EXPLANATION OF PLATE I.

FIG. 1. Male of *Chimæra monstrosa*, reduced from a figure in Agassiz's *Poissons Fossile*, showing the opisthural filament.

FIG. 2. Side view of embryo ray in the lophocercal stage, showing its attachment to the yelk-sack by the hollow vitelline stalk which opens into an ellipsoidal depressed cavity on the yelk, shown in outline. Vessels of one side of the yelk only are indicated. Natural size, from a specimen taken near Wood's Holl, Mass., in 1883.

FIG. 3. Lophocercal tail of young flounder 6 mm. long.

FIG. 4. Lophocercal tail of young flounder a little older than the preceding, beginning to show a slight upbending of the notochord, and the first trace of the permanent caudal lobe *pc* and opisthural lobe *op*.

FIG. 5. Indentation appearing in the caudal lobe of a somewhat older flounder, permanent fin-rays being defined.

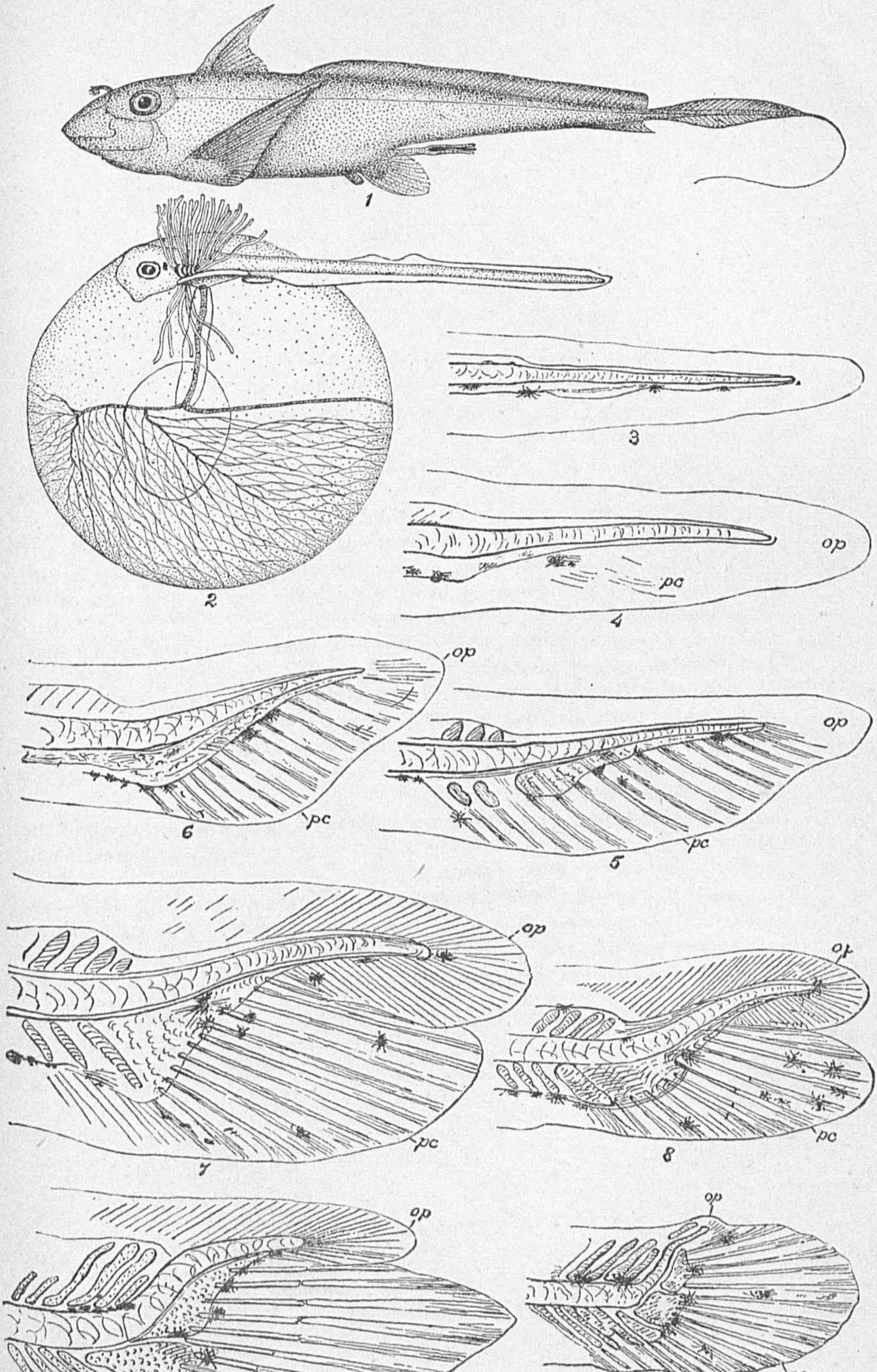
FIG. 6. Tip of notochord still more flexed upward than in the preceding; permanent caudal and opisthural lobes somewhat more distinct.

FIG. 7. Permanent *pc* and opisthural lobes *op* now form a sharp angle where they join; distinction between permanent and embryonic rays well marked.

FIG. 8. Permanent caudal as long as opisthural lobe *op*.

FIG. 9. Cartilaginous supports of fin-rays are now strongly developed; the end of the chorda has begun to degenerate and approximate the position which it will occupy permanently as the urostyle.

FIG. 10. The caudal has become more rounded, the opisthure *op* is almost wholly absorbed and the notochord has suffered atrophy somewhat, and now presents a still closer approximation to the form of the urostyle of the adult. Figs. 3 to 10, inclusive, after A. Agassiz.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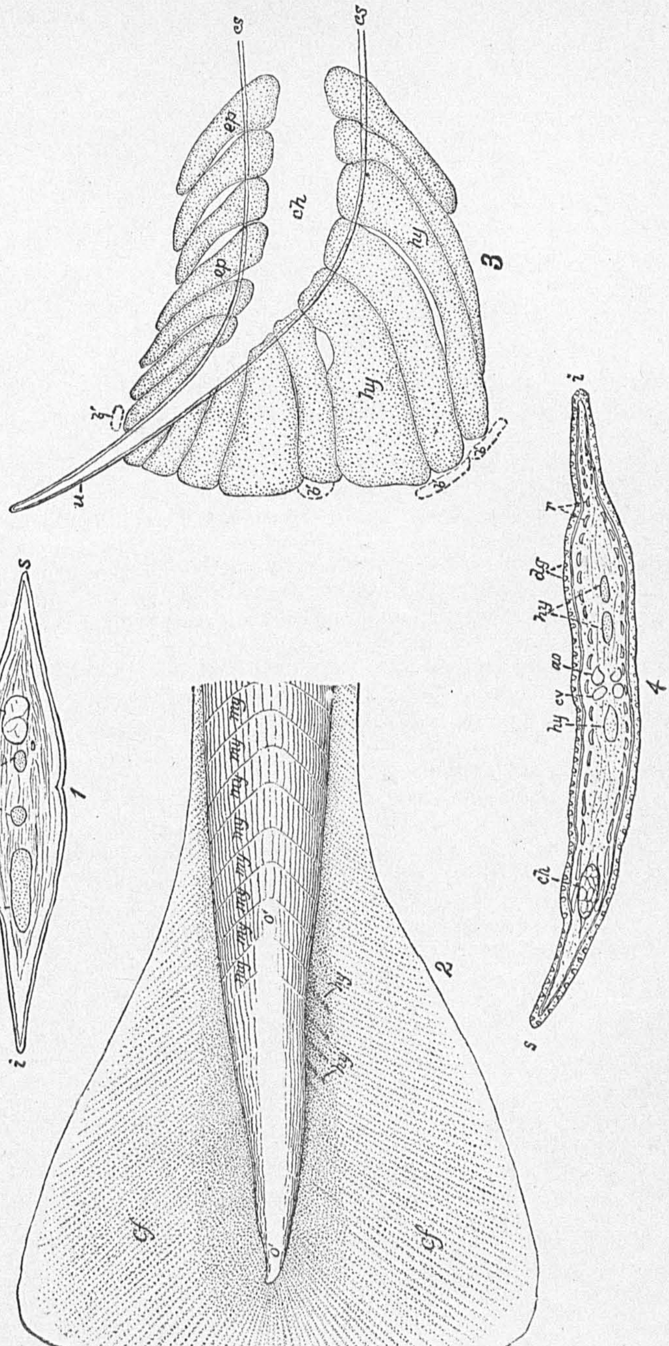
EXPLANATION OF PLATE II.

FIG. 1. Vertical section of the tail of *Alosa sapidissima* 22 days old; *s* superior, *i* inferior border, *hy* hypural cartilages, *ch* chorda surrounded by connective and muscular mesoblastic tissue. x 65.

FIG. 2. Tail of *Alosa sapidissima* 4 days after hatching, showing the striate caudal fold *cf*. The direction of the striæ correspond to the direction in which growth has manifested itself, and seems to be an effect of the development of the embryonic rays. The myotomes *my* are shown to be faintly developed almost to the end of the tail, but there is a space on the side from *o* to *o'* where muscular tissue has degenerated and is not present, so that the voluminous chorda lies in immediate contact with the skin at this point. The hypural elements are just forming and are shown to be related to corresponding somites; their bases have pushed the ventral wall of the chorda inward slightly. From a balsam preparation. x 64.

FIG. 3. Epural and hypural cartilages of the tail of the California salmon, *Oncorhynchus*, with the accessory basilar pieces *b'* in outline; these are developed later. x 32. From a specimen cleaned in a 5 per cent. potash solution and rendered transparent with glycerine.

FIG. 4. Vertical section through the tail of an advanced embryo land-locked salmon; *s* superior, *i* the inferior margin, *hy* hypural pieces, *ch* end of chorda, *cv* caudal vein, *ao* aorta, *r* rays cut across and composed of homogeneous material, *dg* unicellular dermal glands, or goblet cells. The permanent rays *r* are cut across at their proximal ends, and it is evident that they are imbedded in mesoblast. x 32.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EXPLANATION OF PLATE III.

FIG. 1. Tail of the embryo of *Salmo salar*, with two hypural chondrifications in process of formation, on the first day after hatching. Circa x 30. Slightly modified from Lotz.

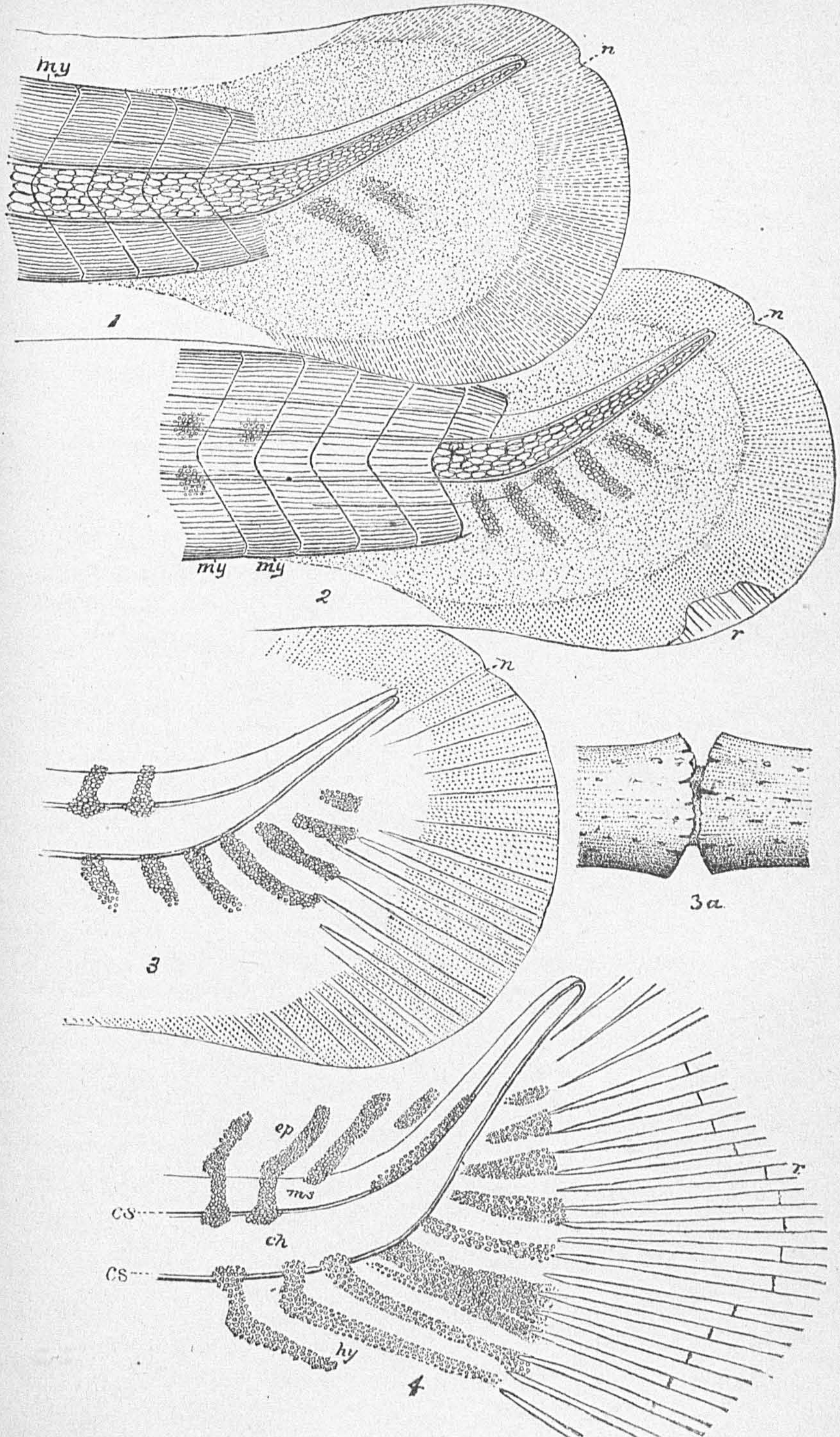
FIG. 2. Tail of a somewhat older embryo of the same, with six hypural chondrifications in the process of formation, with embryonic rays at *r* uncovered at the edge of the caudal fold, on the sixth to seventh day. From the same. x 30.

FIG. 3. Tail of a still older salmon embryo, with seven hypural and two epural chondrifications being developed, and with the caudal rays more developed and approaching the hypural elements, on the tenth to twelfth day. From the same. x 30.

FIG. 3*a*. Magnified view of one of the joints of an ossified fin-ray from a young salmon. x 300. After Lotz.

FIG. 4. Tail of a more advanced embryo, showing the principal caudal rays segmented and in contact proximally with the free end of the hypural pieces, of which there are ten, two of them having coalesced, while there are five epural pieces represented by cartilaginous aggregations, two of which are in contact with the chorda, and three in the position of "false spines," the last two being rudiments around which the *Deck-knoehen* ossify, on about the twenty-fourth day. x 30. From the same.

n, caudal notch dividing secondary caudal lobe from the tip of the primordial larval tail; *ms*, medulla spinalis; *hy*, hypural pieces; *ep*, epural pieces; *r*, rays; *ch*, chorda; *cs*, chorda sheath; *my*, myotomes = muscular somites <proto-vertebræ. (For the details of the development of the rays see Plates IX and X.)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EXPLANATION OF PLATE IV.

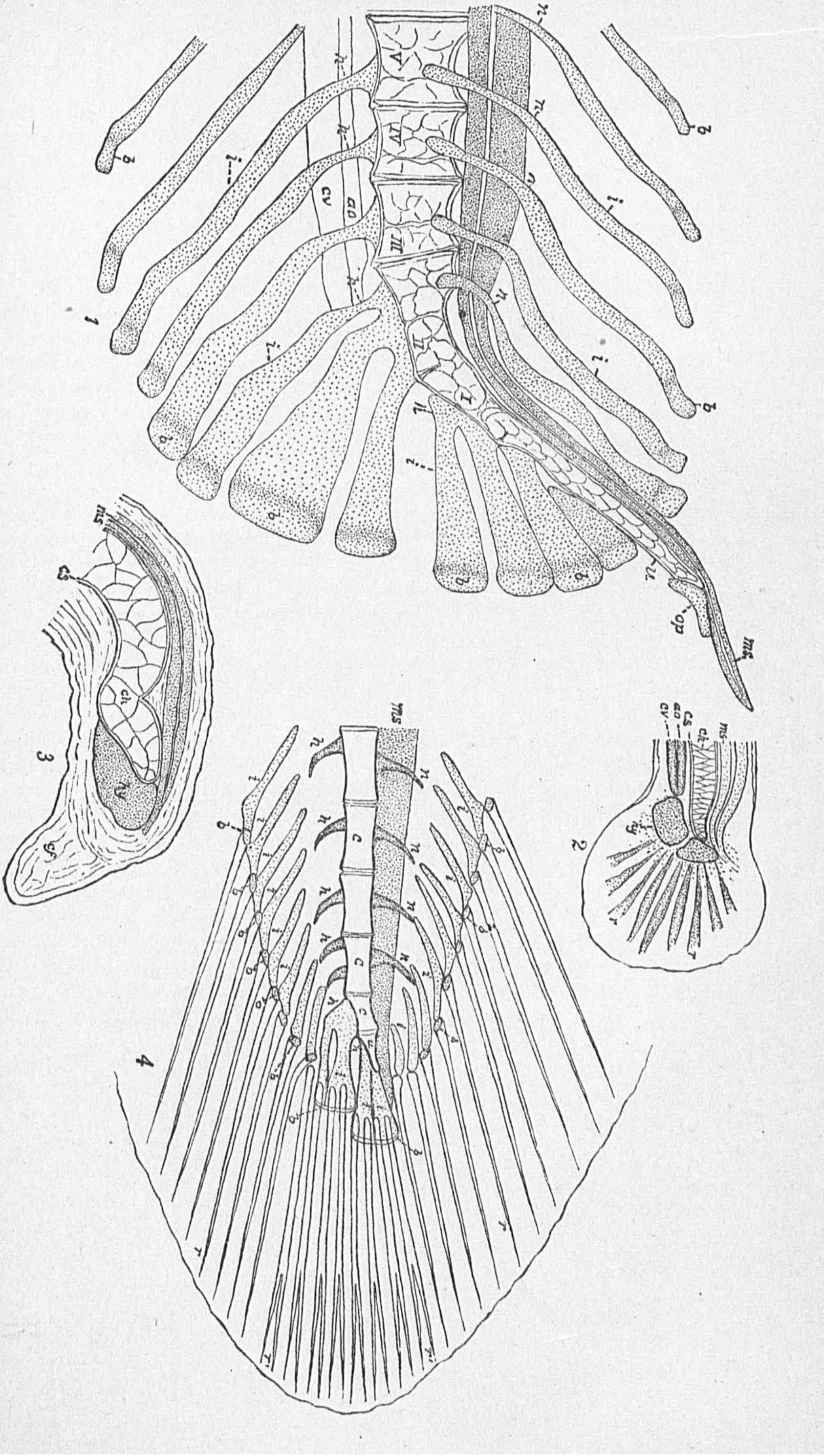
FIG. 1. Caudal skeleton of *Amiurus albidus*, from an embryo fifteen days old; rays not represented; the vertebræ V, IV, III, clearly marked, II and I subsequently become fused and continuous with the urostyle *u*. The cartilaginous epural and hypural pieces consist of neural spines *n*, coalesced with interneural elements *i* and basilar epiphysial elements or actinophores *b*; *ao* and *cv*, aorta and caudal vein embraced by the hæmal arches *h*. Medulla spinalis *ms* embraced by the neural arches *n*, but degenerate posteriorly and exserted beyond the urostyle, and resting partly on the opisthural cartilage *op*. x 64. From a chromic acid specimen which was sectionized and the outlines of the elements superimposed with the camera lucida.

FIG. 2. Tail of an embryo of *Siphostoma*, showing the rudimentary hypural pieces, evidently comprising several coalesced elements, as is shown by the number of rays *r*. x 96. From a transparent specimen mounted in balsam. The upward deflection of the end of the medulla spinalis *ms* is also indicated.

FIG. 3. Tail of a very young *Hippocampus antiquorum*, x 183, showing a very rudimentary caudal fold *cf*, and a trace of the hypural cartilage *hy*, which is partly opisthural or post-chordal.

FIG. 4. Tail of a very young *Anguilla* two and one-third inches long, in the cœlacanthous stage of development, but with the interspinous elements nearly entirely cartilaginous. *i*, interspinous elements; *h*, hæmal arches; *b*, basilar cartilages, all discrete except the four hypural elements, which are reduced by concrescence to two in the adult. The rays from *r'* to *r'* are dichotomous, and belong to the caudal proper, while the rays *r* are dorsal and anal. Some epural interspinous pieces are aborted, and the last vertebra *u* is pointed posteriorly, and represents the urostyle. The last four hypural processes bear two caudal rays each, thus indicating that they each represent two coalesced basilar and interspinous elements, since there are two successive systems of interspinous and basilar elements to each vertebra anterior to the two true caudal segments. The urostyle has therefore degenerated and shortened so that proximal concrescence of the median appendicular skeleton bearing the eight caudal rays has occurred. The last three vertebræ *o c u* are ventrally two-spined, the last two four-spined, if their hypural elements are considered to be double. The last two caudal centra are spineless dorsally. x 32.

PLATE IV.



EXPLANATION OF PLATE V.

FIG. 1. Caudal skeleton of *Coccosteus*, after Pander; *ep* and *hy*, epural and hypural elements, all of which do not bear rays, but, as in Pterichthys, extended out only as far as the scaly covering of the tail; *d* dorsal, *a* anal fins.

FIG. 2. Caudal skeleton of *Polypterus*, from Agassiz's *Poissons Fossile*, modified after Kölliker; *ep'*, styliform ray-bearing and nodular non-ray-bearing interspinous epural elements; *ep*, neural spines; *hy*, hypural ray-bearing elements.

FIG. 3. Caudal skeleton of adult *Lepidosteus*, from Kölliker, showing the urochord more prolonged and attenuated than in the preceding.

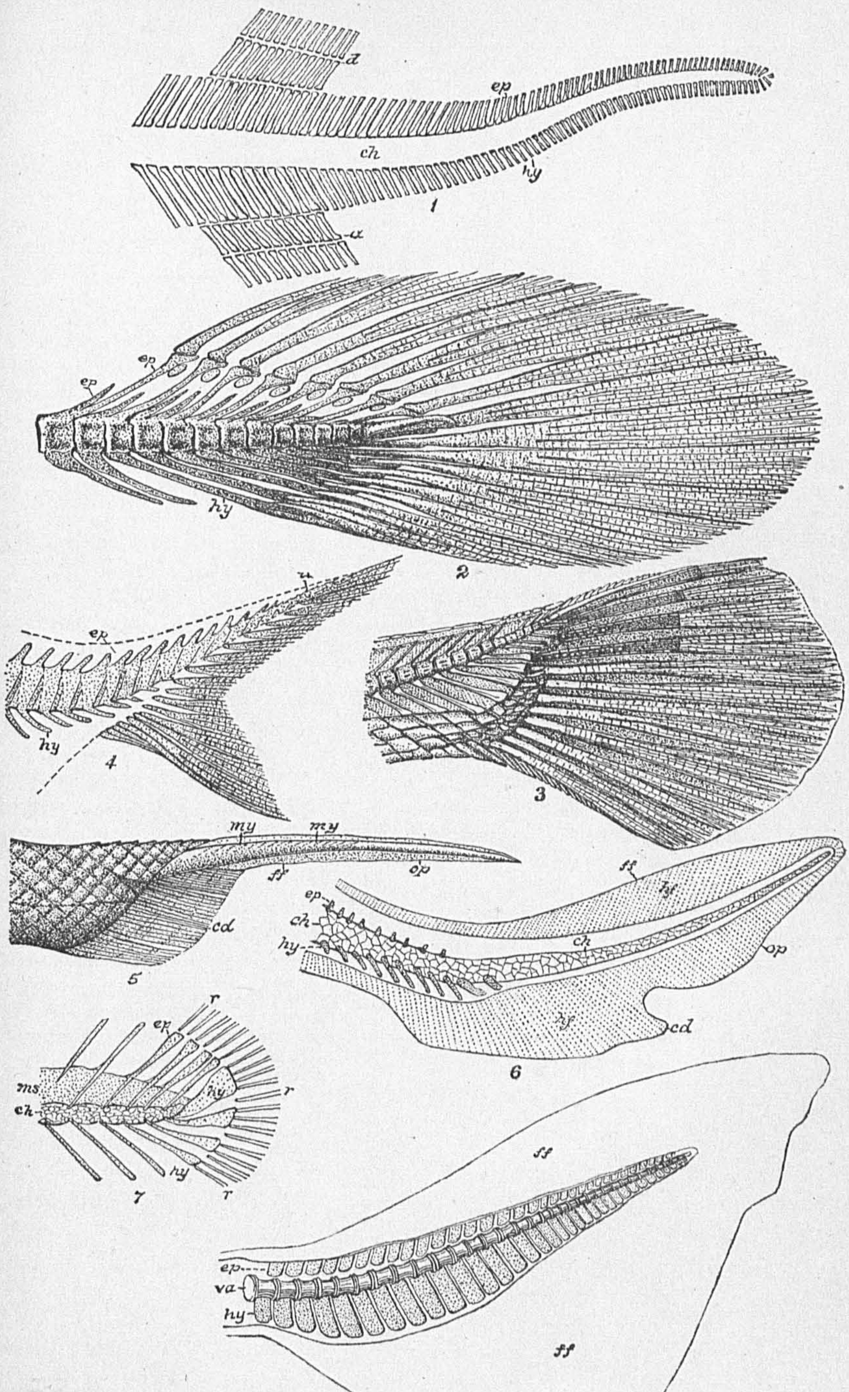
FIG. 4. Caudal fin of *Platysomus* as restored by Agassiz in the *Poissons Fossile; ep* and *hy*, epural and hypural pieces; *u*, urochordal end of the skeletal axis, which was mainly notochordal.

FIG. 5. Tail of a young specimen of *Lepidosteus*, 11 centimeters long, from Balfour and Parker; *cd*, permanent caudal; *ff*, eradiate fin-fold of opisthure; *op*, opisthure; *my*, *my*, its myotomes.

FIG. 6. Side view of the tail of a larva of *Lepidosteus*, 21 millimeters long, dissected and magnified so as to show its structure at this stage; *ep* and *hy*, epural and hypural cartilaginous rudiments of the neural and hæmal arches; *ch*, chorda; *ch*, its opisthural portion, which afterwards becomes partially aborted and included in the upper part of the tail; *cd*, tip of fold, which becomes the permanent caudal; *op*, opisthural lobe of the larval tail; *ff*, lophocercal fin-fold, which contains horn-fibers *hf* throughout its extent. After Balfour and Parker.

FIG. 7. Magnified view of the caudal skeleton of a young Cyprinodont (*Gambusia*), ⅛ of an inch long, and which was removed from the ovarian follicle in which it developed; *ch*, chorda; *ep* and *hy*, epural and hypural cartilages; *ms*, medulla spinalis; *r r r*, rays.

FIG. 8. Caudal skeleton of *Centrina salviani; ep* and *hy* as before; *va*, vertebral axis; *ff*, *ff*, its dorsal and ventral membranous lobes, which include numerous horny and partly osseous supporting fibers. From Günther.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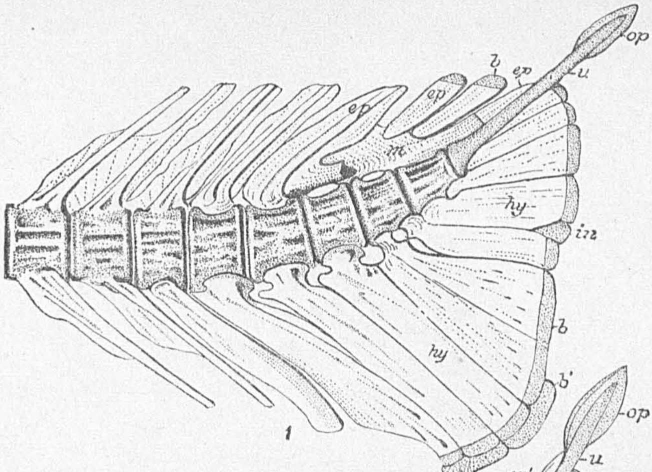
EXPLANATION OF PLATE VI.

FIG. 1. Caudal skeleton of *Salmo fario; b* and *b′*, basilar cartilages or actinophores; *ep*, epural; *hy*, hypural elements; *m*, lateral membrane bone, which has had an epural cartilaginous element as its nucleus; *in*, intercalary cartilage; *u*, urostyle; *op*, opisthural element. X 3. After Lotz.

FIG. 2. Caudal skeleton of *Salmo salar; ep*, epural elements; *ep′*, laterally displaced epural elements, from which the membrane bone *m* has extended in perichondrium; *b* and *b′*, basilar cartilages or actinophores; *in*, intercalary cartilages; *hy*, hypural bones; *u*, urostyle; *op*, opisthural rudiment, nat. size. After Lotz.

FIG. 3. Caudal skeleton of *Barbus fluviatilis; ep*, epural, and *ep′*, laterally displaced epural bones; *hy*, hypural bones; *in*, intercalary cartilages; *b* and *b′*, basilar cartilages or actinophores; *p*, lateral tuberosity for the attachment of the caudal muscles; *u*, urostyle; *op*, hypaxial opisthural rudiment. X 2. After Lotz.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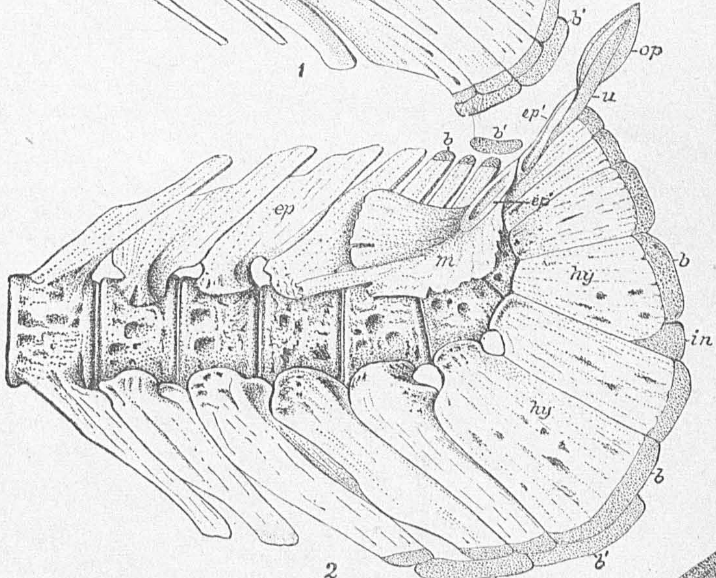
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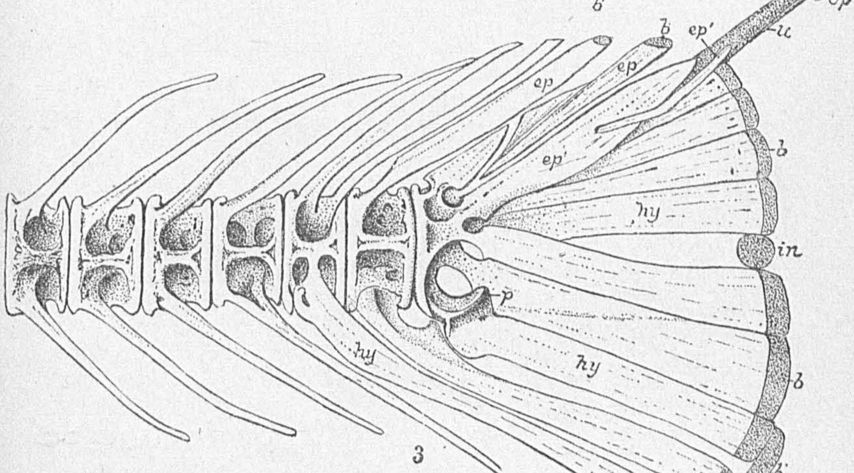
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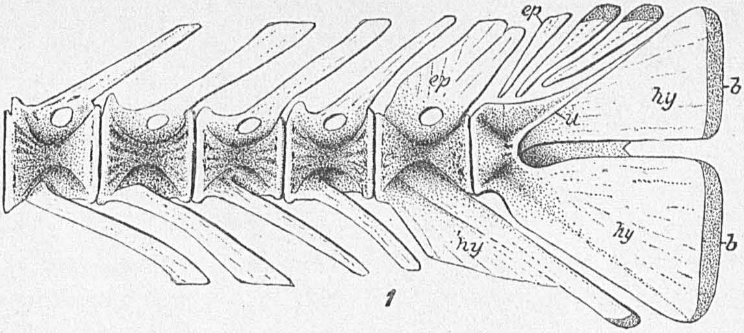
EXPLANATION OF PLATE VII.

FIG. 1. Caudal skeleton of *Cottus gobio; b*, actinophores or basilar interneural cartilages; *ep*, epural; *hy*, hypural elements; *u*, urostyle. x 8. From Lotz.

FIG. 2. Caudal skeleton of *Perca fluviatilis; ep*, epural, *hy*, hypural elements; *b*, basilar cartilages or actinophores; *u*, urostyle; *in*, intercalary cartilages. x 3. From Lotz.

FIG. 3. Gephyrocercal caudal extremity of *Echiodon dentatus; c*, centra; *ep*, epural; *hy*, hypural processes; *i*, interspinous cartilages; *h*, hiatus between dorsal rays *rd* and post-anal rays *rv*. x 17. After Emery.

FIG. 4. Caudal extremity of *Fierasfer acus; ep*, epural processes; *c c c*, centra not in contact; *ch ch ch*, membranous or cartilaginous intercentral intervals; *uch*, exserted end of chorda or urochord; *h*, hiatus between last dorsal rays *rd* and last post-anal rays *rv*. x 55. After Emery.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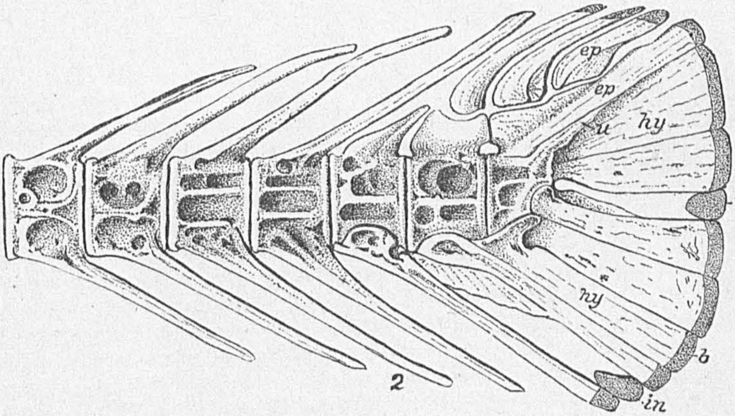
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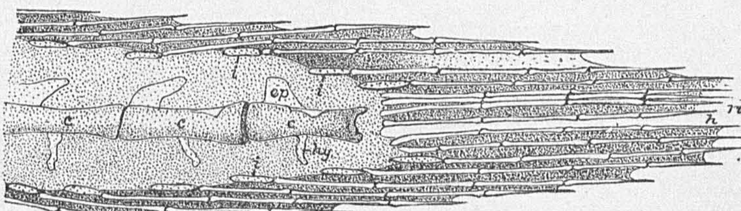
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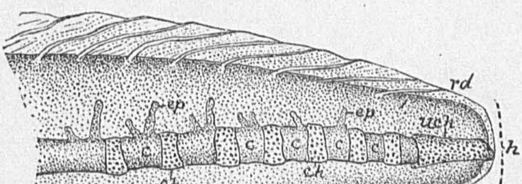
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EXPLANATION OF PLATE VIII.

FIG. 1. Youngest stage of development referred to *Mola*, and known as *Ostracion boops* (from a drawing by Sir J. D. Hooker, published by Richardson), supposed to be enlarged.

FIG. 2. *Molacanthus* stage of *Mola*. From Günther.

FIG. 3. *Molacanthus* stage of *Mola*. Slightly altered from a MS. figure by F. W. Putnam.

FIG. 3*a*. Caudal vertebræ of *Molacanthus*, together with their spines and musculature exposed, showing rudimentary rays and what seem to be traces of caudal interspinous elements, drawn from a specimen in the U. S. National Museum, somewhat enlarged.

FIG. 4. A young specimen of *Mola* some time after it has passed the *Molacanthus* condition, with the dermal spines still in place. (A spine which is found just below the pectoral seems not to be represented.) From Günther.

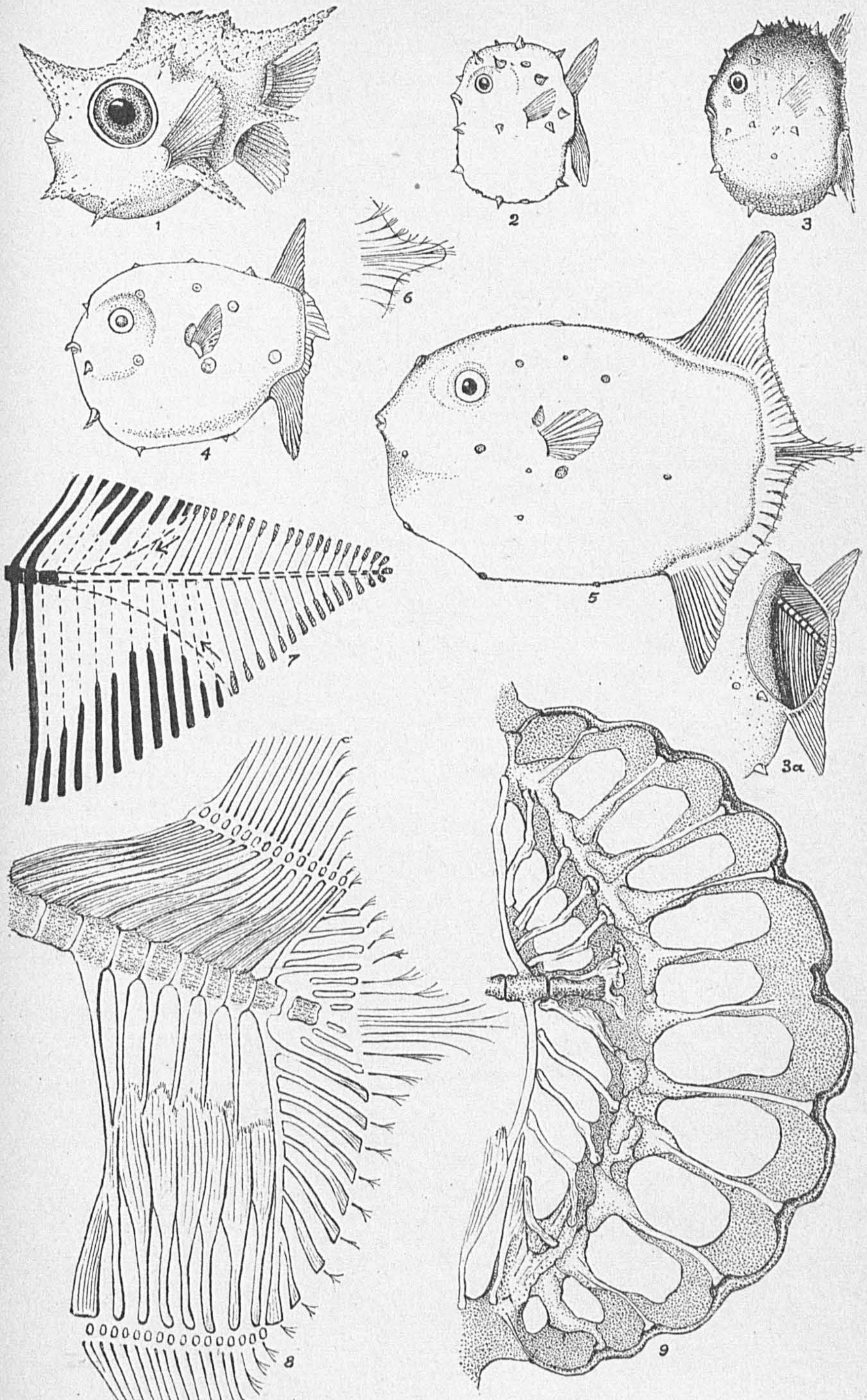
FIG. 5. A young *Mola*, showing the scars where the dermal spines of the *Molacanthus* stage have dropped off, and with the median ray-bearing projection from the center of the caudal represented. (The caudal has been represented as somewhat wider than in the alcoholic specimens, which seem to have been somewhat shrunken.) From specimens in the U. S. National Museum.

FIG. 6. Median caudal projection of a somewhat older specimen than the preceding, showing the rays to be composed of fused horny fibers at this time.

FIG. 7. A diagram intended to show the parts which have been lost in the caudal skeleton of *Mola*. The black interspinous elements are supposed to be swung forward against the neural and hæmal spines of the sixteenth vertebræ. The end of the chorda in dotted outline, and the shaded interspinous pieces, with their corresponding segments, are supposed to have been aborted.

FIG. 8. Caudal skeleton and part of the muscles of the young of Mola in the condition of Fig. 5, somewhat altered from a MS. figure by F. W. Putnam, in order to show the dichotomous caudal rays, which seem to become partially aborted in the central portion as the animal becomes adult, and to undergo other retrogressive changes.

FIG. 9. A reduced figure of the caudal skeleton of an adult of *Mola rotunda*, which shows that the median interspinous elements become coössified, while the ends of the rays become hidden or more thickly covered by the integument. This figure illustrates the most extremely modified example of the gephyrocercal tail. From Wellenbergh.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EXPLANATION OF PLATE IX.

FIG. 1 Tail of a recently-hatched salmon embryo, x 16; *ep* and *hy*, epural and hypural cartilages; *ch*, chorda; *ms*, tip of medulla spinalis; *my my*, myotomes (partially aborted and transformed into the caudal muscles posteriorly); *on*, notch between opisthural and permanent caudal lobe; *hf hf*, horny fibers from which the permanent rays *r r r* are partially formed.

FIG. 2. Insertion of the vibratores spinæ or lateral muscles of the anal fin of a young salmon into the basal sheet in which the horny fibers *hf* end. x 183.

FIG. 3. Part of the tip of the tail and tail-fold of a young codfish, ten days old, to show the development of the horny fibers *hf* from the fusiform cells or pterygoblasts *pt*; *ch*, chorda; *ms*, medulla spinalis; *mf*, posterior margin of tail-fold. x 365.

FIG. 4. Diagram from a vertical transverse section through the basal part of the caudal lobe of a young salmon recently hatched, to show the permanent rays *pr* in section, and the horny fibers *hf*, both being invested by the mesoblast *mes*; *ep*, epiblast or larval skin. x 96.

FIG. 5. Diagram from a section still nearer the base of the caudal of a young salmon of the same age, showing three hypural cartilages *hy* cut across. x 96.

FIG. 6. Diagram from a section through the tail of a young salmon, nearer the margin of the caudal than Fig. 4; *v v*, vessels; *mes*, mesoblast; *pr*, permanent fin-rays, cut across; *pr'*, showing traces of the way in which the horny fibers *hf* become invested by a homogeneous material and fused together. x 183.

FIG. 7. A diagram from a portion of the caudal fold still nearer its margin than that shown in Fig. 6; *g*, unicellular goblet cells of the epithelial layer *ep* of the epiblast; *mp*, Malpighian layer of the skin; *pr*, homogeneous rudiments of the permanent rays between the epiblast and mesoblast, the latter being thickened between the rudimentary halves of the permanent rays of opposite sides; *v v*, vessels; *hf*, horny fibers; *mes*, mesoblast. x 183.

FIG. 8. More enlarged view of a section through the left half of the rudiment of a permanent ray of a young salmon, taken from the same plane as the preceding. Letters the same as in the preceding figure. x 365.

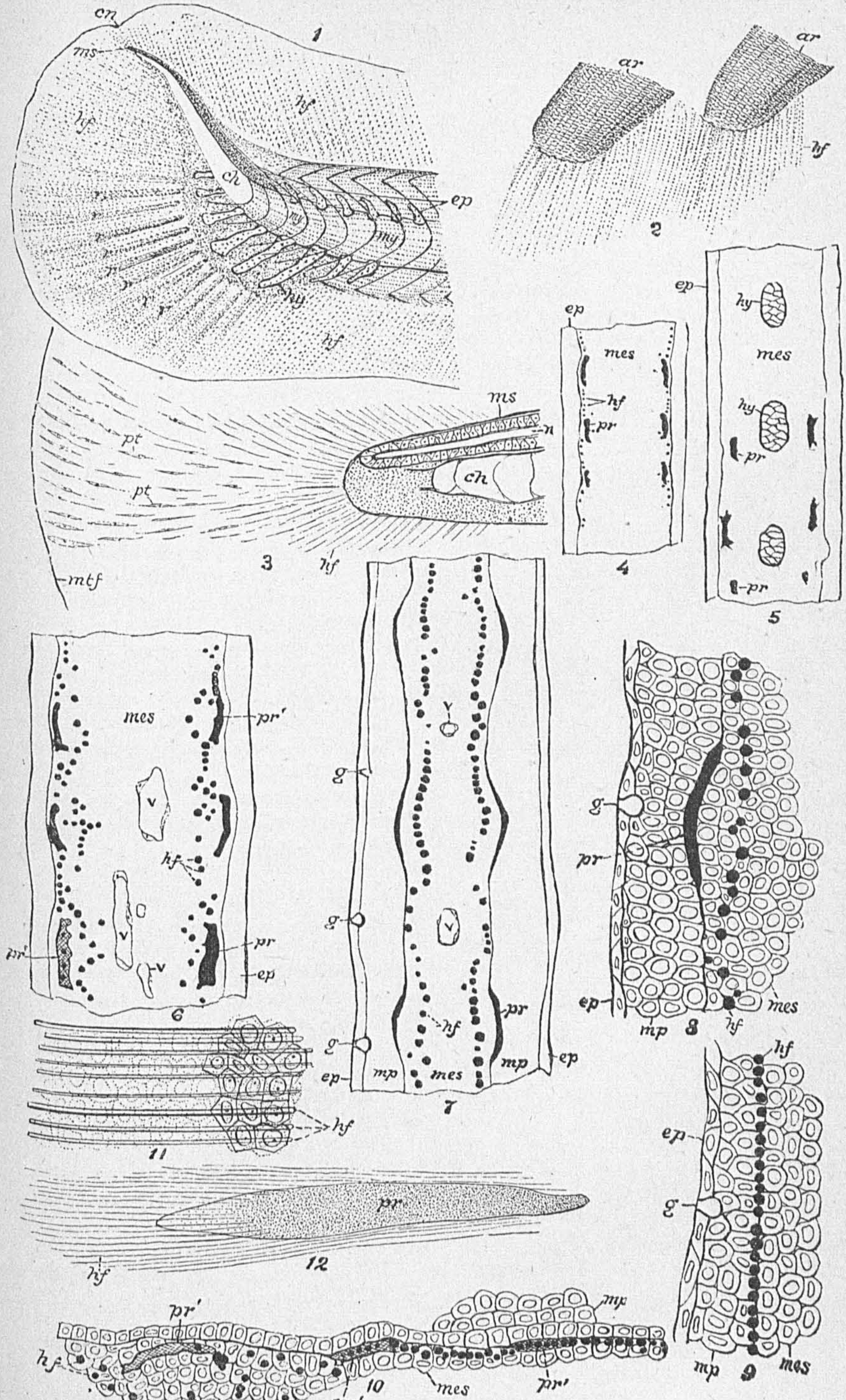
FIG. 9. A similar section from near the edge of the caudal fold of the salmon, to show the cylindrical horny fibers *hf* separate and lodged between the skin *ep* and *mp* and the mesoblast *mes*. x 365.

FIG. 10. A similar section through the layer of horny fibers between the lower layer of the epiblast *mp* and mesoblast *mes*, to show the mode in which the fibres are fused together and enveloped by the matrix of the future permanent rays. x 365.

FIG. 11. A small fragment of the epiblast of the fin-fold of a recently-hatched salmon, viewed from the surface, to show the perfectly straight horny fin-fibers *hf*, partially covered by mesoblastic cells. x 365.

FIG. 12. Diagram to illustrate the mode in which the matrix of the permanent fin-ray *pr* envelopes the horny fibers *hf*, which remain more or less divergent and free at their distal extremities.

PLATE IX.



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EXPLANATION OF PLATE X.

FIG. 1. Section cutting longitudinally and vertically through the basal part of the Wolffian ridge of the chick, six days old; *n*, medulla spinalis; *shl*, hinder somites, which are drawn together more or less at their ventral end, where they are destined to furnish the muscular and nervous supply of the hind limb; *st*, thoracic somites; *hl*, hind limb; *fl*, fore limb. x 16.

FIG. 2. Longitudinal nearly vertical section through the base of the dorsal fin of an embryo of *Squalus* a little off of the median line, to show the muscular buds *mb mb*, which are thrust upward into the dorsal fin-fold, and from which the muscular apparatus of the fin is derived; *ep*, epiblast; *c*, connective tissue. x 35.

FIG. 3. Transverse section through the pectoral fin of a young embryo of *Scyllium stellare*, from Balfour; *v v*, vessels; *mpt*, basipterygial bar (metapterygium); *m*, muscles; *cr*, cartilaginous rays; *mes*, mesoblast; *hf*, horny fibers between mesoblast and epiblast.

FIG. 4. Pelvic fin of a very young female embryo of *Scyllium stellare*; *bb*, basipterygium; *pu*, pubic process of pelvic girdle; *il*, iliac process of pelvic girdle; *f*, foramen through pelvic plate; *hf*, horny fibers. From Balfour.

FIG. 5. Transverse section through the pectoral fin of a recently hatched salmon; *v v*, vessels; *bc*, pericardiac cavity; *ao*, aorta; *dc*, ductus Cuvieri; *cl cl*, membranous matrix of clavicle; *bp*, basipterygial or cartilaginous pectoral plate; *mes* and *c*, mesoblast or connective tissue; *my*, myotomes; *hf*, horny fibers; *m*, muscles of pectoral inserted into the edge of the pectoral plate; *ep*, epiblast.

FIG. 6. A nearly median section through the dorsal of *Amiurus*, fifteen days old; *is' is'*, basilar interneural or median actinophoral cartilages; *i i*, interneurals; *r r*, membranous matrix of permanent rays, the last one, *r'*, showing the effects of concrescence at its lower end; *c*, connective tissue; *es'*, supracarinal muscle; *es*, erectores, and *ds*, depressores spinæ muscles; *my*, myotomes. x 35.

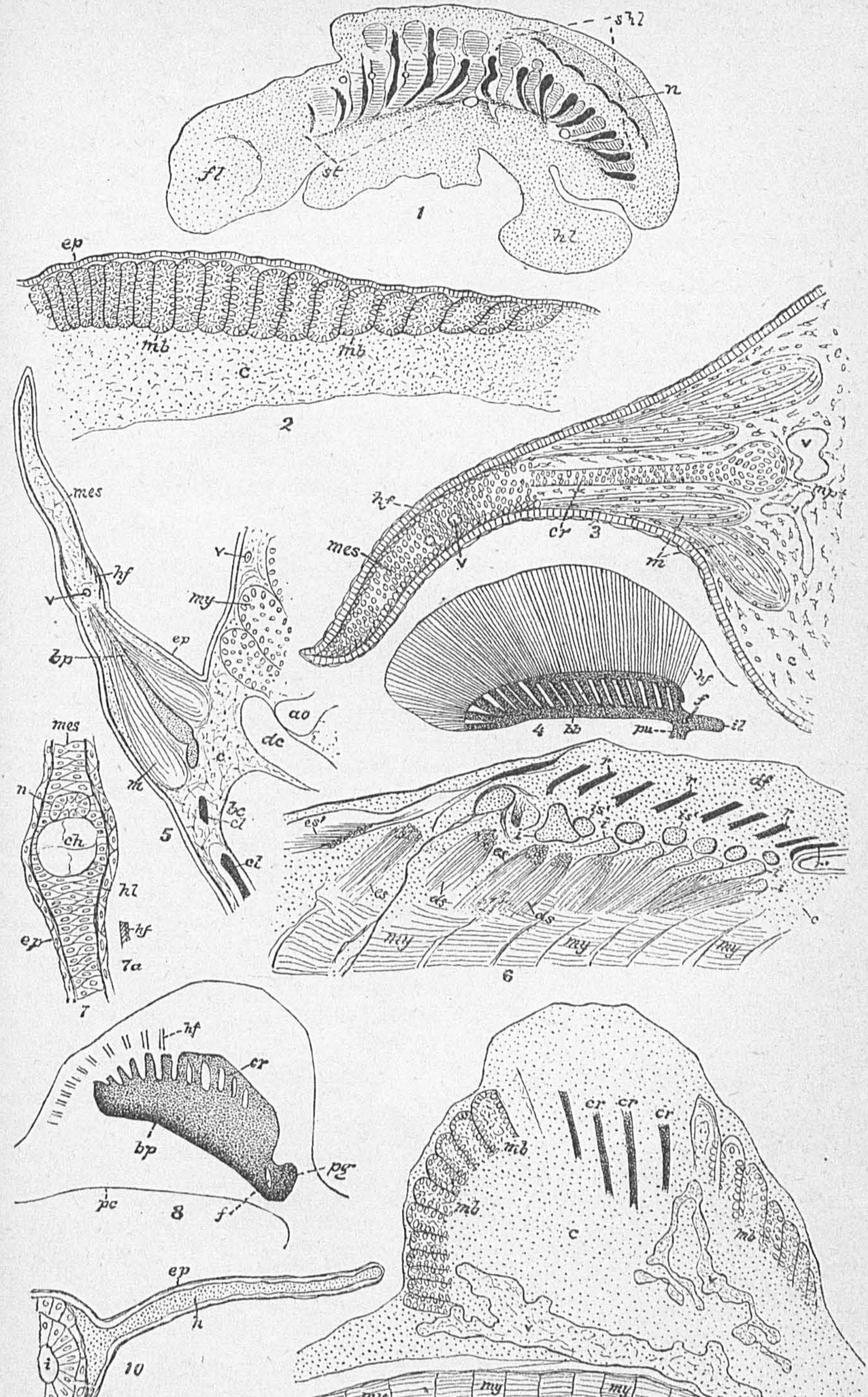
FIG. 7. Transverse section through the central part of the tail of the shad (*Alosa*), cutting the chorda, *ch*, and medulla spinalis, *n*; *ep*, epiblast; *mes*, mesoblast, with the horny layer *hl* between them. x 96.

FIG. 7*a*. A portion of the horny layer *hl* of the preceding nearly opposite the chorda, which shows itself differentiated into embryonic rays or fibers *hf*. x 600.

FIG. 8. Pectoral fin of a young embryo of *Scyllium* in longitudinal and horizontal section; *pc*, wall of peritoneal cavity; *f*, foramen in the pectoral girdle; *pg*, pectoral girdle in transverse section; *cr*, cartilaginous rays; *hf*, horny fibers or rays.

FIG. 9. Horizontal longitudinal section through the pectoral of an embryo of *Squalus* to show some of the muscular buds, *mb*, which have been thrust out by the post-branchial somites into the pectoral fold; *cr cr*, rudiments of cartilaginous rays; *v v*, vessels; *my*, *my* myotomes. x 35.

FIG. 10. Transverse section through the ventral fin-fold of a recently-hatched shad embryo in front of the anus; *i*, intestinal lumen; *mes*, mesoblast; *ep*, epiblast or larval skin; *h*, homogeneous matter which fills the fin-fold before the embryonic rays are differentiated. x 96.



EXPLANATION OF PLATE XI.

d, dorsal; *p*, pectoral; *p'*, pelvic fin.

FIG. 1. Young *Lophius* taken out of the egg just previous to hatching, showing the pelvic fin-fold behind the pectoral.

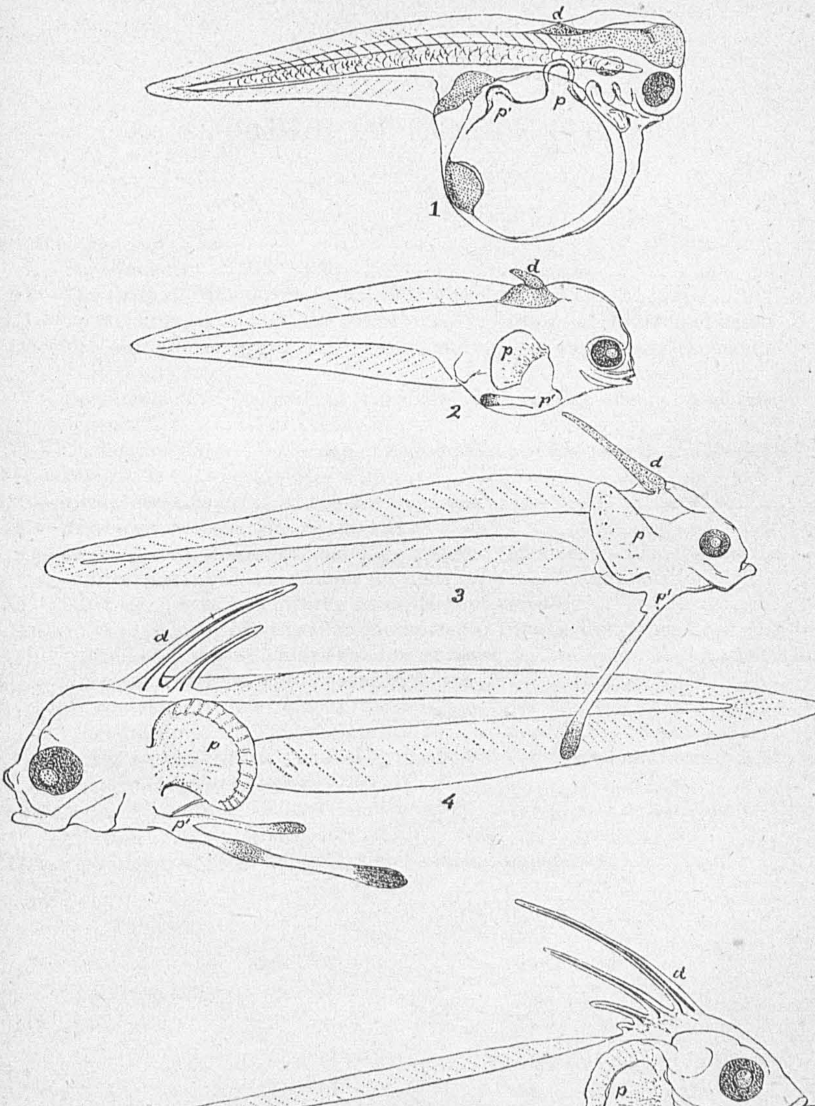
FIG. 2. *Lophius* just after hatching, showing the pelvic fin *p'* in a jugular position below the pectoral, with first dorsal spine appearing as a fleshy process.

FIG. 3. An older stage, with second ray of pelvic fin growing out from the base of the first.

FIG. 4. A still older stage, with two dorsal and two pelvic rays developed.

FIG. 5. A more advanced embryo, with four dorsal rays and the rudiment of a third pelvic fin-ray.

All the figures on this plate are taken from those published by A. Agassiz, but are considerably reduced and rendered diagrammatic.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