

New Taxa of *Corispermum* L. (Chenopodiaceae), with Preliminary Comments on the Taxonomy of the Genus in North America

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ABSTRACT. Five new species and three varieties of *Corispermum* L. (Chenopodiaceae) are described from North America. *Corispermum pacificum* Mosyakin and *C. pallidum* Mosyakin are restricted to the Pacific Northwest; *C. welshii* Mosyakin is known from Utah and adjacent parts of Wyoming; *C. navicula* Mosyakin occurs in Colorado and probably adjacent states; *C. hookeri* Mosyakin is known from Canada. *Corispermum pacificum* is closely related to the Asian taxa *C. crassifolium* Turczaninow and *C. maynense* Ignatov; *C. pallidum* is possibly related to *C. macrocarpum* Bunge ex Maximowicz; the three remaining new taxa and all other native North American taxa are allied to the *C. pallasii* Steven aggregate. The nomenclature of *C. pallasii* [= *C. leptopterum* (Ascherson) Iljin = *C. sibiricum* Iljin subsp. *baicalense* Iljin = *C. bjelorusicum* Klovkov & Krasnova], *C. villosum* Rydberg, and *C. americanum* (Nuttall) Nuttall is discussed. Three new varieties are described: *C. americanum* var. *rydbergii* Mosyakin, *C. hookeri* var. *pseudodeclatum* Mosyakin, and *C. ochotense* var. *alaskanum* Mosyakin. *Corispermum ochotense* Ignatov, a species recently described from the northeastern part of the Russian Far East, is reported from Alaska and northwestern Canada, where it is represented by two varieties. *Corispermum ochotense* var. *alaskanum* differs from the typical variety in having larger fruits. Preliminary results of a study of the genus in North America are discussed.

Corispermum has the reputation of being a problem for taxonomists and may be regarded as one of the most taxonomically complicated groups within Chenopodiaceae. As an example, the name *Corispermum hyssopifolium* L., which refers to a species restricted mostly to a small area in southeastern Europe and adjacent parts of western Asia, has been misapplied to almost all other species of the genus. For a long time the representatives of this genus were believed to have been introduced to North America from Eurasia. In the treatment by Maihle and Blackwell (1978) only three species were reported for North America: *C. hyssopifolium* L., *C. nitidum* Kitaibel ex Schultes, and *C. orientale*

Lamarck (all Eurasian). However, it is now clear from the fossil evidence that *Corispermum* was present in North America at least 38,000 years before the present (for details see Betancourt et al., 1984). Native American species of *Corispermum* are evidently closely related to eastern Asian (especially Siberian) ones (see discussion below).

I strongly believe that even less than 10,000 years was sufficient for Asian ancestors of North American taxa to evolve into several distinct races (species or subspecies) because the high rate of microevolutionary processes is crucial for a successful life strategy of such annual psammophytes of pioneer and marginal habitats. The important microevolutionary patterns within the genus include both allogamy (performed by wind pollination) and autogamy (especially under unfavorable environmental conditions), high degree of morphological variability (including so-called "cryptic variability"), and high possibility of hybridization (especially between closely related species), which is typical for many other chenopods, including *Chenopodium* L. However, polyploids, which are fairly common in *Chenopodium* and many other genera of the family, seem to be absent, or at least extremely rare, in *Corispermum*: all taxa studied until present were diploids with $2n = 18$ (for additional discussion, see Adamkiewicz, 1970; Strazdin'sh, 1985; Mosyakin, 1988a).

In the course of preparation of a taxonomic treatment of *Corispermum* for the *Flora of North America*, it has become evident that several new species and varieties should be described. Before describing these taxa I will briefly discuss the taxonomy of other *Corispermum* species from North America. However, I should mention that the taxonomic treatment of the genus in North America is not yet complete, and more efforts, especially study of variability in the natural habitats, are needed. At present my experience in North American *Corispermum* is based exclusively on herbarium studies, plus some experience with Eurasian species, which was especially crucial for this work, and four weeks of fieldwork in the southwestern United States (Utah and Nevada). Because of this, some of the following

considerations (especially concerning the *C. pallasii* Steven–*C. americanum* (Nuttall) Nuttall aggregate) should be regarded as preliminary, a kind of brief introduction to the taxonomic problems in North American *Corispermum*. A history of taxonomic study of the genus in North America, as well as literature citations, may be found in Maihle and Blackwell (1978); thus, some of the dates and references are not mentioned below in order to avoid repetition.

DISCUSSION

The first taxon described from North America was *C. hyssopifolium* L. var. *americanum* Nuttall [= *C. americanum* (Nuttall) Nuttall]. Unfortunately, its authentic description is insufficient, and the lectotype specimen (Nuttall s.n., PH; labeled “*C. hyssopifolium* var. *pubescens*”) is immature. In my opinion, this specimen cannot be assigned with certainty to any native or introduced species. Because of this, in the early stage of my work on North American *Corispermum* I regarded the name *C. americanum* as a nomen dubium. Fortunately, there is another authentic specimen, which evidently was annotated by Nuttall. This specimen is deposited in the Besser memorial collection at KW. It is labeled “*Corispermum hyssopifolium* * *americanum* m. Nuttall”; as in other similar cases, an asterisk indicates the taxon described by Nuttall himself. The herbarium sheet contains an immature plant, which is almost identical to the PH specimen, and a branch from another plant, which is more mature. *Corispermum americanum* was cultivated by Nuttall (see Nuttall, 1818), and probably the more mature specimen represents a fragment collected from a cultivated plant. Because of this find the long-neglected name *C. americanum* can be restored.

Judging from the description of *Corispermum pilosum* Rafinesque (1836) (since no authentic herbarium material has yet been traced), this taxon does not belong to *Corispermum* at all. It was described from Florida, where no species of *Corispermum* are (or have been) known. The name *C. pilosum* probably refers to the hispid form of *Salsola kali* L. aggregate (immature specimens of *Corispermum* and *Salsola* L. are often confused in herbaria). Moreover, the name is a later homonym of *C. pilosum* Pallas.

In my opinion, *Corispermum villosum* Rydberg (1897) should be regarded as a distinct native species, which is closely related to the North American *C. americanum* and Asian–North American *C. pallasii* Steven (see below), and possibly also to *C. chinganicum* Iljin (more distantly). Intermediate

forms between *C. americanum* and *C. villosum* occasionally occur in regions where these species are sympatric. The characteristic features of *C. villosum* s. str. are small (usually $1.8\text{--}3.0 \times 1.5\text{--}2.0$ mm) fruits, almost wingless, or with a narrow wing up to $0.1\text{--}0.15$ mm broad; both wingless and narrow-winged forms are sympatric, but wingless plants seem to be much more common in the Rockies. In the taxonomy of *Corispermum*, as well as of many other Chenopodiaceae, the most reliable characters are those of the fruits. The degree of pubescence is an unstable character in most representatives of the genus: it largely depends on the age of the plant (plants often become glabrous at maturity). Because of this I can find no sound justification for maintaining *C. villosum* and *C. emarginatum* Rydberg (1904) as separate species. The lectotype of the first species (Montana: Manhattan, 1895, Rydberg 2623, US; isoelectotype at NY) is younger and, consequently, more pubescent; the type of *C. emarginatum* (Wyoming: Laramie, 15 Sep. 1897, Aven Nelson 4282, RM; isotypes at GH, MO, NY) is completely mature and almost glabrous. However, the fruit characters are essentially the same in both species, and, in my opinion, these taxa should be united under the name *C. villosum*, which has priority.

Corispermum imbricatum A. Nelson (1909) and *C. simplicissimum* Lunell (1910), despite their differences in habit, both have small narrow-winged fruits of similar shape and dimensions. The type of *C. imbricatum* (Wyoming: Laramie Hills, 29 Aug. 1902, Elias Nelson 733, RM) represents a morphotype, with stems branched from the base, and inflorescences distinctly clavate and dense at the apex. This morphotype is somewhat transitional toward *C. villosum*. The authentic specimens of *C. simplicissimum* (type: North Dakota: Pierce Co., Barton, on a lake shore, 26 Aug. 1890, Lunell 395, MIN) are branched above the base, and their inflorescences are more lax and narrow; judging from available herbarium specimens, this morphotype seems to be common in the Great Plains region. It differs from typical *C. americanum* only in branching habit. In both *C. imbricatum* and *C. simplicissimum*, branches of inflorescences are simple or nearly so. These taxa probably represent extremes of the variability of *C. americanum* s.l.

Corispermum americanum has the largest area of distribution among the native species of *Corispermum*, centered mostly in the Rocky Mountains and adjacent portions of the Great Plains, and it is very variable, especially in its vegetative characters. Plants occurring in the Great Plains region usually have winged fruits and often show some degree of

morphological transition toward *C. pallasii* (see below).

Specimens related to the *Corispermum pallasii*–*C. americanum* aggregate with unusually large (up to 4.5–5.0 mm long) wingless or narrow-winged fruits are known from the southwestern United States (mostly Texas, Oklahoma, Colorado, New Mexico), and from western central Canada (mostly Alberta and Saskatchewan). The Canadian plants are evidently more closely related to *C. pallasii* s. str. and *C. ochotense* Ignatov var. *alaskanum* Mosyakin described below, but they are very different in habit: inflorescences are usually short-clavate, dense and thick, with strongly imbricate broad bracts. The large-fruited Canadian plants are probably identical to "*C. hyssopifolium*" var. *robustius* Hooker (see Hooker, 1840). However, I have not seen the type of Hooker's variety. Because of this I am not convinced that it is the same as the large-fruited Canadian plants, and prefer to describe the latter as *C. hookeri* Mosyakin (see below).

The large-fruited plants from the southwestern United States are more closely related to *Corispermum americanum* s. str. They differ from northern large-fruited specimens in having fruits more elongate and obovate (more distinctly broadest above the middle than in the Canadian specimens), often with white warts (formed by loose portions of pericarp) and reddish brown spots (a character that occurs in several species, including *C. pallasii*), usually with a more prominent triangular "beak" (formed by the style bases in mature fruits) at the apex. Some of these forms remain enigmatic, and more information is needed to determine their taxonomic status. The most striking and recognizable morphotype is described below as *C. navicula* Mosyakin.

Another complicated case is *Corispermum marginale* Rydberg. In the protologue Rydberg (1903) cited one collection from New Mexico and three localities from Colorado. His description matches the characters of some plants occurring in the southwestern United States and northern Mexico. These plants differ from *C. americanum* s. str. and *C. villosum* s. str. in having fruits larger, up to 4.0(–4.5) mm long, and more prominently winged (wing usually ca. 0.2–0.4 mm broad), and usually a more interrupted inflorescence. Thus, Rydberg's concept of *C. marginale* as a species distinct from *C. villosum* was correct, and it is unfortunate that he cited as the holotype the New Mexican specimen (Albuquerque, 1884, *C. L. Herrick s.n.*, NY) with small narrow-winged fruits. This specimen differs from *C. americanum* s. str. only in having slightly more lax spikes, which is not sufficient for regard-

ing it as specifically distinct. As is evident from his comments, Rydberg (1897) believed that *C. hyssopifolium* s. str. was a species with large fruits (up to 5 mm long); this erroneous concept probably affected his decision, since he apparently tried to stress the difference between his *C. marginale* and *C. hyssopifolium* (sensu Rydberg). The name must stand or fall together with the type, and because of this the epithet "marginale" should be regarded as a synonym of *C. americanum* s. str. However, I believe that other specimens cited by Rydberg (paratypes) represent a distinctive variety (or possibly subspecies), and it is validated below as *C. americanum* var. *rydbergii* Mosyakin. This variety, as well as some other forms of *C. americanum*, usually has lax spikes, and due to this was constantly misidentified by North American authors as *C. nitidum*.

For a better understanding of these taxa, it is necessary to comment briefly on *Corispermum nitidum* Kitaibel ex Schultes (or "so-called *C. nitidum*"). I have seen several herbarium specimens of the true *C. nitidum* collected in North America recently. Judging from the fruit morphology, almost all American representatives of the "*C. nitidum*" morphotype belong to the *C. pallasii*–*C. americanum* aggregate. Because of this I strongly believe that most of the records of this species from North America are referable to *C. americanum*. The first collections of the "*C. nitidum*" morphotype were made as early as 1847 in New Mexico (*A. Fendler* 702, GH, MO); 1852 in Chihuahua, Mexico (*G. Thurber* 811, GH); 1873 (*T. S. Brandegee* 841, MO); 1878 (*Marcus A. Jones* 655, MO); 1881–1882 in Colorado ("Common along Pueblo," *R. W. Woodward s.n.*, GH); 1879 in Texas (*E. Palmer* 1165, GH); these are only examples based on GH and MO collections. This list may be greatly extended by inclusion of references to specimens from other herbaria. In the earliest collections most of the mentioned localities were on the edge of civilization, and I cannot believe that European *C. nitidum* had already been widespread in the relative "wilderness" of the North American West. In the middle of the nineteenth century this species was poorly known even in Europe. Its natural area of distribution originally covered only the Pannonian (southeastern Central Europe, mostly along the Danube River and some of its tributaries in Hungary, Austria, Romania, and Bulgaria) and Pontic (southern Ukraine and southwestern Russia) floristic regions, with a small extension into the Turanian area (northwestern Kazakhstan). Besides, *C. nitidum* does not seem to be a markedly invasive species. It is definitely introduced in some locali-

ties in Europe (e.g., in Poland, Byelorussia, central Russia, etc.), but it cannot be regarded as widespread in the Old World. At present I know only two cases of successful and comparatively wide territorial expansion of *Corispermum* species: *C. pallasii* (= *C. leptopterum*) in central and western Europe, and *C. declinatum* Stephan ex Iljin in eastern Europe and southwestern Siberia.

Amazing morphologic parallelism is common in *Corispermum*. For example, typical specimens of *C. heptapotamicum* Iljin (central Asia) may be distinguished from *C. nitidum* by their broader, usually linear-oblongate lower leaves, and fruits somewhat similar to those of *C. lehmannianum* Bunge; but in many cases herbarium specimens are almost indistinguishable. Such species as *C. filifolium* C. A. Meyer ex A. Becker, *C. aralocaspicum* Iljin, and *C. declinatum* also can be confused with *C. nitidum*. Fortunately, in all these cases the fruit characters help to distinguish the taxa. Another example of this striking parallelism between some New World and Old World taxa of Chenopodiaceae is *Chenopodium novopokrovskyanum* (Aellen) Uotila (see Uotila, 1993), a species of the *C. strictum* Roth aggregate restricted to arid regions of southeastern Europe and the Irano-Turanian portion of Asia, which is similar in habit (but not closely related) to native North American taxa of the *C. leptophyllum* Nuttall ex S. Watson aggregate.

The species that seems to be common in the Great Lakes region is conspecific with *Corispermum leptopterum* (Ascherson) Iljin, a taxon described from central Europe. However, in Europe this species is evidently introduced; the possible means of its introduction will be discussed in the forthcoming review of the European species of the genus. Voss (1985) was the first to suggest that the Great Lakes plants may be conspecific with *C. leptopterum*.

Forms identical with *Corispermum leptopterum* are known from Siberia (especially southern and eastern parts, plus adjacent portions of Mongolia and China), where they are commonly referred to as *C. sibiricum* subsp. *baicalense* Iljin (see Strazdin'sh, 1985). At present I cannot find evident differences between most of the Siberian, European, and North American plants of this aggregate, except for usually narrower leaves, more lax and narrow spikes, and slightly smaller fruits in average North American specimens. I believe that this species may also be native in North America, at least in part.

Deciding which name has priority for Siberian "*Corispermum leptopterum*," one must consider at least two older names: *C. patens* Fisher ex Roemer

& Schultes and *C. pallasii* Steven (both described from Siberia; see Steven, 1817). I have not yet traced any mature and unquestionably authentic specimens of the first species, and it still remains a nomen dubium. The type of *C. pallasii* (Dahuria, *Helm s.n.*, H) belongs to the group that includes plants previously referred to mostly as *C. sibiricum* s.l. The holotype specimen is not completely mature, and because of this I previously hesitated to assign it to a particular race of this group. Moreover, some presumably authentic specimens of *C. pallasii* in Besser and Turczaninov memorial collections at KW belong to *C. redowskii* Fischer ex Steven, a distinctive Siberian species with pubescent undulate-winged fruits. However, Steven knew *C. redowskii* well (see Steven, 1817), and it is improbable that he could confuse it with another species. He mentioned only one collection of his *C. pallasii* ("Semina in specimine juniore a D. Helm mihi dato, videntur emarginata"), which should be consequently regarded as the holotype. Study of several young fruits of the type of *C. pallasii*, and their comparison with immature fruits of European *C. leptopterum* and Siberian *C. sibiricum* subsp. *baicalense*, revealed no evident difference between them. Thus, the earliest available name for this species is *C. pallasii*.

Corispermum pallasii may be distinguished from other species occurring in the United States and Canada by its comparatively large (usually 3.0–4.5 × 2.0–3.5 mm), obovate or obovate-elliptic fruits (normally distinctly broadest above the middle); thick wing (translucent only along margins) (0.2–) 0.3–0.4 mm broad, which is usually long-adnate to the style bases, forming a broadly triangular or rounded-triangular apex; style bases often separated to below the edge of the wing; and inflorescences usually clavate and rather dense, or occasionally clavate-linear (the last character is very variable). Judging from the morphology of the fruits, this species is closely related to *C. americanum*.

Some European forms of the *Corispermum pallasii* aggregate, known mostly as *C. membranaceum* Iljin or *C. leptopterum* var. *membranaceum* (Iljin) Aellen, have smaller and less winged fruits, morphologically approaching *C. americanum*. The Asian relatives of *C. pallasii* are: *C. stauntonii* Moquin-Tandon, *C. elongatum* Bunge ex Maximowicz s.l. (including *C. confertum* Bunge ex Maximowicz), *C. candelabrum* Iljin, *C. bardunovii* M. Popov ex M. Lomonosova, and some other species. *Corispermum sibiricum* Iljin s. str. (subsp. *sibiricum* = subsp. *jenissejense* Iljin) is also related to this aggregate, but more distantly. *Corispermum sibiricum* subsp. *amurense* Iljin is conspecific with *C. elon-*

gatum. For additional information about *C. pallasii* (= *C. leptopterum*) see Iljin (1929), Aellen (1961, 1964), Strazdin'sh (1985), Köck (1986), and Mosyakin (1988b).

In the *Atlas Florae Europaeae* (Jalas & Suominen, 1980) and the second edition of *Flora Europaea* (Aellen & Akeroyd, 1993), *Corispermum pallasii* (= *C. leptopterum*) and another distinct species, *C. gallicum* Iljin, were erroneously submersed in *C. intermedium* Schweigger. The latter is a distinctive endemic of the southeastern coast of the Baltic Sea, and its differences from *C. pallasii* are numerous and evident: constant absence of perianth segments, broadly ovate or almost orbiculate fruits with broader wing rounded at the apex, etc. In spite of some similarity between the habits of *C. intermedium* and the *C. canescens* Kitaibel ex Schultes—*C. marschallii* Steven aggregate, their history and development were independent, representing two hypothetical migration routes in the westward European expansion of the genus: northern route, affected mostly by glacial factors of the Pleistocene, especially Riss-Würm/Mikulino interglacial; and southern route, affected mostly by the pre-Pleistocene and Pleistocene transgressions and regressions of inland seas. The first migration path may be traced from east to west by the present distribution of *C. algidum* Iljin (northeasternmost European Russia), *C. intermedium* (Baltic Sea coasts), and *C. gallicum* (southern France). Additional evidence supporting this geohistorical reconstruction may be found in the discovery of fossil fruits of *Corispermum* in the Late Weichselian deposits in England (ca. 42,000–45,000 years BP) and Belgium (see Godwin, 1975; Bell, 1969). The genus was not known from the British Isles in historical times until the very recent discovery of introduced *C. pallasii* reported by Gibson (1992) as *C. leptopterum*. The end of the second (southern) migration path of *Corispermum* in Europe is marked by the westernmost area of natural distribution of *C. canescens* s. str. and *C. nitidum* in the Pannonian floristic region.

Because of some parallels between arid and nutritionally deficient habitats (see Small, 1973), the xeromorphic species of *Corispermum* are well adapted to both hot deserts of central Asia and southwestern North America, and cool river shores of subarctic Siberia and Alaska. Usually they are most abundant in pioneer, marginal, and naturally and/or artificially disturbed habitats. In the Quaternary the most widescale pre-anthropogenic disturbance was caused by Pleistocene glaciations (see, e.g., Pielou, 1991); the glacial events affected both distribution and evolution of many species

with “weedy” life strategies (see Harlan & de Wet, 1965). An excellent example of a response of “weedy” species to the glacial and post-glacial events of the late Pleistocene and Holocene is *Ambrosia* L. (see Bassett & Terasmae, 1962).

I believe that the Pleistocene glaciations and early Holocene post-glacial events played an important role in the history of *Corispermum*. Expansions and retreats of glaciers, as well as eustatic and isostatic sea level changes, created many pioneer, marginal habitats, especially fluvio-glacial, alluvial, littoral deposits in coastal and limnetic areas, river valleys, etc. Abundance of such habitats provided excellent migration routes for ancestors of modern species of *Corispermum*. Since some evidence exists that paleo-Americans collected and consumed *Corispermum* fruits (see Betancourt et al., 1984), the possible role of prehistoric people in the local dispersal of seeds should also be taken into consideration.

More detailed reconstruction of the history of distribution and migration of *Corispermum* during the Pleistocene and Holocene will be published later. However, it seems to be useful to mention some basic considerations concerning the history of the genus in North America.

Corispermum was present in North America at least 38,000 years BP (before present) in Alaska and the Yukon, 11,000–14,000 years BP in Arizona and Utah, ca. 4,000 years BP in New Mexico (for details see Betancourt et al., 1984; Matthews, 1982; Rosendahl, 1948; Young, 1982).

In my opinion, ancestors of the modern native North American taxa of this genus migrated to non-glaciated parts of Alaska and the Yukon through the Bering Land Bridge after the Pelukian (Kazan-tsevo/Sangamon) sea transgression, most possibly after Zyryanka/Early Wisconsin glaciation, during the Kargin (Zyryanka-Sartan) interstadial. Their further southward expansion became possible after the retreat of Late Wisconsin glaciers and separation of Laurentide and Cordilleran ice sheets. There is also the possibility of their migration to more southern parts of North America during the Middle Wisconsin interstadial; this helps to explain the most ancient records of fossil *Corispermum* fruits in the southwestern United States.

Judging from the present distribution of *Corispermum* species and available fossil records of the genus, there were at least three main paleo-migration routes of ancestors of modern taxa in North America. All these routes started in non-glaciated parts of Beringia. The Pacific route followed the coastal line of the Pacific Ocean and main river valleys of northwestern North America. This route

seems to be the main migration path for ancestors of *C. pacificum* and *C. pallidum*. The two other migration corridors are marked by the present distribution of species of the *C. pallasii*-*C. americanum* aggregate. One of these reconstructed routes went southward and partly southwestward along the Rocky Mountains and adjacent plains, and another crossed Canada in a southeastern direction toward the Great Lakes. During their expansion, species of *Corispermum* probably followed shorelines of Pleistocene glacial and post-glacial paleo-lakes (Agassiz, McConnell, precursors of the Great Lakes, etc.) and ancient river valleys, as well as fluvio-glacial deposits exposed after the retreat of glaciers.

VALIDATION OF NEW TAXA

As stated above, *Corispermum* is represented in North America by several native species belonging to at least three species aggregates (species groups). Five of these species are described below.

Corispermum pacificum Mosyakin, sp. nov.

TYPE: U.S.A. Washington: Wawawai, apparently introduced, Oct. 1893, *C. V. Piper* 1770 (Native ! 1900 *C. V. P.*) (holotype, GH; isotypes, F, GH, MIN, MO, NY, UC). Figure 1A.

Planta annua, ca. 15–40 cm alta, a basi ramosa, glabra vel sparsim stellato-pilosa (saepissime in partibus juvenilibus). Folia 2–5(–7) cm longa, 0.2–0.6 mm lata, anguste lanceolata, lineari-lanceolata vel linearia, plana, apice brevissime mucronulata. Inflorescentia plerumque compacta, densa vel rarius plus minusve remotiflora, apice solum congesta; ovoidea, elongato-ovoidea, elongato-clavata, rarius late linearia. Bractae saepissime (1.0–)1.5–2.5 cm longae, 0.3–0.7(–0.9) cm latae; ovato-lanceolatae, anguste ovato-lanceolatae, ovatae, lanceolatae, apice acuminatae; saepissime late membranaceo-marginatae, imbricatim dispositae. Perianthium monophyllum, apice denticulatum. Fructus maturi 3.0–4.0 × 2.7–3.8 mm, subrotundati vel rotundato-obovati, per lineam medium latissimi vel rarius leviter supra medium, in fronte paulo convexi vel rarius subplani, a tergo plerumque plani vel leviter concavi, nitiduli, alati; ala plerumque (0.2–)0.3–0.6 mm lata, membranacea, subpellucida, margine undulata vel irregulariter minutissime denticulata (rarius integerrima), apice rotundata vel rarius submarginata; nucleus maturus saepissime niger, rarius atro-olivaceus.

Annual plant ca. 15–40 cm tall (or occasionally more?), usually branched from the base; glabrous, or sparsely covered with branched and almost stellate hairs (especially when young). Leaves usually 2–5(–7) cm long, 0.2–0.6 mm broad, narrowly lanceolate, linear-lanceolate, or linear; flat or nearly so; short-mucronulate at apex. Inflorescences usually compact, rather dense, or sometimes ± lax, condensed only near the apex; ovate, ovate-elongate, obovate, elongate-clavate, or occasionally

broadly linear. Bracts (1.0–)1.5–2.5 cm long, 0.3–0.7(–0.9) cm broad; ovate-lanceolate, narrowly ovate-lanceolate, almost ovate, or lanceolate, acuminate at apex; usually with broad membranous margins; overlapping. Perianth segment 1, with erose or denticulate apex. Mature fruits usually 3.0–4.0 × 2.7–3.8 mm, almost orbicular or orbicular-obovate in outline, broadest near the middle (or rarely slightly above the middle); slightly convex (rarely almost flat) at the abaxial side, flat or slightly concave at the adaxial side; shiny; winged. Wing usually (0.2–)0.3–0.6 mm broad, thin, translucent; slightly undulate or indistinctly erose-denticulate at margins; rounded or rarely indistinctly emarginate (notched) at apex. Mature fruit body (nucula, “kernel”) in most cases black (rarely deep olive green), sharply contrasting with greenish semi-transparent wings.

Corispermum pacificum is not closely related to other native or introduced North American taxa. Its closest allies are Siberian *C. crassifolium* Turczaninov and *C. maynense* Ignatov. The latter species occurs in the northeastern Russian Far East and may be expected to occur in Alaska and/or northwestern Canada. *Corispermum pacificum* differs from *C. maynense* by its usually more robust habit, and its wing rounded (rarely rounded-truncate or indistinctly emarginate, but not triangular) at apex. From *C. crassifolium* it may be distinguished by the constant presence of perianth segments, and more flattened black mature fruits. At present *C. pacificum* is known to me only from cited localities in Washington, Oregon, and northwestern Idaho, but it probably also occurs in adjacent regions of British Columbia.

The specimens of this species were misidentified by Maihle and Blackwell (1978) partly as *Corispermum hyssopifolium*, and partly as *C. nitidum*. I do not agree with these determinations, nor with reasons for splitting *C. pacificum* into two species.

Paratypes. U.S.A. **Idaho:** Nez Perce Co., sandy island in Clearwater River, opposite Lewiston, 12 Oct. 1924, *H. St. John* 6792 (UC). **Oregon:** Howell’s Pacific Coast Plants, Josephine Co., Grant’s Pass, Sep. 1887, *Thomas Howell* s.n. (OSC); Multnomah Co., sandy bar on the Columbia River just E of the “Interstate Bridge,” 23 Sep. 1915, *M. A. Flinn* s.n. (OSC); Plants of Oregon. Sand bar on Hayden Island opposite Vancouver, Washington, 11 Oct. 1919, *J. C. Nelson* 2955 (GH); Whitman Co., Wawawai, Snake River, dry river sands, 13 Oct. 1923, *F. A. Warren* 168 (NY); Flora of Northwest America. Sandy ground, Hayden Island, Oregon, 8 Oct. 1927, *J. W. Thompson* 3915 (MO, PH); Hood River Co., sandy muddy bank of the Columbia River, with *Riccia* and *Cyperus*, about 15–20 mi. W of the Dalles, Oregon, 22 Oct. 1961, *Georgia Mason* 4201 (OSC). **Washington:** Flora of Washington Territory. Northern Transcontinental Survey, Yaki-

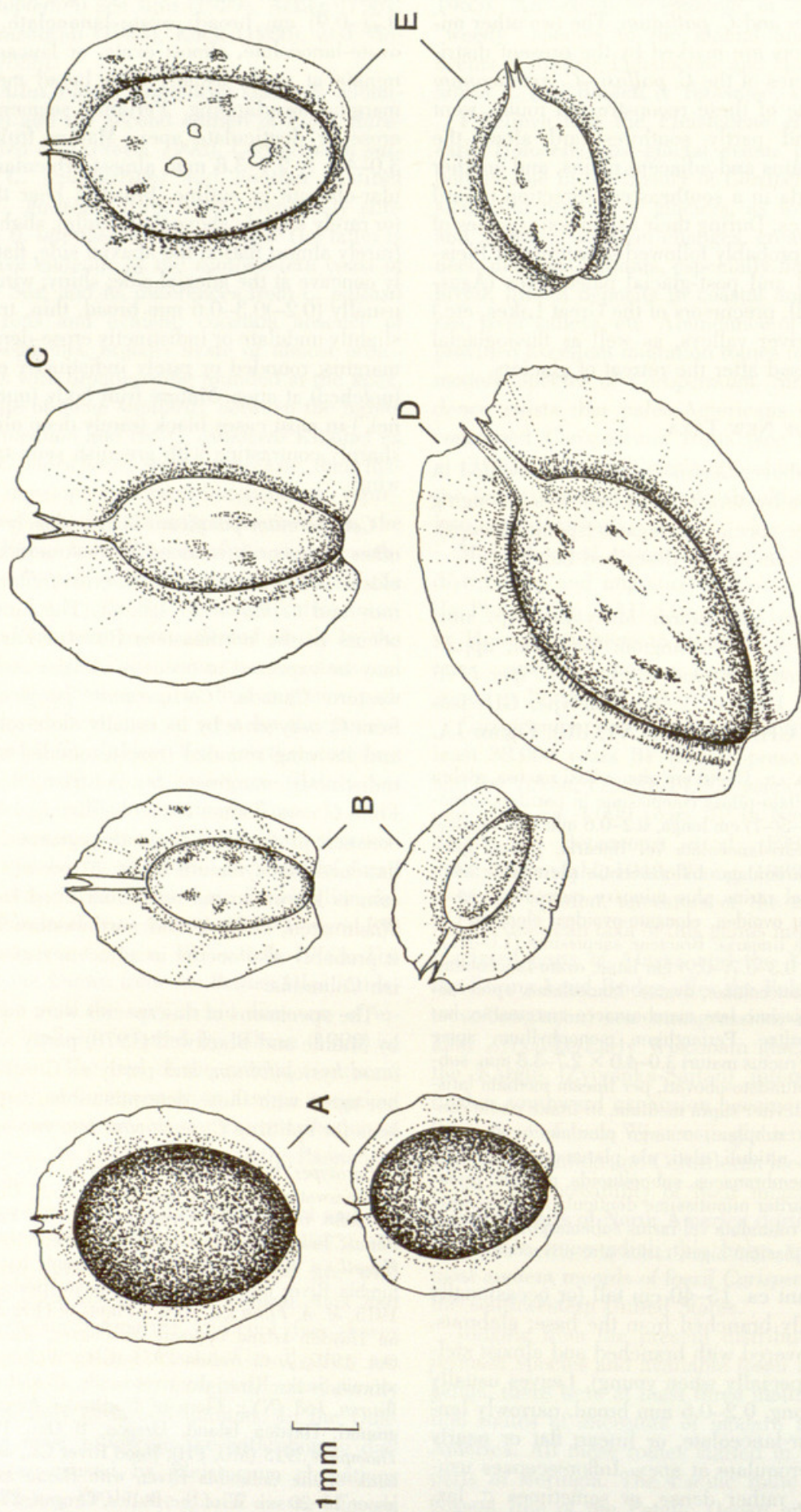


Figure 1. Fruits of *Corispermum*: comparison between North American and Asian species. —A. *Corispermum pacificum* (North America). —B. *Corispermum pallidum* (North America). —C. *Corispermum platypterum* (Asia). —D. *Corispermum macrocarpum* (Asia). —E. *Corispermum welshii* (North America).

ma Region, sands of the Columbia, Oct. 1882, *Frank Tweedy* s.n. (NY); W. Klickitat Co., sandy banks of the Columbia River, 11 Sep., 29 Oct. 1893, *W. N. Suksdorf* 1385 (F, GH, MIN, MO, NY, UC) [A mixed collection; see note below—S.M.]; Klickitat Co., Spedio, sandy shores and sandy slopes, very common, 19 Sep. 1925, *M. W. Gorman* s.n. (OSC); Whitman Co., sandy bank of the Snake River at Wawawai, 15 Oct. 1939, *Marion Ownbey & Ruth P. Ownbey* s.n. (CAN, GH, OSC, PH, RM, RSA, TEX, UC); Whitman Co., Wawawai-Lewiston road along Snake River, on sandy beach at edge of river, 15 Sep. 1956, *R. T. Ogilvie* s.n. (DAO, UBC).

Some degree of reproductive isolation between the sympatric species of *Corispermum* exists because of different phenology, especially different flowering period. However, occasional hybrids probably occur between partly sympatric *C. pacificum* and *C. villosum*. These hybrids are similar in habit to *C. pacificum*: they have usually broad leaves and dense inflorescences. However, many of their fruits (up to 50–70%) are abortive, almost lacking a perisperm. Occasional well-developed fruits are polymorphic and show transitional characters: they are usually narrow-winged or almost wingless, strongly convex at the abaxial side (characters of *C. villosum*), black or nearly so, broadly ovate to orbiculate in outline (characters of *C. pacificum*). The high percentage of abortive fruits indicates that *C. pacificum* and *C. villosum* are taxonomically rather distant species, because hybrids between closely related taxa of *Corispermum* (i.e., belonging to the same species aggregate) usually show no evident loss of fertility. The studied specimens of *C. pacificum* × *C. villosum* are cited below:

U.S.A. **Oregon:** Umatilla Co., mouth of Umatilla River, Umatilla, 11 July 1915, *M. E. Peck* 6667 (OSC); along Columbia, opposite Dalles, Oregon, 1915, *J. Evans* s.n. (OSC); Baker Co., 28 Nov. 1952, *LeRoy Wright* s.n. (OSC); Hood River Co., drifting sand of the Columbia River, 10 Sep. (fl), 1 Oct. 1923 (fr), *L. F. Henderson* 344 (of 1924) (MO). **Washington:** Wallula, sandy soil, alt. 220 m, 17 Sep. 1894, *J. B. Leiber* 912 (OSC).

***Corispermum pallidum* Mosyakin, sp. nov.**

TYPE: U.S.A. Washington: Douglas Co., in drifting sand, Wilson Creeks, 25 July 1893, *J. H. Sandberg & J. B. Leiber* 309 (holotype, MO; isotypes, CAN, F, OSC, PH, UC, US). Figure 1B.

Planta annua, ca. 5–25 cm alta, a basi ramosa, subglabra vel in partibus juvenalibus stellato-pilosa et minutissime papillosa. Folia 2–5 cm longa, 0.1–0.2(–0.3) cm lata, linearia, anguste linearia vel filiformia, plana vel partim convoluta, apice brevissime mucronulata. Inflorescentia plerumque laxiuscula, rarius densiuscula; linearia vel elongato-linearia. Bractaeae (0.5–)1.0–1.5(–2.0) cm longae, 0.2–0.5 cm latae; plerumque anguste ovato-lanceolatae

vel lanceolatae, apice acuminatae; saepissime membranaceo-marginatae, imbricatim dispositae vel plus minusve remotae. Perianthium monophyllum, apice denticulatum. Fructus maturi saepissime 2.8–3.5(–3.8) × 2.4–2.8(–3.3) mm, rotundato-obovati vel obovati, plerumque supra medium vel rarius per lineam mediam latissimi, in fronte subplani vel subplano-convexi, a tergo plerumque plani vel leviter concavi, subnitidi vel opaci, alati; ala plerumque 0.7–1.0 mm lata, membranacea, subpellucida, margine erosa vel irregulariter eroso-denticulata (rarius subintegra), apice stylorum basi longe adnata, emarginata vel rotundata; incisura inter basin stylorum margine alarum profundiore; nucleus maturus pallidus, stramineus vel brunneus, saepe maculatus.

Annual plant ca. 5–25 cm tall (or more?), branched from the base, almost glabrous, or covered with branched and almost stellate hairs and minute papillae (especially on veins of young bracts and upper leaves). Leaves 2–5 cm long, 0.1–0.2(–0.3) cm broad, linear, narrowly linear, or filiform; flat or occasionally convolute (especially at maturity); acuminate or short-mucronulate at apex. Inflorescences usually lax, rarely rather dense; linear or elongate-linear. Bracts usually (0.5–)1.0–1.5(–2.0) cm long, 0.2–0.5 cm broad, usually narrowly ovate-lanceolate or lanceolate, acuminate at apex; in most cases with distinctly membranous margins; overlapping or slightly remote. Mature fruits 2.8–3.5(–3.8) × 2.4–2.8(–3.3) mm, rounded-obovate or obovate in outline, usually broadest above the middle or occasionally near the middle; almost flat or slightly convex at abaxial side, plane or slightly concave at adaxial side; slightly shiny or dull; winged. Wing normally 0.7–1.0 mm broad, thin, translucent, with erose or irregularly erose-denticulate (rarely almost entire) margins; long-adnate to the style bases, emarginate (notched) or rounded at apex. Style bases unusually long (ca. 0.7–1.0 mm, including their parts adnate to wing), in most cases divided to below the edge of the wing. Mature fruit body (“kernel,” nucula) flattened, pale, usually straw-colored or yellowish brown, occasionally with reddish brown spots.

Corispermum pallidum seems to be a well-defined species. The combination of its characters is very distinctive: pale, flattened, and small fruit body; very broad (especially as compared to the fruit dimensions), thin translucent wing with erose margins; and long style bases distinctly divided in their upper parts. Young bracts and upper leaves of *C. pallidum* are often papillose on margins and veins, in combination with typical branched trichomes. This character (papillosity) is quite rare in *Corispermum*, since most of its species are normally covered only with branched or almost stellate hairs. The same combination of branched hairs and min-

ute papillae occasionally occurs in some Asian species. It is hard to believe, but *C. pallidum* seems to be most closely related to the eastern Asian species *C. macrocarpum* Bunge ex Maximowicz, which occurs at present in the southern Russian Far East and northeastern China, mostly along the Amur River and some of its tributaries. Two Manchurian species, *C. stenolepis* Kitagawa and *C. platypterum* Kitagawa, also belong to the same aggregate (for additional information about these Asian taxa, see Kitagawa, 1935; Baranov, 1969; Tsien Cho-po & Ma Cheng-gung, 1979). Fruits of *C. pallidum* are very similar to those of *C. macrocarpum* in their morphological features, but not in their size; the latter species has much larger fruits 5.0–6.0(–6.5) $\times$ 3.8–5.5 mm (Fig. 1B–D).

Maihle and Blackwell (1978) placed rather uniform specimens of *Corispermum pallidum* into two taxa, *C. hyssopifolium* sensu Maihle & Blackwell (Sandberg & Leiberg 309, Thompson 6764) and *C. nitidum* sensu Maihle & Blackwell (St. John, Courtney & Parker 4948).

Paratypes. U.S.A. **Washington:** Flora of Eastern Washington. Wilson Creek, July 1893, J. H. Sandberg & J. B. Leiberg s.n. (MIN); Grant Co., dry sand, SW of Moses Lake, alt. 1000–1150 ft., 25 June 1921, Harold St. John, W. D. Courtney & Charles S. Parker 4948 (GH, UC); Grant Co., sandy sagebrush plains near Quincy, 15 June 1931, J. William Thompson 6764 (GH, MO).

***Corispermum welshii* Mosyakin, sp. nov. TYPE:**

U.S.A. Utah: Kane Co., sand dunes, with ponderosa pine, willow, and gambel oak, ca. 1900 m, Coral Pink Dunes, T43S, R8W, S8, ca. 8 mi. due W of Kanab, 25 Sep. 1992, S. L. Welsh & K. H. Thorne 25170 (holotype, MO; isotypes, BRY, NY). Figure 1E.

Planta annua, ca. 10–35 cm alta, a basi ramosa, dense vel sparsim stellato-pilosa. Folia 2–6 cm longa, 0.2–0.4(–0.5) cm lata, lineari-lanceolata vel linearia, fere plana vel rarissime partim subconvoluta, apice brevissime mucronulata. Inflorescentia plerumque compacta, densa vel rarius plus minusve laxiuscula, apice congesta; ovoidea, elongato-ovovata vel elongato-clavata. Bractae 1.0–3.0 cm longae, 0.3–0.8 cm latae; ovatae vel ovato-lanceolatae, rarius anguste ovato-lanceolatae, apice acuminatae; late membranaceo-marginatae, imbricatim dispositae. Perianthium monophyllum, apice denticulatum. Fructus maturi saepissime (3.3–)3.7–4.6 $\times$ (2.7–)3.0–3.6 mm, obovati vel rotundato-obovati, plerumque supra medium vel rarius per lineam mediam latissimi, in fronte convexi, a tergo plerumque leviter concavi, subnitidi vel opaci, alati; ala plerumque (0.3–)0.4–0.6 mm lata, membranacea, subpellucida (rarius valdiuscula, margine solum subpellucida), margine integra vel irregulariter eroso-denticulata, apice rotundata, truncata vel submarginata; nucleus maturus stramineus, fulvus vel brunneus, saepissime maculatus et albido-verrucosus.

Annual plant ca. 10–35 cm tall (or more?), branched from the base or nearly so, densely or sparsely covered with branched or stellate hairs. Leaves 2–6 cm long, 0.2–0.4(–0.5) cm broad, linear-lanceolate or linear, usually plane, or rarely slightly convolute or folded (especially in dried plants), short-mucronulate at apex. Inflorescences usually rather compact and dense, rarely $\pm$ lax, condensed only at apex; ovate, oblong-obovate, or oblong-clavate in outline. Bracts 1.0–3.0 cm long, 0.3–0.8 cm broad, ovate or ovate-lanceolate (rarely narrowly ovate-lanceolate), acuminate at apex, with broad membranous margins. Perianth segment 1, minutely dentate at apex. Mature fruits normally (3.3–)3.7–4.6 $\times$ (2.7–)3.0–3.6 mm, broadly obovate or obovate-orbicular in outline, in most cases broadest above the middle (rarely near the middle); convex at abaxial side, usually concave at adaxial side; slightly shiny or dull; winged. Wing usually (0.3–)0.4–0.6 mm broad, thin, translucent (or occasionally more thick, translucent only at margin), with entire or irregularly erose-denticulate margins; rounded, truncate, or indistinctly emarginate at apex. Mature fruit body (nucula, “kernel”) straw-colored (yellowish brown), light brown or brown, usually with reddish brown spots and whitish warts.

This species is probably closely related to the broad-winged and large-fruited plants of the southwestern U.S.A. (*Corispermum americanum* var. *rydbergii* Mosyakin), which Rydberg included in his *C. marginale* (excluding the type of *C. marginale*). However, *C. welshii* differs from the mentioned variety, as well as from *C. americanum* sensu proprio, in having shorter, broader, and denser spikes, distinctly broader leaves and bracts, more rounded (occasionally almost orbicular), and often more prominently winged fruits. Its difference from *C. villosum* is also evident, since it has larger fruits approximately twice as long and broad as the latter. From *C. pallasii* it may be distinguished by its more orbicular fruits having membranaceous wings, which are rounded, rounded-truncate, or indistinctly emarginate at apex. In general appearance *C. welshii* resembles some eastern Asian taxa, for example, *C. elongatum* s.l. It is also somewhat similar in habit to European *C. marschallii* but is not closely related to it. At present *C. welshii* is known to me only from Utah and Wyoming, but similar forms (which are in need of additional study) occur also in other southwestern states, particularly in Colorado and western Texas. For example, the following collection from western Texas probably also belongs to *C. welshii* (it differs from typical plants in having more lax spikes and prostrate habit, but the fruits

are almost identical to those of the type): Flora of Texas. Gypsum, Hudspeth Co., from 13 mi. E of Dell City on nearly barren gypsum dunes, 14 Oct. 1984, R. D. Worthington 12752 (TEX).

Paratypes. U.S.A. **Utah:** Millard Co., sand dunes, alt. 4500 ft., 18 Sep. 1926, collected by Cottam, determined by Garrett 1010 (BRY); Millard Co., juniper association, sand dunes, 18 Sep. 1926, coll. A. O. Garrett 1010 (RM); Salt Lake Co., South Salt Lake City, just S of intersection of 7400 South and 20th East in a sand dune area, alt. 4650 ft., T. 25, R. 1 E., SE $\frac{1}{4}$ of Sec. 28, 29 Oct. 1967, L. Arnou 805 (GH), 805a (COLO); Kane Co., Halls Creek Bay, Lake Powell, sandy benchland, 4 June 1972, S. L. Welsh & G. Moore 11797 (BRY) [this plant evidently was buried by sand, and because of this it has developed atypically long branches—S.M.]; Kane Co., Coral Pink Sand-dunes State Park S of Mt. Carmel Junction, elev. 5500 ft., 11 Oct. 1972, B. Albee 1215 (UT); Uintah Co., T3S, R22E, SW Sec. 4, Red Fleet Reservoir, ca. 6000 ft. elev., opens in juniper community, sandy soil, 3 Oct. 1980, E. Neese & M. Chatterley 9894 (NY, RM) [these specimens have fruits slightly smaller than in the type—S.M.]; Kane Co., Navajo Sandstone, Ponderosa, Oakbrush community, T43S R7W S30, Moquith Mountain, ca. 7 mi. W of Kanab, 2142 m elev., 25 Sep. 1992, K. Thorne & S. L. Welsh 15192 (BRY) [also a specimen with slightly smaller fruits—S.M.]. **Wyoming:** Sweetwater Co., sand dunes, near Steamboat Mt., 1 Sep. 1936, Marion Ownbey & Robert L. Lang 1122 (COLO); Niobrara Co., T34N R61W Sec 36 SE $\frac{1}{4}$, sandy roadside, associates: *Cenchrus*, *Salsola*; elev. 4700 ft., 26 Sep. 1986, R. Dorn 4549 (NY) [inflorescences of this specimen are more lax than in the type, showing a transition toward *C. americanum*—S.M.].

***Corispermum navicula* Mosyakin, sp. nov.**

TYPE: U.S.A. Colorado: Jackson Co., North Park, North sand dunes due E of Dowell Ranch, T10N, R78W, Sec. 6, between Government Creek and North Sand Creek, Eagle Hill Quadr., 29 Sep. 1976, F. Martin Brown s.n. (holotype, COLO).

Planta annua, ca. 5–15(–25?) cm alta, a basi ramosa, sparsim stellato-pilosa vel glabriuscula. Folia (1.5–)2–4 cm longa, 0.1–0.5 cm lata, anguste lanceolata vel lineari-lanceolata, plana, rarissime partim convoluta. Inflorescentia plerumque compacta, densa, ovoidea vel elongato-ovoidea. Bracteae 0.5–2.0 cm longae, 0.2–0.6 cm latae; imbricatim dispositae. Perianthium monophyllum. Fructus maturi (4.2–)4.5–5.0(–5.2) $\times$ 2.5–3.0 mm, elongato-obovati, supra medium latissimi; in fronte valde convexi, a tergo plerumque distinctissime concavi; apteri vel anguste alati. Ala plerumque 0.1–0.2(–0.3) mm lata, valdiuscula, non pellucida vel semipellucida; margine integerrima vel minutissime eroso-denticulata, saepe involuta; apice rostrata, triangularia, stylium basi longe adnata. Nucleus maturus atro-brunneus vel atro-viridis, plerumque maculatus et/vel albido-verrucosus.

Annual plant ca. 5–15(–25?) cm tall, branched from the base, sparsely covered with branched and almost stellate hairs, or almost glabrous. Leaves (1.5–)2–4 cm long, 0.1–0.5 cm broad, narrowly lan-

ceolate or linear-lanceolate, flat or rarely convolute. Inflorescences usually compact and dense, ovate or oblong-ovate in outline. Bracts 0.5–2.0 cm long, 0.2–0.6 cm broad, strongly imbricate. Perianth segment 1. Mature fruits (4.2–)4.5–5.0(–5.2) $\times$ 2.5–3.0 mm, elongate-obovate or narrowly obovate-elliptic, broadest above the middle; strongly convex at abaxial side, usually prominently concave at adaxial side; narrowly winged or almost wingless. Wing usually 0.1–0.2(–0.3) mm broad, rather thick, not translucent, or semi-translucent; with entire or indistinctly erose margins, often involute toward the adaxial side; rostrate-triangular and long-adnate to style bases at apex. Mature fruit body (nucula, “kernel”) usually dark brown or dark green, usually with dark spots and whitish warts.

This species is amazingly similar in its fruit morphology to the Siberian species *Corispermum bardunovii* M. Popov ex M. Lomonosova (see M. N. Lomonosova, 1992). *Corispermum navicula* and *C. bardunovii* probably represent results of parallel evolution (or parallel variability?) within North American and Asian representatives of the *C. pallasii* aggregate, respectively. It is also worth mentioning that the most distinctive characters of *C. navicula* and *C. bardunovii*, such as elongated fruit body with almost parallel margins in the middle portion and distinctly triangular apex, show a transition (or a parallel evolutionary trend?) toward the representatives of *Corispermum* sect. *Declinata* Mosyakin (1994). Additional study of *C. navicula* is desirable for clarification of its relationships with other species. Some specimens from Oklahoma (e.g., Stillwater, Oklahoma, in sand on bank of Cimarron, 6 Nov. 1899, E. E. Bogue s.n., MIN) probably also belong to *C. navicula*, or at least approach this species most closely.

Paratype. U.S.A. **Colorado:** Jackson Co., North Sand Hills, E of Cowdrey, T10N, R78W, S6 NE $\frac{1}{4}$, 2575 m, 1 Oct. 1982, D. H. Wilken 13924 (NY, RM).

***Corispermum hookeri* Mosyakin, sp. nov. TYPE:**

Canada. Saskatchewan: District de Moose Jaw, palier sablonneux au pied du Coteau du Mis-souri, 5–6 mi. à l’est de Mortlach, dune éven-trée, 11 Sep. 1960, B. Boivin & G. F. Led-ingham 14079 (holotype, DAO; isotypes, NY, TRT, UBC).

Planta annua, ca. 10–40 cm alta, a basi ramosa, spar-sim stellato-pilosa vel glabriuscula. Folia 2–5 cm longa, (0.1–)0.2–0.5(–0.6) cm lata, anguste lanceolata vel li-neari-lanceolata, plana. Inflorescentia plerumque densa ovoidea, ovato-clavata vel ovato-cylindrica, rarissime in-terrupta. Bracteae 0.5–1.5(–2.0) cm longae, 0.3–1.0 cm latae, ovatae vel ovato-lanceolatae, imbricatim dispositae.

Perianthium monophyllum. Fructus maturi (3.2–)3.5–4.5(–5.0) × 2.2–3.3(–3.5) mm, elongato-obovati vel obovati, per lineam mediam latissimi vel leviter supra mediam latiores; in fronte valde convexi, a tergo concavi vel subplani; apteri vel angustissime alati. Ala ad 0.2 mm lata, semipellucida; margine integerrima, apice rotundata vel leviter triangularia. Nucleus maturus atro-olivaceus, brunneus vel rarissime niger, plerumque non maculatus et non verrucosus, rarius maculatus.

Annual plant ca. 10–40 cm tall (or occasionally more?), branched from the base, sparsely covered with branched and almost stellate hairs. Leaves usually 2–5 cm long, (0.1–)0.2–0.5(–0.6) cm broad, narrowly lanceolate or linear-lanceolate, plane. Inflorescences usually dense, ovate, ovate-clavate, or ovate-cylindric, rarely interrupted (especially near the base). Bracts 0.5–1.5(–2.0) cm long, 0.3–1.0 cm broad, ovate or ovate-lanceolate, imbricate (usually strongly overlapping). Perianth segment 1. Mature fruits (3.2–)3.5–4.5(–5.0) × 2.2–3.3(–3.5) mm, oblong-obovate or obovate, broadest near the middle or slightly above the middle; strongly convex at abaxial side, prominently concave to subplane at adaxial side; wingless or narrowly winged. Wing (when present) up to 0.2 mm broad, semi-transparent; margins entire, apex rounded or indistinctly triangular. Mature fruit body (nucula, “kernel”) usually deep olive green, brown, or rarely almost black, normally without spots and/or warts, or occasionally spotted.

This species seems to be most closely related to *Corispermum pallasii* s. str. and *C. ochotense* var. *alaskanum* (see discussion above and comments on *C. ochotense* below). It is also similar to the small-fruited species, *C. villosum*, and to the large-fruited *C. navicula* described above. Some specimens of *C. hookeri* from British Columbia have unusually elongated fruits somewhat similar to those of Asian species of *Corispermum* sect. *Declinata*. These plants are described below as a new variety.

Paratypes. CANADA. **Alberta:** Lethbridge, 27 Aug. 1911, *M. O. Matt* s.n. (CAN); Battle River, S of Wainwright, sandy soil, near river bank, 8 Sep. 1951, *E. H. Moss* 9725 (DAO) [the voucher specimen: 2n = 18, determined by G. A. Mulligan]; SW of Orion, sand dunes, grazed by livestock in the area, 28 Aug. 1952, *E. H. Moss* 10110 (CAN). **British Columbia:** very common on Dryas Island in Fraser River at Hope, 19 July 1914, *T. L. Thacker* s.n. (UBC); Lytton, 26 Sep. 1922, *W. B. Anderson* 6678 (V); in sand landfill near Alex Fraser Bridge, Annacis Island, many plants in sand, 7 Sep. 1988, *Frank Lomer* s.n. (UBC); sandy ground under the Pattullo Bridge, Surrey, a single plant, 7 Sep. 1991, *Frank Lomer* s.n. (UBC); Steveston, Richmond, Lulu Island, 49°07'N, 123°10'W, 7 Sep. 1992, *Huber Moore & Terry Taylor* s.n. (UBC); sand landfill dredged from Fraser River, near Fraser Surrey Docks, Surrey, many plants in sand, 27 Aug. 1993, *Frank Lomer* s.n. (UBC) [this plant is transitional toward *C. hook-*

eri var. *pseudodeclinatum* Mosyakin described below—S.M.]. **Manitoba:** sand hill 35 mi. SE of Brandon, 23 Sep. 1960, *G. A. Stevenson* 2255 (CAN, DAO). **Northwest Territories:** Mackenzie District, in dry sand near shoreline, sand hills on S shore of Mackenzie River about 16 mi. downstream from Fort Simpson, 61°58'N, 121°45'W, 25 July 1955, *W. J. Cody & J. M. Matte* 8944 (DAO) [the specimen is immature; fortunately, authors also collected some fragments of dry plants remaining from the previous year—S.M.]; Mackenzie District, occasional in disturbed sand along roadside on mainland about 1 mi. S of Fort Simpson island, 61°52'N, 121°22'W, 3 Aug. 1955, *W. J. Cody & J. M. Matte* 9130 (DAO) [the specimen is immature, but very similar to the previous one—S.M.]. **Ontario:** Sarnia, Oct. 1936, *W. A. Dent* s.n. (DAO); Norfolk Co., Long Point, 22 Sep. 1946, *F. A. Clarkson* 6684 (DAO) [a specimen with the same collection number at TRT approaches *C. pallasii*—S.M.]; Long Point Village, sand on open shore, 24 Sep. 1966, *R. Beschel* 15722 (CAN); Norfolk Co., Long Point, South Walsingham Tp., 12 Oct. 1969, *P. M. Catling & J. E. Cruise* s.n. (TRT); Norfolk Co., Long Point, along S shore E of Courtright Ridge, Lake Erie, blow-out on sand dune, 23 Sep. 1976, *K. M. Lindsay & I. D. MacDonald* 1092 (CAN); Bruce Co., boundary between Chiefs' pt. I.R. and Amabel Twp., on sand, beside road at edge of pine plantation, 29 Sep. 1977, *Joseph W. Johnson* (TRT); Norfolk Co., Long Point, Squires Ridge to Little Creek Ridges, 12½ to 14½ mi. from base of Point, on S beach, open, active sand dunes along beach, numerous, with *Ammophila breviligulata* and *Andropogon scoparius*, 20 Sep. 1979, *A. A. Reznicek & P. M. Catling* 5255 (DAO). **Saskatchewan:** Beaver Creek, sandy hillside, 9 Sep. 1937, *W. J. White* s.n. (TRT); Saskatoon, on sands by river, Sep. 1931, *A. W. Anderson* s.n. (CAN); Saskatoon, 20 mi. SW at Pike Lake, partially covered sand dunes, 10 Sep. 1951, *G. F. Ledingham* 1219 (DAO); Moose Jaw Region, Caron, SW ¼ 16–17–29 W. 2nd, shifting sand in and around blow-out spots, long-abandoned land, 24 Sep. 1955, *T. H. Hudson* 1768 (DAO); District de Rosetown-Biggan, coulée Agassiz, Canton Bernard, 12–15 mi. au sud-est de Demaine, Platières de la Saskatchewan-Sud, dune en mouvement, 18 Sep. 1960, *B. Boivin* 14156 (DAO); Saskatoon District, Saskatoon, sandflat between natural levée and cutbank of S Sask. River, local, with *Elymus canadensis*, *Psoralea lanceolata*, 13 Sep. 1964, *J. H. Hudson* 2214 (DAO); Lake Atabasca, E of William Point, *Salix*, *Myrica* on dry, eroding sand beach on shore, 6 Aug. 1975, *G. W. Argus & D. J. White* 9750 (CAN) [inflorescence interrupted—S.M.].

***Corispermum hookeri* Mosyakin var. *pseudodeclinatum* Mosyakin, var. nov. TYPE:** Canada. British Columbia: beside Burnaby Lake, sand dune, 3 Oct. 1965, *I. Bayly* 83 (holotype, UBC).

Fructus elongati vel oblongo-obovati, longitudine latitudinem duplo vel subduplo superanti; in fronte valde convexi, a tergo concavi. Inflorescentia elongata, interrupta, apice solum congesta.

Fruits elongate, oblong-obovate, ca. 2 times as long as broad; prominently convex at abaxial side, concave at adaxial side. Inflorescences elongate, interrupted, condensed only at apex.

Paratype. CANADA. **British Columbia:** Okanagan, Quilchena, 30 July 1906, *E. Wilson* 776 (UBC).

Corispermum americanum (Nuttall) Nuttall var. ***rydbergii*** Mosyakin, var. nov. TYPE: Mexico. Chihuahua: sand dunes, 10–19 Oct. 1935, *Harde LeSueur* 285 (MO).

Fructus maturi (3.2–)3.5–4.0(–4.3) × 2.3–3.2 mm, saepissime late alati, supra medium latissimi. Ala 0.3–0.4(–0.5) mm lata. Inflorescentia plerumque angusta, laxiuscula, non densa, plus minusve remotiflora. Ceterum typo respondet.

Mature fruits (3.2–)3.5–4.0(–4.3) × 2.3–3.2 mm, usually broadly winged, broadest above the middle. Wing 0.3–0.4(–0.5) mm broad. Inflorescences normally narrow, lax; flowers/fruits ± remote. Other characters as in *C. americanum* var. *americanum*.

Paratype. U.S.A. **Colorado:** Huerfano Valley, near Gardner, sandy creek bottom, alt. 7000 ft., 10 Sep. 1900, *F. K. Vreeland* 657 (NY, CAN) [this specimen is also a paratype of *C. marginale* Rydberg; see discussion above—S.M.J.].

Because the *Corispermum americanum* group is currently under revision, I refrain now from citing additional paratypes of this variety. However, it seems to occur in several localities in Arizona, Colorado, New Mexico, Texas, and Utah. New collections of mature specimens from this region would be extremely helpful for detailing its distribution. Due to its characteristic narrow and interrupted inflorescence, this variety, as well as many specimens of *C. americanum* s. str., was constantly misidentified as *C. nitidum*.

Corispermum ochotense Ignatov var. ***alaskanum*** Mosyakin, var. nov. TYPE: U.S.A. Alaska: Onion Portage, Upper Kobuk River, 67°06'N, 158°15'W, in sand dunes, open site, 10 Aug. 1967, *Charles Schweger* 196 (holotype, ALA).

Fructus maturus 3.2–4.0 mm longus, 2.2–2.7 mm latus. Ceterum ut in var. *ochotense*.

Mature fruit 3.2–4.0 mm long, 2.2–2.7 mm wide. Other characters as in variety *ochotense*.

Paratypes. U.S.A. **Alaska:** Yukon River between Rampart and Tanana, 9 Aug. 1932, *L. J. Palmer* 13 (CAN); Ester Siding Field, July 1936, *G. W. Gasser* s.n. (ALA); Kobuk River valley, forming dense “stands” on sandy river bar at Point Goldie on Kobuk River, 2 Aug. 1974, *C. H. Racine* 732 (ALA); Kobuk River valley, low, abundant plant covering sand surface of dunes on S side of Kobuk River opposite mouth of Hunt River, 12 Aug. 1974, *C. H. Racine* 731 (ALA).

Corispermum ochotense, a comparatively small (often dwarf) arctic and subarctic plant, has been

described recently from the northeastern Russian Far East (Ignatov, 1986). It is normally floriferous almost to the base, often developing fruits even in the axils of lower leaves and branches. The lower and middle bracts in the inflorescence are usually linear or linear-oblongate (often broadest toward the apex, as well as some leaves), rather long, leaf-like, almost not different from cauline leaves in their shape and size. In addition, plants often turn deep beet red at maturity. The illustration of “*C. hyssopifolium*” in the *Flora of Alaska* (Hultén, 1968) gives an accurate impression of the habit of *C. ochotense*. The type of *C. ochotense* (“regio Magadan, distr. Ola, pagus Talon, syrtis arenosa riparia, 28–30 Aug. 1971, A. P. Khokhrjakov”), which I have studied at MHA, is conspecific with the Alaskan and northwestern Canadian plants. However, some of the Alaskan specimens differ from their trans-Beringian relatives in having larger fruits. The typical variety of *C. ochotense* also occurs in North America. The species is known to me from the following additional localities in Canada (as many specimens were not completely mature, the varieties are not indicated; however, most of the specimens seem to belong to var. *ochotense*):

CANADA. **Northwest Territories:** District of Mackenzie, Aklavik River near Aklavik, on the section of slit beach, 6 Sep. 1948, *Margaret E. Oldenburg* 48–1241 (GH); Mackenzie District, Norman Wells, forming thick mats on eroding heavy soil on slope by airstrip, 22 July 1953, *W. J. Cody & R. L. Gutteridge* 7466 (COLO, DAO, GH, MICH, MO, OSC, TRT, UBC); Mackenzie District, rare on gravel beach of Mackenzie River, Royal Canadian Corps Signals Transmitters, 5 mi. upstream from Norman Wells, 27 July 1953, *W. J. Cody & R. L. Gutteridge* 7603 (DAO, F); Mackenzie District, 13.0 km WSW of Norman Wells, N.W.T. Site No. 8–10–13, beach ridge, sandy, with *Populus tremuloides*, 10 Aug. 1974, *N. J. Walker* 2303 (DAO); Mackenzie District, E bank of MacKenzie River, Norman Wells, N.W.T. Site No. 8–18–1, riverbank, many disturbance species, rare, 18 Aug. 1974, *N. J. Walker* 2386 (DAO).

The following collection from northern Saskatchewan probably also belongs here (although the plants were not completely mature):

CANADA. **Saskatchewan:** S shore of Lake Atabasca at Beaver Point, lower sandy beach line at, and just above, shoreline, scattered, but frequent, 8 Aug. 1979, *V. L. Harms & R. A. Wright* 27215 (DAO, GH, RM).

As outlined above, the native North American species of *Corispermum* are comparable to most of the widely recognized Eurasian taxa of the genus, regarding the species concept applied to them and morphological differences between species. They are also comparable to some other readily recognized taxa of Chenopodiaceae, e.g., numerous seg-

regate species of such North American aggregates as *Chenopodium leptophyllum* s.l., or *C. fremontii* S. Watson s.l. However, especially for followers of a broader species concept, I would like to outline the species aggregates (groups) of closely related taxa of North American *Corispermum*. Because North American representatives of this genus were commonly misidentified and misunderstood, this explanation would be helpful in preventing possible further mistakes.

The closest Asian allies of American *Corispermum* are *C. pallasii* (for almost all native taxa), *C. macrocarpum* (for *C. pallidum*), and *C. crassifolium* (for *C. pacificum*). In my opinion, in the future *C. pacificum* and *C. pallidum* could not be lumped together with other North American taxa. However, using a very broad species concept, one may regard *C. pacificum* as a subspecies of *C. crassifolium*. *Corispermum pallasii* is most closely related to *C. americanum*, *C. navicula*, and *C. welshii*; under a broad species concept the three latter species could fit at the subspecies level as well. *Corispermum ochotense*, *C. hookeri*, and *C. villosum* form another unit, which is, however, connected to the previous one by occasional forms transitional between *C. americanum* and *C. villosum*, as well as by transitions between *C. pallasii* and *C. hookeri*. Using the ultra-broad species concept, one could unite the mentioned taxa under the priority name *C. pallasii*. However, I believe that at the present stage of our knowledge, such an approach could only obscure the true relationships within this group.

At present I prefer to place the native North American representatives of *Corispermum* into three species aggregates (groups):

the *Corispermum pallasii* aggregate: *C. pallasii* s. str., *C. americanum*, *C. navicula*, *C. welshii*, *C. hookeri*, *C. villosum*, *C. ochotense*; also the Asian *C. sibiricum*, *C. stauntonii*, *C. elongatum*, *C. bardunovii*, and probably some others.

the *Corispermum crassifolium* aggregate: *C. pacificum* plus the Asian *C. crassifolium* s. str. and *C. maynense*.

the *Corispermum macrocarpum* aggregate: *C. pallidum* and the Asian *C. macrocarpum* s. str., *C. platypterum*, and *C. stenolepis*.

A key to the species and species aggregates of *Corispermum* occurring in North America will be published later, in a treatment of the genus for the fourth volume of the *Flora of North America*. Natural arrangement of some Eurasian species and species aggregates will be discussed in an article submitted to the *Ukrainian Botanical Journal* (*Ukrains'kyj botaničnyj žurnal*).

New, more complete (and preferably serial) her-

barium material of North American *Corispermum*, as well as field and experimental studies, would be helpful for further progress in understanding the complicated patterns of taxonomy and distribution of the genus in North America.

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Note added in proof.

Since this article was submitted for publication, some additional isotypes and paratypes have been found in the herbaria at US and LE: *Corispermum pacificum*: C. V. Piper 1770 (isotype, US); W. N. Suksdorf 1385 (paratype, US); *C. pallidum*: J. H. Sandberg & J. B. Leiber 309 (isotype, LE); *C. hookeri*: B. Boivin & G. F. Ledingham 14079 (isotype, LE); *C. ochotense* var. *alaskanum*: L. J. Palmer 13 (paratype, US).

Corispermum welshii is now known from two additional states of the U.S.A.: **Arizona**: Coconino Co., Teetso Spring, sandy soil, 13 Nov. 1971, N. D. Atwood & D. Kaneko 3420 (US); **New Mexico**: Thornton, 19 Oct. 1903, D. Griffiths 6209 (US).



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