further from the pheasant, so that these would be quite infertile. But this is merely argument from analogy; there is no evidence of the result of such superposed "sports," and retrogression to greater fertility seems possible.

This instance is not a good one, because the observed partial infertility (*i.e.* only occasional fertility) between pheasant and black grouse may be due to dislike, not partial impotence. But I doubt whether distaste for pairing and impotence when paired are often quite dissociated.

Mr. Murphy asks, as I asked in these pages in 1884, and others have asked since, for one simple fact which would be decisive. Is it, or is it not, the fact that allied species which are confined each to a particular island, prove, when brought together, far less frequently infertile than species, equally dissimilar, which had lived in the same district, might be expected to prove. On the answer to this question depends, as far as I can see, the fate of the theory of physiological selection. Can no one answer it?

EDMUND CATCHPOOL

THE CORAL REEFS OF THE SOLOMON ISLANDS [1]

OUT of a collection of nearly seventy corals which I made in these islands, nearly a quarter are new or undescribed; and from this fact, as I am informed by Mr. S. Ridley, it may be inferred that there is yet much to be learned of the corals of this region. After describing in my paper the characters of a typical reef, I proceeded to refer to the complex relations that exist between the multitudes of creatures that frequent coral reefs. The protective colouring of the small crabs that live among the branching corals often attracted my attention. I recall, in particular, the instance of a small crab that finds its home among the branches of a *Pocillopora*. The light purple colour of its carapace corresponds with the hue of the coral at the base of the branches, where it lives; whilst the light red colour of the big claws, as they are held up in their usual attitude, similarly imitates the colour of the branches. To make the guise more complete, both carapace and claws possess rude hexagonal markings, which correspond exactly in size and appearance with the polyp-cells of the coral. Another species of crab, that climbs about the blue-tipped branches of a *Madrepora*, has the points of its pincer-claws similarly coloured. It is interesting to note that these two crabs are adapted to live each on its own species of coral. Had I caused them to exchange their homes, their borrowed hues and markings would have at once made them conspicuous objects for their enemies.

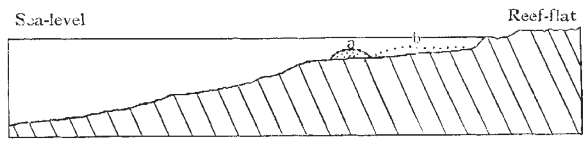
I paid especial attention to the inter-tidal exposure of living corals, and was much surprised at the number of species which are bared by the ebbing tide. Of all the corals in these islands, those belonging to the genus *Cæloria* seem to be the hardiest in this respect. In the paper I have described my observations with some detail.

Coral Reefs and Shoals.—The earliest condition of the coral reefs in this group is to be found in that of the numerous detached submerged reefs or shoals which lie below the limit of the constructive power of the breakers, having been arrested in their upward growth at depths varying between 5 and 10 fathoms according to the exposed or protected character of their situation. This remarkable fact of the arrest of the upward growth of the coral at these depths was utilised by Lieut.-Commander Oldham whilst surveying these submerged reefs in H.M.S. *Lark*. If a shoal was not marked at the surface by a reef-flat or by an islet, we could sail over it with perfect safety. The broken water of the tide-rip that indicated these shoals was no source of danger for a vessel of light draught. In my paper I have given evidence to prove that a shoal which was found by Bougainville in 1768 to be covered by 5 fathoms, remains in the same condition at the present day. The number of coral shoals possessing these characters led me to the conclusion that isolated submerged reefs are unable without the assistance of a movement of elevation to raise themselves to within the constructive power of the breakers. When they have reached their upward limit, they extend laterally, forming ultimately flat-topped shoals. It may appear bold to suggest that atolls and barrier-reefs owe their appearance at the surface to a movement of elevation; but we know that in the regions occupied by the atolls of the Low Archipelago, of the Fiji Islands, and of the Pelew Group, the last movement experienced has been one of elevation; whilst the observations of Mr. Beete Jukes on the Australian Barrier-Reef go to show that, if there has been a recent change of level in that region, it was one of the same nature. In the atoll of Oima in the Solomon Group I found evidence of an anterior elevation.

In my paper I proceeded to describe at some length the reefs that have reached the surface. In this abstract, however, I can only refer to the fact that all the three classes of reefs are to be found in this group; the atolls, I should add, being comparatively few in number and of small size.

The Formation of Atolls.—My observations go to show that atolls of small size (a mile or two across) do not assume their characteristic form until they have reached the surface. After upheaval has brought a submerged coral shoal within the constructive power of the breakers, it soon appears at the surface as an isolated patch of reef. Extensions or wings grow out on either side, and, guided by the prevailing currents (in the manner described by Semper), they ultimately form the common horse-shoe reef, which presents its convexity against the currents. Large atolls evidently begin to assume their characteristic shape below the surface as described by Murray and A. Agassiz.

The Formation of Barrier-Reefs.—The facts on which my conclusions have been based were obtained by the examination of the weather slopes of reefs. For the first 70 or 80 yards from the weather edge of a reef there is a gradual slope, largely bare of living coral, to a depth of 4 or 5 fathoms. There is then a rapid descent to a depth varying between 12 and 18 fathoms. It is this declivity that constitutes the growing edge of the reef, and the sand and gravel produced by the constant action of the breakers collect at its foot. When the submarine slope is more than 10° or 12°, as is usually the case, the sand and gravel extend far beyond the depths in which reef-corals thrive; but when the slope is gradual, *i.e.* less than 5°, the lower margin of this band of detritus lies within the reef-coral zone, and in consequence a line of barrier-reef is ultimately formed beyond this band with a deep-water channel inside (*vide* diagram). Should the



Barrier-reef of Choiseul Bay (drawn on a true scale to the 100-fathom line. *a* = incipient barrier-reef (size purposely exaggerated); *b* = belt of sand and gravel.

area be undergoing elevation, a succession of concentric lines of barrier-reefs will originate, line after line being advanced as fresh portions of the sea bottom are brought towards the surface, each line growing upward along the lower margin of the band of detritus derived from the line of reef inside it. In such a manner have the Shortland Islands been produced. When I arrived at the above conclusion I was not aware that substantially the same explanation had been advanced thirty years before by

[1] Abstract of a Paper by H. B. Guppy, M.B., late Surgeon H.M.S. *Lark*. Communicated by Dr. John Murray to the Royal Society of Edinburgh on July 5, 1886.

Prof. Joseph Le Conte in the instance of the Florida reefs. He then pointed out that since corals will not grow on muddy shores or in water upon the bottom of which sediment is collected, the favourable conditions can only be obtained at some distance from the shore, where a barrier-reef would ultimately be formed *limited on one side by the muddiness and on the other by the depth of the water*.

The foregoing conditions may be described as the determining causes of a barrier-reef. After the reef has been formed, the lagoon-channel will be kept open by such agencies as solution, diminished food-supply, tidal scour, organic degradation, and other influences The circumstance that barrier-reefs are frequently situated at or near the borders of submarine plateaus receives a ready explanation in the view first advanced by Prof. Le Conte, since in such situations the necessary conditions of depth and clearness would be found.

Anomalous Depths of some Atolls and Barrier-Reefs.—One of the principal arguments in favour of the theory of subsidence lies in the assertion that lagoons and lagoon-channels are sometimes deeper than the reef-coral zone. I will, however, endeavour to show that this assertion is founded on a misconception of the conditions that limit the depth of this zone. The extent to which the depth may vary is demonstrated in the great divergence between the estimates of different observers in every region of coral reefs. Those of Quoy and Gaimard, Ehrenberg, Darwin, Dana, Murray, A. Agassiz, and others, range from 5 to 40 fathoms. But this variation may also be found in the same region of coral reefs. Thus, in the Solomon Islands, I found that the depths at which reef-corals flourished ranged in different localities from 12 to 40 fathoms and beyond, the variation being due to differences of local conditions, such as the degree of inclination of the submarine slope, the presence and position of submarine declivities, the amount of sediment held in suspension, the force of the breakers, and other influences. The main determining condition, as Prof. A. Agassiz points out, is to be found in the injurious effect of sand and sediment rather than in the general influence of depth; and the distribution of these materials is dependent on the local conditions above referred to. Local conditions will usually restrict the reef-coral zone to depths less than 30 fathoms; but, where there is a gradual submarine slope, reef-corals are to be found in depths beyond the sand and gravel. Inasmuch as most observers have regarded these materials as necessarily limiting the zone, they did not push their inquiries beyond. Under favourable conditions, however, reef-corals may thrive in depths of 50 or 60 fathoms; and thus we can readily explain the apparently abnormal depths inside some atolls and barrier-reefs.

An apparent objection here presents itself. If reefs begin to build their foundations in depths greater than those which are generally assigned to them, the thickness of the elevated reef-formations discovered by me in the Solomon Group should have been much greater than 150 feet, the actual limit of their thickness. It will, however, have been gathered from the previous remarks that local conditions will usually confine reef-corals to depths less than 25 or 30 fathoms, and that it will be only under occasional circumstances that reefs will commence to be formed in deeper water. Fringing-reefs themselves are at first restricted to shallow waters around the coast, and their seaward extension in localities where the submarine slope is at all steep, as is generally the case, must be extremely slow. Again, in an area of elevation, such as that in which the Solomon Islands are included, barrier-reefs, which may have begun to grow in depths not less than 50 fathoms, might owe their approach towards the surface as much to the elevating movement as to the very slow upward growth of the corals. It should also be borne in mind that the rapid subaërial denudation, to which these regions of heavy rainfall are subjected, would be an important agency in the thinning away of the raised coral formations.

In the latter part of my paper I refer, amongst other subjects, to the extensive character of the degradation of coral reefs by multitudes of organisms. I also give proofs of the outward growth of reefs on their own talus (as described by Murray)—(1) in the circumstance that massive corals may be commonly observed to increase in size as one approaches the lagoon from the outer margin of the reef-flat; (2) in the presence of old lines of erosion evidently produced at the existing sea-level, but which have been cut off from the action of the waves by the advancing edge of the reef-flat; (3) in the characters and position of the wooded islets situated on reefs, which in course of time would cover the whole reef-flat, were it not for one counteracting circumstance, the seaward growth of the reef.

Lastly, I refer to the deposits at present forming on the outer slopes of reefs in depths down to 100 fathoms. Reef-debris, foraminiferous tests, especially of *Orbitolites*, joints of the calcareous alga *Halimeda opuntia*, portions of *Nulliporæ*, and the small detached corals of the genus *Heteropsammia*, enter largely into the composition of these deposits. I should add that a rock of this composition is one of the commonest types of the so-called coral limestones in the Solomon Group.

In this short abstract of a long paper I have not been able to do much more than indicate the general bearing of my conclusions. The facts and data are given at length in the original paper.

THE BRITISH ASSOCIATION AND LOCAL SCIENTIFIC SOCIETIES

THE second annual Conference of Delegates held under the new rules of the British Association met at Birmingham on September 2 and 7, in the library of the Medical Institute. Forty-nine local Societies carrying on work in various parts of the United Kingdom have been enrolled this year as "Corresponding Societies" of the Association, and of these thirty-two were represented by Delegates at the Birmingham meeting. The following report of the proceedings of the Conference, signed by Mr. Francis Galton and Prof. R. Meldola, the Chairman and Secretary of the Committee, has just been circulated among the Corresponding Societies, and it will be seen that this new branch of the work of the Association promises to be of mutual advantage both to the Societies and the Association:—

At the first Conference the chair was taken by Dr. A. W. Williamson, F.R.S., General Treasurer of the British Association, the Corresponding Societies Committee being represented by Captain Douglas Galton, F.R.S., General Secretary of the Association, Dr. Garson, Mr. John Hopkinson, F.L.S., and Prof. R. Meldola, F.R.S., Secretary.

The Secretary read the Report of the Corresponding Societies Committee which had been presented to the Council of the Association.

The Chairman made some remarks explanatory of the objects of the Conference of Delegates, and suggested that among other subjects of investigation in which it might be useful to secure the co-operation of the local Societies was that of injurious insects, already so much studied by Miss E. A. Ormerod.

The Secretary also made some observations in explanation of the constitution of the Corresponding Societies Committee and the relations existing between the Conference of Delegates and the British Association.

Some remarks were made by Mr. J. W. Davis and others with reference to the advisability of securing the co-operation of the local Societies for the purpose of in-