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COMPOSITIONS, DISTRIBUTIONS AND STATUS OF ECONOMIC PLANTS AMONG INVASIVE FLORAS OF UTTARPARA, WEST BENGAL, INDIA

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ABSTRACT: A survey was carried out during the span of 2005-2010 to invent the invasive alien plant species and their economic uses in urban and adjoining rural areas of Uttarpara, Hooghly district, West Bengal. Study revealed occurrence of 103 alien angiospermic plant species under 32 families, of which four families (Araceae, Poaceae, Cyperaceae, Pontederiaceae) are monocots. Dicot family Fabaceae dominated with 20 plant species, followed by Asteraceae with 17, Amaranthaceae with 8, Solanaceae with 7, Euphorbiaceae with 5, and then other families. Rise in number of alien species was evidenced in year-wise quadrat studies, screening 11 most invasive species namely *Parthenium hysterophorus*, *Eupatorium odoratum*, *Ageratum conyzoides*, *A. haustonianum*, *Chromolaena odorata*, *Cassia sophera*, *Leucaena leucocephala*, *Alternanthera sessilis*, *Amaranthus spinosus*, *Lantana camara* and tree, *Trema orientralis* distributed within Aseteraceae (5 taxa), Fabaceae (2 taxa), Amaranthaceae (2 taxa), Verbenaceae (1 taxon) and Ulmaceae (1 taxon). Remarkably, the alien species have been used in diverse economic and commercial purposes by local village folks, showing use of nearly 49% plants in local health-care systems as herbal products

INTRODUCTION: Invasive alien species are colonizer species that have established populations outside their native distributional ranges and that have potential to spread and affect native ecosystems or local human-mediated systems [1, 2]. Biological invasions by alien species are widely recognized second worst threat to native biodiversity and impose high costs to agriculture, forestry, and aquatic ecosystems. The global extent and rapid increase in invasive species is homogenizing the world's flora and fauna [3] and is recognized as a primary cause of global biodiversity loss, diminishing regional distinctiveness of flora and fauna and catalyzing homogenization of biota [4, 5].

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Yet, a large number of alien plants are daily used by local population in fuel, sheltering, fishing, medicinal, and other purposes [6, 7]. At least 10% of the world's vascular plants (3,00,000) have the potential to invade other ecosystems and affect native biota in direct and indirect ways [8]. About 18% of the Indian flora is composed of alien species, of which tropical

America has the largest share (55%), followed by Asia (30%), and Europe, the Mediterranean and others (15%). About 40% of the Indian flora is alien, of which 25% are invasive alien species [8, 9]. As India is considered as a biodiversity rich country, authentic documentation of alien plant species are urgently needed at regional level to get a comprehensive national data base for better management and utilization of exotic floras [10].

The state of West Bengal is located between 85˚ 50′ and 89˚ 50′ E and 21˚ 38′ and 27˚ 10′ N, and one of populas but the biodiversity rich states in India. The lower Indo-Gangetic basin constitutes fertile hub for diverse types of flora and fauna,

introduced by anthropogenic activities since time immemorial. The Hooghly district is an important part of this basin, dotted with numerous wetlands, forest covers and agricultural lands. Hooghly is the major river with some small rivers constituting the riverine and floodplain systems in this district. Uttarpara (situated between 22˚40´N and 22.67˚05´N latitude and 88˚21' and 88˚35´E longitude) is one of the oldest heritage cites in Hooghly district, delimited by Bally khal in South and river Hooghly in the eastern side representing lower part of Gangetic basin.

The climate of the district is tropical monsoon with three distinct seasons-summer (March-early June), rainy (June-September) and winter (October – February), and mean annual rainfall ca, 1300 mm. While maximum summer temperature may sore to 43 °C, winter is extremely chilled with temperature may plummet to 10-12 °C. The region is very rich in biodiversity but extensive urbanization coupled with introduction of exotic plant species cause a threat to native floras. As biological invasions are frequently influenced by ecosystem functioning [11], climate change [12-14], environmental pollution [15], and other physico-chemical mechanisms, a proper first hand inventory in disturbed areas is absolutely necessary to assess threats on indigenous resources.

Although rich in floral diversity, no investigation was carried out to document the economic plants utilizations among invasive alien plants in this area. In the last 5-6 years, activities of trade, various infrastructure development projects, vehicle and rail transport increased to a considerable extent. As invasive species has huge ecological impacts and preference over native species in urban ecology due to their faster rate of growth, biomass production, allelopathic potential, high reproductive efficiency, seed dispersal types, rapid establishments and hardiness to abiotic stress, documentation of alien plants is necessary. The objectives of the present study are, therefore, to document the alien flora, their classification and use by local people in and around the Uttarpara region.

MATERIALS AND METHODS:

Study site:

The present investigation was carried out by extensive field survey during the last six years (2005-2010) in different intervals (March-June, September-January) in Uttarpara area covering both urban and villages adjacent it **(Fig 1)**.

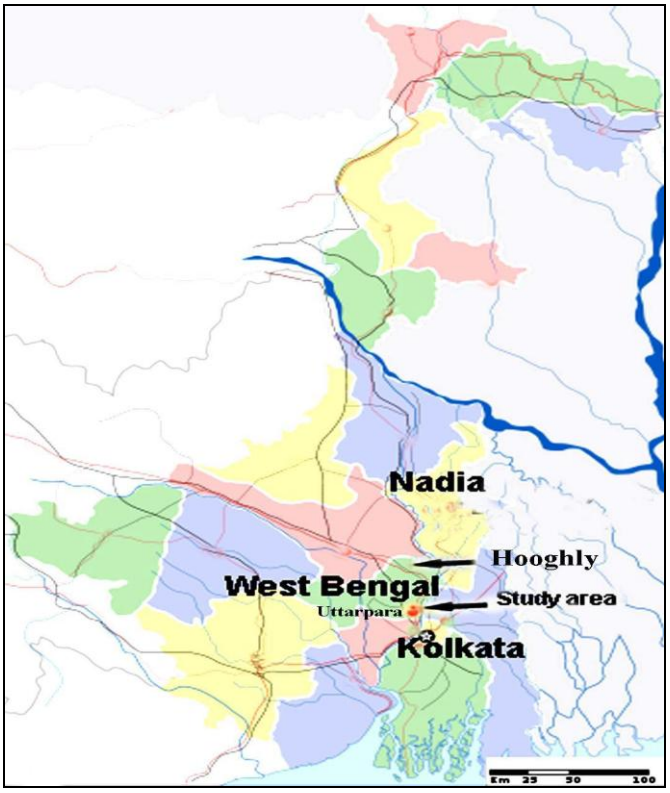

FIGURE 1: A MAP OF STUDY AREAS (RED DOTS) IN UTTARPARA HOOGHLY DISTRICT, WEST BENGAL, INDIA.

Collection of data and methods of inventory:

Plant samples were collected either in flowering or in fruiting stage, and voucher specimens were deposited in departmental herbaria, R.P.M. College, Uttarpara, Hooghly and pressed specimens are being digitalized in Digital Phyto-Informatics Center of the Botany department (http://www.rpmcdigitalphytoinformatics.com/).

Invasive nature of some of the worst alien species, enlisted by previous works [16, 17], was studied using techniques of Baider and Florens [18], namely through a combination of random walks through the area along with a more quantitative sampling of the seedlings and larger woody plants (flowering or fruiting stage) in a series of square quadrats (1 × 1 m for seedlings and 10 × 10 m for tree). Frequency (F%) of particular plant species was calculated by dividing the number of quadrats in which a particular species occur with total number of quadrats laid down.

The specimens were identified through extensive survey of available literatures, monographic works,

and confirmed by IPNI (International Plant Names Index) data base (www.IPNI.org). Use of documented flora was tabulated through interviews of knowledgeable people like temple priests, village head, old experienced folk, medicine men, farmers, teachers, etc. Gathered information was thoroughly cross-checked by structured questionnaires, and documented thereafter. Nativity of the species was tested from the available literatures [19].

RESULTS:

Documentation and classification of alien taxa:

Present inventorization of the alien invasive flora in and around Uttarpara revealed occurrence of 103 species belonging to 83 genera under 32 families (**Table 1**). Among the plant growth form, herbs constituted 85%, and it was followed by shrub (9%), tree (4%) and climbers (2%). Several genera were found to possess three or more species (**Table 1**). Dicotyledonous species contributed major proportion (94%) of alien flora grouped under 96 species and 28 families (**Table 1**), followed by Monocotyledons (6%) distributed in seven genera under four families. Among the total 32 families, Fabaceae dominated with 20 species, followed by Asteraceae (17 species), Amaranthaceae (8), Solanaceae (7) and then others (**Table 1; Fig. 2**).

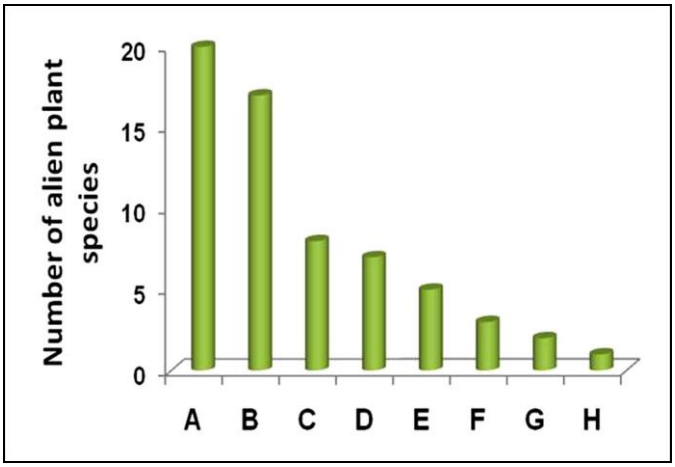

FIGURE 2: DISTRIBUTION OF ALIEN PLANT SPECIES IN DIFFERENT ANGIOPSPERM FAMILIES; A-Family Fabaceae, B-Asteraceae, C- Amaranthaceae, D-Solanaceae, E-Euphorbiaceae, F- Malvaceae/ Scrophulariaceae/ Lamiaceae/ Convolvulaceae/ Asclrpiadaceae/Poaceae (three species each), G-Cuscutaceae/ Verbenaceae/ Pontederiaceae/ Acanthaceae/ Polygonaceae (two species each), H-rest of the 16 families with one species each, as mentioned in **Table 1.**

Habitat distribution:

About 38% of invasive species identified in the present study were most abundant in roadside (GT roads and rural roads) bushes, while inside area was suitable for 32% plant species. Cultivated fields and banks of water bodies were preferred by 20% and 10% species, respectively. Quadrat studies in the last six years revealed high frequency of some of the daisies like *Parthenium hysterophorus*, *Eupatorium odoratum*, *Ageratum conyzoides*, *Ageratum houstonianum*, *Chromolaena odorata* along the roadside than the interior of the villages (**Fig. 3**).

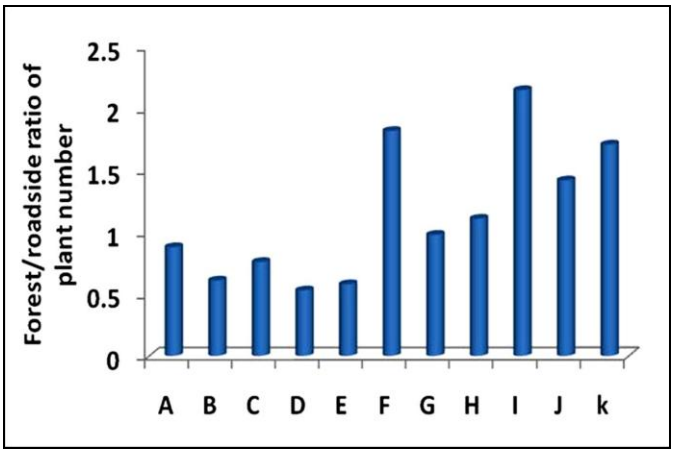

FIGURE 3 VILLAGE-FOREST/ROADSIDES RATIO OF NUMBER OF PLANTS FOR ELEVEN ALIEN TAXA.

The ratio of number of plants (cumulative of 400 quadrats/year in six years) between interior villages/forest area and roadside varied between 0.53-0.88 for these five daisy members, while it was close to 1.0 for *Cassia sophera* (0.98), >1.0 for *Leucaena leucocephala*, *Alternanthera sessilis*, *Trema orientalis* and *Amaranthus spinosus*, and was 2.15 for *Lantana camara* (**Fig. 3**). By contrast, *Wedelia chinensis*, *Tridax procumbens* and *Eclipta prostrata* exhibited higher frequency in interior of the study sites (F=80-86%) than the roadside (F=65-72%).

Within the village area, members of Amranthaceae such as *Achyranthes aspera*, *Alternanthera philoxeroides*, *Alternanthera sessilis* and *Amaranthus spinosus* dominated intermingling with numbers of leguminous plants like *Aeschynomene americana*, different species of *Cassia*, *Crotalaria*, *Leucaena leucocephala*, *Mimosa pudica*, and species of other families in different magnitudes.

Interestingly, frequency of *Parthenium* reduced in plots where species of family Amaranthaceae dominated. The tree *Trema orientralis* flourished within the undisturbed area better than the roadside

(**Fig. 3**). Members of family Polygonaceae, Araceae, Cyperaceae, Pontederiaceae preferred wetland areas, while Solanaceae, Euphorbiaceae, Malvaceae, Cactaceae, Convolvulaceae and Asclepiadaceae were more frequent in dry land.

Documentation of spread of alien flora over the last six years (2005-2010) revealed steep rise in number of certain plant species (quadrat wise) such as species of *Parthenium*, *Ageratum*, *Chromolaena*, *Eupatorium*, *Cassia*, *Leucaena*, *Alternanthera*, *Lantana*, *Amaranthus* and *Trema* (**Fig. 4),** while low to moderate rise was documented for other species (data not presented).

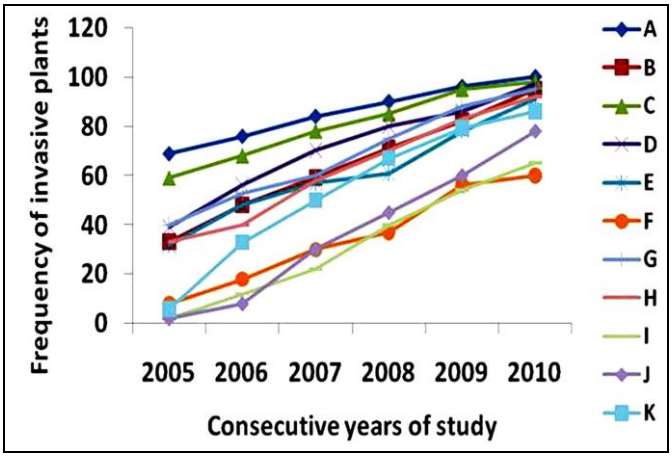

FIGURE 4: FREQUENCY % OF 11 INVASIVE PLANTS AS RECORDED FROM SIX CONSECUTIVE YEARS (2005-2010) WITH 400 SQUARE QUADRATS LAID DOWN/YEAR, A- *Parthenium hysterophorus* L., B-*Eupatorium odoratum* L., C- *Ageratum conyzoides* L., D-*Ageratum houstonianum* Mill., E- *Chromolaena odorata* (L.) King & Robinson, F- *Leucaena leucocephala* (Lam.) de Wit, G-*Cassia sophera* L., H- *Alternanthera sessilis* (L.) R.Br. ex DC, I- *Lantana camara* L, J- *Trema orientralis* (Linn.)Blume, and K- *Amaranthus spinosus* L.

Economic/commercial utilization of alien plants by local people:

The 103 plant species documented as alien flora in the present inventory have been used by local population as food, fodder, medicinal, ornamental, commercial (fishing, thatching, basket making, etc,), religious and other purposes (**Fig. 5**), revealing resource utilization by people in diverse ways. Among the species, members of legume family Fabaceae have been used most extensively as food, fodder, fuel, manure, folk play and other purposes (**Table 1**).

As local people reveled, wild beans (*Phaseolus* spp), *mungs* (*Vigna* spp), *khesari* (*Lathyrus sativus* L.) and *jangli matar (Lathyrus aphaca* L.) have considerable benefits in their daily life; seed flour as food supplement, making *besans*, *pokaras*, whole plant as fodder, soil fertilizer (mulching), and tender pod as vegetables. About 49% of total alien plants were used as medicinal purposes, while 11.6 % plants were utilized as food and 9.7 % used as cattle feed.

Among the small-scale cottage industries, preparation of beads on string using seeds of *Coix* (Poaceae) and commercial 'shola' using *Aeschynomene americana* (Fabaceae) were found highly beneficial for local economics. Different types of wood works, another financially viable activity within the study area, are mainly carried out with *Prosopis julifera* (Fabaceae) tree. Besides, different plant parts have been used as folk play, insecticide and aromatic purposes (**Table 1; Fig. 5**).

TABLE 1: INVASIVE PLANT SPECIES AND THEIR UTILIZATIONS IN UTTARPARA AREAS OF HOOGHLY DISTRICT OF WEST BENGAL, INDIA

Sl.no	Species	Family	Life form	Nativity	Use
1	*Aerva javanica (Burm.f.) Juss.ex Schult*	Amaranthaceae	Herb	Trop. America	M
2	*Achyranthes aspera* L.	Amaranthaceae	Herb	Trop. America	M
3	*Aeschynomene americana* L.	Fabaceae	Herb	Trop. America	Co, 'shola'
4	*Ageratum conyzoides* L.	Asteraceae	Herb	Trop. America	NU
5	*Ageratum houstonianum* Mill.	Asteraceae	Herb	Trop. America	NU
6	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	Herb	Trop. America	Veg
7	*Alternanthera pungens* Kunth	Amaranthaceae	Herb	Trop. America	M
8	*Alternanthera sessilis* (L.) R.Br. ex DC	Amaranthaceae	Herb	Trop. America	M, Veg
9	*Amaranthus spinosus* L.	Amaranthaceae	Herb	Trop. America	M
10	*Argemone mexicana* L.	Papaveraceae	Herb	Trop. America	NU
11	*Bidens pilosa* L.	Asteraceae	Herb	Trop. America	M
12	*Blumea lacera* (Burm.f.) DC.	Asteraceae	Herb	Trop. America	M, veg

13	*Boerhaavia erecta* L.	Nyctaginaceae	Herb	Trop. America	M, veg, Cf
14	*Calotropis gigantea* (L.) R.Br.	Asclepiadaceae	Shrub	Trop. Africa	M
15	*Calotropis procera* (L.) R.Br.	Asclepiadaceae	Shrub	Trop. Africa	M
16	*Cassia alata* L.	Fabaceae	Shrub	West Indies	M, Thatching
17	*Cassia javanica* L.	Fabaceae	Tree	S.E. Asia	Or, M
18	*Cassia occidentalis* L.	Fabaceae	Herb	Trop. S. America	M, Bf
19	*Cassia sophera* L.	Fabaceae	Herb	Trop. S. America	M, Bf
20	*Catharanthus pusillus* (Murray)Don	Apocynaceae	Herb	Trop. America	M
21	**Chromolaena odorata* (L.) King & Robinson	Asteraceae	Herb	Trop. America	NU
22	*Chrozophora rottleri* (Geis.) Spreng.	Euphorbiaceae	Herb	Trop. Africa	M
23	*Chenopodium album* L.	Chenopodiaceae	Herb	Europe	Veg, Cf
24	*Cleome gynandra* L.	Cleomaceae	Herb	Trop. America	M
25	*Cleome monophylla* L.	Cleomaceae	Herb	Trop. America	M
26	*Cleome rutidosperma* DC.	Cleomaceae	Herb	Trop. America	M
27	*Coix lacryma-jobi* L.	Poaceae	Herb	S. E. Asia	Pearl, fishing
28	*Crotalaria pallida* Dryand	Fabaceae	Herb	Trop. America	Bf
29	*Crotalaria retusa* L.	Fabaceae	Herb	Trop. America	Bf
30	*Croton bonplandianum* Boil.	Euphorbiaceae	Herb	Temp.S. America	M
31	*Cryptostegia grandiflora* R.Br.	Asclepiadaceae	Woody Climber	Trop. Africa (Madagascar)	M
32	*Cuscuta chinensis* Lam.	Cuscutaceae	Herb	Mediterranean	NU
33	*Cuscuta reflexa* Roxb	Cuscutaceae	Herb	Mediterranean	NU
34	*Cyperus rotundus* L.	Cyperaceae	Herb	Africa, S. Europe	M
35	*Cytisus scoparius* (L.) Link	Fabaceae	Herb	Europe	M
36	*Datura innoxia* Mill.	Solanaceae	Shrub	Trop. America	M
37	*Datura metel* L.	Solanaceae	Shrub	Trop. America	M
38	*Dentella repens* (L.) Forst	Rubiaceae	Herb	E. Asia, Australia	Veg
39	*Digera muricata* (L.) Mart.	Amaranthaceae	Herb	S. W. Asia	Veg
40	*Duranta repens* L.	Verbenaceae	Shrub	Trop. America	Or
41	*Echinochloa crusgalli* (L.) P.Beauv.	Poaceae	Herb	Trop. S. America	M
42	*Echinacea paradoxa* Britton	Asteraceae	Herb	Europe	NU
43	*Eclipta prostrata* (L.) Mant.	Asteraceae	Herb	Trop. America	M
44	***Eichhornia crassipes* kunth	Pontederiaceae	Aq. Herb	Trop. America	NU
45	**Eupatorium odoratum* L.	Asteraceae	Herb	Europe	NU
46	*Euphorbia hirta* L.	Euphorbiaceae	Herb	Trop. America	Cf
47	*Euphorbia heterophylla* L.	Euphorbiaceae	Herb	Trop. America	Cf
48	*Evolvulus nummularius* (L.) L.	Convolvulaceae	Herb	Trop. America	Cf
49	*Gnaphalium coarctatum* Willd.	Asteraceae	Herb	Trop. America	NU
50	*Gnaphalium pensylvanicum* Willd.	Asteraceae	Herb	Trop. America	NU
51	*Gomphrena serrata* L.	Amaranthaceae	Herb	Trop. America	Or
52	*Hyptis suaveolens* (L.) Poit.	Lamiaceae	Herb	Trop. America	Aromatic
53	*Impatiens balsamina* L.	Balsaminaceae	Herb	Trop. America	Or
54	*Indigofera astragalina* DC.	Fabaceae	Herb	Trop. America	Cloth washing
55	*Indigofera linifolia* (L.f.) Retz.	Fabaceae	Herb	Trop. America	NU
56	*Ipomoea quamoclit* L.	Convolvulaceae	Herb	Trop. America	Bf
57	*Ipomoea aquatica* Forsk	Convolvulaceae	Aquatic	Trop. America	M, veg
58	**Lantana camara* L.	Verbenaceae	Herb	Trop. America	Bf
59	*Lathyrus aphaca* L.	Fabaceae	Herb	Mediterranean	M, Cf, mulching
60	*Lathyrus sativus* L.	Fabaceae	Herb	Mediterranean	Pulse, Fd, besan, Cf, veg
61	*Leonotis nepetiifolia* (L.) R.Br.	Lamiaceae	Herb	Trop. Africa	M
62	**Leucaena leucocephala* (Lam.) de Wit	Fabaceae	Tree	Trop. America	Bf, basket making,
63	*Ludwigia perennis* L.	Onagraceae	Herb	Trop. America	M
64	*Malachra capitata* (L.) L.	Malvaceae	Herb	Trop. America	M
65	*Mecardonia procumbens* (Mill.)	Scrophulariaceae	Herb	Trop. N. America	NU

	Small				
66	*Melilotus alba* Desv.	Fabaceae	Herb	Europe	Insecticide
67	**Mikania micrantha* Kunth	Asteraceae	Climber	Trop. America	NU
68	*Mimosa pudica* L.	Fabaceae	Herb	Trop. S. America	M
69	*Monochoria vaginalis* (Burm.f.)C. Presl.	Pontederiaceae	Aquatic herb	Trop. America	M
70	*Nicotiana plumbaginifolia* Viv.	Solanaceae	Herb	Trop. America	NU
71	*Ocimum basilicum* L	Lamiaceae	Herb	Trop. America	M
72	* *Opuntia stricta* (Haw.) Haw.	Cactaceae	Herb	Trop. America	NU
73	*Oxalis corniculata* (DC.) Raeusch.	Oxalidaceae	Herb	Europe	M
74	*Parthenium hysterophorus* L.	Asteraceae	Herb	Trop. N. America	NU
75	*Pennisetum purpureum* Schum.	Poaceae	Herb	Trop. N. America	Cf
76	*Peperomia pellucida* (L.) Kunth	Piperaceae	Herb	Trop. America	Folk play
77	*Peristrophe paniculata* (Forssk.) Brummitt	Acanthaceae	Herb	Trop. America	NU
78	*Phaseolus aureus* L.	Fabaceae	Herb	Trop. America	Fd, Cf, veg
79	*Phyllanthus fraternus* Webster	Euphorbiaceae	Herb	Trop. America	M
80	*Physalis angulata* L.	Solanaceae	Herb	Trop. America	Folk play
81	*Pilea microphylla* (L.) Liebm.	Urticaceae	Herb	Trop. America	NU
82	*Pistia stratiotes* L.	Araceae	Herb	Trop. America	M
83	*Polygonum barbatum* L.	Polygonaceae	Herb	S. E. Asia	M
84	*Polygonum hydropiper* L.	Polygonaceae	Herb	S. E. Asia	M
85	*Portulaca oleracea* L.	Portulacaceae	Herb	Trop. S. America	Or
86	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Tree	Trop.S. America	Wood works
87	*Ruellia tuberosa* L.	Acanthaceae	Herb	Trop. America	Or
88	*Scoparia dulcis* L.	Scrophulariaceae	Herb	Trop. America	M
89	*Sesbania grandiflora*	Fabaceae	Shrub	Trop. America	Bf, veg, M, Or
90	*Sida acuta* Burm.f.	Malvaceae	Herb	Trop. America	M
91	*Solanum torvum* Sw.	Solanaceae	Shrub	Trop. America	M
92	*Solanum xanthocarpum*	Solanaceae	Shrub	Trop. America	NU
93	*Solanum nigrum* L.	Solanaceae	Herb	Trop. America	M
94	*Sonchus oleraceus* L.	Asteraceae	Herb	Mediterranean	NU
95	*Spilanthes radicans* Jacq.	Asteraceae	Herb	Trop. America	M
96	*Tephrosia purpurea* (L.) Pers.,	Fabaceae	Herb	Trop. America	M
97	*Torenia fournieri* Linden ex E. Fournier	Scrophulariaceae	Herb	Australia	NU
98	*Trema orientralis* (Linn.)Blume	Ulmaceae	Tree	S. E. Asia	M, Bf, fishing, thatching
99	*Tridax procumbens* L.	Asteraceae	Herb	Trop. America	M
100	*Urena lobata* L.	Malvaceae	Herb	Trop. America	M
101	*Wedelia chinensis*	Asteraceae	Herb	S. E. Asia	M
102	*Vernonia cinera* L.	Asteraceae	Herb	Temperate America	NU
103	*Vigna sublobata* (L.) *Wilczek*	Fabaceae	Herb	S. E. Asia	Pulse, 'bori', besan, Cf

* enlisted in database of world's 100 worst invasive; M-medicinal, Co-compost, Or -ornamental, Bf-biomass fuel, Cf-cattle feed, Fd-Food, Veg-Vegetables, NU-not in use

Nativity of documented alien flora:

Contribution of different geographical regions in terms of nativity of documented flora was shown in **Figure 6**. Tropical America accounted for nearly 60% plants, followed by share of South-East Asia,

Europe and tropical South America, tropical Africa, the Mediterranean and other regions.

DISCUSSION: In the present inventory, the share of invasive species with economic utilization in the floral compositions of study areas has been estimated to 57.11%, while rest of the amount was made up of native species, suggesting dominance of alien flora in Uttarpara areas. Herbs constituted major portions (85%) of this alien species and except only seven species, all others belong to 28 different dicot families. This suggests that increasing urbanization in and around Uttarpara has coincided with increase in alien plant population.

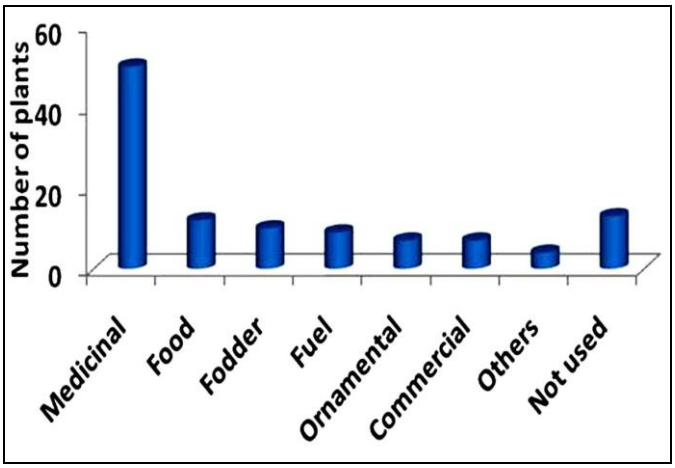

FIGURE 5: UTILIZATION OF RESOURCES OF ALIEN PLANTS BY LOCAL PEOPLE; OTHERS INCLUDE FOLK PLAY, AROMATIC, INSECTICIDE.

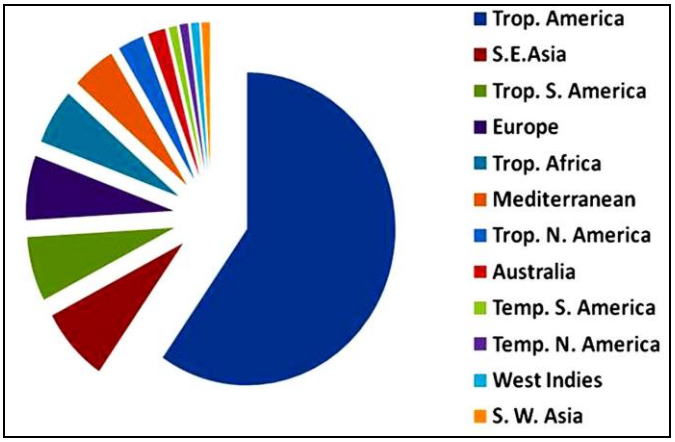

FIGURE 6: NATIVITY OF INVESTIGATED 103 ALIEN TAXA IN 12 WORLD GEOGRAPHIC REGIONS WITH LION'S SHARE IS FROM TROPICAL (TROP) AMERICA, S-SOUTH, E-EAST, N-NORTH, W-WEST.

The dominance of leguminous (Fabaceae) plants in the present study over other species agrees well with earlier reports on Sub-Himalayan North Bengal, India[7]. Although Fabaceae contained highest number of alien species in the present study, dominance of Asteraceae in invasive alien flora was reported in parts of India [19], China [18, 20], and other countries [21]. The higher frequency of some asters along the roadside than the interior of the village/bushes indicated uneven distribution of Asteraceae weeds in the present study area, resulting in interior village/roadside ratio in number of plants below 1.0 for the family. Unlike asters, members of Fabaceae and Amaranthaceae were more evenly distributed as revealed by quadrat plots. Higher number of *Lantana camara* and *Trema orientralis* in forest wasteland suggested invasion of these two aggressive species in nutrient-deficient regions in expense of native flora, leading to village/roadside ratio for these two species over 1.0.

Relative degree of disturbances in habitats, apart from abiotic and biotic constrain, have profound effect to change the physical environment, creating opportunities for introduction and establishment of non-indigenous species to invade native systems in this forest area, as argued in other invasive biological systems [6, 18].

Reduction in frequency of one of the world's worst noxious weeds, *Parthenium hysterophorus* in plots where members of family Amaranthaceae dominated indicated antagonistic/allelopathic effect of amaranth members on spreading of *Parthenium*. Phenomenon of inhibitory or allelopathic effect has been reported in many plant species interactions including effect of aster, *Blumea lacera* L. on rice and common kharif weeds, [22-26].

Recently, allelopathic effect of world's worst invasive plant *Lantana camara* has been revealed in terms of chromotoxicity and severe oxidative imbalance in target crop legumes [27]. However, role of chromosomal rearrangements, ploidy level variations and other intrinsic biochemical mechanisms have been suspected behind aggressiveness of alien invasions, as polyploid species and favorable chromosomal rearrangements, reported in legumes like *Lathyrus* [28, 29, 30] may have better fitness than common native plants [31].

Furthermore, aneuploid genomes and diploid mutated genotypes showing altered morphological, biochemical and molecular make-up may acquire new strategy towards adaptations under diverse stresses [32, 33, 34, 35, 36], and thus, origin of new invasive flora cannot be ruled out.

The steep rise in population of 11 plants species in the present investigated area during the last six years has been revealed by quadrat plots. These 11 plants, therefore, were selected as indicator of alien invasion in the present study area, and their distribution data manifested as ratio of interior village/forest and roadside was presented. The four taxa of asters (*Parthenium, Ageratum, Eupatorium,*

Chromolaena) with 5 species, assessed by this parameter, had not been used by local people in any purposes, but the two legumes, *Cassia* and *Leucaena*, were extensively utilized as medicinal (anti-diabetic) and as fuel, respectively. Similarly, *Trema orientalis* was mainly used as fuel.

The *Lantana camara*, *Amaranths spinosus* and *Alternanthera sessilis*, exhibiting aggressive nature of dominance in degraded land/forest areas, have some use by local people. Utilization of invasive plant resources for diverse economic purposes has been documented in the present inventory. It was found that majority (ca, 49%) of the invasive plant species were used in local health care systems, followed by food and cattle feed. Uses of leguminous plants as both food and forage by village folks have considerable significance as legumes are cheap source of plant protein with many essential amino acids, antioxidant flavonoids and minerals [37].

A recent survey in Sikkim Himalayas (India) revealed extraordinary potential of legumes in formulation of diverse types of ethnic food and medicines [38]. Use of fruits and flowers of the ornamental legume *Sesbania grandiflora* by village folks in different ailments is highly beneficial for their health, as the legume is one of the richest natural sources of vitamin A[39]. Conservation of legume germplasm is absolutely essential to prevent their dwindling genetic diversity throughout the world including India.

The huge potential of under-utilized and 'poor man's' legume like *Lathyrus* in sustainable agro-biodiversity and maintenance of soil nutrition in degraded forest areas due to its remarkable hardiness against abiotic (salinity, heavy metals etc.) and biotic stress has been recognized in recent decade and genetic improvement programs have been undertaken [40, 41, 42, 43, 44]. Identification of wild legumes as alien species in the present study assumes significance for three reasons: first, their utilization in crop improvement, second, their role/effect in alteration of legume-pollinator relationship with existing native cultivars in the invaded region, and third, as almost all parts of the study area is arsenic-contaminated, their potential to accumulate toxic metals in edible part and concomitant risk to consumers.

A recent study in these directions revealed bioaccumulation of arsenic and other heavy metals in photosynthetic part of prominent crop legumes like *Phaseolus vulgaris*, *Lens culinaris*, *Cicer arietinum*, and *Lathyrus sativus* in the lower Bengal Gangetic basin caused severe agronomic loss of yield due to alteration in antioxidant defense mechanisms and severe impairment in plant growth [45, 46, 47]. Quite alarmingly, increase in seed neurotoxin level in grass pea seeds under arsenic stress has been reported [48].

Among the 103 taxa documented in the present inventory, seven species (*Eupatorium odoratum*, *Chromolaena odorata*, *Eichhornia crassipes*, *Lantana camara*, *Leucaena leucocephala*, *Mikania micrantha*, *Opuntia stricta*) are enlisted as world's 100 worst invasive species [17]. The dominance of tropical American flora as alien has been attributed to presence of their strong allelopathic effects on native species [18, 23, 27]. However, it must be noted that after introduction, dominance of alien flora may invite stiff competition among them which can be exploited for their better management and prevention of native species extinction.

It is also important to note that loss of native floral diversity due to alien invasion cannot be straightforward in a dynamic and functional system where increasing stress factors (both biotic and abiotic) may constrain growth and reproduction of existing native species with concomitant introduction (accidental or deliberate) and invasion of more hardy alien species, better utilizing the rapidly depleting soil fertility, habitat fragmentation and other adverse conditions to colonize [48, 49]. A glaring and specific example of legume invasion is the spread of wild *Lathyrus* in diverse climatic conditions through its powerful seed dispersal mechanism from dehiscing pods, a genetic improvement of which is achieved recently to accelerate its domestication [50].

CONCLUSION: Present investigation for the first time documented compositions of alien invasive plants and their status of economic utilization by local people in and around Uttarpara region. It is alarming to note that number of alien species in this area constitutes a major share of floral biodiversity, of which 11 species are enlisted as most aggressive

invasive plants within the study area. It is also important to note that the alien plants have been used by local people for medicinal and other diverse commercial and economic purposes, although they are posing considerable threat to existence of native plant species in the sanctuary.

The present inventory, therefore, can be utilized as an important reference for further risk assessments and management of both alien and alien invasive flora in conservation and co-existence of both native and alien flora in this ecologically significant but fragile region of lower Indo-Gangetic basin of India.

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All authors conducted field study, corresponding author designed the study and prepared the manuscript, authors 1 and 2 prepared graph and figures, authors 3-8 conducted bibliographic study, and all authors read and approved the final manuscript

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