The short life of the Hoyle organ of *Sepia officinalis*: formation, differentiation and degradation by programmed cell death

Norbert Cyran · Anna Palumbo · Waltraud Klepal · Erica A. G. Vidal · Yannick Staedler · Jürg Schönemberger · Janek von Byern

Received: 27 September 2016 / Revised: 1 June 2017 / Accepted: 30 June 2017
© The Author(s) 2017. This article is an open access publication

Abstract Cephalopods encapsulate their eggs in protective egg envelopes. To hatch from this enclosure, most cephalopod embryos release egg shell-digesting choriolytic enzymes produced by the Hoyle organ (HO). After hatching, this gland becomes inactive and rapidly degrades by programmed cell death. We aim to characterize morphologically the development, maturation and degradation of the gland throughout embryonic and first juvenile stages in *Sepia officinalis*. Special focus is laid on cell death mechanisms and the presence of nitric oxide synthase during gland degradation. Hatching enzyme has been examined in view of metallic contents, commonly amplifying enzyme effectiveness. HO gland cells are first visualized at embryonic stage 23; secretion is observed from stage 27 onwards. Degradation of the HO occurs after hatching within two days by the rarely observed autophagic process, recognized for the first time in cephalopods. Nitric oxide synthase immunopositivity was not found in the HO cells after hatching, suggesting a possible NO role in cell death signalling. Although the HO ‘life course’ chronology in *S. officinalis* is similar to other cephalopods, gland degradation occurs by autophagy instead of necrosis. Eggs that combine a large perivitelline space

Guest editors: Erica A. G. Vidal, Ian G. Gleadall & Natalie Moltschaniswksyi / Advances in Cephalopod Ecology and Life Cycles

N. Cyran (✉) · W. Klepal
Core Facility Cell Imaging and Ultrastructural Research, Faculty of Life Sciences, University of Vienna, Vienna, Austria
e-mail: norbert.cyran@univie.ac.at

A. Palumbo
Department of Biology and Evolution of Marine Organisms, Stazione Zoologica Anton Dohrn, Naples, Italy

E. A. G. Vidal
Center for Marine Studies, University of Parana - UFPR, Pontal do Parana, Brazil

Y. Staedler · J. Schönemberger
Division of Structural and Functional Botany, Department of Botany and Biodiversity Research, University of Vienna, Vienna, Austria

J. von Byern
Max F Perutz Laboratories, Centre for Integrative Bioinformatics Vienna, University of Veterinary Medicine, Medical University of Vienna, University of Vienna, Vienna, Austria

J. von Byern
Ludwig Boltzmann Institute for Experimental and Clinical Traumatology, Austrian Cluster for Tissue Regeneration, Vienna, Austria

Published online: 10 July 2017