The Axolotl Lacks Little

Developmental Biology of the Axolotl. Edited by J.B. Armstrong and G.M. Malacinski
New York: Oxford University Press. (1989). 336 pp. $65.00

Everything you wanted to know about axolotls but were afraid to ask is included in this lucid and detailed account of their history and developmental and experimental biology. Armstrong and Malacinski have edited valuable reviews of the developmental biology of axolotls. This is an essential reference book for all those who use axolotls or are contemplating their use.

The book has three themes: the natural history of the axolotl, its developmental biology, and practical information for working with axolotls. Axolotls are native only to certain permanent lakes near Mexico City, and they must have the most romantic history of all laboratory animals. Surely no other experimental organism can claim to be the living embodiment of a god, in this case the Aztec god, Xolotl. Xolotl was the god of games, among other things, and he may not approve of the games to which his body is now being put in the laboratory, although this has undoubtedly saved the axolotl from extinction. They have been eaten by the native Indians for thousands of years, so the next time you visit your local Mexican restaurant don't forget to try some ajolate guacamole, which I'm reliably informed is delicious. Several specimens of axolotl were brought to Paris in 1863, and from these few most of the experimental colonies now in existence have derived. Axolotls immediately became famous for the ability to become sexually mature in the larval form (neoteny), and transform apparently into another species (metamorphose)!

The second theme, the developmental biology of axolotls, is contributed by leading researchers, and new insights and latest data are presented along with general reviews. The full range of topics is covered, including spermatogenesis and oogenesis, early gene expression and regionalization, neurobiology (neurulation, neural crest migration, Mauthner's cell, lateral line), limb regeneration, metamorphosis, and developmental genetics. There are now an amazing 44 axolotl mutant genes, affecting stages of development from oogenesis to pigmentation, each of which is catalogued and described. I particularly enjoyed the pictorial essay on neural crest migration by Lofberg et al.; what clearly emerges in these chapters is the enthusiasm that the researchers have for the axolotl. For example, we are told "the early neurula of the axolotl is a delight to behold" (p. 52), and there is a chapter entitled "The Amazing Mauthner Cell."

The final section on practical information is of immense value with tables of normal development, tables for varying stage with temperature, full descriptions of how to rear, breed, and surgically manipulate axolotls, diagnose and treat disease, and how to culture axolotl cells. For example, even though I have kept axolotls for many years, I did not know that putting plants in the tanks gives the animals a greater sense of security and reduces aggression. Obviously the mountain scenes I had stuck on the backs of the glass tanks as a backdrop to remind them of Lake Xochimilco at home were not enough!

Having read the book, I found myself asking two related questions. Should all people interested in development read this book, and is it true that the axolotl "has become one of the most widely useful experimental subjects in the world" (p. 3), or the axolotl "became the focal point of a scientific revolution unparalleled in biology" (p. 5), or "the axolotl became the most widely popular amphibian experimental animal in the world" (p. 8)? If the latter are true, then the answer to the first question is undoubtedly yes. But are the latter true?

Certainly amphibians in general and axolotls in particular have a large number of unique advantages for the developmental biologist. Unlike mammalian embryos, they are accessible to surgical manipulation, and individual cells can be relocated with relative ease. In axolotls, compared with other amphibians such as Xenopus, development is slower, allowing greater plasticity to be revealed following grafts and the integration of genes injected into the egg. Axolotls can regenerate their limbs, the peripheral nervous system, and the central nervous system (they can regenerate nearly the entire cerebral hemisphere, and transplants of telencephalon from other animals take and survive), and there are many mutant genes now available. So why use anything else?

Unfortunately, axolotls have completely missed out on the molecular biology of development, and all the exciting advances have been made by its "competitor", Xenopus (e.g., Ruiz i Altaba and Melton, Nature *341*, 33-38, 1989). It may be that the large genome size of

Urodele amphibians presents difficulties for the preparation of genomic DNA libraries, although this is not insurmountable in newts (Savard et al., EMBO J., 7, 4275-4282, 1988). This seems to be why axolotls will not take over the world of developmental biology, and why this book will not reach all members of the community. It is to be greatly regretted that axolotls and Xenopus cannot combine their resources, for then they surely would be a formidable force.

Malcolm Maden
Anatomy and Human Biology Group
King's College
London
England

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