***PHYSIOLOGICAL RESPONSES TO THE ENVIRONMENT IN DEVELOPING ANIMALS: COSTS AND BENEFITS***

Bernd Pelster1,2 and Warren W. Burggren3

## 1Institute of Zoology, University of Innsbruck, Austria,

2Center for Molecular Biosciences, University of Innsbruck, Austria

3Department of Biological Sciences, University of North Texas, Denton, Texas

#

#

# Running head: Responses to the Environment

Address for correspondence:

Dr. Bernd Pelster

Institut für Zoologie

Leopold-Franzens-Universität Innsbruck,

Technikerstr.25

A-6020 Innsbruck

Austria

Tel.: +43 512 50751860

Fax.: +43 512 50751899

e-mail: bernd.pelster@uibk.ac.at

The phenotype of an animal is the result of an interaction between genetic information and environmental influences. Because embryos and larvae of most vertebrates are freely exposed to the environment, environmental influences may start affecting development with deposition of the egg. A response to the environment requires information about the environment, which is then used to trigger a modification in cell and organ function. Many studies have shown that even in the earliest developmental stages receptors may be functional and a modification of receptor activity may induce physiological responses or modifications in cell proliferation. In embryos, operation of these control loops, which typically are humoral or neuronal loops in adults, is hampered by the somewhat delayed development of the nervous system. In addition, so called critical windows may severely restrict the time of responsiveness to certain signals or stressors during development. Nevertheless, modifications in heart rate, ventilation or metabolic activity demonstrate the existence of physiological plasticity in earliest developmental stages. In addition, differences in cell number and organ size reveal a remarkable plasticity in structural development. A certain flexibility and plasticity certainly is beneficial because metabolic activity, for example, can be adjusted to changes in oxygen availability, ensuring an optimal outcome especially in an environment with variable oxygen tensions, like aquatic environments. The timing of developmental milestones like hatching can be adjusted to optimal environmental conditions in terms of oxygen availability, temperature or humidity. On the other hand, any reaction takes time and thus may slow down development, increasing perhaps the risk of predation. Additional energy may be required for these responses, which may result in a reduced growth rate. In species with thermal sex determination the environmental influence may result in an unbalanced sex ratio of a population, which obviously may be very disadvantageous for the thriving of a population. Organ size and function may be adjusted to the current situation encountered during development, and cannot be reversed if environmental conditions return to previous settings. In this case reduced fitness may be the consequence. A careful discussion of these options reveals that certain phenotypic plasticity is essential and required for a species to prosper in a variable environment, and our planet is evolving with an ever changing environment. This flexibility, however, does come with a cost and may occasionally result in reduced fitness and disadvantageous phenotypes, which cannot be reversed due to the reduced plasticity of adult animals.