(dynes . cm.$^{-2}$) being the 'partial pressure' of neutrons in the atmosphere. The presence of neutrons should thus entail an apparent decrease of the Newtonian gravitational constant with rise of temperature. The experiments of Shaw[4] (who found a small increase of gravitation with temperature) show that, if M refer to lead and M' to silver, a negative temperature-coefficient of more than 5×10^{-5} per °C. is improbable. If for illustration we put $m/M = 1/200$, $a = a' = 10^{-25}$ cm.^{2}, we find that $p < 5 \times 10^{-6}$ of an atmosphere. The correct cross-sections for slow neutrons are not yet known.

P. B. MOON.

Imperial College of Science,
South Kensington, London, S.W.7,
June 20.

[1] Chadwick, NATURE, **129**, 312, Feb. 27, 1932.
[2] Chadwick, *Proc. Roy. Soc.*, A, **136**, 692, 1932, and following papers.
[3] Cf. §5 of (2).
[4] Shaw, *Phil. Trans.*, A, **216**, 349; 1916.

Currents produced by the Gills of Mayfly Nymphs

BABAK and Foustka[1] were able to show that the movements of the gills of ephemerid nymphs were dependent on the oxygen tension of the water. Later, Dodds and Hisaw[2] demonstrated a relation between the gill area per gram weight of the animal and the oxygen tension of the water inhabited by these animals. That the currents produced by the gills might differ in different species, and that such currents might have an adaptive significance, appear to have escaped notice.

The following five species from stagnant and running waters are being examined: *Chlœon dipterum* and *Leptophlebia marginata* as examples of pelagic animals in stagnant water; *Ephemera vulgata*, a form burrowing in fine mud or sand in running water; *Ecdyonurus venosus*, associated with fast streams with stony beds; and *Cœnis horaria*, a form which burrows in fine mud to such a small depth that the gills are left exposed in the water at the mud surface.

In each case the gills move in metachronial rhythm, and problems comparable with those elucidated by Cannon and Manton[3, 4] on the feeding mechanisms of Crustacea are presented.

The erect plate-like gills of *Chlœon* moving in metachronial rhythm create differences of pressure in the intergill spaces. Thus in any intergill space a period of suction is followed by a period of compression. The main result of this is a symmetrical current passing backwards over the abdomen and outwards in an upward direction between the gills. The last gills are stationary and act as buffers, directing the current strongly to each side. This prevents the setting up of eddies near the animal in that region and ensures that the same water will not be used again for respiration.

In *Leptophlebia* it is not yet clear how far pressures set up between the gills are significant, since the gills lie at different angles to the body. The gills act as paddles, and by their rotation throw water over themselves from in front, or the sides of, or from beneath the body to the middle dorsal line. Since the gills are moving at different levels of the water opposite the several segments of the abdomen, water from all regions round the body is explored for respiratory purposes.

Ephemera in its mud tunnel creates a simple posteriorly directed current over the dorsal side of the abdomen. The gills are held upwards over the back in a roof-like manner. Moving in metachronial rhythm from before backwards, they press backwards the column of water beneath them and thereby set up a rapid current very appropriate for a creature with such burrowing habits.

The gills of *Ecdyonurus* project postero-laterally from the body. Lying in the angles between the broad hind femora and the abdomen these gills are protected from the rapid flow of water in which the animal lives. There is little difference of phase in the metachronial movement of the gills. The current produced passes from the outer sides of the body upwards between the gill plates to the mid-dorsal line. The animal commonly faces upstream, and the environmental flow of water thus assists in the removal of the 'gill current' along the animal's dorsal side to the posterior region.

Cœnis possesses a pair of elytroid protective gills. These are held upwards at an angle of about 40°, while the remaining four pairs of gills, behind and beneath

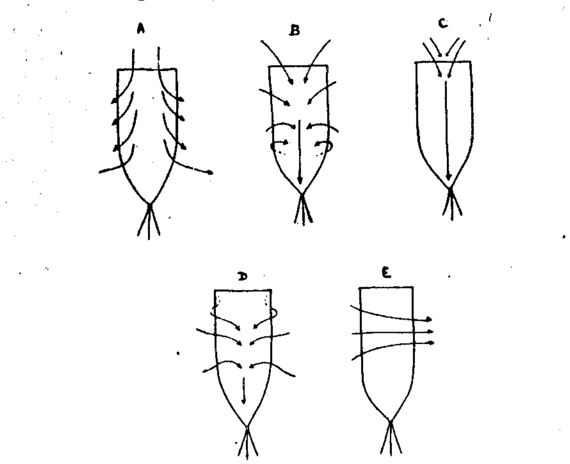

FIG. 1.—Diagrams of currents over the abdomen in A, *Chlœon dipterum*; B, *Leptophlebia marginata*; C, *Ephemera vulgata*; D, *Ecdyonurus venosus*; and E, *Cœnis horaria*.

them, beat in metachronial rhythm. In this form, as opposed to all the others mentioned, the current is asymmetrical. It flows in between the moving gills, beneath the 'elytra' at one side and out at the other. To this fact may be related a remaining one. Whereas, in the first-mentioned species, members of a pair of gills beat simultaneously, here the members of a pair of gills in motion are out of phase with each other. Thus, in addition to a metachronial rhythm along the animal, there is a similar rhythm from side to side in two elements of a pair.

The details of the above phenomena are being investigated with the aid of the stroboscope.

L. EASTHAM.

Department of Zoology, University,
Sheffield.

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[3] Cannon, H. G., *Trans. Roy. Soc., Edin.*, **55**; 1927 and 1928.
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Discontinuous Distribution in Bees

IN 1898, I described a new genus of bees, *Hesperapis*, based on a species found in New Mexico. Since that time, sixteen other species have been referred to this genus, which proves to be especially characteristic of the south-western deserts, in California, Lower California, and adjacent regions. In 1911, Friese described a genus, *Capicola*, from the deserts of South Africa.

Last year's African Expedition led to the discovery of no less than seven new species in South Africa, the localities being Graaff-Reinet, Calvinia, Nieuwoudtville,