4.1 Screening Biodiversity

For the selection of plants heavy metal accumulation and their effects it is imperative. To survey and study aquatic plants biodiversity. Hence, major water bodies in and around vadodara were surveyed.

4.1.1 Collection trip Details

Plants were collected from various sites of Baroda district. Total 94 plants were collected from various sites out of which 90 plant species were identified and 04 were unidentified. List of various sites and number of plants collected from this sites is as shown in table .

Sr. No.	Details of field trip (s) conducted	No. of specimen collected
1	MSU Botanical Garden	04
2	MSU Arboratum	02
3	Harni Pond	40
4	Gotri Pond	04
5	Sewasi Pond	02
6	Timbi Village Pond	14
7	Mahisagar River	13
8	Vadhvana Lake	11
Total		**90**

Table 9: List of plant collection sites

Sr. No.	Scientific name	Common Name	Latitude	Longitude
Acanthaceae				
1	*Hygrophila polysperma* (Roxb.) T.Anderson	Gokulakanta	N 22° 20' 42.9"	E 73° 13' 12.5"
2	*Peristrophe paniculata* (Forssk.) Brummitt	Panicled Foldwing	N 22° 19' 03.9"	E 73° 07' 13.8"
3	*Barleria prionitis* L.	Porcupine Flower	N 22° 26' 13.5"	E 73° 04' 32.4"
4	*Rungia pectinata* (L.) Nees	Comb Rangia	N 22° 10' 59.4"	E 73° 28' 58.7"
Alismataceae				
5	*Limnophyton obtusifolium* (L.) Miq.	Blunt Arrowhead	N 22° 20' 23.3"	E 73° 13' 12.8"
Amaranthaceae				
6	*Alternanthera ficoidea* (L.) R.Br. ex DC.	Sanguinarea	N 22° 20' 41.5"	E 73° 13' 07.1"
7	*Alternanthera pungens* Kunth.	Khaki weed	N 22° 20' 23.3"	E 73° 13' 12.8"
8	*Amaranthus spinosus* L.	Spiny amaranth	N 22° 20' 48.4"	E 73° 08' 05.5"
9	*Alternanthera ficoides*	Joy weed	N 22° 19' 12.1"	E 73° 06' 09.4"
10	*Gomphrena celosioides* Mart.	Gomphrena Weed	N 22° 19' 11.8"	E 73° 06' 10.2"
11	*Alternanthera philoxeroides*	Alligator weed	N 22° 26' 12.7"	E 73° 04' 32.5"
12	*Achyranthes aspera* L.	Prickly chaff flower	N 22° 18' 21.8"	E 73° 16' 37.5"
13	*Aerva lanata* (L.) Juss.	Gorakh-boonti	N 22° 18' 21.8"	E 73° 16' 37.5"
Aponogetanaceae				
14	*Aponogeton natans* (L.) Engl. & K.Krause	Cape pond weed	N 22° 26' 00.1"	E 73° 04' 19.9"
Araceae				
15	*Pistia stratiotes L.*	Shellflower (water Lettuce)	N 22° 20' 42.9"	E 73° 13' 15.5"
16	*Spirodela polyrrhiza* (L.) Schleid.	Great duckweed	N 22° 20' 25.9"	E 73° 13' 13.8"
17	*Colocasia esculenta* (L.) Schott	Elephant's ear	N 22° 20' 25.9"	E 73° 13' 13.8"
18	*Lemna trisulca* L.	Star duckweed	N 22° 18' 21.7"	E 73° 16' 37.5"
Asteraceae				
19	*Vernonia cinerea* (L.) Less.	----	N 22° 20' 41.1"	E 73° 13' 14.2"
20	*Caesulia axillaris*	Pink node flower	N 22° 20' 23.8"	E 73° 13' 12.9"
21	*Sphaeranthus indicus* L.	Gorkhmundi	N 22° 20' 49.4"	E 73° 08' 00.5"
22	*Parthenium argentatum* A.Gray	Guayule	N 22° 20' 49.6"	E 73° 08' 00.8"

Sr. No.	Scientific name	Common Name	Latitude	Longitude
23	*Xanthium spinosum* L.	Prickly burweed	N 22° 19' 10.1"	E 73° 06' 09.2"
24	*Echinops echinatus* Roxb.	Indian globe thistle	N 22° 18' 21.8"	E 73° 16' 37.7"
25	*Blumea laciniata* (Wall. ex Roxb.) DC.	Cutleaf Blumea	N 22° 18' 21.9"	E 73° 16' 37.7"
26	*Blumea lacera* (Burm.f.) DC.	Kakronda	N 22° 18' 21.9"	E 73° 16' 37.5"
27	*Blumea*		N 22° 18' 21.8"	E 73° 16' 37.5"
28	*Spilanthes acmella* (L.) L.	Toothache Plant	N 22° 18' 21.5"	E 73° 16' 37.2"
29	*Vernonia cinerea* (L.) Less.	Little ironweed	N 22° 18' 21.6"	E 73° 16' 37.4"
30	*Tridax procumbens* (L.) L.	*Jayanthi*	N 22° 10' 59.2"	E 73° 28' 58.7"
Azollaceae				
31	*Azolla pinnata var. imbricata* (Roxb. ex Griff.) Bonap	Water velvet	N 22° 20' 25.6"	E 73° 13' 13.4"
Ceratophyllaceae				
32	*Ceratophyllum submersum* L.	Hornwort	N 22° 20' 23.5"	E 73° 13' 12.6"
Characeae				
33	C*hara globularis*	Stoneeworts	N 22° 26' 15.7 "	E 73° 04' 33.6"
Commelinaceae				
34	*Commelina communis* L.	Asiatic Dayflower	N 22° 20' 41.9"	E 73° 13' 14.5"
Convolvulaceae				
35	*Ipomoea aquatica* Forssk.	Water spinach	N 22° 20' 23.3"	E 73° 13' 12.8"
36	*cressa cretica* L.	European water clover	N 22° 19' 10.3"	E 73° 06' 09.9"
Cyperaceae				
37	*Eliocharis dulsis*	Water chestnut	N 22° 19' 11.1"	E 73° 06' 09.1"
38	*Scripus articulatus* L.	Apurau	N 22° 19' 10.1"	E 73° 06' 09.4"
39	*cyperus difformis* L.	Flat sedge	N 22° 19' 09.2"	E 73° 06' 10.4"
40	*Cyperus* sp.	---	N 22° 19' 10.7"	E 73° 06' 09.4"
41	*Cyperus* sp.	---	N 22° 19' 10.4"	E 73° 06' 09.6"
42	*Eleocharis atropurpurea* (Retz.) J.Presl & C.Presl	Purple spikerush	N 22° 18' 21.7"	E 73° 16' 37.5"
43	*Fimbristylis bisumbellata* (Forssk.) Bubani	Grasslike fimbry	N 22° 18' 21.7"	E 73° 16' 37.3"
44	*Cyperus haspan* L.	Papyrus sedges	N 22° 10' 59.6"	E 73° 28' 58.8"
Elaeocarpaceae				
45	*Elaeocarpus variabilis* Zmarzty	Chorphone	N 22° 19' 12.1"	E 73° 06' 09.5"

Sr. No.	Scientific name	Common Name	Latitude	Longitude
Elatinaceae				
46	*Bergia ammannioides*	Jerry Water fire	N 22° 19' 10.1"	E 73° 06' 08.4"
Equisetaceae				
47	*Equisetum ramosissimum* subsp. Debile	Snake grass	N 22° 18' 36.6"	E 73° 11' 10.6"
Euphorbiaceae				
48	*Croton abaitensis* Baill.	----	N 22° 26' 13.7"	E 73° 04' 32.6"
49	*Euphorbia prostate*	Prostrate sandmat	N 22° 10' 59.1"	E 73° 28' 58.8"
Fabaceae				
50	*Aeschynomene indica* L.	Curly indigo	N 22° 19' 09.1"	E 73° 06' 10.4"
51	*Alhagi pseudalhagi* (M. Bieb.) Desv. ex B. Keller & Sh	Camelthorn	N 22° 19' 12.5"	E 73° 06' 09.9"
52	*Crotalaria herpetoclada* Rossberg	Rattlepods	N 22° 10' 59.0"	E 73° 28' 58.8"
Hydrocharitaceae				
53	*Hydrilla verticillata* (L.f.) Royle	Waterweed	N 22° 20' 42.9"	E 73° 13' 15.5"
54	*Vallisneria spiralis* L.	Tapgrass	N 22° 19' 13.8"	E 73° 10' 48.1"
Lamiaceae				
55	Hyptis suaveolens (L.) Poit.	Pig nut	N 22° 26' 15.7 "	E 73° 04' 33.4"
Lentibulariaceae				
56	*Utricularia vulgaris* L.	Common Bladderworts	N 22° 19' 12.1"	E 73° 06' 10.4"
Lythraceae				
57	*Ammania baccifera* L.	Monarch redstem	N 22° 20' 43.1"	E 73° 13' 11.9"
58	*Ammannia multiflora* Roxb.	Red stem	N 22° 19' 11.8"	E 73° 13' 11.9"
59	*Woodfordia cfruticosa* (L.) Kurz	Dhaura	N 22° 26' 12.9"	E 73° 04' 32.7"
Linderniaceae				
60	*Lindernia oppositifolia* (L.) Mukerjee	Yellowseed false pimpernel	N 22° 18' 21.1"	E 73° 16' 37.0"

Sr. No.	Scientific name	Common Name	Latitude	Longitude
Malvaceae				
61	*Urena lobata* L.	Cesarweed	N 22° 18' 21.3"	E 73° 16' 37.0"
62	*Sida alba* L.	broomweed	N 22° 10' 59.5"	E 73° 28' 58.9"
63	*Triumfetta rhomboidea* Jacq.	Burr Bush	N 22° 10' 59.2"	E 73° 28' 58.7"
Marsiliaceae				
64	*Marsilea quadrifolia* L.	Four Leaf Clover	N 22° 19' 11.5"	E 73° 06' 10.8"
Menispermaceae				
65	*Cocculus hirsutus (*L.) W.Theob	Broom creeper	N 22° 18' 21.8"	E 73° 16' 37.5"
Menyanthaceae				
66	*Nymphoides indica* (L.) Kuntze	Water Snowflake	N 22° 26' 00.5"	E 73° 04' 19.5"
Onagraceae				
67	*Ludvigia perennis* L.	Water-primrose	N 22° 20' 24.1"	E 73° 13' 16.0"
68	*Ludvigia octavalvis*	Willow prime rose	N 22° 20' 22.9"	E 73° 13' 12.1"
Nelumbonaceae				
69	*Nelumbo nucifera* Gaertn.	Indian lotus	N 22° 20' 41.9"	E 73° 13' 15.9"
Nymphaeaceae				
70	*Nymphea nouchali* Burm.f.	Star lotus	N 22° 18' 36.8"	E 73° 11' 10.7"
Orobanchaceae				
71	*Lindenbergia muraria*(Roxburgh ex D. Don) Brühl	-----	N 22° 26' 12.6"	E 73° 04' 32.4"
Phyllanthaceae				
72	*Phyllanthus amarus* Schumach. & Thonn.	Carry-me seed	N 22° 20' 22.0"	E 73° 13' 11.1"
73	*Phyllanthus virgatus* G.Forst.	Narrow piss weed	N 22° 10' 59.3"	E 73° 28' 58.9"
Poaceae				
74	*Chloris barbata* Sw.	Windmill grass	N 22° 20' 22.8"	E 73° 13' 12.3"
75	*Hygroryza aristata* (Retz.) Nees ex Wight & Arn.	---	N 22° 20' 23.6"	E 73° 13' 12.4"
76	*Dactyloctenium aegyptium* (L.) Willd	Egyptian grass	N 22° 20' 23.9"	E 73° 13' 10.8"
77	*Paspalidium geminatum* (Forssk.) Stapf	Egyptian panicgrass	N 22° 19' 12.9"	E 73° 06' 09.4"
78	*Ischaemum rugosum* Salisb.	Wrinkle duck-beak	N 22° 19' 10.5"	E 73° 06' 09.6"

Sr. No.	Scientific name	Common Name	Latitude	Longitude
79	*Paspalum*	----	N 22° 18' 21.5"	E 73° 16' 37.2"
80	*Paspalum distichum* L.	Biscuit grass	N 22° 20' 23.7"	E 73° 13' 12.9"
81	*Typha angustifolia* L.	Narrowleaf cattail	N 22° 18' 35.2"	E 73° 11' 11.6"
Polygonaceae				
82	*Polygonum glabrum* willd	Dense flower knotweed	N 22° 26' 12.8"	E 73° 04' 32.7"
Potamogetonaceae				
83	*Potamogeton perfoliatus* L.	Perfoliate pondweed	N 22° 26' 00.3"	E 73° 04' 19.7"
84	*Potamogeton* Sp.	----	N 22° 26' 00.4"	E 73° 04' 19.6"
85	*Zannichellia palustris* L.	Horned pondweed	N 22° 26' 15.9 "	E 73° 04' 33.4"
86	*Pomatogeton crispus*	Curly leaf pond weed	N 22° 18' 36.3"	E 73° 11' 10.4"
Scrophulariaceae				
87	*Limnophila gratioloides* R. Br.	-----	N 22° 19' 11.8"	E 73° 06' 11.5"
88	*Verbascum chinense* (L.) Santapau	Velvet Plant	N 22° 26' 15.6 "	E 73° 04' 33.2"
Solanaceae				
89	*Solanum tampicense* Dunal	Yellow-fruit nightshade	N 22° 20' 16.0"	E 73° 13' 07.02"
Verbenaceae				
90	*Phyla nodiflora* (L.) Greene	Turkey tangle fogfruit	N 22° 19' 11.1"	E 73° 06' 09.7"

Table 10: List of collected plants arranged in the family

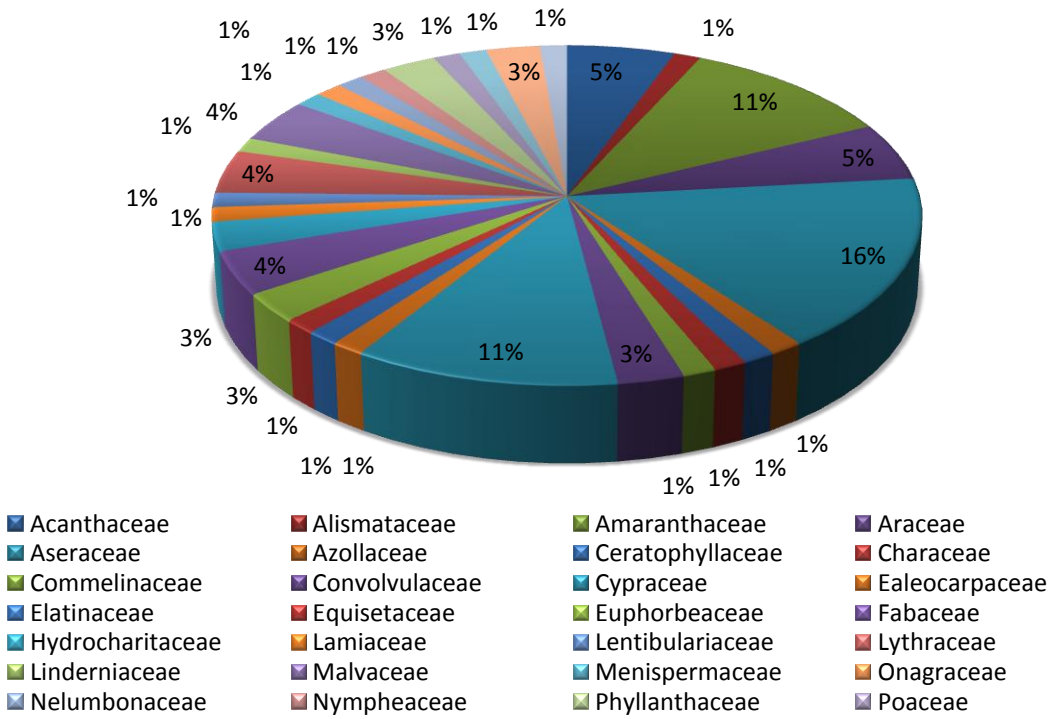


Figure 11: Details of collected plant samples based on family.

Since the study mainly focused ecological parameters, the identified plant species were also categorized in to various ecological groups (Table 11)

Free Floating Hydrophyte					
Sr. No.	**Scientific name**	**Common Name**	**Family**	**Latitude**	**Longitude**
1	*Spirodela polyrrhiza* (L.) Schleid.	Great duckweed	Araceae	N 22° 20' 25.9"	E 73° 13' 13.8"
2	*Azolla pinnata var. imbricata* (Roxb. ex Griff.) Bonap	Water velvet	Azollaceae	N 22° 20' 25.6"	E 73° 13' 13.4"
3	*Marsilea quadrifolia* L.	Four Leaf Clover	Marsiliaceae	N 22° 19' 11.5"	E 73° 06' 10.8"
4	*Aponogeton natans* (L.) Engl. & K.Krause	Cape pond weed	Aponogetanaceae	N 22° 26' 00.1"	E 73° 04' 19.9"
5	*Nymphoides indica* (L.) Kuntze	Water Snowflake	Menyanthaceae	N 22° 26' 00.5"	E 73° 04' 19.5"
6	*Lemna trisulca* L.	Star duckweed	Araceae	N 22° 18' 21.7"	E 73° 16' 37.5"
7	*Ceratophyllum submersum L.*	Hornwort	Ceratophyllaceae	N 22° 20' 23.5"	E 73° 13' 12.6"
8	*Ipomoea aquatica* Forssk.	Water spinach	Convolvulaceae	N 22° 20' 23.3"	E 73° 13' 12.8"
9	*Nelumbo nucifera* Gaertn.	Indian lotus	Nelumbonaceae	N 22° 20' 41.9"	E 73° 13' 15.9"
10	*Nymphea nouchali* Burm.f.	Star lotus	Nymphaeaceae	N 22° 18' 36.8"	E 73° 11' 10.7"
11	*Hygroryza aristata* (Retz.) Nees ex Wight & Arn.	-----	Poaceae	N 22° 20' 23.6"	E 73° 13' 12.4"
Submerged Hydrophyte					
Sr. No.	**Scientific name**	**Common Name**	**Family**	**Latitude**	**Longitude**
12	*Utricularia vulgaris* L.	Common Bladderworts	Lentibulariaceae	N 22° 19' 12.1"	E 73° 06' 10.4"
13	*zannichellia palustris* L.	Horned pondweed	Potamogetonaceae	N 22° 26' 15.9"	E 73° 04' 33.4"
14	*Hydrilla verticillata* (L.f.) Royle	waterweed	Hydrocharitaceae	N 22° 20' 42.9"	E 73° 13' 15.5"
15	*Vallisneria spiralis* L.	Tapgrass	Hydrocharitaceae	N 22° 19' 13.8"	E 73° 10' 48.1"

Submerged Rooted Hydrophyte					
Sr. No.	**Scientific name**	**Common Name**	**Family**	**Latitude**	**Longitude**
16	*Limnophyton obtusifolium* (L.) Miq.	Blunt Arrowhead	Alismataceae	N 22° 20' 23.3"	E 73° 13' 12.8"
17	*Colocasia esculenta* (L.) Schott	Elephant's ear	Araceae	N 22° 20' 25.9"	E 73° 13' 13.8"
18	*Gomphrena celosioides* Mart.	Gomphrena Weed	Amaranthaceae	N 22° 19' 12.1"	E 73° 06' 09.4"
19	*Pomatogeton crispus* L.	Curly leaf pond weed	Potamogetonaceae	N 22° 18' 36.3"	E 73° 11' 10.4"
20	*Potamogeton perfoliatus* L.	Perfoliate pondweed	Potamogetonaceae	N 22° 26' 00.3"	E 73° 04' 19.7"
21	*Potamogeton* Sp.	----	Potamogetonaceae	N 22° 26' 00.4"	E 73° 04' 19.6"
Wetland Hydrophyte					
Sr. No.	**Scientific name**	**Common Name**	**Family**	**Latitude**	**Longitude**
22	*Chloris barbata* Sw.	Windmill grass	Poaceae	N 22° 20' 22.8"	E 73° 13' 12.3"
23	*Dactyloctenium aegyptium* (L.) Willd	Egyptian grass	Poaceae	N 22° 20' 23.9"	E 73° 13' 10.8"
24	*Amaranthus spinosus* L.	Spiny amaranth	Amaranthaceae	N 22° 20' 48.4"	E 73° 08' 05.5"
25	*Sphaeranthus indicus L.*	gorkhmundi	Asteraceae	N 22° 20' 49.4"	E 73° 08' 00.5"
26	*Peristrophe paniculata* (Forssk.) Brummitt	Panicled Foldwing	Acanthaceae	N 22° 19' 03.9"	E 73° 07' 13.8"
27	*Limnophila gratioloides* R. Br.	-----	Schrophulariaceae	N 22° 19' 11.8"	E 73° 06' 11.5"
28	*Bergia ammannioides*	Jerry Water fire	Elatinaceae	N 22° 19' 10.1"	E 73° 06' 08.4"
29	*Cressa cretica* L.	European water clover	Convolvulaceae	N 22° 19' 10.3"	E 73° 06' 09.9"
30	*Phyla nodiflora* (L.) Greene	Turkey tangle fogfruit	Verbenaceae	N 22° 19' 11.1"	E 73° 06' 09.7"
31	*Elaeocarpus variabilis* Zmarzty	Chorphone	Elaeocarpaceae	N 22° 19' 12.1"	E 73° 06' 09.5"
32	*Aeschynomene indica* L.	Curly indigo	Fabaceae	N 22° 19' 09.1"	E 73° 06' 10.4"
33	*Malvastrum coromandelianum (L.) Garcke*	False mallow	Malvaceae	N 22° 19' 09.1"	E 73° 06' 10.4"

Sr. No.	Scientific name	Common Name	Family	Latitude	Longitude
34	*Melgmium indica*	------	Malvaceae	N 22° 19' 10.1"	E 73° 06' 11.4"
35	*Paspalidium geminatum* (Forssk.) Stapf	Egyptian panicgrass	Poaceae	N 22° 19' 12.9"	E 73° 06' 09.4"
36	*Alhagi pseudalhagi* (M. Bieb.) Desv. ex B. Keller & Sh	Camelthorn	Fabaceae	N 22° 19' 12.5"	E 73° 06' 09.9"
37	*Eliocharis dulsis*	Water chestnut	Cyperaceae	N 22° 19' 11.1"	E 73° 06' 09.1"
38	*Scripus articulatus* L.	Apurau	Cyperaceae	N 22° 19' 10.1"	E 73° 06' 09.4"
39	*Ischaemum rugosum* Salisb.	Wrinkle duck-beak	Poaceae	N 22° 19' 10.5"	E 73° 06' 09.6"
40	*Cyperus difformis* L.	Flat sedge	Cyperaceae	N 22° 19' 09.2"	E 73° 06' 10.4"
41	*Ammannia multiflora* Roxb.	Red stem	Lythraceae	N 22° 19' 12.1"	E 73° 06' 11.4"
42	*Alternanthera philoxeroides*	Alligator weed	Amaranthaceae	N 22° 19' 11.8"	E 73° 06' 10.2"
43	*Xanthium spinosum* L.	Prickly burweed	Asteraceae	N 22° 19' 10.1"	E 73° 06' 09.2"
44	*Cyperus* sp.	---	Cyperaceae	N 22° 19' 10.7"	E 73° 06' 09.4"
45	*Cyperus* sp.	----	Cyperaceae	N 22° 19' 10.4"	E 73° 06' 09.6"
46	*Verbascum chinense* (L.) Santapau	Velvet Plant	Scrophulariaceae	N 22° 26' 15.6 "	E 73° 04' 33.2"
47	*Hyptis suaveolens* (L.) Poit.	Pig nut	Lamiaceae	N 22° 26' 15.7 "	E 73° 04' 33.4"
48	*Abutilon indicum* (L.) Sweet	Indian Mallow	Malvaceae	N 22° 26' 13.6"	E 73° 04' 32.8"
49	*Croton abaitensis* Baill.	----	Euphorbiaceae	N 22° 26' 13.7"	E 73° 04' 32.6"
50	*Barleria prionitis* L.	Porcupine Flower	Acanthaceae	N 22° 26' 13.5"	E 73° 04' 32.4"
51	*Woodfordia cfruticosa* (L.) Kurz	Dhaura	Lythraceae	N 22° 26' 12.9"	E 73° 04' 32.7"
52	*Achyranthes aspera* L.	Prickly chaff flower	Amaranthaceae	N 22° 26' 12.7"	E 73° 04' 32.5"
53	*Lindenbergia muraria*(Roxburgh ex D. Don) Brühl	-----	Orobanchaceae	N 22° 26' 12.6"	E 73° 04' 32.4"
54	*Polygonum glabrum* willd	Denseflower knotweed	Polygonaceae	N 22° 26' 12.8"	E 73° 04' 32.7"

Sr. No.	Scientific name	Common Name	Family	Latitude	Longitude
55	*Eleocharis atropurpurea* (Retz.) J.Presl & C.Presl	Purple spikerush	Cyperaceae	N 22° 18' 21.7"	E 73° 16' 37.5"
56	*Paspalumdisticum* L.	Ginger grass	Poaceae	N 22° 18' 21.5"	E 73° 16' 37.2"
57	*Urena lobata* L.	Cesarweed	Malvaceae	N 22° 18' 21.3"	E 73° 16' 37.0"
58	*Echinops echinatus* Roxb.	Indian globe thistle	Asteraceae	N 22° 18' 21.8"	E 73° 16' 37.7"
59	*Blumea laciniata* (Wall. ex Roxb.) DC.	Cutleaf Blumea	Asteraceae	N 22° 18' 21.9"	E 73° 16' 37.7"
60	*Blumea lacera* (Burm.f.) DC.	Kakronda	Asteraceae	N 22° 18' 21.9"	E 73° 16' 37.5"
61	*Blumea*	----	Asteraceae	N 22° 18' 21.8"	E 73° 16' 37.5"
62	*Spilanthes acmella* L.	Toothache Plant	Asteraceae	N 22° 18' 21.5"	E 73° 16' 37.2"
63	*Cocculus hirsutus* L.	Broom creeper	Menispermaceae	N 22° 18' 21.8"	E 73° 16' 37.5"
64	*Lindernia oppositifolia* (L.) Mukerjee	Yellowseed false pimpernel	Linderniaceae	N 22° 18' 21.1"	E 73° 16' 37.0"
65	*Vernonia cinerea* (L.) Less.	Little ironweed	Asteraceae	N 22° 18' 21.6"	E 73° 16' 37.4"
66	*Aerva lanata* (L.) Juss.	Gorakh-boonti	Amaranthaceae	N 22° 18' 21.8"	E 73° 16' 37.5"
67	*Fimbristylis bisumbellata* (Forssk.) Bubani	Grasslike fimbry	Cyperaceae	N 22° 18' 21.7"	E 73° 16' 37.3"
68	*Crotalaria herpetoclada* Rossberg	Rattlepods	Fabaceae	N 22° 10' 59.0"	E 73° 28' 58.8"
69	*Phyllanthus virgatus* G.Forst.	Narrow piss weed	phyllanthaceae	N 22° 10' 59.3"	E 73° 28' 58.9"
70	*Euphorbia prostata*	Prostrate sandmat	Euphorbiaceae	N 22° 10' 59.1"	E 73° 28' 58.8"
71	*Rungia pectinata* (L.) Nees	Comb Rangia	Acanthaceae	N 22° 10' 59.4"	E 73° 28' 58.7"
72	*Tridax procumbens* L.	Jayanthi	Asteraceae	N 22° 10' 59.2"	E 73° 28' 58.7"
73	*Sida alba* L.	Broomweed	Malvaceae	N 22° 10' 59.5"	E 73° 28' 58.9"
74	*Triumfetta rhomboidea* Jacq.	Burr Bush	Malvaceae	N 22° 10' 59.2"	E 73° 28' 58.7"
75	*Cyperus haspan L.*	Papyrus sedges	Cyperaceae	N 22° 10' 59.6"	E 73° 28' 58.8"

Sr. No.	*Scientific name*	Common Name	Family	Latitude	Longitude
76	*Solanum tampicense* Dunal	Yellow-fruit nightshade	Solanaceae	N 22° 20' 16.0"	E 73° 13' 7.02"
77	*Ludvigia perennis* L.	Water-primrose	Onagraceae	N 22° 20' 24.1"	E 73° 13' 16.0"
78	*Vernonia cinerea* (L.) Less.	---	Asteraceae	N 22° 20' 41.1"	E 73° 13' 14.2"
79	*Phyllanthus amarus* Schumach. & Thonn.	Carry-me seed	Phyllanthaceae	N 22° 20' 22.0"	E 73° 13' 11.1"
80	*Pistia stratiotes* L.	Water Lettuce	Araceae	N 22° 20' 42.9"	E 73° 13' 15.5"
81	*Alternanthera ficoidea (L.) R.Br. ex DC.*	Sanguinarea	amaranthaceae	N 22° 20' 41.5"	E 73° 13' 07.1"
82	*Paspalum distichum* L.	Biscuit grass	Poaceae	N 22° 20' 23.7"	E 73° 13' 12.9"
83	*Ludvigia octavalvis* L.	Willow prime rose	Onagraceae	N 22° 20' 22.9"	E 73° 13' 12.1"
84	*Hygrophila polysperma* (Roxb.) T.Anderson	Gokulakanta	Acanthaceae	N 22° 20' 42.9"	E 73° 13' 12.5"
85	*Ammania baccifera* L.	Monarch redstem	Lythraceae	N 22° 20' 43.1"	E 73° 13' 11.9"
86	*Alternanthera pungens kunth.*	Khaki weed	Amaranthaceae	N 22° 20' 23.3"	E 73° 13' 12.8"
87	*Commelina communis* L.	Asiatic Dayflower	Commelinaceae	N 22° 20' 41.9"	E 73° 13' 14.5"
88	*Equisetum ramosissimum* subsp. Debile	Snake grass	Equisetaceae	N 22° 18' 36.6"	E 73° 11' 10.6"
89	*Caesulia axillaris* L.	Pink node flower	Asteraceae	N 22° 20' 23.8"	E 73° 13' 12.9"
90	*Typha angustifolia L.*	Narrowleaf cattail	Poaceae	N 22° 18' 35.2"	E 73° 11' 11.6"

Table 11: List of collected plants arranged in ecological group

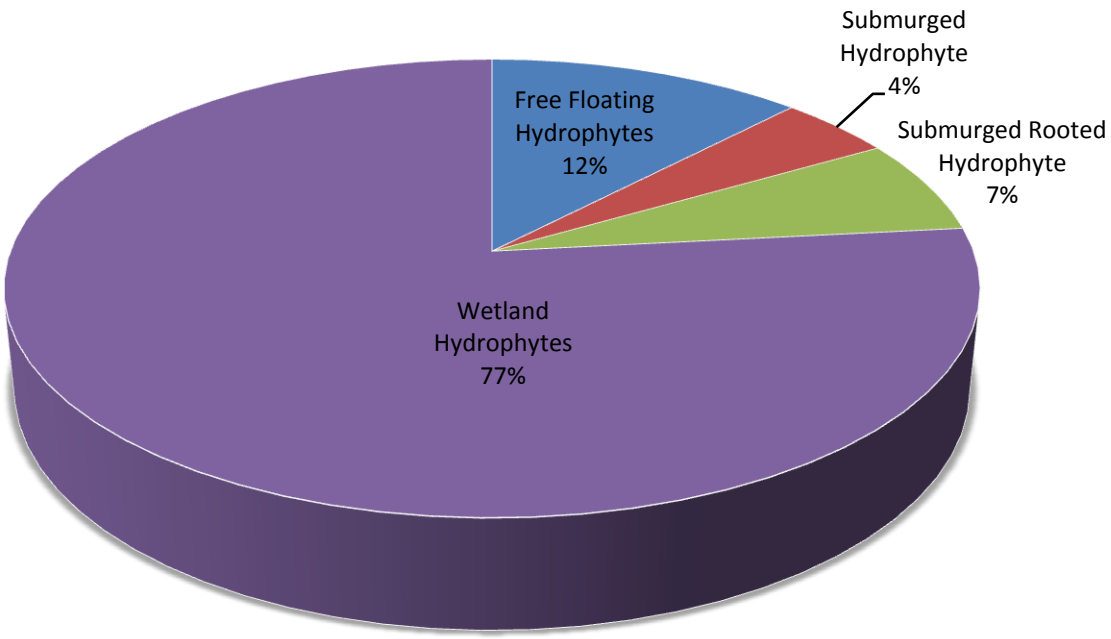


Figure 12: Ecological grouping of collectted plant samples

Free Floating Hydrophytes

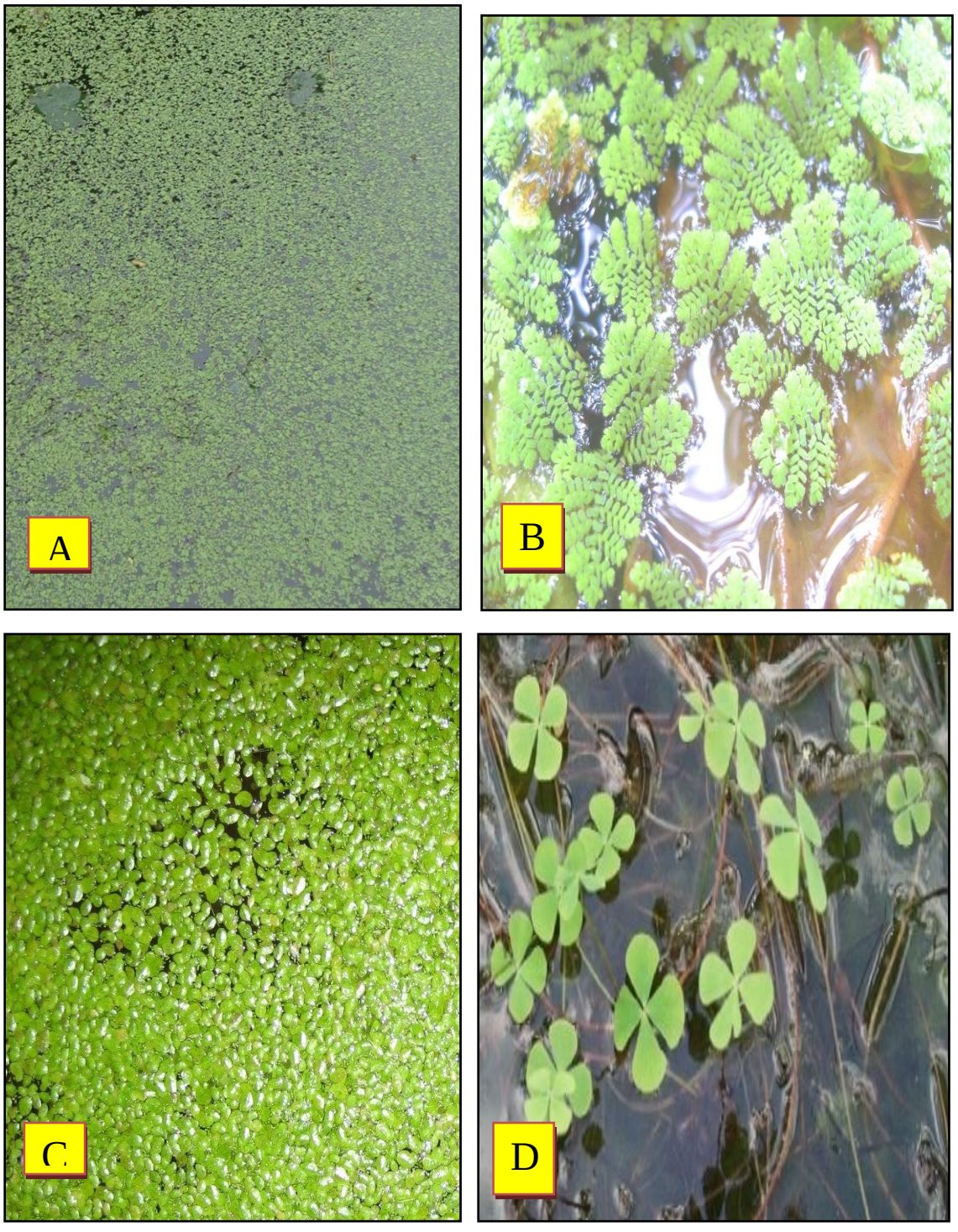


PLATE 1

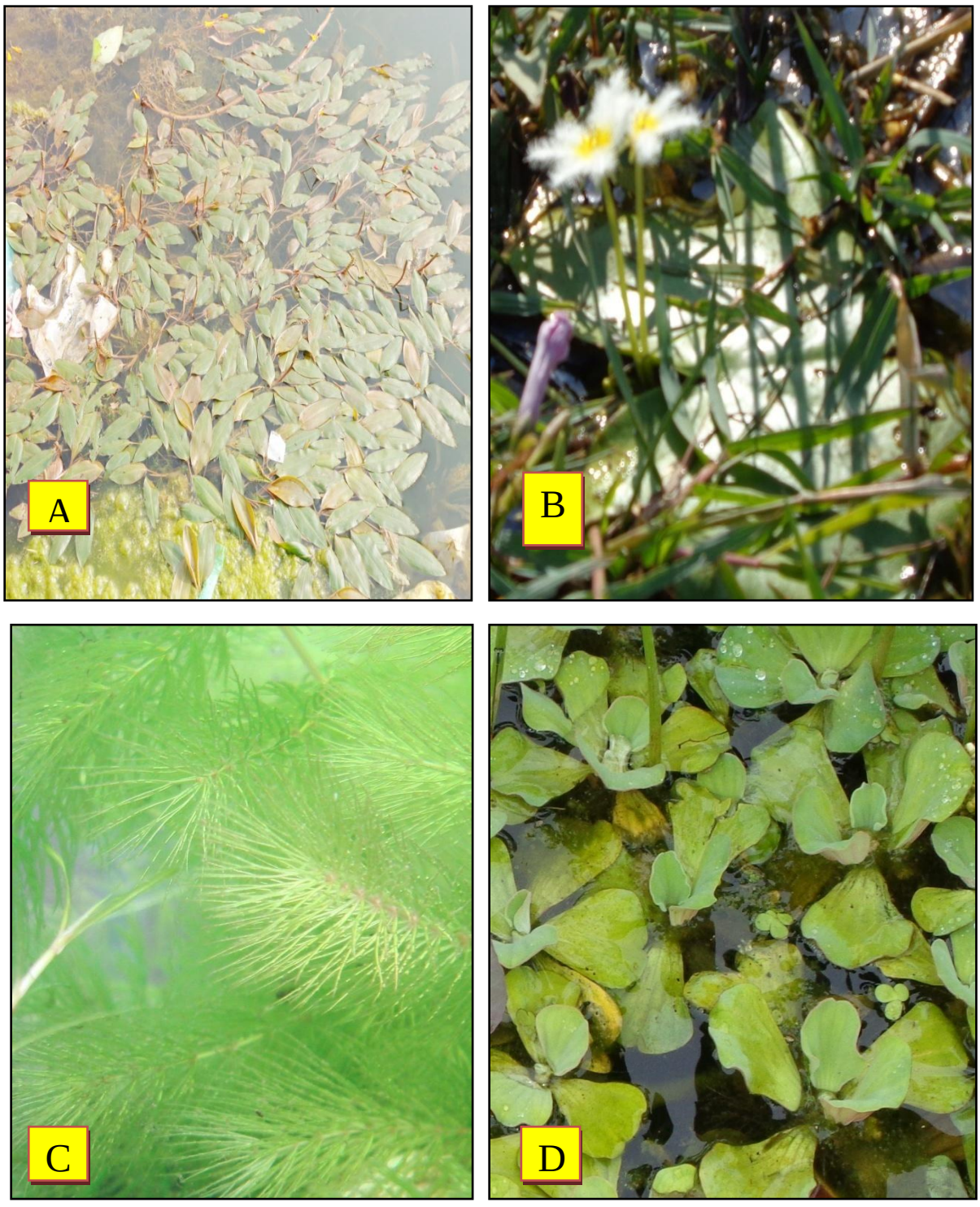


PLATE 2

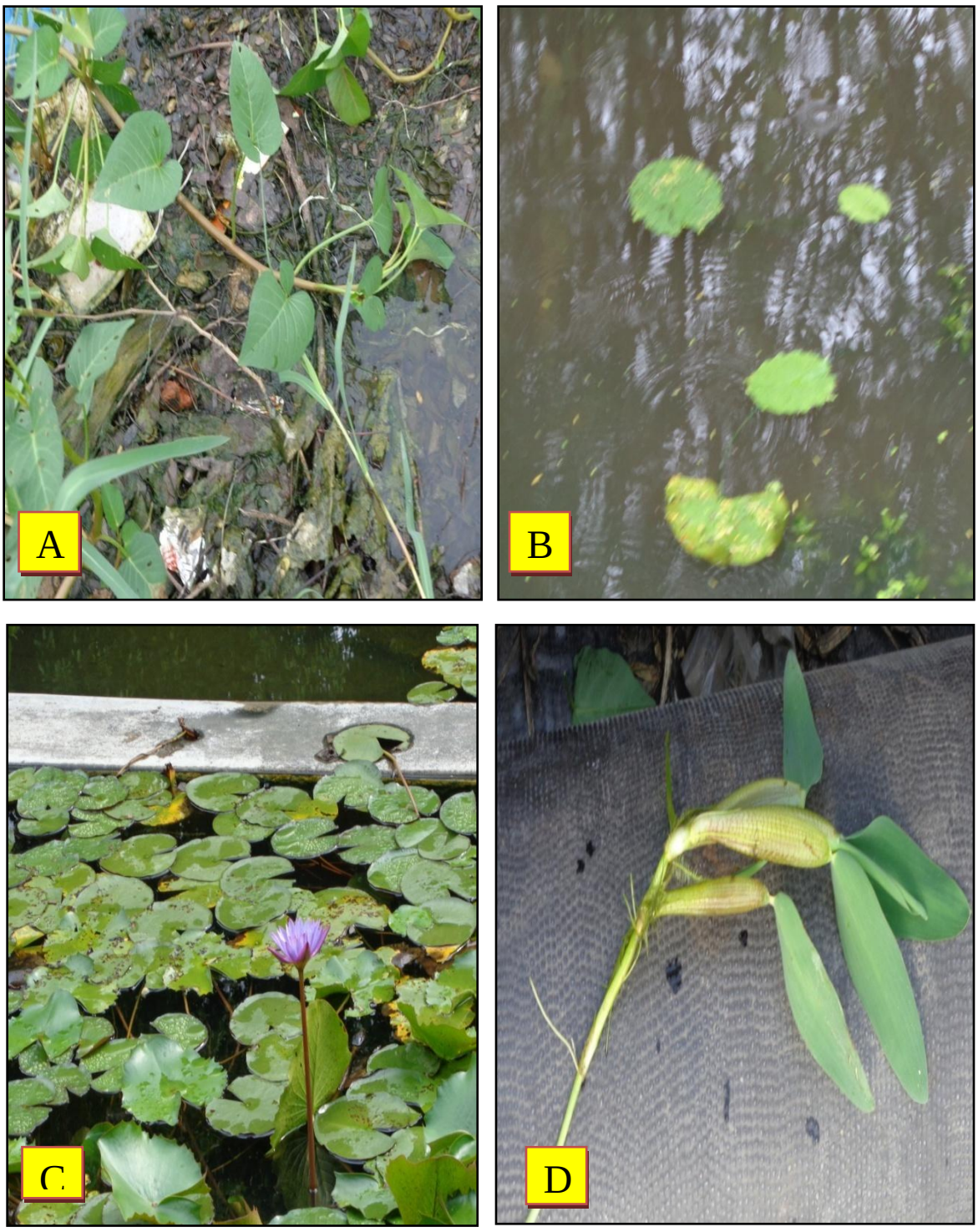


PLATE 3

Submerged Hydrophytes

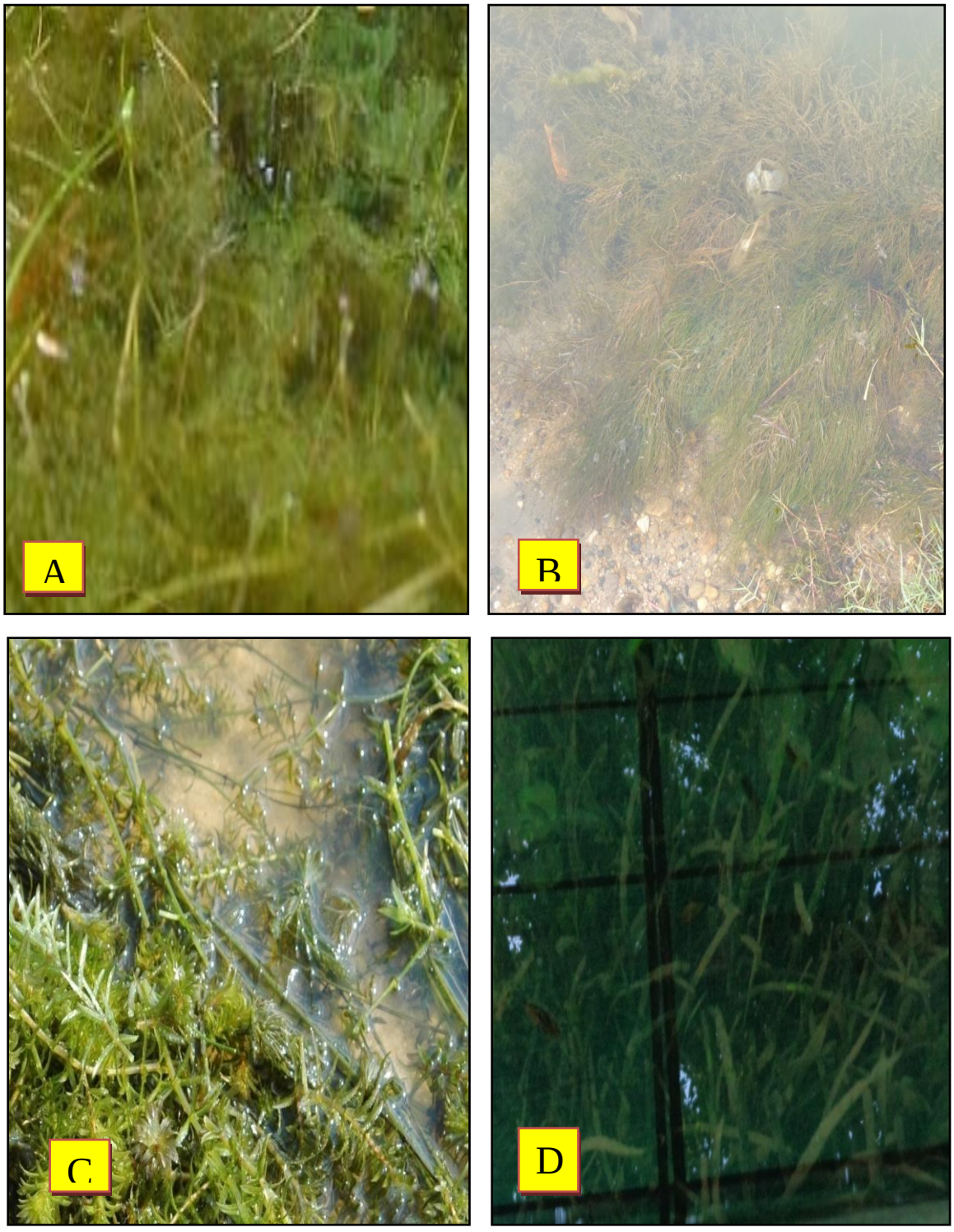


PLATE 4

Submerged Rooted Hydrophytes

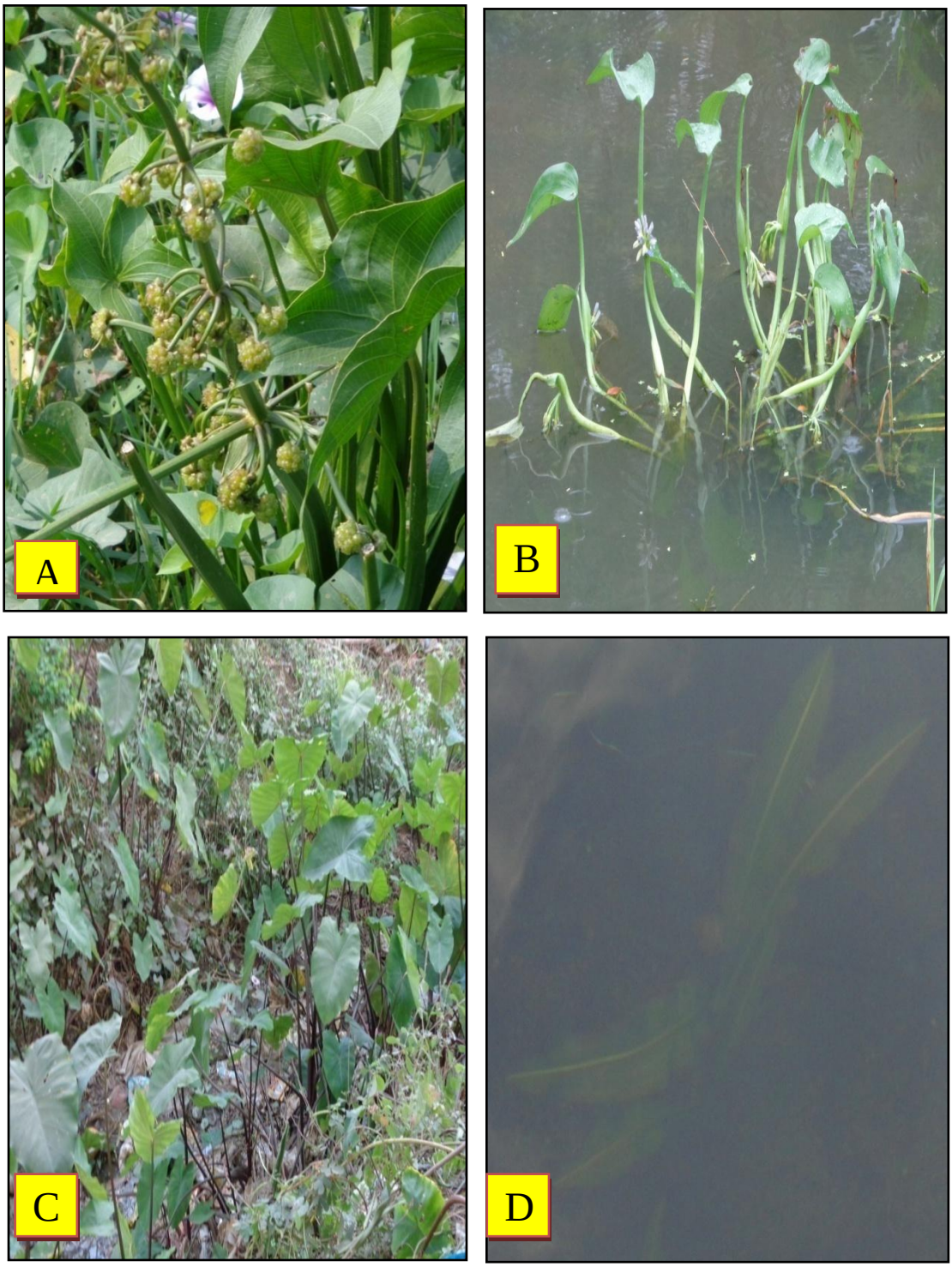


PLATE 5

PLATE 6

Wetland Hydrophyte

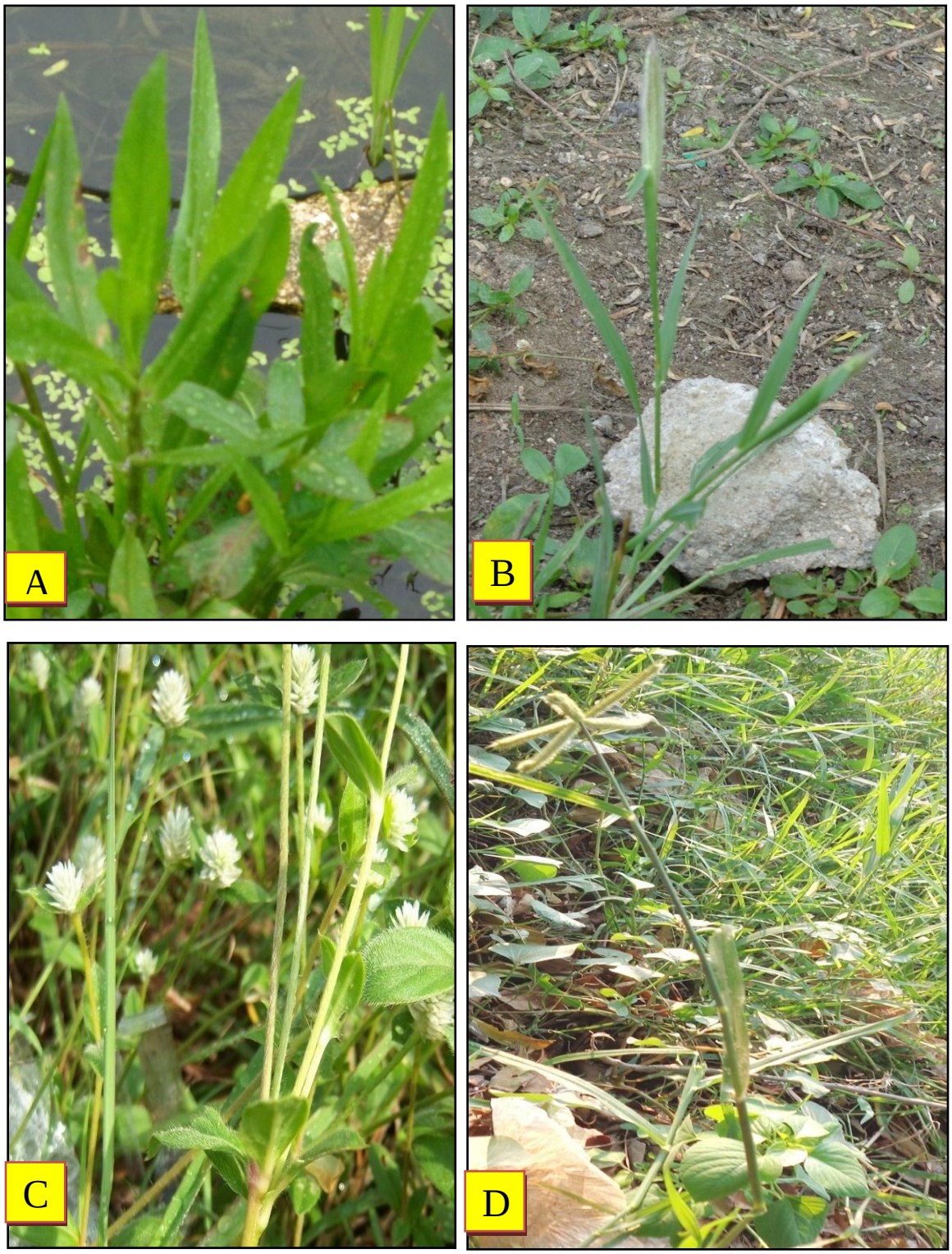


PLATE 7

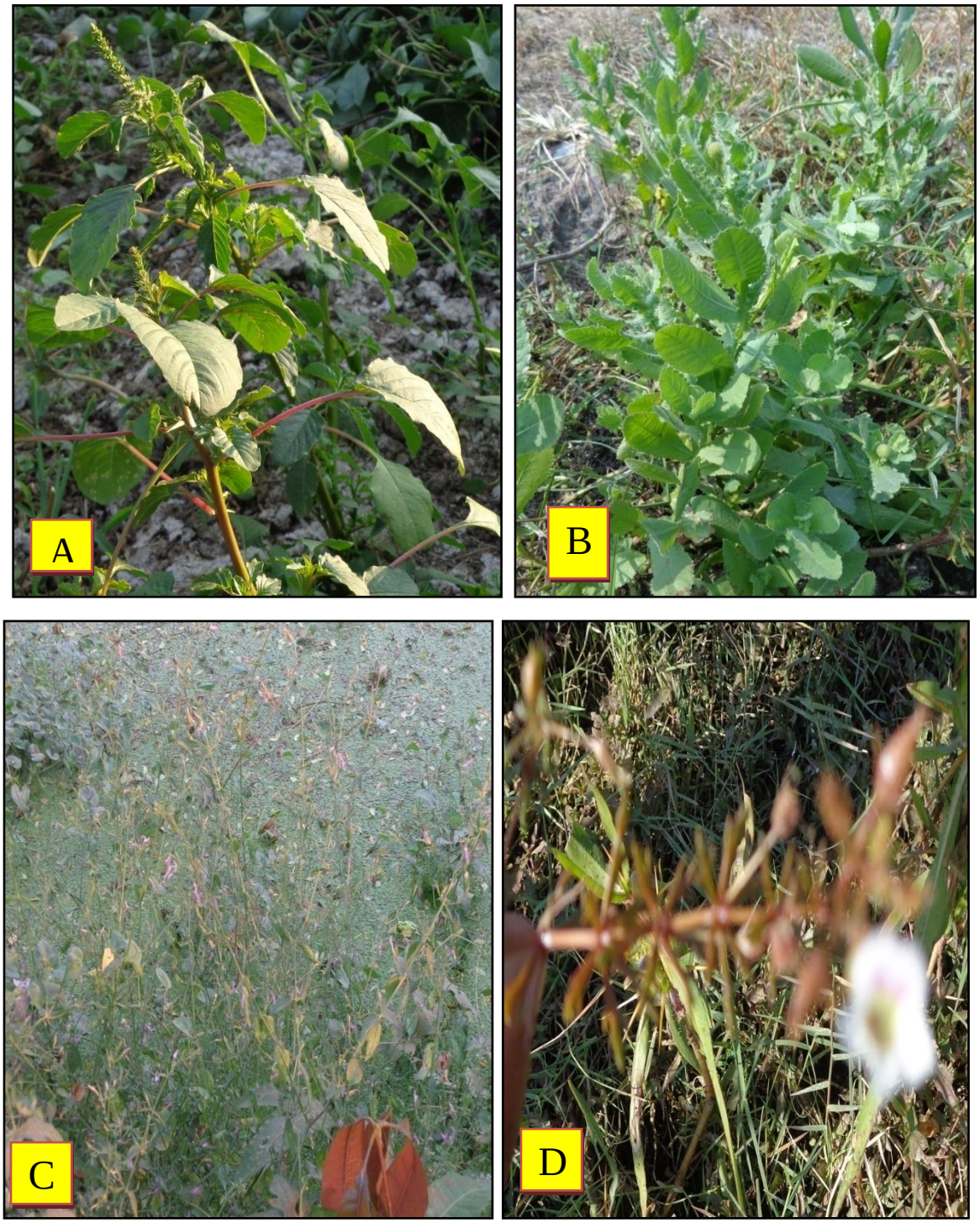


PLATE 8

PLATE 9

PLATE 10

PLATE 11

PLATE 12

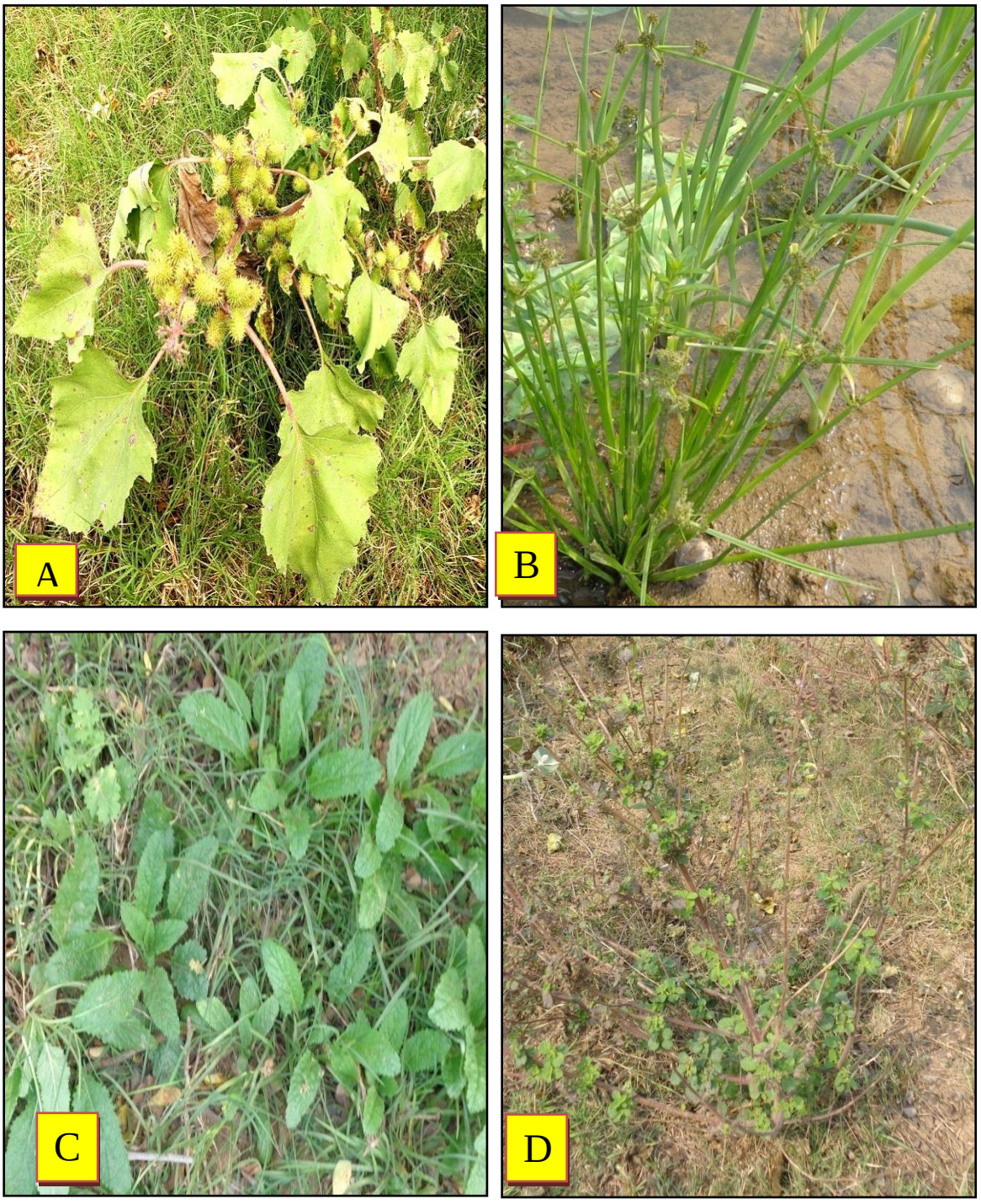


PLATE 13

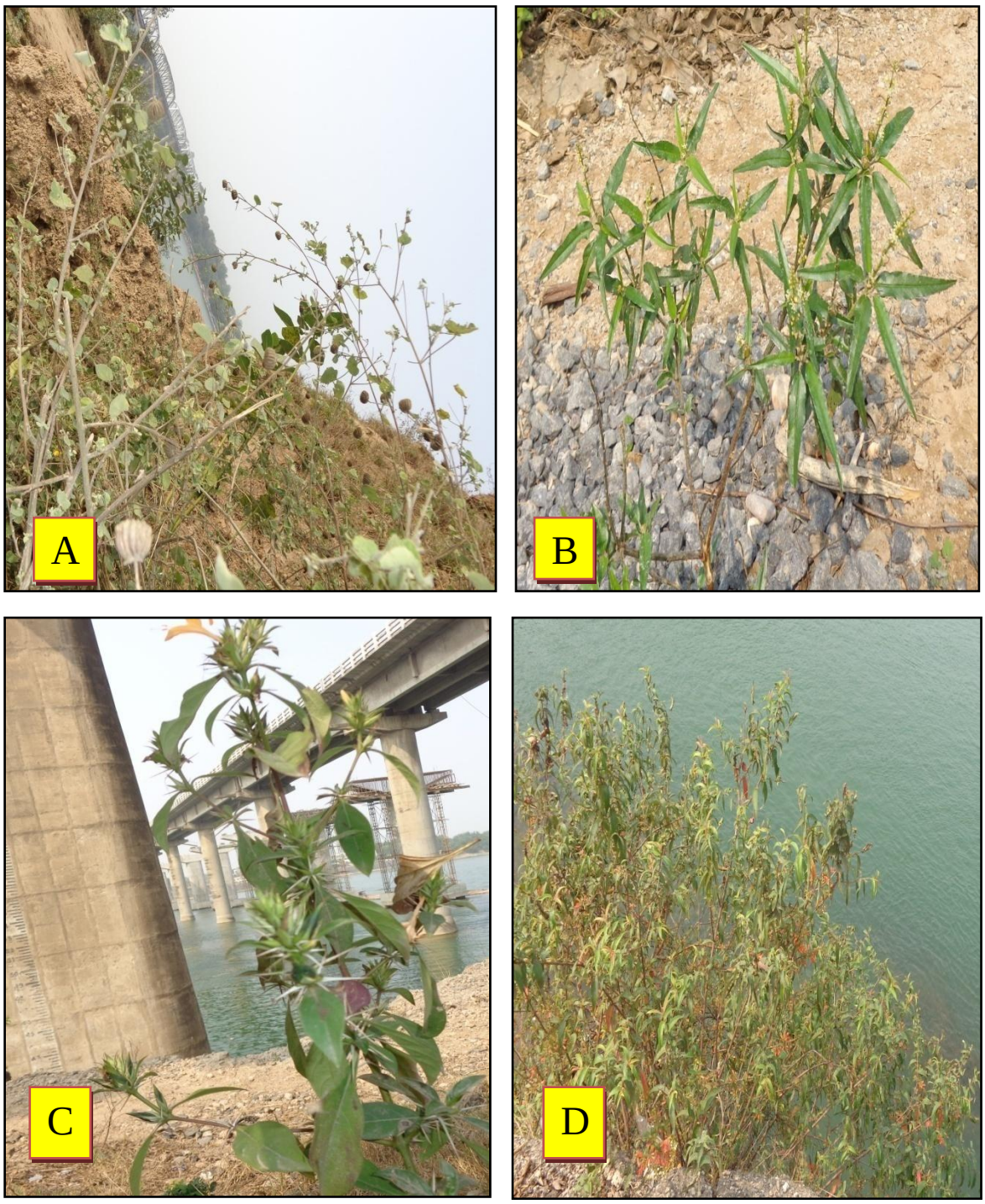


PLATE 14

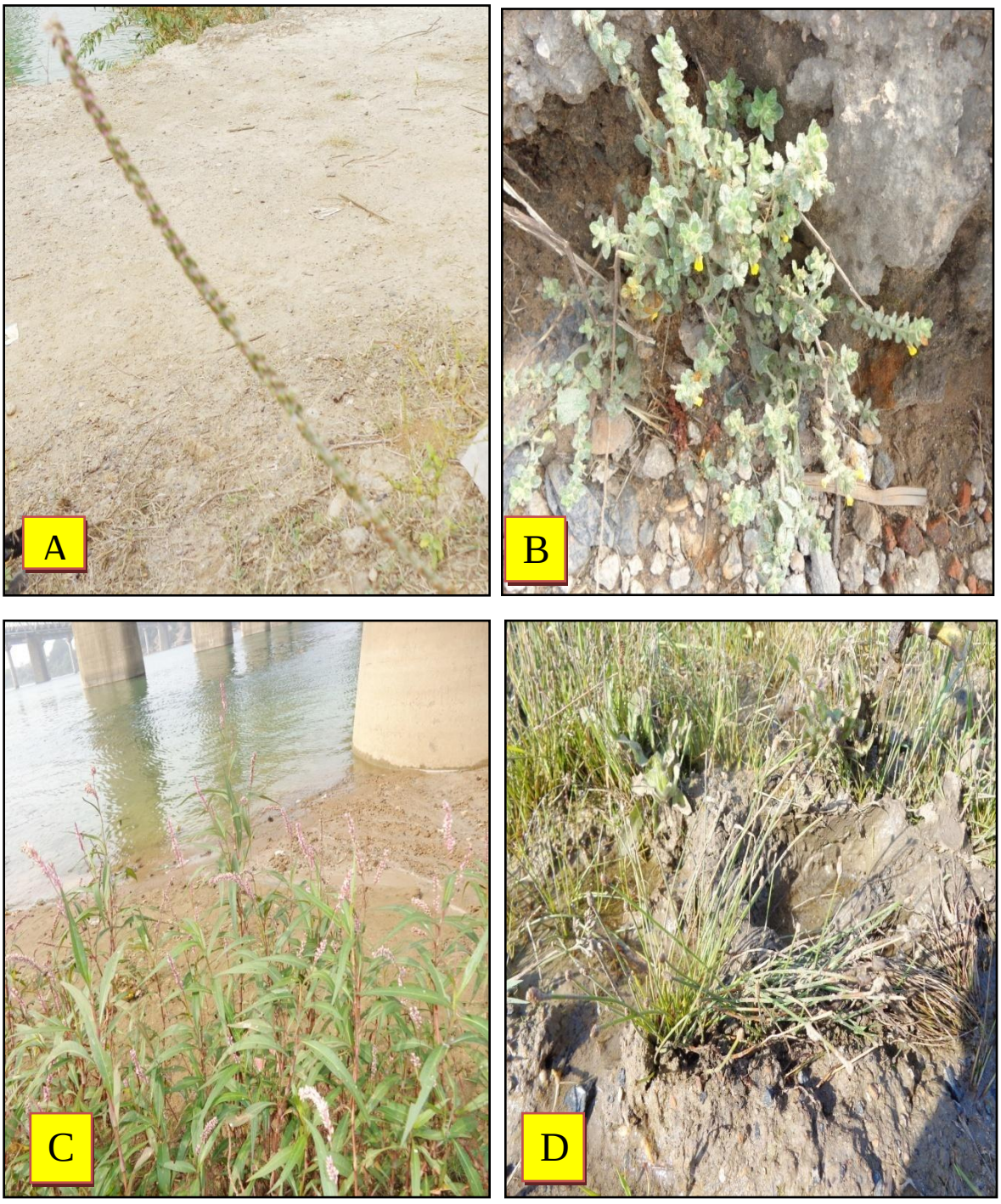


PLATE 15

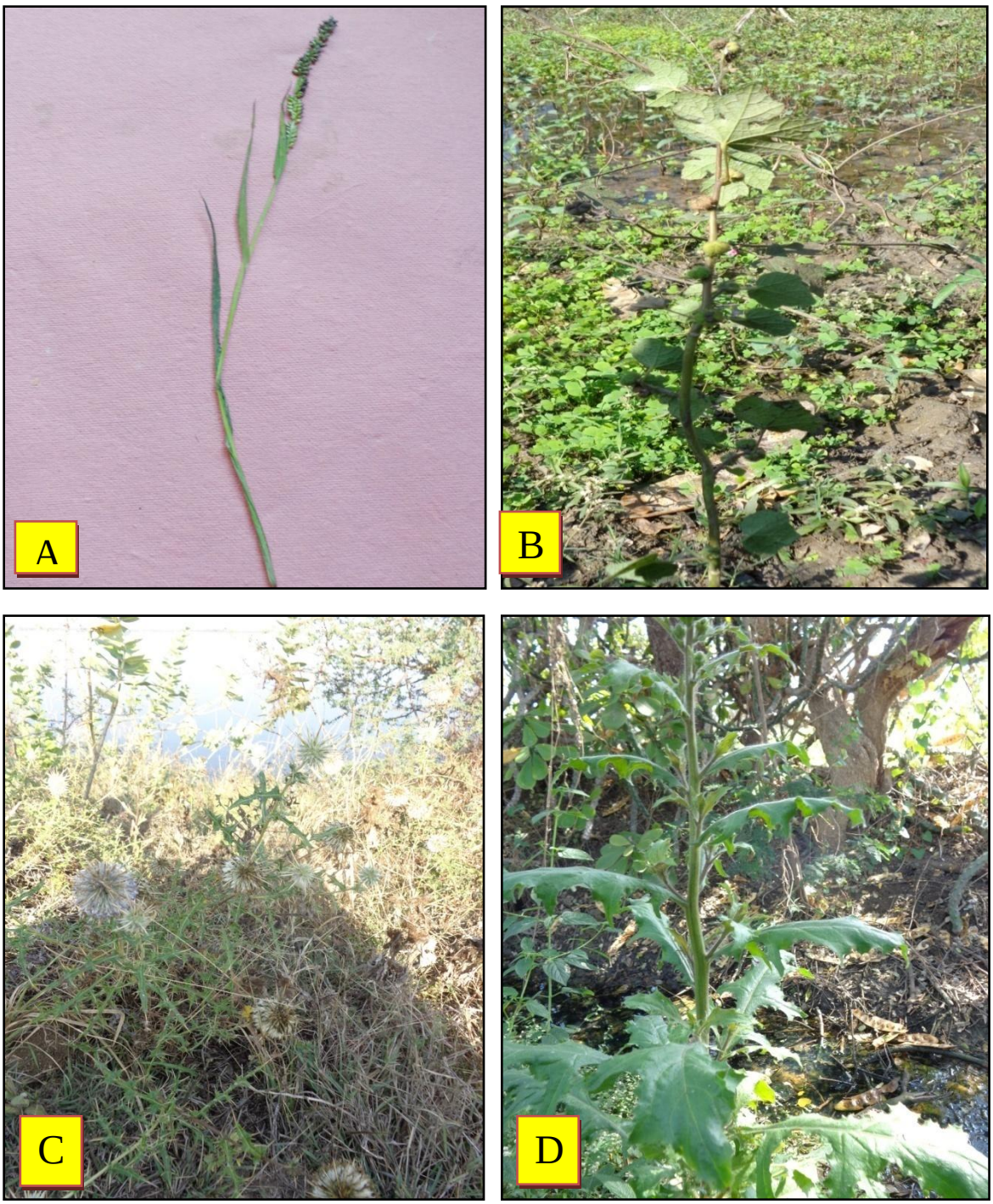


PLATE 16

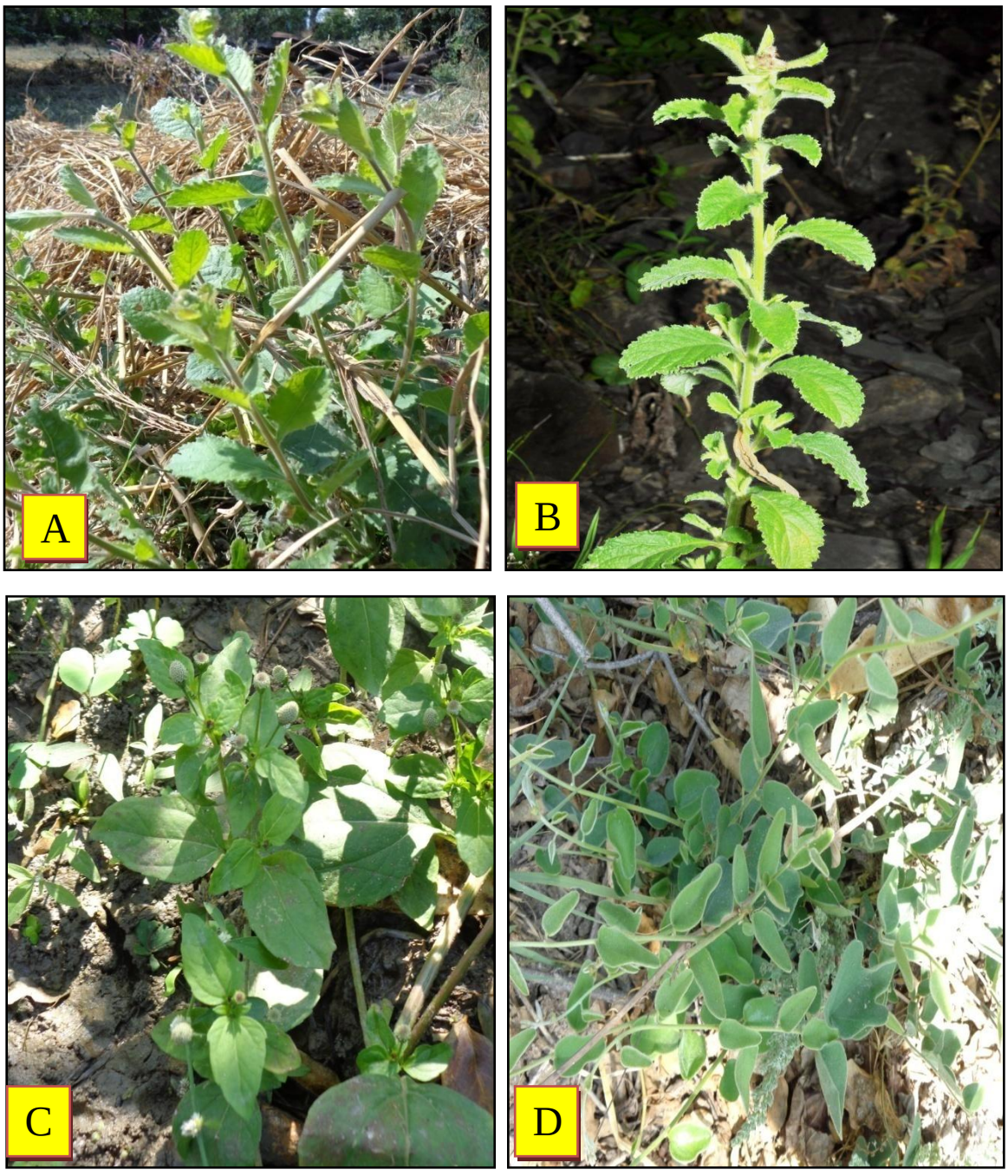


PLATE 17

PLATE 18

PLATE 19

PLATE 20

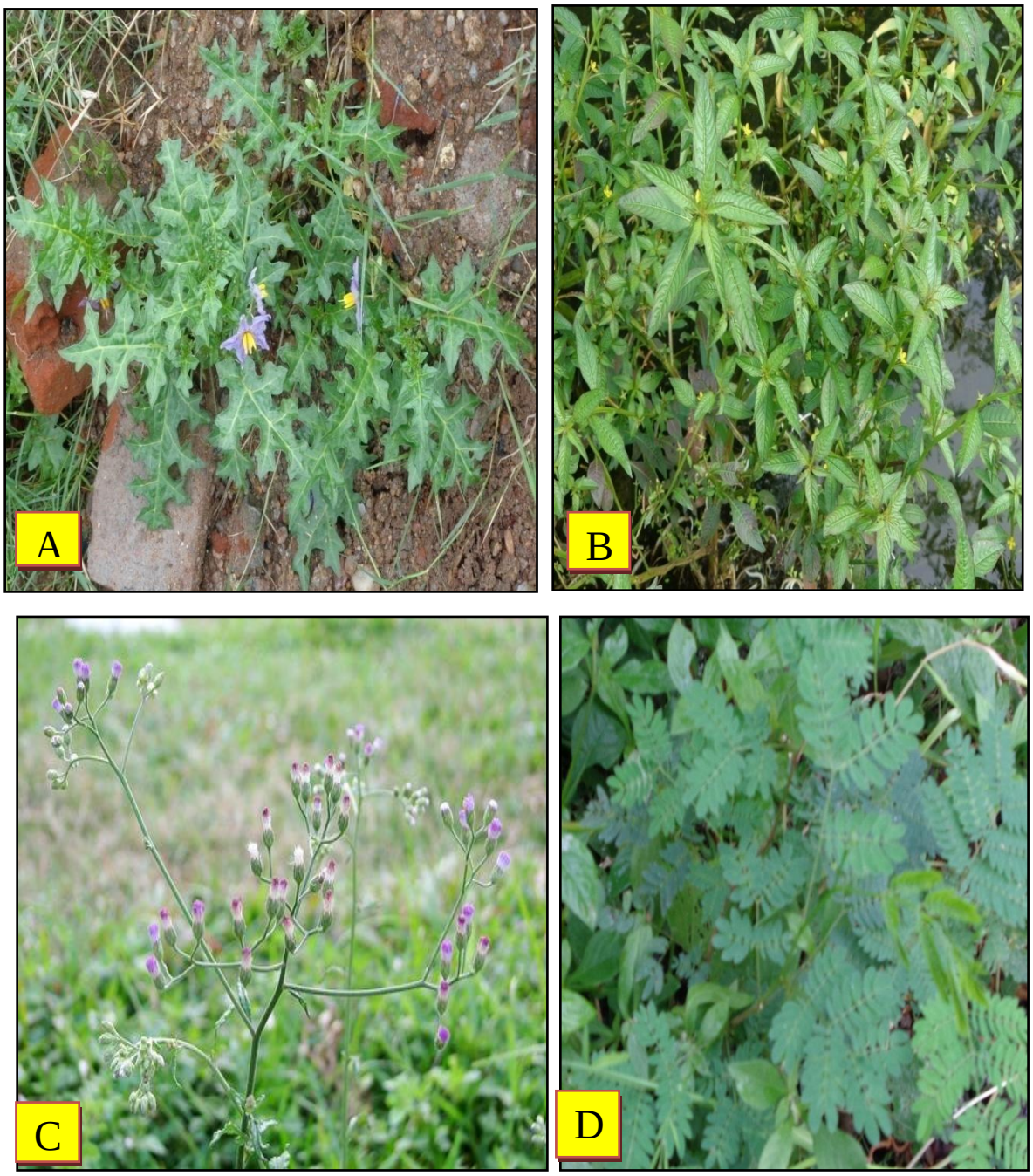


PLATE 21

PLATE 22

PLATE 23

Further for categorization of plant species at generic level DNA isolation and their sequencing had been carried out.

4.2 DNA Barcoding

4.2.1 DNA isolation

DNA Isolation of total 90 samples were carried out. DNA positive results found in 86 samples.

4.2.2 PCR amplification and agarose gel electrophoresis:

Using the designed primers for rbcL, a total of 57/94 (61%) PCR attempts were successful in amplifying the target sequence in collected plants. However, ethidium bromide is commonly used to stain nucleic acid (Sambrook and Russel, 2001) in Metaphor gels for visualization of PCR products. Gels can be stained either before or after electrophoresis. To stain prior to electrophoresis, ethidium bromide was added to the dissolved Metaphor agarose just before pouring the gel. The ethidium bromide stain runs in the opposite direction of the DNA therefore the upper and lower portions of the gels appeared differentially stained especially when gels were electrophoresed at high voltages for a short period of time. Therefore for even staining, ethidium bromide could be included in the electrophoresis buffer.

Gel electrophoresis of the amplified product showed bright bands of the expected product. A higher percentage of amplification results were obtained with designed primers with 57 plants. The size of an amplicon and correspnding primers used are given in the figure legend. This gel (Fig. 13,14,15 and 16) indicates successful PCR amplification where high intensity bands was found.

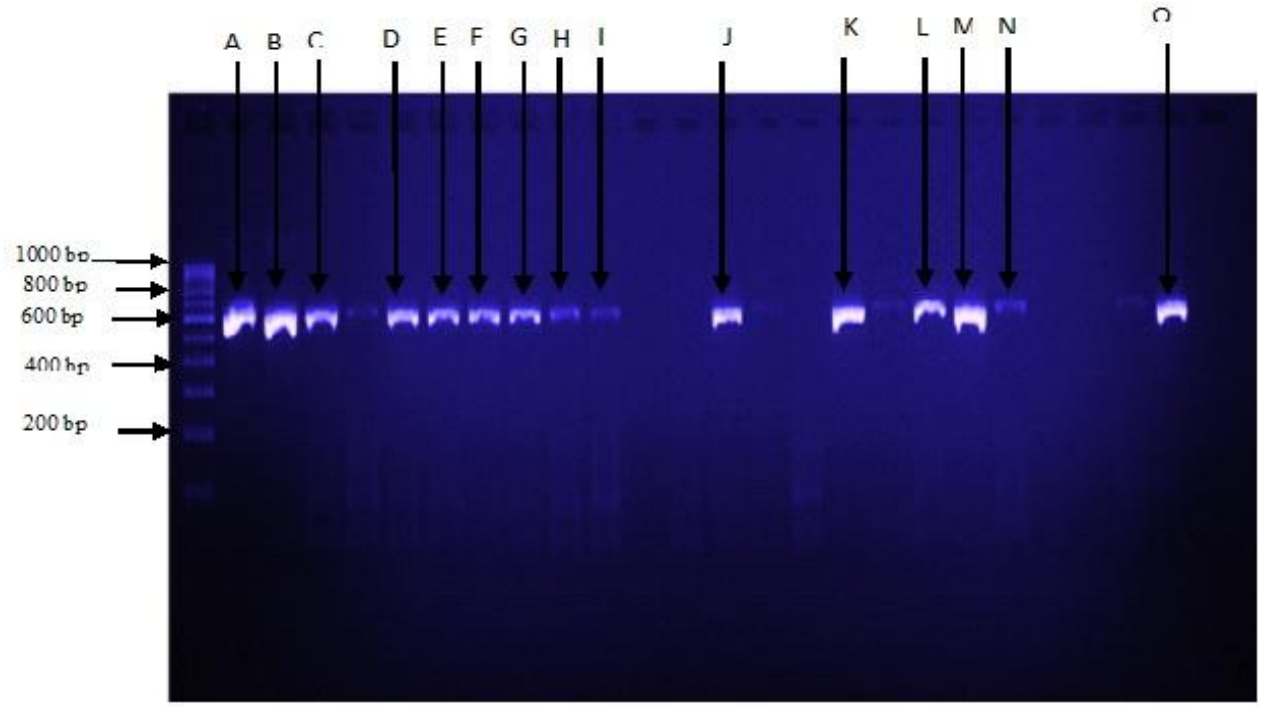


Figure 13 Figure shows successful PCR amplification of rbcL barcode (A.... O) Sample position, L: 100bp DNA ladder).

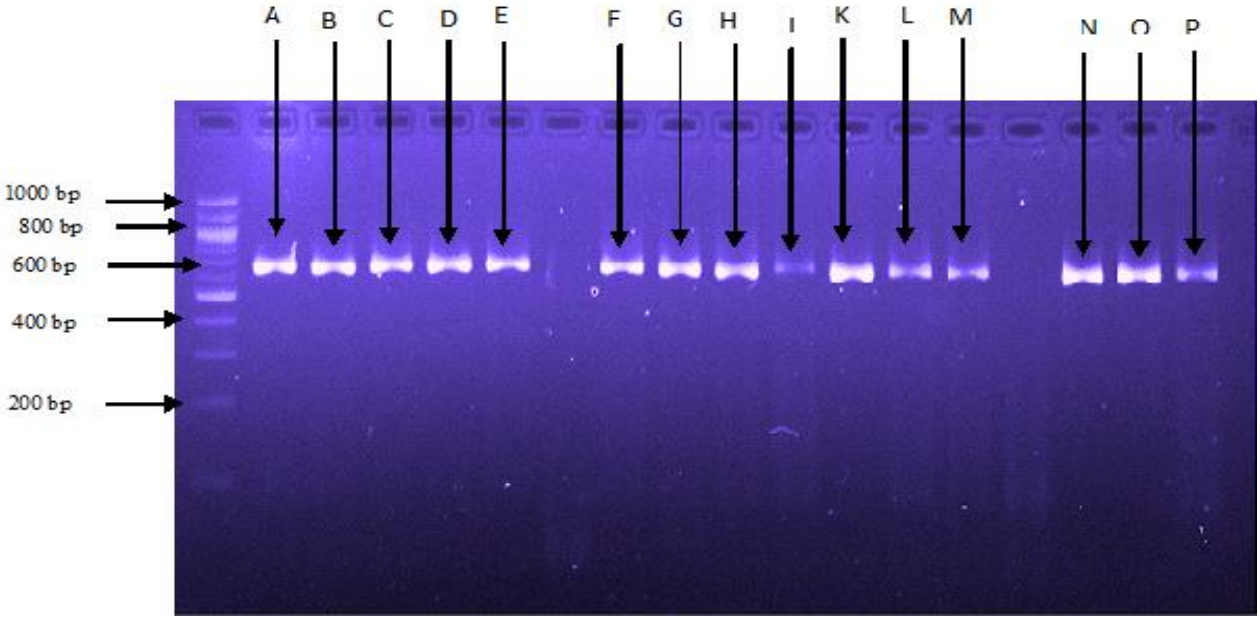


Figure 14 Figure shows successful PCR amplification of rbcL barcode (A.... O) Sample position, L: 100bp DNA ladder)

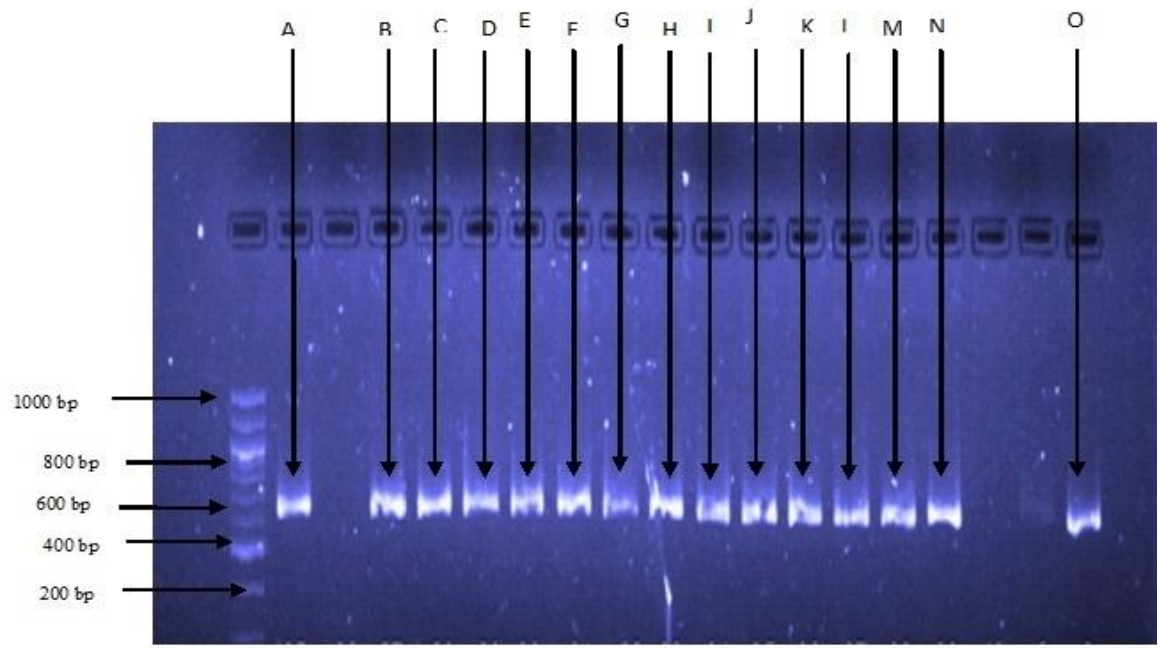


Figure 15 Figure shows successful PCR amplification of rbcL barcode (A.... O) Sample position, L: 100bp DNA ladder)

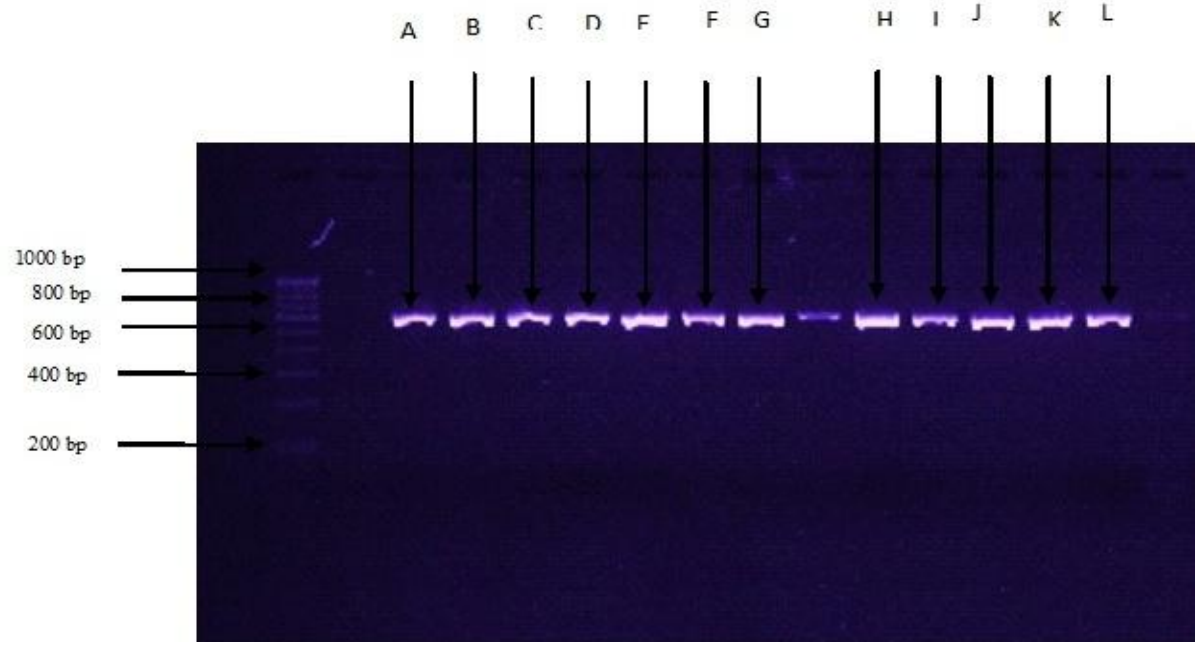


Figure 16 Figure shows successful PCR amplification of rbcL barcode (A.... O) Sample position, L: 100bp DNA ladder)

An important component of any DNA extraction method is its use in downstream applications. Therefore, we compared PCR amplification of a plant rbcL gene using the 57 plant tissue DNA extracts. Figure 12, 13, 14 and 15shows a representative agarose gel containing a 600-bp fragment of plant rbcL gene that was PCR-amplified from DNA of 57 plants tissues. Our results indicated that, the well with low intensity bands reflects low PCR amplification compared to others. All the samples showed equal band size (~600bp) referred from the 100 bp DNA ladder (size marker). 100 bp ladder was loaded at 1st well position in each raw. It has 10 bands of 100 bp difference. It starts at 100 bp (lowest band) and ends with 1000 bp bands (highest band). Samples bands are close to 600 bp size, suggest the similar PCR product size in the samples.

4.2.3 Sequencing Details :

Total 94 Plants were collected out of which sequencing of 86 plants were successfully completed.

4.2.4 BOLD Submission:

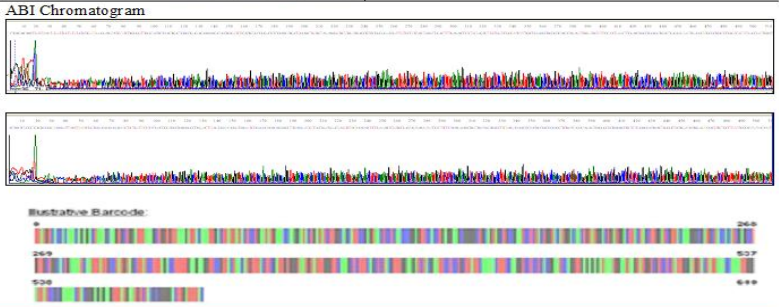
DNA Isolation and gene sequencing of all 90 plants were carried out. In 86 plant samples positive results were obtained. BLAST match of 86 sequence was carried out. Out of which in 57 gene sequence match found in the BLAST tool and remaining 29 plant sequence match were not found in the BLAST tool. Hence, 57 plant samples satisfactory results were obtained which were submitted in BOLD. The illustrative barcode and Accession no. of all 57 plants were generated in BOLD. Detail information about BOLD submission are as shown in table 4,5 and 6.

Sr. No.	Plant name	Accession no.	Sr. No.	Plant name	Accession no.
1	*Solanum virginianum*	GENG335-14	30	*Cressa cretica*	GENG385-14
2	*Potamogeton crispus*	GENG226-14	31	*Phyla nodiflora*	GENG386-14
3	*Ludwigia perrium*	GENG227-14	32	*Elaeocarpus variabilis*	GENG387-14
4	*Vernonia einerea*	GENG228-14	33	*Aeschynomene indica*	GENG388-14
5	*Phyllanthus amarus*	GENG229-14	34	*Eleocharis dulcis*	GENG389-14
6	*Pistia stratiotes*	GENG230-14	35	*Ischaemum rubosum*	GENG390-14
7	*Hydrilla verticillata*	GENG231-14	36	*Cyperus difformis*	GENG391-14
8	*Paspalum disticum*	GENG232-14	37	*Alternanthera philoxeroides*	GENG392-14
9	*Ludwigia octavalvis*	GENG233-14	38	*Xanthium spp.*	GENG393-14
10	*Ipomoea aquatica*	GENG234-14	39	*Cyperus spp.*	GENG394-14
11	*Hygrophila auriculata*	GENG235-14	40	*Hygrophila spp.*	GENG395-14
12	*Nelumbo nucifera*	GENG236-14	41	*Potemogeton natans*	GENG462-14
13	*Vallisneria spiralis*	GENG237-14	42	*Lemna spp.*	GENG463-14
14	*EquisetumSpp.*	GENG238-14	43	*Abutilon indicum*	GENG464-14
15	*Chloris barbata*	GENG370-14	44	*Croton aequatoris*	GENG465-14
16	*Spirodela polyrhiza*	GENG372-14	45	*Barleria prionitis*	GENG466-14
17	*Hygroryza aristata*	GENG371-14	46	*Persicaria glabra*	GENG467-14
18	*Azolla pinnata*	GENG373-14	47	*Eleocharis atropurpurea*	GENG468-14
19	*Limnophyton obtusifolium*	GENG374-14	48	*Blumea spp.*	GENG469-14
20	*Colocasia esculanta*	GENG375-14	49	*Spilanthes acmella*	GENG470-14
21	*Dactyloctenium aegyptium*	GENG376-14	50	*Cocculus hirsutus*	GENG471-14
22	*Amaranthus spinosus*	GENG377-14	51	*Lindernia Spp.*	GENG472-14
23	*Sphaeranthus indicus*	GENG378-14	52	*Cyanthilium cinereum*	GENG473-14
24	*Peristrophe paniculata*	GENG379-14	53	*Aerva Spp.*	GENG474-14
25	*Limnophila indica*	GENG380-14	54	*Rungia Spp.*	GENG475-14
26	*Marsilea quadrifolia*	GENG381-14	55	*Tridax procumbens*	GENG476-14
27	*Utricularia vulgaris*	GENG382-14	56	*Sida rhombifolia*	GENG477-14
28	*Gomphrena celosiodes*	GENG383-14	57	*Pentanema indicum*	GENG478-14
29	*Bergia spp.*	GENG384-14			

Table 12: List of the barcoded plants with their accession no.

Details		Image	Sequence
Collection date	9th Oct, 2013		>ACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAG AGTACAAATTGACTTATTATACTCCTGAGTACCAAACCAAGGATA CTGATATATTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTC CACCTGAAGAAGCAGGGGCCGCGGTAGCTGCCGAATCTTCTACT GGTACATGGACAACTGTATGGACCGATGGACTTACCAGTCTTGA TCGTTACAAAGGGCGATGCTACCGCATCGAGCGTGTTGTTGGAG AAAAAGATCAATATATTGCTTATGTAGCTTACCCTTTAGACCTTTT TGAAGAAGGTTCCGTTACCAATATGTTTACTTCCATTGTAGGTAA TGTATTTGGGTTCAAAGCCCTGCGCGCTCTACGTCTGGAAGATCT GCGAATCCCTCCTGCTTATATTAAAACTTTCCAAGGTCCGCCTCAT GGGATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCGTCC CCTGTTGGGATGTACTATTAAACCTAAATGGGGTTATCTGCTAAA AACTACGGTAGAGCTGTTTATGAATGTCTTC rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Harni lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 16.0"		
Longitude	E 73° 13' 07.02"		
Elevation	108		
Photographer	Krupa Unadkat		

A

Details		Image	Sequence
Collection date	10th Oct, 2013		>TTATGTCACCACAAACAGAGACTAAAGCAAGTGCTGGATTTAA AGCTGGTGTTAAAGATTACAAATTGACTTATTATACTCCTGAATA TGAAACCAAGGATACTGATATCTTGGCAGCATTCCGAGTAACTCC TCAACCCGGAGTTCCACCTGAGGAAGCGGGGGCTGCAGTAGCT GCCGAATCCTCTACTGGTACATGGACAACTGTATGGACTGATGG ACTTACTAGCTTGGATCGTTACAAAGGGCGATGCTACCACATCG AGCCTGTTGCTGGCACTGAAAATCAATTTATTGCCTATGTAGCTT ATCCTTTAGACCTTTTTGAAGAAGGTTCCGTTACTAACATGTTTAC TTCGATTGTGGGTAATGTATTTGGGTTCAAAGCTCTTTCAGCTCT ACGTTTGGAAGATCTACGAATTCCTCCTGCTTATTCAAAAACTTTC CAAGGTCCTCCTCACGGAATCCAGGTTGAGAGAGATAAATGGAA TAAGTATGGTCGTCCTCTATTGGGATGTACTATTAAACCAAAATT GGGATTATCCGCGAAAAACTACGGGAGAGAAGTTTATGAATGTC TACGCGGGGGACTTGATTTTAC rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R :GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	MSU Botonical garden		
Exact Site	Pond area		
Latitude	N 22° 18' 36.3"		
Longitude	E 73° 11' 10.4"		
Elevation	117		
Photographer	Krupa Unadkat		

B

PLATE 24

Details	
Collection date	11th Oct, 2013
Identification	*Ludvigia perennis L.*
Institution	Gujarat Biodiversity Gene Bank
Accession number	GENG227-14
Collection code	BG20131009-0003
Collector	Krupa Unadkat
Phylum	Magniliophyta
Class	Rosids
Order	Mrtales
Family	Onagraceae
Genus	Ludwigia
Species	*perrinis*
Identifier	Dr. P.S. Nagar
Identifier Email	dmagar@gmail.com
Identifier Institution	MSU Baroda
Identification Method	Morphology and Barcoding
Voucher Status	Herbarium, Photographs
Country	India
State	Gujarat
Region	Vadodara
Sector	Hami lake, Baroda
Exact Site	Pond area
Latitude	N 22° 20' 24.1"
Longitude	E 73° 13' 16.0"
Elevation	115
Photographer	Krupa Unadkat

Image

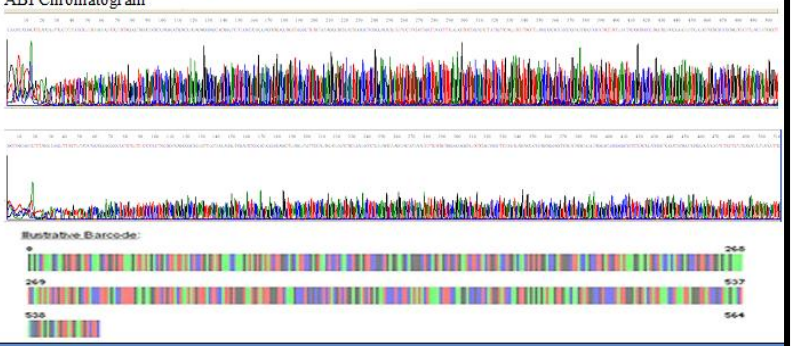
Sequence

>GAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATT
ATAGACTGACTTATTATACTCCTGAGTATGAAACCAAAGATAGTG
ATATCTTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTCCGG
CTGAGGAAGCAGGGGCTGCAGTAGCTGCTGAATCTTCTACTGGT
ACCTGGACAACTGTGTGGACCGATGGGCTTACCAGCCTTGATCG
TTATAAAGGAAGATGCTACCACATCGAGCCTGTTGCTGGAGAAG
AAAATCAATATATCTGTTATGTAGCTTACCCTTTAGACCTTTTGA
AGAAGGTTCTGTTACTAATATGTTTACTTCCATTGTGGGTAATGT
ATTTGGGTTCAAAGCCCTGCGCGCTCTACGTCTGGAGGATCTGA
GAATCCCTCCTTCATATACTAAAACTTTCCAAGGACCGCCTCATG
GTATCCAAGTTGAGAGAGATAAGTTGAACAAGTATGGCCGTCCC
CTATTGGGATGTACTATTAAACCTAAATTAGGGTTATCCGCTAAG
AACTACGGTAGAGCATGTTATGAATGTCTTC

rbcL F: ATGTCACCACAAACAGAGACTAAAGC

rbcL R: GTAAAATCAAGTCCACCRCG

ABI Chromatogram



A

Details	
Collection date	12th Oct, 2013
Identification	*Vernonia cinerea (L.) Less.*
Institution	Gujarat Biodiversity Gene Bank
Accession number	GENG228-14
Collection code	BG20131009-0004
Collector	Krupa Unadkat
Phylum	Magniliophyta
Class	Eucotyledons
Order	Asterales
Family	Asteraceae
Genus	Vernonia
Species	*Cinerea*
Identifier	Dr. P.S. Nagar
Identifier Email	dmagar@gmail.com
Identifier Institution	MSU Baroda
Identification Method	Morphology and Barcoding
Voucher Status	Herbarium, Photographs
Country	India
State	Gujarat
Region	Vadodara
Sector	Hami lake, Baroda
Exact Site	Pond area
Latitude	N 22° 20' 41.1"
Longitude	E 73° 13' 14.2"
Elevation	112
tographer	Krupa Unadkat

Image

Sequence

>ACAGAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAG
ATTATAAATTGACTTATTATACTCCTGAATATAAAACCAAGGATA
CTGATATCTTGGCAGCATTTCGAGTAACTCCTCAACCTGGAGTTC
CGCCTGAAGAAGCAGGGGCCGCAGTAGCTGCCGAATCTTCTACT
GGTACATGGACAACTGTGTGGACCGATGGACTTACGAGCCTTGA
TCGTTACAAAGGGCGATGCTATGGAATCGAGCCTGTTCCTGGAG
AAGAAAGTCAATTTATTGCTTATGTAGCTTACCCATTAGACCTTTT
TGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTAGGTAA
TGTATTTGGGTTCAAAGCCCTGCGTGCTCTACGTCTGGAAGATTT
GCGAATCCCTATTTCGTATGTTAAAACTTTCCAAGGTCCGCCTCA
CGGCATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTC
CCCTGTTGGGATGTACTATTAAACCTAAATTGGGGTTATCCGCTA
AAAACTACGGTAGAGCTGTTTATGAATGTCTTCGTGGTGGACTT

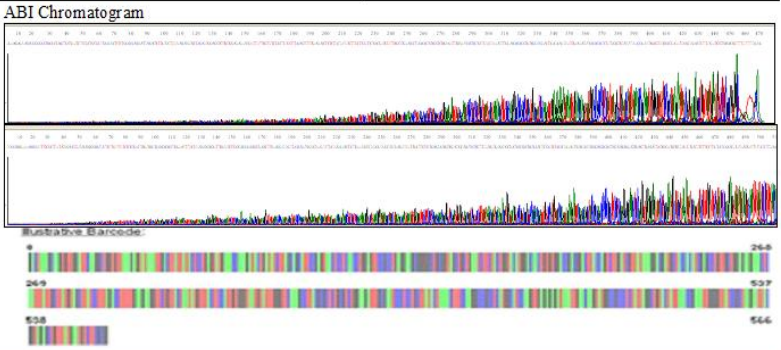
rbcL F: ATGTCACCACAAACAGAGACTAAAGC

rbcL R: GTAAAATCAAGTCCACCRCG

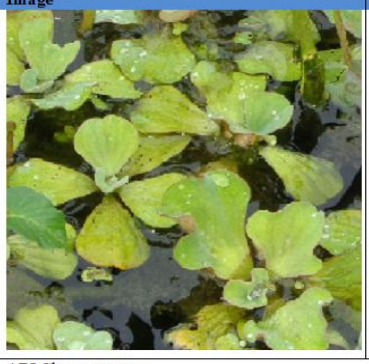
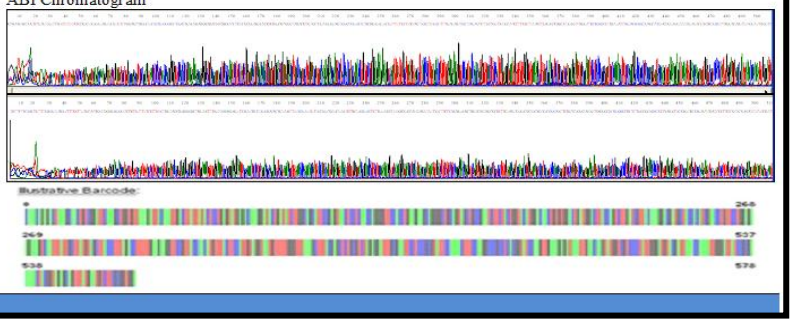
ABI Chromatogram

B

PLATE 25

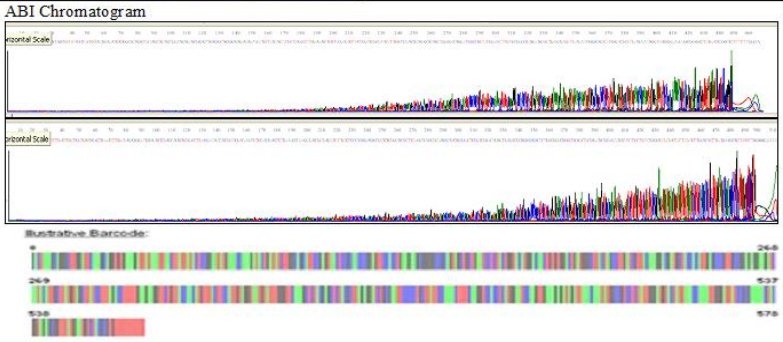
Details		Image	Sequence
Collection date	13th Oct, 2013		>GACTAAAGCAAGTGTTGGATTCAAGGCTGGTGTTAAAGAGTAT AAATTGACTTATTATACTCCTGAGTATGAAACCAAAGATACTGAT ATCTTAGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTCCGCCT GAGGAAGCGGGGGCTGCGGTAGCTGCTGAATCTTCTACTGGTAC ATGGACAACTGTGTGGACCGACGGACTTACCAGTCTTGATCGTT ATAAAGGACGATGCTACCACATCGAGCCTGTTGCTGGAGAAGAA ACTCAATTTATTGCTTATGTAGCTTATCCTTTAGACCTTTTTGAAG AAGGTTCTGTTACTAATATGTTTACTTCCATTGTGGGTAATGTATT TGGGTTCAAAGCCTTACGCGCTCTGCGTCTGGAAGATTTGCGAA TCCCTCCTGCTTATACTAAAACTTTCCAAGGCCCGCCTCATGGCAT CCAAGTTGAGAGAGATAAATTGAACAAGTATGGCCGCCCTCTAT TAGGCTGTACTATTAAACCGAAATTGGGGTTATCCGCTAAGAATT ACGGTAGAGCTGTTTATGAATGTCTTCGCGG rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 22.0"		
Longitude	E 73° 13' 11.1"		
Elevation	127		
Photographer	Krupa Unadkat		

A

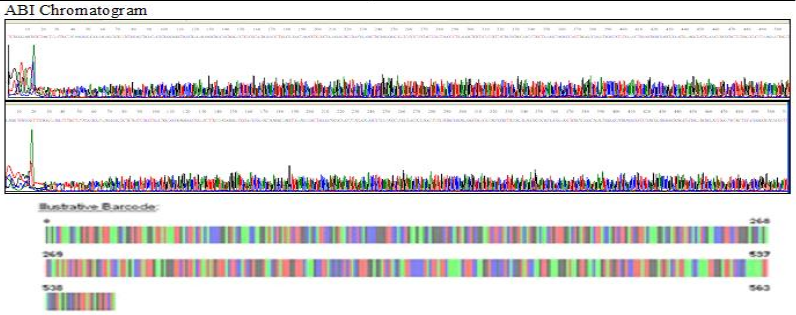
Details		Image	Sequence
Collection date	14th Oct, 2013		>CAAACAGAGACTAAAGCAACTGTCGGATTCAAAGCTGGTGTTA AAGATTACAAATTGACTTATTATACTCCTGAGTATGAGACAAAGG ATACTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCAGGGG TTCCACCTGAAGAAGCAGGGGCTGCAGTAGCTGCCGAATCTTCT ACTGGTACATGGACAACTGTGTGGACTGATGGACTTACCAGTCT TGATCGTTACAAAGGACGATGCTACCACATCGAACCTGTTCCTGG AGAAGAAAGTCAATTTATTGCTTATGTAGCTTACCCTTTAGACCT TTTTGAAGAAGGTTCCGTTACCAACATGTTTACTTCCATTGTAGG TAATGTTTTTGGGTTTAAAGCTTTACGAGCTCTGCGTCTAGAGGA TTTGCGAATTCCTCCCGCGTATTCCAAAACTTTCCAAGGCCCGCCT CACGGTATCCAAGTTGAAAGAGATAAATTGAACAAGTATGGTCG TCCCCTATTGGGATGTACGATTAAACCAAAATTGGGATTATCCGC GAAAAACTACGGTAGAGCAGTTTATGAATGTCTTCGCGGTGGA rbcL: F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 42.9"		
Longitude	E 73° 13' 15.5"		
Elevation	118		
Photographer	Krupa Unadkat		

B

PLATE 26

Details		Image	Sequence
Collection date	16th Oct, 2013		>GACTAAAGCAGGGCTTGGATTCAAAGCAGGTGTGAAAGATTAT AAATTAACTTATTATACTCCGGAATATGAAACCAAAGATACTGAT ATCTTGGCAGCATTCCGAGTAACTCCTCGCAACCCGGAGTTCCACCT GAAGAAGCGGGGGCCGCAGTAGCTGCTGAATCCTCTACTGGTAC ATGGACAACTGTGTGGACTGATGGGCTTACTAGCCTTGATCGTT ACAAAGGACGATGCTACCACATTGAGCCCGTTGCCGGAGAGGA AGATCAATACATTGCTTATGTAGCTTATCCTTTAGACCTTTTTGAA GAAGGTTCTGTTACCAACATGTTTACTTCCATTGTAGGTAATGTA TTTGGGTTCAAAGCTCTACGAGCTCTACGCTTAGAGGATCTGCGA ATTCCCCCTGCTTATTCCAAAACTTTTCAAGGTCCACCTCATGGAA TCCAAGTTGAAAGAGATAGATTAAACAAATATGGCCGTCCTCTAT TGGGATGTACTATTAAACCAAAATTGGGATTATCCGCGAAAAAC TACGGTAGAGCGGTTTATGAATGTCTACGCGTGTTTTTTTTTTT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 42.9"		
Longitude	E 73° 13' 15.5"		
Elevation	112		
Photographer	Krupa Unadkat		

A

Details		Image	Sequence
Collection date	18th Oct, 2013		>GAGACTAAAGCAAGTGTTGGATTTAAAGCAGGTGTTAAGGATT ATAAATTGACTTACTACACCCCGGAGTACGAAACCAAGGATACT GATATCTTGGCAGCATTCCGAGTAACTCCTCAGCCCGGGGTTCCA CCTGAAGAAGCAGGGGCTGCAGTAGCTGCGGAATCTTCTACTGG TACATGGACAACTGTTTGGACTGATGGACTTACCAGTCTTGATCG TTACAAAGGACGATGCTATCACATCGAACCCGTTCCTGGGGAGG CAGATCAATATATCTGTTATGTAGCTTATCCATTAGACCTATTTGA AGAGGGTTCTGTTACTAATATGTTTACTTCCATCGTGGGTAACGT ATTTGGTTTCAAAGCCTTACGCGCTCTACGTTTGGAGGATCTACG AATTCCCCCTACTTATTCAAAAACTTTCCAAGGTCCGCCTCACGGT ATCCAAGTTGAAAGGGATAAGTTGAACAAGTATGGTCGTCCTTT ATTGGGATGTACTATTAAACCAAAATTGGGATTATCCGCAAAAA ATTACGGTAGAGCGTGTTATGAGTGTCTA rbcL F : ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 23.7"		
Longitude	E 73° 13' 12.9"		
Elevation	105		
Photographer	Krupa Unadkat		

B

PLATE 27

Details		Image	Sequence
Collection date	19th Oct, 2013		>TTGTAAAATCCAATCCACCGCGAAGACATTCATAACATGCTCTA CCGTAGTTCTTAGCGGATAACCCTAATTTAGGTTTAATAGTACAT CCCAATAGGGGACGGCCATACTTGTTCAACTTATCTCTCTCAACT TGGATACCATGAGGCGGTCCTTGGAAAGTTTTAGTATATGAAGG AGGGATTCTCAGATCCTCCAGACGTAGAGCGCGCAGGGCTTTGA ACCCAAATACATTACCCACAATGGAAGTAAACATATTAGTAACAG AACCTTCTTCAAAAAGGTCTAAAGGGTAAGCTACATAACAGATAT ATTGATTTTCTTCTCCAGCAACAGGCTCGATGTGGTAGCATCTTC CTTTATAACGATCAAGGCTGGTAAGCCCATCGGTCCACACAGTTG TCCAGGTACCAGTAGAAGATTCAGCAGCTACTGCAGCCCCTGCTT CCTCAGCCGGAACTCCAGGTTGAGGAGTTACTCGGAATGCTGCC AAGATATCACTATCTTTGGTTTCATACTCAGGAGTATAATAAGTC AGTCTATAATCTTTAACACCAGCTTTGAATCCAACACTTGCTTTAG TCTCTGTTTGTGGGTG rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 22.9"		
Longitude	E 73° 13' 12.1"		
Elevation	118		
Photographer	Krupa Unadkat		

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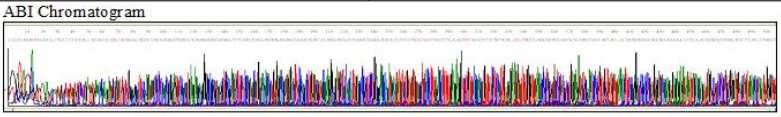
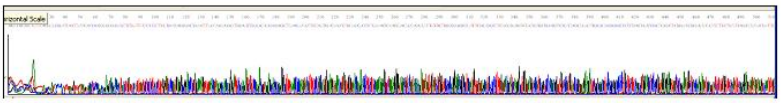
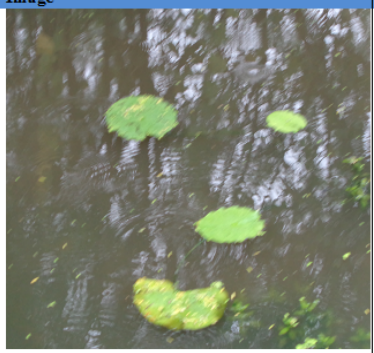
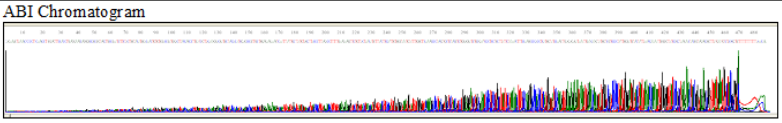
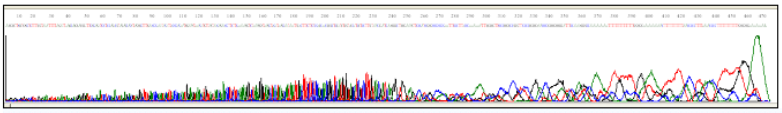
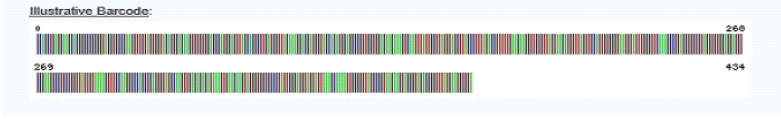
Details		Image	Sequence
Collection date	20th Oct, 2013		>GCGAAGACATTCATAAACCGCTCTACCGTAGTTTTTAGCAGATA ACCCCAATTTTGGTTTAATAGTACATCCCAACAGAGGACGACCAT ACTTGTTCAATTTATCTCTCTCAACTTGGATACCATGAGGCGGGC CTTGAAAAGTTTTAATATAAGCCGTAGGGATTCGTAAATCTTCCA GACGTAGAGCGCGCAGTGCTTTGAACCCAAATACATTACCCACA ATGGAAGTAAACATGTTGGTAACAGAACCTTCTTCAAAAAGGTC TAAAGGGTAAGCTACATAAGCAATATATTGATCTTTTTCTCCAAT AACGCGCTCGATGCGGTAGCATCGCCCCTTGTACCGATCAAGGC TGGTAAGTCCATCGGTCCACACAGTTGTCCATGTACCAGTAGAA GATTCCGCAGCTACCGCGGCCCCTGCTTCTTCAGGCGGAACTCCG GGTTGAGGAGTTACTCGGAATGCTGCCAAGATATCAGTATCTTT GGTTTCGTACTCAGGAGTATAATAAGTCAATTTGTAGTCTTTTAC ACCAGCTTTGAATCCAACACTTGCTTTAGTCTCTGTTTGGGGGG Rbcl F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 23.3"		
Longitude	E 73° 13' 12.8"		
Elevation	110		
Photographer	Krupa Unadkat		

B

PLATE 28

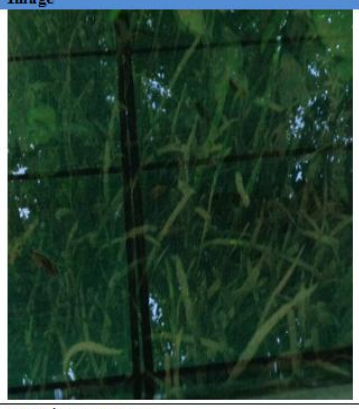
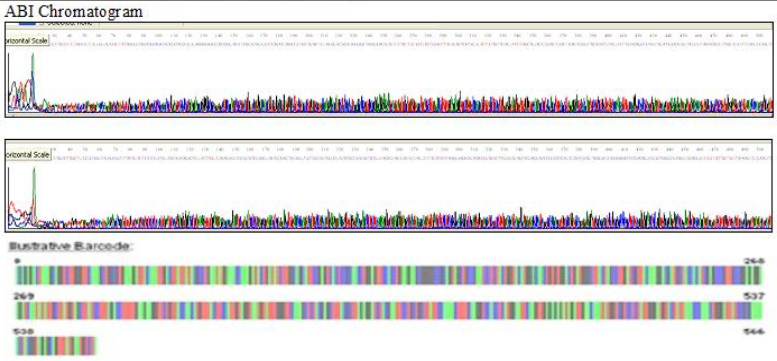
Details		Image	Sequence
Collection date	21st Oct, 2013		>ACAGAGACTAAAGCAAATGTTGGATTCAAAGCGGGTGTTAAAG AGTACAAATTGACTTATTATACTCCTGAATATGAAACCAAAGATA CTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCGGGAGTTC CAGCTGAAGAAGCAGGGGCCGCGGTAGCTGCCGAATCTTCTACC GGTACATGGACAACCGTGTGGACCGATGGACTTACCAGCCTTGA TCGTTACAAAGGGCGATGCTACAACATTGAGCCCGTTCCTGGCG AACCAGATCAATATATCTGTTATGTAGCTTACCCTTTAGACCTTTT TGAAGAAGGTTCTGTTACCAACATGTTTACTTCCATTGTAGGAAA TGTATTTGGGTTTAAAGCCCTGCGTGCTCTACGTCTGGAAGATCT GCGAATCCCTGTTGCTTATGTTAAAACTTTCCAGGGTCCGCCTCA TGGGATCCAAAGTGAGAGAGATAAATTGAACAAGTATGGTCGTC CTCTGCTGGGATGTACTATTAAACCTAAATTGGGGTTATCCGCTA AAAACTATGGTAGAGCGTGTTATGAATGTCTTCGC rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 42.9"		
Longitude	E 73° 13' 12.5"		
Elevation	109		
Photographer	Krupa Unadkat		

A

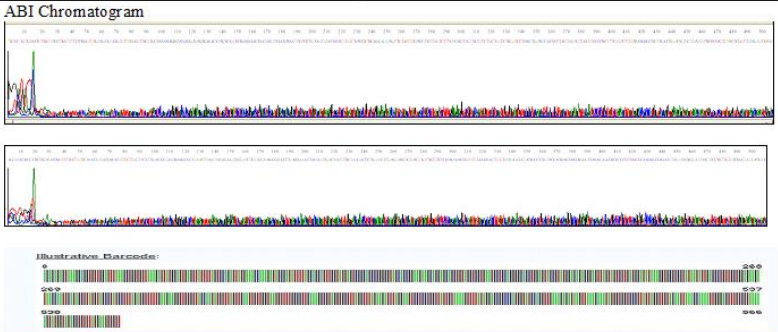
Details		Image	Sequence
Collection date	25th Oct, 2013		>TGTTGTAAAAAAAAAAAAACACGCGTAGACATTCATAAACCGC TCTACCGTAGTTCTTAGCGGATAACCCCAATTTTGGTTTAATAGT ACATCCCAATAGGGGACGACCATACTTGTTCAATTTATCTCTCTC AACTTGGATACCATGAGGTGGGCCTTGGAAAGTTTTAGAATAAG CAGGAGGGATTCGCAGATCCTCCAGACGTAGAGCACGTAGGGC TTTGAACCCAAATACATTACCCACAATGGAAGTAAACATGTTAGT AACAGAACCTTCTTCAAAAAGGTCTAAAGGGTAAGCTACATAAG CAATAAATTGACTTTCTTCTCCAGCAACGGGCTCGATGTGGTAGC ATCGTCCTTTGTAACGATCAAGGCTGGTAAGTCCATCGGTCCACA CAGTTGTCCATGTACCAGTAGAAGATTCGGCAGCTACCGCGGCC CCTGCTTCCTCAGGTGGAACTCCAGGTTGAGG rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R : GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake, Baroda		
Exact Site	Pond area		
Latitude	N 22° 20' 41.9"		
Longitude	E 73° 13' 15.9"		
Elevation	102		
Photographer	Krupa Unadkat		

B

PLATE 29

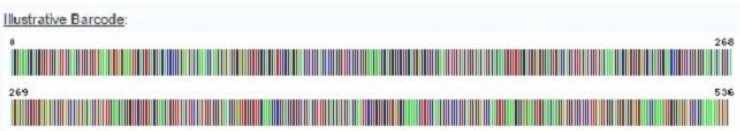
Details		Image	Sequence
Collection date	27th Oct, 2013		>ACAGAGACTAAAGCAGGTCTTGGGTTCAAAGCTGGCGTGAAAGAT TACAAATTGACTTATTATACGCCTGAATATGAAACCAAAGATACTGA TATCTTGGCAGCATTCCGAGTCACTCCGCAACCTGGAGTTCCACCTG AAGAAGCGGGGGCCGCAGTAGCTGCCGAATCCTCTACTGGTACATG GACAACTGTGTGGACTGATGGGCTTACTAGCCTTGATCGTTACAAA GGACGATGCTACCACATCGAGCCCGTTGCCGGAGAGGAAGATCAAT ATATTGCTTATGTAGCTTATCCTTTAGACCTTTTTGAAGAAGGTTCTG TTACCAACATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAG CTCTACGAGCTTTACGCTTAGAGGATCTACGAATTCCTGCTGCTTATT CCAAAACTTTTCAAGGTCCACCTCATGGAATTCAAGTTGAGAGAGAT AGATTGAACAAATATGGTCGTCCTCTATTGGGATGTACTATTAAACC CAAACTGGGATTATCCGCGAAAAACTACGGTAGAGCAGTTTATGAA TGTCTA rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	MSU Arboratum		
Exact Site	Pond area		
Latitude	N 22° 19' 13.8"		
Longitude	E 73° 10' 48.1"		
Elevation	104		
Photographer	Krupa Unadkat		

A

Details		Image	Sequence
Collection date	28th Oct, 2013		>ACAGAGACTAAAGCAGGTGTTGGATTTAAAGCTGGTGTTAAAG ATTATCGATTGACTTATTTTACTCCAGATTATGAAACCAAAGATAC CGATATTTTAGCAGCATTTCGTATGACTCCGCAGCCGGGGGTACC ACCGGAAGAAGCAGGAGCAGCTGTAGCTGCTGAATCCTCCACG GGCACCTGGACTACCGTATGGACAGACGGACTTACTAGTCTTGA TCGATATAAAGGTCGCTGCTATAATATTGAGCCTGTTGCTGGAG AAGATAACCAATTCATAGCTTATGTAGCCTATCCTTTAGATCTTTT TGAAGAAGGTTCTGTTACCAATATGTTTACTTCAATTGTTGGTAA TGTTTTCGGCTTCAAAGCTCTACGTGCTTTACGTTTAGAAGATTTA CGAATTCCTCCTGCTTATTCTAAAACTTTTATAGGACCGCCCCATG GTATCCAGGTTGAAAGAGATAAGTTAAACAAATATGGTCGTCCG TTATTAGGTTGTACAATTAAACCAAAATTGGGACTTTCTGCTAAA AACTATGGTAGAGCTGTTTATGAATGTCTT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	MSU Botonical garden		
Exact Site	Pond area		
Latitude	N 22° 18' 36.6"		
Longitude	E 73° 11' 10.6"		
Elevation	116		
Photographer	Krupa Unadkat		

B

PLATE 30

Details		Image	Sequence
Collection date	21st Nov, 2013		>ACTAAAGCAGGTGTTGGATTTCAAGCTGGTGTTAAAGATTATA AATTGACTTACTACACCCCGGAATACGAAACCAAGGATACTGAT ATCTTGGCAGCATTCCGAGTAACTCCTCAGCCCGGGGTTCCGGCT GAAGAAGCAGGGGCTGCAGTAGCTGCGGAATCTTCTACTGGTAC ATGGACAACTGTTTGGACTGATGGACTTACCAGTCTTGATCGTTA CAAAGGACGATGCTATCACATCGAACCCGTTCCTGGGGAAGACA GTCAATATATCTGTTATATAGCTTATCCATTAGATCTATTTGAAGA GGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTAACGTATTT GGTTTCAAAGCCCTACGTGCTCTACGTTTGGAGGATCTACGAATT CCTGCTGCTTATGCAAAAACTTTCCAAGGTCCGCCTCATGGTATC CAAGTTGAAAGGGATAAGTTGAACAAGTATGGTCGTCCTTTATT GGGATGTACTATTAAACCAAAATTGGGATTATCCGCAAAAAATT AT rbcL F:ATGTCACCACAAACAGAGACTAAAGC rbcL R:GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chormato gram 	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	MSU Botonical garden		
Exact Site	Pond area		
Latitude	N 22° 20' 22.8"		
Longitude	E 73° 13' 12.3"		
Elevation	121		
Photographer	Krupa Unadkat		

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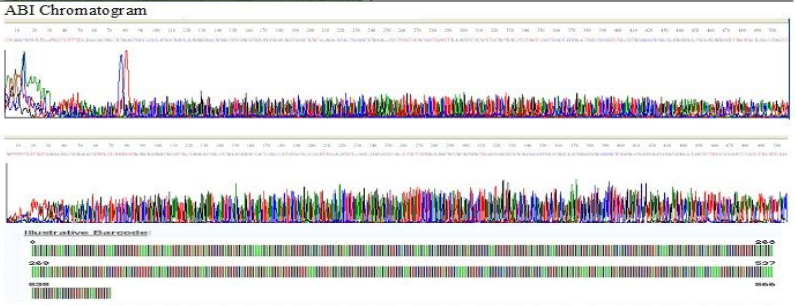
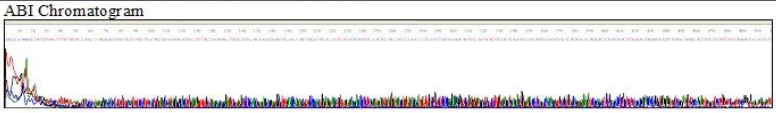
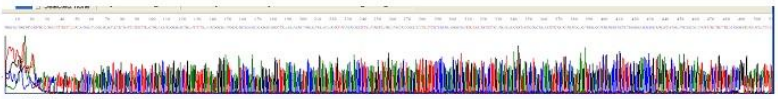
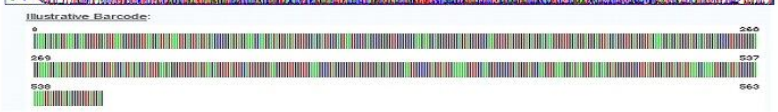
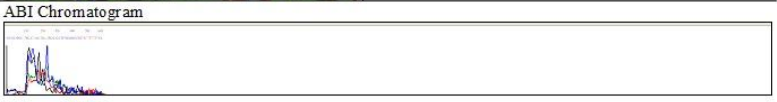
Details		Image	Sequence
Collection date	21st Nov, 2013		<ACAGAGACTAAAGCAAGTGCTGGATTCAAAGCTGGTGTTAAAG ATTACAAATTGACTTATTATACTCCTGAGTATGAGACAAAAGATA CGGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTC CACCTGAAGAAGCAGGGGCTGCAGTAGCTGCCGAATCTTCTACT GGTACATGGACAACTGTGTGGACTGATGGACTTACCAGCCTTGA TCGTTACAAAGGACGATGCTACCATATCGAACCCGTTGTTGGAG AGGAAAATCAATATATTGCTTATGTAGCTTACCCTTTAGACCTTTT TGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTAGGTAA TGTATTTGGGTTTAAAGCTTTACGAGCTCTACGTCTGGAAGATTT GCGAATTCCTCCTGCTTATTCCAAAACTTTCCAAGGCCCACCTCAT GGGATCCAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCC TCTATTGGGATGTACCATCAAACCAAAATTGGGATTATCCGCGAA AAACTACGGTAGAGCGGTTTATGAATGTCTA rbcL F:ATGTCACCACAAACAGAGACTAAAGC rbcL R:GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram 	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake,		
Exact Site	Pond area		
Latitude	N 22° 20' 25.9"		
Longitude	E 73° 13' 13.8"		
Elevation	145		
Photographer	Krupa Unadkat		

B

PLATE 31

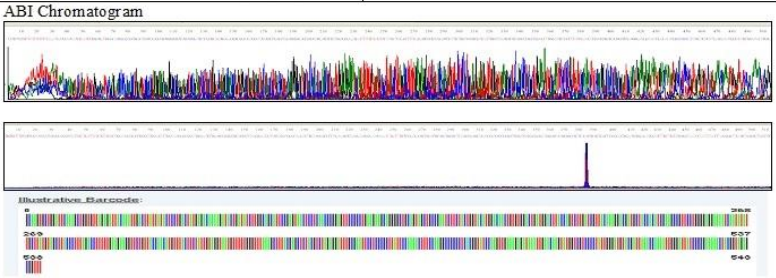
Details		Image	Sequence
Collection date	21st Nov, 2013		<CAAACAGAGACTAAAGCAAGTGTTGGATTTAAAGCTGGTGTTA AGGATTATAAATTGACTTACTACACCCCGGAGTACGAAACCAAG GATACTGATATCTTGGCAGCATTCCGAGTAACTCCTCAGCCGGG GGTTCCGGCCGAAGAAGCAGGGGCTGCAGTAGCTGCCGAATCT TCTACTGGTACATGGACAACTGTTTGGACTGATGGACTTACCAGT CTTGATCGTTACAAAGGACGATGCTATCACATCGAGCCCGTTGCT GGGGAGGAAAATCAATATATCGCTTATGTAGCTTATCCATTAGA CCTATTTGAAGAGGGTTCTGTTACTAACATGTTTACTTCCATTGTG GGTAACGTGTTTGGTTTCAAAGCCCTACGCGCTCTACGTCTGGAG GATCTGCGAATTCCCCCTACTTATTCAAAAACTTTCCAAGGTCCG CCTCATGGTATCCAAGTTGAAAGGGATAAGTTGAACAAGTATGG TCGTCCTTTATTGGGATGTACTATTAAACCAAAATTGGGATTATC CGCGAAAAATTATGGTAGAGCGTGTTATGAG rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake,		
Exact Site	Pond area		
Latitude	N 22° 20' 23.6"		
Longitude	E 73° 13' 12.4"		
Elevation	109		
Photographer	Krupa Unadkat		

A

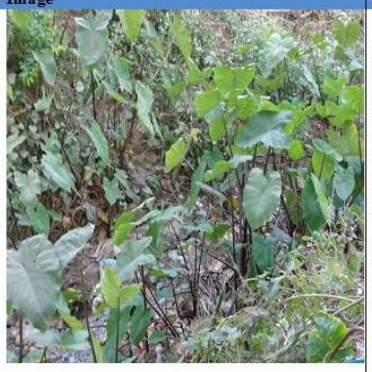
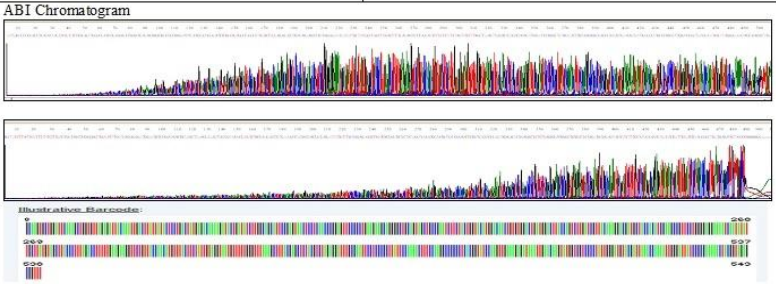
Details		Image	Sequence
Collection date	21st Nov, 2013		GAGACTAAAGCAGGCGTTGGATTCAAAGCTGGTGTTAGAGATTA TCGATTGACCTATTACACTCCTGATTATGTGACCAAAGATACAGA TATTTTGGCAGCTTTCCGAATGACCCCGCAACCCGGAGTCCCACC CGAAGAGGCTGGAGCTGCGGTAGCTGCGGAATCTTCTACAGGT ACATGGACCACTGTATGGACGGATGGACTTACCAGTCTTGATCG TTACAAAGGTAGATGCTATGATATCGAACCTGTTGCTGGAGAAG ACAATCAGTACATCGCATACGTAGCTTATCCCCTAGATTTATTCG AAGAGGGTTCCGTTACCAACATGTTTACCTCTATCGTAGGTAATG TATTCGGGTTTAAAGCTCTACGTGCTCTTCGCCTAGAAGATCTTC GAATTCCCCCTGCTTATTCCAAAACTTTCATAGGACCGCCCCATG GTATCCAGGTTGAAAGGGACAGGTTGAACAAATATGGCCGTCCT CTACTAGGATGCACGATCAAACCAAAACTGGGTTTATCTGCTAAA AATTATGGTAGAGCCGTTTACGAA rbcL F:ATGTCACCACAAACAGAGACTAAAGC rbcL R:GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake,		
Exact Site	Pond area		
Latitude	N 22° 20' 25.6"		
Longitude	E 73° 13' 13.4"		
Elevation	114		
Photographer	Krupa Unadkat		

B

PLATE 32

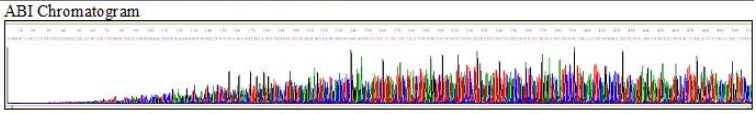
Details		Image	Sequence
Collection date	21st Nov, 2013		AAAGCAGGTGTAGGATTCAAAGCTGGTGTTAAAGATTATAAATT AACTTATTATACTCCGGAATATCAAACCAAAGATACTGATATCTT GGCAGCATTCCGAGTAACCCCACAACCTGGAGTTCCACCTGAGG AAGCAGGGGCCGCAGTAGCTGCCGAATCCTCTACTGGTACATGG ACAACCGTGTGGACTGATGGACTTACTAGCCTTGACCGTTACAA GGGGCGATGCTACCACATCGAACCTGTCATTGGAGAGGAAAATC AATATTTTTGTTATGTCGCTTATCCTTTAGACCTTTTTGAAGAAGG CTCTGTTACCAACATGTTTACTTCCATCGTAGGTAATGTATTTGGG TTTAAAGCGCTACGAGCCCTACGCTTGGAAGATTTGCGAATTCCT CCTGCTTATTCCAAAACTTTCCAAGGTCCACCTCACGGTATCCAA GTGGAAAGAGATAAATTGAACAAATATGGCCGTCCCCTATTAGG ATGTACTATTAAACCAAAATTGGGATTATCCGCGAAAAACTACG GGAGAGCGGTT rbcL F:ATGTCACCACAAACAGAGACTAAAGC rbcL R:GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake,		
Exact Site	Pond area		
Latitude	N 22° 20' 23.3"		
Longitude	E 73° 13' 12.8"		
Elevation	106		
Photographer	Krupa Unadkat		

A

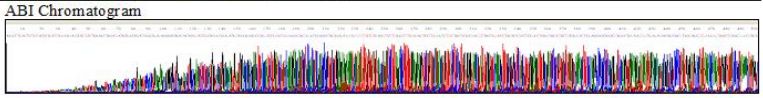
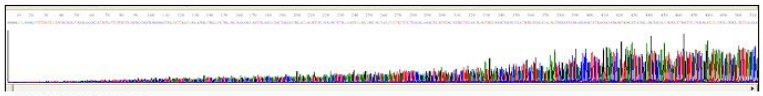
Details		Image	Sequence
Collection date	21st Nov, 2013		GCAAGTGCTGGATTCAAAGCTGGTGTTAGAGATTACAAATTGAC TTATTATACTCCTGACTATGAGACAAAAGATACTGATATCTTGGC AGCATTCCGAGTAACTCCTCAACCCGGAGTTCCGCCTGAAGAAG CAGGGGCTGCAGTAGCTGCCGAATCTTCTACTGGTACATGGACA ACTGTGTGGACTGATGGACTTACCAGTCTTGATCGTTACAAAGG ACGATGCTACCACATCGAAGCCGTTCCTGGGGAGGAAAATCAAT ATATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTC TGTTACCAACATGTTTACTTCTATTGTAGGTAATGTTTTTGGGTTT AAAGCTTTACGAGCTCTACGTCTAGAGGATTTGCGAATTCCTCCC GCTTATTCCAAAACTTTCCAAGGCCCGCCTCACGGTATCCAAGTT GAAAGAGATAAATTGAACAAGTATGGTCGTCCCCTATTGGGATG TACGATTAAACCAAAATTGGGATTATCCGCGAAAAACTACGGTA GAGCGGTTT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Sewasi lake		
Exact Site	Pond area		
Latitude	N 22° 20' 25.9"		
Longitude	E 73° 13' 13.8"		
Elevation	123		
Photographer	Krupa Unadkat		

B

PLATE 33

Details		Image	Sequence
Collection date	21st Nov, 2013		<CAAACAGAGACTAAAGCAGGTGTTGGATTTCAAGCTGGTGTTA AAGATTATAAATTGACTTACTACACCCCGGAATACGAAACCAAG GATACTGATATCTTGGCAGCATTCCGAGTAACTCCTCAGCCCGGG GTTCCGCCTGAAGAAGCAGGGGCTGCAGTAGCTGCGGAATCTTC TACTGGTACATGGACAACTGTTTGGACTGATGGACTTACCAGTCT TGATCGTTACAAAGGACGATGCTATCACATCGAACCCGTTCCTGG GGAAGACAGTCAATATATCTGTTATATAGCTTATCCATTAGATCT ATTTGAAGAGGGTTCTGTTACTAACATGTTTACTTCCATTGTGGG TAACGTATTTGGTTTCAAAGCCCTACGTGCTCTACGTTTGGAGGA TCTACGAATTCCTCCTGCTTATGCAAAAACTTTCCAAGGTCCGCCT CATGGTATCCAAGTTGAAAGGGATAAGTTGAACAAGTATGGTCG TCCTTTATTGGGATGTACTATTAAACCAAAATTGGGATTATCCGC AAAAAATTACGGT rbcL F:ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 20' 23.9"		
Longitude	E 73° 13' 10.8"		
Elevation	120		
Photographer	Krupa Unadkat		

A

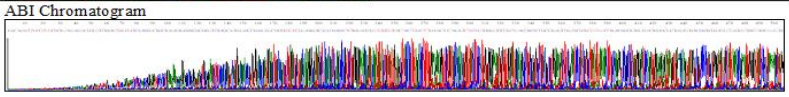
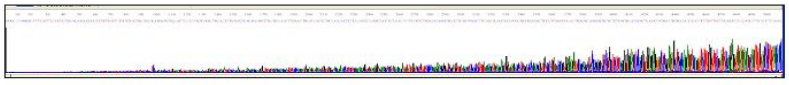
Details		Image	Sequence
Collection date	21st Nov, 2013		<ACTAAAGCAAGTGTTGGATTTAAAGCTGGTGTTAAAGATTACC GATTGACTTATTATACTCCTGAGTATGAAACCCAAGATACTGATA TCTTGGCAGCATTCCGAGTAAGTCCTCAACCTGGAGTTCCACCTG AAGAAGCGGGGGCTGCAGTAGCTGCCGAATCTTCTACTGGTACA TGGACAAGTGTATGGACCGACGGACTTACCAATCTTGATCGTTA CAAAGGACGATGCTACAACATCGAGCCCGTTGCTGGAGAAGAA AATCAATATATTTGTTATGTAGCGTATCCTTTAGACCTTTTTGAAG AAGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTAACGTATT TGGGTTCAAAGCTTTGCGTGCTCTACGTTTGGAAGATTTGCGAAT CCCTGTTGCTTATGTCAAAACTTTCCAAGGCCCGCCTCACGGTAT CCAGGTTGAAAGAGATAAATTGAACAAGTACGGTCGTCCCCTAT TGGGATGCACTATTAAACCAAAATTGGGGTTATCCGCTAAAAACT ATGGT rbcLr F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Gotri lake		
Exact Site	Pond area		
Latitude	N 22° 20' 48.4"		
Longitude	E 73° 08' 05.5"		
Elevation	116		
Photographer	Krupa Unadkat		

B

PLATE 34

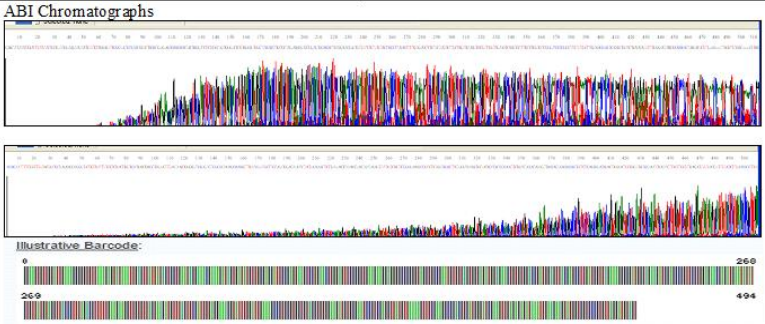
Details		Image	Sequence
Collection date	21st Nov, 2013		GCAGCATTCCGAGTAACTCCTCAGCCGGGGGTTCCGGCCGAAGA AGCAGGGGCTGCAGTAGCTGCCGAATCTTCTACTGGTACATGGA CAACTGTTTGGACTGATGGACTTACCAGTCTTGATCGTTACAAAG GACGATGCTATCACATCGAGCCCGTTGCTGGGGAGGAAAATCAA TATATCGCTTATGTAGCTTATCCATTAGACCTATTTGAAGAGGGT TCTGTTACTAACATGTTTACTTCCATTGTGGGTAACGTGTTTGGTT TCAAAGCCCTACGCGCTCTACGTCTGGAGGATCTGCGAATTCCCC CTACTTATTCAAAAACTTTCCAAGGTCCGCCTCATGGTATCCAAG TTGAAAGGGATAAGTTGAACAAGTATGGTCGTCCTTTATTGGGA TGTACTATTAAACCAAAATTGGGATTATCCGCGAAAAATTATGGT AGAGCGTGTTATGAGTGCCTA rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Collection code	BG20131121-0011		
Collector	Krupa Unadkat		
Phylum	Magnoliophyta		
Class	Eucotyledons		
Order	Asterales		
Family	Asteraceae		
Genus	Sphaeranthus		
Species	*indicus*		
Identifier	Dr. P.S. Nagar		
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs	Illustrative Barcode:	
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Gotri lake		
Exact Site	Pond area		
Latitude	N 22° 20' 49.4"		
Longitude	E 73° 08' 00.5"		
Elevation	115		
Photographer	Krupa Unadkat		

A

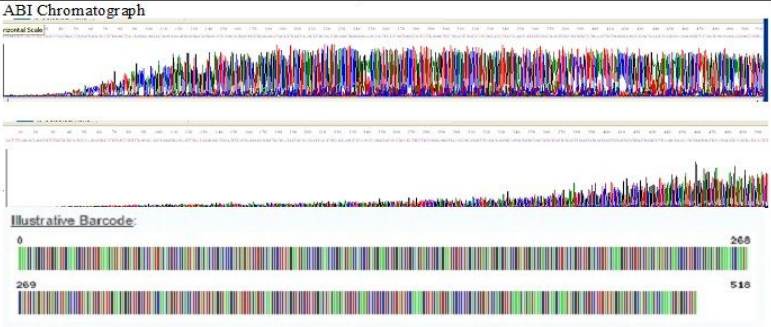
Details		Image	Sequence
Collection date	21st Nov, 2013		GCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTGAC TTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGC AGCATTCCGAGTAACTCCTCAACCGGGAGTTCCACCTGAAGAAG CAGGAGCCGCGGTAGCTGCGGAATCTTCCACCGGTACATGGACA ACCGTGTGGACCGATGGACTTACCAGTCTTGATCGTTACAAAGG GCGATGCTACAACATCGAGCCCGTTCTTGGGGAAACAGATCAAT ATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTC TGTTACCAACATGTTTACTTCCATTGTGGGAAATGTGTTTGGATT CAAAGCCTTGCGTGCTCTACGTCTGGAAGATCTTCGAATCCCTAC TGCTTATATTAAAACTTTCCAAGGTCCGCCTCATGGGATCCAAGT TGAGAGAGATAAGTTGAACAAGTATGGTCGTCCCCTGCTGGGAT GTACTATTAAACCGAAATTGGGGTTATCCGCTAAAAACTATGGT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Collection code	BG20131121-0014		
Collector	Krupa Unadkat		
Phylum	Magnoliophyta		
Class	Eucotyledons		
Order	Lamiales		
Family	Acanthaceae		
Genus	Peristrophe		
Species	*paniculata*		
Identifier	Dr. P.S. Nagar		
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs	Illustrative Barcode:	
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Sewasi lake		
Exact Site	Pond area		
Latitude	N 22° 19' 03.9"		
Longitude	E 73° 07' 13.8"		
Elevation	113		
Photographer	Krupa Unadkat		

B

PLATE 35

Details		Image	Sequence
Collection date	21st Nov, 2013		>GCAAGTGTTGGATTCAAAGCGGGTGTTAAAGAGTATAAATTGA CTTATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGG CAGCATTCCGAGTAACTCCTCAACCTGGAGTTCCGGCTGAAGAA GCAGGGGCCGCGGTAGCTGCCGAATCTTCTACTGGTACATGGAC AACTGTGTGGACCGATGGACTTACCAGCCTTGATCGTTACAAAG GGCGATGCTACAACATCGAGCCCGTTCCTGGAGAACCAGATCAA TATATCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTT CTGTTACTAACATGTTTACTTCCATTGTAGGAAACGTATTTGGATT CAAAGCCCTGCGTGCTCTACGTCTGGAAGATCTGCGAATCCCTCC AGCTTATGTTAAAACTTTCCAAGGCCCACCTCATGGGATCCAAGT TGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTAGGAT GTACT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatographs	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 11.8"		
Longitude	E 73° 06' 11.5"		
Elevation	118		
Photographer	Krupa Unadkat		

A

Details		Image	Sequence
Collection date	21st Nov, 2013		>AAAGCAGGCGTTGGATTCAAAGCTGGTGTTAAAGATTATCGAT TGACCTATTACACTCCCGATTATCAGACCTCACCCCATGATATCTT GGCAGCCTTTAGAATGACCCCGCAACCCGGAGTACCACCTGAGG AAGCTGGAGCTGCAGTAGCTGCAGAATCTTCTACAGGTACATGG ACTACCGTATGGACGGACGGACTTACCAGTCTTGACCGTTACAA AGGTCGTTGCTACGATATCGAACCCGTTCCCGGAGAGGAAAACC AATACATTGCATATGTAGCTTACCCCTTAGATCTATTTGAAGAGG GTTCTGTTACCAACATGTTCACCTCTATTGTAGGTAACGTATTTGG ATTCAAGGCTCTACGTGCTCTTCGACTAGAAGATCTTCGAATCCC TCCTGCTTATTCCAAAACTTTCATTGGACCCCCTCACGGTATCCAG GTTGAAAGAGATAAACTGAACAAATACGGACGTCCTTTATTAGG ATGTACCATCAAGCCAAAACTAGGCTTA rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatograph	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 11.5"		
Longitude	E 73° 06' 10.8"		
Elevation	119		
Photographer	Krupa Unadkat		

A

PLATE 36

Details	
Collection date	21st Nov, 2013
Identification	*Utricularia vulgaris L.*
Institution	Gujarat Biodiversity Gene Bank
Accession number	GENG382-14
Collection code	BG20131121-0018
Collector	Krupa Unadkat
Phylum	Magnoliophyta
Class	Eucotyledons
Order	Lamiales
Family	Lentibulariaceae
Genus	Utricularia
Species	*vulgaris*
Identifier	Dr. P.S. Nagar
Identifier Email	dmagar@gmail.com
Identifier Institution	MSU Baroda
Identification Method	Morphology and Barcoding
Voucher Status	Herbarium, Photographs
Country	India
State	Gujarat
Region	Vadodara
Sector	Hami lake
Exact Site	Pond area
Latitude	N 22° 19' 12.1"
Longitude	E 73° 06' 10.4"
Elevation	150
Photographer	Krupa Unadkat

A

Image

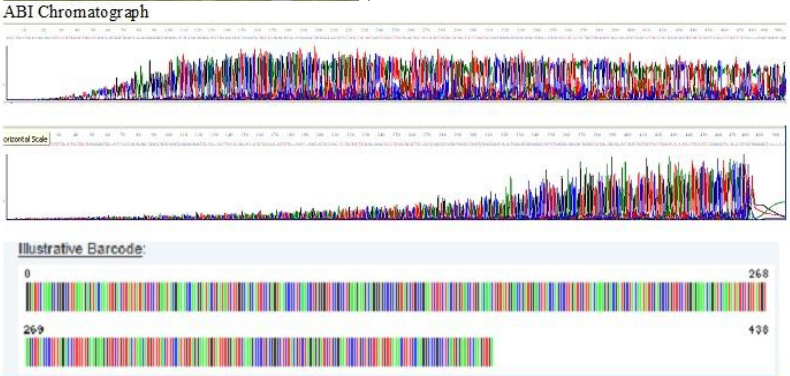
Sequence

>GGATTCAAAGCGGGCGTTAAAGAGTACAAATTGACTTATTATA
CTCCTGAATACGAAACCAAGGATACTGATATCTTGGCAGCATTCC
GAGTAACCCCTCAACCTGGGGTTCCGCCTGAAGAAGCAGGGGCC
GCGGTAGCTGCCGAATCTTCTACTGGTACCTGGACAACTGTATG
GACCGATGGACTTACCAGCCTTGATCGTTACAAAGGACGATGCT
ACAATATCGAGCCGGTTCCTGGAGAAACAGATCAATATATCTGTT
ATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAA
CATGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCT
GCGGGCTCTACGTCTAGAGGATCTGCGAATCCCTGCTGCTTATGT
TAAACTTTCCAAGGCCCGCCTCATGGAATCCAAGTTGA

rbcL F: ATGTCACCACAAACAGAGACTAAAGC

rbcL R: GTAAAATCAAGTCCACCRCG

ABI Chromatograph



Details	
Collection date	21st Nov, 2013
Identification	*Gomphrena celosioides Mart.*
Institution	Gujarat Biodiversity Gene Bank
Accession number	GENG383-14
Collection code	BG20131121-0019
Collector	Krupa Unadkat
Phylum	Magnoliophyta
Class	Liliopsida
Order	Caryophyllales
Family	Amaranthaceae
Genus	Gomphrena
Species	*celosioides*
Identifier	Dr. P.S. Nagar
Identifier Email	dmagar@gmail.com
Identifier Institution	MSU Baroda
Identification Method	Morphology and Barcoding
Voucher Status	Herbarium, Photographs
Country	India
State	Gujarat
Region	Vadodara
Sector	Hami lake
Exact Site	Pond area
Latitude	N 22° 19' 12.1"
Longitude	E 73° 06' 09.4"
Elevation	151
Photographer	Krupa Unadkat

B

Image

Sequence

>ACTAAAGCAAGTGTTGGATTTAAAGCTGGTGTTAAAGATTACA
AATTGACTTATTATACTCCGGAGTATGAAACCCTAGATACTGATA
TCTTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTCCACCCG
AAGAAGCAGGGGCTGCAGTAGCTGCCGAATCTTCTACTGGTACA
TGGACAACTGTATGGACCGACGGGCTTACCAATCTTGATCGTTAC
AAAGGACGATGCTATCATATCGAGCCCGTTGCTGGTGAAGAAAA
TCAATATATTTGTTATGTAGCGTATCCTTTAGACCTTTTTGAAGAA
GGTTCTGTTACTAACATGTTCACTTCCATTGTAGGTAACGTATTTG
GGTTCAAAGCCCTTCGTGCTCTACGTTTGGAGGATTTGCGAATCC
CTGTTGCTTATGTAAAAACTTTCCAAGGCCCACCTCACGGTATCC
AAGTTGAAAGAGATAAATTGAACAAGTATGGCCGTCCTCTATTA
GGATGCACTATTAAACCGAAATTGGGGTTATCCGCTAAAAACTA
CGGTCGAGCATGTTAT

rbcL F: ATGTCACCACAAACAGAGACTAAAGC

rbcL R: GTAAAATCAAGTCCACCRCG

ABI Chromatograph

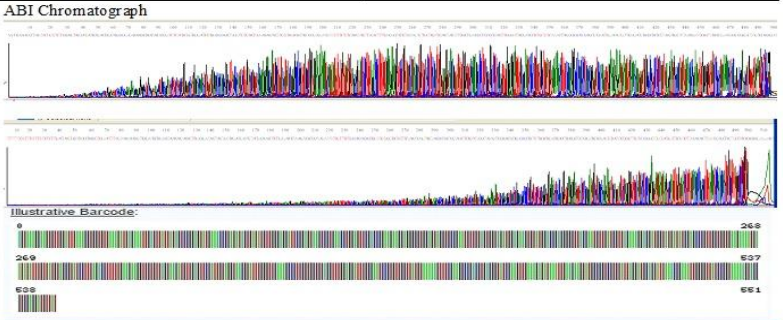


PLATE 37

Details	
Collection date	21st Nov, 2013
Identification	*Bergia ammannioides*
Institution	Gujarat Biodiversity Gene Bank
Accession number	GENG384-14
Collection code	BG20131121-0020
Collector	Krupa Unadkat
Phylum	Magnoliophyta
Class	Eucotyledons
Order	Malpighiales
Family	Elatinaceae
Genus	Bergia
Identifier	Dr. P.S. Nagar
Identifier Email	dmagar@gmail.com
Identifier Institution	MSU Baroda
Identification Method	Morphology and Barcoding
Voucher Status	Herbarium, Photographs
Country	India
State	Gujarat
Region	Vadodara
Sector	Hami lake
Exact Site	Pond area
Latitude	N 22° 19' 10.1"
Longitude	E 73° 06' 08.4"
Elevation	111
Photographer	Krupa Unadkat

Image

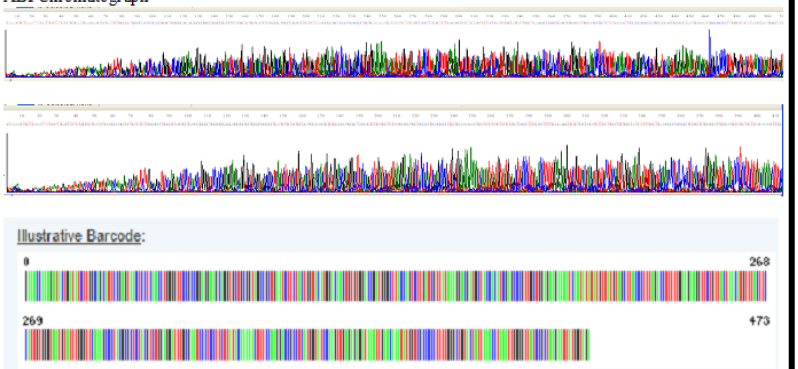
Sequence

GAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGTAACTCCT
CAACCTGGGGTTCCGCCGGAGGAAGCAGGTGCTGCGGTAGCCG
CTGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGG
CTTACCAGTCTTGATCGTTATAAAGGACGATGCTACCACATCGAG
CCCGTTGCTGGAGAAGAAAATCAATATATATGTTATGTAGCTTAC
CCTTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTACTT
CCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTACGCGCTCTAC
GTCTGGAGGATTTGCGAATCCCTCCTTCTTATACAAAAACTTTCC
AAGGACCGCCTCATGGTATCCAAGTTGAGAGAGATAAATTGAAC
AAATATGGTCGCCCCCTTTTGGGCTGTACTATTAAACCTAAATTG
GGGTTATCCGCTAAGAATTATGGTAGA

rbcL F: ATGTCACCACAAACAGAGACTAAAGC

rbcL R: GTAAAATCAAGTCCACCRCG

ABI Chromatograph



A

Details	
Collection date	21st Nov, 2013
Identification	*cressa cretica L.*
Institution	Gujarat Biodiversity Gene Bank
Accession number	GENG385-14
Collection code	BG20131121-0021
Collector	Krupa Unadkat
Phylum	Magnoliophyta
Class	Eucotyledons
Order	Solanales
Family	Convolvulaceae
Genus	Cressa
Species	*cretica*
Identifier	Dr. P.S. Nagar
Identifier Email	dmagar@gmail.com
Identifier Institution	MSU Baroda
Identification Method	Morphology and Barcoding
Voucher Status	Herbarium, Photographs
Country	India
State	Gujarat
Region	Vadodara
Sector	Hami lake
Exact Site	Pond area
Latitude	N 22° 19' 10.3"
Longitude	E 73° 06' 09.9"
Elevation	111
Photographer	Krupa Unadkat

Image

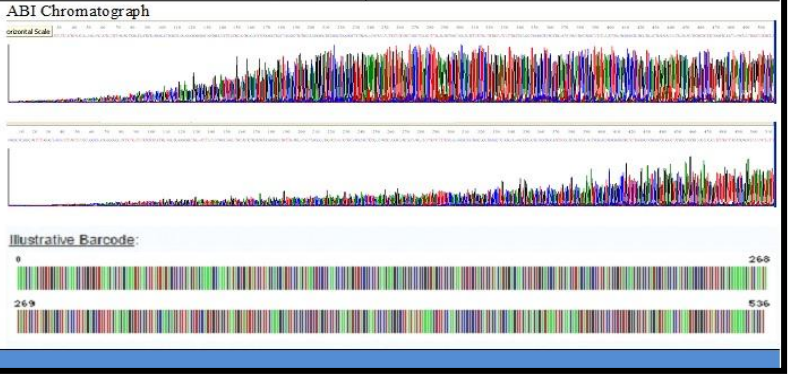
Sequence

>AAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGACTACAAAT
TAACTTATTATACTCCTGAGTACAAAACCAAAGATACTGATATCTT
AGCAGCATTCCGAGTAACTCCTCAACCCGGAGTTCCGCCTGAAG
AAGCAGGGGCCGCGGTAGCTGCGGAATCTTCTACTGGTACATGG
ACAACTGTGTGGACCGATGGACTTACCAGCCTTGATCGGTACAA
GGGGCGATGCTACCGCATCGAGCGCGTTGTTGGAGAAAAAGAT
CAATATATTGCTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAG
GTTCGGTTACCAACATGTTTACTTCCATTGTGGGTAATGTATTTG
GGTTCAAAGCATTGCGCGCTCTACGTCTGGAAGATCTACGAATC
CCTACGGCTTATATTAAAACTTTCCAAGGCCCGCCTCATGGCATC
CAAGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCTCTGTT
GGGGTGTACGATTAAACCTAAATTGGGGGTTATCTGCTAAAAACT
ACGGT

Primer F: ATGTCACCACAAACAGAGACTAAAGC

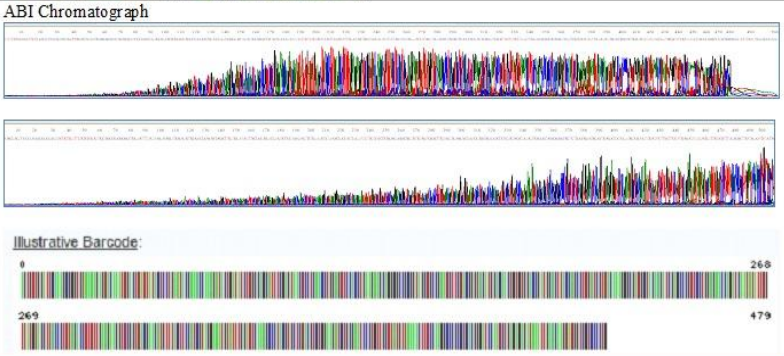
Primer R : GTAAAATCAAGTCCACCRCG

ABI Chromatograph

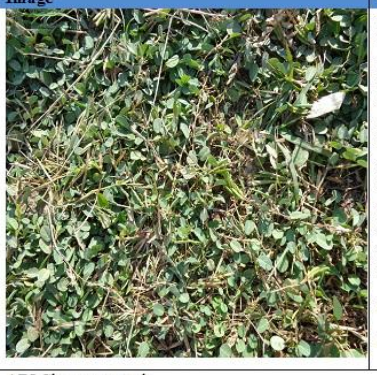
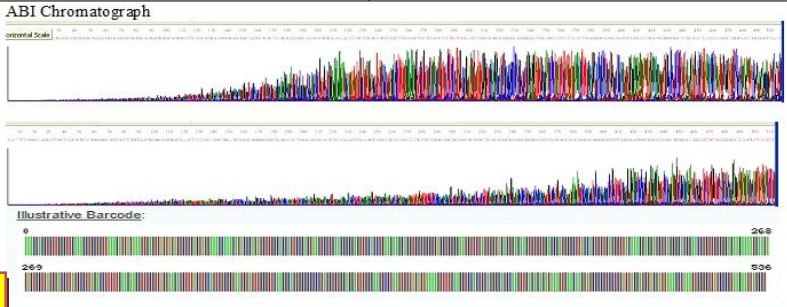


B

PLATE 38

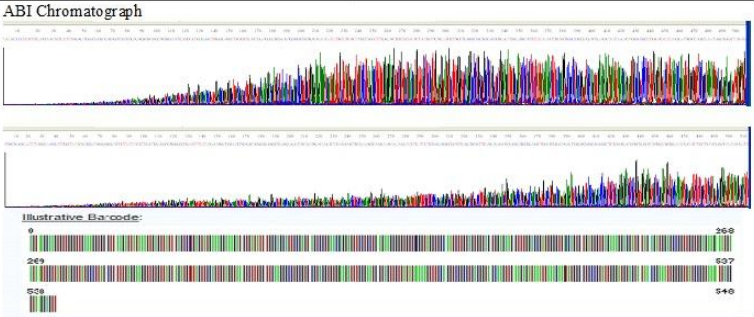
Details		Image	Sequence
Collection date	21st Nov, 2013		>AGTGTTGGATTCAAAGCGGGTGTAAAAGAGTACAAATTGACTT ATTATACTCCTGAATACGAAACCAAAGATACTGATATCTTGGCAG CATTTCGAGTAACTCCTCAACCTGGAGTTCCACCTGAAGAAGCAG GGGCCGCGGTAGCTGCCGAATCTTCTACGGGTACATGGACAACT GTGTGGACCGATGGACTTACCAGCCTTGATCGTTACAAAGGGCG ATGCTACAACATCGAGCCCGTTCCTGGAGAACCAGATCAATATAT TTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCGGTT ACGAACATGTTTACTTCCATCGTAGGAAATGTATTTGGATTCAAA GCCCTACGTGCTCTACGTCTGGAAGATCTGCGAATCCCTGTTGCT TATGTTAAAACTTTCCAAGGCCCGCCTCACGGGATCCAATCTGAG AGAGATAAATTGAACAAGTATGGTCGTCCCCTG Primer F: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatograph	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 11.1"		
Longitude	E 73° 06' 09.7"		
Elevation	120		
Photographer	Krupa Unadkat		

A

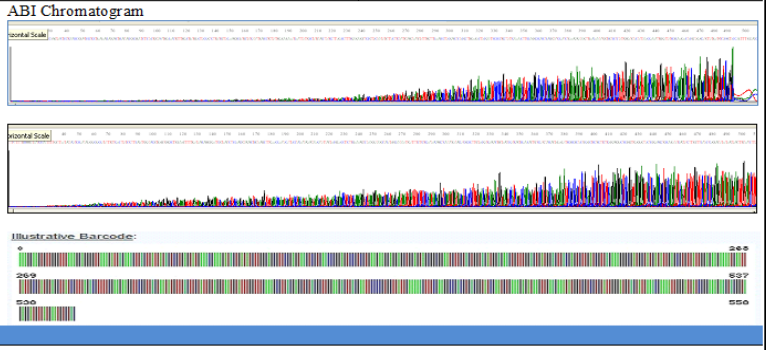
Details		Image	Sequence
Collection date	21st Nov, 2013		>AAAGCACGTGTTGGGTTCAAAGCTGGTGTTAAAGATTATAAAT TGACTTATTATACTCCTGAGTATGAAACCAAAGATACCGATATCT TGGCAGCATTCCGAGTAACTCCTCAACCGGGAGTTCCACCTGAA GAAGCAGGTGCTGCGGTAGCTGCGGAATCTTCTACTGGTACATG GACAACTGTGTGGACCGATGGGCTTACCAGTCTTGATCGTTACA AAGGACGATGCTACGGCATCGAACCTGTTGCTGGAGAAGAAAAT CAATATATTGCTTATGTAGCTTATCCGTTAGACCTTTTTGAAGAA GGTTCTGTTACTAACATGTTTACTTCCATTGTCGGTAATGTATTTG GGTTCAAGGCACTGCGCGCCCTACGTCTGGAGGATTTGCGAATC CCTAATTCTTATATTAAAACTTTTCAAGGTCCACCTCATGGCATCC AAGTTGAGAGAGATAAATTGAACAAGTATGGCCGTCCTCTATTA GGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAGAATTAC GGT Primer F: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatograph	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 12.1"		
Longitude	E 73° 06' 09.5"		
Elevation	123		
Photographer	Krupa Unadkat		

B

PLATE 39

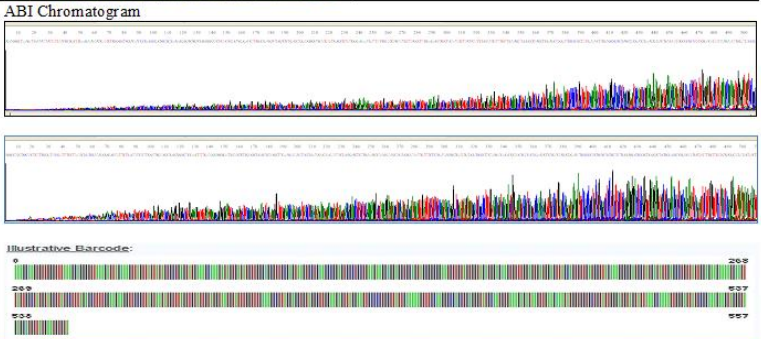
Details		Image	Sequence
Collection date	21st Nov, 2013		>ACTAAAGCAAGTGTTGGGTTCAAAGCTGGTGTTAAAGATTATA AATTGACTTATTATACTCCTGACTATGAAACGAAAGATACTGATA TTTTGGCAGCATTCCGAGTAACTCCTCAACCAGGAGTTCCTCCTG AAGAAGCGGGTGCTGCGGTAGCTGCCGAATCTTCTACTGGTACA TGGACAACCGTTTGGACCGATGGGCTTACCAGTCTTGATCGTTAC AAAGGACGATGCTACAACATCGAGCCCGTTGCTGGAGAAGAAA ATCAATATATTGCTTATGTAGCTTATCCCTTAGACCTTTTTGAGGA AGGTTCTGTTACTAACATGTTTACTTCCATTGTAGGTAATGTCTTT GGGTTCAAGGCCCTGCGTGCCCTACGTCTGGAAGATTTGCGAAT CCCTACTTCTTATATAAAAACTTTCCAAGGTCCGCCTCACGGTATC CAAGTTGAAAGAGATAAATTAAACAAGTATGGCCGTCCCCTATT GGGATGTACTATTAAACCGAAATTGGGGTTATCCGCTAAAAATT ACGGTAGAGCAGTT Primer F:ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatograph	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 09.1"		
Longitude	E 73° 06' 10.4"		
Elevation	99		
Photographer	Krupa Unadkat		

A

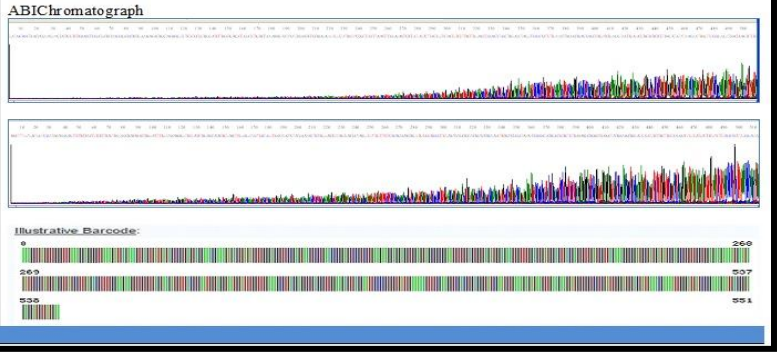
Details		Image	Sequence
Collection date	21st Nov, 2013		>AAAGCAAGTGTTGGGTTTAAAGCAGGGGTTAAAGATTACAAAC TTACTTATTATACTCCTGAGTATGAAACCAAAGATACTGATATCTT GGCAGCGTTCCGAGTAACTCCTCAACCCGGAGTCCCTCCTGAAG AAGCAGGAGCTGCAGTAGCGGCGGAATCTTCTACTGGTACATGG ACAACTGTTTGGACTGATGGACTTACCAGTCTTGATCGTTACAAA GGGCGATGCTATCATATTGAGCCTGTTATTGGAGAAGAAAATCA ATTTATTGCCTATGTAGCTTATCCTTTAGACCTTTTCGAAGAAGGT TCCGTTACTAATATGTTTACTTCTATTGTAGGTAATGTATTTGGTT TCAAAGCCTTACGAGCTCTACGCTTGGAAGACTTACGAATTCCCC CTGCTTATTCAAAAACTTTCCAAGGCCCACCTCACGGTATCCAAT CTGAAAGAGATAAGTTGAACAAATATGGTCGTCCTCTATTGGGA TGTACTATTAAACCAAAATTGGGATTATCCGCAAAGAACTACGGT AGAGCATGTTATGAATGTCTAC Primer F: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	Morphology and Barcoding	ABI Chromatogram	
Identifier Institution	Herbarium, Photographs		
Identification Method	India		
Voucher Status	Gujarat		
Country	Vadodara		
State	Hami lake		
Region	Pond area		
Sector	N 22° 19' 10.1"		
Exact Site	E 73° 06' 09.4"		
Latitude	122		
Longitude	Krupa Unadkat		
Elevation	122		
Photographer	Krupa Unadkat		

B

PLATE 40

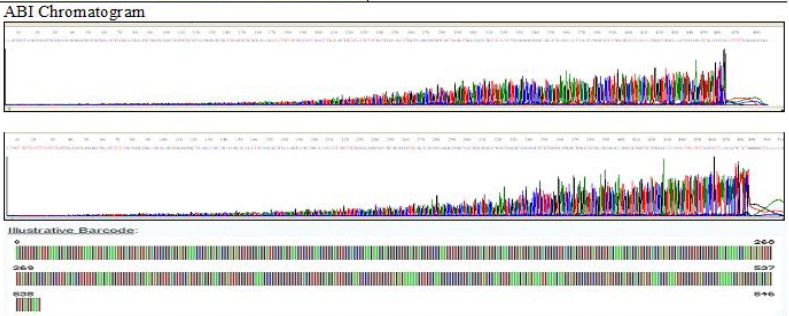
Details		Image	Sequence
Collection date	21st Nov, 2013		>AAAGCAAGTGTTGGGTTTAAAGCAGGGGTTAAAGATTACAAAC TTACTTATTATACTCCTGAGTATGAAACCAAAGATACTGATATCTT GGCAGCGTTCCGAGTAACTCCTCAACCCGGAGTCCCTCCTGAAG AAGCAGGAGCTGCAGTAGCGGCGGAATCTTCTACTGGTACATGG ACAACTGTTTGGACTGATGGACTTACCAGTCTTGATCGTTACAAA GGGCGATGCTATCATATTGAGCCTGTTATTGGAGAAGAAAATCA ATTTATTGCCTATGTAGCTTATCCTTTAGACCTTTTCGAAGAAGGT TCCGTTACTAATATGTTTACTTCTATTGTAGGTAATGTATTTGGTT TCAAAGCCTTACGAGCTCTACGCTTGGAAGACTTACGAATTCCCC CTGCTTATTCAAAAACTTTCCAAGGCCCACCTCACGGTATCCAAT CTGAAAGAGATAAGTTGAACAAATATGGTCGTCCTCTATTGGGA TGTACTATTAAACCAAAATTGGGATTATCCGCAAAGAACTACGGT AGAGCATGTTATGAATGTCTA Primer F: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 09.2"		
Longitude	E 73° 06' 10.4"		
Elevation	101		
Photographer	Krupa Unadkat		

A

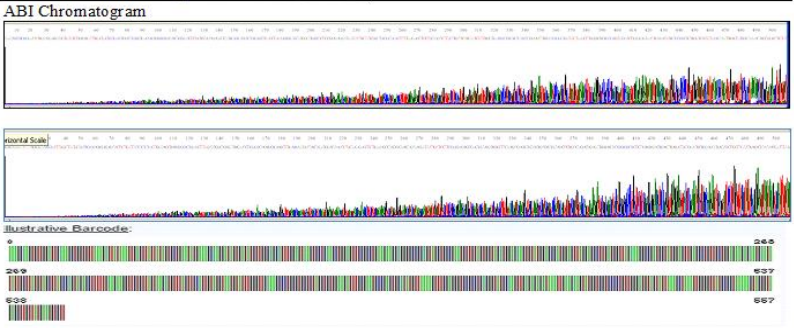
Details		Image	Sequence
Collection date	21st Nov, 2013		>AAAGCTTATGTTGGGTTTAAAGCAGGGGTTAAAGATTACAAAC TTACTTATTATACTCCTGAGTACGAAACCAAAGATACTGATATCTT GGCAGCGTTCCGAGTAACTCCTCAACCCGGAGTCCCTCCTGAAG AAGCAGGAGCTGCAGTAGCGGCGGAATCTTCTACTGGTACATGG ACAACTGTTTGGACTGATGGACTTACCAGTCTTGATCGTTACAAA GGGCGATGCTATCATATCGAGCCTGTTGCTGGAGAAGAAAATCA ATATATTGCCTATGTAGCTTATCCTTTAGACCTTTTCGAAGAAGGT TCTGTTACTAACATGTTTACCTCAATTGTAGGTAATGTATTTGGTT TCAAAGCCTTACGAGCTCTACGCTTGGAAGACTTACGAATTCCCC CTGCTTATTCAAAAACTTTCCAAGGTCCACCTCACGGTATCCAATC TGAAAGAGATAAGTTGAACAAGTATGGTCGTCCTCTATTGGGAT GTACTATTAAACCAAAATTGGGATTATCCGCAAAGAATTACGGTA GAGCATGTTATGAA Primer F: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABIChromatograph	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 12.1"		
Longitude	E 73° 06' 11.4"		
Elevation	104		
Photographer	Krupa Unadkat		

B

PLATE 41

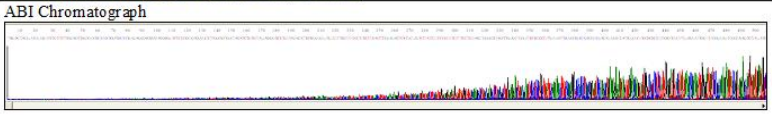
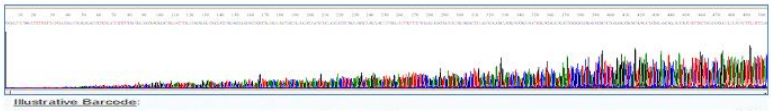
Details		Image	Sequence
Collection date	21st Nov, 2013		>AGTGTTGGATTTAAAGCAGGTGTTAAAGATTACAAATTGACTTA TTATACTCCGGAGTATGAAACCCTAGATACCGATATCTTGGCAGC ATTCCGAGTAACTCCTCAACCTGGAGTTCCACCCGAAGAAGCAG GGGCTGCAGTAGCTGCCGAATCTTCTACTGGTACATGGACAACT GTATGGACTGACGGGCTTACCAGTCTTGATCGTTACAAAGGACG ATGCTACCATATCGAGCCTGTTGCTGGTGAAGAAAACCAATATAT TTGTTATGTAGCCTATCCTTTAGACCTTTTTGAAGAAGGTTCTGTT ACTAATATGTTTACTTCCATTGTAGGTAACGTATTTGGGTTCAAA GCCCTGCGTGCTCTACGTTTGGAGGATTTGCGAATCCCTGTTGCT TATATAAAAACTTTCCAAGGCCCGCCTCACGGTATCCAAGTTGAA AGAGATAAATTAAACAAGTATGGCCGTCCTCTATTGGGATGCAC TATTAAACCTAAATTGGGGTTATCCGCTAAAAACTATGGTCGAGC ATGTTATGAAT PrimerF: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 10.1"		
Longitude	E 73° 06' 09.4"		
Elevation	116		
Photographer	Krupa Unadkat		

A

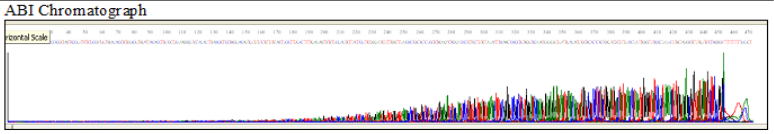
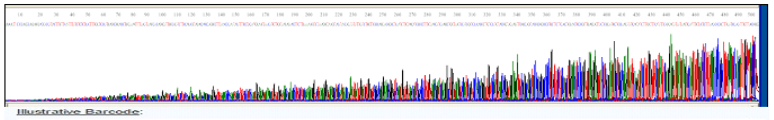
Details		Image	Sequence
Collection date	21st Nov, 2013		>AAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGATTATAAAT TGACTTATTATACTCCTGAATATGAAACCAAGGATACTGATATCT TGGCAGCATTTCGAGTAACTCCTCAACCTGGAGTTCCGCCTGAAG AAGCAGGGGCCGCAGTAGCTGCCGAATCTTCTACTGGTACATGG ACAACTGTATGGACCGATGGACTTACGAGCCTTGATCGTTACAA AGGCCGATGCTATGGACTTGAGCCTGTTCCTGGAGAAGACAATC AATATATTGCTTATGTAGCTTACCCACTAGACCTTTTTGAAGAAG GTTCTGTTACTAACATGTTTACTTCCATTGTAGGTAATGTATTTGG GTTCAAAGCCCTGCGTGCTCTACGTCTGGAAGATTTGCGAATCCC GACTGCATATGTTAAAACTTTCGAGGGTCCGCCTCACGGTATCCA AGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTGG GATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACG GTAGAGCTTGTTATGAATGTCTT Primer F: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 10.1"		
Longitude	E 73° 06' 09.4"		
Elevation	113		
Photographer	Krupa Unadkat		

B

PLATE 42

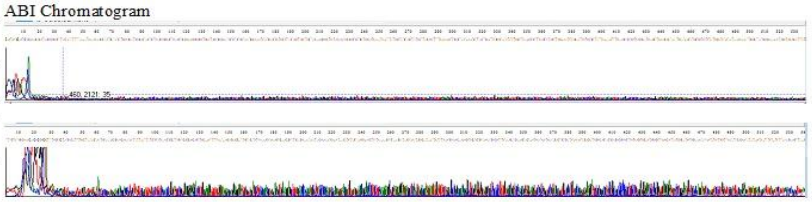
Details		Image	Sequence
Collection date	21st Nov, 2013		>AAAGCTAATGTTGGGTTTAAAGCAGGGGTTAAAGATTACAAAC TTACTTATTATACTCCTGAGTACGAAACCAAAGATACTGATATCTT GGCAGCGTTCCGAGTAACTCCTCAACCTGGAGTCCCTCCTGAAG AAGCAGGAGCTGCAGTAGCGGCGGAATCTTCTACTGGTACATGG ACAACTGTTTGGACTGATGGACTTACCAGTCTTGATCGTTACAAA GGGCGATGCTATCATATCGAACCTGTTGCTGGAGAAGAAAATCA ATATATTGCCTATATAGCTTATCCTTTAGACCTTTTCGAAGAAGGT TCTGTTACTAACATGTTTACTTCTATTGTAGGTAATGTATTTGGTT TCAAAGCCTTACGAGCTCTACGCTTGGAAGACTTACGAATTCCTC CTGCTTATTCAAAAACTTTCCAAGGTCCACCTCACGGTATCCAAG CTGAAAGAGATAAGTTGAACAAGTATGGTCGTCCTCTATTGGGA TGTACTATTAAACCAAAATTGGGATTATCCGCAAAGAATTACGGT AGAGCATGTTATGAATGTCTAC Primer F: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatograph	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 10.1"		
Longitude	E 73° 06' 09.7"		
Elevation	114		
Photographer	Krupa Unadkat		

A

Details		Image	Sequence
Collection date	21st Nov, 2013		>GTTGGATTCAAAGCGGGTGTTAAAGAGTACAAATTGACTTATT ATACTCCTGAATATGAAACCAAAGATACTGATATCTTGGCAGCAT TCCGAGTAACTCCTCAACCGGGAGTTCCAGCTGAAGAAGCAGGG GCCGCGGTAGCTGCCGAATCTTCTACCGGTACATGGACAACCGT GTGGACCGATGGACTTACCAGCCTTGATCGTTACAAAGGGCGAT GCTACAACATTGAGCCCGTTCCTGGCGAACCAGATCAATATATCT GTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTAC CAACATGTTTACTTCCATTGTAGGAAATGTATTTGGGTTTAAAGC CCTGCGTGCTCTACGTCTGGAAGATCTGCGAATCCCTGTTGCTTA TGTTAAAACTTTCCAGGGTCCGCCTCATGGGATCCAAAGTGAGA GAGATAAATTGAACAAGTATGGTCGTCCTCTGCTGGGATGTACT ATTAAACCTAAATTGGGGTTATCCGCTAAAAACTATGGTAGAGC GTGTTATGAATGTCTT Primer F: ATGTCACCACAAACAGAGACTAAAGC Primer R: GTAAAATCAAGTCCACCRCG
Identifier Email	dmagar@gmail.com	ABI Chromatograph	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Hami lake		
Exact Site	Pond area		
Latitude	N 22° 19' 10.1"		
Longitude	E 73° 06' 09.4"		
Elevation	116		
Photographer	Krupa Unadkat		

B

PLATE 43

Details		Image	Sequence
Collection date	3rd Feb, 2014		>GTTAAAGATTACAAATTGACTTATTATACTCCTGAATATG AAACCAAGGATACTGATATCTTGGCAGCATTCCGAGTAAC TCCTCAACCCGGAGTTCCACCTGAGGAAGCGGGGGCTGCA GTAGCTGCCGAATCCTCTACTGGTACATGGACAACTGTAT GGACTGATGGACTTACTAGCTTGGATCGTTACAAAGGGCG ATGCTACCACATCGAGCCTGTTGCTGGCACTGAAAATCAAT TTATTGCCTATGTAGCTTATCCTTTAGACCTTTTTGAAGAAG GTTCCGTTACTAACATGTTTACTTCGATTGTGGGTAATGTA TTTGGGTTCAAAGCTCTTTCAGCTCTACGTTTGGAAGATCT ACGAATTCCTCCTGCTTATTCAAAAACTTTCCAAGGTCCTCC TCACGGAATCCAGGTTGAGAGAGATAAATTGAATAAGTAT GGTCGTCCTCTATTGGGATGTACTATTAAACCAAAATTGGG ATTATCCGCGAAAAACTACGGTAGAGCAGTTTATGAATGT CTA rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Mahisagar river, Baroda		
Exact Site	Pond area		
Latitude	N 22° 26' 00.1"		
Longitude	E 73° 04' 19.9"		
Elevation	93		
Photographer	Krupa Unadkat		

A

Details		Image	Sequence
Collection date	3rd Feb, 2014		>TTATGTCACCACAAACAGAGACTAAAGCAAGTGCTGGATTTAA AGCTGGTGTTAAAGATTACAAATTGACTTATTATACTCCTGAATA TGAAACCAAGGATACTGATATCTTGGCAGCATTCCGAGTAACTCC TCAACCCGGAGTTCCACCTGAGGAAGCGGGGGCTGCAGTAGCT GCCGAATCCTCTACTGGTACATGGACAACTGTATGGACTGATGG ACTTACTAGCTTGGATCGTTACAAAGGGCGATGCTACCACATCG AGCCTGTTGCTGGCACTGAAAATCAATTTATTGCCTATGTAGCTT ATCCTTTAGACCTTTTTGAAGAAGGTTCCGTTACTAACATGTTTAC TTCGATTGTGGGTAATGTATTTGGGTTCAAAGCTCTTTCAGCTCT ACGTTTGGAAGATCTACGAATTCCTCCTGCTTATTCAAAAACTTTC CAAGGTCCTCCTCACGGAATCCAGGTTGAGAGAGATAAATGGAA TAAGTATGGTCGTCCTCTATTGGGATGTACTATTAAACCAAAATT GGGATTATCCGCGAAAAACTACGGGAGAGAAGTTTATGAATGTC TACGCGGGGGACTTGATTTTAC rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R :GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 18' 21.7"		
Longitude	E 73° 16' 37.5"		
Elevation	97		
Photographer	Krupa Unadkat		

B

PLATE 44

Details	
Collection date	3rd Feb, 2014
Identification	*Abutilon indicum*
Institution	Gujarat Biodiversity Gene Bank
Accession number	GENG464-14
Collection code	BG20140203-0010
Collector	Krupa Unadkat
Phylum	Magniliophyta
Class	Eucotyledons
Order	Malvales
Family	Malvaceae
Genus	Abutilon
Species	*indicum*
Identifier	Dr. P.S. Nagar
Identifier Email	drnagar@gmail.com
Identifier Institution	MSU Baroda
Identification Method	Morphology and Barcoding
Voucher Status	Herbarium, Photographs
Country	India
State	Gujarat
Region	Vadodara
Sector	Mahisagar river
Exact Site	Near River
Latitude	N 22° 26' 13.6"
Longitude	E 73° 04' 32.8"
Elevation	96
Photographer	Krupa Unadkat

A

Image

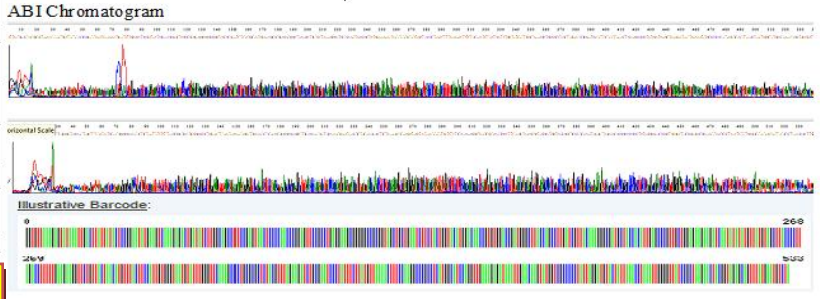
Sequence

>GGTGTTAAAGAGTATAAATTGACTTATTATACTCCGGAATA
TGAAGTCAAAGAGACTGATATCTTGGCAGCCTTCCGAGTAAC
TCCCCAACCCGGAGTTCCGCCTGAGGAAGCGGGGGCCGCGG
TAGCTGCTGAATCTTCTACTGGTACATGGACAACCGTGTGGA
CCGATGGGCTTACCAGCCTTGATCGTTACAAAGGGCGATGCT
ACCACATTGAGCCCGTTGCTGGAGAAGAAGATCAATATATAT
GTTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGT
TACTAACATGTTTACTTCCATTGTGGGTAATGTATTTGGGTTC
AAAGCCCTGCGCGCTCTACGTTTAGAAGATCTGCGAATCCCT
ATTTCTTATGTTAAAACTTTCCAAGGCCCGCCTCATGGCATCC
AGGTTGAAAGAGATAAATTGAACAAGTATGGTCGCCCCCTA
TTAGGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAG
AACTACGGTAGAGCAGTTTATGAATGTCTA

rbcL F: ATGTCACCACAAACAGAGACTAAAGC

rbcL R: GTAAAATCAAGTCCACCRCG

ABI Chromatogram



Details	
Collection date	3rd Feb, 2014
Identification	*Croton aequatoris*
Institution	Gujarat Biodiversity Gene Bank
Accession number	GENG465-14
Collection code	BG20140203-0011
Collector	Krupa Unadkat
Phylum	Magniliophyta
Class	Eucotyledons
Order	Malpighiales
Family	Euphorbiaceae
Genus	*Croton*
Species	*abaitensis*
Identifier	Dr. P.S. Nagar
Identifier Email	drnagar@gmail.com
Identifier Institution	MSU Baroda
Identification Method	Morphology and Barcoding
Voucher Status	Herbarium, Photographs
Country	India
State	Gujarat
Region	Vadodara
Sector	Timbi village pond
Exact Site	Pond area
Latitude	N 22° 26' 13.7"
Longitude	E 73° 04' 32.6"
Elevation	95
Photographer	Krupa Unadkat

B

Image

Sequence

>GGATTCAAGGCTGGTGTTAAAGATTATAAATTGACT
TATTATACTCCTGAGTATCAAACAAAAGATACTGATAT
CTTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTT
CCACCTGAGGAAGCAGGAGCCGCGGTAGCAGCTGAA
TCTTCTACTGGTACATGGACAACTGTGTGGACCGACG
GGCTTACCAGTCTTGATCGTTATAAAGGGCGATGCTA
CGACATCGAGCCCGTTGCTGGAGAAGAAAATCAATAT
ATTGCTTATGTAGCTTACCCCTTAGACCTTTTTGAAGA
AGGTTCTGTTACTAACATGTTTACTTCCATTGTGGGTA
ATGTATTTGGGTTCAAAGCCCTACGTGCCCTACGTCTG
GAGGATTTGCGAATCCCTCCTGCTTATACTAAAACTTT
CCAAGGGCCGCCTCATGGTATCCAAGTTGAGAGAGA
TAAATTGAACAAGTATGGTCGCCCCCTATTAGGTTGT
ACTATTAAACCTAAATTAGGGCTATCCGCTAAGAATT
A

TrbcL F: ATGTCACCACAAACAGAGACTAAAGC

rbcL R: GTAAAATCAAGTCCACCRCG

ABI Chromatogram

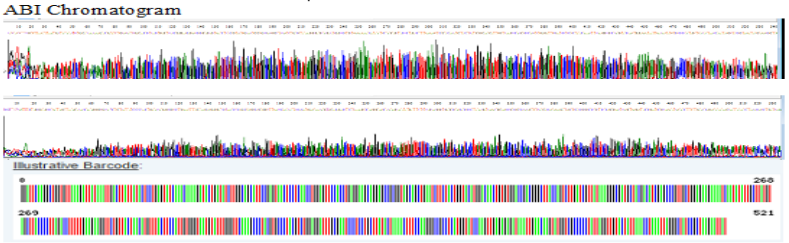
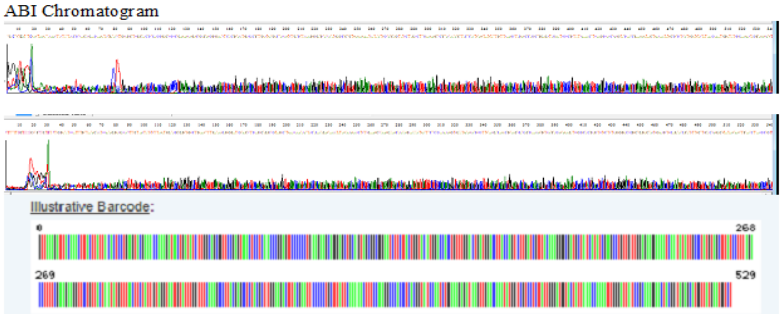


PLATE 45

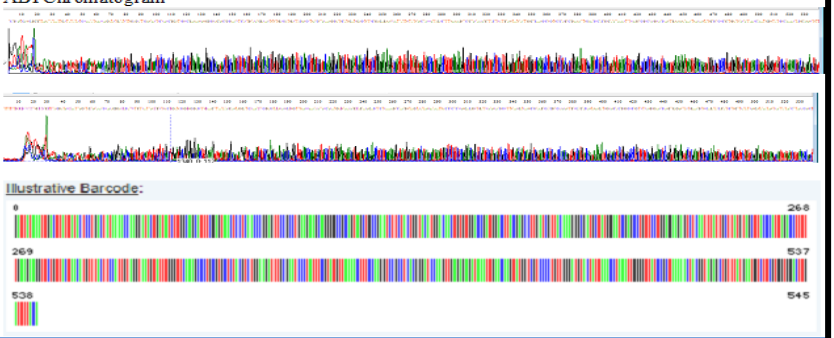
Details		Image	Sequence
Collection date	3rd Feb, 2014		GAAACCAAGGATACTGATATCTTGGCAGCATTCCGAGTAACTC CTCAACCCGGAGTTCCGCCTGAAGAAGCAGGGGCAGCGGTAG CTGCCGAATCTTCCACTGGTACATGGACAACCGTGTGGACCGA TGGACTTACCAGCCTTGATCGTTACAAAGGGCGATGCTACAAC ATCGAGCCCGTTGCTGGCGAAACAGATCAATATATCTGTTATG TAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACCAAC ATGTTTACTTCCATTGTAGGAAATGTATTTGGATTCAAAGCCCT GCGTGCTCTACGTCTGGAAGATCTGCGAATCCCTACTGCTTATG TTAAAACTTTCCAAGGTCCGCCTCATGGGATCCAAGTTGAGAG AGATAAATTGAACAAATATGGTCGTCCTCTGCTGGGATGTACT ATTAAACCTAAATTGGGGTTATCCGCTAAAAACTATGGTAGAG CATGT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country State	India Gujarat		
Region	Vadodara		
Sector Exact Site	Mahi river Pond area		
Latitude	N 22° 26' 13.5"		
Longitude	E 73° 04' 32.4"		
Elevation	94		
Photographer	Krupa Unadkat	A	

Details		Image	Sequence
Collection date Identification	3rd Feb, 2014 *Persicaria glabra*		>GTTAAAGAGTATAAATTGAATTATTATACTCCTGACTAT GAACCCCACGCACATGATATCTTGGCAGCATTTCGAGTA ACTCCTCAACCTGGAGTTCCACCAGAAGAAGCAGGGGC CGCGGTAGCTGCCGAATCTTCTACTGGTACATGGACAAC TGTGTGGACCGATGGACTTACCAGCCTTGATCGTTACAA AGGACGATGCTACGGCATCGAGCCTGTTGCTGGAGAAG AAAATCAATATATTGCTTATGTAGCTTACCCATTAGACCT TTTTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATT GTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTGCTCTA CGTTTGGAGGATTTGCGAATCCCTCCTGCTTATACGAAA ACTTTCCAAGGCCCACCTCACGGTATCCAAGTTGAGAGA GACAAATTAAACAAATACGGACGTCCCCTATTGGGATGT ACTATTAAACCTAAATTGGGATTGTCCGCTAAGAACTAC GGTCGAGCAGTTTATGAATGTCTT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State Region	Gujarat Vadodara		
Sector	Mahisagar river		
Exact Site Latitude	River area N 22° 26' 12.8"		
Longitude	E 73° 04' 32.7"		
Elevation	98		
Photographer	Krupa Unadkat	B	

PLATE 46

Details		Image	Sequence
Collection date	3rd Feb, 2014		>GTTAAAGATTACAAACTTACTTATTACACTCCTGAGTACGAA ACCAAAGATACTGATATCTTGGCAGCGTTCCGAGTAACTCCTC AACCCGGAGTCCCCCCTGAAGAAGCAGGAGCTGCAGTAGCG GCGGAATCTTCTACTGGTACATGGACCACTGTTTGGACTGATG GACTTACCAGTCTTGATCGTTACAAAGGGCGATGCTATCATAT CGAGCCTGTTGTTGGAGAAGAAAATCAATATATTGCCTATGT AGCTTATCCTTTAGACCTTTTCGAAGAAGGTTCTGTTACTAATA TGTTTACTTCTATTGTAGGTAATGTATTTGGTTTCAAAGCCTTA CGAGCTCTACGCTTGGAAGACTTACGAATTCCCCCTGCTTATT CAAAAACTTTCCAAGGCCCACCTCACGGTATCCAATCTGAAAG AGATAAGTTGAACAAATATGGTCGTCCTCTATTGGGATGTACT ATTAAACCAAAATTGGGATTATCCGCAAAGAACTACGGTAGA GCATGTTATGAATGTCT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identification	*Eleocharis atropurpurea*		
Institution	Gujarat Biodiversity Gene Bank		
Accession number	GENG468-14		
Collection code	BG20140203-017		
Collector	Krupa Unadkat		
Phylum	Magniliophyta		
Class	Liliopsida		
Order	Poales		
Family	Cypraceae		
Genus	*Eleocharis*		
Species	*atropurpurea*		
Identifier	Dr. P.S. Nagar		
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village		
Exact Site	Pond area		
Latitude	N 22° 18' 21.7"		
Longitude	E 73° 16' 37.5"		
Elevation	97		
Photographer	Krupa Unadkat		

A

Details		Image	Sequence
Collection date	3rd Feb, 2014		>GTTAAAGATTATAAATTGACTTATTATACTCCTGAATATGAAACCAAG GATACTGATATCTTGGCAGCATTTCGAGTAACTCCTCAACCTGGAGTTC CGCCTGAAGAAGCAGGGGCCGCAGTAGCTGCCGAATCTTCTACTGGTA CATGGACAACTGTGTGGACCGATGGACTTACGAGCCTTGATCGTTACA AAGGGCGATGCTATGGAATCGAGCCTGTTCCTGGAGAAGAGAGTCAAT TTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTT ACTAACATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCT GCGTGCTCTACGTCTGGAAGATTTGCGAATCCCTACTGCGTATATTAAA ACTTTCCAAGGTCCGCCTCACGGCATCCAAGTTGAGAGAGATAAATTG AACAAGTATGGTCGTCCCCTGTTGGGATGTACTATTAAACCTAAATTGG GGTTATCCGCTAAAAACTACGGTAGAGCTGTTTATGAATGTCTTC rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identification	*Blumea Sp.*		
Institution	Gujarat Biodiversity Gene Bank		
Accession number	GENG469-14		
Collection code	BG20140203-023		
Collector	Krupa Unadkat		
Phylum	Magniliophyta		
Class	Eucotyledons		
Order	Asterales		
Family	Asteraceae		
Genus	Blumea		
Species	*Sp.*		
Identifier	Dr. P.S. Nagar		
Identifier Email	dmagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 18' 21.8"		
Longitude	E 73° 16' 37.5"		
Elevation	97		
Photographer	Krupa Unadkat		

B

PLATE 47

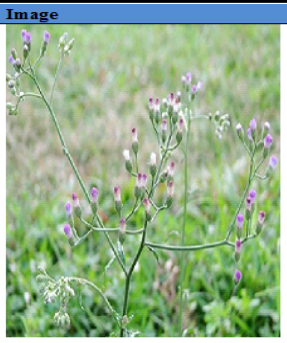
Details		Image	Sequence
Collection date	3rd Feb, 2014		>GATTATAAATTGACTTATTATACTCCTGAATATGAAACCAAGGATACT GATATCTTGGCAGCATTTCGAGTAACTCCTCAACCTGGAGTTCCGCCTG AAGAAGCAGGGGCCGCAGTAGCTGCCGAATCTTCTACTGGTACATGGA CAACTGTATGGACCGATGGACTTACGAGCCTTGATCGTTACAAAGGCC GATGCTATGGAATAGAGCCTGTTCCTGGAGAAGACAATCAATATATTG CTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTTACTAAC ATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCCTGCGTG CTCTACGTCTGGAAGATTTGCGAATACCGGTTGCGTATGTTAAAACTTT CGAGGGTCCGCCTCACGGTATCCAAGTTGAGAGAGATAAATTGAACAA GTATGGTCGTCCCCTGTTGGGATGTACTATTAAACCTAAATTGGGGTTA TCCGCTAAAAACTACGGTAGAGCTTGTTATGAATGTCTTCGTGGTGGA CTTGATTTTACA rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 18' 21.5"		
Longitude	E 73° 16' 37.2"		
Elevation	98		
Photographer	Krupa Unadka A	Illustrative Barcode:	

Details		Image	Sequence
Collection date	3rd Feb, 2014		>GGTGTTAAAGATTACAAATTGACTTATTATACTCCTGAATAT GAAACCAAAGATACTGATACGCTAGCAGCATTCCGAGTAACT CCTCAACCTGGAGTTCCGCCTGAAGAAGCGGGGGCTGCGGT AGCTGCCGAATCTTCTACAGGTACATGGACAACTGTGTGGAC CGATGGACTTACCAGTCTTGATCGTTATAAAGGACGATGCTA CCACATTGAGCCCGTTGCTGGAGAAGAAAATCAATATATTTG TTATGTAGCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTT ACTAATATGTTTACTTCCATTGTGGGTAATGTTTTTGGTTTCA AAGCGCTACGCGCTCTACGTTTGGAGGATCTGCGAATTCCTA CTGCTTATATTAAAACTTTCCAAGGCCCGCCTCACGGCATCCA AGTTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTATT GGGATGTACTATTAAACCAAAATTGGGATTATCCGCTAAGAA CTACGGTAGAGCGGTTTATGAATGTCTCCGCGGT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 18' 21.8"		
Longitude	E 73° 16' 37.5		
Elevation	97		
Photographer	Krupa Unadka B	Illustrative Barcode:	

PLATE 48

Details		Image	Sequence
Collection date	3rd Feb, 2014		>GTTGGGTTCAAAGCGGGTGTTAAAGAGTACAAATTGACTTATTATAC TCCTGAATACGAAACCAAAGATACTGATATCTTGGCAGCATTCCGAGT AACTCCTCAACCTGGAGTTCCGCCTGAAGAAGCAGGGGCCGCGGTAG CTGCCGAATCTTCTACTGGTACATGGACAACTGTGTGGACCGATGGAC TTACCAGCCTTGATCGTTACAAAGGGCGATGCTACAACATCGAGCCCG TTCCTGGAGAACAAGATCAATATATCTGTTATGTAGCTTACCCTTTAGA CCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTACTTCCATTGTAGGA AATGTATTTGGATTCAAAGCCCTGCGTGCTCTACGTCTGGAAGATCTG CGAATCCCTGTTTCTTATGTTAAAACTTTCCAAGGCCCACCTCATGGGA TCCAAAGTGAGAGAGATAAATTGAACAAGTATGGTCGTCCCCTGTTG GGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAAAAACTACGGT AGAGCATGTTACGAATGTCTTCGCGGTGGACTTGATTTTAC rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 18' 21.1"		
Longitude	E 73° 16' 37.0"		
Elevation	98		
Photographer	Krupa Unadkat		

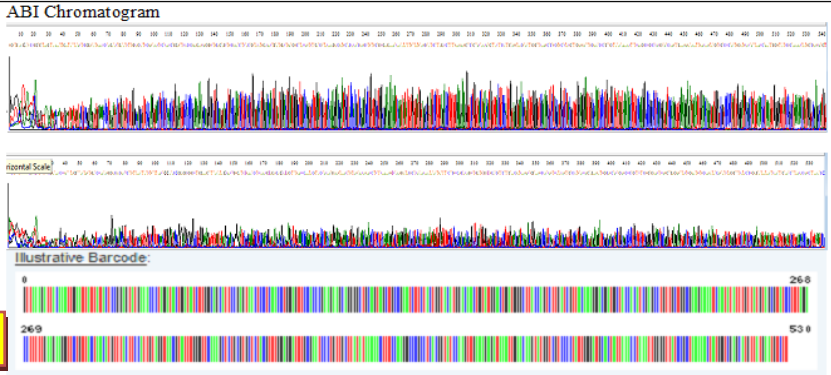
A

Details		Image	Sequence
Collection date	3rd Feb, 2014		>GGTGTTAAAGATTATAAATTGACTTATTATACTCCTGAATATAAAACC AAGGATACTGATATCTTGGCAGCATTTCGAGTAACTCCTCAACCTGGAG TTCCGCCTGAAGAAGCAGGGGCCGCAGTAGCTGCCGAATCTTCTACTG GTACATGGACAACTGTGTGGACCGATGGACTTACGAGCCTTGATCGTT ACAAAGGGCGATGCTATGGAATCGAGCCTGTTCCTGGAGAAGAAAGT CAATTTATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTC TGTTACTAACATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAA GCCCTGCGTGCTCTACGTCTGGAAGATTTGCGAATCCCTATTTCGTATG TTAAAACTTTCCAAGGTCCGCCTCACGGCATCCAAGTTGAGAGAGATA AATTGAACAAGTATGGTCGTCCCCTGTTGGGATGTACTATTAAACCTAA ATTGGGGTTATCCGCTAAAAACTACGGTAGAGCTGTTTATGAATGTCTT CGTGGTGGACTTGATTTTAC rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 18' 21.6"		
Longitude	E 73° 16' 37.4"		
Elevation	98		
Photographer	Krupa Unadkat		

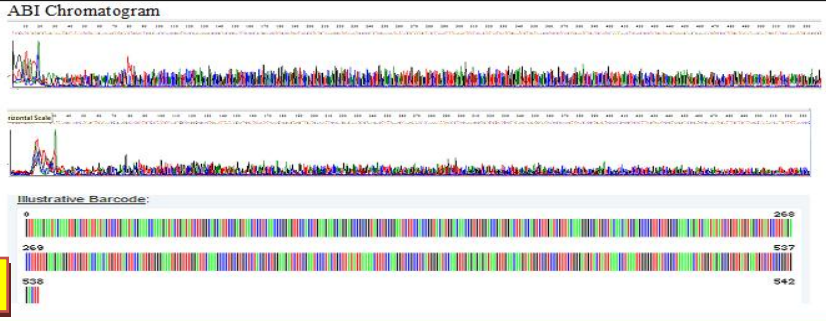
B

Species	*Cyanthilium cinereum*
Identifier	Dr. P.S. Nagar
Species	*inereum*

PLATE 49

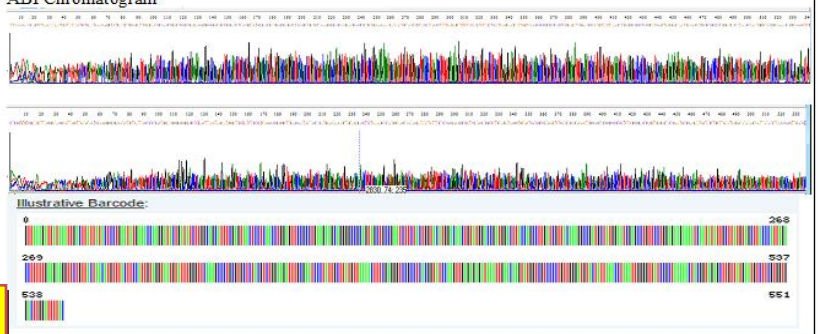
Details		Image	Sequence
Collection date	3rd Feb, 2014		>GTTAAAGATTACAAATTGAATTATTATACTCCGGAGTATGAAACCCTA GATACTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCTGGAGTTC CACCCGAAGAAGCAGGGGCTGCAGTAGCTGCCGAATCTTCTACTGGTA CATGGACAACTGTATGGACTGATGGGCTTACCAGTCTTGATCGTTACA AAGGACGATGCTACCACATCGAGCCTGTTGCTGGCGAAGAAAATCAAT ATATTTGTTATGTAGCGTATCCTTTAGACCTTTTTGAAGAAGGTTCTGTT ACTAACATGTTTACTTCCATTGTAGGTAACGTATTTGGGTTCAAAGCTC TGCGTGCTCTACGTTTGGAGGATTTGCGAATCCCTGTTGCTTATATAAA AACTTTCCAAGGCCCGCCTCACGGTATCCAAGTTGAAAGAGATAAATT GAACAAGTATGGTCGTCCCCTATTGGGATGCACTATTAAACCTAAATTG GGGTTATCCGCTAAAAACTATGGTCGAGCATGTTATGAATGTCTT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identification	*Aerva lanata (L.) Juss.*		
Institution	Gujarat Biodiversity Gene Bank		
Accession number			
Collection code	BG20140203-028		
Collector	Krupa Unadkat		
Phylum	Magniliophyta		
Class	Eucotydeons		
Order	Caryophyllales		
Family	Amaranthaceae		
Genus	Aerva		
Species	*lanata*		
Identifier	Dr. P.S. Nagar		
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Vadhvana Village		
Exact Site	Pond area		
Latitude	N 22° 10' 59.0"		
Longitude	E 73° 28' 58.8"		
Elevation	102		
Photographer	Krupa Unadkat		

A

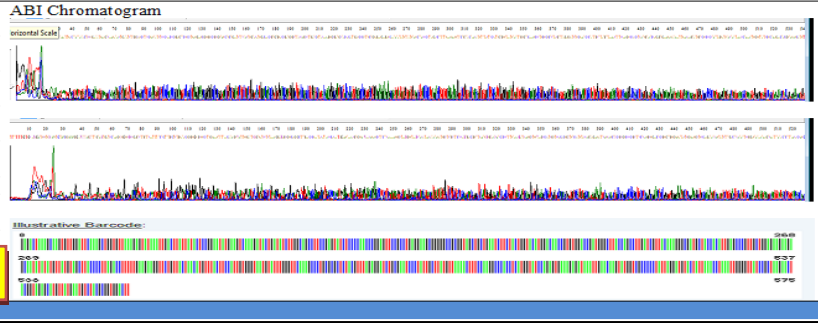
Details		Image	Sequence
Collection date	3rd Feb, 2014		>GTTAAAGAATACAAATTGACTTATTATACTCCTGAATACGAAACCAAA GATACTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCCGGAGTTC CACCTGAAGAAGCAGGAGCCGCGGTAGCTGCGGAATCTTCCACCGGT ACATGGACAACCGTGTGGACCGATGGACTTACCAGTCTTGATCGTTAC AAAGGGCGATGCTACAACATCGAGCCCGTTCTTGGCGAAACAGATCAA TATATCTGTTATGTAGCTTATCCTTTAGACCTTTTTGAAGAAGGTTCTGT TACCAACATGTTTACTTCCATTGTGGGAAATGTGTTTGGATTCAAAGCC CTGCGTGCTCTACGTCTGGAAGATCTTCGAATCCCTACTGCTTATATTA AAACTTTCCAAGGTCCGCCTCATGGGATCCAAGTTGAGAGAGATAAGT TGAACAAGTATGGTCGTCCGTTTCTGGGATGTACTATTAAACCTAAATT GGGGTTATCCGCTAAAAACTATGGTAGAGCGTGTTATGAATGTCTTCG CGGTGGACTT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identification	*Rungia pectinata (L.) Nees*		
Institution	Gujarat Biodiversity Gene Bank		
Accession number	GENG475-14		
Collection code	BG20140203-033		
Collector	Krupa Unadkat		
Phylum	Magniliophyta		
Class	Eucotydeons		
Order	Lamiales		
Family	Acanthaceae		
Genus	Rungia		
Species	*pectinata*		
Identifier	Dr. P.S. Nagar		
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Vadhvana Village		
Exact Site	Pond area		
Latitude	N 22° 10' 59.4"		
Longitude	E 73° 28' 58.7"		
Elevation	101		
Photographer	Krupa Unadkat		

B

PLATE 50

Details		Image	Sequence
Collection date	3rd Feb, 2014		>GTTAAAGATTATAAATTGACTTATTATACTCCTGAATATGAAACCAAG GATACTGATATCTTGGCAGCATTTCGAGTAACTCCTCAACCTGGAGTTC CGCCTGAAGAAGCAGGGGCCGCAGTAGCTGCCGAATCTTCTACTGGTA CATGGACAACTGTATGGACCGATGGACTTACCAGCCTTGATCGTTACA AAGGCCGATGCTATGGAATCGAGCCTGTTCCTGGAGAAGAAAATCAAT ATATTGCTTATGTAGCTTACCCATTAGACCTTTTTGAAGAAGGTTCTGTT ACTAACATGTTTACTTCCATTGTAGGTAATGTATTTGGGTTCAAAGCCC TGCGTGCTCTACGTCTGGAAGATTTGCGAATCCCTATTGCTTATGTTAA AACTTTCGAGGGTCCGCCTCACGGTATCCAAGTTGAGAGAGATAAATT GAACAAGTATGGTCGTCCCCTGTTGGGATGTACTATTAAACCTAAATTG GGGTTATCCGCTAAAAACTACGGTAGAGCTTGTTATGAATGTCTTCGTG GTGGACTTGGATTTTAC rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 10' 59.2"		
Longitude	E 73° 28' 58.7"		
Elevation	100		
Photographer	Krupa Unadkat		

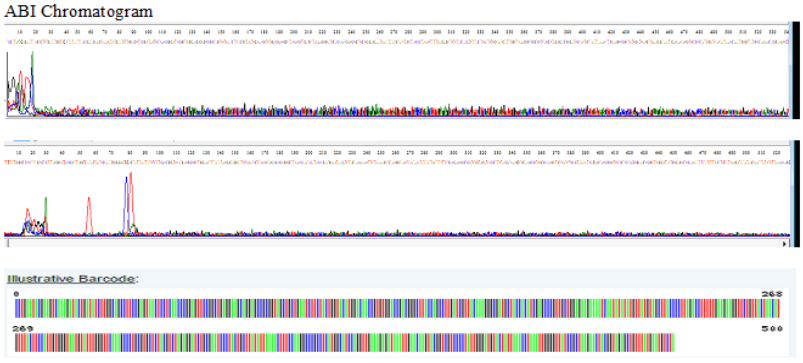
A

Details		Image	Sequence
Collection date	3rd Feb, 2014		>GAGACTAAAGCAAGTGTTGGATTCAAAGCTGGTGTTAAAGAGTATAA ATTGACTTATTATACTCCGGAATATGAAGTCAAAGATACTGATATCTTG GCAGCCTTCCGAGTATCTCCCCAACCCGGAGTTCCGCCTGAGGAAGCG GGGGCCGCGGTAGCTGCTGAATCTTCTACTGGTACATGGACAACCGTG TGGACCGATGGGCTTACCAGCCTTGATCGTTACAAAGGGCGATGCTAC CACATTGAGCCCGTTGCTGGAGAAGAAGAGCAATATATATGTTATGTA GCTTACCCCTTAGACCTTTTTGAAGAAGGTTCTGTTACTAACATGTTTAC TTCCATTGTGGGTAATGTATTTGGGTTCAAAGCCCTGCGCGCTCTACGT TTAGAGGATCTGCGAATCCCTATTGCTTATGTTAAAACTTTCCAAGGCC CACCTCATGGTATCCAGAGTGAAAGAGATAAATTGAACAAGTATGGTC GCCCCCTATTAGGATGTACTATTAAACCTAAATTGGGGTTATCCGCTAA GAACTACGGTAGAGCATGTTATGAATGTCTACGCGGTGGACTT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 10' 59.5"		
Longitude	E 73° 28' 58.9"		
Elevation	103		
Photographer	Krupa Unadkat		

B

PLATE 51

Details		Image	Sequence
Collection date	3rd Feb, 2014		> AAAGAGTACAAATTGACTTATTATACTCCTGAATACGAAACCAAAGATA CTGATATCTTGGCAGCATTCCGAGTAACTCCTCAACCGGGAGTTCCACC TGAAGAAGCAGGAGCCGCGGTAGCTGCGGAATCTTCCACCGGTACAT GGACAACCGTGTGGACCGATGGACTTACCAGTCTTGATCGTTACAAAG GGCGATGCTACAACATCGAGCCCGTTCTTGGGGAAACAGATCAATATA TCTGTTATGTAGCTTACCCTTTAGACCTTTTTGAAGAAGGTTCTGTTACC AACATGTTTACTTCCATTGTGGGAAATGTGTTTGGATTCAAAGCCTTGC GTGCTCTACGTCTGGAAGATCTTCGAATCCCTACTGCTTATACTAAAAC TTTCCAAGGTCCGCCTCATGGGATCCAAGTTGAGAGAGATAAGTTGAA CAAGTATGGTCGTCCCCTGCTGGGATGTACTATTAAACCGAAATTGGG GTTATCCGCTAAAAACTATGGTAGAGCGTGTTATGAATGTCTTCGCGGT GGACTTGATTTT rbcL F: ATGTCACCACAAACAGAGACTAAAGC rbcL R: GTAAAATCAAGTCCACCRCG
Identifier Email	drnagar@gmail.com	ABI Chromatogram	
Identifier Institution	MSU Baroda		
Identification Method	Morphology and Barcoding		
Voucher Status	Herbarium, Photographs		
Country	India		
State	Gujarat		
Region	Vadodara		
Sector	Timbi village pond		
Exact Site	Pond area		
Latitude	N 22° 10' 59.8"		
Longitude	E 73° 28' 58.9"		
Elevation	102		
Photographer	Krupa Unadka		



A

PLATE 52

4.3 Phylogenetic Analysis

The evolutionary history was inferred by using the Maximum Likelihood method based on the Tamura-Nei model. The tree with the highest log likelihood (-16424.5341) is shown. Initial tree(s) for the heuristic search were obtained automatically as follows. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site (next to the branches). The analysis involved 09 nucleotide sequences. All positions containing gaps and missing data were eliminated. There were a total of 435 positions in the final dataset. Evolutionary analyses were conducted in MEGA5.

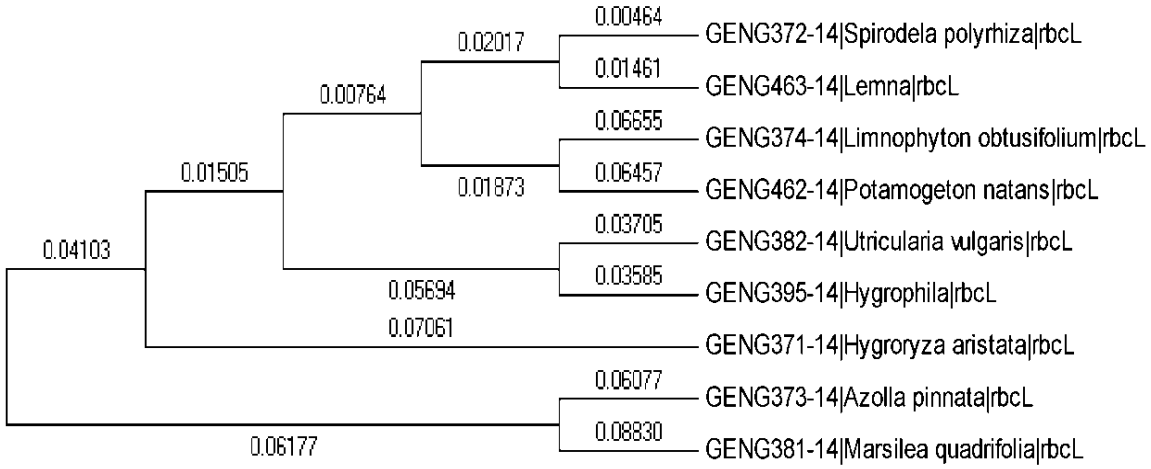


Figure.17: Molecular Phylogenetic anaylsis by Maximum Likelihood method

The clades in the tree constructed with *rbcL* gene sequences were supported by 89% (25/28) of >50% bootstrap values (Figure 1). In a recent study, the *rbcL* marker exhibited intermediate-level (80%) resolution among the evaluated regions (*matK* > *atpF-atpH* > *rbcL* > *trnH-psbA* > *rpoC1*) (Burgess et al., 2011). Phylogenetic methods were applied in a recently conducted study of barcoding species using each barcode locus taken alone and in combinations to evaluate species recovery (Roy *et al.*, 2010).

The NJ, MP, and UPGMA methods were used for both single- and multi-locus analyses with 500 bootstrap replicates. When all sequences for a given locus were considered, ITS, *matK*, and *trnH-psbA* were able to form a species-specific clade for only *Berberis pachyacantha*. Not a single species was recovered with *rbcL* using any of the three methods. The clades formed in the trees were mostly mixtures of several species. Therefore, establishing a local barcode database will be valuable for a broad range of potential ecological applications, including the building of community phylogenies (Kress *et al*. 2009).

	1	2	3	4	5	6	7	8	9
1. GENG371-14|Hygroryza aristata|rbcL									
2. GENG372-14|Spirodela polyrhiza|rbcL	0.115								
3. GENG373-14|Azolla pinnata|rbcL	0.216	0.192							
4. GENG374-14|Limnophyton obtusifolium|rbcL	0.166	0.098	0.237						
5. GENG381-14|Marsilea quadrifolia|rbcL	0.245	0.208	0.149	0.234					
6. GENG382-14|Utricularia vulgaris|rbcL	0.136	0.113	0.242	0.161	0.256				
7. GENG395-14|Hygrophila|rbcL	0.156	0.116	0.249	0.147	0.263	0.072			
8. GENG462-14|Potamogeton natans|rbcL	0.141	0.107	0.229	0.130	0.245	0.151	0.154		
9. GENG463-14|Lemna|rbcL	0.115	0.019	0.186	0.115	0.203	0.122	0.128	0.118	

Table 13: rbcL based Correlation chart

Phylogenetic tree analysis using rbcL sequences assigned the tested plant samples to known species. The plants that were taken into consideration grouped *Spirodela polyrhiza,* Limnophyton obtusifolium *and Lemna sp.* together belongs to Alismatales. *Spirodela polyrhiza* and *Lemna sp.* which were considered under free floating hydrophytes while *Limnophyton obtusifolium* is rooted emergent hydrophytes.

As per chart *Hygroryza aristata* shows lowest value with *Spirodela polyrhiza* and then *Limnophyton obtusifolium*. Similarly *Spirodela polyrhiza* shows lowest value with *Limnophyton obtusifolium* and then *Lemna Sp.* This indicate that this plants are closely related with each other and grouping together.

Moreover, *Hygrophila Sp*. and *Limnophyton obtusifolium* belongs to different families but they are grouped in to Rooted emergent Hydrophyte. In the phylogenic tree *Spirodela polyrhiza* and *Lemna Sp.* shows close relationship so, they are grouped in free floating hydrophyte. Besides this as per correlation chart *Utricularia vulgaris* shows close relationship with *Lemna Sp.*

Contradictory results occur in *Hygrorhyza aristata* is correlating with lowest value at *Spirodela polyrhiza* but *Spirodela polyrhiza* includes in group of free floating hydrophyte while *Hygrorhyza aristata* is rooted emergent hydrophyte. Based on this analysis. Our findings, not withstanding *rbcL* is considered to possess less species-discriminating power than *matK*, are possibly due to its minimal sequence variation (Asahina *et al*., 2010). The estimated range of the total number of plant species worldwide is believed to be approximately 310,000-422,000 (Graham, 2002).

Morphological identification is inapplicable when studying population biology. In such cases, barcoding is an efficient and valuable technique. Some ecologists have started using the barcoding approach to identify specific unknown plant samples for practical purposes (Li *et al*., 2009). Ongoing developments of new primers and improvements in sequencing techniques have facilitated the data-emergence process of plant barcoding (Soltis *et al*., 1996; Burgess *et al*., 2011). Recently, plant diversity belowground was determined using *rbcL* gene sequences as a core plant DNA barcoding marker (Kesanakurti *et al*., 2011).

Configuration	Count
Identical sites in all three sequences	46
Divergent sites in all three sequences	200
Unique differences in Sequence A	99
Unique differences in Sequence B	98
Unique differences in Sequence C	115

Table 14: Tajima's test results

The equality of evolutionary rate between sequences **A** (*GENG371-14 Hygroryza_aristata*) and **B** (*GENG372-14 Spirodela_polyrhiza*), with sequence **C** (*GENG373-14 Azolla_pinnata*) used as an out group in Tajima's relative rate test. The χ^2 test statistic was 0.01 (*P* = 0.94320 with 1 degree[s] of freedom) . *P*-value less than 0.05 is often used to reject the null hypothesis of equal rates between lineages. The analysis involved 3 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There were a total of 558 positions in the final dataset. Evolutionary analyses were conducted in MEGA5.

	A	T/U	C	G
A	-	*4.66*	*3.74*	**11.66**
T/U	*4.33*	-	**18.48**	*3.52*
C	*4.33*	**23.00**	-	*3.52*
G	**14.36**	*4.66*	*3.74*	-

Table 15: Likelihood estimate of Substitution Matrix

Each entry is the probability of substitution (*r*) from one base (row) to another base (column). Substitution pattern and rates were estimated under the Tamura-Nei (1993) model. Rates of different transitional substitutions are shown in **bold** and those of transversionsal substitutions are shown in *italics*. Relative values of instantaneous *r* should be considered when evaluating them. For simplicity, sum of *r* values is made equal to 100, The nucleotide frequencies are A = 26.65%, T/U = 28.67%, C = 23.03%, and G = 21.65%. For estimating ML values, a user-specified topology was used. The maximum Log likelihood for this computation was -1804.400. The analysis involved 9 nucleotide sequences. All positions containing gaps and missing data were eliminated. There were a total of 424 positions in the final dataset. Evolutionary analyses were conducted in MEGA5.

M	***S***	p_s	Θ	Π	***D***
57	435	1.000000	0.216851	0.678036	7.627007

Table16: Tajima's Neutrality Test results

NOTE.-- The analysis involved 09 nucleotide sequences. All positions containing gaps and missing data were eliminated. There were a total of 435 positions in the final dataset. Evolutionary analyses were conducted in MEGA5.

Model	Parameter	BIC	AICc	lnL	Invariant	Gamma	R	Freq A	Freq T	Freq C	Freq G	A=>T	A=>C	A=>G	T=>A	T=>C	T=>G	C=>A	C=>T	C=>G	G=>A	G=>T	G=>C
K2+I	17	3660.6	3554.5	-1760.2	0.553064	n/a	2.4007	0.25	0.25	0.25	0.25	0.04	0.04	0.18	0.04	0.18	0.04	0.04	0.18	0.04	0.18	0.04	0.04
K2+G	17	3661	3555	-1760.4	n/a	0.37971	2.4912	0.25	0.25	0.25	0.25	0.04	0.04	0.18	0.04	0.18	0.04	0.04	0.18	0.04	0.18	0.04	0.04
T92+G	18	3665.5	3553.3	-1758.5	n/a	0.3646	2.5736	0.2766	0.2766	0.2234	0.2234	0.04	0.03	0.16	0.04	0.16	0.03	0.04	0.2	0.03	0.2	0.04	0.03
K2+G+I	18	3667.8	3555.6	-1759.7	0.498922	3.36206	2.4492	0.25	0.25	0.25	0.25	0.04	0.04	0.18	0.04	0.18	0.04	0.04	0.18	0.04	0.18	0.04	0.04
T92+G+I	19	3672.1	3553.6	-1757.7	0.509036	3.48865	2.5266	0.2766	0.2766	0.2234	0.2234	0.04	0.03	0.16	0.04	0.16	0.03	0.04	0.2	0.03	0.2	0.04	0.03
HKY+G	20	3679.6	3554.9	-1757.3	n/a	0.36566	2.557	0.2665	0.2867	0.2303	0.2165	0.04	0.03	0.16	0.04	0.17	0.03	0.04	0.21	0.03	0.19	0.04	0.03
TN93+G	21	3684.4	3553.5	-1755.6	n/a	0.37507	2.5697	0.2665	0.2867	0.2303	0.2165	0.04	0.03	0.12	0.04	0.2	0.03	0.04	0.25	0.03	0.15	0.04	0.03
HKY+G+I	21	3686.3	3555.4	-1756.6	0.505657	3.31966	2.5115	0.2665	0.2867	0.2303	0.2165	0.04	0.03	0.16	0.04	0.17	0.03	0.04	0.21	0.03	0.19	0.04	0.03
TN93+G+I	22	3691.3	3554.1	-1754.9	0.489497	2.8641	2.5266	0.2665	0.2867	0.2303	0.2165	0.04	0.03	0.12	0.04	0.2	0.03	0.04	0.24	0.03	0.15	0.04	0.03
GTR+G	24	3706.4	3556.8	-1754.2	n/a	0.36294	2.58	0.2665	0.2867	0.2303	0.2165	0.03	0.04	0.12	0.02	0.2	0.03	0.05	0.25	0.03	0.15	0.05	0.03
GTR+I	24	3707.2	3557.5	-1754.6	0.555544	n/a	2.4415	0.2665	0.2867	0.2303	0.2165	0.03	0.04	0.13	0.03	0.19	0.04	0.04	0.24	0.03	0.16	0.05	0.03
GTR+G+I	25	3714.6	3558.8	-1754.2	0	0.36294	2.58	0.2665	0.2867	0.2303	0.2165	0.03	0.04	0.12	0.02	0.2	0.03	0.05	0.25	0.03	0.15	0.05	0.03
K2	16	3753.4	3653.6	-1810.7	n/a	n/a	2.0563	0.25	0.25	0.25	0.25	0.04	0.04	0.17	0.04	0.17	0.04	0.04	0.17	0.04	0.17	0.04	0.04
T92	17	3763.5	3657.4	-1811.6	n/a	n/a	2.062	0.2766	0.2766	0.2234	0.2234	0.04	0.04	0.15	0.04	0.15	0.04	0.04	0.19	0.04	0.19	0.04	0.04
T92+I	18	3771.7	3659.5	-1811.6	0.00001	n/a	2.062	0.2766	0.2766	0.2234	0.2234	0.04	0.04	0.15	0.04	0.15	0.04	0.04	0.19	0.04	0.19	0.04	0.04
HKY	19	3777.2	3658.7	-1810.2	n/a	n/a	2.0621	0.2665	0.2867	0.2303	0.2165	0.05	0.04	0.15	0.04	0.16	0.04	0.04	0.19	0.04	0.18	0.05	0.04
TN93	20	3778.9	3654.2	-1807	n/a	n/a	2.0721	0.2665	0.2867	0.2303	0.2165	0.05	0.04	0.12	0.04	0.19	0.04	0.04	0.23	0.04	0.14	0.05	0.04
JC+I	16	3778.9	3679.1	-1823.5	0.539432	n/a	0.5	0.25	0.25	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
HKY+I	20	3785.4	3660.7	-1810.2	0.00001	n/a	2.0621	0.2665	0.2867	0.2303	0.2165	0.05	0.04	0.15	0.04	0.16	0.04	0.04	0.19	0.04	0.18	0.05	0.04
JC+G+I	17	3786.8	3680.7	-1823.3	0.504102	5.89873	0.5	0.25	0.25	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
TN93+I	21	3787.1	3656.2	-1807	0.00001	n/a	2.0721	0.2665	0.2867	0.2303	0.2165	0.05	0.04	0.12	0.04	0.19	0.04	0.04	0.23	0.04	0.14	0.05	0.04
JC+G	16	3789.3	3689.5	-1828.7	n/a	0.76959	0.5	0.25	0.25	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
GTR	23	3803.2	3659.8	-1806.8	n/a	n/a	2.0729	0.2665	0.2867	0.2303	0.2165	0.04	0.04	0.12	0.04	0.19	0.04	0.05	0.23	0.03	0.14	0.05	0.03
JC	15	3861.3	3767.7	-1868.8	n/a	n/a	0.5	0.25	0.25	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Table 17: Models with the lowest BIC scores (Bayesian Information Criterion)

Models with the lowest BIC scores (Bayesian Information Criterion) are considered to describe the substitution pattern the best. For each model, AICc value (Akaike Information Criterion, corrected), Maximum Likelihood value (*lnL*), and the number of parameters (including branch lengths) are also presented . Non-uniformity of evolutionary rates among sites may be modeled by using a discrete Gamma distribution (+*G*) with 5 rate categories and by assuming that a certain fraction of sites are evolutionarily invariable (+*I*). Whenever applicable, estimates of gamma shape parameter and/or the estimated fraction of invariant sites are shown. Assumed or estimated values of transition/transversion bias (*R*) are shown for each model, as well. They are followed by nucleotide frequencies (*f*) and rates of base substitutions (*r*) for each nucleotide pair. Relative values of instantaneous *r* should be considered when evaluating them. For simplicity, sum of *r* values is made equal to 1 for each model. For estimating ML values, a tree topology was automatically computed. The analysis involved 57 nucleotide sequences. All positions containing gaps and missing data were eliminated. There were a total of 435 positions in the final dataset. Evolutionary analyses were conducted in MEGA5.

4.4 Selection of Plants for bioaccumulation of heavy metal ions (Zn, Ni and Cd) *in vitro*

Lemna species, also known as duckweed, grow in stagnant or slow flowing waters in almost all the world. Duckweed is often identified as Lemna minor, however, there are often other species present often even introduced from tropical or subtropical regions such as *L. polyrhiza L*. and *L.triscula* L. which makes identification very difficult. Some species often found in tanks are like *L, minuta* and *L. valdiviana* or the relatively large *Landoltia punctata*. Quite often, several species occure in the same tank. *Lemna minor*, native to Europe does well with very low pH values as well as with very low water temperature. In winter, this tiny floating plant produces so called turions (Small dense organs containing a lot of starch, which sink to the ground). This strategy ensure its survival during longer cold periods or unfavourable conditions in general. Duckweed is a very undemanding plant, however nutrient rich water and at least medium lighting furthers growth considerably. It reproduces mainly by budding: two daughter plants grow from “bags” on the sides of the plant, which break off early in their development. Duckweed oftern becomes a major weed due to its smallness, adaptability and extremely fast growth. Its growth rate makes its highly annoying and difficult to control as well as its tendency to shade off other plants to high degree.

Lemna polyrhhiza L. *(Spirodela polyrhhiza* L. Schleiden*)*

Spirodela polyrhhiza L. Schleiden (giant duckweed) is a cosmopolite representative of the Lemnoideae subfamily araceae. Although *Lemna gibba* L. and *L. minor* L. are the commonly used species in standardized ecotoxicological test procedures. *S. polyrhhiza* is also widely applied as a model organism in plant physiology, ecotoxicology and bioremediation studies (Olah *et al*., 2008). This special attention could partly be attributed to its special way of propogation. However, it can produce not only daughter fronds but turions or turion like fronds as well which serve as dormant buds for surviving unfavourable periods (Jacobs, 1947). *S. polyrhhiza* L. is the most extreme example of this strategy since in temperate regions its winter survival relies exclusively on its turions because normal fronds cannot tolerate low temperatures (Appenroth, 2001). Turions are produced by the same meristematic regions as normal vegetative fronds.

Jacobs (1947) observed that the growing primordium loses its ability to reversibly switch between normal and turion developmental paths when it reaches approximately 0.2 mm length. According structural simplicity and small size of frons, rapid growth and easy observation of turion formation qualify *S. polyrhiza* as an ideal model system for investigating regulation of morphogenesis and dormancy in plant (Chaloupkova and Smart, 1994). Besides their popularity in plant physiological and ecotoxicological research, common advanrages of duckweed species make these plant suitable for various fields of practical applications (Wang *et al*., 2014). Recently duckweeds are considered as potential candidates for bioremediation, waste water treatment, and raw material (eg. Protein and starch production (Cheng and Stomp, 2009).

Despite its extensive application in exotoxicology and phytoremediation research, the effect of heavy metals on turion formation of *S. polyrhiza* are sparingly discussed and the results are rather contradictory. Xylander *et al*. 1993 found that the presence of either cadmium or nickel in the nutrient medium inhibited formation of turions.

Lemna triscula L.

Lemna trisulca L. is an uncommon Lemna species and not easily identified as such at first glance. *L. triscula L.* will occur in most mesotrophic to eutrophic still or slow flowing water bodies, although it will also ocuur in backwaters in fast flowing rivers. It is tolerant of shade and apparently also of hyper eutrophication and will often occur where there are very few other aquatic plant species. *Lemna triscula* L. is a perennial and every frond has a transparent margin that is toothed at the front. It is in flower from may to july. The flowers are monoecious (individual flowers are either male or female, but both sexes can be found on the same plant). Reproduction is by vegetative budding; flowering is very rare. *L. trisulca* L. grows in stagnant waters poor in phosphate with a conductivity of mainly over 100 Mikrosiemens/cm vor, where it is often found floating under the cover of other duckweed species (*Lemna, Spirodela*). During the winter it keeps growing, forming shorter and wider fronds that sink to the ground, where they keep growing at a slower rate.

Duckweed *(Lemna trisulca* L.) is an aquatic plant with an excellent potential for toxicological studies. Like other species of the family Lemnaceae, it is small in size, grows rapidly and, because it is unattached to the substrate, is relatively easy to culture. It differs from the species of duckweed normally used for toxicity assessment such as *L. minor* and *L. gibba*, since it grows entirely submerged. *Lemna trisulca* L. is a truly aquatic plant and working with it *Lemna trisulca* L. is a truly aquatic plant and working with it avoids complications, which may be associated with air/water interfaces (Huebert *et al.,* 1993). Duckweeds (*Lemna, Spirodela, Wolffia* and *Wolfiella*) are worldwide distributed in freshwater to brackish estuaries. These are free-floating, easy to culture in laboratory and area convenient plant material for ecotoxicological investigations (Prasad *et al*., 2001). In particular, species of *Lemna* are reported to accumulate toxic metals and therefore are being used as experimental model systems to investigate heavy metal induced responses. Bioavaibility and bioaccumulation of various heavy metals in aquatic and wetland ecosystems is gaining tremendous significance globally (Greger, 1999). Aquatic macrophytes take up metals from the water, producing an internal concentration several fold greater than their surroundings.

Many of the aquatic macrophytes found to be the potential scavengers of heavy metals from aquatic environment and are being used in wastewater renovation systems (Kadlec *et al*., 2000). Cadmium does not have any metabolic use for plants, it has several industrial applications, electroplating, pigments, (nickel cadmium; silver-cadmium; mercury-cadmium) alloys etc. Intrinsic growth rates of aquatic plants are not constant overtime. Hubert and Gorham (1993), and Landolt and Kandeler (1987) found that the doubling time of *L. minor* varied from 1-3 to 2-8 days over 18 month period. Data on the effect of a reference toxicant over time are scarcer reported no cyclic changes in the effect of relationship between intrinsic growth rate and the Cd reference toxicant (Thorsteinsson *et al*., 1987).

4.4.1 *In vitro* Culturing of L. polyrhiza L. and *L. triscula* L.

L.polyrhhiza L. and *L. triscula* L. were cultured in laboratory using Hoagland culture medium.

The aim of the present work is to investigate the performance of (*Lemna trisulca* L. and *L.polyrrhiza L.*) to absorb Zn, Ni and Cd from aquatic systems and to represent the rate of Zn, Ni and Cd removal.

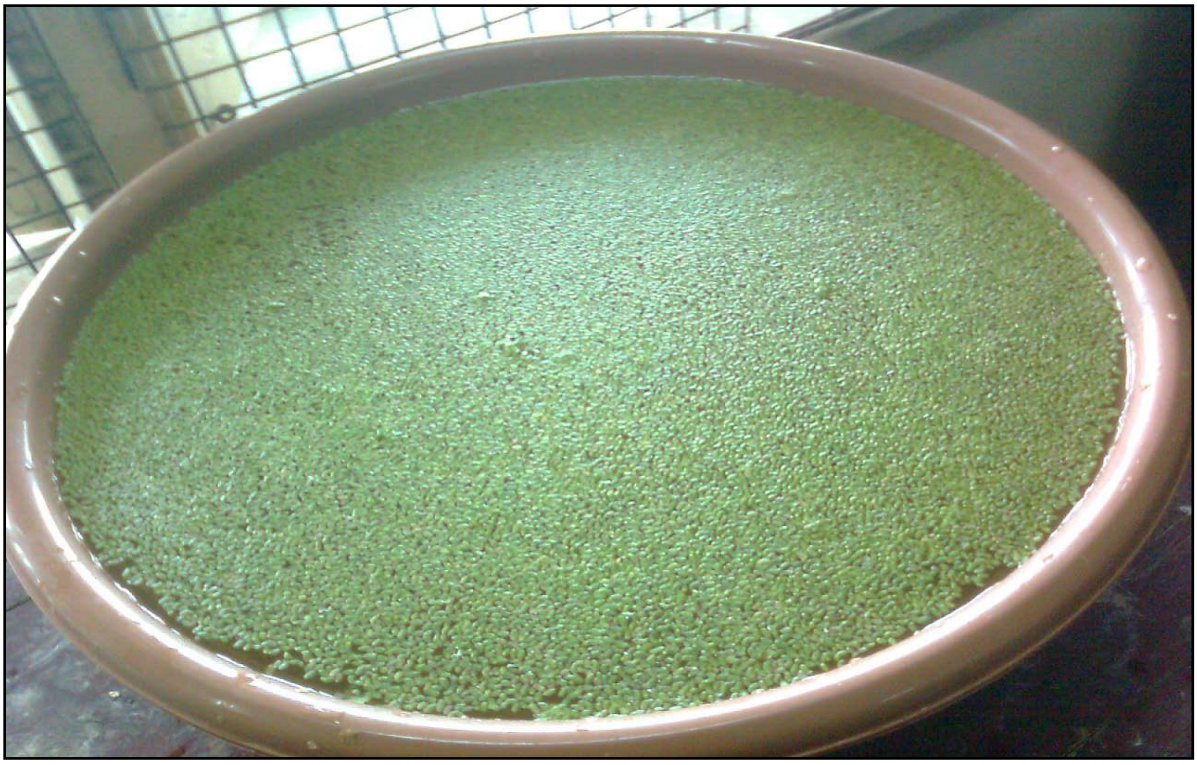


PLATE 53

4.5 Effect of metals on Biochemical Parameter of *L. polyrhiza* L.

4.5.1 Effect of Zn ion on biochemical parameters of *L. polyrhiza* L

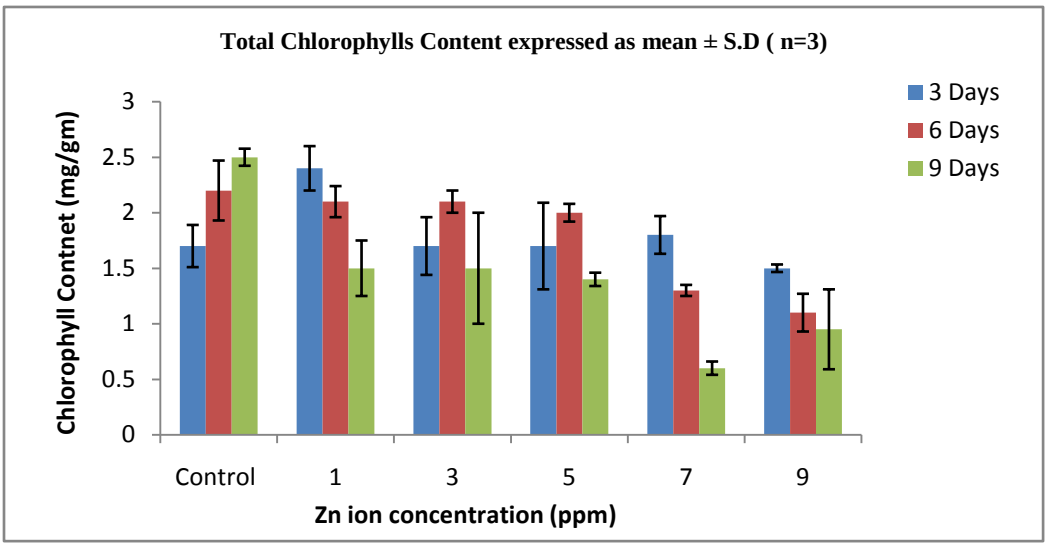


Figure 18 : Total chlorophylls content of *L. polyrhiza* L. at different concentration of Zn metal ion

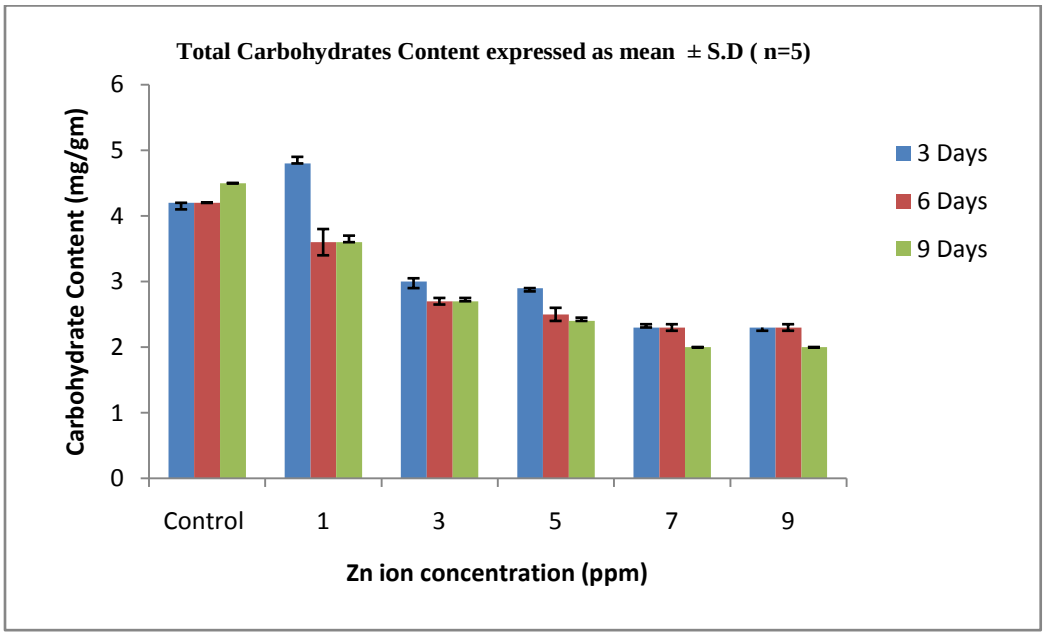


Figure 19 : Total Carbohydrates content of *L. polyrhiza* L. at different concentration of Zn metal ion

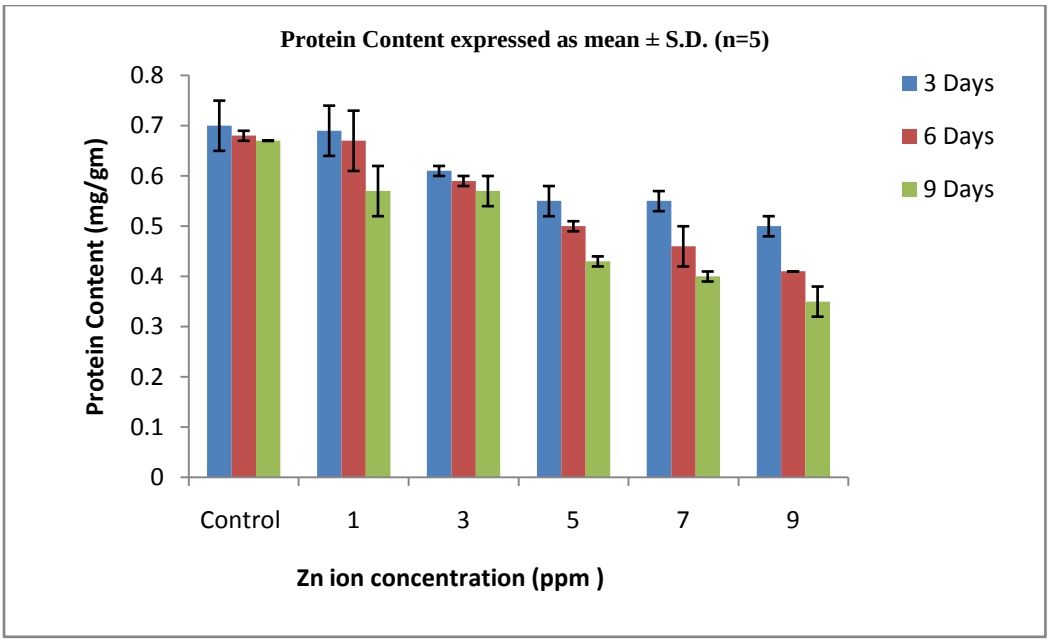


Figure 20 : Protein content of *L. polyrhiza* L. at different concentration of Zn metal ion

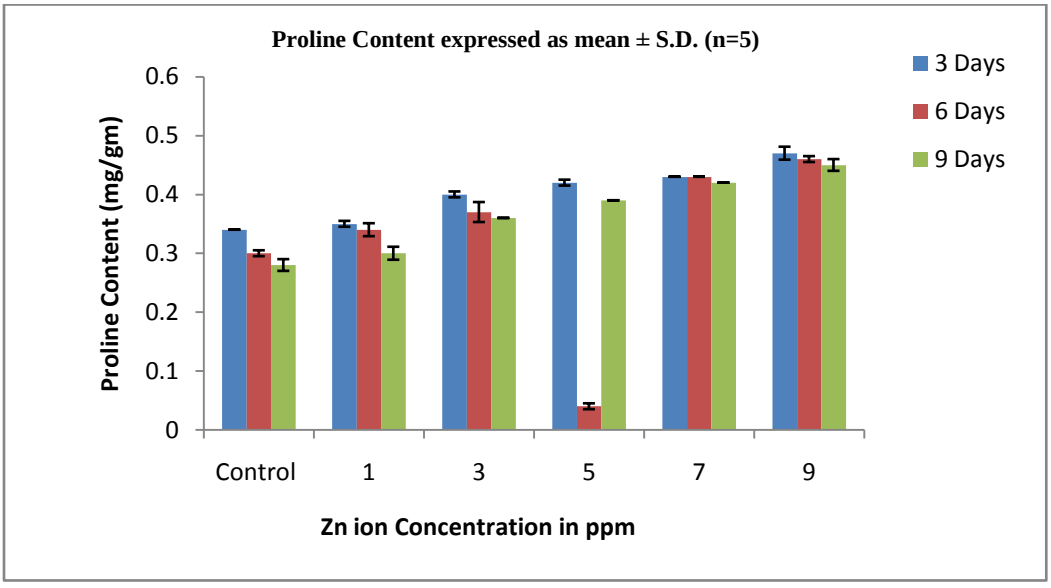


Figure 21 : Proline content of *L. polyrhiza* L.at different concentration of Zn metal ion

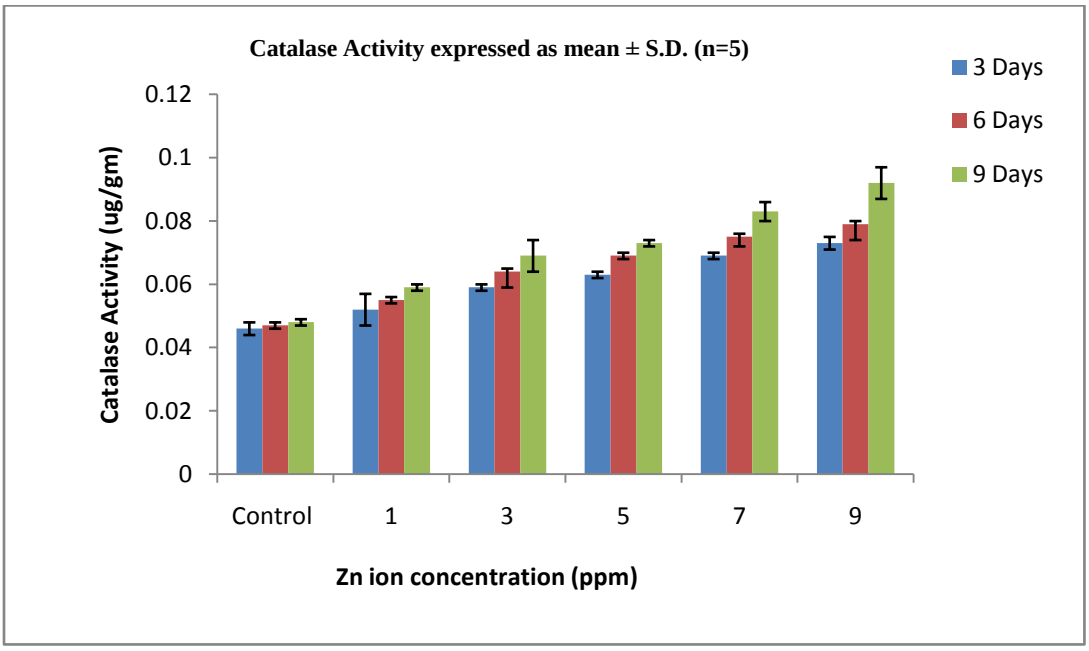


Figure 22: Catalase Activity of *L. polyrhiza* L. at different concentration of Zn metal ion

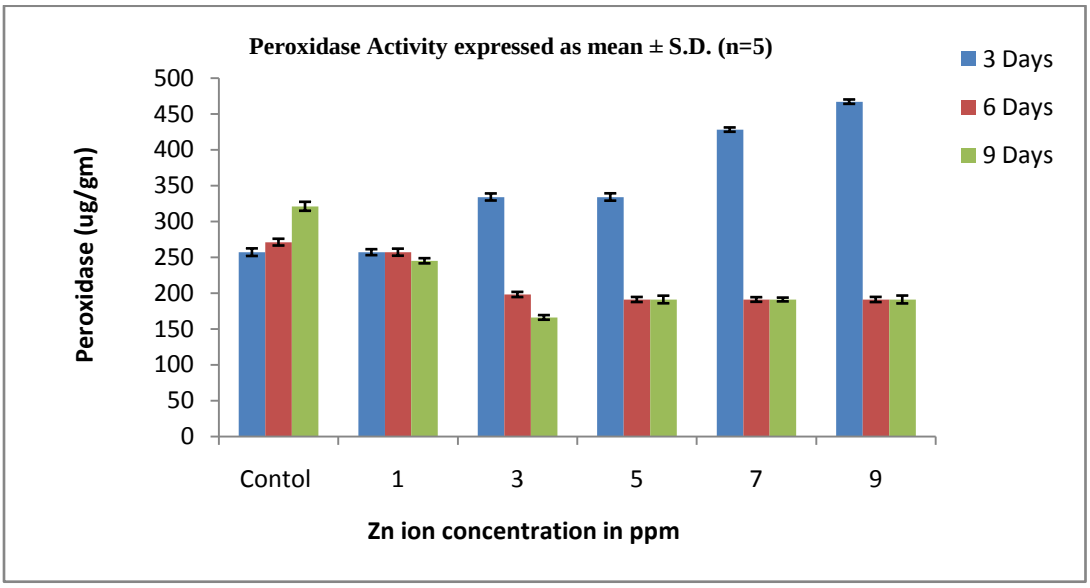


Figure 23 : Peroxidase Activity of *L. polyrhiza* L. at different concentration of Zn metal ion

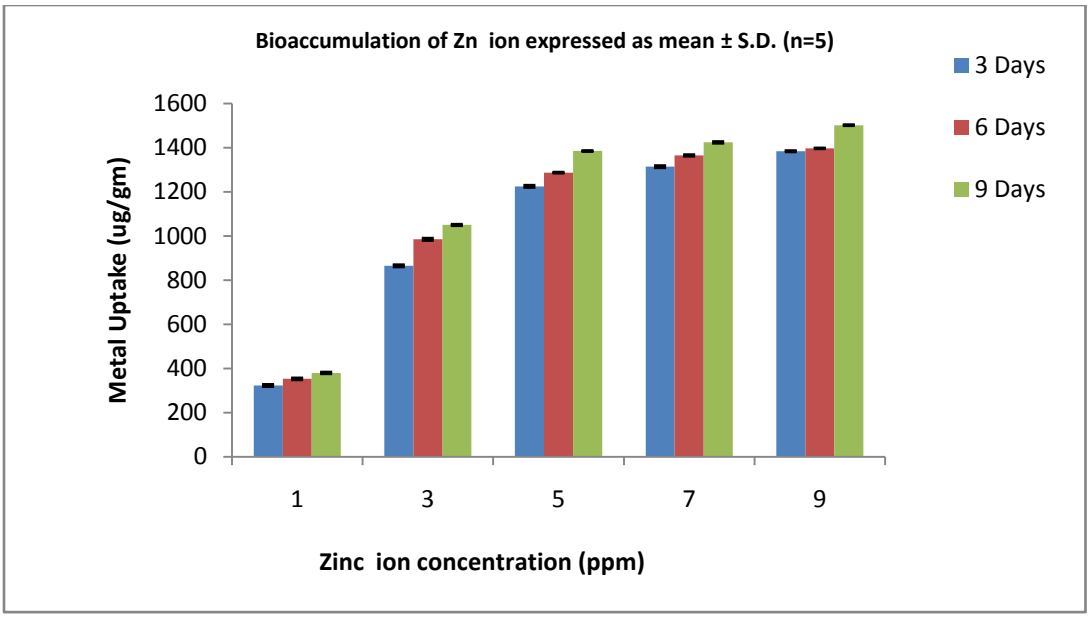


Figure 24: Bioaccumulation of Zn ion of *L. polyrhiza* L. at different concentration of Zn metal ion

Total Chlorophylls Content

The results of effect of Zn metal ion concentration on total chlorophyll content of *L. polyrhiza L.* is represented in Figure 18. It was observed that 1 ppm concentration of the metal ion marginally increased the chlorophyll following 3 days of treatment period. Thereafter, the chlorophyll content showed gradual decline as the treatment period and the metal ion concentration increased. The prolonged exposure of 9 days to high concentration of Zn i.e. 9 ppm significantly reduced (45%) chlorophyll than the control.

Significant difference was observed and results of chlorophyll results were compared with control on 3^{rd} ($P = 0.015<0.05$), 6^{th} and 9^{th} ($P= 0.006< 0.05$) treatment period followed by paired t test. No significant results were obtained ($P = 0.955> 0.05$) when chi square test was performed.

Total Carbohydrates Content

Data presented in Figure 19 revealed that total carbohydrate content a showed a slight rise at 1 ppm metal ion concentration and thereafter at 3 days treatment period. A negative correlation was recorded with the increased metal ion concentrations and the treatment period. No significant difference was observed when carbohydrate content of the treated plants were compared with control on 3rd day ($P = 0.30 > 0.05$). In addition to that we found significant difference when carbohydrate content of 6th day ($P= 0.006< 0.05$) and 9th day ($P= 0.04 > 0.05$) treated plants were compared with control followed by paired t test. Additionally, in chi square test, we did not find significant results ($P= 0.57 > 0.05$).

Protein Content

All the experimental concentrations gradually declined protein content as the period of treatment increased from 3 to 9 days (Figure 20). It also decreased with increased metal ion concentrations in all the treatment periods. Protein showed 49% reduction when the plants were treated with 9 ppm Zn ions following exposure of 9 days. Significant difference was observed when Protein content of the treated plants were compared with control on 3rd day ($P = 0.05 = 0.05$). We obtained significant difference when protein content of 6th day ($P= 0.00 < 0.05$) and 9th day ($P= 0.006 < 0.05$)treatment plant when compared with control followed by paired t test. Furthermore, in chi square test, no significant results were obtained ($P= 0.95 > 0.05$).

Proline Content

The effect of Zn ion on Proline content of the *L. poyrhiza L.* is represented in Figure 21. A concentration dependent rise in the level of proline was observed during all experimental exposure period. But negative correlation was found between the period of exposure and level of proline content. There is significant difference between proline content of the treated and control plants on 3rd day treatment period ($P = 0.01< 0.05$).

Significant difference were observed when protein content of 6^{th} day (P= 0.02 < 0.05) and 9^{th} day (P= 0.001 < 0.05) were compared with control followed by paired t test. Furthermore, in chi square test, there is no significant results were obtained (P= 0.95 > 0.05).

Catalase and peroxidase Activity

As per results obtained the activity of both catalase and peroxidase were significantly higher in treated plants in comparison with the control plants. (Figure 22 and 23) Greater activities of catalase and guaicol peroxidase indicated that the treated plant were under oxidative stress. In the present investigation it was reported that activities of catalase enhanced linearly with increased metal ion concentration whereas the activity of guaicol peroxidase showed increase with metal ion concentration only at 3 day of exposure period. Thereafter it decreased at 6 and 9 day exposure periods. We found significant difference when catalase activity and peroxidase activity of the treated (exposed in 3,6 and 9 days) were compared with control (P = 0.00< 0.05) followed by paired t test. Furthermore, in chi square test, there is no significant results were obtained (P= 1.00 > 0.05) for catalase activity and (P= 0.572>0.05) for Peroxidase activity.

Bioaccumulation of Zn Metal ion

Bioaccumulation of Zn ion in the test plants at different concentration is as shown in Figure 24. Exposure to 1 and 3 ppm increased the accumulation of metal ion in all the experimental exposure periods. The concentration beyond 3 ppm i.e. 5,7 and 9 decreased the uptake at 3 day exposure. Also, no further rise n the uptake were reported at 6 and 9 days in test concentrations. There is significant difference between Zn metal uptake of the test plants were compared with control on 3, 6 and 9 days (P = 0.0 4 < 0.05) followed by paired t test. Furthermore, in chi test, there is no significant results were obtained (P= 1.00 > 0.05).

4.5.2 Effect of Ni ion on biochemical parameters of *L. polyrhiza* L.

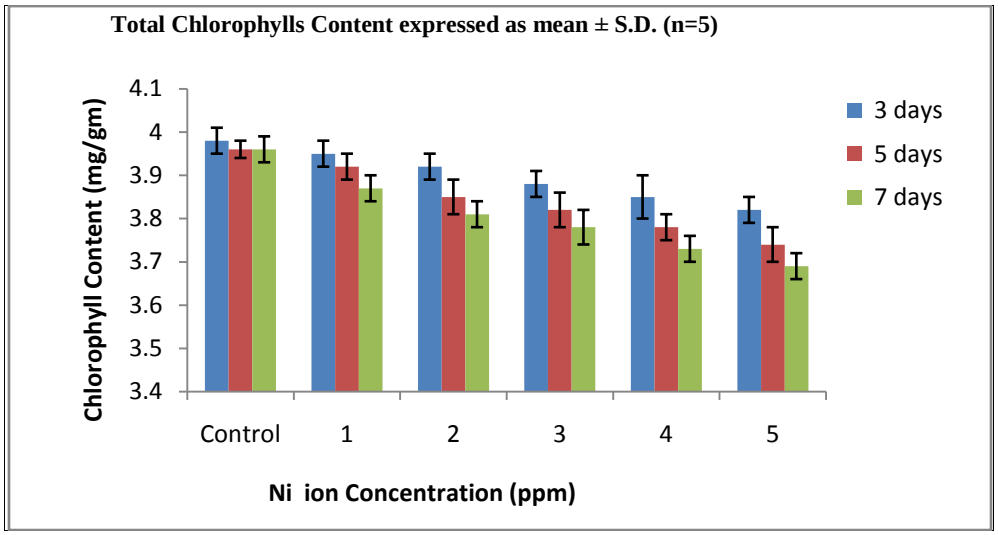


Figure 25: Total Chlorophylls Content of *L. polyrhiza* L. at different concentration of Ni metal ion

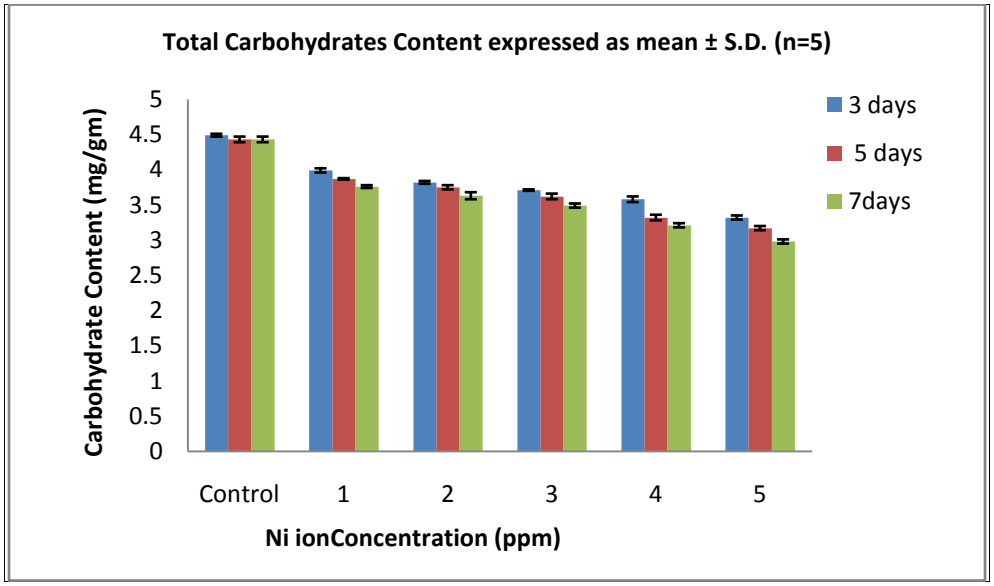


Figure 26: Total Carbohydrates Content of *L. polyrhiza* L. at different concentration of Ni metal ion

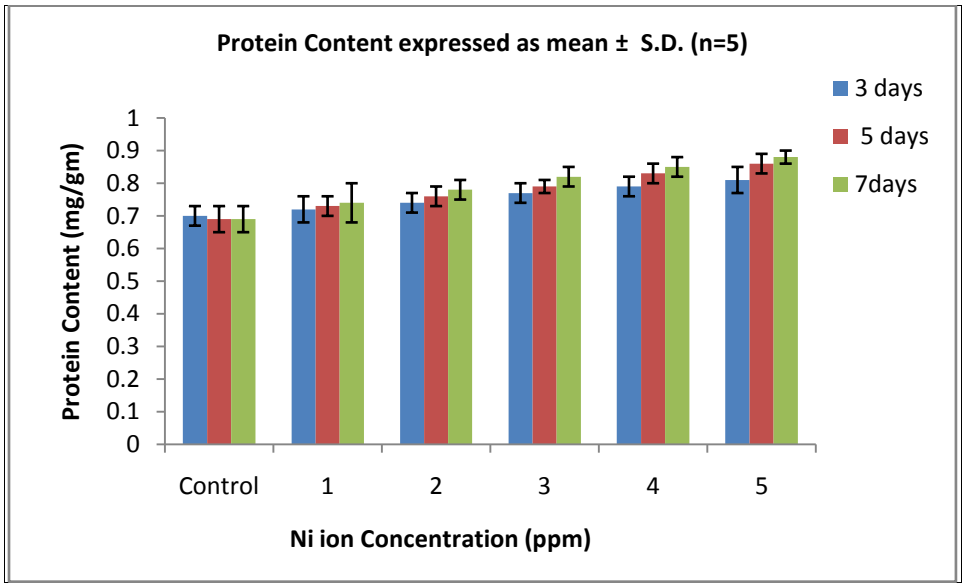


Figure 27: Protein Content of *L. polyrhiza* L. at different concentration of Ni metal ion

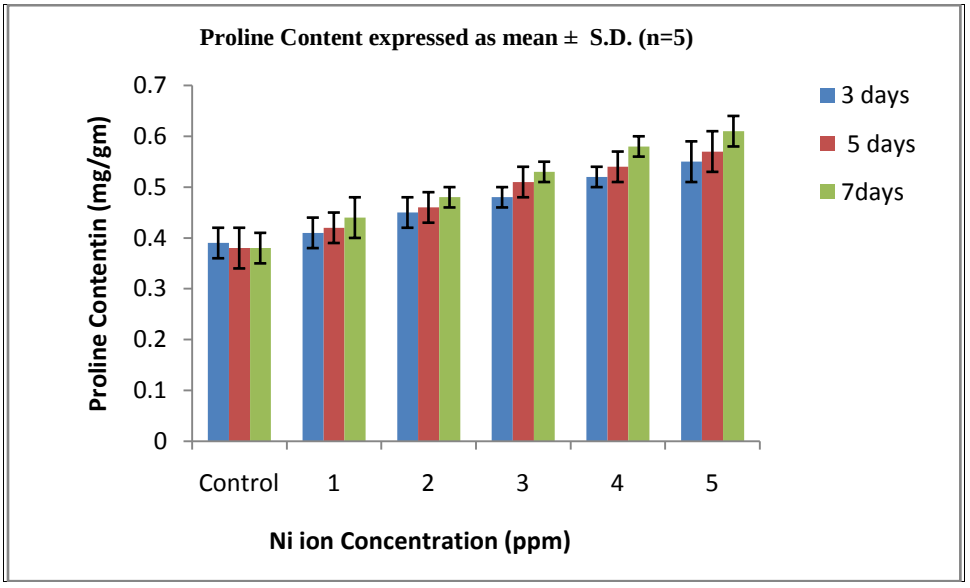


Figure 28: Proline Content of *L. polyrhiza* L. at different concentration of Ni metal ion

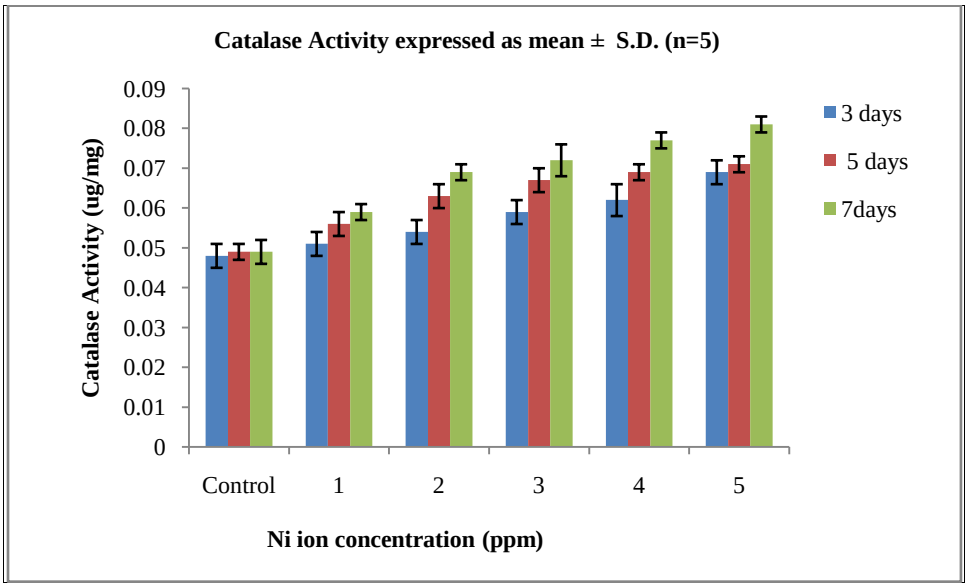


Figure 29: Catalase Activity of *L. polyrhiza* L. at different concentration of Ni metal ion

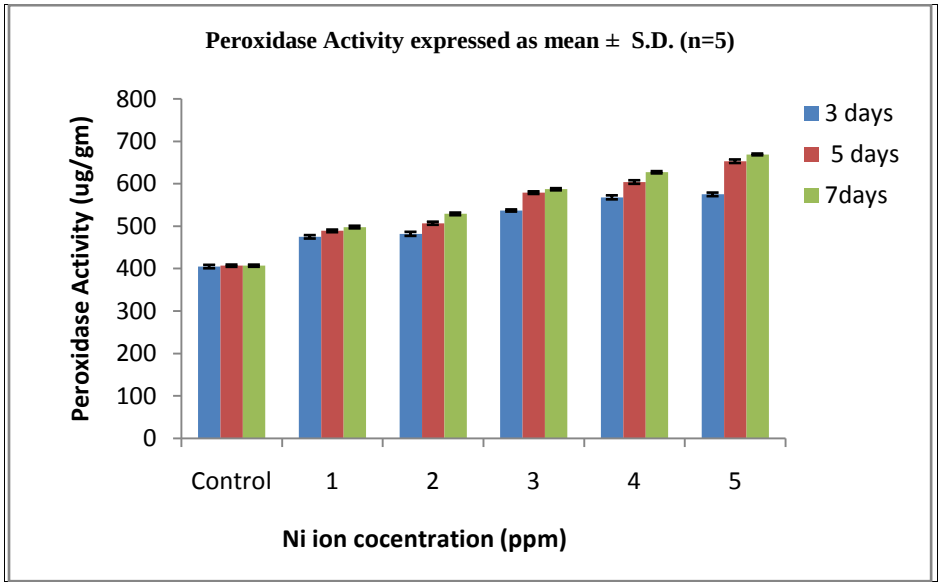


Figure 30: Peroxidase Activity of *L. polyrhiza* L. at different concentration of Ni metal ion

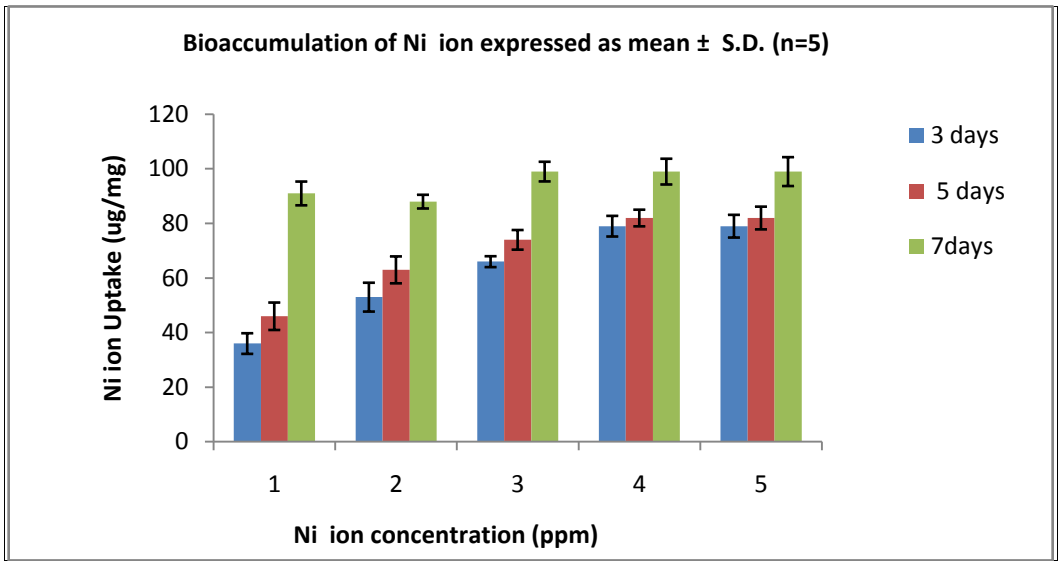


Figure 31: Bioaccumulation of Ni ion of *L. polyrhiza* L. in the different concentration of Ni metal ion

Total Chlorophylls Content

The results of effect of Ni ion concentration on total chlorophyll content of *L. polyrhiza* L. is represented in Figure 25. It was observed that as the concentration of the Ni ion increased from 1 ppm to 5 ppm, total chlorophyll content decreased gradually. The prolonged exposure of 5 days to high concentration of Ni i.e. 5 ppm significantly reduced (45%) chlorophyll than the control. Significant difference was observed and results of chlorophyll results were compared with control on 3^{rd} ($P = 0.00<0.05$), 6^{th} ($P= 0.01< 0.05$) and 9^{th} ($P= 0.00< 0.05$) treatment period followed by paired t test. No significant results were obtained ($P = 0.1 > 0.05$) when chi square test was performed.

Total Carbohydrates Content

Figure 26 shows the effect of Ni ion on carbohydrate content of *L. polyrhiza L.* It depicted total carbohydrate content decreased as concentration of Ni ion increased. A negative correlation was recorded with the increased metal ion concentrations and the treatment period. Significant difference was observed when carbohydrate content of the treated plants were compared with control on various treatment period i.e. 3,5 and 7 days ($P = 0.002 > 0.05$) followed by paired t test. Additionally, in chi square test, we did not find significant results ($P= 1.00 > 0.05$).

Protein Content

All the experimental concentrations showed negligible rise in protein content as the period of treatment increased from 3 to 7 days (Figure 27) and with increased Ni ion concentrations in all the treatment periods. Protein showed 12% rise when the plants were treated with 7 ppm Ni ions following exposure of 7 days. We obtained significant difference when protein content of 6^{th} 5^{th} and 7^{th} day ($P= 0.00 < 0.05$) treated plant as compared to control followed by paired t test. Furthermore, in chi square test, no significant results were obtained ($P= 1.0> 0.05$).

Proline Content

The effect of Ni ion on Proline content of the *L. poyrhhiza* L. is represented in Figure 28. A concentration dependent rise in the level of proline was observed during all experimental exposure period. But a negative correlation was found between the period of exposure and level of proline content. There is significant difference between proline content of the treated and control plants and treatment periods (3,5 and 7 days) ($P = 0.00< 0.05$). While in chi square test, there is no significant results were obtained ($P= 1.0 >0.05$).

Catalase and peroxidase Activity

As per results obtained the activity of both catalase and peroxidase were significantly higher in treated plants in comparison to the control plants. (Figure 29 and 30) Greater activities of catalase and guaicol peroxidase indicated that the treated plant were under oxidative stress. In the present investigation, it was reported that activities of catalase enhanced linearly with increased metal ion concentration whereas the activity of guaicol peroxidase showed increase with metal ion concentration only at 3 day of exposure period. Thereafter it decreased at 5 and 7 day exposure periods. We found significant difference when catalase activity of the treated (exposed in 3,5 and 7 days) were compared with control ($P = 0.00 < 0.05$) and peroxidase activity ($P = 0.00 < 0.05$) followed by paired t test. Furthermore, in chi square test, there is no significant results were obtained ($P = 1.00 > 0.05$) for catalase activity Peroxidase activity.

Bioaccumulation of Ni ion

Bioaccumulation of Ni ion in the test plants at different concentration is as shown in Figure 31. Exposure to 1 to 5 ppm metal ion concentration increased the accumulation of metal ion in all the experimental exposure periods. There is significant difference between Ni metal uptake of the test plants were compared with control on 3, 5 and 7 days ($P = 0.0\ 1 < 0.05$) followed by paired t test. Furthermore, in chi test, there is no significant results were obtained ($P = 1.00 > 0.05$).

4.5.3 Effect of Cd ion on biochemical parameters of *L. polyrhiza* L.

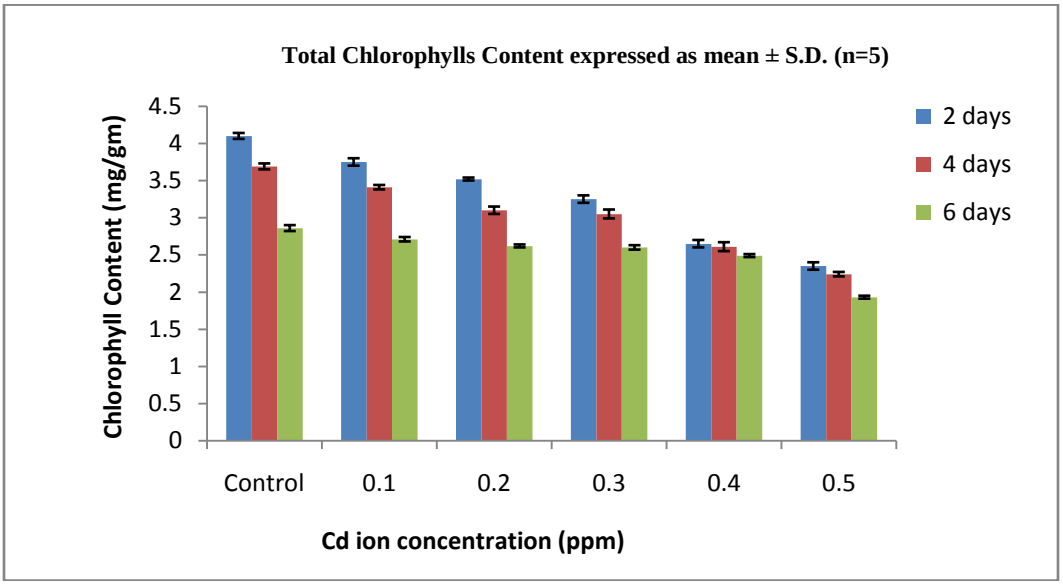


Figure 32: Total Chlorophylls Content of *L. polyrhiza* L. at different concentration of Cd metal ion

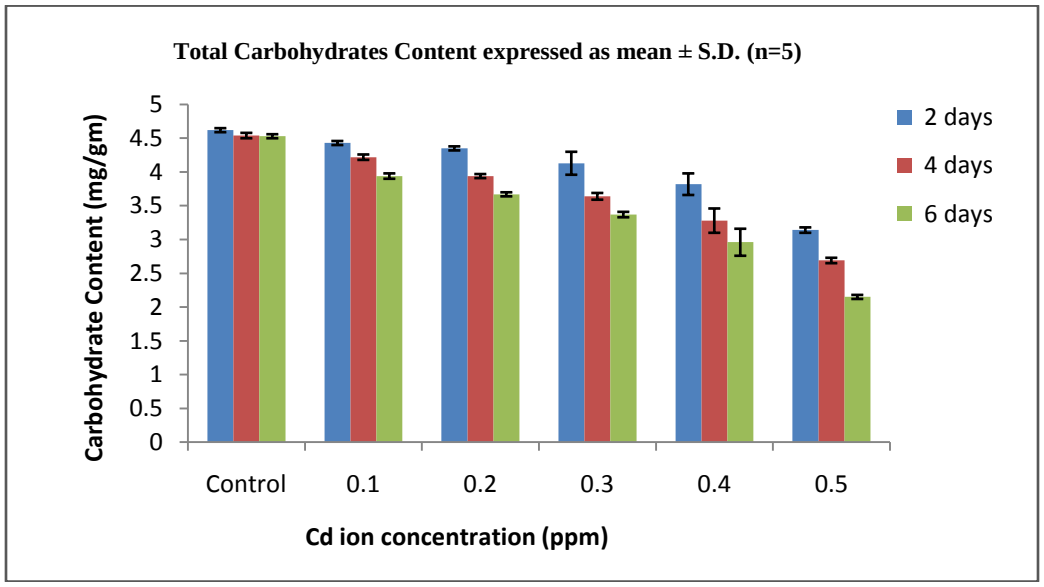


Figure 33: Total Carbohydrates Content of *L. polyrhiza* L. in the different concentration of Cd metal ion

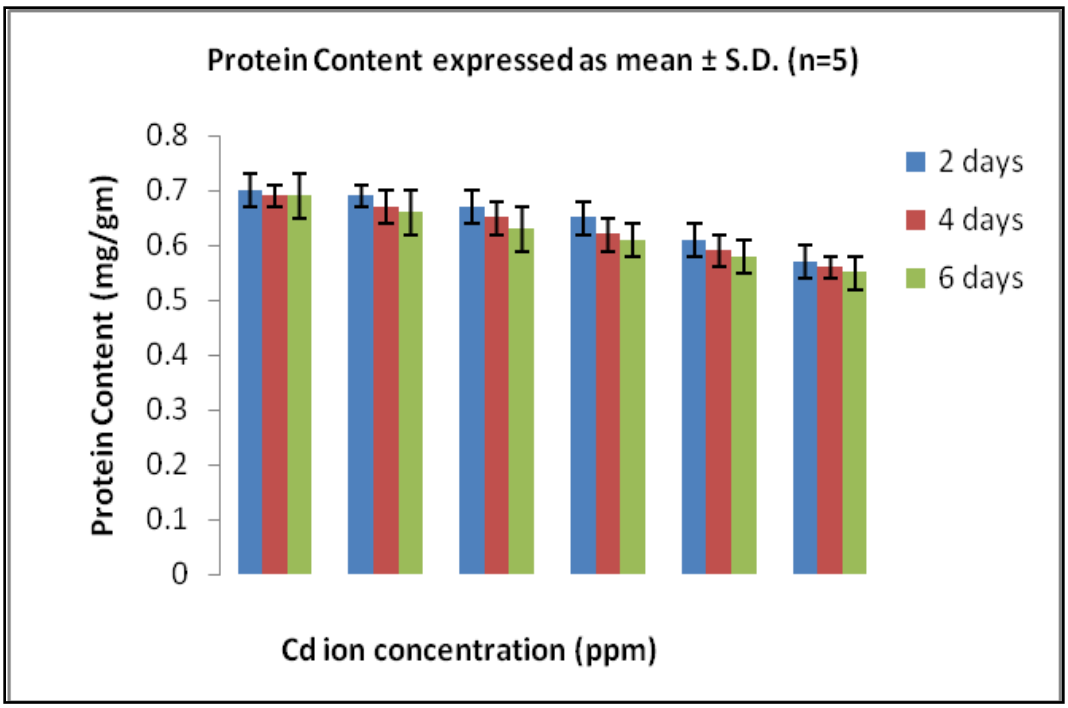


Figure 34: Protein Content of *L. polyrhiza* L. at different concentration of Cd metal ion

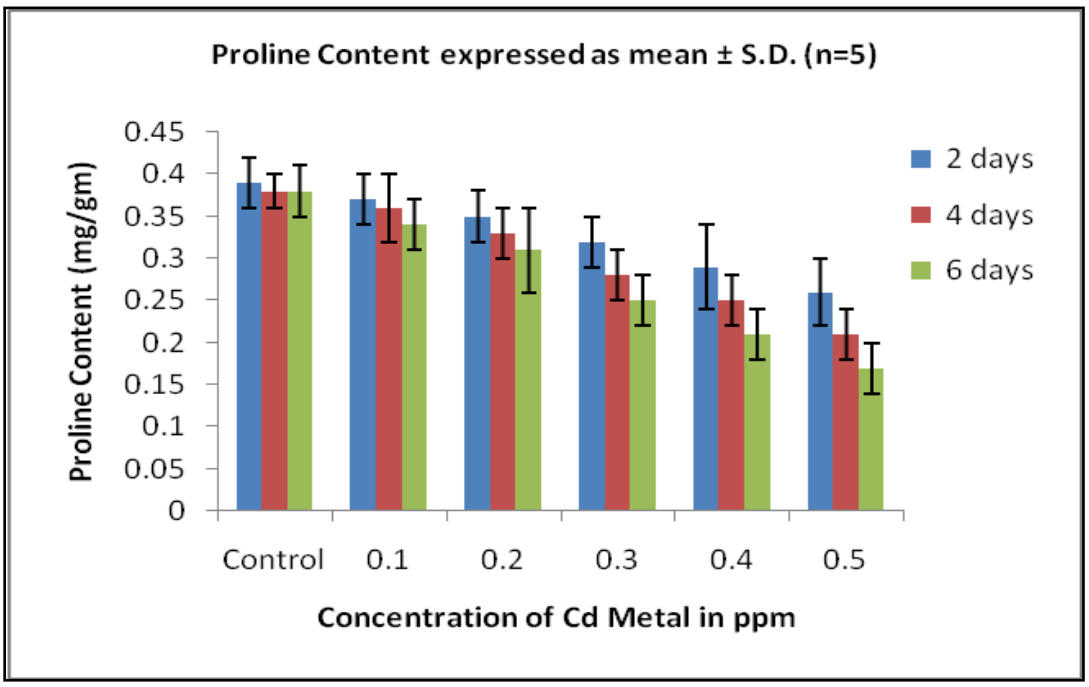


Figure 35: Proline Content of *L. polyrhiza* L. in the different concentration of Cd metal ion

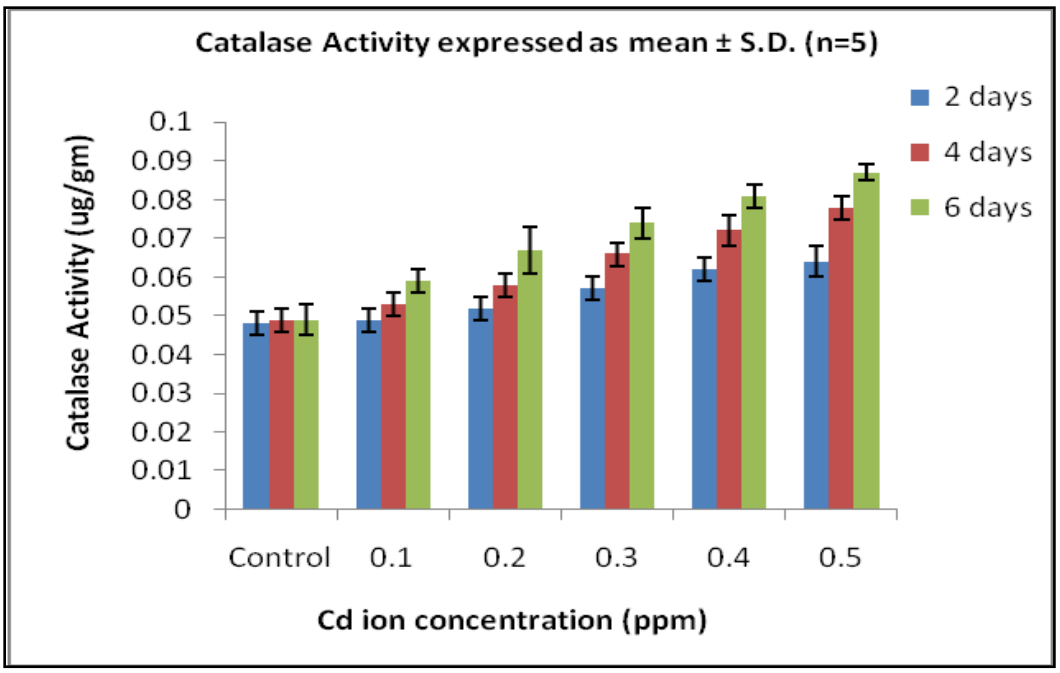


Figure 36: Catalase Activity of *L. polyrhiza* L. at different concentration of Cd metal ion

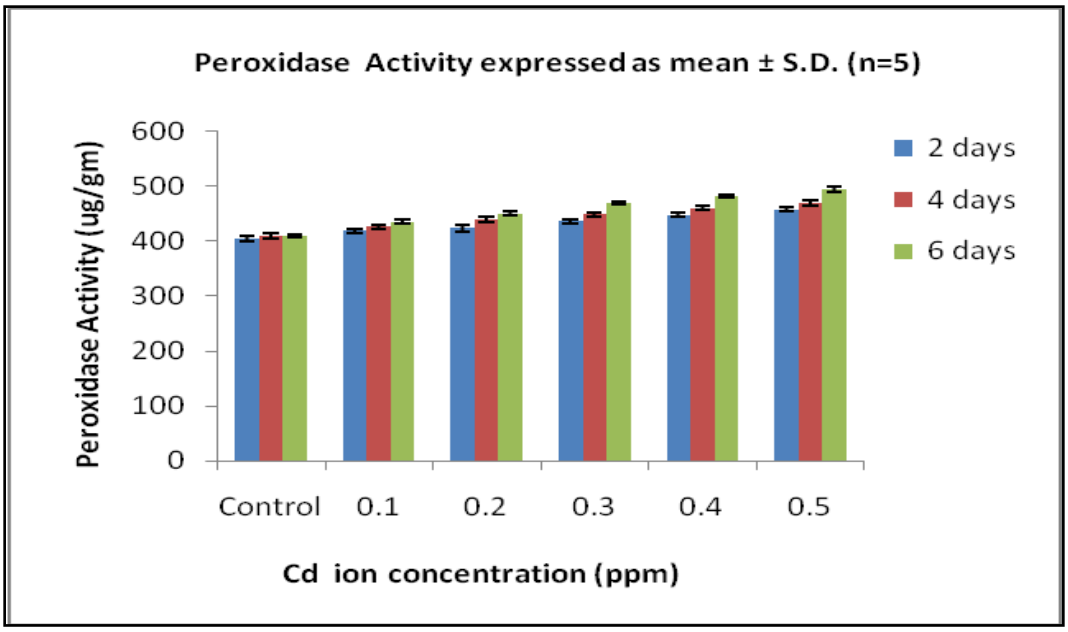


Figure 37: Peroxidase Activity of *L. polyrhiza* L. at different concentration of Cd metal ion

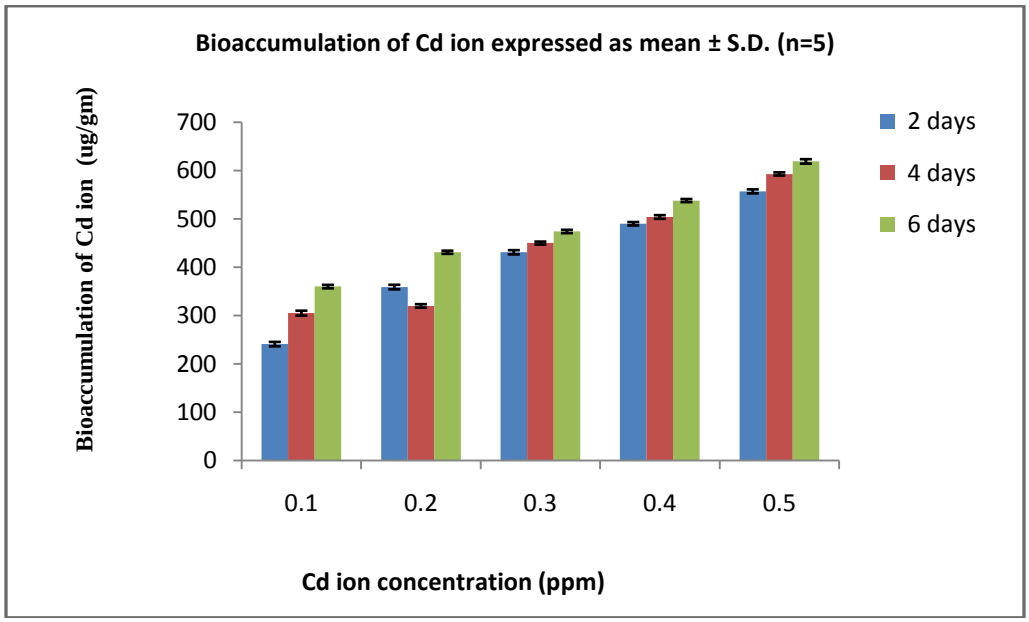


Figure 38: Bioaccumulation of Cd ion of *L. polyrhiza L.* at different concentration of Cd metal ion

Total Chlorophylls Contents

The results of effect of Cd metal ion concentration on total chlorophyll content of *Lemna polyrrhiza* L. is represented in Fig. 32. The chlorophyll content showed gradual decline as the treatment period and the metal ion concentration increased. The prolonged exposure of 6 days to high concentration of Cd i.e. 0.5 ppm significantly reduced (45%) chlorophyll than the control. A significance difference were observed when chlorophyll content of control plant were compared with various treatment period ($P = 0.001<0.05$) followed by paired t test. A significant difference were not obtained when similar results followed by chi square test ($P= 0.85>0.05$)

Total Carbohydrates Contents

Figure 33 shows the effect of Cd ion on carbohydrate content of *L. polyrhiza L.* that total carbohydrate content decrease as concentration of Cd ion increased. A negative correlation was recorded with the increased metal ion concentrations and the treatment period.

A significant difference was observed when carbohydrate content of the treated plants were compared with control on 2rd day (P = 0.017<0.05). In addition to that we found significant difference when carbohydrate content of 4 th day (P= 0.002< 0.05) and 6th day (P= 0.006> 0.05) treated plants were compared with control followed by paired t test. Additionally, in chi square test, we did not find significant results (P= 0.57 > 0.05).

Protein Content

All the experimental concentrations shows decline in protein content as the period of treatment increased from 2 to 6 days and with increased Cd ion concentrations in all the treatment periods (Figure 34). Protein showed 20% decline when the plants were treated with 0.5 ppm Cd ions following exposure of 6 days. We obtained significant difference when protein content of 6th 5th and 7th day (P= 0.00 < 0.05) treatment plant when compared with control followed by paired t test. Furthermore, in chi square test, no significant results were obtained (P= 1.0> 0.05).

Proline Content

The effect of Cd ion on Proline content of the *L. poyrhiza L.* is represented in Figure 35 A concentration dependent rise in the level of proline was observed during all experimental exposure period. But negative correlation was found between the period of exposure and level of proline content. There is significant difference between proline content of the treated and control plants and treatment periods (3,5 and 7 days) (P = 0.00< 0.05). While in chi square test, there is no significant results were obtained (P= 1.0 >0.05).

Catalase and peroxidase Activity

The results depicted that the activity of both catalase and peroxidase were sigificantly higher in treated plants in comparison with the control plants. (Figure 36 and 37) Greater activities of catalase and guaicol peroxidase indicated that the treated plant were under oxidative stress.

In the present investigation it was reported that activities of catalase enhanced linearly with increased metal ion concentration whereas the activity of guaicol peroxidase showed increase with metal ion concentration at 3 day of exposure period. Thereafter it decreased at 5 and 7 day exposure periods. We found significant difference when catalase activity of the treated (exposed in 3,5 and 7 days) were compared with control ($P = 0.00 < 0.05$) and peroxidase activity ($P = 0.00 < 0.05$) followed by paired t test. Furthermore, in chi square test, there is no significant results were obtained ($P = 1.00 > 0.05$) for catalase activity Peroxidase activity.

Bioaccumulation of Cd Metal

Bioaccumulation of cd ion in the test plants at different concentration is as shown in Figure 38. Exposure to 0.1 to 0.5 ppm increased the accumulation of metal ion in all the experimental exposure periods. There is significant difference between Ni metal uptake of the test plants when compared with control on 2, 4 and 6 days ($P = 0.0\ 3 < 0.05$) followed by paired t test. Furthermore, in chi test, there is no significant results were obtained ($P = 1.00 > 0.05$).

4.5.1 Effect of Zn ion on biochemical parameters of *L. triscula* L.

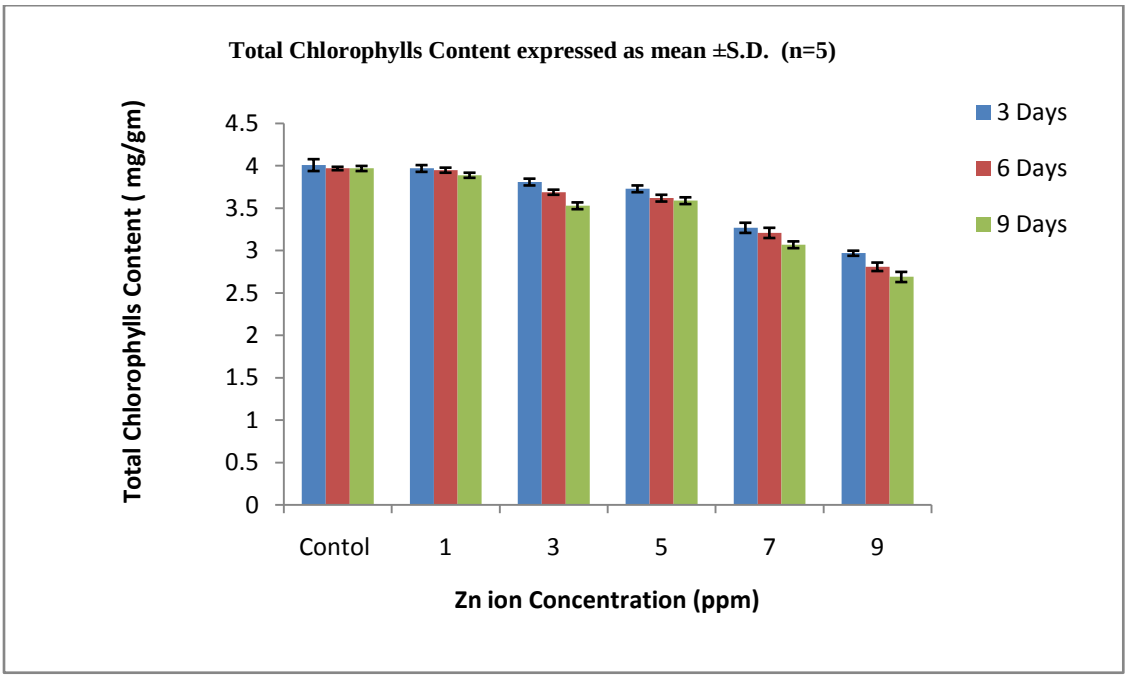


Figure 39 : Total chlorophylls content of *L. triscula* L. at different concentration of Zn metal ion

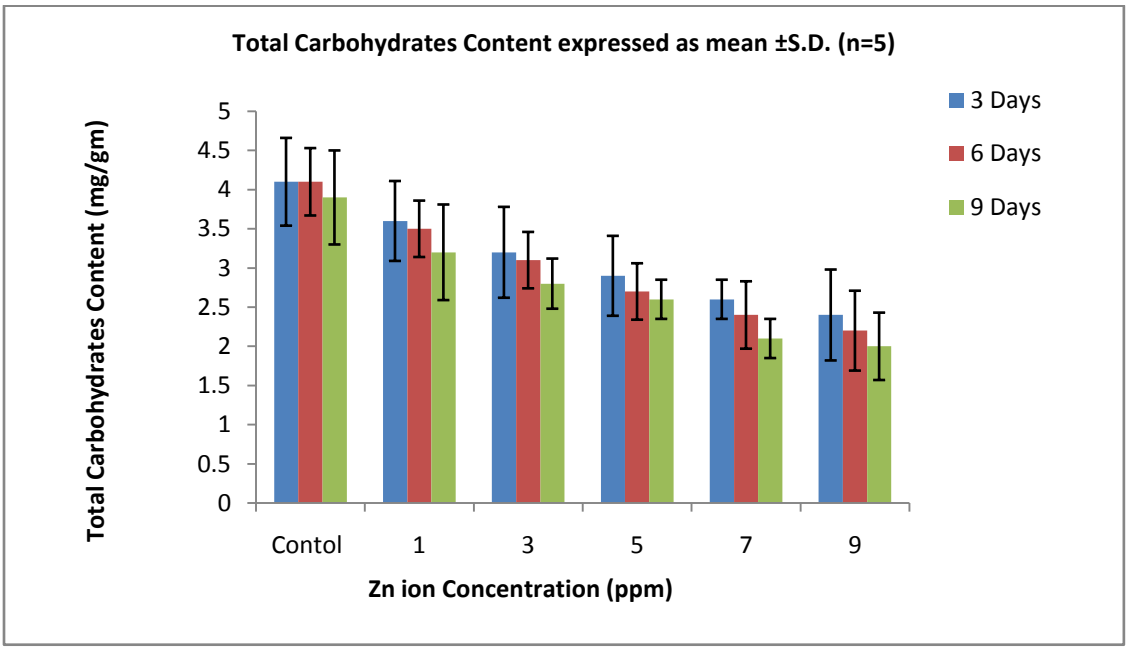


Figure 40 : Total Carbohydrate content of *L. triscula* L. *at* different concentration of Zn metal ion

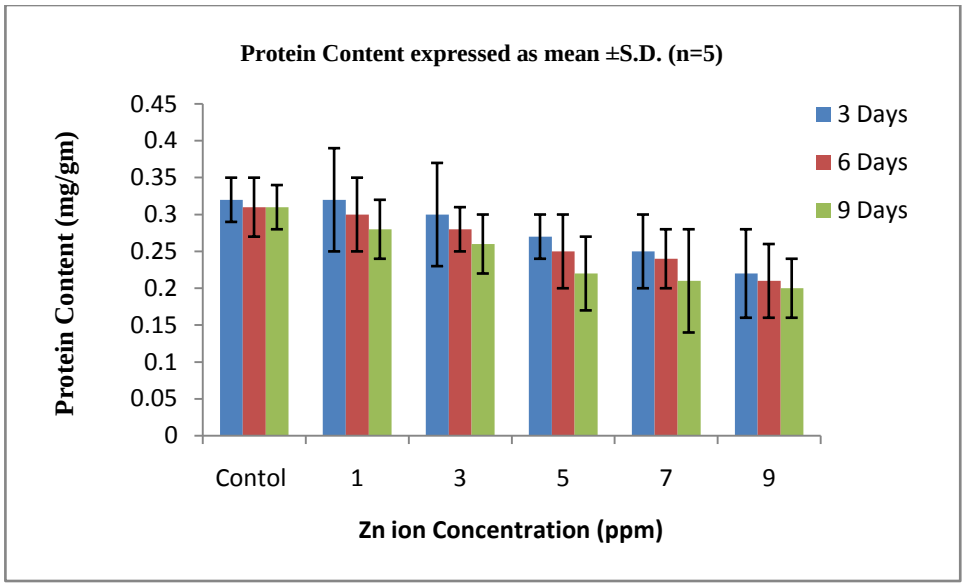


Figure 41 : Protein content of *L. triscula* L. *at* different concentration of Zn metal ion

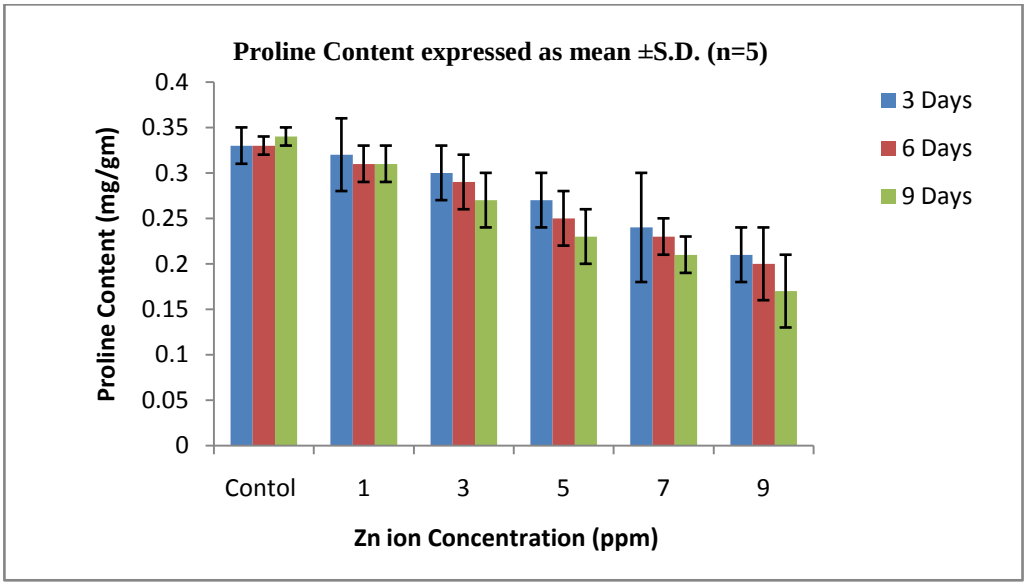


Figure 42 : Proline content of *L. triscula L. at* different concentration of Zn metal ion

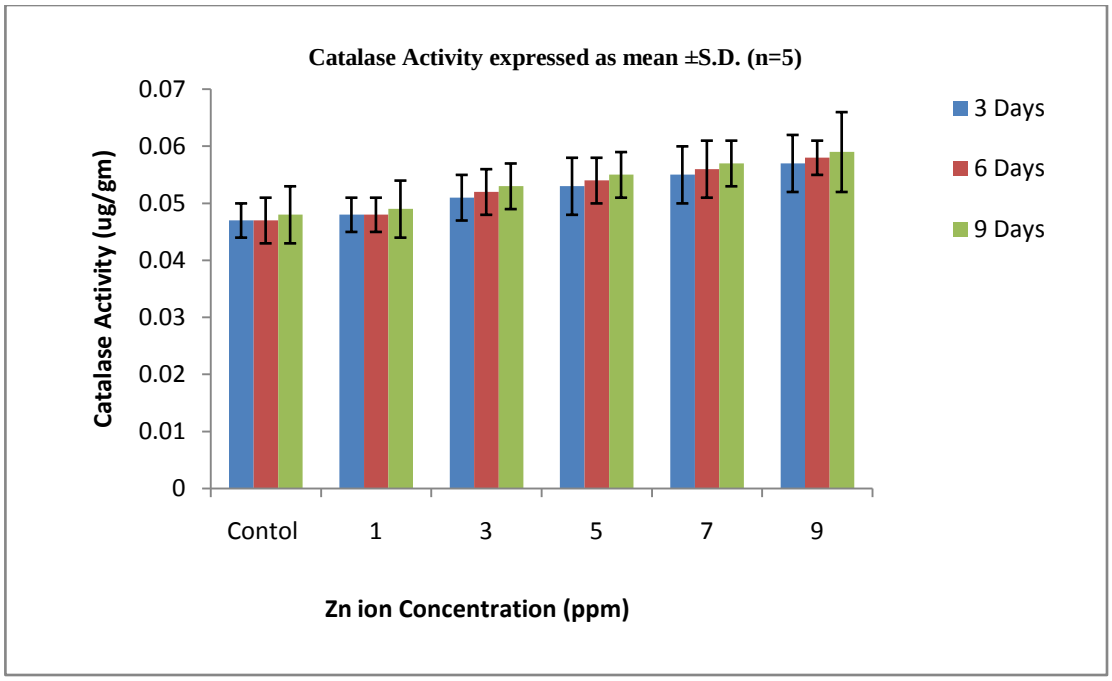


Figure 43 : Catalase activity of *L.triscula* L. *at* different concentration of Zn metal ion

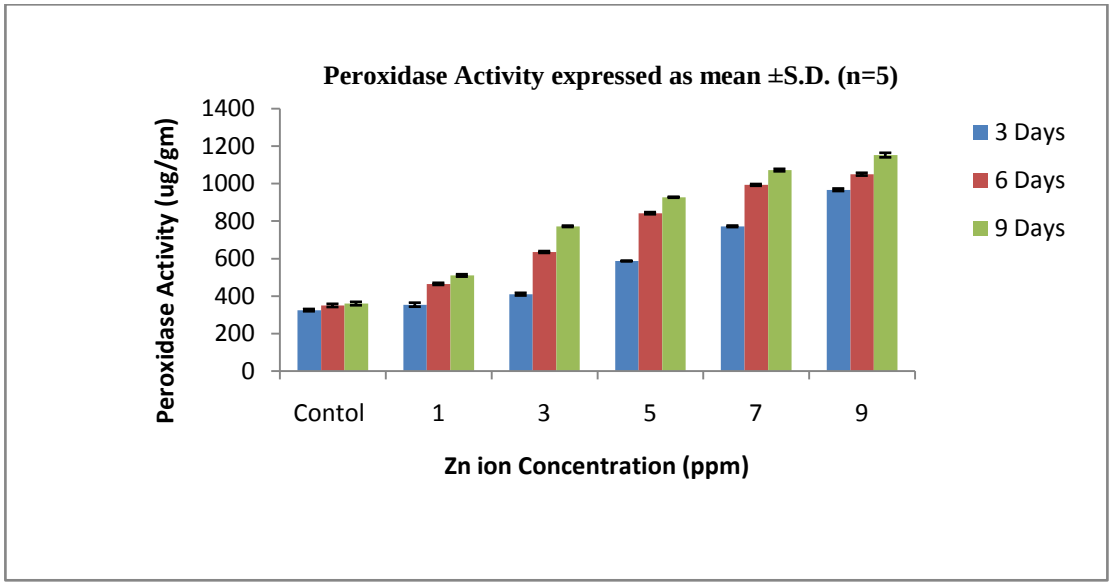


Figure 44 : Peroxidase activity of *L. triscula* L. at different concentration of Zn metal ion

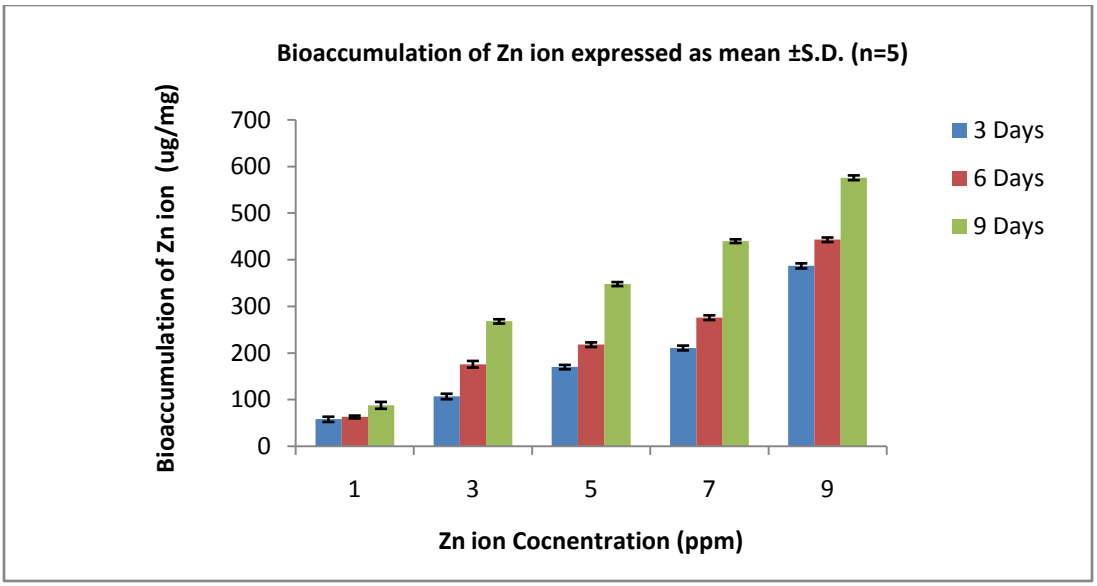


Figure 45: Zn ion uptake of *L. triscula* L. at different concentration of Cd metal ion

Chlorophyll Content

The results of effect of Zn metal ion concentration on total chlorophyll content of *L. triscula L.* is represented in Figure 39. It was observed that the chlorophyll content showed decline as the treatment period and the metal ion concentration increased. The prolonged exposure of 9 days to high concentration of Zn i.e. 9 ppm significantly reduced (50%) chlorophyll than the control. Significant difference was observed and results of chlorophyll results were compared with control on 3^{rd} ($P = 0.007<0.05$), 6^{th} and 9^{th} ($P= 0.009< 0.05$) treatment period followed by paired t test. No significant results were obtained ($P = 1.0 > 0.05$) when chi square test was performed.

Total Carbohydrates Content

Data presented in Figure 40 revealed that total carbohydrate content decreased as the metal concentration and treatment period increased. A negative correlation was recorded with the increased metal ion concentrations and the treatment period. Significant difference was observed when carbohydrate content of the treated plants were compared with control on 3^{rd} day and 6^{th} day ($P = 0.001 >0.05$).

In addition to that we found significant difference when carbohydrate content of 9^{th} day (P= 0.002< 0.05) when treated plants were compared with control followed by paired t test. Additionally, in chi square test, we did not find significant results (P= 1.0 > 0.05).

Protein Content

All the experimental concentrations gradually declined protein content as the period of treatment increased from 3 to 9 days (Figure 41). It also decreased with increased metal ion concentrations in all the treatment periods. Protein showed 62% reduction when the plants were treated with 9 ppm Zn ions following exposure of 9 days. Significant difference was observed when Protein content of the treated plants were compared with control on 3^{rd} day (P = 0.00 < 0.05). We obtained significant difference when protein content of 6^{th} day (P= 0.01 < 0.05) and 9^{th} day (P= 0.007 < 0.05)treatment plant when compared with control followed by paired t test. Furthermore, in chi square test, no significant results were obtained (P= 1.0 > 0.05).

Proline Content

The effect of Zn ion on Proline content of the *L. triscula* L. is represented in Figure 42. A concentration dependent rise in the level of proline was observed during all experimental exposure period. But negative correlation was found between the period of exposure and level of proline content. There is significant difference between proline content of the treated and control plants on 3^{rd} day, 6^{th} day, and 9^{th} day treatment period (P = 0.00< 0.05) were compared with control followed by paired t test. Furthermore, in chi square test, there is no significant results were obtained (P= 0.95 > 0.05).

Catalase and peroxidase Activity

As per results obtained, the activity of both catalase and peroxidase were significantly higher in treated plants in comparison with the control plants. (Fig. 43 and 44) Greater activities of catalase and guaicol peroxidase indicated that the treated plant were under oxidative stress. In the present investigation it was reported that activities of catalase and guaicol peroxidase enhanced linearly with increased metal ion concentration with increase exposure periods. We found significant difference when catalase activity and peroxidase activity of the treated (exposed in 3,6 and 9 days) were compared with control followed by paired t test ($P = 0.00 < 0.05$). Furthermore, in chi square test, there is no significant results were obtained for catalase activity and for Peroxidase activity ($P = 1.0 > 0.05$).

Bioaccumulation of Zn ion

Bioaccumulation of Zn ion in the test plants at different concentrations is as shown in Figure 45. Exposure to 1 and 3 ppm increased the accumulation of metal ion in all the experimental exposure periods. The concentration beyond 3 ppm i.e. 5,7 and 9 decreased the uptake at 3 day exposure. Also, no further rise in the uptake were reported at 6 and 9 days in test concentrations. There is significant difference between Zn metal uptake of the test plants were compared with control on 3^{rd} day ($P = 0.012 < 0.05$). We obtained significant difference when protein content of 6^{th} day ($P = 0.06 < 0.05$) and 9^{th} day ($P = 0.001 < 0.05$)treatment plant when compared with control followed by paired t test. Furthermore, in chi test, there is no significant results were obtained ($P = 1.00 > 0.05$).

4.5.5 Effect of Ni ion on biochemical parameters of L. *triscula* L.

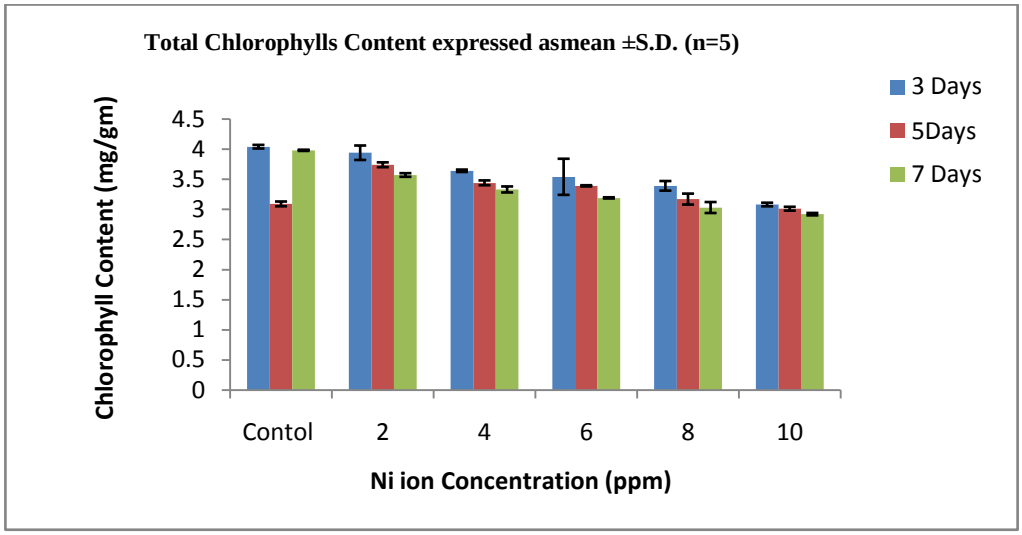


Figure 46 : Total Chlorophylls Content of *L.triscula* L. at different concentration of Ni metal ion

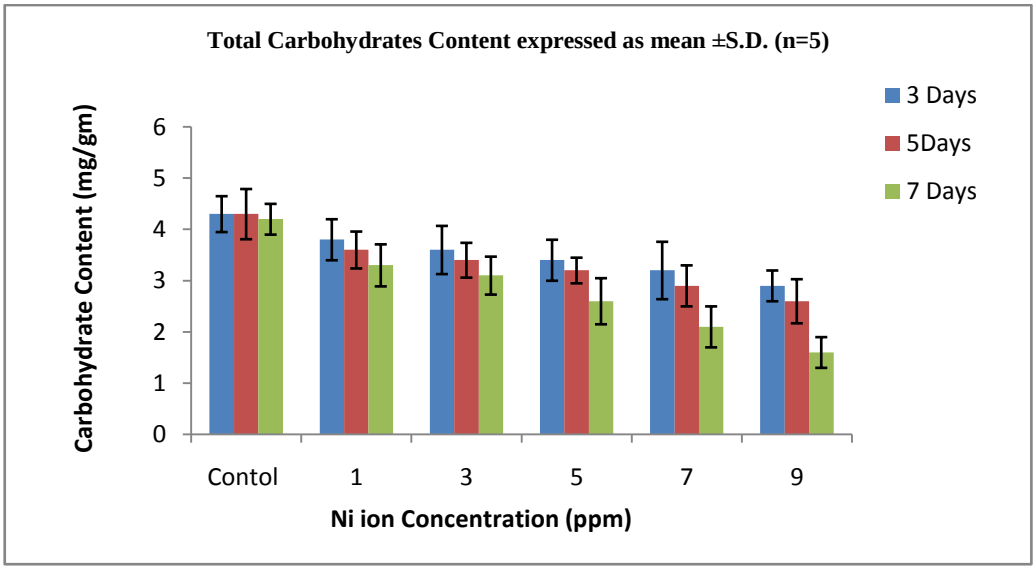


Figure 47 : Carbohydrate Content of *L.triscula* L. at diffenernt concentration of Ni metal ion

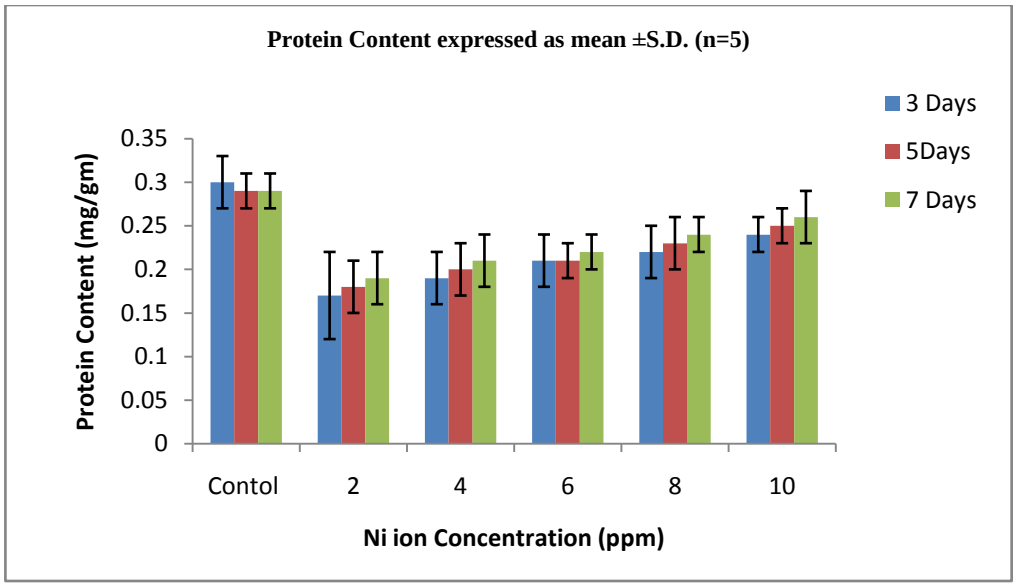


Figure 48 : Protein Content of *L.triscula L.* at different concentration of Ni metal ion

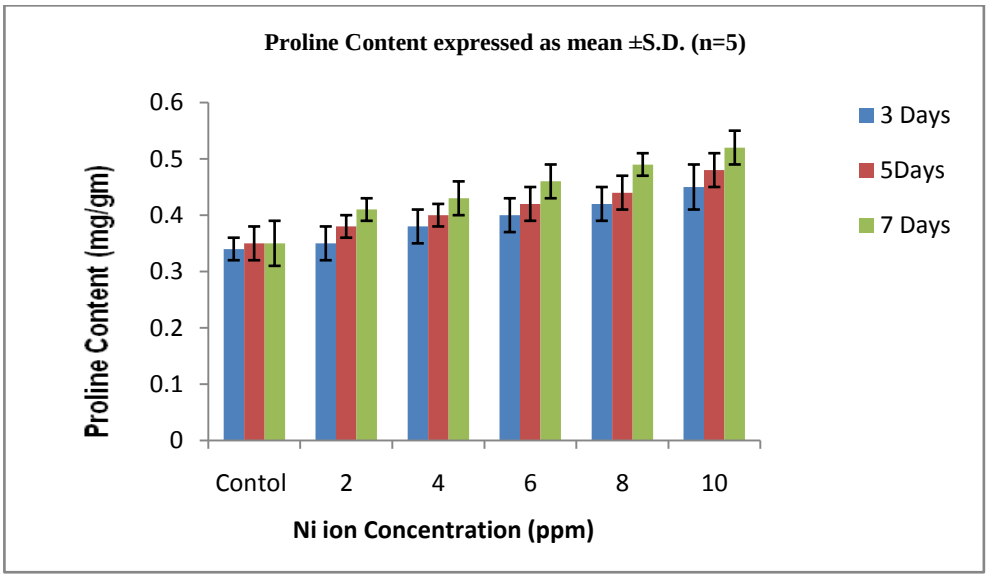


Figure 49 : Proline Content of *L.triscula* L. at different concentration of Ni metal ion

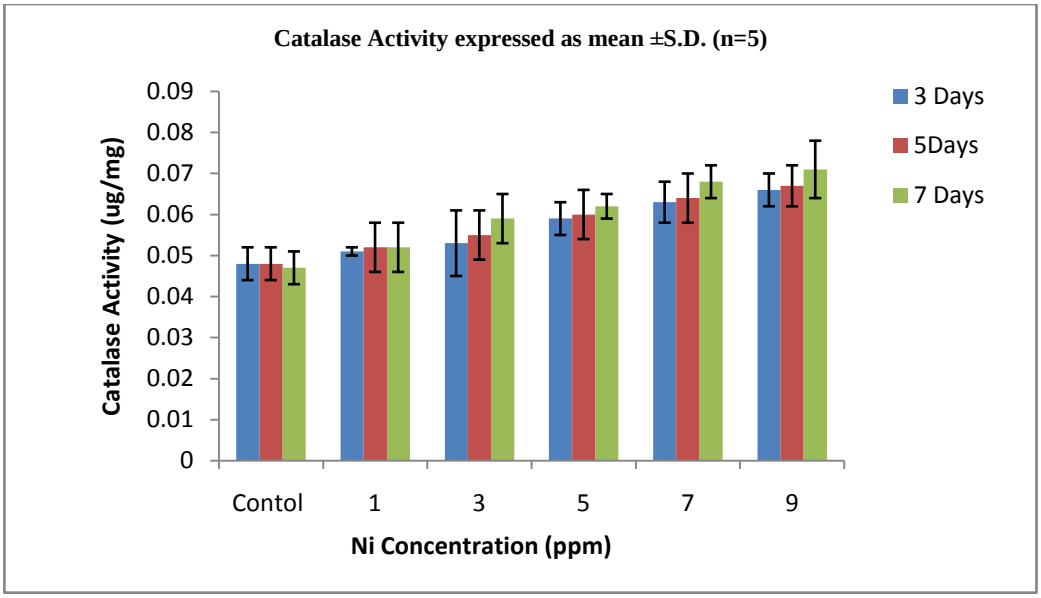


Figure 50 : Catalase Activity of *L.triscula* L. at different concentration of Ni metal ion

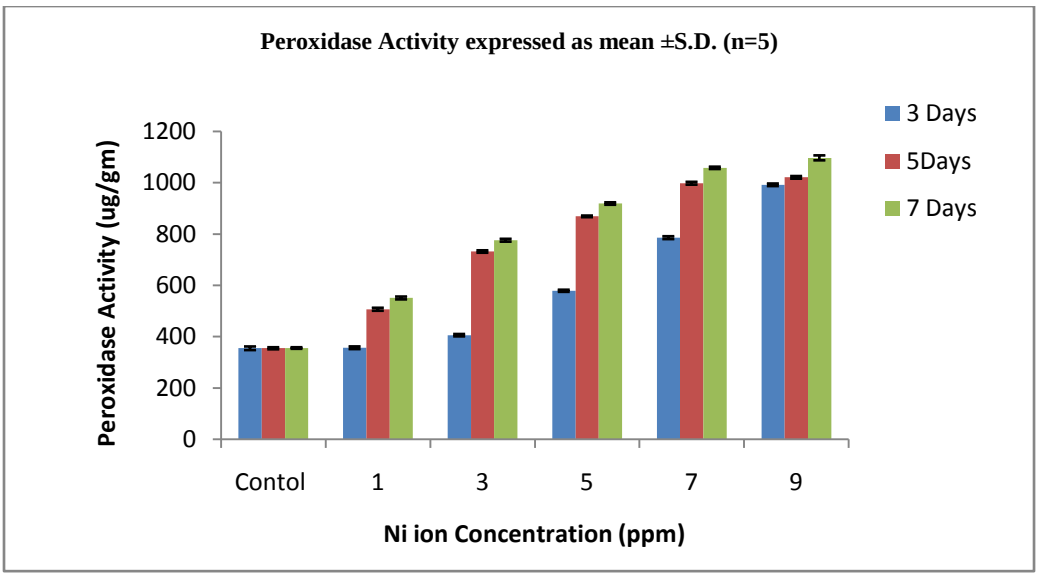


Figure 51 : Peroxidase Activity of *L.triscula* L. at different concentration of Ni metal ion

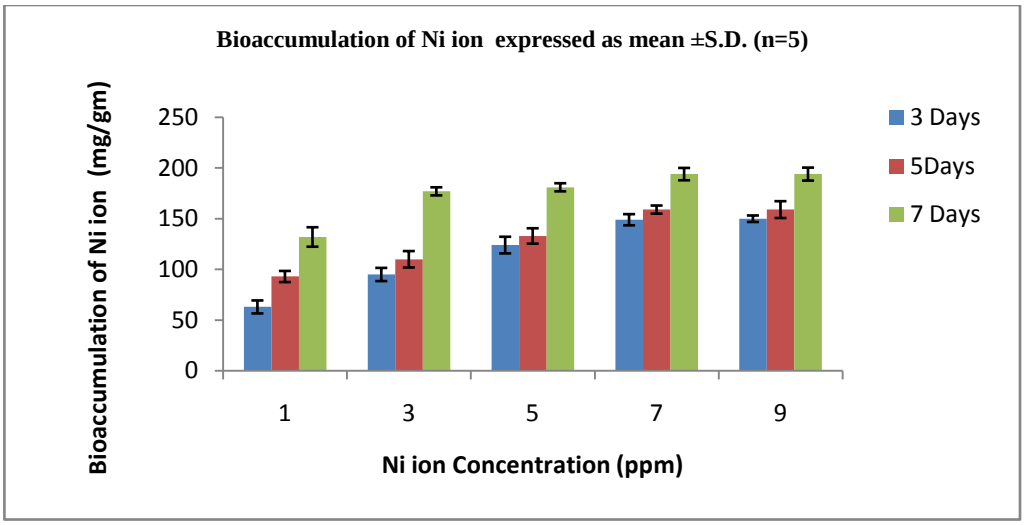


Figure 52 : Bioaccumulation of Ni ion of *L.triscula* L. at different concentration of Ni metal ion

Chlorophyll Content

The results of effect of Ni ion concentration on total chlorophyll content of *L. triscula* L. is represented in Figure 46. It was observed that as the concentration of the Ni ion increased from 2 ppm to 10 ppm, total chlorophyll content decreased gradually. The prolonged exposure of 7 days to high concentration of Ni i.e. 5 ppm significantly reduced (40%) chlorophyll than the control. Significant difference was observed and results of chlorophyll results were compared with control on 3^{rd} and 6^{th} day ($P = 0.03 < 0.05$) and 9th ($P= 0.10< 0.05$) treatment period followed by paired t test. No significant results were obtained ($P = 0.1 > 0.05$) when chi square test was performed.

Total Carbohydrates Content

Figure 47 shows the effect of Ni ion on carbohydrate content of *L. triscula* L. It is evident that total carbohydrate content decreased (37.2%) as concentration of Ni ion increased. A negative correlation was recorded with the increased metal ion concentrations and the treatment period. Significant difference was observed when carbohydrate content of the treated plants were compared with control on treatment period i.e. 3 and 5 days ($P = 0.000 >0.05$) and 7 days ($P= 0.001<0.05$) followed by paired t test. Additionally, in chi square test, we did not find significant results ($P= 1.00 > 0.05$).

Protein Content

All the experimental concentrations showed decreased in protein content as the period of treatment increased from 3 to 7 days and with increased Ni ion concentrations in all the treatment periods (Figure 48). Protein showed increased when the plants were treated with 9 ppm Ni ions following exposure of 7 days. We obtained significant difference when protein content of 3^{th} 5^{th} and 7^{th} day (P= 0.00 < 0.05) treated plant as compared to control followed by paired t test. Furthermore, in chi square test, no significant results were obtained (P= 1.0> 0.05).

Proline Content

The effect of Ni ion on Proline content of the *L. triscula* L. is represented in Figure 49. A concentration dependent rise in the level of proline was observed during all experimental exposure period. But a negative correlation was found between the period of exposure and level of proline content. There is significant difference between proline content of the treated and control plants and treatment periods (3,5 and 7 days) (P = 0.00< 0.05). While in chi square test, there is no significant results were obtained (P= 1.0 >0.05).

Catalase and Peroxidase activity

As per results obtained the activity of both catalase and peroxidase were significantly higher in treated plants in comparison to the control plants. (Fig. 50 and 41) enhanced activities of catalase and guaicol peroxidase indicated that the treated plant were under oxidative stress. In the present investigation, it was reported that activities of catalase enhanced linearly with increased metal ion concentration whereas the activity of guaicol peroxidase showed rise with metal ion concentration at 3 day, 5 and 7 day exposure periods. We found significant difference when catalase activity of the treated (exposed in 3,5 and 7 days) were compared with control (P = 0.01< 0.05) and peroxidase activity (P = 0.005< 0.05) followed by paired t test. Furthermore, in chi square test, there is no significant results were obtained (P= 1.00 > 0.05) for catalase activity Peroxidase activity.

Bioaccumulation of Ni ion

Bioaccumulation of Ni ion in the test plants at different concentration is as shown in Figure 52. Exposure to 2 to 10 ppm metal ion concentration increased the accumulation of metal ion in all the experimental exposure periods. There is significant difference between Ni metal uptake of the test plants were compared with control on 3, 5 and 7 days ($P = 0.0\ 07 < 0.05$) followed by paired t test. Furthermore, in chi test, there is no significant results were obtained ($P= 1.00 > 0.05$).

4.5.6 Effect of Cd ion on biochemical parameters of *L.triscula* L.

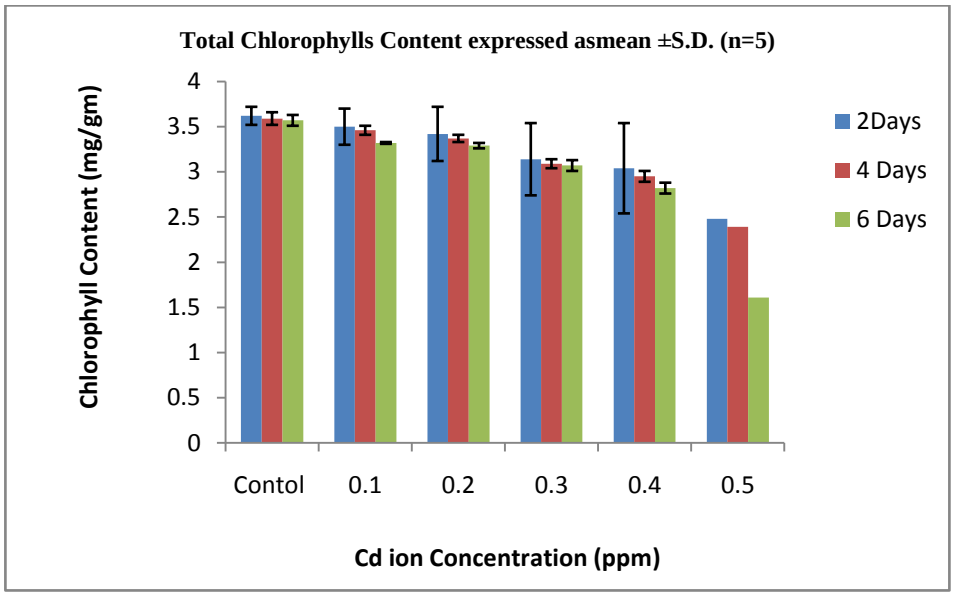


Figure 53 : Total Chlorophylls Content of *L.triscula* L. at different concentration of Cd metal ion

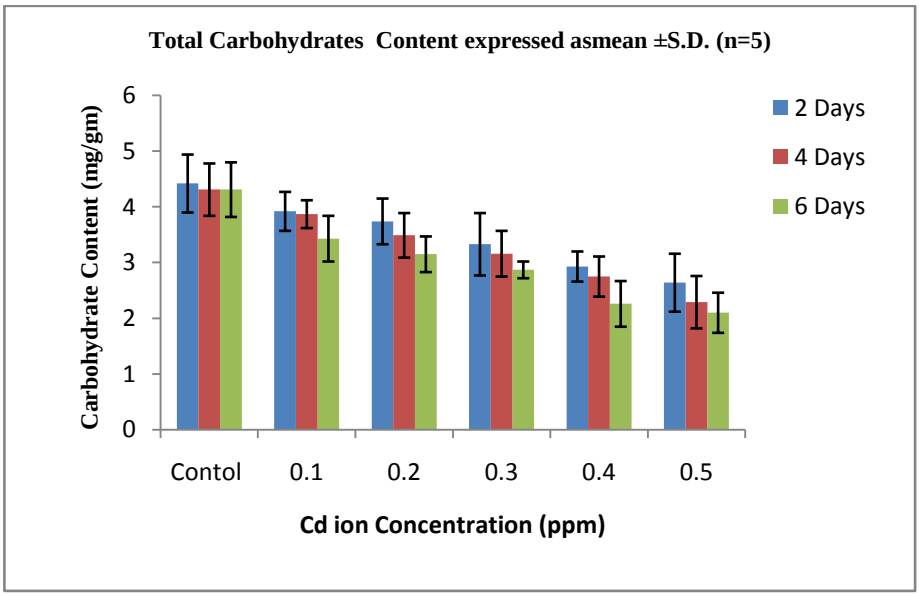


Figure 54 : Total Carbohydrates Content of *L.triscula* L. at different concentration of Cd metal ion

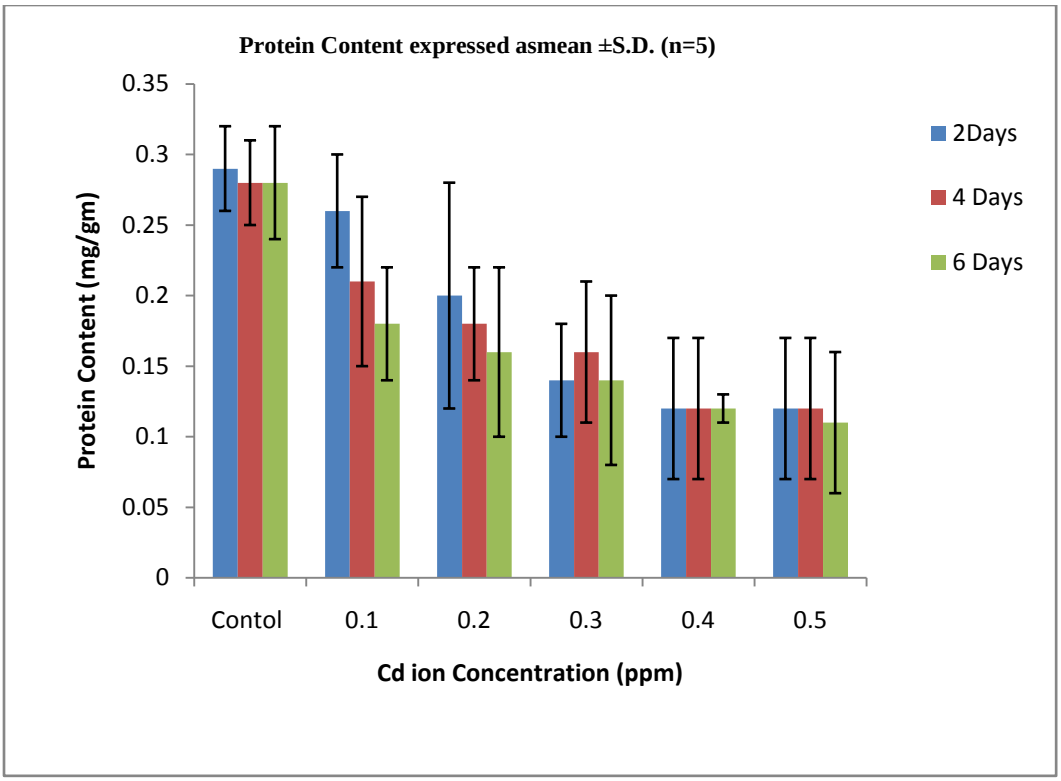


Figure 55 : Protein Content of *L.triscula* L. at different concentration of Cd metal ion

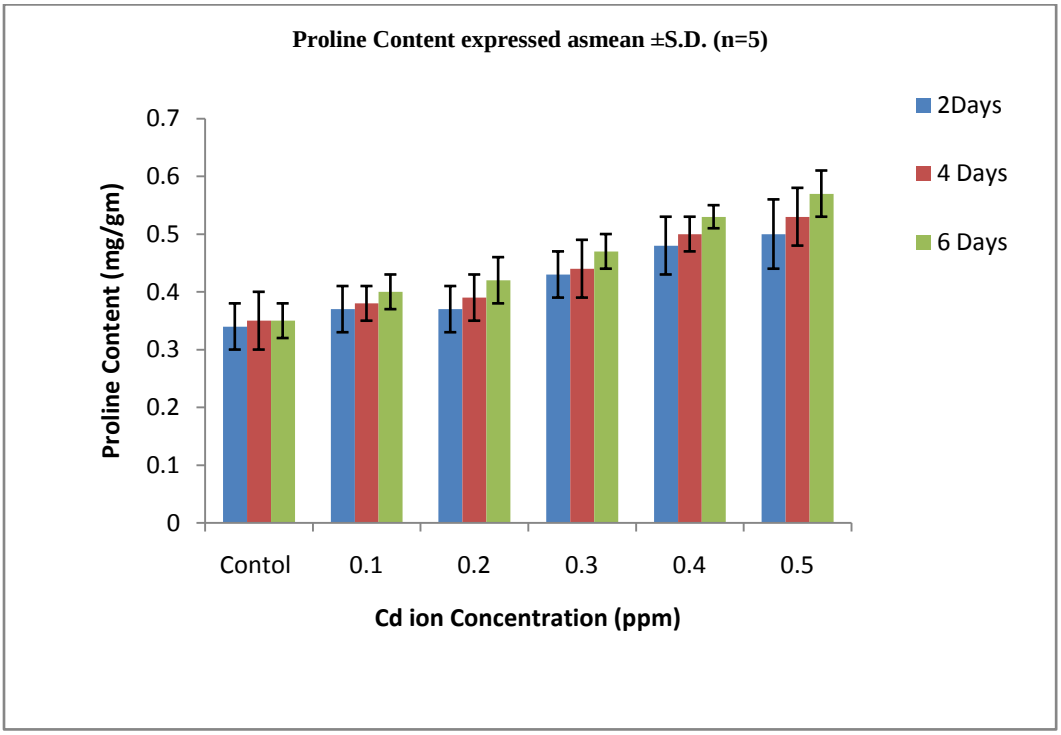


Figure 56 : Proline Content of *L.triscula* L. at diffenernt concentration of Cd metal ion

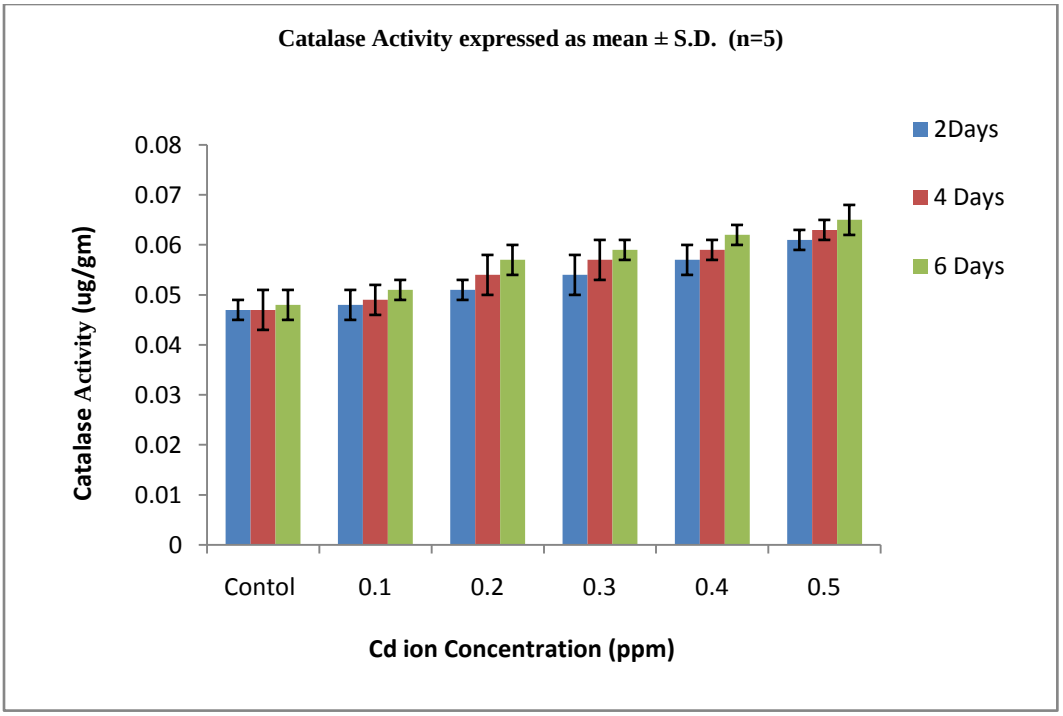


Figure 57 : Catalase Activity of *L.triscula* L. at different concentration of Cd metal ion

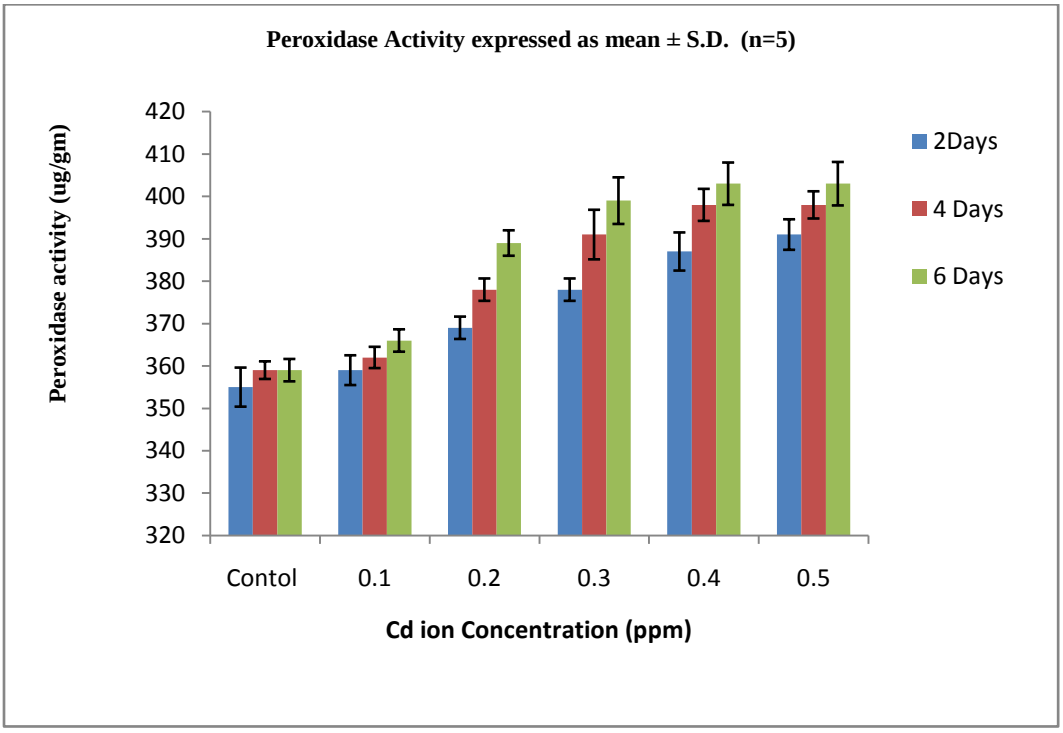


Figure 58 : Peroxidase Activity of *L.triscula L. at* diffenernt concentration of Cd metal ion

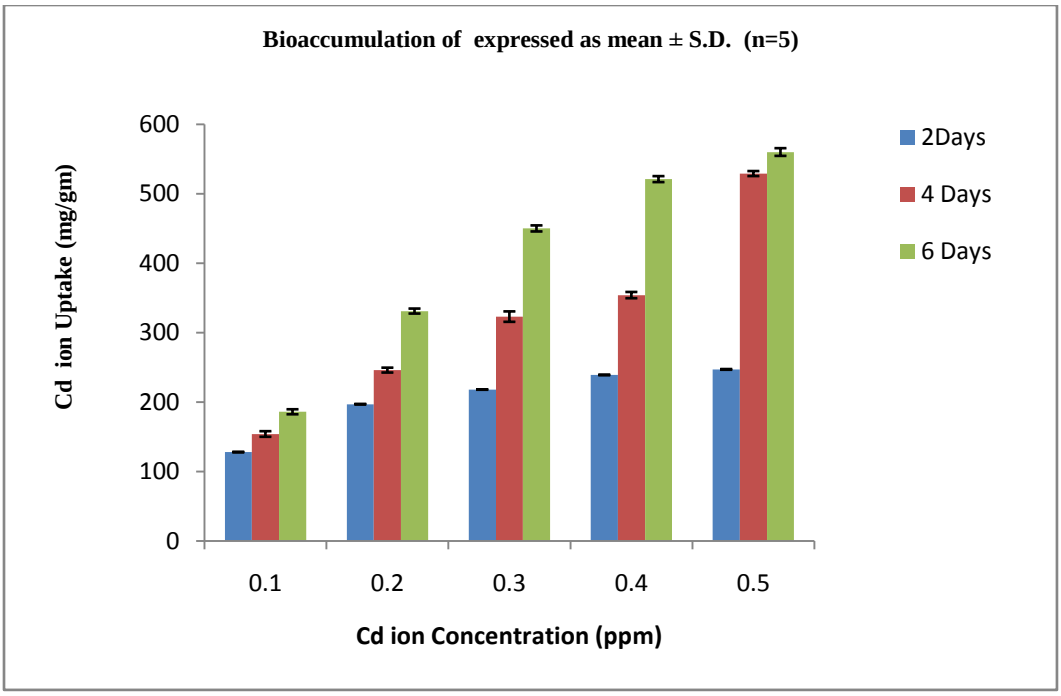


Figure 59 : Cd ion Uptake of *L.triscula L. at* diffenernt concentration of Cd metal ion

Total Chlorophylls Content

The results of effect of Cd metal ion concentration on total chlorophyll content of *Lemna triscula* L. is represented in Fig. 53. The chlorophyll content showed gradual decline as the treatment period and the metal ion concentration increased. The prolonged exposure of 6 days to high concentration of Cd i.e. 0.5 ppm significantly reduced (55%) chlorophyll than the control. No significance difference were observed when chlorophyll content of control plant were compared with various treatment period (P = 0.5 < 0.05) followed by paired t test. A significant difference were not obtained when similar results followed by chi square test (P= 1.0 >0.05)

Total Carbohydrates Content

Figure 54 shows the effect of Cd ion on carbohydrate content of *L. triscula L.* that total carbohydrate content decreased as concentration of Cd ion increased. A negative correlation was found with the increased metal ion concentrations and the treatment period. 4 th day and 6th day treated plants were compared with control followed by paired t test(P= 0.00> 0.05). Additionally, in chi square test, we did not find significant results (P= 1.00 > 0.05).

Protein Content

All the experimental concentrations shows decline in protein content as the period of treatment increased from 2 to 6 days and also with increased Cd ion concentrations in all the treatment periods (Figure 55). Protein showed 20% decline when the plants were treated with 0.5 ppm Cd ions following exposure of 6 days. We obtained significant difference when protein content of 2^{th} 4^{th} and 6^{th} day (P= 0.03 < 0.05) treatment plant when compared with control followed by paired t test. Furthermore, in chi square test, no significant results were obtained (P= 1.0> 0.05).

Proline Content

The effect of Cd ion on Proline content of the *L. triscula* L. is represented in Figure 56. A concentration dependent rise in the level of proline was observed during all experimental exposure period. But negative correlation was found between the period of exposure and level of proline content. There is significant difference between proline content of the treated and control plants and treatment periods (2,4 and 6 days) (P = 0.001< 0.05). While in chi square test, there is no significant results were obtained (P= 1.0 >0.05).

Catalase and peroxidase Activity

The results depicted that the activity of both catalase and peroxidase were significantly igher in treated plants in comparison with the control plants. (Figure 57 and 58) Greater activities of catalase and guaicol peroxidase indicated that the treated plant were under oxidative stress. In the present investigation it was reported that activities of catalase enhanced linearly with increased metal ion concentration whereas the activity of guaicol peroxidase showed increase with metal ion concentration at 2,4 and 6 days of exposure period. We found significant difference when catalase activity of the treated (exposed in 2,4 and 6 days) were compared with control (P = 0.00< 0.05) and peroxidase activity (P = 0.002<0.05) followed by paired t test. Furthermore, in chi square test, there is no significant results were obtained (P= 1.00 > 0.05) for catalase activity Peroxidase activity.

Cd Metal Uptake Experiment

Bioaccumulation of cd ion in the test plants at different concentration is as shown in Figure 59. Exposure to 0.1 to 0.5 ppm increased the accumulation of metal ion in all the experimental exposure periods. There is significant difference between Cd metal uptake of the test plants when compared with control on 2, 4 and 6 days (P = 0.0 5 = 0.05) followed by paired t test. Furthermore, in chi test, there is no significant results were obtained (P= 1.00 > 0.05).

4.6 Effect of metals on plant anatomical structure

4.6.1 Light Microsccopic study

The control samples showed mesophyll cells full of chloroplasts (Figure A) and uniformly distributed and intact thick outer epidermis (Figure B). The cells have retained their original shape and size as well as intercellular spaces. Whereas 0.5 ppm Cd treated plants showed gradual loss in chlorophyll pigment, disturbance in the arrangement of mesophyll cell (Figure C) and disorganization in epidermal layer.(Figure D).

Anatomical observation revealed that the Cd treated plants showed significant changes in the normal structure with an increase in the metal ion concentration. The highest Cd ion concentration i.e. 0.5 ppm caused more pronounced alterations in normal structure after treatment.

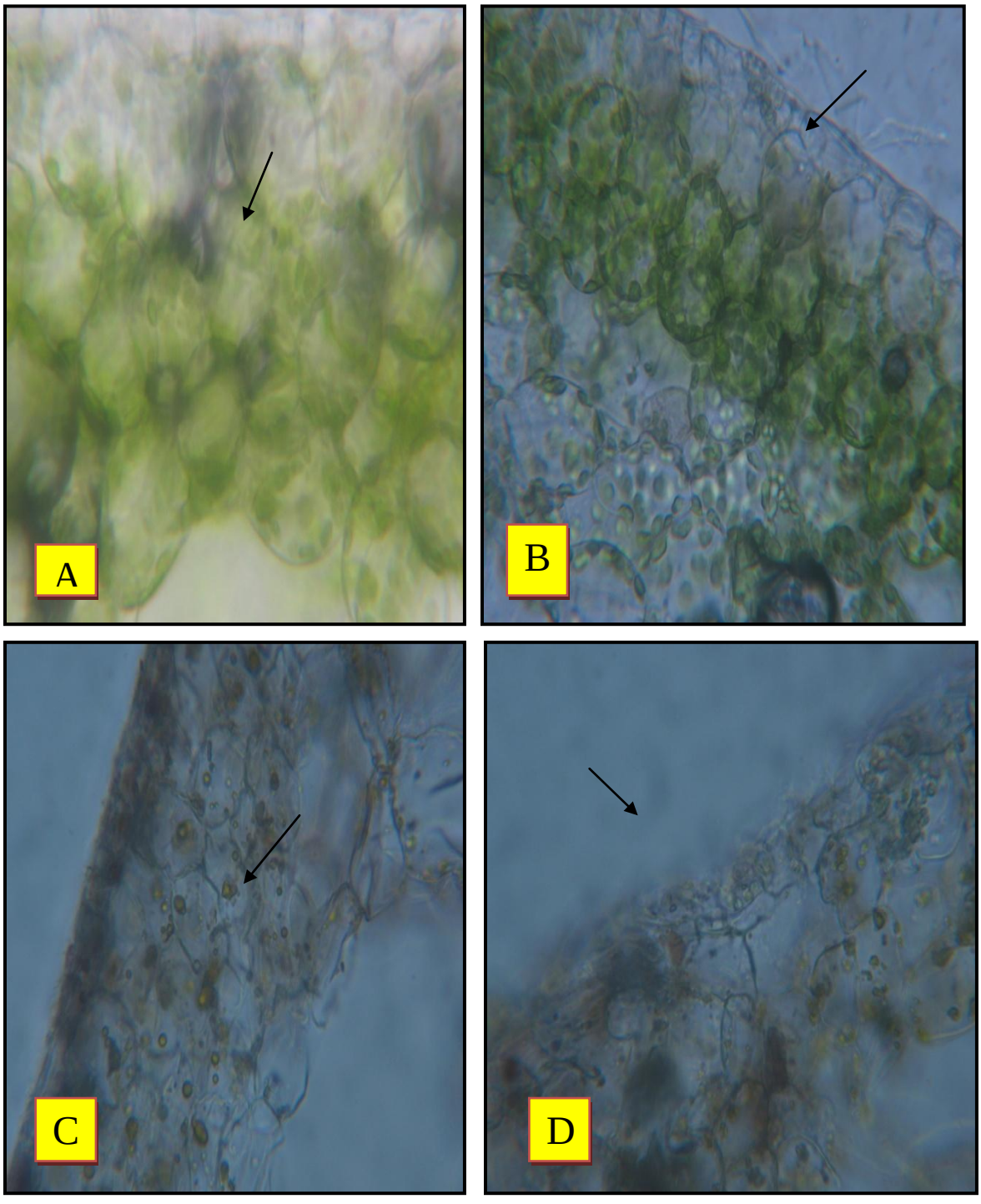


PLATE 54

Bioaccumulation of Cd ion in 3 days treated plants at different concentration is shown in Figure A. The Cadmium treated plants showed gradual changes in the structure with an increase in metal concentration compared to the control group. On examination, of control plants of *Lemna triscula* L revealed that uniformly distributed radially narrow epidermal cells (Figure A), well organized cells of cortical layer with compactly arranged parenchyma cell interrupted by arenchyma cells (Figure C). At the center of the central cylinder was a vasculature (Figure C).

Lemna triscula L growing in excess of Zinc ion exhibits anatomically number of differences compared to the control leaf. Zinc treated leaf showed disruption in arrangement of epidermal cells (Figure D) and cortical cells (aerenchyma) being disintegrated forming dark zone (cavity), Figure E. Most significant feature was the change in structure of vascular system which revealed expansion in the xylem and phloem tissues (Figure F).

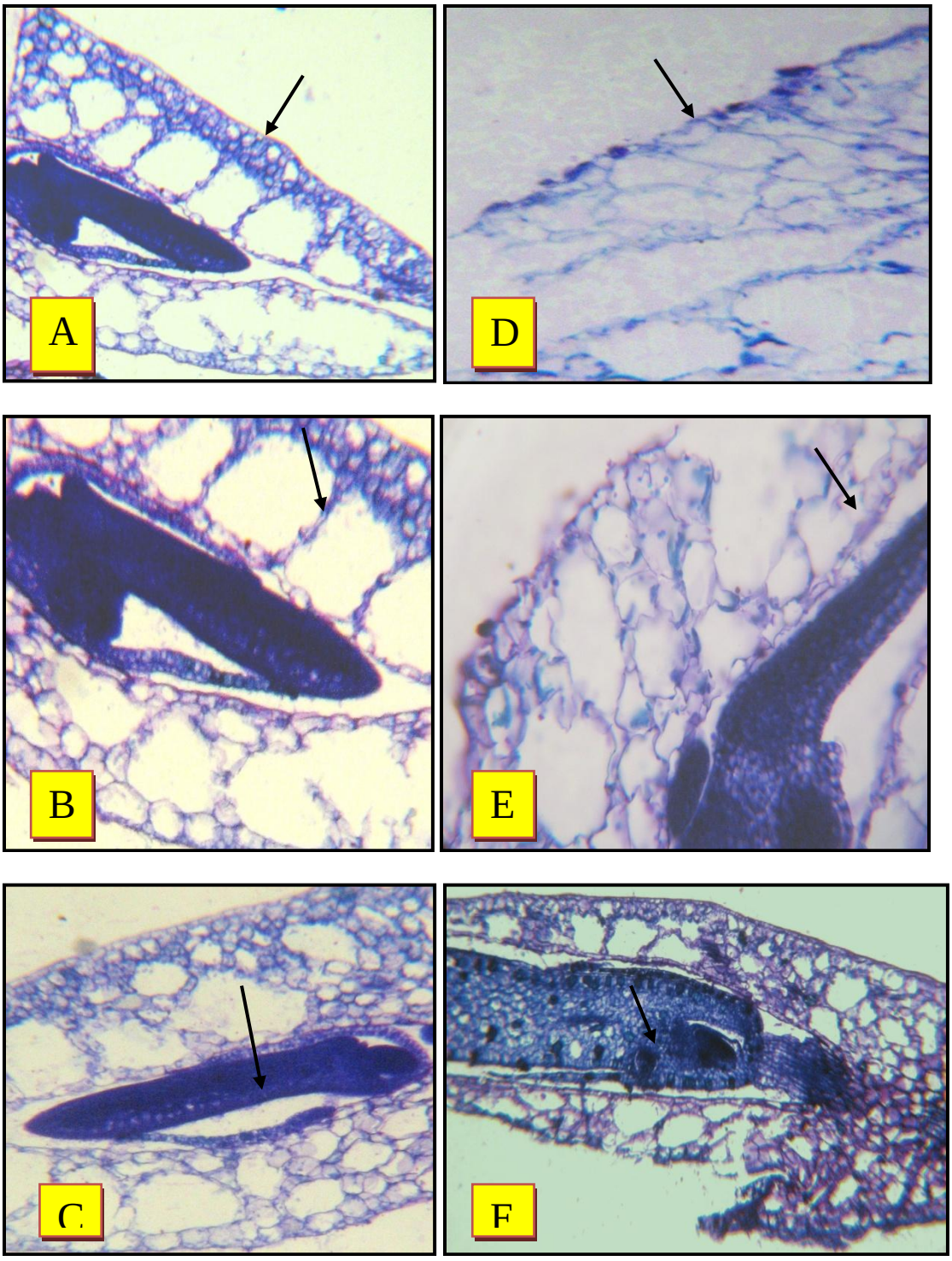


PLATE 55

4.6.2 Scanning Electron Microscopy

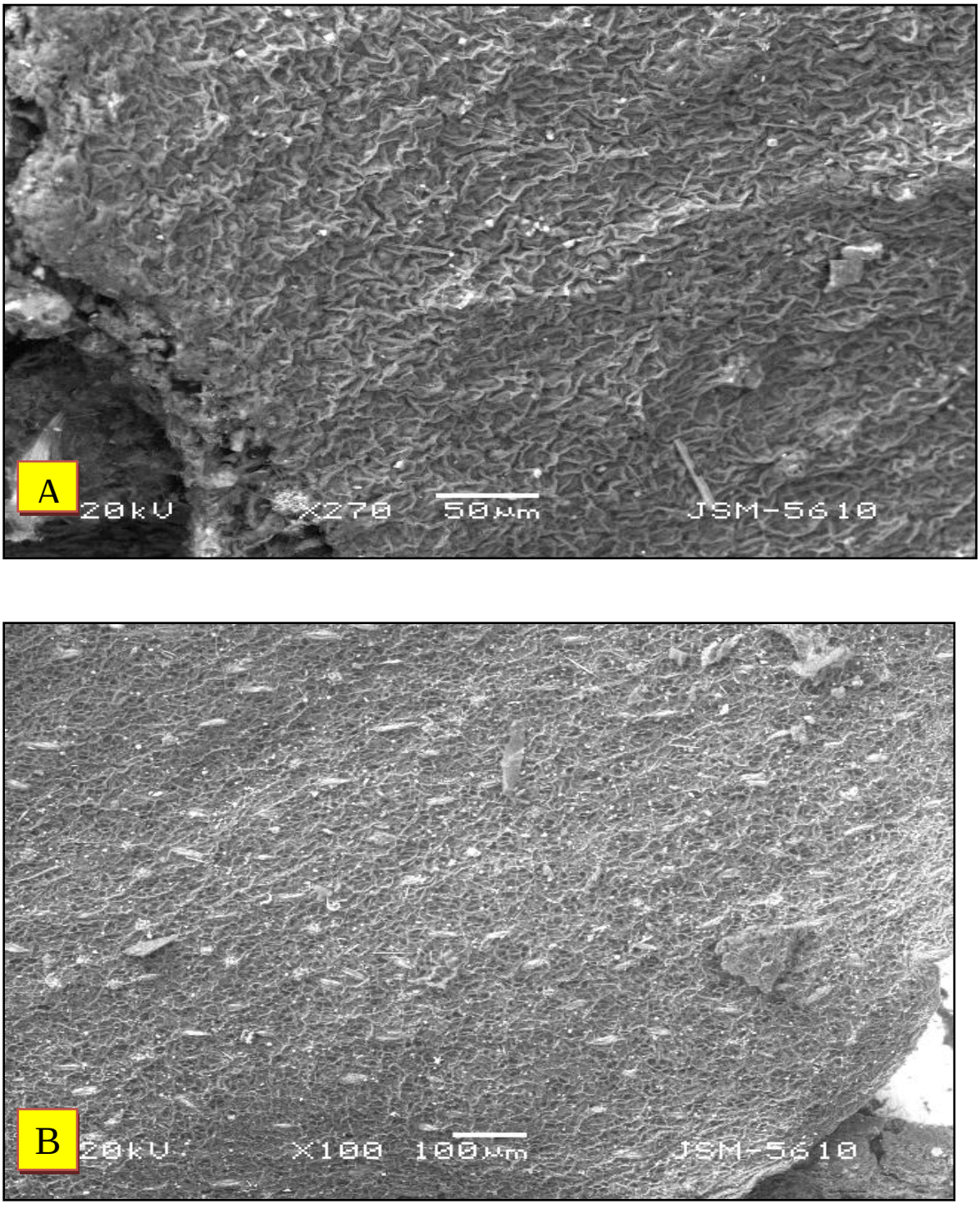


PLATE 56

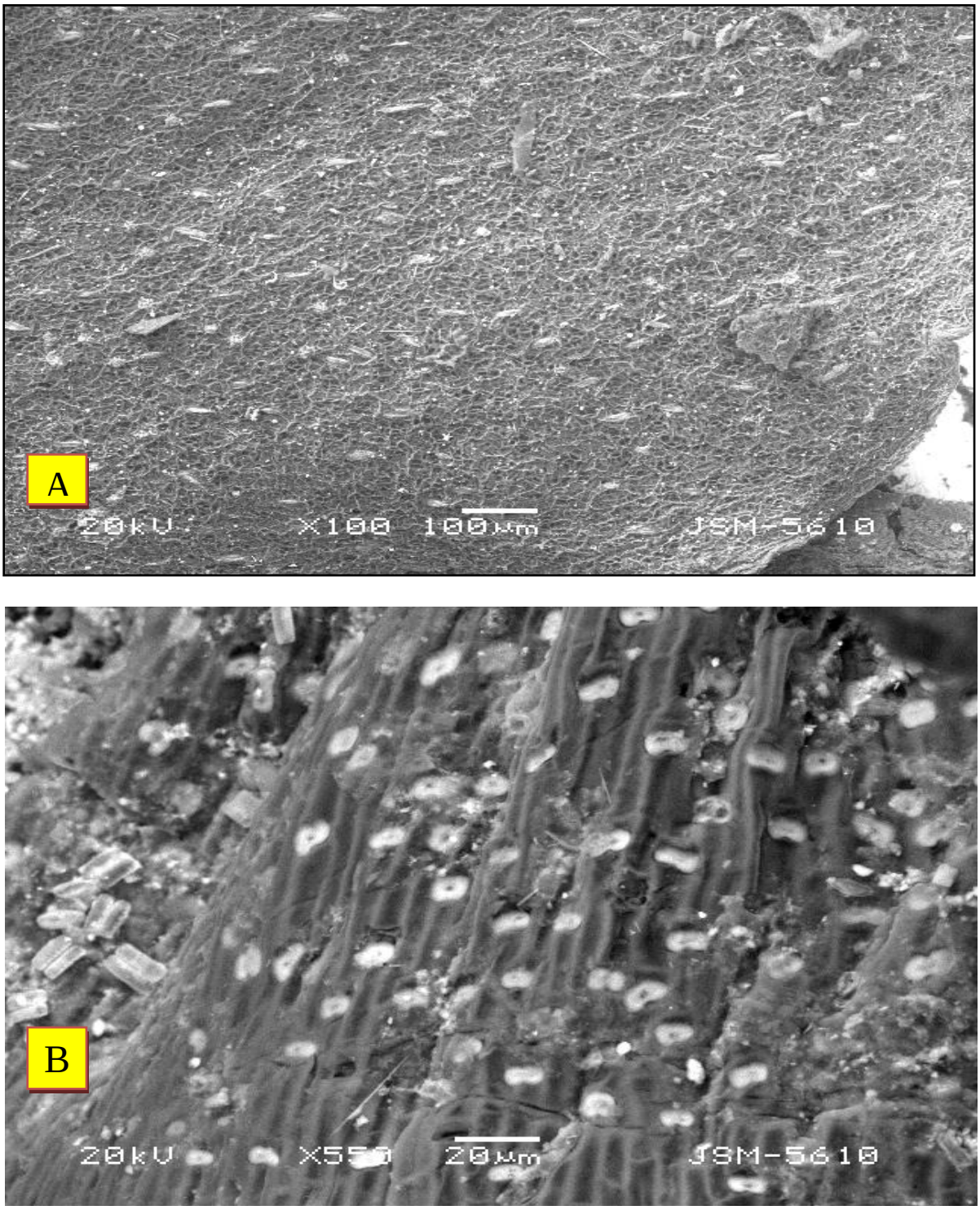


PLATE 57

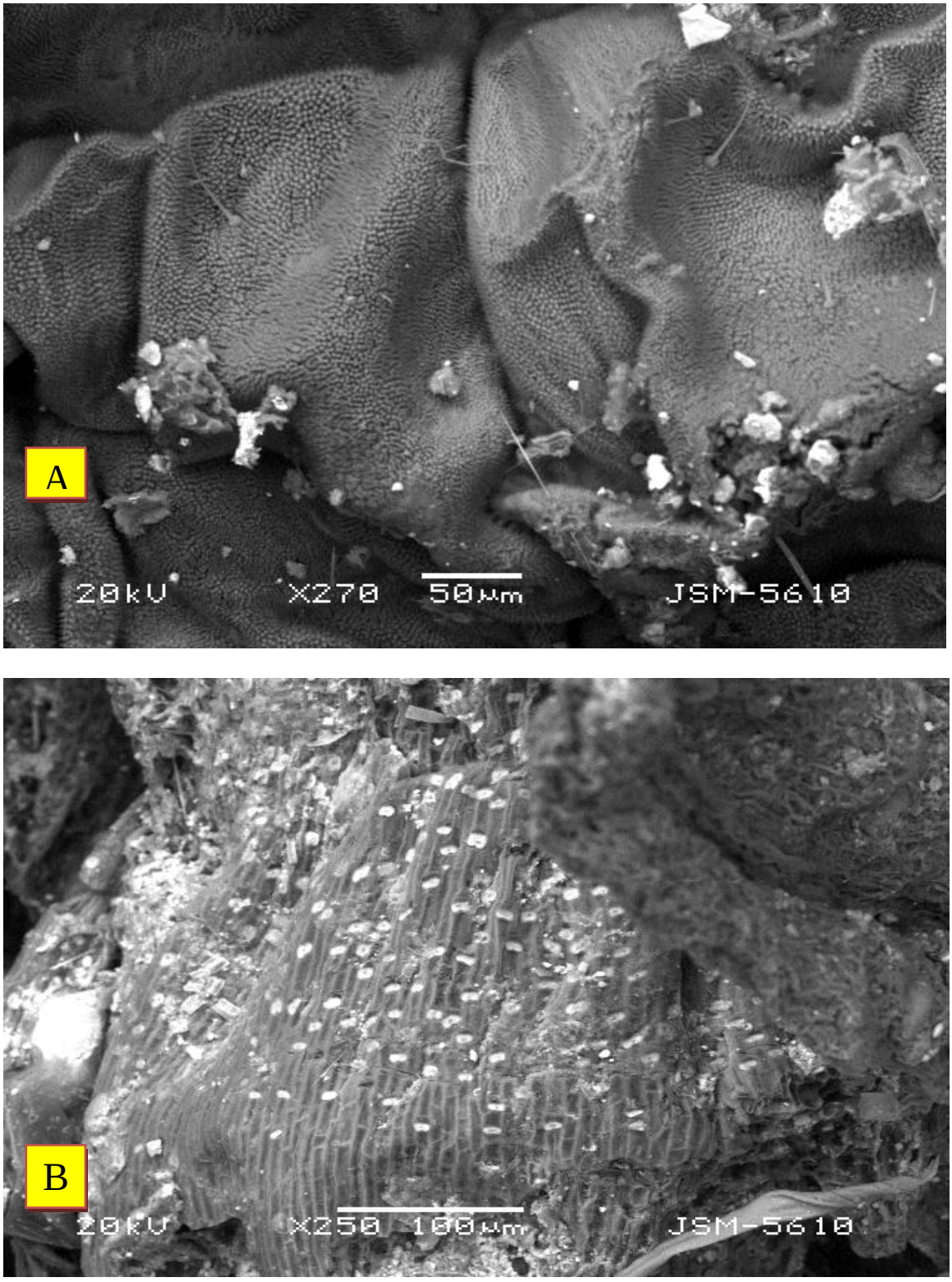


PLATE 58

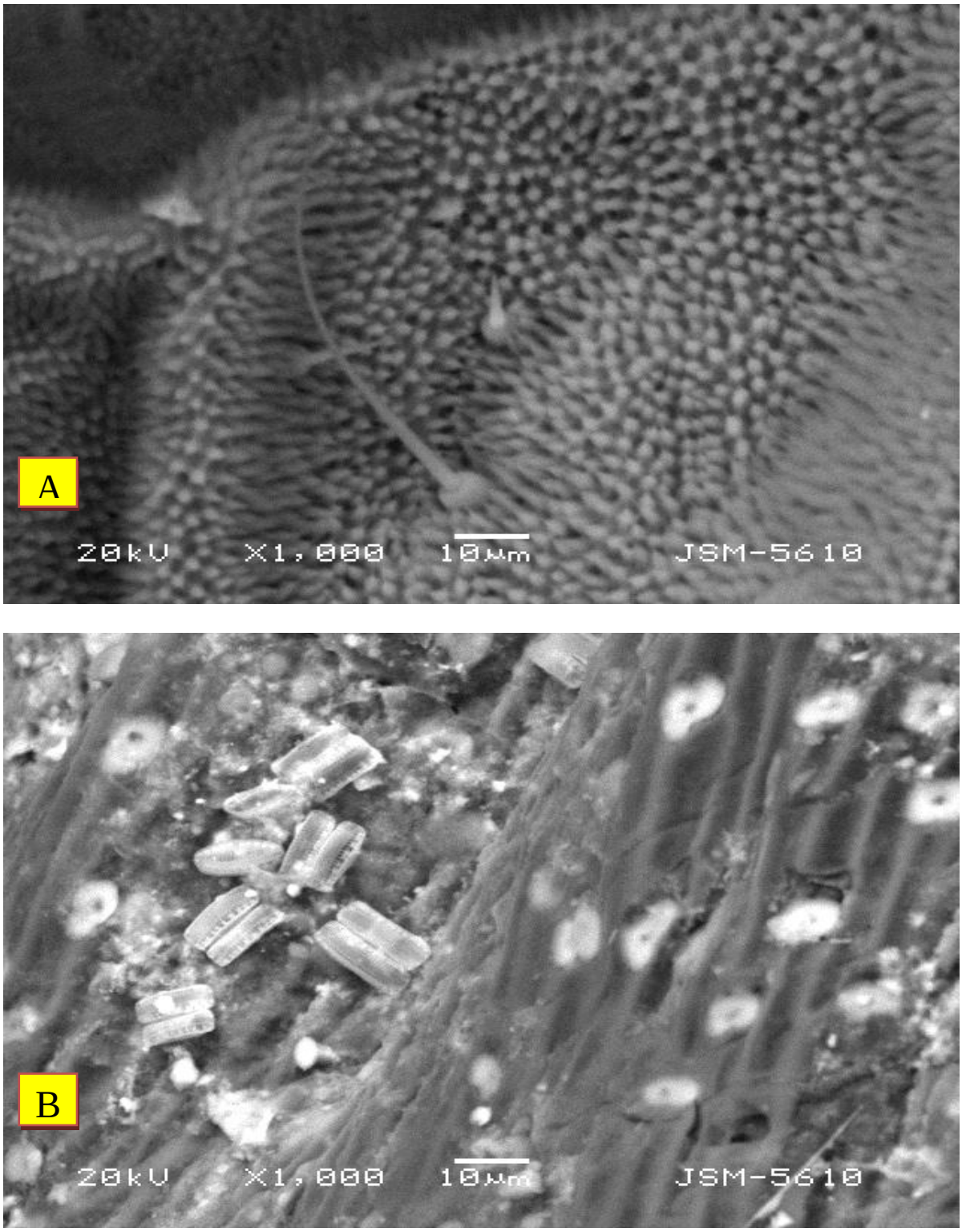
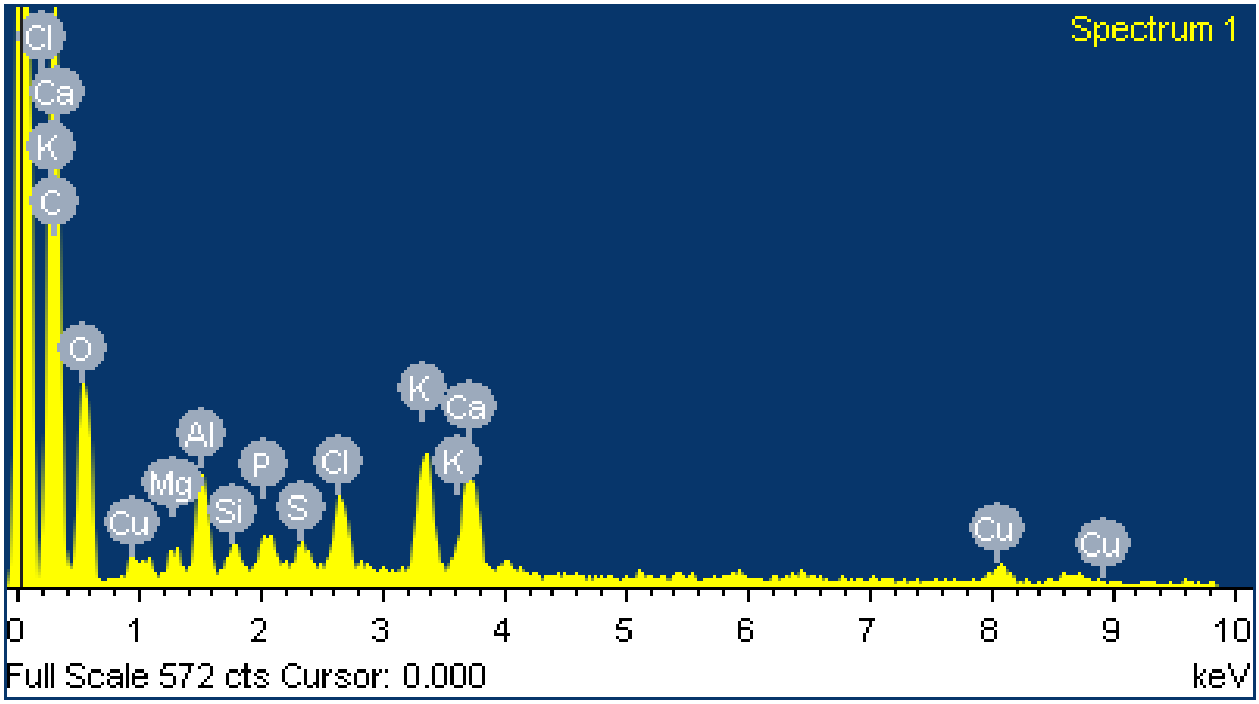


PLATE 59

SEM EDX Analysis:

SEM Micrograph of *L. polyrhiza L.*



Element	Weight %	Atomic %
C K	56.72	67.36
O K	31.49	28.08
Mg K	0.52	0.31
Al K	1.55	0.82
Si K	0.39	0.20
P K	0.65	0.30
S K	0.34	0.15
Cl K	1.43	0.58
K K	2.64	0.96
Ca K	2.29	0.81
Cu K	1.99	0.45
Totals	100.00	

Treated Plant

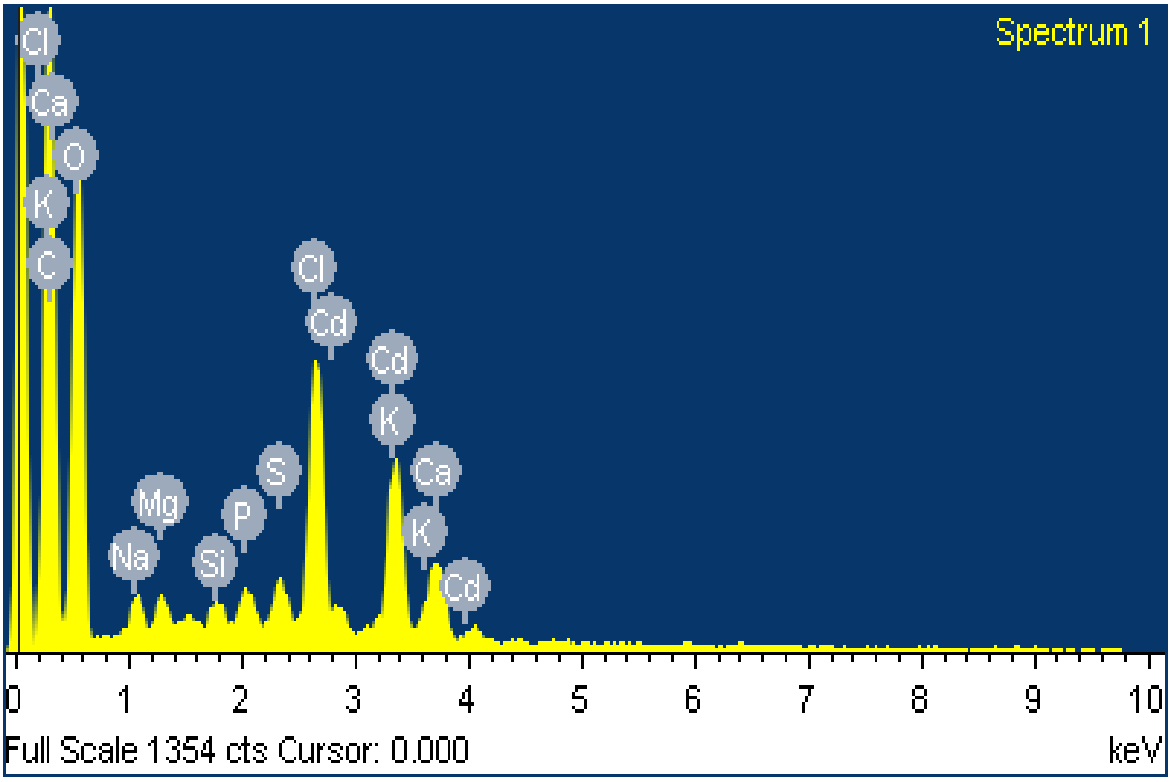
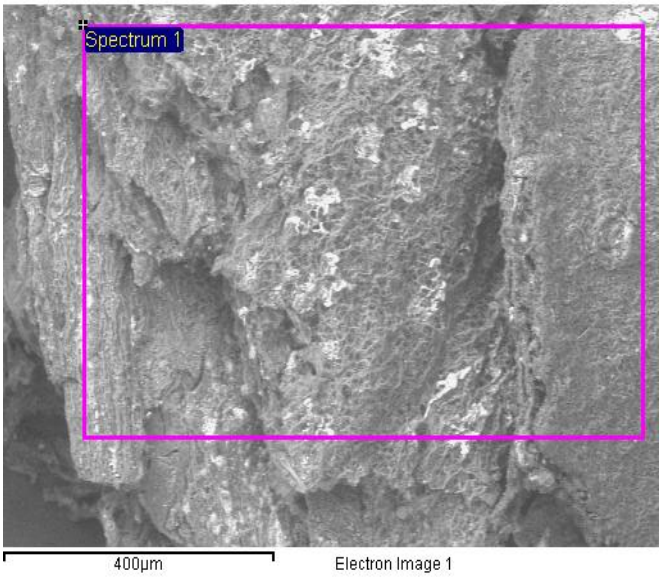


Figure 61: EDX of Control *L. polyrhiza L.*



Element	Weight %	Atomic %
C K	50.50	60.28
O K	39.87	35.74
Na K	0.70	0.44
Mg K	0.45	0.27
Si K	0.31	0.16
P K	0.45	0.21
S K	0.50	0.22
Cl K	3.24	1.31
K K	2.43	0.89
Ca K	1.24	0.44
Cd L	0.30	0.04
Totals	100.00	

SEM EDX Analysis:

In the present research, SEM analysis was conducted to observe the surface morphology of *L. polyrrhiza* L. plant powder before and after biosorption of Cadmium ion. SEM analysis reveals the variation in the ultrastructure of control and 'Cd' treated cells of *L. polyrhiza* L. The surface seemed to be complex and heterogenous. It was observed that after biosorption of the metal surface morphology has got changed and agglomeration of particles were observed.

An observation of the SEM micrographs of *L. polyrhiza L.* in the absence of Cd ion reveals that plant displayed dense and porous surface texture (Plates 56,57,58,59 A).

When *L.polyrhhiza* L. treated with 0.5 ppm solution of Cd ion, many anatomical disorganization occurs. Ultrastructural study indicates the presence of many pores, which did not have regular, fixed shape. The porous nature of the adsorbent for the biosorption of metal ions. The surface morphology of pure leaf signnificantly changed on loading with Cd. It is clear from SEM images that leaf have rough surface morphology, which possesses possibilitiy for more adsorption of Cd ion. In treated SEM micrograph shiny and white surface morphology indicates the Cd metal ion adsorbed at the surface of leaves. The SEM images with magnifying 1000 shows that *L. polyrhiza* L. have porous surface and heterogenoous rough. It is indicate that *L. polyrhiza* L. have good possibilities as biosorbent.After the biosorption process, the SEM image of *L. polyrhiza* L. leaves revealed the combination of small and particles size which was suggested that to be an appropriate structure for metal ion concentration. The observed crystalline depositions on the cell surface may be sequestered by specific molecules like metallothioneins (Plates 56,57,58,59 B).

The difference in surface morphology of control and treated plant were clearely observed It is clear that Sublethal concentrations of cd ion caused alterations in surface structure. Such ultrastructural aberrations occurring in *L.polyrhhiza L.* exposed to Cd, at the cell level might be due to alterations caused by Cd metal ion. The observed crystalline depositions are of metals sequestered by specific molecules like metallothioneins.

EDX analysis was performed to determine the elemental composition of the biosorbents before and after the Cd ion adsorption.

The quantitative analysis using EDX of control plant showed that carbon and oxygen are the major constituents that is 56.72 % and 31.49 % respectively. The spectrum also showed the presence of magnesium 0.52 %, aluminium 1.55%, silicon 0.39%, phosphorous 0.65%, sulphur 0.34, chlorine 1.43% , potassium 2.64%, calcium 2.29%, copper 1.99%. Cd ion not found in control plant. All the metal clearly shows peak while Cd ion peak not occur in control plant.

The quantitative analysis using EDX of treated plant showed that carbon and oxygen are the major constituents that is 50.50 % and 39.87 % respectively in the biosorbents. The spectrum also showed the presence of magnesium 0.45 %, Aluminium1.55%, Silicon 0.31%, Phosphorous 0.45%, Sulphur 0.50, chlorine 3.24% , Potassium 2.43%, Calcium 1.24%, Copper 1.99%. Cadmium ion with concentration of 0.30 % found. This indicate that treated plant absorbed cd ion. This again confirmed by peak of Cd ion.

In addition to that percentage shows that constituent of Carbon, Phosphorous, Sulphur, Chlorine concentrations increased while Oxygen, Silicon, Calcium concentration decreased. So, this results reveals that absorption of Cd ion also effects the absorption of other metal ions.