OCEANOGRAPHY OF LONG ISLAND SOUND

VOL. 17, Art. I, of the *Bulletin of the Bingham Oceanographic Collection** contains six papers on widely different aspects of the oceanography of Long Island Sound, with the emphasis on the cycle of organic production, and a guide for preparing figures written by the editor, Ynge H. Olsen, with James E. Morrow, research associate. The volume opens with an obituary notice of Eugene Harris, who had not fully completed the manuscript of his important contribution on the nitrogen cycle when he died. The senior author, Dr. Gordon A. Riley, completed it, and from the paper itself it is clear to all who wrestle with the problems presented by organic production in the sea that further contributions of high standard would have come from Harris had he lived.

The volume as a whole is a continuation of a series of seasonal studies, continued over a period of years, in the attempt to establish the various parameters, physical, chemical and biological, that seem to exert most influence on the production of plankton, and secondarily on the higher forms of life such as sand-eels and other fishes, in this area. Numerical values for the most important of these parameters having been established, the final approach to solution of the organic cycle is by the mathematical methods previously employed by Dr. Riley in studies of more strictly oceanic areas.

Marine biologists in Great Britain may gain a fair idea of the scope and importance of the work if it is said that it presents a close parallel to that carried out by Dr. Harvey and his co-workers of the Plymouth Laboratory in the coastal waters of the English Channel some twenty-five years ago. Long Island Sound is a more enclosed and more strictly coastal sea-area, with more extreme seasonal variation in such parameters as temperature and salinity, due partly to the climatic differences of an area on the eastern side of a continent. Moreover, the American workers began with all the advantages of the research and discussion that have accrued during the intervening years, with attendant improvements in technique; while the more-sheltered situation must have greatly assisted in the maintenance of wider and more prolonged seasonal coverage.

The general account given by Dr. Riley shows that the phytoplankton cycle is somewhat different from that observed off north-west Europe. A late-winter flowering dominated by diatoms such as *Skeletonema costatum* and *Thalassiosira nordenskiöldii* occurred, with its peak between January and March, in each of the years studied, that is, roughly one month earlier than the spring flowerings studied by European workers. Subsequent less-regular flowerings in May or June consisted predominantly of dinoflagellates. The phytoplankton of the western (enclosed) end of the Sound was so much greater than that near the open end that there the chlorophyll concentrations during post-flowering periods were as high as those representing flowerings at the eastern end. It was thought that relatively low-grazing intensity at the western end partly accounted for this great disparity. Autumnal flowerings were less regular than the others, but of very considerable magnitude. A fairly satisfying argument postulating increased stability of the surface layers as the prime factor promoting the richer antumnal outbursts is presented.

Harris's contribution established nitrogen as the most probable limiting factor among the essential nutrients in this area. As stated in Riley's general account, the relative poverty is shown by nitrogen/phosphate ratio of between 5 : 1 and 8 : 1 by atoms, between one-third and one-half the values found in the Atlantic area generally. It is pleasing to find Cooper's concept of the "anomaly of the phosphate/nitrate ratio" so useful in defining the nutrient characteristics of a region very different from most of those in which such work has been done before.

Harris showed further that ammonia was superior to nitrate and nitrite as a source of nitrogen for the phytoplankton studied in most instances, and not inferior to them in the remainder. In the discussion he developed a most interesting hypothesis to the effect that in strongly stratified surface waters, when nitrogen quantities are near minimal, but organic matter tends to a maximum near the thermocline, vertical zooplankton migrations may help to slow down depletion of the epithalassa in this respect, or even very slightly to increase the quantities available.

Riley and Schurr present a very detailed analysis of the various parameters affecting transparency of the waters as indicated by a fine series of Secchi-disk readings. Here I must confess to feeling rather unconvinced by the mathematical treatment of some of the more obviously inter-related physical factors influencing the maintenance of suspensoids in the upper layers, as wind stress, mean stability, tidal-current speed and depth. The time factor appropriate for the first two seems so uncertain that one doubts the adequacy of the statistically computed partial correlation coefficients to express these. This is not to query the correctness of the conclusions reached, where the possible effects of some of the 'unknowns' are quite fairly stated in more general terms.

A brief trenchant note by Riley on the particulate matter in the Sound shows that although the amount of detritus is exceptionally large its distribution seems to bear little direct relation to the phytoplankton cycle. From the seasonal imbalance between production and consumption it seems that some of it has a slow rate of degradation. Thus it may provide less-suitable food for the zooplankton than would seem probable from the evidence that the latter can assimilate more nitrogen than is to be found in the phytoplankton. The part played by organic detritus in a relatively shallow enclosed sea-area like the Sound, where local turbulence often churns up the bottom deposits, must be more complicated than it is in oceanic areas where it sinks out of the immediate circulation in the surface layers.

Peter J. Wangersky examined the carbohydrate content of water samples from the Sound throughout

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one year's plankton cycle. He found none present during a spring diatom bloom and significant amounts (0·5–1·5 mgm./l.) only towards the end of a July dinoflagellate bloom. These amounts were an order of magnitude less than those found in bacteria-free pure cultures of the same organism. He concludes that the material is being utilized almost as fast as it is released: the small quantities present may even be more indicative of rapid utilization than of small production. I cannot wholly agree with his concluding sentence: "Elucidation of the relationships between dinoflagellates and marine bacteria is *primarily* a task for pure culture techniques in the laboratory" [italic mine]. Doubtless the laboratory approach is likely to be more immediately rewarding in the present state of knowledge (or lack of knowledge) concerning these organisms, but if anything seems certain about them it is that it would be most unsafe to extrapolate from culture conditions to those existing in Nature without concomitant planned field-work, which should surely be regarded as a primary part of such studies.

The collections of fish eggs and larvæ made by Dr. Riley were studied by Sarah W. Richards in continuation of earlier work by Wheatland. The majority of the twenty-two species proved to be summer spawners. In winter no eggs were taken, and larvæ of only one species, *Ammodytes americanus*, occurred in abundance. Fluctuations in annual totals were caused mainly by the most abundant species, particularly the anchovy, *Anchoa mitchilli mitchilli*. Only six other species were recorded in large numbers. A greater abundance and variety of species spawned in the western part of the Sound than in the central and eastern portions throughout the year. It appeared that for summer spawners large larvæ from large eggs did not have an advantage over small larvæ from small eggs since the latter hatched at a time of greater food supply.

R. Wade Covill presents a detailed study of the stomach contents of 200 larval and post-larval sand-eels, *Ammodytes americanus*, 3·2–23·1 mm. long. Comparison with data from elsewhere showed fewer empty stomachs among the Long Island Sound material; evidently the Sound provides good feeding for the young of this species. Copepods and their nauplii were the most important food organisms, but phytoplankton was also an important food, especially for the younger and smaller larvæ. It is shown that the larvæ must ingest a considerably greater quantity of food a day than can be deduced from direct examination of stomach contents for growth to continue.

Finally, the editors offer first-class advice and instruction regarding the production of the figures with which papers of this kind should be illustrated. No marine biologist can cavil at anything they have to say, for all the advice is excellent.

Is it not a little unjust to expect marine biologists to be good draughtsmen as well as possessing the wide range of professional knowledge and other semi-specialist skills that they must strive to attain in order to do their job well? Many who are not so gifted are no wit inferior as scientists to those gifted with a natural facility for drawing. The number of research workers who can hope for the collaboration of a good illustrator is very limited, at least in Great Britain. Too much insistence upon a high standard of graphic presentation can thus lead to suppression of valuable results.

Another point which this, in itself unexceptionable, set of instructions impels one to raise is the need in marine biological papers for less size reduction of figures and more reference lines on graphs (which most editors seem to abhor). Such work often involves voluminous raw data, which for economic and other reasons are nowadays rarely published in full. Graphs from which the values really can be read off are therefore almost the last line of defence against destructive critics who make much of possible alternative arrays of the data, which on close examination are almost always found to be inferior to those selected by the individual who did the work.

T. John Hart

ARTHUR D. LITTLE RESEARCH INSTITUTE

THE annual report for 1959 of the Arthur D. Little Research Institute, which includes a list of thirty-six publications, nineteen during 1959, records a considerable increase in the scale and scope of the Institute's activities during this its third year of operation, though, as Dr. F. N. Woodward, its director, observed in a paper on sponsored research in *Chemistry and Industry* for January 9, 1960, not more than £300,000 was collectively covered by the three contract research institutes in Great Britain and the research associations of the Department of Scientific and Industrial Research for sponsored research in 1958 (pp. 39. Inveresk, Midlothian: Arthur D. Little Research Institute, 1960).

An investigation aimed at the preparation of polymers from derivatives of glucose was initiated under a four-year grant from the United States Department of Agriculture, and a study of the bulk properties of polymers is being jointly sponsored by British and American companies. A study of aluminium chemistry is being undertaken on behalf of the Atomic Energy Authority, and the chemistry and polymerization of ethylene sulphide are being investigated for a European sponsor.

The work on the chemistry of sodium sucrates continued and has opened a new route for the preparation of a wide range of sucrose derivatives of potential value, including the sucrose fatty esters, although the problem of removing 'bound' ammonia from sucrates prepared in liquid ammonia has not been completely solved. In the work on the mechanism and kinetics of the formation of isotactic polymers, a new flow apparatus was built and the continuous-flow technique adopted to overcome the difficulty of preparing a reproducible Ziegler catalyst surface, and to afford some insight into the problem of making the polymer production process continuous. An improved model of the viscodensitometer was built and calibrated.

Work in the corrosion field was particularly fruitful, and 450 organic compounds were tested for inhibitory power using the rapid methods described in the previous report. Although the results did not establish any clear-cut correlation between chemical