Xoconostle-Cazares B, Xiang Y, Ruiz-Medrano R, Wang H, Monzer J, Yoo B, McFarland K C, Franceschi V R and Lucas W J 1999 Plant paralog to viral movement protein that potentiates transport of mRNA into the phloem; *Science* **283** 94–98

ABHILASHA GULATI
Department of Molecular Reproduction,
Development and Genetics,
Indian Institute of Science,
Bangalore 560 012, India.
(Email, abhi@serc.iisc.ernet.in)

Model organisms in biology: Scientific and other uses

A remarkable feature of modern biological research has been the use of several organisms as "model" systems. Starting with Mendel working with his garden peas, investigators have used a variety of organisms in their research, for instance *Zea mays*, *Drosophila melanogaster*, *Escherichia coli*, *Dictyostelium discoideum*, *Caenorhabditis elegans* and *Arabidopsis thaliana* (should we include in this list the house mouse which once had its tail cut off for 19 generations?). The areas of genetics and developmental biology have made spectacular progress thanks to the deployment of these convenient organisms.

In fact, from a historical view point one can trace the evolution of molecular genetics by studying the different research programmes to which an organism like *Drosophila* has been subjected at different points of time, i.e., all the way from the time of the transmission genetics of T H Morgan to contemporary research in molecular genetics and developmental biology. While it is well known that Morgan's work led to very important scientific results, it is interesting to note that his work had important philosophical consequences as well. The work that Morgan did enabled his conversion from being a skeptic regarding the material nature of the Mendelian genes to becoming a firm supporter of it. Prior to his own work with the fruit fly, Morgan along with Bateson tended to see material theories of inheritance as bordering on the ancient doctrine of preformation. Morgan also shared Bateson's idealism in thinking that there was no material basis for the existence of chromosomes in cell structure. But as Allen (1975, p 59) notes, this change in Morgan's attitude in the light of his own experience signalled '. . . the beginning of a far-reaching theory of the physical basis of inheritance'. As this example shows, "model" organisms contribute not only to our understanding of the biological complexity of life but also help in removing our metaphysical presuppositions concerning organic phenomena.

Lest it should be thought that too much is being said about one organism, recent historical research shows that other organisms have also played similar roles in biological research (de Chadarevian 1998; Bonner 1999). In a detailed study of the role played by the nematode worm *C. elegans* in our understanding of development, de Chadarevian shows how the organism was used by Sydney Brenner to move from molecular biology, which 'had become inevitable', to the study of problems 'which are new, mysterious and exciting' in the domain of development (p 82). As had happened in the case of *Drosophila*, *C. elegans* was chosen because it fulfilled all the requirements that Brenner had specified: short life cycle, easily cultivable, and small enough to be handled in large numbers. But as Bonner informs us, Brenner had earlier thought of using the slime mould *Dictyostelium* for his study but since it lacked a nervous system he chose the nematode instead.

De Chadarevian's paper offers a number of historical and philosophical insights regarding the use of this organism in the area of development and, in particular, developmental genetics. One such insight relates to the manner in which the worm at once offered enormous scope for genetic analysis and indicated a set of boundary conditions for the study of specifically developmental problems. Brenner, who had started with the idea of 'microbiologizing' and 'taming' the organism so as to study development directly through a complete genetic analysis, had to concede, 20 years later, that this was not possible. He had to accept that the original expectation that there would be a logic of development encoded in a genetic programme had to be abandoned; and he warned that the notion of a programme had to be handled carefully. He also saw that the representation of genetic space onto organismic space would not be a direct and explicit one. What was required in this move from molecular genetics to development was the realization that the cell was the basic unit of development and this necessitated an understanding of 'how genes get hold of the cell'. Notwithstanding the advantages offered by 'model' organisms, their role in providing answers to all the major questions in genetics and developmental biology should not be over estimated. As Okada (1997) and Bonner (1999) point out, the use of a single organism in a specific research programme cannot by itself lead to overarching generalizations. In other words, model organisms play a double role: one, model organisms qua models indicate similarities between organisms. But at the same time, they also point to dissimilarities or differences, which implies that there is a limit to what the models can do under given circumstances.

Philosophically speaking, the change in Brenner's approach has interesting implications for the study of that major problem in biology, reductionism. An important aspect of studies in reductionism is linked to the direction in which it is supposed to occur – from the complex to the simple. But this unidirectional theory has been vigorously debated by both biologists and philosophers. While pro and contra arguments are available concerning the problem, Brenner's example shows that there is more to and in the organism than what lies in the apparently ubiquitous gene. It shows that to a certain extent at least, reduction can be a bidirectional process – from complex to simple and back.

References

Allen G 1975 *Life science in the twentieth century* (Cambridge: Cambridge University Press)

Bonner J T 1999 The history of the cellular slime moulds as a 'model system' for developmental biology; *J. Biosci.* **24** 7–12

De Chadarevian S 1998 Of Worms and Programmes: *Caenorhabditis elegans* and the study of Development: *Stud. Hist: Phil. Biol. Biomed. Sci.* **29** 81–105

Okada T S 1997 Searching for the background of the flexibility in morphogenesis; in *Taniguchi Symposium on Developmental Biology IX* (Kyoto: The Taniguchi Foundation Publication) pp 5-8

M G NARASIMHAN
Philosophy of Science Unit,
National Institute of Advanced Studies,
Indian Institute of Science Campus,
Bangalore 560 012, India

