ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *OCTOBER* 25–31

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on October 25

Sun rises, 6h. 44m.; souths, 11h. 44m. 7·5s.; sets, 16h. 45m.; decl. on meridian, 12° 16′ S.: Sidereal Time at Sunset, 19h. 2m.

Moon (two days after Full) rises, 17h. 32m.*; souths, 0h. 46m.; sets, 8h. 11m.; decl. on meridian, 12° 52′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 18	12 7	16 56	14 22 S.
Venus	10 56	14 38	18 20	24 54 S.
Mars	0 1	7 26	14 51	15 30 N.
Jupiter	3 15	9 32	15 49	2 33 N.
Saturn	20 13*	4 21	12 29	22 17 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Oct.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
25	B.A.C. 987	6½	3 0	4 10	137 313
26	B.A.C. 1256	6	22 3	near approach	151 —
28	B.A.C. 1930	6½	0 0	1 6	51 249
29	1 Cancri ...	6	22 5	22 26	115 164

Phenomena of Jupiter's Satellites

Oct.	h. m.		Oct.	h. m.	
25	4 3	II. occ. reap.	29	6 0	IV. occ. disap.
28	6 32	I. tr. ing.	29	6 10	I. occ. reap.
29	3 7	I. ecl. disap.	30	3 19	I. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Oct.	h.	
28	17	Saturn in conjunction with and 4° 8′ north of the Moon.

GEOGRAPHICAL NOTES

A RECENT Blue-book (Siam, No. 1, 1885) contains a report by Mr. Archer, of the Consular service in Siam, on silk-culture in the province of Kabin, which lies on the eastern side of the Siamese delta, at the foot of the mountains separating the Meinam valley from that of the Meiking. In the course of his journey Mr. Archer came across certain Laos settlements, of which he gives an interesting account which is deserving of note, on account of the very little known of the Laos. He says the settlements in the provinces of Pachim and Nakon Nayok are, as it were, the south-western outposts of the Laos race, which forms the bulk of the population of Eastern and Northern Siam, but they are "phung khao," or "white-bellied," and therefore distinct from the "black-bellied," or inhabitants of the Chiengmai provinces. They are not, however, the original inhabitants of these provinces, but captives from Muang Kalassin, a province to the north east of Korat, formerly dependent on Wien Chan, who, after the war waged successfully by the Siamese against that ancient kingdom about sixty years ago, were transported to and allowed to settle in the country extending from the province of Nakon Nayok to that of Battambong. This country consists, for the most part, of a series of slight and gradual elevations and depressions, the dwellings, gardens, and any other plantations being generally situated on the former, whilst rice is cultivated in the latter. The population is sparse, and consequently the greater part of the country is covered with jungle. The inhabitants are exceedingly indolent, and appear unable to exert themselves to procure more than enough rice for their bare sustenance. Their mode of living is of the simplest description, and their country being far from any commercial centre and outside any trade route, hardly any foreign goods, with the exception of cotton, are to be found amongst them. All Laos tribes, however, are not characterised by such indolence. Those living in the provinces closer to Korat are much more active, and devote more attention to agriculture, especially to the rearing of silkworms. This is stated to be due to the latter having a poorer soil at a higher altitude, which compels the inhabitants to devote more attention to silk-producing as a means of livelihood.

MR. COUTTS TROTTER read a paper at the Aberdeen Meeting of the British Association "On Recent Explorations in New Guinea," bringing up to date the information he laid before the Section two years ago. It deals with certain hydrographical and other physico-geographical questions on which light has been lately thrown by Mr. Chalmers's journey, and by the ascent of the Amberno River, and points to the conclusions to be drawn from certain temples, with a special priesthood and objects of worship lately discovered—implying an order of religious ideas quite foreign to the Papuan mind. As regards the natives of New Guinea, he believes the conflicting jurisdiction, and different views as to the mode of dealing with them, must be prejudicial to their interests.

THE Arctic steamer *Alert* returned to Halifax on October 18 from Hudson Bay with the observation party who have spent fifteen months there testing the practicability of that route for navigation from the Canadian north-west to Europe. The result of the observations shows that the average temperature is not so low as was expected, nor so low as the average winter temperature in the North-West. The lowest monthly average was 30° below zero. The ice observations show that the Hudson Straits and Bay are navigable by properly built and equipped vessels for from three to four months—from July to October. While this report is somewhat favourable, doubts are expressed in Canada whether the Hudson Bay route can ever be made practicable.

THE GREAT OCEAN BASINS[1]

II.

THE advances during recent years in the knowledge of the forms of life inhabiting the floor of the ocean surpass those in any other department of oceanic investigation. Thousands of new organisms have been discovered in all seas and at all depths in the ocean, and either have been, or are now being, described by specialists in all quarters of the world. There does not seem to be any part of the ocean bed so deep, so dark, so still, or where the pressure is so great as to have effectually raised a barrier to the invasion of life in some of its many forms. Even in the greater depths all the great divisions of the animal kingdom are represented.

As might have been expected, forms of life are most rich and varied in the shallow water surrounding the continents, where there is abundance of food, sunlight, and warmth; where there is motion, rapid change of water through currents, and other congenial conditions. At the depth of half a mile there are still numerous animals, though many of them differ from those of shallower depths, but plant-life seems to have wholly disappeared, if we except the diatoms and calcareous algæ, whose frustules and skeletons have fallen to the bottom from the surface, carrying with them some of their protoplasm and chlorophyll.

At the depth of one mile there are a few animals which are barely distinguishable from, if they be not identical with, shallow water forms; but the majority of the animals are specifically distinct from those found within the 100-fathom line, and many of them belong to species peculiar to the deep sea, and are universally distributed over the ocean bed in deep water.

As we descend into still deeper water, and proceed further seawards from the borders of the continents, species and the number of individuals become fewer and fewer, though they often present archaic or embryonic characters, till a minimum is reached in the greatest depths furthest from continental land. Distance from continental land is, indeed, a much more important factor in the distribution of deep-sea animals than actual depth.

If we neglect the Protozoa and compare the results of twelve of the *Challenger's* trawlings and dredgings in the central line of the Pacific, in depths greater than 2000 fathoms, on globigerina ooze, radiolarian ooze, and red clay, with twelve trawlings and dredgings taken under similar conditions and depths, but on the blue and green muds within 200 miles of the continents, we find that the Central Pacific stations have yielded 92 specimens of animals belonging to 52 species, all, with two doubtful exceptions, new to science, and among them 13 new genera; on the other hand, the stations near the continents have given over 1000 specimens belonging to 211 species, of which 145 are new species and 66 belong to species previously known from

[1] Lecture delivered at the Aberdeen meeting of the British Association by Mr. John Murray, Director of the *Challenger* Reports. Continued from p. 584.

shallower water. These numbers are not final, but the proportions are not likely to be greatly altered when the whole of the *Challenger* Reports are completed. These facts may be in part explained by the greater abundance of food present in the continental *débris* which forms the chief constituent of the terrigenous deposits; but it is probably more closely connected with the greater distance of the seaward stations from the original place of migration. We must suppose that all deep-sea animals have been derived originally from shallow water; those which descended first into deeper water have, generally speaking, been able to migrate to a greater distance seawards than those which set out later, and being derived from older stocks they have retained in the great deeps some of the characters which are now regarded as archaic and embryonic.

Although no new types of structure have been discovered in organisms from the deep sea, the peculiar modifications which animals have undergone to accommodate themselves to abysmal conditions are sufficiently interesting and remarkable; the eyes of some fish and crustaceans have become atrophied or have disappeared altogether, while in others they have become of exceedingly large size or have been so modified as to be scarcely recognisable as eyes: for instance, in the case of the scopelid fish *Ipnops*; fins and antennæ have become extraordinarily elongated and at times appear to simulate the alcyonarians of the deep sea. The higher crustacea and some families of fish have very few and very large eggs in the deep-sea species, while their shallow-water representatives have a very large number of very small eggs, showing apparently that the deep-sea species have relatively few enemies. While some groups, for instance the Pycnogonids, Tubularians, and Nudibranchs, have much more gigantic representatives in the deep sea than in shallow water, the representatives of the majority of groups, and especially the Gasteropods and Lamellibranchs, are much smaller, and generally speaking have a dwarfed and delicate appearance, the shells being poorly supplied with carbonate of lime. Indeed the solid tissues of most deep-sea animals are but feebly developed when compared with shallow-water forms. The experienced dredger has, as a rule, little difficulty in recognising a deep-sea species in a dredging from its general appearance. Many deep-sea animals emit, and some have special organs for the emission of, phosphorescent light, which appears to play a large *rôle* in the economy of deep-sea life.

One of the most striking facts with respect to deep-sea animals is their very wide distribution—the same species being found in all the great ocean basins. At the depth of half a mile identical species are dredged off the coast of Scotland and off the coast of Australia at the Antipodes; the nearly uniform conditions, existing everywhere at depths greater than half a mile, facilitates the wide distribution of species which have once accommodated themselves to a life at that depth. The same consideration probably explains the occurrence of some identical and nearly identical species in the shallow waters of the temperate and polar regions of both hemispheres.

Among the higher crustacea the Brachyurans, which are regarded as a modern group, are found in great numbers in shallow waters, but have very few representatives in deep waters, and appear to be quite absent from the abysmal regions. On the other hand, the representatives of the Schizopoda, Anomoura, and Macrura, which are regarded as older groups, are widely distributed in the deep sea; many similar instances of this kind could be given. The stalked Crinoids, the Elpididæ among the Holothurians, the Pourtalesiæ and Phormosomas among the Echinids, and other groups, have now no representatives in depths less than 100 fathoms, but are widely distributed in all greater depths; while many genera are confined to the abysmal regions. We are not as yet, however, in a position to fully discuss many curious points in distribution, even did time permit.

It may be urged that after all the few hundred scrapings of our small trawls and dredges can give but a very inadequate idea of the condition of things over the millions of square miles covered by the ocean, but against this it may be argued with great force that as the same animals and deposits occurred again and again with little variation, we doubtless have even now a tolerably complete knowledge of deep-sea life.

When we turn to the surface waters, one may exclaim: it is a dull and stupid soul that would not rejoice at the first acquaintance with the teeming pelagic life of the ocean, rich in bizarre forms and varied colours, or that would not be struck with wonder at the magnificent displays of phosphorescent light sent forth on a dark night from the surface of an equatorial ocean, like flashes of "spirits from the vasty deep."

> "Beyond the shadow of the ship
> I watched the water snakes;
> They moved in tracks of shining white,
> And when they reared the elfish light
> Fell off in hoary flakes.
>
> "Within the shadow of the ship
> I watched their rich attire;
> Blue, glossy green, and velvet black,
> They coiled and swam, and every track
> Was a flash of golden fire.
>
> "Oh, happy living things! No tongue
> Their beauty might declare.
> A spring of love gushed from my heart,
> And I blessed them unaware."

Experiments with tow-nets have shown that life exists in all the intermediate waters of the ocean, between the surface and the bottom, yet sparingly there when compared with what occurs just above the bottom, or more markedly when compared with the abundant and luxurious development of life in the surface and sub-surface waters.

In mid-ocean the majority of the organisms are quite distinct from those usually found along the coasts in bays and estuaries, though, like the deep-sea animals, they were, in all probability, originally derived from the shallow waters around the continents. There are species of diatoms, calcareous and other algæ, many foraminifera, siphonophora, a few annelids, many crustaceans, numerous pteropods, heteropods, and other molluscs, the pelagic tunicates, and many fishes whose home is in the great systems of oceanic currents. It is only occasionally, or in special localities, that some of the species are borne to continental shores, for the members of this oceanic pelagic fauna and flora appear to be killed off where the ocean is affected by the fresh waters from the land. In the equatorial regions the species and individuals are most abundant, and they vary with temperature, latitude, and the salinity of the water.

In the Antarctic or Southern Ocean diatoms abound at the surface, and in the same region the sea-floor is covered with their dead siliceous frustules, which form a *diatom ooze*. In the middle and western Pacific, where the surface water is less salt than in the Atlantic, the radiolarians, which likewise secrete silica from sea water, occur in vast numbers at the surface and in intermediate waters, and in these regions their dead shells and skeletons make up the chief part of the deep-sea deposits, known as *radiolarian ooze*.

But it is those species belonging to the varied pelagic oceanic organisms which secrete lime for their shells and skeletons that are principally forced on our attention, both from their prodigious numbers and the part played by their remains in the formation of deposits. These species flourish especially in the warmest and saltest waters. In a square mile of equatorial water 600 feet deep it is estimated that there are over 16 tons of carbonate of lime in the form of shells, which belong to about 30 species of calcareous Algæ, Foraminifera, Pteropods, and Heteropods. When these surface organisms die and fall to the bottom they form the deposits known as *pteropod* and *globigerina oozes*. In descending they, as well as other surface organisms, carry down with them some of the organic matter of their tissues, which, not decomposing rapidly in the cold deep water, forms the chief source of nourishment for deep-sea animals, and the chlorophyll which Prof. Hartley has discovered in some deep-sea deposits is probably derived from diatoms which have fallen to the bottom in this way.

It is, however, a very remarkable fact that the dead shells of these Foraminifera and Pteropods are not found on the bottom of the sea beneath all the regions where they flourish abundantly at the surface. They are found at greater depths beneath warm equatorial waters than elsewhere, but there is barely a trace of them in all the greatest depths, although in an adjacent area, where the surface and intermediate conditions are the same, but where the depth is less than three miles, they may make up 75 or even 90 per cent. of the deposit. It has been abundantly proved that when sea water, and especially sea water containing absorbed carbonic acid, passes over a dead shell or coral, the lime is gradually removed, being carried away by the water as bicarbonate in solution; and the shell or coral is removed more rapidly the more surface it presents to the water in proportion to the amount of carbonate of lime present in the shell. This is what happens to pelagic shells as they fall through the water to the bottom. Where the depth is not very great only the thinnest and most delicate shells are removed, and the others accumulate, forming vast deposits; with increasing depth other shells disappear, only the thicker ones reaching the bottom; but in the very greatest depth nearly every trace of these surface shells is removed, or we find them making up but 1 or 2 per cent. of the deposit. It is possible that this process of solution of the shells may be somewhat accelerated in the deepest layers of water by the great pressure.

In the deepest parts of the abysmal areas, where the carbonate of lime shells are either wholly or partially removed from the bottom, there are met with those peculiar deep-sea clays, the origin of which has been the subject of considerable discussion. They are principally made up of clayey matter resulting from the disintegration of volcanic rocks, and derived chiefly from floating pumice and showers of volcanic ashes. Mixed up with these clayey and volcanic materials are thousands of sharks' teeth, some of them of gigantic size, and evidently belonging to extinct species, also very many ear-bones, and a few of the other bones of whales, some of them also probably belonging to extinct species. These organic fragments are generally much decomposed and surrounded and infiltrated by depositions of peroxide of manganese, which is a secondary product arising from the decomposition of the volcanic material in the deposits. Again, we have in some places numerous zeolitic minerals and crystals formed in the clay, also as secondary products. Lastly, there are numerous minute spherules of native iron and other rare substances, covered with a black coating of oxide, which are referred with great certainty to a cosmic origin—probably the dust derived from meteoric stones as they pass through the higher regions of our atmosphere. Quartz, which is so abundant as a clastic element in deposits around the continents, is almost absent from the deposits of the abysmal regions.

In the abysmal regions, then, which cover one half of the earth's surface, which are undulating plains from two to five miles beneath the surface of the sea, we have a very uniform set of conditions: the temperature is near the freezing point of fresh water, and the range of temperature does not exceed 7°, and is constant all the year round in any one locality; sunlight and plant-life are absent, and although animals belonging to all the great types are present, there is no great variety of form nor abundance of individuals; change of any kind is exceedingly slow. In the more elevated portions of the regions the deposits consist principally of the dead shells and skeletons of surface animals, in the more depressed ones they consist of a red clay mixed with volcanic fragmental matter, the remains of pelagic vertebrates, cosmic dust, and manganese iron nodules and zeolitic crystals, the latter being secondary products arising from the decomposition of the minerals which have long remained exposed to the hydrochemical action of sea-water. The rate of accumulation is so slow in some of these clays that we find the remains of tertiary species lying on the bottom alongside the remains of those inhabiting the present seas. It has not yet been possible to recognise the analogues of any of the deposits now forming in the abysmal regions in the rocks making up the continents.

It is quite otherwise in the areas bordering the continents—the uncoloured areas on the maps. Almost all the matter brought down to the ocean in suspension is deposited in this region, which is that of variety and change with respect to light, temperature, motion, and biological relations. It extends from the sea-shore down, it may be, to a depth of three or four miles, and outwards horizontally from 60 to 300 miles, and includes all partially inclosed seas, such as the North Sea, Mediterranean, Caribbean, and many others. The upper or continental margin of the area is clearly defined by the coast line, which is continually changing from breaker action, elevation, and subsidence; the lower or abysmal margin of the region is less clearly marked out, passing insensibly into the abysmal regions and terminating where the mineral particles from the neighbouring continents disappear from the deposits. In the surface waters the temperature varies from over 80° in the equatorial to 28° in the Polar regions, and from the surface to the ice-cold water at the lower margins of the regions there is in the tropics an equally great range of temperature. Plants and animals flourish luxuriantly near the shore, and animals extend in relatively great abundance down to the lower limits of the region. Here we find now in process of formation deposits which will form rocks similar to those making up the great bulk of continental land, such as schists, shales, sandstones, marls, greensands, and chalks; the glauconitic grains of the green muds and phosphatic nodules can be traced in all stages of formation, and probably, though much less certainly, the initial stages in the formation of flint.

Throughout all geological time the deposits formed in this border or transitional area appear to have been pushed, forced, and folded up into dry land, through the secular cooling of the earth and the necessity of the outer crust to accommodate itself to the shrinking solid nucleus within. These depositions do not in themselves cause elevation or subsidence, but most probably the changes of pressure, resulting from them, tend to destroy the existing equilibrium and to produce lines of weakness along the borders of the continents and in the regions of enclosed and partially enclosed seas, with the result that the borders of continental land have been more frequently thrown into folds and have suffered greater lateral thrusts than any other regions on the surface of the earth.

On the other hand, while we know that there are vast deposits of carbonate of lime taking place over some portions of the abysmal regions, and that volcanic outbursts occur in others, still these are not comparable with the great changes which have taken place in the past, and are now taking place, on the continents and along their borders.

When the coral atolls and barrier reefs which are scattered over the tropical regions of the great oceans are examined in the light of recent discoveries, it is found that their peculiar form and structure can be accounted for by the truncation of some submarine cones through breaker action; by the upward growth of others through the accumulation of marine deposits; by the solution of dead coral through the action of sea-water; and lastly by a study of the source and direction from which the food supply reaches the reef-building animals. That this in all probability is the true history of the origin of these marvellous structures is further confirmed by the recent examination of the upraised coral atolls of the Pacific by Dr. Guppy, and the researches of Mr. Buchanan into the characters of oceanic banks and shoals. Coral atolls and barrier reefs, instead of pointing out great and general subsidences, must be regarded rather as indicating areas of great permanence and stability.

The results of many lines of investigation, then, seem to show that in the abysmal regions we have the most permanent areas of the earth's surface, and he is a bold man who still argues that in Tertiary times there was a large area of continental land in the Pacific, that there was once a Lemuria in the Indian Ocean, or a continental Atlantis in the Atlantic.

In this rapid review of recent oceanographical researches my chief object has been to show you the wide range of the observations, for every science has been enriched by a large store of new facts. It matters little whether the opinions which I have given as to the bearing of some of these be correct or not; for the observations are now or will soon be in the hands of scientific men, and errors in interpretation or deduction will soon be exposed. The great point is that there has been a vast addition to human knowledge, and it must be a matter of satisfaction that our own country has taken so large a share in these important investigations as to call forth the admiration of the scientific men of all countries. You have learnt from the President's address that there is usually not much to say in commendation of the Government for its liberality to science. But in the matter of deep-sea investigation, neglecting mere details, we can say that the successive Governments of the Queen during the past twenty years have, either from design or by accident, undertaken a work in the highest interests of the race, have carried it on in no mean or narrow patriotic spirit, and are likely to carry it to a termination in a manner worthy of a great, free, and prosperous people.

ON A SUPPOSED PERIODICITY OF THE CYCLONES OF THE INDIAN OCEAN SOUTH OF THE EQUATOR[1]

IN papers printed in the *Reports* for 1872, 1873, 1874, and 1876, I endeavoured to show that there were grounds for supposing that the cyclones of the Indian Ocean south of the equator increased in number, extent, and intensity from a minimum in one year to a maximum in another, and then decreased to a minimum, the period or cycle apparently corresponding with the eleven-year period of solar activity.

From the data given in the last of these papers (*Report* for

[1] Paper by Mr. Charles Meldrum, F.R.S., read at the British Association.