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Extended Naturalization Records of Five Non-Native Plant Species to Indian States

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Field survey across various parts of the country coupled with study of literature and examination of herbarium specimens revealed naturalized distribution of five exotic species in various states of India *viz*. *Amaranthus palmeri* S. Wats. (Delhi and Haryana), *Centratherum punctatum* Cass. (Nagaland), *Dysphania pumilio* (R.Br.) Mosyakin & Clemants (Jammu & Kashmir and Rajasthan), *Emex spinosus* (L.) Campd. (Delhi) and *Solanum diphyllum* L. (Andhra Pradesh) which are not earlier reported from these states. The description, phenology, habitat and field notes have been provided in detail.

Key Words: Genetic resource, Indian states, New distribution, Non-native species, Weed

Introduction

Naturalized plants are the plants established as a part of the flora of a particular region other than their place of origin. Maheshwari (1962) reported about 40% of Indian flora comprised foreign elements. These groups of plants predominantly include weeds, exotic crops, especially floricultural plants, crop wild relatives which are deliberately or otherwise got introduced into a region. While undertaking surveys and explorations across different areas, a few species were observed that were not reported in floristic literature pertaining to some Indian states. Such records have been occasionally documented in plant genetic resource studies (Pradheep *et al*., 2011; Sharma, 2012; Pandey *et al*., 2015). Documentation of such species not only helps updating the floristic literature, but also in germplasm collection (in case of crops and related species) as well as in taking prophylactic measures to avoid their fast spread to other areas (in case of weeds). In this paper five such species have been noted as new records to six Indian states. The information on taxonomy, global distribution, phenology and notes on significant findings are provided.

Materials and Methods

The plants were collected at flowering and fruiting stages during explorations undertaken for the past three years (2012-15). Critical observations were made on morphological characters in natural habitats as well as material available in the herbarium. Hand lens (10x) was used for recording observations on micro-morphological characters at field. Herbarium specimens were prepared following the standard procedures (Jain and Rao, 1977) and were studied using Stereoscopic Zoom Microscope (Nikon SMZ1000) and DS Camera Control Unit (DS-L2) at ICAR-NBPGR, New Delhi especially for anthers, stigma, ovary and other minute characters. The botanical information thus obtained was validated with relevant floristic literature, online herbaria at London (BM), Edinburgh (E), Kew (K), Paris (P) and Beijing (PE) including the type specimens. Herbarium specimens were deposited in National Herbarium of Cultivated Plants (NHCP) at ICAR-NBPGR, New Delhi. These species were thoroughly checked against concerned floristic literature (http://efloraindia.nic.in/efloraindia; Kumar, 2001; Pullaiah and Chennaiah, 1997; Naithani, 1990; Shetty and Singh, 1987; Maheshwari, 1963) and were confirmed as new records.

Results and Discussion

1. *Amaranthus palmeri* S.Wats. in Proc. Am. Acad. 12: 274. 1877. Thakur in J. Indian Bot. Soc. 43: 573. 1964. Shetty & Singh, Fl. Rajasthan 2: 728. 1991. Patil in J. Bombay Nat. Hist. Soc. 95(1): 150-151. 1998. [Family Amaranthaceae] Fig. 1 A, B and 2.

Type (lectotype designated by Sauer 1955: 31): United States of America, California, banks of Rio Grande, July 1834, *Berlandier 2407* (GH).

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Fig. 1. New record of plant naturalizations in Indian states/Union Territories – A and B. *Amaranthus palmeri* S. Wats. in Ferozepur Jhirka, Haryana; C. *Centratherum punctatum* Cass. in Mon, Nagaland ; D. *Emex spinosa* (L.) Campd. in Aravalli Biodiversity Park, Delhi; E. and F. *Solanum diphyllum* L. in Malivalasa, Andhra Pradesh (fruiting plant and flowering twig).

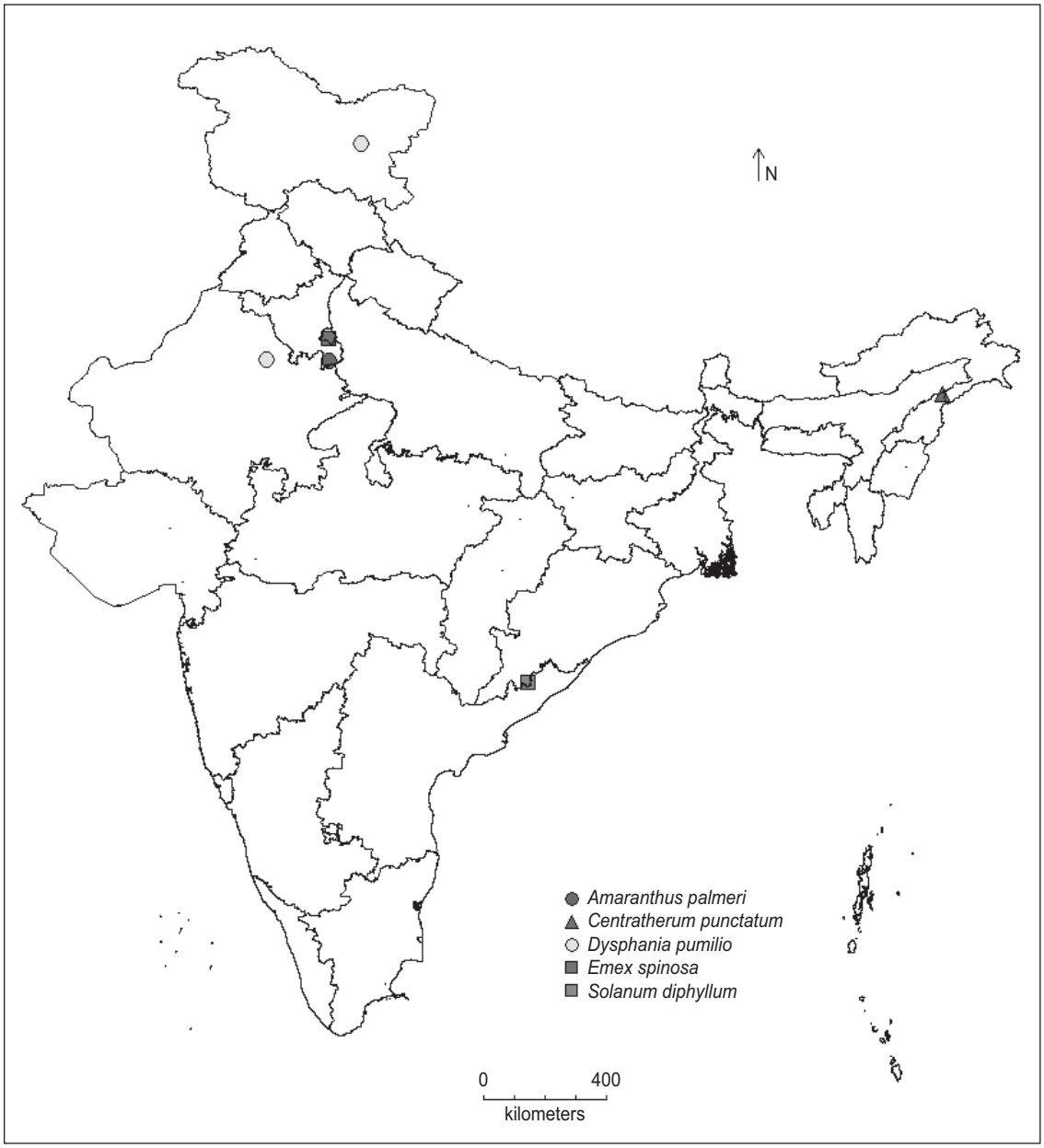

Fig. 2. Map showing new distribution record for *Amaranthus palmeri* S.Wats., *Centratherum punctatum* Cass., *Dysphania pumilio* (R.Br.) Mosyakin & Clemants, *Emex spinosa* (L.) Campd. and *Solanum diphyllum* L.

Herb dioecious, annual, erect, branched, glabrous, up to 1.8 m tall. Stem sulcate-angular, pale green, sometimes pink-tinged. Leaves up to 8 cm long, long-petiolate, petiole often longer than lamina; lamina obovate to lanceolate, obtuse-acute, apex mucronate. Inflorescence terminal, linear-spiked, with occasional few axillary clusters, interrupted in proximal part of rachis. Bract 5-6 mm long, about 2 times longer than tepals, apex acuminate, spine-tipped, particularly of pistillate flowers. Staminate flower tepal 5, unequal, apex acute, stamen 5. Pistillate flower tepal 5, apex acuminate, mucronulate; style branches spreading; stigma 2. Utricle brownish, subglobose, shorter or as long as tepals, rugose. Seed dark brown, about 1.2 mm diam., shiny.

Flowering & Fruiting: Jan.-Dec.

Distribution: Native to Mexico and USA, naturalized in Europe, Asia and Australia. *India*: Bihar, Rajasthan, Maharashtra, Gujarat, Haryana (now), and Delhi (now); along roadsides, wet waste areas and agricultural fields.

Specimens examined: Haryana, Mewat district, Ferozepur Jhirka, 27° 47' 409" N 76° 57' 662" E, 210 m, 23 August, 2015 (flowering twig), *K. Pradheep 2224* [NHCP22212]. Delhi, Central Ridge Reserve Forest, Vandemataram Marg, opp. Buddha Jayanti Park, 28° 36' 396" N 77° 09' 360" E, 234 m, 22 September, 2016 (flowering twig), *E. Roshini Nayar & K. Pradheep/2016-1* [NHCP22379].

Notes: This is the only dioecious *Amaranthus* species (coming under subg. *Acnida*) occurring in India. This aggressive species is spreading very fast on roadsides and crop fields, probably owing to its spiny bracts.

2. *Centratherum punctatum* Cass. in F. Cuvier, Dict. Sci. Nat. ed. 2. 7: 384. 1817. R.R. Rao *et al*., Fl. Ind. Enum.-Asterac. 23. 1988. P.K. Hajra *et al*., Fl. India 13: 394. 1995. [Family Asteraceae] Fig. 1 C and 2.

Type (neotype designated by Kirkman 1981: 15): Brazil, Loreto, *s.d*., *Eiton 4042* (SP).

Spreading herb or undershrub to 50 cm tall. Stem many branched, branches terete, ascending, glabrescent to villous. Leaves 3-5.5 x 1.2-1.5 cm, short petiolate, lamina ovate to elliptic or obovate to spathulate, cuneate to attenuate at base, margin serrate, sparsely pubescent on both sides, teeth with minute mucro. Head terminal, solitary or in cluster of 2-3, peduncle 3-4 cm long. Involucre campanulate, about 1 cm long. Phyllary (involucral bract) imbricate in several series, membranaceus, outer foliaceous, greenish, glabrous or sparsely tomentulose; inner purplish. Corolla purplish or bluish, 5-7 cm long, glandular. Achene not seen.

Flowering & Fruiting: Jan.-Dec.

Distribution: *World*: Mexico, USA, West Indies, Central America and South America. *India*: naturalized in Assam (Talukdar and Deori, 2014) and Nagaland (now); in disturbed places, roadsides.

Specimen examined: Nagaland, Mon district, Mon, 26° 43' 751" N 95° 01' 459" E, 718 m, 24 November, 2013 (flowering twig), *K. Pradheep & Soyimchiten 1601* [NHCP22159].

*Notes***:** Besides Nagaland, the authors observed this neotropical ornamental species as an escape from cultivation in Meghalaya (West Khasi Hills), and Manipur (Tamenglong; http://www.flowersofindia.net/catalog/slides/Brazilian%20Button%20Flower.html accessed 26.05.2016). It was found cultivated as medicinal and ornamental plant in home gardens in the states of Tamil Nadu, Kerala and Maharashtra. An allied infraspecific taxon, subsp. *fruticosum* (S.Vidal) K. Kirkman ex Shih H.Chen, M.J.Wu & S.M.Li, is reported to be naturalized in West Bengal (Chowdhury and Das, 2012), which is distinguished from typical subspecies by large achenes and phyllaries with strong indurate base (Kirkman, 1981).

3. *Dysphania pumilio* (R.Br.) Mosyakin & Clemants, Ukrayins'k. Bot. Zhurn. (Ukr. Bot. J.) 59: 382. 2002. *Chenopodium pumilio* R.Br., Prodr. 1: 407. 1810. Ramayya & Rajagopal in Curr. Sci. 38: 173. 1969. [Family Chenopodiaceae] Fig. 2.

Type: Australia, South Australia, Kangaroo Island, 21 March 1802, *R. Brown 3303* (BM001010202).

Annual herb, prostrate or ascending, aromatic, to 30 cm. Stem branched, glandular, pubescent, green. Leaves alternate, petiolate, petiole about 1 cm long; lamina elliptic-lanceolate or ovate-lanceolate, 2.4-2.7 × 0.75-1.2 cm, glandular-pilose at lower surface, apex obtuse, base cuneate, margin lobed (2-4 each side). Inflorescence in axillary cymes or glomerules, greenish, subglobose, 2.0-3.5 mm in diam. Flower minute; tepals 5, ovate, glandular-pubescent; stamen absent or 1; stigma 2, thread-like. Fruit subglobose. Seed vertical, ovoid, 0.6-0.7 mm, black-brown, testa smooth.

Flowering & Fruiting: Feb.-July & Nov.-Dec.

Distribution: *World*: Native to Australia, and is naturalized in Europe, North America, Japan, New Zealand, Argentina, Iran (Rahiminejad *et al.*, 2004) and China. *India*: Tamil Nadu (Nilgiris), Rajasthan (now) and Jammu & Kashmir (now); in human settlements, occasionally colonizing disturbed areas (roadsides).

Specimens examined: Jammu & Kashmir, Leh district, Leh-Fort Road, 34° 16' 083" N 77° 57' 461" E, 3450 m, 07 September, 2014 (whole plant), *K. Pradheep & Mohar Singh 1717* [NHCP21894]. Rajasthan, Jhunjhunu district, Nawalgarh, 27° 50' 445" N 75° 16' 048" E, 380 m, 24 March, 2013 (a flowering twig), *E. Roshini Nayar 2013* [NHCP21183].

Notes: In Nawalgarh, this weedy species was occurring as scattered rosette along gravelly paths**.** It is characterized by the presence of multicellular glandular hairs. It is distinguished from other species occurring in India – *D. ambrosioides* and *D. botrys* by seeds always vertical (vs usually horizontal), stamen 1 (vs (1-)5), plants slightly aromatic (vs strongly aromatic) (Rahiminejad *et al.*, 2004).

4. *Emex spinosa* (L.) Campd., Monogr. Rumex. 58. 1819. Bhandari, Fl. Ind. Desert 300. 1990. Shetty & Singh, Fl. Rajasthan 2: 745. 1991. *Rumex spinosus* L., Sp. Pl. 33. 1753. [Family Polygonaceae] Fig. 1 D and 2.

Type: Greece, Crete ["Habitat in Creta"], Herb. Linn. 464. 36 (LINN).

Annual herb, glabrous monoecious, upto 30 cm tall. Stem decumbent, branched, often reddish. Leaf alternate, entire; ochrea glabrous, membranous; petiole 2-5 cm long, glabrous; lamina ovate-oblong, 3.5-5.0 × 2.5-3.0 cm, base truncate, apex obtuse. Staminate flowers in axillary fascicles, ovate; tepal 6, greenish, oblong to oblanceolate; stamen 4-6, shorter than tepal. Pistillate flowers in axillary clusters, subsessile, 3-6 per fascicle; tepals 6, connate, arranged in 2 whorls of 3 each, outer ones spinescent; style 3, stigma 3. Nut 3-angled, 4-5 x 3-3.5 mm, enclosed in the spinescent tepals, spine 0.5-1.0 mm long, longitudinally 3-grooved.

Flowering & Fruiting: March-May

Distribution: *World*: Mediterranean region; now naturalized in South America, Eurasia, North Africa and Australia. *India*: Rajasthan, Karnataka, Bihar, Delhi (now); mostly in dry, sandy places and in cultivated fields.

Specimen examined: Delhi, Aravalli Biodiversity Park (near Gurgaon border), 28° 29' 225" N 77° 07' 025" E, 258 m, 19 March, 2015 (fruiting twig), *A. Pandey & K. Pradheep-15/44* [NHCP22091].

Notes: This weed species, though not reported in floristic literature pertaining to the state of Haryana, has been noted as a major weed in wheat and chickpea crops (Punia *et al*., 2009; Chhokar *et al*., 2012). The first author observed occasional occurrence of this species as weed in the experimental fields of Punjab Agricultural University, Ludhiana during March 2015, although unreported from Punjab.

5. *Solanum diphyllum* L., Sp. Pl. 1: 184. 1753. T.K. Paul & M.C. Biswas, *Bull. Bot. Surv. India*, 37: 137-138. 1995. Zhang *et al*., Fl. China 17: 317. 1996. *S. capsicastrum* Link ex Schauer Allg. Gartenzeitung (Otto & Dietrich) 1: 228. 1833. [Family Solanaceae] Fig. 1 E, F and 2.

Type (vide D'Arcy 1974): Herb. Linn. 248. 5 (LINN).

Shrub, glabrous, to 1.5 m tall. Stem erect, terete, dark brown. Leaves unequal-paired, major leaf petiole about 0.5 cm long, winged by leaf bases, lamina entire, elliptic-oblong, 4-6 × 2.5-3.0 cm, base attenuate, apex rounded; minor leaf subsessile, lamina rounded, 1.4-2.0 × 1.2-1.5 cm, entire. Inflorescence leaf opposed, short scorpioid racemes, peduncle short, unbranched. Flowers bisexual, pedicel 5-10 mm long. Calyx constricted at base, c. 2 mm long, 5-lobed. Corolla stellate, whitish, 5-7 mm across, 5-lobed, lobe c. 4 mm long. Stamen 5, equal, epipetalous, anther stout, 1-1.5 cm long; filament short. Ovary glabrous. Fruit a berry, orange, globose, 8-10 mm across, fruiting pedicel erect. Seed yellowish, margin thickened.

Flowering & Fruiting: May-July and June-Sept.

Distribution: Native to Mexico and Central America, naturalized in Taiwan. *India*: Maharashtra, Bihar, Uttar Pradesh, West Bengal, Tamil Nadu and Karnataka, Andhra Pradesh (now); along roadsides.

Specimens examined: Andhra Pradesh, Visakhapatnam district, Araku mandal, Malivalasa, 18°21'370" N 82°53' 404" E, 868 m, 31 October, 2015 (part of fruiting twig), *K. Pradheep & B. Abraham 2083* [NHCP22157].

Notes: In Araku mandal of Andhra Pradesh, this ornamental species appears to be recently naturalised along roadsides and has been spreading fast. Besides, the second author observed it as an escape from cultivation in herbal gardens at Delhi. It is related to a northeast Indian species *S. spirale* Roxb. (Paul and Biswas, 1995).

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