

## Anemotaxis in *Drosophila*

COLE<sup>1</sup> has observed that *Drosophila melanogaster* sometimes walks against an air current. Flüggé<sup>2</sup> showed that this reaction only occurred when the air was scented, and must therefore be regarded as orientation by smell. However, reactions to air currents without smell do occur in *Drosophila*.

Comparing several species of the genus, a division can be made between those which show a distinct positive anemotaxis and those which do not. *Drosophila virilis* +, *D. virilis americana*, *D. subobscura* and *D. funebris* turn very sharply towards a tube from which air is flowing and start walking against it, so long as they are not blown away. *D. melanogaster* and *D. buskii*, on the other hand, show no reaction, whereas *D. pseudo-obscura* shows a slight reaction.

Removal of the wings or antennæ or both does not abolish the reaction in the species showing it. Therefore Fraenkel and Gunn's<sup>3</sup> contention that anemotaxis depends on the perception of body deformation caused by the wind seems plausible for *Drosophila*.

The fact that the two light species observed do not react to wind whereas the four dark species do, may be an indication that the former are not exposed to strong air currents in their natural environment, while the latter are. As wind is a factor which increases evaporation, this is in agreement with some recently published deductions<sup>4</sup>, to the effect that a dark cuticle provides better protection against desiccation than a light one.

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<sup>1</sup> Cole, W. H., *J. Anim. Behaviour*, 7, 71 (1917).

<sup>2</sup> Flüggé, C., *Z. vergl. Physiol.*, 20, 463 (1934).

<sup>3</sup> Fraenkel and Gunn, "Orientation of Animals" (Oxford, 1940).

<sup>4</sup> Kalmus, H., *NATURE*, 1:3, 428 (1941).

## Nomenclature of Biological Movement

HAVING read recently with very great interest Fraenkel and Gunn's "Orientation of Animals", I set about making for my own clarification a classification of all the cases I know of what used to be called 'tropistic' movements.

It is clear that three major groupings are possible: a *taxis*, which is a bodily movement of an animal or motile plant in a direction determined by the direction of the stimulus; a *kinesis*, which is a change of rate of movement of an animal (or perhaps motile plant) in response to a change of intensity of a stimulus, but not in a direction determined by the direction of the stimulus—and often producing an aggregating effect superficially similar to that of a *taxis*; and an *orientation*, which is the placing of the body (usually if not always animal) in a direction determined by the direction of the stimulus. To these three classes many of the cases can be referred.

But the responses of sessile plant organs do not seem to be so conveniently classified. The thigmotropism of *Clematis tendrils* appears to warrant that name, for the response is a directional one. But the same cannot be said of the so-called 'thigmotropism' of *Mimosa leaflets*, *Mimulus stigma* or *Berberis*

stamen, for here the response is not in a direction determined by that of the stimulus. The response in these cases appears to bear a closer resemblance to the photonasty of *Oxalis leaflets* and the thermnasty of *Tulipa flowers*. Is one then justified (disregarding—as often becomes necessary for purposes of coherence—mere etymological niceties) in putting these responses under the heading of 'thigmonasty' (or possibly in some cases—as in Stiles's "Plant Physiology"—'seismonasty')? By the same token may the response of *Mimosa leaflets* to a lighted match in the neighbourhood be called a 'thermonasty', and to ammonia vapour, a 'chemonasty'?

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## An Inland Record of *Triglochin maritimum* L.

IN a previous note<sup>1</sup> I recorded the occurrence of the halophilic alga *Percursaria percursa* Rosenv. from a salt-spring situated at Aldersey<sup>2</sup>, Cheshire. Continuing the ecological survey of this spring, I am now able to report the presence of the halophyte *Triglochin maritimum* L. (Naiadaceæ). It occurs in three small colonies growing in the salt-spring and appears to be well established. I should add that during the past year the spring has maintained a salinity of 1,642 parts per 100,000 with only slight variation.

*Triglochin maritimum*, popularly known as seaside arrow-grass, is a plant frequently found in salt marshes. Its occurrence in a non-littoral region is exceptional and would seem to be unique in so far as the county of Cheshire is concerned. Search of the literature has revealed the fact that *Triglochin* has occasionally been recorded from the counties of Cambridgeshire, Staffordshire and Surrey.

In Cambridgeshire, the plant appears to have been first reported from Tydd Marsh by Skrimshire<sup>3</sup>. A. E. Evans<sup>4</sup>, however, points out that it was never plentiful in that county and has not been found there during recent years. In Staffordshire, J. E. Bagnall<sup>5</sup> mentions records of *Triglochin* by the independent observers, Shaw, Stokes and Brown. In Surrey, C. E. Britton<sup>6</sup> records its discovery by W. A. Todd from the Thames near Putney.

I am indebted to Mr. A. A. Dallman, of Doncaster, for certain of the references quoted.

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<sup>1</sup> Burke, F., *NATURE*, 149, 331 (1942).

<sup>2</sup> Sherlock, Mem. Geol. Survey, Mineral Resources of Gt. Brit., Rock-salt and Brine, 18, 111 (1921).

<sup>3</sup> Relhan, R., "Flora Cantabrigiensis", second edition, 145 (1802).

<sup>4</sup> Evans, A. E., "Flora of Cambridgeshire", 165 (1939).

<sup>5</sup> Bagnall, J. E., "Flora of Staffordshire", 57 (1901).

<sup>6</sup> Britton, C. E., *J. Bot.*, 48, 186 (1910).

## Existence of Electromagnetic-Hydrodynamic Waves

IF a conducting liquid is placed in a constant magnetic field, every motion of the liquid gives rise to an E.M.F. which produces electric currents. Owing to the magnetic field, these currents give mechanical forces which change the state of motion of the liquid.

Thus a kind of combined electromagnetic-hydrodynamic wave is produced which, so far as I know, has as yet attracted no attention.

The phenomenon may be described by the electrodynamic equations

$$\begin{aligned}\operatorname{rot} H &= \frac{4\pi}{c} i \\ \operatorname{rot} E &= -\frac{1}{c} \frac{dB}{dt} \\ B &= \mu H \\ i &= \sigma(E + \frac{v}{c} \times B); \end{aligned}$$

together with the hydrodynamic equation

$$\partial \frac{dv}{dt} = \frac{1}{c} (i \times B) - \operatorname{grad} p,$$

where  $\sigma$  is the electric conductivity,  $\mu$  the permeability,  $\partial$  the mass density of the liquid,  $i$  the electric current,  $v$  the velocity of the liquid, and  $p$  the pressure.

Consider the simple case when  $\sigma = \infty$ ,  $\mu = 1$  and the imposed constant magnetic field  $H_0$  is homogeneous and parallel to the  $z$ -axis. In order to study a plane wave we assume that all variables depend upon the time  $t$  and  $z$  only. If the velocity  $v$  is parallel to the  $x$ -axis, the current  $i$  is parallel to the  $y$ -axis and produces a variable magnetic field  $H'$  in the  $x$ -direction. By elementary calculation we obtain

$$\frac{d^2 H'}{dz^2} = \frac{4\pi\partial}{H_0^2} \frac{d^2 H'}{dt^2},$$

which means a wave in the direction of the  $z$ -axis with the velocity

$$V = \frac{H_0}{\sqrt{4\pi\partial}}.$$

Waves of this sort may be of importance in solar physics. As the sun has a general magnetic field, and as solar matter is a good conductor, the conditions for the existence of electromagnetic-hydrodynamic waves are satisfied. If in a region of the sun we have  $H_0 = 15$  gauss and  $\partial = 0.005$  gm. cm.<sup>-3</sup>, the velocity of the waves amounts to

$$V \sim 60 \text{ cm. sec.}^{-1}.$$

This is about the velocity with which the sunspot zone moves towards the equator during the sunspot cycle. The above values of  $H_0$  and  $\partial$  refer to a distance of about  $10^{10}$  cm. below the solar surface where the original cause of the sunspots may be found. Thus it is possible that the sunspots are associated with a magnetic and mechanical disturbance proceeding as an electromagnetic-hydrodynamic wave.

The matter is further discussed in a paper which will appear in *Arkiv för matematik, astronomi och fysik*.

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## Energy of Dissociation of Carbon Monoxide

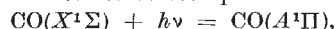
THE energies of dissociation of a number of diatomic molecules have been determined from spectroscopic data, apparently with high accuracy, by the observation of predissociation limits. During the last few years the following values have been proposed for CO:  $D(\text{CO}) = 6.92^1, 8.41^2, 9.14^3, 10.45^4$  e.v.; while values of 9.85 and 11.11 also appear possible<sup>5</sup>. Controlled electron experiments suggest 9.6<sup>5</sup>.

The value obtained by extrapolation of the vibra-

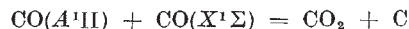
tional levels of the ground state is about 11, and support for this value has been given by Kynch and Penney<sup>6</sup>. Herzberg<sup>7</sup> has recently summarized evidence favouring 9.14.

At first sight, the strongest argument for 9.14 is the observation by Faltings, Groth and Harteck<sup>8</sup> that CO is decomposed by the xenon line at 1295 Å., but not by that at 1470 Å., from which they conclude that  $8.44 < D(\text{CO}) < 9.57$ . This conclusion is not based on an examination of the initial act of absorption. The only known absorption in the 1295 Å. region is that corresponding to the fourth positive bands. The origins of the (9,0) and (10,0) bands lie at 76,839 cm.<sup>-1</sup> and 78,010 cm.<sup>-1</sup>. The xenon line 1295 Å. = 77,172 cm.<sup>-1</sup> falls between these bands and, if absorbed from the lowest vibrational level of CO, would correspond approximately to the line  $P(35)$  of (10,0). This gives as the upper limit of  $D(\text{CO})$  (when the rotational energy is taken into account) a value of 79,722 cm.<sup>-1</sup> = 9.88 e.v. (not 9.57 e.v. as stated by Herzberg<sup>7</sup>). Actually, it is doubtful whether such a high rotational line as  $P(35)$  would be observed at room temperature, and absorption, if it is due to CO, would probably occur from a higher vibrational level, corresponding perhaps to the (13,2) band, in which case the dissociation limit may be placed as high as 10.1.

Taking the first act of absorption as



and assuming a life not less than  $10^{-8}$  sec. for  $A^1\Pi$ , then at atmospheric pressure each molecule experiences at least 100 collisions before radiating. It seems to us that this gives a reasonable chance for a reaction such as



to proceed with quantum efficiency approaching unity. The state of the carbon atom might be either  $^1D$  or  $^3P$ ; the former if spin is to be conserved, the latter if not. In either case the reaction is strongly exothermic. The failure of the xenon line 1470 to induce photodissociation may be due to the reaction requiring an activation energy.

Estimates of  $D(\text{CO})$  less than 10 take no account of the non-crossing rule of Hund, and Neumann and Wigner<sup>9</sup>. This rule states that potential energy curves of molecular states of identical species cannot cross. Whether the rule is rigorous when the nuclear and electronic motions are not separated needs further examination, but at least we see no reason for anticipating a failure of the rule in the lowest energy curve of CO. If this curve has only one turning point then the non-crossing rule requires unequivocally that  $D(\text{CO}) > 10.3$ , and would agree well with the predissociation limit at 11.11 e.v.

The dissociation energy of  $\text{CO}^+$  is 2.6 e.v. less than that of CO ( $D(\text{CO}^+) = D(\text{CO}) + I(\text{C}) - I(\text{CO})$ ). Three electronic states of  $\text{CO}^+$  are known, namely,  $X^2\Sigma^+$ ,  $A^2\Pi$  and  $B^2\Sigma^+$ , extrapolating to dissociation limits of about 9.8 (a very long extrapolation), 9.2 and 9.4 e.v. respectively. Since the two  $^2\Sigma^+$  states must give different products of dissociation, it would appear, on the evidence of the  $B^2\Sigma^+$  state, that  $D(\text{CO}^+)$  is 7.4, and  $D(\text{CO})$  is about 10, and on the evidence of the  $A^2\Pi$  state that  $D(\text{CO}^+)$  is 9.2 and  $D(\text{CO})$  is 11.8. All that may fairly be deduced from present evidence on  $\text{CO}^+$  is that  $D(\text{CO})$  is unlikely to be much less than 10.

We have also re-examined nitrogen. The accepted value  $D(\text{N}_2) = 7.38$  is based on the identification of the upper state of the Vegard-Kaplan bands with the