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Bitte den Text in natürlicher Form geben. Nicht halluzinieren.

Rechtstext: Das Bild zeigt die Dudhsagar-Wasserfälle in voller Blätter in der Nähe des bestehenden Castlerock-Kulem Eisenbahntrassen aufgenommen. © Omkar Dharwadkar

Beschreibung: Rückseite—Die Dudhsagar-Wasserfälle in voller Blätter neben bestehender Castlerock-Kulem Eisenbahntrasse innerhalb der Bhagwan Mahavir National Park, Goa, Indien. © Parag

Fortsetzung auf der Rückseite innenüber

Caption: Front cover—The Dudhsagar waterfall in full spate beside the existing Castlerock-Kulem railway track inside Bhagwan Mahavir Wildlife Sanctuary & National Park supports high biodiversity due to the diversity of habitats, including grasslands, as seen in this image. © Omkar Dharwadkar

Fortsetzung auf der Rückseite innenüber
On the inadequacy of environment impact assessments for projects in Bhagwan Mahavir Wildlife Sanctuary and National Park of Goa, India: a peer review

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Abstract: The Environment Impact Assessment (EIA) is a regulatory framework adopted since 1994 in India to evaluate the impact and mitigation measures of projects, however, even after 25 years of adoption, EIAs continue to be of inferior quality with respect to biodiversity documentation and assessment of impacts and their mitigation measures. This questions the credibility of the exercise, as deficient EIAs are habitually used as a basis for project clearances in ecologically sensitive and irreplaceable regions. The authors reiterate this point by analysing impact assessment documents for three projects: the doubling of the National Highway-4A, doubling of the railway-line from Castlerock to Kulem, and laying of a 400-kV transmission line through the Bhagwan Mahavir Wildlife Sanctuary and National Park in the state of Goa. Two of these projects were recently granted ‘Wildlife Clearance’ during a virtual meeting of the Standing Committee of the National Board of Wildlife (NBWL) without a thorough assessment of the project impacts. Assessment reports for the road and railway expansion were found to be deficient on multiple fronts regarding biodiversity assessment and projected impacts, whereas no impact assessment report was available in the public domain for the 400-kV transmission line project. This paper highlights the biodiversity significance of this protected area complex in the Western Ghats, and highlights the lacunae in biodiversity documentation and inadequacy of mitigation measures in assessment documents for all three diversion projects. The EIA process needs to improve substantially if India is to protect its natural resources and adhere to environmental protection policies and regulations nationally and globally.

Keywords: Biodiversity, development, highway, National Board for Wildlife, protected area, railway, transmission line, Western Ghats.

Abbreviations: Bhagwan Mahavir Wildlife Sanctuary and National Park—BMWS & NP | EC—Environmental Clearance | EIA—Environment Impact Assessment | FC—Forest Clearance | IUCN—International Union for Conservation of Nature and Natural Resources | NP—National Park | PAs—Protected Areas | WC—Wildlife Clearance | WPA—Wildlife (Protection) Act | WS—Wildlife Sanctuary | MoEFCC—Ministry of Environment, Forests and Climate Change, Government of India | UNESCO—United Nations Educational, Scientific & Cultural Organization.
1. BACKGROUND

The Environment Impact Assessment (EIA) process is a standard framework for appraisal and evaluation of development projects. The first EIA notification in India was published in 1994 by the Ministry of Environment and Forests. This was followed by a new EIA notification in 2006 that made it mandatory for most projects in the mining, power, infrastructure, and industrial sectors to seek Environmental Clearance (EC) prior to new developments or the expansion of existing ones. If a project is sited in a protected area or passing through a notified forest it may additionally require a Forest Clearance (FC) and/or Wildlife Clearance (WC). While India has been following the EIA process for over 25 years, studies have frequently highlighted sub-standard and deficient EIA and other assessment reports used by proponents to obtain these clearances by diluting the spirit of the exercise (Comely 2018; Datar et al. 2019; Sheth et al. 2020).

EIA and other assessment reports have often been found deficient in documenting biodiversity, assessing direct, indirect, and cumulative impacts, and proposing mitigation measures (Datar et al. 2019; Khera & Kumar 2010; Sheth et al. 2020). In this Review, the authors present an analysis on three projects that will cumulatively affect Bhagwan Mahavir Wildlife Sanctuary and National Park (BMWS & NP), formerly known as Mollem, in the state of Goa (Figure 1, Image 1–3). These forests are an important part of a larger landscape that affords connectivity not only to other forests in Goa but also across the border to Kali (Dandeli-Anshi) Tiger Reserve in Karnataka. The three projects are as follows:

a. Road: The four-laning of the National Highway 4A (153km in total length, of which 70.07km falls within Goa, with 13km bisecting the BMWS & NP, now redesignated as National Highway 748), that is being carried out by the National Highways Authority of India and by the Public Works Department in Goa. The proposal involves the diversion of about 31.015ha of protected forest area (24.265ha in the NP and 6.75ha in the WS). At present, the road passing through the protected area has a 7m wide two-lane carriageway. The proposal involves widening specific sections of the road, thus creating new intrusions into the forest that have not yet faced the direct and indirect impacts of fragmentation. On the other side of the border in Karnataka, the highway expansion passing through the protected area (PA) has been halted by the Karnataka High Court. The total forest land required is 63.615ha and the total number of trees to be felled are 20,340, of which 12,097 trees will be felled from the PA.

b. Railway: The second project is the doubling of the Castleroock–Kulem railway line, which is part of the larger Hospet–Tinaighat–Castleroock–Kulem–Madgaon–Vasco line. The total length of this railway line is 345km, of which 26km passes through the BMWS & NP, that is being undertaken by MS Rail Vikas Nigam Ltd. The total forest land required is 138.37ha and the total number of trees to be felled are 22,882; of which 20,758 will be felled from the PA. Four underpasses measuring 12m in width and 5.65m in height have been proposed as mitigation measures along the railway line. The existing railway line from Hospet to Vasco was laid in 1900 and presently connects iron ore mining and industrial areas in Hospet to Mormugao Port in Vasco. The alignment of the second proposed railway line runs parallel to the existing line and passes through forest tracts in and around Kali Tiger Reserve and in the BMWS & NP.

c. Transmission line: The third project is the laying of a 3.15km transmission line through BMWS & NP. The line will be set between Narendra, Karnataka and terminating with a 400 kV substation at Xeldem, Goa. This project is being undertaken by M/s Goa – Tamnar Transmission Project Ltd (Sterlite Power) with 12,097 trees that will be felled and 11.54ha of forests being diverted, with the power line being 46m in width. The project also requires diversion of 30.412ha of protected forests of Kali Tiger Reserve in Karnataka. In reality, there are five forest diversion proposals for one single project involving diversion of total 323.596ha of forest land through the state of Goa (146.505ha) and the state of Karnataka (177.091ha). The entire project in the state of Goa would require felling of 43,456 trees and felling of another 62,289 trees in the state of Karnataka. The total trees enumerated to be felled for implementing the entire inter-state project is 1,05,745 trees.

The Indian Ministry of Environment, Forests and Climate Change (MoEFCC) has a web portal, Parivesh, which makes public all project documents required for clearances sought by project proponents. The Parivesh website does not have the Biodiversity Impact Assessment Report of the transmission line project uploaded (as on 1 July 2020), despite in-principle approval being afforded at the 57th National Board for Wildlife meeting held on 7 April 2020.

In this Review, we first present the biodiversity significance of BMWS & NP by reviewing published literature on taxonomic groups, and referring to...
Figure 1. Bhagwan Mahavir Wildlife Sanctuary and National Park (Mollem) along with the three linear projects (400kV transmission line, NH 4A Expansion, Castlerock-Kulem-Madgaon Railway line expansion) planned in the protected area complex. Map credit: Nandini Mehrotra and Shashank Srinivasan, Technology for Wildlife.
Image 1. Actual tree felling for transmission line Xeldem. © Anonymous

Image 2. Castlerock - Kulem Railway line at Dudhsagar. © Omkar Dharwadkar

Image 3. A representative photo of perceived impacts on wildlife by roadkills due to the NH4A expansion inside Bhagwan Mahavir WS & NP. © Ninad Bhosale

Image 3. A representative photo of perceived impacts on wildlife by roadkills due to the NH4A expansion inside Bhagwan Mahavir WS & NP. © Ninad Bhosale

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Image 3. A representative photo of perceived impacts on wildlife by roadkills due to the NH4A expansion inside Bhagwan Mahavir WS & NP. © Ninad Bhosale
unpublished sources such as dissertations, reports, and checklists that have been at least peer-reviewed among expert groups, where published information is scarce. We then present a critique of the two assessment studies (the railway study prepared by the Indian Institute of Science, Bengaluru and the highway study prepared by Aarvee Associates, Hyderabad) and a summary on the impact of the transmission line given that the project report is not available in public domain.

2. ABOUT BHAGWAN MAHAVIR WILDLIFE SANCTUARY AND NATIONAL PARK

Bhagwan Mahavir Wildlife Sanctuary and National Park comprises wet evergreen, semi-evergreen, and moist deciduous forests in the Western Ghats. Both PAs are contiguous and span an area of 240km², with 133km² as WS and 107km² as NP.

Both PAs are classified as Important Bird and Biodiversity Area by the Bombay Natural History Society and Birdlife International, UK (Rahmani et al. 2016).

A summary of the known status of taxonomic groups is provided here to enable a reliable assessment of the ecological value of the PA complex (Image 4).

2.1 Plants and Fungi

BMWS & NP comprise more than 700 plant species (Datar & Lakshminarasimhan 2013; See Appendix II). Of these, at least 127 species are endemic, making about 18% of the total flora (Datar & Lakshminarasimhan 2011).

The region is a hotspot for fungal diversity in the Western Ghats. Nearly 1,200 fungi species are known from Goa, of which at least 500 mushroom species have been identified and many are yet to be described (Nandkumar Kamat in litt. 27.xii.2020). A total of 18 lichen species are known from the PA, although the overall diversity is likely to be higher.

2.2 Insects and Arachnids

Both PAs together support 219 butterfly species (Appendix V) and 80 species of odonates (Appendix VI), of which 14 species of butterflies and 18 species of odonates are endemic to the Western Ghats. Two odonate species Idionyx gomantakensis (Subramanian et al. 2013) and Cyclogomphus flavoannulatus (Rangnekar et al. 2019) have been described from within and immediate outskirts of the PA. A few butterfly species found in the BWWS & NP such as the Danaid Eggfly Hypolimnas misippus, Common Mime Papilio clytia, Common Pierrot Castalius rosimon, Blue Nawab Polyura schreiberi, Kanara Oakblue Arhopala alea, Orchid Tit Hypolicaena othona, Short-banded Sailor Neptis columella, and Crimson Rose Pachliopta hector are protected under Schedule I of the Wild Life (Protection) Act, 1972 (henceforth WPA 1972). Two endemic butterfly species found here are the Malabar Rose Pachliopta pandiyana and the Southern Birdwing Troides minos.

A 2011 report on moth diversity from the northern Western Ghats reports at least 418 moth species out of which 116 species were unidentified, and potentially new to science (Shubhalaxmi et al. 2011). A total of 75 ant species are recorded from the WLS of which seven are endemic (See Appendix IX). Six scorpion species, 16 spider species, and one species each of Whip Scorpion and Whip Spider have been recorded from both the PAs (Bastawade & Borkar 2008). An isolated population of Whip Spider Pherurus phisponi and Whip Scorpion Labochirus tauricornis occurs in the proximity of this PA (Borkar et al. 2006; Borkar 2018).

2.3 Fish

The Western Ghats supports over 300 fish species of which more than 65% are endemic (Kumar & Devi 2013). New fish species and range extensions are being described from this region as yet, suggesting that fish species assessments and distribution patterns remain incomplete (Molur et al. 2011). A comprehensive study in the Mhadei sub-basin (which includes BMWS & NP) has the presence of 49 fish species, of which 18 species are endemic to the Western Ghats (Atkore 2017; See Appendix IV).

2.4 Herpetofauna

The reptilian diversity of the region is represented by 52 species from Crocodylia (Crocodiles), testudines (freshwater turtles & tortoises), and squamates which includes Sauria (Lizards) and Ophidia (Snakes) (See Appendix VII). Amongst the diversity of reptiles, the Indian Rock Python Python molurus, Indian Monitor Lizard Varanus bengalensis, and King Cobra Ophiophagus hannah are some species in the Schedule I and II of WPA, 1972. Other endemics such as the Malabar Pit Viper Trimeresurus malabaricus and the Large-Scaled Shieldtail Uropeltis macrolepis are also reported from the region.

In the past 15 years, 112 new amphibian species have been discovered from the Western Ghats, indicating high species richness and a need for more systematic studies in the landscape. Among the 218 known species of amphibians, 87.8% (158 species) are endemic to the
Image 4. Some representative taxa which would be affected due to the direct and indirect impacts of the three linear projects in the Bhagwan Mahavir Wildlife Sanctuary and National Park in Goa (from top left): South Indian Gliding Lizard *Draco dussumieri*, Malabar Tree Toad *Pedostibes tuberculosus*, Indian Giant Gliding Squirrel *Petaurista philippensis*, Black Rajah *Charaxes solon*, Flame-throated Bulbul *Rubigula gularis*, & the dragonfly *Cyclogomphus flavoannulatus*.
Western Ghats (Nirmal Kulkarni pers. obs. 01.vii.2020).

The two PAs together contain at least 36 amphibian species (See Appendix VIII). Castlerock is the type locality of Nyctibatrachus petraeus (Das & Kunte 2005) and Raorchestes bombayensis (Annandale 1919). Biju et al. (2014a) described 14 new dancing frogs, of which one speciesMicrixalus uttaraghati is found in the streams that cut across the existing Castlerock-Kulem railway line. Similarly, these streams are home to Indosylvirana caesari and Indirana chiravasi, two new frog species that were described recently (Biju et al. 2014b; Padhye et al. 2014). Seven new amphibian species have been discovered in the past two decades from Goa.

2.5 Birds

The first ornithological study in Goa was conducted by Grubh & Ali (1976). During their 16-day survey that included Mollem, the team recorded a total of 97 bird species. Presently, 286 species have been recorded from the BMWS & NP (Rahmani et al. 2016; see Appendix I). The list includes species such as the Critically Endangered Indian Vulture Gyps indicus, Endangered Egyptian Vulture Neophron percnopterus and other globally threatened species such as the Lesser Adjutant Leptoptilos javanicus, Woolly-necked Stork Ciconia episcopus, Nilgiri Wood Pigeon Columba elphinstonii, and Malabar Pied Hornbill Anthracoceros coronatus. A total of 14 bird species recorded from BMWS & NP are endemic to the Western Ghats and 32 of the recorded species are listed in the Schedule I (Part III) of the WPA, 1972. Six bird species are classified as Near Threatened by International Union for Conservation of Nature and Natural Resources (IUCN).

2.6 Mammals

BMWS & NP, along with the Kali Tiger Reserve and surrounding reserved and protected forests cover an area of at least 2,000km² and form an important Bengal Tiger Panthera tigris habitat (Gubbi et al. 2016). The National Tiger Conservation Authority has recommended bringing together the protected areas of Goa and Karnataka for Tiger conservation and improved management. In a document released by the MoEFCC titled “Connecting Tiger Populations for Long-term Conservation” the forests of Goa are mentioned as one (Sahyadri-Radhanagar-Goa) of 32 major Tiger corridors in India. A breeding population of Tigers has been recorded from the tri-junction of Goa–Karnataka–Maharashtra (Girish Punjabi pers. obs. 19.iii.2019; Jhala et al. 2020). In May 2019, the Forest Department of Goa photographed an individual Tiger using trail cameras in the BMWS & NP, and expect more individuals to be present (The Goan Everyday 2019). On the 5 January 2020, carcasses of four Tigers – a female and her three cubs were found in the neighbouring Mhadei Wildlife Sanctuary (Kerkar 2020). The four tigers were poisoned in retaliation for depredating livestock (Kerkar 2020).

More than 60 mammal species are likely to occur in the PAs, of which 11 species belong to Schedule I of the WPA 1972 (See Appendix III). Gad & Shyama (2009) found that Gaur Bos gaurus was widespread and fed on 32 plant species belonging to 17 plant families in the PA. Sengupta & Radhakrishna (2013) encountered a higher number of Bonnet Macaques Macaca radiata in BMWS & NP as compared to other parts of Goa. Krupa et al. (2017) reported two sympatric otter species, the Asian Small-clawed Otter Aonyx cinereus and Smooth-coated Otter Lutrogale perspicillata in the buffer region of Mhadei WS, which adjoins BMWS & NP.

3. REVIEW OF EIA FOR THE NH-4A HIGHWAY EXPANSION PROJECT

After compiling lists of taxonomic groups known from the PAs, the authors reviewed the EIA for NH-4A Highway Expansion (henceforth Road Report) for information provided on taxonomic groups, environmental and social impacts of the project. We found inadequacies in most aspects and as such the Road Report was observed to be of poor quality. The relevant issues are discussed here.

3.1 Plants

i) Several issues were found with the reported methodology for the baseline survey on plant species in the Road Report. The sampling strategy was not clearly indicated. The Report says that the number of quadrats in each habitat type was proportionate to the land in the habitat type, but no further information is provided whether a randomized or systematic sampling protocol was used. In the absence of a protocol, sampling locations would be biased and not fully representative of the habitat type.

ii) Resultantly, the list on floral species in the Road Report is inadequate when compared to existing species list of the area (Datar & Lakshminarasimhan 2011).

iii) The sampling methodology outlined was likely not followed. The data were finally compiled and based on a reconnaissance trip and secondary literature (Section 5.8.2, Page 79). No analysis of species diversity or dominance were performed, and the findings are only provided in the form of a brief species list (Table 5.15,
3.2 Insects and Arachnids

i) The Road Report has no impact assessment of linear intrusions on insect and arachnid diversity, with no details on species richness in the area. No attempt has been made to compile secondary information from published and unpublished sources.

ii) There are many studies from India and the world which have examined the impact of roads on insects. Insects suffer a high mortality while crossing roads or may avoid crossing roads altogether (Muñoz et al. 2015). Studies report that vehicle lights attract many insects, causing mortality during the night (Seshadri & Ganesh 2011). The barrier effect of roads is higher for slow-moving insects (Muñoz et al. 2015), but even flying insects such as butterflies are affected by fragmentation created by roads, as the nature of patch-edge affects their dispersal ability (Ries & Debinski 2001; Dover & Settele 2009). Studies on grasshoppers have demonstrated that males increase their call frequency in response to road noise, which may have population-level consequences (Lampe et al. 2014).

iii) Despite evidence of high levels of diversity and endemism in the BMWS & NP, odonates have not been surveyed. Species of hill streams are more narrowly-distributed and are indicators of water quality (Simaika et al. 2016). A new dragonfly species *Idionyx gomantakensis* (Subramanian et al. 2013) was reported in 2013 from the PAs, a fact that has been overlooked in the Road Report. This raises doubts whether secondary data has been reviewed while compiling the faunal list for the project area.

iv) No details are provided for Arachnids in the Road Report. In so far as the ambilipygid, urropygid, and theraphosid spiders of these areas are concerned, given their fidelity to their habitat type and their rather restricted movement, any alteration of the habitat, due to road construction and widening, shall decimate these small and isolated populations beyond recuperation and renewal, even leading to local extinctions (Maelfait & Hencrickx 1998).

3.3 Fish

i) No fish species or impacts of road expansion have been described in the Road Report. It states that “since most of the water bodies remain dry during the non-monsoon months, this [sediment] impact will be negligible” (Page 98). This statement is inaccurate, as several perennial streams and pool habitats contain water and act as refuges for various fish species in the non-monsoon months. A study cautions against the effects of sedimentation and run-off on the fish communities due to rampant vehicular traffic in the neighbouring Mhadei Sanctuary (Atkore 2017).

ii) Many other impacts are envisioned which the Road Report has not assessed. Soil erosion due to the removal of riparian vegetation would have short-term as well as long-term impacts on stream dwelling communities. Riparian vegetation plays an important role in maintaining ambient temperature in the headwater catchment (region from numerous streams originates) enabling persistence of diverse, endemic and habitat specialist fish species such as *Ballitora sp.*, *Glyptothorax sp.*, *Schistura sp.*, *Bhovania sp.*, and *Garra sp.* (Srekantha et al. 2007).

iii) Increased soil erosion due to the road expansion is likely to multiply the sedimentation load, which may impair water quality greatly due to high turbidity. Sediment deposition is likely to reduce food availability to aquatic communities. Bottom-dwelling fish such as *Ballitora sp.*, *Glyptothorax sp.*, and *Schistura sp.* feed on benthic insects (Daniels 2002), and have a very narrow range of distribution and tolerance level to certain water quality variables.

iv) Higher suspended solids and silt deposition can also affect spawning grounds and various life stages of fish. A few highly sensitive fish species such as Deccan Mahseer *Tor khudree* and *Hypsellobarbus* sp. are known to migrate upstream for feeding and breeding, either once or twice a year. Mahseer, in particular, are known to choose definite and special spawning grounds which...
usually are rich in dissolved oxygen content, neutral pH, and cool water temperature. Eggs, fry and fingerlings stages of this fish are highly sensitive to the slight alterations in their environment and spawning habitats (Daniels 2002). Soil erosion and high deposition of silt along with stream flow are expected to destroy their habitat, and could reduce their population in Dudhsagar and other adjoining waterbodies.

v) Surface dwelling fish such as *Devario* sp., *Barilius* sp., and *Salmostoma* sp. feed largely on insects falling from the canopy (Johnson & Arunachalam 2010). Higher turbidity due to sediment load would reduce their ability to forage and may restrict these fishes to downstream habitats, affecting their survival.

### 3.4 Herpetofauna

i) Details on herpetofaunal diversity in the PAs is not mentioned in the Road Report. Section 5.8 (Page 74) mentions that Goa has a high snake population. While this may be a general statement, it is not backed by any references.

ii) Further, data from existing literature points to an increase in the number of snake and amphibian road-kills with existence of roads (Garriga et al. 2012; Santhoshkumar et al. 2017). There is, however, no mention of the impact of road expansion on herpetofaunal diversity of the PA in the Road Report.

### 3.5 Birds

i) Although the Road Report mentions that a field survey has been carried out (Section 5.8.2 (v), Page 78), there is no bird checklist provided, except for one mention of the Indian Robin *Copsychus fulicatus* along with other fauna (Table 5.16, Page 82). Bird species richness and abundance were not quantified in the project area that may be affected due to the project construction. This is a serious shortcoming given that 286 bird species have been recorded in the BMWS & NP (Rahmani et al. 2016, See Appendix I).

ii) A section (Page 74) of the Road Report matches the Wikipedia page “Flora and Fauna of Goa” (Wikipedia contributors 2020), which mentions that the state bird of Goa is “the Ruby-throated Yellow Bulbul, which is a variation of Black-crested Bulbul”. This is inaccurate, as the state bird of Goa is the Flame-throated Bulbul *Pycnonotus xantholaemus*, which recent studies have elevated to a full species (Rasmussen & Anderton 2012).

iii) There is further confusion about the state bird of Goa; section 5.8.1 of Page 78 of the Road Report refers to the Yellow-throated Bulbul *Pycnonotus sinensis* as the state bird. The Yellow-throated Bulbul is endemic to peninsular India and has no known distribution in Goa. The faunal statistics presented in section 5.8.1 have been taken from Kumar & Somashekar (2008) with no attribution to the original source. The absence of any data on birds, either quantitative or qualitative, from an area that has been classified as an Important Bird and Biodiversity Area (IBBA), undermines the purpose of the EIA.

### 3.6 Mammals

i) To assess faunal diversity, field surveys and a local consultation were conducted in the Road Report, however, it does not contain any methodological specifications or sampling strategy. Sampling methods for different taxa are also not clearly differentiated. The species list is limited with only 16 species recorded. This is a clear underestimate as more than 60 mammal species are known to inhabit this region (See Appendix III).

ii) The presence of the Bengal Tiger in the area is also not mentioned. The report states that no endangered species are found in the area which is clearly misleading considering three endangered mammal species occur, including the Tiger, Dhole, and Indian Pangolin. One of the species mentioned in the Road Report, the Red Giant Flying Squirrel *Petaurista petaurista* is not found in the Western Ghats. Common species such as the Bonnet Macaque and Chital *Axis axis*, are also not reported.

iii) The Road Report states that the road expansion will not affect faunal species, and instead claims that species “may increase in number because of the road structures as the project will not obstruct their movement rather can create new habitats for them” (Section 5.8.1, v, Page 82). This statement is misleading as wide roads are known to create an obstruction to movement for a wide variety of species, including mammals (Bennett 2017). Roads also create forest edges that can harmfully affect native vegetation and rare wildlife due to edge effects, which extend far beyond the area of the road (Gubbi et al. 2012; Poor et al. 2019). Small mammal communities near roads have also been found to differ from those away from roads (Goosem 2002).

iv) Section 5.8.1 (Page 78) of the Road Report mentions the Leopard and Black Panther as two separate species, however, these are colour morphs of the same species *Panthera pardinus*. The Gaur *Bos gaurus*, which is the State Animal of Goa, does not find mention in the checklist. Section 5.8.1. (v) also states that none of the faunal species found here are “endangered or extinct”. This is unsound as endangered species such as the Bengal Tiger, Dhole, and Indian Pangolin are found in the region, while extinct species are found nowhere in the wild.
3.7 Land-use

i) A land-cover map for this project was acquired as a secondary data source, without clarity on how it was prepared. The map presented is for the entire state of Goa (Figure 5.23, Page 75), and not specific to the project site. The impacts on the land-use and land-cover specific to the project area have not been assessed in the EIA. The land-use table (Table 5.14, Page 73) has an error in summation of all land-use types. Further, the land-cover classes in the table do not match the ones in the map. These errors create confusion about which land-cover types will be affected by the project.

3.8 Water

i) The Road Report mentions that there are declining water level pockets in South Goa, indicating the need to strictly regulate groundwater extraction in these pockets, however, Section 5.1.4. (Page 40) of the Report has insufficient information on the river basins in the region. Only water depths are provided, without any data on the coverage area, volumes, or a reasonable level of water extraction that is possible from rivers during road expansion.

ii) Section 5.5.1. (Page 51) states that chloride concentrations are “well within the desirable and permissible limits”. This statement is misleading. Samples GW-02 and -06 both had detected values above the desirable limit range and are at risk of exceeding the Bureau of Indian Standards’ drinking water standards. Thus, there is insufficient evidence to support the statement that there is ‘good’ scope for groundwater exploitation in all the five affected taluks in the South Goa District.

iii) There is inadequate information on the water assessment sampling procedure in the region. Section 5.5.1 (Page 51) suggests that single samples were collected from five separate surface water sites and eight separate groundwater sites, during one sampling visit. No indication of the season or sampling date is provided, nor of repeated sampling to ensure accuracy or reliability. The statement that “total hardness observed to be constant in all samples” is flawed, as notable variation was observed between hardness in the different sample locations of the Road Report.

3.9 Air

i) Air quality would be negatively affected after the road expansion, but there is scarce attention paid to any robust evaluation in the Road Report. The statement that with the “proposed four-laning project, traffic may further come down and ease the vehicles movement and traffic congestion, which may lead to reduce the pollution levels” lacks substantial evidence and cannot be a justification for road expansion within a PA and ecologically-sensitive area.

ii) Table 6.5 (Page 102) proposes that greenhouse gases and other pollutant emissions may be significantly reduced based on the assumption of a small increase in traffic burden along with the avoidance of stopping, idling and congestion, however, traffic projections in the report show that total traffic is projected to only increase over the years, at all the three points where present traffic was surveyed (Table 2.15, Page 20). It is doubtful that vehicular emissions will be reduced with increased number of lanes, when scientific literature indicates that road widening leads to increased emissions which negatively affect air quality (Roberts et al. 2010; Font et al. 2014)

3.10 Soil

i) According to Table 5.13. (Page 72) of the Road Report, among the trace metals likely to contaminate soils due to large-scale construction and traffic pollution, only Lead (Pb) and Iron (Fe) are noted, however, this is insufficient, as several heavy metals such as Cadmium (Cd), Copper (Cu), Zinc (Zn), and Manganese (Mn) originate from material abrasion, fuel combustion and road dust (Chen et al. 2010; Abdel-Latif & Saleh 2012; Świetlik et al. 2013). Heavy metals have been associated with high levels of genotoxicity and mutagenicity in soils contaminated with heavy metals (Husejnovic et al. 2018) and their concentrations should be monitored and potentially reduced in PAs, particularly in view of the risk of trophic transfer, migration, and bioaccumulation (Zhang et al. 2018; Chouvelon et al. 2019).

3.11 Social Impacts

i) Datar & Lakshminarasimhan (2011) documented around 90 floral species to be important for local consumption and livelihood. While the Road Report lists flora of the affected area and people’s reliance on non-timber forest produce (NTFP), it does not mention the potential impacts on the floral community that can hamper NTFP-based livelihoods of the local community around BMWS & NP.

ii) The Road Report mentions that apart from forest land, almost 70.42ha of non-forest land would be acquired affecting 377 civilian and governmental structures (Table 5.17, Page 85). It is not clear what the extent of damage to these structures would be. Further, the assessment does not delve deeper into the livelihood impacts and possible mitigation plans for families
affected by the project. It mentions that a separate land acquisition plan would be devised for these aspects and has no concrete mitigation plans for social impacts.

4. REVIEW OF ASSESSMENT STUDY FOR THE RAILWAY EXPANSION PROJECT

While the assessment study (hereafter Railway Report) for railway expansion was informative and detailed, it suffered from several shortcomings as well. The authors reviewed it for information on the same parameters — assessment of taxonomic groups, environmental, and social impacts. It is noteworthy that the railway expansion will affect not only the BMWS & NP but also the neighbouring Kali Tiger Reserve in Karnataka State. Therefore, a project which will fragment the only intact tiger and elephant population in the north-central Western Ghats will have severe ramifications for wildlife and biodiversity. The Railway Report, however, does not stress on the ecological impacts of railway expansion and instead presents a neutral portrait of the project impacts by emphasizing uncertain mitigation measures.

4.1 Plants

i) In the section on vegetation characteristics, it is mentioned that 255 species of flowering plants were recorded (Page 64), but Appendix 2.1.a. of the Railway Report lists 224 woody trees. The IUCN Red List status is not provided, and a few common endemic species that occur in the region are not mentioned in the tree species list.

ii) The floristic survey results (Page 83) only records seedlings of woody trees but not herbs and orchids, some of which are rare with restricted distribution in the Western Ghats (Joshi & Janarthanam 2004).

iii) Plant species are misspelled or outright erroneous in the Appendix which makes it difficult to identify the plants that will be impacted. For example, *E. undulatus* is misspelled (correct name: *E. angulatus*), while *Lapisanthes microphylla* is an invalid scientific name as per our knowledge.

iv) Appendix 2.1.a of the Railway Report mentions 13 plant species (including vulnerable and endemic species) which are yet to be recorded from Goa. Three of those species may not occur in the BMWS & NP and need further scrutiny as to the validity of their inclusion, however, even if they do occur, it only reveals the importance of the region for plant diversity, and therefore the region should not be diverted for the railway expansion.

4.2 Insects

i) The Railway Report follows standardized protocols to document butterfly diversity of the region but covers a very small area which might not represent all the habitats affected by the project, a fact acknowledged in the study (Page 87).

ii) The survey was carried out from April (2013) to May (2014), however, there is no mention of the duration of data collection, including details on whether surveys were undertaken every month or a few days every season. This would have a bearing on the findings.

iii) There is no mention of whether sampling effort was replicated. This precludes an understanding of how many times a transect was sampled, and whether the same transects were sampled repeatedly in subsequent seasons. Quantitative analysis of data collected with inadequate sampling protocols may lead to incorrect estimates of insect diversity.

iv) The Railway Report mentions that the Family Lycaenidae and Hesperiidae were represented by 33 and 18 species, respectively. The number of species, however, might be under-represented given the difficulty in visual identification of species belonging to these Families. No effort was made to account for detection issues in the Railway Report.

v) The Railway Report also does not provide an assessment on moth diversity. Moths are ecologically important and even more diverse than butterflies and dragonflies. At least 418 species of moths of which 116 species are unidentified, were reported from the north Western Ghats (Shubhalaxmi et al. 2011). Given that the study site is a PA in the Western Ghats, it is likely to have high moth diversity.

vi) There are discrepancies in the listing of species in the Railway Report. For example, butterfly species such as *Neptis columella*, *Doleschallia bisaltide*, *Actolepis puspa*, and *Castalius rosimon* which are Schedule I species are left out of the scheduled species list and the text, with only a passing mention in the Appendix of the Railway Report (Appendix 2, Page 89).

4.3 Fish

i) The Railway Report records the presence of 23 fish species, however, a comprehensive study in the Mhadei sub-basin (which includes BMWS & NP) reported 49 fish species with 18 endemics from the Western Ghats (Atkore 2017; see Appendix IV).

ii) The Railway Report does not assess potential impacts of the project on fish community structure, even though studies have found that alteration of stream environment (changes in water quality and flow
alteration) by anthropogenic pressures have negative influences on fish guild composition (Atkore 2017; Atkore et al. 2020).

4.4 Herpetofauna

i) The Railway Report has a fairly comprehensive assessment of amphibians and reptiles. It reports key details about the diversity of herpetofauna, including endemics, however, it only mentions the impact of the railway-line in causing mortality of reptiles (Page 140), and remains inconclusive of impacts on amphibians (Page 135).

ii) The survey on amphibians clearly finds that 13% of endemic Western Ghats species (14 species out of 24) were found in the project area. This number is likely higher and points to the sensitivity of the region for anurans (See Appendix VIII of this paper).

iii) For reptiles, the Railway Report finds 27 species, which is an underestimate (See Appendix VII of this paper). The report does not have an exhaustive assessment of impacts due to the railway expansion on herpetofauna, reasoning that the study was carried out “during the inactive period of reptiles (winter) where the intensity of the impact could not be assessed properly due to their high seasonal activity, secretiveness and less conspicuousness” (Page 140).

4.5 Birds

i) The Railway Report mentions that a two-day survey for birds was carried out in September 2014 and May 2015. It is not clear why a short survey effort was employed to compile the checklist. The survey enumerates only 35 species, of which nine were endemic species. This is an underestimate, compared to the 286 bird species recorded in the BMWS & NP in a comprehensive checklist (Rahmani et al. 2016; eBird 2017).

ii) Data is collected only for cavity-nesting birds. This omits species that do not nest in cavities, but are dependent on trees and vegetation for nesting and feeding. The reason for surveying only cavity-nesting birds is not provided. Further, migratory birds are under-represented in the survey, given that the survey was not carried out during the migratory season between October–March.

iii) The Railway Report mentions, “The loss of tree specially >10 and >60cm dbh would impact the nesting of birds in the proposed project area” (Page 145). Again, this focuses only on cavity-nesting birds, and undermines the importance of shrubs and undergrowth for passerines and understorey insectivores, which will also be impacted. Such impacts of the loss and fragmentation of the forest cannot be mitigated or compensated for, with respect to ground-nesting and understorey insectivorous birds (Lampila et al. 2005).

iv) The project area description (Page 19) mentions the state bird of Goa as the Ruby-throated Yellow Bulbul Pycnonotus dispar. This is an error. The state bird of Goa is the Flame-throated Bulbul Pycnonotus gularis, while P. dispar is a bird found in the forests of Java and Sumatra.

4.6 Mammals

i) The Railway Report suffers from multiple lacunae such as inadequate sampling effort. Species accumulation curves, which could have accounted for this limitation, were not generated.

ii) The sampling methods also do not account for detection issues (i.e., false negatives; Sollmann et al. 2013). This is especially pertinent given that a much higher number of mammal species occur in the region, which find either inconsistent, or no mention in the Railway Report (See Appendix III of this paper). For example, the Executive Summary (Page 5–6) mentions 42 mammal species were found using a literature survey, but the presence of the Bengal Tiger (India’s National animal) is not explicitly stated. Appendix 2 of the Railway Report (Page 166) mentions 23 species of mammals, but does not mention which of those are Schedule I species, even though the region has 11 Schedule I mammal species. The ecological value of the region may have been underemphasized due to these inadequate methods as many more mammal species that occur in the region are likely to have been missed as they were not accounted for (Hayward et al. 2015).

iii) The description of the methods is very sparse and limits clear understanding (Page 153). The sampling unit was undefined — signs were recorded both inside and outside of belt transects. The study description lacks any detail about statistical methods used to assess species richness or percentage occurrence or relative abundance, using indirect signs or direct sightings.

iv) Randomly placed belt-transects used in the Railway Report are not a suitable choice to assess large and small carnivore species richness and occurrence (Barea-Azcón et al. 2007). Further, signs were recorded opportunistically from outside of belt transects (Results, Page 153–154), but no clear analytical framework is provided for this data. Carnivores often tend to move on forest trails, roads, dry streams therefore a non-random or systematic sampling approach (within beats or grid cells) would be more appropriate to specifically assess
carnivore occurrence in the study region (Karanth et al. 2011).

v) Camera-traps are one of the best tools available to assess the occurrence, density, and abundance of mammals (O’Connell et al. 2011). But, the Railway Report uses a sparse sampling effort by surveying only 16 sites (camera-traps malfunctioned in nine of the 25 sites surveyed). In addition, the cameras were placed for less than six days in most sites. Studies have found a minimum of 20 to 30 error-free days of camera-deployment are required for stable estimates of species occurrence (Hamel et al. 2013). The standard duration for density assessment of large cats in Tiger Reserves and PAs of India is 25 days (with a closure period of 45–60 days). Therefore, a sampling duration of less than six days used in the Railway Report translates to poor data collection, which eventually affects any ecological inferences derived from such studies (Burton et al. 2015).

vi) The camera-trapping protocols lacks any detail about the camera models used, mode of deployment, camera-settings, and study design (Meek et al. 2014).

vii) Table 2.8.1 (Page 154) reports the species *Viverra zibetha* (Large Indian civet) which is not found in the Western Ghats, but in northeastern India. The table also mentions the occurrence of an otter species, *Lutra lutra*, the Eurasian Otter, which has not been recorded from the region. The Railway Report provides no evidence of its presence in the form of photographs. Two other species of otters which have been recorded and photographed in the region, the Asian Small-clawed Otter and the Smooth-coated Otter are not mentioned (Punjabi et al. 2014; Krupa et al. 2017). Page 161 of the Railway Report has erroneously labelled Wild Pig *Sus scrofa* as Indian Porcupine *Hystrix indica*.

viii) Appendix 2 in the Railway Report (Page 166) has incorrect coding for species: Langur and Bonnet Macaque are listed as herbivores (when they are actually primates); Asian Palm Civet is coded as a carnivore, but the Small Indian Civet, Brown Palm Civet, and Stripe-necked Mongoose are incorrectly coded as herbivores; the otter and Indian Pangolin are coded as large mammals, but the Asiatic Wild Dog, which is larger in size is coded as a small mammal. This reveals a naive understanding of mammals and the impacts that railway expansion could have on low-density species such as carnivores.

4.7 Land-use

i) The land-use land-cover map was derived from classification of single date satellite data, acquired in April 2013. Since the project area supports different types of vegetation which have variation in spectral signatures during different seasons, an ideal mapping exercise should have considered seasonal data, for at least two different seasons within one year.

ii) Out of six effective bands of Landsat and eight for vegetation discrimination, only four bands have been used for classification. This essentially leaves out the details of land-cover class categories that are clearly identified by the other two short-wave infra-red bands. These two short-wave IR bands demarcate the response of vegetation to moisture stress, and thus improve the classification of the forest types (Ferreira et al. 2016).

iii) The reasoning behind the number of sampling points used for each land-cover category is not clear. It is stated that unsupervised classification, which yielded 15 classes, was used as a basis for ordering the landscape into distinct units. It is unclear, however, if these ‘distinct units’ were further assigned land-cover classes on the basis of any reference map. A reference map could have informed the locations where ground truth data was necessary for ascertaining land-use types.

iv) The exact methodology for land-cover classification, parametric (maximum likelihood, minimum distance to means), or non-parametric (support vector machines or any other) has not been mentioned. This prohibits a nuanced understanding of the method of classification for a forest complex.

v) Ancillary data such as topographical information from an elevation model have not been utilized for assessments. A simple elevation profile of the proposed railway route indicates an elevation range of 80–500 m. In a high elevation area with varying gradients, the topography of the land determines much of the vegetation assemblages, and this could be important information to include in the classification process. The importance of topographic information for vegetation mapping is a widely accepted methodology (Das et al. 2015; Roy et al. 2015) and earlier work in the Eastern Ghats region has used topographic information effectively to this end (Balaguru et al. 2003).

vi) The basis for accuracy assessment has not been mentioned. An overall accuracy of 88% is indicated, but no reference map seems to have been used for calculation. The report also does not mention the percentage of samples used for training and testing the classification, which is a standard accuracy assessment procedure.
4.8 Water

i) Water pollution is a major concern during the construction as well as during the operation phase. Water pollution analysis, however, was minimal with no monitoring of pollutants done for polycyclic aromatic hydrocarbons (PAHs) and heavy metals because of the existing railway-line, despite high concentrations being often reported in waterways bisected, or bordered by railways (Wilkomirski et al. 2011; Wilkomirski et al. 2012; Levengood et al. 2015).

ii) Furthermore, *Escherichia coli* bacterial contamination was reported in all sampled streams, indicating faecal contamination, which may be attributed to waste disposal from passing trains. The total coliform count ranged from 221/100mL to 542/100mL, while the safe threshold value is 100 count/100mL. The increased risk of coliform contamination resulting from the railway expansion is a severe threat, as many streams that cross the tracks harbour sensitive wildlife, and also supply water to villages downstream for drinking and farming.

4.9 Air

i) No air quality monitoring was performed to provide baseline levels or to establish the risk of railway expansion in this region. The Railway Report assumes that engines will be electrified; however, if existing diesel engines are used then the doubling would increase the amount of pollutants associated with combustion and diesel emissions.

ii) The main constituents of diesel engine exhaust emissions are Carbon (CO, CO₂), Nitrogen (N), Nitrogen Oxides (NOₓ), Sulphur Oxides (SOₓ), Hydrocarbons (HC), Methane (CH₄), Non-Methane Volatile Organic Compounds (NMVOC), PAHs, and particulate matter (PM) (Borda-de-Água et al. 2017). Monitoring of the current pollutant levels should have been performed at least twice a year to avoid data bias due to seasonal variation, although quarterly (or even monthly) sampling events could have been employed (Jayamurugan et al. 2013; Manju et al. 2018).

4.10 Soil

i) Chemical properties of soil and baseline levels of soil pollution were not established during sampling and analysis. Soil and plants surrounding the railway lines should be monitored for organic and inorganic compound contamination, resulting mostly from used lubricant oils and condenser fluids, the transportation of oil derivatives, metal ores and other chemicals, as well as from application of herbicides and other treatments to the train vehicles. These pollutants, however, were not considered in this assessment.

ii) PAHs, heavy metals, oil-derived HC, and to some extent, polychlorinated biphenyls (PCBs) should be monitored in soils, with risks comprehensively assessed as they exhibit toxicity, long-term stability and a cumulative effect in the environment (Wilkomirski et al. 2011; Wilkomirski et al. 2012; Levengood et al. 2015; Pereira et al. 2015). PAHs are carcinogenic and mutagenic to living organisms (IARC 1989). The main source of PAHs in railway areas are machine grease, fuel oils and transformers oils. Heavy metals (such as Pb, Cd, Cu, Zn, Hg, Fe, Co, Cr, Mo) originate mainly from material abrasion and fuel combustion in diesel and electric locomotives, therefore the railway expansion will lead to further heavy metal contamination in soils.

4.11 Social Impacts

i) The Railway Report’s socio-economic survey of 60 families conducted in four villages does not report the total number of affected families, demography and livelihood patterns of concerned villages. The sampling strategy and the criteria for selection of households is unclear. The questionnaire was focussed on the perception of transport models by local communities. The questionnaire did not have open-ended, non-leading questions to bring out local concerns towards the project, and possible impacts on their livelihood and environment. Instead, it addressed questions such as preferred mode of transport, where 90% of the respondents listed trains.

ii) The Railway Report mentions a public consultation meeting regarding the railway expansion project that occurred in June 2016 at Kulem Panchayat (Hindi: Village Council) office (Page 190). The Kulem Panchayat raised concerns about the impact of the project on the Dudhsagar waterfall which contributes revenue from tourists to the local economy, availability of medicinal plants and disturbance to the temple close to Sonalium Station (Page 191). The consultation meeting was attended by only 14 members, most of whom were panchayat office bearers and members of the biodiversity committee, but not by the general public who would be affected by such developmental projects. As this meeting took place in 2016, before the Railway Report was published (in 2017), it is unclear whether a public hearing took place after the report was published. This suggests that the affected public is unaware of the damage the expansion may bring to their livelihoods.

iii) The Railway Report mentions that NTFPs and medicinal plants from the forest area were important for local use (Pages 169–171), but the specific impacts of
the railway expansion on such NTFP and medicinal plant species were not assessed. Datar & Lakshminarasimhan (2011) reported that local communities around BMWS were dependent on the forest for wild edible mushrooms, fruits, herbal medicinal plants, and specific plants for cultural use. This indicates that it is important to assess the impact of the proposed project on NTFP collection.

iv) The Railway Report finds that existing faecal contamination in the streams near to the railway tracks and the level of contamination is already 2–5 times the prescribed limit. Waste generation due to construction debris within the forest can further pollute soil and water resources in this sensitive region, thereby also affecting human communities. Increased waste dumping by railway passengers near villages can attract wildlife to these villages, which can result in human-wildlife conflict scenarios.

5. REVIEW OF THE 400kV TRANSMISSION LINE

The transmission line project did not have the assessment study in the public domain and therefore this limited our review to aspects of this project for which information was available in the public domain on the Parivesh portal. The key concerns with the transmission line project are discussed here.

i) The construction of new power lines in forest areas of high conservation value should be avoided (Eldegard et al. 2015). The transmission line project passes through a PA (11.54 ha inside PA) and the total forest land required for the project is 48.3 ha (almost 50 ha, for which an EIA is necessary from a socio-ecological point of view). The minutes of the meeting of the Goa State Board for Wildlife held on 02 December 2019 mentions that “the Biodiversity Impact Assessment studies and Biodiversity Management Plan have been prepared by ERM India Pvt. Ltd, Gurgaon has been submitted”. The same, however, is not available in the public domain to allow a clear assessment of projected impacts.

ii) The detailed project report that is available for the transmission line makes contradictory statements about the location of the transmission line in the BMWS & NP. It first states that 2.51 km of the transmission line is within the NP, clearing an area of 11.54 ha (Table 1, Page 2, Detailed Project Report). Subsequently, when justifying the reason for choosing between alternative routes of the transmission line, it states that the chosen route fully avoids the NP. These statements severely weaken the report and hinder an effective assessment of the impacts of the transmission line, which already lacks sufficient public scrutiny. An inspection report by the forest department indicates that over 4,146 trees and 985 cane clumps in the PA are to be cut for the project.

iii) The project proponent claims that “transmission line projects are environment friendly and do not involve any disposal of solid effluents and hazardous substances in land, air and water. Moreover, forest area trees are felled below each conductor to facilitate stringing. On completion of construction only one strip is maintained for O & M purpose. Therefore, the actual loss of forest is restricted to some selected areas only.” These statements do not recognize the larger effects of the transmission line on birds and volant mammals such as bats and gliding squirrels, or on arboreal species such as the Slender Loris, Giant Squirrel, Bonnet Macaque, and Grey Langur. For example, due to the absence of tree cover along transmission lines, arboreal mammals such as Lorises are forced to use electric wires of power lines to cross, causing mortality due to electrocution (Raman 2011).

iv) The project requires a clearance for 35 years, during which there will be regular cutting below the transmission line. This is especially concerning given that the project cuts through the PA, so the effects of this project are long-term.

v) The statement “the actual loss of forest is restricted to some selected areas only” fails to take into account existing evidence that power lines are linear intrusions that prevent animal movement, fragment communities of small mammals (Goosem & Marsh 1997), and cause mortality due to electrocution and collision (Jenkins et al. 2011; Rioux et al. 2013; Loss et al. 2014; Uddin 2017). Large mammals have also been electrocuted due to sagging power lines (Raman 2011). The area underlying the proposed transmission line currently (i.e., without the construction of the power line) offers low resistance to large mammal movement, indicating that the area is important for animal movement (Jayadevan et al. 2020; https://indiaunderconstruction.com). In their paper, Jayadevan et al. (2020) recommend avoidance of new infrastructure in areas that currently pose a low resistance to movement.

vi) Transmission lines have several impacts on birds. Studies have shown that birds avoid areas between 0.25 and 0.6 km of transmission lines (Dunkin et al. 2009; Gillan et al. 2013). Transmission lines cause bird mortality due to electrocution and collision (Uddin 2017; Biasotto & Kindel 2018). For example, many birds use structures of transmission lines as a perch, which often leads to electrocution (Biasotto & Kindel 2018). The clearing of
trees for the transmission line affects the movement and nesting success of birds (Biasotto & Kindel 2018).

vii) The conservation value document uploaded by the wildlife warden details the damaging effects of the project. The document, however, concludes that the movement of faunal species will not be affected by the project, and the loss of trees can be compensated via afforestation. This is inaccurate, as transmission lines would impact movement of fauna, in addition to other deleterious impacts including mortality, as we detail above. Further, compensatory afforestation at a different site does not ameliorate any of the ecological impacts within the PA, as mentioned in the document.

6. DISCUSSION

We argue that mitigation measures proposed in the Road Report, Railway Report, and documents for the transmission line are inadequate and will not alleviate serious damage to the BMWS & NP or ecologically-sensitive regions around the PAs. We have explained this in detail in the following sections.

6.1 INADEQUACY OF MITIGATION MEASURES FOR NH-4A

i) For the mitigation measures, the Road Report merely notes that “Mitigation of man versus animal conflict is going to be the important issue that will threaten wildlife in Sanctuary area” (Page 97, Section 6.3.9 (i)). There are, however, no mitigation measures recommended to reduce the conflict created by road expansion. An acknowledgement of an important socio-economic and environmental problem will not equip the Goa Forest Department, National Highways Authority of India, or the Public Works Department of Goa to effectively manage the problem created by road expansion without detailed mitigation plans.

ii) For terrestrial fauna, the Road Report states that no impact on the wildlife is anticipated and hence does not outline any mitigation measures (Page 97, Section 6.3.9 (ii)). Given that nearly 32ha of forest land will be diverted for the project, there is likely to be an impact on wildlife. There is growing scientific evidence demonstrating that building new roads and their upgradation or expansion has serious impacts on wildlife in protected areas. For example, Garriga et al. (2012) found a total of 2,013 wildlife mortalities on roads within protected areas of Catalonia, of which 267 were mammals (13.3%), 253 birds (12.6%), 245 reptiles (12.2%), and 1,248 amphibians (62.0%). A total of 85 different species were affected across all taxa due to roads within PAs over just two seasons, Spring and Autumn, in one year.

iii) As a measure to mitigate vegetation and habitat loss, the Road Report mentions that “an avenue plantation programme shall be promptly adopted to restore and further enrich the loss of vegetation” (Page 96, Section 6.3.9 (ii)). Such measures may increase green cover, but they do not mitigate the impacts of road construction on vegetation or wildlife. Instead, it also puts people at risk due to the increased likelihood of vehicular collision with mammals (Case 1978; Jaren et al. 1991; Putman 1997; Cain et al. 2003).

iv) The Road Report proposes “periodic maintenance of drains to check scouring of soil” to decrease soil erosion (Page 92, Section 6.3.5). Soil erosion is expected to be higher in tropical forests, such as BMWS & NP, due to its wet climatic conditions and steep terrain (Sidle et al. 2006; Sidle & Zeigler 2012). Deposition of eroded soil into rivers at an increased rate is responsible for increasing turbidity and temperature of the water, reducing the amount of dissolved oxygen and changing existing flow regimes, while accelerating eutrophication (Beever et al. 2012; Douven & Buurman 2013). The proposed clearing of land for the development of the road is likely to make cut sections highly susceptible to soil erosion. Drainage structures and culverts are essential to allow better above-ground water drainage, and prevent drastic changes to the hydrology of the landscape and decrease flooding along the road during monsoon seasons (Sidle et al. 2006; Laurance et al. 2009). No site-specific hydrological survey has been carried out to arrive at the optimal number of culverts and bridges, and their spatial placement.

v) Although the Road Report aims to reduce the impact of the developmental project in the “direct path” of the roadworks, it is pertinent to understand that the impacts of road construction are rarely limited to the direct path. Environmental impacts of roads extend beyond the direct impacts of construction and tree clearing, to indirect impacts because of increased human access and vehicular traffic. This includes, but is not limited to, air, water, and noise pollution, disturbance effects, fragmentation due to edge effects, and hindrances to migratory corridors (Alamgir et al. 2017).

6.2 THE IMPACT OF ROADS

We further expand on biotic and abiotic impacts of roads here, for which no mitigation measures have been suggested.
i) Roads compound the impacts of natural disasters

Constructing roads in hilly and mountainous terrain increases the risk of natural disasters such as landslides and flooding (Sidle et al. 2006; Larsen & Torres-Sánchez 1997; Larsen & Parks 1998). There is no information on the susceptibility of the proposed site to extreme weather events in the EIA. Such dissemination of information regarding the socio-economic and environmental risks involved in the project is critical to the decision of investors, decision-makers and taxpayers, whose money is being utilized for the project. Road projects that pass through forested areas and lack proper planning can lead to major cost overruns, corruption, and damage to the environment (Trombulak & Frissell 2000; Alamgir et al. 2017).

ii) Roads are a cause for wildlife mortality (roadkills)

Enabled by the expansion of the highway, an increase in vehicular traffic in the area can be expected. This will likely increase the rates of wildlife-vehicle collisions, impacting species of most terrestrial fauna. A study from Mudumalai Tiger Reserve found road mortality of 40 animal species, including amphibians, reptiles, birds, and mammals (Baskaran & Boominathan 2010). Additionally, animals that are slow-moving or burrowing, such as freshwater turtles, amphibians, snakes, and soil-living fauna, get killed during road construction. The impacts of earthwork and annual maintenance operations on terrestrial fauna are usually overlooked (Clevenger et al. 2003; Fahrig et al. 1995; Trombulak & Frissell 2000; Goosem et al. 2010).

iii) Roads are barriers to wildlife movement, and cause habitat fragmentation

For many species, particularly in the Western Ghats, the expansion of the NH-4A is an additional fragmentation of an already fragmented habitat (Nayak et al. 2020). The resistance to potential large mammal movement posed by the existing NH-4A is higher than the median resistance to mammal movement in the Western Ghats (Jayadevan et al. 2020; https://indiaunderconstruction.com). Expansion of the road can, thus, lead to an increase in the resistance posed to movement, and lead to increased isolation between forest patches on either side of the road.

Subdivision of remnant forest patches due to various linear intrusions such as highways and roads causes “internal fragmentation” (Goosem 1997; Goosem 2007). Such internal fragmentation with wide, cleared roads and their edges, physical barriers such as fences and crash barriers, cuttings, fill batters, and culverts with drop structures, could be a serious threat to movement of wildlife and lead to increased negative human-wildlife interactions (Goosem et al. 2010). For example, many animals in tropical forests avoid even narrow linear clearings (< 30m wide; Holderregger & Di Giulio 2010; Laurance et al. 2009). Increased traffic and continuous vehicular movement can stress the animals or make species alter their behaviour in the vicinity of roads (Trombulak & Frissell 2000). While certain species such as macaques are attracted to roads for scrap food from travellers (a potential ecological trap), species such as Elephants have been observed to avoid roads and highways due to associated risks, or suffer mortality from collisions (Blake et al. 2008). Behavioural avoidance of the road may also be exhibited by animals that can fly over the width of the road (e.g., birds and bats), due to the noise, pollution, and risk of crossing (Laurance et al. 2009).

The problem of fragmentation by roads is particularly acute for canopy dwelling species that use closed-canopy structures to move and do not generally use the ground to cross. In the absence of tree cover, tree-dwelling animals are forced to either use the ground or cross using power lines, which can lead to mortality due to vehicular collisions or electrocution. This is especially the case for primates, arboreal rodents, and some carnivores (Radhakrishna & Singh 2002; Raman 2011).

iv) Roads affect the genetic diversity of animals

Decreased movement of animals across roads leads to decreased genetic variation, due to reduced genetic exchange between populations. For example, studies from India show that roads negatively affect tiger connectivity (Joshi et al. 2013; Dutta et al. 2018; Thatte et al. 2018). Such impacts can be seen after just a few generations in populations of large mammals that have been separated by newly built roads and highways (Holderregger & Di Giulio 2010).

v) Roads affect biodiversity due to increased noise pollution

Although monitoring of noise quality levels created by the existing highway was carried out at eight sites designated as commercial, industrial and residential, there was no monitoring carried out on existing highway stretches within the protected area. Noise quality levels were found to be “within the limits” for commercial and industrial categories but “exceed the limits” in the residential category. Noise pollution associated with roads has been shown to decrease reproductive capacity in bird and amphibian species, as well as in mammals.
such as Tigers (Kerley et al. 2002; Hoskin & Goosem 2010; Qin et al. 2014; Laurance 2015), with impacts seen at the community level as well (Francis et al. 2009; Slabekoorn & Halfwerk 2009).

vi) Roads lead to increased human accessibility

Roads passing through forested areas increase human accessibility and can increase movement, settlement and human activity in frontier forest areas. This has manifold repercussions including forest fires, waste disposal and pollution, illegal timber harvest, poaching and hunting (Alamgir et al. 2017). Studies from protected areas in developing economies show that road expansion and improved accessibility to the market can result in expansion of agricultural and livestock frontiers with reduction in nearby forest areas of the protected area (Ratner et al. 2007; Lama & Job 2014; Phaipasith & Castella 2017; Walelign et al. 2019). Conversion from subsistence agriculture to cash crops, emergence of commercial service economies such as mass tourism resulted in transition from a low-impact economy to a high-impact one (Walelign et al. 2019). Local socio-economic inequality also increased after road-expansion (Ratner et al. 2007). In the long run, the negative impact on the forest, waste generation and excessive use of agro-chemicals resulted in lesser availability of clean water, reduced soil fertility and local extinction of NTFP species (Phaipasith & Castella 2017). This also affected local governance systems negatively and people often could not revert to their subsistence economies which were relatively sustainable (Lama & Job 2014).

vii) Roads as a cause for habitat loss and degradation

During the construction and maintenance of roads and highways, habitat loss and degradation is observed due to direct clearing of vegetation, dumping of excavated earth and materials, regular usage of access roads by heavy machinery, and construction of labour camps. Within tropical forests, disturbance from roads due to fluctuations in light, temperature and humidity, increased mortality of trees beside roads, and spread of exotic species to a width of least 100m from the road (Laurance et al. 2009). Thus, “each kilometre of road directly and detrimentally affects at least 10 ha of habitat”, and the impacts may persist for decades (Laurance et al. 2009; Raman 2011).

viii) Roads as corridors for invasive species

Roads have been found to be a major factor in the spread of invasive flora and fauna into forests (Mortensen et al. 2009; Meunier & Lavoie 2012). These invasive species can use the edge habitats along the road and invade forests by secondary wind dispersal, that would have otherwise been inaccessible (Kowarik & von der Lippe 2011).

6.3 THE IMPACT OF RAILWAY-LINE DOUBLING AND INADEQUACY OF MITIGATION

i) Air quality

No potential impacts on air quality were studied, as the railway line between Castlerock and Kulem was assumed to be electric. If the trains in the proposed stretches run on traditional diesel engines, increased locomotive traffic due to the doubling of the railway line will lead to an increase in harmful exhaust components. The main pollutants from diesel locomotives are Carbon Dioxide (CO2), Carbon Monoxide (CO), Sulphur Dioxide (SO2), Nitrous Oxide (N2O), particulate matter (PM), hydrocarbons (HC), among others. Many of these pollutants are carcinogenic and responsible for health and environmental impacts (Lucas et al. 2017).

The report suggests monitoring of air quality and minimizing air pollution due to dust particles, vehicular and locomotive emissions, during the construction and operational phase. Although necessary, such general recommendations on controlling impacts on air quality during the construction phase will minimally help in reducing pollution as the project will take three years to construct and the operational impacts will be near permanent. Abrasion of brakes, wheels, dust, mineral transport will all still produce PM emissions even if electric locomotives are used (Levengood et al. 2015). No amount of mitigation will compensate for the long-term impacts of air pollution due to the proposed expansion.

ii) Sound (Noise pollution)

The noise levels at various regions within the areas of the proposed project were already noted to be above the permissible level of 91dB, posing a serious threat from noise pollution. Anthropogenic noise can affect acoustic communication among bird species that use calls and songs for a variety of functions such as attracting mates and defending territories (Collins 2004; Marler 2004). Noise emission from railways has also been documented to reduce the density and nesting behaviour of birds, with nests that are farther away from railway lines being more successful (Mundahl et al. 2013).

To reduce noise pollution, the Railway Report recommends switching to electric engines, planting native tree species along the railway line and building sound barriers on both sides of the track, particularly...
within the biodiversity-rich Kali Tiger Reserve (from Castlerock station – Goa border) and BMWS & NP. All of these three recommendations, however, have serious drawbacks which the report has overlooked.

a. Switching to electric engines will not greatly reduce noise pollution. This is because, at a speed of 30–200 km/h (the speed at which most trains will be travelling between stations), all trains, including the electric trains, produce a “rolling noise” which is the dominant source of noise pollution (Clausen et al. 2012).

b. Recovering vegetation beside roads and railways is known to attract wildlife and increase their vulnerability to get killed by moving vehicles (Case 1978; Jaren et al. 1991; Putman 1997; Cain et al. 2003).

c. Sound barriers can cause various negative impacts on wildlife, particularly through isolation of populations (Bank et al. 2002). Given that the minimum height of such barriers is as high as the train, and with electric lines proposed to be running on top of the railway, it would make it impossible for any terrestrial species to freely move to the other side of the track and will be a death trap for wildlife trapped between the barriers.

iii) Water quality

The Railway Report states that the current water quality in streams along existing railway track is pristine (Bureau of Indian Standards 2012), but with harmful levels of bacteria "Escherichia coli" in all streams (221 to 542 per 100mL), it indicates widespread faecal contamination of waterbodies mostly due to existing train traffic (threshold is 100 per 100mL). Creation of new railway embankments for the proposed double gauging will further lead to vegetation loss, soil compression and changes in water drainage, thus increasing runoff, promoting erosion of topsoil and increasing water turbidity (Ferrell & Lautala 2010; Chen et al. 2015). Turbid water has been found to affect the diversity and abundance of aquatic wildlife communities such as odonates and freshwater fish (Luce & Mountain 2002).

The Railway Report mentions that the new railway coaches will be fitted with bio-toilets, hence reducing the likelihood of *E. coli* infiltrating streams along the railway route. Construction of dykes and retaining walls along the railway line to restrict the movement of sediments during the construction phase has been recommended. While this may address sediment runoff, it may indirectly inhibit animal movement, adding to the effects of tree clearing, noise, and train movement.

iv) Biodiversity

The major focus of the studies appears to be to create baseline information on species diversity and abundance, rather than to explicitly study the impact of the proposed expansion on biodiversity. The Railway Report only cursorily mentions that animal movement will be impacted by the doubling of the railway line (Chapter 18, Page 207) and does not address long-term impacts to landscape connectivity that all the taxa under study face from the proposed expansion of the railway line. There is strong evidence of the negative impacts of railway lines on biodiversity.

Railway lines have been shown to be barriers to movement for large mammals such as the tiger (Dutta et al. 2018). The current railway line between Kulem and Castlerock poses a high degree of resistance to large mammal movement (Jayadevan et al. 2020). Doubling of the railway track will lead to a higher frequency of trains, and further increase resistance to movement. This can isolate the forest patches on either side of the railway line. In addition to its impacts on movement, noise and vibrations from railways affect insects, amphibians, and birds. Further, the availability of food (solid food waste; carcases of dead animals) and vegetation along the railway edges attracts reptiles, few species of birds, and several mammals acting as an ecological trap and leading to higher mortality due to collision with trains (Lucas et al. 2017).

The mitigation measures suggested in the Railway Report are very general. The suggestion of the creation of ‘biodiversity parks’ for conserving birds and mammals is not compensatory, when the protected area, which is a biodiversity-rich region, will be fragmented. For aquatic life, it is suggested that railways should adopt the ‘best construction procedures’ to reduce turbidity, siltation, etc., but what these procedures comprise of is unexplained.

The Railway Report highlights cases of Gaur and Sambar being hit by trains on the existing single track, reaffirming that the doubling of the railway line will lead to increased risk of accidental collisions with wildlife.
Although the report identifies 42 animal-crossing points for mammals, a bare minimum of four animal underpasses are finalized at Ch 32/200, Ch 41/100, Ch 45/500, Ch 49/500 (RVNL Letter No.PIU/UBL/ULN654 dated 06.10.2018 to deputy forest officer). The report suggests many other mitigation measures to be followed (Pages 207–208), but such mitigation measures are undetailed, and without strong supervision during implementation have poor application in practice.

6.4 INADEQUATE MITIGATION MEASURES FOR THE TRANSMISSION LINE

i) On the subject of mitigation measures for the transmission line, the inspection report of the transmission line mentions only that “the user agency has agreed to cut minimum trees requirements and to adopt wildlife-friendly mitigation measures.” It adds that “trees listed for felling under this project will be compensated in the long term through the proposed compensatory afforestation programme covering double the degraded forest land.” It is not clear how ‘minimum tree cutting’ will be calculated or enforced. No details are provided on where and when the compensatory afforestation will be executed. Further, without an impact assessment of the transmission line, it is not clear what ‘wildlife-friendly mitigation measures’ will be implemented.

ii) The inspection report fails to take into account the ecological impacts of the transmission line as we have detailed in this paper (Section 5). A background paper for the National Board for Wildlife (Raman 2011) recommends that the first priority for power lines in forests should be prevention, followed by re-alignment. The third option of a mitigation measure is suggested only where the first two have been comprehensively considered and ruled out with sufficient justification (Raman 2011). In case a transmission line passes through a biodiverse region, recommended mitigation measures for transmission lines include insulators on wires to avoid bird electrocution, placing of perch deterrents on cross-arms and poles and using large line-markers on earth wires to increase their visibility during the day and night, thus avoiding collisions by birds and volant mammals (WII 2016). But neither of these are considered as mitigation measures for this project.

7. CONCLUSION

Any major infrastructure projects should be avoided within PAs, unless there are exceptional circumstances that will clearly show forest diversion will benefit wildlife (as per the WPA, 1972). Utmost importance should be given to all environmental and ecological impacts of any project, and as per the background paper of the National Board for Wildlife itself, ecologically-harmful projects should be avoided. In the present case, there is not one, but three large projects which are planned in this ecologically-sensitive region. It is noteworthy that the Western Ghats is a designated Natural World Heritage Site by UNESCO. The cumulative impacts of these three projects may change the entire ecology of the BWWS & NP, as well as the neighbouring Kali Tiger Reserve, and will result in irreparable damage to its fragile environment. Further, such damage will impact the quality of human life within and near the PA. Multiple projects also call for an in-depth investigation into cumulative impacts on the PA. Cumulative impact studies have been considered mandatory in many countries (Braid et al. 1985), and are implemented rigorously for their added value in understanding irreversible changes to existing natural systems (Xue et al. 2004).

It is pertinent to note that two of these projects (NH-4A and transmission line) were awarded wildlife clearances in the 57th meeting of the Standing Committee of the NBWL, held on 7 April 2020 through a video conference, which is unlikely to have had critical evaluation. Our review details how the EIAs and assessments for these projects are considerably weak, and evidently overlooked by the highest statutory authority that is mandated to protect wildlife in the country. Socially- and environmentally-just development is important, but none of these projects provide any benefit to wildlife or the environment in the BMWS & NP. Environmental costs and mitigation measures are not comprehensively assessed in the EIAs and assessment studies. Information on the land area for compensation, overseeing agencies for mitigation measures, monitoring and penalties for non-compliance are also not laid out in detail.

Faulty EIAs and other assessment studies continue to be condoned by successive appraisal boards and governments, with a lack of due process. Such practices consider environmental concerns as a burden on development, rather than a process that guides sustainable development, which should, therefore, be strengthened. This further weakens socio-ecological governance in a country which is ranked a 168 (out of 180 countries) in the Environmental Performance Index.
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(Wendling et al. 2020). Considerable opportunities exist to improve the EIA and assessment process in India (Palival 2006). Incentivising post-clearance monitoring and evaluation is vital (Dufló et al. 2013); however, a rational screening process which fortifies existing legislation and avoids forest diversion proposals in protected areas at the outset itself is most necessary (Rajaram & Das 2011).

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Appendix I. Checklist of birds in Bhagwan Mahavir Sanctuary and National Park.

The list is compiled from data available on eBird (2017) from multiple hotspots and checklist locations within BMWS NP and Rahmani et al. (2016).

**ENDEMISM TO WG (WESTERN GHATS):** Species, whose global distribution range is restricted to within the biogeographical boundaries of the Western Ghats. In other words, they are unique to Western Ghats, and are not found anywhere else in the world.

**IUCN:** Evaluation of species as per IUCN Redlist 2020-1 CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened

**WLPA (1972):** Species listed and protected under five different categories (Schedule I to IV, and VI) in accordance to the Wildlife Protection Act of 1972.

**STATUS:** Evaluation of migratory status of a species. R: Resident; M: Migrant; LM: Local Migrant, making short movements out of the political boundaries of Goa; R/M: Resident population supplemented by a migratory population; VG: Vagrant migrants recorded away from their known migratory range; S: Residents of the Indian Subcontinent with no known resident populations in Goa attributed to as stray; UC: Unclear

**RARITY:** A species that has less than ten independently confirmed records form within the political boundaries of Goa, post 2000.

| Species | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|---------|----------------|------|-------------|--------|--------|
| **I. Anseriformes** | | | | | |
| 1. Anatidae (ducks, geese, swans) | | | | | |
| Lesser Whistling Duck *Dendrocygna javanica* | | | 4 | R | |
| **II. Galliformes** | | | | | |
| 2. Phasianidae (partridges, pheasants, grouse) | | | | | |
| Indian Peafowl *Pavo cristatus* | | | 1 | R | |
| Jungle Bush Quail *Perdicula asiatica* | | | 4 | R | |
| Grey Junglefowl *Gallus sonneratii* | | | 2 | R | |
| Red Spurfowl *Gallinoperdix spadicea* | | | 4 | R | |
| **III. Columbiformes** | | | | | |
| 3. Columbidae (pigeons) | | | | | |
| Rock Pigeon *Columba livia* | | | 4 | R | |
| Nilgiri Wood Pigeon *Columba elphinstonii* | | | VU | 4 | R | |
| Oriental Turtle Dove *Streptopelia orientalis* | | | 4 | R | |
| (Western) Spotted Dove *Streptopelia chinensis suratensis* | | | 4 | R | |
| Orange-breasted Green Pigeon *Treron bicinctus* | | | 4 | R | |
| Grey-fronted Green Pigeon *Treron affinis* | | | 4 | R | |
| Asian Emerald Dove *Chalcophaps indica* | | | 4 | R | |
| Green Imperial Pigeon *Ducula aenea* | | | 4 | R | |
| Mountain Imperial Pigeon *(Nilgiri Imperial Pigeon)* *Ducula badia cuprea* | | | 4 | R | |
| **IV. Caprimulgiformes** | | | | | |
| 4. Podargidae (frogmouths) | | | | | |
| Sri Lanka Frogmouth *Batrachostomus moniliger* | | | 1 | R | |
| 5. Caprimulgidae (nightjars) | | | | | |
| Jungle Nightjar *Caprimulgus indicus* | | | 4 | R | |
| Jerdon’s Nightjar *Caprimulgus atripennis* | | | 4 | R | |
| Indian Nightjar *Caprimulgus asiaticus* | | | 4 | R | X |
| Savanna Nightjar *Caprimulgus affinis* | | | 4 | R | |
| 6. Hemiprocnidae (treeswifts) | | | | | |
| Crested Treeswift *Hemiprocne coronata* | | | R | | |
| 7. Apodidae (swifts) | | | | | |
| White-rumped Spinetail *Zoothera syriatica* | | | R | | |
| Brown-backed Needletail *Hirundapus giganteus* | | | R | | |
| Indian Swiftlet *Aerodramus unicolor* | | | 1 | R | |
| 24. Asian Palm Swift *Cypsiurus balasiensis* | | | LM | | |
| Alpine Swift *Tachymarptis melba* | | | R | | |
| 26. Indian House Swift *Apus affinis* | | | R | | |
| Species | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|---------|----------------|------|-------------|--------|--------|
| 27 Common Swift | Apus apus | | | | |
| V. Cuculiformes | | | | | |
| 28 Greater Coucal | Centropus sinensis | | 4 | R | |
| 29 Blue-faced Malkoha | Phoenicoparrus viridirostris | | 4 | R | |
| 30 Pied Cuckoo | Clamator jacobinus | | 4 | R/M | |
| 31 Asian Koel | Eudynamys scolopaceus | | 4 | R | |
| 32 Banded Bay Cuckoo | Cocamantis sonnerati | | 4 | R | |
| 33 Grey-bellied Cuckoo | Cocamantis passerinus | | 4 | R | |
| 34 Fork-tailed Drongo Cuckoo | Surniculus dicruraoides | | 4 | R | |
| 35 Large Hawk Cuckoo | Hierococcyx sparverioides | | 4 | M | X |
| 36 Common Hawk Cuckoo | Hierococcyx varius | | 4 | R | |
| 37 Indian Cuckoo | Cuculus micropterus | | 4 | R | |
| 38 Common Cuckoo | Cuculus canorus | | 4 | R | |
| VI. Gruidae | | | | | |
| 39 Slaty-legged Crane | Rallina eurizonoides | | 4 | M | |
| 40 White-breasted Waterhen | Amaurornis phoenicurus | | 4 | R | |
| 41 Purple Swamphen | Porphyrio porphyrio | | 4 | R | |
| VII. Ciconiiformes | | | | | |
| 42 Lesser Adjutant | Leptoptilos javanicus | | VU | 4 | R |
| 43 Asian Openbill | Anastomus oscitans | | 4 | R | |
| 44 Black Stork | Ciconia nigra | | 4 | M | X |
| 45 Woolly-necked Stork | Ciconia episcopus | | VU | 4 | R |
| 56 Black-headed Ibis | Threskiornis melanocephalus | | NT | 4 | R/M |
| VIII. Suliformes | | | | | |
| 57 Little Cormorant | Microcarbo niger | | 4 | R | |
| 58 Indian Cormorant | Phalacrocorax fuscicolis | | 4 | R | |
| 59 Oriental Darter | Anhinga melanogaster | | NT | 4 | R |
| Species | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|---------|----------------|------|-------------|--------|--------|
| IX. Charadriiformes | | | | |
| 15. Recurvirostridae (stilts and avocets) | | | | |
| 60 Black-winged Stilt *Himantopus himantopus* | | 4 | M | |
| 16. Charadriidae (plovers & lapwings) | | | | |
| 61 Little Ringed Plover *Charadrius dubius* | | 4 | R | |
| 62 Yellow-wattled Lapwing *Vanellus malabaricus* | | 4 | R | |
| 63 Red-wattled Lapwing *Vanellus indicus* | | 4 | R | |
| 17. Jacanidae (jacanas) | | | | |
| 64 Bronze-winged Jacana *Metopidius indicus* | | 4 | R | |
| 18. Scolopacidae (sandpipers) | | | | |
| 65 Common Snipe *Gallinago gallinago* | | 4 | M | |
| 66 Common Sandpiper *Actitis hypoleucos* | | 4 | LM | |
| 67 Green Sandpiper *Tringa ochropus* | | 4 | M | |
| 19. Turnicidae (buttonquails) | | | | |
| 68 Barred Buttonquail *Turnix suscitator* | | 4 | R | |
| 20. Glareolidae (coursers and pratincoles) | | | | |
| 69 Little Pratincole *Glareola lactea* | | | M | |
| 21. Laridae (gulls and terns) | | | | |
| 70 Gull-billed Tern *Gelochelidon nilotica* | | 4 | R | |
| 71 River Tern *Sterna aurantia* | | NT | 4 | R | |
| X. Accipitriformes | | | | |
| 22. Accipitridae (kites, hawks and eagles) | | | | |
| 72 Black-winged Kite *Elanus caeruleus* | | 1 | M | |
| 73 Oriental Honey Buzzard *Pernis ptilorhynchus* | | 1 | R | |
| 74 Egyptian Vulture *Neophron percnopterus* | | EN | 1 | S | X |
| 75 Crested Serpent Eagle *Spilornis cheela* | | 1 | R | |
| 76 Short-toed Snake Eagle *Circaetus gallicus* | | 1 | S | |
| 77 White-rumped Vulture *Gyps bengalensis* | | CR | 1 | S | X |
| 78 Indian Vulture *Gyps indicus* | | CR | 1 | S | X |
| 79 Mountain Hawk Eagle (Legge's Hawk Eagle) *Nisaetus nipalensis kelaarti* | | | 1 | R | X |
| 80 Changeable Hawk Eagle (Crested Hawk Eagle) *Nisaetus cirrhatus cirrhatus* | | 1 | R | |
| 81 Rufous-bellied Eagle *Lophotriorchis kienerii* | | 1 | R | |
| 82 Black Eagle *Ichnetaetus malaiensis* | | 1 | R | |
| 83 Bonelli's Eagle *Aquila fasciata* | | 1 | R | |
| 84 Booted Eagle *Hieraaetus pennatus* | | 1 | M | |
| 85 Western Marsh Harrier *Circus aeruginosus* | | 1 | M | |
| 86 Crested Goshawk *Accipiter trivirgatus* | | 1 | R | |
| 87 Shikra *Accipiter badius* | | 1 | R | |
| 88 Besra *Accipiter virgatus* | | 1 | R | |
| 89 Eurasian Sparrowhawk *Accipiter nisus* | | 1 | M | |
| 90 White-bellied Sea Eagle *Haliaeetus leucogaster* | | 1 | R | |
| 91 Grey-headed Fish Eagle *Ichthyophaga ichthyaetus* | | NT | 1 | M | X |
| 92 Brahminy Kite *Haliastur indus* | | 1 | R | |
| 93 Black Kite *Milvus migrans* | | 1 | R/M | |
| Species                              | Endemism to WG | IUCN | WLP (1972) | Status | Rarity |
|--------------------------------------|----------------|------|------------|--------|--------|
| XI. Strigiformes                     |                |      |            |        |        |
| 94 White-eyed Buzzard *Butastur teesa* | 1              | R    |            |        |        |
| 95 Sri Lanka Bay Owl *Phodilus assimilis* | 4              | R    |            |        |        |
| 96 Common Barn Owl *Tyto alba*       | 4              | R    |            |        |        |
| 23. Strigidae (owls)                 |                |      |            |        |        |
| 97 Brown Hawk Owl *Ninox scutulata*  | 4              | R    |            |        |        |
| 98 Jungle Owlet *Glaucidium radiatum* | 4              | R    |            |        |        |
| 99 Spotted Owlet *Athene brama*      | 4              | R    |            |        |        |
| 100 Oriental Scops Owl *Otus sunia*  | 4              | R    |            |        |        |
| 101 Indian Scops Owl *Otus bakkamoena* | 4              | R    |            |        |        |
| 102 Brown Wood Owl *Strix leptogrammica* | 4              | R    |            |        |        |
| 103 Spot-bellied Eagle Owl *Bubo nipalensis* | 4              | R    |            |        |        |
| 104 Brown Fish Owl *Ketupa zeylonensis* | 4              | R    |            |        |        |
| XII. Trogoniformes                   |                |      |            |        |        |
| 24. Trogonidae (trogons)             |                |      |            |        |        |
| 105 Malabar Trogon *Harpactes fasciatus* | 4              | R    |            |        |        |
| XIII. Bucerotiformes                 |                |      |            |        |        |
| 25. Bucerotidae (hornbills)          |                |      |            |        |        |
| 106 Great Hornbill *Buceros bicornis* |                |      | NT         | 1      | R      |
| 107 Malabar Pied Hornbill *Anthracoceros coronatus* |                |      | NT         | 1      | R      |
| 108 Malabar Grey Hornbill *Ocyceros griseus* |                |      | WG         | 1      | R      |
| 109 Indian Grey Hornbill *Ocyceros birostris* |                |      |            |        |        |
| 26. Upupidae (hoopoes)               |                |      |            |        |        |
| 110 Common Hoopoe *Upupa epops*      |                |      |            |        |        |
| XIV. Piciformes                      |                |      |            |        |        |
| 27. Picidae (woodpeckers)            |                |      |            |        |        |
| 111 Speckled Piculet *Picumnus innominatus* |                |      | 4          | R      |        |
| 112 Heart-spotted Woodpecker *Hemicircus canente* |                |      | 4          | R      |        |
| 113 Common Golden-backed Woodpecker *Dinopium javanense* |                |      | 4          | R      |        |
| 114 Lesser Golden-backed Woodpecker *Dinopium benghalense* |                |      | 4          | R      |        |
| 115 Rufous Woodpecker *Micropterus brachyurus* |                |      | 4          | R      |        |
| 116 Lesser Yellow-naped Woodpecker *Picus chlorolophus* |                |      | 4          | R      |        |
| 117 White-bellied Woodpecker *Dyacopus javensis* |                |      | 4          | R      |        |
| 118 Greater Golden-backed Woodpecker *Chrysocolaptes guttacristatus* |                |      | 4          | R      |        |
| 119 White-naped Woodpecker *Chrysocolaptes festivus* |                |      | 4          | R      |        |
| 120 Brown-capped Pygmy Woodpecker *Dendrocopos nanus* |                |      | 4          | R      |        |
| 121 Yellow-fronted Pied Woodpecker *Dendrocopos mahatrattensis* |                |      | 4          | R      |        |
| 28. Megalaimidae (barbets)           |                |      |            |        |        |
| 122 Brown-headed Barbet *Psilopagon zeylanicus* |                |      | 4          | R      |        |
| 123 White-cheeked Barbet *Psilopagon viridis* |                |      | 4          | R      |        |
| 124 Malabar Barbet *Psilopagon molabaricus* |                |      | WG         | 4      | R      |
| 125 Coppersmith Barbet *Psilopagon haemacephalus* |                |      |            |        |        |
| XV. Coraciiformes                    |                |      |            |        |        |
| 29. Meropidae (bee-eaters)           |                |      |            |        |        |
| Species | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|---------|----------------|------|-------------|--------|--------|
| 126 Blue-bearded Bee-eater Nyctyornis athertoni | | | | R | |
| 127 Green Bee-eater Merops orientalis | | | | R | |
| 128 Chestnut-headed Bee-eater Merops leschenaulti | | | | R | |
| 129 Blue-tailed Bee-eater Merops philippinus | | | | M | |
| 130 Indian Roller Coracias benghalensis | 4 | | | LM | |
| 131 European Roller Coracias garrulus | 4 | | | M | |
| 132 Oriental Dwarf Kingfisher Ceyx erithaca | 4 | | | R | |
| 133 Blue-eared Kingfisher Alcedo meninting | 4 | | | R | |
| 134 Common Kingfisher Alcedo atthis | 4 | | | R | |
| 135 Pied Kingfisher Ceryle rudis | 4 | | | R | |
| 136 Stork-billed Kingfisher Pelargopsis capensis | 4 | | | R | |
| 137 White-throated Kingfisher Halcyon smyrnensis | 4 | | | R | |
| 138 Black-capped Kingfisher Halcyon pileata | 4 | | | R | |

XVI. Falconiformes

| Species | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|---------|----------------|------|-------------|--------|--------|
| 139 Common Kestrel Falco tinnunculus | 4 | | | M | |
| 140 Amur Falcon Falco amurensis | 4 | | | M | |
| 141 Eurasian Hobby Falco subbuteo | 4 | | | M | |
| 142 Peregrine Falcon Falco peregrinus | 1 | | | | |

XVII. Psittaciformes

| Species | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|---------|----------------|------|-------------|--------|--------|
| 143 Plum-headed Parakeet Psittacula cyanocephala | 4 | | | R | |
| 144 Malabar Parakeet Psittacula columboides | WG | | | | |
| 145 Rose-ring Parakeet Psittacula krameri | 4 | | | R | |
| 146 Vernal Hanging Parrot Loriculus vernalis | 4 | | | R | |

XVIII. Passeriformes

| Species | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|---------|----------------|------|-------------|--------|--------|
| 147 Indian Pitta Pitta brachyura | 4 | | | R | |
| 148 Small Minivet Pericrocotus cinnamomeus | 4 | | | R | |
| 149 Scarlet Minivet (Orange Minivet) Pericrocotus flammeus | 4 | | | R | |
| 150 Large (Indian) Cuckoo-shrike Coracina javensis macei | 4 | | | R | |
| 151 Black-winged Cuckoo-shrike Lalage melaschistos | 4 | | | M X | |
| 152 Black-headed Cuckoo-shrike Lalage melanoptera | 4 | | | R | |
| 153 Black-hooded Oriole Oriolus xanthornus | 4 | | | R | |
| 154 Indian Golden Oriole Oriolus kundoo | 4 | | | LM | |
| 155 Bar-winged Flycatcher-shrike Hemipus pictus | 4 | | | R | |
| 156 Malabar Woodshrike Tephrodornis sylvicola | WG | | | | |
| 157 Common Woodshrike Tephrodornis ponicerianus | 4 | | | R | |
| Species | Endemism to | IUCN | WLPA (1972) | Status | Rarity |
|---------|-------------|------|-------------|--------|--------|
| 38. Aegithinidae (ioras) | | | | | |
| 160. Common Iora Aegithina tiphia | | | | | |
| 39. Dicuridae (drongos) | | | | | |
| 161. Black Dongo Dicrurus macrocercus | | | | | |
| 162. Ashy Dongo Dicrurus leucophaeus | | | | | |
| 163. White-bellied Dongo Dicrurus caerulescens | | | | | |
| 164. Bronzed Dongo Dicrurus aeneus | | | | | |
| 165. Hair-crested Dongo Dicrurus hatteriatus | | | | | |
| 166. Greater Racket-tailed Dongo Dicrurus paradiseus | | | | | |
| 40. Rhipiduridae (fantails) | | | | | |
| 167. White-spotted Fantail Rhipidura albogularis | | | | | |
| 41. Laniidae (shrikes) | | | | | |
| 168. Brown Shrike Lanius cristatus cristatus | | | | | |
| 169. Isabelline Shrike Lanius isabellinus | | | | | |
| 170. Long-tailed Shrike Lanius schach | | | | | |
| 42. Corvidae (crows and jays) | | | | | |
| 171. Rufous Treepie Dendrocitta vagabunda | | | | | |
| 172. House Crow Corvus splendens | | | | | |
| 173. Large-billed Crow (Indian Jungle Crow) Corvus macrorhynchos culminatus | | | | | |
| 43. Monarchidae (monarchs and paradise-flycatchers) | | | | | |
| 174. Black-naped Monarch Hypothymis azurea | | | | | |
| 175. Indian Paradise-flycatcher Terpsiphone paradisi | | | | | |
| 44. Dicaeidae (flowerpeckers) | | | | | |
| 176. Thick-billed Flowerpecker Dicaeum agile | | | | | |
| 177. Pale-billed Flowerpecker Dicaeum erythrorhynchas | | | | | |
| 178. Nilgiri Flowerpecker Dicaeum cancolor | | WG | | | |
| 45. Nectariniidae (sunbirds) | | | | | |
| 179. Little Spiderhunter Arachnothera longirostra | | | | | |
| 180. Purple-rumped Sunbird Leptocoma zeylonica | | | | | |
| 181. Crimson-backed Sunbird Leptocoma minima | | WG | | | |
| 182. Purple Sunbird Cinnyris asiaticus | | | | | |
| 183. Loten’s Sunbird Cinnyris lotenius | | | | | |
| 184. Vigors’s Sunbird Aethopyga vigarsi | | WG | | | |
| 46. Irenidae (fairy-bluebirds) | | | | | |
| 185. Asian Fairy-bluebird Irena puella | | | | | |
| 47. Chloropseidae (leafbirds) | | | | | |
| 186. Golden-fronted Leafbird Chloropsis aurifrons | | | | | |
| 187. Jerdon’s Leafbird Chloropsis jerdoni | | | | | |
| 48. Plöcidae (weavers) | | | | | |
| 188. Baya Weaver Ploceus philippinus | | | | | |
| 49. Estrildidae (waxbills) | | | | | |
| 189. Red Munia Amadina amandava | | | | | |
| 190. White-rumped Munia Lonchura striata | | | | | |
| 191. Scaly-breasted Munia Lonchura punctulata | | | | | |
| Species                                      | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|----------------------------------------------|----------------|------|-------------|--------|--------|
| 192 Black-throated Munia Lonchura kelaarti   |                | 4    | R           |        |        |
| 193 Tricoloured Munia Lonchura malacca       |                | 4    | R           |        |        |
| 50. Passeridae (sparrows, snowfinches and allies) |              |      |             |        |        |
| 194 House Sparrow Passer domesticus          |                | 4    | R           |        |        |
| 195 Yellow-throated Sparrow Gymnoris xanthocollis |            | 4    | R           |        |        |
| 51. Motacillidae (wagtails and pipits)       |                |      |             |        |        |
| 196 Forest Wagtail Dendronotus indicus       |                | 4    | M           |        |        |
| 197 Tree Pipit Anthus trivialis             |                | 4    | M           |        |        |
| 198 Olive-backed Pipit Anthus hodgsoni       |                | 4    | M           |        | X      |
| 199 Paddyfield Pipit Anthus rufulus          |                | 4    | R/M         |        |        |
| 200 Tawny Pipit Anthus campestris            |                | 4    | M           |        |        |
| 201 Western Yellow Wagtail Motacilla flavia  |                | 4    | M           |        |        |
| 202 Grey Wagtail Motacilla cinerea          |                | 4    | M           |        |        |
| 203 White-browed Wagtail Motacilla maderaspatensis |        | 4    | R/M         |        |        |
| 204 White Wagtail Motacilla alba             |                | 4    | M           |        |        |
| 52. Fringillidae (finches, euphonias and Hawaiian honeycreepers) | |      |             |        |        |
| 205 Common Rosefinch Erythrina erythrina    |                | 4    | M           |        |        |
| 53. Emberizidae (Old World buntings)        |                |      |             |        |        |
| 206 Red-headed Bunting Emberiza bruniceps    |                | 4    | M           |        |        |
| 207 Black-headed Bunting Emberiza melaniceps |              |      |             |        |        |
| 208 Grey-necked Bunting Emberiza buchanani   |                | 4    | M           |        |        |
| 54. Stenostiridae (fairy-flycatcher and crested flycatchers) | |      |             |        |        |
| 209 Grey-headed Canary-flycatcher Culicicapa ceylonensis | | 4    | M           |        |        |
| 55. Paridae ( tits, chickadees )             |                |      |             |        |        |
| 210 Black-lored Tit Machlolophus xanthogenys |                | 4    | R           |        |        |
| 56. Alaudidae (larks)                        |                |      |             |        |        |
| 211 Sykes’s Short-toed Lark Calandrella dukhunensis |        | 4    | M           |        |        |
| 212 Malabar Lark Galerida malabarica         |                | 4    | R           |        |        |
| 57. Cisticolidae (cisticolas)                |                |      |             |        |        |
| 213 Zitting Cisticola Cisticola juncidis     |                | 4    | R           |        |        |
| 214 Grey-breasted Prinia Prinia hodgsonii    |                | 4    | R           |        |        |
| 215 Ashy Prinia Prinia socialis              |                | 4    | R           |        |        |
| 216 Plain Prinia Prinia inornata             |                | 4    | R           |        |        |
| 217 Common Tailorbird Orthotomus sutorius    |                | 4    | R           |        |        |
| 58. Locustellidae ( bush warblers )          |                |      |             |        |        |
| 218 Grasshopper Warbler Locustella naevia    |                | 4    | M           |        |        |
| 59. Acrocephalidae (brush, reed and swamp warblers) |            |      |             |        |        |
| 219 Booted Warbler Iduna caligata            |                | 4    | M           |        |        |
| 220 Sykes’s Warbler Iduna rama               |                | 4    | M           |        | X      |
| 221 Blyth’s Reed Warbler Acrocephalus dumatorum |            | 4    | M           |        |        |
| 222 Paddyfield Warbler Acrocephalus agricola |                | 4    | M           |        |        |
| 223 Clamorous Reed Warbler Acrocephalus stentoreus |        | 4    | R/M         |        |        |
| 60. Hirundinidae (swallows)                 |                |      |             |        |        |
| 224 Northern House Martin Delichon urbicum   |                | M    | X           |        |        |
| 225 Streak-throated Swallow Petrochelidon fluvicola |            | M    |             |        |        |
| Species | Endemism to WG | IUCN | WILPA (1972) | Status | Rarity |
|---------|----------------|------|--------------|--------|--------|
| 226 Red-rumped Swallow Cecropis daurica | | | | | K |
| 227 Wire-tailed Swallow Hirundo smithii | | | | | R |
| 228 Barn Swallow Hirundo rustica | | | | | M |
| 229 Eurasian Crag Martin Ptyonoprogne rupestris | | | | | M |
| 230 Dusky Crag Martin Ptyonoprogne concolor | | | | | R |
| 61. Pycnonotidae (bulbuls) | | | | | |
| 231 Square-tailed Bulbul Hypsipetes ganzesa | 4 | R | | |
| 232 Flame-throated Bulbul Pycnonotus melanicterus gularis | WG | 4 | R | |
| 233 Red-whiskered Bulbul Pycnonotus jacosus | | 4 | R | |
| 234 Red-vented Bulbul Pycnonotus cafer | | 4 | R | |
| 235 White-browed Bulbul Pycnonotus liotelus | | 4 | R | |
| 236 Grey-headed Bulbul Brachypodius procephalus | WG | NT | 4 | R | |
| 237 Yellow-browed Bulbul Acritillas indica | | 4 | R | |
| 62. Phylloscopidae (Old World leaf warblers) | | | | | |
| 238 Yellow-browed Warbler Abrornis inornatus | 4 | M | X | |
| 239 Sulphur-bellied Warbler Phylloscopus griseolus | | 4 | M | |
| 240 Tickell’s Leaf Warbler Phylloscopus affinis | | 4 | M | |
| 241 Green Leaf Warbler Seicercus nitidus | | 4 | M | |
| 242 Greenish Leaf Warbler Seicercus trachiloides | | 4 | M | |
| 243 Large-billed Leaf Warbler Seicercus magnirostris | | 4 | M | |
| 244 Western Crowned Leaf Warbler Seicercus occipitalis | | 4 | M | |
| 63. Sylviidae (Sylvia warblers, parrotbills and allies) | | | | | |
| 245 Yellow-eyed Babbler Chrysomma sinense | 4 | R | | |
| 64. Zosteropidae (white-eyes and yuhinas) | | | | | |
| 246 Oriental White-eye Zosterops palpebrosus | 4 | R | | |
| 65. Timaliidae (scimitar babblers and allies) | | | | | |
| 247 Indian Scimitar Babbler Pomatorhinus horsfieldii | 4 | R | | |
| 248 Tawny-bellied Babbler Dumetia hyperotra albogularis | | 4 | R | |
| 249 Dark-fronted Babbler Rhopocichla atriceps | | 4 | R | |
| 250 Puff-throated Babbler Pellorneum ruficeps | | 4 | M | |
| 66. Pellorneidae (smaller babblers) | | | | | |
| 251 Quaker Tit Babbler Alcippe poioicephala | 4 | R | | |
| 67. Leiothrichidae (babblers, laughingthrushes and allies) | | | | | |
| 252 Rufous Babbler Arga subrufa | WG | 4 | R | |
| 253 Jungle (Black-winged) Babbler Turdoides striata somervillei | WG | 4 | R | |
| 254 Yellow-billed Babbler Turdoides affinis | | 4 | S | X | |
| 255 Waynaad Laughingthrush Garrulax delesserti | WG | 4 | R | |
| 68. Sittidae (nuthatches, spotted creepers and wallcreeper) | | | | | |
| 256 Velvet-fronted Nuthatch Sitta frontalis | | 4 | R | |
| 69. Sturnidae (starlings) | | | | | |
| 257 Rosy Starling Pastor roseus | | 4 | M | |
| 258 Brahminy Starling Sturnia pagodarum | | 4 | R | |
| 259 Chestnut-tailed Starling Sturnia malabarica | | 4 | R | |
| 260 Malabar Starling Sturnia malabarica blythii | | 4 | R | |
| 261 Common Myna Acridotheres tristis | | 4 | R | |
| Species                                      | Endemism to WG | IUCN | WLPA (1972) | Status | Rarity |
|---------------------------------------------|----------------|------|-------------|--------|--------|
| 262 Jungle Myna Acridothers fuscus           |                | 4    | R           |        |        |
| 263 Southern Hill Myna Gracula indica       |                | 1    | R           |        |        |
| 70. Muscicapidae (chats ad flycatchers)     |                |      |             |        |        |
| 264 Indian Robin Saxicoloides fulicatus     |                | 4    | R           |        |        |
| 265 Oriental Magpie Robin Copsychus saularis|                | 4    | R           |        |        |
| 266 White-rumped Shama Kittacincla malabarica|              | 4    | R           |        |        |
| 267 Dark-sided Flycatcher Muscicapa sibirica §|            | 4    | VG          | X      |        |
| 268 Asian Brown Flycatcher Muscicapa daurica |                | 4    | M           |        |        |
| 269 Brown-breasted Flycatcher Muscicapa mutui |              | 4    | M           |        |        |
| 270 Rusty-tailed Flycatcher Muscicapa ruficauda |            | 4    | M           |        |        |
| 271 White-bellied Blue Flycatcher Cyornis pallidipes |        |        | R           |        |        |
| 272 Tickell’s Blue Flycatcher Cyornis tickelliae |        |        | R           |        |        |
| 273 Verditer Flycatcher Eumyias thalassinus |                | 4    | M           |        |        |
| 274 Indian Blue Robin Larvivora brunnea     |                | 4    | M           |        |        |
| 275 Malabar Whistling Thrush Myophonus horsfieldii |    | 4    | R           |        |        |
| 276 Red-breasted Flycatcher Ficedula parva  |                | 4    | M           |        |        |
| 277 Taiga Flycatcher Ficedula albicilla      |                | 4    | M           |        |        |
| 278 Ultramarine Flycatcher Ficedula superciliaris |            | 4    | M           | X      |        |
| 279 Black Redstart Phoenicurus ochruros      |                | 4    | M           | X      |        |
| 280 Blue-capped Rock Thrush Monticola cinclorhynchach | 4 |    | M           |        |        |
| 281 Blue Rock Thrush Monticola solitarius   |                | 4    | M           |        |        |
| 282 Siberian Stonechat Saxicola maurus       |                | 4    | M           |        |        |
| 283 Pied Bushchat Saxicola caprata           |                | 4    | R           |        |        |
| 71. Turdidae (thrushes)                     |                |      |             |        |        |
| 284 Orange-headed Thrush Geokichla citrina   |                | 4    |             |        |        |
| 285 Indian Blackbird Turdus simillimus       |                | 4    | R           |        |        |
| 286 Tickell’s Thrush Turdus unicolor         |                | 4    | M           | X      |        |
Appendix II. Wild Angiosperms of Bhagwan Mahavir National Park, Goa, India (adapted from Datar & Lakshminarasimhan 2013).

Abbreviations used for endemism: WG—Western Ghats | PI—peninsular India | AN—Andaman & Nicobar Islands | IN—India | SWI—southwestern India | NWG—northern Western Ghats | WI—western India | WSI—western and southern India | PCI—peninsular and central India | WPI—western peninsular India | Goa—Goa state.

Abbreviations used for Red Listed Species: CR—Critically Endangered | EN—Endangered | VU—Vulnerable

| Species / Family | Local name | Endemism | IUCN |
|------------------|------------|----------|------|
| **ACANTHACEAE**  |            |          |      |
| Andrographis paniculata (Burm.f.) Wall. ex Nees | Chirayat | Endemic WG | |
| Asystasia dalzelliana Santapau | | |
| Barkeria prattensis Santapau | | |
| Barkeria priodontis L. | | |
| Barkeria terminalis Nees | | |
| Cynarospermum asperatum (Nees) Vollesen | | Endemic PCI |
| Dicliptera foetida (Forssk.) Blatt. | | |
| Ecbolium ligustrinum (Vahl) Vollesen | | Endemic PCI |
| Eranthemum capense L. var. concanensis (T.Anderson ex C. B. Clarke) Santapau | | Endemic WG |
| Eranthemum roseum (Vahl) R.Br. | | Endemic WG |
| Gymnostachyum glabrum (Dalzell) T.Anderson | | |
| Haploandras tentaculatus (L.) R.B.Majumdar | | |
| Hemigraphis latebrosa (B.Heyne ex Roth) Nees | | |
| Hygrophila pinnatifida (Dalzell) Sreem. | | |
| Hygrophila ringens (L.) R.Br. ex Steud. | | |
| Hygrophila schulli (Buch.-Ham.) M.R.Almeida & S.M.Almeida | | |
| Justicia adhatoda L. | Adulsa | |
| Justicia procumbens L. | | |
| Justicia simplex D.Don | | |
| Justicia wynaadensis (Nees) Heyne ex T.Anderson | | Endemic WG |
| Lepidagathis cuspidata Nees | | |
| Lepidagathis incerta Buch.-Ham. ex D.Don var. mucronata (Nees) C.B.Clarke ex T.Cooke | | |
| Lepidagathis lutea Dalzell | Koche | |
| Lepidagathis prostrata Dalzell | | |
| Nelsonia canescens (Lam.) Spreng. | | |
| Phaulopsis imbricata (Forssk.) Sweet | | |
| Pseuderanthemum malabaricum (C.B.Clarke) Gamble | | |
| Rostellularia japonica (Thunb.) Ellis | | |
| Rungia parviflora (Retz.) Nees ssp. pectinata (L.) L.H.Cramer | | |
| Strobilanthes callosus Nees | Karaw | Endemic WI |
| Strobilanthes ciliata Nees | | Endemic WG | EN |
| Strobilanthes heyneanus Nees | Karaw | Endemic PI |
| Strobilanthes integrifolia (Dalzell) Kuntze | | Endemic WG |
| Strobilanthes ixocephalus Benth. | Kaarw | Endemic WG |
| **ALISMATACEAE**  |            |          |      |
| Wiesneria triandra (Dalzell) Micheli | | EN |
| **AMARANTHACEAE** | | |
| Achyranthes aspero L. | | |
| Alternanthera sessilis (L.) R.Br. ex DC. | | |
| Amaranthus spinosus L. | | |
| Species / Family                  | Local name | Endemism       | IUCN          |
|----------------------------------|------------|----------------|---------------|
| **AMARYLLIDACEAE**               |            |                |               |
| Celosia argentea L.              |            |                |               |
| Cyathula prostrata (L.) Blume    |            |                |               |
| **ANACARDIACEAE**                |            |                |               |
| Anacardium occidentale L.        |            |                |               |
| Buchanania lanzan Spreng.        |            |                |               |
| Holigarna arnottiana Hook.f.     | Bibba      | Endemic WG     |               |
| Holigarna grahamii (Wight) Kurz  |            |                |               |
| Lannea coromandelica (Houtt.) Merr. |        |                |               |
| Mangifera indica L.              | Amba       |                |               |
| **ANCISTROCLADACEAE**            |            |                |               |
| Ancistrocladus heyneanus Wall. ex J.Graham | | Endemic WG | |
| **ANNONACEAE**                   |            |                |               |
| Miliusa tomentosa (Roxb.) Finet and Gagnep. | | | |
| Orophea zeylanica Hook.f. & Thomson | | | |
| Polyalthia fragrans (Dalzell) Bedd. | | Endemic WG | |
| Sageraea laurina Dalzell | Sadni | Endemic WG | |
| Uvaria narnum (Dunal) Blume | | | |
| **ANTHERICACEAE**                |            |                |               |
| Chlorophytum heynei Rottl. ex Baker | | | |
| **APIACEAE**                     |            |                |               |
| Centella asiatica (L.) Urb.      |            |                |               |
| Pimpinella wallachiana (Miq. ex Hohen.) Gandhi | | | |
| **APOCYNACEAE: SUBFAMILY ASCLEPIADOIDEAE** | | | |
| Asclepias curassavica L.         |            |                |               |
| Calotropis gigantea (L.) R.Br.   |            |                |               |
| Cynanchum calliata Buch.-Ham. ex Wight | | | |
| Dregea volubilis (L. f.) Benth. ex Hook.f. | | | |
| Geniantus laurifolius (Roxb.) Hook.f. | | | |
| Gymnema sylvestre (Retz.) B. Br. ex Schult. | | | |
| Holostemma annulare (Roxb.) K.Schum. | | | |
| Hoya wightii Hook.f.             |            | Endemic PI     |               |
| Tylolphora fasciculata Buch.-Ham. ex Wight & Arn. | | | |
| **APOCYNACEAE: SUBFAMILY APOCYNOIDAE** | | | |
| Aganosma cymosa (Roxb.) G.Don | | | |
| Anodendron paniculatum (Roxb.) A.DC. | | | |
| Chomemorpha fragrans (Moon) Alston | | | |
| Holanthena pubescens (Buch.-Ham) Wall. ex G.Don | | | |
| Ichnornapus frutescens (L.) W.T.Aiton | | | |
| Parsania alboflavescens (Dennst.) Mabb. | | | |
| Species / Family | Local name | Endemism | IUCN |
|------------------|------------|-----------|------|
| Wrightia arborea (Dennst.) Mabb. | | | |
| Wrightia tinctoria (Roxb.) R.Br. | | | |
| APOCYNACEAE: SUBFAMILY RAUVOLFIOIDEAE | | | |
| Alstonia scholaris (L.) R.Br. | | | |
| Carissa spinarum L. | | | |
| Rauvolfia serpentina (L.) Benth. ex Kurz | | | |
| Tabernemontana alternifolia L. | Endemic WSI | | |
| APOCYNACEAE: SUBFAMILY PERIPLOCOIDEAE | | | |
| Cryptolepis buchananii R.Br. ex Roem. & Schult. | | | |
| Hermodiae indicus (L.) R.Br. | | | |
| ARAEACEAE | | | |
| Amorphophallus bulbifer (Roxb.) Blume | | | |
| Amorphophallus commutatus (Schott) Engl. var. commutatus | | | Endemic PI |
| Amorphophallus commutatus var. annomodensis Sivad. & Jaleel | | | Endemic Goa |
| Amorphophallus paconiifolius (Dennst.) Nicolson | | | |
| Ariopsis peltata Nimmo | | | |
| Arisema sivadasanii S.R.Yadav, K.S.Patil & Janarth. | | | Endemic WG |
| Arisema tortuosum (Wall.) Schott | | | |
| Cryptocoryne retrospiralis (Roxb.) Kunth | | | |
| Lagenandra avata (L.) Thwaites | | | |
| Pothos scandens L. | | | |
| Theriophonum dalzelli Schott. | | | Endemic WG |
| ARALIACEAE | | | |
| Schefflera elliptica (Blume) Harms | | | |
| ARECACEAE | | | |
| Arenga wightii Griff | | | Endemic WG |
| Calamus pseudotenuis Becc. | | | Wet |
| Calamus thwaitesii Becc. | | | Wet |
| Caryota urens L. | | | Bherli mad |
| ARISTROLOCHIACEAE | | | |
| Thottea siliquosa (Lam.) Ding Hou | | | |
| ASPARAGACEAE | | | |
| Asparagus racemosus Willd. | | | |
| ASTERACEAE | | | |
| Acanthospermum hispidum DC. | | | |
| Ageratum conyzoides L. | | | |
| Bidens biternata (Lour.) Merr. & Sherff | | | |
| Blumea belangeriana DC. | | | Endemic PI |
| Blumea membranacea DC. | | | |
| Blumea asyadonta DC. | | | |
| Blumea virens DC. | | | |
| Cyathocline purpurea (Buch.-Ham. ex D.Don) Kuntze | | | |
| Dichrocephala integrifolia (L.f.) Kuntze | | | |
| Eclipta prostrata (L.) L. | | | |
| Elephantopus scaber L. | | | |
| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| Emilia sonchifolia (L.) DC. | | | |
| Erigeron sublyratus DC. | | | |
| Eupatorium odoratum L. | | | |
| Gnaphalium polycaulon Pers. | | | |
| Grangea maderaspatana (L.) Poir. | | | |
| Gymnura nitida DC. | | | |
| Phyllocephalum phylloleum (DC.) Narayana | | | |
| Phyllocephalum ritchiei (Hook.) Narayana | | Endemic PI |
| Senecio belgaumensis (Wight) C.B.Clarke | | | |
| Senecio gibsonii Hook.f. | | Endemic WG |
| Spilanthes paniculata Wall. ex DC. | | | |
| Symedrella nodiflora (L.) Gaertn. | | | |
| Tricholepis glaberrima DC. | | | |
| Tridax procumbens L. | | | |
| Vernonia cinerea (L.) Less. | | | |
| **BALSAMINACEAE** | | | |
| Impatiens acaulis Arn. | | | |
| Impatiens bahamina L. | | Terda |
| Impatiens lawii Hook.f. & Thomson | | | |
| Impatiens minor (DC.) Bennet | | Endemic WG |
| Impatiens oppositifolia L. | | | |
| Impatiens pulcherrima Dalzell | | Endemic WG |
| **BEGONIACEAE** | | | |
| Begonia crenata Drynad. | | | |
| Begonia trichocarpa Dalzell | | Endemic NWG |
| **BIGNONIACEAE** | | | |
| Heterophragma quadriloculare (Roxb.) K.Schum. | | Kuski |
| Oxyladium indicum (L.) Benth. ex Kurz | | | |
| Pajanelia longifolia (Willd.) K.Schum. | | Padwal |
| Stereospermum colaïs (Buch.-Ham. ex Dillw.) Mabb. | | | |
| **BOMBACACEAE** | | | |
| Bombax ceiba L. | | Sawar |
| Bombax insignis Wall. | | | |
| **BORAGINACEAE** | | | |
| Caltha procumbens L. | | | |
| Cynoglossum zeylanicum (Vahl ex Hornem.) Thunb. ex Lehm. | | | |
| Eckenia canarensis (C.B.Clarke) Gamble | | | |
| Paracaryopsis coelestina (Lindl.) R.R.Mill | | VU |
| Rotula aquatica Lour. | | | |
| **BUDDLEJACEAE** | | | |
| Buddleja asiatica Lour. | | | |
| **BURMANNIACEAE** | | | |
| Burmannia pusilla (Wall. ex Miers) Thwaites | | | |
| **BURSERACEAE** | | | |
| Canarium strictum Roxb. | | Dhup |
| Species / Family | Local name | Endemism       | IUCN  |
|-----------------|------------|----------------|-------|
| **CAMPANULACEAE** |            |                |       |
| Lobelia alsinoides Lam. |          |                |       |
| Lobelia nicotianaeefolia Roth ex Roem. & Schult. | Rantambhoku |                |       |
| **CAPPARACEAE** |            |                |       |
| Capparis rheedei DC. |          |                | Endemic WG |
| Cleome viscosa L. |            |                |       |
| **CARYOPHYLLACEAE** |            |                |       |
| Polycarpon prostratum (Forsk.) Asch. & Schweinf. |          |                |       |
| **CELASTRACEAE** |            |                |       |
| Celastrus paniculata Wild |          |                | Endemic PI & AN |
| Euonymus indicus B. Heyne ex Wall. |          |                |       |
| Hippocratea grahamii Wight |          |                |       |
| Hippocratea indica Willd. |          |                |       |
| Hippocratea obtusifolia Roxb. |          |                |       |
| Lophopteralum wightianum Arn. |          |                |       |
| Maytenus rothiana (Walp.) Lobreau-Callen |          |                |       |
| Salacia chinensis L. |          | Narbundi |       |
| Salacia oblonga Wall ex Wight & Arn. |          |                |       |
| **CLEOMACEAE** |            |                |       |
| Crateva magna (Lour.) DC. |          |                |       |
| **CLUSIACEAE** |            |                |       |
| Calophyllum calaba L. |          | Wiray          | Endemic WG |
| Calophyllum polyanthum Wall. ex Choisy |          |                |       |
| Garcinia gummi-gutta (L.) N.Robson |          |                |       |
| Garcinia indica (Thouars.) Choisy |          | Bhirand, Kokam, Aamsul | Endemic WG |
| Garcinia morella (Gaertn.) Desr. |          |                |       |
| Mammeea suriga (Buch.-Ham. ex Roxb.) Kosterm. |          | Surangi        |       |
| Mesua ferrea L. |          | Nag-Chapha     |       |
| **COLCHICACEAE** |            |                |       |
| Gloriosa superba L. |          |                |       |
| Iphigineea indica (L.) A. Grey ex Kunth |          |                |       |
| **COMBRETACEAE** |            |                |       |
| Combretum latifolium Blume |          |                |       |
| Getonia floribunda Roxb. |          | Uski           |       |
| Terminalia bellirica (Gaertn.) Roxb. |          |                |       |
| Terminalia chebula Retz. |          |                |       |
| Terminalia elliptica Willd. |          | Matti, Madat |       |
| Terminalia paniculata Roth |          | Kindal         | Endemic PI |
| **COMMELINACEAE** |            |                |       |
| Commelina benghalensis L. |          |                |       |
| Commelina forsskaliae Vahl |          |                |       |
| Cyanotis fasciculata (B.Heyne ex Roth) Schult. & Schult.f. |          |                |       |
| Cynotis cristata (L.) D.Don |          |                |       |
| Floscopa scandens Lour. |          |                |       |
| Murdannia dimorpha (Dalzell) G.Brückn. |          |                |       |

Species / Family

Local name

Endemism

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| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| Murdannia japonica (Thunb.) Faden | | | |
| Murdannia semiteres (Dalzell) Santapau | | | |
| Murdannia simplex (Vahl) Brenan | | | |
| Murdannia spirata (L.) G. Brückn. | | | |
| Murdannia versicolor (Dalzell) G. Brückn. | | | |
| CONNARACEAE | | | |
| Connarus monocarpus L. | Ghagrya | | |
| CONVALLARIACEAE | | | |
| Ophiopogon intermedius D. Don | | | |
| CONVOLVULACEAE | | | |
| Argyrea elliptica (Roth) Choisy | | | |
| Argyrea involucrata C.B. Clarke | | | |
| Erycibe paniculata Roxb. | | | |
| Evolulus nummularius (L.) L. | | | |
| Ipomoea campanulata L. | | | |
| Ipomoea nil (L.) Roth | | | |
| Ipomoea obscura (L.) Ker Gawl. | | | |
| Ipomoea sinensis (Desv.) Choisy | | | |
| Ipomoea violacea L. | | | |
| Merremia umbellata (L.) Hall f. | | Washel | |
| Merremia vitifolia (Burm.f.) Hall f. | | | |
| CORNACEAE | | | |
| Mastixia arborea (Wight.) Bedd. | | | |
| COSTACEAE | | | |
| Costus speciosus (J.J. König) J. E. Sm. | | | |
| CRASSULACEAE | | | |
| Kalanchoe pinnata (Lam.) Pers. | | | |
| CUCURBITACEAE | | | |
| Coccinia grandis (L.) Voigt | Tendli | | |
| Cucumis melo L. | | | |
| Momordica dioica Roxb. ex Willd. | | | |
| Mukia maderaspatana (L.) M. Roem. | | | |
| Solena amplexicaulis (Lam.) Gandhi | | | |
| Trichosanthes cucumerina L. | | Kondal, Fagal | |
| Zanonia indica L. | | | |
| CYPERACEAE | | | |
| Carex caricina (D. Don) Gildyal & U. C. Bhattach. var. caricina | | | |
| Carex caricina (D. Don) Gildyal & U. C. Bhattach. var. glaucina (Boeck.) Gildyal & U. C. Bhattach. | | | Endemic PI |
| Cyperus haspan L. ssp. haspan | | | |
| Cyperus haspan L. ssp. juncoides (Lam.) Kuk. | | | |
| Cyperus iria L. | | | |
| Diplacrum caricinum R. Br. | | | |
| Eleocharis acutangula (Roxb.) Schult. | | | |
| Fimbristylis dichotoma (L.) Vahl | | | |
| Fimbristylis lawiana (Boeck.) J. Kern | | | |
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| Species / Family | Local name | Endemism | IUCN |
|------------------|------------|----------|------|
| Fimbristylis ovata (Burm.f.) J.Kern | Endemic WPI |
| Fimbrystis woodrowii C.B.Clarke | Endemic WPI |
| Hypolytrum nemorum (Vahl) Spreng. | |
| Kyllinga brevifolia Rottb. | |
| Lipocarpha squarrosa (L.) Goetgh. | |
| Mariscus compactus (Retz.) Bold. | |
| Mariscus panicuus (Rottb.) Vahl | |
| Pycreus flavidus (Retz.) T.Koyma | |
| Pycreus malabaricus C.BClarke | |
| Pycreus pumilus (L.) Nees | |
| Pycreus sanguinolentus (Vahl) Nees | |
| Rhynchospora wightiana (Nees) Steud. | |
| Sciria terrestreis (L.) Fassett | |
| DATISCACEAE | |
| Tetrameles nudiflora R. Br. | |
| DILLENIACEAE | |
| Dillenia pentagyna Roxb. | Karmal |
| DIOCOSCACEAE | |
| Dioscorea bulbifera L. | |
| Dioscorea hispida Dennst. | |
| Dioscorea pentaphylla L. | |
| DIPTEROCARPACEAE | |
| Hopea ponga (Dennst.) Mabb. | Endemic WG |
| DRACAENACEAE | |
| Dracaena terniflora Roxb. | |
| DROSERACEAE | |
| Drosera indica L. | |
| EBENACEAE | |
| Diospyros buxiolata (Blume) Hiern | |
| Diospyros candolleana Wight | |
| Diospyros crumenata Thwaites | |
| Diospyros montana Roxb. | Kalakonda |
| Diospyros neigerensis (Wight) Kosterm. | Endemic PI |
| Diospyros oocarpa Thw. | |
| Diospyros paniculata Dalzell | Endemic IND |
| Diospyros prurients Dalzell | |
| ELAEAGNACEAE | |
| Elaeagnus conferta Roxb. | |
| ERIOCAULACEAE | |
| Eriocaulon dalzellii Koern. | Endemic WG |
| Eriocaulon euryeleps Koern. | Endemic WG |
| Eriocaulon heterolepis Steud. | Endemic Wi |
| Eriocaulon lanceolatum Miq. ex Koern. | Endemic WG |
| Eriocaulon robusto-brownianum Ruhland | |
| Eriocaulon sexangulare L. | |
| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| Eriocaulon stellulatum Koern. | Eriocaulon stellulatum Koern. | Endemic WG |
| Eriocaulon xerantherum Mart. | Eriocaulon xerantherum Mart. | Endemic WG |
| Eriocaulon poly spatense R.Ansari & N.P.Balakr. | Eriocaulon poly spatense R.Ansari & N.P.Balakr. | Endemic WG |
| **EUPHORBIAEAE** s.l. | **EUPHORBIAEAE** s.l. | | |
| Actephila excelsa (Dalzell) Mull. Arg. | Actephila excelsa (Dalzell) Mull. Arg. | | |
| Agrostistachys indica Dalzell | Agrostistachys indica Dalzell | | |
| Antidesma acidum Retz. | Antidesma acidum Retz. | | |
| Antidesma menasu (Tul.) Mull. Arg. | Antidesma menasu (Tul.) Mull. Arg. | | |
| Aporusa cardioasperma (Gaertn.) Merr. | Aporusa cardioasperma (Gaertn.) Merr. | | |
| Boliospermum montanum (Willd.) Mull. Arg. | Boliospermum montanum (Willd.) Mull. Arg. | | |
| Bloxia andamanica (Kurz) Hook.f. ssp. demudata (Benth.) N.P.Balakr. & Chakrab. | Bloxia andamanica (Kurz) Hook.f. ssp. demudata (Benth.) N.P.Balakr. & Chakrab. | Endemic WG |
| Breynia retusa (Dennst.) Alston | Breynia retusa (Dennst.) Alston | | |
| Bridelia stipularis Blume | Bridelia stipularis Blume | | |
| Croton persimilis Mull. Arg. | Croton persimilis Mull. Arg. | | |
| Dimorphocalyx globelus Thwaites var. lawianus (Mull. Arg.) Chakrab. & N.P.Balakr. | Dimorphocalyx globelus Thwaites var. lawianus (Mull. Arg.) Chakrab. & N.P.Balakr. | Endemic WG |
| Drypetes venusta (Wight) Pax & K.Hoffm. | Drypetes venusta (Wight) Pax & K.Hoffm. | | |
| Euphorbia erythroclada Boiss. | Euphorbia erythroclada Boiss. | Endemic PCI |
| Euphorbia hirta L. | Euphorbia hirta L. | | |
| Euphorbia ligularia Roxb. | Euphorbia ligularia Roxb. | | |
| Euphorbia notoptera Boiss. | Euphorbia notoptera Boiss. | Endemic WG |
| Falconeria insignis Royle | Falconeria insignis Royle | | |
| Glochidion hohenackeri (Mull.-Arg.) Bedd. | Glochidion hohenackeri (Mull.-Arg.) Bedd. | Endemic NWG |
| Glochidion zeylanicum (Gaertn.) A.Juss. | Glochidion zeylanicum (Gaertn.) A.Juss. | | |
| Homonaia riparia Lour. | Homonaia riparia Lour. | | |
| Jatropha curcas L. | Jatropha curcas L. | | |
| Macaranga peltata (Roxb.) Mull. Arg. | Macaranga peltata (Roxb.) Mull. Arg. | Chanda |
| Mallotus ferrugineus (Roxb.) Mull. Arg. | Mallotus ferrugineus (Roxb.) Mull. Arg. | | |
| Mallotus philippensis (Lam.) Mull. Arg. | Mallotus philippensis (Lam.) Mull. Arg. | | |
| Mallotus resinus (Blanco) Merr. var. stenanthus (Mull. Arg.) Susila & N.P.Balakr. | Mallotus resinus (Blanco) Merr. var. stenanthus (Mull. Arg.) Susila & N.P.Balakr. | Endemic WG |
| Margaritaria indica (Dalzell) Airy Shaw | Margaritaria indica (Dalzell) Airy Shaw | | |
| Microstachys chamaelea (L.) Mull. Arg. | Microstachys chamaelea (L.) Mull. Arg. | | |
| Phyllanthus amarus Schumach. & Thonn. | Phyllanthus amarus Schumach. & Thonn. | | |
| Phyllanthus amblicola L. | Phyllanthus amblicola L. | Awila |
| Phyllanthus juniperinus Mull. Arg. | Phyllanthus juniperinus Mull. Arg. | | |
| Phyllanthus simplex Retz. | Phyllanthus simplex Retz. | | |
| Phyllanthus urinaria L. | Phyllanthus urinaria L. | | |
| Tragia praetervis Chakrab. & N.P.Balakr. | Tragia praetervis Chakrab. & N.P.Balakr. | | |
| **FLACOURTIACEAE** | **FLACOURTIACEAE** | | |
| Casearia ovata (Lam.) Wild. | Casearia ovata (Lam.) Wild. | | |
| Flacourtia montana J.Graham | Flacourtia montana J.Graham | Chaper | Endemic WG |
| Homalium ceylanicum (Gardn.) Benth. | Homalium ceylanicum (Gardn.) Benth. | | |
| Hydrocarpus pentandrus (Buch.-Ham.) Oken | Hydrocarpus pentandrus (Buch.-Ham.) Oken | Kastal | Endemic WG |
| **GENTIANACEAE** | **GENTIANACEAE** | | |
| Canscora diffusa (Vahl) R.Br. ex Roem & Schult. | Canscora diffusa (Vahl) R.Br. ex Roem & Schult. | | |
| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| Canscora perfoliata Lam. | | Endemic WG |
| Exacum pumilum Griseb. | | |
| Exacum tetrogonum Roxb. | | |
| Hoppea fastigiata (Griseb.) C.B.Clarke | | |
| **GESNERIACEAE** | | |
| Rhynchoglossum notonianum (Wall.) Burtt | | |
| Rhynchoglossum obliquum Blume var. parviflorum C.B.Clarke | | |
| **HYCINTHACEAE** | | |
| Ledebouria revoluta (L.f.) Jessop | | |
| **HYDROCHARITACEAE** | | |
| Blyxa auberti Rich. | | |
| Vallisneria spiralis L. | | |
| **HYACINTHACEAE** | | |
| Curculigo archioides Gaertn. | | |
| **ICACINACEAE** | | |
| Gomphandra tetrandra (Wall.) Sleumer | | |
| Nothapodytes nimmoniana (J. Graham) Mabb. | | |
| Sarcostigma kleinii Wight & Arn. | | |
| **LAMIACEAE** | | |
| Anisomeles indica (L.) Kuntze | | Endemic WG |
| Callicarpa tomentosa (L.) L. | | |
| Clerodendrum infortunatum L. | | |
| Colebrookea oppositifolia Sm. | | |
| Gmelina arborea Roxb. | Shiwan |
| Hyptis capitata Jacq. | | |
| Hyptis suaveolens (L.) Poit. | | |
| Leucas biflora (Vahl) R. Br. ex Sm. | | |
| Leucas ciliata Bentham | | |
| Leucas lavendulifolia Sm. | | |
| Leucas stelligera Wall. | | |
| Platostoma hispidum (L.) A.J.Paton | | |
| Pogostemon paniculatus (Wild.) Bentham | | |
| Pogostemon purpurascens Dalzell | | |
| Premna coriacea C.B.Clarke | | |
| Rotheca serrata (L.) D.A.Steane & Mabb. | | |
| Scutellaria discolor Colebr. | | |
| Tectona grandis L.f. | Sagon |
| Vitex altissima L.f. | Bailado |
| Vitex leucayylon L.f. | | |
| Vitex negundo L. | | |
| **LAURACEAE** | | |
| Actinodaphne angustifolia (Blume) Nees | | |
| Beilschmiedia dolzellii (Meisn.) Kosterm. | Miryo |
| Cinnamomum nitidum (Roxb.) Hook. | | |
| Cinnamomum sulphuratum Nees | Tikki |

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| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| Cinnamomum verum J.Presl | Tikki | | |
| Cryptocarya lawsonii Gamble | | Endemic WG | |
| Litsea coryacea (Heyne ex Meisn.) Hook.f. | | Endemic WG | |
| Litsea ghatsha C.J.Saldanha | | Endemic WG | |
| Persea macrantha (Nees) Kosterm. | Olamb | | |
| LECYTHIDACEAE | | | |
| Careya arborea Roxb. | Kumyo | | |
| LEAEACEAE | | | |
| Lecia asiatica (L.) Ridsdale | | | |
| Lecia indica (Burman.) Merr. | Dino | | |
| LEGUMINOSAE: SUBFAMILY CAESALPINIOIDEAE | | | |
| Bauhinia malabarica Roxb. | | | |
| Bauhinia racemosa Lam. | Apto | | |
| Caesalpinia mimosoides Lam. | | Pansi | |
| Cassia fistula L. | | Bayo | |
| Chamaecrista absus (L.) H.S.Irwin & Barneby | | | |
| Moullava spicata (Dalzell) Nicolson | Shamachi Wal | Endemic PI | |
| Saraca asoca (Roxb.) W.J.de Wilde | Ashok | | |
| Seno hirsuta (L.) H.S.Irwin & Barneby | Taykolo | | |
| Seno obtusifolia (L.) H.S.Irwin & Barneby | | | |
| Seno tora (L.) Roxb. | | | |
| LEGUMINOSAE: SUBFAMILY MIMOSOIDEAE | | | |
| Acacia caesia (L.) Willd. | | | |
| Acacia chundra (Roxb. & Rottl.) Willd. | | | |
| Acacia concinna (Willd.) DC. | Shikekai | | |
| Acacia pennata (L.) Willd. | | | |
| Acacia torta (Roxb.) Craib. | | | |
| Albizia chinensis (Osbeck.) Merr. | | | |
| Albizia odoratissima (L.f.) Benth. | | | |
| Entada rheeduc Spreng. | Garmbi | | |
| Mimosa pudica L. | | | |
| Xylia xylocarpa (Roxb.) Taub. | Jambha | | |
| LEGUMINOSAE: SUBFAMILY PAPilionOIDEAE | | | |
| Abrus pulchellus Wall. ex Thwaites | Gunj | | |
| Aeschynomene indica L. | | | |
| Alysicarpus bupleurifolius (L.) DC. | | | |
| Alysicarpus glumaceus (Vahl.) DC. | | | |
| Butea monosperma (Lam.) Taub. | Palas | | |
| Cajanus lineatus (Wight & Arn.) Maesen | | | |
| Crotalaria filipes Benth. | | Endemic WG | |
| Crotalaria lutescens Dalzell | | Endemic WG | |
| Crotalaria pallida Alton | | | |
| Crotalaria prostrata Rottl. | | | |
| Crotalaria retusa L. | | | |
| Dalbergia harrida (Dennst.) Mabb. | | Endemic WG | |
| Species / Family | Local name | Endemism  | IUCN |
|-----------------|------------|-----------|------|
| Dalbergia latifolia Roxb. | Sisam | Endemic PI | |
| Dalbergia rubiginosa Roxb. |  |  | |
| Dendrobium triangulare (Retz.) Schindl. |  |  | |
| Derris heyneana (Wight an&d Arn.) Benth. |  |  | |
| Desmodium heterocarpon (L.) DC. |  |  | |
| Desmodium laxiflorum DC. |  |  | |
| Desmodium motorium (Houtt.) Merr. |  |  | |
| Desmodium triflorum (L.) DC. |  |  | |
| Erithrina stricta Roxb. | Pangaro |  | |
| Flemingia macrophylla (Willd.) Kuntze ex Merr. |  |  | |
| Flemingia strobilifera (L.) R.Br. ex W.T.Aiton |  |  | |
| Flemingia tuberosa Dalzell |  |  | |
| Geissaspe cristata Wight & Arn. |  |  | |
| Geissaspis tenella Benth. |  |  | |
| Indigofera dalzellii T.Cooke |  |  | |
| Indigofera prostrata Willd. |  |  | |
| Mucuna monosperma DC. |  |  | |
| Paradoxus canariensis (Dalzell) Adema |  |  | |
| Pangamia pinnata (L.) Pierre | Karanji |  | |
| Sesbania bispinosa (Jacq.) W.Wight |  |  | |
| Smithia bigemina Dalzell |  |  | |
| Smithia conferta J.E.Sm |  |  | |
| Smithia saluginea Hance |  |  | |
| Spatholobus parviflorus (Roxb. ex DC.) Kuntze |  |  | |
| Spatholobus purpureus Benth. ex Prain |  |  | |
| Tadehagi triquetrum (L.) H.Ohashi |  |  | |
| Tephrosia candida (Roxb.) DC. |  |  | |
| Tephrosia coccinea Wall. |  | Endemic PI | |
| Teramnus labialis (L.) Spreng. |  |  | |
| Uraria rufescens (DC) Schindl. |  |  | |
| Vigna vexillata (L.) A.Rich. |  |  | |
| LENTIBULARIACEAE |  |  | |
| Utricularia caerulea L. |  |  | |
| Utricularia graminifolia Vahl |  |  | |
| Utricularia lauzulina P.Taylor |  |  | |
| Utricularia purpurascens J.Graham |  |  | |
| Utricularia reticulata Sm. |  |  | |
| Utricularia striatula Sm. |  |  | |
| Utricularia uliginosa Vahl. |  |  | |
| LOGANIACEAE |  |  | |
| Strychnos nux-vomica L. | Kaja |  | |
| Strychnos minor Dennst. |  |  | |
| LORANTHACEAE |  |  | |
| Dendrophthoe falcata (L.f.) Blume |  |  | |
| Elytranthe capitellata (Wight & Arn.) Engl. |  |  | |
| Species / Family            | Local name   | Endemism | IUCN |
|----------------------------|--------------|----------|------|
| Scurrula parasitica L.     |              |          |      |
| Taxillus tomentosus (B.Heyne ex W.Roth) Tiegh. |              |          |      |
| Tolypanthus lagensifer (Wight) Tiegh. |              |          |      |
| **LYTHRACEAE**             |              |          |      |
| Lagerstroemia microcarpa Wight | Nana        |          |      |
| Lagerstroemia parviflora Roxb. |            |          |      |
| Rotala densiflora (Roth ex Roem. & Schult.) Koehne |           |          |      |
| Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne |         |          |      |
| Woodfordia fruticosa (L.) Kurz | Dhayti |          |      |
| **MALPIGHIACEAE**          |              |          |      |
| Aspidopterys canarensis Dalzell |          | Endemic WG | CR  |
| **MALVACEAE**              |              |          |      |
| Abelmoschus manihot (L.) Medik. | Ambadi    |          |      |
| Abutilon persicum (Burm.f.) Merr. |            |          |      |
| Daceshistia trilobata Wight | Endemic WG  |          |      |
| Hibiscus hirtus L.         |              |          |      |
| Hibiscus hispidissimus Griff. |            |          |      |
| Kydia calycina Roxb.       |              |          |      |
| Sida acuta Burm.f.         |              |          |      |
| Sida cordata (Burm.f.) Borss. |               |          |      |
| Sida rhombifolia L.        | Tupkadi      |          |      |
| Theesperia lampas (Cav.) Dalzell ex Dalzell & A.Gibson | |      |
| Lireno lobata L.           |              |          |      |
| **MARANTACEAE**            |              |          |      |
| Schumannianthus virgatus (Roxb.) Rolfe |          |          |      |
| **MELASTOMATACEAE**        |              |          |      |
| Melastoma malabathricum L. |              |          |      |
| Memecylon talbotianum D.Brandis |            |          |      |
| Memecylon terminale Dalzell | Endemic PI   |          |      |
| Memecylon umbellatum Burm.f. |                |          |      |
| Memecylon wightii Thwaites |              |          |      |
| Osbeckia muralis Naud.    |              |          |      |
| **MELIACEAE**              |              |          |      |
| Aglaia eleagnoides (A.Juss.) Benth. |          |          |      |
| Aglaia lowii (Wight) C.J. Saldanha ex Ramamoorthy | Maharsangal |          |      |
| Chukrasia tabularis A.Juss. |              |          |      |
| Naregamia alata Wight & Arn. | Pitmado    |          |      |
| Toona ciliata M.Roem.      |              |          |      |
| Trichilia connaroides (Wigh & Arn.) Bentv. |           |          |      |
| Turraea villosa A.W.Benn.  |              |          |      |
| Walsura trifoliata (A.Juss.) Harms |            |          |      |
| **MENISPERMACEAE**         |              |          |      |
| Anamiria cocculus (L.) Wight & Arn. |          |          |      |
| Cocculus hirsutus (L.) Theob. |                |          |      |
| Cyclea peltata (Lam.) Hook.f. & Thomson |           |          |      |
| Species / Family | Local name | Endemism | IUCN |
|----------------|------------|----------|------|
| Diploclisia glaucescens (Blume) Diels | Ramwel, Ramrukhi |
| Stephania elegans Hook. f. & Thomson |
| Stephania japonica (Thunb.) Miers |
| **MOLLUGINACEAE** |
| Gilinus oppositifolius (L.) A.DC. |
| **MORACEAE** |
| Artocarpus gomezianus Wall. ex Trecul ssp. zeylanicus Jarrett | Patphanas |
| Artocarpus heterophyllus Lam. | Patphanas |
| Artocarpus hirsutus Lam. | Patphanas |
| Ficus arnottiana (Miq.) Miq. | Payar |
| Ficus benghalensis L. | Wadi |
| Ficus callosa Willd. | |
| Ficus drupacea Thunb. var. pubescens (Roth) Corner | |
| Ficus exasperata Vahl | |
| Ficus heterophylla L.f. | |
| Ficus hispida L.f. | Karwat |
| Ficus microcarpa L.f. | Nandangol |
| Ficus nervosa Heyne ex Roth | |
| Ficus racemosar L. | Rumad |
| Ficus tinctoria G.Forst. ssp. parasitica (Koenig ex Willd.) Corner | |
| Ficus tsjahela Burm.f. | Kel |
| **MUSACEAE** |
| Ensete superbum (Roxb.) Cheesman | Endemic WG |
| Musa x paradisiaca L. | Keli |
| **MYRISTICACEAE** |
| Knema attenuata (Wall. ex Hook.f. & Thomson) Warb. | Endemic WG |
| Myristica malabarica Lam. | Endemic WG |
| **MYRSINACEAE** |
| Ardisia solanacea Roxb. | Bugadi |
| Embelia tseriam-cottam (Roem. & Schult.) DC. | |
| Maesa indica (Roxb.) DC. | |
| **MYRTACEAE** |
| Eugenia mooniana Wight | |
| Eugenia radburghi DC. | |
| Syzygium caryophyllatum (L.) Alston | Bhirand |
| Syzygium cumini (L.) Skeels | Bhirand |
| Syzygium hemisphericum (Wight) Alston | Zamlo |
| Syzygium laetum (Buch.-Ham.) Gandhi | Endemic SWI |
| Syzygium salicifolium (Wight) J.Graham | Endemic SWI |
| Syzygium zeylanicum (L.) DC. | |
| **OCHNACEAE** |
| Ochna obtusata DC. | |
| **OLACACEAE** |
| Olax imbricata Roxb. | |
| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| **OLEACEAE**    |            |          |      |
| Jasminum coarctatum Roxb. | | | |
| Jasminum malabaricum Wight | | Endemic PI | |
| Jasminum multiflorum (Burm.f.) Andr. | | | |
| Jasminum ritchiei C.B.Clarke | | | |
| Ligustrum perrottetii A.DC. | | Endemic WG | |
| Olea dioica Roxb. | | | |
| Schrebera sweitzenoides Roxb. | | | |
| **ONAGRACEAE**  |            |          |      |
| Ludwigia hyssopifolia (G.Don) Exell | | | |
| Ludwigia octovalvis (Jacq.) P.H.Raven ssp. octovalvis | | | |
| Ludwigia octovalvis (Jacq.) P.H.Raven ssp. sessiliflora (Micheli) P.H.Raven | | | |
| **ORCHIDACEAE** |            |          |      |
| Acampe praemorsa (Roxb.) Blatt. & McCann | | | |
| Aerides crispa Lindl. | | Endemic WG | |
| Aerides maculosa Lindl. | | Endemic PI | |
| Aerides ringens (Lindl.) C.E.C.Fisch. | | | |
| Bulbophyllum neilgherrense Wight | | Bendli | Endemic WG |
| Cleisostoma tenuefolium (L.) Garay | | | |
| Conchidium microchilos (Dalzell) Rauschert | | Endemic PI | |
| Cottonia peduncularis (Lindl.) Rchb.f. | | | |
| Cymbidium aloifolium (L.) Sw. | | | |
| Dendrobium barbatulum Lindl. | | Endemic WG | |
| Gastrochilus flabelliformis (Blatt. & McCann) C.J.Saldanha | | Endemic WG | |
| Habenaria diphylla (Nimmo) Dalzell | | | |
| Habenaria heyneana Lindl. | | Endemic PI | |
| Habenaria longicorniculata J.Graham | | Endemic PI | |
| Habenaria marginata Coleb. | | | |
| Habenaria multicaudata Sedgew. | | Endemic WG | EN |
| Habenaria plantaginea Lindl. | | | |
| Liparis deflexa Hook.f. | | | |
| Liparis nervosa (Thunb.) Lindl. | | | |
| Luisia tenuefolia Blume | | Endemic WG | |
| Malaxis versicolor (Lindl.) Abeyw. | | | |
| Nervilia aragoana Gaudich. | | | |
| Oberonia brachyphylla Blatt. & McCann | | Endemic WG | VU |
| Pecteilis gigantea (J.E.Sm.) Raf. | | | |
| Peristylus plantagineus (Lindl.) Lindl. | | | |
| Pholidota imbricata Hook. | | | |
| Porpax jerdoniana (Wight) Rolfe | | Endemic WG | |
| Porpax reticulata Lindl. | | | |
| Rhynchostylis retusa (L.) Blume | | | |
| Smithsonia viridiflora (Dalzell) C.J.Saldanha | | | |
| Tropidia angulosa (Lindl.) Blume | | | |
| Vanda tessellata (Roxb.) Hook. ex G.Don | | | |
| Species / Family                  | Local name            | Endemism | IUCN |
|----------------------------------|-----------------------|----------|------|
| OROBANCHACEAE                    |                       |          |      |
| Vanda testacea (Lindl.) Rchb.    |                       |          |      |
| Zeuxine longilabris (Lindl.) Trim |                       |          |      |
| OXALIDACEAE                      |                       |          |      |
| Biophytum sensitivum (L.) DC.    |                       |          |      |
| Oxisia corniculata L.            |                       |          |      |
| PANDANACEAE                      |                       |          |      |
| Pandanus odorifer (Forsk.) Kuntze|                       |          |      |
| PAPAVERACEAE                     |                       |          |      |
| Argemone mexicana L.             |                       |          |      |
| PASSIFLORACEAE                   |                       |          |      |
| Adenia hondola (Gaertn.) J.Wilde | Salkando              |          |      |
| PEDALIACEAE                      |                       |          |      |
| Sesamum orientale L.             |                       |          |      |
| PIPERACEACE                      |                       |          |      |
| Peperomia pellucida (L.) Humb.   |                       |          |      |
| Piper argyrophyllum Miq.         | Miri                  |          |      |
| Piper nigrum L.                  |                       |          |      |
| PITTOSPORACEAE                   |                       |          |      |
| Pittosporum dasycaulon Miq.      |                       |          |      |
| POACEAE                          |                       |          |      |
| Apluda mutica L.                 |                       |          |      |
| Arundinella leptochloa (Nees ex Steud.) Hook.f. |        |          |      |
| Arundinella metzii Hocht ex Miq. |                       |          |      |
| Arundinella pumila (Hochst. ex A.Rich.) Steud. |   |          |      |
| Bombusia bambos (L.) Voss        |                       |          |      |
| Brochia ramosa (L.) Stapf        |                       |          |      |
| Capillipedium filiculme (Hook.f.) Stapf |          |          |      |
| Centotheca lappacea (L.) Desv.   |                       |          |      |
| Cynodon dactylon (L.) Pers.      |                       |          |      |
| Cyrtococcum oxyphyllum (Hochst. ex Steud.) Stapf | |          |      |
| Dendrocalamus strictus (Roxb.) Nees |                       |          |      |
| Dichanthium annulatum (Forsk.) Stapf | |          |      |
| Dimeria stapfiana C.E.Hubb. ex Pilger |                       |          |      |
| Echinochloa colona (L.) Link     |                       |          |      |
| Eragrostis gangetica (Roxb.) Steud. |                       |          |      |
| Eragrostis unioloides (Retz.) Nees ex Steud. | |          |      |
| Eulalia trispicata (Schult.) Henrard |                       |          |      |
| Garnotia arborum Stapf. ex T.Cooke |                       |          |      |
| Glyphochloa acuminata (Hack.) Clayton |                       |          |      |
| Glyphochloa veldkampii M.A.Fonseca & Janarth. | |          |      |
| Isachne globosa (Thunb.) Kuntze   |                       |          |      |
| Ischaemum barbatum Retz.         |                       |          |      |
| Ischaemum dalzellii Stapf. ex Bor |                       |          |      |
| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| Ischaemum semisagittatum Roxb. |             |          |      |
| Jansenella griffithiana (C.Muell.) Bor |             |          |      |
| Ochlandra talboti Brandis |             |          |      |
| Oplismenus burmannii (Retz.) P.Beaug. |             |          |      |
| Oplismenus compositus (L.) P.Beaug. |             |          |      |
| Panicum antidotale Retz. |             |          |      |
| Paspalum canarae (Steud.) Veldk. |             |          |      |
| Paspalum scrobiculatum L. |             |          |      |
| Pennisetum pedicellatum Trin. |             |          |      |
| Pennisetum polystachion (L.) Schult. |             |          |      |
| Polytrias indica (Houtt.) Veldkamp |             |          |      |
| Pseudanthistiria heteroclita (Roxb.) Hook.f. |             |          |      |
| Pseudoxytenanthera stockii (Munro) T.Q.Nguyen |             |          |      |
| Sacciolepis indica (L.) A.Chase |             |          |      |
| Setaria pumila (Poir.) Roem. & Schult. |             |          |      |
| Spodiopogon rhizophorus (Steud.) Pilger |             |          |      |
| Themeda triandra Forssk. |             |          |      |
| PODOSTEMACEAE |           |          |      |
| Dalzellia ceylanica (Gardn.) Wight |             |          |      |
| Zeylanidium sessile (Willis) C.D.K.Cook & Rutsh. |             |          |      |
| POLYGALACEAE |           |          |      |
| Polygala elongata Klein ex Willd. |             | Endemic IND |      |
| Salomonia ciliata (L.) DC. |             |          |      |
| POLYGONACEAE |           |          |      |
| Persicaria glabra (Willd.) M.Gomez |             |          |      |
| Persicaria auriculata (Meissn.) S.K.Dixit, B.Datt & G.P.Roy |             |          |      |
| Polygonum plebeium R.Br. |             |          |      |
| PONTEDERIACEAE |           |          |      |
| Monochoria vaginalis (Burm.f.) C.Presl |             |          |      |
| PORTULACACEAE |           |          |      |
| Portulaca oleracea L. |             | Gungune |      |
| RANUNCULACEAE |           |          |      |
| Clematis gauriana Roxb. ex DC. |             |          |      |
| Naravelia zeylanica (L.) DC. |             |          |      |
| RHIZOPHORACEAE |           |          |      |
| Carallia brachiata (Lour.) Merr. |             | Phanshi |      |
| RHAMNACEAE |           |          |      |
| Gauania microcarpa DC. |             |          |      |
| Scutia myrtina (Burm.f.) Kurz. |             |          |      |
| Smythea bombaiensis (Datzeil) S.P.Banerjee & P.K.Mukh. |             | Endemic WG |      |
| Ventilago denticulata Willd. |             | Endemic IND |      |
| Ziziphus mauritiana Lam. |             |          |      |
| Ziziphus aenopia (L.) Mill. |             |          |      |
| Ziziphus rugosa Lam. |             | Churan |      |
| Ziziphus xylopýra (Retz.) Willd. |             |          |      |
| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| **RUBIACEAE**   |            |          |      |
| Argostemma courtallense Arn. |            | Endemic WG |      |
| Argostemma verticillatum Wall. |            |          |      |
| Canthium rheedi DC. |            |          |      |
| Catunaregma spinosa (Thunb.) Tirveng. |            | Gela   |      |
| Chassalia curviflora (Wall.) Thwaites var. ophioxyloides (Wall.) Deb & B.Krishna |            |          |      |
| Discospermum sphaerocarpum Dalzell ex Hook.f. |            | EN      |      |
| *Haldina cordifolia* (Roxb.) Ridsdale |            | Hedu    |      |
| Hedyotis auricularia L. |            |          |      |
| Hedyotis corymbosa (L.) Lam. |            |          |      |
| Hedyotis herbacea L. |            |          |      |
| Hedyotis trinervia (Retz.) Roem. & Schult. |            |          |      |
| Hymenodictyon abovatum Wall. |            | Endemic IND |      |
| *Ixora brachiata* Roxb. |            | Endemic IND |      |
| *Ixora coccina* L. |            | Pentkul  |      |
| *Ixora elongata* B.Heyne ex G.Don |            |          |      |
| *Ixora malabarica* (Dennst.) Mabb. |            |          |      |
| *Ixora nigricans* R. Br. Wight & Arn. |            |          |      |
| Meina laxiflora Robyns |            |          |      |
| Mitragyna parvifolia (Roxb.) Korth. |            |          |      |
| Mussoenda glabrata (Hook.f.) Hutch. ex Gamble |            | Sharwad  | Endemic PI |
| Mussoenda laxa (Hook.f.) Hutch. ex Gamble |            | Sharwad  | Endemic PI |
| Neanotis rheedei (Wall. ex Wight & Arn.) W.H.Lewis |            | Endemic WI |      |
| Neanotis subtulis (Miq.) Govaerts |            | Endemic WG |      |
| Neolamarckia cadamba (Roxb.) Bosser |            | Kadamb  |      |
| Neanouclea purpurea (Roxb.) Merr. |            |          |      |
| Ophiocarpos rugosa Wall. var. prostrata (D. Don) Deb & D.C.Mondal |            |          |      |
| Oxyceros rugulosus (Thw) Tirveng. |            |          |      |
| *Pavetta crassicaulis* Bremek. |            |          |      |
| *Pavetta indica* L. var. tomentosa (Roxb. ex Sm.) Hook.f. |            |          |      |
| *Psychotria dalzellii* Hook.f. |            | Endi     | Endemic WG |
| *Psychotria umbellata* (Wight) Bridson |            | Tupya    |      |
| *Rubia cordifolia* L. |            |          |      |
| *Saprosma glomeratum* (Gardn.) Bedd. |            |          | Endemic PI |
| Spermacoce articularis L. |            |          |      |
| Spermacoce acymoides Burm.f. |            |          |      |
| Spermacoce pusillo Wall. |            |          |      |
| Tomilinadia uliginosa (Retz.) Tirveng. & Sastre |            |          |      |
| Wendlandia thyrsoida (Roth) Steud. |            |          | Endemic WG |
| **RUTACEAE**   |            |          |      |
| *Atlantia racemosa* Wight |            | Malkadlimbi |      |
| *Atlantia wightii* Tanaka |            | Endemic WG |      |
| *Glycosmis pentaphylla* (Retz.) DC. |            | Menaka   |      |
| *Luvunga eleutherandra* Dalzell |            | Endemic WG |      |
| *Milicope lunu-ankenda* (Gaertn.) T.G.Hartely |            |          |      |
| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| Murraya koenigii (L.) Spreng. | Karpil | | |
| Murraya paniculata Jack | | | |
| Paramigna monophyllos Wight | | | |
| Tododia asiatica (L.) Lam. | | | |
| Zanthoxylum rhetsa (Roxb.) DC. | Tirphal | | |
| **SANTALACEAE** | | | |
| Osyris quadripartita Salzm. ex Decne. | | | |
| **SAPINDACEAE** | | | |
| Allaphylos cobbe (L.) Raeusch. | | | |
| Dimocarous longan Lour. | | | |
| Harpullia arborea (Blanco) Radlk. | | | |
| Lepisanthus tetraphyilla (Vahl) Radlk. | | | |
| Schleichera oleosa (Lour.) Oken | Koshim | | |
| **SAPOTACEAE** | | | |
| Chrysophyllum rosapurhi G.Don | | | |
| Mimusops elengi L. | Owal | | |
| Palauquium ellipticum (Dalzell) Bail. | | | |
| Xantolis tomentosa (Roxb.) Raf. | Kumbal | | |
| **SCROPHULARIACEAE** | | | |
| Angelonia gardneri Hook. | | | |
| Centranthera indica (L.) Gamble | | | |
| Dopatrium junceum (Roxb.) Buch.-Ham. ex Benth. | | | |
| Lindernia antipoda (L.) Alston. | | | |
| Lindernia caespitosa (Blume) Panigrahi | | | |
| Lindernia citriata (Closm.) Pennell | | | |
| Lindernia crustacea (L.) F. Muell. | | | |
| Lindernia multiflora (Roxb.) Mukerjee | | | |
| Lindernia oppositifolia (Retz.) Mukerjee | | | |
| Mecardonia procumbens (Mill.) Small | | | |
| Rhamphicarpa longiflora (Am.) Benth. | Endemic WG | | |
| Scoparia dulcis L. | | | |
| Striga asiatica (L.) Kuntze | | | |
| Striga gesnerioides (Willd.) Vatke ex Engl. | | | |
| Torenia indica C.J.Saldanha | Endemic WG | | |
| Torenia violacea (Azalo ex Blanco) Pennell | | | |
| **SMILACACEAE** | | | |
| Smilax asperrima L. | | | |
| **SOLANACEAE** | | | |
| Lycianthes laevis (Dunal) Bitter | | | |
| Physalis minima L. | | | |
| Solanum anguivi Lam. | | | |
| **STERCULIACEAE** | | | |
| Helicteres isora L. | Kewan | | |
| Melochia corchorifolia L. | Mothi Daman | | |
| Species / Family | Local name | Endemism | IUCN |
|-----------------|------------|----------|------|
| Sterculia guttata Roxb. ex DC. | | | |
| **SYMPOCACEAE** | | | |
| Symlocos cochinchenensis (Lour.) S. Moore ssp. laurina (Retz.) Noot. | | | |
| Symlocos racemosa Roxb. | | | |
| **THYMELAEACEAE** | | | |
| Gnidia glauca (Fresen.) Gilg. | | | |
| **TILIACEAE** | | | |
| Corchorus capsularis L. | | | |
| Corchorus olitorius L. | | | |
| Grewia nervosa (Lour.) Panigrahi | Asoli, Chwar | | |
| Grewia serrulata DC. | Chopdi | | |
| Grewia tiliifolia Vahl | Dhaman | | |
| Triumfetta rhomboidea Jacq. | | | |
| **ULMACEAE** | | | |
| Celtis timorensis Spanoghe | | | |
| Holopetleia integrifolia (Roxb.) Planch. | Wawal | | |
| Trema orientalis (L.) Blume | | | |
| **URTIACEAE** | | | |
| Boehmeria macrophylla Hornem. | | | |
| Debregeasia longifolia (Burm.f.) Wedd. | | | |
| Laportea interrupta (L.) Chew | | | |
| Pilea microphylla (L.) Liebm. | | | |
| **VERBENACEAE** | | | |
| Lantana camara L. | | | |
| **VISCACEAE** | | | |
| Viscum monoicum Roxb. ex DC. | | | |
| **VITACEAE** | | | |
| Ampelocissus indicus (L.) Planch. | | | |
| Ampelocissus latifolia (Roxb.) Planch. | | | |
| Caryatia tenuifolia (Wight and Arn.) Gagnep. | | | |
| Caryatia trifolia (L.) Domin | | | |
| Cissus elongata Roxb. | | | |
| Cissus javanica DC. | | | |
| Cissus rependo Vahl | Palkonde | | |
| Cyphostemma auriculatum (Roxb.) P.Singh & B.V.Shetty | | | |
| Tetrastigma sulcatum (M.A.Lawson) Gamble | | | |
| **ZINGIBERACEAE** | | | |
| Alpinia galanga (L.) Willd. | | | |
| Curcuma decipiens Dalzell | Endemic PI | | |
| Curcuma zanthorrhiza Roxb. | | | |
| Kaempferia scaposa (Nimmo) Benth. | Endemic WG | | |
| Zingiber neesanum (J. Graham) Ramamoorthy | Endemic PI | | |
| Zingiber nimmonii (J. Graham) Dalzell | Endemic PI | | |
| Zingiber zerumbet (L.) Roxcoe ex J.E.Sm. | | | |
### Appendix III. Checklist of mammal species in Bhagwan Mahavir Sanctuary derived from open-source lists, IUCN Red List database and field-guides on Indian mammals

| Order | Family | Species | Common name | IUCN Red List Category | WPA schedule |
|-------|--------|---------|-------------|------------------------|--------------|
| 1     | Carnivora | Felidae | Panthera tigris | Bengal Tiger | Endangered | I |
| 2     | Carnivora | Felidae | Panthera pardus | Common Leopard | Vulnerable | I |
| 3     | Carnivora | Felidae | Prionailurus bengalensis | Leopard Cat | Least Concern | I |
| 4     | Carnivora | Felidae | Prionailurus rubiginosus | Rusty-spotted Cat | Near Threatened | I |
| 5     | Carnivora | Felidae | Felis catus | Jungle Cat | Least Concern | II |
| 6     | Carnivora | Canidae | Cuon alpinus | Dhole | Endangered | II |
| 7     | Carnivora | Canidae | Canis aureus | Golden Jackal | Least Concern | II |
| 8     | Carnivora | Ursidae | Melursus ursinus | Sloth Bear | Vulnerable | I |
| 9     | Carnivora | Herpestidae | Herpestes/ Urva smittii | Stripe-necked Mongoose | Least Concern | II |
| 10    | Carnivora | Herpestidae | Herpestes/ Urva smithii | Ruddy Mongoose | Least Concern | II |
| 11    | Carnivora | Herpestidae | Urva edwardsii | Indian Grey Mongoose | Least Concern | II |
| 12    | Carnivora | Mustelidae | Aonyx cinereus | Small-clawed Otter | Vulnerable | I |
| 13    | Carnivora | Mustelidae | Lutrogale perspicillata | Smooth-coated Otter | Vulnerable | II |
| 14    | Carnivora | Viverridae | Vivericula indica | Small Indian Civet | Least Concern | II |
| 15    | Carnivora | Viverridae | Paradoxurus hermaphroditus | Common Palm Civet | Least Concern | I |
| 16    | Carnivora | Viverridae | Paradoxurus jerdoni | Brown Palm Civet | Least Concern | II |
| 17    | Cetartiodactyla | Bovidae | Bos gaurus | Gaur | Vulnerable | I |
| 18    | Cetartiodactyla | Bovidae | Tetracerus quadricornis | Four-horned antelope | Vulnerable | I |
| 19    | Cetartiodactyla | Cervidae | Rusa unicolor | Sambar | Vulnerable | I |
| 20    | Cetartiodactyla | Cervidae | axis axis | Chital | Least Concern | III |
| 21    | Cetartiodactyla | Cervidae | Muntiacus vaginalis | Northern Red Muntjac | Least Concern | III |
| 22    | Cetartiodactyla | Tragulidae | Moschiola indica | Indian Chevrotain/ Mouse deer | Least Concern | I |
| 23    | Cetartiodactyla | Suidae | Sus scrofa | Wild Boar | Least Concern | III |
| 24    | Pholidota | Manidae | Manis crassicaudata | Indian Pangolin | Endangered | I |
| 25    | Primates | Cercopithecidae | Colobus guereza | Black-footed Gray Langur | Vulnerable | II |
| 26    | Primates | Cercopithecidae | Macaca radiata | Bonnet Macaque | Least Concern | II |
| 27    | Primates | Cercopithecidae | Loris lydekkerianus | Slender Loris | Least Concern | I |
| 28    | Lagomorpha | Leporidae | Lepus nigricollis | Indian Hare | Least Concern | IV |
| 29    | Rodentia | Sciuridae | Ratufa indica | Indian Giant Squirrel | Least Concern | II |
| 30    | Rodentia | Sciuridae | Petaurista philippensis | Indian Giant Gliding Squirrel | Least Concern | II |
| 31    | Rodentia | Sciuridae | Funambulus tristriatus | Western Ghats Striped Squirrel | Least Concern | IV |
| 32    | Rodentia | Sciuridae | Funambulus palmarum | Common Palm Squirrel | Least Concern | IV |
| 33    | Rodentia | Hystricidae | Hystrix indica | Indian Crested Porcupine | Least Concern | IV |
| 34    | Rodentia | Muridae | Tatera indica | Indian Gerbil | Least Concern | V* |
| 35    | Rodentia | Muridae | Vandeloria olaracea | Assam Long-tailed Climbing Mouse | Least Concern | V* |
| 36    | Rodentia | Muridae | Mus musculus | House Mouse | Least Concern | V* |
| 37    | Rodentia | Muridae | Mus booduga | Indian Field Mouse | Least Concern | V* |
| 38    | Rodentia | Muridae | Mus saxicolor | Brown Spiny Mouse | Least Concern | V* |
| 39    | Rodentia | Muridae | Mus terricolor | Pygmy Field Mouse | Least Concern | V* |
| 40    | Rodentia | Muridae | Millardia melasta | Soft-furred Metad | Least Concern | V* |
| 41    | Rodentia | Muridae | Madromys blanfordi | White-tailed Wood Rat | Least Concern | V* |
| 42    | Rodentia | Muridae | Golunda elliottii | Indian Bush-rat | Least Concern | V* |
| 43    | Rodentia | Muridae | Bandicota indica | Greater Bandicoot Rat | Least Concern | V* |
| 44    | Rodentia | Muridae | Bandicota bengalensis | Lesser Bandicoot Rat | Least Concern | V* |
| 45    | Rodentia | Muridae | Rattus rattus | House Rat | Least Concern | V* |
| 46    | Rodentia | Muridae | Rattus rattus* | Sahyadris Forest Rat | Vulnerable | V* |
| Order     | Family            | Species                  | Common name                          | IUCN Red List Category | WPA schedule |
|-----------|-------------------|--------------------------|---------------------------------------|------------------------|--------------|
| 47        | Chiroptera        | Pteropodidae             | Pteropus medius                       | Least Concern          | V*           |
| 48        | Chiroptera        | Pteropodidae             | Rousettus leschenaultii               | Least Concern          | V*           |
| 49        | Chiroptera        | Pteropodidae             | Cynopterus sphire                     | Least Concern          | V*           |
| 50        | Chiroptera        | Pteropodidae             | Cynopterus brachyotis                 | Least Concern          | V*           |
| 51        | Chiroptera        | Pteropodidae             | Eonycteris spelaea*                   | Least Concern          | V*           |
| 52        | Chiroptera        | Molossidae               | Tadarida aegyptiaca*                  | Least Concern          | V*           |
| 53        | Chiroptera        | Molossidae               | Chaerophon plicatus*                  | Least Concern          | V*           |
| 54        | Chiroptera        | Molossidae               | Otomops wrougtonti*                  | Data Deficient         | i            |
| 55        | Chiroptera        | Emballonuridae           | Taphozous longimanus*                 | Least Concern          | V*           |
| 56        | Chiroptera        | Emballonuridae           | Taphozous nudiventris*                | Least Concern          | V*           |
| 57        | Chiroptera        | Emballonuridae           | Taphozous melanopogon                 | Least Concern          | V*           |
| 58        | Chiroptera        | Emballonuridae           | Taphozous theobaldii*                 | Least Concern          | V*           |
| 59        | Chiroptera        | Emballonuridae           | Saccoalaimus saccolaimus*             | Least Concern          | V*           |
| 60        | Chiroptera        | Megadermatidae           | Megaderma lyra*                       | Least Concern          | V*           |
| 61        | Chiroptera        | Megadermatidae           | Megaderma spasma                      | Least Concern          | V*           |
| 62        | Chiroptera        | Rhinolophidae            | Rhinolophus rouxi                     | Least Concern          | V*           |
| 63        | Chiroptera        | Rhinolophidae            | Rhinolophus lepidus                   | Least Concern          | V*           |
| 64        | Chiroptera        | Rhinolophidae            | Rhinolophus beddomeii                 | Least Concern          | V*           |
| 65        | Chiroptera        | Hipposideridae           | Hipposiderus fulvus*                  | Least Concern          | V*           |
| 66        | Chiroptera        | Hipposideridae           | Hipposiderus spearis*                 | Least Concern          | V*           |
| 67        | Chiroptera        | Hipposideridae           | Hipposiderus galeritus*               | Least Concern          | V*           |
| 68        | Chiroptera        | Hipposideridae           | Hipposiderus lankadiva                | Least Concern          | V*           |
| 69        | Chiroptera        | Vespertilionidae         | Myotis horsfieldi*                    | Least Concern          | V*           |
| 70        | Chiroptera        | Vespertilionidae         | Pipistrellus coromandra               | Least Concern          | V*           |
| 71        | Chiroptera        | Vespertilionidae         | Pipistrellus tenuis                   | Least Concern          | V*           |
| 72        | Chiroptera        | Vespertilionidae         | Pipistrellus ceylonicus*              | Least Concern          | V*           |
| 73        | Chiroptera        | Vespertilionidae         | Scotaozous dormeri*                   | Least Concern          | V*           |
| 74        | Chiroptera        | Vespertilionidae         | Scotophilus heathii*                  | Least Concern          | V*           |
| 75        | Chiroptera        | Vespertilionidae         | Scotophilus kuhlii*                   | Least Concern          | V*           |
| 76        | Chiroptera        | Vespertilionidae         | Hesperoptenus tickellii*              | Least Concern          | V*           |
| 77        | Chiroptera        | Vespertilionidae         | Kerivoula picta                      | Least Concern          | V*           |
| 78        | Chiroptera        | Vespertilionidae         | Tylonycteris pachyopus*               | Least Concern          | V*           |
| 79        | Chiroptera        | Miniopteridae            | Miniopterus schreibersii               | Least Concern          | V*           |
| 80        | Eulipotyphla      | Soricidae                | Suncus murinus                        | Least Concern          | V*           |
| 81        | Scandentia        | Tupaiidae                | Anathana eliotti                      | Least Concern          | V*           |

*Possible occurrence; *Five-striped palm squirrel mentioned in Schedule IV; *Fruit Bats, Mice, & Rats mentioned in Schedule V; *Distribution records follow IUCN Range maps and Menon (2014).
### Appendix IV. List of fish species in the Mhadei sub-basin (neighbouring Bhagwan Mahavir Wildlife Sanctuary), with status in terms of endemicity to the Western Ghats and IUCN Red List (Atkore 2017).

| Species                                      | Western Ghats | IUCN status     |
|----------------------------------------------|---------------|-----------------|
| 1. Aplocheilus lineatus (Valenciennes, 1846) | Least Concern |                 |
| 2. Arothron leopardus (Day, 1878)            | Data Deficient|                 |
| 3. Carinotetraodon travancoricus (Hora & Nair, 1941) | Endemic | Vulnerable       |
| 4. Chanda nama Hamilton, 1822                | Least Concern |                 |
| 5. Channa gachua (Hamilton, 1822)            | Least Concern |                 |
| 6. Channa marulius (Hamilton, 1822)          | Least Concern |                 |
| 7. Channa striata (Bloch, 1793)              | Least Concern |                 |
| 8. Dawkinsia filamentosa (Valenciennes, 1844) | Endemic | Least Concern    |
| 9. Devario spp                               | Least Concern |                 |
| 10. Devario malabaricus (Jerdon, 1849)       | Least Concern |                 |
| 11. Eropilus suratensis (Bloch, 1790)        | Least Concern |                 |
| 12. Garra bicornuta Narayan Rao, 1920         | Endemic | Near Threatened  |
| 13. Garra mullya (Sykes, 1839)               | Least Concern |                 |
| 14. Garra stenorhynchus (Jerdon, 1849)       | Least Concern |                 |
| 15. Glossogobius giurus (Hamilton, 1822)     | Least Concern |                 |
| 16. Glossogobius spp                         | Least Concern |                 |
| 17. Haludaria melanampyx (Day, 1865)         | Endemic | Data Deficient  |
| 18. Hypselobarbus curmuco (Hamilton, 1807)   | Endemic | Endangered      |
| 19. Hypselobarbus dobsoni (Day, 1876)        | Endemic | Data Deficient  |
| 20. Hypselobarbus jerdoni (Day, 1870)        | Endemic | Least Concern   |
| 21. Lepidocephalichthys thermalis (Valenciennes 1846) | Least Concern |                 |
| 22. Mastacembelus armatus (Lacépède, 1800)   | Least Concern |                 |
| 23. Microphis cuniculus (Hamilton, 1822)*    | Least Concern |                 |
| 24. Mystus armatus (Day, 1865)               | Least Concern |                 |
| 25. Mystus cavasius (Hamilton, 1822)         | Least Concern |                 |
| 26. Mystus giloi (Hamilton, 1822)            | Least Concern |                 |
| 27. Mystus keletius (Valenciennes, 1840)     | Endemic | Least Concern   |
| 28. Migul spp                                | Least Concern |                 |
| 29. Ostecophilichthys nashii (Day, 1869)     | Endemic | Least Concern   |
| 30. Ostecophilichthys thomassi (Day, 1877)   | Endemic | Least Concern   |
| 31. Parambassis ranga (Hamilton, 1822)       | Least Concern |                 |
| 32. Paracanthohabits mooreyi (Sykes, 1839)   | Least Concern |                 |
| 33. Pangio goaensis (Tilak, 1972)*           | Least Concern |                 |
| 34. Pethia narayani (Hora, 1937)             | Least Concern |                 |
| 35. Pethia punctata (Day, 1865)              | Least Concern |                 |
| 36. Pethia setnai (Chhapgar & Sane, 1992)    | Endemic | Vulnerable      |
| 37. Pethia ticta (Hamilton, 1822)            | Least Concern |                 |
| 38. Pseudotrapulus maculatus (Bloch, 1795)   | Least Concern |                 |
| 39. Puntius amphius (Valenciennes, 1842)     | Data Deficient |             |
| 40. Rasbora daniconius (Hamilton, 1822)      | Least Concern |                 |
| 41. Rasbora labiosa Mikerji, 1935            | Endemic | Least Concern   |
| 42. Salmostoma boccale (Hamilton, 1822)      | Least Concern |                 |
| 43. Salmostoma boops (Day, 1874)             | Least Concern |                 |
| 44. Salmostoma novacula (Valenciennes, 1840) | Least Concern |                 |
| 45. Schistura denisoni (Day, 1867)           | Least Concern |                 |
| 46. Schistura spp                            | Least Concern |                 |
| 47. Sicyopterus griseus (Day, 1877)          | Endemic | Least Concern   |
| 48. Tor khudree (Sykes, 1839)                | Endemic | Least Concern   |
| 49. Xenentodon cancila (Hamilton, 1822)      | Least Concern |                 |

* Recorded by other researchers in the Mhadei sub-basin | Pangio goaensis recorded by Talwar & Jhingran (1991); Microphis cuniculus likely occurs based on Pollom (2016)
## Appendix V. Checklist of butterfly species in Bhagwan Mahavir Wildlife Sanctuary and National Park.

| Order    | Family       | Common name          | Scientific name             | WPA Schedule |
|----------|--------------|----------------------|-----------------------------|--------------|
| 1        | Lepidoptera  | Papilionidae         | Southern Birdwing           | Troides minos |
| 2        | Lepidoptera  | Papilionidae         | Malabar Or Ceylon Rose      | Pachliopta pandyana |
| 3        | Lepidoptera  | Papilionidae         | Common Rose                 | Pachliopta aristolochiae |
| 4        | Lepidoptera  | Papilionidae         | Crimson Rose                | Pachliopta hector |
| 5        | Lepidoptera  | Papilionidae         | Southern Bluebottle *        | Graphium teredon |
| 6        | Lepidoptera  | Papilionidae         | Common Jay                  | Graphium dason |
| 7        | Lepidoptera  | Papilionidae         | Tailed Jay                  | Graphium agamemnon |
| 8        | Lepidoptera  | Papilionidae         | Spot Swordtail              | Graphium nomius |
| 9        | Lepidoptera  | Papilionidae         | Five-Bar Swordtail *        | Graphium antiphates |
| 10       | Lepidoptera  | Papilionidae         | Common Mime                 | Papilio clytia |
| 11       | Lepidoptera  | Papilionidae         | Lime                        | Papilio demoleus |
| 12       | Lepidoptera  | Papilionidae         | Malabar Raven               | Papilio dravidorum |
| 13       | Lepidoptera  | Papilionidae         | Red Helen                   | Papilio helenus |
| 14       | Lepidoptera  | Papilionidae         | Common Mormon               | Papilio polytes |
| 15       | Lepidoptera  | Papilionidae         | Blue Mormon                 | Papilio polymnestor |
| 16       | Lepidoptera  | Papilionidae         | Paris Peacock               | Papilio paris |
| 17       | Lepidoptera  | Papilionidae         | Malabar Banded Peacock      | Papilio budha |
| 18       | Lepidoptera  | Pieridae             | Common Emigrant *           | Catopsilia pomona |
| 19       | Lepidoptera  | Pieridae             | Mottled Emigrant            | Catopsilia pyranthe |
| 20       | Lepidoptera  | Pieridae             | Small Grass Yellow          | Eurema brigitta |
| 21       | Lepidoptera  | Pieridae             | Spotless Grass Yellow       | Eurema isota |
| 22       | Lepidoptera  | Pieridae             | Common Grass Yellow         | Eurema hecabe |
| 23       | Lepidoptera  | Pieridae             | Three-Spot Grass Yellow     | Eurema blanda |
| 24       | Lepidoptera  | Pieridae             | One-Spot Grass Yellow *     | Eurema andersoni |
| 25       | Lepidoptera  | Pieridae             | Common Jezebel              | Delias eucharis |
| 26       | Lepidoptera  | Pieridae             | Psyche                      | Leptosia nina |
| 27       | Lepidoptera  | Pieridae             | Common Gull                 | Cepora nerissa |
| 28       | Lepidoptera  | Pieridae             | Lesser Gull                 | Cepora nadina |
| 29       | Lepidoptera  | Pieridae             | Pioneer Or Caper White      | Anaphaes aurata |
| 30       | Lepidoptera  | Pieridae             | Plain Puffin *              | Appias indra |
| 31       | Lepidoptera  | Pieridae             | Chocolate Albatross *       | Appias lynca |
| 32       | Lepidoptera  | Pieridae             | Common Albatross            | Appias albina |
| 33       | Lepidoptera  | Pieridae             | Common Wanderer             | Pareronia valeria |
| 34       | Lepidoptera  | Pieridae             | Dark Wanderer               | Pareronia ceylonica |
| 35       | Lepidoptera  | Pieridae             | Great Orange Tip            | Hedbamaia glaucippe |
| 36       | Lepidoptera  | Nymphalidae          | Southern Duffer *           | Discophora lepida |
| 37       | Lepidoptera  | Nymphalidae          | Common Evening Brown        | Melanitis leda |
| 38       | Lepidoptera  | Nymphalidae          | Great Evening Brown *       | Melanitis zitenius |
| 39       | Lepidoptera  | Nymphalidae          | Dark Evening Brown          | Melanitis phedima |
| 40       | Lepidoptera  | Nymphalidae          | Common Palmfly              | Elynnias hypermenstra |
| 41       | Lepidoptera  | Nymphalidae          | Bamboo Treebrown *          | Letha europa |
| 42       | Lepidoptera  | Nymphalidae          | Tamil Treebrown             | Letha drypetts |
| 43       | Lepidoptera  | Nymphalidae          | Common Treebrown            | Letha rohria |
| 44       | Lepidoptera  | Nymphalidae          | Common Bushbrown            | Mycalesis perseus |
| Order | Family | Common name                  | Scientific name                  | WPA Schedule |
|-------|--------|------------------------------|----------------------------------|--------------|
| 45    | Lepidoptera | Nymphalidae | Dark Branded Bushbrown * | Mycalesis mineus | 45 |
| 46    | Lepidoptera | Nymphalidae | Glad Eye Bushbrown | Mycalesis patria | 46 |
| 47    | Lepidoptera | Nymphalidae | Medus Brown | Orsatrianea medus | 47 |
| 48    | Lepidoptera | Nymphalidae | Common Three-ring * | Ypthima aspera | 48 |
| 49    | Lepidoptera | Nymphalidae | White Or Ceylon Four-ring * | Ypthima ceylonica | 49 |
| 50    | Lepidoptera | Nymphalidae | Common Four-ring | Ypthima huebneri | 50 |
| 51    | Lepidoptera | Nymphalidae | Common Five-ring | Ypthima baldus | 51 |
| 52    | Lepidoptera | Nymphalidae | Common Nawab * | Polyaurs athamas | 52 |
| 53    | Lepidoptera | Nymphalidae | Anomalous Nawab * | Polyaurs agraria | 53 |
| 54    | Lepidoptera | Nymphalidae | Blue Nawab * | Polyaurs schreberi | 54 |
| 55    | Lepidoptera | Nymphalidae | Tawny Rajah | Charaxes bernardus | 55 |
| 56    | Lepidoptera | Nymphalidae | Black Rajah * | Charaxes solon | 56 |
| 57    | Lepidoptera | Nymphalidae | Tawny Coster | Acraea violae | 57 |
| 58    | Lepidoptera | Nymphalidae | Tamil Lacerwing | Cethosis niemer | 58 |
| 59    | Lepidoptera | Nymphalidae | Cruiser | Vindula erota | 59 |
| 60    | Lepidoptera | Nymphalidae | Rustic | Cupha erymanthis | 60 |
| 61    | Lepidoptera | Nymphalidae | Common Leopard | Phalanta phalantha | 61 |
| 62    | Lepidoptera | Nymphalidae | Small Leopard | Phalanta alciqpe | 62 |
| 63    | Lepidoptera | Nymphalidae | Tamil Yeoman | Cimochroha thais | 63 |
| 64    | Lepidoptera | Nymphalidae | Black Prince * | Rohana parisati | 64 |
| 65    | Lepidoptera | Nymphalidae | Painted Courtesan * | Eupirius consimilis | 65 |
| 66    | Lepidoptera | Nymphalidae | Chestnut-Streaked Sailer | Neptis jambh | 66 |
| 67    | Lepidoptera | Nymphalidae | Common Sailer | Neptis hylas | 67 |
| 68    | Lepidoptera | Nymphalidae | Clear Sailer * | Neptis nata | 68 |
| 69    | Lepidoptera | Nymphalidae | Short-banded Sailer * | Neptis culomella | 69 |
| 70    | Lepidoptera | Nymphalidae | Yellow Jack Sailer | Neptis viraja | 70 |
| 71    | Lepidoptera | Nymphalidae | Common Lascar | Pantoporia hordonia | 71 |
| 72    | Lepidoptera | Nymphalidae | Extra Lascar * | Pantoporia sandala | 72 |
| 73    | Lepidoptera | Nymphalidae | Colour Sergeant | Athyma nefte | 73 |
| 74    | Lepidoptera | Nymphalidae | Staff Sergeant * | Athyma selenophora | 74 |
| 75    | Lepidoptera | Nymphalidae | Blackvein Sergeant | Athyma range | 75 |
| 76    | Lepidoptera | Nymphalidae | Common Sergeant | Athyma perius | 76 |
| 77    | Lepidoptera | Nymphalidae | Commander | Limenitis procris | 77 |
| 78    | Lepidoptera | Nymphalidae | Clipper | Parthenos sylvia | 78 |
| 79    | Lepidoptera | Nymphalidae | Grey Count | Tanacedia legidea | 79 |
| 80    | Lepidoptera | Nymphalidae | Common Baron | Euthalia aconthea | 80 |
| 81    | Lepidoptera | Nymphalidae | Gaudy Baron | Euthalia lusntina | 81 |
| 82    | Lepidoptera | Nymphalidae | Redspot Duke * | Dolpha evelina | 82 |
| 83    | Lepidoptera | Nymphalidae | Angled Castor | Ariadne ariadne | 83 |
| 84    | Lepidoptera | Nymphalidae | Common Castor | Ariadne merione | 84 |
| 85    | Lepidoptera | Nymphalidae | Common Map | Cyrestis thydamas | 85 |
| 86    | Lepidoptera | Nymphalidae | Club Beak * | Libythea myrha | 86 |
| 87    | Lepidoptera | Nymphalidae | Yellow Pansy | Junonia hierta | 87 |
| 88    | Lepidoptera | Nymphalidae | Lemon Pansy | Junonia lemonias | 88 |
| 89    | Lepidoptera | Nymphalidae | Peacock Pansy | Junonia almana | 89 |
| Order | Family          | Common name       | Scientific name   | WPA Schedule |
|-------|-----------------|-------------------|-------------------|--------------|
| 90    | Lepidoptera     | Nymphalidae       | Grey Pansy        | Junonia atlites | I and II  |
| 91    | Lepidoptera     | Nymphalidae       | Chocolate Pansy   | Junonia iphita |          |
| 92    | Lepidoptera     | Nymphalidae       | Painted Lady *    | Cynthia cardui |          |
| 93    | Lepidoptera     | Nymphalidae       | Great Eggfly      | Hypolimnas bolina |          |
| 94    | Lepidoptera     | Nymphalidae       | Danaid Eggfly     | Hypolimnas missipus |          |
| 95    | Lepidoptera     | Nymphalidae       | Autumn leaf (Malabar) | Daleschallia bisaltide malabarica | II |
| 96    | Lepidoptera     | Nymphalidae       | South Indian Blue Oakleaf | Kallima horsfieldi | II |
| 97    | Lepidoptera     | Nymphalidae       | Glassy Tiger      | Parantica aglea | II |
| 98    | Lepidoptera     | Nymphalidae       | Blue Tiger        | Tirumala linniae |          |
| 99    | Lepidoptera     | Nymphalidae       | Dark Blue Tiger * | Tirumala septentronics |          |
| 100   | Lepidoptera     | Nymphalidae       | Plain Tiger       | Danaus chrysippus |          |
| 101   | Lepidoptera     | Nymphalidae       | Striped Or Common Tiger | Danaus genuta |          |
| 102   | Lepidoptera     | Nymphalidae       | Common Indian Crow | Euploea core |          |
| 103   | Lepidoptera     | Nymphalidae       | Double-Branded Crow * | Euploea sylvester |          |
| 104   | Lepidoptera     | Nymphalidae       | Brown King Crow * | Euploea klugi |          |
| 105   | Lepidoptera     | Nymphalidae       | Malabar Tree Nymph | Idea malabarica |          |
| 106   | Lepidoptera     | Riodinidae        | Double-Banded Judy * | Abisara albofuscatus |          |
| 107   | Lepidoptera     | Lycaenidae        | Apelfly *         | Spalgis epius |          |
| 108   | Lepidoptera     | Lycaenidae        | Common Pierrot    | Castalius rosimon | I |
| 109   | Lepidoptera     | Lycaenidae        | Angled Pierrot    | Caleta caleta |          |
| 110   | Lepidoptera     | Lycaenidae        | Banded Blue Pierrot | Discolampa ethion |          |
| 111   | Lepidoptera     | Lycaenidae        | Dark Pierrot      | Tarucus ananda | IV |
| 112   | Lepidoptera     | Lycaenidae        | Spotted Pierrot * | Tarucus nora |          |
| 113   | Lepidoptera     | Lycaenidae        | Zebra Blue *      | Leptotes plinius |          |
| 114   | Lepidoptera     | Lycaenidae        | Common Hedge Blue | Acytolepis puspa | I |
| 115   | Lepidoptera     | Lycaenidae        | Plain Hedge Blue * | Celastrina lavendularis |          |
| 116   | Lepidoptera     | Lycaenidae        | Quaker            | Neopithecops zalmora |          |
| 117   | Lepidoptera     | Lycaenidae        | Malayan           | Magisba molaya |          |
| 118   | Lepidoptera     | Lycaenidae        | Dark Grass Blue   | Zizeeria karsandra |          |
| 119   | Lepidoptera     | Lycaenidae        | Lesser Grass Blue | Zisina atis |          |
| 120   | Lepidoptera     | Lycaenidae        | Tiny Grass Blue   | Zisula hylax |          |
| 121   | Lepidoptera     | Lycaenidae        | Lime Blue         | Chilades laius | II |
| 122   | Lepidoptera     | Lycaenidae        | Plains Cupid      | Chilades pandava |          |
| 123   | Lepidoptera     | Lycaenidae        | Grass Jewel *     | Freyeria trochylus |          |
| 124   | Lepidoptera     | Lycaenidae        | Gram Blue         | Euchrysops cnejus | II |
| 125   | Lepidoptera     | Lycaenidae        | Forget-Me-Not     | Catychrysops strabo |          |
| 126   | Lepidoptera     | Lycaenidae        | Pea Blue *        | Lampides boeticus | II |
| 127   | Lepidoptera     | Lycaenidae        | Dark Cerulean *   | Jamides boschus |          |
| 128   | Lepidoptera     | Lycaenidae        | Common Cerulean   | Jamides celena |          |
| 129   | Lepidoptera     | Lycaenidae        | Metallic Cerulean * | Jamides alecto |          |
| 130   | Lepidoptera     | Lycaenidae        | Large 4-Line Blue * | Nacaduba pectoralis | II |
| 131   | Lepidoptera     | Lycaenidae        | Pale 4-Line Blue * | Nacaduba hermus |          |
| 132   | Lepidoptera     | Lycaenidae        | Transparent 6-Line Blue * | Nacaduba kurava |          |
| 133   | Lepidoptera     | Lycaenidae        | Opaque 6-Line Blue * | Nacaduba beroe |          |
| 134   | Lepidoptera     | Lycaenidae        | Common Line Blue * | Prosotas norav |          |
| Order | Family | Common name | Scientific name | WPA Schedule |
|-------|--------|-------------|-----------------|--------------|
| 135   | Lepidoptera | Tailless Line Blue * | Prosotas dubiosa | |
| 136   | Lepidoptera | Dingy Line Blue * | Petrolaea dana | |
| 137   | Lepidoptera | White-Tipped Line Blue * | Prosotas noreia | |
| 138   | Lepidoptera | Red Pierrot | Talcinda rysaeus | |
| 139   | Lepidoptera | Common Ciliate Blue * | Anthene emolus | |
| 140   | Lepidoptera | Pointed Ciliate Blue | Anthene lycaenina | |
| 141   | Lepidoptera | Western Centaur Oakblue * | Arhopala pseudocentaurus | 1 |
| 142   | Lepidoptera | Large Oakblue | Arhopala amantes | |
| 143   | Lepidoptera | Rosy Or Kanara Oakblue * | Arhopala oea | II |
| 144   | Lepidoptera | Aberrant Oakblue * | Arhopala obesus | |
| 145   | Lepidoptera | Tamil Oakblue | Arhopala bazaloides | |
| 146   | Lepidoptera | Common Acacia Blue * | Surendra guercetorum Surendra | |
| 147   | Lepidoptera | Silverstreaked Acacia Blue * | Zinaspa todara | II |
| 148   | Lepidoptera | Silverstreak Blue | Iraota timoleon | |
| 149   | Lepidoptera | Leaf Blue | Amblypodia anita | |
| 150   | Lepidoptera | Common Silverline | Spindasis vulcanus | |
| 151   | Lepidoptera | Longbanded Silverline * | Spindasis lohita | II |
| 152   | Lepidoptera | Yamfly * | Laxura atymnus | |
| 153   | Lepidoptera | Common Imperial | Cheritra freja | |
| 154   | Lepidoptera | Monkey Puzzle | Rathinda amor | |
| 155   | Lepidoptera | Redspot * | Zesius chrysomallus | |
| 156   | Lepidoptera | Silver Royal * | Ancema blanka | |
| 157   | Lepidoptera | Broadtail Royal * | Creno cleobis | |
| 158   | Lepidoptera | White Royal * | Pratapa deva | II |
| 159   | Lepidoptera | Peacock Royal * | Tauria cippus | II |
| 160   | Lepidoptera | Orchid Tit * | Hypolycaena othona | I |
| 161   | Lepidoptera | Fluffy Tit * | Zeitus amasa | |
| 162   | Lepidoptera | Cornelian * | Deudorix epijarbas | |
| 163   | Lepidoptera | Common Guava Blue * | Deudorix isocrates | |
| 164   | Lepidoptera | Large Guava Blue * | Deudorix perse | |
| 165   | Lepidoptera | Plane * | Bindahara phocides | II |
| 166   | Lepidoptera | Indian Red Flash * | Rapala iarbus | |
| 167   | Lepidoptera | Slate Flash | Rapala manea | |
| 168   | Lepidoptera | Indigo Flash * | Rapala varuna | II |
| 169   | Lepidoptera | Indian Sunbeam | Curetis thetis | |
| 170   | Lepidoptera | Shiva Sunbeam * | Curetis siva | |
| 171   | Lepidoptera | Malabar Flash * | Rapala lankana | |
| 172   | Lepidoptera | Common Onyx | Horaga anyx | II |
| 173   | Lepidoptera | Orange-Striped Awl/Orange Awlet * | Burara joana | |
| 174   | Lepidoptera | Orangetail Awl/Pale Green Awlet * | Bibasis sena | II |
| 175   | Lepidoptera | Common Banded Awl * | Hosara chromus | |
| 176   | Lepidoptera | White Banded Awl * | Hosara taminatus | |
| 177   | Lepidoptera | Common Awl * | Hosara badra | |
| 178   | Lepidoptera | Brown Awl | Badamia exclamationis | |

**Order**

- Lepidoptera
- Hesperiidae

**Family**

- Lycaenidae
- Hesperiidae

**Common name**

- Tailless Line Blue
- Dingy Line Blue
- White-Tipped Line Blue
- Red Pierrot
- Common Ciliate Blue
- Pointed Ciliate Blue
- Western Centaur Oakblue
- Large Oakblue
- Rosy Or Kanara Oakblue
- Aberrant Oakblue
- Tamil Oakblue
- Common Acacia Blue
- Silverstreaked Acacia Blue
- Silverstreak Blue
- Leaf Blue
- Common Silverline
- Longbanded Silverline
- Yamfly
- Common Imperial
- Monkey Puzzle
- Redspot
- Silver Royal
- Broadtail Royal
- White Royal
- Peacock Royal
- Orchid Tit
- Fluffy Tit
- Cornelian
- Common Guava Blue
- Large Guava Blue
- Plane
- Indian Red Flash
- Slate Flash
- Indigo Flash
- Indian Sunbeam
- Shiva Sunbeam
- Malabar Flash
- Common Onyx
- Orange-Striped Awl/Orange Awlet
- Orangetail Awl/Pale Green Awlet
- Common Banded Awl
- White Banded Awl
- Common Awl
- Brown Awl

**Scientific name**

- Prosotas dubiosa
- Petrolaea dana
- Prosotas noreia
- Talcinda rysaeus
- Anthene emolus
- Anthene lycaenina
- Arhopala pseudocentaurus
- Arhopala amantes
- Arhopala oea
- Arhopala obesus
- Arhopala bazaloides
- Surendra guercetorum
- Zinaspa todara
- Iraota timoleon
- Amblypodia anita
- Spindasis vulcanus
- Spindasis lohita
- Laxura atymnus
- Cheritra freja
- Rathinda amor
- Zesius chrysomallus
- Ancema blanka
- Creno cleobis
- Pratapa deva
- Tauria cippus
- Hypolycaena othona
- Zeitus amasa
- Deudorix epijarbas
- Deudorix isocrates
- Deudorix perse
- Bindahara phocides
- Rapala iarbus
- Rapala manea
- Rapala varuna
- Curetis thetis
- Curetis siva
- Rapala lankana
- Horaga anyx
- Burara joana
- Bibasis sena
- Hosara chromus
- Hosara taminatus
- Hosara badra
- Badamia exclamationis
| Order | Family | Common name                  | Scientific name                  | WPA Schedule |
|-------|--------|------------------------------|----------------------------------|--------------|
| 179   | Lepidoptera | Hesperiidae | Common Spotted Flat                  | Celaenorrhinus leucocera          |              |
| 180   | Lepidoptera | Hesperiidae | Malabar Spotted Flat *              | Celaenorrhinus ambareesa          |              |
| 181   | Lepidoptera | Hesperiidae | Tamil Spotted Flat *               | Celaenorrhinus ruficornis         |              |
| 182   | Lepidoptera | Hesperiidae | Common/Ceylon Snow Flat *          | Tagiades jepetus                  |              |
| 183   | Lepidoptera | Hesperiidae | Water Snow Flat                    | Tagiades littigosa                |              |
| 184   | Lepidoptera | Hesperiidae | Fulvous Pied Flat                  | Psuedocoladenia dan               |              |
| 185   | Lepidoptera | Hesperiidae | Tricolour Flat                     | Psuedocoladenia indrama           |              |
| 186   | Lepidoptera | Hesperiidae | Common Small Flat                  | Sarangesa dasahara               |              |
| 187   | Lepidoptera | Hesperiidae | Spotted Small Flat *               | Sarangesa purendra                |              |
| 188   | Lepidoptera | Hesperiidae | Angled Flat/Black Angle            | Tapena tawithesi                 |              |
| 189   | Lepidoptera | Hesperiidae | Golden Angle                       | Odonotypilium ransonetti          |              |
| 190   | Lepidoptera | Hesperiidae | Indian Grizzled/Indian Skipper *   | Spilia gaiba                      |              |
| 191   | Lepidoptera | Hesperiidae | Pygmy Grass-/Scrub-Hopper *        | Aeromachus pygmaeus               |              |
| 192   | Lepidoptera | Hesperiidae | Bush Hopper *                      | Ampitilia diassorides             |              |
| 193   | Lepidoptera | Hesperiidae | Indian Ace *                       | Holpe homolea                     | II           |
| 194   | Lepidoptera | Hesperiidae | Madras Ace                         | Thoressa honarei                  | IV           |
| 195   | Lepidoptera | Hesperiidae | Moore’s Ace *                      | Holpe porus                       |              |
| 196   | Lepidoptera | Hesperiidae | Chestnut Bob                       | Lambris salvala                   |              |
| 197   | Lepidoptera | Hesperiidae | Coon                              | Psios fulga                       |              |
| 198   | Lepidoptera | Hesperiidae | Common Banded Demon                | Notocrypta paralysos              |              |
| 199   | Lepidoptera | Hesperiidae | Restricted Demon                  | Notocrypta curvifascia            |              |
| 200   | Lepidoptera | Hesperiidae | Grass Demon                       | Udaspes fulus                     |              |
| 201   | Lepidoptera | Hesperiidae | Indian Palm Bob *                 | Suastus gremius                   |              |
| 202   | Lepidoptera | Hesperiidae | Tree Flicker *                    | Hyarotis adras tus                | IV           |
| 203   | Lepidoptera | Hesperiidae | Giant Redeye                       | Gangara thyrsis                   |              |
| 204   | Lepidoptera | Hesperiidae | Common Redeye *                   | Matapa aria                       |              |
| 205   | Lepidoptera | Hesperiidae | Tamil Grass Dart                  | Taractrocera ceramos              |              |
| 206   | Lepidoptera | Hesperiidae | Pale Palm Dart *                  | Telcota colon                     |              |
| 207   | Lepidoptera | Hesperiidae | Plain Palm Dart *                 | Cephenes acalle                   |              |
| 208   | Lepidoptera | Hesperiidae | African Straight/Straight Swift *  | Pannaro naso                      |              |
| 209   | Lepidoptera | Hesperiidae | Bevan’s Swift *                   | Borbo brevani                     |              |
| 210   | Lepidoptera | Hesperiidae | Dark Small-Branded Swift *        | Pelopidas mathias                 |              |
| 211   | Lepidoptera | Hesperiidae | Conjoined Swift *                 | Pelopidas conjucta                |              |
| 212   | Lepidoptera | Hesperiidae | Paintbrush Swift *                | Baoris farri                      | IV           |
| 213   | Lepidoptera | Hesperiidae | Blank Swift *                     | Caltoris kumara                   |              |
| 214   | Lepidoptera | Hesperiidae | Philippine Swift *                | Caltoris philippina               | II           |
| 215   | Lepidoptera | Hesperiidae | Maculate Lancer *                 | Salanaemia saia                   |              |
| 216   | Lepidoptera | Hesperiidae | Small Palm Bob *                  | Suastus minutus                   |              |
| 217   | Lepidoptera | Hesperiidae | Wax Dart *                        | Cnipitha purirea                  |              |
| 218   | Lepidoptera | Hesperiidae | Common Dartlet                    | Oriens galoides                   |              |

Source: India Biodiversity Portal (https://indiabiodiversity.org/checklist/show/228); Rangnekar & Dharwadkar (2009); *Direct Sightings by Parag Rangnekar, Omkar Dharwadkar & Ravindra Bhamure
### Appendix VI. Odonates of Bhagwan Mahavir Wildlife Sanctuary and National Park.

| Common name                     | Scientific name                  | Family                | IUCN status | Western Ghat Endemism |
|---------------------------------|----------------------------------|-----------------------|-------------|-----------------------|
| 1 Pale Dartlet                  | Agriocnemis pieris               | Coenagrionidae        |             |                       |
| 2 Pygmy Dartlet                 | Agriocnemis pygmea               | Coenagrionidae        |             |                       |
| 3 Splendid Dartlet              | Agriocnemis splendissima         | Coenagrionidae        |             |                       |
| 4 Orange-tailed Marsh Dart      | Ceriagrion cerinarubellum        | Coenagrionidae        |             |                       |
| 5 Coromandel Marsh Dart         | Ceriagrion coramandelianum       | Coenagrionidae        |             |                       |
| 6 Rusty Marsh Dart              | Ceriagrion olivaceum             | Coenagrionidae        |             |                       |
| 7 Sindhudung Marsh Dart         | Ceriagrion chromothorax          | Coenagrionidae        |             |                       |
| 8 Rusty Marsh Dart              | Ceriagrion olivaceum             | Coenagrionidae        |             |                       |
| 9 Golden Dartlet                | Ischnura rubilio                 | Coenagrionidae        |             |                       |
| 10 Pygmy Bluespot                | Mortonagrion varralii            | Coenagrionidae        |             | Endemic               |
| 11 Yellow-striped Blue Dart     | Pseudagrion indicum              | Coenagrionidae        |             | Endemic               |
| 12 Saffron-faced Blue Dart      | Pseudagrion rubriceps            | Coenagrionidae        |             |                       |
| 13 Yellow Bush Dart              | Copera marginipes                | Platycenemididae      |             |                       |
| 14 Blue Bush Dart                | Copera vittata                   | Platycenemididae      |             |                       |
| 15 Pied Reedtail                 | Protosticta gravelyi             | Platystictidae        |             | Endemic               |
| 16 Red-spot Reedtail            | Protosticta sanguinostigma      | Platystictidae        | Vulnerable  | Endemic               |
| 17 Black Bamboottail            | Prodasineura verticalis          | Platycenemididae      |             |                       |
| 18 Blackwinged Bamboottail      | Disparoneura quadrimaculata      | Platycenemididae      |             |                       |
| 19 Coorg Bamboottail *          | Caconeura ramburi                | Platycenemididae      |             |                       |
| 20 Black & yellow bamboottail   | Elattoneura tetrica              | Platycenemididae      |             |                       |
| 21 Emerald Spreadwing           | Lestes elatus                    | Lestidae              |             |                       |
| 22 Stream Glory                  | Neurobasis chinesis              | Calopterygidae        |             |                       |
| 23 Black-tipped Forest Glory    | Vestalis apicalis                | Calopterygidae        |             |                       |
| 24 Clear-winged Forest Glory    | Vestalis gracilis                | Calopterygidae        |             |                       |
| 25 River Heliodor                | Libellago indica                 | Chlorocyphidae        |             | Endemic               |
| 26 Stream Ruby                  | Rhinocypha bisignata             | Chlorocyphidae        |             |                       |
| 27 Malabar Torrent Dart         | Euphaea fraseri                  | Euphaeidae             |             | Endemic               |
| 28 Black Torrent Dart           | Dysphaea ethela                  | Euphaeidae             |             | Endemic               |
| 29 Plain sinuate Clubtail       | Burmagomphus laidlawi            | Gomphidae              |             | Endemic               |
| 30 Forest Hooktail              | Helogomphus promelas             | Gomphidae              |             | Endemic               |
| 31 Kodagu Clubtail              | Gomphidia kodaguensis            | Gomphidae              |             | Endemic               |
| 32 Forest Hooktail              | Helogomphus promelas             | Gomphidae              |             | Endemic               |
| 33 Wayanad Bowtail               | Macrognomphus wyndaicus          | Gomphidae              |             | Endemic               |
| 34 Common Clubtail              | Ictinogomphus rapax              | Gomphidae              |             | Endemic               |
| 35 Giant Clubtail                | Megalognomphus hanningtoni       | Gomphidae              |             | Near Threatened       |
| 36 Long-legged Clubtail         | Mero gnomphus longistigma        | Gomphidae              |             | Endemic               |
| 37 Pigmy Clubtail               | Micrognomphus souteri            | Gomphidae              |             | Endemic               |
| 38 Laidlaw’s Clubtail           | Onychogomphus acinaces           | Gomphidae              |             | Endemic               |
| 39 Common Hooktail              | Paragomphus lineatus             | Gomphidae              |             | Endemic               |
| 40 Blue-tailed Green Darner     | Anax guttatus                    | Aeshnidae              |             |                       |
| 41 Blue Darner *                | Anax immaculifrons               | Aeshnidae              |             |                       |
| 42 Brown Darner                 | Gynacantha dravida               | Aeshnidae              |             |                       |
| 43 Parakeet Darner              | Gynacantha bayadera              | Aeshnidae              |             |                       |
| Common name                  | Scientific name        | Family           | IUCN status   | Western Ghat Endemism |
|------------------------------|------------------------|------------------|---------------|-----------------------|
| 44  Common River Hawk        | Epaphthalmia vittata   | Macromidae       |               |                       |
| 45  Macromia flavicincta     | Macromidae             | Macromidae       |               |                       |
| 46  Macromia irata           | Macromidae             | Macromidae       | Endemic       |                       |
| 47  Evening Torrent Hawk     | Idionyx saffronata     | Cordulidae       |               |                       |
| 48  Goan Shadowdancer        | Idionyx gamantakensis  | Cordulidae       | Endemic       |                       |
| 49  Ditch Jewel              | Brachythemis contaminata| Libellulidae     |               |                       |
| 50  Granite Ghost *          | Bradinopyga geminata   | Libellulidae     |               |                       |
| 51  Konkan Rock Dweller *    | Bradinopyga konkanensis| Libellulidae     |               |                       |
| 52  Emerald-banded Skimmer   | Cratilla lineata       | Libellulidae     |               |                       |
| 53  Ruddy Marsh Skimmer      | Crocothemis servilia   | Libellulidae     |               |                       |
| 54  Ground Skimmer           | Diplacodes trivialis   | Libellulidae     |               |                       |
| 55  Amber-winged Glider      | Hydrobasileus croceus  | Libellulidae     |               |                       |
| 56  Blue Hawklet             | Hylaethemis indica     | Libellulidae     |               |                       |
| 57  Dark Ground Skimmer      | Indothemis carnatica   | Libellulidae     | Near Threatened|                       |
| 58  Asian Bloodtail          | Lathrecista asiatica   | Libellulidae     |               |                       |
| 59  Fulvous Forest Skimmer   | Neurothemis fulvia     | Libellulidae     |               |                       |
| 60  Pale Forest Skimmer      | Neurothemis intermedia | Libellulidae     |               |                       |
| 61  Pied Paddy Skimmer       | Neurothemis tullia     | Libellulidae     |               |                       |
| 62  Stellate River Hawk *    | Onychathemis testacea  | Libellulidae     |               |                       |
| 63  Cherry Skimmer           | Orthetrum chrysis      | Libellulidae     |               |                       |
| 64  Blue Marsh Hawk          | Orthetrum glaucum      | Libellulidae     |               |                       |
| 65  Crimson-tailed Marsh Hawk| Orthetrum pruinosum    | Libellulidae     |               |                       |
| 66  Blue-eyed Marsh Hawk     | Orthetrum luzonicum    | Libellulidae     |               |                       |
| 67  Green Marsh Hawk         | Orthetrum sabina       | Libellulidae     |               |                       |
| 68  Tiny Flufftail *         | Polpopleura sexmaculata| Libellulidae     |               |                       |
| 69  Wandering Glider         | Pantaia flavescens     | Libellulidae     |               |                       |
| 70  Yellow-tailed Ashy Skimmer| Potamarcha congener    | Libellulidae     |               |                       |
| 71  Common Picturewing       | Rhyothemis variegata   | Libellulidae     |               |                       |
| 72  Pigmy Skimmer            | Tetrathemis platyptera | Libellulidae     |               |                       |
| 73  Coral-tailed Cloud-wing *| Tholymis tilarga       | Libellulidae     |               |                       |
| 74  Red Marsh Trotter        | Tramea basilaris       | Libellulidae     |               |                       |
| 75  Black Marsh Trotter      | Tramea limbata         | Libellulidae     |               |                       |
| 76  Crimson Marsh Glider      | Trithemis aurora       | Libellulidae     |               |                       |
| 77  Black Stream Glider      | Trithemis festiva      | Libellulidae     |               |                       |
| 78  Long-legged Marsh Glider *| Trithemis pallidinervis| Libellulidae     |               |                       |
| 79  Iridescent Stream Glider *| Zygonyx iris           | Libellulidae     |               |                       |
| 80  Brown Dusk Hawk          | Zyxomma petiolatum     | Libellulidae     |               |                       |

Compiled from: Prasad & Varsney (1995); Rangnekar et al. (2010); Rangnekar & Naik (2014); Rangnekar et al. (2019); Subramanian et al. (2013); direct sightings (indicated by *) by Parag Rangnekar, Omkar Dharwadkar, Rohan Naik, Sridhar Halali, & Dhiraj Halali.
## Appendix VII. Checklist of reptiles in Bhagwan Mahavir Wildlife Sanctuary and National Park.

| Order | Family | Species | Common name | IUCN Red List category | WPA schedule |
|-------|--------|---------|-------------|------------------------|--------------|
| 1     | Testudines | Bataguridae | Melanochelys trijuga | Indian Black Turtle | Near Threatened |
| 2     | Testudines | Trionychidae | Lissemys punctata | Indian Flapshell Turtle | Least Concern |
| 3     | Squamata | Gekkonidae | Cnemaspis gaensis | Goan Day Gecko | Endangered |
| 4     | Squamata | Gekkonidae | Cyrtodactylus albafasciatus | Boulenger’s Indian Gecko | Not Evaluated |
| 5     | Squamata | Gekkonidae | Hemidactylus frenatus | Asian House Gecko | Least Concern |
| 6     | Squamata | Gekkonidae | Hemidactylus prashadi | Prashad’s Gecko | Least Concern |
| 7     | Squamata | Lacertidae | Ophisops beddomei | Beddome’s Snake-eyed Lizard | Least Concern |
| 8     | Squamata | Mabuyidae | Allapalli grass skink | Allapalli Grass Skink | Least Concern |
| 9     | Squamata | Mabuyidae | Europs macularia | Bronze Grass Skink | Least Concern |
| 10    | Squamata | Mabuyidae | Europs carinata | Common Keeled Skink | Least Concern |
| 11    | Squamata | Lygosomidae | Lygosoma goaensis | Goan Supple Skink | Least Concern |
| 12    | Squamata | Lygosomidae | Lygosoma punctatum | Spotted Supple Skink | Least Concern |
| 13    | Squamata | Varanidae | Varanus bengalensis | Bengal Monitor Lizard | Least Concern |
| 14    | Squamata | Chamaeleonidae | Chamaeleo zeylanicus | Indian Chamaeleon | Least Concern |
| 15    | Squamata | Agamidae | Calotes rouxii | Roux’s Forest Lizard | Least Concern |
| 16    | Squamata | Agamidae | Calotes versicolor | Indian Garden Lizard | Least Concern |
| 17    | Squamata | Agamidae | Draco dussumieri | South Indian Flying Lizard | Least Concern |
| 18    | Squamata | Tylphlopidae | Indotyphlops bairimi | Brahmini Worm Snake | Least Concern |
| 19    | Squamata | Tylphlopidae | Grypytrophlops acutus | Beaked Worm Snake | Least Concern |
| 20    | Squamata | Erycidae | Eryx whitei | Whitaker’s Boa | Least Concern |
| 21    | Squamata | Uropeltidae | Melanophidium kharei | Khare’s Shieldtail | Least Concern |
| 22    | Squamata | Uropeltidae | Uropeltis beddomei | Beddome’s Shieldtail | Least Concern |
| 23    | Squamata | Pythonidae | Python molurus | Rock Python | Near Threatened |
| 24    | Squamata | Pythonidae | Daboia russelii | Russell’s Viper | Least Concern |
| 25    | Squamata | Pythonidae | Echis carinatus | Indian Saw-scaled Viper | Not Evaluated |
| 26    | Squamata | Viperidae | Hypnale hypnale | Common Hump-nosed Pit Viper | Not Evaluated |
| 27    | Squamata | Viperidae | Trimeresurus gramineus | Bamboo Pit Viper | Least Concern |
| 28    | Squamata | Viperidae | Trimeresurus malabaricus | Malabar Pit Viper | Least Concern |
| 29    | Squamata | Elapidae | Bungarus caeruleus | Common Indian Krait | Not Evaluated |
| 30    | Squamata | Elapidae | Calliophis castoe | Castoe’s Coral Snake | Not Evaluated |
| 31    | Squamata | Elapidae | Calliophis melanurus | Slender Coral Snake | Not Evaluated |
| 32    | Squamata | Elapidae | Naja naja | Spectacled Cobra | Least Concern |
| 33    | Squamata | Elapidae | Ophiophagus hannah | King Cobra | Vulnerable |
| 34    | Squamata | Natricidae | Amphisemus stolatum | Striped Keelback | Not Evaluated |
| 35    | Squamata | Natricidae | Atritetum schistosum | Olive Keelback Water Snake | Least Concern |
| 36    | Squamata | Natricidae | Hebius beddomei | Beddome’s Keelback | Least Concern |
| 37    | Squamata | Natricidae | Macrophistodon plumibicolor | Green Keelback | Not Evaluated |
| 38    | Squamata | Natricidae | Rhabdops aquaticus | Aquatic Forest Snake | Not Evaluated |
| 39    | Squamata | Natricidae | Xenochrophis piscator | Checkered Keelback | Not Evaluated |
| 40    | Squamata | Colubridae | Ahaetulla nasuta | Common Vine Snake | Not Evaluated |
| 41    | Squamata | Colubridae | Ahaetulla pulverbula | Brown Vine Snake | Least Concern |
| 42    | Squamata | Colubridae | Boiga beddomei | Beddome’s Cat Snake | Data Deficient |
### Appendix VIII. Checklist of amphibians in Bhagwan Mahavir Wildlife Sanctuary and National Park.

| Order | Family       | Species                        | Common name                      | IUCN Red List category        | WPA schedule |
|-------|--------------|--------------------------------|----------------------------------|------------------------------|--------------|
| 1     | Anura        | Bufoidae                       | Duttaphrynus melanostictus       | Least Concern                |              |
| 2     | Anura        | Bufoidae                       | Duttaphrynus stomaticus          | Least Concern                |              |
| 3     | Anura        | Bufoidae                       | Pedostibes tuberculosis          | Endangered                  |              |
| 4     | Anura        | Dicroglossidae                 | Euphlyctis cyanophlyctis         | Least Concern                |              |
| 5     | Anura        | Dicroglossidae                 | Minervarya rufescens*            | Least Concern                |              |
| 6     | Anura        | Dicroglossidae                 | Minervarya syphadenris*          | Endangered                  |              |
| 7     | Anura        | Dicroglossidae                 | Minervarya gomantaki*            |                             |              |
| 8     | Anura        | Dicroglossidae                 | Minervarya goemchi*              |                             |              |
| 9     | Anura        | Dicroglossidae                 | Minervarya cepfi*                |                             |              |
| 10    | Anura        | Dicroglossidae                 | Minervarya agricola*             |                             |              |
| 11    | Anura        | Dicroglossidae                 | Hoplobatrachus tigerinus         | Least Concern                | Schedule IV  |
| 12    | Anura        | Dicroglossidae                 | Sphaerotheca breviceps           | Least Concern                |              |
| 13    | Anura        | Dicroglossidae                 | Sphaerotheca dossanii            | Least Concern                |              |
| 14    | Anura        | Microhylidae                   | Mixomphyla ornata                | Least Concern                |              |
| 15    | Anura        | Microhylidae                   | Microhyla nilphamariensis        | Not Evaluated                |              |
| 16    | Anura        | Microhylidae                   | Uperodon globulosus              | Indian Balloon Frog          | Least Concern|
| 17    | Anura        | Microhylidae                   | Uperodon marmoratus              | Indian Dot Frog              | Endangered   |
| 18    | Anura        | Nyctibatrachidae               | Nyctibatrachus daniell           | Daniel’s Night Frog          | Least Concern|
| 19    | Anura        | Nyctibatrachidae               | Nyctibatrachus petraeus          | Castle Rock Night Frog       | Least Concern|
| 20    | Anura        | Ranidae                       | Indirana chiravasi               | Amboli Leaping Frog          | Not Evaluated|
| 21    | Anura        | Ranidae                       | Indirana salekari                | Leaping Frog                 | Not Evaluated|
| 22    | Anura        | Ranidae                       | Pseudophiatus amboli             | Amboli Bush Frog             | Critically   |
| 23    | Anura        | Ranidae                       | Philoutus bombayensis            | Maharashtra Bush Frog        | Vulnerable   |
| 24    | Anura        | Ranidae                       | Polyedates maculatus             | Common Indian Tree Frog      |              |
| 25    | Anura        | Ranidae                       | Rhacophorus malabaricus          | Malabar Gliding Frog         | Least Concern|
| 26    | Anura        | Ranidae                       | Raorchestes bombayensis          | Maharashtra Bush Frog        |              |
| 27    | Anura        | Ranidae                       | Hydrophylax malabaricus          | Fungoid Frog                 | Least Concern|

Source: Aengals et al. (2018); Sharma (1976).
### Appendix IX. Ants of Bhagwan Mahavir Wildlife Sanctuary and National Park.

| Species | Ants of Bhagwan Mahavir Wildlife Sanctuary and National Park. |
|---------|---------------------------------------------------------------|
| **AMBLIPONINAE** |                                                      |
| 28 | Anura Ranidae Hydrophylax bahuvistara Wide-spread Fungoid Frog |
| 29 | Anura Ranidae Indosylvirana temporalis Bronzed Frog Near Threatened |
| 30 | Anura Ranidae Indosylvirana caesari Maharashta Golden-backed Frog |
| 31 | Anura Ranidae Clinorattus curtipes Bicoloured Frog Near Threatened |
| 32 | Anura Microsauridae Microsaur uttaraghati Northern Dancing Frog |
| 33 | Gymnophiona Ichthyophiidae Ichthyophis daviidi Choria Striped Caecilian |
| 34 | Gymnophiona Ichthyophiidae Ichthyophis bombayensis Bombay Caecilian Least Concern |
| 35 | Gymnophiona Indotyphlidae Gegeneophis danieli Daniel’s Caecilian |
| 36 | Gymnophiona Indotyphlidae Gegeneophis mhadeiensis Mhadei Caecilian |

*Genus Minervarya used provisionally. Freshwater Frogs are mentioned in Schedule IV. Source: Dinesh et al. (2020); Kulkarni et al. (2013); Gosavi et al. (2020)*

*Species*

| AMYLOPOINAE |
|-------------|
| 1 | Mystrium sp. |
| 2 | Stigmatomma sp. |

| DOLICHODERINAE |
|----------------|
| 3 | Tapinoma indicum Forel, 1895 |
| 4 | Tapinoma melanocephalum (Fabricius, 1793) |
| 5 | Tapinoma alpides (Smith, 1861) |

| DORSYLINAE |
|------------|
| 6 | Aenictus ceylonicus (Mayr, 1866) |
| 7 | Dorylus orientalis Westwood, 1835 |
| 8 | Oesarara biji Forel, 1907 |
| 9 | Parasyscia chitieni Forel, 1900 |

| FORMICINAE |
|-----------|
| 10 | Parasyscia indica Brown, 1975 (E) |
| 11 | Anoplolepis gracilipes (Smith, 1857) (I) |
| 12 | Camponotus angusticollis (Jerdon, 1851) |
| 13 | Camponotus compressus (Fabricius, 1787) |
| 14 | Camponotus irritans (Smith, 1857) |
| 15 | Camponotus parius Emery, 1889 |
| 16 | Camponotus radiates Forel, 1892 (E) |
| 17 | Camponotus sericeus (Fabricius, 1798) |
| 18 | Lepisiota capensis (Mayr, 1862) |
| 19 | Lepisiota apaca (Forel, 1892) |
| 20 | Decophylla smaragda (Fabricius, 1775) |
| 21 | Paratrechina longicornis (Lateirell, 1802) (I) |
| 22 | Polyrhachis exsita (Walker, 1859) |
| 23 | Polyrhachis illisutate Walker, 1859 |
| 24 | Polyrhachis lactijennis Smith, 1858 |
| 25 | Polyrhachis rastellata (Lateirell, 1802) |
| 26 | Polyrhachis scissa (Roger, 1862) |
| 27 | Polyrhachis tibialis Smith, 1858 |

| MYRMINAE |
|----------|
| 28 | Aphaenogaster beccari Emery, 1887 |

| Species |
|---------|
| 29 | Carebara affinis (Jerdon, 1851) |
| 30 | Carebara diversa (Jerdon, 1851) |
| 31 | Ctenoplecta latu Forel, 1891 |
| 32 | Ctenoplecta taphrobae Smith, 1853 |
| 33 | Cretogaster dalbyi Forel, 1902 |
| 34 | Cretogaster rogenhoferi Mayr, 1879 |
| 35 | Cretogaster rotheyi Mayr, 1879 |
| 36 | Cretogaster subnuda Mayr, 1879 |
| 37 | Lophomyrmex quadrispinosus (Jerdon, 1851) |
| 38 | Meranoplus bellii Forel, 1902 |
| 39 | Meranoplus bicolor (Guérin-Méneville, 1844) |
| 40 | Monomorium atomum Forel, 1902 |
| 41 | Monomorium dichroum Forel, 1902 |
| 42 | Monomorium indicum Forel, 1902 |
| 43 | Monomorium pharaonis (Linnaeus, 1758) (I) |
| 44 | Myrmicaria brunnea Saunders, 1842 |
| 45 | Pheidole gracilis Forel, 1902 (E) |
| 46 | Pheidole sharpi Forel, 1902 |
| 47 | Solenopsis geminata (Fabricius, 1804) (I) |
| 48 | Strumigenys hastilis Bolton, 2000 (E) |
| 49 | Strumigenys peracuta Bolton, 2000 (E) |
| 50 | Tetramorium mixtum Forel, 1902 |
| 51 | Tetramorium rugiger Forel, 1897 (E) |
| 52 | Tetramorium simillimum (Smith, 1851) (I) |
| 53 | Tetramorium管理人员 Forel, 1902 |
| 54 | Trachymyrmex destructor (Jerdon, 1851) (I) |
| 55 | Trachymyrmex管理人员 Forel, 1902 |

*PONERINAE*

| 56 | Anochetus graeffei Mayr, 1870 |
| 57 | Anochetus cf. pupulas Brown, 1978 |
| 58 | Bothroponera henryi Donisthorpe, 1942 (E) |
| 59 | Bothroponera sulcata (Mayr, 1867) |
| 60 | Bothroponera tesserodons (Emery, 1877) |
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**Species**

| Species                        | Name                                      |
|-------------------------------|-------------------------------------------|
| 61 Brachypponera lateipeus    | (Mayr, 1862)                              |
| 62 Diacamma indicum           | Santschi, 1920                            |
| 63 Diacamma ceylonense Emerj    | 1887                                      |
| 64 Diacamma rugosum            | Le Guillou, 1842                          |
| 65 Harpegnathos saltator Jerdon, 1851 |                                |
| 66 Leptogenys diminuta         | Smith, 1857                               |
| 67 Leptogenys chinensis       | (Mayr, 1870)                              |
| 68 Leptogenys processionalis  | Jerdon, 1851                              |
| 69 Odontomachus similimus     | Smith, 1858                               |
| 70 Parvapona darwini          | Forel, 1893                               |
| 71 Platythrya paralela        | Smith, 1859                               |
| 72 Pseudoneoponera rufipes    | Jerdon, 1851                              |
| **PSEUDOMYRMECINAE**          |                                           |

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Monograph

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