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Short Communication

Seedling Characteristics of Some Invasive Alien Species of Asteraceae from West Bengal, India

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Abstract

In the present communication, seedling specific identification details of five alien invasive species of Asteraceae from West Bengal, India have been provided. The seedlings of the investigated species revealed some interesting characters as to the shape and surface of cotyledons; phyllotaxy, shape of first two leaves and subsequent leaves; surface and length of hypocotyl and internodes, etc. that can be used to distinguish them at their juvenile stage. The identification of seedlings of these alien species will help in eradicating them from the ecosystem at an early stage to minimize environmental damage and economic loss.

Keywords: Seedling, Alien species, Asteraceae, Artificial key, Morphology.

Introduction

An alien plant is also referred to as exotic, introduced, non-indigenous or non-native plant that is considered to have been introduced intentionally or accidentally from one region to another through human agency or some other factors. Most of the alien species easily naturalize and propagate very fast to displace native species causing economic losses and adverse impact on environment. Such species are considered as invasive species. In the convention on biological diversity, biological invasion of alien species have been recognized as second worst threat for global biodiversity loss and species extinction after habitat destruction.

It is imperative from the above foregoing that such alien species are needed to be identified and eradicated at an early stage to minimize the economic losses vis-a-vis to maintain the indigenous species. In this context, taxonomic study of seedlings of such alien plants may serve the purpose. The taxonomic significance of seedlings derives principally from its morphological characters and all parts contribute to the information. Seedling characteristics are also useful in classifying angiospermic taxa. The perusal of literature revealed that studies based on seedling morphology have successfully separated different species of the same family[1-4]. However, there has been little work on variation in seedling characteristics of species in Asteraceae[5,6].

The renewed interest in juvenile plant morphology in the last decade augurs well for the application of these characters as a systematic tool in the identification and eradication of invasive alien species at a very early stage. In view of this, the present investigation was undertaken in which seedlings of some commonly available invasive alien species of Asteraceae of West Bengal were studied morphologically to provide reliable characters for the identification of these species at juvenile stages i.e. much before flowering and fruiting stages.

Materials and Methods

In the present investigation, seeds, seedlings and adult specimens of five common alien species of Asteraceae (Table-1) were collected from different localities of West Bengal. The adult specimens were identified and their nativity recorded following relevant literature[7-9]. All seeds were grown in the earthen pots in the Experimental Botanic Garden of the Department of Botany, R.B.C. College, Naihati and the developmental stages of seedlings were recorded and studied during germination. Seedlings of different stages of the investigated species were also collected from natural habitats. The natural seedlings were compared and studied with those of seedlings raised from seeds in the garden using a stereo-microscope.

At least eight to ten specimens of different growth forms were studied from different habitats. The seedlings were photographed and documented in the way of Herbarium sheets. For the description of seedlings, 7th-8th leaves stage of each species was selected and the morphology of seedling was described following standard methodology[10-15].

An analytical dichotomous key (bracketed type) was constructed based on observed features of the seedling plant specimens. It provides a choice between two contradictory statements resulting in the acceptance of one and the rejection of the other. By making the correct choice at each level of the key,

one can eventually arrive at the identification of the unknown seedling plant.

Table-1
List of investigated alien species from the family Asteraceae

Sl.No.	Scientific Name	Common Name / Local Name	Nativity
1.	*Ageratum conyzoides* Linn.	Goat Weed, Uchunti, Jangli Pudina	Tropical America
2.	*Cyanthillium cinereum* (L.) H.Rob.	Little ironweed, Kuksim, Sahadevi	Malay Archipelago
3.	*Grangea maderaspatana* (L.) Poir.	Madras carpet, Namuti, Mukhtari	Tropical South America
4.	*Lagascea mollis* Cav.	Silk leaf	Tropical Central America
5.	*Sonchus asper* (L.) Hill	Prickly sow-thistle, Ban-palang	Mediterranean

Results and Discussion

The present study of five invasive alien species of Asteraceae has demonstrated marked variation in their juvenile plant morphology. The seedling morphological descriptions of investigated taxa are given below:

Ageratum conyzoides **Linn. (Figure-1a):** Seedling epigeal, phanerocotylar. Taproot 5 mm - 20 mm long, glabrous. Hypocotyl elongating, 8 mm - 12 mm long, terete, glabrous, reddish-brown in colour. Cotyledons two, opposite, foliaceous, persistent up to 7^{th} – 8^{th} leaves stages, exstipulate, short petiolate; petiole 1 mm - 2 mm, hairy; blade deltoid (2 mm – 2.5 mm x 2 mm - 3 mm); base subtruncate, apex rounded, margin entire, surface glabrous, venation simple craspedodromous. Internodes terete, hairy; first internode 8 mm - 10 mm long, second one 12 mm-13 mm long; next internodes almost equal to that of first one. First two leaves opposite, simple, exstipulate, short petiolate; petiole 2 mm - 3 mm, glabrous; blade ovate (10 mm - 14 mm x 5 mm - 7 mm), base obtuse, apex acute, margin serrate, surface hairy; venation simple craspedodromous; surface hairy. Subsequent leaves opposite. Other characters almost same as that of first two leaves except measurements.

Cyanthillium cinereum **(L.) H.Rob. (Figure-1b):** Seedling epigeal, phanerocotylar. Taproot 8 mm – 18 mm long, glabrous. Hypocotyl elongating, 8 mm - 12 mm, terete, glabrous. Cotyledons two, opposite, foliaceous, exstipulate, petiolate; petiole 1 mm - 2 mm, hairy; blade wide ovate (2 mm - 3 mm x 1.5 mm – 2.5 mm); base obtuse, apex obtuse, margin entire, surface glabrous, venation brochidodromous. Internodes elongating, terete, glabrous, first internode 10 mm - 12 mm long, second one 2 mm - 4 mm long; next internodes almost equal to that of first one. First two leaves alternate, simple, exstipulate, petiolate; petiole 3 mm - 4 mm, glabrous; blade ovate (10 mm - 15 mm x 5 mm - 8 mm), base asymmetrically cuneate, apex obtuse, margin entire, surface hairy; venation simple craspedodromous. Subsequent leaves alternate, blade wide ovate, margin entire or undulating. Other characters almost same as that of first two leaves except measurements.

Grangea maderaspatana **(L.) Poir. (Figure-1c):** Seedling epigeal, phanerocotylar. Tap root 14 mm - 15 mm long, glabrous. Hypocotyl reduced, 2 mm – 4 mm long, terete, glabrous, pale green in colour. Cotyledons two, opposite, foliaceous, persistent up to 10^{th} – 11^{th} leaves stages, exstipulate, petiolate; petiole 1 mm – 1.5 mm long, hairy; blade ovate, 2 mm - 2.5 mm x 1 mm - 1.5 mm, base and apex obtuse, margin entire; glabrous; venation simple craspedodromous. Internodes compressed, first four internodes less than 5 mm, hairy. First two leaves opposite, simple, exstipulate, petiolate; petiole 2 mm – 2.5 mm long, hairy; blade obovate (6 mm – 7 mm x 3 mm - 4 mm), base cuneate, apex obtuse, margin distantly serrate, hairy, venation simple craspedodromous. Subsequent leaves alternate, blade oblanceolate-elliptic, base attenuate, margin serrate to pinnatifid. Other characters almost same as that of the first two leaves except measurements.

Lagascea mollis **Cav. (Figure-1d):** Seedling epigeal, phanerocotylar. Tap root 20 mm - 30 mm long, hairy. Hypocotyl elongating, 15 mm - 20 mm long, terete, hairy, light brown in colour. Cotyledons two, opposite, foliaceous, persistent up to 7^{th} – 8^{th} leaves stages, exstipulate, petiolate; petiole 2 mm - 3 mm long, hairy; blade ovate (3 mm – 3.5 mm x 1.5 mm - 2.5 mm), base and apex obtuse, margin entire, surface hairy, venation simple craspedodromous. Internodes elongating, terete, hairy; first and second internodes 18 mm - 22 mm and 26 mm - 30 mm long respectively. First two leaves opposite, simple, exstipulate, petiolate; petiole 6 mm - 7 mm long, densely hairy; blade elliptic-ovate (8 mm – 8.5 mm x 3 mm – 3.5 mm), base and apex acute, margin entire; surface densely hairy with white adpressed hairs on both surfaces, venation simple craspedodromous. Subsequent leaves elliptic-lanceolate. Other characters almost same as that of the first two leaves except measurements.

Sonchus asper **(L.) Hill (Figure-1e):** Seedling epigeal, phanerocotylar. Tap root 6 mm - 9 mm long, glabrous. Hypocotyl reduced, 4 mm - 5 mm long, glabrous. Cotyledons two, opposite, foliaceous, persistent up to 4^{th} -5^{th} leaves stages, exstipulate, petiolate; petiole 1 mm – 1.5 mm long, glabrous; blade ovate (4 mm - 5 mm x 3 mm – 3.5 mm), base and apex obtuse, margin entire, surface glabrous, venation simple craspedodromous. Internodes compressed, first four internodes less than 5 mm, glabrous. First two leaves alternate, simple, exstipulate, petiolate; petiole 15 mm - 25 mm long, glabrous; blade elliptic (12 mm - 25 mm x 10 mm - 15 mm), base obtuse, apex rounded, margin entire (first leaf) to distantly dentate

(second leaf), surface glabrous, venation simple craspedodromous. Subsequent leaves alternate elliptic-ovate, apex obtuse, margin distinctly dentate, petiole unequal in size. Other characters almost same as that of the first two leaves except measurements.

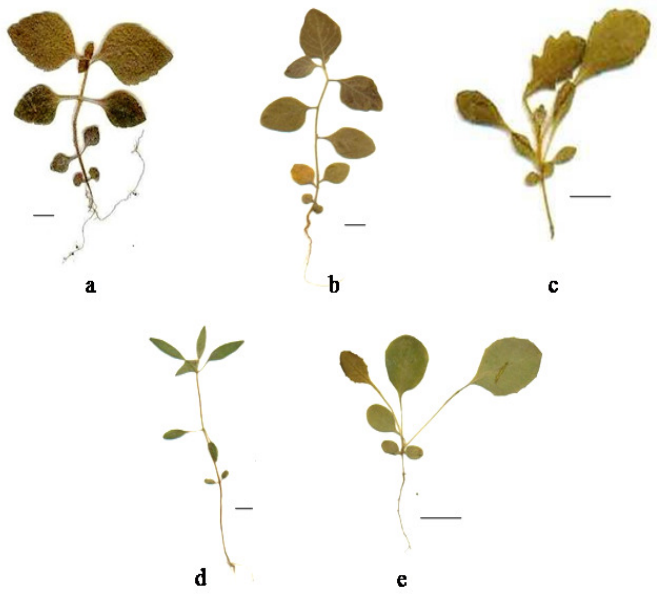

Figure-1a-e
Seedlings of investigated alien species (Scale bar 1 cm) (a) *Ageratum conyzoides* (b) *Cyanthillium cinereum,* (c) *Grangea maderaspatana,* (d) *Lagascea mollis* (e) *Sonchus asper*

The above investigated alien species are characterized by epigeal, phanerocotylar type of germination. Regarding hypocotyl length, it is short and reduced (<0.5 cm) in *Grangea maderaspatana* and *Sonchus asper* whereas elongating (>0.5 cm) in rest of the investigated taxa. Hypocotyl was conspicuously hairy in *Lagascea mollis*. The cotyledons are, in general, the exposed, green, leaf-like assimilating seed leaves (paracotyledons). The shape, base, and apex of cotyledons, etc. are important features for identification of investigated taxa at juvenile stage. The seedlings of *Ageratum conyzoides* can be identified by deltoid cotyledons with sub-truncate base in contrast to ovate cotyledons with obtuse base in the remaining taxa. The foliaceous cotyledons spread out on the stem axis and persist for a longer period but the duration varies among investigated species. The persistency of cotyledons occurs up to 4^{th} - 5^{th} (*Sonchus* sp.), 7^{th} - 8^{th} (*Ageratum* sp., *Lagascea* sp., *Cyanthillium* sp.) and 10^{th} - 11^{th} (*Grangea* sp.) leaves stages. The long duration of cotyledons supports their photosynthetic nature.

The characters of internodes like measurement, colour, and surface are diagnostic and useful in the delimitation of species. *Grangea maderaspatana* and *Sonchus asper* are characterized by compressed internodes. In rest of the three taxa, *Cyanthillium cinereum* is characterized by longer first internode than the second, whereas the first internode is comparatively shorter than the second internode in *Ageratum conyzoides* and *Lagascea mollis*. They may be glabrous or hairy.

The phyllotaxy of juvenile leaves is an important characteristic feature. It may be specific in seedling both for the first two and subsequent leaves. Two types of phyllotaxy have been noticed in the investigated taxa – opposite and alternate. Alternate phyllotaxy is found in *Cyanthillium* and *Sonchus* whereas Opposite phyllotaxy is found in *Ageratum* and *Lagascea*. However, seedlings of *Grangea madersapatana* are characterized by oppositely arranged first two leaves and alternate arrangement of subsequent leaves.

The shape of the first two and subsequent leaves is also an important taxonomic character in the identification of species. The shape of the first two leaves is various among the investigated species. It may be ovate (*Ageratum, Cyanthillium*), elliptic (*Lagascea, Sonchus*) and obovate (*Grangea*). However, *Lagascea* and *Sonchus* having similar lamina shape can be differentiated by their morphology of base, margin and apices of first two leaves and shape of subsequent leaves as reflected in their description. Base balance of lamina is symmetric in all of the investigated species except *Cyanthillium* sp. where it is asymmetric.

The surface of the lamina is glabrous in *Sonchus* sp. and hairy in the rest. Among investigated species, *Grangea maderaspatana* and *Sonchus asper* is characterized by the progressive changes in the morphology of the juvenile leaves referred to as heteroblastic development. In the seedlings of *Grangea maderaspatana*, the first two leaves are opposite, obovate with serrate margin and subsequent leaves are alternate, oblanceolate-elliptic with serrate margin gradually changes to pinnatifid condition. In the seedlings of *Sonchus asper*, first two leaves are elliptic with round apex and entire (first leaf) to distantly dentate margin (second leaf), and subsequent leaves are elliptic-ovate with proper dentate margin. This is the first report of heteroblastic development in *Grangea maderaspatana* and *Sonchus asper*. These seedling characters are considered to be genetic markers as because these are manifested in the seedling developed from a seed just after germination and before attaining secondary growth.

Conclusion

The above fore-going emphasized that seedlings in the family Asteraceae manifested some interesting characters, as to the duration, shape, base, apex and surface of cotyledons; phyllotaxy, shape, base, apex, margin of first two leaves and subsequent leaves; surface and length of hypocotyl and internodes, etc. Using these characters, an analytical key has been constructed which enables easy identification of these alien species of Asteraceae at juvenile stage (much before flowering & fruiting) and subsequent eradication from the ecosystem to maintain the indigenous species.

Key to the investigated taxa
(valid for the taxa mentioned)

1a. First two leaves and subsequent leaves alternate ……..... 2
1b. First two leaves opposite and subsequent leaves either opposite or alternate ……..... 3
2a. First two leaves ovate, apex obtuse, surface hairy; subsequent leaves with entire or undulating margin, internodes and hypocotyl elongating…….. *Cyanthillium cinereum*
2b. First two leaves elliptic, apex round, surface glabrous; subsequent leaves with distinctly dentate margin, internodes and hypocotyl reduced …….. *Sonchus asper*
3a. Subsequent leaves opposite, margin entire or serrate; internodes and hypocotyl elongating……..… 4
3b. Subsequent leaves alternate, margin pinnatifid; internodes and hypocotyl reduced……...…… ……..... *Grangea maderaspatana*
4a. Cotyledons deltoid, base subtruncate; subsequent leaves distinctly ovate, margin serrate …..…… *Ageratum conyzoides*
4b. Cotyledons ovate, base obtuse; subsequent leaves elliptic-lanceolate, margin entire….. *Lagascea mollis*

The present study is an exploratory one involving a limited number of alien species from Asteraceae and offers some insight into the world of seedlings of these alien species. Probably more extensive studies on seedling features covering all invasive alien species would be of great help in understanding relationship between ecology and morphology.

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