Flow cytometry in botanical research: introduction

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Flow cytometry (FCM) is a high-throughput technology that simultaneously measures and analyses multiple parameters of individual particles (e.g. cells, nuclei, chromosomes, etc.). Over the last decade, applications of FCM in plant population and evolutionary biology, ecology, and biosystematics have expanded dramatically both in frequency and scope, primarily addressing questions of phenotypic manifestation, spatial distribution and evolutionary significance of genome duplication (polyploidy), chromosomal variation (aneuploidy) and variation in genome size (Kron et al. 2007). The unsurpassed speed and reliability of estimating differences in nuclear DNA content by FCM paves the way for large-scale surveys at the landscape, population, individual and tissue levels. Representative sampling has made it possible to gain novel insights into the extent of intra- and inter-population ploidy variation, niche differentiation, and ecological preferences of particular cytotypes. Population dynamics, interactions among cytotypes, and unreduced gamete production can be reliably and conveniently assessed with the aid of FCM. The technique is also ideally suited for the detection and quantification of rare evolutionary episodes (e.g. the incidence of minority cytotypes, interspecific crosses, etc.). Another attractive feature of FCM is the possibility of reformulating former taxonomic concepts to propose robust classifications based on a detailed understanding of population structure and phenotypic variation of plant groups under investigation. Discrimination among homoploid taxa and their hybrids, based on differences in nuclear DNA amount, is another unique aspect of FCM. Especially in combination with molecular and phenotypic approaches, FCM represents a powerful analytical tool, which promises qualitative advances in our understanding of the evolutionary significance of genome multiplication and genome size variation in plant systems.

While the first report on FCM analysis of plant samples was published nearly four decades ago (Heller 1973), only quite recently has FCM become a well-established technique in the toolbox of plant biologists. Recent years have seen several milestones in the utilization of plant FCM, including the publication of the first comprehensive book (Doležel et al. 2007) and the development of a web-based Plant DNA flow cytometry database (Loureiro et al. 2008). This special issue aims to pursue previous advances in plant FCM by recapitulating the state of the art of several hotly-debated research topics, presenting model studies that document the value of FCM in botanical research, and outlining promising future directions.

So what is on the menu? The issue includes two reviews, pointing to still largely underestimated possibilities of FCM in studies on homoploid plant groups (Loureiro et al. 2010) and apomicts (Krahulcová & Rotreklová 2010). One of the most controversial issues of current FCM research is the frequency and extent of intraspecific variation in genome size, a topic that is treated in considerable detail by Šmarda & Bureš (2010). Temsch et al. (2010) present the first systematic investigation of genome size variation in liverworts while Kubešová et al. (2010) provide evidence, robust in that it is based on a large set of

alien species, that small plant genomes are associated with successful naturalization of alien species. The case study of Suda et al. (2010) documents how can FCM be effectively used to distinguish phenotypically similar homoploid species on the basis of differences in genome size. There is a dearth of information concerning the ploidy and genome size variation in tropical plant groups. A detailed FCM investigation on the Andean genus *Lasiocephalus* (Dušková et al. 2010) contributes to filling this gap. The most common application of FCM in plant sciences is the estimation of ploidy level. This topic is covered in the papers of Šafářová & Duchoslav (2010) and Trávníček et al. (2010); sample sizes these authors used to address the questions of ploidy distribution at various spatial scales are among the largest that have ever been cytotyped.

For many years, the Czech Republic has been among the leading countries in FCM research, in terms of the breadth of applications, total number of scientific papers, and methodological developments and standards. There are currently at least seven research institutes and/or universities with FCM facilities, with no less than 16 flow intruments, including flow sorters. Therefore, it is perhaps logical that the first special issue on applications of FCM in botanical research is published in the journal of the Czech Botanical Society. We sincerely hope that readers at every level of experience, from newcomers to the field, to seasoned professionals, will find information that meets their specific needs and demands, and that this special issue of Preslia will contribute to further development of plant FCM worldwide.

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