

**Article XXXII.—ON THE SQUAMOSAL AND RELATED BONES  
IN THE MOSASAURS AND LIZARDS.**

BY ROBERT BROOM, D. Sc.

In most lizards' skulls there are two bones in the posttemporal region, one of which is presumably the squamosal and the other something else. Concerning no elements in the reptilian skull have opinions differed more greatly, and even now very different opinions are held by eminent authorities.

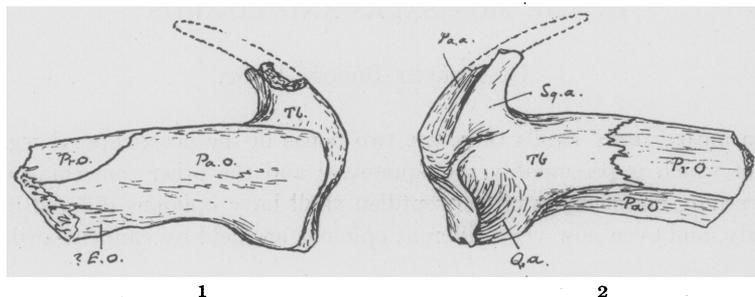
Among the great authorities of the past we have Owen and Huxley and Parker agreeing that the outer of the two bones is the squamosal; while we have Gegenbaur and Zittel regarding the inner one as the squamosal. Cope for long held the same view as Owen, but latterly he came to regard the mammalian bone as made up of two distinct elements, the upper one of which he regarded as homologous with the outer of the bones in the lizard. Baur's view changed three times. In 1886 he regarded the outer as the squamosal; but in 1889 he came to believe it was really the inner, the outer being the quadrato-jugal. In 1894 he came to look on the outer bone as the prosquamosal.

Among living workers opinions vary just as greatly. Gadow, Gaupp, Osborn, Wiedersheim, Beddard, and Fuchs all regard the inner bone as the squamosal. Williston regarded the inner bone as squamosal till 1910 when he became persuaded it was the outer bone. Kingsley, v. Huene, Thyng, and Boulanger regard the outer bone as the squamosal.

Till a few weeks ago I favoured the inner bone being squamosal. The lizards whose skulls I had chiefly studied were *Agama* and *Varanus* and the resemblance of the inner bone to the single bone in the snakes seemed to offer strong support to the view. Recently on examining the skulls of some Mosasaurs in the American Museum and the skulls of recent Iguanoids I feel forced to abandon my earlier view and to agree with Williston.

Though the Mosasaurs are considerably specialized they are the earliest well preserved type we have to study. The outer bone is well developed. It sends a long anterior process to support the postorbital and form the temporal arch. Posteriorly it supports the quadrate and internally it articulates with the posterior process of the parietal. The inner bone has very remarkable relationships as was first pointed out by Cope. It has a moderate sized posterior plate which forms part of the occiput. Superiorly

a flat plate passes upwards, inwards and forwards and completely underlies the parietal. The greater part of the bone is closely articulated to the paroccipital or opisthotic and it has a forward and inward extension which



Right tubulare and related bones in *Platycarpus* sp; 1, from behind and the left side; 2, from the front and right side. Both figures  $\frac{1}{2}$  natural size.

*E. o.*, exoccipital; *Qa.*, articulation for quadrate; *Pa. a.*, articulation for parietal; *Pa. o.*, paroccipital (= opisthotic); *Pr. o.*, Prootic; *Sq. a.*, articulation for squamosal; *Tb.* tabulare.

is wedged in between the paroccipital and the prootic. The large lateral occipital process is apparently mainly paroccipital, at least one specimen in the American Museum collection indicates that the exoccipital only forms about the inner third.

If now we consider these two bones to decide which is squamosal we find that the outer one answers all requirements, while the inner is apparently not a bone of the temporal roof at all except to some extent secondarily.

The Cynodont reptiles are sufficiently near the mammals to leave no doubt as to which bone is the mammalian squamosal, and the outer of the lizard temporal bones is apparently the same.

The question next arises, if the outer bone is the squamosal, what is the inner. From its close association with the paroccipital and from its being more of an occipital element than an element of the temporal roof I feel forced to agree with Williston in regarding it as the tabulare. The tabulare in early types is a membrane bone whose essential function seems to be the support of the parietal on the paroccipital. In most later forms it is lost probably because the parietal gets sufficient support from the supraoccipital.

It may be thought unlikely that the lizards which are generally regarded as a late type should retain this primitive element, but it may be pointed out that there is good reason for believing the Squamata to be a very early group. One undoubted lizard is known from the Middle Trias of South Africa and most likely they will yet be found in the Permian. Though *Sphenodon* is generally held to be the most primitive modern reptile, in quite a lot of characters the lizard is much more primitive.