in a box containing air saturated with formaldehyde vapour, a treatment which should completely inhibit the olfactory functioning of the antennae for at least 30 min[8]. The treated males copulated with virgin females or engaged in homosexual activity a few minutes after their release from the box.

Moreover, the sexual behaviour of groups of males under proper environmental conditions does not change in the presence of TTA or virgin females. In order to demonstrate this, 3 gauze cages with 20 males each, were put in a ventilated fume hood with dim orange light at dawn. The cages were placed side by side and separated by cardboard walls to prevent air communication. The first cage served as a control. In front of the second cage 2 rubber stoppers were placed and treated with 10^{-2} mg of TTA, whereas a cage with 5 virgin females was placed in front of the third cage. No difference in sexual behaviour could be observed in the 3 cages in two subsequent evenings. Within 1 h 4 (4) copulations occurred in the control cage, 3 (5) in the cage with TTA, and 4 (3) in the presence of females.

In a further experiment 5 virgin females were put in a cage containing 20 males. Within 1 hour 3 heterosexual and 4 homosexual copulations occurred.

The results reported in this paper show that males and females of this species will copulate independently of the presence or absence of the pheromone, if they meet each other under proper environmental conditions. Thus control of *Z. diniana* by male confusion tactics is not possible in a forest in which the population density is high enough to enable the sexes to meet accidentally, i.e. without the help of the pheromone.

Zusammenfassung. Das Geschlechtspheromon des Lärchenwicklers *Zeiraphera diniana* wird in einer Drüse des Weibchens an der Basis des Ovipositors produziert und scheint mit *trans*-11-Tetradecenylacetat identisch zu sein. Das Pheromon ist ausschliesslich Lockstoff mit Distanzwirkung und ist für die Kopulation bedeutungslos. Diese wird unter bestimmten Umweltsbedingungen durch rein optische Stimuli ausgelöst. Da die Männchen nicht streng zwischen den Geschlechtern unterscheiden können, kommen homosexuelle Kopulationen vor.

G. BENZ

Department of Entomology,
Swiss Federal Institute of Technology Zurich,
CH–8006 Zürich (Switzerland), 26 February 1973.

[7] P. ALTWEGG, Z. angew. Entomol. *69*, 135 (1971).
[8] L. M. RIDDIFORD, J. Insect Physiol. *16*, 653 (1970).

The Diffusion Coefficient of Sodium in Barnacle Muscle Fibres

One of the unique advantages of conducting experiments with giant cells is that they can be loaded with an isotope fairly rapidly by microinjection. The technique of microinjection as adopted by me is essentially that devised by HODGKIN and KEYNES[1] for experiments on squid axons. This involves insertion of a microinjector down the center of a cannulated preparation e.g. barnacle muscle fibre, and ejection of a small volume of 'hot' solution. Some work based on the microinjection of radiosodium had been reported from this laboratory[2] but no attempt had been made to determine the diffusion coefficient of Na in the sarcoplasm. As pointed out by HODGKIN and KEYNES[1], the problem is 'one of diffusion within an infinite cylinder whose surface is insulated'. Hence the equation given by CARSLAW and JAEGER[3] can be used. The expression is:

$$\frac{y_t}{y_\infty} = 1 + \sum_{\alpha_1, \alpha_2 \ldots} e^{-\alpha^2 Dt/a^2} / J_0(\alpha) ,$$

where Yt/Y_∞ is taken as the Na efflux at time (t) relative to the maximal steady Na efflux, D the diffusion coefficient, α_1, α_2... the positive roots of the first order Bessel function $J_1(\alpha) = 0$ and a the radius of the muscle.

Twenty four experiments carried out on barnacle muscle fibres from *Balanus nubilus* or *B. aquila* were selected from a large amount of data in hand, and analyzed. These were singled out because the rate constant for ^{22}Na efflux in each instance was a constant and because the fibers were about the same in diameter (~1 mm). Computation of D from the above equation with t as 2 min gave a mean value of 2.2 ± 0.093 (S.E. of the mean) × 10^{-6} cm²/sec at 22–23° C. This is more than thrice the value reported for skinned barnacle fibers by KUSHMERICK and PODOLSKY[4] who determined the longitudinal diffusion of Na from the diffusion equation for an infinite slab. On the other hand, the value of 2.2×10^{-6} cm²/sec is half that found by BITTAR, CALDWELL and LOWE[5] in muscle fibers from the crab, *Maia squinado*. One reasonable explanation for this difference is that the T-system in barnacle fibers is more elaborate and well-developed than in *Maia* fibres (BITTAR et al.[2]; RICHARDS[6]).

As reported by BUNCH and KALLSEN[7], the diffusion coefficient of urea and glycerol in barnacle fibres is 1.87×10^{-5} cm²/sec and 1.25×10^{-5} cm/sec, respectively. This result is rather surprising not only in view of such physical factors as the T-system and SR but also the viscosity of the sarcoplasm. That retardation does take place is shown by the recent work of CAILLÉ and HINKE[8] who found the diffusion coefficients of sorbitol and Na reduced by almost 50%.

Zusammenfassung. In Muskelfasern der Entenmuschel (*Balanus nubilus* und *Balanus aquila*) beträgt der Natrium Diffusions-Koeffizient $2{,}2 \times 10^{-6}$ cm²/sec.

E. E. BITTAR[9]

Department of Physiology, University of Wisconsin,
470 North Charter Street, Madison
(Wisconsin 53706, USA), 1 November 1972.

[1] A. L. HODGKIN and R. D. KEYNES, J. Physiol., Lond. *131*, 592 (1956).
[2] E. E. BITTAR, S. CHEN, B. G. DANIELSON, H. A. HARTMANN and E. Y. TONG, J. Physiol., Lond. *221*, 389 (1972).
[3] H. S. CARSLAW and J. C. JAEGER, *Conduction of Heat in Solids* (Clarendon Press, Oxford 1947).
[4] M. J. KUSHMERICK and R. J. PODOLSKY, Science *166*, 1297 (1969).
[5] E. E. BITTAR, P. C. CALDWELL and A. G. LOWE, J. mar. biol. Ass. U.K. *47*, 709 (1967).
[6] C. D. RICHARDS, On the Structure and Ion Movements of Muscle Fibres from the crab *Maia squinado*. Ph. D. Thesis, University of Bristol (1966).
[7] W. H. BUNCH and G. KALLSEN, Science *164*, 1178 (1969).
[8] J. P. CAILLÉ and J. A. M. HINKE, Am. J. Physiol. Pharmac. *50*, 228 (1972).
[9] Acknowledgment. This work was supported in part by grants from the Office of Naval Research and the National Science Foundation.