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MUSCULAR AND SKELETAL ELEMENTS IN SPELERPES LONGICAUDUS.*

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The development of one of our commonest species of Salamander affords an opportunity for the study of many interesting problems. The author was influenced, however, in taking up a study of the skeletal and muscular elements in Spelerpes longicaudus, by several considerations. In the first place, there is a surprising lack of literature, especially on the latter subject. The question of the origination and development of adult muscles and of the number and function of transitory larval muscles, and of the relation of the two, seems to have been entirely neglected. The skeletal elements have been thoroughly worked for the adult form, but there are some modifications in the larval skull that have not been touched upon. Secondly, this form is abundant, of wide distribution, and readily obtainable, and this fact together with the facility with which it may be prepared, renders it valuable material for laboratory purposes. The work was done in the Embryological Laboratory of the Ohio State University, under the direction of Professor F. L. Landacre, and was offered as a thesis for the Baccalaureate degree.

This paper will attempt to cover merely a discussion of the skeletal and muscular elements of a 12 mm. larva, and will be for the most part descriptive, a few comparisons only being drawn with Rana and Cryptobranchus.

Spelerpes longicaudus is one of the commonest and most widely distributed species of the Plethodontidae. Its general appearance and markings are similar to Sp. bilineatus, and they are commonly found associated together in nature. Their habits, larval development and the noticeably longer tail of Spelerpes longicaudus form, however, distinguishing marks. The larval development of Sp. bilineatus is much more rapid than that of its relative; a 9 mm. specimen which I observed had both fore and hind limbs

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fully formed, while a 12 mm. Sp. longicaudus has merely limb buds, scarcely distinguishable to the naked eye. Of its habitat, Cope says: "This beautiful animal is not very active in its habits and is almost always found in rocky ground and in fissures and caves in cliffs." (Batrachia of N. A., p. 154.) This species is scarcely ever found in water save in the breeding season, while Spelerpes bilineatus abounds in rocky brooks. The larvae may be found in open water, but at an early age they show an instinct for concealment, and are more readily found under leaves and pebbles lying in the pool.

EGGS.—The eggs of Spelerpes may be found most abundantly in May and June. "They are deposited in a single layer upon the lower side of submerged stones, each batch containing from thirty to fifty eggs. The stones which are suitable for this purpose must be in the form of an arch allowing the water to flow beneath. They are generally in the more rapidly flowing portions of the brook, but the depth of the water must be such that the eggs are at all times entirely submerged, as otherwise the dash of the ripples striking against them would subject them to mechanical injury." (H. H. Wilder, "American Naturalist" Vol. XXXIII, p. 231.) The eggs are attached to the under surface of the rock by means of a gelatinous envelope in which they are encased; the same envelope keeps the eggs separated from each other much as in the case of frog's eggs.

LARVA.—The larvae of Spelerpes longicaudus are hatched somewhat early and continue for some time in the larval form. The larva at 12 mm. has the gills well developed, partially covered by an opercular fold. The tail is long and tapering, with a broad, delicate and rounded fin. The pigment is well distributed over the upper surface of the tadpole, but is lacking on the under surface, except for a few cells on the fin. The pigmentation is continuous over the anterior part of the head, but under a lens shows a double row of unpigmented areas along the dorsum, beginning behind the eye and running close to the fin. There is very little change in pigmentation at metamorphosis, as the following description of the pigmentation of the adult will show: "* * * generally * * * more thickly crowded along the sides, sometimes forming a distinct spotted band along the sides of the tail; these black bands are generally aggregated into a series of vertical bands. In younger specimens * * * the spots above are arranged in three irregular lines, one median, and two lateral larger ones. The muzzle and entire under parts are immaculate." (Cope, Batrachia of N. A., p. 154.) The pigment spots appear as brown or grayish blotches of irregular contour. The anterior and posterior limbs may be noticed as small buds, just posterior to the gills and anterior to the anus, respectively.

TECHNIQUE.—The specimens were killed and hardened for four weeks in 4 per cent. Formalin. After taking the two grades of paraffin, they were cut (.03″) and lightly stained in a Delafields' Haematoxylin, after which they were washed and ripened in water for 48 hours. This process gives a thoroughly discriminative and brilliant stain, which is admirably adapted for all classes of such material for general purposes. Three series were made, one being the stage studied, and the other two serving as checks on the first. The reconstructions of the skull were plotted in the following manner: a micrometer eyepiece was calibrated, arbitrarily, to co-ordinate paper; then the lens of the eye of the specimen, which is practically spherical, was measured vertically and the distance marked on the co-ordinate sheet. The number of sections in which the lens appears was next carefully noted, and thus the ratio of longitudinal to vertical measurements on the co-ordinate paper was obtained. This ratio was found to be 15 horizontal to 22 vertical. By calling the ratio 5.7, therefore, and adding one section to every 21 read, accurate results were obtained, and a perfectly proportioned plot drawn. Plates 8, 9, 10 were outlined with a camera and filled in by freehand.

OSTEOLOGY.—The skull of the 12 mm. tadpole of Spelerpes longicaudus differs radically from the adult skull, and shows close resemblance to the adult skulls of some lower forms. Wiedersheim lays down the general characteristic visceral skeleton of Urodeles as follows: "We may consider the ground form, as present in the larva, to consist of five pairs of bars. The anterior pair, or hyoid, consists of two pieces, as do also the first two branchial arches. The third and fourth branchial arches are much smaller and are connected with their fellows of the opposite side by a single or double basal piece. At the close of larval life, when the lungs come into use, the two hinder pair of arches disappear entirely * * * In the genus Spelerpes, which possesses a sling-like tongue, the lateral (dorsal) segment of the first true gill-arch grows out into a long cartilaginous filament which extends far back under the skin of the back." (Comparative Anat. of Vertebr., p. 74.)

In general, the hypobranchial apparatus of the 12 mm. larva corresponds very closely to the above description, but there are some minor points of difference. The hyoid is a single bar, the cerato-hyal, and shows no trace of a hypohyal, and the third and fourth branchial arches are not much smaller than the other two. The singular spatula-shaped urohyal is completely lost at the close of larval life. (See Plate 9.)

In Spelerpes, the protective capsule of the eye is not formed from the quadrate as in Rana, but by a slight process from the trabecular cartilages, and while in Rana (at 12 mm.), the auditory apparatus is merely a process arising from the trabeculae, in Spelerpes there

is a fully formed capsule. It is possible that the diverse habits of the two forms may account for this reversion of development. Spelerpes, which spends its larval existence for the most part hidden under rocks and in the dark, needs an acuteness of hearing and a sensitiveness to vibration for which its cousin compensates by an early developed and well protected eye.

TRABECULAE.—(Plate 10.) The trabeculae cranii appear as two longitudinal bars supporting the anterior end of the brain and the nasal sacs. Just behind the superior labial cartilages, they are flattened out into a pair of disk-like, slightly concave projections serving to support and protect the nasal sacs. There is no juncture of the trabecular bars here as is the case in the frog. Just behind the nasal capsule, the trabeculae resume their rod-like form, presently becoming compressed to form a sort of triangle, concave on the outside. This is the optic capsule before mentioned. Back of this point, the trabeculae are pierced by the optic foramena (Plate 8), and again, still further back, by another and larger foramen, which admits some of the larger vessels to the brain. Just above this latter foramen, the quadrate separates from the trabecula. This is given off from the upper half of the trabecular bar (Plate 8) and curves down to meet and articulate with the lower jaw (Meckel's cartilage), while the lower half curves in to meet its fellow just in front of the notochord (Plate 10, bp.), forming a support for the main part of the brain. The auditory capsule is continuous with the quadrate above and trabeculae below. From the point of their juncture, the trabecular bars continue as a pair of flattened rods—the parachordals (Plate 10), which together with the notochord form the floor of the brain case. Just behind the auditory capsule, the parachordals show a leaf-like process, which serves as a protective case for the medulla and upper cord.

UPPER LABIALS.—Plates 8, 9, 10, la.) These labials are a pair of rounded caps which fit over the ends of the trabeculae. They are pointed above and blunt below. It seems that these labials should be used, governed by suitable muscles, in sucking, in case the larva uses that means of obtaining food, but a diligent search failed to reveal any muscles which might be used in that way. The superior labials are, like the trabecular cartilages, entirely separate from one another. They are so freely and loosely articulated, moreover, as to permit of the possibility of considerable movement.

LOWER LABIALS.—(Plates 8, 9, lb.) The inferior labials, on the other hand, are so fused as to present the aspect of a single, compact cap, which fits over the rounded anterior part of the lower jaw. They are comparable in a general way, to the labials of Rana. The upper and lower labials are apparently among the first cartilages to appear, since at this stage they are very com-

pact and dense cartilaginous tissue, from which all trace of cartilage cells has disappeared.

MECKEL'S CARTILAGE.—(Plates 8, 9, mc.) Meckel's Cartilage forms the basis and largest part of the lower jaw. It articulates in front with the bar of the lower labial, and fuses there, more or less completely, with its fellow of the opposite side. Behind, it articulates strongly with the quadrate (Plate 8, qd.). The cartilages are slender and rounded anteriorly, but become much heavier and more ovoid as they near their articulation with the quadrate. The coronary process is plainly marked, just in front of the posterior articulation, and directly under the optic foramen. The massive temporal and masseter muscles, which have their attachments on this process, together with the heavy pillar of the quadrate, form a bulging prominence which is readily discernible with the unaided eye.

THE QUADRATE.—(Plate 8, qd.). The quadrate is fused completely above with the trabecula, at a point dorsal to the second foramen, as before stated. Above and behind it fuses with the auditory capsule, while below it sends a heavy vertical bar to articulate with Meckel's cartilage. The quadrate is the heaviest solid cartilage in the skull at this period, and helps to form the rim of a deep protective socket within which the eyeball rests. The fusion of the quadrate with the capsule of the ear is only slight at this stage, but the mesoderm between the two parts is seen to be rapidly chondrifying, and indicates an extensive fusion later.

AUDITORY CAPSULE.—The auditory capsule, although not completely chondrified, can be traced very readily. The two capsules form the side wall of the skull, and indications of their juncture over the top of the brain can be detected. They are fused with the quadrates in front and with the trabeculae cranii below, but their posterior extremity is a free rounded surface. At the 12 mm. stage, therefore, the brain lies exposed above, but is protected laterally by the heavy auditory capsules and ventrally by the broad trabecular plate, and by the parachordals. The semicircular canals in the ear are fully formed, and there is full nervous connection with the brain. The circular (fibrous) patch so prominent in the frog at a similar stage can be detected, but with difficulty. It is the foreshadowing of the future stapes.

TEETH.—Teeth appear on the upper and lower labials and on both the trabeculae cranii and Meckel's cartilage. They are well along in development, and can be seen pushing their way through the skin of the mouth. They are beginning to appear on the branchial arches and ceratohyals as well.

BRANCHIAL APPARATUS.—(Plate 9.) The branchial apparatus of Spelerpes shows a marked difference from that of both Crytobranchus and Rana. The most noticeable features of the branchial cartilages of Spelerpes longicaudus are (*a*) the absence

of a basi-branchial plate, (*b*) the large size and peculiar contour of the urohyal, (*c*) the ceratohyals, which hang free from the basihyal, and do not articulate with the quadrate as they do in Rana and Cryptobranchus, and (*d*) the absence of any "free" branchials, that is, any branchials unattached to the basihyal cartilage.

BASIHYAL.—(Plates 8, 9, bh.) The basihyal is a rounded and slender rod of cartilage projecting well forward into the tongue and prolonged posteriorly into the slender urohyal. Just behind the rounded anterior extremity is found the articulation of the ceratohyals. This articulation is not close, but the ceratohyals seem to be rather loosely swung from the front of the basal cartilages. From the posterior portion of the cartilage, the first and second cerato-branchials are given off in close succession, and from this point the cartilage continues as the urohyal. In the specimen prepared, the basihyal and branchial cartilages were probably somewhat distorted, on account of the unnatural position of the tongue, so that in the drawing (Plate 8) they are higher in relation to the rest of the skull than they should be; the measurements, however, and relative sizes are accurate.

UROHYAL.—(Plate 9, uh.) The urohyal bar is much longer in Spelerpes longicaudus than in the same stage of the frog. It is median and basal, and forms simply an elongation of the basihyal. The urohyal terminates, however, in a flattened spatula, which affords a place of insertion for two heavy muscles.

CERATOHYALS.—(Plates 8, 9, ch.) The ceratohyals are a pair of curving bars of cartilage, swinging freely from a loose articulation with the anterior part of the basihyal. Their direction is dorso-caudal, and they terminate freely in the mesoderm a short distance behind the quadrate and external to the auditory capsule.

BRANCHIAL ARCHES.—(Plate 9.) The branchial cartilages at the given stage of this specimen are all in junction; that is, none of them hang free at either extremity. They may be classified into three pairs of ceratobranchials and four pairs of epibranchials.

The first ceratobranchial is the largest of all the branchial bars (Plate 9, bra.). It is given off from the anterior extremity of the basihyal. It curves slightly down and out and shortly gives rise to the first epibranchial and joins with the second ceratobranchial in originating the second epibranchial arch. The second ceratobranchials (Plate 9, brb.) are at their beginning noticeably smaller than the first ceratobranchials, but soon increase in size. This ceratobranchial gives rise to the second epibranchials (in conjunction with the first ceratobranchial bar) and to the third ceratobranchial (Plate 9, brc.). The third ceratobranchial soon divides into the third and fourth epibranchial cartilages (Plate 9, bc., bd.). The four epibranchials run free for some distance and at their posterior extremity are again united to one-another by a curving bar of cartilage.

MUSCULATURE.—A careful comparison of the muscles of this stage of Spelerpes longicaudus with the musculature of Rana and Cryptobranchus seems to show a close resemblance to Cryptobranchus, especially in the muscles of the branchial apparatus. Of course, no homologues of these muscles appear in the adult Rana, but even the larger head muscles correspond much more closely with those of Cryptobranchus. There appears to be no special modification for sucking, or any special muscles for that purpose. All of the muscles described are those of the adult Salamander in various stages of development. In the nomenclature of the muscles of the branchial apparatus, the analogies of Cryptobranchus have been very closely followed out.

MUSCLES OF THE HEAD.

M. TEMPORALIS.—(Plate 11, Fig. 1, mtm.) The temporalis is the most prominent of the muscles of the head. It arises on the quadrate cartilage, just posterior to the second foramen, and is inserted on the inner side of the coronary process. It is a broad, heavy sheet of fibres, broader at the insertion than at the origin. Its direction is ventral and slightly caudal. In reality, M. temporalis is made up of two parts, the one just described above, and a second, which I shall describe as—

M. PTERYGOIDEUS.—This is a thin strand of fibres arising on the quadrate bar, just below the origin of M. temporalis, and sending its fibres ventrally to unite with those of the temporalis. It corresponds very closely to the similar muscle in Cryptobranchus, which is described as follows: "This is a very insignificant muscle * * * and might almost be considered a fasciculus of M. temporalis. (Thesis, J. H. McGregor.) The muscle is entirely covered dorsally by M. temporalis, and acts with the temporalis in lifting the mandible, in opposition to the action of M. depressor maxillae inferioris.

M. MASSETER.—(Plate 11, Fig. 1, mm.) The masseter is a heavy, bulging muscle, partly covering M. temporalis. It arises on the anterior third of the auditory capsule, and, running downward and forward, is inserted on the outside of the mandibular bar (Meckel's cartilage), a short distance in front of the coronary process. The insertion of this muscle is comparatively very broad, though it is thick-bellied and rounded in the center.

M. DEPRESSOR MAXILLAE INFERIORIS.—(Plates 11, Fig. 1, mdm.). This is a large and powerful muscle, which, using the base of the lower mandible as a lever, depresses the jaws. It has two origins; the first in the middle of the optic capsule, just posterior to the origin of M. masseter, and a second, which is lower and posterior to the first. The fibres from the two origins, however, soon intermingle, and evidence of the double origination is lost. The muscle extends down and forward, parallel to

M. masseter, and is inserted on the rounded base of the lower mandible (Meckel's cartilage). Turning now to the ventral surface, we find the—

M. SUBMAXILLARIS.—(Plate 11, Fig. 2, msb.) This muscle is a broad, thin sheet of fibres covering in the space between the mandibles almost completely. It extends between the two rami throughout their extent, save for a small space at their anterior extremity. The muscle is a very delicate one, and the fibres are loosely conjoined, seeming to indicate a tardy development as compared with the other muscles. The function of the submaxillaris is still a matter of doubt, but that it is closely connected with the respiratory function seems fairly certain.

M. SUBMENTALIS.—(Plate 11, Fig. 2, msm.). This small and insignificant muscle appears as a tendinous band at the extreme anterior portion of lower jaw. Its function is to approximate the rami of the jaw, but it appears to be of small practical consequence.

MUSCLES OF THE BRANCHIAL APPARATUS.

The branchial muscles of the 12 mm. Spelerpes longicaudus show a very marked similarity to those of the adult Cryptobranchus, although they are not quite so numerous, or so complex. The group consists of a paired sternohyoid, a hypobranchial, a constrictor, levator and depressor of the arches, a geniohyoid, a well-defined cerato-branchialis and a small omohyoideus.

M. STERNO-HYOIDEUS.—(Plate 11, Figs. 2, 3, msh.) This muscle is a direct continuation of the fibres of M. rectus abdominis. The recti abdomini, as they pass forward from the posterior part of the body, alter both in contour and in position. In the body proper, they are seen as two thin vertical sheets of muscle, bounding the body cavity. As they pass into the head region, however, they gradually assume a median position and become thickened to form a pair of round, heavy muscles, which fuse in the region of M. temporalis, and have their common insertion on the basihyal at the point of union of the first ceratobranchial. The muscle is superimposed on the urohyal cartilage.

M. GENIOHYOIDEUS.—(Plate 11, Figs. 2, 3, mgh.) This muscle arises on the lower mandible, just posterior to the insertion of M. submentalis. From this point it extends directly backward, as a small rope-like muscle, to its insertion on the spatular end plate of the urohyal cartilage. Its function is to draw the branchial apparatus forward.

M. HYPOBRANCHIALIS.—(Plate 11, Fig. 3, mhb.) This muscle arises on the ventral surface of the ceratohyal cartilage, inside of the origin of the following muscle. Its fibres run posteriorly and obliquely inward, and are inserted along the course of the posterior two-thirds of the first epibranchial, except at the posterior end of the branchial.

M. CERATOBRANCHIALIS.—(Plate 11, Fig. 3, mcb.) This muscle is a thin sheet of fibres arising on the ventral surface of

the ceratohyal cartilage, just outside of the origin of M. hypobranchialis, and sending its fibres inward to the extremity of the operculum. The function of the muscle is to raise the opercular fold and to create thus a suction through the gill slits. There is, of course, no homologue of this muscle either in Rana or in Cryptobranchus.

M. LEVATOR ARCUUM BRANCHIALIUM.—(Plate 11, Fig. 1, mla.) This slender and insignificant muscle arises as a fasciculus of M. longissimus dorsi. It is given off from that muscle at the extreme posterior end of the otic capsule and extends posteriorly and obliquely downward to an insertion on the first epibranchial bar. It serves to raise the branchial apparatus.

M. CONSTRICTOR ARCUUM BRANCHIALIUM.—Plate 11, Fig. 3, mca., mce., mci.) This muscle is divided into three equal parts, which, from a common origin, separate and run to three distinct and different insertions. The muscle itself is a continuation or prolongation of the fibres of M. hypobranchialis, and takes its course along the inner or body side of the arches. Its first fasciculus is inserted on the course of the second epibranchial cartilage, its second fasciculus on the the third epibranchia and its third part along the course of the last arch. Its evident function is the closing of the branchial clefts, acting with M. ceratobranchialis to create a suction of water through the clefts.

M. DEPRESSOR ARCUUM BRANCHIALIUM.—(Plate 11, Fig. 2, mdb.; Fig. 3, mab.) This muscle is a sheet of fibres arising on the inner side of the last branchia and sending its fibres inward to mingle in the middle line. The main part of the muscle is just anterior to the tracheal opening, and some of its fibres even mingle with those of the following muscle. The name of the muscle indicates its function.

M. OMOHYOIDEUS.—This is a rather small and insignificant muscle at this stage. It arises in the region of the future scapula and sends its fibres downward to mingle around the trachea. This muscle does not function before the metamorphosis, and as no sign of a scapula appears, it cannot now be traced to a definite origin.

BODY MUSCLES.

The two body muscles which appear at the present stage are the M. longissimus dorsi, and M. rectus abdominis.

M. LONGISSIMUS DORSI.—(Plate 11, Fig. 1, mld., mli.) This large and important muscle has a double origin. The first is on the auditory capsule, on the dorsal side next to the surface, and in the region of the articulation of the jaw and of the eighth nerve. The second origin is considerably posterior to the first and is at the base of the brain, on the parachordal cartilages. From their origins, both fasciculi run directly tailwards, uniting in the region of the tenth nerve, to form a dumb-bell-shaped muscle which partially surrounds the medulla. After this point, the muscle rapidly increases in size, as it runs on back toward the tail.

M. RECTUS ABDOMINIS.—(Plate 11, Fig. 1, mra.) The sternohyoideus muscle, already described, is a continuation of M. rectus abdominis. As the muscle runs back, it becomes more and more flattened, until it presents the typical aspect of a thin sheet of tissue lining the ventral body wall. In this specimen it presents no unusual characteristics.

MUSCLES OF THE EYE.

No well defined musculature for the eye was found, but two recti muscles, or traces of them, could be distinguished. They are very small, and while their insertion on the eyeball can be seen plainly, their origin is lost in the surrounding mesoderm.

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EXPLANATION OF PLATES.

KEY TO PLATE 8.

A reconstruction of the skeletal elements of the head.

SIDE VIEW.

la.	Upper labials.	pc.	Parachordal cartilages.
tr.	Trabecula.	pf.	Posterior foramen.
lb.	Lower labials.	pn.	Coronoid process.
qd.	Quadrate cartilage.	au.	Auditory capsule.
mc.	Meckel's cartilage.	ba.	First branchial arch.
bh.	Basihyal cartilage.	bb.	Second branchial arch.
ch.	Ceratohyal cartilage.	bc.	Third branchial arch.
nb.	Nasal capsule.	bd.	Fourth branchial arch.
op.	Optic foramen.		

KEY TO PLATE 9.

A reconstruction of the skeletal elements of the head.

VIEW OF THE BRANCHIAL APPARATUS.

bh.	Basihyal cartilage.	ba.	First epibranchial cartilage.
uh.	Urohyal cartilage.	bb.	Second epibranchial cartilage.
bra.	First ceratobranchial cartilage.	bc.	Third epibranchial cartilage.
brb.	Second " "	bd.	Fourth epibranchial cartilage.
brc.	Third " "	ch.	Ceratohyal cartilage.

KEY TO PLATE 10.

A reconstruction of the skeletal elements of the head.

VIEWED FROM ABOVE.

tr.	Trabeculae.	pc.	Parachordal cartilages.
bp.	Basal plate of the trabeculae.	au.	Auditory capsule.
la.	Upper labials.	ch.	Notochord.
nb.	Nasal process.		

KEY TO PLATE 11.

Reconstruction of muscles.

Figure 1.—Lateral view

Mtm.	M. temporalis.	Mra.	M. rectus abdominis.
Mla.	M. levator arcuum branchialium.	Mcb.	M. cerato-branchialis.
		Mdm.	M. depressor maxillae inferioris.
Mld.	M. longissimus dorsi.		
Mli.	M. longissimus dorsi, inferior fasciculus.	Mm.	M. masseter.

Figure 2.—Ventral view.

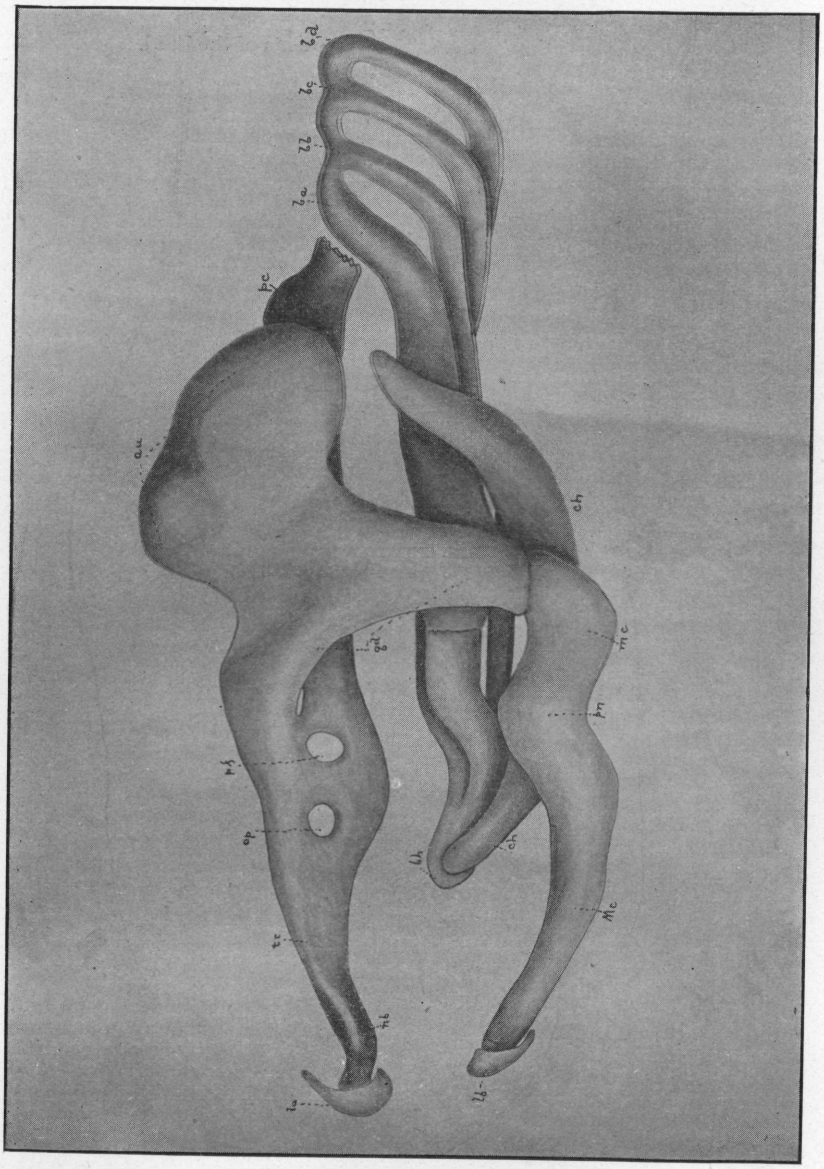
Msm.	M. submentalis.	Mdb.	M. depressor arcuum branchialium.
Msb.	M. submaxillaris.		
Mcb.	M. cerato-brenchialis.	Mgh.	M. genio-hyoideus.
Msh.	M. sternohyoideus.		

Figure 3.

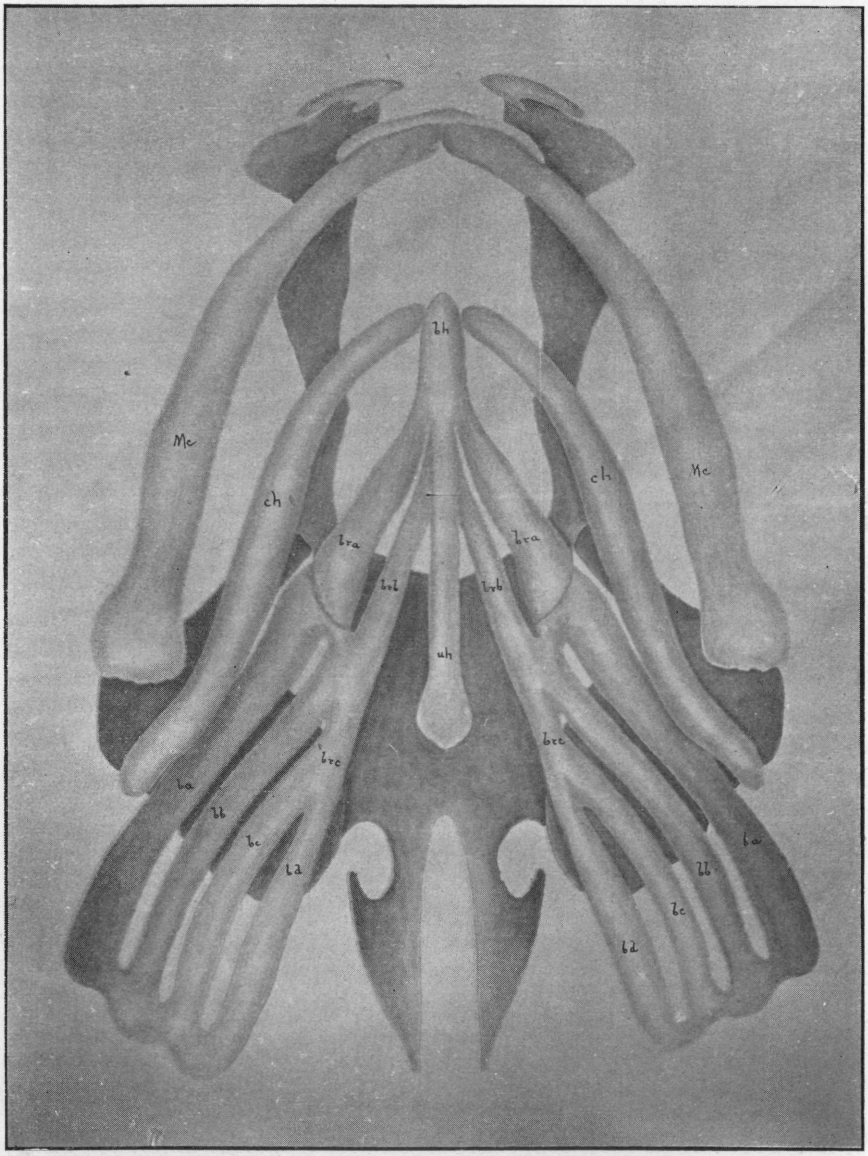
Reconstruction of branchial musculature.

Msm.	M. submentalis.	Msh.	M. sternohyoideus.
Mgh.	M. geniohyoideus.	Mca.	M. constrictor arcuum branchialium, first fasciculus.
Msb.	M. submaxillaris.		
Mcb.	M. cerato-branchialis.	Mce.	M. constrictor arcuum branchialium, 2nd fasciculus.
Mhb.	M. hypobranchialis.		
Mab.	M. depressor arcuum branchialium.	Mci.	M. constrictor arcuum branchialium, third fasciculus.

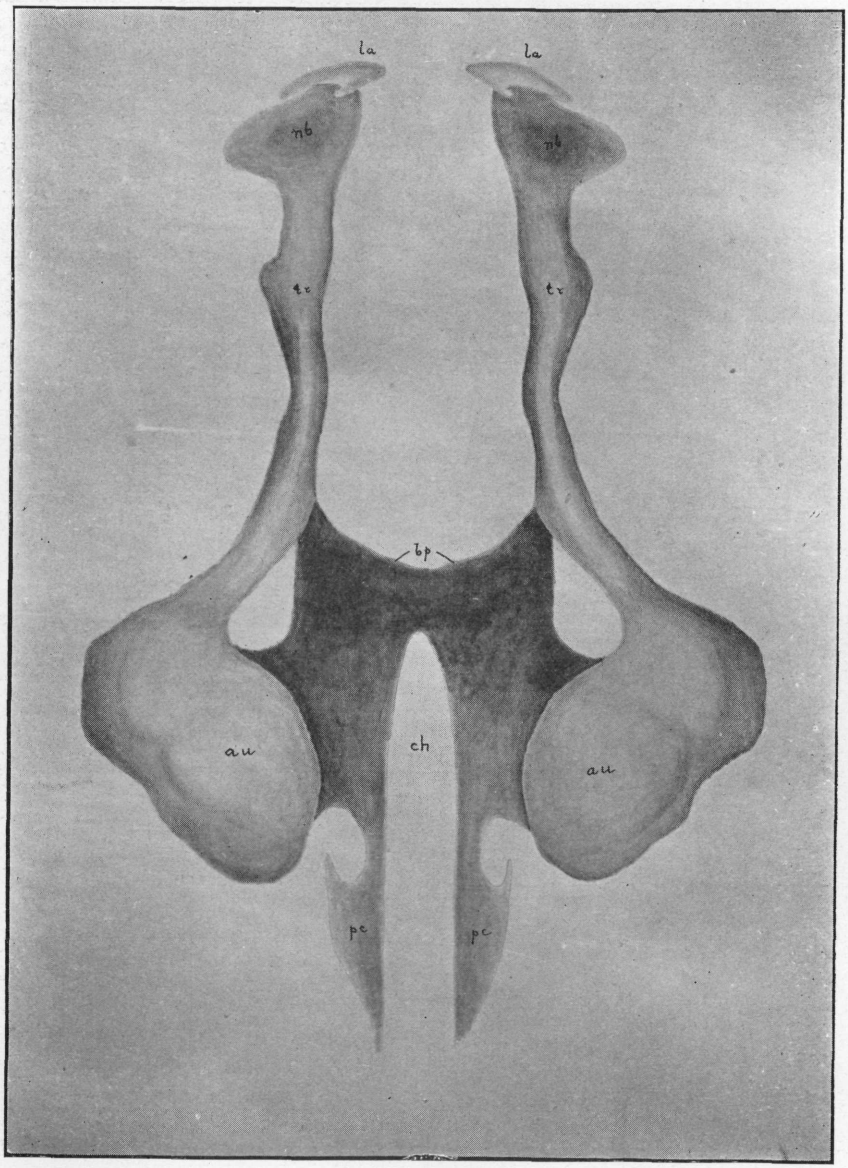
In the reconstruction, the ceratobranchial muscles are removed, the sternohyoideus muscles are cut out so as to show the M. depressor arc-branchialium, and one of the geniohyoideus muscles has been cut to show the origin of M. sternohyoideus. The submaxillaris has been represented as slit, and the flaps turned back.



HOUGHTON on "Spelerpes longicaudus."

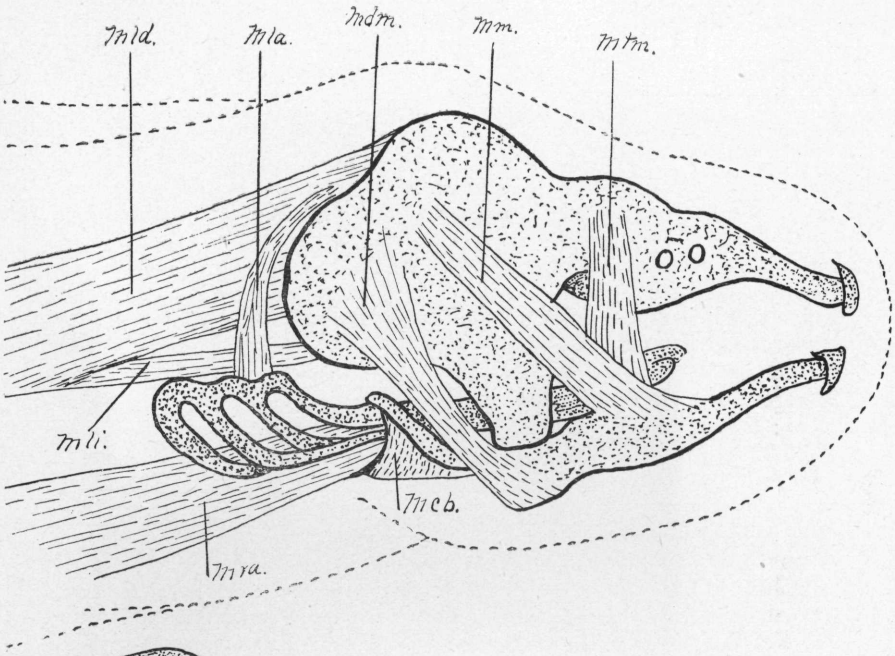


HOUGHTON on "Spelerpes longicaudus."



HOUGHTON on "Spelerpes longicaudus."

Fig. 1.



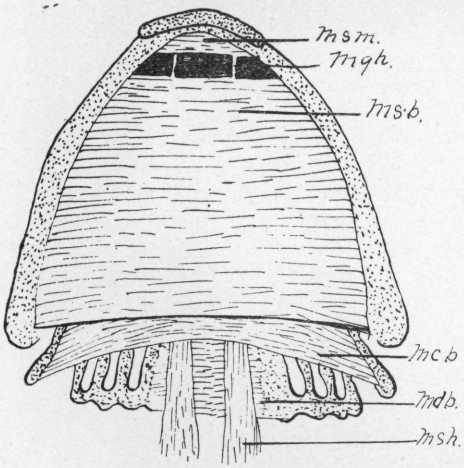


Fig. 2.

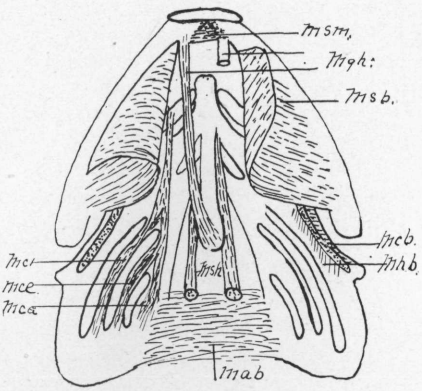


Fig. 3.