A RECONSIDERATION OF CARDAMINE CURVISILIQUA AND C. GAMBELLII AS SPECIES OF RORIPPA (CRUCIFERAE)

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The generic status of Nasturtium is evaluated, and an argument supporting its union with Rorippa is presented. The new name R. floridana and the new combination R. gambellii, based on Cardamine curvisiliqua and C. gambellii, respectively, are proposed. A key to the white-flowered species of Rorippa that grow in North America is given.

One of the most frequently encountered problems in the systematics of the Cruciferae (Brassicaceae) is whether or not generic status should be given to a small group of species that, on the basis of morphology, form a marginal portion of a larger genus. Where sharply defined discontinuities exist, such peripheral groups are usually recognized as independent genera. However, if the differences between the marginal groups and the larger genus break down, whether locally or on a worldwide basis, then the taxonomy of the complex is best treated by not recognizing the smaller species groupings as segregate genera. A case in point involves Rorippa Scop. and Nasturtium R. Br.

Many authors (e.g., Coode & Cullen, 1965; Fernald, 1950; Stuckey, 1972; Valentine, 1964) who recognize both Nasturtium and Rorippa distinguish the former by its white petals, its lack of median nectaries, and its coarsely reticulate seeds. Rorippa has yellow petals, well-developed median nectaries, and variously sculptured (usually not coarsely reticulate) seeds. However, an examination of many species of Rorippa from the Southern Hemisphere reveals that these character sets break down in various combinations, and that none of the other alleged differences between the two genera holds together either. For example, R. laurentii Jonsell (Madagascar) has white flowers, median nectaries, and striate seeds (Jonsell, 1979); R. gigantea (J. D. Hooker) Garnock-Jones (Australia, New Zealand) has white flowers, median nectaries, and coarsely reticulate seeds (Garnock-Jones, 1978; Hewson, 1982); and almost all of the South American species have white flowers, no median nectaries, and colliculate seeds (Martínez-Laborde, 1985). It is evident that there are no solid grounds to support the maintenance of Nasturtium as a genus distinct from Rorippa.

Jonsell (1968) followed Schulz (1936) in uniting Nasturtium and Rorippa and in placing some species of the former in sect. Cardaminum (Moench) DC. Schulz, however, adopted Nasturtium for the combined genus, instead of the

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Scanning electron micrographs of seeds of Rorippa: a, b, *R. floridana* (Curtiss 24, GH); c, d, *R. microphylla* (Knowlton s.n., 25 July 1911, NEBC); e, f, *R. nasturtium-aquaticum* (Cory 1619, GH); g, h, *R. gambelli* (Bingham s.n., 1886, GH). a, c, e, g, × 38; b, d, f, h, × 140.
Comparison among Rorippa floridana, R. microphylla, and R. nasturtium-aquaticum.

| CHARACTER                  | R. floridana       | R. microphylla     | R. nasturtium-aquaticum |
|----------------------------|--------------------|--------------------|-------------------------|
| Seeds                      |                    |                    |                         |
| Color                      | Light or yellowish brown | Reddish brown      | Reddish brown           |
| Arrangement in locule      | Uniseriate         | Uniseriate         | Biseriate               |
| Length (mm)                | 0.65–0.85 (−0.9)   | (0.8−)1–1.2        | (0.8−)0.9–1.1 (−1.2)    |
| Width (mm)                 | 0.42–0.65          | (0.6−)0.7–0.84 (−0.9) | (0.6−)0.7–0.9 (−1)     |
| Reticulation size          | Minute             | Moderate           | Coarse                  |
| No. of areolae per side    | 400 to 500         | 75 to 150 (to 175) | 25 to 50 (to 60)       |
| Fruit width (mm)           | 1–1.5              | 1–1.5              | 2–3                     |
| Emergent leaves            |                    |                    |                         |
| Petiole base               | Not auricate       | Auricate           | Auricate                |
| No. of lateral lobes (pairs)| 1 or 2 (or 3)     | (1 or) 2 to 4 (or 5)| 1 to 4 (to 6)          |
| Chromosome number (n)      | 16                 | 32                 | 16                      |

earlier-published Rorippa. His sect. Cardaminum included the watercress, *R. nasturtium-aquaticum* (L.) Hayek (as *N. officinale* R. Br.), as well as two African and two North American species. Both North American species were originally described in *Cardamine* L. and were treated later in *Nasturtium* (see below). They are transferred in this paper to *Rorippa*, where they are more appropriately placed.

The taxonomic history of both *Cardamine curvisiliqua* Shuttelw. and *C. gambellii* S. Watson, hereafter *Rorippa floridana* Al-Shehbaz & Rollins and *R. gambellii* (S. Watson) Rollins & Al-Shehbaz, respectively, has been discussed previously at some length (Rollins, 1960, 1978) and need not be repeated here. *Rorippa floridana* is endemic to Florida, where it grows in lakes and springs in Brevard, Citrus, Clay, Collier, Columbia, Dade, Duval, Gilchrist, Hillsborough, Lake, Levy, Manatee, Marion, Seminole, Sumter, Taylor, Venable, and Wakulla counties. Plants of *R. floridana*, *R. microphylla* (Clewell, 1985; Godfrey & Wooten, 1981; Rollins, 1978; Wunderlin, 1982). The species does not belong
to *Cardamine* because it does not have the elastically dehiscent fruits, the usually spirally coiled valves, or the narrowly winged replum margin that are unique to that genus. *Rorippa floridana* differs from *R. microphylla* in several features of its seeds (see Figure), in its emergent leaves, and in its chromosome number (see Table). Consistent chromosome counts of $2n = 64$ have been reported for *R. microphylla* from Canada (Mulligan, 1964), Sweden (Jonsell, 1963), Germany (as *Nasturtium officinale*; Tischler, 1935), England (as *N. uniseriatum* Howard & Manton; Howard & Manton, 1946), and Denmark, England, Holland, Ireland, and Scotland (as *N. officinale*; Manton, 1935). *Rorippa floridana* (as *C. curvisiliqua*) has $2n = 32$ (Rollins & Rüdenberg, 1977).

Seeds of *Rorippa floridana* are smaller in size and have much smaller and far more numerous areolae on each side than those of *R. microphylla* and *R. nasturtium-aquaticum* (see Figure). Seeds of the last species are unusual in that their areolae are subdivided by a low understory of reticulum, the units of which contain circular thickenings (see Figure, f). These probably correspond to stomata. To our knowledge, such a peculiar pattern of seed sculpture has not been recorded elsewhere in the Cruciferae. The areolae in *R. gambellii* are somewhat intermediate in size and number between those of *R. floridana* and *R. microphylla*.

Perhaps the earliest known collection of *Rorippa microphylla* from the New World was made by W. Boott in 1861 in Waltham, Massachusetts (Green, 1962). The species has not been collected from any of the southeastern states, whereas *R. nasturtium-aquaticum* is naturalized in all of them. Apparently the oldest specimens of *R. floridana* were collected by Leavenworth in 1836 from Tampa Bay (Gray, 1880; McVaugh, 1947; Torrey & Gray, 1840) and by Rugel in 1843 from St. Marks. Evidently the native *R. floridana* was well represented in several herbaria long before *R. microphylla* was recorded for North America.

The following key is provided to aid in the identification of the indigenous and naturalized North American white-flowered species of *Rorippa*:

A. Lateral leaf lobes with 3 to 5 (to 7) teeth; inflorescences bracteate, the bracts toothlike to filiform and to 3 mm long, sometimes much larger, leafy, and pinnate, always adnate to pedicels; fruiting pedicels conspicuously flattened beneath at attachment to rachis. ........................................... *R. gambellii*.

A. Lateral leaf lobes entire or repand; inflorescences ebracteate; fruiting pedicels not flattened.

B. Petioles of emergent leaves not auriculate at base; seeds yellowish brown, usually $< 0.9$ mm long and $< 0.65$ mm wide, minutely reticulate, with 400 to 500 minute areolae on each side. ........................................... *R. floridana*.

B. Petioles of emergent leaves minutely to coarsely auriculate at base; seeds reddish brown, usually $> 0.9$ mm long and $> 0.65$ mm wide, moderately to coarsely reticulate, with 25 to 175 areolae on each side.

C. Mature fruits 1–1.5 mm wide; seeds uniseriately arranged in each locule, moderately reticulate, with 100 to 150 (to 175) areolae on each side. ........................................... *R. microphylla*.

C. Mature fruits 2–3 mm wide; seeds biseriately arranged, coarsely reticulate-foveolate, with 25 to 50 (to 60) areolae on each side. ........................................... *R. nasturtium-aquaticum*.

**Rorippa floridana** Al-Shehbaz & Rollins, nom. nov. Based on *Cardamine curvisiliqua* Shuttlew. ex Chapman, Fl. South. U.S. 605. 1887. LECTOTYPE
(here designated): in uliginosis subsalsis ad fluv. St. Marks, prope St. Marks, Florida, *Rugel s.n.*, April–May, 1843 (isoelectotypes, gh!). The specific epithet *curvisiliqua* would become a later homonym if transferred to *Rorippa* because of the existence of *R. curvisiliqua* (W. J. Hooker) Bessey ex Britton, Mem. Torrey Bot. Club 5: 169. 1894.

*Nasturtium stylosum* Shuttlew. ex O. E. Schulz in Engler & Prantl, Nat. Pflanzenfam. ed. 2. 17B: 553. 1936; non *N. stylosum* (DC.) O. E. Schulz ex Cheesman, Trans. & Proc. New Zealand Inst. 43: 179. 1911. 3

Putative interspecific hybridization between *Rorippa floridana* (as *R. microphylla*) and *R. nasturtium-aquaticum* has been suggested previously (Rollins, 1978). It is likely that the hybrids are more common than is presently known. However, very little can be said about them, and only future field and experimental work can verify these assumptions.

*Rorippa gambellii* (S. Watson) Rollins & A.-Shehbaz, comb. nov. Based on *Cardamine gambellii* S. Watson, Proc. Amer. Acad. Arts 11: 147. 1876.

*Type*: California, Santa Barbara, *Gambell s.n.* (holotype, gh!; isotype, gh!).

*Nasturtium gambellii* (S. Watson) O. E. Schulz, Bot. Jahrb. Syst. 66: 98. 1933.

Specimens of *Rorippa gambellii* in the Gray Herbarium were annotated by one of us (R. C. R.) as early as 1957, but the new combination was never published. Watson (1895) suggested that the spelling of *gambellii* should be changed to *gambelii* because the plant was named after Gambel, not Gambell. However, the original spelling is retained here.

The distribution of *Rorippa gambellii* is based primarily on old collections, the majority of which were made in the nineteenth century. The species apparently occupied marshy or aquatic habitats in southern California (Los Angeles, San Bernardino, and Santa Barbara counties) and occurred disjunctly in the Valley of Mexico. Areas near Santa Barbara and San Bernardino have been searched on two different occasions, but no plants of the species have been found. Likely habitats have mostly been obliterated by urbanization. The same despoiling of habitat seems to have occurred in Mexico. It now appears possible that *R. gambellii* is extinct.

Both glabrous and pubescent forms are known (Rollins, 1960; Watson, 1876), but this variation is apparently insignificant.

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3Schulz (1936) had recognized both *Nasturtium stylosum* Shuttlew. and the earlier homonym above as distinct species. The earlier homonym, which was transferred to *Rorippa* (as *R. stylosa* (DC.) Allan, Fl. New Zealand 1: 188. 1961; non *R. stylosa* (Pers.) Mansf. & Rothm. Repert. Spec. Nov. Regni Veg. 49: 276. 1940), is now known as *R. gigantea* (J. D. Hooker) Garnock-Jones.
LITERATURE CITED

Clewell, A. F. 1985. Guide to the vascular plants of the Florida panhandle. viii + 605 pp. University Presses of Florida, Tallahassee.

Coope, M. J. E., & J. CULLEN. 1965. Nasturtium and Rorippa. In: P. H. Davis, ed., Fl. Turkey I: 430-433.

Fernald, M. L. 1950. Gray’s manual of botany. ed. 8. lxiv + 1632 pp. American Book Company, New York and other cities.

Garnock-Jones, P. J. 1978. Rorippa (Cruciferae, Arabideae) in New Zealand. New Zealand J. Bot. 16: 119-122.

GODREY, R. K., & J. W. Wooten. 1981. Aquatic and wetland plants of southeastern United States. Dicotyledons. x + 933 pp. University of Georgia Press, Athens, Georgia.

Gray, A. 1880. Some new North American genera, species, etc. Proc. Amer. Acad. Arts 15: 41-52.

Green, P. S. 1962. Watercress in the New World. Rhodora 64: 32-43.

Hewson, H. J. 1982. Brassicaceae. In: B. G. Briggs et al., eds., Fl. Australia 8: 231-357.

Howard, H. W., & I. Manton. 1946. Autopolyploid and allopolyploid watercress with the description of a new species. Ann. Bot. (London), II: 10: 1-13, pl. 1.

Jonsell, B. 1963. On Rorippa x sterilis in Sweden. Bot. Not. 116: 1-6.

——. 1968. Studies in the North-west European species of Rorippa s. str. Symb. Bot. Upsal. 19(2): 1-221, pls. 1-11.

——. 1979. New taxa of Cruciferae from East Tropical Africa and Madagascar. Bot. Not. 132: 521-535.

Manton, I. 1935. The cytological history of watercress (Nasturtium officinale R. Br.). Z. Indukt. Abstammungs Vererbungs. 69: 132-157, pls. 1, 2.

Martinez-Laborde, J. B. 1985. Sinopsis preliminar del género Rorippa (Cruciferae) en la Argentina. Parodiana 3: 269-305.

McVaugh, R. 1947. The travels and botanical collections of Dr. Melines Conkling Leavenworth. Field & Lab. 15: 57-70.

Michaelis, F. B. 1976. Watercress (Nasturtium microphyllum (Boenn.) Rchb. and N. officinale) in New Zealand. Aquatic Bot. 2: 317-325.

Mulligan, G. A. 1964. Chromosome numbers of the family Cruciferae. I. Canad. J. Bot. 42: 1509-1519.

Patman, J. 1962. A checklist of Florida Cruciferae. Quart. J. Florida Acad. Sci. 25: 192-200.

Rollins, R. C. 1960. The American Cruciferae of Sessé and Mociño. Rhodora 62: 11-20.

——. 1978. Watercress in Florida. Ibid. 80: 147-153.

—— & L. RÜDENBERG. 1977. Chromosome numbers of Cruciferae III. Contr. Gray Herb. 207: 101-116.

Schulz, O. E. 1936. Cruciferae. In: A. ENGLER & K. Prantl, eds., Nat. Pflanzenfam. ed. 2. 17B: 227-658.

Small, J. K. 1933. Manual of the southeastern flora. xxii + 1554 pp. Published by the author, New York.

Stuckey, R. L. 1972. Taxonomy and distribution of the genus Rorippa (Cruciferae) in North America. Sida 4: 279-430.

Tischler, G. 1935. Die Bedeutung der Polyploidie für die Verbreitung der Angiospermen. erläutert an den Arten Schleswig-Holsteins, mit Ausblicken auf andere Florengebiete. Bot. Jahrb. Syst. 67: 1-36.

Torrey, J., & A. Gray. 1840. Nasturtium. Fl. N. Amer. 1: 666.

Valentine, D. H. 1964. Rorippa and Nasturtium. In: T. G. Tutin et al., eds., Fl. Europaea 1: 283-285.
Watson, S. 1876. Description of new species of plants, chiefly Californian, with revisions of certain genera. Proc. Amer. Acad. Arts 11: 121–148.
—. 1895. Cardamine. In: A. Gray & S. Watson, Syn. Fl. N. Amer. 1: 155–158.
Wunderlin, R. P. 1982. Guide to the vascular plants of central Florida. 472 pp. University Presses of Florida, Tampa and other cities.
Al-Shehbaz, Ihsan A. and Rollins, Reed C. 1988. "A reconsideration of Cardamine curvisiliqua and C. gambellii as species of Rorippa (Cruciferae)." 
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