tial spring tides. From an examination of living material, the animal was identified as *S. cambrensis* Brambell and Cole, only minor differences in coloration being apparent. Mr. Burdon Jones, who is working on the group, has seen preserved specimens and agrees with this identification.

It is of great interest that *S. cambrensis* should be found at Dale Fort, thus supporting the view of Brambell and Cole that the species might prove to be widely distributed. At Dale Fort it occurs in an environment similar to that described by Brambell and Cole, with a few minor differences which are worthy of note. The beds are at and below chart datum and are inaccessible during many months of the year. Soil analysis of the surface two inches of sand from adjacent parts of the beach have indicated in general about 95 per cent of fine sand and only small quantities of silt, clay and organic matter. Whereas at Bangor the surface 8 in. were so constituted, at Dale, below two inches on the *Saccoglossus* ground, the sand was a dirty grey colour and probably contained more organic matter. No analysis of this deeper sand has yet been made.

At Dale, *S. cambrensis* occurs in association with *Tellina fabula* Gmelin, *Chione striatula* (da Costa), *Ensis ensis* (L.), *Acrocnida brachiata* Montagu, *Echinocardium cordatum* (Pennant) and *Peachia hastata* Gosse. On no occasion, however, did we find either *Ammodytes tobianus* or *Arenicola marina* in this area.

A general account of the marine fauna in the vicinity of Dale Fort is being prepared by one of us (R. D. P.) and will be published elsewhere in due course.

R. D. Purchon
G. T. Jefferson

Department of Zoology,
University College,
Cardiff. June 20.

[1] Brambell, F. W. Rogers, and Cole, H. A., *Proc. Zool. Soc. Lond.*, (B), **109**, 211 (1939).
[2] Brambell, F. W. Rogers, and Goodhart, C. B., *J. Mar. Biol. Assoc.*, N.S., **25**, 2, 283 (1941).

## Non-Adaptive Characters

In an address to Section D at the Newcastle meeting of the British Association, Dr. E. B. Ford, if I understood him correctly, stated or inferred that he considered that all characters must possess 'selection value'.

From the discussion that followed, moreover, it appears that he holds this belief not only in regard to animals but to plants also. In answer to questions he plainly rejected the possibility that, in the cases quoted ('ringed' character in guillemots, 'spotted leaf' character in such plants as *Arum maculatum*, and human blood groups) no adaptive character was involved. To him, apparently, however trivial characters may appear, they must have some adaptive value; evidence for this was, so far as one could gather, derived from experimental work on *Drosophila*.

As there is no mention of this fundamental concept in the summary of his paper published on p. 62 of the *Journal* of the meeting, may I ask Dr. Ford if I have stated his views correctly and, if so, whether he would publish a concise account of the arguments which led him to arrive at these views?

H. Graham Cannon

University, Manchester 13.
Oct. 12.

In reply to Prof. Graham Cannon, I neither stated at the British Association, nor have I ever held, that all characters must possess 'selection value': precisely the contrary, since I took some care to explain that the spread of non-adaptive characters, which certainly exist, cannot be responsible for evolution in wild populations. At the same time I pointed out the danger of stating that any particular character is non-adaptive, since even a 1 per cent advantage can rarely be detectable by the most accurate experiments, though it is considerable from an evolutionary point of view. It is genes, not characters, that must very seldom be of neutral survival value. That is by no means to say that they are never so, but, as stressed at the meeting, such genes cannot spread in a semi-isolated population so as to produce the 'Sewall Wright effect' unless it be numerically very small, of well under a thousand individuals, and such populations are unlikely to be sufficiently permanent units.

It chanced that, among many other forms, I only referred to *Drosophila* in relation to two points. The first was to mention that the chromosome inversions in wild populations of *D. pseudo-obscura*, often stressed as an example of non-adaptive evolution, have recently been proved to be controlled by selection. The second was in reply to the question, "Can some of the trivial characters often used in taxonomy be regarded as non-adaptive?" My answer was that they may be, but that the genes controlling them are not likely to be so. This I illustrated with reference to *Drosophila melanogaster* merely because it is better known genetically than any other organism—animal or plant. That aspect of my answer was very relevant to Prof. Cannon's query. It was this: Many of the known genes are recognized only by minute and trivial effects which (bearing in mind the uncertainty of the statement) we may quite reasonably think non-adaptive (for example, the presence or absence of a bristle), yet every one of these genes has a detectable influence on the viability of the organism.

E. B. Ford

University Museum,
Oxford.

## Torque and Angular Momentum of Centimetre Electromagnetic Waves

When plane electromagnetic waves, which are circularly polarized, are absorbed by a screen disposed perpendicularly to the direction of propagation, or are transformed with a suitable device into linearly polarized waves, they produce on the screen or device a mechanical torque, the intensity of which for unit surface is

$$\frac{S}{\omega}, \qquad (1)$$

where $S$ is the Poynting vector and $\omega$ is the angular frequency of the wave. This effect was pointed out many years ago by A. Sadowsky[1]; and later J. H. Poynting[2] gave a complete theory for it.

Formula (1) may be easily proved, taking into account the fact that photons have a spin $\pm h/2\pi$ (where $h$ is Planck's constant).

In effect, an elliptically polarized wave may be resolved into two components along the principal axis of the ellipse, namely,

$$x = X_0 \cos \omega t, \qquad y = Y_0 \sin \omega t,$$