THE REPRODUCTION OF THE EEL.

By HENRY DE VARIGNY in La Nature.

ONE of the problems that has occupied the attention of naturalists from the time of Aristotle up to the present is the method of reproduction of the eel. It is not because there has been any reason for the belief that this fish multiplies by processes different from those of other living beings, but because the conditions under which the fertilization of the egg is accomplished and where it is hatched have not been known, and because, too, it has never been possible to obtain the fry of this fish. The problem has now been definitely solved by the researches of Prof. G. B. Grassi, of Rome, and of his pupil Signore Calandruccio. The results may be summed up as follows: The fact that eels introduced by man into ponds and lakes that have no communi-

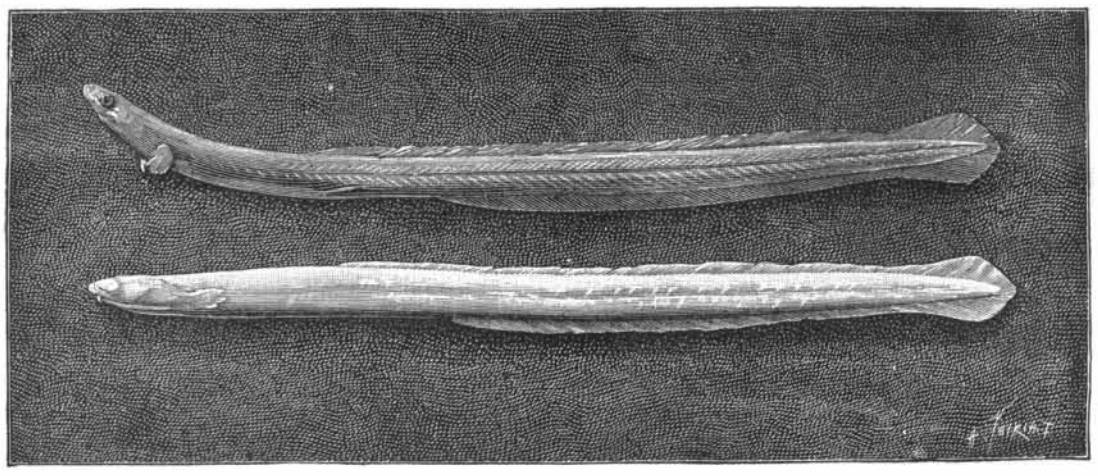

FIG. 1.—YOUNG EELS.

cation with rivers and the sea do not reproduce, and that no young are ever observed therein, has led to the idea that reproduction does not take place in fresh water, and the admission has had to be gradually made that the eel proceeds to the operation of multiplication in salt water. There would be here a migration similar to that made by the salmon and shad, but in inverse order, the latter, inhabitants of salt water, ascending fresh water streams to spawn, and the former, an inhabitant of fresh water, going out to sea to reproduce its kind. This view, à priori, finds some confirmation, moreover, in the fact that the only young eels that are met in rivers are always making the ascent thereof. They ascend, but do not descend streams, and they seem to come from the sea.

The eel therefore appears to reproduce itself in salt water; but where? And how is it that young eels are never found anywhere upon the coasts?

An interesting fact pointed out by Prof. Yves Delage, of the Sorbonne, some eleven years ago, ought to have put investigators upon the track. This fact was that a certain fish captured in the vicinity of Roscoff, and kept in captivity, changed into a conger, or sea eel. This fish belonged to a well-known group, that of the Leptocephala. This group has been a puzzling one, since the fishes that compose it seem to be incomplete, and they have a larval appearance. Their very small head (whence their name), the absence of scales, the slight development of the osseous skeleton, the absence of red corpuscles in the blood, and the general feebleness of their locomotion, all seem to indicate that these fishes, which are divided into several species by systematic zoologists, are young and not adults. In 1861 it was thought that they might be the larvæ of Cepola. In 1864 an American naturalist placed them in the family of eels, but Günther, in 1870, contended against these views in taking as a basis the fact that the Leptocephala are of larger dimensions than the young eels that ascend streams, and he regarded them as monstrous larvæ.

The transformation observed by Yves Delage, however, clearly showed where the truth was to be found, and Messrs. Grassi and Calandruccio resolutely entered the path opened by the French naturalist. Their success has been complete, and they must be congratulated upon it. Through them we now know that the fishes of the family Murenidæ first pass through a larval stage, and that the Leptocephala are nothing but the larvæ of Murenidæ. The Leptocephala therefore disappear, both as regards genera and species. They have no longer any zoological civil state and no longer form a systematic group, any more than do the tadpoles of the Batrachians or the caterpillars of the Lepidoptera; and the fact observed with regard to the common conger eel has likewise been observed with regard to several Murenidæ, and particularly the common eel.

The eel which interests us more particularly goes out to sea to reproduce its species. It does not, however, proceed everywhere to the work of reproduction, but makes a selection from among the innumerable sites that the sea offers it, and invariably takes refuge in the depths. It requires water having a depth of at least 1,600 feet. Is this a matter of taste merely, or is it because the eggs develop properly only under great pressures? This point is not yet elucidated. Among the localities where the conditions are found favorable in proximity to the coast may be mentioned the strait of Messina. Eels evidently visit this locality in large numbers, since the strong currents here often bring eggs and Leptocephala to the surface. In 1895, Prof. Grassi found the latter here by thousands; and when the currents are gentle, an almost certain method of procuring them consists in opening the easily captured Orthagoriscus mola. This fish, which inhabits the deep sea, always contains a few larvæ of Murenidæ in its digestive tube. These larvæ are met with from February to September and have long been known. They have been called by the name of Leptocephalus brevirostris, and it is they that are the young—the larval form—of the common eel, Anguilla vulgaris.

The accompanying figures, which we owe to the kindness of Prof. Grassi, represent the leptocephalus under consideration. It is from 2½ to 2¾ inches in length; and the extreme height of its body, which is very thin, forms a striking contrast with the somewhat cylindrical shape of the young eel. There is no doubt, however, of the connection between the leptocephalus and the eel. Prof. Grassi has directly observed the transformation of the leptocephalus in an aquarium, and, although the young eel is always shorter than the leptocephalus whence it proceeds, that is due to the fact that the latter, during its transformation, does not take any food and necessarily diminishes. While from the view point of external form the leptocephalus differs very greatly from the eel, there is, on the contrary, a complete concordance in the internal anatomy. The myomeras, the vertebral arches and the spinal ganglions are of the same number in each, and the rays of the pectoral fin of the leptocephalus are of the same number as those of the corresponding fin of the eel. We cannot enter here into the technical details given by Prof. Grassi, notwithstanding their interest; but it is well to remark that such interest is rather of a general order. While it is well to know what modifications occur or do not occur in the leptocephalus, it is not necessary to be acquainted with them in order to ascertain whether such transformation really takes place, since, through Prof. Grassi's direct observation, we know that the change occurs, and that the leptocephalus becomes a young eel.

In order briefly to recapitulate the history of the reproduction of the eel, we shall say, then, that the latter descends the rivers from October to January (in Italy at least) and that it reaches the deep sea, where (according to specimens occasionally thrown up by the currents) it undergoes evident modifications. Its eyes acquire dimensions that they never possess in fresh water, and it reaches sexual maturity, a thing that never occurs in rivers, nor in captivity, where we nevertheless find eels of 8 to 12 inches in which the sexual products do not succeed in developing. Reproduction takes place in deep water after the eel has lived therein for some time (a few months), and the pressure and chemical constitution of the medium (and perhaps also other factors that escape us) evidently play a great part in the development of the sexual aptitudes. Eggs are found from the month of August to January, and the Leptocephali show themselves from February to September.

The duration of leptocephalic life is unknown. It is known, however, that a month is sufficient for the transformation into a young eel. It is Prof. Grassi's opinion that the young eel, that which ascends the rivers in spring, is already a year old; but of this year how many months belong to the larval state? This is a point to be cleared up.

And what becomes of the eel that has reproduced its kind? The general opinion is that it dies; that it does not return to fresh water, but ends its existence in the sea shortly after spawning. Such is the opinion given by Cunningham in his excellent "Natural History of the Marketable Marine Fishes of the British Islands."

This is very likely, moreover, since in fresh water we never find eels having the appearance of those that have lived in the sea, and most certainly if the latter returned to the rivers they would, for a time at least, preserve the peculiar character of the eyes that they had acquired in salt water.

Prof. Grassi has therefore very completely solved the problem of the eel; but we must say that he has not stopped here, for he has also studied the problem of other Murenidæ (Congromuraena mystax and C. Balearica, Ophichthys, Nettastoma, Saurenchelys, etc.), and, through a comparison of the larvæ and adults, has been able to show that all of the Murenidæ studied (save two, Chlopsis bicolor and Myrus vulgaris) first pass through a leptocephalic larval stage.

The details of these researches will be found in a memoir that he is publishing, but it has appeared to us useless to await this publication in order to make known the valuable work done by the Roman zoologist and his magistral elucidation of a problem that has defied so many naturalists.

In connection with the subject of the reproduction of eels, it may be of interest to note that the belief once universally entertained that eels present no distinction of sex seems to have been shared by the Massachusetts and Narragansett Indians, who, respectively, called the common fresh and salt water eels (Anguilla Bostoniensis) Nequttikaog and N'quitteconnauog, dialectic variations of the same word, meaning "they go singly," or "one by one."

The Narragansetts, however, observed that there was at least one kind of an eel that apparently mated, and named the fishes of this species Neeshauog, meaning "they go in pairs." This name has been perpetuated, locally, in Massachusetts, in the form Neshaw, as the popular appellation for an eel that is sometimes taken in the salt ponds of Martha's Vineyard, and that Dr. Storer (Report on the Fishes of Massachusetts) supposes to be the silver eel (Muræna argentea).

The fishes so designated by the Indians may have been sea lampreys (Petromyzon Americanus), the sexes of which usually ascend rivers in pairs, aid each other in piling up heaps of stones among which to spawn, and frequently exhibit evidences of mutual attachment.

UTAH UINTAITE DEPOSITS.

THERE has been published in the New York Tribune part of the seventeenth annual report of the United States Geological Survey, giving an account of "The Uintaite (Gilsonite) Deposits of Utah," and prepared by George Homans Eldridge. The name uintaite was given by Prof. W. P. Blake in 1885 to a variety of asphalt found in the vicinity of the Uinta Mountains in Utah. The name gilsonite, of a later derivation, was adopted because the substance was brought into prominence as an article of utility through the efforts of S. H. Gilson, of Salt Lake City. The trade knows it better by the latter name.

According to Mr. Eldridge, uintaite is employed chiefly in the manufacture of black, low grade brush and dipping varnishes, such as are used on the various kinds of iron work and as baking japans. It is employed by one company for mixing with an asphaltic limestone in the manufacture of paving material. Other uses, according to E. W. Parker, in "Mineral Resources of the United States" for 1893, are: preventing electrolytic action on iron plates of ships' bottoms, for coating barbed wire fencing, etc., for coating sea walls of brick or masonry, for covering paving brick, for acid proof lining for chemical tanks, for roofing pitch, for insulating electric wires, for smokestack paint, for lubricants for heavy machinery, for preserving iron pipes from corrosion and acids, for coating poles, posts and ties; for torpedo proof pile coating, for covering wood block paving, as a substitute for rubber in the manufacture of cotton garden hose, and as a binder pitch for culm in making brickette and eggette coal. Mr. Eldridge is inclined to believe,

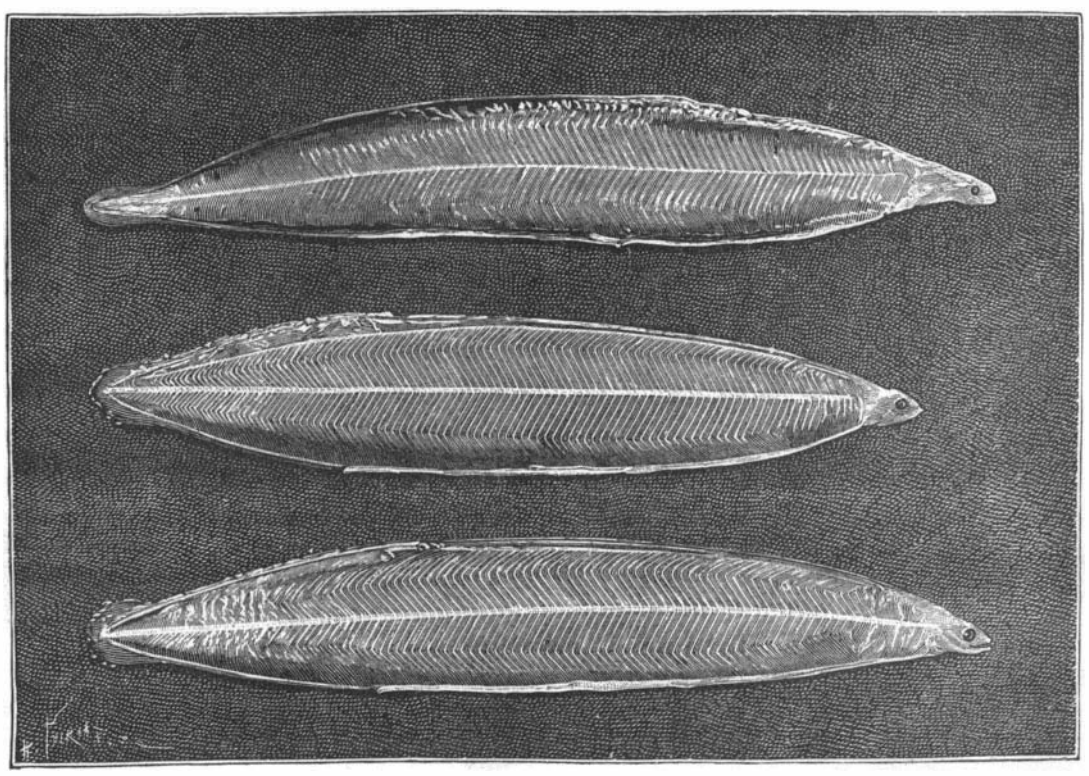

FIG. 2.—LARVA OF THE EEL (LEPTOCEPHALUS BREVIROSTRIS), STILL RELATIVELY YOUNG.