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(WITH FOUR PLATES)

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Probably every teacher who has a class in the anatomy of the frog has been asked by numberless students the name of the obvious protuberence on the ventral surface of the brain, just anterior to the optic chiasma. For some unknown reason almost all laboratory manuals fail to mention this perfectly obvious structure. The writer's interest being aroused, he decided to make a comparative study of this structure, the lamina terminalis, and its adjacent cavity, the preoptic recess, in a considerable number of Amphibia. This seems a rather presumptuous project in view of the numerous papers on the amphibian brain by Dodds, Fish, Hyman, Kingsbury, and many others; and especially by Herrick.

The meanings of the lamina terminalis and of the peroptic recess are variously stated by different workers. Dodds (1907) says: "The lamina terminalis in Amphibia is generally considered as extending from the optic chiasma forward and upward to the choroid plexus." He also says: "Just in front of the chiasma, it (the brain cavity) expands into a narrow pocket, known as the preoptic recess, representing the primitive lumen of the optic vesicle."

Minot (1903) says: "The upper part of the lamina terminalis becomes much thickened to form a broad band of triangular section uniting the two hemispheres. This band is the anlage of the septum lucidum, the corpus callosum, the fornix and the anterior commissure."

Hyman (1942) says: "Ventrally the anterior boundary of the third ventricle is a thin membrane, the lamina terminalis, believed by many to represent the original anterior end of the embryonic brain;" again: "From the anterior commissure a delicate membrane, the lamina terminalis, extends ventrally to the optic chiasma." Herrick (1910) says: "Accordingly, the lamina terminalis, preoptic recess and adjacent parts, instead of being assigned to the diencephalon, are regarded as belonging to the telencephalon." According to Johnston (1909): "In all classes the lateral halves of the telencephalon are connected at the rostral end by the lamina terminalis, a membrane formed by the closing of the anterior neuropore of the embryo."

Ranson (1939) says: "The lamina terminalis, connecting the two hemispheres in front of the third ventricle, represents the original anterior-boundary of the telencephalon."

Stieda (1875), in a ventral view of the brain of axolotl, published as far back as 1875, shows a very obvious lamina terminalis, but does not name it.

As shown in plate 1, figure 1, a sagittal section of the brain of a 4-day chick, copied from Patten (1925), it is largely a matter of choice as to whether the lamina terminalis, *l,* be considered the anterior wall of the diencephalon, *d,* or of the telencephalon, *tc.* When the diencephalon evaginates to form the telencephalon, the median anterior wall of the former becomes, for a time at least, the median anterior wall of the latter. Patten indicates the theoretical boundaries of the cerebral vesicles by dotted lines, in the figure under discussion, which would make the lamina terminalis, *l,* the anteroventral wall of the telocoele, *te.*

In the present study, all the ventral views and their corresponding sagittal sections were drawn with a camera lucida and under the same magnification to show relative sizes. In a few cases, where the exact sagittal plane was not cut, dotted boundaries on the camera drawings have been used, especially to show the deepest part of the preoptic recess.

From one to six or more brains, depending upon the available material, were used of each species. Seven species of Caudata, two of *Rana,* three of *Bufo,* two of *Scaphiopus,* three of *Hyla,* one of *Acris,* and one of *Pseudacris* were drawn. Most of the animals were of about average size for the species. Since the cranial nerves, with the exception of the second, are not being considered, they were not dissected out, thus saving a large amount of time. In a few cases the pituitary was detached from the brain and is not shown in the figures.

While there is considerable variation in the appearance of the ventral aspect of the various brains, including the size, shape, and distinctness of the lamina terminalis, there is great uniformity in the appearance of the preoptic recess and adjacent structures.

The first brain to be described here is that of the common toad, *Bufo a. americanus,* plate 1, figure 2. The most striking characteristic of this brain is its size, which is equaled only by the brain of the giant salamander, plate 4, figure 20. The lamina terminalis, *l,* is large, with an indistinct **V**-shaped ventral groove. The infundibulum, *i,* and pituitary, *p,* are both large; the optic chiasma, *c,* and optic tract, *t,* are distinct. In the sagittal section, drawn from a smaller brain, the lamina terminalis, *l,* is thin ventrally, merging into the chiasma, *c,* caudad, and thickening cephalad as it merges into the other structures of that region. The preoptic recess, *r,* is a very distinct, deep cavity, immediately cephalad to the chiasma, *c.* The pituitary, *p,* was torn from the tip of the infundibulum, *i,* in dissecting the specimen here drawn.

The brain of the marine toad, *Bufo marinus,* plate 1, figure 3, was from a rather small specimen of this very large species. The optic nerves and tract, *t,* are thicker than in *B. a. americanus.* The infundibulum, *i,* is of a different shape and the pituitary, *p,* is smaller. The lamina terminalis, *l,* is smaller, but has a similar V-shaped ventral groove. The optic nerves and tract, *t,* are thicker than in *B. a. americanus.*

The sagittal section of this species, from which the camera drawing was made, did not pass through the deeper part of the preoptic recess, *r,* which was added, as a dotted line, from another section. The lamina terminalis thickens and turns dorsad to form what some authors call the anterior commissure. The optic chiasma, *c,* is very prominent and is distinct from the infundibulun, *i.* The pituitary was missing in this section.

The brain of the last representative of the genus *Bufo* to be described, plate 2, figure 9, is Fowler's toad *B. woodhousii fowleri,* which resembles *B. a. americanus* so closely in appearance that it is sometimes difficult to distinguish them.

The ventral view of the brain is very similar to that of *B. a. americanus,* though the lamina terminalis, *l,* is relatively smaller.

The sagittal view is very similar to that of *B. a. americanus,* the preoptic recess and lamina terminalis being almost identical.

Less than half the size of *B. a. americanus,* is the common spadefoot toad, *Scaphiopus h. holbrookii.* The ventral view of this brain, plate 1, figure 4, shows the optic tracts, *t,* as quite distinct from the infundibulun, *i,* by which they are sometimes hidden. The lamina terminalis *l,* is distinctly triangular in shape and shows no ventral groove, which is nearly always distinct and is shown by most authors, even when the lamina terminalis is not named.

The sagittal section, it will be seen, by comparing it with plate 1, figure 2, and plate 2, figure 9, shows the preoptic recess, *p,* and the lamina terminalis, *l,* to be almost identical with those structures in *B. a. americanus* and *B. woodhousii fowleri.*

The brain of the southwestern spadefoot toad, *S. couchii* is shown in plate 1, figure 5. This brain is relatively very broad, so that the pituitary, *p,* infundibulum, *i,* and lamina terminalis, *l,* are much wider, from side to side, than their anteroposterior diameters. As in *S. h. holbrookii,* there is no visible ventral groove in the lamina terminalis.

The sagittal section, of which only one series was available, was badly torn anteriorly and the section drawn did not pass through the deeper part of the preoptic recess, *r,* which is dotted in from another section on the same slide. The lamina terminalis, *l,* at least in this section, is relatively smaller than in the other Bufonidae.

Of the Caudata seven species were examined, varying in size from the small forms, like the spotted newt, *Triturus,* to the large forms, such as *Cryptobranchus,* the giant salamander. The variation in sizes of the brains is very much less than the differences in the sizes of the entire animals. While the brain of *Cryptobranchus* is about twice the length of that of *Triturus,* the entire body of *Cryptobranchus* is about four times as long as that of *Triturus.*

Plate 2, figure 6, represents the brain of a small salamander, *Gyrinophilus p. porphyriticus,* the purple salamander, about 160 mm. in length. The brain is distinctly long and narrow. The lamina terminalis, *l,* is elongated with a distinct ventral groove. The optic tracts, *t,* are distinct, and the infundibulum, *i,* is strangely narrowed anteriorly.

A satisfactory sagittal section was not obtained. In the figure given the preoptic recess, *r,* does not open to the brain cavity and the lamina terminalis, *l,* is seen only on the floor of the recess. The infundibulum, *i,* and pituitary, *p,* are both rather shapeless structures.

The brain of *Plethodon g. glutinosus,* the slimy salamander, is shown in plate 2, figure 7. This animal is about 140 mm. in length. The brain is distinctly broad and rectangular in form. The lamina terminalis, *l,* is somewhat pointed and has a distinct, narrow ventral groove. The optic tract could not be seen. The infundibulum, *i,* and pituitary, *p,* are large and broad.

The section drawn did not pass through the deepest part of the preoptic recess, *r,* which is dotted in from an adjacent section. The optic chiasma, *c,* and infundibulum, *i,* are hardly distinguishable from each other. The lamina terminalis, *l,* projects dorsad, as in the majority of figures.

Plate 2, figure 8, shows the broad, rather rectangular brain of the mud eel, *Siren lacertina.* This species is said to reach a length of 700 mm., but the specimen from which the brain here figured was taken was only 150 mm. in length.

The lamina terminalis, *l,* is very large and is nearly circular in outline with an indistinct ventral groove. The optic tracts are not visible and the infundibulum, *i,* and pituitary, *p,* are curiously wide and short.

The sagittal section is quite typical as far as the lamina terminalis, *l,* and preoptic recess, *r,* are concerned, The infundibulum, *i,* and pituitary, *p,* are relatively thick and short. The optic chiasma, *c,* is, as in the preceding brain, hardly distinguishable from the infundibulum.

The brain of an average-size mud-puppy, *Necturus m. maculosus,* is shown in plate 4, figure 17. The brain is broad and massive, with a wide, almost circular, infundibulum, *i,* and an oval pituitary, *p.* The optic nerves are relatively narrow and the optic tracts are hidden by the infundibulum. The lamina terminalis, *l,* is narrow and relatively very small with a distinct median groove.

In the sagittal section the preoptic recess, *r,* and chiasma, *c,* are very similar to those structures in the following brain, *Triturus,* and the lamina terminalis, *l,* extends into a very tall, narrow anterior commissure. The infundibulum, *i,* as in *Triturus,* is not sharply distinguishable from the chiasma and has a thin wall. The pituitary was missing in the section drawn and was not added from other sections.

Plate 4, figure 18, shows the brain of the crimson-spotted newt, *Triturus v. viridescens,* the small salamander mentioned above. The brain is rather broad and shapely. The lamina terminalis, *l,* is elongated, with a distinct ventral groove. The optic tracts, *t,* are curiously distinct. The infundibulum, *i,* and pituitary body, *p,* are of the usual shape.

The sagittal section, from which the pituitary is missing, is quite typical except that it is hard to distinguish the chiasma, *c,* from the rather imperfect infundibulum, *i.* The deep preoptic recess, *r,* and the lamina terminalis, *l,* merging into the prominent anterior commissure, are well marked.

The brain of the small, red salamander, *Pseudotriton ruber ruber,* about 100 mm. in length, is shown in plate 4, figure 19. In contrast to the two preceding brains this one is distinctly long and narrow. The optic tracts are obscured by the very large and curiously shaped infundibulum, *i;* the lamina terminalis, *l,* is elongated and has a distinct groove: the pituitary is not shown in either view of this brain.

The most favorable sagittal section for other structures did not pass through the deepest part of the preoptic recess, which is shown in dotted outline, *r.* The lamina terminalis, *l,* is similar to that seen in plate 4, figure 18.

The optic chiasma, *c,* projects ventrad more distinctly than in the other brains shown. The floor of the infundibulum, *i,* is thicker than in the preceding brains.

The brain of the last and largest of the tailed Amphibia to be described is that of the giant salamander or hellbender, *Cryptobranchus* *alleganiensis,* plate 4, figure 20. It is, naturally, much larger than the preceding brains and is broad and massive. The cerebral region is relatively short and the olfactory tracts are very wide. The infundibulum, *i,* and pituitary, *p,* are wide, heart-shaped structures of about the same size. The optic tract is not visible and the optic nerves are narrow, as might be expected in an animal with such minute eyes. The lamina terminalis, *l,* is fairly large, with a distinct groove.

The sagittal section is very similar to the preceding except that the preoptic recess, *r,* is relatively small and the lamina terminalis, *l,* and floor of infundibulum, *i,* are thicker. The chiasma, *c,* is scarcely distinguishable from the infundibulum. The pituitary, *p,* is massive, but this section did not pass through its longest diameter.

Five brains of the tree frogs, Hylidae, were studied.

The swamp cricket form, *Pseudacris nigrita triseriata,* is a tiny form, about one-third the length of Fowler's toad, yet its brain is considerably more than half the length of the latter, as seen by comparison of plate 2, figures 9 and 10. The brain is distinctly conical in form, with a very large infundibulum, *i,* and a curiously shaped pituitary, *p.* The optic nerves are relatively thick and the optic tracts, in the only specimen available, were not visible. The lamina terminalis, *l,* is relatively enormously large with a median groove that seems to split it into equal halves.

The sagittal section is rather typical, but with the lamina terminalis, *l,* not extending into a tall anterior commissure, as in the preceding sections. The preoptic recess, *r,* is deep and the chiasma, *c,* projects distinctly in front of the infundibulum, *i.*

The cricket frog, whose brain is shown in plate 2, figure 11, is about the same size as the preceding; the form used was *Acris crepitans,* which may be a distinct species or may be a variety of *A. gryllus.*

The brain is of about the same size as the preceding but is a somewhat different shape. The lamina terminalis, *l,* is very much smaller, the optic nerves are narrower and the optic tracts are distinct. The infundibulum, *i,* is much smaller. The pituitary, *p,* was dislodged from the specimen drawn and is indicated by a dotted line.

The sagittal section is very similar to the preceding and the optic chiasma, *c,* is distinctly separated from the infundibulum, *i.* The preoptic recess, *r,* is large and the lamina terminalis, *l,* here seen, is fused with a solid mass anteriorly and does not show a projecting anterior commissure.

The brain of one of the southern tree frogs, *Hyla c. cinerea,* is shown in plate 3, figure 14. The frog is about 45 mm. long, considerably longer than the two preceding tree frogs, and the brain is proportionately longer and is more massive. It is deeply notched anteriorly and shows the optic tracts fairly plainly. The infundibulum, *i,* has the usual shape, while the pituitary, *p,* is very large and is wider than the infundibulum. The lamina terminalis, *l,* is externally very small and shows the usual ventral groove.

The sagittal section is typical, with a very roomy preoptic recess, *r.* The optic chiasma, *c,* is separated from the infundibulum, *i,* by a deep groove; and the infundibulum has a thick ventral wall.

The common tree frog, *Hyla v. versicolor,* is 50 mm. in length, about twice the length of *Acris* and *Pseudacris;* but it will be noted, by comparing plate 2, figures 10 and 11, and plate 3, figure 15, that the brain, figure 15, while more massive, is no longer than in the two smaller species. The optic nerves extend laterally at right angles to the long axis of the brain and are so closely applied to the very large infundibulum that neither the optic tracts nor chiasma are distinguishable. The pituitary, *p,* is wide laterally but is very short in the antero-posterior direction. The lamina terminalis, *l,* is a moderate-size oval, with a distinct median groove.

The sagittal section that was drawn did not pass through the deepest part of the preoptic recess, *r,* but the dotted line shows the depth of the recess as shown in an adjacent section. As in the preceding species the chiasma, *c,* is separated from the infundibulum, *i,* by a deep fissure.

The spring peeper, *Hyla c. crucifer,* plate 3, figure 16, is the last of the tree frogs to be described. It is slightly smaller then the preceding and the brain is of about the same length but not so broad. The optic nerves extend straight out to the sides, as in *H. v. versicolor,* and, as in that form, the tracts and chiasma are not visible. The infundibulum, *i,* is proportionately wider than in *H. v. versicolor,* and the pituitary, *p,* is not so wide, but is somewhat longer. The lamina terminalis, *l,* is approximately like that of the preceding species. The sagittal section is very similar to *H. v. versicolor* except that the chiasma, *c,* projects ventrad in a strange way.

The last two brains to be described are those of the common genus *Rana, R. p. pipiens,* the common leopard frog, and *R. pipiens sphenocephala,* the southern leopard frog.

Plate 3, figure 12, *R. p. pipiens,* is about 90 mm. in length and the brain is fairly massive in outline. The optic nerves are thick and may be traced through the chiasma, *c,* to the very obvious tracts. The infundibulum, *i,* and pituitary, *p,* are of moderate size and of the usual shape. The lamina terminalis, *l,* is large and broad, with an obvious ventral groove.

The sagittal section is quite typical, with a large preoptic recess, *r,* and a thin lamina terminalis, *l*. The optic chiasma, *c*, is moderately distinct from the infundibulum.

Rana pipiens sphenocephala is somewhat smaller than *R. p. pipiens*. The brain, as seen in plate 3, figure 13, is considerably narrower and more pointed than the preceding. The infundibulum, *i*, pituitary, *p*, and the optic nerves are not very different from those structures in *R. p. pipiens*. The optic tract and chiasma, *c*, are distinct. The lamina terminalis, *l*, is about the same shape as in the preceding brain, but is much smaller.

The sagittal section is quite typical, with a very roomy preoptic recess, *r*, and a large optic chiasma, *c*, fairly distinct from the infundibulum, *i*. The pituitary, *p*, was accidentally detached and was so drawn.

LITERATURE CITED

Dodds, G. S.
1907. The brain of one of the salamanders (*Plethodon glutinosus*). Univ. Col. Stud., vol. 4, pp. 97-108.

Fish, Pierre A.
1895. The central nervous system of *Desmognathus fusca*. Journ. Morph., vol. 10, pp. 231-282.

Herrick, C. Judson.
1910. The morphology of the forebrain in Amphibia and Reptilia. Journ. Comp. Neur., vol. 20, pp. 413-457.
1924. The amphibian forebrain. I. *Amblystoma*, external form. Journ. Comp. Neur., vol. 37, pp. 457-530.

Hyman, Libby H.
1942. Comparative vertebrate anatomy. Chicago.

Johnston, J. B.
1909. The morphology of the forebrain vesicle in vertebrates. Journ. Comp. Neur., vol. 19, pp. 457-539.

Kingsbury, B. F.
1895. On the brain of *Necturus maculatus*. Journ. Comp. Neur., vol. 5, pp. 139-202.

Minot, C. S.
1903. Human embryology. Philadelphia.

Osborn, H. F.
1888. A contribution to the internal structure of the amphibian brain. Journ. Morph., vol. 2, pp. 51-96.

Patten, B. M.
1925. The embryology of the chick. Philadelphia.

Ranson, S. W.
1939. The anatomy of the nervous system. 6th ed. Philadelphia.

Rubaschkin, W.
1903. Zur Morphologie des Vordershirns der Amphibien. Arch. f. Mik. Anat., vol. 62, pp. 207-243.

Steida, L.
1875. Ueber den Bau des Centralennervensystems des Axolotl. Zeitschr. Wiss. Zool., vol. 25, pp. 285-310.

EXPLANATION OF PLATES

All figures, except the first, were drawn with a camera lucida and with the same magnification.

Abbreviations

c, optic chiasma; *cb*, cerebellum; *d*, diocoele; *e*, epiphysis; *i*, infundibulum; *l*, lamina terminalis; *m*, mesocoele; *my*, myelocoele; *p*, pituitary; *r*, recessus opticus; *t*, telocoele.

Plate 1

Fig. 1. A sagittal section of a typical embryonic brain.

2. A ventral view and sagittal section of the brain of *Bufo a. americanus*. West Virginia.

3. A ventral view and sagittal section of the brain of *B. marinus*. British Guiana.

4. A ventral view and sagittal section of the brain of *Scaphiopus h. holbrookii*. West Virginia.

5. A ventral view and sagittal section of the brain of *S. couchii*. Texas.

Plate 2

Fig. 6. A ventral view and sagittal section of the brain of *Gyrinophilus p. porphyriticus*. West Virginia.

7. A ventral view and sagittal section of the brain of *Plethodon g. glutinosus*. West Virginia.

8. A ventral view and sagittal section of the brain of *Siren lacertina*. Georgia.

9. A ventral view and sagittal section of the brain of *Bufo woodhousii fowleri*. West Virginia.

10. A ventral view and sagittal section of the brain of *Pseudacris nigrita triseriata*. Arkansas.

11. A ventral view and sagittal section of the brain of *Acris crepitans*. Arkansas.

Plate 3

Fig. 12. A ventral view and sagittal section of the brain of *Rana p. pipiens*. West Virginia.

13. A ventral view and sagittal section of the brain of *R. pipiens sphenocephala*. Louisiana.

14. A ventral view and sagittal section of the brain of *Hyla c. cinerea*. Louisiana.

15. A ventral view and sagittal section of the brain of *H. v. versicolor*. West Virginia.

16. A ventral view and sagittal section of the brain of *H. c. crucifer*. West Virginia.

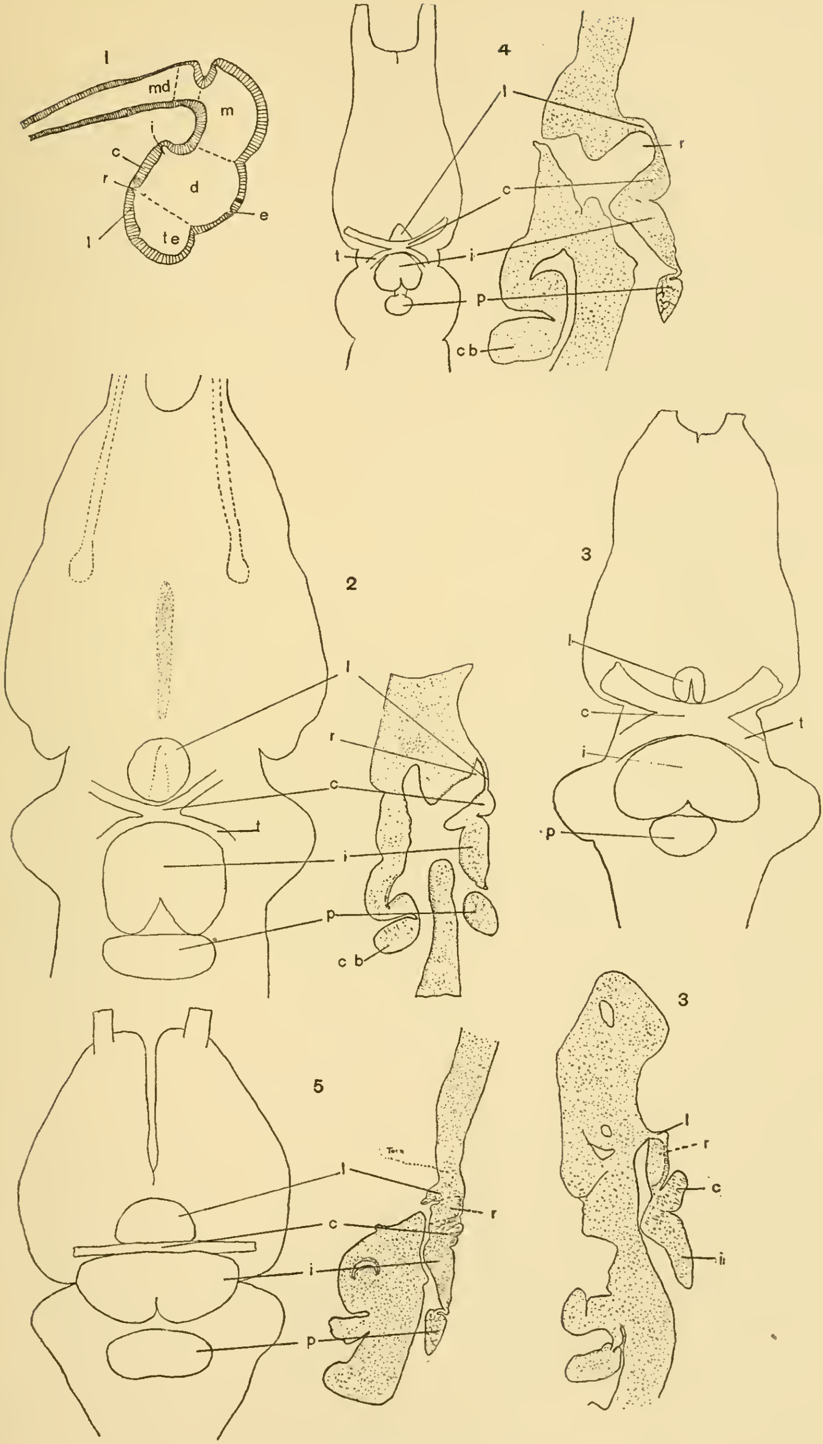
Plate 4

Fig. 17. A ventral view and sagittal section of the brain of *Necturus m. maculosus*. West Virginia.

18. A ventral view and sagittal section of the brain of *Triturus v. viridescens*. West Virginia.

19. A ventral view and sagittal section of the brain of *Pseudotriton r. ruber*. West Virginia.

20. A ventral view and sagittal section of the brain of *Cryptobranchus alleganiensis*. West Virginia.



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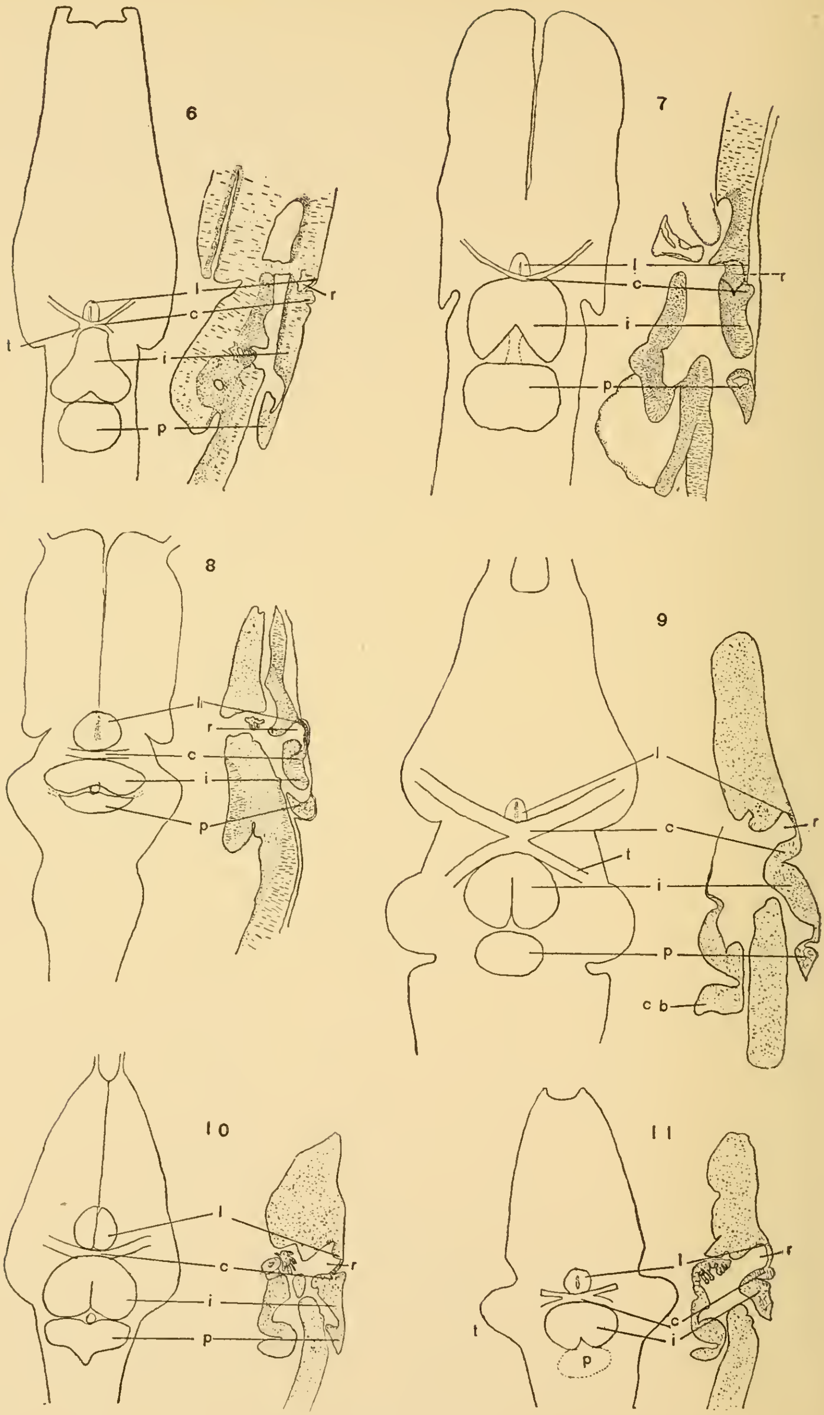

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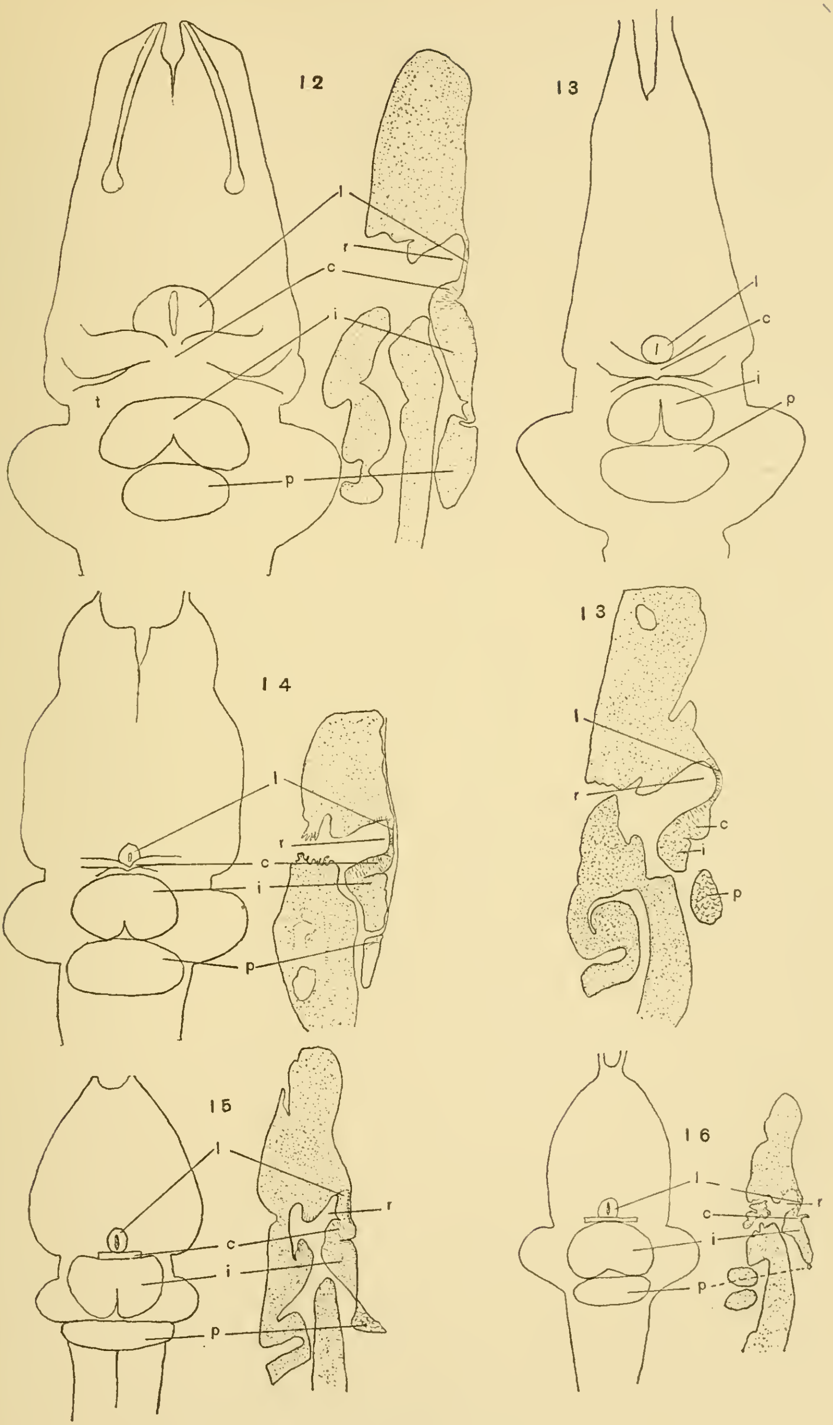

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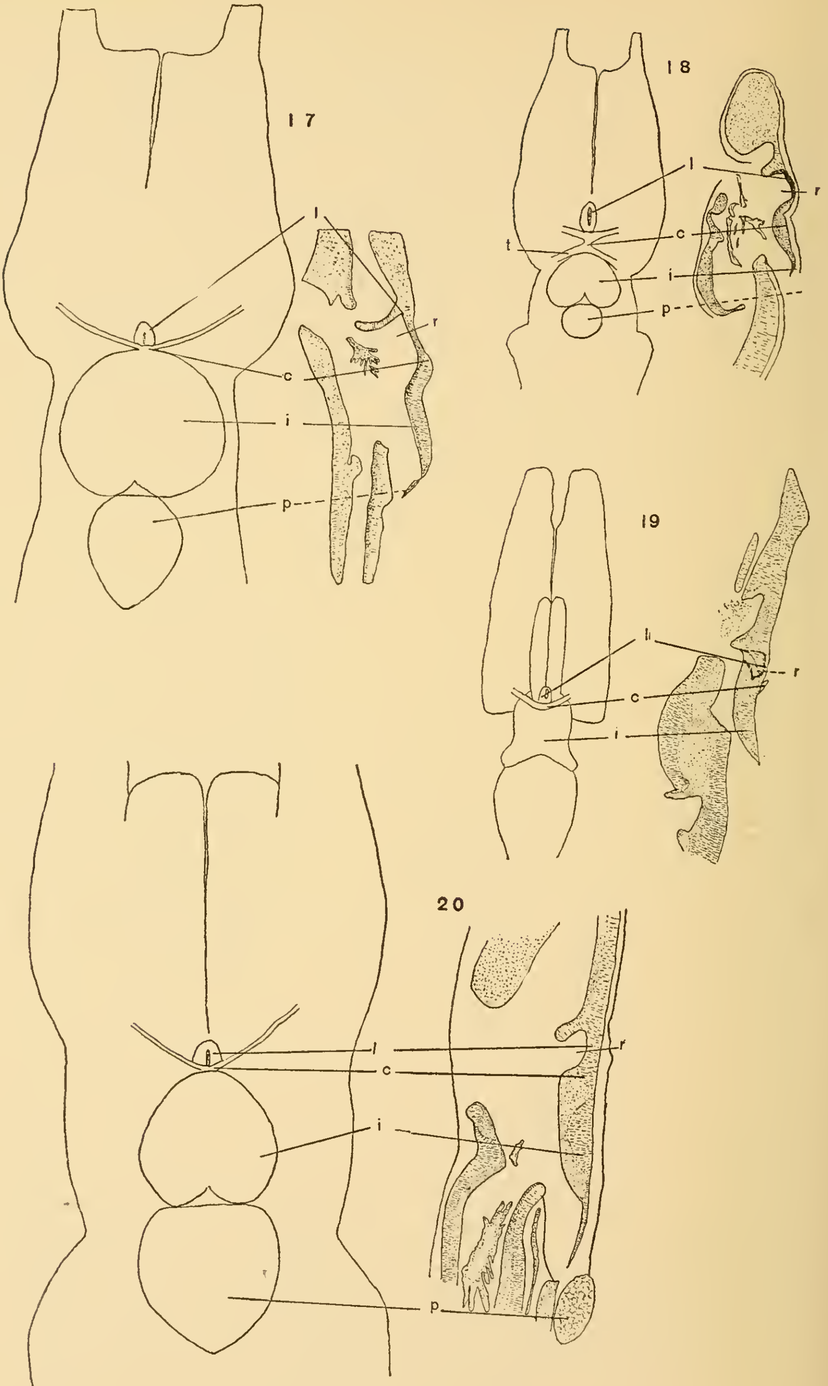

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