DISCUSSION

THE FRESH-WATER FAUNA OF NEW CALEDONIA

NEW CALEDONIA is a long and narrow island, far out in the South Pacific, some eight hundred miles from Australia. It is connected by relatively shallow water with the Loyalty Islands, which agree closely with it in the general character of the fauna, and doubtless was united with it at no very distant epoch. Otherwise, New Caledonia appears isolated, with a fauna and flora containing an enormous proportion of endemic forms. Thus, as recently as 1914 Professor R. H. Compton collected in the island (including the adjacent Isle of Pines) 830 species of flowering plants, of which 230 were new, including ten new genera. There are clear indications, supported by various kinds of evidence, that New Caledonia is part of an ancient land mass, and is to be classed with the "continental," not with the "oceanic" islands. It is also certain that the separation or isolation took place very long ago, perhaps in Mesozoic times, and it is probable that since that time there have been periods of elevation and depression, the former producing union with the not distant Loyalty group and with the still nearer Isle of Pines, the latter perhaps submerging all but the larger mountain masses. On all counts, the island is certainly one of the most interesting places for the biologist in the world, and although much work has been done on its biota, very much remains to be done.

The fresh-water fauna is necessarily somewhat limited, as the narrowness of the island, with a central mountain chain, causes the rivers to be small and short, while the sloping surfaces are unfavorable for the retention of bodies of water. It is therefore a land of creeks and small rivers, separated from one another by elevations. We naturally ask, does the fauna of these waters come down, variously modified, from the remote past when New Caledonia was part of a more or less continental area? Or has it, in various ways, come across the sea, or entered the rivers from the sea?

Max Weber and L. F. de Beaufort (1915) record numerous fresh-water fishes, but with one exception these are very widely distributed forms which undoubtedly came from the sea. They constitute a most striking illustration of the way in which fresh waters may be populated from marine sources, especially when there is no competing fauna of strictly fresh-water fishes.[1] The one exception is described as new, *Galaxias neocaledonicus,* apparently a very distinct species, with a peculiar long head. The genus *Galaxias,* including the so-called native trout of Australia and New Zealand, occurs in rivers of the southern hemisphere as far distant as Australia, Patagonia, the Falkland Islands and the Cape of Good Hope. This distribution, as Dr. Jordan remarks, has been held to support the idea of a great continent Antarctica, the remaining fragments of which still possess one of its most characteristic genera. However, several observers have noted that *Galaxias* runs in the sea, and a marine species has been found at the Chatham Islands. Hence we may infer that the New Caledonia *Galaxias* is not a remnant of continental connections, but a very old migrant from the ocean, now much modified.

A detailed review of the invertebrates would take too much space, but it is worth while to refer to some of the mollusca. In 1871 the French naturalist Crosse described a very interesting little shell which he called *Hemistomia caledonica.* It is minute, fusiform, with a large obliquely placed aperture. I collected it in some numbers in river drift near Bourail, along with other fresh-water shells. It constitutes an isolated genus curiously similar to some of the marine Rissoidae (for instance, *Rissoina,* well represented in New Zealand), and Mr. T. Iredale, of Sydney, in conversation, referred to it as a sort of fresh-water Rissoid. According to this view, it is derived from the sea, like the *Galaxias,* but at a period so remote that it has evolved into a distinct genus. The alternative opinion, supported by the current literature, is that it belongs to the Amnicolidae (Hydrobiidae), and is related to *Potamopyrgus* of Stimpson, which includes all the fresh-water Rissoa-like shells of New Zealand, species in Australia and Tasmania, and in South and Central America, going as far north as Texas. There is even a species described from West Africa, but the accuracy of the locality is not wholly beyond suspicion. Finally, *Hemistomia* is not without a certain resemblance to the African fresh-water group Syrnolopsidae.

New Caledonia is very rich in species of the genus *Physa,* and those I collected have a very ordinary appearance so far as can be seen from the shell. But *Physa* is known from the Mesozoic, and there is apparently no reason why the genus should not have existed in New Caledonia from the time of its origin as an island. We regret that it is impossible to examine the anatomy of the long extinct species, but perhaps indirectly we may do so in certain cases. That is, if we are satisfied that insular species have remained isolated since a given geological period, the anatomical features they possess in common with those of other regions must apparently (or very probably) have existed in the common ancestors, to-day only known as fossils. The importance of the

[1] Even in northern Siam, very far from the sea, I found in the Nan River at Nan a fish of marine affinities, *Tetraodon leiurus* (Bleeker); the species determined for me by Dr. J. T. Nichols.

anatomy is shown by the fact that on investigating the soft parts certain apparent species of *Physa* of the Hawaiian Islands turned out to be sinistral forms of the *Lymnaea* type. One of the New Caledonia species, *Physa varicosa* of Gassies, has been referred to *Bulinus*, which has nothing to do with true *Physa*. Thus the whole *Physa* fauna needs reinvestigation.

The recorded fresh-water bivalves include a remarkable endemic species, *Cyrena sublobata* Deshayes, and certain species of *Batissa*. It turns out that the latter were reported in error; the genus exists in the Fiji Islands, but not in New Caledonia. We must now add a quite different type of shell, belonging to the mytiliform (mussel-like) groups. These mollusks mostly inhabit the sea, but derived from the marine stock, and now very widely distributed in fresh waters, is the family Driessenidae.[2] They exist in Europe, Africa, America and, according to Dall, China and the Fiji Islands. Typically marine are the Mytilidae, represented by the common mussel of our coasts. But the genus *Modiolus* has fresh-water species in Asia, and *M. fluviatilis* (Hutton) occurs in brackish water throughout New Zealand. The related genus *Modiolaria* is marine, but I found a species common in river drift near Bourail, New Caledonia. In New South Wales *Modiolaria subtorta* Dunker is found in fresh or brackish water, but it is so distinct that Iredale has made it (1924) the type of a distinct genus, *Fluviolanatus*. When, in the Australian Museum at Sydney, I showed Mr. Iredale my New Caledonia *Modiolaria*, he produced another fresh-water species from that island, collected by Brazier in the La Foa River! This is quite distinct from mine, being in fact a *Fluviolanatus*. Mr. Iredale kindly gave me a specimen; he will later describe the species. My species, which I will call *Modiolaria bourailensis* n. sp., has a general superficial resemblance to *M. varicosa* Gould, a marine shell found at Sydney. It is, however, quite different, being like *Fluviolanatus* in lacking the sculptured ribs, and in having the beaks less terminal. In place of the sculptured ribs, running to the posterior end, is a pattern simulating them, of straight pale red rays alternating with straw-yellow ones. This is superimposed on a pattern (also seen in *M. varicosa*) of vertical curved or zigzag brown bands at rather wide intervals. The shell is thin, with a pale yellow epidermis, not at all produced into bristles. The upper margin is elevated and obtusely angulate in the middle, a feature quite lacking in *Fluviolanatus*, but somewhat indicated in the broader and (anteroposteriorly) shorter *M. varicosa*. Looking at the shell from within, the beaks are much less prominent than in *Fluviolanatus*. The anteroposterior diameter is about 10 to 11 mm; dorsoventral about 5.3 mm; thickness about 3.2 mm. The upper margin, from the beaks to the highest elevation, is tuberculate within, the tubercles being smaller, much closer and more numerous than in *M. varicosa*. There is no trace of a myophore, such as exists in *Congeria*. The shells were found in numbers in river drift, with many other fresh-water and land shells, close to the sea. The question arose whether they could possibly have been blown from the sea-beach. This idea must be rejected, as there is no such marine species known in the region, and the material was intimately mixed with the river drift. The thinness of the shells suggests life in fresh water.

[2] For the spelling, see Pilsbry and Bequaert, "Aquatic Mollusks of the Belgian Congo," 1927.

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ATMOSPHERIC ELECTRICITY DURING SANDSTORMS

IN the issue of SCIENCE for May 3 appeared a note by R. H. Canfield regarding "Atmospheric Electricity during Sandstorms." Phenomena very similar to those described have repeatedly been observed here in our physics laboratory. A number of times during sand storms I have connected our radio transmitting aerial through a galvanometer to earth, and find that there is a more or less continuous flow of current from aerial to earth. The strength of current in general seems to correspond to the violence of the storm, sometimes exceeding twenty micro-amperes. Our aerial is of the triangular flat top variety supported by steel masts forty feet above the roof of the laboratory and very well insulated.

An undamped electrostatic voltmeter of very short period if connected to the aerial during a storm is set into vigorous vibration indicating a rapidly fluctuating potential of more than 20,000 volts. This is to be expected because of brush discharge from the lead in wire. During one storm while the discharge flowed through the galvanometer the needle indicated a reversal of the direction of discharge a number of times though each time for an instant only. I was somewhat surprised to find the aerial potential drop to almost zero before the first drops of rain fell and the first flash of lightning. During the thunderstorm that followed the potential of the aerial remained undisturbed at zero.

It has been suggested that this phenomenon is due to triboelectricity, but it is interesting to find that on a perfectly still day when the air is heavily laden with dust the aerial potential may fluctuate for hours between 5,000 and 10,000 volts, though if earthed through a galvanometer the current amounts only to about one micro-ampere.