they appear simply as "black boxes".

It is in this aspect that the doubts raised by Meixner about the usefulness of "entropy" as a function to characterize macroscopic non-equilibrium systems arise. His conclusion is quite unequivocal: "Unsere Behauptung ist nun, dass die Definition einer eindeutigen Entropie für Vorgänge nicht nur bisher nicht geschehen sondern sogar unmöglich ist, falls man nur makrophysikalische Überlegungen zulässt, d.h. die Existenz der atomistischen Struktur der Materie ignoriert." ("Our assertion is thus, that the definition of an unambiguous entropy for (non-equilibrium) processes not only has not so far been achieved but is actually impossible, so long as only macroscopic considerations are admitted, i.e. the existence of an atomic structure of matter is ignored.") (*Rheologica Acta*, **7**, 8; 1968.)

Although such a conclusion is strongly suggested by statistical mechanics Meixner's conviction is based on the disarmingly simple observation that a two-terminal resistive network can be reproduced—so far as its input-output characteristics are concerned—by an infinite variety of equivalent "black boxes" containing inductances and capacities. Because these can never be distinguished without some process of opening the boxes and examining their internal structure, neither can the irreversible (resistive) dissipitation of energy be properly separated from the reversible (reactive) energy flow. By the same token the dissipative processes in thermodynamics cannot be unequivocally characterized, except at a sub-microscopic level, in fact only at the point where the continuum approach must give way to an atomistic statistical mechanics.

Thus macroscopic thermodynamics comes up against something like the information-theoretic barriers which are accepted, in somewhat better grace, by the users of black-box formulations in behavioural psychology and automata theory. Meixner has shown that the consequences of this are not irreparable and that an entropy-free thermodynamics may be constructed, at least for linear systems, using the passivity principle. It new seems reasonable to hope that the advances described by Katchalsky, Oster and Perelson may point the way to a similar development for non-linear thermodynamics before long.

Muscling In

MOTILITY, the ability to move, is one of that list of characteristics of living organisms which every schoolboy learns, or used to have to learn, by rote in his first biology lesson. Cells and other organisms exhibit movement at some stage or in some part during their life history and, perhaps not surprisingly, evidence is steadily accumulating which suggests that motility and contraction in many, indeed perhaps even in all biological systems, has a common molecular basis.

Striated skeletal muscle of animals is, of course, the classic, most accessible and most thoroughly analysed contractile apparatus of organisms. It now seems beyond dispute that muscular contraction depends on the interaction of polymers of two contractile proteins, actin and myosin, which are arranged in interdigitating arrays of filaments. At least, when a striated muscle contracts projections from the myosin filaments cyclically attach to, and detach from, adjacent actin filaments in such a way that transient actomyosin bridges pull the actin filaments into the myosin filaments with the net result that the muscle shortens.

Armed with the knowledge that actin and myosin comprise the basic contractile machinery of muscles, biologists have, naturally enough, repeatedly searched for either or both of these proteins in other tissues, cells and organelles which move. And as the techniques for extracting and characterizing proteins have improved actin-like and myosin-like proteins have, sure enough, been identified with increasing frequency and certainty in all sorts of situations.

A few weeks ago, for example, Fine and Bray reported in *Nature New Biology* (**234**, 115; 1971) that as much as about 20 per cent of the total protein in chick neurones is an actin-like protein, which may very well be identical to skeletal muscle actin. They also find actin or actin-like proteins in chick embryonic lens, lung, skin, heart, pancreas, kidney and brain tissue. And in this issue of *Nature* (see page 410) Gawadi reports the location of actin which has been observed in the mitotic spindle apparatus; he believes it occurs in filaments running parallel to the long axis of the spindle but not closely associated with the spindle microtubules. Behnke, Forer and Emmersen (see page 408) reach much the same conclusion about the distribution of actin or actin-like protein in the meiotic spindle of crane fly spermatids and they also report the presence of this muscle protein in crane fly sperm tails. Other workers have claimed to detect actin or myosin-like proteins in mitochondria, chloroplasts and cilia and, recently, Adelstein, Pollard and Kuehl (*Proc. US Nat. Acad. Sci.*, **68**, 2703; 1971) report isolating both actin and myosin-like proteins from thrombosthenin, the complex of contractile proteins in human blood platelets; these examples by no means exhaust the list.

It has to be admitted, of course, that more often than not the criteria for the identification of these two proteins in novel situations are not rigorous enough to satisfy completely the standards set by muscle biochemists. But where serious attempts have been made to compare skeletal muscle actin and actin-like proteins from other sources—the experiments of Fine and Bray are a case in point—few differences have been detected, although, as Fine and Bray themselves comment, nothing short of the total amino-acid sequences of actins from different sources can establish their complete identity or the extent of differences. That proviso notwithstanding, however, the sweeping generalization that actin and myosin-like proteins may universally provide the molecular basis of motility in biological systems becomes almost daily more attractive.

TAXONOMY

Postgraduate Course

FROM next October an MSc course in animal taxonomy will be organized by the Department of Zoology and Applied Taxonomy at Imperial College, London, in collaboration with its neighbour in South Kensington, the British Museum (Natural History). This will be the first postgraduate course devoted specifically to animal taxonomy; it will also be the first linkup between a British national museum and a university department to produce a postgraduate course in the biological sciences.