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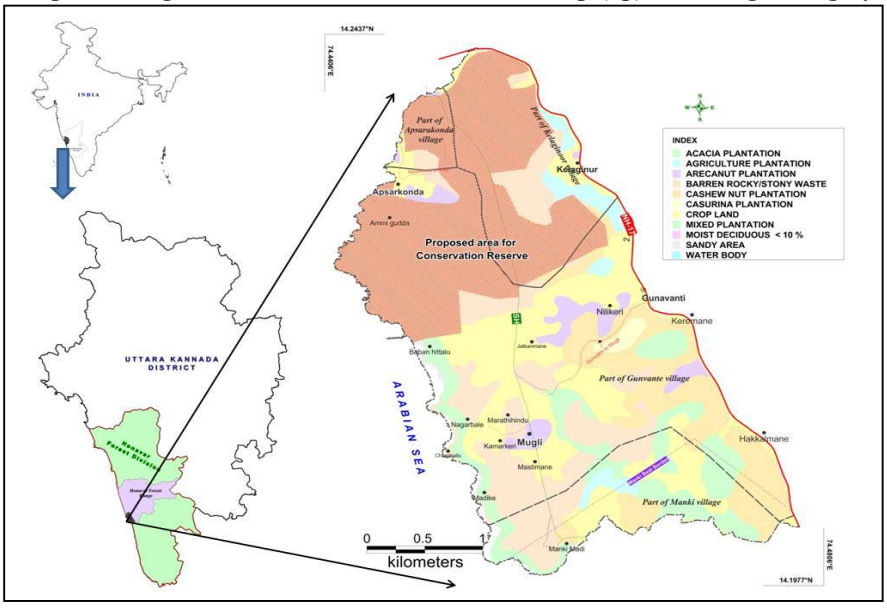
Proposed Mugali laterite Conservation Reserve map (up) and Google imagery



IMPORTANCE OF CONSERVATION OF LATERITC PLATEAU ECOSYSTEMS OF COASTAL UTTARA KANNADA

Preamble

According to the Ministry of Environment and Forests, Conservation Reserves can be declared by the State Governments in any area owned by the Government, particularly the areas adjacent to National Parks and Sanctuaries and those areas which link one Protected Area with another. Such declaration should be made after having consultations with the local communities. Conservation Reserves are declared for the purpose of protecting landscapes, seascapes, flora and fauna and their habitat. ***The rights of people living inside a Conservation Reserve are not affected.*** *This is unlike in National Parks and Sanctuaries where there are many stringent regulations regarding people living within them and on community rights and privileges. The PAs are constituted and governed under the provisions of the Wild Life (Protection) Act, 1972, which has been amended from time to time, with the changing ground realities concerning wildlife.*

1.0 INTRODUCTION TO LATERITES OF UTTTARA KANNADA

1.1. Geological History

Somewhere around 88-90 million years ago, during a time of great turbulence in Earth's geological history, when continents were splitting and drifting, creating even new oceans like the Atlantic and signaling the end of some others like the Tethys Sea, the Western Ghats were born or got an independent identity, when India separated from the east coast of Madagascar (. The elevated rifted edge of the Indian west coast, rising precipitously parallel to the ocean, the Western Ghats, has an undulating leeward side to the east merging with the Deccan Plateau. The separation of Seychelles, further north from the western margin, around 65 million years ago, was marked with some of the most violent Volcanic eruptions in the geological history, destroying much of life on the Earth and covering about 500,000 km area in land and sea with basaltic lava. The Deccan volcanic province on the land, as evident today from basaltic (lava solidified into rocks) outcrops, covers a vast area from almost northwards of Phonda in Goa and Belgaum in Karnataka, spreading eastwards and northwards stretching into Central India.

Whereas Madagascar, after separation from India, remained to the east of southern African coast, the Indian subcontinent drifted northwards from a position far down the equator, closer to Antarctica, through the ancient Tethys Sea towards Eurasia. Crossing of the equator towards the north, was a process that lasted through several million years, a period, understandably marked with high humidity and heavy rains, almost all over India, including the present Rajasthan desert, even which was covered with rain forests, as indicated by fossil pollen grains. The summits and ridges, the escarpment of the Western Ghats, became a dividing line for the watershed, a major drainage divide, creating numerous short distance rivers running down the escarpment towards the newly developing Arabian Sea; the rivers flowing eastwards, gradually descended the leeward slopes, through the Deccan Plateau to the eastern ocean.

Waters flowing down the west facing escarpment of Western Ghats would naturally erode the rocks, a process that probably went through the last 80-90 million years. Sheets of water rushing seawards would carry huge amounts of soils mixed with pieces and pebbles of rocks of diverse kinds depositing them along the coast. The gorges of the rivers Sharavathi (eg. at Jog waterfalls), Aghanashini (at Unchalli Falls), Gangavali (at Magod Falls), Kali (at Lalguli waterfalls), are mere remnants perhaps of scores of rapids that flowed into the Arabian Sea depositing eroded materials all along the coast causing raised platforms and mounds resulting in certain recession of the Western Ghats. Today, in Uttara Kannada district for eg., much of this ancient deposited materials by palaeo-water courses, constitute compact, flat topped low level hills and plateaus abutting the Western Ghats, and flanking present day rivers like Sharavathi, Aghanashini, Gangavali etc., are in all probability predating the Maharashtra coastal formations heavily influenced by Cretaceous-Tertiary boundary volcanism.

The collision of Indian sub-continent with south China region in Eurasia, marking the end of its northward drift, caused the rise of the Himalayas. India's placement today in the northern hemisphere, its southern tip at almost 8°N lat, coupled with the Himalayan barrier caused increased aridity and development of monsoonal climate. Rain forests perished everywhere except in North-East and in southern Western Ghats where they survived due to relatively more rainy months. Everywhere in the peninsular India, water levels would have lowered in the rivers, many ancient watercourses drying up or persisting as streams in deep valleys and gorges. dried up or turned seasonal, but the deposits of eroded materials exposed as the low, hilly compacted coastal landscapes, that is for instance the hallmark of Uttara Kannada.

1.2. What is laterite?

'Laterite' is the Latin word for brick. Francis Buchanan (1807) described laterite for the first time in Angadipuram in Kerala, while looking for iron ore occurrence in Malabar region:

> "In all the hills of the country there is found forming beds, veins, or detached masses in the substratum of industrial clay …. one of the most valuable materials for building. It is diffused in immense masses, without any appearance or stratification, and is placed over

> the granite which forms the basis of Malayala. It is full of cavities and pores, and contains a very large quantity of iron in the form of red and yellow ochres. In the mass, while excluded from the air, it is so soft, that an iron instrument readily cuts it, and is dug up in square masses with a pickaxe…. It very soon becomes as hard as a brick, and resists the air and water much better than any bricks I have seen in India".

The general features of laterites are as shown below:

1. Presence of large amounts of hydrated iron, aluminum and manganese oxides
2. Depletion of free silica
3. Alumina (aluminum oxide) combines with silica to form kaolin, or white clay, that is mainly aluminum silicate
4. Negligible or no bases and alkalies
5. Hardening on exposure to air; in wet conditions it is softer, and can be cut easily, cured and used as bricks.
6. Basically a vesicular rock, having large pores, vesicles and tubular (vermiform) cavities, often filled with kaolin if the laterite is underneath soil and not exposed to severe weathering.

Bourgeon (1989) considers laterites/lateritic soils as characteristic of the coastal hinterland of Western Karnataka. This hinterland is formed by the dissection of old laterized geomorphic levels. In this geological relief closer to the coast are laterite capped mesas (tablelands with steep sides). These are most typical, hardened flat topped hills, more towards the coast (Apsarakonda, Gunavanti, Dhareshwar, Gokarna, Tadadi, Aghanashini fort etc.); but these tablelands may be present inland coast along the river valleys (Eg: Muroor hill and Divgi-Mirjan plateau alongside Aghananshini). These tablelands are not perfectly plain having also elevations and depressions, all laterized on the top. The convex portions have bare laterite and the depressions with pockets of soil as well as crevices have plant growth that is discontinuous clumps (mainly *Sapium insigne, Memecylon umbellatum, Flacourtia indica, Ixora coccinia; Plectranthus rheedei* etc.). Bigger and flatter depressions having thin layers of soil (>50 cm) are cultivated.

Most of the coastal laterite mesas and other elevations are barren, scorified, hard and black with exposed honey comb structure, with soil remaining only in depressions or crevices. Hills with better vegetation, and slopes of these hills are often strewn with massive boulders of exposed laterite with more of soil pockets between them. Such hill sides are covered with better vegetation, including certain evergreen species, which may include even cinnamon and canes otherwise to be found in interior forests.

According to the Geological Survey of India (2006) majority of the rock sequences in Karnataka are laterised due to their exposure to suitable climatic conditions for prolonged period. These laterites occur as extensive cappings in the Western Ghats and coastal plains. Their thickness ranges from a few cm to as much as 60 m. Based on their elevation level, two types are

identified, one at +600 m elevation confined to Western Ghats and the other fringing the coastal lines along the west. The latter type is gravelly to sandy in texture and appears to be transported, whereas those transported to Ghats are homogeneous and less sandy. In the Uttara Kannada district the generalized laterite profile displays a reddish brown lateritic soil on top underlain by hard, concretionary and pisolitic laterite, underneath which is 0.3 m thick aluminous laterite and 0-4 m thick bauxite zone. Kumta, Honavar and Bhatkal laterits are considered good examples.

1.3. Primary laterite (high level laterite)

Palaeomagnetic studies reveal laterites over the tops of plateaus on the Western Ghats are older than those over the coast. The former are found over the Deccan basalt and even over the older Pre-Cambrian. High level laterite reveals an anticlinal structure and could obviously be developed from the basalt strata below. The coastal low level laterite has a general westward slope, indicating possibly the effect of neotectonic activities (of recent origin) in the region (Ramakrishnan and Vaidyanathan, 2008). Many hills and plateaus in Maharashtra are formed by *in situ* transformation of the parent rock beneath, the basalt, which is of volcanic origin. As far as Western Ghats covering Maharashtra and North Goa are concerned Widdowson and Cox (1996) documented the high level laterites as capping the high summits forming a trail from Phonda (16°N), Devrukh (17°N), Bamnoli Range (17°30'N), to Mahabaleswar plateau (18°N). These laterites are very similar in composition to the parent rock the basalt, of volcanic origin. Stratigraphic studies reveal their beginnings in Early Tertiary Age, obviously after Deccan volcanism 65 Mya. Laterite formation is essentially due to a process called laterisation, which involves removal of soluble elements by water. In Maharashtra laterites, both high level and the coastal are formed by weathering related to water. The most extremely laterised rocks predominantly consist of aluminium oxides and ferric oxides. These rocks are largely stripped off easily soluble oxides of silicon, calcium, magnesium and sodium. Potassium oxide is much less depleted and is present in the clay of laterite formations. The less mobile elements are Zirconium and Nobelium, which have their concentrations, nearly as much as in basalt, clearly establishing the laterite of Maharashtra as of basaltic origin (Widdowson and Cox, 1996). We may here refer to parent rock (for eg. basalt) transformed by weathering, involving mainly leaching of soluble elements by water, leaving behind, a porous honey-combed structure, capping the parent rock itself as primary laterite. These are *in situ* formations as seen towards the summits of Maharashtra ghats.

1.4. Secondary laterite (Low level laterites)

In Maharashtra, the Konkan coast low level laterites, often below 100 m, are extensively present filling areas between volcanic basaltic rocks. There has been a severe erosion of mountain tops and deposition along the Konkan coast, happening through millions of years. This created indeed the coastal stretches and the recession of the Western Ghats eastwards. The weathering of these eroded and re-deposited materials created the coastal laterites of Maharashtra. The elemental

composition is more similar to existing rocks, much of it is basaltic, but need not show as much correlation with basalt as in the high level laterites. We may therefore conclude that the coastal laterites of Konkan region are more of origin from deposited materials from erosion of Western Ghats and in situ formation from low level basalts, mingled together.

The Indian south-west coast laterites are considered to be of secondary nature, being formed from sedimentary deposits such as gravels and pebbles by sesquioxide impregnation and cementation. They are pellet type and quite different from the underlying soil or bedrock. These laterites have a continuous softening effect with depth. The laterites are normally subjected to alternate wet and dry climates (Ranjan and Rao, 1991).

1.5. Laterites of Uttara Kannada coast

Anybody who visits Uttara Kannada coastal taluks, particularly Kumta, Honavar and Bhatkal, and Ankola to some extent, will not fail to note the extensive stretches of darkish, honey comb like rocks covering hills and plateaus. Many hills are almost fully covered by a thick and hard mantle of this rock with very little or no soil. The vegetation on such hills is sparse and confined to crevices and depressions having trapped soils. Only during the incessant rains of July to September we find these rocks getting covered with slimy algae and several kinds of tiny herbs, including many insectivorous ones (*Utricularia* spp., and *Drosera indica*). The rock pools during the rains get colonized by several water plants, including the rare endemics. Clinging to the rocks grow woody species like *Memecylon umbellatum, Syzygium caryophyllata, Sapium insigne, Ficus arnottiana* and several thorny bushes. The coastal hills were barren and denuded from the dawn of history. Human impact in the form of shifting cultivation, biomass removal and cattle grazing were cited as the reason for soil erosion and laterisation of the hills.

1.6. Structure of laterite

Laterite hills and plateaus towards the coast may be viewed as mounts of soil covered with iron rich carapace or shell of laterite rock. The outer laterite, exposed to the atmosphere, is dark and gives the appearance of solidified and eroded lava. The inner laterite has varied colours, different hues of red, yellow of purple. The outer laterite has honey-comb appearance, full of empty pores. The inner laterite has vermiform tubes and vesicles or cavities coated by deposits iron rich substance. The cavities are often filled with loose, light coloured material. Below the mantle of laterite, good soil, yellow to orange or red in colour, is found. In the exposed outcrops the filling material is often missing being washed away by rains. The hills of the coastal zone further interior are higher; their sides are more eroded and their tops are not as wide as the tablelands towards the coast. Under forest vegetation there is good soil cover on the surface of ferruginous lateritic layer below. If the forest is cleared, easy leaching of soluble substances and erosion of fine soil particles exposed to heavy rains leaves behind bare laterite rich in iron with honey-combed structure.

The collision of the north drifting India with Eurasia, towards the south of China, resulted in the rise of the Himalayas. The northward drift, away from the humid equatorial regime and the great wall of Himalayas created major climatic changes bringing in monsoonal rains and greater dryness. The rain forests perished everywhere except in South Indian western Ghats and North-Eastern states. The Rajaputana Desert was born and Deccan became a semi-arid territory. As rains would decline even in the Western Ghats the rivers would shrink and valleys, especially along the west through which sheets of water rushed towards the sea, depositing eroded materials along the coast, would vanish or get reduced to smaller streams. These ancient deposits by palaeo-rivers, were in the form of plateaus and flat topped hills, hardly exceeding 100 m in height anywhere.

These coastal highlands formed a distinct geological territory along many parts of the South Indian west coast, most noticeably in the districts of Uttara Kannada (North Kanara), Udupi, Dakshina Kannada in Karnataka and Kasargod and Kannur in Kerala, and to lesser extent in other southern districts. These novo-formed low hills and plateaus would also have had rain forests once, just like the western face of Western Ghats.

1.7. Case for declaration of Laterite Conservation Reserves

Conservation Reserves are declared for the purpose of protecting landscapes, seascapes, flora and fauna and their habitat. The rights of people living inside a Conservation Reserve are not affected. Conservation Reserves can be declared by the State Governments in any area owned by the Government. Particularly stressed are areas adjacent to National Parks and Sanctuaries and those areas which link one Protected Area with another. Such declaration should be made after having consultations with local communities.

In the cases proposed here of the two lateritic plateaus as Conservation Areas, it needs to be admitted that these are not adjacent to National Parks and Sanctuaries, nor they link one PA with another. We recommend these areas strongly for protection because of their uniqueness in flora, and to some extent in fauna, their ancient geological ages, the formation beginning 88-90 Mya.

2. LATERITE BIODIVERSITY OF UTTARA KANNADA

2.1: Plant Diversity

The coastal landscapes of Uttara Kannada, mainly from parts of Ankola taluk in the north to Bhatkal taluk in the south, are notable for spectacular formations of low level laterite hills and plateaus. The valleys in between them are good water yielding places, perhaps were ancient water courses through which greater volumes of waters flowed, before they were reduced, as are today, into a network of green veins running through an otherwise bleak spectacle of denuded low hills and plateaus. These coastal lateritic formations, in all probability lost most of their surface soils during the last three millennia of history of shifting cultivation and savannization for domestic cattle and to keep away predatory wild animals for safety of humans and livestock. Surface laterisation process, as was already explained earlier, resulted in formation of hardened, indurated mantle. These lateritic formations, most of which is under the control of the Forest Department, have been naturally considered as one of the most unproductive terrain, from early British times.

The woody vegetation on such hills was mostly composed of stunted trees and shrubs such as *Sapium insigne, Strychnos nux-vomica, Zizyphus mauritiana, Plectronia parviflora, Grewia microcos, Flacourtia Montana, Ficus arnottiana, Memecylon edule, Syzygium corymbosa, Aglaia roxburgiana* etc. The wetter valleys in between have more evergreen species which are also found in the Western Ghats further interior. Many sparsely populated villages and hamlets, along with their spice gardens and rice fields are situated in these valleys. The village cattle would be seen grazing in these hills, with of course poor forage for them, except in protected portions under private control, where grows tall *karada* grasses, cut and stored by farmers after the end of the rainy season, when these grasses start drying up.

What was often overlooked was the fact that during the period of torrential rains, especially from June to almost the close of September, most of these apparently barren hills turn into altogether a different kind of seasonal ecosystem of wet rocks, shallow bogs and marshes and temporary streams, teeming with numerous herbs in myriad flowers of varied hues which attract a variety of insects, especially bees and butterflies.

These laterite ecosystems have scores of species of herbs, many of them endemic to the Western Ghats west coast regions. The scarcity of nutrients in the rocky substratum favour here a flourish of insectivorous herbs, the bladderworts (*Utriculalria* spp.) and sundews (*Drosera* spp). These make up for t nitrogen deficiency in the medium by resorting to trapping of tiny insects and digesting them using specially modified leaves. Yet another group of plants are some members of the family of Scrophulariaceae, like *Striga, Sopubia* and *Rhamphicarpa* specialized in root parasitism. Some legumes here have root nodules with nitrogen fixing bacteria in them.

The general consideration of these lateritic formations as of not much utility to humans made the government to give concessions to local people to gather biomass from these hills for fuel, manure and fodder. Further, quarrying for laterite bricks, the most common building blocks of the district has been a rampant activity disfiguring the hills and causing damages to their special ecosystems as well as with adverse effects on local hydrology. As tree growth is sparse and slow, over the last three decades the forest Department raised in large scale monoculture plantations of the fast growing exotic tree *Acacia auriculiformis*, to meet the growing demand for timber, fuel and pulpwood.

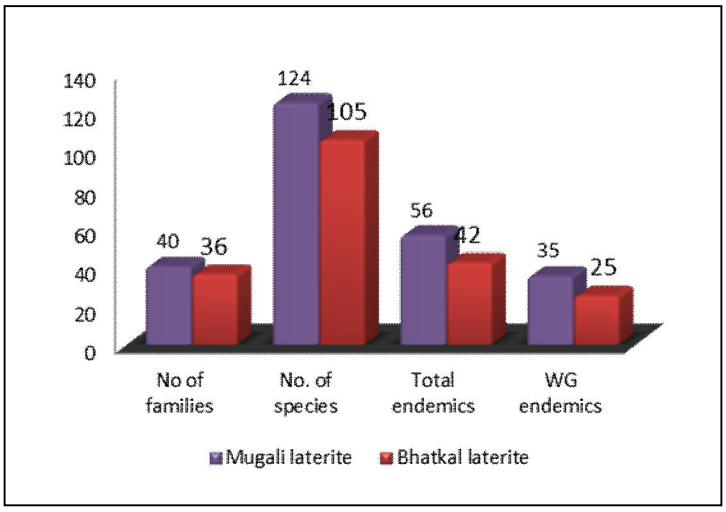
We undertook this survey (Figure 1) specially to survey the vegetation of these laterite hills and plateaus, mainly with the purpose of protecting at least some of these primeval geological formations, with great bearing on continental drift and formation of west coast, along with their for their very special seasonal ecosystems. Out of the many hills and plateaus surveyed during the current rainy season, we recommend specially two of them, one in the taluk of Bhatkal (Bhatkal plateau) and the second in Mugali plateau in Honavar taluk.

Many exclusive species of flowering plants co-evolved with the laterite terrain micro-level heterogeneity. For instance, deeper lateritic bogs support *Eriocaulon cuspidatum*, shallow bogs *Weisneria triandra* while marshy areas have *Utricularias* and other species of *Eriocaulons*. As water is the most critical limiting factor as soon as the rains stop by early October most of these annuals except few such as mat forming hardy perennial herb *Lepidagathis prostrata* and tuber perennating ones like *Euphorbia fusiformis* and *Curculigo orchiodes* die off. Of the two places that we found of the lot as having most specialized lateritic herbs, Bhatkal plateau had richer growth of herbs, since there were more seasonal streams, marshes and meadows. Mugali plateau had its own complement of species and includes as well as the newly developed and spectacular Apsarakonda park, towards its sea facing slope and commanding view of the ocean from the plateau. In comparison was the thinner and sparser vegetation lower diversity of species of Gokarna and Belekeri study areas. Honavar and Kumta laterite formations were intermediate in their biodiversity.

Scrub jungle vegetation with *Memecylon edule, Flacourtia Montana, Canthium parviflora, Sapium insigne* and plantations of cashew-*Anacardium occidentale* were found Mugali plateau. The rainy season splendor of herbal vegetation, especially of insectivorous plants and several rare endemics and the massive flowering at a time when most people hesitate to step into these rocky expanses, is remarkable. Not only these laterites are picturesque to look but they also support wide range of insects such as bees, carpenter bees, beetles, various butterflies etc. acting as a critical food resource for these species during the rainy period when flowering is scanty elsewhere. The numbers of plant species (mainly herbs) and the status of endemism, in Mugali-Apsarakonda lateritic plateau in comparison with that of Bhatkal plateau are given in the Figure 2. Both have excellent assemblage of species and high endemism levels despite openness and harshness of the terrain. Family richness of both the study areas is given in Figures 3 and 4.

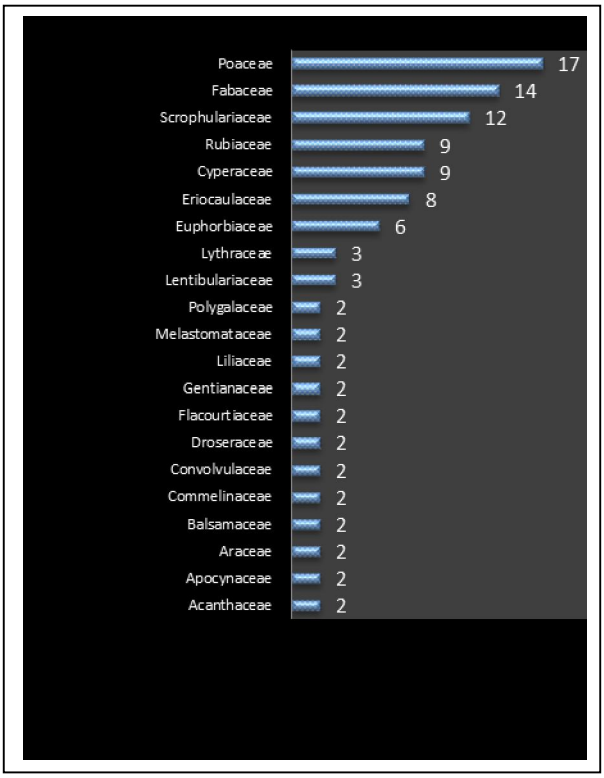
Figure 1: Examining microtopography linked plant species distribution in a laterite plateau

Figure 2: Floristics and endemism in Mugali and Bhatkal laterite plateaus



Note: Total endemics include India and Sri Lanka together

Figure 3 (L): Family richness in Bhatkal plateau; Figure 4 (R): In Mugali plateau



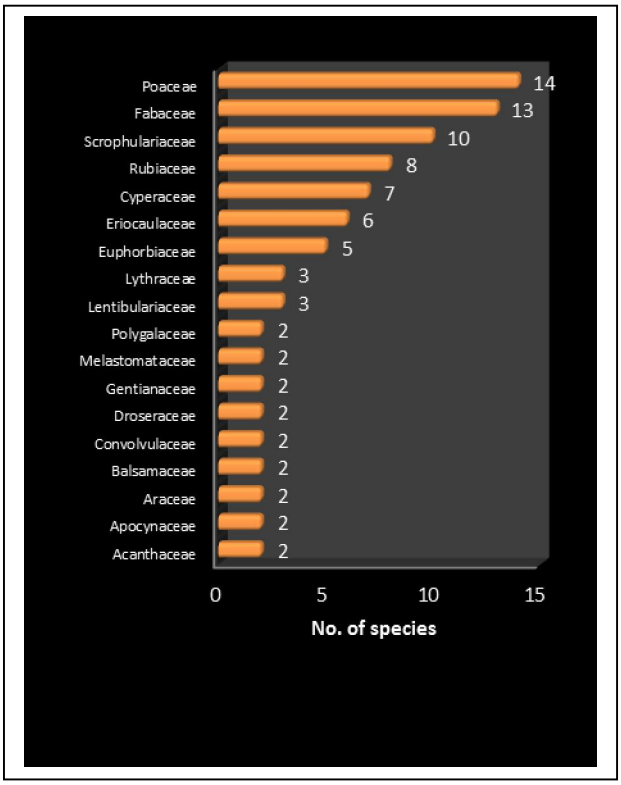


Table 1: Checklist of laterite plants in Mugali plateau of Uttara Kannada

Sn.	Family	Genus	Species	Habit	Endemics
1	Fabaceae	*Alysicarpus*	*bupleurifolius*	Herb	
2	Araceae	*Amorphophallus*	*bulbifer*	Herb	India
3	Poaceae	*Arthraxon*	*lancifolius*	Herb	
4	Poaceae	*Arundinella*	*metzii*	Herb	Western Ghats
5	Scrophulariaceae	*Bacopa*	*hamiltoniana*	Herb	
6	Scrophulariaceae	*Bacopa*	*floribunda*	Herb	
7	Begoniaceae	*Begonia*	*malabarica*	Herb	Western Ghats
8	Poaceae	*Bhidea*	*burnsiana*	Herb	Western Ghats
9	Oxalidaceae	*Biophytum*	*reinwardii*	Herb	Western Ghats
10	Hydrocharitaceae	*Blyxa*	*aubertii*	Herb	
11	Cyperaceae	*Bulbostylis*	*densa*	Herb	
12	Burmanniaceae	*Burmannia*	*pusilla*	Herb	
13	Gentianaceae	*Canscora*	*decurrens*	Herb	Western Ghats
14	Rubiaceae	*Canthium*	*parviflorum*	Shrub	

15	Apocynaceae	*Carissa*	*carandas*	Shrub	
16	Flacourtiaceae	*Casearia*	*zeylanica*	Shrub	India, Sri Lanka
17	Fabaceae	*Cassia*	*tora*	Herb	
18	Fabaceae	*Cassia*	*mimosides*	Herb	
19	Apiaceae	*Centella*	*asiatica*	Herb	
20	Asclepiadaceae	*Ceropegia*	*attenuata*	Herb	Western Ghats
21	Fabaceae	*Crotalaria*	*pallida*	Shrub	
22	Fabaceae	*Crotalaria*	*verrucosa*	Herb	
23	Fabaceae	*Crotalaria*	*filipes*	Herb	Western Ghats
24	Fabaceae	*Crotalaria*	*lutescens*	Shrub	Western Ghats
25	Liliaceae	*Curculigo*	*orchioides*	Herb	
26	Zingiberaceae	*Curcuma*	*neilgherrensis*	Herb	Western Ghats
27	Commelinaceae	*Cyanotis*	*papilionaceae*	Herb	Western Ghats
28	Cyperaceae	*Cyperus*	*iria*	Herb	
29	Cyperaceae	*Cyperus*	*compressus*	Herb	
30	Fabaceae	*Desmodium*	*triflorum*	Herb	
31	Poaceae	*Dimeria*	*ornithopoda*	Herb	
32	Poaceae	*Dimeria*	*hohenackeri*	Herb	Peninsular India
33	Scrophulariaceae	*Dopatrium*	*junceum*	Herb	
34	Droseraceae	*Drosera*	*indica*	Herb	
35	Droseraceae	*Drosera*	*burmanii*	Herb	
36	Poaceae	*Echinochloa*	*colona*	Herb	
37	Poaceae	*Eragrostis*	*uniloides*	Herb	
38	Eriocaulaceae	*Eriocaulon*	*xeranthemum*	Herb	India
39	Eriocaulaceae	*Eriocaulon*	*cinereum*	Herb	
40	Eriocaulaceae	*Eriocaulon*	*lanceolatum*	Herb	South India
41	Eriocaulaceae	*Eriocaulon*	*stellulatum*	Herb	Western Ghats
42	Eriocaulaceae	*Eriocaulon*	*eurypeplon*	Herb	Peninsular India
43	Eriocaulaceae	*Eriocaulon*	*fysonii*	Herb	Western Ghats
44	Eriocaulaceae	*Eriocaulon*	*odoratum*	Herb	Western Ghats
45	Eriocaulaceae	*Eriocaulon*	*cuspidatum*	Herb	Western Ghats
46	Euphorbiaceae	*Euphorbia*	*fusiformis*	Herb	India
47	Euphorbiaceae	*Euphorbia*	*notoptera*	Herb	Western Ghats
48	Euphorbiaceae	*Euphorbia*	*thymifolia*	Herb	
49	Convolvulaceae	*Evolvulus*	*alsinoides*	Herb	
50	Convolvulaceae	*Evolvulus*	*nummularius*	Herb	
51	Cyperaceae	*Fimbristylis*	*schoenoides*	Herb	
52	Cyperaceae	*Fimbristylis*	*littoralis*	Herb	
53	Cyperaceae	*Fimbristylis*	*woodrowii*	Herb	Western Ghats

54	Flacourtiaceae	*Flacourtia*	*indica*	Shrub	
55	Fabaceae	*Geissaspis*	*cristata*	Herb	Western Ghats
56	Fabaceae	*Geissaspis*	*tenella*	Herb	Western Ghats
57	Poaceae	*Glyphochloa*	*acuminata var. acuminata*	Herb	Western Ghats
58	Orchidaceae	*Habenaria*	*commelinifolia*	Herb	
59	Rubiaceae	*Hedyotis*	*cyanantha*	Herb	South India
60	Rubiaceae	*Hedyotis*	*corymbosa*	Herb	
61	Boraginaceae	*Heliotropium*	*indicum*	Herb	
62	Poaceae	*Heteropogon*	*contortus*	Herb	
63	Gentianaceae	*Hoppea*	*fastigiatq*	Herb	
64	Linaceae	*Hugonia*	*mystax*	Shrub	India, Sri Lanka
65	Balsamaceae	*Impatiens*	*rosea*	Herb	India
66	Balsamaceae	*Impatiens*	*raziana*	Herb	Western Ghats
67	Fabaceae	*Indigofera*	*prostrata*	Herb	India
68	Poaceae	*Indopoa*	*paupercula*	Herb	Western Ghats
69	Liliaceae	*Iphiginia*	*pallida*	Herb	Western Ghats
70	Poaceae	*Isacne*	*globosa*	Herb	
71	Poaceae	*Ischaemum*	*mangaluricum*	Herb	Western Ghats
72	Poaceae	*Ischaemum*	*indicum*	Herb	South India
73	Poaceae	*Ischemum*	*semisagittatum*	Herb	India, Sri Lanka
74	Rubiaceae	*Ixora*	*coccinea*	Shrub	Western Ghats, Sri Lanka
75	Acanthaceae	*Justica*	*simplex*	Herb	
76	Leeaceae	*Leea*	*indica*	Shrub	
77	Acanthaceae	*Lepidagathis*	*prostrata*	Herb	India
78	Lamiaceae	*Leucas*	*lavandulifolia*	Herb	
79	Scrophulariaceae	*Lindernia*	*ciliata*	Herb	
80	Scrophulariaceae	*Lindernia*	*crustacea*	Herb	
81	Scrophulariaceae	*Lindernia*	*hyssopoides*	Herb	India, Sri Lanka
82	Scrophulariaceae	*Lindernia*	*pusilla*	Herb	
83	Scrophulariaceae	*Lindernia*	*antipoda*	Herb	
84	Melastomataceae	*Memecylon*	*edule*	Tree	Western Ghats
85	Loganiaceae	*Mitrasacme*	*pygmaea*	Herb	
86	Molluginaceae	*Mollugo*	*pentaphylla*	Herb	
87	Commelinaceae	*Murdannia*	*semiteres*	Herb	
88	Rubiaceae	*Mussaenda*	*laxa*	Shrub	Western Ghats
89	Rubiaceae	*Neanotis*	*foetida*	Herb	Western Ghats
90	Rubiaceae	*Neanotis*	*rheedei*	Herb	Western Ghats
91	Menyanthaceae	*Nymphoides*	*parvifolia*	Herb	

92	Poaceae	*Oplismenus*	*burmanii*	Herb	
93	Poaceae	*Oryza*	*rufipogon*	Herb	E and S India
94	Euphorbiaceae	*Phyllanthus*	*urinaria*	Herb	India
95	Euphorbiaceae	*Phyllanthus*	*simplex*	Herb	
96	Polygalaceae	*Polygala*	*elongata*	Herb	
97	Cyperaceae	*Pycreus*	*stramineus*	Herb	
98	Scrophulariaceae	*Ramphicarpa*	*longiflora*	Herb	Western Ghats
99	Apocynaceae	*Rauvolfia*	*serpetina*	Shrub	
100	Cyperaceae	*Rhynchospora*	*wightiana*	Herb	Western Ghats
101	Lythraceae	*Rotala*	*malampuzhensis*	Herb	Western Ghats
102	Lythraceae	*Rotala*	*indica*	Herb	
103	Lythraceae	*Rotala*	*densiflora*	Herb	
104	Polygalaceae	*Salmonia*	*ciliata*	Herb	
105	Euphorbiaceae	*Sapium*	*insigne*	Tree	
106	Cyperaceae	*Schoenoplectus*	*lateriflorus*	Herb	
107	Pedaliaceae	*Sesamum*	*ratiatum*	Shrub	
108	Fabaceae	*Smithia*	*conferta*	Herb	
109	Fabaceae	*Smithia*	*salsuginea*	Herb	Peninsular India
110	Melastomataceae	*Sonerila*	*rheedii*	Herb	Western Ghats
111	Scrophulariaceae	*Sopubia*	*delphiniifolia*	Herb	Oriental-S India, Sri Lanka
112	Rubiaceae	*Spermacoce*	*articularis*	Herb	
113	Rubiaceae	*Spermacoce*	*pusilla*	Herb	
114	Scrophulariaceae	*Striga*	*lutea*	Herb	
115	Scrophulariaceae	*Striga*	*gesnerioides*	Herb	Western Ghats
116	Araceae	*Theriophonum*	*dalzellii*	Herb	Western Ghats
117	Lentibulariaceae	*Utricularia*	*reticulata*	Herb	India, Sri Lanka
118	Lentibulariaceae	*Utricularia*	*lazulina*	Herb	Western Ghats
119	Lentibulariaceae	*Utricularia*	*striatula*	Herb	
120	Asteraceae	*Vernonia*	*cineria*	Herb	
121	Alismataceae	*Weisneria*	*triandra*	Herb	Western Ghats
122	Xyridaceae	*Xyris*	*pauciflora*	Herb	
123	Fabaceae	*Zornia*	*gibbosa*	Herb	
124	Poaceae	*Zoysia*	*matrella*	Herb	

Table-2: Checklist of laterite plants in Bhatkal of Uttara Kannada

Sn	Family	Genus	Species	Habit	Geographical distribution
1	Fabaceae	*Alysicarpus*	*bupleurifolius*	Herb	
2	Araceae	*Amorphophallus*	*bulbifer*	Herb	India
3	Poaceae	*Arthraxon*	*lancifolius*	Herb	
4	Poaceae	*Arundinella*	*metzii*	Herb	Western Ghats
5	Begoniaceae	*Begonia*	*malabarica*	Herb	Western Ghats
6	Poaceae	*Bhidea*	*burnsiana*	Herb	Western Ghats
7	Hydrocharitaceae	*Blyxa*	*aubertii*	Herb	
8	Cyperaceae	*Bulbostylis*	*densa*	Herb	
9	Burmanniaceae	*Burmannia*	*pusilla*	Herb	
10	Gentianaceae	*Canscora*	*decurrens*	Herb	Western Ghats
11	Rubiaceae	*Canthium*	*parviflorum*	Shrub	
12	Apocynaceae	*Carissa*	*carandas*	Shrub	
13	Fabaceae	*Cassia*	*tora*	Herb	
14	Fabaceae	*Cassia*	*mimosides*	Herb	
15	Apiaceae	*Centella*	*asiatica*	Herb	
16	Fabaceae	*Crotalaria*	*pallida*	Shrub	
17	Fabaceae	*Alysicarpus*	*bupleurifolius*	Herb	
18	Araceae	*Amorphophallus*	*bulbifer*	Herb	India
19	Poaceae	*Arthraxon*	*lancifolius*	Herb	
20	Poaceae	*Arundinella*	*metzii*	Herb	Western Ghats
21	Begoniaceae	*Begonia*	*malabarica*	Herb	Western Ghats
22	Poaceae	*Bhidea*	*burnsiana*	Herb	Western Ghats
23	Hydrocharitaceae	*Blyxa*	*aubertii*	Herb	
24	Cyperaceae	*Bulbostylis*	*densa*	Herb	
25	Burmanniaceae	*Burmannia*	*pusilla*	Herb	
26	Gentianaceae	*Canscora*	*decurrens*	Herb	Western Ghats
27	Rubiaceae	*Canthium*	*parviflorum*	Shrub	
31	Eriocaulaceae	*Eriocaulon*	*xeranthemum*	Herb	India
32	Eriocaulaceae	*Eriocaulon*	*cinereum*	Herb	
33	Eriocaulaceae	*Eriocaulon*	*lanceolatum*	Herb	South India
34	Eriocaulaceae	*Eriocaulon*	*eurypeplon*	Herb	Peninsular India
35	Eriocaulaceae	*Eriocaulon*	*fysonii*	Herb	Western Ghats
36	Eriocaulaceae	*Eriocaulon*	*odoratum*	Herb	Western Ghats
37	Euphorbiaceae	*Euphorbia*	*notoptera*	Herb	Western Ghats
38	Euphorbiaceae	*Euphorbia*	*thymifolia*	Herb	

39	Convolvulaceae	*Evolvulus*	*alsinoides*	Herb	
40	Convolvulaceae	*Evolvulus*	*nummularius*	Herb	
41	Cyperaceae	*Fimbristylis*	*schoenoides*	Herb	
42	Flacourtiaceae	*Flacourtia*	*indica*	Shrub	
43	Fabaceae	*Geissaspis*	*cristata*	Herb	Western Ghats
44	Fabaceae	*Geissaspis*	*tenella*	Herb	Western Ghats
45	Poaceae	*Glyphochloa*	*acuminata var. acuminata*	Herb	Western Ghats
46	Rubiaceae	*Hedyotis*	*corymbosa*	Herb	
47	Boraginaceae	*Heliotropium*	*indicum*	Herb	
48	Poaceae	*Heteropogon*	*contortus*	Herb	
49	Gentianaceae	*Hoppea*	*fastigiata*	Herb	
50	Balsamaceae	*Impatiens*	*rosea*	Herb	India
51	Balsamaceae	*Impatiens*	*raziana*	Herb	Western Ghats
52	Fabaceae	*Indigofera*	*prostrata*	Herb	India
53	Poaceae	*Isacne*	*globosa*	Herb	
54	Poaceae	*Ischaemum*	*indicum*	Herb	South India
55	Poaceae	*Ischemum*	*semisagittatum*	Herb	India, Sri Lanka
56	Rubiaceae	*Ixora*	*coccinea*	Shrub	Western Ghats, Sri Lanka
57	Acanthaceae	*Justica*	*simplex*	Herb	
58	Leeaceae	*Leea*	*indica*	Shrub	
59	Acanthaceae	*Lepidagathis*	*prostrata*	Herb	India
60	Lamiaceae	*Leucas*	*lavandulifolia*	Herb	
61	Scrophulariaceae	*Lindernia*	*ciliata*	Herb	
62	Scrophulariaceae	*Lindernia*	*crustacea*	Herb	
63	Scrophulariaceae	*Lindernia*	*hyssopoides*	Herb	India, Sri Lanka
64	Scrophulariaceae	*Lindernia*	*pusilla*	Herb	
65	Scrophulariaceae	*Lindernia*	*antipoda*	Herb	
66	Melastomataceae	*Memecylon*	*edule*	Tree	Western Ghats
67	Loganiaceae	*Mitrasacme*	*pygmaea*	Herb	
68	Molluginaceae	*Mollugo*	*pentaphylla*	Herb	
69	Commelinaceae	*Murdannia*	*semiteres*	Herb	
70	Rubiaceae	*Mussaenda*	*laxa*	Shrub	Western Ghats
71	Rubiaceae	*Neanotis*	*foetida*	Herb	Western Ghats
72	Rubiaceae	*Neanotis*	*rheedei*	Herb	Western Ghats
73	Menyanthaceae	*Nymphoides*	*parvifolia*	Herb	
74	Poaceae	*Oplismenus*	*burmanii*	Herb	
75	Poaceae	*Oryza*	*rufipogon*	Herb	E and S India
76	Euphorbiaceae	*Phyllanthus*	*urinaria*	Herb	India

77	Euphorbiaceae	*Phyllanthus*	*simplex*	Herb	
78	Polygalaceae	*Polygala*	*elongata*	Herb	
79	Cyperaceae	*Pycreus*	*stramineus*	Herb	
80	Scrophulariaceae	*Ramphicarpa*	*longiflora*	Herb	Western Ghats
81	Apocynaceae	*Rauvolfia*	*serpetina*	Shrub	
82	Cyperaceae	*Rhynchospora*	*wightiana*	Herb	Western Ghats
83	Lythraceae	*Rotala*	*malampuzhensis*	Herb	Western Ghats
84	Lythraceae	*Rotala*	*indica*	Herb	
85	Lythraceae	*Rotala*	*densiflora*	Herb	
86	Polygalaceae	*Salmonia*	*ciliata*	Herb	
87	Euphorbiaceae	*Sapium*	*insigne*	Tree	
88	Cyperaceae	*Schoenoplectus*	*lateriflorus*	Herb	
89	Pedaliaceae	*Sesamum*	*ratiatum*	Shrub	
90	Fabaceae	*Smithia*	*conferta*	Herb	
91	Fabaceae	*Smithia*	*salsuginea*	Herb	Peninsular India
92	Melastomataceae	*Sonerila*	*rheedii*	Herb	Western Ghats
93	Scrophulariaceae	*Sopubia*	*delphinifolia*	Herb	S India, Sri Lanka
94	Rubiaceae	*Spermacoce*	*articularis*	Herb	
95	Rubiaceae	*Spermacoce*	*pusilla*	Herb	
96	Scrophulariaceae	*Striga*	*lutea*	Herb	
97	Scrophulariaceae	*Striga*	*gesnerioides*	Herb	Western Ghats
98	Araceae	*Theriophonum*	*dalzellii*	Herb	Western Ghats
99	Lentibulariaceae	*Utricularia*	*reticulata*	Herb	India, Sri Lanka
100	Lentibulariaceae	*Utricularia*	*lazulina*	Herb	Western Ghats
101	Lentibulariaceae	*Utricularia*	*striatula*	Herb	
102	Asteraceae	*Vernonia*	*cineria*	Herb	
103	Alismataceae	*Weisneria*	*triandra*	Herb	Western Ghats
104	Xyridaceae	*Xyris*	*pauciflora*	Herb	
105	Fabaceae	*Zornia*	*gibbosa*	Herb	

2.2: Fauna

The mammalian diversity was richer once because of the continuity of this hilly coast with the Western Ghat forests, before heavy human settlements and construction of the National Highway 17 and the Konkan Railway track. Heavy coastal traffic practically reduced major mammals. The laterite plateaus are however rich in certain special kinds of mammals like the pangolin and porcupines. Jackals are common and the wild boars sometimes foray into the region, especially in Bhatkal plateau, which also get occasional barking deers. Bird diversity is quite rich because

of the nearness of sea, backwaters, forests, plantations and fields. Peafowls are very notable among the numerous birds. Detailed studies of mammals, birds and reptiles are yet to be taken up. The monitor lizard is a somewhat commoner species. These and pangolins are sometimes hunted for meat. Some kind of conservation status is likely to benefit both these rare species and many others.

Importance of laterite flora for insect diversity

Flower-visiting insects play an important role in maintaining biodiversity and ecosystem services such as pollination, which corresponds to a great economic value. Wild and domestic bees and other pollinators increase production of fruits and vegetables and many other kinds of crops significantly. The emerging threat of a global 'pollinator crisis' was expressed over a decade ago. Since then, declines of pollinator and other flower-visiting insects have been confirmed worldwide. The main driver of decline in flower-visiting insects is generally thought to be the loss of suitable habitat through land-use changes and other human activities. Among the various determinants of habitat quality, the loss of floral nectar resources has been most frequently proposed as a major factor contributing to flower-visiting insect declines. Pollination systems in which the host plant provides breeding sites for pollinators, invariably within flowers, are usually highly specialized mutualisms.

The enormous numbers of herbs that carpet the laterite plateaus during the rainy season flower from July to mid-September and some of them beyond for some more time. This period, especially July to August has very less flowering among the other wild plants, including forest trees and shrubs. The *Utricularias,* balsams, *Eriocaulons,* herbs of Scrophulariaceae and many others, which have their profuse flowering in the plateaus during the peak rainy period, act as keystone resources for pollinator insects, especially bees and butterflies and various dipterans. Therefore the conservation of laterite plateaus near every coastal village is necessary, at least as Biodiversity Heritage sites of respective villages.

Pollination systems in which the host plant provides breeding sites for pollinators, invariably within flowers, are usually highly specialized mutualisms. The non-butterfly insects identified were *Apis dorsata* var. *dorsata, Apis cerana indica, Apis florea, Trigona* sp.*., Xylocop sp.* etc. List of butterflies found in the laterite plateaus during the rainy season is given in Table-3.

Table 3: List of butterflies found during rainy season foraging in laterite vegetation

	Family	Species	Common Name	Host plants in laterite areas
1	Lycaenidae	*Caleta caleta* Hewitson	Angled Pierrot	*Ziziphus mauritiana, Ziziphus rugosa*
2	Papilionidae	*Papilio polymnestor* Cramer*	Blue Mormon	*Zanthoxylum rhetsa*
3	Nymphalidae	*Junonia orithya* L.,	Blue Pansy	*Hygrophila auriculata, Justicia neesii, Justicia procumbens, Lepidagathis prostrate*
4	Hesperidae	*Tirumala limniace* Cramer	Blue Tiger	*Calotropis gigantea, Tylophora indica, Wattakaka volubilis*
5	Nymphalidae	*Junonia iphita* Cramer	Chocolate pansy	*Hygrophila auriculata, Justicia neesii, Carvia callosa*
6	Pieridae	*Catopsilia pomona*	Common Emigrant	*Cassia tora*
7	Nymphalidae	*Ypthima huebneri* Fabricius	Common Four-ring	*Grasses*
8	Pieridae	*Eurema hecabe* L.,	Common Grass Yellow	*Cassia tora, Moulluva spicata*
9	Nymphalidae	*Euploea core* Cramer	Common Indian crow	*Cryptolepis buchanani, Ficus benghalensis, F. racemosa, F.religiosa, Hemidesmus indicus, Holarrhena pubescens, Ichnocarpus frutescens, Tylophora indica.*
10	Nymphalidae	*Phalanta phalantha* Drury	Common Leopard	*Flacourtia indica, Flacourtia montana*
11	Papilionidae	*Papilio polytes* L.,	Common Mormon	*,Glycosmis arborea, Zanthoxylum rhetsa.*
12	Nymphalidae	*Elymnias hypermenstra*L.,	Common Palmfly	*Areca catechu, Cocos nucifera, Phoenix spp.*
13	Lycaenidae	*Castalius rosimon*Fabricius	Common Pierrot	*Ziziphus mauritiana, Ziziphus rugosa*
14	Nymphalidae	*Neptis hylas*Moore	Common Sailer	*Corchorus sp., Flemingia sp., Grewia sp., Triumfetta sp.*
15	Lycaenidae	*Spindasis vulcanus*Fabricius	Common silverline	*Allophylus cobbe, Clerodendrum indicum, Ziziphus mauritiana, Z. rugosa*
16	Nymphalidae	*Ypthima asterope* Klug	Common Three-ring	*Grasses*
17	Papilionidae	*Pachliopta hector*L.,	Crimson Rose	*Aristolochia indica*
18	Lycaenidae	*Jamides bochus* Cramer	Dark Cerulean	*Crotalaria sp., Pongamia pinnata*
19	Pieridae	*Pareronia ceylonica* C &F Felder	Dark Wanderer	*Capparis rheedii*
20	Nymphalidae	*Mycalesis patnia* Moore	Gladeye Bushbrown	*Oryza spp. (wild)*
21	Nymphalidae	*Hypolimnas bolina* L.,	Great Eggfly	*Portulaca oleracea, Sida rhombifolia*
22	Nymphalidae	*Tanaecia lepidea* Butler	Grey Count	*Melastoma malabathricum.*
23	Nymphalidae	*Junonia atlites* L.,	Grey Pansy	*Hygrophila auriculata*
24	Pieridae	*Pieris canidia* L.,	Indian Cabbage White	

25	Nymphalidae	*Junonia lemonias* L.,	Lemon pansy	*Corchorus capsularis, Hygrophila auriculata, Sida rhombifolia.*
26	Lycaenidae	*Chilades laius* Stoll	Lime Blue	*Acacia spp.,*
27	Pieridae	*Catopsilia pyranthe* L.,	Mottled Emigrant	*Cassia tora*
28	Pieridae	*Anaphaeis aurota*Fabricius	Pioneer or Caper White	
29	Hesperidae	*Borbo cinnara*Wallace	Rice Swift	*grasses*
30	Nymphalidae	*Cupha erymanthis* Drury	Rustic	*Flacourtia indica, Flacourtia montana*
31	Papilionidae	*Troides minos* Cramer	Southern birdwing	*Aristolochia indica*
32	Hesperidae	*Sarangesa purendra* Moore	Spotted Small Flat	*Asystasia spp.*
33	Nymphalidae	*Danaus genutia* Cramer	Striped Tiger	*Ceropegia sp.*
34	Papilionidae	*Graphium agamemnon* L.,	Tailed jay	*Annona reticulata*
35	Nymphalidae	*Acraea violae*Fabricius	Tawny Coster	
36	Pieridae	*Ixias marianne* Cramer	White Orange Tip	
37	Lycaenidae	*Talicada nyseus* Guerin-Meneville	Red pierrot	
38	Nymphalidae	*Danaus chrysippus* L.,	Plain Tiger	*Cryptolepis buchnani*

3. CASE FOR COASTAL LATERITE PLATEAUS AS 'CONSERVATION RESERVES'

Conservation Reserves are declared for the purpose of protecting landscapes, seascapes, flora and fauna and their habitat. The rights of people living inside a Conservation Reserve are not affected. Conservation Reserves can be declared by the State Governments in any area owned by the Government. Particularly stressed are areas adjacent to National Parks and Sanctuaries and those areas which link one Protected Area with another. Such declaration should be made after having consultations with local communities.

Reasons for laterite Conservation Reserves: We are proposing here two lateritic plateaus of coastal Uttara Kannada viz. 1.Bhatkal plateau in Bhatkal taluk and 2. Mugali plateau in Honavar taluk under the conservation category called **Conservation Reserves** under the provisions created by the Ministry of Environment and Forests. Details of the two plateaus are as follows:

1. **Bhatkal laterite plateau:** The plateau proposed for Conservation Reserve covers part of Bhatkal forest beat and part of Kotkhanda forest beat in the Bhatkal range of Honavar Forest Division. The proposed plateau covers about 425 ha of area within lat.13.99915° - 14.02062° N and long. 74.55929°-74.59044°E **(Figure 4)**. The detailed study of the flora was carried out and the plateau can be considered one of the richest lateritic floristic provinces of Uttara Kannada, and hence worth of its conservation for the sake of ecology, biodiversity and posterity.
2. **Mugali laterite plateau:** The plateau proposed is also in Honavar Forest Division. It covers area of about 300 ha in the coastal villages of Mugali, Kelaginoor and Apsarakonda villages. The proposed plateau is part of a much larger one and is situated between lat. 14.1977°-14.2437°N and long 74.4406°E-74.4806°E **(Figure 5)**. The detailed floristic study was carried out and details presented in this report.

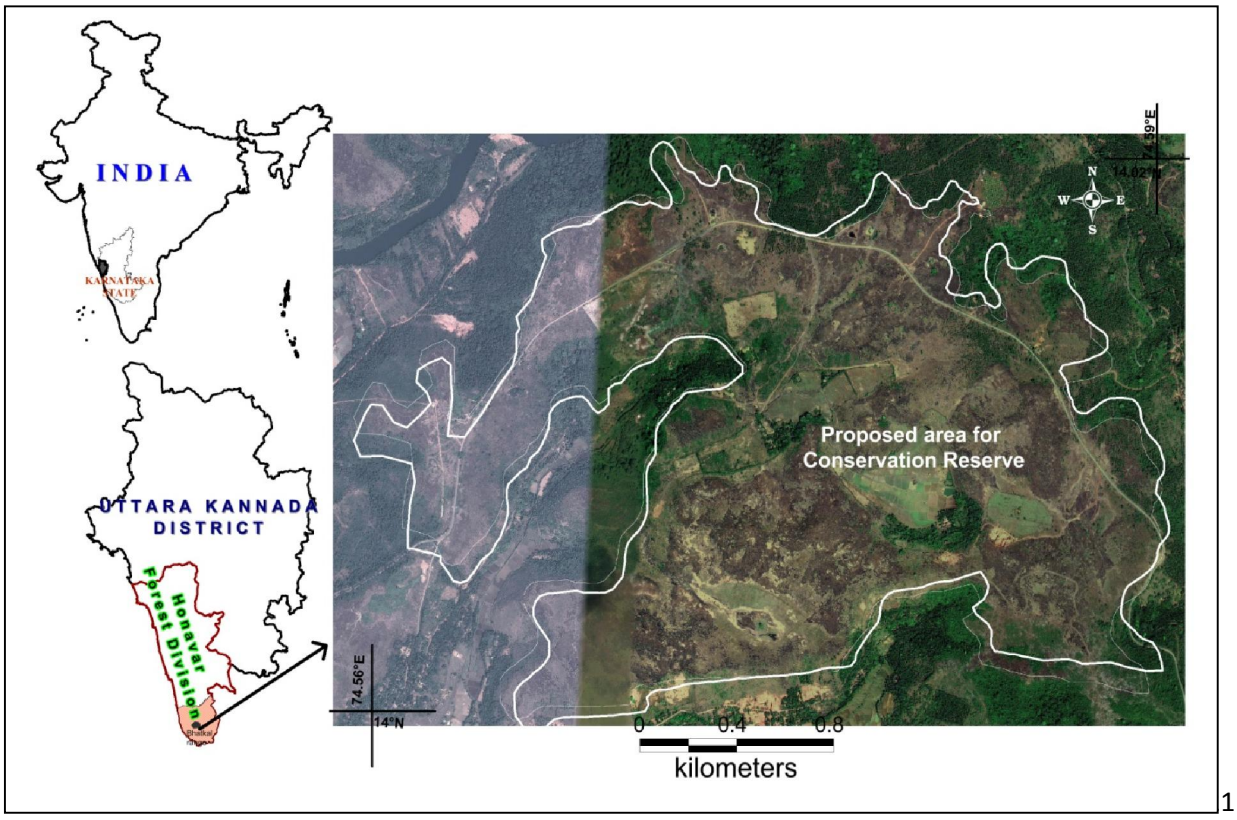
Both the proposed areas are, admittedly, not adjacent to National Parks and Sanctuaries, nor they link one PA with another. Yet they have very important reasons to be considered as such reserves for the following reasons:

- These Conservation Reserves are going to be, perhaps the first in the world, exclusively for lateritic ecosystems
- Laterite is a unique type of tropical sedimentary rock (basalt derived laterite of Maharashtra mountain tops excluded from its purview), and for the first time in the world described by Francis Buchanan during his journey through Kerala-Karnataka coast in 1801. He described it in Angadipuram in Malabar region where the Geological Survey of India erected a monument in laterite in his memory.
- Western Ghats constitute a global biodiversity hotspot, and several sites have been recently declared by UNESCO as World Heritage Sites. Unfortunately there has been

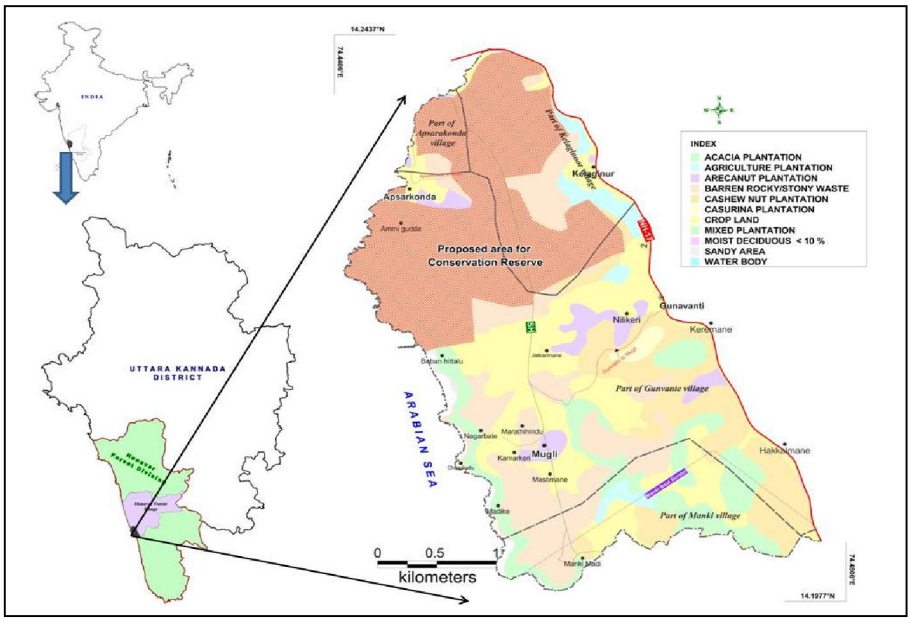
never an effort to recognize the rare herbal vegetation of coastal laterite plateaus and hills, which have a good proportion of rare and endemic herbs.

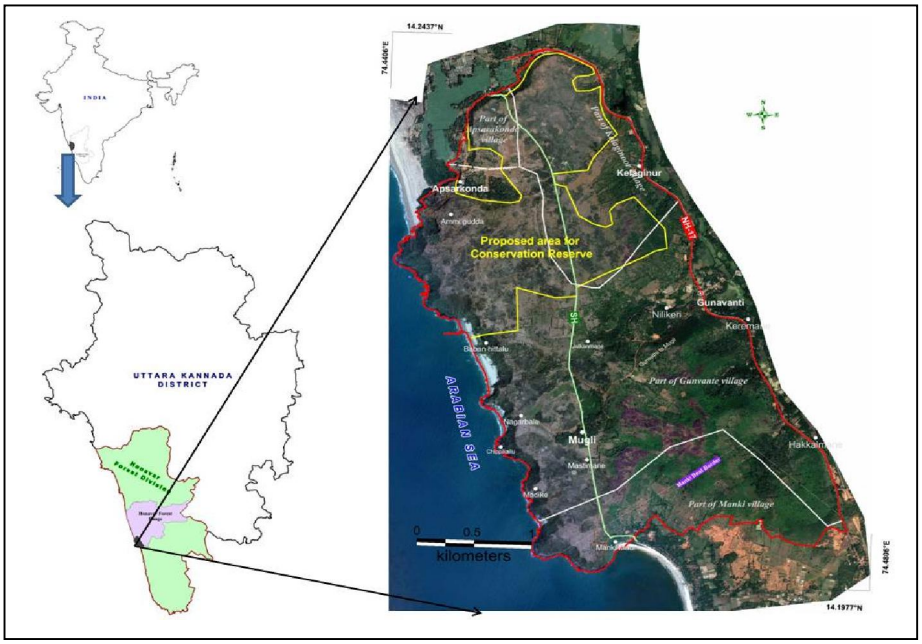
- Rare animals like Pangolin and Monitor lizard can be conserved ideally in such reserves
- The laterite formations are aesthetically pleasing, and particularly so with the massive flowering of rainy season herbs. The terrain is ideal for tourism and scientific studies
- UNESCO Criterion 9 or declaration of a place as Heritage Site pertains to "**outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features".** The coastal laterite formation is a testimony to India's separation from Madagascar almost 90 million years ago, and the erosion that happened through several million years of the primeval Western Ghats, and deposition of such eroded materials along the coastline, which originally belonged to the Tethys Sea, before the Arabian Sea came into existence.
- The seasonal herbs constitute the main foraging sources for honey bees and various other pollinators during the peak of rainy season, when there is absolute scarcity of any feed for them. Hence such plants may be considered as 'keystone resources'.
- Moreover the declaration of Conservation Reserves is not going to affect the rights of the people living in the area. On the other hand community participation in management can earn revenue for them, especially from tourism
- The State Government can declare the Conservation Reserves.

Figure 4: Proposed Bhatkal laterite plateau Conservation Reserve



Figures 5: Proposed Mugali laterite Conservation Reserve map (up) and Google imagery





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Note: Figures 6 to 17 illustrate the rich diversity of the region

Figure 6 & 7: Glimpses of biodiversity of Bhatkal plateau

Figure 8: Looking for insect diversity and Figure 9: Studying the plant diversity

Figure 10: Myriads of flowers blooming in the Bhatkal plateau during the rains. These include insectivorous bladderworts, (*Utricularias*) – a & c – mingled with *Eriocaulons* and grasses – b & d.

Figure 11: a & b – Seasonal laterite marsh and meadow in Mugali plateau; c – Apsarakonda waterfall rich in ferns and herbs in Mugali plateau; d – Sunset view from Mugali plateau

Figure 12: Notable floral diversity – (a) *Impatiens raziana*, a narrow endemic; (b) *Drosera indica*, insectivorous plant; (c) *Drosera burmanii*, insectivorous plant; (d) *Euphorbia fusiformis*, a rare species in Mugali plateau; (e) *Ramphicarpa longiflora*, endemic semi-parasite and (f) *Rotala malampuzhensis*, endemic species and new report for Uttara Kannada

Figure 13: Communities of rare, endemic seasonal blog and marsh plants – (a) *Wiesneria triandra*; (b) *Blyxa aubertii*; (c) *Eriocaulon stellatum*; (d) *Eriocaulon lanceolatum*; (e) *Eriocaulon cuspidatum*- submerged plant and (f) *Eriocaulon fysonii*

Figure 14: (a) *Eriocaulon eurypeplon*; (b) *Hedyotis cynantha* - rare endemic plant; (c) *Lepidagathis prostrate* - A rigid hardy species clinging to rocks; (d) *Oryza rufipogon* - wild rice; (e) *Ceropegia attenuate* – endemic and (f) *Ceropegia candelabrum* – India - Sri Lanka endemic

Figure 15: Some herbs with pretty flowers – (a) *Impatiens rosea*; (b) *Exacum bicolor*; (c) *Habenaria commelinifolia* - A rare orchid

Figure 16: Some woody plant species – (a) *Ixora coccinea*; (b) *Sapium insigne*; (c) *Hugonia mystax* and (d) *Memecylon edule*

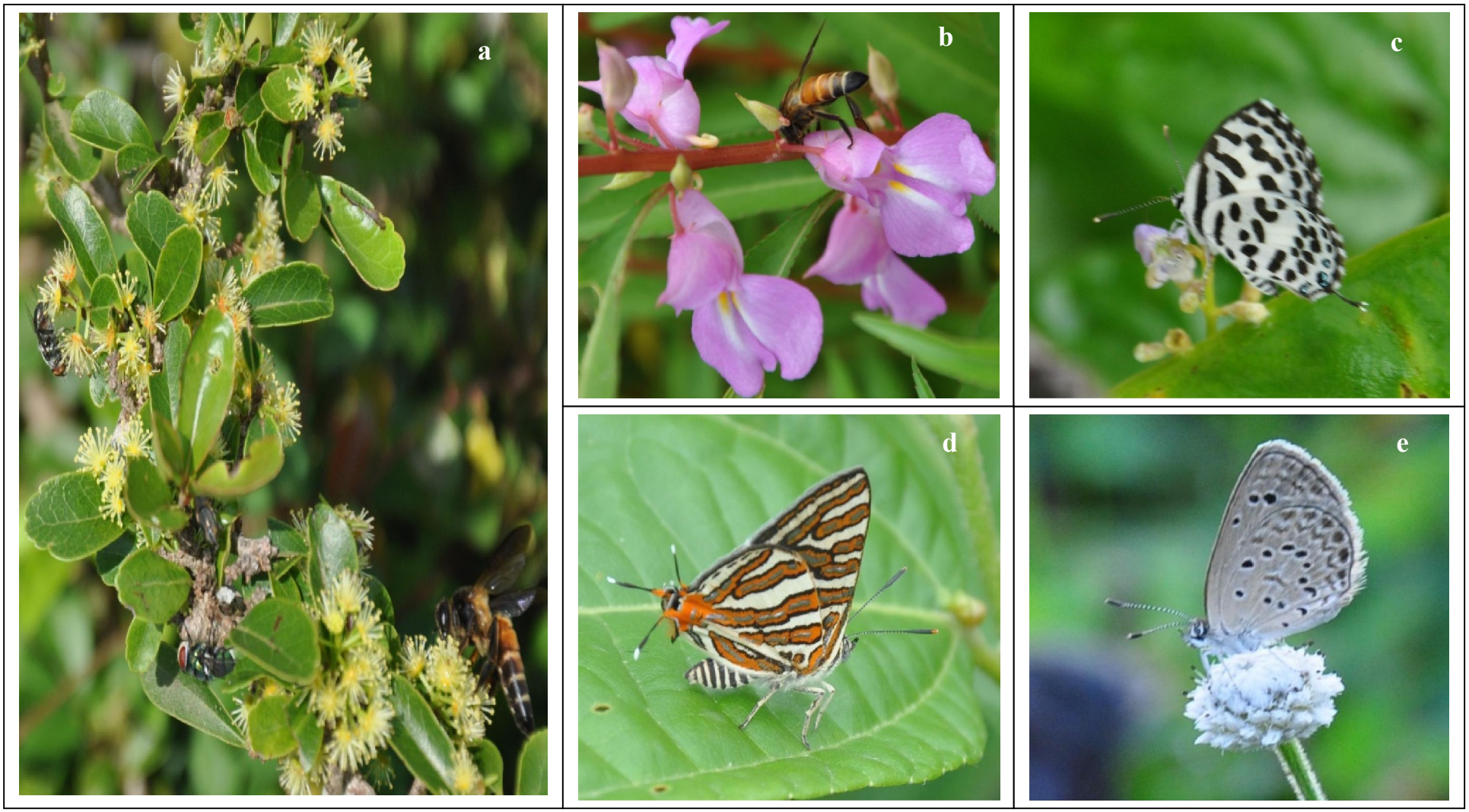
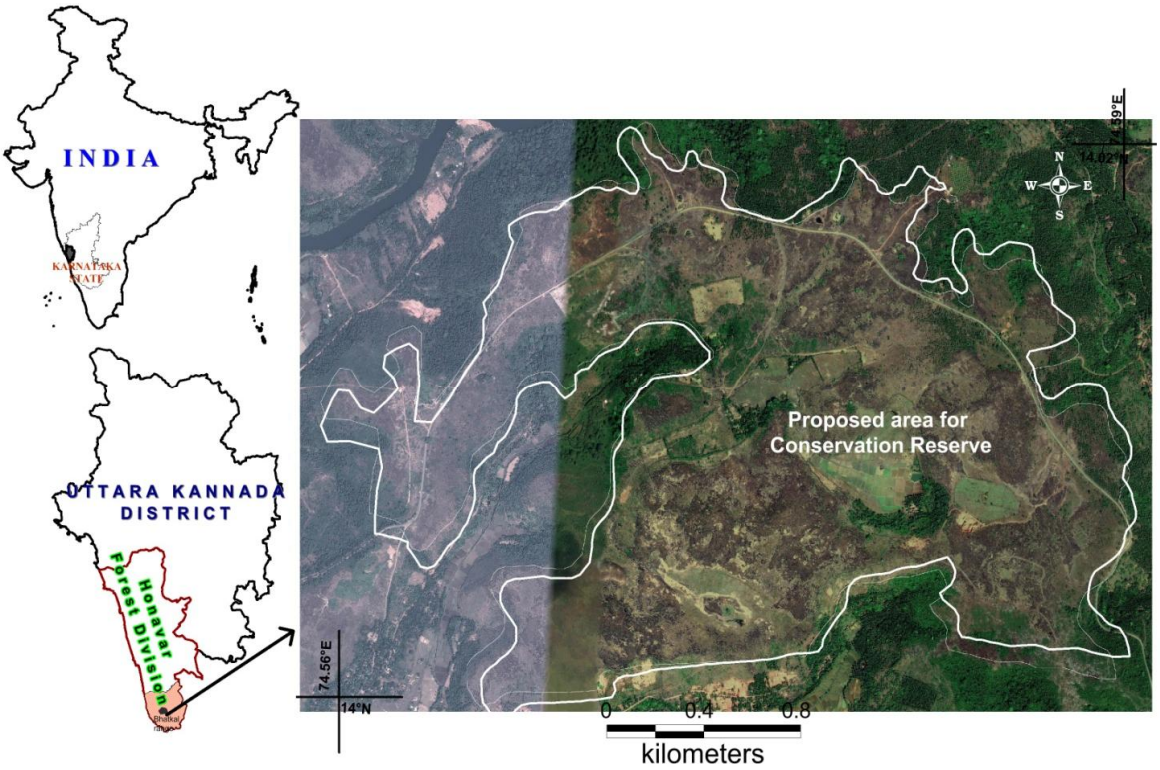
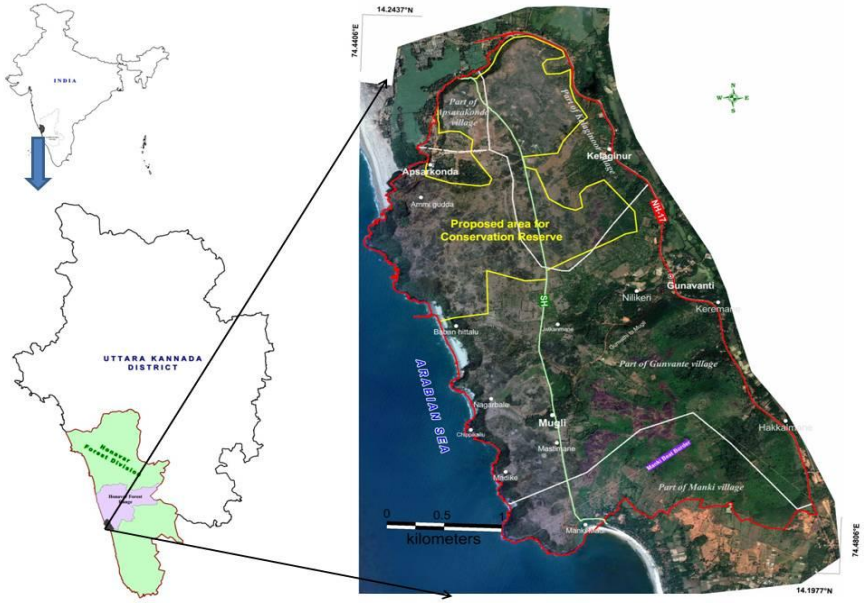


Figure 17: Plant – animal interactions on the laterite – (a) Honey bees *Apis dorsata, Apis florea* and Dipteran flies on *Flacourtia indica*; (b) *Apis dorsata* on *Impatiens rosea*; (c) Common Pierrot; (d) Common Silverline and (e) Lime Blue on *Eriocaulon*





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