

INVASION AND SPREAD OF *COINCYA MONENSIS* (BRASSICACEAE) IN NORTH AMERICA

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ABSTRACT

Invasion and spread of the European native *Coincya monensis* (Brassicaceae) in North America are traced. In the late 1800s the species was found in the Philadelphia, Pennsylvania/Hoboken, New Jersey area on ballast, where it has not persisted. Then, in the mid and late 20th century, naturalized populations of unknown source were documented in North Carolina, Pennsylvania, New York, Michigan, and Kentucky.

RESUMEN

Se esboza la invasión y dispersión de la planta nativa de Europa *Coincya monensis* (Brassicaceae) en Norte América. A fines del siglo XX se encontró la especie en el área de Philadelphia, Pennsylvania/Hoboken, New Jersey sobre cascajos, lugar donde no ha persistido. Luego, a mediados y fines del siglo veinte, han sido documentadas poblaciones naturalizadas de origen desconocido en Carolina del Norte, Pennsylvania, New York, Michigan, y Kentucky.

INTRODUCTION

In August 1992 JWT noted an abundant, robust, showy, yellow-flowered crucifer unknown to him along interstate highway 80 in central Pennsylvania. After making a collection of the plant, he drove on, observing the plant for many more miles at the roadside.

Later, at Northern Kentucky University, work on identification of the plant was begun. That the species is not included in the standard northeastern North American manuals (Fernald 1950; Gleason & Cronquist 1963, 1991) soon became obvious. Referral to *Flora Europaea* (Tutin et al. 1964) finally brought an answer: JWT identified the plant as *Rhynchosinapis monensis* (L.) Dandy ex Clapham in Clapham, Tutin & Warburg, one of several binomials recently applied to it. Wherry et al. (1979) included it as *Rhynchosinapis cheiranthos* (Vill.) Dandy. Al-Shehbaz (1985) treated it as *Hutera cheiranthos* (Vill.) Gómez-Campo, the name under which it appears in Rhoads and Klein (1993). The second edition of *Flora Europaea* (Tutin et al. 1993) uses *Coincya monensis* (L.) Greuter & Burdet, the name determined to be correct by Leadlay and Heywood (1990). As the common name for this species we suggest and will use "coincya."

During our joint field work in Pennsylvania in 1994, we made a special effort to collect *coincya* from as many counties as possible. Then the next year RFCN and JWT separately made additional collections of the species in Pennsylvania, the state in which it appears to be most common and where it is spreading.

In this paper we trace the species' current range in North America and summarize its collection history on the continent.

MATERIALS AND METHODS

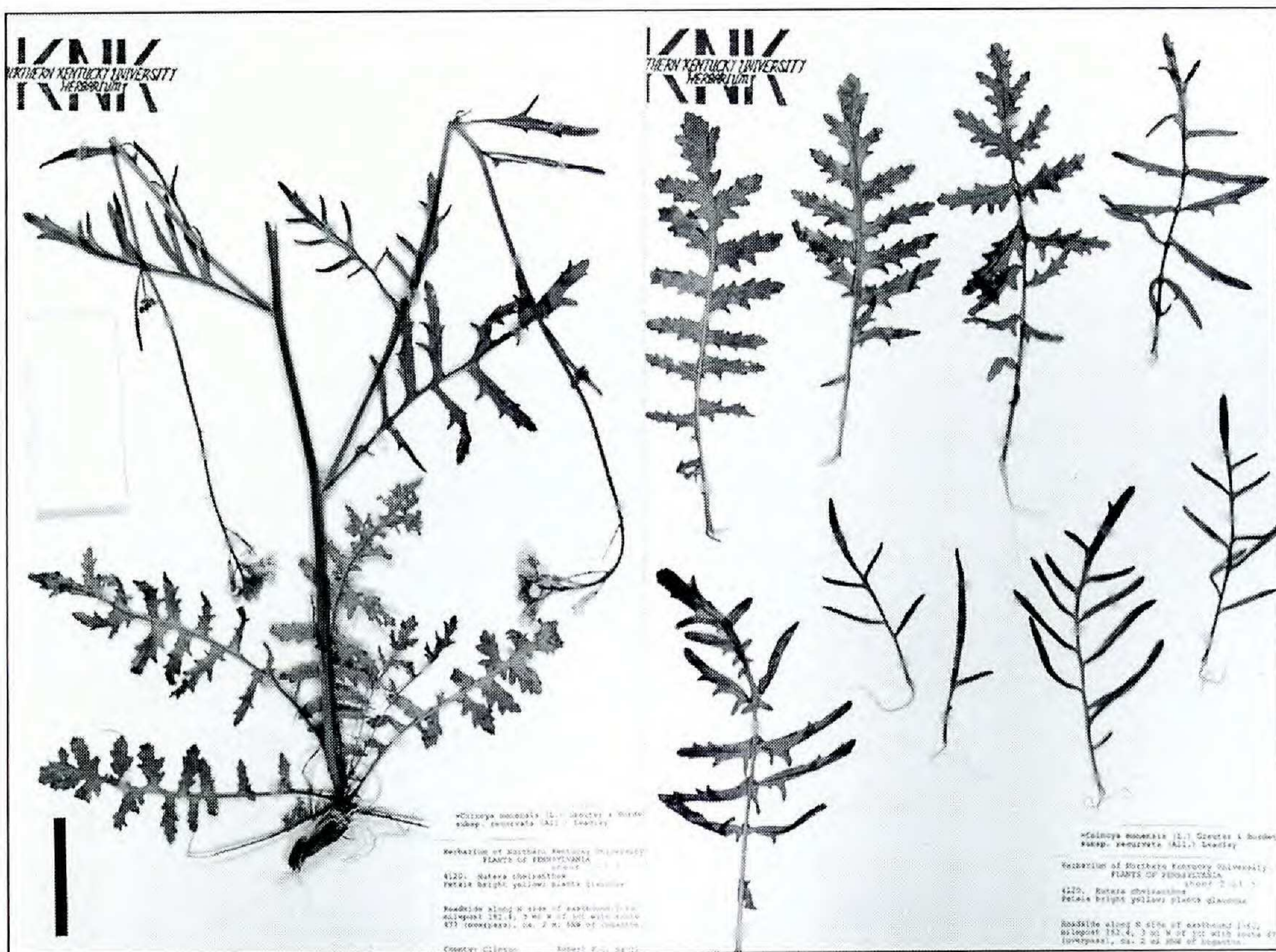
To document the history of invasion and the species' current range in North America, we requested loans of herbarium specimens of North American *Coincya* and of species under which we thought *coincya* might be filed, incorrectly identified. We also asked for loans of unidentified crucifers resembling the species (photocopies of several of our specimens of *coincya* were included with each loan request). Of the 126 United States and Canadian herbaria to which we wrote, 90 responded. Many had no specimens of the species, but overall we received 353 sheets of miscellaneous weedy, silique-bearing crucifers. Among these specimens—including sheets of *Arabis*, *Brassica*, *Erucastrum*, *Erysimum*, *Raphanus*, *Sinapis*, *Sisymbrium*, *Tropidocarpum*, and, especially, *Diplotaxis*—we located 62 sheets of *coincya* representing 22 separate collections (some were widely distributed duplicates). When to these 22 collections are added the 23 that we made, the total is 45 collections of *C. monensis* we have seen from North America (see appendix).

IDENTIFICATION, TAXONOMY, AND NOMENCLATURE

Coincya monensis is best distinguished by its combination of conspicuously glaucous and distinctively shaped leaves (Figs. 1, 2); a usually ebracteate inflorescence (occasionally an elongate, entire bract subtends the most proximal pedicel) (Fig. 3); bright yellow petals with pale brown or violet veins (the blooming season is long: late April through October); a single row of seeds in the siliques, which have clearly 3–5 veined valves and a somewhat flattened, 1–6 seeded beak (Fig. 4). The mature silique is 3.5–8.5 cm long (including the beak); the beak is 15–20 mm long and ca. 2 mm wide at its base.

Most North American botanists are certainly as unfamiliar as we were with *Coincya monensis*. In Table 1 we detail ways to separate *C. monensis* from those crucifers that superficially may resemble it in eastern North America.

Coincya belongs to the tribe Brassiceae of the Brassicaceae (Cruciferae). This tribe is characterized by fruits being usually beaked, the beak typically 1- or few-seeded, and the cotyledons being conduplicate (Al-Shehbaz 1984). The genus is included as *Hutera* in the key to southeastern United States genera of Brassicaceae (equally useful in northeastern United States)



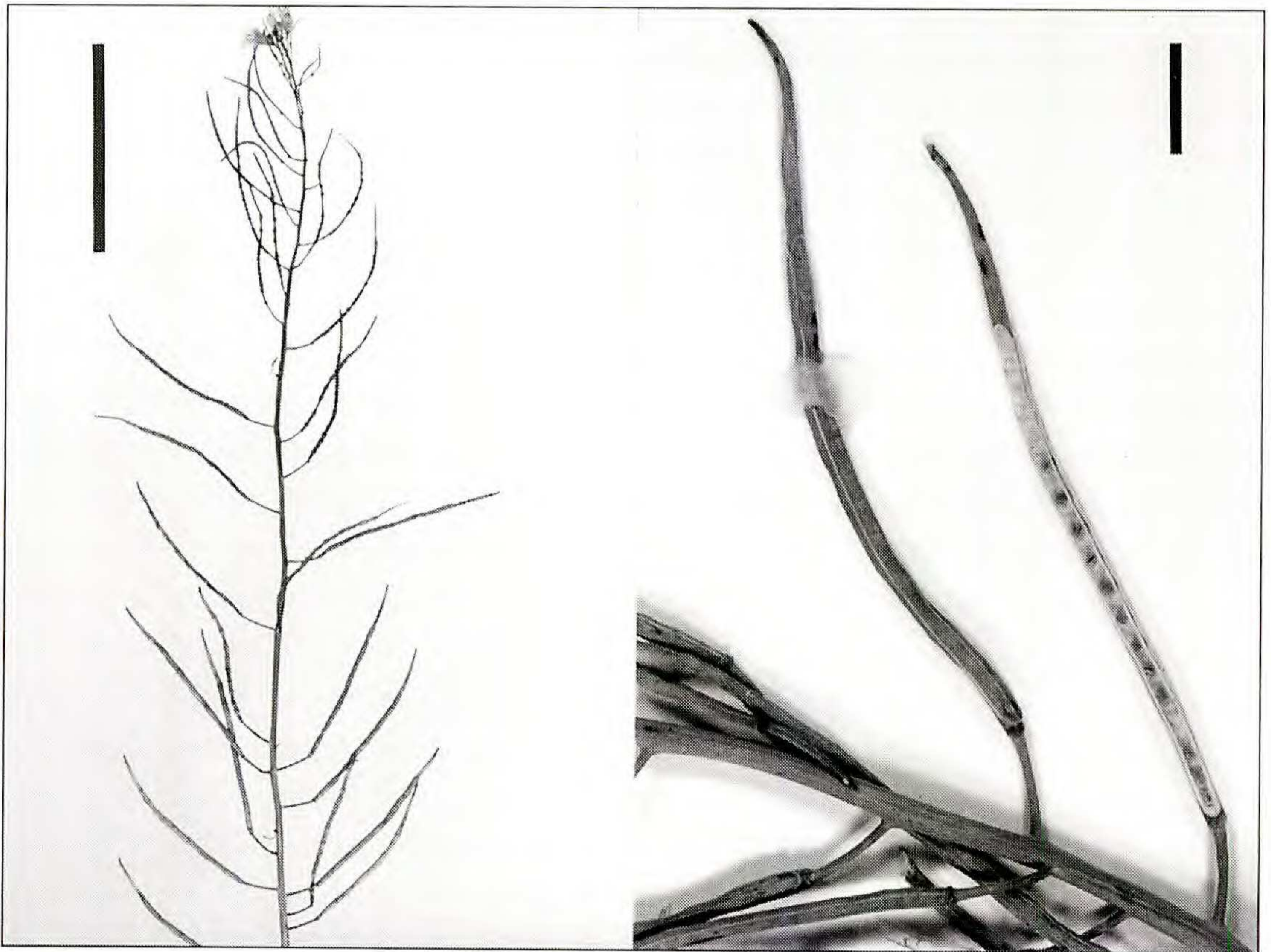
FIGS. 1–2. *Coincya monensis*. Fig. 1 (left). Basal portion of plant. Fig. 2 (right). Selection of leaves from a single plant of *Coincya monensis*. The amount of lobing of the leaves decreases from the base of the plant to the base of the inflorescence. Vertical bar represents 5 cm for both figures.

by Al-Shehbaz (1984) and in his key to southeastern United States genera of Brassicaceae (Al-Shehbaz 1985).

Taxonomy and nomenclature of *Coincya* were discussed by Leadlay and Heywood (1990), who recognized five subspecies of *C. monensis*. Further discussions of the species' nomenclature are in Kartesz and Gandhi (1994) and Rollins (1961, 1993). Our plants are subsp. *recurvata* (All.) Leadlay, a taxon burdened by no fewer than 129 synonyms. This subspecies has the same indigenous range in the Old World as that of the collective species: Corsica, France, Germany, Great Britain, Italy, Morocco, Portugal, and Spain (Leadlay & Heywood 1990).

INVASION AND SPREAD

Except for the species' convoluted nomenclature, the invasion history of *C. monensis* in North America is straightforward. Apparently there are five areas in eastern United States in which the plant has appeared (Fig. 5), one of these in the late 1800s only, the others after the middle of the 20th century. In the Philadelphia/Hoboken area it was collected on ballast in



FIGS. 3–4. *Coincya monensis*. Fig. 3 (left). Fruiting branch. Vertical bar represents 5 cm. Fig. 4 (right). Fruits, one with one valve removed. Note conspicuous beak and the one row of seeds. Vertical bar represents 1 cm.

the 1870s to at least 1890. Then, in 1958, it was found in far western North Carolina, where it has persisted at least into the 1990s. Then followed Pennsylvania and southern New York, where the species was first collected in 1964 and where we made 22 collections of it in 1992, 1994, and 1995. In southwestern Michigan it was first collected in 1989 and again in 1993. Finally, the species was found in Kentucky in 1996.

Philadelphia/Hoboken area on Ballast (1870s to at least 1890)

Coincya monensis was one of many species introduced in ships' ballast in the late 1800s. Soil, sand, and rocks incidentally containing seeds were loaded onto ships in Europe and then exchanged for cargo in the United States. Studies of these ballast floras recorded at least 386 species associated with ballast in New Jersey, New York, and the Philadelphia area alone (Muehlenbach 1979).

The earliest North American reports of *C. monensis* we have located—all from ballast in the vicinity of Philadelphia—are those of Burk (1877) and Martindale (1876, 1877). Further ballast collections were made by Brown (1879, 1880) from Hoboken, New Jersey. In these early reports the species

TABLE 1. Characteristics distinguishing *Coincya* from selected genera of Brassicaceae with which it has most often been confused in eastern North America.

From <i>Brassica</i>	
<i>Coincya</i>	<i>Brassica</i>
Valves of fruit with 3–5 veins	Valves of fruit with 1 vein
From <i>Diplotaxis</i>	
<i>Coincya</i>	<i>Diplotaxis</i>
Seeds in 1 row in fruit	Seeds in 2 rows in fruit
Beak of fruit broad, somewhat flattened, 15–20 mm long, ca. 2 mm wide at base	Beak of fruit style like, 1.5–3 mm long
From <i>Erucastrum</i>	
<i>Coincya</i>	<i>Erucastrum</i>
Inflorescence ebracteate (occasionally an elongate, entire bract at base of most proximal pedicel)	Inflorescence bracteate at least at the most proximal pedicels, the bracts pinnately lobed
Beak of fruit broad, somewhat flattened, 15–20 mm long, ca. 2 mm wide at base	Beak of fruit slender, style-like, to 4 mm long
From <i>Sinapis</i>	
<i>Coincya</i>	<i>Sinapis</i>
Veins of petals darker in color than the rest of the blade	Petals uniform in color
Sepals erect, connivent, the inner two saccate at base	Sepals tend to be spreading (rarely reflexed), not connivent, not saccate at base

was called “*Brassica monensis*” or “*B. cheiranthus*.” It was present at Philadelphia until at least 1890 (the date of the most recent ballast specimen we have seen). At the 19th century ballast sites, *C. monensis* was described as being “scarce” (Brown 1879) to “quite common” (Martindale 1877). Changes in regulations regarding the disposal of ballast eventually closed this avenue of introduction.

These early introductions on ballast apparently did not lead to naturalization of the species in North America. Such naturalization followed only after the post-1950 appearances of the species on the continent.

Far Western North Carolina (1958–Present)

After a hiatus of about seven decades, the plant was again found in North America: collections of it from far western North Carolina (Yancey County) made in 1958 were reported by Ahles and Radford (1959) but under the misidentification *Diplotaxis muralis*; this misidentification was “corrected” in the *Vascular flora of the Carolinas* (Radford et al. 1968), where the species appears as *Brassica erucastrum* L., a misapplied name (Al-Shehbaz 1985; Leadlay & Heywood 1990). The North Carolina collections were discussed by Rollins (1961).

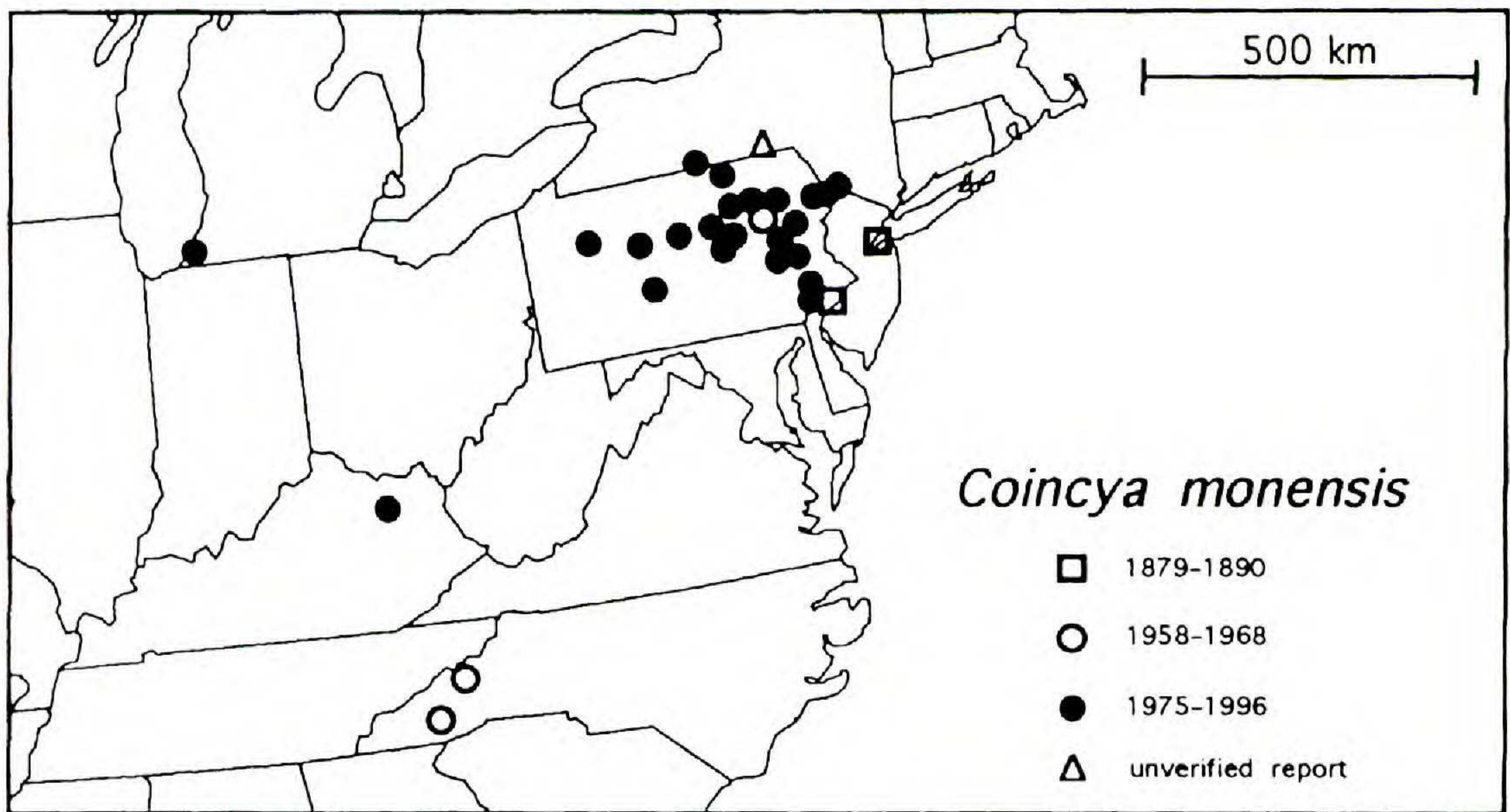


FIG. 5. *Coincya monensis*. Documented range in North America. Symbols indicate year of first collection from a county.

At the sites of this first United States collection in the 20th century, the species was said to be “very abundant, turning roadsides and fields into a yellow haze for miles around when in flower, particularly in the Cane River Valley. As a weed, it would seem to have the potential of becoming a very serious pest” (Ahles & Radford 1959).

The most recent collection of *coincya* we have seen from North Carolina was made in 1994, again in the far western part, about 15–20 miles south of the sites of the original collections from the state.

Pennsylvania/New York (1964–Present)

Pennsylvania.—The earliest 20th century collection of *C. monensis* we have located from Pennsylvania (Luzerne County) is dated 1964. The first published Pennsylvania record is in *Atlas of the flora of Pennsylvania* (Wherry et al. 1979). The updated Pennsylvania atlas (Rhoads & Klein 1993) reported the plant from two counties (Clearfield & Luzerne), mentioning that it is “apparently spreading along Interstate 80.”

Our Pennsylvania collections, made in 1992, 1994, and 1995, are from 19 counties.

New York.—We suggest that *coincya* is spreading into New York from Pennsylvania and that the species will become more common in New York than it seems to be now. We know of two collections and one undocumented report from the state, all near the Pennsylvania border. Both of the New York specimens are from the 1990s: a JWT collection from a roadside near Port Jervis in Orange County; and a Chapman collection from “steep rocky walls and small cliffs” at South Addison in Steuben County. The report is in notes accompanying W. Chapman’s Bradford County, Pennsyl-

vania, collection, which mention that the species is “rare in New York, though it occasionally shows up in the south-central (Binghamton) area.” We located no verifying voucher, although we have no reason to doubt the report’s accuracy.

Michigan (1989–Present)

Swink and Wilhelm (1994) reported collections of the species from southwestern Michigan (Berrien County) in 1989 and 1993. The sites where the plant was found are only about 30 miles north of Interstate 80, the highway along which JWT first noted the plant in Pennsylvania ca. 400 miles to the east.

Kentucky (1996–present)

The first collection of the species from Kentucky was made in 1996 in Rowan County on a rocky roadside slope.

Our map shows not only the documented occurrences of *C. monensis* in North America but also clearly where we made a special effort to search out the species in 1994 and 1995 in Pennsylvania. The advance of *coincya* in Pennsylvania may have been rather rapid: from one county in 1964 to at least 20 counties ca. 3 decades later. We predict with confidence that the range of *C. monensis* will increase. Indeed, the plant is probably already in some states additional to those reported here, having been overlooked or simply ignored by collectors, many of whom do not collect roadside weeds (especially those resembling *Brassica*, so commonly seen but not an esteemed prize for collectors). Indeed, we suggest that in some herbaria from which we did not request loans—and maybe even in those 36 herbaria from which we received no response to our loan request—there might be specimens from states other than those we have verified.

That seeds of *C. monensis* were introduced via ballast at the 19th century sites is clear. The source of the disseminules for the post-1950 introductions is unknown.

Two patterns of spread by invading plants were distinguished by Baker (1974). In the first, “echelon” movement, a species has a single point of introduction followed by movement across the landscape in wave- or step-like progression. In the second, “spot and fill,” several centers of introduction may be followed by a filling in of the intervening open spaces. The pattern exhibited by *C. monensis* in North America in the 20th century would appear to be “spot and fill,” with the “filling in” yet to develop fully.

The European range of *C. monensis* subsp. *recurvata* is from southern Spain north to western Germany and northern Scotland, covering ca. 21° of latitude (Leadley & Heywood 1990). This range extends from hardiness zone 10 (minimum 30° to 40° F) to zone 7 (minimum 0° to 10° F)

(Krüssmann 1984). Considering temperature alone, we note that, in North America, the species already occurs in colder areas (zone 5, minimum -20° to -10° F) than in Europe.

ECOLOGY

One Pennsylvania herbarium specimen (Bradford County, near Wyalusing, "late July" 1983, *Chapman s.n.* [BH]) has attached to it copies of two letters in which are useful data. Chapman wrote in 1983 that the species' preferred habitat is "along the edge of rock ledges . . . and at the bases of such cliffs . . . especially in those areas where small cliffs are formed by the highway department's cutting through a hill to make a road." He further noted that the plants "often live 2–3 years and set a full crop of seeds each year."

The habitats mentioned by Chapman are precisely those from which most of our collections came; particularly impressive is the plant's abundance in some of those habitats. In addition, we have seen the plant among cobbles placed on roadside slopes to retard erosion, along railroad tracks, at weedy edges of roadside rest areas, and at disturbed sites at service stations and motels. Many of the sites in which it grows are gravelly or rocky.

The synanthropes associated with *coincya* in its weedy habitat are frequent to common along highways over much of northeastern United States. We noted *Capsella bursa-pastoris*, annual species of *Cerastium*, *Coronilla varia*, *Erigeron canadensis*, *Erysimum repandum*, *Lotus corniculatus*, *Polygonum aviculare*, *Silene antirrhina*, *S. cucubalus*, and *S. pratensis* (*Lychnis alba*). Some associates of *coincya* in southwestern Michigan are listed in Swink and Wilhelm (1994). We noted in Pennsylvania, though, that *coincya* often dominated its habitat to the apparent exclusion of other species. A single, vigorous plant of *C. monensis*, sometimes nearly 1.5 m long (individuals that large are sprawling, not erect), is seemingly a formidable competitor, capable of covering a large area. Occasional plants of *C. monensis* may be found growing in the midst of otherwise continuous *Coronilla varia*.

Additional data on biology of the species are in Hegi (1918 [under *Brassicella erucastrum*], 1986 [under *Rhynchosinapis cheiranthos*]) and Leadlay and Heywood (1990).

We hope that our summary of data on this species will provide baseline data of some use to future investigators of the spread of the plant.

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NCBS, NCSC, NCU, NDG, NHA, NLU, NY, NYS, ODU, OSC, PAC, PH, PUR, RSA, SDC, SIU, SLRO, TEX, UARK, UC, UMO, UNA, UNCC, US, USCH, UTC, VDB, VPI, VT, WILLI, WIS, WVA, YU. Canada: ACAD, ALTA, CAN, DAO, HAM, MMMN, MT, MTMG, NBM, NFLD, NSPM, OAC, QFA, QK, QUE, SASK, SCS, SFS, TRT, UBC, USAS, UWPG, WAT. The Lloyd Library, Cincinnati, was invaluable for our literature searches. The Spanish translation of the abstract was provided by Dr. Miriam Steinitz-Kannan. Our wives, Mary A. Naczi and Mildred W. Thieret, assisted with field work.

APPENDIX

Coincya monensis—Herbarium Specimens Seen

KENTUCKY. Rowan Co.: 3.5 air mi NE of center of Morehead, along W side of route 32, 1 Jun 1996, *Naczi & Trauth 5561* (BRIT, KNK, US, VDB).

MICHIGAN. Berrien Co.: Coloma, sandy soil along railroad, 29 Aug 1993, *Wilhelm & Dritz 21866* (MICH, MOR); Coloma, weedy hill, 16 Aug 1993, *Wilhelm & Dritz 21579* (MOR); Coloma, sandy soil, 3 Jul 1993, *Dritz 1115* (MOR); roadside between Coloma and Watervliet, 9 Jun 1989, *Swink & Wetstein 8600* (MOR); near a large sandpit between Coloma and Watervliet, 30 May 1989, *Swink & Wetstein 8430* (MOR).

NEW JERSEY. [Hudson Co.]: Hoboken, ballast, 25 Oct 1879, *Brown s.n.* (AC, NY); Hoboken, ballast filling, Jul 1880, *Brown s.n.* (BH, GH, US); Hoboken, ballast, 28 Oct 1879, *Schrenk s.n.* (NY); Hoboken, ballast, 3 Jul 1880, *Martindale s.n.* (CHRB).

NEW YORK. Orange Co.: roadside along I-84, ca. 1.5 mi E of Port Jervis, 10 Sep 1995, *Thieret 59751* (KNK). **Steuben Co.:** steep rocky walls and small cliffs overlooking Tuscarora Creek along route 417, South Addison, [no day, no month] 1994, *Chapman s.n.* (NYS).

NORTH CAROLINA. Jackson Co.: field 3.9 mi NE of Cherokee, 7 May 1968, *Leonard & Radford 1453* (CHRB, FLAS, FSU, ISC, KE, LL, MBG, MIN, NCU, NCY, NHA, NLU, NY, ODU, PAC, PUR, SIU, TEX, UNA, UTC, VDB, WIS, WVA). **Yancey Co.:** roadside 0.8 mi SE of Pensacola, 27 Apr 1958, *Ables & Duke 39158* (NCU); roadside 1.8 mi SW of Burnsville, 7 Jun 1958, *Ables & Duke 42855* CAN, FLAS, KANU, MICH, NCU, NY, RSA, SIU, VDB); roadside 2.9 mi SW of Burnsville, 7 Jun 1958, *Ables & Duke 42859* (NCU); roadside 0.9 mi NW of Ramsaytown, 16 Jul 1958, *Ables & Duke 46824* (FSU, NCU); roadside, Cane River, W of Burnsville, 9 Oct 1958, *Ables & Duke 50846* (NCU); wet rocky face of slope along Blue Ridge Parkway 7.2 mi NE of Black Mountain Gap, 6 Aug 1994, *Vincent & Lammers 6739* (MU, VDB).

PENNSYLVANIA. (NT=collection by R.F.C. Naczi and J.W. Thieret; NN=collection by R.F.C. Naczi and M.A. Naczi; T=collection by J.W. Thieret.) **Blair Co.:** roadside 17 mi S of Altoona, 13 Jun 1994, *NT 4109* (KNK). **Bradford Co.:** roadside, Indian Prayer Rocks, near Wyalusing, [no day] July 1983, *Chapman s.n.* (BH); roadside, Troy, 15 Jun 1994, *NT 4159* (KNK); along railroad tracks, Towanda, 16 Jun 1994, *NT 4237* (KNK). **Carbon Co.:** roadside just E of East Side, 18 Jun 1994, *NT 4356* (KNK). **Clarion Co.:** roadbank 2 mi SW of Clinton, 4 Jul 1995, *NN 4907* (CM, KNK, MICH, PAC, PH, VDB). **Clearfield Co.:** roadside, Clearfield, 19 Aug 1992, *T 58141* (KNK). **Clinton Co.:** roadside 2 mi NNW of Loganton, 14 Jun 1994, *NT 4120* (KNK). **Delaware Co.:** roadside 10 mi S of Norristown, 18 Jun 1994, *NT 4359* (KNK). **Lackawanna Co.:** roadside 2 mi SW of Mt. Cobb, 1 Jul 1995, *NN 4870* (KNK, PH). **Lehigh Co.:** roadside, Allentown, 18 Jun 1994, *NT 4357* (KNK). **Luzerne Co.:** roadside, Hazelton, 10 Sep 1995, *T 59750* (KNK); roadside 2.5 mi SE of Briggsville, 27 Jun 1964, *Wahl 21003* (FSU, ISC, MASS, PAC, UC, VDB). **Lycoming Co.:** roadside 1 mi NE of Picture Rocks, 14 Jun 1994, *NT 4123* (KNK). **Monroe Co.:** roadbank SE of Stroudsburg, 9 Jun 1975, *Rosbach 9216a* (WVA). **Montgomery Co.:** roadbank 5 mi NE of Norristown, 18 Jun 1994, *NT 4358* (KNK). **Northumberland Co.:** roadside 2 mi NW of Turbotville, 14 Jun 1994, *NT 4122* (KNK). **Philadelphia Co.:** ballast, West Philadelphia, 22 Jun 1890, *Mc Elwee 570* (PH). **Pike Co.:** roadside 3.5 mi SSW of Tafton, 1 Jul 1995, *NN 4882* (CM, KNK, PH); roadside 3 mi NW of

Milford, 3 Jul 1995, *NN 4883* (CM, KNK, PAC, PH). Schuylkill Co.: roadside between McAdoo and Delano, 10 Sep 1995, *T 59751* (KNK). Sullivan Co.: roadside 5 mi SW of Laporte, 14 Jun 1994, *NT 4124* (KNK). Union Co.: roadside 7 mi NW of New Columbia, 14 Jun 1994, *NT 4121* (KNK). Wayne Co.: roadside 5 mi NNW of Pocono Springs, 1 Jul 1995, *NN 4871* (CM, KNK, PH). Wyoming Co.: roadside 1.5 mi SE of Meshoppen, 18 Jun 1994, *NT 4353* (KNK).

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