12,000 feet, and the general drowning of the Antillean continent, the animals became extinct alike on the continental margin and the islands.

The key to the physical evolution of the continent seems to be locked up in the West Indies, yet it appears simple. Where the studies will lead, it cannot be predicted. These are fundamental questions in terrestrial movements and continent-making; changes of ocean currents and climates; the production of glacial conditions, and the distribution of the inhabitants.

IV.—On a Series of Saurian Footprints from the Cheshire Trias (with a Note on *Cheirotherium*).[1]

By Osmund W. Jeffs.

EVERY geologist is familiar with the name of Storeton Quarry, which may fitly be termed the "home of the *Cheirotherium*," celebrated as being the scene of the earliest discovery in England of the fossil footprints, first described by Messrs. John Cunningham and James Yates in 1839.

Fifty years' study of these footprints has left their origin, so far as exact identification with any known animal is concerned, a matter of as much mystery as when Sir Richard Owen gave attention to the subject in his classical work on "Palæontology." All the evidence, in fact, which we have accumulated since that time has only brought us to a negative position, and taught us that the explanation first suggested by Owen, and thereafter copied into nearly all our popular geological text-books, is not entirely correct.

The forms described have all been obtained from the "footprint bed" at the Storeton quarries (with the exception, named below, of two specimens from Oxton Heath). This "footprint bed" is a thin stratum of sandstone, with seams of white clay, together some three or four feet in thickness, which is exposed at several points along the quarry excavations, where it may be traced for some distance. The geological structure of the quarries is fully described by Mr. G. H. Morton, F.G.S., in "The Geology of the Country Around Liverpool" (second edition).

I first refer to the well-known impressions to which the name of *Cheirotherium* was originally given by Dr. Kaup, under the idea that the tracks were of mammalian character. In the event of their being afterwards proved to be Saurian, the alternative name of *Chierosaurus* was proposed. The latter term, being the more correct —all the indications pointing to a reptilian origin of the footprints— has been adopted by the British Museum authorities (see "Catalogue of the Fossil Reptilia and Amphibia in the British Museum"), but it does not seem to have found its way into general geological literature, or into our local museums. In a paper read before the Liverpool Geological Association in June last, I described several specimens of this genus, among which were the following:—

1. Slab (No. 130) showing right-hand, hind and fore feet of

[1] Read at the British Association (Section C), Oxford, August 11th, 1894.

https://doi.org/10.1017/S0016756800143742

C. Stortonensis. Pentadactylate digits. Length of pes 7½ inches; length of manus 3 inches. All the digits are perfect. The two feet are close together, being less than 1 inch apart. The toes are narrow and tapering, the first showing the characteristic turning inwards, like a thumb. In all the true *Cheirotherium* impressions the digits radiate from a centre like those in an outspread human hand.

2. Slab containing the natural mould of the impression of a medium-sized footprint; pes about 8 inches in length. These moulds or hollows in which the animal impressed its foot into the sand are far more uncommon than might be imagined, and this is the only perfect specimen I have been able to obtain. Its preservation is evidently due to the sandy matrix. Most of the "moulds" occur in the soft clay which is intercalated in the footprint bed.

3. Genus indet.—Slab (No. 134) showing hind and fore feet of a smaller species, with narrow toes. Length of pes 3 inches; length of manus 1½ inches. The toes in this species all curve inwards, and are not separated, nor do they radiate as in *Cheirotherium.*

4. Slab (No. 142) showing rain-pittings and a remarkable median impression running in a straight line, which may be attributed to the track made by the point of a tail trailing on the ground.

Of impressions made by smaller species of Reptilia, the Keuper, both at Storeton and Oxton, presents several examples. With the exception of *Rhynchosaurus* itself, very little is known of these creatures; for, although a great number of bones have been found in the Triassic strata, not only of Europe but of America and South Africa, it is still a matter of difficulty to correlate the footprints with any known species of animals.

The difficulty in deciphering these small footprints is increased by the fact that several kinds of impressions are often found together on the same slab, in addition to the frequent superposition of one impression upon another, as the animals walked across the expanse of sand in various directions.

Among the specimens exhibited are examples of five species, all of which are probably the prints of small reptiles. The forms marked *b*, *c*, and *d* have not been previously recorded from Storeton.

5. (*a*) *Rhynchosaurus.*—Four well-defined digits, with occasional vestiges of a fifth digit, much shorter that the others, possessing short claws and curved inwards. There is sometimes the mark of a projecting spur at the back of the foot. Length of foot 1½ inches. The middle toe often extends beyond the others. It is difficult to distinguish between the fore and hind feet, and the impressions follow so closely that the successive tracks of the animal's march are not clearly defined. All the toes curve slightly in the same direction. These impressions frequently occur on slabs exhibiting the tracks of *Cheirotherium*, often being superposed on the actual imprint of the larger saurian.

6. (*b*) Genus indet.—Tracks of a smaller animal, ⅔ of an inch in length, with a more stubby foot, and very distinct claws on the digits; the first digit very short, often indicated by a mere point

https://doi.org/10.1017/S0016756800143742

where the claw has penetrated the sand; four distinct toes, probably had a rudimentary fifth. The digits do not display the same parallelism as in the specimens attributed to *Rhynchosaurus*.

7. (*c*) Genus indet.—A minute form, ½ an inch long, showing four digits, tapering to a point; no vestige of claws.

8. (*d*) Genus indet.—Three rather broad digits, with claws (? webbed). Not well defined; may be same as (*b*).

9. (*e*) Genus indet.—An oval impression, with concave terminated digits, four or five in number, and a hinder projecting spur (? Chelonian). Toes webbed.

10. Two slabs from Oxton Heath (found by Dr. Ricketts) covered with impressions of (*a*) *Rhynchosaurus*, and probably of those included under (*b*).

11. A large slab found *in situ* from the South quarry, Storeton, at Easter, 1894, by Mr. Norman Jeffs. Shows specimens of several varieties—the slender-toed *Rhynchosaurus*; the minute form (*c*), several tracks; the stubby form (*b*); and both the fore and hind foot of a similar species to No. 134, resembling the *Cheirotherium*, but of smaller size, and differentiated from that species by having the digits all pointing in the same direction.

Note on *Cheirotherium*.

The larger footprints known as belonging to the *Cheirotherium* have long been attributed, on the authority of Sir R. Owen, to one or other genera of Labyrinthodonts.

In a paper contributed to the Transactions of the Liverpool Geological Association, in 1889, by Mr. James Hornell, the author records an interesting series of investigations on Labyrinthodonts, chiefly from a biological point of view, and though he apparently accepts Owen's correlation—since he terms it "successful" (p. 67)—he shows very clearly that the *Cheirotherium* impressions do not coincide with the normal type of *Labyrinthodon*. For the "hand-footed kind, where the hind limbs by reason of their greatly increased size depart from the central type," Mr. Hornell proposes a separate classification in a sub-order. But it may be pertinently asked whether there exists any evidence from the skeletons of Labyrinthodonts, now so numerously discovered in the Coal-measures, Permian and Triassic strata, of this special type of *Labyrinthodon*?

Since Owen correlated the *Labyrinthodon* with the *Batrachia*, a great mass of evidence has come to light, through the researches of Burmeister and Fritsch in Germany; Professors Huxley, Seeley, and Miall in England; and Professors Cope and Marsh in America. It is now accepted that the *Labyrinthodon* was more akin to the Salamander or Newt than to the Frog. Indeed, the skeletons which have been obtained entire from the petroleum shales of Germany show none of the supposed frog-like affinities. The *Labyrinthodon* was, in fact, a primeval Salamander, the species varying in size from small creatures, 8 inches in length, to huge animals of eight or nine feet.

It is but fair to state that Owen recognised the footprints of

Cheirotherium as resembling those of a Salamander,[1] although he, at the same time, attributed them to a supposed Batrachian. In his restoration of *Mastodonsaurus,* from Coton End, Warwick, Owen judged by the simple relics—chiefly of the teeth, parts of the skull, an ilium and humerus—he found there; but our present knowledge of the structure of these animals (which has been most minutely and elaborately investigated by a Committee of the British Association, reported upon by Professor Miall) is founded upon material which did not exist when Owen wrote his treatise in 1842. Even now our knowledge of the limbs of Triassic species of Labyrinthodonts is imperfect, and thus an important link in the chain of evidence required to enable us to correlate the footprints is wanting. Nor are we helped much by studying the limbs of the Carboniferous species of these Amphibians; for, on the authority of Professor Miall, the corresponding parts of the fore and hind limbs of *Labyrinthodon* are very similar in form, and present no uncommon difference of size. This feature, it is very evident, does not agree with the fossil footprints of *Cheirotherium*; and the more we study the known forms of true Labyrinthodonts, the more we are driven to the conclusion that whatever was the mysterious animal by which the larger footprints at Storeton were made, it cannot be referred to any *known* species of Labyrinthodont.

V.—The Aptychus.

By Ernest H. L. Schwarz, A.R.C.S.

THE discovery of an Ammonite (*Oppelia subradiata,* Sow., from Dundry, now in the British Museum) with the Aptychus *in situ* closing the orifice, would seem sufficient to set all doubts at rest as to the true nature of that body, viz. that of an operculum.[2] Many of the writers on the continent, however, have not seen that specimen, which unfortunately is unique, and are inclined to attribute to the Aptychus other offices, because :—

1. It usually occupies a very definite position within the living chamber of the shell, lying in the middle of the outer edge, with its umboes pointing forward, and its rough surface outwards.

2. The complicated internal structure of the middle layer of the calcareous Aptychi proves them to have been formed beneath the epidermis, and were not therefore homologous with the opercula of other Mollusca, which are dermal in origin.

3. The Aptychus very seldom, either in shape or size, corresponds with the aperture of the Ammonite shell to which it was supposed to belong.

These objections are valid enough if they went to support any

[1] ". . . . in having the shorter toe of the hind foot projecting at a right angle to the line of the mid-toe." Miall considers this feature common to other orders of reptiles.

[2] See article by Dr. S. P. Woodward, F.G.S., "On an Ammonite with an Operculum in situ," "The Geologist," 1860, Vol. III. p. 328 (with a woodcut); also Dr. H. Woodward, F.R.S., Geol. Mag. 1885, p. 346, and "Student," vol. iv. p. 1, pl. i. fig. 12.

https://doi.org/10.1017/S0016756800143742