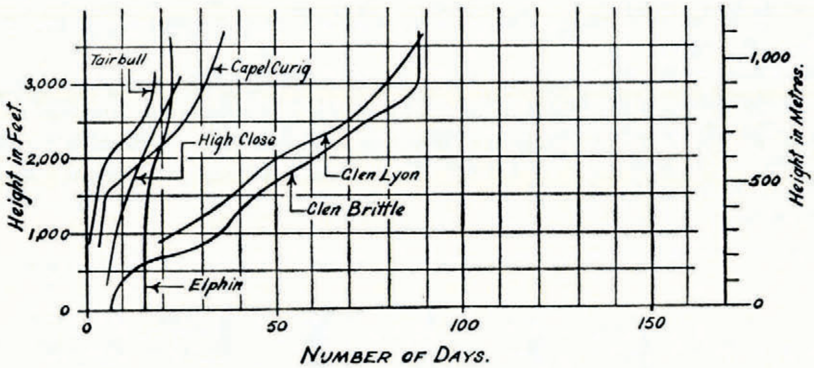

Fig. 1

of the season, though in November it was confined to but one day at 3000 ft. At this station the maximum duration was 11 days at 3500 ft. in January.

At Llanfrothen no snow lay at any level in October, November or May, and in December the duration was but one day at all levels. The maximum duration at all levels occurred in January, reaching 5 days at 2000 ft. No snow cover was reported at any level from Tairbull, Brecknockshire, in November, February or May, and in January the duration did not exceed one day. The duration in March was 9 days at 3000 ft. and 7 days at 2500 ft. In the remaining months the duration did not reach 5 days at any level.

Data from six representative stations are summarized graphically in Fig. 1 above by curves showing the total duration of the snow cover throughout the season. Above the 500 ft. level the duration on the Cuillins, as observed from Glen Brittle, exceeded that at all the other stations, with a maximum of 89 days above 3000 ft. It is of interest to note that the duration of snow cover on this range exceeded that of the 1947–48 season at all levels.

At the remaining stations the duration at all levels above 500 ft. was considerably less than in the previous two seasons and at none of the stations in England or Wales did the duration of snow cover exceed 35 days at any level.

D. L. C.

PRELIMINARY RESULTS FROM THE STUDY OF AN OCEAN CORE OBTAINED BY THE SWEDISH DEEP-SEA EXPEDITION, 1947–48

By C. D. Ovey

(Department of Zoology, British Museum (Natural History), London)

Professor Hans Pettersson returned to his country in the autumn of 1948 after leading the Swedish Deep-Sea Expedition in the *Albatross* round the world on oceanographic and marine biological exploration. One of the members of his staff was Dr. B. Kullenberg, inventor of the Kullenberg piston core-sampler, an apparatus which has raised, relatively uncompressed, the greatest thicknesses of sediments from the ocean bed so far obtained, thus revolutionizing the prospects of elucidating its past history. The first published results of an examination of one of these cores taken on the Expedition comes from Dr. F. B. Phleger [1] of Wood's Hole Oceanographic Institution. Dr. Phleger studied the microfossil content of a core 15·40 m. in length from the Caribbean Sea below 2677 fathoms (4896 m.) in order to discover the climatic fluctuations as shown by the remains of foraminifera, which are temperature-indicating organisms. He examined 75 samples at about 20 cm. intervals and found that the buried shell remains of various species

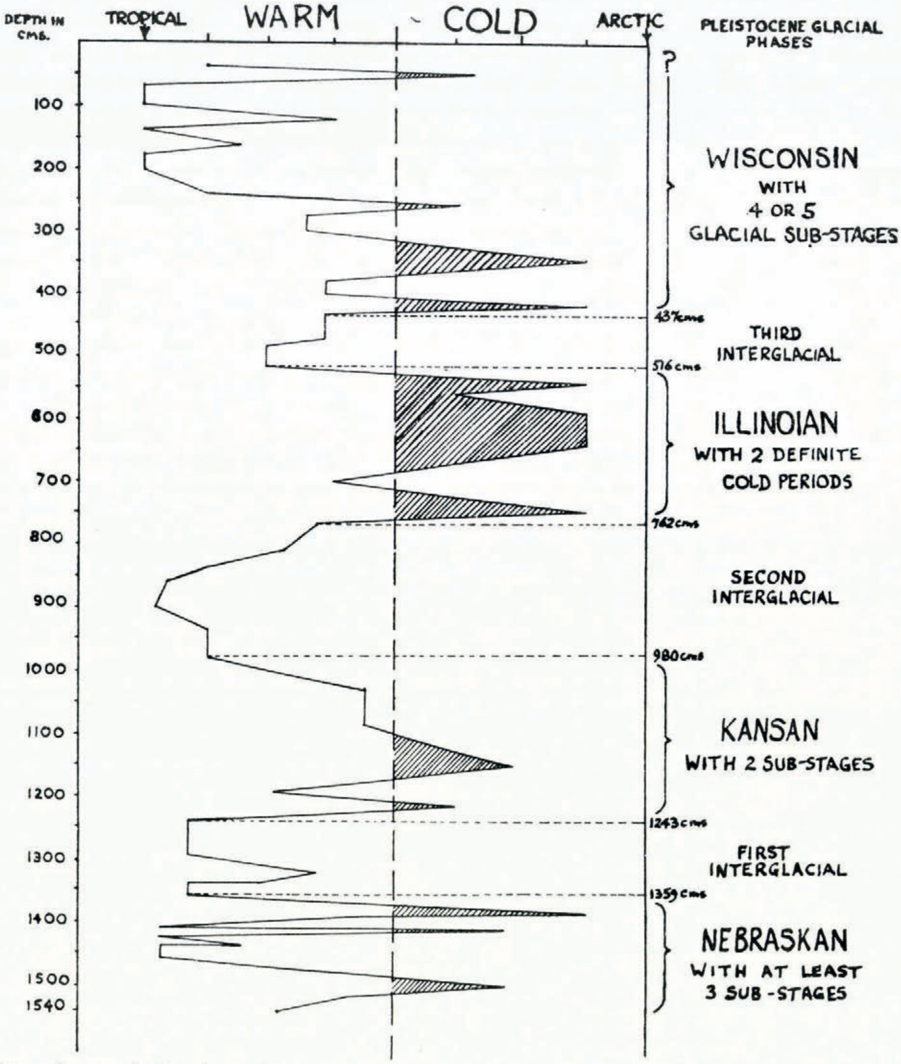

Fig. 1. Approximate relative changes in surface water temperatures, based on the percentage variations of cold and warm water foraminifera from core 34 (15·4 metres in length). "Albatross" Station 10 (1947), Caribbean Sea. The top few centimetres were lost when the core was extracted from the coring apparatus

By courtesy of the Editors of Weather

of foraminifera reflected oscillations in the temperature of the surface waters in which the organisms had once freely lived. The curve reproduced in Fig. 1 above indicates the results of his investigation, with his tentative interpretation of the main Pleistocene ice advances in the United States inserted in the right-hand column by the present writer.[2]

To the glaciologist the value of this work and the great amount of its kind to follow (the *Albatross* collected a total length of over an English mile of bottom cores) will be of first-class importance not only in tracing the climatic history through the Pleistocene but in giving a clue to the problems concerning the origin of the climatic fluctuations involved. Professor Hans Pettersson has sent one such core (from the equatorial Atlantic) to be worked out by the present writer and his colleagues at the British Museum (Natural History). They have considered it advisable to study samples at 5 cm. intervals since the rate of accumulation of Globigerina ooze is approximately 1 cm. per 1000 years, so that even in this case the time interval represented by the gap between the samples will be about 5000 years, time enough for the floating population of the Atlantic of the past to change its character.

It must be remembered that the foraminifera, whose empty shells are accumulating on the sea floor, once lived in the surface layers, and the assemblage of the relative abundance of their species reflects ocean surface temperatures down to a depth of about 1000 metres of water. When a sufficiently large number of cores has been worked out it may be possible to make correlation over wide areas of the ocean, but in so doing it has to be remembered that local changes in climatic conditions and local variations in ocean currents are bound to complicate the issue. In general terms, however, it should be possible to make a reasonable dovetailing of results from individual cores.

Connected with direct evidence from organic remains are many problems concerning the mineral and chemical composition of the deposits. These may together throw light upon bottom conditions which existed on the ocean floor at any given period during the Ice Age oscillations. It is already known from short cores taken by Dr. C. S. Piggott in 1936 on board the cable ship *Lord Kelvin* that glacial marine beds have been found alternating with "warmer" foraminiferal marl (Globigerina ooze) indicating the periodic southward extension of the limit of drift ice—the glacial marine beds being composed of debris dropped by the melting of ice mainly in the form of bergs. Professor Pettersson took a course through the tropical belt in order to avoid bad weather when using Dr. Kullenberg's important invention, but what is needed now, particularly from the point of view of those interested in glaciology and the climate of the Ice Age, is a series of cores taken north–south through the Atlantic Ocean in order to find out, by correlating them, whether the cooling of the climate during any or all of the Pleistocene oscillations was synchronous or not in the two hemispheres. This latter point has recently been stressed by W. D. Urry.[3] A great many conflicting views have been put forward concerning the origin of these oscillations, notably by Brooks,[4] Simpson,[5] Zeuner,[6] Flint,[7] Fuchs and Paterson [8] and others, and it is therefore of vital importance that as many data are assembled from as many cores as possible, so that these theories may be reviewed in the light of the history of changes in ocean surface temperatures.

The Swedish expedition has opened a new field of research into sub-oceanic geology and it is not possible to forecast the results. What, however, seems obvious at the outset is the fact that a great deal will have to be learned concerning the life history and distribution in present day oceans of the planktonic (free living) foraminifera. The whole basis of core interpretation rests primarily on the ecological, biological and taxonomic study of a few microscopic organisms, and only when their distribution and relation to temperature is thoroughly known will it be possible to give more exact interpretation of temperature changes. The present writer and his colleague Dr. J. D. H. Wiseman have in the press a paper in which an experiment (briefly described to the British Association in 1949) was carried out. This gives the results obtained from studying the foraminifera from bottom samples at nine widely separated localities. The experiment clearly indicated that the creatures could very definitely be divided into groups which would indicate surface ocean temperatures within certain limits of variation. With the assistance of data provided by the Hydrographic Department of the Admiralty and the Meteorological Office of the Air Ministry it was possible to determine the relationship between ocean and air temperatures. By inference, therefore, it was clearly demonstrated that assemblages of foraminiferal shells from the ocean floor could, within certain limits, be made a function of surface air temperatures. This theme can only be developed by taking the individual species concerned and working out their present day world distribution in the open oceans, in order to express more accurately Pleistocene temperature changes over wide areas of the ocean.

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ICE PYRAMIDS ON GLACIERS

By Joel E. Fisher (New York)

Paper communicated to a Meeting of the Society on 17 February 1949

Abstract. Waves of ice on the Gorner Glacier (Switzerland) are described. These finally assume an appearance very similar to the ice pyramids of the Himalaya. The author shows that the former originate as avalanche snow which remains above the general surface of the glacier through its lightness and greater resistance to ablation than the denser glacier ice, and suggests, as do Visser and others, that some Himalayan ice pyramids also originate as avalanche snow.

Zusammenfassung. Eiswellen des Gornergletschers (Schweiz) werden beschrieben. Diese nehmen schliesslich eine sehr ähnliche Form an wie die Eis-Pyramiden des Himalaja. Der Verfasser zeigt, dass die ersteren aus Lawinenschnee entstehen. Diese bleiben infolge ihrer Leichtigkeit und ihrer Widerstandsfähigkeit gegen Ablation, die grösser ist als die des dichteren Gletschereises, auf der Oberfläche des Gletschers haften. Der Verfasser vermutet, dass einige der Himalaja Eis-Pyramiden ebenfalls aus Lawinenschnee hervorgegangen sind.

Many accounts of Himalayan mountaineering expeditions give short descriptions of ice pyramids, unique spires of glistening white ice rising to considerable heights above the flat valley glaciers (see Figs. 1 and 2, p. 376).

They have the following characteristics:

1. They consist of unusually clean, white ice. I have been informed by members of the American Alpine Club expeditions to K2 that this ice is more "snowy," definitely whiter than the ice which constitutes the glacier proper in the same vicinity.
2. They rise from the flat, debris-covered floor of the dry glacier.
3. Their height may be 150 ft. (45 m.) or more.
4. They are ranged in a narrow file, lengthwise of the glacier and exist only in one particular lane of the glacier.
5. Along that lane the file of these towers may be one or two miles (1·6–3·2 km.) in length.

There appear to be no photographs in which one can follow an ice pyramid up the glacier to the point of its first appearance with sufficient certainty to ascertain from what particular surroundings the *névé* of that lane was derived. The obvious beauty of these pinnacles and the doubt concerning their origin poses a challenge to us to endeavour to seek the factors which bring them into existence.

While traversing the Gorner Glacier in 1948 I noticed certain phenomena which suggested to me conditions which might be responsible for the formation of at any rate one type of pyramid. The Gadmen-Bétemps trail crosses a lane of ice notably whiter than the rest of the glacier. This white lane is clearly shown in Fig. 3, p. 376. Very conspicuous on the white lane are small ablation holes which, increasing in size as one proceeds towards the valley, ultimately merge into one another until the glacier surface is covered with large holes a metre in diameter, of irregular round shape and some 70 cm. deep. These are the *Kryokonit* holes of von Drygalski.

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