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Taxonomic position of *Zhukowskia* Szlach., R. Gonzalez T. & Rutk. (Cyclopogoninae, Spirantheae, Orchidaceae)

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Abstract: The Mesoamerican genus *Zhukowskia* Szlach. R. Gonzalez T. & Rutk. was established in 2000. An original key to species of this genus is presented. A phenetic analysis was performed (with the use of Manhattan distances for 50 characters, UPGMA and complete linkage) to verify the legitimacy of distinguishing genera within the subtribe Cyclopogoninae. The results confirmed their legitimacy and showed that *Zhukowskia* occupies an intermediate position between *Pachygenium* (Schltr.) Szlach., Tamayo & Rutk. and *Sarcoglottis* Presl., but is closer to the latter. Those genera differ mainly in spur structure. In *Pachygenium* the spur base is saccate and the line of adnation of the spur to the ovary is observable externally, while in *Sarcoglottis*, combined lateral sepals do not form such a line. In *Zhukowskia*, the form of flowers is very similar to that of *Sarcoglottis*, but they have a shallow, sac-like spur, which is not continuous with the ovary, and the line between the ovary and lateral sepals is visible externally.

Key words: taxonomy, Spirantheae, Cyclopogoninae, *Sarcoglottis*, *Pelexia*, *Zhukowskia*, Central America

1. Introduction

The subtribe Cyclopogoninae embraces 10 genera (Mytnik *et al*. 2004). It was described by Szlachetko (1995), basing on flower structure, especially the gynostemium. That author distinguished 7 genera: *Cocleorchis* Szlach., *Cyclopogon* Presl, *Pelexia* Poit. *ex* L.C. Rich., *Sarcoglottis* Presl, *Stigmatosema* Garay, *Veyretia* Szlach. and *Warscaea* Szlach. A few years later, new genera were proposed within the Cyclopogoninae: *Zhukowskia* (Szlachetko *et al*. 2000), *Pachygenium* (Szlachetko *et al*. 2001), and *Potosia* (Mytnik 2003).

The representatives of Cyclopogoninae are characterized mainly by a viscidium being produced on the dorsal surface of a soft rostellum, a blunt rostellum remnant, wishbone-like apices of pollinia, and lamellar caudicles.

The generitype of *Zhukowskia* is *Z. smithii* (Rchb. f.) Szlach., R. Gonzalez T. & Rutk. [=*Spiranthes smithii* Rchb.f.]. The name of the genus is dedicated to Professor Waldemar Żukowski.

The aim of the paper is to present taxonomic position of the genus *Zhukowskia* and the infrageneric classification.

2. Material and methods

There were used methods of the classical taxonomy and the phenetic analysis was conducted. The standard work procedure for the herbarium and living material was applied. Each fragment of the studied material was measured, drawn and photographed. All information on the specimen was analyzed and collected in the database. Then the studied specimen was compared with the type material and the protologue. The studies were conducted with the use of a microscope stereoscopic.

To verify a legitimacy of distinguishing particular genera within the subtribe Cyclopogoninae and find the phenetic connections between the genera, a cluster analysis using the Statistica programme was conducted. For estimating the distance between the taxa there was employed the Manhattan distance method for 50 characters. All phenetic characters were given equal weight and were not given *a priori* discriminant value. Two methods of amalgamation were applied: unweighted pair-group average (UPGMA) and complete linkage (CL, furthest neighbour) for comparison of the results. The characters used in the analysis are presented in the Appendix 1.

3. Results and discussions

3.1. Distribution of the genus *Zhukowskia*

The genus, at present composed of 5 species, is restricted in distribution to Mesoamerica (Fig. 1): *Zhukowskia cerina* (Lindl.) Szlach, R. Gonzalez T. & Rutk. – Mexico, Guatemala, Salvador, Nicaragua; *Zhukowskia smithii* (Rchb. f.) Szlach, R. Gonzalez T. & Rutk. (Fig. 2) – Costa Rica; *Zhukowskia lobata* (Lind.) Szlach, R. Gonzalez T. & Rutk. – Mexico, Guatemala, Salvador; *Zhukowskia scintillans* (Greenwood) Szlach., Mytnik & Rutk. – Mexico; *Zhukowskia richardiana* (Schltr.) Szlach., Mytnik, Rutk. – Mexico, Belize. Quoted also from Salvador and Nicaragua by Hamer (1985), but this information needs to be confirmed.

Fig. 1. Distribution of the genus *Zhukowskia* in Central America (grey colour – the range of distribution of the genus)

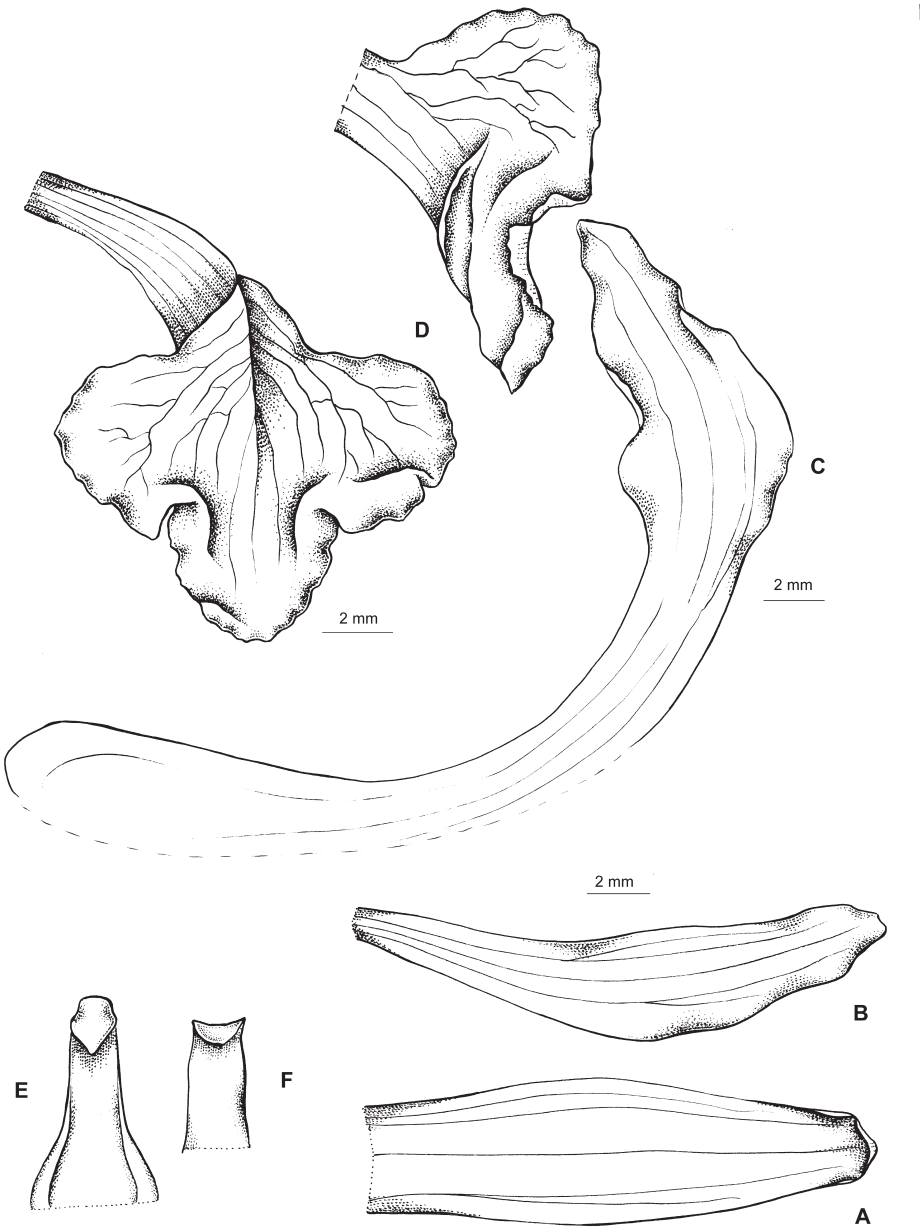

Fig. 2. *Zhukowskia smithii* (Rchb.f.) Szlach., R. Gonzalez T. & Rutk.: A – dorsal sepal; B – petal; C – lateral sepal; D – lip; E – rostellum; F – rostellum remnant; (Smith s. n. W-R, drawing made by J. Mytnik-Ejsmont)

3.2. Key to species of the genus *Zhukowskia*

Below an original key to *Zhukowskia* species is presented:

1 Free part of lateral sepals about 1.5-2.0 times longer than part fused with ovary
Z. cerina

1* Free part of lateral sepals shorter than part fused with ovary ….....….....2

2 Hypochile not constricted, apical third of lip 3-lobed, all lobes subequal in size and shape
Z. smithii

2* Hypochile constricted near apex, lobes of lip absent 3

3 Lower half of hypochile ribbon-like, apical half rapidly expanded, rounded, with truncate apical margins
Z. lobata

3* Hypochile narrowly lanceolate to ovate-lanceolate in outline 4

4 Lip deeply constricted. Epichile as wide as long
Z. richardiana

4* Lip shallowly constricted. Epichile transversely elliptic, twice as wide as long
Z. scintillans

3.3. Taxonomic position of the genus *Zhukowskia*

Previously the species of this Mesoamerican genus were included into *Sarcoglottis* (Schlechter 1920) or *Pelexia* Poit. *ex* L.C. Rich. (Garay 1982). Latest results of research on plastid and nuclear DNA sequences (Salazar *et al*. 2003) show that the recently described genus *Zhukowskia* is closely related to *Sarcoglottis*. Those authors claim that the morphological characters of *Zhukowskia* suggest its intermediate position between *Pelexia* (including *Pachygenium*) and *Sarcoglottis* (including *Potosia*) and its peculiarity is restricted to the presence of a distinct spur only. Every other character resembles the rest of species of *Sarcoglottis*. Those authors recognize *Sarcoglottis* (including *Zhukowskia*, which is treated as a synonym) as a monophyletic taxon.

In some respects *Zhukowskia* occupies an intermediate position between *Pachygenium* (one of the former sections of *Pelexia*) and *Potosia* (one of the former sections of *Sarcoglottis*). The position of the flowers of *Zhukowskia*, form of lateral sepals, the strong adnation of the spur to the ovary, and rostellum structure remind *Potosia,* but the saccate base of the spur and the observable line of adnation of the spur to the ovary make it similar to *Pachygenium* (Szlachetko *et al*. 2005).

A phenetic analysis of Cyclopogoninae (Mytnik 2005) was conducted to verify the legitimacy of distinguishing particular genera within the subtribe. The resultant hierarchic dendrograms (Figs. 3, 4) show phenetic connections between the genera within the Cyclopogoninae. The results of the analysis confirm the legitimacy of distinguishing *Zhukowskia* from other members of the Cyclopogoninae. The genus occupies an intermediate position between *Pachygenium* (12 operational taxonomic units) and *Potosia* (9 operational taxonomic units). The results received by using the UPGMA method show that *Zhukowskia* is more similar to the *Sarcoglottis* group than to the *Pelexia* group.

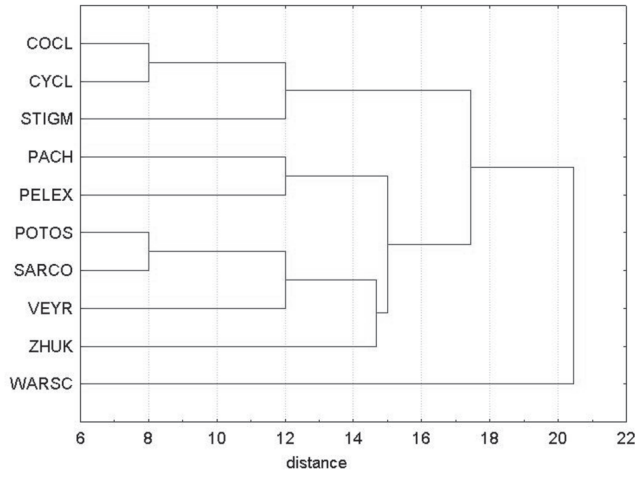

Fig. 3. Dendrogram made by using the UPGMA method: COCL – *Cocleorchis*, CYCL – *Cyclopogon*, STIGM – *Stigmatosema*, PACH – *Pachygenium*, PELEX – *Pelexia*, POTOS – *Potosia*, SRCO – *Sarcoglottis*, VEYR – *Veyretia*, ZHUK – *Zhukowskia*, WARSC – *Warscaea*

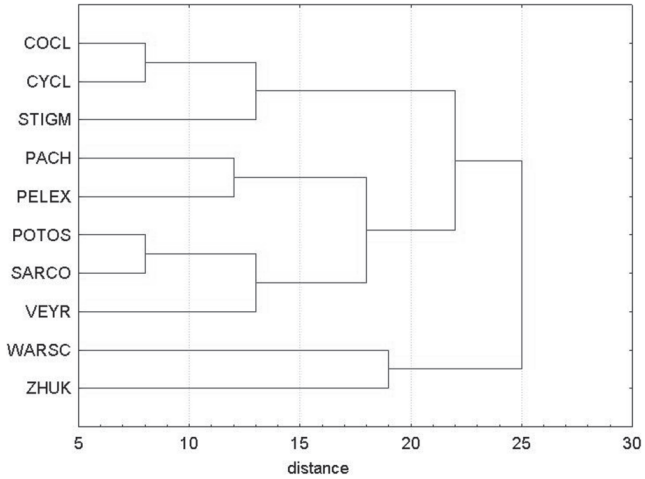

Fig. 4. Dendrogram made by using the CL method: COCL – *Cocleorchis*, CYCL – *Cyclopogon*, STIGM – *Stigmatosema*, PACH – *Pachygenium*, PELEX – *Pelexia*, POTOS – *Potosia*, SRCO – *Sarcoglottis*, VEYR – *Veyretia*, ZHUK – *Zhukowskia*, WARSC – *Warscaea*

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Appendix 1. The set of the characters used in the phenetic analysis

1. leaves present during the anthesis (1) – otherwise (0)
2. leaves gathered in rosette at the base of the stem (1) – leaves along the stem (0)
3. leaf blade grass-like (1) – otherwise (0)
4. leaf petioles narrow (1) – gradually transforming into the leaf blade (0)
5. flowers bent downward strongly (1) – otherwise (0)
6. flowers swollen at the base (1) – otherwise (0)
7. lateral sepals connate together at the base and to the lip in the basal half (1) – otherwise (0)
8. lateral sepals connate together at less than basal half, not less than in 1/5 lenght (1) – otherwise (0)
9. lateral sepals connate one to another at less than 1/5 lenght (1) – otherwise (0)
10. lateral sepals not connate together (1) – otherwise (0)
11. lateral sepals strongly falcate, the angle at least equal 90 degrees (1) – lateral sepals erect or slightly falcate, the angle less than 90 degrees (0)
12. line of adnation of the spur and lateral sepals well visible (1) – not visible (0)
13. spur furcate (1) – otherwise (0)
14. spur oblong cylindrical or conical, distinct (1) – otherwise (0)
15. spur saccate, more or less oval (1) – otherwise (0)
16. spur joined with the ovary completely (1) – otherwise (0)
17. spur joined with the ovary partially, with free apex only (1) – otherwise (0)
18. spur joint with the ovary partially, mostly free (1) – otherwise (0)
19. spur shorter than the half of the ovary (1) – otherwise (0)
20. spur equal or longer than the ovary lenght (1) – otherwise (0)
21. line of adnation of the spur and ovary well visible (1) – otherwise (0)
22. line of adnation of the spur and ovary not visible (1) – otherwise (0)
23. lip isthmus present (1) – absent (0)
24. margins of the isthmus ecallose and involute (1) – otherwise (0)
25. auricles at the lip base oblong, digitate (1) – otherwise (0)
26. gynostemium slender (1) – massive (0)
27. column foot longer than the half of the ovary lenght (1) – otherwise (0)
28. column foot equal or shorter than the ovary lenght, often much shorter (1) – otherwise (0)
29. column foot equal the gynostemium lenght (1) – shorter (0)
30. stigma apex truncate (1) – otherwise (0)
31. rostellum revolute, embracing the pollinia (1) – otherwise (0)
32. rostellum revolute, not embracing the pollinia (1) – otherwise (0)
33. rostellum widest at the apex (1) – otherwise (0)
34. rostellum widest at the base (1) – otherwise (0)
35. rostellum massive after spreading, flabellate, triangular in shape, one of the angles is laid on the stigma apex (1) – otherwise (0)
36. rostellum more or less oblong, lanceolate, slender (1) – otherwise (0)
37. rostellum short, massive, ribbon-like (1) – otherwise (0)
38. rostellum fleshy, massive (1) – otherwise (0)
39. rostellum side-lobes pocket-like, W-shaped in cross-section (1) – otherwise (0)
40. rostellum side-lobes oblong, wing-like (1) – otherwise (0)
41. rostellum side-lobes wing-like, involute, not oblong (1) – otherwise (0)
42. rostellum remnant acute (1) – otherwise (0)
43. rostellum remnant truncate (1) – otherwise (0)
44. rostellum remnant tridentate (1) – otherwise (0)
45. rostellum remnant notched (1) – otherwise (0)
46. rostellum side-lobes distinct (1) – confluent (0)
47. viscidium small, thick, more or less triangular or oblong (1) – otherwise (0)
48. viscidium oblong, slender (1) – otherwise (0)
49. viscidium massive, very thick (1) – otherwise (0)
50. viscidium located on the upper side of the rostellum (1) – viscidium located on the lower and central part of the rostellum (0)