LETTERS TO THE EDITORS

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Hæmoglobin in Crustacea

HÆMOGLOBIN is found in the Crustacea. It occurs dissolved in the blood plasma of the Notostraca[1,2], Anostraca[3], Cladocera[3,4], and parasitic Copepoda[5,6] although it is absent in free-living ones[2]. I have not been able to find hæmoglobin in the Branchiura (*Argulus*). It is found, however, in Ostracoda[7] and in a parasitic member of the Cirripedia[8]. All these groups are Entomostraca; hæmoglobin is unknown in the Malacostraca. Among the latter, the Decapoda have hæmocyanin as a respiratory blood pigment. I have now found hæmoglobin in the one remaining group of the Entomostraca, namely, the Conchostraca, in which, to my knowledge, it has not yet been sought.

There is hæmoglobin in the blood of the conchostracans *Lynceus simicefacies* Harding and *Leptestheria mayeti* (Simon). The former was hatched in London by Dr. J. P. Harding from dried mud brought from Arabia[9]. The latter I found abundantly in April of this year in shallow temporary pools of the Oued Melias at Béni-Ounif on the border of the Algerian Sahara. The animals were pinkish-brown and the oxyhæmoglobin spectrum was strong. This conchostran had much more hæmoglobin in its blood than the anostracans *Branchipus stagnalis* (L.) and *Tanymastix perrieri* Daday of similar dimensions, crowded together with it in the same pools.

In subsequent laboratory experiments I have found that *Leptestheria*, just like *Daphnia*[7,10] and *Triops*[2], synthesizes much more hæmoglobin in oxygen-deficient water than in well-aerated water. *Leptestheria*, raised from the egg at 19° C., attained sexual maturity in a fortnight. Reared in aerated water these animals were brown. Some were then put into water only 17 per cent saturated with air, others into water 75 per cent air-saturated. After a week the latter were still brown but the former were bright pink. The spectroscope showed that the pink colour was due to a higher hæmoglobin content of the blood in these than in the brown animals. As suggested by my colleague Mr. D. S. Johnson, the habit of *Leptestheria* of grubbing and sometimes burrowing in the sandy mud may partly account for its high hæmoglobin content compared with that of the free-swimming fairy shrimps, its companions in the pools, for oxygen would be more deficient in the mud than in the water above it.

Not only Notostraca, Conchostraca and Cladocera increase their hæmoglobin in conditions of oxygen deficiency, but also Anostraca. Miss Barbara Gilchrist in this laboratory has lately found that *Artemia salina* (L.), cultured for 2–3 weeks at 18–20° C. in water only 10–20 per cent saturated with air, develops pink blood which shows strong oxyhæmoglobin absorption bands, while the controls in aerated water have colourless blood without a trace of the oxyhæmoglobin spectrum. Since members of four groups of Crustacea react to oxygen lack by hæmoglobin synthesis, this property seems to be general in hæmoglobin-bearing crustaceans, just as it is in vertebrate animals, among which it is manifested by human mountaineers, by rabbits and by fish[11,12]

I was able to observe and collect phyllopods in desert pools, thanks to the hospitality of the Laboratoire de Biologie Saharienne of the University of Algiers and to generous financial aid by the Museum National d'Histoire Naturelle of Paris, by the French Centre National de la Recherche Scientifique, and by the Centre de Recherches Sahariennes. I wish to thank these bodies most sincerely for their international scientific gesture.

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Auditory Adaptation in the Human Subject

As is well known, raising of the threshold of hearing is caused by exposure to a continuous tone. The magnitude of this effect is a function of the frequency, duration and intensity of the tone. In general it is small, with intensities which do not exceed 90–100 db. above normal threshold in the middle frequency range.

The threshold measurements required for the demonstration of this type of fatigue are carried out *following* the application of the stimulus. We have, therefore, found it convenient to term it *post*-stimulatory fatigue.

By means of a binaural loudness balance technique, it has been possible to demonstrate and investigate a form of fatigue which appears *during* the application of a fatiguing tone, and may be termed *per*-stimulatory fatigue. Two audiometers supply separate ear-pieces, and it is possible by means of an appropriate switching arrangement to stimulate either or both ears. The audiometer on the subject's right is provided with a simple mechanical intensity-level recorder. The two audiometers are first adjusted to the same frequency, for example, 1,000 c./s. The intensity at the subject's left or test ear is kept constant at, say, 80 db. above threshold. The intensity at his right, or control, ear is then varied, in a rhythmical manner over an intensity range of some 5 db., to give

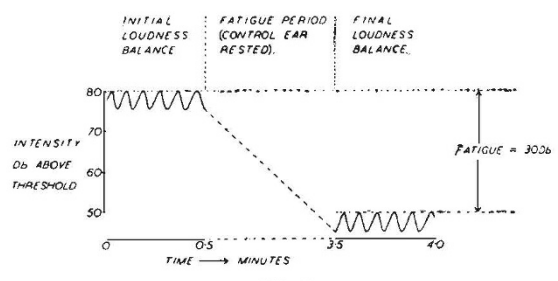

Fig. 1