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WILLIAM WESLEY AND SON, 28 ESSEX STREET, STRAND, LONDON W.C.

ART. XXVII. *The Tertiary Molluscan Fauna of Pakaurangi Point,  
Kaipara Harbour.*

By P. MARSHALL, M.A., D.Sc.

*Read before the Wanganui Philosophical Society, 19th December, 1917; received by  
Editors, 31st December, 1917; issued separately, 24th June, 1918.]*

Plates XVIII-XXII.

In a previous paper<sup>1</sup> a list was given of the Mollusca that had been collected in this locality. Further collections have since been made which have added considerably to the number of the species. Descriptions and figures are given of all the new species. A discussion of the nature of the fauna will be given after the descriptions.

*Vaginella torpedo* n. sp. (Plate XXII, figs. 7, 8.)

Shell of moderate size, 18 mm. by 3.5 mm. Form cylindrical with a conical termination. Slightly compressed at the anterior end. Shell porcellanous with a shining surface. With a low-power pocket-lens a series of fine longitudinal lines can just be made out.

Seven good specimens were obtained. Type in the Wanganui Museum.

*Calliostoma gracilis*. (Plate XVIII, figs. 1, 1a.)

Shell small: height, 7 mm.; breadth, 10 mm.; trochoidal. Spire short, of 3 whorls. Aperture oval. Columella slightly excavated. Protoconch consisting of 2 whorls. Outline of each whorl of the spire slightly concave. Three small spiral threads near the posterior suture of each whorl and a larger one near the anterior suture. Body-whorl with a large number of fine spiral threads in addition to those on the other whorls. Base with similar small spiral lines, with two large and prominent ones that divide the base into three approximately equal parts. Inner layer of the shell highly nacreous.

One specimen, in good condition. Type in the Wanganui Museum.

*Helicacis aucklandicus*. (Plate XVIII, figs. 2, 2a.)

Shell small: height, 3 mm.; breadth, 10 mm. Form obtusely conical. Spire short, consisting of 5 whorls each with a straight outline. Aperture regular. Umbilicus very large, with a strongly crenulated margin. Ornamentation: Each whorl with 4 beaded cinguli; the two most prominent of these border the anterior and posterior sutures closely. Base smooth except for irregular ribs radiating outward from the crenulated margin of the umbilicus.

One specimen only, in a good state of preservation. Type in the Wanganui Museum.

*Epitonium tricinatum* n. sp. (Plate XIX, figs. 8, 12.)

Shell small and slender: length, 8 mm.; breadth, 3 mm. Spire of 6 whorls, but it is not complete. Outline of whorls strongly convex. Suture rep. Aperture not preserved. Ornamentation: On each whorl 3 spiral lines. The uppermost of these is the most prominent: it is situated

<sup>1</sup> *Trans. N.Z. Inst.*, vol. 10, pp. 417-48, 1917.

**Conus (Leptoconus) lyratus** n. sp. (Plate XX, figs. 5, 5*a*.)

Shell of moderate size, 28 mm. by 10 mm. Spire short, about one-fifth the length of the body-whorl. Five whorls, each slightly convex in outline. Each whorl rising by a decided step from the anterior suture. Aperture narrow but expanding slightly anteriorly. Ornamentation: Whorls smooth except for numerous distinct lines of growth which extend completely across them. Body-whorl with distinct spiral lirae over its whole surface, though they are more distinct in the anterior than in the posterior portion. Lines of growth on the body-whorl are not numerous and not distinct.

A single specimen, in good condition. Type in the Wanganui Museum.

**Conus convexus** n. sp. (Plate XX, figs. 6, 6*a*.)

Shell of moderate size, 27 mm. by 13 mm. Spire conical, about one-sixth the length of the shell, and consisting of 5 whorls. Outline of each whorl convex. Aperture linear, narrow. Ornamentation: Whorls of the spire lyrate with about 10 lirae, which are more pronounced on the anterior than on the posterior part of the whorl. Lines of growth not distinct. Body-whorl has fairly well-marked lines of growth, but it is otherwise smooth except for some 10 spiral lirae near the anterior end.

A single specimen, in good condition. Type in the Wanganui Museum.

**Conus (Lithoconus) abruptus**. n. sp. (Plate XX, figs. 7, 7*a*.)

Shell of moderate size, conical, 20 mm. by 11 mm. Spire of 5 whorls, almost flat, and from it the protoconch of 3 whorls projects sharply. Aperture narrow. Columella with a spiral groove near its anterior end. Ornamentation: The whorls of the spire each with about 5 spiral lirae crossed by numerous growth-lines. Suture moderately deep. Body-whorl with numerous but indistinct growth-lines. Eleven distinct spiral lirae near the anterior end. Otherwise the surface is quite smooth.

One specimen, in good condition. This subgenus has not previously been recorded from New Zealand. Type in the Wanganui Museum.

**Crenilabium zelandicum** n. sp. (Plate XVIII, figs. 11, 11*a*.)

Shell small, 10 mm. by 3 mm., tapering. Spire evidently short, but only one whorl remains. Aperture more than half the length of the shell, narrow below but rapidly widening in the middle. A short anterior canal. Outline of whorl almost flat. Ornamentation: A series of rounded spiral lines which extend to the anterior end of the shell. Columella with a thin fold.

One specimen only, somewhat imperfect. It is, however, certainly rightly placed in this genus, which has not previously been recorded from New Zealand. Type in the Wanganui Museum.

**Anomia poculifera** n. sp. (Plate XXI, figs. 1, 1*a*.)

Shell of small size: height, 25 mm.; length, 18 mm. Shape rather obtusely oval. Shell thin and inequilateral, with a nacreous interior. Right valve strongly convex. Anterior end somewhat truncated, posterior end somewhat longer. Foramen moderate, the processes united. Sculpture: 7 large rounded radiating ribs, somewhat bent, and extending from the umbo to the ventral margin. Surface covered with small semilunar cups just in contact with one another and with the convex side nearest the umbo. Muscular impression large.

A single specimen of the right valve, in good condition. Type in the Wanganui Museum.

This collection from Pakaurangi Point is of rather more than usual interest, as it is the first time that any attempt has been made to identify or describe a Tertiary fauna of such an extensive nature from any northern locality in New Zealand.

In the first place, there are several genera that have not previously been recorded from any locality in New Zealand. These are *Dolicholaticus*, *Coptochetus*, *Crenolabium*, *Spindylus*, *Sarepta*, and the subgenus *Cordieria* of *Bosmina*. On the other hand, *Acteon craticulatus*, *Cabibus delicatulus*, and *Crossa labiata*, all members of the Recent molluscan fauna of New Zealand, have not previously been found in the fossil state. The genera *Cymbiola* and *Succaba* are represented by more species than is usual in New Zealand fossil collections from Tertiary localities. The four species of *Conus* that have been collected give this genus a prominence that it fails to attain in any other collections from New Zealand localities.

A more general survey shows that in this collection of 124 species there are as many as forty-five, or 36.3 per cent., which have not been found elsewhere, while 20.3 per cent. are Recent species. Generically and specifically, therefore, this fauna is sufficiently distinct from any other that has been recorded. There are, however, no specially archaic types, while there are very many species identical with those that have been found in Tertiary localities in Canterbury and North Otago in those places where full collections have been made. This consideration, and the further fact that nearly 21 per cent. of the species are of Recent occurrence, shows that the age of the Pakaurangi beds is much the same as that of the beds at the North Otago localities of Wharekuri and Otiake—or, in other words, of the Oamaru limestone. In these localities the percentage of Recent species was found by Marshall to be 23.3 and 24 respectively, but in each case only some sixty species were collected.

In my previous papers insistence has been laid on the fallacy of relying too implicitly on the criterion of the percentage of the Recent species for the determination of the relative age of the Tertiary strata. The personal equation in connection with the identification of the species, the varying depth of the water, the geographical peculiarities of the station, are all matters that have to be taken into consideration before any comparison of real value can be instituted. In the present case, however, Mr. Suter has been good enough to examine and classify the species from both the Otago localities and from Pakaurangi Point: in consequence the personal equation in this comparison is of little importance. Similarly, the depth of the water in which deposition of the strata took place appears to have been of the same order of magnitude in both cases. Probably it was off-shore water in both cases approaching a depth of 100 fathoms.

The geographical features of the different localities may, however, have an important bearing on the question. The localities are nine degrees of latitude apart, and it is obvious that the species in the more northern locality should suggest a warmer climate than those in a locality more than six hundred miles further south, in water relatively so shallow.

There is also a general belief that has been expressed by various authors that the climate of the New Zealand area has become relatively cooler since the early and middle Tertiary times. This opinion is based on the nature of the Tertiary Mollusca as compared with the Recent fauna, on the relatively large size of many of the Tertiary species, and of the greater variety of the species. Similar features have been noticed in regard to other animal groups. It is, of course, obvious that a general reduction of the temperature

within the New Zealand region would be more fatal to the northern species, which, owing to the limited extent of the land, would have no warmer littoral waters to which to migrate, than to the southern species, which would have a large extent of northern coast-line to which they could retire as the climate became cooler. This consideration supports the belief that the small percentage of Recent species in the Pakaurangi beds does not indicate a greater geological age than that of the beds at Wharekuri and of Otiake in North Otago. Actually, as explained in an earlier paper, these Pakaurangi beds succeed the white mudstones conformably, and these mudstones merge into the hydraulic limestones in their lower members. The hydraulic limestone is believed to rest conformably on the greensands, which in certain neighbouring localities contain an Upper Senonian fauna. This fauna includes the ammonoid genera *Kossmaticeras*, *Phylloceras*, *Lytoceras*, and *Baculites*, as well as the gasteropods *Amberlega*, *Cinulids*, and the lamellibranchs *Malletia*, *Panope*, and *Inoceramus*, amongst several others. It is hoped that this fauna, which has been found at Batley and at Bull's Point, both within a few miles of Pakaurangi Point, may be fully described in the next volume of the *Transactions*.

There are at Pahi, some five miles distant, some greensands lying beneath the "hydraulic limestones." In these sediments there are a large number of species of fossil Mollusca, but the shells are in a very poor state of preservation, and no attempt has been made of recent years to classify them. It is, however, the case that the species are mainly, if not entirely, of Cainozoic types, and the horizon is certainly lower than that of the Pakaurangi Point beds. Thus stratigraphically there is not any definite indication of the age of the Pakaurangi beds. There are certainly Upper Senonian beds at about 1,000 ft. below them, and the intervening strata are partly extremely fine mudstones and *Globigerina* oozes with much diatomaceous and radiolarian matter.

Palaeontologically also the exact age of the Pakaurangi beds is not precisely indicated. The percentage of Recent species does not give a satisfactory basis for a comparison with European horizons. The isolation of New Zealand and the relatively rare arrival of species from outside the New Zealand area make it probable that species would survive for a much longer time here than on coast-lines where there was more competition from newly arrived species. It is probable that a fauna in New Zealand with 20 per cent. of Recent species would have a much greater antiquity than a fauna with a similar percentage of Recent species in Europe or America.

The actual genera that have been collected do not appear to indicate any precise Tertiary age. *Exilia*, *Gilbertia*, and other genera from the lowest Tertiary beds of the South Island have not been collected here. *Fulgoraria* has not been found, and *Chione* is poorly represented. But such facts appear to depend upon station rather than age. Relative stratigraphical position with respect to beds deposited in water of similar depth in other parts of New Zealand would suggest an age rather younger than that of Wharekuri and Otiake, and such a position would generally agree with the palaeontological evidence. On the whole, I am inclined to correlate the beds with those of All Day Bay—that is, next above the Oamaru limestone.

As the work of collecting, classifying, and describing the Tertiary Mollusca gradually proceeds the number of species becomes much larger, and the fact emerges that there have been very few generic additions to

our fauna during Tertiary times. On the other hand, it is clear that many genera have become extinct. It is also the case that many of the genera that were in earlier times well represented have but few species in the present fauna. Those that have become extinct include *Cymbiola*, *Niso*, *Cypraea*, *Troca*, *Coccos*, *Laticos*, *Erato*, *Cerithium*, *Cardium*, *Excilia*, *Uvullica*. More generally it may be said that of the 205 genera mentioned in Mr. Suter's *Handlist of New Zealand Tertiary Mollusca* (1915) some forty-eight are now extinct. This statement, however, does not give a complete idea of the magnitude of the change that has taken place. Many of the genera that in Tertiary times contained a large number of species are now reduced to a very small number. Of these, *Epitonium*, *Sarcula*, *Turris*, *Siphonalia*, *Strutholium*, *Mangilia*, *Pecten*, and *Polinices* are the most prominent examples.

In this comparison the purely littoral fauna cannot be properly considered, as remains of such organisms are so seldom preserved. No one Tertiary horizon which has had its Mollusca properly collected and described shows any notable introduction of species or genera which are absent from lower horizons. Such facts go far to support the idea of a continuous isolation of New Zealand throughout Tertiary times - a contention that has been previously urged by the author on purely stratigraphical grounds. This position has lately been supported by Thomson and Morgan, though stated in a different manner: "Each Tertiary fauna seems to merge gradually into the succeeding one."\* Mr. Suter also has written to me as follows: "There is no doubt that our molluscan fauna has greatly decreased, and also that the Tertiary forms gradually merge into one another." These statements appear to me to afford the strongest support from the palaeontological standpoint to the view so frequently urged by me that there is no important break in the succession of Tertiary sediments in New Zealand. In the absence of satisfactory palaeontological material in the past this view has been based on stratigraphical material, and it is satisfactory to note that as the palaeontological material gradually accumulates its verity is placed practically beyond doubt.

It is to be hoped that a complete comparison may be possible ere long between our Tertiary faunas and those of Australia, South America, and North America. In the meantime one can only emphasize the well-known fact that our Tertiary fauna closely resembles that of South America, where the species of *Turritella*, *Malletia*, *Strutholium*, *Epitonium*, and *Polinices* are evidently extremely closely related to ours. Again, the occurrence of the genera *Perissolar* and *Heteroterna* in the Wangaloa beds shows a rather unexpected relationship between our earliest Tertiary beds and those of the Tejon and Martinez districts in California.

In New Zealand I have frequently stated that there does not appear to be any stratigraphical discordance between the Upper Cretaceous (Senonian) and the Tertiary horizons. In all known cases, however, deep-sea beds of *Globigerina* or diatomaceous or radiolarian ooze intervene between the Senonian and Tertiary horizons. In South America Wilckens, as previously pointed out, has insisted on an important break between the Senonian and the Miocene. Other authorities on the South American stratigraphy hold very different opinions. The latest that I have seen is that of von Ihering, who maintains emphatically that there is no break between the Cretaceous and Tertiary: "Überblicken wir die von uns

\* Preface to *Palaontological Bulletin* No. 5, 1917.

gewonnenen Ergebnisse, so muss jede unbefangene Diskussion die Tatsache anerkennen: dass die marinen Ablagerungen der oberen Kreide von Patagonien eine starke, successive Abnahme von mesozoischen Charakterformen aufweisen, dass aber andererseits diese letzteren sich zum Teil erhalten, dass mithin die Elemente der Kreidefauna teils unverändert, teils modifiziert in die patagonische Formation übertreten und dass keine Discordanz zwischen der Kreide und den Ablagerungen der patagonischen Formation besteht."\*

So far as New Zealand is concerned, then, it appears to be probable that at the close of Cretaceous times a great movement of epirogenic depression took place. The land area was reduced to the dimensions of a few small islands. Over much of the present land area deep-sea oozes were deposited for a great lapse of time. Marginal deposits were restricted and small. When elevation again commenced the Upper Cretaceous fauna had been replaced by one of Tertiary characteristics.

ART. XXVIII. *Notes on the Geology of the Tubuai Islands and of Pitcairn.*

By P. MARSHALL, M.A., D.Sc.

[Read before the Wanganui Philosophical Society, 19th December, 1917; received by Editors, 31st December, 1917; issued separately, 24th June, 1918.]

THE scattered islands which constitute the Tubuai Group are situated near 23° south latitude and 150° west longitude. Little geological information has been published about them except in regard to their general configuration and the nature of the coral reefs by which they are encircled.

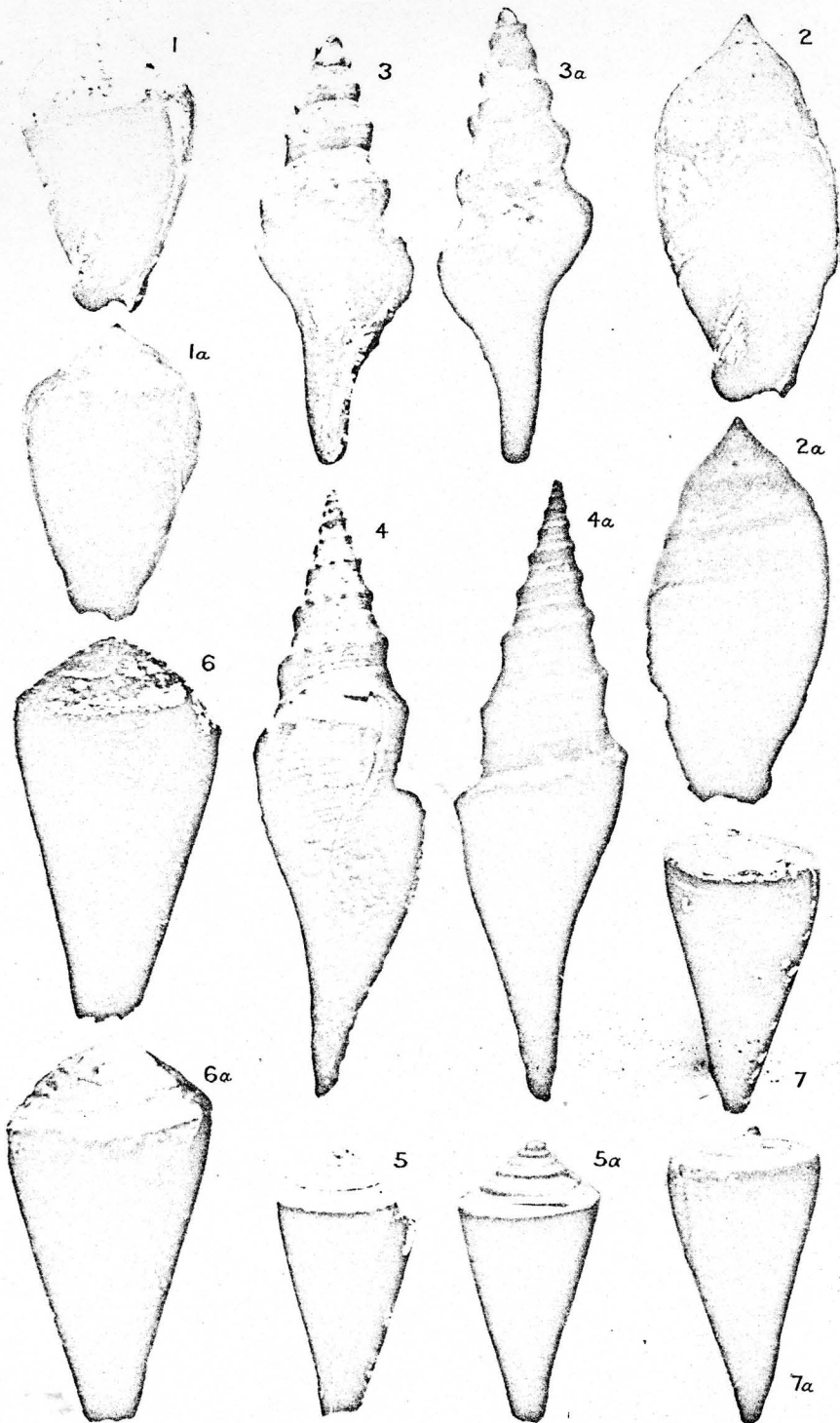
A visit has lately been made to the group by Professor J. Macmillan Brown in connection with his anthropological studies, and he has been good enough to give me chips from implements that he obtained from Tubuai and Rapa. In addition, the Chief Magistrate of Pitcairn sent me several specimens from that island. I have previously published a note on rock-specimens from Rurutu Island, another member of the Tubuai Group.†

*Stone Age, Tubuai Island.*—A dense black rock in hand-specimens. In section the structure is dominated by an abundance of small laths of feldspar with the extinction angle of labradorite. There are a few large crystals of olivine much serpentinized. There is also a little olivine in the groundmass. Augite is very plentiful in the groundmass in small colourless grains. Magnetite very abundant. The rock must be classed as a dense, rather acid basalt.

*Stone Age, Rapa Island.*—In hand-specimens a dark fine-grained rock without any crystals that can be distinguished macroscopically. In section fine laths of feldspar are very abundant. They appear to be an acid labradorite or andesine. Augite is very plentiful, but the grains seldom have any crystalline outline, and they are quite colourless. A little olivine is present in very irregular-shaped grains. Magnetite is very plentiful in crystals up to 0.2 cm. in diameter. A little apatite can be distinguished. This rock is also an acid feldspathic basalt, and, like the specimen from Tubuai, it has an unusual quantity of magnetite.

\* VON IBERING, *Revista do Museu Paulista*, vol. 1, Fasc. 3, p. 130, Sao Paulo, 1914.

† *Trans. N.Z. Inst.*, vol. 46, p. 283, 1914.



FIGS. 1, 1a.—*Ancilla spinigera* n. sp.  
 FIGS. 2, 2a.—*Ancilla cincta* n. sp.  
 FIGS. 3, 3a.—*Surcula latiauridis* n. sp.  
 FIGS. 4, 4a.—*Surcula ordinaria* n. sp.

FIGS. 5, 5a.—*Conus (Leptoconus) lyratus* n. sp.  
 FIGS. 6, 6a.—*Conus convexus* n. sp.  
 FIGS. 7, 7a.—*Conus (Lithoconus) abruptus* n. sp.

(All figs.  $\times 2$ .)