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[REVIEW]

Paleontological Studies Integrated into a New Evolutionary Zoology

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***Zoological Letters*, an open access online journal launched in 2015 is entering its third year of publication, and now seeks to drive new insights in evolutionary and comparative zoology by the inclusion of paleontological studies into its scope.**

Key words: journal, zoology, paleontology, evolution, animals, publishing

INTRODUCTION

Since its launch in January 2015, the open access online journal, *Zoological Letters* (ZL; http://zoologicalletters.biomedcentral.com/), has published 57 papers (35 in 2015 and 22 in 2016, as of November 2016). This journal first sought to publish high-impact original research articles and influential comprehensive reviews. In its first two years, comparative morphology and embryology in evolutionary developmental contexts have been major themes of interest (ex. Hirasawa and Kuratani, 2015; Hojo et al., 2015; Tada and Kuratani, 2015; Hayashi et al., 2015; Nakano, 2015; Onai et al., 2015a, b; Oisi et al., 2015; Shigeno et al., 2015; Kaji et al., 2016; Takeuchi et al., 2016; Suzuki et al., 2016; Hirasawa et al., 2016), a clear trend dating to the launch year, as we reported in a previous review (Fukatsu and Kuratani, 2014). Nonetheless, ZL is open to all areas of basic zoology, and many of the top cited and most frequently accessed papers have been from fields other than evo-devo (Holland, 2015; Kishida et al., 2015; Inoue et al., 2015; Mizunami et al., 2015; Hosokawa et al., 2015; Moriyama and Numata, 2015). Thanks to its affiliation with the Zoological Society of Japan, ZL initially received many contributions from Japanese zoologists, but as international recognition for the journal has grown, papers contributed by authors from other countries have continued to increase. We are delighted that several review articles published in 2015 have been highly cited, and now the journal plans to encourage hypothesis-oriented reviews by creating a new review article format (Perspectives) in addition to the current original articles and reviews.

We also would like to call readers' attention to ZooDiversity Web (ZDW) (http://zdw.zoology.or.jp), a website hub devoted to zoology and biodiversity with an attractive and easy-to-use internet search engine. The ZDW also showcases scientific papers published in this journal, *Zoological Science* (ZS). ZS, the flagship journal of the Zoological Society of Japan, is the sister journal of ZL. The ZDW portal provides free access to over 4000 peer-reviewed zoological articles focused on more than 13,000 animal species.

To Enhance Evolutionary Studies

Integrating neontological (especially anatomical and embryological) data with fossil records is now a standard approach to the reconstruction of evolutionary scenarios, and ZL for this reason has decided to solicit submissions of paleontological papers, extending the journal's scope and re-conceptualizing conventional zoology into neontological and paleontological zoology. We seek to more fully integrate basic and comparative zoology more into the larger field of evolutionary biology by presenting a variety of data and ways of understanding. The importance of paleontological evidence in evolutionary arguments is clear, as is seen in assessments of animal bodies from the perspectives of comparative morphology, embryology, genomic, and developmental biology. Kishida et al. (2015), for example, have demonstrated that baleen whales lost the dorsal domain of the olfactory bulb, known to induce innate avoidance behavior against odors of predators and spoiled foods, before the toothed and baleen whale split based on not only whole genome sequences but also fossil data, indicating that profound changes in the chemosensory capabilities had occurred in the cetacean lineage during the period when ancestral whales migrated from land to water. Shone et al. (2016) evaluated fossil agnathan morphological traits to speculate about an evolutionary sequence in vertebrate gill number. Suzuki et al. (2016) referred to placoderm fossil data (Young, 2008) in suggesting that vertebrate extrinsic eye muscles adhere to ancestral anatomical patterns. As a substantive move in embracing paleontological approaches, ZL has invited Robert Jenkins, a specialist in invertebrate paleontology, to join its editorial board.

The first truly paleontological paper published in ZL was

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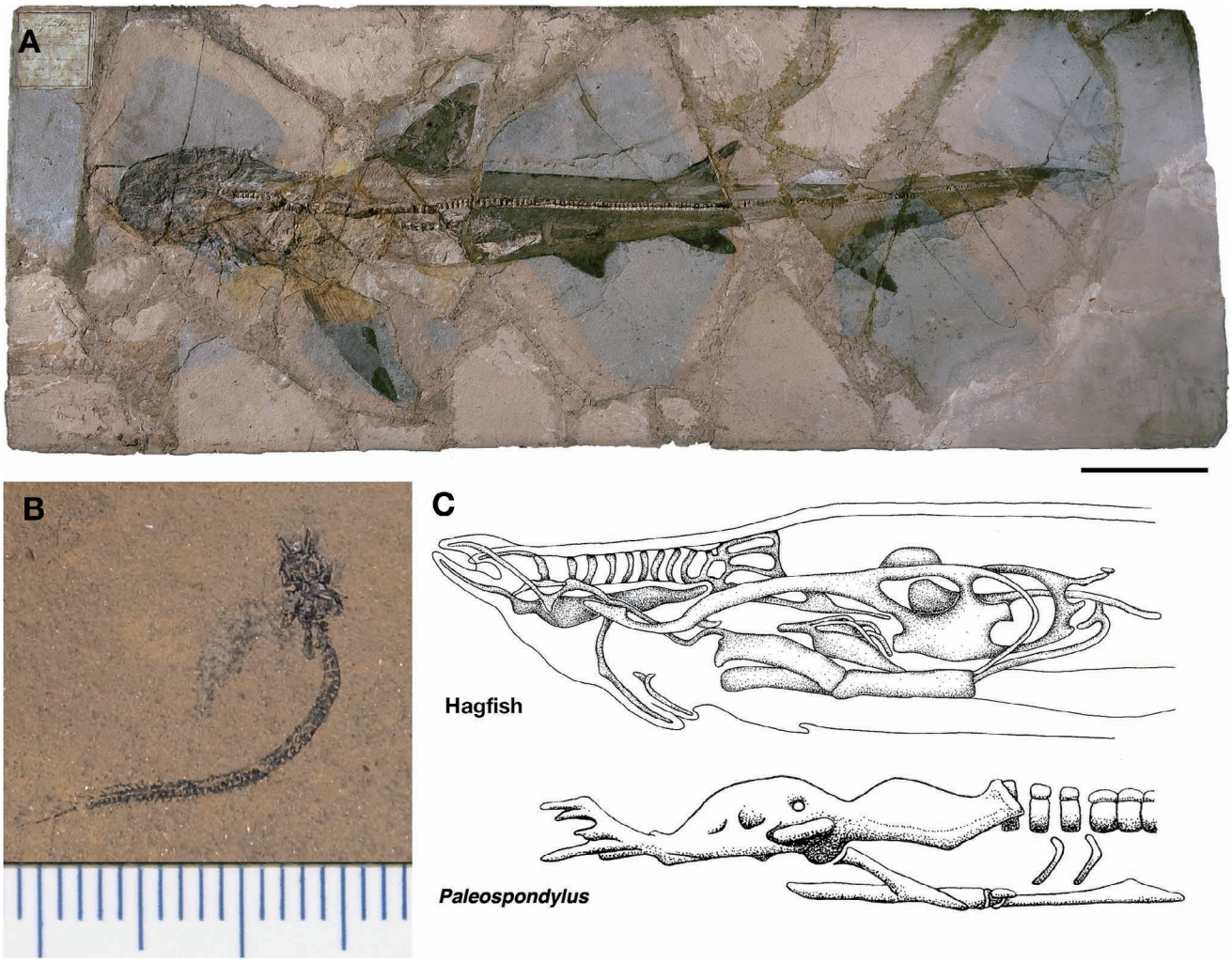

Fig. 1. Paleontology papers in *Zoological Letters* in 2016. **(A)** MGGC (Museo Geologico Giovanni Cappellini) 1976, a school shark (*Galeorhinus cuvieri*) from the Early Eocene locality of Pesciara di Bolca Konservat–Lagerstätte, Italy, with exceptional soft tissue preservation. Scale = 10 cm. See Fanti et al. (2016) for details. Photo from Tetsuo Miyashita. **(B)** AMNH FF 10743 (*Palaeospondylus gunni*) in American Museum of Natural History (New York). **(C)** Schematic comparison of the cranium between hagfish (above) and *Palaeospondylus* (below) by Bulman (1931). Redrawn from Bulman (1931).

Fanti et al. (2016), a reconstruction of the Eocene fauna of a coral reef environment, based on an exceptionally well-preserved shark fossil (Fig. 1A). Hirasawa et al. (2016) provided another impressive example of the integration of comparative embryological and fossil data, which revealed a non-negligible morphological similarity in cranial morphology of the embryonic hagfish and the long-enigmatic fossil vertebrate, *Palaeospondylus*, suggesting that the latter might belong to a basal hagfish lineage (Fig. 1B, C). This same study also suggested that the cyclostome lineage may be more diverse than previously believed.

Highlights from ZL

Zoological Letters recognizes the central value of detailed descriptions of morphology, embryogenesis, and extensive gene expression patterns, as well as reports of hitherto unrecognized phenomena, as much as experimental studies. Detailed datasets will become even more important for the future understanding of the mechanisms underpin-

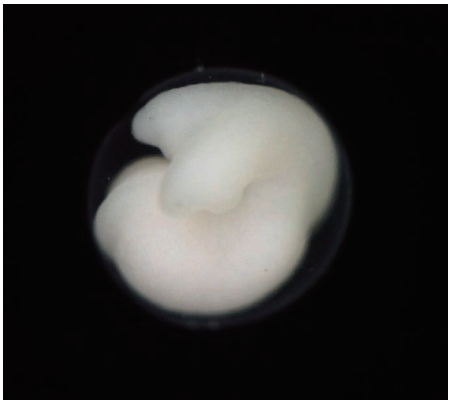

Fig. 2. A two-headed (bicephaly) lamprey embryo. This two-headed embryo of a lamprey, *Lethenteron camtschaticum*, was obtained after artificial fertilization, apparently generated by a disorder in head-organizing activity. Photo provided by Daichi Suzuki. See Suzuki (2016) for details.

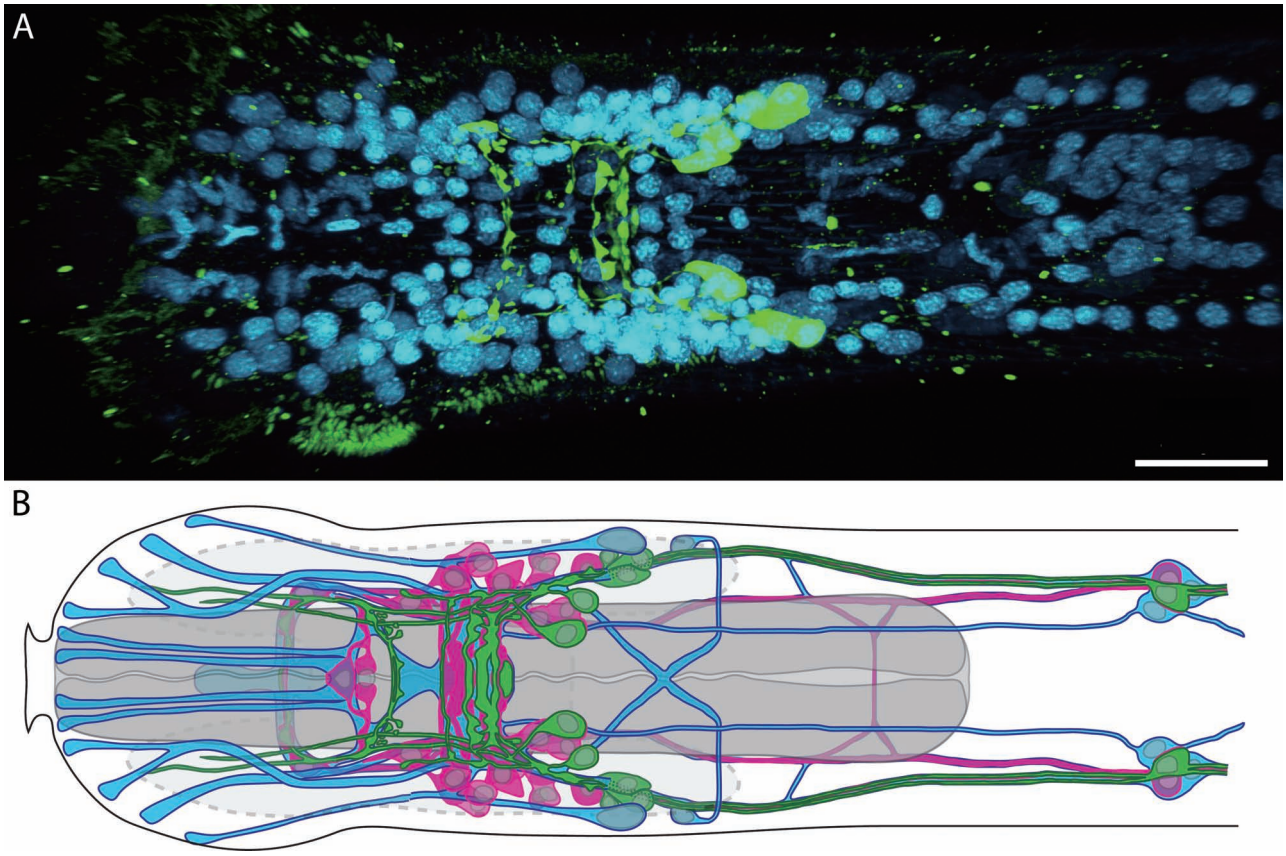

Fig. 3. Morphology of the gastrotrich *Diuronotus aspetos*. **(A)** Confocal laser scanning microscopy (CLSM) of *D. aspetos*, with DAPI in cyan showing the nuclei of the cells. Dorsal view of a maximum intensity projection, with serotonin-like immunoreactivity (LIR) in green, showing parts of the brain. Anterior to the right. **(B)** Schematic drawing of the reconstructed anterior nervous system of with the serotonin-LIR in green, FMRF-LIR in purple and acetylated α-tubulin-LIR in blue. Scale = 20 μm. Photo provided by Nicolas Bekkouche and Katrine Worsaae.

ning body plan evolution, and the links between establishment of anatomical integrity, modularity of organogenesis and genome evolution. Below, we highlight some of the most exciting ZL papers published to date in 2016, showing our focus in these areas.

One interesting paper in this regard is that by Suzuki (2016), which reported double-headed "monsters" in the lamprey, *Lethenteron camtschaticum* (former *L. japonicum*) (Fig. 2). There had been no previous report on this anomaly in any cyclostome, and the authors imputed this phenomenon to a yet-unidentified genetic basis, as all the mutants were derived from a single fertilization. This paper may contribute to our understanding of the ancestral developmental mechanism underlying axis formation and cephalogenesis in vertebrates, which may be coupled in some way at the genomic level.

Another striking description was provided by Wolff et al. (2016) on the water-repellent mechanism of the body surface of a curious arachnid group, whip spiders. The cuticle of these animals is initially wettable, but it later becomes highly hydrophobic for the acquisition of secreted products. Interestingly, skin surface granules and colloid particles of these animals exhibit species-specific ultrastructures, showing an exquisite example of arthropod diversity.

A combined descriptive and comparative approach to morphology is seen in the work of Bekkouche and Worsaae (2016), who studied a new Gastrotrichia genus, *Diuronotus* (Fig. 3), which occupies a crucial position on the phylogenetic tree of Gastrotrichia. This study sheds new light on the evolutionary sequence of changes in the morphological pattern of the muscular and nervous systems in these animals.

In closing, we emphasize that *Zoological Letters* remains dedicated to publishing select, topical zoological papers of broad impact. The scope of the journal encompasses all basic zoological disciplines, and is now expanding to a more integrative and multidisciplinary journal by embracing evolutionary zoology and paleontology as well.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

SK and TF wrote the manuscript.

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