Hydra

Workers from many fields consider the physiology and ultrastructure of hydra and other coelenterates.

Howard M. Lenhoff

During the last decade there has been a renewed and growing interest in the use of hydra as a laboratory animal. This trend was stimulated by the contributions of W. F. Loomis, who devised methods for growing hydra in the laboratory under controlled conditions, introduced new quantitative techniques for the study of these animals, and discovered many fundamental biological phenomena, including the role of the partial pressure of carbon dioxide (pCO_2) in controlling sexual differentiation of hydra.

Since Loomis's initial discoveries, an increasing number of young workers have begun to use hydra and some other coelenterates for their experiments. These investigators represent a wide number of biological disciplines and normally do not all read or publish in the same journals. Consequently, about a year ago plans were made to acquaint these different workers with each other at a meeting having the following aims: (i) to evaluate both recent and previous work; (ii) to define current problems in the field; and (iii) most important, to effect an interdisciplinary synthesis which might otherwise take years through normal channels.

From 29 March through 2 April 1961, about 35 North American workers met for a symposium on "The Physiology and Ultrastructure of Hydra and of Some Other Coelenterates" at the Fairchild Tropical Gardens, Coral Gables, Florida. Of the five days of the symposium, only two and a half were devoted to formal sessions; the rest of the time was left open for informal discussion and expeditions to the nearby coral reefs and Everglades National Park.

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During the first session attention was focused on the ultrastructure of hydra cells, on intercellular attachments, on mesoglea, and on the nervous system. Toward the end of the session the existence of nerve cells in hydra was disputed; the light microscopists claimed that hydra has a nerve net, demonstrable by staining techniques, whereas electron microscopists were unable to find any structures resembling neural elements. The latter suggested that the interdigitations found connecting epitheliomuscular cells might serve in transmiting excitations. They also gave examples of artifacts that might be interpreted as nerve cells.

Research on the nematocyst, a structure which continues to intrigue biologists, has enjoyed a burst of activity in the last few years. The initial paper in a session on nematocysts concerned an electron-microscopic study of the origin and development of nematocysts within clusters of cnidoblasts connected by intercellular bridges. An account of the fine structure of the mature nematocyst stimulated a discussion of the mechanism of its discharge (Fig. 1).

Both the chemists and the electron microscopists presented evidence that the nematocyst capsule contained an unusual type of collagen. The nematocyst toxin was shown to be a small protein inhibiting electron transfer at the reduction of cytochrome *c*. The functions of the varied pharmacological compounds found in coelenterates, such as tetramine and serotonin, were discussed in relation to coelenterate toxins. A comprehensive evaluation of the present state of nematocyst research from the viewpoint of coelenterate systematics, natural history, and behavior concluded this session.

In a session devoted to nutrition, the first topic was the activation of the feeding reflex by reduced glutathione. Next there was a discussion of the complex nutritional requirements of hydra. New vistas to the study of both the biology and the nutrition of coelenterates were opened by a report presenting, for the first time, methods for growing separate clones of coelenterate cells (sea anemone) in tissue culture. The session ended with a stimulating discussion of the role of symbiotic intracellular algae in two unique nutritional relationships: the survival of green hydra and the calcification process by reef corals.

Attention turned in the last two sessions to problems of development and aging. Colonial hydroids were shown to be excellent experimental animals for the study of such developmental problems as (i) the manner in which an organism acquires and regulates its shape, pattern, and proportion; (ii) regression and reconstitution phenomena; (iii) physiological interactions during budding processes; and (iv) aging. The discussion on aging was highlighted by the demonstration of increased numbers of lysosomes and increased acid phosphatase activity in the aging portions of both mortal and immortal coelenterate types. Also, there was much excitement about the demonstration that even after x-irradiation of 100,000 roentgens, *Campanularia* hydranths continued to differentiate for one week.

Two papers on sexual differentiation threw new light on this complex developmental problem. The first paper emphasized a shift from chemical studies of the ambient macroenvironment to consideration of the chemistry of the microenvironment immediately

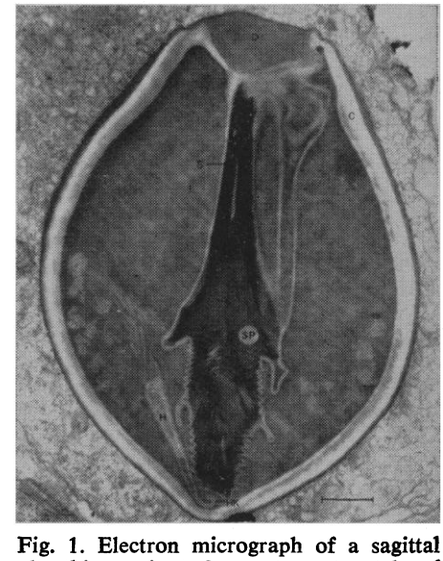

Fig. 1. Electron micrograph of a sagittal ultrathin section of a mature stenotele of hydra. *O*, Operculum; *C*, capsule; *S*, stylets; *SP*, spines; *H*, enlarged head of the internal tubule; *HK*, hook of the tubule (about × 6800). [G. B. Chapman]

surrounding each animal. This delicate interplay between the organism, microenvironment, and macroenvironment was also shown to affect differentiation in other organisms. The second paper reported apparent rhythmicities of sexual differentiation and stressed the possible role of intrinsic as well as extrinsic factors in controlling these developmental phenomena.

During the last day of the symposium papers were presented on regeneration and budding. It seemed especially fitting that such papers should be given because hydra were the first animals in which these two processes were studied. The symposium reports emphasized a chemical approach to these problems. One line of attack involved study of the effects of chemical agents on regeneration. Interestingly, it was proposed that the vitamin lipoic acid exerts its inhibitory effects on regeneration by inhibiting DPN-malic dehydrogenase. Next, the control of regeneration, growth, and cell migration were discussed in relation to postulated growth-stimulating and growth-inhibiting factors. Finally, the finding of a high DNA to protein ratio in buds as compared to the parent hydra was discussed in relation to cell growth.

One of the most refreshing aspects of this meeting was the *espirit de corps* generated among all those who took part. The participants were as follows: P. Broberg, R. Bryden, A. Burnett, G. Chapman, D. Claybrook, S. Crowell, R. Eakin, D. Fawcett, C. Fulton, G. Gauthier, T. Goreau, C. Hand, A. Hess, E. Kline, C. Lane, H. Lenhoff, Y. Li, W. Loomis, P. Lunger, C. Lytle, G. Mackie, E. Martin, L. Muscatine, E. Palincsar, H. Park, L. Passano, J. Phillips, D. Ross, D. Slautterback, D. Spangenberg, B. Strehler, S. Wainwright, E. Wangersky, J. Welsh, and R. Wood.

The proceedings and discussions of the symposium are being published by the University of Miami Press.

Forthcoming Events

December

26–31. American Assoc. for the Advancement of Science, annual, Denver, Colo. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5)

The following 45 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (J. R. Mayor, AAAS, 1515 Massachusetts Ave., NW, Washington, D.C.). 27 Dec.

AAAS Southwestern and Rocky Mountain Div. (M. G. Anderson, New Mexico State Univ., University Park). 26–30 Dec.

Academy Conf. (J. G. Arnold, Jr., Loyola Univ., New Orleans, La.). 27–28 Dec.

Alpha Epsilon Delta (N. F. Witt, Univ. of Colorado, Boulder). 28–29 Dec.

American Astronautical Soc. (M. Pitkin, Martin-Denver Co., Denver, Colo.). 28–29 Dec.

American Astronomical Soc. (H. J. Smith, Yale Observatory, 135 Prospect St., New Haven, Conn.). 26–30 Dec.

American Economic Assoc. (K. E. Boulding, Univ. of Michigan, Ann Arbor). 26 Dec.

American Educational Research Assoc. (D. D. Feder, San Francisco State College, San Francisco, Calif.). 30 Dec.

American Nature Study Soc. (S. G. Baldwin, Danville, Ill.). 27–30 Dec.

American Physiological Soc. (R. E. Smith, Univ. of California, Los Angeles). 29 Dec.

American Political Science Assoc. (J. Korbel, Social Science Foundation, Univ. of Denver, Denver, Colo.). 27 Dec.

American Psychiatric Assoc. (D. A. Hamburg, Stanford Medical Center, Palo Alto, Calif.). 27 Dec.

American Soc. of Criminology (G. H. Barker, Dept. of Sociology, Univ. of Colorado, Boulder). 29–30 Dec.

American Soc. of Naturalists (E. W. Caspari, Univ. of Rochester, Rochester, N.Y.). 27 Dec.

American Soc. of Zoologists (R. L. Watterson, Univ. of Illinois, Urbana). 27–30 Dec.

American Sociological Assoc. (C. Taeuber, Bureau of the Census, Washington, D.C.) 29 Dec.

American Statistical Assoc. (J. A. Niederjohn, Ideal Cement Co., Denver, Colo.). 29–30 Dec.

Association of American Geographers (M. J. Loeffler, Univ. of Colorado, Denver). 26–28 Dec.

Association for Computing Machinery (W. F. Cahill, Goddard Space Flight Center, Greenbelt, Md.). 28 Dec.

Beta Beta Beta Biological Soc. (Mrs. F. G. Brooks, Box 515 Ansonia Station, New York 23). 26–27 Dec.

BIO (Biomedical Information-Processing Organization) (R. S. Ledley, Natl. Biomedical Research Foundation, Silver Spring, Md.). 27 Dec.

Biometric Society, WNAR (F. Graybill, Statistical Laboratory, Colorado State Univ., Fort Collins). 28 Dec.

Committee on Desert and Arid Zones Research, Southwestern and Rocky Mountain Div. of AAAS (T. L. Smiley, Univ. of Arizona, Tucson). 30 Dec.

Conference on Scientific Communication (C. D. Leake, Ohio State Univ., Columbus). 30 Dec.

Conference on Scientific Manpower (T. J. Mills, Natl. Science Foundation, Washington, D.C.). 27 Dec.

Ecological Soc. of America (R. S. Miller, Univ. of Saskatchewan, Saskatoon, Canada). 27–29 Dec.

Institute of Management Sciences (M. M. Flood, Mental Health Research Inst., Univ. of Michigan, Ann Arbor). 29 Dec.