The Stone-axe Factory of Graig-lwyd, Penmaenmawr.

AT a meeting of the Royal Anthropological Institute held on April 19 Mr. S. Hazzledine Warren presented a report on the results of excavations at Graig-lwyd carried out in June, 1920, under a representative committee appointed by the Royal Anthropological Institute. The expenses of the excavation were met by grants from the National Museum of Wales, the Cambrian Archæological Association, and other public and private contributors.

The Neolithic workings follow the chilled margin of the Penmaenmawr intrusive rock for a considerable distance, but the excavation was mainly concentrated upon one important chipping "floor" associated with the site of a large hearth.

The workers made their stone axes either directly from the natural blocks of scree or indirectly by first striking off large flakes. These large primary flakes often weigh from 7 lb. to 14 lb., or even more, and their production in such a tough and intractable material is evidence of remarkable skill. "Core implements" and "flake implements" were made indifferently, according to convenience in working the stone. The stages of manufacture from the natural block to the finished axe may be grouped as (1) preliminary, (2) intermediate, and (3) advanced. The most characteristic forms arrested in the middle stage may be described as "intermediate ovates"; these might well be mistaken for Late Chelles and St. Acheul implements, while many of the smaller specimens in the preliminary stage resemble the earlier Chelles group. Pseudo-Mousterian flakes with faceted platforms, recalling the Levallois technique, were produced in large quantities as a waste product from the flaking of the axes. More than four hundred "ends of celts" (as they are usually called) were found, and thirty-two complete axes have been refitted from these halves broken during manufacture. The industry is essentially similar to that of Grime's Graves and Cissbury.

Four broken polished axes were recovered from the main "floor," and three of these had been rechipped after breakage into makeshift blades. One stone plaque engraved with a series of triangles was also discovered.

In opening a discussion on the report Sir William Boyd Dawkins said that a debt of gratitude was due to Mr. Warren for having brought these facts, the result of much hard work, before the institute. The subject was of the greatest interest and importance to British archæology at the present time. The finds at Graig-lwyd must be grouped with those from Cissbury and Grime's Graves. As a result of a careful comparison with the long series of finds from Cissbury in the Manchester Museum, he had come to the conclusion that every peculiarity in the Graig-lwyd specimens could be paralleled from Cissbury, the one difference being that the Graig-lwyd implements were made of igneous rock, while the Cissbury finds were flint. The Graig-lwyd specimens were consequently larger owing to the difference in material. The shape and the rude character of a specimen did not prove that it was not of Neolithic age. He himself had found at Trenton, New Jersey, side by side with typical Indian stone implements, specimens which in form belong to the Moustier and other European Palæolithic types. The lesson to be learned from this find was that age cannot be estimated from form. As regards the positive evidence for date of these *ateliers*, it was beyond question. At Cissbury Neolithic pottery and the remains of domestic animals had been found. The evidence from Grime's Graves was clear. There the flint from which implements were manufactured was taken from pits and galleries, and was therefore later in date than these, but the workings show that the greater number of these galleries had been excavated with polished stone axes, and therefore the implements of Chellean, Moustier, and other types found on this site were Neolithic. The conclusion to which this evidence pointed was supported by the types in Mr. Warren's find. The examples of specimens broken in course of manufacture in Neolithic times, of which the parts now reassembled by Mr. Warren exhibited differences in patination, were also a proof that patination was no criterion of age. The discovery of this factory had an interesting bearing upon the question of prehistoric trade and communication. Owing to the existence of a felsitic stone implement factory in the Lake District, he had hitherto derived the felsite axes found in the Midlands from this source, but in future the felsite at Graig-lwyd would have to be taken into account.

The implements from the Graig-lwyd excavations, which will be reproduced in illustration of the report when it is printed *in extenso*, were exhibited at the Royal Anthropological Institute on April 20–22. A larger and more representative collection is to be exhibited at the rooms of the Society of Antiquaries, Burlington House, on May 23–25.

Descriptive Botany.

UNDER the title "The Leguminous Plants of Hawaii" (issued by the Experiment Station of the Hawaian Sugar Planters' Association), Mr. J. F. Rock gives a systematic account of the native, introduced, and naturalised trees, shrubs, vines, and herbs belonging to the family Leguminosæ. Detailed descriptions are given of all the native and established species, with notes on distribution and economic uses; keys to the genera and species are also included. In all, 200 species belonging to 71 genera are described, and there are 93 excellent full-page photographic reproductions of the more important species. The percentage of indigenous species in this family is very small, and of these only six are trees, one is a shrub, and the remainder are, with few exceptions, usually shore-plants or grow near the shore, and are distributed over most of the Pacific Islands. This poor representation of one of the largest families of flowering plants contrasts remarkably with its rich representation in tropical Asia, and is a strong argument against the existence of any previous land connection with the Asiatic continent. The writer regards the Leguminosæ as a strong factor in proving the assumption that the Hawaian islands are purely oceanic in character; he proposes to discuss thoroughly the origin of the flora in a work on the phytogeography of the islands which he has in preparation.

In "Icones Plantarum Formosanarum," vol. ix.

(Bureau of Forestry, Government of Formosa), Bunzo Hayata continues his descriptive account of the flora of this island. The volume contains studies of genera of a large number of families of flowering plants, and includes descriptions of 139 new species; the arrangement follows the system of Bentham and Hooker's "Genera Plantarum." The descriptions (in Latin) are full and clear, and the volume is remarkably well illustrated with text-figures and plates. Two new genera are established, one, Dolichovigna, a climbing bean near Phaseolus and Vigna; the other, Pseudosmilax, a member of the family Liliaceæ, and intermediate between Smilax and Heterosmilax. Nine genera are also recorded as new to the flora of the island, which so far as is at present known includes 3608 species of flowering plants representing 1185 genera and 169 families.

In the *Journal of Ecology* (vol. viii., No. 1) Miss L. S. Gibbs gives an account of the phytogeography and flora of the mountain-summit plateaux of Tasmania based on her own observations and collections. The vegetation of the island may be divided into three principal plant formations: (1) The austral-montane flora of the mountain-summit plateaux, which represent the remains of the huge lava plateau of which the island formerly consisted. The major and most interesting portion of the endemic flora is entirely limited to these summit plateaux; one of the peculiar features is the almost complete absence of herbaceous plants. (2) The mixed forest of the west coast, not very rich in species and characterised more by denseness of growth than by height. There is a marked endemic element in this flora which probably originated on the higher lands. (3) Eucalyptus formation, occupying the greater part of the island, consisting mainly of secondary open forest, and purely Australian in type. A description is given of the various portions of isolated tableland which form the mountains of the island and at no point exceed 5000 ft., and the writer describes the chief plant-associations, enumerating the plants which she collected in each. On the most exposed and highest levels a mosaic of small moss-like plants is developed, with inconspicuous flowers, forming a hard, even surface. This is succeeded by a mountain shrubbery, the dominant association of the more exposed portions of the plateau summits. Lower come forest-associations in succession, namely, dwarf mountain forest, low mountain forest, and Eucalyptus scrub. In conclusion, the author refers to the marked relation between the mountain flora of North-West New Guinea, the subject of a former paper, and the so-called "Antarctic flora" of the southern hemisphere. Recent work on meteorological conditions provides an explanation of this relation, namely, in the persistent north-west wind of high altitude over the mountains of New Guinea and across the Australian continent. Seeds transported by this agency would be precipitated in southern latitudes, where they remain within the radius of the persistent westerly winds and gales of the Antarctic seas.

A systematic enumeration is given of the species collected on the mountain-summit plateaux and in the mixed forest from September, 1914, to March, 1915.

Origin of Petroleum and Cause of Gas Pressure.[1]

THE important volume referred to below is bountifully illustrated with photographs, sections, and maps, and gives a comprehensive account of some 150 square miles in the midst of the Californian oilfields, a territory which provides nearly half the oil which the State produces, and includes its greatest oilfield. Here, too, is the famous "Lakeview Gusher," which yielded 8,000,000 barrels of oil in eighteen months. The area has been discussed previously both by State and Federal geologists, notably some ten years ago by R. Arnold, H. Johnson, and R. Anderson in Bulletins 406 and 471, but since that time there has been much further development, and many new facts are available.

The work contains a wealth of information which is rendered easily accessible by its systematic arrangement and clear table of contents. The book commences with a brief "Summary of Results," which is followed by an informative bibliography. "Stratigraphy," which occupies 34 pages, is dealt with under the headings of the various formations. Then follow "Structure" (pp. 54–63) and "Petroleum" (pp. 63–87), whilst a detailed description of the "Productive Field" occupies the latter half of the book. In the pocket at the back of the volume is a geologic map of the region and large-scale topographic and structure maps of the oilfield, together with many sections across the productive area.

The main scientific inferences differ little from those set forth in the earlier bulletins. It is made clear that the petroleum was generated within the Tertiary deposits, which are at least 18,000 ft. in thickness, ranging from Eocene to Pliocene. Regarding the origin of the oil, the author's explanation is that previously formulated by Arnold and Anderson; but he does not ascribe the source of the carbon wholly to the diatoms and foraminifera. "The petroleum has originated in the diatomaceous shale formations, chiefly from the alternation of organic matter contained in diatoms and foraminifers, but probably in part *also from the alteration of terrestrial vegetal débris*." Later "the oil has collected in part in sandy beds that are intercalated with the [diatomaceous] shale, but chiefly in the porous beds of younger formations that rest unconformably upon the shale."

With reference to migration and accumulation, the author affirms that much of the oil in the pools "has migrated from the beds beneath the San Joaquin Valley to the foothills and collected in the small anticlines that extend from the hills out into the valley." The reservoirs of oil are now chiefly in the later Tertiary "[Miocene or Pliocene] sandy beds that rest unconformably upon the diatomaceous shale."

Some interesting matters are discussed in connection with the gas pressure and concerning chemical reactions on the petroleum within the oilsands. The pressure in these fields is not proportionate to depth, and usually is considerably in excess of the theoretical "hydrostatic pressure." The author holds that the oil, whilst within the reservoirs, has been affected by chemical reactions with minerals. In particular, oxidation by sulphate-laden waters has produced a marginal ring of heavy tar around the pool where its bottom rests upon the under-water. This tar seals the oil pool within a definite space, and any further quantities of gas generated from the oil can be accommodated only by increase of pressure. Such conditions probably account for the great gusher-wells of this region. T. O. B.

[1] United States Geological Survey, Professional Paper No. 116: "The Sunset Midway Oil Field of California.' Part i., "Geology and Oil Resources." By R. W. Pack. Pp. 179.