

MODERN PLANT BIOSYSTEMATICS

Modern Plant Biosystematics: Commemorating 50 years of the International Organization of Plant Biosystematists

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The history of the International Organization of Plant Biosystematists (IOPB) dates back to 1960, when the Committee on Biosystematic Terminology of the International Association for Plant Taxonomy (IAPT) was created, and to 1961, when this Committee became an autonomous organization, named IOPB, within the IAPT. The main idea of the organization followed approaches contained within the classical studies of Clausen, Keck and Hiesey (Clausen, 1951) and the coining of the term biosystematics (“biosystematy”) by Camp & Gilly (1943), which emphasized determining the natural units of the plant world. This involves using experimental taxonomy, cytobotany, cytogeography, genecology, biometry, micro-evolutionary and speciation studies as opposed to traditional taxonomy.

Among the first members of the IOPB executive committee were Tyge W. Böcher, Waclaw Gajewski, Claude Favarger, Vernon H. Heywood, Harlan Lewis, Åskell Löve, Børje Lövkvist, Hermann Merxmüller and David H. Valentine. Some recollections of the first Secretary-General of the IOPB, Vernon H. Heywood, are presented in the first paper of this series. In 1983 IOPB became independent from the IAPT and started to publish its own *Newsletter*. The first President of the independent organization was William F. Grant (Montréal). He was followed by Krystyna M. Urbanska (Zurich), Shoichi Kawano (Kyoto), Peter H. Raven (St. Louis), Bengt E. Jonsell (Stockholm), Konrad Bachmann (Amsterdam), Tim Lowrey (Albuquerque), Gonzalo Nieto Feliner (Madrid), and Karol Marhold (Bratislava/Prague). The current President-Elect is Ilse Breitwieser (Lincoln, New Zealand).

Considerable focus in IOPB has been on publishing chromosome number reports. The one hundred parts of the series “IOPB Chromosome Number Reports”, edited first by O.T. Solbrig and Å. Löve and later by Å. Löve only, were published in *Taxon* from 1964 to 1988. Under the editorship of C.A. Stace this activity continued in the *IOPB Newsletter*, where eighteen parts of the *IOPB Chromosome Data* were published from 1989 to 2002. Since 2006 chromosome number records have been published under the heading “IAPT/IOPB Chromosome data” again in *Taxon*, with ten parts already published (available online also from the web page www.iopb.org). Recently, the IAPT and IOPB have also taken over responsibility for publishing the *Index to Plant Chromosome Numbers*, plus maintaining its database. The importance of this activity does not diminish in

the age of molecular systematics, and in fact—quite the opposite—information on ploidy level is crucially important for the interpretation of molecular data, especially at the specific level. Moreover, recent advances in flow cytometry have opened up new possibilities for biosystematic research, enabling large-scale analyses of genome-size evolution, identification and delineation of taxa, studies of polyploids, as well as evolutionary experiments (Kron & al. 2007).

IOPB has organized symposia since 1983 at more or less regular intervals. Symposia were devoted to particular topics, reflecting at the same time current stages of biosystematic research throughout the world. Their topics were as follows: Biosystematic categories and their formal taxonomic recognition (Montréal, Canada, 1962), Plant Biosystematics: 40 Years Later (Montréal, Canada, 1983), Differentiation patterns in higher plants (Zürich, Switzerland, 1986), Biological approaches and evolutionary trends in plants (Kyoto, Japan, 1989), Experimental and molecular approaches to plant biosystematics (St. Louis, U.S.A., 1992), Variation and evolution in arctic and alpine plants (Tromsø, Norway, 1995), Plant evolution in man-made habitats (Amsterdam, The Netherlands, 1998), The origin and biology of desert floras (Albuquerque, U.S.A., 2001), Plant evolution in Mediterranean climate zones (Valencia, Spain, 2004), Evolution of plants in mountainous and alpine habitats (Vysoké Tatry, Slovakia, 2008), and Evolution of plants from tropical to high mountain ecosystems with focus on Asia (Aurangabad, India, 2010). The next symposium will take place in 2013 in Lincoln, New Zealand. Several books and special journal issues have resulted from these symposia (Heywood & Löve, 1963; Grant, 1984; Urbanska, 1987; Kawano, 1990; Hoch & Stephenson 1995; Den Nijs & al., 1999; Van Raamsdonk & Den Nijs, 1999; Lowrey, 2002; Nieto Feliner, 2005). They reflect development of the methodological approaches applied to biosystematics in the last decades and still serve as useful sources of information and insights.

After the Valencia symposium in 2004, it was acknowledged that the main reasons for the split of IOPB and IAPT back in 1983 had disappeared, and that there was no particular reason to keep these two organizations separated. It was decided, therefore, that IOPB should become an interest group of the IAPT and instead of publishing a separate newsletter, to have its own column in *Taxon*. Organization of regular meetings still remains one of the main activities of this group.

The papers presented here derive from the Tenth IOPB Symposium in 2008 in the Vysoké Tatry Mts., Slovakia. Although most of the talks focused on the main topic of the symposium (evolution in mountainous and alpine habitats), in accordance with the tradition of the IOPB symposia, some speakers also addressed more general issues of biosystematics. As the definition of biosystematics grows and evolves with each new generation of scientists (Hoch & Raven, 1995), it is not surprising that it now reflects broad availability and use of molecular tools. This shift is apparent in virtually all contributions presented here.

The current papers contain a mix of reviews and original contributions. The current broad interest in polyploidy is reflected by the high number of papers on this topic in this special issue. **Buggs & al.** address the idea that hybridization promotes whole genome doubling and review developments in this field over the past century. They conclude that there is no current evidence that hybridization between divergent parents serves as a driver for polyploidization. **Brysting & al.** deal with the challenges that come with the reconstruction of reticulate evolutionary patterns using single- and low-copy nuclear data (the RNA polymerase genes). In the arctic-alpine *Cerastium alpinum* complex, they illustrate that the dynamic nature of polyploid genomes is important for evolutionary success, but that at the same time it creates problems for those who attempt reconstructions of evolutionary history of polyploids. Although initially, nascent allopolyploids hold two copies of every single-copy gene in parental taxa, immediately after polyploidization the process of modification of the polyploid genome begins, which involves gene silencing, pseudogenization, and divergence of duplicated genes. *Tragopogon mirus* and *T. miscellus* are important model species for study of the early stages of genome evolution following interspecific hybridization and genome duplication and **Malinska & al.** summarize results from previous and ongoing studies on these species, focusing on rDNA evolution. **Cosendai & al.** evaluate the relationships of polyploidy and apomixis on the alpine species *Ranunculus kuepferi*. They found that the shift to apomixis avoided consequences of meiotic problems and enhanced rapid establishment of autotetraploids. Their results indicate that apomixis is successful even without genomic novelty. [An editorial note here is that ordinarily *Taxon* does not publish papers that deal with only one species, but an exception has been made because this study was contained within the IOPB symposium that focused in part on infraspecific-level evolutionary processes.]

Another block of papers deals with relationships of biogeography and phylogeography. **Nieto Feliner** expresses the idea that well-sampled and well-analyzed phylogeographies may clarify lower-level systematic questions, especially species delimitation and subdivision. He addresses issues connected with southern European refugia, arguing that speaking of single refugia in each of the southern European peninsulas is an oversimplification. Speaking of multiple unconnected refugia, however, also does not seem to reflect the complexity of the processes involved that have shaped current diversity. It may be the case that there simply are no general over-riding phylogeographic patterns in these regions. **Ronikier**, on the

other hand, reviews available phylogeographical studies that include data concerning the Carpathian mountain range. He discusses regional phylogeographical structure and divergence of Carpathian populations of several high-mountain species from those in other European mountain ranges. He indicates several large-scale phylogeographical studies that show a link between these mountains and Siberia and the Alps, or that the Carpathians served as a source area for postglacial recolonization of Scandinavia. **Hörandl** addresses “geographical parthenogenesis” using examples of alpine plants. Alpine biota, with short growing seasons, cold climates, and climatic histories influenced by glaciations, seem predisposed toward evolution and spread of apomictic plants. Nevertheless, as shown in this paper, patterns and causes of geographical parthenogenesis for alpine species remain elusive mainly due to scarce data on their reproductive modes. **Antonelli & Sanmartín** seek answers to the question of why there are so many plant species in the Neotropics. They review evidence for both biotic and abiotic causes of species diversification in this region and suggest possible directions towards further research.

The third block of papers addresses questions of phylogeny and biosystematics of taxa of the genera *Ranunculus* (Ranunculaceae), *Gentiana* (Gentianaceae), and *Melampodium* and *Pilosella* (both Asteraceae). **Hörandl & Emazade** summarize the phylogenetic relationships among alpine species of the almost cosmopolitan genus *Ranunculus*. Using the combined data set of ITS, *matK*, *trnK* and *psbJ-petA* sequences of 245 alpine and lowland species, they examine the origins of alpine buttercups. The conclusion is that most major mountain systems (European Alpine System, Irano-Turanian Mountains, Himalayas, Central Asian Mts., African Mts., and the Andes) have been most likely colonized multiple times independently; only the North American alpine species represent just one clade. **Greimler & al.** provide an overview of the taxonomy, distribution, and regional patterns in groups of closely related taxa of *Gentiana* in the Alps. They discuss evolutionary scenarios based on morphological and AFLP evidence and on cpDNA RFLP data. **Stuessy & al.** tested hypotheses of sectional classification of the genus *Melampodium* using nrITS, 5S rDNA spacer and low copy nuclear *PgiC* gene, as well as plastid *matK* and *psbA-trnH* regions. Finally, **Šingliarová & al.** offer new insights into the evolutionary history and phylogenetic relationships of the *Pilosella alpicola* group with polydisjunctive occurrence across the highest European mountain ranges. Using a wide spectrum of methods, they found that the group comprises several closely related but morphologically distinct and geographically vicariant taxa with specific cytogeographic patterns.

We believe that the following set of papers shows clearly the current stage of development of plant biosystematics as well as its importance within systematics generally. Biosystematics focuses on evolutionary processes that produce diversity that we struggle to classify. Understanding these processes, therefore, is fundamental for constructing informative hierarchies of high predictive quality for societal use. In this context, biosystematics continues to be extremely relevant to activities in our discipline.

Literature cited

- Camp, W.H. & Gilly, C.L.** 1943. The structure and origin of species with a discussion of infraspecific variability and related nomenclatural problems. *Brittonia* 4: 323–385.
- Clausen, J.** 1951. *Stages in the evolution of plant species*. Ithaca: Cornell University Press.
- Den Nijs, J.C.M., Marhold, K. & Hurka H. (eds.).** 1999. Plant evolution in disturbed habitats. *Folia Geobot.* 34: 399–496.
- Grant, W.F. (ed.).** 1984. *Plant biosystematics*. Toronto: Academic Press.
- Heywood, V.H. & Löve, Á. (eds.).** 1963. Symposium on biosystematics. *Regnum Vegetabile* 27. Utrecht: International Bureau for Plant Taxonomy and Nomenclature.
- Hoch, P.C. & Raven, P.H.** 1995. Introduction: Perspectives in biosystematics. *Monogr. Syst. Bot. Missouri Bot. Gard.* 53: ix–xxii.
- Hoch, P.C. & Stephenson, A.G. (eds.).** 1995. Experimental and molecular approaches to plant biosystematics. *Monogr. Syst. Bot. Missouri Bot. Gard.* 53: i–xx, 1–391.
- Kawano, S. (ed.).** 1990. *Biological approaches and evolutionary trends in plants*. London: Academic Press.
- Kron, P., Suda, J. & Husband, B.C.** 2007. Applications of flow cytometry to evolutionary and population biology. *Annual Rev. Ecol. Evol. Syst.* 38: 847–876.
- Lowrey, T.K. (ed.).** 2002. IOPB symposium: Origin and biology of desert floras. *Taxon* 51: 441–473.
- Nieto Feliner, G. (ed.).** 2005. Plant evolution in Mediterranean climate zones. *Taxon* 54: 859–1007.
- Urbanska, K.M. (ed.).** 1987. *Differentiation patterns in higher plants*. London: Academic Press.
- Van Raamsdonk, L.W.D. & Den Nijs, J.C.M. (eds.).** 1999. *Plant evolution in man-made habitats*. Amsterdam: Hugo de Vries Laboratory, Institute for Systematics and Population Biology, University of Amsterdam.