

in the case of London, and less but perceptibly so in that of Brighton, the light has become of a more silvery hue, due doubtless to the extensive use of the electric light. The distance between this place (lat.  $51^{\circ}$ , long. 0) and London is about thirty-five miles in a direct line, and there is no place of any size between these points, so there can be no mistake about it; and that the reflection of light at such a distance should be visible seems worthy of notice. It would be interesting to know how far, under favourable atmospheric conditions, the reflection of the London lights can really be seen.

W. J. TRENTLER

Fletching, Sussex, November 22

#### A Lunar Rainbow

ANY of your readers who happened to observe the heavens on Saturday night, the 17th inst., at about 11.15 to 11.30, could not fail to notice the beautiful lunar rainbow which was then visible. Though the moon had slightly passed its perigee, it was shining with such dazzling brilliance that the marbled shadows on its surface were almost effaced, and it hung in the heavens like a spotless crystal sun. The very stars seemed farther away, as though they had shrunk back, ashamed and frightened by the silver glory. Jupiter and Sirius alone stood fearless and undaunted—the former, below her to the left, as if in attendance, the latter far away in the starless south. A few featherlike clouds which the moon illumined with a splendour of her own, now and again sailed in stately silence across her path, but that portion which spread directly over her face, seemed to melt and become invisible like a snow flake on a warm hand, so that the cloud floated around her as a veil, fringing but not covering her face. It was when surrounded by one of these clouds that the rainbow became visible. I had never seen one before, so cannot say whether it was more distinct and bright than is usually the case, but I could see most vividly the red, yellow, green, and violet bands with their intermediate shades. The bow seemed formed on the cloud that shaded the moon at the time, and lay round her in a perfect, though comparatively small circle. It remained so for some nine or ten minutes, and then faded gradually away into a luminous halo of golden brown. Those of your readers who were fortunate enough to behold this beautiful phenomenon will, I am sure, agree with me that it was a sight not to be forgotten.

J. C. KERNAHAN

The London Institution, November 24

#### Sudden Stoppage of Clocks

I HAVE four clocks in my house; one is on a wall that bears north-east and south-west, while the other three ranged nearly at right angles about north-west and south-east. The times of these clocks were not exactly together, there being from five to fifteen minutes between the times; but all of them stopped on the morning of November 18 at times as recorded by each between 3.25 a.m. and 3.40 a.m. Have any other clocks stopped on the same night? This place—Lurgybrack, Letterkenny, Co. Donegal, is in lat.  $54^{\circ} 56'$  and W. long.  $7^{\circ} 41' 52''$ .

Letterkenny, November 19

G. HENRY KINAHAN

#### Fog Bows

ON November 14, when driving about half way between Convoys and Letterkenny, Co. Donegal, I observed a very complete bow at about 1 p.m., due solely to a fog. For the most part it was quite white, but at the springing there were slight traces of prismatic colours. On November 15 at 7 a.m. at Letterkenny there was also a fog bow; this, however, had all through well developed prismatic colours. The 15th afterwards came on a heavy wet day; the 16th was fine; but since then there have been severe winds accompanied with sleet, snow, and rain.

G. H. KINAHAN

Letterkenny, November 19

#### THE EARLY HISTORY OF THE HERRING<sup>1</sup>

THE Admiralty having intimated on July 31 that they were prepared to grant the use of a gunboat to enable the Board to undertake some investigations into the early

<sup>1</sup> Preliminary Report of the Investigation Committee of the Fishery Board for Scotland.

history of the herring, the convener of the Committee appointed to carry on these inquiries made as complete arrangements as was possible in the limited time, and, along with Sir James R. Gibson-Maitland, proceeded to join Her Majesty's gunboat *Jackal* at Invergordon on August 6. Besides making preparations to collect material to illustrate the growth of the herring during the early stages of its development, it was thought desirable to make arrangements for the examination of the spawning grounds, in order to ascertain under what conditions the spawn was deposited. To assist in the work Mr. J. Gibson, D.Sc., of the Edinburgh University Chemical Laboratory, and Mr. J. T. Cunningham, B.A., of the Zoological Laboratory, were invited to join the expedition.

The trawls, dredges, and other appliances were taken on board on August 6, and on the following day the *Jackal* left Invergordon for the Moray Firth, and began the work of investigating the inshore spawning grounds lying between Wick and Fraserburgh. Each place examined was indicated by a number on the chart, and will be spoken of in the Report as a "station." During the month the *Jackal* was at our disposal sixty stations were made, and nearly as many by the *Vigilant* from the time she relieved the *Jackal* to her return to Granton on October 6. The plan generally adopted at the various stations consisted in (1) taking the depth and the surface and bottom temperatures; (2) collecting samples of water from the bottom, and of the mud, sand, &c., brought up by the sounding apparatus; (3) noting the nature of the surface fauna taken in the tow-net; and (4) examining and, when necessary, preserving the animal and vegetable forms brought up by the trawl, dredges, and tangles. In this way there has been collected a considerable amount of raw material, from which important results will in due time be obtained.

Not the least interesting part of the work consisted in experimenting with herring ova which were successfully artificially impregnated and developed. At first experiments were made with spawn obtained at Helmsdale on August 7, from herring which had been several hours out of the water; but the results being unsatisfactory, it was determined to obtain, if possible, the roe and milt from living fish. We, therefore, frequently remained during the night on the fishing ground, and boarded the herring boats when the nets were being hauled. The fishermen, always pleased to see us, rendered every assistance in their power. Selecting ripe fish, we expressed the roe and milt on squares of glass, which were then placed in carrying boxes specially designed for the purpose. The boxes were conveyed by the *Jackal* to a small laboratory near Geanies, which had been kindly placed at the disposal of the Committee. Once at the laboratory, the glass plates, with the developing eggs firmly adhering to them, were transferred to hatching boxes, through which a constant current of water flowed from a large tank. In from three to five days well-formed active embryos were visible through the thin transparent egg membrane, and in ten days we successfully hatched fry from the artificially impregnated ova. We soon discovered that success depended on having an abundant supply of pure sea-water at an equable temperature. Unfortunately, just as our arrangements for experimenting on a large scale were completed, the herring fishing in the Moray Firth came suddenly to an end, and it was impossible to obtain further supplies of eggs.

We next directed our attention to the nature of the surface forms, which are believed to supply the principal food for the herring fry, and when this, on account of the weather, was no longer possible, we proceeded to examine the mussel scalps in the Dornoch, Cromarty, and Inverness Firths.

As a full account of the autumn's work will be presented to the Board in time for the Annual Report, only a short statement is now given, indicating rather the

lines of further investigations than the results already obtained.

During our stay in the Moray Firth our attention was constantly directed to the change in the position of the spawning grounds. It was stated that, some fifteen years ago, immense shoals of herring visited the inshore ground, in order to deposit their spawn in comparatively shallow water, but that now they had deserted their former favourite haunts for banks from thirty to eighty miles at sea, lying at a depth of from thirty to fifty fathoms. This has caused great distress, as from the absence of suitable harbour accommodation, the large boats fish from distant stations, and the inshore "takes" of the smaller boats (all of which can be beached) is not now sufficient to give employment to the local population in curing. The Report of the Commissioners for British Fisheries for 1862 gives the total take at the ports especially devoted to the inshore fishing, viz. Lybster, Helmsdale, Cromarty, Findhorn, and Buckie, as 158,314 barrels, whereas in 1882 it was only 31,574. On the other hand, at Fraserburgh, a great centre for the deep-sea fishing, the take has increased from 77,124 in 1862 to 233,297 in 1882. Though these figures, and our experience during the autumn, show conclusively that herring are no longer so abundant on the inshore grounds, they do not prove that the shoals are every year spawning farther and farther from our shores, as is often alleged, or that, if we continue to disturb the offshore spawning grounds as we have the inshore, they will disappear from our waters altogether. Some who have had considerable experience believe that spawn deposited in forty fathoms water never develops, and that even if it did the herring fry would perish for want of the proper nourishment.

The disappearance of herring from inshore grounds is accounted for in many ways by the fishermen. Some believe that the offshore fishermen prevent the shoals from reaching the coast by the many miles of nets which they throw across their path; others that the inshore fishing has been destroyed by the winter sprat fishing, most of the so-called sprats being young herring. The former explanation seems to imply that the inshore and deep-sea herring are identical, whereas the latter seems to indicate that they are different. The Report of the German Commission bears that there is a difference between the autumn and spring herring of the Baltic; there may also be a difference between the deep-sea and inshore forms. When this problem is solved we may be able to account for the disappearance of the inshore herring. Should some herring have been so modified that they prefer to spawn on rocky ground in shallow brackish water rather than on deep gravel banks in the open sea, or if herring return to their birthplace to spawn, it will be possible by skilful management to restore the inshore fishing to its original productiveness.

Having examined the inshore spawning grounds, we next proceeded to investigate the banks where the deep-sea herring were believed to spawn. At the outset we felt there was no evidence that these banks had not always been used by herrings as spawning beds. We do know, however, that as the herring boats increased in size enterprising fishermen were enabled to proceed farther to sea, and as a reward they discovered great shoals of herring, the comparative density and condition of which form an interesting subject for immediate investigation. It may have been a mere coincidence that this took place about the same time as the inshore shoals began to diminish. We have no reason for supposing that what we now speak of as deep-sea herring have not been as abundant for centuries as they are at the present day. Man, it seems to your Committee, is not likely much to reduce the number of herring some fifty miles at sea, however much influence he may exert over those which frequent our territorial waters. The time at our disposal did not permit our making a thorough examination of the

offshore grounds; in fact, we were only able to begin this part of the work. But there can be no doubt, from the observations already made, that spawn is deposited on these banks, and that the slight difference of the bottom temperature (some 3° C.) would only slightly retard development. Further, the fry once hatched would find an ample supply of food in the rich surface fauna.

The Committee feel that, in order to obtain satisfactory information as to the food of the herring, it will be necessary to make continuous observations for a year or more at all the principal fishing stations around our coast. This could easily be undertaken through the fishery officers.

As to the so-called migrations of the herring, the Committee has not had sufficient time to make a careful investigation, but from the observations made it seems evident that, as the spawning season approaches, the isolated herring and the small groups congregate together, and thus form dense shoals. The shoals once formed instinctively select banks free from mud and shifting sand, and provided with numerous rocks and stones, or with an abundant coating of seaweeds. Having found a convenient bank covered with water at a suitable temperature, and with the requisite specific gravity, they hover over it, if left undisturbed, apparently not paying much heed to the claims of hunger, but feeding on whatever crustacea, sand eels, or other small forms come in their way. The spawn once ripe, they congregate at the bottom, the females depositing the roe on the rocks and seaweeds, to which it at once firmly adheres, and the males fertilising it with their milt. How long a period is required for the whole of the roe to escape has yet to be ascertained. Soon after the "shotten" condition is reached, both males and females begin to leave the spawning ground,—hunger being probably the chief factor in the dispersal of the spent fish,—and this goes on until the whole shoal is dispersed, the hungry disbanded members, either singly or in small companies, hurrying hither and thither in anxious search of food. When they have partly recovered from their exhausted condition they may collect into larger groups; but their further movements are probably largely influenced by the shoals of crustacea on which they chiefly subsist. In all probability their principal feeding ground lies somewhere between the Shetland Islands and the Scandinavian coast. This region is probably the great reserve feeding ground for the fish of the North Sea, and it should at an early date be carefully explored.

The examination of the three firths—Dornoch, Cromarty, and Inverness—has shown that they are all extremely well adapted for producing mussels. Part of the Dornoch Firth already is a considerable source of wealth to the authorities of Tain, but even there the cultivation might be greatly extended. The demand for mussels is great, and the want of them, when herring are unattainable, is often a great hardship to the fishermen; with a little care, the three firths mentioned would supply bait for the whole east coast of Scotland.

The Committee recommend the Board to remit the consideration of the Scottish mussel and oyster banks to a special committee, with the view of taking steps to have their complete control transferred from the Board of Trade to the Scottish Fishery Board.

As the work of the Committee proceeded they have been impressed with the fact that almost everything has still to be learned regarding the habits and life-history of all our food fishes, and they concur in the truth of the following extract from a recent report of the International Fisheries Exhibition:—"It is a very striking fact that the one point on which all speakers at the conferences held during the past summer at the Exhibition were agreed was this—that our knowledge of the habits, time and place of spawning, food peculiarities of the young, migrations, &c., of the fish which form the basis of British



fisheries is lamentably deficient, and that without further knowledge any legislation or attempts to improve our fisheries by better modes of fishing, or by protection or culture, must be dangerous, and, indeed, unreasonable."

Further, your Committee feel that in order to make any progress the work must be undertaken in a systematic manner; the investigations must not be carried on by fits and starts, but continuously from month to month and from year to year, until all the facts have been collected and all the experiments made that are likely to throw any light on the difficult problems.

It having been alleged that the food fishes were disappearing from the eastern coasts of the United States, the Central Government in 1871 appointed a commissioner of fish and fisheries to inquire into the matter. The commissioner, instead of contenting himself with collecting evidence from people who knew little or nothing about the subject, proceeded to make careful and elaborate investigations. As the result of these inquiries the United States fisheries have been greatly improved, to the benefit of both the general public and the fishermen, and our knowledge of fish has been materially increased.

In the same way, and about the same time, a German Commission set to work, and although their results are not so striking, they are extremely interesting, a fourth section of their report, only published the other day, containing a careful description, with an outline drawing, of all the fish found in the Baltic.

The example set by America, Germany, and other Continental States we must follow. We have as a nation at last made a liberal acknowledgment of our ignorance, and at the conferences of the International Fisheries Exhibition expressed regret.

It is satisfactory that, while we are taking steps to increase our knowledge, we shall at one and the same time be improving our inshore fisheries. The measures necessary, e.g. for enabling us to discover for the first time when herring fry become maties, and when maties reach the stage of full herrings, are exactly the measures required for the artificial cultivation of the herring. From experience gained during the autumn we are now able to hatch immense numbers of herring; each herring produces from 30,000 to 50,000 eggs, but so small are they that 20,000 one layer thick can be placed on a square foot of glass, and from 1000 herrings it would be possible to obtain about 30,000,000 fry, and this in from ten to fifteen days. It is well known that where there is an abundance of herring there is also an abundance of cod and other food fish, hence the annual introduction of some millions of young herring into our territorial waters might serve to attract numerous large food fishes to our shores. And what is true of the herring holds for many other useful fishes, and some of them, such as the sole and turbot, which are less migratory than the herring, might be manipulated in much the same way as trout and salmon, if we only knew more of their habits.

In order to be able to carry on the work of investigation, the importance of which is now universally recognised, the Committee recommend that an application be made for sufficient funds to enable the Board to establish a marine station, and further that a steam vessel take the place of the *Vigilant* at present at the service of the Board.

The *Vigilant* is in every respect inadequate for the ordinary work of the Board, and if there is added to that work the acquiring of new knowledge as to the habits of our food fishes, the nature of their food, their time and place of spawning, and the way in which these may be influenced by the various modes of fishing, a steam vessel will be absolutely necessary.

The Committee have much pleasure in stating that they are deeply indebted to Lieut. Prickett, in command of H.M.S. *Jackal*, for the ready assistance rendered by him

and his officers, and for their unflinching courtesy and kindness during the expedition.

They have also to state that it was a source of great satisfaction to them to find that the commander of the *Vigilant* was not only greatly interested in the work of the Committee, but that, having a strong instinct for scientific work, he will be able to render much assistance in any further investigations that may be undertaken.

To Mr. Romanes, F.R.S., the Committee are greatly indebted for many valuable suggestions, and they are also indebted for the use of the Marine Laboratory instituted some years ago by Mr. Romanes and Prof. Ewart. Without this laboratory much of the work which will form the substance of the forthcoming Report could not have been undertaken.

J. COSSAR EWART, Convener  
J. R. GIBSON-MAITLAND  
A. FORBES IRVINE  
J. MAXTONE GRAHAM

Edinburgh, November 5

#### THE ORIGIN OF CORAL-REEFS

SO much additional information has in recent years been obtained regarding the physical and biological conditions of the sea that such a problem as that presented by the coral-islands of mid-ocean may well be reconsidered. Several able naturalists have lately called attention to this problem, and have insisted that the generally received solution of it is not satisfactory. Among geologists there may not unreasonably be a good deal of unwillingness to admit that this contention can be well-founded. They have long been accustomed to regard Darwin's theory of coral-formation with justifiable pride as a masterpiece of exhaustive observation and brilliant generalisation. It has played an important part in their speculations regarding the larger movements of the earth's crust, and they have been so deeply impressed with its simplicity, and the grandeur of the conclusions to which it leads, that they will naturally and rightly refuse to surrender any portion of it save under the strongest compulsion of evidence. Some, indeed, may be inclined even to resent, almost with the warmth inspired by a personal injury, any attempt to show that it can no longer claim the general applicability which has been regarded as one of the strongest arguments in its favour. But the example of Darwin's own candour and overmastering love of truth remains to assure us that no one would have welcomed fresh discoveries more heartily than he, even should they lead to the setting aside of some of his own work. I propose to give here somewhat in detail the more important data accumulated in recent years on this subject, and to state the conclusions to which a careful consideration of the evidence seems to me inevitably to lead.

Before the memorable voyage of the *Beagle*, the generally received opinion regarding the origin of the circular coral-reefs or atolls of mid-ocean was that they had grown up on the rims of submerged volcanic craters. The enormous size of some of the atolls—thirty miles in diameter—might have been thought a sufficiently formidable objection to this explanation. But it did not appear insuperable even to so cautious a philosopher as Lyell, who only noticed it to refer his readers to the great dimensions reached by truncated volcanic cones, which he thought might retain their forms more easily under a deep sea than on land.<sup>1</sup>

An earlier and better theory, as Darwin admitted, had been started by Chamisso, who supposed that the circular form of an atoll was due to the fact that, as the more massive kinds of coral thrive most vigorously in the play of the surf, they naturally keep to the outside of the reef, and raise that portion to the surface

<sup>1</sup> "Principles of Geology," 4th edit. (1835), vol. iii p. 310.