matters arising

Singing muscles in a katydid

SIR,—Your Insect Physiology Correspondent[1] has perpetrated a common error by stating that the tymbal muscles of cicadas may contract at 4,500 Hz. The song of cicadas, like other types of insect, consists of pulses of sound. The sound frequency, which is controlled by resonance of the abdominal air cavities, was measured by me as 4,500 Hz in some large cicadas in Ceylon, but is considerably higher in small species. The pulse modulation frequency, which may relate to the contraction frequency of the tymbal muscles, has never been observed higher than about 600 Hz, even in species with a myogenic contractile mechanism.

Neither your correspondent, nor Josephson in the article quoted[2] mention that high contraction frequencies in neurogenic muscles have been measured not only in insects but also in some vertebrate muscles producing only a small output of energy (the crichothyroid muscle of the bat[3]; and a fish swim-bladder muscle[4]). In all cases in fast neurogenic muscles, there is a correlated development of the sarcoplasmic reticulum involved in calcium transport.

Yours faithfully,

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[1] *Nature*, **248**, 106 (1974).
[2] Josephson, R. K., *J. exp. Biol.*, **59**, 781 (1973).
[3] Revel, J. P., *J. Cell Biol.*, **12**, 571 (1962).
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Biosynthesis of bacteriochlorophyll

SIR,—Bacteriochlorophyll (BChl) production in nonsulphur purple photosynthetic bacteria growing anaerobically is inversely related to light intensity, and introduction of O_2 causes a rapid suppression of pigment synthesis. In a recent report[1], Davies *et al.* summarise findings which lead them to conclude "the original suggestion of Cohen-Bazire *et al.*[2] that the synthesis of BChl is controlled by the redox state of one or more of the components of the electron transport chain, is correct."

In this connection, Davies *et al.* cite experiments[3] with intact cells in which various respiratory electron transport inhibitors were found to interfere with the synthesis of magnesium protoporphyrin. Since interruption of electron transport in intact cells can be expected to have numerous ramifying effects, there is reason to question the statement that "one or more of these [electron transport] components has been shown to be directly involved in the insertion of magnesium into protophorphyrin".

Davies *et al.*[1] suggest that "direct" control of BChl synthesis by O_2 (and light intensity) is also effected through regulation of aminolaevulinate (ALA) synthetase, the first enzyme of tetrapyrrole biosynthesis. They assert that ALA synthetase may be regulated by a trisulphide of glutathione or cystine which, in its oxidised form, increases activity of the enzyme. According to their scheme, oxygen (or light) has the effect of oxidising carriers of the electron transport chain, which in turn cause oxidation of an unidentified sulphydryl compound to its disulphide form; the latter than is presumed to oxidise the "reduced polysulphide activator" to its active (stimulatory) state. On this basis, O_2 might be expected to accelerate BChl synthesis, rather than inhibit, but Davies *et al.*[1] seem to suggest that O_2 also disturbs sulphur metabolism so as to interfere with biosynthesis of the trisulphide activator. Elsewhere[4], Neuberger *et al.* express the view that "oxygenation may lead to direct inactivation of the activator". We have been unable to rationalise the regulation of BChl synthesis by oxygen in terms of their interpretations.

Our recent experiments[5] with mutants of *Rhodopseudomonas capsulata*, blocked at different points in respiratory electron transport, demonstrate that the rapid inhibition of BChl synthesis by oxygen is independent of the cell's metabolic capacity to use O_2 as a terminal oxidant or to deliver reducing equivalents to the aerobic electron transport system. This argues cogently against the "redox carrier governor" postulation for regulation of BChl synthesis, and we have proposed an alternative working hypothesis in the study cited[5].

Yours faithfully,

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[4] Neuberger, A., Sandy, J. D., and Tait, G. H., *Biochem. J.*, **136**, 491 (1973).
[5] Marrs, B., and Gest, H., *J. Bact.*, **114**, 1052 (1973).

DR NEUBERGER REPLIES: At the time when the paper by Davies *et al.*[1] was first submitted to *Nature*, all the known facts discovered by others and ourselves were compatible with the proposition first put forward by Cohen-Bazire *et al.* in 1957 that the electron transport chain in some way exerted a direct control over bacterial chlorophyll synthesis. Later experiments by Marrs and Gest published in 1973[2] and our own work published later in that year[3] indicated that the effects of oxygen may be more specific and may be exerted through its action on sulphur metabolism, and in particular may be due to the depletion of the cellular content of a trisulphide activator of the enzyme. In this respect we are in