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Pere Alberch (1954–1998). The passion for understanding evolution and development

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Pere Alberch, Research Professor at the National Museum of Natural Sciences in Madrid, died prematurely on March 13, 1998. He was only 44, and at the beginning of a new period of his scientific career. With his death, science has lost a great developmental, theoretical biologist. Unfortunately, we all are going to have only part of his potential scientific creation. From different positions within the University of Valencia, we have had the privilege of being witnesses of the strength and excitement with which Pere lived his last months looking forward to his incorporation to the new Research Institute on Biodiversity and Evolutionary Biology at the University of Valencia. He was in an incredible disposition to be an active researcher and lecturer in postgraduate courses on Evolution.

Fig. 1 Pere Alberch (1954–1998)

His scientific career was devoted mainly to the problems of morphogenesis during evolution (phylogeny) and embryo development (ontogeny). From 1989 to 1995 he was the Director of the Museum to which he dedicated many efforts in a program of complete renovation both of its facilities and scientific activities.

Born in Badalona, a coastal town close to Barcelona, in 1954, he graduated with the highest honors in Biology and Environmental Sciences at Kansas University in 1976. In 1980 he earned the Ph.D. degree in Zoology at the University of California, Berkeley. He lectured on Biology at Harvard University from 1980 to 1989 where he also was Curator of Herpetology at the Museum of Comparative Zoology. He was a member of the Editorial or Advisory Boards, among others, of *Trends in Ecology and Evolution* (since 1993), *Biodiversity Letters* (since 1992), *Journal of Theoretical Biology* (since 1985), and *Journal of Evolutionary Biology* (1986–1991).

His paper published in the *Journal of Morphology* in 1981, and authored also by his brother Jordi, is considered by many scientists (evolutionists) as a classical. Actually, one of the most recent textbooks on developmental biology (Wolpert L. et al., 1998, *Principles of Development*, Oxford University Press) uses Pere Alberch's work on *Bolitoglossa* as a case of study in the chapter of evolution and development (pp. 458–460). Why? When inspecting the diversity of life, we realize that organisms can be classified into two major groups. The first comprises those living entities that are characterized by a plethora of

metabolic capabilities and, broadly speaking, by very similar morphologies. The second group comprises living entities with profound morphological changes among them but with a limited genetic repertoire. Combinations and/or interactions of specific genes are responsible for such new morphologies. In broad sense, unicellular microorganisms accommodate to the first group, and multicellular organisms to the second class. This brief statement may serve to locate in its right place Pere Alberch's contribution to the field of evolutionary and developmental biology. Multicellular organisms can be grouped again according to their major morphologies in a series of groups within which a variety of minor morphological changes have occurred during their evolution.

Based on developmental studies on salamanders, Pere Alberch invented the term "developmental constraint" to explain why the generation of permanent genetic variability by mutation is buffered by physical, mechanical and ontogenetic rules during the development of the organisms. This concept and the theoretical considerations Pere derived from it have been prophetic. Now, we have started to understand, for instance, the molecular bases of developmental processes, and how constraints are responses of living complex systems to basic genetic noise. Moreover, certain new areas of theoretical biology have been benefited from his seminal work, for example, biological self-organization. At different hierarchic levels of biological organization, there is increasing evidence that component elements tend to be self-organized under certain conditions. Pere worked on this topic when he died; he prepared a new book on the *Introduction to Chaos Theory and Complexity with a Special Emphasis to Biological Sciences*. The topics dealt directly with the lack of prediction of the classical neo Darwinian view on different areas of biology. They were as different as ecosystem stability and trophic networks, models in ecology based on individuals, the phenotype-genotype dichotomy and the limits to the reductionistic paradigm, macroevolutionary patterns and processes, regulatory genetic networks during development, morphogenetic and growth models, etc. He was completely involved in the development of a complexity theory of living organisms. The Institute was formally open to the experimental validation of his ideas, and for this reason we would like to continue his task.

The following chronological list of papers is a selection, from more than seventy publications of Prof. Alberch, of his most relevant contributions.

– Alberch P, Gould SJ, Oster GF, Wake DB (1979) Size and shape in ontogeny and phylogeny. Paleobiology 5:296–317

– Alberch P (1980) Ontogenesis and morphological diversification. Amer Zool 20:653–657

– Alberch P (1981) Convergence and parallelism in foot morphology in the neotropical salamander genus *Bolitoglossa*. I. Function. Evolution 35:84–100

– Alberch P, Alberch J (1981) Heterochronic mechanisms of morphological diversification and evolutionary change in the neotropical salamander *Bolitoglossa occidentalis* (Amphibia; Plethodontidae) J Morphol 167:249–264

– Alberch P (1982) Developmental constraints in evolutionary processes. In: Bonner JT (ed) Evolution and Development, Dahlen Konferenzen. New York: Springer-Verlag

– Oster GF, Alberch P (1982) Evolution and bifurcation of developmental programs. Evolution 36:444–459

– Alberch P (1983) Morphological variation in the neotropical salamander genus *Bolitoglossa*. Evolution 37:906–919

– Alberch P, Gale E (1985) A developmental analysis of an evolutionary trend: digital reductions in amphibians. Evolution 39:8–23

–Alberch P (1985) Problems with the interpretation of developmental sequences. Systematic Zool. 34:46–58

– Shubin N, Alberch P (1986) A morphogenetic approach to the origin and basic organization of the tetrapod limb. Evolutionary Biology 20:319–387

– Alberch P (1987) Evolution of a developmental process: irreversibility and redundancy in amphibian metamorphosis. In: Raff RA, Raff EC (eds) Development as an Evolutionary Process. Woods Hole, MA: Marine Biological Laboratory, pp 23–46

– Alberch P (1993) Museums, collections and biodiversity inventories. Trends Ecol Evol 8:372–375

– Alberch P (1994) The identity crisis of natural history museums at the end of the XXth century. In: Miles R, Zavala L (eds) Towards the Museum of the Future. New European Perspectives. New York: Routledge, pp 193–198

– Alcobendas M, Dopazo H, Alberch P (1996) Genetic differentiation in populations of *Salamandra salamandra* (Amphibia, Urodela) exhibiting distinct reproductive modes. J Evol Biol 9:83–102

– Alberch P, Blanco MJ (1996) The structure of ontogeny: from laws to regularities in the evolution of ontogenic organization. Int J Develop Biol 40:845–858