

Bird Habitat Improvement in MGC Complex,
M/s Indian Petrochemical Corporation
Limited, Nagothane, Maharashtra

Preliminary Observations

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1 INTRODUCTION

The Maharashtra Gas Cracker (MGC) Complex Division of M/s Indian Petrochemical Corporation Limited (IPCL), located at Nagothane, Raigad district, Maharashtra invited SACON to visit their complex and to look into the possibilities of developing the area under their control in to a better bird habitat. SACON accepted the invitation, and two scientists (PAA and SB) conducted a reconnaissance survey during 12-14 May 2003. Further to the discussion with the MGC officials, it is learnt, that MGC management desired to have a checklist of birds (including the migratory ones) of their complex, and ecological information on these species. Suggestions were also invited to maintain a bird habitat in a sustainable manner. During this visit, apart from ground surveys, we interacted with officials in-charge of the factory (plant areas), township and also immediate environs of the MGC Complex.

2 MGC COMPLEX OF IPCL

The MGC Complex is situated between the River Amba on one side and a hill range on the other. Agro-ecosystems and villages dominate the area between the IPCL Complex and the hill. A popular cave temple is located on the nearby hill, about 500 m away from the IPCL land.

The area under the MGC complex extends to more than a thousand acres. Comparatively good vegetation cover enshrouds most part of the area. The area receives rainfall in plenty, as it is located in close vicinity of the Western Ghats. The vegetation cover naturally is likely to be rich, but for the nature of soil. Further in due course of time probably due to human activities, and also due to the nature of the terrain and soil the vegetation cover was more or less denuded. However, as a result of the intensive afforestation programmes undertaken by IPCL currently the area under the MGCC is comparatively well vegetated. The terrain in the MGCC complex is more or less plane, but with notable undulations, depressions, streams, rocky outcroppings and exposed laterite strata. The undulations are noteworthy in the township as well as the factory. Rainwater from the both the areas is drained by small nullahs to the nearby streams and getting discharged in the River Amba.

2.1 The MG Cracker Complex

The plant area is less undulating than the township. However, it has a smoother gradient towards the river Amba. Towards the north side of the complex two streams flow close by the integrated waste / effluent treatment plants. Both the streams originate outside the campus. Of these, one enters the campus from its southwest while the other from its northwest. They join together, flow nearby the ethylene storage tanks, cut across the boundary wall of the campus to outside the MGCC complex and join the River Amba. The stream-banks inside the campus are relatively thickly vegetated, partially with natural vegetation interspersed with species that were brought and planted as part of the M/s IPCL's programme. A thick patch of natural vegetation is present on the northeast side of the flare area. This patch is apparently less intermingled with species that were planted as part of the tree-planting programme of M/s IPCL. A depression approximately of 40 x 40 m² is also situated on the southern side of the campus nearby the central engineering services group.

This pond is flooded only during monsoon from direct surface run off from its catchments.

2.2 The MGCC Township

The township accommodates the residential quarters of the officers, staff and other employees of the MGCC. A temple, visited by large number of people, is also present here. The locality has a good verdure with large number of trees, gardens and lawns. A large number of horticultural species and their varieties are cultivated here. A large drain carries away the storm water in the area to a stream flowing nearby. The stream on the other hand joins another stream and flows down to the river Amba that take its course along the eastern side of the MGCC. The drain collects water from the residential areas up to the director's bungalow, the officers clubs, the shopping complex, guesthouses, lawns and gardens. One more major drain collects water from other blocks of residential areas such as A and B type quarters. Although, the drains are mainly intended to carry storm water, in summer they become almost dry, barring small pools and puddles along its course. The pools are probably supplemented by domestic sewage. However, a number of frogs and small fish could be observed in these pools.

A large but seasonal stream runs in the rear of the temple meandering amongst trees (mostly the exotic *Acacia auriculiformes*), boulders and crevices. The stream collects rainwater runoff from the nearby undulating terrain that houses the temple and sculpture park. In monsoon the stream apparently gets flooded, making a picturesque landscape with the elevated mounds turning almost to islands. A lake of about one hectare is present behind the VIP Guest House. The lake is mainly rain fed, the water flowing to it from its immediate catchments that houses the guesthouse, the open area around it, and the nearby hillocks.

3 GENERAL OBSERVATIONS ON FLORA AND FAUNA

3.1 Vegetation in the MGC Complex

MGCC of M/s IPCL has implemented an elaborate tree-planting scheme. The whole complex, both the (factory) plant area and the township, have achieved good greenery because of this programme. A large number of tree species are grown along the roadsides, open areas and gardens. Ornamental plants are planted aplenty in the gardens and along the avenues. The campus has well maintained lawns. MGCC also maintains an orchard just out side the complex growing fruit plants such as mango, sapota, guava and jamun. They also maintain a very commendable green house for floriculture.

Although, a variety of plant species are included in the list for plantation in the MGCC land (Appendix 2), apparently the plant cover is more or less homogeneous dominated by *Acacia auriculiformis*, may be because the species can establish at a faster rate than many others. This is an exotic species, and can also establish in locations that are not very favorable for other species. Possibility of the species inhibiting other species from coming up, especially the shrub and herb layer cannot be ruled out. The litter from the species decomposes very slowly and holds back seeds of other species from germinating and sapling from establishing.

3.2 Vegetation in the environs of MGCC

As noted earlier the environs of MGCC at Nagothane, including the various hillocks, streams and wetlands, villages and flood plains of the river Amba have a large number plant species. No large notable patch of natural forests or other type of vegetation is seen around the complex. However, there are few monoculture plantations apart from a large number of wild species of herbs, shrubs and trees growing around the area. A brief list of species encountered around Nagothane and in the region that was made by us during a previous survey is appended herewith (Appendix 2). The common trees seen here are *Erythrina indica*, *Holoptelia integrifolia*, *Morinda pubescens*, *Pithecellobium dulce*, *Pongamia pinnata*, *Thespesia populnea*, *Trema orientalis* and *Zizyphus mauritiana*. Common shrubs included *Calotropis gigantea*, *Hygrophila auriculata*, *Hyptis suaveolens*, *Ipomoea carnea*, *Jatropha glandulifera*, *Lantana camara*, *Xanthium strumarium* and *Ipomoea* sp. Common herbs and climbers included *Coccinia grandis*, *Achyranthes aspera*, *Alternanthera* sp, *Cassia tora*, *Chloris barbata*, *Cleome viscosa*, *Corchorus* sp, *Cynodon dactylon*, *Cyperus* sp, *Digera muricata*, *Digitaria bicornis*, *Eragrostis* sp, *Fimbristylis* sp, *Gomphrena celosioides*, *Heliotropium indicum*, *Impatiens balsamina*, *Panicum* sp, *Paspalidium flavidum*, *Phyllanthus amarus*, *Tephrosia purpurea*, *Triumfetta rotundifolia* and *Urena lobata*.

The Appendix 2 includes trees, herbs and shrubs that grow in various types of habitats and microhabitats in and around Nagothane and its environs. It is not likely that originally the MGCC land had all these species. This is because of the micro-environmental particularities of the area and also due to long period of human disturbances. The micro-environmental specificities that alter the vegetation types and their species composition include type of soil, terrain, drainage, rocks and local microclimate. However, it is very possible that many of the species that are listed grow in the natural habitats maintained by MGCC nearby their flare area or along the banks of the streams.

3.3 Amphibians, reptiles, birds and mammals in the environs of MGCC

A total of 13 species of herpetofauna was observed during the present field investigation, which includes 6 species of reptiles and 7 amphibians (Appendix 3). Because of the short duration and rapidity of our survey and as amphibians and reptiles are largely shy, crepuscular and distributed sparsely and scattered, the present list is far from complete.

A total of 102 species of birds was observed during this short visit. As the survey was conducted during non-migratory seasons this list is also far from complete (Appendix 4). Of these 32 species are water dependent. A survey during migratory season (especially during winter, November-March) may yield additional 25 species of water birds and over 30 species of migratory land birds. Evidence for only four species of mammals were obtained during this visit. Direct observations of the Common Mongoose (*Herpestes edwardsi*), Flying Fox (Fruit Bat, *Pteropus giganteus*) were made, and indirect evidence such as scats, hoof marks and howls were obtained for Wild Boar (*Sus scrofa*) and Jackal (*Canis aureus*).

4 BIRD HABITAT IMPROVEMENT

A bird habitat should have conducive environmental conditions for successful foraging, feeding, roosting, nesting, breeding and raising the fledglings. However the microhabitat requirements would differ from species to species and a comprehensive habitat improvement plan would address specific requirements for each species. A detailed plan would require further detailed investigations into the ground situation and hence is not attempted here. It is suggested that at a later stage a more detailed study may be undertaken to develop a more elaborate habitat development plan.

A few potential locations are available for developing water bird areas in the IPCL complex. They are (a) behind VIP Guest in the township, (b) Location nearby the bridge adjacent to Ethylene storage tanks, (c) the low-lying area adjacent to Engineering Workshop area and (d) stream besides the temple in the township.

4.1 Township

The township has a good potential to attract birds. A few modifications in the plant community and the water bodies of the township may help render the habitat more favorable for land and water birds.

4.1.1 Developing a water bird area behind VIP Guest House

The perennial lake of less than a hectare located behind the VIP guesthouse is a potential site to develop an attractive bird area in the township. It extends further for 30 to 40 meters towards north in the direction between the crematorium hillock and the road leading to swimming pool and the club. This extension is very shallow and is overgrown by weedy species such as *Ipomoea carnia*. The site can be excavated and deepened so that this water body can hold more. Such a step will also increase the depth diversity that will attract more diverse bird fauna. The lake is supplied by rainwater from its catchments. The major nullah that carries the storm water in the township flows adjacent to the lake. The lake currently offers a good feeding site for egrets and lesser number of cormorants. No ducks and teals were seen in the lake during our visit. As the visit was during non-migratory season, the probable usage of the lake by the migratory species could not be ascertained. The lake currently appears shallow. The low number of cormorants and other diving species is indicative of the shallowness of the water, scarcity of food species or lack of their diversity. The absence of submerged aquatic plant species is hinted by the absence of herbivorous ducks and teals. The lake also does not hold notable emergent aquatic macrophytes.

As noted above, to develop a diverse water bird assemblage a variety of microhabitats are necessary. The following steps are desirable to be done in this direction.

- The lake may be enlarged by excavating the northern shallow stretch. It is possible to lengthen the water body by 30 to 40 m in the direction mentioned above by excavating the shallow parts that is currently invaded by *Ipomoea carnia*.
- Further, by excavating in certain areas a depth gradient may be developed in the lake. That will help achieve higher depth diversity. Various aquatic birds require different depth ranges. The area closer to the guesthouse may be

deepened to a maximum of 2-2.5m. The water depth must gradually decrease to 10-20 cm towards the opposite side. Suitable water depth for diving birds especially cormorants, dab chick and coot is about 60-90 cm; to egrets it is 30-60 cm; teals and duck it is about 10-30 cm and moorhens and waders it is <10 cm.

- Development of one or two earthen mounds in the centre of the lake is suggested. The approximate size of these mounds could be about 10-20 m² and may be created making use of the soil excavated during deepening. Encircling immediate to the mound water may be maintained deeper.
- One or two *Acacia nilotica* trees may be planted on each mound. It may be noted that *A. nilotica* grows well in water logged situation. These trees would provide resting sites to the birds and probably in due course of time develop into a bird nesting colony (heronry), if kept sufficiently sheltered from disturbance. These mounds and trees also would protect the birds, their eggs and chicks from land predators such as mongoose and dogs.
- The possibility of connecting the storm water drain to this pond in monsoon so that it gets filled to the maximum may be explored. Sluice gates may erected at appropriate locations to control the water depth and flow. Connection with the drain may help in bringing in a variety of fishes to the lake. Fishes during monsoon travel upstream and during such migration they will enter the lake, breed and sustain.
- A rapid survey of fish in the lake may be undertaken to assess the fish diversity. A local fisherman can be hired and the fish sampling may be done using cast net. It may be assured that the lake is not dominated by weed species such as Tilapia (*Oreochromis mossambica*). Presence of such a highly adaptive species leads to the disappearance of many other fish species that are preferred by piscivorous birds. *O. mosambica*, a mouth breeder, is known to hinder the growth of other fishes. Tilapia can almost completely eclipse other species, likely to be present in the lake, in terms of comparative abundance. These species may be harvested. After removing such species, fish species, which are commonly seen in the water bodies in the environs of MGCC, can be introduced in the wetland. No exotics should be introduced, even if they are present in the water bodies outside. Fries or fingerlings of local fishes may be collected from the nearby wetlands or rivers and released in the lake. Non-commercial species of fish are preferred for introduction as they grow large and are not preferred by fish eating birds. Maintaining a direct connection with local wetlands or rivers through a canal during the monsoon season may help highly in many desirable local species entering the lake and establishing a population that can support more fish-eating birds.
- Basic water quality tests should be done periodically to ascertain the nature. Also, the availability of phyto and zoo planktons may be measured at regular intervals. Phyto and zoo planktons are important source of food for fish and certain species of birds.

- Removal of overgrown weeds such as *Ipomoea carnia* is suggested. The weed species may gradually reduce water spread area and deprive the birds and other aquatic flora and fauna of the habitat.
- Submerged species such as *Hydrilla*, *Valisneria*, *Potamogeton*, *Nymphaea* etc. are important food plants of the ducks especially the migratory ones. Introducing the seeds, cuttings, stolon or rhizomes of such plants obtained from natural ponds and stagnant river pools enhance the suitability of the habitat for waterbirds.
- The embankments of the water body and nearby open areas may be planted with suitable fruiting trees. Species that are local such as Mango, Tamarind, Banyan, Peepal, Butea, Neem, and Erythrina may grow well. Local varieties that may provide good shades and copious branches and twigs may be selected for plantation in an interspersed manner. Woods with good canopy, intricate branches and fruits offer good resting area for water birds and habitat for terrestrial species.

4.1.2 Rain water harvest and storage tank near the temple

Another area with high potential to develop, as a bird area in the township, is the seasonal stream that meanders behind the temple. This low-lying area if properly planned may form a rainwater harvest and storage reservoir. Apart from serving as water storage, this may develop as a bird area at a later date.

The area gets flooded in monsoon. A check dam slightly downstream from the temple may detain the water flowing down. A perennial water body thus formed can assist development aquatic macrophytes in the area that are usable by water birds such as ducks. Dried up aquatic plants such as *Potamogeton* sp are available already there. With water available round the year related species can grow luxuriously. The topographic setup of the area, with the distinctive landscape and rocky boulders and the tree cover provide a sheltered ambience to the area. Although the area is vegetated the dominant species seen is *Acacia auriculiformis*. Species such as this do not offer much scope to birds and other organisms in terms of foraging, roosting or nesting sites. A good number of the species appear to have completed their lifespan and gradually dying off. Local species indicated in the Appendix 1 and Appendix 5 may be considered to improve vegetation cover. A number of shrub species that attract birds and also butterflies may be selected to grow here. It seems that some measures to improve the quality of the soil are essential here. Trenches made for planting may be filled with good organically rich soil. Microbial treatments with Rhizobium, Azotobacter and Ectomycorrhizal fungi that are replenished with micorhizae may also be considered.

4.1.3 Improvement of storm water nullahs

The nullah that flows through the township can be developed into a habitat for smaller species such as amphibians and small fishes. Currently a number of pools are seen along the course of nullah. The leakages of domestic sewage, through the walls of the drain replenish these pools. Such leakages of domestic waste may be curtailed since that may cause drop in water quality in the pools such as fall in dissolved oxygen or

rise in the BOD load. Small coves (sideway expansions), in certain points along the drain, with water round the year may replenish aquatic fauna. This is especially applicable to the drain in the township on the way to A&B type quarters.

4.1.4 Land Birds

Development of land bird areas is ideal in residential complex than factory area. Land birds may be attracted by planting more fruiting (wild and cultivated) species such as Bannyan, Neem, Jamun, Quvava, Sapota and Neem in a mixed pattern. The flower and fruits are important food resource for birds and bats. In a phased manner the already established exotic *Acacia auriculiformes* may be uprooted, and the same may be replaced with indigenous fruit yielding plants.

4.1.4.1 Tree planting

The township currently has a good vegetation cover. However, majority of the trees seen here are *Peltophorum ferugianum* or copper pod and *Acacia auriculiformis*, the Australian babul. Wider species composition will be ecologically more acceptable. Some of the species that can be attempted to grow here are given in the Appendix 5. Species rich and diverse vegetation offer birds and other associated faunal elements diverse resources. The resources essential for birds and other faunal elements include nesting sites, roosting sites, hiding places, diverse food, specific micro-meteorological conditions and micro-habitats. The associated faunal elements include attractive species such as butterflies, grasshoppers, caterpillars, amphibians, reptiles and small mammals. Development of such a system with diverse components will ensure more birds visiting the area and their long-term sustenance.

4.2 MGC Complex

The MGC complex is a large and partly occupied by the various production units of Gas Cracker Complex, general engineering and maintenance sections, integrated wastewater treatment plants and offices. M/s IPCL maintain good green cover along the streets, bylines and common places. A large number of ornamental herbs, shrubs and trees are grown here. Lawns are also maintained in suitable areas. Vast areas around the various units of gas cracker plant are earmarked for green belts that will accommodate large number of trees. Many of the proposed green belt have developed good number of trees. But, for the dominance of certain tree species the canopy cover and also undergrowth is underdeveloped. It is felt that the litter falling from the dominant species are lowly decomposing and also release compound with allelopathic effects that curtail undergrowth development. Majority of the blocks earmarked for green belt development is planted with tree species. Certain select areas are in the process of identifying species for planting.

Notable areas that have good natural vegetation in the MGC plant complex are i) the area lying between the main entrance and the integrated effluent treatment plant, ii) the area close to the bridge nearby the ethylene tanks, and iii) nearby the flare area, slightly a lower elevation. All these areas have good potential to develop into a haven for birds and other associated species. The first two locations mentioned above are situated along the banks of the stream flow through the campus. The other one is located about 500m away from the stream and about 50 m away from the flare stack.

Four potential bird areas could be identified during our reconnaissance survey. These locations are one adjacent to the effluent treatment plant (Location I), the next nearby the ethylene tanks across the stream (Location II), the third near to the flare area (Location III) and the fourth low lying area adjacent to engineering workshop. Of these the third location is a good site for land birds.

4.2.1 Location I (Near Effluent Treatment Plant)

This site is located between the effluent treatment plant and the main gate along the stream. The banks of the stream are thickly vegetated and the stream a perennial one. However, in summer the flow is highly reduced restricting the stream to large pools and puddles. Augmenting the water availability here would enhance the habitat quality for water birds.

The area does not need any active modification or development to make it a bird area. What is essential here is active protection and minimizing people's movement. The stream here has many secluded expansions and pools that during our visit were actively used by teals. Resident species such as lesser whistling teals and spotbill ducks were seen here. The trees growing luxuriously covering the pools provide good roosting sites for egrets and herons. Attempt to prune the trees, clear the undergrowth or litter may disturb the birds. In case the litter that is accumulated nearby the road or close to the nearby building has to be removed for safety or security reasons such activity may be done prior to the setting of peak summer. Such activities may lead to the bird deserting the area or discourage them from using the area as a permanent location for roosting or latter nesting. On the streamside, on the side of ETP plant species such as *Acacia nilotica*, *Tamarindus indica*, *Prosopis cineraria* may be planted so as to thicken the canopy cover.

4.2.2 Location II (Stream near Flare stack)

This area is located near the two road bridges across the stream flowing out of the campus. The stream at this level is marginally influenced by the tidal effect. A dwarf barrage close to the bridge with appropriate sluice gate arrangement may be ideal to retain a larger water spread area along the stream and existing valley. The area has to be surveyed for the contours before undertaking the barrage construction. It is expected that a barrage can maintain an inundation of about a hectare interrupted with mounds and trees. Little bit of landscaping along the center in the upstream would form an island, which may be suitable for day roost for water birds

The barrage may be designed to maintain an optimal flow and mixing of the saline water and fish movement. This manipulation at landscape level may be ideal for king fishers, herons, egrets and teals. As good vegetation cover is already available, changes are not required on this aspect. The good impact of these modifications could be seen in the upstream up to ET Plant and further above. A few islands with trees can provide good roosting sites for birds, that are preferably arboreal or good canopy cover to water birds that prefer ground. Local species of trees that can withstand inundation can be planted on the islands / mounds that will develop after the barrage is closed and water level rises. A few mounds can also be created at appropriate location about 50 m away from the bridge.

4.2.3 Location III (Terrestrial vegetation near flare)

This terrestrial site is located adjacent to the flare stalk area. It appears that this area housed a human habitation prior to the establishment of the MGCC here. A large number of local mango trees are seen here. These trees provide safe abode for a large number of flying foxes (*Pteropus giganteus*). After decades leaving the area unattended and also due to the protection given by MGCC from human disturbance the area has practically turned wild in terms of vegetation. The vegetation here has become diverse with large trees, climbers, stragglers and also thick undergrowth. As the area is close to the high boundary wall of the MGC Complex the only possible human interference is in the form of security periodically moving along the footpath made for the purpose close to the wall. As in the case of the first location discussed above this location too is primarily needs protection. No further activity may be allowed within the 50 m of its periphery.

4.2.4 Low lying area near the Central Engineering Service Group

A small depression of around 0.2ha is situated on the southern side of the campus nearby central engineering services group (?). This pond receives water during monsoon as runoff from the catchments. There is a potential for developing a water bird area as the area is less disturbed and surrounded by wood. Action plan for developing this area is similar to that of the VIP Guest House one. It is possible to deepen the pond so that it can hold more water and water will be available round the year. During deepening attention should be given to maintain a depth gradient. No aquatic macrophytes are seen in the pond, probably because the pond remains dry for majority of the year. Macrophytes, collected from the nearby wetland may grow nicely in the pond, if water is assured. Local fish species also may sustain in the pond.

5 GENERAL SUGGESTIONS

5.1 Minimizing disturbance

As noted earlier minimizing disturbances in certain areas is important for making the locations better for birds and associated fauna. The location I, and III needs more passive protection. Any further activity in these areas may be avoided. In case it is not possible to avoid any activities for safety or security reasons such activities may be limited to and completed within the shortest possible span of time. Summer and pre-monsoon periods (April - May) may be avoided in case of location I since most of heronry species and duck species may visit the area during these months because of the drying up of suitable habitats in the vicinity. In location III summer and pre-monsoon periods (April - May) are advisable for such works for reasons such as the primary breeding season for majority of resident birds commences with monsoon. In wetland areas such as Location I and II in MGC Complex and the lake adjacent to the VIP guesthouse and the temple in the township any developmental activities may be avoided in winter since it is the main migratory season for wetland birds. Generally bird migration occurs twice in a year, September-November and March-April. It may be noted that the whole western India falls within the Western (Indian) Migratory Flyway of waterfowl (ducks, geese, waders) and a number of other land-birds. About 350 species of Indian birds (Ali and Ripley 1983) are migratory. These migratory birds would stopover at various locations along the flyway at varying times

of the migratory season depending on suitability of the habitat and physiological state of the birds.

During the construction the labor force need to be instructed not to cause any damage or disturbance to natural vegetation, birds or other associated fauna. In wetland areas it is better to avoid development activities during morning and evening hours. These hours are best active hours for the wetland birds.

Species such as *Dalbergia sissoo*, *Erythrina spp*, *Ficus spp*, *Azadirachta indica*, *Melia azedarach*, *Mangifera indica*, *Pongamia pinnata* and *Terminalia crenulata*, which are native to the area, are recommended for plantation. Native species have long-term viability and are adapted to the ambient conditions and local climatic extremes than many exotic species. Native species are also superior in offering appropriate habitats for local faunal species. They are better than many exotics to meet the resource requirements, such as nesting sites, canopy cover, bark with crevices, flowers and fruits. They are also good for fodder and fuel wood and may be many cultural requirements of the residents.

5.2 Agrochemicals

Attempts may be made to avoid application of agrochemicals, especially pesticides herbicides and chemical fertilizers in the gardens and lawns, so that more insects such as grass hoppers and butterflies may survive in the area assuring higher food availability to the birds. Organic manure and bio-compost using the decomposable wastes from the township can be applied for enrichment of the soil. It is understood that M/s IPCL is actively pursuing vermi-compost in the orchards using agricultural wastes. Attempts may be made to use domestic wastes and litter and vegetal wastes to prepare fertilizers that can be used in the gardens and lawns.

5.3 Treated effluents

It is felt that a large quantity of effluents are released to the River Amba from the MGCC. This is after a portion is used for irrigating gardens. It is felt that a larger portion or whole of treated effluents from domestic sources can be used for gardening. In case the treated effluents do not contain large quantity of nitrates and nitrites and micro-organics it is safer to use in maintenance of water levels in the wetlands. However, prior to its use for the purpose detailed studies to confirm that none of the micro-organics or metals is present in the effluents above a no-observable effect toxicant level. Standards prescribed by the authorities for release of effluents to different environments alone may not be sufficient for long-term use in developing a wetland system. Studies on concentration of trace metals in the planktonic or algal species growing in the water may be checked. Studies on fish successfully breeding in the effluent tanks can be conducted to assure that such usage will not have any notable effects on aquatic organisms and other associated species.

5.4 Aquatic macrophytes

Currently the water bodies in the MGC Complex lack aquatic macrophytes or they are present only rarely. Some of the common aquatic macrophytes such as *Hydrilla*, *Vallisneria*, *Seratophyllum*, *Potamageton*, *Nymphoea*, and *Lotus* may be planted in the lakes. Aquatic macrophytes provide better habitats for fishes in terms of food, hiding place etc. They increase the productivity of the system. They are good to

replenish the detrital supply to the wetland for facilitating the development of the system. The growth of macrophytes may be maintained in an optimum level so that the wetland remains as wetland and do not progress in the advanced stages of succession.

5.5 Street lights

Streetlights radiating lights upwards to the trees may be avoided in the township, except in critical areas. The lights may be diffused direct downwards below the canopy level. Similar is the case for the lake behind the VIP Guest house and that behind the temple. For all the three locations in Cracker complex area also same system may be adopted, except in locations of security and safety significance.

5.6 Pets

It is recommended that free ranging domestic carnivores like cats and dogs should be restricted, as stray individuals of such animals can be a serious threat to the survival of the birds and small mammals such as squirrels and shrews in the campus.

5.7 Nest boxes and birdbaths

Establishing nest boxes in different places across the township can attract birds such as sparrows, robins and chats to occupy them. Free availability of nesting sites along with food supply will encourage bird population. The nest boxes may be fixed on trees at various heights or on pillars at secluded places, that will not be disturbed by humans or predators. Pans with water (birdbaths) also may attract birds especially in summer months. Residents in the township may be encouraged to establish these pans and replenish them with water in their own gardens or nearby surroundings. Nest boxes established at suitable locations during late winter may attract the birds during the forthcoming breeding season (March-June).

5.8 Improving butterfly population

Establishing an area with plants that are highly attractive to butterflies will add on to the ecological value of the township and the MGC Complex. List of some such plants are given in the Appendix 6. Such species also can be planted in other areas interspersed with other species. Rich insect fauna may help considerably in attracting the insectivorous bird species. The butterflies and their larvae (caterpillars) form an important food items for the insectivorous birds. Occasionally other birds such as granivores depend on insects and other invertebrates to rear their young ones. Butterflies considerably increase the aesthetic value of the area apart from playing critical role in plant pollination.

Appendix 1 Plant species present in the environs of Nagothane and environs		
No	Habit	Species
1	Tree	<i>Acacia auriculiformis</i>
2	Tree	<i>Acacia ferruginea</i>
3	Tree	<i>Acacia mangium</i>
4	Tree	<i>Acacia sp</i>
5	Herb	<i>Acalypha indica</i>
6	Herb	<i>Acanthospermum hispidum</i>
7	Shrub	<i>Acanthus ebracteatus*</i>
8	Herb	<i>Achyranthes aspera</i>
9	Herb	<i>Adiantum sp</i>
10	Tree	<i>Albizzia lebbeck</i>
11	Herb	<i>Alternanthera paronychioides</i>
12	Herb	<i>Alysicarpus sp</i>
13	Herb	<i>Amaranthus viridis</i>
14	Shrub	<i>Amorphophallus campanulatus</i>
15	Straggler	<i>Ampelocissus latifolia</i>
16	Tree	<i>Anacardium occidentale</i>
17	Tree	<i>Annona squamosa</i>
18	Herb	<i>Aponogeton sp</i>
19	Straggler	<i>Asparagus racemosus</i>
20	Tree	<i>Bambusa arundinacea</i>
21	Herb	<i>Barleria sp</i>
22	Tree	<i>Bauhinia racemosa</i>
23	Herb	<i>Begonia sp</i>
24	Herb	<i>Boerhaavia diffusa</i>
25	Tree	<i>Bombax ceiba</i>
26	Herb	<i>Borreria sp</i>
27	Shrub	<i>Breynia patens</i>
28	Tree	<i>Bridelia retusa</i>
29	Tree	<i>Butea monosperma</i>
30	Tree	<i>Calophyllum inophyllum</i>
31	Shrub	<i>Calotropis gigantean</i>
32	Tree	<i>Careya arborea</i>
33	Tree	<i>Carica papaya</i>
34	Shrub	<i>Carissa carandas</i>
35	Tree	<i>Cassia fistula</i>
36	Tree	<i>Cassia siamea</i>
37	Shrub	<i>Cassia sp</i>
38	Herb	<i>Cassia tora</i>
39	Tree	<i>Casuarina equisetifolia</i>
40	Herb	<i>Celosia argentea</i>
41	Herb	<i>Ceratophyllum demersum</i>
42	Herb	<i>Chloris barbata</i>
43	Shrub	<i>Chromolaena odorata</i>
44	Straggler	<i>Cissus sp</i>
45	Herb	<i>Cleome viscosa</i>
46	Shrub	<i>Clerodendrum inerme</i>
47	Shrub	<i>Clerodendrum serratum</i>
48	Climber	<i>Coccinia grandis</i>
49	Climber	<i>Cocculus hirsutus</i>
50	Tree	<i>Cocos nucifera</i>

51	Shrub	<i>Coleobrookea oppositifolia</i>
52	Shrub	<i>Colocasia esculenta</i>
53	Herb	<i>Commelina benghalensis</i>
54	Herb	<i>Corchorus sp</i>
55	Herb	<i>Crotalaria retusa</i>
56	Climber	<i>Cryptolepis buchananii</i>
57	Climber	<i>Cyclea peltata</i>
58	Herb	<i>Cynodon dactylon</i>
59	Shrub	<i>Cyperus rotundus</i>
60	Herb	<i>Cyperus sp</i>
61	Herb	<i>Dactyloctenium aegyptium</i>
62	Tree	<i>Dalbergia paniculata</i>
63	Tree	<i>Delonix regia</i>
64	Herb	<i>Desmodium triflorum</i>
65	Herb	<i>Digera muricata</i>
66	Herb	<i>Digitaria bicornis</i>
67	Straggler	<i>Dioscorea bulbifera</i>
68	Herb	<i>Elephantopus scaber</i>
69	Tree	<i>Enterolobium saman</i>
70	Herb	<i>Eragrostis sp</i>
71	Tree	<i>Erythrina indica</i>
72	Tree	<i>Eucalyptus sp</i>
73	Herb	<i>Euphorbia heterophylla</i>
74	Herb	<i>Euphorbia hirta</i>
75	Herb	<i>Euphorbia hypercifolia</i>
76	Tree	<i>Euphorbia nivulia</i>
77	Herb	<i>Euphorbia sp</i>
78	Herb	<i>Evolvulus alsinoides</i>
79	Tree	<i>Ficus benghalensis</i>
80	Tree	<i>Ficus rumphii</i>
81	Tree	<i>Ficus sp</i>
82	Herb	<i>Fimbristylis sp</i>
83	Tree	<i>Gliricidia sepium</i>
84	Climber	<i>Gloriosa superba</i>
85	Herb	<i>Gomphrena celosioides</i>
86	Tree	<i>Grewia tiliaefolia</i>
87	Herb	<i>Habenaria grandiflora</i>
88	Herb	<i>Hedyotis sp</i>
89	Shrub	<i>Helicteres isora</i>
90	Herb	<i>Heliotropium indicum</i>
91	Shrub	<i>Holarrhena pubescens</i>
92	Tree	<i>Holoptelia integrifolia</i>
93	Shrub	<i>Hygrophila auriculata</i>
94	Herb	<i>Hygrophila octovalvis</i>
95	Herb	<i>Hygrophila schulli</i>
96	Shrub	<i>Hyptis suaveolens</i>
97	Herb	<i>Impatiens balsamina</i>
98	Herb	<i>Indigofera sp</i>
99	Shrub	<i>Ipomoea carnea</i>
100	Straggler	<i>Ipomoea obscura</i>
101	Straggler	<i>Ipomoea sp</i>
102	Shrub	<i>Jatropha curcas</i>
103	Shrub	<i>Jatropha glandulifera</i>

104	Shrub	<i>Kirganelia reticulata</i>
105	Herb	<i>Kyllingia monocephala</i>
106	Herb	<i>Lagascea mollis</i>
107	Shrub	<i>Lantana camara</i>
108	Shrub	<i>Laportea crenulata</i>
109	Shrub	<i>Lawsonia inermis</i>
110	Shrub	<i>Leea indica</i>
111	Tree	<i>Leucaena leucocephala</i>
112	Herb	<i>Leucas aspera</i>
113	Herb	<i>Lindernia sp</i>
114	Tree	<i>Macaranga peltata</i>
115	Tree	<i>Madhuca longifolia</i>
116	Herb	<i>Malvastrum coromandelianum</i>
117	Tree	<i>Mangifera indica</i>
118	Shrub	<i>Martynia annua</i>
119	Tree	<i>Melia azedarach</i>
120	Climber	<i>Momordica dioica</i>
121	Herb	<i>Mimosa pudica</i>
122	Tree	<i>Morinda pubescens</i>
123	Tree	<i>Moringa oleifera</i>
124	Climber	<i>Mucuna pruriens</i>
125	Climber	<i>Mukia sp</i>
126	Shrub	<i>Musa sp</i>
127	Herb	<i>Oplismenus compositus</i>
128	Herb	<i>Panicum brevifolium</i>
129	Herb	<i>Panicum sp</i>
130	Herb	<i>Parthenium hysterophorus</i>
131	Herb	<i>Paspalidium flavidum</i>
132	Herb	<i>Paspalum sp</i>
133	Herb	<i>Phyllanthus amarus</i>
134	Herb	<i>Phyllanthus maderaspatensis</i>
135	Tree	<i>Pithecellobium dulce</i>
136	Herb	<i>Plumbago zeylanica</i>
137	Shrub	<i>Polygonum barbatum</i>
138	Tree	<i>Pongamia pinnata</i>
139	Tree	<i>Prosopis juliflora</i>
140	Tree	<i>Randia dumetorum</i>
141	Herb	<i>Scoparia dulcis</i>
142	Shrub	<i>Securinega leucopyrus</i>
143	Herb	<i>Selaginella sp</i>
144	Straggler	<i>Sesbania bispinosa</i>
145	Herb	<i>Sida acuta</i>
146	Herb	<i>Sida rhomboidea</i>
147	Herb	<i>Solanum nigrum</i>
148	Shrub	<i>Solanum sp</i>
149	Tree	<i>Stereospermum colais</i>
150	Tree	<i>Strychnos nux-vomica</i>
151	Shrub	<i>Synadenium grantii</i>
152	Tree	<i>Syzygium cumini</i>
153	Tree	<i>Tectona grandis</i>
154	Herb	<i>Tephrosia purpurea</i>
155	Tree	<i>Terminalia bellirica</i>
156	Tree	<i>Terminalia crenulata</i>

157	Shrub	<i>Thespesia lampas</i>
158	Tree	<i>Thespesia populnea</i>
159	Tree	<i>Trema orientalis</i>
160	Herb	<i>Trianthema portulacastrum</i>
161	Herb	<i>Trichodesma indicum</i>
162	Herb	<i>Trichodesma zeylanicum</i>
163	Herb	<i>Tridax procumbens</i>
164	Herb	<i>Triumfetta annua</i>
165	Herb	<i>Triumfetta rotundifolia</i>
166	Herb	<i>Urena lobata</i>
167	Tree	<i>Vitex negundo</i>
168	Shrub	<i>Woodfordia floribunda</i>
169	Shrub	<i>Xanthium strumarium</i>
170	Herb	<i>Zingiber neesianum</i>
171	Tree	<i>Zizyphus mauritiana</i>
172	Shrub	<i>Zizyphus oenoplia</i>
173	Tree	<i>Zizyphus xylopyrus</i>

Appendix 2 Species that are planted in IPCL complex, Nagothane		
No.	Species	Habit
1	<i>Acacia auriculiformis</i>	Tree
2	<i>Acacia nilotica</i>	Tree
3	<i>Acacia catechu</i>	Tree
4	<i>Acacia holsericea</i>	Tree
5	<i>Aegle marmelos</i>	Tree
6	<i>Areca catechu</i>	Tree
7	<i>Acrocarpus fraxinifolius</i>	Tree
8	<i>Achrus sapota</i>	Tree
9	<i>Albizzia lebbbeck</i>	Tree
10	<i>Albizzia falcataria</i>	Tree
11	<i>Albizzia procera</i>	Tree
12	<i>Albizzia saman</i>	Tree
13	<i>Artocarpus heterophyllus</i>	Tree
14	<i>Anthocephala cadamba</i>	Tree
15	<i>Anacardium occidentale</i>	Tree
16	<i>Annona squamosa</i>	Tree
17	<i>Azadiracta indica</i>	Tree
18	<i>Bauhinia variegata</i>	Tree
19	<i>Bixa orellana</i>	Herb
20	<i>Bombax ceiba</i>	Tree
21	<i>Butea monosperma</i>	Tree
22	<i>Ceba pentandra</i>	Tree
23	<i>Cassia fistula</i>	Tree
24	<i>Cassia siamea</i>	Tree
25	<i>Cassia grandis</i>	Shrub
26	<i>Casuarina equisetifolia</i>	Tree
27	<i>Citrus aurantifolia</i>	Tree
28	<i>Cocos nucifera</i>	Tree
29	<i>Dendrocalamus strictus</i>	Tree
30	<i>Dalbergia sisoo</i>	Tree
31	<i>Dalbergia latifolia</i>	Tree
32	<i>Erythrina indica</i>	Tree
33	<i>Eucalyptus sp</i>	Tree
34	<i>Embilica officinalis</i>	Tree
35	<i>Ficus benghalensis</i>	Tree
36	<i>Ficus religiosa</i>	Tree
37	<i>Ficus elastica</i>	Tree
38	<i>Gliricidia sepium</i>	Tree
39	<i>Gmelina arborea</i>	Tree
40	<i>Grevillea robusta</i>	Tree
41	<i>Holoptelia integrifolia</i>	Tree
42	<i>Jacaranda mimosifolia</i>	Tree
43	<i>Lagerstromia flosereginae</i>	Tree
44	<i>Leucaena leucocephala</i>	Tree
45	<i>Mangifera indica</i>	Tree
46	<i>Melia azedarach</i>	Tree
47	<i>Moringa oleifera</i>	Tree
48	<i>Pithacellobium dulcii</i>	Tree
49	<i>Peltophorum ferugianum</i>	Tree

50	<i>Parkinsonia aculeata</i>	Tree
51	<i>Putranjiva roxburghii</i>	Tree
52	<i>Polyalthia longifolia</i>	Tree
53	<i>Pongamia pinnata</i>	Tree
54	<i>Sapindus trifoliatus</i>	Tree
55	<i>Sesbania grandiflora</i>	Tree
56	<i>Spathodia campanulata</i>	Tree
57	<i>Swietenia mahogany</i>	Tree
58	<i>Syzygium cumini</i>	Tree
59	<i>Tectona grandis</i>	Tree
60	<i>Tebouia argentia</i>	Tree
61	<i>Terminalia bellirica</i>	Tree
62	<i>Terminalia cattappa</i>	Tree
63	<i>Terminalia tomentosa</i>	Tree
64	<i>Thespesia populnea</i>	Tree
65	<i>Tamarindus indica</i>	Tree
66	<i>Terminalia chebula</i>	Tree
67	<i>Zizyphus mauritiana</i>	Tree
Source: MGCC, M/s IPCL		

Appendix 3 Amphibians and reptiles observed in the IPCL complex		
No	Scientific name	English name
1	<i>Bufo melanostictus</i> #	Indian Toad
2	<i>Euphlyctis cyanophlyctis</i> #	Indian Skipping Frog
3	<i>Limnonectes limnocharis</i> #	Indian Skipper Frog
4	<i>Tomopterna breviceps</i> #	Shortheaded Burrowing Frog
5	<i>Haplobatrachus tigerina</i> #	Indian Bull Frog
6	<i>Microhyla ornate</i> #	Ornate Narrow-mouthed Frog
7	<i>Philautus sp</i>	Bush Frog
8	<i>Hemidactylus flaviviridis</i>	Yellow-green House Gecko
9	<i>Calotes versicolor</i>	Indian Garden Lizard
10	<i>Calotes rouxi</i>	Forest Calotes
11	<i>Mabuya carinata</i>	Keeled Grass Skink
12	<i>Lygosoma punctatus</i>	Spotted Supple Skink
13	<i>Xenochropis piscator</i> #	Checkered Keelback Water Snake
# Water dependent species		

Appendix 4 Avifauna sighted in the MGCC area and its environs		
S.No.	Scientific name	English name
1	<i>Podiceps ruficollis</i>	Little Grebe*
2	<i>Phalacrocorax fuscicollis</i>	Indian Shag*
3	<i>Phalacrocorax niger</i>	Little Cormorant*
4	<i>Anhinga rufa</i>	Darter or Snake-bird*
5	<i>Ardea cinerea</i>	Grey Heron*
6	<i>Ardea purpurea</i>	Purple Heron*
7	<i>Ardea alba</i>	Large Egret*
8	<i>Ardeola grayii</i>	Pond Heron or Paddy Bird*
9	<i>Bubulcus ibis</i>	Cattle Egret*
10	<i>Egretta intermedia</i>	Smaller (Median) Egret*
11	<i>Egretta garzetta</i>	Little Egret*
12	<i>Nycticorax nycticorax</i>	Night Heron*
13	<i>Ardeola striatus</i>	Little green Heron*
14	<i>Threskiornis aethiopica</i>	White Ibis*
15	<i>Platalea leucorodia</i>	Spoonbill*
16	<i>Dendrocygna javanica</i>	Lesser Whistling Teal*
17	<i>Anas poecilorhyncha</i>	Spotbill*
18	<i>Nettapus coromandelianus</i>	Cotton Teal*
19	<i>Spilornis cheela</i>	Crestedserpent Eagle
20	<i>Elanus caeruleus</i>	Blackwinged Kite
21	<i>Pernis ptilorhynchus</i>	Honey Buzzard
22	<i>Milvus migrans</i>	Pariah Kite
23	<i>Haliastur indus</i>	Brahminy Kite
24	<i>Accipiter badius</i>	Indian Shikra
25	<i>Neophron percnopterus</i>	Scavenger Vulture
26	<i>Francolinus pondicerianus</i>	Grey Partridge
27	<i>Coturnix coturnix</i>	Common quail
28	<i>Amaurornis phoenicurus</i>	Whitebreasted Waterhen*
29	<i>Gallinula chloropus</i>	Indian Moorhen*
30	<i>Porphyrio porphyrio</i>	Purple Moorhen*
31	<i>Hydrophasianus chirurgus</i>	Pheasant Tailed Jacana*
32	<i>Metopidius indicus</i>	Bronzewinged Jacana*
33	<i>Himantopus himantopus</i>	Blackwinged Stilt*
35	<i>Vanellus indicus</i>	Redwattled Lapwing*
36	<i>Tringa stagnatilis</i>	Marsh Sandpiper*
37	<i>Tringa ochropus</i>	Green Sandpiper*
38	<i>Tringa glareola</i>	Wood Sandpiper*
39	<i>Columba livia</i>	Blue Rock Pigeon
40	<i>Streptopelia decaocto</i>	Indian Ring Dove
41	<i>Streptopelia tranquebarica</i>	Red Turtle Dove
42	<i>Streptopelia chinensis</i>	Spotted Dove

43	<i>Streptopelia senegalensis</i>	Little Brown Dove
44	<i>Psittacula krameri</i>	Roseringed Parakeet
45	<i>Psittacula cyanocephala</i>	Blossom headed Parakeet
46	<i>Clamator jacobinus</i>	Pied Crested Cuckoo
47	<i>Cuculus varius</i>	Common Hawk Cuckoo
48	<i>Cuculus canorus</i>	Cuckoo
49	<i>Eudynamys scolopacea</i>	Koel
50	<i>Centropus sinensis</i>	Crow Pheasant
51	<i>Otus bakkamoena</i>	Collared Scops Owl
52	<i>Athene brama</i>	Spotted Owlet
53	<i>Caprimulgus indicus</i>	Indian Night Jar
54	<i>Apus affinis</i>	House Swift
55	<i>Cypsiurus parvus</i>	Palm Swift
56	<i>Ceryle rudis</i>	Lesser Pied Kingfisher*
57	<i>Alcedo atthis</i>	Small Blue Kingfisher*
58	<i>Halcyon smyrnensis</i>	White breasted Kingfisher*
59	<i>Merops orientalis</i>	Small Green Bee-eater
60	<i>Coracias benghalensis</i>	Indian Roller
61	<i>Upupa epops</i>	Hoopoe
62	<i>Tockus birostris</i>	Grey Hornbill
63	<i>Megalaima haemacephala</i>	Crimsonbreasted Barbet
64	<i>Megalaima viridis</i>	Small Green Barbet
65	<i>Dinopium benghalense</i>	Goldenbacked Woodpecker
66	<i>Eremopterix grisea</i>	Ashycrowned Finch Lark
67	<i>Galerida cristata</i>	Crested Lark
68	<i>Alauda gulgula</i>	Skylark
69	<i>Hirundo rustica</i>	Swallow
70	<i>Hirundo smithii</i>	Wire-tailed Swallow
71	<i>Lanius vittatus</i>	Baybacked Shrike
72	<i>Lanius schach</i>	Rufousbacked Shrike
73	<i>Oriolus oriolus</i>	Golden Oriole
74	<i>Dicrurus adsimilis</i>	Black Drongo
75	<i>Acridotheres tristis</i>	Common Myna
76	<i>Sturnus contra</i>	Pied myna
77	<i>Dendrocitta vagabunda</i>	Tree Pie
78	<i>Corvus splendens</i>	House Crow
79	<i>Corvus macrorhynchos</i>	Jungle Crow
80	<i>Tephrodornis pondicerianus</i>	Common Wood Shrike
81	<i>Aegithina tiphia</i>	Common Iora
82	<i>Pycnonotus leucogenys</i>	Whitecheeked Bulbul
83	<i>Pycnonotus cafer</i>	Redvented Bulbul
84	<i>Turdoides affinis</i>	Whiteheaded Babbler
85	<i>Turdoides striatus</i>	Jungle Babbler
86	<i>Terpsiphone paradisi</i>	Paradise Flycatcher

87	<i>Prinia socialis</i>	Ashy Wren-warbler
88	<i>Orthotomus sutorius</i>	Tailor Bird
89	<i>Acrocephalus stentoreus</i>	Indian Great Reed Warbler
90	<i>Copsychus saularis</i>	Magpie Robin
91	<i>Saxicola caprata</i>	Pied Bush Chat
92	<i>Saxicoloides fulicata</i>	Indian Robin
93	<i>Parus major</i>	Grey Tit
94	<i>Motacilla caspica</i>	Grey Wagtail
95	<i>Anthus novaeseelandiae</i>	Paddyfield Pipit
96	<i>Motacilla cinerea</i>	Grey Wagtail*
97	<i>Nectarinia zeylonica</i>	Purplerumped Sunbird
98	<i>Nectarinia asiatica</i>	Purple Sunbird
99	<i>Zosterops palpebrosa</i>	Indian White-eye
100	<i>Passer domesticus</i>	House Sparrow
101	<i>Petronia xanthocollis</i>	Yellowthroated Sparrow
102	<i>Lonchura striata</i>	Whitebacked Munia
* Water dependent species		

Appendix 5 Some plant species helpful to attract birds		
No	Species	Habit
1	<i>Benkara malabarica</i>	Shrub
2	<i>Canthium dicoccum</i>	Tree
3	<i>Capparis sepiaria</i>	Shrub
4	<i>Carissa spinarum</i>	Shrub
5	<i>Cassine glauca</i>	Tree
6	<i>Celtis philippensis</i>	Tree
7	<i>Cordia obliqua</i>	Tree
8	<i>Drypetes sepiaria</i>	Tree
9	<i>Eheretia ovalifolia</i>	Tree
10	<i>Ficuls virens</i>	Tree
11	<i>Ficus benghalensis</i>	Tree
12	<i>Ficus microcarpa</i>	Tree
13	<i>Glycosmis pentaphylla</i>	Shrub
14	<i>Grewia orbiculata</i>	Tree
15	<i>Hugonia mystax</i>	Shrub
16	<i>Ixora pavetta</i>	Tree
17	<i>Maba buxifolia</i>	Tree
18	<i>Manilkara roxburghiana</i>	Tree
19	<i>Morinda coreia</i>	Tree
20	<i>Pachygone ovata</i>	Shrub
21	<i>Premna tomentosa</i>	Tree
22	<i>Santalum album</i>	Tree
23	<i>Schleichera oleosa</i>	Tree
24	<i>Scutia myrtina</i>	Shrub
25	<i>Strychnos nuxvomica</i>	Tree
26	<i>Strychnos potatorum</i>	Tree
27	<i>Syzygium cumini</i>	Tree
28	<i>Toddalia asiatica</i>	Shrub
29	<i>Vitex altissima</i>	Tree
30	<i>Zizyphus oenoplia</i>	Tree

Appendix 6. Common larval food plants attractive to butterflies

No.	Common name	Scientific name	Family	Food plants
1	Common Cerulean	<i>Jamides celeno</i> Cramer	Lycaenidae	<i>Karanj, Abrus precatorius, Saraca asoka, Butea monosperma</i>
2	Red Pierrot	<i>Talicauda nyseus</i> (Guerin)	Lycaenidae	<i>Bryophyllum spp., Kalanchoe spp.</i>
3	Angled Castor	<i>Ariadne ariadne</i> Fruhstorfer	Nymphalidae	<i>Ricinus communis, Tragia sp.</i>
4	Bamboo Treebrown	<i>Lethe europa</i> Fruhstorfer	Nymphalidae	<i>Bamboos, Grasses</i>
5	Baronet	<i>Symphaedra nais</i> Forster	Nymphalidae	<i>Diospyros melanoxylon, Shorea robusta</i>
6	Blue Oakleaf	<i>Kallima horsfieldi</i> Kollar	Nymphalidae	<i>Carvia callosa, Stobilanthes sp.</i>
7	Blue Pansy	<i>Precis orithya</i> Hubener	Nymphalidae	<i>Justicia procumbens, J. migrantha, Lepidagathis prostrata</i>
8	Blue Tiger	<i>Tirumala limniace</i> Butler	Nymphalidae	<i>Asclepias curasavica, Marsdenia tenacissima, Hoya spp. Wattaakaka volubilis,</i>
9	Chocolate Pansy	<i>Precis iphita</i> Cramer	Nymphalidae	<i>Justicia sp. Hygrophilla auriculata</i>
10	Commander	<i>Moduza procris</i> (Cramer)	Nymphalidae	<i>Cinchona, Mussanda frondosa, Anthocephalus cadamba, Mitragyna parvifolia,</i>
11	Common Baron	<i>Euthalia aconthea</i> Fruhstorfer	Nymphalidae	<i>Mangifera indica, Anacardium occidentale</i>
12	Common Castor	<i>Ariadne merione</i> Evans	Nymphalidae	<i>Ricinus communis, Tragia sp.</i>
13	Common Crow	<i>Euploea core</i> Cramer	Nymphalidae	<i>Nerium oleander, N.indicum, Holarrhena pubescens, Ichnocarpus frutescens, Ficus bengalensis, F. religiosa, F. racemosa, F. elastica, Streblus asper, Hemidesmus indicus, Cryptolepis buchanani</i>
14	Common Fivering	<i>Ypthima baldus</i> Fabricius	Nymphalidae	<i>Grasses</i>
15	Common Fourring	<i>Ypthima hubneri</i> Kirby	Nymphalidae	<i>Grasses</i>
16	Common Leopard	<i>Phalanta phalantha</i> Drury	Nymphalidae	<i>Flacourtia montana, F. Ramontchii</i>
17	Common Map	<i>Cyrestis thyodamas</i> (Boisduval)	Nymphalidae	<i>Ficus religiosa, F. bengalensis, F. racemosa</i>
18	Common Nawab	<i>Polyura athamas</i> Drury	Nymphalidae	<i>Acacia catechu, Albizzia lebeck, Delonix regia, Adenantha pavonia, Ceasalpinia sappan, C. bonducella</i>
19	Common Palmfly	<i>Elymnias hypermnestra</i> Linnaeus	Nymphalidae	<i>Palms</i>
20	Common Sailor	<i>Neptis hylas</i> Moore	Nymphalidae	<i>Red Silk Cotton, Helictres Isora, Grewia sp. Mucuna sp.</i>
21	Cruiser	<i>Vindula erota</i> (Fabricius)	Nymphalidae	<i>Passion flowers</i>
22	Danaid Eggfly	<i>Hypolimnas misippus</i> Linnaeus	Nymphalidae	<i>Portulaca oleracea, Abutilon sp.</i>
23	Glassy Tiger	<i>Parantica aglea</i> Moore	Nymphalidae	<i>Tylophora carnosa, Cryptolepis buchanani, Ceropogia sp.</i>
24	Great Eggfly	<i>Hypolimnas bolina</i> Linnaeus	Nymphalidae	<i>Portulaca oleracea, Fleurya interrupta, Elastostemma cunneatum</i>

No.	Common name	Scientific name	Family	Food plants
25	Joker	<i>Byblia ilithyia</i> (Drury)	Nymphalidae	<i>Tragia cannabina</i>
26	Lemon Pansy	<i>Precis lemonias</i> Linnaeus	Nymphalidae	<i>Hygrophilla auriculata</i> , <i>Corchorus olitorius</i> , <i>Lepidagathis sp.</i> , <i>Nelsonia canescens</i>
27	Painted Lady	<i>Cynthia cardui</i> (Linn.)	Nymphalidae	<i>Zorina diphylla</i> , <i>Artemisia sp.</i> , <i>Blumea</i> , <i>Utrica sp.</i>
28	Peacock Pansy	<i>Precis almana</i> Linnaeus	Nymphalidae	<i>Hygrophilla auriculata</i> , <i>Barleria sp.</i> <i>Osbeckia sp.</i> ,
29	Striped Tiger	<i>Danaus genutia</i> Cramer	Nymphalidae	<i>Ceropegia aculata</i> , <i>C. intermedia</i> , <i>Cynanchum dalhousie</i> , <i>Raphistemma pulchellum</i>
30	Tamil Lacewing	<i>Cethosia nietneri</i> Felder	Nymphalidae	Passion flowers
31	Tawny Coster	<i>Acraea violae</i> Horsfield	Nymphalidae	<i>Modecca palmata</i> , <i>Passiflora foetida</i>
32	Yellow Pansy	<i>Precis hierta</i> Evans	Nymphalidae	<i>Hygrophila auriculata</i> , <i>Barleria sp.</i> ,
33	Blue Mormon	<i>Papilio polymnestor</i> Cramer	Papilionidae	Cultivated and wild lime & oranges, <i>Glycosmis pentaphylla</i> ,
34	Common Banded Peacock	<i>Papilio crino</i> Fabricius	Papilionidae	<i>Chloroxylon swietenia</i> (Rutaceae ?)
35	Common Bluebottle	<i>Graphium sarpedon</i> Linnaeus	Papilionidae	Cinnamon, Laurels, <i>Machilus sp.</i>
36	Common Mormon	<i>Priniceps polytes</i> Cramer	Papilionidae	Cultivated lime & oranges, <i>Glycosmis pentaphylla</i> , <i>Aegle marmelos</i> , <i>Muraya koeningi</i>
37	Common Rose	<i>Pachliopta aristolochiae</i> Fabricius	Papilionidae	<i>Aristolochia indica</i>
38	Crimson Rose	<i>Pachliopta hector</i> Linnaeus	Papilionidae	<i>Aristolochia indica</i>
39	Malabar Banded Peacock	<i>Papilio budha</i> Westwood	Papilionidae	<i>Xanthoxylon rhesta</i> ('Tirphal tree', Rutaceae)
40	Malabar Raven	<i>Papilio dravidarum</i> Wood-Mason	Papilionidae	<i>Glycosmis pentaphylla</i>
41	Malabar Rose	<i>Pachliopta pandiyana</i> Moore	Papilionidae	Only <i>Thottea siliquosa</i> (Gaonkar, Larsen)
42	Southern Birdwing	<i>Troides minos</i> (Cramer)	Papilionidae	<i>Aristolochia indica</i> , <i>Thottea wallichii</i>
43	Spot Sword tail	<i>Pathysa nomius</i> Esper	Papilionidae	<i>Polyalthia cerasoides</i> , <i>Miliusa tomentosa</i> ,
44	Tailed Jay	<i>Graphium agamemnon</i> Linnaeus	Papilionidae	<i>Annona squamosa</i> , <i>Polyalthia longifolia</i> , <i>Miliusa tomentosa</i> , <i>Micheliachampaka</i>
45	Common Grass Yellow	<i>Eurema hecabe</i> Moore	Pieridae	<i>Cassia fistula</i> , <i>Pithecellobium dulce</i> , <i>Albizia sp.</i> , <i>Sesbania aculeata</i> , <i>Caesalpinia spp.</i>
46	Common Jezebel	<i>Delias eucharis</i> Drury	Pieridae	<i>Dendrophthoe sp.</i> ,

No.	Common name	Scientific name	Family	Food plants
47	Common Wanderer	<i>Pareronia valeria</i> Fabricius	Pieridae	<i>Capparis sp.</i>
48	Great Orangetip	<i>Hebomoia glaucippe</i> Linnaeus	Pieridae	<i>Crataeva religiosa</i> , <i>Capparis spp.</i> ,
49	Indian Cabbage White	<i>Pieris canidia</i> (Evans)	Pieridae	<i>Cultivated cabbage</i>
50	Lemon Emigrant	<i>Catopsilia pomona</i> Fabricius	Pieridae	<i>Cassia fistula</i> , <i>C. siamea</i> , other <i>Cassia spp.</i> <i>Butea monosperma</i> , <i>Bauhinia racemosa</i>
51	Pioneer	<i>Anaphaeis aurota</i> Fabricius	Pieridae	<i>Capparis sp.</i> ,
52	Psyche	<i>Leptosia nina</i> Fabricius	Pieridae	<i>Capparis heyneana</i> , <i>Crataeva religiosa</i> ,
53	Small Salmon Arab	<i>Colotis calais</i> (Cramer)	Pieridae	<i>Salvodora persica</i>
54	White Orangetip	<i>Ixias marianne</i> (Cramer)	Pieridae	<i>Capparis spp.</i>
55	Yellow Orangetip	<i>Ixias pyrene</i> Butler	Pieridae	<i>Capparis sp.</i>