Natural History in Kinematography.

THE value of the kinematograph as a means of obtaining permanent graphic records of phases of animal movement, and of the various stages of growth and change of form that go to make up the story of the life-history of insects and other invertebrates, is, at long last, becoming more generally appreciated; while to find a British firm devoting its energies entirely to the production of such films is an encouraging sign of the growth of public interest in the pictured story of animal life. The British Instructional Films Ltd., the firm in question, has started the issue of a series of remarkably interesting natural-history films under the general title of "Secrets of Nature," which we are glad to hear will be shown as part of the regular programme at kinematograph theatres in London and the provinces. This is a step in the right direction, and should help further to demonstrate the importance of the kinematograph as a means of popular instruction.

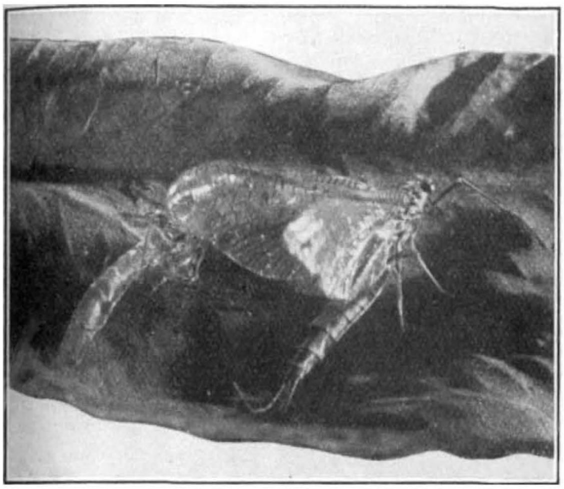

FIG. 1.—Imago of mayfly just emerged from sub-imago stage, showing cast skin, which is waterproof to enable it to escape from water.

The subjects included in the series cover a fairly wide range, and should appeal not only to all who are interested in bird and insect life, but also to the lover of the open countryside and the wild life of field and hedgerow, to the antiquary, and to the angler. There is a wonderfully complete film of the life-history of the Mayfly that must have cost an infinite amount of patience and care to obtain; a reproduction of one of the pictures is given in Fig. 1. This is appropriately followed by a still more striking record of spring salmon-fishing in Scotland amidst the most picturesque surroundings (Fig. 2). In the latter film, use was made of the ultra-rapid kinematograph camera to obtain for the first time a complete record of fresh-run salmon ascending the waterfalls and rapids in their journey up stream to their spawning grounds. By means of the ultra-rapid camera it is possible to take records at as much as eight to ten times the normal speed, so that, given sufficient light for the extremely short exposures entailed, a film may be obtained of every phase of the swift rush and leap of the fish; movements too rapid for the eye to follow or appreciate. These ultra-rapid records are projected on to the screen at the normal rate at which kinematograph films are shown, namely, at sixteen pictures a second, which enables the observer to follow clearly every detail of movement; and the lightning-like dart and leap of the fish passes across the screen as a slow and amazingly graceful series of movements.

Watching these perfect pictures, one cannot help thinking of those early pioneers of chronological photography, Marey and Muybridge, and of how much they would have given to have had at their disposal such apparatus for taking their records of trotting horses and running men. There can be no doubt that this latest development of the kinematograph will prove of invaluable service in the critical analysis of movement. During the past summer there have been taken in the Zoological Society's Gardens at Regent's Park several extremely interesting records with this apparatus, including the movement of the long tongue of the chamæleon, the forked tongue of a python, and the Barbary sheep descending the almost vertical sides of the high rocks in their enclosure in the Mappin Terraces.

Another subject included in the series will undoubtedly arouse considerable interest, for it has an historical as well as a biological aspect: that is the film record of the story of Westminster Hall and its wonderful roof. This film was taken under the direction of Sir Frank Baines, and shows not only the work of restoration in progress, but also the actual cause of the threatened danger to the venerable roof, the larvæ of the deathwatch beetle at work excavating its galleries in the heart of the old oak beams (Fig. 3). The film of the gallant little three-spined stickleback engrossed in the domestic duties of nest-building (Fig. 4), enticing the female to deposit her eggs therein, and then

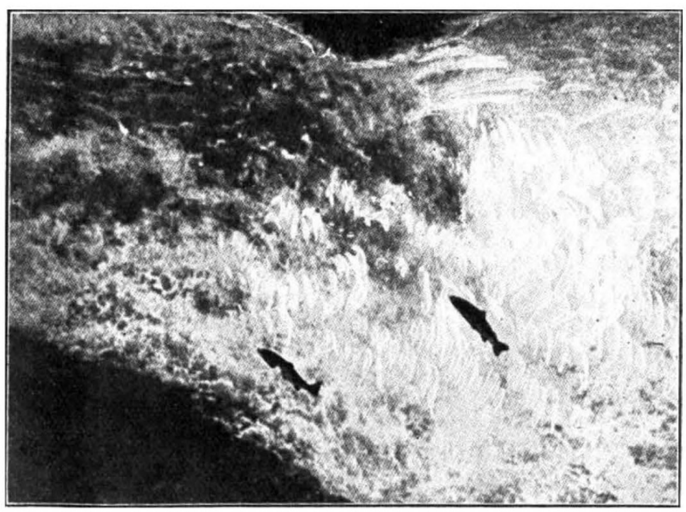

FIG. 2.—Salmon ascending a waterfall on their way to their spawning ground.

mounting guard over the spawn, and later protecting the newly-hatched fry from marauding visitors (Fig. 5),

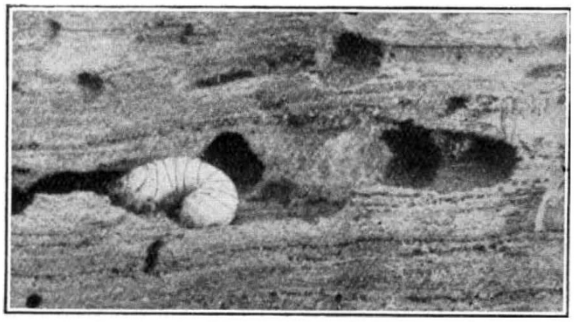

FIG. 3.—Larva of deathwatch beetle eating into roof-timbers of Westminster Hall.

is an ideal nature study subject which is bound to rivet the attention of every boy who has the good fortune to see it. One can but hope that in the near future this class of film may become a regular feature in the programme of the kinematograph theatres throughout the country, and ultimately replace much of the vulgar trash and sordid themes that at present occupy far too prominent a place on the bill.

The production of these natural-history films is by no means a simple matter, for if they are to be of real educational value, not only must the record show the subject clearly, but also they should be taken by, or under the direct supervision of, one who is thoroughly conversant with the habits, characteristic movements, and life-history of the creature, so that no important phase is missed or wrongly interpreted. This the British Instructional Film Company appears fully to have realised, their films having been taken and edited by a band of acknowledged experts. The actual taking of these records of animal life calls for great technical skill and judgment and for the exercise of untiring patience, for the difficulties to be surmounted are infinitely greater than in ordinary photography. Hours of patient watching and waiting have to be faced, and often when the end seems in sight something will happen; the stock of film in the camera runs out, or the sky becomes too overcast to permit of sufficient light for the extremely short exposures necessary, and the final stage is missed—perhaps the last possible chance of the season, and the whole of the work has to be begun all over again the following year. " Light, more light ! " is the constant prayer of the naturalist kinematographer, for he must be able to obtain sixteen fully exposed little film negatives per second if his record is to give an approximately truthful screen picture; while to catch every stage in a swift movement like the leap of a salmon or the beat of an insect's wing, the sixteen pictures may have to be quadrupled at least.

Although the photographic emulsion with which the celluloid film is coated is very fast, the need for such extremely short exposures renders it necessary to employ lenses working at very large apertures, at F.2, or F.3, if sufficient light is to reach the film. Consequently, the depth of field that will be critically sharp when working close up to the subject, as one has to do when recording the movements of small insects, will be limited practically to a few inches, necessitating constant most careful readjustment of the focus, should the creature approach nearer to the camera or elect to move further away; while owing to the enormous subsequent enlargement of the picture when projected on the screen, every detail must be recorded on the negative film with microscopic sharpness. Last, but by no means least, the subject, if a bird or a mammal, has to be accustomed to the presence, and the sound when in operation, of the kinematograph camera; this often calls for considerable patience, for all wild creatures are suspicious of unfamiliar objects or sounds.

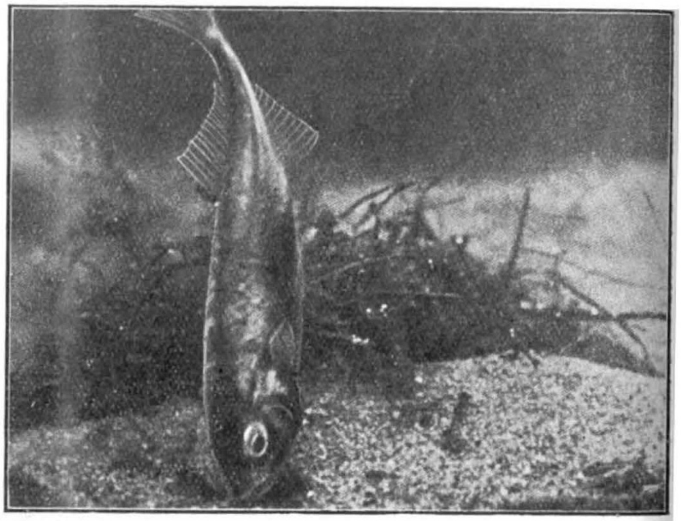

FIG. 4.—Male three-spined stickleback clearing ground preparatory to building nest.

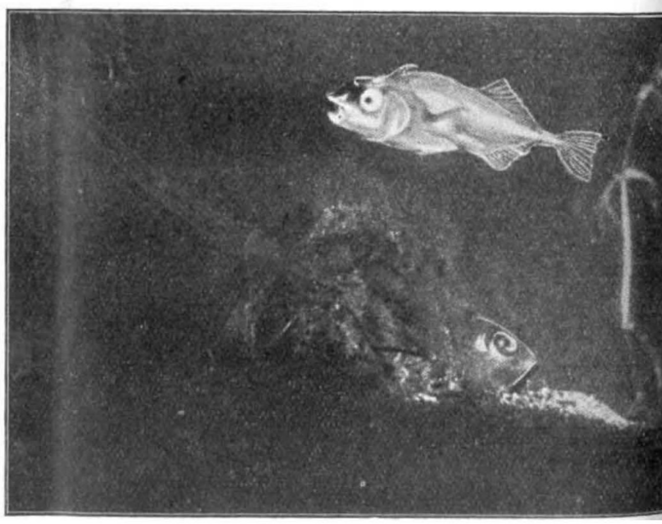

FIG. 5.—Nest completed, and female depositing spawn, while male guards the nest.

Even in captivity, this inborn mistrust and uneasiness in the presence of an unfamiliar sight or sound is maintained, and may result in agitated, unnatural movements, giving a totally false impression of the true natural characteristics of the animal.

This has been demonstrated on several occasions in making records of some of the shyer animals in the collection of the Zoological Society of London. In obtaining successful records of the rare and interesting maned wolf of South America, the kinematograph apparatus had to be set up again and again and the mechanism run without any film, before the animal could be induced to tolerate its presence or move about in a natural manner. On the other hand, the anthropoid apes, like children of the human race, are so intensely curious and interested in what is going on, that they will cease playing about in their normal fashion until they have been permitted thoroughly to examine the apparatus and satiate their curiosity.

We are indebted for the accompanying illustrations to the directors of British Instructional Films Ltd., 26-27 D'Arblay Street, Wardour Street, London, W.1.

Meteorological Perturbations of Sea-Level.

By Dr. A. T. DOODSON.

IT is always understood that the predicted heights of high and low tidal water do not take into account the variations in the height of the sea due to wind and to air-pressure, and that the errors due to these causes may be of considerable magnitude. With the large ships that are now in common use the margin between sea-bottom and ship-bottom is small, and since many of the largest ports in the world are situated in comparatively shallow water, navigation, both in channels and into dock, is carried on only with constant reference to the state of the tide. A particular example of the problem is that of loading a vessel in dock: how much cargo must be left on the quay-side so as to leave sufficient clearance for the vessel to get safely out of dock? The cargo so left has afterwards to be transported by lighter, with consequent increase of expense. If the tide is lower than was expected there is increased risk to the vessel, and if the tide is higher than was expected needless expense has been caused through leaving cargo to be transported by lighter. It is therefore obvious that a forecast of the effects of wind and air-pressure on sea-level and tides would be of very great advantage to navigators in and near a port, and for this reason much attention has recently been given to the subject.

The effects of wind and air-pressure on sea-level are also important factors for engineers engaged in the construction of harbour works. Again, they are of importance in connexion with geodetic surveys, since sea-level is an obvious datum from which to take measurements; but it has been shown by the Ordnance Survey ("Second Geodetic Levelling of England and Wales," p. 34) that measurements by levelling gave mean sea-level at Dunbar and Liverpool respectively 0·8 ft. and 0·4 ft. higher than at Newlyn. These discrepancies cannot be attributed wholly to errors of levelling, and there is reason to believe that part of the explanation is connected with climatic causes. Investigations as to the variation of sea-level with wind and pressure have been made by Mr. H. L. P. Jolly, of the Ordnance Survey, and are referred to below.

Most investigations on this subject have been concerned with air-pressure and not with wind, the sea being regarded as a negative water barometer; the "constant" for the barometer, however, varies much from place to place, and even according to the numerical method used in obtaining it. A British Association Committee in 1896 reported that the effects of wind and pressure were real, but no law could be established; the methods of investigation, however, were faulty. A successful reduction to law for both wind and pressure in connexion with tides at Ymuiden was published by Ortt in 1897, his method being to collect together observations for given ranges of values of pressure, wind direction, and strength. This method has been used, in essence, by other continental workers. Prof. R. Witting (Bulletin de la Société de Géographie de Finlande, Fennia, 39, No. 5, 1918) has elaborated a method of comparing the gradients of the sea-level in the Baltic Sea with the gradients of the pressure-system over the sea; this method is strictly in accordance with theoretical considerations, but it requires a large number of observing stations, and is most confidently applied to narrow seas. His use of pressure gradients instead of wind-strength and direction of wind is very commendable, and was utilised by Mr. Jolly in his investigations, leading to the simple formula

$$\zeta = \kappa(B - \bar{B}) + \lambda(E - \bar{E}) + \mu(N - \bar{N}),$$

where ζ is the meteorological disturbance of sea-level; B, E, N are the values of the local barometric pressure and its gradients to the east and north respectively; bars denote means in the interval of time considered, and κ, λ, μ are constants determined from observation.

This formula is valuable because it lends itself very easily to numerical methods, and fairly accurate values of the constants may be obtained from observations extending over only a month, whereas an elaborate method like Ortt's requires far more observations and much more labour. It represents the perturbations of mean sea-level with a fair degree of accuracy.

The formula has been used extensively at the Tidal Institute at Liverpool, and has yielded some very interesting results. It is easy to deduce from it the direction of the most effective wind for raising sea-level at the place considered, and this has been evaluated from a month's observations at various places on the British coast, the results being illustrated in Fig. 1. The arrows give the direction from which the most effective winds blow, and the lengths of the arrows are proportional to the effects for a given strength of gradient in the most appropriate direction. Many previous investigators dealing with the perturbations of mean sea-level on the Continental coast of the North Sea have found that the most effective winds for raising sea-level there are those which blow towards