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ON CERTAIN VACUITIES OR DEFICIENCIES IN THE CRANIA
OF MAMMALS.

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WITH TWO PLATES.

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No. 8. — *On certain Vacuities or Deficiencies in the Crania of Mammals.* By D. D. SLADE.

CERTAIN vacuities or deficiencies, ranging much in size, position, and relation to neighboring parts, exist in the macerated adult skull of the various orders of the Mammalia.

These vacuities are in themselves due to an arrest of osseous development, and are in no wise to be confounded with the air cells in the cancellous tissue, such as exist for example in the skull of the Elephant, or between the frontal plates of the Ox. These are secondary to the original growth of the bone.

Neither are they, in any sense, the product of absorption.

They occur for the most part at the juncture, or at what, under other circumstances, would be the juncture, of two or more bones, the margins of these bones thus becoming the boundary of the vacuity. They may also occupy the central portions of a bone, or they may hold the position of an ordinary foramen, or of two or more of these combined, thus representing, and even becoming in a true signification, enlarged foramina.

The vacuities may therefore be arranged under two categories:—

1. Those that are dependent upon arrested ossification, in the body of a bone, or at a point where several bones would otherwise come in contact, but neither of which has any special adaptation to function.

2. Those that are due to enlarged openings, the result of arrested ossification, which have adaptation to special function, and retain this, notwithstanding the modifications which they may have undergone.

The regions of the skull occupied by these vacuities may be thus classified: 1. Basal (posterior and lateral); 2. Orbito-nasal; 3. Palatine; 4. Facial; 5. Occipito-squamosal; 6. Squamosal.

1. Under the term "Basal" are included the posterior, lateral, and postero-lateral regions of the base of the skull, comprehending under this last that space existing between the posterior and middle cranial segments which in many cases is imperfectly filled by the periotic, tympanic, and squamosal, whereby deficiencies differing much in size are produced.



These may be properly termed anterior and posterior tympanic vacuities, or foramina, corresponding to the *foramen lacerum medium* and *foramen lacerum posterius basis cranii* of anatomists. Plate II. Figs. 9, 10, *a*.

2. "Orbito-nasal" includes the vertical plate of the palatine, and the margins of the palatine, maxilla, alisphenoid, orbitosphenoid, and frontal, at their lines of juncture, as also the combination of certain foramina. Plate II. Fig. 7, *a, b*.

3. "Palatine" designates the anterior and posterior portions of the palate, one or both. Plate I. Figs. 1, 2, *a, b*.

4. "Facial" includes the side wall of the face, the latero-nasal portions of the maxilla, and the anterior root of the zygoma. Plate II. Fig. 8, *a*. Plate I. Figs. 3, 5, *a, b*.

5. The "Occipito-squamosal" is the space comprehended between the supraoccipital, exoccipital, and squamosal. Plate II. Fig. 11.

6. The "Squamosal" and "Parasquamosal" are indicated by the terms used. Plate I. Fig. 4, *b*.

The cranial vacuities in the various orders of the Mammalia occur as follows.

MONOTREMATA. — The skull of the Echidna presents no vacuities. In the Ornithorynchus, there are relatively large anterior and posterior deficiencies, the first representing the foramen ovale, and the second the jugular and the præcondyloid foramina combined. There are also small ones in the basisphenoid.

MARSUPIALIA. — Many of the Macropodidæ have large posterior palatine vacuities. These are present also in Phascolarctos (Plate I. Fig. 1, *a*), in the Dasyuridæ (Plate I. Fig. 2, *a, b*), and in the Peramelidæ. *Perameles lagotis* has a large oval vacancy which extends from the second pre-molar to the penult molar, and posterior to this are found several small ones. In the Didelphidæ there are large posterior palatine vacuities.

EDENTATA. — This order is singularly free from cranial deficiencies. In the Dasypodidæ the posterior tympanic vacancy, or *foramen lacerum posterius*, is somewhat enlarged. Among the Sloths, *Choloepus hoffmanni* presents considerable deficiencies in the basi-sphenoidal region.

CHIROPTERA. — In a few genera, notably in Pteropus, the posterior tympanic vacuities are large.

INSECTIVORA. — In some of the Erinaceidæ, the post-tympanic are large, while there are also extensive post-palatine vacuities, especially in *Erinaceus europæus*. In Sorex, large latero-basal ones are found, and Tupaia has a large longitudinal central deficiency of the malar, in addition to the palatal vacuities.

RODENTIA. *Lagomorpha*.—In the Hare, at the posterior portion of the inter-orbital septum, the foramen, which serves as a common outlet of the optic nerves, is sufficiently enlarged to constitute a vacuity. There are also large vacuities extending from each orbit into the latero-nasal regions; these being covered externally by the singularly reticulated plate of the maxilla. (Plate I. Fig. 3, *a, b*.) Pre- and post-palatine deficiencies reduce the palate itself to a mere narrow bridge extending across between the premolars.

Sciuromorpha.—In the Sciuridæ, there is a small orbito-nasal deficiency. In *Castor fiber* there are large anterior tympanic spaces.

Myomorpha.—The anterior root of the zygoma presents a vacuity in very many of the Rodentia (Plate I. Fig. 4 *a*), and in the Rats generally this is vertical and dilated superiorly. In *Fiber zibethicum*, the malar vacuity is large, and there is also one in the posterior process of the squamosal (Plate I. Fig. 4 *b*), which is also present in several of the Muridæ. In *Lagostomus*, a thin bony plate separates the infra-orbital foramen from the antorbital vacuity.

Hystricomorpha.—In the Porcupines generally, and especially in *Erethison dorsatus*, the infra-orbital as also the ante-tympanic vacuities are large. In the Capybara, the former is immense. In Chinchilla a large deficiency also occurs in the parasquamosal region between the alisphenoid, parietal, and tympanic. (Plate I. Fig. 5, *a*.) In Paca, the foramina, rotundum, and *lacerum anterius* combine to form a capacious orbito-nasal vacuity.

CARNIVORA. Pinnipedia. *Phocidæ*.—Large latero-posterior basal deficiencies occur in all, while in some, as in *P. vitulina*, *P. groenlandica*, and *P. fætida*, there is in addition to these a more or less extensive perforation in the basioccipital. (Plate I. Fig. 6, *b*.) In the orbito-nasal region, not only is the spheno-palatine foramen much enlarged, but a deficiency occurs at the juncture of the maxilla, palatine, and frontal, often attaining a large size. (Plate II. Fig. 7, *a*.)

Otariidæ.—The *foramen lacerum posterius* is much enlarged, while the orbito-nasal vacuities are extensive, in this family. In *Zalophus* and *Callirhinus*, in addition to the above, there are large vacuities at the juncture of the vertical plate of the palatine with the alisphenoid and orbitosphenoid. (Plate II. Fig. 7, *b*.)

Rosmaridæ.—In the Walruses there are large orbito-nasal and posterior tympanic vacuities, while the anterior root of the zygoma is largely dilated.

Fissipedia. — In this sub-order, with very few exceptions, no vacuities

occur. In *Enhydra* (Sea Otter) the post-tympanic fissure is large; there is also an orbito-nasal deficiency. The infra-orbital opening is capacious.

UNGULATA. Artiodactyla. — In many of the Ruminants, as in the Cervidæ, Camelidæ, Antilocapridæ, and in some of the Bovidæ, as in Antilopinae and Caprinae, a large facial vacuity exists at the juncture of the frontal, lacrymal, malar, and nasal bones, which leads into the nasal cavities. (Plate II. Fig. 8, *a*.) Where the upper incisors are entirely absent, the anterior palatine foramina assume large proportions, becoming veritable deficiencies. In some of the Cervidæ, as in Rangifer, Alces, and in Antilocapridæ, a more or less extensive orbito-nasal vacuity exists at the juncture of the vertical plate of the palatine, alisphenoid, and lacrymal. In Suidæ and Dicotylidæ the *foramen lacerum medium* is large, and in Hippopotamidæ both ante- and post-tympanic foramina are capacious.

Perissodactyla. — In the Equidæ, the anterior and posterior tympanic foramina with the ovale combine to form an extensive deficiency in the postero-lateral basal region. (Plate II. Fig. 9, *a*.) In the Rhinocerotidæ, the foramina, ovale, and *lacerum medium* are combined. There is also a considerable orbito-nasal vacuity, as well as one formed by the combination of the two anterior palatine foramina.

In Tapiridæ, the anterior, posterior tympanic foramina, and the ovale are joined, as also are the anterior palatine, as in the Rhinocerotidæ.

SIRENIA. — In the two genera *Manatus* and *Halicore*, which constitute the present order, the entire latero-posterior basal region, between the occipital and alisphenoid, may be considered as a vacuity, so imperfectly is it filled by the tympanic and periotic. (Plate II. Fig. 10, *a*.) In the latero-occipital region, at the juncture of the squamosal with the supraoccipital and exoccipital, a large vacuity also exists, very imperfectly filled by the periotic. (Plate II. Fig. 11, *a, b*.) The dilatation of the supraorbital foramen is also large, and there are extensive orbito-nasal openings.

HYRACOIDEA. — In *Hyrax*, the anterior tympanic deficiency is relatively large.

PROBOSCIDEA. — In the Elephant, the tympanic deficiencies so uniformly present in the odd-toed Ungulates can scarcely be said to exist.

CETACEA. — In the Odontoceti, and notably in the Delphinoidæ, large irregular openings exist between the recess which holds the united tympanic and periotic and the cranial cavity. The optic foramen, as it passes out through the orbito-sphenoid, is much enlarged, being

converted in some instances into a vacuity. Upon the latero-external walls of the posterior nares large oval notches or deficiencies occur.

PRIMATES. — The sphenoidal and sphenomaxillary fissures in man, as also the *foramen lacerum medium*, which is often very large and irregular in shape, come under the second category of vacuities. The same also applies to the anterior tympanic of the higher Apes.

In studying the etiology of these cranial vacuities in the Mammalia, it would seem at first sight, especially if the imperfect osseous condition of the skull in many of the lower Vertebrates be taken into consideration, that their existence was due to phylogenetic degeneration, taken in the widest acceptation of the term. A closer study of the conditions presented, however, apparently limits this degeneration to one of environment. Take as an illustration the Pinnipedia, in which group the economy of nature as regards the disposition of material is admirably shown. These true Carnivora have become adapted to an existence in water. Consequent changes suited to this aquatic life have been undergone. The thick skull of the Fissipedia is no longer necessary; consequently the cranial walls have become much thinned, and several large and extraordinary vacuities in different regions, notably in the basal, have been formed.

A reduction has taken place in the number and strength of the teeth, and other characteristics of the order have been materially altered or entirely lost. These changes have been foreshadowed in the Enhydra (Sea Otter), as has already been noted.

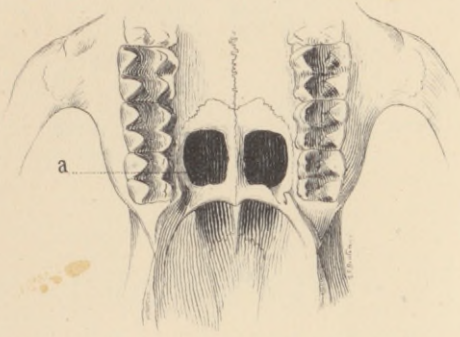
So also any diminution in the strength of the cranial walls of the ancient branch of the Ungulata, the Sirenia, due to large deficiencies, is counterbalanced by the aquatic habits of the order.

In the Rodents, the alveolar border of the maxilla is pushed far back, and thus the unoccupied space between the incisors and premolars is relatively large. This absence of teeth necessitates only a small supply of bony material in the immediate region, so that in the case of the Hare, which feeds upon a succulent diet, little strength or resistance is demanded, and consequently large vacuities are found in the latero-nasal region. The nasal plate of the maxilla is rendered lighter by the reticulation, which may be considered as a series of small vacuities, while it still serves as a protection to the delicate structures beneath. Again, the presence of the vacuity in the side-walls of the face in many of the Ruminants, and in consequence the apparently weakened condition of the parts, may be explained by the statement that either the animal is of so peaceful a nature that consolidated bones such as the frontals

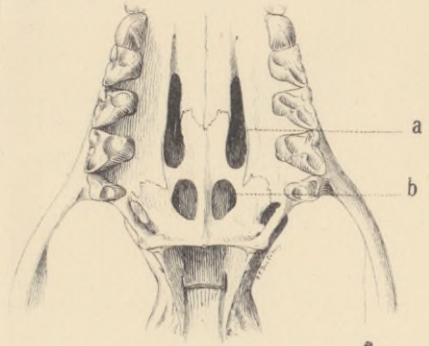
of the Bovinæ are entirely unnecessary, or, being combative, provision is made for purposes of offence and defence by the growth of antlers or other horns.

Thus, without further illustration, it may be said, that while it is difficult in the present state of our knowledge to account for the varied character and position held by cranial vacuities, or to explain why these should be more frequently present in some orders than in others, and in certain genera of an order and not in others, it may nevertheless be safely affirmed that whenever osseous material can be set aside without interference with the general economy, or without detriment to the structure of the immediate parts, it is dispensed with. This general law applies to all vacuities or deficiencies, wherever situated, in the crania of the Mammalia.

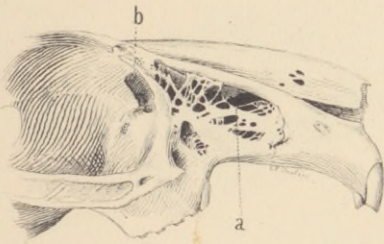
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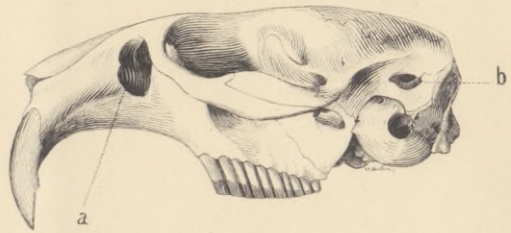
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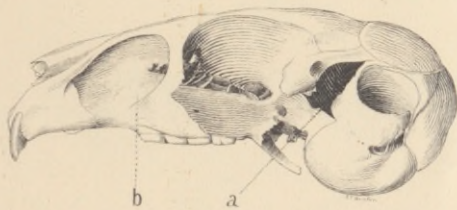
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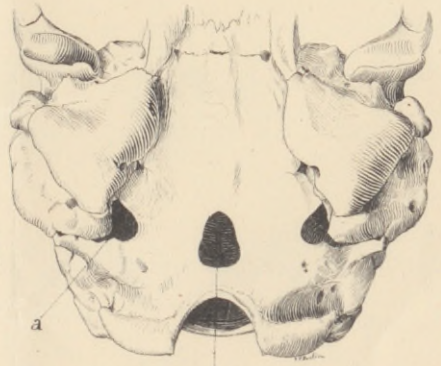
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