

servators of the Zoological Museums, the Directors of the Zoological Gardens, and several lecturers on zoology and botany at the High Burghal Schools.

Accept, then, Sir, on your sixty-ninth birthday, this testimony of regard and esteem, not for any value it can have for you, but as a proof, which we are persuaded cannot but afford you some satisfaction, that the seeds by you so liberally strewn have also fallen on fertile soil in the Netherlands.

We are, Sir, &c.,  
The Directors of the Netherlands  
Zoological Society,  
(Signed) President, A. A. VAN BEMMELN  
Secretary, H. T. VETH

The following is Mr. Darwin's reply:—

Down, Beckenham, February 12

SIR,—I received yesterday the magnificent present of the album, together with your letter. I hope that you will endeavour to find some means to express to the 217 distinguished observers and lovers of natural science, who have sent me their photographs, my gratitude for their extreme kindness. I feel deeply gratified by this gift, and I do not think that any testimonial more honourable to me could have been imagined. I am well aware that my books could never have been written, and would not have made any impression on the public mind, had not an immense amount of material been collected by a long series of admirable observers, and it is to them that honour is chiefly due.

I suppose that every worker at science occasionally feels depressed, and doubts whether what he has published has been worth the labour which it has cost him; but for the remaining years of my life, whenever I want cheering, I will look at the portraits of my distinguished co-workers in the field of science, and remember their generous sympathy. When I die the album will be a most precious bequest to my children. I must further express my obligation for the very interesting history contained in your letter of the progress of opinion in the Netherlands, with respect to evolution, the whole of which is quite new to me. I must again thank all my kind friends from my heart for their ever-memorable testimonial, and

I remain, Sir,  
Your obliged and grateful servant,  
(Signed) CHARLES R. DARWIN

### THE NORWEGIAN NORTH-SEA EXPEDITION OF 1876\*

#### Zoological Researches

AMONG the various scientific objects of our expedition the examination of the biology of those parts of the ocean which we traversed was one of the most important. We had with this view equipped ourselves in the best way with all the apparatus required for the purpose (dredges, trawl-nets, swabs, sieves, &c.), chiefly after the newest English models, a considerable quantity of ropes of various kinds, and heavy iron weights to hold the apparatus to the bottom were also stowed away in the hold of the vessel. There was besides procured a large quantity of glass vessels of different sizes and kinds, from small test-tubes to cylinders a foot in diameter, and a considerable stock of spirits for preserving the specimens that might be collected.

That the zoological material that might be brought up with the apparatus we have named might be arranged and the preliminary examinations made, which would be of great importance for the later working out, we considered it indispensable that as many zoologists as possible should accompany the expedition; we also thought it right that a skilful artist should always be at hand. The zoological party consisted of Overlæge Danielssen, Grosserer Friele, and myself, and as artist we were fortunate enough to engage Herr Schiertz, landscape-painter, whose practised pencil and keen, all-embracing faculty of observation were exceedingly useful to us. There is a series of masterly-coloured pictures from his hand which will be a true ornament to the zoological treatises, which in course of time will be published on the work of the expedition.

The zoological work was divided in this way:—Overlæge Danielssen and Dr. Koren undertook the Echinodermata, Ephyreerna, and Corals; Grosserer Friele, the Mollusca; Dr.

Hansen, the Annelida; and I myself the other classes, the Crustacea, Pycnogonida, Polyzoa, Hydroida, Spongia, together with the lowest organisms standing on the boundary line between the animal and vegetable kingdoms (Foraminifera, Radiolaria, and Diatomacea), and that department of the researches which eventually concerns our salt-water fisheries. We have all been occupied for a considerable time in working out each his own portion of the collected material. But as this has been extraordinarily abundant, it has not been possible for any of us to bring his examination to a conclusion so that a detailed account of it can be given. As, besides, the more special results will be reserved for the collective work, which it is proposed to publish when the expeditions are concluded, it will be sufficient here to state some of the most important results of the expedition. It may also here be mentioned that these researches, carried on far out in the open sea from a comparatively small vessel, and at depths approaching 2,000 fathoms, are, even under the most favourable circumstances, attended with extraordinary difficulties, and occupy a comparatively long time. That we, notwithstanding the exceedingly unfavourable state of the weather during the expedition, were able to obtain such an abundance of zoological material, is due to the skilful and intelligent way in which the work was carried out by Lieut. Petersen, to whom Capt. Wille's command was given over.

During our expedition we had in all employed the dredge from the vessel sixteen times, the trawl-net twelve times, both these together twice, and the swabs but once; there were thus no fewer than thirty-one separate casts, and of these only a few were unsuccessful, while most of them gave very satisfactory results. A net was also employed for examining the marine animals occurring in the upper stratum. Boat dredgings were also undertaken in Sogne Fiord, at Husoe, at Thorshaven in the Færoe Islands, and in the harbour at Reykjavik. Without entering on any detailed specification of the numerous animal forms thus brought from the depths of the sea, I will merely state that there are interesting species, new to science, of nearly all classes, of which complete descriptions and drawings will by-and-by be published.

The greatest depth reached during the expedition was about 2,000 fathoms, almost half-way between Norway and Iceland; there were several casts at depths of over 1,000 fathoms. The zoological researches were begun in Sogne Fiord, where the considerable depth of 650 fathoms was reached, the greatest depth which up to that time had been examined on our coasts. We found here the common deep-sea fauna known from earlier researches, viz., of Hardanger Fiord, and various rarities were collected; among others a well-preserved specimen of the remarkable family, Brisinga, discovered by Asbjørnsen (*B. coronata*, G. D. Sars), several specimens of the *Priapuloides bicaudata*, Danielssen, and great numbers of the beautiful haired *Munida tenuimana*, G. D. Sars, of which previously only very few specimens had been found.

Our researches, however, first attained their peculiar interest when we reached the extended barrier that lies along our coast on the west, the uttermost limit of which forms the so-called Havbro. Here below 300 fathoms begins the yet little examined cold area, with a bottom-temperature of from 0° to 1° 6' C., and the fauna now, in correspondence with this temperature, exhibits a very peculiar character, totally different from that on our south and west coasts. Seventeen of our casts were in the cold area, and we have thus some idea of the peculiar physical and biological conditions prevailing there.

Over the extensive depression which occupies the greater part of the expanse of sea between Norway on the one side, and the Færoe Islands and Iceland on the other, the bottom below 1,000 fathoms appears everywhere to consist of a very peculiar, loose, but very adhesive, exceedingly light, nearly greyish white clay, which is very strongly calcareous, and, on being washed or passed through a sieve, appears to consist almost exclusively of shells of a little, low organism, belonging to the Foraminifera, Biloculina. We have therefore named this deep-sea clay Biloculina clay, to distinguish it from the kind of clay which occurs in the warm area at a great depth in the Atlantic Ocean, and which is called, after a very different Foraminifer, Globigerina. The Biloculina clay of the cold area contains a larger quantity of lime than the Globigerina clay of the Atlantic. It gives off, when treated with an acid, an uncommonly large quantity of gas, and when it is pressed and dried, it is converted in a short time into a very hard and compact sort of limestone. We have here a complete chalk or limestone formation coming into existence, and the fauna occurring here also bears a considerable impress of

\* By Prof. G. D. Sars. From *Dagbladet*, January 26 and 27.

its ancient origin and close alliance with the organic remains preserved in the fossiliferous strata from the close of the Secondary period. First of all may here be named a fine, probably new Crinoid, over a span long, which was here obtained in numerous living specimens, and which shows an unmistakable resemblance to a few of the oldest fossil forms of this, in our time, almost extinct animal group; next a very peculiar and interesting holothuroid animal, colossal chalk sponges, and large numbers of a new and very peculiar Pycnogonide, also a remarkable blood-red coloured Crangon (*Rake*) with integuments thin as paper (*Hymenocaris*), besides several lower crustacea, for the most part new; the mollusc commonly occurring here is that which is so characteristic of our older glacial clay, the *Siphonodentalium vitreum*, M. Sars, which on our coast is first found living in the most northerly part of Finnmark. The fauna in these great depths, though peculiarly interesting, both with reference to zoology and geology, appears however as a whole to be rather poor and without variety. The contrary is the case where the bottom begins to rise towards the sea banks. Here we find at a depth of 400 to 900 fathoms, but still within the cold area, an uncommonly abundant and varied animal life. Quite contrary to what we might be inclined to expect from the prevailing low temperature, so far is there from being any trace of hindering or preventing the development of animal life, in comparison with our coast fauna, that we find the rather as we go downwards an exceedingly remarkable luxuriance in the development of the fauna expressed both in the numerous and varied animal forms occurring here, and in the comparatively colossal dimensions which several of these here reach; indeed, one of the marine animals taken up here, belonging to the Umbellularia, had a length of quite eight feet. From the specimens which we got up with the help of dredges, trawl-nets, and swabs, we have been able, if only approximately, to form a sort of idea of the peculiar physiognomy which the sea-bottom here presents.

Forests of peculiar Cladorhiza, with tree-like branches, here deck the bottom for long stretches. Between the branches sit fast beautiful medusa heads (*Euryale*), and variegated *fjer-sjerner* (*Antedon*), and various crustacea, among them the marvellous object, *Arcturus Baffini*, known from the Polar Sea, and slow-moving Pycnogonida, partly of colossal size (up to a span between the extremities of the feet), creep along between their branches and with the help of their enormously-developed proboscis suck out their organic juices; a whole world of more delicate plant-like animals (*Polyzoa* and *Hydroida*) having at the same time fixed their dwellings on the branches and stems of the sponges when dead and deprived of their organic bark substance. In the open spaces between the sponge forests creep along beautiful purple sea-stars (*Astropecton*) and long-armed Ophiurids, together with numberless Annelids of various kinds, and round about swarm different sorts of Crustacea, long-tailed, bristly Decapoda (*Crangon*), finely-formed Mysida (*Eyrthropros*, *Panerythropros*, *Pserdomma*), masses of Amphipoda (*Anonyx*), and Isopoda (*Munnopsida*). Above all project, like high mast timber in a coppice, the predominating Umbellularia with their delicate straight stems and elegantly-curved crowns set full of fringes of polyps. The light of day does not, properly speaking, penetrate to these great depths, but as a compensation there is produced, by the animals themselves, a splendid illumination of the whole, inasmuch as almost all are strongly phosphorescent, or have the power to produce from their bodies an intense light, by tints bluish, greenish, and reddish.

So often as our bottom-scraper or trawl-net found bottom in that region which, after the animal type that was undoubtedly the most prominent and characteristic, we named the region of the Umbellularia, we were certain to have a rich zoological prize, and the day was indeed in most cases unfortunately quite too short for the proper examination and preservation of all those treasures fetched up from the depths of the sea.

Higher up, in a depth of 300 to 100 fathoms, and at a distance from the coast of from ten to twenty Norwegian miles (about 70 to 140 English), begins that extensive barrier which forms, as it were, the foundation on which our land rests, and by which the cold Polar Sea depths are shut off from it. This barrier begins in most cases with a hard, stony bottom, so that our dredgings were here attended with great difficulties. Numerous rolled stones, whose smooth rounded forms and worn edges clearly enough show that they had at one time been subjected to the powerful action of ice, lie here strewn on the sometimes very uneven bottom, consisting of solid rock, and prevent the dredge from acting properly, or fill up its mouth so that only incomplete specimens of the animal world living here can be

obtained. The fauna has here quite altered its character, and more resembles that common on our coasts; but it appears to be a rule that below this point at the border of the barrier it is considerably richer than that nearer the shore, a fact which also stands in full agreement with the long known great abundance of fish at these places.

When we finally survey what here can only in a general way be pointed out concerning the physical and biological relations of the tract of sea we traversed we may, both in a physiographic and a zoological respect, divide the depths of the sea surrounding our country into two regions differing greatly in character, namely, the warm and the cold areas. The first occupies the whole Skagerak and the North Sea, and farther north the sea along our coast to a distance of ten to twenty Norwegian miles, including herein all the fiords cutting deeply into the land, and stretches towards the north to the northernmost point of Finnmark. The cold area commences where the bottom begins to sink from the sea-banks towards the great deeps lying beyond them, and towards the south reaches nearly to the latitude of Stadt, and towards the south-west extends in the form of a narrow wedge in between the Færoe and the Shetland Islands as far as the 60th degree of latitude. Towards the north the cold area extends to the Pole, which properly is its central point. We have examined it at one of the points where it extends farthest to the south, where it has shown itself to be everywhere very sharply and distinctly defined from the warm area. As we proceed farther north, the boundary between the two becomes less distinctly marked, inasmuch as the cold area little by little raises itself from the depths, until in the Polar Sea it finally rises to the surface, and thus also occupies the littoral region, the warm area being at the same time greatly diminished in extent. The close correspondence with the above-described peculiar physical conditions in the sea surrounding our country has been to a very considerable degree explained by the experience obtained during our expedition, and thus a very important contribution has been made to the meteorology of the sea in general. A fuller explanation of these purely physical phenomena is also of the greatest importance to us zoologists for the right understanding of the different biological conditions in the sea; but as such an explanation belongs properly to the physical-meteorological researches, I will not here enter farther upon it, but keep to the more purely zoological side of the matter.

With regard to the character of the fauna in the cold area, it is purely arctic or glacial without any southern mixture whatever; and we have already been able to identify several of our species with types before collected in the Polar Sea during the various North Polar expeditions fitted out in Sweden, Germany, England, and America. In higher latitudes those animal types, which in that part of the sea which we examined are only found below the 400 fathoms' line, live in comparatively shallow bands, indeed even in the upper stratum of the sea, which interesting fact appears still further to confirm the view held by several men of science that the distribution of animal life in the sea is mainly dependent on temperature, depth having only a comparatively limited influence upon it. The purely Arctic fauna which prevailed on our coasts during the Glacial period, and which has left behind its traces in the glacial clays and in the older glacial shell banks, has, under altered meteorological conditions, little by little drawn down to the depths, where the effect of these conditions was less sensible, while the places which it inhabited have been occupied by more southern, immigrating types. At great depths in our fiords which run far into the land, a remnant of the original Arctic fauna has been able to maintain itself. But this is clearly only a fortuitous circumstance, as clearly enough appears from the generally small size and stunted appearance of these animal types, and their complete extinction is probable. This we are now, after having acquired an accurate acquaintance with the temperature of the sea, able to explain on purely physical grounds. For even to those deep pools in our fiords the influence of the milder climatic conditions has at last reached, so that at depths of 650 fathoms there is a temperature of 6° C., which may be supposed to have a prejudicial influence on the growth of these types. On the other hand, the temperature off our sea-banks at a much smaller depth remains unchanged, such as it was in the Glacial period, both here and close to our coast, and therefore we find also here, even at a remarkably southern latitude, no impoverished and stunted, but as luxuriantly developed an Arctic or glacial fauna as high up in the north in the Polar Sea.

The very important light which from the side of meteorology may be thrown on several yet obscure phenomena in the deve-

lopment and distribution of organic life as on the other hand the often considerable aid meteorological researches may obtain from purely biological facts, render it desirable that these two sciences, which may appear very different, do not become strangers to each other but mutually come into closer alliance with the object in view, to contribute to the scientific solution of the many yet unsolved physical and biological problems.

(To be continued.)

### OUR ASTRONOMICAL COLUMN

THE BINARY STAR  $\xi$  BOOTIS.—Dr. Doberck, of the Markree Observatory, has published elements of this revolving double-star, which appear to represent very satisfactorily the measures up to the present time, allowance being made for some obvious errors of observation. The orbit, which differs materially from those calculated upon shorter series of measures by Mädler, Herschel, and Hind, is as follows:—

Peri-astron passage, 1770.44. Period, 127.97 years.  
 Node ...  $12^{\circ} 1'$  Inclination ...  $37^{\circ} 53'$   
 Node to peri-astron, on orbit ...  $130^{\circ} 54'$   
 Eccentricity ... ..  $0.6781$   
 Semi-axis major ... ..  $4''.813$

At the epoch 1782.28 these elements give the position  $24^{\circ}.1$ , distance  $3''.64$ ; and for 1804.25, position  $352^{\circ}.5$ , distance  $6''.53$ ; for Dembowski's epoch 1870.87 the errors are  $+0''.3$  and  $-0''.11$ . The following figures are deduced from Dr. Doberck's elements:—

1876.0, Pos. $283^{\circ}.7$	Dist. $4''.29$	1892.0, Pos. $224^{\circ}.7$	Dist. $2''.35$
1880.0, ,, $274^{\circ}.5$	,, $3''.84$	1896.0, ,, $188^{\circ}.2$	,, $1''.82$
1884.0, ,, $262^{\circ}.8$	,, $3''.36$	1900.0, ,, $111^{\circ}.9$	,, $1''.31$
1888.0, ,, $247^{\circ}.1$	,, $2''.86$		

Dr. Doberck has now investigated elements of  $\sigma$  Coronæ Borealis,  $\tau$  and  $\lambda$  Ophiuchi,  $\mu^3$ , 44 and  $\xi$  Bootis,  $\gamma$  and  $\omega$  Leonis,  $\eta$  Cassiopeæ, and several other stars, thus greatly adding to our knowledge of the orbits of the binaries, his discussions being at the same time conducted in a very exhaustive manner, to date.

VARIABLE STARS.—In No. 2,119 of the *Astronomische Nachrichten* are observations of a number of variable stars, made in 1875 by Mr. Chandler of New York. There was a well-marked minimum of that irregular variable  $\alpha$  Herculis on August 21; the observations of W and X Sagittarii are worthy of note, as they support the results previously given by Prof. Schmidt, of Athens, and are stated to have been made without any "pre-occupation of mind in the observer," who had no previous knowledge of the character of the light variations. Schmidt's period for W, is 7.5933 days, and for X, 7.0119 days; another star in the same constellation, U Sagittarii of the last catalogue by Prof. Schönfeld, is assigned a period of 6.7452 days. The three stars were added to the variable star list by the indefatigable director of the Observatory at Athens, in the summer of 1866.

Mr. J. E. Gore (Umballa, Punjab) writes, suggesting the variability of Lalande 42360. The place in the catalogue depends upon an observation made August 7, 1793, when the star was rated 7m. Argelander ("Bonn Observations," vol. vii. p. 181) identifies this star with No. 42383 of the catalogue, observed as an 8m., September 29, 1791. Considering that there is an error in the record of the time of transit; the declinations closely agree.

DAMOISEAU'S TABLES OF JUPITER'S SATELLITES.—Independent extensions of these Tables, which run out in 1880, have been made in Europe and America. Prof. Coffin, superintendent of the American Ephemeris, notifies an extension to 1900, which has been carried into effect by Mr. D. P. Todd, we believe under the superintendence of Prof. Newcomb. The work will be sent to any library or astronomer possessing a copy of the

Tables, on application to the office at Washington. Before the time named it may be hoped that both as regards theory and observation, the laborious operation of forming new Tables may be justified by the certainty of obtaining results which will enable us to predict the phenomena of the satellites, with considerably greater accuracy than can be effected by the use of Damoiseau's Tables. And we may also express the hope that as regards systematic observations, the Astronomer-Royal's urgent recommendation will not be lost sight of.

BESSEL'S TREATISES.—Volume iii. of the reprint of the more important of the many papers by Bessel on astronomical and other subjects, which completes the work, was issued a short time since by Dr. Engelmann, and comprises geodesy, physics, and general astronomical subjects, as the libration of the moon, shooting-stars, the mass of Jupiter, and the theory of eclipses. Speaking of the work as a whole, it will prove a very valuable aid to the student of Astronomy, affording him without the labour and difficulty of consulting a number of publications, the means of acquainting himself with the principal memoirs of the illustrious Professor of Königsberg, who may be said to have revolutionised the practice of astronomy. Dr. Busch's "Verzeichniss sämmtlicher Werke, Abhandlungen, Aufsätze, und Bemerkungen, von F. W. Bessel," printed in vol. xxiv. of the Königsberg observations, and subsequently in a separate form, contains 385 articles, and we believe, with only one or two exceptions, Dr. Engelmann's three volumes will be found to contain all that are of more permanent interest and value.

### BIOLOGICAL NOTES

THE ELECTRIC EEL.—Since Humboldt's discovery of the electric eel and his observations of its peculiar properties, carried out unfortunately before the discovery of the voltaic pile, strange to say, no attempt has been made to study this remarkable reptile in its natural surroundings. In view of this fact, the Berlin Academy of Sciences sent the well-known histologist and physiologist Dr. Carl Sachs, last September, to the scene of Humboldt's former activities, well equipped with an ample supply of electro-physiological apparatus, and means for carrying out an extensive series of observations. In the last session of the Academy a letter dated December 7 was read from Dr. Sachs, in which he stated that he had safely performed the journey from Caraccas, over the Cordilleras, to the *Llanos*. The gymnotus had disappeared from the neighbourhood of Rastro, where Humboldt's investigations took place, but at a distance of a few miles from the city of Calabozo, a river was found fairly alive with the dreaded *temblador*. In the five days which had elapsed since the discovery of the locality, many valuable results had been afforded by the observations, and there was every prospect that the expedition would yield a large number of new and important additions to our knowledge of the electro-motive organs.

EARLY DEVELOPMENT OF SPONGES.—At a meeting, on February 8, of the Société Vaudoise des Sciences Naturelles, Prof. Forel spoke on an interesting occurrence of an early development of sponges in the Lake of Geneva, due to the unusually mild winter of this year. The fluviatile sponge of the lake consists of a horny skeleton with very fine siliceous spiculæ, covered with a sheet of soft, perforated animal matter. Usually, in autumn, this soft matter leaves the exterior ramifications and condenses under the form of small gemmulæ, half a millimetre in diameter, in the deepest interior parts of the horny skeleton. There it remains until the spring, when it expands anew upon the ramifications, and covers them with a sheet of living animal matter. But this year M. Forel observed on February 2, besides many sponges in their hibernal state, a colony of other sponges which had already reached their full summer development, differing only by a somewhat paler colour