A Simple Modification of Morse's Rule

MORSE[1] introduced an empirical rule to the effect that

$$\omega_e r_e^3 \approx 3 \times 10^{-21} \text{ cm.}^2 \quad \ldots\ldots\ldots(1)$$

where ω_e, r_e, respectively, are the equilibrium nuclear vibration frequency (in cm.$^{-1}$) and the equilibrium nuclear separation (in cm.) of a diatomic molecule, as deduced from spectra. In a recent paper[2], dealing with the classification of non-hydride diatomic molecules into groups and periods, I have emphasised the importance of the 'group number' n, equal to the number of 'shared' electrons, or total number of 'valency' electrons of the two separate atoms. The way in which the errors from the strict requirements of Morse's rule distribute themselves in certain periods suggests that the insertion of some function of the group number into the Morse expression might lead to better agreement with observation. For non-hydride diatomic molecules of the period containing two completed K rings associated with each nucleus, I have derived the following empirical modification of Morse's relationship :

$$\omega_e r_e^3 \sqrt{n} = 9{\cdot}55 \times 10^{-21} \text{ cm.}^2 \quad \ldots.(2)$$

The mean error in deduction of r_e from ω_e values for 29 test cases of electronic levels of diatomic molecules of the specified kind amounts to $\pm$ 1·3 per cent from experimental values, whilst the mean error using the unmodified Morse expression for the same cases is $\pm$ 5·2 per cent. The results will be communicated in due course in another place.

C. H. DOUGLAS CLARK.

Department of Inorganic Chemistry,
University,
Leeds.
May 4.

[1] P. M. Morse, *Phys. Rev.*, (ii), **34**, 57–64 ; 1929.
[2] C. H. Douglas Clark, *Proc. Leeds Phil. Soc.*, **2**, 502–512 ; 1934.

Inheritance in Fresh-water Ostracods

PROF. MACBRIDE's recent article in NATURE[1], on "Inheritance of Acquired Habits", leads me to direct attention to some interesting information which is available from the study of fresh-water ostracods.

Fresh-water ostracods possess both relatively and absolutely the largest sperms known throughout the animal kingdom, while quite recently it has been discovered that these enormous sperms are highly motile. The sperms are passed into the spermatheca of the female, which possesses a spermathecal duct highly complicated in structure and also exceptionally long. Under the proper conditions, the large sperms can be seen moving very actively both in the spermatheca and also in the upper or proximal region of the duct. The fresh-water ostracods are also remarkable for the wide prevalence of parthenogenesis. In some cases, whole genera exist in which males are unknown. One of the best known genera in this connexion is that of *Herpetocypris*, containing the well-known species *H. reptans* which abounds practically in every pond in the British Isles and is distributed throughout Europe.

The genus is a well-defined one, and two years ago, taking the genus as described by Sars in "Crustacea of Norway" (vol. 9), I estimated that there were some twelve species occurring throughout the world, and in no case were the males known. The most remarkable fact remains, however, that the spermatheca, and in particular the spermathecal duct, remains in *H. reptans* and in all other species examined, nor does it show the slightest sign of degeneration. It is not proposed to give here further taxonomic details, but anyone familiar with the taxonomy of fresh-water ostracods will know many parallel instances.

It is fairly obvious that at one time the males must have existed in each species of *Herpetocypris*, and, since the males have disappeared entirely from the genus, exclusive parthenogenetic reproduction must have been going on for a considerable length of time, most probably for thousands if not millions of generations ; yet this useless spermathecal duct remains.

If we treat the matter from a genetical point of view there is a fairly simple explanation, but it seems to me extremely difficult to account for the persistence of this highly complicated genital organ if we accept the theory of the "Inheritance of Acquired Habit". Moreover, the case becomes all the more striking when we consider other groups of animals in which parthenogenesis occurs. For here it is almost universally true that individuals reproducing solely by parthenogenesis usually have their genital organs impaired in some way.

A. G. LOWNDES.

Marlborough College.

[1] NATURE, **133**, 598, April 21, 1934.

MR. LOWNDES has misunderstood my article. Its purpose was not to put forward a *theory* of the heritability of acquired habit but to show that this heritability has been experimentally *proved to be a fact*. If this is so, it is possible to explain all cases where the course of evolution has been followed in detail, as well as to explain the recapitulatory element in development.

E. W. MACBRIDE.

Imperial College of Science,
London, S.W.7.

Parasitism in Heavy Water of Low Concentration

THE first biological experiments[1] with heavy water (May 1933) showed that a low concentration of diplogen (1 part in 2,000) may have a beneficial effect on forms such as *Spirogyra* (the average longevity of 355 cells, in filament sections of 10–50 cells, in the diplogen water was 7·6 days, and the average for 322 cells in ordinary water was 1·6 days). It was also reported[2] that cell division in *Euglena* is increased in this dilute heavy water (density 1·00006). Meyer[3] confirmed the dilute heavy water effect by demonstrating that mats of *Aspergillus* showed sixteen times the dry weight of controls.

We have found that flatworms (*Planaria maculata* and *Phagocata gracilis*) kept in dilute heavy water for long periods show a striking difference in the rate of shrinkage in body size. After four months, the animals in ordinary water were only one fifth the length of the specimens in the diplogen water. This was probably due to reduced enzymic hydrolysis in the starving animals, since we have shown[4] that the dilute heavy water reduces the activity of amylase and zymin (the enzyme and substrate were incubated separately in the water and no effect was obtained if the substrate only was incubated, or if both were allowed to react immediately). The experiment was repeated in more concentrated heavy water (1 : 213 diplogen ratio) and a new effect appeared. The *Planaria* in heavy water of this concentration were rapidly parasitised by moulds and succumbed within three weeks (Fig. 1). In some cases the living animal becomes invested with slime mould, and in others is covered with tufts of mycelium. The reduced metabolism and movement are possible factors in addition to the specific effect of this concentration of diplogen on mould growth.

A similar increase in the growth of moulds was seen in tests of *Aquilegia* seeds kindly supplied by the Cambridge Seed Testing Station, through the courtesy of Mr. Hugh Richardson of Wheelbirks,

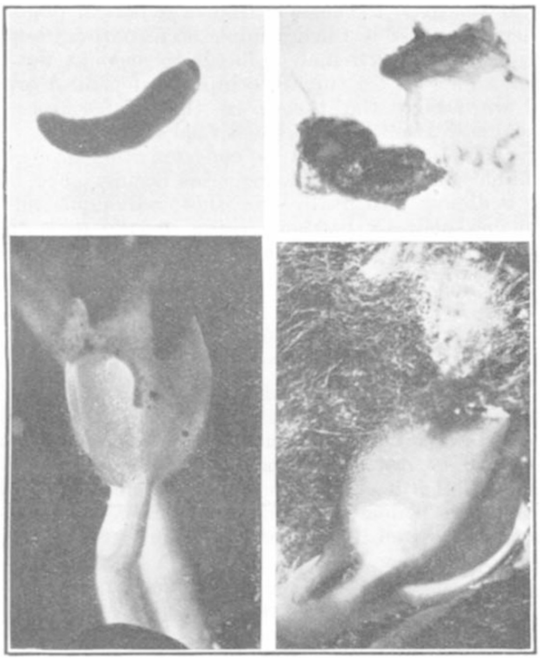

FIG. 1. Upper left: a control planarian in ordinary water. Upper right: two representative planarians killed by mould in 0·47 per cent heavy water. Lower left: sprouting *Aquilegia* seeds in ordinary water. Lower right: seedling in 0·47 per cent heavy water surrounded by white mould.

Northumberland. In the 0·47 per cent diplogen cultures, masses of white mould mycelium appeared (Fig. 1), but these were chiefly saprophytic, since they occurred mostly on the unsprouted seeds.

It would appear from the work of Meyer on *Aspergillus* and the experiments reported in this note, that diplogen in 1 : 200 concentrations has a specific effect in stimulating the growth of moulds and possibly bacteria. This property should afford many interesting problems in parasitology, and might be of considerable importance in the possible therapeutic use of dilute heavy water.

E. J. LARSON.
T. CUNLIFFE BARNES.
Osborn Zoological Laboratory,
Yale University.
May 8.

[1] T. C. Barnes, *J. Amer. Chem. Soc.*, **55**, 4332; 1933.
[2] T. C. Barnes, *Science*, **79**, 370; 1934.
[3] S. L. Meyer, *Science*, **79**, 210; 1934.
[4] T. C. Barnes and E. J. Larson, *J. Amer. Chem. Soc.*, **55**, 5059; 1933.

Physiology of Deep Diving in the Whale

PROF. KROGH in discussing the liability of whales to caisson disease[1] writes: "Supposing the whale to stay 5 minutes at 100 m., the 1,000 litres of blood passing per minute would take up an extra amount of 100 litres . . .", and apparently calculates that diffusion would take place as readily at 100 m. depth as at the surface of the sea. I venture to think that he has overlooked an important consideration.

Prof. Krogh assumes, and I think everyone who has considered the matter will agree with him, that the air in the whale's lungs must stand at the same pressure as the water outside the thorax. At 100 m. the total pressure is about 11 atmospheres absolute, so, at that depth, the whale's lung is compressed until an average alveolus has only one eleventh of the volume it had when the whale left the surface and began to dive. This shrinking of the alveoli must greatly decrease the surface available for diffusion and, in addition, the epithelium of the alveolus must become thicker, still further hindering diffusion. The effect of these changes is to obstruct the entrance of excess nitrogen into the blood when the whale is at a considerable depth and to favour its discharge when the animal is breathing at the surface.

G. C. C. DAMANT.

[1] NATURE, **133**, 636, April 28, 1934.

THE point raised by Capt. Damant is certainly important. I have not found it possible to conjure up a mental picture of the whale's thorax and lungs compressed to one tenth or less, and it becomes especially difficult when the air passages are taken into account, since these must take up an increasing proportion of the total quantity of air available. If the compression fails to interfere with the circulation, I do not think that the diffusion of nitrogen or oxygen will be *very* seriously impaired. M. Krogh found[1] that the diffusion in human lungs became independent of the volume when this was diminished below a certain point and explained this by the folding of the alveolar walls. Such folding must take place to a very large extent in the lungs of the diving whale.

AUGUST KROGH.
Copenhagen.

[1] *J. Physiol.*, **49**; 1915.

The Giorgi System of Units

I REGRET to say my recent article on the Giorgi system[1] contained a mistake, inexcusable I fear in the case of a pupil of Maxwell. In the evaluation of K_0 I used electromagnetic instead of electrostatic units. The value I gave needs dividing by v^2, the square of the velocity of wave propagation. If we take 3×10^{10} cm. per sec. as the value of v, then K_0 becomes

$$\frac{1}{4\pi}\,\frac{10^{11}}{9 \times 10^{20}} \quad \text{or} \quad \frac{1}{36\pi}\,10^{-9}$$

and this is the value used by Prof. Giorgi.

I have to thank more than one correspondent for the correction.

R. T. GLAZEBROOK.

[1] NATURE, **133**, 597, April 21, 1934.