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# Editorial: Duckweed: Biological Chemistry and Applications

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Editorial on the Research Topic

**Duckweed: Biological Chemistry and Applications**

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The duckweeds (Lemnaceae) are a family of simple, higher plants at the far end of the monocotyledon subdivision. All of the 5 genera and the currently accepted 36 species (Bog et al., 2019, 2020) are aquatic, fresh water plants, mostly floaters or slightly submerged, and all have extremely reduced anatomies. The leaf-like frond of the largest (*Spirodela polyrhiza*, Giant Duckweed) is only 1–1.5 cm in size, while the smallest (*Wolffia angusta*), which also represents the smallest Angiosperm, measures less than 1 mm. Duckweeds can flower, but normally propagate vegetatively, both in nature and in the laboratory, by budding from one or two meristematic zones within pockets in the frond. Species of the genera *Spirodela*, *Landoltia*, and *Lemna* have different numbers of adventitious roots with root caps, which may be more for stability in the water than nutrient uptake; the latter task is managed by the entire underside of the frond (Cedergreen and Madsen, 2002). Species of the genera *Wolffiella* and *Wolffia* are devoid of roots altogether.

As its name implies, duckweeds are a favorite food source for fowl, several fish and other animals as well (Appenroth et al., 2015). Under optimal conditions in nature or in the laboratory, several duckweed species can double their biomass almost daily representing the fastest growing Angiosperms (Sree et al., 2015). Depending on the cultivation conditions, the protein content of the biomass may reach up to 40% or more of the dry weight or the biomass may accumulate starch up to 50 % of the dry weight. In controlled conditions, they can be grown axenically, either autotrophically, mixotrophically, or even heterotrophically (Landolt and Kandeler, 1987). In addition, the genomes of some duckweeds (e.g., *S. polyrhiza*; genome size, $160 \pm 3$ Mbp/1C) are among the smallest for a higher plant (Wang et al., 2011; Bog et al., 2015). Presently, the genome sequence of *S. polyrhiza* clone 9509 represents the "gold standard" for duckweed genomes (Hoang et al., 2018). Coupled with the increasing abilities of several groups to genetically transform (Vunsh et al., 2007) various species of this aquatic family (recently, by CRISPR-Cas, Liu et al., 2019), one can think of "upcoming model system" or "biotech applications."

The present Research Topic demonstrates that research and practical application of duckweeds is flourishing, drawing the attention of researchers as well as application specialists from across the globe. This Research Topic contains a review article about genomes and transcriptomes of duckweeds by An et al. and 12 original research articles organized into separate sections devoted to "Ecology and Biomonitoring," "Biochemistry and Physiology," and "Biotechnology."

In the section "Ecology and Biomonitoring," Paolacci et al. report about competition between two duckweed species, *Lemna minuta* and *L. minor* in Ireland. Yang et al. test the effect of heavy metal $Hg^{2+}$ on three species, *L. minor*, *L. gibba*, and *S. polyrhiza* and investigate the criteria to use duckweed species either for biomonitoring or phytoremediation. Gilbert et al. show that the association between bacterial endophytes and duckweeds belonging to a particular genus correlates with the indole related compounds produced by those endophytes.