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Caliciaceae foliosas em Mato Grosso do Sul, Brasil

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CAMPO GRANDE, MS
2019

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"Dissertação apresentada como um dos requisitos para obtenção do grau de Mestre em Biologia Vegetal junto ao Instituto de Biociências da Universidade Federal de Mato Grosso do Sul"

Campo Grande – MS

2019

AGRADECIMENTOS

Ao professor Dr. Adriano Afonso Spielmann por todo o apoio e inspiração ao longo de minha tragetória acadêmica. Por ter guiado meu caminho dentro da taxonomia. Pela grande amizade. Serei eternamente grato por todos esses ensinamentos! Muito obrigado professor!

A Dr. Luciana Canêz pelos conselhos e ensinamentos (principalmente sobre organização).

Ao Dr. Marcos Junji Kitaura por me ensinar diversos conceitos anatômicos e por me mostrar como construir protocolos de descrição. E por ser um grande amigo! A Dr. Natália Mossmann Koch por me explicar muito sobre ecologia dos liquens e sempre me encher de amostras interessantes.

A Dr. Neli Kika Honda que de forma tão carinhosa nos acolheu em seu laboratório e mostrou o fantástico mundo da química dos liquens, como também a importância das "chipas gregas" na busca de respostas.

Ao Dr. Flávio Macedo Alves e o Dr. Arnildo Pott, pelas incontáveis horas de ensinamentos e discussões sobre taxonomia, dentro e fora das salas de aula, como também sobre línguas extrangeiras.

A minha doce namorada Gabriela Hrycyna, por me mostrar um amor imensurável, que me acompanhou por todo o meu curso de mestrado e ainda me deu força e inspiração em momentos difíceis. Te amo muito!

A minha irmã Mayara Duim Barbosa, que muito antes de eu imaginar cursar biologia me ensinou um pouco sobre a língua portuguesa, mesmo eu odiando isso e ao meu cunhado Lucas Ferreira pelo apoio e parceria.

Aos meus pais, Rosanjela Aparecida Duim e Marcos Dias Barbosa, que me proporcionaram realizar os meus sonhos como biólogo.

Aos meus grandes amigos Jean Marc Torres Pineda e Andressa Silva Rodrigues pelas muitas horas de laboratório juntos e coletas divertidas.

Aos técnicos do Laboratório de Botânica Tamires Yule e Joazinho que me salvaram em diversos momentos e também com o fornecimento de muitos reagentes.

A todos aqueles que me auxiliaram e me apoiaram, durante toda minha formação científica.

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RESUMO

Caliciaceae é uma família bastante representativa de liquens e apresenta espécies com talos de hábito crostoso, folioso ou fruticoso. Apesar da grande diversidade de espécies (675), poucos inventários foram realizados no Brasil, sendo este o primeiro trabalho desta natureza em Mato Grosso do Sul e com o foco nas *Caliciaceae* de hábito folioso. Ao todo foram encontrados 38 táxons, incluindo sete novos registros para Mato Grosso do Sul, dois novos registros para o continente americano e quatro espécies novas para a Ciência. São apresentadas descrições detalhadas, comentários e chaves para identificação. Também foi efetuada a revisão teórica sobre o gênero *Dirinaria*, culminando em uma chave mundial, descrições e comentários sobre as espécies, o que inclui a exclusão de três espécies antes classificadas neste gênero.

Palavras-chave: ascosporos, fungos, líquen, novas espécies, taxonomia.

INTRODUÇÃO GERAL

Liquens

Os liquens, mais propriamente classificados como **fungos liquenizados**, são organismos simbióticos de estrutura estável, compostos por diferentes partes: alga (clorofilada – o fotobionte) e o fungo (aclorofilado - o micobionte) (Marcelli 1996). A associação entre o fungo e a alga funciona como uma espécie de "parasitismo controlado": as hifas modificadas do fungo (hifas apressórias) envolvem a alga e a partir destas desenvolvem-se haustórios, cuja função é retirar os produtos da fotossíntese sem causar a morte da alga (Paracer & Ahmadjian 2000).

Estudos recentes (Spribille *et al.* 2016) indicaram que a simbiose liquênica não mais trata somente da presença de uma única espécie de fungo e seus fotobiontes, e que na verdade existe pelo menos a presença de dois fungos: um fungo pertencente ao filo *Basidiomycota* e outro ao filo *Ascomycota*.

O resultado da simbiose entre fungos e algas, formando liquens, geralmente é visível pela formação de um corpo específico, chamado de **talo**. O talo liquênico é bastante complexo. Essa complexidade permite aos liquens possuírem várias formas de crescimento, ter muitas cores, e se reproduzirem de forma variada. Essa diversidade é utilizada na taxonomia de forma a categorizá-los, mesmo que não demonstre uma relação de parentesco, pois determinadas formas podem estar presentes em diversas famílias de fungos liquenizados, e em outros casos um gênero pode englobar diversas formas (Poelt 1973).

Um exemplo de forma de crescimento é o talo **folioso**, que possui córtex inferior na maioria das espécies, e geralmente **lobos** (divisões mais largas do que longas) ou **lacínias** (divisões mais longas do que largas) (Kirk *et al.* 2008).

O substrato no qual os liquens crescem é importante na sua identificação, pois muitas espécies possuem preferências para seu desenvolvimento. Como alguns exemplos, temos os liquens que crescem sobre o córtex de árvores (corticícolas), sobre rochas (saxícolas), sobre o solo (terrícolas), junto a musgos (muscícolas) e sobre folhas (foliícolas) (Marcelli 1996).

Estudos prévios no Mato Grosso do Sul

Inventários taxonômicos com o foco em fungos liquenizados no Mato Grosso do Sul tiveram como ponto de partida as coletas realizadas por Malme durante a Primeira Expedição Regneliana. As coletas feitas por esse pesquisador no Estado foram realizadas no município de Corumbá, região oeste de Mato Grosso do Sul. Sendo assim os principais registros da flora

liquênica do Estado são trabalhos resultantes das coletas realizadas nessa expedição (como por exemplo Malme 1902, 1924, 1925, 1926, 1927, 1928, 1934, 1936; Redinger 1933, 1935).

Depois de Malme, há uma grande lacuna temporal no estudo dos liquens no Estado, até que no final dos anos 1980 tiveram início os trabalhos com liquens na Universidade Federal do Mato Grosso do Sul, através do grupo interdisciplinar, "Química dos liquens", coordenado pela Professora Neli Kika Honda. Para os desdobramentos mais importantes referentes aos trabalhos taxonômicos no Mato Grosso do Sul, bem como as lacunas ainda existentes nesta área, veja Spielmann & Canêz (2012).

Os liquens apresentam uma grande importância ecossistêmica por fornecerem micro-hábitats para diversos tipos de organismos e ainda atuarem como colonizadores primários de diversos ambientes. Também existe uma certa importância social e econômica sobre os liquens, como tribos tradicionais que utilizam os liquens como medicamentos ou corantes (Weerakoon 2015). Por terem uma grande diversidade de metabólitos secundários, os liquens também são objeto de muitos estudos químicos (Honda & Vilegas 1998).

O Mato Grosso do Sul

O Mato Grosso do Sul possui uma área de 357.145,4 km², que se estende até as fronteiras internacionais com as Repúblicas do Paraguai e da Bolívia na sua parte sul, sudoeste e oeste, onde é banhado pela bacia do Rio Paraguai. A fronteira leste e norte/nordeste é banhada pela bacia do Rio Paraná e seus afluentes, fazendo divisa com cinco estados brasileiros: Paraná, São Paulo, Minas Gerais, Goiás e Mato Grosso (Secretaria de Estado de Meio Ambiente e Desenvolvimento Econômico 2015). Dentro da área de abrangência do Estado estão presentes quatro formações vegetacionais: Cerrado, Chaco, Mata Atlântica e Pantanal. Devido a interações entre as formações vegetacionais, nota-se a formação de um mosaico vegetacional, resultando em uma grande diversidade biológica (Silva *et al.* 2010).

O Cerrado é uma formação do tipo savana tropical, com extensão de cerca de dois milhões de km² no Brasil Central, e para o qual são descritos onze tipos fitofisionômicos gerais: Campo Limpo, Campo Rupestre, Campo Sujo, Cerradão, Cerrado *stricto sensu*, Mata Ciliar, Mata de Galeria, Mata Seca, Palmeiral, Parque de Cerrado e Vereda (Ministério do Meio Ambiente 2007). O Cerrado é a formação vegetal com maior cobertura no Estado, cerca de 61%, seguido do Pantanal que cobre cerca de 25% do Estado (Silva *et al.* 2010). O Pantanal é uma das maiores planícies inundáveis do planeta, e está localizado na região central da América do Sul, principalmente nas áreas dos Estados brasileiros do Mato Grosso e Mato Grosso do Sul. As principais feições fitoecológicas presentes são compostas pela Savana Arborizada, Savana

Florestada, Savana Gramíneo-lenhosa, Pastagem e Floresta Estacional Semidecidual Aluvial (Pott *et al.* 2009).

Apesar de não cobrir uma área tão extensa quanto o Cerrado e o Pantanal, a Mata Atlântica apresenta duas formações vegetacionais florestadas que contrastam bastante com as demais: a Floresta Estacional Decidual e a Floresta Estacional Semidecidual (Ministério do Meio Ambiente 2010). Finalmente, o Chaco é a menor formação vegetacional do Brasil e localiza-se no extremo sudoeste de Mato Grosso do Sul, restrita ao município de Porto Murtinho (Prado 1993). Contudo, o Chaco ainda é pouco conhecido do ponto de vista florístico (Sartori 2012), sendo que um inventário liquenológico só foi conhecido recentemente (Torres 2018).

Caliciaceae **Chevall.**

Caliciaceae foi proposta por Chevallier (1826), tendo como gênero-tipo *Calicium* Pers. Atualmente apresenta cerca de 675 espécies dentro de 36 gêneros, sendo a oitava maior família de fungos liquenizados (Lücking *et al.* 2017). Por bastante tempo a família englobava um grupo de ascomicetos prototunicados (ascos de paredes finas e evanescentes) com mazédio (um acúmulo de esporos soltos e maduros cobrindo a superfície do ascoma). Desta forma abrigava outros gêneros com essas características, mesmo não tendo uma relação natural (Prieto & Wedin 2016).

Wedin *et al.* (2000), ao realizar análises de filogenia molecular, concluíram que *Caliciaceae* e *Physciaceae* formavam um grupo monofilético, e Wedin & Grube (2002) uniram as duas famílias sob *Physciaceae*, alegando que este era o nome mais usado (sendo proposto para conservação) em comparação a *Caliciaceae* (mais antigo).

Porém, Prieto & Wedin (2016), com uma nova e mais completa filogenia molecular, restabeleceram *Caliciaceae*, deixando evidente que esta família comporta mais gêneros que *Physciaceae*.

Para o Brasil são conhecidos 15 gêneros de *Caliciaceae* (Marcelli 2003, Cáceres *et al.* 2014), dos quais somente dois são foliosos: *Pyxine* Fr. com 68 espécies (Aptroot *et al.* 2014, Jungbluth & Marcelli 2011, Jungbluth 2010, Jungbluth *et al.* 2011, Mongkolsuk *et al.* 2012 e Nayaka *et al.* 2013), sendo 32 registradas para o Brasil (Aptroot *et al.* 2014, Jungbluth & Marcelli 2011, Jungbluth 2010, Jungbluth *et al.* 2011) e *Dirinaria* (Tuck.) Clem. com 25 espécies (Barbosa *et al. in prep.* Capítulo 2), das quais 12 são relatadas para Brasil (Awasthi 1975, Kalb 1982, Kalb 2001, Kalb 2004). Em Mato Grosso do Sul foram citados seis gêneros e aproximadamente 27 espécies pertencentes às *Caliciaceae*. Destes gêneros, quatro são crostosos: *Buellia* De Not., *Calicium* Pers., *Cratiria* Marbach e *Dimelaena* Norman, e dois foliosos: *Dirinaria* e *Pyxine*. Levando em consideração o total (27 espécies), 19 são de hábito folioso (Bernardo *et al. in prep*.).

No Brasil a Liquenologia é uma área da ciência com escassez de profissionais, o que demonstra um déficit de estudos com liquens e, ainda, estudos florísticos que os abordem. Por apresentar mosaicos vegetacionais, o Mato Grosso do Sul tem uma grande diversidade de ambientes, o que propicia a alta diversidade de diversos grupos de organismos, incluindo liquens. Com o desmatamento e antropização de áreas naturais, a diversidade tende a ser alterada e reduzida, e com isso tornam-se de extrema importância estudos dessa natureza. No futuro, tais inventários poderão servir de base para planos de manejo que visem a preservação da diversidade de liquens. Dessa forma, este é o primeiro trabalho a ter como alvo o estudo de uma família de fungos liquenizados no Estado de Mato Grosso do Sul.

OBJETIVO GERAL

- Inventariar os liquens de hábito folioso pertencentes a *Caliciaceae* em Mato Grosso do Sul, Brasil.

OBJETIVOS ESPECÍFICOS

- Elaborar chaves dicotômicas para os táxons abordados;
- Elaborar descrições detalhadas;
- Realizar ilustrações;
- Determinar a composição química de importância taxonômica de todo o material analisado.

ESTRUTURA DA DISSERTAÇÃO

Capítulo I - Foliose *Caliciaceae* (lichenized *Ascomycota*) from Mato Grosso do Sul State, Brazil.

Capítulo II - Circumscription of the genus *Dirinaria* (*Caliciaceae*, lichenized *Ascomycota*)

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Chapter I

Foliose Caliciaceae (lichenized Ascomycota) from Mato Grosso do Sul State, Brazil

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(http://www.mapress.com/phytotaxa/author.htm)

Foliose Caliciaceae (lichenized Ascomycota) from Mato Grosso do Sul State, Brazil

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Abstract

Caliciaceae show abundance in central Brazil dominated by *Cerrado* (savanna) and are represented by two foliose genera (*Dirinaria* and *Pyxine*). The objective of this study was to evaluate the diversity of the foliose Caliciaceae from Mato Grosso do Sul State. The inventory resulted in 38 taxa, including four new species: *Dirinaria maracajuensis*, *Pyxine denigricans*, *P. flavolucens* and *P. parapetricola*. *Dirinaria africana* and *D. melanoclina* are new to the Neotropics, *D. papillulifera*, *D. picta*, *D. pruinosa, D. purpurascens*, *P. astipitata*, *P. nana* and *P. pustulata* are new to Mato Grosso do Sul State. Keys and illustrations for all taxa are presented.

Key-words: ascospores, fungi, lichen, new species, taxonomy

Introduction

Caliciaceae comprehend approximately 675 species (Lücking *et al.* 2017) and have a cosmopolitan distribution (Awasthi 1975, Kalb 1987). The family was proposed by Chevallier (1826), based on the genus *Calicium* Pers. (1794: 20). According to Prieto & Wedin (2016), for a long time "Caliciaceae was one of several Ascomycete groups characterized by producing prototunicate (thin-walled and evanescent) asci and a mazaedium (an accumulation of loose, maturing spores covering the ascoma surface)". Therefore, Caliciaceae was classified together with all others mazaediate or similar groups in the Caliciales.

Wedin *et al.* (2000) concluded that Caliciaceae and Physciaceae form a natural group, and subsequently Wedin & Grube (2002) proposed the conservation of the name Physciaceae.

Nevertheless, more data, especially from molecular studies, enabled Prieto & Wedin (2016) again to split the two families, a view take up by Lücking *et al.* (2017).

Caliciaceae comprise 37 genera, with only three of them being foliose: *Culbersonia* Essl. (2000: 771) recently included in family (Aptroot *et al.* 2019), *Dirinaria* (Tuck.) Clem. (1931: 323) and *Pyxine* Fr (1825: 267). Important accounts about these genera are: Moore (1968), Dodge (1971), Awasthi (1975), Swinscow & Krog (1978), Kalb (2001), Elix (2009) for *Dirinaria*; Imshaug (1957), Moore (1968), Swinscow & Krog (1975), Kalb (1987), Elix (2009), Jungbluth (2010), and Mongkolsuk *et al.* (2012) for *Pyxine* and Aptroot *et al.* (2019) for *Culbersonia.*

The three foliose genera have a mainly pantropical distribution, and for this reason are abundant in the Neotropical region and consequently in Brazil (Awasthi 1975, Kalb 1987), where approximately 12 species of *Dirinaria* are known, in majority cited by Awasthi (1975). Around 30 species of *Pyxine* are known from Brazil, mainly cited by Kalb (1987), Jungbluth (2010) and Aptroot *et al.* (2014). As shown by Kalb (1987) and Jungbluth (2010), taxonomic studies focused in Brazil tend to raise the diversity. This was also seen in Thailand by Mongkolsuk *et al.* (2012).

Foliose members of Caliciaceae (*Dirinaria* and *Pyxine*) show a great diversity and abundance of species in *Cerrado* (Marcelli 1998). The central region from Brazil is represented mainly by *Cerrado*, with trees, shrubs and rocky outcrops. The state of Mato Grosso do Sul is dominated by this vegetacional formation. In this State, about 25 species of Caliciaceae are known, 20 of which are foliose.

Although Caliciaceae presents a great diversity, just few inventories were made in Brazil. Here we present the first one focused in Mato Grosso do Sul State.

The state of Mato Grosso do Sul (MS) is located in southwestern Brazil, consisting on a territorial area of 357,145 km², which has international borders with Paraguay and Bolivia in the South, Southwest and west, where the Paraguay River basin. In the East and North lies the basin of the Paraná River and its affluents, and the state borders on five Brazilian states: Goiás, Mato Grosso, Minas Gerais, Paraná and São Paulo (Silva *et al*. 2010). In Mato Grosso do Sul State four plant formations are present: the *Cerrado*, the *Chaco*, the Atlantic Forest and the *Pantanal*. Due to interactions between plant formations, we can observe the formation of a vegetative mosaic (Figure 1A), resulting in a great biological diversity (Silva *et al*. 2010).

The *Cerrado* is a tropical savanna-like formation, with an extension of about two million square kilometers in central Brazil. The main vegetation types of *Cerrado* are: *campo limpo* (open grassland), c*ampo rupestre* (rocky field), *campo sujo* (Shrubby grassland), *Cerrado stricto sensu*, *mata ciliar* (riparian forest), *mata de galleria* (gallery forest), *mata seca* (dry seasonal forest), and *Vereda* (palm swamp). The *Cerrado* is the vegetation formation with the greatest coverage in the state, about 61% (Silva *et al*. 2010), followed by the *Pantanal*, which covers about 25% of the

state (Silva *et al.* 2010). The *Pantanal* has a restricted distribution and is located only in the central region of South America, mainly in the Brazilian states of Mato Grosso and Mato Grosso do Sul. The main vegetation features are composed by the woody savanna, grassy-woody savanna, grassland and seasonal semideciduous forest (Pott *et al.* 2009).

Although not so extensive, the Mata Atlântica presents a forested vegetation that contrasts sharply with the others, with two different types: Floresta Estacional Decidual and Floresta Estacional Semidecidual. It is present mainly in the South and Southwest of the state (Silva *et al*. 2010). The *Chaco* is the smallest vegetational formation in Brazil and is in the extreme southwest of Mato Grasso do Sul, being restricted to the municipality of Porto Murtinho (Prado 1993). Although occurring in a restricted mode in Brazil, the *Chaco* presents different environmental gradients, being a very interesting and diverse vegetational type (Sartori 2012).

Material and methods

Sampling

Fresh specimens were collected in 72 localities of Mato Grosso do Sul State, and were deposited in CGMS herbarium. Furthermore, all foliose Caliciaceae (*Dirinaria* and *Pyxine*) from CGMS and COR herbaria were studied, that corresponding to 81 localities. All the collecting sites (153) are indicated in Figure 1B.

Taxa determinations

The literature used to identify specimens to genus level was Jungbluth & Marcelli (2012), who discussed the generic features of the foliose Physciaceae *s.l.* For species identification monographs and floras were checked: Awasthi (1975), Elix (2009), Kalb (2001, 2004) and Swinscow & Krog (1978) were used for *Dirinaria* identification while Aptroot *et al.* (2014), Elix (2009), Jungbluth (2010), Jungbluth & Marcelli (2011), Kalb (1987), Mongkolsuk *et al.* (2012) and Swinscow & Krog (1975) for *Pyxine*.

Morphological and anatomical analyses

The macroscopic morphological measurements were made in millimeters with a stereomicroscope, and were observed on thallus structures (laciniae, upper surface and other features), as well as the vegetative propagules and several characteristics of the apothecia. The medulla in both genera was treated with two distinct regions denominated upper layer and lower layer. This difference is usually evident when pigments are present. For *Dirinaria*, we followed the features discussed in Awasthi (1975), Barbosa *et al.* (*in prep.*, chapter 2), Kalb (2001) and

Jungbluth & Marcelli (2012). For *Pyxine* the features presented by Jungbluth (2010), Jungbluth & Marcelli (2012) and Kalb (1987) were taked in account.

Anatomical sections were made removing the fragment (structure of interest) from the lichen and cutting it with a razor blade, performing cross-sections. The ideal cuts should be smaller than 15 μm thick, so that the anatomical layers can be accurately observed and differentiated. Semi-permanent slides were made in Glycerin 50% plus destiled water 50%, according to Puvis *et al.* (1964). The anatomical measurements were made using these slides and the reticulum present in the ocular lens of the optic microscope.

The terminology utilized for apothecia anatomy (Figure 2A) follows Kirk *et al.* (2008). For ascospores types we adopted Mayrhofer (1982) and Malme (1902) classifications.

Chemical analyses

Spot tests were performed with potassium hydroxide (K), sodium hypochlorite (C), and paraphenylenediamine (P) for all specimens. All specimens were examined under UV light (wavelength 366 nm). When exposed to this light; the lichen emits different colours, as for example yellow for lichexanthone in *Pyxine* (Figure 2B) and bluish for divaricatic acid in *Dirinaria* (Figure 2C). These methods were described by Orange *et al.* (2010).

Thin Layer Chromatography (TLC) was made according to Orange *et al.* (2010). For *Dirinaria* one needs TLC for distinguishing atranorin, divaricatic acid, sekikaic acid and terpenes (Jörgensen 1973). The solvents used to separate divaricatic acid and sekikaic acid were A, B and C, being A= toluene: ethyl acetate: acetic acid (6:4:1 v/v/v), B= n-hexane: ethyl ether: formic acid (5:4:1 v/v/v) and C= toluene: acetic acid (85: 15 v/v). Best results were obtained with solvent B, thus preferentially used for *Dirinaria*.

In *Pyxine*, atranorin, chiodectonic acid, lichexanthone and terpenes need to be distinguished, as was indicated by Jungbluth & Marcelli (2011). We utilized A, B and C solvents. The C solvent revealed the best results.

Taxa distribution and descriptions

The distribution data outside the study area follow the same floras and monographs cited before. For *Pyxine* it is based on Jungbluth (2010), updated with new data on distribution published after the year 2010. For *Dirinaria* it follows Barbosa *et al.* (*in prep.*, chapter 2).

Two protocol descriptions were elaborated, one for each genus. The protocols contain a letterhead with the species name, authors abreviations, bibliography, the basionym of species and type locality, the synonyms are indicated for other bibliography. For *Pyxine* it follows Jungbluth

(2010), Jungbluth & Marcelli (2011) and Kalb (1987); for *Dirinaria* it follows Barbosa *et al.* (*in prep.*, chapter 2).

The description has five parts: morphology, anatomy, spot tests, thin layer chromatography and remarks. The four first parts are the result of direct analyses study of specimens and the last section (remarks) is the space for a discussion about features of importance in the delimitation of that taxon, specific characteristics indicated in the literature and the taxonomic story.

The *Dirinaria* protocol was developed from an extensive bibliographic revision about the main characteristics described for this genus, resulting in a detailed protocol in Excel format (appendix 1). The *Pyxine* protocol was adapted from that proposed by Jungbluth (2010). And also converted to an Excel file (appendix 2).

In these protocols, characteristics of all specimens of each species were annotated, then the protocol was elaborated again, but now with the consensus of all specimens of each species. From this consensus table a direct mail was generated, then fetched in model made in Word format, finally resulting in the final description.

Images

The photographs were taken with a Zeiss stereomicroscope (Discovery V20) with coupled photographic camera, and the scales were made in the Zeiss program; after this stage the images were edited to better show the interesting structures.

Results and discussion

Caliciaceae was considered a synonym of Physciaceae for about a decade, but currently the two families are treated as separate families (Lücking *et al.* 2016), mainly based on molecular study (Prieto & Wedin 2016), which was also the reason for the earlier merger. In a search for morphological features that corroborate with this distinction, a bibliographic study was made, and it was found that an evident difference exists in the ascospore types. In foliose Caliciaceae, two ascospore types occur: *Conradia*-type (Figure 3A) and *Dirinaria*-type (Figure 3B). The *Dirinaria*-type is present in *Dirinaria* and *Pyxine*, while the *Conradia*-type is only known from *Pyxine*. The ascospores of *Dirinaria*-type do not occur in foliose Physciaceae and are considered fundamental criterion for differentiation between the families. The *Conradia*-type is shared between *Pyxine* and *Hyperphyscia* Müll. Arg. (1894: 10) and occurs only in these two genera among the foliose genera of Caliciaceae and Physciaceae. The other ascospore types: *Pachysporaria*-type (Figure 3C), *Physcia*-type (Figure 3D), *Physconia*-type (Figure 3E) and *Polyblastidium*-type (Figure 3F) are reported only for foliose Physciaceae.

In Mato Grosso do Sul State, only two foliose genera of Caliciaceae were found: *Dirinaria* and *Pyxine. Dirinaria* is represented by 14 taxa, *viz. D. africana* D.D. Awasthi (1975: 40) and *D. melanoclina* (C. Knight) D.D. Awasthi (1975: 77), which is mentioned here for the first time from the American Continent*, D. papillulifera* (Nyl.) D.D. Awasthi (1964: 369), and *D. purpurascens* (Vain.) B.J. Moore (1968: 251), which are cited here for the first time from Mato Grosso do Sul State, *D. aegialita* (Afzel. ex Ach.) B.J. Moore (Moore 1968: 248)*, D. applanata* (Fée) D.D. Awasthi (Awasthi & Agarwal 1970: 135)*, D. confluens* (Fr.) D.D. Awasthi (1975: 28)*, D. confluens* (Fr.) D.D. Awasthi var. *coccinea* (Lynge) D.D. Awasthi (1975: 31)*, D. consimilis* (Stirt.) D.D. Awasthi (Awasthi & Agarwal 1970: 135), *D. leopoldii* (Stein) D.D. Awasthi (1975: 140), *D. melanocarpa* (Müll. Arg.) C.W. Dodge (1971: 179), *D. picta* (Sw.) Clem. & Shear (1931: 323)*,* and *D. pruinosa* Kalb (2001: 147). *Dirinaria maracajuensis* T.D. Barbosa, A.A. Spielmann, *sp. nov.* is reported as new to science.

Pyxine is represented by 24 taxa, being *P. astipitata* Jungbluth & Marcelli (2011: 168)*, P. nana* Kalb (1987: 55), and *P. pustulata* Aptroot & Jungbluth (Aptroot *et al.* 2014: 3) cited here for the first time from Mato Grosso do Sul State, *P. berteriana* (Fée) Imshaug (1957: 254)*, P. coccifera* (Fée) Nyl. (1857: 5)*, P. cocoës* (Sw.) Nyl. (1857: 108)*, P. cocoës* (Sw.) Nyl. var. *pallida* Kalb (1987: 43)*, P. cognata* Stirt. (1879: 311)*, P. coralligera* Malme (1897: 40)*, P. daedalea* Krog & R. Sant. (Moberg 1986: 7)*, P. eschweileri* (Tuck.) Vain. (1890: 156)*, P. mantiqueirensis* Marcelli & Jungbluth (Jungbluth & Marcelli 2011: 172), *P. obscurascens* Malme (1897: 42)*, P. petricola* Nyl. (Crombie 1876: 263)*, P. petricola* Nyl. var. *convexula* Kalb (1987: 60)*, P. physciaeformis* (Malme) Imshaug (1957: 257)*, P. primaria* Kalb (1987: 62)*, P. pungens* Zahlbr. (1928: 210)*, P. rhodesiaca* Vain. ex Lynge (1937: 90)*, P. simulans* Kalb (1987: 72), and *P. subcinerea* Stirt. (1897: 397). *Pyxine denigricans* J.-M. Torres, T.D. Barbosa & A.A. Spielmann, *sp. nov.*, *P. flavolucens* T.D. Barbosa, J.-M. Torres, Jungbluth & Spielmann, *sp. nov.; P. parapetricola* T.D. Barbosa, J.-M. Torres, Jungbluth & A.A. Spielmann, *sp. nov.* are new species to science.

A total of 35 species and three varieties of foliose Caliciaceae are reported here, including four new species to the science, one new report from the American Continent and five new reports for the Mato Grosso do Sul State funga. The funga term was utilized according Kuhar *et al.* (2018), who discuss the best term for representing taxonomical inventories.

Key to foliose genera of Caliciaceae from Mato Grosso do Sul State, Brazil

1a. Upper cortex UV+ yellow, K− (lichexanthone present) ..... *Pyxine*

1b. Upper cortex UV−, K+ yellow (atranorin present) 2

2a. Rhizinae or rhizinae precursors absent ..... *Dirinaria*

2b. Rhizinae or rhizinae precursors present 3

3a. Apothecia *cocoës*-type or *obscurascens*-type present ..... *Pyxine*

3b. Apothecia *physciaeformis*-type present 4

4a. Ascospores of *Conradia*-type present ..... *Pyxine*

4b. Ascospores of *Dirinaria*-type present 5

5a. Atranorin and chiodectonic acid or divaricatic acid or sekikaic acid present 6

5b. Only atranorin and terpenes present 7

6a. Atranorin and chiodectonic acid present ..... *Pyxine*

6b. Atranorin and divaricatic acid or sekikaic acid present ..... *Dirinaria*

7a. Medulla white throughout or with yellow to orange upper layer ..... *Pyxine*

7b. Medulla white with red pigment or red throughout ..... *Dirinaria*

Dirinaria (Tuck.) Clem. (1909: 84).

– *Pyxine* sect. *Dirinaria* Tuck., (1877: 166); *Physcia* sect. *Dirinaria* Vain. (1890: 150); *Dimelaena* sect. *Hypomelaena* Trevis (1868: 623); *Physcia* subgen. *Hypomelaena* Vain., (1923: 37).

Type species: *Dirinaria picta* (Sw.) Clem. & Shear (1931: 323).

Description based on Awasthi (1975), Kalb (2004) and Elix (2009).

MORPHOLOGY. **Thallus** foliose, closely adpressed or adglutinated to substrate, corticicolous, ramulicolous or saxicolous. **Upper surface** proximal region grey, whitish grey, white, greyish white to rarely deep yellow, smooth to rugose, not plicate to longitudinally plicate or irregularly plicated, **pruina** absent to present; distal region grey, whitish grey, white, greyish white to rarely deep yellow, smooth to rugose, not plicate to longitudinally plicate or irregularly plicated, **pruina** absent to present. **Maculae** marginal to submarginal or laminal, or absent. **Laciniae** discrete to confluent, not branched to dichotomously or palmatifid branched; apices not flabellate to flabellate, subtruncate to rounded or rarely truncate to retuse, margin smooth to crenate. **Medulla** white, orange, coccineous (red); **pigment** yellow (sulphur) or absent. **Lower surface** generally black, dark brown or rarely light-brown to cream, margin black, dark brown to light-brown.

Rhizinae precursors laminal or absent. **Isidia** present or absent. **Polysidiangia** present or absent, submarginal to laminal, irregular; **soredia** whitish green, granulose. **Soralia** crateriform or erumpent, generally hemispherical to globose capitate or absent. **Lacinulae** present or absent. **Apothecia** *physciaeformis*-type, 0.5−3.0 mm diam., laminal, immersed to sessile, base constrict or substipitate or absent; **disc** black to dark brown, plane to convex or rarely concave, **pruina** white, bluish, yellowish or purplish or absent; **margin** smooth to crenate; **amphithecium** smooth, ornament isidia or soredia; **internal stipe** present or absent.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–5 cell layer; **algal layer** photobiont trebouxioid, continuous; **medulla** colorless to yellow or coccineous (red); **lower cortex** prosoplectenchymatous, dark-brown. **Apothecia epihymenium** light-brown; **hymenium** colorless to yellowish, paraphyses apices not capitate or capitate; **subhymenium** brown-black, dark brown, light brown or rarely colorless; **ascospores** *Dirinaria*-type.

KNOWN CHEMISTRY. Atranorin, divaricatic acid, sekikaic acid, arthothelin and terpenes.

REMARKS.

Dirinaria is characterized by the foliose thallus, the paraplectenchymatous upper cortex, prosoplectenchymatous lower cortex, generally with dark-brown subhymenium, ascospores *Dirinaria*-type, baciliform conidia and atranorin in the upper surface.

Pyxine is closely related to *Dirinaria*. However, *Pyxine* has well developed rhizinae, the epihymenium is K+ purple, and rarely a plicate upper surface is present. *Dirinaria* has some similarities with foliose genera of the Physciaceae. *Heterodermia* Trevis. (1869: 613) shows the prosoplectenchymatous upper cortex and rhizinae, *Leucodermia* Kalb (Mongkolsuk *et al.* 2015: 33) has no lower cortex and shows rhizinae, *Anaptychia* Körb. (1848: 197), *Culbersonia* Essl. (2000: 771), *Kashiwadia* S.Y. Kondr., L. Lőkös & J.-S. Hur (Kondratyuk *et al.* 2014: 375), *Physcia* (Schreb.) Michx. (1803: 326) and *Polyblastidium* Kalb (Mongkolsuk *et al.* 2015: 38) have rhizinae and no plicate thallus.

Hyperphyscia does not have rhizinae, nor atranorin. Other genera without atranorin are *Culbersonia* Essl., *Phaeophyscia* Moberg (1977: 29) and *Physconia* Poelt (1965: 30) but they have rhizinae. In the foliose genera of Physciaceae no ascospores of the *Dirinaria*-type occur, this being the main difference between *Dirinaria* and the foliose genera of Physciaceae.

Worldwide about 25 species are known, plus five varieties and one form (Barbosa *et al. in prep.*). In Brazil 12 species are known (Barbosa *et al. in prep.*, chapter 2). *Dirinaria* was proposed by Clements (1909) but it was in Clements & Shear (1931) that the type species was selected (*Dirinaria picta*), although the genus *Dirinaria* was proposed in 1909, several species were described before the genus was erected and consequently these taxa has a long taxonomic story.

After Clements (1909) and Clements & Shear (1931), few authors cited the genus, until Awasthi (1975) accepted the change and monographed *Dirinaria*, made a worldwide key, described the known taxa in the genus and solved a large part of taxonomic problems. Since that time, only some authors, such as Swinscow & Krog (1978), Kalb (2001, 2004), and Elix (2008, 2009), contributed to the taxonomy of the genus.

Concomitant to this work, a manuscript was made that treats the *Dirinaria* genus in the whole world. For more details about this taxonomic story, synonyms and distribution see Barbosa *et al.* (*in prep.*, chapter 2).

Dirinaria is a pantropical to subtropical genus (Awasthi 1975) and present a great diversity in Brazil, but no study was made with the purpose to study the Brazilian species of *Dirinaria*. On the same way, the studies focusing on *Pyxine* were made by Kalb (1987) and Jungbluth (2010). The major part of the records consists of citations found in regional inventories and not by a taxonomic revision or monograph.

From Mato Grosso do Sul, so far five species were cited (Fleig & Riquelme 1991) and more one as mentioned by Torres (2018). Here we present 13 species and one variety, increasing considerably the knownlegd on the genus to the state. One species is mentioned for the first time to the American Continent, two are cited for the first time from Mato Grosso do Sul State, and one new species is described here.

Key to the species of *Dirinaria* from Mato Grosso do Sul State, Brazil

1a. Thallus with vegetative propagules 2
1b. Thallus without vegetative propagules 9

2a (1a). Isidia present; polysidiangia and soralia absent ..... *D. papillulifera*
2b. Isidia absent; polysidiangia or soralia present 3

3a (2b). Polysidiangia present; soralia absent 4
3b. Polysidiangia absent; soralia present 6

4a (4a). Sekikaic acid present; divaricatic acid absent ..... *D. consimilis*
4b. Sekikaic acid absent; divaricatic acid present 5

5a (3a). Apothecial disc epruinose or with white pruina ..... *D. aegialita*
5b. Apothecial disc with purple pruina ..... *D. pruinosa*

6a (3b). In morphology medulla with red pigment ..... *D. leopoldii*
6b. In morphology medulla without red pigment 7

7a (6b). Laciniae confluent, with apices flabellate; thallus longitudinally plicate ..... *D. applanata*

7b. Laciniae not confluent, with apices not flabellate 8

8a (7b). Apothecial discs with brown pruina; subhymenium 100–112 µm thick; ascospores (10–)12–13(–14) × (4–)5–6 µm ..... *D. melanoclina*

8b. Apothecial discs epruinose; subhymenium (110–)150–190 µm thick ascospores 12–17 × 5–7 µm ..... *D. picta*

9a (1b). Medulla with red pigment ..... *D. confluens* var. *coccinea*

9b. Medulla without red pigment 10

10a (9b). Lower surface yellow to cream in proximal region..... *D. melanocarpa*

10b. Lower surface black or brown-black in proximal region..... 11

11a (10b). Apothecial discs with purple pruina ..... *D. purpurascens*

11b. Apothecial discs epruinose or when with pruina not purple 12

12a (11b). Subhymenium colorless to yellowish; apothecial discs with yellow pruina ..... *D. maracajuensis*

12b. Subhymenium dark brown to brown-black; apothecial discs epruinose to with whitie pruina 13

13a (12b). Laciniae up to 0.8 mm width; apothecia subimmersed to sessile with contrict base; apothecial; hymenium 60−75(−85) µm thick; ascospores 13−15(−18) × 5−6(−7) µm ..... *D. africana*

13b.Laciniae up to 2 mm width; apothecia sessile, base constrict; hymenium 80−110 µm; ascospores 15−18(−25) × 5−8(−10) µm ..... *D. confluens*

Dirinaria aegialita (Afzel. *in* Ach.) B.J. Moore (1968: 248). (Figures 4A-F, 39A-B array 2, 40A array 2)

≡ *Parmelia aegialita* Afzel. *in* Ach. (1803: 193).

Lectotype:—SIERRA LEONE. ‘ad lapides mari inundatos propr litora’, *Afzelius*, (S-SW L1617).

MORPHOLOGY. **Thallus** saxicolous or corticicolous; 3.5–5.5 cm diam. **Upper surface** proximal region greenish grey to whitish grey, smooth, irregularly plicated, frequent, **pruina** absent to frequent without board; distal region whitish grey, smooth, longitudinal plication scarce to frequent, **pruina** frequent to abundant without board. **Maculae** in the proximal region absent to scarce, submarginal, linear to irregular; in the distal region scarce, marginal to submarginal, linear. **Laciniae** confluent overlapping, not branched to palmatifid branched, 0.4–0.5(–0.7) mm width in

base and 0.4–0.7(–1.1) mm in maximum width; apices slightly flabellate, subtruncate to rounded or rarely truncate to retuse, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** only in the old region, yellow (sulphur) or absent. **Lower surface** proximal region black; distal region light-brown to cream, 0.2–1.3 mm length, margin rarely variegated between light-brown and black or grey and white. **Rhizinae precursors** scarce, black, laminal. **Polysidiangia** abundant to covering the thallus, submarginal to laminal, irregular; **soredia** whitish green, granulose, the polysidiangia is soredioid in the origin. **Isidia**, **Soralia** and **Lacinulae** absent. **Apothecia** ca. 0.5 mm diam., laminal, sessile, base constrict; **disc** black, plane, **pruina** white; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** white with yellow incrustations, ca. 0.2 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–4 cell layer, (10–)15–18 µm thick; **algal layer** continuous, (12–)15–25 µm thick; **medulla** upper layer colorless, lower layer colorless, 80–190 µm thick; **lower cortex** prosoplectenchymatous, 10–15 µm thick, dark-brown. **Apothecia epihymenium** ca. 10 µm thick, light-brown; **hymenium** 80–90 µm thick, colorless, paraphyses capitate apice; **subhymenium** ca. 130 µm thick, brown-black; **ascospores** *Dirinaria*-type, 14–18 × 5–6 µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K− or K+ pink (after 5–10s), C−, KC−, UV+ bluish white; **medulla pigment** K+ purple, C− or C+ orange, KC−; **lower cortex** K−, C−; **apothecial disc** UV+ dark-green.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria aegialita is characterized by presence of polysidiangia, atranorin and divaricatic acid, and white pruina on the disc of the apothecia.

Three species are known with polysidiangia within *Dirinaria*, *viz. D. aegialita*, *D. consimilis*, and *D. pruinosa*. *Dirinaria consimilis* is differentiated mainly by presenting sekikaic acid while *D. aegialita* has divaricatic acid, *D. pruinosa* has divaricatic acid, but shows purplish pruinose apothecial discs, and Kalb (2001) mention that the spores are larger than those found in *D. aegialita*, but this feature was not observed here.

Dirinaria aegialita was historically confouded in the literature, until Awasthi (1975) makes important observations on the type and mentions that most lichenologists poorly understood this species. This species was described as *Parmelia aegialita* Ach. (1803: 190), however Nylander (1861) treated this species as *Physcia* and proposed a new synonym, making *Parmelia confluens* Fr. (1825: 284) a synonym of *Physcia aegialita* (Ach.) Nyl. (1861: 43), apparently without comparing the type specimens of both taxa (Awasthi 1975). Lynge (1924) cited *Physcia aegialita*,

emphasizing that his specimens did not have "*lobis marginibus elevate crenulato-pulverulentis"* (apparently the polysidiangia) as the specimens observed by Acharius.

Dirinaria aegialita sensu Moore (1968) refers to specimens without polysidiangia and with divaricatic acid or sekikaic acid. Awasthi (1975) mentioned that this combination is valid, but the specimens mentioned by Moore do not match this taxon.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Aquidauana municipality, highway MS-450, on tree branch, 188 m elev., 20º27′27.40″S, 55º29′12.00″W, 26 November 2014, *S.R. Ramalho, et al. 43* (CGMS 47809); Campo Grande municipality, Rua Abrão Julio Rahe, next to Praça da Bolívia, on tree, 620 m elev., 20º26′57.90″S, 54º35′14.40″W, 24 October 2011, *A.A. Spielmann & N.K. Honda 9680* (CGMS 42771); *ibid., A.A. Spielmann & N.K. Honda 9753* (CGMS 42781); *ibid., A.A. Spielmann & N.K. Honda 9756* (CGMS 42733); Corumbá municipality, subregion *Pantanal* do Paraguai, in the margin of the Taquaral Bay, on rock, 89 m elev., 18º02′48.90″S, 57º29′49.50″W, 26 November 2010, *L.S. Canêz et al. 3636* (CGMS 32081); *ibid.,* 83 m elev., 18º02′42.30″S, 57º30′15.20″W, 26 November 2010, *C.O. Dourado, et al. 77* (CGMS 30239); *ibid.,* RPPN Eliezer Batista (Novos Dourados), on tree, 95 m elev., 18º05′40.20″S, 57º29′15.50″W, 24 November 2010, *C.S. Robles et al. 26* (CGMS 30308).

Dirinaria africana (Mull. Arg.) D.D. Awasthi (1975: 40). (Figures 5A-F, 39A-B array 3, 40A array 3).
≡ *Physcia africana* Müll. Arg., (1880: 33).
Lectotype:—ANGOLA. Pungo Andongo, on rocks, 1880, *Schweinfurth 247 pr. p.* (G).

MORPHOLOGY. **Thallus** saxicolous, adglutinated to substrate; 3.4–5.5 cm diam. **Upper surface** proximal region greenish grey to whitish grey, rugose to verrucose, irregularly plicated, abundant, **pruina** absent; distal region yellowish grey to whitish grey, rugose, longitudinal plication frequent, **pruina** frequent without board or rarely absent. **Maculae** in the proximal region scarce or rarely absent, laminal, linear to punctiform; in the distal region scarce, marginal to laminal, linear to rarely subreticulate. **Laciniae** confluent contiguous to overlapping, irregularly branched, 0.5–0.8 mm width in base and 0.5–1.6 mm in maximum width; apices not flabellate to slightly flabellate, rounded, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** absent. **Lower surface** proximal region black; distal region light-brown or rarely cream, 1–1.5 mm length, not variegated. **Rhizinae precursors** scarce, black, laminal. **Lacinulae** absent or frequent, adventitious, concolor to thallus, not branched, 0.5 × 0.2–0.3 mm, rounded apices. **Isidia**, **Polysidiangia** and **Soralia** absent. **Apothecia** 0.3–1.3 mm diam., laminal, subimmersed to sessile,

base constrict; **disc** black, plane, **pruina** absent or white; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** white with yellow incrustations, 0.03–0.2 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3–4 cell layer, 15–20 µm thick; **algal layer** continuous, 15–25 µm thick; **medulla** upper layer colorless, lower layer colorless, 110–155 µm thick; **lower cortex** prosoplectenchymatous, 8–12 µm thick, dark-brown. **Apothecia epihymenium** 8–12 µm thick, light-brown; **hymenium** 60–75(–85) µm thick, colorless, paraphyses capitate apice; **subhymenium** 130–150(–175) µm thick, light-brown; **ascospores** *Dirinaria*-type, 13–15(–18) × 5–6(–7) µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K−, C−, KC−, UV+ bluish white; **lower cortex** K−, C−; **apothecial disc** UV+ dark-green.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria africana is characterized by adglutinated to substrate, the exclusively saxicolous habit, the white internal stipe with yellow incrustations (sometimes absent), and the presence of atranorin and divaricatic acid.

Dirinaria confluens has the laciniae apically flabellate, the thallus mainly corticicolous and spores larger (15–18 × 5–8 µm). *Dirinaria melanocarpa* shows the colorless to yellow subhymenium and a yellow to cream lower surface. *Dirinaria purpurascens* is exclusively corticicolous or ramulicolous and is distinguished mainly by the apothecial disc with purplish pruina. *Dirinaria maracajuensis* is very similar to *D. africana* but shows the colorless to yellow subhymenium larger than 150 µm thick, the apothecial disc strongly convex and with yellowish white pruina. This is the first record of *D. africana* from the American Continent.

This species was described as *Physcia africana* Müll. Arg. (1880: 40); this species was placed in *Dirinaria* by Awasthi (1975) who observed the saxicolous habit and the adhesion of the specimens, but the most important features are that apothecia are immersed and the subhymenium that is projecting into the center.

Swinscow & Krog (1978) treated *Dirinaria africana* as a synonym of *Dirinaria confluens*, emphasizing that the characteristics presented by Awasthi (1975) were subjective and did not correspond to the real diversity of the African species of the *Dirinaria* genus.

In this work, we prefer to follow Awasthi (1975), who had a broad understanding of the genus *Dirinaria*, while Swinscow & Krog (1978) treated African species only, and the features showed by them are insufficient for this synonymy.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Parque Monumento Natural Serra do Bom Jardim, Trilha do Pôr do Sol, rupestrian *Cerrado*, on rock, 639 m elev., 18º06′58.8″S, 53º41′21.8″W, 17 October 2017, *T.D. Barbosa & A.A. Spielmann 1745* (CGMS); *ibid., T.D. Barbosa & A.A. Spielmann 1751* (CGMS); *ibid.,* Trilha da Gruta da Paca, rupestrian *Cerrado*, on rock, 619 m elev., 18º06′49.7″S, 53º40′01.8″W, 18 October 2017, *A.S. Rodrigues 353* (CGMS); *ibid.,* Trilha dos Pilares, rupestrian *Cerrado*, on rock, 550 m elev., 18º08′58.27″S, 53º40′38.4″W, 19 October 2017, *S.M.L. Souza et al. 92* (CGMS); Aquidauana municipality, Sítio Arqueológico CERA, UEMS, near to the watercourse, on rock, 185 m elev., 20º26′06.60″S, 55º39′33.00″W, 25 November 2014, *A.L. Simal et al. 177* (CGMS 46757); *ibid.,* Piraputanga district, on rock, 188 m elev., 20°27′27.42"S, 55°29'11.96"O, 26 November 2014, *A.A. Spielmann 12190* (CGMS); *ibid.,* 180 m elev., 20º27′22.06″S, 55º30′0.87″W, 26 May 2014, *T.D. Barbosa & C.M. Bernardo 101* (CGMS); Corumbá municipality, subregion, *Pantanal* do Paraguai, RPPN Eliezer Batista (Novos Dourados), top of the hill, on rock, 95 m elev., 18º05′40.20″S, 57º29′15.50″W, 24 November 2010, *A.A. Spielmann 8741* (CGMS 42740); *ibid.,* 208 m elev., 18º05′33.40″S, 57º29′31.20″W, 24 November 2010, *L.S. Canêz et al. 3566b* (CGMS 32013)*; ibid., L.S. Canêz et al. 3569* (CGMS 32017).

Dirinaria applanata (Fée) D.D. Awasthi *in* Awasthi & Agarwal (1970: 49). (Figures 6A-F, 39A-B array 4, 40A array 4)
≡ *Parmelia applanata* Fée (1824: 126).
Neolectotype:—CUBA. ‘ex Herb. Montagne’, (REN, neoisotypes: BM, NY, UPS).

MORPHOLOGY. **Thallus** corticicolous or rarely saxicolous; 3.4–10.0 cm diam. **Upper surface** proximal region whitish grey to light-green, rugose to rarely verrucose, irregularly to longitudinal plication frequent to abundant, **pruina** absent to abundant without board; distal region whitish grey to light-green, rugose, longitudinal plication scarce to frequent, **pruina** absent to frequent with or without board. **Maculae** in the proximal region absent; in the distal region absent to scarce, submarginal to laminal, linear. **Laciniae** confluent contiguous to overlapping, dichotomously to irregularly branched, 0.1–0.5(–0.9) mm width in base and 0.3–1.2(–1.6) mm in maximum width; apices flabellate to rarely slightly flabellate, rounded to retuse, margin smooth to crenate. **Medulla** upper layer cream to white; lower layer cream; **pigment** yellow (sulphur) or absent. **Lower surface** proximal region black; distal region cream to rarely yellow, 0.5–1.5(–2.5) mm length. **Rhizinae precursors** scarce, black, laminal. **Soralia** frequent to abundant, laminal, hemispherical to globose shape; **soredia** whitish green, farinose. **Isidia**, **Polysidiangia** and **Lacinulae** absent. **Apothecia** absent.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–4 cell layer, 15–25 µm thick; **algal layer** continuous, 15–25(–30) µm thick; **medulla** upper layer colorless, lower layer colorless to yellow, (80–)100–140 µm thick; **lower cortex** prosoplectenchymatous, 8–15 µm thick, dark-brown.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K− or K+ yellow, C−, KC−, UV+ bluish white; **medulla pigment** K+ purple, C−, KC−; **lower cortex** K− or K+ yellow to pink, C− or C+ red to pinkish.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria applanata is characterized by the strongly plicate thallus, hemispherical soralia, flabellate laciniae, and the presence of atranorin and divaricatic acid.

Dirinaria picta is commonly confouded with *D. applanata* due to the soralia shape and chemical constituents present in both taxa. But these species show striking differences, such as the strongly plicate thallus, the evidently flabellate laciniae and dichotomously to irregularly branched in *D. applanata* while *D. picta* shows no plicate or rarely a slightly plicate thallus, apices without flabellate laciniae and palmatifid branching. The latter species is also much thinner and the pruina type is different.

Dirinaria leopoldii is another sorediate species but it is easily separated from *D. applanata* for having the upper layer of the medulla red and red to whitish green soralia and the presence of only atranorin.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Parque Estadual Nascentes do Rio Taquari, on tree, 436 m elev., 18º09′53.7″S, 53º24′09.2″W, 18 November 2015, *G.P. Freitas et al. 99* (CGMS 59523); *ibid.,* Parque Monumento Natural Serra do Bom Jardim, Trilha da Gruta, on tree, 604 m elev., 18º06′48.3″S, 53º40′00.9″W, 18 October 2017, *T.D. Barbosa & A.A. Spielmann 1907* (CGMS); Aparecida do Taboado, next to Br-158, on tree, 440 m elev., 19º52′40.10″S, 51º07′54.80″W, 18 March 2012, *A.A. Spielmann et al. 10348* (CGMS 42760); Aquidauana municipality, Piraputanga district, on rock, 180 m elev., 20º27′22.06″S, 55º30′0.87″W, 26 May 2014, *T.D. Barbosa & C.M. Bernardo 92* (CGMS); *ibid.,* Camisão district, Morraria Paxixi, 573, 20º26′46.4″S, 55º38′25.3″W, 7 July 2016, *T.D. Barbosa 1075* (CGMS 60273); Bodoquena, Serra da Bodoquena, Sítio Boa Vista, on fence pole, 179 m elev., 20º42′52.30″S, 56º44′14.60″W, 15 August 2010, *L.S. Canêz et al. 3175* (CGMS 31902); Corumbá municipality, Morraria do Urucum, on tree branch, 733 m elev., 19°12'08.20"S, 57°36'04.60"W, 3 September 2010, *L.S. Canêz et al. 3243* (CGMS 32341); Costa Rica, Parque

Estadual das Nascentes do Rio Taquari, on tree, 780 m elev., 18º14′03.3″S, 53º18′25.5″W, 24 October 2017, *A.S. Rodrigues 375* (CGMS); Jaraguari municipality, Furnas do Dionísio, on tree, 425 m elev., 20º08′54.10″S, 54º34′15.10″W, 22 November 2011, *R. Lücking 35047* (CGMS 34752); *ibid.* 25 September 2017, *T.D. Barbosa & Spielmann 1719* (CGMS); Jateí municipality, Parque Estadual das Varzeas do Rio Ivinhema, on tree, 236 m elev., 22º55′43.00″S, 53º41′45.01″W, 13 November 2015, *G.M. Shiroma et al. 62* (CGMS 53995); Nova Andradina municipality, Reserva legal da Fazenda Laranjal, on tree, 345 m elev., 22º04′03.30″S, 53º23′51.40″W, 3 December 2014, *F.M.R. Godoy et al. 83* (CGMS 47904); Sidrolândia municipality, on tree, 441 m elev., 20°55'15.36"S, 54°58'53.48"W, 26 November 2017, *T.D. Barbosa 1912* (CGMS).

Additional specimens examined:—BOLIVIA. German Busch Province, Mandioré bay, on tree branch, 90 m elev., 18°11'50.70"S, 57°30'39.70"W, 23 November 2010, *T.H.D. Leandro et al. 33* (CGMS 30348), *pr. p.*; *ibid., T.H.D. Leandro et al. 35* (CGMS 30350), *pr. p.*

Dirinaria confluens (Fr.) D.D. Awasthi (1975: 28). (Figures 7A-F, 39A-B array 5, 40A array 5)
≡ *Parmelia confluens* Fr. (1825: 284)

Neotype:—INDIA. Neelgherries (=Nilgiri), *Perrottet*, annotated as "*Parmelia confluens* Fr. p. 284" (H-NYL 31808, isoneotypes: BR, H-NYL 31809, m elev., PC, REN).

MORPHOLOGY. **Thallus** corticicolous or saxicolous; 2–9.5 cm diam. **Upper surface** proximal region whitish grey to greenish grey, rugose to verrucose, longitudinally to irregularly plicated frequent to abundant, **pruina** absent to frequent with board; distal region whitish grey, smooth to rugose, longitudinal plication scarce to frequent, **pruina** absent to abundant without board. **Maculae** in the proximal region absent; in the distal region absent, to scarce, submarginal, linear. **Laciniae** confluent contiguous to overlapping, dichotomic to irregularly branched, 0.3–1.2 mm width in base and (–0.3)0.6–1.6(–2) mm in maximum width; apices slightly flabellate to flabellate, rounded to retuse rarely subtruncate, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** yellow (sulphur) or absent. **Lower surface** proximal region black to rarely light-brown; distal region light-brown to yellow, 0.5–2(–3) mm length, sometimes the distal region is concolor to proximal region. **Rhizinae precursors** frequent, black, laminal. **Lacinulae** absent or scarce, adventitious, concolor to thallus, not branched, 0.5 × 0.25 mm, rounded apices. **Isidia**, **Polysidiangia** and **Soralia** absent. **Apothecia** 0.3–1.5(–1.6) mm diam., laminal to rarely submarginal, sessile, base constrict to rarely substipitate; **disc** black to brown-black, plane to convex, **pruina** absent or white to grey; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.1–0.3 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3–4 cell layer, 15–20(–25) µm thick; **algal layer** continuous, 15–25(–30) µm thick; **medulla** upper layer colorless to yellow, lower layer colorless to yellow, 80–150(–175) µm thick; **lower cortex** prosoplectenchymatous, 8–15(–30) µm thick, dark-brown to light-brown. **Apothecia epihymenium** 8–12(–17) µm thick, dark-brown; **hymenium** (70–)75–100 µm thick, colorless to rarely yellow, paraphyses capitate apice; **subhymenium** (–70)110–150 µm thick, brown to brown-black rarely yellowish; **ascospores** *Dirinaria*-type, 15–18(–25) × 5–8(–10) µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K− or K+ yellow, C−, KC−, UV+ bluish white; **medulla pigment** K+ purple, C− or C+ orange, KC−; **lower cortex** K− or K+ pink, C− or C+ red to pinkish; **apothecial disc** UV+ dark-green or rarely UV−.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria confluens is characterized by a strongly plicate thallus, flabellate laciniae, abundant apothecia with plane to convex disc and white pruina, and also the presence atranorin and divaricatic acid.

Another taxon that resembles *D. confluens sensu str.* is *D. confluens* var. *coccinea,* that has red pigment in the medulla and is strongly verrucose in the proximal region of the thallus. These features can easily differentiate both taxa. Also having a strongly plicate thallus and abundant apothecia, *D. melanocarpa* can be recognized by the colorless to yellow subhymenium and yellow to cream lower surface. *Dirinaria purpurascens* is mainly differentiated by the purplish pruinose apothecial disc and the non-plicate thallus. *Dirinaria maracajuensis* has an adglutinated to substrate and saxicolous thallus and also the colorless to yellow subhymenium.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Parque Estadual das Nascentes do Rio Taquari (PENT), on rock, 554 m elev., 18º09′03.17″S, 53º24′07.82″W, 16 November 2015, *J.M. Torres et al. 405* (CGMS 57927); Aquidauana municipality, highway MS-450, on tree, 217 m elev., 20º27′23.60″S, 55º29′16.30″W, 26 November 2014, *F.M.R. Godoy et al. 60* (CGMS 47793); *ibid.,* Piraputanga district, Slope of Serra de Maracajú, next to Acampamento Batista, on tree, 188 m elev., 20º27′27.4″S, 55º29′12.0″W, 26 November 2014, *A.A. Spielmann et al. 8404* (CGMS 54307); Bodoquena municipality, Serra da Bodoquena, Sítio Boa Vista, on fence pole 20º42′52.30″S, 56º44′14.60″W, 15 August 2010, *L.S. Canêz et al. 3169* (CGMS 31896); Campo Grande municipality, Inside of the Universidade Federal do Mato Grosso do Sul, on tree, 545 m elev., 20º29′57.74″S, 54º36′52.35″W, 8 August 2014, *T.D. Barbosa & C.M. Bernardo 127* (CGMS), *ibid., N.M. Koch 959* (CGMS); Corguinho municipality,

Taboco district, Fazenda Colina Dourada, Nascente do Rio Negro, on tree, 365 m elev., 19º43′30.89″S, 55º07′32.27″W, 2 October 2013, *S.S. Moura et al. 98* (CGMS 40278), *ibid., S.S. Moura et al. 99* (CGMS 40279) *pr. p.*; Corumbá municipality, subregion *Pantanal* do Paraguai, RPPN Eliezer Batista (Novos Dourados), on tree, 95 m elev., 18º05′40.20″S, 57º29′15.50″W, 24 November 2010, *C.S. Robles et al. 45* (CGMS 30327); *ibid.,* 95 m elev., 18º01′09.20″S, 57º32′03.80″W, 24 November 2010, *L.S. Canêz et al. 3556* (CGMS 32000); *ibid.,* RPPN Acurizal, close to ECOTROPICA, on tree, 17º52′38.20″S, 57º33′12.00″W, 27 November 2010, *T.S. Amaral et al. 159* (CGMS 30420); Jaraguari municipality, Furnas do Dionísio, on tree, 357 m elev., 20º08′55.9″S, 54º34′13.9″W, 26 September 2017, *T.D. Barbosa & Spielmann 1716* (CGMS); Nova Andradina municipality, Fazenda Laranjal, RPPN Cabeceira do Mimoso, on tree, 362 m elev., 22º02′40.70″S, 53º23′25.70″W, 2 December 2014, *A.L. Simal et al. 197* (CGMS 46892); Porto Murtinho municipality, Fazenda Santa Virgínia close to Retiro 13, on tree, 95 m elev., 22º06′42.4″S, 57º50′01.9″W, 24 November 2011, *A.A. Spielmann & L.S. Canêz 10097* (CGMS 54311); *ibid. A.A. Spielmann & L.S. Canêz 10098* (CGMS); *ibid.,* 85 m elev., 22º06′42.0″S, 57º50′01.2″W, 15 December 2010, *A.A. Spielmann et al. 9423* (CGMS); *ibid.,* road to Morro Pão de Açúcar, on fence pole, 89 m elev., 21º29'09.80"S, 57º55'46.10"W, 13 June 2017, *T.D. Barbosa et al. 1572* (CGMS).

Dirinaria confluens var. ***coccinea*** (Lynge) D.D. Awasthi (1975: 31). (Figures 8A-F, 398A-B array 6, 40A array 6)

≡ *Physcia aegialita* (Afzel. *in* Ach.) Nyl. f. *coccinea* Lynge (1924: 43-printed in 1925).

Lectotype:—BRAZIL. Mato Grosso do Sul State: Corumbá municipality, on Cereum arborescentum, 26 July 1894, *G. Malme s/n* (S; isotypes: LD, UPS).

MORPHOLOGY. **Thallus** corticicolous; 5–17 cm diam. **Upper surface** proximal region light-green to whitish grey, rugose to verrucose, irregularly to longitudinal plication, abundant, **pruina** absent; distal region light-green to whitish grey, rugose, longitudinal plication frequent, **pruina** frequent without board. **Maculae** in the proximal region absent; in the distal region scarce, marginal to submarginal, linear. **Laciniae** confluent contiguous to overlapping, not branched to dichotomously branched, 0.5–1(–1.8) mm width in base and (0.7–)0.9–2 mm in maximum width; apices flabellate to slightly flabellate, rounded to retuse, margin smooth to crenate. **Medulla** upper layer mainly red or rarely white; lower layer white rarely red, the red pigmentation is mainly concentrated in the upper layer of the medulla; **pigment** reddish or absent. **Lower surface** proximal region black; distal region light-brown to black, 1–3 mm length. **Rhizinae precursors** scarce to frequent, black, laminal. **Lacinulae** absent or frequent, adventitious, concolor to thallus, not branched, 0.5 × 0.2–

0.3 mm, rounded apices. **Isidia**, **Polysidiangia** and **Soralia** absent. **Apothecia** 0.4–1.9 mm diam., laminal, sessile, base constrict to rarely substipitate; **disc** black, plane, **pruina** absent or white; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** white to red, 0.1–0.2 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3–4 cell layer, 15–22 µm thick; **algal layer** continuous, 15–30 µm thick; **medulla** upper layer red, lower layer colorless to yellow, 90–180 µm thick; **lower cortex** prosoplectenchymatous, 10–15(–18) µm thick, dark-brown. **Apothecia epihymenium** 8–12 µm thick, dark-brown to light-brown; **hymenium** 90–110 µm thick, colorless, paraphyses capitate apice; **subhymenium** 100–120 µm thick, brown-black to rarely light-brown; **ascospores** *Dirinaria*-type, 15–20 × 5–8 µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K−, C−, KC−, UV+ bluish white in white region; **medulla pigment** K+ purple to black, C+ orange, KC−; **lower cortex** K−, C−; **apothecial disc** UV− or rarely UV+ dark-green.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria confluens var. *coccinea* is characterized by a strongly plicate thallus, flabellate laciniae, apothecia with plane disc and white pruina, and the presence atranorin and divaricatic acid, and has as main feature the red pigment primarily concentrated in the upper layer of the medulla.

This variety is exclusively neotropical, with a distribution restricted to the central region of the South America. Awasthi (1975) mentioned the possible relationship between the red pigment and verrucose condition in the thallus surface.

Another species with red pigments in the medulla, present in Mato Grosso do Sul State, is *D. leopoldii*, but this species shows hemispherical soralia and produces atranorin and sekikaic acid.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Água Clara municipality, margin of the highway MS-377, 450 m elev., 20º11'16.50"S, 52º39'52.80"W, 13 June 2017, *A.A. Spielmann et al. 10324* (CGMS 42746); Alcinópolis municipality, Monumento Natural do Serra do Bom Jardim, Trilha do Pôr do Sol, on tree, 639 m elev., 18º06'58.8"S, 53º41'21.8"W, 16 October 2017, *L.K. Reis et al. 21* (CGMS 64823); *ibid., T.D. Barbosa & A.A. Spielmann 1732* (CGMS); *ibid., T.D. Barbosa & Spielmann 1780* (CGMS); *ibid., T.D. Barbosa & Spielmann 1786* (CGMS); *ibid., T.D. Barbosa & Spielmann 1789* (CGMS); *ibid., T.D. Barbosa & Spielmann 1795* (CGMS); *ibid.,* Trilha da Gruta da Paca, on tree, 621 m elev., 18º06'48.3"S, 53º40'04.3"W, 18 October 2017, *A.S. Rodrigues 449* (CGMS); *ibid.,* 604 m elev., 18º06'48.3"S, 53º40'00.9"W, 18

October 2017, *T.D. Barbosa & A.A. Spielmann 1886* (CGMS); *ibid., T.D. Barbosa & A.A. Spielmann 1891* (CGMS); *ibid.,* Parque Estadual das Nascentes do Rio Taquari, on tree, 469 m elev., 18º09'08.67"S, 53º24'37.03"W, 16 November 2015, *J.M. Torres et al. 472* (CGMS 57995); *ibid.,* 773 m elev., 18º14'17.0"S, 53º18'18.9"W, 19 November 2015, *M.L.Z. Colado et al. 203* (CGMS 56215); *ibid.,* 576 m elev., 18° 9'3.29"S, 53°24'7.77"W, 23 October 2017, *T.D. Barbosa & A.A Spielmann 1806* (CGMS); *ibid.,* 576 m elev., 18º09'03.3"S, 53º24'07.8"W, 23 October 2017, *T.D. Barbosa & A.A. Spielmann 1828* (CGMS); *ibid.,* on tree, 521 m elev., 18º9'1.47"S, 53º24'12.31"W, 23 October 2017, *T.D. Barbosa & A.A. Spielmann 1871* (CGMS); *ibid., T.D. Barbosa & A.A. Spielmann 1872* (CGMS); *ibid.,* 786 m elev., 18°14'18.17"S, 53°18'12.80"W, 24 October 2017, *M.J. Kitaura 4269* (CGMS); *M.J. Kitaura 4306* (CGMS); Aquidauana municipality, Camisão district, Morraria Paxixi, on tree, 507 m elev., 20º26'24.00"S, 55º37'25.09"W, 27 November 2014, *B.H.S. Ferreira et al. 57* (CGMS 47445); *ibid., N.F. Silva et al. 69* (CGMS 47556); *ibid.,* 600 m elev., 20º25'37.09"S, 55º36'39.05"W, 5 December 2015, *C.M. Bernardo 983* (CGMS 60268); *ibid., T.D. Barbosa 865* (CGMS 60269); *ibid., T.D. Barbosa 867* (CGMS 60270); *ibid., T.D. Barbosa 874* (CGMS 60278); *ibid., T.D. Barbosa 893* (CGMS 60279); *ibid.,* 365 m elev., 20º27'03.3"S, 55º37'17.5"W, 9 July 2016, *C.M. Bernardo 1167* (CGMS 60280); *ibid., J.M. Torres 546* (CGMS 60272); *ibid., T.D. Barbosa 1043* (CGMS 60271); *ibid.,* Piraputanga district, on tree, 188 m elev., 20º27'27.4"S, 55º29'12.0"W, 26 November 2014, *A.A. Spielmann et al. 12153* (CGMS 54326); *ibid.,* 216 m elev., 20°27'23.58"S, 55°29'16.32"W, 26 November 2014, *A.A. Spielmann 12167* (CGMS); *ibid.,* highway MS-450, on tree, 217 m elev., 20º27'23.60"S, 55º29'16.30"W, 26 November 2014, *P.P. Oliveira et al. 267* (CGMS 47757); *ibid.,* 188 m elev., 20º27'27.40"S, 55º29'12.00"W, 26 November 2014, *S.R. Ramalho et al. 42* (CGMS 47808); *ibid.,* 170 m elev., 20º27'37.40"S, 55º30'41.60"W, 25 November 2014, *A.L. Simal et al. 154* (CGMS 46734); Bonito municipality, Fazenda América, Retiro do Ruivo, 414 m elev., 21º10'12.90"S, 56º35'59.40"W, 22 May 2010, *V.J. Pott et al. 11325* (CGMS 48481); Campo Grande municipality, UFMS Cerradinho (RPPN), on tree, 539 m elev., 20º30'31.70"S, 54º36'51.30"W, 28 August 2010, *L.S. Canêz et al. 3187* (CGMS 32348); *ibid., L.S. Canêz et al. 3188* (CGMS 32349); *ibid., L.S. Canêz et al. 3193* (CGMS 32385); *ibid., L.S. Canêz et al. 3216* (CGMS 32386); *ibid., L.S. Canêz et al. 3217* (CGMS 32387); *ibid., L.S. Canêz et al. 3218* (CGMS 32388); *ibid., L.S. Canêz et al. 3220* (CGMS 32389); *ibid., L.S. Canêz et al. 3221* (CGMS 32390); *ibid., L.S. Canêz et al. 3223* (CGMS 32391); *ibid., L.S. Canêz et al. 3224* (CGMS 32392); *ibid., L.S. Canêz et al. 3225* (CGMS 32393); *ibid., L.S. Canêz et al. 3227* (CGMS 32394); *ibid.,* 9 September 2014, *T.D. Barbosa 151* (CGMS); *ibid.,* 03 April 2018, *T.D. Barbosa 1922* (CGMS)*; ibid.,* 540 m elev., 20º30'31.70"S, 54º36'51.30"W, 28 August 2010, *A.A. Spielmann et al. 8479* (CGMS 42775); *ibid., A.A. Spielmann et al. 8485* (CGMS 42710); *ibid., A.A. Spielmann et al.*

8565 (CGMS 42727); *ibid.,* UFMS next to INBIO (oldest CCBS), on tree, 537 m elev., 20º30'04.3"S, 54º36'42.6"W, 17 October 2013, *A.A. Spielmann 11148* (CGMS 52138); *ibid., A.A. Spielmann 11149* (CGMS 52146); *ibid.,* Parque Ecológico do Sóter, 653 m elev., 20º25'42.1"S, 54º34'28.0"W, 29 May 2015, *A.A. Spielmann et al. 11854* (CGMS 52196); Corguinho municipality, Taboco district, 395 m elev., 19º44'40.25"S, 55º15'53.30"W, 30 September 2013, *T.R.F. Sinani et al. 21* (CGMS 40554); Corumbá municipality, Subregion *Pantanal* do Paraguai, Taquaral bay, on tree, 83 m elev., 18º02'42.30"S, 57º30'15.20"W, 26 November 2010, *L.S. Canêz et al. 3595* (CGMS 32043); *ibid.,* 95 m elev., 18º05'40.20"S, 57º29'15.50"W, 24 November 2010, *C.S. Robles et al. 42* (CGMS 30324); *ibid., L.S. Canêz et al. 3558* (CGMS 32002); Costa Rica municipality, Parque Estadual das Nascentes do Rio Taquari, on tree, 790 m elev., 18º14'14.3"S, 53º18'00.8"W, 24 October 2017, *A.S. Rodrigues 374* (CGMS); Jaraguari municipality, Furnas do Dionísio, on tree, 498 m elev., 20º08'50.30"S, 54º34'08.10"W, 13 November 2015, *C.M. Bernardo 859* (CGMS); *ibid.,* 23 October 2010, *A.A. Spielmann & L.S. Canêz 8933* (CGMS 42724); *ibid., A.A. Spielmann & L.S. Canêz 8999* (CGMS 42735); *ibid., L.S. Canêz & A.A. Spielmann 3434* (CGMS 31757); Jardim municipality, Camping Seu Assis, 230 m elev., 21º25'14.20"S, 56º23'16.70"W, 4 June 2010, *L.S. Canêz et al. 2969* (CGMS 32477); Nova Andradina municipality, Fazenda Laranjal (RPPN), on tree, 373 m elev., 22º02'09.50"S, 53º23'23.10"W, 1 December 2014, *A.C. Gomes et al. 53* (CGMS 47096); *ibid.,* 373 m elev., 22° 3'42.60"S, 53°23'23.09"W, 1 December 2014, *A.A. Spielmann 11484* (CGMS); *ibid.,* 387 m elev., 22º09'09.05"S, 53º21'45.04"W, 4 December 2014, *B.H.S. Ferreira 80* (CGMS 47388); *ibid., K.C.R. Arruda et al. 70* (CGMS 47406); Porto Murtinho municipality, road to Morro Pão de Açúcar, on tree, 89 m elev., 21º29'09.8"S, 57º55'46.1"W, 13 June 2017, *T.D. Barbosa 1552* (CGMS); *ibid., T.D. Barbosa 1570* (CGMS); *ibid., T.D. Barbosa 1579* (CGMS); Rio Negro, margin of the highway MS-419, on fence pole, 165 m elev., 19º17'55.83"S, 55º06'1.04"W, 3 October 2013, *A.A. Spielmann et al. 11131* (CGMS 54124); *ibid., A.A. Spielmann et al. 11133* (CGMS 54125); *ibid., A.P. Souza 44* (CGMS 40939); Terenos municipality, Fazenda Modelo da EMBRAPA, on tree, 512 m elev., 20º33'41.10"S, 54º47'23.20"W, 22 September 2010, *A.A. Spielmann et al. 8595* (CGMS 42712); *ibid., L.S. Canêz et al. 3402* (CGMS 31725).

Dirinaria consimilis (Stirt.) D.D. Awasthi, *in* Awasthi & Agarwal (1970: 135). (Figures 9A-F, 39A-B array 13, 40A array 13)

≡ *Physcia consimilis* Stirt. (1879: 310).

Lectotype:—INDIA. near Chinsurah, on bark of *Artocarpus integrifolia* tree, *G. Watt 111* (GLAM; isotype: BM).

MORPHOLOGY. **Thallus** saxicolous or corticicolous to rarely ramuliculous; 4–11 cm diam. **Upper surface** proximal region whitish grey to light-green, rugose to verrucose, irregularly plicated abundant, **pruina** absent to scarce with board; distal region whitish grey to light-green, rugose to rarely verrucose, longitudinal plication abundant to frequent, **pruina** scarce without board to abundant with board. **Maculae** in the proximal region absent to scarce, laminal, linear to irregular; in the distal region scarce to frequent, marginal to submarginal, linear. **Laciniae** confluent overlapping, not branched to palmatifid branched, 0.4–0.9 mm width in base and 0.4–1.2 mm in maximum width; apices not flabellate to slightly flabellate, rounded to subtruncate, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** yellow (sulphur) or absent. **Lower surface** proximal region black to rarely light-brown; distal region light-brown to cream, 0.1–0.5(–1.2) mm length, margin rarely variegated between light-brown and black or light-brown and white. **Rhizinae precursors** frequent, black, laminal. **Polysidiangia** abundant to covering the thallus, laminal to submarginal, irregular; **soredia** whitish green, granulose. **Lacinulae** absent or scarce, adventitious, concolor to thallus, not branched, 0.1–0.25 × 0.1–0.2 mm, rounded apices. **Isidia** and **Soralia** absent. **Apothecia** 0.3–1.5 mm diam., laminal, sessile, base constrict to rarely subimmersed; **disc** black, plane to rarely concave, **pruina** absent or white to grey; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.1–0.3 mm thick.
ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–4(–5) cell layer, (10–)15–20 µm thick; **algal layer** continuous, 15–30 µm thick; **medulla** upper layer colorless to yellow, lower layer colorless, (80–)100–175(–250) µm thick; **lower cortex** prosoplectenchymatous, (5–)10–15(–25) µm thick, dark-brown. **Apothecia epihymenium** 8–15 µm thick, yellow to light-brown; **hymenium** (65–)75–100(–115) µm thick, colorless to yellow, paraphyses capitate apice; **subhymenium** 100–175(–200) µm thick, brown-black to brown; **ascospores** *Dirinaria*-type, 13–22(–25) × 5–8(–10) µm.
SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K− or K+ pink (after 5–10s), C−, KC−, UV+ bluish white; **medulla pigment** K− or K+ purple, C−, KC−; **lower cortex** K−, C−; **apothecial disc** UV− or UV+ dark-green.
TLC. Atranorin, sekikaic acid and terpenes.

REMARKS.

Dirinaria consimilis is characterized by presence of polysidiangia, atranorin and sekikaic acid, and also by the apothecial disc being white to grey pruinose.

This species can be easily confouded with *D. aegialita*, due the identical characteristics (morphology and anatomy), but *D. consimilis* has sekikaic acid and *D aegialita* has divaricatic

acid. *Dirinaria pruinosa* has divaricatic acid, no plicate thallus and the apothecial disc purplish pruinose.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural do Serra do Bom Jardim, Trilha da Gruta, on tree, 604 m elev., 18º06'48.3"S, 53º40'00.9"W, 18 October 2017, *T.D. Barbosa & A.A. Spielmann 1902* (CGMS); *ibid.,* 521 m elev., 18º9'1.47"S, 53º24'12.31"W, 23 October 2017, *T.D. Barbosa & A.A. Spielmann 1821* (CGMS); *ibid.,* 550 m elev., 18º07'52.4"S, 53º41'22.1"W, 20 October 2017, *K.C.B.S. Santos 27* (CGMS); Aquidauana municipality, Camisão district, Morraria Paxixi, on rock, 365 m elev., 20º27'03.3"S, 55º37'17.5"W, 9 July 2016, *A.A. Spielmann 12255* (CGMS 60277); *ibid., C.M. Bernardo 1148* (CGMS 60266); *ibid., T.D. Barbosa 1040* (CGMS 60265); *ibid.,* Piraputanga district, Acampamento Betânia, on rock, 150 m elev., 20º27'38.40"S, 55º49'35.30"W, 19 September 2010, *L.S. Canêz et al. 3376* (CGMS 31917); *ibid.,* Acampamento Batista, on rock, 180 m elev., 20°27'22.06"S, 55°30'0.87"W, 26 May 2014, *T.D. Barbosa & C.M. Bernardo 87* (CGMS); *ibid., T.D. Barbosa & C.M. Bernardo 88* (CGMS); *ibid.,* Sítio Arqueológico CERA – UEMS, on rock, 185 m elev., 20º26'06.60"S, 55º39'33.00"W, 25 November 2014, *A.L. Simal et al. 149* (CGMS 46729); *ibid., A.L. Simal et al. 168* (CGMS 46748); Campo Grande municipality, Inferninho, on rock 496 m elev., 20°22'18.80"S, 54°40'39.76"W, 14 November 2016, *A.P.S. Campelo 26* (CGMS); Corumbá municipality, Subregion *Pantanal* do Paraguai, RPPN Eliezer Batista (Novos Dourados), on tree, 95 m elev., 18°05'40.20"S, 57°29'15.50"W, 24 November 2010, *C.S. Robles et al. 29* (CGMS 30311); *ibid.,* Taquaral bay; on tree, 89 m elev., 18°02'48.90"S, 57°29'49.50"W, 26 November 2010, *C.O. Dourado et al. 57* (CGMS 30219); 83 m elev., 18°02'42.30"S, 57°30'15.20"W, 26 November 2010, *C.O. Dourado et al. 43* (CGMS 30205); *ibid., C.O. Dourado et al. 45* (CGMS 30207); *ibid., C.O. Dourado 58* (CGMS 30220); *ibid.,* on rock, *L.S. Canêz et al. 3626* (CGMS 32073); Jaraguari municipality, Furnas do Dionísio, on rock, 357 m elev., 20°8'55.87"S, 54°34'13.92"W, 26 September 2017, *T.D. Barbosa 1727* (CGMS); Nova Andradina, RPPN – Cabeceira do Mimoso, Fazenda Laranjal, on tree, 373 m elev., 22°03'42.60"S, 53°23'23.10"W, 1 December 2014, *T.C. Piva et al. 46* (CGMS 47041); Porto Murtinho municipality, Cachoeira do Apa, on tree, 90 m elev., 22°10'05.90"S; 57°31'13.40"W, 14 June 2017, *T.D. Barbosa 1603* (CGMS); Rio Negro municipality, on tree, 165 m elev., 19°17'55.83"S; 55°06'1.04"W, 3 October 2013, *A.P. Souza 44b* (CGMS); Terenos municipality, Colônia Velha, on tree, 357 m elev., 20°22'6.15"S; 54°51'53.12"W, 4 February 2017, *C.M. Bernardo et al. 1123* (CGMS).

Dirinaria leopoldii (Stein) D.D. Awasthi (1975: 89). (Figures 10A-F, 39A-B array 1, A array 1)
≡ *Crocynia leopoldii* Stein (1888: 140).

Lectotype:—DEMOCRATIC REPUBLIC OF CONGO. Vivi, on *Ficus* branches, *Ledien*, 1885-1886 (G).

MORPHOLOGY. **Thallus** corticicolous; ca. 4 cm diam. **Upper surface** proximal region whitish grey, rugose, irregularly plicated abundant, **pruina** frequent without board; distal region whitish grey, rugose, longitudinal plication abundant, **pruina** frequent without board. **Maculae** in the proximal region absent; in the distal region scarce, marginal to laminal, linear. **Laciniae** confluent contiguous to overlapping, dichotomously to palmatifid branched, 0.6–1 mm width in base and 0.9–1.3 mm in maximum width; apices flabellate, retuse to irregular, margin crenate. **Medulla** upper layer white; lower layer white; **pigment** red. **Lower surface** proximal region black; distal region cream, 1–2 mm length. **Rhizinae precursors** absent. **Soralia** frequent, laminal, hemispherical shape; **soredia** green to red, farinose. **Apothecia** absent. **Isidia**, **Polysidiangia** and **Lacinulae** absent.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3–4 cell layer, 15–18 µm thick; **algal layer** continuous, 20–25 µm thick; **medulla** upper layer red, lower layer yellow, 150–190 µm thick; **lower cortex** prosoplectenchymatous, 10 µm thick, dark-brown.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K+ purple in red region, C−, KC−, UV−; **lower cortex** K−, C−.

TLC. Atranorin, sekikaic acid and terpenes.

REMARKS.

Dirinaria leopoldii is characterized by the red and green soredia, plicate thallus, flabellate laciniae apicesand atranorin and sekikaic acid as chemical constituents.

This is the only sorediate species with a red pigment in the medulla, a very distinctive feature. Up to now, *Dirinaria leopoldii* is known in Brazil from Mato Grosso do Sul, Pernambuco and Sergipe. We found only one sterile specimen, collected in the *Chaco* region.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Porto Murtinho municipality, Fazenda Barbas, 105 m elev., 21°41'06.50"S, 57°43'10.20"W, on tree, 12 June 2017, *T.D. Barbosa et al. 1508* (CGMS).

Dirinaria maracajuensis T.D. Barbosa & A.A. Spielmann, *sp. nov.* (Figures 11A-F, 39A-B array 12, 40A array 12)

Mycobank number: xxxxx

Diagnosis: Saxicolous *Dirinaria* with irregularly plicate thallus, non-flabellate to slightly flabellate laciniae, apothecial disc strongly convex and with yellowish white pruina, atranorin in cortex and divaricatic acid in medulla.

Holotype:—BRAZIL. Mato Grosso do Sul State: Aquidauana municipality, Camisão district, Morraria Paxixi, 365 m elev., 20°27'03.3"S, 55°37'17.5"W, 9 July 2016, *A.A. Spielmann et al. 12247* (CGMS 60267).

MORPHOLOGY. **Thallus** saxicolous, adglutinated to substrate; ca. 5 cm diam. **Upper surface** proximal region yellowish grey, rugose, irregularly plicated abundant, **pruina** absent; distal region yellowish grey, rugose, longitudinal plication abundant, **pruina** absent to scarce without board. **Maculae** in the proximal region present, laminal, linear; in the distal region frequent, submarginal, linear. **Laciniae** confluent overlapping, not branched to irregularly branched, 0.3–0.4 mm width in base and 0.3–0.4 mm in maximum width; apices not flabellate to slightly flabellate, subtruncate to rounded or rarely retuse, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** yellow (sulphur). **Lower surface** proximal region black; distal region black. **Rhizinae precursors** absent. **Isidia**, **Polysidiangia** and **Soralia** absent. **Lacinulae** frequent, adventitious, concolor to thallus, not branched, 0.5 × 0.3 mm, rounded apices. **Apothecia** 0.6–1.6 mm diam., laminal, sessile, base constrict; **disc** brown to black, strongly convex **pruina** yellow; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** white to cream, 0.25–0.3 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3–4 cell layer, 20–25 µm thick; **algal layer** continuous, 25–35 µm thick; **medulla** upper layer yellow, lower layer yellow, 200–210 µm thick; **lower cortex** prosoplectenchymatous, 15–20 µm thick, light-brown. **Apothecia epihymenium** 12 µm thick, light-brown; **hymenium** 80–95 µm thick, colorless, paraphyses capitate apice; **subhymenium** 150–225 µm thick, colorless to yellow; **ascospores** *Dirinaria*-type, (10–)13–17(–20) × 5–7(–8) µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K−, C−, KC−, UV+ bluish white; **medulla pigment** K+ purple, C+ orange, KC−; **lower cortex** K−, C−; **apothecial disc** UV+ dark-green.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria maracajuensis is characterized by irregularly plicate thallus, non-flabellate to slightly flabellate laciniae, saxicolous habitat, apothecial discs strongly convex and with yellowish white pruina, and atranorin and divaricatic acid.

This species is closely related to *D. batavica* D.D. Awasthi (1975:42) by presenting the colorless to yellow subhymenium and the saxicolous habit. They are differentiated as follows: *D. batavica* has smaller apothecia (up to 0.5 mm), smaller subhymenium (up to 80 µm) and substipitate apothecia, while *D. maracajuensis* has larger (up to 1.6 mm) apothecia, larger subhymenium (up to 225 µm) and sessile apothecia with the base constricted. Another similar species is *D. melanocarpa*, but this has a yellow to cream lower surface and corticicolous habit. Others species without vegetative propagules have a dark brown to brown-black subhymenium. *Dirinaria maracajuensis* is known only from the holotype.

The epithet is a tribute to Serra de Maracaju a important mountain range localized in Mato Grosso do Sul State, Brazil.

Dirinaria melanocarpa (Mull. Arg.) C.W. Dodge (1971: 179). (Figures 12A-F, 39A-B array 7, 40A array 7)

≡ *Physcia melanocarpa* Müll. Arg. (1888: 58).

Lectotype:—PARAGUAY. Guarapi: prope Asuncion, 1879, *B. Balansa 4198* (REN; isotype: H-NYL. 2325).

MORPHOLOGY. **Thallus** corticicolous; 4–10 cm diam. **Upper surface** proximal region yellowish grey to whitish grey, verrucose, longitudinal plication abundant, **pruina** absent; distal region yellowish grey to whitish grey, rugose, longitudinal plication abundant, **pruina** absent. **Maculae** in the proximal region absent; in the distal region frequent, marginal to laminal, linear. **Laciniae** confluent overlapping, not branched to palmatifid branched, 0.5–1.5 mm width in base and 0.9–2.5 mm in maximum width; apices slightly flabellate to flabellate, rounded, margin smooth to crenate. **Medulla** upper layer white to cream; lower layer white; **pigment** yellow (sulphur). **Lower surface** proximal region yellow to cream; distal region concolor to proximal region. **Rhizinae precursors** scarce, yellow to cream, laminal. **Isidia** absent. **Polysidiangia** absent. **Soralia** absent. **Lacinulae** absent. **Apothecia** 0.4–1.8 mm diam., laminal, sessile, base constrict to rarely substipitate; **disc** black, plane to convex, **pruina** absent; **margin** crenate; **amphithecium** smooth, ornament absent; **internal stipe** white to cream, 0.2–0.3 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3–4 cell layer, 15–25 µm thick; **algal layer** continuous, 20–35 µm thick; **medulla** upper layer colorless, lower layer colorless, 65–120

µm thick; **lower cortex** prosoplectenchymatous, 12–15 µm thick, colorless to yellow. **Apothecia epihymenium** 10–15 µm thick, yellow; **hymenium** 100–125 µm thick, colorless, capitate paraphyses apice; **subhymenium** 110–125(–200) µm thick, colorless to yellow; **ascospores** *Dirinaria*-type, 15–21 × 6–7 µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K−, C−, KC−, UV+ bluish white; **medulla pigment** K+ purple, C+ orange, KC−; **lower cortex** K−, C−; **apothecial disc** UV+ dark-green.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria melanocarpa is characterized by a abundant plicate thallus, flabellate laciniae apices, apothecia with plane disc, and the presence of atranorin and divaricatic acid, and as main features the yellow to cream lower surface and the colorless to yellow subhymenium.

This species is very closely related to *D. confluens* but has a yellow to cream lower surface and a colorless to yellow subhymenium. *Dirinaria melanocarpa* is the only species with a pale lower surface and a colorless subhymenium.

Dirinaria melanocarpa can be confouded with *Physcia* species, mainly due the pale lower surface and pale subhymenium color but does not have rhizinae.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, Trilha da Gruta, on tree, 604 m elev., 18°06'48.3"S, 53°40'00.9"W, 18 October 2017, *T.D. Barbosa & A.A. Spielmann 1892* (CGMS); *ibid.,* Trilha do Pôr do Sol, on tree, 639 m elev., 18°06'58.3"S, 53°41'21.8"W, 17 October 2017, *T.D. Barbosa & A.A. Spielmann 1785* (CGMS); Aquidauana municipality, Camisão district, Morraria Paxixi, on tree, 507 m elev., 20°26'24.00"S, 55°37'25.09"W, 27 November 2014, *C.H. Simão et al. 42* (CGMS 47476); *ibid.,* 26 November 2014, *S.R. Ramalho 46b* (CGMS) *pr. p.*; Campo Grande municipality, A.P.A do Rio Grariroba, Nascente do córrego Saltinho, Fazenda Cantagalo, on tree, 555 m elev., 20°32'36.70"S, 54°23'57.08"W, 9 April 2010, *A.A. Spielmann et al. 8039* (CGMS 42732); *ibid.,* RPPN Cerradinho (UFMS), on tree, 540 m elev., 20°30'31.7"S, 54°36'51.3"W, 15 July 2014, *A.A. Spielmann et al. 11204* (CGMS 52159); Corguinho municipality, Taboco district, RPPN Estância do Sol, on tree, 290 m elev., 19°46'25.29"S, 55°14'34.54"W, 29 September 2013, *A.A. Spielmann et al. 11059* (CGMS 54305); *ibid.,* 365 m elev., 19°43'30.89"S, 55°07'32.27"W, 2 October 2013, *S.S. Moura 99b* (CGMS) *pr. p.*; Corumbá municipality, subregion *Pantanal* do Paraguai, RPPN Eliezer Batista (Novos Dourados), on tree, 95 m elev., 18º05′40.20″S, 57º29′15.50″W, 24 November 2010, *C.S. Robles et al. 58* (CGMS 30340); Costa Rica

municipality, Parque Estadual das Nascentes do Rio Taquari, Canyons, 790 m elev., 18°14'14.3"S, 53°18'00.8"W, 24 October 2017, *A.S. Rodrigues 383* (CGMS); *ibid., T.D. Barbosa 1898* (CGMS); *ibid.,* 786 m elev., 18°14'18.17"S, 53°18'12.80"W, 24 October 2017, *M.J. Kitaura 4266* (CGMS); Jateí municipality, on fence pole, 235 m elev., 22°54'5.93"S, 53°45'5.49"W, 15 November 2015, *A.A. Spielmann 11982* (CGMS); Nova Andradina municipality, Fazenda Laranjal, RPPN Cabeceira do Mimoso, on tree, 362 m elev., 22°02'40.70"S, 53°23'25.70"W, 2 December 2014, *A.L. Simal et al. 202* (CGMS 46897); *ibid.,* 354 m elev., 22°04'03.30"S, 53°23'51.40"W, 3 December 2014, *P.P. Oliveira et al. 303* (CGMS 47914); Porto Murtinho municipality, 94 m elev. 21º36'41.60"S, 57º48'04.30"W, corticicolous, in *Caesalpinia pluviosa* in open vegetation, 21 November 2011, *A.A. Spielmann 9528* (CGMS); *ibid., A.A. Spielmann et al. 12284* (CGMS).

Dirinaria melanoclina (C. Knight) D.D. Awasthi (1975: 77). (Figure 13A-F)

≡ *Physcia melanoclina* C. Knight (1882: 49), Tab 7, Fig. 10.

Lectotype:—AUSTRALIA. New South Wales, 1880, *C. Knight 13* (in pencil), (WELT; Isotypes: H–NYL. 31807; M).

MORPHOLOGY. **Thallus** corticicolous; ca. 4 cm diam. **Upper surface** proximal region green, rugose, not plicated to slightly longitudinally plicated, **pruina** absent; distal region green, rugose, not plicated, **pruina** scarce without board. **Maculae** in the proximal region absent; in the distal region absent. **Laciniae** discrete to contiguous, not branched to palmatifid branched, 0.3–0.4 mm width in base and 0.4–0.6 mm in maximum width; apices slightly flabellate, rounded to rarely retuse, margin smooth. **Medulla** upper layer white; lower layer white; **pigment** absent. **Lower surface** proximal region black; distal region light-brown, ca. 0.1 mm length. **Rhizinae precursors** scarce, black, laminal. **Soralia** frequent, laminal, hemispherical to irregular shape; **soredia** green, granulose. **Lacinulae** absent. **Isidia** and **Polysidiangia** absent. **Apothecia** 0.5–0.8 mm diam., laminal, sessile, base constrict; **disc** dark-brown, plane to slightly convex, **pruina** brown; **margin** crenate; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.1–0.2 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–3 cell layer, 12–15 µm thick; **algal layer** continuous, 20–25 µm thick; **medulla** upper layer colorless, lower layer colorless, 85–130 µm thick; **lower cortex** prosoplectenchymatous, 10–12 µm thick, light-brown. **Apothecia epihymenium** 7.0–8.0 µm thick, light-brown; **hymenium** 75 µm thick, colorless, capitate paraphyses apice; **subhymenium** 100–112 µm thick, brown; **ascospores** *Dirinaria*-type, (10–)12–13(–14) × (4–)5–6 µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K−, C−, KC−, UV+ bluish white; **lower cortex** K−, C−; **apothecial disc** UV−.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria melanoclina is characterized by the non-plicate thallus, apices of laciniae non-flabellate, hemispherical soralia, brown pruina and the production of atranorin and divaricatic acid.

It is similar to *D. picta* but has smaller ascospores, smaller subhymenium and brown pruina in apothecial discs, while *D. picta* has larger ascospores and subhymenium, and epruinose apothecial discs. Another closely related species are *D. applanata* (plicate thallus and flabellate laciniae) and *D. melanoclina* (without plication and laciniae not flabellate).

The examined specimen of *D. melanoclina* has ascospores (10–)12–13(–14) × (4–)5–6 µm and brown pruina in apothecial discs, features that are not exactly the same as that described by Awasthi (1975): ascospores 16–20 × 6–8(–9) µm and pruina purple. Over time all the mentions about this species were restricted to two regions: South Africa (Awasthi 1975) and Australia (Knight 1882 as *Physcia melanoclina*, Awasthi 1975 and Elix 2009). In this way, it is possible that what we found actually belong to a different taxon. The specimen is being study genetically, but fresh collections from the places above are necessary for comparison.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Corumbá municipality, municipality, UFMS - Base de Estudos do *Pantanal* (BEP), Pantanal 43 km SE of Corumbá, on bark of tree, 85 m elev., 19°32'S, 57°24'W, 02 March 2019, *A. Aptroot.78156* (CGMS).

Dirinaria papillulifera (Nyl.) D.D. Awasthi (1964: 369). (Figures 14A-F, 39A-B array 8, 40A array 8)

≡ *Physcia papillulifera* Nyl. *Acta Societatis Scientiarum Fennicae* 26(10): 9 (1900).

Lectotype:—SRI-LANKA. Point de Galles, in horto, 'Vega Exped', 1879, *E. Almquist* (S; isotype: H-NYL 31791).

MORPHOLOGY. **Thallus** corticicolous or ramulicolous; 3–12 cm diam. **Upper surface** proximal region whitish grey to greenish grey, verrucose to rugose, longitudinal plication abundant, **pruina** absent; distal region whitish grey to greenish grey, smooth to rugose, not plicated to longitudinal plication scarce, **pruina** absent to scarce without board. **Maculae** in the proximal region absent; in the distal region absent. **Laciniae** confluent overlapping, not branched to palmatifid branched, 0.3–0.8 mm width in base and (0.3–)0.4–1 mm in maximum width; apices slightly flabellate, rounded to retuse, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** yellow (sulphur), mainly in the old region. **Lower surface** proximal region black; distal

region dark-yellow, 0.2–0.4 mm length. **Rhizinae precursors** scarce, black, laminal. **Isidia** frequent to abundant, laminal to submarginal, papilliform to cylindrical, not branched to irregularly branched, concolor to thallus surface. **Polysidiangia**, **Soralia** and **Lacinulae** absent. **Apothecia** 0.3–1.9 mm diam., laminal, sessile, base constrict; **disc** black, plane to convex, **pruina** absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent to isidiate; **internal stipe** white to cream, 0.1 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–3(–4) cell layer, 15–20 µm thick; **algal layer** continuous, 20–30 µm thick; **medulla** upper layer colorless, lower layer colorless, 120–140 µm thick; **lower cortex** prosoplectenchymatous, (5–)8–12 µm thick, dark-brown. **Apothecia epihymenium** (5–)8–12 µm thick, dark-brown to light-brown; **hymenium** 75–90(–110) µm thick, colorless, capitate paraphyses apice; **subhymenium** (150–)210–275 µm thick, brown to brown-black; **ascospores** *Dirinaria*-type, 15–22 × 5–6 µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K−, C−, KC−, UV+ bluish white; **medulla pigment** K+ purple, C+ red, KC−; **lower cortex** K+ yellow, C+ red to pink; **apothecial disc** UV−.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria papillulifera is characterized by a plicate thallus, slightly flabellate laciniae, the presence of papilliform to cylindrical isidia and the presence of atranorin and divaricatic acid.

This is the only species with isidia in the *Dirinaria* genus; the epithet name *"papillulifera*" refers to the young stages of the isidia when they resemble papillae. Only the specimen "*T.H. Stefanello et al. 10*" was collected from Mato Grosso do Sul State, but as additional specimens examined are from the border region of the Bolivia with Brazil, it is probable that there exist some more populations of this species in the state.

This is the first record of *D. papillulifera* from Mato Grosso do Sul State; in Brazil it was so far only known from Amazonas and Rondônia States, a quite disjuct occurrence.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Corumbá municipality, subregion *Pantanal* do Paraguai, Baía do Castelo, on branch, 86 m elev., 18°35'17.30"S, 57°32'10.80"W, 22 November 2010, *T.H. Stefanello et al. 10* (CGMS 30052).

Additional specimens examined:—BOLIVIA. German Busch Province, Mandioré bay, on tree, 90 m elev., 18°11'50.70"S, 57°30'39.70"W, 23 November 2010, *A.A. Spielmann 8710a* (CGMS 42729); *ibid., A.A. Spielmann et al. 8723* (CGMS 42387); *ibid., L.S. Canêz et al. 3518* (CGMS

31963); *ibid., L.S. Canêz et al. 3525a* (CGMS 31970); *ibid., L.S. Canêz et al. 3532* (CGMS 31977); *ibid., L.S. Canêz et al. 3534* (CGMS 31979).

Dirinaria picta (Sw.) Clem. & Shear (1931: 323). (Figures 15A-F, 39A-B array 9, 40A array 9)
≡ *Lichen pictus* Sw. (1788: 146).
Lectotype:—JAMAICA. *Swartz*, 'ex Herbarium Swartz' (S; isotype: UPS).

MORPHOLOGY. **Thallus** ramulicolous; 3–8 cm diam. **Upper surface** proximal region whitish grey, rugose, not plicated, **pruina** absent; distal region whitish grey, smooth, not plicated to rarely longitudinally plicated, **pruina** absent to scarce without board. **Maculae** in the proximal region absent; in the distal region scarce, submarginal to laminal, linear. **Laciniae** discrete contiguous to overlapping, not branched to palmatifid branched, 0.1–0.5 mm width in base and 0.1–0.5 mm in maximum width; apices not flabellate, rounded to subtruncate or rarely truncate, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** absent or rare, yellow (sulphur). **Lower surface** proximal region black; distal region cream to rarely yellow, 0.05–0.08 mm length. **Rhizinae precursors** scarce, black, laminal. **Soralia** frequent, laminal, hemispherical to rarely irregular shape; **soredia** whitish green, granulose. **Lacinulae** absent or scarce, adventitious, concolor to thallus, not branched, 0.08–0.1 × 0.05–0.06 mm, subtruncate apices. **Isidia** and **Polysidiangia** absent. **Apothecia** 0.2–1 mm diam., laminal, sessile, base constrict; **disc** black, plane to convex, **pruina** absent; **margin** crenate; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.06–0.1 mm thick.
ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–4 cell layer, 10–15(–20) µm thick; **algal layer** continuous, (10–)15–20 µm thick; **medulla** upper layer colorless, lower layer colorless, 50–80 µm thick; **lower cortex** prosoplectenchymatous, 10–12(–15) µm thick, light-brown. **Apothecia epihymenium** 7–12(–15) µm thick, light-brown; **hymenium** 65–80(–90) µm thick, yellow, capitate paraphyses apice; **subhymenium** (110–)150–190 µm thick, brown to brown-black; **ascospores** *Dirinaria*-type, 12–17 × 5–7 µm.
SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K−, C−, KC−, UV+ bluish white; **medulla pigment** if present K+ purple, C+ brown, KC−; **lower cortex** K− or rarely K+ pink, C−; **apothecial disc** UV−.
TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria picta is characterized by non-plicate thallus, apices non-flabellate of laciniae, hemispherical soralia, and atranorin and divaricatic acid as chemical constituent. The examined

specimens were mostly collected on young branches of trees, demonstrating that this species is preferably ramulicolous.

Dirinaria picta is similar to *D. applanata* but does not show the plicate thallus and does not have flabellate laciniae. The material was morphologically compared with images of the lectotype of *D. picta* deposited in (S), for a better understanding of taxon.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Corumbá municipality, subregion *Pantanal* do Paraguai, Baía do Castelo, on tree branch, 95 m elev., 18°34'52.20"S, 57°31'36.60"W, 22 November 2010, *L.S. Canêz et al. 3499* (CGMS 31944); *ibid.,* 86 m elev., 18°35'17.30"S, 57°32'10.80"W, 22 November 2010, *T.H. Stefanello et al. 9* (CGMS 30051); *ibid.,* Baía do Taquaral, on tree branch, 83 m elev., 18°02'42.30"S, 57°30'15.20"W, 26 November 2010, *C.O. Dourado et al. 99* (CGMS 30261); *ibid., C.O. Dourado et al. 103* (CGMS 30265); *ibid, L.S. Canêz et al. 3611* (CGMS 32058); Jaraguari municipality, Furnas do Dionísio, on tree, 357 m elev., 20º08′55.9″S, 54º34′13.9″W, 26 September 2017, *A.S. Rodrigues 320* (CGMS).

Additional specimens examined:—BOLIVIA. German Busch Province, Mandioré bay, on tree branch, 90 m elev., 18°11'50.70"S, 57°30'39.70"W, 23 November 2010, *A.A. Spielmann et al. 8710b* (CGMS); *ibid., L.S. Canêz et al. 3515* (CGMS 31960); *ibid., L.S. Canêz et al. 3519* (CGMS 31964); *ibid., L.S. Canêz et al. 3520* (CGMS 31965); *ibid., L.S. Canêz et al. 3522* (CGMS 31967); *ibid., L.S. Canêz et al. 3525b* (CGMS); *ibid., L.S. Canêz et al. 3527* (CGMS 31972); *ibid., L.S. Canêz et al. 3529* (CGMS 31974), *pr. p.*; *ibid., L.S. Canêz et al. 3532b* (CGMS); *ibid., L.S. Canêz et al. 3538* (CGMS 31983); *ibid., T.H.D. Leandro et al. 30* (CGMS 30345); *ibid., T.H.D. Leandro et al. 31* (CGMS 30346); *ibid., T.H.D. Leandro et al. 33* (CGMS 30348), *pr. p.*; *ibid., T.H.D. Leandro et al. 35* (CGMS 30350), *pr. p.*; *ibid., T.H.D. Leandro et al. 40* (CGMS 30355); *ibid., T.H.D. Leandro et al. 41* (CGMS 30356); *ibid., T.H.D. Leandro et al. 42* (CGMS 30357); *ibid., T.H.D. Leandro et al. 68* (CGMS 30383).

Dirinaria pruinosa Kalb (2001: 147). (Figures 16A-F, 39A-Barray 10, 40A array 10)

Holotype:—BRAZIL: Piauí, entrance to Parque Nacional de Sete Cidates, 04º8'S, 41º45'W, transitional vegetation between open *Cerrado* and caatinga, 300 m elev., 6 August 1993, *K. Kalb & A. Kalb 27108* (SP).

MORPHOLOGY. **Thallus** corticicolous or rarely saxicolous; 4–7 cm diam. **Upper surface** proximal region greenish grey, rugose, irregularly plicated scarce to frequent, **pruina** absent; distal region whitish grey to greenish grey, rugose, longitudinal plication, scarce to frequent, **pruina** absent. **Maculae** in the proximal region absent to scarce, laminal, irregular; in the distal region absent to

scarce, marginal to submarginal, linear. **Laciniae** confluent contiguous to overlapping, palmatifid branched, 0.3–1 mm width in base and (0.4–)0.5–1.2 mm in maximum width; apices not flabellate to slightly flabellate, rounded to retuse, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** yellow (sulphur) in the old region or absent. **Lower surface** proximal region black; distal region light-brown to cream, 0.1–1(–1.5) mm length. **Rhizinae precursors** scarce, black, laminal. **Polysidiangia** abundant to covering the thallus, marginal to laminal, irregular; **soredia** whitish green, granulose, the polysidiangia is soredioid in the origin. **Lacinulae** absent to scarce, adventitious, concolor to thallus, not branched, 0.1–0.5 × 0.1–0.4 mm, rounded apices. **Isidia** and **Soralia** absent. **Apothecia** 0.4–1.5 mm diam., laminal, sessile, base constrict; **disc** black, plane to rarely convex, **pruina** purple; **margin** crenate; **amphithecium** smooth or rugose with the age, ornament absent; **internal stipe** white, 0.05–0.075 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–4(–5) cell layer, 10–18 µm thick; **algal layer** continuous, 15–25 µm thick; **medulla** upper layer colorless, lower layer colorless, (60–)75–130(–150) µm thick; **lower cortex** prosoplectenchymatous, 5–15 µm thick, dark-brown. **Apothecia epihymenium** 8–12 µm thick, yellow to colorless; **hymenium** 75–90(–100) µm thick, colorless, paraphyses capitate apice; **subhymenium** (75–)130–175(–250) µm thick, brown to brown-black; **ascospores** *Dirinaria*-type, 15–18(–20) × 5–8 µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K− or K+ pink (after 5–10 sec), C−, KC−, UV+ bluish white; **medulla pigment** if present K+ purple, C+ orange, KC−; **lower cortex** K−, C−; **apothecial disc** UV−.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria pruinosa is characterized by presence of polysidiangia, plicate thallus, atranorin and divaricatic acid, and also the apothecial disc being purplish pruinose.

Dirinaria pruinosa is distinguished from the other species with polysidiangia by the plicate thallus, non-flabellate laciniae and the apothecial disc being purplish pruinose. This is the second report of this taxon to Brazil after the type specimen. Another species with purple pruina species is *D. purpurascens*, but it has not polysidiangia, only apothecia.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Parque Estadual das Nascentes do Rio Taquari (PENT), 773 m elev., 18°14'17.0"S, 53°18'18.9"W, 19 November 2015, *M.L.Z. Colado et al. 202* (CGMS 56214); Corumbá municipality, Subregion *Pantanal* do Paraguai, RPPN Eliezer Batista (Novos Dourados), Ínicio da trilha, on tree, 95 m elev., 18°01'09.20"S, 57°32'03.80"W, 24 November 2010, *L.S. Canêz et al. 3554* (CGMS 31998);

ibid., L.S. Canêz et al. 3556b (CGMS); *ibid.,* start of trail for Morro do Amolar, Baía do Taquaral, on rock, 89 m elev., 18°02'48.90"S, 57°29'49.50"W, 26 November 2010, *L.S. Canêz et al. 3637* (CGMS 32082).

Dirinaria purpurascens (Vain.) B.J. Moore (1968: 251). (Figures 17A-F, 39A-B array 11, 40A array 11)

≡ *Physcia purpurascens* Vain. (1915: 68).

Lectotype:—'WEST INDIES'. St. Croix Island: Fair Plane, on bark, *Boergesen 235*, 1906 (FH).

MORPHOLOGY. **Thallus** corticicolous or rarely ramulicolous; 3–4.5 cm diam. **Upper surface** proximal region whitish grey, smooth, not plicated, **pruina** absent; distal region whitish grey, smooth, not plicated, **pruina** absent. **Maculae** in the proximal region absent; in the distal region scarce, marginal to submarginal, linear. **Laciniae** discrete to confluent contiguous, not branched to palmatifid branched, 0.2–0.5(–0.7) mm width in base and 0.3–0.9 mm in maximum width; apices not flabellate to slightly flabellate, rounded to subtruncate, margin smooth to crenate. **Medulla** upper layer white; lower layer white; **pigment** absent. **Lower surface** proximal region black; distal region cream, 0.09–0.15 mm length. **Rhizinae precursors** scarce, black, laminal. **Isidia**, **Polysidiangia**, **Soralia** and **Lacinulae** absent. **Apothecia** 0.3–1.1(–1.5) mm diam., laminal, sessile, base constrict; **disc** black, plane to rarely convex, **pruina** purple or rarely absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.03–0.1 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3–4 cell layer, 15–20 µm thick; **algal layer** continuous, 15–25 µm thick; **medulla** upper layer colorless, lower layer colorless, (70–)100–120 µm thick; **lower cortex** prosoplectenchymatous, 8–10(–12) µm thick, dark-brown. **Apothecia epihymenium** (5–)10(–15) µm thick, light-brown; **hymenium** 80–90 µm thick, colorless, paraphyses capitate apice; **subhymenium** 75–100(–150) µm thick, brown-black; **ascospores** *Dirinaria*-type, 13–16 × 5–6(–7) µm.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−; **medulla** K−, C−, KC−, UV+ bluish white; **lower cortex** K−, C−; **apothecial disc** UV−.

TLC. Atranorin, divaricatic acid and terpenes.

REMARKS.

Dirinaria purpurascens is characterized by non-plicate thallus, slightly or not non-flabellate laciniae, atranorin and divaricatic acid, and also by the apothecial disc being purplish pruinose.

In some cases, the scarcity of pruina on apothecial discs complicates the determination of this taxon. *Dirinaria confluens* can be confouded with *D. purpurascens* because of the absence of vegetative propagules but that species has a strongly plicate thallus and evidently flabellate laciniae. This is the first record of *D. purpurascens* from Mato Grosso do Sul State; it was known in Brazil from Mato Grosso, Pernambuco, Rondônia and Sergipe States.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Aquidauana municipality, Acampamento Betânia, on tree, 150 m elev., 20°27'38.0"S, 55°49'35.30"W, 18 September 2010, *L.S. Canêz et al. 3386* (CGMS 31927); Corumbá municipality, UFMS - Base de Estudos do *Pantanal* (BEP), on tree, 96 m elev., 19°34'36.40"S, 57° 1'8.53"W, 10 August 2016, *T.D. Barbosa 1915* (CGMS); *ibid., T.D. Barbosa 1916* (CGMS); *ibid., T.D. Barbosa 1917* (CGMS); *ibid.,* Subregion *Pantanal* do Paraguai, Baía do Mandioré, on branch, 90 m elev., 18°11'50.70"S, 57°30'39.70"W, 23 November 2010, *L.S. Canêz et al. 3526* (CGMS 31971); *ibid., L.S. Canêz et al. 3528* (CGMS 31973); *ibid.,* Subregion Nhecolândia, Baía do Jacaré, Fazenda Nhumirim, on tree, 10 September 1988, *V.J. Pott et al. 638* (COR 1448); *ibid., V.J. Pott et al. 639* (COR 1449); *ibid.,* Pomar da sede da Fazenda Nhumirim, 26 October 1988, *V.J. Pott et al. 685* (COR 1495); *ibid.,* Morro São Domingos, on tree, 25 November 1990, *E.F. Rocha et al. s/n* (COR 7324); Jateí municipality, Parque Estadual das Várzeas do Rio Ivinhema, on branch, 235 m elev., 22°55'57.0"S, 53°43'11.1"W, 10 November 2015, *B.B. Brandão et al. 96* (CGMS).
Additional specimens examined:—BOLIVIA. German Busch Province, Mandioré bay, on tree branch, 90 m elev., 18°11'50.70"S, 57°30'39.70"W, 23 November 2010, *L.S. Canêz et al. 3529* (CGMS 31974), *pr. p.*

Pyxine Fr. (1825: 267).
Type species: *Pyxine sorediata* (Ach.) Mont. (1842: 188).
Description based in Kalb (1987), Elix (2009) and Jungbluth (2010).

MORPHOLOGY. **Thallus** foliose, loosely adpressed to the substrate, corticicolous, ramulicolous or saxicolous. **Upper surface** proximal region grey, whitish-grey, greenish-grey to yellowish-grey, smooth, rugose to verrucose, fissures originated from maculae marginal to laminal, linear or absent, **pruina** scarce to abundant, without or with board or absent; distal region grey, whitish-grey, greenish-grey to yellowish-grey, smooth to rugose, fissures originated from maculae marginal to laminal, linear or absent, **pruina** scarce to abundant, without or with board or absent; in lacinia center, subapical to apical region. **Maculae** in the proximal region, scarce to abundant, marginal, submarginal to laminal, punctiform, linear, subreticulate to reticulate, plane to high or

absent; in the distal region, frequent to abundant, marginal, submarginal to laminal, punctiform, linear, subreticulate to reticulate, plane to high or absent. **Laciniae** discrete, contiguous to overlapping, irregularly, dichotomously, palmatifid or rarely not branched, apices not flabellate to slightly flabellate to rarely flabellate, rounded, subtruncate, truncate or rarely retuse, plane, convex to concave; margin not ascendent to ascendent, smooth to crenate, black line inconspicuous to conspicuous or absent. **Medulla** upper layer white, yellow, orange to rarely ochraceous or cream; lower layer white to ochraceous, **pigment** absent or red. **Lower surface** proximal region smooth to rarely rugose, black to dark-brown, dull; distal region smooth to rugose or papillate, olivaceous, dark-brown to rarely black, dull, naked margin absent present or absent. **Rhizinae** abundant, not branched, irregularly to rarely trichotomously or dichotomously branched, black to olivaceous or rarely light-brown, laminal to marginal. **Isidia** present or absent. **Polysidiangia** present or absent. **Pustules** rarely present (occurs in one species) or absent. **Soralia** present or absent. **Lacinulae** present or absent. **Apothecia** *cocoës*-type, *obscurascens*-type or *physciaeformis*-type, 0.1−2.5 mm diam., laminal to rarely submarginal, sessile of constrict base or apothecia absent; **disc** black, plane to concave or convex, **pruina** present white or absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** present or absent.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2−4 cells layer; **algal layer** photobiont trebouxioid, discontinuous; **medulla** upper layer colorless, yellow, orange or rarely red, lower layer colorless; **lower cortex** prosoplectenchymatous, dark-brown to colorless. **Apothecia epihymenium** grey to black μm thick; **hymenium** colorless; **subhymenium** light-brown, yellow, brown or rarely brown-black; **ascospores** *Dirinaria*-type or *Conradia*-type.

KNOWN CHEMISTRY. Atranorin, chiodectonic acid, lichexanthone and terpenes.

REMARKS.

Pyxine is characterized by the foliose thallus, generally with a two-colored medulla, apothecia with considerable variation into the genus with three different types of development, *viz.* the *physciaeformis*-type that correspond to lecanorine apothecia, the *obscurascens*-type that corresponding to lecideine apothecia and *cocoës*-type, this last corresponding to intermediary apothecia, beginning as lecanorine apothecia and with time the thalline margin turning carbonized as in lecideine apothecia. Further characters are the rhizinate lower surface, paraplectenchymatous upper cortex, prosoplectenchymatous lower cortex, ascospores *Dirinaria*-type, baciliform to sublageniform conidia, the K+ purple in the epihymenium and atranorin or lichexanthone in the upper surface. The presence of lichexanthone in many species is interesting, as this substance is absent in all other foliose Caliciaceae or Physciaceae genera.

The genus most closely related to *Pyxine* is *Dirinaria* but it shows some differences such as the rhizinate lower surface, never plicate upper surface and the K+ purple epihymenium.

Pyxine show similarity with foliose genera of Physciaceae and therefore, some differences between *Pyxine* and these genera will be mentioned. *Anaptychia* and *Heterodermia* have a prosoplectenchymatous upper cortex. *Leucodermia* does not have lower cortex, *Physcia* is differentiated by the colorless subhymenium and has a throughout white medulla. *Culbersonia* has a white lower surface and medulla, *Kashiwadia* has the upper and lower cortex paraplectenchymatous and has ascospores of the *Pachysporaria*-type. *Polyblastidium* has an ecorticate lower surface and ascospores of the *Polyblastidium*-type. *Hyperphyscia* does not have rhizinae and does not have atranorin or lichexanthone. Other genera without atranorin nor lichexanthone are *Culbersonia, Phaeophyscia* and *Physconia.*

Worldwide about 75 species are known and two varieties. Jungbluth (2010) cited 64 species and two varieties; after her work one species was synonymized and 12 others species were described by Kalb *et al.* (2009), Jungbluth & Marcelli (2011), Jungbluth *et al.* (2011), Mongkolsuk *et al.* (2012), Nayaka *et al.* (2013) and Aptroot *et al.* (2014).

The genus *Pyxine* was proposed by Fries (1825) however, Eschweiler (1833) and Nylander (1855) did not follow Fries, thus keeping *Pyxine* as a section of *Lecidea.*

Pyxine was treated as genus only by Tuckerman (1882) who added other species that now belong to *Dirinaria*. Vainio (1890) and Stirton (1897) made contributions about *Pyxine,* but the genus was better circumscribed by Malme (1897) and this generic circumscription is accepted until nowadays. Imshaug (1957) made new combinations, described new species.

Swinscow & Krog (1975) was the first study to utilize modern chemical analyses, which was another important step towards species delimitations. Kalb (1987) monographed the genus to Brazil, analyzing several type specimens, proposing new species, introducing new morphological and anatomical terms. Another paper with considerable species number is Elix (2009); it includes 26 species from Australia; the study did not focus on revision of type specimens, but detailed descriptions and pertinent comments about Australian species were made, in addition to an excellent identification key for Australian species.

Jungbluth (2010) made an extensive revision of *Pyxine* from Brazil, revised the taxonomical history about all taxa known from Brazil, studying type specimens, resolved species complex, made detailed descriptions, illustrations of taxa and presented identification keys with a greater number of species; Also, she explained the history of the genus in Brazil. Mongkolsuk *et al.* (2012) made a revision of *Pyxine* from Thailand, Nayaka *et al.* (2013) elaborated on a revision of *Pyxine* from India and Aptroot *et al.* (2014) produced a world key for species with

lichexanthone. For more information on *Pyxine* is recommended to consult Malme (1897), Kalb (1987) and Jungbluth (2010).

Pyxine is a tropical to subtropical genus (Mongkolsuk *et al.* 2012) and presenting a great diversity in Brazil. The more important studies about *Pyxine* from Brazil are Malme (1897) who treated 11 species, after his work Kalb (1987) monographed this genus in Brazil and added 15 species and two varieties, Jungbluth (2010) who mentioned 26 species and two varieties, soon after Jungbluth & Marcelli (2011) cited 20 species and two varieties from Brazil. However, we made a revision of the latest works (Jungbluth & Marcelli 2011, Jungbluth *et al.* 2011, Aptroot *et al.* 2014) about the genus and this known species number increased for 30 species and two varieties from Brazil.

From Mato Grosso do Sul State so far 14 species and one variety are known, but in this study, we found 22 species and two varieties, of which three species and one variety are mentioned for the first time from Mato Grosso do Sul State; and three new species to science are described here.

Key to *Pyxine* from Mato Grosso do Sul State, Brazil

1a. Upper cortex K+ yellow, UV−; atranorin present; lichexanthone absent 2

1b. Upper cortex UV+ yellow, K−-; atranorin absent; lichexanthone present 12

2a. (1a). Vegetative propagules present 3

2b. Vegetative propagules absent 8

3a (2a). Polysidiangia present; soralia absent 4

3b. Polysidiangia absent; soralia present 6

4a (3a). Marginal to submarginal polysidiangia ..... *P. eschweileri*

4b. Laminal polysidiangia 5

5a (4b). Medulla upper layer orange; medulla K+ black ..... *P. obscurascens*

5b. Medulla upper layer yellow; medulla K− ..... *P. coralligera*

6a (3b). Maculae red; reddish soredia; medulla with red pigment ..... *P. coccifera*

6b. Maculae white; whitish-green soredia; medulla without pigment 7

7a. Medulla upper layer cream; medulla UV− ..... *P. daedalea*

7b. Medulla upper layer yellow; medulla UV+ dark-yellow ..... *P. flavolucens*

8a (2b). Medulla upper layer yellow medulla K−; ascospores *Conradia*-type ..... *P. primaria*

8b. Medulla upper layer orange; medulla K+ black; ascospores *Dirinaria*-type 9

9a (8b). Maculae evident, reticulate to subreticulate ..... *P. rhodesiaca*

9b. Maculae absent or if present discrete, linear to punctiform 10

10a (9b). Apothecia *obscurascens*-type ..... *P. mantiqueirensis*

10b. Apothecia *cocoës*-type 11

11a (10b). Internal stipe present ..... *P. pungens*

11b. Internal stipe absent ..... *P. astipitata*

12a (1b). Polysidiangia, pustules or soralia present 13

12b. Polysidiangia, pustules and soralia absent 17

13a (12a). Polysidiangia present; pustules and soralia absent ..... *P. physciaeformis*

13b. Polysidiangia absent; pustules and soralia present 14

14a (13b). Pustules present; soralia absent ..... *P. pustulata*

14b. Pustules absent; soralia present 15

15a (14b). Medulla upper layer yellow ..... *P. subcinerea*

15b. Medulla upper layer white 16

16a (15b). Internal stipe red; internal stipe K+ red to brown ..... *P. cocoës*
16b. Internal stipe white; internal stipe K− ..... *P. cocoës* var. *pallida*

17a (12b). Medulla upper layer white 18
17b. Medulla upper layer yellow 20

18a (17a). Maculae evident, reticulate to subreticulate; ascospores (9−)10−14(−15) × 5−6 µm ….
..... *P. parapetricola*
18b. Maculae absent or if present discrete, linear; ascospores 15−21 × 5−8 µm 19

19a (18b). Internal stipe red; internal stipe K+ red to purple ..... *P petricola*
19b. Internal stipe white; internal stipe K− ..... *P. petricola* var. *convexula*

20a (17b). Apothecia *obscurascens*-type present; apothecia *cocoës*-type and *physciaeformis*-type absent ..... *P. cognata*
20b. Apothecia *obscurascens*-type absent; apothecia *cocoës*-type and *physciaeformis*-type present 21

21a (20b). Apothecia *cocoës*-type present; apothecia *physciaeformis*-type absent 22
21b. Apothecia *cocoës*-type absent; apothecia *physciaeformis*-type present..... 23

22a (21a). Internal stipe white in center and yellow in lateral ..... *P. denigricans*
22b. Internal stipe thoroughly yellowish-white ..... *P. berteriana*

23a (21b). Laciniae 0.5−0.8 mm wide; fissures originated from maculae absent; apothecia 0.4−0.8 mm diam.; ascospores 13−18 × 5−6 µm; medulla upper layer K+ orange ..... *P. nana*
23b. Laciniae 0.6−1.5 mm wide; fissures originated from maculae present; apothecia 0.5−2.5 mm diam.; ascospores 17−23 × 6−8 µm; medulla upper layer K−. ..... *P simulans*

Pyxine astipitata Jungbluth & Marcelli (2011: 168). (Figures 18A-E, 40B array 2, 41A-B array 2)
Holotype:—BRAZIL. São Paulo: Altinópolis municipality, Fazenda da Gruta, on trunk of a thin tree at the border of a secondary forest, 21º04′08.9″S, 47º26′14.5″W, 650 m elev., 6 June 2008, *P. Jungbluth & M.J. Kitaura 2078* (SP).

MORPHOLOGY. **Thallus** corticicolous; ca. 4 cm diam. **Upper surface** proximal region whitish-grey, smooth, fissures originated from maculae absent, **pruina** absent; distal region whitish-grey, smooth, fissures originated from maculae absent, **pruina** absent. **Maculae** in the proximal region

absent; distal region, in the discrete, submarginal, linear, plane. **Laciniae** discrete to contiguous, irregularly branched, 0.4−1 mm width; apices not flabellate, truncate to subtruncate, plane to convex; margin not ascendent, smooth to crenate, black line inconspicuous. **Medulla** upper layer orange; lower layer white, **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth to veins, light-brown to olivaceous, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black to olivaceous, laminal to marginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *cocoës*-type, 0.3−1 mm diam., submarginal, sessile of constrict base; **disc** black, plane to convex, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** absent.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 20−25 µm thick; **algal layer** discontinuous, 20−30 µm thick; **medulla** upper layer orange, lower layer colorless, 75−80 µm thick; **lower cortex** prosoplectenchymatous, 15−20 µm thick, dark-brown. **Apothecia epihymenium** 10−12 µm thick, grey; **hymenium** 60−70 µm thick, colorless; **subhymenium** 100−125 µm thick, brown; **ascospores** *Dirinaria*-type, 14−17 × 4−7 µm, 1-septate.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K+ black, C+ reddish, KC+ reddish, P+ black, UV−; **lower layer** K−, C−, KC−, P-, UV−; **apothecial disc** UV−.

TLC. Atranorin and terpenes.

REMARKS.

Pyxine astipitata is characterized by orange upper layer of medulla (K+ black), the apothecia of *cocoës*-type without internal stipe, and atranorin and terpenes.

According to Jungbluth & Marcelli (2011), the *Pyxine pungens* complex is formed by a group of species without vegetative propagules or lichexanthone in the upper cortex and orange upper layer of medulla (K+ black). This complex currently comprises six species, four of which are known from Mato Grosso do Sul state.

Pyxine astipitata is close to *P. pungens*, However, *P. pungens* shows an internal stipe that is orange throughout or with a white base. *Pyxine rhodesiaca* differs by evident and abundant reticulate to subreticulate maculae. *Pyxine mantiqueirensis* has apothecia of the *obscurascens*-type and smaller laciniae (up to 1.8 mm).

Two species of the "*Pyxine pungens* complex" were not found in the study area, viz. *P. exoalbida* Jungbluth & Marcelli (2011) and *P. schechingeri* Kalb (1987)*;* these taxa are differentiated by the presence of norstictic acid in the medulla in *P. exoalbida* and in the epihymenium in *P. schechingeri*.

The other species without vegetative propagules found in study area present lichexanthone as cortical substance (UV+ yellow), except *P. primaria* that has atranorin and ascospores of the *Conradia*-type (with 1−3 septa).

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, São Paulo State (Jungbluth & Marcelli 2011: 168), Minas Gerais State (Jungbluth & Marcelli 2011: 170).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, Trilha do Pôr do Sol, on tree branch, 639 m elev., 18º06′58.8″S, 53º41′21.8″W, 17 October 2017, *T.D. Barbosa & A.A. Spielmann 1731* (CGMS); *ibid.*, *T.D. Barbosa & A.A. Spielmann 1787* (CGMS); *ibid., T.D. Barbosa & A.A. Spielmann 1790* (CGMS); Aquidauana municipality, Camisão district, Morraria Paxixi, on tree, 590 m elev., 20º24′50.02″S, 55º35′54.72″W, 30 August 2015, *T.D. Barbosa 761* (CGMS 60369); *ibid.,* on tree branch, 600 m elev., 20º25′37.09″S, 55º36′39.05″W, 5 December 2015, *C.M. Bernardo 925* (CGMS 60367); *ibid., C.M. Bernardo 975* (CGMS 60368); *ibid., T.D. Barbosa 863* (CGMS 60370); *ibid.,* on tree, *T.D. Barbosa 871* (CGMS 60371); *ibid., T.D. Barbosa 873* (CGMS 60372).

Pyxine berteriana (Fée) Imshaug (1957: 254). (Figures 18F, 19A-D, 40B array 12, 41A-B array 12)

≡ *Circinaria berteriana* Fée (1825: 128).

Holotype:—Insula Martinicensi (MARTINIQUE). ad corticem *Quassiae excelsae* (G).

MORPHOLOGY. **Thallus** corticicolous; 6−7 cm diam. **Upper surface** proximal region greenish-grey, rugose to verrucose, fissures originated from maculae absent, **pruina** scarce without board; distal region greenish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** frequent without board; apical to subapical. **Maculae** in the proximal region scarce, discrete, submarginal, linear to punctiform, high; in the distal region frequent to abundant, evident, marginal to submarginal, linear, high to plane. **Laciniae** contiguous to overlapping, irregularly branched, 0.5−1.2 mm width; apices slightly flabellate, rounded, plane; margin not ascendent, crenate, black line absent or inconspicuous. **Medulla** upper layer yellow; lower layer white; **pigment** absent. **Lower surface** proximal region smooth to rugose, black, dull; distal region smooth to rugose, black, dull, naked margin absent. **Rhizinae** abundant, not branched to irregularly branched, black, laminal to marginal. **Isidia**, **Polysidiangia**, **Pustules** and **Soralia** absent. **Lacinulae** absent to frequent, marginal, concolor to thallus, not branched, 0.3−0.5 × 0.3−0.5 mm, rounded apices. **Apothecia** *cocoës*-type, 0.5−1.5 mm diam., laminal, sessile of constrict base; **disc** black, plane,

pruina absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** yellowish-white, 0.1−0.2 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 15−20 µm thick; **algal layer** discontinuous, 25−40 µm thick; **medulla** upper layer yellow, lower layer colorless, 90−120 µm thick; **lower cortex** prosoplectenchymatous, (12−)15−20 µm thick, dark-brown. **Apothecia epihymenium** (5−)10−12 µm thick, grey; **hymenium** 60−75 µm thick, colorless; **subhymenium** 45−50 µm thick, brown-black, colorless; **ascospores** *Dirinaria*-type, 14−20 × 5−8 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K+ yellow, C−, KC−, P+ yellow, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine berteriana is characterized by yellow upper layer of medulla (K+ yellow), Apothecia of *cocoës*-type with yellowish-white internal stipe K−, and lichexanthone and terpenes as chemical compounds.

Pyxine primaria and the species of the "*Pyxine pungens* complex" differ from *P. berteriana* mainly by atranorin in the upper cortex (K+ yellow). *Pyxine nana* and *P. simulans* have lichexanthone but apothecia of the *physciaeformis*-type.

Pyxine cognata is closely related but has laciniae dichotomously branched, apothecia of the *obscurascens*-type, and abundant pruina on laciniae. *Pyxine denigricans* has apothecia of the *cocoës*-type and an internal stipe with white center and yellow margins and also laciniae and pruina similar to *P. cognata*. *Pyxine parapetricola* and *P. petricola* have the medulla white throughout.

According to Jungbluth (2010) there is a possibility that *P. berteriana* comprises two taxa, one with apothecia of the *cocoës*-type (*Pyxine meissneri*) and the other with apothecia of the *obscurascens*-type (*P. berteriana*). Imshaug (1957) studied the holotype of *P. berteriana* and concluded that it did not have a "thalloid exciple". However, the type of *P. meissneri* was described as containing two apothecium types, with and without "thalline exciple", and Imshaug decided that both taxa were the same species. Jungbluth (2010) commented in detail the taxonomic history of these taxa. All material from Mato Grosso do Sul State corresponds to *P. meissneri,* mainly with apothecia *cocoës*-type.

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Alagoas, (Menezes *et al.* 2011: 887), Mato Grosso do Sul State (Torres 2018: 185); THAILAND (Mongkolsuk *et al.* 2012: 37, van den Boom *et al.* 2014: 59).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Parque Estadual das Nascentes do Rio Taquari (PENT), on tree, 436 m elev., 18º09′53.7″S, 53º24′09.2″W, 18 November 2015, *G.P. Freitas et al. 101* (CGMS 59525); *ibid.,* on tree, 442 m elev., 18° 9'11.58"S, 53°24'49.91"W, 22 October 2017, *M.J. Kitaura 4271* (CGMS); *ibid., M.J. Kitaura 4275* (CGMS); *ibid., M.J. Kitaura 4276* (CGMS); *ibid., M.J. Kitaura 4277* (CGMS); *ibid., M.J. Kitaura 4299* (CGMS); *ibid.,* on tree, 442 m elev., 18°06'48.3"S, 53°40'00.9"W, 18 October 2017, *T.D. Barbosa & A.A. Spielmann 1901* (CGMS); *ibid.,* on tree branch, *T.D. Barbosa & A.A. Spielmann 1906* (CGMS); Aquidauana municipality, Sítio Arqueológico CERA, UEMS, on tree, 162 m elev., 20°26'10.70"S, 55°39'33.90"W, 25 November 2014, *A.L. Simal et al. 158* (CGMS 46728); *ibid.,* Camisão District, Morraria Paxixi, on tree, 600 m elev., 20°25'37.09"S, 55°36'39.05"W, 5 December 2017, *C.M. Bernardo 945* (CGMS 60373); Bonito municipality, on tree, 437, 21°7'41.64"S, 56°32'5.75"W, 30 January 2016, *T.D. Barbosa 939* (CGMS); *ibid., T.D. Barbosa 943* (CGMS); Campo Grande municipality, Campus of UFMS, close to INBIO, on tree, 537 m elev., 20°30'04.3"S, 54°36'42.6"W, 17 October 2013, *A.A. Spielmann 11164* (CGMS 52141); *ibid., A.A. Spielmann 11165* (CGMS 52142); *ibid.,* Rua Abrão Julio Rahe, close to Praça da Bolívia, on tree, 620 m elev., 20°26'57.90"S, 54°35'14.40"W, 24 October 2011; *A.A. Spielmann & N.K. Honda 9679* (CGMS 42366); Corumbá municipality, Morraria do Urucum, on tree branch, 733 m elev., 19°12'08.20"S, 57°36'04.60"W, 3 November 2010, *L.S. Canêz et al. 3291* (CGMS 32291); *ibid., L.S. Canêz et al. 3302* (CGMS 32293); Costa Rica municipality, Parque Estadual das Nascentes do Rio Taquari, on tree, 790 m elev., 18°14'14.3"S, 53°18'00.8"W, 24 October 2017, *A.S. Rodrigues 427* (CGMS); Jaraguari municipality, Furnas do Dionísio, on tree branch, 500 m elev., 20°08'50.30"S, 54°34'08.10"W, 23 October 2010, *A.A. Spielmann & L.S. Canêz 8896* (CGMS 42389); *ibid., A.A. Spielmann & L.S. Canêz 8898* (CGMS 42364); *ibid.,* on tree branch, *L.S. Canêz & Spielmann 3440* (CGMS 31763); *ibid.,* on tree, 450 m elev., 20°08'55.20"S, 54°34'11.60"W, 23 October 2010, *A.A. Spielmann & L.S. Canêz 9013* (CGMS 42343); *ibid.,* on tree, 425 m elev., 20°08'54.10"S, 54°34'15.10"W, 22 November 2011, *A.A. Spielmann & L.S. Canêz 9729* (CGMS)*; ibid. A.L. Simal 101b* (CGMS)*; ibid.,* on tree branch, *R. Lücking 35020* (CGMS 34727); *ibid., R. Lücking 35040* (CGMS 34747); *ibid., R. Lücking 35056* (CGMS 34762); *ibid., R. Lücking 35076* (CGMS 34783); *ibid.,* on tree, 12 August 2015, *C.M. Bernardo 757* (CGMS); *ibid.,* on tree branch, 13 November 2015, *C.M. Bernardo 827* (CGMS); *ibid.,* on tree branch, 357 m elev., 20°08'55.9"S, 54°34'13.9"W, 26 September 2017, *A.A. Spielmann 12710* (CGMS); *ibid. A.S. Rodrigues 325* (CGMS); *ibid., K.F. Cardoso 18* (CGMS); *ibid., T.D. Barbosa 1706* (CGMS); *ibid., T.D. Barbosa 1717* (CGMS); Porto Murtinho municipality, Fazenda Santa Virgínia, on tree, 85 m elev., 22°06'42.0"S, 57°50'01.2"W, 15 December 2010, *A.A. Spielmann et al. 8976* (CGMS); *ibid.,* Retiro Conceição, on tree, 95 m elev., 21°40'46.1"S, 57°46'46.3"W, 23 November 2011, *A.A.*

Spielmann & L.S. Canêz 9723 (CGMS); *ibid.,* on tree, 87 m elev., 21°38'46.41"S, 57°49'25.91"W, 23 November 2017, *A.A. Spielmann 12021* (CGMS); *ibid*., Cachoeira do Apa, Trilha da cachoeira, on tree, 90 m elev., 22°10'05.90"S; 57°31'13.40"W, 14 June 2017, *A.S. Rodrigues 206* (CGMS).

Pyxine coccifera (Fée) Nyl. (1857: 108). (Figures 19E-F, 20A-D, 40B array 1, 41A-B array 1)
≡ *Parmelia coccifera* Fée (1825: 126)
Holotype:—WITHOUT LOCALITY. ad corticem *Alcornocae* (G).

MORPHOLOGY. **Thallus** corticicolous; 2−5 cm diam. **Upper surface** proximal region whitish-grey, smooth, fissures originated from maculae present marginal, linear, **pruina** absent; distal region whitish-grey, smooth, fissures originated from maculae present marginal, linear, **pruina** absent to scarce without board; subapical. **Maculae** in the proximal region abundant, evident, marginal to laminal, linear, plane; in the distal region abundant, evident, marginal to submarginal, linear, plane, red. **Laciniae** contiguous to overlapping, irregularly branched, 0.4−0.9 mm width; apices not flabellate, rounded to subtruncate, plane to concave; margin ascendent, smooth to crenate, black line absent. **Medulla** upper layer white; lower layer white; **pigment** red, the red color is distributed mainly in marginal region of thallus and below soralia. **Lower surface** proximal region smooth, black, dull; distal region smooth to papillate, olivaceous, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black to olivaceous, laminal to submarginal. **Soralia** erumpent, frequent, marginal to submarginal, linear, hemispherical to irregular; **soredia** red to greenish, granulose, originate from maculae fissures. **Isidia**, **Polysidiangia**, **Pustules** and **Lacinulae** absent. **Apothecia** *obscurascens*-type, 1 mm diam., laminal, sessile of constrict base; **disc** black, plane, **pruina** absent; **margin** crenate; **amphithecium** smooth, ornament absent, variegate between black and red; **internal stipe** white, 0.15 mm thick.
ANATOMY. **Thallus upper cortex** paraplectenchymatous, 4−5 cells layer, 20−30(−35) µm thick; **algal layer** discontinuous, (20−)25−30 µm thick; **medulla** upper layer colorless to reddish, lower layer colorless to reddish, (50−)60−70 µm thick; **lower cortex** prosoplectenchymatous, 14−20 µm thick, light-brown. **Apothecia epihymenium** 10−12 µm thick, grey; **hymenium** 65−70 µm thick, colorless; **subhymenium** 85−90 µm thick, brown to yellow, colorless; **ascospores** *Dirinaria*-type, (12−)14−16(−17) × 5−7 µm, 1-septate.
SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **medulla pigment** K+ black, C−; **internal stipe** K−, C−; **apothecial disc** UV−.
TLC. Atranorin, chiodectonic acid and terpenes.

REMARKS.

Pyxine coccifera is characterized by white medulla with red pigment (K+ black), presence of red soredia, red maculae that form fissures in upper surface, the internal stipe throughout white (K−), but with red amphithecia, apothecia of the *obscurascens*-type, and atranorin, chiodectonic acid and terpenes as chemical compounds.

This taxon is the only species known inside of the genus that presents a red pigment in the medulla. Chiodectonic acid is the substance responsible for the red color and it occurs only in *P. coccifera*. The pattern distribution of red pigment is related with the development of maculae and soralia.

Apothecia are rare in *P. coccifera* (Jungbluth 2010); in the examined material only one apothecium was found in one specimen (*S.M.L. Souza 80*). This species has a wide distribution in Brazil and was cited from Mato Grosso do Sul State by Kalb (1987), Fleig & Riquelme (1991) and Fernandes *et al.* (2015).

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Mato Grosso do Sul State (Fernandes *et al.* 2015: 58); THAILAND (Mongkolsuk *et al.* 2012: 40, van den Boom *et al.* 2014).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Água Clara municipality, Margin of highway MS-377, on tree, 450 m elev., 20°11'16.50"S, 52°39'80.80"W, 17 March 2012, *A.A. Spielmann et al. 10327* (CGMS 42372); *ibid., A.A. Spielmann et al. 10330* (CGMS 42351); *ibid., A.A. Spielmann et al. 10333* (CGMS 42371); Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, Trilha do Pôr do Sol, on tree, 639 m elev., 18°06'58.8"S, 53°41'21.8"W, 17 October 2017, *M.J. Kitaura 4257* (CGMS); *ibid., T.D. Barbosa 1753* (CGMS); *ibid., T.D. Barbosa 1779* (CGMS); *ibid., T.D. Barbosa 1781* (CGMS); *ibid., T.D. Barbosa 1782* (CGMS); *ibid., T.D. Barbosa 1783* (CGMS); *ibid., T.D. Barbosa 1784* (CGMS); *ibid.,* on tree, 604 m elev., 18°06'48.31"S, 53°40'00.94"W, 18 October 2017, *A.A. Spielmann 12769* (CGMS); *ibid., A.A. Spielmann 12770* (CGMS); *ibid., A.S. Rodrigues 334* (CGMS); *ibid., S.M.L. Souza 80* (CGMS); Campo Grande municipality, A.P.A. do Rio Guariroba, Nascente do Rio Saltinho, Fazenda Cantogalo, on tree, 555 m elev., 20°32'36.7"S, 54°23'57.8"W, 9 April 2010, *A.A. Spielmann et al. 8012* (CGMS 52190); Corguinho municipality, Taboco District, on tree, 395 m elev., 19°44'40.25"S, 55°15'53.30"W, 30 September 2013, *T.R.F. Sinani et al. 37* (CGMS 40570); Rio Verde de Mato Grosso municipality, Sítio Passarim, on tree, 390 m elev., 18°56'26.6"S, 54°55'16.6"W, 23 August 2015, *A.A. Spielmann & R.A. Lemke.11939* (CGMS 54108).

Pyxine cocoës (Sw.) Nyl. (1857: 108). (Figures 20E-F, 21A-D, 42A-B array 1, 43A array 1)
≡ *Lichen cocoës* Sw. (1788: 146)
Holotype:—JAMAICA. on *Cocos*, *Swartz* (S; isotype: H-ACH 379).

MORPHOLOGY. **Thallus** saxicolous; ca. 6 cm diam. **Upper surface** proximal region whitish-grey, rugose, fissures originated from maculae present marginal, linear, **pruina** absent; distal region whitish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** frequent with board; laciniae center. **Maculae** in the proximal region scarce, discrete, submarginal to laminal, linear to punctiform, plane; in the distal region frequent, evident, submarginal, linear, plane. **Laciniae** contiguous to overlapping, irregularly to palmatifid branched, 0.7−1(−1.5) mm width; apices not flabellate, rounded to subtruncate, plane to slightly concave; margin not ascendent, crenate to rarely smooth, black line absent. **Medulla** upper layer white; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, black, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black to olivaceous, laminal to marginal. **Soralia** crateriform, frequent, laminal to submarginal, linear to circular; **soredia** whitish-green, granulose. **Isidia**, **Polysidiangia**, **Pustules** and **Lacinulae** absent. **Apothecia** *cocoës*-type, 0.2−1 mm diam., laminal, sessile of constrict base; **disc** black, plane, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** red to brown, 0.2 mm thick.
ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 20−25 µm thick; **algal layer** discontinuous, 20−35 µm thick; **medulla** upper layer colorless, lower layer colorless, 90−130 µm thick; **lower cortex** prosoplectenchymatous, 20−25 µm thick, dark-brown. **Apothecia epihymenium** 8 µm thick, black; **hymenium** 90 µm thick, colorless; **subhymenium** 80−130 µm thick, brown, light-brown to reddish; **ascospores** *Dirinaria*-type, 13−18 × 5−6 µm, 1-septate.
SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K+ orange to red, C−; **apothecial disc** UV−.
TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine cocoës is characterized by a white medulla (K−), presence of linear to circular, crateriform soralia, red to brown internal stipe (K+ orange to red), apothecia of the *cocoës*-type, and lichexanthone and terpenes as chemical compounds.

Pyxine cocoës var. *pallida* is the most related taxon but differs mainly by throughout white internal stipe. Another taxon that is very similar to *P. cocoës* is *P. petricola*; both taxa have white

medulla and red to brown internal stipe and the same chemistry. However, *P. petricola* has no soralia.

For comparisons with *P. coccifera,* see the respective comments. *P. daedalea*, *P. flavolucens* and *P. subcinerea* also have soralia but a yellow upper layer of the medulla.

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Mato Grosso do Sul State (Torres 2018: 187); THAILAND (Mongkolsuk *et al.* 2012: 41).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Corumbá municipality, Fazenda Nhumirim, Pomar da Sede, coordinates are not, on tree, 26 October 1988, *V.J. Pott et al. 692* (COR 1529); *ibid., V.J. Pott et al. 837* (COR 1556), *pr. p.*; *ibid.,* Subregion *Pantanal* do Paraguai, Baía do Castelo, on fence pole, 88 m elev., 18°35'26.00"S, 57°32'44.70"W, 22 November 2010, *L.S. Canêz et al. 3502* (CGMS 31947); *ibid.,* on tree branch, 95 m elev., 18°34'52.20"S, 57°31'36.50"W, 22 November 2010, *T.H. Stefanello et al. 18* (CGMS 30058); *ibid.,* RPPN Elieser Batista (Novos Dourados), on rock, 87 m elev., 18°05'29.70"S, 57°28'27.40"W, 24 November 2010, *C.S. Robles et al. 7* (CGMS 30289); *ibid.,* Baía do Taquaral, on rock, 83 m elev., 18°02'42.30"S, 57°30'15.20"W, 26 November 2010, *C.O. Dourado et al. 79* (CGMS 30241); *ibid., C.O. Dourado et al. 86* (CGMS 30248); *ibid., C.O. Dourado et al. 87* (CGMS 30249); *ibid., C.O. Dourado et al. 88* (CGMS 30250); *ibid., C.O. Dourado et al. 90* (CGMS 30252); *ibid., C.O. Dourado et al. 91* (CGMS 30253); *ibid., L.S. Canêz et al. 3607* (CGMS 32054); *ibid.,* RPPN Rumo ao Oeste, Baía do Guaíba, on rock, 17°44'18.10"S, 57°41'27.80"W, 91 m elev., 28 November 2010, *A.A. Spielmann et al. 8815* (CGMS 42744); *ibid., T.H. Stefanello et al. 402* (CGMS 30147); Jardim municipality, Campim Seu Assis, on tree, 230 m elev., 21°25'14.20"S, 56°23'16.70"W, 4 June 2010, *L.S. Canêz et al. 2986* (CGMS 32476); Porto Murtinho municipality, Retiro Conceição, on tree, 80 m elev., 21°40'57.00"S, 57°46'45.00"W, 14 December 2010, *A.A. Spielmann et al. 8981* (CGMS); *ibid.,* 95 m elev., 21°40'46.3"S, 57°46'46.3"W, 23 November 2011, *A.A. Spielmann & L.S. Canêz. 9718* (CGMS 54309); *ibid.,* Cachoeira do Apa, on tree, 90 m elev., 22°10'05.90"S; 57°31'13.40"W, 14 June 2017, *T.D. Barbosa et al. 1652* (CGMS); *ibid., T.D. Barbosa et al. 1654* (CGMS); *ibid.,* on tree, 89 m elev., 21º42'39.50"S, 57º44'11.20"W, 14 June 2017, *T.D. Barbosa 1920* (CGMS).

Pyxine cocoës var. ***pallida*** Kalb (1987: 43). (Figures 21E-F, 22A-D, 42A-B array 2, 43A array 2)

Holotype:—BRAZIL. Mato Grosso State. Santo Antonio de Leverger municipality, etwa 40 km südlich von Cuiabá, an freistehenden Bäumen am Rio Cuiabá, 100 m elev.., 5 July 1980, *K. Kalb 12322* (Herb. Kalb).

MORPHOLOGY. **Thallus** saxicolous to corticicolous; 4−7 cm diam. **Upper surface** proximal region whitish-grey, rugose to verrucose, fissures originated from maculae present marginal to laminal, linear, **pruina** absent; distal region whitish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** scarce to frequent with board; laciniae center. **Maculae** in the proximal region scarce, discrete to evident, submarginal to laminal, linear to punctiform, plane; in the distal region scarce to frequent, discrete to evident, submarginal to laminal, linear, plane. **Laciniae** contiguous to overlapping, dichotomously to irregularly branched, 0.5−1.3 mm width; apices not flabellate, rounded to subtruncate, plane to slightly concave; margin ascendent, smooth to rarely crenate, black line absent. **Medulla** upper layer white; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, dark-brown to olivaceous, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black to olivaceous, laminal to marginal. **Soralia** crateriform, frequent to abundant, laminal to submarginal, circular to linear; **soredia** white to whitish-green, granulose. **Isidia**, **Polysidiangia**, **Pustules** and **Lacinulae** absent. **Apothecia** *cocoës*-type, 0.3−0.6 (—1.6) mm diam., laminal, sessile of constrict base; **disc** black, plane, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.05−0.1 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 20−30 µm thick **algal layer** discontinuous, 25−40 µm thick; **medulla** upper layer colorless, lower layer colorless, 75−150 µm thick; **lower cortex** prosoplectenchymatous, 20−25 µm thick, dark-brown. **Apothecia epihymenium** 8−10 µm thick, black; **hymenium** 80−85 µm thick, colorless; **subhymenium** (80−)90−130(−140) µm thick, light- brown, colorless; **ascospores** *Dirinaria*-type, 14−20 × 5−7 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine cocoës var. *pallida* is characterized by a white medulla (K−), presence of circular to linear, crateriform soralia, throughout white internal stipe (K−), apothecia of the *cocoës*-type, and lichexanthone and terpenes as chemical compounds.

The main difference between *P. cocoës* and this variety is white internal stipe in *P. cocoës* var. *pallida*. This taxon was described by Kalb (1987) and it was known only from type locality and from Mato Grosso do Sul State (Torre 2018). One additional specimen that was examined is from Bolivia; this the first report of this taxon from Bolivia.

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010):—BRAZIL, Mato Grosso do Sul State (Torres 2018: 189).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Corumbá municipality, subregion *Pantanal* do Paraguai, RPPN Eliezer Batista, (Novos Dourados), on rock, 87 m elev., 18°05'29.70"S, 57°28'27.40"W, 24 November 2010, *L.S. Canêz et al. 3546* (CGMS 31990); *ibid.,* 91 m elev., 17°44'18.10"S, 57°41'27.80"W, 28 November 2010, *L.S. Canêz et al. 3644* (CGMS 32089); Porto Murtinho municipality, Retiro Conceição, on tree, 88 m elev., 21°41'11.78"S, 57°46'17.26"W, 14 December 2015, *J.M. Torres 486* (CGMS).
Additional specimens examined:—BOLIVIA. German Busch Province, Baía do Mandioré, on tree, 90 m elev., 18°11'50.70"S, 57°30'39.70"W, 23 November 2010, *A.A. Spielmann 8733* (CGMS 42353).

Pyxine cognata Stirt. (1879: 311). (Figures 22E-F, 23A-C, 42A-B array 3, 43A array 3)
Holotype:—INDIA. Nilgherries [Nilgiri], *A. Watt s. n.* (BM).

MORPHOLOGY. **Thallus** corticicolous to ramulicolous; 2.5−5 cm diam. **Upper surface** proximal region yellowish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** frequent with board; distal region whitish-grey, smooth, fissures originated from maculae absent, **pruina** abundant with board; laciniae center. **Maculae** in the proximal region absent; in the distal region absent. **Laciniae** contiguous, dichotomously to irregularly branched, 0.4−1.3 mm width; apices not flabellate to slightly flabellate, rounded to subtruncate, plane to concave; margin not ascendent, crenate, black line inconspicuous. **Medulla** upper layer yellow; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region papillate, olivaceous, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black to olivaceous, laminal to submarginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *obscurascens*-type, 0.2−1.4 mm diam., laminal, sessile of constrict base; **disc** black, plane, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** yellow to rarely white, 0.05−0.75 mm thick.
ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3 cells layer, 15−18(−25) µm thick; **algal layer** discontinuous, 20−25 µm thick; **medulla** upper layer yellow, lower layer colorless, 45−75 µm thick; **lower cortex** prosoplectenchymatous, (10−)12−15 µm thick, dark-brown. **Apothecia epihymenium** 8−10 µm thick, black; **hymenium** 65−75 µm thick, colorless; **subhymenium** 60−70 µm thick, brown, yellow; **ascospores** *Dirinaria*-type, 15−18 × 5−6 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K+ reddish or rarely K−, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine cognata is characterized by the yellow upper layer of medulla (K−), presence of apothecia as reproductive structure, yellow to rarely white internal stipe (K+ reddish), apothecia of the *obscurascens*-type, and lichexanthone and terpenes as chemical compounds; it is usually pruinose.

Pyxine denigricans is the species more closely related to *P. cognata*; both species have an identical vegetative morphology, but *P. denigricans* has apothecia of the *cocoës*-type and an internal stipe with generally white color in the center and yellow color in both margins. *Pyxine berteriana* is morphologically and with similar secondary metabolites to this taxon but has apothecia of the *cocoës*-type. *Pyxine nana* and *P. simulans* also are similar to *P. cognata,* but the two taxa present apothecia of the *physciaeformis*-type.

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Mato Grosso do Sul State (Torres 2018: 191); THAILAND (Mongkolsuk *et al.* 2012: 42).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Campo Grande municipality, Campus UFMS, on tree, 528 m elev., 20°30'2.12"S, 54°36'48.77"W, 15 March 2014, *C.M. Bernardo 45* (CGMS); Costa Rica municipality, Canyons, on tree, 733 m elev., 18°14'17.03"S, 53°18'18.90"W, 24 October 2017, *T.D. Barbosa 1899* (CGMS); Jaraguari municipality, Furnas do Dionísio, on tree, 500 m elev., 20°08'50.30"S, 54°34'08.10"W, 23 October 2010, *A.A. Spielmann & L.S. Canêz 8889* (CGMS 42355); *ibid., A.A. Spielmann & L.S. Canêz 8929* (CGMS 42368); *ibid., L.S. Canêz & A.A. Spielmann 3424* (CGMS 31747); *ibid., L.S. Canêz & A.A. Spielmann 3448* (CGMS 31771); *ibid., L.S. Canêz & A.A. Spielmann 3449* (CGMS 31772); Miranda municipality, coordinates are absent, on tree branch, 7 February 2016, *D.A. Finati 11* (CGMS); Porto Murtinho municipality, on tree, 89 m elev., 21°29'9.78"S, 57°55'46.12"W, 23 November 2011, *A.A. Spielmann 12044* (CGMS); *ibid., A.A. Spielmann 12055* (CGMS); *ibid.,* Cachoeira do Apa, on tree, 90 m elev., 22°10'05.9"S, 57°31'13.4"W, 14 June 2017, *T.D. Barbosa 1629* (CGMS); Terenos municipality, Fazenda Modelo Embrapa, on tree, 500 m elev., 20°33'33.80"S, 54°47'33.60"W, 13 March 2010, *A.A. Spielmann et al. 8104* (CGMS 42365).

Pyxine coralligera Malme (1897: 40). (Figures 23D-F, 24A, 40B array 3, 41A-B array 3)

Lectotype:—BRAZIL. Mato Grosso: Serra da Chapada, near São Jeronymo municipality, ad rupes apricas, 3 June 1894, *G. O. A. Malme* [*Exped. Prim. Regnell. Lichens* 2749c] (S).

MORPHOLOGY. **Thallus** corticicolous; 6−8 cm diam. **Upper surface** proximal region grey, rugose, fissures originated from maculae present laminal, linear, **pruina** absent; distal region grey, smooth to rugose, fissures originated from maculae present laminal, linear, **pruina** absent. **Maculae** in the proximal region frequent, evident, submarginal to laminal, linear, punctiform to subreticulate, high; in the distal region abundant, evident, submarginal to laminal, subreticulate to reticulate, high. **Laciniae** contiguous to overlapping, irregularly branched, 0.5−1 mm width; apices not flabellate, truncate to subtruncate, plane to slightly concave; margin not ascendent, crenate, black line inconspicuous or conspicuous. **Medulla** upper layer yellow; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, black to cream, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black to olivaceous, laminal to marginal. **Polysidiangia** abundant to covering the thallus, laminal, irregular; **soredia** absent. **Isidia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** absent.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2 cells layer, 10−12 µm thick; **algal layer** discontinuous, 25−30 µm thick; **medulla** upper layer colorless, lower layer colorless, 120−150 µm thick; **lower cortex** prosoplectenchymatous, 10−12(−15) µm thick, colorless.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−.

TLC. Atranorin and terpenes.

REMARKS.

Pyxine coralligera is characterized by medulla with yellow upper layer (K−), presence of laminal polysidiangia, according to Jungbluth (2010) has apothecia of the *obscurascens*-type, and atranorin and terpenes as chemical compounds.

Four species with polysidiangia were found in Mato Grosso do Sul State. *Pyxine eschweileri* is the species most similar to *P. coralligera*. The main difference between both taxa is the ascospores type (not seen in examined material) and the K reaction in the medulla; ascospores of *P. coralligera* were cited only by Malme (1897) and Kalb (1987) to possess one septum (therefore *Dirinaria*-type), while *P. eschweileri* has ascospores of the *Conradia*-type (1−3 septa).

Within specimens from Mato Grosso do Sul State, it was possible to separate two taxa to other morphologically features. *Pyxine coralligera* presents reticulate to subreticulate maculae in the distal upper surface region, fissures from maculae, truncate to subtruncate laciniae apices,

yellow upper layer of medulla, rhizinae irregularly branched and only laminal polysidiangia, *P. eschweileri* does not have fissures from maculae, has linear maculae in the distal upper surface region, rounded to retuse laciniae apice, cream upper layer of medulla, rhizinae not branched and marginal to submarginal polysidiangia.

Pyxine obscurascens has atranorin in the upper cortex but shows an orange upper layer of medulla (K+ purple) similar to species of the "*Pyxine pungens* complex". *Pyxine physciaeformis* presenting lichexanthone in the upper cortex (UV+ yellow) and apothecia of the *physciaeformis*-type.

For more information about taxonomy of this taxon see Jungbluth (2010). *Pyxine coralligera* was mentioned from Mato Grosso do Sul State by Kalb (1987) and Fleig & Riquelme (1991).

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —THAILAND (Mongkolsuk *et al.* 2012: 42).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, Trilha do Pôr do Sol, on tree, 639 m elev., 18°06'58.8"S, 53°41'21.8"W, 17 October 2017, *T.D. Barbosa 1743* (CGMS); *ibid., T.D. Barbosa 1747* (CGMS); Jateí municipality, on tree, 238 m elev., 22°56'6.31"S, 53°43'13.71"W, 10 November 2015, *A.A. Spielmann 12068* (CGMS).

Pyxine daedalea Krog & R. Sant. *in* Moberg (1986: 7). (Figures 24B-E, 40B array 4, 41A-B array 4)

Holotype:—COSTA RICA. Cartago Province: 13 km SE of Cartago, 2.5 km SE of Orosi near the bridge over Rio Grande de Orosi, on a large boulder in a field, ca. 1150 m; 9°47' N, 83°50' W, 10 January 1979, *H. Krog & R. Santesson 29074* (O; isotype: Herb. Kalb).

MORPHOLOGY. **Thallus** corticicolous; ca. 6 cm diam. **Upper surface** proximal region whitish-grey to yellowish-grey, rugose, fissures originated from maculae present submarginal, linear, **pruina** absent; distal region whitish-grey to yellowish-grey, smooth, fissures originated from maculae present submarginal, linear, **pruina** absent. **Maculae** white in the proximal region frequent, discrete, laminal to submarginal, linear, plane; in the distal region frequent to abundant, evident, laminal to marginal, subreticulate, slightly high. **Laciniae** discrete, contiguous to overlapping, dichotomously to irregularly branched, 0.4−1.5 mm width; apices not flabellate, rounded to subtruncate, plane to slightly concave; margin ascendent, crenate, black line absent.

Medulla upper layer cream; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth to papillate, cream, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black, laminal to marginal. **Soralia** erumpent, frequent, submarginal to laminal, hemispherical to irregular; **soredia** whitish-green, granulose, in some regions the soralia is elevated by thallus projections. **Isidia**, **Polysidiangia**, **Pustules** and **Lacinulae** absent. **Apothecia** *obscurascens*-type, 0.4−0.6 mm diam., laminal, subimmersed to sessile of constrict base; **disc** black, plane, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** white to cream, 0.05 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3 cells layer, 15−20 µm thick; **algal layer** discontinuous, 18−25 µm thick; **medulla** upper layer colorless, lower layer colorless, 55−70 µm thick; **lower cortex** prosoplectenchymatous, 10−12 µm thick, dark-brown. **Apothecia epihymenium** 8−10 µm thick, grey; **hymenium** 75 µm thick, colorless; **subhymenium** 110 µm thick, brown, colorless; **ascospores** *Dirinaria*-type, 13−16 × 5−6 µm, 1-septate.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Atranorin and terpenes.

REMARKS.

Pyxine daedalea is characterized by a medulla with cream upper layer (K−), presence of hemispherical to irregular, submarginal to laminal, erumpent soralia, white to cream internal stipe (K−), apothecia of the *obscurascens*-type, and atranorin and terpenes as chemical compounds.

Pyxine cocoës and *P. subcinerea* differ from *P. daedalea* mainly by lichexanthone in the upper cortex (UV+ yellow). *P. coccifera* has atranorin and soralia but has red pigment in the medulla. *Pyxine obscurascens* has atranorin in upper cortex (K+ yellow) but polysidiangia and an orange medulla (K+ black). *Pyxine eschweileri* can be confouded with *P. daedalea* because of soredioid polysidiangia. However, these polysidiangia are marginal and *P. eschweileri* has apothecia of the *obscurascens*-type and ascospores of the *Conradia*-type (1−3 septa).

Another similar taxon is *P. flavolucens*; it has a similar chemistry and shows laminal soralia but the main difference is that the rhizinae are trichotomously to dichotomously branched and it has a yellow upper layer of the medulla with a UV+ yellow reaction (unknown substance).

Pyxine daedalea was cited from Mato Grosso do Sul State by Fleig & Riquelme (1991). Jungbluth (2010) made pertinent comparisons with similar taxa not found in Mato Grosso do Sul State and it is recommended to see her work.

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —THAILAND (Mongkolsuk *et al.* 2012: 45).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, Trilha da Gruta, on tree, 604 m elev., 18°06'48.3"S, 53°40'00.9"W, 18 October 2017, *T.D. Barbosa 1885* (CGMS); Costa Rica municipality, Parque Estadual das Nascentes do Rio Taquari (PENT), on tree, 790 m elev., 18°14'14.3"S, 53°18'00.8"W, 24 October 2017, *A.S. Rodrigues 372* (CGMS); Jateí municipality, Parque Estadual das Várzeas do Rio Ivinhema, on tree, 236 m elev., 22°55'43.00"S, 53°41'45.01"W, 13 November 2015, *G.M. Shiroma et al. 73* (CGMS 54006).

Pyxine denigricans J.-M. Torres, T.D. Barbosa & A.A. Spielmann, *sp. nov.* (Figures 24F, 25A-E, 42A-B array 4, 43A array 4)

Mycobank number: xxxxx

Diagnosis: Corticicolous *Pyxine* with bicolor medulla, apothecia of the *cocoës*-type, internal stipe with the center white and margins yellow, lichexanthone in the cortex and terpenes in the medulla.

Holotype:—BRAZIL. Mato Grosso do Sul State: Porto Murtinho municipality, highway BR-267, on tree, 21º43'08.12"S, 57º37'12.05"W, 99 m elev., 12 June 2017, *J.M. Torres et al. 598* (CGMS).

MORPHOLOGY. **Thallus** corticicolous; 4−5 cm diam. **Upper surface** proximal region greenish-grey, smooth, fissures originated from maculae absent, **pruina** absent; distal region greenish-grey, smooth, fissures originated from maculae absent, **pruina** frequent with board; subapical to laciniae center. **Maculae** in the proximal region scarce, discrete, marginal, linear, plane; in the distal region scarce, discrete, marginal to laminal, linear to subreticulate, plane. **Laciniae** discrete, dichotomously branched, 0.3−1.5 mm width; apices not flabellate to slightly flabellate, rounded, concave to plane; margin not ascendent, smooth, black line inconspicuous. **Medulla** upper layer yellow; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, olivaceous, dull, naked margin absent. **Rhizinae** abundant, not branched, black to olivaceous, laminal to submarginal. **Lacinulae** abundant, marginal, concolor to thallus, not branched, 0.4−1 × 0.2−0.5 mm, rounded apices. **Isidia**, **Polysidiangia**, **Pustules** and **Soralia** absent. **Apothecia** *cocoës*-type, 0.2−1.1 mm diam., laminal, sessile of constrict base; **disc** black, plane to convex, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent;

internal stipe white in center region and yellow in lateral region or rarely entire yellow, 0.1−0.2 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, (12−)15−18 µm thick; **algal layer** discontinuous, 20−30 µm thick; **medulla** upper layer yellow, lower layer colorless, (40−)50−60 µm thick; **lower cortex** prosoplectenchymatous, 10−12 µm thick, light-brown. **Apothecia epihymenium** ca. 10 µm thick, grey; **hymenium** 65−75 µm thick, colorless; **subhymenium** 50−70 µm thick, brown, colorless to yellow; **ascospores** *Dirinaria*-type, (14−)15−19 × 5−7 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K− or K+ reddish, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine denigricans is characterized by a yellow upper layer of medulla (K−), presence of apothecia as reproductions structure, internal stipe with the center white and both margins yellow (K− to rarely K+ reddish), apothecia of the *cocoës*-type, and lichexanthone and terpenes as chemical compounds.

The two taxa most similar to *P. denigricans* are *P. berteriana* and *P. cognata*. *Pyxine cognata* has apothecia of the *obscurascens*-type and *P. berteriana* has laciniae that are irregularly branched and the medulla is K+ yellow.

Pyxine nana and *P. simulans* have as main difference the apothecia of the *physciaeformis*-type. *Pyxine primaria* has apothecia of *obscurascens*-type and ascospores of the *Conradia*-type (1−3 septa). Other taxa without vegetative propagules have atranorin in the upper cortex (K+ yellow).

Pyxine denigricans is known only from the type locality in Brazilian *Chaco*; the name "*denigricans"* refers to the apothecia of the *cocoës*-type, which gradually becomes black during the development.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Porto Murtinho municipality, highway BR-267, on tree, 99 m elev., 21º43'08.12"S, 57º37'12.05"W, 12 June 2017, *T.D. Barbosa et al. 1549* (Parátipo, CGMS); *ibid.,* road to Morro Pão de Açúcar, on tree, 89 m elev., 21º29'09.8"S, 57º55'46.1"W, 13 June 2017, *T.D. Barbosa et al. 1586* (CGMS).

Pyxine eschweileri (Tuck.) Vain. (1890: 156). (Figures 25F, 26A-E, 40B array 6, 41A-B array 6)
≡ *Pyxine cocoës* (Sw.) Nyl. var. *eschweileri* Tuck. (1877: 167).

Lectotype:—CUBA. Lichenes Cubae, *Wright* 97 *pr. p.* (FH pr. p., with the lectotype of *P. cocoës* (Sw.) Nyl. f. *isidiophora* Müll. Arg.; duplicates from the lectotype L, UPS pr. p., with *P. cocoës* f. *isidiophora* and *P. cocoës* (Sw.) Nyl.).

MORPHOLOGY. **Thallus** corticicolous; 4.0−14 cm diam. **Upper surface** proximal region whitish-grey to greenish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** absent to frequent without board; distal region whitish-grey to greenish-grey, smooth, fissures originated from maculae absent, **pruina** scarce to frequent without board; subapical. **Maculae** in the proximal region scarce, discrete, submarginal, linear, plane to slightly; in the distal region frequent, evident, marginal to submarginal, linear, plane to slightly high. **Laciniae** contiguous to overlapping, irregular branched, 0.4−1 mm width; apices not flabellate, rounded to rarely retuse, plane to concave; margin not ascendent, smooth to crenate, black line inconspicuous. **Medulla** upper layer cream; lower layer white, **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, cream, dull, naked margin absent. **Rhizinae** abundant, not branched, black, laminal to submarginal. **Polysidiangia** abundant, marginal to submarginal, irregular; **soredia** green, granulose, delicate. **Isidia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *obscurascens*-type, 0.3−2.1 mm diam., laminal, sessile of constrict base; **disc** black, plane, **pruina** absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.1−0.15 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 15−18 µm thick; **algal layer** discontinuous, 20−25 µm thick; **medulla** upper layer yellow, lower layer colorless, 50−60 µm thick; **lower cortex** prosoplectenchymatous, 10−12 µm thick, dark-brown. **Apothecia epihymenium** 7.5−10 µm thick, grey; **hymenium** 80−95 µm thick, colorless; **subhymenium** 100−130 µm thick, brown, colorless to yellow; **ascospores** *Conradia*-type, 17−28 × 6−9(−10) µm, 1−3-septa.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Atranorin and terpenes.

REMARKS.

Pyxine eschweileri is characterized by the cream upper layer of medulla (K−), the presence of marginal to submarginal polysidiangia, a white internal stipe (K−), apothecia of the

obscurascens-type, ascospores of the *Conradia*-type (1−3 septa), and atranorin and terpenes as chemical compounds.

Pyxine coralligera is most similar to *P. eschweileri.* See remarks on *P. coralligera* for differences; *P. obscurascens* has laminal polysidiangia, orange upper layer of the medulla and ascospores of the *Dirinaria*-type (1-septate). *Pyxine physciaeformis* has lichexanthone in the upper cortex and apothecia of the *physciaeformis*-type.

Jungbluth (2010) made extensive comments about this taxon and other similar species. This species was first reported from Mato Grosso do Sul State by Kalb (1987).

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Mato Grosso do Sul State (Torres 2018: 193).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, on tree, 18°6'44.14"S, 53°43'44.30"W, 567 m elev., 19 October 2017, *A.A. Spielmann 12801* (CGMS); *ibid.,* on tree branch, 442 m elev., 18°9'11.58"S, 53°24'49.91"W, 22 October 2017, *A.A. Spielmann 12778* (CGMS); Aquidauana municipality, Acampamento Betânia, on tree, 150 m elev., 20°27'38.40"S, 55°49'35.30"W, 18 September 2010, *L.S. Canêz 3396* (CGMS 31937); Campo Grande municipality, Campus da UFMS, on tree, 20°30'2.12"S, 54°36'48.77"W, 528 m elev., 1 May 2015, *T.D. Barbosa 620* (CGMS); Corguinho municipality, Taboco District, Fazenda Colina Dourada, Nascente do Rio Negro, on tree, 19°43'15.72"S, 55°07'29.87"W, 365 m elev., 2 October 2013, *S.S. Moura et a. 126* (CGMS 40306); Corumbá municipality, Morraria do Urucum, on tree branch, 733 m elev., 19°12'08.20"S, 57°36'04.60"W, 3 September 2010, *L.S. Canêz et al. 3285* (CGMS 32298); *ibid., L.S. Canêz et al. 3305* (CGMS 32296); Jaraguari municipality, Furnas do Dionísio, on tree branch, 498 m elev., 20°08'50.30"S, 54°34'08.10"W, 23 October 2010, *A.A. Spielmann & L.S. Canêz. 8894* (CGMS); *ibid., A.A. Spielmann & L.S. Canêz 8938* (CGMS); *ibid., L.S. Canêz & A.A. Spielmann 3444* (CGMS 31767); *ibid., L.S. Canêz & A.A. Spielmann 3460* (CGMS 31783); *ibid.,* on tree, 425 m elev., 20°08'54.1"S, 54°34'15.1"W, 22 November 2011, *A.L. Simal et al. 101a* (CGMS); *ibid.,* on tree, 357 m elev., 20°08'55.87"S, 54°34'13.92"W, 26 September 2017, *T.D. Barbosa 1712* (CGMS); *ibid., T.D. Barbosa 1718* (CGMS); Jardim municipality, Camping Seu Assis, on tree, 230 m elev., 21°25'14.20"S, 56°23'16.70"W, 4 July 2010, *L.S. Canêz et al. 2912* (CGMS 32427); Nova Andradina municipality, Edge of the Reserva Legal Fazenda Laranjal, on tree, 347 m elev., 22°03'44.10"S, 53°24'10.10"W, 3 December 2014, *P.P. Oliveira et al. 308* (CGMS 47919); *ibid., P.P. Oliveira et al. 309* (CGMS 47920); Porto Murtinho municipality, Cachoeira do APA, Trilha da Cachoeira, on tree, 90 m elev., 22°10'05.9"S, 57°31'13.4"W, 14 June 2017, *T.D. Barbosa 1620*

(CGMS); *ibid., T.D. Barbosa 1632* (CGMS); Terenos municipality, Colônia Velha, on tree, 357 m elev., 20°22'6.15"S, 54°51'53.12"W, 4 February 2017, *C.M. Bernardo 1210* (CGMS).

Pyxine flavolucens T.D. Barbosa, J.-M. Torres, Jungbluth & A.A. Spielmann, *sp. nov.* (Figures 26F, 27A-E, 40B array 5, 41A-B array 5)

Mycobank number: xxxxx

Diagnosis: Corticicolous *Pyxine* with bicolor medulla, has soralia, presenting UV+ dark-yellow in upper layer of medulla (unknown substance), and atranorin in cortex and terpenes in medulla.

Holotype:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, on tree, 521 m elev., 18° 9'1.47"S, 53°24'12.31"W, 23 October 2017, *A.A. Spielmann 12795* (CGMS).

MORPHOLOGY. **Thallus** corticicolous; 5−6 cm diam. **Upper surface** proximal region whitish-grey to greenish-grey, smooth to rugose, fissures originated from maculae present marginal to laminal, linear, **pruina** absent; distal region whitish-grey, smooth, fissures originated from maculae absent, **pruina** absent to frequent without board; apical to subapical. **Maculae** white in the proximal region scarce, discrete, submarginal to laminal, punctiform to linear, plane; in the distal region frequent to abundant, evident, marginal to laminal, punctiform to subreticulate, plane. **Laciniae** discrete to contiguous, rarely overlapping, irregularly to dichotomously branched, 0.5−1.1 mm width; apices not flabellate, rounded to truncate, convex to concave; margin not ascendent, crenate, black line conspicuous. **Medulla** upper layer yellow; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, black to olivaceous, dull, subapical region naked and margins with rhizinae. **Rhizinae** abundant, trichotomously to dichotomously branched, black to olivaceous, laminal to marginal. **Soralia** erumpent, scarce to frequent, laminal to submarginal, hemispherical to irregular; **soredia** whitish-green, farinose. **Isidia**, **Polysidiangia**, **Pustules** and **Lacinulae** absent. **Apothecia** absent.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 15−18 µm thick; **algal layer** discontinuous, 25−35 µm thick; **medulla** upper layer yellow, lower layer colorless, 95−105 µm thick; **lower cortex** prosoplectenchymatous, 10−12 µm thick, grey.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K−, C−, KC−, P-, UV+ dark-yellow; **lower layer** K−, C−, KC−, P-, UV−.

TLC. Atranorin and terpenes.

REMARKS.

Pyxine flavolucens is characterized by a medulla with yellow upper layer (K−, UV+ dark-yellow), presence of laminal to submarginal, hemispherical to irregular, erumpent soralia, abundant trichotomously to dichotomously branched rhizinae, and atranorin and terpenes as chemical compounds.

For the first time an UV reaction in the medulla of a *Pyxine* is reported. The upper layer of the medulla reacts UV+ dark-yellow. The UV reaction in the medulla is a different color than expected from lichexanthone, and with TLC no lichexanthone was found. We suspect that some steroid could be responsible for this UV reaction (but this hypothesis not was corroborated yet with analytical methods). The upper cortex reacts K+ yellow and UV− indicating atranorin.

Another characteristic observed in this species is the abundant trichotomously to dichotomously branched rhizinae, resembling rhizinae generally seen in *Hypotrachyna* (Vain.) Hale (Hale 1974). The rhizinae conformation is peculiar in comparisons with the rest of species of *Pyxine,* as they are present in the laminal region (central region of lower surface) and absent in the submarginal region but present again in the marginal region and joining the marginal black line.

Pyxine daedalea is similar to *P. flavolucens* but differs mainly by the marginal black line, trichotomously to dichotomously branched rhizinae and the medulla UV+ dark-yellow. *P. cocoës* has a cream to white medulla and lichexanthone in the upper cortex (UV+ yellow), *P. subcinerea* has a medulla similar to *P. flavolucens,* but no UV reaction in the medulla but lichexanthone in the upper cortex (UV+ yellow).

Pyxine pustulata is different by having pustules and lichexanthone in the upper cortex (UV+ yellow). *Pyxine coralligera, P. eschweileri* and *P. obscurascens* have atranorin in the upper cortex (K+ yellow) but these three species presenting polysidiangia. *Pyxine physciaeformis* also has polysidiangia but also differs by the presence of lichexanthone in the upper cortex (UV+ yellow). *Pyxine flavolucens* is a new species; the epithet "*flavolucens"* makes mention to UV+ yellow medulla and until this moment it is known only from Alcinópolis municipality in Mato Grosso do Sul State.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, on tree, 521 m elev., 18° 9'1.47"S, 53°24'12.31"W, 23 October 2017, *T.D. Barbosa 1893* (Parátipo, CGMS); *ibid.,* Trilha da Gruta da Paca, on tree, 621 m elev., 18°06'48.6"S, 53°40'04.9"W, 18 October 2017, *A.S. Rodrigues 348* (CGMS); Jateí municipality, 235 m elev., 22°54'5.93"S, 53°45'5.49"W, 11 November 2015, *A.A. Spielmann 11973* (CGMS).

Pyxine mantiqueirensis Marcelli & Jungbluth (2011: 172). (Figures 27F, 28A-D, 40B array 7, 41A-B array 7)

Holotype:—BRAZIL. Minas Gerais State: São Tomé da Letras Municipality, on rock in open woodland next to the Flávio Waterfall, 959 m elev., 21°44'36"S, 44°58'39"W, 19 January 2009, *M.J. Kitaura et al. 1361* (SP).

MORPHOLOGY. **Thallus** corticicolous; ca. 1.8 cm diam. **Upper surface** proximal region whitish-grey, smooth, fissures originated from maculae absent, **pruina** absent; distal region whitish-grey, smooth, fissures originated from maculae absent, **pruina** absent. **Maculae** in the proximal and distal regions absent. **Laciniae** discrete, dichotomously to palmatifid branched, 0.2−0.8 mm width; apices not flabellate, rounded, convex; margin not ascendent, smooth, black line inconspicuous. **Medulla** upper layer orange; lower layer white, **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, dark-brown, dull, naked margin present 0.1 mm length. **Rhizinae** abundant, irregularly branched, black, laminal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *obscurascens*-type, 0.1−0.5 mm diam., laminal, immersed to sessile of constrict base; **disc** black, plane, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** orange, 0.1 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 20−22 µm thick; **algal layer** discontinuous, 20−35 µm thick; **medulla** upper layer orange, lower layer colorless, 90−120 µm thick; **lower cortex** prosoplectenchymatous, 16 µm thick, dark-brown. **Apothecia epihymenium** 5−8 µm thick, grey; **hymenium** 60−75 µm thick, colorless; **subhymenium** 60−75 µm thick, yellow, yellow; **ascospores** *Dirinaria*-type, 13−14 × 5−6 µm, 1-septate.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K+ black, C+ reddish, KC+ reddish, P+ black, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K+ reddish, C−; **apothecial disc** UV−.

TLC. Atranorin and terpenes.

REMARKS.

Pyxine mantiqueirensis is characterized by an orange upper layer of the medulla (K+ black), presence of apothecia as reproductive structure, orange internal stipe (K+ reddish), apothecia of the *obscurascens*-type, and atranorin and terpenes as chemical compounds.

This taxon is a recent segregate of the "*Pyxine pungens* complex" and is the only species of this complex to possess apothecia of the *obscurascens*-type. For comparisons with *P. astipitata* see under that species, *P. rhodesiaca* has apothecia of the *cocoës*-type and reticulate to subreticulate maculae, *P. pungens* has also apothecia of the *cocoës*-type. *Pyxine exoalbida* and *P.*

schechingeri are also species of the "*Pyxine pungens* complex", differentiating by norstictic acid, the first in the medulla and the last in the epihymenium.

Only one specimen of *P. mantiqueirensis* was found, from *Chaco* region, the specimen also examined by Torres (2018) during his study on macrolichens from the Brazilian *Chaco*. *Pyxine mantiqueirensis* is known in Brazil from Minas Gerais and São Paulo States. Torres (2018) was the first to report it from Mato Grosso do Sul State.

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Mato Grosso do Sul State (Torres 2018: 195), Minas Gerais State (Jungbluth & Marcelli 2011: 173), São Paulo state (Jungbluth & Marcelli 2011: 173).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Porto Murtinho municipality, road to Morro Pão de Açúcar, on tree, 21°33'30.23"S, 57°48'49.42"W, 84 m elev., 13 June 2017, *A.S. Rodrigues 201* (CGMS).

Pyxine nana Kalb (1987: 55). (Figures 28E-F, 29A-C, 42A-B array 5, 43A array 5)

Holotype:—BRAZIL. São Paulo State: near José Bonifácio municipality, ca. 45 km SW of São José do Rio Preto municipality, in a *Cerrado*, 450 m elev., 21°05'S, 49°40'W, 13 October 1979, *K. Kalb & G. Plobst 12314* (Herb. Kalb).

MORPHOLOGY. **Thallus** corticicolous; 3−4 cm diam. **Upper surface** proximal region greenish-grey, rugose to verrucose, fissures originated from maculae absent, **pruina** absent; distal region greenish-grey, smooth, fissures originated from maculae absent, **pruina** scarce without board; subapical. **Maculae** in the proximal region scarce, discrete, submarginal to laminal, punctiform, plane; in the distal region scarce, evident, submarginal to laminal, punctiform, plane. **Laciniae** overlapping, irregularly branched, 0.5−0.8 mm width; apices not flabellate, rounded, concave to plane; margin not ascendent, crenate, black line absent. **Medulla** upper layer yellow; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, black to cream, dull, naked margin absent. **Rhizinae** abundant, not branched, black, laminal to submarginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *physciaeformis*-type, 0.4−0.8 mm diam., laminal, sessile of constrict base; **disc** black, plane, **pruina** white; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.1−0.12 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3 cells layer, 15−17 µm thick; **algal layer** discontinuous, 20−25 µm thick; **medulla** upper layer yellow, lower layer colorless, 70−80 µm thick; **lower cortex** prosoplectenchymatous, 12−13 µm thick, dark-brown. **Apothecia**

epihymenium 5−7 µm thick, grey; **hymenium** 65−70 µm thick, colorless; **subhymenium** 70−90 µm thick, light-brown, colorless; **ascospores** *Dirinaria*-type, 13−18 × 5−6 µm, 1-septate.
SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K+ orange, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.
TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine nana is characterized by a yellow upper layer of medulla (K+ orange), presence of apothecia as reproductive structure, white internal stipe (K−), apothecia of the *physciaeformis*-type, and lichexanthone and terpenes as chemical compounds.

Four taxa in *Pyxine* are known with apothecia of the *physciaeformis*-type and lichexanthone in the upper cortex (UV+ yellow). Of these only *P. astridiana* Kalb (Kalb 1987) is not found in Mato Grosso do Sul State; the main difference between this and *P. nana* is the white medulla (K−, P−) in *P. astridiana.*

Pyxine physciaeformis has the same chemical constituents and apothecia type as *P. nana* but has polysidiangia. *Pyxine simulans* can be easily confouded with *P. nana* but has wider laciniae (0.6−1.5 mm width) and the upper layer of the medulla is K−.

Pyxine nana is mentioned here for the first time from Mato Grosso do Sul State; before it was only known from São Paulo State.

NO DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis, Parque Estadual das Nascentes do Rio Taquari, on tree, 773 m elev., 18°14'17.0"S, 53°18'18.9"W, 24 October 2011, *M.L.Z. Colado et al. 186* (CGMS 56198); Campo Grande municipality, Rua Abrão Julio Rahe, close to praça da Bolívia, on tree, 620 m elev., 20°26'57.90"S, 54°35'14.40"W, 24 October 2011, *A.A. Spielmann & N.K. Honda 9765* (CGMS 42358); Costa Rica municipality, Parque Estadual das Nascentes do Rio Taquari, on tree, 780 m elev., 18°14'03.3"S, 53°18'25.5"W, 24 October 2017, *A.S. Rodrigues 419* (CGMS); *ibid., A.S. Rodrigues 422* (CGMS); *ibid., A.S. Rodrigues 423* (CGMS); Porto Murtinho Municipality, Cachoeira do Apa, on tree, 90 m elev., 22°10'05.90"S; 57°31'13.40"W, 14 June 2017, *T.D. Barbosa 1618* (CGMS).

Pyxine obscurascens Malme (1897: 42). (Figures 29D-F, 30A-C, 40B array 8, 41A-B array 8)
Lectotype:—BRAZIL. Mato Grosso State: Serra da Chapada, prope Bocca da Serra, ad rupem sat apricam, 3 June 1894, *Malme 3895* (S).

MORPHOLOGY. **Thallus** corticicolous; 5−6.5 cm diam. **Upper surface** proximal region whitish-grey, rugose, fissures originated from maculae absent, **pruina** absent; distal region whitish-grey, smooth to foveolate, fissures originated from maculae absent, **pruina** scarce; subapical. **Maculae** in the proximal region absent; in the distal region scarce, discrete, submarginal to laminal, linear, plane. **Laciniae** contiguous to overlapping, dichotomously to irregularly branched, 0.5−1.1 mm width; apices not flabellate, rounded, concave to convex; margin not ascendent, crenate to smooth, black line conspicuous. **Medulla** upper layer orange; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth to papillate, light-brown, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black to light-brown, laminal to marginal. **Polysidiangia** frequent, laminal, irregular; **soredia** whitish-green, granulose. **Isidia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *obscurascens*-type, 0.3−1.2 mm diam., laminal, sessile of constrict base; **disc** black, convex to concave, **pruina** absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** orange, 0.1−0.12 mm thick.
ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2−3 cells layer, 15−20 µm thick; **algal layer** discontinuous, 20−25 µm thick; **medulla** upper layer orange, lower layer yellow, 90−100 µm thick; **lower cortex** prosoplectenchymatous, 15−22 µm thick, dark-brown. **Apothecia epihymenium** 10−12 µm thick, grey; **hymenium** 65−70 µm thick, colorless; **subhymenium** 45−50 µm thick, brown, orange; **ascospores** *Dirinaria*-type, (12−)15−18 × (5−)6−8 µm, 1-septate.
SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K+ black, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K+ red, C−; **apothecial disc** UV−.
TLC. Atranorin and terpenes.

REMARKS.

Pyxine obscurascens is characterized by an orange upper layer of the medulla (K+ black), presence of laminal polysidiangia, an orange internal stipe (K+ red), apothecia of the *obscurascens*-type, ascospores of the *Dirinaria*-type (1 septate), and atranorin and terpenes as chemical compounds. This is the only species with polysidiangia that has an orange upper medullar region.

Pyxine physciaeformis has lichexanthone in the upper cortex (UV+ yellow) and apothecia of the *physciaeformis*-type. For comparisons with *P. coralligera* and *P. eschweileri* see under these species. *Pyxine obscurascens* was cited from Mato Grosso do Sul State by Kalb (1987) and Fleig & Riquelme (1991).

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —THAILAND (Buaruang *et al.* 2017: 72).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, Trilha do Templo dos Pilares, on tree, 550 m elev., 18°08'58.5"S, 53°40'37.8"W, 19 October 2017, *S.M.L. Souza 86* (CGMS); *ibid.,* Trilha do Pôr do Sol, on tree branch, , 639 m elev., 18°06'58.8"S, 53°41'21.8"W, 17 October 2017, *T.D. Barbosa & A.A. Spielmann 1748* (CGMS); *ibid., T.D. Barbosa & A.A. Spielmann 1765* (CGMS); *ibid., T.D. Barbosa & A.A. Spielmann 1775* (CGMS); *ibid., T.D. Barbosa & A.A. Spielmann 1788* (CGMS); Aquidauana municipality, Camisão District, Morraria Paxixi, on tree, 540 m elev., 20°26'32.5"S, 55°37'54.4"W, 30 August 2015, *T.D. Barbosa 734* (CGMS 60374); *ibid.,* 600 m elev., 20°25'37.09"S, 55°36'39.05"W, 5 December 2015, *T.D. Barbosa 887* (CGMS 60375); Corguinho municipality, Serra de Maracajú, eastern border of *Pantanal*, Taboco District, Fazenda Colorado, on tree, 586 m elev., 19°41'51.90"S, 55°19'52.07"W, 1 September 2013, *B. Ferreira et al. 4* (CGMS 40763); Nova Andradina municipality, RPPN Cabeceira do Mimoso, Fazenda Laranjal, on tree, 373 m elev., 22°02'09.50"S, 53°23'23.10"W, 1 December 2014, *A.C. Gomes et al. 9* (CGMS 47095).

Pyxine parapetricola T.D. Barbosa, J.-M. Torres, Jungbluth & A.A. Spielmann, *sp. nov.* (Figures 30D-F, 31A-B, 42A-B array 6, 43A array 6)

Mycobank number: xxxxx

Diagnosis: Saxicolous *Pyxine* with abundant reticulate to subreticulate maculae, palmatifid branched laciniae, white medulla, apothecia of *cocoës*-type, red internal stipe, lichexanthone in the cortex and terpenes in the medulla.

Holotype:—BRAZIL. Mato Grosso do Sul State: Porto Murtinho municipality, Morro close to a estrada de acesso ao Morro Pão de Açúcar, on granitic rock, 89 m elev., 21°29'09.8"S, 57°55'46.1"W, 13 June 2017, *T.D. Barbosa et al. 1583* (CGMS).

MORPHOLOGY. **Thallus** saxicolous; 7−9 cm diam. **Upper surface** proximal region yellowish-grey, smooth to rugose, fissures originated from maculae present laminal, linear, **pruina** absent; distal region whitish-grey, smooth, fissures originated from maculae present laminal, linear, **pruina** scarce with board; subapical. **Maculae** in the proximal region abundant, evident, laminal to submarginal, reticulate to subreticulate, high; in the distal region proximal region abundant, evident, laminal to submarginal, reticulate to subreticulate, high; distal region abundant, evident,

laminal to marginal, reticulate to subreticulate, high. **Laciniae** contiguous, palmatifid branched, 0.2−0.8(−1.2) mm width; apices not flabellate to slightly flabellate, rounded, convex; margin not ascendent, smooth, black line absent. **Medulla** upper layer white; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth to papillate, dark-brown to olivaceous, dull, naked margin absent. **Rhizinae** frequent, not branched, black, laminal to submarginal. **Lacinulae** frequent to abundant, marginal, concolor to thallus, not branched, 0.2−0.4(−1) × 0.2−0.3 mm, rounded to subtruncate apices. **Isidia**, **Polysidiangia**, **Pustules** and **Soralia** absent. **Apothecia** *cocoës*-type, 0.3−1.2 mm diam., laminal, sessile of constrict base; **disc** black, plane to convex, **pruina** absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** red, 0.1−0.25 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 20−25 µm thick; **algal layer** discontinuous, 50−65 µm thick; **medulla** upper layer colorless, lower layer colorless, 25−30(−50) µm thick; **lower cortex** prosoplectenchymatous, 15−25 µm thick, dark-brown. **Apothecia epihymenium** 10−12 µm thick, grey; **hymenium** 70−75 µm thick, colorless; **subhymenium** 50−60 µm thick, yellow, yellow; **ascospores** *Dirinaria*-type, (9−)10−14(−15) × 5−6 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K+ purple, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine parapetricola is characterized by a white medulla (K−, C−), presence of apothecia as reproductive structure, red internal stipe (K+ purple), apothecia of the *cocoës*-type, reticulate to subreticulate maculae, and lichexanthone and terpenes as chemical constituents.

Pyxine petricola is closely related to *P. parapetricola* (etymology); both species possess a white medulla, apothecia of the *cocoës*-type with red internal stipe, lichexanthone in the upper cortex (UV+ yellow) and no vegetative propagules. However, *P. parapetricola* is proposed as a new species for its smaller laciniae (in general 0.2−0.8 mm wide), smaller ascospores (10−14 µm length) and abundant and evident reticulate maculae (as in *P. rhodesiaca*).

Another similar taxon is *P. microspora,* but this species has apothecia of the *obscurascens*-type and a white internal stipe (Jungbluth 2010) and *P. microspora* is not found in Mato Grosso do Sul State; is was cited only from Santa Catarina State (Kalb 1987).

Pyxine parapetricola was found in the *Chaco* region in Porto Murtinho municipality, on granitic rocks. Until this moment it is known only from the type locality.

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Porto Murtinho municipality, hill close to the road ao Morro Pão de Açúcar, on granitic rock, 21°29'09.8"S, 57°55'46.1"W, 89 m elev., 13 June 2017, *J.M. Torres et al. 627* (Parátipo, CGMS); *ibid., T.D. Barbosa et al. 1559* (CGMS); *ibid., T.D. Barbosa et al. 1561* (CGMS); *ibid., T.D. Barbosa et al. 1578* (Parátipo CGMS).

Pyxine petricola Nyl. *in* Cromb. (1876: 263). (Figures 31C−F, 32A, 42A-B array 7, 43A array 7)

Lectotype:—ISLAND OF RODRIGUEZ: 9 December 1874, *I. B. Balfour* 2391 (Transit of Venus Expedition), (BM, isolectotypes H-NYL 31754, H-NYL 2336).

MORPHOLOGY. **Thallus** corticicolous to ramulicolous; 3.5−10 cm diam. **Upper surface** proximal region yellowish-grey to whitish-grey, rugose to verrucose, fissures originated from maculae absent, **pruina** absent; distal region yellowish-grey to whitish-grey, smooth, fissures originated from maculae absent, **pruina** scarce without board to abundant with board; subapical to laciniae center. **Maculae** in the proximal region scarce, discrete, laminal, linear, plane; in the distal region scarce, discrete, marginal, linear, plane. **Laciniae** contiguous to overlapping, irregularly branched, 0.5−1.5 mm width; apices not flabellate, rounded, plane; margin ascendent, smooth to crenate, black line absent. **Medulla** upper layer white; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth to rugose, light-brown to olivaceous, dull, naked margin present 0.1−0.2 mm length. **Rhizinae** abundant, not branched, black, laminal to submarginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *cocoës*-type, 0.3−1.2 mm diam., laminal, sessile of constrict base; **disc** black, plane to convex, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** red, 0.2 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 4−5 cells layer, 25−30 µm thick; **algal layer** discontinuous, 20−35 µm thick; **medulla** upper layer colorless, lower layer colorless, 90−105 µm thick; **lower cortex** prosoplectenchymatous, 20−30 µm thick, dark-brown. **Apothecia epihymenium** 7−10 µm thick, grey; **hymenium** 75−80 µm thick, colorless; **subhymenium** 75−80(−100) µm thick, yellow, light-brown to orange; **ascospores** *Dirinaria*-type, 15−18 × 5−7 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K+ red to K+ purple, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine petricola is characterized by a white medulla (K−, C−), presence of apothecia as reproductive structure, red internal stipe (K+ purple), apothecia of the *cocoës*-type, and lichexanthone and terpenes as chemical constituents.

Pyxine petricola var. *convexula* is the taxon most related taxon to *P. petricola* var. *petricola* but differs mainly by the white internal stipe (K−) and abundant linear to subreticular maculae in the distal region. For comparison with *P. parapetricola* see remarks under that species.

Pyxine petricola possesses an extensive synonym list, cited and explicated by Kalb (1987) and Jungbluth (2010).

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Mato Grosso do Sul State (Torres 2018: 198); THAILAND (Mongkolsuk *et al.* 2012: 47, Buaruang *et al.* 2017: 72).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Campo Grande municipality, Campus UFMS, close to ao INBIO, on tree, 20°30'04.3"S, 54°36'42.6"W, 537 m elev., 17 October 2013, *A.A. Spielmann 11147* (CGMS 52137); *ibid., A.A. Spielmann 11161* (CGMS 52144); *ibid., A.A. Spielmann 11162* (CGMS 52152); *ibid.,* 7 March 2014, *C.M. Bernardo 39* (CGMS); *ibid.,* Parque Ecológico do Sóter, on tree, 653 m elev., 20°25'42.1"S, 54°34'38.00"W, 29 May 2015, *L.S. Canêz 4360* (CGMS 53621); *ibid.,* Rua Abrão Julio Rahe, close to Praça da Bolívia, 620 m elev., 20°26'57.90"S, 54°35'14.90"W, 24 October 2011, *A.A. Spielmann & N.K. Honda 9774* (CGMS 42363); *ibid.,* on tree, 539 m elev., 20º30'31.70"S, 54º36'51.30"W, 10 August 2015, *T.D. Barbosa 1922* (CGMS); Corumbá municipality, Fazenda Nhumirim, Salina do Oito, on tree, coordinates absent, 10 September 1988, *V.J. Pott et al. 623* (COR 1433); *ibid., V.J. Pott et a. 838* (COR 1557); Pomar da Sede, coordinates are not, on tree, 26 October 1988, *V.J. Pott et al. 837* (COR 1556), *pr. p.*; *ibid.,* Tromba dos Macacos, on tree, coordinates are not, 2 November 1993, *M.P. Marcelli et al. 24819* (COR 3123); *ibid., M.P. Marcelli et al. s/nº,* (COR 3137); *ibid., s/coll.* (COR 3141); *ibid., Pantanal*, Base de Estudos do *Pantanal* (BEP), estrada de acesso, on tree, 95 m elev., 19°34'27.60"S, 57°01'23.00"W, 21 August 2011, *A.A. Spielmann et al. 9435* (CGMS 42356); *ibid., A.A. Spielmann et al. 9437* (CGMS 42352); *ibid., A.A. Spielmann et al. 9444* (CGMS 42373); *ibid.,* Subregion *Pantanal* do Paraguai, RPPN Eliezer Batista (Novos Dourados), on tree, 95 m elev., 18°05'40.20"S, 57°29'15.50"W, 24 November 2010, *C.S. Robles et al. 46* (CGMS 30328); *ibid., C.S. Robles et al. 53* (CGMS 30335); *ibid., L.S. Cânez et al. 3562* (CGMS 32006); *ibid., L.S. Cânez et al. 3563* (CGMS 32007); *ibid.,* Baía do Castelo, on tree branch, 86 m elev., 18°35'17.30"S, 57°32'10.80"W, 22 November 2010, *T.H. Stefanello et al. 11* (CGMS 30053); *ibid.,* Baía do Mandioré, 90 m elev., 18°11'50.70"S, 57°30'39.70"W, 23 November 2010, *T.H.D.*

Leandro et al. 39 (CGMS 30354); Porto Murtinho municipality, Fazenda Santa Vergínia, near Retiro 13, 88 m elev., 22º01'12.60"S, 57º52'40.50"W, on tree, 15 December 2010, *A.A. Spielmann et al. 9414* (CGMS); *ibid., A.A. Spielmann et al. 9419* (CGMS); *ibid., A.A. Spielmann et al. 9431* (CGMS); *ibid.,* 95 m 22º06'42.40"S, 57º50'01.90"W, 24 November 2011, *A.A. Spielmann et al. 9708* (CGMS); *ibid., A.A. Spielmann et al. 10088* (CGMS); *ibid., A.A. Spielmann et al. 10163* (CGMS); *ibid.,* on tree branch, 95 m elev., 22º40'46.1"S, 57º46'46.3"W, 23 November 2011, *A.A. Spielmann & L.S. Canêz 9726* (CGMS); *ibid., A.A. Spielmann & L.S. Canêz 9731a* (CGMS); *ibid.,* Retiro Conceição, on tree, 80 m elev., 21º40'57.00"S, 57º46'45.00"W, 14 December 2010, *A.A. Spielmann et al. 8970* (CGMS); *ibid.,* 94 m elev., 21º36'41.60"S, 57º48'04.30"W, 21 November 2011, *A.A. Spielmann et al. 12282* (CGMS); *ibid.,* on tree, 88 m elev., 21°41'11.78"S, 57°46'17.26"W, *J.M. Torres 484* (CGMS); *ibid., J.M. Torres 533* (CGMS); *ibid., J.M. Torres 534* (CGMS); *ibid.,* on fence pole, 21°40'30.54"S, 57°44'05.73"W, 15 December 2015, *J.M. Torres 511* (CGMS); *ibid., J.M. Torres 517* (CGMS); *ibid.,* Fazenda Barbas, on tree branch, 105 m elev., 21°41'06.50"S, 57°43'10.20"W, 12 June 2017, *A.S. Rodrigues et al. 193* (CGMS); *ibid., J.M. Torres et al. 578* (CGMS); *ibid., J.M. Torres et al. 534* (CGMS); *ibid., T.D. Barbosa et al. 1502* (CGMS); *ibid., T.D. Barbosa et al. 1520* (CGMS); *ibid., T.D. Barbosa et al. 1525* (CGMS); *ibid., T.D. Barbosa et al. 1529* (CGMS); *ibid., T.D. Barbosa et al. 1530* (CGMS); *ibid., T.D. Barbosa et al. 1531* (CGMS); *ibid., T.D. Barbosa et al. 1536* (CGMS); *ibid., T.D. Barbosa et al.* (CGMS); *ibid.,* Cachoeira do Apa, on tree, 90 m elev., 22°10'05.90"S; 57°31'13.40"W, 14 June 2017, *J.M. Torres et al. 662* (CGMS); *ibid., T.D. Barbosa et al. 1605* (CGMS); *ibid., T.D. Barbosa et al. 1623* (CGMS); *ibid., T.D. Barbosa et al. 1633* (CGMS); *ibid.,* road BR-267, on tree, 99 m elev., 21°43'08.10"S, 57°37'12.10"W, 12 June 2017, *J.M. Torres et al. 595* (CGMS); *ibid.,* margin of Rio Paraguai, on tree, 89 m elev., 21°42'39.48"S, 57°44'11.25"W, 14 June 2017, *J.M. Torres et al. 608* (CGMS); *ibid.,* margin of Rio Paraguai, on tree, 78 m elev., 21°42'09.90"S, 57°53'31.40"W, 14 June 2017, *T.D. Barbosa et al. 1566* (CGMS); *ibid., T.D. Barbosa et al. 1593* (CGMS); *ibid., T.D. Barbosa et al. 1597* (CGMS); *ibid*., 89 m elev., 21º42'39.50"S, 57º44'11.20"W, on tree, 14 June 2017, *T.D. Barbosa et al. 1662* (CGMS); *ibid., T.D. Barbosa et al. 1663* (CGMS); *ibid., T.D. Barbosa et al. 1664* (CGMS); *ibid., T.D. Barbosa et al. 1666* (CGMS); *ibid., T.D. Barbosa et al. 1670* (CGMS); *ibid., T.D. Barbosa et al. 1672* (CGMS); *ibid., A.S. Rodrigues et al. 228* (CGMS); *ibid*., 94 m elev., 21º36'41.6"S, 57º48'04.3"W, on tree, 21 September 2011, *Spielmann et al. 12286* (CGMS).

Pyxine petricola var. ***convexula*** (Malme) Kalb (1987: 60). (Figures 32B-F, 42A-B array 8, 43A array 8)

≡ *Pyxine meissneri* Tuck. ex Nyl. var. *convexula* Malme (1897: 42).

Lectotype:—BRAZIL. Mato Grosso do Sul State, Corumbá municipality, ad arborem Euphorbiaceam, 10 August 1894, *Malme 3889* [non 3885 neither 3887] (S, duplicates from the lectotype G).

MORPHOLOGY. **Thallus** corticicolous; 3−15 cm diam. **Upper surface** proximal region yellowish-grey, rugose to verrucose, fissures originated from maculae absent, **pruina** absent; distal region whitish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** frequent to abundant without board; apical to laciniae center. **Maculae** in the proximal region absent; in the distal region abundant, discrete, marginal to laminal, linear, high. **Laciniae** contiguous to overlapping, irregularly branched, 0.5−2.2 mm width; apices not flabellate, rounded, plane to slightly concave; margin ascendent, smooth to crenate, black line absent. **Medulla** upper layer white; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth to rugose, light-brown to olivaceous, dull, naked margin present 0.1−0.5 mm length. **Rhizinae** abundant, not branched, black, laminal to submarginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *cocoës*-type, 0.4−1.7 mm diam., laminal, sessile of constrict base; **disc** black, plane to convex, **pruina** absent; **margin** smooth to crenate; **amphithecium** smooth to rugose, ornament absent; **internal stipe** white, 0.2−0.3 mm thick.
ANATOMY. **Thallus upper cortex** paraplectenchymatous, 4−5 cells layer, 25−30 µm thick; **algal layer** discontinuous, 25−35 µm thick; **medulla** upper layer colorless, lower layer colorless, 90−100 µm thick; **lower cortex** prosoplectenchymatous, 25−30 µm thick, dark-brown. **Apothecia epihymenium** 5−7 µm thick, grey; **hymenium** 85−90 µm thick, colorless; **subhymenium** 140−150 µm thick, light-brown, colorless; **ascospores** *Dirinaria*-type, 15−21 × 6−8 µm, 1-septate.
SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.
TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine petricola var. *convexula* is characterized by a white medulla (K−, C−), presence of apothecia as reproductive structure, white internal stipe (K−), apothecia of the *cocoës*-type, and lichexanthone and terpenes as chemical constituents.

This variety was proposed by Malme (1897) as *P. meissneri* var. *convexula*, however Swinscow & Krog (1975) described a similar variety called *P. petricola* var. *pallida* (based on white internal stipe and K−). But Kalb (1987), after seeing the type collection, combined the variety described by Malme (1897) in *P. petricola* var. *convexula* and treated the variety described

by Swinscow & Krog (1975) as synonym. For more information about the taxonomy of this taxon see Kalb (1987) and Jungbluth (2010).

The lectotype was chosen by Rogers (1986) a specimen collected by Malme in 1884 (Malme no. 3989), from Corumbá municipality, in Mato Grosso do Sul State.

NO DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Campo Grande municipality, Campus UFMS, close to ao INBIO, on tree, 537 m elev., 20°30'04.3"S, 54°36'42.6"W, 17 October 2013, *A.A. Spielmann 11145* (CGMS 52145); *ibid., T.D. Barbosa 1918* (CGMS); *ibid.,* Parque Ecológico do Sóter, on tree, 653 m elev., 20°25'42.1"S, 54°34'28.0"W, 29 May 2015, *A.A. Spielmann et al. 12081* (CGMS 54115); Corumbá municipality, *Pantanal*, Fazenda Nhumirim, Pomar da Sede, coordinate are not, 26 October 1988, *V.J. Pott et al. 836* (COR 1555); Subregion *Pantanal* do Paraguai, Baía do Castelo, on tree, 92 m elev., 18°33'52.80"S, 57°34'29.30"W, 22 November 2010, *T.H. Stefanello et al. 77* (CGMS 30104); *ibid. T.H. Stefanello et al. 90* (CGMS 30117); *ibid.,* RPPN Eliezer Batista (Novos Dourados), topo do Morro, on tree, 208 m elev., 18°05'33.40"S, 57°29'31.40"W, 24 November 2010, *L.S. Canêz et al. 3570* (CGMS 32018); Terenos municipality, Fazenda Modelo da EMBRAPA, on tree, 500 m elev., 20°33'33.80"S, 54°47'33.60"W,13 April 2010, *A.A. Spielmann et al. 8065a* (CGMS 42361).

Pyxine physciaeformis (Malme) Imshaug (1957: 257). (Figures 33A-F, 42A-B array 9, 43A array 9)

≡ *Pyxine meissneri* Tuck. var. *physciaeformis* Malme (1897: 42).

Lectotype:—BRAZIL. Mato Grosso State: Corumbá municipality, in *silva minus* densa, in declivibus collis, 10 August 1894, *Malme 3880* (S, duplicate from the lectotype: UPS).

MORPHOLOGY. **Thallus** corticicolous to saxicolous; 7−10 cm diam. **Upper surface** proximal region yellowish-grey to greenish-grey, rugose, fissures originated from maculae absent, **pruina** absent; distal region yellowish-grey to greenish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** scarce to frequent without board; subapical. **Maculae** in the proximal region absent; in the distal region scarce, discrete, submarginal to laminal, punctiform to linear, plane. **Laciniae** discrete to overlapping, irregularly branched, 0.3−0.8 mm width; apices not flabellate, rounded, concave to plane; margin ascendent, smooth to crenate, black line absent. **Medulla** upper layer yellow; lower layer white, **pigment** absent. **Lower surface** proximal region rugose, black, dull; distal region smooth to papillate, light-brown to cream, dull, naked margin

absent 0.4−0.8 mm length. **Rhizinae** abundant, not branched to furcate branched, black to light-brown, laminal to submarginal. **Polysidiangia** frequent to covering the thallus, laminal, irregular; **soredia** absent. **Isidia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *physciaeformis*-type, 0.5−1.2 mm diam., laminal, sessile of constrict base; **disc** black, plane to concave, **pruina** white; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.2−0.25 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 20−25 µm thick; **algal layer** discontinuous, 20−35 µm thick; **medulla** upper layer yellow, lower layer colorless, 65−70 µm thick; **lower cortex** prosoplectenchymatous, 10−15 µm thick, dark-brown. **Apothecia epihymenium** 5−7 µm thick, grey; **hymenium** 75−80 µm thick, colorless; **subhymenium** 45−50 µm thick, light-brown, colorless; **ascospores** *Dirinaria*-type, 14−16 × 4−5 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K+ reddish, C−, KC−, P+ reddish, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine physciaeformis is characterized by a yellow upper layer of the medulla (K+ reddish), laminal polysidiangia, white internal stipe (K−), apothecia of the *physciaeformis*-type, and lichexanthone and terpenes as chemical compounds.

This is the only species with polysidiangia, apothecia of the *physciaeformis*-type and lichexanthone in the upper cortex (UV+ yellow). *Pyxine physciaeformis* was described by Malme (1897) as *P. meissneri* var. *physciaeformis* Malme, based on material from Corumbá, Mato Grosso do Sul State, Brazil.

Although the type specimen is from Mato Grosso do Sul State, *P. physciaeformis* was found only in two municipalities: Campo Grande and Alcinópolis.

NO DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Parque Natural Serra do Bom Jardim, on tree, 576 m elev., 18°09'3.29"S, 53°24'7.77"W, 23 October 2017, *A.A. Spielmann 12784* (CGMS); Campo Grande municipality, Rua Abrão Julio Rahe, close to Praça da Bolívia, on tree, 620 m elev., 20°26'57.90"S, 54°35'14.40"W, 24 October 2011, *A.A. Spielmann & N.K Honda 9685* (CGMS 42359).

Pyxine primaria Kalb (1987: 62). (Figures 34A-E, 40B array 9, 41A-B array 9)

Holotype:—BRAZIL. Mato Grosso do Sul State, Estrada do *Pantanal*, a few km E von Coxim, in a dense *Cerrado* along a tributary of Rio Taquari, corticicolous 300 m elev., 18°30' S, 54°45' W, 29 June 1980, *K. Kalb 12267* (Herb. Kalb).

MORPHOLOGY. **Thallus** corticicolous; ca. 4 cm diam. **Upper surface** proximal region yellowish-grey to greenish-grey, smooth, fissures originated from maculae absent, **pruina** absent; distal region yellowish-grey to greenish-grey, smooth, fissures originated from maculae absent, **pruina** scarce without board; subapical to laciniae center. **Maculae** in the proximal region scarce, discrete, laminal, linear, plane; in the distal region scarce, discrete, laminal to submarginal, linear, plane. **Laciniae** discrete to contiguous, dichotomously branched, 0.3−1.1 mm width; apices not flabellate, rounded, concave to plane; margin not ascendent, smooth to crenate, black line present, evident. **Medulla** upper layer yellow; lower layer white, **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, black, dull, naked margin absent. **Rhizinae** abundant, furcate to irregularly branched, black, laminal to marginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *obscurascens*-type, 0.3−1.7 mm diam., laminal, sessile of constrict base; **disc** black, plane to concave, **pruina** absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** yellowish-white, 0.15 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2−3 cells layer, 18−20 µm thick; **algal layer** discontinuous, 20−25 µm thick; **medulla** upper layer yellow, lower layer colorless, 90−100 µm thick; **lower cortex** prosoplectenchymatous, 15 µm thick, dark-brown. **Apothecia epihymenium** 10−12 µm thick, grey; **hymenium** 75−80 µm thick, colorless; **subhymenium** 125−130 µm thick, light-brown, colorless; **ascospores** *Conradia*-type, 18−20 × 6−7 µm, 1−3-septa.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Atranorin and terpenes.

REMARKS.

Pyxine primaria is characterized by a yellow upper layer of the medulla (K−), presence of apothecia as reproductive structure, yellowish-white internal stipe (K−), apothecia of the *obscurascens*-type, ascospores of the *Conradia*-type (1−3 septa), and atranorin and terpenes as chemical compounds.

Other species found in the study area with atranorin in upper cortex (K+ yellow) and without vegetative propagules are of the *"Pyxine pungens* complex" and they have an orange upper

layer of the medulla and ascospores of the *Dirinaria*-type (1 septate). *Pyxine mantiqueirensis* is the only species in this complex that has apothecia of the *obscurascens*-type, but for reasons cited above it is hard confouded these taxa.

Pyxine cognata has apothecia of the *obscurascens*-type but ascospores of the *Dirinaria*-type and lichexanthone in the upper cortex (UV+ yellow).

The holotype of *P. primaria* is from Coxim municipality, in Mato Grosso do Sul State, and was collected by Kalb in 1980 (K. Kalb 12267), see Kalb (1987).

NO DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Bodoquena municipality, Serra da Bodoquena, Sítio Boa Vista, on tree, 173 m elev., 20°44'33.00"S, 56°44'17.30"W, 14 August 2010, *L.S. Canêz et al. 3138* (CGMS 31865); *ibid.,* 165 m elev., 20°43'58.80"S, 56°43'56.40"W, 14 August 2010, *L.S. Canêz et al. 3154* (CGMS 31881); Jaraguari municipality, Furnas do Dionísio, on tree, 546 m elev., 20º10'53.3"S, 54º34'37.3"W, 1 March 2015, *C.M. Bernardo & T.D. Barbosa 474* (CGMS); *ibid.,* 2 May 2015, *C.M. Bernardo & T.D. Barbosa 799* (CGMS).

Pyxine pungens Zahlbr. (1928: 210). (Figures 34F, 35A-D, 40B array 10, 41A-B array 10)

Holotype:—INDONESIA: Java island: Hortus Bogoriensis (=Buitenzorg), ramicola, *C. van Overeem 23* (W, isotype: O).

MORPHOLOGY. **Thallus** corticicolous to ramuliculous; 5.5−9 cm diam. **Upper surface** proximal region whitish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** absent; distal region whitish-grey, smooth to rugose, fissures originated from maculae absent, **pruina** absent. **Maculae** in the proximal region scarce, discrete, submarginal to laminal, linear to punctiform, plane; in the distal region scarce, discrete, submarginal to laminal, linear to punctiform, plane. **Laciniae** contiguous to overlapping, dichotomously to irregularly branched, 0.5−1.3 mm width; apices not flabellate, truncate, plane to convex; margin not ascendent, smooth, black line absent. **Medulla** upper layer orange; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth to papillate, olivaceous, dull, naked margin absent. **Rhizinae** abundant, irregularly branched, black to olivaceous, laminal to submarginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *cocoës*-type, 0.3−1(−2) mm diam., laminal, sessile of constrict base; **disc** black, plane to convex, **pruina** absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** orange, 0.15−0.4 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 20−25 µm thick; **algal layer** discontinuous, 25−35 µm thick; **medulla** upper layer orange, lower layer colorless, 90−110 µm thick; **lower cortex** prosoplectenchymatous, 15−18 µm thick, dark-brown. **Apothecia epihymenium** ca. 5 µm thick, grey; **hymenium** 60−65 µm thick, colorless; **subhymenium** 55−60 µm thick, yellow, yellow; **ascospores** *Dirinaria*-type, 13−16 × (4−)5−7 µm, 1-septate.
SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K+ black, C+ reddish, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.
TLC. Atranorin and terpenes.

REMARKS.

Pyxine pungens is characterized by an orange upper layer of the medulla (K+ black), presence of apothecia as reproductive structure, orange internal stipe (K−), apothecia of the *cocoës*-type, and atranorin and terpenes as chemical compounds.

This taxon gives the name to the "*Pyxine pungens* complex", because it was the first species described in this group. Jungbluth & Marcelli (2011) revised the type collection of this species and segregated several taxa. For comparisons with *P. astipitata* and *P. mantiqueirensis* see their respective descriptions; *P. rhodesiaca* is easily differentiated by the reticulate to subreticulate maculae. *Pyxine exoalbida* and *P. schechingeri* are in the "*Pyxine pungens* complex", but differ by the presence of norstictic acid, in the medulla in *P. exoalbida* and in the epihymenium in *P. schechingeri*.

Pyxine pungens is abundant in Mato Grosso do Sul State and demonstrates a preference for ramulicolous habitats.

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BOLIVIA (Flakus *et al.*: 2016); BRAZIL, Mato Grosso do Sul (Torres 2018: 200), São Paulo State (Jungbluth & Marcelli 2011: 175).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Parque Estadual das Nascentes do Rio Taquari, on tree branch, 790 m elev., 18°13'51.9"S, 53°18'29.4"W, 19 November 2015, *M.L.Z. Colado et al. 215* (CGMS 56224); *ibid.,* 22 October 2017, *M.J. Kitaura. 4286* (CGMS); *ibid.,* Parque Natural da Serra do Bom Jardim, Fazenda Harmonia, Trilha do Pôr do Sol, on tree branch, 639 m elev., 18°06'58.08"S, 53°41'58.08"W, 16 October 2017, *L.K. Reis et al. 22* (CGMS 64824); Aquidauana municipality, Camisão District, Morraria Paxixi, on tree branch, 507 m elev., 20º26'24.00"S, 55º37'25.09"W, 27 November 2014, *B.H.S. Ferreira et*

al. 64 (CGMS 47452); *ibid., K.C.R. Arruda et al. 46* (CGMS 47512); *ibid., K.C.R. Arruda et al. 65* (CGMS 47531); *ibid., T.F.C. Viana et al. 46* (CGMS 47574); *ibid.,* 600 m elev., 20º25’37.09”S, 55º36’39.05”W, 5 December 2015, *T.D. Barbosa 866* (CGMS 60376); *ibid.,* Piraputanga District, Acampamento Batista, on tree branch 188 m elev., 20º27’27.4”S, 55º29’12.0”W, 26 November 2014, *A.A. Spielmann et al. 11169* (CGMS 54293); *ibid., A.A. Spielmann et al. 11448* (CGMS 54329); *ibid., S.R. Ramalho et al. 37* (CGMS 47803); *ibid., S.R. Ramalho et al. 39* (CGMS 47805); *ibid., S.R. Ramalho 46* (CGMS 47812) *pr. p.*; Bonito municipality, Fazenda América, Retiro do Ruivo, on tree branch, 414 m elev., 21º10’12.90”S, 56º35’59.40”W, 23 May 2010, *V.J. Pott et al. 11327* (CGMS 48483); Corumbá municipality, RPPN Acurizal, close to headquarters ECOTROPICA, on tree branch, 140 m elev., 17º52’38.20”S, 57º33’12.00”W, 27 November 2010, *T.S. Amaral 146* (CGMS 30407); Porto Murtinho municipality, road to Morro Pão de Açúcar, on fence pole, 89 m elev., 21º29'09.80"S, 57º55'46.10"W, 13 June 2017, *T.D. Barbosa et al. 1569* (CGMS); *ibid., T.D. Barbosa et al. 1571* (CGMS); *ibid.,* Cachoeira do Apa, on tree, 90 m elev., 22°10'05.90"S, 57°31'13.40"W, 14 June 2017, *T.D. Barbosa et al. 1617* (CGMS).

Pyxine pustulata Aptroot & Jungbluth (2014: 3). (Figures 35E-F, 36A-D, 42A-B array 10, 43A array 10)

Holotype:—BRAZIL. São Paulo State, Botucatu municipality, Botanical Garden on campus, on bark of tree in park 850 m elev., 22°53'09"S; 48°29'56"W, 13 September 2012, *M. Cáceres & A. Aptroot 13638* (SP, isotype: ABL).

MORPHOLOGY. **Thallus** corticicolous; 2.5 cm diam. **Upper surface** proximal region whitish-grey, smooth to rugose, fissures originated from maculae present laminal, linear, **pruina** absent; distal region whitish-grey, smooth, fissures originated from maculae absent, **pruina** scarce without board to scarce with board; apical to subapical. **Maculae** in the proximal region scarce, discrete, laminal, punctiform, plane; in the distal region scarce, discrete, submarginal to laminal, linear to punctiform, plane. **Laciniae** overlapping, not branched to irregularly branched, 0.6−1.6 mm width; apices not flabellate, rounded, plane to concave; margin not ascendent, smooth, black line absent. **Medulla** upper layer white to ochraceous; lower layer white to ochraceous, **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth to papillate, black, dull, naked margin absent. **Rhizinae** abundant, not branched, black, laminal to marginal. **Isidia**, **Pustules** frequent to abundant, laminal to submarginal, irregular; **soredia** green, granulose. **Lacinulae** marginal, concolor to thallus, not branched, 0.5 × 0.5 mm, rounded apices. **Polysidiangia** and **Soralia** absent. **Apothecia** *cocoës*-type, 0.4 mm diam., laminal, subimmersed;

disc black, plane, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** ochraceous, 0.02 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 15−20 µm thick; **algal layer** discontinuous, 20−30 µm thick; **medulla** upper layer colorless, lower layer colorless, 75 µm thick; **lower cortex** prosoplectenchymatous, 20−25 µm thick, dark-brown. **Apothecia epihymenium** 10 µm thick, grey; **hymenium** ca. 70 µm thick, colorless; **subhymenium** ca. 90 µm thick, light-brown, colorless; **ascospores** *Dirinaria*-type, 12−15 × 5−7 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine pustulata is characterized by a white or partly ochraceous (upper layer) medulla (K−), presence of pustules, ochraceous internal stipe (K−), apothecia of the *cocoës*-type, and lichexanthone and terpenes as chemical compounds.

Pyxine cocoës is similar but has marginal soralia. According to Aptroot *et al.* (2014) this taxon is the only species with pustules in *Pyxine.*

Aptroot *et al.* (2014) described *P. pustulata* but did not see apothecia in the type material. This is the first report of apothecia of this species, and they turn out to be of the *cocoës*-type. *Pyxine pustulata* is cited here for the first time from Mato Grosso do Sul State and also for the first time outside the type locality. The specimens examined here are from the *Chaco* region in Porto Murtinho municipality.

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, São Paulo State (Aptroot *et al.* 2014: 3).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Porto Murtinho municipality, Cachoeira do Apa, on tree, 90 m elev., 22°10'05.90"S; 57°31'13.40"W, 14 June 2017, *T.D. Barbosa et al. 1639* (CGMS); *ibid., T.D. Barbosa et al. 1647* (CGMS).

Pyxine rhodesiaca Vain. ex Lynge (1937: 90). (Figures 36E-F, 37A-C, 40B array 11, 41A-B array 11)

Holotype:—RHODESIA. Salisbury: on *Ficus*, *F. Eyles 3953* (TUR-Vainio 34628).

MORPHOLOGY. **Thallus** corticicolous; 4.0−6.5 cm diam. **Upper surface** proximal region whitish-grey to greenish-grey, rugose, fissures originated from maculae absent, **pruina** frequent to abundant without board; distal region whitish-grey to greenish-grey, foveolate, fissures originated from maculae absent, **pruina** frequent without board; irregular. **Maculae** in the proximal region abundant, evident, laminal to submarginal, reticulate to subreticulate, high; in the distal region abundant, evident, laminal to submarginal, reticulate, high. **Laciniae** contiguous to overlapping, irregularly branched, 0.5−1.5 mm width; apices not flabellate, subtruncate to rounded, convex to rarely concave; margin ascendent, smooth to crenate, black line conspicuous. **Medulla** upper layer orange; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black to dark-brown, dull; distal region smooth to papillate, olivaceous, dull, naked margin 0.3 mm length. **Rhizinae** abundant, not branched to furcate branched, black to olivaceous, laminal to marginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *cocoës*-type, 0.4−1.5 mm diam., laminal, sessile of constrict base; **disc** black, plane to convex, **pruina** absent; **margin** smooth; **amphithecium** smooth, ornament absent; **internal stipe** white, 0.12 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 15−20 µm thick; **algal layer** discontinuous, 20−25 µm thick; **medulla** upper layer yellow, lower layer colorless, 70−90(−110) µm thick; **lower cortex** prosoplectenchymatous, 10−12 µm thick, dark-brown. **Apothecia epihymenium** 10−12 µm thick, grey; **hymenium** 70 µm thick, colorless; **subhymenium** 100 µm thick, brown, colorless; **ascospores** *Dirinaria*-type, 15−20 × 5−7 µm, 1-septate.

SPOT TESTS. **Upper cortex** K+ yellow, C−, KC−, UV−; **medulla upper layer** K+ black, C+ reddish, KC−, P+ reddish, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Atranorin and terpenes.

REMARKS.

Pyxine rhodesiaca is characterized by an orange upper layer of the medulla (K+ black), presence of apothecia as reproductive structures, white internal stipe (K−), apothecia of the *cocoës*-type, but the feature that facilitates the recognition of this species are the reticulate to subreticulate maculae. It has atranorin and terpenes as chemical compounds.

This species shows evident and abundant maculae with reticulate to subreticulate forms. This is the only species of the "*Pyxine pungens* complex" with this maculae type. For comparisons with similar taxa see remarks under *P. astipitata, P. mantiqueirensis* and *P. pungens.*

Another species with evidently reticulate maculae and without vegetative propagules is *P. parapetricola,* but this taxon has a white medulla and presence of lichexanthone and terpenes. For more information about *Pyxine rhodesiaca* consult Jungbluth & Marcelli (2011) and Kalb (1987).

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Distrito Federal (Jungbluth & Marcelli 2011: 176), São Paulo State (Jungbluth & Marcelli 2011: 176).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Alcinópolis municipality, Monumento Natural Serra do Bom Jardim, Trilha da Gruta, on tree, 604 m elev., 18°06'48.3"S, 53°40'00.9"W, 18 October 2017, *T.D. Barbosa & A.A. Spielmann 1874* (CGMS); *ibid., K.C.B.S. Santos 28* (CGMS); Aparecida do Taboado, road BR-158, on tree, 440 m elev., 19°52'40.10"S, 51°07'54.80"W, 18 March 2012, *A.A. Spielmann et al. 10349* (CGMS 42357); Aquidauana municipality, Camisão District, Morraria Paxixi, on tree, 600 m elev., 20°25'37.09"S, 55°36'39.05"W, 5 December 2015, *T.D. Barbosa 926* (CGMS 60378); *ibid., C.M. Bernardo 958* (CGMS 60377); Costa Rica municipality, Parque Estadual das Nascentes do Rio Taquari, on tree, 780 m elev., 18°14'03.3"S, 53°18'25.5"W, 24 October 2017, *A.S. Rodrigues 424* (CGMS).

Pyxine simulans Kalb (1987: 72). (Figures 37D-F, 38A, 42A-B array 11, 43A array 11)

Holotype:—BRAZIL. Mato Grosso do Sul State: ca. 50 km SW of Campo Grande municipality, on a deciduous tree in a humid gallery forest, corticicolous, 21°00’ S, 54°40’ W, 500 m elev., 16 November 1979, *K. Kalb* & *G. Plöbst 12241* (Herb. Kalb).

MORPHOLOGY. **Thallus** corticicolous; 6−10 cm diam. **Upper surface** proximal region greenish-grey, rugose to verrucose, fissures originated from maculae laminal, linear, **pruina** absent; distal region greenish-grey, foveolate, fissures originated from maculae present laminal, linear, **pruina** frequent without board; apical to subapical. **Maculae** in the proximal region abundant, evident, laminal to submarginal, subreticulate, high; in the distal region abundant, evident, laminal to submarginal, reticulate to subreticulate, high. **Laciniae** contiguous to overlapping, irregularly branched, 0.6−1.5 mm width; apices not flabellate, rounded, concave; margin not ascendent, crenate, black line absent. **Medulla** upper layer yellow; lower layer white; **pigment** absent. **Lower surface** proximal region smooth to rugose, black, dull; distal region smooth to rugose, black, dull, naked margin absent. **Rhizinae** abundant, not branched to irregularly branched, black, laminal to submarginal. **Isidia**, **Polysidiangia**, **Pustules**, **Soralia** and **Lacinulae** absent. **Apothecia** *physciaeformis*-type, 0.5−2.5 mm diam., laminal, sessile of constrict base; **disc** black, plane to

convex, **pruina** white or rarely absent; **margin** smooth to crenate; **amphithecium** smooth, ornament absent; **internal stipe** white to yellow, 0.15−0.2 mm thick.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2−3 cells layer, 15−20 µm thick; **algal layer** discontinuous, 30−40 µm thick; **medulla** upper layer colorless, lower layer colorless, 90−100 µm thick; **lower cortex** prosoplectenchymatous, 10−12 µm thick, dark-brown. **Apothecia epihymenium** 10−12 µm thick, grey; **hymenium** 60−75 µm thick, colorless; **subhymenium** 60−80 µm thick, light-brown, colorless; **ascospores** *Dirinaria*-type, 17−23 × 6−8 µm, 1-septate.

SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−; **internal stipe** K−, C−; **apothecial disc** UV−.

TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine simulans is characterized by a yellow upper layer of the medulla (K−), presence of apothecia as reproductive structures, white to yellow internal stipe (K−), apothecia of the *physciaeformis*-type, and lichexanthone and terpenes as chemical compounds.

For comparisons with closely related taxa see the comments under *P. nana*. *Pyxine simulans* was described from Campo Grande municipality in Mato Grosso do Sul State and is until this moment only known from Campo Grande surroundings and Porto Murtinho municipality (Brazilian *Chaco* region).

NO DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Campo Grande municipality, Rua Abrão Julio Rahe close to praça da Bolívia, on tree, 620 m elev., 20°26'57.90"S, 54°35'14.40"W, 24 October 2011, *A.A. Spielmann & N.K. Honda 9582* (CGMS 42327); *ibid., A.A. Spielmann & N.K. Honda 9760* (CGMS 42377); *ibid., A.A. Spielmann & N.K. Honda 9769* (CGMS 42350); *ibid., A.A. Spielmann & N.K. Honda 9770* (CGMS 42370); *ibid.,* Campus UFMS, on tree, 528 m elev., 20°30'2.12"S, 54°36'48.77"W, 4 May 2014, *T.D. Barbosa 119* (CGMS); Jaraguari municipality, Furnas do Dionísio, on tree, 425 m elev., 20°08'54.10"S, 54°34'15.10"W, 22 November 2011, *R. Lücking 35021* (CGMS 34728); *ibid., R. Lücking 35073* (CGMS 34780); *ibid.,* 357 m elev., 20° 8'55.87"S, 54°34'13.92"W, 26 September 2017, *T.D. Barbosa 1715* (CGMS); Porto Murtinho municipality, Cachoeira do Apa, on tree, 90 m elev., 22°10'05.90"S; 57°31'13.40"W, 14 June 2017, *T.D. Barbosa et al. 1634* (CGMS); *ibid., T.D. Barbosa 1640* (CGMS); Sidrolândia municipality, on tree, 441 m elev., 20°55'15.36"S, 54°58'53.48"W, 26 November 2017, *T.D. Barbosa 1911* (CGMS).

Pyxine subcinerea Stirt. (1897: 397). (Figures 38C−F, 42A-B array 12, 43A array 12)
Holotype:—AUSTRALIA. Queensland: [locality unknown], *F. M. Bailey 22*; (BM).

MORPHOLOGY. **Thallus** corticicolous; 3−4.5 cm diam. **Upper surface** proximal region yellowish-grey, smooth, fissures originated from maculae absent, **pruina** abundant with board to rarely absent; distal region whitish-grey, smooth, fissures originated from maculae absent, **pruina** frequent to abundant with board; laciniae center. **Maculae** in the proximal region absent; in the distal region scarce, discrete, submarginal, linear, plane. **Laciniae** contiguous to rarely overlapping, dichotomously branched, 0.5−1.2 mm width; apices slightly flabellate, rounded to retuse, plane; margin not ascendent, smooth to crenate, black line absent. **Medulla** upper layer yellow; lower layer white; **pigment** absent. **Lower surface** proximal region smooth, black, dull; distal region smooth, olivaceous, dull, naked margin absent. **Rhizinae** abundant, not branched to furcate branched, black, laminal to submarginal. **Soralia** crateriform, frequent, marginal, crescent-shape to labriform; **soredia** whitish-green, granulose. **Isidia**, **Polysidiangia**, **Pustules** and **Lacinulae** absent. **Apothecia** absent.
ANATOMY. **Thallus upper cortex** paraplectenchymatous, 3−4 cells layer, 15−20 µm thick; **algal layer** discontinuous, 20−25 µm thick; **medulla** upper layer yellow, lower layer colorless, 60−70 µm thick; **lower cortex** prosoplectenchymatous, 10−12 µm thick, dark-brown.
SPOT TESTS. **Upper cortex** K−, C−, KC−, UV+ yellow; **medulla upper layer** K−, C−, KC−, P-, UV−; **lower layer** K−, C−, KC−, P-, UV−.
TLC. Lichexanthone and terpenes.

REMARKS.

Pyxine subcinerea is characterized by a yellow upper layer of the medulla (K−), presence of crateriform soralia, which are marginal and usually crescent-shape to labriform, and lichexanthone and terpenes as chemical compounds.

Pyxine cocoës is somewhat similar to *P. subcinerea* because of the lichexanthone and the marginal soralia, but *P. cocoës* has a cream to white medulla. Jungbluth (2010) comments on the differences between this taxon and others taxa that occur in Brazil but are not known in Mato Grosso do Sul state. *P. subcinerea* was cited from the state by Kalb (1987).

DISTRIBUTION RECORDS PUBLISHED AFTER JUNGBLUTH (2010): —BRAZIL, Mato Grosso do Sul (Torres 2018: 202); REPUBLIC OF KOREA (Kondratyuk *et al.* 2015: 135); THAILAND (Mongkolsuk *et al.* 2012: 52, Buaruang *et al.* 2017: 73).

Specimens examined:—BRAZIL. Mato Grosso do Sul State: Aparecida do Taboado, close to road BR-158, on tree, 440 m elev., 19°52'40.10"S, 51°07'54.80"W, 18 March 2012, *A.A. Spielmann et al. 10358* (CGMS 42374); Campo Grande municipality, Campus UFMS, RPPN Cerradinho, on tree, 540 m elev., 20°30'31.70"S, 54°36'51.70"W, 28 August 2010, *A.A. Spielmann et al. 8555* (CGMS 42384); *ibid.,* on tree, 14 April 2014, *T.D. Barbosa 781* (CGMS); Corumbá municipality, Morraria do Urucum, on tree, 730 m elev., 19°12'08.2"S, 57°36'04.6"W, 3 September 2010, *A.A. Spielmann et al. 8489* (CGMS 52185); *ibid., L.S. Canêz et al. 3296* (CGMS 32292); Terenos municipality, Fazenda Modelo da EMBRAPA, on tree, 512 m elev., 20°33'41.10"S, 54°47'23.20"W, 22 September 2010, *L.S. Canêz et al. 3412* (CGMS 31735).

Acknowledgements

Dr. Marcos Junji Kitaura is acknowledged for assistance in anatomical analyses and the structuring of the description protocols. We thank CNPq/Protax for the scholarship to the first author.

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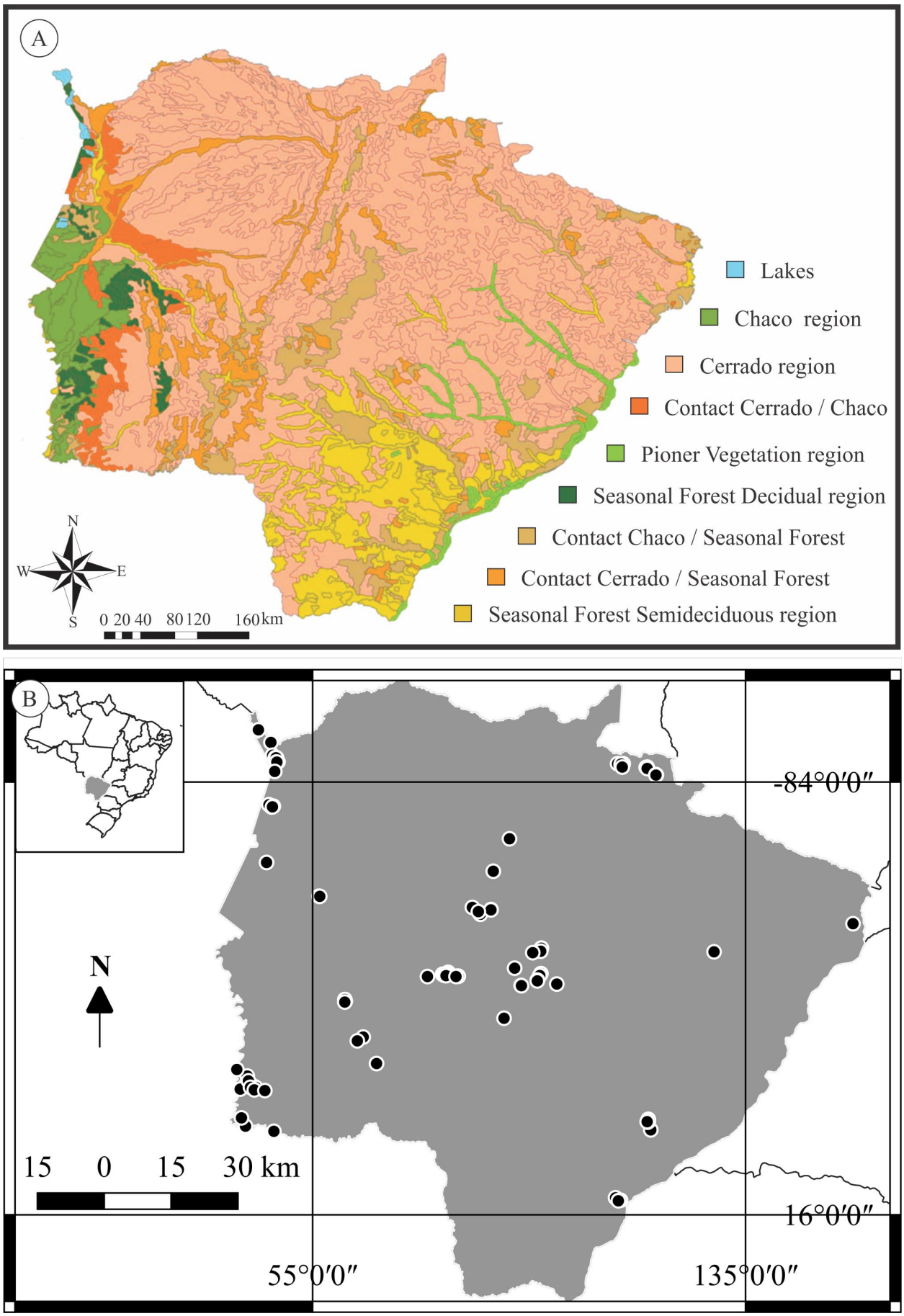


FIGURE 1. A. Vegetational mosaic of Mato Grosso do Sul State. Modified from SEMAC/SUPLAN/CPPPPM (2010). B. Mato Grosso do Sul State map with black balls representing the collected points.

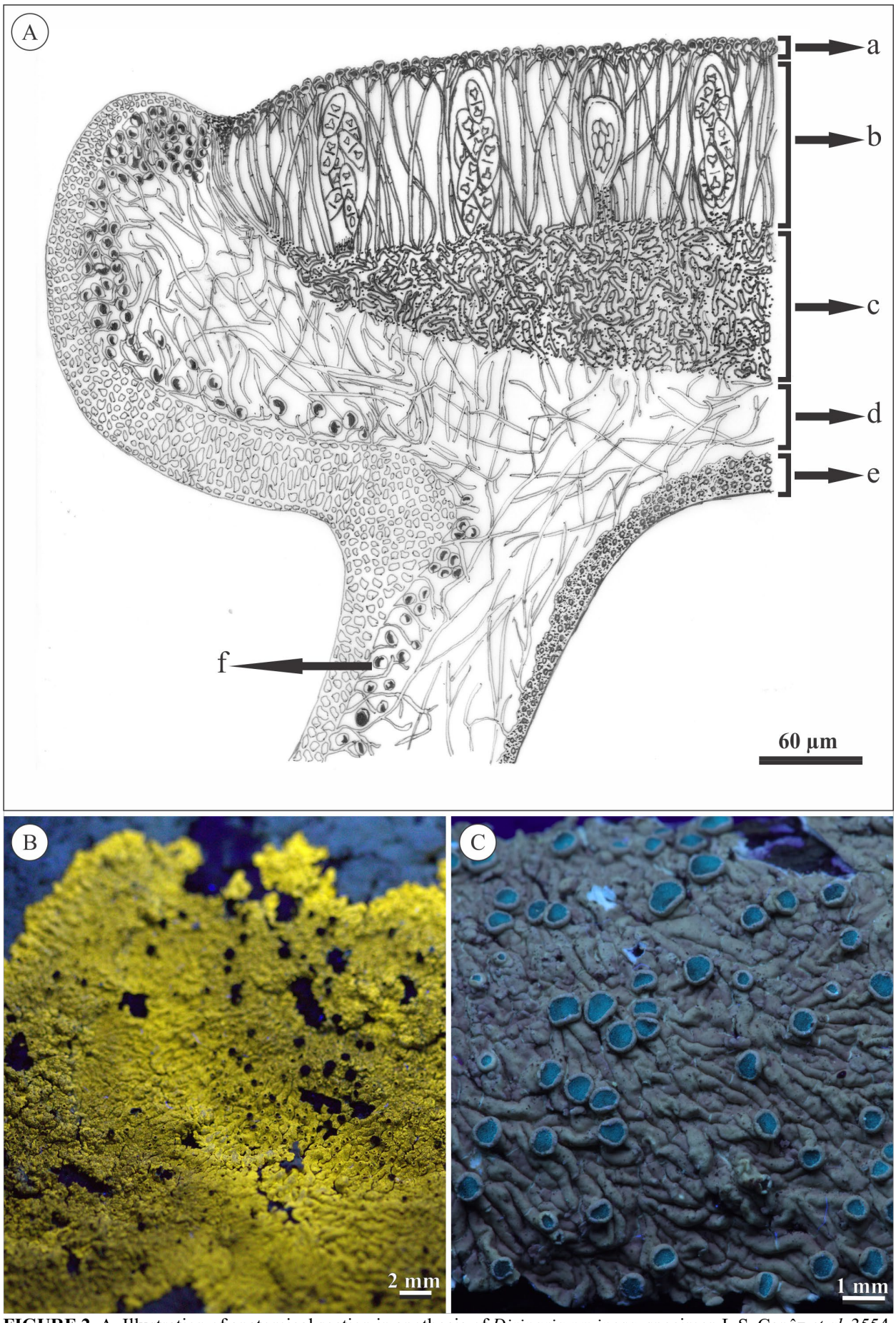


FIGURE 2. A. Illustration of anatomical section in apothecia of *Dirinaria pruinosa,* specimen L.S. Canêz *et al.* 3554. a- epihymenium, b- hymenium, C− subhymenium, d- medulla, e- lower cortex and f- algal layer. B. UV+ yellow in upper cortex of *Pyxine* indicates the lichexanthone presence. C. UV+ bluish-white in medulla in *Dirinaria* indicates the divaricatic or sekikaic acid and UV+ greenish-blue in pruina of apothecial disc.

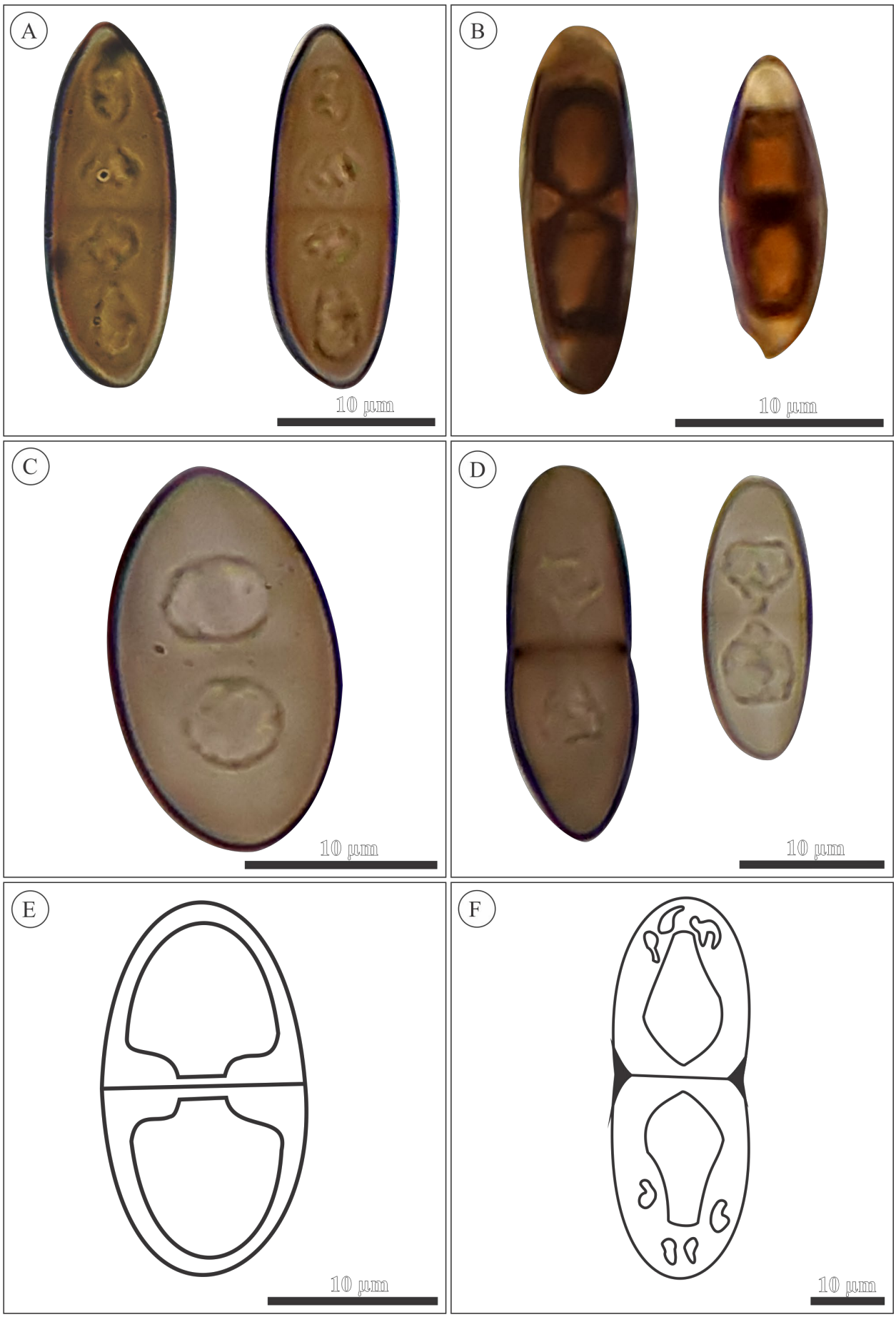


FIGURE 3. A. Ascospores *Conradia*-type of *Pyxine* in optical microscopy. B. Ascospores *Dirinaria*-type of *Dirinaria* in optical microscopy. C. Ascospores *Pachysporaria*-type of *Physcia* in optical microscopy. D. Ascospores *Physcia*-type of *Physcia* in optical microscopy. E. Ascospores *Physconia*-type of *Physconia,* illustration by T.D. Barbosa. F. Ascospores *Polyblastidium*-type of *Polyblastidium,* illustration by T.D. Barbosa.

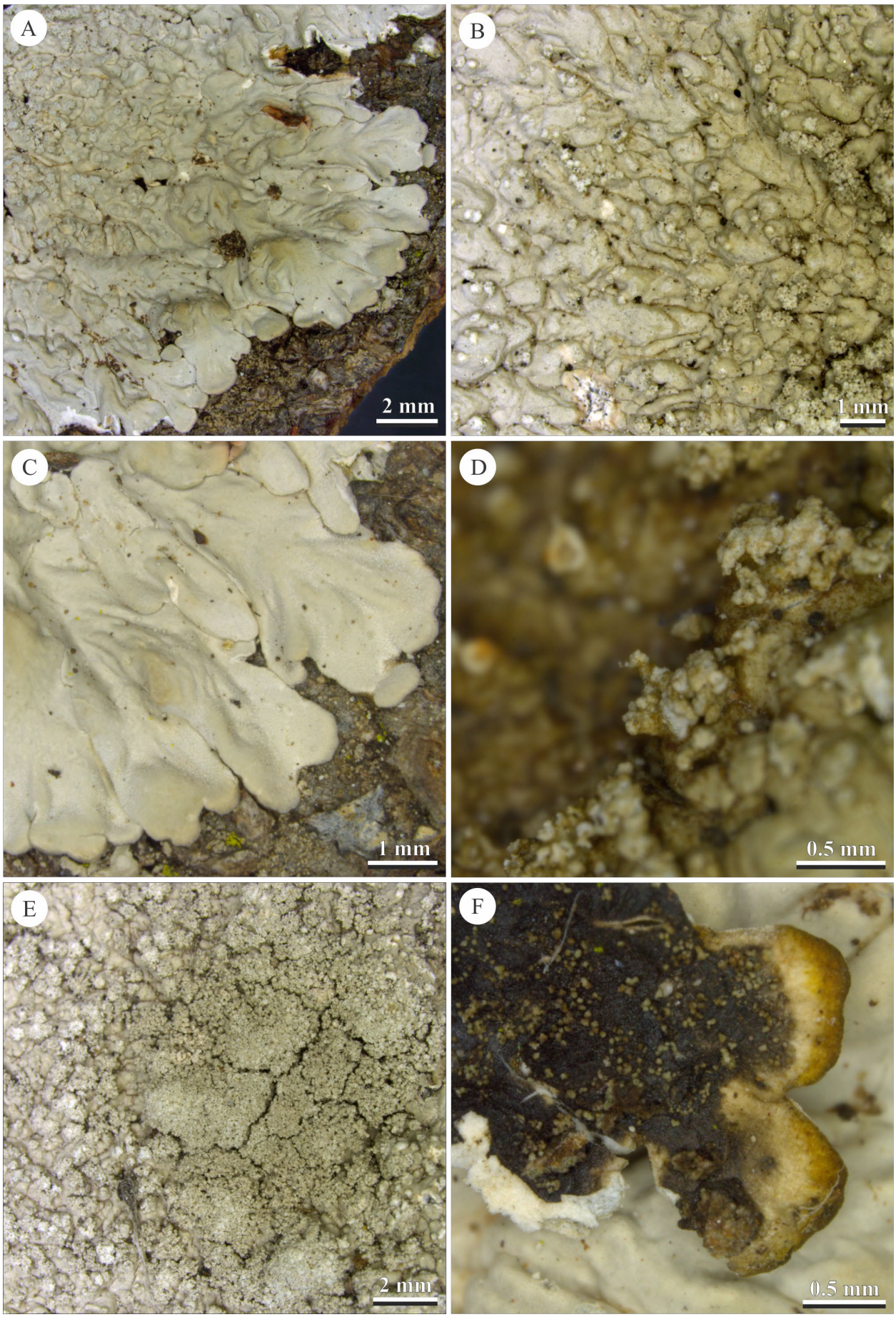


FIGURE 4. A. *Dirinaria aegialita*, thallus morphology (A.A. Spielmann 9680). B. Longitudinal plication (C.O. Dourado 77). C. Laciniae with slightly flabellate apices A.A. Spielmann 9680). D. Polysidiangia (L.S. Canêz 3636). E. Polysidiangia covering the thallus (C.O. Dourado 77). F. Marginal lower surface (A.A. Spielmann 9680).

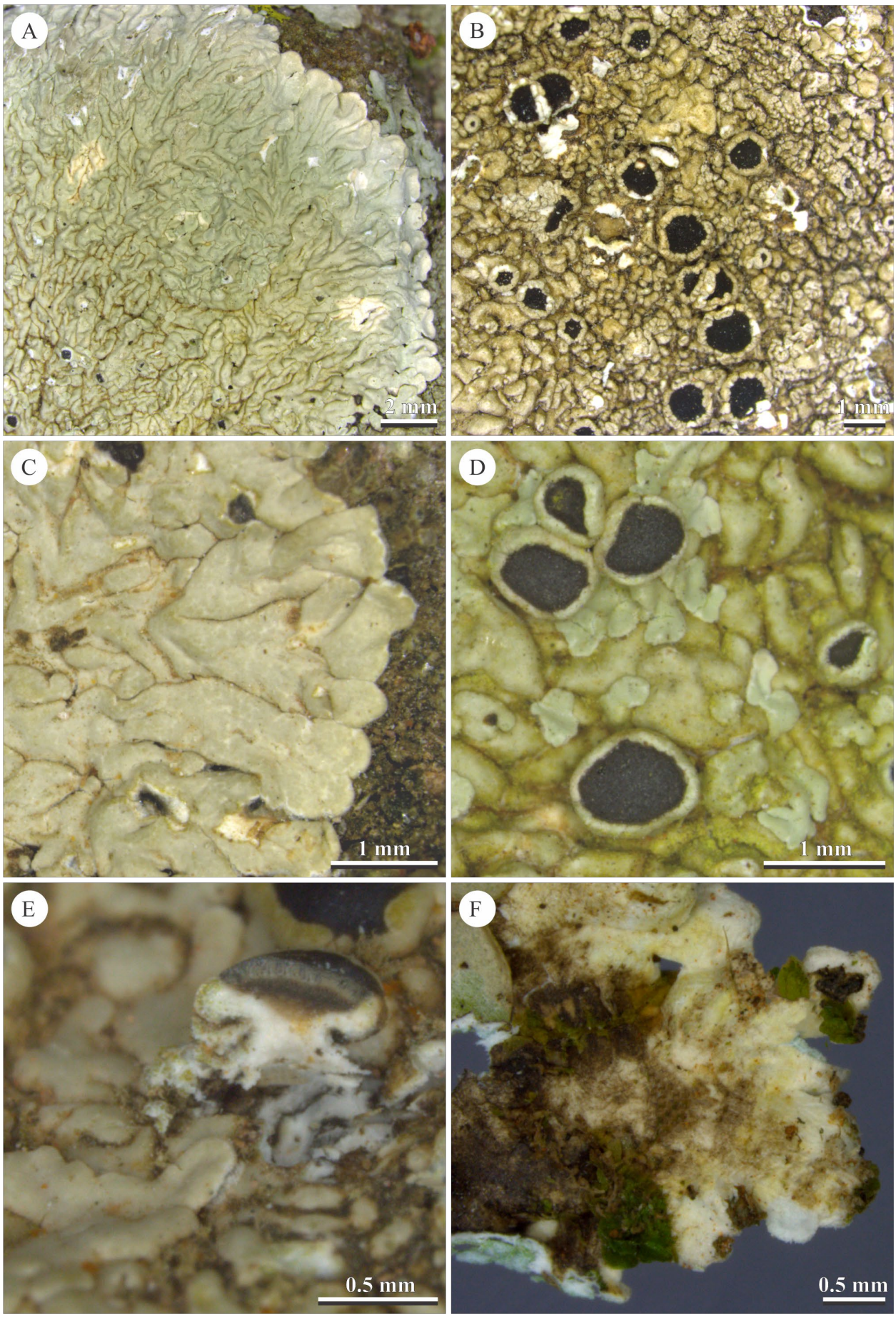


FIGURE 5. A. *Dirinaria africana*, thallus morphology (A.S. Rodrigues 353). B. Irregular plication and verrucose proximal upper surface (L.S. Canêz 3566b). C. Laciniae with slightly flabellate apices and linear maculae (A.S. Rodrigues 353). D. Apothecia with smooth margin (A.S. Rodrigues 353). E. Internal stipe with yellow spot (A.L. Simal 177). F. Marginal lower surface (A.S. Rodrigues 353).

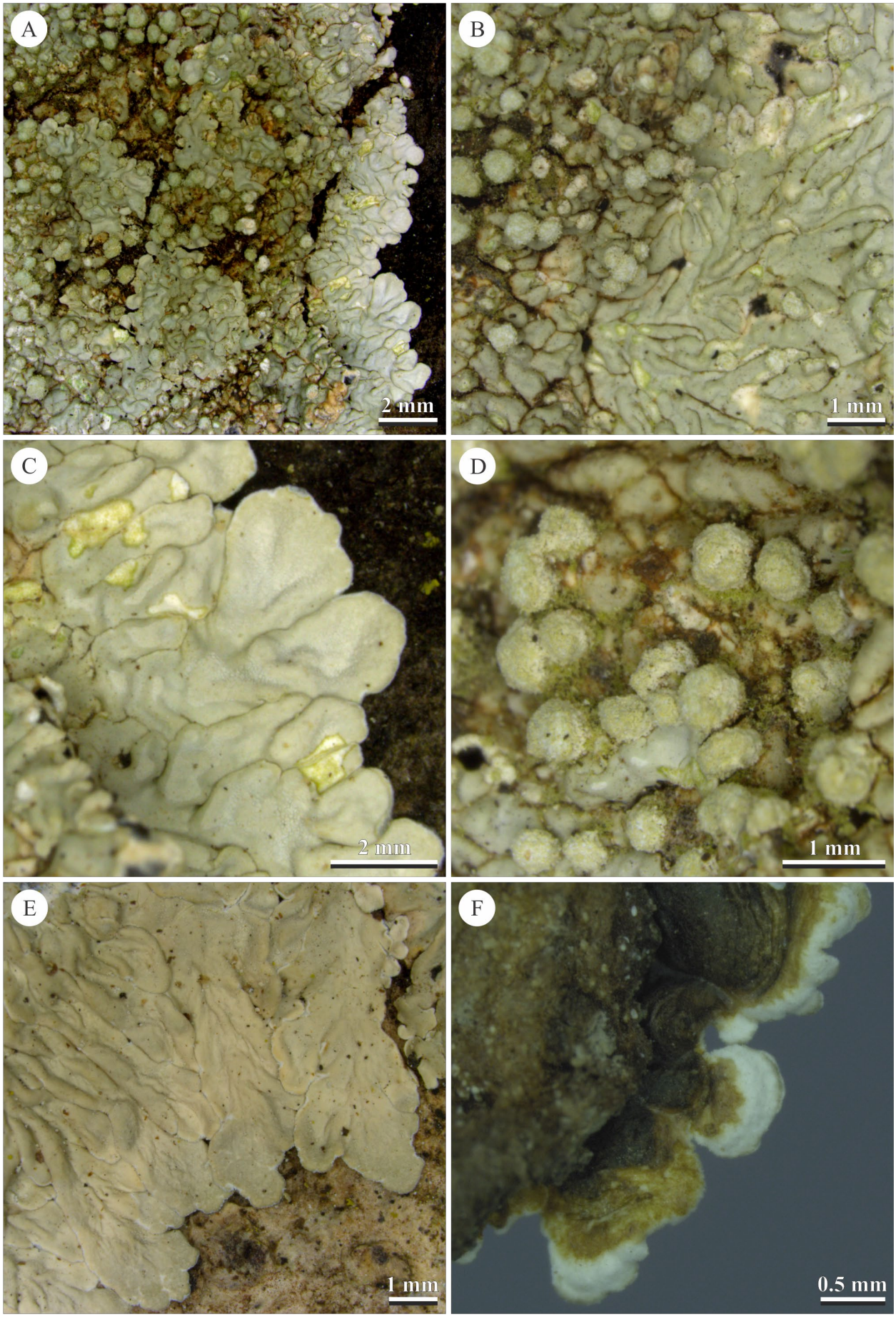


FIGURE 6. A. *Dirinaria applanata*, thallus morphology (T.D. Barbosa 1912). B. Longitudinal plication (T.D. Barbosa 1912). C. Laciniae with flabellate apices and pruina board (T.D. Barbosa 1912). D. Hemispherical to capitate soralia (T.D. Barbosa 1912). E. Laciniae subdichotomously branched and linear maculae (T.D. Barbosa 1715). F. Marginal lower surface (L.S. Canêz 3243).

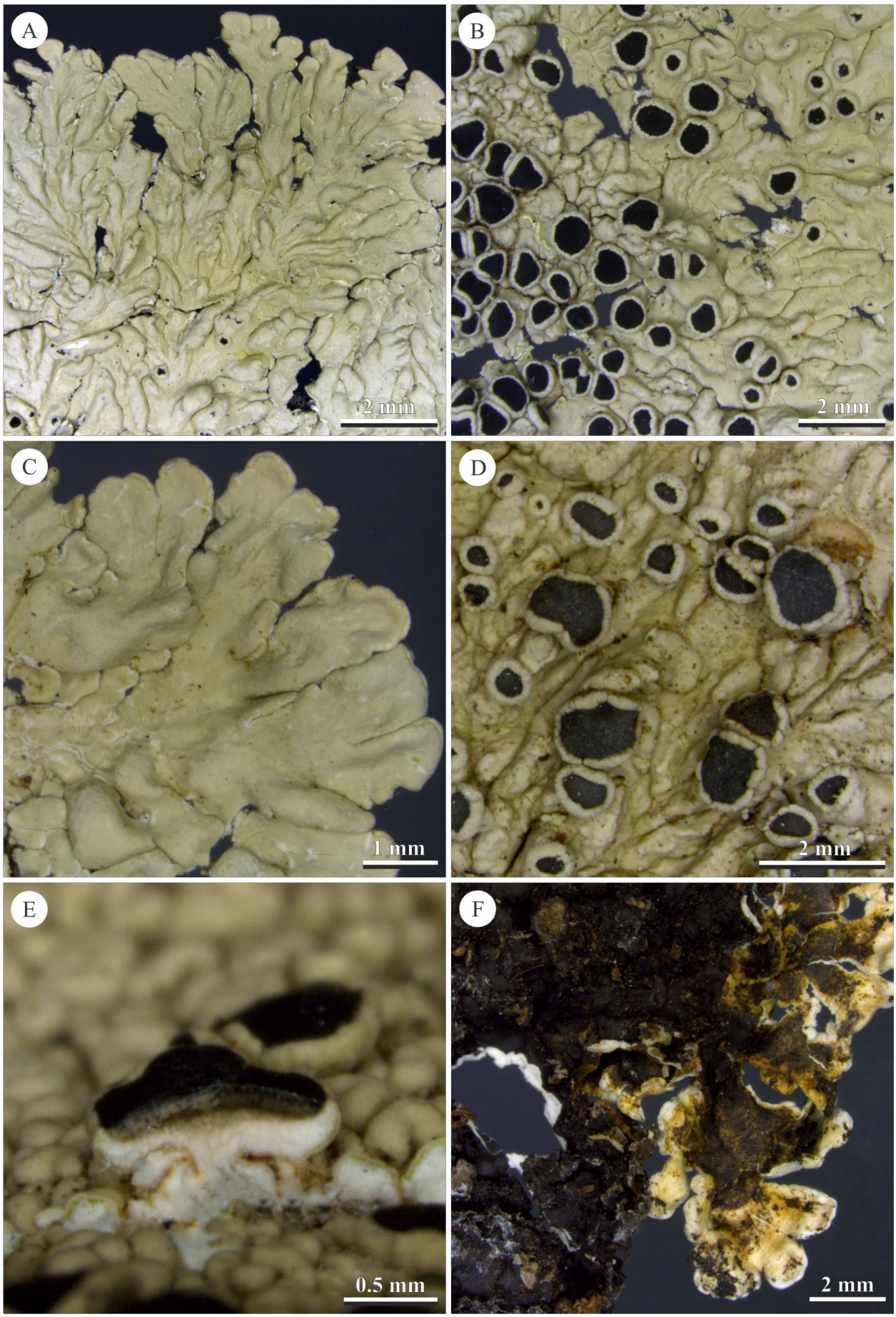


FIGURE 7. A. *Dirinaria confluens*, thallus morphology (L.S. Canêz 3169). B. Longitudinal plication, verrucose proximal upper surface and pruina board (L.S. Canêz 3169). C. Laciniae with flabellate apices and linear maculae (L.S. Canêz 3169). D. Apothecia with crenate margin (T.D. Barbosa 127). E. White internal stipe (L.S. Canêz 3169). F. Marginal lower surface (T.D. Barbosa 127).

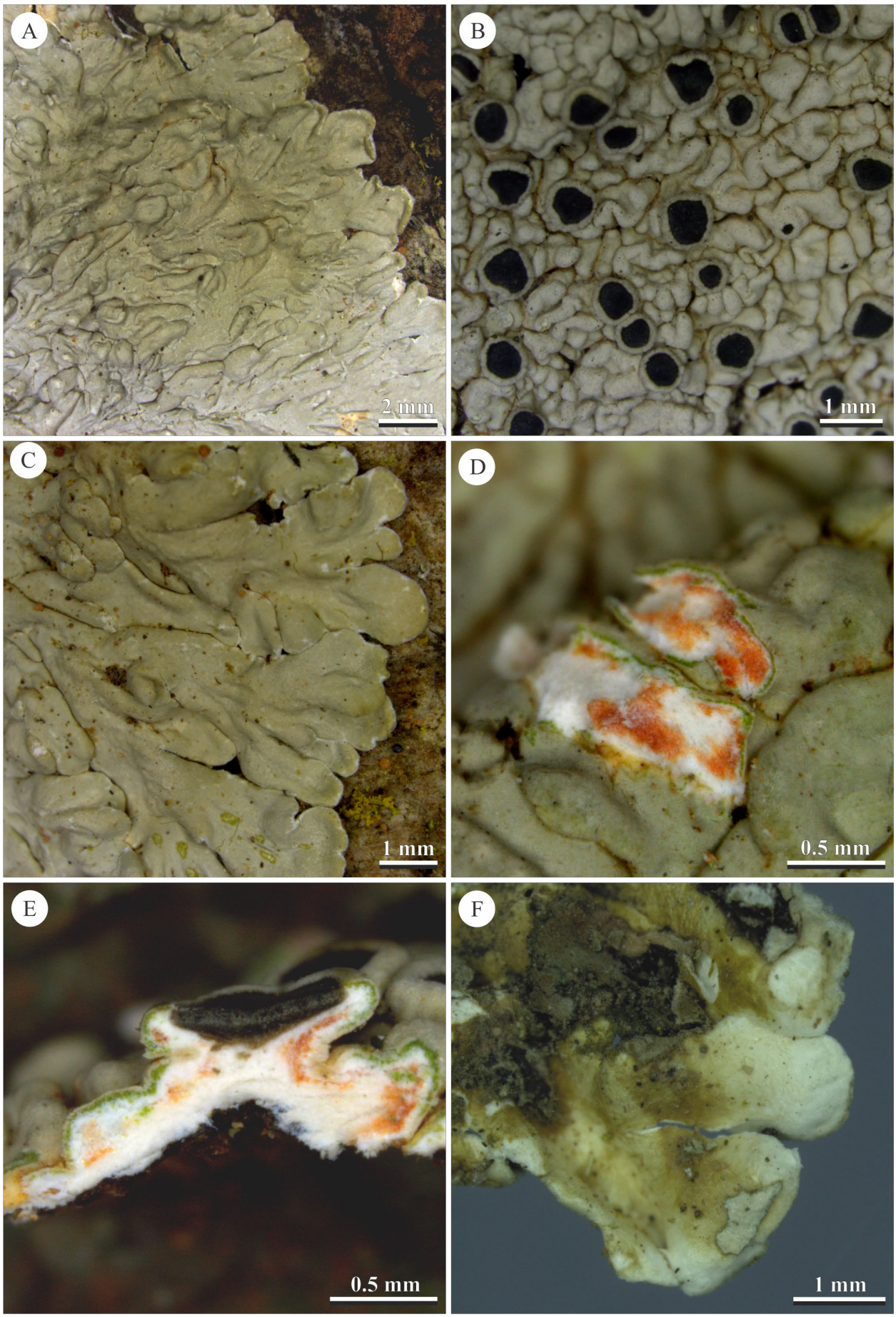


FIGURE 8. A. *Dirinaria confluens* var. *coccinea*, thallus morphology (J.M. Torres 546). B. Irregular plication, verrucose proximal upper surface and apothecia (T.D. Barbosa 1732). C. Laciniae with flabellate apices and linear maculae (J.M. Torres 546). D. Coccineous pigment in upper layer of medulla (M.J. Kitaura 4306). E. Coccineous pigment in internal stipe (M.J. Kitaura 4306). F. Marginal lower surface (J.-M. Torres 546).

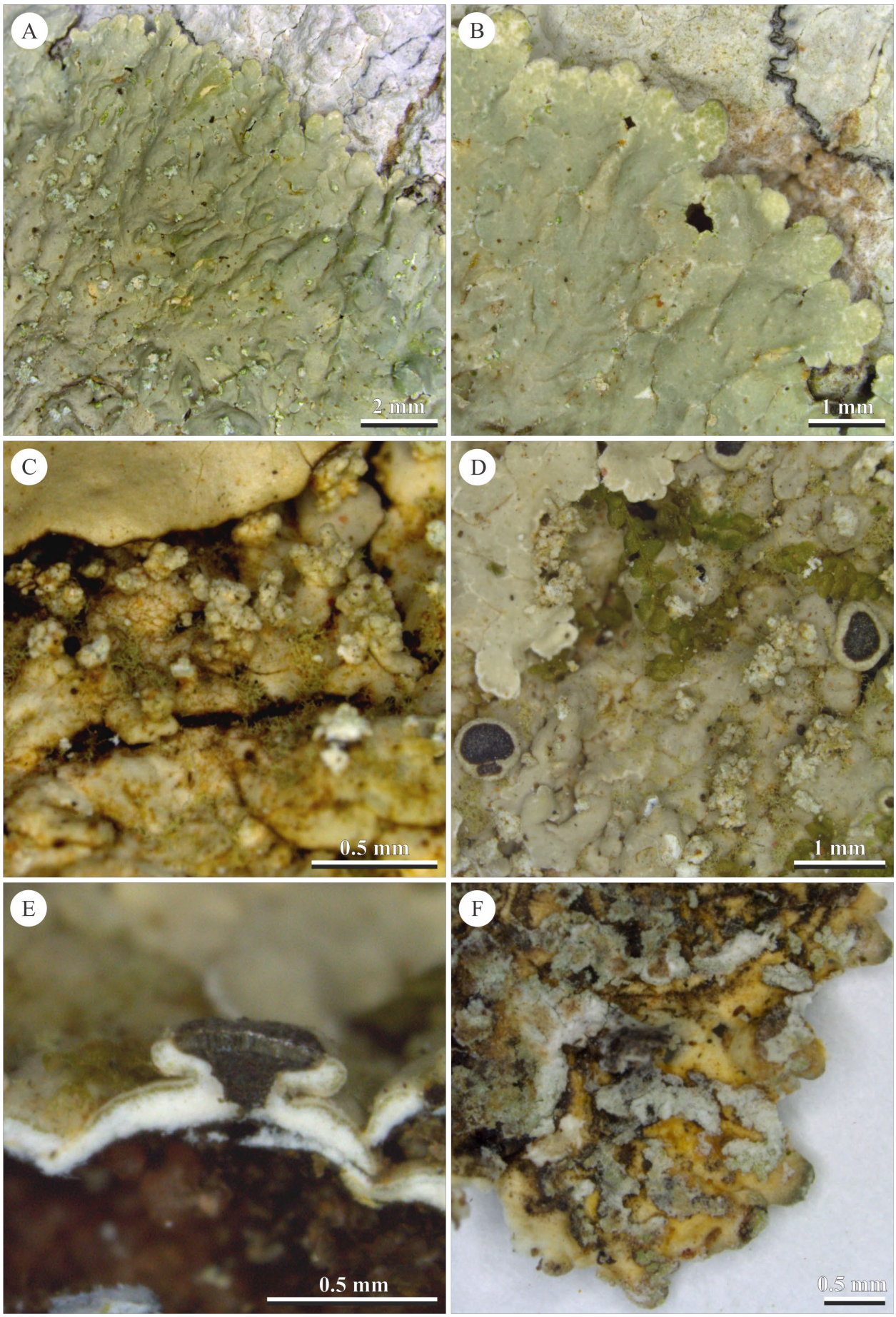


FIGURE 9. A. *Dirinaria consimilis*, thallus morphology (T.D. Barbosa 1902). B. Laciniae with slightly flabellate apices and linear to subreticulate maculae (T.D. Barbosa 1902). C. Polysidiangia (A.L. Simal 149). D. Apothecia with smooth margin (A.L. Simal 149). E. Reduced internal stipe, subhymenium develops in lower cortex direction (A.L. Simal 149). F. Marginal lower surface (T.D. Barbosa 1902).

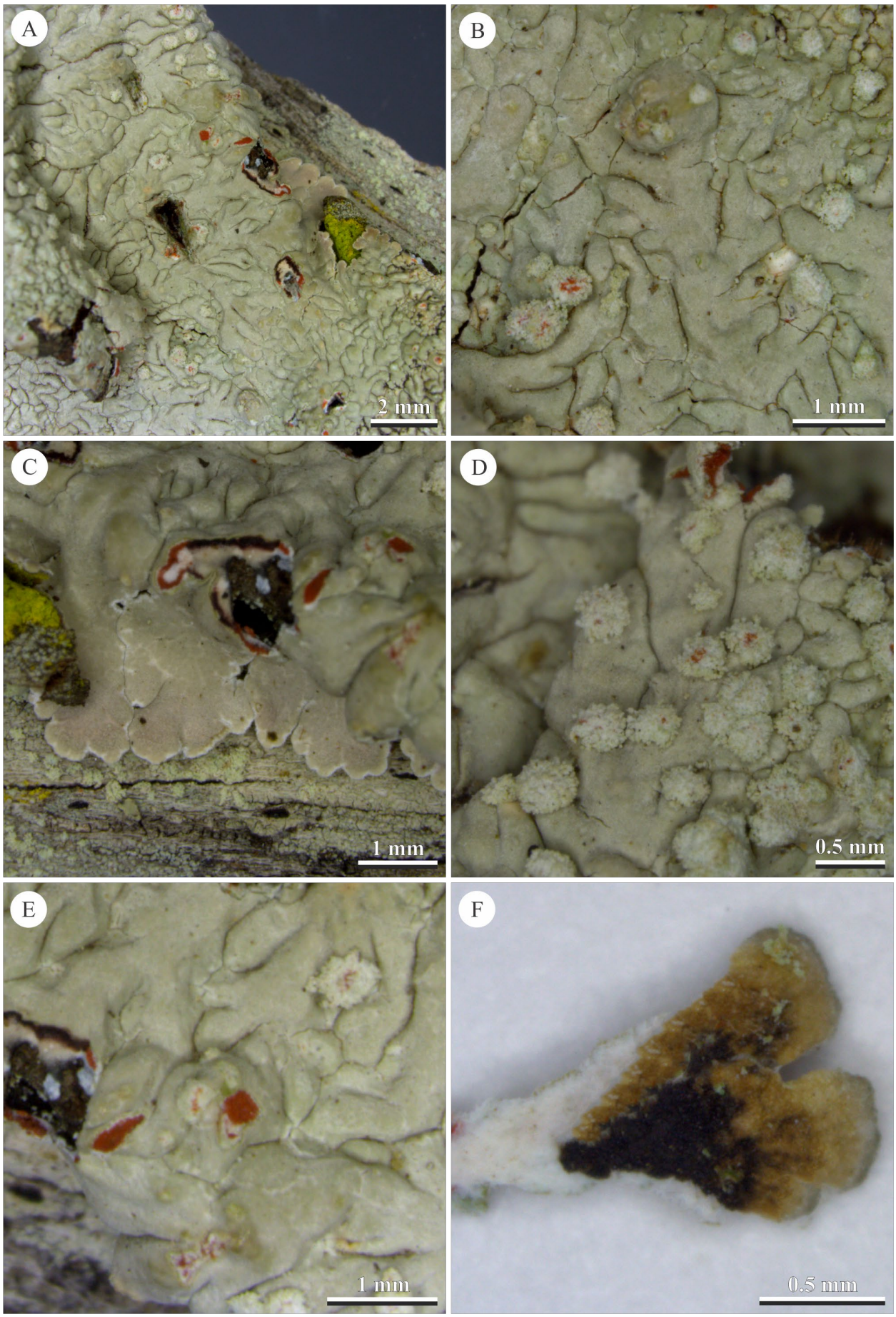


FIGURE 10. A. *Dirinaria leopoldii*, thallus morphology (T.D. Barbosa 1508). B. Irregular plication in proximal upper surface (T.D. Barbosa 1508). C. Laciniae with slightly flabellate, retuse apices and linear maculae (T.D. Barbosa 1508). D. Hemispherical soralia with coccineous pigment (T.D. Barbosa 1508). E. Coccineous pigment in upper layer of medulla (T.D. Barbosa 1508). F. Marginal lower surface (T.D. Barbosa 1508).

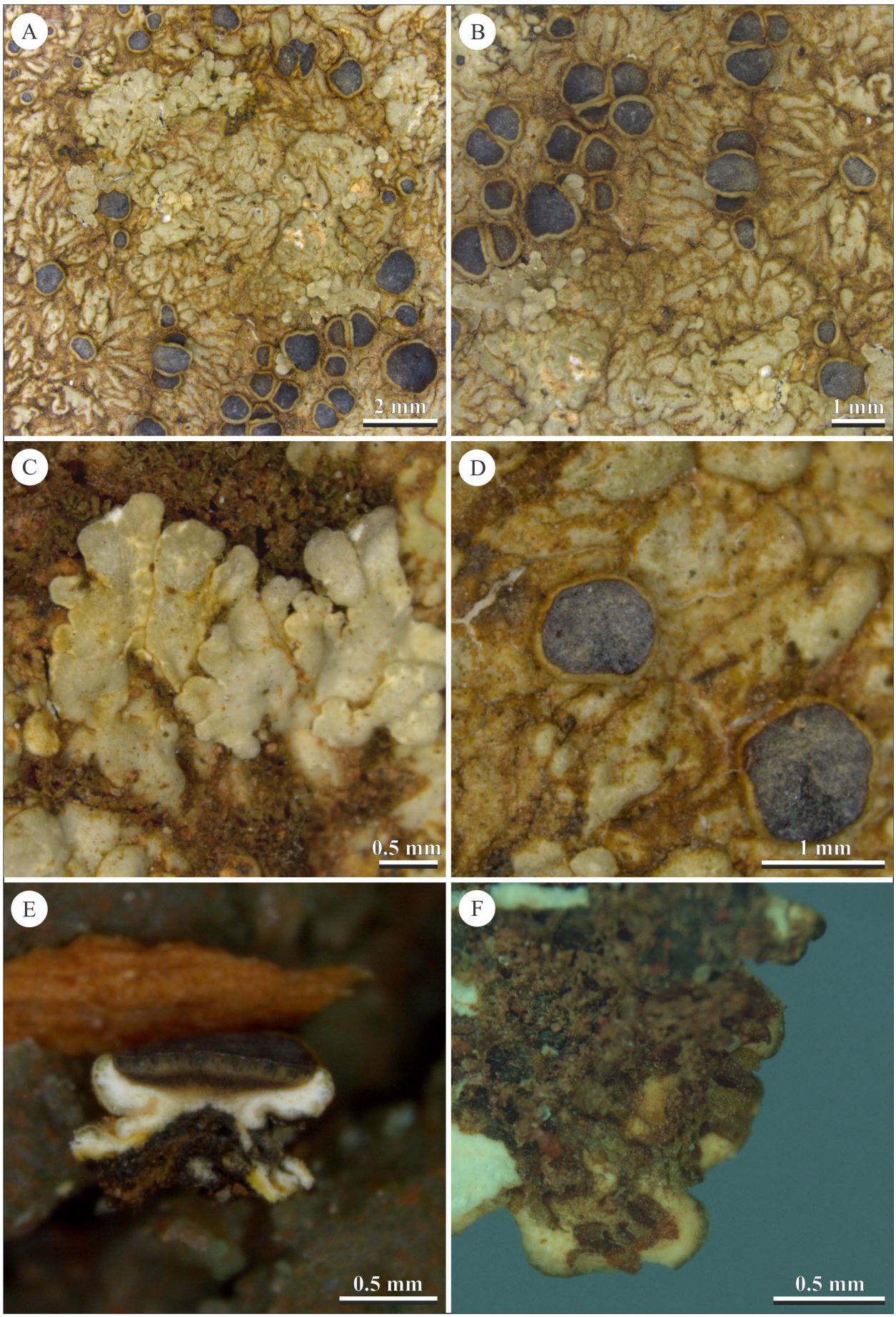


FIGURE 11. A. *Dirinaria maracajuensis*, thallus morphology (A.A. Spielmann 12247-holotype). B. Irregularly plicate upper surface (A.A. Spielmann 12247-holotype). C. Laciniae with not flabellate apices (A.A. Spielmann 12247-holotype). D. Apothecia with smooth margin and apothecial disc yellowish pruinose (A.A. Spielmann 12247-holotype). E. Internal stipe (A.A. Spielmann 12247-holotype). F. Marginal lower surface (A.A. Spielmann 12247-holotype).

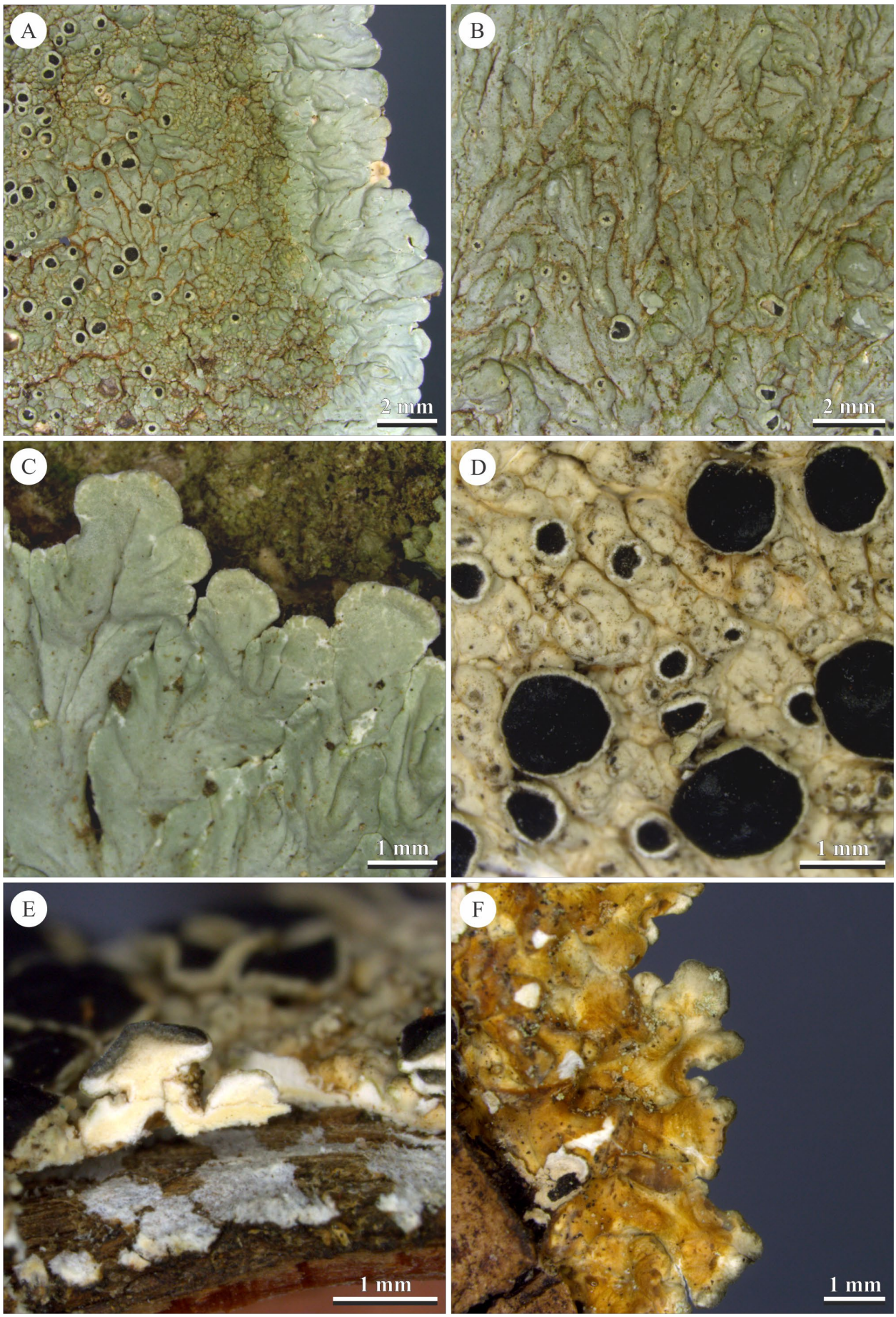


FIGURE 12. A. *Dirinaria melanocarpa*, thallus morphology (T.D. Barbosa 1898). B. Longitudinal plication in proximal upper surface (T.D. Barbosa 1898). C. Laciniae with flabellate apices and linear maculae (T.D. Barbosa 1898). D. Apothecia with smooth margin and white pruina (A.A. Spielmann 11982). E. Internal stipe with yellowish medulla (A.A. Spielmann 11982). F. Marginal lower surface (T.D. Barbosa 1785).

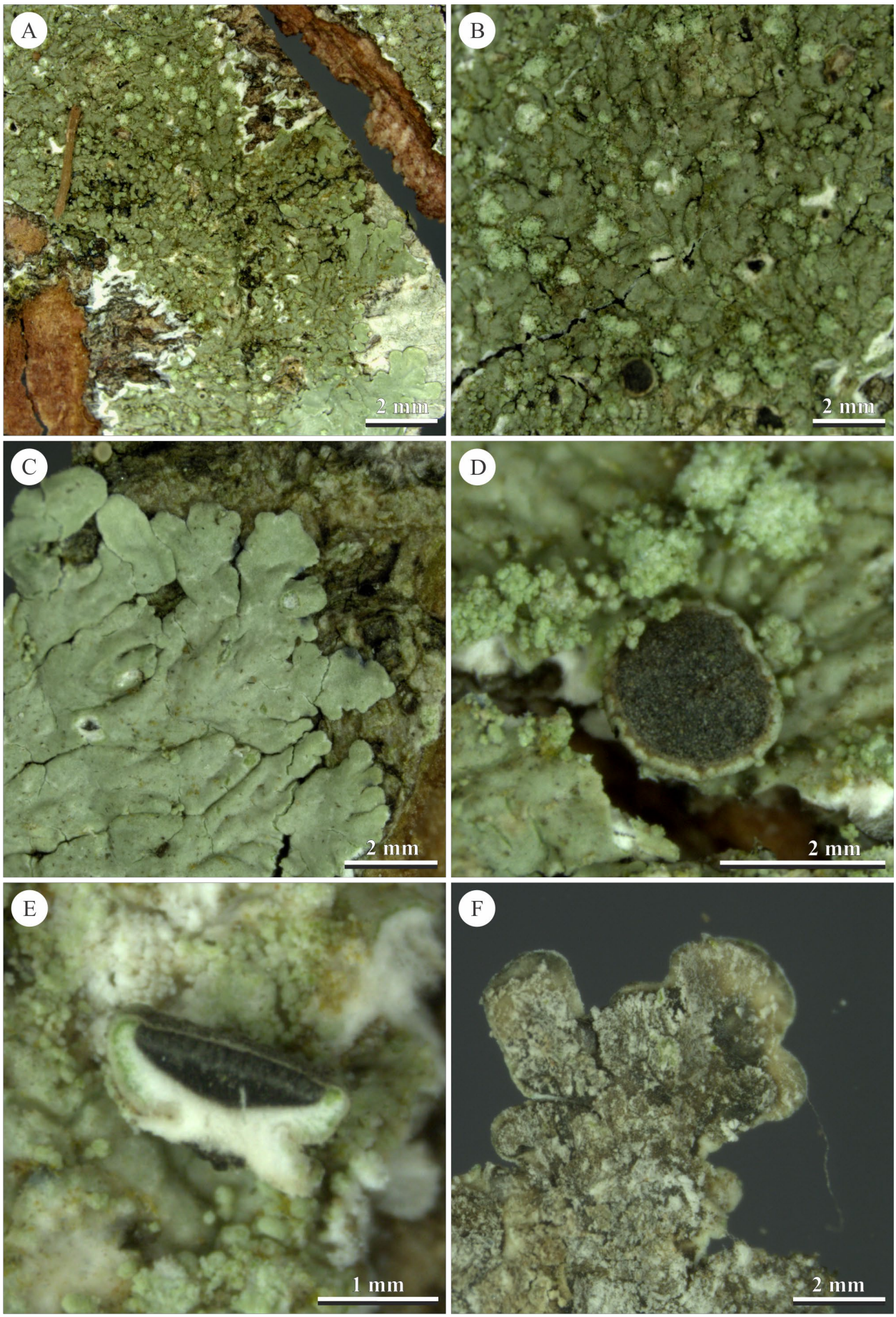


FIGURE 13. A. *Dirinaria melanoclina*, thallus morphology (A. Aptroot 78156). B. Not plicated (A. Aptroot 78156). C. Not flabellate laciniae (A. Aptroot 78156). D. Apothecial disc with brown pruina and hemispherical soralia (A. Aptroot 78156). E. White internal stipe (A. Aptroot 78156). F. Marginal lower surface (A. Aptroot 78156).

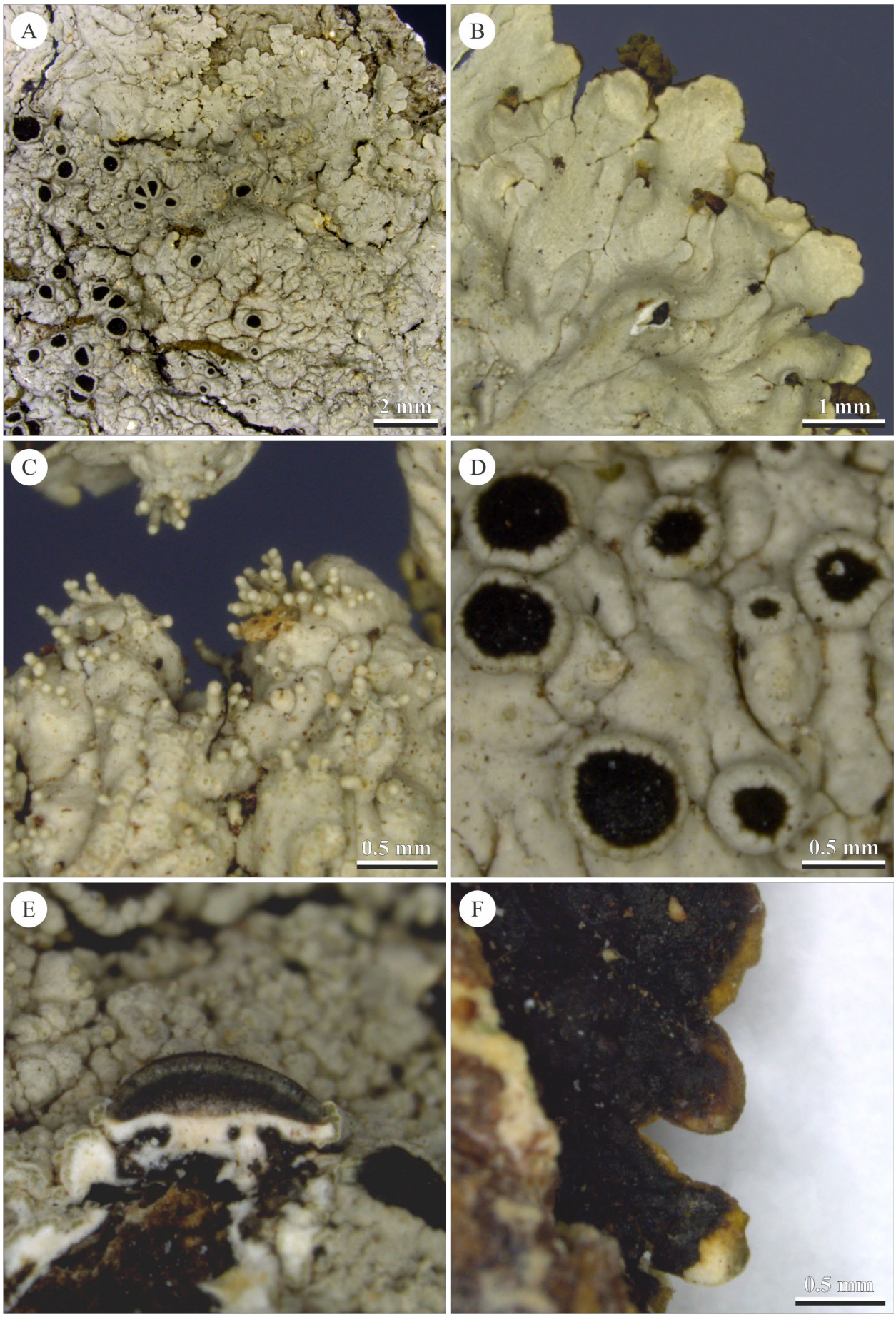


FIGURE 14. A. *Dirinaria papillulifera*, thallus morphology (A.A. Spielmann 8723). B. Laciniae with flabellate apices (A.A. Spielmann 8723). C. Cylindrical isidia (A.A. Spielmann 8723). D. Apothecia with smooth to crenate margin (A.A. Spielmann 8723). E. Internal stipe (A.A. Spielmann 8723). F. Marginal lower surface (A.A. Spielmann 8723).

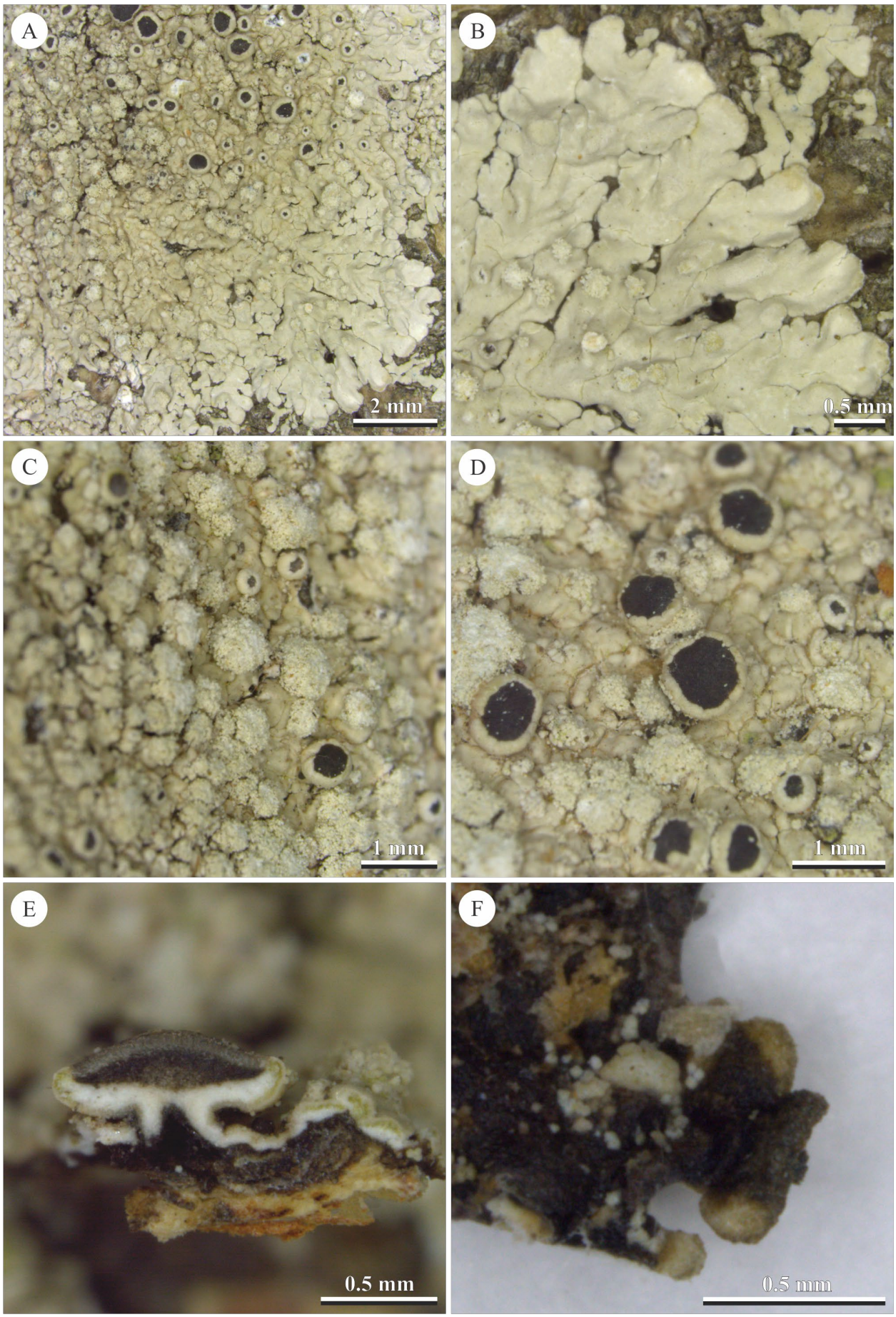


FIGURE 155. A. *Dirinaria picta*, thallus morphology (C.O. Dourado 99). B. Laciniae with not flabellate apices (C.O. Dourado 99). C. Hemispherical to globose soralia (C.O. Dourado 99). D. Apothecia with smooth margin and epruinose disc (C.O. Dourado 99). E. Internal stipe (C.O. Dourado 99). F. Marginal lower surface (C.O. Dourado 99).

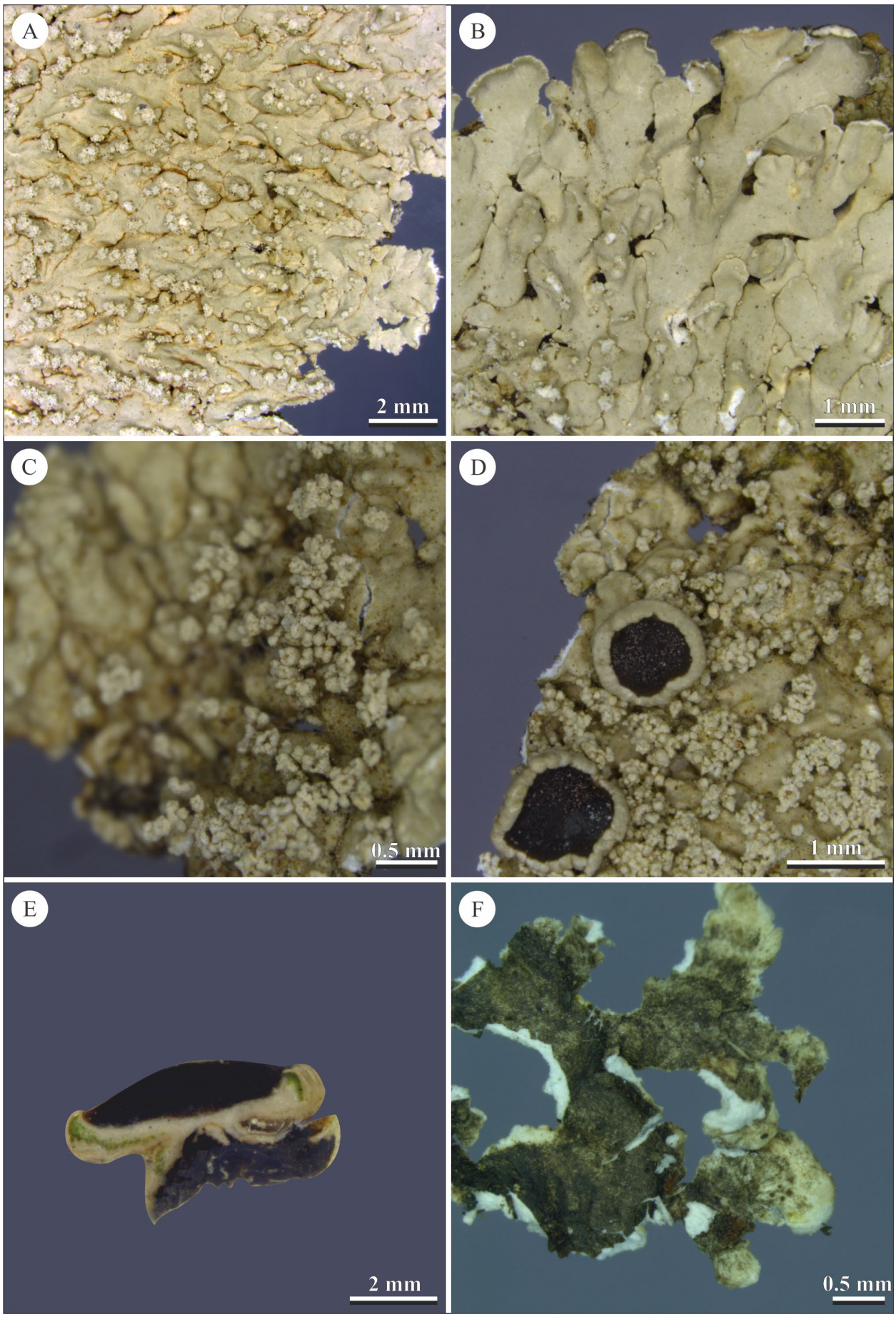


FIGURE 16. A. *Dirinaria pruinosa*, thallus morphology (M.L.Z. Colado 202). B. Laciniae with flabellate to slightly flabellate apices (M.L.Z. Colado 202). C. Irregular polysidiangia (M.L.Z. Colado 202). D. Apothecia with smooth to crenate margin and purplish pruinose disc (M.L.Z. Colado 202). E. Internal stipe (L.S. Canêz 3554). F. Marginal lower surface (L.S. Canêz 3554).

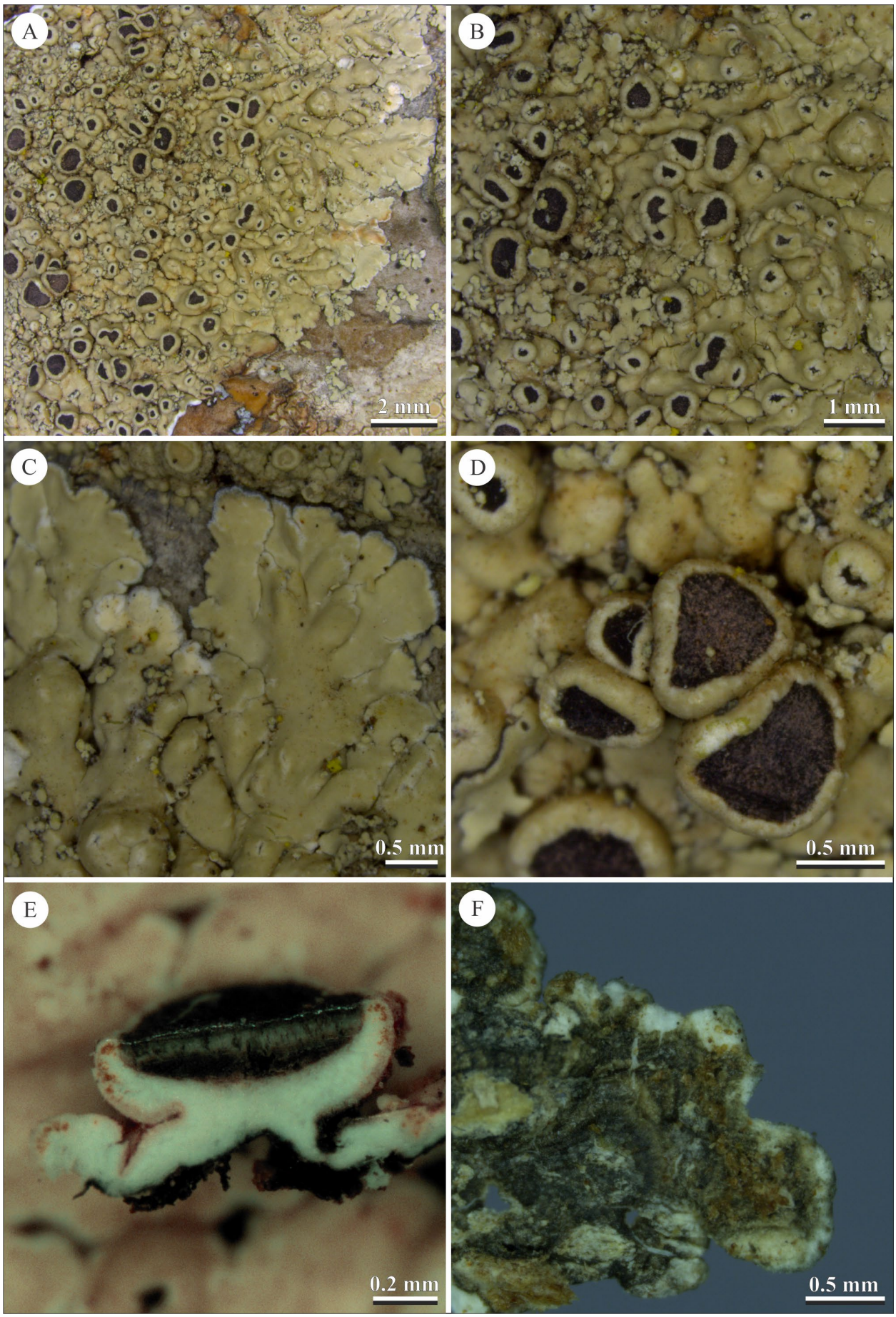


FIGURE 17. A. *Dirinaria purpurascens*, thallus morphology (T.D. Barbosa 1917). B. Not plicate thallus (T.D. Barbosa 1917). C. Not flabellate laciniae (T.D. Barbosa 1917). D. Apothecia with smooth margin and purplish pruinose disc (T.D. Barbosa 1917). E. Internal stipe (T.D. Barbosa 1916). F. Marginal lower surface (T.D. Barbosa 1916).

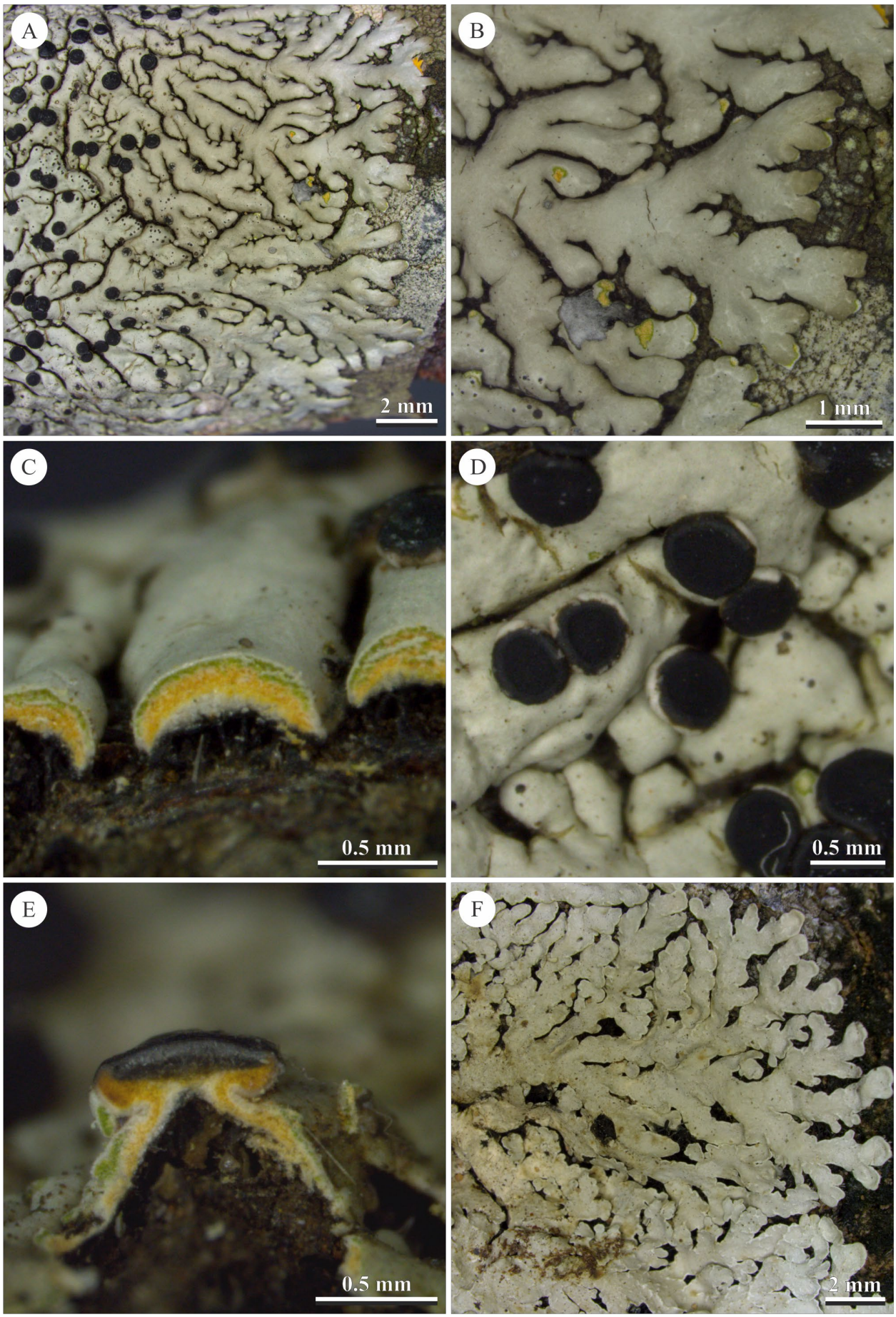


FIGURE 18. A. *Pyxine astipitata*, thallus morphology (T.D. Barbosa 1787). B. Laciniae discrete, irregularly branched and with subtruncate to truncate apices (T.D. Barbosa 1787). C. Transversal section in thallus, evidencing the bicolor medulla (T.D. Barbosa 1787). D. Apothecia of *cocoës*-type (T.D. Barbosa 1787). E. Internal stipe region, internal stipe absent (T.D. Barbosa 1787). F. *Pyxine berteriana,* thallus morphology (G.P. Freitas 101).

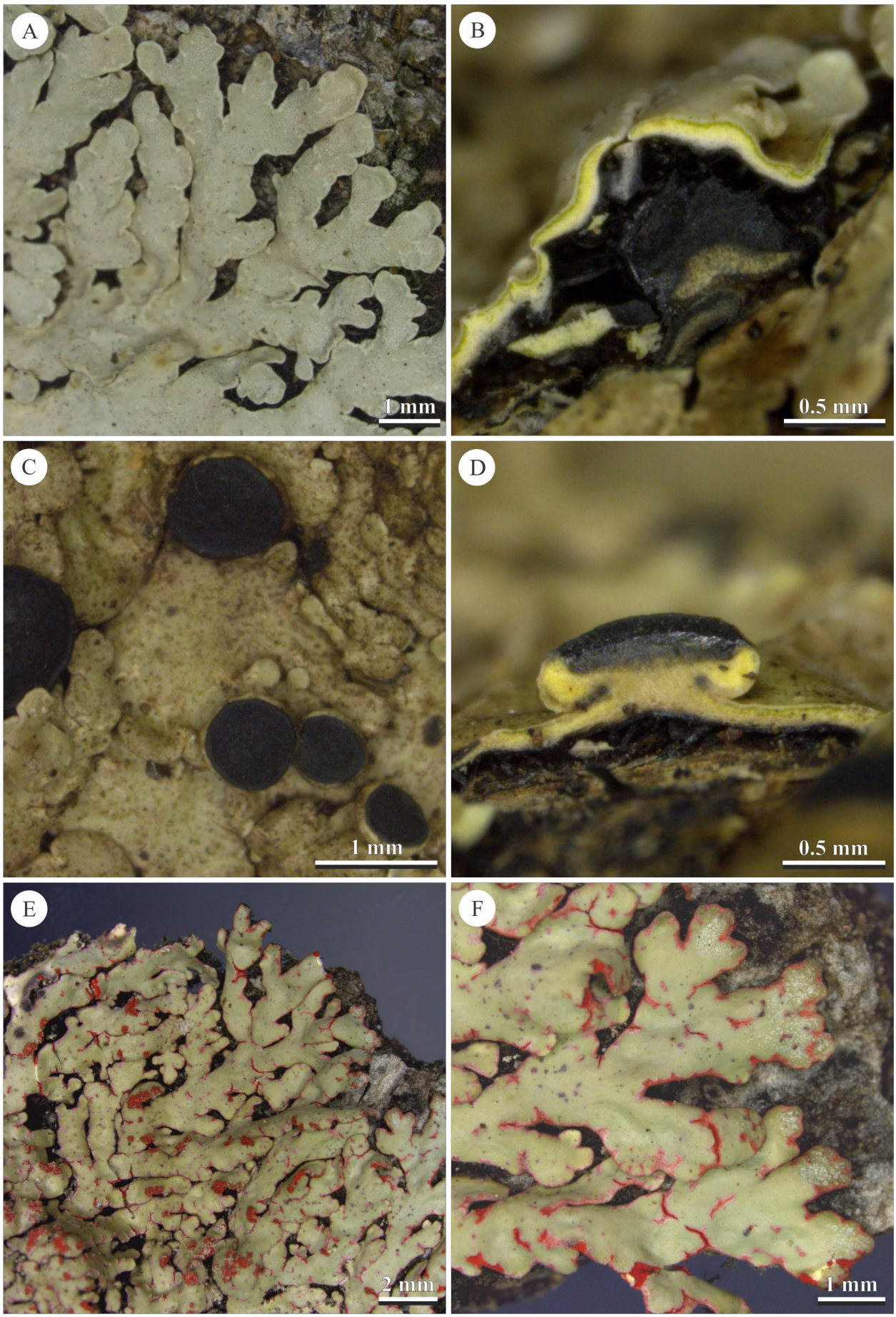


FIGURE 19. A. *Pyxine berteriana*, laciniae contiguous to overlapping, irregularly branched with rounded apices (G.P. Freitas 101). B. Transversal section in thallus, evidencing the bicolor medulla (G.P. Freitas 101). C. Apothecia of *cocoës*-type (G.P. Freitas 101). D. Yellow internal stipe (G.P. Freitas 101). E. *Pyxine coccifera,* thallus morphology, presence of red maculae (A.S. Rodrigues 334). F. Laciniae contiguous to overlapping, irregularly branched and with rounded to subtruncate apice, also presence of white pruina in laciniae apices (A.S. Rodrigues 334).

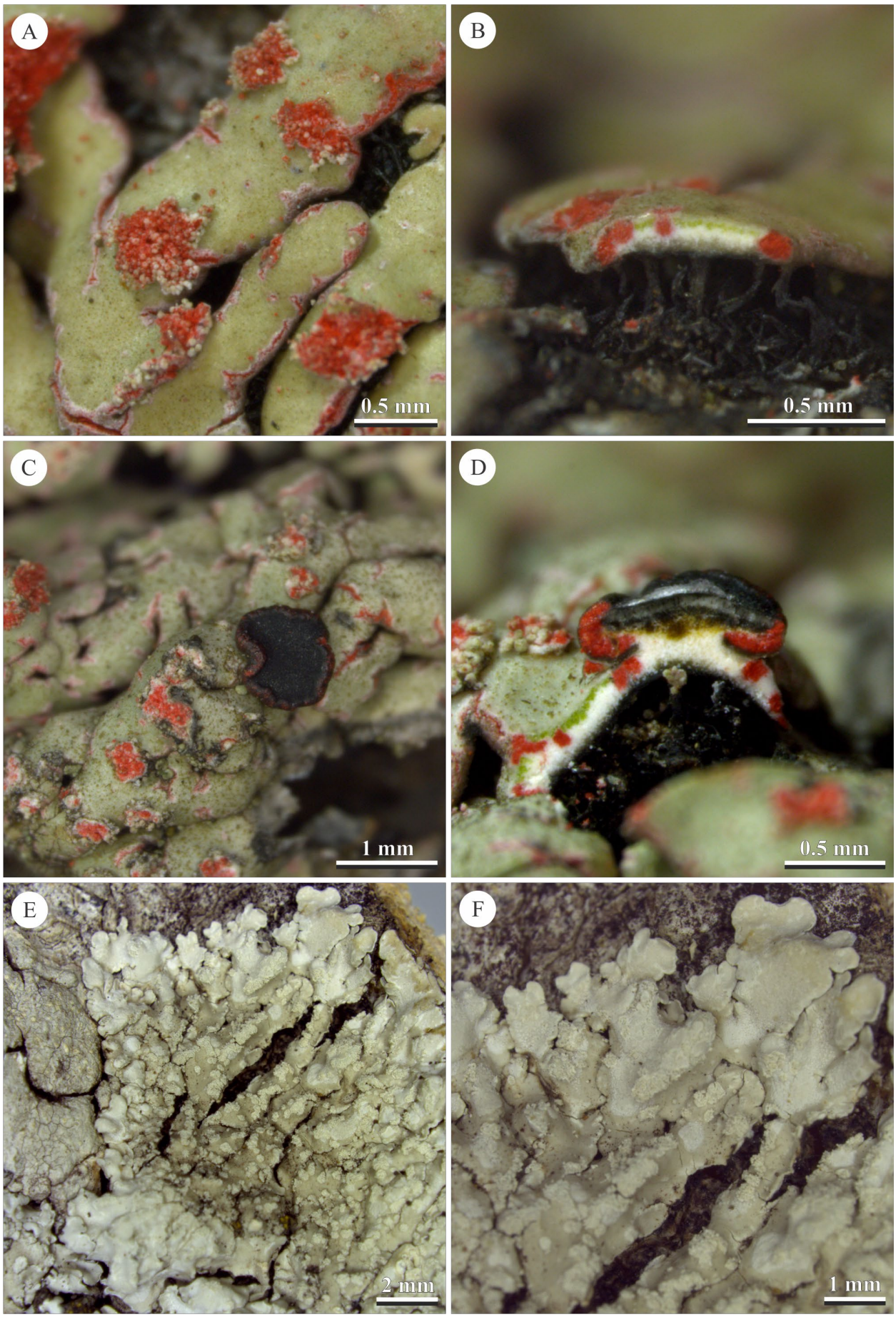


FIGURE 20. A. *Pyxine coccifera*, hemispherical soralia (A.S. Rodrigues 334). B. Transversal section in thallus, evidencing white medulla with red pigment (A.S. Rodrigues 334). C. Apothecia *obscurascens*-type and with variegate amphithecia between black and red (S.M.L. Souza 80). D. White internal stipe and red medulla of amphithecia (S.M.L Souza 80). E. *Pyxine cocoës,* thallus morphology (A.A. Spielmann 9718). F. Laciniae irregularly branched and rounded to subtruncate apices (A.A. Spielmann 9718).

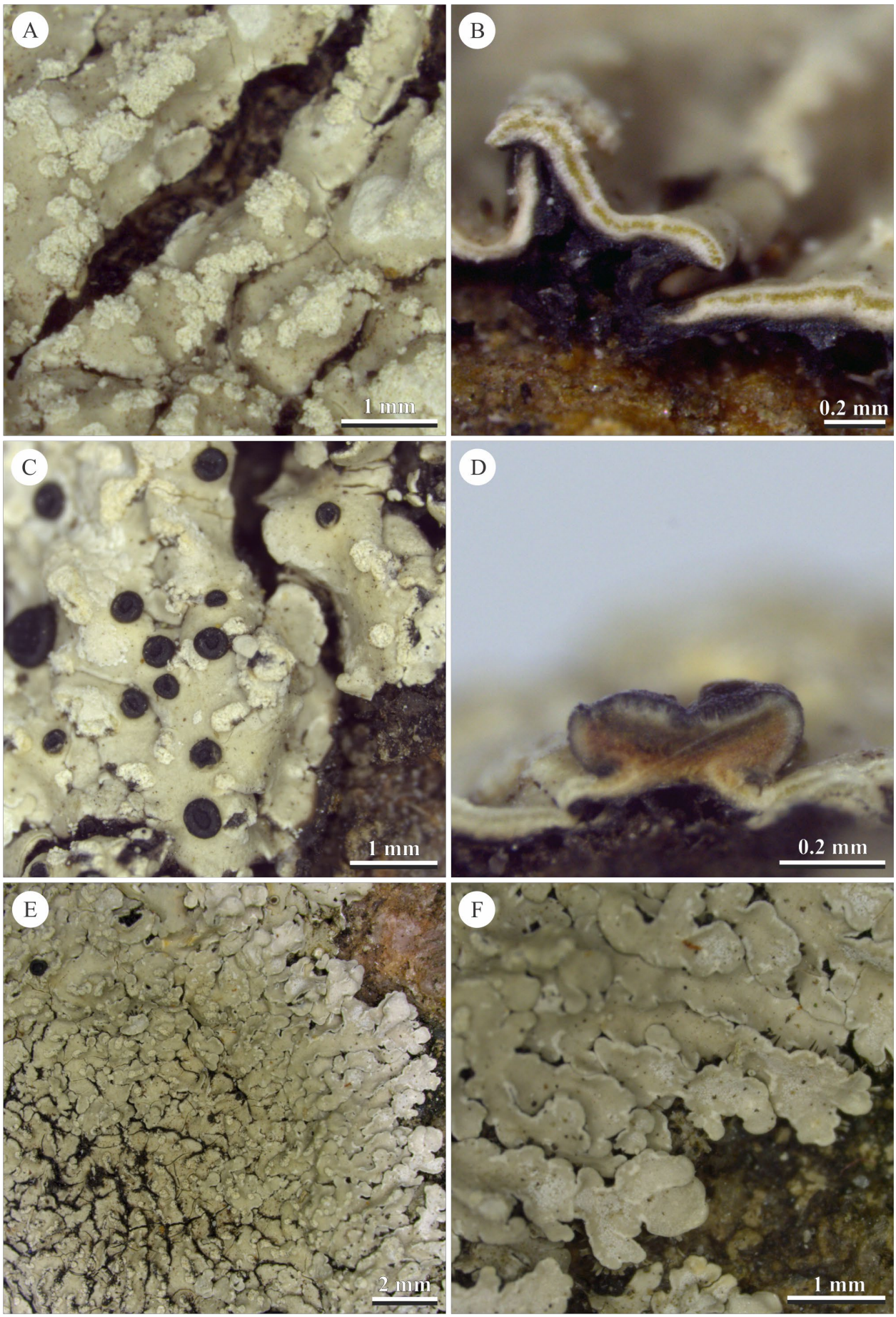


FIGURE 21. A. *Pyxine cocoës*, linear to circular soralia (A.A. Spielmann 9718). B. Transversal section in thallus, evidencing throughout white medulla (A.A. Spielmann 9718). C. Apothecia of *cocoës*-type (A.A. Spielmann 9981). D. Red to orange internal stipe (A.A. Spielmann 8981). E. *Pyxine cocoës* var. *pallida,* thallus morphology (L.S. Canêz 3546). F. Laciniae contiguous to overlapping, irregularly branched and with rounded to subtruncate apices (L.S. Canêz 3546).

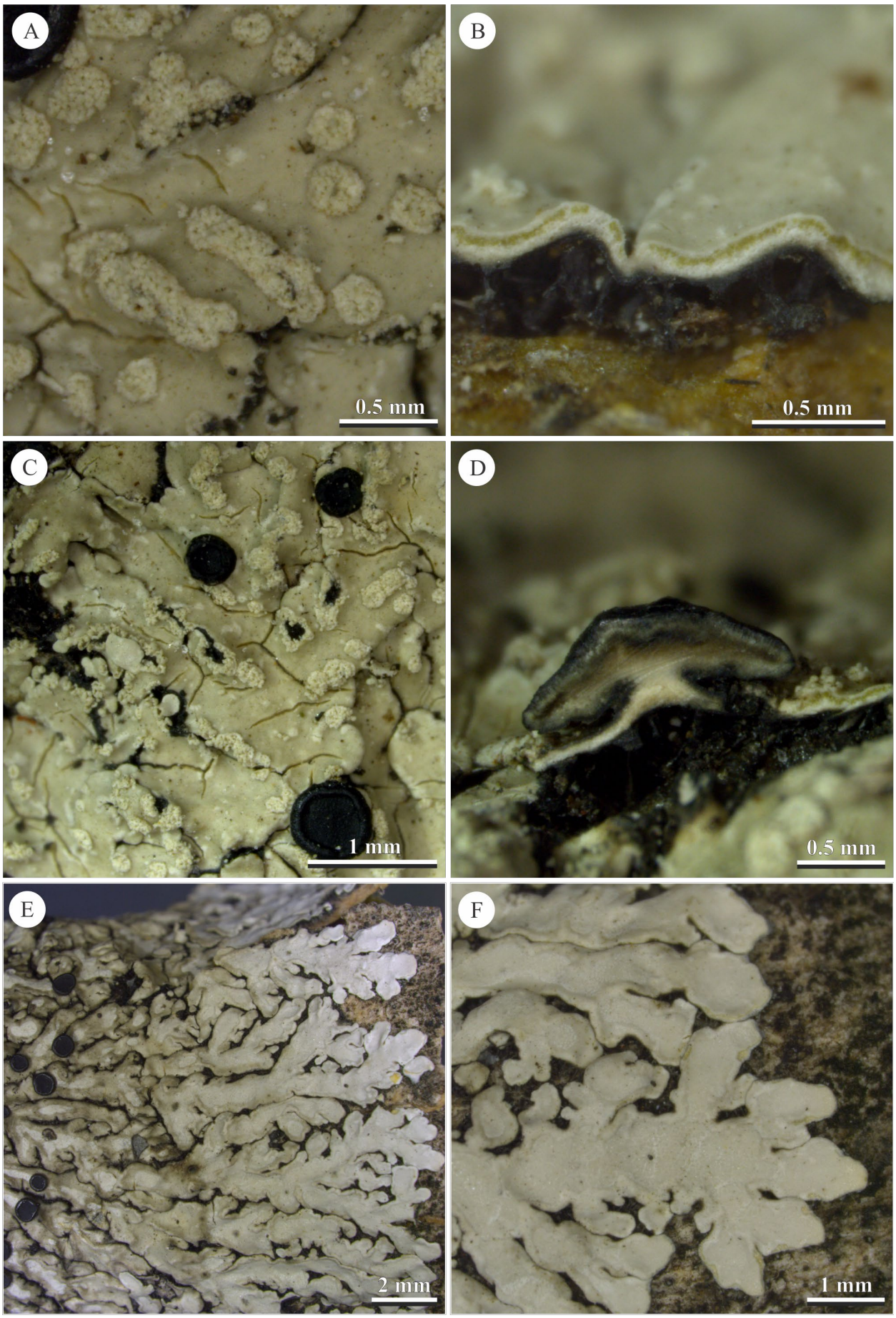


FIGURE 22. A. *Pyxine cocoës* var. *pallida,* linear to circular soralia (L.S. Canêz 3546). B. Transversal section in thallus, evidencing the throughout white medulla (L.S. Canêz 3546). C. Apothecia of *cocoës*-type (L.S. Canêz 3546). D. White internal stipe (L.S. Canêz 3546). E. *Pyxine cognata,* thallus morphology (A.A. Spielmann 12055). F. Laciniae contiguous, irregularly branched, with rounded to subtruncate apice, also board of pruina laciniae center (A.A. Spielmann 12055).

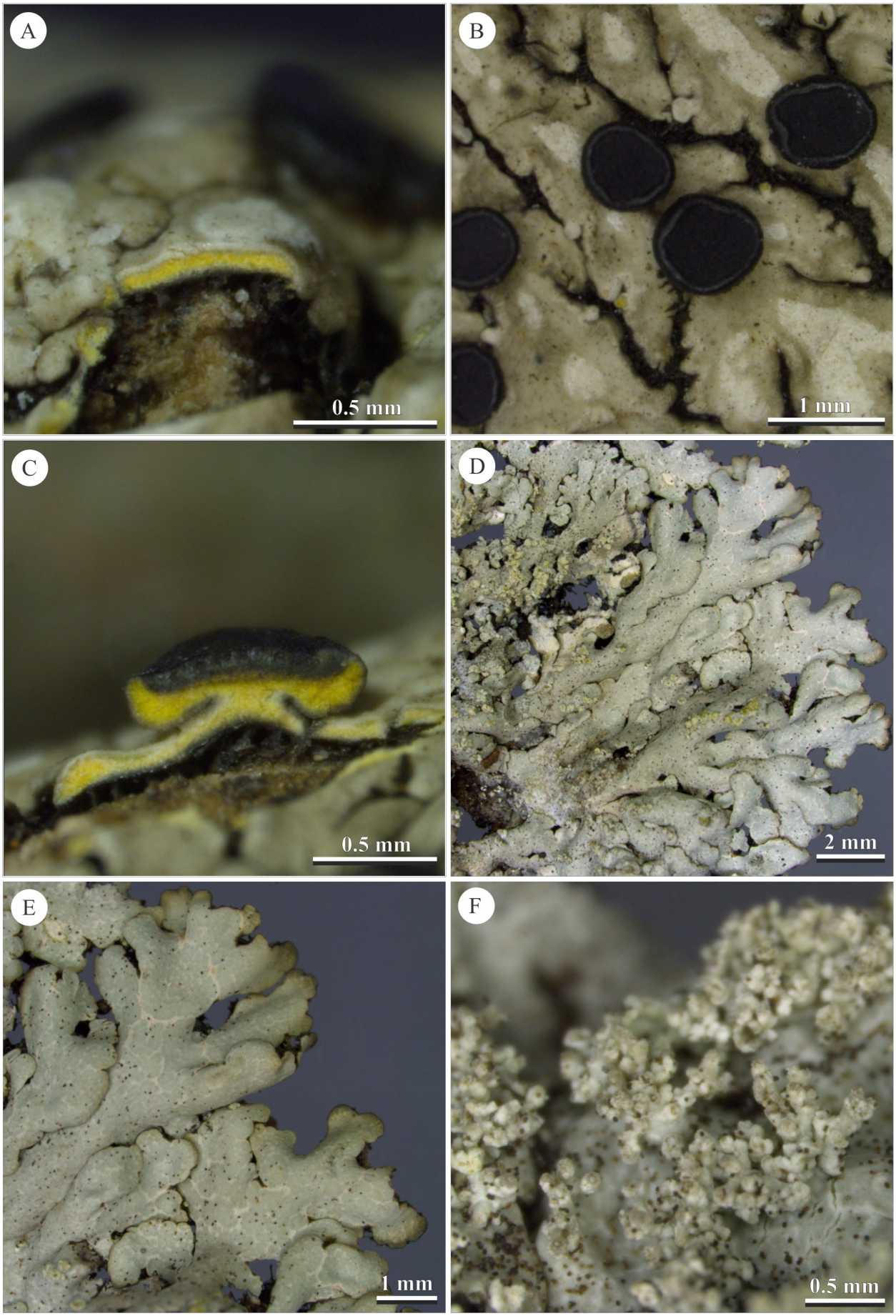


FIGURE 23. A. *Pyxine cognata,* transversal section in thallus, evidencing the bicolor medulla (A.A. Spielmann 12055). B. Apothecia of *obscurascens*-type (A.A. Spielmann 12055). C. Yellow internal stipe (A.A. Spielmann 12055). D. *Pyxine coralligera,* thallus morphology (T.D. Barbosa 1743). E. Laciniae contiguous to overlapping, irregularly branched, with truncate to subtruncate apices and subreticulate maculae (T.D. Barbosa 1743). F. Irregular and laminal polysidiangia (T.D. Barbosa 1743).

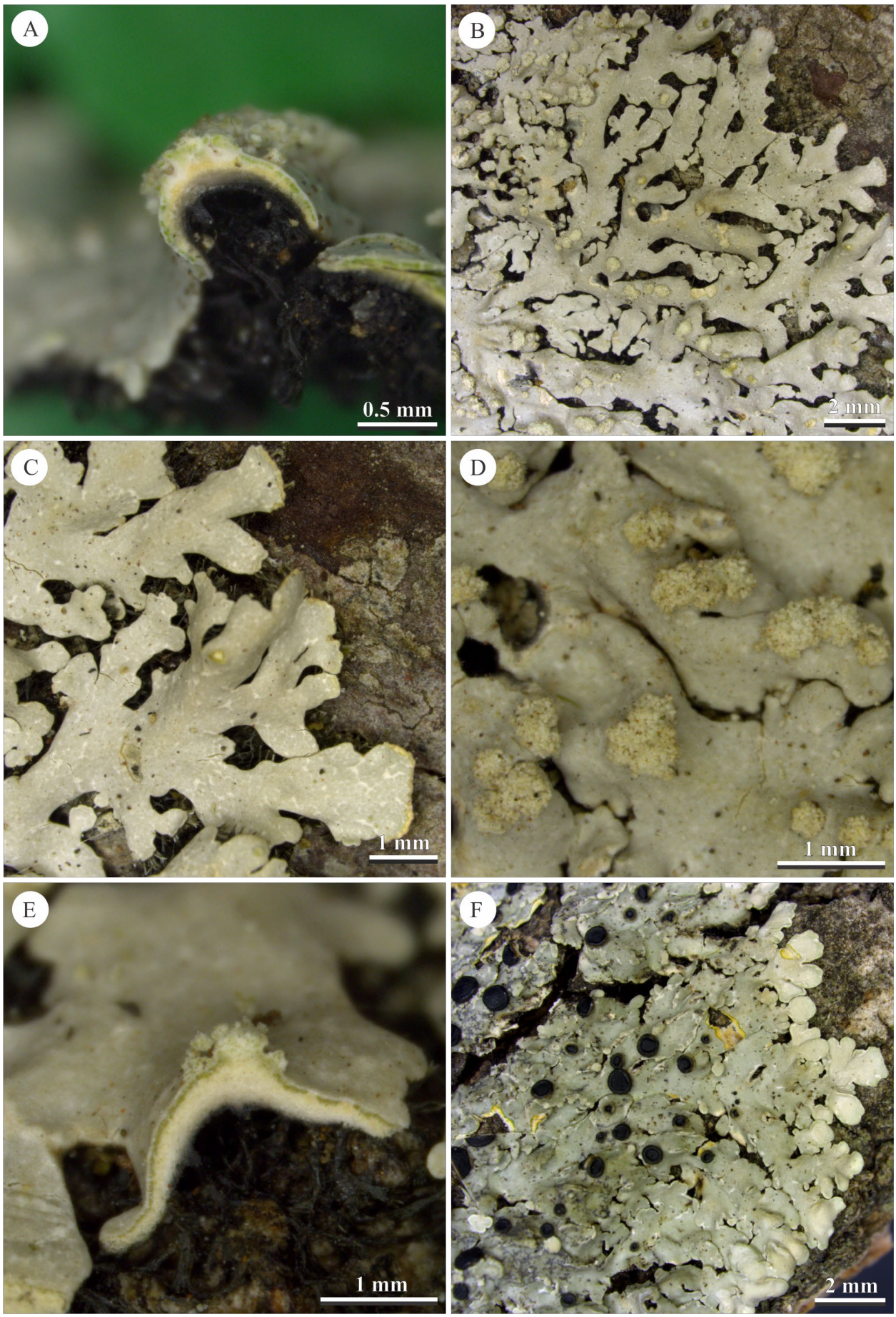


FIGURE 24. A. *Pyxine coralligera,* transversal section in thallus, evidencing the bicolor medulla (T.D. Barbosa 1743). B. *Pyxine daedalea,* thallus morphology (G.M. Shiroma 73). C. Laciniae contiguous to overlapping, dichotomously to irregularly branched, with rounded to subtruncate apices (G.M. Shiroma 73). D. Hemispherical soralia (G.M. Shiroma 73). E. Transversal section in thallus, evidencing the bicolor medulla (G.M. Shiroma 73). F. *Pyxine denigricans,* thallus morphology (J.M. Torres 598-holotype).

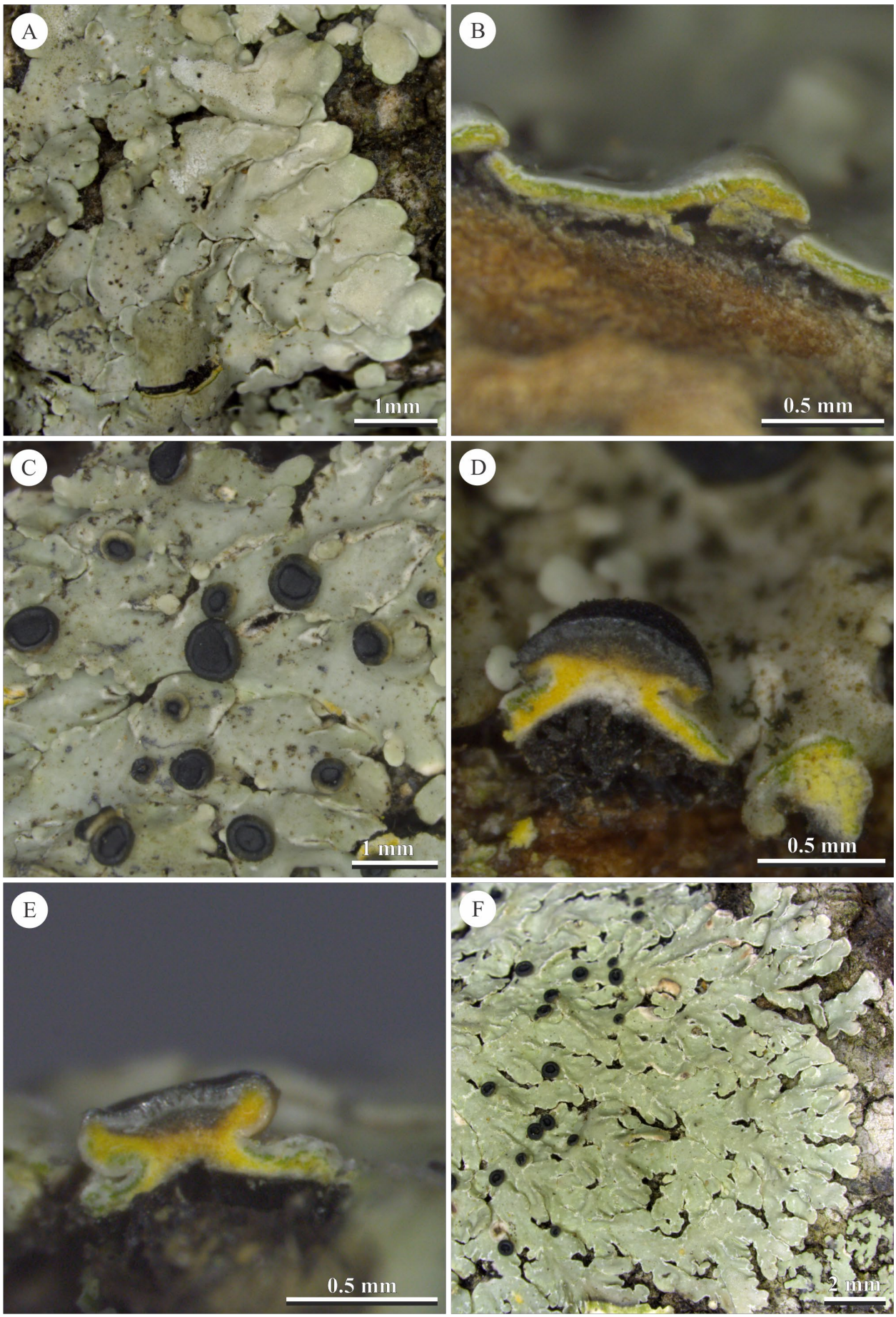


FIGURE 25. A. *Pyxine denigricans*, laciniae contiguous to overlapping, irregularly branched with rounded apices (J.M. Torres 598-holotype). B. Transversal section in thallus, evidencing the bicolor medulla (J.M. Torres 598-holotype). C. Apothecia of *cocoës*-type (J.M. Torres 598-holotype). D. Internal stipe with white center and yellow margins (J.M. Torres 598-holotype). E. Throughout yellow internal stipe (J.M. Torres 598-holotype). F. *Pyxine eschweileri,* thallus morphology (A.A. Spielmann 12801).

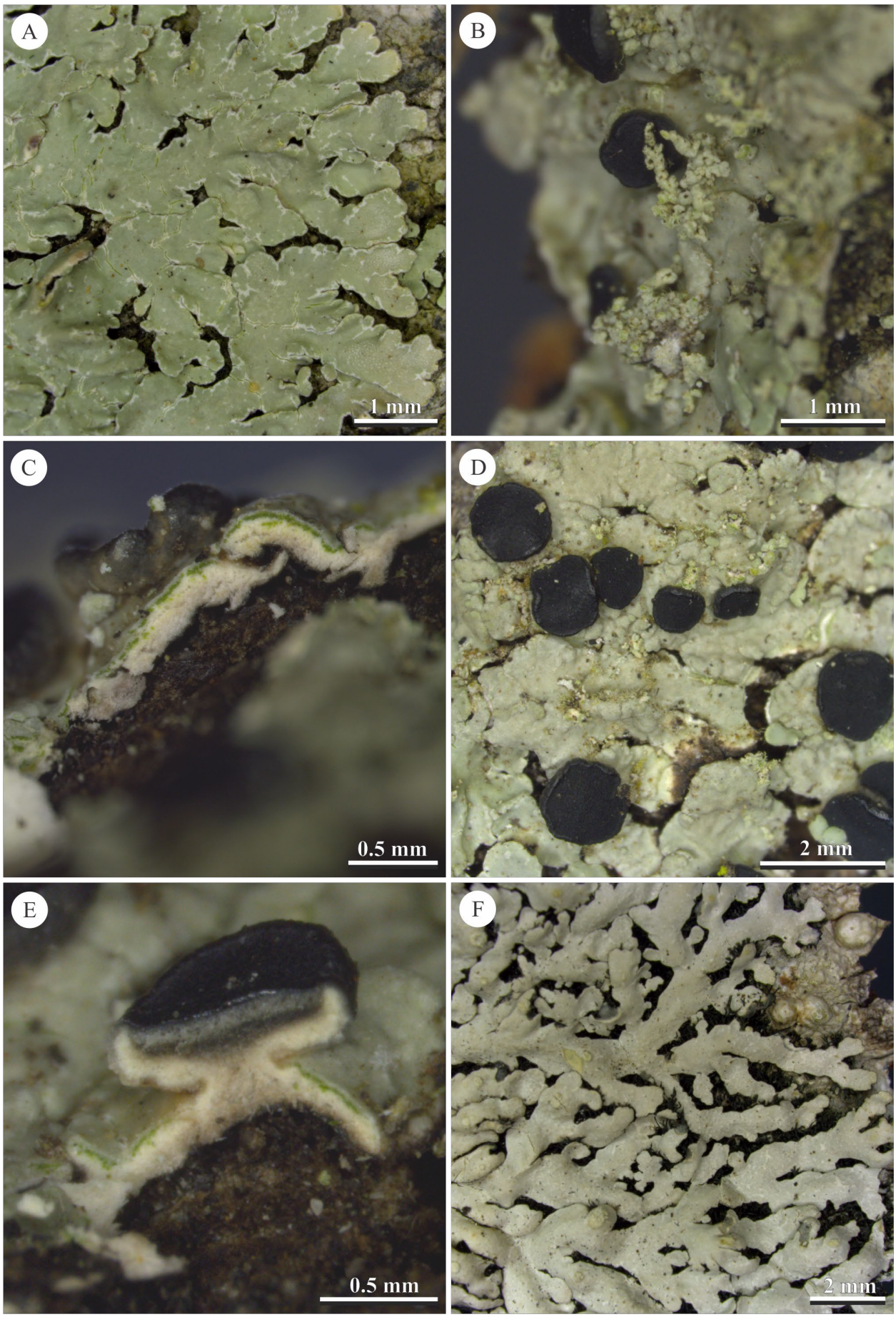


FIGURE 26. A. *Pyxine eschweileri,* laciniae contiguous to overlapping, irregularly branched with rounded apices (A.A. Spielmann 12801). B. Marginal polysidiangia (A.A. Spielmann 12801). C. Transversal section in thallus, evidencing the bicolor medulla (A.A. Spielmann 12801). D. Apothecia *obscurascens*-type (A.A. Spielmann 12801). E. White internal stipe (A.A. Spielmann 12801). F. *Pyxine flavolucens,* thallus morphology (A.S. Rodrigues 334).

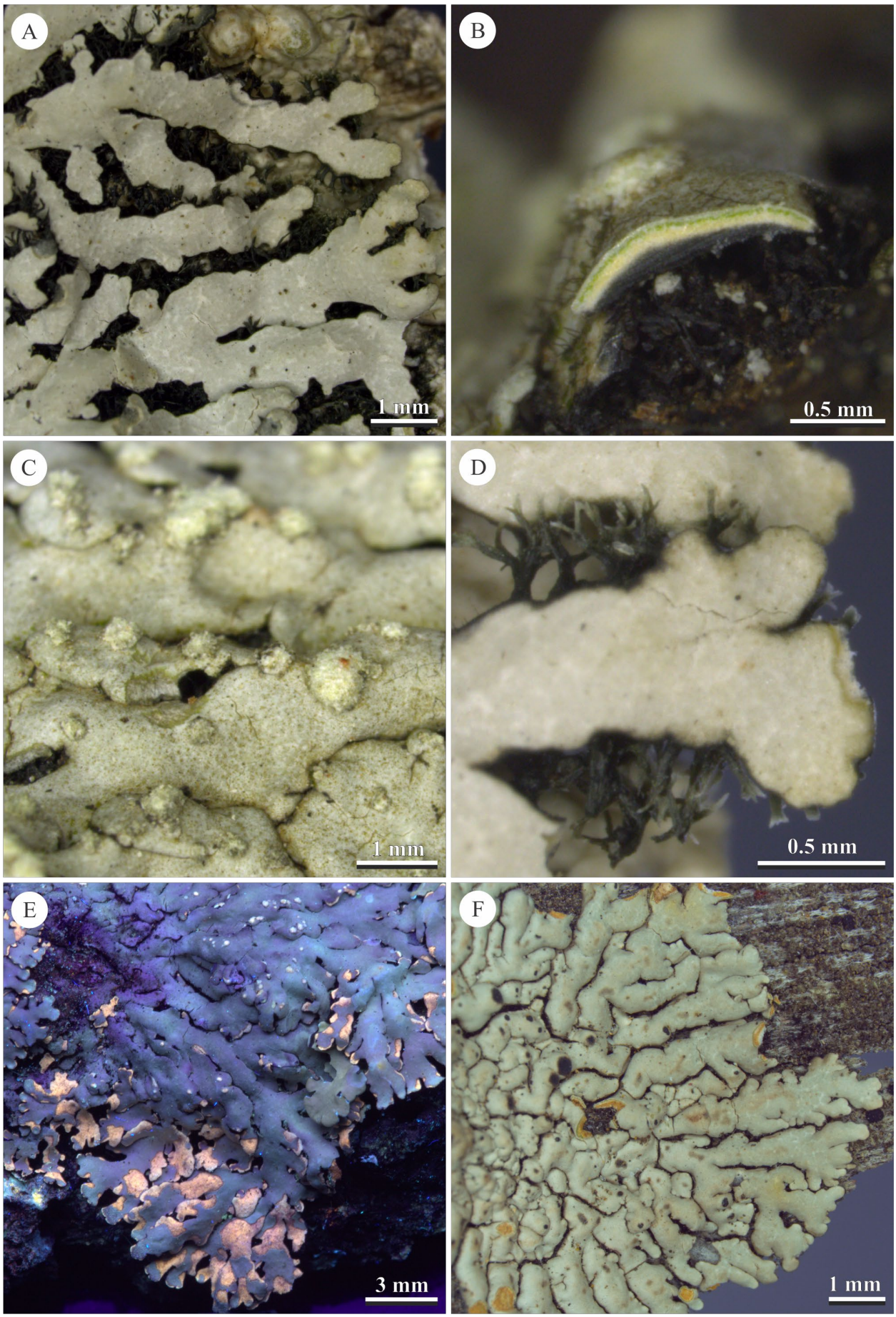


FIGURE 27. A. *Pyxine flavolucens*, laciniae contiguous to overlapping, irregularly branched with rounded apices (A.A. Spielmann 11973). B. Transversal section in thallus, evidencing the bicolor medulla (A.A. Spielmann 12785-holotype). C. Hemispherical soralia (A.A. Spielmann 12785) (holotype). D. Dichotomously branched rhizinae (A.A. Spielmann 11973). E. Medulla UV+ dark-yellow, unknown substance (A.A. Spielmann 11973). F. *Pyxine mantiqueirensis,* thallus morphology (A.S. Rodrigues 201).

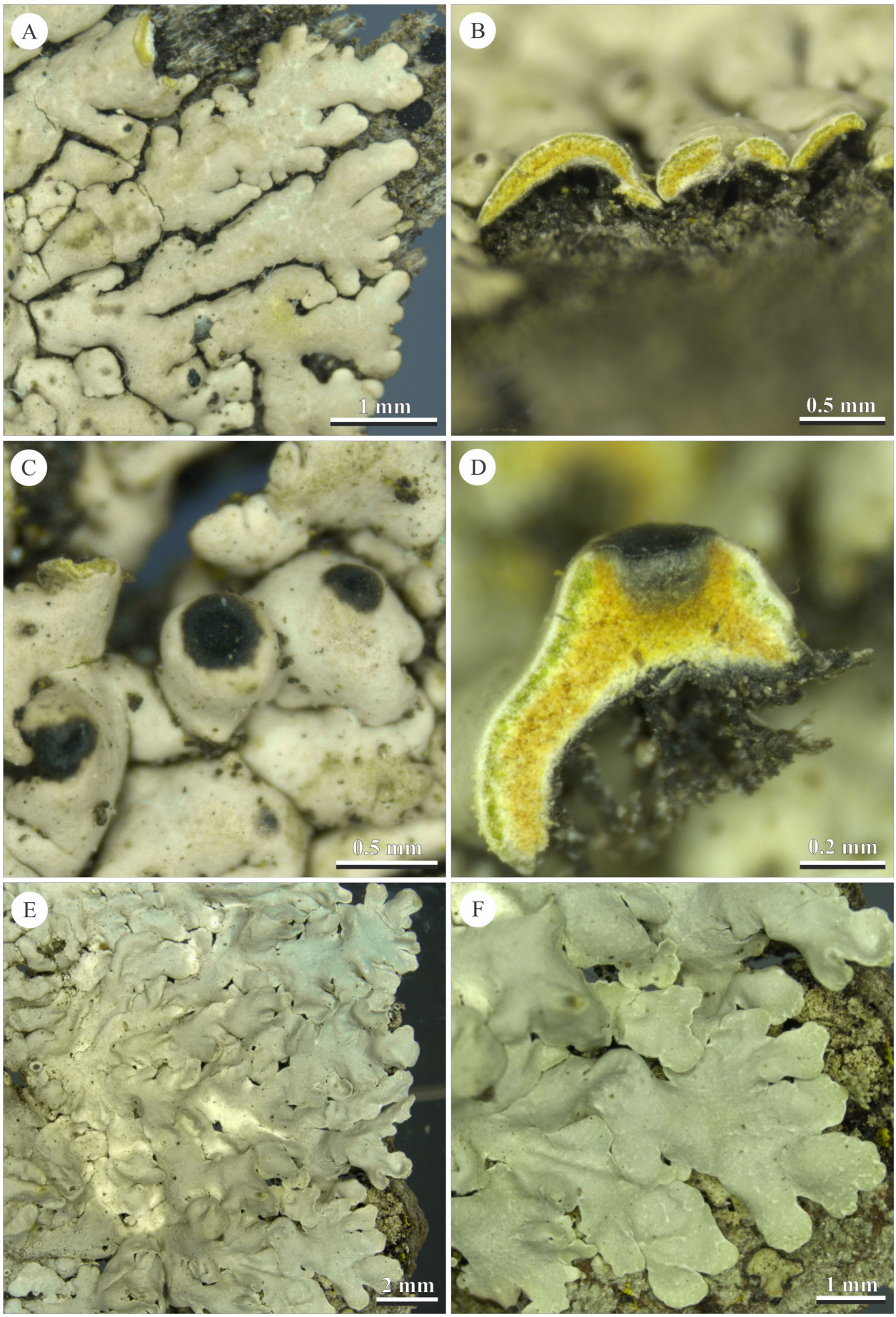


FIGURE 28. A. *Pyxine mantiqueirensis,* laciniae contiguous, irregularly branched with rounded apices (A.S. Rodrigues 201). B. Transversal section in thallus, evidencing the bicolor medulla (A.S. Rodrigues 201). C. Apothecia *obscurascens*-type (A.S. Rodrigues 201). D. Orange internal stipe (A.S. Rodrigues 201). E. *Pyxine nana*, thallus morphology (A.S. Rodrigues 422). F. Laciniae contiguous, irregularly branched with rounded apices (A.S. Rodrigues 422).

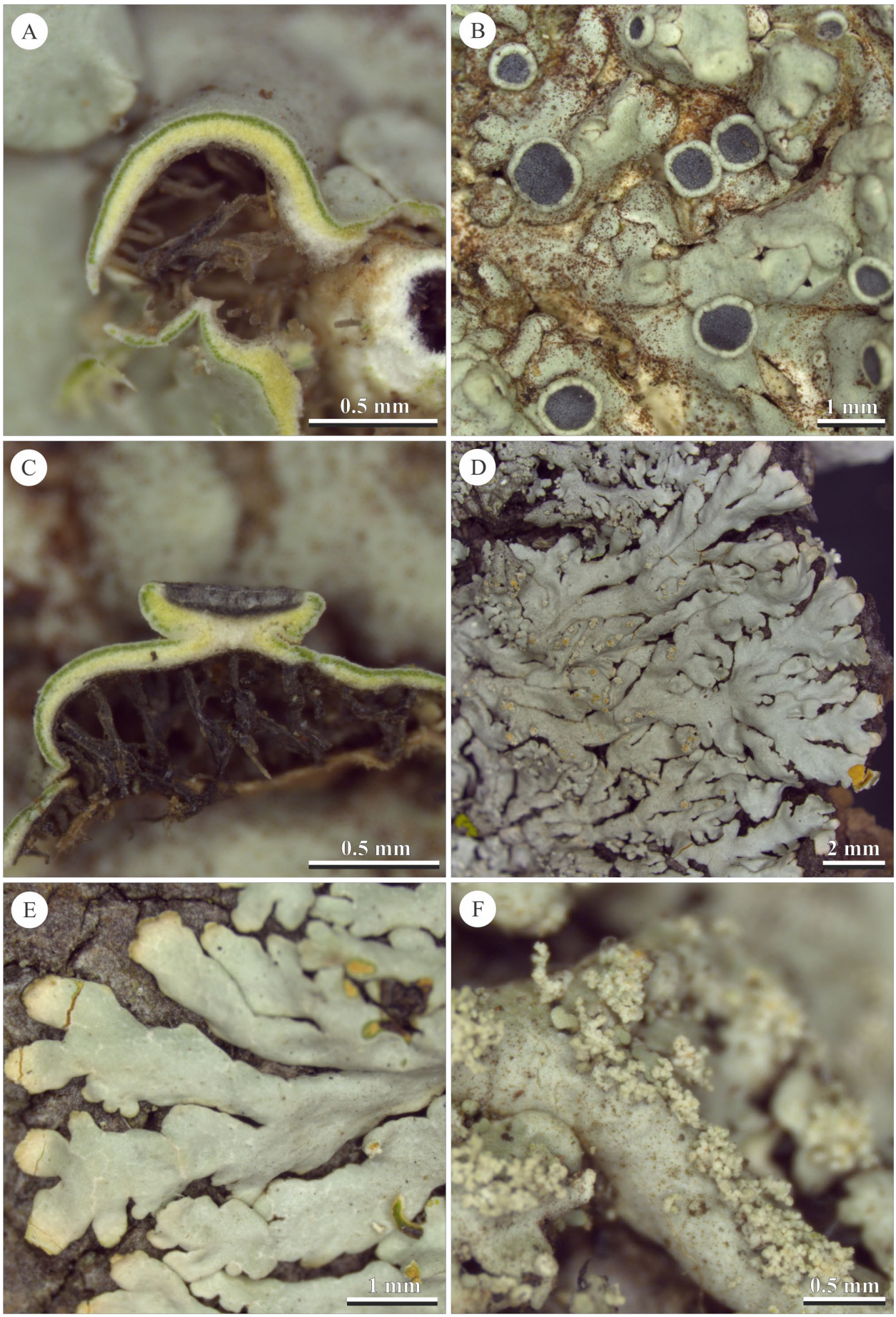


FIGURE 29. A. *Pyxine nana,* transversal section in thallus, evidencing the bicolor medulla (A.S. Rodrigues 422). B. Apothecia *physciaeformis*-type (A.S. Rodrigues 422). C. Internal stipe white in center and yellow in margins (A.S. Rodrigues 422). D. *Pyxine obscurascens*, thallus morphology (T.D. Barbosa 1748). E. Laciniae contiguous, irregularly branched with rounded apices (T.D. Barbosa 1748). F. Soredioid polysidiangia (T.D. Barbosa 1748).

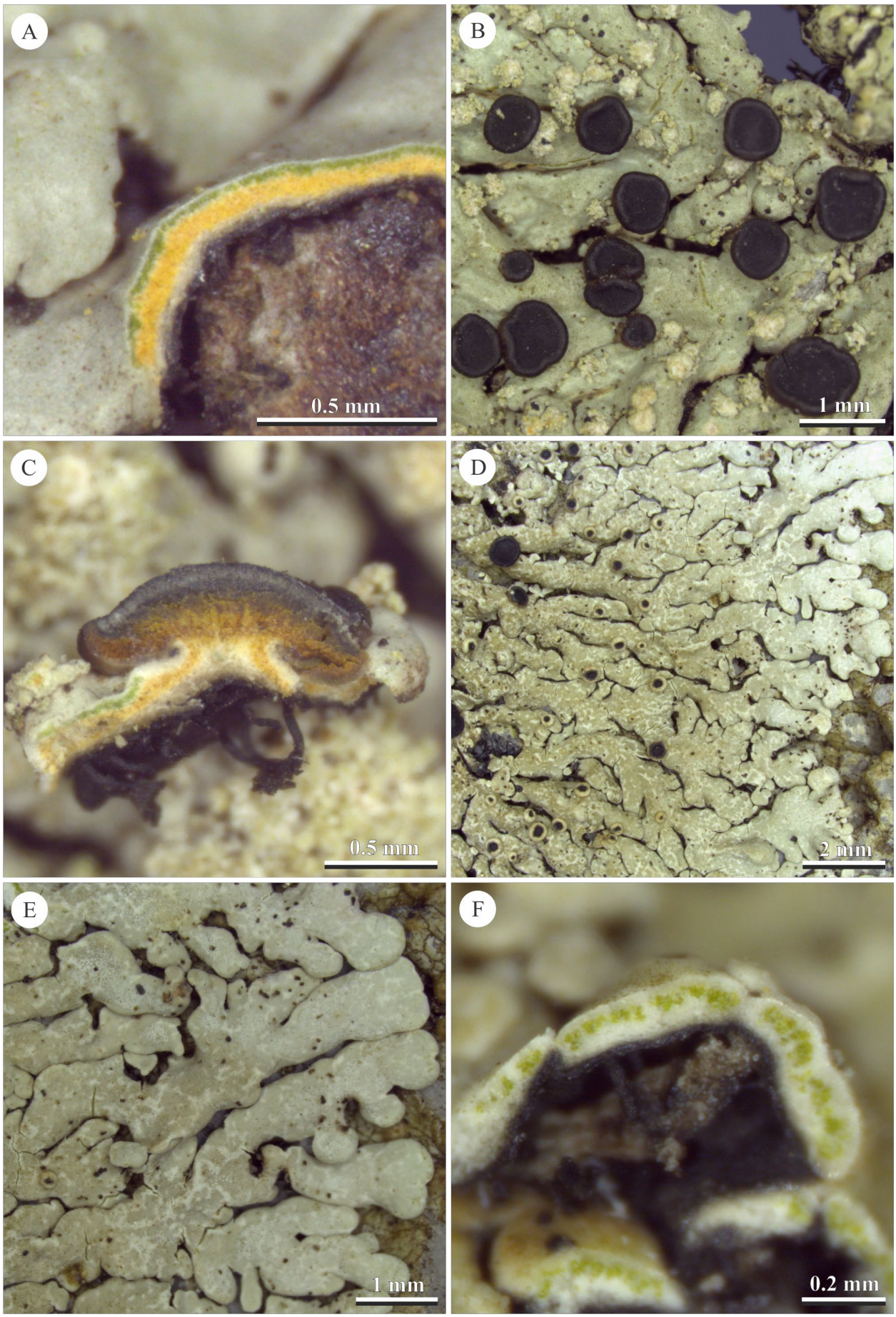


FIGURE 30. A. *Pyxine obscurascens,* transversal section in thallus, evidencing the bicolor medulla (T.D. Barbosa 1748). B. Apothecia *obscurascens*-type (T.D. Barbosa 1748). C. Internal stipe white in center and orange in margins (T.D. Barbosa 1748). D. *Pyxine parapetricola*, thallus morphology (T.D. Barbosa 1853-holotype). E. Laciniae contiguous, irregularly branched with rounded apices and reticulate to subreticulate maculae (T.D. Barbosa 1853-holotype). F. Transversal section in thallus, evidentially throughout white medulla (T.D. Barbosa 1853-holotype).

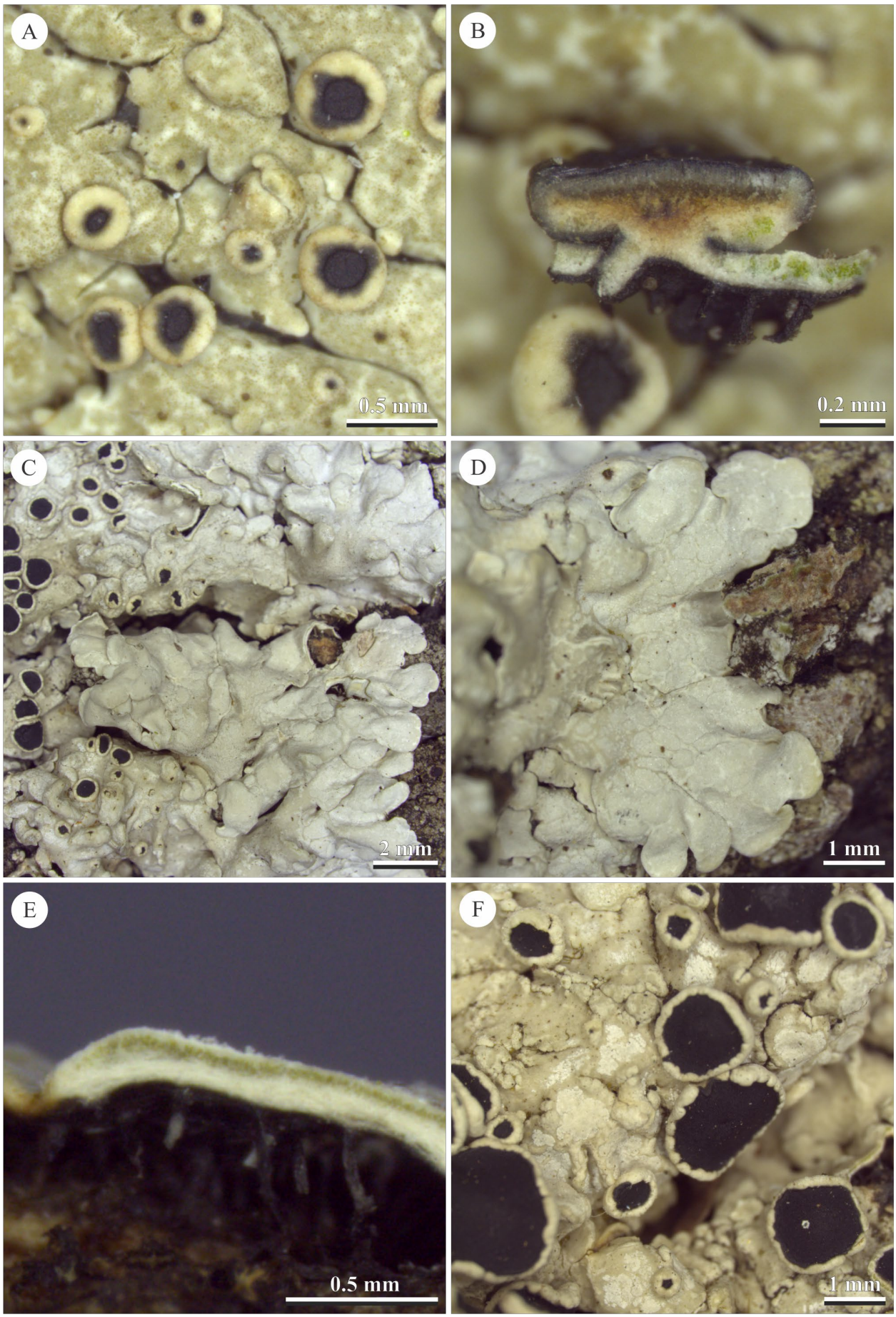


FIGURE 31. A. *Pyxine parapetricola,* apothecia *cocoës*-type (T.D. Barbosa 1853-holotype). B. Orange to reddish internal stipe (T.D. Barbosa 1853-holotype). C. *Pyxine petricola*, thallus morphology (J.M. Torres 533). D. Laciniae contiguous, irregularly branched with rounded apices (J.M. Torres 533). E. Transversal section in thallus, evidentially throughout white medulla (J.M. Torres 533). F. Apothecia *cocoës*-type (J.M. Torres 533).

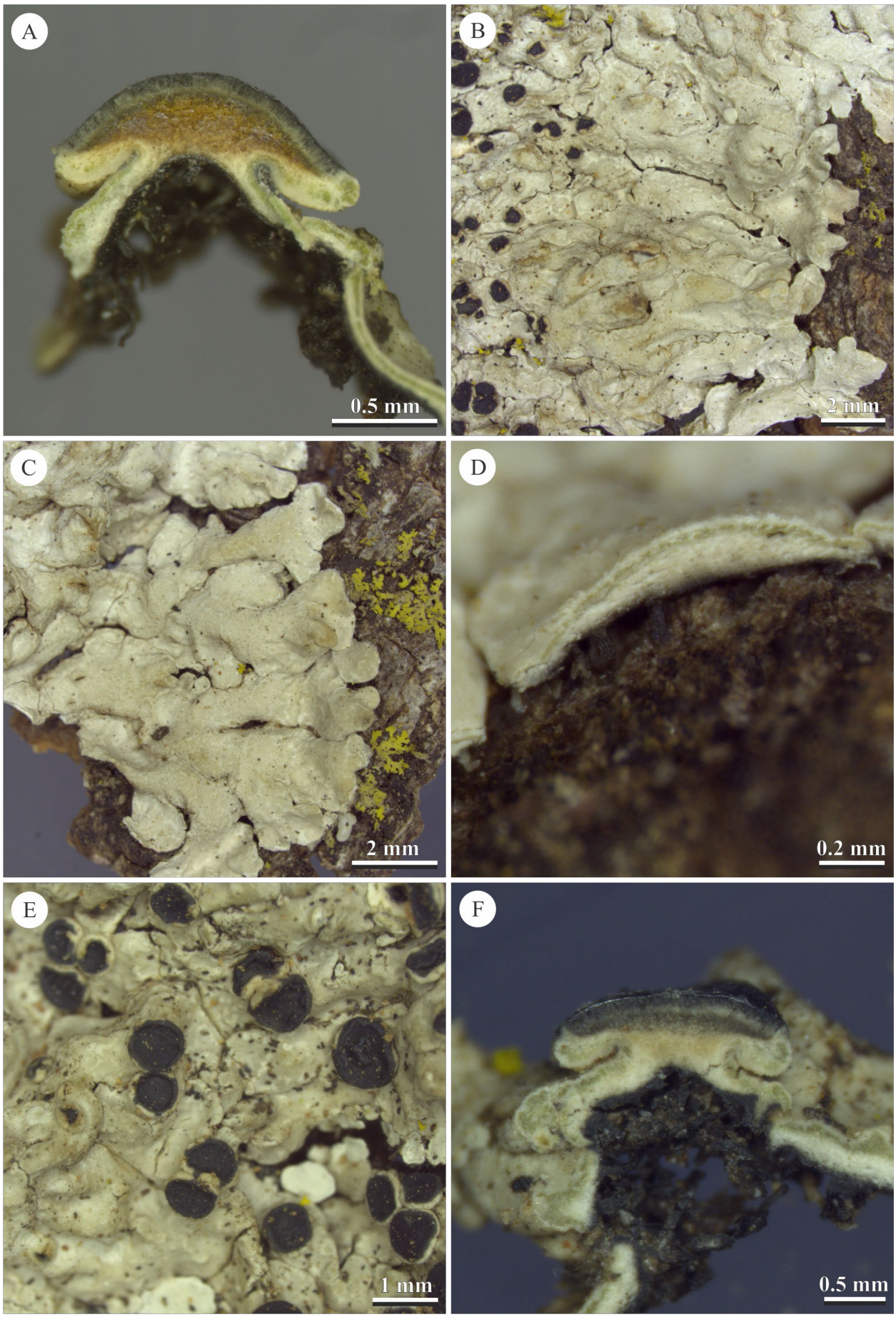


FIGURE 32. A. *Pyxine petricola,* orange to reddish internal stipe (J.M. Torres 533). B. *Pyxine petricola* var. *convexula*, thallus morphology (A.A. Spielmann 12081). C. Laciniae contiguous, irregularly branched with rounded apices (A.A. Spielmann 12081). D. Transversal section in thallus, evidentially throughout white medulla (A.A. Spielmann 12081). E. Apothecia *cocoës*-type (A.A. Spielmann 12081). F. Throughout white internal stipe (A.A. Spielmann 12081).

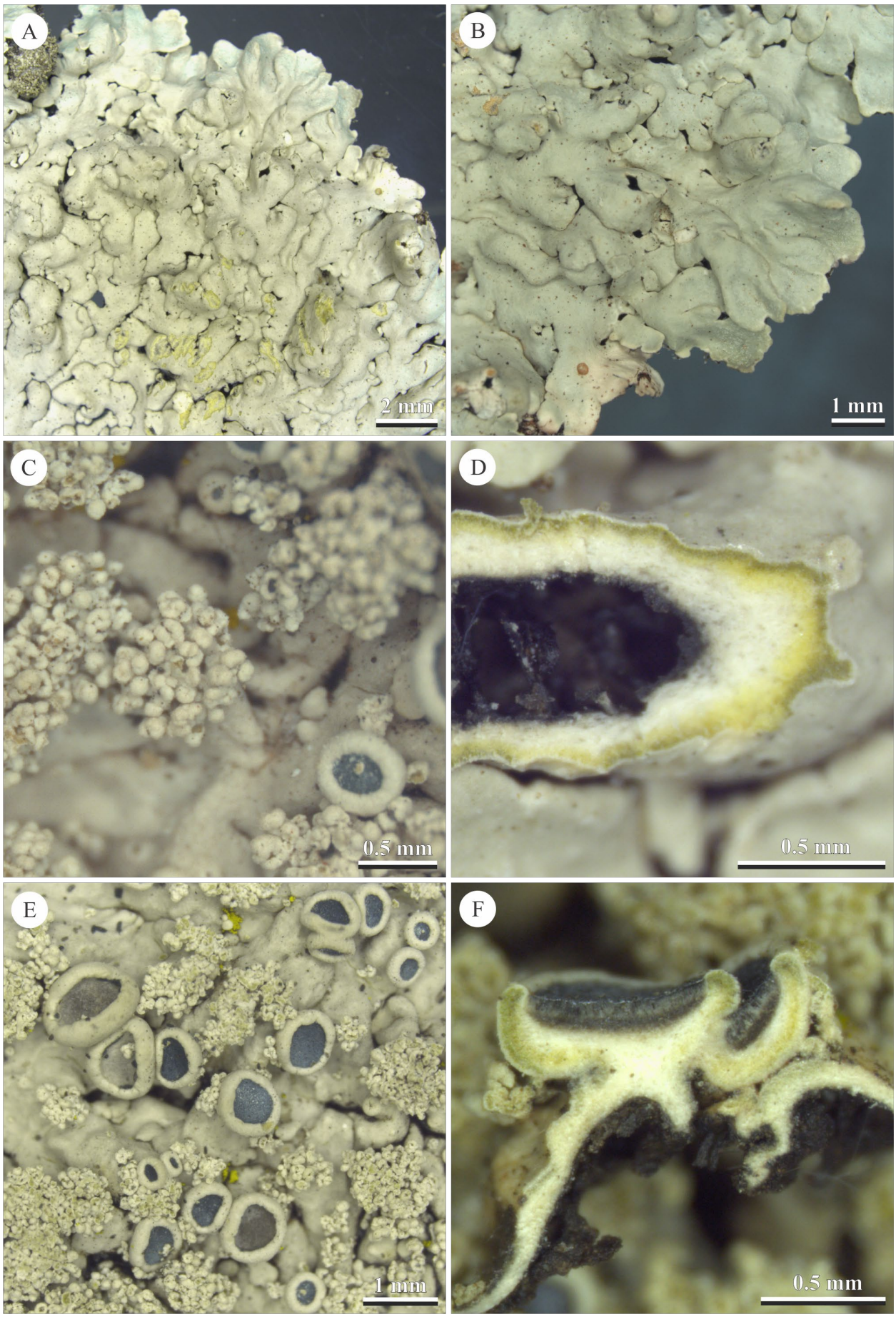


FIGURE 333. A. *Pyxine physciaeformis,* thallus morphology (A.A. Spielmann 12784). B. Laciniae contiguous, irregularly branched with rounded apices (A.A. Spielmann 12784). C. Coralloid polysidiangia (A.A. Spielmann 9685). D. Transversal section in thallus, evidencing the bicolor medulla (A.A. Spielmann 9685). E. Apothecia *physciaeformis*-type with white pruina (A.A. Spielmann 9685). F. Throughout white internal stipe (A.A. Spielmann 9685).

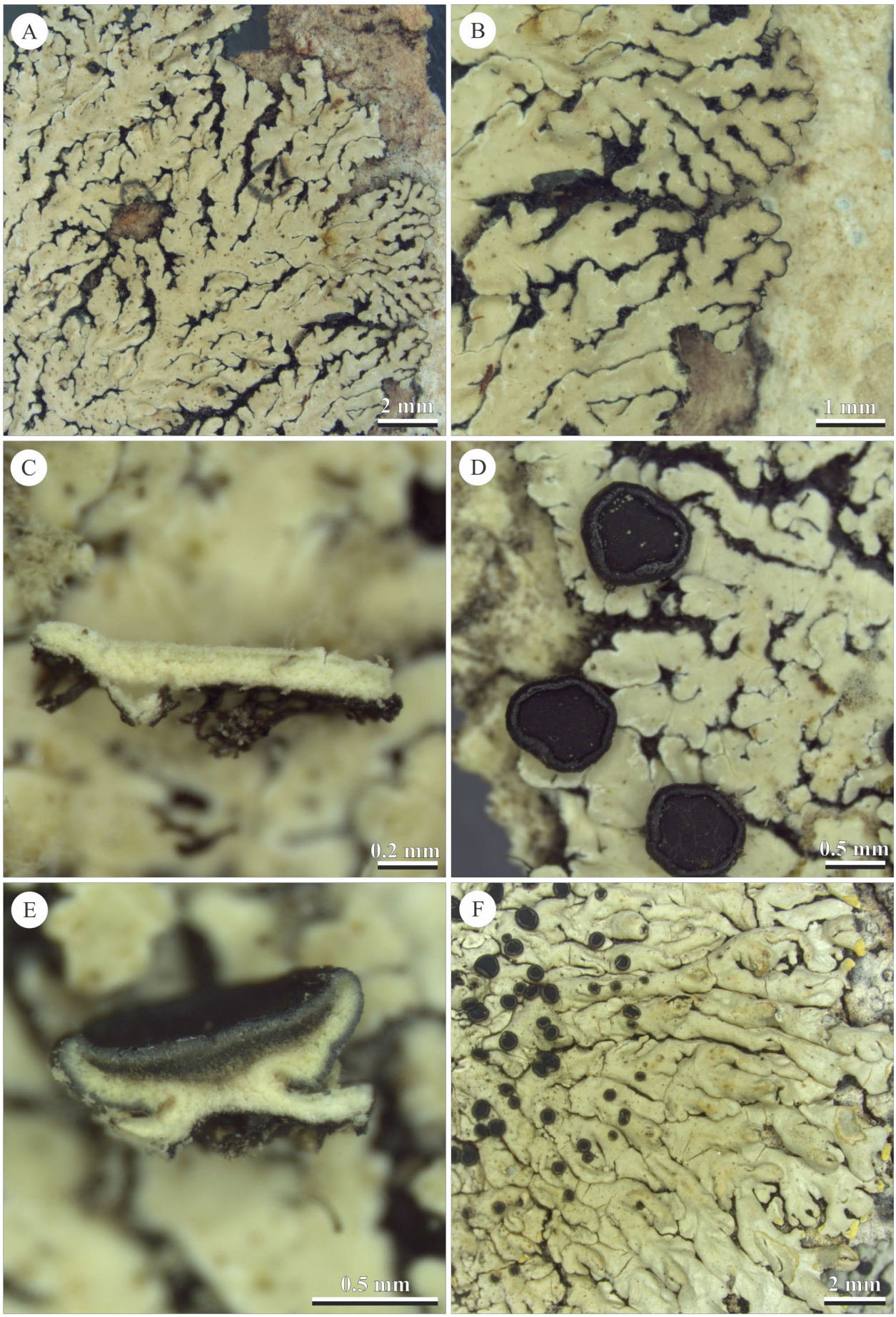


FIGURE 344. A. *Pyxine primaria,* thallus morphology (C.M. Bernardo 799). B. Laciniae contiguous, irregularly branched with rounded apices (C.M. Bernardo 799). C. Transversal section in thallus, evidencing the bicolor medulla (C.M. Bernardo 799). D. Apothecia *obscurascens*-type (C.M. Bernardo 799). E. Throughout yellowish-white internal stipe (C.M. Bernardo 799). F. *Pyxine pungens,* thallus morphology (A.A. Spielmann 11169).

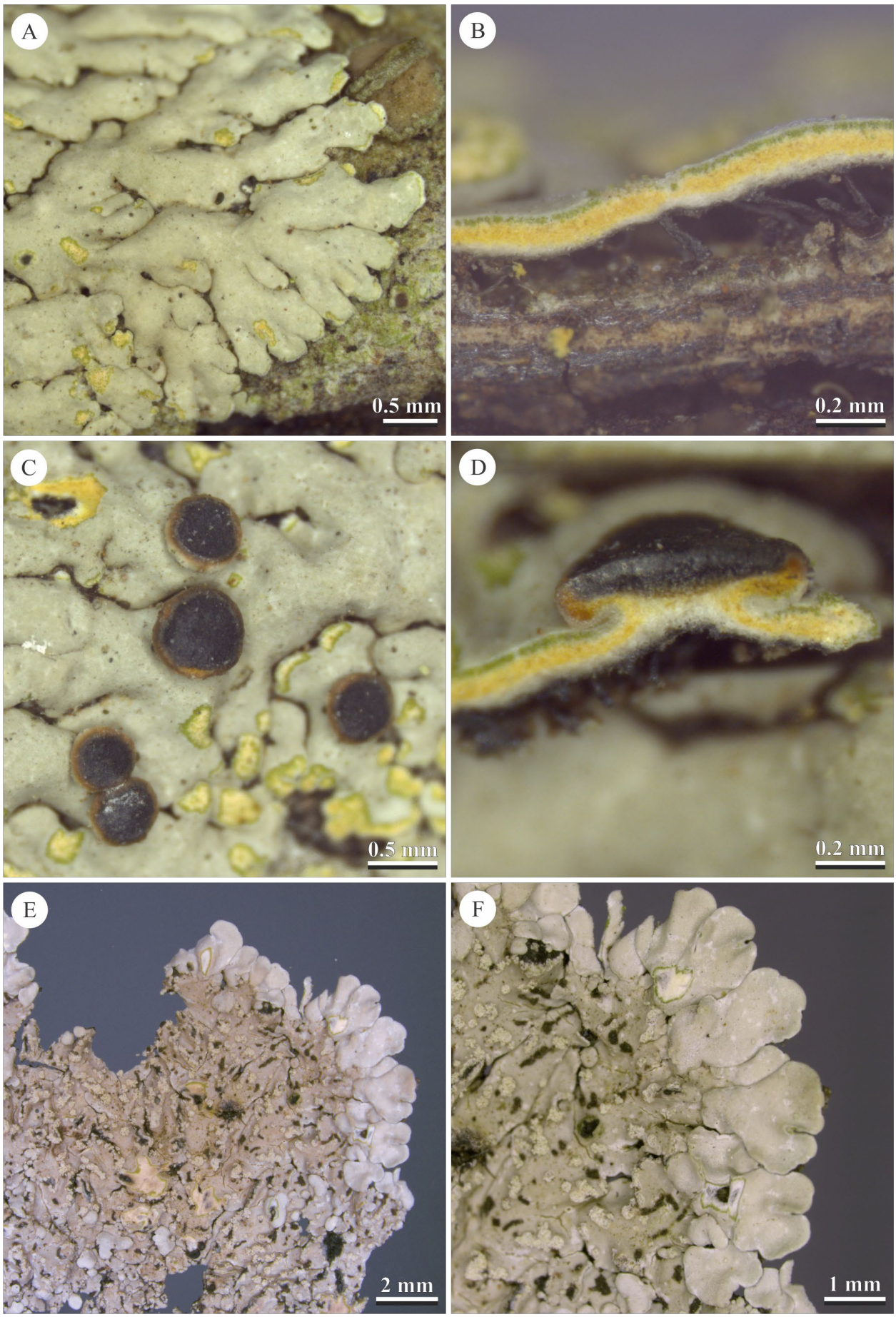


FIGURE 35. A. *Pyxine pungens,* laciniae contiguous, irregularly branched with rounded apices (M.J. Kitaura 4286). B. Transversal section in thallus, evidencing the bicolor medulla (M.J. Kitaura 4286). C. Apothecia *cocoës*-type (M.J. Kitaura 4286). D. Internal stipe white in center and yellow in margins (M.J. Kitaura 4286). E. *Pyxine pustulata,* thallus morphology (T.D. Barbosa 1652). F. Laciniae contiguous, not branched with rounded apices and white pruina board (T.D. Barbosa 1652).

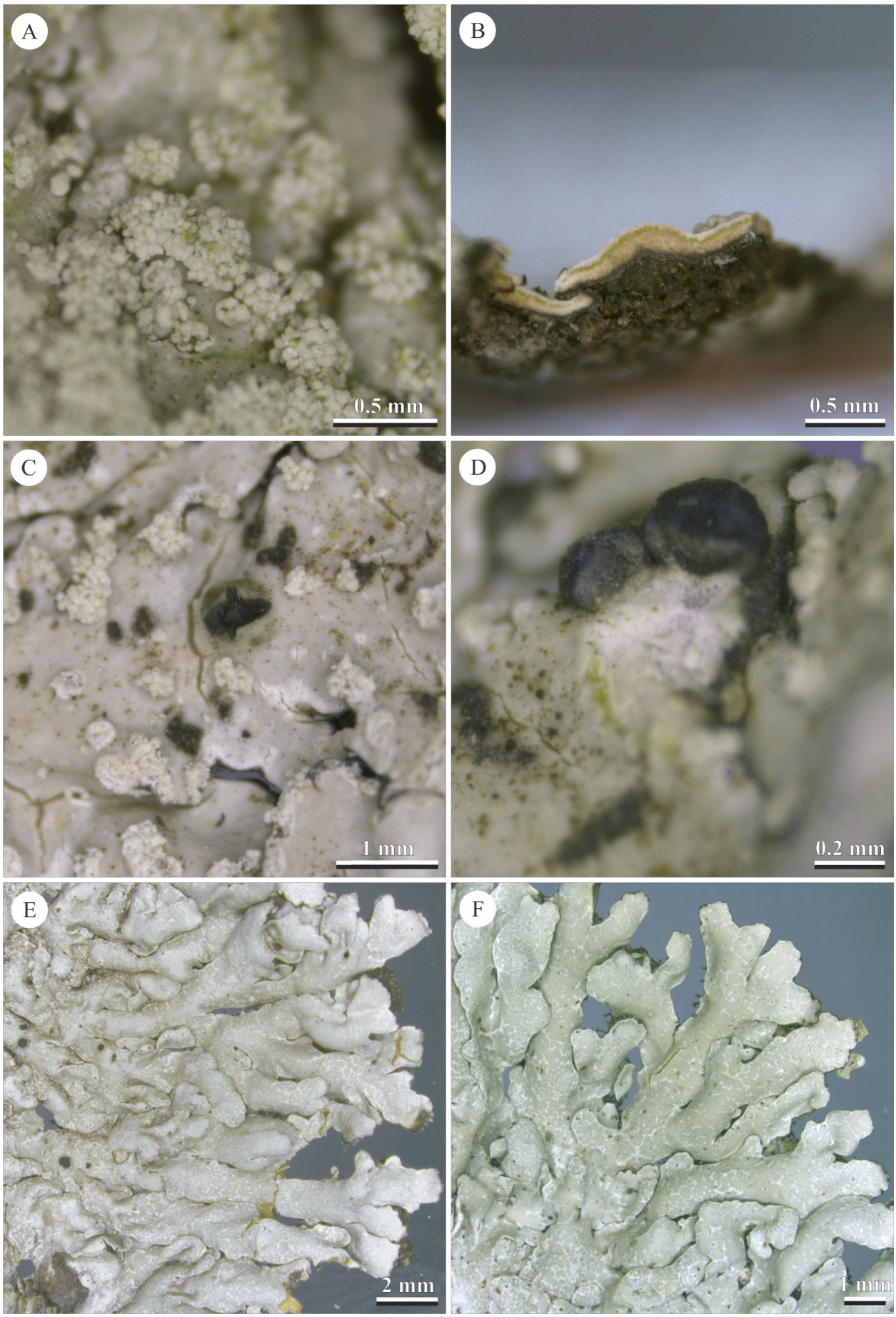


FIGURE 36. A. *Pyxine pustulata,* pustules breaking in soredia (T.D. Barbosa 1647). B. Transversal section in thallus, evidentially ochraceous medulla (T.D. Barbosa 1652). C. Apothecia *cocoës*-type (T.D. Barbosa 1652). D. White internal stipe (T.D. Barbosa 1652). E. *Pyxine rhodesiaca,* thallus morphology (C.M. Bernardo 958). F. Laciniae contiguous to overlapping, irregularly branched, subtruncate to rounded apices and reticulate to subreticulate maculae (C.M. Bernardo 958).

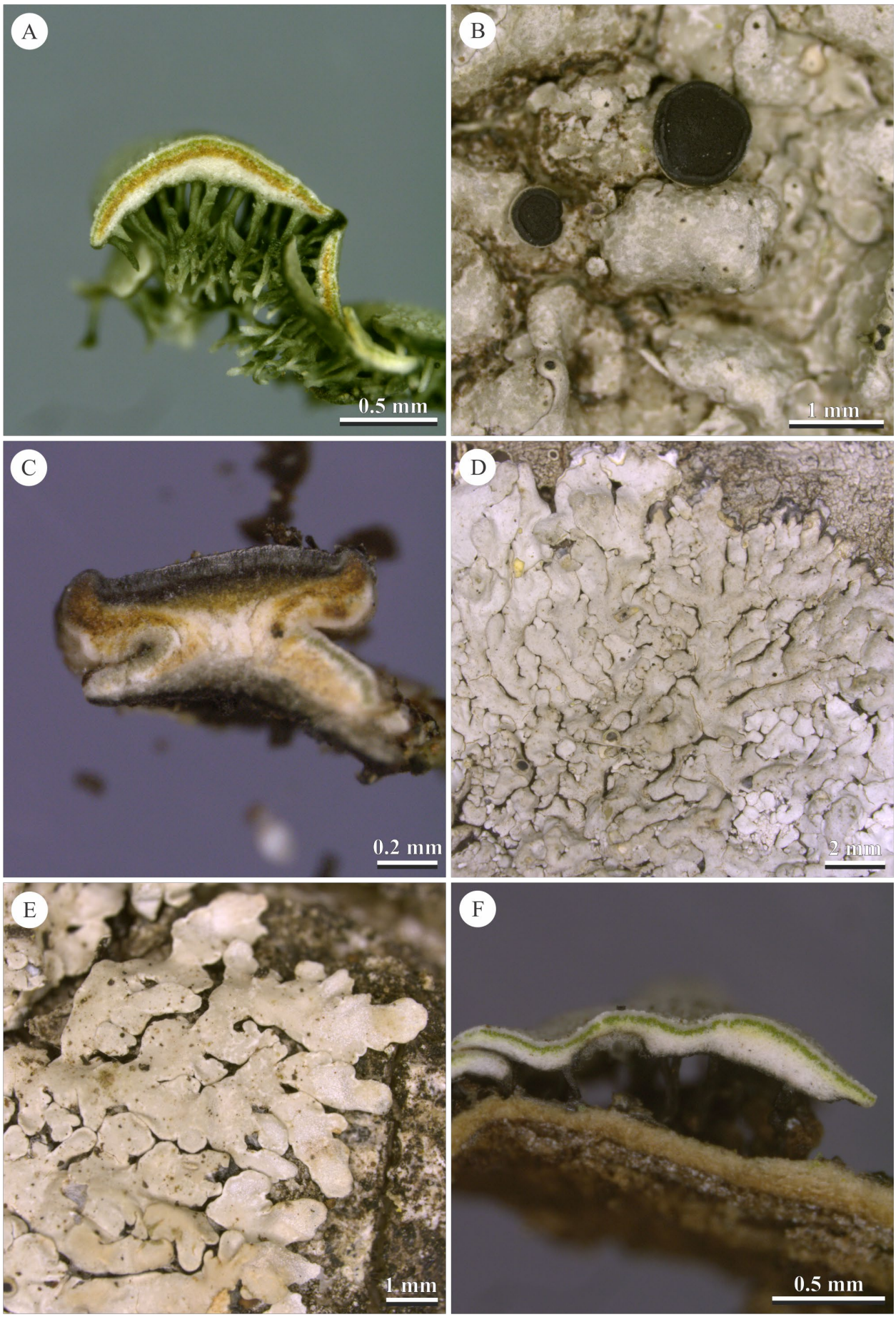


FIGURE 37. A. *Pyxine rhodesiaca,* transversal section in thallus, evidencing the bicolor medulla (C.M. Bernardo 958). B. Apothecia *cocoës*-type (C.M. Bernardo 958). C. Internal stipe white in center and orange in margins (C.M. Bernardo 958). D. *Pyxine simulans,* thallus morphology (R. Lücking 35073). E. Laciniae contiguous to overlapping, irregularly branched, rounded apices and subreticulate to punctiform maculae (R. Lücking 35073). F. Transversal section in thallus, evidentially evidencing the bicolor medulla (T.D. Barbosa 1715).

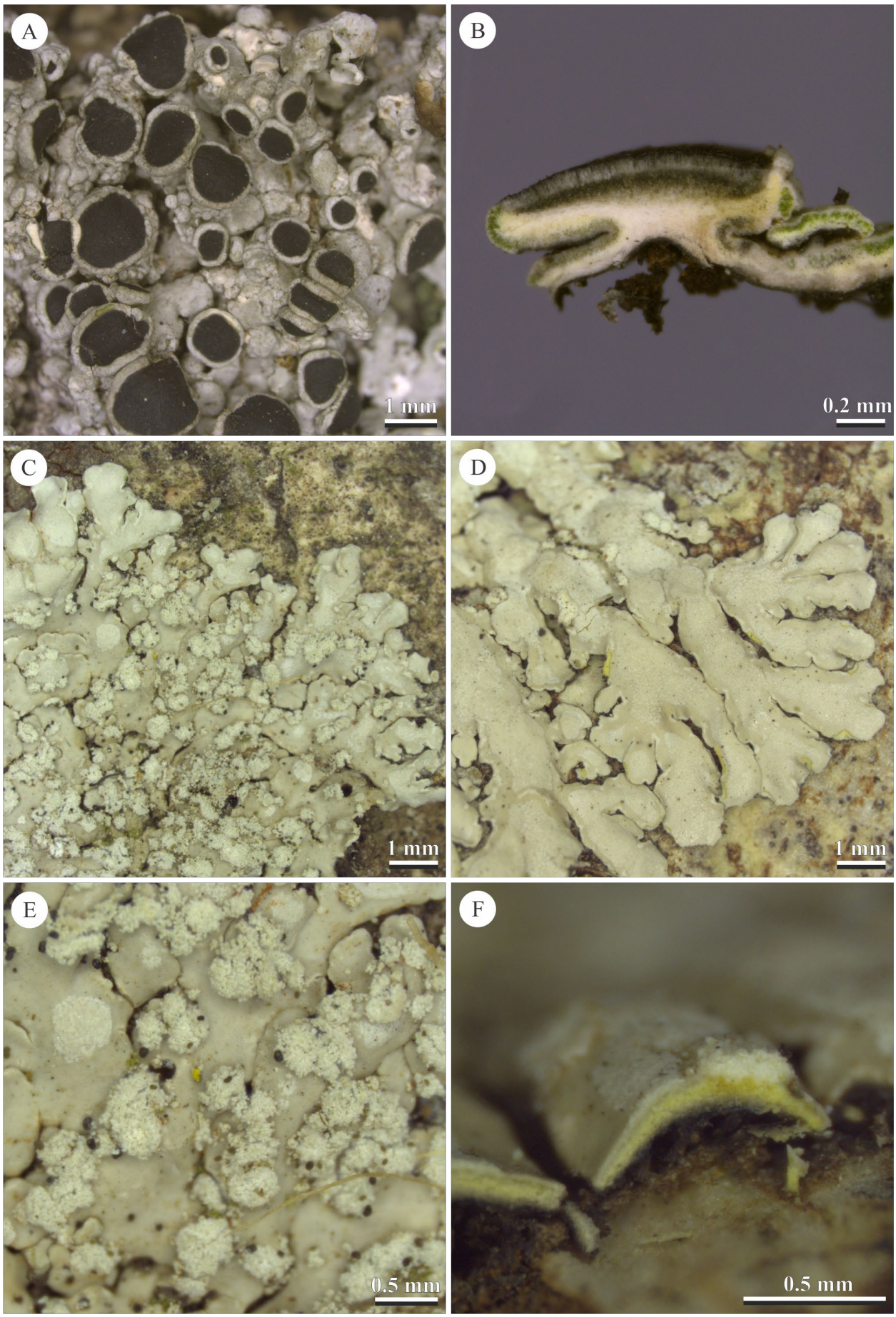


FIGURE 38. A. *Pyxine simulans,* apothecia *physciaeformis*-type (T.D. Barbosa 1715). B. Yellowish-white internal stipe (T.D. Barbosa 1715). C. *Pyxine subcinerea,* thallus morphology (A.A. Spielmann 8555). D. Laciniae contiguous to overlapping, irregularly branched, rounded apices (A.A. Spielmann 8555). E. Crateriform and marginal soralia in crescent-shape to labriform (A.A. Spielmann 10358). F. Transversal section in thallus, evidentially evidencing the bicolor medulla (A.A. Spielmann 10358).

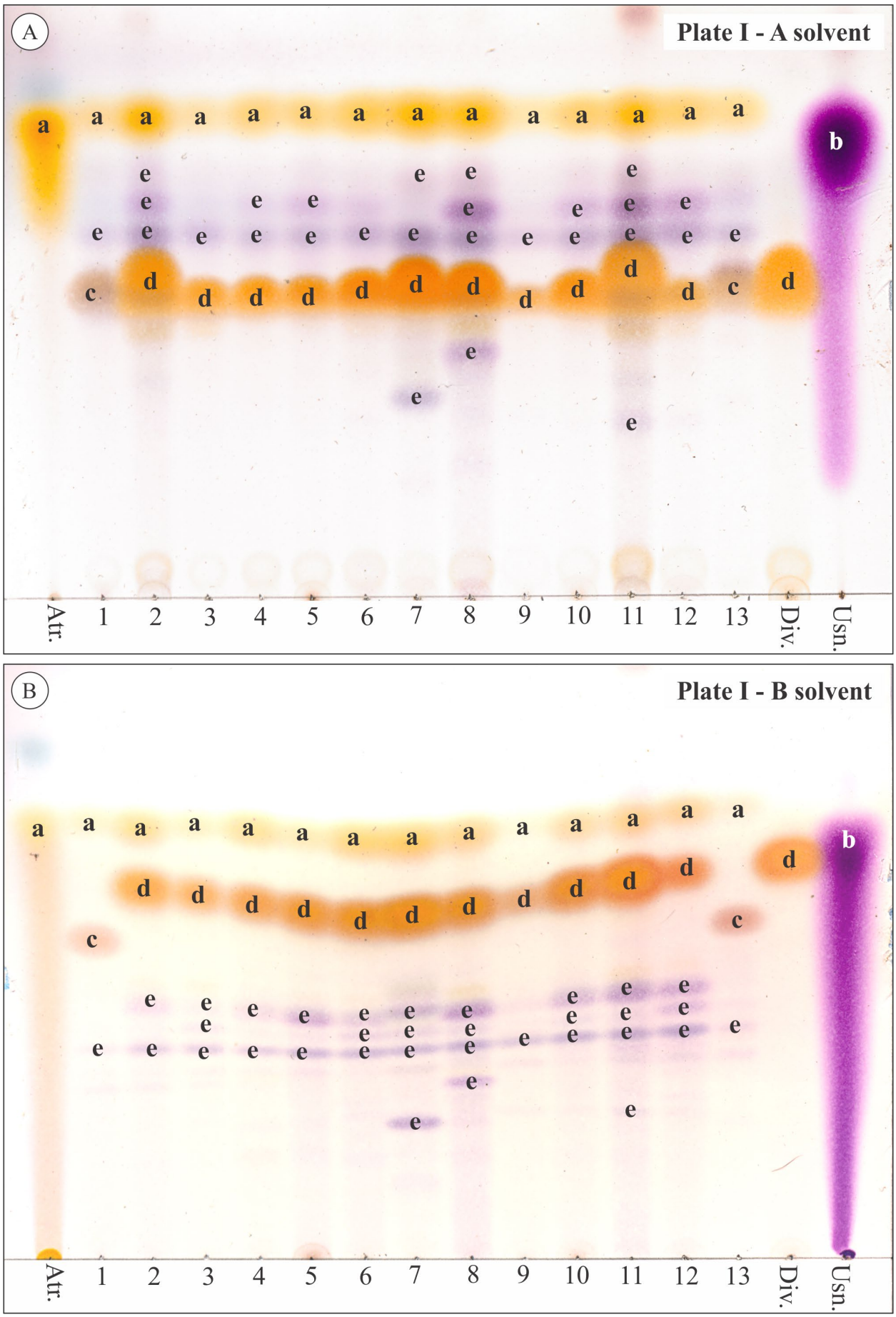


FIGURE 39. (a) atranorin, (b) ustic acid, (c) sekikaic acid, (d) divaricatic acid, (e) unknown terpene, (1) *Dirinaria leopoldii*, (2) *Dirinaria aegialita*, (3) *Dirinaria africana*, (4) *Dirinaria applanata*, (5) *Dirinaria confluens*, (6) *Dirinaria confluens* var. *coccinea,* (7) *Dirinaria melanocarpa*, (8) *Dirinaria papillulifera*, (9) *Dirinaria picta*, (10) *Dirinaria pruinosa*, (11) *Dirinaria purpurascens*, (12) *Dirinaria maracajuensis*, (13) *Dirinaria consimilis*. A. TLC in "solvent A". B. TLC in "solvent B".

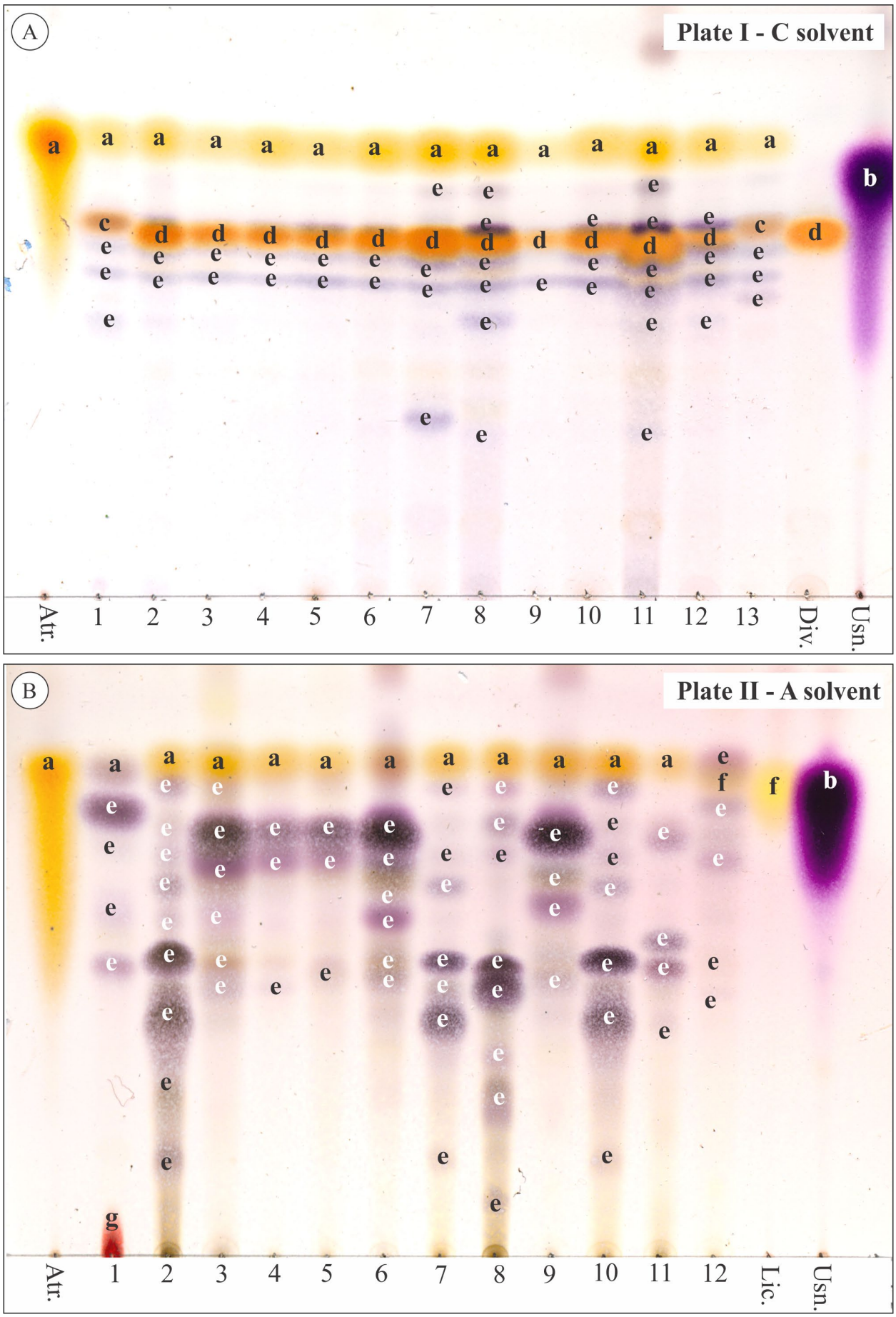


FIGURE 40. (a) atranorin, (b) usnic acid, (c) sekikaic acid, (d) divaricatic acid, (e) unknown terpene, (f) lichexanthone. A. TLC in "solvent C" (1) *Dirinaria leopoldii*, (2) *Dirinaria aegialita*, (3) *Dirinaria africana*, (4) *Dirinaria applanata*, (5) *Dirinaria confluens*, (6) *Dirinaria confluens* var. *coccinea,* (7) *Dirinaria melanocarpa*, (8) *Dirinaria papillulifera*, (9) *Dirinaria picta*, (10) *Dirinaria pruinosa*, (11) *Dirinaria purpurascens*, (12) *Dirinaria maracajuensis*, (13) *Dirinaria consimilis*. B. TLC in "solvent A" (1) *Pyxine coccifera*, (2) *Pyxine astipitata*, (3) *Pyxine coralligera*, (4) *Pyxine daedalea*, (5) *Pyxine flavolucens*, (6) *Pyxine eschweileri,* (7) *Pyxine mantiqueirensis*, (8) *Pyxine obscurascens*, (9) *Pyxine primaria*, (10) *Pyxine pungens*, (11) *Pyxine rhodesiaca*, (12) *Pyxine berteriana*.

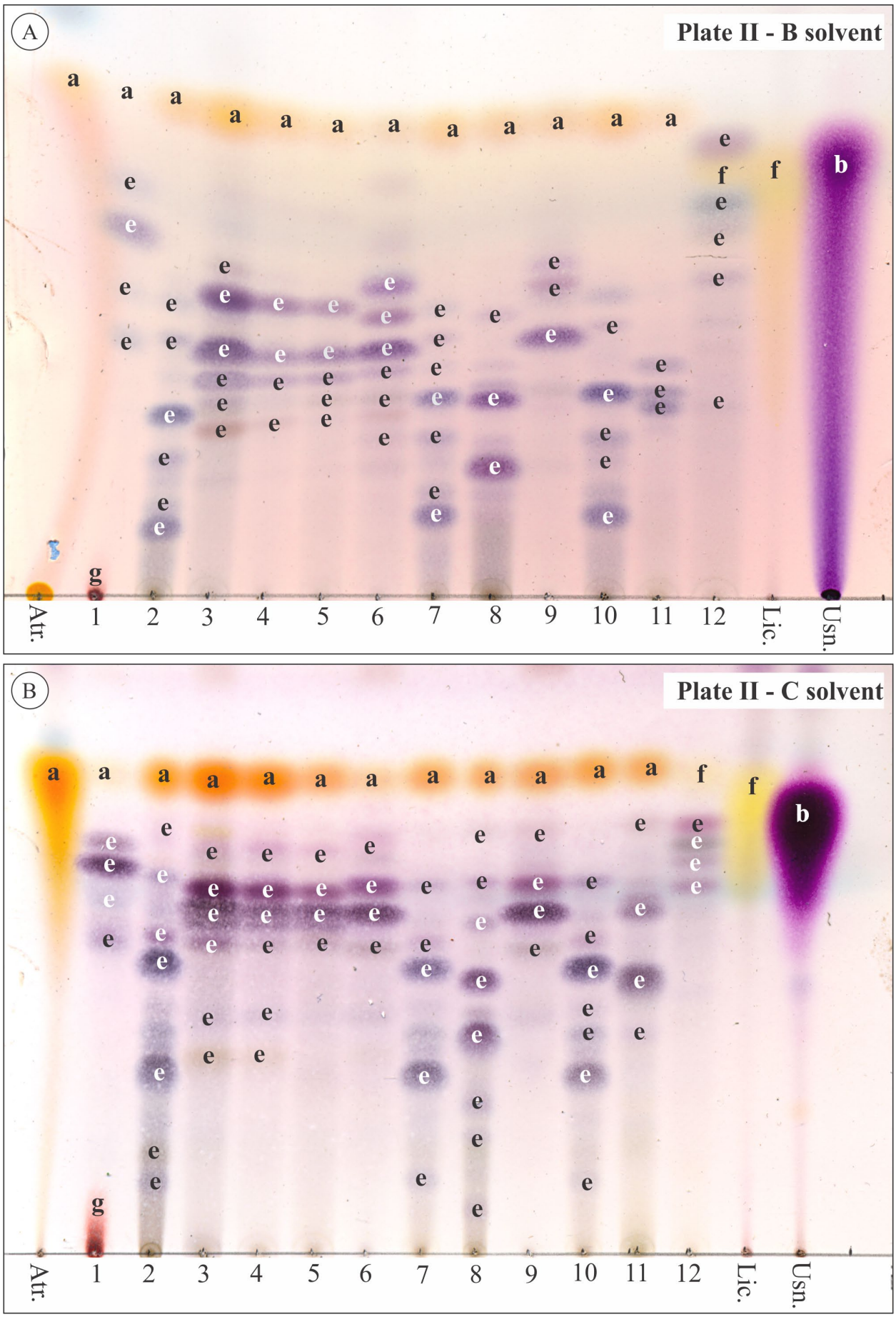


FIGURE 41. (a) atranorin, (b) usnic acid, (e) unknown terpene, (f) lichexanthone, (1) *Pyxine coccifera*, (2) *Pyxine astipitata*, (3) *Pyxine coralligera*, (4) *Pyxine daedalea*, (5) *Pyxine flavolucens*, (6) *Pyxine eschweileri,* (7) *Pyxine mantiqueirensis*, (8) *Pyxine obscurascens*, (9) *Pyxine primaria*, (10) *Pyxine pungens*, (11) *Pyxine rhodesiaca*, (12) *Pyxine berteriana*. A. TLC in "solvent B". B. TLC in "solvent C".

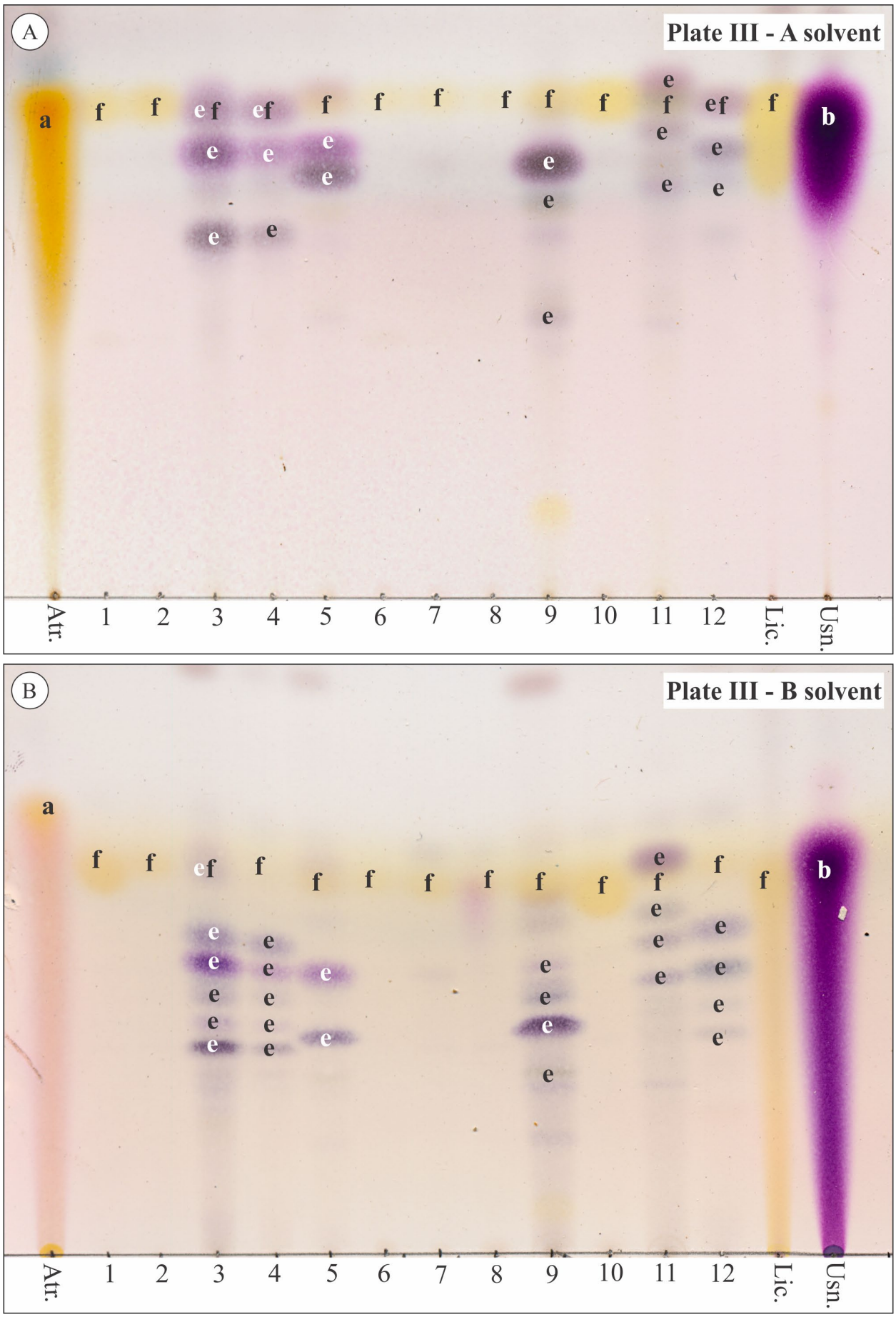


FIGURE 42. (a) atranorin, (b) usnic acid, (e) unknown terpene, (f) lichexanthone, (1) *Pyxine cocoës*, (2) *Pyxine cocoës* var. *pallida*, (3) *Pyxine cognata*, (4) *Pyxine denigricans*, (5) *Pyxine nana*, (6) *Pyxine parapetricola,* (7) *Pyxine petricola*, (8) *Pyxine petricola* var. *convexula*, (9) *Pyxine physciaeformis*, (10) *Pyxine pustulata*, (11) *Pyxine simulans*, (12) *Pyxine subcinerea*. A. TLC in "solvent A". B. TLC in "solvent B".

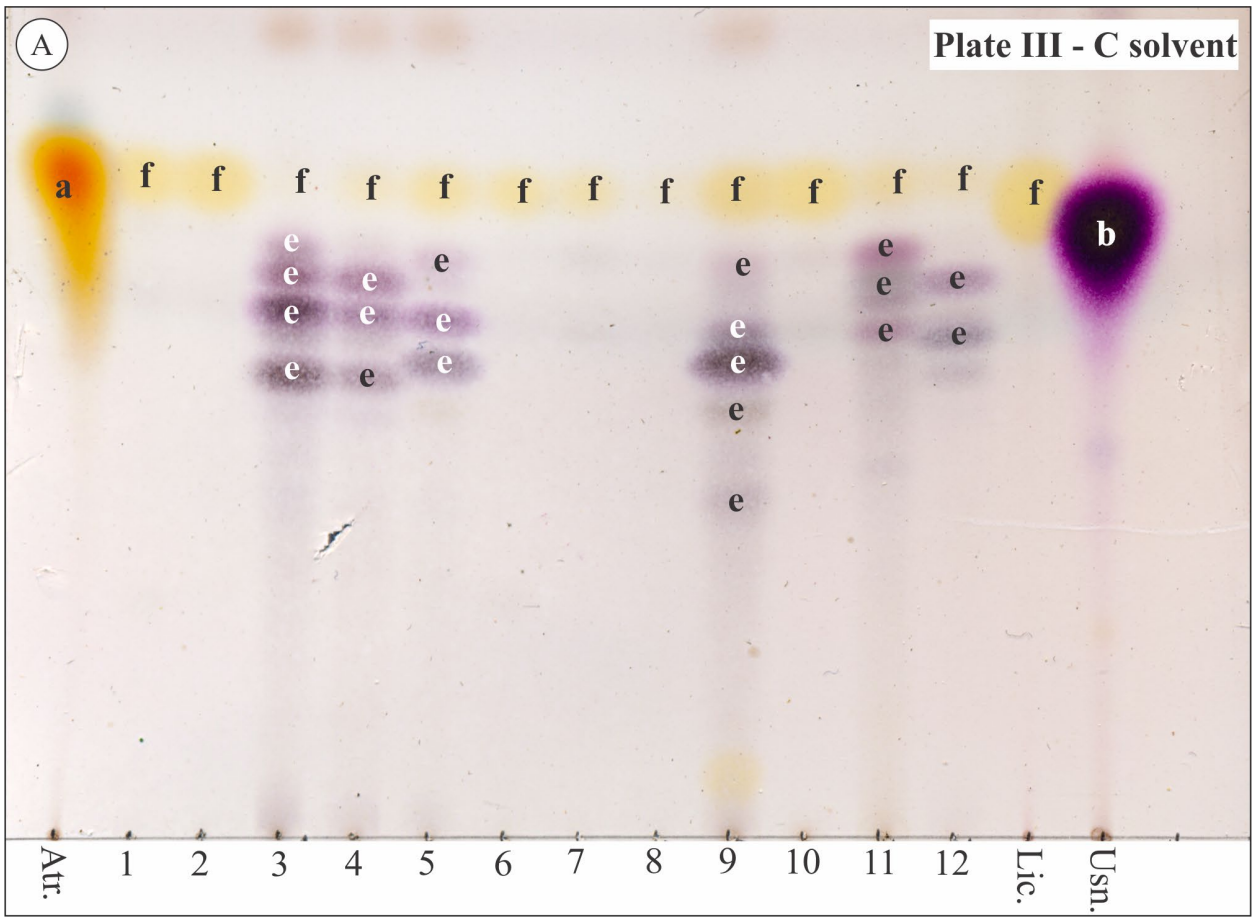


FIGURE 43. (a) atranorin, (b) usnic acid, (e) unknown terpene, (f) lichexanthone, (1) *Pyxine cocoës*, (2) *Pyxine cocoës* var. *pallida*, (3) *Pyxine cognata*, (4) *Pyxine denigricans*, (5) *Pyxine nana*, (6) *Pyxine parapetricola,* (7) *Pyxine petricola*, (8) *Pyxine petricola* var. *convexula*, (9) *Pyxine physciaeformis*, (10) *Pyxine pustulata*, (11) *Pyxine simulans*, (12) *Pyxine subcinerea*. A. TLC in "solvent C".

Chapter II

Circumscription of the genus *Dirinaria* (Caliciaceae, lichenized Ascomycota)

Thiago Dias Barbosa, André Aptroot & Adriano Afonso Spielmann

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Circumscription of the genus *Dirinaria* (Caliciaceae, lichenized Ascomycota)

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Abstract

The genus *Dirinaria* is cosmopolitan and it was globally revised in 1975 by D.D. Awasthi. Since then, many taxa were described and/or transferred to or from other genera, or synonymized, leading to an unrealisticconcept about the diversity of the genus. We compiled the available information in the literature and organized the results in form of keys and tables, including the characterization of the accepted taxa, taxonomical history about each taxon and the synonyms. Three taxa are being excluded from *Dirinaria*.

Key-words: monograph, cosmopolitan, lichen, revision, taxonomy

Introduction

The genus *Dirinaria* (Tuck.) Clem. (1909: 84) is frequently collected together with other macrolichens in all over the world, except in boreal and arctic regions, although most commonly in tropical countries. The identification of species, however, is usually hard because after Awasthi´s monograph in 1975, no other comprehensive account embraced all the known species. The purpose of this paper was to compile from the literature the taxonomical and nomenclatural knowledge about the species of *Dirinaria*, providing an identification key, descriptions, taxonomical history of the genus and its species, the known distribution of each taxon, and making remarks about taxa delimitation that remain poorly understood and discussing closely related species.

Material and methods

We gathered all names in *Dirinaria* independent of the category or the validity of the name. We took as basis Awasthi (1975), which was the only monograph of the genus. In addition, we consulted online databases, *viz*. MycoBank [http://www.mycobank.org] and Index Fungorum

[http://www.indexfungorum.org], thus obtaining a list with 63 names (species, forms and varieties). Also, we consulted Zahlbruckner's Catalogus lichenum universalis (Zahlbruckner 1931) and Index nominum lichenum (Lamb 1963) to check the names that preceded *Dirinaria*. The Recent Literature on lichens (RLL) database [http://nhm2.uio.no/botanisk/lav/RLL/RLL.HTM] was consulted to find bibliographic records.

We made an extensive bibliography review about every name obtained in the list, checking its status (valid name or synonym). In the case of synonyms, we filed the currently corresponding names. Afterwards a new list was compiled with literature data about the distribution of all taxa found. Non-exhaustive efforts but trying to give at least one citation for every country each taxon was reported from, prioritizing papers with taxonomists participation.

We assembled a spreadsheet (appendix 1) based on bibliographical data with the main characteristics of each species. From this we elaborated an identification key that includes all the accepted species known to the moment. As a complement to the key, characterizations were provided whenever possible based in Awasthi (1975) or in protologues of taxa for species described after Awasthi (1975) and comparative comments between nearby species and also the taxonomic history of them. For the characterizations, we used mainly morphological and anatomical standard terms.

Finally, a list of excluded taxa from *Dirinaria* was made, where the accepted names and their respective names are listed when belonging to the genus *Dirinaria.* We propose three new exclusions of the *Dirinaria* genus based on the protologues since the type material has not been recently studied.

Results and Discussion

HISTORY OF THE GENUS *DIRINARIA*

Awasthi (1975) presented a detailed account of the history of *Dirinaria* and the reader is referred to that monograph. We present here a temporal line focused on the evolution of the concept of *Dirinaria*, mainly the changes after 1975.

Most species of the genus were originally described in other genera (Awasthi 1975). The oldest species was described by Swartz (1788), as *Lichen pictus* Sw. (1788: 146) [*Dirinaria picta* (Sw.) Clem. & Shear (1931: 323), the type species of the genus] based on specimens from Jamaica. Acharius (1803) placed *Lichen pictus* in *Parmelia* Ach. (1803: 153) and also described *Parmelia aegialita* Ach. (1803: 191). Later Acharius (1810) transferred *Parmelia aegialita* to *Lecanora* Ach. (Lyuken 1809: 90) and described one more species, *Lecanora adscensionis* Ach. (1810: 422). Fée

(1824) described *Parmelia applanata* Fée (1824: 126), and Fries (1825) described *Parmelia confluens* Fr. (1825: 284).

Nylander (1858-1860) dealt with these species but treated all of them as belonging in *Physcia* (Schreb.) Michx. (1803: 326). However, based on different concepts Trevisan (1868) placed *Lichen pictus* and *Parmelia confluens* in the genus *Dimelaena* Norman (1852: 231), in section *Hypomelaena* Trevis. (1868: 623) characterized by "subhymenium fusco-nigrum, sporae biloculares". It seems that Trevisan was thinking about this section as a transition to *Pyxine* Fr. (1825: 267) or as an independent genus. Baglietto (1875) included this section in *Hagenia* Eschw. (1824: 20). Some years later Tuckerman (1877) established a new section *Dirinaria* Tuck. inside *Pyxine.*

The shift to the genus *Pyxine* was based on the dark coloration of the subhymenium. Nevertheless, Nylander (1867) retained the species in *Physcia* and was followed by Vainio (1890, 1923), Müller Argoviensis (1894), Zahlbruckner (1907, 1926, 1931), Lynge (1924), Magnusson & Zahlbruckner (1945) and Thomson (1963). During this period, several new taxa that now belong to *Dirinaria* were described from different parts of the world, all as *Physcia*. Those authors used mainly the thalline margin as a distinctive feature, and not the subhymenium, even when these taxa were arranged in the section *Hypomelaena* (Awasthi 1975).

The name of the section *Hypomelaena* is older than *Dirinaria,* but for unknown reasons, Clements (1909) proposed a new status for the *Dirinaria* section, which was elevated to the genus level. According to Clements the presence of the persistent thalline exciple and black subhymenium characterized and distinguished *Dirinaria* from the closely similar genera *Physcia* and *Pyxine.*

After Clements (1931) combined *D. picta*, Awasthi (1964) combined three species in *Dirinaria*, viz. *D. aspera* (H. Magn.) D.D. Awasthi (1964: 371), *D. papillulifera* (Nyl.) D.D. Awasthi (1964: 369), and *D. persoredians* (Nyl.) D.D. Awasthi (1964: 370), and Moore (1968) combined two species that occur in North America, *D. aegialita* (Ach.) B.J. Moore (1968: 248) and *D. purpurascens* (Vain.) B.J. Moore (1968: 251). Afterwards Hale & Culberson (1970) combined another taxon from North America, *D. frostii* (Tuck.) Hale & W.L. Cul. (1970: 513), and finally Awasthi & Agarwal (1970) made two new combinations, *D. applanata* (Fée) D.D. Awasthi (Awasthi & Agarwal 1970: 135) and *D. consimilis* (Stirt.) D.D. Awasthi (Awasthi & Agarwal 1970: 135).

A work with many additions to the genus was Dodge (1971), with 14 new combinations and two new species. However, Dodge ignored the previous contributions of Awasthi (1964), Moore (1968) and Awasthi & Agarwal (1970) and many of his combinations were not valid, as they had already been made by these authors. Dodge seemed to be hesitant with the

circumscription of *Dirinaria* and *Pyxine* and proposed the combination of *Pyxine devertens* (Nyl) Vain. (1915: 70) in *D. devertens* (Nyl.) C.W. Dodge (1971: 181), a combination not accepted by Swinscow & Krog (1978).

Although several authors after Clements (1909, 1931) such as Imshaug (1957), Awasthi (1964), Poelt (1965), Moore (1968), Hale & Culberson (1970), Awasthi & Agarwal (1970), and Dodge (1971) have accepted *Dirinaria* as a valid genus, the genus was better defined only in the monograph made by Awasthi (1975).

Awasthi (1975) was the first to make a monograph of all species of *Dirinaria* known at that the time, with identification key and detailed descriptions for the taxa based on the type specimens. He also described new species. Awasthi disagreed with Dodge (1971) for many reasons but did not have the necessary time to analyze the specimens examined by Dodge and Awasthi commented that these species were probably more related to *Pyxine* than to *Dirinaria*.

The problematic species were discussed in the appendix of the work of Awasthi (1975) and he demonstrated the incoherence of some of the arguments presented by Dodge (1971), although the specimens were not reviewed and doubts about these taxa remained.

The next significant change in *Dirinaria* was made by Swinscow & Krog (1978) for species of the East Africa, which is a supplement to the Awasthi monograph. These authors made statistical analyses, correlating the hymenium thickness with apothecia diameter, since this characteristic was utilized by Awasthi (1975) as specific character. The results did not support the use of this characteristic for specific delimitation, thus Swinscow & Krog (1978) included several synonyms within *D. confluens* (Fr.) D.D. Awasthi (1975: 28).

Swinscow & Krog (1978) analyzed other morphological, anatomical and chemical characteristics, and transferred *D. subpicta* (Nyl *in* Cromb.) C.W. Dodge (1971: 188) to the genus *Diploicia* A. Massal. (1852: 86), as a synonym of *Diploicia canescens* (Dicks.) A. Massal. (1852: 86). After Swinscow & Krog, no work aimed the understanding *Dirinaria* from the taxonomic point of view. The contributions were restricted to geographical citation and descriptions of some species, the principal authors being Kalb (2001, 2004a) and Elix (2008, 2009).

As *Dirinaria* was considered a section of *Physcia* for a long time, when it was elevated to genus level by Clements (1909, 1931), the genus was included by many authors as belonging to the Physciaceae, e.g. by Dodge (1971), Awasthi (1975), Swinscow & Krog (1978), Kalb (2004a) and Jungbluth & Marcelli (2012).

The circumscription of the Physciaceae and the relationship with the Caliciaceae was discussed by Nordin & Mattson (2001), Helms *et al.* (2003), and after Pietro & Wedin (2016) and Lücking *et al.* (2017) both families are treated as sister groups and *Dirinaria* is considered to be a genus of the Caliciaceae.

DIVERSITY IN *DIRINARIA*

The knowledge about the diversity in *Dirinaria* had as starting point the monograph of Awasthi (1975), who was the first author to compile all species of the genus in a single work, with minute descriptions. In this work he cited 25 species and nine varieties, one form and he commented about three species described by Dodge (1971) but he did not make clear if these three species were accepted by him. However, when considering these species, 28 species were known until 1975. In the treatment for the African species of *Dirinaria* by Swinscow & Krog (1978) three species were reduced to synonymy, remaining 22 species, eight varieties and one form in the genus.

Afterwards, the number of known species was given by Kalb (2004a) as 35 species, Awasthi (2007) as 25 species, Kirk *et al.* (2008) 29 species and Elix (2009) considered 36 species. In the last classification of the lichenized fungi in Ascomycota and Basidiomycota, Lücking *et al.* (2017), probably based on Kalb (2004a), cited 35 species.

After an exhaustive bibliographic review, we were able to find 28 species, six varieties and one form, but of these only 25 species and four varieties and forms were considered as accepted (for the other three see discussion on excluded species).

GENERAL ACCOUNT

Morphology

Thallus foliose (Figure 1A), generally strongly attached to substrate, the radiating laciniae dichotomously, subdichotomously to palmatifid branched, the laciniae can be confluent and contiguous or confluent overlapping, parallel (not touching) or parallel contiguous, the apices vary from flabellate, slightly flabellate to discrete and the surface of the thallus can be smooth or rugose, the plication, when present, can be longitudinall or irregular. The plication condition in some taxa can vary over time, giving the surface in proximal region a verrucose condition, resembling a crustose thallus (Awasthi 1975).

The combination of the features of the laciniae was divided by Awasthi (1975) in two principal types, the first is *Dirinaria picta*-type (Figure 1B) that consists of parallel laciniae, presenting non plicate or slightly longitudinally plicate surface, discrete apices and palmatifid branched; the second is *Dirinaria applanata-Dirinaria confluens*-types (Figure 1C) that show the confluent laciniae, strongly longitudinally plicate surface, flabellate apices and dichotomously to

subdichotomously branched. This classification is mentioned by Jungbluth & Marcelli (2012) in a synthesis of the genus.

Upper surface generally longitudinally plicate (Figure 1D) to irregularly (Figure 1E) or rarely complicate in *D. complicata* D.D. Awasthi (1975: 51), greyish white, grey, dark grey, rarely yellowish grey or yellowish white and only one species shows the deep yellow, *D. flava* (Müll. Arg.) C.W. Dodge (1971: 181), but the upper surface color does not demonstrate, a good character for discrimination of other species. The other characteristic commonly used in the taxonomy is the pruina (Figure 1F). This feature may not always be present and if present, may vary in quantity, agglomeration pattern and distribution (proximal region or distal region). Maculae (Figure 1G) are present in some species, but this feature has not been widely used, only Awasthi (1975) cited it for one species and Swinscow & Krog (1978) mention it for more species but referred to them as "pseudocyphella"; the maculae are marginal or laminal, generally common in the distal region, can be linear, effigurate or subreticular.

The medulla shows a variety of colors: white (Figure 1H), yellow (Figure 1I), red (Figure 1J), orange. However, the colors in some cases do not correspond with other taxonomic characters (Lynge 1924), but authors as Awasthi (1975) and Kalb (2004a) utilized this feature for the description of new species to science. This feature was never tested systematically. The red color that occurs in *D. confluens* var. *coccinea* (Lynge) D.D. Awasthi (1975: 31) and *D. coccinea* (Müll. Arg.) D.D. Awasthi (1975: 53), and the orange color occuring in *D. neotropica* Kalb (2004a: 102) seem to be quite stable characters.

The lower surface is smooth or rugose, without rhizinae, although some species have precursors of rhizinae, generally black (Figure 1K) to dark brown, rarely yellowish-white (Figure 1L) to white; only two species have a pale lower surface: *D. complicata* and *D. melanocarpa* (Müll. Arg.) C.W. Dodge (1971: 179).

Vegetative propagules are common in *Dirinaria* and three different structures can be distinguished: isidia, polysidiangia and soralia.

Isidia (Figure 2A) occur only in one species, *D. papillulifera* (Nyl.) D.D. Awasthi (Awasthi 1964); they are cylindrical, unbranched to irregularly branched, concolorous with the thallus, and the initial stage is similar to papillae.

Polysidiangia (Figure 2B) starts as structures similar to verrucae becoming coralloid with irregular branching, that may or may not release granular soralia. This vegetative propagule was described by Kalb (1987) for the genus *Pyxine* and was applied to *Dirinaria* by Kalb (2001). These vegetative propagules occur in three species: *D. aegialita, D. consimilis* and *D. pruinosa* Kalb (2001: 147).

Soralia (Figure 2C) are generally laminal, and in origin could be erumpent or crateriform. The only species with crateriform soralia is *D. frostii*. The other sorediate species have erumpent soralia that present many forms, such as orbicular capitate, hemispherical, linear or irregular. The development and form of the soralia are helpful for species delimitation and identification. Soredia can be farinose when they are delicate or granular when they are robust. No corticate propagules are known in the genus.

Apothecia present variable sizes (0.3−3.0 mm), are lecanorine (Figure 2D) and can be immersed, sessile with constricted base or substipitate; only *D. batavica* D.D. Awasthi (1975: 42) has substipitate apothecia; *D. africana* (Müll. Arg.) D.D. Awasthi (1975: 40) can have subimmersed (Figure 2E) to immersed apothecia. The most common type is sessile with constricted base (Figure 2F). The apothecial disc is generally black to dark brown, and commonly presents a pruina that can be white (Figure 2G), grey, yellowish (Figure 2H), bluish or purplish (Figure 2I); *D. melanoclina* (C. Knight) D.D. Awasthi (1975: 77), *D. purpurascens* and *D. pruinosa* have a purplish pruinose discs. The margin of the apothecia can be smooth or crenate. The feature of the internal stipe as used in *Pyxine* by Imshaug (1957) and Kalb (1987) has not been systematically applied in *Dirinaria*, but Awasthi (1975) mentioned that *D. africana* possesses yellow incrustations in the region of the medulla under the apothecia. This character is cited only for this species and needs to be better studied in other taxa.

Anatomy

The upper cortex is paraplectenchymatous with three to five layers of colorless cells; in the upper surface a layer of crystals (pruina) can be present. The algal layer varies in thickness and is continuous in all species. The medulla is generally composed of lax hyphae and can vary in color. The lower cortex is prosoplectenchymatous; due to the compaction of the hyphae it is not possible to count the number of cell layers and it is generally dark brown to black.

The epithecium can be yellowish to colorless in *D. melanocarpa* or dark brown to brown in most of the species (Awasthi 1975, Elix 2009). The hymenium was considered by Awasthi (1975) as a tissue of importance in the delimitation of the species; in general, the thickness is measured and can be colorless or yellowish. The subhymenium is also important for the taxonomy of the genus; only two species have a yellowish (Figure 2J) to colorless subhymenium: *D. batavica* and *D. melanocarpa,* in most species it is dark-brown to brown-black (Figure 2K). The thickness is also used as additional character with taxonomical importance. Awasthi (1975) used the subhymenium form too, but this character was shown by Swinscow & Krog (1975) to be insignificant and it is not used here.

Ascospores are two-celled, brown to dark brown, of the *Dirinaria*-type (Mayrhofer 1982) (Figure 2L) with thick walls and the lumen of the two cells connected by an isthmus in young stages (Awasthi 1975). Dodge (1971) described species with two or three septate ascospores. However, three-celled ascospores are not known in *Dirinaria*, although present in *Pyxine*.

Conidia are bacilliform, with 3−6 µm length and show no taxonomic importance (Jungbluth & Marcelli 2012), but only Awasthi (1975) observed this character.

Chemistry

The genus shows three main chemical components: atranorin, divaricatic acid and sekikaic acid (Awasthi 1975), the two last show a reaction UV+ bluish-white (Figure 3A). Arthothelin occurs in *D. flava* and unknown terpenes in other species (Elix 2009). All species have atranorin, but there are some species that contain only atranorin: *D. caesiopicta* (Nyl.) D.D. Awasthi (1975: 94)*, D. leopoldii* (Stein) D.D. Awasthi (1975: 89) and *D. naggarana* (Kremp.) D.D. Awasthi (1975: 61). Sekikaic acid is present in four species: *D. confusa* D.D. Awasthi (1975: 56)*, D. consimilis, D. minuta* Kalb (2001: 145) and *D. sekikaica* Elix (2008: 36). The remaining species have divaricatic acid. Culberson & Culberson (1970) reported the main chemical groups in the genus. Jörgensen (1973) commented on the importance of sekikaic acid in the taxonomy of the genus.

TAXONOMIC TREATMENT OF *DIRINARIA*

Dirinaria (Tuck.) Clem. (1909: 84).

– *Pyxine* sect. *Dirinaria* Tuck. (1877: 166); *Physcia* sect. *Dirinaria* (Tuck.) Vain. (1890: 150); *Dimelaena* sect. *Hypomelaena* Trevis. (1868: 623); *Physcia* subgen. *Hypomelaena* (Trevis.) Vain. (1923: 37).

MORPHOLOGY. **Thallus** foliose, closely adpressed or adglutinated to substrate, corticicolous, ramuliculous or saxicolous. **Upper surface** proximal region grey, whitish grey, white, greyish white to rarely deep yellow, smooth to rugose, not plicate to longitudinally plicate or irregularly plicate, pruina absent to present; distal region grey, whitish grey, white, greyish white to rarely deep yellow, smooth to rugose, not plicate to longitudinally plicate or irregularly plicated, pruina absent to present. **Maculae** present to absent, marginal to submarginal or laminal. **Laciniae** discrete to confluent, not branched to dichotomously or palmatifid branched; apices not flabellate to flabellate, subtruncate to rounded or rarely truncate to retuse, margin smooth to crenate. **Medulla** white, orange, coccineous (red); pigment absent or present yellow (sulphur). **Lower**

surface generally black, dark brown or rarely light-brown to cream, margin black, dark brown to light-brown. **Rhizinae precursors** present or absent, laminal. **Isidia** present or absent. **Polysidiangia** present or absent, submarginal to laminal, irregular; **soredia** whitish green, granulose. **Soralia** present or absent, crateriform or erumpent, generally hemispherical to capitate. **Lacinulae** present or absent, generally adventitious. **Apothecia** generally present, 0.5−3.0 mm diam., laminal, immersed to sessile of the constrict base or substipitate; **disc** black to dark brown, plane to convex or rarely concave, pruina present or absent, white, bluish, yellowish or purplish; **margin** smooth to crenate; **amphithecium** smooth, ornament present or absent, isidia or soredia; **internal stipe** present or absent.

ANATOMY. **Thallus upper cortex** paraplectenchymatous, 2–5 cell layer; **algal layer** photobiont trebouxioid, continuous; **medulla** colorless to yellow or coccineous (red); **lower cortex** prosoplectenchymatous, dark-brown. **Apothecia epihymenium** light-brown; **hymenium** colorless to yellowish, paraphyses apices not capitate or capitate; **subhymenium** brown-black, dark brown, light brown or rarely colorless; **ascospores** *Dirinaria*-type.

KNOWN CHEMISTRY. Atranorin, divaricatic acid, sekikaic acid, arthothelin and terpenes.

Description based on Awasthi (1975), Kalb (2004a) and Elix (2009).

REMARKS.

Dirinaria is characterized by the foliose thallus, the paraplectenchymatous upper cortex, prosoplectenchymatous lower cortex, generally with brown-black subhymenium, ascospores of *Dirinaria*-type and atranorin in the upper surface.

Currently 37 genera are recognized in the Caliciaceae. Of these, only three are foliose, *viz*. *Culbersonia* Essl., *Dirinaria* and *Pyxine*. *Pyxine* has rhizinae in the lower surface, is in general not plicate and as principal difference has a K+ violet epithecium. *Diploicia* is a crustose genus but presents an appearance proximity to a foliose thallus and shows the longitudinally plicate upper surface; however, it has no lower cortex.

All species of *Dirinaria* are compared with each other, in order to facilitate a rapid recognition of the main anatomical, morphological and chemical groups (Table 1).

World key to the species of *Dirinaria*

1a. Thallus with vegetative propagules 2

1b. Thallus without vegetative propagules 14

2a. (1a). Isidia present, polysidiangia and soralia absent ..... *D. papillulifera*[20]

2b. Isidia absent, polysidiangia and soralia present 3

3a. (2b). Polysidiangia present, soralia absent 4

3b. Polysidiangia absent, soralia present 6

4a. (3a). Laciniae with flabellate apices; apothecial disc epruinose or whitish pruinose 5

4b. Laciniae without flabellate apices; apothecial disc purplish pruinose ..... *D. pruinosa*[22]

5a. (4a). Apothecial disc black; ascospores 14–23 × 6–8 µm; sekikaic acid present, divaricatic acid absent ..... *D. consimilis*[11]

5b. Apothecial disc black; ascospores 13–17(–19) × 5–7 (–8) µm; sekikaic acid absent, divaricatic acid present ..... *D. aegialita*[2]

6a. (3b). Medulla white or yellowish, without coccineous pigments 7

6b. Medulla white or yellowish white, with coccineous pigments (reddish orange) *D. leopoldii*[14]

7a. (6a). Soralia hemispheric to capitate present, but soralia crateriform and botryose absent 8

7b. Soralia hemispheric to capitate absent, but soralia crateriform and botryose present 13

8a. (7a). Laciniae flabellate; thallus strongly longitudinally plicate 9

8b. Laciniae not flabellate; thallus not or rarely longitudinally plicate 10

9a. (8a). Divaricatic acid present, sekikaic acid absent ..... *D. applanata*[4]

9b. Sekikaic acid present, divaricatic acid absent ..... *D. sekikaica*[24]

10a. (8b). Upper cortex greyish, C– (xanthones absent) 11

10b. Upper cortex yellow, C+ orange-red (xanthones present) ..... *D. flava*[12]

11a. (10a). Thallus on rock; black lower surface; only atranorin present ..... *D. caesiopicta*[6]

11b. Thallus on bark; brown-black lower surface; atranorin and divaricatic acid present 12

12a. Apothecia disc epruinose or withish pruinose ..... *D. picta*[21]

12b. Apothecia disc purplish pruinose ..... *D. melanoclina*[16]

13a. (7b). Crateriform soralia present, botryose soralia absent ..... *D. frostii*[13]

13b. Crateriform soralia absent, botryose soralia present ..... *D. naggarana*[18]

14a. (7b). Medulla non-pigmented (white), or yellowish 15

14b. Medulla with pigments, orange or coccineous 25

15a. (14a). Lower surface black or brown-black 16
15b. Lower surface pale yellowish, or pale brown 23

16a. (15a). Flabellate laciniae apices 17
16b. Not flabellate laciniae apices 20

17a. (16a). Thallus corticicolous; apothecia sessile with constrict base 18
17b. Thallus saxicolous; apothecia immersed or substipitate 19

18a. (17a). Divaricatic acid present, sekikaic acid absent ..... *D. confluens*[9]
18b. Divaricatic acid absent, sekikaic acid present ..... *D. confusa*[10]

19a. (17b). Apothecia immersed; dark-brown subhymenium ..... *D. africana*[3]
19b. Apothecia substipitate; brown to light-brown subhymenium ..... *D. batavica*[5]

20a. (17b). Thallus not longitudinally plicate 21
20b. Thallus longitudinally plicate 22

21a. (20a). Apothecial disc with purple pruina ……. ..... *D. purpurascens*[23]
21b. Apothecial disc epruinose ..... *D. subconfluens*[25]

22a. (20b). Divaricatic acid present, sekikaic acid absent ..... *D. adscensionis*[1]
22b. Divaricatic acid absent, sekikaic acid present ..... *D. minuta*[17]

23a. (15b). Thallus longitudinally plicate; subhymenium light-brown to yellow or 24
23b. Thallus complicate (bending over itself); subhymenium dark-brown or brown-black ……..
..... *D. complicata*[8]

24a. (23a). Thallus on bark; laciniae 1−3 width mm; apothecia sessile of constrict base; subhymenium 100 µm ..... *D. melanocarpa*[15]
24b. Thallus on rock; laciniae 0.3−0.8 mm width; apothecia substipitate; subhymenium 60−80 µm
..... *D. batavica*[5]

25a. (14b). Medulla throughout coccineous; divaricatic acid absent ..... *D. coccinea*[7]
25b. Medulla white with pigments orange only the lower region, or medulla white with pigments coccineous distributed especially in the upper region; divaricatic acid present 26

26a. (25b). Medulla white with orange pigments, only the lower region ..... *D. neotropica*[19]
26b. Medulla white with coccineous pigments distributed especially in the upper region
…… ..... *D. confluens* var. *coccinea*[9.1]

Table 1. Species of *Dirinaria* grouped by anatomical, morphological and chemical characteristic.

	Atranorin	**Atranorin and divaricatic acid**	**Atranorin and sekikaic acid**	**Atranorin, divaricatic acid and arthothelin**
Without propagules	*D. coccinea*	*D. adscensionis* *D. africana* *D. batavica* *D. complicata* *D. confluens* *D. confluens* var. *coccinea* *D. frostii* *D. melanocarpa* *D. neotropica* *D. purpurascens* *D. subconfluens*	*D. confusa* *D. minuta*	
Isidia		*D. papillulifera*		
Polysidiangia		*D. aegialita* *D. pruinosa*	*D. consimilis*	
Soralia	*D. caesiopicta* *D. leopoldii* *D. naggarana*	*D. applanata* *D. melanoclina*	*D. sekikaica*	*D. flava*
Complicate thallus		*D. complicata*		
Medulla throughout red	*D. coccinea*			
Medulla partially reddish	*D. leopoldii*	*D. confluens* var. *coccinea*		
Medulla partially orange		*D. neotropica*		
Yellow to light-brown lower surface		*D. batavica* *D. complicata* *D. melanocarpa*		
Flabellate laciniae	*D. coccinea* *D. leopoldii*	*D. applanata* *D. batavica* *D. complicata* *D. confluens* *D. confluens* var. *coccinea* *D. melanocarpa* *D. neotropica* *D. papillulifera* *D. purpurascens*	*D. confusa* *D. sekikaica*	
Not flabellate laciniae	*D. caesiopicta* *D. naggarana*	*D. adscensionis* *D. aegialita* *D. africana* *D. frostii* *D. melanoclina* *D. subconfluens*	*D. consimilis* *D. minuta*	*D. flava*
Immersed apothecia		*D. adscensionis*		
Substipitate apothecia		*D. batavica*		
Apothecial disc purplish pruinose		*D. melanoclina* *D. pruinosa* *D. purpurascens*		
Colorless to yellowish subhymenium		*D. melanocarpa*		

1. *Dirinaria adscensionis* (Ach.) C.W. Dodge (1971: 178).

≡ *Lecanora adscensionis* Ach. (1810: 422). Lectotype:—ASCENSION ISLAND. on volcanic rocks, *Unknown* "Museum Swartz" (H–ACH).

= *Dimelaena ascensionis* Müll. Arg., (1884: 136). Holotype:—ASCENSION ISLAND. on lava flow, 1883, *Naumann B37* (G); ≡ *Lecanora ascensionis* Müll. Arg. (1888a: 209). ≡ *Physcia ascensionis* (Müll. Arg.) Müll. Arg. (1892: 277); ≡ *Dirinaria ascensionis* (Müll. Arg.) C.W. Dodge (1971: 180).

CHARACTERIZATION.

Thallus saxicolous, adglutinated to the substrate. Upper surface pale yellow, longitudinally plicate, epruinose. Laciniae contiguous, flabellate, 0.5−0.7 mm width, dichotomously to subdichotomously branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia immersed to sessile, 0.3–0.5 mm diam.; disc plane, black, epruinose. Apothecial anatomy: epithecium pale brown, 10 µm thick; hymenium hyaline to pale yellowish, 65–75 µm thick; subhymenium dark brown 110–130 µm thick. Ascospores *Dirinaria*-type 10–13(–16) × 5–6 µm. **Spot tests:** upper surface K+ yellowish C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS

This species is characterized by a saxicolous thallus, white medulla, small ascospores (10–13 × 5–6 µm) and the presence of atranorin and divaricatic acid.

Dirinaria subconfluens D.D. Awasthi (1975: 33) is the most similar taxon, but has greater ascospores, higher subhymenium and a corticicolous thallus. *Dirinaria africana* and *D. batavica* have the same habitat, but the first has a higher subhymenium (150−180 µm) and wider laciniae (up to 1 mm), the second has substipitate apothecia and a colorless to yellowish subhymenium.

Dirinaria coccinea, D. confluens var. *coccinea* and *D. neotropica* have coccineous or orange pigment in the medulla. *Dirinaria purpurascens* has the apothecia disc purplish pruinose and a lower subhymenium (70−80 µm). *Dirinaria confluens* has wider laciniae (up to 2 mm), larger apothecia (1−2.5 µm) and larger ascospores (16−24 × 8−10 µm). *Dirinaria complicata* and *D. melanocarpa* have a pale brown to yellowish white lower surface. *Dirinaria confusa* and *D. minuta* have sekikaic acid. The other species have vegetative propagules.

Acharius (1810) described this species as *Lecanora adscensionis* based on specimens of the "Museum Swartz" coming from Ascension Island. Müller Argoviensis (1884) based on other material (also from this island) described *Dimelaena ascensionis* Müll. Arg. (1884: 136), but

comparing Acharius' and Müller Argoviensis' description, it is evident that they are the same species.

Dodge (1971) combined *Lecanora adscensionis* as *D. adscensionis* (Ach.) C.W. Dodge (1971: 178) and *Dimelaena ascensionis* as *D. ascensionis* (Müll. Arg.) C.W. Dodge (1971: 180), however without to see the type specimens or any other specimen from Ascension Island of either species. Dodge mentioned "The systematic position of this species is doubtful", but Awasthi (1975) confirmed the systematic position of this species.

Awasthi (1975) did not examine the type specimen collected by Acharius, but described this taxon based on images provided by the Botanical Museum in Helsinki and also on data sent by Dr. Teuvo Ahti (curator at the time). He also examined additional specimens from Ascension Island.

DISTRIBUTION.

ATLANTIC OCEAN: ASCENSION ISLAND (Acharius 1810: 422 as *Lecanora adscensionis*, Müller Argoviensis 1884: 136 as *Dimelaena ascensionis*, Stizenberger 1890: 209, Müller Argoviensis 1892: 277 as *Physcia ascesionis*, Dodge 1971: 180 as *Dirinaria ascensionis*, Awasthi 1975: 27).

2. *Dirinaria aegialita* (Afzel. *in* Ach.) B.J. Moore (1968: 248). (Figure 3B)

≡ *Parmelia aegialita* Afzel. *in* Ach. (1803: 191). Holotype:—SIERRA LEONE. '*ad lapides mari inundatos propr litora*', *Afzelius* (S–SW.); ≡ *Lecanora aegialita* (Afzel. *in* Ach.) Ach. (1810: 423); ≡ *Physcia aegialita* (Afzel. *in* Ach.) Nyl. (1861: 43); ≡ *Hagenia aegialita* (Afzel. *in* Ach.) Bagl. (1875: 241); ≡ *Physcia picta* var. *aegialita* (Ach.) Hue (1900: 80).

= *Anaptychia decipiens* A. Massal. (1853: 40), fig. 43. Holotype? Isotype:—BRAZIL. *Casaretto*, '*Ex Herbarium De Notaris*' (UPS).

= *Physcia persoredians* Nyl. (1900: 8). Holotype:—SRI-LANKA. Rampodde, elev. 3400 ft., 1879, '*Vega Exped.*', *E. Almquist* (S; Isotype: H–NYL 32268); ≡ *Dirinaria persoredians* (Nyl.) D.D. Awasthi (1964: 370).

= *Physcia aspera* H. Magn., *in* H. Magn. & Zahlbr. (1945: 63). Holotype:—HAWAIIAN ISLANDS. N. of Hualalai, Punwaawaa region, 1856 flow, Bog Survey, on bark, 11 September 1938, *O. Selling 5668* (S); ≡ *Dirinaria aspera* (H. Magn.) D.D. Awasthi (1964: 371).

= *Dirinaria aegialita* var. *angolica* D.D. Awasthi, (1975: 68). Holotype:—ANGOLA. Malnje, Duque de Bragança waterfall, W. Side, 1100–1200 m. elev., on tree, 5 March 1960, *G. Degelius* (Degel.)- mixed with *D. aegialita*. var. *aegialita*.

= *Dirinaria aspera* var. *linearis* D.D. Awasthi, (1975: 72). Holotype:—ANDAMAN ISLAND. South Point, on bark of *Albizzia elata*, 1867, *S. Kurtz* (M).

CHARACTERIZATION.

Thallus saxicolous or corticicolous, adpressed to the substrate. Upper surface grey, longitudinally plicate, epruinose to white pruinose. Laciniae discrete, flabellate, 0.5−1.5 mm width, subdichotomously to irregularly branched, rounded to retuse apices. Polysidiangia present, irregularly with granular soredia. Isidia and soralia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia immersed to sessile of the constrict base, 1–1.5(–2) mm diam.; disc plane to slight convex, black epruinose. Apothecial anatomy: epithecium pale brownish 6–8 µm thick; hymenium hyaline, 80–90 µm thick; subhymenium dark brown to brown-black, 100–120(–150) µm thick. Ascospores *Dirinaria*-type 13–17(–19) × 5–7(–8) µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by presence of polysidiangia, apothecial disc epruinose and atranorin and divaricatic acid.

Only three species have polysidiangia as vegetative propagules, *viz*. *D. aegialita, D. consimilis* and *D. pruinosa. Dirinaria consimilis* is morphologically similar but has sekikaic acid. *Dirinaria pruinosa* has divaricatic acid, the apothecial disc is purplish pruinose, the thallus is rarely plicate and it has larger ascospores (20–25 × 7–8 µm).

This species was described by Afzelius in Acharius (1803) as *Parmelia aegialita*. Acharius (1810) combined it as *Lecanora aegialita* (Afzel. *in* Ach.) Ach. (1810: 423) based on the same material utilized in the original description. Nylander (1861) combined it as *Physcia aegialita* (Afzel. *in* Ach.) Nyl. (1861: 43), Baglietto (1875) made the new combination *Hagenia aegialita* (Afzel. *In* Ach.) Bagl. (1875: 241) but this classification was not followed by other authors. Last, Hue (1900), following Nylander's classification, proposes the combination *Physcia picta* var. *aegialita* (Ach.) Hue (1900: 80).

Lynge (1924) cited this species as "*Physcia aegiliata"* (probably a spelling mistake) and emphasized that their specimens had no soralia, as Acharius specimens, but mentioned that his identification was according to Vainio (1890). Awasthi (1975) affirmed that the material described by Vainio is *D. confluens.*

The combination of this taxon was proposed by Moore (1968), but again the species was misunderstood and the specimens cited by Moore belong to *D. confluens* and *D. confusa,* as explained in Awasthi (1975).

Dodge (1971) ignored Moore's combination and proposes the same new combination in *Dirinaria*, but this combination was superfluous, as Moore had already done. Awasthi (1975) commented about that in the appendix.

Anaptychia decipiens A. Massal. (1853: 40) and *D. persoredians* were included in the synonym list of this species as explained by Awasthi (1975). *Dirinaria aspera* was the last species reduced to the synonym of *D. aegialita,* by Swinscow & Krog (1978) and this was followed by Awasthi (2007).

DISTRIBUTION.

AFRICA: ANGOLA (Dodge 1971: 179, Awasthi 1975: 68 as *Dirinaria aegialita* var. *angolica,* Awasthi 1975: 71 as *Dirinaria aspera*); CENTRAL AFRICAN REPUBLIC (Awasthi 1975: 68); COMORO ISLANDS (Awasthi 1975: 71 as *Dirinaria aspera*); ETHIOPIA (Baglietto 1875: 241 as *Physcia aegialita,* Swinscow & Krog 1988: 78); GUINEA (Acharius 1810: 423, Acharius 1814: 179 as *Lecanora aegialita,* Awasthi 1975: 71 as *Dirinaria aspera*); KENYA (Awasthi 1975: 68, Awasthi 1975: 71 as *Dirinaria aspera,* Swinscow & Krog 1988: 78); MADAGASCAR (Aptroot 1988: 143); MOZAMBIQUE (Awasthi 1975: 68); NIGERIA (Dodge 1971: 179); REPUBLIC OF CÔTE D'IVOIRE (Awasthi 1975: 68, Awasthi 1975: 71 as *Dirinaria aspera*); SIERRA LEONE (Acharius 1803: 192 as *Parmelia aegialita,* Dodge 1971: 179, Awasthi 1975: 68); SOUTH AFRICA (Awasthi 1975: 68, Awasthi 1975: 71 as *Dirinaria aspera*); TANZANIA (Swinscow & Krog 1988: 78); UGANDA (Awasthi 1975: 68, Swinscow & Krog 1988: 78); ZAMBIA (Dodge 1971: 179).

AMERICAN CONTINENT: CENTRAL AMERICA. BAHAMAS (Thomson 1963: 162 as *Physcia aspera*); BERMUDA (Awasthi 1975: 72 as *Dirinaria aspera*); COSTA RICA (Kalb 1990: 8); CUBA (Thomson 1963: 159 as *Physcia aegialita*); JAMAICA (Thomson 1963: 162 as *Physcia aspera*); NICARAGUA (Thomson 1963: 162 as *Physcia aspera,* Awasthi 1975: 71 as *Dirinaria aspera*); PUERTO RICO (Thomson 1963: 159 as *Physcia aegialita*); TRINIDAD AND TOBAGO (Vainio 1915: 68 as *Physcia aegialita*); NORTH AMERICA. MEXICO (Bouly de Lesdain 1914: 9 as *Physcia aegialita,* Thomson 1963: 159 as *Physcia aegialita,* Kalb 2004a: 99); UNITED STATES OF AMERICA (Hue 1900: 80 as *Physcia picta* var. *aegialita*, Magnusson & Zahlbruckner 1945: 64 as *Physcia aspera,* Thomson 1963: 159 as *Physcia aegialita,* Moore 1968: 249 as *Dirinaria aspera,* Moore 1968: 248, Awasthi 1975: 71 as *Dirinaria aspera*, Harris 1995: 44, Brodo *et al.* 2001: 306). SOUTH AMERICA. ARGENTINA (Awasthi 1975: 72 as *Dirinaria aspera,* Calvelo & Liberatore 2002: 61); BRAZIL (Massalongo 1853: 40 as *Anaptychia decipiens*), MG (Aptroot 2002: 35, Awasthi 1975: 72 as *Dirinaria aspera*), MS (Fleig & Riquelme 1991: 7), MT (Lynge 1924: 42 as *Physcia aegialita,* Brako *et al.* 1985: 130, Awasthi 1975: 72 as *Dirinaria*

aspera), RJ (Vainio 1890: 151 as *Physcia aegialita,* Lynge 1924: 42 as *Physcia aegialita,* Awasthi 1975: 68, Awasthi 1975: 72 as *Dirinaria aspera*), RO (Aptroot & Cáceres 2014: 791), RS (Lynge 1924: 42 as *Physcia aegialita,* Osorio & Fleig 1984a: 276, Fleig 1988: 12, Osorio *et al.* 1997: 17, Mazzitelli *et al.* 1999: 62), SC (Kalb 1982a: 2, Kalb 1982b: 8), SP (Benatti & Jungbluth 2014: 18); CHILE, Easter Island (Awasthi 1975: 72 as *Dirinaria aspera*); COLOMBIA (Thomson 1963: 160 as *Physcia aegialita,* Awasthi 1975: 72 as *Dirinaria aspera*); FRENCH GUIANA (Aptroot 1987: 18); PARAGUAY (Lynge 1924 as *Physcia aegialita*); SURINAM (Aptroot 1987: 18); VENEZUELA (Thomson 1963: 160 as *Physcia aegialita,* Thomson 1963: 162 as *Physcia aspera* Awasthi 1975: 68, Awasthi 1975: 72 as *Dirinaria aspera*).

ASIA: INDIA (Hue 1900: 80 as *Physcia picta* var. *aegialita,* Awasthi 1975: 67, Awasthi 1975: 71 as *Dirinaria aspera*, Awasthi 1975: 72 as *Dirinaria aspera* var. *linearis,* Awasthi 2007: 148); INDONESIA (Thomson 1963: 162 as *Physcia aspera,* Awasthi 1975: 68, Awasthi 1975: 71 as *Dirinaria aspera*); JAPAN (Kurokawa 2003: 36); MALAYSIA (Awasthi 1975: 71 as *Dirinaria aspera,* Awasthi 1975: 72 as *Dirinaria aspera* var. *linearis*); NEPAL (Awasthi 1975: 71 as *Dirinaria aspera,* Awasthi 2007: 148); PHILIPPINES (Awasthi 1975: 68, Awasthi 1975: 71 as *Dirinaria aspera*); REUNION (Awasthi 1975: 68, Awasthi 1975: 71 as *Dirinaria aspera*); SRI LANKA (Nylander 1900: 9 as *Physcia aegialita,* Nylander 1900: 8 as *Physcia persoredians,* Awasthi 1975: 68, Awasthi 1975: 71 as *Dirinaria aspera*, Awasthi 2007: 148); TAIWAN (Awasthi 1975: 68, Aptroot *et al.* 2002: 283); THAILAND (Wolseley *et al.* 2002: 22); VIETNAM (Müller Argoviensis 1891: 182 as *Physcia aegialita,* Awasthi 1975: 68); YEMEN (Mies & Schultz 2004: 438).

OCEANIA: AUSTRALIA (Stevens 1979: 299 as *Dirinaria aspera*, Elix 2009);

PACIFIC OCEAN: EASTER ISLAND (Elix & McCarthy 2008a); FIJI ISLAND (Awasthi 1975: 68, Elix & McCarthy 2008a); MARQUESAS ISLANDS (Hue 1900: 80 as *Physcia picta* var. *aegialita*); GALAPAGOS ISLANDS (Thomson 1963: 162 as *Physcia aspera,* Bungartz *et al.* 2016a); HAWAIIAN ISLANDS (Magnusson & Zahlbruckner 1945: 63 as *Physcia aegialita*, Magnusson & Zahlbruckner 1945: 63 as *Physcia aspera,* Thomson 1963: 162 as *Physcia aspera,* Awasthi 1964: 371 as *Dirinaria* aspera, Awasthi 1975: 68, Awasthi 1975: 72 as *Dirinaria aspera,* Elix & McCarthy 2008a); ISLAS REVILLAGIGEDO (Elix & McCarthy 2008a); MARQUESAS ISLANDS (Elix & McCarthy 2008a); NEW CALEDONIA (Nylander 1861: 43 as *Physcia aegialita,* Hue 1900: 80 as *Physcia picta* var. *aegialita*); SAMOA ISLAND (Zahlbruckner 1908: 277 as *Physcia picta* var. aegialita, Awasthi 1975: 68). NORTHERN MARIANA ISLANDS (Elix & McCarthy 2008a, Elix & McCarthy 2008b: 11); OGASAWARA-SHOTO (Elix & McCarthy 2008a); PITCAIRN ISLANDS (Elix & McCarthy 2008a); SOCIETY ISLANDS (Elix & McCarthy 2008a); WESTERN SAMOA (Elix & McCarthy 2008a).

3. *Dirinaria africana* (Müll. Arg.) D.D. Awasthi (1975: 40).

≡ *Physcia africana* Müll. Arg. (1880a: 33). Lectotype:—ANGOLA, Pungo Andongo, on rocks, 1880, *Schweinfurth 247 pr. p.* (G).

CHARACTERIZATION.

Thallus saxicolous, adglutinated to the substrate. Upper surface grey to pale yellowish grey, slightly longitudinally plicate, white pruinose to epruinose. Laciniae discrete, flabellate, ca.1.0 mm width, subdichotomously branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia immersed 0.7–1.5(–2) mm diam.; disc plane, brown-black, epruinose internal stipe with yellow pigment. Apothecial anatomy: epithecium pale brown, 6–8 µm thick; hymenium hyaline to light-yellow, 60–80 µm thick; subhymenium dark-brown 150–180 µm thick. Ascospores *Dirinaria*-type (9–)12–18 × (–5)6–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by a saxicolous thallus, white medulla, immersed apothecia, yellow pigment in the internal stipe and the presence of atranorin and divaricatic acid.

Dirinaria confluens is the morphologically closest species but has wider laciniae (up to 2 mm), hardly plicate thallus, corticicolous habitat and larger ascospores (16−24 × 8−10 µm). *D. batavica* has the same habitat, but substipitate apothecia and a colorless to yellowish subhymenium.

Dirinaria africana was described by Müller Argoviensis (1880a), as *Physcia africana* Müll. Arg. (1880a: 33); in his description, he compares this species with *Physcia aegialita* and *Physcia picta,* evidencing a proximity of the taxa. Awasthi (1975) combined this species in *Dirinaria* but did not mention on the history of the taxon. Later, Swinscow & Krog (1978) synonymized this species with *D. confluens*, based on a statistical analysis of the apothecial features. However, they had given little attention to other differences present in the thallus.

The arguments presented by Swinscow & Krog (1978) were considered insufficient for this synonymizing, since there are differences as to the shape of the laciniae, thallus upper surface and plication.

DISTRIBUTION.

AFRICA: ANGOLA (Müller Argoviensis 1880a: 33 as *Physcia africana*, Vainio 1901: 411 as *Physcia africana,* Awasthi 1975: 41); GUINEA (Awasthi 1975: 41); NIGERIA (Awasthi 1975: 41); REPUBLIC OF CÔTE D'IVOIRE (Awasthi 1975: 41); RODRIGUES ISLAND (Awasthi 1975: 41); SOUTH AFRICA (Awasthi 1975: 41); SWAZILAND (Awasthi 1975: 41); UGANDA (Awasthi 1975: 41); ZIMBABWE (Awasthi 1975: 41).
ASIA: SRI LANKA (Awasthi 1975: 41).

4. *Dirinaria applanata* (Fée) D.D. Awasthi, *in* D.D. Awasthi & M.R. Agarwal (1970: 135).

≡ *Parmelia applanata* Fée (1824: 126) tab. 32, fig. 2, suppl. 123 and (1837) tab. 42, fig. 18. Holotype:—PERU. 'supra Cinchonas nec non-insula Santo Domingo ad arbores et epidermidem *Lauri Cassiae'*, *Unknown* (PC). Neolectotype:—CUBA, 'Herbarium Montagne', annotated *Parmelia applanata* Fée (REN; Isoneotype: BM, NY, UPS), the specimens are associated with *Physcia s.s.* (subhymenium hyaline); ≡ *Anaptychia applanata* A. Massal. (1853: 40); ≡ *Physcia applanata* (Fée) Nyl. (1857: 107).

= *Parmelia picta* var. *sorediata* Schäer., *in* Zoll. (1854: 6). Holotype:—INDONESIA. Java, 'ad arbores pr. Bogor. Etiam supra Nr. 2103', *H. Zolliger 39* (unknown).

= *Haegenia picta* f. *rupicola* Bagl. (1875: 242). Holotype:—ETHIOPIA. Deban Mts., on granite rocks, *Beccari* (unknown); ≡ *Physcia picta* var. *sorediata* (Bagl.) Müll. Arg. (1879: 293); ≡ *Dirinaria rupicola* (Bagl.) C.W. Dodge (1971: 185).

= *Physcia aegialita* (Afzel. *in* Ach.) Nyl. var. *murita* Zahlbr., (1927: 362). Isotype:—JAPAN. Idzu Province, Ito, VI. 8. 1924, *Asahina 172* (TNS).

= *Placodium flavostramineum* Müll. Arg. (1895a: 29). Holotype:—AUSTRALIA. Victoria Province, 'ad saxa quartosa', *R.M. Wilson 331*, 1893 (G); ≡ *Lecanora flavostraminea* (Müll. Arg.) Zahlbr. (1928: 621).

= *Parmelia redacta* Stirt. (1899: 76). Holotype:—AUSTRALIA. Illawarra, New South Wales, *W. Kirton,* 1882 (GLAM, Isotype: BM).

CHARACTERIZATION.

Thallus corticicolous or saxicolous, adpressed to the substrate. Upper surface grey to yellowish grey, strongly longitudinally plicate, white pruinose to epruinose. Laciniae confluent, flabellate, 1.0−1.5(−2) mm width, dichotomously to irregularly branched, rounded apices. Isidia and Polysidiangia absent. Soralia present, hemispheric and capitate, soredia farinose. Medulla white, pigment absent. Lower surface black, rhizinae precursors present. Apothecia sessile of the constrict base, 0.6–1(–2) mm diam; disc plane, black, epruinose to rarely white pruinose. Apothecial anatomy: epithecium dark-brown to yellowish, not mentioned the thickness;

hymenium hyaline, 75–85 µm thick; subhymenium dark-brown to brown-black, 160–200 µm thick. Ascospores *Dirinaria*-type (12–)16–22(–24) × 6–8(–10) µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by the strongly plicate thallus, flabellate laciniae, hemispherical and capitate soralia, and the presence of atranorin and divaricatic acid.

Dirinaria picta is commonly confounded with this species; both present an almost cosmopolitan distribution. Nevertheless, *D. picta* has not the strongly plicate thallus, but discrete and non-flabellate laciniae which are thinner, and palmatifid branched laciniae. The differences are evident when both species grow side by side, what is frequent. *Dirinaria sekikaica* is morphologically and anatomically close to *D. applanata* but differs by the presence of sekikaic acid instead of divaricatic acid. *Dirinaria caesiopicta, D. leopoldii* and *D. naggarana* present only atranorin.

Fée (1824) described this taxon as *Parmelia applanata*; later, this species was combined in two other genera, *viz*. *Anaptychia* Körb. (1848: 197) and *Physcia*. Two species were synonymized, *Placodium flavostramineum* Müll. Arg. (1895a: 29) described based on Australian specimens and revised and synonymized by Elix (2009), the other was *Parmelia redacta* Stirt. (1899: 76) also reviewed by Elix (2009). Some varieties were synonymized with *D. applanata*; for more details see Awasthi (1975).

Parmelia applanata was combined in *D. applanata* in Awasthi & Agarwal (1970), who did not find the type specimen mentioned by Fée (theoretically preserved in PC). Because of this Awasthi (1975) proposed a neotype and many other isoneotypes, all specimens from Cuba and annotated as "*Parmelia applanata* Fée".

Dirinaria applanata is one of the oldest species known from *Dirinaria* and has an almost cosmopolite distribution.

DISTRIBUTION.

AFRICA: ANGOLA (Awasthi 1975: 82); ANNOBAR ISLAND (Awasthi 1975: 83); ETHIOPIA (Awasthi 1975: 82, Swinscow & Krog 1988: 80); KENYA (Awasthi 1975: 82, Swinscow & Krog 1978: 165, Swinscow & Krog 1988: 80, Scutari 1995: 156); MADAGASCAR (Awasthi 1975: 83); MALAWI (Czeczuga *et al.* 2001: 82); MOZAMBIQUE (Awasthi 1975: 82); REPUBLIC OF CÔTE D'IVOIRE (Awasthi 1975: 82); REPUBLIC OF THE CONGO (Awasthi 1975: 82); SENEGAL (Awasthi 1975: 82); SOUTH AFRICA (Awasthi 1975: 82); TANZANIA (Awasthi

1975: 83, Swinscow & Krog 1988: 80); UGANDA (Awasthi 1975: 83, Swinscow & Krog 1988: 80); ZANZIBAR ISLAND (Awasthi 1975: 83); ZIMBABWE (Awasthi 1975: 83).

AMERICAN CONTINENT: CENTRAL AMERICA. DOMINICAN REPUBLIC (Fée 1824: 126 as *Parmelia applanata*). ANTILLES (Czeczuga *et al.* 2001: 82); BAHAMAS (Awasthi 1975: 83); BERMUDA (Awasthi 1975: 83); COSTA RICA (Awasthi 1975: 83, Monge-Nájera *et al.* 2002: 315); CUBA (Montagne 1838-1842: 223 as *Parmelia applanata,* Awasthi 1975: 83); CURAÇAO (Czeczuga *et al.* 2001: 82); JAMAICA (Awasthi 1975: 83); PUERTO RICO (Awasthi 1975: 83); NORTH AMERICA. MEXICO (Awasthi 1975: 83, Czeczuga *et al.* 2001: 82, Kalb 2004a: 99); UNITED STATES OF AMERICA (Tuckerman 1860: 298 as *Physcia applanata,* Awasthi 1975: 83, Harris 1995: 44). SOUTH AMERICA. ARGENTINA (Awasthi 1975: 83, Osorio 1976: 359, Osorio 1977a: 363, Osorio 1981a: 3, Osorio 1982: 2, Scutari 1992: 170, Scutari 1995: 154); BOLIVIA (Awasthi 1975: 83, Flakus *et al.* 2015: 709); BRAZIL, AL (Cáceres 2007: 70), MG (Awasthi 1975: 83, Aptroot 2002: 35), MS (Fleig & Riquelme 1991: 7, Osorio 1992a: 2), MT (Awasthi 1975: 83, Brako *et al.* 1985: 130), PR (Osorio 1977b: 4), RJ (Awasthi 1975: 83), RO (Aptroot & Cáceres 2014: 791), RS (Awasthi 1975: 83, Osorio & Homrich 1978: 452, Osorio *et al.* 1980: 3, Osorio 1981b: 73, Zanette et al 1981: 112, Osorio *et al.* 1982: 480, Osorio & Fleig 1983: 138, Osorio & Fleig 1984a: 276, Osorio & Fleig 1984b: 2, Osorio & Fleig 1985: 2, Osorio & Fleig 1987: 3, Fleig 1990: 40, Osorio & Fleig 1991: 3, Fleig 1995: 419, Osorio *et al.* 1997: 17), SP (Awasthi 1975: 83, Benatti & Jungbluth 2014: 19); CHILE (Awasthi 1975: 83); COLOMBIA (Awasthi 1975: 83, Aptroot 1989: 273); ECUADOR (Czeczuga *et al.* 2001: 82); FRENCH GUIANA (Awasthi 1975: 83, Aptroot 1987: 18, Czeczuga *et al.* 2001: 82); GUYANA (Aptroot 1987: 18); URUGUAY (Osorio 1979a: 319, Osorio 1979b: 290, Osorio 1980a: 251, Osorio 1980b: 138, Osorio 1985: 2, Osorio 1992b: 38, Osorio 1992c: 50, Osorio 1995: 4, Osorio 1998: 4, Osorio 2000: 3); VENEZUELA (Awasthi 1975: 83, López-Figueiras 1986: 138, Marcano *et al.* 1996: 202);

ASIA: CHINA (Awasthi 1975: 81, Wolseley *et al.* 2002: 22); INDIA (Awasthi 1975: 81, Wolseley *et al.* 2002: 22, Awasthi 2007: 148 as *Dirinaria applanata* var. *applanata*); INDONESIA (Awasthi 1975: 81, Wolseley *et al.* 2002: 22); JAPAN (Tuckerman 1860: 298 as *Physcia applanata,* Awasthi 1975: 81, Kashiwadani 1979: 104, Czeczuga *et al.* 2001: 82, Ohmura *et al.* 2014: 215); MALAYSIA (Awasthi 1975: 82, Wolseley *et al.* 2002: 22); PHILIPPINES (Awasthi 1975: 82, Czeczuga *et al.* 2001: 82, Wolseley *et al.* 2002: 22); RUSSIA (Trass 1998: 148); SINGAPORE (Hue 1892: 317 as *Physcia picta* f. *sorediata,* Czeczuga *et al.* 2001: 82); SRI LANKA (Awasthi 1975: 81, Breuß & Brunnbauer 1997: 729, Wolseley *et al.* 2002: 22); TAIWAN (Awasthi 1975: 81, Wolseley *et al.* 2002: 22); THAILAND (Czeczuga *et al.* 2001: 82, Wolseley *et al.* 2002: 22,

Saipunkaew *et al.* 2005: 351); SOUTH KOREA (Wei & Hur 2007: 130, Jayalal et al 2013: 157); VIETNAM (Awasthi 1975: 82, Wolseley *et al.* 2002: 22).

ATLANTIC OCEAN: AZORES ISLAND (Jörgensen1973: 9, Awasthi 1975: 83, Czeczuga *et al.* 2001: 82); CANARY ISLANDS (Østhagen & Krog 1976); MADEIRA (Arvidsson & Wall 1985: 42); TRISTAN DA CUNHA (Jörgensen 1977: 11).

INDIAN OCEAN: MAURITIUS (Awasthi 1975: 82); ST. PAUL ISLANDS (Awasthi 1975: 82).

OCEANIA: AUSTRALIA (Awasthi 1975: 83, Stevens 1979: 79, Czeczuga *et al.* 2001: 82, Kalb 2001: 147, Elix 2009).

PACIFIC OCEAN: MARQUESAS ISLANDS, Low Archipelago (Awasthi 1975: 83); GALAPAGOS ISLAND (Weber 1986: 487), HAWAIIAN ISLANDS (Awasthi 1975: 83, Kalb 1986: 8, Czeczuga *et al.* 2001: 82, Elix & McCarthy 2008a); ISLAS GALÁPAGOS (Elix & McCarthy 2008a); MARIANA ISLANDS (Elix McCarthy 2008a, Elix & McCarthy 2008b: 12); NEW CALEDONIA (Elix & McCarthy 2008a); NORTHERN MARIANA ISLANDS (Elix & McCarthy 2008a); PAPUA NEW GUINEA (Czeczuga *et al.* 2001: 82, Wolseley *et al.* 2002: 22); PITCAIRN ISLANDS (Elix & McCarthy 2008a); SAMOA (Elix & McCarthy 2008a); SOCIETY ISLANDS (Elix & McCarthy 2008a); TUAMOTU (Elix & McCarthy 2008a).

4.1. ***Dirinaria applanata*** var. ***austro-africani*** D.D. Awasthi (1975: 84).

Holotype:—MOZAMBIQUE. sul do Save, District Lourenço Marques 8 km. E of Impamputo, near road, on trees, *O. Almborn 7005*, X. 18. 1953 (LD).

CHARACTERIZATION.

Thallus corticicolous, adglutinated to the substrate. Upper surface whitish grey, slightly longitudinally plicate, white pruinose to epruinose. Laciniae confluent, flabellate, 0.5−1.0 mm width, dichotomously to irregularly branched, rounded apices. Soralia present plane to concave not capitate. Isidia, polysidiangia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia sessile of the constrict base ca. 0.5 mm diam.; disc plane, black, epruinose. Apothecial anatomy: subhymenium dark brown ca. 200 µm thick. Ascospores *Dirinaria*-type 14–18 × 6–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This variety is distinguished by the confluent laciniae, not capitate soralia, the presence of atranorin and divaricatic acid.

The differences between this variety and *D. applanata* var. *applanata* was pointed out by Awasthi (1975). *Dirinaria applanata* var. *austro-africani* is mentioned only by Awasthi.

DISTRIBUTION.

AFRICA: MOZAMBIQUE (Awasthi 1975: 84).

4.2. *Dirinaria applanata* var. ***endochroma*** (H. Magn. & D.D. Awasthi) D.D. Awasthi, *in* D.D. Awasthi & M.R. Agarwal (1970: 135).

≡ *Physcia picta* var. *endochroma* H. Magn. & D.D. Awasthi, *in* D.D. Awasthi (1960: 8). Holotype:—NEPAL. below Phidim, Phenikhola valley, *D.D. Awasthi 2165*, V. 19. 1953 (LWG–D.D. Awasthi; Isotype: UPS).

CHARACTERIZATION.

Thallus corticicolous. Upper surface glaucous grey to pale grey. Laciniae (not mentioned). Soralia present, hemispherical and capitate, soredia granular. Isidia and polysidiangia absent. Medulla (not mentioned). Lower surface (not mentioned). Apothecia sessile of the constrict base, 1 mm diam.; margin entire to sometimes sorediate. Apothecial anatomy; subhymenium K+ red violet. Ascospores *Dirinaria*-type 18–20 × 7–8 µm. **Spot tests:** not mentioned. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This variety is characterized by hemispheric soralia, subhymenium K+ red violet, and the presence of atranorin and divaricatic acid. This taxon was described as *Physcia* in Awasthi (1960) and combined in *Dirinaria* in Awasthi & Agarwal (1970). After that, just Awasthi (1975) mentioned this taxon again.

DISTRIBUTION.

AFRICA: ANGOLA (Awasthi 1975: 85); GUINEA (Awasthi 1975: 85); REPUBLIC OF THE CONGO (Awasthi 1975: 85).

ASIA: INDIA (Awasthi 1960: 8, Awasthi 1970, Awasthi 1975: 85, Awasthi 2007:); NEPAL (Awasthi 1975: 85).

5. *Dirinaria batavica* D.D. Awasthi (1975: 40).

Holotype:—JAVA. Batavia (=Djakarta), ‘op dakpan’ (= on tile), 9 May1941, *P. Groenhart 1763* (L).

CHARACTERIZATION.

Thallus on tiles or saxicolous, adpressed to almost adglutinated to the substratum. Upper surface glaucous grey, longitudinally plicate. Laciniae contiguous, flabellate, 0.3−0.8(−1) mm width, subdichotomously branched, rounded apices. Isidia and polysidiangia and soralia absent. Medulla white, pigment absent. Lower surface light brown to brown, rhizinae precursors absent. Apothecia substipitate, up to 0.5 mm diam.; disc black, epruinose. Apothecial anatomy: epithecium dark brown 10 µm thick; hymenium colorless, 80–90(–100) µm thick; subhymenium brown to light brown 60–80 µm thick. Ascospores *Dirinaria*-type 10–14(–16) × 5–6 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by saxicolous thallus, white medulla, light brown to brown lower surface, substipitate apothecia, brown to light brown subhymenium and the presence of atranorin and divaricatic acid.

Dirinaria complicata also has a pale lower surface but differs by the complicate thallus and brown-black subhymenium. This species was described by Awasthi (1975), based on material collected on tiles. It is the only species with substipitate apothecia, and since its description it has been mentioned only a few times in the literature.

DISTRIBUTION.

ASIA: INDONESIA, Java Islands (Awasthi 1975: 43).

OCEANIA: AUSTRALIA (Kalb 2001: 147, Elix 2009:).

6. *Dirinaria caesiopicta* (Nyl.) D.D. Awasthi (1975: 94).

≡ *Physcia caesiopicta* Nyl., (1890: 34). Lectotype:—JAPAN. Nagasaki, on rock, 'Vega Exped.' Almquist, 1879 (S; Isolectotype: H–Herb. Nyl.).

CHARACTERIZATION.

Thallus saxicolous, adpressed to the substratum adhesion. Upper surface grey to bluish grey, not longitudinally plicate. Laciniae discrete, not flabellate, 0.5−1.0 mm width, subdichotomously branched, apices not mentioned. Isidia absent. Polysidiangia absent. Soralia present hemispheric capitate, soredia granular. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia amidst the verrucae, sessile, 0.5–1.5 mm diam.; disc plane to slightly

convex, epruinose. Apothecial anatomy: epithecium brownish, 5 µm thick; hymenium colorless to greyish, 75–85 µm thick; subhymenium dark brown, ca. 120 µm thick. Ascospores *Dirinaria*-type 12–18(–20) × 6–7 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin. Based in Awasthi (1975).

REMARKS.

This species is distinguished by the bluish grey upper surface, longitudinally plicate thallus, granular soralia, apothecia disc epruinose and contains only atranorin.

Dirinaria applanata is closely related to *D. caesiopicta*, but has a whitish grey upper surface, wider laciniae (up to 2 mm), non-flabellate laciniae apice, a higher subhymenium (160−200 µm) and has divaricatic acid. *Dirinaria picta* has non-plicate thallus, but palmatifid laciniae and also divaricatic acid.

Dirinaria melanoclina has the laciniae palmatifid branched, apothecial disc purplish pruinose and divaricatic acid. *Dirinaria naggarana* has only atranorin, botryose soralia and apothecial disc bluish grey pruinose. *Dirinaria sekikaica* is a similar taxon differing in the presence of sekikaic acid.

Dirinaria caesiopicta was described by Nylander (1890) as *Physcia caesiopicta* Nyl. (1890: 34), based on Japanese specimens. Hue (1890) mentioned this taxon but did not describ the material. This species was described in detail by Awasthi (1975); since then it has not been cited often in other literature.

DISTRIBUTION.

ASIA: CHINA (Hue 1890: 322); JAPAN (Nylander 1890: 34 as *Physcia caesiopicta*, Hue 1890: 322 as *Physcia caesiopicta*, Awasthi 1975: 96); MALAYSIA (Awasthi 1975: 96); TAIWAN (Awasthi 1975: 96).

INDIAN OCEAN: ST. PAUL ISLANDS (Awasthi 1975: 96).

GALAPAGOS ISLANDS (Awasthi 1975: 96, Weber 1986: 467, Elix & McCurthy 2008).

7. *Dirinaria coccinea* (Müll. Arg.) D.D. Awasthi (1975: 53).

≡ *Physcia picta* var. *coccinea* Müll. Arg. (1885: 503). Lectotype:—KENYA. Tchamtei (Txamtei) in Duruma, on small twigs, *J.M. Hildebrandt 2350*, 1877 (M); ≡ *Physcia coccinea* (Müll. Arg.) C.W. Dodge (1971: 192).

= *Pyxine picta* **erythrocardia* Tuck. (1882: 79); ≡*Physcia erythrocardia* (Tuck.) Vain. (1901: 411). Holotype: UNITED STATES OF AMERICA. South Carolina, on tree in dead wood, *Ravenel s/n*

= (?) *Crocynia* (?) *haematina* Stein (1888: 140). Holotype:—TANZANIA. Kilimandjaro, *H. Meyer*, 1887.

CHARACTERIZATION.

Thallus corticicolous to ramuliculous, closely adpressed. Upper surface glaucous grey, irregularly plicate. Laciniae contiguous to confluent, flabellate, 2−3 mm width, not branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla thoroughly red to rarely with thin white layer in the lower region, other pigment absent. Lower surface brown-black to black, rhizinae precursors absent. Apothecia immersed to sessile amidst the verrucae, 1–1.5 mm diam.; disc plane, black, epruinose. Apothecial anatomy: epithecium pale brown, 10 µm thick; hymenium colorless to yellowish, 80–95 µm thick; subhymenium dark brown, 110–140 µm thick. Ascospores *Dirinaria*-type 15–22 × 6–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K+ purple violet (coccineous region), C–, P–. **Chemistry:** atranorin. Based on Awasthi (1975).

REMARKS.

This species is characterized by the totally coccineous (red pigment) medulla and the presence of only atranorin.

Other taxa with red or orange pigments and without vegetative propagules are *D. confluens* var. *coccinea* and *D. neotropica*; the first has the red pigment irregularly distributed in the medulla, concentrated in the upper region while the lower region generally is white; the latter has an orange pigment distributed in the lower region and upper region generally white; besides both present divaricatic acid.

Among the species with vegetative propagules exists a species with red pigment (*D. leopoldii*); it has the same pattern of pigment as *D. confluens* var. *coccinea*.

Müller Argoviensis (1885) described *D. confluens* var. *coccinea* as *Physcia picta* var. *coccinea*, mentioning the presence of the coccineous pigment and absence of soralia, without knowing that Tuckerman (1882) named this taxon as *Pyxine picta* **erythrocardia* Tuck. (1882: 77). Vainio (1901) following Tuckerman, however proposed the new combination *Physcia erythrocardia* (Tuck.) Vain. (1901: 411).

Dodge (1971) apparently did not know the combination proposed by Vainio (1901) and suggested a new combination of *Physcia picta* var. *coccinea* Müll. Arg., (1885: 503) as *Physcia coccinea* (Müll. Arg.) C.W. Dodge (1971:192) and added *Crocynia haematina* Stein (1888: 140) as synonym; his classification was based on the type specimen of *Crocynia haematina*.

Awasthi (1975) analyzed the type specimen of *Physcia picta* var. *coccinea,* and based on this, made the combination *D. coccinea*, but did not mention the combination proposed by Dodge

(1971) and did not find the type specimen of *Crocynia haematina.* However, Awasthi concluded that it was a synonym of *D. coccinea,* based on the description made by Stein (1888).

It is unknown why Awasthi (1975) maintained the name *coccinea* as epithet instead of *erythrocardia*, because the name *erythrocardia* is older, although it has no priority at species level.

DISTRIBUTION.

AFRICA: ANGOLA (Awasthi 1975: 54, Swinscow & Krog 1988: 80); DEMOCRATIC REPUBLIC OF THE CONGO (Vainio 1901: 411 as *Physcia erythrocardia,* Dodge 1971: 192 as *Physcia coccinea*); KENYA (Müller Argoviensis 1885: 503 as *Physcia picta* v. *coccinea*, Dodge 1971: 192 as *Physcia coccinea*, Awasthi 1975: 54, Swinscow & Krog 1988: 80); SOUTH AFRICA (Awasthi 1975: 54, Swinscow & Krog 1988: 80); UGANDA (Dodge 1971: 192 as *Physcia coccinea*).
AMERICAN CONTINENT: NORTH AMERICA. UNITED STATES OF AMERICA (Tuckerman 1882: 71 as *Pyxine picta *erythrocardia*).

8. *Dirinaria complicata* D.D. Awasthi (1975: 51).

Holotype:—KENYA. 6 miles South of Nyong Hills, ca 1º 30' and 36º 36; on bark of *Acacia* in groove along water course, *C. F. Hemming 219*, I. 29. 1953 (EA).

CHARACTERIZATION.

Thallus corticicolous, loosely fixed to the substratum. Upper surface glaucous white to light grey, complicate. Laciniae contiguous, flabellate, 1−3(−5) mm width, subdichotomously branched, rounded apices. Isidia polysidiangia and soralia absent. Medulla white pigment absent. Lower surface pale yellowish to pale brown, rhizinae precursors absent. Apothecia sessile of the constrict base, up to 2 mm diam.; disc plane, black, epruinose. Apothecial anatomy: epithecium pale yellowish; hymenium colorless, (90–)100–110 µm thick; subhymenium dark brown to brown-black, 180–200 µm thick. Ascospores *Dirinaria*-type (12–)16–20(–22) × (6–)7–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C– or C+ reddish, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by the complicate thallus, pale yellow to pale brown lower surface, brown to brown-black subhymenium, and the presence of atranorin and divaricatic acid.

Dirinaria complicata is close to *D. confluens* but has the complicate thallus and pale lower surface, while *D. confluens* has a plicate thallus and a dark lower surface. *Dirinaria melanocarpa* has a pale lower surface but has a colorless to yellowish subhymenium. *Dirinaria complicata* was described by Awasthi (1975) and is known only from Africa. Besides Awasthi, only few authors cited this species, notably Swinscow & Krog (1978), Swinscow & Krog (1988) and Elix (2009).

DISTRIBUTION.

AFRICA: KENYA (Awasthi 1975: 53, Swinscow & Krog 1978: 165, Swinscow & Krog 1988: 80); MADAGASCAR (Awasthi 1975: 53, Swinscow & Krog 1988: 80, Aptroot 1988: 143, Aptroot 2016: 358); TANZANIA (Awasthi 1975: 53, Swinscow & Krog 1978: 166, Swinscow & Krog 1988: 80); UGANDA (Awasthi 1975: 53, Swinscow & Krog 1978: 165, Swinscow & Krog 1988: 80).

OCEANIA: AUSTRALIA (Elix 2009).

9. *Dirinaria confluens* (Fr.) D.D. Awasthi (1975: 28).

≡ *Parmelia confluens* Fr. (1825: 284). Type:—*"India Orientalis, ad cortices"* precise locality and name of collector not given. Neotype:—INDIA. Neelgherries (=Nilgiri), Perrottet, annotated as "*Parmelia confluens* Fr. p. 284" (H–NYL 31808; isoneotypes: BR, H–NYL 31809, PC, REN); ≡ *Physcia confluens* (Fr.) Nyl. (1858-1860: 430); ≡ *Dimelaena confluens* (Fr.) Trevis. (1868: 623).

= *Physcia areolata* Vain. (1901: 411). Lectotype:—ANGOLA. ad truncus arb. Spec. non notatae in sylvis Claris inter Ambriz et mussulo, District Ambriz, November 1853, *Welwitsch 123 (a)* (BM); The taxon was not validly published, as Vainio did not accept it as species (vide Rules, Bot. Nomencl., Art. 34); *fide* Awasthi (1975); ≡ *Dirinaria areolata* (Vain.) C.W. Dodge (1971: 179).

= *Physcia palmarum* Vain. (1901: 410). Lectotype:—ANGOLA. Insula Principe *"ad cortices Palmarum* (*Elaeis guineensis*) *aliarumque arborum, corti arcte adhaerentes*", *Welwitsch 95* (*pr. p.*), IX. 1852 (BM); ≡ *Physcia palmarum* f. *sophodes* Vain. (1901: 410); ≡ *Dirinaria palmarum* (Vain.) C.W. Dodge (1971: 184).

= *Physcia singularis* Hue (1916: 12). Lectotype:—ANGOLA. *Vicounte de Poncins nº 1006*, 1912, in two packets numbered 20 (red ink) and 21 (blue ink). [PC–1006 (20); Isolectotype: PC–1006 (21)]; ≡ *Dirinaria singularis* (Hue) C.W. Dodge (1971: 187).

= *Physcia palmarum* f. *undulata* Vain. (1901: 410). Holotype:—ANGOLA. Insula Principe *"ad cortices Palmarum* (*Elaeis guineensis*) aliarumque arborum, corti arcte adhaerentes*"*,

Welwitsch 95 (*pr. p.*), IX. 1852 (BM); ≡ *Dirinaria palmarum* var. *undulata* (Vain.) D.D. Awasthi (1975: 39).

= *Placodium paumotense* Tuck., *in* C. Wikes (1862: 146). Lectotype:—MARQUESAS ISLANDS. Carlshoff Island, Paumotu Group (NY).

CHARACTERIZATION.

Thallus corticicolous or saxicolous, closely adpressed to substrate. Upper surface glaucous white, longitudinally plicate, white pruina. Laciniae confluent, flabellate, 1.0−2.0(−2.5) mm width, dichotomously to subdichotomously branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors present. Apothecia sessile of the constrict base, 1–2(–2.5) mm diam.; disc plane to slightly convex, black, epruinose. Apothecial anatomy: epithecium pale brown, 10 µm thick; hymenium colorless to yellowish, 80–110 µm thick; subhymenium dark brown to brown-black, (100–)150–200(–250) µm thick. Ascospores *Dirinaria*-type (14–)16–24 × (6–)8–10 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by the hardly plicate thallus, flabellate laciniae, black lower surface, brown-black subhymenium up to 250 µm thick, and the presence atranorin and divaricatic acid.

Dirinaria subconfluens has a lower hymenium (60−70 µm), and not a plicate thallus. *Dirinaria confluens* var. *coccinea* and *D. neotropica* have coccineous or orange pigment in the medulla. *Dirinaria purpurascens* does not have a plicate thallus and the apothecial disc with purple pruina. *Dirinaria melanocarpa* has a pale lower surface and a colorless to yellowish subhymenium. *Dirinaria confusa* is morphologically close to *D. confluens* but has sekikaic acid. *Dirinaria minuta* also has sekikaic acid as mainly difference.

This species was described by Fries (1825) as *Parmelia confluens.* He mentioned the proximity with *Parmelia picta* (Sw.) Ach. (1803: 211). Later, Nylander (1858-1860) made the new combination *Physcia confluens* (Fr.) Nyl. (1858-1860: 430). Trevisan (1869) combined *Parmelia confluens* in *Dimelaena confluens* (Fr.) Trevis. (1868: 623), probably without awareness of Nylander's combination.

Awasthi (1975) combined it as *D. confluens*, but the synonym list was extendeded by Swinscow & Krog (1978), which was based on statistical analyses of the apothecial features. This

way, *D. areolata, D. palmarum*, *D. singularis* and their varieties (consequently older names are included in the synonym list).

The last synonym of this species was *Placodium paumotense* Tuck. (Wilkes 1862: 146), which was based on three species (*Dirinaria confluens, Pyxine petricola* Nyl. (Crombie 1876a: 263) and *Physcia* sp.), but this synonymy is well explained by Kalb (2004b).

Awasthi (1975) could not find the type specimen of *Parmelia confluens* utilized by Fries. In the absence of the precise locality "*India Orientalis*" cited in the protologue, Awasthi proposes a neotypication utilizing the older specimens collected by Perrottet from Nilgiri Hills annotated "*Parmelia confluens* Fr., conforming to the type description by Fries; he has proposed a neotype and various isoneotypes. For more details see Awasthi (1975).

DISTRIBUTION.

AFRICA: AFRICA MERIDIONALIS (Nylander 1858-1860: 430 as *Physcia confluens*, Trevisan 1969: 623 as *Dimelaena confluens,* Trevisan 1869: 124 as *Dimelaena confluens*); ANGOLA (Vainio 1901: 411 as *Physcia areolata*, *Physcia palmarum, Physcia palmarum* f. *sophodes* and *Physcia palmarum* f. *undulata,* Dodge 1971: 180 as *Dirinaria areolata,* Dodge 1971: 185 as *Dirinaria palmarum*, Awasthi 1975: 39 as *Dirinaria palmarum* and *Dirinaria palmarum* var. *undulata,* Awasthi 1975: 37 as *Dirinaria singularis*); DEMOCRATIC REPUBLIC OF THE CONGO (Awasthi 1975: 39 as *Dirinaria palmarum,* Awasthi 1975: 31); ETHIOPIA (Swinscow & Krog 1988: 80); KENYA (Dodge 1971: 180 as *Dirinaria areolata,* Dodge 1971: 187 as *Dirinaria singularis,* Swinscow & Krog 1988: 80, Scheidegger *et al.* 2001: 28); MADAGASCAR (Aptroot 1988: 143, Aptroot 2016: 358); MOZAMBIQUE (Awasthi 1975: 30); NIGERIA (Dodge 1971: 185 as *Dirinaria palmarum*); REPUBLIC OF CÔTE D'IVOIRE (Dodge 1971: 185 as *Dirinaria palmarum,* Awasthi 1975: 37 as *Dirinaria singularis*); REPUBLIC OF THE CONGO (Awasthi 1975: 39 as *Dirinaria palmarum* and *Dirinaria palmarum* f. *undulata,* Awasthi 1975: 37 as *Dirinaria singularis,* Awasthi 1975: 30); SOUTH AFRICA (Awasthi 1975: 30); TANZANIA (Swinscow & Krog 1988: 80);UGANDA (Awasthi 1975: 31, Awasthi 1975: 37 as *Dirinaria singularis,* Swinscow & Krog 1988: 80); ZAMBIA (Dodge 1971: 185 as *Dirinaria palmarum,* Awasthi 1975: 39 as *Dirinaria palmarum*); ZIMBABWE (Awasthi 1975: 31).

AMERICAN CONTINENT: CENTRAL AMERICA. GUATEMALA (Awasthi 1975: 31); PUERTO RICO (Awasthi 1975: 31); NORTH AMERICA. MEXICO (Awasthi 1975: 31, Kalb 2004a: 100); UNITED STATES OF AMERICA (Awasthi 1975: 31, Harris 1995: 44, Kalb 2004a: 100). SOUTH AMERICA: ARGENTINA (Scutari 1995: 157, Marcano *et al.* 1996: 202); BOLIVIA (Flakus *et al.* 2015: 83); BRAZIL, AL (Menezes *et al.* 2011: 888), AM (Awasthi 1975: 31), MG (Awasthi 1975: 31), MS (Fleig & Riquelme 1991: 7), MT (Awasthi 1975: 31), PA (Awasthi 1975: 31), PE (Cáceres 2007:

70), RJ (Awasthi 1975: 31), RS (Awasthi 1975: 31, Osorio & Homrich 1978: 453, Osorio 1981b: 73, Fleig 1990: 40, Osorio & Fleig 1991: 3, Osorio *et al.* 1997: 17, Mazzitelli *et al.* 1999: 62); COLOMBIA (Awasthi 1975: 31, Aptroot 1989: 273); PARAGUAY (Awasthi 1975: 31); URUGUAY (Awasthi 1975: 31); VENEZUELA (López-Figueiras 1986: 138).

ASIA: INDIA (Awasthi 1975: 30, Singh & Sinha 1994: 588, Awasthi 2007: 149, Logesh *et al.* 2012: 885); INDONESIA (Awasthi 1975: 30); NEPAL (Awasthi 1975: 30, Awasthi 2007: 149); SRI-LANKA (Awasthi 1975: 30, Breuß & Brunnbauer 1997: 729, Awasthi 2007: 149); THAILAND (Aptroot *et al.* 2002: 284, Aptroot *et al.* 2007); YEMEN (Mies & Schultz 2004: 438).

ATLANTIC OCEAN: ASCENSION ISLANDS (Aptroot 2007: 155).

INDIAN OCEAN: REUNION (Awasthi 1975: 39 as *Dirinaria palmarum* f. *undulata,* Awasthi 1975: 30); RODRIGUES ISLANDS (Awasthi 1975: 30).

OCEANIA: AUSTRALIA (Awasthi 1975: 31, Czeczuga & Rogers 1999: 448, Kalb 2001: 147, Elix 2009).

PACIFIC OCEAN: GALAPAGOS ISLANDS (Awasthi 1975: 31, Weber 1986: 467, Elix & McCarthy 2008a, Bungartz *et al.* 2013, Bungartz *et al.* 2016a); HAWAIIAN ISLANDS (Awasthi 1975: 31, Elix & McCarthy 2008a); MARQUESAS ISLANDS (Nylander 1859: 239, Awasthi 1975: 31, Elix & McCarthy 2008a); NEW HEBRIDES ISLANDS (Awasthi 1975: 31); PITCAIRN ISLANDS (Elix & McCarthy 2008a); SOCIETY ISLANDS (Awasthi 1975: 31, Elix & McCarthy 2008a); TUAMOTU (Elix & McCarthy 2008a); TUAMOTU (Tuckerman 1862: 146 as *Placodium paumotense*); VANUATU (Elix & McCarthy 2008a).

9.1. *Dirinaria confluens* var. ***coccinea*** (Lynge) D.D. Awasthi (1975: 31). (Figure 4A)

≡ *Physcia aegialita* f. *coccinea* Lynge (1924: 43 printed in 1925). Lectotype:—BRAZIL. Mato Grosso do Sul State: Corumbá municipality, on *Cereum arborescentum*, 26 July 1894, *G. Malme*, (S; Isotypes: LD, UPS).

CHARACTERIZATION.

Thallus corticicolous. Upper surface glaucous grey to grey, longitudinally plicate, white pruina. Laciniae confluent, flabellate, width (not mentioned), dichotomously to subdichotomously branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment red, concentrated in the upper region. Lower surface black, rhizinae precursors present. Apothecia sessile with constrict base, 1–2(–2.5) mm diam.; disc plane to slightly convex, black, epruinose. Apothecial anatomy: epithecium pale brown, 10 µm thick; hymenium colorless to yellowish, 80–110 µm thick; subhymenium dark brown to brown-black, (100–)150–200(–250) µm thick. Ascospores *Dirinaria*-type (12–)15–19 × 6–7 µm. **Spot tests:** upper surface: K+ yellow, C–;

medulla K– (white region), K+ purple violet (red region), C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

The variety is characterized by the medulla that is coccineous in the upper region, and the presence of atranorin and divaricatic acid.

Three other species with coccineous (red) or orange pigment in the medulla exist, *viz*. *D. leopoldii* which differs by the presence of soralia, *D. coccinea* that has the medulla totally coccineous (red) and only atranorin, and *D. neotropica* that has an orange pigment distributed mainly in lower region of the medulla.

Awasthi (1975), when reviewing the lectotype and isotypes, proposed a new combination and new status of *D. confluens* var. *coccinea*, and made a correction to the type locality, since Lynge (1924) cited the Malme collection as being from of Cuiabá (MT), and Awasthi noticed that in fact the type locality of the material was Corumbá (MS).

This variety is known only to the central region of South America.

DISTRIBUTION.

AMERICAN CONTINENT: SOUTH AMERICA. BOLIVIA (Flakus *et al.* 2015: 83); BRAZIL, MS (Awasthi 1975: 32, Fleig & Riquelme 1991: 7, Torres 2018: 85), MT (Lynge 1924: 43 as *Physcia aegialita* f. *coccinea,* Awasthi 1975: 32); PARAGUAY (Lynge 1924: 43 as *Physcia aegialita* f. *coccinea,* Awasthi 1975: 32); VENEZUELA (Lópes-Figueiras 1986: 141).

10. *Dirinaria confusa* D.D. Awasthi (1975: 56).

Holotype:—MEXICO, Blanco District, Bonn, on bark of various trees, mostly cedar, *C. Wright 55*, 1850 (FH).

- *Dirinaria aegialita sensu* B.J. Moore (1968: 248). *pr. p.*; *fide* Awasthi (1975).
- *Physcia aegialita* (Afzel. *in* Ach.) Nyl., *sensu auct. plur., pr. p.*; *fide* Awasthi (1975).

CHARACTERIZATION.

Thallus corticicolous, adpressed but not adglutinated to substrate. Upper surface glaucous grey to dark grey, not plicate to slightly longitudinally plicate. Laciniae discrete to rarely confluent, slightly flabellate, 2−3 mm width, palmatifid branched to irregularly branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigement absent. Lower surface black, rhizinae precursors present. Apothecia sessile of constrict base, 1–2 mm diam.; disc plane to rarely slightly convex, black, epruinose. Apothecial anatomy: epithecium dark brown, 10 µm thick;

hymenium colorless, 80–90 µm thick; subhymenium dark brown, 80–120 µm thick. Ascospores *Dirinaria*-type (13–)16–22 × 6–9 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K– or rarely K+ purple violet, C–, P–. **Chemistry:** atranorin and sekikaic acid. Based on Awasthi (1975).

REMARKS.

This species is distinguished by a not to slightly longitudinally plicate thallus, flabellate laciniae, and the presence of atranorin and sekikaic acid.

This species is closely related to *D. confluens,* but *D. confusa* has sekikaic acid; the other species without vegetative propagules and with sekikaic acid is *D. minuta,* but this has a smaller thallus, smaller laciniae (up to 1.5 mm), lower subhymenium (30−40 µm) and smaller ascospores (12−14 × 4.5−5.5 µm). *Dirinaria consimilis* and *D. sekikaica* have sekikaic acid, but both have vegetative propagules.

Moore (1968) included material of this species in *D. aegialita,* this fact was noted by Awasthi (1975), who described it as a new taxon for the science.

Awasthi (1975) suggested this name, based on the confusion of names that was found on the specimen label. Another observation made by him was that "most of the specimens from America, earlier annotated s. n. *Physcia aegialita* (Ach.) Nyl., belong to *D. confusa*". Because of that *Physcia aegialita sensu auct. plur., pr. p*. is in the list of synonyms (Awasthi 1975).

DISTRIBUTION.

AMERICAN CONTINENT: NORTH AMERICA. MEXICO (Awasthi 1975: 58, Kalb 2004a: 100); UNITED STATES OF AMERICA (Awasthi 1975: 57, Harris 1995: 44, Brodo *et al.* 2001: 306, Kalb 2004a: 100). SOUTH AMERICA. BRAZIL, PE (Cáceres 2007: 70), RJ (Awasthi 1975: 58); ECUADOR (Awasthi 1975: 58); VENEZUELA (Awasthi 1975: 58).

ASIA: CHINA (Wolseley *et al.* 2002); TAIWAN (Awasthi 1975: 57); THAILAND (Wolseley *et al.* 2002).

OCEANIA: PAPUA NEW GUINEA (Wolseley *et al.* 2002).

PACIFIC OCEAN: GALAPAGOS ISLANDS (Awasthi 1975: 58, Weber 1986: 467, Elix & McCarthy 2008a, Bungartz *et al.* 2016a); ISLAS REVILLAGIGEDO (Elix & McCarthy 2008a).

10.1. ***Dirinaria confusa*** var. ***endocrocea*** D.D. Awasthi (1975: 60). (Figure 4B)

Holotype: —BRAZIL, Rio de Janeiro, Boa Vista (in horto), *G. Malme 105*, VIII. 18. 1892 (S; Isotype: LD, UPS).

CHARACTERIZATION.

Thallus corticicolous, adpressed but not adglutinated to substrate. Upper surface glaucous grey to dark grey, not plicate to slightly longitudinally plicate. Laciniae discrete to rarely confluent, slightly flabellate, width (not mentioned), palmatifid branched to irregularly branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment croceous in lower region. Lower surface black, rhizinae precursors present. Apothecia sessile of the constrict base, 1–2 mm diam.; disc plane to rarely slightly convex, black, epruinose. Apothecial anatomy: epithecium dark brown, 10 µm thick; hymenium colorless, 80–90 µm thick; subhymenium dark brown, 80–120 µm thick. Ascospores *Dirinaria*-type (13–)16–22 × 6–9 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K– (White region), K+ purple violet (croceous region), C–, P–. **Chemistry:** atranorin and sekikaic acid. Based on Awasthi (1975).

REMARKS.

This variety is characterized by the croceous pigment (K+ purple) in the lower region of the medulla. This variety was described by Awasthi (1975), but it was not mentioned anymore in later literature.

DISTRIBUTION.

AMERICAN CONTINENT: SOUTH AMERICA. BRAZIL, RJ (Awasthi 1975: 60).

11. *Dirinaria consimilis* (Stirt.) D.D. Awasthi, *in* D.D. Awasthi & M.R. Agarwal (1970: 135).

≡ *Physcia consimilis* Stirt. (1879: 310). Lectotype:—INDIA. near Chinsurah, on bark of *Artocarpus integrifolia* tree, *G. Watt 111* (GLAM; Isolectotype: BM); ≡*Pyxine consimilis* (Stirt.) Stirt. (1897: 395).

= *Dirinaria mikawensis* Kashiw. (1975: 65). Holotype:—JAPAN. Pref. Aichi, Mt. Horaiji, *H. Kashiwadani 9902* (TNS).

CHARACTERIZATION.

Thallus corticicolous or rarely saxicolous, closely adpressed to almost adglutinated to the substrate. Upper surface glaucous grey, yellowish gray to dark grey, longitudinally plicate. Laciniae confluent, flabellate, 1−2 mm width, subdichotomously to palmatifid branched, rounded apices. Polysidiangia present, irregular, granular soredia. Isidia and soralia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors rarely present. Apothecia sessile of the constrict base, 0.5–1(–1.5) mm diam.; disc plane, black, epruinose to lightly white pruinose. Apothecial anatomy: epithecium pale brown, 10 µm thick; hymenium colorless, 70–80 µm thick; subhymenium dark brown to brown-black, 180–220 µm thick. Ascospores *Dirinaria*-type 14–23

× 6–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and sekikaic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by the presence of polysidiangia, apothecial disc whitish pruinose, and atranorin and sekikaic acid.

Only three species show polysidiangia as vegetative propagules; see under *D. aegialita*. *Dirinaria consimilis* is the only species known with polysidiangia and sekikaic acid. The other species with sekikaic acid are *D. confusa* and *D. minuta* (without vegetative propagules) and *D. sekikaica* (with soralia).

This taxon was described by Stirton (1879) as *Physcia consimilis* Stirt. (1879: 310). Stirton (1897) combined it in *Pyxine*, and Awasthi (1975) placed it in *Dirinaria*. Concomitant to Awasthi´s monograph, Kashiwadani proposed *D. mikawensis* Kashiw. (1975: 65) as a new species. However, after examining the lectotype of *D. consimilis* selected by Awasthi (1975), Kashiwadani (1979) realized that the two taxa are conspecific.

DISTRIBUTION.

AFRICA: ETHIOPIA (Awasthi 1975: 93); GUINEA (Awasthi 1975: 93); MADAGASCAR (Awasthi 1975: 93, Aptroot 2016: 358); REPUBLIC OF CÔTE D'IVOIRE (Awasthi 1975: 93); REPUBLIC OF THE CONGO (Awasthi 1975: 93); UGANDA (Awasthi 1975: 93).

AMERICAN CONTINENT: NORTH AMERICA. UNITED STATES OF AMERICA (Awasthi 1975: 94). SOUTH AMERICA. ARGENTINA (Scutari 1992: 170, Scutari 1995: 157); BRAZIL, MS (Kalb 2009: 228), RJ (Awasthi 1975: 94); ECUADOR, Galapagos Islands (Bungartz *et al.* 2016a); VENEZUELA (Marcano *et al.* 1996: 203).

ASIA: INDIA (Stirton 1879: 310 as *Physcia consimilis*, Stirton 1897: 395 as *Pyxine consimilis,* Awasthi & Agarwall 1970, Awasthi 1975: 93, Singh & Sinha 1994: 590, Wolseley *et al.* 2002: 22, Awasthi 2007: 149); INDONESIA (Awasthi 1975: 93, Wolseley *et al.* 2002: 22); JAPAN (Kashiwadani 1975: 65 as *Dirinaria mikawensis*, fide Kashiwadani 1979: 100); MALAYSIA (Awasthi 1975: 93, Wolseley *et al.* 2002: 22); MYANMAR (Awasthi 1975: 93, Wolseley *et al.* 2002: 22); NEPAL (Awasthi 1975: 93, Awasthi 2007: 149); THAILAND (Awasthi 1975: 93, Wolseley *et al.* 2002: 22); VIETNAM (Wolseley *et al.* 2002: 22).

OCEANIA: AUSTRALIA (Stevens 1979: 299, Elix 2009).

11.1. ***Dirinaria consimilis*** var. ***ochracea*** D.D. Awasthi (1975: 94).

Holotype:—INDONESIA, Java, Bourdoeroto, on bark of *Havea brasiliensis* tree, *Groenhart 4911*, X. 16. 1936 (L).

CHARACTERIZATION.

Thallus corticicolous, closely adpressed to almost adglutinated to the substrate. Upper surface deep yellow to ochraceous, longitudinally plicate. Laciniae confluent, width (not mentioned) subdichotomously to palmatifid branched, slightly apices (not mentioned). Polysidiangia present, irregular, granular soredia. Isidia and soralia absent. Medulla white, pigment ochraceous in lower region. Lower surface black, rhizinae precursors absent. Apothecia sessile of the constrict base, up to 2 mm diam.; disc plane to convex, black, epruinose. **Spot tests:** upper surface: K+ yellow, C–; medulla K– (white region), K+ purple violet (ochraceous region), C–, P–. **Chemistry:** atranorin and sekikaic acid. Based on Awasthi (1975).

REMARKS.

This variety is characterized by the presence of polysidiangia, apothecia disc epruinose, medulla with ochraceous lower region, and atranorin and sekikaic acid.

This variety is known only from the type locality and was not mentioned in further literature.

DISTRIBUTION.

OCEANIA: INDONESIA (Awasthi 1975: 94).

12. ***Dirinaria flava*** (Müll. Arg.) C.W. Dodge (1971: 181).

≡ *Physcia flava* Müll. Arg. (1892: 277). Lectotype:—ASCENSION ISLAND. N. W. of Red Hill, elev. 900 m., on rocks, July 1889, *Henrry J. Gordon 90*, (K; isotype: G).

= *Physcia picta* var. *flavicans* Müll. Arg., *in* A. Engler (1895b: 261). Holotype:—TANZANIA. Mt Kilimanjaro, on bark, St. Paul-Hillaire 25; ≡ *Dirinaria flavicans* (Müll. Arg.) C.W. Dodge (1971: 182).

= *Pyxine sulphurans* Nyl., (1895: 103). Lectotype:—MOZAMBIQUE. Lourenço Marques, on bark, *F. Quintas, 1895* (H–NYL. 31752).

CHARACTERIZATION.

Thallus corticicolous or saxicolous, closely adpressed to substrate. Upper surface yellow, not plicate. Laciniae discrete, not flabellate, 0.5−0.7(−1) mm width, subdichotomously branched,

rounded apices. Soralia present, hemispherical and capitate, granular soredia. Isidia and polysidiangia absent. Medulla white, pigment absent. Lower surface brown-black, rhizinae precursors absent. Apothecia sessile of the constrict base, 0.5 mm diam.; disc plane, brown to brown-black, epruinose to lightly white pruinose. Apothecial anatomy: epithecium pale brown; hymenium colorless, 65–75 µm thick; subhymenium dark brown, 125 µm thick. Ascospores *Dirinaria*-type 10–15 × 4–7 µm. **Spot tests:** upper surface: K+ yellow, C+ orange-red to rose-red, KC+ red; medulla K–, C–, P–. **Chemistry:** atranorin, divaricatic acid, arthothelin. Based on Awasthi (1975) and Elix (2009).

REMARKS.

This species is characterized by upper surface deep yellow (C+ orange), soralia present, and atranorin, divaricatic acid and arthothelin.

Dirinaria flava is the only species with this color on the upper surface and the C+ orange reaction.

The chemical description was based on Elix (2009), because Awasthi (1975) did not detect the chemical substance responsible for the deep yellow color in upper surface.

This species was described by Müller Argoviensis (1892) as *Physcia flava* Müll. Arg. (1892: 277); the name was chosen based on the upper surface color. Dodge (1971) combined it as *D. flava.* Another species combined by him was *D. flavicans* (Müll. Arg.) C.W. Dodge (1971: 182), based on a variety described by Müller Argoviensis (1895b), viz. *Physcia picta* var. *flavicans* Müll. Arg. (1895b: 261). Awasthi (1975) revised the taxon history and concluded that *D. flavicans* is a synonym of *D. flava* and he added *Pyxine sulphurans* Nyl. (1895: 103) to the list of synonyms.

DISTRIBUTION.

AFRICA: KENYA (Swinscow & Krog 1978: 166, Swinscow & Krog 1988: 81); MOZAMBIQUE (Nylander 1895: 103 as *Pyxine sulfurans*, Tavares 1961: 43 as *Physcia flava*, Awasthi 1975: 89, Swinscow & Krog 1988: 81); TANZANIA (Swinscow & Krog 1978: 166, Swinscow & Krog 1988: 81).

ATLANTIC OCEAN: ASCENSION ISLAND (Müller Argoviensis 1892: 277 as *Physcia flava*, Awasthi 1975: 89, Swinscow & Krog 1988: 81).

OCEANIA: AUSTRALIA (Kalb 1996, Elix 2009).

13. *Dirinaria frostii* (Tuck.) Hale & W. Culb. (1970: 513).

≡ *Squamaria frostii* Tuck. (1858: 425). Lectotype:—UNITED STATES OF AMERICA. Massachusetts: Needham, on granite rocks, June 1843, *Tuckerman H 53, 245*, (FH); ≡ *Lecanora*

frostii (Tuck.) Tuck. (1866: 267); ≡ *Pyxine frostii* (Tuck.) Tuck. (1882: 79); ≡ *Physcia frostii* (Tuck.) Zahlbr. (1931: 582).

CHARACTERIZATION.

Thallus saxicolous, closely adnate to adglutinated to the substrate. Upper surface glaucous yellowish, yellowish grey, not plicate. Laciniae discrete, flabellate, 0.5(−1) mm width, palmatifid branched, flabellate, rounded apices. Soralia present, crateriform rarely capitate, farinose soredia. Isidia and polysidiangia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia not see by Awasthi (1975). **Spot tests:** upper surface: K+ yellow, C– ; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by non-plicate thallus, laciniae discrete, crateriform soralia, and the presence of atranorin and divaricatic acid.

Dirinaria picta is a very similar species but differs in the shape and origin of the soralia, that are hemispherical to capitate. *Dirinaria applanata* has a plicate thallus and hemispherical soralia, *D. sekikaica* has sekikaic acid. *Dirinaria leopoldii* has a coccineous pigment in the medulla. *Dirinaria naggarana* presents botryose soralia and has only atranorin, *D. melanoclina* has the apothecial disc purplish pruinose and hemispherical soralia.

This species was described by Tuckerman (1858) as *Squamaria frostii*, and he combined it later on as *Lecanora frostii* (Tuck.) Tuck. (1866: 267) and even later in 1882, combined this taxon as *Pyxine frostii* (Tuck.) Tuck. (1882: 79). Zahlbruckner (1931) considered this species as *Physcia frostii* (Tuck.) Zahlbr. (1931: 582), although not mentioning it as being a new combination. Hale & Culberson (1970) combined it as *D. frostii.* This species is known only from North America.

DISTRIBUTION.

AMERICAN CONTINENT: NORTH AMERICA. MEXICO (Kalb 2004: 101); UNITED STATES OF AMERICA (Tuckerman 1858: 425 as *Squamaria frostii*, Tuckerman 1866: 267 as *Lecanora frostii*, Tuckerman 1882: 79 as *Pyxine frostii*, Thomson 1963: 165 as *Physcia frostii*, Awasthi 1975: 87, Skorepa 1977, Skorepa 1979, Harris 2004: 60, Kalb 2004: 101).

14. *Dirinaria leopoldii* (Stein) D.D. Awasthi (1975: 89).

≡ *Crocynia leopoldii* Stein (1888: 140). Lectotype:—DEMOCRATIC REPUBLIC OF THE CONGO. Vivi, on *Ficus* branches, 1885-1886, *Ledien* (G).

= *Pyxine picta*. var. *erythrocardia* Tuck. (1877: 166). Lectotype:—CUBA. *Wright 94* (FH; isolectotypes: BM; K; PC; REN; UPS); ≡ *Physcia erythrocardia* (Tuck.) Vain. (1901: 411)., *non sensu* Vainio; ≡*Physcia picta* f. *erythrocardia* (Tuck.) J.W. Thomson (1963: 164).

CHARACTERIZATION.

Thallus corticicolous or rarely saxicolous, closely adpressed to substrate. Upper surface glaucous grey to grey, longitudinally plicate. Laciniae discrete to confluent, flabellate, 1 mm width, subdichotomously to palmatifid branched, rounded apices. Soralia present, hemispherical and capitate, farinose and red soredia. Isidia and polysidiangia absent. Medulla white, pigment red in upper region. Lower surface black, rhizinae precursors present. Apothecia sessile of constrict base, 0.5–0.7 mm diam.; disc plane, black, epruinose. Apothecial anatomy: epithecium yellowish brown; hymenium 75–85 µm thick; subhymenium dark brown, (80–)110–150 µm thick. Ascospores *Dirinaria*-type (12–)14–18 × 6–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K– (white region) K+ purple violet (red region), C–, P–. **Chemistry:** atranorin, sekikaic acid and terpenes. Based on Rogers (2015).

REMARKS.

This species is distinguished mainly by the coccineous pigment in the medulla, hemispherical and capitate oralia and the presence of atranorin only.

Dirinaria applanata and *D. picta* are similar but have divaricatic acid and no coccineous pigment in the medulla. *Dirinaria frostii* and *D. naggarana* have only atranorin but no coccineous pigment in the medulla.

This species was described as *Crocynia leopoldii* Stein (1888:140) and was combined as *D. leopoldii* by Awasthi (1975). However, Tuckerman (1877) had described a variety corresponding to this taxon (*Pyxine picta* **erythrocardia*); later this variety was studied by Vainio (1901) who treated it as *Physcia erythrocardia.* Thomson (1963) proposed a new status for this species as *Physcia picta* f. *erythrocardia* (Tuck.) J.W. Thomson (1963: 164) but this name was used only by him.

DISTRIBUTION.

AFRICA: DEMOCRATIC REPUBLIC OF THE CONGO (Stein 1888: 140 as *Crocynia leopoldii*, Vainio 1901: 411 as *Physcia erythrocardia*); KENYA (Swinscow & Krog 1978: 167, Swinscow & Krog 1988: 83); MOZAMBIQUE (Awasthi 1975: 91); REPUBLIC OF CONGO (Awasthi 1975: 91); REPUBLIC OF CÔTE D'IVOIRE (Awasthi 1975: 91); SIERRA LEONE (Awasthi

1975: 91); SOMALI REPUBLIC (Awasthi 1975: 91); SOUTH AFRICA (Awasthi 1975: 91); TANZANIA (Awasthi 1975: 91, Swinscow & Krog 1978: 167, Swinscow & Krog 1988: 83).

AMERICAN CONTINENT: CENTRAL AMERICA. CUBA (Thomson 1963: 164 as *Physcia picta* f. *erythrocardia*, Awasthi 1975: 91); JAMAICA (Thomson 1963: 164 as *Physcia picta* f. *erythrocardia*). NORTH AMERICA. UNITED STATES OF AMERICA (Tuckerman 1882: 79 as *Pyxine picta* var. *erythrocardia*, Thomson 1963: 164 as *Physcia picta* f. *erythrocardia*, Awasthi 1975: 91, Harris 1995: 44). SOUTH AMERICA. ARGENTINA (Estrabou *et al.* 2006: 27); BRAZIL, MS (Torres 2018: 86), PE (Cáceres 2007: 70), SC (Kalb 1982b: 8), SE (Cáceres *et al.* 2014: 110); VENEZUELA (Thomson 1963: 164 as *Physcia picta* f. *erythrocardia*, López-Figueiras 1986: 141, Marcano *et al.* 1996: 203).

ASIA: INDIA (Rogers 2015: 12); YEMEN (Mies & Schultz 2004: 438).

OCEANIA: AUSTRALIA (Rogers 2015: 12).

PACIFIC OCEAN: GALAPAGOS ISLANDS (Weber 1986: 468, Elix & McCurthy 2008, Bungartz *et al.* 2013, Bungartz *et al.* 2013).

15. *Dirinaria melanocarpa* (Müll. Arg.) C.W. Dodge (1971: 179).

≡ *Physcia melanocarpa* Müll. Arg. (1888b: 58) Lectotype:—PARAGUAY. Guarapi, *prope* Asuncion, 1879 *B. Balansa 4198* (REN; isolectotype: H–Herb. Nyl. 2325 P.M.).

CHARACTERIZATION.

Thallus corticicolous, adpressed to substrate. Upper surface glaucous grey to yellowish grey, longitudinally plicate. Laciniae confluent, flabellate, 1−3 mm width, subdichotomously to palmatifid branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment absent. Lower surface white to yellowish white, rhizinae precursors present. Apothecia sessile of constrict base, (0.5–)1–1.5 mm diam.; disc plane to convex, black, epruinose. Apothecial anatomy: epithecium brown, 10–12 µm thick; hymenium 100–110 µm thick; subhymenium yellow to colorless, ca. 100 µm thick. Ascospores *Dirinaria*-type (15–)17–21 × (5–)6–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is distinguished by the yellowish white lower surface, yellow to colorless subhymenium, and the presence of atranorin and divaricatic acid.

Three other species have a pale lower surface, *viz*. *D. batavica, D. complicata* and *D. minuta,* but these three species have a dark brown to brown-black subhymenium. All other species have a dark lower surface.

Müller Argoviensis (1888b) described this species as *Physcia melanocarpa* Müll. Arg. (1888b: 58), with the type specimen "corticola ad Guarapi nº 4198, leg. Balansa et prope Asuncion". However, Awasthi (1975) after seeing the material mentioned, noted that it did not correspond to the taxon described by Müller Argoviensis.

Dodge (1971) commented about *D. aegialita* too and proposed the new combination of this taxon as *D. melanocarpa,* but Awasthi (1975) did not find material that corresponded to Müller Argoviensis' description and proposed a lectotype for this species.

DISTRIBUTION.

AMERICAN CONTINENT: SOUTH AMERICA. BOLIVIA (Flakus *et al.* 2015: 83); BRAZIL, MS (Awasthi 1975: 50, Fleig & Riquelme 1991: 7, Torres 2018: 87), MT (Awasthi 1975: 50, Brako *et al.* 1985: 130); COLOMBIA (Awasthi 1975: 50, Aguirre & Rangel 2007: 259, Aguirre & Rangel 2007: 259 as *Dirinaria aspera*, Sipman *et al.* 2008); PARAGUAY (Müller Argoviensis 1888b: 58 as *Physcia melanocarpa*, Awasthi 1975: 50).

16. *Dirinaria melanoclina* (H. Knight) D.D. Awasthi (1975: 77).

≡ *Physcia melanoclina* H. Knight (1882: 49), Tab 7, Fig. 10. Lectotype:—AUSTRALIA. New South Wales, 1880, *C. Knight 13* "in pencil" (WELT; isolectotypes: H–NYL 31807; M).

CHARACTERIZATION.

Thallus corticicolous, adpressed to the substrate. Upper surface glaucous white to yellowish grey, scarcely longitudinally plicate. Laciniae discrete to confluent, not flabellate, 1 mm width, palmatifid branched, rounded apices. Soralia present, hemispherical not capitate, farinose soredia. Isidia and polysidiangia absent. Medulla white, pigment absent. Lower surface brown-black, rhizinae precursors present. Apothecia sessile of constrict base, 0.6–1 mm diam.; disc plane to subconvex, reddish brown to brownish black, purplish pruinose. Apothecial anatomy: epithecium dark brown, 15 µm thick; hymenium 65–75 µm thick; subhymenium dark brown, 140–160 µm thick. Ascospores *Dirinaria*-type 16–20 × 6–8(–9) µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by the non-flabellate laciniae, the presence of hemispherical soralia, apothecial disc purplish pruinose, and the presence of atranorin and divaricatic acid.

This species is very similar to *D. picta* but is differentiated by the apothecia disc purplish pruinose. *Dirinaria applanata* has hardly flabellate laciniae, *D. frostii* has whitish pruina on the apothecial disc and crateriform soralia. *Dirinaria leopoldii* has a coccineous pigment in the medulla. *Dirinaria naggarana* has botryose soralia and only atranorin, *D. sekikaic* has sekikaic acid, *D. caesiopicta* has only atranorin, *D. flava* has a deep yellow upper surface (C+ orange).

The other species with apothecial disc purplish pruinose are *D. purpurascens* that does not present vegetative propagules and *D. pruinosa* that has polysidiangia as vegetative propagules. This species was rarely mentioned in the literature; it was described as *Physcia melanoclina* H. Knight (1882: 49) and combined as *D. melanoclina* by Awasthi (1975); furthermore, only Elix (2009) cited this taxon.

DISTRIBUTION.

AFRICA: SOUTH AFRICA (Awasthi 1975: 78).

OCEANIA: AUSTRALIA (Knight 1882: 49 as *Physcia melanoclina*, Awasthi 1975: 78, Elix 2009).

17. *Dirinaria minuta* Kalb (2001: 145).

Holotype:—AUSTRALIA. Northern Territory: Keep River National Park, 40 km NE of Kununurra, 15º50’ S, 129º07’, elev. 110 m elev., 9 August 1995, *K. & A. Kalb 29565*, (CANB; Isotype: Herb. Klaus Kalb).

CHARACTERIZATION.

Thallus saxicolous, adpressed to the substrate. Upper surface grey to olive-grey, longitudinally plicate. Laciniae discrete, not flabellate, 1.0−1.5 mm width, subdichotomously to irregularly branched, rounded apices. Isidia, polysidiangia and soralia absent. Lower surface not mentioned. Medulla white, pigment absent. Apothecia sessile of the constrict base, 0.3–0.8 mm diam.; disc plane to convex, black, epruinose. Apothecial anatomy: epithecium brown ca. 10 µm thick; hymenium colorless, 70–90 µm thick; subhymenium light-brown, 30–40 µm thick. Ascospores *Dirinaria*-type 12–14 × 4.5–5.5 µm. **Spot tests:** upper surface K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and sekikaic acid. Based on Elix (2009).

REMARKS.

This species is characterized by the saxicolous thallus, light-brown subhymenium, and the presence of atranorin and sekikaic acid.

This species is chemically closely related to *D. confusa,* but *D. minuta* has a smaller thallus, smaller laciniae (up to 1.5 mm), lower (30−40 µm) and pale brown subhymenium, and smaller ascospores (12−14 × 4.5−5.5 µm). *Dirinaria consimilis* and *D. sekikaica* have sekikaic acid, but both have vegetative propagules.

Kalb (2001) described this species based in the features previously presented, and this species was mentioned only by him and Elix (2009).

DISTRIBUTION.

OCEANIA: AUSTRALIA (Kalb 2001: 146, Elix 2009).

18. *Dirinaria naggarana* (Kremp.) D.D. Awasthi (1975: 61).

≡ *Physcia naggarana* Kremp. (1874: 101). Tab. 14, Fig. 16. Lectotype:—VITI ISLANDS ('Insula vitii'). Leon, Naggarana Island, *Dr. Graeffe 39* (M).

CHARACTERIZATION.

Thallus corticicolous, adpressed to almost to the substrate. Upper surface glaucous white to yellowish grey, not plicate. Laciniae discrete, not flabellate, 0.5−1.0 mm width, palmatifid to subdichotomously branched, rounded apices. Isidia absent. Polysidiangia absent. Soralia present, hemispheric to botryose, granular soredia. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia sessile of the constrict base, 0.3–0.8 mm diam.; disc plane to convex, black, epruinose. Apothecial anatomy: epithecium not mentioned; hymenium light yellow, 80–90(–100) µm thick; subhymenium dark brown to brown-black, 150–250 µm thick. Ascospores *Dirinaria*-type (14–)18–22 × 7–9 µm. **Spot tests:** upper surface K+ faintly yellowish or K–, C–; medulla K–, C–, P–. **Chemistry:** atranorin present in traces. Based on Awasthi (1975).

REMARKS.

This taxon is distinguished by the non-plicate thallus, botryose soralia and only atranorin present.

Apparently, *D. naggarana* has no similarity with another species, mainly because of the shape of the soralia. This species is a mystery, because it has modified soralia mentioned by Awasthi (1975), but he did not understand the nature of this structures and treated them as "botryose soralia". Only Krempelhuber (1874) and Awasthi (1975) mentioned this species.

DISTRIBUTION.

ASIA: MALAYSIA (Awasthi 1975: 62); PHILIPPINES (Awasthi 1975: 62).

PACIFIC OCEAN: FIJI (Krempelhuber 1874: 101 as *Physcia naggarana,* Awasthi 1975: 62, Elix & McCarthy 2008a).

19. *Dirinaria neotropica* Kalb (2004a: 102).

Holotype:—MEXICO, Sonora: 7 km NE of Huasabas above Río Bavispe, 29º50' N, 109º13' W, *T.H. Nash III 14788* (ASU).

= *Physcia aegialita* var. *saxicola* Räsänen (1947: 47). Holotype:—URUGUAY. Lavellaja Department, Cerro Arequita, *'ad rupem praeruptum*', 5 April 1946, *I.M. Lamb 3* (H–Räsänen); ≡ *Dirinaria confusa* var. *saxicola* (Räsänen) D.D. Awasthi (1975: 60).

CHARACTERIZATION.

Thallus saxicolous, closely appressed to agglutinated to the substrate. Upper surface yellowish grey to greenish grey, longitudinally plicate. Laciniae discrete, not flabellate to flabellate, 0.5−1.2 mm width, palmatifid branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment orange in lower region. Lower surface black, rhizinae precursors absent. Apothecia sessile of the constrict base, 0.5–1 mm diam.; disc plane, black, epruinose or grey pruinose. Apothecial anatomy: not mentioned. Ascospores *Dirinaria*-type 10–15 × 4.5–6 µm. **Spot tests:** upper surface K+ faintly yellowish or K–, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Kalb (2004a).

REMARKS.

This species is characterized by an orange pigment, mainly in the lower region of the medulla, and the presence of atranorin and divaricatic acid.

Dirinaria coccinea, *D. confluens* var. *coccinea* and *D. leopoldii* have a red pigmentation in the medulla, but this pattern of distribution of this pigment is different in each species; for more details see under the respective taxa. The other species do not have a coccineous or orange pigment in the medulla.

Kalb (2004a) described this species and proposed the synonymizing of *D. confusa* var. *saxicola* (Räsänen) D.D. Awasthi (1975: 60), because he analyzed two paratypes, and found the presence of divaricatic acid, which was in contradiction to Awasthi (1975) who mentioned "Divaricatic acid was not found in GAW. Sekikaic acid was also not always present in GAW".

This is a neotropical species, hence the name that Kalb (2004a) suggested.

DISTRIBUTION.

AMERICAN CONTINENT: CENTRAL AMERICA. DOMINICAN REPUBLIC (Awasthi 1975: 60 as *Dirinaria confusa* var. *saxicola*); MEXICO (Awasthi 1975: 60 as *Dirinaria confusa* var. *saxicola*, Kalb 2004a: 102). SOUTH AMERICA. BRAZIL, MT (Awasthi 1975: 60 as *Dirinaria confusa* var. *saxicola*), COLOMBIA (Awasthi 1975: 60 as *Dirinaria confusa* var. *saxicola*); ECUADOR, Galapagos Island (Bungartz *et al.* 2013, Bungartz *et al.* 2016a); PARAGUAY (Awasthi 1975: 60 as *Dirinaria confusa* var. *saxicola*); URUGUAY (Räsänen 1947: 47 as *Physcia aegialita* var. *saxicola*, Awasthi 1975: 60 as *Dirinaria confusa* var. *saxicola*); VENEZUELA (Marcano *et al.* 1996: 203 as *Dirinaria confusa* var. *saxicola*).

20. *Dirinaria papillulifera* (Nyl.) D.D. Awasthi (1964: 369). (Figure 5A)

≡ *Physcia papillulifera* Nyl., (1900: 9). Lectotype:—SRI-LANKA. Point de Galles, in horto, 'Vega Exped', 1879, *E. Almquist* (S; isolectotype: H–NYL 31791).

– *Physcia picta* f. *isidiophora* Nyl. Misunderstood name, see Awasthi (1964).

= *Physcia isidiophora* Abbayes (1951: 753). Holotype:—REPUBLIC OF CÔTE D'IVOIRE. Mankomo, cercle de Seguela, 400 m elev., on shaded granite, *H. des Abbayes*; ≡ *Dirinaria isidiophora* (Abbayes) C.W. Dodge (1971: 183).

CHARACTERIZATION.

Thallus corticicolous, closely adpressed to almost agglutinated to the substrate. Upper surface glaucous white to glaucous grey, longitudinally plicate. Laciniae discrete to confluent, flabellate, 1.0−1.5 mm width, subdichotomously to, palmatifid branched, rounded apices. Isidia present, cylindric, not branched to irregularly branched. Polysidiangia and soralia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia sessile of the constrict base, 0.7–1 mm diam.; disc plane to slightly convex, black, epruinose. Apothecial anatomy: epithecium yellow 10–12 µm thick; hymenium colorless 90–100(–110) µm thick; subhymenium dark brown to brown-black, 250–300 µm thick. Ascospores *Dirinaria*-type 12–16 × 5.5–8 µm. **Spot tests:** upper surface K+ faintly yellowish or K–, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based in Awasthi (1975).

REMARKS.

This species is characterized mainly by the isidia, a plicate thallus, and the presence of atranorin and divaricatic acid.

Dirinaria papillulifera is the only species with isidia as vegetative propagules and is easily characterized by this.

Nylander (1900) described this species as *Physcia papillulifera* Nyl. (1900: 9) based on material from Sri Lanka. The choice of the epithet name was motivated by the young isidia that look like papillae (Awasthi 1975). Awasthi (1964) proposed the new combination as *D. papillulifera* and explained the nomenclatural confusion, in which *Physcia picta* f. *isidiophora* is included and pointed out the reason for the erroneous interpretation by des Abbayes (1951). Dodge (1971) considered *Physcia isidiophora* Abbayes (1951: 753) a valid name, making a new combination, *D. isidiophora* (Abbayes) C.W. Dodge (1971: 183). He clearly ignored the nomenclatural explanation made by Awasthi (1964). Nevertheless, in his wide monograph, Awasthi (1975) also ignored the new combination proposed by Dodge. It is not clear if Dodge or Awasthi have examined the specimens examined by des Abbayes. Anyway, they can be taxonomic synonyms.

DISTRIBUTION.

AFRICA: REPUBLIC OF CÔTE D'IVOIRE (Dodge 1971: 183 as *Dirinaria isidiophora*); SIERRA LEONE (Dodge 1971: 183 as *Dirinaria isidiophora*).

AMERICA CONTINENT: CENTRAL AMERICA. JAMAICA (Awasthi 1975: 64); PANAMA (Awasthi 1975: 64). NORTH AMERICA. UNITED STATES OF AMERICA (Harris 1995: 44). SOUTH AMERICA. BRAZIL, AM (Awasthi 1975: 64), RO (Aptroot & Cáceres 2014: 791); FRENCH GUIANA (Aptroot 1987: 19); GUYANA (Aptroot 1987: 19); SURINAM (Aptroot 1987: 19).

ASIA: INDIA (Awasthi 1975: 64, Awasthi 2007: 150); INDONESIA (Awasthi 1975: 64); PHILIPPINES (Aptroot & Sipman 1989: 35); SRI LANKA (Nylander 1900: 3 as *Physcia papillulifera*, Awasthi 1975: 64, Breuβ & Brunnbauer 1997: 729, Awasthi 2007: 150).

PACIFIC OCEAN: GALAPAGOS ISLANDS (Bungartz *et al.* 2013, Bungartz *et al.* 2016a); HAWAIIAN ISLANDS (Elix & McCarthy 2008a); WESTERN SAMOA (Elix & McCarthy 2008a).

21. *Dirinaria picta* (Sw.) Clem. & Shear (1931: 323). (Figure 5B)

≡ *Lichen pictus* Sw. (1788: 146). Lectotype:—JAMAICA. *Swartz* (S–SW L1617; isolectotype: UPS); ≡ *Parmelia picta* (Sw.) Ach. (1803: 211); ≡ *Physcia picta* (Sw.) Nyl. (1855: 175); ≡ *Dimelaena picta* (Sw.) Trevis. (1868: 623); ≡ *Hagenia picta* (Sw.) Bagl. (1875: 242); ≡ *Pyxine picta* (Sw.) Tuck. (1882: 79).

= *Parmelia plumosa* T. Taylor (1847: 173). Lectotype:—MARQUESAS ISLANDS. Low Island, on bark, *Beechey* (FH–T. Taylor; Isolectotype: BM, H–NYL 31803); ≡ *Physcia plumosa* (T. Taylor) Nyl. (1857: 106).

= *Physcia picta* f. *foliicola* Cromb., *in* Cromb. & Nyl. (1884: 52). Lectotype:—MALAYSIA. Malacca, on *Garcinia mangostana* leaves, *A.C. Maingay* (BM; isolectotype: FH).

= *Pyxine adamesii* C.W. Dodge (1953: 396). Holotype:—SIERRA LEONE, Sefadu (Gbense), on trunk of *Elaeis guineensis, P. Adames & F. C. Deighton M4756a* (BM).

CHARACTERIZATION.

Thallus corticicolous, closely adpressed to the substrate. Upper surface glaucous white to glaucous grey, not plicate. Laciniae discrete, not flabellate, 1.0−1.5 mm width, palmatifid branched, rounded apices. Isidia absent. Polysidiangia absent. Soralia present, hemispherical and capitate, farinose soredia. Medulla white, pigment absent. Lower surface black, rhizinae precursors present. Apothecia sessile of the constrict base, 1–1.5 mm diam.; disc plane to slightly convex, black, epruinose. Apothecial anatomy: epithecium pale brown, 10 µm thick; hymenium 80–90 µm thick; subhymenium dark brown to brown-black, 120–160(–200) µm thick. Ascospores *Dirinaria*-type (12–)14–17(–21) × 5–7(–9) µm. **Spot tests:** upper surface K+ faintly yellowish or K–, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based in Awasthi (1975).

REMARKS.

This species is characterized by the non-plicate thallus, palmatifid branched and non-flabellate laciniae, hemispherical and capitate soralia, and the presence of atranorin and divaricatic acid.

Dirinaria caesiopicta and *D. frostii* have non-flabellate laciniae too, but *D. caesiopicta* has only atranorin, *D. frostii* differs mainly by the crateriform soralia. *Dirinaria leopoldii* has a coccineous pigment in the medulla and is easily differentiated by this feature. *Dirinaria applanata* shows the strongly plicate thallus and flabellate laciniae, *D. sekikaica* has sekikaic acid. *Dirinaria flava* has a deep yellow upper surface (C+ orange). *Dirinaria melanoclina* has the apothecial disc purplish pruinose and *D. naggarana* has botryose soralia and only atranorin. The other species either do not have vegetative propagules or have isidia or polysidiangia.

The history of this taxon is very old; it started with Swartz (1788), who described it as *Lichen pictus* at a time that almost all lichens belonged to this genus. Acharius (1803) divided this genus and this species was transferred to *Parmelia*. Nylander (1855) combined it as *Physcia picta* (Sw.) Nyl. (1855: 175), later Trevisan (1869) treated it as *Dimelaena picta* (Sw.) Trevis. (1868: 623) and Baglietto (1875) as *Hagenia picta* (Sw.) Bagl. (1875: 242); however, these classifications were not often followed and Tuckerman (1882), based on Nylander's description proposed a new combination as *Pyxine picta* (Sw.) Tuck. (1882: 79). *Dirinaria picta* was proposed by Clements

(1931) without mentioning "*comb. nov.",* but this classification was accepted by many authors, such as Imshaug (1957), Poelt (1965), Hale & Culberson (1970) and Awasthi (1975).

For more details on the synonyms, see Awasthi (1975).

DISTRIBUTION.

AFRICA: ETHIOPIA (Baglietto 1975: 242 as *Hagenia picta*, Swinscow & Krog 1988: 82); KENYA (Awasthi 1975: 75, Swinscow & Krog 1978: 167, Swinscow & Krog 1988: 82); MADAGASCAR (Hue 1900: 79 as *Physcia picta*, Aptroot 1988: 143, Aptroot 2016: 358); MOZAMBIQUE (Awasthi 1975: 75); REPUBLIC OF CÔTE D'IVOIRE (Awasthi 1975: 75); SIERRA LEONE (Awasthi 1975: 75); SOUTH AFRICA (Awasthi 1975: 75); TANZANIA (Stein 1888: 135 as *Physcia picta*, Müller Argoviensis 1895b: 261 as *Physcia picta*, Awasthi 1975: 75, Swinscow & Krog 1978: 167, Swinscow & Krog 1988: 82); UGANDA (Swinscow & Krog 1978: 167, Swinscow & Krog 1988: 82).

AMERICAN CONTINENT: CENTRAL AMERICA. BAHAMAS (Thomson 1963: 163 as *Physcia picta*, Awasthi 1975: 76); BERMUDA (Lynge 1924: 40 as *Physcia picta*, Thomson 1963: 163 as *Physcia picta*, Awasthi 1975: 76); COSTA RICA (Thomson 1963: 163 as *Physcia picta*, Awasthi 1975: 76); CUBA (Montagne 1838-1842: 221 as *Parmelia picta*, Hue 1900: 79 as *Physcia picta*, Lynge 1924: 40 as *Physcia picta*, Thomson 1963: 163 as *Physcia picta*, Awasthi 1975: 76); CURAÇAO Island (Awasthi 1975: 76); GRENADA (Awasthi 1975: 76); GUADALUPE (Awasthi 1975: 76); JAMAICA (Acharius 1803: 211 as *Parmelia picta*, Acharius 1810: 480 as *Parmelia picta*, Acharius 1814: 212 as *Parmelia picta*, Thomson 1963: 163 as *Physcia picta*, Awasthi 1975: 76); PUERTO RICO (Thomson 1963: 163 as *Physcia picta*, Awasthi 1975: 76); SWAN ISLAND (Thomson 1963: 163 as *Physcia picta*, Awasthi 1975: 76); TOBAGO (Thomson 1963: 163 as *Physcia picta*); CENTRAL AMERICA. PANAMA (Lynge 1924: 40 as *Physcia picta*, Awasthi 1975: 75). NORTH AMERICA. MEXICO (Tuckerman 1882: 79, Hue 1900: 79 as *Physcia picta*, Thomson 1963: 163 as *Physcia picta*, Kalb 2004a: 103); UNITED STATES OF AMERICA (Tuckerman 1882: 79, Hue 1900: 79 as *Physcia picta*, Thomson 1963: 163 as *Physcia picta*, Moore 1968: 250, Awasthi 1975: 75, Brodo *et al.* 2001: 306, Kalb 2004a: 103). SOUTH AMERICA. ARGENTINA (Müller Argoviensis 1888b: 58 as *Physcia picta*, Lynge 1924: 40 as *Physcia picta*, Osorio 1968: 286as *Physcia picta*, Osorio 1969: 3 as *Physcia picta*, Osorio 1970: 393 as *Physcia picta*, Osorio 1975: 84 as *Physcia picta*, Awasthi 1975: 76, Osorio 1981a: 14 as *Physcia picta*, Scutari 1992: 170, Scutari 1995: 159, Estrabou *et al.* 2006: 32); BOLIVIA (Lynge 1924: 40 as *Physcia picta*); BRAZIL, AL (Cáceres 2007: 70), BA (Lynge 1924: 40 as *Physcia picta*, Awasthi 1975: 76), MG (Vainio 1890: 150 as *Physcia picta*, Lynge 1924: 40 as *Physcia* picta, Awasthi 1975: 76), MT (Lynge 1924: 40 as *Physcia picta*), PE (Cáceres 2007: 70), RJ (Lynge 1924: 40 as *Physcia picta*,

Awasthi 1975: 76), RO (Aptroot & Cáceres 2014: 791), RS (Lynge 1924: 40 as *Physcia picta*, Awasthi 1975: 76, Osorio 1981b: 73), SE (Cáceres *et al.* 2014: 110), SP (Hue 1900: 79 as *Physcia picta*, Osorio 1989: 161, Benatti & Jungbluth 2014: 20); CHILE (Hue 1892: 114 as *Physcia picta*); COLOMBIA (Hue 1892: 114 as *Physcia picta*, Aptroot 1989: 273); ECUADOR (Nöske *et al.* 2007: 113, Bungartz *et al.* 2013, Bungartz *et al.* 2016a); FRENCH GUYANA (Awasthi 1975: 76, Aptroot 1987: 20); GUYANA (Awasthi 1975: 76, Aptroot 1987: 20); PARAGUAY (Lynge 1924: 40 as *Physcia picta*, Awasthi 1975: 76); PERU (Hue 1892: 114 as *Physcia picta*); SURINAM (Awasthi 1975: 76, Aptroot 1987: 20); URUGUAY (Osorio 1967: 6 as *Physcia picta*, Osorio 1972: 31 as *Physcia picta* Osorio 1979a: 319 as *Physcia picta*); VENEZUELA (Awasthi 1975: 76, López-Figueiras 1986: 142, Marcano *et al.* 1996: 203).

ASIA: CHINA (Nylander & Crombie 1884: 52 as *Physcia picta*, Hue 1892: 114 as *Physcia picta*, Hue 1900: 79 as *Physcia picta*, Lynge 1924: 40 as *Physcia picta*, Awasthi 1975: 75, Wolseley *et al.* 2002: 23); INDIA (Lynge 1924: 40 as *Physcia picta*, Wolseley *et al.* 2002: 23, Awasthi 2007: 150); INDONESIA (Nylander 1858-1860: 430 as *Physcia plumosa*, Hue 1892: 114 as *Physcia picta,* Nylander 1857: 106 as *Physcia plumosa*, Awasthi 1975: 75, Wolseley *et al.* 2002: 23); JAPAN (Hue 1892: 114 as *Physcia picta*, Hue 1900: 79 as *Physcia picta*, Awasthi 1975: 75); MALAYSIA (Awasthi 1975: 75); MYANMAR (Awasthi 1975: 75, Wolseley *et al.* 2002: 23); PHILIPPINES (Awasthi 1975: 75, Wolseley *et al.* 2002: 23); SINGAPORE (Wolseley *et al.* 2002: 23); SOUTH KOREA (Jayalal *et al.* 2013: 157); SRI LANKA (Nylander 1857: 106 as *Physcia plumosa*, Nylander 1858-1860: 430 as *Physcia plumosa*, Hue 1892: 114 as *Physcia picta*, Awasthi 1975: 75, Wolseley *et al.* 2002: 23, Awasthi 2007: 150); TAIWAN (Awasthi 1975: 75, Wolseley *et al.* 2002: 23); THAILAND (Wolseley *et al.* 2002: 23, Aptroot *et al.* 2007: 81); VIETNAM (Awasthi 1975: 75, Wolseley *et al.* 2002: 23).

INDIAN OCEAN: MALDIVES (Aptroot 1991: 59).

OCEANIA: AUSTRALIA (Hue 1892: 114 as *Physcia picta*, Kalb 2001: 147, Elix 2009); NEW CALEDONIA (Nylander 1858-1860: 430 as *Physcia plumosa*, Hue 1892: 114 as *Physcia picta*, Awasthi 1975: 76); PAPUA NEW GUINEA (Awasthi 1975: 76); NEW ZEALAND (Hue 1892: 114 as *Physcia picta*);

PACIFIC OCEAN: AMERICAN SAMOA (Elix & McCarthy 2008a)

COOK ISLAND (Awasthi 1975: 75, Elix & McCarthy 2008a); EASTER ISLAND (Elix & McCarthy 2008a); FIJI ISLAND (Awasthi 1975: 75, Elix & McCarthy 2008a); HAWAIIAN ISLANDS (Magnusson & Zahlbruckner 1945: 62 as *Physcia picta*, Awasthi 1975: 76, Elix & McCarthy 2008a); ISLAS JUAN FERNÁNDEZ (Elix & McCarthy 2008a); ISLAS REVILLAGIGEDO (Elix & McCarthy 2008a); MARIAN ISLANDS (Lynge 1924: 40 as *Physcia picta*); MARQUESAS ISLANDS (Nylander 1858-1860: 430 as *Physcia plumosa*, Hue 1892: 114

as *Physcia picta*); MARSHALL ISLAND (Awasthi 1975: 76, Elix & McCarthy 2008a); MICRONESIA (Elix & McCarthy 2008a); NEW CALEDONIA (Elix & McCarthy 2008a); NEW HEBRIDES (Awasthi 1975: 76); NORTHERN MARIANA ISLANDS (Elix & McCarthy 2008a, Elix & McCarthy 2008b: 12); OGASAWARA-SHOTO (Elix & McCarthy 2008a); PITCAIRN ISLANDS (Elix & McCarthy 2008a); SAMOA ISLAND (Awasthi 1975: 76); SOCIETY ISLANDS (Awasthi 1975: 76, Elix & McCarthy 2008a); TONGA ISLAND (Awasthi 1975: 76, Elix & McCarthy 2008a); TUAMOTU (Awasthi 1975: 76, Elix & McCarthy 2008a); VANUATU (Elix & McCarthy 2008a); WESTERN SAMOA (Elix & McCarthy 2008a)

22. *Dirinaria pruinosa* Kalb (2001: 147).

Holotype:—BRAZIL. Piauí: entrance to Parque Nacional de Sete Cidates, 04º8'S, 41º45'W, transitional vegetation between open cerrado and caatinga, elev. 300 m elev., 6 August 1993, *K & A. Kalb 27108* (SP).

CHARACTERIZATION.

Thallus corticicolous, adpressed to the substrate. Upper surface whitish grey to grey, not plicate. Laciniae discrete, not flabellate, 1.0−1.5 mm width, subdichotomously to irregularly branched, rounded apices. Polysidiangia present, irregular, producing granular soredia. Isidia and soralia absent. Medulla white, pigment absent. Lower surface not mentioned. Apothecia sessile of constrict base, 0.6–1.3 mm diam.; disc plane to slightly convex, black, purple pruina. Apothecial anatomy: epithecium brownish; hymenium ca. 100 µm thick; subhymenium brown 60–70 µm thick. Ascospores *Dirinaria*-type (17–)20–25 × (6–)7–8 µm. **Spot tests:** not mentioned. **Chemistry:** atranorin and divaricatic acid. Based on Kalb (2001).

REMARKS.

This species is characterized by the presence of polysidiangia, apothecial disc purplish pruinose, and the presence of atranorin and divaricatic acid.

For comparisons with closely taxa, see *D. aegialita*. *Dirinaria pruinosa* was described by Kalb (2001) and is known only from the type locality.

DISTRIBUTION.

AMERICAN CONTINENT: SOUTH AMERICA. BRAZIL, PI (Kalb 2001: 147).

23. *Dirinaria purpurascens* (Vain.) B.J. Moore (1968: 251).

≡ *Physcia purpurascens* Vain. (1915: 68). Lectotype:—WEST INDIES, St. Croix Island, Fair Plane, on bark, 1906, *Boergesen 235* (FH).

CHARACTERIZATION.

Thallus corticicolous, adpressed to almost adglutinated to the substrate. Upper surface glaucous white to glaucous grey, slightly longitudinally plicate. Laciniae discrete, not flabellate, 0.2−0.7 mm width, palmatifid branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors absent. Apothecia sessile of constrict base, 0.5–1(–1.5) mm diam.; disc plane to rarely convex, black, purplish pruinose. Apothecial anatomy: epithecium reddish brown, ca. 10 µm thick; hymenium 80–90 µm thick; subhymenium dark brown to brown-black, 70–80 µm thick. Ascospores *Dirinaria*-type (11–)14–18(–20) × 5–7 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized mainly by the purplish pruinose apothecia disc, absence of vegetative reproductive structures, the slightly plicate thallus, and the presence of atranorin and divaricatic acid.

Dirinaria subconfluens and *D. confluens* are similar to *D. purpurascens* but have whitish pruinose apothecial discs and bigger ascospores. Other species with purplish pruinose apothecia disc are *D. melanoclina* and *D. pruinosa,* however, the first has soralia and the last has polysidiangia.

Dirinaria purpurascens was described by Vainio (1915) as *Physcia purpurascens* Vain. (1915: 68); in his description the purplish pruinose apothecia disc is mentioned, what probably motivated the choice of the epithet. Moore (1968) combined this species in *Dirinaria* and cited that its main distribution is neotropical.

DISTRIBUTION.

AFRICA: SOUTH AFRICA (Awasthi 1975: 47).

AMERICAN CONTINENT: CENTRAL AMERICA. BAHAMAS (Thomson 1963: 161 as *Physcia purpurascens*, Awasthi 1975: 47); COSTA RICA (Awasthi 1975: 47); CUBA (Thomson 1963: 161 as *Physcia purpurascens*, Awasthi 1975: 47); JAMAICA (Awasthi 1975: 47); NICARAGUA (Thomson 1963: 161 as *Physcia purpurascens*, Awasthi 1975: 47); PUERTO RICO (Thomson 1963: 161 as *Physcia purpurascens*, Awasthi 1975: 47); ST. CROIX ISLAND (Vainio 1915: 68

as *Physcia purpurascens*); NORTH AMERICA. MEXICO (Thomson 1963: 161 as *Physcia purpurascens*, Awasthi 1975: 47); UNITED STATES OF AMERICA (Thomson 1963: 161 as *Physcia purpurascens*, Moore 1968: 251, Hale & Culberson 1970: 513, Awasthi 1975: 47, Harris 1995: 44, Brodo *et al.* 2001: 307). SOUTH AMERICA. BRAZIL, MT (Thomson 1963: 161 as *Physcia purpurascens*, Awasthi 1975: 47), PE (Cáceres 2007: 70), RO (Aptroot & Cáceres 2014: 791), SE (Cáceres 2007: 70); COLOMBIA (Awasthi 1975: 47, Aptroot 1989: 273); GUYANA (Aptroot 1987: 21); SURINAM (Aptroot 1987: 21); VENEZUELA (Thomson 1963: 161 as *Physcia purpurascens*, Awasthi 1975: 47).

ASIA: THAILAND (Aptroot *et al.* 2007: 97).

OCEANIA: AUSTRALIA (Kalb 2001: 147, Elix 2009).

23.1. ***Dirinaria purpurascens*** f. ***colorata*** D.D. Awasthi (1975: 47).

Holotype:—SOUTH AFRICA. Natal: Nongoma (Zululand), on trees, in the savannah at Mumyana river, 16 August 1929, *O.A. Höeg* (LD; Isotypes: LD, TRH, UPS).

CHARACTERIZATION.

Thallus corticicolous, adpressed to the substrate. Upper surface pale grey, longitudinally plicate. Laciniae discrete, flabellate (not mentioned), 0.5 mm width, palmatifid branched, rounded apices. Isidia, polysidiangia and soralia absent. Medulla white, pigment ochraceous. Lower surface black, rhizinae precursors absent. Apothecia sessile of the constrict base, up to 1 mm diam.; disc plane to rarely convex, black, purplish pruinose evanescent with the age. Apothecial anatomy: epithecium not mentioned; hymenium 80–90 µm thick; subhymenium reddish brown, 130–160 µm thick. Ascospores *Dirinaria*-type 14–18 × 5–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K– (white region), K+ deep yellow to purple (ochraceous region), C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This form is characterized by the medulla with both white and ochraceous regions (K+ deep yellow to purple) and the purplish pruinose apothecia disc.

This form was described by Awasthi (1975), based in the ochraceous region of the medulla. It has never been cited again in the literature.

DISTRIBUTION.

AFRICA: SOUTH AFRICA (Awasthi 1975: 47).

24. *Dirinaria sekikaica* Elix (2008: 36).

Holotype:—AUSTRALIA. New South Wales, Old Macleay River estuary, Stuarts Point, 30º49'S, 153º00'E, 1 m elev., on *Casuarina glauca* in strand vegetation adjacent to mangrove swamp, *J.A. Elix 21346*, I. 18. 1987 (CANB).

CHARACTERIZATION.

Thallus corticicolous, adpressed to the substrate. Upper surface bluish grey to yellowish grey, longitudinally plicate. Laciniae confluent, flabellate, 0.5−2.0 mm width, palmatifid branched, rounded apices. Isidia and polysidiangia absent. Soralia present, hemispherical to elongate, farinose soredia. Medulla white, pigment absent. Lower surface black, rhizinae precursors not mentioned. Apothecia sessile of the constrict base, 0.5–1.5 mm diam.; disc plane, black, epruinose to greyish pruinose. Apothecial anatomy: epithecium dark yellow, ca. 10 µm thick; hymenium colorless, 75–85 µm thick; subhymenium dark brown to brown-black, 160–200 µm thick. Ascospores *Dirinaria*-type 15–22 × 6–8 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and sekikaic acid. Based on Elix (2008).

REMARKS.

This species is characterized by the strongly plicate thallus, flabellate laciniae, hemispherical to elongate soralia, and the presence of atranorin and sekikaic acid.

Dirinaria sekikaica is morphologically and anatomically similar to *D. applanata,* but this has divaricatic acid instead of sekikaic acid. Besides *D. sekikaica* there exist three species with sekikaic acid, viz. *D. confusa* and *D. minuta* which do not have vegetative propagules and *D. consimilis* that has polysidiangia as vegetative propagules. *Dirinaria caesiopicta, D. leopoldii* and *D. naggarana* have atranorin only, the other sorediate species of the genus have atranorin and divaricatic acid.

DISTRIBUTION.

OCEANIA: AUSTRALIA (Elix 2008: 36, Elix 2009).

AMERICAN CONTINENT: SOUTH AMERICA. BRAZIL, BH (Kalb 2009: 229), PE (Kalb 2009: 229).

25. *Dirinaria subconfluens* D.D. Awasthi (1975: 33).

Holotype:—NEW CALEDONIA, on bark, *Vieillard*, 1863 (H; isotype: H).

CHARACTERIZATION.

Thallus corticicolous, adpressed to the substrate. Upper surface glaucous white to glaucous grey, not plicate. Laciniae discrete, not flabellate, 0.5−0.7(−1.0) mm width, palmatifid to subdichotomously branched, rounded apices. Isidia, polysidiangia and Soralia absent. Medulla white, pigment absent. Lower surface black, rhizinae precursors present. Apothecia sessile of constrict base, 0.5–0.7(–1.5) mm diam.; disc plane, black, epruinose. Apothecial anatomy: epithecium pale brown, ca. 10 µm thick; hymenium colorless to yellow, 60–70(–80) µm thick; subhymenium dark brown, ca. 150 µm thick. Ascospores *Dirinaria*-type 13–18 × 5–7 µm. **Spot tests:** upper surface: K+ yellow, C–; medulla K–, C–, P–. **Chemistry:** atranorin and divaricatic acid. Based on Awasthi (1975).

REMARKS.

This species is characterized by the non-plicate to slightly plicate thallus, non-flabellate laciniae, a low hymenium (60–70 µm), absence of vegetative propagules, and the presence of atranorin and divaricatic acid.

As the name suggests, this species is closely related to *D. confluens*. However, *D. confluens* has a strongly plicate thallus, hardly flabellate laciniae, and a higher hymenium (80−110 µm).

Awasthi (1975) described this species from New Caledonia; it has being cited several times after that, but only from the Oceania region and South-East Asia.

DISTRIBUTION.

ASIA: INDIA (Awasthi 1975: 34); INDONESIA (Awasthi 1975: 34); PHILIPPINES (Awasthi 1975: 34); VIETNAM (Awasthi 1975: 34).

OCEANIA: AUSTRALIA (Awasthi 1975: 34, Kalb 2001: 147, Elix 2009).

PACIFIC OCEAN:

HAWAIIAN ISLANDS (Awasthi 1975: 34, Elix & McCarthy 2008a); NEW CALEDONIA (Awasthi 1975: 34, Elix & McCarthy 2008a); NEW HEBRIDES (Awasthi 1975: 34); SOCIETY ISLANDS (Awasthi 1975: 34, Elix & McCarthy 2008a); VANUATU (Elix & McCarthy 2008a).

EXCLUDED *DIRINARIA* TAXA

Dirinaria subpicta (Nyl.) C.W. Dodge (1971: 188) is ***Diploicia canescens*** (Dicks.) A. Massal. (1852: 86).

This supposed *Dirinaria* was described by Nylander in Crombie (1876b) as *Physcia subpicta* Nyl. (1876b: 170): “Comparabilis videtur cum *P. picta* vel *aegialita* (Ach.)” showing the

similarity between both taxa. Dodge (1971) combined in *Dirinaria subpicta* but did not described the taxon. This concept was followed by Awasthi (1975), who asserted that this was the single species in *Dirinaria* that doesn't have lower cortex. However, Swinscow & Krog (1978) found diploicin and not divaricatic acid in the type specimen. Based on this information and comparing the morphological and anatomical characteristics, we propose the synonymizing of *Dirinaria subpicta* in *Diploicia canescens.*

Dirinaria endopyxinea (Müll. Arg.) C.W. Dodge (1971: 181) is ***Diploicia endopyxinea*** (Müll. Arg.) Kalb, Elix & Bungartz, *in* Bungartz *et al.,* (2016b: 503).

This taxon was described as *Physcia endopyxinea* Müll. Arg. (1888c: 459) and Dodge (1971) combined it in *Dirinaria*. Awasthi (1975) followed this classification, describing the species in details. *Dirinaria endopyxinea* (Müll. Arg.) C.W. Dodge (1971: 188) was treated in *Dirinaria* until Bungartz *et al.* (2016b) combined it in the *Diploicia* genus, based mainly in the chemical constituents, verifying the presence of diploicin, as asserted by Swinscow & Krog (1978).

Dirinaria autenboeri (C.W. Dodge) C.W. Dodge (1973: 378) is ***Physcia caesia*** (Hoffm.) Hampe ex Fürnr. (1839: 250).

Dirinaria autenboeri was described by Dodge (1968) as *Physcia*, inside the *Dirinaria* section. Later one, Dodge (1973) combined it in *Dirinaria*. Dodge noted characters not common in *Dirinaria*, such as "underside and short rhizinae white"; only two species of *Dirinaria* show light lower surface (*Dirinaria complicata* and *Dirinaria melanocarpa*), but none have rhizinae or the subhymenium "15µ thick". As it was an Antarctic species, Castello & Nimis (1995) reviewed the type and concluded that it is composed of two species: the thallus of *Physcia caesia* (Hoffm.) Hampe ex Fürnr (1839: 250) and the apothecia of *Tetramelas grimmiae* (Filson) Elix (2018: 44); so they selected *Physcia caesia* as type of *Dirinaria autenboeri.*

Dirinaria: *Dirinaria leoniae* (Hue) C.W. Dodge (1973: 378) is ***Physcia caesia*** (Hoffm.) Hampe ex Fürnr. (1839: 250)?

This taxon was described as *Physcia leoniae* Hue (1915: 45) and was not mentioned until Dodge (1973) combined it as *Dirinaria leoniae*. The descriptions presented by Hue and Dodge are compatible with a *Physcia* species, especially the rhizinae size and the thallus morphology. Lewis-

Smith (2000) cited *Physcia leoniae* in Lamb's unpublished revisions of Antarctic lichens, and Olech (2001) placed this species as a probable synonym of *Physcia caesia*, The type (seemingly in PC) should be revised to permit a clear conclusion.

Dirinaria devertens (Nyl.) C.W. Dodge (1971: 181) is ***Pyxine devertens*** (Nyl.) Vain. (1915: 70).

This species was fist described as *Physcia devertens* Nyl. (1896: 3) and then combined in *Pyxine* by Vainio (1915). Magnusson & Zahlbruckner (ano?) also treated it as *Pyxine.* The combination in *Dirinaria* was proposed by Dodge (1971) and Awasthi (1975) only commented the ambiguity of the interpretation of Dodge over the genus concept. Eventually Swinscow & Krog (1975) accepted it as *Pyxine devertens*, being followed by Kalb (1987) and Jungbluth (2010).

NEW EXCLUSIONS

Dirinaria inelegans (Hue) C.W. Dodge (1971: 181) is ***Pyxine eschweileri*** (Tuck.) Vain. (1890: 156).

This taxon was described by Hue (1916) as *Lecanora inelegans* Hue (1916: 15) inside the section *Rinodina* Ach. (1810: 344). Zahlbruckner (1931) aceepted it as *Rinodina inelegans* (Hue) Zahlbr. (1931: 562). This combination not following by Dodge (1971), who preferred to combine this taxon in *Dirinaria.* The type specimen was not cited by Dodge (1971), and probably not found by him. Awasthi (1975) mentioned this taxon but only discussed the ambiguity of the species in relation to the circumscription of the genus *Dirinaria*. Swinscow & Krog (1978) mentioned that they have not found the type specimen and choose not to propose the transference for *Pyxine*.

Dirinaria inelegans has different characteristics of the genera *Dirinaria, Lecanora* and *Rinodina* (Ach.) Gray (1821: 448). The *Lecanora* genus have colourless ascospores and does not shows septa, Dodge (1971) cited "ascospores distichous, fuscous 2-3-locular", *Rinodina* has the characteristics mentioned above, however, have not lower cortex, and Hue (1916) mentioned the thickness lower cortex "Cortex inferior fusconiger 40-60μ" that escapes of the *Rinodina* circumscription. The genus *Dirinaria* presenting lower cortex but, present ascospores *Dirinaria*-type with one septa. The genus *Pyxine* has lower cortex generally black or dark brown, ascospores 1-3-septate and morphology closely related to *Dirinaria.* Dodge's description shows features in common between *D. inelegans* and *P. eschweileri*, e.g. two characteristics of thallus surface that resemble polysidiangia: (1) the "center verrucose" and (2) "nubilated with gray granules". The accumulations of polysidiangia in thallus surface can be similar to a verrucose surface and

produces granules. The reaction mentioned by Dodge for medulla of *D. inelegans* is mentioned by Kalb (1987) for *P. eschweileri*, the description of anatomical section by Dodge (1971) "parathecium fuscuous black" is one feature of apothecia *obscurascens*-type that occurs in *P. eschweileri* and the more evident characteristic is the ascospores of *Coradia*-type mentioned by Dodge as "distichous, fuscous 2-3-locular, ellipsoid". Based in this information we conclude that *D. inelegans* is synonym of *P. eschweileri.*

Dirinaria robsonii C.W. Dodge (1971: 185). (Figure 6A) is ***Pyxine pungens*** Zahlbr. (1928: 210).

This taxon was described as "*Dirinaria robsoni*" by Dodge (1971), however because a tribute to the collector N.K.B. Robson Awasthi (1975) proposes the name correction for *Dirinaria robsonii* C.W. Dodge (1971: 185) and discussed the possibility this species do not belong to *Dirinaria* genus, during the monograph Awasthi mentioned the absence of true rhizinae in *Dirinaria* and make it clear to presents a term for adhesion structures of the genus as "precursors of rhizinae" that arrive up to 4 µm. Dodge (1971) cited "short black rhizinae" with "50µ in diameter" and mentioned the "hypothecium 15µ thick", this characteristic was not seen by Awasthi (1975) in any one of the species of *Dirinaria.* Based in the pictures provide by FH herbaria, we concluded that the holotype of *D. robsonii* is a specimen of *P. pungens* and is possible to see in medulla two layers: orange upper layer and white lower layer, the apothecia *cocoës*-type and internal stipe orange with white base, thus, we proposed the synonymy of *D. robsonii* in *P. pungens.* Other important observation is about another material (*António Pinto 23*) also in FH that was determinate by Dodge as *D. robsonii,* this material corresponds to one thallus of *D. leopoldii* in the imagens is clearly sorediate and has coccineous pigment in medulla.

Dirinaria: *Dirinaria mozambica* C.W. Dodge (1971: 183). (Figure 6B) is ***Pyxine simulans*** Kalb (1987: 72).

This species was described by Dodge (1971) based in the specimen from Mozambique as this name suggest, in the Dodge description is possible to recognize characteristics common to *Pyxine* genus, for example upper surface "light grayish olive K– "and lower surface "black, rugose with dense black rhizinae". The upper surface K– supposedly the lichexanthone presence (common constituent of *Pyxine*). To read Dodge description is evident some similarities with *Dirinaria* and *Pyxine* genera, but *Dirinaria* have not rhizinae and upper surface is K+ yellow, which indicates the atranorin. Based in the arguments we concluded that this taxon corresponding to *Pyxine,* but only was possible concludes the real position of this name to see the images from

holotype of *D. mozambica,* and this specimen has features in common with *P. simulans* as the bicolor medulla: light-yellow upper layer light-yellow and white lower layer, apothecia *physciaeformis*-type, presence of maculae and the upper cortex K- that demonstrate the absence of atranorin and for this reason *D. mozambica* is proposed as synonym of *P. simulans.*

Acknowledgements

We thank CNPq/Protax for the grant to the first author, to Tocci (Lewis Gentry), Genevieve E. and FH herbarium for to provid the images of type specimens of *Dirinaria mozambica* and *Dirinaria robsonii*. Marcos Kitaura, Arnildo Pott, Flávio Alves and Natália Koch (UFMS) are warmly thanked for reading previous versions of the text. Robert Lücking by for providing a sample table for compiling data for the worldwide key.

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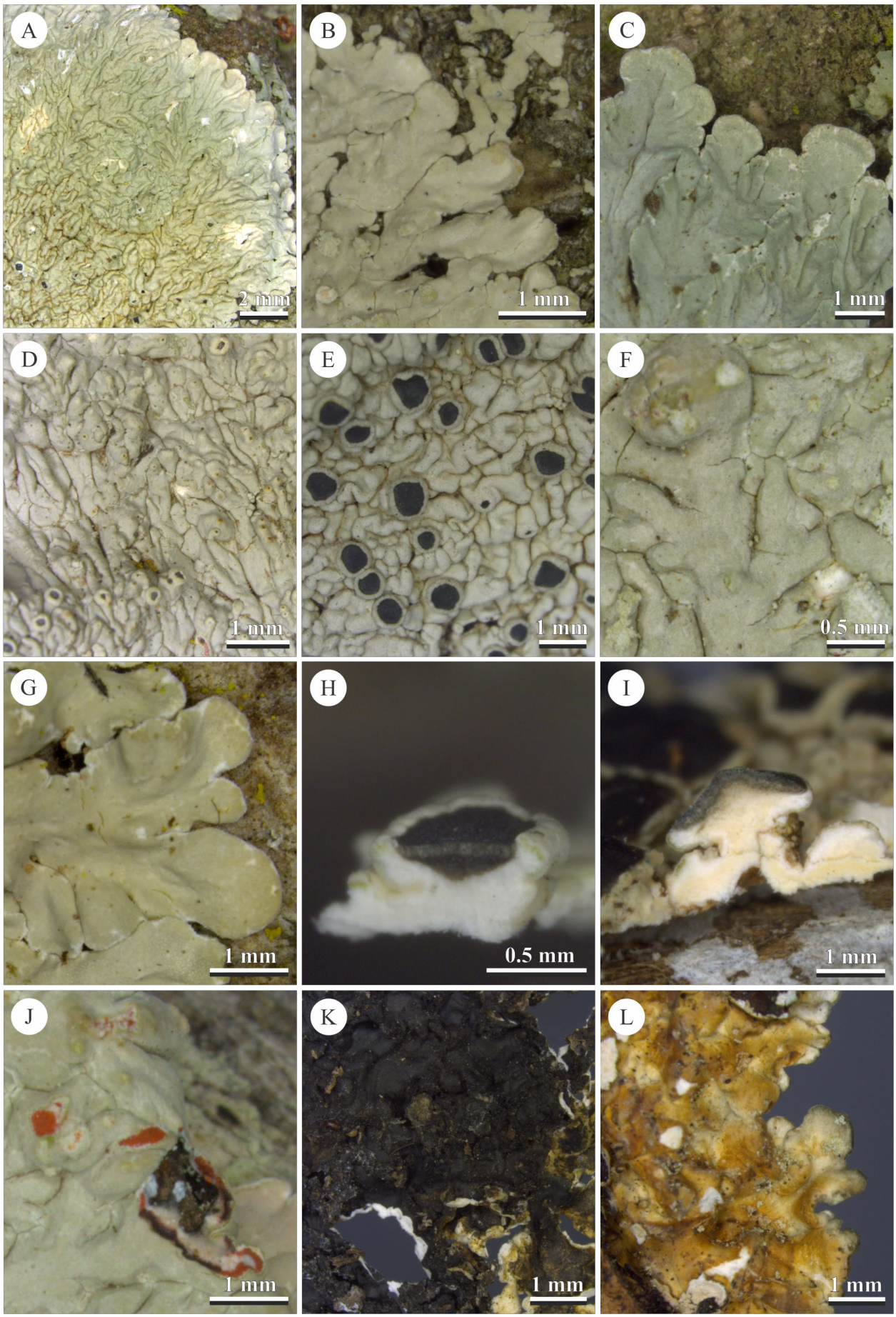


FIGURE 44. A. Foliose thallus in *D. africana*. B. Laciniae of *Dirinaria picta*-type in *D. picta.* C. Laciniae *Dirinaria applanata-Dirinaria confluens*-type in *D. melanocarpa.* D. Longitudinally plication in *D. confluens*. E. Irregularly plication in *D. confluens* var. *coccinea*. F. Pruina patches under thallus surface in *D. leopoldii.* G. Maculae presence in laciniae margins of *D. confluens* var. *coccinea*. H. White medulla in *D. confluens*. I. Yellow medulla in *D. melanocarpa.* J. Red pigment in medulla of *D. leopoldii.* K. Black lower surface in *D. confluens.* L. Yellowish-white lower surface in *D. melanocarpa.*

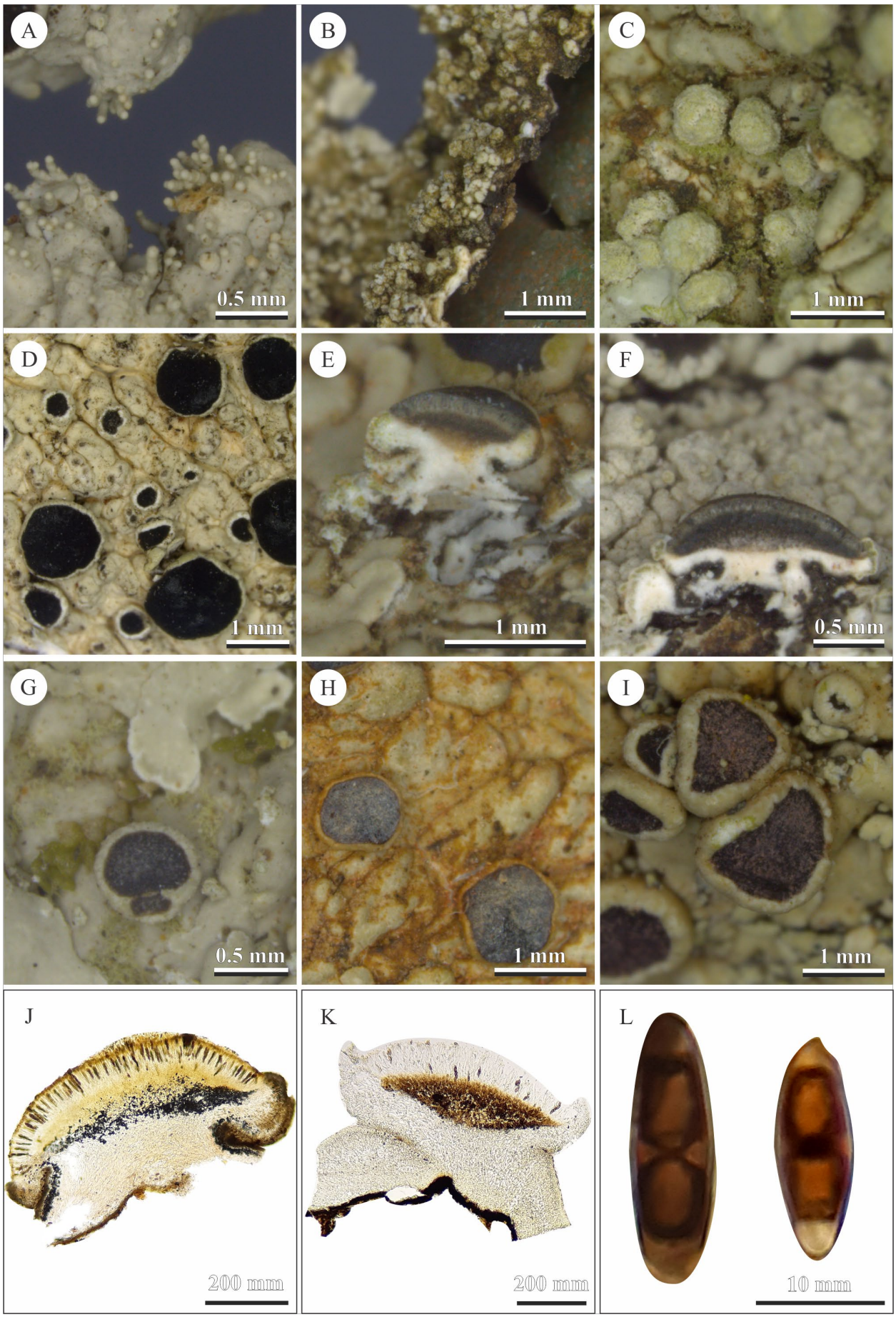


FIGURE 45. A. Cylindrical isidia in *D. papillulifera*. B. Polysidiangia in *D. pruinosa.* C. Hemispherical soralia in *D. applanata.* D. Lecanorine apothecia in *D. melanocarpa*. E. Subimmersed apothecia and yellow pigmentation in internal stipe of *D. africana*. F. Apothecia sessile of constricted base in *D. papillulifera.* G. Apothecial disc with white pruina in *D. consimilis*. H. Apothecial disc with yellowish pruina in *Dirinaria* sp. I. Apothecial disc with purple pruina in *D. purpurascens.* J. Yellow subhymenium in *D. melanocarpa.* K. Brown-black subhymenium in *D. confluens.* L. Ascospores of *Dirinaria*-type.

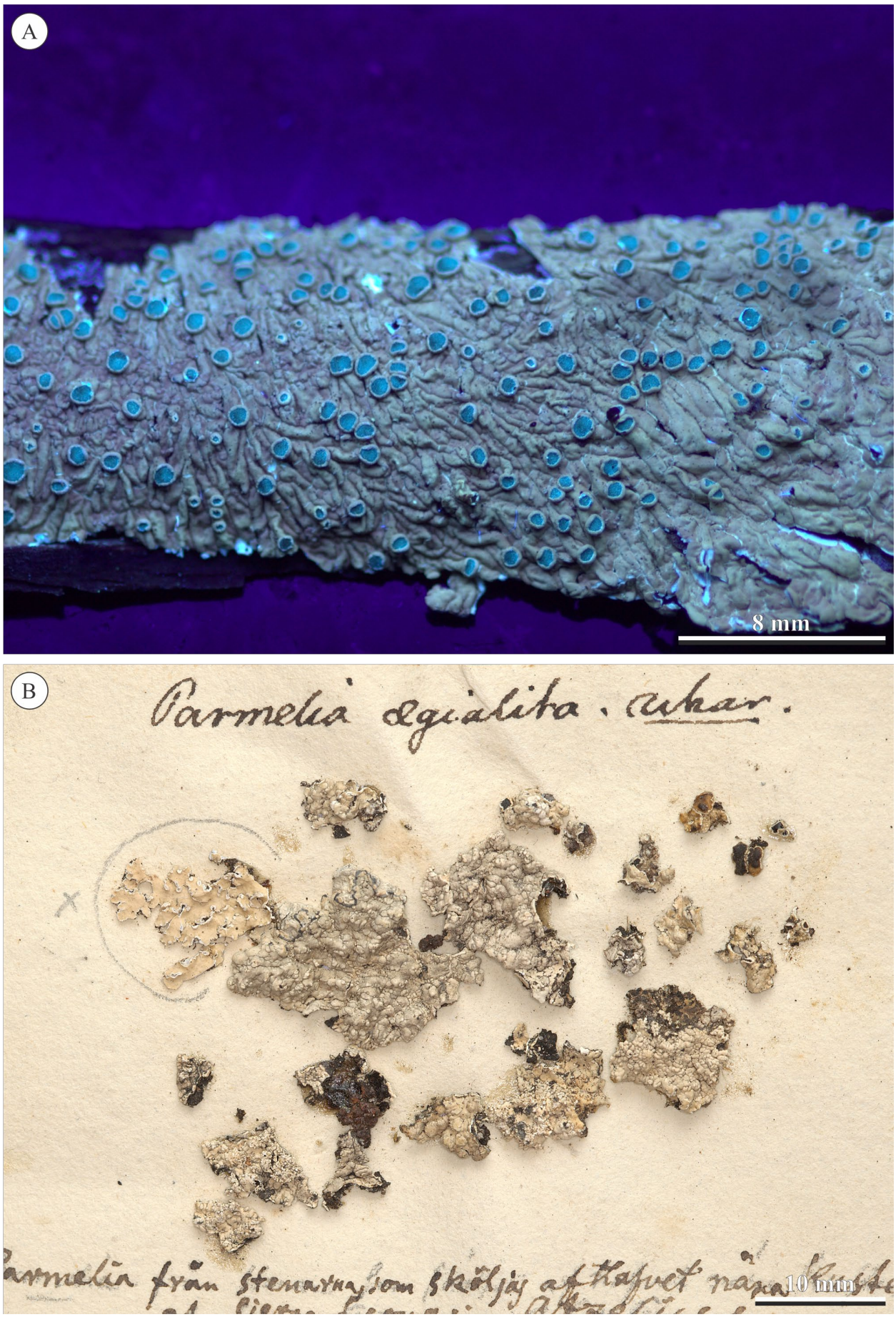


FIGURE 46. A. Reaction UV+ bluish-white in medulla and UV+ green in apothecial disc of *D. confluens*. B. Holotype of *Parmelia aegialita* (*D. aegialita*); photograph by Reisborg, Christopher (provided by http://herbarium.nrm.se/).

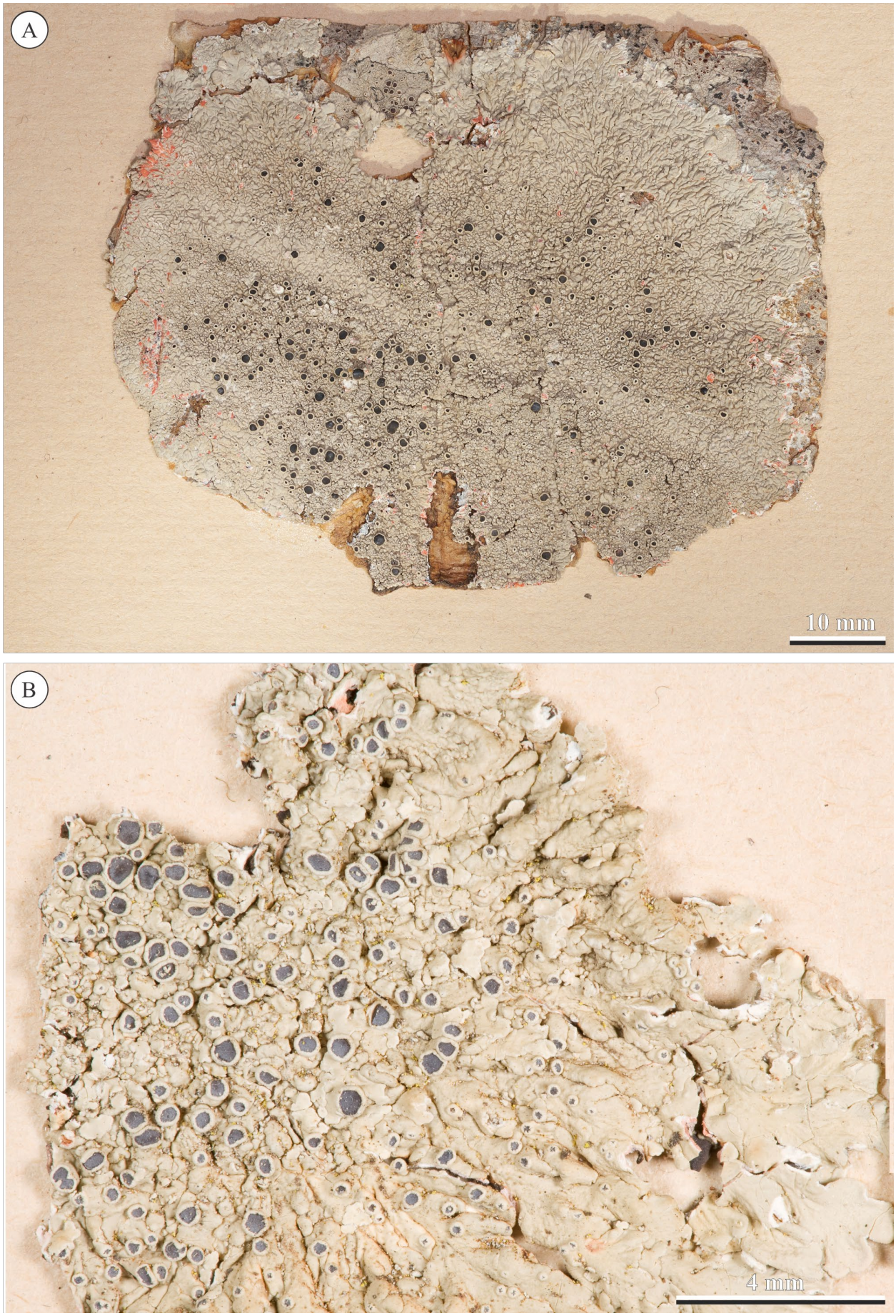


FIGURE 47. A. Lectotype of *Physcia aegialita* f. *coccinea* (*D. confluens* var. *coccinea*); photograph by Kearey, Jennifer (provided by http://herbarium.nrm.se/). B. Holotype of *D. confusa* var. *endocrocea*; photograph by Ubral Hedenberg, Ramona (provided by http://herbarium.nrm.se/).

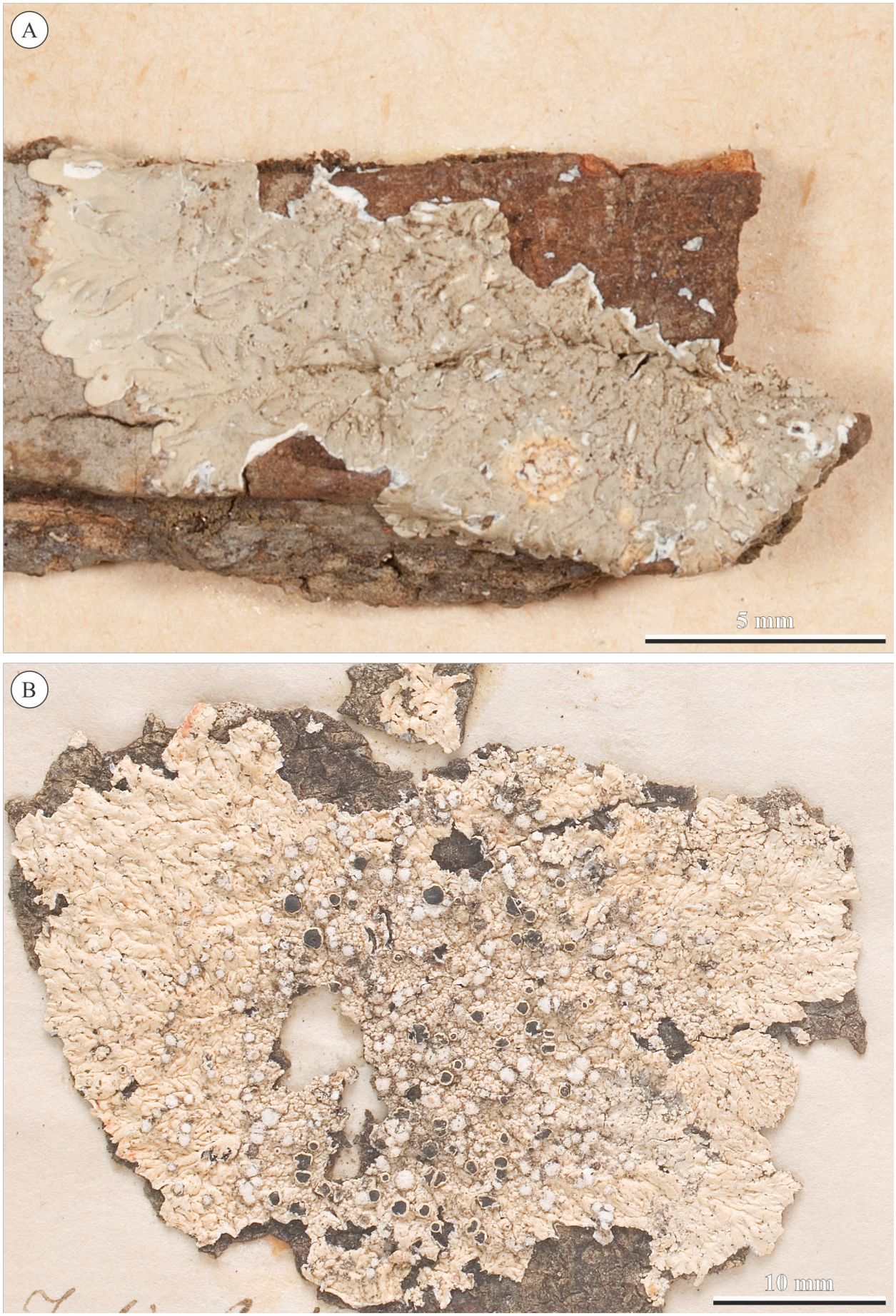


FIGURE 48. A. Isotype of *Physcia papillulifera* (*D. papillulifera*); photograph by Ubral Hedenberg, Ramona (provided by http://herbarium.nrm.se/). B. Lectotype of *Lichen pictus* (*D. picta*); photograph by Reisborg, Christopher (provided by http://herbarium.nrm.se/).

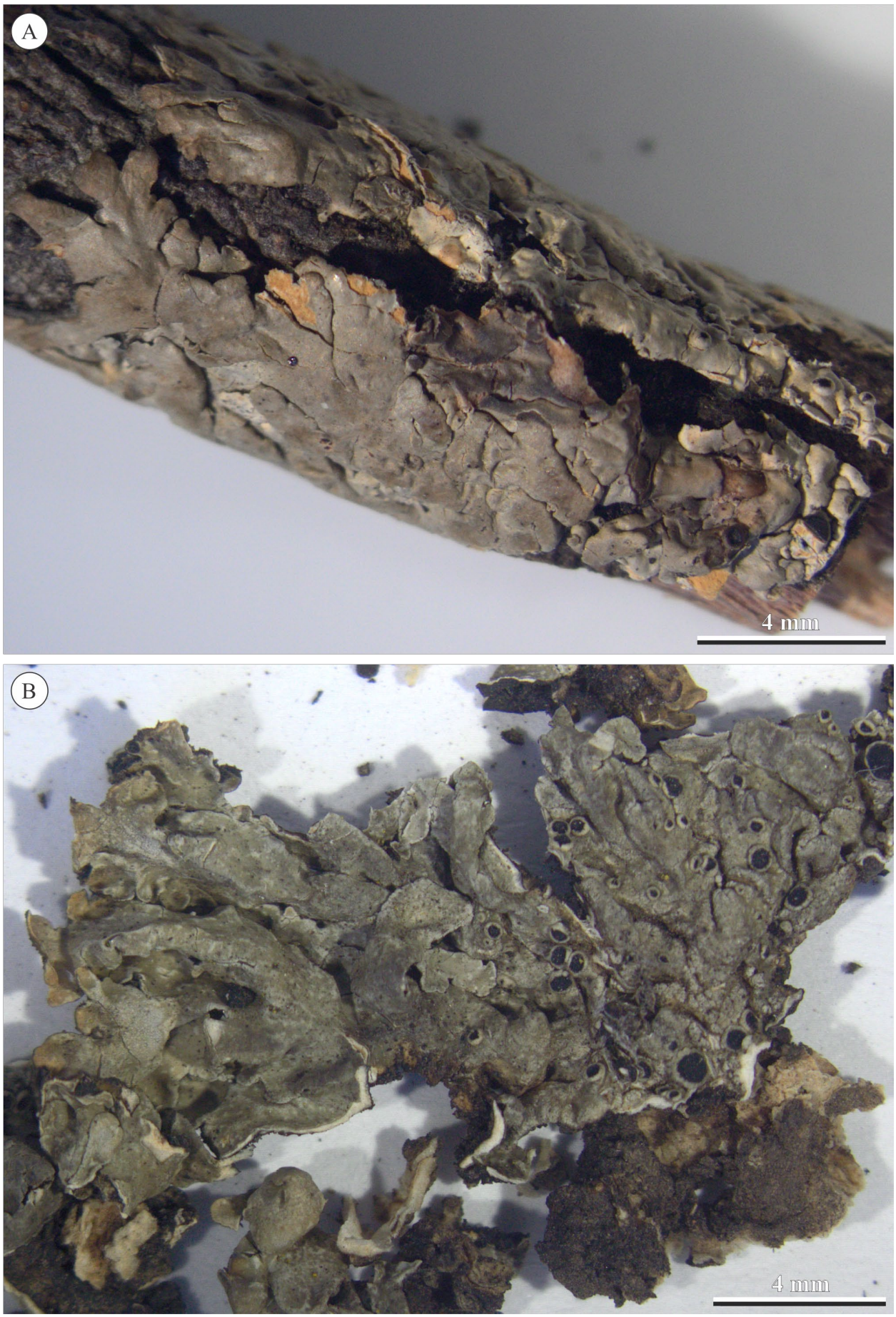


FIGURE 49. A. Holotype of *D. robsonii* (*Pyxine pungens*); photograph by Tocci (Lewis Gentry), Genevieve E. (FH herbarium). B. Holotype of *D. mozambica* (*Pyxine simulans*); photograph by Tocci (Lewis Gentry), Genevieve E. (FH herbarium).

ANEXO I

Material information											
				Date							
Species	**Remarks**	**Colector**	**Colector N°**	**Day**	**Month**	**Year**	**State**	**Municipality**	**Latitude**	**Longitude**	**Altitude**
Identification name	Observations	Colector name	Colector number	Date of collect			State	Municipality	Co-ordinates		Altitude

e	Herbarium	Colector N°	Thallus Substratum	Great	Color	Relief	Proximal region Plication
m	Herbarium acronym and number		0- unknown 1- corticicolous 2- ramulicolous 3- muscicolous 4- saxicolous 5- terricolous	cm	1- whitish-grey 2- greenish-grey 3- bluish-grey 4- yellowish-grey 5- yellow 6- white 7- cream 8- light-green	1- smooth 2- rugose 3- verrucose	0- absent 1- longituginal-scarce 2- longitudinal-frequent 3- longitudinal-abundant 4- irregular-scarce 5- irregular-frequent 6- irregular-abundant 7- complicate

Upper surface			Distal region		
Pruina	**Color**	**Relief**	**Plication**	**Pruina**	**Presence**
0- absent	1- whitish-grey	1- smooth	0- absent	0- absent	0- absent
1- scarce without board	2- greenish-grey	2- rugose	1- longituginal-scarce	1- scarce without board	1- scarce
2- frequent without board	3- bluish-grey	3- verrucose	2- longitudinal-frequent	2- frequent without board	2- frequent
3- abundant without board	4- yellowish-grey		3- longitudinal-abundant	3- abundant without board	3- abundant
4- scarce with board	5- yellow		4- irregular-scarce	4- scarce with board	
5- frequent with board	6- white		5- irregular-frequent	5- frequent with board	
6- abundant with board	7- cream		6- irregular-abundant	6- abundant with board	
	8- light-green		7- complicate		

	Maculae					
Proximal region			Distal region			
Localization	Shape	Precence	Localization	Shape	Laciniae proximity	Branching
1- marginal	1- linear	0- absent	1- marginal	1- linear	1- discrete-contiguous	1- not branched
2- submarginal	2- punctiform	1- scarce	2- submarginal	2- punctiform	2- discrete-parallel	2- dicotomic
3- laminal	3- subreticulate	2- frequent	3- laminal	3- subreticulate	3- confluent-contiguous	3- irregular
	4- irregular	3- abundant		4- irregular	4-confluent-overlapping	4- palmatifid

	Laciniae Width				Color	
base	Greater width	General apice shape	Apice termination	Margin	Upper surface	Lower surface
mm	mm	1- not flabellate 2- slightly flabellate 3- flabellate	1- rounded 2- truncate 3- subtruncate 4- acute 5- cuneate 6- retuse 7- irregular	1- smooth 2- crenate	1- white 2- yellow 3- red 4- orange 5- cream	1- white 2- yellow 3- red 4- orange 5- cream

Medulla		Lower surface			
Pigment presence and color	Remark	Proximal color	Distal color	Margin legth	Remark
0- absent 1- yellow (sulphur) 2- orange 3- red	additional observations	1- black 2- dark-brown 3- light-brown 4- yellow 5- white 6- variegated	1- black 2- dark-brown 3- light-brown 4- yellow 5- olivaceous 6- cream 7- white 8- dark-yellow	mm	additional observations

Rhizines precursors				Isidia			
Presence	**Abundance**	**Color**	**Distribution**	**Presence**	**Abundance**	**Position**	**Shape**
0- absent 1- present	1- scarce 2- frequent 3- abundant	1- black 2- dark-brown 3- light-brown 4- yellow 5- white 6- variegated	1- marginal 2- submarginal 3- laminal	0- absent 1- present	1- scarce 2- frequent 3- abundant	1- marginal 2- submarginal 3- laminal 4- laminal to submarginal	1- cylindrical 3

			Polisydiangia					Sore
Branching	**Color**	**Remarks**	**Presence**	**Abundance**	**Position**	**Shape**	**Color**	
1- not branched 2- irregular - not branched to irregular	1- concolor	additional observations	0- absent 1- present	1- scarce 2- frequent 3- abundant 4- covering the thallus	1- marginal 2- submarginal 3- laminal	1- irregular	1- green 2- whitish-green 3- white 4- yellow 5- red 6- whitish-red 7- grey	

						Soral		
ɛdia							Soredia	
Granulation	Remarks	Presence	Abundance	Position	Soral shape	Color	Granulation	
1- farinose 2- granulose	additional observations	0- absent 1- present	1- scarce 2- frequent 3- abundant	1- marginal 2- submarginal 3- laminal	1- globose 2- linear 3- hemispherical 4- botriose 5- irregular	1- green 2- whitish-green 3- white 4- yellow 5- red 6- whitish-red 7- grey	1- farinose 2- granulose	

Observação	Lacinulae						
						Measure	
	Presence	Abundance	Position	Color	Branching	Length	Width
additional observations	0- absent 1- present	1- scarce 2- frequent 3- abundant 4- covering the thallus	1- marginal 2- submarginal 3- laminal 4- adventitious	1- concolor 2- greenish-grey	1- not branched 2- dicotomic 3- irregular	mm	mm

Apice	Remarks	Presence	Diameter	Position	Adnation	Color
1- rounded 2- pinnate 3- truncate 4- sub-truncate	additional observations	0- absent 1- present	mm	1- marginal 2- submarginal 3- laminal 4- laminal to submarginal	1- immersed 2- sessil of the constrict base 3- sub-stipitate 4- sub-immersed	1- black 2- black-bluish 3- grey 4- brown 5- purple 6- grey-whitish 7- brown-black

Apothecia							
Disc		Margin	Amphitecium				Internal stipe
Shape	Pruina	Cutting	Surface	Ornamentation	Presence	Color	Thickness
1- plane	0- absent	1- smooth	1- smooth	0- ausente	0- absent	1- white	mm
2- convex	1- white	2- crenate	2- crenate	1- isidia	1- present	2- yellow	
3- concave	2- grey	3- split		2- soralia		3- red	
4- plane to convex	3- grey-bluish	4- smooth to crenate		3- lacinulae		4- orange	
5- plane to concave	4- purple			4- thallus projections		5- white to yellow	

	Thallus					Thall
	Upper cortex					Algal l
Remarks	Type	N° cel.	Thikness		Remarks	Continuity
additional observations	1- paraplectenchymatous	unitis	µm		additional observations	1- continuous 2- descontinuous

us ayer Thickness	Thallus Medulla Upper region color	Lower region color	Thiackness	Thallus Lower cortex Type	Thickness
µm	1- colourless 2- yellow 3- red	1- colourless 2- yellow 3- red	µm	1- prosoplectenchymatous	µm

	Apothecia					
	Epithecium		Hymenium			Hypothe
Color	Thickness	Color	Thickness	Color	Paraphyses apice	Thickness in center
1- black 2- dark-brown 3- light-brown 4- colourless 5- yellow	µm	1- black 2- dark-brown 3- light-brown 4- grey 5- yellow 6- colourless to yellow	µm	1- colourless 2- yellow 3- light-brown	1- not capitate 2- capitate	µm

cium	Apothecia			Upper surface			
	ascospores						
Color	Type	Length	Width	K	C	KC	K
1- black	1- Dirinaria	µm	µm	0- negative	0- negative	0- negative	0- negative
2- brown-black	2- *Pachysporaria*			1- yellow	1- yellow		1- yellow
3- brown	3- *Physcia*			2- orange	2- orange		2- orange
4- yellow							3- pink (after 5-10 seg)
5- colourless							4- yellowish
6- light-brown							5- purple

"Spot test"							
Medulla			pigment in medulla			Lower surface (in apice region)	
C	KC	UV	K	C	KC	K	C
0- negative 1- yellow 2- orange 3- pink (after 5-10 seg) 4- yellowish	0- negative 1- yellow 2- orange 3- pink (after 5-10 seg)	0- negative 1- white-bluish 2- white	0- negative 1- yellow 2- pink 3- orange 4- purple 5- brown 6- black	0- negative 1- yellow 2- pink 3- orange 4- purple 5- brown 6- red	0- negative 1- yellow 2- pink 3- orange 4- purple 5- brown	0- negative 1- yellow 2- pink	0- negative 1- yellow 2- pink 3- red or pinkish

UV test in apothecial disc	General remarks	Thin layer chromatography (TLC) Substance found
0- negative 1- dark-green		0- absent 1- atranorin 2- atranorin, divaricatic acid 3- atranorin, sekikaic acid

ANEXO II

Material information										
				Date						
Species	**Remarks**	**Collector**	**N° collector**	**Day**	**Month**	**Year**	**State**	**Municipality**	**Latitude**	**Longitude**

Identification name	Observations	Collector name	Collector number	Colect date	State	Municipality	Co-ordinates

Altitude		Herbarium	N° collector	Thallus Substratum	Great	Color	Relief	Proximal region Breaks from maculae
Altitude	m	Herbarium acronym and number		0- unknown 1- corticicolous 2- ramulicolous 3- muscicolous 4- saxicolous 5- terricolous	cm	1- whitish-grey 2- greenish-grey 3- bluish-grey 4- yellowish-grey 5- yellow 6- white 7- cream 8- light-green 9- grey	1- smooth 2- rugose 3- verrucose 4- foveolate	0- absent 1- linear - marginal - laminal 2- linear - laminal

Upper surface			Distal region		
Pruina	**Color**	**Relief**	**Breaks from maculae**	**Pruina**	**Pruina region**
0- absent 1- scarce without board 2- frequent without board 3- abundant without board 4- scarce with board 5- frequent with board 6- abundant with board	1- whitish-grey 2- greenish-grey 3- bluish-grey 4- yellowish-grey 5- yellow 6- white 7- cream 8- light-green 9- grey	1- smooth 2- rugose 3- verrucose 4- foveolate	0- absent 1- linear - marginal - laminal 2- linear - laminal	0- absent 1- scarce without board 2- frequent without board 3- abundant without board 4- scarce with board 5- frequent with board 6- abundant with board	1- apical 2- subapical 3- laciniae center

Maculae									
		Região proximal					Região distal		
Presence	**Intensity**	**Localization**	**Shape**	**High**	**Presence**	**Intensity**	**Localization**	**Shape**	**High**
0- absent 1- scarce 2- frequent 3- abundant	1- discrete 2- evident	1- marginal 2- submarginal 3- laminal	1- linear 2- punctiform 3- subreticulate 4- reticulate 5- irregular	1- high 2- plane 3- low	0- absent 1- scarce 2- frequent 3- abundant	1- discrete 2- evident	1- marginal 2- submarginal 3- laminal	1- linear 2- punctiform 3- subreticulate 4- reticulate 5- irregular	1- high 2- plane 3- low

Remarks	Laciniae proximity	Branching	Width	General apice shape	Apice termination
additional observations	1- discrete 2- contiguous 3- overlaping	1- not branched 2- dicotomic 3- irregular 4- palmatifid	mm	1- not flabellate 2- slightly flabellate 3- flabellate	1- rounded 2- truncate 3- subtruncate 4- acute 5- cuneate 6- retuse 7- irregular

Laciniae					
Apice surface	**Ascent**	**Margin**	**Black line presence**	**Remarks**	**Upper region color**
1- plane 2- concave 3- convex 4- plane to cocave 5- plane to convex 6- convex to concave 7- plane to slightly concave	0- not ascendent 1- ascendent	1- smooth 2- crenate 3- smooth to crenate	0- absent 1- Present soft 2- Present evident	additional observations	1- white 2- yellow 3- red 4- orange 5- cream 6- yellow-ochraceous

Medulla			Lower surface				
			Proximal region				Distal
Lower region color	Spot presence	Remark	Surface	Color	Brightness	Surface	Magin color
1- white 2- yellow 3- red 4- orange 5- cream 6- yellow-ochraceous	0- absent 1- yellow (sulphur) 2- orange 3- red	additional observations	1- smooth 2- rugose 3- veins	1- black 2- dark-brown 3- light-brown 4- yellow 5- white 6- variegated	1- dull 2- lustrous	1- smooth 2- rugose 3- veins 4- papillate	1- black 2- dark-brown 3- light-brown 4- yellow 5- olivaceous 6- cream 7- white 8- dark-yellow

region			Rhizine				
Brightness	**Margin legth**	**Remark**	**Presence**	**Branching**	**Color**	**Distribution**	**Abundance**
1- dull 2- lustrous	mm	additional observations	0- absent 1- present	0- not 1- dicothomously 2- irregular 3- squarrosely 4- furcate 5- trichotomously	1- black 2- dark-brown 3- light-brown 4- yellow 5- white 6- variegated 7- olivaceous	1- marginal 2- submarginal 3- laminal	1- scarce 2- frequent 3- abundant

Isidia								
	Measure							
Presence	Length	Width	Position	Shape	Color	Abundance	Branching	Remarks
0- absent 1- present	mm	mm	1- marginal 2- submarginal 3- laminal 4- laminal to submarginal	1- cylindrical 2- globose	1- concolor	1- scarce 2- frequent 3- abundant	1- not branched 2- irregularly 3- not branched to irregularly	additional observations

Polysidiangia						
				Granules		
Presence	**Position**	**Shape**	**Abundance**	**Presence**	**Color**	**Grunulation soredia**
0- absent 1- present	1- marginal 2- submarginal 3- laminal 4- laminal to submarginal	1- irregularly	1- scarce 2- frequent 3- abundant 4- covering the thallus	0- absent 1- present	1- green 2- whitish-green 3- white 4- yellow 5- red 6- whitish-red 7- grey	1- farinose 2- granulose

Remarks	Soralia					Sored
	Presence	Position	Soralia origin	Soral shape	Abundance	Color
additional observations	0- ausente 1- presente	1- marginal 2- submarginal 3- laminal 4- laminal to submarginal	1- crateriforme 2- erumpent	1- globose 2- linear 3- hemispherical 4- botryose 5- irregular 6- labriform 7- crescent-shape 8- circular	1- scarce 2- frequent 3- abundant 4- covering the thallus	1- green 2- whitish-green 3- white 4- yellow 5- red 6- whitish-red 7- grey

ia									
								Lacinulae	
			Measure						
Granulation	Remarks	Presence	Length	Width	Position	Color	Abundance	Apice	
1- farinose 2- granulose	additional observations	0- absent 1- present	mm	mm	1- marginal 2- submarginal 3- laminal	1- concolor 2- greenish-grey	1- scarce 2- frequent 3- abundant 4- covering the thallus	1- rounded 2- pinated 3- truncate 4- subtruncate	

Branching	Remarks	Presence	Type	Diam.	Position	Adnation
1- not 2- dichotomously 3- irregular	additional observations	0- absent 1- present	1- *physciaeformis* 2- *cocoës* 3- *obscurascens*	mm	1- marginal 2- submarginal 3- laminal 4- laminal to submarginal	1- immersed 2- sessil of the constrict base 3- sub-stipitate 4- sub-immersed

Apothecia							
	Disc		Margin		Amphitecium		
Shape	**Color**	**Pruina**	**Cutting**	**Surface**	**Ornamentation**	**Remarks**	**Presence**
1- plane	1- black	0- absent	1- smooth	1- smooth	0- ausente	additional observations	0- absent
2- convex	2- black-bluish	1- white	2- crenate	2- rugose	1- isidia		1- present
3- concave	3- grey	2- grey	3- split		2- soralia		
4- plane to convex	4- brown	3- grey-bluish	4- smooth to crenate		3- lacinulae		
5- plane to concave	5- purple	4- purple			4- thallus projections		
6- concave to convex	6- grey-whitish						
	7- brown-black						

Internal stipe		Thallus					Thallus
		Upper cortex					Algal lay
Color	Thickness	Type	N° cel.	Thickness		Remarks	Continuity
1- white 2- yellow 3- red 4- orange 5- white to yellow 6- branco-amarelado 7- ocráceo	mm	1- paraplectenchymatous	unitis	µm		additional observations	1- continuous 2- descontinuous

s ver Thickness	Thallus Medula Thickness	Upper region color	Lower region color	Remarks	Type
µm	µm	1- colourless 2- yellow 3- red 4- orange	1- colourless 2- yellow 3- red 4- orange	additional observations	1- prosoplectenchymatous

Thallus			Apotheci
Lower cortex			
Thickness	Color	Remarks	

Epihymenium		Hymenium		Apotheci
Thickness	Color	Thickness	Color	Thickness
µm	1- black 2- dark-brown 3- light-brown 4- colourless 5- yellow 6- grey	additional observations	µm	1- black 2- dark-brown 3- light-brown 4- grey 5- yellow 6- colourless to yellow	µm	1- colourless 2- yellow 3- light-brown	µm

ia			Apothecia				
ubhymenium	Medulla internal stipe		Ascospores				
Color	Color	Remarks	Length	Width	Septes	Type	K
1- black	1- colourless	additional observations	µm	µm		1- *Dirinaria*	0- negative
2- brown-black	2- yellow					2- *Pachysporaria*	1- yellow
3- brown	3- light-brown					3- *Physcia*	2- orange
4- yellow	4- orange					4- *Conradia*	
5- colourless							
6- light-brown							

									"Spot test"	
	Upper surface					Upper medulla				I
C	P	KC	UV	K	C	KC	P	UV	K	C
0- negative 1- yellow 2- orange	0- negativo 1- yellow 2- orange	0- negativo 1- yellow 2- orange	0- negativo 1- yellow	0- negative 1- yellow 2- orange 3- reddish 4- yellowish 5- black	0- negative 1- yellow 2- orange 3- reddish 4- yellowish 5- black	0- negative 1- yellow 2- orange 3- reddish 4- yellowish 5- black	0- negative 1- yellow 2- orange 3- reddish 4- yellowish 5- black	0- negativo 1- dark-yellow	0- negative 1- yellow 2- orange 3- reddish 4- yellowish	0- negative 1- yellow 2- orange 3- reddish 4- yellowish

Lower medulla			Spot		Internal stipe		
KC	**P**	**UV**	**K**	**C**	**K**	**C**	**General remarks "spot test"**
0- negative 1- yellow 2- orange 3- reddish 4- yellowish	0- negative 1- yellow 2- orange 3- reddish 4- yellowish	0- negative 1- yellow 2- orange 3- reddish 4- yellowish	0- negative 1- yellow 2- orange 3- reddish 4- yellowish 5- black	0- negative 1- yellow 2- orange 3- reddish 4- yellowish 5- black	0- negative 1- yellow 2- orange 3- reddish 4- red 5- purple	0- negative 1- yellow 2- orange	

Thin layer chromatography (TLC)

Substance found

additional observations