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Pilea microphylla (L.) Liebm. (Urticaceae) and *Solidago canadensis* L. (Asteraceae): first report of naturalized status in Nepal

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Abstract

Two herb species, *Pilea microphylla* (L.) Liebm. (Urticaceae) and *Solidago canadensis* L. (Asteraceae), are reported as naturalized for the first time in Nepal. Voucher specimens of these plants were collected from different parts of Nepal including Kathmandu valley. A detailed description with taxonomic notes, distinguishing characters, habitat, distribution and color photographs of the species are provided. In addition, the morphological characters of these plants are compared with their allied species. The potential for these species to become invasive is also briefly discussed.

Keywords: Flora of Nepal, Naturalized species, *Pilea*, *Solidago*

1. Introduction

Despite the long and extensive history of botanical exploration in Nepal (Rajbhandari, 2016), the documentation of the flora of Nepal (both native and alien) is far from complete. Till now, a total of 5379 native species (Shrestha et al., 2022), 183 naturalized species (Shrestha & Shrestha, 2021; Shrestha et al., 2021) and 30 invasive alien plant species (Adhikari et al., 2022; Shrestha et al., 2024)are recorded from Nepal and these numbers are likely to increase as many new species are recorded from Nepal each year.

A population of an introduced alien species is said to be *naturalized* in the environment when it escapes from the introduced location (e.g., garden, farmland) and completes several cycles of survival and reproduction with a positive population growth rate in the new environment (Blackburn et al., 2011). Cultivation escape, commodity release, commodity contaminant, vector-mediated introduction and natural dispersal of alien plant species across political borders are the major pathways of species introduction and subsequent naturalization in the introduced range (Hulme et al., 2008). Cultivation escape, especially from ornamental garden, is a major pathway of species introduction globally.

This communication is based on the opportunistic observations of the authors during 2021 and 2022 in Kathmandu valley and other parts of the country. Here, we confirm the occurrence of *Pilea microphylla* (L.) Liebm. (Urticaceae) and *Solidago canadensis* L. (Asteraceae) in Nepal, and discuss their naturalized status for the first time in the country. The genus *Pilea* (Urticaceae; Elatostemaea) has pantropical and subtropical distribution except in Australia and New Zealand with an estimated 715 species globally (Monro, 2004; Fu et al., 2022). In Nepal, 16 species of *Pilea* have been previously reported, all of which are native to the region

(Shrestha et al., 2022). The genus *Solidago* (Asteraceae; Astereae) is represented by about 140 species globally, which are primarily found in North America with some species in South America and Eurasia (Semple & Cook, 1993; Semple & Beck, 2021). In Nepal, the genus is represented by two species (*S. decurrens* Lour. and *S. virgaurea* L.), both of which are native to the region (Shrestha et al., 2022). With the addition of one species each, the number of species of *Pilea* and *Solidago* becomes 17 and 3, respectively, in Nepal.

2. Materials and Methods

During opportunistic observations in Kathmandu valley, Nepal the authors noticed two interesting species of weeds, with self-reproducing populations and growing in different habitats.The herbarium specimens were collected and detailed photographs were taken for further studies. Subsequent study of the collected specimens and careful review of the literature (Melville & Morton, 1982; Monro, 2001; Chen & Monro, 2003; Chen & Semple, 2011) by all authors revealedthat the two species are *Pilea microphylla* and *Solidago canadensis*. This identification was further confirmed by comparing our specimens with the herbarium specimens at Royal Botanic Garden Edinburgh (E). Besides Kathmandu, specimens of *Pilea microphylla* were collected from different places in central and eastern Nepal by the first and second authors through different field surveys during 2021 to 2022. Although, *S. canadensis* is recorded as garden plant in Nepal by Shrestha et al. (2022), it has not been collected and reported as naturalized plant species in Nepal. Similarly, the occurrence of *P. microphylla* in Kathmandu valley, central Nepal, was reported by S Kasaju in 2020 (eFloraofIndia, 2024); however, we could not trace its specimen in the national herbarium of Nepal (KATH) and its naturalized status remains unknown. The presence of established and wild populations of *Solidago canadensis* in the Kathmandu valley, and of *Pilea microphylla* in different regions of central and eastern Nepal suggest that both species have naturalized in Nepal. All the specimens collected during the study were deposited at TUCH and KATH.

3. Taxonomic treatment

Pilea microphylla(L.) Liebm., Kongel. Danske Vidensk. Selsk. Skr., Naturvidensk. Math. Afd. ser. 5, 2: 296. 1851.*Parietaria microphylla* L., Syst. Nat. ed. 10, 2: 1308. 1759. **Type**: Jamaica, *Anons.n.*(lectotype designated by De Rooij in Lanjouw & Stoffers, 1975: LINN [LINN1220.8], image!). **Synonyms**: *Urtica microphylla* (L.) Sw.; *Adicea microphylla* (L.) Kuntze Annual, monoecious herbs. Stems angular, up to 15 cm in length, suberect or prostrate, profusely branched, glabrous, light green with pinkish spots or brownish. Leaves simple, opposite, unequal in pair, subsessile to petiolate; petioles up to 4.5 mm long; lamina obovate or oblanceolate, smaller 1.5-3 × 1-2 mm, larger 2-8 × 1-3.5 mm, base oblique, margin entire, apex sub-acute or obtuse, upper surface glabrouswith horizontal vein-like stripes and dotted structures in between, lower surface glabrouswith distinct honey comb-like pattern, midvein distinct, lateral veins not distinct. Flowers in axillary, sub-capitate cymes. Male flowers pedicellate; pedicels c. 0.6 mm long; tepals 4, subequal, c. 0.6 mm long, pinkish-purple or reddish with green base; stamens 4. Female flowers pedicellate; pedicels usually less than 0.5 mm long; tepals 3, unequal, up to 0.5 mm long, greenish or greenish with pinkish apex. Achenes ovoid or ellipsoid, c. 0.5 mm long, warty at base, brown.

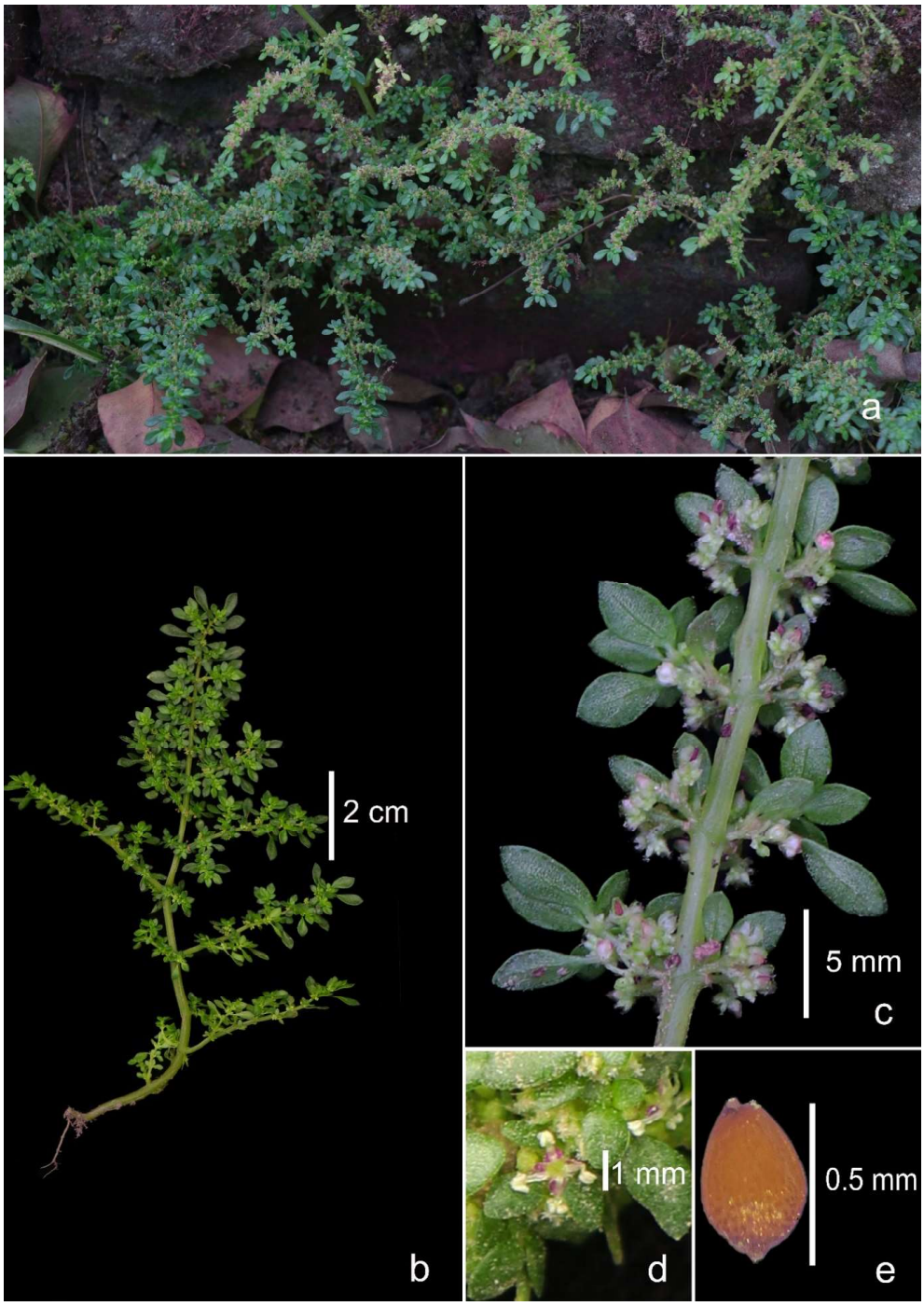

Fig 1. *Pileamicrophylla* (L.) Liebm.: **a.** Habit; **b.** Whole plant; **c.** Branch showing sub-capitate cymes; **d.** Male flower; **e.** Achene.

Flowering and fruiting: April-November.

Habitat: *Pilea microphylla* has been recorded from central and eastern Nepal between 80–1400 m above sea level in different habitats such as moist and shady disturbed places, cracks and crevices of pavement, cracks on concrete walls, brick walls and drainage canals.

Distribution: It is a native of Mexico and tropical South America (Monro, 2001) and has been naturalized in many subtropical and tropical countries, including Nepal.

Specimens examined: NEPAL, **Bagmati province**, Chitwan district, Khairahani, Jyamire, N 27.62°, E 84.55°, 200 m, 17.04.2022, *S. Poudel* 225 (KATH); Kathmandu district, Kirtipur, N 27.70°, E 85.28°, 1390 m, 18.09.2021, *S. Poudel* 208 (KATH); Kathmandu district, Kirtipur, N 27.67°, E 85.27°, 1347 m, 25.08.2021, *B.B. Shrestha* BBS 21-05 (TUCH, KATH); Makawanpur district, Hetauda, Buddha chowk, N 27.43°, E 85.03°, 460 m, 16.04.2022, *S. Poudel* 224 (TUCH); **Gandaki province**, Gorkha district, Gorkha Darbar, N 27.99°, E 84.63°, 1060 m, 25.11.2021, *S. Poudel* 209 (KATH); **Koshi province**, Jhapa district, Bhadrapur, Chandragadhi, N 26.57°, E 88.07°, 100 m, 03.03.2022, *S. Poudel* 207 (KATH); **Lumbini province**, Rupandehi district, Butwal, Butwal Multiple Campus area, N 27.71°, E 83.47°, 200 m, 01.04.2022, *Y.B. Poudel* YBMC-01 (TUCH, KATH).

Distinguishing features: It is easily distinguished from other reported species of Nepal by a combination of the following characters: smaller leaves (usually <10 mm long) with entire margin and indistinct lateral veins, and sub-capitate axillary cymes. The leaves of all other reported species are usually large (>10 mm long) with serrate or crenate margin and distinctly 3-veins at base or sometimes pinnately veined. Morphologically, *Pilea microphylla* (L.) Liebm. matches more with *Pilea peploides* (Gaudich.) Hook. & Arn., which has a doubtful distribution in Nepal. *Pilea microphylla* can be distinguished from *P. peploides* by the absence of distinct 3 veins at the leaf base.

Invasion risks: *Pilea microphylla*is considered as an invasive species in Nepal's bordering countries India (Nayak et al., 2020; Khuroo et al., 2021) and China (Xu et al., 2012). It is also a problematic weed species in the Pacific islands (PIER, 2005). Our collection records indicate widespread occurrence of this plant in Nepal, however, the exact time and pathway of introduction to Nepal is currently not known. There are possibilities of both intentional (e.g., as garden plant) and accidental (e.g., as contaminant) introductions. We observed this plant being grown on home garden pots as an ornamental plant in Tarai of central Nepal. Although the environmental and economic impacts of this plant have not been assessed systematically, field observations suggest that it may degrade walls of old buildings, including cultural monuments.

Solidago canadensis L., Sp. Pl. 2: 878. 1753. **Type**: Virginia, Canada, *Anons.n.* (lectotype designated by Reveal *et al.*, 1987: LINN [LINN998.2], image!). **Synonyms**: *Aster canadensis* (L.) Kuntze.; *Doria canadensis* (L.) Lunell Perennial, rhizomatous herbs. Stem terete, up to 2 m tall, erect, simple, pubescent in distal half, glabrous or sparsely pubescent in proximal half. Leaves simple, alternate, proximal leaves withering by flowering, sub-sessile or sessile; lower leaf lamina distinctly oblanceolate, upper leaf lamina elliptic-oblanceolate, 5.5–21 × 0.7–3.7 cm, base attenuate, margin distinctly serrate, apex

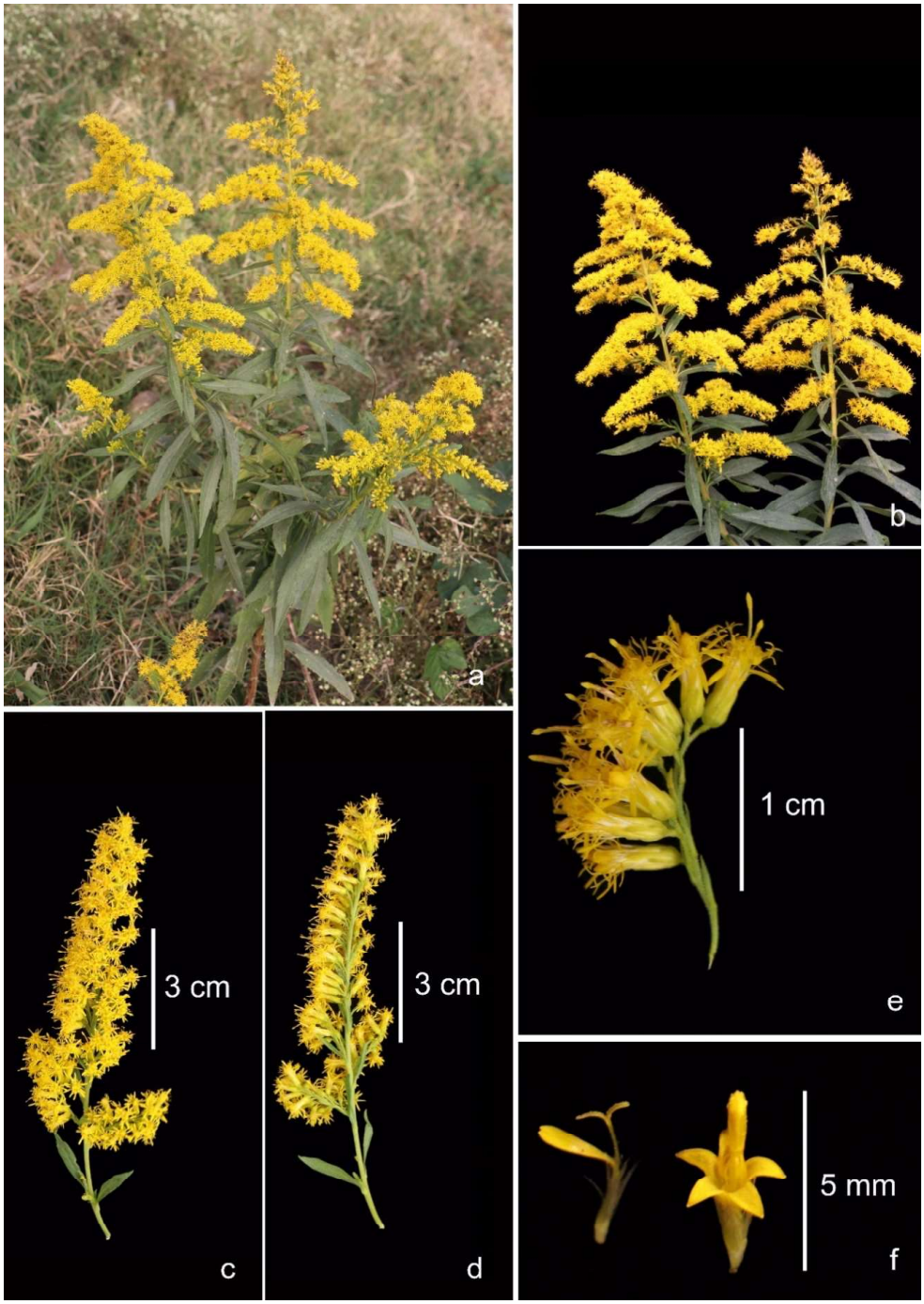

Fig.2. *Solidago canadensis* L.: **a.** Habit; **b.** Flowering branches; **c.** Racemes- upper side view; **d.** Racemes- lower side view; **e.** A section of raceme; **f.** Ray floret (left) and disc floret (right).

acute or shortly acuminate, upper surface glabrous, lower surface pubescent throughout or sparsely pubescent at veins, triplinerved. Capitula secund, radiate, in paniculi form synflorescences. Racemes slightly recurved. Involucres cylindric, 3–4 mm long; phyllaries in 3–4 series, unequal. Ray florets c. 12 in number, female, c. 4.5 mm long, 2-dentate, yellow. Disc florets 2–3 in number, bisexual, 3–5 mm, 5-lobed, yellow. Pappus of white bristles, 2–3 mm long. Mature cypselae obconic, c. 1 mm long, pubescent.

Flowering & fruiting: October-December.

Habitat: Naturalized population of *Solidago canadensis* was found spreading in disturbed and open habitats along roadsides and foot trails in Kathmandu valley around 1300 m.

Distribution: It is a native of North America (Mexico, eastern and southern USA and Canada, between the latitude 26° N and 65° N) and has been introduced to Europe and parts of Asia (now also in Nepal) (CABI, 2023).

Specimens examined: NEPAL, **Bagmati province**, Kathmandu district, Kirtipur, Tribhuvan University, N 27.68°, E 85.29°, 1354 m, 26.11.2021, *B.B. Shrestha, Y.B. Poudel & S. Poudel* BBS21-06 (KATH, TUCH); N 27.68°, E 85.28°, 1337 m, 26.11.2021, *Y.B. Poudel, K. Panthi& S. Poudel* YKS21-01 (KATH).

Distinguishing features: *Solidago canadensis* L. is easily distinguished from other two reported species in Nepal i.e., *S. virgaurea* L.and *S. decurrens* Lour. by the following characters: synflorescences with slightly recurved branches, secund capitula and leaves with 2 distinct lateral veins. The other two species have synflorescences with ascending branches, capitula not secund and leaves with more than 2 lateral veins. *Solidago canadensis* L. is a highly variable complex with many infraspecific taxa (Melville & Morton, 1982). *Solidago canadensis* L. is very similar to *S. altissima* L. and only distinguished by its glabrous or sparsely pubescent stem in proximal half and distinctly serrate leaves (Chen & Semple, 2011; Verloove et al., 2017). Our specimens have longer involucre (i.e., 3-4 mm long) than it is stated in Chen and Semple (2011) and Verloove et al. (2017).

Invasion risks: *Solidago canadensis* has been reported as invasive weed in several countries in Asia and Europe (Weber, 1997; Dong et al., 2015). It is a clonal plant which reproduces aggressively by both sexual and asexual means (Hartnett & Bazzaz, 1985) and has serious negative impacts on species diversity in both native and non-native ranges (Ledger et al., 2015). Further, it is reported to have allelopathic effects to outcompete native species (Sun et al., 2006; Zhang et al., 2009; Yuan et al., 2013; Yuan et al., 2024). In Nepal, the plant seems to have escaped from the garden (Shrestha et al., 2022) and is now growing along road verges, urban parks, and farmlands in the Kathmandu valley. Dual reproductive modes (rhizome and seed), capacity to form dense patch, likely high introduction efforts (for medicinal and ornamental uses), and invasive status in Nepal's neighboring countries China and India suggest that *S. canadensis* may spread and become invasive in Nepal.

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