similar increase in the depth of the main valley of the Wye so altered the general drainage of the district, that water almost or entirely ceased to flow along the old channel. The point of chief interest is, therefore, this—that the facts lead us to believe that by far the greater part of such a valley as Deep Dale has been excavated since the surrounding country was dry land, probably chiefly by means of the same slow process of erosion as is now taking place, though the distribution of gravel brought from a distance indicates that this part of England has been again below the level of the sea at a comparatively recent period.

IV.—ADDITIONAL NOTES ON THE GROWTH OF SOIL.

By G. H. KINAHAN, M.R.I.A., etc.

IN the former notes¹ "On the growth of soil," I omitted to speak of the labours of the ants—these workers, although such pigmys in this country, and, therefore, compared with the earth-worms, less capable, individually, of work, are so numerous and energetic, that in the special places to which they resort, their yearly work is much more conspicuous than the annual worm-work; but the animals operate in different places, for while the earth-worm luxuriates in rich highly-cultivated land, the hill-building-ant loves a dry, sandy or peaty soil. In the spring the ants may be observed beginning their work, and from that time they carry on their operations all through the summer, to the late autumn, or early winter. On a moor they raise hillocks scattered promiscuously about over the ground, getting closer and closer together as the colonies increase. But where the ants are most useful is in places where crags and large stones are mixed up with patches of sandy peat. In such a locality they will always build on a rock, the foundation of their habitation being at its junction with the soil. These ants seldom raise their structures as high as the moorland ants, but they make up in extent for absence in height, and by this means the rocks are gradually covered with soil and vegetation; for, on account of the season of the year at which they build, the growth of the plants keeps pace with the formation of the ant-soil, and protects it in a great measure from "Meteoric abrasion."² During the winter, however, the shape of the ant-hills is somewhat modified, but the matted roots of the plants preserve the major part of the soil which will thus remain, forming an envelope for the rock.

As the annual work of one colony is rarely less than two square feet in superficial area, and sometimes exceeds a square yard, the yearly work done by a number of colonies must be very considerable. The ants that build in the sandy moors seem to frequent

¹ GEOLOGICAL MAG., June, 1869, page 260.

² When I proposed *chemico-fluvial denudation* as a better name than the vague term *sub-aërial denudation*, I had quite forgotten that Mr. Scrope some time since, called the same action *Meteoric abrasion*.—[*Geology and Extinct Volcanoes of Central France*.] This name is evidently so much superior to any since proposed, that I am surprised it has not been universally adopted.

the same spot year after year, and some of the hillocks after a number of years are of a considerable height, some that were measured in the county Cork being four feet high and nearly a yard in diameter at the base. But the ants that build on rocks in general appear yearly to occupy new places, but, perhaps, not always, as it has been remarked in a few instances that the new work was carried on in a place where other works had been in progress the previous year; but whether it was the same colony that worked the two successive years I am unable to say. The rock-covering ants are undoubtedly the more useful animal, but the others have also a serviceable place in nature, as they change a cold unprofitable peat into a good vegetable soil.

A fact in favour of vegetable decay as a soil-producer, and apparently against worm-work, which was not alluded to in my previous paper, may now be mentioned. The greatest enemy a gardener can have to his grass-plots is the earth-worm, for, if allowed to live in them, their appearance will be spoiled. To prevent worms frequenting the place, previous to sowing the grass-seed or sodding the plots, the gardener will place a layer of charcoal under the surface soil or the sods, according to whichever plan he is following. The charcoal, although it is a great preventive, will not quite eradicate the worms, therefore after each cutting of the grass all worm-holes must be carefully searched out, and a weak infusion of mustard and water, or a decoction of *Tussilago farfara* ("Coltsfoot") poured down each, which drives the worms to the surface, when they can be picked off, and thus eventually they are all eradicated. After the worms are all destroyed, if they were the only soil-producers, the surface should not increase; yet that it does is evident from the growth up the pedestal of flower vases, and on the edges of the walks and flower beds. It must be admitted, however, that the increase is very small, the vegetable decay being at a minimum, by reason of the constant, artificial, removal of the grass-crop.

A remarkable instance of the growth of soil was observed in the Moycullen hills, the south-east group of mountains in Yar-Connaught, Co. Galway, Ireland; at a lake called Slieveaneena Lough. This lake lies on the north and south water-shed between the river-basins of the Corrib and Boliska [*anglice*, The Black water], and has two outlets, one leading respectively into each of the rivers just mentioned.¹ Formerly this lake, during low water, only flowed into the Corrib river-basin, the eastern margin being naturally lower than the western. The former, however, was composed of drift, while the latter was a bare granite rock; therefore on account of the small quantity of water flowing from the lake during the dry months of the year, and the moist nature of the climate, bog grew on the drift, while it could not on the granite, and eventually the eastern bank out-topped the western, so that now during low water there is a westward stream, and only during the winter months can the water flow east as well as west.² Lough Slieveaneena occupies about

¹ Memoirs Geol. Survey of Ireland, Explanation of sheet 105, p. 6.

² At the present time there is an artificial drain cut towards the east through the

twelve acres, has a small water table on the north and south, and lies in a rock basin, that bears east and west. The eastern margin of this rock-basin, previous to the drift being deposited on it, was much lower than the western, and even afterward all the water would have flowed to the Corrib, had not the growth of the soil formed a barrier.

Mr. John Edward Lee, F.S.A., F.G.S., the translator of Dr. Keller's "Lake Dwellings of Switzerland," in a note on the depth of soil covering the "Mainland Settlement of Ebersberg," records a remarkable growth of soil at Caerleon, South Wales. Mr. Lee thus writes: "In a field which forms the south-west portion of the ancient city of Isca Silurum, I have frequently excavated for the sake of archæology, and in one instance, when the summer was dry, the grass showed where walls were probably to be found, indicating the ancient Roman houses forming the corner of the inhabited portion, an open space of the street being between them and the city walls. It was, however, very singular that these indications, though correct, were not verified till the ground had been excavated to a depth of five or six feet; and before the actual base of the wall and the floor of the street were reached, a tall labourer was entirely hidden from view. The first foot or two may be accounted for by the rubbish when the place was destroyed, but as no soil is likely here to have been brought down by floods, we are almost obliged to attribute the remaining four or five feet to the annual addition of vegetable mould. The excavation above referred to, is not the only fact which indicates a great accumulation of soil; a handsome tessellated pavement lately discovered in the churchyard was four or five feet below the present surface, etc., etc."¹ This is a startling fact in favour of the growth of soil, by vegetable decay; and Mr. Lee further states, in a subsequent communication on the subject: "The old town of Isca is on a tongue of land slightly above the flats on the rivers' banks (the Usk and the Avon Llwydd), and from the situation there is no chance whatever of any earth being brought down from the hills to the place I mentioned." Although apparently so large in the aggregate, yet, when the yearly amount is calculated, it seems not so large. It must be about 1700 years since the Romans occupied the site, and if two feet are allowed for the depth of the debris of the building, there will be four feet to be formed by the growth of the soil: this is equal to 2·82 inches in a century, or ·028 inch annual growth; scarcely equal to the thickness of five sheets of foolscap paper,—or, another way to explain it, one inch growth in every 34·6 years. Furthermore, all may not be due to the vegetable decay; for, as the field is near Caerleon, it is

bog. When the lake was first visited in the early summer this drain had just been opened, about five feet deep, to make up the fences, and although it did not reach to the bottom of the peat, yet it was lower than the western *embouchure*, and carried off all the summer water. At a subsequent visit, nearly two years afterwards, the eastern cut was choked up by aquatic plants, among and behind which a peaty sediment had been deposited, and thereby formed a dam, which drove the summer water to flow westward, to the Boliska.

¹ Keller's *Lake Dwellings*, p. 367 *footnote*.

probable that it has often been "top dressed," a process which would quickly add to the depth of the soil. It should, however, be mentioned, that some years since, a field, in the north part of the county Tipperary, was broken up, that had a soil fourteen inches deep, and this field a man, seventy years old, knew to be exactly 110 years in grass. As the average depth of soil, in this part of that county, is from ten to twelve inches in depth, it would leave about 2·5 inches of soil to grow in the century, which is very similar to the results found near Caerleon.

V.—NOTE ON THE CAUSE AND NATURE OF THE ENLARGEMENT ON SOME CRINOIDAL COLUMNS.

By JOHN ROFE, F.G.S.

AMONG a great number of specimens of *Crinoidea* from the Mountain Limestone collected by me during several years past, there are many parts of columns which shew an enlargement of the diameter or bulging similar to that described by Miller as representing "the remedial effect of calcareous secretion in repairing an injury of the joints of the stem," and some few portions have occurred having the appearance of a small column rising from the centre of a larger one as shewn in Woodcut *fig. 1*.

These last, for some time, were a puzzle not only to myself but to several friends better able to give an opinion on the subject. The small column a seems to be growing from the centre of the larger one without any appearance of a head or of side arms, and without any apparent cause; but further examination of a large number of specimens, an accidental fracture of one of them, and the subsequent dissection of others, suggest an elucidation of this difficulty, and of the cause and nature of these enlargements generally, and at the same time give a clue to the process of the growth of these Zoophytes.

The column of a Crinoid appears to have been not unfrequently used as a place of attachment for Corals, Bryozoa, or Serpulæ. Phillips (*Geol. of Yorks.*, vol. ii, pl. 1, fig. 61) figures the *Calamopora parasitica* on a stem, and MM. Edwards and Haime (*Monographs Pal. Soc.*) giving it M'Coy's designation Favosites, also figure and describe it as usually adhering to the stem of an Encrinite. Another Coral, with which this note is more particularly connected, is described by McCoy as *Jania crassa*, and subsequently as *Cladochonus crassus*, and he states that "the mode of attachment of the young is most usually by the early branches growing in a circle round a Crinoidal stem." It is over and around the coral thus attached to the Crinoidal column that the enlargement above alluded to is very frequently formed. The coral having fixed itself to and surrounded the column prevents its further natural growth laterally; but the zoophyte when enlarging its column, which it evidently effected by secreting and depositing fresh shelly matter on the outside, encloses the body or cup of the coral with the column, and by so much increases the size. Certainly in most cases, and probably in all, the