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.

WOODS HOLL, September 10, 1896.

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.

The rhythm used is that of a movement of the forearm. A series of movements is made in a natural rhythm, then other series in unnatural rhythms. The average and the mean variation (mean error) are computed for each series. The psychological mean variation (all apparatus errors being rendered negligible) is a good measure of the subject's irregularity or of the difficulty of his mental processes. Using the mean variation thus as a measure of the disadvantage of a rhythm, we can express the relation of disadvantage to length as $m = f(r)$ where m is the mean variation and r the length of the rhythm. Now, the law that I believe myself able to assert is

$$\frac{m}{\text{abs } (r - R)} = \text{const.}$$

where m and r have the same meanings as before, R is the length of the natural rhythm and abs indicates that the sign of the quantity is disregarded. In other words, the amount of irregularity is proportional to the amount of deviation from the natural rhythm.

The full proof of the law with a determination of the constants I hope to furnish during the coming year.

E. W. Scripture.

Yale University, September 20, 1896.

Scientific Literature.

The American Lobster: A Study of Its Habits and Development. By Francis Hobart Herrick.

This monograph, issued as a portion of the Bulletin of the U. S. Fish Commission for 1895, has over 250 pages of text and 64 plates, and represents the work of the author as an investigator of the U. S. Fish Commission from 1890 to 1895. Its general appearance is quite up to the improved standard of the more recent government publications. The typography is good and many of the plates are really excellent.

It is presumed that the publications of the Fish Commission will have some practical bearing upon the innumerable problems of fish-culture, and Dr. Herrick has not confined himself to mere questions of morphology and embryology, but, following the suggestion of Prof. Rathbun, has endeavored to determine the *natural history* of this most important and strangely persecuted invertebrate; and it is to be hoped that with these natural data at hand the government will adopt some rational method of experimentation which shall finally lead to successful lobster culture.

In the Introduction the author considers the immediate questions of nomenclature, the methods of lobster capture, and the rise and inexcusable decline of the lobster fishery in America.

Chapter II. deals at considerable length with the general subject of reproduction. The essential and secondary organs are described, the peculiar pairing habits of certain Crustacea are mentioned, and the methods of oviposition are discussed. In describing the spermatozoa the author writes: "The sperm cells have a characteristic shape and are absolutely immobile in the conditions under which they are ordinarily observed, but it is impossible to suppose that this is always the case." The reviewer has seen the spermatozoa in active movement, swimming across the field of the microscope with the same nervous contractions that are characteristic of the Hydromedusæ.

The facts collected in reference to the time of egg-laying and period of incubation are very complete, and indicate the time when artificial hatching should commence. We cannot, however, agree with the author that there are at present adequate data for the assumption that eggs are frequently deposited during the fall and winter. When the temperature of the water is known to be so important a factor in the rate of development, and when the range of temperature variation is from 35.5° F. in February to 71.4° F. in August, it is extremely hazardous to estimate the actual age of 'winter' embryos from the known age of those whose growth has been accelerated by the warmer water of midsummer.

The data illustrating the law of production, arranged in Table XV., have been gathered from an examination of 4,000 adult lobsters, and represent a vast amount of work. The rearrangement of this material in other tables, and the author's conclusions regarding the period of greatest fertility, are especially instructive.

In dealing with the destruction of the egg-lobster and its spawn, it is to be regretted that