Patterns of developing embryos

The most important discovery this year (so far) is the recognition that genes controlling pattern formation in Drosophila *have pieces in common with genes of unknown function in higher organisms.*

THE geometrical regularity of living things has always been a source of wonder, some of it frankly superstitious. The bilateral symmetry of leaves, the axial symmetry of many flowers and the complex geometrical regularity of insect eyes are among the common observations of the natural world which, over the centuries, have excited speculation about the nature of the invisible hand that guides the development of living things. At the turn of the century, D'Arcy Thompson (in *Growth and Form*) managed an evocative celebration of the symmetry of living things without falling into this trap. Since then, embryologists have sought in vain more objective explanations of the patterns on which living things develop. Now there is a sporting chance that the search is at an end.

The importance of the two articles appearing in this issue (pp.25 and 70) and of two just published in *Cell* is assessed overleaf by Dr Gary Struhl. What follows is meant as a plain man's incautious guide to what is certain to be a continuing source of high excitement in the months ahead, to judge both from the flood of articles now joining the queue for publication and the unmistakable inherent interest of those now published.

The new development is yet another vindication of *Drosophila* geneticists, their frequent whimsy notwithstanding. (The dominant mutation *Antennapedia*, from the Latin words for antenna and foot, gives a fruit fly a pair of legs instead of antennae, perhaps because some geneticist did not know how to decline *crux*.) The one chiefly responsible for the foundations of what has now been done is Edward B. Lewis of California Institute of Technology, who by six years ago had shown that some of the genes that control development in *Drosophila* are both functionally and physically a complex. Functionally, a mutation of one gene will lead directly to some abnormality but will also affect the expression of other genes in what appears to be a hierarchy. Physically, the genes are a complex in that they lie close together in chromosome 6 — more accurately, they lie in two clutches.

The classical analysis of the genes that control the development of *Drosophila* is nevertheless complicated enough (see E.B. Lewis, *Nature* **276**, 565; 1978), simple though the animal itself may be. *Drosophila* is built on the simplest principles. The larvae and the adults consist of twelve compartments — a head (at the front), three thoracic (chest) segments and ten abdominal segments. Each segment develops autonomously from the point in the development of the fertilized cell at which segmentation first becomes apparent. That the development is genetically controlled — not an obvious conclusion — is proved by the recognition that mutations of the development genes can make development abnormal.

Autonomous development in *Drosophila* is carried to extremes. Each of the twelve segments of a *Drosophila* larva carries inside itself a mass of tissue (called the imaginal disk) which is destined to become the corresponding segment of the adult fly at metamorphosis. Mutations of the development genes will be evident in the bizarre shape of the adult. So the destiny of the cells in each of the twelve compartments must be embodied in them almost from the outset.

How is this done? These days, the obvious way to find out is to learn more about the DNA of which the development genes are made. This time last year, the effort was well under way (see "Cloning the genes that specify the fruit fly", G. North, *Nature* **203**, 134; 1983). Now, that effort has borne fruit. There may be two views of the outcome: either it is sheer luck that what is true for *Drosophila* seems in some sense also to hold for other organisms, or this turn of events is another illustration of the principle of parsimonious natural evolution that if you come across a useful gene (histones and globin, for example), you stick with it.

Meanwhile, there is certain to be even further interest in *Drosophila* as people scour the animal for other regulatory genes (see box). It seems at this stage to be clear that the genes now identified are concerned with the specification of the form of the organism, not with the differentiation of different functions in different tissues. (Each segment of *Drosophila* generates its own nervous tissue, for example.) So the hunt for the genes that control differentiation will continue. So will that for an understanding of how the development genes function.

Others will inevitably be more concerned with the function of the genes marked by the distinctive piece in organisms other than *Drosophila*. Organisms which are not so neatly segmented as *Drosophila* are a greater challenge, but one that can now be taken up with the techniques that have been developed in *Drosophila*. In brief, embryologists have been unexpectedly given a tool that will make the exploration of development in other organisms much more tangible than in the past, both in the cataloguing of crucial events in the course of the development of embryos and in the specification of their timing.

The importance, practical as well as abstract, of these opportunities needs little justification, which provokes an ironic chain of speculation. In Britain, the Warnock committee is about to recommend to the British Department of Health rules for the use of early human embryos in research, with a time-limit (said to be 15 days from fertilization) for the duration of such work. Hitherto, embryologists have been hard-pressed to suggest what observations might usefully be carried out. That is no longer the case.

John Maddox

Aegean celebration

Kolymbari (Crete)

WALTER Gehring and Matthew Scott presented their groups' data on the "homoeobox" at a meeting last week at the Orthodox Academy here. The meeting, one of a biennial series of the European Molecular Biology Organization (EMBO) workshops on the genetics and biology of *Drosophila*, will be reported in more detail in forthcoming issues of *Nature*. It seems clear that there is an exciting time ahead for developmental biologists of all persuasions if indeed it turns out that the genetic control of development in vertebrates and fruit flies is similar, in principle if not in detail.

Gehring's group from Basel now has evidence for at least eleven copies of the "homoeobox" sequence in the genome of *Drosophila*, but the signs are that the final tally will turn out to be less than twenty. Struhl points out (overleaf) that some copies of the homoeobox fall outside the bithorax and Antennapedia complexes, but this observation is not discouraging. A number of speakers reported on some of the other genes concerned with regulating development on which the new powerful techniques applied to homoeotic genes are being unleashed. Of particular interest was the report of Kathryn Anderson (Tübingen) that a gene called *Toll* encodes a product that has a crucial role very early in development in establishing the dorsal-ventral polarity of the embryo.

Geoffrey North