about the axis. The amplitude of oscillation of the gyroscope, as Sir William White proceeded to point out, depends upon many conditions, among which the period of oscillation and its ratio to the period of rolling of the vessel are important.

In order to utilise the gyroscopic effect in checking rolling it is necessary to have a means of braking the apparatus so as to check movement on its trunnions and the rotary motion of the fly-wheel. To control the swinging motion a simple band-brake was fitted, the drum for which is shown on the left of Fig. 1. In addition to this a socket was fitted on each side of the gyroscope casing below the fly-wheel, the braking effect being supplied by hydraulic power and regulated by a valve. With the casing held by the brake the gyroscope would have no effect on the rolling motion, but on the friction band being loosened the casing would oscillate on its athwartship trunnions, and the gyroscopic action would come into play. Sir William White says that, when standing upon the deck, which maintained a practically horizontal position, the vessel heaving vertically, it was curious to notice that though the gyroscope might be oscillating longitudinally the impression was conveyed that the vessel herself was pitching.

Still-water rolling experiments were made with the *Seebar*, rolling being set up by the crew running from side to side. With the gyroscope fixed, the period of a complete double roll was found to be 4·136 seconds. When the fly-wheel was running at 1600 revolutions per minute, the period was six seconds. The boat was next hove down by a crane to an inclination of 10° to 15° from the vertical, and when let go the successive extreme inclinations were noted until they fell to about ½°.

The still-water rolling experiments strikingly illustrated the enormous extinctive effect of the gyroscope, as shown by a diagram given by the author of the paper. Selecting two experiments for illustration, it was found that with "an initial angle of inclination of 10° with the gyroscope at rest 20 single oscillations took place before the extreme inclination to the vertical was reduced to half a degree; whereas the same amount of extinction was obtained with little more than two single oscillations when the gyroscope was free to oscillate and the fly-wheel was rotating at 1600 revolutions per minute."

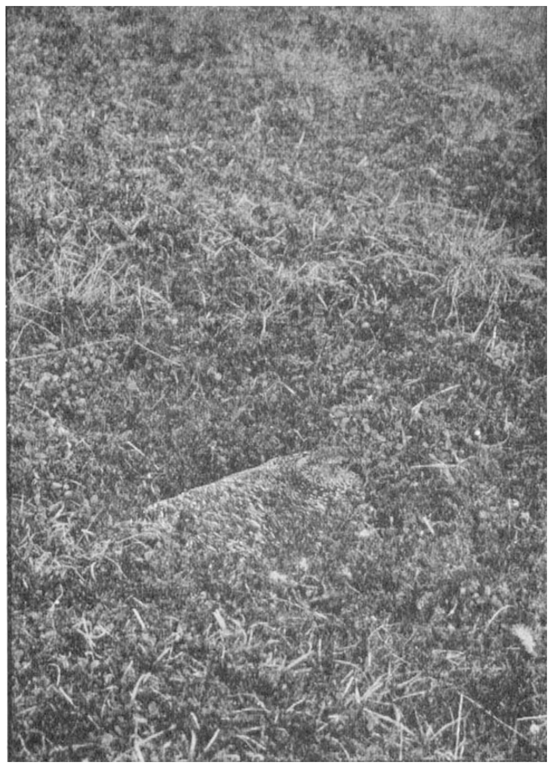
In Fig. 2 we reproduce from Sir William White's paper a graphic record of rolling experiments made with the *Seebar* off Cuxhaven. The point marked B denotes the time when the brake band was released, the gyroscopic wheel becoming free to swing on its trunnions, and the extinctive forces coming into action. The revolutions were 1600 per minute, and, as will be gathered, the practical result was to extinguish the rolling motion almost immediately, although the vessel was naturally still subject to heaving motion. The inclinations were insignificant, varying from about ½° to 1°.

Sir William White in his paper discussed the further application of the apparatus to war vessels, and though he did not commit himself to any definite opinion, it may be said that the impression given was decidedly of a hopeful nature. In connection with this subject the experiments of Sir John Thornycroft with his steam yacht, the *Cecile*, and those of the late Mr. Beauchamp Tower with his hydraulic steady gun platform controlled gyroscopically, will doubtless be remembered. Particulars of both series of investigations are to be found in the Transactions of the Institution of Naval Architects.

G. R. DUNELL.

BRITISH NESTS AND EGGS.[1]

THIS handsome and exquisitely illustrated volume (which is practically a new work, so greatly does it exceed its predecessor in bulk and in wealth of illustration) makes its appearance, no doubt purposely, at an opportune time, and if it induces but half-a-dozen collectors in the coming season to devote their attention to photographing the nests of our native birds in place of robbing their eggs, it will have done a great service to British ornithology. According to the letter of an admirer quoted in the preface, such a conversion has already taken place in several instances as the result of the Messrs. Kearton's previous works, and an extension of the new practice may therefore be confidently awaited. Mr. Kearton observes that "it is a curious kind of morality that will scorn to steal from the individual



Ptarmigan on Nest. From "British Birds' Nests."

and yet rob the community without compunction. Wild birds are national property, and no individual has a right to harm one of them without the sanction of the law to do so." Although this is, no doubt, to a great extent true, it must be remembered that by nature we are all essentially hunters and spoilers, and as many of us, at any rate, have not yet fully imbibed the socialistic spirit, it would not do for the present to be too hard on the egg-collector if he conducts his operations with moderation. *Festina lente* is an admirable motto in this and many other matters.

As regards the book itself, a critic is frequently embarrassed as to what he should write from the intrinsic badness of the work set before him; in the present instance the reverse of this is the case, and

[1] "British Birds' Nests, How, Where and When to Find and Identify Them." By R. Kearton. New edition, revised and enlarged. Pp. xii+520; illustrated. (London: Cassell and Co., Ltd., 1907.) Price 21s. net

the reviewer scarcely knows how to control his pen so as not to appear unduly laudatory. To say that the book is practically perfection is a mild way of putting it, for, as a matter of fact, it is one that can never be equalled or rivalled so long as the copyright of its illustrations holds good, since no other man is likely to undertake the labour and expense necessary to produce a similar series of pictures from nature, even if he had the energy and patience necessary to the task. How great a debt ornithologists and bird-lovers generally owe to the Messrs. Kearton (for a large number of the photographs have been taken by the author's brother, Mr. Cherry Kearton) it is, indeed, impossible to estimate, and a part of their reward, at any rate, must consist in the pleasure they afford to, let us hope, an ever-widening circle of readers.

Of the photographs of nests and eggs, as well as of those of the parent birds, it is impossible to speak too highly, and where all are on such a high level of excellence it would be almost invidious to select any for special commendation. The one here reproduced has been chosen on account of its size rather than from any other consideration. The plates of eggs are admirable examples of the best style of three-colour process. Taken as a whole, the volume (which is a marvel of cheapness) will probably prove the most attractive natural history book of the year.

THE ORIGIN OF "BOTTOM WATERS" IN THE NORTHERN SEAS.

A SERIES of valuable tables and charts, in which the results of a great series of observations made in 1901 by Captain Roald Amundsen in the Arctic Seas are summarised, is contained in a monograph recently published.[1] These observations are supplemented by, and compared with, results published by other observers, chiefly Russian and Norwegian, and as a collection of facts the little volume is certain to prove of great value to all students of oceanography. Dr. Nansen's. main purpose in the discussion of the observations has been the scientific explanation of the origin of the intensely cold and heavy "bottom waters" found in the basins of the Norwegian seas and North Polar Ocean. In discussing the scientific results of the Norwegian North Polar Expedition of 1893–6, Nansen had already dealt with this subject, and reached the provisional conclusion "that the cold bottom water of the Barents Sea is divided into two portions; the northern cold water coming from the sea to the North, North East, and East; and the southern cold water having two or three sources, namely bottom currents from the East and North East, and the surface of the sea itself which is cooled during the winter." In the light of more recent and extensive observations, Nansen has revised his opinion, and puts forward a different explanation of the origin of bottom water. This explanation accords with the facts observed, and may be briefly summarised.

The conditions required for the formation of bottom water are that near the surface water shall be found having a salinity of about 34·9 per cent., and that during winter this water may be cooled down to $-1^{\circ}{\cdot}3$ C. or $1^{\circ}{\cdot}4$ C. Its density may thus be between 28·11 and 28·13, and possibly greater, so that it becomes sufficiently heavy to sink. The assumed salinity of surface water Nansen thinks will only exist in places where Atlantic water has mixed with Arctic water. Further, he considers that when bottom water is being formed there must be no rapid horizontal circulation which would bring in new supplies of relatively warm water. As the surface water becomes heavier it sinks, and will be replaced by somewhat warmer water of higher salinity, which in its turn will be cooled until it becomes heavier than the previous surface water, when it will sink still deeper, and be replaced by warmer water of still higher salinity from below. The uppermost strata will by this process be gradually increased in salinity, and approach that of the bottom water—about 34·9 per cent. The depth of vertical circulation will increase until it reaches down into the typical bottom water, and at that stage all strata from the surface downwards will have attained nearly uniform temperature, salinity, and density. Subsequent cooling at the surface will produce water so heavy that it may sink far down into the bottom water, or even to the bottom of the sea.

The heaviest sea-water of which Nansen has any knowledge was found at a depth of 120 metres—8 metres above the bottom—off the coast of Nova Zembla in May, 1900; the temperature of bottom water has in some cases approached -2° C., with a salinity exceeding 35 per cent. and a density of 28·33. The observations made extended to depths of 3000 metres, where the temperature was $-1^{\circ}{\cdot}1$ C. Amundsen reached 2000 metres, at which the temperature was $-1^{\circ}{\cdot}3$ C.

The circulation of bottom water in the Norwegian Sea Nansen describes as follows:—The bottom water is chiefly formed and sinks towards the bottom during the winter and spring in the regions between 73° and 76° north latitude, and between 4° west longitude and 4° east longitude. From this region it moves along the bottom and spreads out laterally, producing cyclonic movements in the deep strata of the Norwegian Sea. During this circulation the bottom water is slowly heated from the underlying warmer sea bottom and from the overlying warmer water. In this manner its temperature near the bottom is gradually raised from about $-1^{\circ}{\cdot}3$ C. to about -1° C. Nansen estimates that at least two-thirds of the whole basin of the Norwegian Sea is filled with cold bottom water. The renewal of the cold bottom water in the basin of the Norwegian Sea must be an extremely slow process, and it has been established by actual observation that the bottom water does not extend across the ridge anywhere between Iceland and Norway, where the temperature is nowhere below zero. Further, he thinks that it is very improbable that any bottom water with a temperature below -1° C. ever gets across the ridge between Iceland and Greenland.

For the North Polar basin Nansen considers the minimum temperature to be between $-0^{\circ}{\cdot}8$ C. and $-0^{\circ}{\cdot}9$ C., the salinity being about 35·1 per cent. If existing observations are confirmed, in his judgment the possibility of a communication between the deep North Polar basin and the deep basin of the Norwegian Sea, as well as of their bottom waters, will be finally excluded. In that case he thinks that there are two regions where the bottom waters of the North Polar basin might originate by being cooled down directly through radiation from the sea surface, namely, in the seas north of Spitsbergen and near northern Nova Zembla. Nansen is further of opinion that the renewal of the cold bottom water of the enclosed North Polar basin will occur even more slowly than the corresponding renewal in the Norwegian Sea, so that a much smaller quantity of water

[1] "Northern Waters: Capt. Roald Amundsen's Oceanographic Observations in the Arctic Seas in 1901, with a Discussion of the Origin of the Bottom-waters of the Northern Seas." By Fridthjof Nansen. Pp. 154; 11 plates. (Christiania: Jacob Dybwad, 1906.)