Phytotaxa 172 (2): 081–093
www.mapress.com/phytotaxa/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

http://dx.doi.org/10.11646/phytotaxa.172.2.3

The carpology and taxonomy of some Chinese *Corispermum* (Amaranthaceae s.l.)

ALEXANDER P. SUKHORUKOV[1,2], MINGLI ZHANG[1,3*] & MAYA V. NILOVA[2]

[1] *Key Laboratory of Biogeography and Bioresource in Arid Land, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi, Xinjiang, China; zhangml@ibcas.ac.cn*

[2] *Department of Higher Plants, Biological Faculty, Moscow Lomonosov State University, 119234, Moscow, Russia; suchor@mail.ru*

[3] *Institute of Botany, Chinese Academy of Sciences, Beijing, China.*

**Corresponding author*

Abstract

Corispermum iljinii from Qinghai and Ningxia provinces and *C. nanum* from Xizang (Tibet) are described as new species. The new variety *C. dutreuilii* var. *montanum* is described. Lectotypes of *C. declinatum*, *C. elongatum* and C. *macrocarpum* have been designated. The fruit anatomy of 16 Chinese taxa has been investigated for the first time. Both molecular and carpological data support the specific status of *C. ellipsocarpum*. The general fruit structure of *Corispermoideae* is specified and discussed.

Key words: Chenopodiaceae, China, distribution, fruit anatomy, lectotypification, new taxon

Introduction

The genus *Corispermum* (Linnaeus 1753: 4) comprises at least 70 annual taxa distributed in Eurasia and North America. Central Asia appears to be one of the richest regions in *Corispermum* species. Twenty-seven species are recorded in temperate China (Zhu *et al.* 2003). All of them belong to various groups distinguished in having a perianth with 1(−2) hyaline segments. Concerning the other reproductive characters, especially in fruit morphology, the Chinese taxa highlight an high differentiation. However, their relationships have so far been insufficiently investigated, involving contradictory morphological data (Popov 1959, Klokov 1960, Mosyakin 1994, 1997), carpological investigations (Sukhorukov 2007) and recently combined molecular studies (Xue & Zhang 2011). Nevertheless, molecular phylogeny confirms the existence and distant position of at least some aggregates, such as *C. puberulum* Iljin s.str. (Iljin 1929: 645) and *C. puberulum* var. *ellipsocarpum* C.P.Tsien & C.G.Ma (Kung *et al*. 1978: 118), *C. macrocarpum* Bunge (Bunge 1859: 226) and *C. macrocarpum* var. *rubrum* Fu & Wang-Wei (Liou 1959: 84). Despite the widely accepted view that there are transitional forms between some species (Grubov 1966), or that the number of taxa in the genus might be reduced (Zhu *et al.* 2003), both fine carpology and molecular phylogeny currently reveal a considerable taxonomic diversity in the genus that can be regarded as morphologically cryptic. Among all the traditional methods, fruit anatomy appears to be pivotal for taxonomy and species delimitation when the morphological data do not allow precise identification (Sukhorukov 2007). For the majority of taxa known from China, the fruit anatomy has never been studied, and the present research is focused on filling the existing gaps in the carpology of Chinese taxa. The particular aims of our study are:

(1) taxonomic revision of the *Corispermum* specimens in Chinese collections, including lectotypifications where necessary;

(2) carpological investigations of Chinese species with reference to their taxonomy as well as precise description of the carpological characters of the genus in general.

Materials and Methods

Material preserved in the herbaria LE, MW, PE, XJA, and XJBI (herbarium abbreviations according to Thiers 2008+) was studied. One or two loose fruits from some specimens were used for the carpological analysis (see the Appendix for the

Accepted by Duilio Iamonico: 3 May 2014; published: 13 Jun. 2014

and Sukhorukov (2007, 2009), especially the occurrence of large air cavities (up to 400 μm) between the pericarp and the seed coat in the species having a smooth (not wave-like) pericarp with a well-developed wing [especially *C. huanghoense* C.P.Tsien & C.G.Ma (in Kung *et al*. 1978: 118), *C. pseudofalcatum* C.P.Tsien & C.G.Ma (in Kung *et al*. 1978: 119)]. This characteristic has been evolved only in 'winged' *Corispermum* in contrast to the similar fruits of all spacies belong to *Anthochlamys* Fenzl (1837: 300) (Sukhorukov & Konstantinova 2012). We can also conclude that the well developed wing (more than 0.6–0.7 mm long) occurs in all taxa always thin and narrowly triangular in cross-section. On the other hand the short-winged (up to 0.3 mm) taxa have broadly triangular fruit margins. The average wing length appears to be triangular in cross-section.

In contrast to other Chenopodiaceae, which are often heterocarpous or heterospermous, the fruits and seeds of *Corispermum* species seem to be monomorphic. This can be explained by the reduction of 3- or several-flowered cymes to solitary flower. It is well known that the different types of morphological and anatomical fruit/seed heteromorphism have evolved within one cyme in at least a part of the Chenopodioideae (Kondorskaya 1983, Veselova & Kondorskaya 1990) or Suaedoideae (Iljin 1936). In *Corispermum* (as well as in other Corispermoideae) the solitary flowers are aggregated in spikes with no differences in the developmental stages of the flowers within the partial inflorescences. In general the subfamily *Corispermoideae* Raf. is distinguished from other family members in having the pericarp divided into two different topographical zones: parenchymatous uppermost layers and sclerenchyma below, without any crystalliferous layers in the fruit wall (see Sukhorukov 2008, Kadereit *et al*. 2010, Sukhorukov & Zhang 2013, Sukhorukov *et al.* in prep.). The similar pericarp structure in one of two heterocarpic types in *Axyris* Linnaeus (1753: 979) (Chenopodioideae-Axyrideae: Sukhorukov 2005, 2011) is a synapomorphic trait which has arisen independently in the Corispermoideae and Chenopodioideae subfamilies. The seed coat of the Corispermoideae is thin, mostly up to 10 μm, and consists of 2(−3) equal or subequal [*Agriophyllum* Bieberstein (1819: 6)] layers filled with tannins but without stalactites in the outer cell walls of the testa (the outer seedcoat layer).

Acknowledgments

We are grateful to D. Iamonico (editor of Caryophyllales section of "Phytotaxa"), Irina Belyaeva (Royal Botanic Gardens, Kew), Geoffrey Harper (Royal Botanic Garden Edinburgh), and Maria Kushunina (Lomonosov Moscow State University) for discussion of some parts of the present article, Xian-chun Zhang and Qi Lin (PE Herbarium, Institute of Botany, Chinese Academy of Sciences, Beijing), Ying Feng (XJBI Herbarium, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi), and Dun-yan Tan (XJA Herbarium, Xinjiang Agricultural University, Urumqi) for help in working in herbaria and also the herbaria staff who allowed fruit material to be obtained for the investigation. The investigation was carried out with the support of the Chinese Academy of Sciences visiting professorship for senior international scientists, grant 2012T1Z0020, China National Key Basic Research Program (grant 2014CB954201), and grant of the Russian Fund for Basic Research (project 14-04-00136-a).

References

Baar, H. (1913) Zur Anatomie und Keimungsphysiologie heteromorpher Samen von *Chenopodium album* und *Atriplex nitens*. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften Wien* 121: 21–40.

Baranov, A.I. (1969a) The species of *Corispermum* (Chenopodiaceae) in northeastern China. *The Journal of Japanese Botany* 44(6): 161–169.

Baranov, A.I. (1969b) The species of *Corispermum* (Chenopodiaceae) in northeastern China. *The Journal of Japanese Botany* 44(7): 195–206.

Bieberstein, M. (1819) *Flora Taurico-Caucasica* 3. Typis Academicis, Kharkov. http://dx.doi.org/10.5962/bhl.title.10825

Bunge, A. (1859) *Corispermum* sp. nova. *In:* Maximowicz, C.J. (ed.) *Primitiae Florae Amurensis.* Buchdruckerei der Kaiserl. Akad. Wissenschaften, St.-Petersburg, pp. 224–227.

Butnik, A.A. (1981) Carpological characteristics of the Chenopodiaceae family. *Botanicheskiy Zhurnal* 66: 1433–1443 (in Russian).

Fenzl, E. (1837) *Anthochlamys* (description). *In*: Endlicher, S. (ed.) *Genera plantarum secundum ordines naturales disposita*. Beck Univ. Bibl., Vienna.

Grubov, V.I. (1966) *Plantae Asiae Centralis* 2. Nauka, Moscow–Leningrad, 135 pp (in Russian).

Huang, R.F. (1995) Two new varieties of *Corispermum* (Chenopodiaceae) from Qinghai. *Acta Phytotaxonomica Sinica* 33(3): 306–307.

Iljin, M.M. (1928) *Corispermum declinatum* Stephan – a new weed in fields of the European part of USSR. *Trudy po prikladnoy botanike, genetiki i selektsii* 19(2): 69–72.

Iljin, M.M. (1929) The new *Corispermum* species. *Bulletin Jardin Botanique Principal de l'URSS* 28 (5–6): 637–654.

Iljin, M.M. (1936) Chenopodiaceae. *In:* Shishkin, B.K. (ed.) *Flora of USSR* 6. Izdatelstvo Akademii Nauk, Moscow-Leningrad, pp. 3–254 (in Russian).

IPNI (2013 continuously updated) *The International Plant Names Index*. Available from: http://www.ipni.org/ (accessed: 11 August 2013)

IUCN (2010) The IUCN red list of threatened species, version 2010.4. IUCN Red List Unit, Cambridge, U.K. Available from: http://www.iucnredlist.org/ (accessed 20 January 2012).

Kadereit, G., Zacharias, E., Mavrodiev, E. & Sukhorukov, A.P. (2010) Molecular phylogeny of Atripliceae (Chenopodioideae, Chenopodiaceae): Implications for systematics, biogeography, flower and fruit evolution, and the origin of C4 photosynthesis. *American Journal of Botany* 97 (10): 1664–1687. http://dx.doi.org/10.3732/ajb.1000169

Kitagawa, M. (1935) *Corispermum* in Manshuria and Korea. *Report of the First Scientific Expedition to Manchoukuo*, sect 4(2): 99–105.

Klokov, M.V. (1960) *Corispermum* species growing on Dnepr River and their relatives. *Botanicheskie Materialy Gerbariia Botanicheskogo Instituta imeni V.L. Komarova Akademii Nauk SSSR 20: 90–136.*

Kondorskaya, V.R. (1983) About the inflorescences of the genus *Chenopodium* L. *Bulletin of Moscou Society of Naturalists* 88: 78–87 (in Russian).

Kung, H.W., Chu, G.L., Tsien, C.P., Li, A.J. & Ma, C.G. (1978) The Chenopodiaceae in China. *Acta Phytotaxonomica Sinica* 16(1): 99–123 (in Chinese).

Linnaeus, C. (1753) *Species Plantarum* 1, 2. Salvius, Stockholm, 1-560 pp.; 561–1200.

Liou, N.T. (1959). *Flora plantarum herbacearum Chinae boreali-orientalis* 2. Science Press, Beijing, 120 pp (in Chinese).

McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Proud'Homme van Reine, W.F., Smith, J.F. & Wiersema, J.H. (eds.) (2012) International Code of Nomenclature for algae, fungi and plants (Melbourne Code): Adopted by the Eighteenth International Botanical Congress, Melbourne, Australia, July 2011. Regnum Vegetabile 154: 1–274.

Mosyakin, S.L. (1994) New infrageneric taxa of *Corispermum* L. (Chenopodiaceae). *Novon* 4: 153–154. http://dx.doi.org/10.2307/3391586

Mosyakin, S.L. (1997) New subsections in *Corispermum* L. (Chenopodiaceae). *Thaiszia* 7: 9–15.

Popov, M.G. (1959) Flora of the Middle Siberia 2. Akademiya Nauk, Moscow-Leningrad, pp 1–913 (in Russian).

Sukhorukov (Suchorukow), A.P. (2005) Karpologische Untersuchung der *Axyris*-Arten (Chenopodiaceae) im Zusammenhang mit ihrer Diagnostik und Taxonomie. *Feddes Repertorium* 116 (3–4): 168–176. http://dx.doi.org/10.1002/fedr.200511070

Sukhorukov, A.P. (2007) Fruit anatomy and its taxonomic significance in *Corispermum* (Corispermoideae, Chenopodiaceae). *Willdenowia* 37: 63–87. http://dx.doi.org/10.3372/wi.37.37103

Sukhorukov, A.P. (2008) Fruit anatomy of *Anabasis* (Salsoloideae, Chenopodiaceae). *Australian Systematic Botany* 21(6): 431–442. http://dx.doi.org/10.1071/SB08013/

Sukhorukov, A.P. (2009) Ergänzungen zur Flora Iranica – Familie Chenopodiaceae. *Annalen des Naturhistorischen Museums in Wien* 110 B: 153–158.

Sukhorukov, A.P. (2011) *Axyris* (Chenopodiaceae s.str. or Amaranthaceae s.l.) in the Himalayas and Tibet. *Willdenowia* 41(1): 75–82. http://dx.doi.org/10.3372/wi.41.41108

Sukhorukov, A.P. & Konstantinova, A.I. (2012) Fruit anatomy of *Anthochlamys* (Chenopodiaceae/Amaranthaceae). *In*: Timonin, A.K. & al. (eds.), *Caryophyllales: New insights into the phylogeny, systematic and morphological evolution of the order*: Proceedings of the Symposium held in Moscow on 24th-27th September 2012. Grif & Co, Tula, pp. 92–97 (in Russian).

Sukhorukov, A.P. & Zhang, M. (2013) Fruit and seed anatomy of *Chenopodium* and related genera (Chenopodioideae, Chenopodiaceae/Amaranthaceae): Implications for evolution and taxonomy *Plos One* 8(4): 1–18. http://dx.doi.org/10.1371/journal.pone.0061906

Thiers, B. (2008+) [continuously updated] *Index herbariorum*: *A global directory of public herbaria and associated staff*. New York Botanical Garden, Bronx, NY. Available from: http://sweetgum.nybg.org/ih/ (accessed 20 June 2013).

Trautvetter, E.R. (1884) Incrementa florae phaenogamae rossicae. Fasc. 3 *Trudy Imperatorskogo Sankt-Peterburskogo Botanicheskogo Sada* 9(1): 1–220. http://dx.doi.org/10.5962/bhl.title.9939

Veselova, T.D. & Kondorskaya, V.R. (1990) Development of the reproductive organs in *Atriplex nitens* Schkuhr. *In:* Tikhomirov, V.N. & Sladkov. A.N. (eds.) *Morphology of Centrospermae as source of evolutionary information*. Univ. Press, Moscow, pp. 48–65 (in Russian).

Xue, J.J. & Zhang, M. (2011) Monophyly and infrageneric variation of *Corispermum* L. (Chenopodiaceae), evidence from sequence data psbB-psbH, rbcL and ITS. *Journal of Arid Land* 3: 240–253.

Zhu (Chu), G.-L., Mosyakin, S.L. & Clemants, S.E. (2003) Chenopodiaceae. *In:* Wu, Z. & Raven, P.H. (ed*.) Flora of China* 5: Ulmaceae–Basellaceae. St. Louis, pp. 351–414.