zooplankton was sparse and no species clearly dominant.

In the Atlantic, *C. carinatus* is widely distributed between 47° N. and 37° S., although it is by no means a common species[3]. It was not recorded by Scott[4] in his monograph on the Entromostraca of the Gulf of Guinea collected during the cruise of the *Buccaneer* in 1886 although this expedition covered much the same area as that sampled by the *Cape St. Mary* sixty-six years later. However, the results of this latter survey suggest that the distribution of the species is, in some way, related to colder surface water. The cruise of the *Buccaneer*, between Cape Three Points and Lagos, took place during January and February and Scott's records showed that surface temperatures at this time exceeded 27° C.

The distribution of zooplankton along this coast is of interest in connexion with the fishery for *Sardinella aurita* Valenciennes. This fish is rare in Nigerian waters but abundant off the coast of Ghana[5], where high landings correspond closely to the period when the surface temperature is below 25° C. (ref. 6). Recent work on *S. aurita* has shown that its chief food groups are copepods together with other planktonic Crustacea, and that aggregations are often closely related to the available food supply[7,8].

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[1] Janke, J., *Arch. Deutsch. Seewarte*, **38** (1920).
[2] Howat, G. R., *Nature*, **155**, 54 (1945).
[3] Vervoort, W., *Temminckia*, **8**, 1 (1949).
[4] Scott, T., *Trans. Linn. Soc. Lond. (Zool.)*, **6**, 1 (1894).
[5] Postel, E., World Scientific Meeting on the Biology of Sardines and Related Species. Stock and Area Paper No. 3 (F.A.O., Rome, 1959).
[6] Gold Coast Fisheries Dept., Report for the year 1950–51 (Government Printer, Accra, 1952).
[7] Komarovsky, B., *Proc. Gen. Fish. Coun. Medit.*, **5**, 311 (1959).
[8] Chromov, N. S., Comité de la Sardine, Paper No. 166, Cons. Int. Explor. Mer, C.M. (1960).

Internal Waves and Waves of Sand

A DESCRIPTION has been given of some large sand waves on La Chapelle Bank which lie parallel to the general direction of the edge of the continental shelf[1]. They occur within a zone about 10 miles wide, have a mean separation of 2,800 ft. and are up to 40 ft. high. Berthois[2] believes them to be fossil ridges while Cartwright[3] has shown in some detail how they could be formed by stationary waves, which develop in the thermocline as the tidal streams, moving landwards, feel the constraining influence of the shelf. These would be equivalent to lee-waves found on the down-wind side of a mountain.

Internal waves (not necessarily stationary) of similar amplitude and wave-length to the sand waves are the only possible explanation of the abnormal oscillation of a scattering layer shown in Fig. 1. The pattern was recognized on August 15, 1959, and on August 3, 1960, when R.R.S. *Discovery II* passed over the bank using a 36-kc./s. narrow-beam echo sounder. The new information appears to support Cartwright's theory, and adds interest to the study of the internal waves in the western approaches to the English Channel.

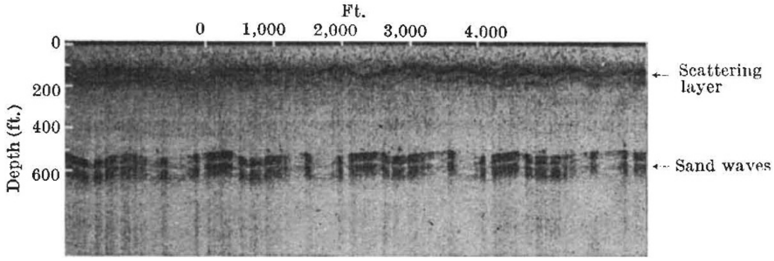

Fig. 1. An echo sounder record over La Chapelle Bank, showing internal waves (revealed by a well-developed scattering layer) overlying sand waves of similar size. The record was taken approximately at right-angles to the crests of the sand waves and its mid-point is situated about 8 miles from the oceanward side of the bank. (The vertical white stripes are due to defective recording paper)

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[1] Cartwright, D., and Stride, A. H., *Nature*, **181**, 41 (1958).
[2] Berthois, L., *Rev. Trav. Inst. Pêches marit.*, **23**, 225 (1959).
[3] Cartwright, D., *Proc. Roy. Soc.*, **253**, 218 (1959).

METALLURGY

'Intrinsic Stress', σ_0, in the High-Temperature Behaviour of Metals

THE governing relation between strain ε and stress σ for the behaviour of metals at temperatures above about half the melting point seems to be of the form:

$$\frac{d\varepsilon}{dt} = \frac{1}{E}\frac{d\sigma}{dt} + M \sinh \frac{\sigma}{\sigma_0}$$

where E is the elastic modulus and M is a function of temperature[1]. The quantity σ_0, which has the dimensions of stress, is a constant for a metallurgically stable material and is independent of temperature. Its value does, however, vary considerably, depending on the presence of impurities or of alloying material.

The constancy of σ_0 with temperature has been a mystery, but a recent paper[2] has perhaps thrown some light on the matter. In this paper the authors relate creep to the presence in the metal of so-called 'bad sites' which impede the free movement of dislocations. These bad sites are provided by crystal imperfections, impurities, and alloying elements. At these sites there develops a stress concentration which is relieved by diffusion of matter in the vicinity of the site. Such a movement of matter permits the activation energy for creep to be rationally identified with the activation energy for self-diffusion in agreement with experimental observations.

The authors, who call σ_0 an 'intrinsic stress', have attempted to compute its value on the basis of the postulated material with its bad sites. They find that:

$$\sigma_0 = \frac{nk\theta}{v}\varphi^2$$