We point out that these criticisms are unjustified because: (*a*) all mutants in the cultures used by De Ley *et al.*[2,3] were deliberately removed by them before experimentation; (*b*) that these workers have omitted all mention of our stringent precautions against contamination[4]; (*c*) that young and old colonies could not have been confused, because we always picked, replated, and determined the distinguishing characters of all different colony forms.

Finally, although De Ley[3] says that from cultures received he isolated and used "the strain corresponding to the name on the label . . . ", this is difficult to understand, for in 1961, at the request of the Curator of the National Collection of Industrial Bacteria, we typed every *Acetobacter* strain in that collection, and found that a good proportion of them were misnamed. These cultures, however, had not been re-labelled with their correct names when they were obtained by De Ley[3]. Thus, for example, cultures *A. ascendens* 4397 and *A. ascendens* 8163, used by Schell and De Ley[2], were still so labelled, although they were actually *A. rancens*. Similarly, *A. kuetzingianus* 3934, also used, had lost all starch-producing power as long ago as 1957, being, even then, also *A. rancens*.

J. L. Shimwell

Research Department,
British Vinegars, Ltd., Frome, Somerset.

J. G. Carr

Research Station,
Long Ashton, Bristol.

[1] Shimwell, J. L., *Antonie van Leeuwenhoek*, **25**, 49 (1959).
[2] Schell, J., and De Ley, J., *Antonie van Leeuwenhoek*, **28**, 445 (1962).
[3] De Ley, J., *J. gen. Microbiol.*, **24**, 31 (1961).
[4] Shimwell, J. L., *J. Inst. Brew.*, **62**, 339 (1956).

ENTOMOLOGY

Possible Function of Hæmoglobin in *Anisops*

Members of the aquatic sub-family Anisopinae (Notonectidae, Hemiptera) are remarkable for at least two reasons. They possess a large number of tracheal cells in the abdomen packed with hæmoglobin[1–3], and they are able to remain poised in mid-water for a considerable part of each dive. Both Hutchinson[4] and Hungerford[5] have suggested that this exploitation of the mid-water environment is made possible by the presence of hæmoglobin.

While in Uganda I was able to make some observations on *Anisops debilis* Gerstaecker and *A. pellucens* Gerstaecker, and to compare their dive performance with that of other notonectids lacking hæmoglobin. Most notonectids remain buoyant throughout a dive and can stay submerged only by continual swimming strokes or by clinging to underwater vegetation. *Anisops*, however, has a relatively small airstore and its density is always near that of water. The dive duration is about 2 min in *A. debilis* and 5 min in *A. pellucens*, which is a larger species. A normal dive comprises an initial phase when the bug is less dense than the water, a long mid phase when it is more or less in density equilibrium and a short final phase when it starts to sink. A dive is terminated by a rapid ascent to the surface and renewal of the ventral abdominal airstore. There is no active control of density, and rising or sinking is counteracted by appropriate swimming strokes of the hind legs so that an approximately constant depth is maintained.

It seemed possible that during a dive oxygen might be released from hæmoglobin into the tracheal system and that the rate of depletion of the gaseous store would therefore be diminished. Experiments in which the air above an aquarium containing *Anisops* was replaced with carbon monoxide mixtures in air have produced results which are consistent with this theory. After filling their store from air containing 8 per cent carbon monoxide bugs performed dives of less than half the normal duration; the phases were telescoped and the middle phase was very brief. Moreover, the modified dive pattern persisted for more than 1 h after return to air. These results can be explained by assuming that carboxyhæmoglobin has been formed and that the bugs are dependent on their airstore alone for the supply of oxygen.

Bugs in water containing little or no dissolved oxygen, and with air above the aquarium, perform dives of approximately the same duration as those in well-aerated water. Normally, the store does not, therefore, act as an efficient physical gill. This might be explained if the hæmoglobin had a low affinity for oxygen and surrendered the gas after only a small fall in the pO_2 of the surroundings; this would counteract the tendency of oxygen to diffuse in from the surrounding water and replace that consumed in respiration. Moreover, since the species of *Anisops* investigated in Uganda inhabit waters which are probably very poor in dissolved oxygen, physical gill action would be of little value to the bugs.

The presence of hæmoglobin is associated with giant spiracles on abdominal segments 3–7. Each is covered by a large white sieve plate and the total plate area per mg live body-weight is about 50 times the equivalent area of the spiracle apertures in *Enithares sobrin* Stål, a notonectid of similar size but containing no hæmoglobin. The sieve plate has been investigated in whole mounts and in sections, the latter by light and electron microscopy. It comprises a three-dimensional cuticular mesh, 15–20μ thick, made up of a central reticulum of stout trabeculæ which supports smaller branching and anastomosing struts on the inner and outer surfaces; the struts surround irregular rectangular pores, the area of which is estimated to lie between 2 and 10μ^2.

The airflow through the sieve plates of *Anisops pellucens* under a constant pressure of 10 cm water is 9·92 ml./min/mm^2. This value is about 4 times greater than that from the abdominal spiracles of *Hydrocyrius colombiae* (Belostomatidae), or 6–7 times if the supposed flow through the central lips is ignored[6]. The greater resistance to the passage of air under pressure through the plates of *Hydrocyrius* probably results from the smaller pore area in this species. The entry of water can thereby be resisted more effectively and *Hydrocyrius* will be able to swim to greater depths without danger of flooding. The high permeability of the sieve plates of *Anisops*, however, together with their large surface area, probably ensures the rapid and complete recharging of hæmoglobin with oxygen at the water surface under the action of abdominal pumping movements.

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P. L. Miller

Department of Zoology,
University of Oxford.

[1] Hungerford, H. B., *Canad. Entomol.*, **54**, 262 (1922).
[2] Poisson, R., *Arch. Zool. Exp. et Gén.*, **65**, 181 (1926).
[3] Bare, C. O., *Univ. Kansas Sci. Bull.*, **18**, 265 (1928).
[4] Hutchinson, G. E., in *The Elementary Chemical Composition of Marine Animals*, edit. by Vinogradov, A. P., footnote on p. 443 (1953).
[5] Hungerford, H. B., *Proc. Tenth Intern. Cong. Entomol.*, **1**, 337 (1958).
[6] Miller, P. L., *J. Ins. Physiol.*, **6**, 243 (1961).

GENETICS

A Polaron Model of Genetic Recombination by the Formation of Hybrid Deoxyribonucleic Acid

The theory of genetic recombination by the formation of hybrid DNA[1] postulates that a recombinational event involves breakage of single DNA nucleotide chains (primary breaks), and rejoining by base pairing between homologous chains. Thus the DNA molecules are hybrid in the region of the break, and, when these hybrid molecules include sites of heterozygosity, a correction process,