March 22, 1888.

Professor G. G. STOKES, D.C.L., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The Right Hon. Charles Douglas Richard Hanbury-Tracy, Lord Sudeley, whose certificate had been suspended as required by the Statutes, was balloted for and elected a Fellow of the Society.

The following papers were read:—

I. "On the Skull, Brain, and Auditory Organ of a new Species of Pterosaurian (*Scaphognathus Purdoni*) from the Upper Lias, near Whitby, Yorkshire." By E. T. NEWTON, F.G.S., F.Z.S., Geological Survey. Communicated by Dr. ARCHIBALD GEIKIE, F.R.S. Received March 1, 1888.

(Abstract.)

The fossil Pterodactyl skull which is the subject of this communication was obtained from the Upper Lias of Lofthouse, near Whitby, by the Rev. D. W. Purdon, of Wolverhampton. It is the first Pterodactyl found in the Yorkshire Lias, and is a new form, allied to the Continental Jurassic species *Scaphognathus* (*Pterodactylus*) *crassirostris* of Goldfuss. The structure of the skull, including the back, base, and palatal regions, is better shown than in any previously discovered specimen; and in addition to this the brain and parts of the auditory organs have been exposed.

In its present condition the skull is about five and a half inches long; but apparently about two inches of the front are wanting. The elongated snout gives the skull a very bird-like appearance; but its most striking features are the five apertures, surrounded by bone, seen on each side. The orbit is the largest of these apertures; in front of this, and next in size, is the ant-orbital fossa; still further forward is the somewhat smaller external nostril. Behind the orbit is the temporal space, divided by a bony bar into the supra- and infra-temporal fossæ. The premaxillæ are united to form the prenasal part of the snout, and send backwards an upper median process which meets the frontals between the orbits. The maxilla is not clearly divided from the premaxilla; but there can be no doubt that

the bone separating the nasal aperture from the ant-orbital fossa is a process of the maxilla. Alveoli for four teeth are preserved on each side; but it is not quite certain whether they all belong to the premaxillæ.

On the upper surface of the skull are to be seen the nasals and prefrontals, on each side of the premaxillary process. The frontals form the upper boundaries to the orbits and are confluent posteriorly with the parietals. The supra-occipital region has been broken away. Strong buttresses extend outward from the postfrontal and parietal regions to form the supra-temporal bar. There is on each side a large lachrymal bone forming the greater part of the upper and hinder boundary of the ant-orbital fossa. The jugal and quadrato-jugal are of a somewhat unusual form; the former bounding the lower half of the orbit, and the latter enclosing in an open V the greater part of the infra-temporal fossa. The quadrate is a wide but thin plate seen chiefly at the back of the skull. The base of the cranium is remarkable for its depth and extreme antero-posterior flattening; and viewed from behind, a pair of long rods are seen extending from its lower margin, one on each side, to the inner angles of the quadrates. These bones are regarded as the homologues of the basi-pterygoid processes of the sphenoid, such as are seen in some lizards and birds, as for example in the Chameleon and Emu.

From the point of junction of the quadrate and basi-pterygoid process a bone runs along the palate, and dividing anteriorly forms the hinder boundary of the internal nostril, its outer portion joining the maxilla and its inner being continuous with a median bone occupying the position of a vomer. This bony bar, it is thought, represents the palatine and pterygoid bones, and its relations agree better with those of the lizard than with those of the bird, seeing that it does not come into such close contact with the base of the skull as it does in birds, but is thrust outwards by the long basi-pterygoid process.

The back of the skull is essentially lacertilian. A large paroccipital bone extends outwards from the sides of the foramen magnum, and its distal end expanding, embraces the upper part of the quadrate. The relation which the base of the paroccipital bears to the semicircular canals shows that it must be chiefly formed by the opisthotic element, as Prof. W. K. Parker has shown to be the case in lizards, and not by the exoccipital as it is in birds.

By removing the frontal and parietal bones of the left side, a cast of the brain cavity has been exposed, which there can be no doubt represents the form of the brain, just as closely as does that of a bird's cranial cavity. In proportion to the size of the entire skull, the brain of this Pterodactyl is very small, being not more than one-eighth of its length. Each cerebral lobe is oval in shape,

and about as thick as it is wide. The olfactory lobe is small. Behind the cerebrum is a pair of large optic lobes, occupying a prominent position on the sides of the brain, and extending upwards well to the upper surface, but not meeting above in the middle line. The region of the cerebellum has been broken away, and its exact form therefore is somewhat uncertain; but judging from portions which remain, it is tolerably clear that it extended between the optic lobes, and may have reached as far forwards as the cerebrum. Attached to the side of the medulla oblongata is a large flocculus, such as occurs in this position in birds.

It was the finding of the flocculus which led to the discovery of some parts of the auditory apparatus. On clearing away the stone in this region, a small tube filled with matrix was found arching over the pedicle of the flocculus and dipping down between it and the optic lobe. This tube occupies the position of the anterior vertical semicircular canal in the goose. By tracing the canal backwards and downwards it was found to join another similar tube forming an arch behind the flocculus, that is, in just the position of a posterior vertical semicircular canal. By careful excavation below the flocculus, a portion of a third tube was found, arching outwards in a horizontal plane, and this is believed to be the external semicircular canal.

The similarity between the base of the fossil skull and that of the Chameleon led to the inference that the fenestra ovalis would be found to be similarly placed in both, and by clearing away the matrix from the orbit and temporal fossa this inference was proved to be correct. The form and relations of the quadrate bone make it highly probable that this Pterosaurian had no ear-drum.

A comparison of this fossil with the skulls of known Pterosauria, leaves no doubt that it is more nearly related to the *Scaphognathus* (*Pterodactylus*) *crassirostris* than to any other species, but as it differs from that form, and is evidently new, it is to be named specifically *Scaphognathus Purdoni*.

The Pterosaurian skull, as exemplified by this Lias fossil, resembles more the Lacertilian than any other type of Reptile skull; and seeing that the skulls of birds and lizards are in many points very similar, one is not surprised to find in this fossil characters which are also found in both these groups. In considering, therefore, the relation which the Pterosaurian skull bears to those of birds and lizards, the characters should be especially noticed which serve to distinguish between the two groups, thus:—

1. In birds the brain-case is larger in proportion to the size of the skull than it is in lizards.

2. The quadrate, pterygoid, and palatine bones are movable on the skull in birds; but more or less fixed in lizards.

3. In birds the hinder end of the palatine and front end of the pterygoid are brought into close relation with the rostrum of the sphenoid. This is not the case with lizards.

4. The orbit is rarely completed by bone in birds, and never by the jugal. In lizards the orbit is surrounded by bone, and the jugal forms part of it.

5. In birds there is no prefrontal bone, while it is always present in lizards.

6. No bird has a supratemporal bar of bone, but it is always developed in lizards.

7. In lizards the paroccipital process is large and formed by the opisthotic. In birds the paroccipital is small and formed by the exoccipital.

8. In birds the bones of the cranium are early ankylosed; in lizards they nearly always remain separate.

9. Birds have the premaxillæ large and united into one bone, in lizards they are usually small.

10. The ant-orbital fossa which is present in birds is only occasionally present in lizards.

11. In birds there is always a lower temporal bar of bone extending from the maxilla to the quadrate. This bar is incomplete in all lizards except *Sphenodon*, although well developed in other reptiles.

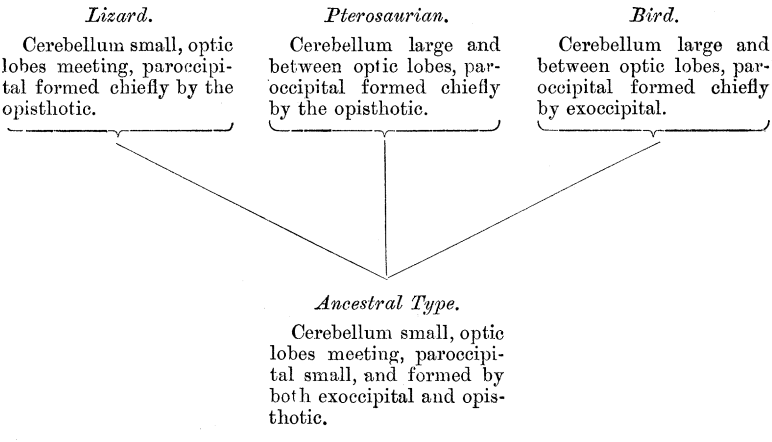
The skull of *Scaphognathus Purdoni* agrees with lizards in the first seven of the above characters; and with birds in those numbered 8, 9, 10. Number 11 need not be considered, as it can scarcely be regarded as distinctive. The greater importance of the first seven characters makes it clear that in the structure of the skull, *S. Purdoni* most nearly resembles the Lacertilia.

The brain of *Scaphognathus Purdoni* agrees with that of reptiles in its relatively small size; while the separation of the optic lobes by the cerebellum and the meeting of the latter with the cerebrum, as well as the possession of a distinct flocculus, are important points in which it resembles the brain of the bird. On the other hand the form of the optic lobes is unlike that of any living bird.

The brain of the American fossil bird, *Hesperornis*, shows a striking resemblance to that of *Scaphognathus Purdoni*, for not only is it proportionally smaller than in recent birds, but the relation of the cerebellum and cerebrum to the optic lobes is very similar.

The facts above stated seem to show that the Pterosauria are related to the birds in the form of the brain, and to the lizards in the structure of the skull. This, however, does not constitute the Pterosaurian a transitional form between birds and reptiles, in the sense of the Pterosauria having been derived from reptiles, or of the birds having been derived from Pterosauria; but rather points to *Aves*, *Pterosauria*, and *Reptilia* having been derived from some

common ancestral type. These relationships may be thus indicated, taking only a few of the characters of each.



II. "The Atoll of Diego Garcia and the Coral Formations of the Indian Ocean." By G. C. Bourne, B.A., F.L.S., Fellow of New College and Assistant to the Linacre Professor in the University of Oxford. Communicated by Professor E. Ray Lankester, F.R.S. Received March 12, 1888.

[Plate 4.]

The whole of the following paper was planned and a great part of it was written when Captain Wharton's letter appeared in 'Nature,' on Feb. 23. Captain Wharton has anticipated my objections to the theory put forward by Mr. Murray in explanation of the formation of atolls and barrier reefs, and has suggested that the growth of corals on the periphery of a submerged bank is sufficient to explain the elevated rim of a barrier reef or atoll, and the contained lagoon channel or lagoon. In this I cordially agree with him, and can only express my satisfaction that so eminent an observer should have arrived, after an extended study, at conclusions nearly identical with mine. In accounting for the luxuriance of coral growth upon the peripheral slopes of an atoll, I differ slightly from Captain Wharton, and the publication of his letter has led me to extend and modify the plan of the latter half of this paper, in order to show more clearly the points in which I agree with and those in which I differ from him. I may take this opportunity of expressing my thanks to Captain Wharton for his kindness in sending me notes on the structure of the Cosmoledo and Farquhar groups, and to Dr. S. J. Hickson who has given me the benefit of his experience in N. Celebes.