Europe now included a most remarkable diversity of life of Asiatic, North Siberian, Oriental and African origin. The climate was cold and relatively dry. The Reindeer, first the barren ground then the woodland variety, increased rapidly in number during this period and constituted its most distinctive form, hence this is known as the Reindeer period.

This stage is famous for the skeletons of man, the man of Néanderthal and Spy, very primitive in the structure of the skull, the oldest human skeletal remains with the exception of the *Pithecanthropus* of Java.

III. *Upper Pleistocene. Postglacial.*

As above observed there is a difference of opinion as to the interglacial or postglacial age of the loess. All the North Siberian, Oriental and African types gradually disappear, the modern European forest and field fauna alone survives. There is some evidence that both the Mammoth and Reindeer lived for a time in this period, the latter being now confined to more northern Europe. The Irish deer, *Megaceros hibernicæ* the Reindeer, the bovidæ *Bos taurus*, *Bos longifrons*, and *Bos brachyceros*, are the characteristic ruminants. *Alces palmatus* is a postglacial Russian moose. The horse, *E. caballus*, of larger and smaller varieties was now domesticated and used for food. The carnivora, rodentia and insectivora were all of modern type.

The detailed comparison of the Pleistocene of Europe, America and Asia is still under way, and very important results may be expected from it. It will be equally serviceable to American anthropologists and paleontologists, for our own Pleistocene is far from being understood. The stages represented by our horse or *Equus Beds*, which are usually considered Lower Pleistocene, as well as of the Megalonyx and Cave Fauna of the East remain to be exactly fixed. Interest in this problem is greatly enhanced by the fact that we may at any moment discover the remains of man or of his ancestors associated with *Equus excelsus* and positively demonstrate the existence of man upon this continent at a period contemporaneous with his first appearance in Europe.

Henry Fairfield Osborn.

CRUISE OF THE ALBATROSS.

IV.

Mr. Agassiz's final letter to the U. S. Fish Commission on the voyage of the *Albatross* is dated Yokohama, Japan, March 5, 1900.

After coaling and refitting we left Suva on the 19th of December, and arrived at Funafuti on the 23d, stopping on the way at Nurakita, the southernmost of the Ellice Islands. I was, of course, greatly interested in my visit of Funafuti, where a boring had been made under the direction of a committee of the Royal Society, in charge of Professor David, of Sydney, after the first attempt under Professor Sollas had failed. The second boring reached a depth of more than 1100 feet. This is not the place to discuss the bearing of the work done at Funafuti, as beyond the fact of the depth reached we have as yet no final statement by the committee of the interpretation put upon the detailed examination of the core obtained, and now in the hands of Professor Judd and his assistants. In addition to the above-named islands, we also examined Nukufetau, another of the Ellice group.

After leaving Nukufetau we encountered nothing but bad weather, which put a stop to all our work until we arrived under the lee of Arorai, the southernmost of the Gilbert Islands. On our way to Tapateuea from there we steamed to Apamama and Maiana, which we examined, as well as Tarawa. We next examined Maraki, an atoll which is nearly closed with high

beaches, having only two small boat passages leading through the narrow outer land-rims. Both Maraki and Taritari, the the last island of the Gilberts which we examined, are remarkable for the development of an inner row of islands and sand-bars in certain parts of the lagoon parallel to the outer land-rim, a feature which also exists in many of the Marshall Islands atolls.

We reached Jaluit the 9th of January, and after a few days spent in coaling, we spent about three weeks in exploring the Marshall Islands, taking in turn the atolls of the Ralick Chain to the north of Jaluit: Ailinglab Lab, Namu, Kwajalong, and Rongelab; and then the atolls of the Ratack Chain, Likieb, Wotje, and Arhno. The atolls of the Marshall Group are noted for their great size and the comparatively small area of the outer land-rims, the land-rims of some of the atolls being reduced to a few insignificant islands and islets. In none of the atolls of the Ellice, Gilbert or Marshall Islands were we able to observe the character of the underlying base which forms the foundations of the land areas of these groups. In this respect these groups are of striking contrast to the Paumotus, the Society Islands, the Cook Group, Niue, the Tongas, and the Fiji Islands where the character of the underlying foundations of the land-rims is readily ascertained. But, on the other hand, these groups give us the means of studying the mode of formation of the land-rims in a most satisfactory manner, and nowhere have we been able to study as clearly the results of the various agencies at work in shaping the endless variations produced in the islands and islets of the different atolls by the incessant handling and rehandling of the material in place, or of the fresh material added from the disintegration of the sea or lagoon faces of the outer land, or of the corals on the outer and inner slopes. It has been very interesting to trace the ever-varying conditions which have resulted in producing so many variations in the appearance and structure of the islands and islets of the land-rims of the different groups.

The boring at Funafuti will show us the character and age of the rocks underlying the mass of recent material of which the land-rim, not only of that atoll, but probably also that of the other atolls of the group and of neighboring groups, is composed, though of course we can only judge by analogy of the probability of the character of the underlying base from that of the nearest islands of which it has been ascertained. When we come to a group like the Marshalls we have as our guide only the character of the base rock of the islands of the Carolines, which is volcanic, while Nauru and Ocean Islands, to the west of the Gilberts and to the southwest of the Marshalls, indicate a base of ancient tertiary limestone.

Owing to the continued stormy weather and the probability of not being able to land at these islands while the unfavorable conditions lasted, we did not attempt to visit them.

After leaving Suva we made a number of soundings from south of Nurakita toward the Marshall Group, which, in addition to those of the 'Penguin,' clearly show that the Ellice Islands are isolated peaks rising from considerable depths (from 1500 to over 2000 fathoms) and that the same is the case with the Gilbert Islands. We made about thirty soundings between the atolls of the Marshalls, which appear to show that they also rise as independent peaks or ridges, with steep slopes, from 2000 to 2500 fathoms, and that the so-called parallel chains of atolls of the Marshalls, the Ralick and Ratack, are really only the summits of isolated peaks rising but a few feet above the sea-level. The Marshall Islands, as well as the Ellice and

Gilbert, seem to be somewhat higher than the Paumotus, but this difference is only apparent and is due to the difference in the height of the tides, which is very small in the Paumotus, while in these groups it may be five and even six feet.

From Jaluit we visited among the Carolines, the islands and atolls of Kusaie, Pingelap, Ponapi, Andema, Losap, Namu, the Royalist Group, Truk and Namonuito, obtaining thus an excellent idea of the character of the high volcanic islands of the group from our examinations of Kusaie and of Ponapi, while the others represent the conditions of the low atolls, having probably a volcanic basis, but this was not observed at any of those we examined.

The reefs of the volcanic islands of the Carolines are similar in character to those of the Society Islands, though there are some features, such as the great width of the platforms of submarine erosion of Ponapi and of Kusaie, and the development of a border of mangrove islands at the base of the volcanic islands, which are not found in the Society Islands.

The Truk Archipelago was perhaps the most interesting of the island groups of the Carolines, and it is the only group of volcanic islands surrounded by an encircling reef which I have thus far seen in the Pacific which at first glance lends any support to the theory of the formation of such island-groups as Truk by subsidence. This group was not visited by either Darwin or Dana; and I can well imagine that an investigator seeing this group among the first coral reefs would readily describe the islands as the summits, nearly denuded, of a great island which had gradually sunk. But a closer examination will readily show, I think, that this group is not an exception to the general rule thus far obtaining in all the island groups of the Pacific I have visited during this trip; that we must look to submarine erosion and to a multitude of local mechanical causes for our explanation of the formation of atolls and of barrier and encircling reefs and that, on the contrary, subsidence has played no part in bringing about existing conditions of the atolls of the South and Central Pacific.

Nowhere have we seen better exemplified than at Truk how important a part is played by the existence of a submarine platform in the growth of coral reefs. The encircling reef protects the many islands of the group against a too rapid erosion, so that they are edged by narrow fringing reefs, and nowhere do we find the wide platforms so essential to the formation of barrier reefs. The effect of the northeast trades blowing so constantly in one direction for the greater part of the year is of course very great; the disintegration and erosion of islands within its influence is incessant, and their action undoubtedly one of the essential factors in shaping the atolls of the different groups, not only according to the local positions of the individual islands, but also according to the geographical position of the groups. Thus far I do not think any observer has given sufficient weight to the importance of the trades in modifying the islands within the limits of the trades, nor has anyone noticed that the coral reefs are all situated practically within the limits of the trades both north and south of the equator.

The soundings made going west from Jaluit to Namonuito indicate that there is no great plateau from which the Carolines rise, but that the various groups are, as is the case with the neighboring groups of the Marshalls and Gilberts, isolated peaks with steep slopes rising from a depth of over 2000 fathoms. The line we ran from the northern end of Namonuito to Guam developed the eastern extension of a deep trough running south of the Ladrones. The existence of this trough had been indicated by a sounding of 4475 fathoms to the south-

west of Guam made by the *Challenger*. We obtained, about 100 miles southeast of Guam, a depth of 4813 fathoms, a depth surpassed only, if I am not in error, by three soundings made by the *Penguin* in the deep trough extending from Tonga to the Kermadecs.

I was very much surprised, in approaching Guam from the eastward, to find that the island was not wholly volcanic, but that the northern half has been built up of elevated coralliferous limestone. The vertical cliffs bordering the eastern face rise from a height of 100 to 250 or 300 feet at the northern extremity, and resemble in a way similar islands in the Paumotus (Makatea), Niue, Eua, Vavau and others in the Fijis which had made their cliffs a familiar feature in our explorations. In fact, outside of Viti Levu and Vanua Levu, this is the largest island known to me where we find a combination of volcanic rocks and of elevated coralliferous limestone. The massif forming the southern half of the island is volcanic, and the highest ridge, rising to about 1000 feet, runs parallel to the west coast, the longest slope being toward the east.

This volcanic mass has burst through the limestone near Agaña, and the outer western extension of the coralliferous limestone exists only in the shape of a few spurs running out from the volcanic mass, the largest of which are those forming the port of San Luis d'Apra. These spurs are separated by lower ridges of volcanic rocks extending to the sea from the main central mass. To the north of Agaña the limestone forms an immense irregular mesa, cut by deep crevasses, full of pot-holes and sinks, rising gradually westward to a height of 350 or 400 feet. Near the northern extremity of the island a volcanic mass, Mt. Santa Rosa, has burst through the limestone and rises about 150 feet above the general level of that part of the island. The shore stratification of the bluffs is much distorted in the vicinity of that volcanic outburst.

We left Guam in time to reach Rota by day, and found that this island is a mass of elevated coralliferous limestone, the highest cliffs of which reach a height of 800 feet. Perhaps in none of the elevated islands have we been able to observe the terraces of submarine elevation as well as at Rota, especially in the small knob at the southwest point of the peninsula separating Sosanlagh and Sosanjaya bays, which itself is also terraced; no less than seven distinct terraces could be traced. There was no sign of any volcanic outburst except at the northwest point of the island, where both the character of the slope and of the vegetation would seem to indicate volcanic structure.

It is quite probable that others of the Ladrones, like Saipan, and the islands to the south, are composed in part at least of elevated limestone judging from the hydrographic charts and the sketches which accompany them. On many of the northern Ladrones there are active volcanoes, so that it is very possible that the volcanic outbursts which have pushed through the limestone, or have elevated parts of the islands of the group, are of comparatively recent date.

During the last part of our cruise, from Suva to Guam, the unfavorable weather greatly interfered with our deep-sea and pelagic work; in fact, with the exception of the soundings made to develop as far as practicable the depths in the regions of the various coral-reef groups we visited, we abandoned all idea of carrying out the deep-sea and pelagic work planned for the district between the Gilbert and Marshall and Caroline groups. To our great disappointment hardly any marine work could be accomplished, and our investigations were limited almost entirely to the study of the coral reefs of the regions passed through.

After Mr. Townsend's departure, Dr.

Moore continued to collect the birds of the islands where we anchored, and they have brought together a fairly typical collection of the avifauna of the South Sea Islands. Dr. Pryor collected the characteristic plants, and Dr. Mayer the insects and reptiles in addition to such pelagic work as could be done in port. Both Dr. Woodworth and Dr. Mayer took a large number of photographs, and we must have at least 900 views illustrating the coral reefs of the Pacific. Dr. Woodworth also collected incidentally such ethnological material as could readily be obtained during our short stay at different places.

We were everywhere received with the greatest cordiality and courtesy: by the Governor of the Paumotus, the King of Tonga, Sir George O'Brien (the High Commissioner of the Western Pacific at Suva), Mr. E. Brandeis (the Landes-Hauptman in charge of the Marshall Islands at Jaluit), and the Governor of the Carolines. The State Department at Washington having kindly asked through the French, English and German Embassies at Washington for the kind offices of the representatives of these nations in Oceania to the *Albatross* while in their respective precincts, thanks to these credentials nothing could exceed the interest shown everywhere in the success of our expedition.

I must also thank Capt. Moser and the officers of the *Albatross* for the untiring interest shown by them during the whole time of our expedition in the work of the ship, which was so foreign to the usual duties of a naval officer. A. Agassiz.

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*THE PRESENT STATE OF PROGRESS OF THE NEW REDUCTION OF PIAZZI'S STAR OBSERVATIONS.**

Between the years 1791 and 1814, Giuseppe Piazzi executed at Palermo, Sicily, the series of observations which enabled him to publish in 1814 his *Præcipuarum Stellarum Inerrantium Positiones Mediæ ineunte Sæculo XIX.* This was by far the most accurate and extensive catalogue of stars which had ever been published from original observations. But modern advances in this sphere of astronomical research have been fruitful in detecting many sources of error affecting the positions of stars as given in this catalogue. Methods for obviating these errors are known, however, provided there should be an entirely new reduction of all the observations—proceeding directly from each nightly record.

Several abortive attempts to supply this need of astronomy have been made during the last half-century. The impetus was given to the present undertaking by the writer in the summer of 1895, though the calculations were not actually begun until the fall of 1896.

Quotations from letters from such eminent astronomers as Professor Auwers, Dr. David Gill, Professor Schiaparelli, and others; and from the published works of Professor Simon Newcomb, Professor Lewis Boss, Dr. B. A. Gould and many others, show the imperative need of such a new reduction of Piazzi's observations.

In planning a work of this kind, after regard for general methods the first consideration becomes the quantity of work involved—as on that depends the financial outlay and the best disposition of energy. Some data on this point may be of interest.

The observations were made with two instruments: a transit instrument and a meridian circle. The catalogue records a few more than 147,600 observations with both telescopes. Of these Piazzi* himself estimated that 30,000 were made with the transit. The original observations are in

*Summary of a paper read before the Philosophical Society of Washington on March 31, 1900.

* Corrispondenza Astronomica fra Giuseppe Piazzi e Barnaba Oriani—letter of 26 May, 1815.