tion is primarily industrial stacks. In London the principal contaminant appears to be the various components and derivatives from the combustion of coal, while in Los Angeles automobile emissions contribute the main atmospheric burden.

The ability of a community to control atmospheric pollution was discussed by S. Smith Griswold (Air Pollution Control, Los Angeles County) and Joseph R. Christian (St. Luke's Hospital, Chicago). Atmospheric inversion, a prerequisite for the development of high concentrations of harmful irritants, is obviously not subject to control. All other modes of control have to be fitted to the particular problems of the community, the source of emissions, their chemical nature, their concentration, and their effects, which may include simple nuisance value and economic loss.

JOHN S. CHAPMAN
*University of Texas Southwestern Medical School, Dallas*

## Mollusks

Sensory, integrative, and effector aspects of the responses of marine gastropods, cephalopods, and bivalves to significant aspects of environment were emphasized in a symposium on the Mollusca at the Zoological Society of London, 4–5 March 1964.

In the first session on bivalves, P. Korringa (Netherlands Institute for Fishery Investigation) emphasized the decisions required of the oyster larva at the end of its free-swimming stage. The larva tests a substrate for suitability by crawling over it with the foot, and may make temporary byssal attachments. However, once an attachment is made, the decision to affix permanently is irrevocable for the cement gland secretes its adhesive only once. Several environmental factors are unimportant to this decision, among them temperature, light, attitude of substrate and its color. However, currents play an important role in transport and physical-chemical properties of the surface provide relevant sensory information. The size of the object is also important.

Sedentary adults are characteristic of the class Bivalvia, and the larval stages are important in maintaining species distributions. However, K. W. Ockelmann (Marine Biological Laboratory, Helsingør, Denmark) reported on evolutionary tendencies in response to the conflicting selective pressures for species dispersal and for protection of eggs and developing young. Absence of an endogenous dispersal mechanism does not necessarily indicate a restricted distribution. Some relatives of mussels may be distributed primarily by the marine plants to which their juveniles are attached. The main factors determining type of development and mode of dispersal in marine bivalves appear to be food conditions, water movements, and availability of substrates appropriate to the habits of the individual species.

Bivalves of commercial importance continue to interest biologists. A. Ansell (University of Southampton) and D. A. Hancock (Fisheries Laboratory, Burnham-on-Crouch) discussed the particularly challenging stages of early life history. Ansell described seasonal biochemical changes occurring in the introduced American clam, *Venus mercenaria.* Successful reproduction has occurred in colonies at Southampton but not elsewhere in Britain. Ansell explained that temperatures above 18°C, required for spawning, occur in Southampton Water because of the warming of sea water used in industrial cooling systems. In discussing the edible cockle, *Cardium edule*, Hancock showed that an inverse correlation exists between the success of larval spatfall and the density of the adult population even though space for recruits seems to be available. The highest densities of young cockles are most likely to occur when a warm summer induces successful reproduction by adults remaining after a severe winter has reduced adult populations.

C. M. Yonge (University of Glasgow) and T. H. J. Gilmour (University of Exeter) dealt with functional morphology of bivalves. Yonge discussed general changes of form which enabled primitive bivalves to exploit soft sediments. Such changes in habitat subject animals to novel selective forces favoring further morphological changes. As a specialized example, Gilmour showed that the reduction of the anterior regions of the mantle cavity in some bivalves increases the strength of water currents leaving the oral grooves. These intensified currents, generated by the beating of cilia of the ctenidia, palps, and lips, are prevented from interfering with the passage of food toward the mouth by a complicated lip apparatus.

Gastropods are in general more active animals, and their responses are often more apparent and easier to study. G. E. Newell (Queen Mary College, London) described in detail the functional morphology of the complex eye of the intertidal snail, *Littorina.* Sun orientation and form vision are structurally possible and necessary to explain such behavior. Supporting evidence for form vision, as a requisite for the observed orientation on the shore, was presented by F. Evans (Dove Marine Laboratory, Cullercoats). The establishment of zonation by *Littorina* was shown by his experiments, in which he used tanks with manipulated artificial topography, tide, and light-dark cycles.

Various aspects of the feeding biology of gastropods were discussed. An ingenious approach to the difficult problem of the nature of the food of deposit feeders was reported by R. C. Newell (Westfield College, London). From measurements of carbon and nitrogen removal from test foods of varying composition by the snail, *Hydrobia,* Newell tentatively concludes that microorganisms are much more important as food than the organic debris of fine sediments. The latter are an additional link in the food chain and provide nutrient and surfaces essential for the bacteria.

E. H. Smith (Marine Station, Millport) discussed his comparative study of the proboscis of carnivorous gastropods of the suborder Toxoglossa. A single radula tooth is moved to the tip of the proboscis and injected with a paralyzing venom into the prey. The morphology and functioning of the feeding mechanism is remarkably similar to that of the most specialized Toxoglossa, *Conus,* and appears to have evolved mainly in more primitive members of the group. The feeding behavior of *Conus* was reviewed by A. J. Kohn (University of Washington) who emphasized ecological and evolutionary implications. A direct correlation has been found between food specialization and *Conus* species diversity. Where the latter is high, each common species feeds primarily on a different species or higher taxon of food organisms. This specialization thus aids in maintaining populations of many closely related sympatric species.

In a paper entitled "Taxonomy and distribution of the subspecies of *Littorina saxatilis*," B. L. James (University College of Swansea) showed correlations between morphological variation, habitat, and distribution.

Recent observations by Anna Bidder on living *Nautilus* have renewed interest in this fabled but biologically little known animal, which very few zoologists have seen. J. Z. Young (University College, London) reported on his detailed neuroanatomical study of *Nautilus*. This study has contributed to an evaluation of its sensory and neural mechanisms and abilities. The pinhole of the eye is large and may not form an image. If it does form an image, the visual information remains inverted, because there are no dorsal-ventral neural chiasmata. The olfactory lobe of the brain is better developed than in any other living cephalopod, and the importance of this sensory modality to *Nautilus* has been verified in behavioral observations by Bidder. The cerebral cord does not show the divisions found in coleoids; it has complex plexiform regions which allow for interaction between signals from various receptors. The nervous system contains large numbers of neurons and is very far from the primitive molluscan condition.

In her report on locomotion in cephalopods, Bidder (Cambridge) explained water movement in and out of the mantle cavity of *Nautilus*. Differences from the more typical cephalopod mechanism are necessitated by the presence of the shell and absence of a flexible, muscular mantle. While jet propulsion is the dominant mode of cephalopod locomotion, other methods help and in some cases supersede it. These methods are diverse and include flange-like fins with wave motion, wing- and propeller-like posterior fins, the use of the arms in walking, and a web between the arms in medusoid swimming.

Locomotion by the arms in *Octopus* raises problems because of limited sensory equipment, but enables the solution of problems that would otherwise be formidable. The visual and locomotor methods used by experimental octopus to obtain a crab, initially visible behind a glass wall but accessible only after a course which temporarily obscures it from view, supported the hypothesis that cephalopods lack knowledge of the spatial position of their arms (M. J. Wells, Cambridge). Such knowledge would require an extreme array of receptors along the arms, neurons from them, and integrative centers in the brain for which space does not seem available. The information required would be much greater than in the vertebrate or arthropod with its limited number of joints separating inflexible segments.

A. Packard (Stazione Zoologica, Naples) also investigated the visual abilities of *Octopus* by means of an ingenious experimental device which rotates the visual field around a stationary animal, or rotates the animal within the stationary field. Oculomotor responses tend as much as possible to bring the stimulus toward the center of the retina of both eyes.

Emphasis was placed on the fact that the well developed sensory, neural, and motor apparatus of cephalopods permits rapid responses to environmental variables. (N. A. Holme, Marine Biological Association, Plymouth). The distribution and reproduction of *Loligo* in the English Channel are closely related to distribution patterns of water temperature.

In other reports on cephalopods, J. S. Alexandrowicz (Marine Biological Association, Plymouth) demonstrated rhythmic contractions of the ganglion situated near the heart in *Octopus*. Pulsations occurring with the same frequency as those of the organs of blood circulation are brought about by a spherical body situated within the ganglion and containing muscle tissue. It is possible that this body has a neurosecretory function. M. R. Clarke (National Institute of Oceanography) discussed the difficult problem of obtaining information on growth rate in cephalopods with particular attention to recognizable increments in the growth of hard parts.

This symposium was organized by C. M. Yonge.

ALAN J. KOHN
*Department of Zoology, University of Washington, Seattle*

## Forthcoming Events

### August

*9–12.* **Heat Transfer**, 7th natl. conf., Cleveland, Ohio. (W. Chenoweth, American Inst. of Chemical Engineers, 345 E. 47 St., New York 17)

*9–13.* American Soc. of **Animal Science**, Knoxville, Tenn. (J. E. Oldfield, Dept. of Animal Science, Oregon State Univ., Corvallis)

*9–14.* South American Union of **Engineers'** Federations, 10th conv., Rio de Janeiro, Brazil. (Federacão Brasileira de Associacões de Engenheiros, Caixa Postal 1229, Rio de Janeiro)

*10–14.* **Structural Developments in Inorganic Chemistry**, New Hampton, N.H. (W. G. Parks, Dept. of Chemistry, Univ. of Rhode Island, Kingston)

*10–15.* Pan American Federation of **Engineering** Socs., 8th biennial conv., Caracas, Venezuela. (L. K. Wheelock, Engineers Joint Council, 345 E. 47 St., New York 10017)

*12–14.* **Ballistic Missile and Space Technology**, 9th symp., U.S. Naval Training Center, San Diego, Calif. (C. Morrow, Aerospace Corp., P.O. Box 95085, Los Angeles, Calif. 90045)

*12–14.* **Galaxies**, preliminary conf., Uppsala, Sweden. (T. Page, Van Vleck Observatory, Wesleyan Univ., Middletown, Conn. 06457)

*12–14.* **X-Ray Analysis** Applications, 13th annual conf., Denver, Colo. (W. G. Mueller, Metallurgy Div., Univ. of Denver, Denver Research Inst., Denver 80210)

*12–31.* **Mathematics** seminar, Canadian Mathematical Congr., Laval Univ., Quebec, Canada. (L. F. S. Ritcey, CMC, 985 Sherbrooke St., W., Montreal, P.Q.)

*13–15.* International Soc. for **Horticultural Science**, Edinburgh, Scotland. (G. de Bakker, Le v.d. Boschstraat 4, The Hague, Netherlands)

*16–21.* **Histochemistry and Cytochemistry**, intern. congr., Frankfurt am Main, Germany. (T. H. Schiebler, Anatomisches Institut der Universität, Koellikerstr. 6, 87 Würzburg, Germany)

*16–23.* Latin American **Schools of Medicine**, 4th conf., Pocos de Caldas, Brazil. (O. Versiani Caldeira, Univ. of Minas Gerais Medical School, Belo Horizonte, Minas Gerais, Brazil)

*16–24.* **Human Economy**, conf., Inst. of Paper Chemistry, Appleton, Wis. (A. N. McLeod, IPC, Appleton)

*17–20.* American Assoc. of **Clinical Chemists**, 16th natl., Boston, Mass. (F. F. Ronan, AACC, 19 Bay State Rd., Boston 15)

*17–20.* **Natural Ultra Low Frequency Electromagnetic Fields**, symp., Boulder, Colo. (W. H. Campbell, National Bureau of Standards, Boulder)

*17–21.* **Combustion**, 10th intern. symp., Cambridge, England. (Combustion Inst., 986 Union Trust Bldg., Pittsburgh 19, Pa.)

*17–21.* **Cryogenic Engineering**, conf., Philadelphia, Pa. (K. D. Timmerhaus, Engineering Research Center, Ketchum 129, Univ. of Colorado, Boulder)

*17–21.* **Simulation in Space Technology**, Blacksburg, Va. (F. J. Maher, Virginia Polytechnic Inst., Blacksburg)

*17–22.* International **Astronomical** Union, symp., Thessaloniki, Greece. (Maj. B. R. Agins, Air Force Office of Scientific Research, SRMA, Washington, D.C.)

*17–22.* **Cardiology**, 4th European congr., Prague, Czechoslovakia. (H. Kafka, Karlovo nám. 32, Prague 2)

*17–22.* **Endocrinology**, 2nd intern. congr., London, England. (A. S. Mason, London Hospital, Whitechapel, London, E.1)

*17–22.* **Social Psychiatry**, 1st intern. congr., London, England. (J. Bierer, 7 Hollycroft Ave., London, N.W.3)

*17–28.* **Molecular Biophysics**, intern. inst., Squaw Valley, Calif. (Prof. Weissbluth, Biophysics Laboratory, Stanford Univ., Stanford, Calif.)

*18–20.* International Assoc. of **Milk and Food Sanitarians**, Portland, Ore. (H. L. Thomasson, P.O. Box 437, Shelbyville, Ind.)