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Point-of-View

The imminent environmental setback in Brazil driven by the Devastation Bill

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Abstract: The Brazilian Congress has just approved Bill No. 2159/2021, which significantly weakens national environmental licensing regulations. The text dismantles fundamental safeguards, expands licensing exemptions without rigorous criteria, and allows self-licensing of medium-impact environmental activities. Amendments deepen the setback by introducing a "Special Environmental License" which a maximum one-year deadline for evaluating projects deemed strategic, regardless of their magnitude and socio-environmental consequences. The Bill opens the door to widespread environmental degradation, threatens public health, increases land conflicts, and perpetuates the deceptive narrative of "green capitalism". It prioritizes the profits of a few over the collective well-being. In defense of natural heritage, environmental justice, and public health, we call for its veto.
Keywords: *Climate policy; Environmental justice; Environmental legislation; Governance.*

O iminente retrocesso ambiental no Brasil impulsionado pelo Projeto de Lei da Devastação

Resumo: O Congresso brasileiro acaba de aprovar o Projeto de Lei nº 2159/2021, que enfraquece significativamente a regulamentação nacional de licenciamento ambiental. O texto desmantela salvaguardas fundamentais, amplia as isenções de licenciamento sem critérios rigorosos e permite o autolicenciamento de atividades ambientais de médio impacto. Emendas aprofundam o retrocesso ao introduzir uma "Licença Ambiental Especial" com prazo de um ano para avaliação de projetos considerados estratégicos, independentemente de sua magnitude e consequências socioambientais. O Projeto de Lei abre caminho para a degradação ambiental generalizada, ameaça à saúde pública, aumenta os conflitos fundiários e perpetua a narrativa enganosa do "capitalismo verde". Prioriza o lucro de alguns em detrimento do bem-estar coletivo. Em defesa do patrimônio natural, da justiça ambiental e da saúde pública, pedimos seu veto.
Palavras-chave: *Política climática; Justiça ambiental; Legislação ambiental; Governança.*

Just a few months before hosting COP30, the Brazilian Congress passed Bill No. 2,159/2021 (Brazil, 2021), which significantly weakens nationwide environmental licensing regulations and now proceeds to presidential sanction. Known as the "Devastation Bill" and driven by the agribusiness caucus and corporate lobbying, this project represents an unprecedented setback in the country's environmental management (Observatório do Clima, 2025; Ministério do Meio Ambiente e Mudança do Clima, 2025).

The approved text dismantles core elements of environmental licensing. Among several concerning provisions, it broadens the exemptions from Environmental Licensing for various activities, in a generalized manner and without rigorous criteria. It implements the "License by Adhesion and Commitment" (LAC), allowing the self-licensing of activities classified as having low and medium environmental impact, by entrepreneurs who sometimes are unaware of environmental complexities or neglect them due to a strong economic bias. The Senate amendments further intensify the setback, especially with the inclusion of a "special environmental license," which imposes a maximum one-year deadline for the licensing process of so-called "strategic" projects, regardless of the complexity or severity of their

socio-environmental impacts. This provision pressures environmental agencies and compromises the quality of technical evaluations.

This Bill opens the door to widespread environmental degradation, with severe impacts on public health due to the potential increase in soil and water contamination, and the proliferation of diseases (Fundação Oswaldo Cruz, 2025), loss of ecosystem services, and the intensification of environmental disasters, disproportionately affecting vulnerable populations. It increases land conflicts, including affecting Indigenous and traditional peoples, and perpetuates the misleading narrative of "green capitalism." Furthermore, it distances Brazil from addressing contemporary environmental challenges. It weakens international commitments assumed by Brazil and threatens its credibility in the global market, resulting in imminent economic losses.

Moreover, it violates the Federal Constitution, which guarantees everyone the right to an ecologically balanced environment, essential for quality of life. It undermines the principle of prohibition of environmental regression, which has been increasingly consolidated in Brazilian jurisprudence, and contradicts the Federal Supreme Court, which recognized the unconstitutionality of the LAC (Ministério do Meio Ambiente e Mudança do Clima, 2025). These changes are not merely an attack on nature; they constitute a devastating project that prioritizes the profits of a few over collective well-being. This is a pact of irresponsibility that tarnishes Brazil's image regarding environmental issues, especially at a critical moment in the climate crisis. It is unacceptable that this bill weakens the country's already fragile, and often disregarded, environmental laws. Therefore, in the name of our natural resources, economic development with social justice, public health, and people's quality of life, we call for the presidential veto of this Bill.

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Carlos Joly

Conflicts of Interest

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

Author Contributions

Breno Dias Vitorino: conceptualization-equal; writing – original draft-lead; writing – review & editing-equal.

Angélica Vilas Boas da Frota: conceptualization-equal; writing – review & editing-equal.

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Data Availability

All the data supporting the results of this study have been published within the article itself and in the referenced sources.

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Article

The lined flat bark beetles (Coleoptera: Laemophloeidae) from Fernando de Noronha Archipelago, with the first record of Propalticinae Crowson, 1952 in the New World

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BENTO, M., ZEBALLOS, L., SAMPAIO, A., BENÁ, D., LIMEIRA-DE-OLIVEIRA, F., RAFAEL, J.A. **The lined flat bark beetles (Coleoptera: Laemophloeidae) from Fernando de Noronha Archipelago, with the first record of Propalticinae Crowson, 1952 in the New World**. Biota Neotropica 25(3): e20251798. https://doi.org/10.1590/1676-0611-BN-2025-1798

Abstract: This paper records and illustrates the Laemophloeidae from the Brazilian oceanic archipelago of Fernando de Noronha. This family is represented in the region by two subfamilies and five genera, each of which includes a single species: *Cryptolestes ferrugineus* (Stephens, 1831), *Dysmerus impolitus* Thomas, 2009, *Lathropus parvulus* Grouvelle, 1878, and *Rhabdophloeus* sp. (all Laemophloeinae); and *Propalticus* sp. (sole representative of Propalticinae). All the taxa are hereby newly recorded in Fernando de Noronha (except *Rhabdophloeus* sp.). Based on these findings, Propalticinae Crowson, 1952 represents a new record for the New World, while *Lathropus* Erichson, 1845 is recorded for the first time in Brazil. In addition, *Propalticus* sp. is briefly characterized and illustrated, including the female genital morphology. We also provide an illustrated key to subfamilies and genera of Laemophloeidae from Fernando de Noronha.
Keywords**:** *Neotropical region 1; oceanic islands fauna 2; taxonomy 3; morphology 4; Cucujoidea 5.*

Os “lined flat bark beetles” (Coleoptera: Laemophloeidae) do arquipélago de Fernando de Noronha, com o primeiro registro de Propalticinae Crowson, 1952 no Novo Mundo

Resumo: Este artigo registra e ilustra os Laemophloeidae do arquipélago oceânico brasileiro de Fernando de Noronha. Esta família é representada na região por duas subfamílias e cinco gêneros, cada um dos quais inclui uma única espécie: *Cryptolestes ferrugineus* (Stephens, 1831), *Dysmerus impolitus* Thomas, 2009, *Lathropus parvulus* Grouvelle, 1878 e *Rhabdophloeus* sp. (todos Laemophloeinae); e *Propalticus* sp. (único representante de Propalticinae). Todos os táxons são aqui registrados pela primeira vez para Fernando de Noronha (exceto *Rhabdophloeus* sp.). Com base nesses achados, Propalticinae Crowson, 1952 representa um novo registro para o Novo Mundo, enquanto *Lathropus* Erichson, 1845 é registrado pela primeira vez no Brasil. Além disso, *Propalticus* sp. é brevemente caracterizada e ilustrada, incluindo a morfologia genital feminina. Também fornecemos uma chave ilustrada para subfamílias e gêneros de Laemophloeidae de Fernando de Noronha.
Palavras-chave: *Região Neotropical 1; fauna de Ilhas Oceanicas 2; taxonomia 3; morfologia 4; Cucujoidea 5.*

Introduction

Fernando de Noronha is an archipelago of the Brazilian state of Pernambuco, in the Atlantic Ocean, more than 350 km off Brazil’s northeastern coast. Renowned for its exceptional biodiversity, the archipelago hosts a considerable variety of insects, although limited by its size and isolation, nonetheless playing a crucial role in maintaining the local ecosystem’s health and balance. In recent decades, entomologists have made significant efforts to bridge the knowledge gaps of the island’s fauna by collecting and identifying various insect groups (Rafael et al. 2020, Costa-Pinto et al. 2021, Fernandes et al. 2021a, Fernandes et al. 2021b, Fernandes et al. 2022, Rafael et al. 2021a, Rafael et al. 2021b, Mahlmann et al. 2022, Rafael et al. 2022, Rafael et al. 2023, Soares et al. 2024, Vieira et al. 2024). To date, 21 orders have been recorded in Fernando de Noronha (Rafael et al. 2020).

Regarding Coleoptera, 35 families have been identified, among which Laemophloeidae stands out.

The Laemophloeidae comprises a highly peculiar beetle family whose adults are primarily characterized by nearly flattened bodies and visible sublateral lines on the head and pronotum, distinctive traits that give rise to their English common name: "lined flat bark beetles". In addition, members of this family possess distinct elytral cells, elongated antennae, and male genitalia with inverted aedeagus (Thomas 1993, Thomas 2002). Both adult and larval dorsoventrally flattened bodies have evolved due to adaptation to subcortical regions of dead wood, where the adults primarily feed on fungi, although the members of some species have secondarily adapted to predation on scolytid bark beetles, presenting subcylindrical bodies (Thomas 1993, Lawrence & Ślipiński 2013).

Little has been published concerning the biological and behavioral aspects of Laemophloeidae without economic importance (Thomas 2002, Lawrence & Ślipiński 2013). However, several genera, such as *Cryptolestes* Ganglbauer, 1899, *Placonotus* MacLeay, 1871, *Planolestes* Lefkovitch, 1958, *Leptophloeus* Casey, 1916 and *Passandrophloeus* Kessel, 1921, include some widespread species known to be important pests of stored food and dry plants (Howe & Lefkovitch 1957, Halstead 1993). For these, numerous studies are available relative to genetics, ecology, and behavior (Bishop 1959, Lefkovitch & Currie 1967, Banks 1979, Halstead 1993, Wang et al. 2014; Varadínová et al. 2015).

Laemophloeidae is currently composed of two subfamilies: Laemophloeinae, which includes almost 500 species distributed across 41 genera (McElrath et al. 2025); and Propalticinae, a small group of 44 species in two genera (Gimmel 2011), which was only recently transferred to Laemophloeidae to reflect the evolutionary history recovered in successive phylogenetic studies hypothesizing the former Propalticidae as derived from within Laemophloeidae (McElrath et al. 2015, Robertson et al. 2015). While Laemophloeinae is distributed in all biogeographical regions worldwide, reaching its greatest diversity in tropical areas (Thomas 2002), Propalticinae is known from the African, Oriental, Australasian, and Oceanian realms of the world (Gimmel 2011). In Brazil, Laemophloeidae is currently represented only by Laemophloeinae, with 56 species and 11 genera (Caron et al. 2024).

Thus, this study aims to reduce the lack of knowledge about the fauna of the Fernando de Noronha archipelago by inventorying the Laemophloeidae of this region. We provide an illustrated key to laemophloeid subfamilies and genera of Fernando de Noronha, taxonomic notes and illustrations of each species, and expanded distributional knowledge by supplying new geographical records.

Material and Methods

1. Study area

The specimens were collected in the Brazilian archipelago of Fernando de Noronha. The total land area is 18.4 km^2, of which 16.9 km^2 is the main island (Lopes and Ulbrich, 2015), and the remaining area is distributed among 20 smaller islands. The main archipelago's island is called Fernando de Noronha, representing 85% of the archipelago (SECTMA 2006). The specimens were collected (under the license number 62.821 issued by the Instituto Chico Mendes de Conservação da Biodiversidade - ICMBio, Brazil) in the Golfinhos, Sancho, and Capim-Açu trails and the Xaréu dam (Figure 1), using the following passive methods: Malaise traps (Townes 1972) of two different sizes; and a Pennsylvania light trap equipped with 160-watt blended light lamp.

2. Specimens and label data transcription

The specimens studied in this work are deposited in the following entomological collections (collection acronym and curator name in parenthesis): Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil (INPA; Marcio de Oliveira), Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP; Sonia Casari), Coleção Entomológica Pe. Jesus Santiago Moure, Universidade Federal do Paraná, Curitiba, Brazil (DZUP; Lúcia Massutti Almeida), Museu Paraense Emilio Goeldi, Pará, Belém, Brazil (MPEG; Orlando Tobias), Museu Nacional do Rio de Janeiro, Rio de Janeiro, Brazil (Marcela Monné), Coleção Zoológica do Maranhão, Universidade Estadual do Maranhão, Caxias, Maranhão, Brazil (CZMA, Francisco Limeira-de-Oliveira), Coleção Entomológica do Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, João Pessoa, Paraíba, Brazil (DSEC; Alessandre Pereira Colavite). Regarding the transcription of labels in the examined material section, "//" indicates the start and end of an individual label, and "/" indicates a line break.

3. Photographs and map

Specimen photographs were taken using a Leica DFC295 camera attached to a Leica M205C stereomicroscope. The map (Figure 1) was created with QGIS 3.40.1 software (https://www.qgis.org/), using the geographic coordinate system Datum SIRGAS 2000 and the Cartographic bases of Google Satellite. The figures and map were edited using Helicon Focus and Adobe Photoshop software programs. The pink arrows in the figures indicate the morphological structures utilized in the identification key.

4. Classification, terminology and morphological study

This study follows the classification proposed by McElrath et al. (2015) and Robertson et al. (2015) that subsume the former family Propalticidae Crowson, 1952 within Laemophloeidae as a subfamily. Morphological terms follow Beutel and Lawrence (2005). The body length was measured from the anterior margin of the clypeus to the apex of the elytra, and the body width was measured at mid-elytra. Genera and species were identified using the available keys provided by: Gimmel (2011) for *Propalticus*, Thomas (2009) for *Dysmerus*, Thomas (2010) for *Lathropus*, Thomas (1988) and Halstead (1993) for *Cryptolestes* Ganglbauer, 1899, as well as comparison with type material of *Rhabdophloeus* Sharp, 1899 (following an ongoing revision of the genus).

Results

Key to the subfamilies and genera/species of Laemophloeidae from Fernando de Noronha Archipelago

1. Body broadly ovate, twice or less as long as wide (Figure 2A). Eyes posteriorly convergent in dorsal view (Figure 2B). Pronotum with a median endocarina (Figure 2B). Protibiae larger than meso- and metatibiae (Figure 2C). Larger protibial spur spatulate (Figure 2D)…..…….....**Propalticinae**...***Propalticus*** sp.

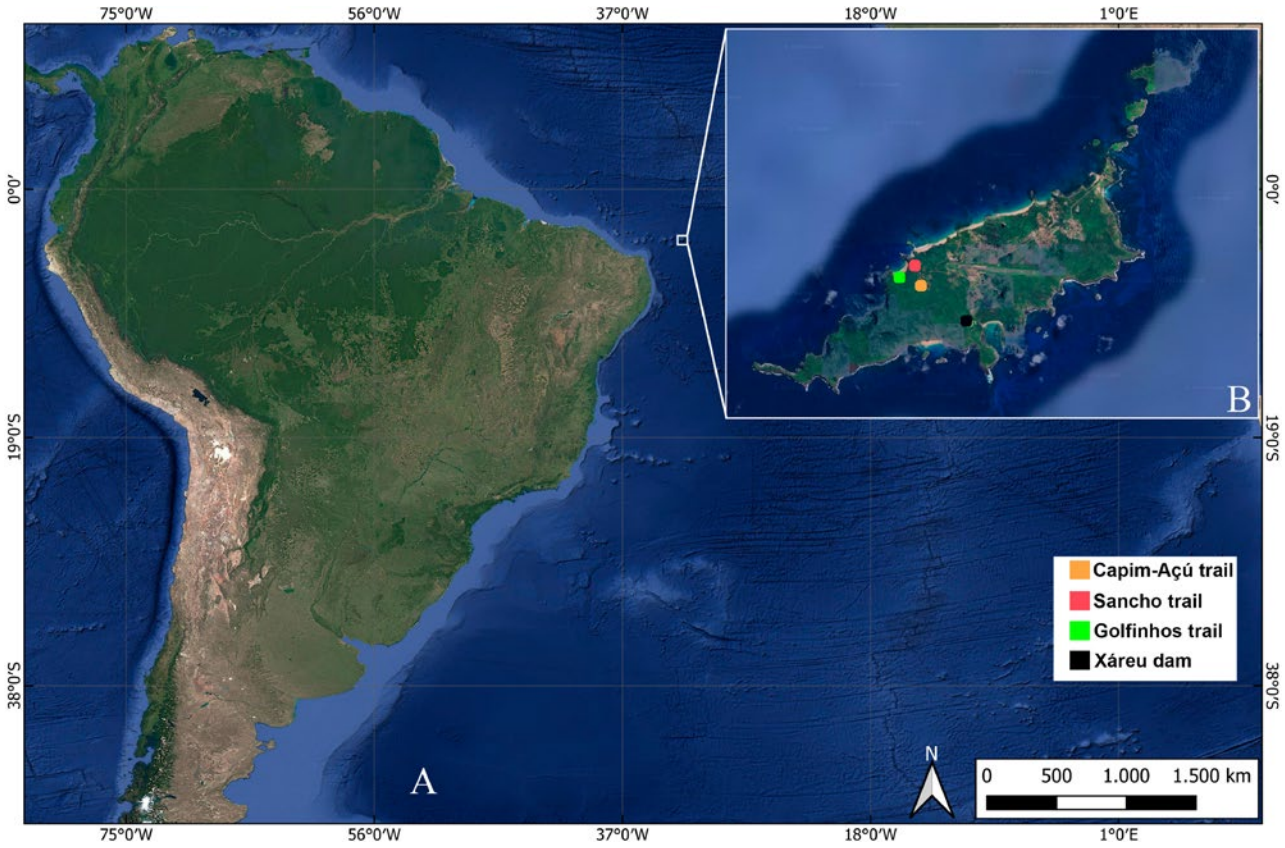

Figure 1. Map of the study area. A: South American continent; B: Fernando de Noronha archipelago, with colored squares indicating the trails where Laemophloeidae specimens were collected.

1′. Body narrow, subparallel-sided, more than twice as long as wide (Figure 2G). Eyes not posteriorly convergent in dorsal view (Figure 2E). Pronotum without median endocarina (Figure 2E). Pro-, meso-, and metatibiae subequal in size (Figure 2F). Larger protibial spur acute …..…….…….. **Laemophloeinae...**2.

2. Head without lateral lines (Figure 2E, 2G). Pronotum and elytra not explanate laterally (Figures 2E, 2G). Elytra not carinate laterally, without distinct elytral cells (Figure 2G) ..…….…… ……..……***Lathropus parvulus*** **Grouvelle, 1878**.

2′. Head with lateral lines (Figure 2H). Pronotum and elytra explanate laterally (Figure 2I). Elytra carinate laterally, forming longitudinal cells (Figure 2I) ……..…….... 3.

3. Body subcylindrical (Figure 2I). Head strongly declivous and somewhat prolonged anteriorly (Figure 2H). Pedicel attached laterally to scape, which is enlarged and projected in males (Figure 2H) ……. ***Dysmerus impolitus*** **Thomas, 2009**.

3′. Body strongly flat dorsoventrally (Figure 2J). Head plane not prolonged anteriorly (Figure 2J). Pedicel attached axially to scape, which is not modified in males (Figure 2J, L) ….....……....….. 4.

4. Lateral margins of pronotum strongly undulating, forming irregular, barely defined teeth (Figure 2J). Intercoxal process of ventrite III acute to narrowly rounded apically (Figure 2K) …..…….…… ***Rhabdophloeus*** sp.

4′. Male antennal scape projected or not (Figure 2L). Lateral margins of pronotum straight, untoothed (Figure 2L). Intercoxal process of ventrite III broadly rounded apically (Figure 2M) ……..***Cryptolestes ferrugineus*** **(Stephens, 1831)**.

Taxonomic treatment
Laemophloeidae
Laemophloeinae

Cryptolestes ferrugineus (Stephens, 1831)
(Figure 3A)

Material examined. 1 male specimen (INPA), labeled: "BRASIL, PE, Fernando de Noronha, Açude Xareu/3°51′30′′S - 32°25′50′′W" // "1-9.vi.2019, Malaise/J.A.Rafael, F. Limeira-de-Oliveira, D.M.M. Mendes".

Distribution. Cosmopolitan.

Taxonomic remarks. This species (type species of *Cryptolestes*) is taxonomically well-known and can be easily recognized by external characters. Although it belongs to a complex group of species with male antennal scapes unmodified, *C. ferrugineus* is unequivocally distinguished from its most similar congeners, *C. pusillus* (Schönherr, 1817) and *C. pusilloides* (Steel and Howe, 1952), by the head without a posterior transverse line, male mandibles externally

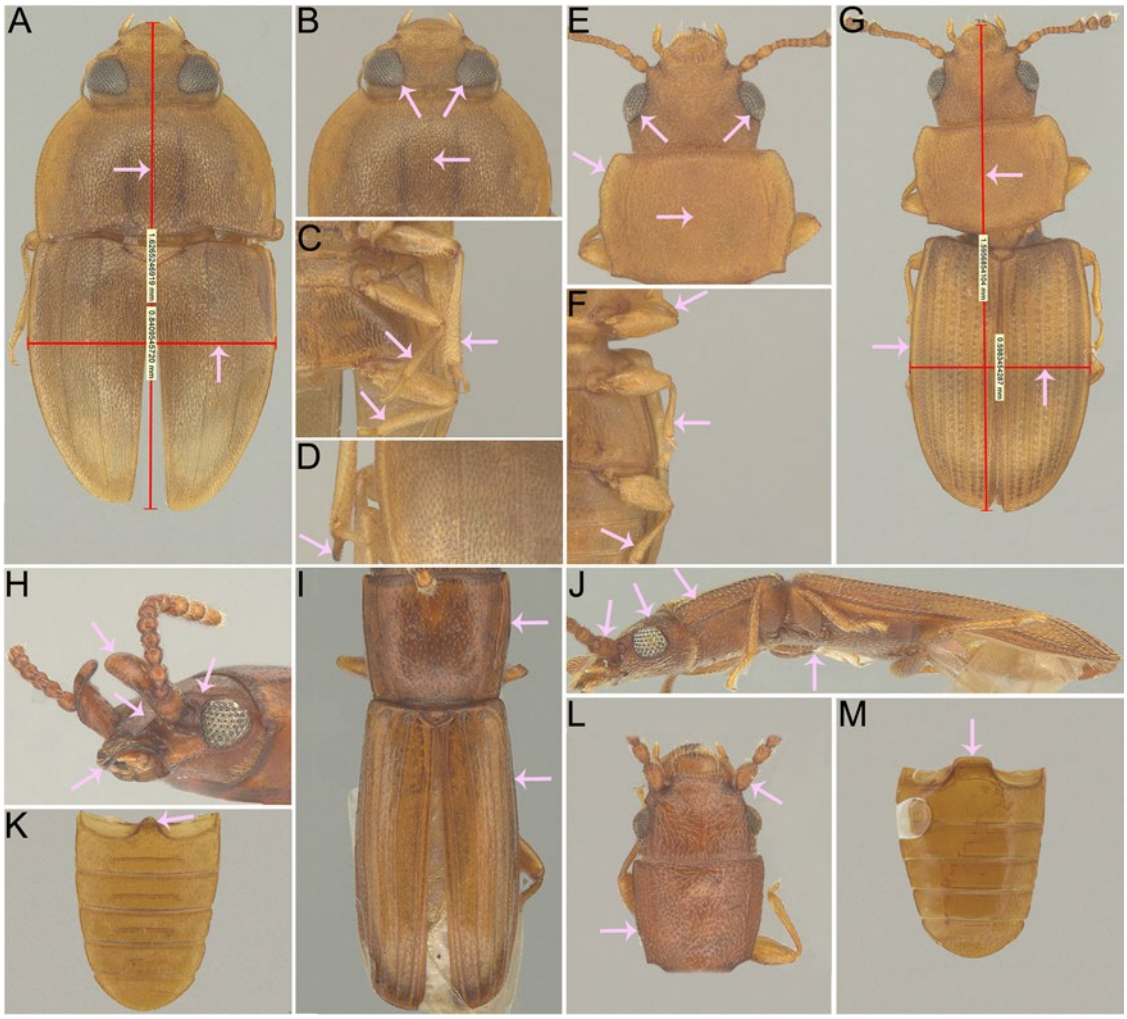

Figure 2. A-D, *Propalticus* Sharp, 1879: A, body, B, head and pronotum, C, tibiae, D, tibial spur; E-G, *Lathropus* Erichson, 1845: E, head and pronotum, F, tibiae, G, body; H, I, *Dysmerus* Casey, 1884: H, head, I, pronotum and elytra; J, K, *Rhabdophloeus* Sharp, 1899: J, body, K, ventrites; L, M, *Cryptolestes* Ganglbauer, 1899: L, head and pronotum, M, ventrites.

expanded, elytral intervals with four setal rows, as well as the form of the male endophallus (Lefkovitch 1962, Halstead 1993, Thomas 1988). In opposition, *C. pusillus* and *C. pusilloides* share the head surface with a posterior transverse line present, and the male mandibles are simple, not laterally expanded (Halstead 1993).

Dysmerus impolitus Thomas, 2009
(Figure 3B)

Material examined. 1 male specimen (INPA), labeled: "BRASIL, PE, Fernando de Noronha, Tr[trilha]. Golfinhos/3°51′17′′S - 32°26′26′′W"//"22.vii-5.viii.2019, Malaise gd[grande]/J.A.Rafael, F. Limeira-de-Oliveira, L.C.Castro".

Distribution. BRAZIL: Rondônia, Minas Gerais, São Paulo, Rio de Janeiro (Thomas 2009), Fernando de Noronha: Golfinhos trail (new record) (Figure 1). PARAGUAY: Itapúa (Thomas 2009).

Taxonomic remarks. *Dysmerus* is Neotropical in distribution and was revised by Thomas (2009), who described 12 of the 15 species currently composing the genus. All of the known species exhibit a strong modification in the male antennal scape, which is extremely enlarged and inserted in an excavation on the frontal surface of the head. This is the only species of the genus so far found in Fernando de Noronha and can be easily distinguished from its congeners by the head with median carina, the dorsal integument dull and microreticulate, and the form of the male antennal scape, which is strongly curved internally (Figure 3B). Although the identification of female specimens of *Dysmerus* is problematic because of their unmodified antennal scapes, the female of *D. impolitus* can be readily associated with the male by the median, longitudinal carina of the head as well as the dull, microreticulate cuticular surface (Thomas 2009). However, caution is necessary when identifying *Dysmerus* females, as they are more reliably identified when collected with associated males.

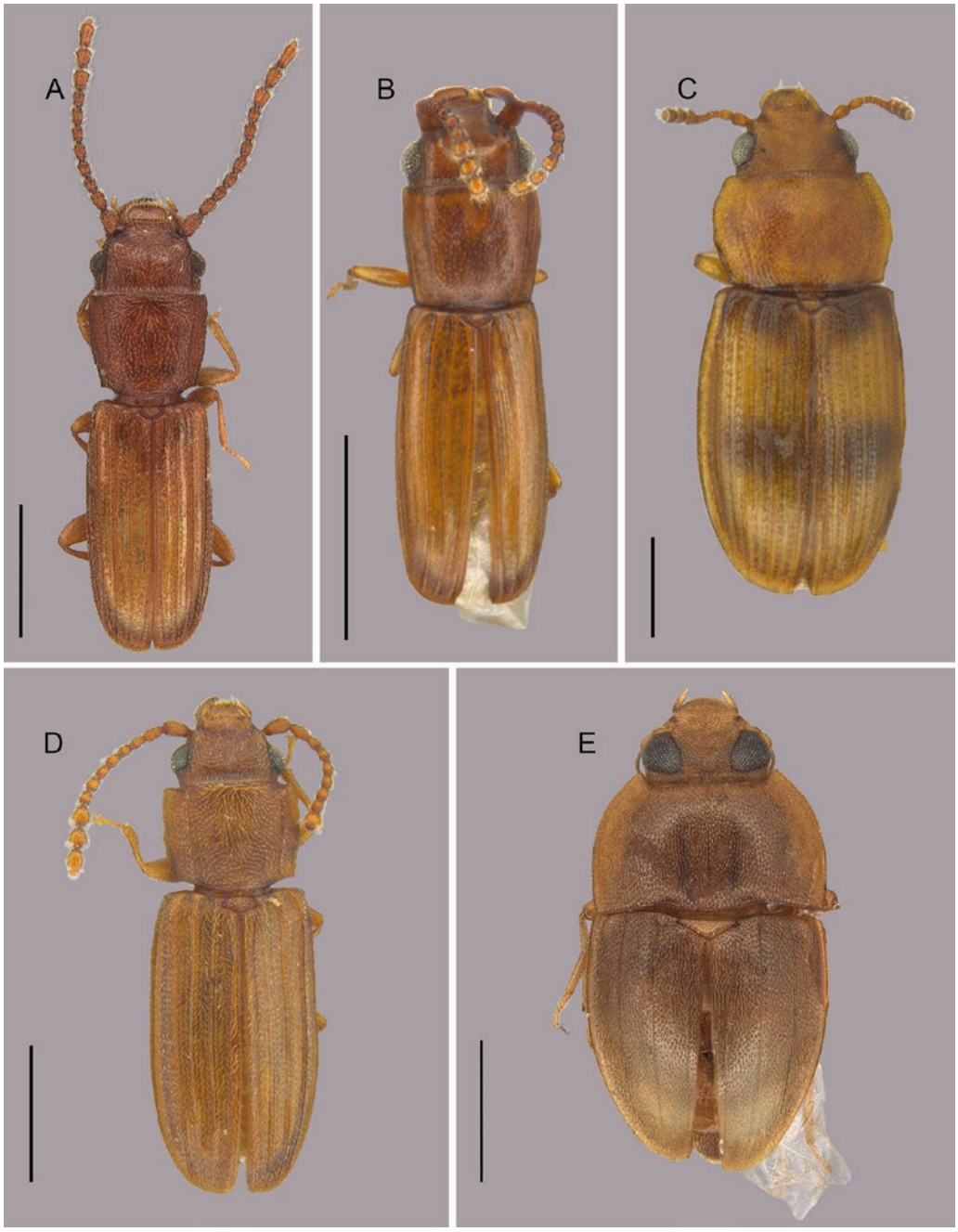

Figure 3. Laemophloeidae (A, B, C and D: Laemophloeinae; E: Propalticinae) from Fernando de Noronha Archipelago, dorsal view. A: *Cryptolestes ferrugineus* (Stephens, 1831); B: *Dysmerus impolitus* Thomas, 2009; C: *Lathropus parvulus* Grouvelle, 1878; D: *Rhabdophloeus* sp.; E: *Propalticus* sp. Scale bar: 0.2 mm: C; 0.5 mm: A, B, D and E.

Lathropus parvulus Grouvelle, 1878
(Figure 3C)

Material examined. 7 specimens (INPA), labeled: "BRASIL, PE, Fernando de Noronha, Trilha Sancho/3°51´30´´S - 32°25´50´´W" // "28.I.2020, Luz mista,/Pensilvânia, D.M.M. Mendes & J.C. Oliveira".

Distribution. MEXICO. CENTRAL AMERICA. BAHAMAS: Great Inagua. CAYMAN ISLANDS: Cayman Brac, Grand Cayman, Little Cayman. DOMINICAN REPUBLIC: Barahona, Monseñor Novel, Pedernales, Peravia, La Vega. TURKS AND CAICOS: Grand Turk. BOLIVIA: no locality (Thomas, 2010). BRAZIL: Fernando de Noronha: Sancho Trail (new record) (Figure 1).

Taxonomic remarks. *Lathropus parvulus* (Figure 4D) resembles *L. robustulus* because of the rounded pronotum and the similar shape of the endophallic sclerite (Figure 4E), but *L. parvulus* is distinguished by the bicolored elytra, with pale transverse bands (dark elytra in *L. robustulus*, with no transverse bands). Another bicolored species,

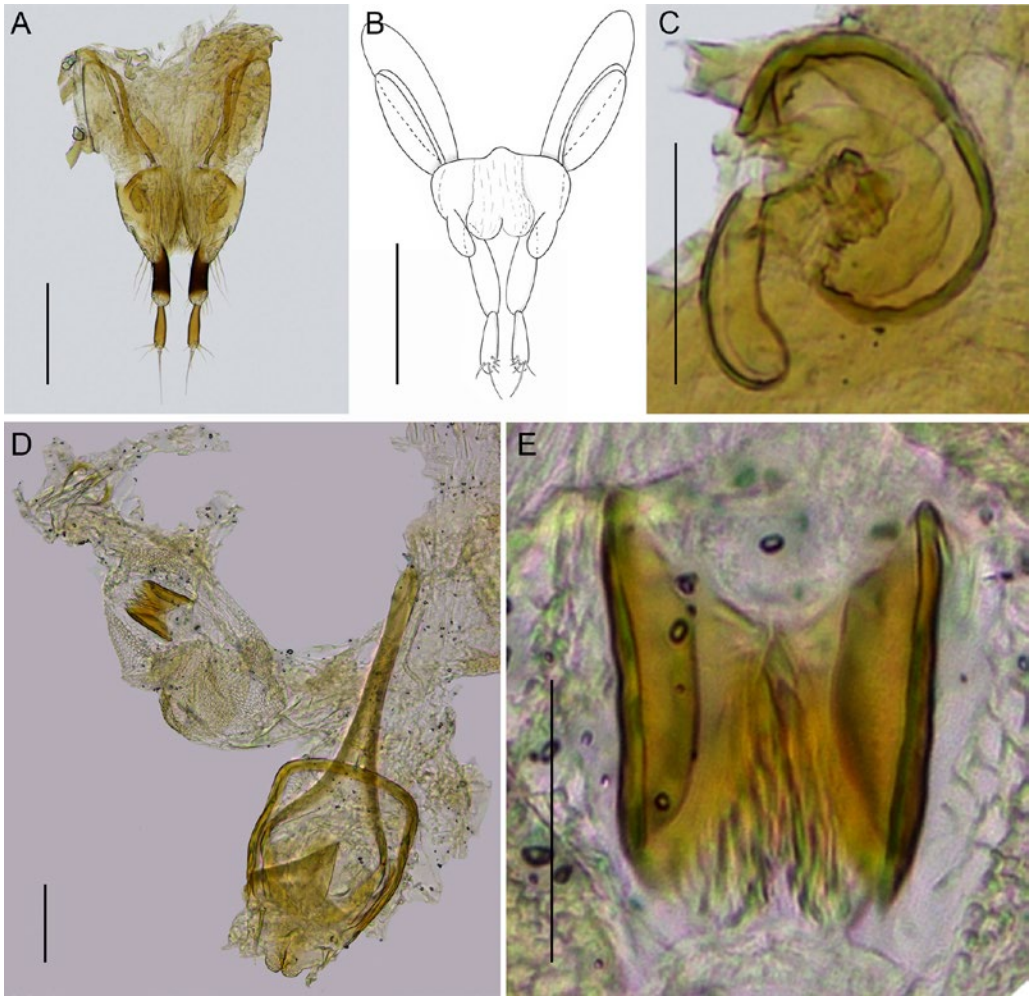

Figure 4. A-C: *Propalticus* sp. female. A-B: external genitalia; C: spermatheca. D-E: *Lathropus parvulus* Grouvelle, 1878. Male. D: genitalia; E: endophallic apical sclerite. Scale bar, A, B: 0.1 mm; C: 0.05 mm; D: 0.05 mm; E: 0.025 mm

L. chickcharnie Thomas, 2010, has an elytral color pattern similar to that of *L. parvulus*. However, both species are separated from each other by the shape of the endophallic sclerite, which is heavily sclerotized and much broader in *L. parvulus* (compare Figures 34 and 38 in Thomas (2010)). According to Thomas (2010), the West Indian individuals of this species are paler than the Central American population. This pattern can be seen in individuals of *L. parvulus* from Fernando de Noronha, which have lighter elytral surfaces and match those from the West Indies described by Thomas (2010: Figure 2).

***Rhabdophloeus* sp.**

(Figure 3D)

Rhabdophloeus sp.; Rafael et al. (2020: 8).

Material examined. 326 specimens (INPA), labeled: "Brasil, PE. Fernando de/Noronha, Tr. Golfinhos/3°51´17´´S - 32°26´26´´W/ 23.i-12.ii.2020. Malaise Gd,/J.A.Rafael, F. Limeira-de-Oliveira, L.C. Castro" (29 indiv., INPA); same, but 25.xi-9.i.2019" (6, INPA); same, but "24.x-9.xi.2019" (5, INPA); same, but "Capim-Açu/27.xi-9.xii.2019" (14, DZUP, 13, MNRJ; 24, INPA); same, but "11-27.xi.2019" (14, MZUSP; 13, MPEG; 40, INPA); same, but "21.viii-8.ix.2019" (14, CZMA); same, but "24.ix-9.x.2019" (10, DSEC; 7, INPA); same, but no date (9, INPA); same, but "9-26.xi.2019" (6, INPA); same, but "9-24. xi.2019" (13, INPA); same, but "22.vii-5.viii.2019" (7, INPA); same, but 27.x-11.xi.2019" (11, INPA); same, but "9-27.xii.2019" (6, INPA); same, but "Tr. Golfinhos/12-27.ii.2020" (8, INPA); same, but "Capim-Açu/20.viii-8.xi.2020" (1, INPA); same, but "23.vii-7. viii.2019" (4, INPA); same, but 8-23.vii.2019" (3, INPA); same, but "8-27.x.2019" (9, INPA); same, but "25.ix.-8.x.2019" (7, INPA); same, but "Golfinhos/26.ix.-8.xii.2019" (3, INPA); same, but "23.vi-7. vii.2019" (5, INPA); same, but "7-22.vii.2019" (12, INPA); same, but "capim-açu/7-21.vii.2019" (4, INPA); same, but "golfinhos/1-15. iii.2020" (9, INPA).

Distribution. BRAZIL: Fernando de Noronha (Rafael et al., 2020) (Figure 1).

Taxonomic remarks. This is the only species of Laemophloeidae previously recorded from Fernando de Noronha (Rafael et al. 2020). *Rhabdophloeus* currently includes 10 obscure, poorly circumscribed

species distributed from the southern region of the United States to the Brazilian state of Santa Catarina in the South (Casey 1884, Kessel 1926). The genus includes many synonymous species and requires revisionary work. One of us (MB) checked the types of all valid species of *Rhabdophloeus*, including the male genitalia of the Central and South American species, which enabled the comparison with the specimens from Fernando de Noronha treated in this paper. Through external and genital characters, our analysis showed that the *Rhabdophloeus* species collected in Fernando de Noronha is not conspecific with any of the Neotropical species. Instead, this species closely resembles two North American species, *R. horni* (Casey, 1884) and *R. disseptus* (Casey, 1916), the only species whose male genitalia of type specimens could not be analyzed. An ongoing revision of *Rhabdophloeus* (Bento, in prep.), including the study of male genital morphology of the North American species, will clarify the identity of the species from Fernando de Noronha, which could be an undescribed species.

Propalticinae
***Propalticus* sp.**
(Figure 3E)

Material examined. 5 female specimens, labeled: "BRASIL, PE, Fernando de Noronha, 3°51′17′′S-/32°26′26′′W, Capim-Açu" // "7-21.viii.2019, Malaise/G, J.A.Rafael, F. Limeira-/de-Oliveira, L.C.Castro" (♀, INPA); same, but "27.XII–10I.2020" (♀, INPA); same, but 9–27.XII.2019" (2♀, INPA); same, but "11–27.XI.2019" (♀, INPA).

Distribution. BRAZIL: Fernando de Noronha: Capim Açu trail (new record).

Taxonomic remarks. Propalticinae is divided into two genera, *Propalticus* Sharp, 1879 and *Slipinskogenia* Gimmel, 2011 (replacement name for *Discogenia* Kolbe, 1897). *Propalticus* is relatively diverse, currently comprising 33 described species, and is easily recognized by the antennal insertions on the top of the head, eyes posteriorly convergent dorsally, protibial spur large and spatulate, scutellum pointed behind, and body form narrow relative to the nearly circular body form in *Slipinskogenia* (Sen Gupta 1978, Gimmel 2011). The genus is represented in Fernando de Noronha by a single species whose identity is unclear from the literature, as its closest congeners are poorly defined and remain unrevised. Nevertheless, although undetermined in this paper, this species is shortly characterized below, thus making morphological information available for future comparisons with other *Propalticus* species and allowing for further identification.

The undetermined species collected in Fernando de Noronha is known only from female specimens, which are distinctive by the following features: length 1.6 to 1.83 mm; width 0.8 to 0.96 mm. Dorsal surface uniformly dark brown, bearing no spots or pattern of scale-like setae; ventral surface and legs light brown to yellow. Protibial spur large, with outer margin serrate. Female genitalia (Figure 4A–B) with distal gonocoxites cylindrical, dark brown, and well sclerotized; gonostylus slender, elongated, distinctly longer than half the distal gonocoxites, with long apical setae; spermatheca globose (Figure 4C), with a long, digitiform lateral projection.

Propalticus sp. is most similar to and may prove to be conspecific with *P. sarawakensis* John, 1960 from Southeast Asia (Borneo, Indonesia, and Palau) or *P. sierraleonis* John, 1960 from the Southwestern coast of West Africa (Sierra Leone) because of their superficial appearance, body size (1.6 mm long), dorsal surface uniformly dark brown, with no spots or pattern of scale-like setae. Despite being generally similar to these species, individuals of *Propalticus* sp. from Fernando de Noronha are distinguished by their general body form, which is somewhat slender, with uniform, less convex lateral sides (body stout, with lateral sides more rounded in *P. sarawakensis* and *P. sierraleonis*). The analysis of type specimens and comparison between male and female genitalia of these species will clarify the identity of *Propalticus* sp. as a described or undescribed species.

Checklist of the Laemophloeidae species from Fernando de Noronha
(Figure 3)

Laemophloeinae
- *Cryptolestes ferrugineus* (Stephens, 1831)
- *Dysmerus impolitus* Thomas, 2009
- *Lathropus parvulus* Grouvelle, 1878
- *Rhabdophloeus* sp.

Propalticinae
- *Propalticus* sp.

Discussion

All of the laemophloeid species treated in this paper are currently the sole representatives of their respective genera within Fernando de Noronha, with only *Rhabdophloeus* sp. presenting a previous record from this locality (Rafael et al. 2020). *Dysmerus impolitus* is widely distributed across continental Brazil, with prior records extending to the North and Southeast regions, as well as Paraguay (Thomas 2009). This species is hereby recorded in Fernando de Noronha for the first time, representing the first record from Northeast Brazil. *Lathropus* was previously recorded in Mexico and Central America (Thomas 2010). In addition, Thomas (2010) stated: "I have also seen undescribed South American species from as far south as Bolivia". Based on the new record of *L. parvulus* in Fernando de Noronha presented hereby, the genus is recorded from Brazil for the first time.

Cryptolestes ferrugineus is one of the most common secondary pests of a range of stored products, causing a significant loss to stored grains and dry plants (Howe & Lefkovitch 1957, Thomas 1988, Halstead 1993, Bharathi et al. 2022). Although more abundant in drier and cooler areas of the globe, this species may be considered cosmopolitan in distribution (Howe & Lefkovitch 1957, Thomas 1988). It has been recorded on every continent and numerous islands worldwide, including the Maltese Islands (Halstead & Mifsud 2003), Réunion Island and Mauritius (Lefkovitch 1964), Hawaii (Loschiavo & Okumura 1979), and the island regions of New Zealand (Chapman et al. 2016). The widespread distribution of *C. ferrugineus*, including its occurrence in Fernando de Noronha, was likely facilitated by international trade, which has played a significant role in its dispersal worldwide.

The genus *Cryptolestes* includes 9 species recorded from stored products (Halstead 1993): *C. capensis* (Waltl, 1834), *C. cornutus* Thomas and Zimmerman, 1989, *C. divaricatus* (Grouvelle, 1898), *C. ferrugineus*, *C. klapperichi* Lefkovitch, 1962, *C. pusilloides*, *C. pusillus*, *C. turcicus*

(Grouvelle, 1876), and *C. ugandae* Steel and Howe, 1955. It is plausible to assume that other economically important species with nearly worldwide distributions (e.g. *C. turcicus*, *C. pusillus*, and *C. pusilloides*) may have already been introduced in Fernando de Noronha over time and could have established populations within the archipelago like many other insect species (see Rafael et al. 2020).

According to Sen Gupta (1978), members of Propalticinae (formerly Propalticidae) seem confined to the warmer regions of the Old World. While *Slipinskogenia* is restricted to continental Africa, the genus *Propalticus* is widely distributed throughout the African, Oriental, Australasian, and Oceanian regions, including many Indian and Pacific islands (John 1960, Gimmel 2011, Pal & Baraik 2012). In this respect, the subfamily Propalticinae is recorded in the New World for the first time as a result of the new record of the genus *Propalticus* from Fernando de Noronha, which is represented by a single species in this region. Although *Propalticus* sp. shows a distributional disjunction with the rest of Propalticinae, which might indicate introduction in the archipelago, the status of this species as invasive or native remains uncertain and pending future studies to clarify its identity as well as to confirm or reject the previous hypothesis by Sen Gupta (1978).

Adults of most laemophloeid genera are predominantly attracted to lights at night, and large numbers of individuals of most Neotropical species are collected using blacklight traps (Thomas 1988, 2009, 2010, 2013, 2014, 2015, M. Bento, pers. observation). The new records of *Cryptolestes ferrugineus* and *Dysmerus impolitus* from Fernando de Noronha presented hereby are based on only one male individual for each species, potentially reflecting the limited efficiency of flight interception methods for trapping members of these genera. In contrast, *Rhabdophloeus* sp. was abundantly collected using Malaise traps (330 individuals), suggesting that this method may be particularly effective for this genus. These findings underscore the need for targeted sampling of Laemophloeidae in Fernando de Noronha. This would expand our knowledge of the archipelago's species diversity, which should be significantly greater than presently recorded, including many other economic and non-economic species of Laemophloeidae.

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Conflicts of Interest

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

Ethics

This study did not involve human beings and/or clinical trials that should be approved by one Institutional Committee.

Data Availability

The datasets generated during and/or analyzed during the current study are available at: https://data.scielo.org/dataset.xhtml?persistentId=doi:10.48331/scielodata.1JKNE0.

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Article

Botanical efforts reveals unrecorded thalloid liverworts for both State of Maranhão and Brazilian Cerrado, northeastern Brazil

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Abstract: Despite its rich biodiversity, the State of Maranhão, northeastern Brazil, is one of the less explored and known Brazilian states from a bryological perspective. Until recently, the recorded thalloid liverwort flora of Maranhão comprised 13 species, distributed in seven families. This study reports first records of some species of thalloid liverworts for both Maranhão and the Brazilian Cerrado, based on botanical expeditions carried out in different areas of Maranhão between 2017 and 2025. We report 10 species newly recorded for the state, including *Riccardia leptophylla*, *R. multifida*, *Riccia breutelii* and *R. subdepilata*, which also represent new records for the Brazilian Cerrado, and *Pteropsiella frondiformis*, new record for Northeastern Brazil. These new records increased the number of thalloid liverwort species documented for Maranhão to nearly double, reaching a total of 23 species. The most rich family is Ricciaceae (9 species), followed by Aneuraceae (6), while Corsiniaceae, Lepidoziaceae, and Pallaviciniaceae are each represented by two species, and Cyathodiaceae and Monocleaceae by one species. This study underscores the importance of floristic and taxonomic research in underexplored regions and emphasizes the need for increased attention to overlooked plant groups such as bryophytes.
Keywords: *Bryophytes; Cerrado domain; Marchantiophyta; new records; taxonomy.*

Esforços botânicos revelam hepáticas talosas não registradas para o estado do Maranhão e para o Cerrado brasileiro, nordeste do Brasil

Resumo: Apesar de sua rica biodiversidade, o estado do Maranhão, nordeste do Brasil, é um dos estados brasileiros menos explorados e conhecidos do ponto de vista briológico. Até recentemente, a flora de hepáticas talosas do Maranhão era composta por 13 espécies, distribuídas em sete famílias. Este estudo relata os primeiros registros de algumas espécies hepáticas talosas para o Maranhão e para o Cerrado brasileiro, com base em expedições botânicas realizadas em diferentes áreas do Maranhão entre 2017 e 2025. São relatadas 10 espécies recém registradas para o estado, incluindo *Riccardia leptophylla*, *R. multifida*, *Riccia breutelii* e *R. subdepilata*, que também representam novos registros para o Cerrado brasileiro, e *Pteropsiella frondiformis*, novo registro para o Nordeste do Brasil. Esses novos registros aumentaram para quase o dobro o número de espécies de hepáticas talosas documentadas para o Maranhão, atingindo um total de 23 espécies. A família mais rica é Ricciaceae (9 espécies), seguida por Aneuraceae (6), enquanto Corsiniaceae, Lepidoziaceae e Pallaviciniaceae são representadas por duas espécies cada, e Cyathodiaceae e Monocleaceae por uma espécie. Este estudo sublinha a importância de investigações florísticas e taxonômicas em regiões pouco exploradas e enfatiza a necessidade de uma maior atenção a grupos de plantas negligenciados, como as briófitas.
Palavras-chave: *Briófitas; domínio do Cerrado; Marchantiophyta; novos registros; taxonomia.*

Introduction

Thalloid liverworts are characterized by a dorsiventrally flattened gametophyte or thallus, which lacks differentiation into stems and leaves. The thallus is usually dichotomously branched, occasionally regularly or irregularly pinnate, and highly variable in its internal structure (Bischler-Causse et al. 2005, Gradstein et al. 2001, Gradstein & Costa 2003). These liverworts are commonly terricolous or saxicolous and exhibit notable drought tolerance, allowing them to thrive in arid, harsh, and disturbed habitats (Gradstein & Costa 2003, Bischler-Causse et al. 2005). Their resilience to desiccation is attributed to specific features of gametophyte metabolism, cellular capacity to resume growth following water stress, and the rapid development of gametophytes and fast-maturing sporophytes during brief periods of water availability (Bischler-Causse et al. 2005). Globally, about 850 species of thalloid liverworts have been described (Söderström et al. 2016), of which 105 species were recorded in Brazil (Flora e Funga do Brasil 2025).

This paper presents new records of thalloid liverworts for the State of Maranhão, northeastern Brazil, also including species newly documented for the Brazilian Cerrado. Despite encompassing portions of three major Brazilian phytogeographic domains — Amazonia, Cerrado and Caatinga — as well as important transitional zones between them (Ab'Saber 1977, Montes et al. 1997, Muniz 2006, Dias et al. 2009, Stella 2011, Bandeira 2013, Spinelli-Araujo et al. 2016), Maranhão is one of the less explored and known Brazilian states from a bryological perspective.

To date, 13 species of thalloid liverworts have been reported for Maranhão, based on recent studies (Yano et al. 2009, Peralta et al. 2011, Varão et al. 2011, Silva et al. 2018, Oliveira et al. 2018, Costa et al. 2021, Fernandes et al. 2021, Silva et al. 2024, Carvalho et al. 2025). The first records for the state were provided by Yano et al. (2009), who documented *Cronisia weddellii* (Mont.) Grolle, *Riccia stenophylla* Spruce and *R. vitalii* Jovet-Ast. Additional contributions included the report of *Riccia planobiconvexa* Steph. (Peralta et al. 2011), and the documentation of *R. mauryana* Steph. and *R. weinionis* Steph. in a diversity study of the genus *Riccia* L. by Silva et al. (2018). Fernandes et al. (2021), studying the bryophyte flora of the Chapada das Mesas National Park, located in the southern portion of Maranhão, reported seven species, four of which were previously undocumented for the state: *Cyathodium cavernarum* Kunze, *Monoclea gottschei* Lindb., *Pteropsiella metzgeriiformis* Steph., and *Symphyogyna leptothelia* Taylor. Further additions include *Riccardia cataractarum* (Spruce) Schiffn. (Costa et al. 2021) and, most recently, *Riccardia chamedryfolia* (With.) Grolle and *Symphyogyna brasiliensis* (Nees) Nees & Mont., recorded by Silva et al. (2024) in the Nascentes do Rio Parnaíba National Park, the largest protected area of the Brazilian Cerrado.

Between 2017 and 2025, several field expeditions were carried out in different areas of Maranhão, with particularly focus on areas within the Cerrado domain. These surveys resulted in the identification of several thalloid liverwort previously unrecorded for the state, including four species new records for the Brazilian Cerrado and one for Northeastern Brazil. This paper aims to provide a comprehensive list of thalloid liverworts from Maranhão, including these new records. Examined specimens are presented with remarks on their distribution, ecology, morphology as well as photographs of the plants in the field.

Material and Methods

The specimens of thalloid liverworts were collected during expeditions between 2017 and 2025, from different areas of the State of Maranhão (Figure 1), northeastern Brazil: Chapada das Mesas National Park and its surroundings (municipality of Carolina); villages Caraíbas, Estrela and Centro Velho in the Chapada Limpa (municipality of Chapadinha); and village Pau D'arco (municipality of Pedreiras). Collections were carried out in rainy and dry seasons. The specimens were collected in specific and likely areas of colonization such as waterfalls, stream banks, riparian and gallery forests. The methodology of collection followed the one described by Yano (1989). The specimens were sun dried and subsequently deposited in the CCAA herbarium of the Universidade Federal do Maranhão campus Chapadinha. Duplicates of some species were sent to the RB herbarium (in Rio de Janeiro State).

The specimens were identified and described based on specialized studies such as Uribe & Aguirre (1995), Gradstein & Costa (2003), Bischler-Causse et al. (2005), Gradstein & Ilkiu-Borges (2009), Gradstein & Reeb (2018) and Gradstein (2021). The classification system followed Crandall-Stotler et al. (2009). The geographic distribution was based on the studies of Bischler-Causse et al. (2005), Gradstein & Costa (2003) and Gradstein (2021), as well as on online data available on REFLORA (http://floradobrasil.jbrj.gov.br) and TROPICOS (https://www.tropicos.org/home). The species names are in accordance with Söderström et al. (2016). In taxon authorities, the "ex" authors are omitted for brevity since their citation are not obligatory.

The list of thalloid liverwort recorded for the State of Maranhão was based on the following published studies: Yano et al. (2009), Peralta et al. (2011), Varão et al. (2011), Oliveira et al. (2018b), Silva et al. (2018), Fernandes et al. (2021), Costa et al. (2021), Silva et al. (2024) and Carvalho et al. (2025).

Results

1. New records of thalloid liverworts for Maranhão

Ten species of thalloid liverwort are first recorded for the State of Maranhão (see annotated list below), four of these species being also first records for the Brazilian Cerrado domain and on for Northeastern Brazil. The new records belong to four genera (*Cronisia* Berk., *Pteropsiella* Spruce, *Riccardia* Gray and *Riccia*) and four families (Aneuraceae, Corsiniaceae, Lepidoziaceae and Ricciaceae). Aneuraceae and Ricciaceae was the families that showed the highest increase in species richness with four new records each, followed by Corsiniaceae and Lepidoziaceae with one species each.

The new records are treated in alphabetical order by family, genera and species. Taxa new to state of Maranhão are marked by a single asterisk (*), Northeastern region by two asterisks (**) and for the Brazilian Cerrado by three asterisks (***). Remarks are provided for all new records with data on distribution, ecology and morphology.

ANEURACEAE

Riccardia digitiloba (Spruce) Pagán

Figure 2A

Examined specimen. BRAZIL. Maranhão: Carolina Municipality, Chapada das Mesas National Park, Farinha River, Mariazinha Creek,

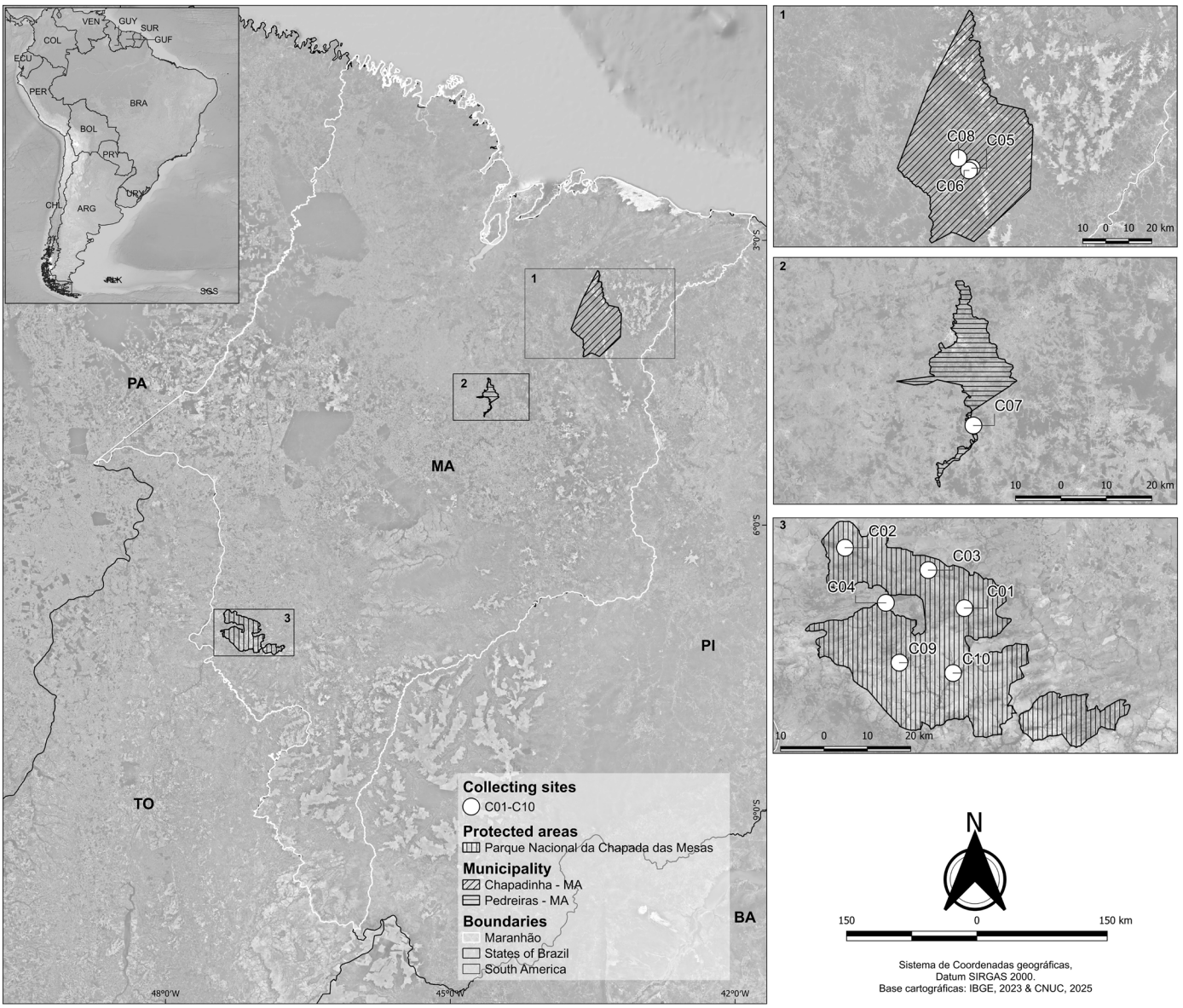

Figure 1. Distribution map of collections carried out in Maranhão.

06º56'51,30"S, 047º20'23,34"W, 187 m, March 11, 2017, *J. A. S. Silva 39* (CCAA).

Remarks. *Riccardia digitiloba* is a widespread neotropical species, common in Brazil (Flora e Funga do Brasil 2025, Gradstein 2021). This species usually grows on decaying or living tree trunks and rock, in shaded and humid areas, from sea level to 1400 m (Gradstein & Costa 2003, Flora e Funga do Brasil 2025). *Riccardia digitiloba* is distinguished by dioicous plants with ca. 1 cm long, prostate, irregularly 1–2-pinnate to dichotomous, main axis 4–12 cells thick, ellipsoid, cell walls thin, epidermis cells smaller than medullary cells, margin without wing, branches linear with rounded to retuse apex, without wing or occasionally with 1 cell wide wing, margins entire, and gemmae usually present and abundant, produced on decurved branch tips.

******Riccardia leptophylla*** (Spruce) Herzog
Figure 3

Examined specimen. BRAZIL. Maranhão: Carolina Municipality, Chapada das Mesas National Park, Prata waterfall, Farinha River, 6º59'39.35"S, 047º09'56.95"W, 228 m, March 12, 2017, *J. A. S. Silva 93* (CCAA).

Remarks. *Riccardia leptophylla* occurs in tropical America (Gradstein 2021). In Brazil, this species was recorded in Amazonia domain (Amazonas and Pará States) and in the Atlantic Forest (Minas Gerais and São Paulo States), on rotten wood or living tree trunk, in humid sites, in moist lowland and montane forests, at 100–1000 m [Gradstein & Costa 2003, as *R. tenuicula* (Spruce) Meenks, Flora e Funga do Brasil 2025]. *Riccardia leptophylla* can be dioicous or rarely monoicous, usually smaller, less than 1 cm long, prostate, irregularly 2-pinnate to palmate, main axis 3–6 cells thick, plano-convex to ellipsoid, cell walls thin, epidermis cells smaller than medullary cells, margin winged, wings 1–3 cells wide, branches linear to tongue-shaped, apex rounded, broadly winged, wings

Figure 2. Thalloid liverworts species in the field. A. *Riccardia digitiloba*. B. *Riccardia regnelii*. C. *Riccardia caractarum*. D. *Riccardia chamedryfolia*. E. *Cronisia weddellii*. F. *Cyathodium carvenarum*. G. *Riccia vitalii*. H. *Riccia mauryana*. Photograph: Lázaro Nikael Araújo-Oliveira.

Figure 3. *Riccardia leptophylla*. A. Median cells. B-C. Cross section of a thallus. D, F-G, I, J, L. Thallus. E. Wing cells. H. Spores. K. Plant in the field (A, E, H = 50 µm; B-D, F-G, I = 200 µm; J = 500 µm; K = 30 cm; L = 25 mm). Photograph: Lázaro Nikael Araújo-Oliveira.

usually wider than the midrib, the midrib vanishing below apex, margins entire, and gemmae present.

******Riccardia multifida*** (L.) S.F.Gray

Figure 4

Examined specimen. BRAZIL. Maranhão: Carolina Municipality, Chapada das Mesas National Park, São Romão waterfall, 07º04'25,0"S, 047º05'26,2"W, 227 m, June 7, 2018, *J. A. S. Silva 296* (CCAA).

Remarks. *Riccardia multifida* is widely distributed in temperate regions of the Northern Hemisphere, South Africa and rare in tropical America (recorded only in Brazil) (Gradstein & Costa 2003, Gradstein 2021). In Brazil, this species was recorded in the Atlantic Forest, where it grows on moist soil, from sea level to 1000 m (Gradstein & Costa 2003, Flora e Funga do Brasil 2025). *Riccardia multifida* is characterized by delicate, monoicous plants, prostate, regularly 1–3-pinnate, main axis 2–3 cells thick, ellipsoid, biconvex to plane-convex, epidermis cells smaller than medullary cells, margin winged, wings 2–3 cells wide, branches linear, tongue-shaped to oblong, 3–4 cells thick, apex rounded to truncate, winged, wings 3–4 cells wide, and margins crenulate.

****Riccardia regnellii*** (Ångstr.) K.G.Hell

Figure 2B

Examined specimen. BRAZIL. Maranhão: Carolina Municipality, Chapada das Mesas National Park, Vereda Bonita Ecological Ranch, 07º03'45,1"S, 047º15'16,2"W, 191 m, February 5, 2020, *J. A. S. Silva 499* (CCAA).

Remarks. *Riccardia regnellii* has a wide distribution in tropical South America (Gradstein & Reeb 2018, Gradstein 2021). In Brazil, this species occurs on decaying trunk or rock, in Amazonia, Brazilian Cerrado and Atlantic Forest, from sea level to 2200 m (Gradstein & Costa 2003, Flora e Funga do Brasil 2025). Characteristic are the delicate plants that can be dioicous or monoicous, thallus prostate, 0.5–1.5 cm long, irregularly 1–2-pinnate, main axis 4–8 cells thick, with a flat dorsal side and a convex ventral side, without wing or with a narrow, 1–2-cells wide wing, branches flat, winged, with straight or curved margins, often tongue-shaped, apex rounded to retuse, surface cells on ultimate branches frequently arranged in oblique rows.

LEPIDOZIACEAE

*****Pteropsiella frondiformis*** Spruce

Figure 5

Examined specimens. BRAZIL. Maranhão: Carolina Municipality, Chapada das Mesas National Park, near the Gavião waterfall, 07°12'33.1"S, 047°06'50.7"W, 222 m, January 17, 2025, *L. N. Araújo-Oliveira et al. 342* (CCAA).

Remarks. *Pteropsiella frandiformis* is distributed in northern South America (Fulford 1968, Gradstein & Costa 2003). In Brazil, this species occurs on decaying trunk, rocks and moist sand, in the Amazonia, with few records in the Brazilian Cerrado, from sea level to 100 m (Gradstein & Costa 2003, Flora e Funga do Brasil 2025). The species is characterized by prostrate, dioicous plants, thallus olive-green to dark green, 1–3 cm long, with broad lateral wings and a dorsally flattened axis, branches occasionally flagelliform or forked (*Frullania*-type), wing margin entire or irregularly toothed, with elongate papillae; cells quadrate to rectangular, 0.34–.075 × 0.3–0.4 mm, underleaves 2–4 cells wide. Androecia ventral or terminal, spike-like, gynoecia with large bifid bracts, and perianth cylindrical below, trilobed at apex, lobes ciliate-laciniate.

CORSINIACEAE

****Cronisia fimbriata*** (Nees) Whittem. & Bischl.

Examined specimen. BRAZIL. Maranhão: Chapadinha Municipality, Chapada Limpa, Caraíbas village, March 29, 2020, *J. A. S. Silva 435* (CCAA).

Remarks. *Cronisia* is a rare and small neotropical genus represented by two species, *C. fimbriata* and *C. weddellii* (Mont.) Grolle (Bischler-Causse et al. 2005). While the latter species is scattered in tropical America (Bischler-Causse et al. 2005, Gradstein 2021) and recorded for Maranhão in different studies (*e.g.*, Yano et al. 2009, Fernandes et al. 2021), *C. fimbriata* is known from Mexico, Brazil and Argentina, but cited here for the first time for Maranhão, although currently known from eight states in Brazil (Flora e Funga do Brasil 2025). *Cronisia fimbriata* grows on exposed rock or soil, in semi-arid zones, from sea level to 300 m (Gradstein & Costa 2003, Bischler-Causse et al. 2005, Flora e Funga do Brasil 2025). The morphological difference between *Cronisia fimbriata* and *C. weddellii* is that the latter has dorsal surface of thallus smooth, pores not elevated, and ventral scales not projecting beyond thallus margins, while in *C. frimbriata* the dorsal surface of thallus is roughened by numerous conical swellings, the pores are elevated, and the ventral scales are projecting beyond thallus margin (Gradstein & Costa 2003, Bischler-Causse et al. 2005).

RICCIACEAE

******Riccia breutelii*** Steph.

Figure 6

Examined specimens. BRAZIL. Maranhão: Carolina Municipality, Chapada das Mesas National Park, road from Cabeceira das Emas to Elias waterfall, anthropized area, with pasture and farms, on sandy soil by the side of the road, 07°11'15.0"S, 047°13'34.1"W, 210 m, January 18, 2025, *L.N. Araújo-Oliveira* et al. *366* (CCAA).

Remarks. *Riccia breutelii* is a neotropical species occurring in Mexico, Central America, the Caribbean, and South America (Bischler-Causse et al. 2005). In Brazil, this species has been recorded on sandy and clayey soils or on rocks, in the Amazonia domain, 50 to 4175 m (Bischler-Causse et al. 2005, Flora e Funga do Brasil 2025). This species is recognized by its thin thallus, 1–2.2 mm wide, with lobes 2–3 times forked, median groove deep apically, banishing below, and spores subtetrahedral, 100–140 µm in diam., wingless or with incomplete, narrow, yellow strip equator, distal face with 6–10 areoles across diam., with thick, dark red or nearly black ridges and big tubercles. These morphological characters distinguish it from other Neotropical *Riccia* species, particularly *R. brittonii* M.Howe and *R. elliottii* Steph. (see Bischler-Causse et al. 2005).

****Riccia membranacea*** Gottsche & Lindenb.

Examined specimens. BRAZIL. Maranhão: Chapadinha Municipality, Chapada Limpa, March 29, 2020, *J. A. S. Silva* 394, 395 (CCAA); Ibid., Centro Velho village, March 29, 2020, *J. A. S. Silva 398* (CCAA). Pedreiras Municipality, Pau D'arco village, balneário Cesário, 04º44'19.9"S, 044º34'20.7"W, July 3, 2021, *R. S. Fernandes 1087* (CCAA).

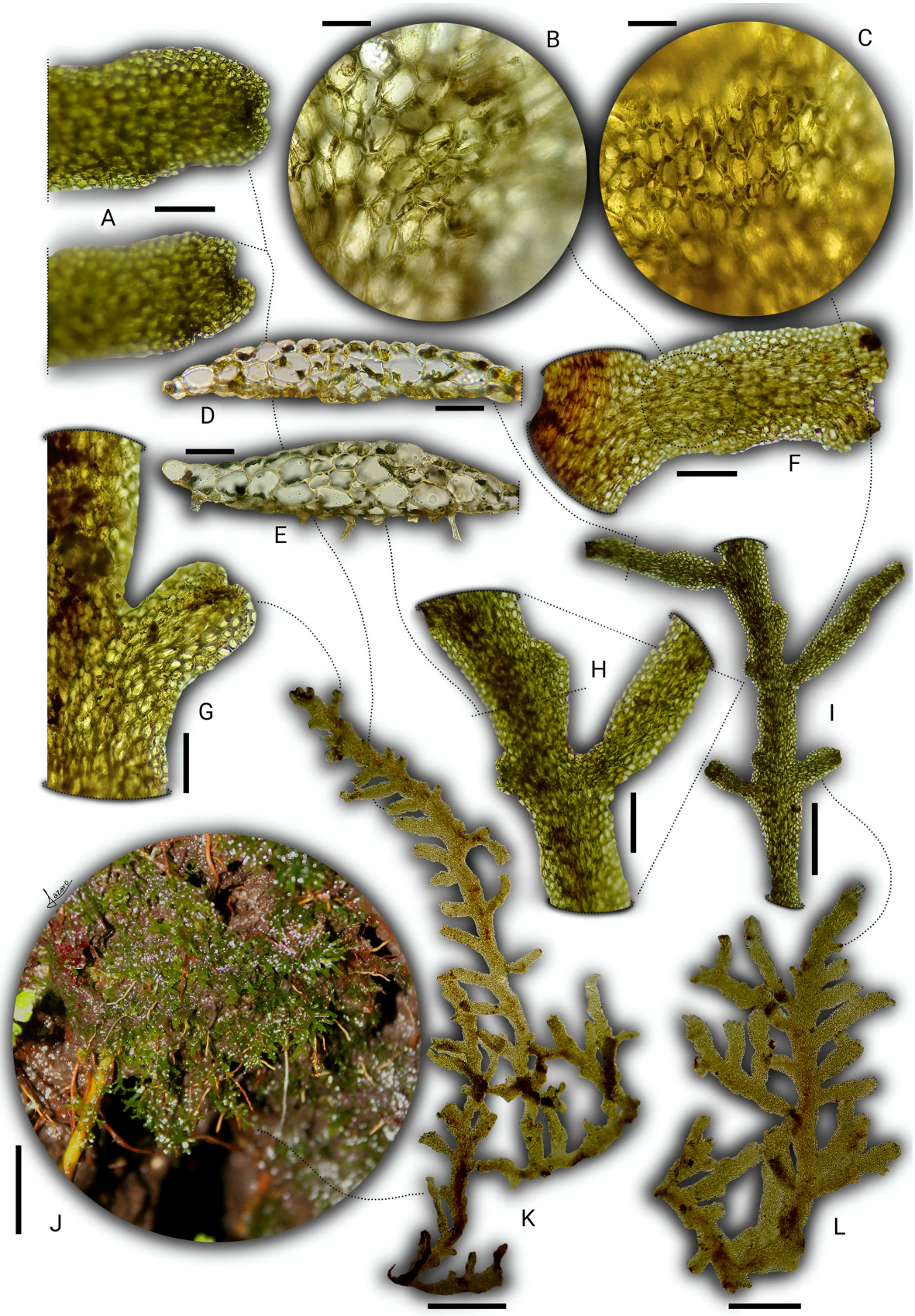

Figure 4. *Riccardia multifida*. A. Branch apex. B. Median cells of a branch. C. Median cells of a main thallus. D. Cross section of a branch. E. Cross section of a main thallus. F-G. Branch. H-I, K-L. Thallus. J. Plant in the field. (A-C, F-G, I = 200 µm; D, E, H = 50 µm; J = 30 cm; K = 25 mm; L = 500 µm). Photograph: Lázaro Nikael Araújo-Oliveira.

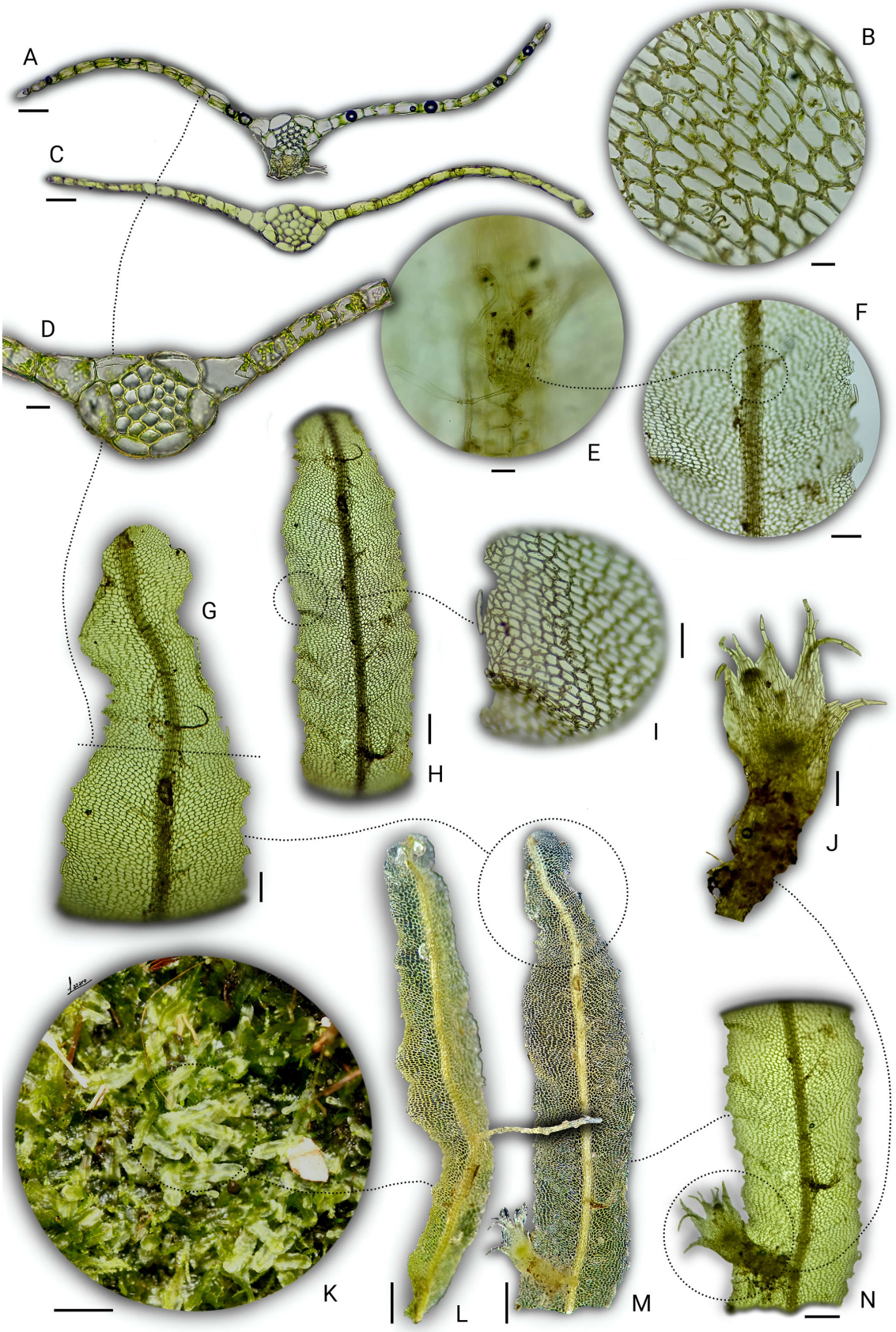

Figure 5. *Pteropsiella frondiformis*. A, C, D. Cross section of thallus. B. Cells of a thallus. E-F. Rhizoids. G-H. Thallus. I. Margin with elongate slime papillae. J. Gynoecia. K. Plant in the field. L. Thallus. M-N. Thallus with gynoecia (A, C, F, I, J = 200 µm; B, D, E = 50 µm; G, H, N = 500 µm; K = 40 cm; L-M = 25 mm). Photograph: Lázaro Nikael Araújo-Oliveira.

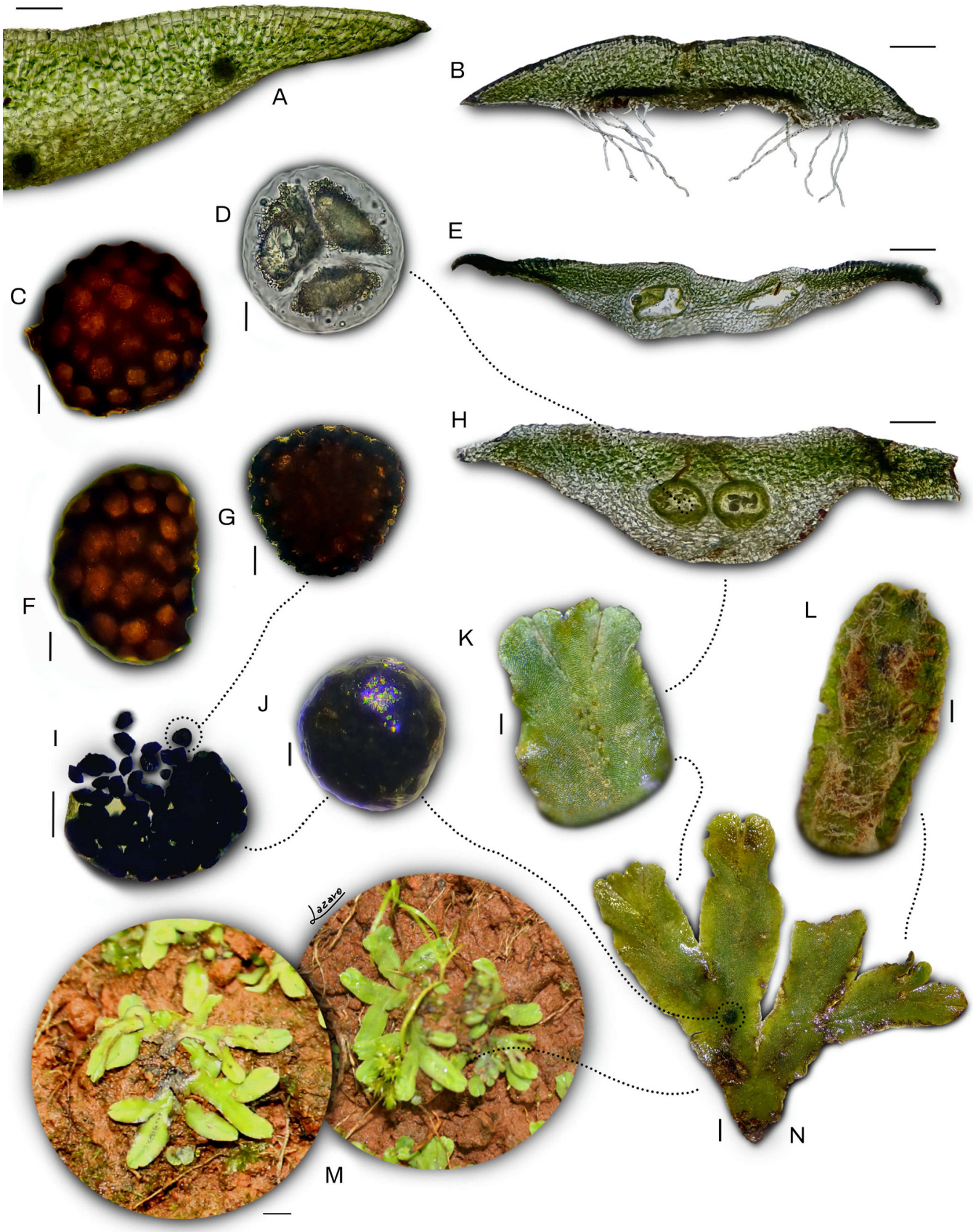

Figure 6. *Riccia breutelii*. A-B, E. Cross section of a thallus. C. Spore, ventral view. D. Tetrahedral spore. F. Spore, lateral view. G. Spore, dorsal view. H. Cross section of a thallus, showing sporophyte channels. I. Spores. J. Capsule. K. Thallus lobe, dorsal view. L. Thallus lobe, ventral view. N. Habit. M. Plant in the field (A = 200 µm; B, E, H, I = 500 µm; C, D, F, G = 50 µm; J = 40 mm, K = 30 mm, L = 25 mm; N = 20 mm; M = 40 cm). Photograph: Lázaro Nikael Araújo-Oliveira.

Remarks. *Riccia membranacea* occurs in tropical America, tropical Africa and U.S.A (Bischler-Causse et al. 2005). In Brazil, this species grows on soil along rivers and ponds, in open places, in Amazonia, Pantanal and Atlantic Forest, from sea level to 1000 m (Gradstein & Costa 2003, Flora e Funga do Brasil 2025). *Riccia membranacea* (the only species in subg. *Leptoriccia* R.M.Schust.) is recognized by the thin thallus with 2–3 cells thick, the thallus with lobes widened toward the apex, and brownish spores, which are densely covered by sharp spines. The thin thallus and the spiny spore distinguished the species from all others neotropical *Riccia* (Bischler-Causse et al. 2005).

***Riccia sorocarpa** Bisch.

Examined specimen. BRAZIL. Maranhão: Carolina Municipality, Chapada das Mesas National Park, Prata waterfall, Farinha River, 06º59'37,4"S, 047º09'57"W, 228 m, March 12, 2017, *J. A. S. Silva 84* (CCAA).

Remarks. *Riccia sorocarpa* has a worldwide distribution (Bischler-Causse et al. 2005). In Brazil, this species was recorded in humid soil and rock, in Caatinga, Brazilian Cerrado and Atlantic Forest (Yano & Andrade-Lima 1987, Flora e Funga do Brasil 2025). *Riccia sorocarpa* (subg. *Riccia*) is recognized by smooth thallus, subepidermal cells thick-walled (in cross section), and spores winged.

****Riccia subdepilata** Jovet-Ast

Figure 7

Examined specimens. BRAZIL. Maranhão: Chapadinha Municipality, Chapada Limpa, Estrela village, da Ponte River, 03º53'45,5"S, 043º29'21,8"W, 41 m, July 11, 2019, *J. A. S. Silva 371* (CCAA); Ibid., August 23, 2022, *V.F. Ferreira & R.S. Fernandes 13* (CCAA).

Remarks. *Riccia subdepilata* is a rare species, endemic to Brazil (Gradstein & Costa 2003, Bischler-Causse et al. 2005). It was recorded for Bahia (type locality) and Pernambuco. This species grows on moist soil in Caatinga vegetation, at ca. 200 m (Gradstein & Costa 2003, Bischler-Causse et al. 2005). *Riccia subdepilata* (subg. *Riccia*) is recognized by a few cilia in the margin, ventral scales hyaline and spores rather small, with smooth triangular area bounding the pores on the proximal face. The spore wall ornamentation is similar with *Riccia horrida* but the latter species has numerous, long cilia in the margin and ventral scale violaceous (Bischler-Causse et al. 2005).

2. Thalloid liverworts of Maranhão: an updated list

With these new records, the total number of thalloid liverwort species known from Maranhão has increased to 23 species (Table 1). Among the seven families recorded, Ricciaceae (genus *Riccia*) exhibits the highest species richness, with nine species, followed by Aneuraceae (*Riccardia*) with six. Corsiniaceae (*Cronisia*), Lepidoziaceae (*Pteropsiella*) and Pallaviciniaceae (*Symphyogyna*) are each represented by two species, while Cyathodiaceae (*Cyathodium* Lehm.) and Monocleaceae (*Monoclea* Hook.) are each represented by a single species.

Discussion

With the addition of nearly 44% more species to the previous list of thalloid liverworts of the State Maranhão, this study represents a significant contribution to the knowledge of Brazilian bryophytes, particularly relevant for the Cerrado. This finding reinforces the ecological importance of the region and corroborate the view expressed by several researchers that increased efforts in botanical collection, particularly in poorly studied or unexplored areas, are essential for advancing floristic knowledge (Hallingbäck & Hodgetts 2000, Oliveira-da-Silva & Ilkiu-Borges 2020, Zorzanelli et al. 2017). In this context, Maranhão and the Cerrado emerge as priorities for future bryological research, with the potential to reveal even greater, yet undocumented, diversity.

The thalloid liverwort flora in Brazil, comprising approximately 106 species, includes 37 species recorded in the Brazilian Cerrado (Flora e Funga do Brasil 2025). With 62% of these Cerrado species now documented in Maranhão, the state emerges as a significant area for thalloid liverwort diversity within this biome. These records were compiled from various regional studies and floristic surveys (Yano et al. 2009, Peralta et al. 2011, Silva et al. 2018, Costa et al. 2021, Fernandes et al. 2021). The new occurrences of thalloid liverworts reported in this study were expected, considering the Cerrado's favorable ecological conditions that promote the establishment and persistence of such species.

Notably, three families found in the Amazonia, Cerrado and in Caatinga, such as Marchantiaceae, Dumortieraceae, and Metzgeriaceae, have not yet been collected in Maranhão. However, this absence is likely due to sampling gaps rather than true absence, as many ecologically suitable areas, including conservation units and remote habitats, remain scientifically unexplored. These regions may harbor not only missing families but potentially new or rare taxa as well.

Thalloid liverworts are not usually the main focus of floristic studies in contrast to other groups of bryophytes (mosses and leafy liverworts). The group often occupy specialized microhabitats such as moist rock surfaces, the margins of streams, and shaded forest understories; niches that are frequently overlooked in broader floristic surveys. This ecological specificity may partially explain their underrepresentation in botanical inventories. Moreover, their sensitivity to environmental changes makes them valuable bioindicators for monitoring ecosystem health, particularly in regions like the Cerrado.

Despite their ecological significance, thalloid liverworts remain among the least studied groups of bryophytes in Brazil. Existing studies are relatively few and often geographically limited (*e.g.*, Hell 1969, Silva et al. 2018, Fernandes et al. 2021), resulting in a fragmented understanding of their distribution and ecological roles. Therefore, expanding field research and taxonomic revisions, supported by molecular tools and ecological data, is crucial for revealing the full extent of species diversity and endemism.

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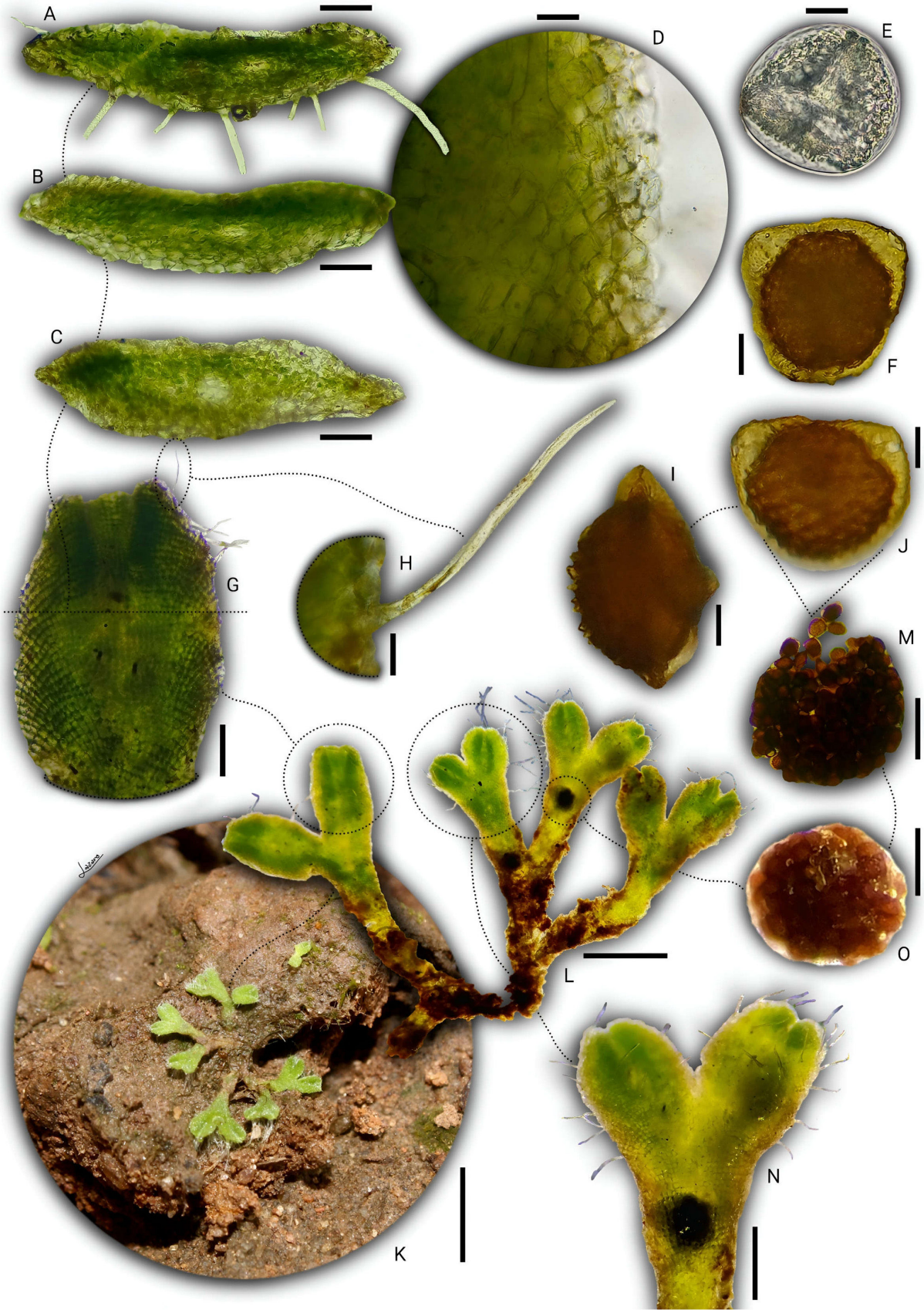

Figure 7. *Riccia subdepilata.* A-C. Cross section of a thallus. D. Margin cells of a thallus, dorsal view. E. Imature spore. F. Spore, dorsal view. G. Thallus lobe. H. Cilia. I. Spore, lateral view. J. Spore, ventral view. K. Plant in the field. L. Habit. M. Spores. N. Section of a thallus. O. Capsule (A, B, C, G = 200 µm; D, E, F, H, I, J = 50 µm; K = 20 cm; L = 25 mm; M = 500 µm; N = 30 mm; O = 40 mm). Photograph: Lázaro Nikael Araújo-Oliveira.

Table 1. List of all thalloid liverworts recorded for the State of Maranhão, with data on distribution, citation of the first record and voucher. (*) New record for Maranhão, (**) New record for the northeastern Brazil and (***) New record for the Brazilian Cerrado.

Family	Species	Worldwide distribution	First record for Maranhão	Voucher
Aneuraceae	*Riccardia cataractarum* (Spruce) Schiffn.	Neotropical	Costa et al. (2021)	J. P. Silva 138 (CCAA)
	Riccardia chamedryfolia (With.) Grolle	Southern Hemisphere and Tropics	Silva et al. (2024)	J. P. Silva 95 (CCAA)
	**Riccardia digitiloba* (Spruce) Pagán	Neotropical	This study	J. A. S. Silva 39 (CCAA)
	****Riccardia leptophylla* (Spruce) Herzog	Neotropical	This study	J. A. S. Silva 93 (CCAA)
	****Riccardia multifida* (L.) S.F.Gray	North Hemisphere, South Africa and Brazil	This study	J. A. S. Silva 296 (CCAA)
	**Riccardia regnellii* (Ångstr.) K.G.Hell	tropical South American	This study	J. A. S. Silva 499 (CCAA)
Corsiniaceae	**Cronisia fimbriata* (Nees) Whittem. & Bischl.	México, Brazil and Argentina	This study	J. A. S. Silva 435 (CCAA)
	Cronisia weddellii (Mont.) Grolle	Neotropical	Yano et al. (2009)	J. A. S. Silva 302 (CCAA)
Cyathodiaceae	*Cyathodium cavernarum* Kunze	Wide	Fernandes et al. (2021)	J. A. S. Silva 551 (CCAA)
Lepidoziaceae	*Pteropsiella metzgeriiformis* R.M.Schust.	Brazil and Colombia	Fernandes et al. (2021)	J. A. S. Silva 294 (CCAA)
	***Pteropsiella frondiformis* Spruce	Neotropical	This study	L. N. Araujo-Oliveira et al. 342 (CCAA)
Monocleaceae	*Monoclea gottschei* Lindb.	Neotropical	Fernandes et al. (2021)	J. A. S. Silva 557 (CCAA)
Pallaviniaceae	*Symphyogyna leptothelia* Taylor	Neotropical	Fernandes et al. (2021)	J. A. S. Silva 491 (CCAA)
	Symphyogyna brasiliensis (Nees) Nees & Mont.	Afro-American	Silva et al. (2024)	J. P. Silva 98 (CCAA)
Ricciaceae	****Riccia breutelii* Steph.	Neotropical	This study	L. N. Araujo-Oliveira et al. 366 (CCAA)
	Riccia mauryana Steph.	American	Silva et al. (2018)	J. A. S. Silva 134 (CCAA)
	**Riccia membranacea* Gottsche & Lindenb.	Afro-American	This study	J. A. S. Silva 398 (CCAA)
	Riccia planobiconvexa Steph.	Tropical and subtropical American	Peralta et al. (2011)	E. S. Brito 23 (SP)
	**Riccia sorocarpa* Bisch.	Worldwide	This study	J. A. S. Silva 84 (CCAA)
	Riccia stenophylla Spruce	American	Yano et al. (2009)	A. L. F. Rodrigues 11 (CCAA)
	****Riccia subdepilata* Jovet-Ast	Endemic to Brazil	This study	J. A. S. Silva 371 (CCAA)
	Riccia vitalii Jovet-Ast	Neotropical	Yano et al. (2009)	J.A.S. Silva 85 (CCAA)
	Riccia weinionis Steph.	Neotropical	Silva et al. (2018)	J.A.S. Silva 135 (CCAA)

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Conflicts of Interest

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

Ethics

The authors of the present paper are aware of and comply with research ethics policies. This study did not involve human beings and/or clinical trials that should be approved by an Institutional Committee.

Data Availability

The data used in this study are available at: https://doi.org/10.48331/scielodata.FJNBOK.

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