3. GEOLOGICAL OBSERVATIONS on the WAIPARA RIVER, NEW ZEALAND.

By T. H. COCKBURN HOOD, Esq., F.G.S.

IN 1859, whilst travelling in the Province of Canterbury, I discovered certain beds underlying the Waipara tertiaries, which I referred at the time to the Liassic series, and obtained from the bed of the River Waipara bones of an Enaliosaurian, which were placed in the British Museum, and which were recognized by Professor Owen as belonging to a new species of Plesiosaur, named by him *P. australis*.

Returning to the colony after ten years' absence, I found that a survey of that province had been completed by the Government Geologist, Dr. Haast, whilst the northern and southern portions of the Middle Island had been explored by that accurate and painstaking observer Dr. Hector. The Canterbury and Wellington museums afford interesting evidence of their careful labours: in the latter a collection of fossils from Triassic deposits of the Nelson Province is placed; and an excellent one adorns the former, from the Tertiary beds of the Waipara and other adjacent districts, which crop out here and there from beneath the vast accumulations of Postpliocene gravels.

With the exception of some small fragments of bones (ribs chiefly) of Reptilian origin, nothing appeared to have been found to assist in determining the species of the antipodean monsters. I determined therefore to make as thorough an exploration of the wild ravines of the Waipara as possible, with the assistance of my friend Mr. Innes, who is the proprietor of the Mount-Brown estate, under the base of which the river here runs, and who had taken much interest in collecting specimens.

A portion of this singularly broken country consists of a plain two miles and a half wide by about three miles in length, which appears at one time to have formed a lake (Fig. 1); the surface is now varied by a number of circular lagoons of some depth. The river and its affluents, which encircle this area, have cut their beds down through the lower Tertiary limestones and Septaria clays to the depth of many hundred feet; and the Upper Crag has been removed by denudation. The Cretaceous limestone, which affords an excellent building-material, is distinguished by a great abundance of a peculiar cup-shaped Bryozoon and remains of Echinoderms, and contains many Cetacean bones.

After some days spent in examining the deposits in the broad river-bed and that of the tributary flowing through the fantastically broken gorge shown in the sketch, we returned with a considerable quantity of bones, chiefly of *Plesiosaurus* (ribs, iliums, ischium, coracoid and digital bones), obtained from the intensely hard crystalline boulders (many weighing several tons), which I came to the conclusion were of an older date than the marly clay in which they are imbedded, having probably fallen from the cliffs on the shore of the Eocene sea, which, for some reason, was apparently destitute of life; the nucleus of all we succeeded in breaking was either a Saurian's bone, a *Gryphaea*, or a mass of calcareous spar. Nearly all contain great quantities of fucoids.

There was one deep dark defile which much tempted exploration ; but the only possible means of access seemed to be far from agreeable. The mouth of the gorge was very narrow ; two precipitous cliffs hung over a dark pool, at the base of a high slippery rock, over which the diminished summer stream fell in spray. We succeeded in creeping on our hands and knees along a narrow ledge, along the side of the cliff, and climbed the precipice ; and the extraordinary scene alone would have rewarded us. Gigantic walls of rock ascended on either side 600 or 700 feet precipitously, from which threateningly projected the great indurated masses, circular, pear-shaped (some double, like huge hourglasses), ready apparently to fall at the slightest touch and add to the mass of fallen blocks, piled upon each other, which choked up the ravine to the depth of 50 feet and more, most of them containing fossil remains. In one lay displayed to view on the surface fifteen caudal vertebræ of a great *Plesiosaurus* : another had the cervical vertebræ and two forearms, with paddle-bones and digits, which we gazed at with longing eyes ; but the size and hardness of the rocks rendered their extrication impracticable with such small tools as we had been able to bring. From the middle of another projected a small suspicious-looking bone, which might chance to prove a portion of what I so desired to obtain, the skull of the creature. Underneath the Septaria-clays lies a small seam of brown coal, having immediately above it a shell-bed some 18 inches in thickness, in which I found remains of fishes (palatal teeth of Rays &c.). I broke out with a hammer and wedge one large mass of oyster-shells, carbonized wood, and rolled quartz-pebbles cemented together, containing, along with several small lacertian teeth, two very perfect large vertebræ of procœlian character.

Returning on the next and several following days, we conveyed to the place large sledgehammers and crowbars, and brought additional arms to help us. Leaving a stonemason to cut out the vertebræ, Mr. Innes and I set to work at the large boulder ; and when at last we managed with wedges to effect a fissure and get our heavy crowbar inserted, we had the infinite gratification of splitting it in half, and found that it divided along the surface of a magnificent skull in splendid preservation, with all the teeth complete, of a Teleosaurian 2 feet 8 inches in length from the point of the snout to the base of the cranium.

After a day's hard labour we succeeded in breaking it out of its crystalline matrix, in three portions, weighing about 100 lbs. each. On returning to where the stonemason was at work, it was not a little mortifying to find that he had smashed the specimen to pieces ; however, it was a consolation that we had not intrusted the disengagement of the more valuable prizes to his hands. These we carried, step by step, to the edge of the precipice, and, lowering them with ropes, placed them where we were able to bring a packhorse up the river-bed. The collection obtained subsequently in this spot included several vertebræ of *Ichthyosaurus*, bones of the pelvis, also a femur and humerus of large dimensions.

From a rock by itself we also obtained portions of the skeleton of

Fig. 1.—Bird's-eye view of Basin at the Gorge of the Waipara River, Canterbury, New Zealand.

a. "Red Crag." *b.* Tertiary Limestone. *c.* Septaria-clays. *e.* Conglomerate, overlying Brown Coal, underlain by Ferruginous sand containing sulphur. *k.* Deep Gorge, with boulders containing Saurian bones. *t.* Secondary slates and sandstones. *p.* Cordillera.

a different Crocodilian, which had frequented the shores of the ancient estuary and, so far as my imperfect acquaintance with the subject enabled me to judge, appeared to belong to a species of *Teleosaurus* which had stood much higher off the ground than any hitherto figured. Considerable quantities of coprolites were imbedded in one of the boulders found in the river-bed; and in a gully some three or four miles to the north-west (which had been so deeply excavated by the great floods of late years, especially of 1866*, as scarcely to be recognized, any more than the upper part of the larger tributary, by one who had not visited the district for many years) valuable additions were made to the spoils. Here we were rewarded by finding a boulder with bones sticking out of it in all directions. It was intensely hard, however; and the fossils were in a very friable condition, and broke to pieces when the stone was struck, however carefully. We collected the fragments and covered them with gelatine in the shape of liquid glue; and the specimens (very splendid ones) proved quite perfect, and, when joined together, scarcely showed the fractures.

* The writer hopes to be able, in a future paper, to give exact details of the changes effected by the great storms which have within the last few years surprised the settlers in the Canterbury Province, and afforded most striking evidence of the power of running water to accomplish what, without such demonstration, most observers would probably deem it necessary to refer to the agency of ice. The great flood above referred to, descending suddenly without apparent adequate cause, was attributed in one place to the giving way of the barrier of some glacier-lake; in another district the astonished settlers, escaping from their submerged dwellings, imagined that a water-spout had burst over the lofty peaks of the inner ranges; but when the fact became known that the floods had extended throughout the country, from Nelson to Southland, it was plain that neither explanation sufficed. It is not difficult to account for such a débâcle in the Middle Island, subject to such storms as that which occurred in the winter of 1867, when the snow lay on the plains to the depth of 6 feet, and the drifts obliterated valleys of 500 feet in the lower ranges, so that in one instance a surveying party passed over a gorge of fully that depth, without being aware of its existence until the following summer. The accumulations of severe winters are exposed suddenly to the breath of the hot N.W. wind, which, rising up over the lower currents, passes across the intervening sea from Australia, and strikes upon the summits of the lofty Cordillera, and there rapidly melts the snows, and sweeps down upon the eastern plains with its dry scorching blasts, which, even in early spring raise the thermometer to 90° in the shade. Under such circumstances we may be prepared to witness even greater changes rapidly effected in the contour of the country, in which such remarkable memorials remain of the times when, under different cosmical influences, the climate was more rainy, and the glaciers (although still descending through noble forests to within a few hundred feet of the sea, upon a scale of almost unequalled grandeur) attained much vaster proportions, and other operations went on in proportionate magnitude. In Dr. Haast's excellent paper upon the formation of the Canterbury plains, the enormous deposits of gravel and sand are described that compose this great tract of country, which, although seemingly a dead level, slopes on an average 30 feet in the mile to the sea. In such a region one can understand great changes of the surface taking place also gradually and unobserved, under the eyes of the inhabitants. A curious evidence of this was afforded by the discovery of a silver ornament, at the depth of 50 feet, in digging a well at Christchurch, which gave rise to surmises as to the Peruvian origin of the aborigines, until the article was recognized by a lady as having been lost by her ten years before, when her husband pitched his tent near the spot.

They consisted of fourteen very large vertebræ of very slightly procelian character (with processes in perfect preservation), bones of the pelvis and extremities, and a most singular one shaped like the ischium of a *Plesiosaurus* found in the other ravine, but much more angular. Here also a small hard concretionary boulder, as brilliant when fractured as fine granite, contained a very beautiful *Stenopteris*.

The whole collection, being brought safely to Christchurch, was forwarded to England in the 'Matoaka,' which sailed in May last, but has not since been heard of.

DISCUSSION.

MR. BOYD DAWKINS remarked on the presence of Crocodilia in New Zealand being proved by the procelian vertebræ.

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4. *On the DISCOVERY of ORGANIC REMAINS in the CARIBBEAN SERIES of TRINIDAD.* By R. J. LECHMERE GUPPY, Esq., F.L.S., F.G.S., President of the Scientific Association of Trinidad, &c. &c.

[Abstract.]

THE author described the formation called the "Caribbean Group" by the Government Geological Surveyors of the West Indies as forming a considerable portion of the littoral cordillera of Venezuela, and as extending eastward through the north of Trinidad to Tobago. It consists of gneiss, gneissose, talcose, and micaceous slates, and compact limestones. The metamorphic rocks of Guiana lately described by Mr. Ralph Tate (Quart. Journ. Geol. Soc. vol. xxv. p. 343) are regarded by him as of the same age as those of the littoral chain of Venezuela; and it is probable that the series occurs again in New Granada. Mr. David Forbes mentions the occurrence of gneissic and metamorphic strata on the Bolivian coast and in the desert of Atacama. According to M. Pissis, an extensive series of micaceous and gneissoid strata underlies the Silurian beds of Illimani in Bolivia; and Mr. Darwin alludes to strata of clay-slate &c. older than the Silurians of the Chilian Andes. The author considered that the Caribbean formation will be found to mark one of the "stable areas" insisted upon by Prof. Dana.

The northern range of mountains of Trinidad is composed entirely of rocks belonging to the Caribbean formation. The section from N.N.W. to S.S.E. from the sea, through the valleys of Diego Martin, Maraval, and St. Ann, shows the following succession of rocks in ascending order:—

1. Mica-slates, with quartzose sandstone; 2. Crystalline limestone; 3. Argillaceous slates, with hard sandstones, conglomerates, and thin beds and strings of calcareous matter; 4. Compact limestone, forming the Laventille hills bordering the plain of Caroni.

The total thickness of these rocks in Trinidad is stated by the author at upwards of 10,000 feet; and he is of opinion that the thick-