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THE ORIGIN OF THE FAUNA OF FIJI

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More than twice the area of the Atlantic and covering over a third of the globe, the Pacific Ocean extends over an area of 63 million square miles. The smallness and isolation of any particular group of islands in Oceania is very evident from a glance at the map, thus Fiji is over 1,700 miles from Australia and over 1,100 miles from New Zealand, the nearest large land mass. The problem of how the relatively rich fauna and flora of Fiji reached these islands is a question which suggests itself but some generalisations are required about the past history of the area around Fiji before this can be understood. Except for Taveuni all the islands of Fiji are believed to have been formed under the sea and then uplifted to their present sites.

1.—Types of Pacific Islands.

Much earth movement, involving the elevation of land, has taken place within comparatively recent geological times when the present islands of Melanesia were still part of a continent.

The eastern limit of this former land-mass was to the east of where Fiji now is, Australia and New Zealand being other portions of this continent before the appearance of the Tasman Sea. Charts of the sea bed show a submarine ridge and deep trough running from the north of New Zealand to the east of Tonga, a distance of over 1,000 miles and in places this is over 5,000 fathoms (say 6 miles) in depth. This feature marks fairly accurately the eastern margin of the former continent which included New Guinea, the Solomons, New Hebrides, New Caledonia, Fiji and Tonga but not Samoa, which is separated from Fiji by a stretch of sea over 2,000 fathoms, say 2½ miles deep. It should be stressed that permanence of oceans as well as actual depth, limits distribution of animals.

This brings us to the question of the division of islands proposed by Alfred Russel Wallace as long ago as 1880 at the time of the drawing of his famous "line" between Bali and Lombok (1). Islands are considered by him to be either continental or oceanic, according as to whether they were or were not at one time united to a large land-mass. The "oceanic" islands are smaller and are composed of fine-grained volcanic rocks (e.g., basalts) and sedimentary (e.g., limestones and sandstones) types,

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examples being Samoa, Tahiti and the Marquesas. In contradiction are the larger "continental" islands which, in addition to the two rock-types mentioned, have also coarse-grained plutonics (e.g., granite) and rocks much altered by heat or pressure (metamorphosed); examples are the Solomons, Fiji and New Caledonia. As most of my listeners will be aware, England was united by land to the Continent within Neolithic times, i.e., well after man had reached some degree of civilization.

Another difference between the two kinds of islands is that the fauna of "oceanic" islands has had in some way to cross immense distances of open and deep ocean whereas "continental" islands are separated from the nearest continent by seas which are much shallower and usually less extensive. A third group of islands, peculiar to the Pacific, are the so-called "low" islands which are coral atolls usually only a few feet above sea level, devoid of any true rock and with a particularly scanty fauna and flora. These are well seen in the Gilbert and Ellice and Phoenix Islands.

2.—Geology of Viti Levu.

Only the surface of this subject can be touched upon here but it is safe to say that enormous thicknesses of rock have been removed by erosion on Viti Levu and also the vocanic cone of Buke Levu on Kadavu. Viti Levu also shows, as does Tonga, evidence of former colossal uplift as proved by the occurrence of fossil molluscs and foraminifera in rocks now lying over 2,000 feet above sea level.

As the following table shows, the rocks which form the core of the island are either plutonic or metamorphosed, and though taken to be Mesozoic may well be late Palaezoic as is well shown by Ladd in his study (2) of these islands. The main mountain-folding occurred during this period.

Table 1.

Groups	System	Series	Rock Type	Age in Millions of Years
Cainozoic	Quaternary	Recent	Alluvium	½
		Pleistocene	Reef limestone	1
	Tertiary	Pliocene and Miocene	Suva "soap stone" and limestone	20–25
		Oligocene	Viti limestone	30
		Eocene	Sabeto volcanics and sediments	40
	Unconformity			
Mesozoic	Cretaceous		Colo plutonics (and granite)	60
	U. Jurassic	Oolitic	Wainimala volcanics and tuffs	120

Between the plutonics and the succeeding Sabeto volcanics and sediments is what is known as the unconformity between the

Mesozoic and Cainozoic which culminates in the Quarternary reef limestone and alluvium, comparable in age with the Ice Age of Northern Europe. During the Tertiary, great elevation to at least 3,000 feet occurred followed by the sundering, by continued faulting, of the continental connection with Australia and finally New Zealand, resulting in Fiji becoming an archipelago. The vexed question of continental displacement according to Wegener's theory cannot be dealt with in this brief sketch, fascinating though it is.

3.—Origin of the Fauna of Fiji.

For non-flying organisms to reach an island they must have arrived by one (or more) of three ways, viz.:—

(1) By land-bridges before the island was isolated.

(2) By sea on floating logs, in canoes or ships.

(3) By the air in wind currents, on bird's feet or aeroplanes.

This implies that any insects which have specialised habitats must have reached the land before separation occurred, thus most internal parasites, cave dwellers, gall-makers and leaf-miners are necessarily more ancient than those able to live in rotten logs, humus or damp soil, all of which could travel for weeks in drifting vegetation.

If the distribution of certain insects is traced throughout Oceania it will be observed that there is always a fading out towards the east. This is seen in the following table which shows that invertebrates and vertebrates are both invariably richer in species in the New Guinea region and fewer or even absent as one proceeds towards Fiji and the islands to the east thereof. This shows therefore that the bulk of our fauna came from the west.

Table 2.

Genus	New Guinea	Solomons	Fiji	Samoa	Tonga	Eastern Polynesia
Anopheles	10	1	0	0	0	0
Megarhinus	1	0	0	0	0	0
Promecotheca	?	4	2	1	1	0
Frogs	10	6	2	0	0	0
Land Snakes	?	11	3	1	1	0
Hawks	?	4	3	0	0	0

A point to note is that Fiji is the eastern limit of frogs while Samoa marks the eastern limit of land snakes in Oceania. The above table could be continued indefinitely, thus the Mutillid wasps are fairly abundant in New Guinea, have several species in the Solomons (though Tillyard (3) denies this), and only one species in the New Hebrides which is their eastern limit, so that these interesting velvet wasps are absent from Fiji.

Much of the information about Pacific fauna and its distribution is to be found in Buxton's excellent account of Samoa (4), the nature of whose oceanic fauna he so well describes.

Some idea of the endemicity in Fiji is given in a few selected groups which have been worked out:—

Dragonflies (*Odonata*): endemic genera 12.5%, species 60%.

Ants (*Formicoidea*): endemic species 70%.

Higher flies (*Diptera Brachyera* and *Cyclorrhapha*) endemic, species 60%.

Brachycera (gad and robber flies, etc.) endemic, species 83%.

Cyclorrhapha (house, fruit and carrion flies) endemic, species 17%.

4.—Man's Influence on the Fauna.

The contribution made by that peculiarly specialised tool-using mammal, man, is not easy to over emphasize. These islands are supposed to have been colonized in two waves, one during the tenth and another in the twelfth century and quite considerable supplies of animal and vegetable food would have been carried in the large canoes on these long voyages from the east. Let us consider what would be carried intentionally and probably unintentionally: water for drinking in earthenware pots would be likely to contain mosquito larvae and the same holds goods for *taro* (*dalo*) in whose axils mosquito larvae, snails, slugs and land crabs are usual. On the various plants (*dalo*, coconuts, *yaqona*, yams, sweet potatoes, bananas) which must have been transported, one could expect scale insects, mealy bugs, leaf-miners, scab moth larvae, besides pupae and eel worms in soil adhering to the roots. Gecko eggs are quite often found under thwarts of canoes and in folded mats.

Considerable as would such additions be to the fauna made by the ancestral Fijians they are slight compared with what was brought in by the white man. Neither Bligh (1789) nor Wilson (1797) could have brought in much but Duperrey in 1824 and D'Urville (1827) almost certainly did and certainly by 1804, if not before, whalers followed by traders, must have initiated a series of unwanted additions, including cockroaches, lice, fleas, ants and flies. The early Fijians referred to the bed bug (*Cimex hemipterus*) as "*kutu ni Tanna*," which would have been pointless had it not been brought here in schooners by New Hebridean labourers in the 'sixties or 'seventies.

The effect of only one of these introduced insects can be touched upon here and that is the small ant with a large head known as *Pheidole megacephala*. This ant also occurs in Hawaii and has done much harm there by exterminating native insects, particularly beetles. In Fiji, as also in Hawaii, it is now certainly the dominant ant in settled localities but has done a service by eating house-fly maggots.

Another instance of how man introduces new members of a fauna is seen in the case of a canoe which was blown out of its way from the Woodlark Archipelago to Vella Island in the Solo-

mons. After this voyage of 300 miles an ornamented piece of the rescued canoe was used in Tulagi as a chair back for several years before it was found in 1936 to be infested with the white ant *Kalotermes buxtoni* Hill which does not occur naturally in the Solomon Islands.

The chance of an insect reaching a new island by this method without being noticed, at least by the joiner who made the chair, would seem too remote to happen but here is an actual instance only six years old showing how easily entry can be made. The general effect on the fauna of such human agencies as deforestation, poor soil conservancy, deliberate introduction of goats and sheep (disastrous in Malta and Mauritius), mongoose and mynah and the unintentional introduction of rats, ants, fleas, flies, bed bugs, lice and insect pests of the garden, field and house are only too well known, and it is not a record of which we can feel proud.

Only within the last few years has the amount of insect life carried in upper air currents been appreciated. At considerable altitudes green flies or aphids, other plant bugs, flies and other insects are borne aloft for hundreds of miles and reach places which they could not possibly reach by their own flight. This has been going on for thousands of years but was recognised only recently when it was found that the direction was opposite to the trades, i.e., was N.W. to S.E.

Until the fauna of Fiji has been worked out in the same detail as has been done for Hawaii, Marquesas, Rapa, Samoa and Guam, so long will it be impossible to give precise details of how much of the fauna is indigenous and how much has been introduced by floating logs, air currents, former land bridges and by man himself. Further work on the validity of Wegener's theory of continental drift will also be required but if we take it that Fiji has a fauna which is highly endemic with a strong Austro-Malayan origin which had begun to be isolated by early Cretaceous times we shall have a tolerably accurate picture of the composition of our fauna.

It now remains for us to see that the newest mode of travel, the aeroplane, does not allow us to suffer invasion from malaria (present in the New Hebrides and Solomons), plague (recently reported at a girls' school in New Caledonia) or any other unwanted pest or organism from which our insular position has if not protected us it has in the past, at least made more difficult for such unwanted organisms to arrive in force.

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SOME FIJI FUNGI

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INTRODUCTION.

In Fiji, there has been little published work on fungi. In Seeman's *Flora Vitiensis* (31), W. G. Smith describes only six species collected by R. B. Hinds and Seeman up to the year 1860. Nearly fifty years later, L. Gibbs (6) collected twenty-two species in the vicinity of Nadarivatu, including two new species of *Laschia* and one of *Lentinus*, which were described by A. Lorrain Smith. Of interest in this collection was the rust fungus *Aecidium balansae* Cornu., parasitic on the Dakua, *Agathis vitiensis.*

During the next seventeen years, C. H. Knowles, then Director of Agriculture, reported a considerable number of fungi, mainly species parasitic on economic crop plants. He was the first to study locally the "Fungi imperfecti" as a fundamental basis of plant protection. A tribute must be paid to his painstaking work which resulted in some forty species of plant pathogens being placed on record (8 to 16). J. C. Campbell (1 to 4), worked mainly on banana diseases during the period 1926 to 1931, confirmed a number of the earlier records; and did a great deal of cultural work in the course of which a few new species records were made.

During the past eight years (1933 to 1942), the present writer has added to these records; and in the present paper mention is made of several species not hitherto recorded for Fiji. Specimens of most of these are preserved in the herbarium of the Department of Agriculture, Fiji.

Owing to the fact that most of the records of the work referred to above are to be found only in official reports (many now out of print) and in other out-of-the-way publications, it has appeared desirable to prepare a preliminary list in which are enumerated not only the plant pathogens but also the saprophytic and terrestrial species which have been collected in the Colony.

For the purpose of the present introduction, the species are grouped under the following heads, examples of each group being available for demonstration and illustration.