
Review: The Tanganyika Problem

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wayfarer, on payment of about a quarter of a farthing, can obtain a basin with a few tea-leaves in it and as much boiling water as he cares to drink. Sometimes the tea is absent, but no matter—you drink the boiling water. This custom is universal: I do not think I ever saw one of them drink cold water, and they have even tried to dissuade me from drinking of a mountain torrent far above all habitation. Certainly upon the plain, where the land is heavily manured, and all the water has been used for irrigation somewhere or other, it would be simply suicidal to touch unboiled water, and no doubt the natives have learned the lesson from experience. As an example, I have even seen the village water-supply taken out of one end of a rice-field while the village sewage was being emptied into the other.

In conclusion, I can only say that the district described is one of the greatest interest to the traveller, not only for the fine scenery of the surrounding hills and the beauty of the plain, but—and chiefly, to my mind—as an example of what can be done with a systematic and complete system of irrigation, and the most intense cultivation probably in the world, to carry a teeming population scrupulously careful to return to the soil everything that can be given it, and the reward is six crops a year according to Chinese information. The prevalent crops we saw were: March 17, rape in flower and pod; April 25, poppy; May 31, tobacco; June 20, rice being planted out. I can quite believe the statement that another crop of rice and a sixth crop is raised. These appeared to be the main crops, but wheat, barley, buckwheat, saffron, beans, cabbage, egg-plant, and others of lesser importance were also to be seen. Unfortunately, as we did not see the same fields carrying these crops in succession, proof is lacking, but each trip was through one main crop. Most of the main crops are raised in seed-beds, and immediately the residue of the last crop is ploughed in, the seedlings are planted out. For example, the rice is about a foot high when planted out stalk by stalk into the paddy-fields. The labour, of course, is enormous, but the result is that 4,000,000 people live on a plain of perhaps 3000 square miles.

'THE TANGANYIKA PROBLEM.'*

THE contents of this volume are zoological and geological, but the principal questions under consideration are of geographical importance. These questions are: the physical geography of Central Africa in past times, and the distribution, past and present, of the animals inhabiting

* 'The Tanganyika Problem: an Account of the Researches undertaken concerning the Existence of Marine Animals in Central Africa.' By J. E. S. Moore, F.R.G.S. Hurst & Blackett, Ltd.

the lakes and rivers of that region. The problem to be solved was the occurrence in Lake Tanganyika of certain shells and a jelly-fish belonging to types supposed to be exclusively marine.

For the solution of this problem and for inquiries into the geography, geology, and zoology of the lake region in Central Africa, two expeditions in succession under Mr. Moore's charge were dispatched to Lake Tanganyika and some other Central African lakes. Both of these expeditions have been fully described in the *Geographical Journal*, and it will suffice in the present case to notice briefly the scientific results as presented in the present volume.

Mr. Moore's task has been successfully achieved. Whether his conclusions be accepted or not, there can be no doubt of the thoroughness of his work. The fact that he has, as he states, added two hundred new species to the fauna of Central African lakes, shows how extensively he must have collected, and he has himself investigated the anatomy of the mollusca and of some other invertebrates. There are but few travellers, even at the present day, who have the anatomical and zoological knowledge which have been employed in the investigation of the Tanganyika fauna. Mr. Moore has also, with the assistance of Mr. Fergusson, been able to add considerably to our knowledge of the geology of the African lake region.

The results of the Tanganyikan exploration may be divided into two series: those which are mainly geological, and those which relate to the distribution of animal life. The two are closely connected, but as they are the subjects of different chapters in the present work, they may be noticed separately.

The principal great systems of rocks in the lake region of Central Africa are stated by Mr. Moore to be, in descending order—

1. African lake pleistocenes.
2. Drummond's beds: sandstones and shells of approximately Triassic age.
3. Old African sandstones: sandstones and shales, unfossiliferous, of great thickness and of unknown age.
4. Crystalline formations: schist, gneiss, granite, etc.

This succession, if the subrecent lake-beds be neglected, is in the main similar to that found in South Africa and in the peninsula of India, the Drummond's beds being apparently the equivalents of the Karoos and Gondwânas, whilst the old African sandstones may possibly represent the Table mountain sandstones of South Africa and the Vindhyan of India. The older series has hitherto proved unfossiliferous, and its origin is obscure. It is commonly supposed to be of marine origin, but in the absence of fossils proof is wanting that the ancient sandstones and shales were formed in seas or oceans like those of the present day.

The occurrence in the Drummond's beds of ganoid fishes and of bivalve mollusca related to those found in Lake Tanganyika, together

with the reported discovery of an echinoderm near Lake Nyasa, is regarded by Mr. Moore (p. 72) as evidence that the strata are of marine origin. The bivalve shells of Tanganyika are, however, of exclusively fresh-water types, as are the ganoid fishes also (there is no reason why some Triassic ganoids may not have lived in fresh water), and the echinoderm noticed by Dr. Gregory was of doubtful origin and of Oliocene age, so that it clearly could not have come from the Drummond's beds. The view that these rocks are of marine origin cannot be regarded, on the evidence brought forward, as even probable. It is more likely that, as in the case of their South African representatives, they are of fresh-water origin and very largely fluvatile.

The point would have been hardly worth mentioning but for the circumstance that Mr. Moore has prominently attacked what he terms (p. x.) "Murchison's erroneous hypothesis concerning African stability." If, however, the strata here termed Drummond's beds are of inland origin, Murchison's views are not very far wrong, and the theory that Central Africa is part of an ancient land area is greatly strengthened. It is true that Mr. Moore's criticism is chiefly put forward in opposition to the idea that no mountain ridges have been formed in Africa since Mesozoic times; but that changes may have taken place in parts of the area was fully admitted by Murchison (*Jour. Roy. Geogr. Soc.*, vol. xxii., 1852, p. 123).

The principal geological question to which attention was directed in connection with the Tanganyika problem was the origin of the lake area. This is thus explained. At a period subsequent to the formation of the Drummond's beds, but not clearly determinable, a great change in the physical geography of Central Africa commenced, and has continued to the present day, resulting in the elevation of a meridional axis extending from the Nile to the Zambezi. For this axis, which culminates in Ruwenzori, Mr. Moore proposes the name of the "Great Central Range." In this tract of elevated ground, the "Graben" of Suess and "Rift-valleys" of Gregory and other writers, for which is proposed the new name of "Eurycolpic folds," have been formed as a result of the general folding from lateral pressure. It is shown that these valleys are not simply meridional, but that they branch and intersect each other in places, and Mr. Moore is inclined to compare them to the equatorial canal-system of Mars rather than to the rifts on the Moon's surface.

It is doubtful whether the new term, "eurycolpic fold," is an improvement on "rift-valley" (trough valley would have been better), for these remarkable features are not, strictly speaking, folds, but longitudinal blocks let down by trough faults, and they are not always "eurycolpic" (broad bosomed), some being comparatively of no great breadth. Unfortunately, the difficulty of accounting for these valleys is not removed by renaming them.

In the bottom of these curious troughs volcanic cones are of somewhat frequent occurrence, and testify to the immense pressure accompanying the dislocations that have taken place. One of the volcanic areas, that of the Mfumbiro mountains, north of Lake Kivu, received especial attention, for it forms the water-parting between the Congo and Nile drainage areas. It is shown that, previously to the eruptions to which the Mfumbiro cones are due, the water of Lake Kivu, south of them, drained northward to the Albert Edward Nyanza and Albert Nyanza, which occupy the northern extension of the Tanganyikan trough, and that the present drainage of Kivu to the southward into Tanganyika by the Russisi river is due to the dam formed by the volcanic accumulations.

In several places Mr. Moore calls attention to evidence showing how recent some of the dislocations must be to which the valley troughs are due. It is clear that if the cliffs bordering the valleys were not of very recent geological date, they would have been destroyed by the action of denudation.

Turning now to the biological questions involved in the Tanganyika problem, we enter upon debatable ground. The preliminary question as to whether the marine types were confined to Lake Tanganyika or whether representatives were to be found in other inland waters has been decided. An examination of the fauna found in the numerous lakes of Central Africa, from Rudolf and Albert Nyanza to Bangweolo, Nyasa, and Shirwa, has shown that the marine forms of mollusca, or "halolimnic types," as they are termed by Mr. Moore, are confined to Tanganyika. The absence of these shells from Kivu, Albert Edward, and Albert, to the north of Tanganyika, is opposed to a theory once suggested—that the marine forms found their way into Tanganyika from the Red sea.

The explanation of the Tanganyika problem offered by Mr. Moore is the following: The fauna of the lake is twofold, an ordinary fresh-water fauna consisting of genera of fish, mollusca, etc., common to other African lakes, and in most cases of wide distribution, and the "halolimnic" group. The latter are regarded as the original inhabitants, and the ordinary fresh-water forms are of more recent introduction. The "halolimnic" mollusca belong to fourteen genera, all univalves, and of these no less than eight so closely resemble forms found fossil in the Jurassic rocks of Western Europe, that there is good reason to regard them as descendants of the same or similar species. It must be remembered that evidence of this kind is accumulative, the resemblance of one or two shells might be due to accidental similarity, but it is very questionable whether the numerous instances here described and illustrated by excellent figures of the modern and ancient forms side by side can be attributed to fortuitous resemblance. The halolimnic fauna is therefore regarded as derived from marine organisms of Jurassic age, and as

the structure of the animals is shown to be of a generalized or primitive type, it is a reasonable conclusion that these genera have retained the external and internal structure of forms belonging to Middle Mesozoic times. In retaining a structure less specialized than that of their nearest marine relations, the halolimnic types of Tanganyika agree with most forms of fresh-water life, but they are distinguished by their relation to a fossil fauna of a definite geological age.

How these descendants of old Jurassic molluscs found their way into Tanganyika is not quite so clear, but it is inferred that they may have inhabited the area of the lake since this tract formed part of a Jurassic sea, which is supposed to have extended over the Congo basin.

So far as this the views expressed in the present work may be accepted as justified by the evidence, though some of the data on which the former existence of a marine area in the Congo basin is inferred are not convincing. For instance, some weight is attached to the presence in the present Congo estuary of a genus *Tympanotomus*, allied to one of the Tanganyikan genera. But this same genus abounds on the shores of the Indian ocean, and might consequently be regarded as showing that the Tanganyikan halolimnic fauna is of Eastern origin.

The weakest point in the connection between the Tanganyikan halolimnic fauna and the Jurassic marine fauna is that it is confined to univalve shells belonging to a single section. In Mr. Moore's opinion, besides the halolimnic mollusca, the prawns, crabs, sponges, jelly-fishes, and several of the fishes, the ganoid *Polypterus*, the dipnoan *Protopterus*, some of the Characinidæ, and most of the Cichlidæ (p. 340), should be included in the halolimnic group. So far as some of the invertebrata are concerned, he may be right, but none of them have the same specially Jurassic affinities as the mollusca, whilst not only are all the fishes widely spread types, but the Cichlidæ in especial are perch-like forms, nothing resembling which is known from Jurassic rocks, or in any beds older than Upper Cretaceous. It is urged (p. 340) that Tanganyika is the original centre from which the Cichlidæ were distributed, firstly, because of the number of species occurring in the lake; secondly, because of their primitive character. The second argument may be of some importance; the first is not, as a single instance will show. The majority of living antelopes are African, but the original source of the antelopes was in all probability in Europe and Asia.

There are some other opinions expressed in 'The Tanganyika Problem' to which it is desirable to call attention, because they are different from those held by biologists generally. They are found in chapter ii. Mr. Moore discusses the distribution and origin of fresh-water faunas, and concludes (p. 29) that they are "chiefly composed of the remains of a once widely distributed and ancient sea-fauna, the ancestors of the surviving components of which were forced out of the ocean into the fresh waters of the globe owing to a change in the

character of the sea itself. This change appears to have become sufficiently strongly marked to have produced an appreciable differentiation at a period roughly corresponding to the commencement of the secondary rocks. In this matter it would appear that assemblages of similar organisms have of necessity taken to fresh water all over the world about the same time."

This startling hypothesis is a return to the doctrine of the "sporadic origin" of species and genera current in pre-Darwinian times. The whole subject of the origin of fresh-water faunas was discussed by Darwin in chapter xii. of the 'Origin of Species,' and his conclusions are opposed to those expressed in 'The Tanganyika Problem.'

There is one objection to the hypothesis of the ordinary fresh-water fauna having been derived from the marine life of any single geological epoch, which may be mentioned, because it has a particular reference to the Tanganyikan fauna. Mr. Moore has shown that near allies of several Tanganyikan halolimnic shells are found in Jurassic strata, and has inferred that the Jurassic forms were the ancestors of the recent genera. But where is the ancient marine fauna from which *Unio* and *Corbicula*, *Vivipara* and *Melania*, *Lymnea* and *Planorbis*, are probably derived? The first step towards establishing a common origin for these genera is to show that a fauna once existed from which all might have descended.

The earliest strata in which an assemblage of fresh-water mollusca is found at all nearly approaching that of the present day is in the Purbeck and Wealden, Upper Jurassic and Lower Cretaceous. Had these forms established themselves in fresh waters about "the commencement of the formation of the secondary rocks," why are none of them found in the Trias, in which there is no lack of strata of fresh-water origin? It may be added that, although many fish are known from Triassic rocks, nothing resembling the commonest forms of fresh-water fish-life, such as carps, siluroids, and percoids, occurs amongst them.

The opinion is expressed (p. 30) that fresh-water mollusca have but little tendency to migrate, and that fresh-water fishes and the more active invertebrata have greater migratory powers than mollusca. This is opposed to the views generally held. It is well known how quickly an artificial pond, with which no stream is connected, becomes stocked with fresh-water shells, and Darwin and others have shown how the young are transported by birds, whilst it is a well-known fact that the larvæ of pond-mussels (*Unio*) attach themselves to fishes. The specific differences between the different African lakes, strongly and repeatedly insisted upon by Mr. Moore as evidence of a separate origin of the mollusca inhabiting those sheets of water, will not weigh much with those who know on what trivial differences "species" of fresh-water mollusca are founded.

There is one more argument of Mr. Moore's which must be challenged.

He says (pp. 19, 20), "The distribution of Characinid fishes in the American and African fresh waters is quite inexplicable on any supposition of their having originated as a relic fauna in some one arm of the sea, . . . for there is no evidence that there has been any connection between the remote state (*sic*) land masses which these bodies now inhabit. . . . It is the same with the Cichlidæ and many other forms of fish." The view advocated is that these African and American fresh-water fishes must have originated, on both sides of the Atlantic, from marine forms simultaneously, but independently. It is sufficient to say that no such origin could account for the distribution of Amphisbænidæ, a family of land lizards, with a similar distribution to that of the Cichlidæ and Characinidæ. Mr. Moore cannot be acquainted with all that has been written, both by biologists and by geologists, as to the former land connection between Africa and South America, a connection which appears to have existed during Jurassic and Cretaceous times, and which probably continued in the early Tertiaries. The geological data are treated by Suess in the 'Antlitz der Erde;' the biological, palæontological, and recent facts are to be found scattered through a number of works, the earliest being by the late Prof. Neumayr. The principal data known in 1890 are contained in the presidential address to the Geological Society for that year, but additional evidence has since been brought forward by Gregory, Beddard, and others, one of the most recent contributions to the subject being that of Dr. Max Schoeller, noticed in this *Journal* for January, p. 67. But the facts are so widely known, that it is remarkable to find them, together with those contained in Darwin's 'Origin of Species,' completely ignored by a writer who is propounding novel views on the distribution of animals.

If, however, no favourable opinion can be expressed on some of the biological theories announced in 'The Tanganyika Problem,' the descriptions and figures of the animals found are of great merit. The account of the fishes is by Mr. Boulenger, and the accompanying figures, both coloured and uncoloured, are admirably executed. The descriptions of the mollusca and of the other invertebrata are by Mr. Moore, and form a valuable addition to knowledge, and the accompanying cuts are good. The landscapes in the earlier part of the book are less successful, and it is to be regretted that misprints are rather numerous throughout.

W. T. B.

THE HIGHEST MOUNTAIN IN THE WORLD.

By DOUGLAS W. FRESHFIELD.

SOME years ago (in 1886) I argued,* with a pertinacity which I am afraid may have seemed presumptuous to some of my readers, against

* *Proceedings of the Royal Geographical Society*, vol. viii. New Series; and *Alpine Journal*, vol. xii.