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Studies on nectar plants of butterflies of Uplaon Nature Park, Kalaburagi district, Karnataka, India.

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Abstract: A total of 83 butterfly species under Superfamily Papilionoidea, from 5 families (Papilionidae, Hesperiidae, Pieridae, Lycaenidae and Nymphalidae), 16 subfamilies, 19 tribes and 48 genera were recorded from the study area. Family-wise distribution of species was: Papilionidae 6, Hesperiidae 7, Pieridae 21, Lycaenidae 25 and Nymphalidae 24. A total of 105 plants were identified out of which 96 species were nectaring plants. 43 families of plants including herb, shrubs and trees were visited by all five families of butterflies. Family wise dependence of butterfly species on nectar plants was: Papilionidae 10, Hesperiidae 8, Pieridae 9, Lycaenidae 15, and Nymphalidae 26.

Introduction

Insects are herbivores, carnivores or secondary consumers, and 50% of insect species feed on plants and the major herbivores insect orders are – Coleoptera, Diptera, Lepidoptera, Hymenoptera, Hemiptera and Orthoptera (Speight *et al,* 2008). Janz *et al,* (2006) concludes that herbivory has led to high diversification rates in insects. Plant chemistry influences the abundance of insects; although it is difficult to detect a major influence on the ecology of insects, the two

basic influences could be food and defense (Speight *et al*, 2008). Host chemistry is thought to be the dominant factor responsible for two tight linkages between most insect herbivores and specific plant taxa (Ehrlich and Raven 1964; Becerra 1997). The considerable amount of information available about butterflies and their food plants make them particularly suitable for coevolution investigations (Ehrlich and Raven 1964). There is an intimate association between butterflies and plants and their lives are exceptionally interlinks (Feltwell 1986). The interlinked relationship between plants and butterflies leads to different patterns in their distribution depending on the availability of their food plants (Nimbalkar *et al*, 2011). Butterflies and their caterpillars are dependent on specific host plants for foliage, nectar and pollen as their food. Thus butterfly diversity reflects overall plant diversity, especially that of herbs and shrubs in the given area (Nimbalkar *et al,* 2011). Habitat association of butterflies can be directly related to the availability of food plants (Thomas 1995). Two main plants serve butterflies, nectar giving plants and host plants; nectaring plants are those plants that the butterflies will sip nectar from and host plants are species specific plants on which they lay eggs and which the caterpillars will eventually eat (Jyoti and Kotikal 2012). As herbivorous insects, the distribution of larval hosts and nectar plants has a distinctive impact on the status of butterfly diversity (Culin 1997; Solman Raju 2004). The nectar of flowers is the only source of carbohydrate to the adult butterflies to influence their longevity, fecundity and flight energetics (Sandhya Deepika *et al,* 2014). Butterflies prefer certain floral nectars with specific chemical composition and their visits to different flower also depend on other factors like floral colour, shape, size, position and arrangement in their inflorescence (Solman Raju *et al,* 2011). Opler (1983) suggested that corolla color, shape, positioning of sexual parts, position on plant, presence of nectar guides, fragrance, and time of anthesis play important role in the section of flower foragers. Butterflies have moved to the forefront of investigations into plant-herbivore interactions. This has in turn stimulated detailed studies of host plant associations in several butterfly groups, resulting in a wealth of new information to supplement the more traditional sources (Ackery 1998). However, the feeding behavior of adult butterflies is often neglected in the study of butterfly biology (Hall and Willmott 2000). There is no report or data pertaining to the nectar plants of adult butterflies from Kalaburagi district, Karnataka, India. In this article an attempt was made to study and provide baseline information about nectar plants of adult butterflies of the research station Uplaon Nature Park, Kalaburagi district, Karnataka, India.

Materials And Methods

Study Area

Study was conducted at Uplaon Nature Park, (17^0 23'39.1826'' N and 76^0 52' 33.5019'' E, altitude 471 m above mean sea level) situated about 13 km away from Kalaburagi Central bus stand, of survey number 16, with a geographical area 44.05 acre (18.88 Hectare.), in Kalaburagi District, Karnataka State, India.

During peak Summer maximum temperature reaches 45^0C and December is the coldest month with minimum temperature 10 to 15^0C, Average rain fall is 1-839 mm (Source– Kalaburagi District Profile Government of Karnataka: the knowledge hub Asia).

Plant collection and identification

Extensive field visits were carried out from June 2015 to December 2017 (two years, 7 months) in both the dry and wet seasons. Sampling was carried out by quadrate method (Kent and Coker 1992). Quadrates were laid near the butterfly transects randomly. The length of quadrates were 100×100 m^2, measuring tapes were used for laying quadrates. Most of the plant species were identified with the aid of Flora of Gulbarga District (Seetharam et al.,2000**)** and accompanying botanist. Few species which could not be identified were collected and kept in plastic bags to prevent the dehydration and they were identified by plant taxonomists. Many important host plants for butterflies exhibit distinct clonal growth and patchy distribution and they did have a chance of being missed while sampling in predefined quadrates, such plants were also considered by visiting those patches separately (Sutherland and Krebs 1997; Whitlock and Schluter 2009). Flora of Gulbarga District was followed for classification, common English names, and common Kannada (Regional language of Karnataka State, India) names.

Results And Discussion

During the study period a total of 105 plants were identified out of which 96 plant species were identified as nectaring plants belonging to 43 families including

herb, shrubs and trees used by all the five families of butterflies. (Table 1). In the present study focus was made only on nectaring plants. Highest plant species were recorded in the family Fabaceae (18 species), followed by Asteraceae (8species), four species each in Amranthaceae, Euphorbiaceae and Malvaceae. Three species were recorded in Apocynaceae, Lamiaceae, Rubiaceae, Rutaceae and Verbenaceae. Fig.2, shows the nectar plants, Fig. 3, shows the adult butterflies nectaring on their nectar plants, in the study area.

I. Family - Papilionidae

Ten plant families were recorded on which adult butterflies of Papilionidae species depend on for nectar namely, Acanthaceae, Annonaceae, Apocyanaceae, Combretaceae, Malvaceae, Menispermaceae, Rutaceae, Zygophyllaceae, Verbenaceae, and Asteraceae. (Table 2). Common Mormon (*Papilio polytes*) was found nectaring on *Murraya koenigi* (Rutaceae), Common Jay (*Graphium doson*) on *Lantana camara* (Verbenaceae), Lime Butterfly (*Papilio demoleus*) on *Citrus lemon* (Rutaceae), Tailed Jay (*Graphium agamemnon*) on Lantana camara.

Ehrlich and Raven (1964) listed 27 plant families on which Papilionidae butterflies rely for food. Papilionidae species depended on Aristolochiaceae family for nectaring, laying eggs and caterpillar feeding. Jyoti and Kotikala (2012) reported 27 plant species belonging to the families: Rutaceae, Aristolochiaceae, Rhamnaceae, Fabaceae, Papilionaceae, Lauraceae, Annonaceae, Magnoliaceae, Caparidaceae, Guttiferae and Rubiaceae on which Papilionidae species were dependent.

In the tribe Troidini two species recorded from the study were – Common Rose (*Pachliopta aristolochiae*) and Crimson Rose (*Pachliopta hector*). They fed on plant families Verbenaceae, Asteraceae, Rutaceae and Menispermaceae. Ehrlich and Raven (1964) also recorded Rutaceae and Menispermaceae along with the families Aristolochiaceae, Piperaceae, Rosaceae and Combretaceae as used by these two butterfly species.

In the tribe Papilionini two species - Lime butterfly (*Papilio demoleus*) and Common Mormon (*Papilio polytes*) primarily feed on the familiy Rutaceae. Similar result was also reported by Ehrlich and Raven (1964). Apart from Rutaceae, Papilionini feed on Annonaceae, Apocynacea and Malvaceae. Ehrlich and Raven (1964) listed Combretaceae, Annonaceae, Lauraceae, Nerbenaceae, Acanthaceae, Piperaceae, Umbelliferae, Malvaceae, Aceraceae, Betulaceae, Oleaceae, Plantanacae, Rhamnaceae, Rosaceae and Aristolochiaceae as important host/nectar plants. Range extension and multiplication of species was accompanied by the exploitation of other presumably chemically similar plant groups with alkaloids such as Woody Ranales (Dicotyledonous group), in areas where Aristolochiaceae were poorly represented (Ehrlich and Raven 1964). Asia is one of the biggest continents where the diversity of Aristolochiaceae and Papilionidae is highest. Any group of phytophagous animals must draw its food supply from those plants that are available in its geographical and ecological range (Dethier 1954).

II. Family - Hesperiidae

Seven species from this family visit eight families of plant for nectar – Asteraceae, Punicaceae, Sterculiaceae, Malvaceae, Fabaceae, Palme, Poaceae, and Verbenaceae. (Table 3). Common Awl (*Hasora badra*) and Common Banded Awl (*Hasora chromus*) were found in close association with *Pongamia glabra*, family Malvaceae.

Jyoti and Kotikal (2012) report that Hesperiidae fed on 12 different species belonging to plant families Graminae, Palmae and Malvaceae while Sandhya Deepika *et al,* (2014) reported a total of 29 plant families including 54 plant species. Major plant families on which Hesperiidae butterfly fed were – Verbenaceae, Rubiaceae, Asteraceae, Apocyanaceae, Fabaceae and Malvaceae. *Borbo cinnara* from Hesperiidae fed on seven plant species namely – *Duranta repens*, *Lantna camara*, *Tectona grandis*, *Tridax procumbens*, *Caesalpinia coriaria, Asystasia gangetica*, and *Antigonon leptopus*. According to Gunathilagaraj *et al,* (2015) Skippers visit only those flowers which are white, violet or purple range and we found this to be true in our study.

III. Family - Pieridae

Anacardiaceae, Rubiaceae, Tiliaceae, Euphorbiaceae, Asteraceae, Verbenaceae, Convolvulaceae, Fabaceae, Lamiaceae plant families were visited by Pieridae butterflies to sip the nectar (Table 4)**.**

The species belonging to genus *Eurema* of subfamily Coliadinae, mainly feed on *Tridax procumbens* (Asteraceae) while Small Grass Yellow (*Eurema brigitta*), Common Grass Yellow (*Eurema hecabe*) were

found feeding on *Lecuas aspera* (Lamiaceae), *Lantana camera* (Verbenaceae), and *Senna uniflora* (Fabaceae).

There were two species recorded in genus Catopsilia of subfamily Coliadinae of family Pieridae, *Catopsilia pomona* (Common Emigrant) and *Catopsilia pyranthe* (Mottled Emigrant) that frequently visited *Lantana camera* flowers (Verbenaceae), *Tridax procumbens* (Asteraceae), *Tricholepis radicans* (Asteraceae).

In our study there is no remarkable difference between the tribes of subfamily pertaining to the selection of plants. In the tribe Pierini of subfamily Pierinae – *Colotis amata* (Small Salmon Arab), *Colotis aurora* (Plain Orange Tip), *Colotis danae* (Crimson Tip) usually found sipping nectar from, *Tricholepis radicans* (Asteraceae).

In tribe Pierini, *Belenois aurota* (Pioneer), *Cepora billberg* (Common Gull) was found feeding on *Tridax procumbens* (Asteraceae), and *Tricholepis radicans* (Asteraceae).

According to Alston and Turner (1963) most of the Pieridae family butterflies were associated with plants that contain mustard oil glycosides and myrosinae enzyme. They listed families that contain mustard oil glycosides and myrosinae enzyme – Capparidaceae, Crusiferae, Resedaceae, Salvadoracea and Tropaeolaceae. None of these mentioned families were recorded from the Uplaon Nature Park. Jyoti and Kotikala (2012) listed plant families on which Pieridae butterflies depend on their study area from Bagalkot, Karnataka, India -Fabaceae, Papilionaceae, Caesalpiniaceae, Araceae, Euphorbiaceae, Hypericaceae, Caparidaceae, Loranthaceae, Salvadoraceae.

IV. Family - Lycaenidae

All the butterfly species from this family were recorded to feed on following families – Acanthaceae, Amaranthaceae, Anacardiaceae, Arecaceae, Asclepiadaceae, Asteraceae, Celastraceae, Euphorbiaceae, Malvaceae, Moraceae, Myrtaceae, Rubiaceae, Sterculiaceae, Tiliaceae and Verbenaceae (Table 5).

Spindasis vulcanus (Common Silver Line) was observed to feed on *Celosia argentea* (Amaranthaceae) while *Castalius rosimon* (Common Pierrot), *Tarucus extricates* (Rounded Pierrot), *Tarucus nara* (Stripped Pierrot) were recorded to feed on *Tricholepis radicans* (Asteraceae), *Justica procumbens* (Acanthaceae); while *Spindasis vulcanus* (Common Silver Line), *Zizeeria karsandra* (Dark Grass Blue), *Spindasis vulcanus* (Common Short Silverline), *Freyeria trochylus* (Grass Jewel) were found on *Tridax procumbens* (Asteraceae); and Pea blue on *Vicoa indica.* Plains cupid was also found on *Celosia argentea* (Amaranthaceae).

Jyoti and Kotikala (2012) listed plant families for Lycaenidae as- Rhamnaceae, Fabaceae, Papilionaceae, Rubiaceae, Sapindaceae, Menispermaceae, Verbinaceae. Ehrlich and Raven (1964) listed 41 plant families on which Lycaenids were dependent. In addition, they have explained special feeding habits of tribes Leptinini, Liphyrini and Lycaenini of subfamily Lycaeninae. Leptinini species were found associated with Lichens. There is no record of phytophagy in the tribe Liphyrini, Lycaenini species that were found to feed primarily on Leguminosae plant families, along with this many larvae of this tribe were closely associated with ants.

V. Family - Nymphalidae

25 butterfly species were recorded in the family Nymphalidae. These butterflies were associated with 26 plant families namely – Acanthaceae, Amaranthaceae, Anacardiaceae, Annonaceae, Apocynaceae, Asclepiadaceae, Bombacaceae, Celastraceae, Convolvulaceae, Cucurbetaceae, Euphorbiaceae, Malvaceae, Meliaceae, Menispermaceae, Moraceae, Myrtaceae, Passifloraceae, Portulacaceae, Rhamnaceae, Rubiaceae, Rutaceae, Scrophulariaceae, Sterculiaceae, Tiliaceae, Verbenaceae and Zingiberaceae (Table 6). Ehrlich and Raven (1964), listed more than 115 plant families on which Nymphalids were aasociated. Jyoti and Kotikal (2012) listed following Nymphalidae nectar plants - Annonaceae, Rubiaceae, Euphorbiaceae, Loranthaceae, Amaranthaceae, Acanthaceae, Scrophulariaceae, Malvaceae, Tiliaceae, Urticaceae, Portulacaceae, Cannabinaceae, Melastomataceae, Plantaginaceae, Lamiaceae, Convolvulaceae, Violaceae, Anacardiaceae, Moraceae, Rosaceae, Cucurbitaceae, Asclepiadaceae, Apocynaceae, Periplocaceae, Musaceae, Passifloraceae, Sapindaceae, Menispermaceae, Bambusaceae, and Poaceae.

The species of the subfamily Danainae butterflies closely associated with plant families Apocynaceae and Asclepiadaceae, and similar observation is reported by Ehrlich and Raven (1964). *Danaus chrysippus* (Plain tiger), *Danaus genutia* (Common Tiger), *Tirumala limniace* (Blue Tiger), were usually found sipping nectar from *Catharanthus roseus* (Apocynaceae). *Ypthima*

asterope (Common Threering) on *Alternanthera sessilis*.

Most of the species in subfamily Nymphalinae were associated with – Amaranthaceae, Anacardiaceae, Annonaceae, Malvaceae, Myrtaceae, Sterculiaceae, Tiliaceae and Verbenaceae.

Ehrlich and Raven (1964) listed 44 plant families including the families mentioned above for the subfamily Nymphalinae, and they also opined that Nymphalinae depends on dicotyledons only. In Nymphalidae family three genera – C*haraxes*, *Nymphalis*, *Euphaedra* feed on monocotyledons and two genera of Riodininae in Lycaenidae feed on monocotyledons along with dicotyledons. This shows butterfly feeding pattern switching from dicotyledons to Monocotyledons. The general mechanisms behind host shifts are of great importance for understanding the dynamics of the co-evolutionary process (Niklas and Soren 1998). There is no universally acceptable food plant; and this doubtless has always been true. This statement is based on the chemical variation observed in plants and the physiological variation observed in insects. Plants and phytophagous insects have evolved in response to one another and these stages have developed by a stepwise coevolutionary process (Ehrlich and Raven 1964). Plants evolve defenses against natural enemies, and these enemies in turn evolve new capacities to cope with these defenses. Plants that escape from herbivores can diversify in the absence of enemies. Insects that eventually colonize one of these plants will enter a new zone and can in turn diversify onto the relatives of this plant, because they will be chemically similar (Niklas and Soren 1998). The evolution of secondary plant substances and the stepwise evolutionary responses to these by phytophagous organisms have clearly been the dominant factors in the evolution of butterflies and other phytophgous groups (Ehrlich and Raven 1964).

Most of the butterfly species recorded in the Uplaon Nature Park visit *Calotropis procera, Calotropis gigantia, Lantana camara, Tridax procumbens, Celosia argentea, Tephrosia purpurea* flowers majorly; and their flowering throughout the year could be the reason. Same result is also reported by Nimbalkar *et al,* (2011) in their study.

Conclusion

A total of 83 butterfly species under Superfamily Papilionoidea, from 5 families (Papilionidae, Hesperiidae, Pieridae, Lycaenidae and Nymphalidae), 16 subfamilies, 19 tribes and 48 genera were recorded from the study area. Family-wise distribution of species was: Papilionidae 6, Hesperiidae 7, Pieridae 21, Lycaenidae 25 and Nymphalidae 24. A total of 105 plants were identified out of which 96 species were nectaring plants. 43 families of plants including herb, shrubs and trees were visited by all five families of butterflies.

Ten plant families were recorded on which adults of Papilionidae depended for nectar - Acanthaceae, Annonaceae, Apocyanaceae, Combretaceae, Malvaceae, Menispermaceae, Rutaceae, Zygophyllaceae, Verbenaceae, and Asteraceae. Seven Hesperiidae species visited eight families of nectar plants – Asteraceae, Punicaceae, Sterculiaceae, Malvaceae, Fabaceae, Palme, Poaceae, and Verbenaceae. Nine nectar plant families were visited by Pieridae - Anacardiaceae, Rubiaceae, Tiliaceae, Euphorbiaceae, Asteraceae, Verbenaceae, Convolvulaceae, Fabaceae, Lamiaceae. All the Lycaenidae species fed on 15 plant families – Acanthaceae, Amaranthaceae, Anacardiaceae, Arecaceae, Asclepiadaceae, Asteraceae, Celastraceae, Euphorbiaceae, Malvaceae, Moraceae, Myrtaceae, Rubiaceae, Sterculiaceae, Tiliaceae and Verbenaceae. The Nymphalidae family were associated with 26 plant families– Acanthaceae, Amaranthaceae, Anacardiaceae, Annonaceae, Apocynaceae, Asclepiadaceae, Bombacaceae, Celastraceae, Convolvulaceae, Cucurbetaceae, Euphorbiaceae, Malvaceae, Meliaceae, Menispermaceae, Moraceae, Myrtaceae, Passifloraceae, Portulacaceae, Rhamnaceae, Rubiaceae, Rutaceae, Scrophulariaceae, Sterculiaceae, Tiliaceae, Verbenaceae and Zingiberaceae

There is an intimate relationship between butterflies and plants. Each butterfly families and each species have their own specific plant on which both adults and caterpillars depend. The species diversity, richness, abundance and distribution of butterflies depends on the diversity, richness abundance of the plants apart from the abiotic components of the habitat. Our recommendations are : Uplaon Nature Park already has abundant host and nectar plants for butterflies, but forest fires (February and March 2017), over grazing, unscientific mowing of "weeds" should be controlled and long term monitoring of the Park is recommended.

An attempt was made to study the plants on which adult butterflies depend for nectar and baseline data

for five families of butterflies and their nectar plants is presented. Further studies on larval host plants of each butterfly family needs to be undertaken.

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Author Contributions:

Survey and Data collection, Laboratory Experimental work, Manuscript Preparation - Kavya. K Saraf Original Idea, Data analysis, and Design of the study - K Vijayakumar

Table 1, Checklist list - Nectar plant species of butterflies recorded at Uplaon Nature Park

S.N.	Scientific name	Family
1	*Abelmoschus ficulneus* (L.) wt. and Arn., 1834.	Malvaceae
2	*Abrus precatorius* L., 1767.	Fabaceae
3	*Abutilon indicum* (L.) Sweet., 1826.	Malvaceae
4	*Acacia karroo* (Hayne) Banfi and Galasso., 1922.	Fabaceae
5	*Achyranthes aspera* L., 1753.	Amaranthaceae
6	*Aegle marmelos* (L.) Corr., 1800.	Rutaceae
7	*Albizia lebbeck*, (L.) Benth., 1844.	Fabaceae
8	*Alteranthera sessilis* (L.) R. Br., 1813.	Amaranthaceae
9	*Alysicarpus rugosus* (Willd.) Dc., 1825.	Fabaceae
10	*Alysicarpus vaginalis* (L.) DC.	Fabaceae
11	*Amaranthus spinosus* L., 1753.	Amaranthaceae
12	*Andropogon sorghum* (L.) Brot., 1804	Poaceae
13	*Annona squamosa* L., 1753.	Annonaceae
14	*Argemon mexicana* L., 1753.	Papaveraceae
15	*Azadirachta indica* A., 1830	Meliaceae
16	Beans sp	Fabaceae
17	*Biophytum sensitivum* (L.) Dc., 1824.	Geraniaceae
18	*Boerhavia diffusa* L., 1753.	Nyctaginaceae
19	*Borreria pusillal* (wall.) DC., 1830.	Rubiaceae
20	*Bougainvillea spectabilis* willd	Nyctaginaceae
21	*Brassica juncea* (L.) Czernajew., 1859.	Brassicaceae
22	*Caesalpinia pulcherrima* (L.) Sw.	Fabaceae
23	*Calotropis gigantean* (L.) R.Br., 1811.	Asclepiadaceae
24	*Calotropis procera* R.Br., 1811.	Asclepiadaceae
25	*Capparis grandis* L., 1781.	Capparaceae
26	*Cascabela thevetia* (L.) Lippold., 1980.	Apocynaceae
27	*Cassia auriculata* L., 1753.	Fabaceae
28	*Cassia fistula* L., 1753.	Fabaceae

29	*Catharanthus roseus* (L.) G.Don, Gen. syst., 1873-38.	Apocynaceae
30	*Celosia argentea* L., 1753.	Amaranthaceae
31	*Citrus limon* (L.) Osbeck., 1765.	Rutaceae
32	*Cocos nucifera* L., 1753.	Arecaceae
33	*Commelina forskalaei* Vahl., 1806.	Commelinaceae
34	*Conzy japonica* (Thunb.) Less., 1832.	Asteraceae
35	*Coomelina benghalensis* L., 1753.	Commelinaceae
36	*Corchorus olitorius* L., 1753.	Tiliaceae
37	*Croton bonplandianus* Baill., 1864.	Euphorbiaceae
38	Cucurbetaceae family Species	Cucurbetaceae
39	*Cyanotis fasciculate* (Roth) J. and J. Schult., 1830.	Commelinaceae
40	*Duranta repens* L., 1753.	Verbenaceae
41	*Evolvulus alsinoides* (L.) L., 1762.	Convolvulaceae
42	*Ficus religiosa* L., 1753.	Moraceae
43	*Gliricidia sepium* (Jacq.) Kunth.ex.walp.	Fabaceae
44	Grass family species	Poaceae
45	*Heliotropium indicum* L., 1753.	Boraginaceae
46	*Hemidesmus indicus* (L.) Schult., 1820.	Asclepiadaceae
47	*Hibiscus rosa sinensis* L., 1753.	Malvaceae
48	*Hyptis suaveolens* (L.) Poit., 1806.	Lamiaceae
49	*Indigofera cordifolia* Heyne., 1821.	Fabaceae
50	*Ixora arborea* Roxb. Ex Sm., 1811.	Rubiaceae
51	*Jasminum roxburghianum* Cl., 1888.	Nymphaeaceae
52	*Jatropa glandulifera* Roxb., 1814.	Euphorbiaceae
53	*Justica procumbens* L., 1753.	Acanthaceae
54	*Lantana camara* L., 1753.	Verbenaceae
55	*Lecuas aspera* (Willd.) Link., 1822.	Lamiaceae
56	*Mangifera indica* L., 1753.	Anacardiaceae
57	*Maytenus senegalensis* (Lam.) Excell., 1952.	Celastraceae
58	*Michelia champaca* L., 1753.	Magnoliaceae
59	*Morinda pubescens* J.E.Sm., 1813.	Rubiaceae
60	*Muntingia calabura* L., 1859.	Muntingiaceae
61	*Murraya koenigii* (L.) Spreng., 1825.	Rutaceae
62	*Nerium indicum* Mill., Gard., 1768.	Apocynaceae
63	*Ocimim basilicum* L., 1753.	Lamiaceae
64	*Parthenium hysterophorus* L., 1753.	Asteraceae
65	*Passiflora foetida* L., 1753.	Passifloraceae
66	*Pithecellobium dulce* (Roxb.) Benth., 1844.	Fabaceae
67	*Polyalthia longifolia* (Sonn.) Thw., 1864.	Annonaceae
68	*Pongamia glabra* (L.) Vent.	Fabaceae
69	*Portulaca oleraceae* L., 1753.	Portulacaceae
70	*Punica granatum* L., 1753.	Punicaceae
71	*Ricinus communis* L., 1753.	Euphorbiaceae

72	*Ruellia tuberose* L., 1753.	Acanthaceae
73	*Senna uniflora* (Mill) H.S. Irwin and Barneby	Fabaceae
74	*Sesamum radiatum* Schumach. And Thonn., 1827.	Pedaliaceae
75	*Sida acuta* N.Burm., 1768.	Malvaceae
76	*Striga gesnerioides* (Willd.) Vatke, Oesterr., 1875.	Scrophulariaceae
77	*Syzygium cumini* (L.) Skeels., 1912.	Myrtaceae
78	*Tagetes erecta* L., 1753.	Asteraceae
79	*Tecoma stans* (L.) Kunth., 1819.	Bignoniaceae
80	*Tectona grandis* L., 1781.	Verbenaceae
81	*Tectona grandis* L., 1781.	Verbenaceae
82	*Tephrosia purpurea* (L.) Pres., 1807.	Fabaceae
83	*Terminalia catapa* L., 1767.	Combretaceae
84	*Tinospora cordifolia* (Willd.) J. Kock and Thoms., 1855.	Menispermaceae
85	*Tragia hildebrandtti* Muell., 1880	Euphorbiaceae
86	*Tribulus terrestris* L., 1753.	Zygophyllaceae
87	*Trichodesma indicum* (L.) Lehmann., 1818.	Bombacaceae
88	*Tricholepis radicans* (Roxb.) Dc., 1838	Asteraceae
89	*Tridax procumbens* L., 1753.	Asteraceae
90	*Vicoa indica* (L.) Dc., 1834.	Asteraceae
91	*Vitex negundo* L., 1753.	Verbenaceae
92	*Waltheria indica* L., 1753.	Sterculiaceae
93	*Wedelia trilobata* (L.) Hitchc., 1893	Asteraceae
94	*Zingiber officinale*	Zingiberaceae
95	*Zizyphus mauritiana* Lam., 1789.	Rhamnaceae
96	*Zornia gibbosa* Spanoghe, Linnaeus, 1841.	Fabaceae

Table 2, Nectar plant list of family Papilionidae recorded at Uplaon Nature Park

S.N	Scientific name
1	*Abelmoschus ficulneus* (L.) wt. and Arn., 1834.
2	*Abutilon indicum* (L.) Sweet., 1826.
3	*Conzy japonica* (Thunb.) Less., 1832.
4	Grass family species
5	*Hibiscus rosa sinensis* L., 1753.
6	*Parthenium hysterophorus* L., 1753.
7	*Pongamia glabra* (L.) Vent.
8	*Punica granatum* L., 1753.
9	*Sida acuta* N.Burm., 1768.
10	*Tagetes erecta* L., 1753.
11	*Tectona grandis* L., 1781.
12	*Tricholepis radicans* (Roxb.) Dc., 1838
13	*Tridax procumbens* L., 1753.
14	*Vicoa indica* (L.) Dc., 1834.
15	*Waltheria indica* L., 1753.
16	*Wedelia trilobata* (L.) Hitchc., 1893

Table 3, Nectar plant list of family Hesperiidae recorded at Uplaon Nature Park

S.N.	Scientific name
1	*Abutilon indicum* (L.) Sweet., 1826.
2	*Aegle marmelos* (L.) Corr., 1800.
3	*Annona squamosa* L., 1753.
4	*Citrus limon* (L.) Osbeck., 1765.
5	*Hibiscus rosa sinensis* L., 1753.
6	*Lantana camara* L., 1753.
7	*Murraya koenigii* (L.) Spreng., 1825.
8	*Nerium indicum* Mill., Gard., 1768.
9	*Polyalthia longifolia* (Sonn.) Thw., 1864.
10	*Sida acuta* N.Burm., 1768.
11	*Terminalia catapa* L., 1767.
12	*Tinospora cordifolia* (Willd.) J. Kock and Thoms., 1855.

Table 4, Nectar plant list of family Pieridae recorded at Uplaon Nature Park

S. N.	Scientific name
1	*Abutilon indicum* (L.) Sweet., 1826.
2	*Achyranthes aspera* L., 1753.
3	*Achyranthes aspera* L., 1753.
4	*Amaranthus spinosus* L., 1753.
5	*Amaranthus spinosus* L., 1753.
6	*Calotropis gigantean* (L.) R.Br., 1811.
7	*Calotropis procera* R.Br., 1811.
8	*Citrus limon* (L.) Osbeck., 1765.
9	*Cocos nucifera* L., 1753.
10	*Corchorus olitorius* L., 1753.
11	*Ficus religiosa* L., 1753.
12	*Hemidesmus indicus* (L.) Schult., 1820.
13	*Hibiscus rosa sinensis* L., 1753.
14	*Ixora arborea* Roxb. Ex Sm., 1811.
15	*Lantana camara* L., 1753.
16	*Mangifera indica* L., 1753.
17	*Maytenus senegalensis* (Lam.) Excell., 1952.
18	*Morinda pubescens* J.E.Sm., 1813.
19	*Murraya koenigii* (L.) Spreng., 1825.
20	*Ricinus communis* L., 1753.
21	*Sida acuta* N.Burm., 1768.
22	*Tragia hildebrandtti* Muell., 1880
23	*Waltheria indica* L., 1753.
24	*Waltheria indica* L., 1753.

Table 5, Nectar plant list of family Lycaenidae recorded at Uplaon Nature Park

S. N.	Scientific name
1	*Abutilon indicum* (L.) Sweet., 1826.
2	*Calotropis gigantean* (L.) R.Br., 1811.
3	*Calotropis procera* R.Br., 1811.
4	*Cocos nucifera* L., 1753.
5	*Ficus religiosa* L., 1753.
6	*Hemidesmus indicus* (L.) Schult., 1820.
7	*Hibiscus rosa sinensis* L., 1753.
8	*Ixora arborea* Roxb. Ex Sm., 1811.
9	*Lantana camara* L., 1753.
10	*Mangifera indica* L., 1753.
11	*Maytenus senegalensis* (Lam.) Excell., 1952.
12	*Morinda pubescens* J.E.Sm., 1813.
13	*Ricinus communis* L., 1753.
14	*Sida acuta* N.Burm., 1768.
15	*Tragia hildebrandtti* Muell., 1880
16	*Waltheria indica* L., 1753.

Table 6, Nectar plant list of family Nymphalidae recorded at Uplaon Nature Park

S.N	Scientific name
2	*Abutilon indicum* (L.) Sweet., 1826.
3	*Achyranthes aspera* L., 1753.
4	*Aegle marmelos* (L.) Corr., 1800.
6	*Amaranthus spinosus* L., 1753.
7	*Annona squamosa* L., 1753.
10	*Calotropis gigantean* (L.) R.Br., 1811.
11	*Calotropis procera* R.Br., 1811.
15	*Citrus limon* (L.) Osbeck., 1765.
16	*Corchorus olitorius* L., 1753.
21	*Ficus religiosa* L., 1753.
22	*Hemidesmus indicus* (L.) Schult., 1820.
23	*Hibiscus rosa sinensis* L., 1753.
24	*Ixora arborea* Roxb. Ex Sm., 1811.
27	*Lantana camara* L., 1753.
28	*Mangifera indica* L., 1753.
29	*Maytenus senegalensis* (Lam.) Excell., 1952.
30	*Morinda pubescens* J.E.Sm., 1813.
31	*Muntingia calabura* L., 1859.
32	*Murraya koenigii* (L.) Spreng., 1825.
33	*Nerium indicum* Mill., Gard., 1768.
34	*Passiflora foetida* L., 1753.
35	*Polyalthia longifolia* (Sonn.) Thw., 1864.
36	*Portulaca oleraceae* L., 1753.
37	*Ricinus communis* L., 1753.
39	*Sida acuta* N.Burm., 1768.
43	*Tinospora cordifolia* (Willd.) J. Kock and Thoms., 1855.
44	*Tragia hildebrandtti* Muell., 1880
47	*Waltheria indica* L., 1753.

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Abutilon indicum

Abrus precatorius

Achyranthes aspera

Acacia karroo

Aegle marmelos

Agave cantula

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Alteranthera sessilis

Alysicarpus vaginalis

Alysicarpus rugosus

Amaranthus spinosus

Andropogon sorghum

Annona squamosa

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Argemon mexicana

Azadirachta indica

Biophytum sensitivum

Boerhavia species

Boerhavia diffusa

Bougainvillea spectabilis

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Brassica juncea

Caesalpinia pulcherrima

Calotropis gigantean

Calotropis procera

Capparis grandis

Cascabela thevetia

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Cassia fistula

Catharanthus roseus

Celosia argentea

Citrus limon

Cocos nucifera - Coconut

Convolvulus species

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Conzy japonica

Corchorus olitorius

Croton bonplandianus

Cucurbetaceae family Species

Cyanotis fasciculate

Duranta repens

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Echinopsis species

Evolvulus alsinoides

Ficus benghalensis

Ficus religiosa

Gliricidia sepium

Grass family species

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Hibiscus rosa sinensis

Hyptis suaveolens

Tecoma stans

Zingiber officinale

Borreria pusillal

Indigofera cordifolia

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Jasminum roxburghianum

Jatropa glandulifera

Justica procumbens

Albizia lebbeck

Leucas aspera

Mangifera indica

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Maytenus senegalensis

Lantana camara

Morinda pubescens

Muntingia calabura

Murraya koenigii

Nerium indicum

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Ocimim basilicum

Parthenium hysterophorus

Passiflora species

Pithecellobium dulce

Polyalthia longifolia

Pongamia glabra

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Portulaca oleraceae

Psidium guajava

Punica granatum

Ricinus communis

Abelmoschus ficulneus

Raphanus sativus

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Ruellia tuberose

Senna auriculata

Senna Species

Senna uniflora

Sesamum radiatum

Sida acuta

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Striga gesnerioides

Syzygium cumini

Tagetes erecta

Tamarindus indica

Tecoma stans

Tephrosia purpurea

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Terminalia catapa

Tinospora cordifolia

Tragia hildebrandtti

Tribulus terrestris

Trichodesma indicum

Tricholepis radicans

PLATE NO. 1: NECTAR PLANTS RECORDED AT UPLAON NATURE PARK, KALABURAGI DISTRICT, KARNATAKA, INDIA

Tridax procumbens

Vicoa indica

Vitex negundo

Wedelia trilobata

Zizyphus mauritiana

Zornia gibbosa

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Diversity of corvids (Aves: Passeriformes: Corvidae) in Lolab valley of Kashmir Himalaya

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Large-billed Crow

Abstract

We present data on distribution, diversity and abundance of Corvidae in the Lolab valley (34^0 25' and 34^0 42' N and 74^{0}15' and 74^0 32' E) of Kashmir Himalaya. The valley covers an area of about 350 km^2 and is characterized by various habitat types: coniferous forests, deciduous forests, riverine areas, agricultural land and alpine pastures. Seasonal diversity of corvids in these habitat types was recorded from January to December, 2018 by line transect method and eight species have been reported from the valley. Seasonal species richness was highest for spring (eight species) and summer (eight species) followed by autumn (six species) and winter (five species). The number and diversity of corvid species was maximum in deciduous forest (n=141, H' = 1.63) and minimum in alpine meadows (n=23, H'= 1.23). Seasonal diversity was maximum in summer (H'= 1.77) and minimum in winter (H'= 1.44).

Introduction

The cosmopolitan bird family, Corvidae comprises of more than 120 species of crows, ravens, rooks, jackdaws, jays, magpies, treepies, choughs and nutcrackers (Goodwin, 1983; Vander Wall, 1990), out of which, 20 species have been reported from India (Praveen *et al.,* 2016) and 10 species from the Himalayan region (Dewar, 2006). Over one-third of the family is constituted by genus *Corvus*. Corvids, the moderate to large sized birds, with strong feet and bills are found throughout the globe except the tip of the South America and polar ice caps (Clayton *et al*., 2003). Most of them are found in tropical South and Central America, Southern Asia and Eurasia. They are generally sedentary but show eruptive migrations during food shortage (Robertson, 2000). They are omnivorous and their diet is composed of invertebrates, nestlings of different birds, small mammals, seeds,

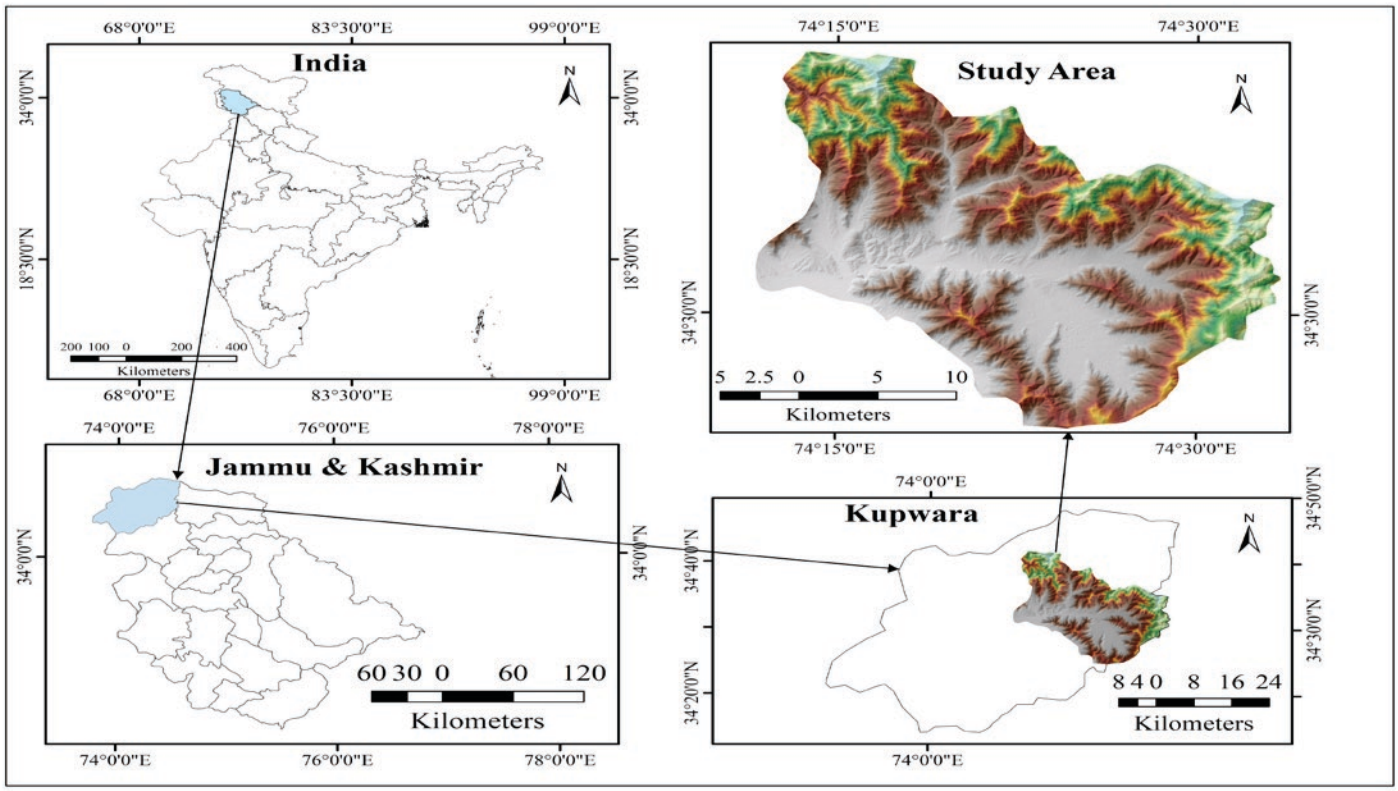

Figure 1: Location map of lolab valley Kashmir Himalayas

fruits and carrion (Wani *et al*., 2019). They are regarded as the key functional species for regeneration and maintenance of forests, through a seed dispersal mechanism known as "scatter-hoarding" (Wani *et al*., 2019). Due to their seed dispersal behaviour, corvids could act as a competent habitat restoration instrument (Pesendorfer *et al*., 2016). Despite their important ecological service, corvids have been neglected as far as research work in Kashmir Himalaya is considered. The present study was undertaken with a view to assess the diversity of corvids in the Lolab valley of Kashmir Himalaya. This work will help in augmenting existing information on corvids in the region and initiating conservation action.

Methods

Study area

Lolab valley (34^0 25' and 34^0 42' N latitude and $74^0$15' and 74^0 32' E longitude) is located in District Kupwara of Jammu and Kashmir (Figure 1). The valley spreads over an area of about 350 km^2 with an altitudinal range between 1661m to 3846m and is beautified by forests, pastures, and water bodies (Bhat *et al.*, 2015). The vegetation of the valley is divided into coniferous forests, deciduous forests, riverine areas, agricultural land and alpine pastures. The coniferous forests are dominated by deodar (*Cedrus deodara*) and Kail (*Pinus wallichiana*) (Bhat et al., 2014).The main faunal elements of the area include black bear (*Ursus thibetanus*), leopard (*Panthera uncia*), jackal (*Canis aureus*), red fox (*Vulpes vulpes*), etc.

Methodology

Line Transect method

Data on diversity of corvids was collected from January to December, 2018 by conducting regular field visits. The year was divided into spring (March-May), summer (June-August), autumn (September-November) and winter (December-February) seasons (Wani *et al*., 2020). The observations were recorded by walking along transects (Harisha and Hosetti 2009) in five different habitat types mentioned earlier. Observations were made with the help of (10x50) X binoculars. Birds were identified using standard field guide (Grimmett and Inskipp 2016).

Local status of different species of corvids in Lolab valley was assigned following Bull (1964) and Mc Caskie (1970): Very abundant (VA): over 1000 individuals seen per day; Abundant (A): 201-1000 individuals seen per day; Very common (VC):

51-200 individuals seen per day; Common (C): 21-50 individuals seen per day; Fairly common (FC): 7-20 individuals seen per day; Uncommon (UC): 1-6 individuals seen per day; Rare (Re): 1-6 individuals seen per season; Very rare (R): infrequent occurrence.

Data analysis

Corvid diversity in different seasons and habitat types of Lolab valley was calculated using Shanon-Weiner (Shannon and Weiner, 1949) index as:

$$H' = -\sum_{i=1}^{R} pi \ln pi$$

Where, Pi= Proportion of individual species and R= Total number of species of the community.

To calculate whether a species is distributed evenly across landscape and seasons, evenness index was calculated using the following formula:

E= H' / ln S

Where, H' is Shannon-Wiener's diversity index and S is species richness

The probability that two randomly selected individuals in the community belong to the same category was calculated using Simpsons's index:

$$\mathbf{D = \sum ni(ni-1)/N(N-1)}$$

Where, ni= the total number of birds of each individual species and N= the total number of birds of all species

Results

Corvid community structure of Lolab valley revealed the presence of eight species of corvids belonging to five genera (Table 1). Season-wise species richness was highest for spring (Eight species) and summer (Eight species); and lowest for winter (five species) (Table 2). In case of habitat types, the number of individuals of corvid species were maximum in deciduous forest

Table1. Checklist of corvids from Lolab valley of Kashmir Himalaya

S.No.	Species	Scientific name	Resident/ Migrant	Local status	IUCN status
1	Eurasian Jackdaw	*Corvus monedula*	Resident	Very Common	LC
2	House Crow	*Corvus splendens*	Resident	Very Common	LC
3	Large-billed Crow	*Corvus macrorhynchos*	Resident	Very Common	LC
4	Yellow-billed Blue Magpie	*Urocissa flavirostris*	Resident	Common	LC
5	Black-headed Jay	*Garrulus lanceolatus*	Resident	Fairly Common	LC
6	Spotted Nutcracker	*Nucifraga caryocatactes*	Resident	Rare	LC
7	Red-billed Chough	*Pyrrhocorax pyrrhocorax*	Resident	Rare	LC
8	Raven	*Corvus corax*	Resident	Common	LC

Table2. Season-wise species richness, diversity index and evenness index for corvids of Lolab valley

Season/Index	Spring	Summer	Autumn	Winter
Total no. of individuals	130	148	111	89
Species richness	8	8	6	5
Shannon-Weiner diversity index, (H')	1.73	1.77	1.51	1.44
Simpson's index (D)	0.19	0.19	0.23	0.24
Evenness index (E)	0.83	0.85	0.84	0.89

Table3. Habitat-wise species richness, diversity index and evenness index for corvids of Lolab valley

Habitat type/Index	Alpine meadows	Deciduous forest	Coniferous forest	Riverine	Agriculture
Total no. of individuals	23	141	102	99	113
Species richness	4	6	6	6	5
Shannon-Weiner diversity index, (H')	1.23	1.63	1.56	1.47	1.45
Simpson's index (D)	0.28	0.20	0.22	0.28	0.24
Evenness index (E)	0.89	0.91	0.87	0.82	0.90

Table 4: Season-wise presence of different species of corvids in Lolab Valley

Species	Spring	Summer	Autumn	Winter
Eurasian Jackdaw	Present	Present	Present	Present
House Crow	Present	Present	Present	Present
Large-billed Crow	Present	Present	Present	Present
Yellow-billed Blue Magpie	Present	Present	Present	Present
Black headed jay	Present	Present	Present	Absent
Spotted Nutcracker	Present	Present	Absent	Absent
Red-billed Chough	Present	Present	Absent	Absent
Raven	Present	Present	Present	Present

Table 5: Habitat-wise presence of different species of corvids in Lolab valley

Species	Alpine	Deciduous	Coniferous	Riverine	Agricultural
Eurasian Jackdaw	Present	Present	Present	Present	Present
House Crow	Absent	Present	Present	Present	Present
Large-billed Crow	Present	Present	Present	Present	Present
Yellow-billed Blue Magpie	Absent	Present	Absent	Present	Present
Black-headed Jay	Absent	Present	Present	Present	Absent
Spotted Nutcracker	Present	Present	Absent	Absent	Absent
Red-billed Chough	Present	Present	Absent	Absent	Absent
Raven	Present	Present	Present	Present	Present

(n=141) and minimum in alpine meadows (n=23) (Table 3). Season-wise, the number of individuals were maximum in summer (n=148) and minimum in winter (n=89) (Table 2).

Season wise, the Shannon-Weiner diversity index was highest for summer (1.77) and lowest for winter (1.44). Simpson's index was maximum for winter (0.24) and minimum for spring and summer (0.19 each). Similarly, Evenness index was highest for winter (0.89) and lowest for spring (0.83) (Table 2). According to habitat type, the Shannon-Weiner diversity index was highest for decidous forests (1.63) and lowest for alpine meadows (1.23). Similarly, Simpson's index was highest for alpine and riverine (0.28 each); and lowest

for deciduous forests (0.20). Evenness index was maximum for deciduous forests (0.91) and minimum for riverine habitat (0.82) (Table3).

Discussion

A total of 454 resident and non-resident bird species have been recorded from the erstwhile state of Jammu and Kashmir (Grimett et al., 2004). Among them, 10 species of Corvids have been reported from Himalayan region (Dewar 2006; Wani et al., 2019). Wani (2012) recorded eight species of corvids belonging to six genera from Dachigam National Park. Habib et al., 2014 reported nine corvid species from Dachigam National Park. We recorded a total of eight species of corvids during the study of which three (Eurasian Jackdaw, House Crow and Large-billed Crow) were very common, two (Yellow-billed Blue Magpie and Raven) were common, one (Black-headed Jay) was fairly common and two (Spotted Nutcracker and Red-billed Chough) were rare. Genus *Corvus* was represented by four species. *Urocissa, Garrulus, Nucifraga* and *Pyrrhocoran* were represented by one species each (Table 1). Habib et al., 2014 found *Corvus* as the biggest genera of Corvids with five speices from Dachigam and its adjoining areas. According to Wani *et al*., 2019 more than one-third of entire corvidae is composed of genus Corvus, which includes crows, rooks, ravens and jackdaws. All the eight species of corvids in Lolab valley were residents.

Corvid diversity (Shannon-Weiner's index) was highest during summer (1.77) followed by spring (1.73), autumn (1.51) and winter (1.44). High diversity during summer can be related to earlier works of Gaston (1995) and Mahabal (2005) which reveal that Himalayas receive abundant breeding birds during summer months from adjacent areas.

Bird communities are closely related to environments they inhabit. Previous studies have shown interaction between forest and bird communities (Mac Arthur and Mac Arthur, 1961, Schwab and Sinclair, 1994). Lolab valley is diverse with rich forest cover (Bhat et al., 2015) and thus provides suitable environment to avifauna for nesting and resting. During the present study deciduous forests had maximum corvid diversity (1.63), followed by coniferous forests (1.56), riverine (1.47), agricultural field (1.45) and alpine meadows (1.23) (Table 3). The variation in observed species diversity at various habitat types may be due to variations in availability of food and nesting sites. It has been observed that abundance of numerous bird species is highly influenced by the vegetation composition that forms a major element of their habitats (Noor et al., 2014). As vegetation changes along complex environmental gradients, a particular species can increase, decrease, appear or disappear and vanish as the habitat changes (Lee and Rotenberry, 2005; Noor *et al*., 2014; Wani and Nazir, 2020). In the current study, high diversity of corvids in deciduous forests may have been influenced by presence of vital resources like food availability and nesting sites.

Conclusion

The current study provides information on status and diversity of corvid species in different habitat types of Lolab valley. This study will act as a baseline for conducting detailed ecological studies on corvids and for initiating long term conservation programs in the region.

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Eurasian Jackdaw

Black-headed Jay

Yellow-billed Blue Magpie

Red billed chough

First record of a feral breeding population of the exotic apple snail *Pomacea diffusa Blume*, 1957 from the Mumbai region.

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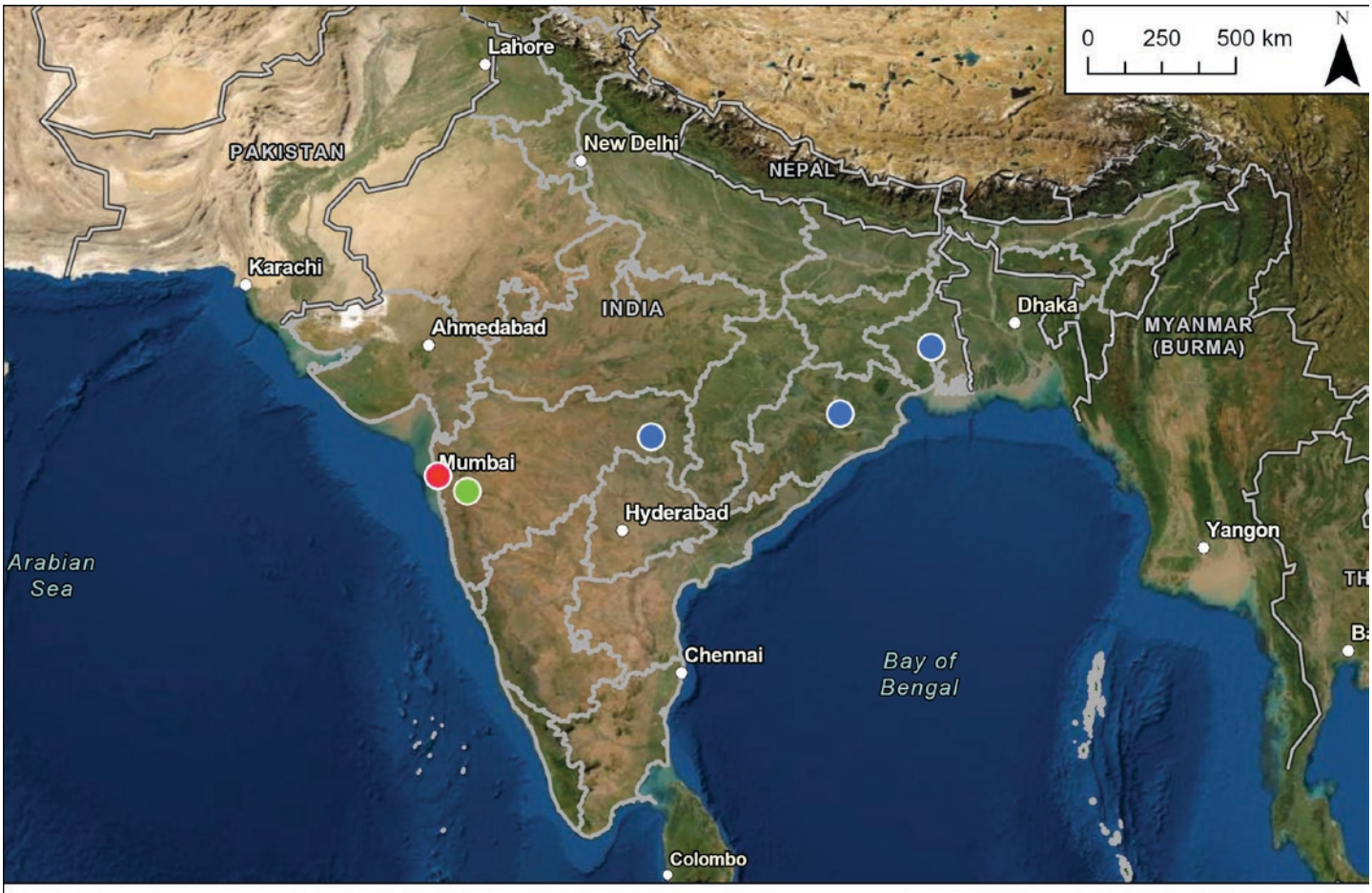
The Ampullariidae, J. E. Gray, 1824 are a diverse group of pantropical freshwater snails, with nine extant genera namely: *Pila* Röding, 1798 (Asia and Africa); *Pomacea* Perry, 1810 (southern South America, to southeastern USA, and the Caribbean islands in the far west of the Atlantic); *Marisa* Gray, 1824, *Pomella* Gray, 1847, *Felipponea* Dall, 1919, and *Asolene* d'Orbigny, 1838 (South America); Afropomus Pilsbry & Bequaert, 1927, Lanistes Montfort, 1810, and Saulea Gray, 1867 (Africa).

Popularly termed 'apple snails', they reach their highest diversity in South America, and play vital roles in the freshwater bodies they inhabit, creating an integral link between aquatic and terrestrial food chains. They can also be keystone species, in some of the ecosystems they inhabit, especially in important wetland biomes such as the Florida Everglades, the Llanos of Venezuela, and the Pantanal of central South America, (Berthold, 1991; Cowie et al., 2006 ; Donnay & Beissinger, 1993 ; Ebenman & Jonsson, 2005 ; Tanaka et al., 2006 ; K. A. Hayes et al., 2008, *as cited in* Kenneth A. Hayes et al., 2009).

In East Asia, native ampullariids occur in India, the basin of the Ganges, Sri Lanka, Thailand, Myanmar, Malaysia, and the islands of the Malay Archipelago, as far east as Bali and the Celebes and northwards to the Philippines (Baonan & Pagulayan, 2006).

Figure 1



Data sources: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, FAO, NOAA, SOI, and the GIS User Community. Basemap imagery © 2021 DigitalGlobe.

In India, the family is represented by the Genus *Pila* Röding, 1798, in the plains, and the somewhat controversial sub-genus *Turbinicola* Annandale & Prashad, 1921, in hill-streams (Prashad 1925, as cited in Baonan & Pagulayan, 2006; The Apple Snail Website: https://www.applesnail.net/content/species/pila_ampullacea.htm).

Amongst the non-native apple snails, only a single species, *Pomacea diffusa* Blume, 1957, has been recorded from the country thus far, from the states of Odisha and West Bengal in Eastern India, and Maharashtra in Western India. In the latter state, feral populations have been observed (and collected) in the Tadoba Andhari Tiger Reserve, in Chandrapur district, with a captive population recorded breeding in private aquaria in Kaspate Vasti, Wakad, in the city of Pune, Pune district (Raut & Aditya, 1999, in Pati & Sharma, 2013) (Figure 1).

The present report of a feral population from the city of Mumbai, in the Mumbai suburban district, is the first record of the species from the Mumbai region.

Specimens were found inhabiting the drainage system of the Kurla neighbourhood, in East Mumbai (19°04'01.2"N 72°53'09.6"E). The entire population consisted of the popular 'golden morph' (brightly colored yellow-orange specimens) of the species, prevalent in the aquarium trade, which is also the most likely source of feral populations of the species across its known distribution range within the country. (Figures 2*a*-*2*e).

The snails were first spotted being offered for sale by a local fish store, in Eastern Mumbai. Upon further inquiry, the proprietor, who was unaware of their South American origin, revealed that they were locally

Figure 2a

Figure 2b

Figure 2c

Figure 2d

Figure 2e

collected, and further added that the species has been seasonally harvested from local waters, and offered for sale in aquarium stores across Mumbai, from time to time, for many years.

A total of five specimens were maintained in the principal author's home aquaria for further observation, over a period of six months (Aug 2020-Feb 2021) where they displayed a distinct preference for prepared fish feed with high algae content, and also dead plant and animal matter. Living plants were not consumed.

Identification was based on the following morphological traits unique to the species, namely, apex (spire) is distinctly raised, possessing 5 to 6 sharply 'stepped' whorls, with square shoulders, and non-channelled sutures angled at almost 90˚ (Perera & Walls 1996; Bronson 2002, in Collier et. al 2011). Aperture (shell opening) is oval in shape, and the umbilicus deep. The species is also known as the 'spike-topped apple snail' on account of the aforementioned raised spire (Cowie et. al 2006, Rawlings et. al 2007) (Figures 3*a*-3*c*).

It should be noted that all records of P. *bridgesii* from India, and indeed the world, as an introduced

Figure 3a- Shell of 'Golden Morph' Pomacea diffusa, dorsal

Figure 3b- Shell of 'Golden Morph' Pomacea diffusa, ventral.

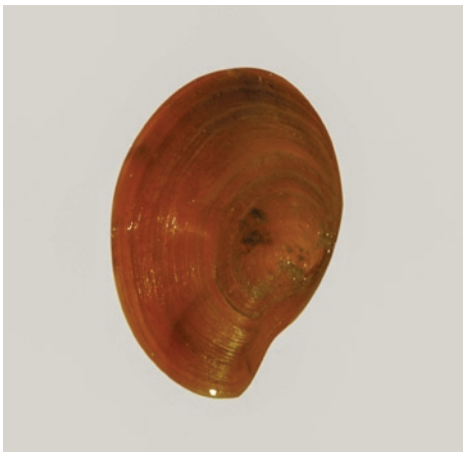


Figure 3c - Operculum

species, likely refer to *P. diffusa*, which was originally considered a subspecies of *P. bridgesii*, but has since been elevated to species. Additionally, *P. diffusa* has a much wider distribution, through much of the Amazon basin, as compared to *P. bridgesii*, which is restricted in range to Bolivia, and the western Amazon basin. *P. diffusa* is also the third most widely introduced species in the world, and has been introduced in India, Sri Lanka, Australia, and parts of the USA. (Raut & Aditya, 1999; Pati & Sharma, 2013; Cowie & Thiengo, 2003, Cowie et al., 2006, Rawlings et al., 2007, Hayes et al., 2008, 2009, Pain, 1960, Rawlings et al., 2007, Hayes et al., 2008; *in Joshi et. al, 2017*).

P. diffusa largely feeds on decaying organic matter, and algae, ignoring living plant tissue, and is therefore not considered a threat to aquatic plants, or cultivated crops such as rice (Morrison 2010; Wong et al. 2010, in Collier et. al 2011), unlike the much larger *P. canaliculata* (Lamarck, 1819), also offered in the aquarium trade, which is notorious for the damage it causes to rice paddy farming systems across Asia (Halwart, 1994), and displays a propensity for preying on amphibian eggs (Karraker & Dudgeon, 2014).

P. diffusa has also been observed preying on eggs of the ram-horn snail *Indoplanorbis exustus* (Deshayes, 1834) in captivity - a known disease vector, contributing to the spread of schistosomiasis, fascioliasis and amphistomiasis in domestic animals, and humans (Malek and Cheng 1974; Chen et al. 1986; Biswas 1991, in Aditya & Raut, 2002). This behavior, along with reports of the species readily incorporating animal carcasses (a behavior also observed by the principal author in his home aquaria), and live worms in its diet, in addition to a primary diet of aufwuchs [biofilm coating rocks and other surfaces, under water], raise concerns of similar behavior when introduced to ecosystems outside of its native range, which might result in competition with native species for comparable resources, even though potential direct, and indirect impact on habitats, and native species remains largely unknown, and requires further research (Rawlings et. al, 2007, Collier et. al, 2011).

Raghavan et. al, 2013, called for the aquarium pet trade in India to be regulated, especially in lieu of the unregulated export of threatened freshwater fish, while also noting that many international aquarium trade organizations advocated environmentally responsible practices, while condemning the collection of endangered species as bad for the industry (even if they have not been widely acknowledged). The authors of the present note earnestly support this point of view, while also echoing the sentiments expressed by Maceda-Veiga et al. 2016, in that while the aquarium hobby has certainly impacted habitats, species and ecosystems adversely, primarily through overcollection, and the introduction of alien species, it has also contributed to the conservation of several species of freshwater fish, and their habitats, and that dedicated, conscientious aquarists can aid conservation efforts by engaging in scientific research, public outreach campaigns, as well as in-situ, and ex-situ conservation programmes for native species, both nationally, and on a global scale.

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Macro-benthic molluscan spectrum in three maritime eastern states and one union Territory of India

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Abstract:

Intertidal zones are the havens for macro-benthic molluscan communities. The macro-benthic molluscan diversity in the estuaries of east coast of India was studied during May 2016 to April 2017. The intertidal mudflats in four maritime states of India namely West Bengal (Shankarpur coast), Odisha (Bahuda estuary), Andhra Pradesh (East Godavari estuary) and Puducherry (Kalapet coast) were selected for the present work. A total of 17 molluscan species were observed under two major classes namely Bivalvia and Gastropoda. The mean value of Shannon-Weiner species diversity index varied between 2.210 (Shankarpur coast in West Bengal) to 2.730 (Bahuda estuary in Odisha) which reflects different degree of stress operating on the estuarine/coastal ecosystem. Anthropogenic stress is one of the major causes for the degradation of marine faunal communities. Establishment of any new polluting industrial units, ship-yards or ports along the extensive eastern coastline might prove detrimental to both marine flora and fauna of the region, particularly in view of the vulnerability of the coastline to devastating cyclones, tsunamis and other natural disasters.

Keywords: intertidal, estuaries, ecosystems, anthropogenic, degradation, management

Introduction:

Estuaries are transitional zones between freshwater and marine ecosystems and are ecotones subjected to marine influences such as tidal flows, waves, ocean currents and the influx of saline water as well as impacts

of riverine environment. Estuaries are considered to be one of the most productive ecosystems of the world (McLusky, et al. 2004) covering less than 8% of total area of the oceans but more than 50% of the global fish harvest (Kennish, 2019). The hard substratum of the estuaries act as the ecological haven for large variety of molluscan species, which include trunks of mangrove trees, sluice gates, lighthouses, stony boulders used for beach reclamation, jetties, groins, cross-spurs, guide wall etc. Various studies on estuarine biodiversity have been carried out (Day, 1989; Kathiresan and Rajendran, 2005; Mitra and Banerjee, 2005; Jha, et al., 2008; Wafer, et al., 2011; Mitra and Zaman, 2014; Mitra and Zaman, 2015) but information on the spatial variation of macro-benthic molluscan diversity is scanty from the east coast of India (Das Sharma, et al., 2016). Few studies have reported the macrobenthic diversity from Odisha state (Satapathy, 1990; Nayak, 1996; Ingole, 2002; Ingole, 2007; Pati, 2007; Sahu, 2007; Mahapatro, 2009; Mahapatro, 2011; Behera and Nayak, 2013; Pati, 2014; Mahapatro, 2015 and Raman, 2015), and most of the studies have emphasized on the macrobenthic community of Chilka Lake (Ingole, 2002; Sahu, 2007; Mahapatro, 2009; Mahapatro, 2015). Other studies have focused on estuarine regions (Nayak, 1996; Pati, 2007 and Behera and Nayak, 2013). Heavy metal concentrations on benthic fauna have been studied (Banerjee et al., 2006). Molluscs are facing anthropogenic stress like never before and a study along the Mumbai coast reconfirms this observation (Kantharajan, et al., 2017). Phylum Mollusca is the second largest phylum of the animal kingdom with around 0.2 million species documented and 85,000 species described worldwide including about 52,525 species with marine origin, 24,000 from terrestrial sources and 7,000 species from freshwater ecosystems (Chapman, 2009). 3270 species are documented from Indian coasts belonging to 220 families and 591 genera of which the most diverse and dominant category are the bivalves with 1100 species, followed by 210 species of cephalopods, 190 species of gastropods, 41 species of polyplacophores and 20 species of scaphopods (weblink 1). The current paper deals with the spatial variation of macro-benthic molluscan community structure in the intertidal zone along the east coast of four states of India.

2. Materials and Methods

2.1. Sampling:

The current study was carried out during May 2017 to April 2018 in the intertidal mudflats randomly selected in four maritime states of India namely Shankarpur coast of West Bengal, Bahuda estuary of Odisha, East Godavari estuary of Andhra Pradesh and Kalapet coast of Puducherry. The population of molluscan species was estimated in fifty quadrates (each quadrat of 1 m × 1 m); ten from each station. The molluscs were carefully hand-picked, collected in paper bags with proper ventilation for air passages and brought to the laboratory. The molluscan specimens were cleaned, photographed and finally preserved in 4% formalin. The standard literature of Zoological Survey of India (ZSI) was used for identification of the molluscan species (). The taxonomic identification of molluscan species was confirmed by experts from ZSI Mollusca group.

The standard literature of Zoological Survey of India (ZSI) was used for identification of the molluscan species(http://www.recordsofzsi.com/index.php/zsoi/article/view/144125)

2.2. Statistical analysis:

Data from randomly selected ten quadrates in each station (n = 50) were collected.The mean values were finally employed to enumerate the macro-benthic mollusk community structure in the study area with the application of standard equation of Shannon - Weiner species diversity index (Shannon and Weiner, 1949).

$$\text{Species diversity index } (\overline{H}) = -\sum_{i=1}^{s} Pi \log_e Pi$$

$$\text{or, } (\overline{H}) = -\sum_{i=1}^{s} ni/N \log_e ni/N$$

(Pi = Importance probability for each species, ni = Importance value for each species, N = Total of importance values).

Results:

Macro-benthic molluscan species were observed and identified during the current study covering four study sites along the different coasts of India's Eastern Coastal Plain (ECP). 17 inhabiting the inter-tidal zones were recorded from the four major estuaries. These species represent 85-90% of the total molluscan spectrum in the study area. 6 bivalve species and 4 gastropod species were recorded during the study

period along the Shankarpur coast of West Bengal, 9 bivalve species and 8 gastropod species were recorded in the Bahuda estuary of Odisha, 8 bivalve species and 8 gastropod species from the East Godavari mudflats of Andhra Pradesh. In the Kalapet coast of Puducherry, the number of bivalve and gastropod species was 9 and 7 respectively (Figures 1-8). In the figures below, the value for each locality represents the mean value of 10 quadrats.

The results of Shannon-Weiner species diversity index ranges from 2.180 to 2.226 (in Shankarpur coast of West Bengal), 2.693 to 2.765 (in Bahuda estuary of Odisha), 2.176 to 2.474 in (East Godavari estuary of Andhra Pradesh) and 2.138 to 2.578 (in Kalapet coast of Puducherry). Considering the mean values of Shannon-Weiner species diversity index, it is observed that the value is highest in Bahuda estuary (2.787), followed by East Godavari estuary (2.638), Kalapet coast (2.599) and Shankarpur coast (2.278). The mean population density is also highest in Bahuda estuary (115.60 m^{-2}), followed by Kalapet coast (110.4 m^{-2}), Shankarpur coast (107.6 m^{-2}) and East Godavari estuary (74.2 m^{-2}). Shankarpur coast reveals lowest diversity index of macro-benthic molluscs despite of considerable population density, which may be the result of uneven distribution of population amongst the species, which is an indication of high degree of environmental stress in and around the selected sampling stations. Fig (9-12) represents the total population (N) of the four selected sampling stations and Fig (13-16) represents the Shannon-Weiner Species Diversity Index of the four sites. A three class stress scale representation determines the health of an estuary or a coastal zone across the four sampling stations of the current study (Fig. 17).

Discussion and Conclusion:

Macro-benthic molluscs are potential candidates of bioremediation (Mitra and Choudhury, 1993, Mitra et al., 1993; Mitra, 1998), and can be largely employed as bio-indicators (Goldberg, 1975; Mitra and Zaman, 2014, for the purpose of carbon sequestration (Nayak et al., 2014; Mitra and Zaman, 2014; Mitra and Zaman, 2015), as well as alternate livelihood generation among majority of fisher folks in our country who are dependent on oceanic resources (Mitra and Banerjee, 2005; Bhattacharyya et al., 2010) etc. However, optimal utilization of these marine resources is to be encouraged without exploitation. Molluscs are considered to be the scavengers of estuarine ecosystems.

The present study documents the bivalves and gastropods in the study area spanning across three major coastline states of Eastern Coastal Plain (ECP) and one Union Territory (UT). Shannon–Weiner species diversity index was used and maximum value was observed in the Bahuda estuary of Odisha. Tourism pressures, overfishing, rising population are the major problems that are rising every day in absence of strict regulations. Shrimp culture and salt pan activities are an adage to the contributing stress factors. It is likely that East Godavari estuary and Kalapet coast delivers a moderate value stress. It is also likely that the Shankarpur coast of West Bengal fairs lowly due to heavy bulk in pollution load and also aquaculture activities. Lack of tourist awareness is to be blamed too (Mitra, 1998; Mitra, 2013; Mitra and Zaman, 2015). Small scale industries such as boat and trawler servicing and repairing units in Sankarpur Coast are probably negatively influencing the marine biodiversity, and this needs to be studied further

An indirect scale of pollution in terms of species diversity (3.0-4.5 slight, 2.0-3.0 light, 1.0-2.0 moderate and 0.0-1.0 heavy pollution) has been described by (Staub, et al., 1970). In a Shannon-Weiner index, the aquatic environment of soil and water is categorized as very good when $H > 4$, good quality is 4-3, moderate quality 3-2, poor quality 2-1 and very poor quality < 1. The Shannon-Weiner index (2.114-2.863) indicates overall lesser environmental stress on the macro-benthic molluscan species inhabiting the east coast of India. Therefore, the picture is not so gloomy and requires urgent intervention of concerned stakeholders.

The species distribution in terms of population density is inversely proportional to environmental stress as is documented from Shankarpur coasts of West Bengal. The two primary variable considered for health-checkup includes (i) number of species and (ii) distribution amongst the population of different species in the present macro-benthic molluscan community. A 3-class stress scale (2.000 - 2.300, 2.300 – 2.600, 2.600–2.900) based on mean values of Shannon-Weiner index thus reflects that Bahuda estuary of Odisha presents a comparatively better picture as mollusc habitats. On the contrary, in the Shankarpur coast of West Bengal, the situation is worst as per the range and classification of our constructed stress scale (Fig. 17). The magnitude of stress follows the following sequence: Shankarpur

coast (in West Bengal) > East Godavari estuary (in Andhra Pradesh) > Kalapet coast (in Puducherry) >Bahuda estuary (in Odisha).

This work is a pragmatic step towards the need assessment of monitoring across Shankarpur coast of West Bengal in specific and entire east coast of India in general. It is not advisable to establish new polluting industrial unit or port along the region. Increase in anthropogenic activities might provide a death knell to the mangrove flora of the region. It might be detrimental considering the vulnerability of East Coast to cyclones, tsunamis and other natural disasters.

Declaration

The authors declare no conflicts of interest.

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Authors' contributions:

JD and AM analyzed the data and wrote the manuscript. PF and AM designed the study and analyzed the data. AM conceptualized and have coordinated the entire research work. All authors read and approved the final manuscript.

Shankarpur Coast of West Bengal

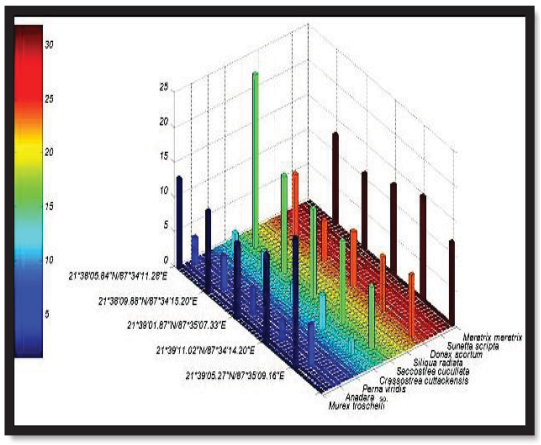


Fig. 1 Number of bivalve species

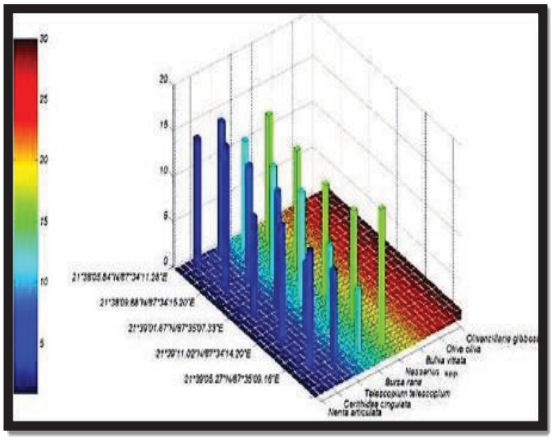


Fig. 2 Number of gastropod species

Bahuda Estuary of Odisha

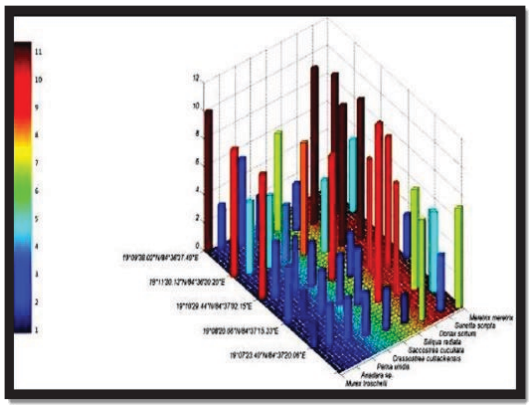


Fig. 3 Number of bivalve species

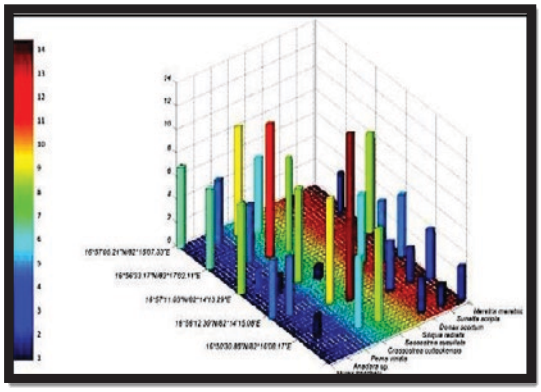


Fig. 4 Number of gastropod species

East Godavari Estuary of Andhra Pradesh

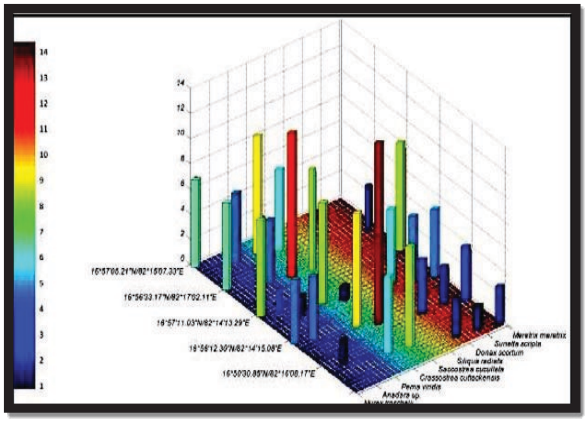


Fig. 5 Number of bivalve species

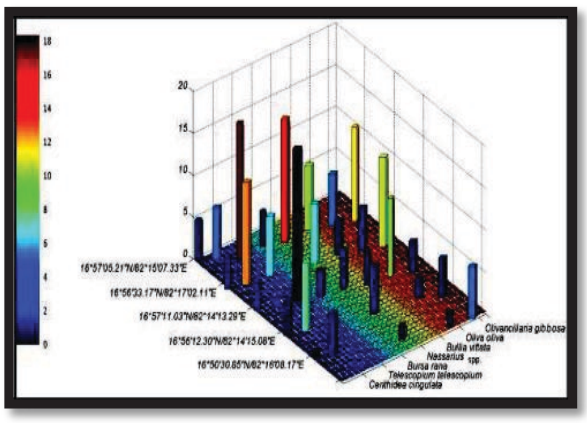


Fig. 6 Number of gastropod species

Kalapet Coast of Puducherry

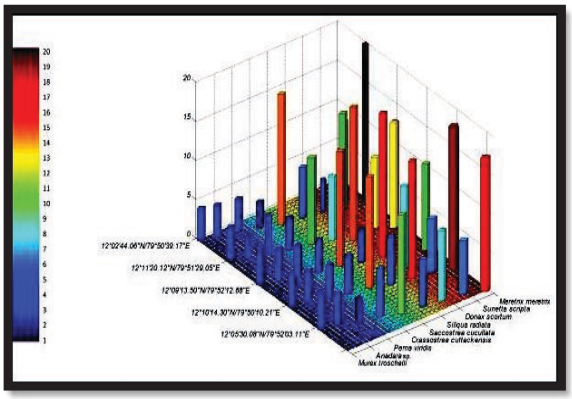


Fig. 7 Number of bivalve species

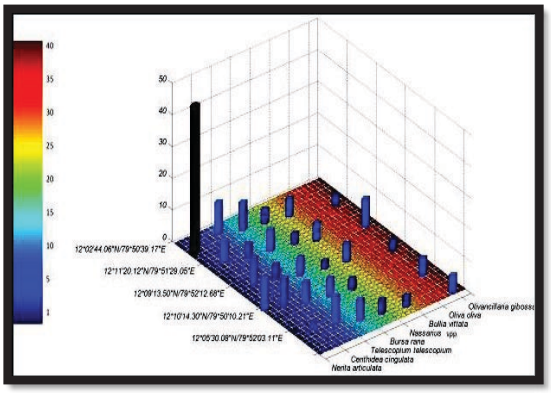


Fig. 8 Number of gastropod species

Total Population (N) in study areas

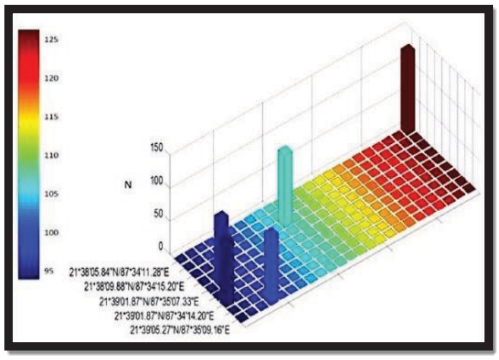


Fig. 9: Total Population of mollusc species in Shankarpur Coast of West Bengal

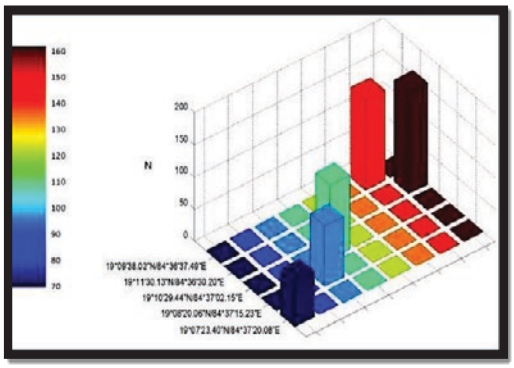


Fig. 10: Total Population of mollusc species in Bahuda Estuary of Odisha

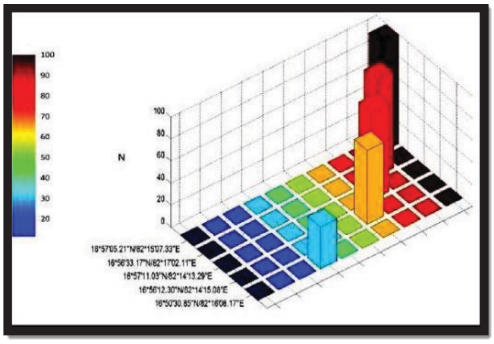


Fig. 11: Total Population of mollusc species in East Godavari estuary of Andhra Pradesh

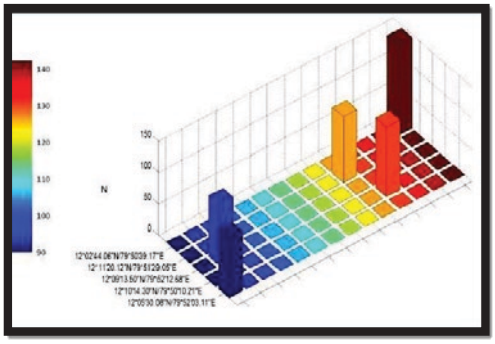


Fig. 12: Total Population of mollusc species in Kalapet Coast of Puducherry

Shannon-Weiner species diversity index (H) in study areas

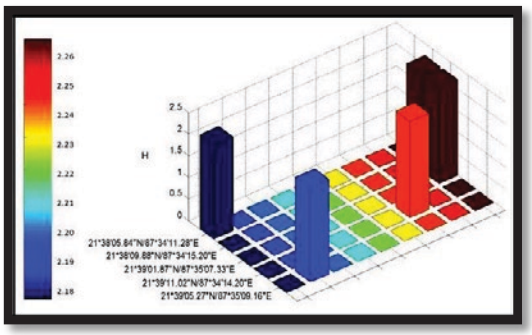


Fig. 13: Shannon-Weiner species diversity index (H) in Shankarpur coast (West Bengal)

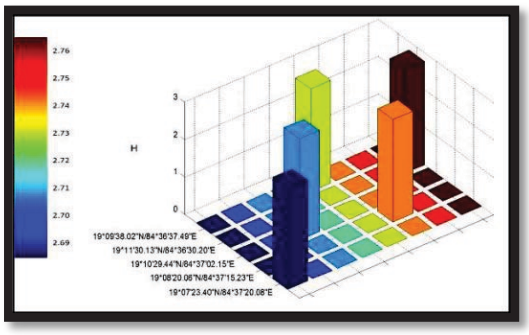


Fig. 14: Shannon-Weiner species diversity index (H) in Bahuda Estuary (Odisha)

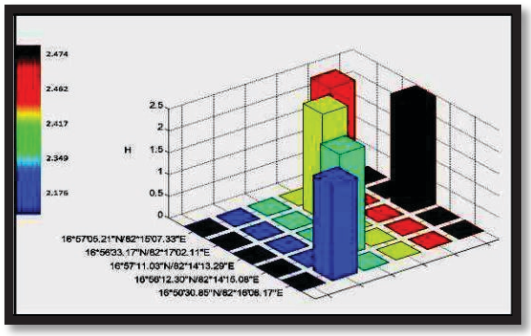


Fig. 15: Shannon-Weiner species diversity index (H) in East Godavari estuary (Andhra Pradesh)

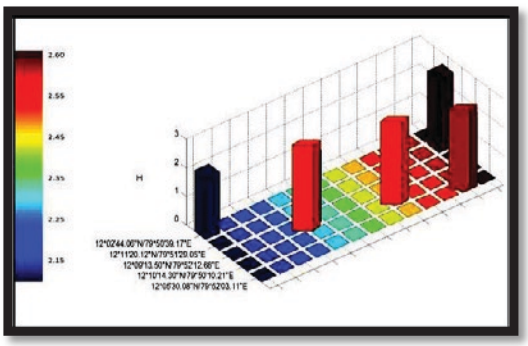


Fig. 16: Shannon-Weiner species diversity index (H) in Kalapet Coast (Puducherry)

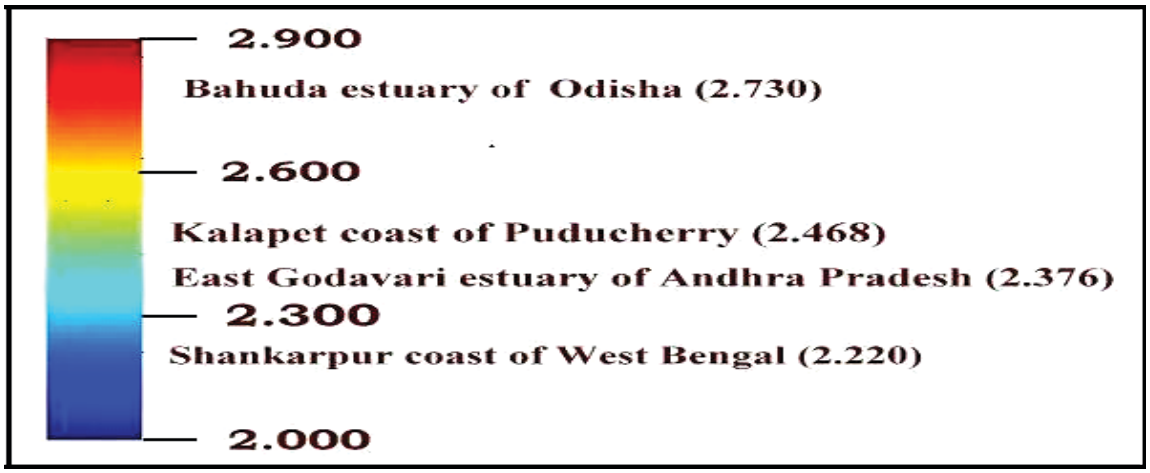
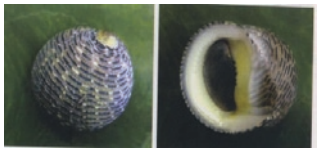
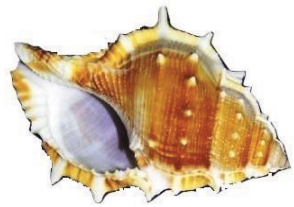


Fig. 17 A 3- class stress scale to indicate the health of estuary/ coastal zone

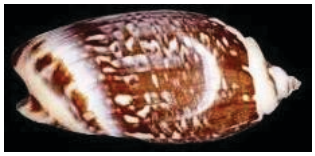
Annexure 1

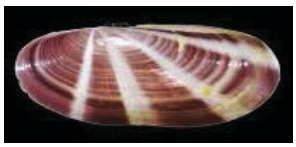
Mean population density (individuals/m^2) of the major Molluscan Species from the study site

Species	Shankarpur coast (West Bengal)	Bahuda estuary (Odisha)	East Godavari estuary (Andhra Pradesh)	Kalapet coast (Puducherry)
 *Nerita articulata*	2	6.6	3.2	2
 *Cerithedia cingulata*	13.4	10	6.4	13.4
 *Telescopium telescopium*	11.8	9.8	8	6
 *Bursa rana*	10.4	7.6	1.2	5.6
 *Nassarius* spp	13.2	8.8	6.4	3
 *Bullia vittata*	0	6.4	3	3.6
 *Oliva oliva*	0	7.8	4.6	0

Annexure 1

Mean population density (individuals/m^2) of the major Molluscan Species from the study site

Species	Shankarpur coast (West Bengal)	Bahuda estuary (Odisha)	East Godavari estuary (Andhra Pradesh)	Kalapet coast (Puducherry)
 *Olivancillaria gibbosa*	0	7.8	6.8	4.6
 *Murex troschelli*	13.6	6.8	5.4	4
 *Anadara* sp.	4.4	3.4	1.8	3.8
 *Perna viridis*	0	4.2	2.2	4
 *Crassostrea cuttackensis*	3.4	3.4	8.6	4.4
 *Saccostrea cucullata*	14.6	6.2	7.4	13.6

Species	Shankarpur coast (West Bengal)	Bahuda estuary (Odisha)	East Godavari estuary (Andhra Pradesh)	Kalapet coast (Puducherry)
 *Siliqua radiata*	**0**	**4.4**	**0**	**6**
 *Donax scortum*	**8**	**8.8**	**2.6**	**12.4**
 *Sunetta scripta*	**0**	**8**	**2**	**8.4**
 *Meretrix meretrix*	**12.8**	**5.6**	**4.6**	**15.6**
N	**107.6**	**115.6**	**74.2**	**110.4**
H	**2.278**	**2.787**	**2.638**	**2.599**

N=Total of the mean population density of all major macro-benthic molluscan species of the site
H= Shannon Weiner Index of the major macro-benthic molluscan species

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http://www.recordsofzsi.com/index.php/zsoi/article/view/144125

A Taxanomic Enumeration of Algal Diversity around Chandoli National Park, Maharashtra, India

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Introduction:

Freshwater green algae are among the most diverse life forms on earth. They inhabit lakes and streams to acidic peat swamps, inland saline lakes, snow and ice, wetlands, wastewater treatment plants, and are symbiotic on numerous plants, parasites, and animals. In terms of biogeography, some algae are generalists having a cosmopolitan distribution; others are specialists, either restricted to a particular habitat or a geographic region and a third category are invaders from either marine or other freshwater habitats depending on their physiology.

In most habitats they function as primary producers. Besides forming the basic food source in food chains, they also produce vital oxygen. Humans rarely directly consume algae as such, but harvest organisms higher up in the food chain (i.e., fish, crustaceans, shellfish). Red and brown algae are harvested and eaten as a vegetable, or the mucilages are extracted from the thallus for use as gelling and thickening agents.

Chandoli National Park is spread over Satara, Kolhapur and Sangli districts in Maharashtra state. It was established in May 2004. It is situated near the Chandoli dam (longitudes $73^0$40' and $73^0$53'E and latitude $17^0$03' and $17^0$20'N). Chandoli National Park lies between Radhanagari and Koyna Wildlife sanctuaries. A remarkable range of environmental conditions are present in the study area, due to their gradients of elevation and rainfall and several areas remain unexplored. Several perennial and seasonal, lentic and lotic fresh water bodies are present. Despite being well known as a location for the study of seed bearing plants, little is known about the composition of the freshwater algal flora of the area.

We conducted a biodiversity survey of the freshwater algae of water bodies around Chandoli National Park.

We aimed to provide a baseline data for the evaluation of future biodiversity changes in the region.

Material and Methods:

Water samples and algal samples from six different localities around the Chandoli National Park of Kolhapur district were collected during January 2018. All habitats like ponds, river, water streams, tanks, paddy fields were monitored during different seasons. They were collected and stored in glass bottles of 200ml capacity. Samples were preserved in 4% Formalin. The algal specimens were identified by using standard literature and microphotographs were taken with the help of Dewinter Optical microscope.

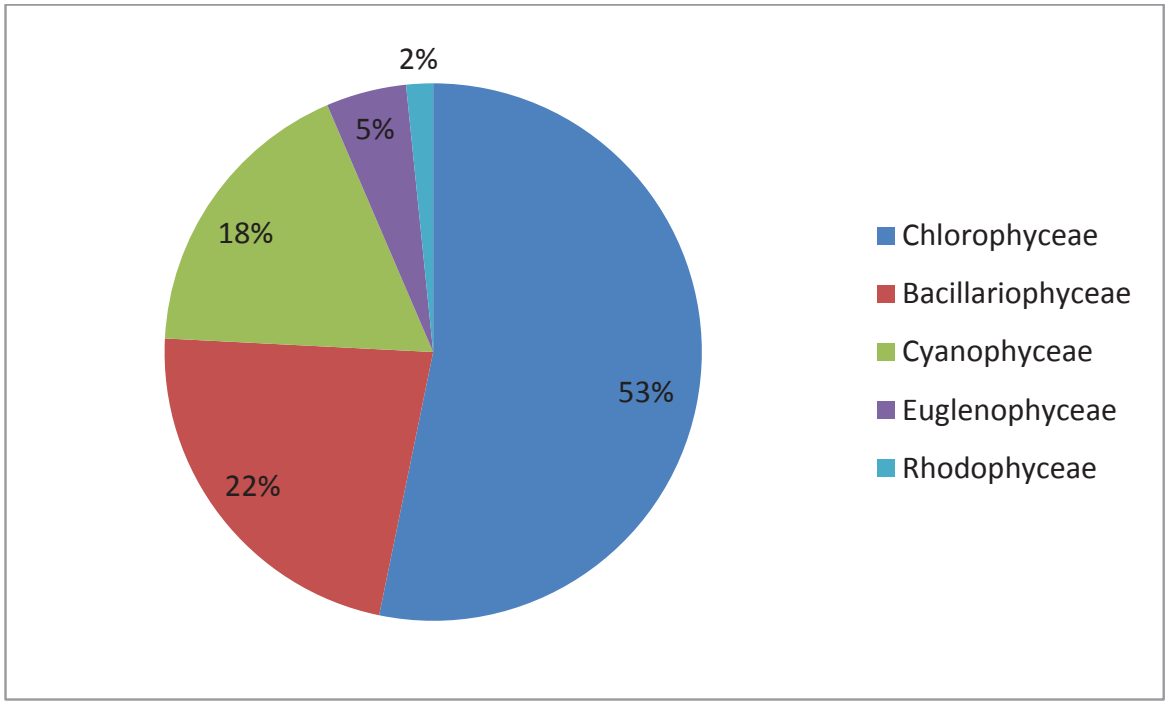
Result and Discussion:

In the present study, a total of 62 algal species were recorded from 42 genera **(Table 1)**. Microphotographs of the same are represented in the **Plates I to VI,** while the numbers indicate the sequence of taxa as per the **Table 1**. Among these, 35 species under 20 genera belong to Chlorophyceae and 9 species under 9 genera belonged to Cyanophyceae, 14 species under 9 genera belonged to Bacillariophyceae, 3 species within 3 genera belonged to Euglenophyceae and Rhodophyceae was a monotypic group being represented by single species making it the least diverse member during this investigation **(Figure 1)**.

Sachinkumar Patil and coworkers (2015) reported 41 species of phytoplankton from major fresh water bodies of Ajara District. Alka Patil (2012) during her survey of temporal and spatial changes in phytoplanktons in reservoirs of Sangli district reported 34 species of phytoplanktons. During the studies of impact of anthropogenic activities on planktonic diversity of Rajaram reservoir, Kolhapur, Gaikwad et al (2013) reported 120 phytoplanktonic members. Leela Bhosale with coworkers (2010) reported 174 species of both phytoplanktons and filamentous algae from lakes in and around Kolhapur City. Gandhi reported 25 species of diatoms during his investigations from Radhanagari. Pawar and Sonawane (2011) reported 53 species of planktons from three water bodies of Satara district. During the present investigation Chlorophycean members were found dominant. Kamble et al (2014) recorded 127 species of blue green algae from 82 different localities of Satara District.

The algal diversity of Chandoli National Park was not previously reported. This record will be encouraging further studies like correlating electric conductivity, alkalinity, and hardness of water samples with current flora. Also phenological studies with studies of associates will aid better understanding of the microenvironment of the area.

Figure 1: Shows the relative percent proportion of various phytoplankton classes



Acknowledgements:

Authors are grateful to the Head, Department of Botany, Miraj Mahavidyalaya, Miraj for providing research facilities.

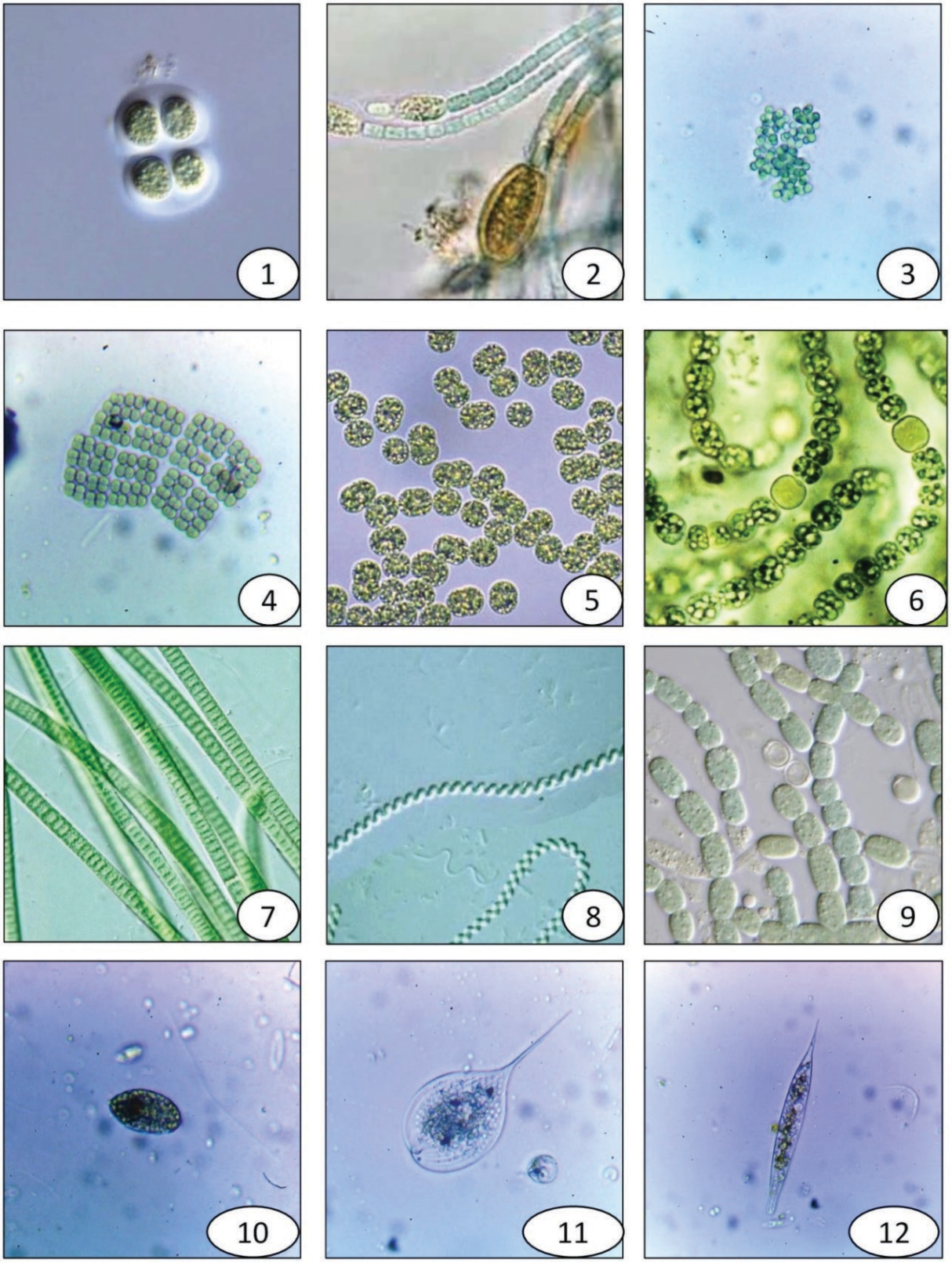
Table 1: showing algal species with their respective classes recorded during the survey

Sr.No.	Class of species	Name of Species
1	**Cyanophyceae**	*Chroococcus turgidus* (Kutzing) Naegeli
2		*Cylindrospermum indicum* Rao
3		*Gleocapsa punctata* Naegeli
4		*Merismopedia elegans* A. Braun
5		**Microcystis aerugenosa* (Kutzing) Kutzing
6		**Nostoc commune* Vaucher
7		*Oscillatoria* sp.
8		**Spirulina major* Kutzing
9		*Trichormus khannae* (Skuja) Komárek & Anagnostidis
10	**Euglenophyceae**	*Euglena gracilis* Klebs
11		*Lepocinclis acus* (O.F.Müller) B.Marin & Melkonian
12		**Monomorphina pyrum* (Ehrenberg) Mereschkowsky
13	**Bacillariophyceae**	*Cymbella aspera* (Ehrenberg) Cleve
14		**Diatoma vulgare* Bory
15		*Encyonema ventricosum* (C.Agardh) Grunow
16		*Fragilaria sp.*
17		*Frustulia rhomboides* (Ehrenberg) De Toni
18		*Navicula rhycocephyla* Kutzing
19		*Navicula viriduloides* Gandhi
20		*Pinnularia brebissonii* (Kutzing) Rabenhorst
21		*Pinnularia maharashtrensis* Sarode and Kamat
22		*Pinularia simplex* Ake Berg
23		*Pinularia venkateshwari* Sarode and Kamat
24		*Rhopalodia gibba* (Ehrenberg) O.Muller
25		*Stauroneis ancep* Ehrenberg
26		**Stauroneis phoniecentron* (Nitzsch) Ehrenberg
27	**Chlorophyceae**	*Ankistrodesmus falcatus* (Corda) Ralfs

Sr.No.	Class of species	Name of Species
28		*Ankistrodesmus spiralis* (Turner) Lemmermann
29		*Chlamydomonas elegans* G.S. West
30		*Chlorella vulgaris* Beyerinck
31		**Chlorococcum infusionum* (Schrank) Meneghini
32		*Closterium ehrenbergii* Meneghinii
33		*Closterium moniloferum* (Bory) Ehrenberg
34		*Closterium parvulum* Naegeli
35		*Coelastrum microporum* Naegeli
36		*Cosmarium contractum* Kirchner
37		*Cosmarium cucumis* Scott & Prescott
38		*Cosmarium cuneatum* Joshua
39		*Cosmarium perfissum* G.S.West
40		*Cosmarium quadrifarium* Lundell
41		*Cosmarium retusiforme* (Wille) Gutwinski
42		*Cosmarium tagmasterion* Scott and Prescott
43		*Desmodesmus perforatus* (Lammermann) E. Hegewald
44		*Euastrum bombayense* var *gokakense* Bongale et Kaulapur
45		*Euastrum dubium* Naegeli
46		*Euastrum incavatum* var *platycephalus* Prescott
47		**Monactinus simplex* (Meyen) Corda
48		*Oocystis borgei J.W.Snow*
49		*Oocystis kolhapurensis* N.D.Kamat
50		*Pediastrum duplex* Meyen
51		*Pediastrum subgranulatum* (Raciborski) J.Komárek & V.Jankovsk
52		*Pediastrum tetras* (Ehr.) Ralfs
53		*Pleurotaenium ehrenbergii* (Ralfs) De Bary
54		*Rhizoclonium sp.*
55		*Scenedesmus bijugatus* (Turpin) Kuetzing
56		*Scenedesmus quadricauda* (Turpin) Brebisson
57		*Spirogyra rhizobrachialis* C. Jao
58		*Tetradesmus dimorphus* (Turpin) M.J. Wynne
59		*Triploceras gracile* Bailey
60		*Verrucodesmus parvus* (Smith) E. Hegewald
61		*Zygnema sp.*
62	**Rhodophyceae**	*Bactrachospermum sp.*

PLATE NO. 1-6 Microphotographs of the algal taxa representing the survey area

PLATE NO. 1



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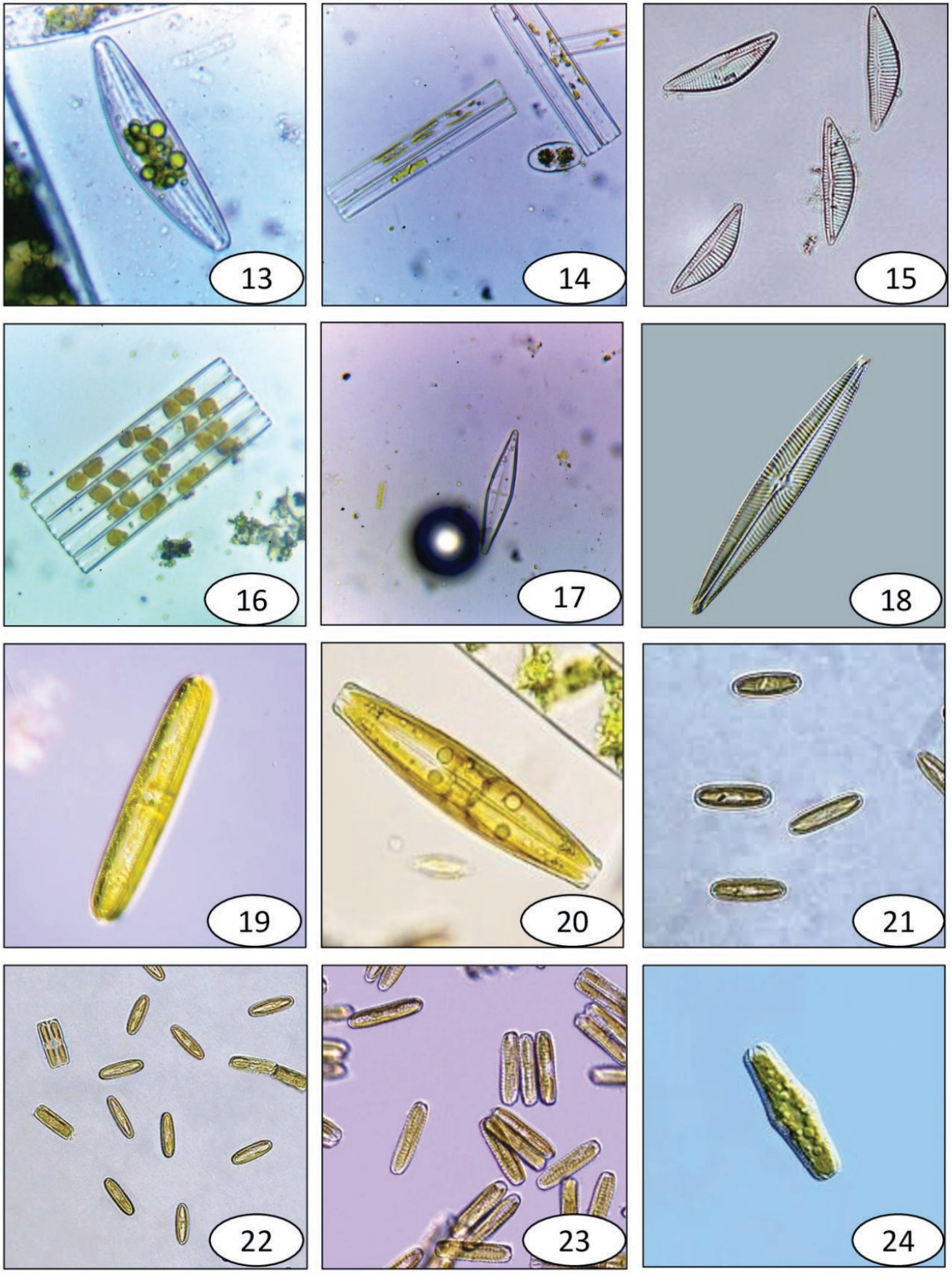

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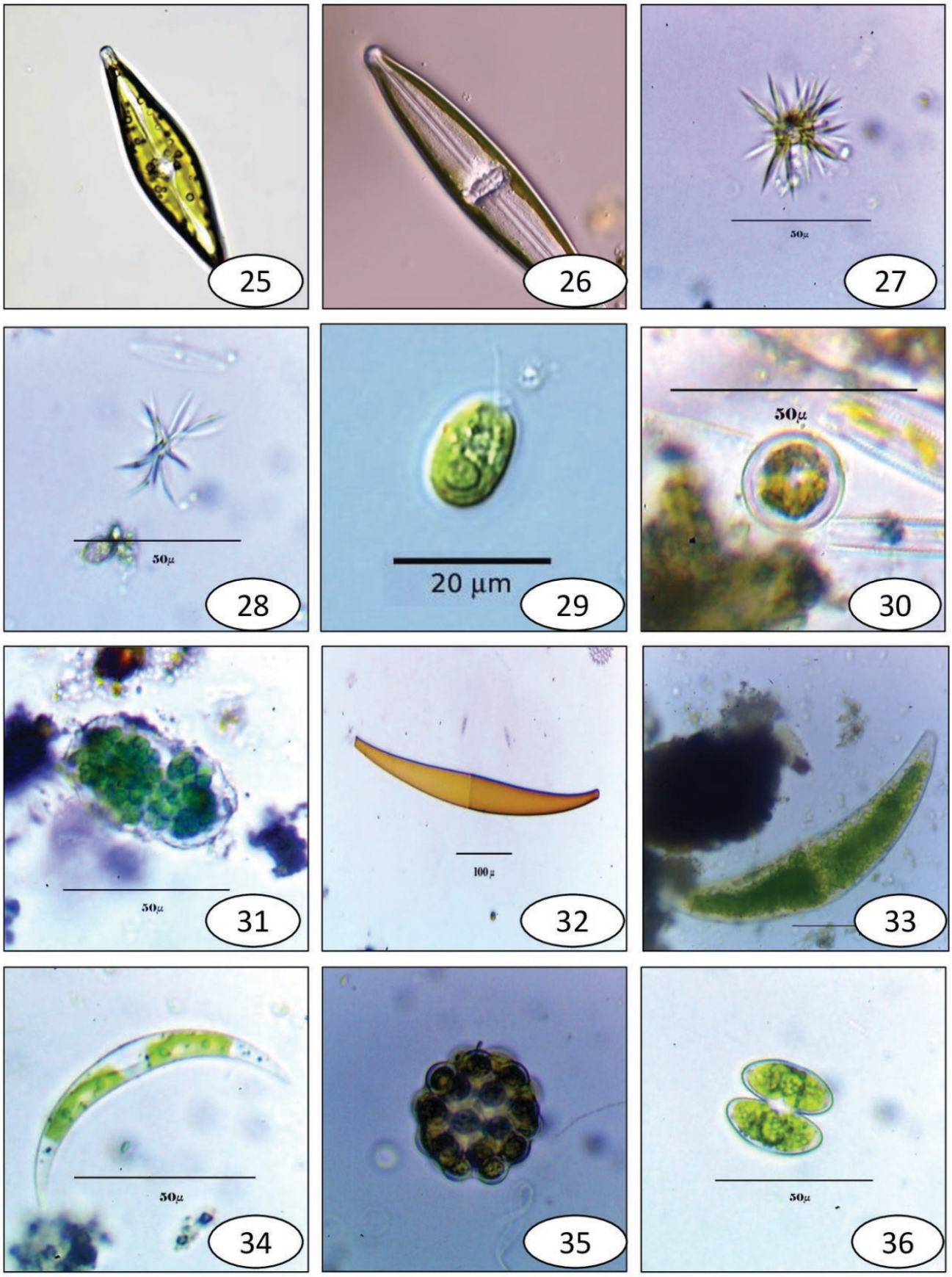
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PLATE NO. 4

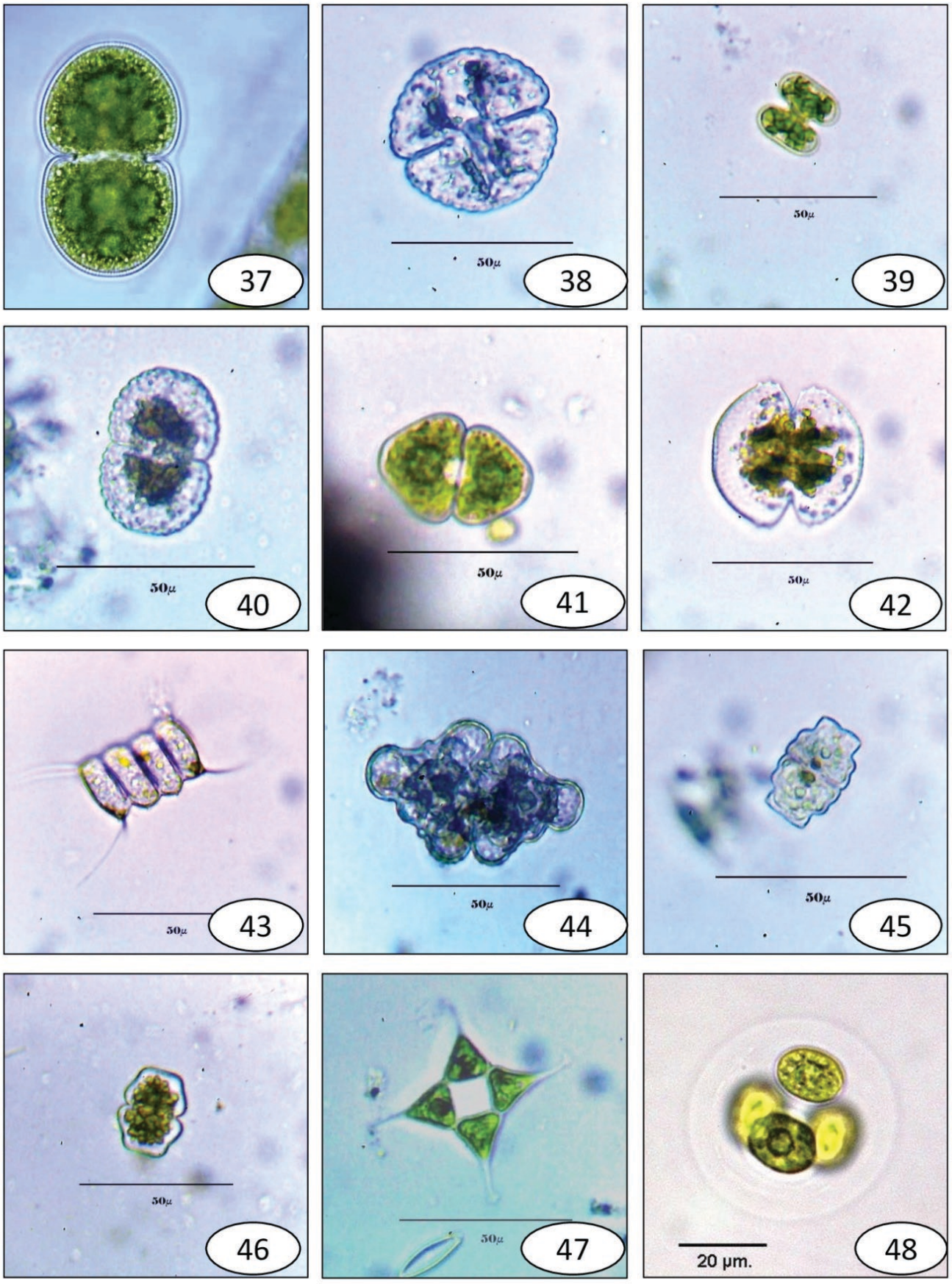
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PLATE NO. 5

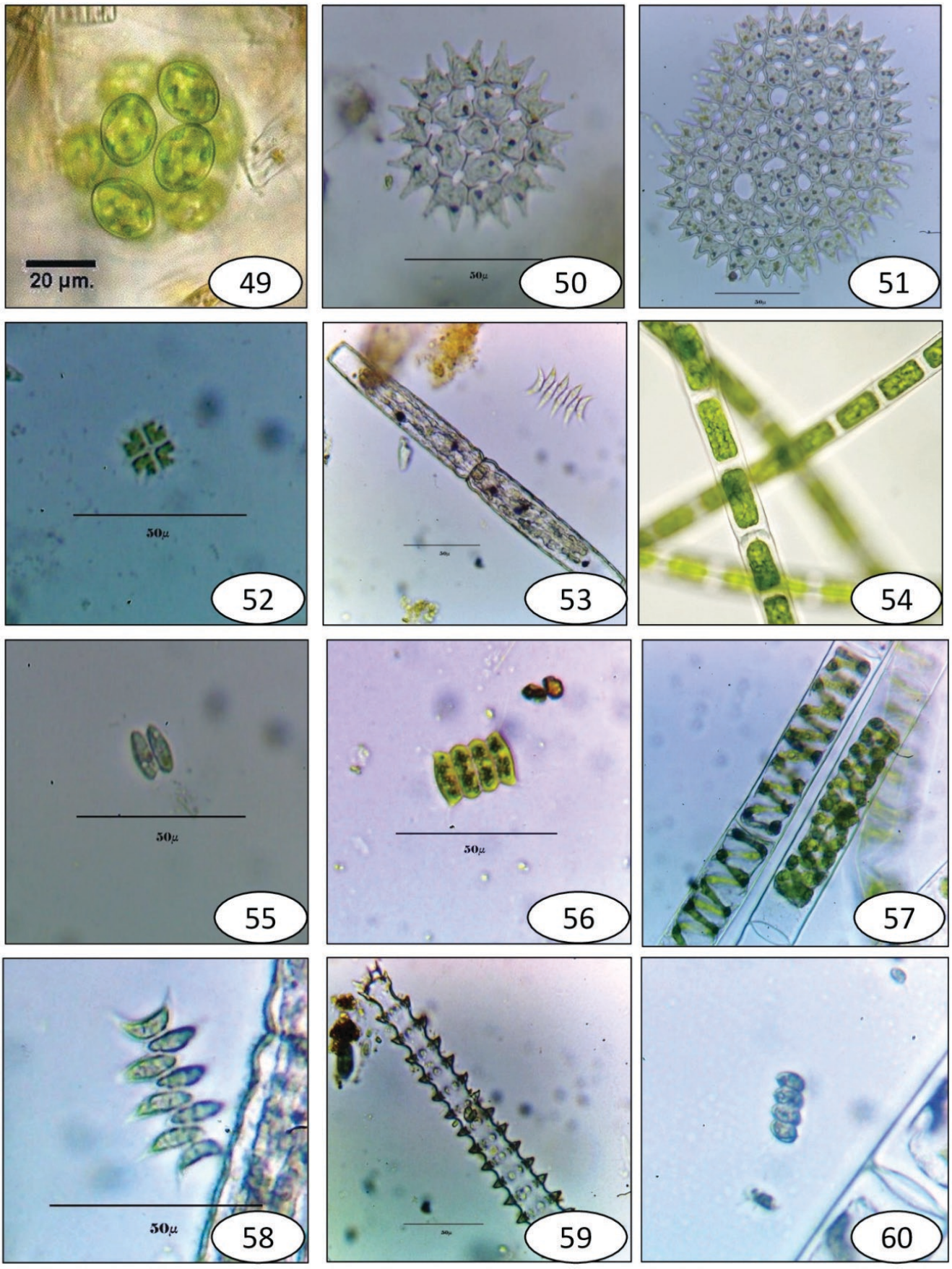
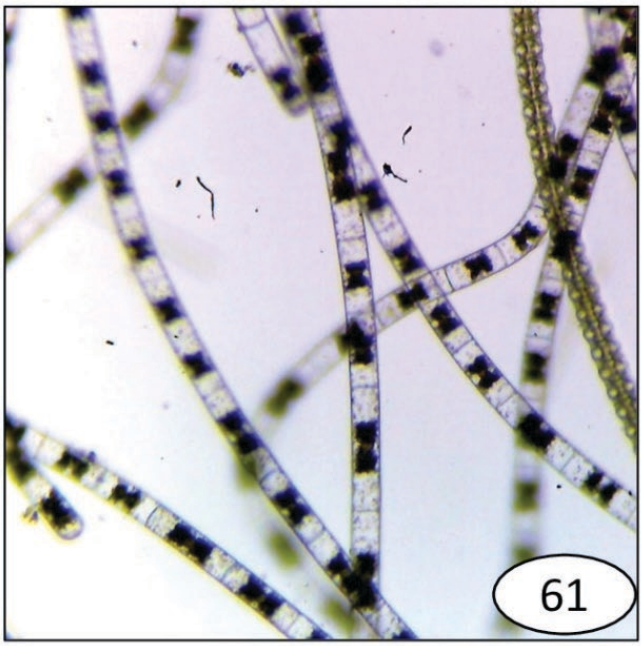


PLATE NO. 6



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Probable First Report Of *Terminalia ivorensis* (A. Chev.) From Ahmednagar District, Maharashtra, India

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Citation: **Kurhade Sudhakar, Vidya Pawar and Chaya Pawar** Probable First Report Of *Terminalia ivorensis* (A. Chev.) From Ahmednagar District, Maharashtra, India.
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Terminalia ivorensis A. Chev. (family Combretaceae) a native tree of Africa is also known as Black Afara, Ivory Coast Almond, Framire, Emire and Idigbo. It is found in Cameroon, Ghana, Ivory Coast, Liberia, Guinea, Nigeria etc. *T. ivorensis* is listed as vulnerable by the IUCN Red List and is threatened by habitat loss. It is highly valued for its medicinal properties and as a timber. It is a fast growing species, with straight stem and self-pruning habit even at an early age, which makes it an ideal species for the creation of large-scale, even-aged plantations in several countries.

*Terminalia ivorensis, (*A.Chev) trees are bi-sexual or hermaphroditic with male and female flowers carried on the same plants. These flowers are small, and cream to pale, bright yellow or greenish-white (Alamu Lateef Oyewole1 and Alabi Adedamola, 2015). The tree measures 15m to 46m in height. *Terminalia* being a genera of large deciduous forest trees it occurs in Maharashtra, India.

During the tree plantation campaign in the college premises (in 2016-17), we procured a sapling of this plant along with many others from a local nursery. As most of the plants are now well grown, we confirmed the said plant species as *T. ivorensis* (www.theplantlist.org) that was growing in our premises (N 19^0 7′ 54.24′′, E $74^0$42′ 51. 58′′). Literature survey reveals that, this species is not mentioned earlier in the Flora of Ahmednagar District (Pradhan, 1992), which describes five species of *Terminalia*, viz. *T. crenulata, T. arjuna, T. bellirica, T. catappa* and *T. chebula.* Almida (2007) also reports above five species only. As

there is no any other published work on this species from Ahmednagar district till today, this could be the first report.

Acknowledgement:

We thank plant taxonomist Dr. R. G. Khose (Retd. Head, Dept. of Botany, New Arts, Commerce and Science College, Ahmednagar) for visiting garden on 6th February 2021 and confirming the identification of *T. ivorensis*.

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Threat behaviour of male Greater Painted Snipe *Rostratula benghalensis* in Indore, Madhya Pradesh

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Email: ajay.gadikar@lmsin.com

Citation: Ajay Gadikar & Neel Gadikar, Threat behaviour of male Greater Painted Snipe Rostratula benghalensis in Indore, Madhya Pradesh.
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- **Name of species**- Greater Painted Snipe
- **Scientific Name-**.
- **Status**- Least Concern. (IUCN Red List, 2016).
- **Date of sighting**- 22nd October 2020.
- **Time of sighting**- 8:02 AM.
- **Weather parameters**- Sunny.
- **Number of times sighted**- Thrice.
- **Number of birds**- 02.
- **Gender of bird**- Male with one chick.
- **Locality**- Indore Bypass, near DPS School, Indore.
- **Habitat description**- Mudflats including small pond around steppes and barren land.
- **Distance from human habitation**- Approximately 200 Meters.
- **Any other bird/animal associates**- Plenty of Little Egrets *Egretta garzetta* and a few Cattle Egrets *Bubulcus ibis*.
- **Bird behaviour**- While watching birds near a water body we came across an interesting observation of Greater Painted Snipe Male was seen defending its lone chick against various threats by birds and reptiles. In an hour of observation we saw the Greater Painted Snipe's male bird exhibiting his bigger size by stretching both the wings and trying to frighten intruder. Due to the unique pattern of open wings he was able to frighten bigger birds like Pond Heron *Ardeola grayii*, Little Egret, Cattle Egret and a Checkered Keelback *Fowlea piscator* snake.
- **Threats to the habitat**- Advancing human habitation.
- **Photographs**- Attached.
- **Previous records**- There are several records of Greater Painted Snipe from Indore.

Record of a leucistic Eurasian hoopoe *Upupa epops ceylonensis* In the Perundurai town, Erode district, Tamilnadu

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Citation: **Natarajan Yoganathan, G.Bhoobalakrishnan and A. Thirunavukkarasu,** Record of a leucistic Eurasian hoopoe *Upupa epops ceylonensis* In the Perundurai town, Erode district, Tamilnadu.
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- **Name of the species :** Eurasian hoopoe
- **Scientific name**: *Upupa epops ceylonensis*
- **Status:** Least Concern (IUCN 3.1)
- **Date of sighting**: 03.09.2020
- **Time of sighting**: 04.00 PM
- **Weather parameters**: Cloudy and imminent showers
- **Number of times sighted** : 1
- **Number of birds**: 8 Hoopoes out of which one was leucistic.
- **Gender of bird**: Unidentified but in a pair
- **Locality**: IRTT Medical College, Perundurai, Erode, Tamilnadu (11°16'5.07"N 77°35'26.15"E)
- **Habitat distribution** : Scrub forest amidst trees and open grassland
- **Distance from habitation:** 0 km
- **Any other bird associates :** Black drongo (*Dicrurus macrocercus*), Yellow billed Babbler (*Argya affinis*), Plain Prinia (*Prinia inornata*)
- **Bird behaviour** : Foraging on ground and later perching on a tree
- **Threat to habitat** : From human development work
- **Photographs** : Attached
- **Previous records** : None from this region

Sighting of Striated Grassbird *Megalurus palustris* at Deepnagar-Bhusawal, Maharashtra

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(Email: lakshmikant.bird@gmail.com; lakshmikant40@gmail.com)

Citation: **Neve Lakshmikant Rajaram and Loukika Lakshmikant Neve** Sighting of Striated Grassbird *Megalurus palustris* at Deepnagar-Bhusawal, Maharashtra.
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31 December 2020

ISSN 2319-4361

Photos: L. R. Neve

- **Name of species**- Striated Grassbird
- **Scientific Name**- ***Megalurus palustris***
- **Status**- Least Concern.
- **Date of sighting**- 25 January 2020.
- **Time of sighting**- 10:30AM.
- **Weather parameters**- Sunny.
- **Number of times sighted**- Twelve
- **Number of birds**- Three.
- **Gender of bird**- Unidentified .
- **Locality**- (21.057,75.841) Bed of Tapti River, behind Bhusawal Thermal Power Station (BTPS), Deepnagar-Bhusawal-Maharashtra. The location is next to the reservoir which is used by BTPS .
- **Habitat description**- Location chosen by the bird is such that the wetland, grass/bushes is surrounded by water & algae.
- **Distance from human habitation**- Approximately 1-2km.
- **Any other bird/animal associates**- Dogs **- Canis lupus familiaris**, cattle (cows **-Bos taurus**, buffalos **- Bubalus bubalis**), Mongoose **- Herpestes edwardsii**, Snakes **-Serpentes** Also, Bluethroat **-Luscinia svecica**, Redwattled Lapwing **-Vanellus indicus**, Egrets (Cattle Egrets **-Bubulcus ibis ,** Little Egrets **-Egretta garzetta** , Intermediate Egrets-**Ardea intermedia**), Indian Pond Heron-**Ardeola grayii**, Wagtail (White browed **-Motacilla maderaspatensis**, Grey **-Motacilla cinerea**, White **-Motacilla alba**,Western Yellow-**Motacilla flava**), Asian Open Bill-**Anastomus oscitans**, Wood Sandpiper **-Tringa glareola**.

- **Bird behaviour**- The bird came out after every 20/22 minutes and perched on the top of grass / branch. Eventually started calling loudly and eventually the amplitude of call reduced. Occasionally we could hear a very low pitch call. After 1/2 minutes of calling bird took to flight and disappeared in bushes. The bird always kept some distance from me.

- **Threats to the habitat**- Overflow of the reservoir, extraction of mud from both side of the bank for making bricks.
- **Previous records -** Sighted by me (Lakshmikant Neve)

1) 7 Dec 2017 : (21.054,75.786)
2) 17 Feb 2018 :(21.057,75.841)
3) 5 May 2018 : (21.057,75.841)
4) 16 May 2018 :(21.064,75.786)
5) 24 May 2018 : (21.057,75.842)
6) 31 May 2018: (21.057,75.841)
7) 7 June 2018: (21.057,75.841)
8) After 25/01/2020 the bird was seen "

Other records.

1) 1889: Breeding records from the Western subcontinent from March to September with atleast two broods (by Barnes 1889B)
2) 1983: Tapti and Mahanadi river (by Ali & Ripley)
3) 1992: Nakama tank area (by PM vyawahare)
4) 1998: Untraced isolated record from Aurangabad (by Grimmett et al.)
5) 26 &28 Jan 2001: Nandur ,Madhameshwar around Niphad (By NJ , birdsofbombay@yahoogroup.com)
6) This bird is earlier reported from Maharashtra by Anand, Mahabal and Kurhade, separately. Kindly look in the references.

Note :- Bird identified, call recorded.
First Photographic and Videographic record of Maharashtra

Panel of Experts/Referees for Ela Journal of Forestry and Wildlife

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