CHAPTER XII.

Melbourne to Sydney—Sydney—Excursion to Queensland—The Marsupialia—Sydney to Wellington—Procalistes—Wellington to the Kermadec and Friendly Islands—Tongatabu, Friendly Islands to the Fiji Islands—The Fiji Islands.

Melbourne to Sydney.

The Expedition remained at Melbourne until the 1st April, refitting the ship and obtaining magnetic and other observations on shore, and the stay was greatly enlivened by the receptions and excursions arranged for the members of the Expedition by the inhabitants of Victoria.

The German frigate "Arcona," Captain von Reibnitz, which had also recently visited Kerguelen and Heard Islands to ascertain their fitness as a Station for observing the transit of Venus, was anchored off Melbourne at the same time. The "Arcona" had passed round the south end of Heard Island, so, from the information received from her officers, it was possible to add somewhat to the Challenger's plan of that island. The relations between the officers of the Challenger and those of the "Arcona" were most cordial; visits were frequently interchanged, and several pleasant reunions held on both vessels.

On the 1st April, at 6 A.M., the vessel left Port Philip for Sydney, passing the heads at 2 P.M. When outside a few trawlings were obtained, and at 5.30 P.M. a course was shaped for Rodondo Island.

On the 2nd April, at 5.30 A.M., the Glennie Islands and the land about Wilson Promontory were seen, and the ship was steered to the southward of Rodondo Island, which was passed at 8.30 A.M. During the forenoon an exploring party was landed on East Moncœur Island,[1] and dredgings and trawlings were obtained off the island in 38 to 40 fathoms (Station 162; see Sheet 25), after which the ship proceeded to the northeastward. West Moncœur Island has two small rocky islets off its southern end, instead of one as marked on the chart, and the eastern island has a rock separated from it by a narrow channel both at the northwest and southwest points. The weather in the forenoon was gloomy, with rain, but shortly after noon a southwest breeze sprang up, the rain gradually cleared off, and the weather became finer.

On the 3rd April the land about Mount Everard was observed at 11.30 A.M., and the ship was steered to pass Gabo Island at a distance of 3 or 4 miles, fixing with Mount Everard, Rame Head, Genoa Peak, and Howe Hill, which objects were easily recognised. At 5.30 P.M. Gabo Island was passed, and a course shaped to get outside the edge of the 100-fathom bank of soundings to ascertain the depth and temperature the

[1] The rock specimens collected were typical granite.

next day. At 6 and 8 P.M., when close to the land, the temperature of the surface water fell to 60°, having previously been 66°; as the distance from the shore increased it again rose to 66°.

On the 4th April, at 9 A.M., being then about 10 miles east of the 100-fathom contour line, a sounding was taken in 2200 fathoms, the bottom temperature being 34°·5. The current was found to be running to the southward at the rate of 1½ miles per hour, the surface temperature being 71°. Serial temperatures were taken to 300 fathoms, by which it appeared that the temperature of 71° was very superficial, as at 50 fathoms the thermometers registered 65°·2. The position of the sounding was fixed by angles to objects on shore, the angles being Mount Imlay 27° Mount Massey 48° 40′ Mount Dromedary. After completing the observations the ship steamed towards the shore, and trawlings were obtained, in 120 to 150 fathoms, many Invertebrates and Teleosteans being procured, among which were a quantity of Grey Mullet (*Percis allporti*, Günther) sufficient to provide the officers' mess with fish for dinner. At 6.30 P.M. a course was shaped to the northward towards Montague Island, the ship being first swung to ascertain the errors of the compass. The temperature of the surface water rose to 71° at 4 A.M., and remained nearly the same throughout the day, being considerably higher than the temperature of the air.

On the 5th April, at 6 A.M., when abreast of Montague Island, the vessel proceeded inshore, and was then swung to ascertain the errors of the dipping needle. This occupied until 2 P.M., when a course was again shaped to the northward. During the previous night a current of two miles per hour was experienced running to the southward. During the operation of swinging the current was only one mile per hour, but the approach of the flood tide, which in this part of the Australian coast comes from the southward, may have caused a retardation of the current; whilst the ship was close inshore from Montague Island little or no current was experienced until midnight, at which time the ship was abreast of Jervis Bay, the temperature of the surface water having fallen to 68°·5.

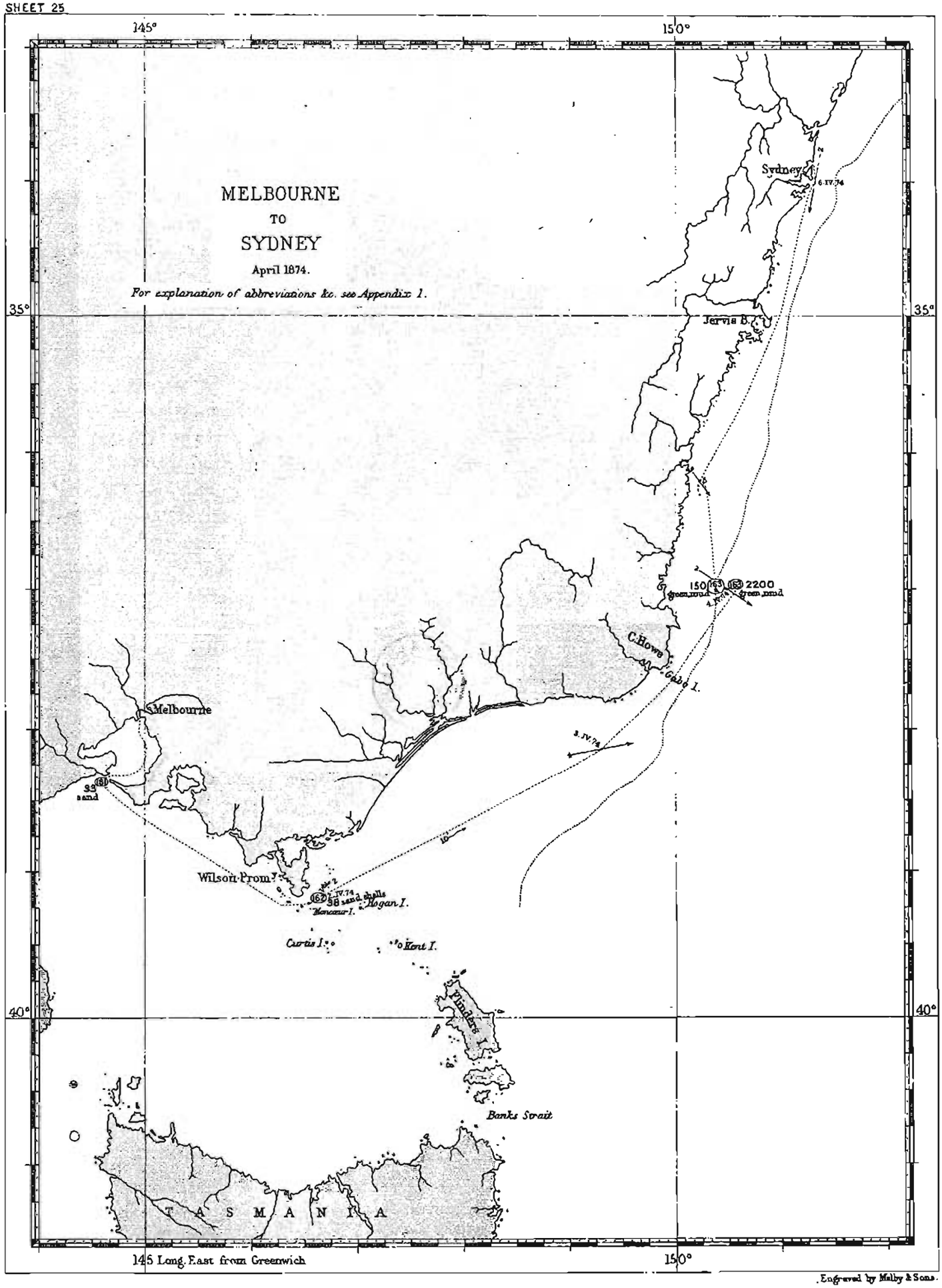
On the 6th April, at 6 A.M., the surface temperature again rose to 71°, the position of the ship being Mount Berry 20° 20′ Broughton Head 74° Mount Kiera. From here to Port Jackson Head a current was experienced running south 1½ miles per hour. At 2 P.M. the vessel entered Port Jackson, and at 3 P.M. was moored in Farm Cove.

SYDNEY.

Sir Wyville Thomson gives the following account of an excursion to Queensland during the stay at Sydney:—

"There seemed to us, from what we heard at Sydney, to be a chance of making valuable additions to the knowledge of the natural history of northeast Australia, by

SHEET 25


145°
150°
MELBOURNE
TO
SYDNEY
April 1874.
For explanation of abbreviations &c. see Appendix 1.
35°
40°
Sydney
6.IV.74
Jervis B.
150 (63) (62) 2200
green mud
C. Howe
Gabo I.
3.IV.74
Melbourne
33
sand
Wilson Prom.
Hogan I.
Curtis I.
Hunter I.
Flinders I.
Banks Strait
TASMANIA
145 Long. East from Greenwich
150°
Engraved by Malby & Sons.

examining carefully the faunæ of some of the rivers. Those in which *Ceratodus* had lately been discovered had the greatest interest for us, for we hoped that, besides getting a number of specimens of *Ceratodus* in various stages, we might by effective netting and other means find some additional forms of Dipnoi. Accordingly a little party, consisting of Lieutenant, now Captain, Aldrich (who afterwards commanded the sledge party which proceeded westwards from the 'Alert's' winter quarters along the coast of Grinnell's Land), Mr. Murray and myself, with Mr. Pearcey and a couple of blue-jackets in attendance, was organised to go to Brisbane during the stay of the ship at Sydney, with the view of pushing on, if time permitted, to the upper reaches of the Mary or the Burnet.

"We got information and introductions from Dr. Bennett, Mr. Hill, and others. We prepared a stock of trammel nets, lines, and other fishing appliances, a box of dynamite cartridges, fowling pieces, and collecting gear of all kinds, and we arranged to leave Sydney by the 'City of Brisbane' on Tuesday the 29th April 1874; the vessel was, however, detained by bad weather till the 4th May. We arrived at Brisbane on the morning of the 7th. An intimation of our intended trip had preceded us, and we found a kind invitation from the Marquis of Normanby to Government House awaiting us at the club, of which we had already been made honorary members.

"We stayed a few days at Brisbane seeing all that was to be seen. The Governor's A.D.C. tried to make arrangements to send us on to Gympie in carriages, but we found it more convenient to go by a coasting steamer to Maryburgh. The departure of the 'Lady Bowen,' the regular trading packet, was hurried to give us more time, and on Sunday the 10th we were steaming past a monotonous undulating coast line, the low hills crowned with dusky woods of sombre gum-trees, past Fraser Island, one of the districts given up entirely to the natives, many of whom we saw in the distance, with a fine walk and gait, but absolutely unclothed. We were disappointed that none of them swam off to the steamer as they often do.

"We reached Maryburgh on the morning of the 11th, and introduced ourselves to Mr. Sheridan, the Collector of Customs, to whom we had been referred by Lord Normanby We found Mr. Sheridan a most pleasant companion, and a man of great intelligence and considerable special knowledge of natural science. He most kindly placed himself at our disposal during our stay, and afterwards took the trouble to collect and send home to us a valuable collection of such species as we had not an opportunity of procuring in sufficient quantity during our short visit.

"We went on in the evening in a couple of buggies through the bush of scattered gum-trees, to a little group of wooden shanties called 'Tiaro,' about 20 miles above Maryburgh, on a pretty bend of the river Mary, with a good long stretch of open stream, succeeded by some irregular rapids and deep pools, and overhanging woods farther up. The influence of the tide was slightly felt for a considerable distance beyond Tiaro, and some of the fishes had consequently an estuarine character.

"We got the loan of a boat from a contractor who was deepening the river a little below Tiaro for the Queensland Government, and on the following day were joined by Mr. Sheridan with his boat and servant. It was reported on all hands that the Barramunda (the native name for *Ceratodus*) was to be found occasionally in the neighbourhood, and we determined to spend the short time at our disposal in exploring the fauna of the river for a few miles up stream.

"Lieutenant Aldrich and Mr. Murray, with our escort and one or two natives whose services we had secured, camped a little way up the river, and Mr. Sheridan and I, as the seniors of the party, slept at Tiaro, rowing up the river in the morning, and usually reaching the camping-ground in time to supply the materials of stew for luncheon, in the shape of cockatoos, wallaby, ducks, &c., which we had shot by the way. For about ten days the river was fished day and night with net and rod, and fishes of several species were taken in large numbers, but we found no trace of *Ceratodus* or of any allied form. We had taken with us a number of powerful dynamite cartridges, and these were thrown, with a few feet of Bickford's fuse attached, into the deeper pools, and in a minute or so a shock like a blow from a heavy wooden mallet was felt on the bottom of the boat, one could see a slight rise on the surface of the water, and perhaps a hundred fishes of different sorts and sizes rose to the surface and floated on their backs or sides. Those we required were taken into the boat with a landing net, and the rest recovered from their shock in a few minutes and swam away. The number of individual fishes taken in this way was very large, but it is somewhat singular that *Ceratodus* never occurred among them. At the end of about ten days, however, three specimens were taken, one by Lieutenant Aldrich with hook and bait, one in the trammel net, and one by the natives.

"As our leave of absence was nearly exhausted, we now returned to Maryburgh, and after waiting for a few days to catch a return steamer, rejoined the Challenger at Sydney."

Two crania and a skeleton[1] of the aborigines were obtained in the Queensland district, and a number of Marsupials were collected during the trip above described, as well as during other excursions in different parts of Australia. The latter, together with two specimens of *Thylacinus cynocephalus*, which were sent to the Expedition from Tasmania by the Governor of that colony, were on the return of the Expedition handed to Professor D. J. Cunningham for anatomical examination, and a Report giving the result of his investigations appears in the Zoological Series of Reports.[2]

The Marsupialia.—This Report deals with the myology, the arrangement of the spinal nerves, and the visceral anatomy of the Marsupial animals brought home. Two

[1] Described in the Report on the Human Skeletons, The Crania, by Prof. Turner, F.R.S., Zool. Chall. Exp., part xxix., 1884.

[2] Report on some points in the Anatomy of the Thylacine (*Thylacinus cynocephalus*), Cuscus (*Phalangista maculata*), and Phascogale (*Phascogale calura*); with an account of Comparative Anatomy of the Intrinsic Muscles and the Nerves of the Mammalian Pes, by Prof. D. J. Cunningham, M.D., Zool. Chall. Exp., part xvi., 1882.

plates also are devoted to the osteology of *Thylacinus cynocephalus*. Owing to the prevalent belief that the genus, of which this animal is the sole member, is rapidly becoming extinct, special care has been taken in recording its anatomical peculiarities.

The chief interest of the Report, however, is centred in the fact that it contains the results of an investigation into the comparative anatomy and homologies of the intrinsic muscles and nerves of the Mammalian foot. The author was induced to engage in this research from conditions which he found in the Marsupial foot, and special opportunities were afforded him for carrying on the work by the many valuable specimens of Mammalia collected during the voyage, which were also placed at his disposal.

The conclusions arrived at may be briefly stated to be the following:—That the typical arrrangement of the intrinsic muscles of the Mammalian pes is seen to best advantage in the feet of certain of the Marsupialia. In these animals the muscles are disposed in

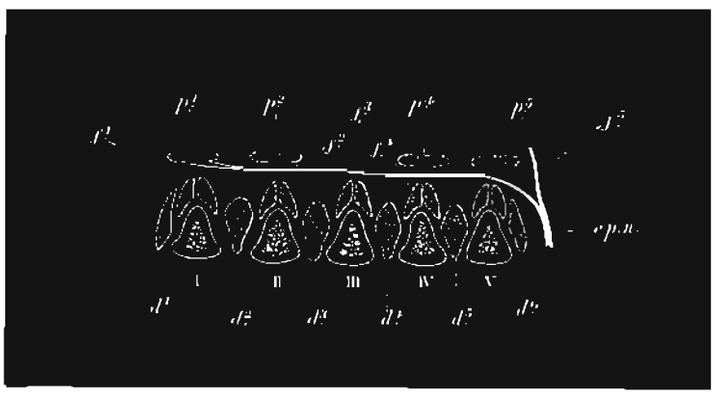


FIG. 171.—Schematic view of a section through the metatarsus of a typical mammalian foot.
I.–V. Metatarsals; p^1–p^5, adductores; f^1–f^3, flexores breves; d^1–d^6, abductores; *e.p.n.*, external plantar nerve.

three layers, viz., (1) a plantar layer of adductores, (2) an intermediate layer of flexores breves, and (3) a dorsal layer of abductores.

Deviations from this typical trilaminar disposition may take place—(*a*) by subdivision of certain of the members of one or other of the layers, (*b*) by fusion of certain of the elements of the different strata, or (*c*) by suppression or non-development of some of the muscles.

The first of these deviations is to be found in a few Marsupial animals (*e.g.*, *Cuscus*) in which a tendency is exhibited to the development of a fourth layer by the splitting of the dorsal interossei. Fusion of the constituents of the intermediate and dorsal layers is extremely common, whilst fusion between the plantar and intermediate muscles is a very rare occurrence. Suppression of certain of the muscles may take place in two ways; it may either be complete—not a trace of the lost muscle being left—or partial, in which case the place of the missing muscular belly is taken by a ligamentous structure, having

the same connections, and probably a distinct function to play in the mechanism of the foot.

The *plantar layer* constitutes a very constant part of the intrinsic muscle apparatus of the Mammalian foot. In the feet of forty-six different species possessed of three or more toes, it was absent entirely in three cases only. In the monodactylous and didactylous feet of Solipeds and Ruminants not a trace of adducting muscles is to be found. The original number of these muscles is five, one for each toe, but they exhibit a distinct tendency to disappear from the centre of the foot towards the margins, and this disappearance takes place in a more marked degree outwards towards the minimus than in an inward direction towards the hallux. The central adductor (*i.e.*, adductor medii) was only found in three specimens. The sudden disappearance of this adductor is probably due to the tendency which these muscles have to arrange themselves so as to act with reference to the middle toe.

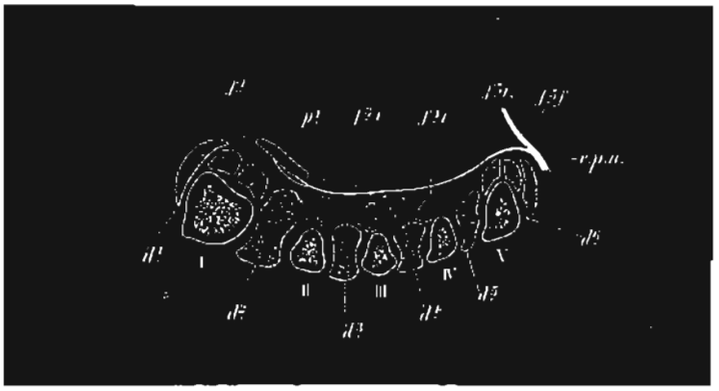


FIG. 172.—Schematic view of a transverse section through the metatarsus showing the intrinsic muscles of the left human foot.

I.–V. Metatarsals; f^1, flexor brevis hallucis; f^2t, tibial head of flexor brevis medii (1st plantar interosseous); f^4t, tibial head of flexor brevis annularis (2nd plantar interosseous); f^5t, tibial head of flexor brevis minimi digiti (3rd plantar interosseous); f^5f, fibular head of flexor brevis minimi digiti; p^1, adductor obliquus hallucis; d^1, abductor hallucis; d^6, abductor minimi digiti; d^2-d^5, dorsal interossei; *e.p.n.*, external plantar nerve.

The *intermediate group* of flexores breves is the most constant layer, and is closely associated with the *dorsal layer*, which is the least constant and most variable. It is quite possible that the latter (*i.e.*, dorsal interossei, abductor hallucis, and the abductor of the minimus) may have originally been derived from the former. Ruge's [1] investigations into the development of the muscles of the human foot favour this view.

If the human foot be studied in the light of these results, it will be seen that the *dorsal layer* is the most fully represented. It consists of (1) the abductor hallucis, (2) the abductor minimi digiti, and (3) the four dorsal interossei.

The *plantar layer* is represented by the adductor hallucis and the transversalis pedis,

[1] Zur vergleichenden Anatomie der tiefen Muskeln in der Fusssohle, *Morphol. Jahrb.*, Bd. iv. pp. 644–660, 1878.

whilst the *intermediate layer* is composed of the flexor brevis hallucis, flexor brevis minimi digiti, and the three plantar interosseous muscles.

The hypothesis that the relationship between "nerve supply" and "muscle-homology" is invariable and immutable has also been tested in this Report. The author maintains that the nerve of supply is not an infallible guide to the homology of a muscle; at the same time he is inclined to consider it in many cases the most important factor to be taken into account in determining this point.

During the stay at Sydney Mr. Moseley made two excursions to Browera Creek, one of the many branches of the main estuary, or rather inlet, into which the Hawkesbury River runs, and is a place full of interest to the naturalist. Suddenly, after traversing a high plateau of the horizontal sandstone, the traveller meets with a deep chasm about 1000 feet in depth, but not more than a quarter of a mile wide. This chasm or channel has precipitous rocky walls on either side, with more or less sloping talus, and at the bottom runs the river, a small stream over which one can easily jerk a pebble when standing at its brink. The chasm or creek takes a winding course, so that only short sweeps of it can be seen at a time, and as it widens out and turns sharply or again contracts, one seems, when in a boat on its waters, to pass through a succession of long narrow lakes. The river, or rather stream, at the place where the creek was approached, is tidal. It is impossible to say where the river ends and the sea begins. The main part of the creek is a long tortuous arm of the sea, 10 to 15 miles in length, and is itself provided with numerous branches and bays, which are perfectly bewildering to a man not accustomed to row on them every day in his life; the whole is, in fact, like a maze. The side walls of the creek are covered with a luxuriant vegetation, with huge masses of Stagshorn Fern (*Platycerium*) and "Rock Lilies" (*Orchids*), and a variety of timbers, whilst there are Tree-ferns and small Palms in the lateral shady gullies. As an example of denudation, the creek appears to correspond exactly to what is seen at a much higher level in the Blue Mountains. The extraordinary proximity into which animals found usually only in the open sea, are here brought with those only occurring inland, is of great interest from a geological point of view; it recalls at once to the mind such mixtures of marine and terrestrial animal remains as those occurring in geological deposits, such as the Stonesfield beds. Here is a narrow strip of sea water, 20 miles distant from the open sea; on a sandy shallow flat close to its head are to be seen basking in the sun numbers of Sting-rays (*Trygon*), a kind of Skate provided with a sharp saw-edged bony weapon (the sting), at the base of its tail. All over these flats, and throughout the whole stretch of the creek, shoals of Grey Mullet are to be met with; numerous other marine fish inhabit the creek, some growing to 150 lbs. in weight, and often caught weighing as much as 60 or 80 lbs. A *Diodon* or Trunk-fish occurs amongst the fishes. Porpoises chase the Mullet right up

to the commencement of the sand-flat. At the shores of the creek the rocks are covered with masses of excellent Oysters and Mussels, and other shell-bearing molluscs are abundant, whilst a small Crab is to be found in numbers in every crevice. On the other hand the water is overhung by numerous species of forest trees, by Orchids and Ferns, and other vegetation of all kinds; Mangroves grow only in the shallow bays. The Gum-trees lean over the water in which swim the *Trygon* and Mullet, just as willows hang over a pond full of Carp. The sandy bottom is full of branches and stems of trees, and is covered in patches here and there by their leaves. Insects constantly fall on the water, and are devoured by the Mullet. Land birds of all kinds fly to and fro across the creek, and when wounded may easily be drowned in it. Wallabies swim across occasionally, and may add their bones to the débris at the bottom. Hence here is being formed a sandy deposit, in which may be found Cetacean, Marsupial, bird, fish, and insect remains, together with land and sea shells, and fragments of a vast land flora; yet how restricted is the area occupied by this deposit, and how easily might surviving fragments of such a record be missed by a future geological explorer! The area occupied by the deposit will be sinuous and ramified like that of an ancient river-bed. The inlet being so extremely long and narrow, although the rise of the tide is two feet or more at the head of the creek, the interchange of water with the ocean is very small; the water in the upper parts of the creek is merely forced back to a higher level by the tide below at flood-tide, and similarly lowered again at ebb. Hence, after heavy rain, the surface water in all the upper parts of the creek is so diluted by the torrent of fresh water from the stream, that it becomes almost fresh; indeed, at the time of the visit, it was for three or four miles down, as far as explored, so slightly brackish as to be drinkable. At a little depth, no doubt, the water was salt. Here are the most favourable conditions possible for turning marine animals into fresh water animals; in fact the change of mode of life presents no difficulty. Below, no doubt the water is always salt, but the fish find a fluid gradually less and less salt as they rise to the surface. Grey Mullet are caught here in almost fresh water, and Oysters flourish in the same water, and with them Mussels and Crabs; abundance of Medusæ were swimming in the creek above the sand-flats, where there is scarcely any salt at all in the water, yet evidently in most perfect health. Occasionally in times of long drought the water becomes as salt as the sea. A fisherman said that after sudden very heavy freshes of water from the river, some of the shell-fish sickened and died. He accounted for the presence of numerous dead cockle shells (*Cardium*) in the bed of the creek, since he had never found the animals there alive, by supposing that they had all been killed off by some unusual influx of fresh water many years before.

But beyond all that has been described, and beyond the extreme beauty of its wild and rocky scenery, the Browera Creek has yet another interest; it was in old times the haunt of numerous aborigines, who lived on its banks in order to eat the Oysters,

Mussels, and Fish. On every point or projection, formed where a side branch is given off by the main creek, is to be seen a vast kitchen midden or shell mound. So numerous are these heaps of refuse, and so extensive, that it has been a regular trade at which white men have worked all their lives to turn over these heaps and sift out the undecomposed shells for making lime by burning them; unfortunately the numerous weapons thus found in the heaps have mostly been thrown away. There is now not a single black on the creek. Many of the mounds are very ancient, and it must have taken hundreds of years for such heaps to accumulate. Stone hatchet blades are still to be picked up in considerable numbers, and several were obtained. The softer layers weathering out from under the harder slabs of the horizontally bedded sandstones, form numerous shelters and low-roofed caves along the creek banks. It was in these caves or "gunyas" that the blacks used to camp, and in front of all of them a mass of shells slopes down towards the creek just as at the Cape of Good Hope. One of the heaps was dug into; places were found where fires had been made, and there were numerous bits of burnt stick and charcoal, a piece of wallaby bone charred by the fire, and the thigh bone of a black woman. This latter was found without any of the remaining bones, the woman having been perhaps eaten piecemeal. These relics were buried in a mass of cockle, oyster, and mussel shells mingled with much black powdery matter composed of decayed shells and other débris.

The walls and roofs of the caves are covered all over with drawings executed by the blacks in charcoal on the rock. These are interesting from their rude character. They represent Opossums, Fish, Sharks, and white men. Near one of the caves, on a flat slab of stone standing naturally erect, is a figure of a Kangaroo cut out in the stone itself; the figure is 5 feet in height, and is marked out by means of an incised groove, an inch and a half in depth. The figure is shaded, or rather rendered more conspicuous by the chipping of irregular small holes all over the area representing the body, and also, as in the charcoal drawings of Opossums, by means of lines. The fore-legs of the Kangaroo seem not to have been finished, or the artist has been especially unsuccessful in his attempts to represent them, and perhaps has tried to correct them, as appears possible from the number of lines. The contour line of the body is carried across the root of the tail. Similar drawings executed by cutting grooves in stone are common about Sydney.

Besides the drawings, in almost every cave were hand marks. These marks have been the subject of much discussion, and various speculations have been made as to some important meaning of the "Red Hand of Australia." They have been made by placing a hand against the flat stone, and then squirting a mixture of whitish clay and water from the mouth all around. The hand being removed, a tracing of it stands out in relief, and where the sandstone is red, appears red on a whitish ground. The hand marks have evidently been made haphazard, like the drawings.

They are now often out of easy reach, the former floors of the caves having slipped away. They are grouped in all sorts of ways, and amongst them one was seen in which a finger was missing, the native having possibly had a finger cut off as a matter of ceremony. The figure of a whole man is said to exist thus executed, in Cowan Creek, close by. Exactly similar hand marks, made in the same way by the Pueblo Indians, occur in New Mexico in caves in the neighbourhood of the town of Zũni.

The steam pinnace was frequently engaged in dredging and trawling in Sydney Harbour, and the tow-nets were extensively used. Annelid and Ascidian larvæ were especially abundant on the surface, and large collections of Invertebrates were made from the bottom. Of the numerous forms here obtained none were more interesting to the naturalists than *Trigonia* (*Trigonia lamarckii*), a genus of which over a hundred fossil species from Secondary formations of Europe, the United States, parts of South America, Africa, India, &c., are already known. The genus was supposed to be extinct until discovered living in Bass Strait by Quoy and Gaimard, by whom the soft parts were first described. Huxley subsequently gave further details of the anatomy, and Selenka has still more recently published a memoir on this subject. Von Willemoes Suhm, who examined all the recent species known, at the time of his death, thought they might be reduced to four—*Trigonia lamarckii* and *Trigonia strangii* from Port Jackson and Botany Bay, *Trigonia uniophora* from the region of Torres Strait, and *Trigonia margaritacea* (=*Trigonia pectinata*) from Bass Strait and Southeast Australia. Besides these there is in the Sydney Museum (in single valves) a *Trigonia* showing very large tubercles on the radiating ribs like some of the fossil forms, which appears to be undescribed. Since von Willemoes Suhm made the above notes another species (*Trigonia acuticostata*), which was previously only known as a Miocene fossil, has been dredged alive in Bass Strait.

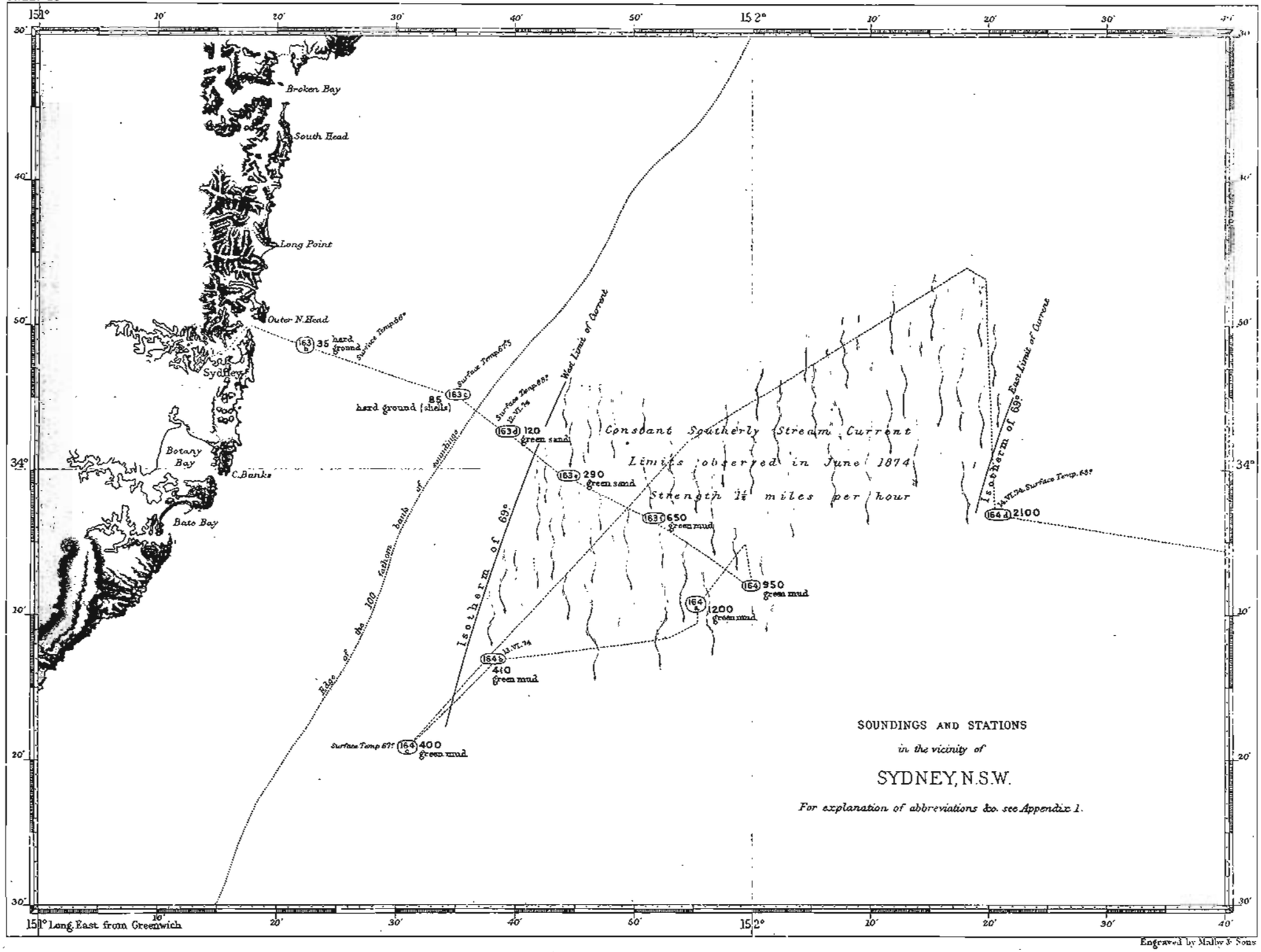
Several specimens of the Port Jackson Shark (*Cestracion philippi*) were also procured, and it is interesting to note that the remains of a closely allied Plagiostomous fish have been found in Secondary deposits along with *Trigonia*.

Von Willemoes Suhm says:—"The Phyllopods got at Sydney belong to the genera *Limnetis* and *Limnadia*, and are especially interesting because of *Limnadia*, found in some places in Europe, is constantly parthenogenetic, the male being known only from the Australian species, as described by Claus. Kreeft says that males and females are constantly found together here, except in the wet season, as now, when no living animals but only some shells, could be got."[1]

The Challenger remained at Sydney from the 6th April to the 8th June, as the ship required docking and a general overhaul, and during this time the members of the

[1] A Dipterous insect was obtained by von Willemoes Suhm, which has been made the type of a new species, *Dasypogon dicersipes*, Kirby (*Ann. and Mag. Nat. Hist.*, ser. 5, vol. xiii. p. 458, 1884).

SHEET 26


151°
10'
20'
30'
40'
50'
152°
30'
40'
50'
34°
10'
20'
30'
Broken Bay
South Head
Long Point
Outer N.Head
Sydney
Botany Bay
C.Banks
Bate Bay
163 b 35 hard ground
Surface Temp 68°
Surface Temp 67.5
163 c 85 hard ground (shells)
Surface Temp 68°
13.VI.74
163 d 120 green sand
163 e 290 green sand
163 f 650 green mud
164 950 green mud
164 a 1200 green mud
164 b 13.VI.74 410 green mud
164 c Surface Temp 67° 400 green mud
Ridge of the 100 fathom bank off Sydney
Isotherm of 69°
Most Limit of Current
Constant Southerly Stream Current
Limits observed in June 1874
Strength 1½ miles per hour
Isotherm of 69° East Limit of Current
14.VI.74 Surface Temp. 65°
164 d 2100
SOUNDINGS AND STATIONS
in the vicinity of
SYDNEY, N.S.W.
For explanation of abbreviations &c. see Appendix 1.
151° Long. East from Greenwich
Engraved by Malby & Sons

Expedition met with great hospitality from the Governor, Sir Hercules Robinson, and the inhabitants of New South Wales. The collections made during the Antarctic cruise were carefully packed and catalogued, and despatched to England in sixty-five large boxes and ten casks.

On the 8th June, at 4 P.M., the Expedition left Sydney for Wellington, New Zealand. At 5.30 P.M., when well outside the heads, sail was made and the ship lay to for the night, ready to sound and dredge the next day, but towards midnight the wind freshened considerably, and the morning of the 9th was so stormy and the sea so short and confused that being unable to get satisfactory soundings, the vessel returned to Port Jackson and anchored in Watson's Bay at 4.30 P.M. until the weather should improve.

Sydney to Wellington.

Rough weather detained the ship in Watson's Bay until 7.30 A.M. on the 12th, when the Expedition again left for Wellington. When outside the heads a course was shaped to the eastward to get a line of soundings into ocean depths, in order to ascertain the nature of the slope from the land for the submarine cable to connect Australia with New Zealand. At 11 A.M. a sounding of 85 fathoms was obtained in lat. 33° 55′ S., long. 151° 35′ E. (see Sheet 26), the position of the ship being fixed by angles to objects on shore, but after this hour the rain squalls hanging over the land prevented the points on shore being seen, so that it was necessary to trust to astronomical observations in ascertaining the position of the other soundings. Proceeding eastward, depths of 120, 290, 650, and 950 fathoms were successively obtained, as shown on Sheet 26. The last sounding, at 5.30 P.M., was fixed by satisfactory observations of Jupiter, Sirius, and Canopus; and observations of the sun for longitude were obtained when the other soundings were taken. The current was found running to the southward at the rate of 2 miles per hour from 0.30 P.M., at which time the surface temperature had risen to 69°·5. After the line was hove in the ship made sail to double-reefed topsails and stood to the northward to stem the current, in order to retain as nearly as possible the same position during the night, so that sounding operations might be resumed early next day.

On the 13th June, at 6 A.M., the position of the ship as ascertained by observations of Saturn, Canopus, and Rigel showed a current of 1⅓ miles per hour to the southward during the night, the surface temperature continuing steady at about 70°. At 7 A.M. a sounding was obtained in 1200 fathoms, the surface current running to the southward at the rate of 1½ miles per hour. The ship then stood in towards the land to dredge. At 11 A.M. a sounding was obtained in 410 fathoms (see Sheet 26), and the trawl then put over. From this Station (164B) the land was distinctly visible from the deck, but Mount Kembla was the only conspicuous object. The current still continued strong to

the southward, and the temperature of the surface water was 69°. At 2 P.M. the trawl was hove up and the dredge put over, another sounding being obtained in 400 fathoms (Station 164c, see Sheet 26). The difference in position between this sounding and that of 410 fathoms is due partly to the drift of the ship whilst trawling, owing to the southerly current. At Station 164c there was very little current, and the temperature of the surface water fell to 67°. Serial observations showed that this temperature extended to the depth of 40 fathoms, after which a gradual decrease took place to the bottom. At 5 P.M. the dredge was hove up, and sail was made to the northward under double-reefed topsails and courses. At 6 P.M. the temperature of the surface water again rose to 69°·7, and continued above 69° during the night.

On the 14th June, at 6.15 A.M., the ship's position was ascertained by observations of α Andromedæ and α Aquilæ, showing a current of 25 miles in a S. 17° E. direction (true) since 6 P.M. yesterday, or 2 miles per hour. After altering the course to get into a convenient position for sounding, the temperature of the surface water fell to 67° at 10 A.M. At 11 A.M. a sounding was obtained in 2100 fathoms at Station 164D (see Sheet 26), and here no current was experienced. At noon sail was made to triple-reefed topsails, and a course shaped to the eastward. A fresh southwesterly gale prevented temperatures being obtained.

The Challenger observations on the current off Sydney, New South Wales, showed that in June 1874 the surface temperature, which was 62° in Port Jackson, and 66°·5 just outside the heads, rose to 69° at a distance of 20 miles from the land, and continued at, or above, that temperature for 30 miles, when it again fell, at 50 miles from the shore, to 67°, and gradually decreased to 63°. When the temperature of the surface water was at, or above, 69°, it was found both by astronomical observations and from observations whilst sounding, that the current was running to the southward at an average rate of $1\frac{1}{2}$ miles per hour; but directly the temperature of the surface fell to 67°, little, if any, current was experienced. The highest temperature registered in the heart of the stream was 70°·7. The impossibility of mooring a boat by the dredge or trawl rope, in order to obtain a good observation of the speed of the current in the centre of the stream, was much regretted, but the weather was very unfavourable, there being strong breezes with a considerable swell, so that the rate could only be estimated whilst sounding, and calculated from the differences between the position of the ship by D.R. and observation. In April, when steaming along the land from Montague Island to Sydney, the stream was found close in shore (from Jervis Bay to Port Jackson); in June, after a continuance of westerly winds, its inner edge was 20 miles from the coast. This seems to indicate that the wind has much to do with the distance of this stream from the shore. The temperature of the stream in April was 72°, and in June 69°, showing a diminution of 3°. The mean temperature of the air at Sydney in April is 65°, and in June 54°·6.

SHEET 27

SOUNDINGS AND STATIONS
in the vicinity of
RAINE ISLET

SYDNEY TO WELLINGTON
touching at
PORT HARDY AND Q. CHARLOTTE Sds

WELLINGTON TO FIJI Is
touching at
TONGATABU
and
FIJI Is TO C. YORK
touching at
API I. AND RAINE ISLET
June, July, August 1874.

For explanation of abbreviations &c. see Appendix I.

Long East from Greenwich 180° Long West from Greenwich

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On the 15th June, at 2.30 A.M., the force of the wind was 10, and as there was a considerable sea on, the waves lifted the lee cutter inboard, and the ship had to bear up to secure it. At 3.20 A.M. the ship was again brought to the wind until the weather moderated sufficiently to allow of sounding. At 6 A.M. star observations showed that a N. 30° E. current of 15 miles had been experienced since noon of the previous day. At 8.30 P.M. the wind began to moderate, and a reef being shaken out of the topsails, the ship wore and stood to the southwestward. The swell was heavy all day, the waves being at least 20 feet from trough to summit.

On the 16th, the weather being favourable, a sounding was taken at noon in 2550 fathoms at Station 164E (see Sheet 27). Unfortunately, the line parted when heaving in, owing to two strands having been cut, probably on its passage out from England, and the circumstance is of special interest since this was the last sounding line lost during the commission. Having obtained temperatures down to 1500 fathoms, at 4 P.M. sail was made towards Cook Strait, but the wind being foul, and falling light, at 8 P.M. the ship proceeded under steam. The surface current was again southerly, its average rate being one mile per hour, the temperature fairly steady at 63°·5.

On the 17th a sounding and dredging were obtained in 2600 fathoms at Station 165 (see Sheet 27); but the dredge came up empty at 4 P.M., when, the weather being fine, with a moderate southerly breeze, sail was made. From observations at 6 A.M. and noon it appeared that during the past twenty-four hours the current had run 23 miles N. 65° W. (true), and whilst sounding the direction and speed were found to be the same, the rate being estimated at about one mile per hour.

On the 18th, the wind being light and variable, the vessel proceeded under steam. The current still running steadily to the northward; by star and sun observations its direction and rate for the last twenty-four hours were found to be N. 15° W. 16 miles, and the surface temperature 64°.

On the 19th, at 2 P.M., a sounding and serial temperatures were obtained in 2600 fathoms, at Station 165A (see Sheet 27), the bottom temperature 34°·4. No current was experienced whilst sounding, but star observations at 6 A.M., confirmed by those at noon, showed a set of S. 60° E., 0·6 mile per hour. The temperature of the surface water fell gradually during the day from 64° to 62°.

On the 20th no current was experienced, thus confirming the observation whilst sounding at 2 P.M. on the 19th; the surface temperature gradually fell to 59°·5.

On the 21st, at 6.30 A.M., a sounding, with serial temperatures, was obtained in 1975 fathoms, bottom temperature 34°·7, at Station 165B (see Sheet 27). The current was S. 23° W., three quarters of a mile per hour, and the surface temperature 59°·5. During the day a fresh northerly breeze was experienced, which at midnight amounted to a gale.

On the 22nd, at 0.20 A.M., the ship was brought to the wind under close-reefed topsails, a fresh gale blowing with dirty rainy weather. At 3 A.M. the wind suddenly

subsided, and at 6 A.M. the weather was quite fine and bright, and the vessel again proceeded on her course. At 1.15 P.M. a sounding and serial temperatures were obtained in 1100 fathoms at Station 165c (see Sheet 27), and then the course was resumed towards Cook Strait. At 6 A.M. star observations proved that a current of 28 miles, S. 39° W., had been experienced since noon of yesterday, but between 6 A.M. and noon there was no current; the temperature of the surface water was 58°·5.

On the 23rd June, at 6.30 A.M., a sounding and trawling were obtained in 275 fathoms, at Station 166 (see Sheet 27). Star observations showed no current at 6 A.M., but between that time and noon a current of 8 miles, S. 56° E., was experienced. Part of this was no doubt due to the drift of the ship whilst trawling in shallow water. At 1.30 P.M. sail was made and the vessel proceeded towards the centre of an imaginary line, joining Mount Egmont and Cape Farewell. At 5.30 P.M. a sounding was obtained in 350 fathoms (Station 166A, see Sheet 27), and star observations showed a current of 7 miles, N. 53° E. since noon, or nearly the same rate, though not the same direction, as in the forenoon. At 10 P.M. a sounding was obtained in 400 fathoms, at Station 166B (see Sheet 27). From these soundings it is evident that a bank extends some 200 miles west of Mount Egmont, and may possibly reach as far as Lord Howe Island.

On the 24th, at 4 A.M., bottom was obtained in 400 fathoms, Station 166c (see Sheet 27). At 6 A.M. star observations showed a current of 9 miles, or three-quarters of a mile per hour, to the eastward since 5:30 P.M. on the previous day. At 7.30 A.M. a sounding and trawling were obtained in 150 fathoms at Station 167 (see Sheet 27). At noon all sail was made for Wellington, no current having been experienced since 6 A.M. At 6 P.M. star observations showed a slight E.S.E. set of half a mile per hour. At 9 P.M. the wind increased and became squally, with rain, which necessitated working to the eastward under steam and fore and aft sails. The temperature of the surface water was 58°.

On the 25th June, at 8.30 A.M., the land about Separation Point was observed, and at 9.30 A.M. the position of the ship was fixed by angles to objects on the shore, showing a westerly current of 16 miles since 5.30 P.M. on the 24th, or of one mile per hour. Passing along the land a remarkable yellow patch was observed at Cape Farewell, which is most probably Sandstone Island, but it is not mentioned in the sailing directions. At 10.30 A.M. the lighthouse on Farewell Spit was seen, and the ship steered for Port Hardy, anchoring there at 5 P.M. in 15 fathoms, off the Squadron Rocks. The vessel remained there until 4 A.M. on the 27th June, when the wind moderated, and at 6 A.M. Stephen Island was rounded, and the ship worked to windward under steam and fore and aft sails; but, finding at noon that Port Nicholson could not be reached that day, the vessel was anchored in Queen Charlotte Sound at 1.30 P.M., between Long and Motu Ara Islands.

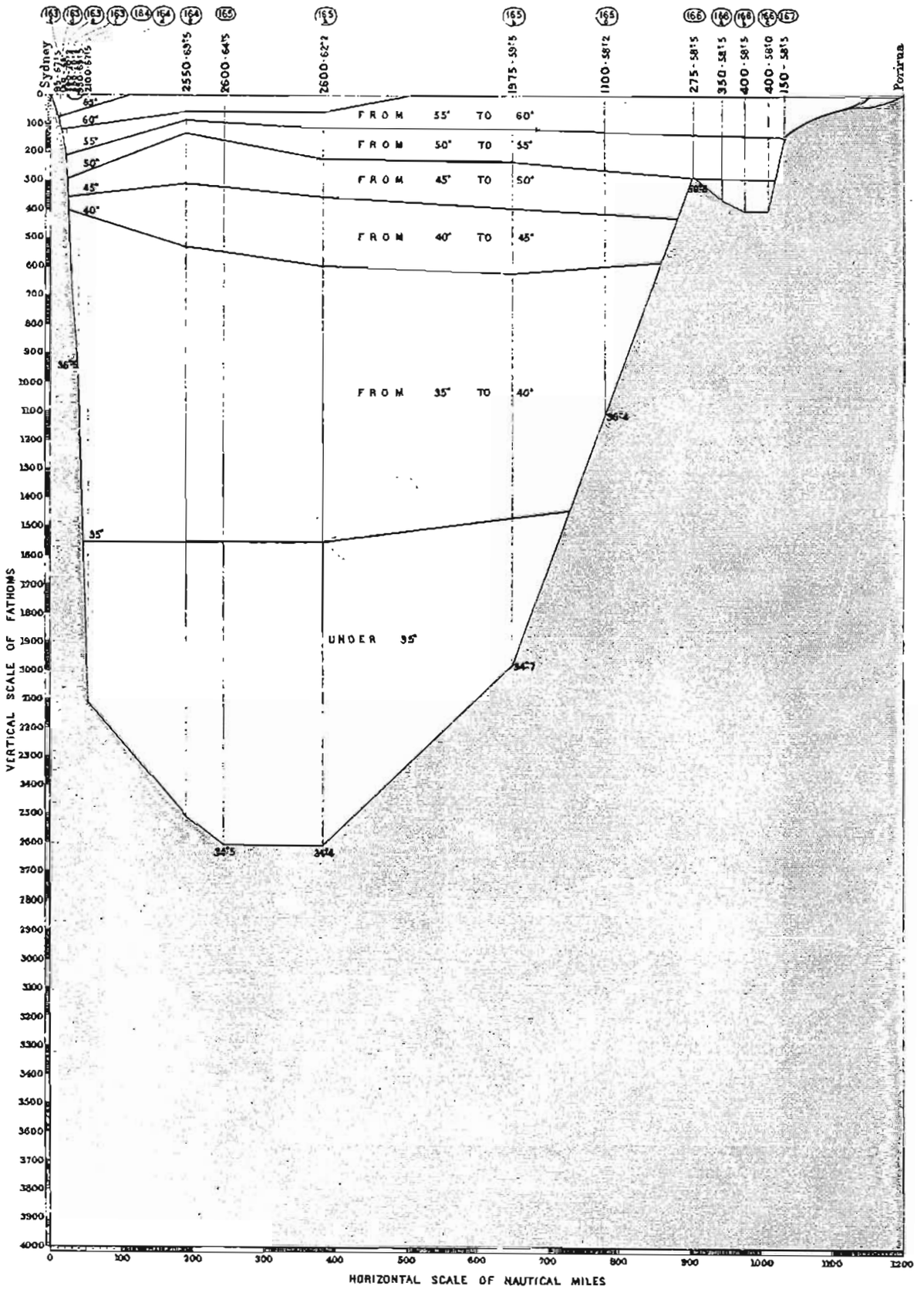
The ship left Queen Charlotte Sound at 8 A.M. on the 28th, and worked to windward under steam and fore and aft sails through Cook Strait for Port Nicholson, against a strong southeast wind, which raised a short heavy sea, so much so that the leadsman

PACIFIC OCEAN

Longitudinal Temperature Section

Sydney, New South Wales, to Porirua, Cook strait, New Zealand.

For explanation of Symbols see Appendix 1.



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was washed out of the chains just after noon; he must have sunk immediately, for although the vessel was stopped for about an hour, no sign of him could be seen. At 4 P.M. the ship entered Port Nicholson, and at 5 P.M. anchored in 9 fathoms off the town. In passing through Cook Strait the surface temperature was found to be 9° higher at the western entrance than in Port Nicholson.

The section from Sydney to Cook Strait shows that on the Australian coast the incline of the bottom from the 100 fathom line (which was 17 miles from the shore), to a depth of 2100 fathoms 57 miles from the land, was about 1 in 20, which is less abrupt than had been previously found to be the case farther to the southward off Twofold Bay, where it was about 1 in 6. From Station 164D, 2100 fathoms, the bottom slopes gradually to 2600 fathoms, at a distance of 240 miles from the coast, and continues at that depth for 140 miles, when it rises with a gentle incline to 1100 fathoms, 780 miles from Sydney, and 335 miles from the entrance to Cook Strait, after which comparatively shallow soundings were obtained (under 400 fathoms) to the entrance of Cook Strait. The most westerly of these shallow soundings was one of 275 fathoms, 200 miles from the land, and 125 miles east of the 1100 fathoms sounding. The bottom on this bank was extremely hard, so much so that but a small quantity was brought up by the sounding rods; but as both the trawl and dredge dragged freely along, without catching in any irregularities, it seems to be smooth on the surface. A reference to the general chart seems to indicate that a bank of soundings, of less than 500 fathoms, extends a considerable distance west of the North Cape of New Zealand. Such being the case, the bank is probably continuous all along the western side of the North Island.

The bottom temperature in this section at depths exceeding 2000 fathoms was 34°·5, in less than 2000 fathoms the temperature increased gradually to the surface.

The surface temperature increased from 62° at Sydney to 69° twenty miles from Port Jackson, remaining at or above that for 30 miles, and then decreased gradually for the next 50 miles to between 63° and 64°, which temperature was retained for 300 miles, after which it gradually fell to 58° at the entrance of Cook Strait.

The serial temperatures show that immediately adjacent to the Australian coast, the warm southerly current appears to affect considerably the position of the isotherms above 45°; the isotherms of 40°, 45°, 50°, and 55° are found at greater depths on the New Zealand side of the section than on the Australian side (see Diagram 11).

The deposits in depths of from 290 to 1200 fathoms off the Australian coast were green muds, containing a considerable quantity of glauconite, and resembling in many respects the deposits at similar depths off the south coast of Africa. The carbonate of lime ranged from 44 to 48 per cent., and consisted of the shells of *Globigerina*, *Orbulina*, *Pulvinulina*, *Pullenia*, *Miliola*, *Textularia*, *Discorbina*, *Cristellaria*, and

other Foraminifera; Coccospheres and Rhabdoliths; fragments of Pteropods, and other pelagic Molluscs; Ostracode valves, fragments of Echinoderms, Polyzoa, and other calcareous organisms. The mineral particles in these green muds were about 0·2 mm. in diameter, and consisted of rounded fragments of quartz, felspars, hornblende, magnetite, mica, volcanic glass, in addition to glauconite. There were a few Radiolarians and Sponge spicules. A quantity of the glauconitic grains and casts were carefully collected, after the removal of the calcareous organisms by dilute acid, and a careful analysis of these was made by Dr. Sipöcz. A microscopic examination of the substance analysed showed it to be, by estimation, made up of about 10 per cent. of white, pale grey, and yellow casts, about 25 per cent. of pale green casts, about 60 per cent. of dark green ones, and about 5 per cent. of mineral particles and siliceous organisms. In practice it was found impossible to separate the siliceous organisms and small mineral particles from the casts.

Analyses of Glauconitic Grains and Casts.

	I.	II.	III.	
Silica (SiO_2),	51·80	...	...	51·80
Ferric Oxide (Fe_2O_3),	24·21	...	...	24·21
Alumina (Al_2O_3),	8·67	...	...	8·67
Ferrous Oxide (FeO),	...	...	1·54	1·54
Lime (CaO),	1·27	...	...	1·27
Magnesia (MgO),	3·04	...	...	3·04
Potash (K_2O),	...	3·86	...	3·86
Soda (Na_2O),	...	0·25	...	0·25
Water (H_2O),	5·68	...	..	5·68
Manganese Peroxide (MnO_2),	traces	...	...	traces
				100·32

I. 0·7312 gramme of the substance fused with double carbonate of soda and potash gave 0·0416 grm. water (H_2O), 0·3788 grm. silica (SiO_2), 0·1896 grm. ferric oxide (Fe_2O_3), 0·0634 grm. alumina (Al_2O_3), traces of manganese, 0·0093 grm. lime (CaO), and 0·0618 grm. magnesium pyrophosphate ($Mg_2P_2O_7$), equivalent to 0·02227 grm. magnesia (MgO).

II. 0·6827 gramme of the substance treated with hydrofluoric and sulphuric acids gave 0·0450 grm. potassium chloride (KCl) and sodium chloride (NaCl), which gave 0·1367 grm. potassium platinochloride (K_2PtCl_6), equivalent to 0·0417 grm. potassium chloride (KCl), corresponding to 0·02634 grm. potassium oxide (K_2O), and 0·0033 grm. sodium chloride (NaCl), corresponding to 0·00175 grm. sodium oxide (Na_2O).

III. 0·3205 gramme of the substance treated with hydrofluoric and sulphuric acids required for oxidation, 0·85 c.c. permanganate of potassium corresponding to 0·00496 grm. ferrous oxide (FeO) [1 c.c. permanganate of potassium = 0·0058355 grm. of ferrous oxide (FeO)].

The two soundings in 2600 fathoms contained respectively 7 and 19 per cent. of carbonate of lime. In 1975 fathoms there was 77 per cent., in 1100 fathoms 84 per cent., and in 275 fathoms 88 per cent. The carbonate of lime in all these consisted essentially of the shells of pelagic Foraminifera, with Coccoliths, Coccospheres, and Rhabdoliths. It will be noticed that the amount of lime was less the greater the depth from which the deposits came, and this was due to the gradual removal of the more delicate and smaller shells. While these small shells and Coccospheres made up most of the deposit at 275 and 400 fathoms, they were very rare at a depth of 2600 fathoms; these organisms appeared to be quite as abundant at the surface over the one locality as the other. The mineral particles were very minute in these soundings, and consisted chiefly of felspars and glassy fragments. As the entrance of Cook Strait was approached, the mineral particles derived from the coast of New Zealand increased both in number and size, and the pelagic shells diminished, while glauconite, which was absent in the soundings from the middle of the section, again made its appearance.

The dredgings along the Australian coast were very successful, and yielded a large number of specimens belonging to characteristic species. In 950 fathoms there were two specimens of *Lætmogone violacea*, Théel, one of the Elasipodous Holothurians. The only other known specimens of this species were subsequently obtained by Mr. Murray at a depth of 555 fathoms in the Færöe Channel, when over three hundred specimens were taken in one haul.[1] Dr. Théel says "it is impossible to discover any characteristic by which these almost antipodal specimens may be distinguished from each other." From 2600 fathoms several Polyzoa, a siliceous Sponge, and some worm tubes were obtained.

The surface nets were continually in use, and the naturalists on several occasions went out in boats to observe the surface life. *Pulvinulina micheliniana* was more abundant than had been previously observed, the best hauls being got when the net was dragged as nearly as possible at 80 fathoms. In the majority of the specimens the brownish-yellow sarcode enveloped the shell, and on two occasions the sarcode was observed thrown out in bubble-like expansions, apparently serving the purpose of a float, similar to what was afterwards observed in *Hastigerina*. Coccospheres were especially

[1] *Proc. Roy. Soc. Edin.*, vol. xi. p. 694, 1882.

abundant on the surface. Minute, quite transparent, masses of jelly were frequently picked up on the surface, which when examined under the microscope were found to enclose great numbers of Coccospheres, and occasionally Rhabdospheres and other foreign particles. These masses of jelly at once recalled the *Myxobrachia* of Haeckel, but it

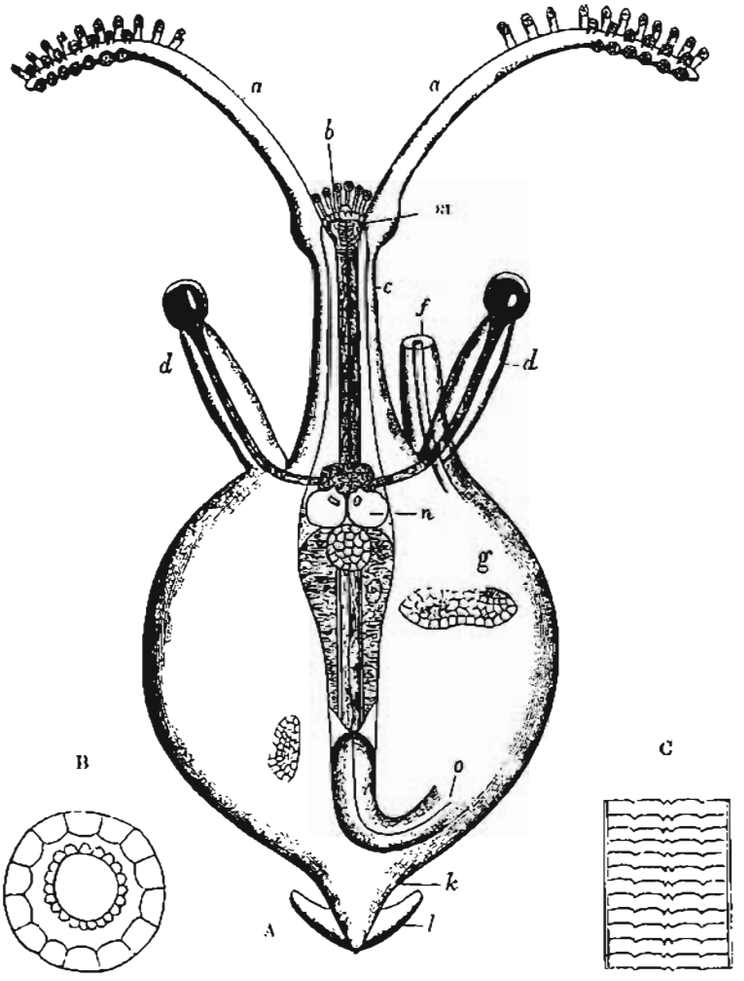


FIG. 173.—(*Procalistes*) *Taonius suhmii*, Lankester.

A. Youngest specimen of (*Procalistes*) *Taonius suhmii*, Lankester, drawn by R. von Willemoes Suhm from a living specimen; magnified 25 diameters. *a*, The long "arms" or processes of the fore-foot; *b*, the six small suckers, representing the eight short processes of the fore-foot of a typical Decapod; *c*, the elongated neck; *d*, the pedunculated eyes; *f*, the funnel or siphon; *g*, the anal process seen through the transparent mantle; *k*, the median posterior process of the body; *l*, the lateral fins attached to the same; *m*, the buccal apparatus; *n*, the oto-cysts; *o*, the intestine.

B. One of the suckers of the long arms, more highly magnified.

C. A portion of the lingual ribbon, more highly magnified.

was impossible to make out in them the structures which that naturalist has described. R. Hertwig has since shown that the various supposed species of *Myxobrachia* are in reality curious malformations of *Thalassicolla sanguinolenta*.[1]

[1] Hertwig, R., Der Organismus der Radiolarien, *Jenaische Denkschriften*, Bd. ii., p. 129, 1879.

Procalistes.—On June 16th, Dr. von Willemoes Suhm found among the surface animals an interesting form, concerning which he wrote in his journal as follows:—"Among the surface gatherings there is a transparent and very interesting Pteropod, with large eyes on the tentacles and without any 'ptera' or foot. Having obtained three more or less

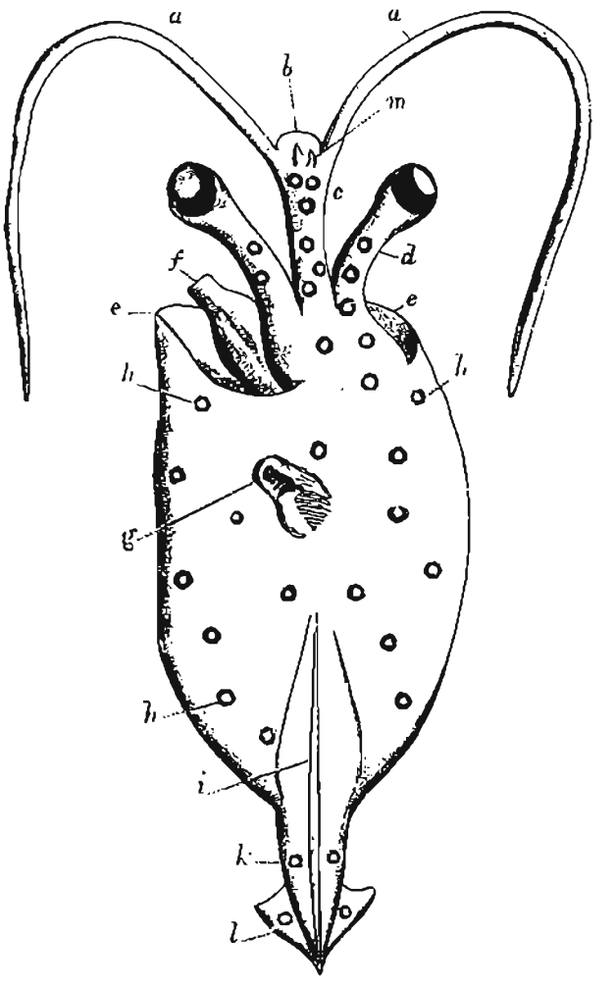


FIG. 174.—A somewhat older specimen of (*Procalistes*) *Taonius suhmii*, Lankester, drawn by Professor E. Ray Lankester, F.R.S., from a specimen mounted on a glass slide in balsam by R. von Willemoes Suhm; magnified 20 diameters.

a, The long "arms" or processes of the fore-foot; *b*, the smooth buccal margin devoid of processes; *c*, the elongated neck; *d*, the pedunculated eyes; *e*, the edge of the mantle flap, separated from its attachment to the head and funnel by pressure; *f*, the funnel or siphon; *g*, the anal process seen through the transparent mantle, and showing a spiral band of black pigment lying in the ink-bag; *h*, chromatophores; *i*, the pen; *k*, the median posterior process of the body; *l*, the lateral fins attached to the same; *m*, the two horny beaks of the buccal apparatus.

damaged specimens from which I could not complete its anatomy, I shall have to defer giving a proper account of it. The animal belongs to the Clionidæ, and is probably allied to *Pelagia*, Quoy and Gaimard."

He also made a drawing of the animal to which are appended the following notes :— "Clionid Pteropod: June 16–18, 1874. In the warm East Australian current coming from the north (surface temperature 70°), together with *Calcarella* on the voyage from Sydney to Wellington. In all only three specimens, of which the largest alone showed the eyes well. It measured 13 mm. long; tentacles 6–7 mm. long; eye-peduncles 2 mm. long. Neither of the smaller specimens showed anything new. Tentacles with suckers, of which one is strongly magnified below (woodcut, fig. 173B). Mouth with six suckers, two teeth, and radula; the latter, as far as I could make it out without injury to the animal, is drawn below to the right hand side (woodcut, fig. 173c). The mouth leads into an œsophagus; this into a muscular stomach, in the muscular wall of which is a unicellular gland *à la nematode.* Sharply defined intestine which I could not follow out to the anus on the process to the right (woodcut, fig. 173, *f*). Ganglion superius sends out the nerves to the eyes; between it and the ganglion inferius are the two otolithic vesicles. On the right side the generative gland is seen with reddish oil specks, and in the corner black pigment; to the left is a cellular body, probably an excretory organ. Subsequently it seemed to me as though there were a calamus in the hindermost portion of the animal; this must, however, have been a mistake. Heart not seen."

Professor Lankester, after an examination of the drawing and the specimens, showed the animal to be a Dibranchiate Cephalopod, and erected it into a new genus *Procalistes*, one of the characters of which was the absence of suckers[1] (fig. 174). Mr. W. E. Hoyle has since had the opportunity of examining several other specimens in the Challenger collection, and of comparing them with those of the genus *Taonius*, Stp., in the Copenhagen Museum, and believes that the form in question is a new species of that genus; the reasons for this view will be given at length in the Report on the Cephalopoda.

WELLINGTON.

The former observing position at Port Nicholson was Pipitea Point, but owing to the New Zealand Government reclaiming the ground off the Point, and from it to the southward, and to the fact that a railway runs into Wellington past the old observing station, satisfactory observations could not be obtained there, consequently it was necessary to select another position, and the Protestant Cathedral was chosen for the purpose, which is 5″ S. and 13″ W. of the former observing station.

The coast hills in this part of New Zealand, as seen from the sea, recalled Kerguelen Island in the general appearance and colour of their vegetation, especially the shores about D'Urville Island, but all the valleys and inland slopes are covered with a dense

[1] Lankester, On Procalistes, a young Cephalopod with pedunculate eyes, taken by the Challenger Expedition, *Quart. Journ. Micr. Sci.*, N. S., vol. xxiv., pp. 311–318, 1884.

forest and almost impenetrable bush. The trees are covered with epiphytic ferns, Astelias, and Liliaceous epiphytes, which, perched in the forks of the branches, remind one in their habit and appearance of the Bromeliaceous epiphytes of Tropical America. One of the most remarkable trees, as pointed out by Mr. T. Kirk, F.L.S., is the Rata (*Metrosideros robusta*).[1] This, though a Myrtaceous plant, has all the habits of the Indian Figs, simulating them in the closest manner. It starts from a seed dropped in the fork of a tree, and grows downward to reach the ground; then having taken root there, and gained strength, chokes the supporting tree and entirely destroys it, forming a large trunk by the fusion of its many stems. Nevertheless, it occasionally grows directly from the soil, and then forms a trunk more regular in form. Another species of Rata (*Metrosideros florida*) is a true climbing plant.

Few birds were seen. The Gull of Kerguelen Island (*Larus dominicanus*) was common in the harbour. On the telegraph wires along the shore sat a Kingfisher (*Halcyon sanctus*) in abundance, and dashed down from thence on its prey into the shallow water of the harbour. It was interesting as being the first Kingfisher met with on the voyage leading a littoral existence and feeding on sea fish. Afterwards Kingfishers similarly inhabiting the sea shores became familiar in the Strait of Magellan. In the poulterers' shops the curious parrot, or Kaka (*Nestor meridionalis*), was hung up for sale. Mr. T. H. Potts[2] describes this bird as tearing away the dead wood of trees in search of insects, and appearing by its habits to replace to some extent the woodpecker, which is totally absent in New Zealand.

The New Zealand *Peripatus* (*Peripatus novæ zealandiæ*)[3] is abundant near Wellington amongst dead wood, and forty or fifty specimens were brought to the ship as the result of a day's search in the Hutt Valley. As in the case of the species from the Cape of Good Hope (*Peripatus capensis*), the males are much less abundant than the females. In essential structure and habits the animal closely resembles the South African species, but is distinguished by having fewer pairs of feet, viz., fifteen instead of seventeen. The females all contained young, although it was mid-winter (see p. 284).

Land Planarian worms are also pretty common near Wellington. In their anatomical structure, the New Zealand species are more nearly allied to South American forms of the genus *Geoplana* than to the Australian Land Planarians. These latter belong to a special genus (*Cœnoplana*), which has affinities with the genus *Rhynchodemus* of India and the Cape of Good Hope.

Mr. W. T. Travers, F.L.S., to whom the Expedition was indebted for much kindness and scientific information during the stay at Wellington, brought on board specimens of *Peripatus novæ zealandiæ* and also of Land Planarians, together with the egg capsules

[1] T. Kirk, F.L.S., On the Habit of the Rata, Metrosideros robusta, *Trans. New Zealand Inst.*, vol. iv. p. 267, 1871.
[2] *Trans. New Zealand Inst.*, vol. iii. p. 82, 1870.
[3] H. N. Moseley, *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xix. pp. 85–91, 1877.

of the latter, which were hitherto unknown. They are spherical in form, of about the size of sweet-pea seeds and of a dark brown colour. The capsules have a tough chitinous wall, and each contains four or five young Planarians.[1] Mr. Travers also presented a Maori skull; and other Maori crania, together with some crania of the Chatham Islanders, were given by the authorities of the Colonial Museum.[2] From the same Museum also some bones of Cetacea were obtained, which have been described by Professor Turner in his Report on the Bones of Cetacea collected by the Expedition.[3]

The Governor of the colony, Sir James Fergusson, and many of the inhabitants gave entertainments in honour of the Expedition.

Wellington to the Kermadec Islands and Tongatabu.

On the 6th July, at 4 P.M., the Expedition left Lambert Harbour, Port Nicholson; but when passing Gordon Point the weather became so thick that it was not considered advisable to proceed; the ship was therefore anchored for the night in Worser Bay, and finally left Port Nicholson at 6.40 A.M. on the 7th, rounding Cape Palliser at 11.20 A.M., and then a course was shaped to the northward along the coast as the wind permitted. Some difficulty was experienced in distinguishing the hills north of Cape Palliser, owing principally to the fact that their heights had not been determined. On leaving Port Nicholson the temperature of the surface water rose from 47° to 52°, or 5° less than at the western entrance of the Strait.

On the 8th July, at 10 A.M., a sounding was obtained in 1100 fathoms, and afterwards a trawling and serial temperatures. The surface temperature rose at 1 A.M. to 57°, or nearly the same as on the other side of the island, showing that the cold surface water is almost entirely confined to Cook Strait, and is probably caused by tidal action over a shallow bottom. Whilst sounding the surface current was running slowly to the northward, but the observations showed a total drift of 19 miles, S. 39° E., since noon of the previous day. The weather being calm and fine steam was used until 1 A.M. on the 9th, when a breeze sprang up from the southwestward, which enabled the ship to proceed under sail. In the evening there was a most wonderful display of phosphorescent light on the surface, caused by *Pyrosoma*, the ship passing through several "banks" of them.

On the 10th, at 6 A.M., a sounding, trawling, and temperatures were obtained in 700 fathoms (see Sheet 27), 40 miles east of East Cape. On the 12th and 13th a strong easterly current was experienced, which continued regularly up to 6 P.M. on the 13th, as was seen from both star and sun observations. At 10 P.M. on the 13th Macauley Island,

[1] H. N. Moseley, On the Anatomy and Histology of the Land Planarians of Ceylon, *Phil. Trans.*, vol. clxiv. pp. 105–171, pls. x.–xv., 1874. Also Notes on the Structure of Several Forms of Land Planarians, *Quart. Journ. Micr. Sci.*, N. S., vol. xvii. p. 275, 1877.

[2] Zool. Chall. Exp., part xxix., 1884.

[3] Zool Chall. Exp., part iv., 1880.

one of the Kermadec group, was sighted, and the ship passed between it and Raoul or Sunday Island.

At 6 A.M. on the 14th star observations showed a strong northerly current. At 7 A.M. a sounding and trawling were obtained in 520 fathoms at Station 170 (see Sheet 27). Raoul and Macauley Islands both being in sight, and the former having been surveyed and fixed by Captain Denham, it was possible to determine the height of Macauley Island, which proved to be 800 feet. From the northward Macauley Island appeared to be wedge-shaped, but from the eastward it looked round-backed. At noon another sounding and trawling and serial temperatures were taken in 630 fathoms (Station 170A, see Sheet 27), and at 4.30 P.M. the ship proceeded to the northward under steam, passing west of Raoul Island.

Kermadec Islands.—The Kermadec group of islands, which are all very small, forms with New Zealand, Macquarie Island, and the Tonga group, a direct line of volcanic action, stretching in a northeasterly direction, and thus nearly at right angles to the northwest lines, which are followed by many of the remaining Pacific groups, such for example as the Fijis.

The flora of Raoul Island was described by Sir J. D. Hooker[1] from collections made by Mr. Macgillivray of H.M.S. "Herald." Forty-two vascular plants are known from the islands, of which five are endemic species. Half the number are New Zealand ferns; the large proportion of ferns in the flora is most remarkable, and also their New Zealand character. The group lies just at the northern limit of the zone of westerly winds, and within that of calms and changeable winds, but so close to the limit that the winds may well have transported many of the plants, and the preponderance of ferns may possibly be due to the fact, that the winds have been the main agents in transporting vegetation to the islands, and have sufficed to carry the minute fern spores, whilst heavier seeds have seldom reached the island, by other means of transit. If fern spores be diffused mainly by wind, it should be especially difficult for them to cross the zones of constant rains, and there ought to be a marked separation of fern forms in distribution about those lines. There is no connection between the flora of the Kermadecs and that of Norfolk Island, although on all considerations such would have been expected to occur, as is also pointed out by Sir J. D. Hooker. The soundings of the "Gazelle" and "Tuscarora" have proved that a channel of more than 1000 fathoms in depth passes up between New Zealand and the Kermadec Islands, hence an ancient land connection cannot be looked to as an explanation of the New Zealand affinities of the Kermadec flora.

On the 15th July, at 6.30 A.M., a sounding and trawling were obtained in 600 fathoms, in lat. 28° 33′ S., long. 177° 50′ W. From this position Raoul Island was just visible,

[1] Sir J. D. Hooker, Botany of Raoul Island, *Journ. Linn. Soc., Lond.* (Bot.), vol. i. p. 125, 1857.

bearing S. ¼ E. After trawling, sail was made at 10 A.M. towards the Friendly Islands. It was intended at first to try to pass over the La Rance Banks, but on due consideration it was thought more advisable to avoid them, as from the description given they appear to be merely the shoal parts on the outside of a large coral bank, which would require more time to survey than could be spared for the purpose.

On the 17th, at 9 A.M., a sounding and serial temperatures were taken in 2900 fathoms, at Station 171A (see Sheet 27), the bottom temperature being 34°·3, slightly colder than that between Australia and New Zealand, after which the ship again proceeded towards the Friendly Islands. During the past forty-eight hours a strong easterly current was experienced, running more than a mile per hour.

After leaving the Kermadecs, no Cape Pigeons, Albatrosses, Prions, nor any other of the southern birds, which had been constant attendants on the ship while in the Southern Ocean, were noticed. For several days between the latitudes of 25° and 28° S., no birds were noticed from the deck of the ship. The night before arriving at Tongatabu a *Phaëthon flavirostris* came on board; it flew straight at the quartermaster's light near the wheel, and nearly knocked it over.

On the 19th, at 3 A.M., having run within 15 miles of the island of Eooa, the vessel was hove to until daylight, the weather being dark and misty. At 6 A.M. sail was made for Tongatabu, the low land of which and of Euaigee Island were seen at 7 A.M., and at 9 A.M. the ship proceeded under steam through the east channel for the anchorage.

Between Wellington, New Zealand, and Tongatabu the Stations were few, and at too irregular distances to admit of a section being constructed; the deepest water obtained was 2900 fathoms, where the bottom temperature, as stated above, was nearly the same as that between Australia and New Zealand, but sufficient observations were obtained to allow a temperature section being drawn between New Zealand and the Fiji Islands, from which it will be seen that the isotherms all close together as the latitude decreases, or in other words that whilst the surface temperature gradually increased from 57° to 78°, the isotherm of 40°, which at New Zealand was at the depth of 800 fathoms, was found to be only 490 fathoms from the surface at the Fiji Islands (see Diagram 12).

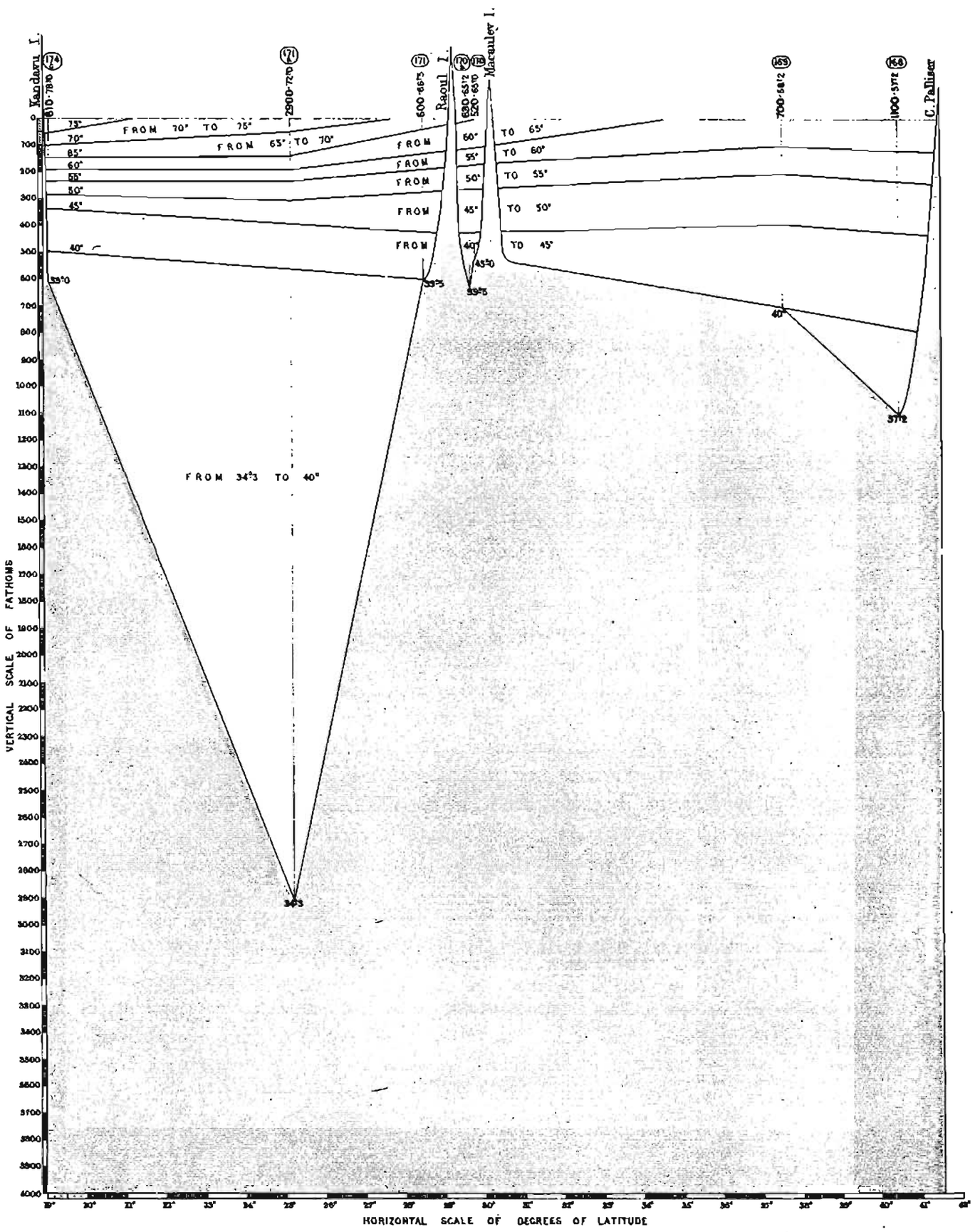
The deposits off the east coast of New Zealand in 1100 and 700 fathoms were blue muds, with a thin characteristic layer of a reddish colour on the surface. They contained only from 4 to 9 per cent. of carbonate of lime, the chief part of the deposit consisting of continental débris derived from the neighbouring land. The dredgings were rich in *Pourtalesia laguncula*, Agass., *Scrolis bromleyana*, Suhm, *Protocaulon molle*, Köll., and *Leptoptilum gracile*, Köll., and contained a very large number of other deep-sea species in addition.

The deposits off the Kermadec Islands in 520, 630, and 600 fathoms were volcanic muds, containing very many large blocks of pumice. The dredgings here also yielded

PACIFIC OCEAN

Meridional Temperature Section. Kandavu I. to C. Palliser, New Zealand.

For explanation of Symbols see Appendix 1.



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many deep-sea forms. A very large fragment of a huge new Hexactinellid Sponge was brought up from 630 fathoms. This will be described by Professor Schulze under the name of *Poliopogon gigas;* it measured about 2 feet by 3 feet 6 inches. Many of the deep-sea forms obtained here were identical with those found in the Atlantic. The deposit at 2900 fathoms was a red clay, which showed only a very slight trace of effervescence with weak acid, and did not contain more than one per cent. of carbonate of lime. The mineral particles were very small, the bulk of them being less than 0·05 mm. in diameter, and consisted of felspar, magnetite, and hornblende; there were, however, some large fragments of pumice, while the great bulk of the deposit was composed of very minute fragments of pumice.

Tongatabu.

Euaigee Island is higher than the other islets, and can be seen farther than Tongatabu itself. A narrow coral reef fringes its shore, and off its southeast end is a small detached reef, about half a mile from the island. From the east point of Tongatabu along the coast to the southward, the fringing coral reef does not extend above a few yards from the shore; but from the east point to the westward it gradually extends until it reaches a distance of about a quarter of a mile from the land. From the point opposite Onevah Islet to Makkaha Island, the coral patches on the south side of the channel into Tongatabu anchorage are much broken up and ill-defined, whilst the reef on the north side of the channel has a sharp edge with no outlying knobs. It is therefore preferable to sail near to this side. The quarter fathom rock in the channel between Makkaha and Monuafai Islands is not exactly in the centre of the channel, the passage on its western side being wider than that on the eastern. On a dull day this rock cannot be readily distinguished; but the edge of the reef extending from Makkaha Island is well-defined, and by keeping close towards it, the rock will be avoided. The church on the hill at Nukalofa is a most conspicuous object. At noon the ship anchored off it, with Faffao Island N. 31° E., the right extremity of Pangimodu, in line with the left extremity of Onevah N. 81° E., King's House S. 16° W., in 13 fathoms.

Three whaling vessels were at Tongatabu when the ship arrived, and from them it was ascertained that Raoul or Sunday Island of the Kermadec group, had been abandoned, in consequence of a sudden eruption of the volcano, by an American family who had settled there. The island was certainly quite quiet when the Challenger passed, not the slightest sign of smoke issuing from any part, but the whalers said that this state of things was exceptional, and they reported also that a rock or shoal rose, and again sunk, in its west bay.

The whaling season at the Friendly Islands commences in the middle of June, and continues to the end of October; during this time the Humpbacked Whale (*Megaptera lalandi*) frequents the neighbourhood of these islands for breeding purposes, and is then easily captured. Several whales were passed just outside the reefs. A small

German vessel, belonging to the firm of Godeffroy Brothers, the famous collectors of South Sea Island productions, was also at anchor in the harbour.

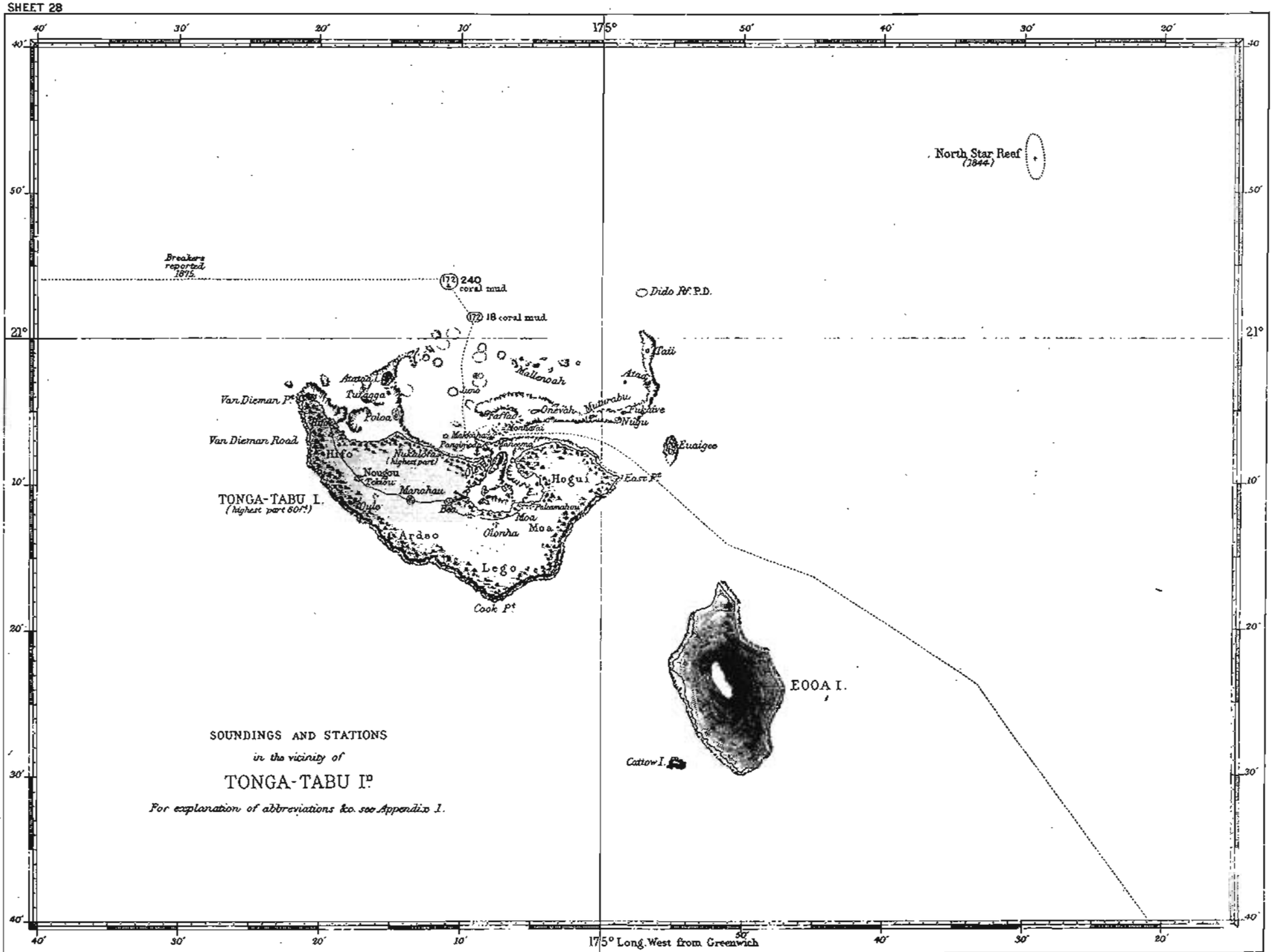
The sky was dull, covered with grey clouds, and the air even somewhat chilly as the islands were approached, and they did not look bright and sunny, as might have been expected of the first South Sea Islands met with on the voyage. As the small island of Eooa was passed, the surf in places raised jets of spray at its base, looking from a distance like thin white smoke.

Tongatabu was seen 7 miles distant from Eooa, stretching along the horizon as a long narrow neutral tint band, with an indented upper margin; towards the northern end the band thinned out into isolated rows and groups of palm trees, which looked like dots on the watery horizon. As the vessel approached nearer, the forms of the cocoanut trees became more and more distinct. At length sail was shortened and the Challenger steamed through the reefs with a long stretch of palm-covered land on the one hand, and numerous islets on the other, some bearing many cocoanut palms, others few.

The main island is exceedingly flat and low, its highest point being only 60 feet above the sea level. It thus stretched itself before the view as a green horizontal streak of uniform width, the width being due merely to the height of the vegetation; here and there at the water's edge were seen small inlets and stretches of white sandy beach, or low honeycombed and weathered clifflets of coral rock. Above these appeared a band of dark foliaged shrubs, and shrubby trees with shore-loving plants growing in the sand at their feet; and as a background behind, rose a mass of cocoanut trees of various heights, but densely packed together, and thus forming with their crowns a tolerably even line; no palms other than cocoanuts were to be seen in the mass. On the small scattered islets which were near at hand, Screw Pines (*Pandanus*) were conspicuous, their stems surrounded with prop-like aerial roots, whilst on the main island these trees, which are numerous along the shore, were almost lost to view against the general background of dark foliage.

As the vessel steamed on, there came into view beneath the cocoanut trees on the shores, the villages of the islanders, composed of small houses of palm mats and grass thatch, and as the news spread, the villagers assembled on the beach in their conspicuous white or red clothing, to gaze at the ship. Not until the ship had passed the most difficult twist in the passage into the harbour, did the pilot come out, in a small English-built whale-boat belonging to the king, manned by four sturdy Tongans. These were naked, except that they had a cloth round the waist, and one of them a further girdle of green Screw Pine leaves; they had all, however, linen shirts with them, which they put on as they became cool; and the coxswain, formerly a Mataboolo, or lord amongst the Tongans, had on a pea jacket also. As is always the case, the men being so little clothed, appeared bigger than they really were. They were, however, remarkably finely made men, with all their muscles well developed, and all of them were extremely

SHEET 28



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well nourished. The Tongans have large broad foreheads and faces, the lower jaw being wide at the articulation, the chin narrowing off rather abruptly from the face. The nose is flattened, but not very much; the eyebrows straight; and the lips neither large nor protuberant. The colour of the skin is a light brownish yellow with a tinge of red (see Pl. E. fig. 5). Their hair forms the most remarkable feature in their appearance, being worn in a sort of mop sticking straight up from the head, and composed of a mass of small curls; naturally it is black, as are the eyebrows, beard, and moustache, which latter are, however, scanty as a rule; but it is altered to a rusty colour by the application of coral lime, which is usually only applied partially, so as to give variety from the contrast between the black and red locks. With some the centre of the head is left black, and a marginal zone coloured red; with others isolated locks all over the head are reddened so as to show a black mop variegated with red, and various other fashions are adopted. The Tongans often sit on their heels like Indian races, but more usually cross-legged in the posture in which Buddha is ordinarily represented.

To those who had read Mr. Darwin's work On the Expression of the Emotions, the unusually marked development of facial expression exhibited by the men conversing in the boat with one another was very striking. The muscles of the forehead during animated conversation are contracted and relaxed incessantly, and in a most varied manner; the brow is strongly wrinkled, and the eyebrows are jerked up to such an extent as to remind the observer at once of the jerking up of the eyebrows in monkeys. Mr. Moseley made as careful a study as time would permit of the various expressions of the emotions; all of them appear to coincide in their intimate character with those of Europeans, and this holds good also in the case of the expressions of children, but the movements made use of are much more strongly marked in the Tongans than in Europeans: thus, for example, in the expression of astonishment the eyebrows are thrown up with a succession of strong jerks, not merely raised once as with Europeans. The use of the forehead muscles is very peculiar, and indeed seems to be the most characteristic feature in a Tongan. No similar exaggerated facial expression was observed amongst Hawaiians or Tahitians, nor was there anything of special interest noticed about their means of expression; probably they have copied European modes to a large extent. In some of their gestures the Tongans differ remarkably from Englishmen; in beckoning a person, they use, like the Malays and others, the hand with its back turned towards their bodies, and the palm directed towards the person called; the hand is moved downwards and inwards, instead of upwards and inwards as by Europeans. In affirmation the head is jerked slightly upwards, the eyebrows being raised a little at the same time. One of the missionaries who visited the ship was asked about this matter, and to test it he pronounced the word for "yes," and involuntarily threw up his head. The gestures accompanying the language are necessary to its perfect use, and to speak without them would be like speaking a European language with a false accent. In negation, the

head is sometimes moved slowly from side to side, but never shaken. In pointing out the way to a place, the lips are pouted in order to indicate direction at the same time that the hand is used to point with in the ordinary manner. The use of the arms and head in gesture language is very remarkable, and conversations are carried on thus in an extremely animated manner with the help of very few actual words.

As has been said, the coxswain of the pilot's boat, the ex-member of the nobility, wore a pea-jacket; when a photograph was taken of the boat's crew, it was impossible to persuade him to take it off in order to make the group uniform; he would only promise that if he were photographed in the group with the jacket on, he would allow himself to be taken separately afterwards without it. The jacket was a thick garment of the usual pilot cloth, fit only for an English winter, but the man evidently regarded it as a decoration and mark of distinction, and a proof that he was coxswain.

Much difficulty was experienced in getting a lock of hair from one of the boat's crew, and success was attained only by the help of a missionary, who explained that it was not wanted for purposes of witchcraft. The man also evidently was loth to part with even a single lock of what was his chief pride.

The Friendly Islands were, at the time of the Expedition's visit, treated as an independent power; they had a national flag (white cross quartered on red), a King, taxes, and other accompaniments of national life. A poll tax of seven dollars a year was levied on each adult, a duty of one dollar per gallon on wine, two dollars per gallon on spirit, and one shilling on each bottle of beer, and there was a charge of £100 for a licence to sell intoxicating drinks. In consequence of these prohibitory duties no liquor was sold at any of the islands, and to protect the morals of the natives, seamen were fined if they remained on shore after 9 P.M.

The most prominent feature in the town of Nukalofa (see fig. 175), as the principal place in the island is called, is the small white church which stands on the summit of a rounded hill about 40 feet in height. Conspicuous also is the King's House, a respectable looking small one-storied wooden building with a verandah. There is, further, the Government Building, a neat wooden structure with a tower in the centre and a wing on either side, each containing a single office. Here the revenue of the Friendly Island group, which amounts to about £7000 or £8000, is dispensed, and the King's seal attached to documents. At a small printing office close by an almanac, a magazine, bibles, and a few books are printed in the native language. The remainder of the town consists almost entirely of native houses. The houses of the Tongans are small and oblong in shape, about 20 feet by 10 feet in dimension; the walls are of reed mats or plaited cocoanut leaves, and the thatch of reeds; the posts and beams, often of cocoanut stems, are lashed together with plaited cocoanut fibre; the ground within is simply covered with *Pandanus* mats. There are usually two doors or openings opposite one another in the middle of each side of the house, which are closed with a mat only, and in most

houses a sleeping chamber is partitioned off at one end by means of mats. The only furniture to be seen within is the kaava bowl and the pillows, wooden rods supported on four legs, on which the neck is rested in sleep in order that the elaborately dressed hair may not be disarranged. Most Polynesians, and various other races, such as the modern Japanese, use similar pillows, and they were also used by the ancient Egyptians. Long practice is required to allow of their use. Near the houses are small sheds, underneath which a hole in the ground serves as an oven for cooking. The houses at Nukalofa are clustered under the cocoanut trees, with three or four open roadways between them.

The people are remarkably hospitable, and delighted to get a strange visitor into their

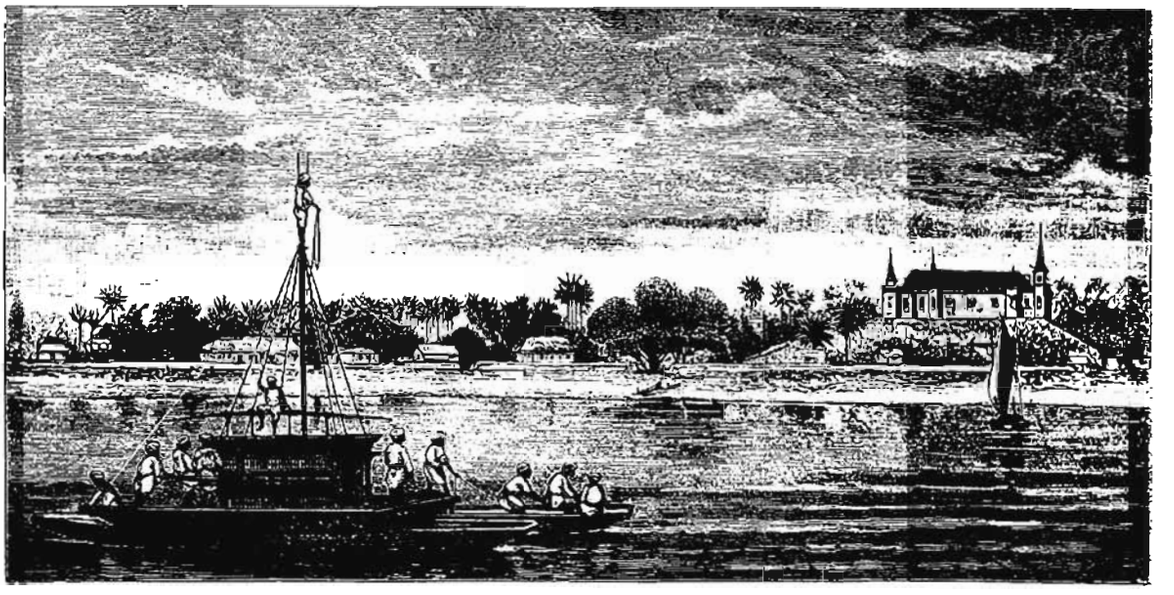


FIG. 175.—Nukalofa, Tongatabu.

houses to sit and communicate what little can be managed in this way between persons knowing almost nothing of each other's language. They offer kaava or cocoanuts as refreshment. The women are large, have fine figures, and are, most of them, handsome. They wear a cotton cloth round the loins reaching down below the knees, or often, and especially on week-days, a "tappa" or native cloth made from the bark of the paper mulberry. The missionaries have compelled them to cover their breasts, which is done with a flap of cloth thrown up in front, and a fine is imposed on any woman seen abroad without this additional covering. The women, however, evidently have little idea of shame in the matter, and often the cloth is put on so loosely that it affords no cover at all. The hair of the women was formerly cut short as amongst so many savages where the men keep to themselves the right of cultivating and decorating the hair, but now it is

often allowed to grow long and fall down the back; it is oiled and powdered with sandal-wood dust as a perfume. On Sundays a few women appear in complete European dress, wearing muslin gowns, and hats profusely decorated with gaudy artificial flowers. The girls are most accomplished coquettes. The missionaries have prohibited dancing, and also the chewing of the kaava root, which is now grated instead. The chewing method was believed to spread disease. The people are diminishing notwithstanding all the efforts of the missionaries, there being now only about 8000 islanders in the whole group.

The Tongans are a fine manly race, and delighted everybody, and a longer stay in their island would have been appreciated by the Members of the Expedition. They are extremely merry, fond of practical jokes, and when a crew of them was rowing anyone on shore, they kept playing all kinds of pranks on one another between the strokes of the oars, such as bending over and catching at each other's legs, and were full of laughter the whole time.

Some difficulty was experienced in persuading one of the natives to get fire by friction of wood. Matches are now so common in Tonga that the natives do not care to undergo the labour necessary for getting fire by the old method, except when driven by necessity. No doubt the younger generation will lose the knack of getting fire by friction altogether. The method adopted in Tonga is the usual Polynesian one of the stick and groove. The wood of the "Vau" (*Hibiscus tiliaceus*), which when dried is extremely light, is used for this purpose. In order to procure fire, a stick or stout splinter of very dry wood about a foot in length is cut at one end so that it has a sharp edge bounded by two sloping surfaces on one side of the end. The side of the tip is thus in the form of a wedge with a sharp edge. This stick is held in a slanting position between the two thumbs crossed behind it, and the fingers of the two hands crossed in front of it. The sharp edge of the wedge is applied to the surface of a large billet or stem of the same dry wood, and the stick is rubbed backwards and forwards, a certain amount of pressure being exerted. A V-shaped groove is thus cut into the billet about four or five inches in length. If the piece of wood to be grooved is rounded and smooth, a slight score is sometimes made upon it with a knife beforehand in order to prevent the stick from slipping. Of course everything depends on the larger billet being kept absolutely immovable during the process; sometimes the operator holds it with his own feet, or often gets some one else to stand on it for this purpose. The stick is rubbed backwards and forwards slowly at first. It must not be pressed too hard or the rubbing surfaces become polished, nor too softly or no heating results. A great deal of the knack of getting fire readily, no doubt, depends upon applying the exact amount of pressure. If the operation is proceeding well, there should be a constant feeling of slightly grating friction to the operator as he rubs, and a fine powder should be rubbed off from the surface of the groove, and pushed along by the end of

the stick, so that it accumulates at the far end of the groove in a small heap. Great care must be taken that this small heap of powder is not shaken or blown away. The friction being kept up slowly and steadily, the sides of the groove begin to blacken and soon to smoke. Rapid strokes are now resorted to, the fine dust rubbed off becomes black like soot, and at last ignites at the end of the stroke just as it is pushed into the small accumulated heap, which acts as tinder. A tiny wreath of smoke ascending from the heap shows that the operation has been successful. A gentle blowing soon sets the whole heap aglow. The operation is excessively tiring to the wrists, since it has to be prolonged for a considerable time, but the greater the practice the less the waste of force. Very few Europeans have been able to get fire by friction in this way with their hands unassisted by mechanical appliances, though Mr. Darwin succeeded at Tahiti, and Dr. Goode, R.N., frequently lighted a candle in this way to show the process on board H.M.S. "Dido" at Fiji. It is easy enough to get smoke and char the wood a little, but very difficult to get the actual fire. The slightest halt during the friction is fatal.

The old stone implements have entirely gone out of use in Tonga, and they are not plentiful. Several were bought from natives who had them put away in their houses. They call them "toki Tonga," Tongan axe, or adze, in distinction to foreign axes, whereas the Sandwich Islanders speak of their adzes as stone adzes "pohaku koi." All the stone adzes seen were unmounted; no doubt the handles had been used long ago, when iron was introduced, to fasten hoop iron blades to in place of the discarded stone ones. The manners and customs of the ancient Tongans are probably better understood than those of any other Polynesian Islanders, because of the existence of Mariner's well-known account of them.[1]

The island of Tonga is about 27 miles in extreme length and 10 in extreme breadth, and is entirely composed of coral reef rock, without, as far as is known, any blown sand formation. The sand on the beaches is scanty. The presence of blown sand rock on coral islands must depend on the freedom of some part of the coast from breakwaters of coral, in order that a heavy surf may form sand in abundance. In Bermuda the sand is derived from the unsheltered side of the island. In some rock about 30 feet above sea level were seen, as Dana describes, some Brain Corals imbedded in the position in which they had grown. About the reefs are to be seen curious cylindrical blocks of coral standing on end, and often hollowed out at the top. These arise from the growth of a mass of ordinarily rounded coral until the top reaches the surface of the water or an insufficient depth to allow of further growth. The top of the mass then dies, whilst growth goes on round the sides, and the dead core is hollowed out by decay, and by the subsequent solution of lime by the water. The surface of the rock in Tonga is covered with a reddish soil like that of Bermuda. It is so hidden with soil and vege-

[1] An Account of the Natives of the Tonga Islands, compiled from communications by Mr. W. Mariner, several years resident in those islands, by John Martin, M.D., London, 1817.

tation that it is very difficult to observe the rock structure. The wells, which are round holes sunk to a depth of four or five feet close to the shore, show a mere continuation of the reef-structure of the shore covered by about a foot of soil.

It was interesting to recognise amongst the littoral plants of Tonga many forms which had been gathered on the shores of the far-distant Bermuda; these were cosmopolitan tropical plants, and became familiar objects on nearly all the tropical shores visited subsequently. One plant (*Nitella flexilis*) which grows in Tonga is almost identical with one occurring in Kerguelen Island (*Nitella antarctica*), but it again is cosmopolitan and a water weed. The *Casuarina* trees in Tonga remind one of Australia, but they are nowhere abundant. In every direction there are large tracts of land which have been under cultivation, but are now overrun with a wild growth of a dense low tangle of several species of *Convolvulus* and a trailing bean, affording plain evidence of the reduction of the population (see Pl. XVIII.). The position of the more recent clearings is marked in the distance by the projection from the main mass of dark foliage of the dead branches of trees that have had their bark ringed.

Bats are the only indigenous mammals in Tonga. A large Fruit Bat, probably *Pteropus keraudrenii*, which occurs in Fiji and Samoa and also in the Caroline Islands,[1] is very abundant. These Fruit Bats appear on the wing in the early afternoon in full sunlight, and at the time of the visit were feeding on the bright red flowers of one of the indigenous trees. Flowers form a large proportion of the food of the Fruit Bats. At Botany Bay, New South Wales, in May, numbers of Fruit Bats were to be seen feeding on the flowers of the gum trees. The bats probably often act as fertilizers, by carrying pollen from tree to tree, adherent to their fur. As dusk comes on, the Fruit Bats on the wing become more and more plentiful, and it is probably only those specially driven by hunger that come out before dusk. Besides these large bats, there are small insectivorous bats in Tonga, which dart about amongst the cocoanut trees, but no specimens were obtained. The heavy flapping of *Pteropus* is as strongly contrasted with the rapid motion of the true bats as is the flight of a goose with that of a swallow. There are plenty of horses and cattle in Tonga, and the high ground of Eooa is occupied as a sheep run.

A small Heron (*Demiegretta sacra*) wades about on the coral reefs at Tonga, and catches small fish, and is also to be seen frequently inland all over the island. This bird changes its plumage from pure white to uniform grey, and all stages of parti-coloured plumage were to be seen during the visit; contrary to the usual rule, the bird is white when young, and dark in the mature state, hence it is probable that the ancestors were white, and the race is assuming a darker plumage for protection. In the groves, the most abundant bird is one about the size of a sparrow, brown with yellow wattles (*Ptilotis carunculata*), which has a sweet and very loud song, and fills the

[1] Die Carolinen Insel Yap oder Guap, *Journal des Museum Godeffroy*, Heft. ii., 1873.

Horsburgh, Edinburgh. Permanent Phototype.

Wood Scenery, Tonga.

woods with its melody. A Kingfisher (*Halcyon sacra*) is constantly to be seen sitting on dead twigs, ready to dart on its prey. Amongst the cocoanut trees a beautiful little Swift (*Collocalia spodiopygia*) skims about with a constant twittering. It belongs to the same genus as the species by which the edible birds' nests, the well known Chinese luxury, are made, which, however, is a Swift and not a Swallow as it is commonly called. These Tree-swifts are especially abundant about the villages, though they nest in the crowns of the cocoanut palms.[1] In the thickest masses of foliage, a most beautiful small Fruit Pigeon (*Ptilinopus porphyraceus*), of a bright green colour, with a patch of the purest purple on its head, is to be heard cooing gently, and the Great Fruit Pigeon (*Carpophaga pacifica*), the note of which is harsh and drawling, but still derivable from a coo, is to be shot with ease by creeping up to the trees on the berries of which it feeds at this season. There are two parrots known from Tonga, but they are very scarce. One of them (*Platycercus tabuensis*) is found only in Tonga and in the neighbouring island of Eooa, and is called the Pompadour Parrot, from the peculiar purple red of its head and neck; the natives procure it alive from Eooa, where it is abundant, and one was bought for a shilling in the port during the stay. The other is a Parroquet (*Coriphilus fringillaceus*); neither of the parrots was seen in the wild condition.

Lizards are abundant, but there are only two or three species. One of them is *Mabouya cyanura*, while *Otosaurus microlepis*, one of the Scincidæ, is peculiar to the group. On the reefs occurs an Eel (*Muræna*), of a whitish yellow colour spotted with brown. It is very snake-like in its movements, and it may easily be mistaken, when encountered in the water, for the true Sea-snake (*Pelamys bicolor*), which also occurs here. Eight species of land shells were collected, none of them, however, being new to science; *Nanina tongana* is peculiar to these islands.[2] Rev. O. P. Cambridge writes that the Arachnida collected at Tongatabu included *Epeira mangareva*, Walck., *Meta tuberculata*, Keys, *Nephila victorialis*, L. Koch, *Nephila nigritarsis*, L. Koch, *Argyrodes* sp.?, *Diœa septempunctata*, L. Koch, and immature examples of *Tetragnatha*, *Dolomedes*, and *Icius*.

Among the insects collected by the Expedition, the following have been made types of new species, viz., Neuroptera,[3] *Diplax pacificus*, Kirby; Lepidoptera,[4] *Hypolimnas thomsoni*, Butler, *Hypolimnas moseleyi*, Butler, *Hypolimnas naresi*, Butler, *Terias aprica*, Butler; Hymenoptera,[5] *Schizaspidia murrayi*, Kirby.

A large Foraminifer (*Orbitolites*) is very common on the reefs. The specimens collected were handed to Dr. W. B. Carpenter, C.B., F.R.S., who has written a special memoir on the genus.[6]

[1] For an account of the nesting of *Collocalia*, see Bernstein On the genus Collocalia, *Acta Societatis Scientiarum Indo-Nederlandicæ*, vol. ii. For the nesting of the closely allied "Tree-swift," *Dendrochelidon*, see Bernstein, Habits of Javan Birds, *Ibid.*, vol. iii.

[2] E. A. Smith, *Proc. Zool. Soc. Lond.*, p. 271, 1883.

[3] Kirby, W. F., *Ann. and Mag. Nat. Hist.*, ser. 5, vol. xiii. p. 455, 1884.

[4] Butler, A. G., *Ibid.*, vol. xi. p. 402.

[5] Kirby, W. F., *Ibid.*, vol. xiii. p. 403.

[6] Zool. Chall. Exp., part xxi., 1883.

A meteorological register had been kept for some time at the college, under the superintendence of Mr. Baker, the Wesleyan missionary; he was kind enough to supply a copy of it, and as it may be useful, the chief results are appended.

METEOROLOGICAL TABLE compiled from observations made during the years 1872–74, by the Rev. J. Baker, at the Mission House, Nukalofa, Tongatabu.

Barometer readings reduced to 32° and sea level.

MONTH.	BAROMETER.		Mean Temp. in shade.	Mean daily Range of Temp.	Max. Temp. in shade registered.	Min. Temp. in shade registered.	Clouds—0 to 10 Mean Amount.	RAIN.		WIND.									No. of days Calm.	No. of days Foggy.
	Mean Height.	Ext. Range.						Total Fall.	No. of days.	Av. Hourly velocity.	No. of days from									
											N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.		
	in.	in.	°	°	°	°		in.		miles										
JANUARY,	29·830	·33	77·6	15·4	90·0	51·7		9·16	10	4·0	10	12	2	2	2	1	0	2	0	
FEBRUARY,	29·750	·37	79·0	15·1	98·0	51·0		6·83	11	3·5	7	8	3	2	3	1	1	3	0	
MARCH,	29·890	·34	77·1	16·8	89·2	51·0		6·36	8	4·2	4	8	9	3	2	1	2	2	0	
APRIL,	29·890	·49	75·5	14·8	89·7	67·0		10·35	11	1·8	7	7	5	2	3	1	1	4	0	
MAY,	29·950	·37	72·7	13·0	89·7	50·5		6·20	9	2·7	7	9	7	4	2	0	1	1	0	
JUNE,	30·020	·37	70·3	17·4	90·5	50·0		8·10	9	2·3	1	5	4	9	6	1	1	3	0	
JULY,	29·930	·44	69·2	16·4	90·0	50·2		1·66	3	2·4	0	3	10	4	5	1	1	1	0	
AUGUST,	29·970	·42	68·5	15·4	82·7	51·2		3·66	6	3·4	4	4	4	4	9	0	1	1	4	
SEPTEMBER,	29·990	·37	68·6	15·8	82·7	51·2		7·07	8	4·2	6	1	11	5	5	2	0	0	0	
OCTOBER,	29·930	·23	71·7	14·4	88·2	52·2		7·18	5	3·8	4	7	13	4	1	0	0	2	0	
NOVEMBER,	29·940	·43	72·7	15·7	88·0	56·2		3·57	7	3·5	1	12	11	2	2	0	0	0	2	
DECEMBER,	29·890	·21	74·7	15·1	88·7	54·0		4·45	10	3·8	6	12	7	4	1	0	1	0	0	
MEANS AND TOTALS,	29·915	·49	73·1	15·7	98·0	50·0		77·59	97	3·3	63	88	86	46	41	8	9	18	6	

The water on Tongatabu is scanty and not good, owing to the flatness of the land and the absence of streams. The water in all the wells which have been dug is brackish, owing to the percolation of the sea water through the coral reefs.

The landing place is between the King's House and the Church on the hill; at high water a gig can reach the shore through a narrow channel cut in the reef, but at low water this is impracticable. A "hard" of loose stone has, however, been constructed from the beach to the outer edge of the reef to facilitate communication at low water.

The observing station chosen by the Expedition was the church on the hill at Nukalofa, as the observers were there less disturbed than elsewhere. It may be as well to mention that at Tongatabu the day is the same as in Australia, that is, that although the island is in west longitude, and the inhabitants should, properly speaking, reckon time as slow on Greenwich, they reckon it fast on Greenwich, or for the longitude of 184½° E.

At the time of the ship's visit a schooner ran between Tongatabu and Sydney about every two months.

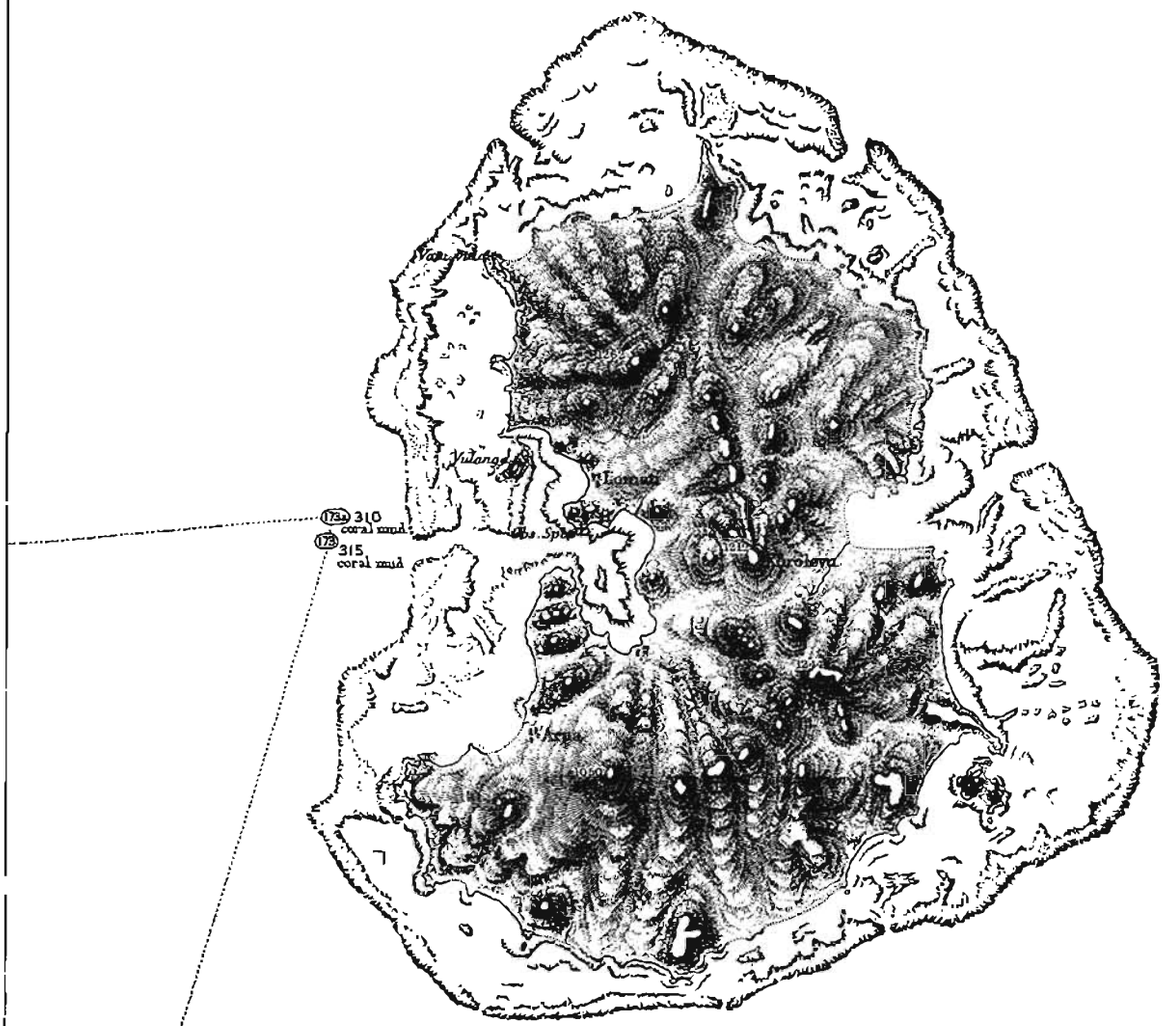
SOUNDINGS AND STATIONS

in the vicinity of

MATUKU ISLAND

Obs. Spot + Lat. 19°9'38"S. Long. 179°43'23"E.

For explanation of abbreviations see Appendix 1.



Cables 10 0 1 2 3 4 Sea Miles

Scale of Latitude & Distance

Engraved by Malby & Sons

Tongatabu to the Fiji Islands.

On the 22nd July, at 8 A.M., the Challenger left Tongatabu for the Fiji Islands, passing out to the northward between Mallenoah and Atataa Islands. Nothing was seen of the Juno Shoal, or of any belt of shallow water, the shallowest sounding being 9 fathoms. This northern route appeared to be a better channel into and out of the harbour than the eastern, for, although the water is not so deep, the channel is wider. Cook on his first visit used it, but ran on shore two or three times, and left by the east channel, out of which he had to beat against a fresh trade wind. The water appears to have deepened since his time, at any rate the shoals are fairly known, and can be avoided, and no one would now think of working out through the narrow east channel, when he could proceed through the northern with a leading wind. When outside a line joining Mallenoah and Atataa Islands dredgings were obtained, first in 18 fathoms (Station 172), and then in 240 fathoms (Station 172A, see Sheet 28). The deposit at both these depths was a coral mud containing 90 per cent. of carbonate of lime, and composed of fragments of Coral, calcareous Algæ, *Orbitolites* and many other Foraminifera, fragments of Polyzoa, Echinoderms, and Molluscs. At the greater depth farther from the reef, the fragments were smaller and the pelagic shells more abundant than in the depth of 18 fathoms nearer the reef. At 0.30 P.M. the ship proceeded to the westward towards Turtle Island, which was sighted at 11 A.M. on the 23rd. At 2 P.M. on that day the northern extremity of the detached reef off Turtle Island was passed, and a course shaped towards Matuku Island, the weather being rainy and cloudy.

On the 24th July, at 6 A.M., Matuku Island was sighted, and the vessel having proceeded to the lee side, a party was landed and remained on the island for two or three hours. During this time the ship was engaged in dredging off the mouth of the harbour in 310 and 315 fathoms (Stations 173 and 173A, see Sheet 29).

The Fiji Islands.

Matuku Island.—Matuku Island (see fig. 141), one of the Fiji group, lying about 70 miles east of Kandavu, is volcanic, and surrounded by a barrier reef which is about 16 miles in circumference. The highest peak is about 1200 feet in height. From its summit the island was seen to consist of a single crater, the edge of which had been denuded and cut into a series of fantastic peaks, with intervening steep-sided gullies. The ancient crater itself now forms the harbour, the inlet to which is through an opening in the girdling reef, at a spot where the border of the crater has been broken down. The surfaces of the irregular hills showed the peculiar sharp-angled ridges so characteristic of volcanic cones denuded by pluvial action. The windward side of the main peak was precipitous, and

covered with thick vegetation, whilst the leeward side was open, covered only with grass and *Pandanus* trees. It seemed uncertain whether this condition was due partly to clearing by the natives or entirely to the greater access of moisture from the trade wind on the windward side. Seemann[1] describes a similar condition, produced by aspect, as common to all the Fiji Islands. There are also, however, dense patches of wood here and there on the leeward side of the crater in Matuku, and it may be that all the grass-covered area has been cleared at some time for cultivation, the island being too small and low to vary much in atmospheric conditions. At all events the most prominent feature in the appearance of the vegetation of Matuku is the contrast of the light green open grass slopes with the dark patches of wood. The grass is high and reedy, and very tiring to force one's way through, as are also the wooded tracts; through which latter a road had to be cleared with the knife. In some places the grass had been intentionally fired by the natives as a preliminary to cultivation.

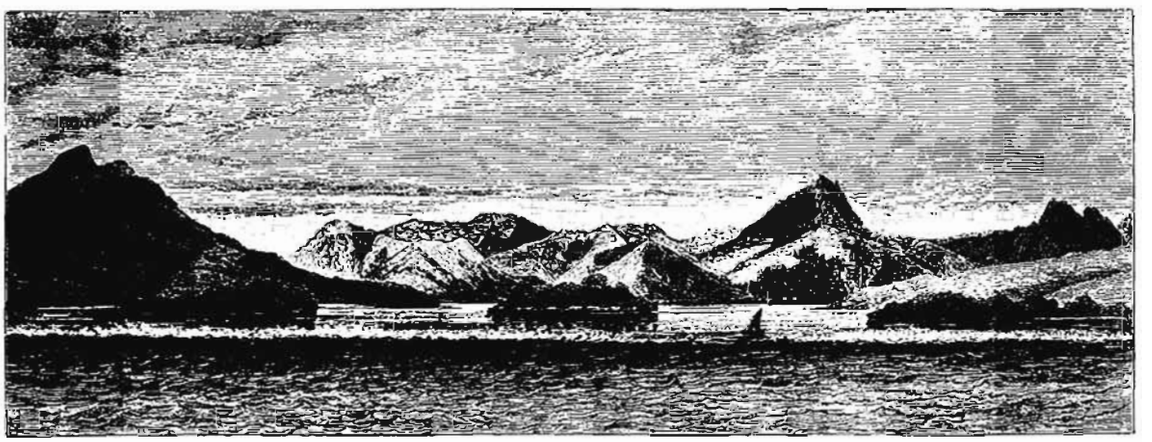


FIG. 176.—The Island of Matuku, from the entrance through the Barrier Reef.

The view from the summit of the island was most interesting as well as beautiful. The exploring party stood on what is now the highest point of the edge of the weathered crater. On the one side a steep slope led down to a narrow tract of flat land bordering the sea. This was partly open and swampy, covered with sedges and ferns, and with *Pandanus* trees dotted about over it, and partly covered with groves of cocoa-nut trees. On the other side a vertical precipice, terminating in a similar steep slope, led down into the crater itself. The cliff and internal slope of the crater were covered with thick and tangled wood, amongst which grew, even close to the summit, a few cocoa-nut palms, and one or two of the palms called "Niu Sawa" by the natives (*Kentia exorhiza*).

All round the island, except for a very short interval at the entrance to the harbour, was a circling zone of white breakers, marking the position of the barrier reef. This zone

[1] *Journ. Geogr. Soc. Lond.*, vol. xxxii. p. 52, 1862.

was separated from the shore of the island by a band of water which had a slightly yellowish tinge, caused by its shallowness and the colour of the coral-built bottom. The lagoon channel was very shallow, and in many places it was possible to wade from the shore to the outer edge of the reef. The reef, in short, may be regarded as a transitional stage between a fringing and a barrier reef.

The vegetation of Matuku is very different from that of Tongatabu, though no doubt much like that of Eooa. Ferns are numerous instead of scanty, and amongst them a beautiful climbing species (*Lygodium reticulatum*) is abundant. At the time of the visit the most conspicious trees, after the screw pines and cocoanut palms, were those of a species of *Erythrina*,[1] which was in full scarlet blossom. On the honey of the flowers of this tree a most beautiful Lory (*Domicella solitaria*) was feeding, and with it some little Honey Birds (*Myzomela jugularis*). The Lory is one of the most beautiful little parrots existing, showing a splendid contrast of the richest colours, jet black, red, and green. It is peculiar to the Fiji Islands, and flies in flocks, and hence the term "*solitaria*" is apt to give an erroneous impression as to its habits. A Swallow (*Hirundo tahitica*) was flying about in considerable numbers at the summit of the peak. Several lizards were found at the Fijis, *Hemidactylus* sp., at Matuku, and *Gymnodactylus* sp., one of the Agamidæ, at Kandavu, and *Mabouya cyanura* at both islands.

Hopping about on the mud beneath the mangroves on the shore was the extraordinary little fish, *Periophthalmus*, which skips along with great rapidity on the surface of the water by a series of jumps, each being as much as a foot in length, and it prefers escaping in this way to swimming beneath the surface. It is very nimble on land, and difficult to catch, using its very muscular pectoral fins to spring with, and when resting on shore the fore part of its body is raised and supported on these. The eyes of the fish, which is one of the Gobies, are remarkably prominent, projecting directly upwards from the skull. In the mangrove swamps the fish often sits on the lower branches and roots. From what is known of its habits, it is probable that it would be drowned by long immersion in water. The Fijian species is *Periophthalmus koelreuteri*. Its prey is said to consist of terrestrial insects[2] and Crustaceans left by the receding tide; according to Semper it feeds also on *Onchidium*.[3]

Sixteen species of land shells were obtained at the Fiji Islands, among them one novelty, *Helix* (*Trochomorpha*) *latimarginata*, E. A. Smith.[4]

The Arachnida obtained by the Expedition at Matuku were *Meta tuberculata*, Keys, *Meta granulata*, Walck., *Nephilengys* sp. ?, *Nephila* sp. ?; from Kandavu were brought *Epeira moluccensis*, Dol., *Epeira mangareva*, Walck., *Meta tuberculata*, Keys, *Meta*

[1] *Erythrina indica*. The "Araba" flowers in August, the time to plant yams; hence the flowering of this tree is the basis of the Fijian calendar. Seemann, Flora Vitiensis, London, 1865–73.

[2] Dr. A. Günther, *Brit. Mus. Cat.*, Fishes, vol. iii. p. 97, 1861; Introd. Study of Fishes, p. 487, Edinburgh, 1880.

[3] Animal Life (Internat. Sci. Series), p. 189, London, 1881.

[4] *Proc. Zool. Soc. Lond.*, p. 270, 1884.

insularis, Keys, *Nephila victorialis*, L. Koch, *Pholcus ancoralis*, L. Koch, *Tetragnatha* and *Chiracanthium* (immature), *Heteropoda* sp. (immature), *Argyrodes* sp. ?, *Argiope* sp., and *Attus* sp.? The Lepidoptera included the following new species—*Xois fulvida*, *Hypolimnas murrayi*, *Hypolimnas thomsoni*, and *Astura fluminalis*.[1] The Hymenoptera included one new species, *Belenogaster bidentatus*.[2]

The natives of Matuku were mostly true Fijians, though there were some pure Tongans amongst them, immediately to be distinguished by their use of the frontal muscles in conversation. There is no doubt also mixed blood in the island. The houses of the people were miserably dirty, and built on filthy black muddy flats close to the sea. A boy was observed to make his way over a mangrove swamp, with remarkable rapidity, by crawling over the tops of the mangrove roots, and thus avoiding the mud below; just as the coast natives in parts of New Guinea are said to traverse the low swampy shore.

In dredging off Matuku Island, in 310 and 315 fathoms, on a coral bottom, some *Phorus*, *Turritella*, and a few other shells were brought up, as well as numerous specimens of the blind Crustacean, *Polycheles*, and other animals showing the fauna to be a true deep-water one.

A living specimen of the Pearly Nautilus (*Nautilus pompilius*), so rarely seen in the living condition by any naturalist, was captured here. This was the only specimen of this animal obtained by the dredge or trawl during the voyage. The animal was very lively, though probably not so lively as it would have been if it had been obtained from a less depth, the sudden change of pressure having no doubt very much disarranged its economy. However, it swam round and round a shallow tub in which it was placed, moving after the manner of all Cephalopods, backwards, that is with the shell foremost. It floated at the surface with a small portion of the top of the shell just out of the water, as observed by Rumphius.[3] The shell was maintained with its major plane in a vertical position, and its mouth directed upwards. The animal seemed unable to sink, and the floating of the shell, as described, was due no doubt to some expansion of gas in the interior, occasioned by diminished pressure. The animal moved backwards slowly by a succession of small jerks, the propelling spouts from the siphon being directed somewhat downwards, so that the shell was rotated a little at each stroke, upon its axis, and a slightly greater area of it raised above the surface of the water. Occasionally, when the animal was frightened or touched, it made a sort of dash, by squirting out the water from its siphon with more than usual violence, so as to cause a strong eddy on the surface of the water. On either side of the base of the membranous opereulum-like headfold, which when the animal is retracted, entirely closes the mouth of the shell, the fold of the mantle closing the gill

[1] A. G. Butler, *Ann. and Mag. Nat. Hist.*, ser. 5, vol. xi. p. 402, 1883.
[2] W. F. Kirby, *Ibid.*, vol. xiii. p. 410, 1884.
[3] De Amboinsche Rariteitkamer, p. 61, Amsterdam, 1705.

cavity was to be seen rising and falling, with a regular pulsating motion, as the animal in breathing took in the water, which was afterwards expelled through the siphon. The tentacle-like arms contrast strongly with those of most other Cephalopods, because of their relatively extreme slightness and shortness, though they are not shorter proportionately than those of the living *Sepia*. They are held by the animal, whilst swimming, extended radially from the head, somewhat like the tentacles in a sea anemone; but each pair has its definite and different direction, which is constantly maintained. This direction of the many pairs of tentacles at constant but different angles from the head, is the most striking feature to be observed in the living Nautilus. Thus, one pair of tentacles was held pointing directly downwards; two other pairs, situated just before and behind the eyes, were held projecting obliquely outwards and forwards, and backwards respectively, as if to protect the organs of sight. In a somewhat corresponding manner, the tentacular arms of the common cuttle-fish whilst living are maintained in a marked and definite attitude, as may be observed in any aquarium. Another living Nautilus was brought to the Consul at Kandavu during the stay of the Challenger. The natives were said to frequently catch them alive, and to give them to their chiefs, who eat them.

Ngaloa.—The ship left Matuku at 4 P.M. on the 24th July, and on the following morning at daylight the whole of the Kandavu group was well in sight, and the ship was steered for Ngaloa Harbour, which it was proposed to survey in consequence of its having been made a port of call for the mail steamers running between Sydney and San Francisco. No difficulty was experienced in entering the harbour under sail, for the reefs and dangers can all be readily distinguished from aloft. At 11 A.M. the vessel "came to" on the south side of Ngaloa Island, in 15 fathoms, and in the afternoon a tide pole was put up and other preliminary operations performed so that the survey might be commenced at once.

The survey was continued, and astronomical observations obtained on the 26th; on the 27th the ship left Kandavu for the capital of the Fiji group, to connect the island with Captain Denham's position at Levuka, and to complete the stock of coals and other necessaries. At 6 P.M. on the 27th, when to the southward of Kandavu, the light cast by the moon on the water ahead, appeared exactly like a reef, and for a short time it was thought to be one; and once again, shortly afterwards, the same deceptive appearance caused the officers of the watch to stop and go full speed astern. Such phenomena are frequently reported as reefs, and had it not been ascertained that this appearance was merely caused by a break in the clouds, through which the moon cast a peculiar reflection on the water, it might have been inferred that a shoal existed. At 10.30 P.M., after the vessel rounded the eastern end of Kandavu Island, the fires were put out and sail was made for Levuka.

At daybreak on the 28th the vessel was close to the position of a recently reported reef, Metcore, but nothing was seen of it; the traders at Kandavu knew nothing of it,

and doubted its existence. Steering for Levuka Harbour, with the islands of Angau, Nairai, Mbatiki, Wakaya, Makogai, and Ovalau in sight, no difficulty was experienced in ascertaining the position of the ship. At 1.30 P.M. the leading marks through the reefs into Levuka were seen, and the vessel sailed into the harbour, anchoring at 2 P.M off the town.

The two beacon-houses, or light-boxes, were very indistinctly seen from seaward, and the old mission house, used for Government purposes, could not be distinguished from the surrounding buildings until close to the shore.

Levuka.—The Expedition remained at Levuka until the evening of August 1st, obtaining sights at the old observing position of Captain Denham, at the mission house, and completing the store of coals from a vessel which had been freighted from Sydney for the purpose.

On the 31st July, a party of officers and naturalists left Levuka in the barge for a trip to Mbau and Rewa, thence to sail across to Kandavu Island. The following is an account of this excursion from Mr. Moseley's Journal :—

"At 6 A.M. on July 31st, I started on a cruise in one of the ship's boats, called the barge, to the island of Mbau, and the Wai Levu, with a party which was to join the ship again at Kandavu. There being little wind all day, we failed in reaching Mbau on the first day, but arriving in its neighbourhood about dusk, we mistook a projecting headland of Viti Levu,[1] some miles north of Mbau, for the island of Viwa, and a small island lying off this headland for Mbau. It was impossible to distinguish in the gloom what were islands and what promontories, against the dark background of the Viti Levu coast. All around Mbau, Viwa, and the neighbouring coast are extensive shallow coral and mud flats, the mud being brought down by one of the mouths of the river Wai Levu, which opens in the direction of Mbau. After making several attempts to reach the island which we supposed to be Mbau, and constantly grounding on the coral, we anchored in a deep channel between the coral flats for the night. In the early morning we made out Mbau, conspicuous from the white house of the missionary upon its summit, and soon reached it.

"Mbau is a very small island, not more than half a mile in circumference, and consists of a central hill, of about 50 feet elevation, with a flat area at its top, and bounded by steep grass-covered slopes, surrounded by a tract of flat ground. The central mass is composed of a friable stratified rock, of a greyish or reddish colour. An exactly similar rock composes the mainland immediately opposite the island, and the strata there correspond in inclination with those of Mbau. The central mass of the island is thus a small detached fragment left standing by the denuding waves. The passage between the mainland and Mbau is so shallow as to be fordable at high water, and is nearly dry at low water. The flat lower part of Mbau, which is raised only a few feet above the sea, con-

[1] Viti Levu (pronounced Veetee lāȳvoo). Levu means "great." Settlers often clip the u, and talk of "Viti lib."

sists of made ground, built up of blocks of coral and mud and stones collected from the vicinity at low water, and secured all around against the action of the sea, by means of large slabs of a stratified tufa which have been brought in canoes from the main island, a distance of several miles. These stone slabs are set up on end, so as to form a parapet, and keep the earth from being washed down; they project far above the level of the land surface, and thus form at the same time a sort of fence or wall. At intervals, openings are left in the parapet, through which the water flows up short channels into the area of made ground, and forms as it were small harbours into which canoes can be put at high water. The top of the hill was formerly used as a general refuse heap by the natives, but it is now occupied by the house of the missionary. The native houses all lie on the low flat tract close to the sea. Mbau has long been a native fortress of great strength and hence the immense labour which has been spent on its formation. It is now the residence of King Thackombau, and almost every one in the island is a chief or of high family. The surface of the island, including the hill-ground, is covered almost everywhere with a thick kitchen-midden deposit of black soil, full of the shells of a large *Trochus* and Cockles (*Cardium*), which abound on the mud flats all around. Mingled with these are quantities of human bones, Mbau having been one of the places in Fiji at which cannibalism was most largely practised. There are very few trees growing on Mbau, and the food, such as taro and yams, is all brought from the mainland, where there are extensive plantations.

"One of the most interesting features in Mbau is perhaps the stone against which the heads of the human victims destined for the oven were dashed, in the ceremony of presenting them to the god Denge. This stone stands close to one corner of the remains of the foundations of the ancient temple of Denge, the 'Na Vatani Tawake.' The temple itself was destroyed when the Mbauans became Christians, but the mound on which it stood remains, and is of great interest. It is a large oblong tumulus of earth, supported by two series of vertically placed slabs of stone, exactly similar to those used for the sea parapet. The slabs of the lower series are much larger than those of the upper, and the latter being placed farther inwards, a sort of step is thus formed in the tumulus all round. The mound must be about 12 feet high, and some of the stones of the lower series are more than 6 feet in height. Opposite the centre of one side is set up a large column of basalt, and there is another opposite the strangers' house. These columns are said to have been taken in war, from some enemies on Viti Levu, and were intended to be used as posts for the king's house. The columns are said by Dana,[1] however, to have been brought by a Mbau chief from a small island in the harbour of Kandavu, which is composed of them, and where they were long desperately defended by the inhabitants,

[1] Dana, U.S. Expl. Exped., Geology, p. 348, Philadelphia, 1849. The columns at Mbau are referred to by Capt. Erskine, Islands of the Western Pacific, p. 193, London, 1853, who, however, did not recognise them as of unartificial formation.

who held them sacred. The whole mound most strikingly reminds one of ancient stone circles and similar erections at home. Were the earth of the mound washed away, numbers of the stone slabs might remain standing on end. Its condition before its destruction is to be seen in a book on Fiji, by Thos. Williams.[1] The tumulus supported a large 'Mbure' or temple, with the usual high-peaked roof and long projecting decorated ridge pole. Now the mound is falling into decay and covered with grass, and a small pony (there are very few horses in Fiji, and of course only room for this one in Mbau) belonging to Ratu David, the king's eldest son, found the top of it a pleasant place to graze on. The pony led a quiet life, for Ratu David having been kicked off on his first attempt at riding, had not tried again. The sacrificial stone against which the heads of the victims were dashed, is an insignificant looking one, in no way different from the other slabs, except that it is smaller and stands by itself a little in front of them, near one corner of the mound. In old time, bodies have been heaped up in front of it till they formed a pile 10 feet high. Whilst I was sketching the mound and its stones, a very pretty daughter of one of the chiefs came and looked on, and at my request wrote her name and the Fijian name of the mound in my sketch-book, in a very good round hand. There are several similar slab-built foundations of temples about the open space near the site of the Na Vatani Tawake, but except in the case of one small one, they are not in such good preservation. The slabs from one of these are now being used to construct the foundations for a Wesleyan church. Conspicuous amongst the buildings close by is the large 'visitors' house,' where guests were formerly entertained, and if of distinction, always provided with human flesh, at least once, by their hosts. Beside the building, a slight depression in the turf is the remains of one of the ovens used for cooking the 'long pig,' which is the actual name by which human flesh always went in the Fijian language; I always thought it a joke, until I was told by the interpreter. On a tree overhanging the ovens are to be seen notches, cut in the trunk from its base to its summit, an old score of the number of victims cooked beneath. There is another stone not far from Thackombau's house, which is smooth, and somewhat like a millstone in appearance. The ground around this is paved with slabs of coral rock, which had been perforated with holes by boring molluscs and worms before it was taken from the water. So many heads have been dashed against this stone, that it has happened that human teeth have fallen into almost all the holes in the slabs, and have become jammed there. The slabs were quite full of them. This second stone was seen by Captain Wilkes' officers, and is mentioned by Brenchley. We were told by the people that a second ceremony was performed at it, the heads of bodies being a second time pounded to pieces here, in honour of the slayer, who drank kaava from some grooves which are to be seen in the slab in front. The grooves are, however, very irregular, and look much rather as if they had been made in sharpening stone axes. I think this second stone must have been used by a separate tribe,

[1] Williams, T., Fiji and the Fijians, London, 1870.

occupying this quarter of Mbau, for even on this small island the people were often much divided. On going up the hill we came suddenly upon two old women bathing in a fresh water pool; they made for deep water in a hurry, but I saw that they were tattooed of a uniform indigo blue colour, from the hips to near the knees, just like the Samoan men.

"King Thackombau was visited in the morning by two of our party, who took him by surprise; he was found lying on his stomach, reading his Bible. I went with a party afterwards and we were regularly announced. The King, who was dressed in a flannel shirt, and a waist cloth reaching to his knees, rose to receive us, and came forward and shook hands. He is a very fine looking man, 6 feet high, with his dark face set off by an abundance of grey hair; his eyes are bright and intelligent, and his face full of expression, in this respect very different from that of the ordinary Fijian of lower rank. Three chairs were produced, this being the whole stock in the house, and those of our party without chairs sat on the matted floor. The King reclined on his stomach as before, on his own peculiar mat, at the head of our circle, with his Bible and Prayer Book neatly piled on the right hand front corner of the mat. We said, through our interpreter, that we were glad to see His Majesty looking so well, and explained the nature of the voyage we were making in the Challenger. I was then deputed to give an account of the wonders of the deep sea. In this subject Thackombau took the liveliest interest, inquiring about what kinds of animals existed in the deep water, evidently knowing the shallow water ones well. He was very much interested in the fact that they are so often blind. He said he could not understand the depth in miles, but comprehended it perfectly in fathoms. He then inquired the strength of the various navies, asking after that of England, Germany, France, Russia, and America, and wanting to know even the numbers of wooden and iron ships. The information we gave him drew from him the remark that the English were a wonderful people, far greater than the Fijians. The house was a large barn-like one of ordinary Fijian structure, with tall open roof, and a sleeping place separated off at one end with a 'tappa' curtain. There was the usual square hearth, with its edging of stone. Overhead were stored the heads of canoe masts. A European chest of drawers, a table, a lamp, and two tin coffee-pots, were the only visible articles of luxury. Against the door-post hung a fine club, freshly painted blue, belonging to the king's youngest son. We asked the king for a pilot to take us up the mouth of the Wai Levu, the great river which opens nearly opposite Mbau. He sent out at once to order one for us, and we took our leave of this knowing old Christian, who is currently reported to have partaken of two thousand human bodies, and is certainly known to have cut out, cooked, and eaten a man's tongue, in the man's sight, as a preparation to putting the rest of him in the oven, and that merely to spite the man because he begged hard not to be tortured, but clubbed at once. The contrast between Thackombau and King George of Tonga was very striking, at least as far as concerns their behaviour before visitors: Thackombau took the liveliest

interest in everything, and put question after question, whereas it seemed impossible to interest King George in any subject; he said nothing at all during our interview. Both are warriors of renown, and have fought their way to their positions. Ratu David, the eldest son of Thackombau, was very hospitable, and invited us to drink kaava with him in the evening, when he produced a bottle of brandy also. We wished to see a dance, but this was impossible, because it was Saturday evening, which is by order of the missionaries kept in a certain way sacred, as a preparation for Sunday. For the same reason Ratu David dared not allow his retinue to sing a chant used during kaava drinking, which we were anxious to hear.

"We pitched a sort of tent on a very small islet about forty yards off Mbau, and slept there. Ratu David sent us off a young pig and a couple of fowls all alive, a most welcome present. They were killed and consumed within an hour of their arrival. The islet on which we slept is made up of blocks of coral, weathered and bored by various animals, piled up by the waves. The blocks near tide mark are so blackened by exposure, that I took them at first for vesicular lava.

"Around Mbau are extensive shallow mud flats, the mud being brought down by the Wai Levu. Across these flats we sailed next morning, with scarcely a breath of wind, though our pilot, whom we christened 'Joe,' kept constantly calling for a breeze, using an old Fijian pilot's chant, 'Come down, come down, my friend, from the mountains.' As we drifted slowly away over the glassy water, the view behind us was beautiful. Far away, blue in the distance, was a long range of the lofty peaked mountains of Viti Levu, the abode of the Kaivolos, who are a long-haired race of mountaineers, and still cannibals. Nearer lay a streak of dark green, undulating, low country, bounded seawards by low cliffs, and showing near the coast the numerous cultivated clearings of the natives. Just off the cliffs of Vitu Levu lay the small island of Viwa. In the foreground was the island of Mbau, with its crowded reed houses, its strange stone parapets, and its green hill topped by the missionaries' white house. From the centre of the village came the sound of what was the old cannibal death drum, beating now for morning prayers. There were two of these drums in front of the strangers' house; they are simply logs of wood, hollowed out above into troughs, and supported horizontally on posts about 3 feet above the ground, looking like horse-troughs. One was larger than the other, and they were beaten with two wooden billets alternately, and gave out different low bass booming notes. Very similar drums are used amongst the Melanesians, as at Efate in the New Hebrides,[1] and at the Admiralty Islands, where, however, they are stuck upright in the ground, and the mouths of the trough-like cavities are contracted to narrow slit-openings, the trunks being hollowed out through these. The Japanese wooden bell, or narrow-mouthed wooden drum, seems to be merely a more perfect development of these drums, and no doubt the actual bell was derived from the copying of some such wooden

[1] F. A. Campbell, A Year in the New Hebrides, p. 111, Melbourne, 1873.

instrument in metal. The addition of a clapper to a bell is a late improvement; Japanese bells still have none, but are sounded by means of a beam of wood swung against them from outside. The term 'drum' should perhaps be restricted to instruments with a tense membrane. As a musical instrument, our ordinary English chapel bell is much on a par with the Fijian drum, and makes an equally uncultivated and unpleasant noise.

"We ascended by the northernmost of the several mouths by which the great river, the Rewa River, or Wai Levu (great water), opens into the sea. About the mouth of the river the land is flat and alluvial, and the river is bordered on either hand by a thick growth of mangroves. Below these trees, slimy mud slopes are left bare at low tide, on which a *Periophthalmus* hops about like a frog. Close to the sea the mud is covered with a Sea Grass (*Halophila*), and hence looks greenish when left uncovered. Ducks (*Anas superciliosa*) are common on the mud at the river's brink, as is also a Heron (*Ardea sacra*), which pitches often in the mangroves, where also the *Ptilotis* sings and the Parrot (*Platycercus splendens*) screams.

"After a stay at Novaloa, where there is a mission college for training native teachers, in which Fijians even learn rudimentary algebra, we drifted up with the rising tide, grounding once and having to wait an hour to float off again. We passed many villages, and several canoes full of people. We slept at Nadawa, where a small paddle steamer, the property of a resident trader, Mr. Page, and built by him there, was under repairs and waiting for new engines from Sydney. Here also was a sort of hotel kept by two Englishmen. Mr. Page, who was extremely hospitable, gave me a bed. In the morning we had to beat against the land breeze up the main river, which we had entered just below Nadawa. The Wai Levu is a fine large river, in some reaches 300 yards across, and occasionally in flood time pouring so much fresh water into the sea that ships at anchor three miles off its entrance are able to take in their store for drinking from the water alongside them. Dana[1] calculates the volume of water poured into Rewa Harbour at 500,000 cubic feet per minute, and that discharged by all the mouths of the river together at 1,500,000 cubic feet; the area of the delta is 60 square miles. The mangrove thickets had ceased before the main river was reached, and here above Navusa the low banks on either hand were hidden by a dense mass of a tall grass, a species of *Saccharum*, or Wild Sugar Cane. For the first 12 miles or so of its lower course, the river flows through its delta, and hence the banks are low and the country flat. Some few miles above Navusa the banks become steeper, and low hills commence. These gradually become more frequent as the ascent is continued, until steep slopes with intervening stretches of flat land are of constant occurrence on either hand. The view up the river now shows a succession of ridges, one behind the other, rising gradually in the distance, and terminating in a line of distant blue mountains. The steep slopes

[1] Dana, U.S. Expl. Exped., Geology, p. 348, Philadelphia, 1849.

are covered with a thickly interwoven vegetation, the large trees being covered with epiphytes, ferns, lycopods, and climbing aroids, and festooned with creepers, which form in places a continuous sheet of bright green, falling in gracefully curved steps from the top of the slopes to the bottom, and almost entirely concealing their supports. Here and there tall tree-ferns rear their heads amongst the tangled mass, and palms (two species of *Kentia*) form a conspicuous feature amongst the foliage. We were forced to anchor in the evening to await the turn of the tide. As it became dusk numbers of Fruit Bats flew overhead, whilst in the beds of reeds a constant cry was kept up by the coots and water rails. On the tide turning we had to take spells of an hour each at the oars as our time was short, and by paddling on gently all night we reached before daylight a spot, about 35 miles from the mouth of the river, called 'Viti.'

"Mr. Storck, a German, and his wife live at Viti. He was the assistant of Mr. Seemann during his investigation of the plants of Fiji, and was extremely hospitable. He had taken to growing sugar, as cotton had failed, and had a splendid crop, which he calculated to weigh 62 tons of cane to the acre. Mills were about to be erected, and there seemed every prospect of sugar paying well. There were already twenty plantations of sugar on the Rewa River. It was curious to see a man from the New Hebrides Islands, so notorious for the murders of white men committed in them, acting as nurse to one of Mrs. Storck's children, and hushing the baby tenderly to sleep in his arms; he was one of the imported labourers, concerning whom so much has been written. About Viti there are abundance of large Fruit Pigeons and of the pigeons with purple heads, identical with those of Tongatabu (*Ptilinopus porphyraceus*); also of the 'Kula' (*Domicella solitaria*), and the 'Kaka' (*Platycercus splendens*). The Kaka attacks the sugar canes, and does considerable damage. There are some huge fig-trees at Viti, with the typical plank-like roots and compound stems. Here also grow one or two cocoanut trees, which are rarities so far up the river, for at the inland villages along the river there are no cocoanut trees, and a regular trade is carried on by the natives in bringing the nuts up the river from the coast in canoes, to barter them with the inland people. The black rat and Norway rat are abundant at Viti, and, according to Mr. Storck, there is also a native field mouse, but I could not procure one in the short time available. I do not know whether a field mouse is known from Fiji. A large fresh water prawn is common, and is caught for eating by the Fijian women, and in their baskets I saw also an Eel (*Muræna*). A red stratified tufa, with a slight inclination of its strata, is exposed in section opposite Mr. Storck's house; it is said to contain no fossils. An exactly similar rock is exposed at various spots for several miles down the river.

"On the way down the river, the barge constantly grounded on shoals, our pilot, Joe, knowing nothing of the upper part of the river. We had to strip our clothes off constantly and jump overboard to shove the boat over the shallows, and at last stuck

fast and had to remain in that condition till the tide came up and turned again. Joe cautioned us against jumping over into the water, as he said there were sharks. A shark about 3 feet long is common as far up as Mr. Storck's plantation, and large ones are believed to be common in the lower parts of the stream, and are mentioned in Jackson's Narrative, in the appendix to Capt. Erskine's Islands of the Western Pacific, as often taking down natives in the neighbourhood of Rewa. At Nadawa, however, Mr. Page had never seen one, and I saw women there constantly standing up to their necks in the water, collecting fresh water Mussels (*Unio*), evidently without fear. The Shark of the Wai Levu is *Carcharias gangeticus*, found also in the Tigris at Bagdad, 350 miles distant in a straight line from the sea, where it attains a length of 2½ feet, and is common in large rivers in India. It breeds in fresh water in Viti Levu, inhabiting a lake shut off from the sea by a cataract.[1] There are sharks inhabiting fresh water in other parts of the world, as in South America, in the Lake of Nicaragua;[2] and in a fresh water lake in the Philippines there lives permanently a 'ray,' a species of saw fish. A peculiar genus of Mugilidæ occurs in the Wai Levu, *Gonostomyxus* ('sa loa,' Fijian), which has been described by Dr. Macdonald.[3]

"Joe was, I suppose, about thirty-five years old. He had no notion of his age, but said, when asked by the interpreter in his own language, for he knew no English at all, that he was five years old. When asked if he had eaten human flesh, he said 'No,' that he had killed four men, but had never been allowed a taste by the chiefs; he evidently thought himself in this respect an injured man. He had had four wives. He suffered much from cold on the river in the early morning; but, dressed up in a blanket suit by the blue-jackets, who were very kind to him, he managed to keep alive, and seemed to enjoy himself pretty well, especially at meal times.

"We passed a hill, opposite which the water of the river is supposed to have the effect of making the whiskers and beard grow, and the spot is resorted to by young Fijians, in order to force their hair. Joe said that he had been and bathed there when young. We passed numerous villages on the river side, and landed at some to buy clubs, spears, kaava bowls, and other implements, and the river was lively with canoes laden with yams and cocoanuts. In most places the people crowded to the banks to stare at us, and the girls and boys shouted as we passed. On the upper part of the river I heard a call used which reminded me somewhat of a European mountaineer's 'Jodel'; it sounded like 'Hē, Hāh, hŏ, hŏ, hŏ.' Our guides to the top of the mountain in Matuku used the same call when at the summit. Mountaineers in all parts of the world seem to have a similar cry; the echo no doubt provokes it.

"One village, Navusa, some few miles above Nadawa, interested me, as having its

[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. iv. p. 36, 1874.
[2] Thos. Belt, The Naturalist in Nicaragua, p. 45, London, 1874.
[3] J. D. Macdonald, *Proc. Zool. Soc. Lond.*, p. 38 1869.

fortifications still perfect. It occupies an oblong rectangular area, two sides of which are protected by a natural water defence. On the other two a deep ditch is dug and the earth has been thrown up inwards to form a bank, on the summit of which is set a strong palisade, which extends around the whole area. Three narrow openings, only wide enough to admit one man at a time, give means of access. The openings are guarded by a sort of stile, over which a slab with notches for the foot leads up on one side, a similar one leading down the other. The whole site of the village has been levelled and raised. Nearly all the houses rest upon raised platforms of earth, a foot or six inches in height, the chief's house being especially elevated. Around all the houses were immense heaps of the shells of the fresh water Mussel (*Unio*), which is very common in the river. The site of the old village on Mr. Storck's estate was made up of beds of these mussel shells. We saw canoe-building going on at Navusa. For an adze, a broad chisel was used, fixed into what had been the handle of an old stone adze, just as the Admiralty Islanders fix blades of hoop iron into the old handles of their shell adzes. A chisel of hard wood was used for caulking, shaped just like our own caulking irons.

"Near Nadawa on the road to Nakello is the village of Tongadrava, which has also been strongly fortified. It is of an oval form, with two deep broad ditches encircling it, a zone of flat ground intervening between them; narrow cross banks on opposite sides of the village lead across the ditches. Formerly all Fijian towns were fortified; those in the Rewa district appear to have been remarkable for their strength,[1] especially a town called Tokotoko, where there was a perfect labyrinth of moats and ditches.

"The people of Nakello, a large village, about two miles from Nadawa, according to Jackson's Narrative, were peculiar amongst the Fijians for not eating human flesh, it being forbidden 'tambu' with them. In the centre of Nakello are the tombs of two chiefs, consisting of two large tumuli of earth, adjoining one another, one being older than the other. The older tumulus is oval in form, about 20 yards in diameter at the base, with sloping sides, and about 10 feet in height. At the top is a flat circular space, which is enclosed by a wall formed of slabs of coral and coral rock, set on edge, none of the slabs being very large. Another line of slabs surrounds the mound about half-way up, and here there is a sort of step on the side of the mound. Within the upper circle of stones are some slabs of tree-fern stems set on end like the stones. The more recent mound has no circles of stones, and is oblong in form.

"Our object in visiting Nakello was to be present at a grand dancing performance, which happens in each district only once a year, and which we were lucky enough to arrive just at the right time to see. The dance takes place on the occasion of the collection of the contributions made to the Wesleyan Missionary Society by the natives. Such dancing performances used always to be held when the annual tribute was paid over to the chiefs, and dancing on their collection days has been encouraged by the missionaries.

[1] Capt. Erskine, Islands of Western Pacific, App. A, p. 459, London, 1853.

The policy of the Wesleyan Society pursued in Fiji is very different from that maintained by the missionaries in Tonga, where dancing is suppressed. The village was full of visitors, and everyone was dressed in his best. The dancing green in front of the chief's house was cleared, and a white tappa flag was stuck up in the centre. We called on the chief, and found him sitting on his mat in a fine large house, about 40 feet long by 20 broad, 10 feet in height to the slope of the roof, and 25 feet to the ridge pole, built of a wooden frame, the rafters and beams being secured with plaited cocoanut fibre or sennit. The walls were of reed, the roof a thatch of grass; the sleeping place at one end was on slightly raised ground, 6 inches above the rest of the floor, and divided off by a curtain of tappa suspended from a cord stretched across; the floor was merely the earth covered with mats. This description will suit any Fijian house except as to dimensions. The chief sat on his mat near the middle of the house, whilst four or five servants and a visitor sat at the far end. The chief's little boy was being polished up by his nurse for the festivities, and another woman was making girdles of jasmine twigs for the chief's little daughter, holding one end of the garlands between her toes, as she twined the twigs into the sennit with her fingers at the other. When the small boy was handed from one nurse to another, each, after passing him to the other, went through the usual ceremony of respect to a chief, sat still a moment and clapped her hands four times reverently, and did the same after handing the boy to his father. The clapping was not done so as to make a noise, the palms of the hands were merely brought together quietly four times. The women looked reverently on the floor whilst doing it, as if saying a prayer. It was not at all done as an act of ostentation—indeed the women's backs might be turned to the company at the time—but appeared much more like a ceremony of private devotion. The posture of the hands whilst being clapped together is the same as that of Europeans and Japanese and so many races during prayer. The chief dressed his son's head himself. The head dressing consisted in shaving off all the boy's wool, except a vertical ridge which was left intact at the back and looked somewhat like the crest of a Greek helmet, and in smearing the whole of the shaved part with a thick coating of a bright vermilion red.

"We drank kaava and tasted Fijian puddings, which are glutinous semi-fluid masses, made of taro and cocoanut, and flavoured with molasses. The puddings are kept done up in a bag of banana leaf, and are very nasty, though specially prepared as a luxury on this occasion. The chief showed us two clubs, family heirlooms, which had killed a large number of illustrious enemies; but since, as he told us, they are always kept very carefully oiled, just as we oil our cricket bats, there was no hair nor remains of blood or brains about them.

"It was past noon before the people began to assemble in numbers, and seat themselves on the banks and rising ground, commanding a view of the dancing place. The dancing was begun by the body of about eighty young men which I had

before seen practising the same dance for this grand occasion at Bureta, in Ovalau. A party stood together in the centre and kept up a sort of chant, one of their number beating time with two sticks upon a small bar of light wood, which was held by the hands of another. The remainder danced round to the chorus in a ring, but every now and then, changes between members of the ring and chorus took place. One of the chants I took down as 'Rāihī vāl sāl sāte ă dūmm,' the last sound being uttered with a peculiar lingering humming sound. The words chanted usually have no meaning, corresponding to our 'fal la la,' and similar sounds. The chant was commenced always as a solo, the chorus joining in after the first few notes. Combined with the music, with excellent effect at various stages of the dance, was the loud clapping of hands, which was done in most perfect time, the claps of all the dancers and chorus sounding as one. Two kinds of claps were used, one with the hands hollowed, and the other with them flat. The two sounds thus produced served further to diversify the effect, and there was also added a loud shrill cry used in some of the figures just before their conclusion and uttered by one performer only, and which came in very well. The dancing consisted in most varied motions of the head, arms, body, and legs, the same motions exactly being gone through by every member of the circle in most perfect time. At one time the head and shoulders were bent forward, and the hands swung clapping together, at the same time as short side steps were made, carrying the performers round in the circle. Then a half-squatting position was suddenly assumed and the head was thrown first on to one shoulder, then on to the other. Then the performers would move on again, and stretch their arms out with a fixed gaze, as if shooting with the bow. None of the motions were very quick, and none very fantastic. The men wore fringes of various kinds, hanging from round their waists, mostly a combination of the yellow and red *Pandanus* leaf strips and the black fibrous girdles of the Fungus (*Rhizomorpha*). Most of them had also fringes of *Rhizomorpha* just below the knee, often with beads strung upon them. All had their bodies well covered with cocoanut oil, and their hair trimmed with great care.

"By the time the first dance was over, there was a dense concourse of spectators round the green. The missionary arrived, a table was set out under a tree opposite the chief's house, and three native teachers, two of them Tongan men, sat behind it to receive the money. The inhabitants of the various villages and smaller districts now advanced in separate troops, walking up in single file to the table and throwing down, each man or woman, their contributions upon it, with as loud a rattle as possible. As each contribution fell, the three teachers and some of the members of a further large body of teachers from the college, who were squatting close by, shouted 'Vinaka, vinaka' (slowly), 'Vinaka, vinaka, vinaka' (quickly), which means 'good, good,' or 'hear, hear.' Many bystanders joined in the applause. The money consisted of all sorts of silver coins, and a very few copper ones, and over £100 must have been collected

M. Hanhart lith. Hanhart imp.

1. 2. 3 AND 4. VARIOUS DANCING COSTUMES WORN AT NAKELLO, FIJI. Nº 1 AND Nº 2 OF THE FISHERMAN TRIBE.
Nº 5. A TONGAN TO SHOW THE COLOUR OF THE RACE.

in coin. The people of the various villages, and the districts subject to the chiefs of these, prepare dances for this yearly festival for many months, and they vie with one another in the splendour and perfection of the performance. As each band came up and made its contribution, a part or the whole of it at once proceeded to perform the prepared dance, and when this was over another party approached the table, and so on.

"The people as they filed up to the table formed a wonderful spectacle. The girls were most of them without coverings to their breasts, but the upper parts of their bodies were literally running with cocoanut oil, and glistened in the sun. The men and boys were painted in all imaginable ways, with three colours, red, black, and blue (see Plate E, figs. 1, 2, 3, and 4). There were Wesleyans with face and body all red, others with them all blackened soot black, others with one half the face red, and the other black; some had the face red and the body black, and *vice versa*; some were spotted all over with red and black; some had black spectacles painted round the eyes; some had a black forehead and red chin; some were blue spotted, or striped on the face with blue, and so on in infinite variety. How amused would John Wesley have been if he could have seen his Fijian followers in such guise! For many of the dances the men were most elaborately dressed. They were covered with festoons of the finest gauzy white tappa, or cuticle of the shoot of the cocoanut tree. These hung in long folds from the backs of their heads, and were wrapped round their bodies as far up as the armpits, and hung from the waist down to the knees in such quantity as to stick out almost in crinoline fashion. Round the men's heads were turbans, or high cylindrical tubes or mitres of white tappa, whilst hanging on their breasts were pearl oyster shells (see Plate E, figs. 1, 2) set in whales' teeth, the most valuable ornament which a Fijian possesses, and which he is forbidden by the chiefs to sell. Some of the men had remarkable head-dresses. One of them for instance had, sticking out from the front of his head, and secured in his hair, a pair of light thin twigs of wood, which were a yard in length; they were slightly bent over in front of his face, and at their extremities were fastened plumes of red feathers (see fig. 177). The whole was elaborately decorated, and as he danced, the red plumes swayed and shook at each jerk of his head with great effect.

"The most interesting dances were a club dance and a fan dance, in each of which a large body of full-grown fighting men, some of them with grey beards, performed. In all the dances, except the first one already described, the chorus sat on the ground at a corner of the green, and usually contained a number of small girls and boys, and used in addition to the wooden drum, a number of long bamboo joints open at the upper end, which when held vertically and struck on the ground, give out a peculiar booming note. In each of the dances there was a leader, who gave the word of command for the changes in the figures, and his part was especially prominent in the club dance, in which

all the attitudes of advance, retreat, and the striking of the blow were gone through with various manœuvres, such as the forming of single file and of column. Clubs are carefully decorated when used for dancing; some indeed seem to be kept for this purpose, and to correspond to our court swords in being merely decorative. There are flat spaces near the heads of the curved clubs, which on festive occasions are freshly smeared with red, blue, or white paint. Coloured strips of screw pine leaf are often wound round the clubs, and some are decked with beads strung on *Rhizomorpha* fibres. Thackombau's son's club was, as I have said, freshly painted blue near the top. The King himself on state occasions had a decorated club carried before him, just as at home the Vice Chancellor of Oxford, and even the President of the Royal Society, now have.

"In the fan dance all the dancers were provided with a fan of tappa stretched on a wooden frame. They divided themselves into two parties, forming into single file in the same line with one another, but with a considerable interval between the two parties.

FIG. 177.—Fijian Native with remarkable head-dress, part of dancing costume. From a drawing by Lieut. Swire, R.N.

The two bands took up the chant and danced alternately, answering each other as it were. The fans were waved in various attitudes, and at the end of each movement thrown suddenly up over the head (still held in the hands), and a wild war-cry was uttered by the whole line simultaneously with the movement. The war-cry was a single prolonged high-pitched note, and sounded intensely savage. In another dance, performed by a large body of men, about one hundred and twenty I think, the dancers formed a sort of rectangular group, arranging themselves in eight rows, the leader being in the centre of the front row. Once or twice the leader came forward to the chorus, and addressed a few words in a dramatic manner partly to them, exhorting them to do their duty well, and partly to the spectators. A club dance by boys was one of the performances. In one figure of this the boys, standing in a line with their bodies bent forwards, jerked their hips with a most astonishing facility, first to one side and then to the other. The motion, especially in cases where the boys had a large quantity of tappa projecting behind as a sort of bustle,

was most ludicrous, and the audience, instead of crying the oft repeated 'Vinaka, vinaka,' fairly shouted with laughter. A band of women of the district, headed by the Queen of Rewa and her daughter, who were both dressed in bright blue striped prints, marched slowly forwards across the green to deposit their offerings, singing a chant, descriptive of various incidents from the New Testament, the descriptive part being a solo, whilst the whole band joined in a constantly repeated chorus containing the words 'Allelujah, Amen.' This song was in lieu of a dance.

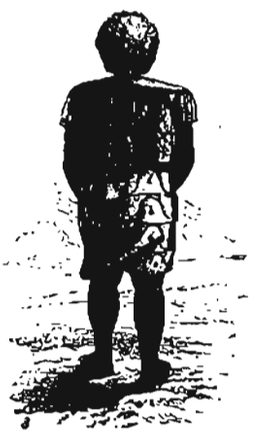


FIG. 178.—Queen of Rewa, from a Sketch by Lieut. Swire, R.N.

"The principal interest of the performances, however, lay in the obvious fact that here were to be observed in development the germs of the drama, of vocal and instrumental music, and of poetry in almost their most primitive condition. In these Fijian dances they are all still intimately connected together, and are seen to arise directly out of one another, not having as yet reached the stage of separation. The dance is evidently first invented by the savage, then rhythmical vocal sounds are used by the dancers to accompany it, and simple instruments of percussion are employed to keep time. As the dance becomes gradually more varied and complex, the accompanists are separated as an orchestra, the actual performers joining less and less in the vocal part, until, as here, they merely utter a single loud cry or note occasionally during the dance. The instrumental music of the orchestra remains long subordinate to the vocal and very simple, being represented at Fiji, as described, by the single small wooden drums and the bamboos. The orchestra continuing its performance in short intervals in the dancing, and commencing somewhat before the first figures, in order to allow the dancers to be ready to take up the measure, as was the case at Nakello, comes at length to perform solos; and hence the origin of music apart from dancing. The gradual complication of the music and improvement and multiplication of instruments follow, until vocal and instrumental music change places in importance and become also at length separated from one another. The dances being descriptive of victorious battles and such exploits, the chants, at first mere musical sounds and war-cries, become short descriptions of the fight, or praises of the warriors, and hence the origin of poetry. I could get no explanation of the meaning of the chants used at Nakello; as far as I could gather, they were without meaning, mere convenient sounds; but Fijian songs do exist, for Joe, our pilot, sang part of one, and explained that it related to the superiority of the Mbau men to the Rewa men. The origin of the drama is clearly seen in the stepping forward of the leader of the dance, as described, and dramatic enunciation by him of a short speech. A further step was to be seen in one of the other dances, when the leader, before his troop came on to the ground, rushed forward brandishing two spears in his hands, and gave a short

harangue descriptive of what he was going to do. The separation of the dancers in the fan dance into two parties, performing alternately and responsively, is also interesting, and brought the Greek chorus and drama into one's thoughts. It was of course unnecessary to have recourse to Fiji in order to trace the origin of dancing, music, and the drama; this has been done fully long ago. But nowhere, I believe, is the primitive combination of these arts so forcibly brought before the view as a matter of present-day occurrence as in this group of islands.

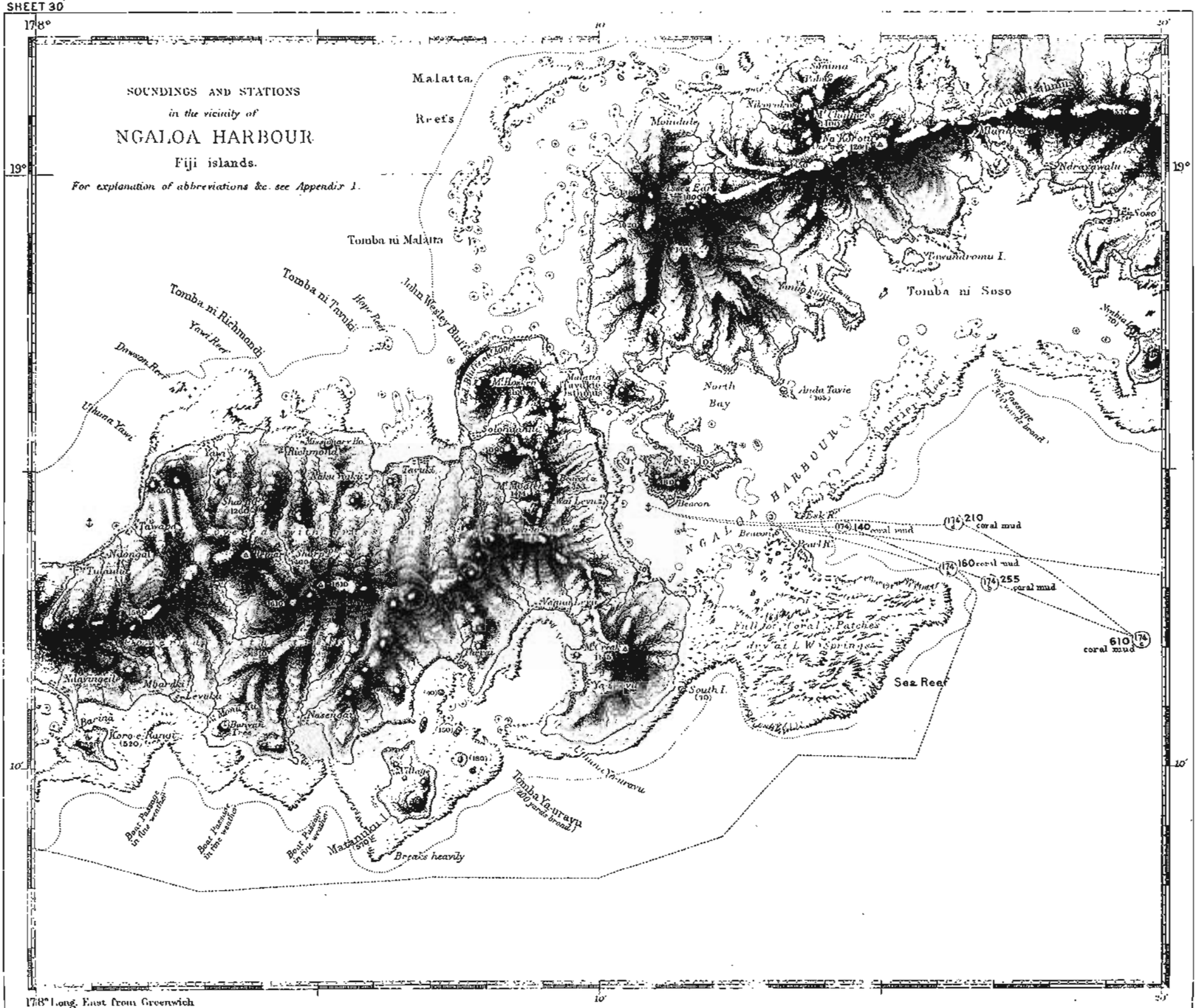
"The most extraordinary feature in the Nakello performance was the extreme order and decorum of this concourse of three or four thousand people. It seemed astounding, whilst looking on at these blue, red, and black-painted Fijians flourishing their clubs and shouting their war-cries, to reflect that this was a Wesleyan Missionary meeting. The representative of the power which has tamed these savages was a little missionary with battered white tall hat and coat out at elbows, who stood beside us and who took no prominent part in the ceremonies, but yet had full sway over the whole, no dance having been prepared without his previous sanction. There could be no doubt as to the amount of good which had been done to these people, and it is sincerely to be hoped that the Wesleyan Missionaries will be left unmolested to continue the work in which they have been so successful, and which they have begun and carried out often at the risk, in some instances with the loss, of their lives.

"The men and children attending the meeting vied with one another in getting money to contribute, and were ready to sell almost anything they had for what we would give them. One boy pestered us to buy an old hen, and followed us about with the bird. Others sold us clubs and ornaments. The great wish was to have several pieces of silver to make a rattle on the table, and two sixpences were worth much more than a shilling, two shillings than half-a-crown. Immediately the ceremony was over, everything went up in value, and a good many articles pressed on us before were not now to be had at any price.

"Amongst the crowd was an Albino boy, who was perfectly white, his skin having a peculiar look, almost as if covered with a white powder, in places. His eyes, which he hid either from the light or because of shyness, appeared as if the iris were of a pale grey colour. His parents said he could see perfectly, but I could not examine him closely as he roared at the prospect. Albinos seemed unusually common amongst Melanesians, and are constantly mentioned by travellers; hence these savages, when first seeing whites, no doubt often took them for a race of Albinos. I saw several hunch-backed dwarfs amongst the crowd.

"We sailed from the Wai Levu, or Rewa River, to Kandavu, stopping at a small island on the way, to buy a pig and some fowls. A voyage in an open boat has many discomforts, especially when the boat is crowded. It was a difficult matter to sleep six together in the confined space of the stern-sheets of a ship's barge, especially

SHEET 30


SOUNDINGS AND STATIONS
in the vicinity of
NGALOA HARBOUR
Fiji islands.
For explanation of abbreviations &c. see Appendix 1.
Malatta
Reefs
Tomba ni Malatta
Tomba ni Richmandi
Tomba ni Tavuki
Hope Reef
John Wesley Bluff
Dawson Reef
Yawi Reef
Uluna Yawi
Tomba ni Soso
Tawandromu I.
Ndravuwalu
Moindule
Nabukelevu
Mt Gladstone
Na Koroni
Mbuke Levu
Mbuke Lailai
Mt Horden
Malatta Levuka
Solonda Ra.
North Bay
Anda Tavie
Ngaloa Harbour
Barrier Reef
Sand Passage
Beacon
Beacon
Pearl R.
Pearl R.
Yawi
Richmond
Tavuki
Waikalou
Taivanua
Ndongai
Tulaulau
Nukuvingeli
Mbandi
Levuka
Barina
Koro e Rungi
Nasendeu
Banyan Tree
Village
Vagunu
Yaqaqa
South I.
Full for Coral Patches dry at L W Springs
Sea Reef
Uluna Ya-uravu
Tomba Ya-uravu 200 yards broad
Matamboli I.
Breaks heavily
Boat Passage in fine weather
Boat Passage in fine weather
Boat Passage in fine weather
(174) 140 coral mud
(174) 210 coral mud
(174) 160 coral mud
(174) 255 coral mud
(174) 610 coral mud
178° Long. East from Greenwich
19°
10'

as the available surface was rendered extremely irregular by the various articles necessarily stowed upon it, such as provision boxes and beer cases. We all slept with our shooting-boots on, to ensure mutual respect, as we lay packed like herrings in a barrel. On the whole the trip was pleasant enough, and the inconveniences were nothing compared with the interest of a visit to such places as Mbau and Viti Levu."

The ship left Levuka Harbour at dusk on the 1st August, steaming out of the passage between the reefs and then far enough to get an offing, when sail was made for Kandavu Island, to complete the survey of Ngaloa Harbour. The 2nd (Sunday) was calm nearly all day, so the vessel steamed during the night, and arriving off Ngaloa Harbour at 8 A.M. on the 3rd, despatched the boats to proceed with the survey, whilst the ship obtained some soundings and dredgings off the reef, anchoring in the evening in Ngaloa Harbour (see Sheet 30).

Kandavu.—Ngaloa Harbour, which at the time of the visit had already acquired some importance as a port of call for the mail steamers running between Sydney and San Francisco, is an indentation in the south coast of Kandavu Island, protected to seaward by a line of coral reefs rising to the surface, and forming a natural breakwater, through which is a deep narrow channel into the anchorage. The harbour is divided into two parts by Ngaloa Island, and the anchorage on the west side of the island is again divided by reefs, occupying a considerable area, into an inner and outer harbour, both of which are perfectly safe in all weathers. The anchorage ground on the east side of Ngaloa Island is named North Bay, and this also is well protected, and is capable of affording shelter to a large number of vessels. At the head of the harbour is a narrow isthmus named Tavukie, which separates Ngaloa from Malatta Bay, and on the west side a range of high hills, culminating in Koroh-to-Sarra, a conical peak covered with trees, 1643 feet above the level of the sea.

Inside the harbour, more particularly in the immediate vicinity of the barrier reef, are numerous coral knobs; they can, however, be readily seen by a look-out from aloft, and with the chart as a guide, no difficulty should be experienced in entering or leaving this port. During the survey of Ngaloa Harbour several marks on the shore were noticed which appeared to indicate that either the level of high water was different at other seasons of the year, or that the land is now more elevated than formerly. On the side of the small rocky islet, 15 feet high, in the passage between the North Bay and Inner Harbour, is a water mark 4 feet above high water, and other points showed these water marks, though not so distinctly as the small islet. These marks cannot be caused by the sea in bad weather, for the reef protects the harbour from any such swell.

The native chief at Kandavu on two occasions sent off a large Green Turtle as a

present to Captain Nares, and the large double canoe which brought the present was photographed from the ship (see Plate XIX.). The supplies at the Fiji Islands were few and expensive; the beef was, however, good, better even than the Australian meat.

Whilst at Levuka the slope from the barrier reef was taken outside the north entrance to the harbour; 65 fathoms from the edge of the reef awash the depth was 21 fathoms, or a slope of 1 in 3; at 150 fathoms' distance the depth was 80 fathoms, or a slope of 1 in 1·4 from the last sounding; farther out the slope was fairly uniform at 1 in 2 to 300 fathoms. The reefs around Kandavu have generally the character of fringing reefs, and in other places are barrier reefs. Indeed, throughout the Fiji Islands the three varieties of barrier, atoll, and fringing reefs are distributed in such a manner as to render it difficult to understand how the two former have been formed by subsidence. It has already been stated that at Kandavu there were indications of recent elevation.

A new genus and species of Reef Corals (*Tichoseris obtusata*)[1] was obtained at these islands, and some rocks, collected at Kandavu, are referable to the type of amphibolic andesite, very often containing augite and biotite, with tufa of the same composition.

Having heard at Ovalau that there were a number of natives of the New Hebrides who had just completed their engagement and wished to return to their native island (Api), which would be passed on the way to Australia, they were received on board.

On the 10th August the ship left Ngaloa Harbour, steering to the westward along the land. Passing within a moderate distance of the edge of the coral reef off Kandavu Island, it was observed that the bay next west of Ngaloa Harbour (Tomba Ya-uravu) had apparently good anchorage and a clear channel into it through the reef. In the bay are four small islands, just eastward of the large island which forms its western boundary. This island, which is round-backed, was estimated to be 700 feet high; it is called Matanuku. West of Matanuku the land trends to the westward, and then projects in the form of a peninsula, which terminates in a bluff point with a knob on it, five miles from Matanuku Island. To the westward of the knob bluff (Koro-e-Rangi) is another bay, formed between the bluff and a hill joined to the mainland by a low narrow isthmus, which makes it appear like an island when first seen. Off this False Island there is only a small reef running out to the southward, but just east of it is a reef stretching to the south-westward from the knob bluff, on which the sea breaks very heavily. There is a passage between False Island and this reef to the shore, and probably anchorage, but there appeared to be some detached reefs inside, so that it must be approached with great caution. To the westward of False Island (Thickombia) the sea was seen breaking against the sandy beach joining it to the shore, and the land trended to the northwestward, forming a bay between it and a low point (the western extremity of Kandavu Island), off which is a flat island (Denham Island), from which a reef stretches to the southwestward. At Denham Island the reef apparently ended. The whole of Kandavu

[1] Quelch, *Ann. and Mag. Nat. Hist.*, ser. 5, vol. xiii. p. 296, 1884.

Horsburgh, Edinburgh. Permanent Phototype.

FIJI CANOE.

Island west of Ngaloa Harbour is high, culminating in Mount Washington at its western extremity, a fine flat-topped mountain with precipitous sides, about 2500 feet high. The exact height and position with reference to the coast could not be ascertained, as its summit was clouded the whole afternoon.

At 6.30 P.M. the ship was stopped to hoist in the barge, which had sailed round the north side of the island from Malatta Bay, and then "laid to" under fore and aft sails for the night. At this time Denham Island bore N. by W. and False Island N.E.