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Source: Zoological Science, 33(1) : 1-5

Published By: Zoological Society of Japan

URL: https://doi.org/10.2108/zs150160

ZOOLOGICAL SCIENCE **33**: 1–5 (2016)

[REVIEW]

Launch of Zoological Letters

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A new open-access journal, *Zoological Letters*, was launched as a sister journal to *Zoological Science*, in January 2015. The new journal aims at publishing topical papers of high quality from a wide range of basic zoological research fields. This review highlights the notable reviews and research articles that have been published in the first year of *Zoological Letters*, providing an overview on the current achievements and future directions of the journal.

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

INTRODUCTION

In January 2015, BioMed Central launched a new open access journal, *Zoological Letters* (ZL), as a sister journal to *Zoological Science* (ZS). The primary aim of ZL is to disseminate original articles of high impact as well as comprehensive reviews of far-reaching influence to the international scientific community. By contrast, the primary mission of ZS is to publish scientifically sound, basic studies from a wide range of zoological fields. Together, these journals seek to mutually support and promote basic studies in various fields of zoology worldwide. Here, we provide a brief overview of the history of ZS, the relationship between ZL and ZS, and the current status and future directions of ZL.

ZS was originally established in 1888 as two separate journals, a Japanese-English-based journal, *Doubutsugaku-Zasshi* (Zoological Magazine), and an English-only journal, *Annotationes Zoologicae Japonenses* (Nihon Doubutsugaku-Iho), both of which were affiliated with the Zoological Society of Japan. In 1984, these journals were reorganized and integrated into the current format as an English-language international journal. Since that time, ZS has supported basic zoological activities and research in the global community of zoologists, and now consists of 33 volumes, for which more than half of all submissions are contributed from countries outside of Japan.

Many topical papers are freely downloadable from the ZS website under the BioOne platform, which has attracted an enormous number of readers from around the world. In order to further broaden the visibility and scientific influence of ZS, while maintaining its primary mission of communicating basic zoological achievements to the world, the Zoological Society of Japan decided to launch ZL as a new online-only, open access journal dedicated to highly selected, topical zoological papers of broad impact.

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doi:10.2108/zs150160

As sister journals, ZL and ZS should together serve to strongly promote scientific publications in the field of basic zoology in a cooperative and complimentary manner. Since ZL is a specialized journal focused on publishing topical zoological papers of broad impact, a considerable proportion of manuscripts submitted to ZL are rejected, although they may be scientifically sound, technically solid, and show potential for making a significant contribution to zoological research fields. Following careful consideration by the editors, the authors of such manuscripts may be offered the option of manuscript transfer from ZL to ZS, which enables rapid handling and seamless publication of a variety of valuable scientific achievements in the field of zoology.

HIGHLIGHTS FROM ZL

During its launch year of 2015, six reviews and 20 research articles were published in ZL. Here, we highlight some of the most exciting papers that have been published to date in the new journal, providing an overview of the research topics on the forefront of the field that have been addressed to date, and indicating promising research areas awaiting future exploitation.

Notably, a considerable number of papers listed on the ZL website (http://www.zoologicalletters.com/content) represent research in the field of evolutionary developmental biology (commonly known as “evo-devo”). On account of the dazzling diversity of metazoans, evo-devo has been, and will continue to be, a central issue in zoological research from comparative and evolutionary perspectives. It should also be noted that ZL regards paleontology as a research field within its scope for future publications, since this field now incorporates modern histological techniques to examine the soft tissues of fossil records at the microscopic level. In particular, paleontologists are now viewing animal bodies from the joint perspectives of comparative morphology, embryology, and developmental biology, and have also begun incorporating advances in genomics to obtain a deeper understanding of animal evolution.

The Cambrian explosion and homeotic gene duplication

The monumental first paper of ZL was contributed by Peter Holland, who conducted an ambitious study with the aim of interpreting the so-called Cambrian explosion of bilaterian animals from the perspective of the genomic duplication of homeotic gene complexes (Holland, 2015). This paper is symbolic of the journal's scope and aims, in that it encompasses research on extremely diverse animal taxa from comparative and evolutionary perspectives, which is the fundamental theme interwoven into the basis of zoology.

Evo-devo of vertebrate morphologies

Vertebrates have offered a number of curious models for studies of evolutionary morphology. Among the highly sophisticated organ systems in vertebrates, the skeletomuscular system shows a substantial contribution to the overall phenotypic diversity of this animal group. Hirasawa and Kuratani comprehensively reviewed the classification of skeletal elements and tissues of vertebrates, offering detailed definitions of the ossifications and bone types from developmental, comparative morphological, and paleontological viewpoints (Hirasawa and Kuratani, 2015).

To better elucidate the evolution and diversification of vertebrates, the basal-most lineages of extant vertebrates, namely lampreys (Fig. 1A) and hagfish (Fig. 1B), are of pivotal importance. Especially the embryology of the hagfish had long been hindered by their deep-sea habitat and difficulties in lab rearing; however, Kuratani's group demonstrated a breakthrough by obtaining the first fertilized hagfish eggs in 2007 (Ota and Kuratani, 2006; Ota et al., 2007). They have thus far published several papers on hagfish development in ZS (Ota and Kuratani, 2008; Oisi et al., 2013). Oisi and colleagues discovered that the hagfish hypobranchial muscles and the nerves innervating them exhibit a very peculiar morphological pattern, which violates a basic rule of homology shared by all the other vertebrate lineages (Oisi et al., 2015). Furthermore, Tada and Kuratani (2015) investigated the evolutionary origin of the accessory nerve and cucullaris muscles that are missing from the cyclostomes, thereby identifying them as newly added features in the vertebrate body plan to define the gnathostomes.

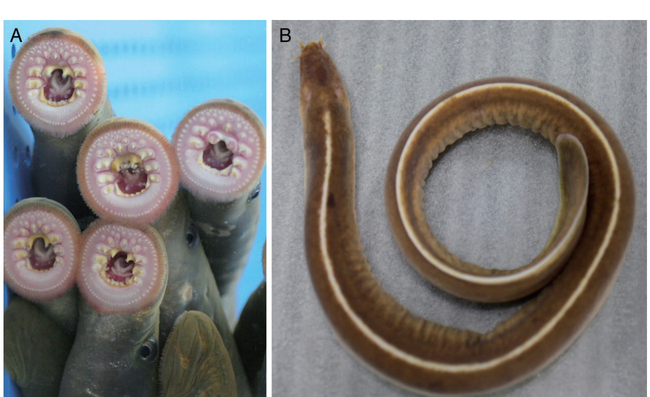

Fig. 1. The lamprey *Lethenteron japonicum* **(A)** and the hagfish *Eptatretus burgeri* **(B)**. Photos by Y. Takio **(A)** and Kinya G. Ota **(B)**.

Discovery of the sixth digit in amphibians

The evolution of jawed vertebrates can be viewed, in a way, as the evolution of paired appendages (fins or limbs). For example, humans have a pair of arms and legs with five fingers or toes on their tips. All mammals, birds, reptiles, and amphibians also possess five or less digits on their limbs, except for certain limbless animals such as snakes, glass lizards, and caecilians. It is generally believed that the number of digits in extant tetrapod animals is conservatively stabilized at five or less, which has been referred to as the pentadactyl constraint. Tamura's research group at Tohoku University has long been studying the problem of vertebrate digit/limb evolution from developmental biological perspectives (Yonei-Tamura et al., 2008; Uejima et al., 2010; Tamura et al., 2011), and recently challenged the above conventional morphological concept with respect to a constrained tetrapod digit number (Hayashi et al., 2015). Specifically, the authors investigated the anterior-most clawed protrusion on the hindlimbs, so-called the prehallux, of the western clawed frog (Fig. 2A). Detailed examinations of its morphology, tissue composition, development, and expression of molecular markers revealed that the frog's prehallux is actually a sixth digit (Fig. 2B). This striking finding sheds new light on the evolutionary morphology of vertebrates, especially considering the fact that many frogs and some salamanders possess the prehallux on their limbs, and that some extinct basal tetrapod lineages such as Ichthyostega had more than five digits.

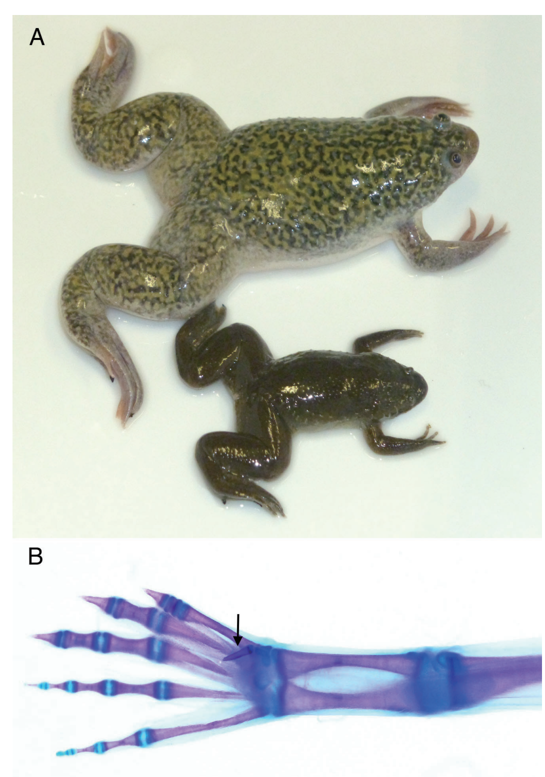

Fig. 2. **(A)** The African clawed frog *Xenopus laevis* (Top) and western clawed frog *X. tropicalis* (Bottom). **(B)** Embryonic hindlimb digits and the sixth protrusion (arrow) of *X. tropicalis*. Photos by K. Tamura.

Whales incapable of smell and taste perception

Although evolutionarily derived from an even-toed ungulate lineage (Shimamura et al., 1997), whales exhibit a number of remarkable morphological, physiological, and ecological specializations for an aquatic lifestyle. By comparison of genomes and anatomical features between a baleen whale and toothed whales and ruminants, Kishida and colleagues found that baleen whales lack the dorsal domain of the olfactory bulb and functional taste receptors in the genome (Kishida et al., 2015). These findings highlight profound changes in the chemosensory capabilities associated with the whale's dramatic ecological transition from terrestrial to aquatic life.

Unexpected commonality between the fish ear stone and the sea urchin spicule

In vertebrates, gravity and motion sensing are mediated by calcium carbonate particles called otoliths or ear stones, which are encased within the inner ear (Fay and Popper, 2000). The otoliths of fish are particularly valuable for ecological and fishery research, as the annual rings formed on the otoliths are useful for age estimation (Francis and Campana, 2004). By analyzing an otolith-deficient mutant of the medaka fish, Hojo and colleagues demonstrated that a small deletion in a polyketide synthase gene is responsible for the mutant phenotype (Hojo et al., 2015). This was unexpected, given that polyketide synthases are known for their role in the synthesis of structurally complex secondary metabolites, some of which are used in the development of pharmaceutically important antibiotics, immunosuppressants, and anti-cancer agents, in a variety of microorganisms. However, database searches revealed a broad distribution of the polyketide synthase gene across diverse metazoans, and knocking down of gene expression in sea urchin embryos resulted in disappearance of the spicules, the larval skeletons of echinoderms composed of calcium carbonate (Hojo et al., 2015). These results uncover a surprising but general molecular mechanism underlying calcium carbonate biomineralization among diverse animal phyla.

Detailed descriptions of animal development

ZL also places value on traditional and descriptive zoological studies of high quality. In particular, detailed comparative developmental descriptions serve as an important basis for molecular-level analyses aimed at a better understanding of the evolution of the animal body plan. For example, Shigeno and colleagues, who are well-known experts of the molluscan nervous system (Shigeno et al., 2001a, b, 2008), described the developmental patterns of the cephalopod's central nervous system in detail (Shigeno et al., 2015). This description served to postulate a new evolutionary sequence of the central nervous system in molluscans and shed new light on the evolution of lophotrochozoans. Weidhase and colleagues reported a detailed morphological description of the post-traumatic regeneration of the musculature and nervous system in a marine annelid (Weidhase et al., 2015), which consolidates the basis by which the annelid serves as an excellent model for regeneration studies.

Enigmatic animal phyla

Thus far, more than 30 metazoan phyla have been described, although many, especially those consisting of tiny, marine, and benthic or planktonic creatures, have been poorly, rarely, or only superficially investigated. Needless to say, exploration and understanding of these minor and understudied animal phyla constitute one of the primary missions of basic zoology. The phylum Xenoturbellida contains only two species of the genus Xenoturbella, which are unique flat marine forms that are found only on the west coast of Sweden (Fig. 3A). Nakano was among the experts who first advocated the deuterostomic affinity of Xenoturbella (Philippe et al., 2011) and first reported its development as well (Nakano et al., 2013), and he presented a comprehensive review on the morphology, phylogeny, development, and ecology of Xenoturbella in ZL (Nakano, 2015), thereby providing invaluable insights into this enigmatic animal group. The phylum Loricifera, comprising some 35 described species from 11 genera, consists of tiny animals (0.1–1 mm in size) that are found in the spaces between marine gravel, and are characterized by a protective outer case called the lorica (Fig. 3B). Yamasaki and colleagues, who are best known for their phylogenetic studies on minor animal phyla (Yamasaki et al., 2013), updated the molecular phylogenetic placement of the Loricifera (Yamasaki et al., 2015), which sheds new light on a long-standing controversial phylogenetic issue.

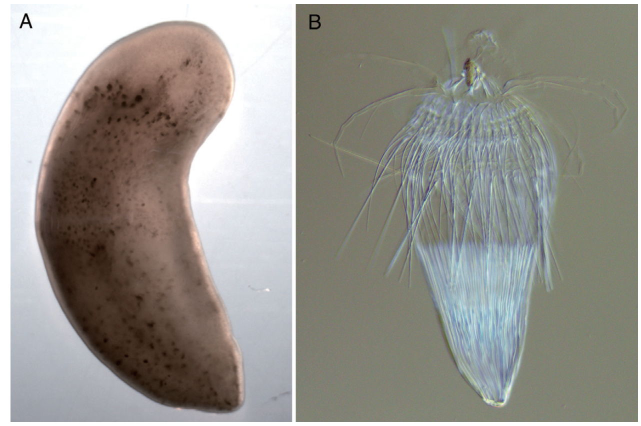

Fig. 3. (A) *Xenoturbella bocki*. Photo by H. Nakano. **(B)** The loriciferan *Rugiloricus* sp. Photo by H. Yamazaki.

Mechanisms underlying animal behavior

In general, animals move but plants and fungi do not. Not only in a naive sense but also from a scientific perspective, behavior is a particularly animal character, and is thus an important research area within the scope of ZL. Mizunami and colleagues reviewed the neural mechanisms of learning and memory in insects, in particular crickets, and fruit flies, thereby highlighting the commonalities and diversity across different insect taxa (Mizunami et al., 2015). Focusing on planarians, Inoue and colleagues performed a series of experiments to analyze the decision-making behaviors in response to simultaneously provided environmental stimuli (Inoue et al., 2015). These experiments demonstrated that even very simple bilaterian animals can adjust their own behavior by integrating multiple external signals in the brain.

Ecological and physiological diversity of animals

The ecological and physiological aspects underpinning the adaptation and survival of animals are also of general importance in zoology. In Lake Tanganyika, herbivorous cichlid species are differentiated into multiple feeding ecomorphs, including grazers, browsers, scrapers, and scoopers, which are sympatric and were thus considered to be segregated by different dietary niches. Hata and colleagues analyzed the carbon and nitrogen stable isotopes in the muscles of these cichlid fish, thereby confirming that the different cichlid ecomorphs are segregated by nutrient sources as well as by feeding depth (Hata et al., 2015). Omote and colleagues investigated the population genetic structure of Blakiston's fish owl, which should further contribute to the conservation of this critically endangered bird species in Japan (Omote et al., 2015). Ogoshi and colleagues investigated expression of a family of peptide hormones, called adrenomedullins, in medaka in response to environmental salinity, suggesting their osmoregulatory function in the freshwater fish (Ogoshi et al., 2015).

Insects as a core group of terrestrial animal diversity

More than half of the animal species that have been described are insects. Although this situation may reflect the biased abundance of insect taxonomists to some extent, many researchers regard insects as the major component of terrestrial metazoan diversity. Consequently, ZL has published a variety of papers addressing different biological aspects related to insects, including circadian rhythms and clocks (Numata et al., 2015; Komada et al., 2015), chemical and structural basis of body colors (Stavenga et al., 2015), the ecological impact of urbanization (Moriyama and Numata, 2015), symbiotic microorganisms (Hosokawa et al., 2015), and other insect-related topics.

Concluding remarks

From 2016 onwards, original articles and reviews of even higher impact and broader interest to world's scientific communities are expected to be published in ZL. Although ZL has not yet covered the entire range of zoology, we anticipate that more papers will be published from fields other than those represented in the present review. We would like to emphasize that the mission advocated by ZL will become increasingly important, considering that we currently face a difficult situation in which zoological studies tend to be pushed towards in the direction of applied science. As an open access journal, ZL will play a substantial role by serving as an interactive forum for zoology, where traditional zoological knowledge and materials are integrated and synthesized with modern biology, genomics, and informatics. Readers are encouraged to enjoy this opportunity and submit their papers to ZL.

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(Received October 1, 2015 / Accepted October 15, 2015)