

*Conservation Plan for Gaur and Endemic Flora of
Shevaroy Bauxite Mines, Yercaud,*

*M/s The Madras Aluminium Company Limited, Mettur Dam
Salem District, Tamilnadu*

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1 INTRODUCTION

1.1 Background

The Shevaroy, one of the major hill ranges in Tamilnadu is a southern extension of the Eastern Ghats. Yercaud, a well-known tourist destination of the south India, is located in the southern half of the western section of the Shevaroy hills in the Salem District of Tamilnadu (Figure 1). The location is in an undulating plateau on the isolated hill range of the discontinuous Eastern Ghats mountain system. The Shevaroy hills have an area of 470 sq. km. Its altitude ranges from 600 to 1600 m above MSL, with a northeast to southwest trend. The range has many valleys and sholas (moist forests) that are rich in biodiversity. The soil along the slopes of the hill is red sandy loam. A number of streams drain the slopes of the hill to the river Vaniyar that ultimately joins the river Cauvery.

The Madras Aluminum Company Limited (MALCO), one of the pioneers to extract primary aluminum in the country, have been excavating bauxite from the Shevaroy hills (Figure 2) for the past thirty years. The company has mining lease in three areas namely Semmadavu (Hill numbers I, II, IV, V, and Part of III), Manjakuttai (Hill number III) and Puliur (Hill number VI) (MALCO EIA report 1999). The lands under lease have been classified as hill poromboke, assessed wasteland or un-assessed wasteland. The total area under lease is 190.93 ha of which only from 60 ha bauxite can be extracted.

1.2 Expansion project

M/s MALCO proposes to increase their aluminum production in the coming years. Currently they extract 101052 TPA of bauxite and they propose to increase extraction to 227000 TPA. That means the daily excavation will increase from 340 tonnes to 760 tonnes. The total geological reserves in the area is 3058000 tonnes of which

2365730 is mineable. The proposed increase in the production does not envisage expansion of the area already leased to the company for excavating bauxite. It is envisaged that by increasing mining activity in the same leased areas increased production can be achieved. Of the hills numbering from I to VI, the largest deposit (1567000 tonnes) is present in hill number II from which the largest extraction (80%) is envisaged. The hill number VI carries only 57000 tonnes of deposit of which 80% are proposed for extraction.

1.3 Mining activity

At Shevaroy mines proposed method of mining bauxite is by opencast method. Mining will be done both by manual and semi-mechanized schemes. Excavation will be done to form benches of 3 m height and 10-20 m width. A number of equipments such as wagon drill, compressor, jackhammer drill and tipper will be put into use. Earth moving machineries will be engaged for removal of overburden, loading bauxite and transportation. Jack Hammer, compressor, JCB pay loader, bulldozer, crowbars, spades etc are common equipments that will be used for mining. The overburden will be deposited to form suitable benches and it will be used to reclaim the depressions left after mining. Drilling using machinery will be adopted for dislodging and fragmentation of the deposits. However, blasting also will be used according to need to loosen hard strata. It is stated that blasting will be done only during noon at 1300 hrs. On an average for every kilogram of explosive used 14.5 tonnes of ore will be loosened. For hard strata each bore hole for blast carries 125-250 gm of charge. Daily consumption of explosives (gelatin) is estimated as 6 kg while that currently is only 2 kg.

1.4 Mining time, fuel requirement and employment

Drilling, blasting and other mining activity will be done only during day hours. The mining activity, that may spread to almost 300 days / annum is expected to

engage directly 43 on a permanent basis and 38 persons on temporary basis in mining activity. Apart from this personnel directly engaged in the mining activity there would be persons who are indirectly engaged such as drivers and helpers of the trucks transporting the recovered ore materials. Currently the fuel requirement for mine operation is only 350 l/day that will increase to 850 l/day after the expansion programme is implemented.

1.5 Transportation of bauxite

The bauxite extracted from Shevaroy mines are currently transported daily by 36 trips of tippers of 10 tones capacity. After the increased production the trips will be increased to 74 trips per day. Trucks have to travel about 85 km to transport the bauxite to Mettur alumina production unit of MALCO. Only during day hours between 0800 and 1500hr loading bauxite into the tippers will be done.

1.6 Environmental impact

The EIA Study conducted by Enviro Energy Systems to find out the possibilities of environmental impact viz., Air, Water and Noise Pollution. Ecological Changes by the proposed mining expansion project concludes that the possible environmental damages are insignificant. Since the bauxite deposits are located on topmost portion of the hillocks and generally many trees do not grow on the deposits it is stated that “due to the proposed increased production in the mines there is no need for removal of any trees or vegetation” (Enviro Energy Systems 1999). Although landscape changes are unavoidable, the proposed Environmental Management Plan envisages ways and means to reclaim and re-vegetate the mined-out locations (Plate I).

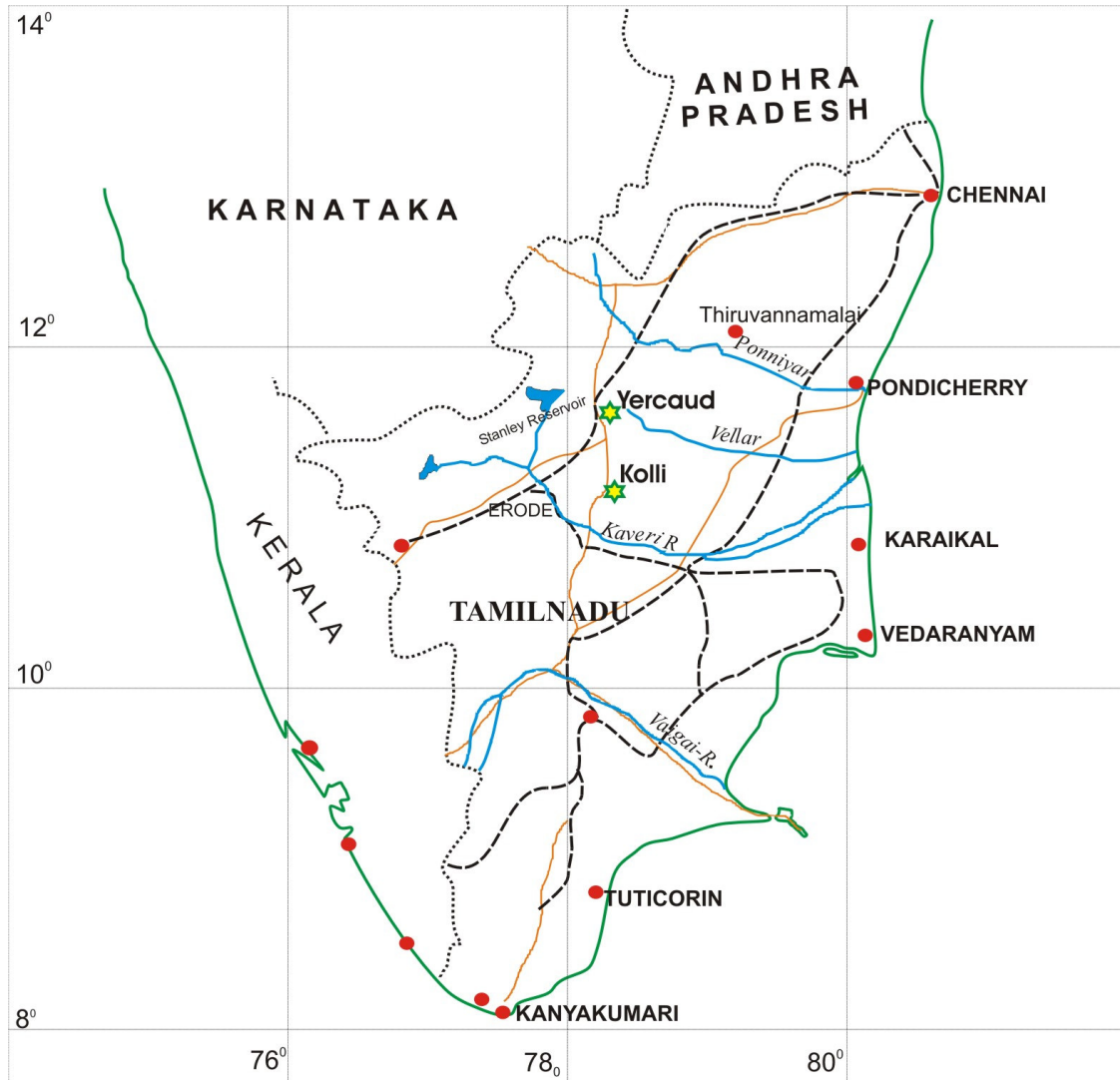


Figure 1 MALCO Bauxite mines (Yercaud and Kolli) in Tamilnadu

1.7 Environmental management

The proposal for expansion of mining at Shevaroy by M/s MALCO envisages environmental management plans to reduce environmental impact of the proposed expansion activities.

- Proposals for land reclamation, that is indispensable in the case of opencast mines, are made. They include physical reclamation followed by biological reclamation. It is intended that the original stratification of soil profile is maintained to the extent possible. During mining the topsoil is stored separately so that during the physical reclamation the layer is laid back as top layer.
- For dust suppression it is proposed to continue sprinkling water along the transportation route. Currently M/s MALCO use about 9 m³ water for the purpose that will be increased to 12 m³.
- Revegetation programmes in the reclaimed mine areas and greenbelt development plans (Plate I) are identified for locations where mining activity is proposed for expansion. 5000 plants will be planted every year. Greenbelts of 30 m width are proposed around the mines. Green belt is planned around the roads, and also outside the mine-waste dumps. Mainly three species of trees will be planted.
- Measures are also identified to control erosion, air and water pollution, noise and accidents during blasting. Management strategies for soil and mineral wastes are identified. Suitable sites for dumping the wastes are selected so that it would not affect future operations of the mines; the area has capacity to accommodate the waste generated during the life of the mines and is closer to the mines for easy backfilling.

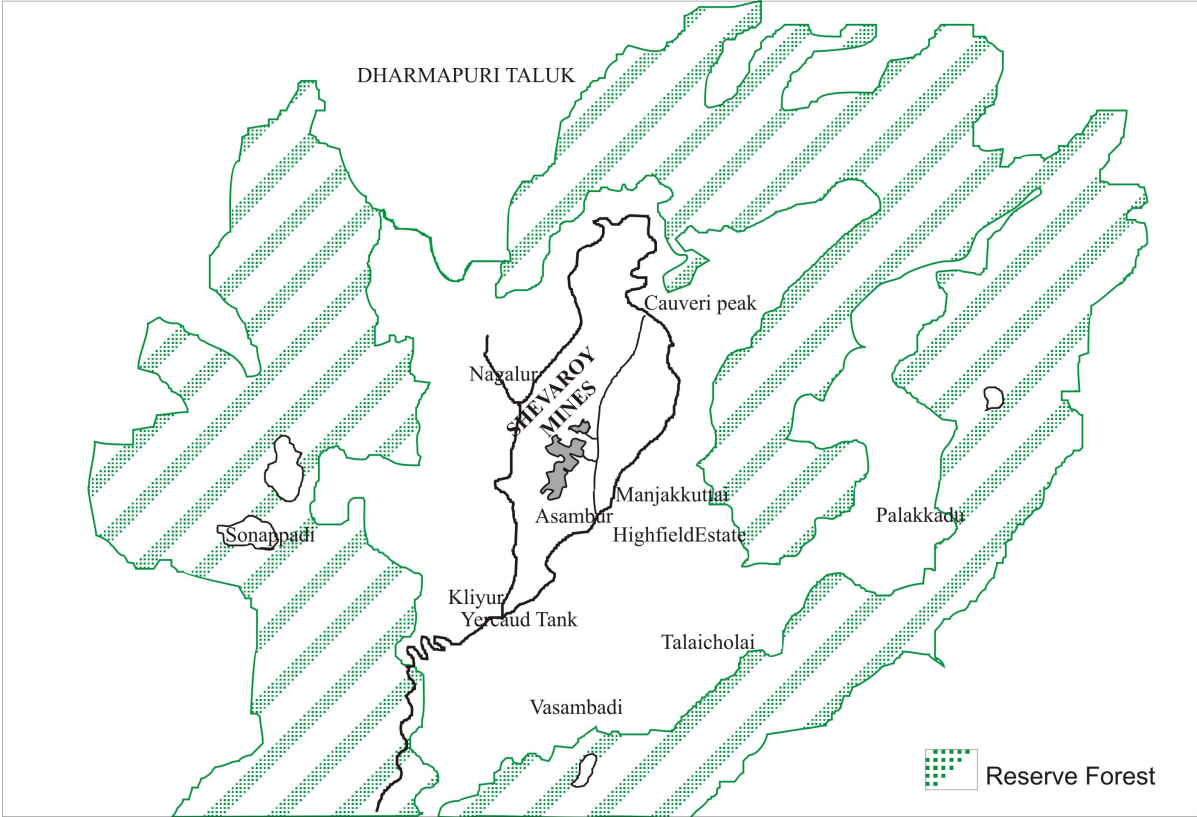


Figure 2 The location of Shevaroy mines of MALCO

1.8 Origin of the study

M/s Madras Aluminium Company Limited (MALCO), one among the five integrated aluminium industries in India, have their manufacturing facility at Mettur Dam and captive bauxite mines at Shevaroy hills at Yercaud, Salem District and Kolli hills, Namakkal District, both in Tamilnadu. The company in recent years has invested more than Rs 400 crores in its development and plans to expand its production capacity. As a step in this direction they propose to enhance mining activity from their captive mines for which they have valid leases. To avail the clearance from Ministry of Environment and Forest, Government of India M/s MALCO has conducted an Environmental Impact Assessment (EIA), the report of which is in the consideration of the Ministry. Meanwhile, the Expert Committee of the ministry has recommended to conduct a study for developing a Conservation Plan for Gaur and Endemic Flora of Shevaroy Bauxite Mines (M/s MALCO comm. 28 November 2002). In this regard, M/s MALCO approached SACON to undertake the studies. As an organization dedicated to the cause of conservation, SACON undertook a rapid assessment of the areas during January - February 2003.

1.9 Scope of the Study

The scope of the present study was

- Preparation of Conservation Plan for flora and fauna of Shevaroy bauxite mine lease area located at Yercaud, Salem District with emphasis on Gaur and Endemic Flora.

2 METHODOLOGY

The methodology for a study with the scope mentioned above involves i) examination of the proposed project, ii) environmental impact assessment already conducted by M/s MALCO, iii) examination of the baseline data on flora and fauna

in the project site to identify species that need special protection or conservation actions, and iv) examination of the mitigatory measures proposed in the project with respect to the biological environment and exploration of other possible means to reduce the impacts.

Of the above different aspects of the study information on the project, Environmental impacts and baseline data were adopted from the documents provided by M/s MALCO. To supplement data already available in these documents we conducted field surveys. We also used relevant scientific literature and secondary information on the study area and elsewhere, available from authentic sources such as scientific journals and reports.

2.1 Field Survey

Two field surveys were undertaken in January and February 2003 to collect the baseline data. The general techniques adopted to generate primary data on the environment were randomized cluster sampling. The sampling points were randomly distributed. Nevertheless, higher attention was given to the plateau where the expansion of mine is proposed. In our study the mines are considered as the project sites and an area falling within 10 km radial distance as tentatively the impact area. According to the group of animals or plants appropriate sampling methods were adopted to collect data on occurrence, distribution and abundance.

2.2 Flora

The flora was examined following standard methods. To examine the trees quadrats of 100 x 100m were laid in 11 locations (Table 4). In each of the larger quadrats species and their number were recorded (Chaturvedi and Khanna 1982). In 5 x 5m quadrats shrubs were enlisted and enumerated. At each location 2-3 plots (quadrats) were examined for quantitative data and the average was computed. In the smaller

quadrats (1x1 m) herbs were enlisted and enumerated. Identities of certain species were confirmed at the Botanical Survey of India (Southern circle), Coimbatore.

2.3 Fauna

The fauna was studied by intensive survey in the environs of the project site. A summary of field techniques employed to study the flora and fauna is given in Table 1. At each sampling plots, direct encounters and indirect evidences, such as tracks, signs and scats (Bang et al 1972) were recorded. Since birds (Lawton 1996) and butterflies (Chakravarthy et al 1997, Lawton et al 1998) are considered as ecological indicators, attempt was made to gather data on these faunal groups.

Table 1 Sampling methods used for the study

| Taxa | Sampling Methods |
|-------------|---|
| Plants | Quadrat sampling and enumeration |
| Butterflies | Visual encounter survey |
| Amphibians | Visual encounter survey (search) |
| Reptiles | Visual encounter survey (search) |
| Birds | Random walk, opportunistic observation |
| Mammals | Tracks and signs, and visual encounter survey |

3 OBSERVATIONS

3.1 Botanical studies in Shevaroyan hills

Shevaroyan hills have been explored by several investigators for its floristic composition (Gamble 1957, Subramanyam et al 1960, Matthew 1981, 1987 & 1989, Hariharan 1991, Senthil Kumar 1991, Ansari et al 1993, Senthilkumar & Krishnamoorthi 1993, Krishnamurthy and Kumar 1998). A total of 1101 species of flowering plants belonging to 647 genera under 149 families are recorded so far in this region (Senthilkumar & Krishnamoorthi 1993). Subramanyam et al (1960) have recorded about 50 fern and fern allies from the Shevaroy hills. About 111 lichens also are recorded in the area (Hariharan 1991).

3.2 Vegetation of Shevaroy Hills

Vegetation varies considerably with altitude. The foothill is composed of scrub vegetation (400-700m); deciduous forests occur between 800-1200m and semi-evergreen forests between 1300 -1600m. The natural forests all over the Shevaroy hills are under great pressure. Most of the forest areas are in degraded, in varying degrees, condition.

3.3 Scrub forests

Scrub forests (tropical thorn forest) are available at the foothills. *Euphorbia antiquorum*, *E. tirucalli*, *Capparis grandis*, *Erythroxylum monogynum*, *Limonia alata* and *Canthium dicoccum* are dominant trees. Common shrubs are *Opuntia dillenii*, *Lantana camara*, *Securinega leucopyrus* and *Tarenna asiatica*. *Pterolobium hexapetalum*, *Cissus quadrangularis*, *Cardiospermum halicacabum*, *Dioscorea oppositifolia* and *Smilax ovalifolia* are common climbers. The herb layer is dominated by *Mollugo oppositifolia*, *Justicia tranquebariensis*, *Blepharis maderaspatensis*, *Ocimum canum*, *Tephrosia purpurea*, *Polycarpaea corymbosa*, *Borreria ocymoides*, *Desmodium triflorum* and *Boerhavia diffusa*.

3.4 Dry deciduous forests

Dry deciduous forests are seen at higher elevations (800m – 1200m) along the fringes of estates. Tree species such as *Anogeissus latifolia*, *Pterocarpus marsupium*, *Semecarpus anacardium*, *Buchanania lanzan*, *Zizyphus oenoplia*, *Sterculia villosa*, *Terminalia chebula* and *Terminalia bellirica* dominate the tree layer. Common shrub species are *Toddalia asiatica*, *Lantana camara*, *Chromolaena odorata*, *Tarenna asiatica*, *Argyreia cuneata* and *Securinega leucopyrus*. *Clematis gouriana*, *Jasminum rigidum*, *Ipomoea hedracea* and *Thunbergia alata* are the common climbers. Herb layer is dominated by *Justicia simplex*, *Blepharis maderaspatensis*, *Hemionitis arifolia*, *Adiantum lunulatum*, *Tridax procumbens*, *Sida acuta* and *Leucas biflora*.

3.5 Semi-evergreen forests

Degraded semi-evergreen forests are seen near the mine 1. Common trees are *Neolitsea scrobiculata*, *Maesa indica*, *Memecylon* sp, *Machilus macranga*, *Macaranga peltata*, *Mallotus tetracoccus* and *Vernonia arborea*. *Cyathea nilgiriensis*, a tree fern is also seen in this forest.

Besides the above forests types, plantations of *Coffea arabica* (Coffee) are common in the Shevaroyan hills. Trees like *Erythrina* spp., *Grevillea robusta* (Silver Oak) and *Artocarpus hetrophyllus* (Jackfruit) are common shade trees grown in the coffee plantations. *Callitris rhomboidea* (Local name: Cyprus tree), an introduced gymnosperm is common in Shevaroy hills. *Jacaranda mimosifolia*, an avenue tree is common along the road.

3.6 Floristic composition of sampling locations

In all 76 plant species were recorded from the project area during our field survey (Appendix 1), which included 24 trees, 23 herbs, 14 shrubs, 2 epiphytes, 10 stragglers, one liana, one parasite and one climber (Table 2).

Table 2 Plant species recorded in the project area and its environs

| Habit | Number of Species |
|------------|-------------------|
| Shrubs | 14 |
| Herbs | 23 |
| Epiphytes | 2 |
| Trees | 24 |
| Stragglers | 10 |
| Climber | 1 |
| Liana | 1 |
| Parasite | 1 |
| Total | 76 |

3.6.1 Mine 1

Degraded semi-evergreen forest is seen on the slopes of the mine 1. Common trees in the slopes are *Linocera ramiflora*, *Litsea oleoides*, *Machilus macrantha*, *Macaranga peltata*, *Mallotus tetracoccus*, *Memecylon edule*, *Maesa indica*, *Phoenix loureiri*, *Symplocos cochinchinensis*, *Eucalyptus* sp, and *Syzygium cumini*. Epiphytic orchids such as *Bulbophyllum* sp and *Dendrobium* sp are also common. Common undergrowths are *Chromolaena odorata*, *Cipadessa baccifera*, *Crotalaria shevaroyensis*, *Dodonaea viscosa*, *Jasminum cuspidatum*, *Lantana camara*, *Strobilanthes kunthiana*, *Elaeagnus indica*, *Piper hymenophyllum*, *Rubus ellipticus*, *Ageratum conyzoides*, *Pepromia tetraphylla*, *Toddalia asiatica* var *floribunda*, *Smilax zeylanica* and *Zizyphus xylopyrus*. In the mine area *Dodonaea viscosa*, *Ageratum conyzoides*, *Strobilanthes kunthiana*, *Jasminum cuspidatum*, *Polypodium* sp, *Anisochilus carnosus* and *Ageratina adenophora* are common plants.

3.6.2 Mine 2

Common tree species on the slopes of the mine 2 included *Vernonia* sp, *Macaranga peltata*, *Memecylon edule* and *Mallotus tetracoccus*. Common undergrowths are *Passiflora subpeltata*, *Rubus ellipticus*, *Solanum giganteum* and *Polygonum plebium*. In the mine area *Dodonaea viscosa*, *Ageratum conyzoides*, *Polypodium* sp, *Anisochilus carnosus* and *Ageratina adenophora* are common plants.

3.6.3 Mine 3 (Near Shevaroyan temple)

Grevillea robusta (Silver Oak) is extensively planted in the area. Common undergrowths are *Lantana camara*, *Ageratina adenophora*, *Polypodium* sp, *Impatiens chinensis*, *Ageratum conyzoides* and *Apocosis mangalorensis*. Evergreen trees such as *Syzygium cumini*, *Litsea oleoides*, *Neolitsea scrobiculata* and *Cyathea nilgiriensis*, a tree fern are common near the temple area. *Drosera burmanii*, an insectivorous plant is common near the temple.

3.6.4 Mine 4

Common trees in the mine 4 are *Macaranga peltata* and *Mallotus tetracoccus*. Common shrubs and stragglers included *Toddalia asiatica* var *floribunda*, *Lantana camara*, *Solanum erianthum*, *Ageratina adenophora*, *Strobilanthes kunthiana*, *Dodonaea viscosa*, *Passiflora subpeltata*, *Elaeagnus indica*, *Rubus ellipticus* and *Smilax zeylanica*. *Ageratum conyzoides*, *Bidens pilosa*, *Cyanotis cristata*, *Leucas aspera*, *Triumfetta pentandra* and *Knoxia sumatrensis* are common herbs in the area. *Balanophora fungosa* ssp *indica* is a common root parasite in the area.

3.6.5 Mine 5

Mined area is re-vegetated with medicinal plants such as *Adathoda vasica* (Tamil name: Adathoda), *Lippia nodiflora* (Tamil name: Poduthalai), *Lavandula* sp (Lavender), *Pelargonium* sp (Geranium), *Rosmarinus officinalis* (Rosemary), *Plantago ovata*, *Andrographis* sp and *Hibiscus rosasinensis* (Tamil name: Semparuthi). Common trees in the area are *Callitris rhomboidea* and *Psidium guajava*. *Strobilanthes kunthiana* (Tamil name: Kurinji) and *Jasminum* sp are common shrubs in the area.

3.7 Cultivated plants

Common cultivated plant included, Coffee (*Coffea arabica*), pear (*Pyrus communis*), pepper (*Piper nigrum*), jackfruit (*Artocarpus heterophyllus*), pineapple (*Ananas comosus*), guava (*Psidium guajava*) and banana (*Musa paradisiaca*).

3.8 Natural-dye yielding plants

Krishnamurthy et al (2002) reported occurrence of 22 dye yielding angiosperm plant species belonging to 15 different families in the Shevaroyan hills. In addition they also reported three dye-yielding lichens from the area.

3.9 Endemic plants

The term endemic refers to the population or species with narrow ecological or other restrictions, which limit it to a specific habitat or very restricted geographical range. Of the estimated 17,000 species of angiosperms in India, about 1932 taxa are endemic to Peninsular India (Ahmedullah and Nayar 1987). A recent study reports 454 endemic taxa in the Eastern Ghats, which pertain to 243 genera and 78 families of flowering plants. Of the 454 endemic taxa, 95 are restricted to Eastern Ghats and 359 taxa are distributed in others parts of Peninsular India also (Sudhakar et al 2002). Of the 1101 species of flowering plants reported from the Shevaroyan hills, 3 species are already extinct (Table 3), 13 are endangered and 69 are endemic plants (Senthilkumar & Krishnamoorthi 1993). Distributions of endemic plants reported in the Shevaroyan hills are listed in Appendix 2.

Table 3 List of endangered and extinct plants in the Shevaroyan hills

| | | |
|--|---|-----------------|
| 1 | <i>Caralluma adscendens</i> (Roxb.) Haw. | Asclepiadaceae |
| 2 | <i>Crotalaria longipes</i> Night & Arn. | Papilionaceae |
| 3 | <i>Crotalaria shevaroyaensis</i> Gamble | Papilionaceae |
| 4 | <i>Crotalaria superfoliata</i> Wight ex Wight & Arn. | Papilionaceae |
| 5 | <i>Delonix elata</i> (L.) Gamble | Caesalpiniaceae |
| 6 | <i>Grewia abutilifolia</i> Vent. Ex A.L. Juss. | Tiliaceae |
| 7 | <i>Ilex denticulata</i> Wallich ex Wight* | Aquifoliaceae |
| 8 | <i>Impatiens acaulis</i> Arn. | Balsaminaceae |
| 9 | <i>Lilium wallichianum</i> Schultes & Schultes* | Liliaceae |
| 10 | <i>Neanotis indica</i> (Dc) Lewis | Rubiaceae |
| 11 | <i>Ochna obtusa</i> DC. Var. <i>gamblei</i> (Brandis) Kanis | Ochnaceae |
| 12 | <i>Pittosporum dacycaulon</i> Miq. | Pittosporaceae |
| 13 | <i>Sterospermum personatum</i> (Hassk.) Chatterjee | Bignoniaceae |
| 14 | <i>Vernonia arborea</i> Buch-Ham. | Asteraceae |
| 15 | <i>Vernonia shevaroyensis</i> Gamble* | Asteraceae |
| 16 | <i>Ximenia Americana</i> | Olcaceae |
| * Extinct plants (Senthilkumar & Krishnamurthy 1993) | | |

3.10 Fauna

A total of 75 vertebrate fauna was observed in the impact area (10 km radius) of the Bauxite mines during January - February 2003 (Table 4). Number of species decreased as one approaches towards the mine site. This could be due to the lack of forest cover near the mines and prevailing agricultural practices. Slash and burn techniques are used to clear forest to prepare the land for agricultural purpose. Unlike in North-eastern India, the farmers settle and continue the agriculture evermore (i.e. never left free for regeneration).

Table 4 Vertebrate fauna sighted in and around the mines during the study

| No. | Taxa | Project area | Impact Area |
|---------------|------------|--------------|-------------|
| 1 | Amphibians | 3 | 4 |
| 2 | Reptiles | 7 | 9 |
| 3 | Birds | 38 | 58 |
| 4 | Mammals | 3 | 4 |
| Total species | | 51 | 75 |

3.10.1 Butterflies

During the present survey 27 species of butterflies belonging to Five families were recorded from the study area with Nymphalidae being the most specious group with 14 species. Hesperidae and Lycaenidae were the least diverse families with only two representative species each. All the species recorded were generalists with wide distributions. Considering the short duration of the field surveys, the butterfly population of the area is promising. The deteriorating habitat conditions and resulting biodiversity depletion might be the major reason for the absence of specialist species.

3.10.2 Amphibians and Reptiles

Four species of amphibians and 10 species of reptiles were sighted during the present rapid investigations. None of the amphibians found are endemic to these hills. However, reptiles such as the dwarf gecko, worm gecko, forest calottes and rock lizard are endemic to the Western and Eastern Ghats (Table 5 and 6). The dwarf

gecko and worm geckoes were found in the mine area (Hill No. 1). These species prefer boulders and rock for retreat (Plate II). The occurrence of these reptiles suggests that this area is intact habitat. These species are present in the Evergreen and semi ever green forests of the Western Ghats indicating their congruous distribution in Eastern Ghats as well. However they are currently restricted to the intact forests of the hillocks suggesting their conservation value.

Table 5 Amphibians sighted in and around the mines

| No | Common name | Species name | Mines | Impact Area |
|----------------------------|----------------------------|---------------------------------|---------|-------------|
| 1 | Common Asian Toad | <i>Bufo melanostictus</i> | Present | Present |
| 2 | Indian Skipping Frog | <i>Euphlyctis cyanophlyctis</i> | Present | Present |
| 3 | Cricket Frog | <i>Limnonectes limnocharis</i> | Present | Present |
| 4 | Ornate Narrow-mouthed Frog | <i>Microhyla ornata</i> | | Present |
| Number of species recorded | | | 3 | 4 |

Table 6 Reptiles observed in and around the mines

| No. | English name | Species | Mines | Impact area |
|-------------------|--------------------------|--|---------|-------------|
| 1 | Bonnet Macaque | <i>Maccaca radiata</i> | Present | Present |
| 2 | Asian House Gecko | <i>Hemidactylus frenatus</i> | Present | Present |
| 3 | Western Ghats Worm Gecko | <i>Hemiphyllodactylus aurantiacus*</i> | Present | Present |
| 4 | Indian Garden Lizard | <i>Calotes versicolor</i> | | Present |
| 5 | Forest Calotes | <i>Calotes rouxi*</i> | | Present |
| 6 | Rock Lizard | <i>Psammophilus blanfordanus</i> | Present | Present |
| 7 | Spotted Supple Skink | <i>Lygosoma punctatus</i> | | Present |
| 8 | Brahminy Worm Snake | <i>Ramphotyphlops braminus</i> | Present | Present |
| 9 | Travancore Wolf Snake | <i>Lycodon travancoricus</i> | Present | |
| 10 | Western Rat Snake | <i>Ptyas mucosus</i> | Present | Present |
| Number of species | | | 7 | 9 |

3.10.3 Birds and Mammals

A total of 57 species of birds and four species of mammals were observed within the impact area (10 km radius) during the present study (Appendix 4, Table 7). None of them are endemic or restricted to the impact area of the bauxite mines. The populations of mammals in general were scarce. Larger mammals such as Gaur (bison) were observed nearby Mine 1. However, the population of gaur appears to be low as very few animal signs (dung, hoof marks) were seen during the fieldwork. This observed low number of species especially that of mammals could be due to

rampant habitat destruction and commercial agro farming (Estate) and exploitation (hunting). The Gaur is the only large mammal seen in the Shevaroyas as on today. Species such as Spotted deer, Sambar and Sloth bear known to co-habit with Gaur in nature are not found in this area. The Gaur would have escaped extermination largely due to local sentiments and adaptability to utilise the marginal habitats.

Table 7 Mammals observed in and around the Bauxite mines

| No. | English name | Species | Mines surveyed | | Impact Area |
|---------------|----------------|----------------------------|----------------|---------|-------------|
| | | | I, II, IV, V | III | |
| 1 | Bonnet Macaque | <i>Macaca radiata</i> | | | Present |
| 2 | Palm Squirrel | <i>Funambulus palmaram</i> | Present | Present | Present |
| 3 | Indian Hare | <i>Lepus nigricolis</i> | Present | Present | Present |
| 4 | Indian Bison | <i>Bos gaurus</i> | Present | | Present |
| Total species | | | 3 | 2 | 4 |

3.10.4 Status of Gaurs in Shevroy hills

The present study was restricted to the upper plateau of the Shevaroy hills. The study (January- March 2003) revealed that Gaurs are ranging in MALCO mines (near the mine office (Hill number 1), however their number is very low (only 2 dung piles were observed). Interviews with local people reveal that currently Gaur is rarely seen in MALCO mine area, and are reportedly common near estates and villages. Duraimurugan (2000) studied the movement patterns of gaur in 383 sq km of Shevaroy hills, and estimated about 350 gaurs. This study also reported the occurrence of two herds in MALCO mines area during June-August 2000 comprising 19 individuals indicating the rarity of the species. Many herds totalling over 300 gaurs were observed near estates.

4 CONSERVATION PLAN

4.1 Flora

- 1) Mainly coffee plantations on almost all sides surround the Shevaroy mines. Portions of some reserved forest are seen within 10 km radial distance. Some of the Reserved Forest are Nartanchedu RF on the north, Vaniyar RF on the

northeast side, Manchavadi Ghats RF on the east, Kurumbapatti RF on the southwest, Ponnikaradu RF on the west and Atur Ghat forest on the northwest. Despite intensive human activity some of the estates have patches of natural forest. In the reserved forests also good natural vegetation is seen. The activity of the bauxite mines will not have notable impacts on the natural vegetation in these areas.

- 2) However, for conserving the natural biodiversity of an area where they have been in operation for decades and plan to continue their operations for more decades, MALCO may adopt suitable steps. Traditional conservation practices such as sacred groves (Samikkadu or Koil Kadu) can be encouraged and promoted in the Shevaroyan hills. This would in turn protect the whole biotic communities in the area. In Kolli hills, already the locals are following this practice. One of such notable sites in the Shevaroy mines is near the water pump about 100 m downhill of the mines office. The area provides habitat for a rich variety of plants such as *Vernonia* sp. and *Gnetum ula* (Plate II) and giant ferns. A small perennial first order stream also flows through the location. All the vegetation along the slopes of the hillocks also should be considered on par with sacred groves and proper monitoring and protection measures may be implemented. No encroachments for agriculture or rolling rubbles from waste dumps should be tolerated.
- 3) Many rare or endangered plants that are seen in and around the mines area need protection. Measures are essential for their propagation also. A nursery may be established in a suitable area adjacent to the mines for the purpose. MALCO already have such a small setup adjacent to Shevaroy mines office. But it remains only as a token attempt. More serious attempt has to be made to develop a larger nursery run under proper technical guidance. The area adjacent to the nursery towards hill number I also have good natural vegetation. Efforts may be made towards total protection of the area, which

extends and skirts around the hillock.

- 4) Many species seen in the adjacent areas to the mines, especially on the slopes of the hillock may be grown, propagated and maintained in the National Orchidarium and Botanical Garden of Botanical Survey of India, Yercaud. MALCO may seek the help of local Botanical Survey of India to attempt such an exercise.
- 5) It is felt that MALCO currently have undertaken plantation of trees. However, they have more or less confined to planting only few select species. The species composition for plantation and afforestation programmes needs further widening. More natural / local species need to be included.
- 6) Endemic and endangered plants can be planted in the wastelands. Planting exotic species may be discouraged. Plants listed in the appendix 2 may be used for the purpose.
- 7) The growth rate of the seedlings is apparently low in the reclaimed area, probably for low nutrient level, or less favourable soil texture and quality. Attempts may be made to modify the soil in the planted areas using suitable means such as replenishing with rich organic topsoil and also microbial treatments. Rhizobium, Azotobacter and Ectomycorrhizal fungi (de Omenaca, 1994) can be applied to increase the performance of saplings to be planted in reclaimed areas.
- 8) MALCO need to undertake utmost care in protecting the vegetation along the slopes and immediate vicinity. The check dams made to prevent spilling and rolling down may be strengthened. Proper terracing and alignment of the waste dumps may also be made. Steps to vegetate the waste dumps may be also enhanced to avoid runoff carrying large silt and clay load.

4.2 Conservation plan for Gaur, *Bos gaurus*

The Indian Bison protected under the Wildlife Protection Act of 1972 (Anon 1991), was once distributed extensively in the vast stretches of intact forests of the peninsula. Gaurs, although confined to Evergreen, Semi-Evergreen and Moist deciduous forests (Schaller 1967) currently their populations in the subcontinent are distributed mainly in the moist deciduous and semi deciduous forests. As the forests of the plains got rapidly converted to Agricultural and Urban areas, along with many others, these animals also became restricted to the surviving fragments of forests. Hence their preference to hilly forests of lower altitudes, as its present day distribution suggests, might be a forced one rather than by choice. Owing to diminishing availability of pristine pastures, they are now forced to compete for feeding grounds with domestic cattle in many areas. They have become highly vulnerable to anthropogenic pressures and cattle-borne diseases. As a result the population of these magnificent large herbivores have suffered sharp decline in the recent past. Habitat changes and mortality due to Rinderpest and Foot and Mouth Disease (FMD), all have synergistically contributed to the decline.

Normally the bauxite deposit areas would not encourage large trees to grow and hence the grassland community dominates such areas. Hence it may be assumed that the Gaurs were common in the mine areas in the past. Gaurs are far ranging grazers moving long distances in response to the seasonal changes in the resource availability. They require large area for foraging. Hence, care should be taken to avoid the disturbances to areas where they frequent. Mammalian fauna in Yercaud especially around MALCO mines is poor as is evidenced from the record of only 4 species (Table 7). It is observed that the number of Gaur (*Bos gaurus*) ranging near MALCO mines is low i.e. about 19 only (Alaivallal 1999, Duraimurugan 2000). The estates near Yercaud, Kottachchedu, Maramangalam and Kombutukki had higher number of Gaurs (Duraimurugan 2000). It is possible that the animals have found

more resources in the estates. Incidentally, Gaurs here are also reported to be engaged in crop raiding (Duraimurugan 2000)

Measures need to taken for the conservation of endangered Gaur in the Yercaud hills with particular reference to MALCO mines.

1. MALCO mines are located on hilltop, and any activity there would affect the valleys and slopes. To protect the slopes and valleys, soil protection bunds/ embankments may be placed. MACLO has already constructed many such bunds that may be strengthened,
2. Natural vegetation along the slopes and valleys found in the immediate vicinity should be protected by the project authorities involving stakeholders such as Forest Department, local villagers and estate owners as these localities offer (habitat) cover for wild animals especially for Gaurs. Forest found along the slopes and valleys in the vicinity of the exhausted mine (mine 1), where signs of Gaurs were observed should be protected and further encroachment from lower altitude or from settlements should be stopped. Eco-development Committees (EDC) may be formulated to facilitate prevention of such encroachments. The committees may be formed including the local people, forest and MACLO officials. Local NGO, if interested in conservation of local fauna and flora and socio-economic development, can be also integrated in the committees.
3. Vehicle movements may be kept at minimum, and activities during dawn and dusk may be stopped, as Gaurs are most active during these periods. Water holes during the water scarcity seasons may also be provided. However, the waterholes should be located away from zones of intensive human activity. They may be developed in forest areas that can be physically protected by MALCO.

4. Exhausted mines may be restored with grazing plants preferred by Gaur. Ilangoan (1999) and Sathya (2001) found that *Axonopus compressus*, *Impereta cylindrica* and *Cyperus brevifolius* are important fodder species preferred by Gaur. Attention may be given to vegetate the area with these grass and sedge species. Waterholes may be provided in the reclaimed mine sites making use of available depressions. The project authorities may protect these areas, and appropriate authorities involving the Forests and district administration may decide the duration of the period for protection.

Mine 1 and 2 and its environs showed evidences of Gaur and many smaller animals such as peninsular endemic lizards are also found. Apart from this, presence of rare plants such as *Vernonia* sp. also adds on to the importance of this area. Hence it is suggested that the Mine 1, 2 and their environs including the slopes should be protected. It is understood that these mine are almost exhausted of their deposits. The area may be protected by re-vegetating the area with native species and declaring it as a MALCO Biodiversity Zone. Such a Zone may be of great potential to serve as a repository of biological and Genetic diversity of Yercaud hills. During the planning and implementation stages of the Biodiversity Zone, experts and departments such as forest, revenue and agriculture may be involved.

5 SUMMARY AND CONCLUSIONS

M/s Madras Aluminium Company limited, based in Mettur were excavating bauxite for aluminium production from Yercaud hills for the last few decades. The mines are located in area under their lease. They propose to increase production of aluminium and envisage this by expanding mining activity in their captive mines. For the clearance from Ministry of Environment and forests MALCO has conducted and EIA. The Ministry's expert committee wanted MALCO to look into the wildlife and floral conservation in view of expansion project. SACON was requested to undertake the study.

SACON's rapid field study supplements the baseline data available in the EIA report submitted by MALCO. Our study hints that Gaur is the only large wild herbivore species present in the mine environs. Their number in the immediate vicinity of the mines is very low. However, it is felt that immediate steps are necessary for conserving the species. The hills, known to be rich in floral biodiversity a number of measures to conserve the natural vegetation and its animal components are proposed. Proper implementation of the suggestions may help in conserving the environment in Yercaud hill ranges.

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Appendix 1 Plants recorded in the project area and its environs

| No | Species | Habit |
|----|---------------------------------------|-----------|
| 1 | <i>Adathoda vasica</i> | Shrub |
| 2 | <i>Ageratina adenophora</i> | Shrub |
| 3 | <i>Ageratum conyzoides</i> | Herb |
| 4 | <i>Andrographis sp</i> | Herb |
| 5 | <i>Anisochilus carnosus</i> | Herb |
| 6 | <i>Apocosis mangalorensis</i> | Herb |
| 7 | <i>Argemone mexicana</i> | Herb |
| 8 | <i>Balanophora fungosa ssp Indica</i> | Parasite |
| 9 | <i>Bidens pilosa</i> | Herb |
| 10 | <i>Buchanania lanzan</i> | Tree |
| 11 | <i>Bulbophyllum kaitense</i> | Epiphyte |
| 12 | <i>Callitris rhomboidea</i> | Tree |
| 13 | <i>Chromolaena odorata</i> | Shrub |
| 14 | <i>Cipadessa baccifera</i> | Shrub |
| 15 | <i>Citrus limon</i> | Tree |
| 16 | <i>Citrus reticulata</i> | Tree |
| 17 | <i>Crotalaria shevaroyensis</i> | Shrub |
| 18 | <i>Crotalaria verrucosa</i> | Herb |
| 19 | <i>Cyanotis cristata</i> | Herb |
| 20 | <i>Delonix regia</i> | Tree |
| 21 | <i>Dendrobium sp</i> | Epiphyte |
| 22 | <i>Dodonaea viscosa</i> | Shrub |
| 23 | <i>Drosera burmanii</i> | Herb |
| 24 | <i>Elaegnus indica</i> | Straggler |
| 25 | <i>Eucalyptus sp</i> | Tree |
| 26 | <i>Gnetum ula</i> | Straggler |
| 27 | <i>Grevillea robusta</i> | Tree |
| 28 | <i>Hibiscus rosasinensis</i> | Shrub |
| 29 | <i>Impatiens chinensis</i> | Herb |
| 30 | <i>Ipomoea hederifolia</i> | Straggler |
| 31 | <i>Jasminum cuspidatum</i> | Shrub |
| 32 | <i>Kalanchoe floribunda</i> | Herb |
| 33 | <i>Knoxia sumatrensis</i> | Herb |
| 34 | <i>Lantana camara</i> | Shrub |
| 35 | <i>Lavandula sp</i> | Herb |
| 36 | <i>Leucas aspera</i> | Herb |
| 37 | <i>Linocera ramiflora</i> | Tree |

| | | |
|----|---|-----------|
| 38 | <i>Lippia nodiflora</i> | Herb |
| 39 | <i>Litsea oleoides</i> | Tree |
| 40 | <i>Macaranga peltata</i> | Tree |
| 41 | <i>Maesa indica</i> | Tree |
| 42 | <i>Mallotus tetracoccus</i> | Tree |
| 43 | <i>Memecylon edule</i> | Tree |
| 44 | <i>Mimosa pudica</i> | Herb |
| 45 | <i>Neolitsea scrobiculata</i> | Tree |
| 46 | <i>Oxalis latifolia</i> | Herb |
| 47 | <i>Passiflora subpeltata</i> | Climber |
| 48 | <i>Pelargonium sp</i> | Herb |
| 49 | <i>Pepromia tetraphylla</i> | Herb |
| 50 | <i>Persea macrantha</i> | Tree |
| 51 | <i>Phoenix loureiri</i> | Tree |
| 52 | <i>Piper hymenophyllum</i> | Straggler |
| 53 | <i>Plantago ovata</i> | Herb |
| 54 | <i>Pogostemon mollis</i> | Shrub |
| 55 | <i>Polygonum plebium</i> | Straggler |
| 56 | <i>Polypodium sp</i> | Shrub |
| 57 | <i>Psidium guajava</i> | Tree |
| 58 | <i>Pyrus communis</i> | Tree |
| 59 | <i>Quiscalis indica</i> | Straggler |
| 60 | <i>Rosmarinus officinalis</i> | Herb |
| 61 | <i>Rubus ellipticus</i> | Straggler |
| 62 | <i>Rubus niveus</i> | Straggler |
| 63 | <i>Shorea roxburghii</i> | Tree |
| 64 | <i>Smilax zeylanica</i> | Straggler |
| 65 | <i>Solanum erianthum</i> | Shrub |
| 66 | <i>Solanum giganteum</i> | Shrub |
| 67 | <i>Spathodea campanulata</i> | Tree |
| 68 | <i>Stachtarpheta jamaicensis</i> | Herb |
| 69 | <i>Strobilanthes kunthiana</i> | Shrub |
| 70 | <i>Symplocos cochinchinensis</i> | Tree |
| 71 | <i>Syzygium cumini</i> | Tree |
| 72 | <i>Toddalia asiatica var floribunda</i> | Liana |
| 73 | <i>Triumfetta pentandra</i> | Herb |
| 74 | <i>Vernonia arborea</i> | Tree |
| 75 | <i>Vernonia sp</i> | Tree |
| 76 | <i>Zizyphus xylopyrus</i> | Straggler |

Appendix 2 Distribution of endemic plants reported in the Shevaroy's hills

| No | Species | Family | Distribution |
|----|---|------------------|---|
| 1 | <i>Goniothalamus cardiopetalus</i> Hook.f. & Thomson | Annonaceae | Small tree; Southern W.Ghats, Kanara, Coorg, Wynad, Anamalais, 800-1200m. Shevaroy's of E.Ghats |
| 2 | <i>Polyalthia cerasoides</i> (Roxb.) Beddome | Annonaceae | Evergreen tree; Peninsular India, Extending up to 1000m, less common in W.Ghats |
| 3 | <i>Mahonia leschenaultii</i> (Wight & Arn.) Takeda | Berberidaceae | Shrub, Southern W.Ghats, Nilgiris, Anamalais; Coimbatore & Madurai, Salem of E.Ghats above 1500m. |
| 4 | <i>Pittosporum dasycaulon</i> Miq. | Pittosporaceae | Shrub/small tree, W.Ghats, Kanara to Travancore and Nilgiris, E.Ghats; Salem, 900m, Rare |
| 5 | <i>Polygala wightiana</i> (Wall.) Wight & Arn | Polygalaceae | Erect/ascending herb; Coimbatore, Madurai, Ramanathapuram, Tirunelveli, Dharmapuri, Salem and Trichirapalli |
| 6 | <i>Shorea roxburghii</i> Don | Dipterocarpaceae | Large tree; almost throughout South peninsular India |
| 7 | <i>Impatiens fruticosa</i> Leschen. Ex. DC. | Balsaminaceae | Large erect shrub; W.Ghats, Mysore, Nilgiris, Palni hills, Travancore, Tirunelveli and Salem of E.Ghats, 600-1800m |
| 8 | <i>Ochna obtusa</i> DC. Var. <i>gamblei</i> (Brandis) Kanis | Ochnaceae | A small tree; Central and northeast peninsular India, Chengalpet, North Arcot, Dharmapuri, Salem. Rare |
| 9 | <i>Glyptopetalum lawsonii</i> Gamble | Celastraceae | Large shrub/small tree; southern W.Ghats, Nilgiris, Coimbatore, at low altitudes |
| 10 | <i>Maytenus heyneana</i> (Roth.) raju & Babu | Celastraceae | Shrub; southern W.Ghats, Travancore, Nilgiris, Palni hills |
| 11 | <i>Ampleocissus araneosa</i> (Dalz.& Gibson) Planchon | Vitaceae | Slender climbing shrub; W.Ghats, Konkan(?), Mysore, Nilgiris, Anamalais and Palni hills, Tirunelveli, Madurai, Trichirapalli; Southern E.Ghats, Shevaroy's, 1350m |
| 12 | <i>Crotalaria longipes</i> Wight & Arn. | Papilionaceae | Stiff undershrub; southern E. Ghats, Kollimalai hills of Salem; Tiruchirapalli and Nilgiri, Rare |
| 13 | <i>Crotalaria priestleyoides</i> Benth. | Papilionaceae | Low trailing undershrub; W.Ghats, Konkan, Canara to Nilgiris and Anamalais (Coimbatore), up to 1500m. Rare and Threatened |

| | | | |
|----|---|-----------------|---|
| 14 | <i>Crotalaria shevaroyensis</i> Gamble | Papilionaceae | Tall shrub; E. Ghats, Shervaroys of Salem; Dharmapuri, Madurai District. Rare |
| 15 | <i>Crotalaria superfoliata</i> Wight ex Wt & Arn. | Papilionaceae | Tall herb; southern W. Ghats, Travancore, Palani hills (Madurai); Ramanathapuram; Salem of E. Ghats, Rare |
| 16 | <i>Indigofera mysorensis</i> Rottler ex Dc | Papilionaceae | Pubescent shrub; E.Ghats, Chengalpet hills, North Arcot, Salem; Deccan hills of Karnataka, W.Ghats, Nilgiris, up to 1200m |
| 17 | <i>Cassia montana</i> Heyne ex Roth | Caesalpiniaceae | Handsome shrub; peninsular India, Deccan, Karnataka, Tamil Nadu, Coimbatore, Madurai, Dharmapuri and Nilgiris of W. Ghats; N. Arcot, South Arcot and Salem of E. Ghats, up to 900m. |
| 18 | <i>Pimpinella candolleana</i> Wt. & Arn | Apiaceae | Tall pubescent herb; W.Ghats-Not common in North, Mysore (?), Nilgiri and Palni hills, Coimbatore, Tirunelveli; Dharmapuri of E.Ghats, Salem, Above 1800m |
| 19 | <i>Lonicera leschenaultii</i> Wallich | Caprifoliaceae | Climbing shrub; W.Ghats, above 1500m. Hills of Deccan and Northern Tamilnadu |
| 20 | <i>Anaphalis aristata</i> DC | Asteraceae | Viscid herb with woody rootstock; Southern W.Ghats, Nilgiris & Palni hills, 1800 m. |
| 21 | <i>Anaphalis lawii</i> (Hook. F.) Gamble | Asteraceae | Tall herb; Northern E.Ghats, Circars, 1500m, Deccan-Nandidurg; W.Ghats, South of Coorg, 1600m |
| 22 | <i>Gynura nitida</i> DC | Asteraceae | Tall succulent herb, hills of Western Deccan and W.Ghats, 900-1800m |
| 23 | <i>Vernonia shevaroyensis</i> Gamble | Asteraceae | Small tree, Andhra Pradesh; Southern Circars, Tamil Nadu, Salem dist. |
| 24 | <i>Myrsine capitellata</i> Wall. Ex. Roxb. | Myrsinaceae | Tree; W.Ghats, Anamalais and Travancore hills, 1800m |
| 25 | <i>Decalepis hamiltonii</i> Wt & Arn | Periplocaeeae | Climbing shrub; Peninsular India |
| 26 | <i>Argyreia cuneata</i> (Willd.) Ker Gawler | Convolvulaceae | Silky shrub, W.Ghats, hills near Pune, Deccan hills, 100-1500m |
| 27 | <i>Andrographis serpyllifolia</i> (Vahl.) Wight | Acanthaceae | Trailing herb; Deccan & dry districts of Tamil Nadu, 1200m |
| 28 | <i>Aystasia dalzelliana</i> Santapau | Acanthaceae | Erect herb; W.Ghats, from S.canara, southwards at low altitudes. |
| 29 | <i>Dicliptera cuneata</i> Nees | Acanthaceae | Branching herb; Deccan, Horseleykonda in Chittoor, 1350m; hills of N. Coimbatore, Carnatic, Salem, Trichirapalli and Madurai to S. Travancore of W.Ghats, 1000m |
| 30 | <i>Stenosiphonium parviflorum</i> T. Anderson | Acanthaceae | Erect shrub; Deccan up to Travancore |
| 31 | <i>Leucas prostrata</i> (Hook.f.) Gamble | Lamiaceae | Low herb; Southern W.Ghats, Nilgiris, Anamalais and Shevaroys of E.Ghats, 1550m-2400m. |

| | | | |
|----|---|---------------|--|
| 32 | <i>Leucas pubescens</i> Benth | Lamiaceae | Erect herb; Southern W.Ghats, Nilgiris, 1550m, Deccan (?) Rare |
| 33 | <i>Plectranthus wightii</i> Benth. | Lamiaceae | A tall herb; Southern W.Ghats, Nilgiris, Anamalais, Palni hills up to 2450m, E.Ghats, Salem-Shevaroy. |
| 34 | <i>Pogostemon mollis</i> Benth. | Lamiaceae | Low woody undershrub; southern W.Ghats, Nilgiris, Palani hills and Tirunelveli hills, 1800m, E. Ghats, Salem-(Shervaroys hills) |
| 35 | <i>Pepromia dindigulensis</i> Miq. | Piperaceae | Erect succulent herb; W.Ghats, Konkan, southwards; E.Ghats, N.Circars to Shevaroys; Kollimalai hills of Tiruchirapalli |
| 36 | <i>Cinnamomum macrocarpum</i> Hook.f. | Lauraceae | Tree; W.Ghats, Kanara-Nilgiris, Coimbatore, 1800m |
| 37 | <i>Litsea oleoides</i> (Meissner) Hook.f. | Lauraceae | Large tree southern W.Ghats, Anamalais, Travancore and Nilgiri hills, above 1200m. |
| 38 | <i>Neolitsea scrobiculata</i> (Meissner) Gamble | Lauraceae | Tree; W.Ghats, Tirunelveli hills & Nilgiris, 1800m |
| 39 | <i>Elaeagnus indica</i> Servetz | Elaeagnaceae | Slender straggling herb; Deccan, Coimbatore hills; E. Ghats, Arcot and Salem Districts extending westwards to Madurai and W. Ghats, 1200m. |
| 40 | <i>Helixanthera intermedia</i> (Wight) Danser | Loranthaceae | Parasitic shrub; Southern W.Ghats, Nilgiri, Palni & Travancore hills, 900-1800m. |
| 41 | <i>Bridelia crenulata</i> Roxb. | Euphorbiaceae | Large tree; W. Ghats, all hill districts of Maharashtra and Karnataka, Coimbatore; E. Ghats, Shervaroys of Salem. |
| 42 | <i>Euphorbia corrigioloides</i> Boiss | Euphorbiaceae | Herb with stout rootstock; S. Deccan, Northern districts of Tamilnadu, usually near the coast; Inland Bellery. |
| 43 | <i>Glochidion neilgherrense</i> Wight | Euphorbiaceae | Medium sized tree; southern W.Ghats, Nilgiris, 1700-2300m |
| 44 | <i>Ficus beddomei</i> King | Moraceae | Large tree, southern W.Ghats, Chikmagalur, Shimoga, Travancore, Nilgiris, Anamalai and Tirunelveli, 900 to 1500m. |
| 45 | <i>Ficus dalhousiae</i> Miq. | Moraceae | Small tree; W.Ghats, Nilgiris and Cuddapah, southwards in E.Ghats |
| 46 | <i>Bulbophyllum kaitense</i> Reichb.f. | Orchidaceae | Epiphytic herb ; southern W.Ghats of Kerala & Tamilnadu (Below Kartairy river), 1200-1800m. |
| 47 | <i>Dendrobium anamalayanum</i> Chandrb. & Nair | Orchidaceae | Epiphytic herb; Southern W.Ghats, Anamalais, 1400-1900m. |

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|----|--|-------------|---|
| 48 | <i>Dendrobium aqueum</i> Lindl. | Orchidaceae | Epiphytic herb with white flowers: southern W.Ghats, Konkan, Hassan, Nilgiris (?), Anamalais (?), 900-1100m. |
| 49 | <i>Dendrobium microbulbon</i> A.Rich | Orchidaceae | Small epiphytic herb with white flowers; Gujarat, W.Ghats, Konkan, N.Canara, Nilgiris, Anamalais. Rare & Threatened. |
| 50 | <i>Dendrobium nanum</i> Hook.f. | Orchidaceae | Small caespitose herb with white flowers; W.Ghats, Karnataka hills (Coorg, Hassan, Mysore), Anamalais extending eastwards through Madurai to Shevaroy of E.Ghats, 1200m |
| 51 | <i>Eria nana</i> A. Rich. | Orchidaceae | Spreading herb with greenish yellow flowers; W.Ghats, Mysore, Nilgiris, 1500-2200m. |
| 52 | <i>Eria polystachya</i> A. Rich | Orchidaceae | Pseudobulbous, caespitose herbs with pale yellowish creamy white flowers; southern W.Ghats, Nilgiris, 1800-2000m. |
| 53 | <i>Flickingeria nodosa</i> (Dalz.) Seidenf. | Orchidaceae | Epiphytic herb; Throughout the W.Ghats |
| 54 | <i>Habenaria decipiens</i> Wight | Orchidaceae | Tuberous herbs; Southern W.Ghats, Nilgiris, Tirunelveli, up to Shevaroy 1200-2100m. |
| 55 | <i>Habenaria grandifloriformis</i> Blatter & Mc Cann Wight | Orchidaceae | Herb with white flowers; W.Ghats, Konkan, hills of Karnataka to Shevaroy of E.Ghats |
| 56 | <i>Habenaria heyneana</i> Lindley | Orchidaceae | Small tuberous herbs with white flowers; W.Ghats, Konkan, throughout Karnataka hills to Nilgiris; eastward to Shevaroy, 1600-2400m. |
| 57 | <i>Habenaria longicornu</i> Lindley | Orchidaceae | Tuberous herbs with white flowers; W.Ghats, from Karnataka (Mysore) to Travancore, Nilgiris; E.Ghats, Horsleykonda-Kollimalai hills, 1500-2000m. |
| 58 | <i>Habenaria longicorniculata</i> J Graham | Orchidaceae | Herb, white flowers with green spur; W.Ghats, Konkan, Karnataka hills to Nilgiris; Eastwards to Shevaroy, 1600-2400m. |
| 59 | <i>Habenaria multicaudata</i> L. J. Sedwick | Orchidaceae | Tall terrestrial herb with pale brownish green flowers; W.Ghats, N.kanara, Hassan, Nilgiris & Anamalais, 600m. |
| 60 | <i>Habenaria rariflora</i> A.Rich. | Orchidaceae | Often lithophytic with white flowers, W.Ghats, Konkan, Kolar, Mysore, Shimoga to Travancore, Nilgiris, 900-2000m. |
| 61 | <i>Liparis bilopa</i> Wight | Orchidaceae | Small pseudobulbous herb with purple flowers; W.Ghats, Chikmagalur, Nilgiris, 2200m. |

| | | | |
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| 62 | <i>Oberonia brunoniana</i> Wight | Orchidaceae | Large erect/pendulous herb, W.Ghtas most districts of Karnataka, Nilgiris, 800-2200m. |
| 63 | <i>Oberonia santapau</i> Kapadia | Orchidaceae | Herb with straw-coloured flowers; W.Ghats, Chikmagalur, Hassan, Mysore, North Canara to Nilgiris, 400-1600m. |
| 64 | <i>Curcuma neilgherrensis</i> Wight | Zingiberaceae | Stemless herb with tuberous rootstock; W.Ghats throughout high altitudes |
| 65 | <i>Chlorophytum malabaricum</i> Baker | Liliaceae | Herb; southern W.Ghats |
| 66 | <i>Eriocaulon odoratum</i> Dalz. | Eriocaulaceae | Odorous marshy herb; W.Ghats, Konkan southwards to Travancore, Anamalai & Palni hills, Madurai). |
| 67 | <i>Eriocaulon polycephalum</i> Hook.f. | Eriocaulaceae | Herb; W.Ghats, 900-2100m. |
| 68 | <i>Fimbristylis pauperula</i> Boeckeler | Cyperaceae | Herb; Southern W.Ghats, Nilgiris, Palni, Tirunelveli and Madurai hills. |
| 69 | <i>Zenkeria elegans</i> Trin. | Poaceae | Tall perennial herb; southern W.Ghats of Tamil Nadu, Tirunelveli district, Agastiamalais |
| Source: Senthilkumar & Krishnamurthy (1993); Ahmedullah & Nayar (1987) | | | |

Appendix 3 Butterflies encountered in the environs of MALCO mines at Yercaud

| Family: Nymphalidae | | |
|----------------------|---|---------------------|
| 1 | <i>Ariadne merione assama</i> Evans | Common Castor |
| 2 | <i>Danaus genutia</i> Cramer | Striped Tiger |
| 3 | <i>Euploea core core</i> Cramer | Common Crow |
| 4 | <i>Hypolimnas misippus</i> Lin. | Danaid Eggfly |
| 5 | <i>Melanitis phedima</i> Cramer | Dark Evening Brown |
| 6 | <i>Melanitis leda ismene</i> Cramer | Common Eveningbrown |
| 7 | <i>Neptis hylas varmona</i> Moore | Common Sailor |
| 8 | <i>Neptis hordonia hordonia</i> Stoll | Common Lascar |
| 9 | <i>Orsotrioena medus medus</i> Fabricius | Nigger |
| 10 | <i>Parantica aglea melanoides</i> Moore | Glassy Tiger |
| 11 | <i>Tirumala limniace leopardus</i> Butler | Blue Tiger |
| 12 | <i>Tirumala septentrionis</i> Butler | Dark Blue Tiger |
| 13 | <i>Ypthima baldus baldus</i> Fabricius | Common Fivering |
| 14 | <i>Ypthima hubneri hubneri</i> Kirby | Common Fourring |
| Family: Papilionidae | | |
| 15 | <i>Papilio polymnestor</i> Cramer | Blue Mormon |
| 16 | <i>Princeps polytes romulus</i> Cramer | Common Mormon |
| 17 | <i>Princeps helenus helenus</i> Lin. | Red Helen |
| Family: Pieridae | | |
| 18 | <i>Anaphaeis aurota aurota</i> Fabricius | Pioneer |
| 19 | <i>Delias eucharis</i> Drury | Common Jezebel |
| 20 | <i>Eurema hecabe contubernalis</i> Moore | Common Grass Yellow |
| 21 | <i>Hebomoia glaucippe glaucippe</i> Lin. | Great Orangetip |
| 22 | <i>Ixias pyrene familiaris</i> Butler | Yellow Orangetip |
| 23 | <i>Leptosia nina nina</i> Fabricius | Psyche |
| Family: HesperIIDae | | |
| 24 | <i>Matapa aria</i> (Moore) | Common Redeye |
| 25 | <i>Udaspes folus</i> Cramer | Grass Demon |
| Family: Lycaenidae | | |
| 26 | <i>Horsfieldia anita</i> Hewitson | Leaf Blue |
| 27 | <i>Jamides celeno celeno</i> Cramer | Common Cerulean |

Appendix 4 Birds recorded in and around MALCO Mines, Yercaud Hills

| No | English name | Species name |
|----|--------------------------|----------------------------------|
| 1 | Pond Heron or Paddy bird | <i>Ardeola striatus</i> |
| 2 | Cattle Egret | <i>Busbulcus ibis</i> |
| 3 | Smaller (Median) Egret | <i>Egretta intermedia</i> |
| 4 | Little Egret | <i>Egretta garzetta</i> |
| 5 | Blackwinged Kite | <i>Elanus caeruleus</i> |
| 6 | Pariah Kite | <i>Milvus mirans</i> |
| 7 | Brahminy Kite | <i>Haliastur indus</i> |
| 8 | Black Eagle | <i>Ictinaetus malayensis</i> |
| 9 | Crested Serpent Eagle | <i>Spilornis cheela</i> |
| 10 | Indian Shikra | <i>Accipiter badius</i> |
| 11 | Grey Partridge | <i>Francolinus pondicerianus</i> |
| 12 | Whitebreasted Waterhen | <i>Amaurornis phoenicurus</i> |
| 13 | Redwattled Lapwing | <i>Vanellus indicus</i> |
| 14 | Blue Rock Pigeon | <i>Columba livia</i> |
| 15 | Indian Ring Dove | <i>Streptopelia decaocto</i> |
| 16 | Little Brown Dove | <i>Streptopelia senegalensis</i> |
| 17 | Spotted Dove | <i>Streptopelia chinensis</i> |
| 18 | Rose-ringed Parakeet | <i>Psittacula krameri</i> |
| 19 | Pied Crested Cuckoo | <i>Clamator jacobinus</i> |
| 20 | Brainfever Bird | <i>Cuculus varius</i> |
| 21 | Koel | <i>Eudynamis scolopacea</i> |
| 22 | Crow-Pheasant | <i>Centropus sinensis</i> |
| 23 | Spotted Owlet | <i>Athene brama</i> |
| 24 | Nightjar | <i>Caprimulgus asiaticus</i> |
| 25 | Palm Swift | <i>Cypsiurus parvus</i> |
| 26 | House Swift | <i>Apus affinis</i> |
| 27 | Lesser Pied Kingfisher | <i>Ceryle rudis</i> |
| 28 | Small Blue Kingfisher | <i>Alcedo atthis</i> |
| 29 | Whitebreasted Kingfisher | <i>Halcyon smyrnensis</i> |
| 30 | Small Green Bee-eater | <i>Merops orientalis</i> |
| 31 | Indian Roller | <i>Coracias benghalensis</i> |
| 32 | Hoopoe | <i>Upupa epops</i> |
| 33 | Common Grey Hornbill | <i>Tockus birostris</i> |
| 34 | Crimsonbreasted Barbet | <i>Megalaima haemacephala</i> |
| 35 | Large Green Barbet | <i>Megalaima zeylanica</i> |
| 36 | Goldenbacked Woodpecker | <i>Dinopium benghalense</i> |
| 37 | Ashycrowned Finch Lark | <i>Eremmopterix grisea</i> |

| | | |
|-------------------------|-----------------------------|------------------------------|
| 38 | Sky Lark | <i>Alauda arvensis</i> |
| 39 | Wire-tailed Swallow | <i>Hirundo simthii</i> |
| 40 | Golden Oriole | <i>Oriolus oriolus</i> |
| 41 | Black Drongo | <i>Dicrurus adsimilis</i> |
| 42 | Ashy Swallow-shrike | <i>Artamus fuscus</i> |
| 43 | Common Myna | <i>Acridotheres tritis</i> |
| 44 | Tree Pie | <i>Dendrocitta vegabunda</i> |
| 45 | House Crow | <i>Corvus splendens</i> |
| 46 | Jungle Crow | <i>Corvus macrorhynchos</i> |
| 47 | Redvented Bulbul | <i>Pycnonotus cafer</i> |
| 48 | Whitecheeked Bulbul | <i>Pycnonotus leucogenys</i> |
| 49 | Large Grey Babbler | <i>Turdoides malcoimi</i> |
| 50 | Ashy Wren-warbler | <i>Prinia socialis</i> |
| 51 | Tailor Bird | <i>Orthotomus sutorius</i> |
| 52 | Magpie Robin | <i>Copsychus saularis</i> |
| 53 | Indian Robin | <i>Saxicoloides fulicata</i> |
| 54 | Pied Bush Chat | <i>Saxicola caprata</i> |
| 55 | Orange-headed Ground thrush | <i>Zoothera spiloptera</i> |
| 56 | Purple Sunbird | <i>Nectarinia asiatica</i> |
| 57 | House Sparrow | <i>Passer domesticus</i> |
| Total number of species | | |



a



b



c

Plate I

- a) The hoarding by MALCO at Yercaud depicting the greenbelt program
b) A freshly mined out area c) Revegetation program on the mined area



a



b



c

Plate II

- a) One of the rocky slopes of the hills: Habitat of the Dwarf gecko
b) *Gnetum ula* and c) *Vernonia* sp.