Vasculum to electron microscope

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In the mid-nineteenth century, the amateur naturalist and botanist was important. Botanical expeditions, often arranged by local botanical societies, made major scientific contributions to the study of plants and their distribution. They had social as well as scientific value. A curiously significant part of the equipment was the vasculum¹, a tin box carried on a shoulder strap and used for collecting plant specimens that were subsequently identified and annotated, often with great artistry. The vasculum also doubled as a convenient lunch-box.

The importance of the amateur botanist has decreased over the years, but the continuing involvement of the amateur in compiling local floras is significant. Nowadays, scientific plant collecting is often only part of a more highly organized and complicated professional enterprise.

In the fifty years after the founding of the British Association, microscopes in Britain reached a peak of perfection with the introduction of the compound microscope with fully corrected lenses. Cheap microscopes became readily available and came to be regarded as desirable curiosities. However, little progress was made beyond the initial observations made earlier with the simple microscope². Further development of the microscope became centred in Germany, and great advances in the knowledge of plant (and animal) structure as seen in the light microscope took place in a few German universities in the second half of the nineteenth century. The idea was developed that form and function could be correlated; there was also a tradition for teams of scientists to work together in Germany. The resulting encyclopaedic volumes written by Haberlandt³ and others in the 1890s still represent a fount of eminently useful knowledge. The conventional light microscope reached its limits by 1900, by which time the nucleus, mitochondria, chloroplasts and chromosomes had all been recognized as had the behaviour if not the significance of the chromosomes in mitosis and meiosis.

Observations on living material are limited by the degree of contrast. The advent of chemical dyes made the staining of tissues possible. The development of the Mendelian hypothesis and the theory of genes led to a search with stained material for the carriers of the genes and their identification as the chromosomes. The introduction of the fluorescence microscope^{2,4} has allowed other organelles to be identified and characterized. The phase contrast microscope when properly set up allows examination of living material. However, the light microscope is limited by the wavelength of light. Within the past 40 years this limitation has been overcome by the development of the

transmission electron microscope, which uses a beam of electrons at 50–100k V (refs 2,4).

The use of the electron microscope as a tool in biology depended on new methods of fixing tissue, the selection of suitable heavy metal stains to give adequate contrast and the development of embedding materials and of knives capable of cutting ultra-thin sections. The internal fine structure of many of the organelles previously recognized by light microscopy has been revealed and the nature of their membrane systems made clear. Microtubules and previously unknown membranes and other structures have also been identified. The scanning electron microscope is of particular importance in the investigation of surfaces and, of taxonomic significance, "large" objects like pollen grains. The development of the transmission electron microscope to extremely high voltage (1,000kV) offers a new technique for the examination of "thick" sections (1–5 μm) which, when observed as stereoscopic pairs, can give a magnificent indication of the three-dimensional distribution of organelles.

Developments in plant physiology have also depended on the availability and application of new techniques, as illustrated by studies of photosynthesis. Before 1831, the basic features of this fundamental process had been established by the work of Priestley, Ingen-Housz, Senebier and others. There then followed a long hiatus until the application of interrupted light sources by Blackman shortly after 1900 allowed the identification of light and dark reactions and set the scene for the further analysis. Biochemical work established the

evolution of oxygen by isolated chloroplasts (the Hill reaction), the path of carbon (the Calvin cycle — which depended on the availability of $^{14}\text{CO}_2$), the features of photosynthetic phosphorylation (in Arnon's laboratory) and the existence of two light reactions. Current work is largely concerned with control mechanisms in photosynthesis, much of it of physiological importance to agricultural productivity.

Darwin's voyage on the *Beagle* in 1831, the implications of which are still causing reverberations in the literature, was in the tradition of the earlier explorers such as von Humboldt, who were mainly concerned with describing the marvellous new species, plant and animal, to be found in lower latitudes. The monumental work of Schimper⁵, based on observations of many expeditions made in the nineteenth century, correlated the distribution of plants with the habitats in which they are found and stimulated interest in more localized plant distribution within the temperate zone. In the early 1930s, Clements in the United States and, later, Tansley in Britain were among the earliest proponents of the new science of ecology.

With increased awareness of the interdependence of plants and animals and their habitats there has been an increase in public concern about species conservation and the dangers of pollution. It is these aspects of botany which for today's amateur seem to have replaced the Victorian preoccupation with collecting. □

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Sociology — another 150 years?

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SOCIOLOGY springs from the wish to do something about the dreadful state of the social world — even if only to understand it. Its special characteristic is the hope of rooting whatever it does in knowledge sufficiently cogent, disciplined and objective to pass as science. What distinguishes sociologists from other socially-concerned citizens is the attempt to achieve some demonstration of the science-like nature of their statements about the social world. Unfortunately, that distinction does not save them, as it saves those who wish to make science-like statements about microbes, or planets or fish, from also being part-and-parcel of their own object of study. The problem for sociology is not that of being a science like other sciences but of being a science *appropriate* to the peculiar nature of the social and of sociology's own place in it.

As it happens, 1831 was quite a significant year for sociology; the problem of the relationship between social knowledge and social action was first clearly seen as a problem and defined, albeit mistakenly, as a problem of science. The reasoned analysis of carefully gathered and ordered empirical evidence about society was already widely practised. Such work was something that might be expected of anyone who wanted to contribute seriously to the discussion of matters of state or the condition of society. There was in the 1820s a certain unity of inquiry, analysis and government. By 1831, however, as politics became more open, pluralistic and contested it was a crumbling unity. Social inquiry and analysis came to be seen as controversial and problematic; their relationship to government, and to purposive social action in general, could no