MARINE BIOLOGICAL PHOTOGRAPHY.

THOUGH year by year photography plays a greater part in the illustration of works on natural history, marine biology does not appear to have received its full share of attention from the scientific photographer.

It can be claimed for photography that it is an accurate and rapid method of making marine biological records. The rapidity admits of the recording of delicate structures during life, thus avoiding the opacity and distortion that so soon follow death; but the main advantage lies in the fact that by means of photography the number of workers making records can be greatly increased. Expert biologists who have the time to make drawings of minute structures are distinctly limited in number, whereas the photographer with but a general biological knowledge is able to make accurate and useful records of structures, possibly quite new to him, and many points of which he might miss were he to draw them.

FIG 1.—Young Thornback Ray.

In order to derive the full advantages offered by photography, the worker must be prepared, in addition to illustrating minute structures, to deal with the habits, movements, characteristic postures, and general external appearance of any particular marine animal. Such records should preferably be made in natural environments, but, failing this, in special tanks.

Prof. Reighard, in his contribution "Photography of Aquatic Animals in their Natural Environments," describes very fully subaquatic photography and photography with the camera above water. Subaquatic photography, however, has a very limited application, mainly in consequence of the want of light, and for obtaining details of external structure is not nearly so satisfactory as photography in special tanks.

With the camera above water the main difficulty to be overcome is due to the photograph having to be taken through two media, air and water, for the light reflected from the surface of the water, being greater than that reflected from the object to be photographed, the desired image is obscured in the general fogging of the photographic plate. When photographing a submerged object with the camera directed at an angle to the surface of the water, this reflection from the water can be avoided by holding a screen at a suitable angle immediately above the object.

When taking a photograph directly above the object, the light must be cut off above the camera. The illustration of a young thornback ray was taken in 8 inches of water, with a golf umbrella held over the head of the operator.

For tank work the most useful arrangement is a tank about 3 feet long, 2 feet high, and 6 to 8 inches from front to back, the bottom and sides being of wood, the front and back of $\frac{1}{4}$-inch plate-glass. Inlet and outlet pipes pierce the sides, and there must be arrangements for a constant supply of salt or fresh water which can be sent through the tank at will. The specimen placed in the tank usually sulks at the bottom; if, after a time, the water is suddenly turned on, the fish or other creature heads up to the stream, and a snapshot can be taken in a natural position. For the above work it is desirable to use a reflex camera with a rapid lens of not less than 8-inch focal length.

For the photography of comparatively small and microscopic marine objects a special apparatus is necessary. I use a portable apparatus with which it is possible to take a photograph of a specimen in a horizontal or vertical position, by transmitted or reflected light, and by means of a mirror to see the object up to the last moment before exposure, so as to ensure a living specimen being photographed in a suitable position. There is also a fixed stage upon which a specimen can be placed in a tank or cell, and a photograph taken of any desired magnification without moving the specimen.

When photographing from life-size up to 25 magnifications I use lenses of 6-inch, $3\frac{1}{2}$-inch, and 35-mm. focal lengths, on a camera having an extension of 36 inches without a microscope. For higher magnifications I drop a microscope into the apparatus, and get any desired magnification up to 2600 with a 1/12-inch oil immersion.

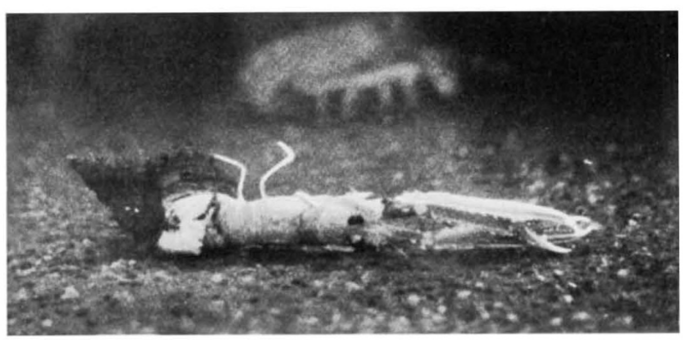

FIG. 2.—Whelk feeding on Crayfish.

The exceptional length of bellows extension is necessary in order to obtain a high degree of magnification from a lens of comparatively long focus, thus ensuring all parts of the specimen being in focus at the same time.

The advantages of such an apparatus at a biological station or on a research boat are obvious, for specimens taken from the trawl or tow-net can be placed in suitable tanks or cells by the biologist and

FIG. 3.—Pecten turning over.

photographed, living, anæsthetised, or dead, by an assistant. Any number of useful records could thus be made from fresh specimens of any particular catch. For photographic purposes it is desirable to obtain perfect living specimens; but the photography of numerous imperfect specimens is also very valuable, for at any time a perfect drawing can be made from the material so collected.

As an additional use, this apparatus can with advantage be employed when counting specimens in the analysis of a plankton catch, for the area under the field of the microscope can be thrown on to a sheet of paper and the specimens ticked off.

When working with artificial light, the illuminant should be of sufficient power to ensure against the want of light being a hindering factor. I use a very useful little arc lamp made by Messrs. Leitz, when electric power is available; failing this, an oxyhydrogen light, though good results can be obtained with an acetylene lamp. When using arc or limelight it is necessary to have a cooling tank between the light and the specimen.

With either arc or limelight, working with a Zeiss microplanar lens at F. 4·5 on a medium rapid plate, a full exposure can be obtained in one-tenth of a second up to twenty-five magnifications.

Reference has been made already to photographs taken in natural environments. As an illustration of the recording of the habits of marine animals is shown the photograph of the common dog-whelk (Buccinum) holding with its foot the abdomen of a dead crayfish. On removing the crayfish it was found that the whelk had partially sawn through the shell by means of its radula.

A characteristic movement is shown in the photograph of a pecten turning itself over.

Recently I had the opportunity of taking numerous pecten photographs under the direction of Mr. W. J. Dakin, and by his kind permission I am able to show an instantaneous photograph of this mollusc, in the act of turning itself over, after having been placed on the left valve. The other photographs taken showed the gradual opening of the pecten, until the valves were separated as much again as in the photo-

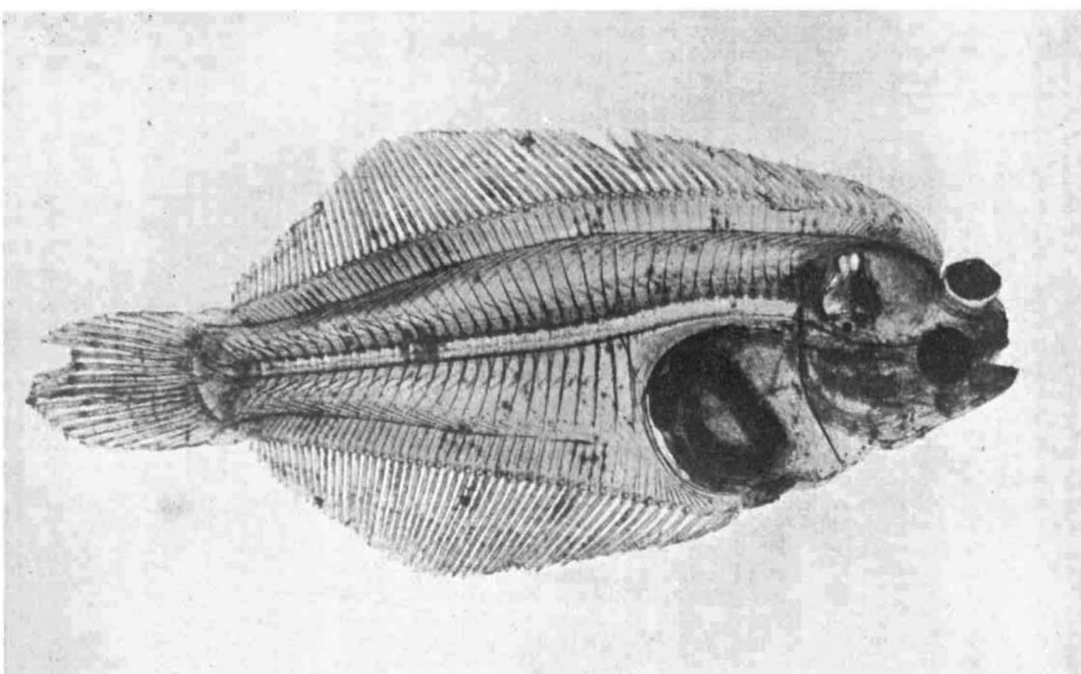

FIG. 4.—Plaice Larva.

graph shown. The present illustration shows the sudden act of closure, by which the turning movement is brought about, almost completed.

Of photographs taken with the special apparatus described, two illustrations are given; the first that of a plaice larva 13 mm. in length, and magnified five times; the second that of a crustacean, one of the Mysidacea, 2 mm. in length, magnified fifteen times. This photograph shows very distinctly the two statocysts on the uropods or appendages of the sixth abdominal segment, and gives a good general view of the animal.

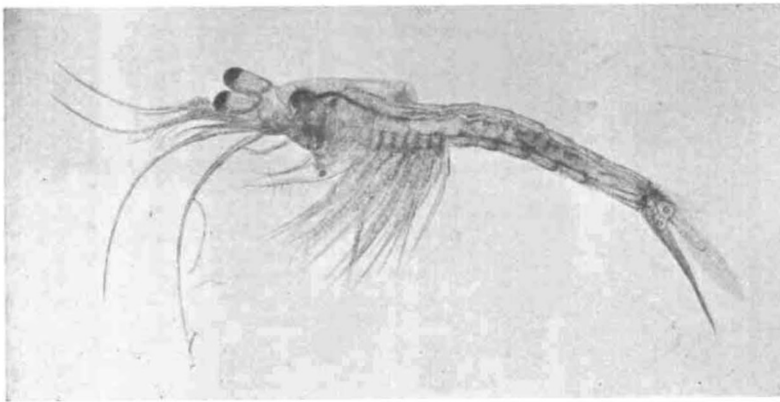

FIG. 5.—A Mysidacea.

Higher magnifications of any particular part are obtained as described by slipping the microscope into the apparatus.

In addition to the above methods, the natural colours of marine animals may be recorded on the autochrome plate. The autochrome plate is particularly useful when it is desired to make a permanent record of a stained specimen where the staining is of a fugitive character.

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SOME EXTINCT VERTEBRATE ANIMALS FROM NORTH AMERICA.[1]

A NEW volume of collected papers, published by the American Museum of Natural History, New York, enables us to realise how important and numerous are the additions to our knowledge of extinct vertebrate animals still made by systematic explorations in North America. The contributions now received deal with the work of only four years, 1904–8, accomplished by one institution; but they make great advances in nearly all parts of the subject to which they relate, and their value is increased by the excellent text-figures and plates with which they are illustrated. The pioneer discoveries of Leidy, Marsh, and Cope furnished for many years a continual series of surprises for the student of extinct vertebrates; their successors during the past decade and a half have not only filled in many details in the preliminary view thus obtained, but have also been scarcely less successful in recovering unexpected groups and missing links. Present explorers have, indeed, the advantage of being able to pursue their work in the remote west in peaceful leisure, without any armed escort, and so have facilities for determining the relative positions of the strata from which they excavate the various fossils. In the early days, with hurried traverses, there was a tendency to decide the relative ages of the fossils solely by their own peculiar features, without any exact observations in the field. The result was sometimes an argument in a vicious circle. As shown by the volume now before us, that is all changed. We find detailed descriptions of specimens from the Permian of Texas, the Upper Cretaceous of Montana, the Eocene of Wyoming, and the Miocene of South Dakota. Accompanying them are well-illustrated exact accounts of all these formations and localities, determining the relative ages of the genera and species which were obtained from them.

The scientific work of the palæontologists in the American Museum is of two kinds. Part is devoted to the reconstruction and mounting of skeletons of general interest; part is concerned with the most detailed and special research, for which it often happens that not more than mere fragments are available. The publications record the results in both directions, and thus provide ample material, not only for the specialist, but for anyone interested in the broader features of natural history. It must also be added that the reconstructed skeletons are prepared with the greatest scientific care. The fine example of the Columbian mammoth now described, for example, was mounted after an elaborate study of the arrangement of the footprints of a living elephant and the attitude of its limbs when walking. The skeletons of Equidæ were similarly mounted after studies of the living horse—especially after a study of the Arab, to which one article in the new volume is devoted. Among startling mounts for which existing animals give little help may be specially mentioned the reconstructed skeleton of Naosaurus, which is one of the primitive reptiles from the Permian of Texas not hitherto found in a complete state. It is a long-bodied, squat reptile, with a formidable array of sabre-like teeth, and a high, thorny frill along the back, which is supported by the much-elongated neural spines of the vertebræ (Fig. 1). Prof. Osborn, who describes this specimen, is careful to explain exactly on what material the various parts of the recon-

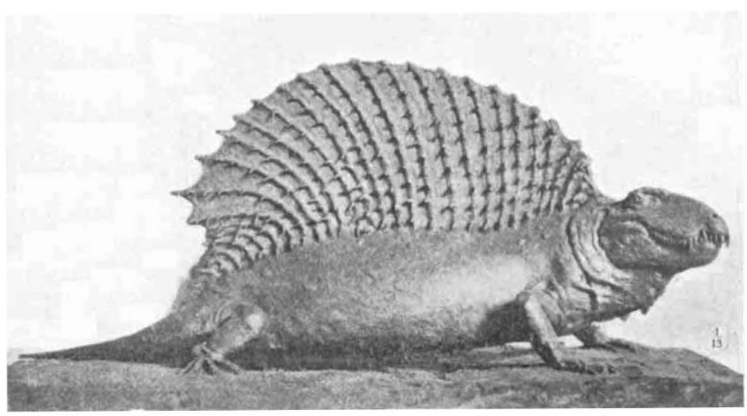

FIG. 1.—Model of *Naosaurus claviger*, by Mr. C. R. Knight.

[1] "Fossil Vertebrates in the American Museum of Natural History." Department of Vertebrate Palæontology. Vol. iii., Articles collected from the American Museum Bulletin for the years 1904–8, by H. Fairfield Osborn, &c. (New York, 1909.)