

EMBRYOS OF THE SMOOTH DOGFISH (*GALEUS CANIS*).

DURING the early part of September, while working on some integumentary structures of the selachians at the Marine Biological Laboratories, Woods Holl, Mass., I was fortunate enough to secure two female dogfish which had been kept during the summer in the U. S. Fish Commission aquaria. Each fish measured 1.07 m. from the end of the snout to tip of tail. On opening their body cavities I secured three embryos from one and four from the other, the smallest measuring 84 mm., the largest 89 mm. The specimens had well-developed external gills, and were attached by long spirally twisted umbilical cords to the yolk sac, which was still filled with abundant yolk material. One of the embryos has been drawn by Mr. Hayashi, the laboratory artist, and serial sections have been made of another. Fuller description and figures will be given in my paper on the Ampullæ of Lorenzini of the Selachian Fishes.

The condition of the genital organs of the females was interesting. In the first specimen the three embryos were all contained in the right uterus, the left being empty, although the walls of the latter were thickened and highly vascular. At the anterior end of the body cavity the dorsal region of the right ovary was distended with immature eggs. Five of the eggs, varying in diameter from 8 mm. to 15 mm., were supplied with yellow yolk, and were doubtless to be the eggs for next year's young. Other white spherical bodies, presumably very immature eggs, in size from $\frac{1}{4}$ mm. to 5 mm., were thickly imbedded in the stroma of the ovary. Both uteri were developed equally in the second specimen, each carrying two embryos.

These facts seem to throw some light on the breeding habits of this fish and suggest a means of securing the stages now much needed in the study of the development of the nervous system.

The smooth dogfish is very abundant at Woods Holl throughout the spring and is supplied to the laboratory in great quantities from the fishtraps. This species is viviparous, and if the adult females are dissected in May or early June they are found to carry eggs in the earlier

embryonic stages. During July the dogfish begins to leave these shores, and in August it is impossible to get any material. Where the fish spends the winter is not known. The embryos secured during the latter part of July average 10-20 mm., or at most 40 mm. in length. So far as I know, sizes larger than this have not been taken before along the south shore of Massachusetts. When the fish reappear in the early spring the embryos have reached the 'pup' stage, 15-20 cm. in length, and are often born while the fish are in the traps. I have never seen the 'pups' in the uterus of the female later than May.

Hence it seems certain that the breeding habits of *Galeus* are as follows: Eggs which have received their yolk in the ovary during the previous year begin their development in the uterus in late spring. The embryos are carried in the body of the mother until the next April or May, when the young 'pups' are extruded.

It is probable, therefore, that embryos of any required length may be obtained if the large females are secured in April or May, confined in as natural surroundings as possible, and killed when the young have reached the stage of development desired.

JAMES E. PEABODY.

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THE LAW OF RHYTHMIC MOVEMENT.

It has long been known that in such rhythmic movements as walking, running, etc., a certain frequency in the repetition of the movement is most favorable to the accomplishment of the most work. Thus, to go the greatest distance in steady traveling day by day the horse or the bicyclist must move his limbs with a certain frequency; not too fast, otherwise fatigue cuts short the journey, and not too slow, otherwise the journey is made unnecessarily short. This frequency is a particular one for each individual and for each condition in which he is found. Any deviation from this particular frequency diminishes the final result.

Some measurements that I have already made on natural and unnatural rhythms have suggested a law governing the amount of deviation from the natural rhythm and the resulting loss.