

greatly enlarged as a deeply staining block adhering to the nucleus behind it, while the distal centriole becomes a ring and is drawn out along the flagellum as a long pessary-shaped structure extending over a considerable length of the tail filament. No granular centrioles are found in the adult spermatozoon of any Urodele.

The 'Middle piece'.—The term 'middle piece' is used to designate any region, however different in structure, provided it is immediately posterior to the nucleus. This is more clear in Amphibia than in any other group, for the 'middle piece' is different in the three orders of Amphibia. In the Anura, the centrioles are, as has been observed, behind the nucleus and the mitochondria invest the base of the axial filament as a sheath. The mitochondrial sheath with the two centrioles is called the 'middle piece'. In *Hyla* (Retzius, 1906), the centrioles are separated by a short space and this space with the mitochondrial aggregation is called the 'middle piece'. In the Apoda, since both the centrioles are more closely associated with the nucleus than in the Anura, the 'middle piece' is purely a mitochondrial aggregation behind the nucleus. In the Urodela on the other hand, the conditions are quite different. There are generally no mitochondria in the adult urodele sperm and the term 'middle piece' is, therefore, applied to the conspicuously large proximal centriole which is just behind the nucleus (Fig. 1 A). So, while the term 'middle piece' is applied to the mitochondrial aggregation in the Anuran and Apodan sperms, it is the proximal centriole itself that is termed 'middle piece' in the urodele sperm.

The mitochondria in the 'middle piece' of the Apodan sperm (presumably also in the Anuran) occur inside a cylindrical transparent tube fitted to the posterior end of the nucleus. The origin of this tubular sheath I have been able to trace in *Ichthyophis* (1943a). Around the posterior end, and at the sides of the transforming spermatid nucleus there appears a space which is gradually pushed backwards and becomes the tubular sheath in which mitochondria aggre-

gate and arrange themselves in a spiral fashion around the axial filament. The presence of three different structures in the 'middle piece' of the Apodan sperm has to be recognised: (1) The axial filament which arises in relation with one of the centrioles, (2) the mitochondrial aggregation which is a spiral investment around the base of the axial filament, and (3) the transparent tubular sheath which holds the mitochondria in place. While the earlier workers had described the first two of these, the presence of the third has not been explained so far.

From the foregoing account of the spermatozoa of the three groups of Amphibia, it is clear that they fall under three entirely different categories. Of these, the Anuran sperm is the simplest. The Apodan sperm resembles it greatly, especially in the close association of the two centrioles with the nucleus as well as in the mitochondrial 'middle piece'. The Urodelan sperm on the other hand, in the great enlargement of the proximal centriole to form a solid body and the curious elongation of the distal centriole to form an accessory structure running along the tail filament, provides a condition unique in the animal kingdom.

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OBITUARY

SIR EDWIN BUTLER, C.M.G., C.I.E., F.R.S.

AS it must to all living beings, death came to Sir Edwin Butler on April 4, 1943, following an attack of influenza. That he was ill was known for some time but no one had realised that his end was so near.

Edwin John Butler was born on August 13, 1874, in Co. Clare, Ireland and received his early education at the Queen's College, Cork. He took the Bachelor's degree in medicine from the Royal University, Ireland, in 1898, but having come under the influence of Professor M. M. Hartog at the Queen's College, he preferred the study of fungi to the practice of medicine. That aquatic Phycomycetes should

attract him in Hartog's laboratory is natural and obtaining a travelling fellowship in 1899, he spent two years on the continent where the study of fungi had made great strides. He studied under Cornu and van Tieghem at Paris and Poirault at Antibes and spent some time at Freiburg where a few decades previously de Bary studied and taught mycology and attracted students from all over Europe.

In 1901 Butler was appointed Cryptogamic Botanist to the Government of India with headquarters at the Royal Botanic Gardens, Calcutta. In India fungi had been collected by Koenig, a student of Linnaeus and the first

Indian fungus was named by Linnaeus himself, *Lycoperdon pistillare* [= *Podaron pistillaris* (L.) Fr.]. Other collections had also been made and named but a study of fungi did not begin in India until after D. D. Cunningham's arrival in 1869.

Cunningham, an Indian Army Medical Officer, came to India to discover the cause of Cholera and other tropical diseases and later became Professor of Physiology at the Calcutta Medical College. He had received training in mycology under Berkeley, Hallier and de Bary and his interest in fungi was thus natural. It was his practice, therefore, to deal with all enquiries regarding fungi received at the Royal Botanic Gardens at Calcutta from all parts of



India. At about the same time, between 1885-1892 to be precise, A. Barclay was conducting at Simla very critical experiments on the life-histories of rusts. The work done by Cunningham and Barclay must have been so effective that Government evidently realised the need for the services of a whole-time Cryptogamic Botanist which led to Butler's appointment. In 1902 Butler was transferred to Dehra Dun and in 1905 to the newly started Agricultural Research Institute at Pusa with the designation of Imperial Mycologist.

In India the years 1901 to 1921 must have been of great activity. Fungi, both those occurring on wild and crop plants had to be collected, studied and identified; a mycological laboratory had to be established, a herbarium

started and contacts made with mycologists abroad for obtaining literature and specimens. Pressing problems in plant diseases needed immediate attention and countless enquiries had also to be attended to but above all students had to be trained to man the different provincial agricultural departments.

To these tasks Butler set himself with zest and vigour. The work started in Europe on aquatic Phycomycetes was completed, four species of *Pythium*, five of *Pleolpidium* and two of *Nowakoskiella* being established. The classical studies on the diseases of palms and sugarcane, on wilt of pigeon peas, on wheat rusts, on the downy mildews, etc., were commenced and carried out with thoroughness and the papers written on them will ever remain models of clear thinking, lucidity and scholarship. Collections made in different parts of India were all carefully studied and named, resulting in five papers on Indian fungi in collaboration with Sydow. One genus of rusts, *Cystopsora* and another of water moulds, *Allomyces*, were established, the latter of which has yielded the most interesting life-history among the Oomycetes. Nearly one hundred and fifty species stand to Butler's credit, some of them with Sydow.

In 1910 Butler started collecting material for a book on Indian plant diseases, *Fungi and Disease in Plants*, published in 1918, being the result. This book which is now unobtainable, will, in spite of any number of new books, ever remain the reference text in India. In 1931 he published, with G. R. Bisby, the *Fungi of India*.

Butler finally left India in 1921 to take up the Directorship of the newly established Imperial Bureau of Mycology, now Imperial Mycological Institute, at Kew. Here he became a figure not only of Empire but of international repute. He founded the *Review of Applied Mycology*, a journal indispensable in all institutions where mycological problems, be they agricultural, medical or industrial, have to be dealt with. In 1926 he was elected to the fellowship of the Royal Society and to its Council in 1934. He was the Chairman of the mycological section of the International Congress of Plant Science held at Ithaca in 1926 and gave, in 1939, the Lowell lectures at Harvard, from where had lectured such eminent men as Farlow, Thaxter and Blakeslee.

Indian mycologists will always speak of him in terms of gratitude for the fillip he gave to the study of fungi, for founding a fine herbarium and for the exhaustive research he did on the plant diseases of India. His knowledge of Mycology and Pathology was encyclopædic and in him the two sciences represented a happy mean.

He was made a C.I.E. in 1912 and C.M.G. in 1931 and was Knighted in 1939. He leaves behind Lady Butler, one son and two daughters.

B. B. MUNDKUR.