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NEW CALEDONIA AND THE ISLE OF PINES

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Read at the Meeting of the Society, 18 December 1916. Map following p. 160.

THE following is a condensed account of the general features of the largest island of the Pacific Ocean (if we exclude New Zealand) and its smaller associated islets. Mr. P. D. Montague and I spent the whole of 1914 in making zoological and botanical collections and investigations in this most interesting French colony. The expenses of the expedition were largely defrayed by grants from the Royal Society, the Percy Sladen Trust Fund, and the Worts Fund of the University of Cambridge.

The archipelago (comprising the two parallel ranges of islands, New Caledonia and outliers and the Loyalties) lies between 17° and 23° S. and 163° and 167° E. of Greenwich. New Caledonia itself is 898 miles east of Australia, 966 miles north-west of New Zealand, and 1103 miles south-east of New Guinea. Its length is 248 miles, and its mean breadth 25-30 miles; its area being 6274 square miles.

Though the Solomon Islands were discovered by Mendana in 1568 and Spiritu Santo by Queiro in 1606, the neighbouring great island of New Caledonia remained unknown until 1774 when Cook first landed. Bougainville on his voyage south from the New Hebrides in 1768 had passed to the west of New Caledonia and had noticed coconuts and branches floating in the sea around him. Acting on this indication Cook succeeded in discovering land, and anchored at Balade on the north-east coast on 4 September 1774. Cook named the island New Caledonia from its physical resemblance to Scotland, and called a certain headland Cape Colnett after the sailor who first espied the land. Cook then tried to double the north-west end of the island, but was prevented by the far-stretching reefs. He returned along the east coast, and on 26 September 1774 he discovered the Isle of Pines. Thence he sailed on September 30 to New Zealand.

In 1788 La Perouse left Botany Bay, but his expedition was lost by shipwreck on Vanikoro, and it is not certainly known whether he reached New Caledonia, one of his objectives. In 1791 another French expedition

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under d'Entrecasteaux and Huon de Kermadec set out to find La Perouse. They reached the Isle of Pines on 16 June 1792 and sailed along the east coast of the mainland. This expedition also ended disastrously, both commanders dying and the remainder being captured by the English.

In 1791 Captain Hunter explored the southernmost reefs; and in 1793 Captain Kent entered Port St. Vincent on the west coast and explored the surrounding district for six weeks.

The Loyalty Islands remained unknown until 15 June 1827, when Dumont d'Urville discovered Mare. Later on he also found Lifu and Uvea and rounded the northern reefs of the mainland. He completed his survey of the Loyalty waters in 1840.

The missionary period began about 1840, but annexation was not contemplated until some years later. A curious fact is that in 1848 a Dr. Lang of Sydney sent an address to the Frankfurt Parliament urging it to establish a German colony in New Caledonia. This, however, was completely overlooked.

In 1853, in singular circumstances, Admiral Febvrier-Despointes hoisted the tricolour at Balade—the traditional landing-place—on September 24. While he was thus occupied a zealous missionary (the intelligent botanist Montrouzier) brought the news that an English admiral was about to take possession of the Isle of Pines. With shouts of “Qu'on chauffe ! Qu'on chauffe !” Despointes steamed away instantly at top speed for the Isle of Pines. Here the French missionaries had not been idle, and the result was that on September 27 the admiral of the *Phoque* and the native chief ran up the French colours. The English admiral, who, it was said, had received his orders to make the annexation a year previously, blew out his brains on the return of the *Herald* to Sydney.

Since 1853 New Caledonia and Dependencies have remained under the French flag, the chief French possession in the Pacific. The islands are governed by an elected Chamber of Representatives and by a Governor periodically appointed at Paris. The British and Japanese are represented by Consuls.*

Physical Geography.—New Caledonia is essentially a mountainous country. The greater part of it consists of hard rocks, and the softer rocks are still in an early stage of erosion. The highest mountains are formed by the serpentine culminating in Mont Humboldt, 5361 feet, in the south, and by the gneiss in the north with Mont Panie, 5413 feet, as the highest point. It is customary to speak of “the central chain.” This is an entire misnomer. The only mountain chain of more than a few miles in length is the gneiss ridge along the north-east coast from Pam to Waieme. The serpentine, it is true, extends in a series of isolated *massifs* from Belep to the Isle of Pines, but does not constitute a mountain chain in the ordinary sense.

* To the British Consul, Mr. H. O. Venables, we are deeply grateful for much valuable assistance and charming hospitality.

The largest river, the Diahot, runs in the direction of the axis of the island. It is navigable for small craft for about 20 miles. The other rivers are all of comparatively small size and are not usually navigable for more than 4 or 5 miles. The eastern side is more mountainous than the western, with the result that on the whole the rivers flowing east are shorter and more rapid than those flowing west. A further consequence of this configuration is that mangrove swamps, very extensively developed on the west coast, are only found in a few localities on the east.

The main agent of denudation is water. Frosts do not occur. There is no sandblast, and there are no pronounced signs of rock-splitting through alternations of heat and cold. On the other hand, innumerable features testify to the activity of water denudation. Large wash-outs are a frequent occurrence in the softer rocks, and follow upon torrential rains. Fig. 1 shows an example photographed by Mr. Montague near the Rivière du Carénage. In the rainy season the rivers rise rapidly and bring down large quantities of silt, which are carried out to sea, or deposited by floods on the extensive alluvial plains that occur chiefly on the west coast. The River Yate, which drains a great area of the rainiest part of the island and flows to the sea through a narrow gorge, has been known to rise 40 feet in a single night. A characteristic of the serpentine rivers is that in times of ordinary dryness they often run underground for some distance: but they also have a surface course which is used in times of heavy rain.

An interesting example of impending river-capture is shown in the region of the Plaine des Lacs. This is a great, flat serpentine plain which is normally drained by the Rivière des Lacs, a tributary of the Yate River. In times of excessive rain the whole plain is flooded and the Rivière des Lacs cannot carry away the water rapidly enough owing to the slight gradient. In such conditions a large quantity of the flood water overflows the rim of the plain and is carried away in the opposite direction by the Rivière du Carénage which flows into the Bay of Prony. It seems certain that in a comparatively short time the Rivière du Carénage will become the chief outlet of the Plaine des Lacs basin. Lakes and fresh-water swamps are very rare. The only lakes of any size are three in the serpentine of the south end, and these are not of the montane type and have a depth not greater than 25 feet.

There is no active volcano in New Caledonia and earthquakes are quite infrequent and unimportant. The absence of volcanic activity is particularly remarkable when we consider that New Caledonia lies along the line of volcanic disturbance of the Western Pacific, and is so near the New Hebrides where considerable volcanic activity takes place. Moreover, there are no obvious remains of volcanic craters in the island, though it may be suggested that the Plaine des Lacs, a broad flat plain in the serpentine, almost completely surrounded with steep mountains, is the remains of a great crater of the lunar type. Apart from the occasional

drifted fragments of pumice found on the shore there is no volcanic lava or ash to be found in the island.

Geology.—Our knowledge of the geological structure of New Caledonia is due largely to the work of Pelatan, whose map is the foundation of the one reproduced herewith. It is unnecessary to go into geological matters deeply, but a few remarks must be made on the subject.

Both igneous and sedimentary formations occur in the island in large quantity. The sedimentary rocks are, however, confined to the zone a few miles broad on the west coast extending from the Bay of Bulari in the south to Kumak in the north with certain interruptions. Igneous rocks of various character make up the rest of the island, if we exclude the recent maritime formations of growing reefs, sandbanks and emerged coral. The sedimentary rocks are considered to belong to the Triassic and Cretaceous epochs. In some parts the strata are regularly disposed, in others they are very much twisted and metamorphosed. Of special interest is the occurrence of veins of coal in the Cretaceous rocks.

The sedimentary rocks produce a country of broad, gently undulating plains, with some steep-sided hills which, however, do not reach a great elevation. In the central parts of the island, however, we have a Triassic region which includes two more or less extensive elevated plateaus of a little more than 3000 feet. These are known as Table Unio and the Plateau de Dogny.

The igneous rocks are divided by Pelatan into two groups: firstly the primitive crystallophyllian rocks, which are specially developed in the north of the island, and may be considered as the original basis upon which the more modern sedimentary rocks were laid down; and, secondly, the eruptive serpentine rocks which attain their chief development in the south, and which extend in a chain of progressively more isolated *massifs* to the extreme north.

The primitive rocks are of a very varied character, and produce several totally distinct types of landscape. In the north, extending from Pam to Waieme, there is a magnificent gneiss mountain chain, which includes Mont Panié, 5413 feet. On the seaward side this ridge slopes to the coast with scarcely a break, and the streams descend steeply in a series of cataracts, of which the finest is at Tao. On the landward side the mountain chain descends as steeply into the valley of the Diahot, the largest of the Caledonian rivers. The rest of the northern extremity of the island consists of hard crystalline schists of very varied composition, with occasional isolated limestones. The country is exceedingly irregular and broken, a multitude of small hills occurring with no apparent order. In the region between Waieme and Wagap, the rocks are hard, slaty shales and hornblende, which produce some of the most striking mountain scenery in the island. Fig. 3 shows the scenery at the mouth of the River Tanghène in this region. Mont Cantalupai may be mentioned as a peak of remarkable beauty, steep and slender, suggesting a smaller Matterhorn.

1. WASH-OUT IN SERPENTINE EARTH

2. FLOOD PLAIN OF RIVER KUAKUÉ, LOOKING SEAWARD

3. VALLEY OF RIVER TANGHÈNE, LOOKING INLAND

4. ARAUCARIA COOKI AND "LES TOURS DE NOTRE DAME," HIENGHENE

In the centre of the island, between Punereuin and Tio, the primitive rocks are of a much softer consistency, and largely consist of mica-schists, this producing a gently rolling landscape, reminiscent of chalk-downs.

The last great division of the rocks, viz. eruptive, is extraordinarily uniform throughout the archipelago, and may be called, for the sake of simplicity, the serpentine formation, after one of the most abundant constituents. The greatest extent of serpentine is found in the southern extremity extending north uninterruptedly as far as Naketi. Further north than this the serpentine occurs in larger or smaller areas, and in the north of the island it is represented by isolated *massifs* such as those of Taom, Kaala, Tiebaghi and Pume.

The serpentine rocks are extremely hard with small isolated veins and pockets of softer ferruginous clay, which are apparently the result of weathering. The structure of the serpentine mountains, as we know from borings, is mixed and irregular, and their surface is consequently strewn with boulders. Another curious feature of these serpentine rocks is the presence on the surface of great numbers of nodular masses of practically pure hæmatite. The formation of this substance depends upon weathering. It is rarely found below 500 feet, and never above 3000 feet. The aspect of the serpentine landscape is very striking and characteristically Caledonian. A serpentine district generally consists of a number of irregular chains of mountains with very steep sides separated by narrow stream valleys. The slopes are boulder-strewn, and the summits generally take the form of narrow ridges. Only in the Dôme de Tiebaghi have we an elevated plateau, though somewhat extensive lowland plains of soft serpentine earth occur in the plateau of the Isle of Pines and in the Plaine des Lacs. Precipices are exceedingly rare, this being due to the heterogeneity of the rock structure, and the slopes are generally at about the angle of rest. Owing to the great quantity of iron contained in the rocks the whole of the serpentine country has a very characteristic red ochre colour, which is scarcely disguised by the sparse scrubby vegetation that is dominant over most of the hillsides and ridges below 3000 feet. Owing to the same abundance of iron the magnetic compass becomes unreliable in certain districts. The serpentine contains a very low proportion of soluble material, and the result is that the rivers which drain this rock are of extreme purity and clearness. For the same reason, combined with the rapidity with which water soaks through the surface layers, the vegetation is of a sclerophyllous type somewhat similar to the *mâquis* of Corsica. In the narrow sheltered valleys and above 3000 feet where the atmospheric humidity is greater, forest is developed. It is in the serpentine that the chief mineral wealth resides.

Coral Reefs.—Apart from the Great Barrier Reef of North-East Australia the New Caledonian reef is the largest specimen of its kind in existence. Excluding the Loyalty Islands, coral reefs enclose the whole of the New Caledonian Archipelago from the Huon Islands in the extreme

north through the islands of Pott and Art, the small islets of Yande, Neba, Muao, etc., and the mainland of New Caledonia proper to the Isle of Pines in the extreme south. The whole of this reef is essentially a single formation; that is to say, the individual islands do not possess their own distinct coral reef, and the whole archipelago is a unit of geographical structure.

The coral attains its most perfect development as a barrier reef on the east coast, where no extensive fringing reef is developed. The barrier reef lies at a distance from the land of from 1 to 8 miles. Outside this reef soundings reveal great depths, but inside there is a comparatively shallow channel. This channel is deepest in the middle, and becomes shallower both towards land and towards the reef. Generally speaking, the reef is single, and forms a band of coral rock awash with the sea, interrupted here and there by numerous passes. In these passes the water is approximately of the same depth as that in the middle of the channel. In most cases the passes in the reef lie opposite the mouths of rivers. This is a very interesting and important fact, and appears to be a strong piece of evidence for the view that the barrier reef began as a fringing reef, and that it was gradually separated from the land by subsidence of the whole region. At a distance of several miles it is inconceivable that fresh water discharged by the rivers into the channel could suffice to prevent the growth of coral in the passes of the reef. On the other hand, if such a pass existed for any reason it would certainly be kept open by the scouring action of the tides. The structure of the reefs is, I think, adequately explained by the theory that they are the direct descendants of fringing reefs, which were naturally interrupted by the river mouths.

The reefs of the west coast differ in some respects from those of the east coast. A large part of the west coast is bordered with broad plateaus which stretch out for several miles from the shore, and which are only broken by passages leading from the river mouths to the open sea. Whereas on the east coast shipping can keep in the comparatively calm waters of the channel between the reef and the shore, on a great part of the west coast it is necessary for shipping to go outside the reef into the open sea and enter by the river passages to make the various ports. In the part of the coast opposite Wako there is a broad plateau known as the Plateau des Massacres, and outside this there is a barrier reef. A similar feature is noticeable at the extreme north, where there is a broad plateau encircling the Island of Balabio, and outside this at a distance of 10 miles the great reef of Captain Cook.

The reasons for these variations appear to be connected with the contours of the dry land. On the east coast the mountains approach very near to the sea, and the shore is almost always steep. The result is that the fringing reef, when present, is very narrow, for there is no breadth of substratum on which it can grow. At Balabio and Wako a

barrier reef has apparently been formed from the original fringing reef as the result of subsidence; later a second fringing reef has appeared, and, owing to the gentle contours of the shore, has been able to grow out to a considerable breadth. In other parts of the west coast, where the coastal rocks are mainly sedimentary, the amount of subsidence that has taken place has been insufficient to produce a deep channel between the low coast and the outer margin of the reef.

The idea mentioned above that the whole archipelago must be regarded as a single geographical unit is borne out by several other features. In the first place, we have the configuration of the group, which lies entirely between two parallel lines drawn 60 miles apart. The direction of these lines is north-west to south-east, exactly parallel to the neighbouring Loyalty Islands, and with the same general direction as the north-east coast of Queensland, the Bismarck Archipelago, the Solomon Islands and the New Hebrides, the mountain chains of the south-east part of New Guinea, and the northern extremity of New Zealand.

In addition to the arrangement of the land masses in a single straight line there is an essential similarity in the geological structure, especially with regard to the serpentine formation. We meet with the peculiar and characteristic serpentine rocks in the Belep Islands, in Yande, in the Pume Peninsula, in a series of mountain masses on the west coast, crossing the island by way of the Chingu group between Tuo and Kone, following the east coast from Punereuin to the extreme south, and spreading all over the southern region of the mainland with the exception of a narrow zone of sedimentary rocks along the west coast. This serpentine formation reappears as the central core of the Isle of Pines.

Moreover, between the Isle of Pines and the south end of the mainland is a region of very shallow water, which is full of small and large coral reefs and sandbanks. An exactly similar area is found in the north of the island between the mainland and the Belep Islands. It seems clear that these two coral-filled seas represent the former sites of dry land connecting the outlying islands with the mainland. The subsidence that affected the whole of the archipelago submerged these land bridges, and the coral that was growing as a fringe on their shores was left to mark the place.

Other Evidences of Subsidence.—Apart from the arrangement of reefs and the geological structure there are certain features of the coast-line which make it probable that a subsidence has occurred. As has been mentioned, the mountains approach the east coast much more nearly than they do the west. Thus as a result of subsidence we should expect the indentations of the east coast to be narrow, corresponding with narrow montane valleys, and when promontories and islands occur we should expect them to be of the nature of mountain chains and peaks. This is what we actually find.

As examples of narrow inlets may be mentioned the great Bay of Kanala, the Bay of Kuaua, and the Bay of Ba. In the case of Cape

Bocage, Mara Point, and Mount Winne we have examples of mountain promontories ; and in the Islands of Tupeti and Porc-Épic we have isolated outliers of serpentine just separated from the mainland by narrow sand-spits. The other islets off the east coast are all sandbanks, if we except Balabio, which is an outlier of the great gneiss mountain range of the north of the island.

On the west coast, however, a broad zone of plains intervenes between the axial mountains and the sea. The effects of subsidence in such an area would be to produce broad irregular coastal indentations, not obviously related with the land structure, these inlets being strewn with small islands representing the original hilltops.

This is actually what we find on the west coast, the outline of which is diversified by a series of broad island-bestrewn bays. The most noteworthy of these are the Bay of Nehue in the north, the Bay of Mueo in the centre of the island, and the great Bays of St. Vincent and Dumbéa in the south. The beautiful Bay of Prony in the extreme south of the island lies in a montane region and thus approximates in character to the inlets of the east coast. It is a singularly perfect example of a drowned valley system into which discharge a number of rivers from nearly all points of the compass.

Other Changes in Level.—I have given reasons for my view that the New Caledonian system has suffered considerable subsidences at a more or less remote epoch. In contrast with this I may now mention evidence which shows that in more recent times a certain amount of elevation has taken place. A glance at the map shows that a considerable area in the archipelago is composed of emerged corals. The Loyalty Islands, the outer zone of the Isle of Pines, and a narrow belt of country extending from Unia to Goro at the south-east end of the mainland consist of more or less elevated and metamorphosed madreporic rocks.

In the case of the Isle of Pines, Mare and the Yate belt the coral is superposed upon a serpentine basis. The altitudes of these different coral areas are instructive. The Astrolabe Reefs are awash with the sea. Uvea consists partly of emerged corals, partly of an actively growing atoll, the maximum altitude being 40–50 feet. Lifu has a maximum altitude of 180 feet. Mare reaches a height of 280–320 feet ; that is to say, the further we go towards the south-east the higher the emerged corals become. The Yate strip is only a few feet above sea-level, agreeing in this respect with part of Uvea, while the coral zone of the Isle of Pines reaches about the same general altitude as Lifu. An isolated rock of true coral has also been observed at Yengen, and the Champignon islets at the mouth of the Bay of St. Vincent are also emerged and undercut corals. These facts taken together indicate, in my opinion, that a tilting of the ocean floor has taken place in recent times, the elevation becoming progressively greater towards the east.

Other Limestones.—The coral formation of which the Loyalty Islands,

the Isle of Pines, and the Yate strip are composed is frequently very much altered by the action of water, being tunnelled out and precipitated as stalactites and in various crystalline forms. In the north part of the island a totally different series of limestones also occur which show no trace of their relationship to coral, and which certainly have an entirely different origin. Three main outcrops of these limestones occur: one extends along the east coast from Yengen to Tipindie; another in the mica-schist area between Pilu and Kumak, and a third in the centre of the island between Poia and Punereuin. In all cases the surrounding rock belongs to the series of the primary schists.

The limestone itself is crystalline and semi-translucent; it is exceedingly hard and rings like a bell when struck. It gives rise near Yengen to a series of remarkable rocks of fantastic shape. Fig. 4 shows the curious rock known to the colonists as "Les Tours de Notre Dame de Paris." These reach an altitude of about 450 feet, and resemble on a small scale the structure of the Tyrolean Dolomites. The outline is exceedingly irregular and often sharply serrate: planes of cleavage run in all directions, and the sharp edges and resistance to weathering testify to the hardness and durability of the rock. In some cases the interior of these rocks is hollowed out into capacious caverns, but true stalactites are very scarce and the caverns are probably rather lysigenous than water-worn. In these caverns, it is interesting to note, the peculiar endemic tailed bats make their home.

Climate.—Since 1908 there have been a number of meteorological stations in New Caledonia, the Isle of Pines, Lifu and Mare. These have been conducted under the guidance of Dr. Mialaret, who has published from time to time the facts which have been collected with regard to the climate. Previous to 1908, only sporadic observations had been made, apart from Numea, whose climate is, on the whole, somewhat exceptional.

Temperature.—The mean minimum is $17^{\circ}17$ C., the mean maximum, $27^{\circ}85$; the mean temperature for the whole year being $22^{\circ}51$. Thus the climate is mesothermic. There is little variation between the east and west coasts, though it is evident that the temperatures vary much according to the altitude. The highest temperature on record is $39^{\circ}5$, and the lowest is $3^{\circ}5$; in general, however, the maximum temperature does not exceed 36° . The months of December, January, and February are the hottest of the year, and June, July, and August are the coolest.

It may be remarked that the height of the summer temperature is much modified by the prevailing trade wind, which blows by day almost continually with considerable force from the east-south-east. There is often great temperature variation between day and night. This is particularly marked in the winter, and is largely due to the land-breeze which blows from the mountains from shortly after sunset until next morning.

Rain.—The average rainfall from 1908 to 1912 was 1845 mm. (73 inches)

per annum, distributed over 142 rainy days. The seasons are not strictly delimited, and heavy rains may occur throughout the year; but, generally speaking, it is possible to distinguish a rainy season in January, February, and March, and a dry season in September, October, and November. The total rainfall varies greatly in different years. The mean rainfall in 1910 was 2439 mm. (96 inches); in 1911 it was 1264 mm. (49.5 inches).

These figures refer to observations made over the whole extent of the island, but there may be local variations in rainfall. Dr. Mialaret divides the mainland into four regions: (1) The east coast with 2696 mm. (106 inches) in 156 days; (2) the south with 2531 mm. (100 inches) in 161 days; (3) the centre with 1874 mm. (74 inches) in 162 days; (4) the west coast with 1471 mm. (58 inches) in 131 days. It rains more in the night than in the day, and diluvial rains are not rare. The highest rainfall in 24 hours ever recorded was on 12 February 1909, when 486 mm. (19 inches) fell at the Col d'Amieu.

Pressure and Wind.—The barometer varies little, the usual daily movements being observed with maxima at 10 a.m. and 10 p.m., and minima at 4 a.m. and 4 p.m. The reigning wind is a fresh and strong trade from the east to the south-south-east. This wind blows with little intermission from the middle of the spring to the middle of the autumn. During the winter the wind is much more variable, and has generally less force.

New Caledonia is visited by destructive cyclones. These occur almost exclusively in the months of January–March. They are heralded by stormy weather, a leaden overcast sky, and a sharp lowering of the pressure. They are exceedingly destructive to buildings, coconut plantations, etc. The use of the barometer is understood by every one who owns a boat, and owing to the abundance of good harbours comparatively few wrecks occur. Thunderstorms are very rare.

The question as to whether the climate is to be considered dry or wet is, perhaps, an unprofitable one. The rainfall, as we have seen, is relatively abundant, but for various reasons evaporation is exceedingly great in the open, and the result is that many parts of the country give an impression of aridity. For instance, in 1884, at Numea, 888 mm. (35 inches) of rain fell, but the amount of water evaporated by a free surface was almost double this, viz. 1789 mm. (70 inches), and it is probable that evaporation from the soil would be greater still. As every visitor to Numea notices, the district surrounding that town is for the greater part of the year dry and burnt up. Moreover, the soil over a great part of the country is very permeable, and the rain that falls is absorbed rapidly and transferred to the numerous streams, which in times of heavy rain often produce destructive floods. This applies particularly to the serpentine districts.

The aspect of the country varies tremendously according to the configuration of the land. The open plains, such as occur generally on the west coast, are green and luxuriant in the warm wet summer months only.

During the greater part of the year the vegetation is burnt up, except close to streams.

The open exposed hillsides, whether of serpentine, gneiss, schists, or sedimentary rocks, are covered with vegetation whose whole aspect suggests drought. Low shrubs prevail, mixed with great quantities of *Pteridium esculentum* and a few Cyperaceæ: all these plants possessing leaves of rigid coriaceous texture and thick cuticles. When, however, we enter the forests we find ourselves in the midst of a vegetation of tropical luxuriance. A great variety of trees abound, many reaching considerable heights. Beneath them are shrubs and lianes, and on their branches is a great variety of epiphytic orchids, filmy ferns, and bryophytes. The alternations between the scrub of the open hillsides and the forest of the valleys is often very sharp. In passing from one into the other one passes from a hot, dry atmosphere, from a scorched soil with no drop of water visible, and from small-leaved xerophilous shrubs, to an atmosphere saturated with moisture, to wet and dripping trunks and soil, and to a vegetation consisting largely of trees with immense leaves, palms, arborescent ferns, and all the splendour of the forest which we regard as characteristically tropical.

Natural Resources.—The only animal products suitable for export are troca-shell and bêche-de-mer. The former is exploited on a considerable scale by the French, Japanese, and Kanakas. During the past fifteen years the reefs have been practically cleared of this shell, and it is now necessary to dive in order to obtain specimens. The industry has recently been regulated by law, there being a close season and a minimum size; but the evil has been done, and it is doubtful whether troca collecting will recover from the wholesale depredations of the first few years.

The native vegetable products are numerous and valuable. Sandalwood, which formerly grew abundantly over the whole archipelago, has now been almost extinguished. The three species of kaori yield valuable timbers for ship and house building, but owing to the difficulty of exploitation in mountainous country very little timber is cut and none is exported. Other valuable timber trees are the chêne-gomme *Spermolepis gummifera*, *Callitris Balansæ*, *Araucaria Rulei*, and *A. Cooki* (Fig. 4), of which only the last is worked on the large scale. There are also a number of hard and fancy woods suitable for furniture and cabinet-making. The native kaoris yield large quantities of resin, and some gum-digging takes place. As in Australia, there is a singularly small number of edible native fruits. The French population brought their own fruits in the same way that the natives in earlier times brought theirs.

Minerals and Mines.—The mineral wealth of New Caledonia is great and varied. Deposits, large and small, of almost all the metals occur. Iron is by far the most abundant, but, owing to the lack of good coal, its exploitation is impracticable. The most valuable deposits are ores of nickel, chromium, and cobalt. Other metals have been mined in small

quantity, especially copper and gold, but these are not commercially profitable at present.

Rich deposits of cobalt occur on the summits of a large proportion of the low serpentine hills, and in the past these have been worked by innumerable small enterprises on the part of solitary settlers, escaped convicts, and so on. The discovery of argentiferous cobalt in North America, however, killed the Caledonian industry, and now the only traces remaining are scarred hillsides and broken-down washing arrangements.

Mining for nickel and chromium is in a flourishing condition, and a high percentage of the world's supply of these important metals comes from New Caledonia. Small quantities of both metals occur scattered throughout the serpentine, and in some places, chiefly on the crests of lateral ridges of the mountain chains, sufficient deposits of the minerals are found to be worth mining. Nickel occurs in various forms of garnierite and as a peculiar brown light nickel ore. Chromium occurs as chromite. The chrome mine of Tiebaghi is reputed to be the richest in the world, and is within a few miles of the sea (Fig. 7). All the mines are superficial. It is stated that the minerals only occur in surface pockets, and indeed they appear to be the products of weathering of serpentine. The reason for the occurrence of rich local deposits must be considered an unsolved problem.

Other Industries.—The igneous rocks are the only ones productive of minerals; on the other hand, they are generally unsuitable for cattle-raising and cultivation. It is even impossible to drive a herd of cattle across the serpentine country without taking fodder, as the natural vegetation affords no forage. The sedimentary rocks yield no minerals, but on these agriculture and cattle-raising can be practised.

Although the soil derived from the sedimentary rocks is often rich in mineral salts the natural vegetation over great areas of hill and plain appears poor and unprofitable. Vast areas are covered by a kind of savannah in which the only tree is the niaouli, *Melaleuca viridiflora*. The undergrowth consists almost entirely at the present day of alien grasses. Some of these afford fair pasture for cattle, but the raising of sheep is difficult owing to the abundance of the cosmopolitan *Andropogon Allioni*, whose awns become entangled in the wool and cause ulceration, and sometimes death. The chief enemy of cattle-raising is the erratic nature of the water supply. Droughts are frequent, and as the evaporation is intense the shallow-rooted grasses become completely burnt up. In general the colonist makes no attempt to remedy this by pumping and irrigation, with the result that the cattle are often extremely poor, and large numbers die. Apart from the small amount of meat used for immediate consumption, which, owing to the heat of the climate and the primitive means of communication, is very limited, all the beef is canned. The mining population obtains fresh meat only at rare intervals, and the same is the case with vegetables and fruits.

5. NATIVE ROUND HOUSE, HIENGHENE

6. SINGLE OUTRIGGER CANOE

7. CHROME MINE, DÔME DE TIEBAGHI

8. CORAL "CHAMPIGNON" AND WHALEBONE, ISLE OF PINES

The cultivation of many different crops has been attempted. Comparatively few have succeeded, but it seems probable that the reason for this is rather in the primitiveness of the means of cultivation than in the soil and climate. The colonist uses practically no irrigation nor manuring, the result being that though in the first year or two good crops may be obtained, deterioration and disease soon set in with disheartening results. Moreover the twin enemies of torrential rains, giving rise to devastating floods, and drought render culture difficult.

The most successful of the colonists' cultures are those of coffee and maize. Coffee has succeeded especially in the north of the island. In addition there is the staple product of so many tropical countries—copra. A great variety of plants are grown on a small scale to satisfy the immediate wants of the colonist. The export trade in agricultural products is confined to coffee, maize, and copra. It is clear that the agricultural resources of the country are not developed to their fullest extent. This is very largely due to the slowness with which the country has been colonized, which may be attributed, in part, at any rate, to the penal system.

Flora.—The flora of New Caledonia is large and varied, and presents many exceptional features. My own collections and those of MM. Sarasin and Roux are not yet fully worked out, so the following particulars are founded on a list compiled by M. Guillaumin in 1911. The total number of species of Phanerogams given in this list is 2253, and the number of Pteridophyta is certainly in excess of 300 species. It will be seen that this number is much higher than that in the majority of Pacific Islands.

Not only is the flora rich in species, but the proportion of endemic forms is exceptionally high. Exact figures are wanting at present, but the endemism extends to numerous genera, and to one group, the Balanopsidales, which is considered by Engler as a distinct order.

The families which contain the highest number of species are the following:—

Rubiaceæ	...	...	...	169	Rutaceæ	...	...	...	58
Orchidaceæ	...	...	...	152	Sapindaceæ	...	...	...	53
Myrtaceæ	...	...	...	142	Sapotaceæ	...	...	...	51
Euphorbiaceæ	...	...	...	120	Myrsinaceæ	...	...	...	47
Apocynaceæ	...	...	...	97	Proteaceæ	...	...	...	44
Araliaceæ	...	...	...	89	Cyperaceæ	...	...	...	40
Saxifragaceæ	...	...	...	88	Artocarpaceæ	...	...	...	37
Leguminosæ	...	...	...	79	Compositæ	...	...	...	34
Gramineæ	...	...	...	75					

The most striking feature shown by this list is the position of the Leguminosæ, Compositæ, and Gramineæ. These three families, which are dominant in almost all the local floras of the world, here occupy a very low position on the list. This peculiarity is emphasised by the fact that the great majority of the representatives of these families in New Caledonia are of alien origin and are indeed plants of economic importance and

cosmopolitan weeds of the tropical and sub-tropical zone. For instance, of the seventy-five Gramineæ only about half a dozen are native. The majority of the Compositæ are plants with easily distributed seeds which have arrived accidentally with imports, and the Leguminosæ include a number of culinary and other useful plants. The absence of these families is especially noticeable in the serpentine districts, where the alien flora has made comparatively little inroad; the Compositæ, for instance, are represented by a single species, which occurs sparsely at 3000 feet altitude.

When we consider the large indigenous families we notice that the main affinities of the flora are twofold. On the one hand, certain families occur in great variety which are of the Indo-Malay type; such are the Rubiaceæ, Euphorbiaceæ, Sapotaceæ, and Artocarpaceæ. Other smaller families with the same geographical affinities are the Nepenthaceæ and Chloranthaceæ; while the New Caledonian members of the Orchidaceæ, Palmaceæ, and Pandanaceæ are more closely allied to the Indo-Malayan sub-families than to those of other neighbouring regions.

On the other hand, we have equally clear relations with the flora of South-East Australia. The Myrtaceæ with capsular fruits are very abundant constituents of the flora. (The Myrtaceæ with fleshy fruits, which are pantropical with many species in Indo-Malaya, are also present in New Caledonia in plenty.) The Proteaceæ number no fewer than 44, showing the clearest relationship with Australia, the Indo-Malay genus *Helicia* being unrepresented. The Epacridaceæ (20 spp.), Dilleniaceæ (21 spp.), Rutaceæ (58 spp.), Goodeniaceæ (4 spp.), and others also bear out the connexion, particularly with the flora of New South Wales.

It is noteworthy that the Indo-Malayan elements of the flora are chiefly represented in the forest regions, and the Australian elements in the scrub and savannah regions. Schlechter's division of the island into a north region with Indo-Malayan floristic affinities, and a south region with Australian affinities seems to depend on the dominance of forest in the north and of scrub and savannah in the south. The littoral zone is related floristically to the Pacific area in general, and need not be further discussed here.

A consideration of the flora leads to the conclusion, supported by other lines of evidence, that New Caledonia is a very ancient land mass and has been separated from continental areas for a very long period, the date of separation apparently preceding the period in which the Compositæ, Gramineæ, and Papilionateæ were evolved and distributed over the Earth's surface. That a land connexion previously existed appears to be certain from the wholesale nature of the resemblances of the flora to its distant neighbours, and from the fact that the majority of native New Caledonian plants have no natural distribution mechanisms which would account for their transportation over wide spaces of sea.

Fauna.—The most striking feature of the fauna is the almost complete

absence of mammals. The only representatives of this group native to the island are the bats and flying-foxes (among which may be specially mentioned a species with a distinct tail), a rat and a pig, the latter two apparently dating from prehistoric times. An East Indian stag has been introduced, and is now locally abundant.

There are no marsupials nor amphibians, though the French have introduced species of frog. Land snakes are absent, but lizards are represented by several species of skink and gecko, including one of exceptional size. The birds are not numerous in species, but contain representatives of most of the families. The kagou, *Rhynchoetus jubatus*, is perhaps the most remarkable; its systematic position has been extremely doubtful. It has large, well-developed wings, but is entirely flightless. It can easily be captured by dogs, and for this reason is rapidly diminishing in numbers.

Among the insects the Orthoptera are represented by a remarkable variety of Mantids and Phasmids, and the Hemiptera, Diptera, and Coleoptera are also represented by large numbers of forms, but the Lepidoptera and Hymenoptera comprise comparatively few species. On the whole there seems to be a lack of insects which depend for locomotion exclusively on flight. Myriapoda, spiders, and scorpions are all represented in some variety. The land Mollusca comprise some remarkable forms, including species of *Placostylus* which may be 4 inches long.

The fauna in general, like the flora, shows features which may be correlated with long isolation, viz. the great development of certain peculiar genera, often of a primitive type, the large lacunæ in the series, and the high degree of endemism. The geographical relationships are, on the whole, with the New Hebrides, East Australia, and the Indo-Malayan region.

Population.—The native population follows the more fertile soil and the river valleys, and is exceedingly scanty in the serpentine districts. Tribes occur both on the coast and in the interior, speaking a great variety of languages and dialects whose distribution does not correspond with the physical features of the country. The coastal tribes rely upon fishing as well as agriculture, and those on the east coast also carry on trade with the Loyalty Islands. The tribes of the interior rely solely on their crops and on game.

The French population depending upon commerce has installed itself chiefly along the coast in a number of settlements. The capital, Numea, is almost exclusively commercial and administrative. The coastal settlements were founded mainly near river mouths on fertile agricultural soil where the early settlers naturally came into conflict with the natives. Insurrections and massacres occurred from time to time, and there seems to be no doubt that colonization, the imposition of the poll-tax, and the seizure of the best land were strongly resented by the natives, despite statements to the contrary.

At present the natives are confined to limited reserves; they have been reduced in numbers by about half since the beginning of colonization, this

being due to the introduction of European diseases, alcohol, and the stigma attached to illegitimacy. The native population suffers largely from consumption, leprosy, frambœsia, and plague, and there is a certain amount of elephantiasis. Leprosy is making some headway among the white population, as isolation is not strictly enforced ; though in the Isle of Pines, where the natives have instituted their own leper isolation station, the disease is in a fair way to become extinct.

Means of Communication.—The chief means of communication is coast-wise by vessels which skirt the coast and call at the various ports, most of which provide excellent anchorages ; and by means of roads and paths which also follow the coast. There is a single metalled road about 100 miles long from Numea to Burai. A number of other roads and cart-tracks connect the various centres, and two or three cross the so-called "*chaîne centrale*" from one coast to the other. There are also a considerable number of native tracks which generally follow the river valleys and ridges, but these last are falling into disuse owing to the decrease in the native population. The result is that it is very easy to get from one point to another along the coast ; but owing to the very rough and mountainous nature of the country it is very difficult to make journeys in the interior. There is a narrow-gauge single-line railway from Numea to Paita, and a daily service of motors runs between Numea and Burai. The telephone has been installed along almost the whole length of coast, and foot mails reach most of the agricultural settlements twice a week.

Convict System.—New Caledonia is best known in this country as a convict settlement. The transportation of convicts there began in 1864, and ceased in 1894. In 1889 there were over 7000 convicts in the island. At present there are only about 300 old men, invalids, and imbeciles at Nu Iland, the chief penitentiary, and a number of *libérés*, or ticket-of-leave men, who work for the colonists at a wage.

The period of maximum number of convicts was also the period of the maximum commercial prosperity of the French population. The convicts were employed partly in works of public importance, the construction of roads and buildings, and in part they were hired at a nominal wage to mine proprietors and other colonists. This latter course, while bringing prosperity to individual capitalists, and revenue to the administration, was, however, shortsighted ; and there can be little doubt that if the convicts had been employed exclusively on improving the means of communication the future welfare of the colony would have been better served.

The result of the stoppage of transportation has been to create commercial depression, and the prosperity of the colony has been on the down grade since 1894. The stoppage of the supply of cheap convict labour has led to the importation of a large number of aliens for various purposes. Japanese are present to the number of several thousand, being employed as miners, and in the trocha fisheries. Japanese, Tonkinese, and Chinese come as domestic servants and as field workers, Arabs as stokers and

greasers, and a variety of Melanesian people from the New Hebrides, Loyalties, and Solomons, as well as native Caledonians, are employed as general handymen, and in shipping. Numea is one of the most cosmopolitan towns in the world, it being quite possible in the course of a short promenade to notice twelve or fifteen totally distinct human races.

Natives.—The native population of New Caledonia is a branch of the Melanesian stock, and there is some reason to think that it may be among the most primitive of that group of races. As to the relations of the New Caledonian race with those of the surrounding land masses, it appears probable that they are more closely connected with the natives of Australia than with those of the New Hebrides or the Solomon Islands. They are of medium stature, the average height being about 5 feet 8 inches. Information as to the anthropometric features of the indigenous New Caledonian race is scanty, but it is to be hoped that the researches of MM. Sarasin and Roux, who were in the island two years before Mr. Montague and myself, will supply this lack. The head is dolichocephalic and the forehead slants backwards. The supraorbital ridges are prominent, and a striking feature is the deep depression at the root of the nose. The hair is short and frizzy in both sexes, and is almost always black. The men are capable of growing long frizzy beards, and the older men make it a habit to do so. The colour of the skin is rather difficult to define. It is a dull brown with a somewhat sallow tinge, very different from the dark rich brown of the Loyalty Islanders.

It is very necessary to distinguish between the original natives of the island and the immigrants. In some districts, particularly on the east coast in the neighbourhood of Kanala, Wailu, and Tuo, one meets with a population which shows marked similarities with the natives of the Loyalty Islands, and it is precisely these places which are the most easily accessible from that group. On the other hand, in the south of New Caledonia the natives are all colonists from the Isle of Pines. We actually find the most primitive inhabitants of the island in the north and in the centre of the island. Mr. Montague spent some time in the tribe of Gondé at the head of the Wailu valley, which is far enough away from the coast to have suffered little contamination from Loyalty Island immigrants, and is visited rarely by Europeans. His discoveries as to religion, magic, music, and ceremonial are of great interest, but I must not forestall his account of them. I will confine myself to what I have actually observed.

The hand of civilization is heavy upon the island and has affected mainly the native tribes along the coast. Here all the native arts and industries have been abandoned, beaten bark and cocoanut fibre have given place to cotton garments printed in many colours, thatch and niaouli bark have been replaced by sawn wood and galvanized iron, the native fruits and vegetables have yielded to canned beef and chemical wine, and the cookery is no longer done in the native earthenware vessels, but in

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Australian billies and American kerosine tins. Certain objects difficult to destroy and impossible to sell have withstood the general disorganization. Houses and canoes remain in certain localities, though more often than not the canoes are rigged in European fashion and the houses are decorated with Christian symbols. It is necessary to be very careful before deciding whether an object used by the natives is primitive or acquired. As an instance I may mention the remarkable piercing drill figured and described by Father Lambert, the author of the fullest study of the customs and implements of the New Caledonians. This was a pointed piece of hard stone mounted on a vertical axis, which was made to rotate by means of a cross-bar and spirally wound strings. It was used for boring holes in beads and stone axes. The device from the first appeared to me as of too complicated a nature mechanically for the simple mind of the New Caledonian, and I have since learned that an exactly similar implement is used in Brittany by menders of china and earthenware. It seems to me possible that this device was introduced by the early Marist missionaries who commenced to settle in the island about 1840, or by even earlier arrivals from Europe.

Houses.—The native house is of substantially the same type throughout the whole of New Caledonia and in the Isle of Pines. Fig. 5 represents a house near Yengen. The ground plan is almost always circular,* and the sides rise vertically to a height of about 4 or 5 feet. There is a stout central post of variable height, to the top of which are attached the beams which spring from the ring of short posts forming the skeleton of the walls. The roof is therefore conical, and is invariably covered with a thick thatch of tall grasses and sedges. The lower margin of this thatch protrudes for some distance beyond the walls and throws off the rain. The walls are made of different material according to the locality. In districts where the niaouli is abundant, its bark, which can be detached in large pieces from the trunk, is sewn on to the uprights and makes an excellent wall. Even better is the bark of the chène-gomme (*Spermolepis gummifera*); this is detached from the tree in large sheets, and is spread out flat under weights in the sun to dry, when it becomes extremely hard and durable. This tree is abundant in the serpentine districts where the niaouli is rare. In other places where neither of these trees is sufficiently abundant, the natives make use of thatch for the walls as well as for the roof. The door of the house is its only opening to the exterior. It is low and narrow, and is flanked by two large doorposts. The top of these posts is carved into a grotesque face with exaggerated features and often a protruding tongue. The lower part of the post is carved in a conventional pattern of curves or diamonds, the spaces being supposed to represent, so Mr. Montague tells me, the stomachs of the figure. The apex of the roof is terminated by a large

* Rectangular houses were seen by Mr. Montague in a primitive tribe near Table Unio, but these appear to be exceptional.

ornament of very varied design which may or may not bear a remote resemblance to a human face. It is often carved very cleverly, when the primitive tools at the disposal of the native are taken into account. Any projecting points in this ornament are always decorated with conch shells.

The front of the house is occasionally approached through a short "drive," enclosed between two low stone walls, often terminated by posts (Fig. 5). The floor of the house is usually raised above the outside level. On it the fire is made and the food is cooked. For sleeping purposes the bare earth is strewn with palm-leaves, dry grasses, or bracken. On the walls are hung the various implements used by the owner of the house, his nets, his spears, his thatching-needles, his calabashes, his sling and bag of sling-stones. Of furniture there is none, except that in one place in the Poyes tribe I have seen the natives use a curious wooden pillow, carved out of a single block of wood, with a concave upper surface to support the head, and standing on two broad legs. The whole arrangement is reminiscent of the African native pillow, and of those found nearer New Caledonia, as, for instance, in New Guinea. The above description applies to the vast majority of native dwelling-houses, but variations of this primitive, simple type also occur in the case of houses used as the residence of the chief, or for ceremonial purposes. In the Isle of Pines there are two large houses which may here be briefly described.

At Vao there is an unusually large round house, built just above the shore. It is no less than 40 feet in diameter, and the central pole is a huge hardwood 7 feet in circumference. The wall has sixteen main posts and the sides and roof are thatched. There is a double doorway with three carved and painted doorposts of the same type as those found on the mainland. The house is not inhabited at the present day, but is used as a store for fishing and turtle nets. In it were also a number of parts of an old double pirogue. By the side of this house is a fence composed of big logs 10 feet high set close to one another. The form of the tops of these posts shows them to be the central poles of native houses. The village of Vao was evidently much more populous formerly than it is at present. It is now the headquarters of the Catholic Mission, and the old round house carries a rough crucifix instead of the usual carefully carved taboo-post.

At the other end of the island is the magnificent old house of the grand chief in the village of Gaji. This house is built on quite a different plan from that of the round house (Fig. 10). The ground plan is rectangular, the length being 57 feet and the breadth 12 feet, the total height being 13 feet. The middle line of the house is formed by five equidistant central posts, each 18 inches in diameter, these supporting the horizontal ridge-pole. The ridge-pole carries the upper ends of the beams which spring from a series of wall-posts each 4 feet high. The walls and roof are thatched. On one of the long sides are two double doorways. A strange feature is the total lack of ornament. The doors open into a courtyard enclosed by a stockade of logs, many having carved tops like those at Vao. A narrow winding

passage between two rows of these posts leads to the outside through a doorway cut through the trunk of a large living banyan tree (Fig. 9). Adjoining the main courtyard is a smaller space originally enclosed in a palisade which was used as a store for gifts of fish, yams, coconuts, taros, and other produce brought in preparation for the native dance ceremonies or *pilou-pilous*. The house is now unoccupied, but was formerly the residence of the chief: an adjoining house, now destroyed, was used by him for receiving his festival guests.

Canoes.—The canoes may be simply classified into single and double. In the double canoes there are two dug-outs connected by transverse booms; in the single canoes there is only one dug-out which is connected by transverse booms to a float. The double variety is, I believe, completely extinct, though I was able to see the parts of a dismantled one at the Isle of Pines. The single canoe, on the other hand, is abundant along the coast and up the larger rivers (Fig. 6). Two types may be distinguished, the decked and the deckless. The former can be rigged with a mast and sail and is capable of making considerable voyages. The latter is propelled by punting or paddling and is suitable only for alongshore work. Canoes without outriggers are never met with.

The construction of a canoe in the old days was a lengthy process. First of all the forest had to be searched for a suitable tree, and the native thought nothing of going many miles inland up mountain sides to find what he wanted. The tree found, it had to be felled, and with the stone axes, which constituted almost the only tool, the felling might take two or three years. The tree was roughly shaped in the forest, and was then hauled down the mountain side and across country until the shore was reached. The log was here dug out by means of stone adzes and fire. Holes were bored through the gunwales, and the outrigger booms, two or three in number, according to the size of the canoe, were lashed to it by means of twine made from coconut fibre. The far ends of the booms were attached to the float by means of pairs of Y-shaped sticks; this arrangement being closely similar to that observed in the canoes of the Torres Straits. The result was a deckless pirogue.

In the decked pirogues the two ends of the dug-out are covered in, and a coffin-shaped structure of planks is erected amidships. On the top of this are placed the booms and the broad deck. The whole structure is made water-tight by means of split saplings and plugs of niaouli bark, caulked with resin obtained by chewing the buds of a species of *Gardenia* abundant in the forests. Steering was done by a long paddle lashed on near the stern.

The double canoe was a much more elaborate structure, and was ornamented with carving. A deck was built all across the booms, and projected out on either side beyond the dug-outs. In the middle of this deck was erected a kind of deck-house, and on the top of this was a "bridge," which was mounted by the "navigating officer." There was

9. ENTRANCE TO HOUSE AT GAJI, ISLE OF PINES

10. INTERIOR OF HOUSE AT GAJI, ISLE OF PINES

11. CORAL RESTING ON SERPENTINE, ISLE OF PINES

12. TUMULUS ON CENTRAL PLATEAU, ISLE OF PINES

an immense lateen sail made of woven rush leaves with two diverging yards, the apex of which was inserted in a depression in the bow. When it was necessary to tack, the tip of the boom was lifted out of the depression, and was carried round and put in a similar depression at the other end. The result was that the stern now became the bow. Four huge paddles were carried for steering, one at each end of each dug-out. These canoes were exceedingly seaworthy, and made long voyages. They could carry a crew of twenty men, and were used in the Isle of Pines for predatory raids upon the mainland.

Native Cultivation.—The native depends for sustenance firstly on the coconut, which may be native in the north of the island, and on the pig, which appears to have been present here as in the New Hebrides from prehistoric times. The only other native products that he consumes are one or two native fruits and leaves of inferior quality, flying-foxes, wild pigeons, and a number of small birds. Cannibalism was formerly frequent, human flesh being eaten partly for the sake of satisfying hunger and partly because the qualities of the part eaten were supposed to pass into the eater. The native also brought from his ancestral home several varieties of yams, taro, and banana. These he cultivates with the greatest care. For the taro he has a system of irrigation which astonishes by its perfection and by the success which results from it. The water is often brought across hilly country for miles, and is then distributed in a series of terraces which cover whole hillsides. Large areas of country are covered with derelict Kanaka cultivation terraces which have been abandoned owing to the decrease in population consequent upon the arrival of Europeans.

ISLE OF PINES.

The Isle of Pines (or Kunie) is situated 40 miles from the southern extremity of the mainland, with which it forms part of the same system. This is shown by the identity of the serpentine formation of the two islands, and also by the shallow water full of patches of coral which intervenes between them.

The island is roughly quadrangular, and measures 10 by 8 miles. It is divided into two highly distinct regions. In the centre is a core of serpentine formation, very similar in character to that which is found in the southern extremity of the mainland. This consists almost entirely of a plateau which rises at one point to an altitude of 880 feet. Surrounding the serpentine plateau is found a zone of emerged coral rocks, this zone varying greatly in breadth. The serpentine at no point reaches the coast. Outside this zone again we have the reefs and actively growing corals which encircle almost the whole of the island.

The Isle of Pines is thus related to the serpentine formation of the mainland on the one hand and to the coralline formation of the Loyalty Islands on the other. It may be noted that in the island of Maré there

is a small core of igneous rock, first recorded by Chambeyron, and recently revisited by Prof. Davis.

The maximum elevation of the coral plain above sea-level is about 100 feet. Here and there isolated rocks of hard coral project above the general level, but for the most part the country is quite flat. Water has undermined the coral rock in various places and produced extensive caves with copious growths of stalactites and stalagmites. In some cases the water standing in these caves is in direct communication with the sea and rises and falls with the tide. The roof of the caves is often quite thin and roots of banyans occasionally penetrate through it and hang down to the floor. The typical vegetation of the coral zone is high forest with various species of banyan as conspicuous elements. The undergrowth is dense and almost impenetrable. The coral itself comes to the surface in many places, but is generally overlaid by a more or less scanty deposit of red earth derived from the leaching-out of the coral.

It is in the coral zone that the native dwellings are entirely situated, and their cultivation frequently follows the line of junction between the coral and serpentine.

The coastline is exceedingly irregular, being broken up into small bays with a fringing archipelago of islands of the undercut mushroom type. One of these small islands was recently broken in half by a cyclone. Fig. 8 shows a coral "champignon" near Gaji. On the beach in the foreground are bones of a stranded whale.

The surrounding serpentine region is marked off from the coral zone by a more or less pronounced escarpment, the general level of the plateau being about 350 feet. The vegetation of the serpentine is entirely different from that of the coral. The poverty of the soil brings about a great reduction in the size and luxuriance of the vegetation, and a totally different series of species occurs. The greater part of the plateau is covered with a low heath-like vegetation, in which bracken is dominant over large areas. In slightly more favourable spots a low scrub formation occurs, and this may even rise to a height of 12 or 15 feet. The characteristic niaouli, so rarely found on serpentine soils on the mainland, is here abundant, mixed with *Acacia spirorbis*. Perhaps the most remarkable feature of the plateau is the presence of scattered dome-shaped mounds of earth, which occur to the number of about fifty, both in the open heath and to a smaller extent in the forest (Fig. 12). These resemble nothing so much as burial tumuli so frequent in many parts of England. These tumuli are approximately circular, averaging about 20 feet in diameter, are about 6 to 8 feet high, and are composed entirely of the loose granular serpentine earth. They are scattered quite irregularly over the plateau. Excavation has revealed no contents of interest. They are not regarded with any fear or reverence by the natives who, while positive that they are not the work of man, advance no explanation of them. Various suggestions have been put forward to explain them. It

has been hazarded that they are ant hills, against which view it may be said that they are composed of loose earth and that no ant is known which builds such hills. On the other hand, it is suggested that they may have served as beacons used by the natives to signal to the mainland; but many of these hills are completely shut off from the mainland by the contours of the plateau. I am quite unable to offer any suggestion as to their origin myself.

The road from Kuto to Vao passes through the junction between the serpentine and the coral, and a fortunate cutting permitted me to photograph the serpentine rocks with superposed coral (Fig. 11; the line **xx** indicating the line of junction). In some cases the coral could be seen actually in position of growth upon what was probably the original serpentine seashore of the island. An example can be seen in the centre of the upper part of Fig. 11.

Around the coast are numerous small sandbanks, raised a few feet above sea-level, and presenting a most singular appearance owing to the dense forest of *Araucaria Cooki* (see Fig. 4), with which they are covered. This remarkable tree, which may grow to the height of 200 feet, but which always remains slender and columnar, is also found in abundance on the Isle of Pines itself: their form caused members of Captain Cook's original expedition to mistake them at a distance for basaltic columns!

Before the paper the PRESIDENT said: Our business for this evening is a paper on an island of which most of us probably know very little, and of which I believe the literature is comparatively limited—New Caledonia, formerly a French penal settlement, and one of the largest islands in the Pacific. Our lecturer, Mr. Compton, is a Fellow of Caius, Cambridge, and has worked for some time in the Botany School at the University. In 1914 he spent a year in New Caledonia, chiefly engaged in botanical work, with a colleague who was looking after the zoology and mineralogy of the island. Both kept their eyes open to its geography. It was a scientific expedition, supported not only by the Royal Society but also by the Percy Sladen Trust and the Travelling Scholars' Fund at Cambridge. I will ask Mr. Compton to read his paper.

(Mr. Compton then read the paper printed above and a discussion followed.)

The MASTER OF DOWNING (Prof. SEWARD): I fear I have very little to say that will be of interest; but I should like to express my thanks to the President for giving me the opportunity of being here to-night. I have been very greatly interested in what Mr. Compton has told us, more especially from the point of view of a botanist. I think I may lay claim to have had something to do with his visit to New Caledonia; it was partly on my suggestion that Mr. Compton determined to go. One felt quite sure that any expedition by a botanist to New Caledonia would bring back results of the greatest value. It is still too early to estimate the value of Mr. Compton's results. The war has seriously interfered with the work; but I have seen a great deal of Mr. Compton's material, and feel sure that, given time and opportunity, we shall derive from the working out of that material results of the greatest interest. One reason why New Caledonia appeals to botanists is that it is exceedingly

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1220

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Sedimentary

GEOLOGICAL MAP OF NEW CALEDONIA

to illustrate a paper by

R. H. COMPTON.

Scale 1/1,250,000 or 1 Inch = 19.73 Statute Miles.

NOTE.

The outline is taken from the map of New Caledonia in Pelet's *Atlas des Colonies Françaises*, with the reefs added from the Admiralty Charts. The geology is based on the surveys of M. Louis Pelatan.

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