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New Zealand Bittercress (*Cardamine corymbosa*; Brassicaceae): New to the United States

A. R. Post, J. C. Neal, A. Krings, B. R. Sosinski, and Q. Xiang*

New Zealand bittercress is reported as new to the United States. While collecting specimens to determine what *Cardamine* species occur in the nursery trade, New Zealand bittercress was discovered in a container nursery in Wilkes County, North Carolina. The nursery tracked the shipment of contaminated plants to a wholesale nursery in Washington County, Oregon. It was subsequently confirmed that New Zealand bittercress also occurs in a nursery in Clackamas County, Oregon, and has likely been distributed throughout the United States as a contaminant in container grown ornamental plants. Thus far there have been no reports of naturalized populations outside of container nursery crop production facilities.

Nomenclature: New Zealand bittercress, *Cardamine corymbosa* Hook. *f.* Brassicaceae.
Key words: Bittercress, *Cardamine*, new species, weed.

New Zealand bittercress has not been reported in the United States and is not currently cited by USDA PLANTS database (USDA-NRCS 2008). The vouchers cited here constitute the first reports of the occurrence of this species in the United States and, specifically, North Carolina and Oregon.

Voucher specimens: U.S.A. North Carolina. Wilkes Co.: growing in 10-L containers with weeping Colorado blue spruce recently delivered from an Oregon nursery, August 4, 2006, Post and Adkins *84* (North Carolina State College [NCSC]). U.S.A. Oregon. Clackamas Co.: growing in containers at a nursery, October 2006, Altland *s.n.* (NCSC).

New Zealand bittercress is a winter annual native to New Zealand and several sub-Antarctic islands (Cheeseman 1925; Wace 1960). In its native range, the species occurs in high-mountain and boreal habitats, as well as rocky coastal outcrops (Bleeker et al. 2002; Pritchard 1957). The species has been accidentally introduced, as a contaminant of container nursery crops, to other parts of the world including Australia, the United Kingdom, and Ireland (Reynolds 2002; Rozefelds et al. 1999; Yeates and Williams 2006). More recently, it was discovered in the United States in container-grown nursery crops in Wilkes County, North Carolina [*Post and Adkins 84* NCSC]. New Zealand bittercress plants were observed growing in 10-L containers with weeping Colorado blue spruce (*Picea pungens* Engelm.). The 10-L stock plants were distributed to North Carolina from a larger nursery located in Washington County, Oregon. Subsequently, we were able to confirm the presence of New Zealand bittercress in a nursery in Clackamas County, Oregon by examining a specimen collected and provided by Dr. James Altland [*Altland s.n.,* NCSC]. It is not clear how New Zealand bittercress was introduced to Oregon. But with such a large wholesale nursery industry in the state, it was likely introduced in contaminated container stock imported from overseas. A composite illustration from the listed specimens is provided (Figure 1).

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* First author: Graduate Student, Cornell University, Plant Biology, 412 Mann Library Building, Ithaca, NY 14853; second author: Professor/Extension Specialist, North Carolina State University, Horticultural Science, 262 Kilgore Hall, Box 7609, Raleigh, NC 27695-7609; third author: Extension Assistant Professor, North Carolina State University, Plant Biology, Gardner Hall 2109, Box 7612, Raleigh, NC 27695; fourth author: Associate Professor, North Carolina State University, Horticulture, Kilgore Hall 272, Box 7609, Raleigh, NC 27695; and fifth author: Associate Professor, North Carolina State University, Plant Biology, Gardner Hall 4209, Box 7612, Raleigh, NC 27695. Corresponding author's E-mail: arp232@cornell.edu

Description

New Zealand bittercress was first described as "a small and very distinct species of *Cardamine*, wiry and fragile in every part" (Hooker 1844). The species has a decumbent habit with wiry, unbranched stems, which creep along the ground. It is capable of rooting at the nodes to produce daughter plants. Basal leaves are compound with three to five leaflets, the terminal leaflet being up to two times larger than lateral ones. Leaflets are sessile or nearly so, and obovate to orbicular in shape. Terminal leaflets may approach a reniform shape. Flowers are dimorphic. The first flowers produced in spring follow the typical Brassicaceae form: four sepals alternating with four clawed petals. In these petaliferous flowers, one or more of the petals may be fused. There are six stamens, four long and two short. Later in the life cycle, flowers having no petals and only four long stamens are produced. These flowers are likely equivalent to the cleistogamous flowers described for New Zealand bittercress by Schulz (1903). Inflorescences are formed in a corymb rather than the typical cruciferous raceme. Each flower is borne on a pedicel 0.8 to 1.5 cm long. Inflorescences are indeterminate and may elongate past the first corymb to produce another corymb after siliques have formed on the prior inflorescence. Fruit is a two-valved silique which dehisces forcefully, though not as explosively as close relatives woodland bittercress (*Cardamine flexuosa* With.) or hairy bittercress (*Cardamine hirsuta* L.). Siliques are 1.8 to 2.7 cm and produce 6 to 7 mature seed per valve (or 12 to 14 seed per fruit). Seed are less than 1 mm in diameter and weigh ~10.8 mg per hundred seed. Preliminary evidence suggests that seed is ~70% viable as soon as it is shed, and has no apparent dormancy (Post et al., unpublished data). New

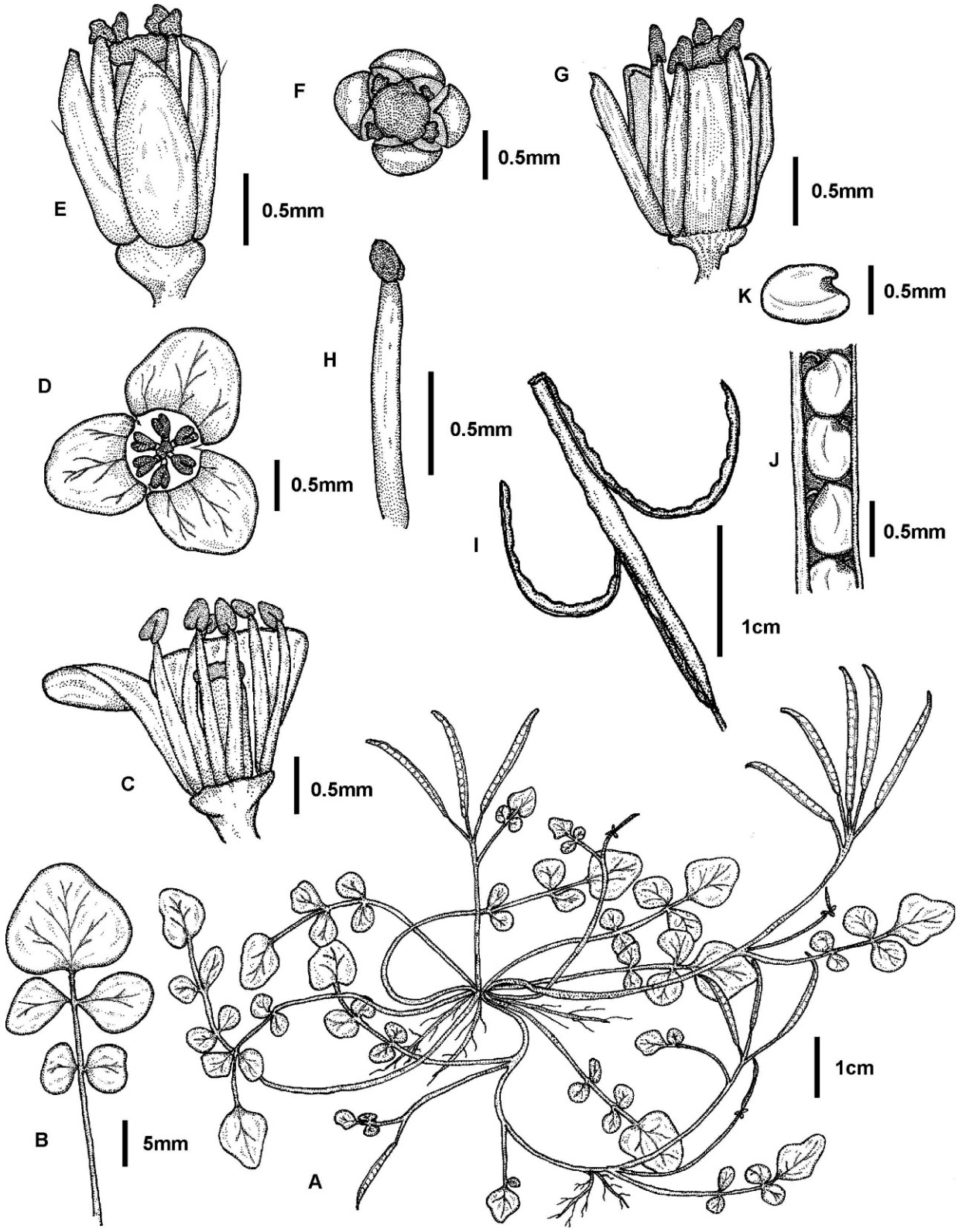

Figure 1. Illustration of New Zealand bittercress (A) habit, (B) basal leaf, (C) petaliferous flower—cutout, (D) petaliferous flower—top view, (E) apetalous flower, (F) apetalous flower top view, (G) apetalous flower—cutout, (H) stamen, (I) silique, (J) silique—cutout, (K) seed. (Illustrations by Nancy C. Routh).

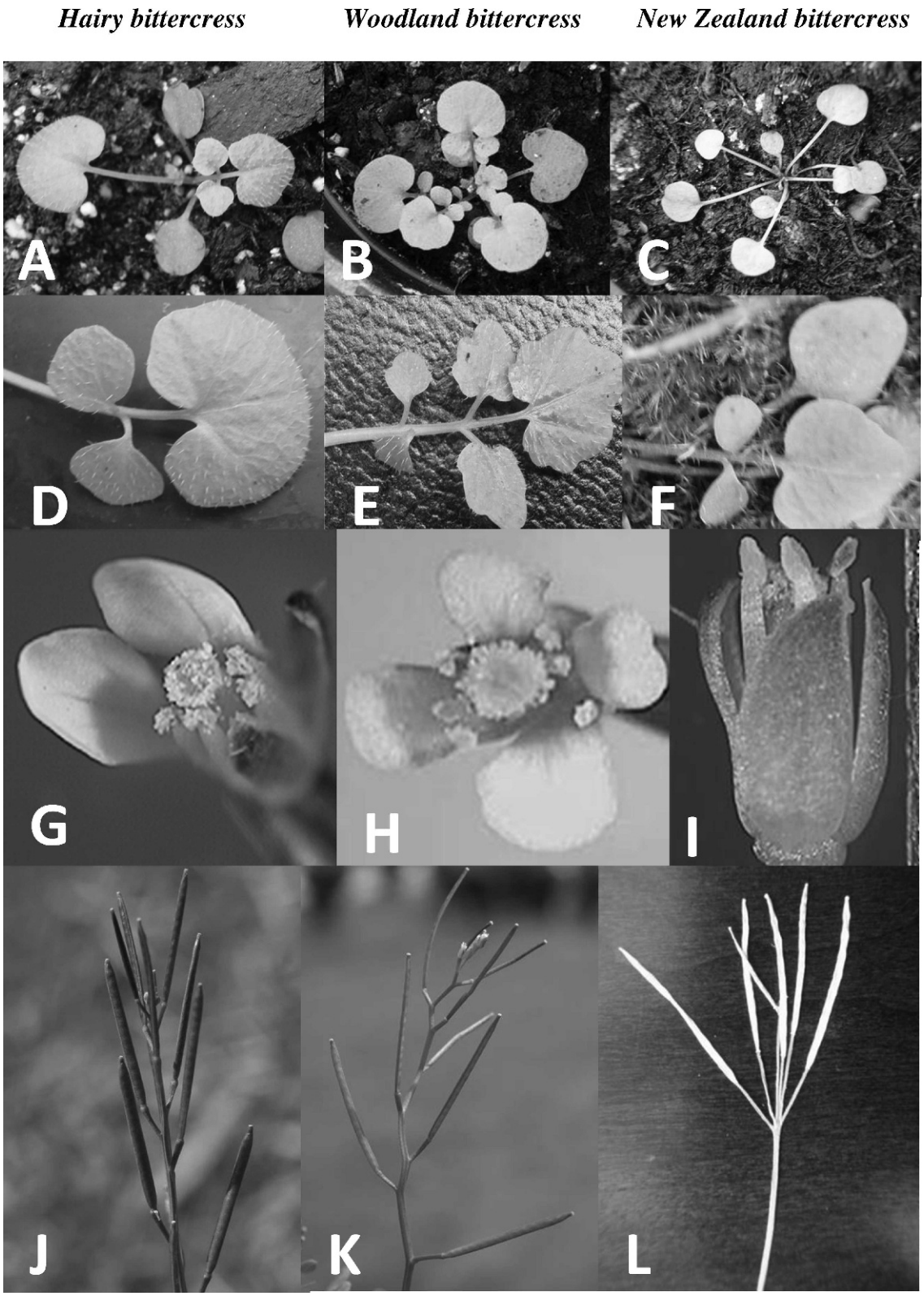

Figure 2. Photographic comparison of common *Cardamine* species present in U.S. container nurseries: hairy bittercress, woodland bittercress, and New Zealand bittercress *f.* Hook. (A) hairy bittercress seedling; (B) woodland bittercress seedling; (C) New Zealand bittercress seedling; (D) hairy bittercress leaf; (E) woodland bittercress leaf; (F) New Zealand bittercress leaf; (G) hairy bittercress flower with two petals removed; (H) woodland bittercress flower; (I) New Zealand bittercress apetalous flower; (J) hairy bittercress siliques; (K) woodland bittercress siliques; (L) New Zealand bittercress siliques.

Zealand bittercress can germinate and reproduce at any time of year in greenhouses, and can be problematic for open container nurseries 8 months of the year, from late winter through late fall. It is not known how many seed a single plant can produce in one life cycle, but weedy relatives in the same genus are reported to produce 600 to several thousand seed each, depending on plant size (Salisbury 1961).

Discussion

In 2007, Oregon was reported to have the second largest number of nursery operations in the United States, and the greatest area under nursery crop production at 21,695 ha (USDA-ERS 2007). The total value of wholesale nursery crops sold from Oregon in 2007 was $988 million, and Oregon is the largest exporter of nursery crops in the United States. It is estimated that two-thirds of their stock is sold to out of state operations (USDA-NASS 2007). Consequently, it is likely that New Zealand bittercress occurs throughout the United States, at least in container nurseries. The species has not been reported in the landscape, or as a naturalized plant in any United States location to date. However, as contaminated nursery stock is planted into the landscape by homeowners and professional landscapers, New Zealand bittercress establishment is likely. The species has already been reported as a troublesome weed of polytunnels in Australia, New Zealand, England, and Ireland (Anonymous 1999), and was subsequently reported as a garden weed in these same regions (Reynolds 2002; Rozefelds et al. 1999).

New Zealand bittercress is of concern to the container nursery industry because of its close relationship to two other troublesome nursery crop weeds, woodland bittercress and hairy bittercress (Figure 2). New Zealand bittercress has the potential to become particularly problematic for nurseries because of its ability to produce stolons, which would make it difficult to effectively hand-weed containers. Hand-weeding is a common nursery practice where there are limited herbicide options for sensitive ornamental species. Despite the availability of numerous herbicides labeled for bittercress control, it remains one of the most common and costly weeds in container nurseries (Mathers 1996). In 2007, the U.S. Department of Agriculture IR-4 Ornamental Horticulture annual survey reported bittercress to be the most prominent weed in U.S. greenhouse and nursery production systems, and the third most prominent weed in landscapes (Anonymous 2007). An additional bittercress species to deal with, particularly one such as *C. corymbosa*, which spreads by stems rooting at the nodes, may further increase the cost of bittercress control in nursery crops.

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