

#### 4. The relationship between the Air-bladder and Auditory organ in *Amiurus*.

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Since the appearance of E. H. Weber's »De aure animalium aquatilium«, many observers have studied the »auditory ossicles« which effect a communication between the airbladder and the auditory apparatus of the Cyprinoids. Baudelot<sup>1</sup> has given a résumé of the earlier attempts to determine the morphology of these, and himself successfully solved the problem in recognising the fusion of the 2<sup>nd</sup> and 3<sup>rd</sup> vertebrae. Later accounts<sup>2</sup> differ little from Baudelot's as will be seen from the subjoined table, where, except in the case of Grassi's interpretation of the Claustra, discrepancies are chiefly in nomenclature.

	Baudelot	Nusbaum	Grassi
Clastrum . . .	Intercrural <sup>3</sup> I.	Proc. Spin I.	derived from Skull I.
Stapes . . . .	Neural Arch I.	Neural Arch I.	distal part Neural Arch I.
Incus . . . .	Neural Arch II.	Neural Arch II.	distal part Neural Arch II.
Malleus . . .	Haemal Arch III.	Rib III.	Proc. Trans. III.

With regard to Grassi's interpretation of the Claustra I may state that their resemblance in *Catostomus* (the only Cyprinoid I have examined) to the undivided Proc.: Spin. II. and the relations which they bear to that bone are conclusive of the accuracy of the position taken by Baudelot and Nusbaum.

I find no observations concerning the morphology of the anterior vertebrae in the Siluroids except Baudelot's remark that »chez les Silures les osselets de Weber ont absolument la même signification que chez les Cyprins«. The object of the present note is to describe the condition of the parts in our commonest Siluroid *Amiurus catus*.

##### The auditory ossicles.

The Stapes is similar in shape to the same bone in *S. glanis* as figured by Weber, and has three processes 1) a globular articular cartilaginous process fitting into a cup on the dorsal surface of the body of the 1<sup>st</sup> vertebra, 2) an anterior spoon-shaped process which closes the Atrium sinus imparis laterally, and to the lateral surface of which the malleus is attached by means of the incus, and 3) a slender

<sup>1</sup> Comptes Rendus 1868. p. 330 f.

<sup>2</sup> Nusbaum, Zool. Anz. IV. p. 552 and (polish) in Kosmos. Lemberg 1883. Grassi, Morphol. Jahrb. VIII. p. 461.

<sup>3</sup> The spinous processes of several of the anterior vertebrae in the Cyprinoids are set on »intercrurally': they are in part formed of elements comparable to the intercalary cartilages described by Goette in the Pike.

ascending process which unlike the others contributes to the formation of the wall of the neural canal.

The Claustrum is triangular in shape and fits with its apex pointing downwards and backwards into the angle between the anterior and ascending processes of the stapes. It has no relation to the Atrium sinus imparis as in *Cyprinus*, but contributes to the formation of the lateral wall of the neural canal in this region. In young cat-fish of 3—4cm length the Claustra are almost entirely cartilaginous and in horizontal sections through such are to be recognized as distinct rods between the roof of the foramen magnum and the cartilage covering the spinal cord in the region of the second and third vertebrae.‡

The incus of the adult is similar as to that in *S. glanis*, but in young forms is a slender spicule the anterior end of which is lodged in the ligament between malleus and stapes, while the posterior end stretches back towards the upper surface of the 2<sup>nd</sup> vertebra. Like the anterior and ascending processes of the Stapes it is not preformed in cartilage and I have not been able to trace it back so far as the cartilaginous patch in the body of the 2<sup>nd</sup> vertebra to which as modified neural arch it belongs. The incus increases in size in the adult by the ossification of the ligament between malleus and stapes. I am able here to confirm Baudelot's observation that the incus in *Catostomus* is slender and style-like and has similarly lost all connection with the body of the 2<sup>nd</sup> vertebra — In form it resembles that of the young cat-fish, and, as might be expected from the greater richness in cartilage in this region of the vertebral column of the Cyprinoids, does not become entirely ossified except in the adult.

The malleus is developed in two parts, the anterior of which (the transverse process of the 3<sup>rd</sup> vertebra) only becomes connected with the posterior sickle-shaped part in the adult. The latter is in fact nothing but an ossification in the tunica externa of the air bladder. — There is never any trace of cartilage in the malleus except just at its junction with the body of the 3<sup>rd</sup> vertebra.

The Vertebrae concerned.

The 6<sup>th</sup> is the first rib-bearing vertebra. The vertebrae in front of that have no ribs, but only rib-bearing pedicles, »Basal-Stümpfe«, which I shall call here Transverse Processes.

The 1<sup>st</sup> vertebra has very rudimentary transverse processes, its body bears on the dorsal surfaces two articular cavities for the Stapedes, while on the ventral surface are accessory articulating lamellae which fit between similar processes from the combined 2<sup>nd</sup> and 3<sup>rd</sup> Vertebrae. As described above the neural arches are converted into the stapedes, and the spinous process into the Claustra.

The 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> vertebrae are fused in the adult: they are the 2<sup>nd</sup> and 3<sup>rd</sup> vertebrae of Weber. The 5<sup>th</sup> is the most independent, especially as to its arch and neural spine, and in young forms readily separates from the 4<sup>th</sup>.

The reduction affecting the incus noted above has extended to the rest of the 2<sup>nd</sup> vertebra so that no trace is left in the adult, except a little cartilage in the region of the neural spine. — The body serves apparently merely to deepen the anterior cavity of the third vertebra, although in horizontal sections through fish of 3—4 cm length, the 2<sup>nd</sup> and 3<sup>rd</sup> vertebrae appear of almost equal size.

The usual intervertebral growth of the notochord does not take place between the 3<sup>rd</sup> and 4<sup>th</sup> vertebrae so that the posterior cone of the one and the anterior cone of the other are only very incompletely developed, and very little trace of the notochord is left between the two vertebrae in the adult. The limit between the bodies is marked however by a rough ridge which serves for the attachment of the air-bladder. The transverse processes of the 3<sup>rd</sup> vertebra are converted into the mallei, the arches are ossified as is the strong neural spine which projects forwards and receives in its bifid extremity the supra-occipital above the foramen magnum. The 4<sup>th</sup> and 5<sup>th</sup> vertebrae together form as much as  $\frac{4}{5}$ ths of the length of the bone which results from the fusion of the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> vertebrae. }The suture between the centra is often obscured in the adult on the outside by the formation of superficial ossifications corresponding to the attachment of the air-bladder but is always evident in the neural canal.

The transverse processes of the 4<sup>th</sup> are of great size forming on each side a flattened plate which projects horizontally outwards from the body, and possesses a thick anterior edge suturally united with the transverse portion of the supraclaviculare. — Thus like the mallei the transverse processes of the 4<sup>th</sup> project considerably in front of the vertebra to which they belong. — The ventral surface of the thickened anterior edge serves for the attachment of the air-bladder; and the dorsal surface of the whole plate for the insertion of muscles.

#### The Emergence of the Spinal Nerves.

The roots of the anterior spinal nerves emerge through independent apertures in the arches of the vertebrae. The 1<sup>st</sup> spinal nerve emerges through the occ. lat., the 2<sup>nd</sup> and 3<sup>rd</sup> very close to each other in the membranous wall of the neural canal between the ascending process of the stapes and the anterior margin of the arch of the 3<sup>rd</sup> vertebra, the 4<sup>th</sup> through the posterior margin of the arch of the 3<sup>rd</sup>, the 5<sup>th</sup> similarly through the 4<sup>th</sup> and so on. The 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> take part

in the formation of the brachial plexus. — The ganglia of these nerves lie in a very small *Saccus paravertebralis* which does not communicate with the cranial cavity as in *Cyprinus*, and indeed can hardly be said to communicate with the *Atrium sinus imparis*, to such an extent is the *apertura externa atrii* closed by a thickened cushion of *dura mater* against which the spoonshaped process of the stapes rests, and through which the tendon connecting that bone with the *incus* passes.

Although the 2<sup>nd</sup> and 3<sup>rd</sup> nerve emerge from the neural canal so near each other, their origin from the spinal cord is by no means so close. The fact that the 2<sup>nd</sup> nerve especially the ventral root emerges so far back is due to the formation of the *Atrium sinus imparis*.

#### The air-bladder.

As in *Silurus* the air-bladder of the Cat-fish is subdivided by a median vertical partition for the hinder  $\frac{2}{3}$ <sup>rds</sup> of its length. — The entrance of each subdivision into the anterior undivided part is narrowed by a flattened vertical pillar, the dorsal edge of which is attached to the side of the body of the 5<sup>th</sup> vertebra, and to the ventral surface of the transverse process of the 4<sup>th</sup>. Apart from these pillars the anterior part alone of the air-bladder is attached to the vertebral column. In addition to the two lines of attachment noted above (the posterior border of the body of the 3<sup>rd</sup> vertebra and the thick part of the 4<sup>th</sup> transverse process), the dorso-median part of the *tunica externa* is firmly bound down over the bodies of the 4<sup>th</sup> and 5<sup>th</sup> vertebrae, and to a knob on the anterior end of an oblique ossification which passes backwards and outwards to become coalesced with the ventral surface of the 4<sup>th</sup> transverse process. This ossification represents the line of strain in the movements of the malleus, for the knob occupies the concavity of the sickle shaped portion of that bone to which the fibres of the ventral and lateral parts of the *tunica externa* in this region converge. The hinge between the sickle shaped end of the malleus and the knob is formed by a ligament with tendinous lustre. From the mode of attachment of the air-bladder to the malleus, the sickle-shaped end of that bone is pulled away from the vertebral column by distension of the bladder, with a resulting inward movement of the anterior end of the malleus and of the stapes and a propulsion of the perilymph towards the labyrinth.

#### The Labyrinth.

With Nussbaum I find a transverse *Ductus* connecting the *Sacculi* and an impair *Sinus endolymphaticus* projecting from that into the *Cavum sinus imparis*. The sinus is pyriform in shape and extremely thin walled. I have not as yet succeeded in find-

ing otoliths or maculae acusticae or in osmic preparations any branch of the cochlear nerve proceeding towards the Ductus, but renewed examination may prove the existence of these in *Amiurus* as well as in *Cyprinus*.

From the above description it is obvious that the apparatus by which the communication of the air-bladder and auditory labyrinth is effected in the Siluroids is a further specialisation of that in the Cyprinoids. A more extended investigation of other genera of the latter family may demonstrate the existence of forms still living, in which the bones concerned depart less from their normal structure than they do in *Cyprinus*.

The third neural spine of *Amiurus* has been described as extending from the third vertebra to the exoccipitals. It does so in reality as a perichondrial ossification investing the cartilaginous roof of the neural canal in this region. The underlying cartilage belongs to the system of intercalary neural pieces and the Claustra (although here they do not meet in the middle line above as in *Silurus glanis* Baudelot [?]) are the anterior pair of these ossified.

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### III. Mittheilungen aus Museen, Instituten etc.

#### 1. Entwässerungsapparate für macro- und microscopische Praeparation.

Von Dr. Wilhelm Haacke, Director des Südaustralischen Museums zu Adelaide.

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Um bei der Conservation in Alcohol Schrumpfung der Objecte und andere Übelstände möglichst zu vermeiden, ist es meistens nothwendig, dieselben, mögen sie nun vorher in anderen Flüssigkeiten gelegen haben oder nicht, zunächst in schwachen Alcohol zu bringen und diesen nach und nach durch stärkeren zu ersetzen — eine umständliche, zeitraubende und langweilige Procedur. Der von mir in No. 150 dieser Zeitschrift beschriebene Apparat, der dazu dienen sollte, die Conservation in Alcohol bedeutend zu erleichtern, hat sich in meinem Museum zwar für größere Objecte ausgezeichnet bewährt, leistet für kleinere macroscopische Gegenstände aber noch nicht alles Wünschenswerthe und ist zum Gebrauch bei Herstellung microscopischer Praeparate wenig zweckmäßig. Ich schlage deshalb jetzt zwei andere Apparate vor, von deren Brauchbarkeit ich mich durch Experimente überzeugt habe. Der erste soll zur microscopischen Praeparation dienen, der zweite soll in Verbindung mit meinem früheren Apparate zur Conservation kleinerer macroscopischer Objecte gebraucht werden.

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