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Identification Key

Plant Species in a tract of insular Atlantic Forest in Ilhabela (SP): Floristics, photographic documentation, and identification keys of arboreal dicotyledons based on vegetative characteristics

Andrea Garafulic Aguirre[1]*, Juliana Teixeira[1], João Paulo Fernandes Zorzanelli[3], Gabriel Dalla Colletta[2] & Daniela Sampaio[4]

[1]Universidade Estadual Paulista Júlio de Mesquita Filho, Departamento de Biologia Vegetal, Rio Claro, SP, Brasil
[2]Universidade Estadual de Campinas, Departamento de Biologia vegetal, Campinas, SP, Brasil
[3]Universidade Federal do Espírito Santo, Departamento de Ciências Florestais e da Madeira, Jerônimo Monteiro, ES, Brasil
[4]Universidade Estadual Júlio de Mesquita Filho, Departamento de Zoologia e Botânica, São José do Rio Preto, SP, Brasil
**Corresponding author: Andrea Garafulic Aguirre, e-mail: deia.aguirre@gmail.com*

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Abstract: The Ilhabela State Park (PEIb, for Parque Estadual Ilhabela in Portuguese)—located between 23º 46' 28" south latitude and 45º 21' 20" west latitude—is responsible for the conservation of one of the most important, and most devastated, fragments of insular Atlantic Forest. To catalog the arboreal species along the trails of the Conservation Unit, and to provide a practical instrument to facilitate the recognition of these species, we aimed with this work to conduct a floristic and photographic survey of distinct life forms and create an identification key for arboreal dicotyledonous species based on vegetative characters. We cataloged 123 species belonging to 99 genera and 46 botanical families. The best-represented families were Rubiaceae (15 spp.), Fabaceae (10), Piperaceae (10), Myrtaceae (8), Melatomataceae (7) and Lauraceae (7). We found three species threatened with extinction, two new occurrences for the state of São Paulo, and one plant species new to science, demonstrating the floristic importance of the region. We developed three vegetative dichotomous identification keys: to species with compound leaves; simple and opposite leaves; and alternate simple leaves. The dichotomous keys presents 97 arboreal species, distributed among 37 families, and was based on vegetative characters such as phyllotaxis, composition and shape of the limbus, presence or absence of stipules, exudate, lenticels, indument, glands and dots. We also elaborated a photographic board with 118 species as a supplementary material to support the use of the identification key.
Keywords: *Insular environments, dichotomous keys, Atlantic Forest, Ilhabela State Park.*

Espécies vegetais em um trecho de Mata Atlântica insular em Ilhabela (SP): Florística, documentação fotográfica e chaves de identificação de dicotiledôneas arbóreas baseadas em características vegetativas

Resumo: O Parque Estadual de Ilhabela – PEIb (23º 46' e 28" de latitude sul e 45º 21' 20" de latitude oeste) é responsável pela conservação de um dos mais importantes e devastados fragmentos de Mata Atlântica insular. Como forma de listar as espécies arbóreas nas trilhas da Unidade de Conservação e fornecer um instrumento prático para auxiliar no reconhecimento dessas espécies, objetivamos nesse trabalho realizar um levantamento florístico e fotográfico com distintas formas de vida para elaborar uma chave de identificação das espécies de Dicotiledôneas arbóreas com base em caracteres vegetativos. Listamos 123 espécies, presentes em 99 gêneros e 46 famílias botânicas. As famílias mais bem representadas foram Rubiaceae (15 spp.), Fabaceae (10), Piperaceae

(10), Myrtaceae (8), Melatomataceae (7) e Lauraceae (7). Encontramos três espécies ameaçadas de extinção, duas novas ocorrências para o estado de São Paulo e uma nova espécie de planta para a ciência, demonstrando a importância florística do local. Elaboramos três chaves dicotômicas vegetativas de identificação sendo elas: para espécies com folhas compostas; folhas simples e opostas; e folhas simples e alternas. As chaves apresentando 97 espécies arbóreas, distribuídas em 37 famílias, baseadas em caracteres vegetativos tais como filotaxia, composição e formato do limbo, presença ou ausência de estípulas, exsudado, lenticelas, indumento, glândulas e pontuações. Nós também elaboramos pranchas fotográficas como um material suplementar de auxílio à utilização da chave de identificação.

Palavras-chave: *Ambientes insulares, chaves dicotômicas, Floresta Atlântica, Parque Estadual de Ilhabela.*

Introduction

Large-scale conservation planning is based on information about vascular plants, because they provide the structure for ecosystems (Kreft & Jetz 2007, Marques 2015). This information depends on taxonomic studies and cataloging of flora, primarily at local and regional scales, and is then extrapolated to understand global patterns of distribution (Kreft et al. 2008, Myers et al. 2000).

Within this perspective, insular environments are significant for their importance to the conservation of biological diversity around the world, as a quarter of all known vascular plant species are endemic to these ecosystems (Kier et al. 2009). As biodiversity hotspots, they are extremely vulnerable to human activities, especially concerning biological invasions and climate changes (Braje et al. 2017, Hofman & Rick 2017, Nogue et al. 2017), which leads to biodiversity loss at an accelerated rate relative to the pace of registration and documentation of species distribution and diversity (Kier et al. 2009, Kreft et al. 2008).

In Brazil, one of the centers of global priority for conservation (Brooks et al. 2006) and of vascular plant richness (IUCN 1997), this situation is grave, because vegetation is restricted to small landscape fragments, especially for the Brazilian Atlantic Forest (Ribeiro et al. 2009, Haddah et al. 2015), and many plant species still await formal description (Trias-Blasi & Vorontsova 2015). According to the federal government's database on Brazilian biodiversity, *Sistema de Informação sobre a Biodiversidade Brasileira* (http://www.sibbr.gov.br/), only an estimated 11% of the nation's total biodiversity is known, and 1.821% of this total is represented by recorded species of angiosperms. However, there are few inventories of the biodiversity and stages of conservation of biota in geographic isolation (Gibson et al. 2017), such as the vegetation of the Ilhabela State Park (PEIb).

Among the more recent studies conducted in insular environments of southeastern Brazil, Nunes-Freitas and collaborators (2009) assessed the status of knowledge on the family Bromeliaceae in Ilha Grande, RJ; Ferreira et al. (2007) did a floristic survey covering several families on Franceses Island, Espírito Santo State; Kurtz et al. (2017) described the vascular flora and vegetation on Ilha Queimada Grande, São Paulo; and Bovini et al. (2014) studied the floristic diversity of the Ilhas Cagarras natural monument in Rio de Janeiro.

The creation of identification keys is instrumental in advancing the knowledge of Brazil's wide biodiversity while it still exists, being of fundamental importance to the knowledge of insular flora. As one of the recent concerns of scientists, these keys become even more relevant when based on vegetative morphological characteristics (Braz et al. 2004, Duarte 2003, Eltink et al. 2011, Rejmanek & Brewer 2001, Urbanetz et al. 2010), because they present simplified information, making them fast and easy to use, and they do not depend mainly on one specific period of the year. Therefore, our objective was to create a dichotomous key based on vegetative characters, using the species collected in an archipelago-park that has 92% of its territory covered by native vegetation in different stages of conservation, and is the largest and most populous on the southeast coast of Brazil (Galetti et al. 2016), the Ilhabela State Park.

Material and Methods

We collected fertile botanical materials during semiannual field expeditions between 2012 and 2014, along three trails in the PEIb, in São Sebastião municipality, São Paulo (geographic coordinates 23º 46' 28" south latitude and 45º 21' 20" west latitude), ranging from 200 to 500 m in altitude. All fertile materials were photographed and incorporated into the collections Instituto Florestal (SPSF) and the Escola Superior de Agricultura Luiz de Queiroz (ESA) Herbariums (Acronyms according to Thiers 2017).

The trails where we collected the botanical materials are, specifically, the most vulnerable of the Conservation Unit due to the large volume of visitors. The names of these trails are *"Cachoeira da Laje"*, *"Três Tombos"*, "*Praia dos Castelhanos*" and *"Cachoeira da Água Branca"*.

The studied areas are included in the category of Submontane Dense Ombrophilous Forest (IBGE, 2012), with stages of conservation varying from middle to advanced, usually presenting a closed canopy structure and three strata. Although these areas share the same vegetation formation, they present a configuration of differentiated species. This condition may be influenced by several factors such as variation in distinct soil types, slope, face and altitude. There is not much illegal logging in the park, but it suffers constant fires in the areas nearest the protective boundary zone, and hunting of wildlife occurs. The regional climate, according to the Köppen classification approximated for Brazil (Alvares et al. 2013), is classified as regional humid tropical without a dry season, type *Cfb*, and with an average annual temperature of 18–22 °C.

The taxonomic identification of the specimens was performed using specialized bibliography, consultation with specialists, and comparison

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with the collections deposited in the Instituto Florestal (SPSF) and the Escola Superior de Agricultura Luiz de Queiroz (ESA) Herbariums. The classification of the botanical families was made based on the system proposed by the APG IV (2016). Correct spelling, authorship and synonyms of the species were consulted in the online database *Flora do Brasil 2020* under construction (http://floradobrasil.jbrj.gov.br/). The taxonomic key was elaborated after all the materials has been identified. We started observing each voucher species collected by us for elaborated an initial diagnosis for each specie, based on their main morphological characteristics, with terminologies following Harris & Harris (1994), Souza & Lorenzi (2008), Gonçalves & Lorenzi (2007). After the initial diagnosis, we consulted in literature which main characteristics was used by taxonomists to describe the species. Than we compare these information with the initial diagnosis elaborated with the materials collected by us to create characteristic components for elaborate the vegetative dichotomous key. We consult the volumes in the Flora Fanerogâmica de São Paulo (Wanderley et al. 2002, 2003, 2005, 2009, 2012, 2016, Melhem et al. 2007) in all the steps to develop the identification key. Our last step to create the keys was separate the species into three main groups based on their phyllotaxis and leaf type. Thus, we made three keys: Key one representing the species with compound leaves; Key two for the species with opposite or subopposite simple leaves; and Key three for species with simple alternate leaves. In addition of the identification keys we produced photographic boards with general images of species sampled highlighting some morphological detail when necessary, as a detailed graphic material to support the use of the keys.

Threatened species have been categorized according to three distinct lists: a general list with international information, realized by the International Union for Conservation of Nature (IUCN); a national list that includes all threatened species in Brazil, the Brazilian Flora (CNCFlora); and a list of threatened species of the State of São Paulo (Resolution SMA n. 57/2016), which published the second revision of the official list of endangered flora species in the State of São Paulo.

Results and Discussion

We collected and identified 123 species (trees, shrubs, arborescent herbs, and herbs) distributed among 99 genera and 46 botanical families (Table 1, Figures 1 to 30). The best-represented families were Rubiaceae (15 spp.), Fabaceae (10), Piperaceae (10), Myrtaceae (8), Melatomataceae (7) and Lauraceae (7). This study's samples included one specie new to science, belonging to the genus Eugenia (Myrtaceae) (Mazine et al. in prep.); four species threatened with extinction (*Phyllostemonodaphne geminiflora*, *Ficus pulchella*, *Trichilia casaretti* and *Nectandra barbellata* - The IUCN Red List 2017); and two new occurrences for the state of São Paulo, *Phyllostemonodaphne geminiflora* and *Simira glaziovii*.

The botanical families with the greatest richness in our work are also among the best represented in coastal vegetation in the state of São Paulo, such as Fabaceae, Myrtaceae, Rubiaceae and Lauraceae (e.g. Rochelle et al. 2011, Prata et al. 2011). In the same way, most of the listed species presented a similar pattern being distributed along the Atlantic Forest, suggesting that the distance to the continental shelf does not constitute a physical barrier to the dispersion of these species.

New records of species and new descriptions from the state of São Paulo attest to the existence of knowledge gaps and low sample effort in some locations. This bias is also demonstrated for other states (e.g. Hassemer et al. 2015, Luber et al. 2016) and corresponds basically to the scarcity of floristic knowledge along the Atlantic Forest, where only 0.01% of its total area is sampled (Lima et al. 2015). This information is important to improve our understanding of geographic distribution and to provide references to species that are listed as "deficient data" (Zorzanelli et al. 2017), which are essential for planning and elaboration of conservation policies, especially in environments vegetation.

The three dichotomous key represented 97 tree species, distributed among 37 families. Two species have been incorporated in distinct keys: *Esenbeckia grandiflora* and *Bauhinia forficata*. *E. grandiflora* is considered a specie with compound leaves, but according to the observations in the field the specie shows alternate simple leaves. *B. forficata* exhibit compound leaves 2-leafleted, but can be confused with simple lobed leaves. For this reason, both species were added into the compound leaves key and alternate simple leaves key.

We also produced 30 boards with general images of 118 sampled species photographed, present on Figure 1 to 30. The boards present photos of branches, flowers and/or fruits, in addition to details of the species fertile structures, such as inflorescence (i.e. Figure 4a, 5d, 19b) and fruits (i.e. Figure 6a, 13b, 24b, 30b).

Dichotomous keys based on fertile and vegetative morphological characters are widely disseminated, generally as the final product of cataloging local and regional flora. These tools are fundamental for research in different knowledge areas, because they require primarily the information generated by floristic studies (Eltink et al. 2011) and botanical collections. Although the keys have a broad functionality, their uses are limited by the acquisition of botanical materials in a fertile state, something common in rapid inventory works such as structural and phytosociological surveys. Therefore, the construction of dichotomous keys based only on vegetative characters represents an important tool for the knowledge of plant species where the samples do not have flowers and fruits, especially for local information, where the characters included can be clearly interpreted (Rejmánek & Brewer 2000).

The publication of keys complemented by images of the details of fresh plants, in the laboratory or in situ, is an interesting proposal (Bittrich et al. 2012) and could improve the accuracy of correct plant species determination (Hawthorne et al. 2014). Ensuring and facilitating the process of plant species identification makes nature conservation strategies more effective.

Large islands tend to have high plant species richness, because they present different formations (Callado et al. 2009). Specifically, the archipelago of Ilhabela can be considered one of the leading insular samples of the Atlantic Forest, not only for its size and conservation, but also for its variation of altitudinal gradients and different formations. Therefore, efforts to catalog PEIb flora are necessary because we have little knowledge of this important vegetation until now.

Table 1. List of species found, with their respective collection numbers in the herbariums of the Instituto Florestal (SPSF) and the Escola Superior de Agricultura Luiz de Queiroz (ESA); and information on the threatened species, obtained from the lists of the International Union for Conservation of Nature (IUCN), "*Livro Vermelho da Flora do Brasil*" – CNCFlora (Matinelli & Moraes 2013) and the Secretariat of Environment of the State of São Paulo (SMA 057/2016), respectively. Conservation status levels: EN (In Danger); LC (Least Concern); VU (Vulnerable); DD (insuficiente data).

Family/Scientific name	ESA	SPSF	IUCN	CNCFlora	SMA
Acanthaceae					
Aphelandra longiflora (Lindl.) Profice.	128869	47329			
Avicennia schaueriana Stapf & Leechm. ex Moldenke.	128890				
Anacardiaceae					
Schinus terebinthifolius Raddi.		52235			
Annonaceae					
Annona dolabripetala Raddi.	128846	47332			
Guatteria australis A.St.-Hil.		47321			
Apocynaceae					
Aspidosperma olivaceum Müll.Arg.	128865	47370			
Aquifoliaceae					
Ilex taubertiana Loes.		52246			
Araceae					
Anthurium sellowianum Kunth.	128862	47317			
Monstera adansonii Schott.	128877	47368			
Araliaceae					
Dendropanax monogynus (Vell.) Seem.	128828	47377			
Arecaceae					
Geonoma elegans Mart.		47365			
Asteraceae					
Eremanthus erythropappus (DC.) MacLeish.		47343			
Stifftia parviflora (Leandro.) D.Don.		47471		DD	
Vernonanthura lindbergii (Baker.) H.Rob.	128876			DD	
Begoniaceae					
Begonia convolvulacea (Klotzsch.) A.DC.		47337			
Boraginaceae					
Cordia taguahyensis Vell.		51836			
Varronia curassavica Jacq.	128901				
Cannabaceae					
Trema micrantha (L.) Blume.	128909	47473			
Celastraceae					
Cheiloclinium cognatum (Miers.) A.C.Sm.	128895				
Monteverdia ardisiifolia (Reissek.) Biral.	128829	47379			
Salacia grandifolia (Mart. ex Schult.) G.Don.		51841			
Chrysobalanaceae					
Hirtella racemosa Lam.		51847			
Clethraceae					
Clethra scabra Pers.		51855			
Clusiaceae					
Clusia criuva Cambess.		52237		LC	

Continuation Table 1.

Family/Scientific name	ESA	SPSF	IUCN	CNCFlora	SMA
Commelinaceae					
Dichorisandra hexandra (Aubl.) C.B.Clarke.		47347			
Cyperaceae					
Scleria latifolia Sw.		47316			
Elaeocarpaceae					
Sloanea hirsuta (Schott.) Planch. ex Benth.	128859	47462			
Euphorbiaceae					
Algernonia brasiliensis Baill.		51849			
Croton floribundus Spreng.		51853			
Fabaceae					
Bauhinia forficata Link.		51852			
Dalbergia frutescens (Vell.) Britton.	128904	47369			
Erythrina crista-galli L.	128898	47457			
Inga marginata Willd.	128870	47362	LC		
Inga striata Benth.	128866	47364	LC		
Machaerium nyctitans (Vell.) Benth.	128875	47353			
Piptadenia gonoacantha (Mart.) J.F.Macbr.	128913				
Senna multijuga (Rich.) H.S.Irwin & Barneby.		52234			
Swartzia langsdorffii Raddi.		51845			
Zollernia ilicifolia (Brongn.) Vogel.		51851			
Lamiaceae					
Aegiphila integrifolia (Jacq.) Moldenke.	128903	47452			
Lauraceae					
Aniba viridis Mez.		47354			
Endlicheria paniculata (Spreng.) J.F.Macbr.		47355			
Licaria armeniaca (Nees.) Kosterm.	128881	47356			
Nectandra barbellata Coe-Teix.		52245	VU	VU	VU
Nectandra membranacea (Sw.) Griseb.	128914	47469			
Ocotea dispersa (Nees & Mart.) Mez.		51844			
Phyllostemonodaphne geminiflora (Mez.) Kosterm.		50435	EN		
Loganiaceae					
Spigelia beyrichiana Cham. & Schltdl.		47323			
Strychnos brasiliensis Mart.		52243			
Malvaceae					
Eriotheca pentaphylla (Vell. & K.Schum.) A.Robyns.		52241			
Quararibea turbinata (Sw.) Poir.	128841	47376			
Luehea divaricata Mart. & Zucc.	128873	47319			
Melastomataceae					
Leandra ionopogon (Mart.) Cogn.	128855	47345			
Miconia cinnamomifolia (DC.) Naudin.	128883	47315			
Miconia dodecandra Cogn.	128888	47330			
Miconia fasciculata Gardner.	128833	47346			

Continuation Table 1.

Family/Scientific name	ESA	SPSF	IUCN	CNCFlora	SMA
Miconia tristis Spring.	128826	47344			
Tibouchina clavata (Pers.) Wurdack.	128905	47477			
Tibouchina pulchra Cogn.		51842			
Meliaceae					
Cabralea canjerana (Vell.) Mart.		52236			
Trichilia casaretti C.DC.	128916	47467	VU		
Moraceae					
Ficus insipida Willd.	128868	47313			
Ficus pulchella Schott.			VU		
Sorocea racemosa Gaudich.		47464			
Myrtaceae					
Eugenia sp. (Mazine et al. in prep.)	128843				
Eugenia fusca O.Berg.		51837			
Calyptranthes lanceolata O.Berg.		47350			
Campomanesia guaviroba (DC.) Kiaersk.		47349			
Marlierea excoriata Mart.	128852				
Myrcia hebepetala DC.		52244			
Myrcia spectabilis DC.		47351			
Myrcia splendens (Sw.) DC.		47455			
Nyctaginaceae					
Guapira opposita (Vell.) Reitz.		47348			
Ochnaceae					
Ouratea parviflora (A.DC.) Baill.		47314			
Olacaceae					
Heisteria silvianii Schwacke.		52240			
Phytolaccaceae					
Gallesia integrifolia (Spreng.) Harms.		52242			
Seguieria langsdorffii Moq.		52238			
Piperaceae					
Peperomia pseudoestrellensis C.DC.	128858	47336			
Peperomia urocarpa Fisch. & C.A.Mey.		47338			
Piper arboreum Aubl.	128845	47334			
Piper amplum Kunth.	128879				
Piper hispidum Sw.	128836	47359			
Piper lepturum Kunth.	128880	47310			
Piper morisonianum C.DC.		47360			
Piper rivinoides Kunth.	128915	47468			
Piper solmsianum C.DC.		47361			
Piper umbellatum L.		47358			
Primulaceae					
Myrsine coriacea (Sw.) R.Br. ex Roem. & Schult.	128871	47339			
Myrsine guianensis (Aubl.) Kuntze.	128874	47357			
Myrsine venosa A.DC.		47322			
Stylogyne pauciflora Mez.		51850			

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Continuation Table 1.

Family/Scientific name	ESA	SPSF	IUCN	CNCFlora	SMA
Rosaceae					
Prunus brasiliensis (Cham. & Schltdl.) D.Dietr.		51857			
Rubiaceae					
Alseis floribunda Schott.		51839			
Chomelia pedunculosa Benth.		51840			
Cordiera myrciifolia (K.Schum.) C.H.Perss. & Delprete.		51858			
Coussarea meridionalis (Vell.) Müll.Arg.	128840	47372			
Coussarea nodosa (Benth.) Müll.Arg.	128848	47374			
Coutarea hexandra (Jacq.) K.Schum.	128902	47453			
Faramea truncata (Vell.) Müll.Arg.	128886	47328			
Manettia gracilis Cham. & Schltdl.	128839	47335			
Psychotria carthagenensis Jacq.	128835	51854			
Psychotria leiocarpa Cham. & Schltdl.	128847	47327			
Psychotria patentinervia Müll.Arg.	128834	47325			
Psychotria suterella Müll.Arg.		51848			
Rudgea jasminoides (Cham.) Müll.Arg.		47371		VU	
Rustia formosa (Cham. & Schltdl.) Klotzsch.		47456			
Simira glaziovii (K.Schum.) Steyerm.	128878	47373			
Rutaceae					
Esenbeckia grandiflora Mart.		52239			
Neoraputia magnifica (Engl.) Emmerich ex Kallunki.		47320			
Zanthoxylum caribaeum Lam.	128912	47470			
Salicaceae					
Casearia sylvestris Sw.	128863	47312			
Sapindaceae					
Allophylus petiolulatus Radlk.		50434			
Cupania oblongifolia Mart.	128882	47363			
Sapotaceae					
Pouteria venosa (Mart.) Baehni.	128883				
Simaroubaceae					
Picramnia ciliata Mart.	128864	47340			
Siparunaceae					
Siparuna brasiliensis (Spreng.) A.DC.	128830	47333			
Solanaceae					
Cestrum intermedium Sendtn.	128867	47342			
Cestrum schlechtendalii G.Don.		51856			
Solanum swartzianum Roem. & Schult.	128850	47366			
Urticaceae					
Cecropia pachystachya Trécul.	128910	47472			
Coussapoa microcarpa (Schott.) Rizzini.		51846			
Urera nitida (Vell.) P.Brack.	128887	47367			
Violaceae					
Noisettia orchidiflora (Rudge.) Ging.		47318			

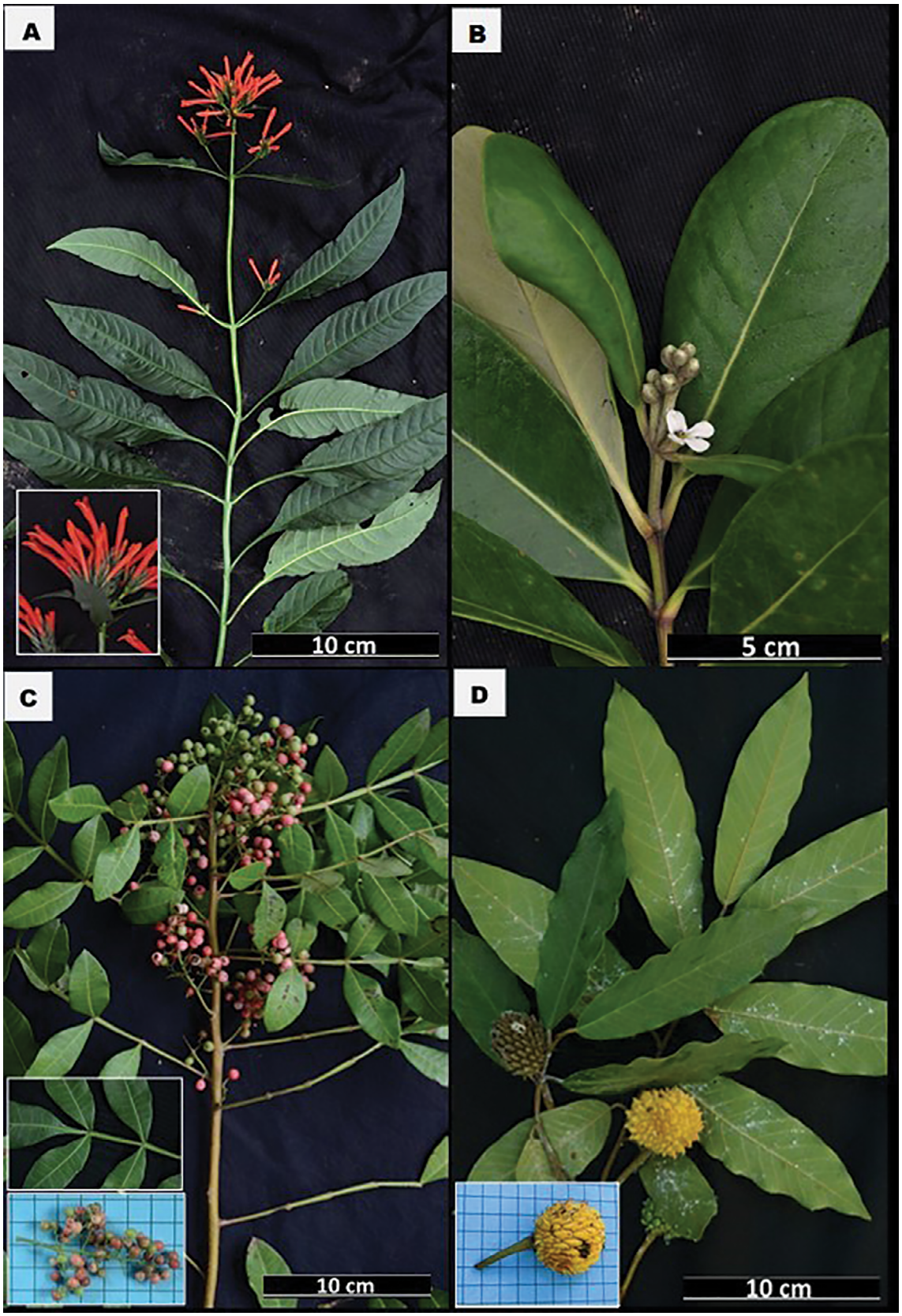

Figure 1. Acanthaceae: (A) *Aphelandra longiflora*, inflorescence in detail; (B) *Avicennia schaueriana*. Anacardiaceae: (C) *Schinus terebinthifolius*, details of the fruit and the winged compound leaf are highlighted. Annonaceae: (D) *Annona dolabripetala*, details of the fruit are highlighted.

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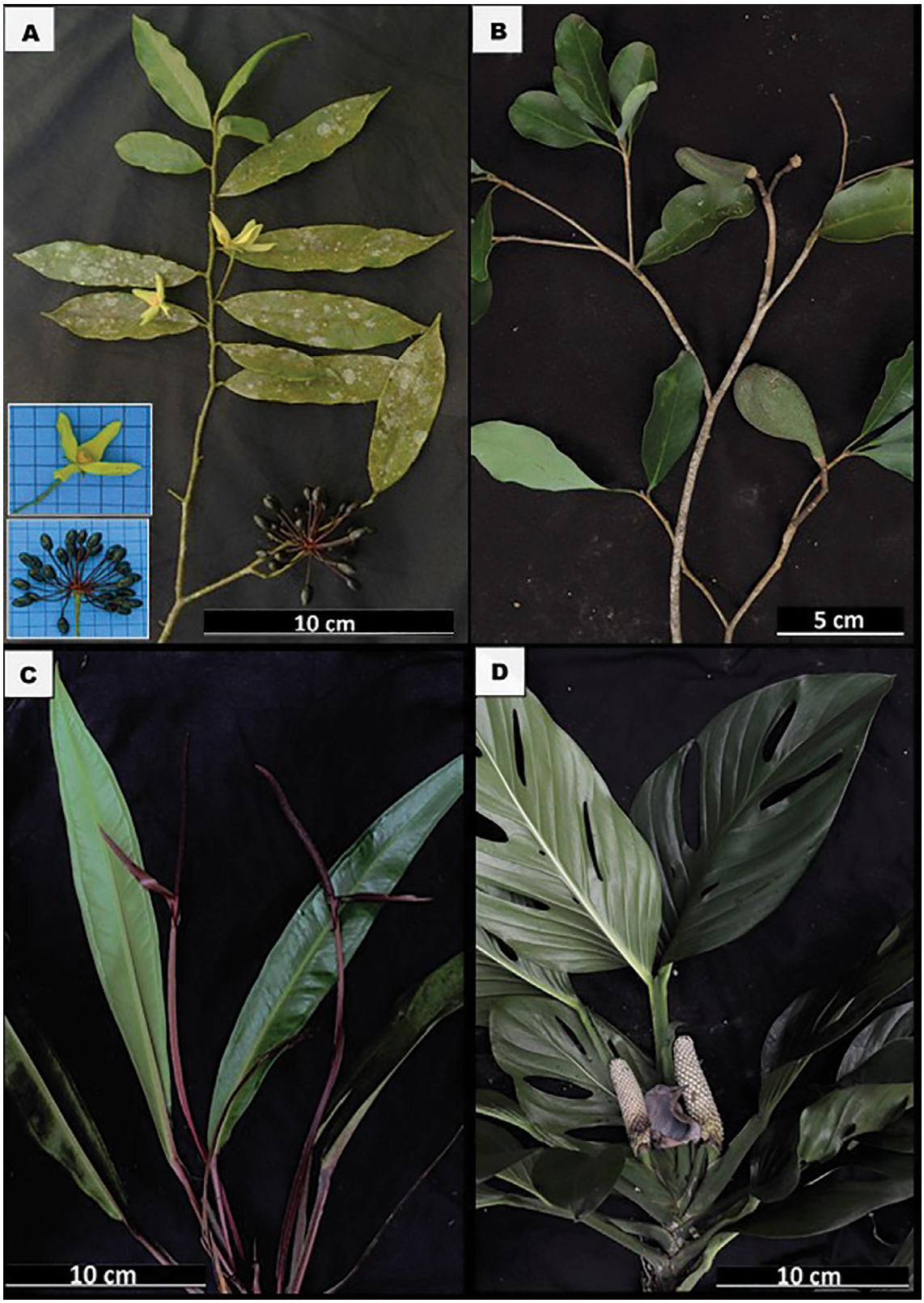

Figure 2. Annonaceae: (A) *Guatteria australis*, details of the inflorescence and fruits are highlighted. Apocynaceae: (B) *Aspidosperma olivaceum*. Araceae: (C) *Anthurium sellowianum*; (D) *Monstera adansonii*.

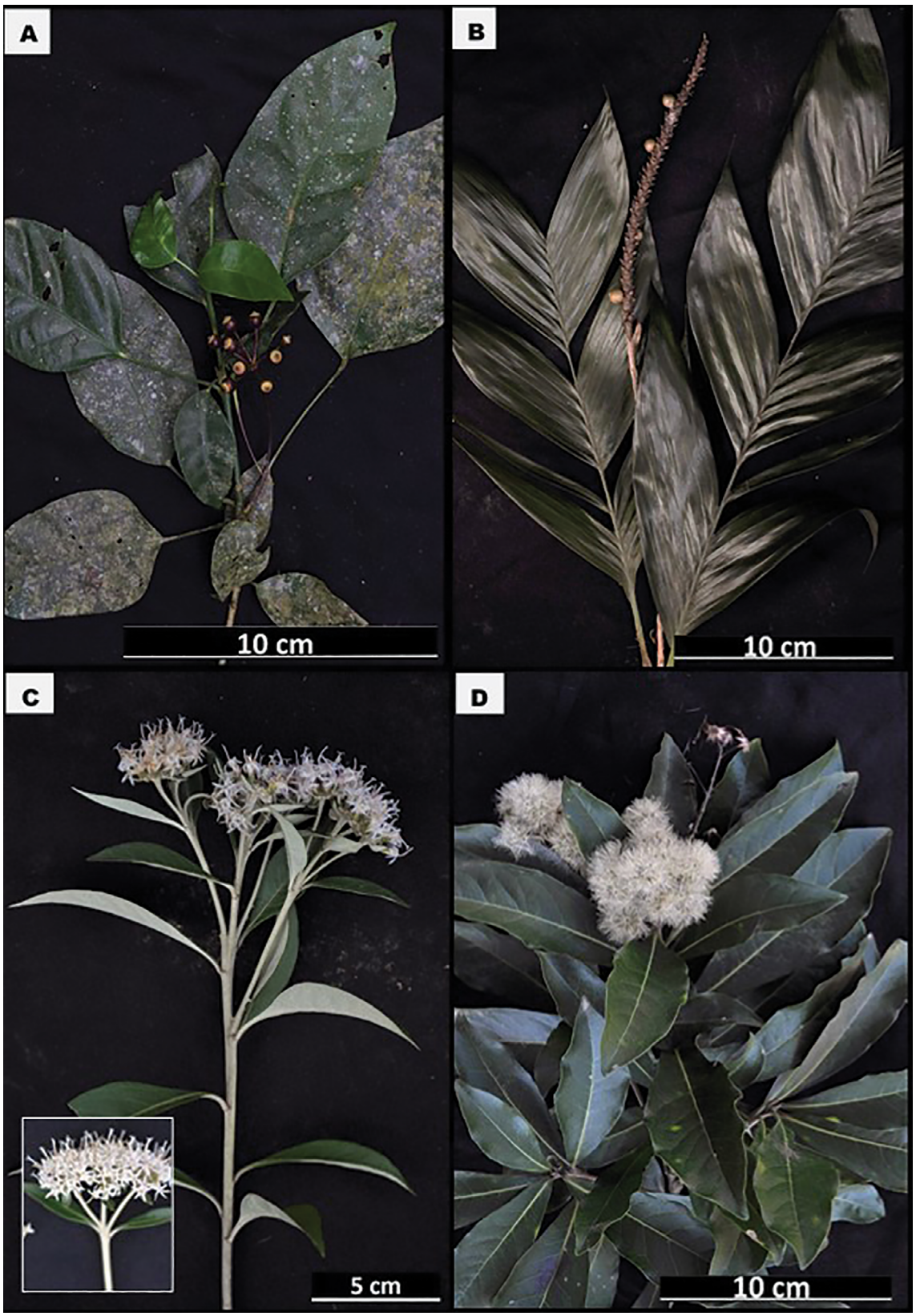

Figure 3. Araliaceae: (A) *Dendropanax monogynus*, details of the fruits are highlighted. Arecaceae: (B) *Geonoma elegans*. Asteraceae: (C) *Eremanthus erythropappus*, details of the inflorescence are hightlighted; (D) *Stifftia parviflora*.

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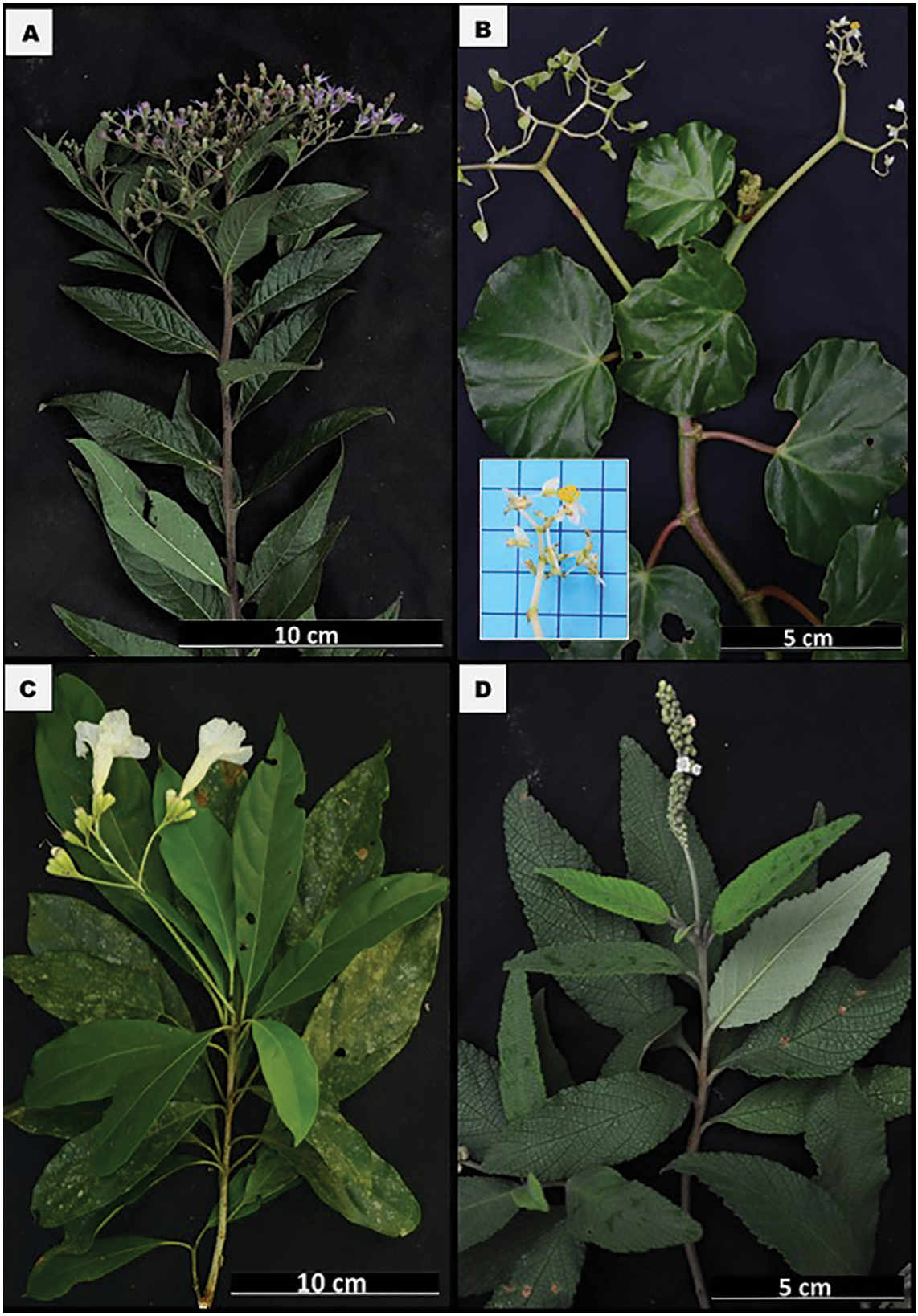

Figure 4. Asteraceae: (A) *Vernonanthura lindbergii*. Begoniaceae: (B) *Begonia convolvulacea*, details of inflorescence are highlighted. Boraginaceae: (C) *Cordia taguahyensis*; (D) *Varronia curassavica*.

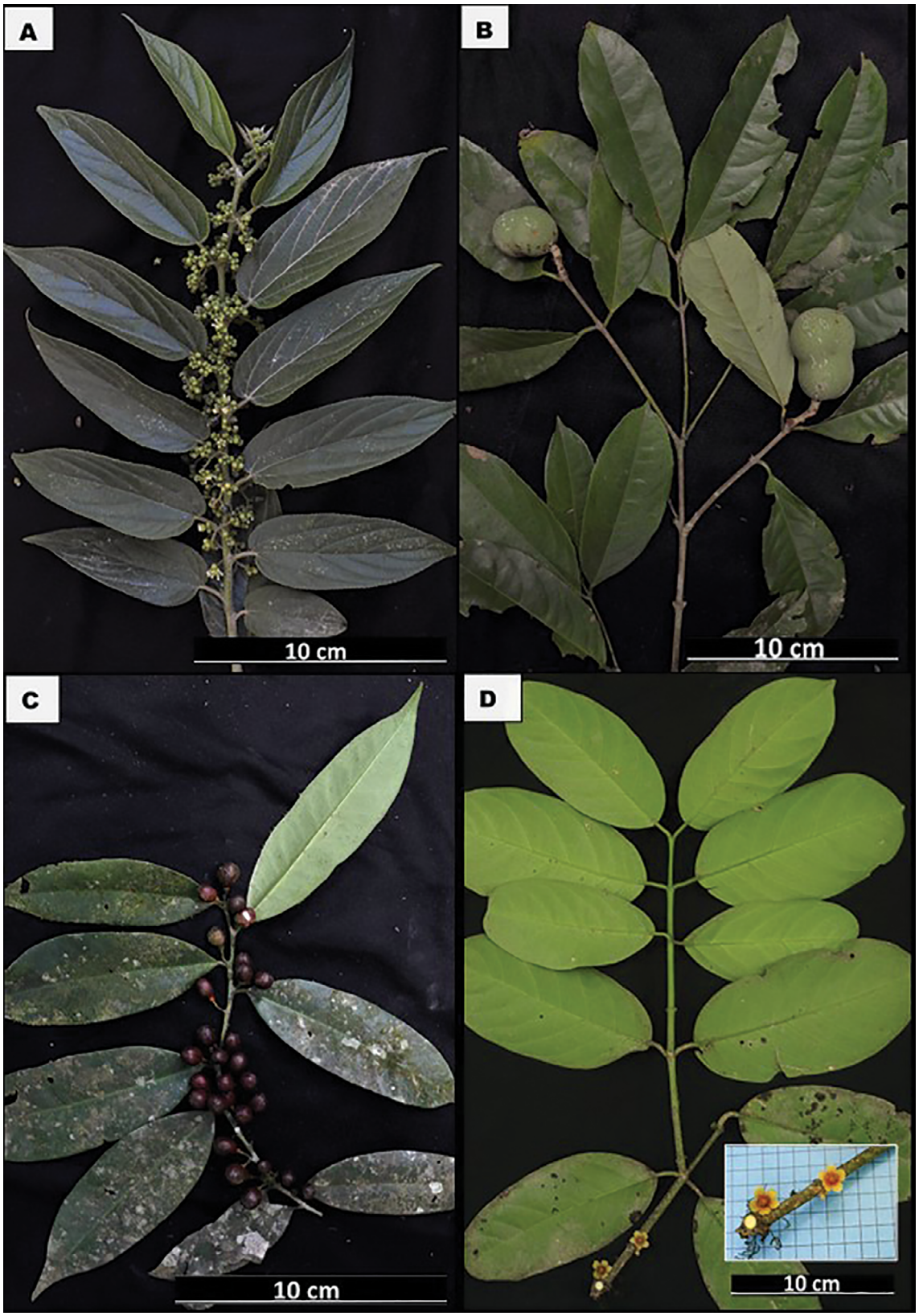

Figure 5. Cannabaceae: (A) *Trema micrantha*. Celastraceae: (B) *Cheiloclinium cognatum*; (C) *Monteverdia ardisiifolia*; (D) *Salacia grandiflora*, details of the inflorescence are highlighted.

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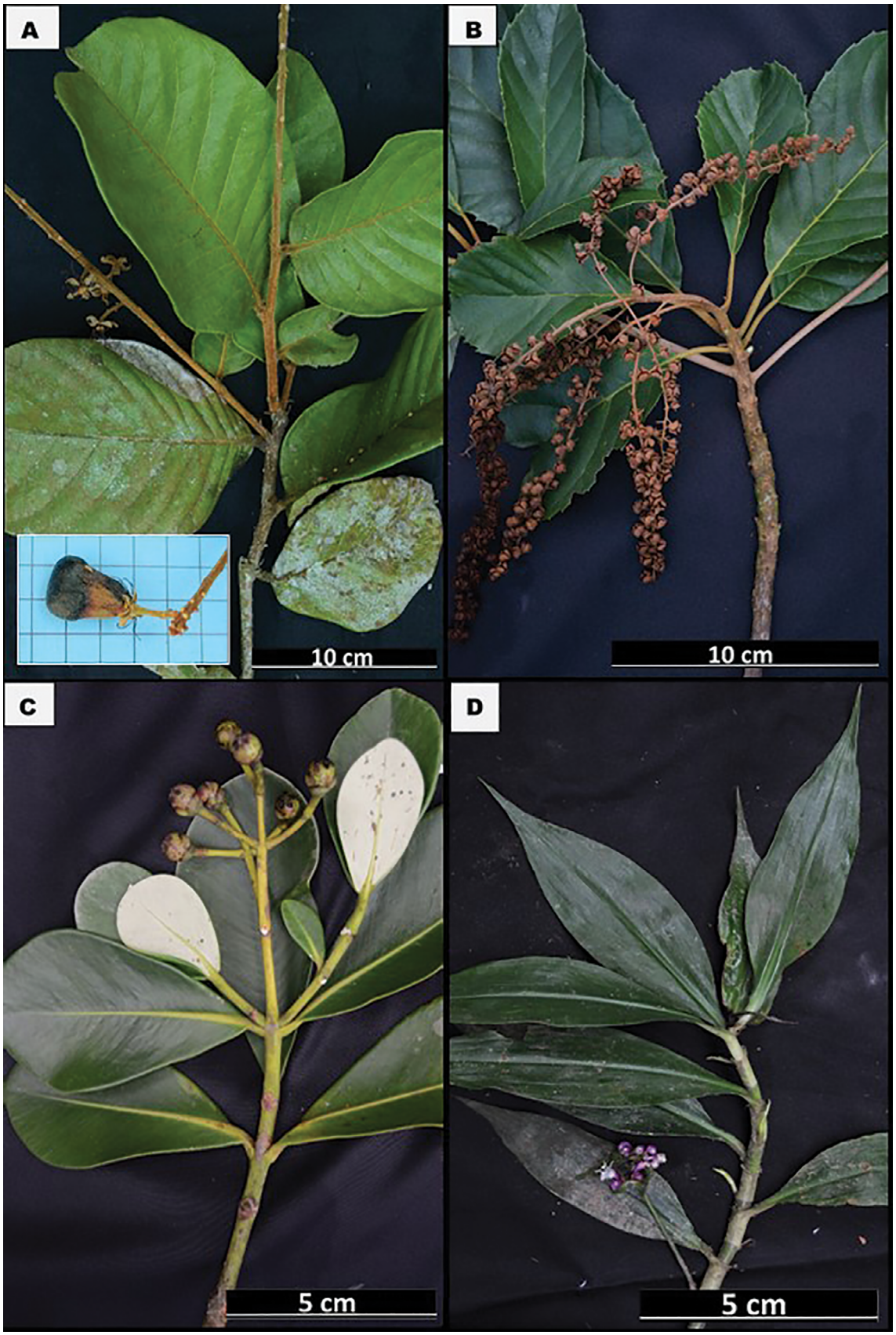

Figure 6. Chrysobalanaceae: (A) *Hirtella racemosa*, details of the fruit are highlighted. Clethraceae: (B) *Clethra scabra*. Clusiaceae: (C) *Clusia criuva*. Commelinaceae: (D) *Dichorisandra hexandra*.

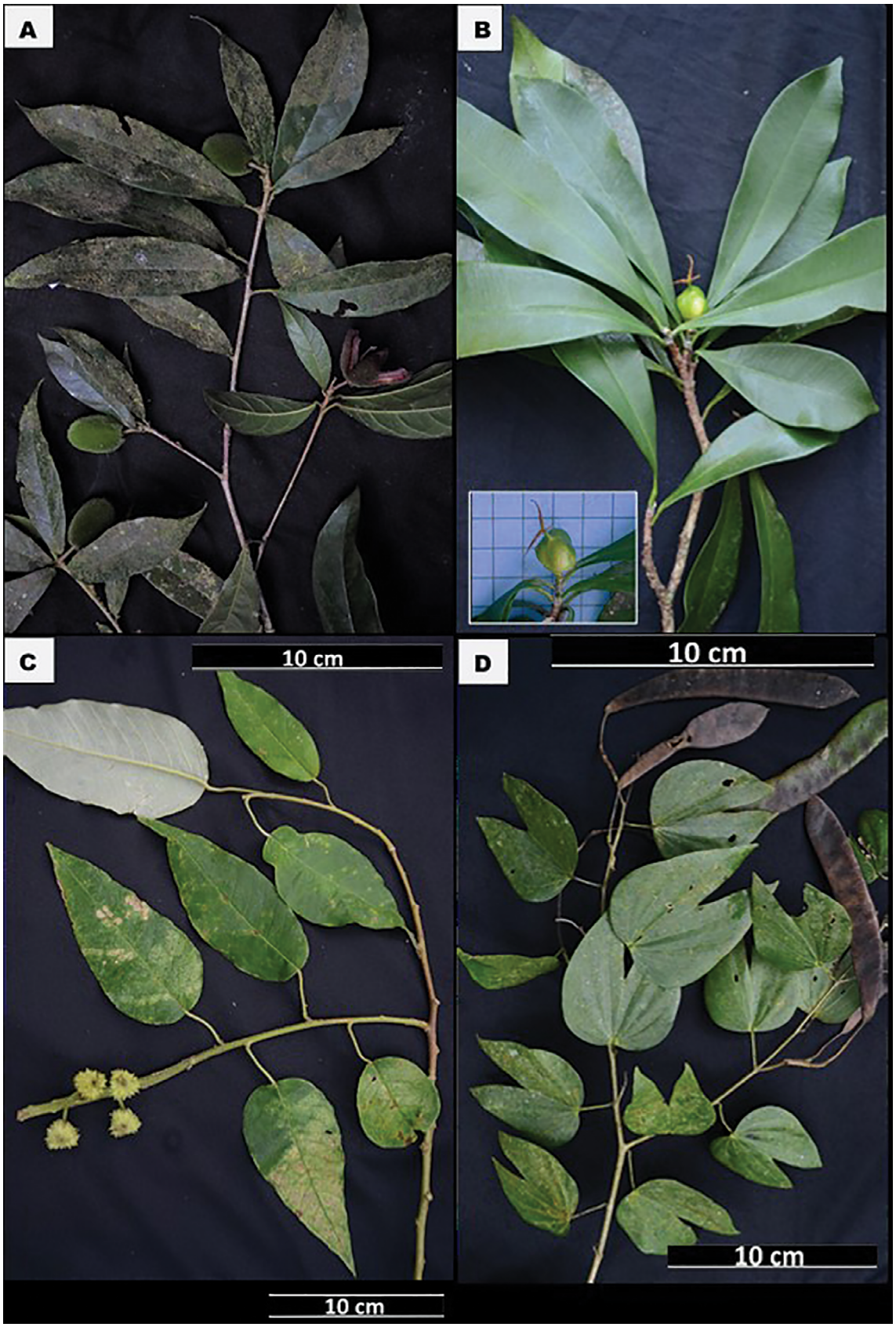

Figure 7. Elaeocarpaceae: (A) *Sloanea hirsuta*. Euphorbiaceae: (B) *Algernonia brasiliensis*, details of the fruit are highlighted. Euphorbiaceae: (C) *Croton floribundus*. Fabaceae: (D) *Bauhinia forficata*.

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Figure 8. Fabaceae: (A) *Dalbergia frutescens*; (B) *Erythrina crista-galli*; (C) *Inga marginata*; (D) *Inga striata*.

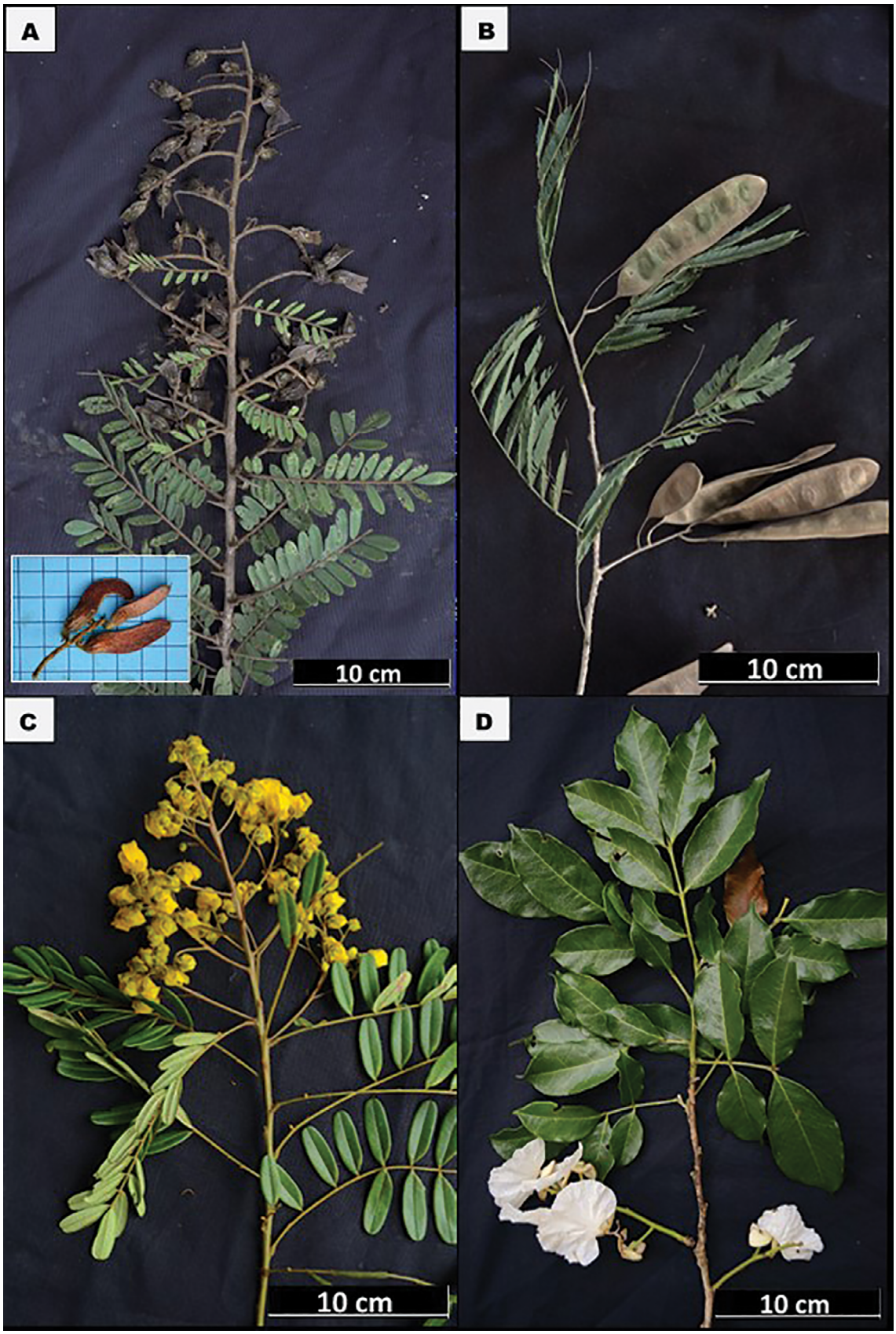

Figure 9. Fabaceae: (A) *Machaerium nyctitans*, details of the fruits are highlighted; (B) *Piptadenia gonoacantha*; (C) *Senna multijuga*; (D) *Swartzia langsdorffii*.

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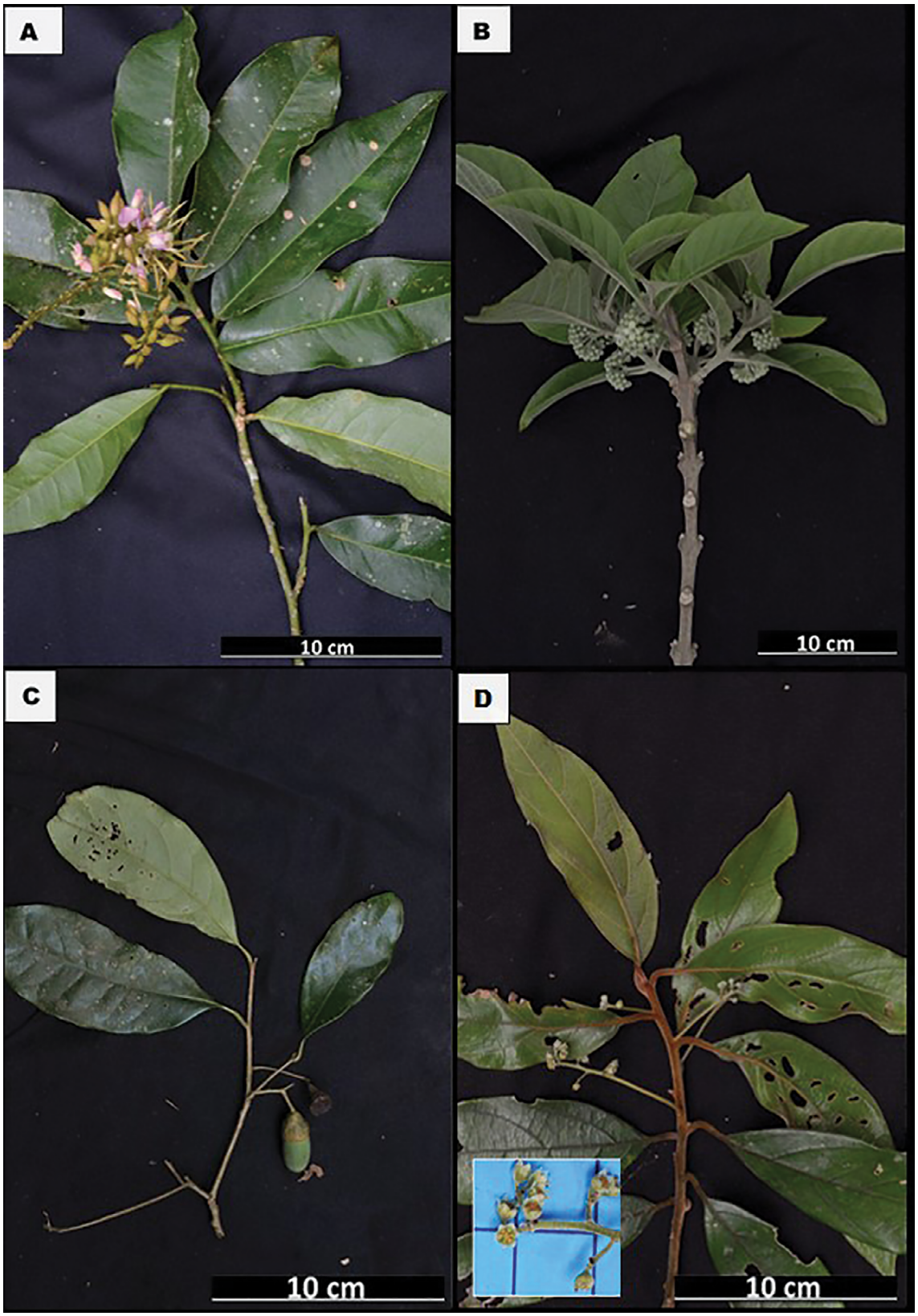

Figure 10. Fabaceae: (A) *Zollernia ilicifolia*. Lamiaceae: (B) *Aegiphila integrifolia*. Lauraceae: (C) *Aniba viridis*; (D) *Endlicheria paniculata*, details of the inflorescence are hightlighted.

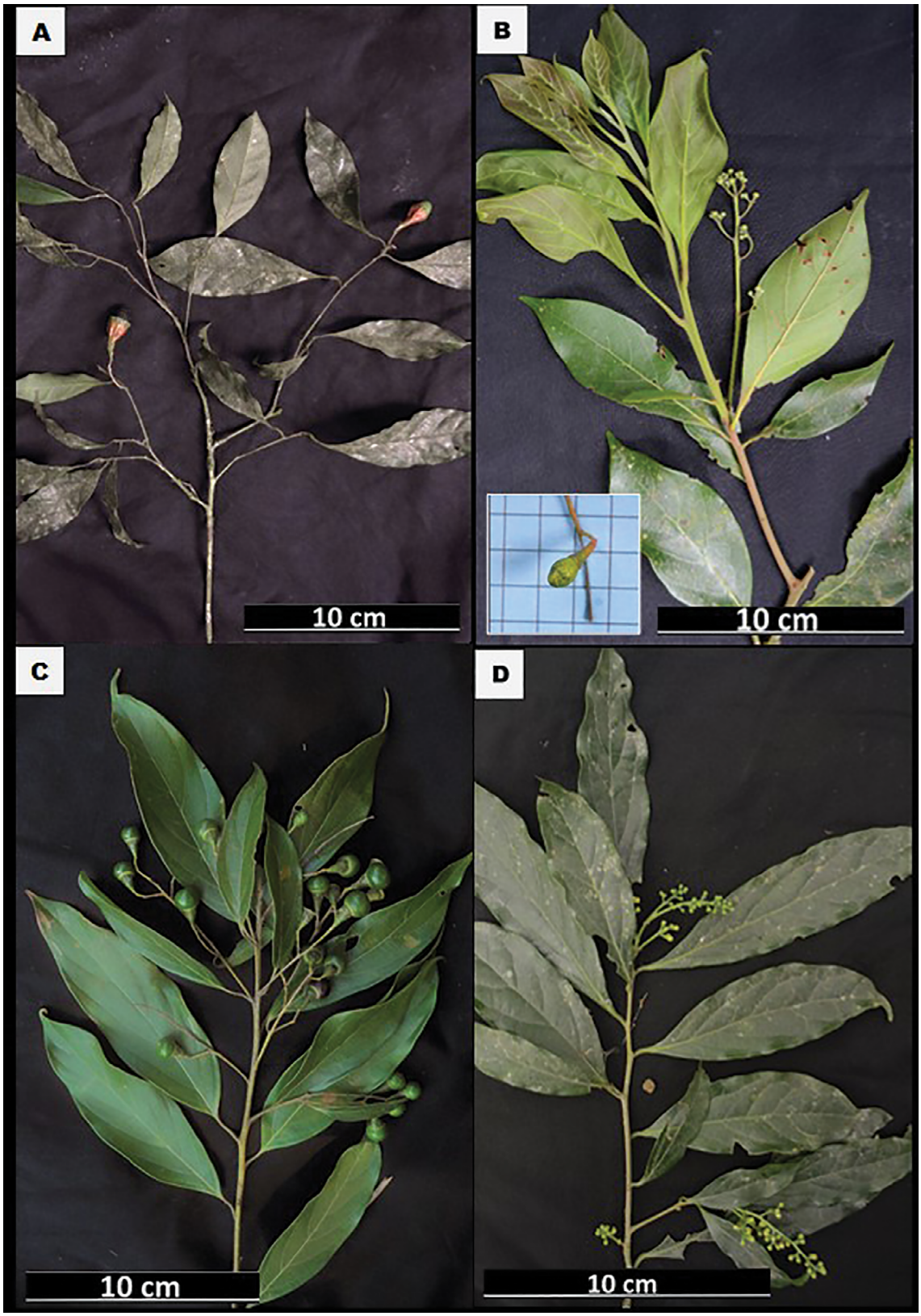

Figure 11. Lauraceae: (A) *Licaria armeniaca*; (B) *Nectandra barbellata*, details of the fruit are hightlighted; (C) *Nectandra membranacea*; (D) *Ocotea dispersa*.

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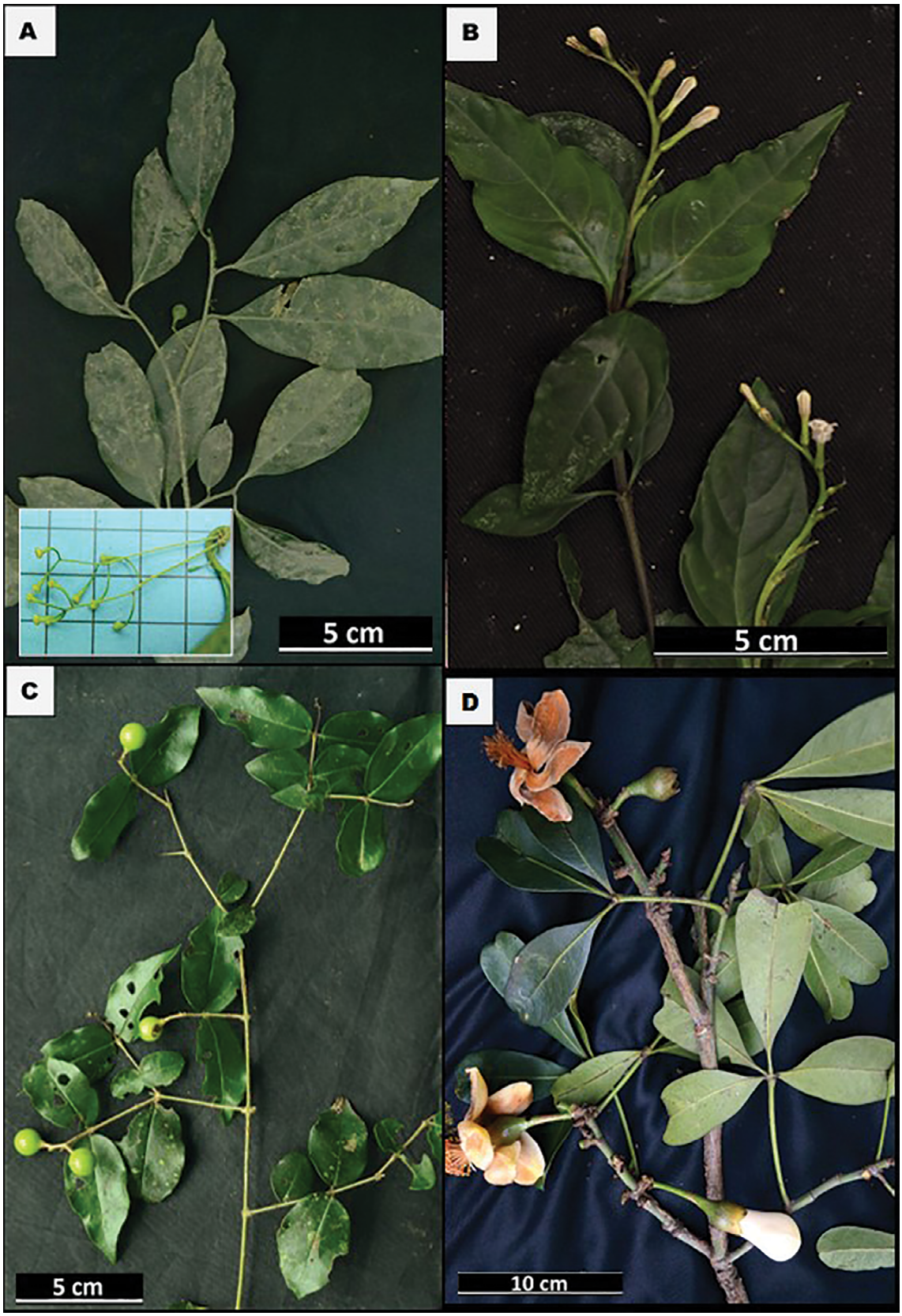

Figure 12. Lauraceae: (A) *Phyllostemonodaphne geminiflora*, details of the inflorescence are hightlighted. Loganiaceae: (B) *Spigelia beyrichiana*; (C) *Strychnos brasiliensis*. Malvaceae: (D) *Eriotheca pentaphylla*.

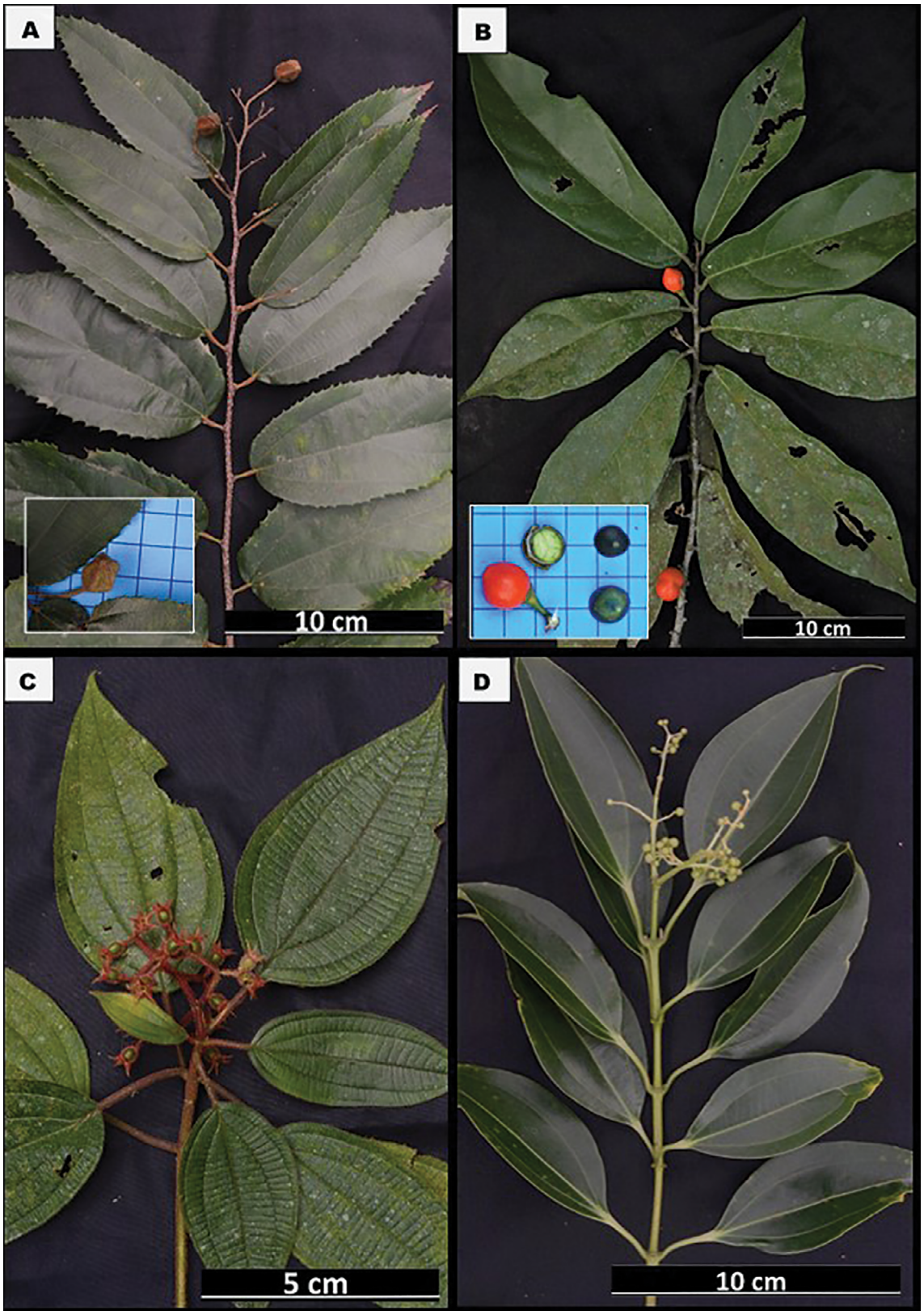

Figure 13. Malvaceae: (A) *Luehea divaricata*, details of the fruits are highlighted; (B) *Quararibea turbinata*, details of the fruits are highlighted. Melastomataceae: (C) *Leandra ionopogon*; (D) *Miconia cinnamomifolia*.

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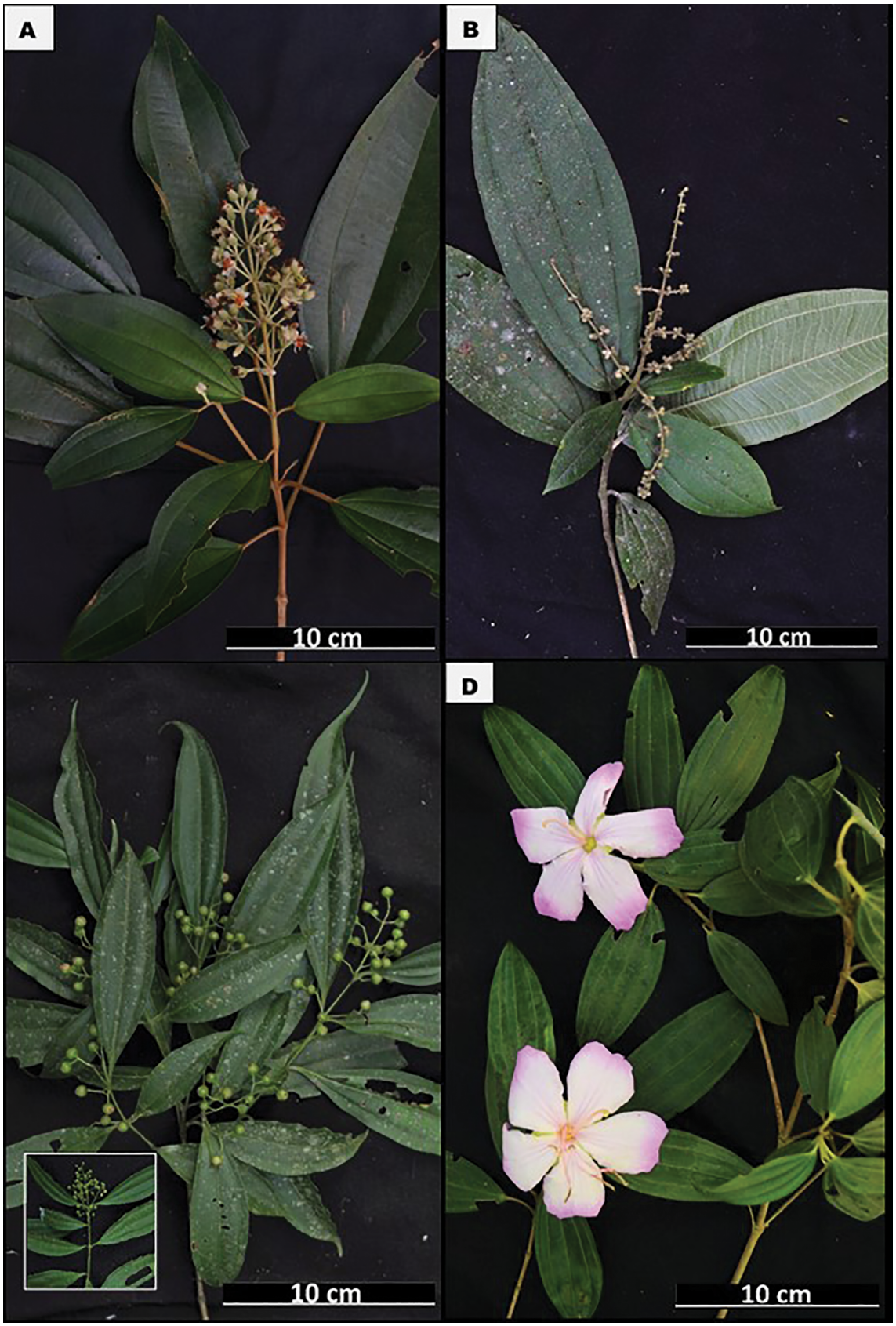

Figure 14. Melastomataceae: A) *Miconia dodecandra*; (B) *Miconia fasciculata*; (C) *Miconia tristis*, details of the fruits are highlighted; (D) *Tibouchina pulchra*.

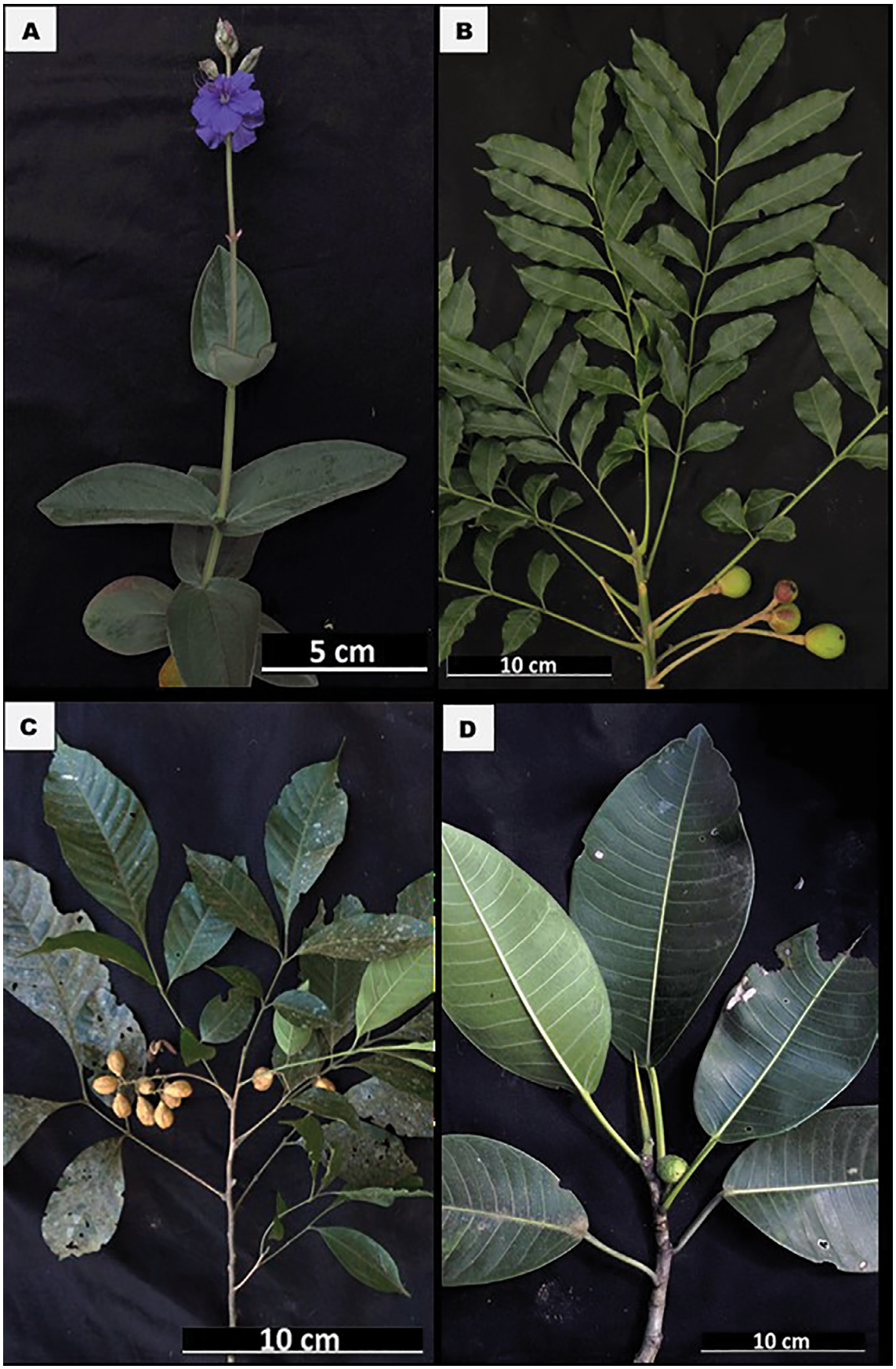

Figure 15. Melastomataceae: (A) *Tibouchina clavata*. Meliaceae: (B) *Cabralea canjerana*;(C) *Trichilia casaretti*. Moraceae: (D) *Ficus insipida*.

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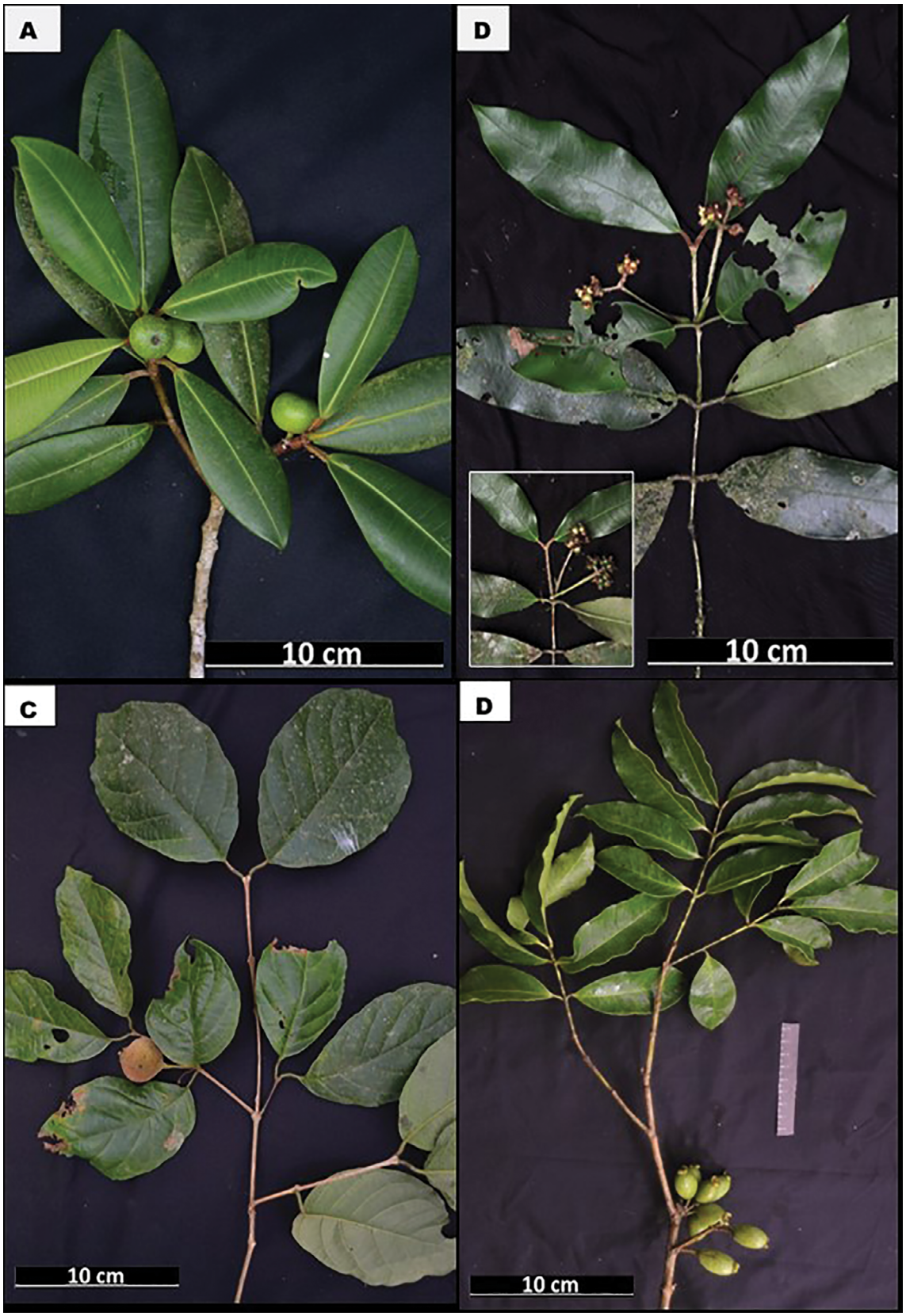

Figure 16. Moraceae: (A) *Ficus pulchella*. Myrtaceae: (B) *Calyptranthes lanceolata*, details of the fruits are highlighted; (C) *Campomanesia guaviroba*; (D) *Eugenia fusca*.

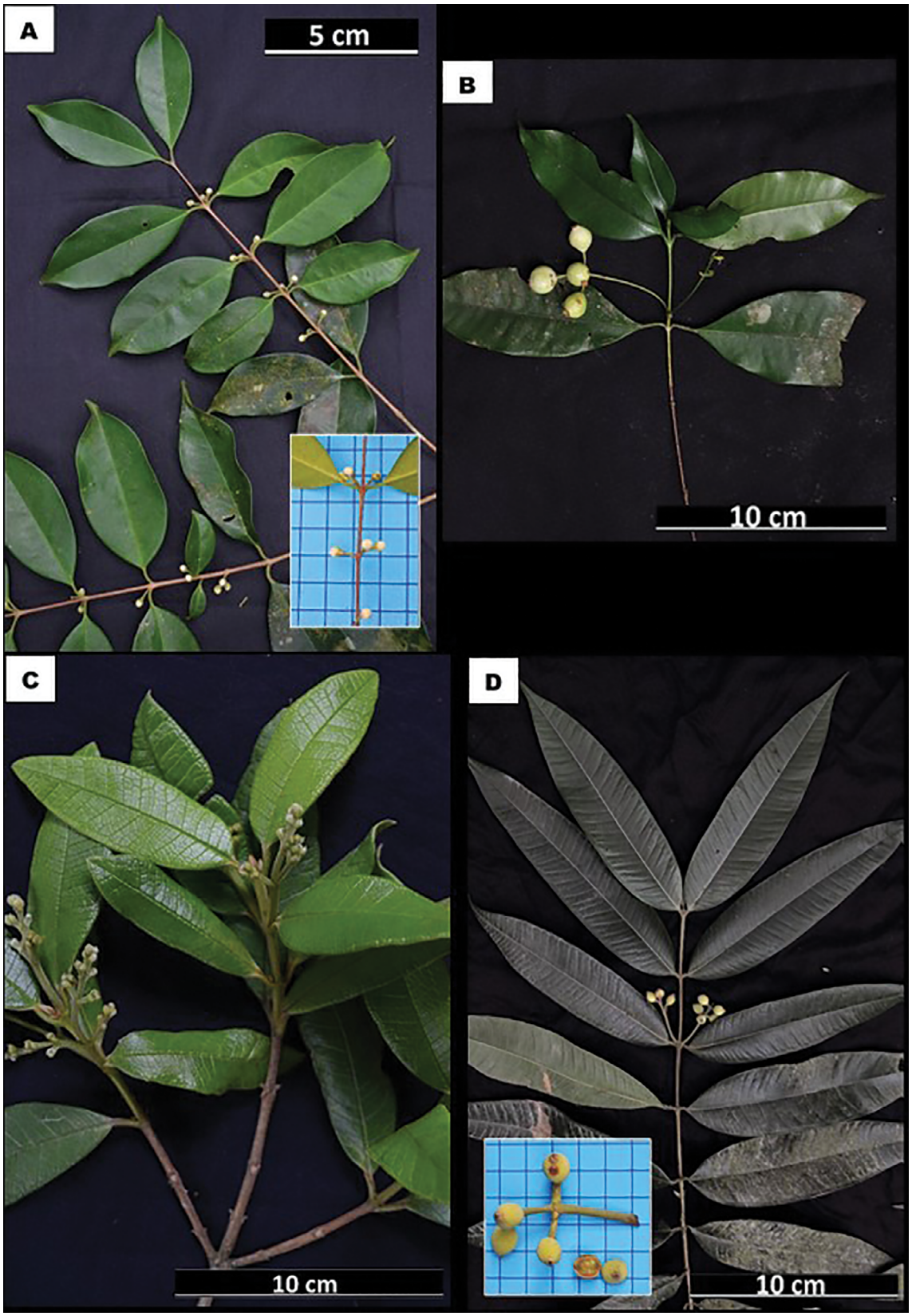

Figure 17. Myrtaceae: (A) *Eugenia sp*. (Mazine et al. in prep.), details of the fruits are highlighted; (B) *Marlierea excoriota*; (C) *Myrcia hebepetala*, details of the fruits are highlighted; (D) *Myrcia spectabilis*.

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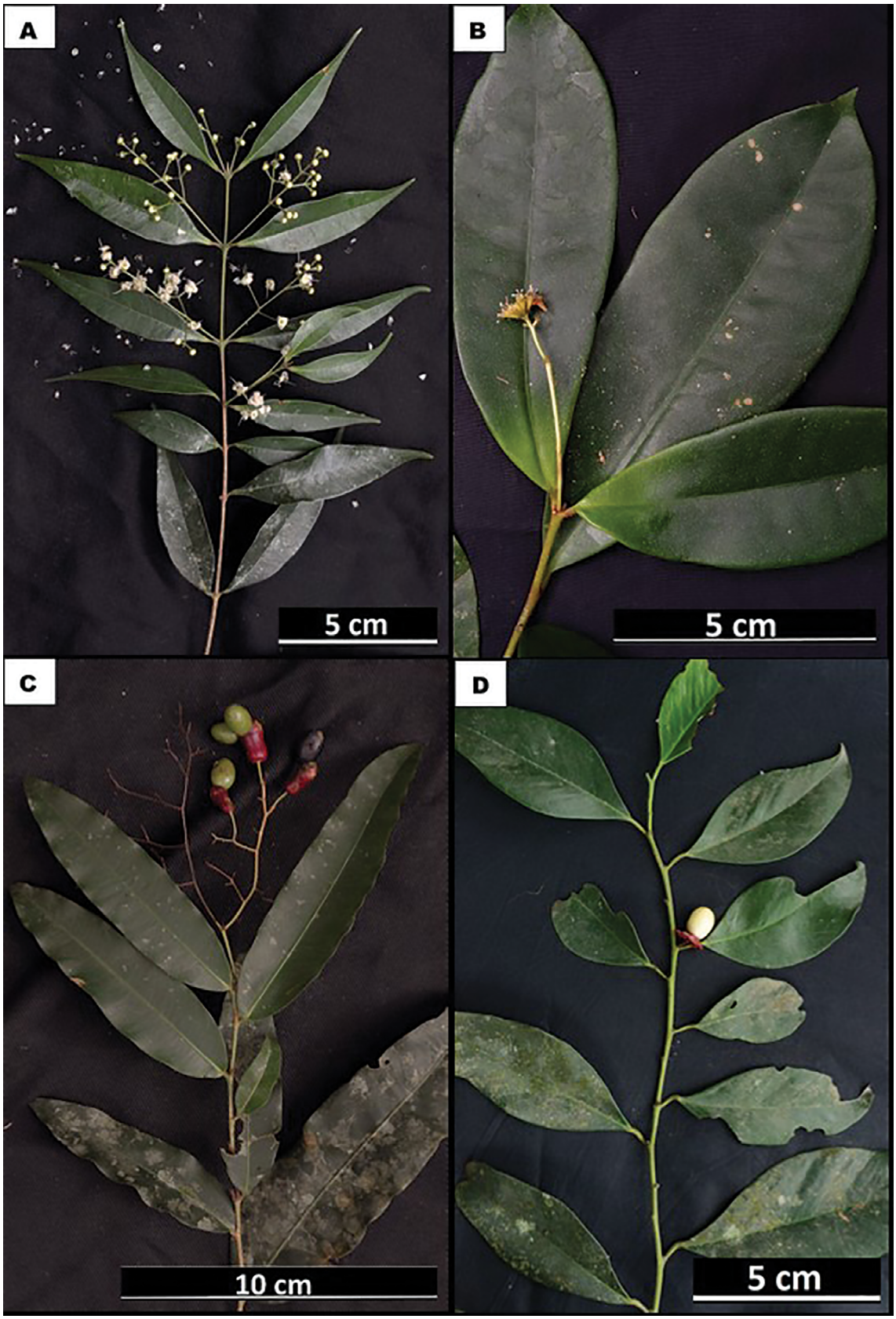

Figure 18. Myrtaceae: (A) *Myrcia splendens*. Nyctaginaceae: (B) *Guapira opposita*. Ochnaceae: (C) *Ouratea parviflora*; Olacaceae: (D) *Heisteria silvianii*.

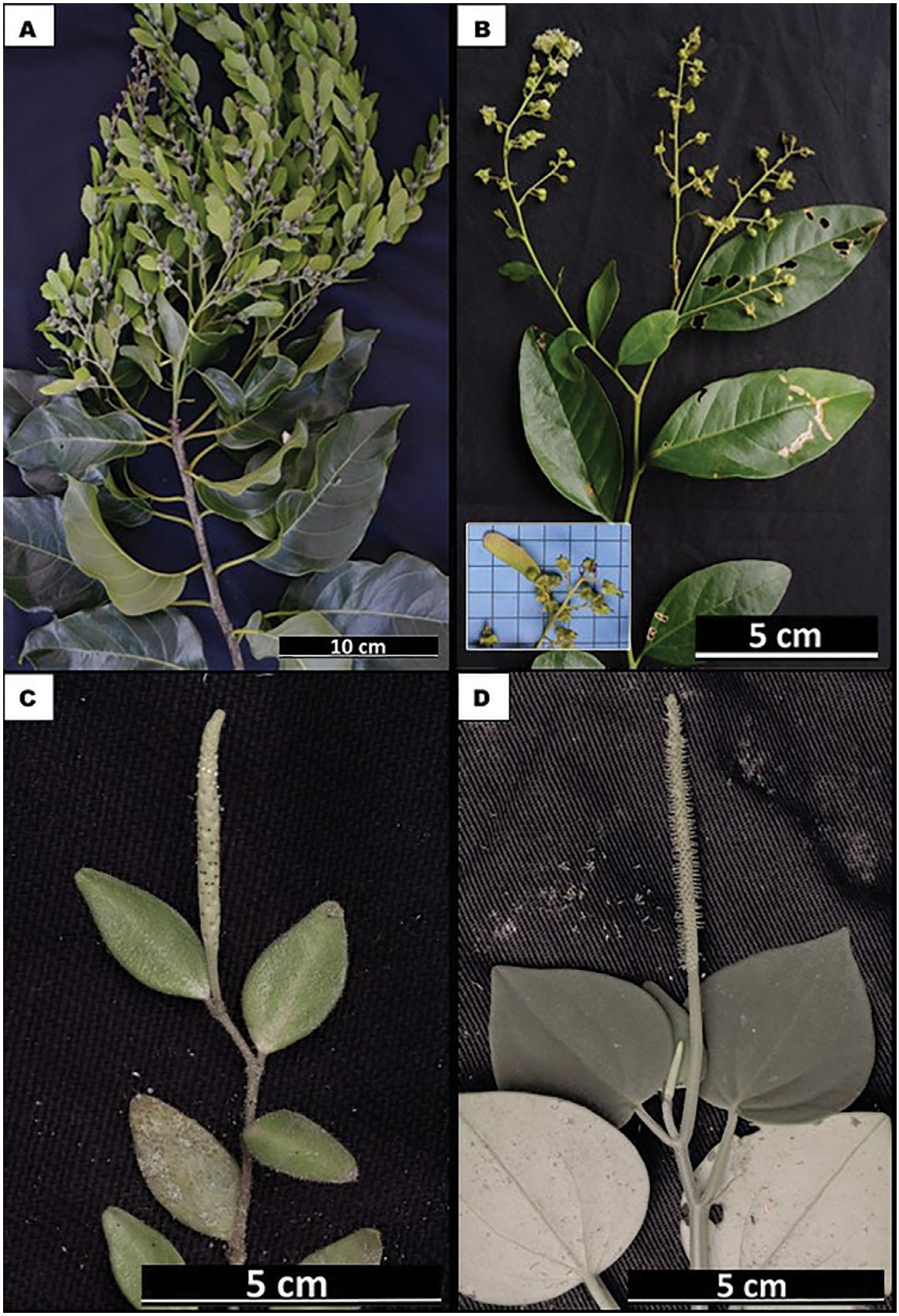

Figure 19. Phytolaccaceae: (A) *Gallesia integrifolia*; (B) *Seguieria langsdorffii*, details of the inflorescence and fruits are highlighted. Piperaceae: (C) *Peperomia pseudoestrellensis*; (D) *Peperomia urocarpa*.

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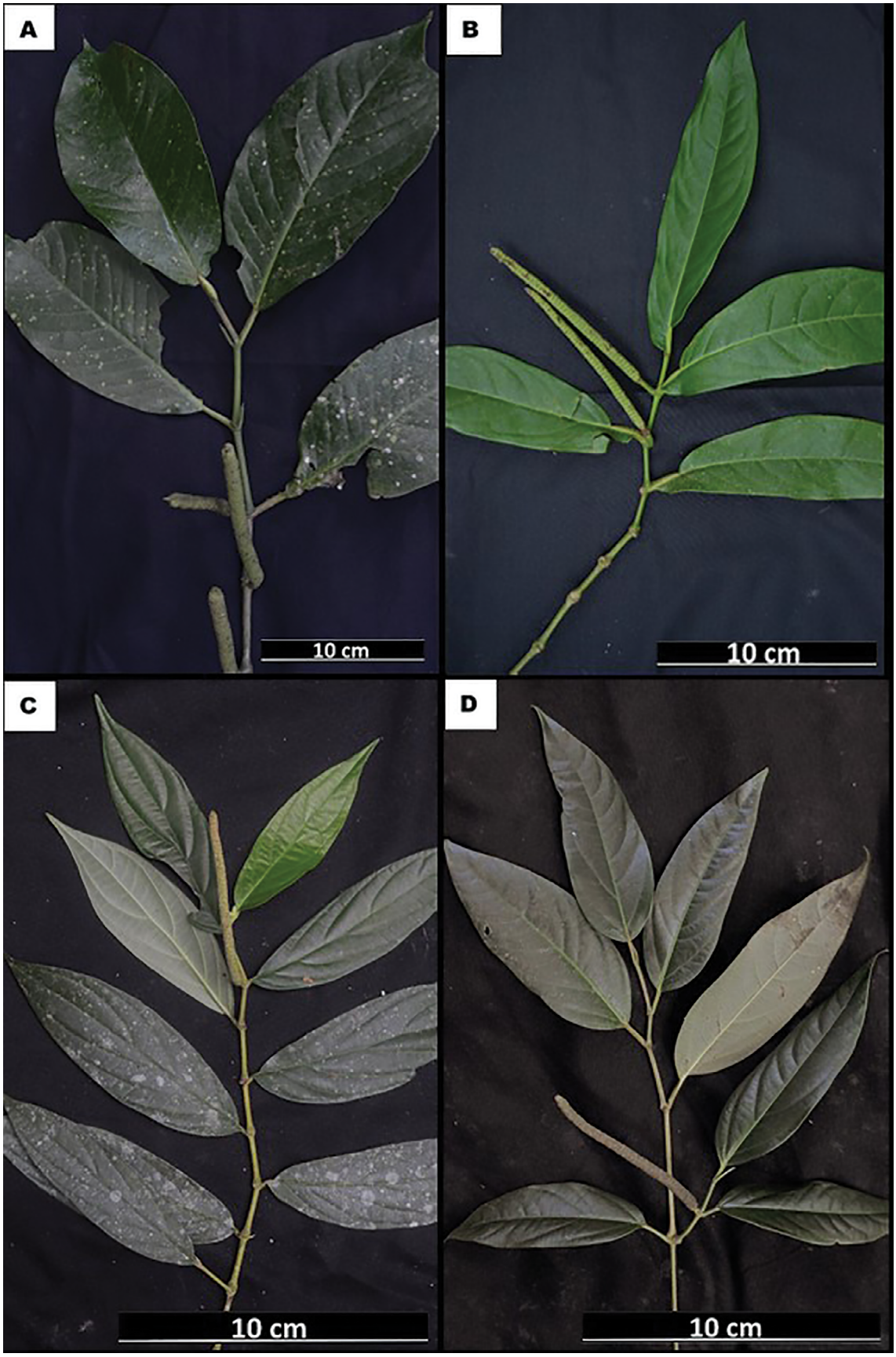

Figure 20. Piperaceae: (A) *Piper amplum*; (B) *Piper arboreum*; (C) *Piper hispidum*; (D) *Piper lepturum*.

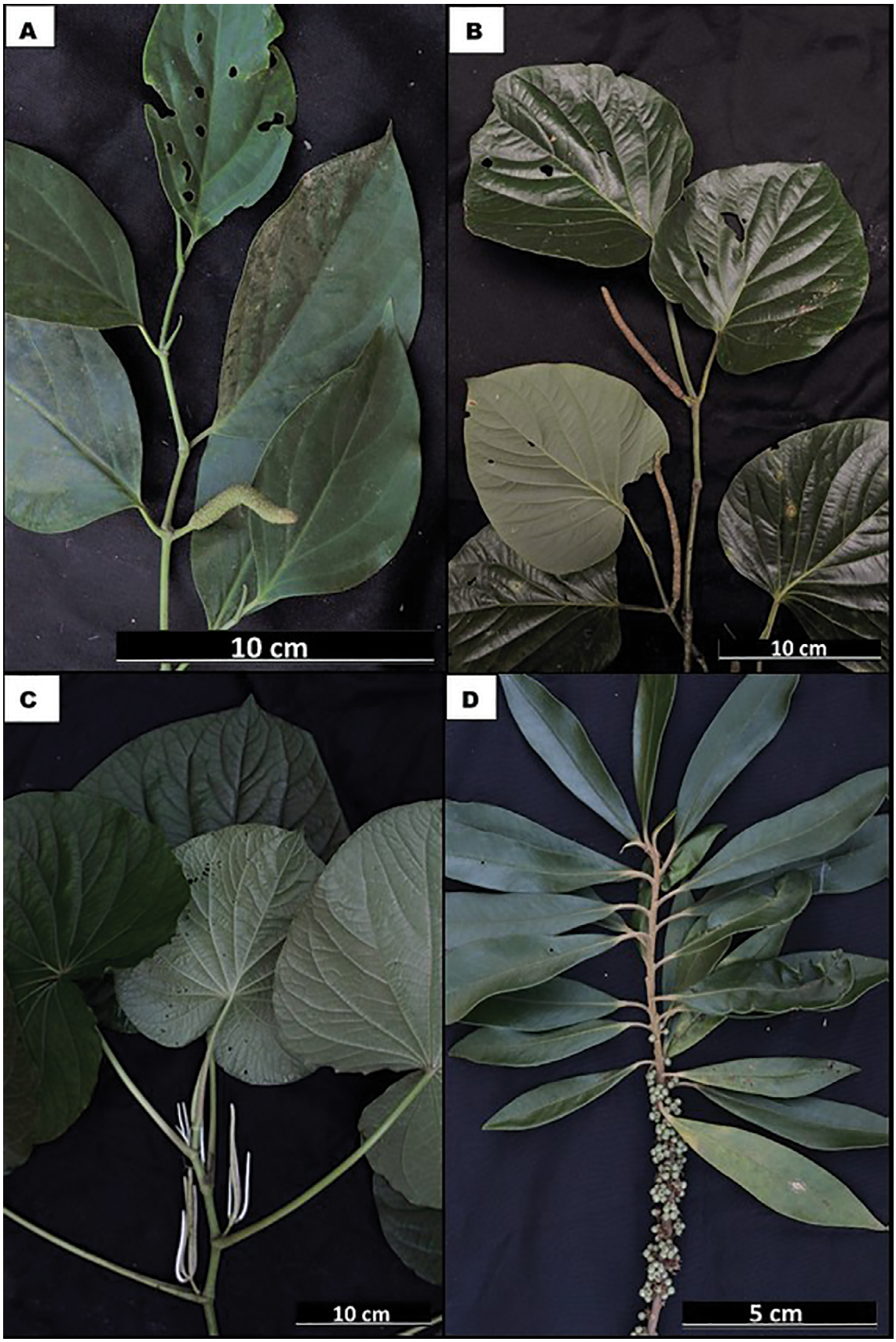

Figure 21. Piperaceae: (A) *Piper rivinoides*; (B) *Piper solmsianum*; (C) *Piper umbellatum*. Primulaceae: (D) *Myrsine coriaceae*.

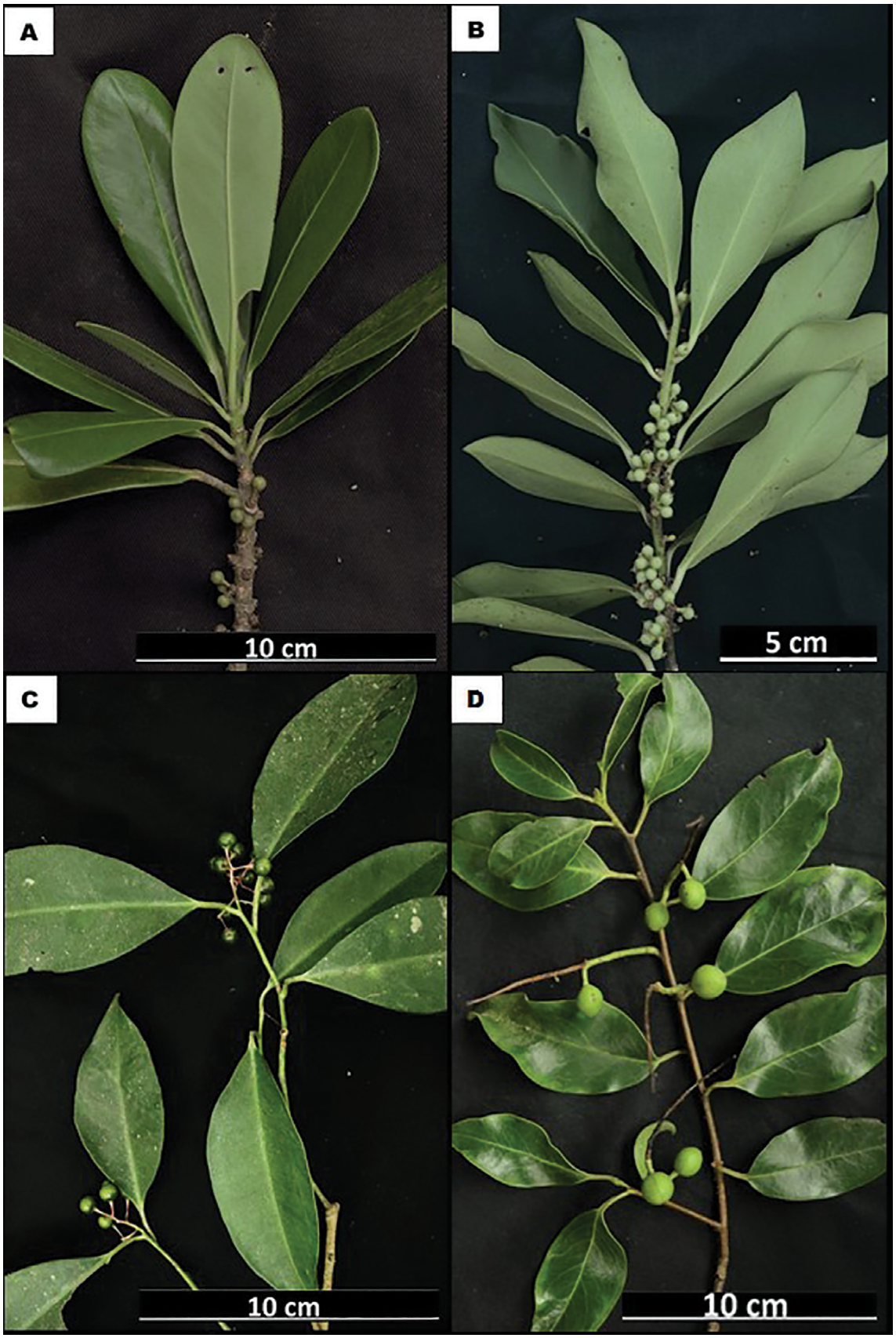

Figura 22. Primulaceae: (A) *Myrsine guianensis*; (B) *Myrsine venosa*; (C) *Stylogyne pauciflora*. Rosaceae: (D) *Prunus brasiliensis*.

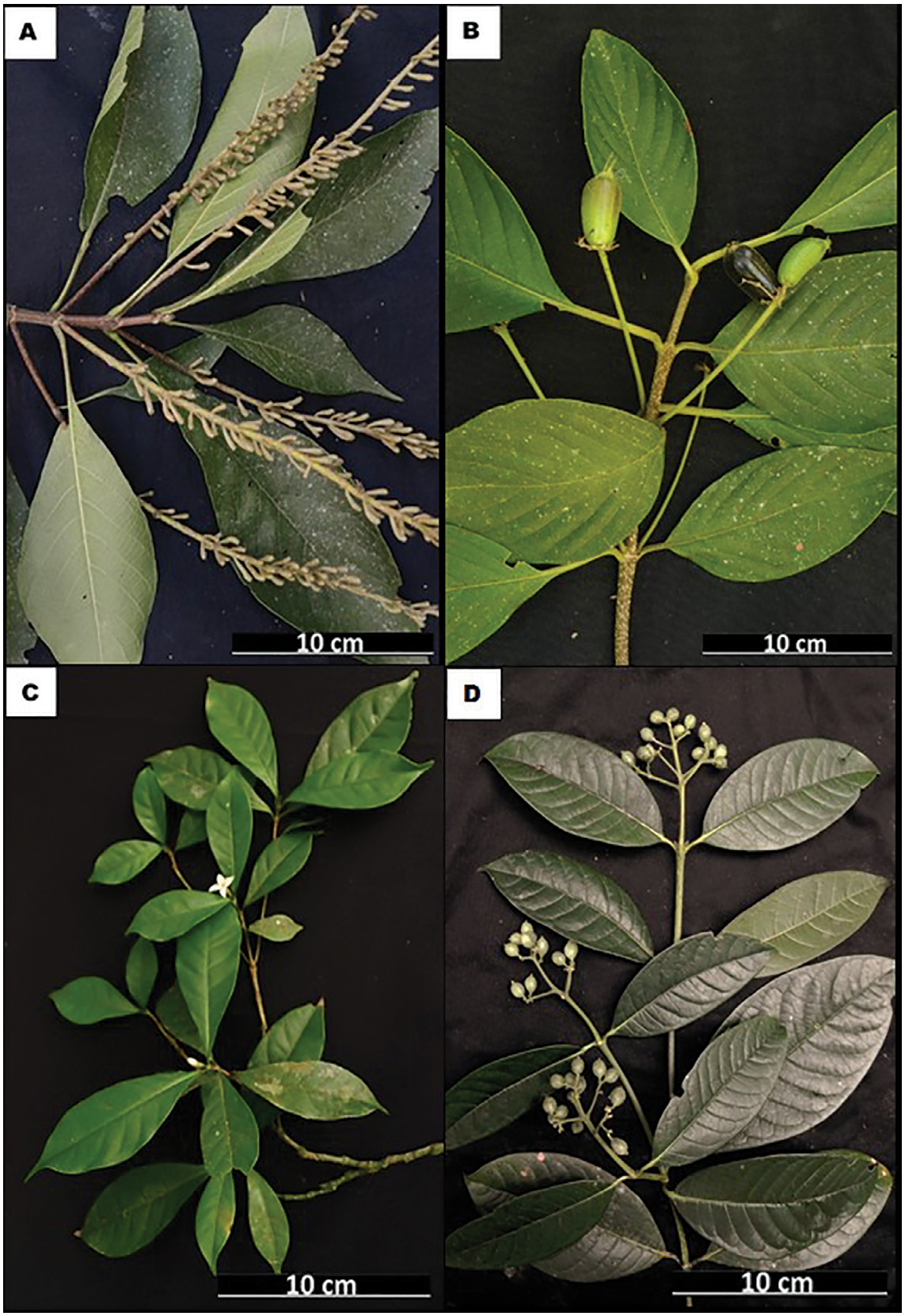

Figure 23. Rubiaceae: (A) *Alseis floribunda*; (B) *Chomelia pedunculosa*; (C) *Cordiera myrciifolia*; (D) *Coussera meridionalis*.

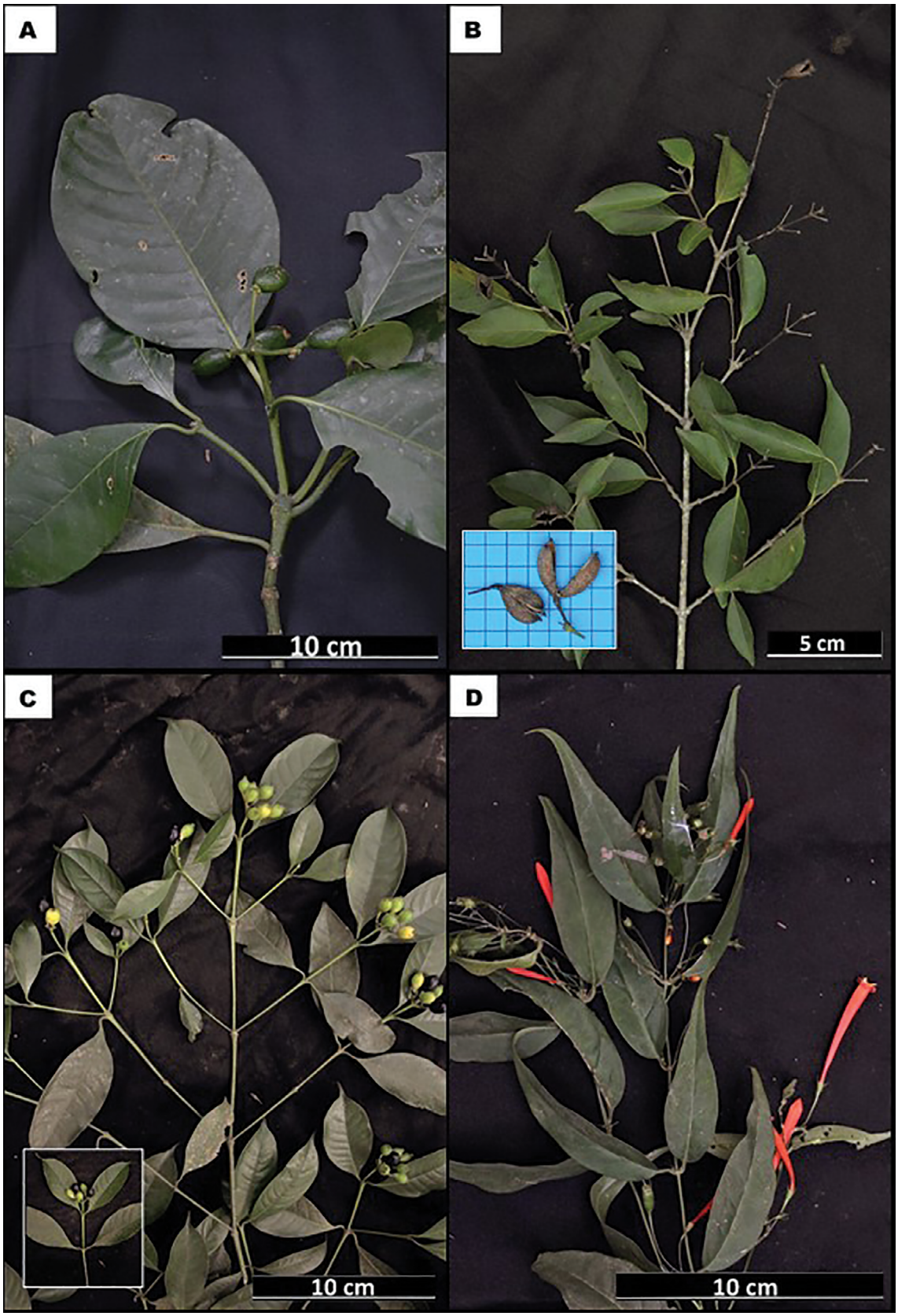

Figure 24. Rubiaceae: (A) *Coussarea nodosa*; (B) *Coutarea hexandra*, details of the fruits are highlighted; (C) *Faramea truncata*; (D) *Manettia gracilis*.

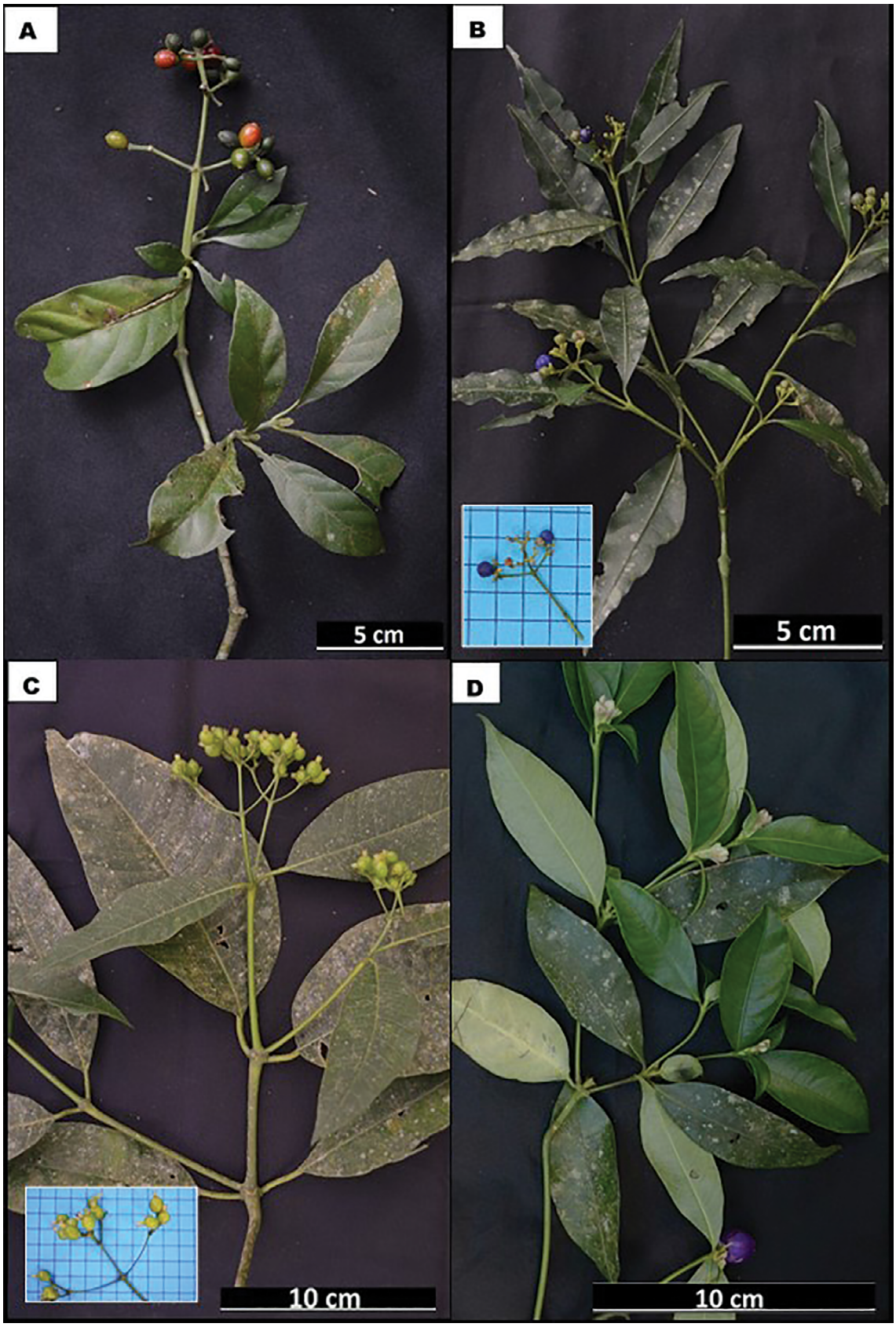

Figure 25. Rubiaceae: (A) *Psychotria carthagenensis*; (B) *Psychotria leiocarpa*, details of the fruits are highlighted; (C) *Psychotria patentinervia*, details of the fruits are highlighted; (D) *Psychotria suterella*.

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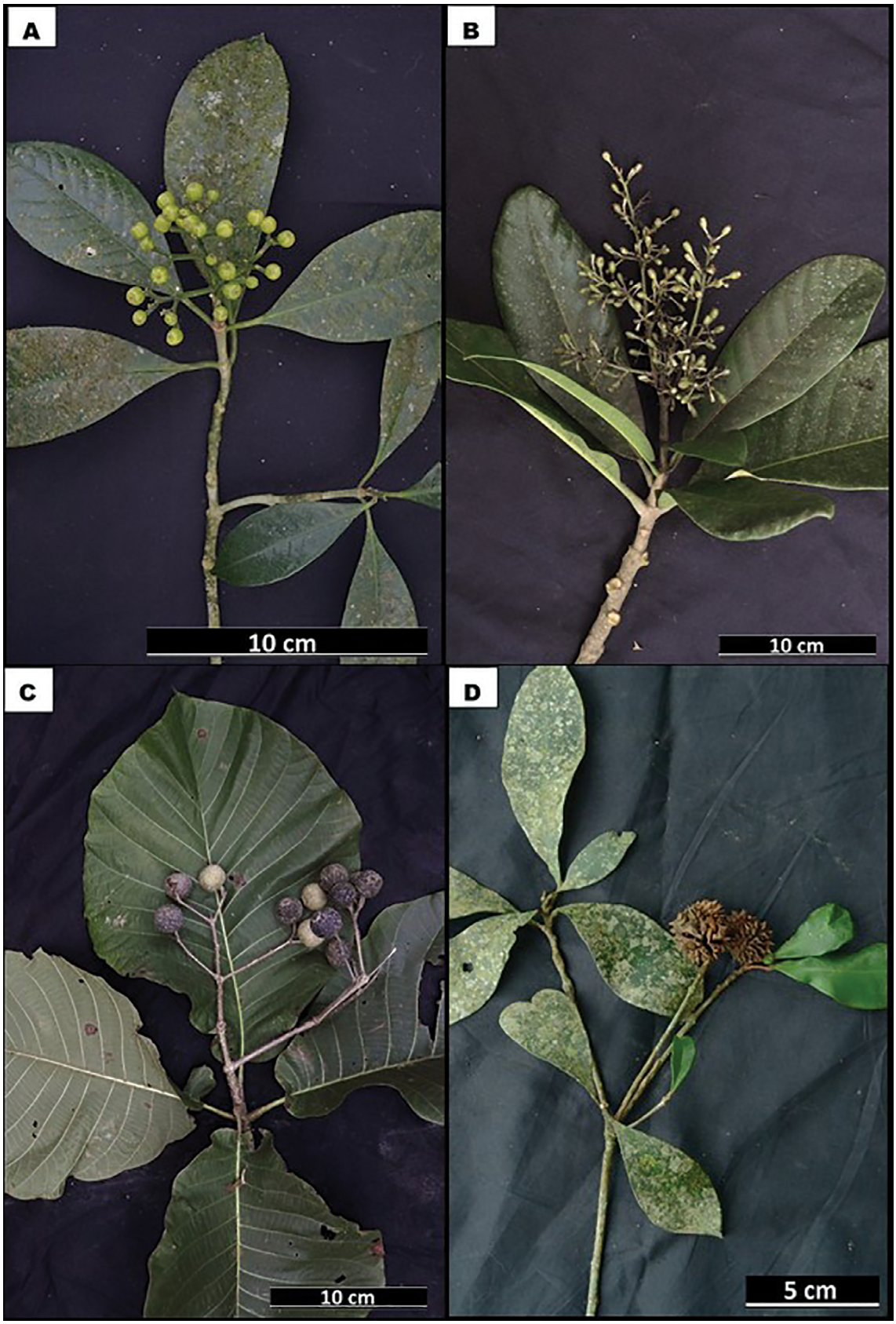

Figure 26. Rubiaceae: (A) *Rudgea jasminoides*; (B) *Rustia Formosa*; (C) *Simira glaziovii*. Rutaceae: (D) *Esenbeckia grandiflora*.

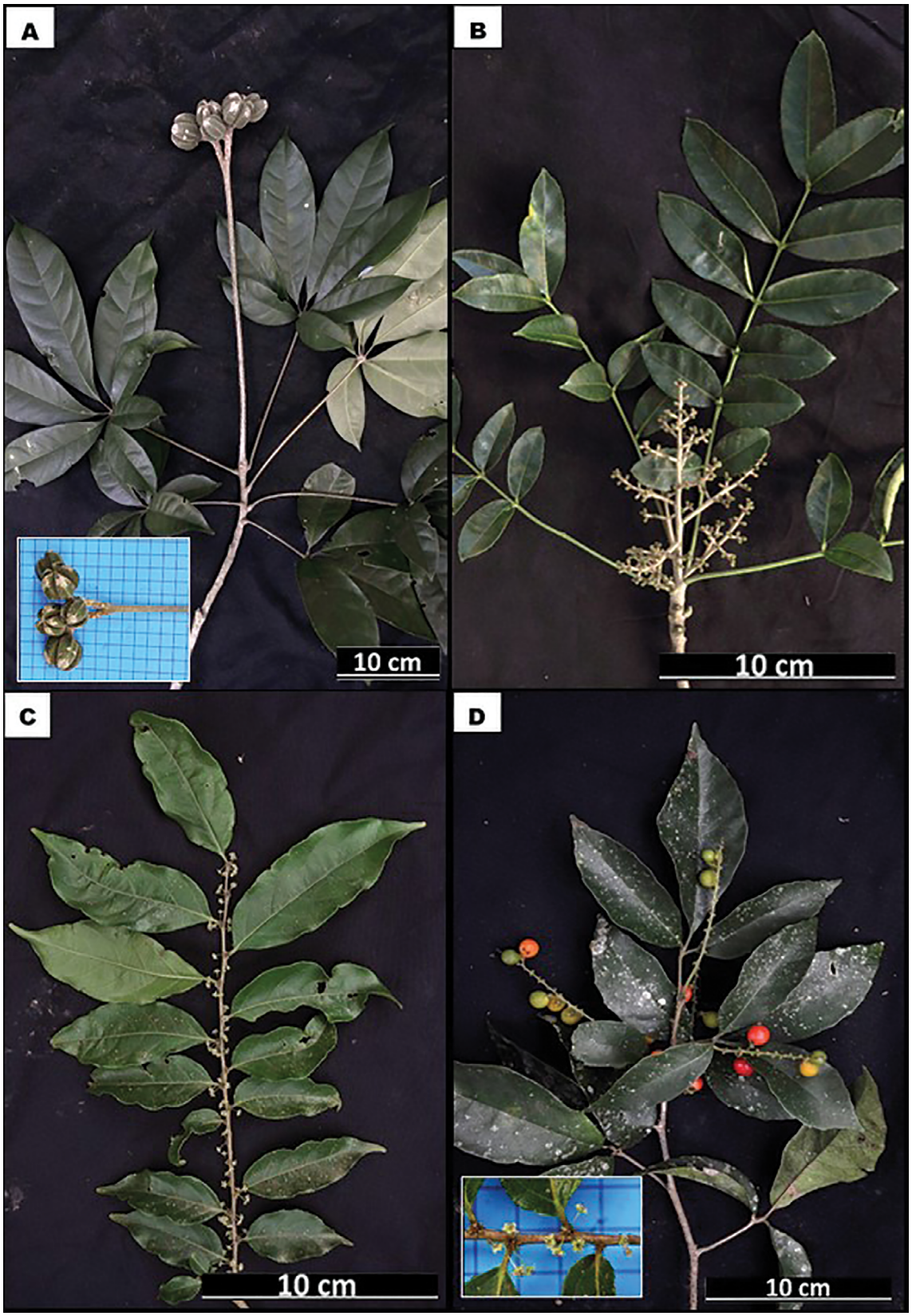

Figure 27. Rutaceae: (A) *Neoraputia magnifica*, details of the fruits are highlighted; (B) *Zanthoxylum caribaeum*. Salicaceae: (C) *Casearia sylvestris*, details of the inflorescence are highlighted. Sapindaceae: (D) *Allophylus petiolulatus*.

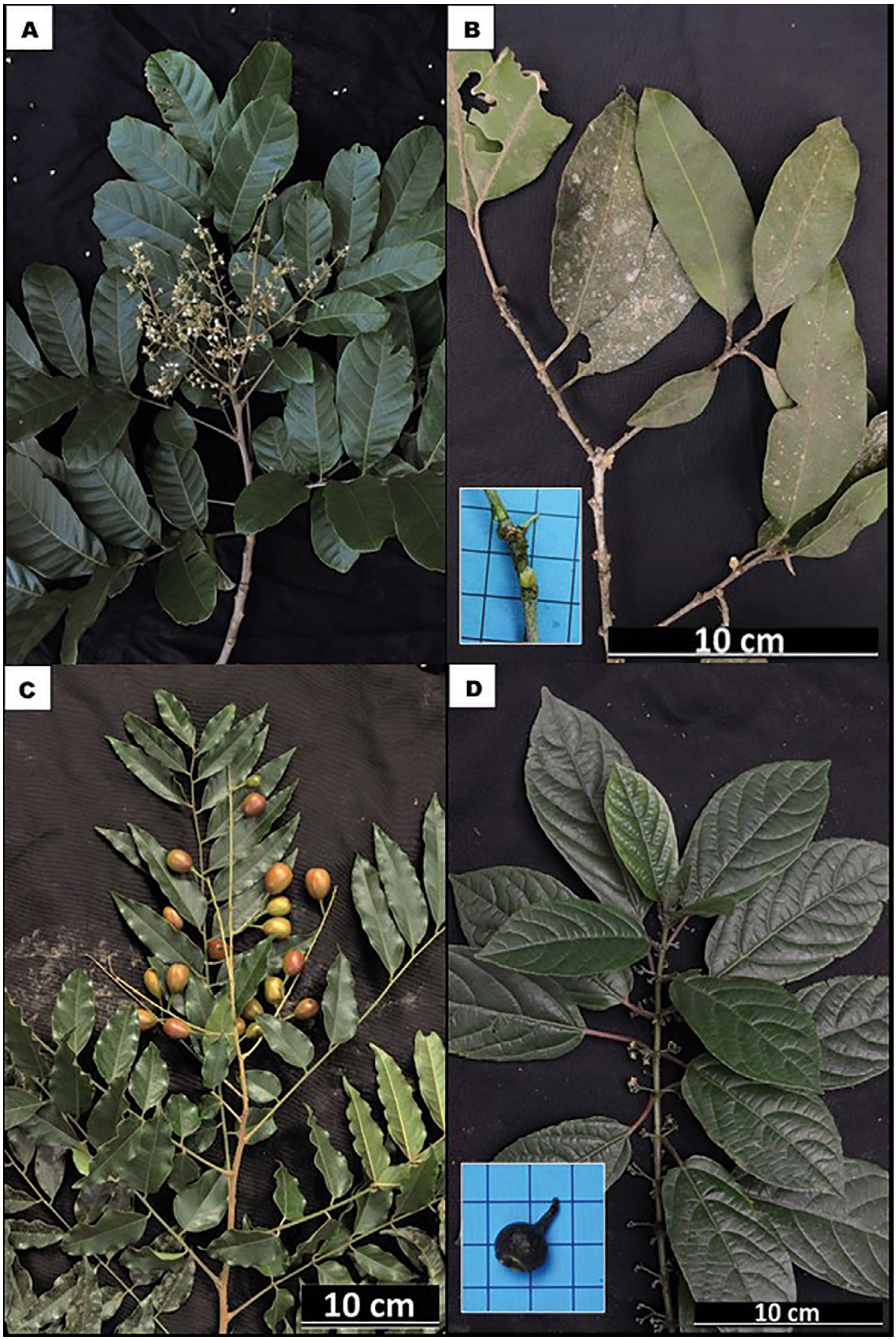

Figure 28. Sapindaceae: (A) *Cupania oblongifolia*, details of the inflorescence are highlighted. Sapotaceae: (B) *Pouteria venosa*, details of the inflorescence are highlighted. Simaroubaceae: (C) *Picramnia cilata*. Siparunaceae: (D) *Siparuna brasiliensis*, details of the fruits are highlighted.

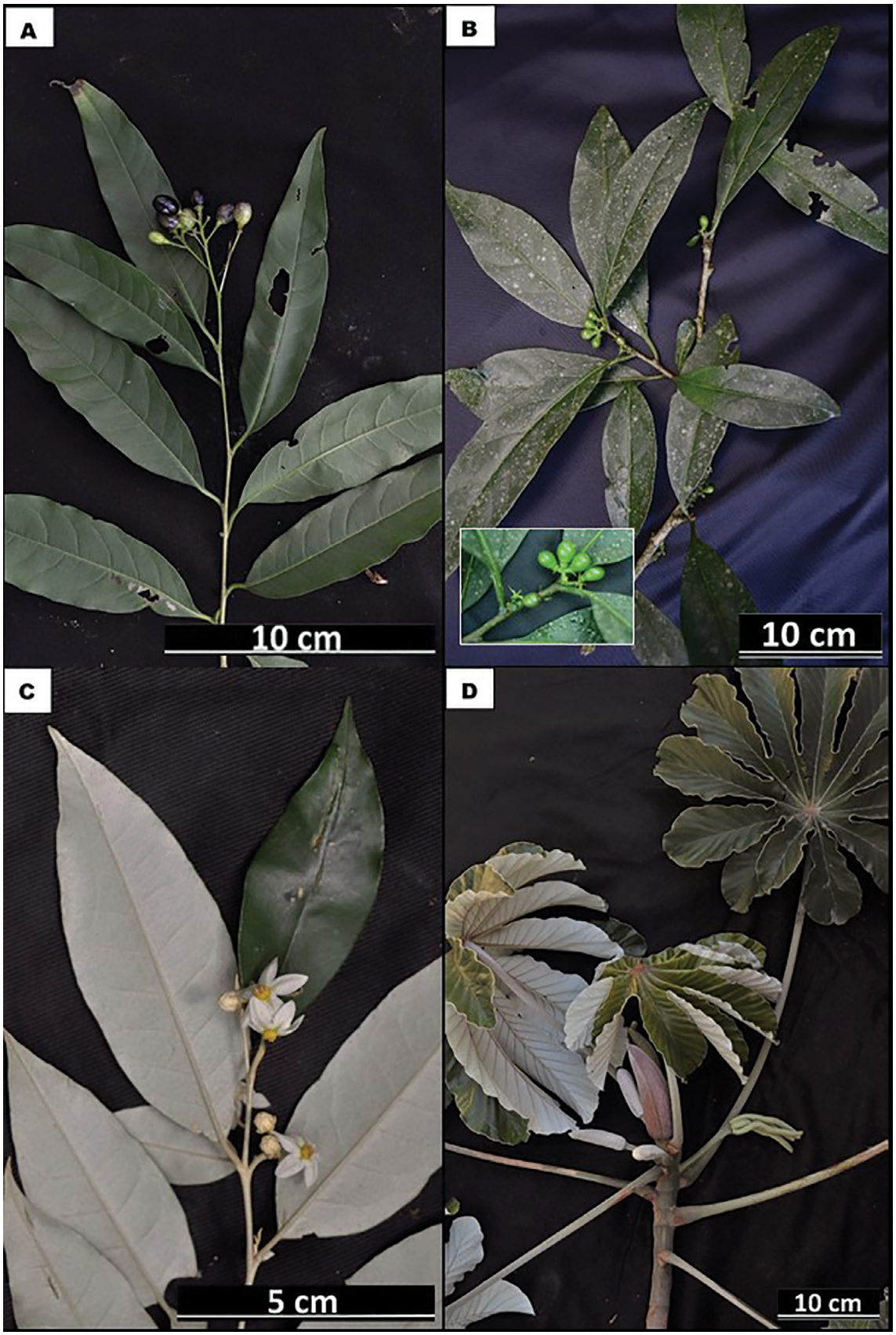

Figure 29. Solanaceae: (A) *Cestrum intermedium*; (B) *Cestrum schlechtendalii*, details of the fruits are highlighted; (C) *Solanum swartzianum*. Urticaceae: (D) *Cecropia pachystachya*.

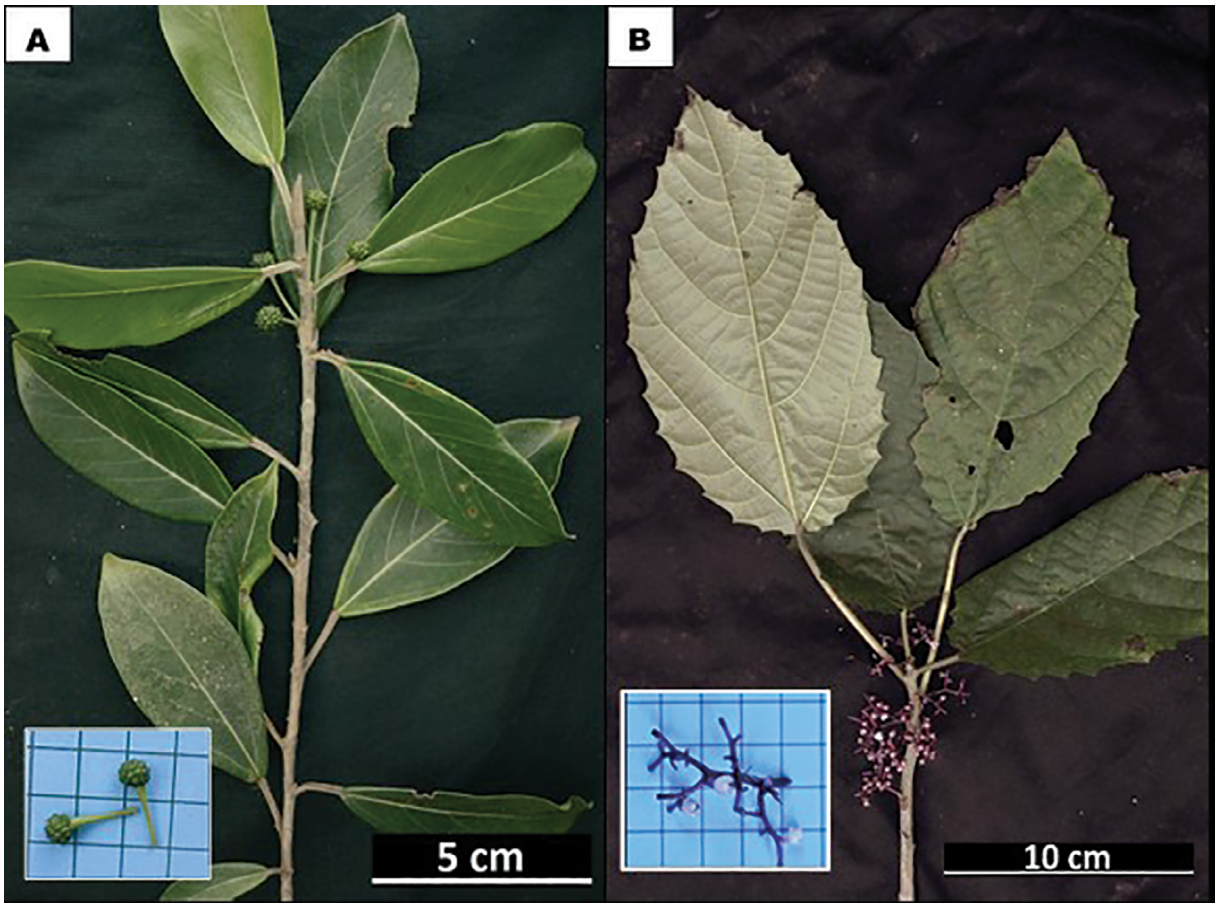

Figure 30. Urticaceae: (A) *Coussapoa microcarpa*, details of the fruits are highlighted; (B) *Urera nitida*, details of the inflorescence are highlighted.

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Supplementary Material

The following online material is available for this article:
Identification key 1
Identification key 2
Identification key 3

Author Contributions

Andrea Garafulic Aguirre: substantial contribution in the concept and design of the study; contribution to data collection, analysis, interpretation, and manuscript preparation.

Juliana Teixeira: substantial contribution in the concept and design of the study; contribution to data collection, analysis, interpretation, and manuscript preparation.

João Paulo Fernandes Zorzanelli: substantial contribution in the concept and design of the study, data analysis, interpretation and manuscript preparation.

Gabriel Dalla Colletta: contribution to data collection, analysis and interpretation.

Daniela Sampaio: contribution to manuscript preparation and critical revision, adding intelectual content.

Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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