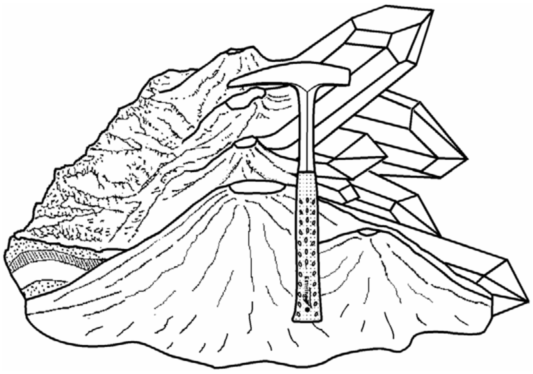

Geocene

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Contributions about the geology of New Zealand (particularly northern New Zealand) from members are welcome. Articles are lightly edited but not refereed.

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GEOLOGICAL SETTING AND INTERPRETATION OF FOSSIL MOA FOOTPRINTS, MOSQUITO BEACH, KAIPARA SOUTH HEAD

Bruce W. Hayward

Unpublished report BWH 216/22
April 2022

On 27 March 2022, a couple (Mathew Brown and Ava Peters) discovered three large bird (inferred moa) footprints in a block of soft sandstone at the foot of low cliffs near high-tide level at the south end of Mosquito Beach, Kaipara South Head (Figs 1–3). The footprints are preserved as casts on the underside of a bedding plane (Figs 1–2). On Wednesday 30 March a party from Auckland Museum, local Ngāti Whātua o Kaipara iwi and Massey University reduced the size of the huge block (Fig. 4) and then managed to remove the footprints from the site.

This brief report discusses the inferred environmental setting and age constraints from geological evidence.

Fig. 1. The ~1 m^3 block of sandstone with moa footprint casts on the underside of the bedding plane, Mosquito Beach. Photo: NZ Herald.

Fig. 2. Moa footprint casts with discoverer's hand for scale. Photo: NZ Herald.

Fig. 3. Location where block of sandstone containing moa footprints was found, at the south end of Mosquito Beach, Kaipara South Head.

Fig. 4. Party from Auckland Museum and local iwi reducing the size of the sandstone block before removal of the bed containing the moa footprint casts. Photo: Stuff.

Geology of Mosquito Beach to Te Kawau Pt

The low (up to 25 m high) cliffs at the back of the beach and intertidal rocks along this short stretch of coast are mapped as consolidated sandstones of the Kariotahi Group of inferred early Pleistocene age (2.6–0.8 Myrs old) (Edbrooke, 2001). The sandstones in the cliff and shore platform can be informally divided into two units. Both units contain laminae rich in titanomagnetite black sand, which supports deposition since the start of eruptions and supply of this mineral to the west coast sand system from the central North Island and Taranaki volcanoes (last 2 Myrs). The sandstone beds appear to be lying approximately horizontally, suggesting there has been no large-scale tilting or folding since deposition.

Lower Unit

The lower unit consists of several thick beds (each 2–3 m thick) of cross-bedded sandstone separated by up to 0.5 m of more flat-lying layers. These couplets are typical of accumulating dunes with foreset layers deposited on the steep front of the advancing dune at ~30° angle and more flat-lying topset layers deposited on top of them on the more gently sloping upwind or up current side of the advancing dune. Most commonly, cross-bedded sands like this in the west Auckland coastal barriers were formed by wind-deposited sand dunes.

In the low cliffs and shore platform nearer Te Kawau Pt, this lower unit is best exposed for closer examination. Here the layers contain features that point to deposition under water, such as soft-sediment folding due to slumping of layers down the steep face (Hayward, 2018) (Figs 5–9) and fossil burrows and in particular a near horizontal, back-filled burrow (*Scolicia*-like), 2–3 cm in diameter, and typical of those made by marine echinoids (e.g. heart urchin) (Fig. 7).

Thus, I infer that this lower unit accumulated in a shallow subtidal environment subject to strong tidal currents. This location is close to the entrance to the Kaipara Harbour

Fig. 5. Cliff between Mosquito Beach and Te Kawau Pt. The lower half of the cliff (darker) is the lower unit and here consists of two beds of cross-bedded sandstone separated by flat-lying topset beds.

Fig. 6. Wavy-bedding in cross-bedded sandstone of lower unit - suggestive of subaqueous rather than subaerial deposition.

Fig. 8. Titanomagnetite-rich horizons within cross-bedded lower bed emphasizes the small burrow (trace fossil) above the hammer head.

Fig. 7. Tight folds in cross beds inferred to be formed by slumping of water-saturated sand on the steep, advancing slope of the subaqueous dunes. This is exposed in the high-tide shore platform near Te Kawau Pt.

Fig. 9. Meniscus back-filled low-angle burrow (*Scolicia*-like) (above and to right of the head of hammer) within a cross-bedded lower unit. This type of burrow is typically produced by a marine echinoid, like a heart urchin.

today. One place where cross-bedded sand units typically accumulate in shallow subtidal environments is on the inside and outside of the mouth of a large harbour. The direction of the depositing currents, as indicated by the cross-bedding, was from NW to SE, which is consistent with accumulation inside the mouth of the ancient harbour in a flood-tidal delta setting (Hayward, 2018).

Upper Unit

The upper half of the cliffs do not extend down to the intertidal zone and are therefore not as fresh, as clearly visible, nor as easily accessible as the lower unit. The upper unit consists of 5 m+ thickness of flat-lying, consolidated sandstone containing cm–dm-thick beds (Figs 10–12). Some laminae have common black titanomagnetite sand (Fig. 13). Also present are two 1–4 cm-thick beds with a lighter, cream-white matrix (Fig. 14). These latter beds could include reworked rhyolitic tephra, but most of the cream-white material is mud-sized clay.

Although overall the beds are flat-lying, they exhibit considerable lenticular bedding, some low-angle erosional unconformities and some smaller-scale, bi-directional, low-angle cross-bedded units (flaser bedding). A few examples of hummocky cross-bedding (bidirectional in scallop-shaped hollows) are present within this unit (Fig. 15). These hummocks usually form subtidally below fair-weather wave-base during storms. In this instance, inside the entrance to the harbour, the fair-weather wave base may have been shallower than ~1 m and so these features could have formed at or just below low tide level. These bedding features are not found in subaerial foreset sand dune beds and suggest that they were probably deposited intertidally to shallow subtidally.

Fig. 10. Cliff face ~20 m southeast of moa-footprint site showing sharp contact (and undercut) unconformity between the lower cross-bedded unit and the upper more flat-lying and lensing unit.

Fig. 11. Actual site where moa footprint-bearing block has been removed from (middle of photo at base of cliff). The block has fallen down from the upper part of the exposed cliff here. The contact between the lower and upper units is the prominent change of slope about two-thirds of the way up the cliff.

Fig. 12. Upper two-thirds of cliff directly above where moa footprint sandstone block was found. The lower one-third is cross beds of the lower unit and everything above the red marker (right) is the flatter-lying upper unit. The footprint block had just recently fallen out from the upper part of this cliff face.

Fig. 13. Close-up of part of the upper unit showing lensing, minor erosion and bi-directional low-angle cross-bedding features (flaser bedding) characteristic of moderate to high energy intertidal sand deposits. This is 1–2 m stratigraphically below where footprint block fell out from.

Fig. 14. Upper part of the cliff close to the source of the footprint block of sandstone showing lenticular bedding in the foreground, low-angle cross-bedding in the middle, and a light-coloured bed that may be a reworked and mixed rhyolitic ash bed higher up.

Fig. 15. A small section of "hummocky" cross-bedding within the upper unit, 20 m southeast of the footprint block source. Hummocky cross-bedding usually forms in sand during storms in aqueous environments below fair-weather wave base, which would have been shallow (? <1 m) at this locality.

Preservation of the footprint casts

It is inferred that the footprints were made in soft, wet sand on an intertidal beach. When the sand has the right degree of water saturation, footprints can remain for some time after they are made. When they are again covered by water, they lose their shape and sand will flow in from the sides to destroy them. To preserve intertidal footprint depression requires their rapid burial by sediment (in this instance more sand of a different grain size) without disturbing their shape. This is most likely to have been achieved by wind-blown fine sand sweeping across the beach which was later buried by further accumulation of beach sand without the footprints being eroded and lost. Most footprint trace fossils (including moa footprints) are preserved in sediments containing mud which tends to retain the footprint shape more easily, thus this site is somewhat unusual in that the sediment consists of clean sands with virtually no mud component. One other example of inferred moa footprints preserved in clean sand occurs 40 km further south in sandstone of similar age at Muriwai (Hayward, 2016).

It was highly fortuitous that, when the sandstone block containing the footprints fell out of the cliff, it split open along the bedding plane containing the footprint casts and, in this instance, the softer underlying sand bed fell away, leaving the layer that filled the depressions after they were made. In the surrounding cliffs there are several examples of sandstone beds splitting away at bedding planes and falling down the cliff leaving small sections of overhanging beds.

Age of the footprints

The age of the South Kaipara sand barrier, which extends from Muriwai to the Kaipara Harbour mouth, is inferred to be Pleistocene (last 2.6 Myrs) to Holocene (last 11,000 yrs). The youngest sediments are in Holocene sand belts along the lower western side. The Mosquito Beach cliff section could reasonably be interpreted to be composed of some of the older sandstones that are overlain by a younger Pleistocene sequence that forms the weathered, high-standing backbone of the barrier. To my knowledge there are no moderately precise dates on any of the South Kaipara Barrier, north of Muriwai. No airfall primary tephra (volcanic ash beds) have yet been identified within the sequence that would hold potential for dating, but some must be present somewhere inland. The Awhitu Sand Barrier is of similar character to the older high-standing parts of the South Kaipara barrier and contains a thick ignimbrite (Potaka Ignimbrite, ~1 Myr) eroding near sea level on its western side (Alloway *et al*., 2004). Thus, an age of this order is inferred for the main parts of the South Kaipara Barrier.

The nearest dated rhyolitic tephra occurs in the southern section of the South Kaipara Barrier where it laps onto and over the early Miocene Waitakere Group rocks between Muriwai and Te Henga. Air fall Potaka Tephra (~1 Myr) has been identified in the ancient sand dunes south of Muriwai at an elevation >150 m (Claessens *et al*., 2009) and the associated sand sequence was probably deposited about the same time as the marine sandstones we see at Mosquito Beach.

The Mosquito Beach sediments are inferred (above) to be shallow marine and intertidal deposits. They undoubtedly accumulated during one of the numerous interglacial intervals during the Pleistocene climate cycles when sea level was similar to or slightly higher than today. There were a number of candidate periods with slightly higher sea levels than now between 1.4 and 0.9 Myrs ago (e.g. Hayward, 2017, fig. 11.1). Unless fresh glass shards can be obtained from the inferred reworked rhyolitic tephra layers at this site, it is hard to speculate how a reliable approximate age could be determined.

An upper age limit (youngest possible age) can be estimated from the nearby topography (Fig. 16). There are

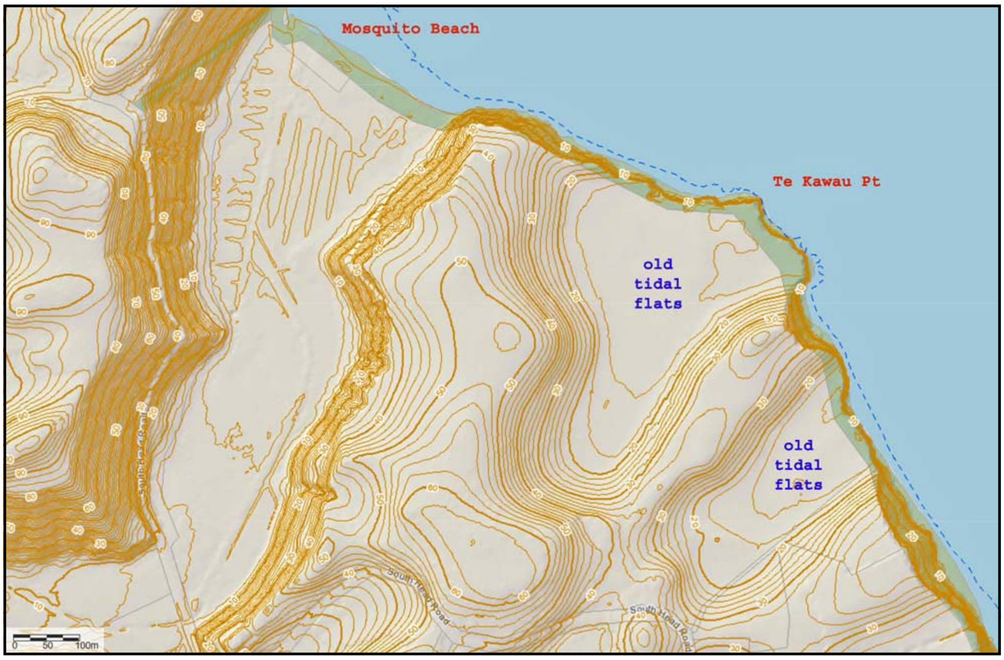

Fig. 16. Contour map (1 m interval) of area around Mosquito Beach, Kaipara South Head, showing location of two inferred old bays with tidal flats at 17–20 m above present sea level.

two flat-floored embayments 0.5 to 1 km southeast of the site. Both are 17–18 m above present MSL on their seawards sides and slowly rise to 20 m above MSL around their landward heads. This 2 m of slope is likely the intertidal slope of the tidal flats. There are no streams entering either of these paleobays so they have to have been eroded down to intertidal by the sea during an interglacial period of high sea level.

At Te Rau Puriri Regional Park, 3–4 km south of here, there are coastal terraces that were formed intertidally during the Holocene high stand sea level (2 m above present mid-high tide beach level), and the Last interglacial (MIS5e, 120,000 yrs ago; 9–11 m above MSL). A third, even higher terrace (18–20 m above MSL), is the same elevation as the inferred flat-bottomed bays with tidal flats. This terrace was inferred by Hayward (2017, fig. 11.99) to have been formed during the interglacial period with the warmest climate and highest known sea level in the Pleistocene (MIS 11, 400,000 yrs ago) when global sea level was ~11 m above present. From this, Hayward (2017) inferred there had been 8 m of uplift in the northern South Kaipara Barrier region in the last 400,000 yrs. If we accept these correlations, then the sandstones forming the Mosquito Beach section were eroded into by the sea ~400,000 yrs ago to form the bays to the south. Thus, the youngest possible age for the moa-bearing sandstone is older than 400,000 yrs. From all the evidence currently available, an age of ~1 ±0.5 Myrs is probably the most acceptable.

Acknowledgments
I thank Hugh Grenfell for his company and thoughts in the field and Matt Rayner for providing directions to the exact site of where the footprint-bearing block had been removed.

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BORING OLD REEF CORALS FROM THE EARLY MIOCENE OF HOKIANGA, NORTHLAND, NEW ZEALAND

Seabourne Rust

Introduction

As Hayward (1977, 2017) noted, the fossil remains of colonial reef corals are occasionally found in Early Miocene rocks from northern New Zealand. They are usually fragments, often transported and abraded, of single solitary convex coral heads. These structures were perhaps originally up to 1m across and scattered across the sea floor or forming patch reefs rather than true extensive coral reef structures. Hayward (1977) identified a dozen coral species from Waitakere Group rocks and suggested they may have grown on shallow (0–90 m depth) water boulder banks around volcanic islands. Comparable members of **Order Scleractinia** (stony corals) can be seen today in shallow sub-tropical waters of temperatures above 16”C around the Kermadec region for example (Brook, 1999, Morton, 2004). These large hermatypic corals belong to the **Family Faviidae** and contain symbiotic algae (i.e. zooxanthellate), enabling more rapid growth (in the photic zone) than exhibited by the ahermatypic solitary corals found in deeper water. The reef coral heads form significant microhabitats for other organisms, including providing hard substrates for epibionts such as bryozoans and sponges, as well as boring bioeroders.

Bored corals

Dead coral heads can also be extensively occupied by a unique community of organisms. They include the actively boring polychaete and sipunculan worms, bioeroding urchins and sponges. In the tropics today are boring bivalve molluscs such as piddocks (Pholadidae), ark shells (*Arca* spp.), mussels (eg. *Lithophaga* spp.) and clams (*Tridacna* spp.). Of course, there is then a diverse succession of later species that nestle in and enlarge the cavities prepared by the primary bioeroders (Morton, 2004).

Waitiiti Formation examples

In the course of our study of Early Miocene (~21 Ma) fossils from the Otaian muddy sandstones of the Waitiiti Formation (Otaua Group) from the Taita Stream catchment, Waimamaku, South Hokianga (Fig. 1) (FR: O06/f0121, see Rust & Yanakopulos, 2011), we have recovered a number of specimens of colonial reef coral. Local farmer, Ernie Wilkins, also found several large worn pieces in river gravels a number of years ago (Fig. 2). We suspect these were washed downstream from the Taita Stream section of the Waitiiti Formation, perhaps hundreds of years ago. Reef coral genera represented

Fig. 1. Taita Stream locality, Waimamaku, South Hokianga.

in our Waitiiti Formation samples include *Leptastrea*, *Goniastrea*, *Montastrea* and *Cyphastrea*, similar to those taxa recorded by Hayward (1977). Specimens often have well-preserved corallites with visible radial septa that were once the calcium carbonate supporting cups that each housed an individual polyp.

Many of the fossil corals and large lithic blocks from the Taita Stream locality exhibit scars and boreholes from the activity of bioeroding organisms (Figs 3–6), some even have the original borer preserved (Fig.4). Occasionally we find the casts or tubular traces of these boreholes as infilling sediment has hardened (Figs 6 & 7).

One small (~1 cm) well preserved bivalve was removed and found to belong to the **Family Pholadidae**, tentatively identified as a juvenile *Pholadidea* (*cf. Hatasia*) or *Parapholas* sp. (Fig.7). These bivalves are mechanical borers, using rotation of their shell to produce clean circular drilling, as commonly seen bored into siltstones today by *Barnea* or *Pholadidea*. Modern *Parapholas* are known to bioerode dead coral and a New Zealand Otaian species *Parapholas thomsoni* has been previously noted as boring into large oysters and greywacke boulders (Beu & Raine 2009).

While many of the holes bored into our reef coral samples are circular (Fig.3), some faunal marks and traces are not so simple and undoubtedly represent the action of other bioeroders, epifaunal grazers and encrusters.

Once again fossils from the Waitiiti Formation are providing a fascinating window into a once richly inhabited subtropical environment that existed in the Early Miocene of Northland. Not so boring after all!

Fig. 2. Local Waimamaku farmer E. Wilkins and his coral finds (probably *Leptastrea* sp. - note the radial septa and fine details of the corallites are eroded away).

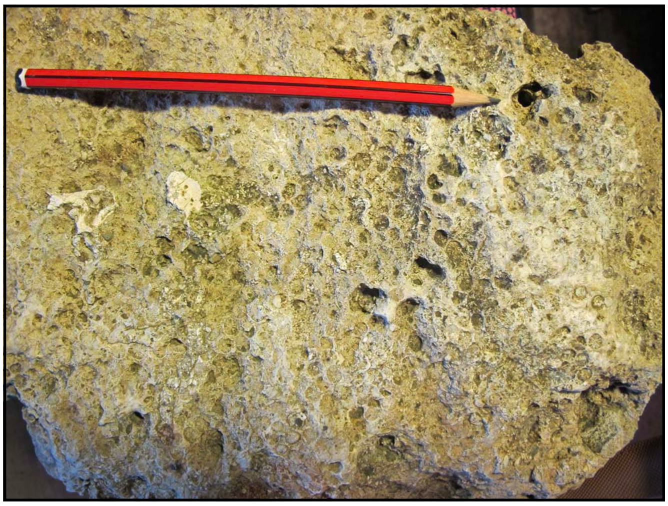

Fig. 3. A large coral head (?*Leptastrea* sp.) from the Waitiiti Formation with pencil pointing to a circular bore hole (diameter = 5 mm). This piece measures 30x30x13 cm and weighs 13 kg!

Fig. 4. An encrusted and bioeroded lithic block from the Waitiiti Formation Taita Stream locality with boring bivalve *in situ* (diameter of hole = 8 mm).

Fig. 5. *Cyphastrea* sp. coral heads from the Taita Stream locality with traces of boring. Note small widely spaced circular corallites (diameter 4mm).

Fig. 6. Close up of *Cyphastrea* with a sediment filled boring.

Acknowledgements
Thanks to Diane Yanakopulous and Bruce Hayward for field assistance and input, Ernie Wilkins for access to his specimens plus James Crampton and Alan Beu for their thoughts on the pholad bivalve.

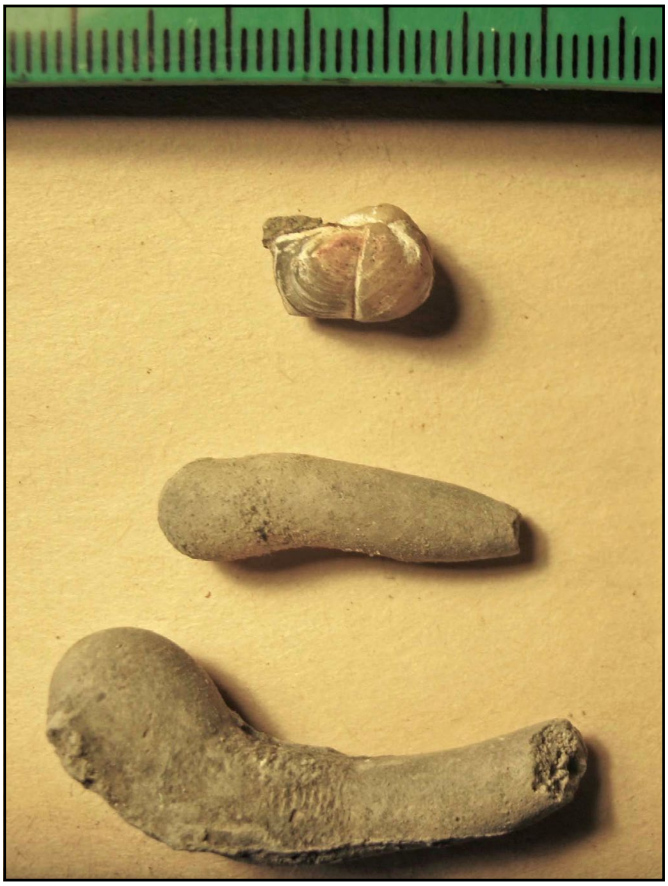

Fig. 7. At top is a juvenile pholad bivalve (note prominent umbonal-ventral groove), and below are two casts of boreholes (scale in mm).

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FOSSIL MOLLUSCS ON WOOD FALL IN EARLY MIOCENE WAITEMATA GROUP

Bruce W. Hayward & Bruce Marshall

Summary

This note records the first definite fossil occurrence of a wood-associated skeneimorph gastropod from New Zealand. It is tentatively referred to the genus *Dillwynella* and occurs in Early Miocene (Otaian) flysch of the Waitemata group south of Waiake Bay, on Auckland's North Shore. Numerous specimens occur in association with a carbonized piece of wood along with *Teredo* tubes and at least two specimens of the wood-ingesting limpet *Pectinodonta waitemata*.

In February 2022, a group of 14 geoclubbers visited Waiake Bay (Torbay) on Auckland's North Shore (Fig. 1) to explore the Early Miocene Waitemata Sandstones exposed in the cliffs to the north and south of the beach. We examined the thick Parnell Grit bed at the south headland and walked along its upper surface forming the shore platform for maybe another 400 m. The group was examining the beautiful suite of trace fossils in the rocks on the north side of Tipau Pt and carbonaceous and log-bearing layers (Fig. 2). Then BWH noticed a lump of carbonised wood with small white fossil gastropods in and around it (Figs 3–5). There were also numerous *Teredo* tubes (shipworm) through it.

Closer examination showed the tiny snail shells to be smooth, globular and trochospiral, resembling naticids, but this was an odd place (deep water associated with wood) for the shells of this carnivore to be clustered. Some specimens were collected and taken home (R10/f184), excavated from the enclosing rock, and several photographed (Fig. 6). The photographs were sent to Alan Beu, who suggested Marshall's papers on deep-water wood-fall gastropods be consulted. The specimens from Tipau Pt are somewhat decalcified and not well preserved, but seem to be referrable to the skeneid genus *Dillwynella* sp. and perhaps other genera in other families. Study of living skeneid gastropods shows that they are detritivores and those living on wood-fall substrates are specialist detritivores living on microbes scraped from the substrate, rather than the wood itself (Marshall, 1988). It

Fig. 1. Location of fossil wood-fall fauna (red dot), Tipau Pt, south of Waiake Bay.

Fig. 2. Log of flattened, carbonised wood in same horizon as fossil gastropods, Tipau Pt, south of Waiake Bay.

Fig. 3. North side of Tipau Pt showing location of fossil wood-fall fauna (circled). Photo 10 m across.

is difficult to identify skeneimorph taxa from their shell alone and these specimens are tentatively referred to *Dillwynella* because of their large size among such gastropods (up to 5–6 mm diameter) and smooth shell. There are three living *Dillwynella* species from bathyal depths (550–1200 m) around New Zealand (Marshall 1988), but there are no previously recorded fossil occurrences.

While excavating the skeneimorph gastropods, two small (10 mm-long) specimens of the wood-ingesting limpet *Pectinodonta waitemata* Marshall, 1985 (Fig. 7) were also found. Marshall (1985, 1998) records that the pectinodontine limpets occur at bathyal-abyssal depths today (400–4500 m) and are the only acmaeid limpets that ingest wood. There are four known fossil species of this genus, all from the early or middle Miocene of New Zealand and a number of living species (WoRMS), three of which occur off New Zealand (Marshall 1985). *P. waitemata*, as the species name suggests, was described from specimens collected by John Buckeridge from the East Coast Bays Formation (Waitemata Group) in the cliffs north of Long Bay. Like the occurrence at Tipau Pt, the type specimens were associated with a large piece of flattened carbonised wood with fragments of *teredo* tubes and casts of small trochospiral gastropods inferred to belong to the Skeneidae (Marshall, 1985). Additional unpublished records of *P. waitemata* are from the deep-water Waitakere Group (Early Miocene, Altonian Stage) along the coast south of Muriwai (Hayward, 1975) (Q11/f7002, f7012, f7577, f7579).

Fig. 4. Fossil wood-fall site with white fossils being mostly *Teredo* tubes or skeneimorph gastropods. Photo 50 cm across.

Fig. 5. Closer view of in-situ wood-fall site with fossil skeneimorph gastropods. Photo 8 cm across.

Fig. 6. Six extracted skeneimorph gastropods referred to ?*Dillwynella* sp. from the Early Miocene East Coast Bays Formation at Tipau Pt. Scale intervals 1 mm.

Fig. 7. Close up photo showing two somewhat decalcified, skeneimorph gastropods (right) and one of the two wood-ingesting limpets, *Pectinodonta waitemata* (concentric ribs, left). Photo 3 cm across.

Paleobathymetry

The depth at which this log was lying on the floor of the Early Miocene Waitemata Basin is of interest for understanding the bathymetric range of these two wood-associated molluscs. Ballance (1974) estimated depositional depth of the East Coast Bays Formation at about 1600 m using a turbidity current model. Hayward and Triggs (2016) placed foraminiferal faunas from this Formation in their associations E and F2, which they estimated from the planktic percentage and benthic composition to have accumulated at 1200±500 and 1350±600 m water depth. The foraminifera extracted from the wood-bearing fine sandstone at Tipau Pt contain 95% planktics and a sparse benthic fauna that includes deep-water-restricted *Siphonodosaria lepidula* and *Neugeborina longiscata*. These faunas are consistent with an inferred lower bathyal, possibly upper abyssal, depth (~1000–3000 m).

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WoRMS https://www.marinespecies.org/aphia.php?p=taxdetails&id=137617

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Quiz - QUIRKY GEOLOGY FACTS ABOUT TE TARA–O–TE–IKA–A–MAUI / COROMANDEL PENINSULA

Wendy Goad

“The geology of this region is not easily unravelled: adding to the great variety of volcanic rocks, there is poor rock exposure owing to extensive rainforest cover and deep chemical weathering. A further obscuring factor is hydrothermal alteration of many of the older rocks. Chemical weathering and hydrothermal alteration both tend to alter rocks to clay, and as such it is difficult to separate the effects of the two processes. The rocks involved are both volcanic and non-volcanic, the latter comprising basement greywacke rocks that lie underneath the volcanics.” - Ballance, 2017.

Geographically, the spine of the peninsula is formed by a chain of eroded volcanoes extending as far south as Mt Te Aroha and the Kaimai Ranges, and including Aotea/Great Barrier and the Mercury Islands. Subduction-related volcanic activity in the Coromandel Volcanic Zone (CVZ) commenced 18 Ma, and progressed southwards between 16 and 5 Ma. Between 1.9 and 1.6 Ma, subduction volcanism shifted to the Taupo Volcanic Zone, where today it forms the beginning of the Hikurangi Subduction Back-Arc Volcanic Chain (Gravis *et al*. 2020).

Within the wider volcanic landscape of the CVZ one can find an extensive suite of volcanic rocks including: basaltic lava and scoria, ignimbrites andesite lavas and pyroclastic succession, rhyolitic coherent and pyroclastic rocks, various intrusive igneous rock outcrops. epithermal mineral deposits and various, mostly vent/crater-filling exhumed volcanic breccias (Gravis *et al*. 2020).

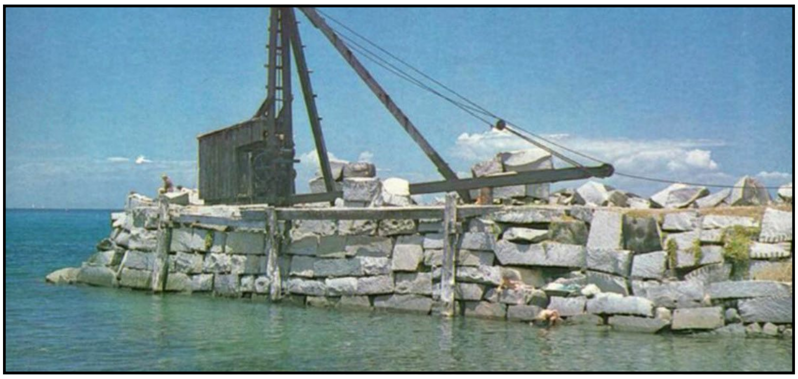
Volcanic landscape features include basalt cone erosion remnants, eroded andesitic volcanoes, exposed lava plugs, and dissected, and exhumed caldera remnants. Most of these erosion remnants shows near-vent, vent/crater-filling or proximal volcanic successions associated with a great diversity of volcano types ranging from small-volume mafic monogenetic, through intermediate strato-, silicic lava dome, and caldera volcanoes (Gravis *et al*. 2020).

Question 1: At 892 m asl, Moehau is the highest point on the Coromandel Peninsula. It is comprised primarily of what type of rock?

Link to Answers on p.17

A disused stone wharf beside the road at Paritu on the east coast of the northern Coromandel was used for loading blocks of building stone onto scows for shipment around New Zealand up to the 1950s. Referred to as ‘Coromandel granite’, it is a coarse-grained, black and white, speckled plutonic rock. A strong, durable building stone, it was used in many well-known projects, including old Parliament Building in Wellington and the obelisk atop Maungakiekie.

Question 2: The rock referred to as Coromandel Granite is around 16mya old and whilst it is a plutonic rock it is not a granite. What is it?



The CVZ was active in the early Miocene to the early Pleistocene (18–2mya) and hydrothermal alternation is widespread across the peninsula. Mineral assemblages formed during hydrothermal alternation reflect the geochemical composition of the ore-forming fluids. Gold is mainly transported in solution as Au-Cl and Au-S. Changes in conditions such as temperature, pressure, oxygen and sulphur fugacity are effective mechanisms for gold precipitation.

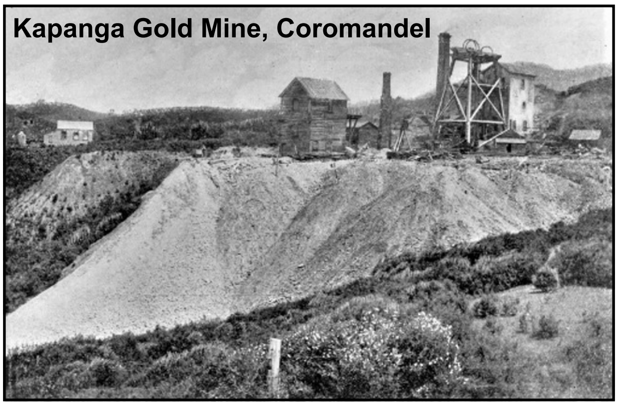
Question 3: The first gold discovered in New Zealand was in 1852 when a small patch of alluvial gold flakes was discovered in Driving Creek – where is Driving Creek located?

Alluvial gold was not an economic proposition on the Coromandel. In 1857, Charles Heaphy surveyed for quartz lodes and not long afterwards a party of prospectors began working the Kapanga Reef, a short distance from Coromandel township. The host rock for Kapanga is andesite, with hydrothermal alteration around the veins consisting of quartz, illite, chlorite, pyrite, epidote and calcite.

New Zealand's first two hard-rock gold mines are visible in this 1860s view.

The Kapanga mine, in the foreground on the left, produced some 71,454 ounces of bullion (gold and silver) over the next 50 years.

Nearby Scotty's mine, on the ridge at upper left, was a financial failure.



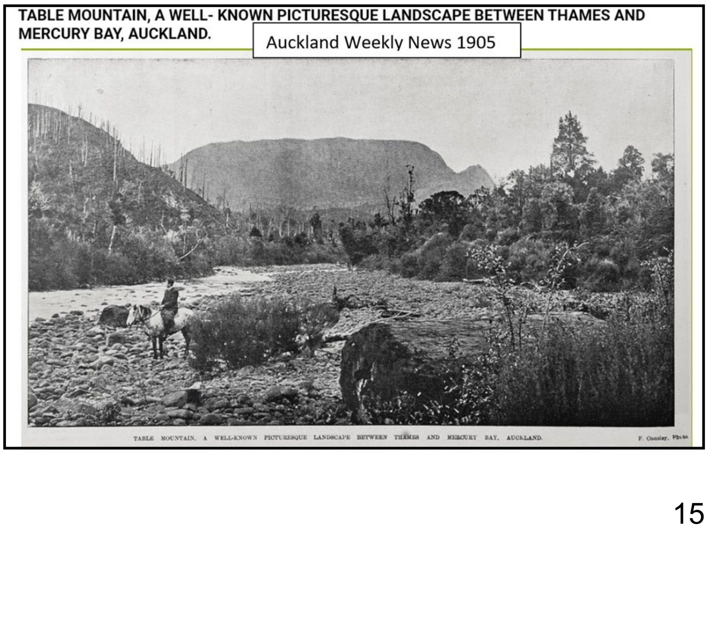
Question 4: The deepest mine in the Coromandel Goldfield - how deep did the Kapanga mine get?

The first news of opals on the Coromandel was from near Tairua in 1897 stating that the Opal Mining Co. was obtaining blocks of stone traversed by opal veins. The NZ Herald reported that stone from the mine was on display at the Mines Department in Auckland and that the company was seeking investors in the enterprise. Nothing further is heard until 1912 when the Herald reports the enterprise as a new discovery and once again calling for investors.

Potential investors were conned that bore holes, sunk surrounding the original reef, found one solid opal 33 feet thick. The opal-bearing rock was reported as 800 feet long and 200 feet wide. Newspapers in 1912 quoted the so-called Opal Mining Co. in writing that *"Opal in boulders everywhere on the surface glint in the sun." "The opal is better than that from Australia, in fact, unequalled anywhere in the world."*

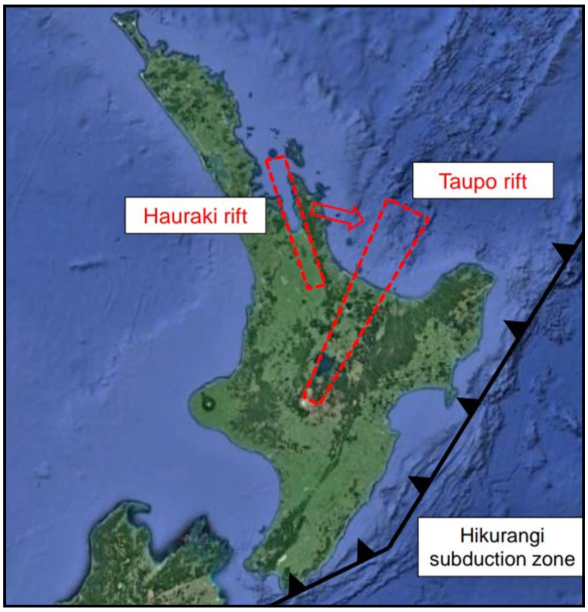
Question 5: Did the Tairua Opal Ltd, formed in 1912, repay its investors?

The Table Mt area is a region of steeply dissected andesitic, rhyolitic, and associated sedimentary deposits (Hayward, 1974). Table Mt/Te Kohatu-Whakiri-a-Ngatoroirangi is a distinctively shaped mountain, in behind Thames, rising to 837m asl. It has 150 m high sides of columnar-jointed andesite.



Question 6: What is the explanation for the shape of the mountain? (See Hayward, 2017)

A distinctive feature of Te Tara-O-Te-Ika-A-Maui is the Hauraki Rift which contains Tikapa/the Firth of Thames, the waterway separating the Peninsula from the Hunua Ranges. The rift consists of up to three half-grabens and contains up to 2.5km of sediment. Thought to have originated in the late Miocene, it was probably accumulating sediment by 5–7Ma (Edbrooke, 2001).

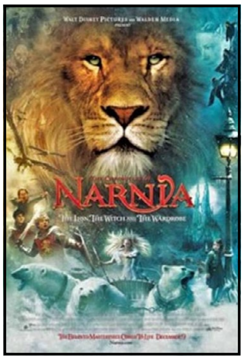


Question 7: Can you name the three faults associated with the Hauraki Rift?

Obsidian (tuhua or matā) was of considerable importance to pre-European Māori since the sharp flakes that could be produced by striking a natural cobble of this volcanic glass could be used for a variety of purposes, such as the cutting of flax, flesh and hair, scraping of wood and flax, and drilling holes. Mayor Is/Tuhua was the most important source of obsidian, but significant quantities were also procured by pre- European Māori from Northland, the CVZ, and the TVZ (Moore, 2010).

The CVZ includes nine geographically discrete obsidian sources; Fanal, Awana, Te Ahumata, Cooks Beach, Hahei, Tairua, Whangamata, Maratoto and Waihi. Each has a distinctive chemical composition, and some can also be differentiated on the basis of visual characteristics of the obsidian (Moore, 2010).

Question 8: Obsidian from six of the above sources is known to have been utilized by pre-European Maori.
Name the three sources that are not known to have been used.



Question 9: In the 2005 film The Lion, The Witch and The Wardrobe, the Pevensie children take their first steps into Narnia against a backdrop of what iconic Coromandel feature?

Great Mercury Island/Ahuahu is primarily rhyolitic in nature. Great Barrier/Aotea is made up primarily of andesites and dacites.

Question 10: What makes up the major rock type on Cuvier Island/Repanga to the NE of Coromandel Peninsula?

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www.mindat.org/loc-30148.html - then chose 'Opal'

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Answers

Question 1: Greywacke of the Waipapa Terrane.

Question 2: 'Coromandel granite' is in fact a tonalite from the Paritu Plutonics. Tonalite lacks the orange-pink potassium feldspar of true granites.

Question 3: Driving Creek to the North East of Coromandel Town off the Kennedy Bay Rd.

Question 4: The Kapanga Mine was the deepest in the Coromandel Goldfield, going down to 200m below sea level. Around 1896, deeper levels in the mine were explored with a shaft down to 1000 feet. Little gold was found and from then on work focused on areas above 420 feet from the surface.

Question 5: No. It is believed that this investment opportunity was a con and that the high-grade opals exhibited to potential investors were actually from Australia.

Question 6: It is a solidified andesite lava lake of about 8 mya of age. It would appear that the lava erupted into a 1 km diameter elongate crater. It has not eroded away because the andesite is much harder than the surrounding ignimbrite that once formed the crater walls. (See Hayward, 2017)

Question 7: Hauraki Fault on the eastern side of the rift, Firth of Thames Fault on the west, Kerepehi Fault roughly down the centre.

Question 8: There is no evidence for exploitation of the Awana, Maratoto and Tairua deposits. (See Moore, 2010)

Question 9: Cathedral Cove/Te Whanganui-A-Hei.

Question 10: The Cuvier pluton is a composite, high level intrusive, contemporaneous with the Paritu pluton. It comprises gabbro, diorite and granodiorite with andesite-dacite dike swarms, which intrude a probable Waipapa Group basement. Whilst contemporaneous with the Paritu pluton, the chemistry suggests the rocks are not cogenetic. (See Edbrooke, 2001)

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BOOK REVIEW by Liz Hoskin

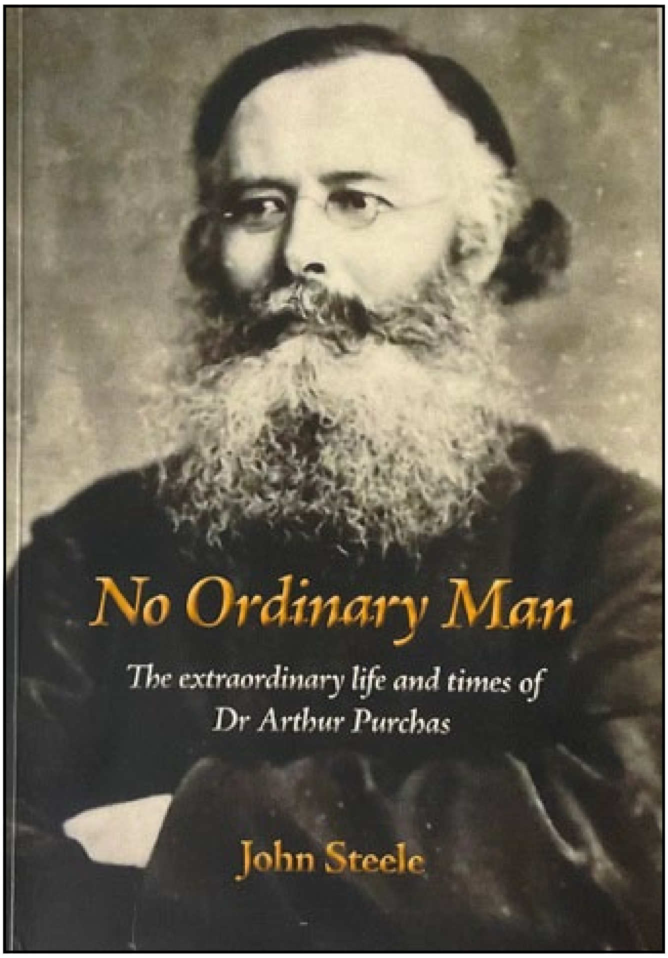
"No Ordinary Man: The Extraordinary Life and Times of Dr Arthur Purchas"

John Steele, 2019. Published by David Ling Publishing Ltd. Paperback/softback, 352 pages.

One of my most memorable lockdown reads last year was an historical biography of one of Auckland's most extraordinarily multi-talented early pioneers, the reverend Dr Arthur Guyon Purchas. He left his mark in so many areas of the emergent city's development.

He was an innovative and skilled surgeon, architect, engineer, geologist, linguist, arbitrator, priest, botanist, chemist and musician, yet his contribution is hardly recognised today.

This book helps to redress the matter.



We know of the 10,000 year old Purchas Hill/Te Tauoma Volcano, named after him by German geologist, Ferdinand Hochstetter, yet although this was once wider than - but has since been half buried by - the later Mt Wellington/ Maungarei Volcano, little of it remains, as most of the remainder has been quarried away.

Purchas was born in1821 in SE Wales. He grew up with a strong interest in mineralogy and geology, and was tutored in languages, science and biology.

His focus from a young age was to serve in New Zealand and to that end, he set about gathering all knowledge that may be of use to an emergent nation.

He was apprenticed to a GP at 15 and entered Guys in London at 19. Here he became a GP and Member of the Royal College of Surgeons and graduated as "one of the most active and intelligent students at Guys"

He began his life in New Zealand in charge of the new hospital at Bishop Selwyn's settlement at St Johns. Here, he was to study not only theology, but also Greek, Maori, architecture, botany and the local horticulture. Bishop Selwyn gave him the parish of Onehunga to minister to, which at this time included the farming districts of Epsom, Remuera, Otahuhu, Waiuku,and Mauku, and as far south as Taupiri.

His ministry was largely on foot or by boat, and consequently he became very familiar with the geology, botany and inhabitants of the area. He became the first European to discover the Huntly and Drury coalfields. He developed close relationships with Ngati Mahuta leaders, and worked hard as an intermediary and communications link during the build up to the Land Wars of the early 1860s.

In December 1958, Purchas and his wife hosted Hochstetter on his supposed short stopover at Christmas, and they inspected the Drury/Hunua coal and limestone fields together. The Auckland Provincial Government had asked Hochstetter to remain in New Zealand for a few months to conduct a geological and natural history survey of the entire province. Hochstetter, however, declined this proposition to stay on for longer in New Zealand, the reasons being the territorial difficulties, the lack of any maps and no knowledge of the Maori language. But, due to "the eloquence and amiability of my friends Mr Purchas and Dr Fischer", he was persuaded to change his mind. Thus, Hochstetter, accompanied by Purchas or Heaphy, or both, began the detailed assessment of Auckland's volcanic field. Hochstetter gave Te Tauoma the English name of Purchas Hill.

The book traces Purchas' little-known contribution as an architect. He designed and built several 'Selwyn' style churches, five of which still stand today, several with New Zealand Heritage Accreditation.

He was an engineer. He designed and took out New Zealand's first ever patent. It was for a flax dressing machine, and he invented an internal combustion engine using compressed kerosene vapour. He designed bridges and roads.

Purchas became Auckland's self-appointed watchdog for public health, devising a system for supplying clean water to Auckland town. He introduced a revolutionary new treatment for typhoid, pioneered abdominal surgery in New Zealand and was one of the first in the world to adopt Lister's new antiseptic measures.

Purchas was a founding member of the Auckland Institute, later to become Auckland War Memorial Museum, served 3 terms as its president and donated his large selection of plants and seeds to its collections.

He was a social worker, a trustee for many of his parishioners, an artist, a chemist, a minerologist and a well-respected arbitrator.

Dr Arthur Guyon Purchas has been described as a polymath - a person who excels across a diverse range of areas.

The book is a fascinating portrayal of a cheerful, conciliatory man who played a pivotal role in some of Auckland's most prominent cultural, educational, intellectual and environmental legacies in the context of early settler situations. His name, reputation and achievements deserve much more recognition, and I feel the portrayal in this book does address this paucity.

I highly recommend it.

Liz Hoskin

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FIELD TRIP TO TE HENGA, WEST AUCKLAND, 1859

Roger Evans

For the geologist who dabbles in local history, the occasional exciting discovery can be made. The narrow rural road at the back of Swanson on which I live was for many decades an abandoned clay track, only reopened as a road in the 1980s. It was Vivien Burgess of the West Auckland Historical Society who brought to my attention Ormsby's 1860 survey, establishing an existing track as the main "highway" to the settlement district of Waitakerei West.*

Trawling through Papers Past online (1859a, b), I came across an anonymous account in two parts written in 1859 by a member of Ferdinand Hochstetter's travelling party, describing a field trip to the West Coast. Proceeding north from Henderson and turning off at today's Don Buck Road (Fig. 1), the party followed that rough uphill track heading west, remarking on the scenery and prospects of the district. Aspects of the geology (Hayward, 1976) were noted intermittently; from the "vari-coloured" red and yellow soils exposed near the top of the hill (signalling a change from East Coast Bays to Cornwallis Formation), to the marked change in soil and fertility at Dilworth's Farm (indicating transition to volcanic soils of the Waitakere Group (Fig. 1).

After lunch at Maungatoetoe on the Raupo-Tamaki ridgeline, the party followed a native track down the Waitakere valley; continuing by canoe to Parawai (Hayward & Diamond, 1977), the kainga of their Maori hosts. Next morning, they set out to examine the breccias and volcanic intrusions on the coast at Te Henga, spending another night at Parawai before returning toward Auckland. During the trip, Hochstetter made a field sketch map of the geology, from Dilworths Farm to the West Coast (Fig. 2).

The back roads of Swanson and Waitakere still follow that original route (Evans, 2020). "Partridge's Creek" (Swanson Stream) is crossed at Glen Road. "The Backbone" is Crows Road, continuing to McEntee Road. From Waitakere township, Bethells Road crosses what was Charles Dilworth's farm to Maungatoetoe, continuing thence down the Waitakere valley.

Each time I walk up our road I am walking in the footsteps of Ferdinand von Hochstetter. Regrettably, I am 163 years too late for the field trip.

Notes of a trip from Auckland to Waitakeri, on the West Coast

"From hence the party to which we were attached the other day, proceeded via the gradually rising ridge known in the district as "The Backbone" (and along which, for the present - and it is to be hoped, only for the present - a portion of the Great North Road runs), to Raupo-Tamaki, where Mr. Dilworth has a fine sheep-farm of some 2400 acres all but fenced in, and in course of ploughing. The road, after crossing Partridge's Creek (the Mungawhau) is anything but favourable for quick or, in wet weather, safe travelling; but the singular mixture of vari-coloured clays at the top of the ridge and the view of the country on every side are very fine; and from here can be seen how the hill-streams now part - on the one side for the Kaipara, and on the other for the Waitemata waters. The land on this side of Mr. Dilworth's continues poor, with occasional patches of better soil; but soon after entering upon his land, the soil improves, and at the very highest

* *Editor's Note: In the past, the name 'Waitakere' has also been spelt 'Waitakeri' and 'Waitakerei'.*

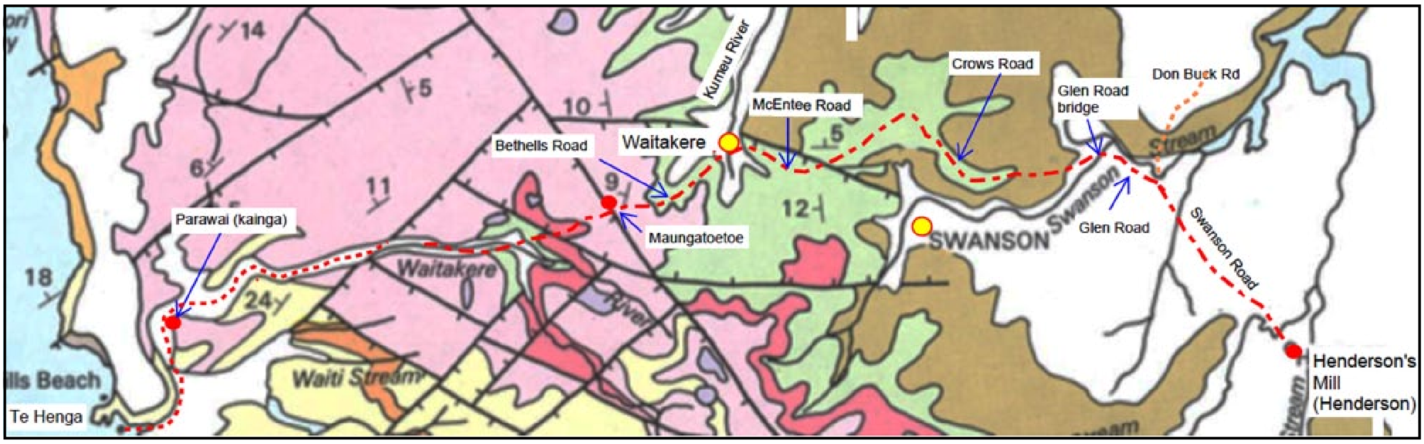

Fig. 1. Route taken by Hochstetter's party from Henderson to Te Henga, 1859. Dashed line = land route, dotted line = canoe. Road to Kumeu (today's Don Buck Road) dashed orange. Red dots mark locations extant in 1859, yellow dots mark subsequent settlements.
Geological base map shows East Coast Bays Formation (brown) and Cornwallis Formation (green) overlain westward by Waitakere Group (red pink and orange). Modified from Hayward (1976).

Fig. 2: Hochstetter's sketch map of Waitakere district, 1859. Pencil and ink on tracing paper mounted on linen-backed card, 23 x 27 cm. Published in Nolden & Nolden, 2013.

part of the hill-range, we saw red clover with stems three feet long and with a rich profusion of leaf and flower. …"

"From the top of the highest hill on this farm the visitor obtains a grand panoramic view of the Waitemata as far as Auckland, with the vessels in harbour, Rangitoto in the distance, and of the whole intervening country, as well as of the numerous homesteads dotted about the Titirangi Ranges towards the Manukau. A day can be very pleasantly and profitably spent here in taking a first lesson in New Zealand farming, and we would not wish a better guide than "Arthur," the bush cognomen of Mr. Bradley, the stockman, who is too hospitable to allow visitors to feel the cravings of hunger. On this occasion the party, which included Dr. Hochstetter and other inquiring strangers, were the guests of the proprietor of the farm, and what with wild pigeons from the bush, and fish from the streams, and peaches for dessert, the bill of fare afforded satisfactory proof that no one need starve either in the bush or on the hill-tops, or in the valleys of Auckland. …"

"Of what we saw there – of the magnetic-iron-sand hills, the lake, the conglomerate cliffs with their volcanic dyke, the large and deep caves, the wreck and the remains of the French barque " Posthumus," the view of Kaipara and Manukau Heads from the outer headland, the industry and civility of Waterhouse and his tribe … and of their appreciation of the importance of Dr. Hochstetter's exploration … of all this we must defer mention till our next issue."

Reference to "our next issue" implies that the writer was Editor of The New Zealander, George Smallfield. The full account in two parts can be read by opening the links in Papers Past (1859a, b). A separate account, which mentions George Smallfield as one of the party, is presented in Johnston and Nolden (2011).

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FOSSIL CASTS OF LARGE ESTUARINE MUSSELS AT WATTLE DOWNS, SOUTH AUCKLAND

Bruce W. Hayward

In November 2021, 20 members of Auckland Geoclub undertook a recky of the geology around the western and southern shore of Wattle Downs peninsula on the southeastern Manukau Harbour. The group walked from A to B on the accompanying map (Fig. 1), missing out the section of coast that is fronted by mangroves and deep mud around Kauri Pt. In January 2022, the author completed the traverse by walking around the coast from B to C, where mangroves and mud made further advance difficult.

Fig. 1. Map of the end of Wattle Downs peninsula, in the southeast Manukau Harbour showing the newly registered fossil records (prefixed by R12/f) where the large estuarine mussel *Xenostrobus huttoni* and other Late Pliocene fossils have recently been found.

The entire length of coast was composed of Pliocene sedimentary rocks, predominantly a massive iron-rich sand unit but also a carbonaceous grey mudstone and muddy sandstone that lay beneath. In most places bedding was horizontal but on the west corner of the peninsula (C) the iron-rich sand was bedded and tilted at ~50° to the NE with a ~8 m thick sequence that included a 1 m thick bed of massive conglomerate with clasts of Waitemata Group lithologies. Berry (1986) included the Wattle Downs coast in the area he mapped around the southern Manukau Harbour. Several of his sections now seem to have become overgrown and the sequence could no longer be investigated. Berry (1986) showed the coast between B and C as Waitemata Group, and although it has extensive sandstone intertidal platforms, it is actually the Pliocene iron-rich sandstone.

During the Geoclub traverse, I periodically opened up the case-hardened exposures of sedimentary rock with a hammer and in three places exposed the decalcified casts and corresponding moulds of a 6–8 cm long mussel. Closer examination of photographs and specimens I collected and comparison with the literature indicate that these are of the extinct large estuarine mussel *Xenostrobus huttoni* (Suter), which has a recorded time range of late Pliocene to Pleistocene (Waipipian to Castlecliffian stages). These three localities have all been assigned New Zealand fossil record numbers (prefixed by R12/f*) and are shown on Fig. 1, together with a further fossil site (R12/f84) that lacked the estuarine mussel. In each occurrence they occurred at a similar stratigraphic level, below the iron-rich sandstone, in dark grey carbonaceous mudstone or sandy mudstone that weathers chocolate brown on the outside.

At locality R12/f83, only 2 mussel casts were uncovered (Fig. 2) in a sandy mudstone and their occurrence was rather puzzling until the later localities were discovered and provided more evidence for environmental interpretation. At locality R12/f85 (Fig. 3), the mussel fossils (Fig. 4) occur in a single mudstone horizon that is packed with the casts of shells. The surrounding mudstone has fossilised seeds (Fig. 5), a bracket fungus (Fig. 6) and pieces of wood, some of which have ship-worm, *Teredo*, boreholes. These last-mentioned trace fossils indicate that the environment

Fig. 2. Casts of two *Xenostrobus huttoni* from locality R12/f83. Photo 15 cm across.

Fig. 3. Geoclub members examining the visible plant fossils at locality R12/f85.

Fig. 4. Fossil casts of *Xenostrobus huttoni* from locality R12/f85. Photo 15 cm across.

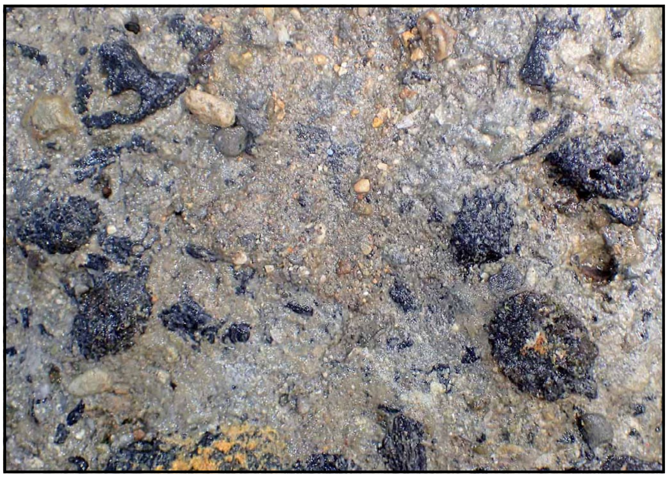

Fig. 5. Fossil *Casuarina* seeds at locality R12/f85. Photo 10 cm across.

of deposition must have been influenced by the sea and the wood was presumably washed up at extreme high tide. The richness of the associated plant debris and fossils is consistent with it having been near the head of an estuary. At locality R12/f86, the mussel fossils occur in carbonaceous mudstone that is packed with fossil leaves, particularly those of a large-leaved (*brassi*-group) beech tree. This association is also suggestive of the upper high tidal reaches of an estuary, similar to the setting described by Moore and McKelvey (1971) for Pliocene leaf and shell-bearing sedimentary rocks at nearby Weymouth peninsula.

These fossil localities have not previously been recorded and the occurrence of *Xenostrobus huttoni* in the Pliocene around the Manukau Harbour also appears to be a new record.

Fig. 6. Fossil bracket fungus at locality R12/f85. Photo 10 cm across.

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MARGARET S. MORLEY, 1938 – 2016
AUCKLAND GEOLOGY CLUB FOUNDATION MEMBER AND COMMITTEE MEMBER

Bruce W. Hayward

Margaret Morley (1938-2016) was one of the founding members of Auckland Geology Club in 1992 (then called the Auckland Museum Geology Club). For the next 23 years she attended virtually every monthly meeting and almost every one of over 200 Geoclub field trips. She became a Geoclub committee member in 2006 and was still serving in that role when she passed away in 2016. Margaret was a much-loved institution within the club. She knew everyone and made it her business to keep up to date with everyone's news and to offer assistance to anyone who might need it. She was a trained orthopaedic nurse and physiotherapist and often held well-patronised free physio massage clinics for the sore and injured on longer Geoclub trips. With her medical background Margaret was always on hand and ready to jump in and help when any incident occurred on a field trip, such as the rogue wave incident in southern Westland in 2014 or the blackout incident climbing out of Mercer Bay in 2005, to name just two of the more serious ones.

Fig. 1. Margaret Morley with one of her drawings – a reconstruction of the early Miocene fossil polychaete *Archesabella bartrumi*, Feb 2016.

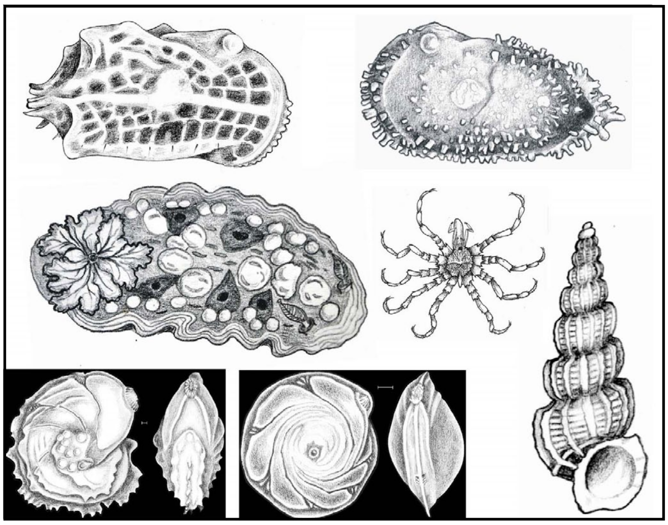

Fig. 2. Examples of some of Margaret Morley's published scientific illustrations of ostracods, a nudibranch, a pycnogonid, a gastropod and two foraminifera.

Although Margaret joined Geoclub with virtually no knowledge of geology she was a quick and eager learner and readily absorbed the basic concepts. As a result, she was quite happy to put her hand up and present on a small geological topic at the annual members' presentation evenings. She gave pictorial accounts of her geological observations on a winter cruise in Fiordland (1996), a camping trip to SW USA (1999), holiday in the Wairarapa (2002), Iguazu Falls (2007), and Kawau geology (2011). Other talks were on Holey rocks made by boring bivalves (2000), fossil molluscs (2004), Auckland's original shoreline (2007), Devonian brachiopods (2008), Oamaru Limestone (2009), world's first woman paleontologist (2011), Eastern beach anticline rock fall (2011), clays and pottery (2013), vivianite (2013) and vermiculite (2014). She also led the odd field trips, with more of a marine ecology theme, to Howick Beach (2004), Leigh Marine Lab (2011), and Buckland's Beach beach rock (2013). She authored four articles for Geocene on Mary Anning (#7), the lost basalt jetties of Pakuranga Creek (#5), book review of Wegener's jigsaw (#6) and Oamaru Limestone (#6) and co-authored two

Fig. 3. Margaret Morley (centre, blue shorts) on Geoclub trip to Matauri Bay ceramic quarry, 1995.

Fig. 4. Margaret Morley (left) on Geoclub trip to Broken Hill mine, 2001.

others. The topics above illustrate the vast breadth of her interests and ability to communicate to others what she had learnt.

But there was yet another side to Margaret that would be revealed in conversation, but few knew what a significant and productive avocational researcher she was, particularly in New Zealand molluscs, marine ecology and later also in ostracods. Margaret considered shopping and housework were necessary evils and hung a sign on her study door at home saying – “Forget the housework, gone to the beach.” As a researcher she was entirely self-taught, having taken up an interest in shells and joined the Auckland Museum Conchology Section in 1980, as her children were growing up. She was a key person on their committee for many years (1982–2010) and was President for six years (1987–1993) and Vice-Patron (2011–2016).

Margaret spent at least one day a week along the shoreline making observations, sketches and collections. In the last 20 years she examined almost every stretch of shoreline, including the intricate harbour coasts, from Pakiri in the north to Miranda in the south on the east coast and from Muriwai to Port Waikato on the west. As a result of this work, she became the go-to expert on the shallow marine biota and focusing on Mollusca of the inner Hauraki Gulf, Waitemata Harbour and especially her local Tamaki Estuary. Her studies made major contributions to the understanding of the life histories and ecologies of many species, and documented the arrival and spread of a number of introduced shallow marine species that were introduced by shipping to the Waitemata Harbour.

Not content with identifying and documenting the larger shells, Margaret took up the study of micromolluscs and became one of New Zealand’s leading experts in their identification and ecology. She also adored the sea slugs and became the most prolific contributor to our knowledge of their distribution around the coast of northern New Zealand. These skills contributed to her documentation of the molluscan biodiversity and biogeography of many parts of the New Zealand coast – mostly in northern New Zealand, but also Mahia Peninsula and the subantarctic Campbell and Auckland islands, which she visited twice to undertake her studies. In 2000 she took up another challenge and taught herself to identify the seaweeds of northern New Zealand, which she added to her repertoire. Her molluscan and seaweed studies also contributed to wider research (undertaken by a small group of colleagues from Auckland Museum) on the full marine biodiversity of a number of areas and towards major studies of the seafloor biota of the Bay of Islands and Waitemata Harbour. The latter study showed that the major changes that have occurred in the seafloor biota of the Waitemata since Powell’s study in the 1930s have been from the introduction of four bivalves from SE Asia that have become widespread and dominant components of the biota.

Because of her molluscan expertise, Margaret was made an Honorary Research Associate of Auckland Museum in 1993 and spent one day a week volunteering her services there until early 2016 when she was forced to stop because of her deteriorating health. In 2014 she was awarded an Associate Emeritus of Auckland Museum Medal for her services to the Museum in the marine field. She also served five years as an elected Council Member of the Auckland Museum Institute. From 2004 on she was a Research Associate at Geomarine Research where she also spent one afternoon a week undertaking voluntary research and cheering up some of the Geoclub crew who worked there, such as Ashwaq Sabaa, Hugh Grenfell, Rhiannon Daymond-King, Jill Kenny and Bruce Hayward.

Fig. 5. Margaret Morley (front right) on a very wet Geoclub trip up the Sugarloaf, Matakana, 2012.

In 2006 Margaret took on the first studies of the ecological and biogeographical distribution of Recent ostracods of northern New Zealand. In the following ten years she published six papers on their distribution and added 92 additional species to the list of living ostracods known from New Zealand. Her ostracod results also contributed to studies by Geomarine Research personnel on the Holocene record of earthquake displacements in Hawkes Bay and Marlborough, the breaching of maar lakes by Holocene sea level rise and the impact of humans on the marine ecology of the Waitemata Harbour. Margaret was a highly skilled artist and illustrated all of her 119 research papers with accurate and beautiful drawings of many of the species. In 2004 her popular guidebook "A photographic guide to the seashells of New Zealand" was published with photographer Iain Anderson. It sold so well that three editions were produced in the following decade.

In other activities Margaret became a skilled table-tennis player, was a tutor and Director of the NZ College of Massage (1998-2002), committee member of the Tamaki Estuary Protection Society (1992–2003), and Commissioner for the Wakaaranga Division of Girl Guides (1965–1974). No wonder there was no time left for shopping or housework.

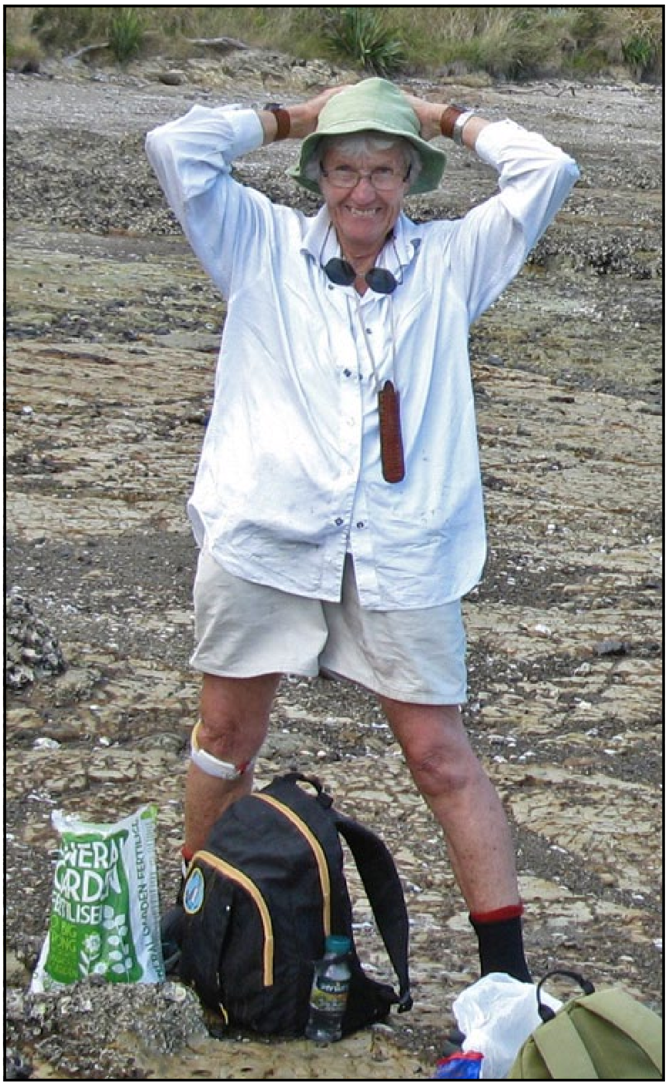

Fig. 6. Margaret Morley at her favourite place – the beach! Station Bay, Motutapu, 2012.

Selection of Margaret Morley's more significant publications

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