Commentary

Molecular endocrinology: a welcome extension to, but not a replacement for, endocrinology

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In any history of biology, the 1980s will surely be noted for the extremely rapid pervasion of the concepts and techniques of molecular biology into other fields. Endocrinology is one of those fields and we have new conferences and new journals (including our new sister journal) to reflect this burgeoning interest. The pervasiveness of molecular biology is not surprising since there is no doubt that this new discipline brings enormous heuristic power in science and applicability in technology: it allows the exploration of biological mechanisms in terms and with exactitudes undreamt of even a few years earlier; equally it holds the key to major advances in the manipulation of biological processes in medicine and agriculture as well as in the newer industrial processes labelled as biotechnology.

But there are dangers in the headlong rush. The explanatory reductionist approach, of which molecular biology is the newest example, has been extremely successful in elucidating biological mechanisms ("Reductive analysis is the most successful research strategy ever devised", Medawar & Medawar, 1984). The dangers are those that arise from the inherent imbalance between explanatory power and predictive power up the hierarchical levels of biological organization (i.e. molecules; macromolecules; organelles; cells; tissues; organs; organisms; populations; communities). Research at a lower level can provide mechanistic explanations of a phenomenon discovered at a higher level. But knowledge at a lower level can supply only a limited amount of information on phenomena at higher levels. In their already classics of the 1980s, Ernst Mayr in The Growth of Biological Thought (Mayr, 1982) and the Medawars in Aristotle to Zoos (Medawar & Medawar, 1984) gave apposite and splendid examples. I will attempt only one: one could not predict the role of diamonds in human reproduction from even the most extensive knowledge of the carbon atom.

In modern biological research, reminders of the truth of the imbalance between explanatory power and predictive power between the different levels in the hierarchy of biological organization often arise. For example, my research group has a major interest in the autocrine control of milk secretion, an interest that pre-dates the coining of the term autocrine. This control operates within an individual mammary gland to match, within limits, the rate of milk secretion to the rate of milk removal (see Peaker & Wilde, 1987). This research has been pursued at all levels of organization between that of the whole animal and the molecular, but to review it in the context of other autocrine control mechanisms that have been proposed we did a computerized literature search. Nearly all the references to autocrine control that emerged were from cell biologists who had detected biologically active substances in the medium from cell or tissue cultures. Lacking a role for these substances the authors simply suggested that they must be involved in autocrine control! Many other possibilities were ignored but since they were not seeking a mechanistic explanation of a known phenomenon they simply had a guess – and the latest passing bandwagon was as convenient a guess as any. Incidentally, we found that the number of cases in which autocrine control has been investigated properly and at the appropriate organization levels is very small.

There is a real concern that an overemphasis on molecular biology will denude research at the complex organizational levels at which new biological phenomena and integration of control are discovered. In physiology – and I use the term in the wide sense rather than as the narrow discipline it has become since successive new disciplines and groups like biochemists, endocrinologists, reproductive and cell biologists hived themselves off – the level of approach has moved away from the more complex levels even though new and important integrative mechanisms are still being discovered at the whole animal and whole organ levels. The conceptual and experimental move to these lower levels may be applauded as explanatory reductionism is used to explore known
phenomena but there is the danger that the virtual desertion of the higher levels will lead to intellectual stagnation and the loss of conceptual approaches and skills that have been developed over decades.

In evolutionary and ecological studies at the organismal level, discoveries are being made which not only have fundamental relevance at their own level but which also make predictions and expose ignorance of mechanisms at lower levels. Fascinating and important phenomena have been described in recent years which raise many questions in integration and signalling of interest to endocrinologists. For example, evidence has accumulated that the sex ratio at birth in some mammalian species and in some physiological circumstances is not 1 : 1 (see Clutton-Brock, 1985). While sociobiologists argue over the adaptive significance of this shift, questions of how, when and where are of obvious relevance to fundamental reproductive physiology as well as to applications in agriculture. Other examples of phenomena exposed by research at the organismal level are differential parental investment in male and female offspring (Anderson & Fedak, 1987, for example), unilateral control of function in paired organs and possible 'memory' of environmental effects in morphogenesis (see Trivers, 1985, pp. 355–357), adjustment of gestation period to synchronize the time of parturition in herd animals (Watson, 1969) and control of reproduction by social interactions (see Hearn, 1984). Unfortunately, the phenomena and concepts being discussed at these high organizational levels are often poorly known to those working in the rest of animal biology, including medical and agricultural research.

There is not simply a lack of communication between workers at the different levels, there is often an underlying lack of sympathy. It is a strange aspect of scientists’ behaviour that they condemn work at the levels of complexity above that at which they work as out-of-date and as mere natural history. Unfortunately, the divisions and intellectual isolation that lead to these attitudes appear to be increasing as universities reorganize their administrative and teaching structures for the biological sciences. The fashion is for organismal biology to be split from the rest of the biological sciences, while cell biology and molecular biology are being isolated at the other end of the scale. Thus the new disciplines are becoming horizontal divisions corresponding to the level of biological complexity. The older disciplines like zoology and physiology are becoming identified with a particular level rather than with the study of a broad spread of biological phenomena at all levels. It is already evident that many university departments in Europe and North America are producing biologists who cannot investigate biology other than at one level; biologists who cannot see the relevance of their work as part of a mechanistic reductionist approach to higher level phenomena.

Endocrinology has always been a broad church, drawing scientists and technologists into it from many different disciplines. It accommodated the new concepts and levels of approach as they were developed. It is coping with becoming the wider science of integrative slow signalling now that the endocrine system has come to be recognized as the first-to-be-discovered member of a wider set of physiological control mechanisms (see the commentary by Henderson, 1987). But it achieved its present position in an era when science was expanding. Now, with fixed or falling funding for biological research throughout the world, any expansion in one area leads to contraction in another. We must take care in the headlong rush to molecular endocrinology that we maintain the broad concept of endocrinology as a multi-level subject. In other words, we have to regard molecular biology as an extension of, and not a replacement for, existing disciplines. If we do not then eventually we shall learn less and not more of the natural world, why and how it works, how to nurture it and how, when necessary, to manipulate it.

REFERENCES


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*Journal of Endocrinology* (1989) 120, 361–362