Oberlin, S. 2025. First reports and distribution of *Potentilla hebiichigo* (Rosaceae) outside Asia. Phytoneuron 2025-02: 1–5.
Published 30 April 2025. ISSN 2153 733X

FIRST REPORTS AND DISTRIBUTION OF *POTENTILLA HEBIICHIGO* (ROSACEAE) OUTSIDE ASIA

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ABSTRACT

Potentilla hebiichigo (Yonek. & H. Ohashi) has previously been reported as restricted to Asia. This article reports the species for the first time as naturalized in multiple countries outside of Asia, as documented on the citizen science website iNaturalist. Records of *P. hebiichigo*, commonly mistaken for *P. indica*, show widespread populations in the countries of Georgia, starting in 2022 as recorded on iNaturalist, and the USA, starting in 1995. New first occurrence records are given per state to document the chronological spread of the species across 16 states in the USA. A habitat in North Carolina is documented. *Potentilla hebiichigo* has not yet spread into USA areas west of the 100th meridian and is unlikely to spread into elevations above 850 meters or arid environments.

Potentilla hebiichigo Yonek. & Ohashi, Lesser Mock-strawberry (Vascular Plants of North Carolina 2025), and *P. indica* (Andrews) Th. Wolf are both creeping perennial plants that are native to Asia (Faghir et al. 2022). As of 2008, *P. hebiichigo* was documented as present only in Japan, Taiwan, Korea, China, Philippines, and Indonesia (Yonekura et al. 2008). *Potentilla indica* has been more widely naturalized across Africa, Europe, and North America (Li et al. 2003). When this author learned of the identifying characteristics of *P. hebiichigo* in 2024, it was immediately clear that many photographic records on the citizen science website iNaturalist, previously presumed to show *P. indica*, showed the presence of *P. hebiichigo* in the USA as well as in the country of Georgia.

The two species are very similar, sharing traits of enlarged trilobed epicalyx bractlets and the accessory fruit structure (Ertter & Reveal 2014). The most stable morphological characteristics to distinguish the two species are the color and surface texture of the fruiting receptacles and achenes (Hara & Kurosawa 1959). *Potentilla hebiichigo* (*Duchesnea chrysantha*) has the distinctive

Figure 1. *Potentilla hebiichigo*. A. Fruit showing rugose achenes and matte pink fruiting receptacle. B. Rounded-obovate, yellowish-green leaves with cleft and uncleft paired outer leaflets. Photos, S. Oberlin, Pitt Co., North Carolina, 24 Nov 2024.

morphological characteristics of matte white or pink fruiting receptacles, matte red to brown rugose/tuberculate achenes, and thin, yellowish-green leaves (Hara & Kurosawa 1959; Li et al. 2003; Sojak 2012; Heo et al. 2019). *Potentilla indica* (*Duchesnea indica*) can be identified by its shiny red fruiting receptacles, glabrous red achenes that are glossy when fresh (Li et al. 2003; Hara & Kurosawa 1959), and somewhat thick green leaves (Sojak 2012; Heo et al. 2019).

This author, in collaboration with the identifier community of iNaturalist, has corrected the iNaturalist data to prepare it for use. Georeferenced photographs that had been identified previously on iNaturalist as "*Potentilla indica*" worldwide, excluding Asia, were examined by the author for *Potentilla hebiichigo* characteristics. The records identified as *P. hebiichigo* by the consensus of the iNaturalist identifier community (known as Research Grade — RG), were further vetted by the author for appropriate licensing (compatible Creative Commons licenses, or permission granted for All Rights Reserved observations), open geoprivacy, and location uncertainty ≤ 200m. The observers are listed by their iNaturalist display name.

Only photographic records showing fruit with visibly rugose achenes are listed here as evidence of the species distribution. The white receptacle is not consistently visible in immature fruit and may be confused with the glossy receptacle of *Potentilla indica* in some photographs. One exception was made for the iNaturalist observation 195862166, as it is the oldest Research Grade record of *P. hebiichigo* outside of Asia, which was evaluated based on its fruiting receptacle color and texture, as well as leaf characteristics.

First records of *Potentilla hebiichigo* in the USA, on iNaturalist

Year	Observation ID	State	County	Observer
2007	195862166	Texas	Harris	Lisa Appelbaum
2012	143650376	Connecticut	Fairfield	Michael S. Richardson
2016	4228916	Louisiana	East Baton Rouge Parish	Jonathan (JC) Carpenter
2018	10422811	Mississippi	Harrison	Loren
2019	21176285	Alabama	Mobile	Amy Ferguson
2019	27318819	New York	Westchester	Devon Cummings
2019	37225557	South Carolina	Dorchester	selimahharmon
2020	37531642	Florida	Santa Rosa	Grayson Sasser
2020	63911544	Georgia	Columbia	Anthony A Simmons
2020	46638504	Maryland	Baltimore	agoodnathan
2020	48951456	New Jersey	Bergen	Megan R. King
2021	80425650	Pennsylvania	Buck	Savannah M
2022	120178862	Maine	Sagadahoc	Tari
2023	166444504	Rhode Island	Washington	Ginger
2024	204677312	Arkansas	Pulaski	ashleyrsteel
2024	253013639	North Carolina	Pitt	Sarah Oberlin

As of writing this paper, there are 18 RG iNaturalist records of *Potentilla hebiichigo* in Georgia and more than 2100 RG records of *P. hebiichigo* across 16 states in the USA. The first eligible observation of *P. hebiichigo* in Georgia (120783843) was recorded in Buknari, in the region of the Autonomous Republic of Adjara, in 2022 (Arvidas 2022). Later records in Georgia are similarly dispersed along the coast of the Black Sea, between latitudes 42.7 and 41.5 (GBIF 2024). This species should be considered adventive to Georgia (following definitions in Nesom 2000). These records show *P. hebiichigo* in North America as between Maine (latitude 44) and Texas (latitiude 29), which widely

concurs with previous documentation of growth between latitude 43 in Hokkaido and latitude -8 in Bali (Yonekura et al. 2008). Given its ongoing presence and multistate spread, *P. hebiichigo* should be considered both naturalized and established in the USA.

iNaturalist records suggest two loci of introduction in the USA: one in the Texas/Louisiana region and one later in Connecticut. For earlier records of *Potentilla hebiichigo* in the USA, digital herbarium records labeled as *P. indica* available online through the SouthEast Regional Network of Expertise and Collections (SERNEC) consortium were examined (SERNEC Data Portal 2024). Searching for "*Potentilla indica*" specimens collected within 150 kilometers of the Texas observation 195862166 yielded multiple Texas specimens that might be *P. hebiichigo* based on leaf characteristics. The oldest of these, BAYLU 046855, which was collected in Texas in 1995, was selected for further examination. That specimen was confirmed to be *P. hebiichigo* by experts Professor Emeritus Dr. Naohiro Naruhashi of University of Toyama and Mamoru Sugimoto, via macro photographs of the leaves and achenes. A similar SERNEC search within 150 kilometers of Louisiana observation 4228916 found Louisiana State University herbarium specimen LSU(NPS) 00125203, collected in 2006, which was confirmed by the author to be *P. hebiichigo* based on macro photos of the achenes and leaf characteristics. Searching digital records via SERNEC and the Consortium of Northeastern Herbaria for specimens labelled as "*Potentilla indica*" within 150 kilometers of Connecticut observation 143650376 did not show any herbarium specimens that appeared to be *P. hebiichigo*. Overall, these herbarium searches found BAYLU 046855 to be the earliest record of *P. hebiichigo* in the USA, dating the arrival of *P. hebiichigo* in North America as 1995 or earlier.

Once introduced to the USA, multiple dispersal methods are likely to have contributed to the spread of *Potentilla hebiichigo*. Multiple ant species have been documented to disseminate *P. hebiichigo* achenes in Japan, attracted by their nutritional content (Ishikawa & Naruhashi 2003). Dispersal of intact *P. indica* seeds has been documented to occur via the droppings of multiple species of frugivorous birds (Heleno et al. 2011), with the spread of *P. indica* within the USA attributed to the American Robin (Mink et al. 2019). The similarity of the two *Potentilla* species in habitat and fruit type would suggest frugivorous birds as a similarly viable natural dispersal method for *P. hebiichigo*. Lawnmowers or other rolling machinery may also unintentionally disperse *P. hebiichigo* via their wheels, as the plant grows readily among grass and other creeping lawn-height plants. At the location in Pitt Co., North Carolina, the furthest spread and smallest patches were growing directly in tire ruts in the trail, likely left by commercial lawnmowers or all-terrain vehicles.

Habitat of *Potentilla hebiichigo* as observed in Pitt Co., North Carolina

Multiple patches of *Potentilla hebiichigo*, distinguishable by leaf and fruiting characteristics, were found growing in the Central Greenville area, northeast of the intersection of Evans Street and Clifton Street. On 24 November 2024, Sarah Oberlin, with Elinor Lee, found 16 *P. hebiichigo* patches growing in partial shade or full sun on an unpaved trail on the city greenway. The patches were growing in partial shade to full sun, with sandy to loamy soil, in proximity to a creek. These patches ranged in size from 0.5 to 66 square meters; the modal size was 1.5 square meters. The total number of plants was estimated to be over 100. Nearby species included *Acer rubrum, Cardamine occulta, Lepidium virginicum, Ligustrum sinense, Persicaria longiseta, Phyllanthus urinaria, Platanus occidentalis, Potentilla indica, Scutellaria racemosa,* and *Stachys floridana. Potentilla indica* was identified based on leaf characteristics, with 0 fruit, 4 fruit buds and 4 flowers in a 0.5 square meter patch; a nearby 0.5 square meter patch of *Potentilla hebiichigo* contained 3 fruit, 15 fruit buds and 6 flowers. Contrary to the original paper from Hara & Kurosawa (1959) distinguishing the species, *P. hebiichigo* was observed to have more paired outer leaflets that were bifid or cleft than neighboring *P. indica* at the Greenville site.

Voucher: North Carolina. Pitt Co.: Greenville, 0.2 mi N of the NE side of Evans St. and Clifton St. intersection, 35.59550, -77.37549, weedy unpaved trail by a creek, 9 m, 21 Dec 2024, *Oberlin s.n* (NCU690987, US).

The Greenville Parks & Recreation representative stated that no dirt or seed mix had been introduced to the greenway to the best of his knowledge (Riv Temple, pers. comm., 3 Dec 2024) so no obvious explanation for the introduction of *Potentilla hebiichigo* at this location is apparent. Plants were not significantly withered by the cold and continued to flower after a week of nighttime temperatures below 40°F later in December.

Predicted future spread of *Potentilla hebiichigo* within the USA

Potentilla hebiichigo has been documented to prefer meadows, sunny roadsides, or cultivated grounds, which fits with its widespread distribution in the southeastern and eastern coast of the USA (Li et al. 2003; Hara & Kurosawa 1959). No records of *Potentilla hebiichigo* have been found along the western coast of USA. The western and eastern coasts have comparable populations of Asian immigrants and ports for Asian imports, showing ample opportunity for either intentional or accidental introduction of *P. hebiichigo* by humans. Neither are there iNaturalist records of *P. hebiichigo* in Mexico, despite its presence in neighboring Texas for three decades. Many iNaturalist participants live on the western USA coast, making *P. hebiichigo* unlikely to be present but undetected there. iNaturalist reporters are relatively fewer in Mexico.

Global Biodiversity Information Facility (GBIF) data for *Potentilla hebiichigo* were used to determine the highest recorded elevation for it in the USA (GBIF 2024). Only RG iNaturalist records with appropriate Creative Commons licensing, open geoprivacy, and locational uncertainty ≤ 200m were used. The Bulk Point Query Service (v 2.0) tool provided by the U.S. Geological Survey was used to generate elevation data from the GBIF long/lat data (USGS 2025). In the dataset, the highest recorded location of *Potentilla hebiichigo* was found to be approximately 337 meters in elevation, as per observation 223404794 in Livingston Co., New York. Naruhashi et al. (2005) found that *P. indica* and *P. hebiichigo* were found only below 850 meters in elevation in Japan.

Traditionally the 100th meridian west has roughly divided the arid western USA from the humid eastern USA, as shown in the July relative humidity map by Daly et al. (2015). All *Potentilla hebiichigo* observations in the USA have been from east of the 100th meridian west (GBIF 2024). The reduced density of trichomes on *P. hebiichigo* as compared to *P. indica* (Li et al. 2003) make it worse adapted to elevated or arid environments, as dense trichomes reduce water loss by trapping moisture and reflecting sunlight. The 100th meridian west also roughly marks the increase in terrain elevation to over 850 meters. This suggests that *P. hebiichigo* should not be expected to spread significantly in elevations over 850 meters or in arid environments, such as those west of the 100th meridian west.

ACKNOWLEDGEMENTS

I thank all the photographers who uploaded these observations on the platform iNaturalist and all the identifiers, especially Lisa Appelbaum, peakaytea, bottanydot and seblivia, who aided in correcting this data set. Joseph White at BAYLU and Jennifer Kluse at LSU provided macro photos of the herbarium specimens. Carol Anne McCormick at NCU advised on how to make a pressed specimen. Dr. Naohiro Naruhashi and Mamoru Sugimoto confirmed the identification of the BAYLU herbarium specimen. Nikita Myullyari and Elinor Lee assisted with in-person observations and measurements. I would like to thank Guy Nesom for reviewing this paper.

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