SYMPOSIUM

Symposium: The evolution and biodiversity of asexual organisms

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The evolution of asexual eukaryotes provides challenging questions for evolutionary biology. Various reproductive strategies exist in plants and animals (Hojsgaard & al., 2014; Brandeis, 2018). Apomixis, the asexual reproduction via seeds in flowering plants, is often associated with considerable biodiversity and has a wide taxonomic and biogeographic distribution (Asker & Jerling, 1992; Hojsgaard & al., 2014). In plant sciences, considerable progress has been made in understanding genetic and epigenetic control mechanisms, especially focusing on the perspective of utilizing apomictic crop plants (Hand & Koltunow, 2014). However, for many naturally apomictic flowering plants it is still unknown how apomictic lineages originate, establish and persist in natural populations. The long known connection between apomixis, hybridization and polyploidy (Ernst, 1918; Grant, 1981) provides perhaps the most important evolutionary driver for diversification of apomictic plants complexes.

This special issue is an outcome of the Symposium “The evolution and biodiversity of asexual organisms” at the international BioSyst.EU conference (http://www.biosyst.eu/) held in Gothenburg, Sweden, 15–18 August 2017. The symposium dealt with current approaches of assessment of mode of reproduction, evolution, and classification of asexual organisms. Here we present seven papers dealing with various aspects of apomixis research in plants. A major problem for apomixis research is the theoretical and practical difficulty to define species as basic units of biodiversity. The evolution of apomictic lineages and the current approaches of defining asexual species in flowering plants are reviewed by Hörandl (p. 1066). The natural background of this problem is exemplified in Hodač & al. (p. 1082), who analyzed the origin of apomictic taxa via hybridization and the phenotypic diversification of early hybrid generations in *Ranunculus* (Ranunculaceae). By utilizing geometric morphometrics, the paper shows the origin of the huge phenotypic diversity of apomictic complexes out of segregating hybrid offspring, which illustrates the pitfalls of purely descriptive phenetic taxonomic treatments. A second block of three papers deals with Rosaceae, which is one of the prominent families expressing apomixis in many genera. The review article by Dickinson (p. 1093) focuses on occurrences of apomixis in Rosaceae. The importance of unreduced gamete formation, and fertilization, for the origin and dynamics of lineage formation in apomictic polyploid complexes is highlighted. Two further papers present recent research progress in the genus *Potentilla*. By using a combination of molecular data (AFLPs, cpDNA) and flow cytometric data, Nardi & al. (p. 1108) show the recurrent origin of novel polyploid apomictic lineages, especially also via autopolyploidy. The processes during fertilization within and between cytotypes, and the pollen precedence of homoploid pollen are the subject of the study by Alonso-Marcos & al. (p. 1132) on *Potentilla puberula*. The last two papers deal with apomixis in *Limonium* (Plumbaginaceae), a diverse genus distributed on the coasts of Europe. Caperta & al. (p. 1143) report cytotype and genome size variation in sexual and apomictic taxa. Genome size variation appeared to be correlated with taxonomically significant phenotypic variation, notably in leaf size and composition. The paper by Conceição & al. (p. 1153) deals with experimental inter- and intraspecific hybrids in *Limonium*. Hybridization results not only in developmental abnormalities in seedlings, but also in a genetically very diverse offspring, including some neopolyploids.

The symposium demonstrates that a wide range of theoretical and methodical approaches is needed to understand the evolution of apomictic complexes. The review articles by Hörandl (p. 1066) and Dickinson (p. 1093) demonstrate that an understanding of developmental pathways is crucial for understanding the diversity of genotypes and cytotypes in apomictic complexes. Conceptual frameworks are needed to ensure that classifications are relevant to a broad range of concerns, including phylogenetic accuracy, usability, and conservation (Coates & al., 2018). Remarkably, three of the seven papers (Hodač & al., p. 1082, Alonso Marcos & al., p. 1132; Conceição & al., p. 1153) used experimental crosses to get insights into the natural processes shaping the evolution of apomictic plants. This approach is in the tradition with the seminal experiments of Gregor Mendel, who unintentionally detected the hybridogenetic background of most apomictic lineages by experimental crosses in *Pilosella*, and was confronted with the puzzling and unexpected phenotypic diversity of segregating hybrid offspring (Nogler, 2006). The traditional approaches of characterizing leaf shape are being improved by objective data collection and statistical analyses of geometric morphometric data (Hodač & al., p. 1082). The need to collect basic karyological data on ploidy level and genome size variation in many taxa is exemplified by Caperta & al. (p. 1143), while Conceição & al. (p. 1153) and Nardi & al. (p. 1108) demonstrate the usefulness of combining molecular and cytological data for understanding the origins of apomictic plants.

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