for *aa* which is found in other combinations where it has the same signification.

So far I have found no marks indicating the plural; this may be represented by duplications.

OSTEOLOGICAL NOTES.

BY D. D. SLADE.

THE jugal arch is present in all of the order Rodentia, and is generally complete, although it exhibits many modifications in its composition. Three bones form the arch, which is straight or slightly curved horizontally, while it almost invariably presents a curvature downwards. The position of the jugal therein serves as a determining character in grouping the various families of the order.

The temporal fossa is often little developed, showing feeble energy in the action of the temporal muscle. On the contrary, the pterygoid plates and fossæ are often largely increased in relation to the enlarged development of the muscular insertions. In close connection with these conditions, the coronoid process of the mandible is small, and even rudimentary, while the parts about the angle are largely expanded. The condyle is little elevated and presents, with few exceptions, an antero-posterior articulating surface.

Post-orbital processes of the frontals exist in a few of the families, but there is in no case a corresponding process from the arch. The orbit is never separated from the temporal fossa.

In many of the rodents there is present a more or less extensive dilatation of the infra-orbital foramen, through which passes, in addition to the nerve, that portion of the masseter muscle which has its insertion upon the maxilla. This extends around the back of the jugal process of the maxilla in a pulley-like manner, to an insertion just below the socket of the mandibular præmolar, and thus co-operates with the temporal in moving the mandible in a vertical direction. This attachment of a head of the masseter is peculiar to the order, and explains the use of the vacuity in the maxilla which is oftentimes of vast relative proportions.

Assuming the present classification, all existing Rodentia may be brought into two groups, the Simplicidentata and the Duplicidentata. The first embraces the Sciuromorpha, Hystricomorpha, Myomorpha, and the second, the Lagomorpha.

In the Sciuromorpha, the jugal forms the greater part of the arch, extending forward to the lacrymal, and posteriorly to the glenoid cavity, of which it forms the outer wall, and it is not supported below by a continuation backwards of the process of the maxilla. In the more typical forms there is no enlargement of the infra-orbital opening, while the post-orbital processes of the frontals are characteristic of the family Sciuridæ. The external pterygoid plate is entirely wanting, and there is no fossa.

The jugal arch in the Myomorpha is for the most part slender, and the jugal, which does not extend far forward, is supported by the continuation below of the maxillary process. The zygomatic process of the squamosal is short. No post-orbital process of the frontal exists. The infra-orbital opening varies. In the family Muridæ, especially in the typical forms, this opening is perpendicular, wide above and narrow below, while the lower root of the zygomatic process of the maxilla is flattened into a thin perpendicular plate. Very much the same condition exists in the Myoxidæ, while in the Dipodidæ the foramen is as large as the orbit, rounded, and has a separate canal for the nerve. The malar ascends to the lacrymal in a flattened plate. In close connections with these conditions the coronoid process of the mandible is small and rudimenary, while the parts around the angle of the ramus are much developed.

In the Hystricomorpha the arch is stout. The jugal is not supported by the continuation of the maxillary process, and generally does not advance far forward. The infra-orbital vacuity is large, and is either triangular or oval. The coronary process and the condyle are but slightly elevated above the dental series.

In the Chinchillidæ the jugal extends forward to the lacrymal. In the Dasyproctidæ, Cælogenys is characterized by the extraordinary development of the jugal arch, which presents an enormous vertical curvature, two-thirds of the anterior portion of which, constituting the maxilla, is hollowed out into a cavity which communicates with the mouth. The nerve passes through a separate canal, adjacent to the infra-orbital opening.

In the sub-order Duplicidentata, the jugal arch is well developed. In the family Leporidæ there are large wing-like, post-orbital processes, while the jugal, but feebly supported by the maxillary process, continues posteriorly to aid in the formation of the outer side of the glenoid articular surface, passing beneath the process of the squamosal.

In the Lagomyidæ there are no post-orbital processes, and the posterier angle of the jugal is carried backward nearly to the auditory meatus. The infra-orbital opening in the Duplicidentata is of the usual size. The angle of the jaw is rounded and the coronoid process much produced upwards.

In considering the significance of the jugal arch in the Rodentia, the peculiar vertical curvature downwards, which has already been noted, and which is a decided manifestation of weakness, must be taken into account. This condition is compensated in some of the families by the unusual arrangement made in the distribution of the muscular insertions of the masseter through the infra-orbital opening, by which increased energy is imparted to the powers of mastication, and whereby the action of the mandible is rendered fully equal to the demand upon its efforts.

In those families where the above condition does not exist it is evident that the strength of the arch is still sufficient for the antero-posterior movement of the articulation so peculiar to the Rodentia and so characteristic of the act of gnawing.

The relation of the arch to the neighboring parts must also be remarked. For example, the ascending ramus of the mandible differs according to the food. Elevated in the Leporidæ, it is short in the Sciuridæ, and still shorter in the Muridæ.

In the first the coronoid is broad, projects but slightly, is near the condyle, and far distant from the molar series, while the angle of the jaw is broad and well rounded, as in the Lagomyidæ.

In the other two families, squirrels and rats, the coronoid is feeble, pointed, and placed at equal distances between the condyle and the last molar; thus the masseter does not possess a leverage as advantageous as in the hare. This muscle, however, in the rats has its maxillary attachments much developed, while few fibres spring from the arch — a condition correlative with the feebleness of this last.

Cambridge, June 21.