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Multivariate karyomorphometric analysis and taxonomic implications in *Allium* sect. *Cupanoscordum* (*Amaryllidaceae*)

Allium cupanii Raf. is a species complex of the subgenus *Allium*, widely distributed throughout the Mediterranean area and spreading eastwards into the Irano-Turanian region. Its populations are generally scattered and geographically isolated.

Up to now, about 20 distinct species have been described as belonging to this group. Nevertheless, numerous populations having high morphological diversity reveal critical taxonomic assignments and need further investigations.

Despite the marked variability, all populations of *A. cupanii* s. l. show a distinctive combination of morphological features and other anatomical, ultra-structural and cytological peculiarities (Garbari & al. 1979; Tzanoudakis 1983; Tzanoudakis & al. 1991; Brullo & al. 1995, 2008), which support their inclusion in the autonomous sect. *Cupanoscordum* Ceschm. (Brullo & al. 2015; Salmeri & al. 2015).

Significant karyological variation occurs amongst different taxa/populations in the *A. cupanii* group. It is recognized that the ancestral diploid chromosome complement is $2n = 16$, with basic number $x = 8$, as common in the whole subgenus *Allium*. Populations of *A. cupanii* s.l. also exhibit dysploidy ($2n = 14$), polyploidy ($2n = 4x = 32$, $2n = 4x = 30$).

These different chromosome assets are associated to specific diagnostic morphological characters and well-defined eco-geographical patterns, which cluster different taxa and populations in 5 series (Brullo&al. 1995, 2008): *A. callidictyon* Kunth, $2n = 16$ attached bulb-coats, 2-valved spathe, 4bostryces (W-Anatolia, Caucasus, E-Mediterranean); *A. balcanicum* Brullo, Pavone & Salmeri, $2n = 16$ attached bulb-coats, 1-valved spathe, 2-bostryces (EMediterranean); *A. cupanii*, $2n = 32$ attached bulb-coats, 1-valved spathe, 2-bostryces (Sicily, NAfrica); *A. antonii-bolosi* P. Palau, $2n = 30$ attached bulb-coats, 1-valved spathe, 2-bostryces (Balears); *A. hirtovaginatum* Kunth, $2n = 14$ detached bulb-coats, 1-valved spathe, 2-bostryces (SMediterranean coasts). The first group includes all the putative ancestral features of the species complex, modified in the other taxa and series by merging and reduction processes. The occurrence of lacinate tepals is also considered an ancestral character-state, which is shared by most of the species of *A. callidictyon* series (i.e. *A. lacerum* Freyn, *A. incisum* Fomin, *A. fimbriatum* Schischkin, etc.) and further occurs in some W-Anatolian populations of *A. hirtovaginatum*.

In order to test the impact of inter- and intra-specific variation in chromosome structure on the systematic treatment of the *A. cupanii* group and its contribution to allow comparing and understanding affinities and relationships among taxa, multivariate statistics was applied to 34 karyomorphometric parameters from 34 samples belonging to 22 taxa

(known species and critical populations) which represent the main variability with respect to morphological, cytological and ecological patterns within *A. cupanii* s. l.

All statistical analyses were performed on standardized data against standard deviation. The significance of variation among samples for each trait was tested using the Kruskal-Wallis test followed by Steel-Dwass multiple comparison test. The contribution of parameters in discriminating populations was assessed by PCA. Morphological relationships among populations were also analyzed by an agglomerative cluster analysis (CAG).

Results from different combinations of karyomorphometric parameters were very similar and interestingly corroborate relationships among taxa and critical populations already highlighted on the basis of morphological and ecological data, validating the taxonomic and phylogenetic role of karyo-morphometry in biosystematic studies. Both PCA scatter plots and CAG dendrograms showed each polyploid group as well delimited but close together, while species belonging to the diploid series of *A. callidictyon* were rather separated, confirming their taxonomic and geographic isolation, except for *A. lacerum* and *A. incisum* with lacinate tepals, respectively falling next to the related derivative series of *A. balcanicum* (diploid, merged spathevalves, reduced bostryces) and *A. hirtovaginatatum* (dysploid $2n = 14$), especially the populations with incised perigone.

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