

Rapid Communication***Evolvulus nummularius* (L.) L. (Convolvulaceae): a new alien plant record for Pakistan**Iram M. Iqbal^{1,*}, Asad Shabbir^{1,2}, Kanzah Shabbir¹, Mary E. Barkworth³, Firdaus-e-Bareen¹ and Shujaul M. Khan⁴¹Department of Botany, University of the Punjab, Lahore 54590, Pakistan²The University of Sydney, School of Life and Environmental Sciences, Camden, 2570 NSW, Australia³Department of Biology, Utah State University, Logan, 84322-5305 Utah, U.S.A.⁴Department of Plant Sciences, Quaid-i-Azam University, Islamabad, PakistanAuthor e-mails: iram.phd.botany@pu.edu.pk (IQ), asad.shabbir@sydney.edu.au (AS), kanza.shabbir@gmail.com (KS), Mary.Barkworth@usu.edu (MB), firdaus.botany@pu.edu.pk (FB), smkhan@qau.edu.pk (SK)

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Evolvulus nummularius (L.) L., a member of the Convolvulaceae, is native to Mexico and South America but nowadays grows around the world in many tropical and subtropical regions. Its presence in Pakistan, where it has become naturalized, is reported here for the first time. It was first discovered in Pakistan in the Jhok Reserve Forest in Lahore city of Punjab Province on September 5, 2016. It has since been found in four more localities in Lahore. Although *E. nummularius* has some medicinal value and is edible, it is usually considered a weed in the south and southeast of Asia. A detailed morphological description and comparison with other species of *Evolvulus* now established in Pakistan. In addition, the geographic distribution, ecology, economic importance, and invasive potential of *E. nummularius* are discussed. The description and key have been integrated with other floristic resources for Pakistan via two web sites, OpenHerbarium and KeyBase, to facilitate their discovery. Eradication of this introduced herb is probably impossible, but steps can and should be taken now to restrict its further spread within Pakistan before it affects the productivity of croplands.

Key words: non-native plant, new record, invasive species, emerging weed, *Evolvulus***Introduction**

Members of the Convolvulaceae (bindweed/morning glory family) grow in the tropical and temperate regions throughout the world (GBIF 2020a). The family includes about 60 genera and 1650 species (Fang and Staples 1995; Stefanović et al. 2003). Genus *Evolvulus* L. includes 90 to 100 species which are mostly native to the Americas (Woodson et al. 1975; Fang and Staples 1995). The genus includes annual and perennial herbs with prostrate to erect non-twining stems and small, alternately arranged sessile leaves (Ward 1968). Two species, *E. alsinoides* (L.) L. and *E. nummularius* (L.) L., have become established around the world (Ooststroom 1934; GBIF 2020b, c). Only one species of the genus, *Evolvulus alsinoides* has been reported from Pakistan so far (Austin and Ghazanfar 1979). It was first

reported from the Indo-Pak subcontinent in the early 1700s (Austin 2008). Today, it is known from the tropical and subtropical regions throughout the world (GBIF 2020c).

This paper reports the presence of a second species of the genus in Pakistan, *Evolvulus nummularius*, which was found growing in a protected area, the Jhok Reserve Forest Lahore during 2016–2017 surveys. Here, we synthesize the existing information concerning its taxonomy and distribution, discuss the implications of its discovery in Pakistan, and draw attention to two web sites where the floristic information presented here is integrated with other floristic information for the Convolvulaceae of Pakistan (Austin and Ghazanfar 1979).

Materials and methods

This study began with the discovery of an unknown species growing in Jhok Reserve Forest, Lahore (Punjab Province) in 2016. To enable its identification, specimens were collected, the locality georeferenced using a ETREX 20, and images recorded using a DSLR-Nikon 5300. Fieldwork during 2016–2019 revealed several additional populations, each of which was documented in a similar manner. A distribution map of the species was prepared using ArcMap 10.5 ESRI (Supplementary material Table S1). The specimens were identified using the Flora of China (Fang and Staples 1995) and their identification confirmed using images on the E-flora of India Google Group (<https://sites.google.com/site/efloraofindia/>). They have been deposited in the herbarium of the University of Punjab (LAH; Thiers 2020), Lahore.

We consulted OpenHerbarium (2020) and GBIF (2020c) to determine the known distribution of *E. nummularius* and Tropicos (2020) to develop the list of nomenclatural and taxonomic systems. The listing in this paper includes only taxonomic synonyms derived from Ooststroom (1934) and the Flora of China (Fang and Staples 1995). The examination of type specimens was beyond the scope of this project.

Results

As stated in the introduction, the unknown species proved to be *E. nummularius*, a member of the Convolvulaceae. All populations discovered from different sites of Lahore, seem to be well established, suggesting that the species is probably more widespread, at least in Lahore if not in other parts of Pakistan. The following description of *E. nummularius* is based on the specimens collected as part of this study.

Description:

Plants stoloniferous perennial herbs with prostrate stems (Figure 1A), rooting at the lower nodes, roots 2–4 cm long (Figure 1B). Stems 15–40 cm

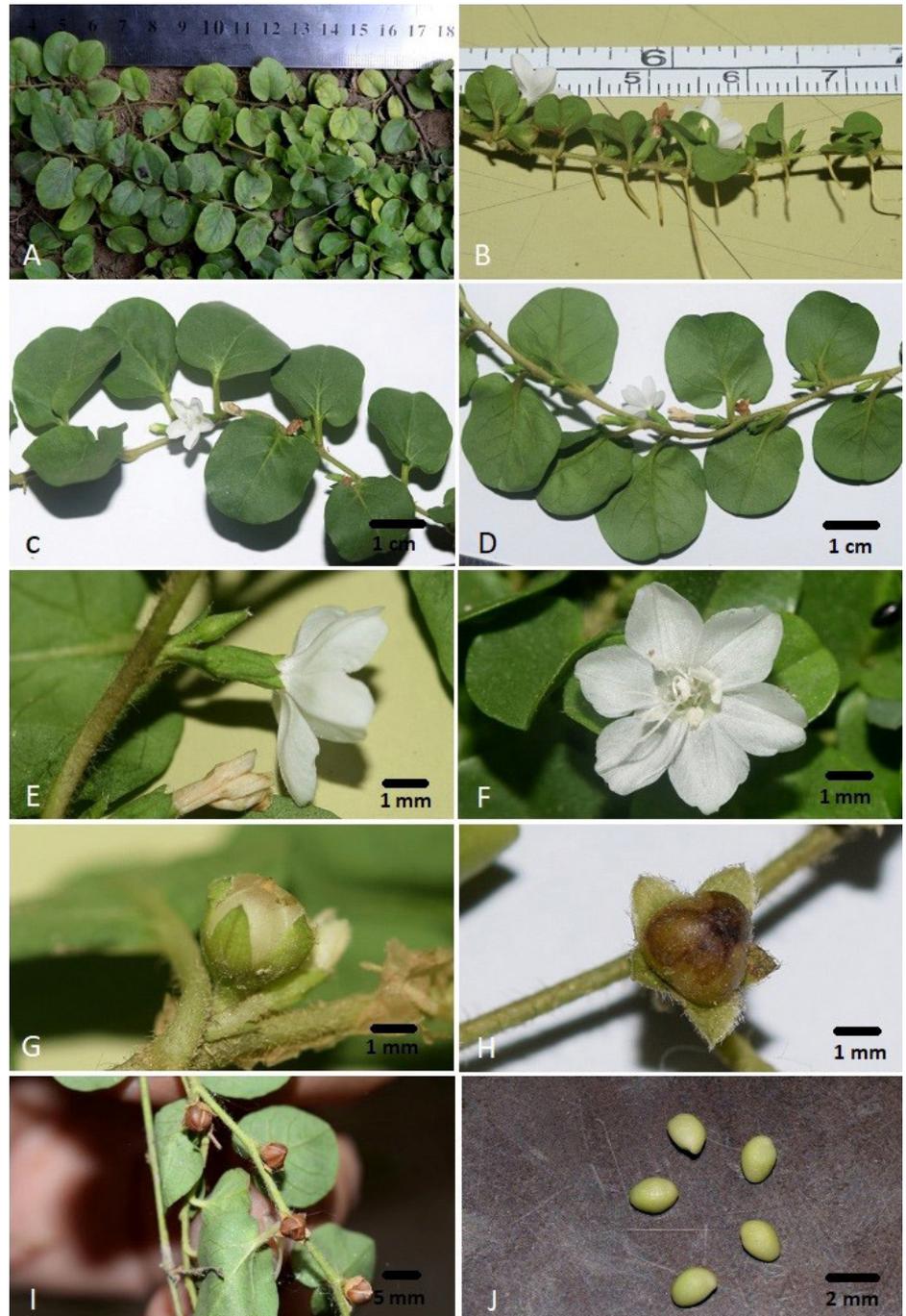


Figure 1. *Evolvulus nummularius* showing its creeping habit (A), lower portion of creeping stem with rooting at each node (B), alternate arrangement of leaves on an adaxial surface (C), abaxial side of leaves (D), flower and flower bud emerging from leaf axil (E), flower with deeply lobed corolla and stamens (F), young globose capsule (G), brown capsule and sepals along with ciliate margins (H), position of mature fruits on lower side of stem (I), ovoid seeds (J). Photographed by Iram Mujahid Iqbal.

long, brown-pilose. Leaves alternate (Figure 2D), petiolate; petioles 4–6 mm long, brown-pilose; blades round to obovate, about 1–1.7 cm long and about 1.5 cm wide, margins entire, apices round, emarginate (Figure 1C; Figure 2D), veins of abaxial surfaces sparsely pubescent (Figure 1D). Flowers axillary, 1–2 per leaf axil, pedicellate (Figure 1E), pedicels sparsely pilose, 2–5 mm long, becoming reflexed in fruit. Sepals 5, about 2 mm long

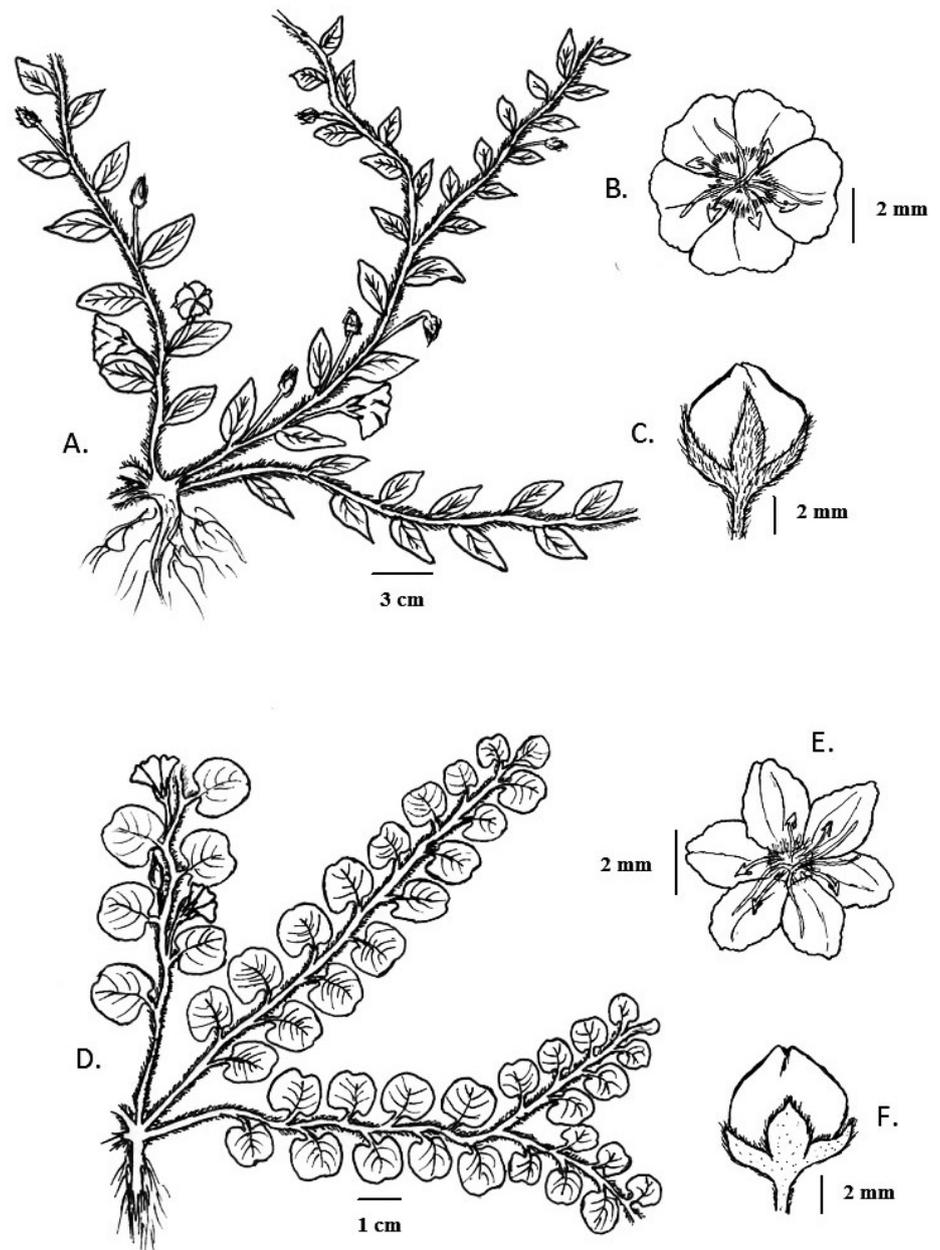


Figure 2. Comparison of *Evolvulus nummularius* with a closely resembling species, *E. alsinoides*: *E. alsinoides* (A–C): A. habit showing leaves and flower position, B. flower shape, C. fruits with pubescent sepals. *Evolvulus nummularius* (D–E): D. habit showing leaves along with flower position, E. flower shape, F. fruit. Drawings by Iram Mujahid Iqbal

and 1 mm wide, 2 outer, two inner, the fifth overlapping both. Corollas white, united, deeply 5(–6)-lobed (Figure 2E), tube about 2 mm long, 1 mm wide, lobes about 3 mm long, emarginate, about 5 mm across, opening at dawn, closing in strong sunlight, (Figure 1F); Stamens 5, inserted on corolla tube; filaments about 4 mm long. Ovaries 5-locular glabrous; styles 2-branched, branches subclavate. Fruits capsules, globose to ovoid (Figure 2F), always bent downwards, about 3 mm in diameter, with 2–4 seeds (Figure 1G), initially purplish, becoming light brown at maturity (Figure 1H–I); seeds ovoid, about 2 mm long and 1.5 mm wide, straw-colored with purplish spots (Figure 1J).

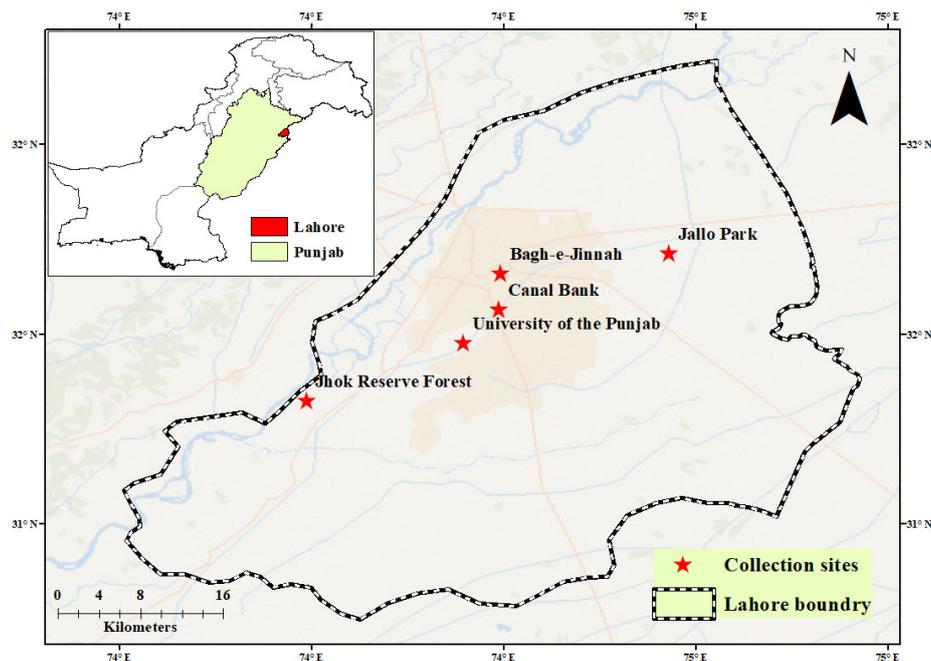


Figure 3. Distribution map of *Evolvulus nummularius* in District Lahore, Punjab.

Specimens examined:

PAKISTAN. Jhok Reserve Forest, Lahore, September 2016–2017, near moist area of a riverbank, 31.412°N; 74.130°E, elev. 217 m. University of the Punjab, Quaid-e-Azam Campus, Lahore, May 2017, in the lawns and along the roadside, 31.493°N; 74.300°E, elev. 210 m. Jallo Park, Lahore, September 2017, turf grassland, lawns, 31.572°N; 74.477°E, elev. 219 m. Bagh-Jinnah, Lahore, 2017, lawns and playing grounds, 31.554°N; 74.330°E, elev. 214 m. (Figure 3). Unfortunately, all specimens were inadvertently mounted on the same herbarium sheet, LAH#285025, without being labelled as to their source.

Ecology in Pakistan:

It grows in moist localities along the roadsides, canal banks, riverbanks, under shady areas, and grassy lawns and athletic fields. At the sites examined, it continued growing through winter, spring, and summer but flowering occurred only from April to October. The flowers open in the late afternoon and early morning but close in intense daylight.

Identification key for Evolvulus in Pakistan:

1. Leaves nearly circular, emarginate; pedicels 1–3 mm long; corollas white *E. nummularius*
2. Leaves oblong, mucronate; pedicels 20–30 mm long; corollas blue *E. alsinoides*

Discussion

Evolvulus nummularius is reported for the first time for the flora of Pakistan. Five naturalized populations were found in Lahore District, Punjab. Although native to Mexico to Argentina, it has become established in tropical and sub-tropical areas of Africa, Malaysia, Ceylon, Bhutan, India and Nepal (Chen et al. 2009; Tamilarasan et al. 2015; GBIF 2020b). It is usually known in English as roundleaf bindweed but in Pakistan, especially Lahore, it is called “hazar dani”, a reference to the large number of small seeds produced throughout the year.

Four other names have been used for *E. nummularius*. Two are based on the same type specimen: *Convolvulus nummularius* L. and *Volvulopsis nummularia* (L.) Roberty (Corrected from *V. nummularium*, cf. Art. 23.5 of the *International Code of Nomenclature for algae, fungi, and plants* Turland et al. (2018)). The other two names are based on different types. One, *Evolvulus capreolatus* Mart. ex Choisy, is invalid because it was cited as a synonym (Choisy 1845). The other, *Evolvulus yunnanensis* S.H. Huang, was treated as a synonym by Fang and Staples (1995). We accept their judgement because, as authors of the generic treatment in the *Flora of China*, they will have examined its type and other specimens initially identified as *E. yunnanensis*.

Similar species

Evolvulus nummularius resembles *E. alsinoides* in being a perennial, creeping herb but, in *E. nummularius*, the leaves have truncate to lobed bases and rounded or emarginate apices (Figure 2) whereas in *E. alsinoides* the bases are obtuse-angled and the apices mucronate. The stems and leaves of both species are pubescent but those of *E. nummularius* are less densely so and its trichomes are not spreading. The two species also differ in shape and color of their floral features. *Evolvulus nummularius* has shorter, more sparsely hairy pedicels and glabrous sepals, apart from their ciliate margins, whereas the sepals of *E. alsinoides* are hairy over the whole outer surface (Figure 2). In addition, the corollas of *E. nummularius* are white and deeply lobed and sometimes 6-lobed whereas in *E. alsinoides* the corollas are blue and always five-lobed (Table 1).

Economic importance

Evolvulus nummularius is used as a vegetable in Assam and Majuli Island in India (Barua et al. 2007). It is also considered to have medicinal importance, being used as an anthelmintic, and to treat scorpion stings, cuts, fever, wounds and burns (Mullick et al. 2018) and is used in India as a mild sedative for the treatment of hysteria and convulsion. In Nepal, *E. nummularius* paste is used to treat scabies (Namrata et al. 2014).

Table 1. Comparative morphology of *Evolvulus nummularius* and *E. alsinoides*.

Structure	Character	<i>Evolvulus nummularius</i>	<i>Evolvulus alsinoides</i>
Leaves	Length	1–1.7 cm	1–2.5 cm
	Shape	Nearly circular	Oblong
	Base	Truncate to lobed	Obtuse
	Tip	Emarginate	Mucronate
Pubescence	Leaves and stem	Sparse	Dense
Pedicels	Length	1–3 mm	20–30 mm
	Pubescence	Sparsely pilose	Densely pilose
Sepals	Shape	Oblong-ovate	Lanceolate
	Length	2–4 mm	3–4 mm
	Surfaces	Glabrous	Villous
	Margins	Ciliate	Not ciliate
Corolla	Lobing	Deeply 5–6-lobed	Shallowly 5-lobed
	Color	White	Blue
	Diameter	5–6 mm	Up to 10 mm

Invasive potential

Although *E. nummularius* is used as a vegetable and medicine, it is considered a weed of lawns, grasslands and agricultural lands (Pandey et al. 2011; Nagaraju et al. 2014; Rahman et al. 2014; Sahu and Barik 2017; Kaur et al. 2018). It is found in all the districts of Bangladesh (Moniruzzaman et al. 2013; Zahra and Rahman 2018). In the Indian States of Tamil Nadu and Odisha, it has spread throughout the cities (Udayakumar et al. 2011; Panda et al. 2018). The species is known as an agricultural weed of groundnut, sugarcane, rice and lentil crops in India (Pragada and Venkaiah 2012; Talukdar 2013; Nagaraju et al. 2014; Das et al. 2018) and of wheat and mulberry in Bangladesh (Rahman et al. 2014; Rahman and Mamun 2017). It has become established on coal soils in dry tropical areas of India (Pandey et al. 2011; Singh 2012). *Evolvulus nummularius* is regarded as an invasive species in Dharwad district and Lucknow, India (Kotresha et al. 2011; Singh et al. 2015), while recent reports suggest that it is becoming invasive in forest areas of Jharkand and wetlands of India (Reddy et al. 2009; Divakara et al. 2013). It is considered a naturalized alien plant in Taiwan (Wu et al. 2010) and the Tiwi Islands of Australia (Fensham and Cowie 1998).

The introduction pathway of *E. nummularius* is not known but apparently, it is mainly a weed of turfgrasses and lawns. It is interesting to observe that it was first recorded in Ludhiana Punjab, India in 2009 (Kaur et al. 2018), a location only 98 miles away from the Lahore. Therefore a possible route of introduction is through India. Its presence in the Jhok Reserve forest can also be attributed to the river Ravi that comes from India as water diversion facilitates the spread of alien species (Zhan et al. 2015). Discussions with groundkeepers suggest that the species has only recently been introduced but it is now naturalized in Lahore city. Its status as naturalized is confirmed by the presence of established populations in the studied areas for a few years. It spreads both by seed and by rooting of its prostrate stems. This vigorous rooting means that the plants form a

dense mat-like cover on the ground, which invades and displaces turf grasses or existing herbs, both in lawns and forest areas. It also means that it cannot be controlled by mowing. Literature suggests that mowing sometimes also contributes to the spread of weed seeds due to the adherence of seeds on the equipment (James et al. 2019).

Eradication of *E. nummularius* from Pakistan is probably impossible but, if uncontrolled, it could negatively impact many agricultural systems. Its presence in protected forest areas could present a serious threat to Pakistan's indigenous plant diversity. Additionally, the aesthetic and athletic value of playing fields is threatened by the rapid spread of *E. nummularius* in such habitats. Mowing alone may not be sufficient to control the spread of this alien plant because of its abundant adventitious roots and its prostrate habit. The gardeners we spoke with said that an herbicidal spray "EAGLE" (amidosulforan formulation) is sometimes used to control it, but the species usually reappears from seeds in the soil seed bank. It may be that the most effective solution is awareness and vigilance so that new infestations are eliminated before they become established. To assist in informing the public and botanists about this new alien species, we have posted the identification key to the Flora of Pakistan project in KeyBase (2020) and linked the taxon names to taxon pages generated in OpenHerbarium (2020).

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Supplementary material

The following supplementary material is available for this article:

Table S1. Distribution of *Evolvulus nummularius* in District Lahore, Punjab.

This material is available as part of online article from:

http://www.reabic.net/journals/bir/2020/Supplements/BIR_2020_Iqbal_etal_SupplementaryMaterial.xlsx