of 2·170 feet at Benares, was brought from Calcutta across the mountainous region of Hazaribagh. This levelling was carefully observed, but no levelling over mountains can have a high degree of accuracy. The rays to the fore and aft staves are exposed to unequal refraction. I do not think that the level of the flat plains of Bihar can be tested by mountain levelling. A bench-mark on Hazaribagh rock would be a reliable standard datum for Bihar, provided it were not high up, but on a steep ascent levelling accuracy deteriorates.

Dinajpur Levelling. In 1900 (after the publication by the Geological Survey of the memoir on the great earthquake of 1897) a line of levels was carried across Bengal from south to north, from Calcutta to Dinajpur, by Capt. H. L. Crosthwait and Lieut. H. M. Cowie: this line was in every way scientific, and the height of Dinajpur was determined as accurately as was possible. In 1925 a new line of levels intersected the 1900 line at Dinajpur. The discrepancy between the 1900 and the 1925 results was 0·963 foot.

Dr. Hunter assumes this discrepancy of 0·963 foot to be due to the rise of Bengal between 1900 and 1925, and he converts the observed error of 0·963 into a theoretical rise of 4 feet in 100 years. Dr. Hunter's procedure is based upon the assumption that there was no levelling error on either of the lines that met at Dinajpur. Such an assumption is contrary to experience. If we bear in mind that the 1925 level-line had to pass through the streets of Calcutta and to cross the Hugli, and that both the 1900 and 1925 lines had to cross the main stream of the Ganges, we may feel justified in thinking that a discrepancy of 0·963 foot in 500 miles is within the limits of accumulated error.

The safest way of proving whether Dinajpur has risen in height would be to re-observe the whole levelling line of 1900, bench-mark by bench-mark, from Calcutta to Dinajpur. A single intersection of this line by another line does not furnish convincing evidence.

By DR. J. DE GRAAFF HUNTER, C.I.E.

MY short account of the results of spirit-levelling in Bengal, accumulated between 1862 and 1930, and their interpretation, are given in the Survey of India Geodetic Report (6, 104–6). In such a report considerations of space preclude the inclusion of every corroborative detail which the full records of the work contain.

Sir Sidney Burrard, not quite rightly, says that my theory rests on three levelling results. Actually it rests on a group of levelling circuits all giving evidence in the same direction; but the results which he cites are certainly important. The first of these does not rest on the single bench-mark at the railway station. If reference is made to pp. 71–97 *loc. cit.*, it will be seen that two bench-marks, a quarter of a mile apart, were picked up at Pirpainti and gave results agreeing within 0·05 ft. Further, the connexion with Pirpainti was made after results at Bhagalpur and Luckeesarai had indicated a rise of more than two feet; which the Pirpainti connexion confirmed. The 'secondary' levelling of 1929 is almost of the same type as what was formerly (before the introduction of levelling of high precision) known as levelling of precision.

The Benares result depends in part on Pirpainti, now justified, and on modern levelling through the mountainous region of Hazaribagh. In the case of a much more mountainous Himalayan circuit, I investigated the refraction anomaly, and found it to be trivial, a much more important error being due to the variation in length of the wooden levelling staves, during the course of the day. This tends to increase with the total amount of ups and downs of the line, which in the case of the Hazaribagh line are not enough to justify rejection of results, though nowadays we should employ invar staves in such a case.

Careful consideration was given to the errors which might naturally be expected in all these levelling lines, including those on which the Dinajpur result was based; and the special difficulties of wide river crossings were not forgotten.

The geographical evidence is sufficient to cause Sir Sidney to mistrust the levelling of 1862 because the workers were inexperienced and had primitive instruments; and more modern work when it passes through mountains such as occur in Hazaribagh. I cannot bring myself to discount all the spirit levelling in this way and prefer to judge it by its own internal and unbiased evidence, not omitting to consider the 'systematic' error as usually evaluated.

The spirit levelling evidence is limited to the area of its observations, and so gives only a partial picture. This covers roughly the triangle Calcutta–Darjeeling–Benares. So the contours of my chart (NATURE, Feb. 17, p. 236) extend little into the area of Sir Sidney's sketch of the rivers of Bihar. Most of this river area may have risen almost uniformly, which would certainly be in keeping with my area of underloading. Why, then, should extensive geographical changes be expected, or their absence be regarded as in opposition to the results of much spirit-levelling?

In my opinion much of the so-called 'systematic error' in levelling must be due to secular changes of ground level operating during the progress of the lines forming a circuit. On this account we are probably assessing the precision of spirit levelling below its true value.

Research in the Sea*

THE latest available issue of the *Journal of the Marine Biological Association* contains many valuable memoirs, being records of research undertaken chiefly at the Plymouth Marine Laboratory but also at the Scottish Marine Station, Millport, the Port Erin Marine Station, Isle of Man, and the Dove Marine Laboratory, Cullercoats, Northumberland. The whole is admirably planned and emphasises the fact that oceanography in its broadest sense is the object of all the work done in these laboratories, that is to say, the study of the sea and its contents both animate and inanimate and of all factors which influence these, centring round the fish itself. It is impossible nowadays to separate pure science from the practical side, or to say that any matter connected with the sea is irrelevant to its study, and we find these researches carried on in the marine laboratories of Great Britain tend more and more to fit into one another and show real progress in general knowledge of the interpretations of marine phenomena.

A glance at the subject matter will show how varied are the contents, but yet how well everything

* *Journal of the Marine Biological Association*, N.S., **19**, No. 1, August 1933, pp. 1–286. (Plymouth: The Association.)

© 1934 Nature Publishing Group

really hangs together. Perhaps the most notable of the contributions is Mr. E. Ford's account of the herring investigations conducted at Plymouth during the years 1924–1933, which is a summary of his own work in connexion with the Plymouth herrings covering this period. He shows how far we have now gone in elucidating herring problems—a considerable distance, for we now can predict fairly well the probable constituents of the main portion of the herring fishery some years ahead, although weather and other agents may always upset calculations. The breeding of the herring is now becoming well understood: where the eggs are deposited, where the newly-hatched larvæ are to be found and those slightly older, their migrations out to sea in search of food and their spawning migrations inshore. Intensive studies of bones show how temperature has a distinct influence on the number of vertebræ and therefore of size, and thus the problem of races may be interpreted; and the reading of the scales tells us the ages of the fishes and the year classes to which they belong, so that we may know what classes are likely to make up the fisheries of future years. This full and valuable paper is indeed worth reading.

Mr. G. A. Steven's account of the food of the shags and cormorants round the Cornish coast also appeals directly to the fishing industry. Here a long-standing error is corrected, showing that the shag, which is far commoner on the open coast than the cormorant, is innocent of the destruction of commercially important fishes, its main food being smaller fishes of little value and usually not consumed by man. The cormorant, feeding much farther inland, certainly does considerable damage by preying on our edible fishes, especially flat-fishes.

Trematode parasites of fishes are dealt with by Mr. E. Idris Jones, and Miss D. Atkins describes a very interesting new orthonectid in the bivalve mollusc *Heteranomia* showing quite new features.

The shell-fish industry is represented by an important paper on oysters by Prof. J. H. Orton, following up his previous work on sex, showing the fate of unspawned ova and the change from male to female. The results described here of years of experiment with oysters in cages prove definitely for the first time that male individuals of *Ostrea edulis*, our common commercial oyster, pass into the female condition in significant proportion within twelve months, and that greater proportions attain the female condition in two years.

Information as to the food of fishes and of invertebrates is at all times desirable, and on this subject there are several papers dealing with the plankton, Mr. F. S. Russell on the seasonal distribution of macroplankton, Miss O. Jorgensen on the marine *Cladocera* of the Northumberland plankton, and three papers of great interest by Dr. A. G. Nicholls and Miss S. M. Marshall on *Calanus finmarchicus* from the Clyde area. In these last the copepod, which is of the greatest significance as fish food, especially of the herring, is dealt with in a masterly way, and its reproduction and seasonal distribution, its variation in size and its vertical and diurnal migrations are described. Mr. G. N. Spooner's experiments on the reaction of marine plankton to light are very suggestive and may lead to the elucidation of some of the difficult problems connected with migrations.

From animal plankton we come to vegetable plankton, and find Mr. H. W. Harvey's paper on the rate of diatom growth, showing how the neritic diatom *Nitzschia closterum*, taken from the pure cultures grown by Dr. E. J. Allen continuously for many years, react to experimental conditions, and Mr. F. M. Ghazzawi, on the littoral diatoms of the Liverpool and Port Erin shores, touches a section of these Algæ which has been too long neglected and is of considerable importance in the economy of the sea.

In connexion with the long standing and classic Mendelian work on *Gammarus* by Mrs. E. W. Sexton, which has been going on for many years in the Plymouth Laboratory, it is interesting to find that Mr. Bassindale has discovered abnormal eyes in wild *Gammarus* in the Tay Estuary.

The inorganic element is well to the fore, and in two papers Dr. L. H. N. Cooper continues his work on chemical constituents of biological importance in the English Channel and shows how winds influence the salt content in the sea, whilst Dr. W. R. G. Atkins and Dr. H. H. Poole discuss the use of cuprous oxide and other rectifier photo-cells in submarine photometry, and Dr. Atkins describes a method for rapid estimation of the copper content of sea water.

University and Educational Intelligence

A MATHEMATICAL Colloquium will be held in St. Andrews on July 18–28, under the auspices of the Edinburgh Mathematical Society. Courses of lectures will be given by Prof. E. A. Milne (Oxford), Prof. B. M. Wilson (Dundee), Prof. H. W. Turnbull (St. Andrews), and Mr. W. L. Ferrar (Oxford). The local secretary is Dr. D. E. Rutherford, United College, St. Andrews.

THE educational film has now an assured place as a teacher's tool. The Central Information Bureau for Educational Films, established to further its employment, publishes a bulletin, *Film Progress*, in the December–January issue of which is announced the completion of a catalogue (price 3*s*. 9*d*., post free, Central Information Bureau for Educational Films, 103 Kingsway, W.C.2) of about two thousand films (35 mm., 16 mm. and 9·5 mm.) already made and approved by authoritative associations or individual experts on agriculture, engineering and industry, geography and travel, vocational guidance, and science, including hygiene, physics, chemistry, geology, physiology and psychology.

WE have received from the University of Leeds a handsomely illustrated booklet presenting the salient features of its organisation, actual and projected, and an account of its chief courses of study. It recalls the fact that the land and buildings of the University have been provided almost entirely as a result of private generosity, sometimes unsolicited and sometimes in response to public appeals such as that which has recently produced £430,000. Unshackled by commitments of imperfectly prescient founders of long ago, the University is taking shape in the disposition of its main buildings as an example of planning for maximum efficiency; the departments comprised in the faculties of arts, law, economics and commerce, science and technology being grouped around the new Brotherton library and within five minutes' walk of the medical and dental schools, which are adjacent to the General Infirmary. Attention is directed to the fact that more than a quarter of the full-time students are in halls of residence.

© 1934 Nature Publishing Group