observed in the stalks of the genera so far examined may all be potentially contractile. The function of the canal and its membrane in contractile species may be analogous to the function of the sarcoplasm and the sarcolemma in muscle fibres. Alternatively, the filaments may not themselves be contractile but may merely perform a strengthening or supporting function. Contractility may be achieved through an as yet unverified system of fibrils within the central canal, through the contractility of the canal membrane, or through the contraction of the amorphous gel surrounding the outer filaments. It is hoped that further comparative studies may help to solve this intriguing problem.

The outer boundary of the zooid of *Carchesium* is quite different from the periplast of *Stentor* or *Spirostomum* and may be seen in transverse section at *F* in Fig. 12. This boundary has a fluted appearance which may be caused by a longitudinally arranged series of tubular structures. The overall width of this system in the fixed material is about 5000 A.

Stentor polymorphus (Müller)

Stentor polymorphus (Fig. 17) is a heterotrich which is trumpet-shaped and, like *Spirostomum*, highly contractile. Only a limited number of the characteristic structures revealed by electron microscopy can be discussed here. In longitudinal sections of the body the most interesting structures are those probably associated with contractility; they are referred to below as myonemes, although it will be again obvious that electron micrographs do not in themselves provide evidence of contractility. Transverse views of the myonemes to be seen in Fig. 19 show them to be not unlike those shown in Fig. 5 for *Spirostomum*; the myonemes of *Stentor* are also situated asymmetrically in each ridge. Present evidence from many micrographs indicates that the myonemes are of indefinite length and in the form of closely associated narrow sheets or ribbons. The coarsely fibrillar structure of *Spirostomum* is not evident in *Stentor polymorphus*. In longitudinal section the sheets appear as a series of closely spaced parallel lines (Fig. 18). Comparison of micrographs suggests that each myoneme comprises about twenty to thirty such sheets (Fig. 18). The thickness of each sheet is about 130 A. and the width about 5000 A. A striking feature of Fig. 19 is the condensation of these sheets into thicker and denser objects; in this form these (presumably contractile) structures are apparently attached to the oral cilia (Fig. 20). In addition, the myonemes which lie in the ridges of the body appear to be attached to the locomotive cilia. This in turn suggests that the ciliary and contractile mechanisms are co-ordinated with one another, and that the contractile fibrils are identical with the kinetodesmata.

Some further remarks must be made about the adoral cilia. Fig. 21 shows that these are in small groups. From each such group an extremely long (8–12μ) root system depends into the body. This system is apparently highly organized; in longitudinal section it is filamentous; in oblique section a lattice-like arrangement is visible, the whole suggesting a regularly arranged system of interweaving sheets. Several very long bodies without clear structural characteristics have also been observed in sections of the endoplasm. It is not known what these are, although they may, of course, be another type or form of contractile structure. Fauré-Fremiet and Rouiller have very recently[13] reported a number of observations on the fine structure of *Stentor* species.

Even at this early stage, mention must be made of the nuclei observed in the three animals so far investigated. In all three the nuclei present a rather grossly granular appearance, and the large granular bodies are composite and react positively to the Feulgen stain. The whole of the space between the granules is filled with very small particles about 100 A. in diameter (Fig. 16). In view of the known difficulties of fixation of Protozoa, the possibility of nuclear artefact cannot by any means be excluded. The recent X-ray diffraction evidence for the long filamentous helical structure of nucleic acid (DNA) in certain intact nuclei makes it all the more necessary to study methods of nuclear fixation with extreme care; and it may be suggested that such methods should be based rather on the expected physical behaviour of polyelectrolytes under defined conditions than on earlier traditions of cytology.

I am indebted to the Botanical School, Cambridge, for the provision of specimens of *Spirostomum* from its collection, and to Dr. J. A. Kitching, of the University of Bristol, for the provision of *Carchesium* and *Stentor*. Dr. Kitching and Dr. Muriel Robertson have been most helpful in initiating me into this field and in the discussion of results. I wish to acknowledge valuable discussion with Prof. E. Fauré-Fremiet, who has simultaneously been investigating similar problems, and with Dr. Jean Hanson of this Laboratory.

It is a pleasure to record the invaluable help of Miss S. Fitton Jackson at all stages of the work.

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OBITUARIES

Prof. A. J. Kluyver, For.Mem.R.S.

During the night of May 13–14, 1956, Albert Jan Kluyver, professor of microbiology at the Technological University of Delft, Holland, suddenly died at his home of a heart attack, at the age of nearly sixty-eight years. The news of his death will deeply affect all who have known him, because they realize that it signifies the loss of a universally beloved personality and great scientist.

For almost thirty-five years he directed the work at his Institute in a manner that has made the Delft laboratory famous throughout the world as a centre of microbiological research. Under the leadership of M. W. Beijerinck from 1895 until 1921, it had already acquired an enviable reputation; and at the time of his succession to the chair, Kluyver was keenly aware of this and hence also of his great responsibilities, especially in view of the very limited training in microbiology he had received. But he possessed an excellent and highly perceptive mind, and an unrivalled capacity for work. By strenuous and undeviating application he rápidly succeeded in mastering the field, and in a few years he was ready to start developing a programme of his own that has resulted in some of the most far-reaching advances in biochemistry.

His chemical background inclined him from the start to a study of the biochemical activities of micro-organisms. Convinced by an early exhaustive review of the literature on this subject that the existing information did not reach much beyond providing a confusing picture of an almost endless variety of patterns, he began to look for unifying principles. How successful this search has been must be obvious to everyone who is conversant with the fundamental features of present-day biochemistry, which rests squarely on the concepts of the 'unity in biochemistry', and of 'comparative biochemistry' that Kluyver developed in the course of a very short time. These concepts have exerted a fertilizing influence on biochemical progress fully comparable to that which followed the introduction of the comparative anatomical and embryological approach into general biology. The foundation, inception and elaboration of these principles have been brilliantly presented by Kluyver in the series of lectures that he delivered in 1930 before the University of London, published in 1931 by the University of London Press under the title "The Chemical Activities of Micro-Organisms", and in the first two of the John M. Prather Lectures given in 1954 at Harvard University, and recently also published in book form ("The Microbe's Contribution to Biology", Harvard University Press, 1956). It is not too much to say that Kluyver's contributions have been instrumental in establishing the biochemical foundation for Darwin's concept of the monophyletic origin of living beings.

The recognition of the fundamental unity underlying the biochemical activities of extant living organisms should be attributed not only to Kluyver's philosophically inclined mind; equally significant for this development was his profound knowledge of the vast variety of microbes and his perception of their great biochemical potentialities. The possibility of using a particular bacterium, yeast or mould for the investigation of some specific biochemical process has been ably exploited in many studies carried out in his institute. During the first decade of his career as a microbiologist, Kluyver often expressed surprise and regret that this notion was not more prevalent, in spite of his ardent advocacy of its advantages in lectures and publications; he was too enthusiastic to be content with that form of mental inertia that impedes the speedy diffusion of novel ideas. But gradually his admonitions, supported by striking examples of fruitful applications, have had their effect, and developments during the past fifteen years have amply justified the high expectations he had for this type of approach, which has finally been used on a rapidly increasing scale. A consequence of this has been that general microbiology has come into its own as an important branch of biological science, and the reputation of the Delft laboratory has certainly not suffered from Beijerinck's retirement. In fact, the "Delft School" that has so strongly stimulated the rise of general microbiology is a term that properly refers to the period of Kluyver's leadership (see, for example, *Bact. Rev.*, **13**, 161; 1949).

It is, however, not merely the scientific output that has made his laboratory one of the most sought-after institutions, to which microbiologists from all over the world have come to learn from the master. It has been the experience of all who have worked there that he contributed far more than his vast factual knowledge and the penetrating insight of a fine scientific mind. For they have also been exposed to a noble personality who had a deep understanding of human behaviour and a profound appreciation of the meaning of individuality. His whole demeanour was an inspiring example of a life radiating encouragement, tolerance and compassion. This attitude compelled much more than respect, and created in his institute a warm and conspicuous atmosphere of enthusiastic, generous and effective co-operation, of love for work, and of personal responsibility.

The same characteristics also made Kluyver a highly valued adviser, and his services were more and more frequently solicited on important national and international committees, where his wisdom usually led to finding genuine conciliatory solutions rather than compromises for difficult problems.

His outstanding significance as a scientist has been widely recognized. Only five years after his appointment to the Delft chair he was elected to membership in the Netherlands' Koninklijke Akademie van Wetenschappen; during 1947–52 he served as president of its section for natural sciences. He was also a member of many foreign scientific societies; his election as foreign associate of the U.S. National Academy of Sciences, as foreign honorary member of the American Academy of Arts and Sciences, and as foreign member of the Royal Society may be specifically mentioned. Microbiological societies, such as the British Society for General Microbiology and the Society of American Bacteriologists, were proud to count him among their honorary members. A recipient of several honorary degrees and other marks of distinction, he was perhaps most deeply touched when he was awarded the Copley Medal by the Royal Society.

Now his active and productive life has come to an end. Nevertheless, his contributions to science and society will continue through the work of his numerous pupils in various parts of the world. They will be aware of the great obligations which their association with A. J. Kluyver has engendered, and which implies the desire to perpetuate his way of life, to the benefit of humanity.

C. B. VAN NIEL

Prof. J. M. D. Olmsted

JAMES MONTROSE DUNCAN OLMSTED was born of New England forbears at Lake City, Iowa, on May 21, 1886, and died at Berkeley, California, on May 26 just after his seventy-first birthday. Olmsted received an A.B. degree from Middlebury College (Vermont) in 1907 and four years later a B.A. from Oxford, where he was a Rhodes Scholar. He returned to the United States in 1911, served as professor of natural science at Shorter College, Rome, Virginia, and in 1912 became associate professor (later professor) of biology at Richmond College, also situated in Virginia, where he remained until 1915. During 1916–17 he held an Austin teaching fellowship (zoology) at Harvard, but he spent most of this period as a private in the U.S. Army, being demobilized in 1919 as a second lieutenant in the Sanitary Corps. After the War, J. J. R. Macleod made him assistant professor of physiology (later associate professor) in the University of Toronto. He remained there until 1927,