THE

STRUCTURE

OF

CILIA AND TRICHOCYSTS

by

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Introduction

The determination of the structure of fibrous proteins presents a series of problems the solution of which requires the resources of many branches of science. Present knowledge of such important proteins as the contractile fibrils of muscle owes much to X-ray diffraction and electron microscope techniques.

Bacterial flagella have been shown to possess a molecular structure similar to that of muscle and the other k-m-e-f fibrous proteins (Astbury 1951). Cilia, flagella and sperm tails, the thread-like projections from certain cells of plants and animals, appear in some ways to resemble bacterial flagella, and their contractile properties and general size and shape suggest that they might represent one stage farther in complexity from bacterial flagella to vertebrate muscle.

Trichocysts are small spindle-shaped bodies lying beneath the pellicle of protozoa such as Paramecium; their function is not entirely understood. The trichocysts are discharged under certain conditions, and the greatly elongated shafts are seen, in the electron microscope, to consist of an interesting fibrous protein, in some ways resembling collagen (Jakus 1945).

Although the molecular structure of cilia and
trichocysts is of fundamental importance, the microanatomy of such small organelles is, in itself, of great interest.

In this thesis the use of the term 'flagella' will be restricted to organelles which occur singly or in pairs, whereas the term 'cilia' will be applied to the organelles when occurring in large groups. If attached to single cells (or small groups of cells) the organelles, by their beating, provide a mechanism for the propulsion of the cell, but if attached to large masses of tissue they circulate streams of fluid near the cell surfaces. The functions of cilia are diverse. For example, in lower animals such as Paramaecium, ciliary currents serve to guide and propel the animal through the water, as well as to direct food to its mouth. The cilia on the epithelial cells of the trachea of the rat and higher animals propel mucus over the surface, whilst those on the ctenidia of the mussel serve to maintain water currents carrying supplies of respiratory gases and food materials.

A detailed examination of the cilia occurring on the ctenidia of an Australian fresh water mussel, Hyridella australis (Lam.), was undertaken. The distribution of the three groups of cilia, the frontal, latero-frontal, and lateral cilia, is similar to that in other species (Hiscock 1952) described in textbooks. Large numbers of these cilia
were examined in the electron microscope, both after simple
drying down on to collodion films ('whole' cilia) and after
sectioning. Further experiments on these cilia were
designed to compare the properties of the ciliary fibrils
with those of such proteins as actomyosin, keratin, and
collagen. The susceptibility of the cilia to digestion by
certain enzymes, the effect of heat on the cilia, and their
solubility in some acids and alkalis, in potassium chloride
solutions and in urea solutions, were examined. The
possibility of preparing bulk quantities of cilia for X-ray
diffraction experiments was investigated.

Observations were also made on whole and sectioned
cilia and trichocysts from the protozoan Paramecium. The
cilia covering the surface of Paramecium are of uniform size
except at the posterior end of the organism, while various
groups of cilia line the oral groove and cytopyneynx.
Investigations on the trichocysts were included because these
could be carried out at the same time.

Whole cilia from the rat trachea were examined in
the electron microscope.