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Forest trees of Odisha, India: An updated checklist

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Abstract

An exhaustive taxonomic inventory of forest trees of Odisha in the Eastern Ghats of India was made during 2015–2020, which revealed the presence of a total of 501 species of wild and naturalised trees belonging to 284 genera under 80 families. The family Euphorbiaceae was the most species-rich represented by 45 species, followed by Rubiaceae (28), Mimosaceae (27), Moraceae (26) and Meliaceae (23). The genus *Ficus* (Moraceae) had highest number of 21 tree species, followed by *Diospyros* (10 species), *Syzygium* (8 species), *Albizia* (8 species), *Senegalia* (7 species), *Vitex* (7 species) and *Terminalia* (6 species). *Nothopodytes nimmoniana*, *Alphonsea madraspatana*, *Lasiococca comberi*, *Siphonodon celastrineus*, *Searsia paniculata*, *Syzygium schmidii*, *Cassipourea ceylanica*, *Prunus pygeoides*, *Sonneratia griffithii*, *Eriolaena hookeriana* var. *viridis*, *Dimorphocalyx glabellus*, *Garcinia xanthochymus* and *Litsea glutinosa* have been identified as regionally threatened species needing conservation intervention. *Cocculus laurifolius* is reported here as a new distributional record for the state. Field observation on the occurrence and dominance of tree species in different forest types of Odisha has been discussed. A checklist of the tree species of Odisha is presented in this article, along with the correct botanical name, synonym(s), local name, flowering and fruiting time, locality of occurrence and citation of voucher herbarium specimens.

Keywords

Enumeration, flora, biodiversity, Eastern Ghats

Introduction

Tropical forests are the most species-rich terrestrial ecosystems in the world. Though they cover only 6–7% of the landmass on Earth, more than half of the described and unknown species of plants, animals and microorganisms of the globe are reported to occur in the tropics (1, 2). Due to a wide range of variation in topographic, climatic and edaphic conditions, the world's tropical forests hold strikingly rich genetic diversity at species and intra-specific levels (3). However, many tropical forests are under tremendous anthropogenic pressure and require management intervention to maintain the overall biodiversity, productivity and sustainability (4). Understanding tree composition and structure of the forest is a vital instrument in assessing the sustainability of the forest, species conservation and management of forest ecosystems (5). Long-term biodiversity conservation depends on the knowledge of the structure, species richness and the ecological characteristics of vegetation, especially trees (6).

Because of their dominance, density and biomass, the trees form the main structural and functional components of tropical forests. They are considered robust indicators of climatic change and man-made alterations at the landscape level (7). Trees are one of the main features of most forest ecosystems of the world, and they make available habitats, food and other resources for a range of epiphytes, mosses, fungi, lichens, birds, insects and other forest-dwelling organisms (8). The biological diversity of tree species in tropics varies according to the geographical location, forest types, habitat conditions and intensity of disturbance (9).

Though trees find a place in general floristic accounts of Odisha (10, 11), no exclusive publications on trees of Odisha have been brought out except that of the Similipal Biosphere Reserve (12). As regards the trees of Odisha state, the Botany of Bihar and Orissa (10) provides an account of the flora and vegetation of the then Bihar and Odisha and as many as 386 tree species have been listed therein. Subsequently, occurrence of 475 species of tree has been reported from the state in "Flora of Orissa" (11) and the same authors later recorded the distribution of *Siphonodon celastrineus* Griff. from Odisha (13). Another work "Wild edible fruit plants of Eastern India" mentioned about 98 wild tree species producing edible fruits. The book on “Floral diversity of Nandankanan Wildlife Sanctuary” records the presence of 175 tree species (15). Subsequently, several tree species such as *Sloanea sterculiacea* (Benth.) Rehder & Wilson (16), *Dysoxylum gotadhora* (Buch.-Ham.) Mabb. (17), *Searsia paniculata* (Wall. ex G. Don) Moffett (18) and *Nothapodytes nimmoniana* (J. Graham) Mabb. (19) have been added to the list of trees of Odisha. Till date, there is no publication dealing exclusively on diversity, distribution and phenology of forest trees of Odisha state.

Materials and Methods

Study area

The study area covers the entire state of Odisha, located between 17.49' N and 22.34' N latitudes and 81.27' E and 87.29' E longitudes on the east coast of India (Fig. 1). This coastal state covers an area of 155820 km^2. It is surrounded by the States of Jharkhand, West Bengal, Chhattisgarh, Andhra Pradesh and the Bay of Bengal. One-third of the area of the state is under forest cover and three-fourths of the area is covered with hills and mountainous ranges. Based on homogeneity, continuity and physiographic characteristics, Odisha has been divided into 5 major regions such as (i) The Odisha coastal plains, (ii) The middle mountainous and highlands, (iii) The Central plateau, (iv) The western rolling uplands and (v) the major flood plains. Eleven major rivers and their tributaries flow in the state and drain into the Bay of Bengal. Odisha enjoys a tropical monsoon type of climate characterized by high temperature and humidity, medium to high rainfall, and short and mild winters. The average summer temperature can be as high as 45 °C and a minimum of 5 °C in winter. The period from mid-June to September is the monsoon season and the state receives an average annual rainfall about 1500 mm.

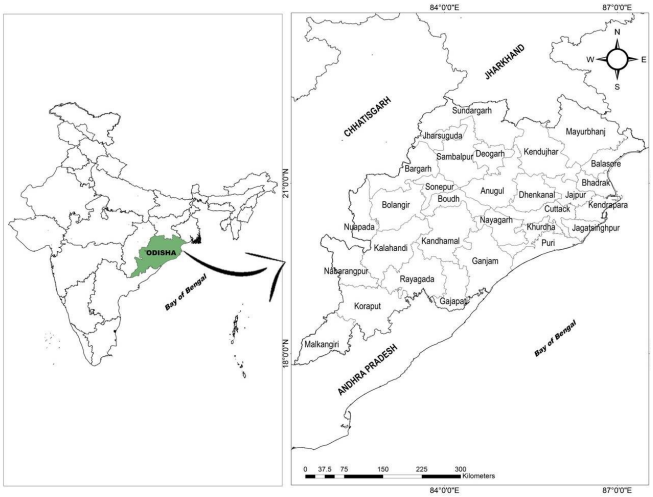

Fig. 1. Map of study area: (**A**) Map of India showing the geographical location of Odisha, (**B**) Map of Odisha showing all the 30 districts

Despite degradation, both in extent and density, the existing forests of Odisha can be classified under 5 broad forest types and sub-types as per the classification of Champion and Seth (20). These are (i) Orissa Semi-Evergreen Forests, (ii) Tropical Moist Deciduous Forests, (iii) Tropical Dry Deciduous Forests, (iv) Central Indian Hill Forests and (v) Littoral and Tidal Swamp Forests.

Field and herbarium methods

Regular collection trips were organised in all the 30 districts of Odisha in different seasons of the year, with special emphasis on protected areas like Biosphere Reserve, National Parks, Wildlife sanctuaries and other floristically diversified habitats. Since most of the tree species flower during the summer months, extensive field trips were conducted during this season to collect and photograph flowering specimens. Before collection, general observations on the type of vegetation, dominant species, habitat condition, soil type, plant association, dominance and distribution, level of disturbance etc., of each site were recorded. Authentic field notes were recorded on the spot, which includes place of collection, local name, tree height, GBH, phenology and other characters which cannot be detected in dried specimens. Herbarium specimens were prepared following the standard herbarium techniques (21, 22). Some flowering and fruiting twigs were preserved in polythene bags and brought to the laboratory for subsequent diagnosis, botanical description and correct identification. The voucher specimens have been deposited in the Herbarium of the Regional Plant Resource Centre (RPRC), Bhubaneswar, India.

The identity of the plants was ascertained in consultation with the artificial identification keys and descriptions provided in the local floras such as "The Botany of Bihar & Orissa" (10), its "Supplement" (23), “Flora of Orissa” (11), other floras, monographs and revisions. Some doubtful specimens were taken to Central National Herbarium, Calcutta (CAL) and were matched with authentic materials to ascertain identity

Results

Tree inventory conducted in the forests of Odisha during the period 2015-2020 revealed the presence of 501 species of wild and thoroughly naturalised trees belonging to 284 genera under 80 families. The family Euphorbiaceae was the most species represented by 45 tree species, followed by Rubiaceae (28 species), Mimosaceae (27 species), Moraceae (26 species), Meliaceae (23 species), Rutaceae (21 species), Verbenaceae (18 species), Caesalpiniaceae (16 species), Fabaceae (16 species) and Lauraceae (16 species). Some 27 families like Alangiaceae, Aquifoliaceae, Araliaceae, Averrhoaceae, Bixaceae, Caprifoliaceae, Casuarinaceae, Cochlospermaceae, Dipterocarpaceae, Eleocarpaceae, Hernandiaceae, Hippocataceae, Icacinaceae had 1 tree species each. The genus *Ficus* (Moraceae) included a maximum number of 21 tree species, followed by the genera *Diospyros* (10 species), *Syzygium* (8 species), *Albizia* (8 species), *Senegalia* (7 species), *Vitex* (7 species) and *Terminalia* (6 species).

The enumeration of 501 species of forest trees in Odisha is provided in Supplementary Table 1. The families are alphabetically arranged, and the species under a family also follow alphabetic order. For each species, correct botanical name, synonym(s), family to which it belongs, local name, flowering and fruiting time, locality of collection from Odisha and herbarium voucher specimen number have been given. The correct name used in this paper is according to the name cited in the online world plant database (http://www.worldfloraonline.org) and the synonym as available in the “Flora of Orissa” (11), “The Botany of Bihar and Odisha” (10) and “Supplement to the Botany of Bihar and Orissa” (23) only have been cited. Photographs of some important tree species collected from the forests of Odisha have been provided (Figs. 2-8).

Discussion

The present study reports the presence of as many 501 tree species against 386 species reported earlier (10) and 475 species listed (11). The occurrence of several interesting and threatened tree species like *Nothopodytes nimmoniana* (J. Graham) Mabb., *Cocculus laurifolius* DC., *Searsia paniculata* (Wall. ex G. Don) Moffett has been reported in this study. The natural distribution of many species of trees was observed to be restricted to specific forest types and habitat conditions. While the dominant trees in the top storey of semi-evergreen forests were *Artocarpus lacucha* Roxb. ex Buch.-Ham., *Mangifera indica* L., *Protium serratum* (Wall. ex Colebr.) Engl., *Magnolia champaca* (L.) Baill. ex Pierre, *Diospyros malabarica* (Desr.) Kostel., *Celtis tetandra* Roxb., *Bridelia retusa* (L.) A. Juss., *Dillenia pentagyna* Roxb., *Ficus racemosa* L., *Ficus nervosa* Heyne ex Roth, *Firmiana colorata* (Roxb.) R. Br., the middle storey was composed of *Mesua ferrea* L., *Phoebe wightii* Meissn., *Polyalthia cerasoides* (Roxb.) Bedd., *Polyalthia suberosa* (Roxb.) Thw., *Macaranga peltata* (Roxb.) Muell.-Arg., *Litsea nitida* (Roxb.) Hook. and a few other small-statured trees. The Tropical Moist Deciduous Forests of Odisha are characterized by predominance of *Shorea robusta* Gaertn. (sal) in almost pure formations along with associated trees like *Terminalia alata* Heyne ex Roth, *Pterocarpus marsupium* Roxb., *Schleichera oleosa* (Lour.) Oken, *Careya arborea* Roxb., *Dalbergia latifolia* Roxb., *Desmodium oogeinense* (Roxb.) H. Ohashi, *Xylia xylocarpa* (Roxb.) Taub., *Toona ciliata* Roem. etc. Species such as *Cleistanthus collinus* (Roxb.) Benth.ex Hook.f., *Dendrocalamus strictus* (Roxb.) Nees, *Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr., *Terminalia alata* Heyne ex Roth, *Diospyros melanoxylon* Roxb., *Boswellia serrata* Roxb. ex Colebr. etc., along with Sal (*Shorea robusta* Gaertn.) are common in the Tropical Dry Deciduous Forest patches in the state. Central Indian Hill Forests are seen between 900-1200 m and the vegetation closely resemble the tropical dry deciduous vegetation with a higher proportion of evergreen species such as *Syzygium cumini* (L.) Skeels, *Manilkara hexandra (*Roxb.) Dubard, *Firmiana simplex* (L.) W. Wight, *Firmiana colorata* (Roxb.) R. Br., *Ficus racemosa* L., *Ficus virens* Ait. and *Mallotus philipinensis* (Lam.) Muell.-Arg.

The estuaries of rivers like the Subarnarekha, the Budhabalang, Baitarani, Mahanadi, Daya and Bansadhara etc., all of which together have built up the coastal alluvium of Odisha harbour Littoral and Tidal Swamp Forests, either as a continuous belt or as broken patches, from Chandipur in the Balasore district to Gopalpur in the Ganjam District. The dominant tree species of tidal swamp (mangrove) forests are *Bruguiera parviflora* (Roxb.) Wight & Arn. ex Griff., *B. gymnorrhiza* (L.) Lam., *Rhizophora mucronata* Lam., *R. apiculata* Bl., *Ceriops decandra* (Griff.) W. Theob., *Lumnitzera racemose* Willd., *Excoecaria agallocha* L., *Sonneratia caseolaris* (L.) Engl., *S. apetala* Buch.-Ham., *Thespesia populnea* (L.) Sol. ex Corr., *Hibiscus tiliaceus* L., *Xylocarpus granatum* Koenig., *Heritiera littoralis* Dryand ex Ait., *Aegiceras corniculatum* (L.) Blanco, *Kandelia candel* (L.) Druce, *Avicenia marina* (Forssk.) Vierh., *A. officinalis* L. and *Phoenix paludosa* Roxb.

In the present tree inventory, *Nothopodytes nimmoniana* (J. Graham) Mabb., *Alphonsea madraspatana* Bedd., *Lasiococca comberi* Haines, *Siphonodon celastrineus* Griff., *Cocculus laurifolius* DC., *Searsia paniculata* (Wall. ex G. Don) Moffett, *Syzygium schmidii* Rathakr. & N. C. Nair, *Cassipourea ceylanica* (Gardn.) Alston, *Prunus pygeoides* Koehne, *Sonneratia griffithii* Kurz, *Eriolaena hookeriana* Wight & Arn. var. *viridis* Haines, *Dimorphocalyx glabellus* Thw., *Garcinia xanthochymus* Hook. f. ex T. Anders. and *Litsea glutinosa* (Lour.) Robins. have been identified as regionally threatened taxa.

Conclusion

The forest tree inventory of Odisha in this article is the first comprehensive study in the state based on intensive fieldwork, herbarium and literature consultations for about 6 years. It enumerates 501 species of wild and naturalised trees, representing 19.25% of India's tree diversity, estimated as 2603 species (24) and lists several threatened taxa needing conservation actions. The present work will help the forest managers and conservationists to formulate suitable strategies for conservation of threatened tree species and a better understanding of the tree flora of the

state.

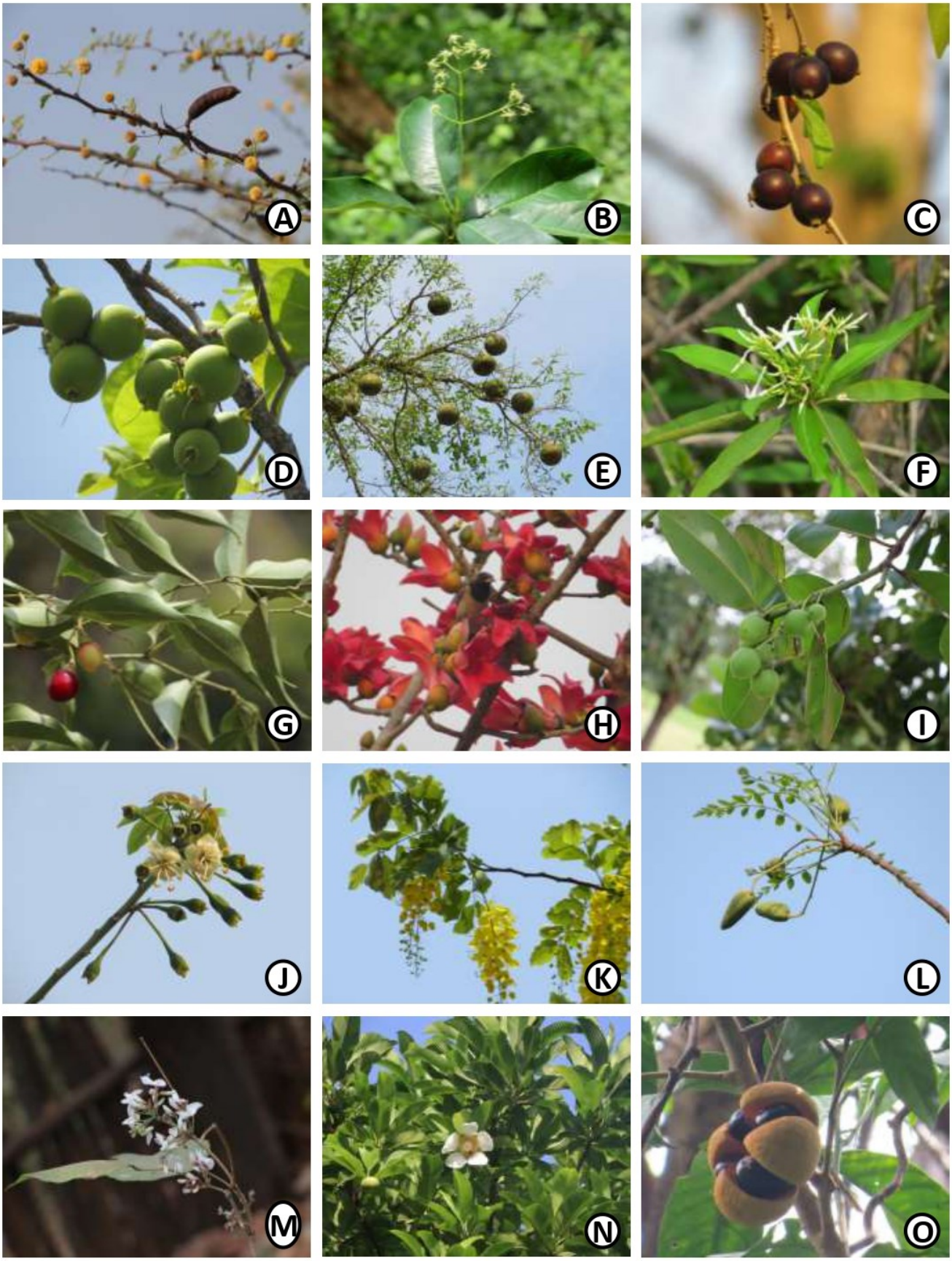

Fig. 2. Trees of Odisha**. A.** *Acacia farnesiana,* **B.** *Acronychia pedunculata*, **C**. *Alangium salviifolium*, **D**. *Careya arborea*, **E**. *Aegle marmelos*, **F**. *Alstonia venenata*, **G**. *Neocinnamomum caudatum,* **H**. *Bombax ceiba*, **I.** *Calophyllum inophyllum*, **J**. *Ceiba pentandra*, **K**. *Cassia fistula*, **L**. *Chloroxylon swietenia*, **M.** *Desmodium oojeinense*, **N**. *Dillenia indica*, **O**. *Dysoxylum gotadhora*

Fig. 3. Trees of Odisha. **A.** *Acacia leucophloea*, **B**. *Alphonsea madraspatana*, **C**. *Ardisia solanacea*, **D**. *Buchanania lanzan*, **E**. *Saraca asoca*, **F**. *Cleistanthus patulus*, **G**. *Ehretia laevis*, **H.** *Diospyros chloroxylon*, **I**. *Garcinia xanthochymus*, **J**. *Glochidion lanceolarium*, **K**. *Harpullia arborea*, **L**. *Kydia calycina*, **M**. *Lasiococca comberi*, **N**. *Gardenia latifolia*, **O**. *Eugenia roxburghii*

Fig. 4. Trees of Odisha. **A.** *Aphanamixis polystachya*, **B**. *Artocarpus lacucha*, **C.** *Bauhinia purpurea*, **D**. *Callicarpa tomentosa*, **E**. *Debregeasia longifolia*, **F**. *Dillenia pentagyna*, **G**. *Erythrina variegata*, **H**. *Ficus benjamina*, **I**. *Gmelina arborea*, **J**. *Haldina cordifolia*, **K**. *Lagerstroemia parviflora*, **L.** *Lannea coromandelica*, **M**. *Leea indica*, **N**. *Madhuca longifolia*, **O**. *Melia dubia*

Fig. 5. Trees of Odisha**. A.** *Ailanthus excelsa*, **B**. *Anogeissus latifolia*, **C**. *Bischofia javanica,* **D**. *Psydrax dicoccos,* **E.** *Cerbera odollam*, **F**. *Cassine glauca*, **G**. *Dillenia aurea,* **H.** *Flacourtia jangomas*, **I.** *Mammea suriga*, **J**. *Limonia acidissima*, **K**. *Miliusa velutina*, **L**. *Neolitsea zeylanica*, **M**. *Ochna obtusata*, **N**. *Phyllanthus emblica,* **O**. *Pithecellobium dulce*

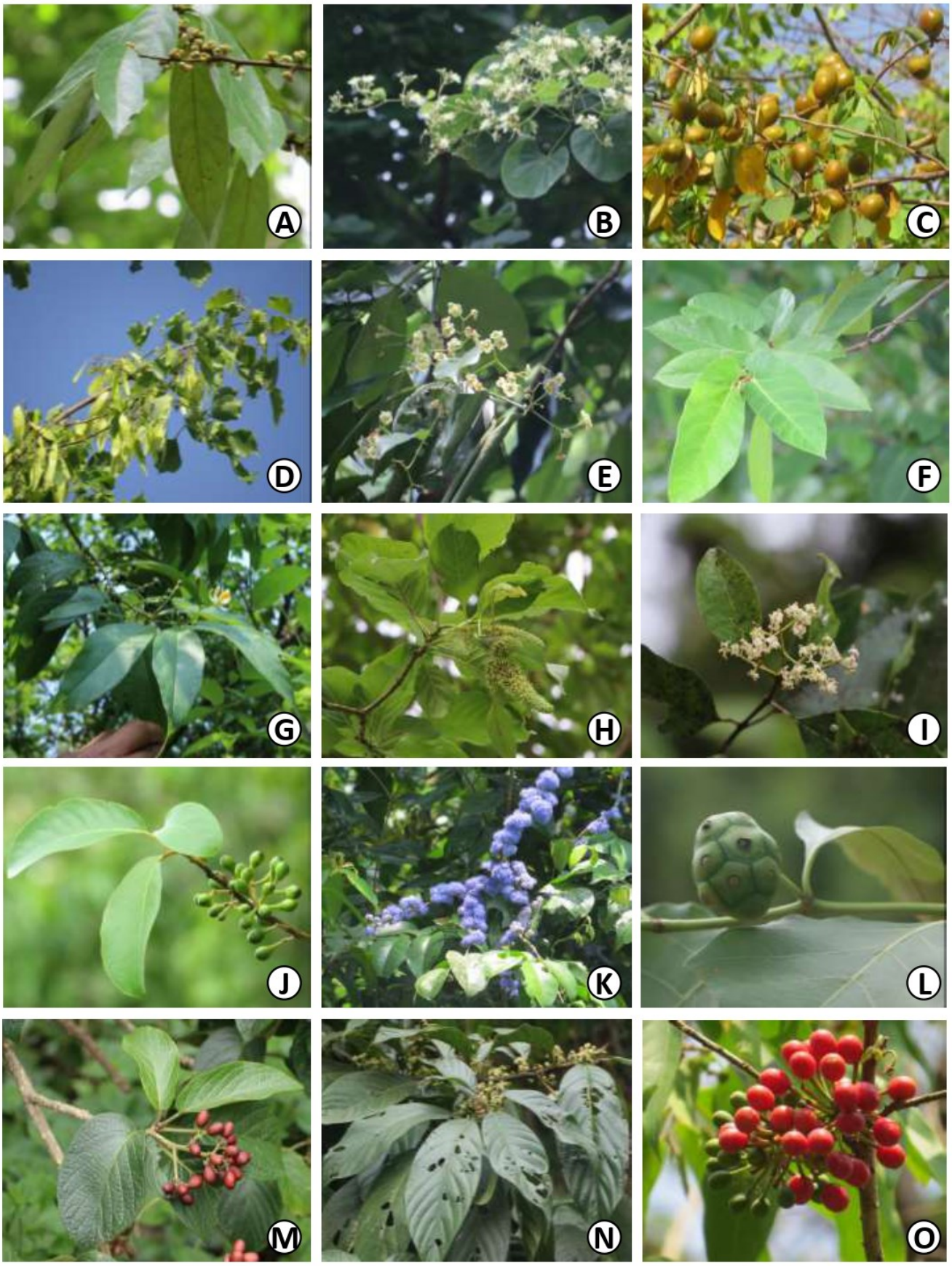

Fig. 6. Trees of Odisha. **A.** *Actinodaphne gullavara*, **B**. *Bauhinia semla*, **C**. *Cleistanthus collinus*, **D**. *Dalbergia sissoo*, **E**. *Euonymus glaber*, **F**. *Ficus semicordata*, **G**. *Grewia serrulata*, **H**. *Hymenodictyon orixense*, **I**. *Ligustrum gamblei*, **J**. *Litsea monopetala*, **K**. *Memecylon umbellatum*, **L**. *Morinda coreia*, **M.** *Nothapodytes nimmoniana*, **N.** *Oreocnide integrifolia*, **O**. *Polyalthia cerasoides*

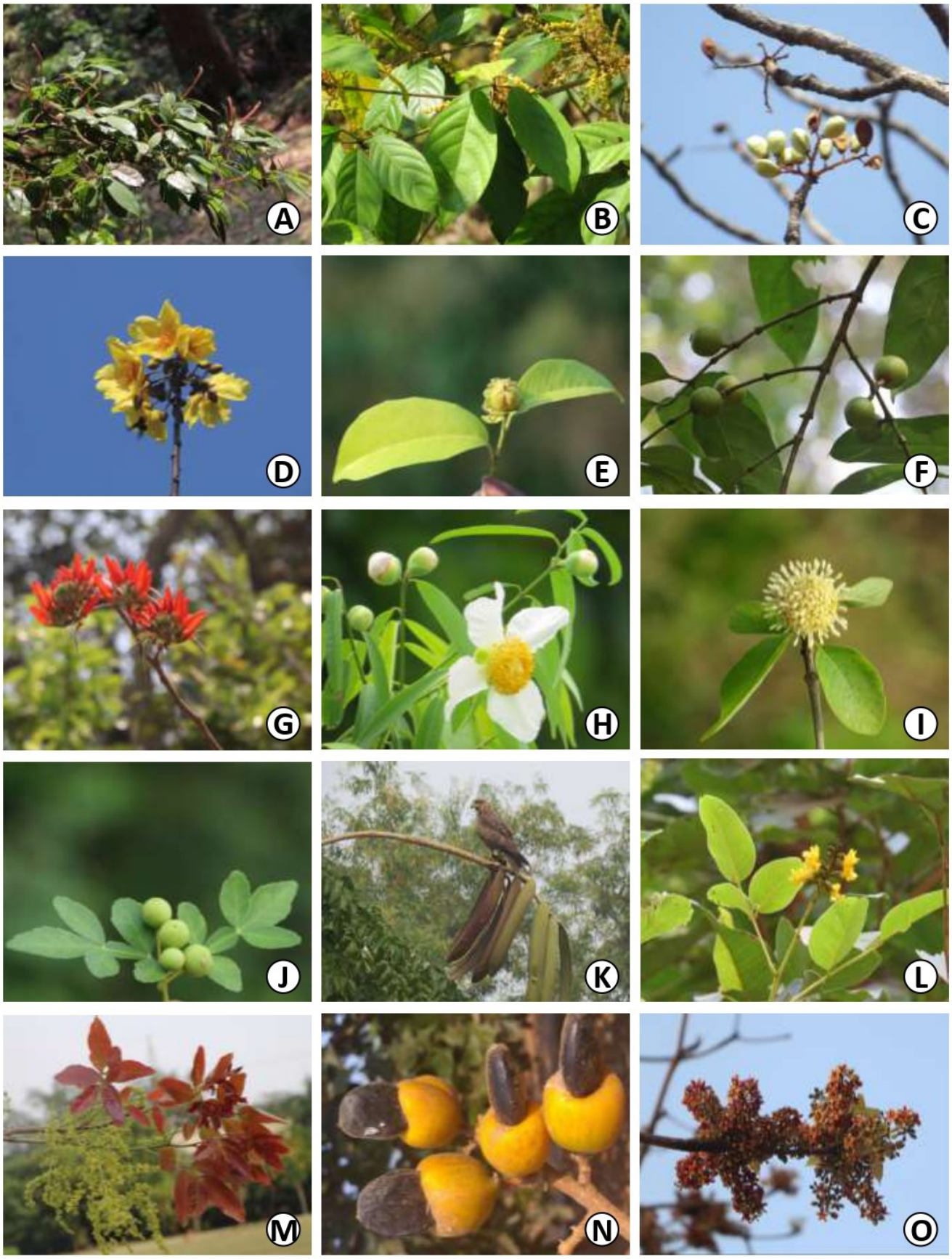

Fig. 7. Trees of Odisha**.** A. *Antidesma bunius*, B. *Baccaurea ramiflora*, C. *Boswellia serrata*, D. *Cochlospermum religiosum*, E. *Dimorphocalyx glabellus*, F. *Diplospora singularis*, G. *Erythrina suberosa*, H. *Mesua ferrea*, I. *Mitragyna parvifolia*, J. *Naringi crenulata*, K. *Oroxylum indicum*, L. *Pterocarpus marsupium*, M. *Schleichera oleosa*, N. *Semecarpus anacardium*, O. *Sterculia foetida*

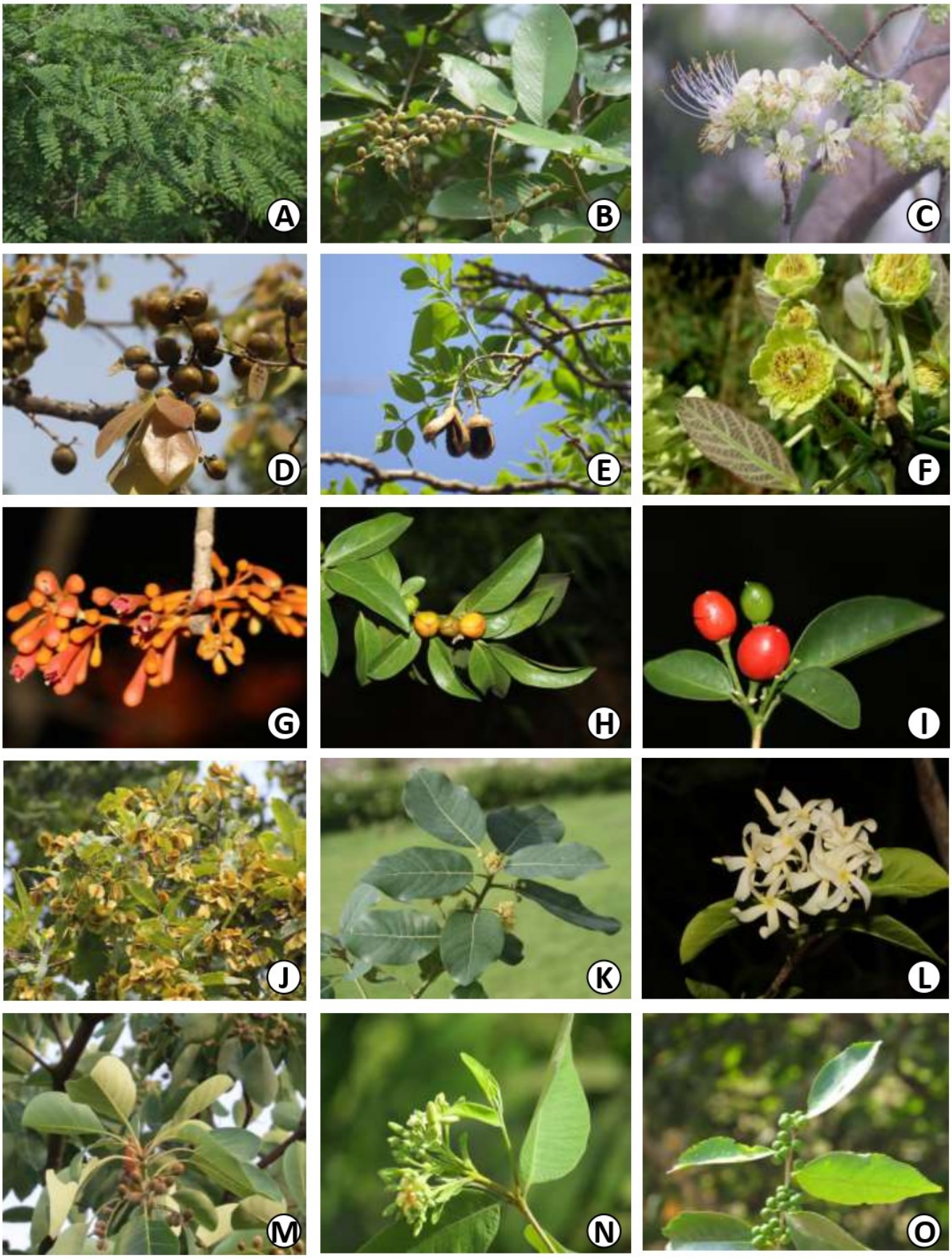

Fig. 8. Trees of Odisha. **A.** *Albizia chinensis*, **B**. *Bridelia retusa*, **C**. *Crateva magna*, **D**. *Diospyros melanoxylon*, **E.** *Schrebera swietenioides*, **F**. *Sloanea sterculiacea*, **G**. *Firmiana colorata*, **H**. *Suregada multiflora*, **I**. *Murraya paniculata*, **J**. *Terminalia alata*, **K**. *Litsea glutinosa*, **L**. *Holarrhena antidysenterica,* **M.** *Terminalia bellirica*, **N**. *Wrightia arborea*, **O**. *Xylosma longifolium*

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Authors contributions

PKD and TS: Plant collection, photography, herbarium preparation, data analysis and draft manuscript preparation. PCP- Plant identification, nomenclature and manuscript correction.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None.

Supplementary data

Table 1. Enumeration of tree species of Odisha

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