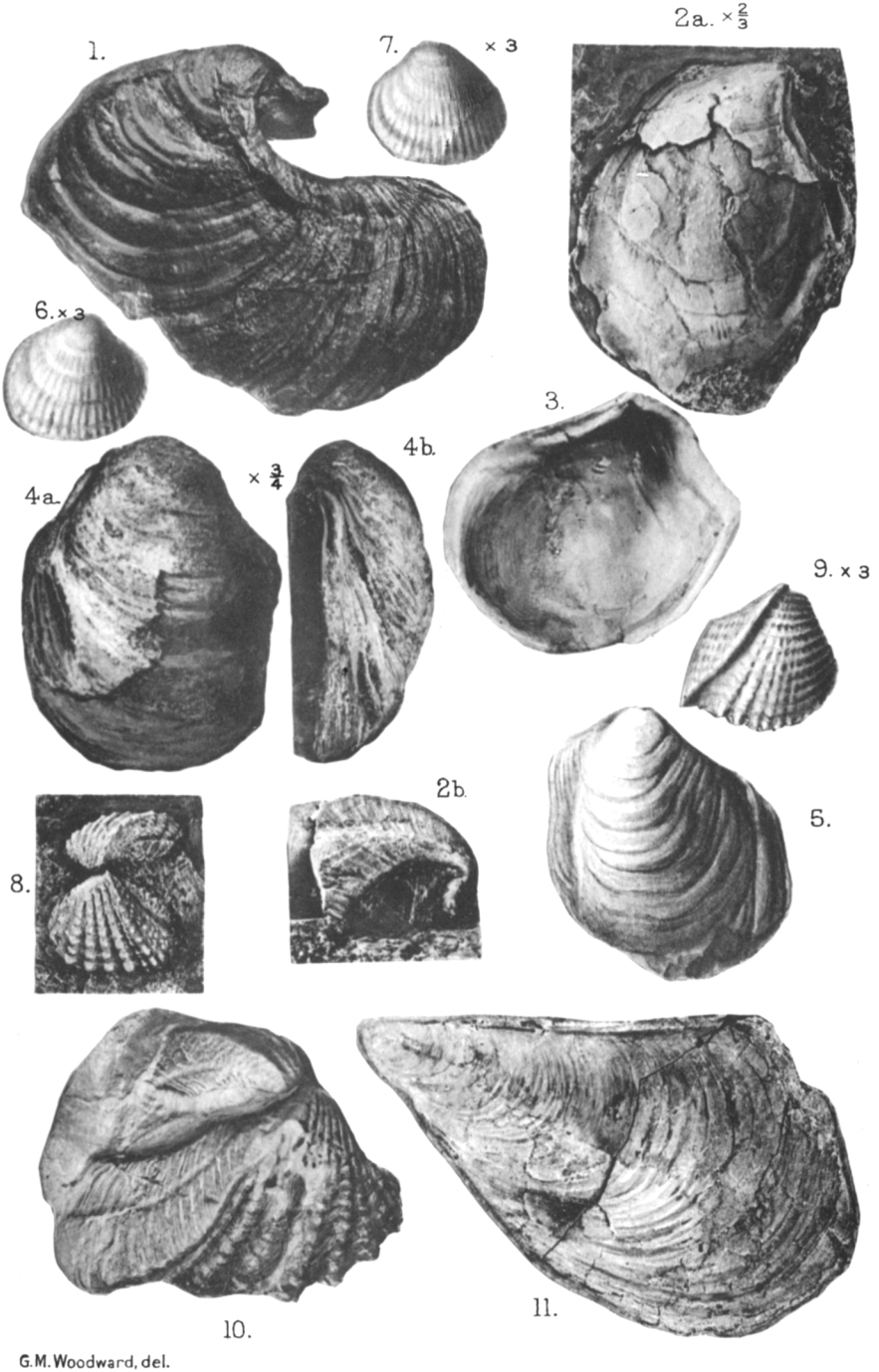

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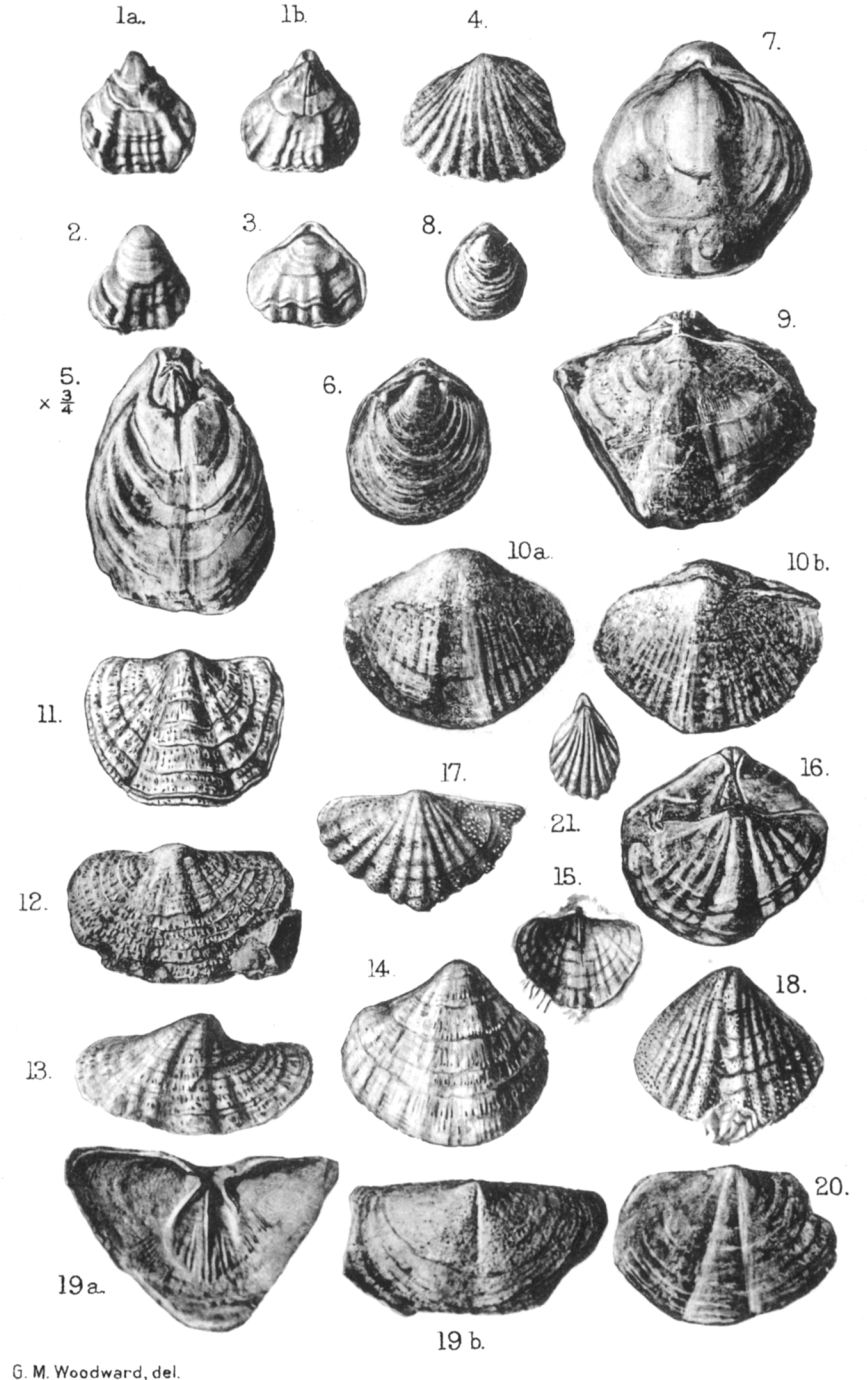

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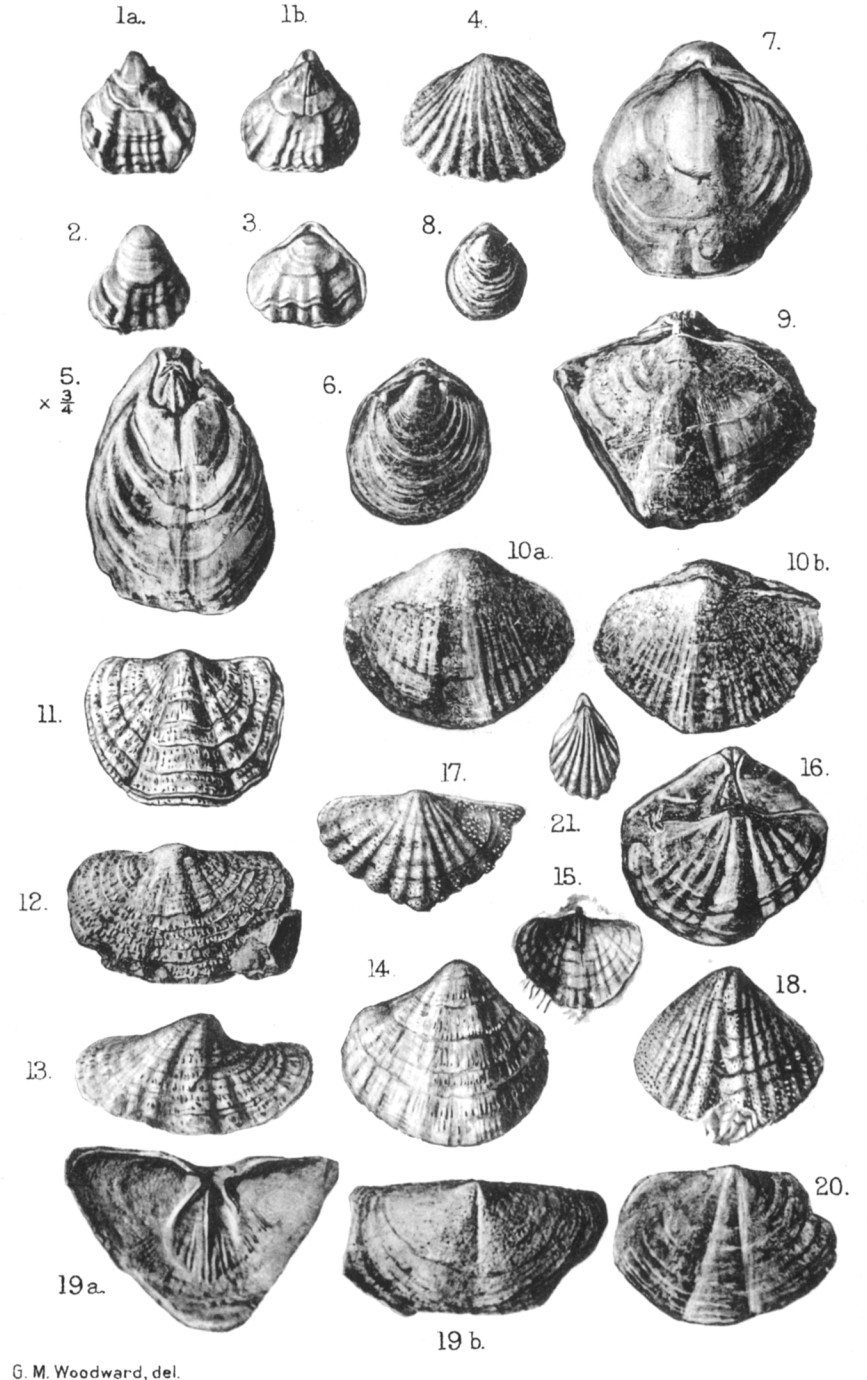

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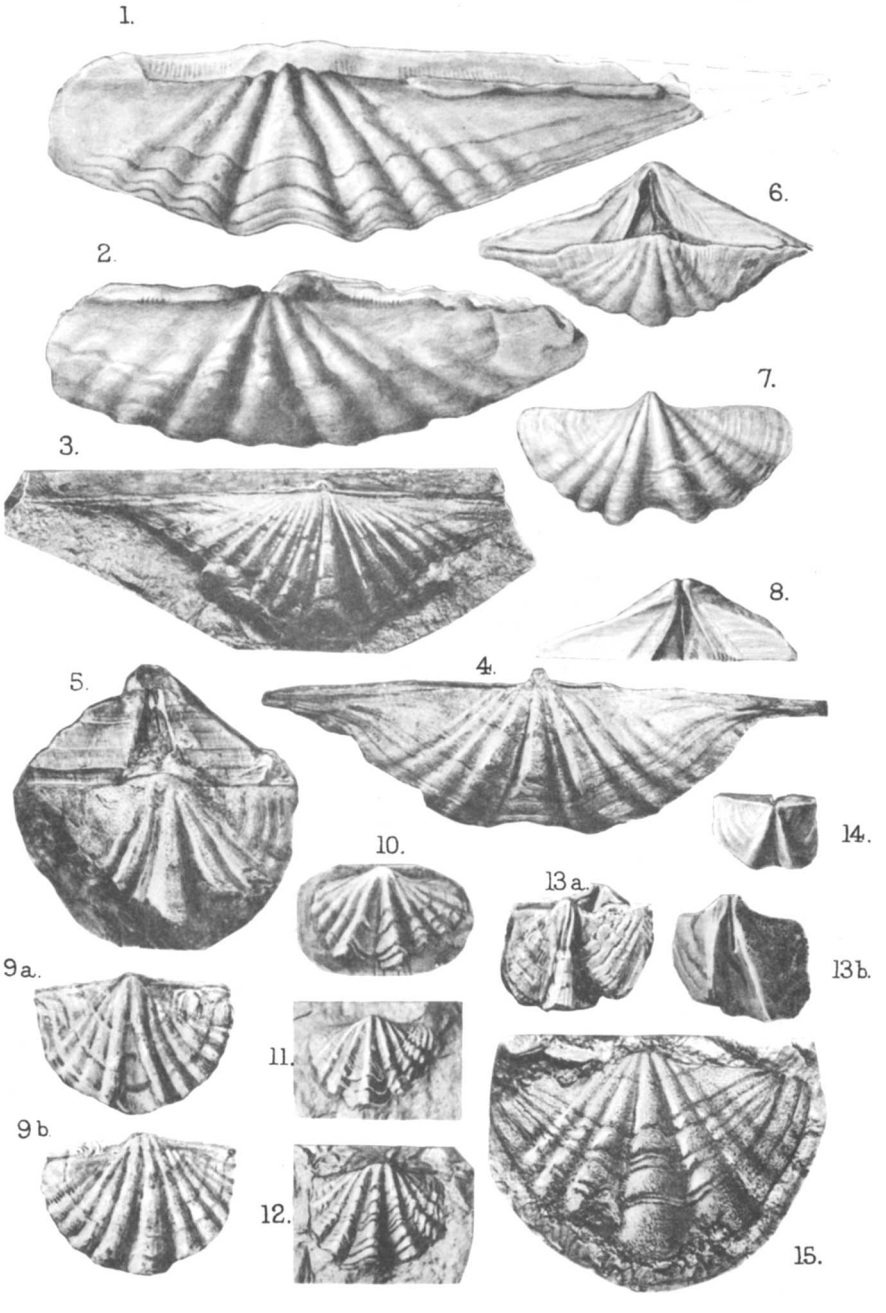

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TRIASSIC SPIRIFERINÆ FROM NEW ZEALAND.

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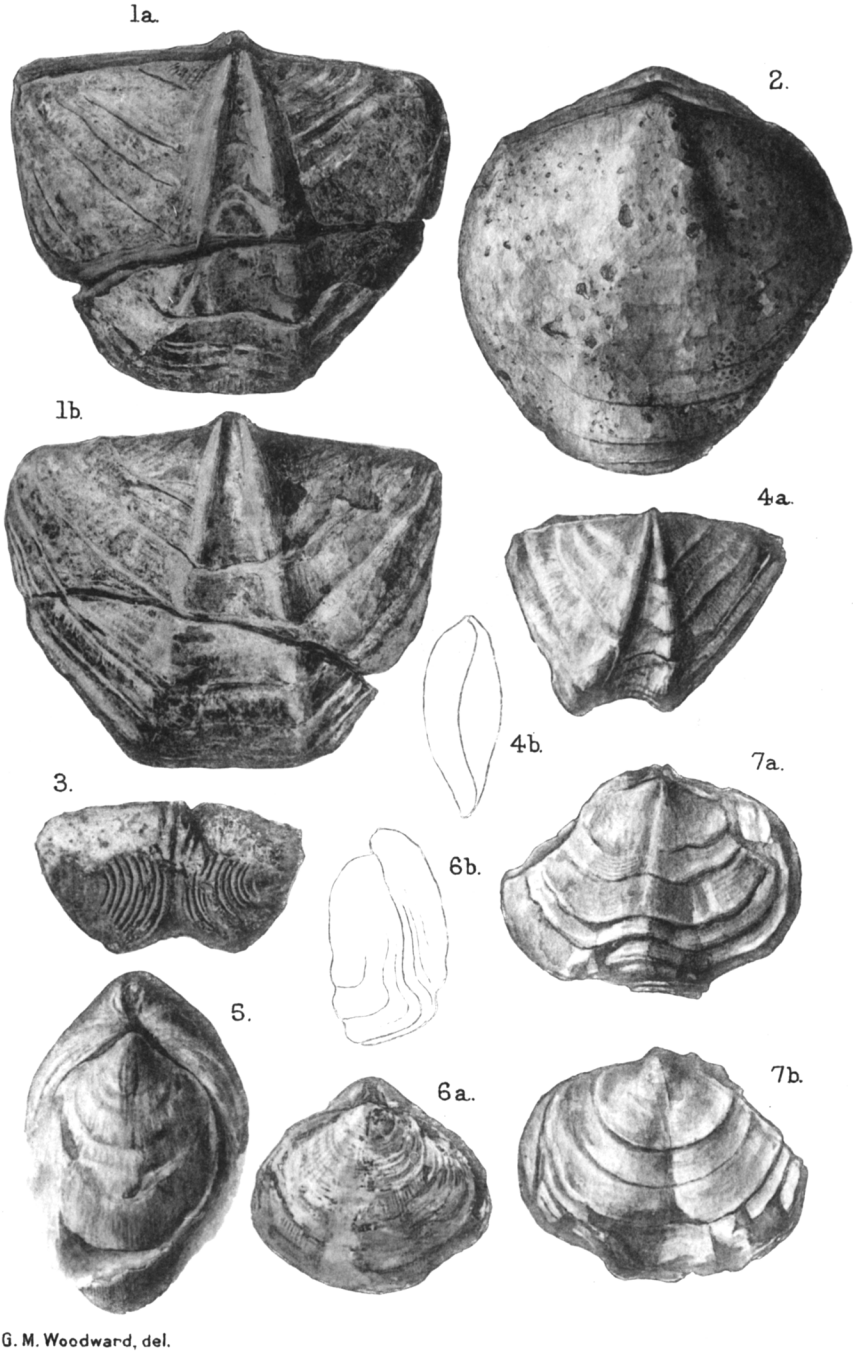

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