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Floristic Assessment of Monocotyledonous Plant Diversity in and Around Rourkela-An Urban Area of Sundargarh District, Odisha, India

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HIGHLIGHTS

- The diversity of monocot flora present in Rourkela are studied..
- Higher number of monocot plants present in Poaceae family.
- The economic importances of moocot plants in Rourkela are studied.

Abstract: Due to human activities in urban areas, they are in a state of rapid change for ecological alteration, which has resulted in a threat to the local plant diversity. Floristic study of a particular region helps everyone to get knowledge about forest management and the ecosystem associated with the existing plant resources of that particular region. Survey and documentation of the floristic wealth of a region are prerequisites for planning and proper utilization of its potential plant resources on the one hand and the depleting genetic resources on the other. The present paper provides the first and most comprehensive account of the monocotyledon flora of Rourkela Steel City in Sundargarh, Odisha. The floristic study of this region demonstrates a wide range of species diversity and growth. From the present investigation of the study area, the floristic exploration of monocotyledons of the Rourkela Steel City revealed the presence of 146 species in 96 genera under 28 families. Poaceae is the most dominant family with 40 species, followed by Cyperaceae (20 spp.).The dominant genus is *Cyperus,* with 12 species, followed by *Dioscorea* and *Fimbristylis* with four species each. The resulted plants had high utility values for food, fodder, ethnomedicine, fiber, etc. Since Rourkela is one of the units for the development of area and programs, the present inventory work will be helpful for the completion of the Rourkela flora as well as the Flora of Sundargarh district and will provide necessary information for an up-to-date compilation of the “Flora of Odisha”.

Keywords: Biodiversity; Conservation; Flora; Monocotyledons; Rourkela; Sundargarh.

INTRODUCTION

Floristic diversity, which serves as the biota of total plants present in a particular area with a variety of plants, acts as a tool for ecologists, botanists, gardeners, botanists, researchers, and the general public. The flora of a region, countryor geographical boundary represents the number of plant populations, types, taxa, or all the plant groups existing in the region. Floristic study of a particular region helps everyone to get knowledge about forest management and the ecosystem associated with the existing plant resources of that particular region. Besides these, the documentation of existing flora helps for studying the medicinalimportance of the plants along with other economically valuable information associated with the local plants [1]The need for a region's biodiversity or flora assessment has grown in recent decades as a result of flora biodiversity loss and the increased need for biological resource conservation [2].Singh and Dash[3] reported 17926 angiosperm species in India, whereas the most recent estimate accounts for 47513 plant species of all groups occurring in Indian flora and 18117 flowering plant species [4].

The flowering plant groups called angiosperms under Spermatophyte have been divided into two groups, the monocotyledons, and dicotyledons, where monocots evolved from dicotyledons. Monocotyledons are the most distinctive angiosperms plant group, which is different from the dicotyledons presence of a single cotyledon, which character was first noticed by John Ray in 1703. Leaves are present with parallel venation, and the flowers are tri-merous. Monocotyledons, in contrast to the dicotyledons, have a single cotyledon in the embryo, usually tri-merous flowers on various kinds of underground stems, parallel leaf venation with long leaves, the presence of sheath base, the presence of nodes, and hollow internodes in the stem. Monocotyledons are small in size and grow to be more than 20 ft. in height in the bamboo of Poaceae, which is known as the "Tallest grass of the plant kingdom". The grass habit is the characteristic feature of monocotyledons mostly seen in the families Cyperaceae, Poaceae, and Juncaceae. It is marked by slender tufted leaves arising from slender aerial stems and rhizomes [5].In economic terms, monocotyledons are the major source of food, fodder, fiber, medicine, and ornamentals grown in gardens as this group has the largest families of angiosperms. For most of the vegetation, like grassland, sedges, meadows, savannas, and aquatic areas, So, an inventory of the monocot group of plants in the study area is essential for resource management and developmental planning of an area.

Rourkela one of the major steel industrial centers in India and is regarded as the “Industrial capital of Odisha is located in Sundargarh district, the north-eastern part of Odisha state located at 20º 12 ’North latitude and 84º 53’ longitude, at an elevation of about 219 meters above the mean sea level (Figure 1). Better communication and the abundance of natural mineral resources like iron ore, limestone, dolomite, water and other infrastructure in and around Rourkela are the main reasons for the start of industrialization in1956. With the day-by-day expansion of urbanization and industrialization;the study area has has become one of the smart cities in India. There is no detailed study of the current flora present in Rourkela which has become in threat to the presence of naturalized flora. Studies on the flora of Sundargarh district as well as Rourkela have not been fully explored. Whereas a few reports on the ethnobotany of plants in Sundargarh district have been published [6-9] whilefew reports on the flora of Sundargarh districtabout Rourkela [10-15] have been published. However, due to excessive deforestation, settlements of urban areas, agriculture, and an increase in the population in search of jobs and industrial activities after the establishment of the Rourkela Steel Plant (RSP), the fortune of local biodiversity and the future of a huge human population dependent on plant resources are now in danger.Although rich in floral diversity, limited information is available regarding the status of the flora and the conservation of flora in this region is not present because no comprehensive study for floral diversity has been carried out in Rourkela steel city for which the present field study was undertaken in and around the surrounding areas of the Rourkela township area with three main goals: (I) to create a catalog of plant communities with special references to flowering plants, particularly monocotyledonous plants, and (II) to identify plants used for various purposes, which form an important part of vegetation, food, and fodder, and contribute significantly to the diversity of monocot and eventually angiosperm flora before the loss of plant diversity due to urbanization.(III) Documentation of present flora for preparation of the flora of Rourkela and Sundargarh and their traditional knowledge associated with the plants.

METHODOLOGY

Survey and collection

The survey was conducted from September 2019 to March 2021 in the Rourkela Steel City along with the surrounding villages near Rourkela. Regular field visits were carried out during different seasons in various parts of the Rourkela urban area like steel city areas (Sector areas), civil township areas, Udit Nagar, Fertilizer township, NIT, Raghunathpalli, Tumkela, Basanti colony, Jhirpani, Vedvyas, Panposh, Bisra, and villages present in the surroundings of Rourkela like Bondamunda, Phulwari, Tumkela, Luhakera, Birkera,etc.,once a week to collect the plant parts, photographs, and information such as plant uses by local people, habitat, etc. Collection of plant materials and preservation of plant specimens for each of the species from all the study sites were processed into the mounted herbarium sheets following the standard taxonomic procedure [16] with detailed field notes were recorded on the spot, which included the place of collection, name of the collector, field number, date of collection, local name, use values (if available) and most importantly, the characters which cannot be detected in dried form.

This present survey includes forty-six (46) knowledgeable individuals of different age groups (30–85) who have indigenous knowledge about plants and were purposively asked to identify the plants with their local names and share the ethnobotanical knowledge associated with monocot plants studied in the area during the survey year from September 2020 to March 2021.The respondents include housewives, medicine people, farmers, elderly people of the locality, and younger peoplewho are also included and questioned in the survey. During exploration, different questions were asked of the individuals, like local name, size of the plants, season of fruiting and flowering, phenology, and traditional uses associated with the plants.

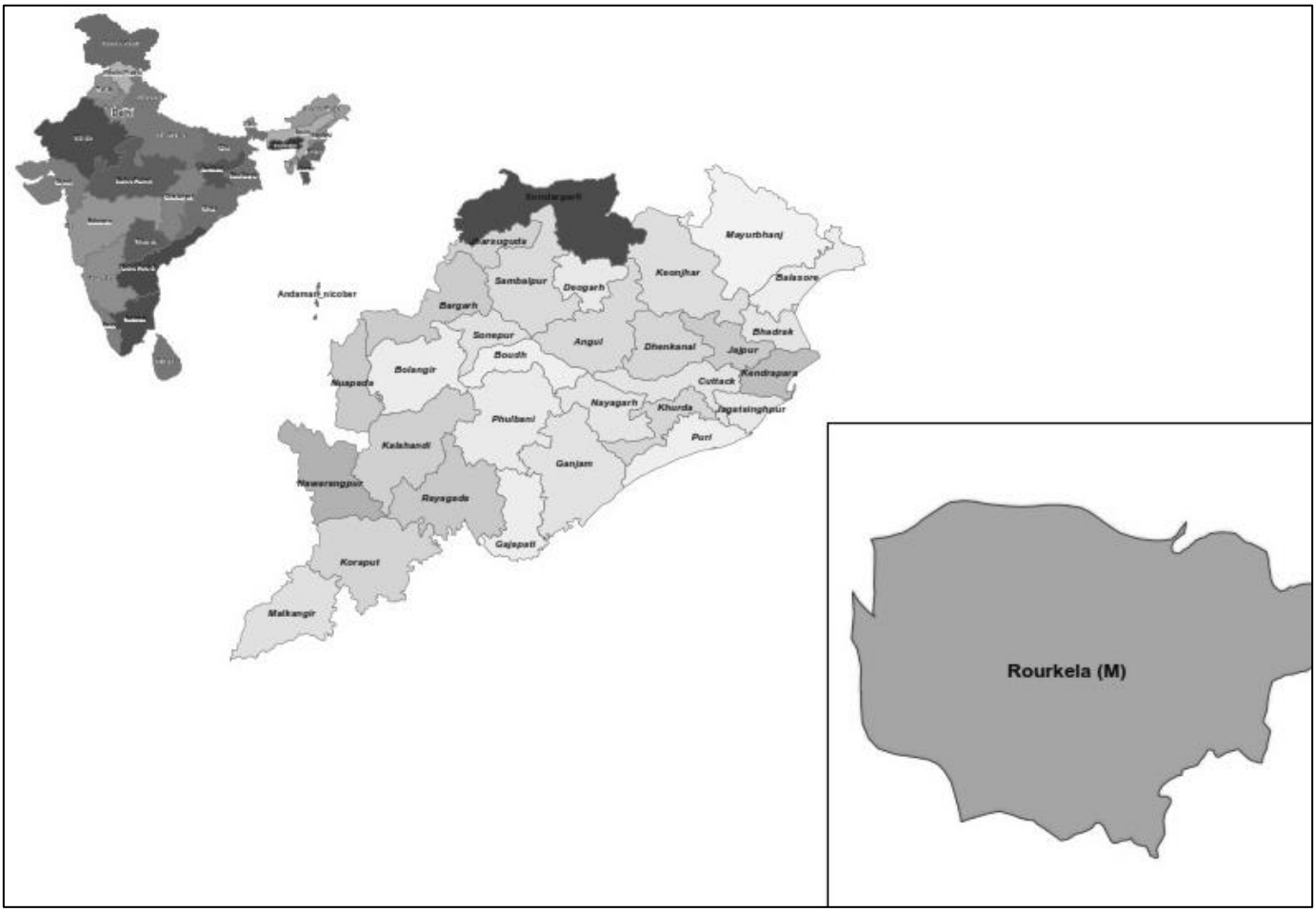

Figure 1. The study site of monocotyledonous flora in Rourkela.

Identification

Regular collection trips were made in different seasons of the year to the different parts of the study areas and adjacent forests by local tribal collectors. The local name of the species, parts used, propensity, and environment of blooming and fruiting were obtained from the accompanying people in the first instance, which was authenticated later in the laboratory with the help of local floras [17-18]. The plants were collected,

ordered, and identified by following the APG classification. Herbarium specimens of each collected plant species were prepared according to Jain and Rao [16] to serve as vouchers and were saved at the PG Department of Botany herbarium of Govt. Autonomous College, Rourkela, after appropriate identification. The ethnobotanical information was gathered in the study region by meeting with the nearby occupants and proficient individuals of the towns and metropolitan region.

RESULT

The present study indicated that the study site has a good variety of monocotyledons. In the present study investigation, the various monocot plant species collected were identified with the help of the local flora and local inhabitants mentioned in the methodology. Among the habits of the plants recorded from the study site, pro-state herb, creeping herb, and tall herb were included in the category of herb, small shrub, under shrub, climbing shrub, and large shrub were in the category of shrub, creeper, twiner, and straggler were in the category of climber, and small trees were included in the tree category.The monocotyledonous plants of the study area represent 146 species in 96 genera belonging to 28 families (Table 1) and (Figure 2.)According to a habit-wise study (Figure 3), herbs were found to be more numerous, with 112 species (80%), than trees, with 12 species (8%), followed by shrubs, with nine species (6%), and climbers, with eight species (6%).The herbs are mostly found during the rainy season as weeds while other groups are found most of the year. These herbaceous weeds are higher use values for food and medicinal properties used by the locals while trees are used for food, ornamental, and fuel purposes. The shrubs with 6% of this study areaare mostly used for medicinal purposes. Climbers which are less in number (6%) by habit wise are highly medicinal like *Gloriosa superba* L, *Smilax zeylanica* L.,*Asparagus racemosus*Willd. etc.*Gloriosa superba* L. one of the rare and endangered climbers found near water bodies is in threat due to over-exploitation of the roots collected by local healers.The habitat study showed that 105 species (72%) were grown in the terrestrial region, which was followed by aquatic habitats with thirty-nine species (27%) and epiphytic conditions with two species (1%) (Figure 4).

Table 1. Enumeration of the diversity of monocot plant species studied in Rourkela.

Sl. No	Botanical Name	Family	Native	Habit	Habit at	Voucher Specimen Code
1	*Acorus calamus* L.	Acoraceae	America	Herb	A	HGACR541
2	*Agave americana* L.	Asparagaceae	-	Shrub	T	HGACR218
3	*Agave desmettiana* Jacob	Asparagaceae	Mexico	Shrub	T	HGACR644
4	*Alisma plantago-aquatica* subsp. *Orientale* (Sam,) Sam.	Alismataceae	-	Herb	A	HGACR201
5	*Allium cepa* L.	Amaryllidaceae	Mediterranean	Herb	T	HGACR115
6	*Allium sativum* L.	Amaryllidaceae	-	Herb	T	HGACR116
7	*Alocasia macrorrhizos* (L.) G.Don.	Araceae	Malaysia	Herb	T	HGACR006
8	*Aloe vera* (L.) Burm.f.	Xanthorrhoeaceae	Mediterranean	Shrub	T	HGACR174
9	*Amorphophallus bulbifera* (Roxb.) Blumea	Araceae	-	Herb	T	HGACR180
10	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Araceae	-	Herb	T	HGACR276
11	*Ananas cosmosus* (L.) Merr.	Bromeliaceae	-	Herb	T	HGACR107
12	*Aponogeton natans* (L.) Engl. & Krause	Aponogetonaceae	-	Herb	A	HGACR600
13	*Areca catechu* L.	Arecaceae	-	Tree	T	HGACR007
14	*Aristida setacia* Retz.	Poaceae	-	Herb	T	HGACR015
15	*Asparagus racemosus* Willd.	Asparagaceae	-	Climber	T	HGACR021
16	*Bambusa arundinacea*(Retz) Willd.	Poaceae	-	Herb	T	HGACR207
17	*Bambusa vulgaris* Schrad.	Poaceae	-	Herb	T	HGACR078
18	*Bismarckia nobilis* Hildebr. &H.Wendl.	Arecaceae	Madagascar	Tree	T	HGACR140
19	*Borassus flabellifer* L.	Arecaceae	Tropical America	Tree	T	HGACR164
20	*Brachiaria mutica* (Forssk.) Stapf.	Poaceae	-	Herb	T	HGACR123
21	*Brachiaria distachya* (L.) Stapf.	Poaceae	-	Herb	A	HGACR386
22	*Brachiaria ramosa* (L.) Stapf.	Poaceae	-	Herb	A	HGACR056
23	*Bulbostylis barbata* (Rottb.) C.B.Clarke	Cyperaceae	Indigenous	Herb	T	HGACR251
24	*Caladium bicolor* (Aiton.) Vert.	Araceae	South America	Herb	T	HGACR087
25	*Canna indica* L.	Cannaceae	Tropical America	Herb	T	HGACR345
26	*Caryota urens* L.	Arecaceae	-	Tree	T	HGACR183

Cont. table 1

27	*Cheilocostus speciosus* (J.Koenig) C.D.Specht	Costaceae	-	Herb	T	HGACR070
28	*Chloris barbata* Sw.	Poaceae	Tropical America	Herb	T	HGACR563
29	*Chlorophytum arundinaceum* Baker	Asparagaceae	-	Herb	T	HGACR360
30	*Chrysopogon aciculatus* (Retz.) Trin.	Poaceae	-	Herb	T	HGACR089
31	*Cocos nucifera* L.	Arecaceae	-	Tree	T	HGACR242
32	*Colocasia esculenta* (L.) Schott	Araceae	-	Herb	A	HGACR068
33	*Commelina benghalensis* L.	Commelinaceae	South Africa	Herb	A	HGACR026
34	*Commelina erecta* L.	Commelinaceae	-	Herb	A	HGACR540
35	*Commelina longifolia* Lam.	Commelinaceae	-	Herb	A	HGACR205
36	*Commelina paludosa* BI.	Commelinaceae		Herb	A	HGACR111
37	*Crinum asiaticum* L.	Amaryllidaceae	-	Herb	A	HGACR018
38	*Crinum latifolium* L	Amaryllidaceae	-	Shrub	T	HGACR260
39	*Crinum viviparum* (Lam.) R.Ansari&V.J.Nair	Amaryllidaceae	-	Herb	T	HGACR375
40	*Curculigo orchioides* Gaertn.	Hypoxidaceae	-	Herb	T	HGACR283
41	*Curcuma amada* Roxb.	Zingiberaceae	-	Herb	T	HGACR367
42	*Curcuma longa* L.	Zingiberaceae	-	Herb	T	HGACR402
43	*Cyanotis axillaris* (L.) D.Don ex Sweet	Commelinaceae	-	Herb	A	HGACR231
44	*Cyanotis cristata* (L.) D.Don	Commelinaceae	-	Herb	A	HGACR447
45	*Cymbopogon flexuosus* (Nees ex Steud.) W.Watson	Poaceae	-	Herb	T	HGACR035
46	*Cynodon dactylon* (L.) Pers.	Poaceae	Africa	Herb	T	HGACR105
47	*Cyperus articulatus* L.	Cyperaceae	-	Herb	A	HGACR161
48	*Cyperus compactus* Retz	Cyperaceae	-	Herb	A	HGACR255
49	*Cyperus compressus* Jacq.	Cyperaceae	-	Herb	T	HGACR049
50	*Cyperus cuspidatus* Kunth.	Cyperaceae	-	Herb	T	HGACR009
51	*Cyperus difformis* L.	Cyperaceae	Tropical America	Herb	A	HGACR391
52	*Cyperus diffuses* Vahl	Cyperaceae	-	Herb	A	HGACR084
53	*Cyperus distans* L.f.	Cyperaceae	-	Herb	A	HGACR371

Cont. Table 1

54	*Cyperus imbricatus*Retz.	Cyperaceae		Herb	A	HGACR141
55	*Cyperus iria* L.	Cyperaceae	Tropical America	Herb	A	HGACR071
56	*Cyperus rotundus* L.	Cyperaceae	Indigenous	Herb	T	HGACR110
57	*Cyperus dubius* Rottb.	Cyperaceae	-	Herb	A	HGACR299
58	*Cyperus paniceus* (Rottb.) Boeckeler	Cyperaceae	-	Herb	T	HGACR579
59	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	-	Herb	T	HGACR315
60	*Dendrocalamus strictus* (Roxb.) Nees	Poaceae	-	Tall herb	T	HGACR118
61	*Digitaria abludens* (Roem. &Schult) veldk	Poaceae	-	Herb	T	HGACR230
62	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	-	Herb	T	HGACR156
63	*Dioscorea alata* L	Dioscoreaceae	-	Climber	T	HGACR304
64	*Dioscorea bulbifera* L.	Dioscoreaceae	-	Climber	T	HGACR630
65	*Dioscorea hamiltonii* Hook.f.	Dioscoreaceae	-	Climber	T	HGACR144
66	*Dioscorea oppositifolia* L.	Dioscoreaceae	-	Climber	T	HGACR167
67	*Dypsis lutescens* (H.Wendl.) Beentze&J.Dransf.	Arecaceae	Madagascar	Tree	T	HGACR356
68	*Echinochloa colona* (L.) Link	Poaceae	South America	Herb	A	HGACR302
69	*Echinochloa crus-galli* (L.) P.Beauv.	Poaceae	Tropical South America	Herb	A	HGACR213
70	*Echinochloa glabrescens* Munro ex Hook. f.	Poaceae	-	Herb	T	HGACR421
71	*Eichhornia crassipes* (Mart.) solms-Laub.	Pontederiaceae	Tropical America	Herb	A	HGACR225
72	*Eleusine indica* (L.) Gaertn.	Poaceae	-	Herb	T	HGACR199
73	*Epipremnum pinnatum* (L.) EngL.	Araceae	-	Tall climber	T	HGACR208
74	*Eragrostis ciliaris* (L.) R.Br.	Poaceae	-	Herb	T	HGACR010
75	*Eragrostis ciliate* (Roxb.) Nees.	Poaceae	-	Herb	T	HGACR417
76	*Eragrostispilosa* (L.) P.Beauv.	Poaceae	-	Herb	T	HGACR023
77	*Eriocaulon quinquangulare* L.	Eriocaulaceae.	-	Herb	A	HGACR109
78	*Fimbristylis acuminata* VahL.	Cyperaceae	-	Herb	T	HGACR263
79	*Fimbristylis aestivalis*(Retz.) Vahl	Cyperaceae	-	Herb	T	HGACR061
80	*Fimbristylis argentea* (Rottb.) Vahl	Cyperaceae	-	Herb	T	HGACR344
81	*Fimbristylis quinquangularis* (Vahl) Kunth	Cyperaceae	-	Herb	A	HGACR557
82	*Fuirena ciliaris* (L.) Roxb.	Cyperaceae	Tropical America	Herb	A	HGACR258

Cont. Table 1

83	*Furcraea foetida* (L.) Haw.	Asparagaceae	North South America	Shrub	T	HGACR328
84	*Gloriosa superba* L.	Asparagaceae	-	Climber	T	HGACR132
85	*Hedychium coronarium*J.Koenig	Zingiberaceae	-	Herb	T	HGACR269
86	*Heliconia rostrata* Ruiz &Pavon	Heliconiaceae	-	Rhizomatic herb	T	HGACR320
87	*Heteropogon contortus* (L.) P.Beauv. ex Roem. &Schult.	Poaceae	Indigenous	Herb	T	HGACR543
88	*Hippeastrum reginae (*L.) Herb	Amaryllidaceae	-	Herb	T	HGACR063
89	*Hydrilla verticillata*(L.f.) Royle.	Hydrocharitaceae	-	Aquatic Herb	A	HGACR316
90	*Hyophorbe lagenicaulis* (L.H. Bailey) H.E. Moore	Arecaceae	-	Tree	T	HGACR409
91	*Kaempferia galanga* L	Zingiberaceae	-	Shrub	T	HGACR170
92	*Kyllinga brevifolia* Rottb.	Cyperaceae	-	Herb	A	HGACR119
93	*Licula grandis* H.Wendl.	Arecaceae	-	Tree	T	HGACR125
94	*Melinis repens* (Willd.) Zizka	Poaceae	-	Herb	T	HGACR175
95	*Molineria capitulata* (Lour.) Herb	Hypoxidaceae	-	Herb	T	HGACR128
96	*Monochoria hastata* Solms-Laub	Pontederiaceae	-	Herb	A	HGACR149
97	*Monochoria vaginalis* (Burm.f.) Presl.	Pontederiaceae	Tropical America	Herb	A	HGACR321
98	*Monstera adansonii* Schott.	Araceae	South America	Climber	T	HGACR288
99	*Murdannia nudiflora* (L) Brenan	Commelinaceae	-	Herb	A	HGACR237
100	*Murdannia vaginata* (L.) Brueck.	Commelinaceae	-	Herb	A	HGACR142
101	*Musa paradisiaca* Linn	Musaceae	-	Rhizomatic herb	T	HGACR091
102	*Oplismenus burmanni* (Retz.) P.Beauv.	Poaceae	-	Herb	T	HGACR232
103	*Oryza rufipogon* Griff.	Poaceae	-	Herb	T	HGACR165
104	*Oryza sativa* L.	Poaceae	-	Herb	T	HGACR168
105	*Ottelia alismoides* (L.) Pers.	Hydrocharitaceae	-	Herb	A	HGACR085
106	*Pandanus amaryllifolius Roxb*	Pandanaceae	-	Shrub	T	HGACR303
107	*Panicum notatum* Retz.	Poaceae	-	Herb	T	HGACR148
108	*Paspalum distichum* L.	Poaceae	-	Herb	T	HGACR192
109	*Paspalum scrobiculatum* L.	Poaceae	-	Herb	T	HGACR022
110	*Pennisetum glaucum* (L) R. Br.	Poaceae	-	Herb	T	HGACR055
111	*Pennisetum pedicellatum*Trin.	Poaceae	-	Herb	T	HGACR143

Cont. Table 1

112	*Pennisetum purpureum* Schumach	Poaceae	Tropical America	Herb	T	HGACR102
113	*Perotis indica* (L.) Kuntze	Poaceae	-	Herb	T	HGACR215
114	*Phoenix acaulis* Roxb.	Arecaceae	-	Tree	T	HGACR336
115	*Phoenix dactylifera* L.	Arecaceae	-	Tree	T	HGACR177
116	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	-	Tree	T	HGACR130
117	*Pistia stratiotes* L.	Araceae	Tropical America	Herb	A	HGACR533
118	*Polyanthes tuberosa* L.	Asparagaceae	-	Herb	T	HGACR120
119	*Potamogeton nodosus*Poir.	Potamogetonaceae	-	Herb	A	HGACR591
120	*Pycreus polystachyos* (Rottb.) P.Beauv	Cyperaceae	-	Herb	T	HGACR368
121	*Ravenala madgascariensis*Sonn.	Strelitziaceae	Madagascar	Rhizomatic herb	T	HGACR334
122	*Rhoeo discolo*r Hance.	Commelinaceae	Central America	Herb	T	HGACR351
123	*Roystonea regia* (Kunth.) O.F.Cook.	Arecaceae	Tropical America	Tree	T	HGACR532
124	*Saccharum officinarum* L.	Poaceae	-	Herb	T	HGACR160
125	*Saccharum spontaneum* L.	Poaceae	Tropical West Asia	Herb	T	HGACR317
126	*Sagittaria sagitifolia* auct.non.L	Alismataceae	-	Herb	A	HGACR366
127	*Sagittaria trifolia* L.	Alismataceae	-	Herb	A	HGACR326
128	*Sansevieria roxburghiana* Schult. &Schult.f.	Asparagaceae	Africa	Herb	T	HGACR314
129	*Sansevieria trifascicata* Prain.	Asparagaceae	West Africa	Shrub	T	HGACR501
130	*Scadoxus multiflorus* (Martyn)Raf.	Amaryllidaceae	-	Herb	T	HGACR138
131	*Setaria pumila* (Poir.) Roem &Schult	Poaceae	Europe	Herb	T	HGACR619
132	*Smilax zeylanica* L.	Smilacaceae	Indo Malaysia	Climber	T	HGACR096
133	*Sorghum bicolor* (L.) Moench	Poaceae	Tropical Africa	Herb	T	HGACR034
134	*Sporobolus subtilis* Kunth	Poaceae	-	Herb	T	HGACR106
135	*Tradescantia spathacea* Sw.	Commelinaceae	Mexico	Herb	T	HGACR241
136	*Triticum aestivum* L.	Poaceae	Tropical America	Herb	T	HGACR216
137	*Typha aungustifolia* L.	Typhaceae	Tropical America	Herb	A	HGACR430
138	*Typhonium trilobatum* (L.) Schott	Araceae	-	Herb	T	HGACR124
139	*Vanda roxburghii* R.Br.	Orchidaceae	-	Herb	E	HGACR333
140	*Vanda tessellata* (Roxb.) Hook. ex G.Don	Orchidaceae	-	Herb	E	HGACR429
141	*Zea mays* L.	Poaceae	America	Herb	T	HGACR312

Cont. Table 1

142	*Zephyranthes citrina* Baker	Amaryllidaceae	Mexico	Herb	T	HGACR173
143	*Zephyranthes candida* (Lindl) Herb.	Amaryllidaceae	America	Herb	T	HGACR259
144	*Zephyranthes minuta* (Kunth) D.Dietr.	Amaryllidaceae	Mexico	Herb	T	HGACR636
145	*Zingiber officinale* Roscoe	Zingiberaceae	-	Herb	T	HGACR373
146	*Zingiber zerumbet* (L.) Roscoe ex Sm.	Zingiberaceae	-	Herb	T	HGACR234

T- Terrestrial. E- Epiphytes. A- Aquatic HGACR-Herbarium Govt Auto College, Rourkela.

Out of the total species found, Poaceae is the most dominant family with 40 spp., followed by Cyperaceae with twenty spp., followed by Commelinaceae and Amaryllidaceae with ten spp. each, while Araceae and Asparagaceae with six spp. each (Table 2). The maximum number of species has been recorded in the genus *Cyperus* (twelve species), which is followed by *Commelina*, *Dioscorea,* and *Fimbristylis* (4 species) each. Most of the families have only a single species in their study area. The number of species per number of genera was highest in the family Poaceae (1.48) followed by Cyperaceae (3.33) and Asparagaceae (1.28), while the percent of species to total plant species was also highest in Poaceae (27.39%), after which it was more in Cyperaceae (13.69%) and Arecaceae (8.21%), followed by other family members. The lowest percentage of species to total plants was 0.68%, which was found in families like Acoraceae, Bromeliaceae, Costaceae, Aponogetonaceae, etc. (Table 2).

Figure 2. Diversity of monocot flora A-*Eichhornia crassipes* , *B-Saccharum spontaneum* , C-*Commelina benghalensis* D-*Alocasia macrorrhizos* , E-*Furcraea foetida*, F-*Pennisetum pedicellatum, G-Canna indica* , H-*Bismarckia nobilis* , *I-Areca catechu* , J-*Caryota urens* , K-*Cocos nucifera* ,L-*Phoenix sylvestris* , *M-Dioscorea bulbifera* , N-*Caladium bicolor* , O-*Crinum asiaticum* , P-*Dypsis lutescens*

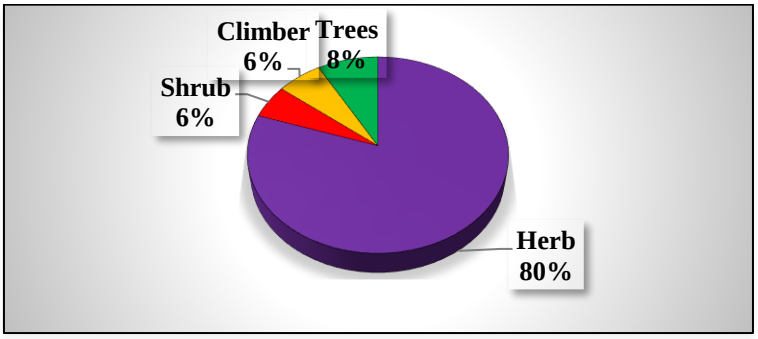

Figure 3. Habit wise monocot plant species found in Rourkela.

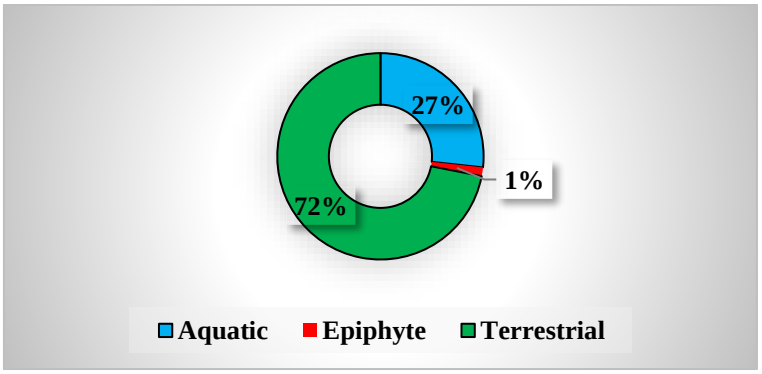

Figure 4. Habitat-wise monocot plant species studied in Rourkela and its surroundings.

Exotic plants

Exotic plants are plant groups that have native origins other than India and are intentionally or unintentionally introduced**.**The result from the study area shows the number of monocot exotic plant species grown in and around Rourkela. The survey resulted in about 45 monocot plant species among the total 146 monocot flora. The exotic plants studied mostly originated from tropical America, Africa, the Mediterranean, Malaysia, tropical West Asia, indigenous plants, etc. (Table 1). It was revealed that most of the plants originated from different parts of America (twenty-seven spp.), like Tropical America, South America, Mexico, and North America. The results for the nativity of plants were followed by Africa (six sp.), Europe, Madagascar (three spp.), Indigenous (four spp.), etc. (Figure 5).A total of forty-five exotic plants are domesticated in the study area resembledexotic plants studied in different areas of Odisha[19-22]for different purposes like food, fodder, and ornamental purposes (Figure 2). Most of the exotic species were introduced for food grain purposes from American nativity whereas some species like *Chloris barbata*,*Bulbostylis barbata*, *Commelina benghalensis, Eichhornia crassipes, Cyperus rotundus,Echinochloa colona,Monochoria vaginalis,* etc.are introduced unintentionally or accidentally from different nativity are now naturalized and showing invasive activity. Their population is increasing day by day after being naturalized which is a threat to the local biodiversity as well as these invasive exotic plants are also affecting agriculture directly even though they have many economic uses.

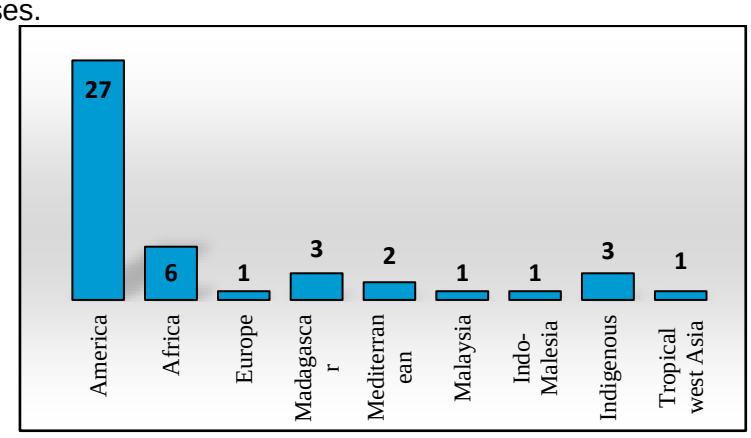

Figure 5. Category of the nativity of exotic monocot plant species studied in Rourkela.

Table 2. Monocot genera per species with family studied in the study area.

Sl.No.	Family	No.of Genera	No.of Species	Species /Genera	% of Species /Total Species
1	Poaceae	27	40	1.48	27.39
2	Cyperaceae	6	20	3.33	13.69
3	Arecaceae	10	12	1.2	8.21
4	Commelinaceae	5	10	2	6.84
5	Amaryllidaceae	5	10	2	6.84
6	Araceae	8	9	1.12	6.16
7	Asparagaceae	7	9	1.28	6.16
8	Zingiberaceae	4	6	1.5	4.1
9	Dioscoreaceae	1	4	4	2.73
10	Alismataceae	2	3	1.5	2.05
11	Pontederiaceae	2	3	1.5	2.05
12	Hydrocharitaceae	2	2	1	1.36
13	Hypoxidaceae	2	2	1	1.36
14	Orchidaceae	1	2	2	1.36
15	Acoraceae	1	1	1	0.68
16	Aponogetonaceae	1	1	1	0.68
17	Bromeliaceae	1	1	1	0.68
18	Cannaceae	1	1	1	0.68
19	Costaceae	1	1	1	0.68
20	Eriocaulaceae.	1	1	1	0.68
21	Heliconiaceae	1	1	1	0.68
22	Musaceae	1	1	1	0.68
23	Pandanaceae	1	1	1	0.68
24	Potamogetonaceae	1	1	1	0.68
25	Smilacaceae	1	1	1	0.68
26	Strelitziaceae	1	1	1	0.68
27	Typhaceae	1	1	1	0.68
28	Xanthorrhoeaceae	1	1	1	0.68
Total		96	146		

Utility of the plant species

On the utility of the plant species as food, fodder, medicinal as well as ornamental plant groups, the monocot flora of Rourkela has a variety of uses for which information was gathered from local people through interviews. The result shows the maximum monocot flora were grasses which were grown as weeds (sixty seven spp.) while thirty one plant spp. were used by local healers and local people as ethnomedicine for various diseases. A total of thirty-five species of monocot plants were used as food, while twenty five species of plants were grown for ornamental purposes.There are twenty two species of monocots used for thatching of houses, mat and hand fan making, as well as broom making. The monocot plants were used as fodder (twenty nine spp.) for cattle as well as twenty spp. as fuel for cooking by the locals in rural areas present around Rourkela city (Figure 6).

(a) Food plants: Plant species like *Oryza sativa, Triticum aestivum, Sorghum vulgare* were cultivated for the production of cereals while *Saccharum officinarum* was grown for the production of sugar. *Cocos nucifera* and *Borassus flabellifer* were also found in the study site even though they grow in coastal areas for fruit. The corm and stem of *Amorphophallus* spp., tubers of *Dioscorea* spp., and rhizomes of *Cheilocostus speciosus, Colocasia esculenta, Alocasia macrorrhizos, and Typhonium trilobatum were* also collected as wild food for making various food items. The young shoots of *Bambusa* spp. and *Dendrocalamus strictus* were used for making curry with fish by the locals. Fresh shoots called "Karadi" while dried shoots called "Hendua" are sold in local markets by tribal ladies and they get a good economy from it.

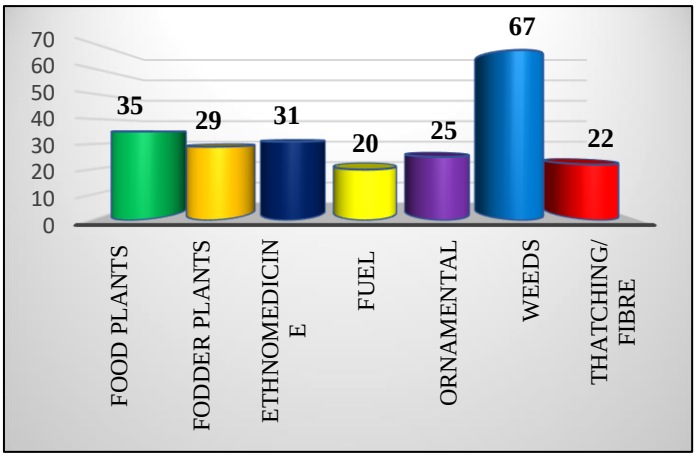

Figure 6. Different utility of monocot flora in and around Rourkela.

Curcuma longa and *Zingiber officinale* rhizomes are used medicinally and as spices in growth period as well as after harvested. The corn (*Zea mays) is* eaten as snacks after roasting, boiling, or making popcorn during the growing period, while the younger corn is made into different food items. The tender leaves of *Commelina* spp. were used as wild leafy vegetables, which were consumed after being fried with different leafy vegetables. The fruits of *Phoenix* during the summer season were collected to be consumed as seasonal wild fruits. Fermented rice (*Oryza sativa*) was used to make fresh country liquor or alcoholic beverages. Fresh leaf saps from *Phoenix dactylifera, P. sylvestris,* and *Caryota urens* species were also collected before sunrise to avoid fermentation, which is used to make health drinks or beverages. The leaf sap collected from *Phoenix is* called "Tadi" or "Neera", while the sap used to consume it is collected from*C. urens,* called "Salapa" or "Salapiras". The fresh roots of *Phoenix acaulis* are collected as wild food to consume in raw form as well as in curry.

(b) Ethnomedicine*:* Various monocot floras were used to cure various diseases revealed during the survey work. According to the study, 31 monocot plant species have been traditionally used by local healers and residents. Plants like *Acorus calamus, Aloe vera, Allium species, Asparagus racemosus, Dioscorea bulbifera, Cheilocostus speciosus, Cocos nucifera, Curcuma longa, and Zingiber officinale* are commonly used for their medicinal property. The rhizome of *A. calamus is* used to clear throat infections as well as by women with waist problems post-delivery of a baby. The dry root powder of *Asparagus racemous* and *Curculigo orchioides* was directed to be taken with warm milk to overcome impotency problems. *Kaempferia galanga* and *Zingiber officinale* rhizomes are used for coughs and colds, while *Zingiber zerumbet* rhizome is used to control poisoning in snakebites. The fresh green coconut water is collected after keeping

the green coconut buried in soil for a night to use as a moisturizer in the case of marks and scars after chickenpox and also in cut or burnt marks. The boiled coconut oil is massaged over the whole body for skin problems.

(c) Weeds: The weeds grow wild along with the crop plants (agro-ecosystems), wastelands, open barren fields, roadsides, and moist places and are regarded as disturbances or nuisances for crops as well noxious to animals and human beings. Weeds grow in undesirable activity, which makes them a threat to other vegetation. They grow much faster than other naturalized plants. There were reported to be sixty-seven monocot plants thatgrow likeweeds in terrestrial as well as aquatic conditions. Poaceae was the dominant family that has the highest number of plant groups growing likeweeds, which was followed by Cyperaceae members. The genus *Cyperus* was the most common weed found throughout the world. *Cyperus rotundus, C. difformis, C. iria, C. distans, C. articulates, C. compactus, Fimbristylis acuminata, F. quinquangularis, F. aestivalvis.*The main weed plants growing both on terrestrial and aquatic land were *Eragrostis pilosa, E. cilliaris, E. cilliata, Saggitaria sagitifolia, Echinochola crus-galli*, *Paspalum distichum*, *Panicum notatum, Pistia stratiotes, Ottelia alismoides, and Typha aungustifolia.Eichhornia crassipes* and *Monochoria vaginalis,*grow very rapidly and are invading the other indigenous naturalized aquatic plant species in aquatic bodies. *E. crassipes* grow rapidly in the water body and invadingthe total aquatic reason and makingthe water unsuitable for life*. Echinochloa crus-galli* was found as one of the noxious weeds. *Pistia stratiotes,* an aquatic weed that is beneficial in rice cultivation, act as an organic fertilizer for rice plants.

(d) Thatching/basket/broom/Fibreyield: Monocot plants were not only used for medicine, food, or growing likeweeds; it was found the plants or plant parts were collected for use in making houses, brooms, baskets, and fiber making. Plant species like *Oryza sativa*, *Triticum aestivium*, *Bambusa vulgaris*, *B. bambusa*, *Dendrocalamus strictus*, leaves of *Phoenix spp., and Borassus flabellifer* were found to be used in the making of houses and thatching of roofs. Dry plant parts after collection of cereals from *O. sativa and T. aestivium*. The plants were made into handmade fibers which were used to conserve paddy and also in various agricultural fields. Fibers made from *Cocos nucifera* are in high demand due to their usefulness in domestic work and also in agricultural fields. Women of tribal areas in the surroundings of Rourkela make handmade brooms from leaves of *Phoenix* spp*., Aristida setacia, Dactyloctenium aegyptium, and Cocos nucifera,* which are sold in the markets of Rourkela at good prices.The weaving of mats and baskets by tribal women residing atthe study site provides income for their livelihood. Baskets made from *Bambusa* spp. and *D. strictus* have good values due to their use by every group of people. Mats were weaved by tribal ladies from leaves of *Phoenix spp*. and stems of *Typha aungustifolia*. Hand fans prepared from leaves of *Borassus flabellifer* were the most economical fans used mostly during the summer season.

(e) Ornamental Plants: Ornamental plants are generally planted on roadsides, parks, and home gardens for beautification purposes. Most of the ornamental plants that are grown as perennials generally belong to the monocot plant groups. Plants like *Agave americana, A. dosmettiana, Caladium bicolor, Typhonium trilobatum, Heliconia rostrata, Tradescantia spathacea, Vanda roxburghi, Ravenala madgascariensis, Rhoeo discolour* were the common plants grown in home gardens, parks, etc. Different ornamental palms like *Bismarckia nobilis, Caryota urens, Dypsis lutescens, Hyophorbe lagenicaulis, and Roystonea regia* were planted in home gardens and parks too.

(f) Fodder plants: Monocot plants in the form of grasses are most commonly used as fodder plants. After harvesting cereals from *O. sativa, T. aestivium, S. bicolor, and Zeamays*, the plant parts are given to cattle as fodder. Other plant groups were grasses, those given as cattle feed, e.g., *Pennisetum spp., Eragrostis ciliaris, E. ciliate, E. pillosa, Panicum notatum, Paspalum distichum, P. scrobiculatum, Fimbristylis* spp., etc.

(g) Fuel Plants: Monocot plants were used as fuel for daily wages or in rural areas other than township areas. Plant species like *Cocos nucifera, Borassus flabellifer, Areca catechu*, *Bambusa* spp., *Pennisetum* spp., *Oryza sativa, and* leaves of *Phoenix* spp. were commonly used for fuel purposes. *Saccharum officinarum, Zea mays, Eleusine indica*, and *Sorghum bicolor* wastes were used as fuel.

DISCUSSION

Biodiversity, which means the variety and variability among living organisms, is the basis for ecological stability, the ecological complexes in which they occur, andhow they interact with each other and their environment. One of the greatest challenges facing society today is the need to conserve the unsustainable use of natural resources in the form of biodiversity. The knowledge of the distribution patterns of flora in a particular region plays an important role in conserving the larger patterns of distribution of biodiversity. There should be a need to give attention to the conservation of the plant resources in an area because, without the undisturbed characteristic flora of the area, the native fauna can’t persist for a longer period [23].

From the present study, it was found the study area of Rourkela city has a diverse monocot flora, which contributes to the rich diversity of the area by playing a key role in local inhabitants' lives and also provides a preliminary checklist of plants. This information will provide insight into the adaptability of the monocots to the environment of the study area. The data also helps in suggesting suitable staple foods from monocots as well as their economic and medicinal properties. The study site, Rourkela Steel City, is not fully explored, as is the flora of Sundargarh, which has not been completed. There is no updated list of floras studied in the study area except for a few reports available on flora and ethnobotanical studies of the district [10-15].In 2007, Acharya and his coworkers [10] reported a preliminary report on plant diversities present in and around Rourkela, while Acharya and other workers [11] reported more than 100 species of seasonal herbs from Rourkela in their presentation. Acharya and coauthors [12] published a report about the economic plant's checklist of Rourkela, in which some monocot plants were reported in the present study too where as Mallick and coauthors described about diversity of weed plants in and around Rourkela [14]. In 2017, Kumar and coauthors [15] described 154 flora of Rourkela with ethnobotanical details. Some of these monocots were used in the present study. The present study reported 146 monocot species, which is more than the number of monocot species collected from the Karjat tehsil of Ahemdnagar [24] and of Satara district of Maharastra [25] and the diversity of monocot flora in Assam [5] which were 66, 68, and 141 respectively.The result showed there were a high number of varieties of monocot flora in Rourkela even after the area had become an industrial area. The study site is due to the presence of the Rourkela Steel Plant, many small industries, and sponge iron industries. As a result, for a better life, education, and population size also increased. With the day-by-day expansion of urbanization, there is a threat to the presence of naturalized flora. There is a need to give attention to the presence of natural undisturbed flora on which native fauna also depends, for which the conservation of this flora should be studied before it disappears from the study site. Therefore, the inventory of the monocot plants of an area is very essential for taxonomic study as well as for the biodiversity of the study area, which will be helpful for the completion of the flora of Rourkela as well as Sundargarh district.

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