

### The Connexion between the Eotvos Magnitudes

In the problem of locating subterranean anomalies of density, the Eötvös balance measures two quantities, the horizontal gravity gradient and the difference between the principal curvatures of the level surface at the point of observation. In the two-dimensional case these reduce to  $U_{xx}$  and  $-U_{yy}$ , denoted by  $G(x)$  and  $K(x)$  respectively. In all treatments of the subject which I have seen  $G(x)$  and  $K(x)$  appear to be considered independent of one another. It can be shown, however, that there is a one-to-one relation between the two functions, namely, that they are conjugate trigonometrical integrals of one another; <sup>1</sup> in fact:

$$G(x) = \frac{1}{\pi} \int_0^{\infty} dx \int_{-\infty}^{+\infty} K(t) \sin \alpha(t-x) dt$$

and 
$$K(x) = -\frac{1}{\pi} \int_0^{\infty} d\alpha \int_{-\infty}^{+\infty} G(t) \sin \alpha(t-x) dt,$$

or,

$$G(x) = \frac{1}{\pi} \int_0^{\infty} \frac{K(x+t) - K(x-t)}{t} dt = \frac{1}{\pi} P \int_{-\infty}^{+\infty} \frac{K(t)}{t-x} dt$$

and

$$K(x) = -\frac{1}{\pi} \int_0^{\infty} \frac{G(x+t) - G(x-t)}{t} dt = -\frac{1}{\pi} P \int_{-\infty}^{+\infty} \frac{G(t)}{t-x} dt$$

where  $P$  denotes the principal part of the subsequent integral.

The second of these pairs of formulæ in particular enables one of the quantities to be obtained from the other, whether given in functional form or as a series of observations.

These results depend solely on the density anomalies lying all on the same side of  $Ox$ ; which is, of course, the usual thing, the observations being made along the surface of the ground. They do not depend on the density changes being either continuous or discontinuous.

In the recent experimental survey in Australia <sup>2</sup> it is stated that the gradiometer, which only measures  $G(x)$ , is more satisfactory from a practical point of view than the torsion balance; it appears now that the latter instrument provides no further information than the former, so far as two-dimensional structures are concerned, since the measurement of  $K(x)$  as well as  $G(x)$  is redundant, or is only a check.

O. F. T. ROBERTS.

University of Aberdeen,  
June 4.

<sup>1</sup> E. C. Titchmarsh, *Proc. L.M. Soc.*, II, 24, p. 109.

<sup>2</sup> "Geophysical Prospecting", Imperial Geophysical Experimental Survey, p. 173.

### Swarming of Collembola in England

A RECENT letter in NATURE <sup>1</sup> directed attention to instances of swarming of certain species of Collembola. It was stated that "In most . . . cases . . . (if not all) the factor producing this phenomenon would seem to be the relative abundance of the food supply". In another instance it was suggested that "migration may account for swarming".

While in agreement with the first suggestion as a possible explanation of this swarming habit, certain observations made from time to time during studies on this order of insects might assist in carrying the subject a stage further. In September 1928 I examined, by means of a binocular microscope, the habits of individuals in a swarm of *Podura aquatica*, L. I was at first surprised at the number of head-capsules of adults which could be seen in the colonies; each head-capsule was completely devoid of all save the merest traces of the body. Observations revealed the fact that under these conditions the Collembola were carnivorous, and even cannibalistic, in habit.

Individuals could be seen vigorously attacking other members of the swarm; the point of attack was evident, in some cases, by a drop of body fluid which exuded. During an attack the victim struggled and fought with mouth-parts and tarsal claws, but was gradually overpowered. When it succumbed, several other members of the swarm quickly collected around its mutilated body and devoured it, until the head-capsule alone remained. This habit appeared not only to provide food for the support and development of the colonies but also was a factor in keeping the small groups of the Collembola together while they fed, collectively, on the scattered dead bodies. Individuals about to moult proved ready prey for the more active members of the swarm.

A similar observation was recorded to a lesser extent among *Hypogastrura* spp. The swarming of *Sminthurus viridis*, Lubb.—a species which is mainly phytophagous in habit—has not been observed, but it has been a common experience, in heavily infested fields, to find that this species will readily congregate and devour specimens that had recently died.

I am not aware of any reference to this interesting habit among Collembola, and this no doubt explains why the observed species can remain congregated in swarms for long periods in such barren sites as surface water in cart ruts, bare stones, and even on tap water in glass dishes.

A factor which undoubtedly affects this swarming habit is humidity. It has been shown <sup>2</sup> that species of Collembola, particularly atracheate forms, require a saturated atmosphere to survive any length of time. Individuals, therefore, tend to congregate in local environments where these conditions are provided. Species which hibernate in the egg stage (*Sminthurus viridis*, *Bourletiella hortensis*, *B. lutea*, etc.) attain enormous numbers when temperature and humidity favour hatching; the movement of the young Collembola is then influenced by humidity. Such was the case <sup>3</sup> of *Bourletiella hortensis*, Fitch., which swarmed over the mangold field during the early morning when the soil was moist, but later in the day moved below soil-level, except when near plants which they had damaged. In this latter case the point at which plants' juices exuded provided both food and favourable humidity, hence this species swarmed in such sites.

W. MALDWYN DAVIES.

University College of North Wales  
(Memorial Buildings), Bangor,  
June 20.

<sup>1</sup> NATURE, 129, 830, June 4, 1932.

<sup>2</sup> Davies, W. M., *Brit. J. Exp. Biol.*, 6, 1, 79, Sept. 1928.

<sup>3</sup> Davies, W. M., *Bull. Ent. Soc.*, 17, 159; 1926; *J. Min. Agric.*, 32, iv., July 1925.

### The Rearing of *Hæmatopota pluvialis*, Linné (Cleg, Tabanidæ) under Controlled Experimental Conditions

DESPITE the potential or actual importance of blood-sucking insects in the transmission of pathogenic micro-organisms, investigation of the life-histories of the European species of the Tabanidæ, including that of the cleg, the most common of our palæarctic species, has been comparatively neglected. Hitherto the number of larval stages has not been ascertained in any European tabanid species, and for the rest this has been determined only in one bivoltine North American species <sup>1</sup> and in five trivoltine Indian species. <sup>2</sup>

In our experiments, which commenced in 1930, we have succeeded in inducing females previously fed on human or rabbit hosts to deposit typical tabanid egg-masses in the laboratory. In individual cases females have oviposited twice, the two acts of oviposition being separated by an interval during which a second