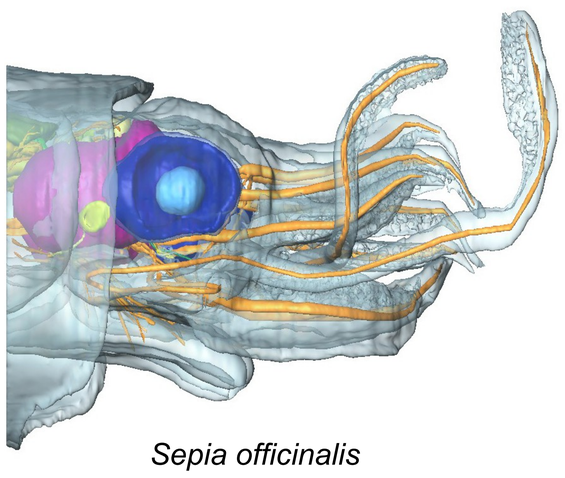
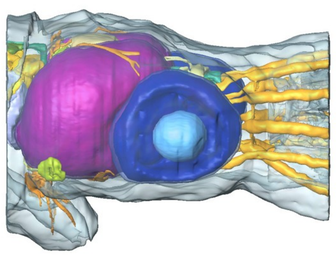
3D-Microanatomy of Cephalopod brains: A comparative study on the hatchlings of six species

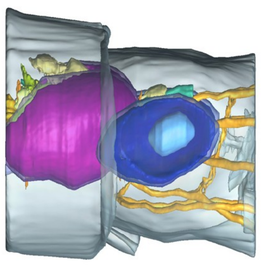
Elvira Scharpf, Gerhard Haszprunar, Martin Heß
BioZentrum der LMU München, Großhaderner Str. 2, 82152 Planegg, Germany
elvira.scharpf@gmx.de, hess@bio.lmu.de



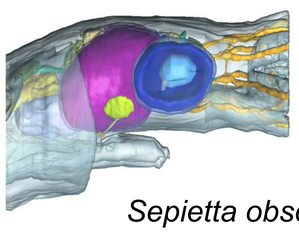
Sepia officinalis



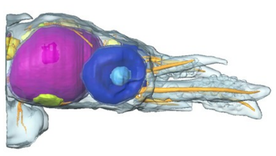
Idiosepius notoides



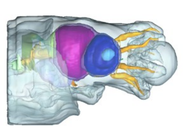
Rossia sp.



Sepietta obscura



Loligo vulgaris



Octopus vulgaris

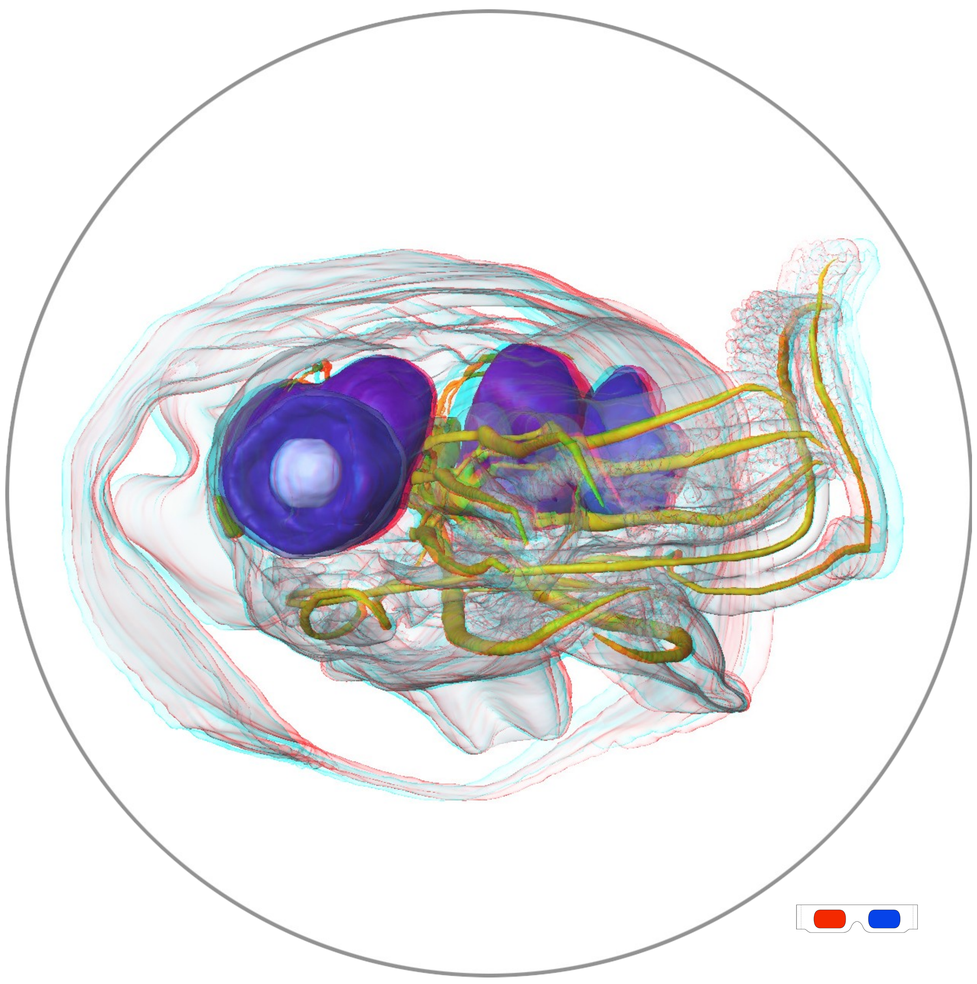
1 mm

Introduction

The nervous system of cephalopods is the largest of all invertebrates and the most complex within molluscs. Directly after hatching cephalopod paralarvae start to interact with their environment, e.g. food capture and predator avoidance with the aid of their eyes. For this purpose already the hatchlings possess well-developed visual systems, which differ between species in size, internal organization, and developmental stage in accordance with differing integrative capabilities and behavioural patterns.

Material & Methods

For a comparative morphological approach we acquired 3D structure-data of the head region of six coleoid cephalopod species (*Sepia officinalis*, *Rossia* sp., *Sepietta obscura*, *Loligo vulgaris*, *Octopus vulgaris*) with light microscopic resolution, based on semithin section series (transversal planes, 2 µm, epoxy resin). Digital light micrographs of the slices were aligned, segmented lobe by lobe, surface-rendered, and analyzed with Amira® 3D software.

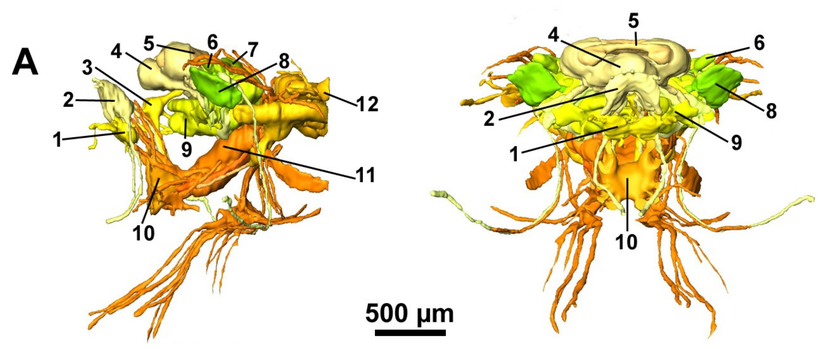


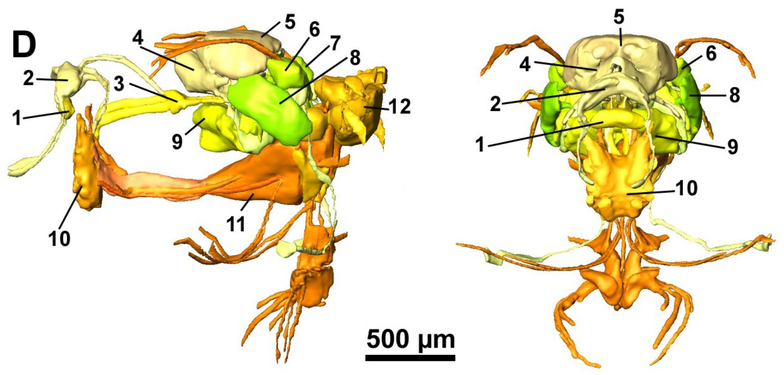
Results

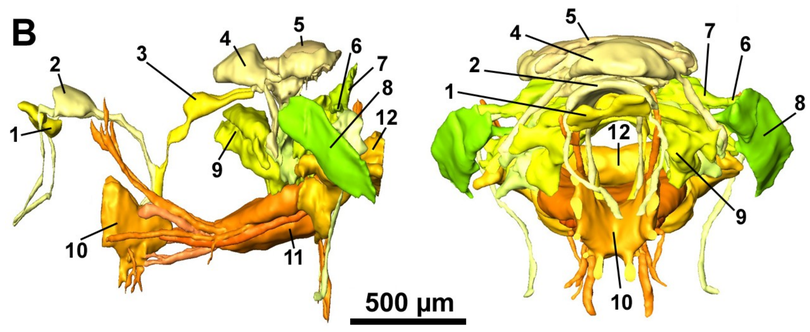
We obtained virtually explorable, digital 3D models which display the complex structures of the central nervous systems. The six investigated species have most lobes and nerves in common, whereupon the complexity, relative size of lobes and eyes, and the degree of centralization differ. For instance one can observe an increasing centralization from decapod to octopod brains. *O. vulgaris* hatchlings have the smallest and most compact CNS due to shortening of the connectives between the lobes. *Loligo vulgaris* has rather long connectives, *Sepia officinalis* shows intermediate conditions.

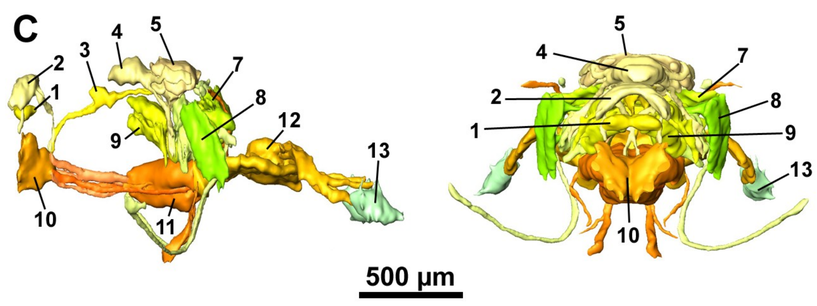
Discussion

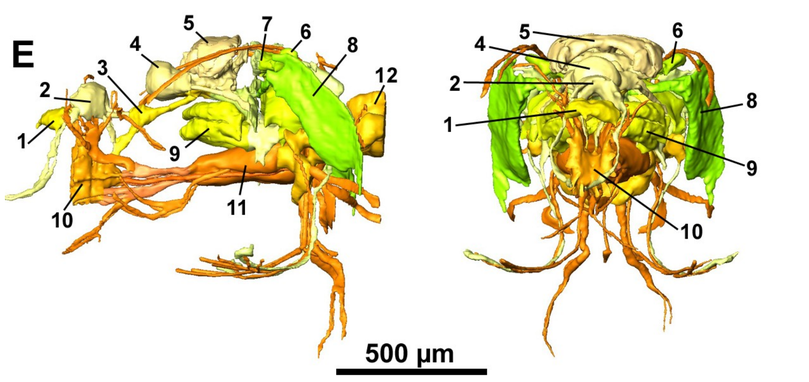
The morphological differences, with partly functional implications, can be discussed in the interdependent contexts of 1. the importance of vision immediately after hatching (e.g. transiently lecithotrophic *Octopus* vs. hunting *Sepia*), 2. the adaptation to different photic habitats (benthic vs. pelagic) and 3. the phylogenetic position (e.g. body shape; preformation of adult conditions).

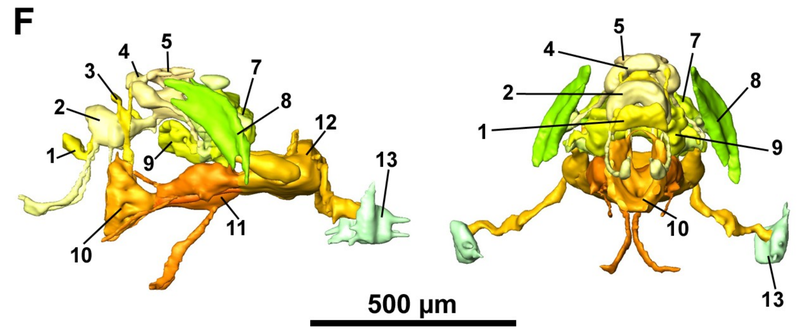












1: inferior buccal lobe, **2:** superior buccal lobe, **3:** inferior frontal lobe, **4:** superior frontal lobe, **5:** vertical lobe, **6:** dorso-lateral lobe, **7:** dorsal basal lobe, **8:** peduncle lobe, **9:** anterior basal lobe, **10:** brachial lobe, **11:** pedal lobe, **12:** visceral lobe, **13:** stellate ganglion.