A preliminary explanation of the links between biology and the visual arts made possible by microscopy.

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For many years I have maintained that staff and students in Schools of Art have "missed out" in gaining experience of things microscopic. In an attempt to redress the situation I offered my services as part technical college and school of art liaison, and from time to time this invitation was accepted.

The aim of this article is to touch on some aspects of biology and its associated technology which teachers of art and design might find useful. It is not meant to be an authoritative review of history of the modern scene, merely one scientist's personal view which developed from his involvement in technical education.

The 17th Century is a convenient starting point, as it was in this period that the optical microscope began–

> ..... to help our Blindnesse so as to device
> a pair of new and Artificial eyes
> By whose augmenting power we now see more
> then all the world Has ever doun Before.' (Henry Powers 1664)

The early microscopists did in fact draw or describe very precisely what they saw, and Robert Hooke in *Micrographia* (1665) drew cells of cork using his undoubted skill as an artist – just one facet of this remarkable man of science. In Holland in 1676 Antony van Leeuwnhoek a Dutch draper, first saw his "little animalcules" – bacteria – and wrote chatty letters to the Royal Society; in Italy Marcello Malpighi investigated the anatomy and embryology of plants and animals. Nehemiah Grew, an English doctor, published an extensively illustrated volume summarizing his detailed studies of plant anatomy (1672). A few of the books which might well be included in the libraries of Schools of Art (if they are not already there), which cover developments during the 18th and 19th Centuries, are given at the end of this review of the subject.

Over the last 25 years the technology of electron microscopy has produced images of up to one million times magnification compared with the maximum satisfactory resolution of about one thousand times for the best optical instruments. Of interest to those for whom shape and texture have appeal are photographs taken of objects under the Scanning Electron Microscope. Much of the credit for design goes to the Cambridge Scientific Instrument Company who developed "Stereoscan" with which most published photographs have been taken. Perceptive and sensitive research workers were quick to realize how beautiful pollen grain and leaf surfaces could be at low magnifications, and how dramatic the wall thickening of wood cells could be at its upper limit of resolution – 4300 x. Naming individuals in this article would not mean a lot to non-scientists but Patrick Echlin is coming to Norwich from Cambridge in September to talk about the

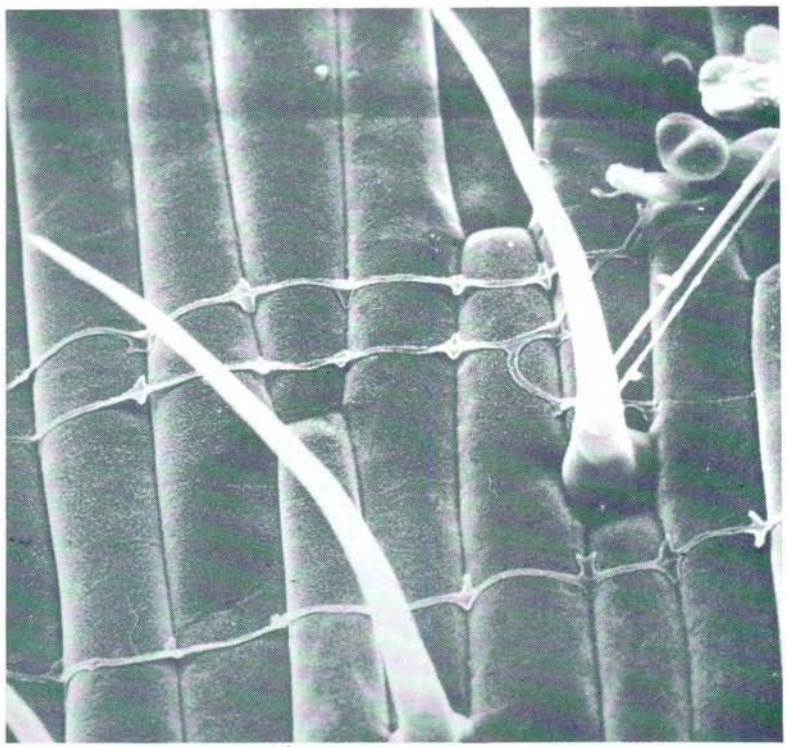

Fig. 1

sculpture of pollen grains and will review his early work with the Scanning Electron Microscope. Jeff Day will also contribute to the planned symposium and talk about fungal invasion of leaves – work which he did in his post-graduate research at the University of East Anglia. Fig. 1 shows the tube like hypha of an invading fungus growing at right angles to the long dimension of cells of the surface of a wheat leaf. Such growth, the statisticians tell us, results in its reaching and "recognising" a stomatal pore through which it will enter its host and digest the cells of the interior. Emergence of spore-producing structures have an almost "Dr. Who" quality; perhaps the graphic designers have been doing their home-work! Glands on the surface of insectivorous plants (Fig. 2) look like 18th Century follies, and the hairs on a Geranium leaf (Fig. 3) give the impression of anti-tank defences – a fair analogy on a different dimensional scale for those of Leonardo's tanks!

Engravings made in 1861 by the Tulasne brothers in Paris (Fig. 4) showed the nature of the fungus which Pasteur was later able to show was the cause of the disease of vines. Often overtones of emotion creep into what are superbly accurate illustrations of the stages in the life-cycle of the organism. This was the beginning of what was later to become the branch of applied biology termed plant pathology. Modern agriculture,

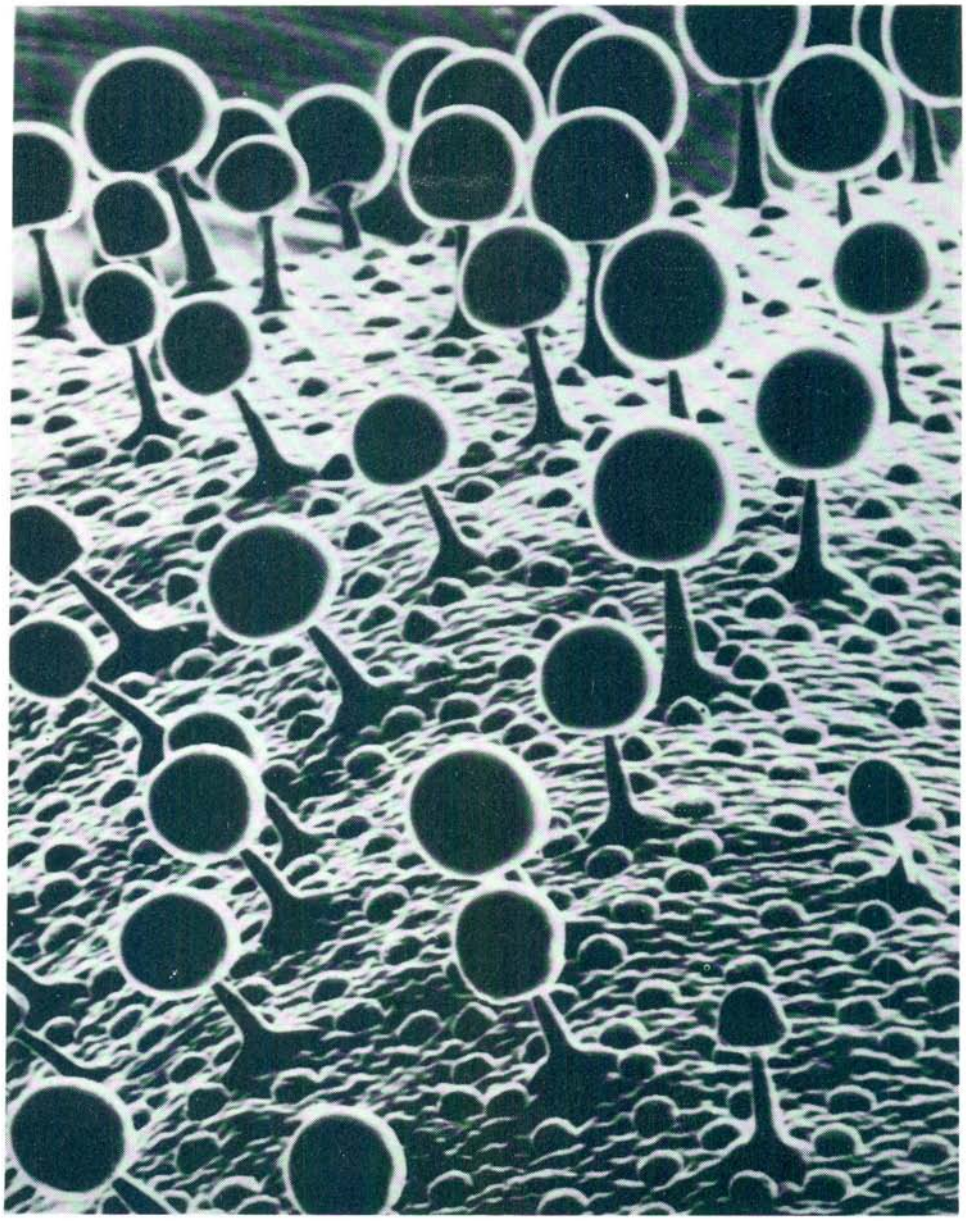

Fig. 2

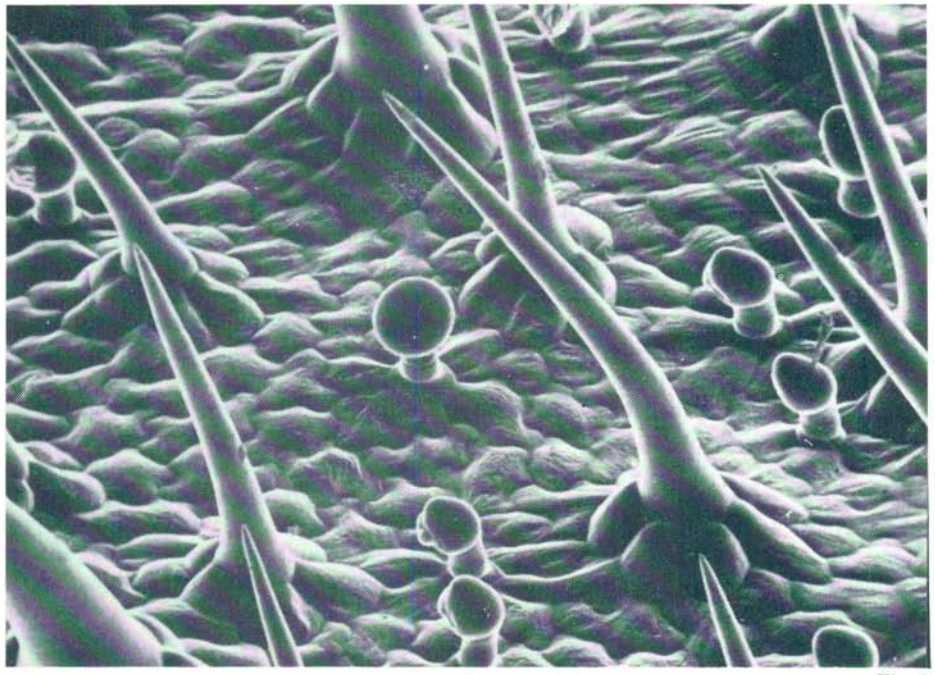

Fig. 3

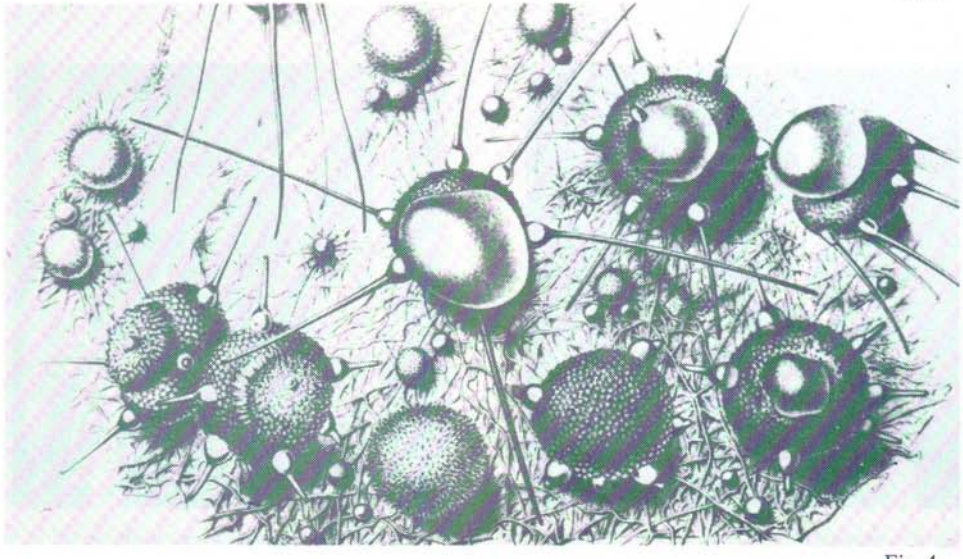

Fig. 4

horticulture and forestry have greatly benefited from work in this field carried on in universities and research institutes. Four members of staff of the New Zealand Department of Scientific and Industrial Research last year published two books devoted to Scanning Electron Microscopy, published in this country by Chapman and Hall. They are *Probing Plant Structure* – Troughton and Donaldson, and *The Three-dimensional Structure of Wood.* To my mind they should be set books for students of sculpture, and architects too. (Fig. 5)

It was my own encounters with research material, mainly in connection with Dutch Elm Disease, that led me to suggest to the East Anglian Branch of the Institute of Biology that a Symposium entitled "Biology and Visual Arts" might be worth-while. Support has been encouraging and it is to be held in Norwich on 14th-16th September of this year.

Was it not the architecture of Denys Lasdun's Aztec-style student residences for the University of East Anglia which formed the back-cloth to Lord Clark's last programme in his 'Civilization' series? On the rising ground on the other side of the River Yare are congregated a number of Research Institutes. These include the John Innes, Food Research, and British Sugar Corporation, and the Coastal Ecology Unit of the Nature Conservancy. The professional scientists collectively form what biolgists might call a "gene pool" of biological expertise, and the work they do is internationally recognised. A relatively large number of Fellows of the Royal Society and electron microscopes occupy a square mile of East Anglia – and the odd Nobel prize-winner too! It is in this centre of biological research that some of the meetings will be held. Others will be based in the centre of the City of Norwich where residential facilities will be offered at reasonable cost.

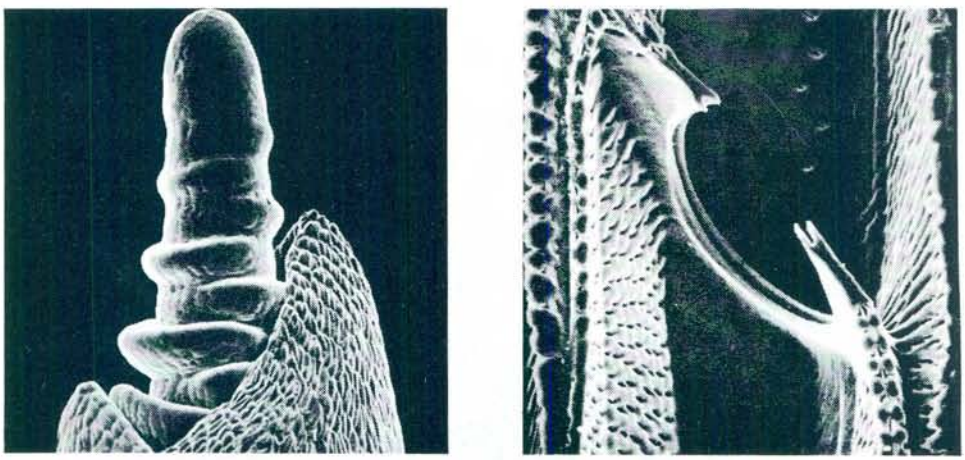

Fig. 5. Cover illustrations from *Probing Plant Structure* and *The Three-dimensional structure of Wood.* Reproduced by courtesy of Chapman and Hall Ltd.

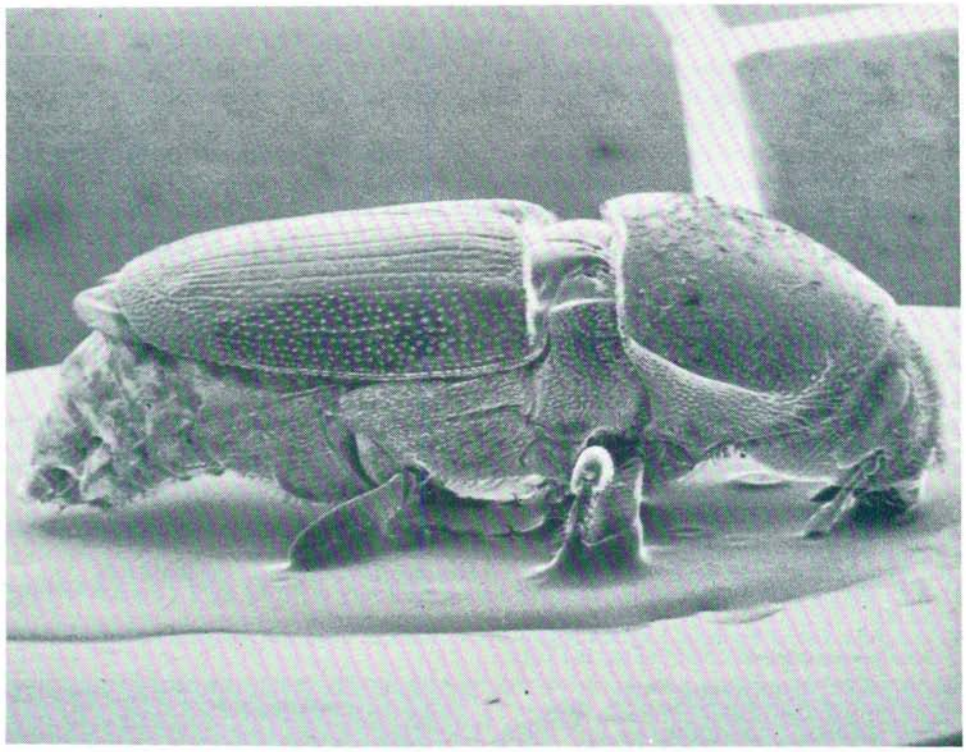

Fig. 6

The Programme is already complete and the School of Art has designed a broadsheet which includes scanning electron micrographs of the glandular hairs of butterwort – part of the research work of the wife of Professor Heslop-Harrison, Director of the Royal Botanic Garden at Kew. Speakers will include David Bellamy who has done much to rekindle an enthusiasm in botany with late night television viewers, and Professor Robert Horne who will compare the architecture of viruses with buildings of man's creation. In the Year of the Tree, Dr. Norman Hicken has agreed to demonstrate his technique of scraper-board drawing which he has used in his books on forest biology. An artist as well as a professional scientists, he has written many technical books on the protection of timber from insect pests. Students of the Graphic Design section of the School of Art, where the Saturday meetings will be held are at present involved in preparing an exhibit showing the life-sycle of the fungus causing Dutch Elm Disease and the beetle which spreads it. (Fig. 6)

Form and function usually march together in biological material. Structures not adapted to the life of the organism are usually lost or atrophy in evolution. There are many structures, like the sensory hairs in the back of the Scolytus beetle (Fig. 7), which give us pleasure to look at, and it will be up to a new generation of biologists to reflect on their functional significance.

We hope that given opportunity to meet, eat and drink in congenial surroundings that research workers, practising artists and writers will find enough in common to make this enterprise interesting and rewarding to themselves and those of us who look and listen.

1. Quoted from S. Bradbury *The Microscope Past and Present* 1968 Pergamon International.
2. Robert Hooke *Micrographia* 1665 Dover book facsimile 1970.
3. Dobell Antony van Leeuwenhoek and His "Little Animals"
4. A.E.E. MacKenzie *The Major Achievements of Science* Cambridge C.U.P. 1960, Chapter 6 Vol 1 pp. 69–78, Chapter 6 Vol 2 pp. 36–42 extracts from Micrographia and Leewenhoek's letters.
5. G. Rattray Taylor *The Science of Life* (very readable review of history of biology – illustrated) Thames and Hudson 1963.
6. Albert Bettex *The Discovery of Nature* Thames and Hudson 1965.
7. Gabriel & Fogel (Editors) *Great Experiments in Biology* Prentice-Hall 1955. Reprints of original papers and summaries of advances in particular topics. Cell Biology 1–22, Microbiology 105–140.
8. E.C. Large *The Advance of the Fungi* Jonathan Cape 1940, compulsive reading – a history of plant pathology, Potato murrain the Irish famine; Oidium on the vines; wheat rust; Louise Pasteur..... development of fungicides.
9. L.R. & C. Tulasne *Selecta Fungorum Carpologia* 3 vols in folio. English trans. Grove ed. Buller and Shear Clarendon Oxford 1931.
10. J. Troughton & Lesley Donaldson *Probing Plant Structure* 1972 Chapman and Hall £1.75.
11. B.A. Meylan & B.G. Butterfield *Three-dimensional Structure of Wood* 1972 Chapman and Hall £2.00;
12. P. Echlin, Use of Scanning Electron Microscope in study of plant and microbial material *J. Royal Microscopical Soc 88* 1968 Vol 88, 407–418.

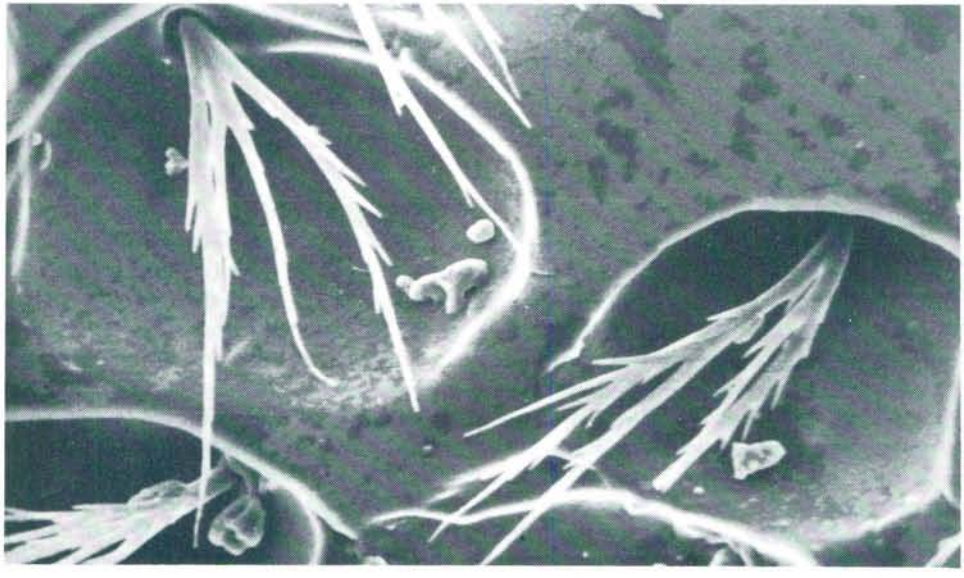

Fig. 7