their external morphology. Therefore, the existence of different classes of sensilla may actually aid in clarifying the heterogeneous response patterns often noted in single unit recordings (*2–4*) and may ultimately further our understanding of olfactory coding in insects and improve the use of pheromones in the biorational control of insect pests.

ROBERT J. O'CONNELL
ALAN J. GRANT
Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts 01545
M. S. MAYER
R. W. MANKIN
Insect Attractants, Behavior, and Basic Biology Research Laboratory, U.S. Department of Agriculture, Gainesville, Florida 32604

References and Notes

1. V. B. Wigglesworth, *Q. J. Microsc. Sci.* **94**, 93 (1953); J. R. Sanes and J. G. Hildebrand, *Dev. Biol.* **51**, 300 (1976).
2. R. J. O'Connell, in *Olfaction and Taste IV*, D. Schneider, Ed. (Wissenschaftliche Verlagsgesselschaft, Stuttgart, 1972), p. 180; E. Priesner, *Z. Naturforsch.* **35**, 990 (1980); J. N. C. Van Der Pers, P. L. Cuperus, C. J. Den Otter, *J. Insect Morphol. Embryol.* **9**, 15 (1980); M. S. Mayer and R. W. Mankin in *Comprehensive Insect Physiology, Biochemistry, and Pharmacology*. G. A. Kerkut and L. I. Gilbert, Eds. (Pergamon, New York, in press), vol. 9.
3. R. A. Steinbrecht, *Z. Morphol. Tiere* **68**, 93 (1970); K. E. Kaissling, in *Olfaction*, L. M. Beidler, Ed. (Springer-Verlag, Berlin, 1971), p. 351; R. A. Steinbrecht and B. Muller, *Z. Zellforsch. Mikrosk. Anat.* **117**, 570 (1971).
4. R. J. O'Connell, *J. Gen. Physiol.* **65**, 179 (1975).
5. The stimuli consisted of 1.8-ml puffs of purified, O_2-free N_2 that had passed over a filter paper loaded with a known amount of pheromone. Between stimuli the animal was bathed in a stream of humidified synthetic air (80 ml/min). The timing of stimuli, action potential intervals, and evaluation of responses have been described [(*4*); R. J. O'Connell, W. A. Kocsis, R. L. Schoenfeld, *Proc. IEEE* **61**, 1615 (1973)].
6. After a recording was made, a portion of the antenna, including the segment of interest, was removed, washed in methylene chloride (1 to 2 days), mounted on a stub, air dried, coated in a rotary evaporator with ~ 200 Å of a mixture of gold and palladium (6:4), and examined in an SEM (model 1000, AMR) at 30 kV.
7. Spontaneous activity can be manipulated by grading the deformation caused by electrode insertion. This factor was evaluated in 20 additional sensilla. One of us (A.J.G.) selected sensilla by length and pointed the recording electrode at the sensillum. Random selection order was obtained by another individual so that an equal number of HS and LS sensilla were evaluated. The recording electrode was inserted into the sensillum by a third individual (R.J.O.), who was unaware of either the length or desired class. Spontaneous activity and responses to pheromone were evaluated in the usual manner. In 95 percent of the sensilla the expected relationship between length, spontaneous activity, and the concentration dependence of the response was obtained. One B neuron from an HS sensillum was slower than usual.
8. E. Priesner, *Ann. Zool. Ecol. Anim.* **11**, 533 (1979); R. J. O'Connell, in *Perception of Behavioral Chemicals*, D. M. Norris, Ed. (Elsevier/North-Holland, Amsterdam, 1981), p. 133; J. N. C. Van Der Pers, *Entomol. Exp. Appl.* **31**, 255 (1982).
9. The compounds used as stimuli included (*Z*)-7-dodecenyl acetate, (*Z*)-7-dodecenyl alcohol, (*E*)-11-tetradecenyl acetate, (*E*)-7-dodecenyl acetate, (*Z, E*)-7,11-hexadecadienyl acetate, (*E*)-7-dodecenyl alcohol, and (*E*)-9-dodecenyl alcohol. Small amounts (0.01 μg) of (*Z*)-7-dodecenyl acetate and (*Z*)-7-dodecenyl alcohol were effective stimuli for the A and B units of HS sensilla, respectively. Larger amounts (10 μg) of (*Z*)-7-dodecenyl acetate, (*E*)-11-tetradecenyl acetate, (*E*)-7-dodecenyl acetate, and (*Z,E*)-7,11-hexadecadienyl acetate were effective stimuli for the B cell of LS sensilla.
10. W. L. Roelofs, in *Crop Protection Agents*, N. R. McFarlane, Ed. (Academic Press, London, 1977), p. 147.
11. D. M. Light and M. C. Birch, *J. Insect Physiol.* **25**, 161 (1979).
12. We thank R. Hall, G. Lanier, H. Oberlander, S. Treistman, and J. Walker for their comments and D. Hunt, K. Bedigian, and R. Cassidy for technical assistance. This work was supported by NSF grant BNS-8016395 and NIH grant NS14453.

2 December 1982; revised 8 April 1983

Sea Spray Production from Bubbles

Like Wu (*1*), we believe that sea spray is produced primarily by bursting bubbles, but we do not believe that proof of this is found in a similarity of the slopes of the droplet size spectra and the bubble spectra. There is a fallacy in this approach. First, it is not the bubble spectra in the sea that produce the droplet spectra; it is the bubble-flux spectra at the surface of the sea. The latter, obtained from the former by considering the rise speeds of the bubbles, has a different slope. Second, once the droplets are produced, turbulent mixing in the air and gravitational fallout take over to produce the droplet spectra.

Even if Wu's argument is correct, we think he used the wrong bubble spectra for his comparison. His spectra, the pseudo–steady state background spectra (*2*), were not obtained directly in a breaking wave. Most of the droplets that rise from the sea originate from bubble-flux spectra produced within 5 to 10 seconds after a wave breaks (*2, 3*). These spectra do not have the same slopes as the background spectra used by Wu.

DUNCAN C. BLANCHARD
RAMON J. CIPRIANO
Atmospheric Sciences Research Center, State University of New York, Albany 12222

References and Notes

1. J. Wu, *Science* **212**, 324 (1981).
2. D. C. Blanchard and A. H. Woodcock, *Ann. N.Y. Acad. Sci.* **338**, 330 (1980).
3. R. J. Cipriano and D. C. Blanchard, *J. Geophys. Res.* **86**, 8085 (1981).

27 April 1981

I thank Blanchard and Cipriano for giving me the opportunity to clarify some points on the correlation between sea spray in the atmospheric surface layer and air bubbles in the near-surface ocean.

Undoubtedly, it is not the bubble spectra at greater depths but those near the sea surface that produce the spray spectra. However, I showed earlier that the spray spectrum does not vary with height (*2*) above and the bubble spectrum does not vary with depth (*3*) below the sea surface. The absence of variation of bubble spectrum with depth casts doubt on the adoption of the bubble-flux spectrum, while the absence of variation of droplet spectrum with elevation indicates that the droplet spectrum near the sea surface may not differ significantly from those presented.

The second point of Blanchard and Cipriano's discussion is that the bubble spectra used in my comparison were in the form of a pseudo–steady state background spectrum, not those obtained directly in a breaking wave. While this is generally true, if we look further we see that the bubble spectrum in a breaking wave was found to reach an equilibrium shape a few seconds after the passage of the breaker (*4*) and that the spectrum obtained in a breaking wave was not much different from the so-called pseudo–steady state background spectrum.

JIN WU
College of Marine Studies, University of Delaware, Newark 19711

References and Notes

1. J. Wu, *J. Geophys. Res.* **84**, 1693 (1979).
2. ______, *ibid.* **86**, 457 (1981).
3. D. C. Blanchard and A. H. Woodcock, *Tellus* **9**, 145 (1957).

10 March 1982