LETTERS TO THE EDITORS

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Instability of the Earth's Axis

In connexion with the theory of the instability of the earth's axis of rotation[1], it may be worth pointing out that, besides the evidence from fossil magnetism, it is possible that independent biological confirmation could be found of the occurrence of major latitude changes in the past history of the earth.

However the climate may have changed in the past, it is certain that the seasonal variation in length of day at any particular latitude must always have been the same ; however warm the arctic winter may have been, it was always dark. Since photosynthesis is possible only in daylight, there must always have been a check to plant growth at high latitudes during the winter, whatever the temperature, and this will have left its mark in the form of annual growth rings in trees and other perennial plants. If plant fossils showing continuous growth without well-defined annual rings or other signs of a winter check could be found at the present time at higher latitudes, that would be good evidence of past latitude changes, for continuous growth without an annual winter check can never have been possible far outside tropical latitudes.

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[1] Gold, T., *Nature*, **175**, 526 (1955).

The possibility that changes have occurred during the past in the position of the earth's axis of rotation, relative to present surface features, is of great interest to all students of fossil plants. It has long been clear that the geological evidence of former vegetation shows that the lands around the Arctic Sea bore an ample covering of plants during a long period, probably from Devonian to Tertiary times. This vegetation included many large trees and was very different from the scanty flora of those regions living to-day. From other areas, such as South Africa, India and Australia, there is evidence of glacial conditions associated with relatively small flora.

Hitherto, almost all palæobotanists of the past twenty years have accepted the hypothesis of continental drift as being the only possible explanation of all the observed facts, in spite of the objections frequently raised to this theory. The new views summarized by Mr. T. Gold[1] will stimulate a re-examination of the palæobotanical evidence.

The use of fossil plants as tests of past climates has been under consideration for many years by many investigators, especially by Seward. The interpretation of the evidence is by no means easy, since the factors of temperature, rainfall, length of day and intensity of light are involved. The significance of growth rings in the stems of woody plants found in a petrified condition has been discussed by Gothan, Antevs and others ; but there is a great lack of information about the stems of coniferous and other plants from the older rocks of high latitudes. Well-marked growth rings were present in trees of Mesozoic age from the arctic regions ; but we should like to know whether they also occurred in trees of the same area during the Upper Devonian and Carboniferous periods. At this time the gymnospermous trees from Europe and North America showed little or no signs of a seasonal cessation of growth, whereas those from South Africa, India and Australia have very conspicuous growth rings. A specimen of petrified wood from the Antarctic Continent was described by Seward, in the report of the Scott expedition[2], as showing annual rings ; but these were much less conspicuous than those in somewhat similar wood from South Africa.

There can be little doubt that the climatic changes, of which both rocks and fossils provide evidence, were of great importance in relation to the evolution of plants, and consequently to the past history of terrestrial animals. If geophysical research can establish how these changes came about, an important contribution to biology will be made.

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[1] Gold, T., *Nature*, **175**, 526 (1955).

[2] *British Antarctic (Terra Nova) Expedition*, 1910, **1**, 17 (1914).

Reactions of Herring Larvæ to Light : a Mechanism of Vertical Migration

During the course of studies on the reactions of fish to light the opportunity arose for observing the behaviour of herring larvæ, *Clupea harengus* (Linn.). Initial observations were made on larvæ in shallow dishes illuminated from below by diffuse light. Each larva was dark-adapted and then observed for fifteen minutes at different light intensities, the total time spent moving in this period being recorded as a measure of its activity. The larvæ exhibited a positive photo-orthokinesis[1], their activity being proportional to the light intensity between two limits. The lower threshold for the kinesis was about 20 metre-candles, the larvæ being active for 20 per cent of the time below this intensity (down to at least 0·3 m.c.). At higher intensities, activity increased to a maximum at 4,000 m.c. when larvæ were active for 35 per cent of the total time ; still higher intensities (up to 65,000 m.c.) did not increase activity further. When a light was shone at the side of the dish, larvæ swam directly towards it, showing a positive phototaxis.

Later experiments were carried out in a tall glass cylinder illuminated by diffuse light from above. Inactive larvæ sank head first weighted by their yolk-sacs ; active larvæ swam directly upwards 'standing on their tails' or maintained their mid-water level, swimming horizontally. Very little swimming was observed at inclinations between these planes in larvæ up to five days old at 7·5° C., although the behaviour of older larvæ became more variable. Time spent swimming horizontally, vertically, and the distance swum vertically were recorded during each observation period. The positive photo-orthokinesis persisted in this apparatus. At lower light intensities (down to 3 m.c.) and also in red light (above 6500 A.) the larvæ swam only vertically upwards when active or sank passively. After a period in the dark, larvæ were always found in mid-water, so that they would appear to be active in total darkness, activity probably being at the basal