

**The Landscape, Ecological Status, Conservation Potential,
Threats to the Forests and Biodiversity of the
Gudarakal Range, Ranni Forest Division
(Southern Forest Circle, Kerala)**

A Report of the Rapid Biodiversity Assessment Carried Out During the
2nd to 8th April 2006

Conceptualized
by
Periyar Foundation

Joint Venture
of
Kerala Forest Department and Periyar Foundation

Coordinated
by
**Division of Ecology and Conservation Biology
Periyar Foundation**

Summary

Humankind is currently in the process of assessing the true value of all the natural resources. Our resource management strategies are being reoriented to a sustainable biospheric management. Biodiversity is no longer the scientific subject for the study of biologists. Biodiversity is the web of life of which we are an inalienable part and understanding it better is essential for our own survival.

The Gudarakal Forests Range is the most important segment of the Pandalam Hill landscape unit of the Southern Western Ghats of Kerala. Its contiguity to the Periyar Tiger Reserve and its evergreen forest ecosystems besides its watershed value as the source of Pamba River makes it an invaluable area.

A comprehensive documentation of the potentials, sensitivities and the accurate present status of the Gudarakal forests is needed for us to safeguard it. As part of a long-term study, the Periyar Foundation had organized a multi-disciplinary study team to carryout a rapid biodiversity assessment of the area during 2nd to 8th April, 2006. This preliminary report presents the findings of the study.

During this study the topography of the area was analysed and is depicted in the report. The ecosystems are described and the fragmentation and modification of the forest due to the seven hydroelectric dams in the Gudarakal Plateau are outlined on the basis of field survey. The ecological status of the middle elevation grasslands of the Pamba basin has been briefly outlined. The history of forestry operations and the current status, especially the modification of forests due to the various developmental activities during the past few decades have been listed. The human communities living inside the forests, namely the Malampondarams and the numerically largest section of people working within it namely the reed workers and the fringe populations along the western edge have been studied.

The study of plants and animals, essentially a taxonomic cataloguing is appended which lists more than 1250 species of flowering plants, 150 species of birds apart from a number of representatives of the other faunal groups.

On the basis of the analysis of the primary and secondary data, a set of recommendations has been drawn up.

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The Study Team

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Biodiversity Assessment

The term biodiversity refers to the entire spectrum of living forms occurring in the biosphere. It can also explicitly mean the biodiversity of a particular location. The concept of biodiversity as articulated now reflects our growing, more holistic understanding of the dynamic life processes occurring around us. What was labelled as wildlife so far has now expanded to include the broader spectrum of plants and animals. As we understand the complexity of the stream of life in greater detail, the realisation of our true position within the web of life is growing. We are seeing our living surroundings more clearly. Hence assessment of biodiversity has come to be accepted as the most reliable indicator of the potential richness of the ecological stability and the environmental health of any area. It is also a natural resource, which we are directly exploiting and using. Therefore taking stock of biodiversity is a preliminary step in any developmental planning. We have to know the status of the resource capital to plan for its sustainable use.

What we call natural resources is not a static assemblage of some species of plants and animals which we can use, they are actually integral components of constantly evolving intricate living systems. For the natural resource to be available sustainably or our activities to be viable on a long-term basis, we should have a clear understanding of the functioning of these systems. For example, a forest is not a random assemblage of plants and animals, which we consider as our 'resources'. It is an extremely complex ecosystem the state of health of which decides the continuing presence of plants and animals, the water discharge downstream into rivers, the local weather and climate, the soil nutritional status and so on. Hence forest management is not only understanding and sustainably utilising identified resources of this ecosystem, but also understanding and sustaining all the other modulatory functions of the forest.

Biodiversity can be looked at from many different ways. The listing of all the different lifeforms, from the smallest to the largest, microbes, plants as well as animals gives us an understanding of the species richness of the area. Studying the interrelations of organisms, their structural and functional organisations into hierarchically complex systems through species, populations, biotic communities, ecosystems, biomes and so on is another way to understand biodiversity. This helps us understand what each component in the system does as well as how the different systems function. Ultimately the realisation of the fact that all the diversity in the biosphere acts together, creates and sustains the unique liveable nature of our planet Earth, is in the highest plane a truly holistic understanding of life.

But in the practical sense it is impossible to study biodiversity in totality. We have catalogued only a tiny fraction of the lifeforms occurring in any part of the earth. Science is yet to develop the degree of competence to understand the design and

functioning of all the ecosystems. This is especially true of the tropical forest ecosystems, which harbour more than 90 per cent of all the potential biodiversity on earth. At present we can only assess the relative richness through listing select better-studied groups of plants and animals. We can attempt to understand the environmental roles of some ecosystems on the landscapes under study. Essentially the final objective of any biodiversity assay is to protect areas specially endowed with a rich assemblage of biodiversity. We have to identify and protect benchmark ecosystems for our better understanding of the life processes in the biosphere. Our survival on earth ultimately depends on how close to the natural design we can redesign our cultural landscapes to maintain the efficiency, productivity and sustainability of the latter.

Why the Biodiversity Assay of Gudarakal Forest Range?

In any map of India depicting priority areas for nature conservation, Periyar Tiger Reserve occupies the pride of the place in the Peninsula and in particular in the Western Ghat hill range. Automatically there should be efforts to safeguard this area to the best of our ability. We have to identify the natural landscape unit, which alone would be viable in the long run as our Protected Area, identify all the possible threats and evolve contingency plans to counter them. Where the entire natural landscape unit cannot be treated as a single Protected Area, the vicinity of the primary site should be surveyed to create a cluster of Protected Areas around it to ensure the chances of survival of the maximum number of species. In the context of the Western Ghats with its diversity of habitats and richness of species, such a cluster is particularly relevant. Gudarakal Forest Range located in the south-west flank of Periyar Tiger Reserve with an unbroken stretch of evergreen forest extending beyond the boundary of the Park, will then automatically be a priority candidate for such biodiversity surveys.

Periyar Tiger Reserve is located on the extreme south-eastern corner of the Cardamom Hills. The western portions of the Reserve extend into the north-western portion of the adjacent landscape sub-unit, the Pandalam Hills, located to its south. Both these landscape sub-units are contiguous, located on the segment of Southern Western Ghats extending from the Anamalai Hill Range and the Idamala Valley in the north, extending through the High Ranges further south up to the Achankovil Valley and the Ariyankavu-Tenmala Pass.

The richest repositories of biodiversity in the entire world, particularly on land, are the tropical wet evergreen forests, commonly called the rainforests. South of the Mullaperiyar reservoir, at the source of Periyar River, there is an unbroken stretch of about 350sq.km. of sheltered, unmodified rainforests within the Periyar Tiger Reserve. Currently this is the largest single segment of intact wet evergreen forests inside the Protected Area network in Kerala. Silent Valley is the second largest unit. But the Periyar rainforest island extends further west into the adjacent Pamba basin within the Gudarakal Forest Range. This forest continues south beyond the Gudarakal Range into the forests of the Achankovil Division. Hence it is possible that the combined area of Periyar Tiger Reserve and the Gudarakal block of forest together would contain about 600-700 km² of undisturbed wet evergreen forests typical of the Western Ghats. This could very well be the largest remaining benchmark climax forest vegetation in the entire peninsular part of India. Around this core area and contiguous to it towards south as well as west, in the Achankovil, Konni and Ranni

Forest Divisions, there is a fragmented mosaic of forest types including smaller islands of evergreen forests, mid-elevation grasslands, semi-evergreen and moist deciduous forests of great biodiversity value. Even though not so extensive, a greater range of forest types continues from the Periyar Tiger Reserve towards north-east into the High Wavies in Tamil Nadu, towards east through the Meghamalais down the eastern slopes of Western Ghats and towards south-east into the Vasudevanellur forests of Tamil Nadu. This large complex mosaic of forest habitats extending over almost 2500 km² with the core area of the undisturbed evergreen extending over more than 600sq.km would form the best potential Inter-State site for the long-term conservation of Peninsular Indian biodiversity.

Regional landscape level planning incorporating data on biodiversity distribution must become a routine practice especially in the hill areas with their fragile ecosystems of great modulatory role for the downslope areas. The Periyar Tiger Reserve – Gudarakal forest complex forming the catchment of two major west flowing rivers and one east flowing river needs such an ecological approach for any sustainable resource husbandry planning. The current biodiversity assay is the first step towards such a planning process. Wherever primary basic data for such planning is not available, the process of collecting, collating and creating a comprehensive image of the physical landscape with its living components in it and the landuse patterns human beings have imposed on it must commence. This is a long-term work with no precedence in the Western Ghats area. Periyar Foundation is initiating such a pioneering experiment.

The southern half of Periyar Tiger Reserve south of 9° 27' latitude and east of 77° 13' longitude is extremely difficult terrain with no road access and with only a few trek paths. Even these trek paths are through the forests on the right bank of the river. The forests on the left flank of Periyar River extends towards west up the slopes of the Pamba – Periyar watershed divide and continues further west through very broken terrain up to the lip of the western slopes of the Ghats. Here a north-south strip of grasslands almost breaks the forest continuity. Due to the inaccessibility these forests are very little known and its biodiversity remains practically unexplored. Hence this is a priority area for a detailed field survey. Such information is critically needed also for assessing the full value of the core area of Periyar Tiger Reserve. The physical protection of the core area of the Periyar Tiger Reserve requires field information on this exposed unguarded flank of the Tiger Reserve. Hence a detailed field coverage of the area is needed.

The Area – An Overview

Gudarakal Forest Range, which is a part of Ranni Forest Division has apart from the Gudarakal Reserved Forest, parts of Ranni and Konni Reserved Forests included within it. It is the largest Forest Range in Kerala and is located on the north-eastern corner of Pathanamthitta district, Pathanamthitta taluk, Ranni Block. To the north of Gudarakal Range is the Vallakkadavu Range of Periyar East Division and to the north-east is the Periyar Range of Periyar East Division. The south-eastern corner of Gudarakal Range extends up to the State boundary and across the crest line of the Ghats is the Vasudevanellur Reserved Forest in the Tirunelveli Forest Division falling within the Tirunelveli-Kattabbomman district of Tamil Nadu. To the south of the Gudarakal Range is the Kanayar Range of Achankovil Forest Division.

Vadasserikkara Range of Ranni Division is located to the south-west and to the west is the Ranni Range of Ranni Division.

The entire Gudarakal Range is located in the Ghat segment of the Pamba drainage basin. The Pamba, Kakki and Kakkad tributaries of the main Pamba River drains this Forest Range. Vechoochira, Ranni-Perunad, Seethathodu, Thannithodu and Chittar panchayats cover the Range and its western fringe. The Kakkad-Moozhiyar-Kakki-Anathodu-Pamba-Gavi-Pachakanam-Kozhikanam part of the Angamoozhi-Vandiperiyar road traverses the southern part of the range along the outer face of the Ghats and then bisects it along the Gudarakal Plateau.

The Survey Methodology and the Field Coverage

A preliminary reconnaissance of some locations within the Gudarakal Forest Range was attempted during the 2nd to 8th of April 2006 through an field survey organised by the Periyar Foundation. Along with the scientists from the Foundation there were invitees from outside and this team was assisted by Forest Department field staff from Periyar Tiger Reserve as well as the Gudarakal Forest Range. EDC trackers from PTR and local labour procured from the KFDC Gavi cardamom plantation provided the field support. The preliminary briefing session was held on the 2nd April afternoon and the objectives of the field survey and the methodology were explained to the team. The team moved into the field on the 3rd April morning. The researchers covering the socio-economic themes were based at Kochu Pamba during the 3rd, 4th and 5th April and collected secondary data from various official sources on the management history, resource exploitation and other information of relevance to this study.

The first field camp for the scientist documenting biodiversity was on the eastern edge of Chenthamarakokka. This is close to the junction of PTR boundary with the Downdan private holding and the Gudarakal Range (9° 27' N, 77° 08' E). On the 4th noon the team shifted camp to near the Gavi dam. Till 7th morning Gavi was the field base from where teams surveyed the forests around. On the 7th the entire team using the mini bus travelled south up to the Upper Moozhiyar dam site and carried out data collection along various locations enroute. The team returned to Kumily on the 7th late evening. The full field survey team assembled in the Kalari, Bamboo grove, Thekkady on the 8th forenoon, discussed the findings and finalised the format of the survey report.

All members of the field team were provided with data sheets for recording their observations along with compasses, altimeters, GPS and digital cameras to assist in the field survey. The biodiversity field team had three botanists who assessed the floristic composition of the forests along traverse routes. Plant community study plots were demarcated in various types of forests and the data on species and age-class distribution recorded. On the basis of the checklist provided, the field team identified the fauna. Direct observations of mammals and evidences of mammalian species using spoor and scat identification were recorded. Students of fish and amphibian fauna carried out visual identification and collected specimens. In all possible cases photographic records of the species encountered were made. There is very little published literature available on the tract. A bibliography of all published material on this tract is under preparation. Experts on many animal groups were not available and

hence specimens specifically of important invertebrate groups may have to be collected in future. During the present study this was not attempted.

The Gudarakal Range covers a vast difficult tract. It is not possible to cover such an extensive area within a short time. Hence the rapid reconnaissance was designed to cover a north to south transect along the broadest part of the Gudarakal Forest Range and the objectives were limited to carry out a reconnaissance of the terrain, generate an overview of the ecological conditions of the area covered, collect data on presence of significant species of biota and record the major anthropogenic disturbances. The recent history of the major human interventions in the area needs to be documented. This is a time consuming task. Hence priorities were set. The conservation value of locations visited as well the overall conservation value of the Range could be broadly outlined. From the perspective of protecting PTR and protecting biodiversity of Gudarakal Range, the sensitivity of locations visited were recorded. The survey was also meant to select locations for a more detailed biodiversity documentation in future. This preliminary trial also attempted to evolve more effective practical field survey methods and work out the logistics for a detailed study of the area in future.

A Brief Summary of the Field Coverage of Gudarakal Forest Range

The first campsite was at Chenthamarakokka located on the south-western edge of grasslands covering the Rattendon Plateau. The entire area was earlier planted with *Eucalyptus grandis*. The camp was on the edge of a stream draining into the gorge with an undisturbed rainforest patch on the opposite bank of the stream. The stream flows west down into the gorge. There were many similar scattered pockets of forests all along the edge of the plateau from Arjunan Kotta in the north till south of Kakki. Some of these evergreen forest patches have links with the forest cover in the scarp face but many have been isolated. They are wildlife refugia providing shelter to large mammals like gaur and sambar which graze or browse in the grasslands. The forest pockets also shelter most of the small mammals and very many birds found in this type of habitat. Sample plots were laid out in these forest islands and sampling data were collected on plant communities along with species identification.

Chenthamarakokka drains into the gorge cut by the Pamba River below the Pamba dam. From the western edge of the grassland Sabarimala temple is visible towards the south-west. The evergreen forest patch adjacent to the camp was surveyed on the 3rd afternoon and the forest-grassland margin further north was covered on the 4th forenoon.

The second field camp was intended to be near the Kullar dam but as the site was found to be inconvenient, the camp was shifted to a location upstream and immediately on the right flank of Gavi dam. The site was in the KFDC cardamom plantation. On the 4th of April the team covered the forests towards north-east from Gavi beyond Kullar dam and up to the PTR boundary. The Ponnambalamedu area as well as Varayattukokka, both located on the western edge crestline of the grasslands south of Gavi were covered from this base camp. On the 5th April some team members surveyed the area towards south-east of Gavi along Meenar, beyond the KFDC cardamom plantation into the natural forests towards Pamba reservoir.

The third field camp should have been at Upper Moozhiyar. This plan was abandoned and the team based at Gavi using the PTR mini bus travelled along the road to Moozhiyar, surveyed a few sites along the western side of the road up to Kakki dam. The team travelled up to Upper Moozhiyar dam and some members continued on foot a few kilometres further towards the south-east towards Pancharamanal along the Chinna Kakki Ar.

On the 7th evening all members of the team returned to Kumily via Gavi and Vallakkadavu. A debriefing session was held on the 8th forenoon.

Observations of the Rapid Biodiversity Field Survey

Preface

It is to be reiterated at the outset that five field days spent in the extremely rugged terrain of the Gudarakal Forest Range extending over 600 km² are grossly inadequate even to form a superficial impression of the area. In the absence of previous published scientific information on the habitat and ecosystems, serious scientific sampling cannot be carried out. Hence the focus of the study was limited to generating an overall clear image of the physical condition of the area, that too limited to the main north-south transect taken across the Range during the field days. This transect was along the existing main road which was essentially laid for construction of the dams of the Sabarigiri Project. The road is mostly along the western edge of the Gudarakal Plateau with grasslands on the western side and the five reservoirs on the eastern side. The forest in between the reservoirs for most of the distance is KFDC cardamom plantations which commencing from near Dowlan Estate continue up to the Pamba dam. The remaining forests accessible from the road south of Pamba dam as well as forests further east towards Chinna Kakki Ar and Upper Moozhiyar have been extensively and severely damaged by selection felling two decades ago and further degraded by fires in 1983 and 1987. The time available during the field survey was not adequate to range deeper into the undisturbed forest ecosystems and assess its biodiversity potential. Gudarakal Range extends west down through the Pamba and Kakki gorges almost up to the foothills far to the west. This western part was also not visited. So essentially the present report deals with approximately 20 percent of the area of the Forest Range. But incidentally this segment is the most sensitive and vulnerable part of the Forest Range. The activities in this segment will affect the viability of the eastern undisturbed forests as well as the western more exposed, vulnerable as well as valuable scarp and lower valley forests. From the point of view of protection of the biodiversity of the Gudarakal Range forests and the long-term protection of the biodiversity of the PTR core area, most of the anthropogenic threats would emanate from the area covered. Hence the identification of environmental related issues obvious on the ground in the surveyed area and mitigative measures conceived are of great importance. Hence the true relevance of this tract transcends the boundaries of the Gudarakal Range and is vital for the protection of potentially the largest biodiversity conservation landscape unit in the entire Western Ghats.

The Landscape Unit Encompassing the Pamba River Basin: Topography, Climate, Drainage, Ecosystems, Biota and Human Communities

South of Palakkad Gap the Western Ghat hill range is practically continuous all the way to Aruvaimozhi Pass near Kanyakumari. The east-west valley carved out through a diagnostic tectonic faultline by the Achankovil River is the natural southern boundary of the Pandalam Hills landscape unit. Immediately to the south of the Achankovil Valley, the main crestline of the Ghats break down into a few low saddles almost creating a second discontinuity in the Ghats. This particular location in the Southern Western Ghats is often referred to as the Ariyankavu-Tenmala Pass.

The section of the Western Ghats immediately to the south of the Palakkad Gap is the Nelliampathies. It is more of a plateau very clearly identifiable in Parambikulam, with a number of east-west higher ridges ending near the Karappara Valley. The outermost edge of the Nelliampathies gradually descend towards west to the Thrissur plains. The south-eastern corner of the Nelliampathies rises up steeply into a very high narrow ridge – the Anamalais. This ridge sweeps in a huge arc towards south and south-west. The deep Idamala gorge cut by the northernmost tributary of Periyar, the Idamalar, separates the Sholayar forests in the Nelliampathies from the southern Anamudi Reserved Forest and the High Range Plateau.

The widest stretch of the Western Ghats is located to the south of Anamalais. The southern face of the Anamalais has been thrust up as a narrow east-west high plateau called the High Ranges. This plateau drains south into Periyar through the Muthirapuzha and Panniar. The High Ranges and the Anamalais meet the Palni Hills near Top Station. Palni Hills also called the Kodaikanal Hills is a high eastern spur of the Western Ghats. South of High Ranges the extensive Cardamom Hills begin. It is separated from the High Ranges located to its north by a distinct east-west high ridge. The Cardamom Hills currently referred to in general as 'Idukky' is actually constituted of three distinct sub-regions. The portion west of the main Periyar channel which flows from south to north in here, is the true Idukky sub-plateau. This is the lowest part of the Cardamom Hills in which the Idukky reservoir is located. East of the river channel the undulating plateau rises up to the watershed line of the Western Ghats. The State boundary follows this line. This portion of the Cardamom Hills is lower than the High Ranges but is higher than the Idukky sub-section. Most of the remaining forest vegetation left in the original Cardamom Hill Reserve is in this part. This section drains through the Perinjankutty Ar and the drainage channel is essentially from the south-east to north-west into Periyar. The broad Cardamom Hill part of the Western Ghats gets sharply constricted south of an imaginary line extending from Vagamon in the west to Kambam in the east. The tributaries of Meenachil, Manimala and the Azhutha tributary of Pamba have eroded away extensive areas of the Periyar basin between Vallakkadavu and Ayyappankovil and here the Cardamom Hills have become narrow. Periyar has only a narrow strip of Cardamom Hill tableland to flow northward. South of Peermade the Cardamom Hill landscape unit projects almost like a promontory towards south-west. This is the Rattendon Plateau.

The southern most part of the Cardamom Hills i.e. the source of Periyar River is a narrow valley extending south of Kumily. It is less than 20km wide and is about 40km long. Its eastern border is the Sivagiri Hills and it is separated from the western

Pamba Basin by another north-south ridge running parallel to the watershed line of the Western Ghats. This ridge terminates south of Kozhikanam. There is another eastern spur of the Western Ghats projecting from the Cardamom Hills. This is the High Wavies, a series of three high steep ridges projecting towards the north-east from near the Kambam-Kumily Gap.

The section of the Western Ghats south of the Cardamom Hills is called the Pandalam Hills. It extends from south of Rattendon Plateau all the way south to the Ariyankavu Gap. It is narrowest south of Kozhikanam at the head of the Chenthamarakokka. It broadens towards south in the catchment area of the Kakki tributary of the main Pamba River. Here it extends and continues up to the eastern crestline of the Western Ghats. This southern part of the Pandalam Hills is actually an undulating wide plateau abruptly terminating towards south in the Achankovil Gap. The southernmost part of the Pandalam Hills is drained by the Achankovil River and the rest of the area by the Pamba River. The Pandalam Hills-Southern Cardamom Hills is possibly the only section of the Western Ghats which has two drainage basins accommodated in its higher reaches side by side. Normally the western slopes drain towards the Lakshdweep Sea in a series of drainage basins arranged parallel to each other latitudinally. But in Gudarakal Range because of two parallel high ridges, half the higher ghat area is drained towards north through Periyar and half towards west through Pamba. In fact in many locations in the Gudarakal Range the secondary watershed divide is higher than the principal east-west dividing ridge of the Western Ghats. Because of the complexity of terrain and its influence on rainfall and distribution of incoming solar energy, there could be very many locations within Gudarakal Range which have unique micro-climatic conditions. This would be reflected in the edaphic conditions which in turn would influence forest characteristics as well as the distribution of species.

Topography

The watershed divide between Periyar and Pamba in the higher Ghats begins in the north near Peermade, from near Murinjapuzha located on the Kottayam-Kumily road. This part of the western slope of the Western Ghats is located at the junction of Cardamom Hills and Pandalam hills and is drained through Panniar, a tributary of Azhutha, located within the Ranni Reserved Forest. This area has been subjected to forest encroachment and the terrain is extensively damaged. The watershed divide then continues in a sweeping curve extending east, then south-east and then finally turns south approaching very closely the main Periyar channel. There is hardly 2km aerial distance between Vallakkadavu on the banks of the main Periyar River and Chattram Colony located to its west on the very edge of the plateau. Potentially here headward erosion of Pamba channels could capture the upper Periyar runoff upstream of Vallakkadavu and redirect it to the Pamba basin. Rattendon Valley Annexe Reserved Forest located on the north, Mount Plateau Annexe Reserved Forest in the south and Ranni Reserved Forest to the west meet here. The watershed boundary of Pandalam Hills projects out towards west at Arjunan Kotta but thereafter swings back sharply towards east near Vamanankulam. It moves further towards south-east along the eastern edge of Downdan Estate till the source of Kullar. Thereafter it continues due south. From near Murinjapuzha till Kullar source the watershed line is along the western edge of the Mount Plateau and the Rattendon Plateau. The two aforementioned tracts are mostly devoid of forests and are gently rolling grassy areas

at an elevation of 1000 and 1200m. From near the source of Kullar, the Pamba-Periyar dividing ridge rises steeply to elevations up to 1800m.

Originally from the crest of this Pamba-Periyar dividing ridge a rolling plateau must have extended west till somewhere in between $77^{\circ} 5' E$ or $77^{\circ} 6' E$ longitude. This must have been heavily forested. But at some time in the past due to tectonic activity, fractures developed resulting in two deep almost parallel channels running from south - south-east to north - north-west along its western edge. The northern gorge is of Pamba and the southern gorge is of Kakki. Both are of 600 to 900m deep. They meet at Triveni. The channel of Moozhiyar, which later becomes Kakkad Ar, originating further south of Kakki is also parallel to the other two northern tributaries but is not such a deep gorge.

The watershed divide between Pamba and Periyar gradually rises up south of the source of Kullar and at the source of Pamba in Nagamala it reaches an elevation of 1830m. On an average the ridge is more than 1600m high with shola-grassland ecosystems in some of the higher peaks and stunted montane evergreen forests in most parts. At its extreme southern point ($9^{\circ} 17' N$, $77^{\circ} 14' E$) the Pamba-Periyar divide ridge swings abruptly east and passing through Chokkampetty Mala (1802m) it joins the Western Ghat watershed crestline near Kallimala (1611m). This junction of the south-easternmost point of Periyar Basin and the north-easternmost point of Kakki Basin is located at $9^{\circ} 16' N$, $77^{\circ} 17' E$. Keeriar and Irukkalar, which are tributaries of Kakkiar, originate from the western slopes of the main Western Ghat ridge from elevations of around 1700m in this part of the Gudarakal Range. The south-eastern most point of Gudarakal Range is Urani in the State border located at $9^{\circ} 11' N$, $77^{\circ} 15' E$. The terrain along the western slope of the watershed divide between Periyar and Pamba and that at the source of Kakkiar further south is extremely broken terrain with a complex array of ridges and valleys under heavy forest cover.

The entire stretch of Pamba basin, from the very source of the three northern tributaries located at elevations ranging from 1400m to 1800m till they exit from the higher Ghats at elevations of around 900 to 1000m through cascades and cataracts along the western face of the Ghats, was a heavily forested plateau. This could be called the Gudarakal Plateau. South of Kakki reservoir and at the source of Moozhiyar, the Gudarakal Plateau is relatively flat with an average elevation of 1000m. But further south and west it again becomes steeply undulating at the source of the southernmost tributary of Pamba namely Kallar. The Pandalam Hills along its south-western flank descends to the midlands in the Pathanamthitta district in a series of spur hills.

The western edge of the Gudarakal Plateau from near Chentamarakokka in the north almost up to a point immediately to the east of Moozhiyar in the south is a sheer scarp face dropping off from heights of around 1000 to 1200m to 400 or 500m at the bottom of gorges through which the rivers exit. There are very few western spurhills along this entire stretch. In many locations paleo-rockslides and incipient slides are evident. This 50 to 60km north-south stretch of the western face of the Western Ghats is possibly the most actively weathering segment along the entire Western Ghats. Complex bio-geochemical processes and biotic community changes are taking place here due to rapid terrain evolution. This scarp face has a few prominent vantage points providing panoramic overview of the landscape. Arjunan Kotta is the northern

most such location. Ponnambalamedu, Swargavathil and Nanattupara are the other prominent vantage points.

Gudarakal Range forests extend further west through the scarp face down along the spurs and valleys deep into the midlands. Above the scarp face they continue east up to the crestline of the Western Ghats. But between the scarp face forests and the far more extensive forests along the Pamba-Periyar divide, there is the strip of grasslands of an average width of 2 to 4km. This is the only western slope of the Western Ghats where the terrain and forest remain relatively intact from elevations of more than 1800m to elevations as low as less than 100m.

Weather and Climate

The complexity of the terrain with many west opening valleys and hill slopes exposed to different directions occurring in this particular part of the Southern Western Ghats, extensive forest cover and range of elevations indicate considerable variation in weather and climate within the study area. The only private holding within this tract is at its north-eastern corner i.e. the Downdan Estate. The absence of such old coffee and tea estates in the rest of the tract precludes meteorological data collection in the pre-Independence period. During the 1960-80 period, there was extensive river valley development i.e. dam construction for hydel power generation in the area. But surprisingly there had not been much of meteorological or hydrological data collection preceding the dam construction. In the absence of human settlements and communication network, not even people's perceptions are available to understand the climate of the area. The KSEB has projected a range of rainfall varying from around 4100mm in the lower western portions to well over 4800mm in the higher eastern portions. Considering the topographical complexity, it will be unscientific to project generalised figures for the entire tract. Basic meteorological information particularly rainfall data and maximum-minimum temperature must be recorded from as many locations as possible from within the Gudarakal Range.

Drainage, Dams and Water Resource Utilisation

Pamba River is the third longest river in Kerala with a length of 176km draining an area of 2235 km². It is the fourth largest river in Kerala by the extent of basin area. Out of the total extent of the basin more than 1800sq.km. is in the Western Ghat hill tract and approximately 1200sq.km. area is forestland. Only Chalakkudy River in Kerala has such a high proportion of the basin under forest cover. Hence potentially Pamba could be a very healthy river without any drastic reduction in the lean season flow.

Pamba flowing west through the narrow midland part of the Pathanamthitta district swings north approaching the coastal tract, splits up and is joined by a branch of Achankovil and one channel of Pamba joins an arm of Manimala. Achankovil, Pamba and Manimala empty into the southernmost part of Vembanad Backwaters in locations close to each other. With its very significant discharge volume, Pamba had a major role in the complex hydrological processes taking place in the Vembanad and Kuttanad tract. By affecting the lives of more than 50lakh people living in and around Kuttanad and Vembanad, spread over the districts of Alappuzha, the western part of Kottayam and Pathanamthitta and even the southern part of Ernakulam district,

Pamba has importance disproportionate to the mere length of the river or the extent of the basin. Its role in hydel power generation has been recognised early and almost fully tapped. But its role in the agriculture of this fertile tract, as a drinking water source and in the environmental health of an extensive region has not been appreciated and safeguarded adequately. Now during the Sabarimala pilgrimage season in early winter every year, with about a crore pilgrims depending on a short stretch of the river for almost three months, water scarcity in the river and health hazards through the pollution of the river waters are slowly being highlighted. Yet a detailed study of the basin from the point of view of eco-restorative watershed treatment has not been thought of. The so-called 'Pamba Action Plan' only envisages sanitary engineering activities and sewage disposal measures in the midland portion for cleaning up the river. The catchment area forests which actually give life to the river is not even recognised as a significant component.

The main tributaries of Pamba River are Azhutha, Pamba, Kakki, Kakkad and Kallar. The northernmost tributary, Azhutha, drains the south-western edge of Peermade Plateau and the spur hills projecting west along the Kottayam-Pathanamthitta district border. It flows south-west and joins the next southern tributary Pamba near Kanamala. Its upper catchments fall within the Erumeli Range of Kottayam Division, Azhutha Range of Periyar West Division and Ranni Range of Ranni Division.

The Pamba tributary of the river drains the north-western edge of Pandalam Hills and the south-western part of the Rattendon Plateau. Coming down from the more than 1000m high plateau, the river has cut a deep gorge running roughly from south-east to north and north-west. Five dam impoundments are in this sub-basin. They are, apart from the main Pamba dam, the Kullar, Meenar I and II, Gavi and Kochu Pamba. The next southern tributary of the main Pamba River is Kakki River. It drains a wide stretch of the western slope of the Western Ghats and after a long meandering course through a rolling higher Gudarakal Plateau comes out of the Ghats through a narrow deep gorge running north - north-west parallel to and to the south-west of the Pamba gorge. Kakki joins Pamba at Triveni, located immediately to the south of Sabarimala Temple. The Kakki reservoir is in this sub-basin.

South of Kakki river a small portion of the south-western edge of the Gudarakal Plateau and the western outer slopes of the Pandalam Hills are drained by Manianar and Moozhiyar. They join together to form the Kakkad Ar. Kakkad Ar joins the main Pamba River at Perunad. The Moozhiyar tributary has a small impoundment higher up in the Gudarakal Plateau. Waters from all the impoundments in the upper part of the Pamba Basin are finally brought into the Kakki reservoir. After power generation at the Moozhiyar power house located on the right bank of Moozhiyar the tailrace waters are let out into Moozhiyar. Further downstream the tailrace waters are again impounded by the Kakkad dam and power is generated again. Downstream in Kakkad Ar at a place called Maniyar there is an irrigation barrage to divert the waters through a right and left bank canal to supply a net command area of 19,800ha.

The southernmost tributary of Pamba River is Kallar which drains the extreme south-west corner of the Pandalam Hills. It flows north – north-west and joins the main Pamba at Vadasserikkara. There is a proposal to construct a dam across this river and to link up the reservoir with another dam impoundment to be created further south-east across the Kallar tributary of Achankovil River for generating electricity.

Dams within the Forests of Gudarakal Forest Range

After the construction of the Mullaperiyar dam, Madras Government had proposed utilisation of waters in Pamba River to augment waters of Periyar flowing into Tamil Nadu. But it was only during the Second Five Year Plan that dam construction began in the Pamba Basin. With assistance from the Government of the United States of America, the Sabarigiri Hydroelectric Project Phase I was initiated in 1962. It involved construction of two reservoirs, the smaller one in Pamba and the larger one in Kakki. The Pamba reservoir is expected to store 31.15MCuM behind a 52.12m high dam and the Kakki reservoir is to store 447.41MCuM of water behind a 109.73m dam. Waters from Pamba is brought into Kakki reservoir through a tunnel and all the runoff from the combined catchment of 316.12sq.km. located entirely within the Gudarakal Range is then diverted down to the Moozhiyar sub-basin to use the head of 761.68m to generate 138MW of power at 60percent load factor.

In the 1980s the Sabarigiri Augmentation Project was taken up to enhance the power generation potential of the Moozhiyar Power House to divert waters from the Kullar, Gaviar, Meenar and Moozhiyar tributaries of Pamba River through five smaller dams into the Pamba-Kakki reservoirs. This is to generate an additional 14.3MW of power at 100 percent load factor. Another plan was prepared to utilise the waters downstream of the Pamba dam from a 3.88sq.km. catchment by storing it 1.5km downstream and pumping it back to the Pamba reservoir and also using it as a reservoir for releasing waters during the Sabarimala pilgrimage season to maintain stream flow in Pamba. This is called the Swami Saranam Project.

Dams constructed as part of the Augmentation Project are,

- Kullar dam is a 88.5m long and 19.2 m. high masonry gravity dam which stores the runoff from a 9.4sq.km of catchment. The waters are then diverted through a 223m long channel into the Gavi reservoir.
- Gavi dam is also a masonry gravity dam which is 110m long and 17.07m high which taps the runoff from a 7.5sq.km. catchment area in addition to receiving waters from Kullar and diverts it through a 2104m long tunnel into Meenar I dam.
- Meenar I dam is also a masonry gravity dam which is 36.57m long and 9.14m high, storing the runoff from a 0.40sq.km. of independent catchment. It also receives waters from the earlier mentioned dams and diverts it through a 457.02m long tunnel into Meenar II dam.
- Meenar II dam which is 82m long has an independent catchment of 1.10sq.km. It receives the waters from the three previously mentioned dams and diverts it through a 152.4m long open channel into the Pamba dam.
- The Upper Moozhiyar dam is a rolled earth filled dam 97m long and 18.29m high storing waters from a 7.70sq.km. of catchment. The waters are diverted to the Kakki reservoir through a 690m long tunnel.

The Kakkad Hydroelectric Project uses the tailrace waters from the Moozhiyar Power House by a 27m high weir across the Kakkad Ar which diverts the waters through a 11km long tunnel to a power house located on the left bank of Kakkad Ar close to where it receives Seethathode. The weir also uses the runoff from a 36sq.km. independent catchment.

The most crucial aspect of this hydropower development is that practically the entire Gudarakal Range is the vital catchment area of the Sabarigiri and Kakkad Hydroelectric Projects. In that sense this range must be the most intensively exploited part of Western Ghat forests for power generation. In view of the huge investment made in power generation in the Upper Pamba basin, the overriding management objective of the forests of this Range has to be watershed protection.

Ecosystems of the Gudarakal Forest Range

Forests of the Gudarakal Range extend from elevations lower than 100m to heights of more than 1800m. The annual rainfall everywhere in the Range is well above 4000mm. Hence the plesioclimax vegetation of the entire area will be wet evergreen forests. But the current vegetation is a complex mosaic including montane evergreen forests and wet temperate grasslands in the higher elevations to various drier forest types in the lower elevations. There are open grasslands, extensive sheet rock scarp faces and also swampy pockets within the forests in depressions. In general ecosystems found in the Range can be categorised as follows according to past interferences and future management priorities.

In areas above 1400m it would be higher elevation stunted evergreen forests and shola-grassland mosaic. Potentially this vegetation occurring on the Pamba-Periyar dividing range would be ecologically different from the forest occurring on the main Western Ghat crestline.

Forests in the medium elevation i.e. between 600-1400m could be broadly segregated into the following categories. They are forests occurring in the plateau area, forests found on the hill slopes, riparian forests, vegetation on the scarp face and forests in the deeper valleys. The current status of the forest vegetation could be undisturbed extensive forest tracts, undisturbed fragments, disturbed regenerating areas where the main disturbance could have been selection felling or fire damage or disturbance from being located on the reservoir fringe. Disturbed forests may be undergoing the process of further degradation as in abandoned cardamom areas, severely fire damaged areas, selection felled and damaged areas around the dam sites or on the reservoir fringe where the process of succession is not taking place.

Between 900m and 1200m there are extensive grasslands within this Range. Some pockets of it may be totally undisturbed. But most of the area is abandoned after plantations have failed. Some areas planted with eucalyptus still have the stock and this is being tended or even being replanted. There could be planted areas with some stock which has been abandoned. There are also severely degraded grasslands. Planted abandoned areas may have serious weed infestation and many areas have different degrees of regeneration of forests.

Gudarakal Range has extensive stretches of ecotonal areas between grasslands and forests. These could be at the outer face of the scarp or these could be along the eastern edge in the plateau facing the extensive belt of forests.

The western face of the Western Ghats within the Gudarakal Range has a long scarp face. This scarp face has its specialised plant communities where the slope is too steep to support grasslands or a multi-tiered forest plant community. The plantation activity

in the grasslands and the dam construction as well as the power lines have caused extensive fire damage to the western part of the grasslands. In many locations these grassfires have moved downslope towards west and affected the vegetation on the scarp faces. In some locations the exfoliation of rock and rock falls have affected the scarp vegetation which may be in various stages of succession.

Gudarakal Range has the most extensive cardamom plantations in the public sector in Kerala. Cardamom cultivation and the manipulation of the forest plant community have created a specific type of degraded evergreen forest system.

In elevations lower than 600m Gudarakal Range has scattered all over its area a complex mosaic evergreen, semi-evergreen and moist deciduous forests. Various degradative phases of all these three forest types occur intermingled with the main forest types.

There is also a small teak plantation occurring in the Range. Apart from the reservoirs, other non-forest landuses do not occur in this Forest Range with the exception of the Downdan private estate and one tribal settlement.

History of Forestry Operations

The Gudarakal Reserved Forest was notified in 19.6.1939. It covers an area of 50,246.31ha. The Gudarakal Range was established in 16.9.1965. It has an area of 653.97sq.km. The earliest forestry operation carried out in the Range is the plantation attempts in the grasslands. Because of the presence of extensive grasslands around Pamba, a separate Division was created called the Pamba Valley Grassland Afforestation Division. Raising of *Eucalyptus grandis* started on an experimental basis in 1959. Between 1959 and 1967 an area of 7942ha is reported to have been planted. In 1967 at Pachakkanam and near Pamba more than 100ha of evergreen forests were clearfelled for raising eucalyptus.

The first Working Plan for Ranni Division of which Gudarakal Range is a part was prepared by K. Narayana Pillai for the period 1959-1973. The second Working Plan for 1973-74 to 1984-85 was prepared by N. Madhavan Pillai. K. Achuthan prepared the third Working Plan for the period 1983-84 to 1993-94. The current Working Plan for 2002-03 to 2011-12 was prepared by N.M.Naushad.

The Current State of the Forest

Cardamom Cultivation and Dam Fragmentation

The forests surveyed during the biodiversity assessment were along the eastern edge of the grasslands. Although of evergreen nature, they range from pristine evergreen patches to extremely degraded sites due to recent human interferences. The entire stretch of forests on either side of the road from near Kozhikanam to Kochu Pamba has been converted to cardamom plantations. Cardamom plantation in the area started as a small venture by the Kerala Forest Department in 1969 over an area of 145ha near Pachakkanam. Later with Central Government funding this was expanded as a rehabilitation venture for Sri Lankan repatriates. In 1976 the management of the plantation was taken over by the Kerala Forest Development Corporation. The

cardamom area was expanded to 1025ha. Currently only a portion of the area is under cardamom crop. The remaining areas which have been opened up have become degraded. In the 1980s the four feeder dams of Sabarigiri Augmentation were constructed, further destroying the best valley forests. Destabilisation of the forest architecture, particularly clearance of undergrowth lead to microclimatic change and forest degradation and in the late 1980s there was very heavy wind fall of the canopy trees during monsoon. These were then extracted accelerating the degradation. The construction of dams which resulted in laying of extensive road networks, powerlines, labour colonies, canals linking reservoirs, tunnels, quarries and so on added to the damage caused by the clear-felling of the submergible area. KFDC constructed a series of check dams during the late 1980s and early 1990s funded by the Western Ghat Development Programme for storing water for irrigation. These further pockmarked the already severely fragmented and degraded area. The forests to the west of the road between Gavi and Kochu Pamba on the lip of the scarp are affected by violent winds during the monsoon. This was also converted to cardamom. So a belt of forest 7-8 km long from Gavi to Pamba and 2-4 km wide east-west covering approximately 2000ha has been severely damaged and fragmented. This forest tract is a climatic buffer to the extensive grasslands along the left flank of the Mullaperiyar reservoir extending west to the Mount Plateau. Hence in a landscape level management planning, carefully planned restorative management of the cardamom plantation is a priority task for protecting the habitat in Periyar Tiger Reserve. The value of this forest has now increased because it is the watershed that guarantees forest-regulated runoff into six dams in the Pamba tributary of the main Pamba River.

The strip of forest in which the KFDC cardamom plantation and the Downdan Estate are located is (or was) a forest link between the large forest tract further east along the Pamba-Periyar divide and the western scarp face vegetation continuing down to the Pamba gorge. North of this forest corridor there is no large forest patch in the Mount Plateau or the Rattendon Plateau. The grasslands extend from near Chenthamarakokka all the way east to the Periyar River and along the left bank of the river and the Mullaperiyar reservoir east up to Choorakkota Thodu. South of Kochu Pamba, grasslands again expand and the next narrow east-west forest corridor used to be exactly where the Anathodu flanking dam is located at present. These two forest corridors are almost severed now.

Selection Felling

Along with the construction of the Kakki and Pamba dams, salvage felling of timber from the submergible areas commenced. Gradually selection-felling activity began in the evergreen forest of the Gudarakal Range. For example, during the period from 1975-76 to 1980-81 an area of 4925ha of pristine rainforest was subjected to destructive selection felling. The annual target which was less than 450ha in the early years of this period rapidly increased to more than 1270ha. Selection felling caused extensive damage to the previously untouched forests of Gudarakal, that too around the Pamba and Kakki reservoirs. During the 1970s and 1980s, salvaging operations to retrieve timber supposed to be left unfelled and submerged in the reservoir also was going on simultaneously. This became a big forest controversy during that period. The 1983 and 1987 droughts and the exceptionally widespread forest fires affected these overworked and damaged forests. Practically all the accessible parts of Gudarakal Reserve in the plateau got directly or indirectly damaged.

It is essential that detailed surveys are carried out to map the current state of regeneration or degradation of this most important catchment forests with exceptional biodiversity value. It needs very special restorative management measures to nurse it back to some state of ecological health.

Forest Plantations

Gudarakal Range earlier had more than 70sq.km. of its area in the grasslands managed as eucalyptus plantations. Some of this area with some stocking, particularly towards the northern parts will be subjected to routine working. The ecological and economic cost-benefit analysis of this costly venture has never been attempted. There is need to carryout a detailed assessment of the present stock of the planted area and decide on future management strategies taking into consideration the ecological and biodiversity values of the area in a larger perspective.

The Working Plan records the extent of teak plantations in the area as 65.66ha, Teak-Elavu plantations as 80.94ha and miscellaneous mixed plantation as 85.96ha. In addition failed eucalyptus plantations to the extent of 110ha is also recorded. So a total of 342.56ha of forests have been converted to some form of monoculture. All the teak plantations are reaching the first rotation period. The 1965 Veluthode plantation covering 80.94ha is reaching its felling schedule during 2005-06. The 1967 Veluthode plantation covering 44.82ha will have to be extracted during 2007-08 and the 1968 Veluthode plantation covering 20.84ha is to be felled during 2008-09. Compared with any other Forest Range in Kerala, the extent of teak plantation in Gudarakal is relatively small. Hence the option of regenerating the area with indigenous evergreen species should be considered.

Reed Extraction

The heavy timber extraction and the consequent opening up of the canopy, at times followed by fire damage to the lower strata of vegetation, triggered extensive successional changes. Opening up of interior forests due to the reservoir waterspread created long perimeters where at least for a couple of months there is waterlogging of some areas of the forest floor. Reed (*Ochlandra travancorica*) regenerated over vast areas of Gudarakal forests. After the stopping of selection-felling, reed extraction commenced in this Range primarily to supply the Hindustan Newsprint Ltd. Extensive reed extraction is actually preventing forest regeneration. Roads have been cut through the valleys destroying stream channels. Large labour force moving in the interior forests at least for four months is causing extensive disturbance to wildlife apart from causing incidental damage to the forests. Actually the entire forest tract should have been taken out of all destructive exploitation and given rest. Special measures should have been taken for fire control both in the opened up forest and in the vast extent of grasslands. In locations where regeneration is obviously lacking, ecorestorative husbandry will have to be resorted to. During the biodiversity assessment survey it was seen that reed had started flowering gregariously along Kakki reservoir. How the ongoing reed extraction will affect regeneration of reed after flowering and how the flowering and the consequent death of reeds will affect the reed working in the coming years must be carefully monitored for management

interventions. After flowering and death of reed beds the forest would become highly susceptible to fire damage. Adequate fire prevention measures will have to be planned in advance and implemented wherever the reeds are drying up.

Fragmentation of Forests and Degradation Threats to the Forest Islands due to Powerlines, Roads and Townships

A very tenuous east-west forest corridor exists south of Pamba almost up to Anathodu. This is a valuable corridor especially for the larger mammals. Here the western slope of the Gudarakal plateau is not a precipitous scarp. All along the western portion of the Gudarakal Reserve, the high-tension electricity transmission lines have cut wide swathes of clearance through the forests. In many locations many lines running parallel to each other have fragmented the habitat repeatedly. Especially along the western edge of the grasslands where narrow belts of vegetation extend up the hill folds into the plateau, this fragmentation has been ecologically disastrous. Even though no remedial measures are immediately feasible, at least the impact of such fragmentation could be documented. It has been reported from many parts of the State where high tension lines cross forest stretches, especially over open degraded forests or grasslands, electrical sparks from the powerlines set fire to forest vegetation in summer months. This is reported to have happened during this summer near Pamba. The sensitivity of the grasslands in the Gudarakal Range to damage is thus enhanced by the number of powerlines crossing it and this will demand specially drawn up detailed fire prevention measures reflecting the field reality. Electric lines passing through forests often cause electrocution and death of many wildlife species. Either the lines may sag and hang low within the reach of large mammals like elephants or plants might grow and touch the line and while feeding the animals might get electrocuted when they come in contact with the plants that are touching the live circuits. During the period 1988 to 2003, in the Ranni Division, 18 elephants have been electrocuted to death. A routine inspection of the high tension lines passing through Gudarakal Range forests need to be carried out to locate potentially dangerous stretches where the lines might be hanging low. It should be explored whether any powerlines not of current use are still being retained.

The construction of the number of dams and ancillary structures within the forests of the Gudarakal Range demanded the construction of an extensive network of roads. Practically all these roads remain in usable condition even now. The extensive selection-felling activity carried out within the evergreen forests necessitated the construction of another network of roads. The Grassland Afforestation Division's work also resulted in the laying of a great length of roads across the grasslands. The ongoing reed extraction process not only keeps many of the old roads repaired and under use, additional roads have been laid for reed extraction. So in reality the accessible parts of the forests of Gudarakal Range, especially the plateau part of it has a great length of roads fragmenting the forest continuity, damaging the terrain, modifying the surface runoff pattern, causing soil erosion as well as in some places causing waterlogging through blocking drainage channels. In many locations movement of wildlife is blocked due to cutting of hill slopes for laying the roads. Roads have also triggered minor landslides, slumping of hill slopes and soil creep in many locations due to redirected surface flow. Although it may be stated that roads are of use for protection, they can also be used for illegal entry into the forest interior. It would be worthwhile to map all the existing road network and block all the

unnecessary access routes and in some locations even dig up the laid surface and plant it over to relink forest islands.

Gudarakal Range forests in the plateau has seven dams and extensive areas along the reservoir fringe where the forests have been cleared. There are at least two locations near the dam sites where temporary townships were located during the construction phase. Kochu Pamba, Pamba, Anathodu and Kakki are locations where thousands of workers stayed for a few years in the 1960s. Although the dams were completed decades ago, the dam sites even now remain derelict eco-disaster sites. Extensive treeless weed grown open areas, crumbling buildings, kilometres of abandoned roads, rusting machinery, electricity and telephone lines no longer used mar the landscape. All these pollutive sites are practically on the edge of the reservoirs. Encroachments into the lands, unauthorised occupation, pilferage of material etc create social problems apart from posing a grave threat to the remaining forests, biodiversity and even the dams and other assets. Down the plateau the same condition is repeated in Moozhiyar and Kakkad. They are also within the same Forest Range. In various parts of the State there are scores of such sites inside Reserve Forests, most of them in ecologically sensitive and biodiversity rich locations. Although they should have been taken back by the Forest Department long ago, these sites of river valley development continue to remain untended and fester. Gudarakal Range must have the largest number of such sites for any Forest Range in Kerala. There must be a comprehensive plan to reclaim all such locations and heal the ecological damage. Actually this should have been part of the original river valley development plan with an explicit timeframe and fund allocation.

The Value of Forests as Living Communities

It was only after the beginning of colonial administration that forest management began. Before that local communities directly depended upon forests. But when forests began to be looked upon as a revenue source, large-scale extraction of timber began. Timber is the most easily extracted resource from forests. Evergreen forests like that of Gudarakal Range have few hardwood species. With the development of plywood industry and the increasing demand for railway sleeper, evergreen forests also started getting exploited. Even then the forbidding terrain prevented any large-scale extraction from the road-less eastern segment of the Gudarakal forests. But the true wealth of these forests was its rainforest biotic communities. They have the widest spectrum of plants and animals. Especially in a well-buffered forest tract like Gudarakal, the continuous evolution of the living forms without any serious disturbances over a long time has resulted in an extraordinary diversity as well as very high endemism. The taxonomic explorations into the richness of new colonies were initially the prerogative of the European Planters and the British Government officials. Neither of these two categories of people ventured into the interior of the Gudarakal Reserve. Hence practically there is no benchmark data on the vegetation of this large tract of forests. Status of faunal studies also remains much the same. Actually Gudarakal Reserve remains the largest chunk of biologically little known tract in the Western Ghats. In the post-Independence period, unfortunately within a span of a quarter of a century, development resulting in large-scale destruction of forests was implemented in the most sensitive part of the Gudarakal forest. Prior to this development there was practically no data available on the biodiversity of the area. During the phase of destruction of these forests there was no data collection and

even thereafter there was no post-implementation assessment. Even the fragmentation of the forests which could be directly recorded has not been attempted. Reduction in the habitat of species cannot be properly assessed in the absence of benchmark data. Vulnerability of the residual species population cannot be assessed in the absence of information on the existing distribution range. The area has not been mapped for its ecosystem diversity.

The biodiversity assessment study initiated by the Periyar Foundation has begun to collect information on all aspects of the area with special emphasis on its natural systems and species wealth towards the better understanding of the management measures needed to protect its remaining biodiversity. Automatically the study of the flora is one of the most basic steps towards a better understanding of the area. This has to be followed up by a detailed study of the fauna. Unlike floral taxonomy, study of fauna requires collections of specimens, which itself would be more difficult than in the case of rooted plants, specialised preservation methods and a considerably more difficult procedures for identification. Especially in the case of invertebrate fauna, there is so much of structural specialisation and distinctly different groups of animals that taxonomists with specialisation on each group are needed to carryout inventorying. Only vertebrate groups have fairly comprehensive field manuals available for easy identification of the species. In the case of the invertebrates only freshwater molluscs, crustaceans, arachnids, odonates, and butterflies from among the group of insects, field identification of species can be attempted by a non-specialist. It would be a gigantic but unavoidable task to catalogue the biodiversity of the Gudarakal forests. The biodiversity assay initiated by the Periyar Foundation began by listing the birds, mammals and some of the vertebrate groups during the reported study.

Flora

The plant world provides the basic sustenance for the animal world. The richer the diversity of plants in an area, it automatically means that these plants are integrated as components in complex natural plant communities. Practically everywhere in the world animal species and animal communities are inseparably linked with plant communities forming biotic communities. Of all the existing biotic communities surviving in the world, the tropical rainforests are one of the richest as well as complex, containing the vast majority of existing biodiversity. 49,955 species of plants, which is roughly 20 percent of all the identified plant species, are found as endemics in 18 locations in different parts of the tropical world. These are referred to as hotspots. The Western Ghats is one of the two hotspots located in India. We have some data regarding the rapidity with which forests are vanishing in the Western Ghats. According to Prasad et al (1998) natural forests were lost from the Western Ghats of Kerala at the rate 0.90 percent per year during the period 1961-1988. 25.6 percent of the forest cover of the Western Ghats has been estimated to have been lost during the last quarter of the twentieth century according to Jha et al (2000). It is estimated that 7500 species of organisms are becoming extinct every year in the world (Chatterjee 1995). IUCN estimates ten percent of the world's flora to be in danger of extinction. According to Balakrishnan (1996) Western Ghats now harbour about 45,000 species of plants. The extinction of each species of plant we now know, will lead to the extinction of a number of animal species. If we are to extrapolate the ongoing deforestation rate and species richness of the tropical rainforests in the

Western Ghats, and project the possible rate of species extinction in here, we can get the indication of the disaster confronting us. Conservation measures require identification of relatively intact evergreen forest areas and their protection for safeguarding the contained species diversity. On the basis of detailed field surveys, even from among the disturbed and fragmented pockets, the more valuable tracts have to be protected. Habitats of species with restricted distribution wherever they are located will also have to be identified and protected.

Forests of the Gudarakal Range because it is mostly of the wet evergreen forest category can be assumed to be rich in plant diversity. Although this area has not been extensively surveyed for plant biodiversity, the contiguous eastern and northern tract – the forests of Periyar Tiger Reserve – has been fairly extensively studied. Because of the more western aspect, greater diversity of topography and higher rainfall it is possible that the forests of Gudarakal might harbour an even richer wealth of plants. The genus *Impatiens* with over 400 species recorded from all over the world, mainly from the mountains of Africa and South and South-east Asia, is remarkable for its high concentration in the southern Indian Peninsula. The moist or wet nature of the terrain in Gudarakal is reflected by the fact that 9 species of *Impatiens* has been recorded from here and there could possibly be more. A more systematic coverage of the western scarp faces would possibly add more species to the list. The fact that 77 species coming under the family *Cyperaceae* was recorded from here is an indication of its special ecological status. 73 species of plants belonging to the family *Orchidaceae* has been recorded from this area and out of these 14 species are restricted to the Southern Western Ghats or to Peninsular India. That many of these are rare species is an indication of the richness of this tract. Similarly 11 species of palms belonging to the family *Arecaceae* have been recorded from this tract and six of these are endemic to Western Ghats and one endemic to the western Peninsular India. One of them, *Bentinckia condapanna*, grows only along sheer cliff faces between 600 to 1400m elevations and hence the very exact habitat requirement of this species limits the area available for the species to survive in. Of the family *Araceae* which can grow only in moist soils, 21 species were recorded in the study area of which 5 species are strictly endemic to the Southern Western Ghats. Four of these endemic species are very endangered. In forests with adequate moisture and gaps, especially along the edges of grasslands and also in the understorey of hill forests, plants belonging to the family *Acanthaceae* are found. The genus *Strobilanthes*, belonging to this family, conspicuous by its gregarious flowering and monocarpic nature with over 200 species in the world is well represented in the Southern Western Ghats. 11 species belonging to this genus have been recorded from Gudarakal. 45 species belonging to family *Acanthaceae* have been recorded from the study area. 16 of these species are restricted to the Southern Western Ghats. Three of these species are reported to be rare. The genus *Actinodaphne*, normally a pioneer small tree on forest edges and gaps, belonging to the family *Lauraceae* has five different species occurring in this area and of the 34 species recorded from this family here 14 species are endemic to the Southern Western Ghats. This is one indication of the significance of this area from the point of view of evolution of some families, genera and species. 19 species of plants belonging to the family *Asclepiadaceae* have been recorded from the area 6 of which are restricted to the Southern Western Ghats. Seven species from the family are recorded to be endangered. The only indigenous conifer *Nageia wallichiana* recorded from Peninsular India, is strictly endemic to the Southern

Western Ghats and recorded from very few localities. This has been recorded from one location in the Gudarakal Range.

The forests of Gudarakal Range, particularly the eastern higher reaches of it, receiving heavy rainfall are also a rich habitat of pteridophyte flora. But during the present biodiversity survey the lower plant groups were not surveyed.

In the Gudarakal Range many areas of difficult access with potentially specialised habitats have never been biologically surveyed. This includes the scarp faces, forests along the gorges, the higher elevation shola-grassland vegetation and the middle elevation undisturbed grasslands. Hence seasonal plants, especially those found during the rainy season, could very well be missing out of the list. (Annexure 1)

Fauna

During the rapid biodiversity survey of Gudarakal Range only select faunal groups were sampled. Mammals, birds, reptiles, amphibians and fishes were listed. From among the vast diversity of invertebrate groups, only the butterflies were recorded. Expertise was not available to survey most of the other animal groups. In the case of most invertebrates as well as lower vertebrates, specimens will have to be collected, scientifically preserved and subjected to laboratory studies to confirm the exact taxonomic position. This is a time-taking task. This was not attempted during the present study. Because of the short duration of the survey and the nature of the habitat covered, the data generated cannot be considered as truly representative of the Gudarakal Range. But even this very cursory study brings out the biodiversity potential of the area. The faunal list appended is incomplete and tentative. Some records remain to be confirmed. Among fishes some specimens collected remain to be identified. A list of the faunal elements is appended.

Mammals

Among the fauna in any landscape the biodiversity component we observe and document first is often mammals. We see them more often as resources or as competitors in the habitat and respond to them accordingly. Being the more evolved forms, the abundance of mammalian fauna naturally is an indicator of the health of the ecosystem. As wilderness or the ultimate naturalness is eliminated from the face of the earth, we react to its disappearance partly by craving for it and wanting to interface with it almost as a spiritual quest. This should have been the guideline for true ecotourism – a sort of a spiritual pilgrimage into nature for recharging ourselves. Because of some quirk in our make-up, landscapes with wild mammals bring back to us the feeling of wilderness.

Gudarakal Range first and foremost gives us this feeling of wilderness not only through the impressions of the landscape, forests and the relative absence of human beings but also by the frequent encounter with wild mammals. Along with the contiguous Periyar Tiger Reserve forests, Gudarakal must be the best and the largest elephant habitat with the largest elephant population south of the Palakkad Gap in the Western Ghats. Although the prime elephant habitat in the lower reaches towards west had been severely disturbed by human intrusion and the habitat higher up in the Gudarakal Plateau practically totally destroyed by the reservoirs of the seven dams,

there is a large elephant population occurring within the Range. During the biodiversity survey every part of the forest surveyed had an abundance of evidences of elephants. Only one herd was encountered directly in the forest and two other herds were seen on the road by the team carrying out the socio-economic survey. However, fresh signs of elephant movement were seen in every part of these forests surveyed.

The Periyar Wildlife Sanctuary became a Tiger Reserve not on the basis of any estimation of the tiger population available in the area, but because it was the largest Protected Area in Kerala. In all probability the largest population of wild tigers anywhere in the Southern Western Ghats must be occurring in here. The mosaic of habitats, particularly the extensive grasslands along the western part of the Gudarakal Plateau had many signs indicating the presence of tigers. Our knowledge of the currently surviving tiger population is inadequate. We have very incomplete understanding of the minimum viable population needed for the species to survive. Even the extent of habitat required for a single animal to survive is not known in our type of forests. Hence we should aim at the protection of the largest possible contiguous tiger habitat to save the species from extinction. Gudarakal Range due to its contiguity with the Periyar Tiger Reserve, range of habitats suitable for tigers, very high prey density, absence of large human settlements and the absence of conflicting human demands on the forest resources presents the best potential location to be considered as an area for tiger conservation.

The extensive rainforest tract especially on the eastern part of the Gudarakal Range is an ideal primate habitat. The Lion Tailed Macaque, the Nilgiri Langur and the Bonnet Macaque were encountered in all the areas surveyed. The Nilgiri Langur population was particularly evident in the KFDC cardamom plantation area near Gavi. Because the survey was mostly restricted to the disturbed area on either side of the main north-south road traversing the Range, the extensive evergreen areas further to the east as well as the high statured forest in the sheltered valleys to the west which would be prime lion tailed macaque habitat were not covered. Only after surveying these areas the true status of the Nilgiri Langur and the Lion Tailed Macaque in the Gudarakal Range can be assessed.

The Gudarakal Range has two or more populations of Nilgiri Tahr along the western edge of the grasslands near the scarp face. The species was seen near Varayattukokka and evidences seen around Ponnambalamedu. Yet other populations could occur within the range not covered during the study.

Indicating the health of the ecosystem and the relatively less human interferences the area is being subjected to, evidences of other carnivores including leopard, wild dog and jungle cat were recorded in all the areas surveyed. Along the western part of the grasslands signs of sloth bear was very plentiful. Along the stream margins droppings of otters were encountered but identity of the species could not be ascertained. Again on the grasslands stripe-necked mongoose was seen. Droppings of two different species of civets were plentiful along the forest-grassland border.

In all the areas surveyed possibly with the exception of the dense secondary regenerating forests in the selection felled and damaged areas signs of sambar were encountered. West of Kochu Pamba a congregation of more than thirty sambar was seen and in the same area smaller groups of three or four were seen repeatedly. Both

in the grasslands and in the forest evidences of gaur were recorded but none were seen directly. The smaller ungulates namely wild boar, barking deer and chevrotain were encountered and evidence of their presence were recorded in all the areas surveyed.

The Malabar Giant Squirrel was seen in all the areas surveyed and a fairly large population could be reported from all the areas although more were seen in the KFDC cardamom plantations due to better visibility. The Large Brown Flying Squirrel was heard calling at Gavi at night. The duration of the field survey was too inadequate to assess the status of smaller mammals such as rodents, bats, shrews, pangolin etc. Around rocky outcrops within the forests and the grasslands, droppings of Black-Naped Hare and Porcupine were seen frequently. (Annexure 2)

Avifauna

The Western Ghats has been recognised as a global biological diversity hotspot and is known to be a habitat with a significant number of endemic bird species. 507 bird species have been recorded so far from the Western Ghats (Daniels 1997). The biodiversity of the Western Ghats includes a larger number of species that typically occur in the dry and moist deciduous and dry thorn forests. Fewer species occur in the evergreen forests but a higher proportion of them are endemics and species with restricted range. About hundred species can be stated as inhabitants of rainforests which include 16 endemic species. The endemics are Malabar Parakeet, Nilgiri Wood Pigeon, Malabar Grey Hornbill, Grey-headed Bulbul, White Bellied Tree Pie, Wayanad Laughing Thrush, Grey-breasted Laughing Thrush, Nilgiri Laughing Thrush, Rufous Babbler, Black and Orange Flycatcher, Nilgiri Flycatcher, White-bellied Flycatcher, White-bellied Short Wing and Crimson-backed Sunbird. In addition two species are not only endemic but with restricted range occurring in the higher altitude grasslands. They are the Nilgiri Pipit and the Broad-tailed Grass Bird. Out of the 16, six species are restricted to the Western Ghats south of Karnataka in the highest elevations. Some more species occurring in the Western Ghats are not widely distributed but are found in the other mountain ranges of Peninsular India, Himalayas and Sri Lanka. The Malabar Trogon, White-bellied Woodpecker, Great Hornbill, Asian Fairy Bluebird, White-cheeked Barbet, Mountain Imperial Pigeon, Rufous-bellied Eagle, Oriental Bay Owl, Jerdon's Baza, Black Baza and Sri Lanka Frogmouth are rainforest species with such a distribution pattern (Birdlife International 2001).

From the point of view of conservation of avifauna, the status of Western Ghat rainforest birds are very inadequately documented. According to Stattersfield et al, (1998) twelve species have been accorded near-threatened conservation status out of the sixteen species of birds with restricted range in the Western Ghats. Recent assessments report Nilgiri Laughing Thrush as an endangered species and Nilgiri Wood Pigeon, White-bellied Short Wing and Broad-tailed Grass Bird as vulnerable species. Grey Headed Fish Eagle, Malabar Pied Hornbill, Great Hornbill, Nilgiri Pipit, Grey-breasted Laughing Thrush, Black and Orange Flycatcher and Nilgiri Flycatcher have been categorised as threatened species.

The biodiversity assessment of Gudarakal was attempting to assess not only the overall avifaunal status but also record a presence of endangered, vulnerable and threatened species. However many potential habitats such as the higher elevation

forests which could harbour most of the endemics were not covered during this study. During the five-day field survey 150 bird species were recorded. The Periyar Tiger Reserve adjacent to Gudarakal Range is reported to have more than 270 bird species (Robertson & Jackson, 1992). It is to be expected that most of these species would also occur in the adjoining Gudarakal Range. During the survey seven endemic species, six winter migrants to rainforests and two threatened bird species were recorded. The Sri Lanka Frogmouth and the Great Hornbill are the threatened species observed. The Great Hornbill was heard in Chenthamarakokka area, Gavi, Kullar dam and seen in both Ponnambalamedu and Varayattukokka. The siting of Lesser Coucal and Zitting Cisticola in the mid elevation grasslands is another very interesting observation.

A full list of birds observed with the English name, the scientific name as well as the taxonomic position is given in the appendix. The taxonomy and nomenclature used is from Inskipp et al (1996) and Grimmett et al (1998). (Annexure 3)

Reptiles

The varied ecosystems found in the Gudarakal Range would be harbouring a rich reptilian fauna including snakes, tortoises, monitor lizard and other species of lizards, skinks and geckos. During the biodiversity survey only a few species of snakes and the monitor lizard were recorded.

Amphibians and Fishes

The freshwater fish and amphibian fauna occurring in any habitat have a special significance in assessing the biodiversity value of an area. The presence of both these vertebrate groups indicates availability of water. This is reflected upon the atmospheric humidity. Under terrestrial conditions this sustains rich and varied plant growth. In the climatic and terrain conditions occurring in the Western Ghats, at the sources of rivers tiny rivulets originate coursing down the slopes and joining together form hill torrents with many cascades and waterfalls. These tributaries coming off the mountains join together to form proper rivers. All along these watercourses a variety of micro-habitats are found. Because of the steepness of slopes, peaked heavy rainfall and violent discharge off the rocky slopes, river channels are separated by high ridges which prevent the movement of freshwater fishes across basin boundaries. Hence isolation results in speciation and the specialisation resulting from adaptation to specialised hill stream ecological conditions lead to very many species having limited distribution. The species richness of freshwater fishes in any habitat also indicates its biogeographic linkages and biogeographic history.

In comparison with our state of knowledge with respect to many other faunal groups, the fish fauna of Western Ghats are fairly well documented. Apart from the pioneering work of Jerdon (1847), Day (1865; 1878), Hamilton (1877) and Hora (1952) many recent workers have also studied the fish fauna of the Western Ghats. Out of the 287 species recorded from the Western Ghats, 196 species have been from Kerala. 60 species have been recorded from the Pamba basin so far even though many areas within the basin remain to be explored. Pamba basin is an exceptional river basin in Kerala because of the extensive forest cover in the basin from the highest reaches from around 1800m to very low elevations often as low as 60m above the sea

level. Because of the uninhabited forest cover there would have been very little pollution or modification of the river ecology. The terrain drained by Pamba is exceptional. The river has torrential stretches in the higher reaches and rapids along low elevations through gorges. There is also an extensive mid-elevation plateau where a large number of channels have meandering courses and wetland systems. Once they were within pristine forests but now these forests have been severely manipulated adversely affecting the morphology of the river channels and the very ecology of the freshwater systems. The Southern Western Ghats, particularly southward from the Pamba basin, is also exceptional in that the rainfall is well dispersed round the year with rainless months often reduced to two. Earlier practically most of the watercourses and wetland systems never dried up. Hence one could have considered Pamba basin as potentially an area capable of supporting a very rich diversity of freshwater fishes and amphibians.

But in this basin within the short span of a quarter of a century, a series of eight dams have come up. Practically every tributary excepting the southern most Kallar has been dammed and drastically modified. Almost simultaneously as the dams were stopping the free flow of rivers, all the forests in the midland plateau around dams were extensively severely subjected to timber extraction. This would have altered the ecology of all the freshwater systems in the area. This and the subsequent fire damage led to a large number of streams becoming seasonal. A large number of wetlands, shallow pools and swamps have been silted up and have become dry. Automatically, this ecological degradation of the forested part of the basin would have severely and adversely affected the fish and amphibian diversity. Hence all the more reason why the remaining less destroyed part of the basin be subjected to a systematic fish and amphibian survey.

Out of the 60 species so far recorded from the Pamba basin 16 are endemic to the Western Ghats and 8 are endemic to the Kerala part of the Western Ghats. This is an exceptionally high degree of endemism for a small basin covering just over 2200sq.km. area. Because of the inaccessible nature of the upper reaches of Pamba basin within the Gudarakal Reserved Forest, collections are difficult. It was not possible to survey this part of the Gudarakal Range during the current study. It is to be expected that if the remaining unmodified habitat is systematically surveyed the number of species recorded from the basin would increase significantly. One of the sixty species so far collected from Pamba i.e. *Puntius ophicephalus* has so far been collected only from Pamba and Periyar rivers. Menon (1999) has included it in the endangered category. Some introduced species have also become established in this basin. Three such species have been recorded so far and one of them was collected from the uppermost reaches of the Pamba tributary. (Annexure 4)

The survey was carried out during summer and most of the areas surveyed were along the grasslands or around the reservoirs. Amphibian collections were not attempted. Some species encountered were photographed and some fairly common species were visually identified. Hence the list of amphibians appended consisting of 17 species is very incomplete. A separate survey of amphibians in this tract is warranted. (Annexure 5)

Invertebrates

The vast majority of fauna fall within the invertebrate groups. The tropical rainforest harbour an exceptional wealth of insect fauna. The freshwater bodies and the rivers which abound in the Gudarakal Range would have a rich assemblage of aquatic invertebrate fauna. But the study team did not have the taxonomic expertise to document this major chunk of the biodiversity. The butterfly fauna alone was partially listed (Annexure 6). A detailed study of the aquatic invertebrate fauna particularly the dragonflies will be very valuable because of the potential list of species occurring in the study area. Because of the wide range of major taxonomic groups within invertebrates, each requiring specialist taxonomists, no attempt was made to collect them or identify them. This is a long-term work but should be started as early as possible because invertebrate fauna, particularly insects, play a very crucial role in the rainforest dynamics.

Human Communities Occurring within the Gudarakal Forest Range

Malampandarams are the only indigenous human community residing in the forests of the Gudarakal Range. But no detailed enumeration could be carried out of this population. Further west of the area covered, in the Chippankuzhy, there is a Ullada tribal settlement with a population of 51 people belonging to 13 families. Outside the study area on the western fringe at Attathodu there is a population of Mala Arayas and Ulladas. There is another tribal settlement at Bhayankaramudi. Within the study area the largest human population is within the KFDC cardamom plantation, most of whom are Sri Lankan repatriates. There are about 960 Tamil labour in the plantation. There are KSEB staff deployed at Kochu Pamba, Pamba, Kakki and Moozhiyar. There is also a small police force deployed to guard the dams. There is a Forest Station near Kochu Pamba although the station is called the Pachakkanam Station. There are a number of encroachment households at Pamba and Kochu Pamba. There are a number of illegal occupants in the disused KSEB quarters in the dam sites and the Moozhiyar Powerhouse site.

Possibly the largest transitory population in the study area is the reed workers. The Hindustan Newsprint Ltd and the Bamboo Corporation have been allocated four reed felling series with three coupes in each area. Cumulatively this covers about 440.32sq.km. They are Moozhiyar, Urani, Meenar and Chalakkayam. During the year 2004-2005, 13926 metric tonnes of reed is reported to have been extracted. They through sub-contractors employ a large labour force within the study area to extract reed during the four summer months. They have a significant impact on the forests even though their presence is seasonal.

Apart from timber and reed 16 types of non-wood forest products (NWFP) are legally permitted to be collected through the Seethathodu Scheduled Tribe Service Co-operative Society. The highest quantum collected consistently during the past six years has been kunthirikkam (damar). The estimated value of NWFP marketed through the Society during 2004-05 at that year's market price was Rs.3,40,000.

Sabarimala Pilgrimage

Within the Sabarimala pilgrim season practically the entire pilgrim movement is through Gudarakal Range. Only a small percentage who travel from Vandiperiyar via Vallakkadavu and Uppupara through the Periyar Tiger Reserve area and the pilgrims who use the traditional route from Erumeli and Kalaketti through forests of the Erumeli Range of Kottayam Division skirt the Gudarakal Range. Most of the pilgrims use the Chalakkayam-Pamba route. A few pilgrims travel through the Sathram Colony and then down to Sabarimala. This route is entirely through Periyar Tiger Reserve area. Ponnambalamedu located in the study area although not an open pilgrim site does attract visitors apart from Devaswam Board officials. On the Makaravilakku day the Makarajyothi is visible here. But during the field survey four busloads of pilgrims from Chennai were seen in the area. It was reported that they have been coming regularly during the last few years in April in connection with a new temple in Kochu Pamba, to partake in the festival and visit Ponnambalamedu also. This flow of people could very well expand and pose a threat to the tract.

Tourism

The sheer beauty of the landscape, verdant forests, the number of reservoir waterspreads, possibility of seeing wildlife especially in the grasslands, road access to the area and more than anything else the proximity to the well-established tourism destination of Thekkady points to the possibility of tourism development, especially what is currently labelled as ecotourism into the Gudarakal Range. Already the KFDC has developed an ecotourism facility at Gavi. Although forest check posts exist at Vallakkadavu, Kozhikanam, Pachakkanam and at Kochandy near Angamoozhi it is uncertain whether they block all vehicles coming to the area without any official reason. There could be movement of people residing in the KFDC plantations along the road up to Kochu Pamba. But in the section of the road beyond Kochu Pamba towards south and down to the plains up to Kochandi, there could only be Forest Department and KSEB personnel and reed workers using the road. All the other people using the road will have to be assumed to be unauthorised visitors. There has to be a very careful impact assessment study carried out before any tourism activity is permitted or developed in the area even if it is labelled ecotourism. To cite an example, the scarp edges along the western edge of the Pamba grasslands have very attractive locations such as Varayattukokka or Ponnambalamedu. One has a population of the Nilgiri Tahr while the other has great religious sanctity. Any human ingress into the Varayattukokka edge could simply destroy the existing Tahr population. The population occupies a very constricted habitat totally exposed to the east where the entire grazing range is easily accessible for people. By simply disturbing the animals during feeding hours the population can be destroyed. Ponnambalamedu is a very different site with a different tourism development possibility but the dangerous portents are very comparable. With the religious sentiments attached to the site, it is easy to trigger volatile situations by opening up the area to the public. The presence of the Downdan Estate and the large-scale development of tourism centred around plantations and conversion of estates into the so-called resorts result in misuse or use of public resources like forest and wildlife for private profit-making. Regulatory mechanisms and legally valid sharing of profits from such ventures must be worked out.

The Significance of the Forests of Gudarakal Range

- This forest has possibly the largest single unit of benchmark wet evergreen forests in Kerala.
- It is the most potentially valuable buffer and actually contiguous habitat located along the south-western part of the Periyar Tiger Reserve.
- This forest is possibly the most extensive tract of forests in Kerala which remains to be scientifically explored.
- Although it is extensive and very little known, parts of this forest have been so heavily disturbed in the recent past, it needs special protection and restorative management to regain its ecological health.
- Being the catchment forests in the upper reaches of Pamba River it has special importance for its watershed protection role for the hydroelectric projects.
- Due to the presence of the Sabarimala Temple Pamba River has to meet the water demands of the huge influx of pilgrims. To guarantee this water availability this forest has to be specially safeguarded.
- The extensive area, the range of biotopes and the biogeographical location suggest that this forest will have unusual biodiversity potential of both plants and animals. This has to be protected as an invaluable gene pool.

Potential Locations for more Detailed Biodiversity Studies

Although only a small fraction of the forests of the Gudarakal Range could be surveyed during this field visit, it was felt that three different segments of the Range would warrant priority exploration.

The deep gorges of the Pamba and Kakki Rivers at the base of the scarp offers sheltered habitats the like of which do not occur anywhere else in Kerala. Wherever the forests in these gorges have been left untouched by selection-felling or other human interferences they may very well provide the best representative locations of lowland evergreen forests in Kerala. The riparian vegetation along the river margins in these gorges and the sheltered slopes along the left bank of the rivers must be given priority for biodiversity assessment studies.

The Pamba-Periyar divide, especially its western slope forest falling within the Gudarakal Range must be the most insulated Ghat forest surviving at present. It has an extensive buffer belt of fairly undisturbed forests both towards east and west and has not been subjected to any significant human interferences in recent history. The higher reaches of this ridge above 1600m could have possibly many endemic species as well as species recorded from the Southern Western Ghats with very restricted range of distribution.

Along the southern margin of the Kakki reservoir and extending south and west is the least undulating part of the Gudarakal Range. This area must have had climax rainforests of exceptional richness. Very little of this old growth forests remain. There are only small residual islands of the original vegetation surrounded by extensive areas in various successional phases. In fact this is an ideal location for studying the process of regeneration of evergreen forest after heavy disturbance. Severe soil erosion after forest destruction and modified runoff have altered the wetlands, swamps and stream channels. A detailed biodiversity survey of this area is essential to locate the remnants of flora and fauna typical of the original wetland systems. The survey team could not cover this area. It could still be a habitat with a rich assemblage

of moisture loving plants, freshwater fishes, amphibians and some reptile groups which prefer such habitats. There is no comparable habitat anywhere in the Kerala Western Ghats.

Conclusions and Recommendations

- The study area falls within the Pandalam Hill section of the Southern Western Ghats. Part of the area immediately to the south-west of Periyar Tiger Reserve is a mid-elevation plateau extending from the source of the Pamba tributary of the main Pamba River south and south-east. It is separated from the lower slopes of the Ghats by a very pronounced sheer scarp face on the west. This plateau is called the Gudarakal Plateau. It slopes south-west and gradually south to the Achankovil Valley. This is a composite natural landscape unit which has to be treated as an entity in any natural resource development planning or conservation action.
- The Pandalam Hills landscape unit has an unusual range of topographic features. There are also a variety of forest ecosystems including the largest extent of mid-elevation grasslands and low-elevation as well as higher elevation evergreen forests. There are also within the evergreen forest tract an exceptional number of small scattered waterlogged or swampy patches and riparian biotic communities. Hence for preserving various biotopes within the rainforest biome this is an ideal location.
- The surveyed area has 7 hydroelectric dams located within it and another on the immediate western fringe. Hence the area is of exceptional sensitivity as catchment forests of already completed dams.
- The past working of forests and the construction of the dams have subjected a part of the Gudarakal Range to extremely severe habitat destruction and destructive disturbance to forest ecosystems. These forests hence must be given special protection and management assisting recuperation.
- The areas extremely severely degraded around the dams and the dam site colonies must be cleared of non-essential construction and restored to forests.
- Areas within the KFDC cardamom plantation, which do not have cardamom growth must be restored to natural forest vegetation.
- All measures must be taken to prevent further habitat fragmentation around the dam sites and along the grassland-forest interface.
- An extensive area of grasslands in the Range was planted up with eucalyptus earlier but most of the area does not have any crop. In view of this past experience, the intrinsic ecological value of natural grasslands must be recognised and should form part of future forest management measures. The areas where eucalyptus plantations have failed should be given total protection for natural regeneration. The plantation management measures adopted for eucalyptus should be reassessed if it is to be applied to the eucalyptus plantations in the grasslands of this Range in view of the changed perceptions regarding the area.
- At present the most widespread disturbance to the forest of the Gudarakal Range is reed extraction. The desirability, viability, consequences and all socio-economic aspects of reed extraction must be carefully re-evaluated and it must be curtailed in a phased manner. The phasing out of reed extraction must be gradual on the basis biodiversity or ecosystem value of the area.

- More than 1250 species of flowering plants were recorded with a high proportion of species endemic to the Southern Western Ghats and there were also a few species so far recorded only from the Periyar Tiger Reserve. A very rare indigenous conifer, *Nageia wallichiana*, also occurs in a few restricted localities in this area. On the basis of the assessment of the floral value of the area it is apparent that the exceptionally rich Gudarakal forests require protection on par with the forests of Periyar Tiger Reserve.
- The Gudarakal Range has a very rich mammalian fauna in particular with a large population of elephants. The area also has more than one Nilgiri Tahr population. Evidences indicate a very healthy population of all the other wild ungulates typical of the Western Ghat forests. The primate population is also recorded to be very healthy and includes lion tailed macaques. The Periyar Tiger Reserve and the adjacent Gudarakal Range combined would potentially have numerically the largest assemblage of the wild mammals of the Western Ghats.
- 7 of the 16 species of birds endemic to the Western Ghats were recorded during this short study. Direct observations during this survey indicated a good population of the Great Hornbill and hence in any conservation measure to protect this typical endangered rainforest bird, Gudarakal forest should have a pre-eminent position.
- The reptilian, amphibian and fish fauna also indicate the richness of biodiversity of the area, which again substantiates the potential value of the area as a biodiversity reserve.
- Proximity to Sabarimala and the flow of pilgrims through part of the area suggest a detailed perspective plan to regulate pilgrim movement through the area and reduce ecodegradation.
- Fortunately encroachment into the forest and conversion of natural forest into other land uses illegally is minimal in the study area. The existing illegal occupations must be eliminated as early as possible.

Looking Forward

Evolution of life of on earth has an unbroken continuity stretching over billions of years. Starting from an unfathomable whirlpool of physical and chemical forces, a simple spark of life began. It gradually went through the process of multiplying forms, functions and interrelationships into extremely complex systems of unrivalled functional integration and efficiency. Over this very long span of time, repeatedly life on earth has been beset by tidal waves of extinction. Yet life has rebounded and diversity regained always to richer than ever before levels. Now the stream of life is confronting another cataclysmic phase of dilution and disappearance due to human agency.

Simultaneously all over the world, consciousness of this happening and the corrective response are also gaining momentum. Areas in every part of the world are being set aside to protect ecosystems, species, specialised habitats and sensitive indigenous human communities. Means to reduce the pollution of our surroundings through technological measures, recycling, reusing and reducing consumption is also gradually permeating into all our routine activities. In a different dimension, the search for the rightful niche of our species in the larger design of life is also deepening in the spiritual, political and philosophical plane. Of all the various lines of

enquiry to safeguard our own existence through securing the right of existence of all other species, perhaps the easiest means is to protect those areas which have the richest of assemblage of lifeforms. Naturally these are the healthiest locations on the Biosphere. They would also automatically be the pivotal locations that maintain harmony of the various biophysical processes happening on earth.

In our small State of Kerala, within its ancient Western Ghat hill tract, of all the remaining immeasurably valuable rainforest ecosystems, the Periyar Tiger Reserve – Gudarakal complex is the most extensive and least disturbed tract. It is also the tract which can be most easily protected from human interferences. It has no large human habitations, roads cutting across it, unavoidable resource commitments, private enclosures or extensive plantations other than the KFDC cardamom plantation. It could possibly be the single largest compact tiger and elephant habitat with large viable populations of both the species. Together this area would also shelter the most extensive remaining riverine tract and associated freshwater ecosystems in the entire Southern Western Ghats. It would also be insulating a part of the home range of the Malampandaram tribal community.

In India conservation of natural forest ecosystems have another vital responsibility above and beyond species and benchmark ecosystem conservation i.e. safeguarding the vital security of water availability. Manipulation of tropical rainforest in the heavy rainfall steep mountainous areas of Western Ghats results in the degradation of forests and adversely affects their regulatory role in watersheds. Pamba is a very important river especially in view of the annual Sabarimala pilgrimage. Hence the catchment area of such an important river should not be subjected to any disturbance. The Gudarakal – Periyar complex proposed to be treated as a composite conservation complex would safeguard the sources of two major rivers in southern Kerala. Although Periyar Tiger Reserve protects the upper catchments of Periyar, the western flanks are exposed. Greater protection to Gudarakal Range is protecting Periyar and Pamba headwaters.

Over the past centuries, from a reckless tampering of the life supporting processes in the Biosphere and over-exploitation of all natural resources, the humankind is realising that our activities are only undermining the foundations of our own survival. The return to an ecologically viable existence and survival security is possible through gradual steps. The realisation of the true value of everything around us is one small but big step. Deciding to rectify the harm we have done to an area and doing our best to heal it may be for us in here a big step. But in the global context it is still a very small step. The way to true progress is after all step by step. How big a step we are willing to take is the challenge of the times and the answer is nothing but we proving to ourselves what we really are capable of. The whole future of Gudarakal forests is posing precisely this challenge to us.