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The genus *Parmotrema* (*Parmeliaceae*, *Lecanoromycetes*) in the Galapagos Islands

Frank Bungartz[1,2,3*] & Adriano A. Spielmann[4]

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Abstract. As part of an ongoing comprehensive inventory of all Galapagos lichens, the genus *Parmotrema* has been revised. In Galapagos this genus is represented by thirty-five species, seven described as new to science: *Parmotrema cactacearum*, *P. erectociliatum*, *P. lawreyi*, *P. marcellianum*, *P. pustulotinctum*, *P. saxoisidiatum* and *P. weberi*. *Parmotrema weberi*, although previously informally recognized by Mason E. Hale, is now formally described here, the name thus validated. Reports of four species are doubtful or incorrect. Nine species are reported from the Galapagos for the first time, seven of those being also new for Ecuador. *Parmotrema cooperi*, previously known only from Central America, is now also reported from South America. Detailed descriptions and illustrations are provided for all thirty-five species, together with a dichotomic key for their identification. Diagnostic differences are discussed. If all newly described species are confirmed as endemic to the archipelago, the proportion of endemism within *Parmotrema* appears to be similar to most other groups of lichens recently reviewed.

Key words: Census of Galapagos Biodiversity, Galapagos Lichen Inventory, taxonomy, identification key, South America.

Introduction

The genus *Parmotrema*, comprising mostly large foliose lichens, may be considered one of the better-known lichen genera in the Neotropics, where it possibly has its center of diversity. In Central and South America the genus has received considerable attention, particularly in Brazil (Hale 1965, 1974; Fleig 1997; Ribeiro 1998; Eliasaro 2001; Donha 2005; Canêz 2005; Jungbluth 2006; Benatti & Marcelli 2008, 2009; Spielmann & Marcelli 2009; Spielmann 2009), Argentina (Adler 1988; Adler & Estrabou 2000; Michlig & Ferraro 2012; Michlig et al. 2014), Mexico (Nash & Elix 2002; Egan et al. 2016), Bolivia (Kukwa et al. 2012; Flakus et al. 2012, 2014, 2016), and historically also in Venezuela (Vareschi 1962; López Figueiras 1986).

From Ecuador relatively few species have previously been reported (Cevallos Solórzano 2012). For continental Ecuador most of these records are based on indirect reports, that is, as substrates of lichenicolous fungi (Etayo 2017). Only the Galapagos have received more attention. Species of *Parmotrema* from the archipelago were first reported by Dodge (1936) and Weber (1966, 1981, 1986), with more records subsequently added to the list, which was again updated by Elix & McCarthy (1998), and most recently online as part of the checklist published by the Charles Darwin Foundation for the Galapagos Islands (Bungartz et al. 2016).

None of these checklists critically examined all material of *Parmotrema* collected throughout the archipelago. As part of the Galapagos Lichen Inventory (Bungartz et al. 2016) and a revision of all specimens known from historical collections, we now present for the first time a critical revision of the genus within the Galapagos, describing several species as new, reporting new additions, and assessing some previous reports as doubtful or erroneous.

Material and methods

The Galapagos Archipelago comprises more than 123 islands in the eastern Pacific Ocean: islands, islets and large rocks that emerged from the sea as a result of

[1] Biodiversity Integration Knowledge Center, Arizona State University, PO Box 874108, Arizona State University, Tempe, AZ 85287-4108, USA
[2] Charles Darwin Foundation for the Galapagos Islands, Puerto Ayora, Ecuador
[3] Instituto Nacional de Biodiversidad (INABIO), Quito, Ecuador
[4] Universidade Federal de Mato Grosso do Sul, Instituto de Biociências, Laboratório de Botânica / Liquenologia, Avenida Costa e Silva s/n, Bairro Universitário, CEP 79070-900, Campo Grande, Brasil. spielmann.adriano@gmail.com
[*] Corresponding author e-mail: frank.bungartz@gmail.com

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volcanic hotspot activity. Geist (1996) first estimated the youngest islands in the west to have emerged 60,000–300,000 years ago, the oldest ones in the east between 2,800,000 and 5,600,000 years ago; further east lie volcanoes that are today submerged seamounts. Due to variation of sea level, the map of the archipelago has been highly dynamic (Ali & Aitchison 2014), but even revised age estimates (the youngest islands may have emerged as recently as 35,000 years ago, and the oldest extant islands are less than 4 million years old) suggest that 'over the past 5 million years at least 7 major islands have existed within the archipelago' (Geist et al. 2014). At present, fourteen islands are recognized as principle islands because of their size; smaller ones are typically grouped along with these major islands because of their geological connection and biogeographic affinities (Snell et al. 1995, 1996). The climate of the Galapagos is unusually dry, characterized by a hot and cool season, with prevailing winds from the south and southeast (Trueman & d'Ozouville 2010). Five principal vegetation zones can be distinguished: coastal, dry, transition, humid, and high altitude dry zone (Tye et al. 2002; Bungartz et al. 2010; Tye & Francisco-Ortega 2011).

As part of the Galapagos Lichen Inventory the following islands have been visited, where all vegetation zones were surveyed: Isabela (including Volcán Sierra Negra, Volcán Alcedo, Volcán Darwin, Volcán Cerro Azul), Santiago (including Rábida, Bartolomé), Santa Cruz (including Santa Fé, Plaza Sur, Plaza Norte, Roca Gordon, Pinzón), Pinta, Española, Floreana and San Cristóbal.

Herbarium collections of the inventory are deposited at CDS; specimens from historical ollections have also been examined (B, BM, COLO, CAS, FH, H, S). Detailed collection information for the Galapagos specimens used in this study can be downloaded from the Charles Darwin Foundation (CDF) Collections Database online at http://www.darwinfoundation.org/datazone/collections/.

All specimens were examined with a Zeiss Stemi DV4 dissecting microscope and a Zeiss Imager A1 compound microscope equipped with differential interference contrast. Macrophotos were taken with a Nikon D300 and/or D7000, D800E, 62 mm Nikkor Micro Lens and R1C1 macro flash directly in the field, or using a Novoflex macro-table to take images of herbarium specimens; for photographic magnifications higher than 1:1 an extension tube or Novoflex bellows was used. For microphotos the compound microscope was equipped with a Nikon DSLR phototube. Photos in the laboratory were taken with ControlMyNikon 5 (https://www.tetherscript.com/controlmynikon-home/); all photos were databased with the program PhotoSupreme (http://www.idimager.com/WP/?page_id=20) using the Darwin Core XML schema to embed collection and identification information as XMP metadata (http://owl.phy.queensu.ca/~phil/exiftool/TagNames/DarwinCore.html). Photos were processed with Photoshop CS6.

Whenever possible, a minimum of at least 10 spores from 3 different specimens were measured, and the results for length and width are here presented as follows: (minimum–)average-standard deviation–average+standard deviation(–maximum) (n = number of ascospores measured).

Secondary metabolites were examined from a selection of specimens using standardized thin-layer chromatography, routinely using solvent C, for selected specimens also solvent B′ or solvent A (Orange et al. 2001, 2010). Instead of the conventional upright TLC tanks, a horizontal HPTLC developmental chamber was used (Arup et al. 1993). A protocol first suggested by Egan (2001) to document and conserve TLC results was modified here as follows: TLC plates were photographed with a Nikon D7000 digital camera. Photos were taken immediately after running the solvent, under long wave (λ365 nm) and short wave (λ254 nm) UV light, before applying 10% H_2SO_4. After H_2SO_4 treatment and charring in a laboratory oven for ~8 min at 110°C, a second set of photos in visible light and long wave (λ365 nm) were taken. Standard spot tests with reagents P, K and C were routinely carried out using methods described in Bungartz (2002). UV-fluorescence of thalli was studied under long wave UV light (λ365 nm).

Results

A total of thirty-five taxa are reported here, of which seven (20%) are new to science. Nine species are for the first time reported from the Galapagos, of which seven are also new for Ecuador. One species, *P. cooperi*, is new for South America.

Species Descriptions

Parmotrema clavuliferum (Räsänen) Streimann, Biblthca Lichenol. 22: 93. 1986. (Fig. 10A–C)

Type: Tahiti, [State or Province unknown]: *ad corticem arboris*, 1868, Leclerc de Buffon, G.C. or Vieillard, E. s.n. (lectotype – H!, designated by Hale & Fletcher 1990; paralectotype – H!).

Description. Thallus corticolous, rarely saxicolous; upper surface white to whitish gray, dull to shiny, epruinose or pruinose, densely reticulate-maculate, often cracked; abundantly sorediate; soralia capitate, conspicuously stalked, at the tip of distinct, short to elongate, laciniate lobes (clavulae); soredia farinose to ±granular, surface creamy white, typically not discolored; lobes moderate-sized to large, broad, 2–6(–10) mm wide, ±angular, abundantly ciliate; cilia short and slender, 0.3–1.5 mm long, black, mostly simple, very rarely branched; lower surface often blackened throughout, the rhizines growing close to the lobe margin, but some lobes typically with a deep brown, erhizinate, ~1–2 mm wide margin, particularly the elongate laciniae typically erhizinate and bright white below, lacking pigmentation; rhizines, where present, long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+

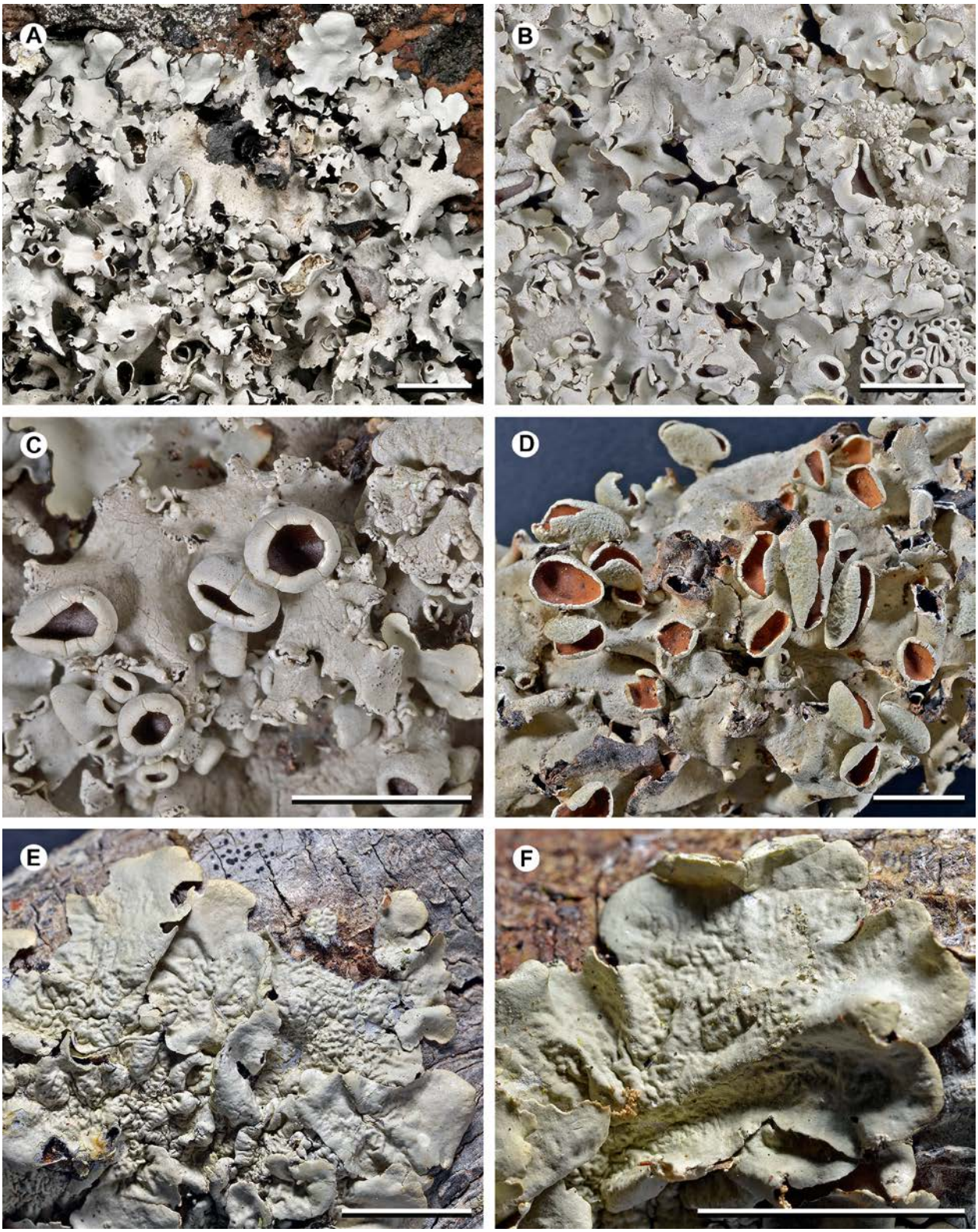

Figure 1. *Parmotrema* species lacking vegetative propagules. A – *Parmotrema eborinum*, overview of the thallus growing on rock (Bungartz, F. 8458, CDS 41104); B – close-up with lobulate lobes and apothecia (Bungartz, F. 9106, CDS 45924); C – close-up of crenate apothecia (Bungartz, F. 9106, CDS 45924). D – *Parmotrema latissimum*, overview of the thallus (Bungartz, F. 8684, CDS 41330. E – *Parmotrema mesotropum*, overview of the thallus (Bungartz, F. 7372, CDS 37859); F – Detail of thallus lobes (Bungartz, F. 7372, CDS 37859). Scales: A–F = 5 mm.

deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Ecology and distribution. Oceania (Lamb 1963; Feuerer 2008; Spielmann 2009), Asia (Feuerer 2008; Ohmura et al. 2012; Ahn & Moon 2016), Hawaii (Moon et al. 2001), Brazil (Barros & Xavier Filho 1972; Jungbluth 2006; Benatti & Marcelli 2008; Spielmann & Marcelli 2009). Previously reported only online (Bungartz et al. 2016); a common and abundant species, from the dry zone through the transition and humid zone into the high altitude dry zone; most abundant within the transition

and humid zone; most frequently on bark, wood or cactus pads, often on twigs or branches of both native and endemic and introduced trees and shrubs; occasionally on rock, typically at sunny and exposed sites. The typical morphotype with long 'clavulae' is the most common one, but a second morphotype (see below) apparently does not differ in habitat preferences.

Notes. A corticolous, sorediate species with a gray reticulate-maculate surface and salazinic acid in its medulla; usually easily recognized by its clavulae, i.e., the distinctly stalked, capitate soralia protruding from long, slender, laciniate lobes. In some specimens the surface is heavily pruinose; others have a shiny, epruinose cortex. The characteristic reticulate-maculae are not always easily seen in these shiny or heavily pruinose specimens and can often only be distinguished upon closer inspection.

Although some authors do not recognize this taxon as distinct from *P. reticulatum* s.str., the Galapagos specimens are easily distinguished already in the field. *Parmotrema clavuliferum* does not only form distinct clavulae; these laciniate lobes are also characteristically unpigmented below, the lower side of the lobes subdividing into clavulae with a mottled appearance of white, unpigmented areas towards their tips, brown pigmented areas further below, eventually blackened towards the thallus center. Whereas the clavulae of *P. clavuliferum* always lack rhizines, the broad lobes of *P. reticulatum* are typically densely rhizinate even close to the margin; these lobes often lack the broad erhizinate margin otherwise so typical for this genus.

Here we consider these two taxa, *P. clavuliferum* and *P. reticulatum*, as distinct, well distinguished, separate species, especially since a recent study by Ahn & Moon (2016) found molecular support for this opinion. Our experience suggests that specimens with less conspicuously stalked but nevertheless capitate soredia also deserve attention. With *P. clavuliferum* and *P. reticulatum* s.str. they share the same chemistry (cortex with atranorin, medulla with salazinic acid), but their capitate soralia are morphologically closer to *P. clavuliferum*, and these short clavulae also share a mottled white-brown-blackened lower lobe side. We have provisionally treated them below as morphotypes – *P. clavuliferum* with long vs. short clavulae. In Brazil, material commonly identified as *P. clavuliferum* is morphologically also rather heterogeneous (e.g., Benatti & Marcelli 2008) and it has be argued that some of these specimens may constitute a separate species (Spielmann 2009).

Almost all collections of *P. clavuliferum* in the Galapagos are corticolous. Only one specimen has been found on rock (Spielmann 10450, CDS 51806). The species shares many characteristics with *P. marcellianum*, which grows exclusively on rock and generally has much smaller lobes (description further below).

Specimens examined from Ecuador, Galápagos [typical morphotype with long clavulae]. ISLA FLOREANA: inside the crater of Cerro Laguna at E side of island, on W-exposed slope, 1°16′11.80″S, 90°23′17″W, 245 m alt., transition zone, dense forest of *Prosopis juliflora*, *Clerodendrum molle*, very few *Bursera graveolens* and some *Jasminocereus thouarsii* in the upper part among lava outcrops and boulders; *Ramalina usnea/anceps* hanging in curtains from *Clerodendrum* twigs, on twigs of *Clerodendrum molle*, sunny, wind- and rain-exposed, 20-Jan-2011, Bungartz, F. 9953 (CDS 47322); lower S-slope of Cerro Ventanas, 1°16′36.10″S, 90°25′41.10″W, 295 m alt., transition zone, open shrubland of *Macraea laricifolia* and some lower *Waltheria ovata* shrubs in between, on fallen branch, 18-Jan-2011, Yánez-Ayabaca, A. 2029 (CDS 48379); Yánez-Ayabaca, A. 2016 (CDS 48366); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, cliff at NE side of trail (Mirador), 1°17′4.298″S, 90°26′36.60″W, 365 m alt., transition zone, ~10 m high lava cliff within dense scrub of *Clerodendrum molle*, *Croton scouleri* and *Macraea laricifolia*, one single *Acacia rorudiana* on top of cliff, on branch of *Acacia rorudiana*, sunny, wind- and rain-exposed, 25-Jan-2011, Bungartz, F. 10226 (CDS 47645); Yánez-Ayabaca, A. 2124 (CDS 48496). ISLA PINTA: along the trail up to the summit from the S-coast, 0°34′15″N, 90°45′2″W, 289 m alt., transition zone, open woodland of *Zanthoxylum fagara*, *Pisonia floribunda*, and few *Trema micrantha*; grasses, *Justicia galapagana*, and *Alternanthera filifolia* in the understory, on twigs of dead *Trema micrantha*, sunny, wind- and rain-exposed, 27-Feb-2007, Bungartz, F. 5900 (CDS 33577). ISLA PINZÓN: along the trail going up from Playa Escondida, SW-slope of the top, 0°36′36″S, 90°40′11″W, 310 m alt., transition zone, dry transition zone with *Prosopis juliflora*, *Opuntia galapageia* ssp. *macrocarpa*, *Croton scouleri*, *Cordia lutea*, *Scalesia baurii* ssp. *baurii*, on *Opuntia*, 16-Feb-2006, Aptroot, A. 64069 (CDS 30630). ISLA SAN CRISTÓBAL: Cerro Partido along trail from entrance to Cerro Pelado to El Ripioso, 0°51′23″S, 89°27′37″W, 376 m alt., transition zone, rocky SW-exposed slope of hill with *Jasminocereus thouarsii*, *Clerodendrum molle* var. *glabrescens*, *Psidium galapageium*, Bromeliaceae and ferns growing in rock crevices, on twigs of *Psidium galapageium*, S-exposed, sunny, wind- and rain-exposed, 28-Apr-2007, Bungartz, F. 6589 (CDS 34809); Bungartz, F. 6602 (CDS 34822); sector of the 'Gotera de agua', trail to Cerro Pelado, 0°51′40.60″S, 89°27′37.20″W, 397 m alt., transition zone, upper transition zone, forest stand with *Psidium guajava*, *Hippomane mancinella*, *Macraea laricifolia* and *Rubus niveus* invading the understory, slope 15°NE, on bark, 23-Aug-2008, Herrera-Campos, M.A. GAL-441 (CDS 43332); slope of Cerro Tortuga, ~4 km inland from the NW-coast, 0°44′51″S, 89°23′25″W, 155 m alt., dry zone, rocky S-exposed slope with few *Bursera graveolens*, *Piscidia carthagenensis*, *Zanthoxylum fagara*, and *Mentzelia aspera* in the understory, on trunk of *Piscidia carthagenensis*, ESE-exposed, semi-shaded, wind- and rain-sheltered, 25-Apr-2007, Bungartz, F. 6578 (CDS 34796). ISLA SANTA CRUZ: abandonned farm below El Puntudo, 0°38′25″S, 90°19′55.10″W, 692 m alt., humid zone, tall forest of *Persea americana*, *Cinchona pubescens* and *Scalesia pedunculata*, with banana and sugar cane plantations in the understory, on W-exposed trunk of *Scalesia pedunculata*, sunny, wind- and rain-exposed, 27-Sep-2013, Bungartz, F. 10958 (CDS 54933); above Mina Granillo Rojo, on the N side of the island, 0°36′58.10″S, 90°21′59.77″W, 597 m alt., transition zone, upper transition zone, open zone (road) at the border of the forest, N-exposed, very little slope, om fallen trunks of *Bursera graveolens* at the forest border, 07-Aug-2008, Clerc, P. 08-84 (CDS 39938); above the quarry Mina Granillo Rojo, off the main road to the channel, on the N side of the island, 0°37′5.798″S, 90°21′59.10″W, 617 m alt., transition zone, open and dry forest of mainly *Psidium galapageium*, with some *Scalesia pedunculata* and *Pisonia floribunda*, and basalt outcrops, on SE-exposed trunk of *Bursera graveolens*, semi-shaded, wind- and rain-exposed, 21-Oct-2007, Bungartz,

F. 7117 (CDS 37602); along the road from Los Gemelos towards the N-coast of the island, ~1 km N of Los Gemelos, 0°37′22″S, 90°22′47″W, 584 m alt., transition zone, upper transition zone with open dry forest, *Scalesia pedunculata*, *Chiococca alba*, *Tournefortia rufo-sericea*, *Cordia leucophlyctis*, and *Zanthoxylum fagara*, on twigs, 12-Feb-2006, Aptroot, A. 63769 (CDS 30329); antes del Puntudo, 0°38′47.77″S, 90°20′5.5″W, 694 m alt., zona húmeda, bosque de *Scalesia penduculata* con árboles invasores *Cinchona pubescens*, sobre corteza de *Cinchona pubescens*, altura al pecho, exposición NE, 17-Jul-2007, Nugra, F. 414 (CDS 36163); at the flanks of Cerro Crocker, 0°38′42.89″S, 90°20′0.1000″W, 766 m alt., humid zone, small *Cinchona* forest with elephant grass and little *Miconia robinsoniana*, on N-exposed trunk of *Cinchona pubescens*, sunny, wind- and rain-exposed, 28-Oct-2010, Bungartz, F. 8790 (CDS 45292); Bellavista, near parking place for trail to Media Luna, 0°40′10″S, 90°19′22″W, 400 m alt., humid zone, on bark of *Cinchona*, 27-May-2005, Aptroot, A. 63152 (CDS 29882); Camote, finca de René Valle, lindero del Parque Nacional Galápagos, al borde, 0°38′20.69″S, 90°17′50.77″W, 473 m alt., zona húmeda, bosque secundario de *Scalesia pedunculata*, perturbado y PNG intervenido por especies vegetales invasoras, sobre corteza de *Scalesia pedunculata*, altura al pecho, 11-Jan-2007, Nugra, F. 338 (CDS 35093); cerca del Puntudo, 0°38′47.77″S, 90°20′5.5″W, 694 m alt., zona húmeda, zona húmeda con árboles invasores, *Cinchona pubescens*, sobre corteza de *Cinchona pubescens*, exposición NE, altura al pecho, 17-Jul-2007, Nugra, F. 411 (CDS 36160); cerca la vía sector Los Gemelos, 0°38′0.1000″S, 90°23′35.5″W, 661 m alt., zona húmeda, bosque de *Scalesia pedunculata*, sobre corteza de *Scalesia pedunculata*, altura al pecho, 15-Feb-2007, Nugra, F. 394 (CDS 35149); Nugra, F. 445 (CDS 36759); E side of island, along road from Cascajo to El Garrapatero, 0°40′22.10″S, 90°14′41.70″W, 137 m alt., transition zone, lower transition zone, open mixed forest of *Bursera graveolens*, *Pisonia floribunda*, *Piscidia carthagenensis*, *Psidium galapageium*, *Erythrina velutina* with an understory of *Plumbago scandens*, *Alternanthera halmifolia*, *Bastardia viscosa*, *Zanthoxylum fagara* a, on bark of *Erythrina velutina*, 16-Jun-2010, Spielmann, A.A. 8179 (CDS 45370); Media Luna, cerca el camino vía al Puntudo, 0°39′43.27″S, 90°19′29.89″W, 558 m alt., zona húmeda, bosque de *Scalesia pedunculata*, con especies introducidas, dominante la *Cinchona pubescens* mayor a 5 metros de alto, sobre corteza de *Psidium guajava*, altura al pecho, 07-Jul-2006, Nugra, F. 84 (CDS 32738); near Puntudo, 0°38′41″S, 90°20′13″W, 750 m alt., humid zone, on bark of *Cinchona pubescens*, 27-May-2005, Aptroot, A. 63159 (CDS 29890); near the CDRS field-weather station below the summit of Cerro Crocker, 0°38′35″S, 90°19′42″W, 830 m alt., humid zone, much overgrown with dead *Cinchona pubescens* trees, N-exposed slope, on trunks and twigs of dead *Cinchona pubescens* trees, 28-Dec-2005, Bungartz, F. 3320 (CDS 26975); Bungartz, F. 3311 (CDS 26966); on the North side of the island, along the dirt road to the ash quarry Mina Granillo Rojo, 0°36′56″S, 90°22′3″W, 570 m alt., transition zone, lower transition zone; dry semi-deciduous forest with *Bursera graveolens* and *Zanthoxylum fagara*, on branches of *Bursera graveolens*, sunny, wind- and rain-exposed, 23-Feb-2006, Bungartz, F. 3916 (CDS 27798). ISLA SANTIAGO: 4 km E of eastern summit, 0°13′15″S, 90°44′30″W, 645 m alt., transition zone, open *Bursera-Zanthoxylum* forest, on bark, 06-May-1971, Pike, L.H. ID28-49 (OSC 101810); Pike, L.H. ID28-59 (OSC 101730); summit of Cerro Gavilan, inner N- and NE-exposed crater rim, 0°12′20″S, 90°47′3″W, 840 m alt., humid zone, N- and NE-exposed, steep basalt cliffs of crater rim with ferns (*Pityrograma calomelanos* var. *calomelanos*, *Polypodium tridens*, *Doryopteris palmata*, *Adiantum concinnum*, *Blechnum polypodioides*) growing in crevices, on NE-exposed front of basalt boulder on top of cliff, 23-Mar-2006, Bungartz, F. 4804 (CDS 28936). ISLA ISABELA, VOLCÁN ALCEDO: on the crater rim near the hut, 0°26′33″S, 91°5′31″W, 1100 m alt., humid zone, *Pteridium arachnoideum* and *Stachytarpheta cayennensis*, scattered low shrubs of *Tournefortia rufo-sericea* and outcrops of basalt tuff in between, on basalt rock, 07-Mar-2006, Aptroot, A. 65270 (CDS 31856); Aptroot, A. 65193 (CDS 31778); lower crater slopes above the first Caseta del Parque; within the cloud layer, 0°57′55.60″S, 91°25′1.899″W, 767 m alt., humid zone, open pasture with some *Tournefortia rufo-sericea* scrub, and occasional large clusters of *Cladonia confusa* on the ground, on top of sunny rock, 03-May-2012, Spielmann, A.A. 10450 (CDS 51806); VOLCÁN DARWIN: ~1.5 km from the southwestern crater rim, 0°12′20.5″S, 91°18′52.77″W, 1280 m alt., high altitude dry zone, basalt outcrop for the most part bare of vegetation, lava pebbles on S-exposed slope under overhang, shaded, wind- and rain-sheltered, 14-Nov-2007, Bungartz, F. 7608 (CDS 38104); southwestern crater rim, 0°12′11.5″S, 91°18′41.27″W, 1286 m alt., high altitude dry zone, open forest of *Scalesia microcephala*, few trees of *Zanthoxylum fagara*, *Cordia revoluta* and *Croton scouleri* shrubs, many young *Scalesia* in the understory, on stem of *Croton scouleri* (~4 cm in diam.), sunny, wind- and rain-exposed, 13-Nov-2007, Bungartz, F. 7498 (CDS 37989); southwestern slope, above Tagus Cove, 0°13′57.89″S, 91°20′5.096″W, 613 m alt., transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Croton scouleri*, *Dodonaea viscosa*, *Scalesia microcephala*, *Cordia revoluta* and *Opuntia insularis*), on branches and twigs of large *Cordia revoluta* shrub, sunny, wind- and rain-exposeed, 12-Nov-2007, Bungartz, F. 7388 (CDS 37875); Bungartz, F. 7390 (CDS 37877); 0°14′15.4″S, 91°20′40.27″W, 351 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri*, *Macraea laricifolia* and *Waltheria ovata*, few trees of *Acacia rorudiana*, on twig of *Zanthoxylum fagara*, semi-shaded, wind- and rain-sheltered, 16-Nov-2007, Bungartz, F. 7901 (CDS 38410); 0°13′43.27″S, 91°19′47.27″W, 724 m alt., transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Dodonaea viscosa*, *Croton scouleri*, *Cordia revoluta* and *Jasminocereus thouarsii*), on stem and branches of *Jasminocereus thouarsii*, sunny, wind- and rain-exposed, 12-Nov-2007, Bungartz, F. 7454 (CDS 37941).

Specimens examined from Ecuador, Galápagos [morphotype with short clavulae]. ISLA SAN CRISTÓBAL: on top of Cerro Colorado, 0°54′55.77″S, 89°26′3.899″W, 145 m alt., dry zone, upper dry zone; open shrubland of *Croton scouleri*, *Macraea laricifolia* and *Waltheria ovata* with lava boulders, on stem of *Croton scouleri*, S-exposed, sunny, wind- and rain-exposed, 24-Aug-2008, Bungartz, F. 8598 (CDS 41244); trail from Cerro Pelado to El Ripioso, S of Cerro Partido, 0°51′28.10″S, 89°27′38″W, 372 m alt., transition zone, open flat area with the abundant annual herb *Malachra capitata* and scattered shrubs of *Psidium guajava* and *Croton scouleri*, on twigs of *Clerodendrum molle*, sunny, wind- and rain-exposed, 23-Aug-2008, Bungartz, F. 8534 (CDS 41180). ISLA SANTIAGO: along the trail from Bucanero to Jaboncillos, ~1 km below the summit, Cerro Gavilan, 0°11′45″S, 90°47′20″W, 680 m alt., transition zone, open *Psidium galapageium* forest with *Zanthoxylum fagara*, *Blainvillea dichotoma*, *Mentzelia aspera* and *Senna obtusifolia*, basalt boulders and outcrops in between, on bark of Zanthoxylum fagara, 22-Mar-2006, Aptroot, A. 65456 (CDS 32044). ISLA ISABELA, VOLCÁN ALCEDO: in the crater near fumaroles, 0°27′1″S, 91°7′19″W, 780 m alt., transition zone, mostly *Bursera graveolens* and dense scrub on uneven lava, on bark of *Bursera*, 07-Mar-2006, Aptroot, A. 64776

(CDS 31351); VOLCÁN DARWIN: ~1 km from the southwestern crater rim, 0°12′20.5″S, 91°18′52.77″W, 1276 m alt., high altitude dry zone, dense young *Scalesia microcephala* forest with few trees of *Zanthoxylum fagara*, on branches of *Scalesia microcephala*, semi-shaded, wind- and rain-sheltered, 13-Nov-2007, Bungartz, F. 7563 (CDS 38057); southwestern slope, above Tagus Cove, 0°13′57.89″S, 91°20′5.096″W, 613 m alt., transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Croton scouleri*, *Dodonaea viscosa*, *Scalesia microcephala*, *Cordia revoluta* and *Opuntia insularis*), on branches and twigs of large *Cordia revoluta* shrub, sunny, wind- and rain-exposeed, 12-Nov-2007, Bungartz, F. 7389 (CDS 37876); VOLCÁN SIERRA NEGRA: Velasco, 0°49′57.77″S, 91°11′11″W, 650 m alt., humid zone, on bark, 25-Jan-2006, Jaramillo, P. 2828 (CDS 38775); Jaramillo, P. 2825 (CDS 38772); Jaramillo, P. 2826 (CDS 38773); Jaramillo, P. 2817 (CDS 38766); Jaramillo, P. 2837 (CDS 38784).

Parmotrema cactacearum Bungartz & Spielmann, sp. nov. (Fig. 2C–D)

MycoBank MB 832662

Diagnosis: Differs from *P. conformatum* by the more angular, more flattened, often abundantly lobulate and sparsely to abundantly ciliate lobes, with rounded lobe axils.

Type: Ecuador. Galápagos: Isla Pinta, along the trail up to the summit from the S-coast, 0°34′15″N, 90°45′2″W, 289 m alt., transition zone, open woodland of *Zanthoxylum fagara*, *Pisonia floribunda*, and few *Trema micrantha*, grasses, *Justicia galapagana*, and *Alternanthera filifolia* in the understory, old cactus pad lying on the ground, sunny, wind- and rain-exposed, 27-Feb-2007, Bungartz, F. 5888 (CDS 33565 – holotype!).

Thallus corticolous (on cactus pads); upper surface pale greenish yellow, dull, emaculate, not cracked; sparsely to abundantly isidiate; isidia marginal to sublaminal, cylindrical, mostly simple to sparsely branched, 0.05–0.1 mm in diam., concolorous with the thallus to deep brown at their tip, eciliate; lobes small to moderate-sized, 2–5 mm wide, angular, ±flattened, with rounded lobe axils, margins sparsely to abundantly ciliate; cilia short and stout, 0.2–0.5(–0.6) mm long, black, mostly simple, rarely branched; lower surface often blackened throughout or becoming dark brown towards the margin, typically with an erhizinate 0.5–1(–1) mm marginal zone; rhizines short and stout, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with usnic acid [P–, K–, KC± dirty yellowish brown, C–, UV–]; medulla with protocetraric acid [P+ yellow, quickly turning red; K+ dirty yellowish brown; KC–, C–, UV–].

Etymology. Named for its substrate.

Ecology and distribution. Currently only known from the type, possibly endemic.

Notes. *Parmotrema cactacearum* is in many respects very similar to *P. conformatum*. The two species share almost the same chemistry. In Galapagos all specimens of *P. conformatum* contain fumarprotocetraric acid, whereas this secondary metabolite is absent from *P. cactacearum*. However, this chemical difference alone may not constitute the most reliable character to distinguish the two species. Hale (1965), Ribeiro (1998) and Canêz (2005) all report fumarprotocetraric acid from *P. conformatum*, but Winnem (1975) suggests that she found usnic acid, protocetraric acid and an unknown substance in the type (at BM). This suggests that the type material should be re-examined.

More important than the chemical differences, however, is the distinctly different growth morphology of the two species. *Parmotrema conformatum* forms broadly rotund, loosely undulating lobes with incised axils; these lobes are typically not lobulate and are mostly eciliate (only a few specimens occasionally bear cilia). *Parmotrema cactacearum* has flattened, appressed, angular lobes with rounded axils. These lobes are often abundantly lobulate with sparse cilia; where the lobes lack lobules they are more abundantly ciliate. The two species also differ in their isidia ontogeny. In both species, isidia are most abundant and best developed at the lobe edges, but in *P. conformatum* the isidia generally emerge from a much broader gnarled surface area along the lobe margins. Towards the margin this irregular surface becomes increasingly granular and the lobe margins are then abundantly cylindrically isidiate. In *P. cactacearum* the isidia appear more confined to the lobe edge; the thallus surface generally remains smooth and only occasionally bears a few immature, scattered isidia. In Galapagos both species are not common.

Parmotrema conformatum (Vain.) Hale, Phytologia 28(4): 335. 1974. (Fig. 2E–F)

Type: Brazil, Minas Gerais: Sitio [nowadays Antônio Carlos], Vainio, E.A. Lich. Bras. Exs. 615 (TUR-V 2489 – holotype, BM – isotype, fide Hale 1965).

Thallus corticolous; upper surface pale greenish yellow, dull, emaculate, not cracked; sparsely to abundantly isidiate, parts of the surface often gnarled and ±granular, where the isidia eventually emerge; isidia marginal, sublaminal to laminal, granular to cylindrical, rarely sparsely branched, 0.05–0.1(–0.2) mm in diam., concolorous with the thallus or brown to blackened at their tip, eciliate; lobes small to moderate-sized, 2–5 mm wide, rotund, undulating, axils incised, margins eciliate to very rarely sparsely ciliate; cilia, if present, short and slender, 0.3–0.5(–1) mm long, black, mostly simple, very rarely branched; lower surface often blackened throughout or becoming dark brown towards the margin, typically with an erhizinate 0.5–1(–1.5) mm marginal zone; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with usnic acid [P–, K–, KC± dirty yellowish brown, C–, UV–]; medulla with fumarprotocetraric and protocetraric acid [P+ yellow, quickly turning red; K+ dirty yellowish brown; KC–, C–, UV–].

Ecology and distribution. Africa and North, South and Central America (Hale 1965); in South America previously known from Brazil (Hale 1965; Ribeiro 1998; Canêz 2005) and Venezuela (Vareschi 1962). In Ecuador so far only reported from the Galapagos, first by Weber (1986), subsequently by Elix & McCarthy (1998) and recently online

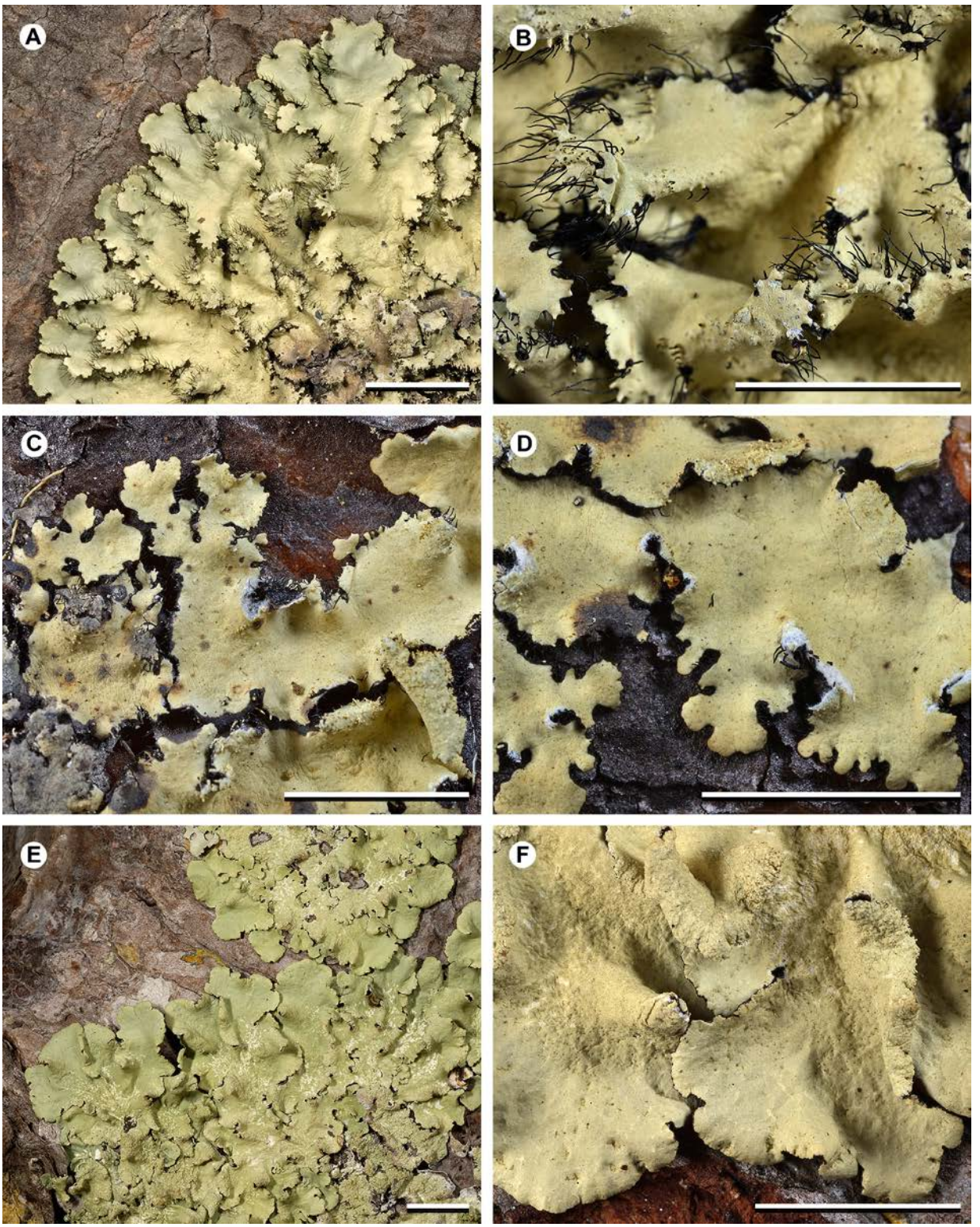

Figure 2. Isidiate *Parmotrema* species with greenish yellow surface (cortex with usnic acid). A – *P. nyasense*, overview of thallus growing on bark (Bungartz, F. 7766, CDS 38274); B – *P. nyasense*, close-up of marginal ciliate isidia (Bungartz, F. 7766, CDS 38274); C – *P. cactacearum*, overview of thallus growing on cactus pad (Bungartz, F. 5888, CDS 33565 – holotype); D – *P. cactacearum*, close-up of angular isidiate lobes (Bungartz, F. 5888, CDS 33565 – holotype); E – *P. conformatum*, overview of thallus growing on bark (Bungartz, F. 4338, CDS 28422); F – *P. conformatum*, close-up of rotund isidiate lobes (Bungartz, F. 4338, CDS 28422). Scales: A–F = 5 mm.

(Bungartz et al. 2016); an uncommon corticolous species known only from a few collections on several islands, in exposed habitats, from the dry zone into the transition zone; typically growing on trunks and branches of *Bursera* trees, one specimen from *Clerodendrum* scrub (both *Bursera* and *Clerodendrum* are native to the Galapagos).

Notes. See the description of *P. cactacearum* for a discussion of how these two isidiate species with usnic acid can be distinguished.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: trail from Black Beach to highlands, dry zone, on *Bursera*, 25-Apr-1976, Weber, W.A. s.n. (L-62917, COLO

294604). ISLA SAN CRISTÓBAL: trail from Cerro Pelado to El Ripioso, S of Cerro Partido, 0°51′28.10″S, 89°27′38″W, 372 m alt., transition zone, open flat area with the abundant annual herb *Malachra capitata* and scattered shrubs of *Psidium guajava* and *Croton scouleri*, on twigs of *Clerodendrum molle*, sunny, wind- and rain-exposed, 23-Aug-2008, Bungartz, F. 8535 (CDS 41181). ISLA SANTA CRUZ: on the North side of the island, along the dirt road to the ash quarry Mina Granillo Rojo, 0°36′56″S, 90°22′3″W, 570 m alt., transition zone, lower transition zone; dry semi-deciduous forest with *Bursera graveolens* and *Zanthoxylum fagara*, on branches of *Bursera graveolens*, sunny, wind- and rain-exposed, 23-Feb-2006, Bungartz, F. 3914 (CDS 27796); Aptroot, A. 64572 (CDS 31144). ISLA ISABELA, VOLCÁN ALCEDO: along the trail going up the E-slope, at the NW side of the trail, 0°24′5″S, 91°2′36″W, 420 m alt., dry zone, open *Bursera graveolens* stand with an occasional *Pisonia floribunda* and *Zanthoxylum fagara* and shrubs of *Macraea laricifolia* and *Waltheria ovata*, on trunk of *Bursera graveolens*, sunny; wind- and rain-exposed, 09-Mar-2006, Bungartz, F. 4338 (CDS 28422); basalt rubble field to the SE side of the trail and the barranco, 0°24′3″S, 91°2′35″W, 434 m alt., dry zone, basalt rubble field with scattered vegetation (*Bursera graveolens*, *Zanthoxylum fagara*, *Pisonia floribunda*, *Senna pistaciifolia*), on bark of Bursera, 09-Mar-2006, Aptroot, A. 64963 (CDS 31542).

Parmotrema cooperi (J. Steiner & Zahlbr.) Sérus., Bryologist 87(1): 4. 1984. (Fig. 13A–B)

Type: South Africa, Capeland: Kaprana, Cooper, P.J. 1813 (W – lectotype, H, M, UPS, US – isotypes, fide Sérusiaux 1984).

Thallus saxicolous; upper surface whitish gray to ivory, dull to ±shiny, epruinose, emaculate, occasionally cracked, but not forming a distinctly reticulate pattern; abundantly sorediate; soralia marginal, linear to labriform (±crescent-shaped), or subcapitate; soredia ±granular, ±discolored by a brownish tinge, pale inside; lobes moderate-sized, 5–7(–10) mm wide, rotund, axils incised, margins sparsely ciliate; cilia short and slender, 0.4–2.5 mm long, black, mostly simple, very rarely branched; lower surface often blackened throughout or becoming dark brown towards the margin or, especially below the soredia, often mottled white, typically with a distinct, 1–2 mm wide, erhizinate marginal zone; rhizines short, stout, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with lecanoric acid [P–, K–, C+/KC+ bright red (C and KC reactions are evanescent and must be examined under continuous observation); UV–].

Ecology and distribution. Australia, India, Africa, Papua New Guinea, Mexico (Hale 1965; Sérusiaux 1984; Swinscow & Krog 1988; Elix 1994; Louwhoff & Elix 1999; Divakar & Upreti 2005; Egan et al. 2016). New for South America and the Galapagos; known from a single collection at the summit of Cerro Gavilan on Santiago Island, where the specimen was collected among ferns in sheltered crevices.

Notes. Superficially similar species are *P. grayanum* and *P. rampoddense*, but unlike *P. cooperi*, these two species do not contain lecanoric acid in their medulla. The medulla of *P. grayanum* contains no secondary metabolites and all spot tests are therefore negative. *Parmotrema rampoddense* contains alectoronic acid with α-collatolic acid and thus reacts KC+ rosé, quickly turning orange, and displays greenish blue fluorescence in ultraviolet light. Both *P. grayanum* and *P. cooperi* typically have sparse, relatively short cilia, and the lobes have a broadly erhizinate lower margin that is mottled white, brown and black. *Parmotrema rampoddense* has abundant, very long and slender cilia, and the lobes are also broadly erhizinate below but lack the mottled appearance and instead are uniformly deep brown, gradually darkening towards the thallus center.

Specimens examined from Ecuador, Galápagos. ISLA SANTIAGO: summit of Cerro Gavilan, inner N- and NE-exposed crater rim, 0°12′20″S, 90°47′3″W, 840 m alt., humid zone, N- and NE-exposed, steep basalt cliffs of crater rim with ferns (*Pityrograma calomelanos* var. *calomelanos*, *Polypodium tridens*, *Doryopteris palmata*, *Adiantum concinnum*, *Blechnum polypodioides*) growing in crevices, on lava rock, 23-Mar-2006, Aptroot, A. 65659 (CDS 32250).

Parmotrema crinitum (Ach.) M. Choisy [as 'crinita'], Bull. mens. Soc. linn. Soc. Bot. Lyon 21: 175. 1952. (Fig. 5A–B)

Type: North America [Country unknown], [State unknown]: Muhlenberg, H. s.n., (H – holotype, fide Hale 1965).

Thallus corticolous, lignicolous, or saxicolous; upper surface whitish gray to ivory, shiny to ±dull, epruinose, emaculate, but occasionally in parts irregularly cracked; abundantly isidiate; isidia initially marginal but soon spreading across the thallus surface, cylindrical, simple to sparsely branched, occasionally closely clustered (caespitose), brown to blackened at their tip and frequently ciliate (cilia of caespitose isidia having a 'tufted' appearance); lobes broad, small to moderate-sized, 0.7–6(–8) mm wide, ±rotund, axils incised to ±rounded but not distinctly looped, margins abundantly ciliate; cilia very long and slender, 1–7(–8) mm long, black, mostly simple, very rarely branched; lower surface blackened throughout or with a narrow, deep brown, erhizinate, ~1–1.5 mm wide margin, blackening and becoming densely rhizinate towards the thallus center; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with stictic, cryptostictic and constictic acid [P+ yellow, slowly orange; K+ yellow, KC–, C–, UV–].

Ecology and distribution. Cosmopolitan (e.g., Hale 1965; Elix 1994; Brodo et al. 2001; Chen et al. 2005; Divakar & Upreti 2005; Egan et al. 2016). First reported for Galapagos, Ecuador, by Weber (1986), subsequently by Elix & McCarthy (1998) and online (Bungartz et al. 2016). A moderately common species; found from the dry zone through the transition and humid zones into the high altitude dry zone; most abundant in the transition zone;

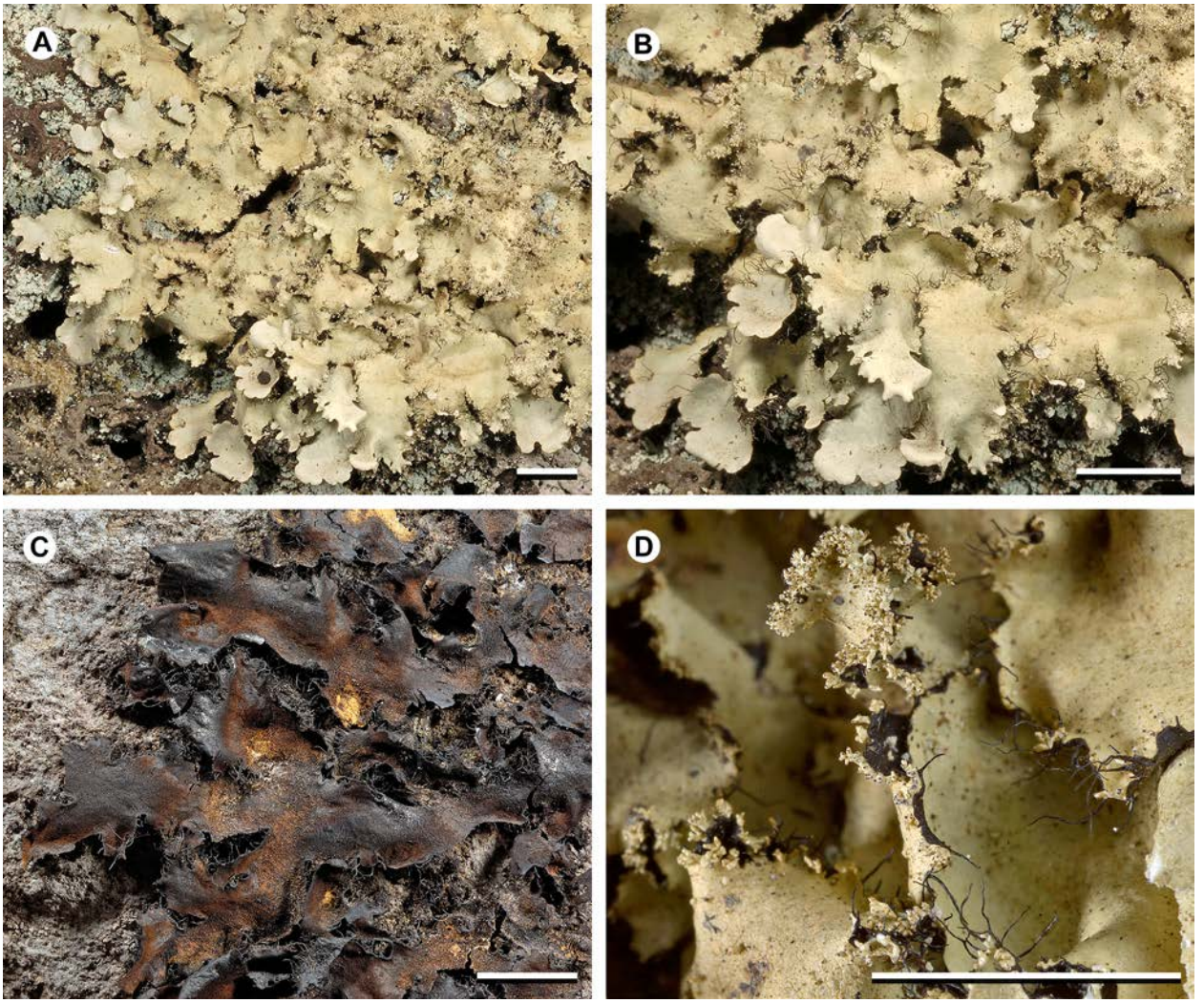

Figure 3. *Parmotrema flavescens*, an isidiate species with a greenish yellow surface (cortex with usnic acid). A, B – overview of thallus growing on rock (Bungartz, F. 6813, CDS 36244); C – thallus scorched black by the heat from a volcanic eruption of Volcán Sierra Negra in October 2005, photograph of specimen taken in the field in September 2007 (Bungartz, F. 6795, CDS 36214); D – close-up of isidiate, abundantly ciliate lobes (Bungartz, F. 6795, CDS 36214). Scales: A–D = 5 mm.

typically on bark, rarely on wood or rock, often in somewhat sheltered and shaded habitats, but less frequently also at exposed sites; not known from introduced trees or shrubs, most common on *Clerodendrum* and *Croton*, often also on *Bursera*, *Zanthoxylum* or *Hippomane*.

Notes. Morphologically very similar is *P. neosubcrinitum*, which has isidiate, abundantly ciliate lobes, typically also with ciliate isidia. The two species differ by their chemistry. The medulla of *P. crinitum* contains stictic acid and thus turns yellow in K. *Parmotrema neosubcrinitum* contains salazinic acid and its medulla in K quickly turns deep blood-red.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: along rim trail of Cerro Pajas, eastern part of rim, 1°17′44.77″S, 90°27′15.6″W, 442 m alt., humid zone, low dense vegetation of *Zanthoxylum fagara*, *Scalesia pedunculata*, *Macraea laricifolia*, *Croton scouleri* and ferns (*Polypodium tridens*) over lava boulders; bryophytes hanging in curtains from trees, on NW-exposed slope of basalt boulder, semi-shaded, wind- and rain-sheltered, 26-Jan-2011, Bungartz, F. 10258 (CDS 47677); on W-slope of Cerro Alieri, 1°17′24.10″S, 90°27′8.90″W, 347 m alt., transition zone, dense forest of *Croton scouleri* with few *Scalesia pedunculata*, *Citrus* sp. and *Zanthoxylum fagara*, on fallen branches of *Zanthoxylum fagara*, semi-shaded, wind- and rain-exposed, 12-Jan-2011, Bungartz, F. 9317 (CDS 46543); Bungartz, F. 9336 (CDS 46623); Yánez-Ayabaca, A. 1752 (CDS 48030); Yánez-Ayabaca, A. 1760 (CDS 48038); S of Cerro Asilo de la Paz, edge of Pampa Larga, 1°19′38.20″S, 90°27′9.596″W, 249 m alt., transition zone, shrubland of *Psidium guajava*, *Clerodendrum molle*, *Macraea laricifolia* and *Croton scouleri* with *Phila strigosa*, *Sidastrum paniculatum* and other herbs and grasses, on branch of *Clerodendrum molle*, sunny, wind- and rain-exposed, 13-Jan-2011, Yánez-Ayabaca, A. 1853 (CDS 48207); Yánez-Ayabaca, A. 1857 (CDS 48211); Bungartz, F. 9500 (CDS 46782); trail from La Primavera Farm to La Corona and Arco de la Reina, southeastern part of the island, 1°19′21.60″S, 90°24′45.89″W, 219 m alt., transition zone, very dense scrub of *Clerodendrum molle* with some *Croton scouleri*, *Waltheria ovata*, few *Prosopis juliflora* and occasional trees of *Geoffroea spinosa* in flat area on generally SE-exposed, moderately inclined slope with few boulders, on branch of *Clerodendrum molle*, sunny, wind- and rain-exposed, 24-Jan-2011, Yánez-Ayabaca, A. 2086 (CDS 48432); Yánez-Ayabaca, A. 2090 (CDS 48436); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, 1°17′17.30″S, 90°26′35″W, 360 m alt., transition zone, low and dense forest of *Croton scouleri*, *Clerodendrum molle*, *Zanthoxylum fagara*, and *Macraea laricifolia*, occasional *Pisonia floribunda* trees

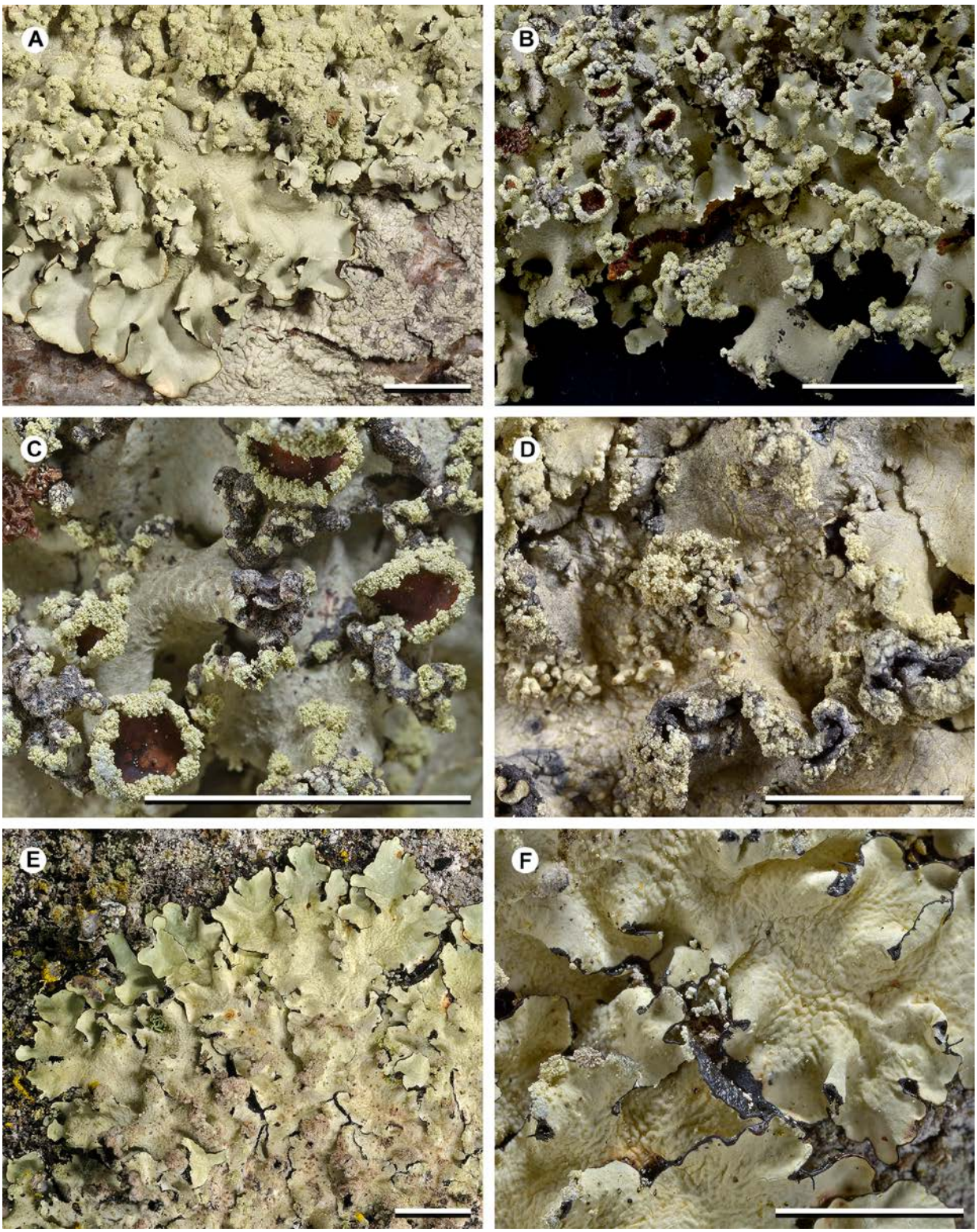

Figure 4. Pustulate-isidiate and sorediate *Parmotrema* species with greenish yellow surface (cortex with usnic acid). A – *P. dominicanum*, overview of thallus growing on bark (Bungartz, F. 6318, CDS 34533); B, C – *P. dominicanum*, close-up of apotheciate thallus with soredia (Spielmann, A. 10729, CDS 52132); D – *Parmotrema lawreyi*, with pustulate isidia rupturing into soredia (Bungartz, F. 6187, CDS 34399); E – *P. virescens*, overview of thallus growing on rock (Bungartz, F. 8211, CDS 40857); F – *P. virescens*, close-up of wrinkled thallus with marginal capitate soredia (Bungartz, F. 8211, CDS 40857). Scales: A–F = 5 mm.

and epiphytic orchids (Ionaspis), 25-Jan-2011, Yánez-Ayabaca, A. 2108 (CDS 48471). ISLA PINTA: on the western cliff, W of Las Pampas, 0°34′51.70″N, 90°46′25.89″W, 411 m alt., transition zone, W-exposed forest of *Zanthoxylum fagara*, *Croton scouleri*, *Cordia lutea* and *Pisonia floribunda*, on fallen tree trunk, semi-shaded, 01-Feb-2008, Nugra, F. 628 (CDS 39006); Nugra, F. 627 (CDS 39005); plateau on top of the western cliff, W of Las Pampas, 0°34′52.60″N, 90°46′29.19″W, 425 m alt., transition zone, W-exposed forest of *Zanthoxylum fagara*, *Croton scouleri*, and *Pisonia floribunda*, on SSW-exposed branches of *Croton scouleri*, semi-shaded, 01-Feb-2008, Nugra, F. 646 (CDS 39024). ISLA PINZÓN: from the NE-coast to the

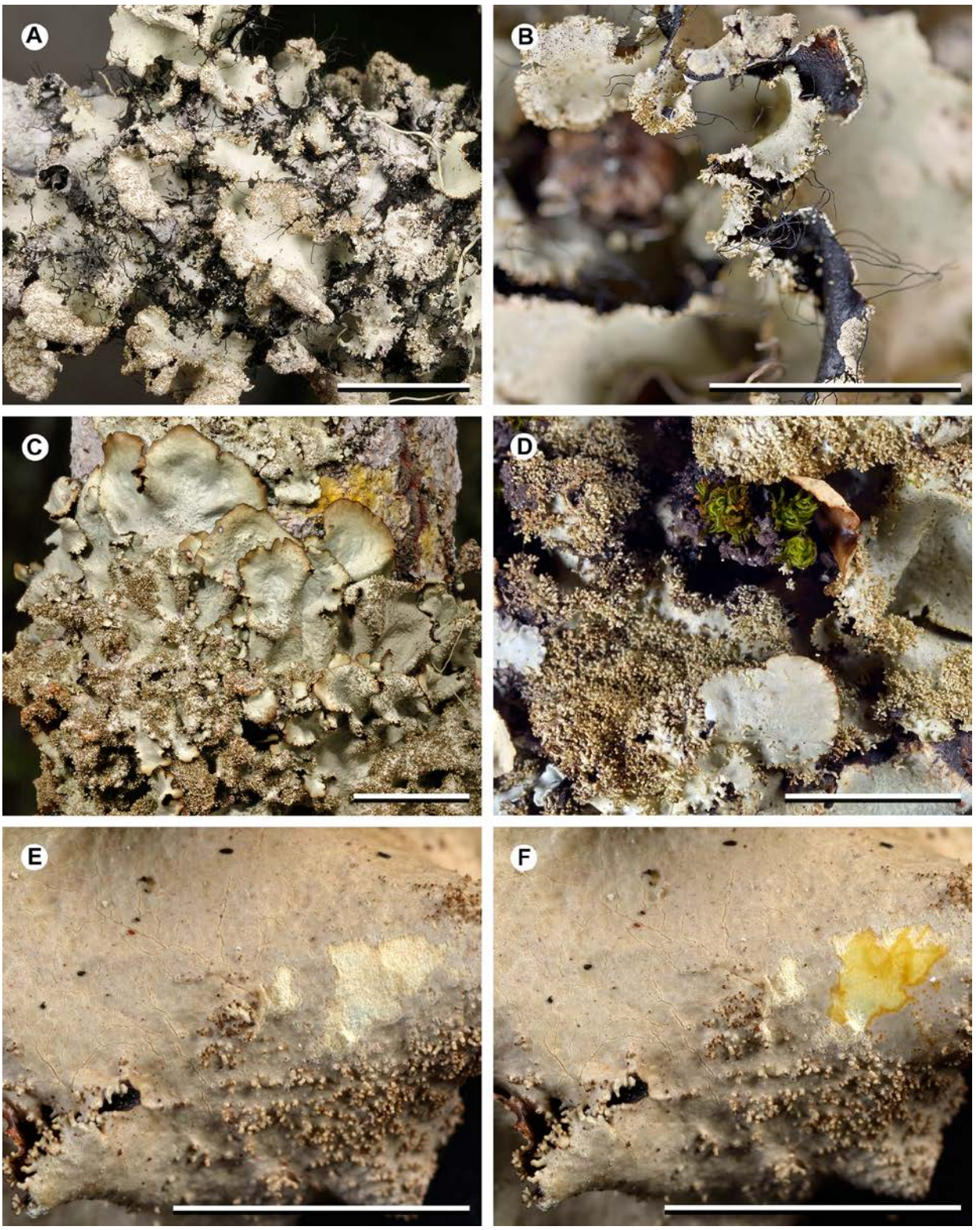

Figure 5. Isidiate *Parmotrema* species with gray surface (cortex with atranorin, medulla without salazinic acid). A – *P. crinitum*, overview of thallus growing on twig (Bungartz, F. 8542, CDS 41188); B – *P. crinitum*, close-up of abundantly isidiate lobes with long cilia and black lower surface extending almost all the way to the lobe edge (Bungartz, F. 10258, CDS 47677); C – *P. endosulphureum*, abundantly isidiate specimen growing on branch (Bungartz, F. 8597, CDS 41243); D – *P. endosulphureum*, close-up of densely isidiate thallus lobes (Spielmann, A. 10401, CDS 51756); E, F – *P. endosulphureum*, scratched thallus surface exposing the pale salmon-yellow medulla (Bungartz, F. 4981, CDS 29194; E – before applying spot test reagents; F – C/KC+ yellow medullary spot test reaction). Scales: A–F = 5 mm.

highest summit, 400 m alt., transition zone, mixed *Scalesia* forest of trees 4 m tall on rocky soil, on horizontal branch of *Pisonia*, 02-Jul-1976, Sipman, H.J.M. s.n. (L-63576, COLO 297860); 60 m alt., dry zone, on rocks and dead twigs, 15-Aug-1905, Stewart, A. s.n. (CAS 119455). ISLA SAN CRISTÓBAL: bordering lake at El Junco, humid zone, steep slope bordering lake, on rock, 21-May-1976, Lanier, J. s.n. (L-63759, COLO 298420); Cerro Colorado, enclosure for *Calandrinia galapagosa* near the viewpoint on the top, 0°54′58″S, 89°26′5″W, 130 m alt., transition zone, open scrubland of mostly *Croton scouleri*,

Waltheria ovata, and *Macraea laricifolia* on W-exposed cinder cone, on stems and branches of *Croton scouleri*, sunny, wind- and rain-exposed, 29-Apr-2007, Bungartz, F. 6754 (CDS 35005); trail from Cerro Pelado to El Ripioso, S of Cerro Partido, 0°51′28.10″S, 89°27′38″W, 372 m alt., transition zone, open flat area with the abundant annual herb *Malachra capitata* and scattered shrubs of *Psidium guajava* and *Croton scouleri*, on twigs of *Clerodendrum molle*, sunny, wind- and rain-exposed, 23-Aug-2008, Bungartz, F. 8542 (CDS 41188); trail to Cerro Mundo from the border of the National Park, NE of Puerto Baquerizo Moreno, 0°53′36″S, 89°34′41.5″W, 206 m alt., transition zone, dry bed of periodical stream, forest of *Psidium galapageium* and *Hippomane mancinella* with *Zanthoxylum fagara*, *Tournefortia rufo-sericea* and *Piscidia carthagenensis*, on top of *Hippomane mancinella* branch, shaded, wind-and rain-sheltered, 25-Aug-2008, Bungartz, F. 8659 (CDS 41305). ISLA SANTA CRUZ: above Mina Granillo Rojo, on the N side of the island, 0°36′58.10″S, 90°21′59.77″W, 597 m alt., transition zone, upper transition zone, open zone (road) at the border of the forest, N-exposed, very little slope, on *Bursera graveolens*, 07-Aug-2008, Clerc, P. 08-55 (CDS 39909); along the dirt road from Bellavista to Media Luna, farmland on the W side of the dirt road, 0°40′54″S, 90°19′26″W, 285 m alt., humid zone, agricultural area, fenced pastures with old trees (*Cedrela odorata*, *Persea americana*, *Citrus* sp.), on wood pole, 28-Feb-2006, Aptroot, A. 64697 (CDS 31271); along the road from Los Gemelos towards the N-coast of the island, ~1 km N of Los Gemelos, 0°37′22″S, 90°22′47″W, 584 m alt., transition zone, upper transition zone with open dry forest, *Scalesia pedunculata*, *Chiococca alba*, *Tournefortia rufo-sericea*, *Cordia leucophlyctis*, and *Zanthoxylum fagara*, on bark of *Scalesia*, 12-Feb-2006, Aptroot, A. 63770 (CDS 30330); vicinity of Academy Bay, 100 m alt., transition zone, on bark of *Bursera*, 15-Feb-1964, Itow, S. s.n. (L-40625A, COLO 196997); Weber, W.A. s.n. (L-40622A, COLO 196996). ISLA SANTIAGO: along trail to summit above Santiago Bay lava flow, 0°13′0″S, 90°47′30″W, 680 m alt., humid zone, dense stand of *Zanthoxylum*, *Croton*, and *Psychotria*, 03-May-1971, Pike, L.H. s.n. (L-56192, COLO 263558); E of salt lake at James Bay, 0°14′25″S, 90°48′50″W, 170 m alt., transition zone, *Bursera-Psidium* forest on pahoehoe lava flow, on bark of *Bursera*, 30-Apr-1971, Pike, L.H. 2715 (OSC 101757); Pike, L.H. s.n. (L-56469, COLO 260294). ISLA ISABELA, VOLCÁN ALCEDO: on the crater rim near the hut, 0°26′33″S, 91°5′31″W, 1100 m alt., humid zone, *Pteridium arachnoideum* and *Stachytarpheta cayennensis*, scattered low shrubs of *Tournefortia rufo-sericea* and outcrops of basalt tuff in between, on bark of *Zanthoxylum*, 07-Mar-2006, Aptroot, A. 65208 (CDS 31794); outer SE-exposed slope, ~2 km below the crater rim, 0°26′16″S, 91°4′36″W, 798 m alt., transition zone, ±dense shrubby vegetation of *Tournefortia rufo-sericea* with scattered trees of *Psidium galapageium*, *Zanthoxylum fagara*, and *Solanum erianthum*, on the upper side of inclined *Zanthoxylum fagara* trunk, ~10 cm in diam., shaded, ±wind- and rain-sheltered, 07-Mar-2006, Bungartz, F. 4188 (CDS 28230); Bungartz, F. 4181 (CDS 28223); plain at the base of the outer E-exposed slope, along the trail going up to the rim, 0°25′0″S, 91°4′40″W, 860 m alt., humid zone, stand of *Psidium galapageium* with *Zanthoxylum fagara*, *Croton scouleri* and *Pisonia floribunda* among basaltic outcrops, trail markers, on plastic, 08-Mar-2006, Aptroot, A. 64862 (CDS 31439); VOLCÁN CERRO AZUL: Iguana Cove, on the side of the cliff above the coast, on rock, 20-Mar-1906, Stewart, A. s.n. (CAS 119456); lower crater slopes above the first Caseta del Parque; within the cloud layer, 0°57′55.60″S, 91°25′1.899″W, 767 m alt., humid zone, open pasture with some *Tournefortia rufo-sericea* scrub, and occasional large clusters of *Cladonia confusa* on the ground, on branches and twigs of shrubs, sunny, 03-May-2012, Spielmann, A.A. 10460 (CDS 51816); lower half of path from the Caseta del Parque to Caleta Iguana at the coast, 0°58′52.39″S, 91°26′41″W, 74 m alt., dry zone, shaded forest of huge Manzanillo (*Hippomane manzinella*) trees, some *Zanthoxylum fagara* scrub, shrubs of *Clerodendrum molle* and *Psidium galapageium*, on trunk of *Hippomane manzinella*, semi-shaded, 08-May-2012, Spielmann, A.A. 10720 (CDS 52098); Spielmann, A.A. 10722 (CDS 52125); Spielmann, A.A. 10719 (CDS 52096); approx. half of the way, 0°59′1.8″S, 91°26′15.4″W, 205 m alt., transition zone, dense, shaded woodland of few introduced fruit trees (abandonned farm); *Citrus* spp., and several natives like *Croton scouleri*, *Ipomoea* sp., and *Hippomane manzinella*, on dead tree at the forest border, semi-shaded, 08-May-2012, Spielmann, A.A. 10698 (CDS 52065); approx. one third of the way, 0°59′9.5″S, 91°26′4.90″W, 224 m alt., transition zone, dense *Psidium guajava* woodland with few large *Zanthoxylum fagara* trees, *Pisonia floribunda* and *Scalesia cordata* trees, understory with *Tournefortia rufo-sericea* shrubs and ferns, on branches and twigs of *Zanthoxylum*, semi-shaded, 08-May-2012, Spielmann, A.A. 10678 (CDS 52033); Spielmann, A.A. 10644 (CDS 52011); Spielmann, A.A. 10667 (CDS 52022); S-slope above Iguana Cove, 400 m alt., humid zone, on old, dying, isolated *Zanthoxylum* tree, 24-Jun-1976, Sipman, H.J.M. s.n. (L-63547, COLO 297889); VOLCÁN DARWIN: ~1 km from the southwestern crater rim, 0°12′20.5″S, 91°18′52.77″W, 1276 m alt., high altitude dry zone, dense young *Scalesia microcephala* forest with few trees of *Zanthoxylum fagara*, on wood of dead twig, semi-shaded, wind- and rain-sheltered, 13-Nov-2007, Bungartz, F. 7566 A (CDS 38060); southwestern crater rim, 0°12′11.5″S, 91°18′41.27″W, 1286 m alt., high altitude dry zone, open forest of *Scalesia microcephala*, few trees of *Zanthoxylum fagara*, *Cordia revoluta* and *Croton scouleri* shrubs, many young *Scalesia* in the understory, on bark of *Zanthoxylum fagara*, 13-Nov-2007, Ertz, D. 11829 (CDS 37188); VOLCÁN SIERRA NEGRA: La Esperanza, around the 'casa del corazón verde' of the Charles Darwin Research Station, 0°51′17.30″S, 91°1′32.5″W, 324 m alt., humid zone, farming areas, slope 20° ESE, on fencepost, 15-Aug-2008, Clerc, P. 08-172 A (CDS 40026).

Parmotrema cristiferum (Taylor) Hale, Phytologia 28: 335. 1974. (Fig. 15A–D)

Type: India, West Bengal: Calcutta, Wallich, N. s.n. (lectotype: FH!, designated by Berry 1941).

Thallus corticolous, rarely saxicolous; upper surface whitish gray to ivory, shiny to ±dull, epruinose, emaculate, typically not cracked, but older parts ±wrinkled and rarely becoming cracked; abundantly sorediate; soralia marginal, linear to labriform (±crescent-shaped); soredia farinose, ±concolorous with the thallus surface, typically not discolored, pale inside; lobes broad, moderate-sized to very large, 5–15 mm wide, ±rotund, axils incised, margins eciliate (very rarely with few, short cilia, less than 0.5(–0.7) mm in the axils); lower surface with a broad, pale to deep brown or frequently mottled white (particularly below the soredia), erhizinate, ~5–7 mm wide margin, blackening and sparsely rhizinate towards the thallus center; rhizines short, stout, black, mostly simple, rarely sparsely branched, often clustered in groups, with erhizinate areas in between; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Ecology and distribution. Africa (Hue 1899; Hale 1965; Krog & Swinscow 1981), Asia (Taylor 1847; Hue 1899; Vainio 1909; Hale 1965; Chen et al. 2005; Divakar & Upreti 2005), Oceania (Hue 1899; Merrill 1909; Hale 1965; Elix 1994; Louwhoff & Elix 1998), North America (Merrill 1909; Berry 1941; Hale 1965; Brodo et al. 2001; Egan et al. 2016), Central America (Hue 1899; Hale 1965), South America (Hue 1899; Hale 1965). In South America cited from Bolivia (Kukwa et al. 2012), Brazil, British Guiana, Colombia, Ecuador (Galapagos), Peru, Suriname and Venezuela (Hale 1965; Spielmann 2009; Marcelli & Benatti 2010). In Galapagos first reported by Dodge (1936) and subsequently by Weber (1966, 1986), Elix & McCarthy (1998) and online (Bungartz et al. 2016). Together with *P. endosulphureum* and *P. tinctorum*, *P. cristiferum* is among the most common of all Galapagos *Parmotrema* species. All three species are widely distributed and have been collected in all vegetation zones, in many different habitats. *Parmotrema cristiferum* has most commonly been found in the transition zone and humid zone, only rarely in the dry zone; most specimens are from bark, less frequently wood or rock, on a variety of different endemic, native and introduced trees and shrubs, both at exposed and ±sheltered sites.

Notes. In Galapagos, *P. cristiferum* is one of the most common gray sorediate, emaculate species. Like the newly described *P. erectociliatum* it contains salazinic acid in its K+ blood-red medulla. The two species nevertheless display distinctly different morphology, with *P. erectociliatum* forming long, conspicuous cilia, an underside almost entirely blackened throughout, and the thallus lobes distinctly delimited by a blackened edge (compare figs. 15A–D with 15E–F).

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: Asilo de la Paz, Cerro Wittmer, road to Post Office Bay, 1°18′41.27″S, 90°27′4.298″W, humid zone, on branch, semi-shaded, wind- and rain-sheltered, 03-Jan-2010, Hillmann, G. GAL-127 (CDS 44904); ~1 km S of Cerro Verde, 1°18′33.77″S, 90°25′19.19″W, 299 m alt., upper transition zone; dense forest of *Citrus* sp. with *Croton scouleri*, *Zanthoxylum fagara* and *Tournefortia rufo-sericea*; bryophytes hanging from branches in long curtains, on trunk of *Croton scouleri*, sunny, 15-Jan-2011, Yánez-Ayabaca, A. 1942 (CDS 48294); caldera of Cerro Pajas, trail at the end of road leading up to crater rim, 1°17′47″S, 90°27′23.19″W, humid zone, forest, on branch, semi-shaded, wind- and rain-sheltered, 02-Jan-2010, Hillmann, G. GAL-35 (CDS 44797); Cerrito La *Cedrela*, trail along the border of the agricultural area with the park, Finca Primavera, 1°18′17.60″S, 90°26′10.80″W, 416 m alt., humid zone, on wooden fence posts of farmland, S-exposed side of wooden fence post, sunny, wind- and rain-exposed, 22-Jan-2011, Bungartz, F. 10062 (CDS 47457); Cerro Alieri, 1°17′17″S, 90°27′2″W, 380 m alt., zona húmeda, sobre tallo de *Zanthoxylum fagara*, 25-Mar-2006, Simbaña, W. 567 (CDS 32403); interior del cráter, 1°17′20″S, 90°27′0″W, 360 m alt., zona húmeda, sobre tallo de *Scalesia pedunculata*, 23-Mar-2006, Simbaña, W. 559 (CDS 32395); Cerro Pajas, inside the crater, around the small hut, at the end of trail off the dirt road to the highlands, 1°17′50.5″S, 90°27′23.19″W, 376 m alt., humid zone, edge of *Scalesia pedunculata* forest with *Croton scouleri* and ferns in the understory, on branch of *Croton scouleri*, sunny, wind- and rain-exposed, 12-Jan-2011, Yánez-Ayabaca, A. 1801 (CDS 48085); lower S-slope of Cerro Ventanas, 1°16′36.10″S, 90°25′41.10″W, 295 m alt., transition zone, open shrubland of *Macraea laricifolia* and some lower *Waltheria ovata* shrubs in between, on fallen branch, 18-Jan-2011, Yánez-Ayabaca, A. 2028 (CDS 48378); near Wittmer Farm, Asilo de la Paz, in the lower slope of Cerro Asilo de la Paz, 1°18′54.27″S, 90°27′15.30″W, 352 m alt., transition zone, young *Scalesia pedunculata* forest with *Zanthoxylum fagara*, *Croton scouleri*, *Macraea laricifolia*, *Chiococca alba* and some small lava boulders on NW-exposed slope, on dead trunk of tree, sunny, wind- and rain-exposed, 13-Jan-2011, Yánez-Ayabaca, A. 1836 (CDS 48186), 1837 (CDS 48187), 1850 (CDS 48204), Yánez-Ayabaca, A. 1835 A (CDS 48185), 1839 (CDS 48190); on W-slope of Cerro Alieri, 1°17′24.10″S, 90°27′8.90″W, 347 m alt., transition zone, dense forest of *Croton scouleri* with few *Scalesia pedunculata*, *Citrus* sp. and *Zanthoxylum fagara*, on branch of *Croton scouleri*, sunny, wind- and rain-exposed, 12-Jan-2011, Yánez-Ayabaca, A. 1764 (CDS 48042), 1780 (CDS 48062); plain between the two hills Cerro de los Chanchos and Cerro de los Burros, 1°16′40.27″S, 90°24′12.4″W, 311 m alt., transition zone, open herbaceous area surrounded by dense forest of *Clerodendrum molle* and *Croton scouleri*, some rocks and boulders on the ground, on twigs of *Castela galapageia*, sunny, wind- and rain-exposed, 21-Jan-2011, Bungartz, F. 10011 (CDS 47380); S of Cerro Asilo de la Paz, edge of Pampa Larga, 1°19′38.20″S, 90°27′9.596″W, 249 m alt., transition zone, shrubland of *Psidium guajava*, *Clerodendrum molle*, *Macraea laricifolia* and *Croton scouleri* with *Phila strigosa*, *Sidastrum paniculatum* and other herbs and grasses, on branch of *Clerodendrum molle*, sunny, wind- and rain-exposed, 13-Jan-2011, Yánez-Ayabaca, A. 1852 (CDS 48206); SE-part of island, between Lechosos and Cerro Pajaros, slope opposite Cerro Pajaros, 1°18′26.10″S, 90°24′21.39″W, 278 m alt., upper transition zone; mixed forest of *Psidium galapageium* and *Croton scouleri* with *Macraea laricifolia* on NNW-exposed slope, on twigs of *Zanthoxylum fagara*, semi-shaded, wind- and rain-sheltered, 15-Jan-2011, Bungartz, F. 9637 (CDS 46916); trail from Black Beach to highlands, 25-Apr-1976, Weber, W.A. s.n. (L-62989, COLO 294533); trail from La Primavera Farm to La Corona and Arco de la Reina, southeastern part of the island, 1°19′21.60″S, 90°24′45.89″W, 219 m alt., transition zone, very dense scrub of *Clerodendrum molle* with some *Croton scouleri*, *Waltheria ovata*, few *Prosopis juliflora* and occasional trees of *Geoffroea spinosa* in flat area on generally SE-exposed, moderately inclined slope with few boulders, on branch of *Clerodendrum molle*, sunny, wind- and rain-exposed, 24-Jan-2011, Yánez-Ayabaca, A. 2097 (CDS 48453); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, 1°16′57.27″S, 90°26′41.10″W, 310 m alt., transition zone, open shrubland of *Croton scouleri*, *Zanthoxylum fagara*, *Macraea laricifolia*, *Waltheria ovata* and lava rocks; *Ramalina usnea/anceps* forming long curtains hanging from branches, on twigs of *Zanthoxylum fagara*, sunny, wind- and rain-exposed, 14-Jan-2011, Bungartz, F. 9582 (CDS 46861); W of dirt road to water tank, off the main dirt road to the highlands, 1°16′56.10″S, 90°28′50.89″W, 67 m alt., dry zone, dense *Prosopis juliflora* shrubland with some *Castela galapageia* and few trees of *Bursera graveolens*, on branch of dead and fallen tree of *Prosopis juliflora*, sunny, wind- and rain-exposed, 12-Jan-2011, Bungartz, F. 9411 (CDS 46698); 15-Feb-1964, Koford, C.B. s.n. (L-40567, COLO 192478); Oertiz-C., F. s.n. (L-40792, COLO 192300);

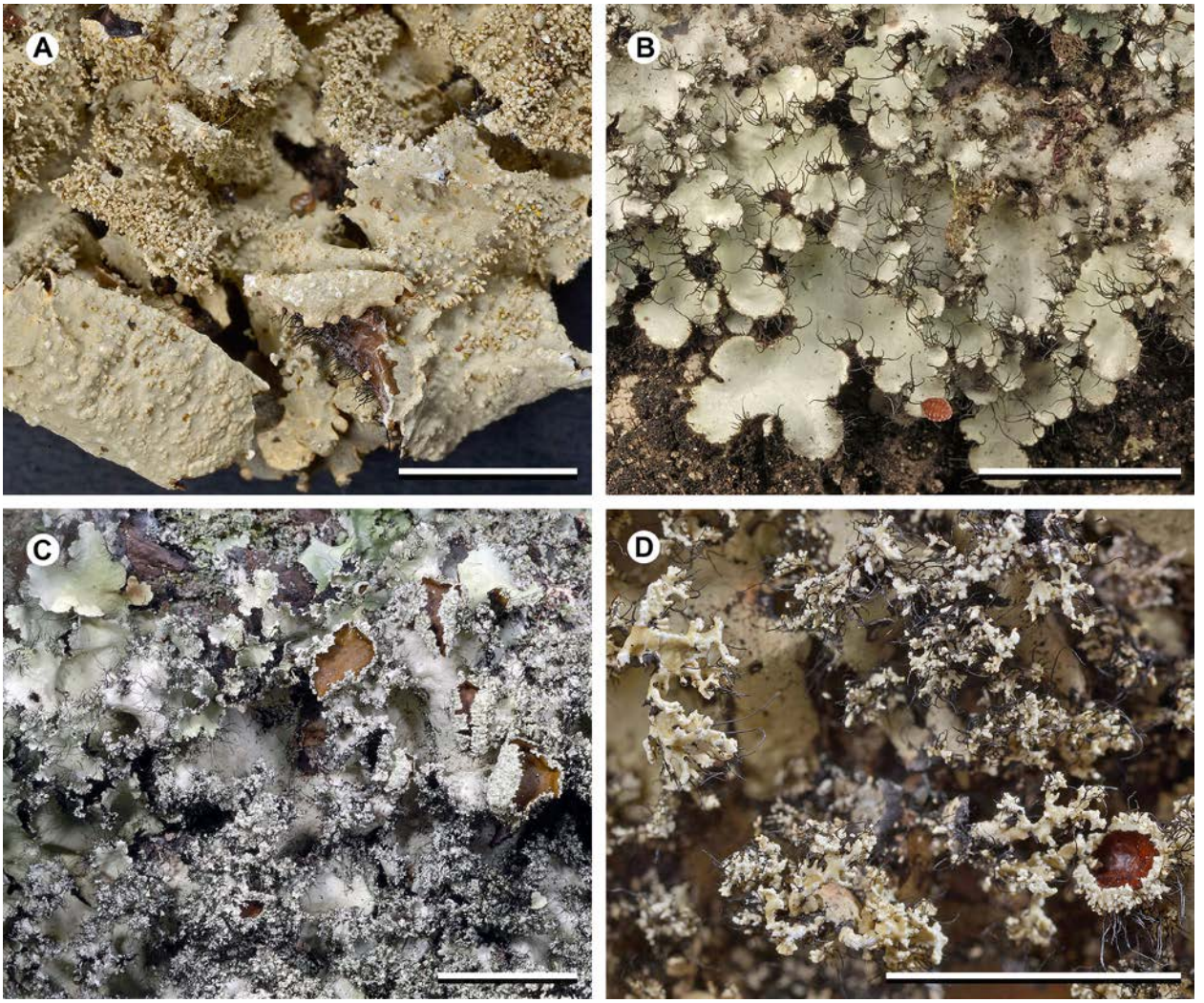

Figure 6. Isidiate *Parmotrema* species with gray surface (cortex with atranorin, medulla without salazinic acid). A – *P. internexum*, densely isidiate thallus with conspicuous circular scars where isidia have broken off (Aptroot, A. 65545, CDS 32134); B – *P. mellissii*, overview of thallus growing on rock (Bungartz, F. 4754 A, CDS 28886); C – *P. mellissii*, fertile, abundantly caespitose isidiate specimen (Bungartz, F. 4744, CDS 28855); D – *P. mellissii*, close-up of caespitose, ciliate isidia (Bungartz, F. 4303, CDS 28376). Scales: A–D = 5 mm.

300 m alt., on rocks and trunks, 07-Oct-1905, Stewart, A. (348) 441 (CAS 119453), (347) 440 (CAS 119452); 01-Jan-1934, Taylor, W.R. 868 A (FH 197221); 300 m alt., on bark, 11-Oct-1905, Stewart, A. (347) 440 (FH 197227). ISLA PINTA: along the trail up to the summit from the S-coast, 0°34′15″N, 90°45′2″W, 289 m alt., transition zone, open woodland of *Zanthoxylum fagara*, *Pisonia floribunda*, and few *Trema micrantha*; grasses, *Justicia galapagana*, and *Alternanthera filifolia* in the understory, on the upper side of horizontal branch of *Pisonia floribunda*, 27-Feb-2007, Bungartz, F. 5890 (CDS 33567); 0°34′27″N, 90°45′5″W, 369 m alt., upper transition zone; open woodland of *Zanthoxylum fagara*, *Pisonia floribunda*, and few *Trema micrantha*; understory of grasses and *Justicia galapagana*, on trunk of *Zanthoxylum fagara* (~15 cm in diam.), W-exposed, semi-shaded, wind- and rain-sheltered, 27-Feb-2007, Bungartz, F. 5846 (CDS 33521); 0°34′34″N, 90°45′8″W, 414 m alt., transition zone, *Pisonia floribunda*, *Zanthoxylum fagara*, the vine *Cissampelos pareira*, and *Justicia galapagana* in understory, on the upper side of *Pisonia floribunda* branch (~5 cm in diam.), semi-shaded, wind- and rain-exposed, 25-Feb-2007, Bungartz, F. 5722 (CDS 33365); 0°34′39″N, 90°45′7″W, 436 m alt., humid zone, dense forest of *Zanthoxylum fagara*, few *Pisonia floribunda*, and the vine *Cissampelos pareira*; *Justicia galapagana* in understory, on branches of *Pisonia floribunda* (~10 cm in diam.), sunny, wind- and rain-exposed, 26-Feb-2007, Bungartz, F. 5788 (CDS 33461); E-slope of the highest crater, 500 m alt., humid zone, in open mossy *Zanthoxylum* forest, on leaning *Croton* sapling, 10-Jul-1976, Sipman, H.J.M. L-134 (L-63611, COLO 297825); northern part of the western cliff above Las Pampas, 0°35′10.80″N, 90°46′33.89″W, 356 m alt., dry zone, open forest of small trees, *Pisonia floribunda*, *Zanthoxylum fagara*, *Opuntia galapageia* and *Croton scouleri* in E-exposed barranco, on twigs of *Zanthoxylum fagara*, semi-shaded, 31-Jan-2008, Nugra, F. 609 (CDS 38987); on the western cliff, W of Las Pampas, 0°34′51.70″N, 90°46′25.89″W, 411 m alt., transition zone, W-exposed forest of *Zanthoxylum fagara*, *Croton scouleri*, *Cordia lutea* and *Pisonia floribunda*, on twigs of dead trunk, semi-shaded, 01-Feb-2008, Nugra, F. 616 (CDS 38994); Nugra, F. 626 (CDS 39004); SW-part of the island, along trail going up the southwestern slope to Las Pampas on the western saddle, 0°34′13.5″N, 90°45′38.20″W, 316 m alt., transition zone, open forest of *Trema micrantha*, *Bursera graveolens*, *Pisonia floribunda*, *Opuntia galapageia*, *Zanthoxylum fagara* and *Chiococca alba* on flat lava flow, on trunk of *Pisonia floribunda*, semi-shaded, 30-Jan-2008, Nugra, F. 544 (CDS 38922); Nugra, F. 578 (CDS 38956). ISLA PINZÓN: along the trail going up from Playa Escondida, N- to W-facing cliff above a crater, 0°36′29″S, 90°40′14″W, 318 m alt.,

transition zone, dry transition zone with *Cordia lutea*, *Croton scouleri*, and at the bottom of the cliff also *Scalesia baurii* ssp. *baurii*, on twigs, 16-Feb-2006, Aptroot, A. 64055 (CDS 30616); from the NE-cosat to the highest summit, 400 m alt., transition zone, mixed *Scalesia* forest of trees 4 m tall on rocky soil, 02-Jul-1976, Sipman, H.J.M. L-103 (L-63579, COLO 297857); 370 m alt., transition zone, on rocks and dead twigs, 11-Dec-1905, Stewart, A. s.n. (CAS 119451). ISLA SAN CRISTÓBAL: along trail between entrance to Cerro Pelado and Cerro Partido, trail to El Ripioso, 0°51′38″S, 89°27′37″W, 383 m alt., transition zone, dry and dense scrubland of *Macraea laricifolia*, *Scalesia pedunculata*, *Croton scouleri*, and *Zanthoxylum fagara*, on trunk of *Senna* sp. (~25 cm in diam.), NE-exposed, semi-shaded, wind- and rain-sheltered, 28-Apr-2007, Bungartz, F. 6672 (CDS 34908); area W of Cerro Pelado on the way to El Ripioso, 0°51′50.60″S, 89°27′40.39″W, 400 m alt., transition zone, open *Psidium guajava* shrubland with *Macraea laricifolia* and dominant annual herb *Malachra capitata*, on dead twigs of *Psidium guajava*, sunny, wind- and rain-exposed, 23-Aug-2008, Bungartz, F. 8488 (CDS 41134); Cerro Colorado, enclosure for *Calandrinia galapagosa* near the viewpoint on the top, 0°54′58″S, 89°26′5″W, 130 m alt., transition zone, open scrubland of mostly *Croton scouleri*, *Waltheria ovata*, and *Macraea laricifolia* on W-exposed cinder cone, on wood lying on the ground, sunny, wind- and rain-exposed, 29-Apr-2007, Bungartz, F. 6760 (CDS 35011); Bungartz, F. 6753 (CDS 35004). ISLA SANTA CRUZ: abandoned farm along the northern part of the loop road from Bellavista to Garrapatero, 0°40′58″S, 90°18′31″W, 255 m alt., humid zone, overgrown farm area with introduced trees like *Cedrela odorata*, *Persea americana*, *Syzygium malaccense*, *Cestrum auriculatum* and others; small open clearing in between, on bark of *Cedrela*, 19-Feb-2006, Aptroot, A. 64315 (CDS 30880); above Mina Granillo Rojo, on the N side of the island, 0°37′4.40″S, 90°21′57″W, 600 m alt., transition zone, upper transition zone with *Bursera graveolens*, *Psidium galapageium*, *Scalesia pedunculata* and *Opuntia echios*, N-exposed, very little slope, on *Chiococca alba*, 07-Aug-2008, Clerc, P. 08-93 A (CDS 39947), 08-34 (CDS 39888); along old trail from Puerto Ayora (Academy Bay) to Bella Vista, 90 m alt., dry zone, on bark of *Piscidia carthagenensis*, 11-Apr-1976, Weber, W.A. s.n. (L-63326, COLO 297095); along the road from Bellavista to Los Gemelos, 0°38′10″S, 90°23′45″W, 579 m alt., humid zone, open *Scalesia pedunculata* forest with *Rubus niveus*, *Psychotria rufipes*, *Zanthoxylum fagara*, and scattered lava boulders, on fallen, rotten trunk (~8 cm in diam.), semi-shaded, wind- and rain-sheltered, 12-Feb-2006, Bungartz, F. 3471 (CDS 27227); Aptroot, A. 63828 (CDS 30386); 0°38′12″S, 90°23′46″W, 574 m alt., humid zone, NNW-exposed road bank with annual

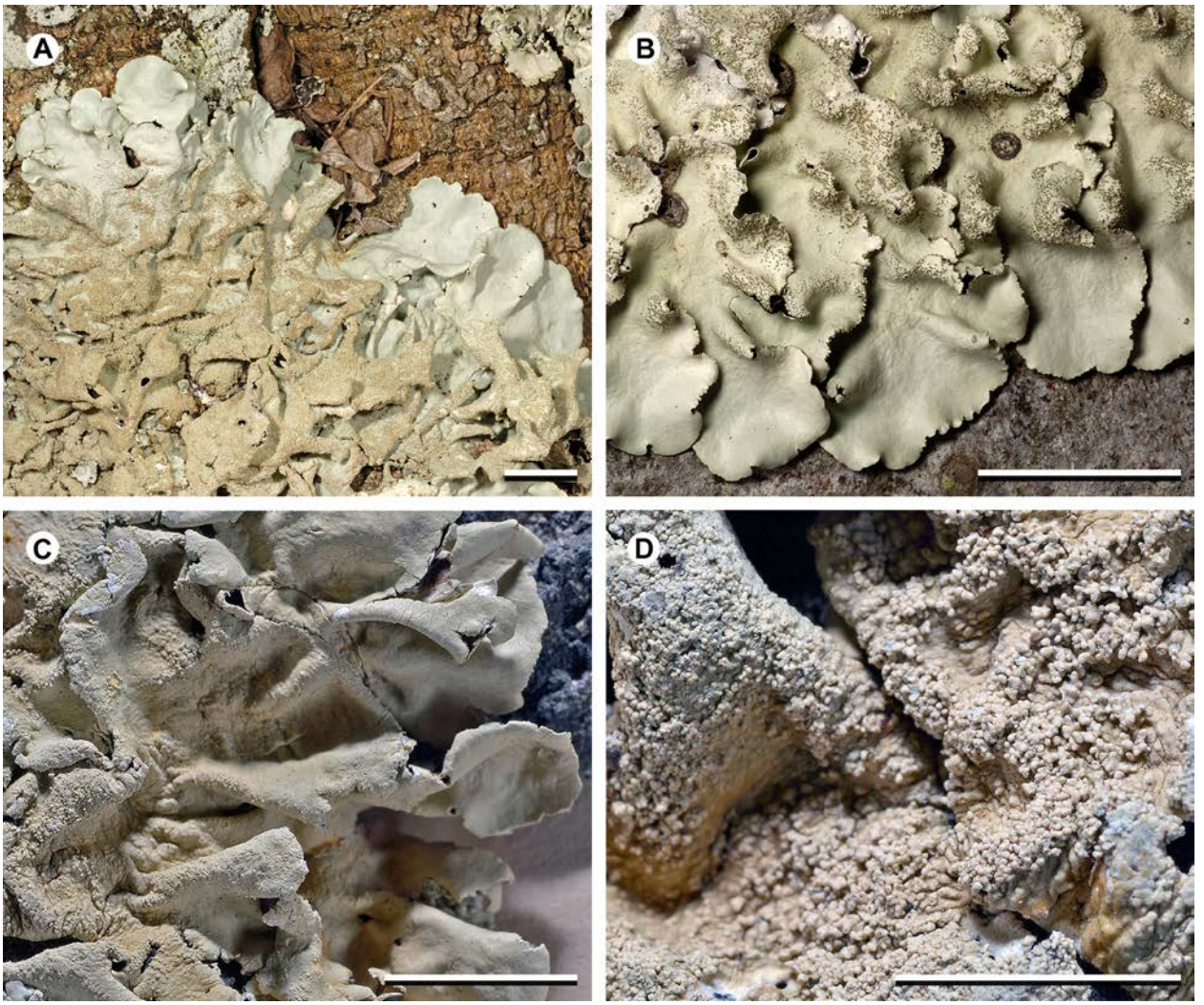

Figure 7. Isidiate *Parmotrema* species with gray surface (cortex with atranorin, medulla without salazinic acid). A – *P. tinctorum*, overview of thallus growing on bark (Bungartz, F. 4312, CDS 28386); B – *P. tinctorum*, close-up of thallus lobes with abundant laminal, dark-tipped isidia (Bungartz, F. 4404, CDS 28489). C – *P. pustulotinctum*, close-up of marginal lobes (Bungartz, F. 4624, CDS 28711 – holotype); D – *P. pustulotinctum*, granular-globose, pustulate isidia covering the lobe surface (Bungartz, F. 4624, CDS 28711 – holotype). Scales: A–C = 5 mm; D = 2 mm.

vegetation partially dry and died-back, and some lava rocks along *Scalesia pedunculata* forest, on lava rock, 12-Feb-2006, Aptroot, A. 63919 (CDS 30475); ~1 km N of Los Gemelos, 0°37′22″S, 90°22′47″W, 584 m alt., transition zone, upper transition zone with open dry forest, *Scalesia pedunculata*, *Chiococca alba*, *Tournefortia rufo-sericea*, *Cordia leucophlyctis*, and *Zanthoxylum fagara*, on twigs, 12-Feb-2006, Aptroot, A. 63775 (CDS 30335); ~1.2 km N of Los Gemelos, 0°37′18″S, 90°22′43″W, 573 m alt., upper transition zone; open dry decidous forest with *Bursera graveolens*, *Psychotria rufipes*, and *Zanthoxylum fagara*, on trunk of *Bursera graveolens*, sunny, wind- and rain-exposed, 12-Feb-2006, Bungartz, F. 3528 (CDS 27313); Bellavista, near parking place for trail to Media Luna, 0°40′10″S, 90°19′22″W, 400 m alt., humid zone, on bark of *Cinchona*, 27-May-2005, Aptroot, A. 63138 (CDS 29868); propiedad de Paola Pozo, lote, 0°41′38″S, 90°19′17″W, 200 m alt., humid zone, agricultural area, garden with *Citrus* trees, on large vertical bark scaling off the trunk of a *Citrus* × *paradisii* tree, 22-Jan-2006, Pozo, P. 1885 (CDS 32354); Camote, finca de René Valle, lindero del Parque Nacional Galápagos, al borde, 0°38′20.69″S, 90°17′50.77″W, 473 m alt., zona húmeda, bosque secundario de *Scalesia pedunculata*, perturbado y PNG intervenido por especies vegetales invasoras, sobre *Scalesia pedunculata*, altura al pecho, 11-Jan-2007, Nugra, F. 331 (CDS 35086); 0°38′21″S, 90°17′53″W, 473 m alt., zona húmeda, área agrícola, bosque de *Scalesia pedunculata* recuperandose, sobre *Psidium galapageium*, 12-Dec-2006, Nugra, F. 221 (CDS 35070); 0°38′20.69″S, 90°17′50.77″W, 473 m alt., zona húmeda, bosque secundario de *Scalesia pedunculata*, perturbado y PNG intervenido por especies vegetales invasoras, *Erythrina smithiana*, sobre corteza, 11-Jan-2007, Nugra, F. 313 (CDS 33229); Nugra, F. 297 (CDS 33213); 0°38′21″S, 90°17′53″W, 473 m alt., zona húmeda, área agrícola, bosque de *Scalesia pedunculata* recuperandose, sobre *Croton scouleri*, 12-Dec-2006, Nugra, F. 213 (CDS 35062); close to boundary of the National Park of Galápagos, 0°38′21″S, 90°17′53″W, 473 m alt., humid zone, edge of a young and dense forest of *Scalesia pedunculata* with undergrowth of *Chiococca alba*, on dead wood of fallen trunk, semi-shaded, wind- and rain-sheltered, 12-Dec-2006, Bungartz, F. 5586 (CDS 33027); cerca de la Mina de Granillo Rojo, vía a Baltra, 0°37′2″S, 90°22′6″W, 290 m alt., zona de transición, con árboles de *Bursera*, *Opuntia* y *Croton*, *Psidium galapageium* 'guayabillo', *Piscidia carthagenensis* 'matazarno', en la base de *Pisonia floribunda*, 21-Jun-2006, Nugra, F. 3 (CDS 32656); cerca la vía sector Los Gemelos, 0°38′2.100″S, 90°23′37.89″W, 661 m alt., zona húmeda, bosque de *Scalesia pedunculata*, bosque secundario, perturbado y restaurado, sobre arbusto muerto, 04-Jan-2007, Nugra, F. 277 (CDS 33193), 273 (CDS 33189); dirt road from Bellavista to Media Luna, 0°40′15.1″S, 90°19′21.80″W, 450 m alt., humid zone, farming areas, slope 20° SW, on trunks of *Cinchona pubescens* serving as fenceposts along pastures, 10-Aug-2008, Clerc, P. 08-133 (CDS 39987); El Puntudo, 0°39′9″S, 90°20′2″W, 637 m alt., zona húmeda, bosque de *Scalesia penduculata* con árboles invasores *Cinchona pubescens*, sobre *Cinchona pubescens*, altura al pecho, exposición NE, 01-Aug-2007, Nugra, F. 416 (CDS 36165); E side of island, along road from Cascajo to El Garrapatero, 0°40′22.10″S, 90°14′41.70″W, 137 m alt., transition zone, lower transition zone, open mixed forest of *Bursera graveolens*, *Pisonia floribunda*, *Piscidia carthagenensis*, *Psidium galapageium*, *Erythrina velutina* with an understory of *Plumbago scandens*, *Alternanthera halmifolia*, *Bastardia viscosa*, *Zanthoxylum fagara*, on twig, 16-Jun-2010, Spielmann, A.A. 8183 (CDS 45371); Spielmann, A.A. 8177 (CDS 45395), 8187 (CDS 45391); 0°40′9.193″S, 90°15′24.19″W, 227 m alt., upper transition zone, *Scalesia* forest with *Psidium galapageium*, *Tournefortia rufo-sericea*, *Senna pistaciifolia* and *Zanthoxylum fagara*, on *Zanthoxylum fagara*, 16-Jun-2010, Nugra, F. 897 (CDS 44974); Spielmann, A.A. 8188 (CDS 45393), 8175 (CDS 45394); farm along the southern part of the loop road from Bellavista to Garrapatero, 0°41′12″S, 90°18′22″W, 214 m alt., humid zone, agricultural area, Coffee and Guava plantations with living fence of old *Erythrina* spp. trees shaded and logged trees of *Erythrina* spp. sunny, on branches and trunk of recently logged *Cedrela odorata* tree on the ground, sunny, wind- and rain-exposed, 19-Feb-2006, Bungartz, F. 3731 (CDS 27591), 3735 (CDS 27595); farm of Don Cabrera between Bellavista and Cascajo, ~1 km W of Cascajo, 0°40′38.89″S, 90°17′21.39″W, 249 m alt., humid zone, agricultural area, coffee plantation with *Cedrela odorata*, *Inga* spp., bananas, *Persea americana*, *Citrus* spp., on *Cedrela odorata*, 16-Jun-2010, Spielmann, A.A. 8184 A (CDS 45403), 8152 (CDS 45396), 8176 (CDS 45404), 8155 (CDS 45397); línea del Parque Nacional Galápagos, sector el Camote a lindero de la finca de Don René Valle, 0°38′21.10″S, 90°17′57.20″W, 487 m alt., zona húmeda, bosque de *Scalesia pedunculata*, suelo húmedo y fecundo, sobre *Psidium galapageium*, 10-Aug-2006, Nugra, F. 141 B (CDS 38722); Los Gemelos, viewpoint, 0°37′32.10″S, 90°23′5.596″W, 608 m alt., humid zone, view point with wooden banister and surrounded by *Scalesia* forest, slightly shaded, on bark, 16-Jun-2010, Spielmann, A.A. 8178 (CDS 45411); near Horneman farmhumid zone, Bailey, A.M. s.n. (S-27006, COLO 151345); off the dirt road to Mina Granillo Rojo, on the N side of the island, 0°37′2″S, 90°22′6″W, 294 m alt., transition zone, deciduous forest of *Zanthoxylum fagara*, *Psidium galapageium*, *Pisonia floribunda* and few *Bursera graveolens* and *Cedrela odorata*, on stems of *Psidium galapageium* (~10 cm in diam.), semi-shaded, wind- and rain-sheltered, 21-Jun-2006, Bungartz, F. 4950 (CDS 29163), (CDS 29164), 4959 (CDS 29172); Steve Divine's Farm at the end of Tortoise Road, off the main road to Baltra, Tortoise Territory, 0°40′8″S, 90°24′17″W, 364 m alt., humid zone, agricultural area, open farmland with *Cedrela odorata*, *Persea americana*, *Citrus* sp., on branches of *Citrus* shrub, sunny, wind- and rain-exposed, 23-Feb-2006, Bungartz, F. 3953 (CDS 27835); Aptroot, A. 64509 (CDS 31081); Tortoise Country, about 8 mi. w. of Academy Bay, 90 m alt., dry zone, on trees, 10-Apr-1930, Svenson, H.K. 230 (FH 197247); vicinity of Academy Bay, 160 m alt., transition zone, on *Pisonia*, 15-Feb-1964, Itow, S. s.n. (L-40730, COLO 192254); Weber, W.A. s.n. (L-40429, COLO 190139), s.n. (L-40282, COLO 193716); s.n. (L-40276, COLO 193549); Schuster, R.O. s.n. (L-40127, COLO 189434); s.n. (L-40125, COLO 189432), s.n. (L-40128, COLO 189435); trail to La Copa (= Media Luna) at Horneman Farm, humid zone, moist zone, agricultural area, trees, on bark, 15-Feb-1964, Weber, W.A. s.n. (L-44025, COLO 190204), W.A. s.n. (L-44025, CAS-DS 685647). ISLA SANTIAGO: 2 km E of eastern peak, 0°13′0″S, 90°45′0″W, 725 m alt., humid zone, open *Zanthoxylum* forest in the highlands, 06-May-1971, Pike, L.H. s.n. (L-55409, COLO 256019); along trail to summit above James Bay lava flow, 0°12′35″S, 90°47′5″W, 895 m alt., humid zone, dense stand of *Zanthoxylum* and *Psychotria*, 04-May-1971, Pike, L.H. ID23-16 (OSC 101753); E of salt lake at James Bay, 0°14′25″S, 90°48′50″W, 170 m alt., transition zone, *Bursera-Psidium* forest on pahoehoe lava flow, on bark of *Bursera*, 30-Apr-1971, Pike, L.H. ID16-20 (OSC 101704). ISLA ISABELA, VOLCÁN ALCEDO: on the crater rim near the hut, 0°26′33″S, 91°5′31″W, 1100 m alt., humid zone, *Pteridium arachnoideum* and *Stachytarpheta cayennensis*, scattered low shrubs of *Tournefortia rufo-sericea* and outcrops of basalt tuff in between, on basalt, 07-Mar-2006, Aptroot, A. 65271 (CDS 31857); outer SE-exposed slope, ~2 km below the crater rim, 0°26′16″S, 91°4′36″W, 798 m alt.,

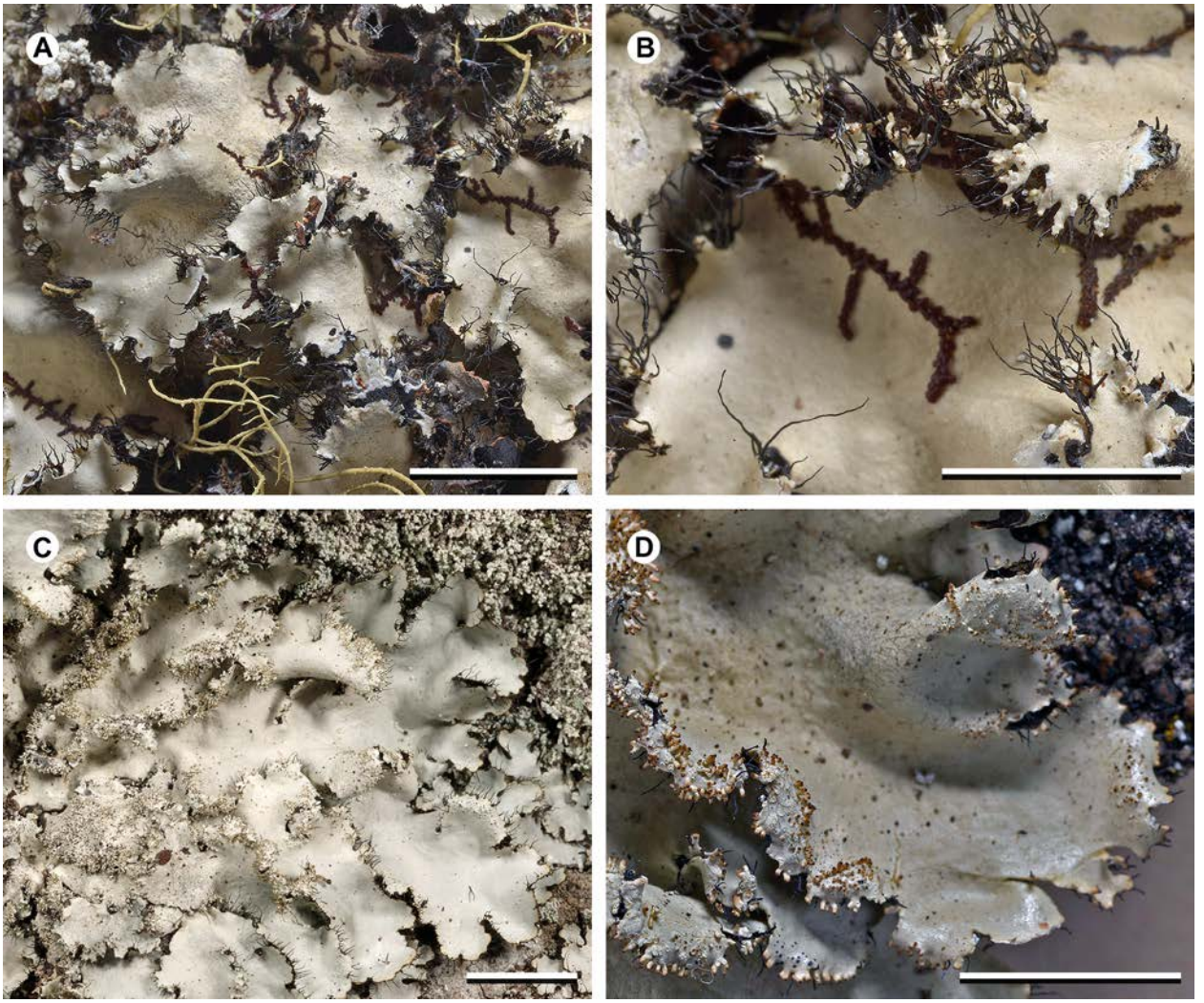

Figure 8. Isidiate *Parmotrema* species with gray surface (cortex with atranorin, medulla with salazinic acid). A – *P. neosubcrinitum*, close-up of thallus (Bungartz, F. 6593, CDS 34813); B – *P. neosubcrinitum*, ciliate lobe margin with branched isidia, some ciliate (Bungartz, F. 6593, CDS 34813); C – *P. ultralucens*, close-up of thallus (Bungartz, F. 4702, CDS 28800); D – *P. ultralucens*, lobe margin with short isidia, some ciliate (Bungartz, F. 4702, CDS 28800). Scales: A–D = 5 mm.

transition zone, ±dense shrubby vegetation of *Tournefortia rufo-sericea* with scattered trees of *Psidium galapageium*, *Zanthoxylum fagara*, and *Solanum erianthum*, on upper side of inclined *Zanthoxylum fagara* trunk, ~10 cm in diam., shaded, ±wind- and rain-sheltered, 07-Mar-2006, Bungartz, F. 4189 (CDS 28231); ~2.5 km below the crater rim, 0°26′9″S, 91°4′34″W, 795 m alt., transition zone, dense scrub of *Tournefortia rufo-sericea* and *Solanum erianthum* with few trees of *Pisonia floribunda* among basalt rocks, on edge of NE-exposed small basalt rock, semi-shaded, wind- and rain-sheltered, 07-Mar-2006, Bungartz, F. 4262 (CDS 28333), 4261 (CDS 28332); ~500 m below the crater rim, 0°27′13″S, 91°5′46″W, 1035 m alt., humid zone, grassland of *Paspalum conjugatum* with scattered shrubs of *Tournefortia rufo-sericea*, on *Tournefortia*, 06-Mar-2006, Aptroot, A. 64841 (CDS 31417); VOLCÁN CERRO AZUL: along the trail from Caleta Iguana to the first Caseta del Parque, 0°59′12.1″S, 91°25′35.77″W, 276 m alt., transition zone, isolated tree close to a *Psidium guajava* forest, on twigs and branches, semi-shaded, 02-May-2012, Spielmann, A.A. 10381 (CDS 51738); 0°59′13.6″S, 91°25′39.27″W, 300 m alt., transition zone, open *Psidium guajava* forest, with *Zanthoxylum fagara*, *Tournefortia rufo-sericea*, and *Darwiniothamnus lancifolius*, on sunny basaltic rock, 02-May-2012, Spielmann, A.A. 10373 (CDS 51736); Spielmann, A.A. 10368 (CDS 51724); Nugra, F. 1013 (CDS 52176) 1006 (CDS 52169), Nugra, F. 1018 (CDS 52181); 0°59′12.1″S, 91°25′35.77″W, 276 m alt., transition zone, on isolated tree close to a *Psidium guajava* forest, twigs and branches, semi-shaded, 02-May-2012, Spielmann, A.A. 10378 (CDS 51732); Spielmann, A.A. 10380 A (CDS 51734); 0°59′18.69″S, 91°25′30.80″W, 289 m alt., transition zone, low and dense *Psidium guajava* forest with *Zanthoxylum fagara* and *Tournefortia rufo-sericea*, on branches and twigs of *Psidium guajava*, semi-shaded, 03-May-2012, Spielmann, A.A. 10422 (CDS 51777); 0°59′9.5″S, 91°26′4.90″W, 224 m alt., transition zone, dense *Psidium guajava* woodland with few large *Zanthoxylum fagara* trees, *Pisonia floribunda* and *Scalesia cordata* trees, understory with *Tournefortia rufo-sericea* shrubs and ferns, on wood of dead tree trunk, 07-May-2012, Nugra, F. 1100 (CDS 52263); Nugra, F. 1119 (CDS 52471); Spielmann, A.A. 10693 (CDS 52060), 10636 (CDS 52003), 10695 (CDS 52062), 10647 (CDS 52014), 10668 (CDS 52023), 10670 (CDS 52025); S-slope above Iguana Cove, 300 m alt., humid zone, mixed forest with many clearings, on slanting trunk in shade, 23-Jun-1976, Sipman, H.J.M. L-64 (L-63539, COLO 297897); VOLCÁN DARWIN: southwestern slope, above Tagus Cove, 0°13′27.60″S, 91°19′21.19″W, 860 m alt., transition zone, open scrubland of *Dodonaea viscosa*, *Croton scouleri*, *Macraea*

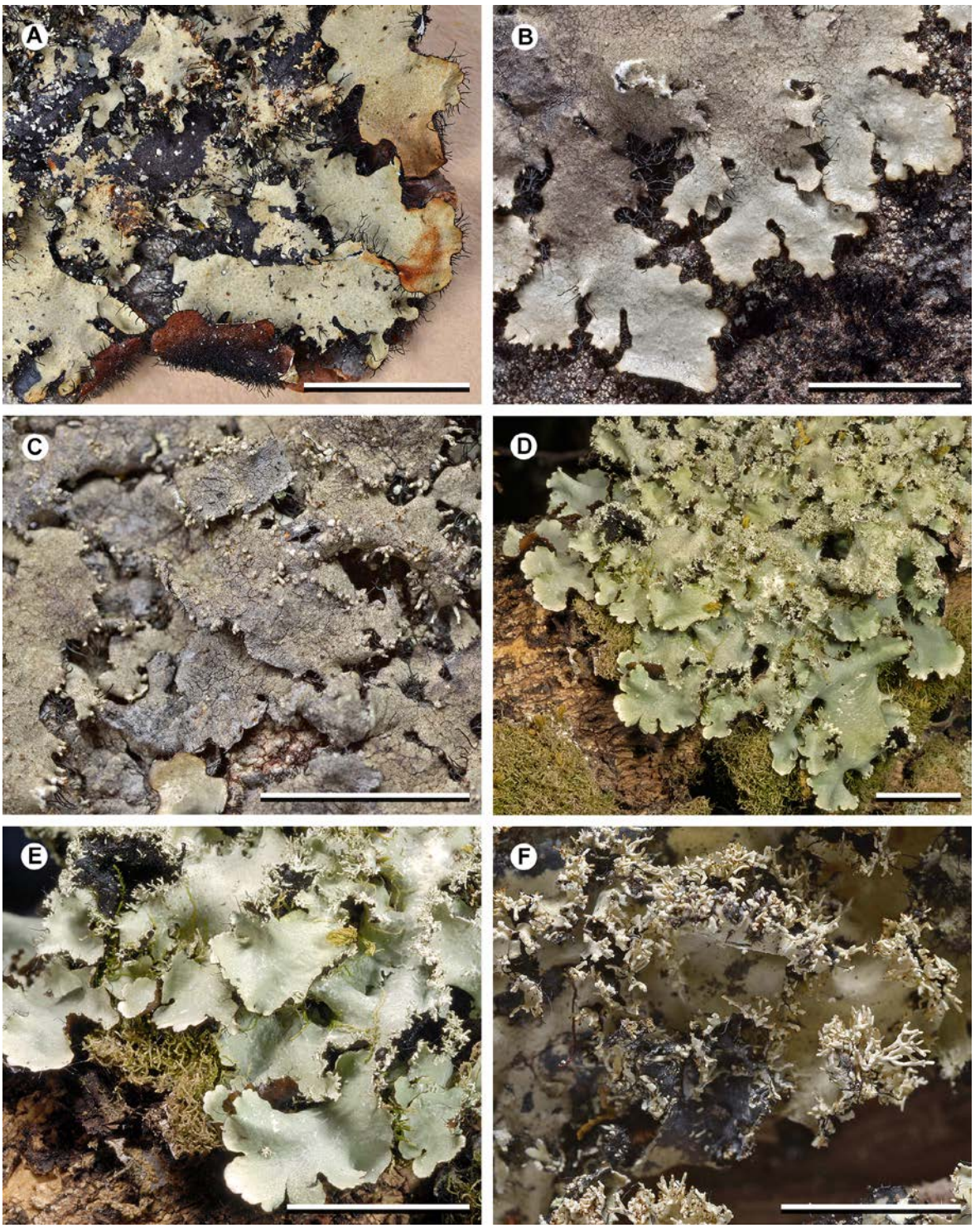

Figure 9. Isidiate *Parmotrema* species with gray, reticulate-maculate surface (cortex with atranorin, medulla without salazinic acid). A – *P. lacteum*, thallus with reticulate-maculate surface, blackened in parts, lobes densely ciliate, lower side gradually dark brown towards the margin, marginal rhizines shorter, but lacking a distinct erhizinate marginal zone, surface ±sprinkled with coarse soredia, derived from broken-down isidia (Clerc, P. 08-30, CDS 39884). B – *P. saxoisidiatum*, thallus margin with angular lobes and reticulate-maculate surface (Bungartz, F. 47626, CDS 10207 – holotype); C – *P. saxoisidiatum*, thallus center with short, sublaminal cylindrical isidia (Bungartz, F. 47626, CDS 10207 – holotype); D – *P. subisidiosum*, large thallus growing on branch (Bungartz, F. 7528, CDS 38019); E – *P. subisidiosum*, close-up of the same thallus (Bungartz, F. 7528, CDS 38019); F – *P. subisidiosum*, sparsely ciliate lobe margin with coralloid isidia, some ciliate (Bungartz, F. 6809, CDS 36240). Scales: A–F = 5 mm.

laricifolia, *Scalesia microcephala*, few *Opuntia insularis* and dry grasses in the understory, on dead stem of *Croton scouleri*, sunny, wind- and rain-exposed, 15-Nov-2007, Bungartz, F. 7665 (CDS 38168); ISLA ISABELA, VOLCÁN SIERRA NEGRA: along dirt road from Puerto Villamil to crater of Sierra Negra, farmland, 0°50′38″S, 91°3′45.5″W, 550 m alt., humid zone, abandoned *Psidium guajava* orchard with few *Inga* sp. and dense understory of shrubs, fallen trees, grasses and ferns, on top of inclined *Psidium guajava* trunk, sunny, wind- and rain-exposed, 09-Sep-2007, Bungartz, F. 6861 (CDS 36310); Cueva del Sucre, at the entrance (parking), SE side of the island, 0°50′32.5″S, 91°1′36.89″W, 369 m alt., humid zone, abandoned farming areas with forest stands, flat, on branches of *Syzygium jambos*, 15-Aug-2008, Herrera-Campos, M.A.

10641 (CDS 40378); abandoned farm bought by the National Park, 0°50′34.60″S, 91°1′39.10″W, 362 m alt., humid zone, agricultural area, *Syzygium jambos* trees and *Coffea arabica* shrubs along a trail, on twigs in the crown of a fallen *Syzygium jambos* tree, sunny, wind- and rain-exposed, 15-Aug-2008, Bungartz, F. 8264 (CDS 40910); La Esperanza, around the 'casa del corazón verde' of the Charles Darwin Research Station, 0°51′17.30″S, 91°1′32.5″W, 324 m alt., humid zone, farming areas, slope 20° ESE, on living fencepost (still with bark), 15-Aug-2008, Herrera-Campos, M.A. 10629 (CDS 40366); Clerc, P. 08-172 B (CDS 56246); trail climbing up to Sierra Negra crater, 0°49′41.39″S, 91°5′30.10″W, 967 m alt., humid zone, *Psidium guajava* shrubland with *Pteridium arachnoideum* on the ground, slope 25° SE, on rotting wood of dead branches with mosses on the ground, 14-Aug-2008, Herrera-Campos, M.A. 10548 (CDS 40284).

Parmotrema dilatatum (Vain.) Hale, Phytologia 28: 335. 1974. (Fig. 12C–D)

Type: Brazil, Minas Gerais: Sítio [nowadays Antônio Carlos], Vainio, E.A. Lich. Bras. Exs. 397 (TUR-V 2548 – holotype, BM, FH, M, UPS – isotypes, fide Hale 1965).

Thallus saxicolous; upper surface whitish gray to bright white, shiny, epruinose, emaculate, not cracked; densely lobulate, lobules breaking apart into cauliflower-like soralia with granular coarse soredia (these may sometimes be lacking, see comments below); lobes small to moderate-sized, 2–7 mm wide, ±rotund, eciliate, distinctly delimited along the lobe edge by a conspicuous black rim; lower surface with a ±narrow, deep brown, erhizinate, ~1–2.5 mm wide margin, blackening and rhizinate towards the thallus center; rhizines short, stout, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with protocetraric and echinocarpic acid [P+ yellow turning orange, K+ dirty yellowish brown, KC+ rosé to orange, C–, UV–].

Ecology and distribution. Africa, Australia, India, North, Central and South America, New Zealand (Hale 1965; Elix 1994; Egan et al. 2016). First reported from Galapagos by Weber (1986), subsequently by Elix & McCarthy (1998) and online (Bungartz et al. 2016). A rare species, typically found on sunny, wind- and rain-exposed rock (one specimen on bark of the hardwood tree *Acacia*). Specimens that are fertile only, not producing soredia, are treated here as *P. eborinum*; these fertile exemplars generally appear to be more common in the transition zone, whereas *P. dilatatum* s.str. may be restricted to the dry zone. *Parmotrema weberi* is morphologically extremely similar, but chemically distinct; it is generally more common than both *P. dilatatum* and *P. eborinum*.

Notes. The circumscription of *P. dilatatum* is still problematic and the descriptions in the literature are inconsistent. Quite possibly the name is being used for different species that share similar habitats, morphology and chemistry (Benatti & Marcelli 2010). The species has been reported from a large geographic area (see ecology and distribution above), and several authors have reported that it contains usnic acid (Hale 1965; Winnem 1975 – the isotype; Swinscow & Krog 1988; Elix 1994; Eliasaro 2001; Donha 2005; Benatti & Marcelli 2010; Egan et al. 2016). Some of these authors (e.g., Benatti & Marcelli (2010) cite only corticolous specimens with usnic acid. All Galapagos specimens are saxicolous, however, and not one of the specimens analyzed contains usnic acid. Without examining a broader range of material from different regions of the world, it is, at this stage, not possible to ascertain whether the Galapagos records refer to *P. dilatatum* s.str. Nevertheless, all specimens of *P. dilatatum* cited immediately below are clearly distinct from both *P. weberi* and *P. eborinum*. We did observe one specimen that lacks both apothecia and soredia and that contains echinocarpic acid. Although this specimen [Bungartz, F. 6287 (CDS 34499): ISLA SAN CRISTÓBAL: rim of crater to the NW of Media Luna, inland from the NW-coast, 0°43′51″S, 89°18′55″W, 149 m alt.] differs in its chemistry from *P. weberi*, it cannot clearly be assigned to either *P. dilatatum* or *P. eborinum* (see comments there).

Specimens examined from Ecuador, Galápagos [typical morphotype with soredia]. ISLA FLOREANA: ~500 m S of La Lobería, ~200 m inland from coast, 1°17′12.69″S, 90°29′36″W, 20 m alt., dry zone, very open Bursera forest with *Waltheria ovata*, few *Scalesia affinis* and some grasses on lava flow, on top of basalt rock, 16-Jan-2011, Yánez-Ayabaca, A. 1979 (CDS 48329). ISLA SANTA CRUZ: along old trail to Bella Vista, on bark of Acacia, 29-Apr-1976, Weber, W.A. (QCA); vicinity of Academy Bay, 15-Feb-1964, Weber, W.A. s.n. (L-40820, COLO 192404). ISLA SANTIAGO: near James Bay, 0°14′0″S, 90°49′30″W, 45 m alt., dry zone, on nearly barren, recent pahoehoe lava flow, 27-Apr-1971, Pike, L.H. 2602 (OSC 101818). ISLA ISABELA, VOLCÁN SIERRA NEGRA: along dirt road from Puerto Villamil to crater of Sierra Negra, 0°55′12.4″S, 90°59′38.20″W, 30 m alt., dry zone, SW-slope of old lava flow with scattered vegetation (*Bursera graveolens*, *Opuntia echios*, and *Waltheria ovata*), on top of basalt lava outcrop, sunny, wind- and rain-exposed, 10-Sep-2007, Bungartz, F. 6939 (CDS 36439), 6952 (CDS 36456); Cerro Orchilla, ~4 km W of Puerto Villamil, 0°57′47.27″S, 91°0′27.19″W, 56 m alt., dry zone, S exposed slope of hill, open *Bursera graveolens* forest with *Croton scouleri* and *Opuntia echios*, on S-exposed front of basalt outcrop, sunny, wind- and rain-exposed, 17-Aug-2008, Bungartz, F. 8460 (CDS 41106).

Parmotrema dominicanum (Vain.) Hale, Phytologia 28(4): 336. 1974. (Fig. 4A–C)

Type: Dominican Republic, Hispaniola: Soufrière Hills, Crater, Elliott, W.R. 114 (TUR – holotype, fide Hale 1965).

Thallus corticolous; upper surface pale greenish yellow, dull, emaculate, smooth, not wrinkled, occasionally cracked, but not forming a distinctly reticulate pattern; abundantly sorediate; soralia marginal, linear to labriform, in parts becoming crowded, sublaminal and then increasingly capitate; soredia farinose to ±granular, typically concolorous with the thallus surface, not discolored, pale inside; lobes moderate-sized, (3–)7–10 mm wide, rotund, axils incised, margins eciliate (very rarely with few cilia); cilia, if present, stout, short, 0.3–0.5 mm long, black,

mostly simple, rarely branched; lower surface with an erhizinate, ~1–2(–2.5) mm wide, deep brown margin, moderately to densely rhizinate and blackened towards the center; rhizines short, stout, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with both usnic acid and atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with protocetraric acid only [P+ yellow turning orange, K+ dirty yellowish brown, KC–, C–, UV–]; one analyzed specimen (Herrera-Campos, M.A. 10594, CDS 40331) additionally contains traces of echinocarpic acid [its medulla reacts KC± rosé to faintly orange].

Ecology and distribution. North, Central and South America, Africa, Hawaii (Hale 1965; Egan et al. 2016). First reported from the Galapagos by Weber (1981, 1986), subsequently by Elix & McCarthy (1998) and online (Bungartz et al. 2016). A common species, particularly throughout the coastal zone and dry zone, less abundant in the transition zone, only very rarely found in the humid zone; most specimens grow on bark, few on rock, typically in sunny, wind- and rain-exposed, less frequently ±shaded and sheltered habitats; most commonly found on *Bursera* or generally dry zone vegetation, i.e., *Erythrina* or *Zanthoxyllum* trees, *Croton* scrub and cacti (*Jasminocereus*, *Opuntia*), along the coast also in mangroves (*Laguncularia*, *Hippomane*); one specimen was collected in the agricultural area of Santa Cruz, on *Cedrela*.

Notes. For differences from the newly described *P. lawreyi*, see the description below.

Specimens examined from Ecuador, Galápagos. ISLA ESPAÑOLA: trail from Bahía Manzanillo on the N-coast of the island to the highest point, 1°21′40.60″S, 89°41′56.60″W, 48 m alt., dry zone, open scrub of *Cordia lutea* and *Prosopis juliflora* with grasses and few trees of *Bursera graveolens* over weathered lava boulders, on trunk of *Bursera graveolens*, sunny, 11-Nov-2010, Yánez-Ayabaca, A. 1663 (CDS 45546), (CDS 45551); 1°22′18.69″S, 89°42′7.40″W, 125 m alt., dry zone, *Cordia lutea* shrubland with some *Prosopis juliflora* shrubs at bottom of a basalt outcrop, on trunk of *Cordia lutea*, sunny, 11-Nov-2010, Yánez-Ayabaca, A. 1698 B (CDS 54893); 1°21′40.60″S, 89°41′56.60″W, 48 m alt., dry zone, open scrub of *Cordia lutea* and *Prosopis juliflora* with grasses and few trees of *Bursera graveolens* over weathered lava boulders, on W-exposed side of *Bursera graveolens* branch (~10 cm in diam.), semi-shaded, wind- and rain-exposed, 11-Nov-2010, Bungartz, F. 9065 (CDS 45883); along trail from Black Beach to Cruz farm, on bark of *Bursera*, 25-Apr-1976, Weber, W.A. s.n. (CDS 10851), W.A. s.n. (QCA); along trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, at Laguna Seca, 1°15′30.80″S, 90°26′26.60″W, 206 m alt., dry zone, very open *Bursera graveolens* forest over SE-exposed lava flow with *Prosopis juliflora*, on SW-exposed trunk/branch of *Bursera graveolens* (~15 cm in diam.), sunny, wind- and rain-exposed, 14-Jan-2011, Bungartz, F. 9529 (CDS 46812); at the base of Cerro Comunista, 1°17′22.89″S, 90°28′22.39″W, 158 m alt., dry zone, dense low scrub-woodland of *Croton scouleri*, *Waltheria ovata* and *Castela galapageia* with occasional trees of *Acacia rorudiana* and *Bursera graveolens*, on branch of *Acacia rorudiana*, sunny, 16-Jan-2011, Yánez-Ayabaca, A. 1963 (CDS 48313); Ladera N del Cerro Ventanas, 1°16′12″S, 90°25′49″W, 400 m alt., zona húmeda, sobre tallo de *Bursera graveolens*, 27-Mar-2006, Simbaña, W. 552 (CDS 32388); trail from Black Beach to highlands, on *Bursera*, 25-Apr-1976, Weber, W.A. s.n. (L-62913, COLO 294608), s.n. (L-62912, COLO 294609). ISLA PINTA: along the trail up to the summit from the S-coast, 0°33′57″N, 90°44′51″W, 215 m alt., transition zone, dense vegetation of *Bursera graveolens*, *Croton scouleri*, *Scalesia baurii*, *Pisonia floribunda*, and *Zanthoxylum fagara*, on upper SE-exposed side of inclined *Opuntia galapageia* trunk, sunny, wind- and rain-exposed, 25-Feb-2007, Bungartz, F. 5686 (CDS 33323), 5687 (CDS 33324); 0°34′5″N, 90°44′57″W, 237 m alt., transition zone, open woodland with *Bursera graveolens*, *Zanthoxylum fagara*, *Opuntia galapageia*, *Pisonia floribunda*, *Croton scouleri*, and with *Alternanthera filifolia* shrubs and grasses in between, on trunk of *Bursera graveolens* (~25 cm in diam.), W-exposed, sunny, wind- and rain-exposed, 28-Feb-2007, Bungartz, F. 5915 (CDS 33592); 0°34′3″N, 90°44′56″W, 233 m alt., transition zone, open woodland with *Bursera graveolens*, *Zanthoxylum fagara*, *Pisonia floribunda*, *Croton scouleri*, and few *Opuntia galapageia* among old lava flows; in between *Alternanthera filifolia* and grasses, on trunk of *Bursera graveolens* (~10 cm in diam.), SE-exposed, sunny, wind- and rain-exposed, 28-Feb-2007, Bungartz, F. 5962 (CDS 33640). ISLA SAN CRISTÓBAL: along the trail from Galapagera at the NW-coast of the island to Media Luna, 0°42′41″S, 89°18′15″W, 33 m alt., dry zone, open woodland of *Piscidia carthagenensis*, *Bursera graveolens*, and *Gossypium darwinii* shrubs, on branches of *Bursera graveolens*, E-exposed, semi-shaded, wind- and rain-exposed, 22-Apr-2007, Bungartz, F. 6318 (CDS 34533); Cerro Colorado, enclosure for *Calandrinia galapagosa* near the viewpoint on the top, 0°54′58″S, 89°26′5″W, 130 m alt., transition zone, open scrubland of mostly *Croton scouleri*, *Waltheria ovata*, and *Macraea laricifolia* on W-exposed cinder cone, on stems and branches of *Croton scouleri*, sunny, wind- and rain-exposed, 29-Apr-2007, Bungartz, F. 6751 (CDS 35002); El Ripioso, fenced off area, 0°50′48.70″S, 89°27′47.27″W, 128 m alt., dry zone, on rock, 16-May-2006, Jaramillo, P. 2970 D (CDS 38823); from Punta Tortuga ~3 km inland close to Cerro Tortuga, 0°44′39″S, 89°23′32″W, 79 m alt., dry zone, dense woodland of *Bursera graveolens*, *Piscidia carthagenensis*, with *Scutia spicata* and *Croton scouleri* in the understory at edge of young lava flow, on trunk of *Bursera graveolens* (~15 cm in diam.), SE-exposed, semi-shaded, wind- and rain-sheltered, 25-Apr-2007, Bungartz, F. 6510 (CDS 34727); near Rosa Blanca, inland from the SE-coast of the island, 0°49′9″S, 89°21′48″W, 12 m alt., dry zone, open *Bursera graveolens* woodland with *Mentzelia aspera* and *Scalesia incensa* shrubs on lava flow, on trunk of *Bursera graveolens* (~7 cm in diam.), SE-exposed, semi-shaded, ±wind- and rain-sheltered, 23-Apr-2007, Bungartz, F. 6405 (CDS 34620); near Tortugueria Cerro Colorado, 0°54′56″S, 89°26′18″W, 130 m alt., transition zone, on *Hippomane*, 02-Jun-2005, Aptroot, A. 63434 (CDS 30189); northwestern foothills of Media Luna, inland from the NW-coast, 0°43′41″S, 89°18′44″W, 75 m alt., dry zone, open woodland of *Cordia lutea* and *Bursera graveolens*, on top of inclined branch of *Bursera graveolens*, semi-shaded, wind- and rain-sheltered, 22-Apr-2007, Bungartz, F. 6216 (CDS 34428), 6232 (CDS 34444); NW-slope of Cerro Colorado, close to the lighthouse, 0°54′53.5″S, 89°26′1.7″W, 141 m alt., upper dry zone; dense shrubland of *Croton scouleri*, *Macraea laricifolia*, few *Psidium galapageium* shrubs, on top of *Bursera graveolens* branch, semi-shaded, wind- and rain-sheltered, 24-Aug-2008, Bungartz, F. 8607 (CDS 41253); on top of Cerro Colorado, 0°54′55.77″S, 89°26′3.899″W, 145 m alt., upper dry zone, open shrubland of

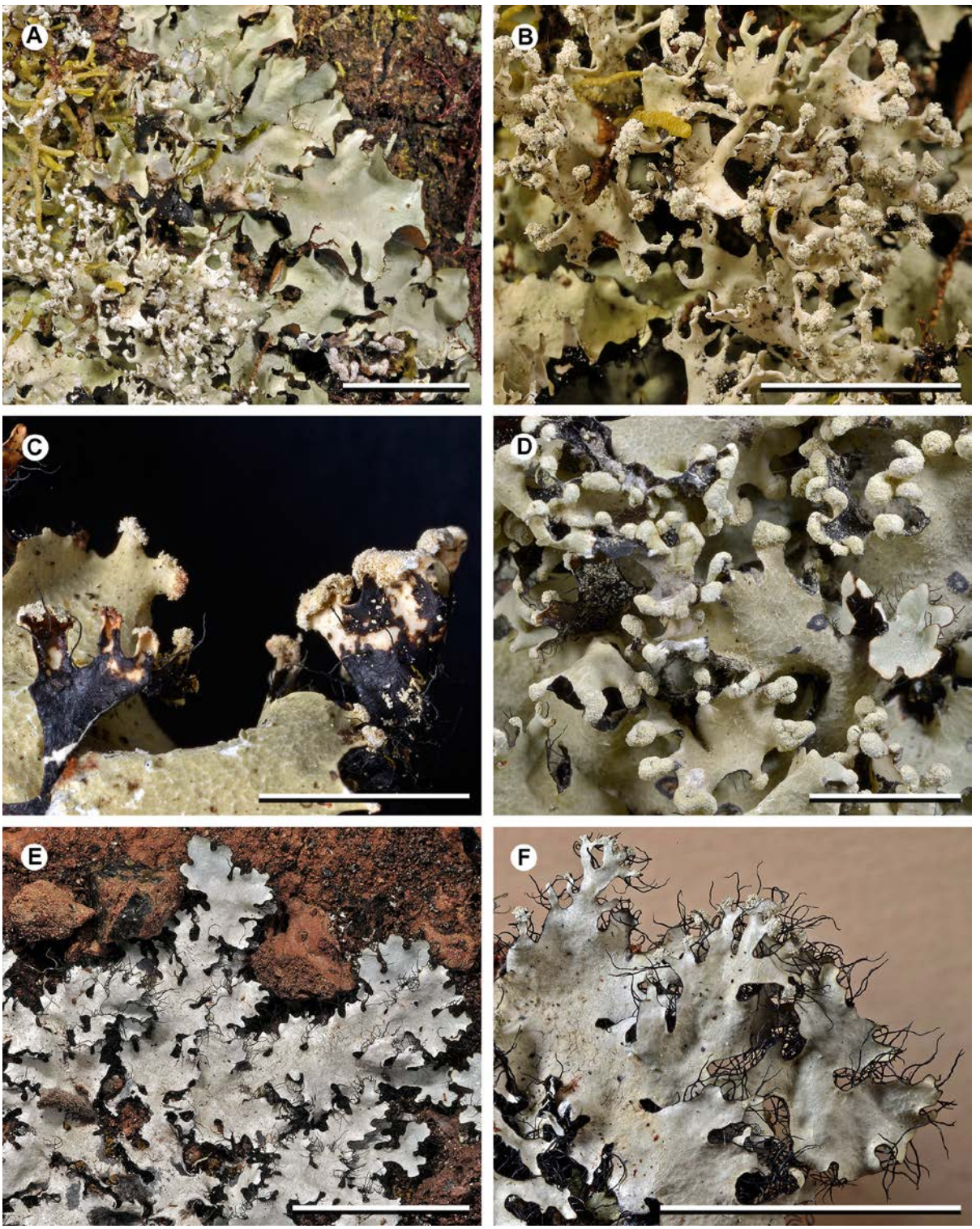

Figure 10. Sorediate *Parmotrema* species with gray, reticulate-maculate surface (cortex with atranorin). A – *P. clavuliferum* overview of thallus growing on tree trunk (Bungartz, F. 8790, CDS 45292); B – *P. clavuliferum*, close-up of clavulae (i.e., distinctly capitate soredia developing at the tip of laciniate lobes) (Bungartz, F. 8790, CDS 45292); C – *P. clavuliferum*, close-up of thallus lobe with clavulae, the lower side mottled white, the upper surface reticulate-maculate (Nugra, F. 394, CDS 35149); D – *Parmotrema clavuliferum* s.l., atypical morphotype with distinct reticulate-maculate surface but unusually short clavulae (Bungartz, F. 8598, CDS 41244). E – *P. marcellianum*, overview of thallus growing on rock (Bungartz, F. 9881, CDS 47219 – holotype); F – *P. marcellianum*, close-up of angular, reticulate-maculate lobes with cilia and clavulae (Bungartz, F. 9881, CDS 47219 – holotype). Scales: A–F = 5 mm.

Croton scouleri, *Macraea laricifolia* and *Waltheria ovata* with lava boulders, on branch of *Croton scouleri*, sunny, wind- and rain-exposed, 24-Aug-2008, Bungartz, F. 8605 (CDS 41251); trail to Cerro Mundo from the border of the National Park, NE of Puerto Baquerizo Moreno, 0°53′33.39″S, 89°34′42.5″W, 157 m alt., transition zone, dry bed of periodical stream with lava boulders, abundant *Hippomane mancinella* and few *Bursera graveolens* trees, on ESE-exposed inclined and dead trunk of *Bursera graveolens*, semi-shaded, wind- and rain-sheltered, 25-Aug-2008, Bungartz, F. 8667 (CDS 41313) 8658 (CDS 41304). ISLA SANTA CRUZ: along the trail from Puerto Ayora to Bahía Tortuga, 0°44′48″S, 90°19′14″W, 28 m alt., dry zone,

decidous forest in dry zone; with *Bursera graveolens*, *Acacia rorudiana*, and *Opuntia echios*; over basalt, on trunk of *Bursera graveolens*, sunny, wind- and rain-exposed, SW-exposed, 05-Jan-2006, Bungartz, F. 3337 (CDS 27004); E side of island, along road from Cascajo to El Garrapatero, 0°40′22.10″S, 90°14′41.70″W, 137 m alt., lower transition zone, open mixed forest of *Bursera graveolens*, *Pisonia floribunda*, *Piscidia carthagenensis*, *Psidium galapageium*, *Erythrina velutina* with an understory of *Plumbago scandens*, *Alternanthera halmifolia*, *Bastardia viscosa*, *Zanthoxylum fagara*, on *Erythrina velutina*, 16-Jun-2010, Spielmann, A.A. 8154 (CDS 45368), 8186 (CDS 45390); Nelson's Landing, Academy Bay, coastal zone, on *Laguncularia racemosa*, 27-Jan-1964, Weber, W.A. s.n. (FH 197228); farm N of Bellavista, 0°41′4″S, 90°19′29″W, 250 m alt., humid zone, agricultural area, on *Cedrela*, 30-May-2005, Aptroot, A. 63312 (CDS 30052); Puerto Ayora, cliff behind Charles Darwin Research Station, 0°44′30″S, 90°18′40″W, 20 m alt., dry zone, *Bursera* woodland, on *Opuntia*, 18-Feb-2006, Aptroot, A. 64201 (CDS 30767); cliff N of the town, 0°43′59″S, 90°18′45″W, 20 m alt., dry zone, on lava rock, 11-Feb-2006, Aptroot, A. 63717 (CDS 30272), 63718 (CDS 30273); near Charles Darwin Research Station, 0°44′32″S, 90°18′10″W, 5m alt., coastal zone, on shrub, 24-May-2005, Aptroot, A. 63051 (CDS 29779); vicinity of Academy Bay, dry zone, barranca talus, on *Jasminocereus*, 15-Feb-1964, Weber, W.A. s.n. (L-40890, COLO 190281), s.n. (CAS-DS 685646); barranca near seismic stationdry zone, on *Bursera*, 15-Feb-1964, Weber, W.A. s.n. (L-41186, COLO 195008); between dormitories and first barranca, dry zone, 29-Jan-1964, Schuster, R.O. s.n. (L-40122, COLO 189724). ISLA SANTIAGO: 9 km E of the eastern summit, 0°13′45″S, 90°42′0″W, 250 m alt., dry zone, *Bursera* forest with *Croton* and *Clerodendrum* on hilltop, on *Bursera*, 10-May-1971, Pike, L.H. ID36-33 (OSC 101727); along the trail from the caseta in La Central to La Bomba, halfway down to the coast, 0°12′54″S, 90°43′21″W, 293 m alt., dry zone, open woodland of *Bursera graveolens* and *Opuntia galapageia* with shrubs of *Castela galapageia* among basalt boulders and rocks, on *Bursera graveolens*, 25-Mar-2006, Aptroot, A. 65609 (CDS 32199); E of salt lake at James Bay, 0°14′25″S, 90°48′50″W, 170 m alt., transition zone, *Bursera-Psidium* forest on pahoehoe lava flow, on *Bursera*, 30-Apr-1971, Pike, L.H. 2716 (OSC 101729), ID15-10 (OSC 101728). ISLA ISABELA, VOLCÁN CERRO AZUL: atop basalt cliffs south of Caleta Iguana, 0°58′51.70″S, 91°26′52″W, 10 m alt., coastal zone, low woodland of large *Hippomane* trees immediately above the cliffs, on branches, semi-shaded, 09-May-2012, Spielmann, A.A. 10746 (CDS 52149), 10750 (CDS 52154); lower half of path from the Caseta del Parque to Caleta Iguana at the coast, 0°58′52.39″S, 91°26′41″W, 74 m alt., dry zone, shaded forest of huge *Hippomane* trees, some *Zanthoxylum fagara* scrub, shrubs of *Clerodendrum molle* and *Psidium galapageium*, on branches, 09-May-2012, Spielmann, A.A. 10729 (CDS 52132), 10730 (CDS 52133), 10718 (CDS 52095); VOLCÁN DARWIN: southwestern foothills, above Tagus Cove, 0°14′50″S, 91°21′29.89″W, 67 m alt., dry zone, open *Bursera graveolens* forest with *Waltheria ovata* and *Macraea laricifolia*, few *Acacia rorudiana* and *Cordia lutea*, along small lava flow, on N-exposed trunk of *Bursera graveolens* (~10 m in diam.), sunny, wind- and rain-exposed, 11-Nov-2007, Bungartz, F. 7352 (CDS 37839); 0°14′15.4″S, 91°20′40.27″W, 351 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri*, *Macraea laricifolia* and *Waltheria ovata*, few trees of *Acacia rorudiana*, on NE-exposed base of *Zanthoxylum fagara* trunk, semi-shaded, wind- and rain-sheltered, 16-Nov-2007, Bungartz, F. 7886 (CDS 38395); VOLCÁN SIERRA NEGRA: along dirt road from Puerto Villamil to crater of Sierra Negra, 0°55′12.4″S, 90°59′38.20″W, 30 m alt., dry zone, top of old lava flow with scattered vegetation (*Bursera graveolens*, *Opuntia echios*, and *Waltheria ovata*), on branches and trunk of *Bursera graveolens*, sunny, wind- and rain-exposed, 10-Sep-2007, Bungartz, F. 6993 (CDS 36497); Cerro Orchilla W of Puerto Villamil, close to the top, 0°57′45.60″S, 91°0′25.30″W, 98 m alt., dry zone, with *Bursera graveolens* and *Opuntia echios*, slope 45°, on basalt lava, 17-Aug-2008, Herrera-Campos, M.A. GAL-419 (CDS 43310); El Mango, on the E side of the dirt road, 0°53′1.7″S, 91°0′50.77″W, 162 m alt., lower transition zone; basalt lava outcrop with scattered vegetation (*Polypodium* sp., *Pityrogramma calomelanos*, *Darwiniothamnus tenuifolia*), on NW-exposed front of basalt outcrop, semi-shaded, wind- and rain-sheltered, 15-Aug-2008, Bungartz, F. 8213 (CDS 40859), 8210 (CDS 40856); Herrera-Campos, M.A. 10600 (CDS 40337), Herrera-Campos, M.A. 10601 (CDS 40338); 10594 (CDS 40331); Clerc, P. 08-201 (CDS 40055).

Parmotrema eborinum (Hale) Hale, Phytologia 28(4): 336. 1974. (Fig. 1A–C)

Type: Honduras, Morazán: El Zamorano, Standley, P.C. 236, (F – holotype!, US – isotype).

Thallus saxicolous; upper surface whitish gray to bright white, shiny, epruinose, emaculate, not cracked; lacking vegetative propagules, but densely lobulate; lobes small to moderate-sized, 2–7 mm wide, ±rotund, eciliate, distinctly delimited along the lobe edge by a conspicuous black rim; lower surface with a ±narrow, deep brown erhizinate, ~1–2.5 mm wide margin, blackening and rhizinate towards the thallus center; rhizines short, stout, black, mostly simple, rarely sparsely branched; medulla white. Apothecia rare to moderately abundant, 0.3–8 mm in diam., with a cupulate thalline margin, disc dark brown, deeply concave, imperforate; asci clavate, *Lecanora*-type, ascospores 8/ascus, simple, broadly ellipsoid, (10.5–)11.6–13.0(–13.5) × (6.4–)6.5–6.8(–7.0) µm (n = 40), thick-walled (~1 µm thick). *Pycnidia* immersed, flask-shaped to globose; ostiole brownish black; conidia sublageniform, (5–)6–8 × ~1 µm (n = 30).

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with protocetraric and echinocarpic acid [P+ yellow turning orange, K+ dirty yellowish brown, KC± rosé to faintly orange, C–, UV–].

Ecology and distribution. Central and South America (Hale 1965; Brako et al. 1985; Nuñez-Zapata et al. 2015). First reported from the Galapagos by Weber (1986), subsequently by Elix & McCarthy (1998) and online (Bungartz et al. 2016). A rare species in the dry zone and transition zone, typically found on sunny, wind- and rain-exposed boulders, outcrops and cliffs (see also comments for the sorediate *P. dilatatum*).

Notes. *Parmotrema eborinum*, *P. dilatatum* and *P. weberi* are superficially similar. They share the same white, shiny thallus with conspicuous lobulate lobes that are distinctly blackened along their edge. In the field the three species can be confused, especially if not producing soredia. *Parmotrema eborinum* and *P. dilatatum* share the same secondary chemistry, but specimens of *P. eborinum* are generally fertile, never forming soredia, although we

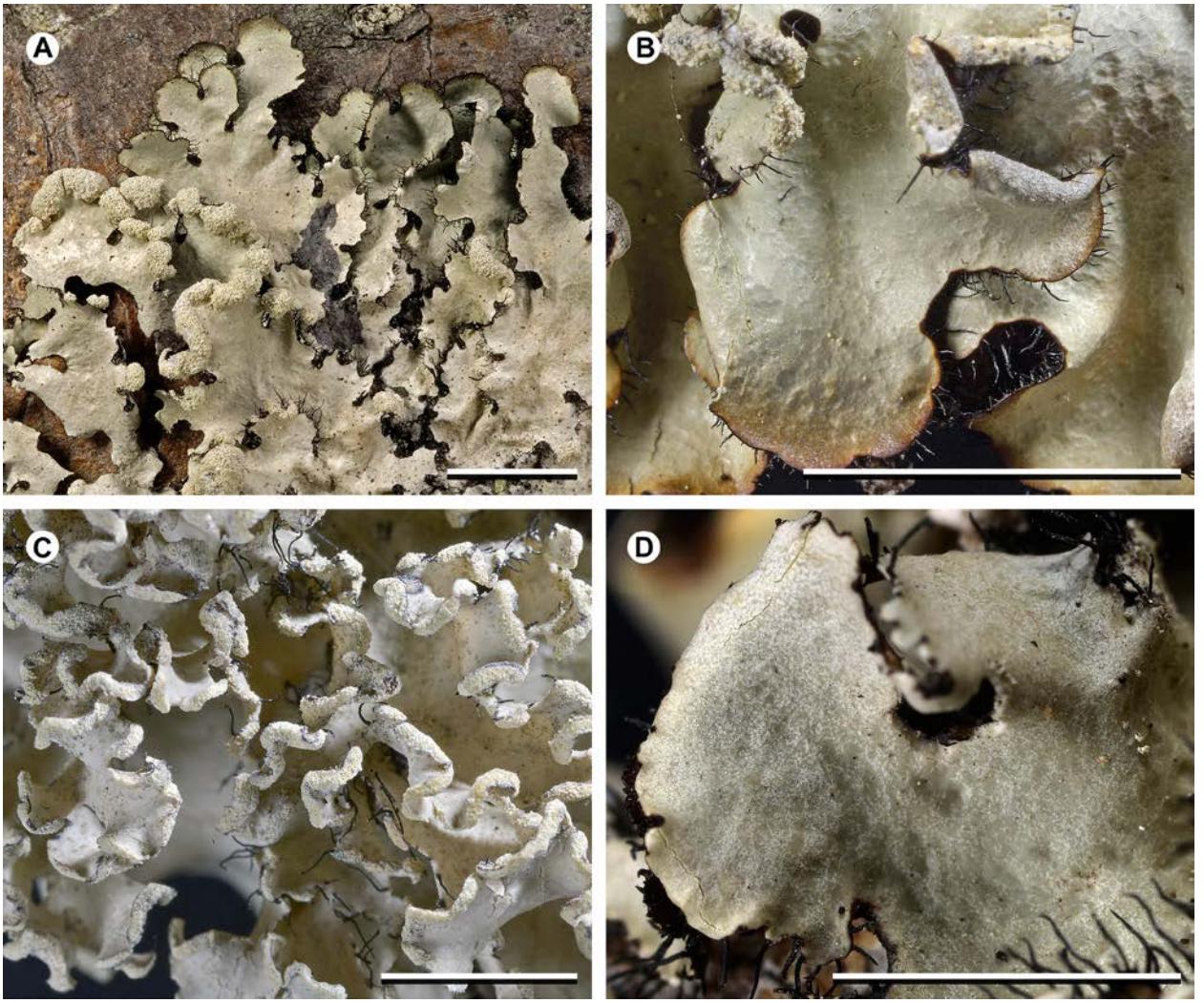

Figure 11. Sorediate *Parmotrema* species with gray, reticulate-maculate surface (cortex with atranorin). A – *P. reticulatum*, thallus growing on bark (Bungartz, F. 7437, CDS 37924); B – *P. reticulatum*, close-up of lobe margin with reticulate-maculae and linear soralia (Spielmann, A. 10532, CDS 51889).C – *P. hypotropum*, thallus lobes with long cilia and crescent-shaped soralia (Yánez-Ayabaca, A. 1622, CDS 45511); D – *P. hypotropum*, close-up of lobe surface with abundant, effigurate maculae (Yánez-Ayabaca, A. 1622, CDS 45511). Scales: A–D = 5 mm.

observed one specimen with echinocarpic acid that is not fertile and lacks soredia [Bungartz, F. 6287 (CDS 34499)]. This material can at this point unfortunately not reliably be distinguished as either *P. dilatatum* or *P. eborinum*.

In the Galapagos, *Parmotrema dilatatum* is typically sorediate; fertile specimens of this species have not been found. Elsewhere, however, where fertile specimens of the two species have been found, the two species can also be distinguished by their spore size. *Parmotrema eborinum* consistently has spores much smaller (11–14 × 5–7 µm) than those of *P. dilatatum* (20–28 × 8–10 µm).

Morphologically very similar but chemically distinct is *P. weberi*. With *P. eborinum* and *P. dilatatum* the medulla of *P. weberi* shares protocetraric acid, but instead of echinocarpic acid the latter species contains caperatic acid (KC–). Most specimens of *P. weberi* are sorediate (including the type). Some specimens are fertile and esorediate, but even though the ascospores of these specimens are similar in size to those of *P. eborinum*, this material can still reliably be distinguished by its secondary chemistry (caperatic, not echinocarpic acid).

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: along trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, at Laguna Seca, 1°15′30.80″S, 90°26′26.60″W, 206 m alt., dry zone, very open *Bursera graveolens* forest over SE-exposed lava flow with *Prosopis juliflora*, on front of lava rock, sunny, wind- and rain-exposed, 14-Jan-2011, Yánez-Ayabaca, A. 1882 (CDS 48237); inside the crater of Cerro Laguna at E side of island, on W-exposed slope, 1°16′11.80″S, 90°23′17″W, 245 m alt., transition zone, dense forest of *Prosopis juliflora*, *Clerodendrum molle*, very few *Bursera graveolens* and some *Jasminocereus thouarsii* in the upper part among lava outcrops and boulders; *Ramalina usnea/anceps* hanging in curtains from *Clerodendrum* twigs, on W-exposed slope of basalt outcrop, sunny, wind- and rain-exposed, 20-Jan-2011, Bungartz, F. 9980 (CDS 47349). ISLA PINZÓN: caldera rim, N-slope, 300 m alt., transition zone, 15-Feb-1964, Cavagnaro, D. s.n. (Weber, W.A. 305) (L-40505, COLO 192832); summit area, transition zone, 15-Feb-1964, Cavagnaro, D. 146 (COLO 190032); 14-Dec-1982, Luong, T.T. s.n. (CDS 10893). ISLA ISABELA, VOLCÁN SIERRA NEGRA: Cerro Orchilla, ~4 km W of Puerto Villamil, 0°57′47.27″S, 91°0′27.19″W, 56 m alt., dry zone, S exposed slope of hill, open *Bursera graveolens* forest with *Croton scouleri* and *Opuntia echios*, on S-exposed front

basalt outcrop, sunny, wind- and rain-exposed, 17-Aug-2008, Bungartz, F. 8458 (CDS 41104).

Parmotrema endosulphureum (Hillmann) Hale, Phytologia 28(4): 33. 1974. (Fig. 5C–F)

Type: Mexico, [State unknown]: Orcutt, C.R. 4728 (MO – holotype, fide Hale 1965).

Thallus corticolous, lignicolous, less frequently saxicolous; upper surface whitish gray to ivory, shiny to ±dull, epruinose, emaculate, not cracked; abundantly isidiate; isidia laminal, irregularly spread across the thallus surface, cylindrical, simple to sparsely branched, brown to blackened at their tip, eciliate; lobes broad, moderate-sized to large, 0.8–10(–14) mm wide, ±rotund, axils incised, margins eciliate; lower surface with a broad, pale to deep brown, erhizinate, ~4–6 mm wide margin, blackening and sparsely rhizinate towards the thallus center; rhizines short, stout, black, mostly simple, rarely sparsely branched, often growing in clusters; medulla mostly white, but the uppermost part distinctly yellow or pale salmon-yellow (check carefully, the pigmented layer can be very thin). Apothecia often absent but occasionally observed, 0.2–9 mm in diam., with a cupulate thalline margin, disc dark brown, deeply concave, imperforate, ascospores not observed. Pycnidia not observed.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with gyrophoric acid and ergochrome AA (= enthothein, secalonic acid A) [P–, K± dirty yellowish brown, KC+ yellow, C+ yellow, UV–].

Ecology and distribution. Asia, Africa, North, Central and South America (Hale 1965, 1974; Donha 2005; Benatti & Marcelli 2009), including continental Ecuador (Cevallos Solórzano 2012). First reported from the Galapagos by Weber (1986), subsequently by Elix & McCarthy (1998) and online (Bungartz et al. 2016). Along with *P. cristiferum* and *P. tinctorum* it is one of the most common and often abundant species; from the dry zone through the transition zone and humid zone, and all the way up to the high altitude dry zone; most frequent in the transition zone; typically growing on bark, very rarely on rock or other substrates; both in sunny, exposed and ±shaded and sheltered habitats; on a wide range of mostly native or endemic but also some introduced trees or shrubs.

Notes. One of the most common species of *Parmotrema* in the Galapagos. Unless the medullary pigmentation is observed, the species is easily confused with the very similar and equally common *P. tinctorum*. The medullary pigmentation of *P. endosulphureum* can be conspicuously yellow or salmon-colored and is then easily observed, but the pigmentation can sometimes be very faint, and the presence of ergochrome AA is then best verified by its KC+/C+ yellow spot test reaction.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: ~1 km S of Cerro Verde, 1°18′33.77″S, 90°25′19.19″W, 299 m alt., upper transition zone; dense forest of *Citrus* sp. with *Croton scouleri*, *Zanthoxylum fagara* and *Tournefortia rufo-sericea*; bryophytes hanging from branches in long curtains, on trunk of *Croton scouleri*, sunny, 15-Jan-2011, Yánez-Ayabaca, A. 1943 (CDS 48295), 1953 (CDS 48305); ~200 m from the northern limit of the Primavera Farm in the highlands of the island, 1°18′48.10″S, 90°26′6.798″W, 339 m alt., humid zone, very dense *Psidium guajava* forest with some *Zanthoxylum fagara* and *Croton scouleri*, *Tournefortia rufo-sericea* and *Pteridium arachnoideum* in the understory; all trees and shrubs overgrown by lianas (*Cissus verticilata*), on twigs and branches of *Psidium guajava*, semi-shaded, wind- and rain-sheltered, 22-Jan-2011, Bungartz, F. 10037 (CDS 47406); caldera of Cerro Pajas, trail at the end of road leading up to crater rim, 1°17′47″S, 90°27′23.19″W, humid zone, forest, branch, semi-shaded, wind- and rain-sheltered, on bark, 02-Jan-2010, Hillmann, G. GAL-36 (CDS 44799); cerca de cráter de Cerro Pajas, 1°18′1.3″S, 90°27′15.9″W, zona húmeda, área agrícola, sobre tronco de Naranja (*Citrus* × *sinensis*), 05-Feb-2006, Pozo, P. 1993 C (CDS 38873); inside the crater, 1°17′49.27″S, 90°27′23″W, 379 m alt., humid zone, *Scalesia pedunculata* forest with *Croton scouleri*, *Tournefortia rufo-sericea*, *Zanthoxylum fagara*, *Macraea laricifolia*, *Chiococca alba* and ferns in the understory, N-exposed on trunk of *Croton scouleri*, shaded, wind-and rain-sheltered, 12-Jan-2011, Bungartz, F. 9270 (CDS 46496); Yánez-Ayabaca, A. 1738 (CDS 48016), 1750 (CDS 48028); Cueva de Wittmer, zona húmeda, sobre ramas, 06-Feb-2006, Pozo, P. 2014 A (CDS 32362); inside the crater of Cerro Laguna at E side of island, on W-exposed slope, 1°16′11.80″S, 90°23′17″W, 245 m alt., transition zone, dense forest of *Prosopis juliflora*, *Clerodendrum molle*, very few *Bursera graveolens* and some *Jasminocereus thouarsii* in the upper part among lava outcrops and boulders; *Ramalina usnea/anceps* hanging in curtains from *Clerodendrum* twigs, on twigs of *Clerodendrum molle*, sunny, wind- and rain-exposed, 20-Jan-2011, Bungartz, F. 9954 A (CDS 47323), 9936 (CDS 47305), 9947 A (CDS 47316); lower S-slope of Cerro Ventanas, 1°16′36.10″S, 90°25′41.10″W, 295 m alt., transition zone, open shrubland of *Macraea laricifolia* and some lower *Waltheria ovata* shrubs in between, on branch of *Zanthoxylum fagara*, sunny, wind- and rain-exposed, 18-Jan-2011, Bungartz, F. 9844 (CDS 47182); on outer slope of Cerro Laguna at E side of island, 1°16′6.5″S, 90°23′33.39″W, 277 m alt., transition zone, open *Macraea laricifolia* shrubland with some *Cordia leucophlyctis* on W-exposed steep rocky slope with large lava boulders, on twigs of *Macraea laricifolia*, sunny, wind- and rain-exposed, 20-Jan-2011, Bungartz, F. 9990 (CDS 47359), 9986 (CDS 47355); on W-slope of Cerro Alieri, 1°17′24.10″S, 90°27′8.90″W, 347 m alt., transition zone, dense forest of *Croton scouleri* with few *Scalesia pedunculata*, *Citrus* sp. and *Zanthoxylum fagara*, on twigs of *Croton scouleri*, 12-Jan-2011, Bungartz, F. 9334 (CDS 46621); Pampa Larga, S of Cerro Asilo de la Paz, 1°19′38.70″S, 90°27′11.6″W, 249 m alt., transition zone, herbaceous vegetation with dominant *Phyla strigulosa*, occasional grasses and other herbs, few small shrubs of *Geoffroea spinosa*, on twigs of *Geoffroea spinosa*, sunny, wind- and rain-exposed, 13-Jan-2011, Bungartz, F. 9443 (CDS 46730); Yánez-Ayabaca, A. 1817 (CDS 48108); plain between the two hills Cerro de los Chanchos and Cerro de los Burros, 1°16′40.27″S, 90°24′12.4″W, 311 m alt., transition zone, open herbaceous area surrounded by dense forest of *Clerodendrum molle* and *Croton scouleri*, some rocks and boulders on the ground, on branch of *Macraea laricifolia*, semi-shaded, wind- and rain-sheltered, 21-Jan-2011, Bungartz, F. 10005 (CDS 47374); S of Cerro Asilo de la Paz, edge of Pampa Larga, 1°19′38.20″S, 90°27′9.596″W, 249 m alt., transition zone, shrubland of *Psidium guajava*, *Clerodendrum molle*, *Macraea laricifolia* and *Croton scouleri* with *Phila strigosa*, *Sidastrum paniculatum* and other herbs and grasses, on branch of *Clerodendrum molle*, sunny, wind- and rain-exposed, 13-Jan-2011,

Yánez-Ayabaca, A. 1854 (CDS 48208); SE-part of island, between Lechosos and Cerro Pajaros, slope opposite Cerro Pajaros, 1°18′26.10″S, 90°24′21.39″W, 278 m alt., upper transition zone; mixed forest of *Psidium galapageium* and *Croton scouleri* with *Macraea laricifolia* on NNW-exposed slope, on twigs of *Zanthoxylum fagara*, sunny, 15-Jan-2011, Yánez-Ayabaca, A. 1923 (CDS 48276); trail from Black Beach to highlands, on *Citrus*, 25-Apr-1976, Weber, W.A. s.n. (L-62938, COLO 294584); trail from La Primavera Farm to La Corona and Arco de la Reina, southeastern part of the island, 1°19′21.60″S, 90°24′45.89″W, 219 m alt., transition zone, very dense scrub of *Clerodendrum molle* with some *Croton scouleri*, *Waltheria ovata*, few *Prosopis juliflora* and occasional trees of *Geoffroea spinosa* in flat area on generally SE-exposed, moderately inclined slope with few boulders, on branches and twigs of *Clerodendrum molle*, semi-shaded, ±wind- and rain-exposed, 24-Jan-2011, Bungartz, F. 10139 (CDS 47534); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, 1°16′57.27″S, 90°26′41.10″W, 310 m alt., transition zone, open shrubland of *Croton scouleri*, *Zanthoxylum fagara*, *Macraea laricifolia*, *Waltheria ovata* and lava rocks; *Ramalina usnea/anceps* forming long curtains hanging from branches, on fallen branch, 14-Jan-2011, Yánez-Ayabaca, A. 1905 (CDS 48260), 1899 (CDS 48254); Bungartz, F. 9581 (CDS 46860); 1°17′17.30″S, 90°26′35″W, 360 m alt., transition zone, low and dense forest of *Croton scouleri*, *Clerodendrum molle*, *Zanthoxylum fagara*, and *Macraea laricifolia*, occasional *Pisonia floribunda* trees and epiphytic orchids (*Ionopsis utricularioides*), on branch of *Clerodendrum molle*, semi-shaded, wind- and rain-exposed, 25-Jan-2011, Yánez-Ayabaca, A. 2129 (CDS 48502); cliff at NE side of trail (Mirador), 1°17′4.298″S, 90°26′36.60″W, 365 m alt., transition zone, ~10 m high lava cliff within dense scrub of *Clerodendrum molle*, *Croton scouleri* and *Macraea laricifolia*, one single *Acacia rorudiana* on top of cliff, on fallen trunk, 25-Jan-2011, Yánez-Ayabaca, A. 2112 (CDS 48477); 540 m alt., humid zone, 15-Feb-1964, Itow, S. s.n. (L-40725, COLO 192188); Oertiz-C., F. s.n. (L-40793, COLO 192310); 01-Jan-1934, Taylor, W.R. 868 C (FH 197223); near Wittmer Farm, Asilo de la Paz, in the lower slope of Cerro Asilo de la Paz, 1°18′54.27″S, 90°27′15.30″W, 352 m alt., transition zone, young *Scalesia pedunculata* forest with *Zanthoxylum fagara*, *Croton scouleri*, *Macraea laricifolia*, *Chiococca alba* and some small lava boulders on NW-exposed slope, on dead tree trunk, 13-Jan-2011, Yánez-Ayabaca, A. 1835 B (CDS 55140); along the trail up to the summit from the S-coast, 0°34′47″N, 90°45′8″W, 493 m alt., humid zone, dense woodland of *Zanthoxylum fagara*, *Chiococca alba*, *Croton scouleri*, *Cissampelos pareira*, and *Pisonia floribunda*, on branches of *Zanthoxylum fagara* (~4 cm in diam.), shaded, wind- and rain-sheltered, 26-Feb-2007, Bungartz, F. 5777 (CDS 33450); 0°33′57″N, 90°44′51″W, 215 m alt., transition zone, dense vegetation of *Bursera graveolens*, *Croton scouleri*, *Scalesia baurii*, *Pisonia floribunda*, and *Zanthoxylum fagara*, on slightly overhanging trunk of *Pisonia floribunda* (~25 cm in diam.), W-exposed; ±shaded, ±wind- and rain-sheltered, 25-Feb-2007, Bungartz, F. 5692 (CDS 33329); 0°34′39″N, 90°45′7″W, 436 m alt., humid zone, dense forest of *Zanthoxylum fagara*, few *Pisonia floribunda*, and the vine *Cissampelos pareira*; *Justicia galapagana* in understory, on trunk of *Opuntia galapageia* (~20 cm in diam.), semi-shaded, wind- and rain-exposed, 26-Feb-2007, Bungartz, F. 5793 (CDS 33466), 5819 (CDS 33492); 0°34′15″N, 90°45′2″W, 289 m alt., transition zone, open woodland of *Zanthoxylum fagara*, *Pisonia floribunda*, and few *Trema micrantha*; grasses, *Justicia galapagana*, and *Alternanthera filifolia* in the understory, on trunk of *Bursera graveolens* (~20 cm in diam.), SW-exposed, sunny, wind- and rain-exposed, 27-Feb-2007, Bungartz, F. 5889 (CDS 33566). ISLA PINTA: northern part of the western cliff above Las Pampas, 0°35′10.80″N, 90°46′33.89″W, 356 m alt., dry zone, open forest of small trees, *Pisonia floribunda*, *Zanthoxylum fagara*, *Opuntia galapageia* and *Croton scouleri* in E-exposed barranco, on SSW-exposed branches of *Zanthoxylum fagara*, semi-shaded, 31-Jan-2008, Nugra, F. 604 (CDS 38982); on the western cliff, W of Las Pampas, 0°34′51.70″N, 90°46′25.89″W, 411 m alt., transition zone, W-exposed forest of *Zanthoxylum fagara*, *Croton scouleri*, *Cordia lutea* and *Pisonia floribunda*, on SW-exposed trunk of *Zanthoxylum fagara*, sunny, 01-Feb-2008, Nugra, F. 622 (CDS 39000); SW-part of the island, along trail going up the southwestern slope to Las Pampas on the western saddle, 0°34′13.5″N, 90°45′38.20″W, 316 m alt., transition zone, open forest of *Trema micrantha*, *Bursera graveolens*, *Pisonia floribunda*, *Opuntia galapageia*, *Zanthoxylum fagara* and *Chiococca alba* on flat lava flow, on SW-exposed trunk and branches of *Pisonia floribunda*, semi-shaded, 30-Jan-2008, Nugra, F. 545 (CDS 38923), Nugra, F. 543 (CDS 38921), 573 (CDS 38951), 583 (CDS 38961). ISLA PINZÓN: along the trail going up from Playa Escondida, SW-slope of the top, 0°36′36″S, 90°40′11″W, 310 m alt., dry transition zone with *Prosopis juliflora*, *Opuntia galapageia* ssp. *macrocarpa*, *Croton scouleri*, *Cordia lutea*, *Scalesia baurii* ssp. *baurii*, on twigs, 16-Feb-2006, Aptroot, A. 64067 (CDS 30628); from the NE-coast to the highest summit, 400 m alt., transition zone, mixed *Scalesia* forest of trees 4 m tall on rocky soil, on horizontal branch of *Pisonia*, 02-Jul-1976, Sipman, H.J.M. s.n. (L-63577, COLO 297859); summit area, transition zone, 15-Feb-1964, Cavagnaro, D. s.n. (L-40236, COLO 189752). ISLA SAN CRISTÓBAL: Cerro Partido along trail from entrance to Cerro Pelado to El Ripioso, 0°51′23″S, 89°27′37″W, 376 m alt., transition zone, rocky SW-exposed slope of hill with *Jasminocereus thouarsii*, *Clerodendrum molle* var. *glabrescens*, *Psidium galapageium*, Bromeliaceae and ferns growing in rock crevices, on twigs and branches of *Croton scouleri*, semi-shaded, wind- and rain-sheltered, 28-Apr-2007, Bungartz, F. 6619 (CDS 34839); on top of Cerro Colorado, 0°54′55.77″S, 89°26′3.899″W, 145 m alt., upper dry zone; open shrubland of *Croton scouleri*, *Macraea laricifolia* and *Waltheria ovata* with lava boulders, on stem of *Croton scouleri*, S-exposed, sunny, wind- and rain-exposed, 24-Aug-2008, Bungartz, F. 8597 (CDS 41243); W of the cemetery of El Progresso at the border of the National Park, 0°54′44.77″S, 89°34′34″W, 170 m alt., transition zone, at the edge of a forest of native and introduced trees (*Hippomane mancinella*, *Tamarindus indica*, *Leucaena leucocephala*, *Clerodendrum molle* and vines), on NW-exposed branch of *Hippomane mancinella*, shaded, wind- and rain-sheltered, 24-Aug-2008, Bungartz, F. 8551 (CDS 41197). ISLA SANTA CRUZ: abandoned farm along the northern part of the loop road from Bellavista to Garrapatero, 0°40′58″S, 90°18′31″W, 255 m alt., humid zone, overgrown farm area with introduced trees like *Cedrela odorata*, *Persea americana*, *Syzygium malaccense*, *Cestrum auriculatum* and others; small open clearing in between, on *Cedrela*, 19-Feb-2006, Aptroot, A. 64319 (CDS 30884); along the road from Bellavista to Baltra, between Bellavista and Santa Rosa, close to the road, 0°39′38″S, 90°24′13″W, 571 m alt., humid zone, agricultural area, farmland with an alley of large *Cedrela odorata* trees, on *Cedrela*, 23-Feb-2006, Aptroot, A. 64499 (CDS 31071); along the trail down into the crater at Camote, 0°38′13″S, 90°17′44″W, 364 m alt., humid zone, NE-exposed inside crater wall, steep, open scrubland (*Chiococca alba*, *Cestrum auriculatum*, and few *Scalesia pedunculata*) over basalt rubble, trunk of *Zanthoxylum fagara* (~4 cm in diam.), SE-exposed, sunny, ±wind- and rain-sheltered, 19-Feb-2007, Bungartz, F. 5617 (CDS 33242); Camote, finca de René Valle, lindero del Parque

Nacional Galápagos, al borde, 0°38′20.69″S, 90°17′50.77″W, 473 m alt., zona húmeda, bosque secundario de *Scalesia pedunculata*, perturbado y PNG intervenido por especies vegetales invasoras, sobre *Erythrina smithiana*, 11-Jan-2007, Nugra, F. 298 (CDS 33214), 448 (CDS 36762); 0°38′7.5″S, 90°17′57.5″W, 409 m alt., zona húmeda, bosque de *Psidium galapageium* con pocos árboles de *Scalesia pedunculata*, bosque secundario, perturbado, restaurado e intervenido por especies vegetales invasoras, sobre *Psidium galapageium*, exposición NE, 04-Jan-2007, Nugra, F. 534 (CDS 37456); cerca la vía sector Los Gemelos, 0°38′0.1000″S, 90°23′35.5″W, 661 m alt., zona húmeda, bosque de *Scalesia pedunculata*, sobre *Scalesia pedunculata*, 15-Feb-2007, Nugra, F. 393 (CDS 35148); dirt road to Mina Granillo Rojo, on the N side of the island, 0°36′52.60″S, 90°22′11.80″W, 547 m alt., upper transition zone with *Bursera graveolens*, *Psidium galapageium* and *Zanthoxylum fagara*, slope 10° N, on fallen branches on the ground, 20-Aug-2008, Truong, C. 1365 (CDS 39676); El Puntudo, 0°39′9″S, 90°20′2.298″W, 637 m alt., zona húmeda, bosque de *Scalesia penduculata* con árboles invasores *Cinchona pubescens*, sobre *Cinchona*, exposición NE, 01-Aug-2007, Nugra, F. 415 (CDS 36164); E side of island, along road from Cascajo to El Garrapatero, 0°40′22.10″S, 90°14′41.70″W, 137 m alt., lower transition zone, open mixed forest of *Bursera graveolens*, *Pisonia floribunda*, *Piscidia carthagenensis*, *Psidium galapageium*, *Erythrina velutina* with an understory of *Plumbago scandens*, *Alternanthera halmifolia*, *Bastardia viscosa*, *Zanthoxylum fagara*, on bark, 16-Jun-2010, Spielmann, A.A. 8197 (CDS 45389); farm of Don Cabrera between Bellavista and Cascajo, ~1 km W of Cascajo, 0°40′38.89″S, 90°17′21.39″W, 249 m alt., humid zone, agricultural area, coffee plantation with *Cedrela odorata*, *Inga* spp., bananas, *Persea americana*, *Citrus* spp., on *Cedrela odorata*, 16-Jun-2010, Spielmann, A.A. 8182 (CDS 45402); línea del Parque Nacional Galápagos, sector el Camote a lindero de la finca de Don René Valle, 0°38′21.10″S, 90°17′57.20″W, 487 m alt., zona húmeda, bosque de *Scalesia pedunculata*, suelo húmedo y fecundo, sobre *Psidium galapageium*, 10-Aug-2006, Nugra, F. 140 (CDS 32794); off the dirt road to Mina Granillo Rojo, on the N side of the island, 0°37′2″S, 90°22′6″W, 294 m alt., transition zone, deciduous forest of *Zanthoxylum fagara*, *Psidium galapageium*, *Pisonia floribunda* and few *Bursera graveolens* and *Cedrela odorata*, on twigs of *Zanthoxylum fagara*, near the ground, S-exposed, semi-shaded, wind- and rain-sheltered, 21-Jun-2006, Bungartz, F. 4938 (CDS 29151), 4949 (CDS 29162), 4964 (CDS 29177), 4981 (CDS 29194); Steve Divine's Farm at the end of Tortoise Road, off the main road to Baltra, Tortoise Territory, 0°40′8″S, 90°24′17″W, 364 m alt., humid zone, agricultural area, open farmland with *Cedrela odorata*, *Persea americana*, *Citrus* sp., on the metal surface of an old car, 23-Feb-2006, Aptroot, A. 64510 (CDS 31082); trail to El Chato, 0°40′18.69″S, 90°25′47.70″W, 253 m alt., humid zone, forest stand with *Cedrela odorata*, *Zanthoxylum fagara* and *Psidium guajava*, flat, on *Zanthoxylum fagara*, 07-Aug-2008, Clerc, P. 08-50 (CDS 39904); tras del Puntudo, ex finca de Don Benito, 0°38′23.23″S, 90°19′57.28″W, 732 m alt., zona húmeda, plantaciones de plátano, yuca, piña dentro de un bosque de *Scalesia pedunculata* de árboles muy grandes y maduros, sobre *Cinchona pubescens*, 28-Dec-2006, Nugra, F. 246 (CDS 33162), 239 (CDS 33155); 25-Jan-2007, Nugra, F. 352 (CDS 35107); vicinity of Academy Bay, 100 m alt., transition zone, on *Bursera*, 15-Feb-1964, Itow, S. s.n. (L-40625A, COLO 192149); 120 m alt., transition zone, on *Pisonia*, 15-Feb-1964, Itow, S. 29 (L-40624, COLO 192150); barranca along old traildry zone, on tree, 15-Feb-1964, Weber, W.A. s.n. (L-40622A, COLO 192535), 415 B (L-40620, COLO 192533); Bellavista trail, 90 m alt., dry zone, on bark, 04-Feb-1964, Schuster, R.O. s.n. (L-40137A, COLO 196995); Schuster, R.O. s.n. (L-40239, COLO 189751), s.n. (L-40120, COLO 189295); on *Bursera graveolens*, 11-Jan-1929, Herre, A.W.C.T. 31 (CAS-DS); 01-Apr-1964, Horneman, S.H. s.n. (L-67370, COLO 316718). ISLA SANTIAGO: along the trail from Bucanero to Jaboncillos, ~1 km below the summit, Cerro Gavilan, 0°11′45″S, 90°47′20″W, 680 m alt., transition zone, open *Psidium galapageium* forest with *Zanthoxylum fagara*, *Blainvillea dichotoma*, *Mentzelia aspera* and *Senna obtusifolia*, basalt boulders and outcrops in between, on *Bursera graveolens*, 22-Mar-2006, Aptroot, A. 65447 (CDS 32035); along the trail from the caseta in La Central to La Bomba (at the coast), halfway down to the coast, 0°12′54″S, 90°43′21″W, 293 m alt., dry zone, open woodland of *Bursera graveolens* and *Opuntia galapageia* with shrubs of *Castela galapageia* and *Clerodendrum molle* among basalt boulders and rocks, on twigs of *Clerodendrum molle*, semi-shaded, wind- and rain-sheltered, 25-Mar-2006, Bungartz, F. 4922 (CDS 29126); ~7 km inland from the E-coast, ±at the same latitude as Bahía Sullivan, 0°17′4″S, 90°38′18″W, 192 m alt., dry zone, scrubland of *Castela galapageia* and *Macraea laricifolia* with occasional trees, mostly *Bursera graveolens* and few *Pisonia floribunda*, on branches of *Pisonia floribunda*, semi-shaded, wind- and rain-exposed, 17-Jul-2006, Bungartz, F. 5161 (CDS 29374); 600 m alt., humid zone, on the trunks of trees, 08-Aug-1905, Stewart, A. (351) 444 (CAS 119454). ISLA ISABELA, VOLCÁN ALCEDO: al lado este del cumbre, 0°26′18.10″S, 91°4′37.10″W, 800 m alt., zona húmeda, plantaciones de plátano, yuca, piña dentro de un bosque de *Scalesia pedunculata* de árboles muy grandes y maduros, sobre *Psidium galapageium*, 01-Dec-2006, Nugra, F. 166 (CDS 32820); VOLCÁN CERRO AZUL: along the first few meters of the path from the Caseta del Parque to Caleta Iguana, 0°58′44.20″S, 91°26′46.27″W, 12 m alt., dry zone, dense scrubland of mostly *Clerodendrum molle*, some *Gossypium darwinii* and *Croton scouleri*, very sparse *Bursera graveolens* trees, on *Bursera* branches, sunny, 09-May-2012, Spielmann, A.A. 10753 (CDS 52157); along the trail from Caleta Iguana to the first Caseta del Parque, 0°59′13.6″S, 91°25′39.27″W, 300 m alt., transition zone, at the border of open *Psidium guajava* forest, with *Zanthoxylum fagara*, *Tournefortia rufo-sericea*, and *Darwiniothamnus lancifolius*, on twigs of *Zanthoxylum fagara*, 02-May-2012, Spielmann, A.A. 10401 (CDS 51756), 10402 (CDS 51757); Nugra, F. 1022 (CDS 52185); 0°59′18.69″S, 91°25′30.80″W, 289 m alt., transition zone, low and dense *Psidium guajava* forest with *Zanthoxylum fagara* and *Tournefortia rufo-sericea*, on branches and twigs of *Psidium guajava*, semi-shaded, 03-May-2012, Spielmann, A.A. 10421 (CDS 51776); 0°59′12.1″S, 91°25′35.77″W, 276 m alt., transition zone, isolated tree close to a *Psidium guajava* forest, on twigs and branches, semi-shaded, 02-May-2012, Spielmann, A.A. 10383 (CDS 51740), 10382 (CDS 51739), 10370 (CDS 51726); 0°59′22.39″S, 91°25′26.19″W, 273 m alt., transition zone, very sheltered vertical cliff face with abundant bryophytes and few lichens, surrounded by forest of *Psidium guajava* and *Trema micrantha*, on dead leaves of ferns and on the ground among mosses, 02-May-2012, Spielmann, A.A. 10398 (CDS 51753); Iguana Cove, Snodgrass, R.E. s.n. (CAS-DS 684819); lower crater slopes above the first Caseta del Parque; below the cloud layer, 0°58′39.20″S, 91°25′25.80″W, 434 m alt., transition zone, open Guajava forest, with sparse *Psidium guajava* shrubs, few larger *Zanthoxylum fagara* trees, and *Tournefortia rufo-sericea* scrub, on twigs and trunk of isolated *Zanthoxylum* in a field with *Psidium guajava*, 03-May-2012, Spielmann, A.A. 10433 (CDS 51789); lower half of path from the Caseta del Parque to Caleta Iguana at the coast, 0°58′52.39″S, 91°26′41″W, 74 m alt., dry zone, shaded forest of huge Manzanillo (*Hippomane manzinella*)

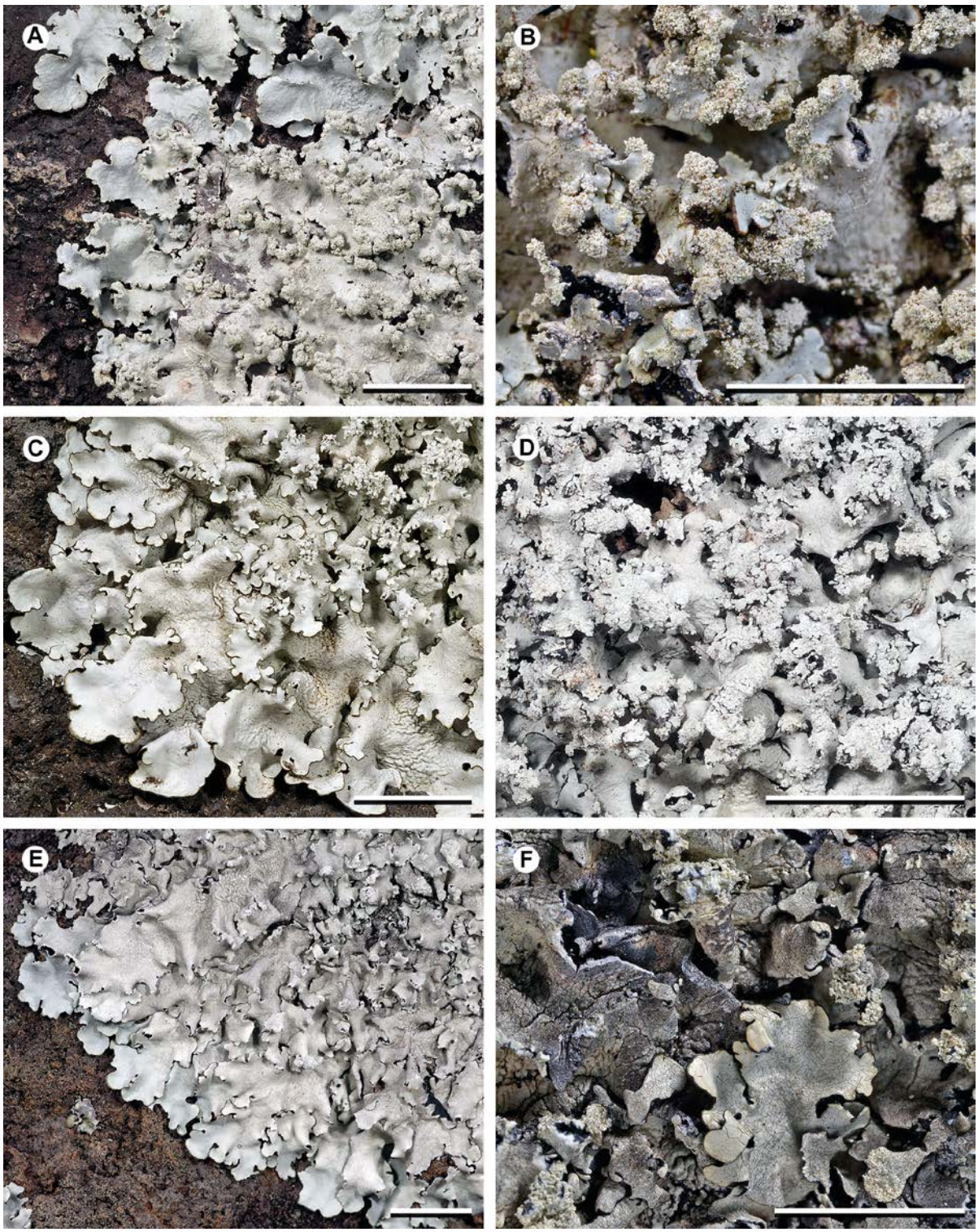

Figure 12. Sorediate *Parmotrema* species with gray, emaculate surface (cortex with atranorin, medulla with protocetraric). A – *P. mordenii*, overview of thallus growing on rock (Bungartz, F. 4397, CDS 28482); B – *P. mordenii*, close-up of central lobes with subcapitate soralia (Spielmann, A. 10441, CDS 51797); C – *P. dilatatum*, overview of thallus growing on rock (Bungartz, F. 6939, CDS 36439); D – *P. dilatatum*, close-up of thallus center with lobes abundantly lobulate, developing into cauliflower-like soralia with granular soredia (Bungartz, F. 8460, CDS 41102). E – *P. weberi*, overview of thallus growing on rock (Bungartz, F. 5199, CDS 29412); F – *P. weberi*, close-up of thallus center, lobes covered in dark striae from a lichenicolous fungus infection, some of the lobes lobulate, the lobules breaking up into clusters of coarsely granular soredia (Bungartz, F. 5226, CDS 29441). Scales: A–F = 5 mm.

trees, some *Zanthoxylum fagara* scrub, shrubs of *Clerodendrum molle* and *Psidium galapageium*, on scar of *Hippomane manzinella* branch, 09-May-2012, Bungartz, F. 10541 (CDS 52553); path from the first Caseta del Parque to Caleta Iguana at the coast, approx. half of the way, abandonned farm 'La Lima', 0°59′1.100″S, 91°26′17.10″W, 198 m alt., transition zone, dense, shaded woodland of large, predominantly introduced fruit trees; *Citrus* spp. (Lima, Limón, Naranja), *Carica papaya*, but also some natives like *Croton scouleri*, and *Pisonia floribunda*, semi-shaded, on bark, 08-May-2012, Spielmann, A.A. 10709 (CDS 52077); path from the first Caseta del Parque to Caleta Iguana at the coast, approx. one third of the way, 0°59′9.5″S,

91°26′4.90″W, 224 m alt., transition zone, dense *Psidium guajava* woodland with few large *Zanthoxylum fagara* trees, *Pisonia floribunda* and *Scalesia cordata* trees, understory with *Tournefortia rufo-sericea* shrubs and ferns, on branches and twigs of *Zanthoxylum*, semi-shaded, 08-May-2012, Spielmann, A.A. 10684 (CDS 52039), 10646 (CDS 52013), 10648 (CDS 52015), 10690 (CDS 52057), 10686 (CDS 52041), 10694 (CDS 52061), 10682 (CDS 52037), 10696 (CDS 52063), 10672 (CDS 52027), 10685 (CDS 52040); S-slope above Iguana Cove, 300 m alt., humid zone, mixed forest with many clearings, on slanting trunk in shade, 24-Jun-1976, Sipman, H.J.M. s.n. (L-63538, COLO 297898); VOLCÁN DARWIN: ~200 m from the southwestern crater rim, 0°12′17.19″S, 91°18′45.20″W, 1304 m alt., high altitude dry zone, open forest of *Scalesia microcephala*, few trees of *Zanthoxylum fagara*, *Cordia revoluta* and *Croton scouleri* shrubs, many young *Scalesia* in the understory, on branch of *Zanthoxylum fagara*, semi-shaded, wind- and rain-sheltered, 13-Nov-2007, Bungartz, F. 7537 (CDS 38028); VOLCÁN SIERRA NEGRA: along dirt road from Puerto Villamil to crater of Sierra Negra, farmland, 0°51′39.89″S, 91°1′41.60″W, 330 m alt., humid zone, *Cedrela odorata* and *Psidium guajava* trees along road bordering a pasture, on S-exposed trunk of *Cedrela odorata*, sunny, wind- and rain-exposed, 09-Sep-2007, Bungartz, F. 6920 (CDS 36419); around the mirador El Mango, 0°53′2.20″S, 91°0′51.20″W, 174 m alt., transition zone, mixed stand with *Cedrela odorata* and *Kalanchoe pinnata* invading the understory, slope 15° SE, on branches of *Cedrela odorata*, 15-Aug-2008, Herrera-Campos, M.A. 10675 (CDS 40412); SE side of island, 0°53′1.399″S, 91°0′48.39″W, 161 m alt., transition zone, rocky area with shrubs of *Psidium guajava*, ferns and *Stereocaulon* covering the ground, on exposed basaltic rocks, 15-Aug-2008, Herrera-Campos, M.A. 10608 (CDS 40345).

Parmotrema erectociliatum Spielmann & Bungartz, sp. nov. (Fig. 15E–F)

MycoBank MB 832663

Diagnosis: Differs from *P. cristiferum* by the abundant and conspicuous, long, slender, typically erect cilia along the lobe margins (±perpendicular to the lobe), and by the overall darker, mostly blackened lower side, only a narrow dark brown marginal zone that is not mottled white.

Type: Ecuador. Galápagos: Isla Santa Cruz, vicinity of Academy Bay, just N of Research Station, dry zone, below barranco, on huge boulder of a talus slope, 15-Feb-1964, Weber, W.A. 403 (L-40540, COLO 192658 – holotype!).

Thallus saxicolous; upper surface whitish gray to ivory, shiny to ±dull, epruinose, emaculate, but in parts irregularly cracked; abundantly sorediate; soralia marginal, linear to labriform (±crescent-shaped); soredia farinose, ±concolorous with the thallus surface, in parts typically discolored by a brownish or dark grayish tinge, pale inside; lobes broad, small to moderate-sized, 2–6(–7) mm wide, ±rotund, axils incised, margins ciliate, distinctly delimited along the lobe edge by a conspicuous black rim; cilia long, stout and slender, 0.5–1(–1.5) mm long, black, mostly simple, very rarely branched, typically erect (±perpendicular to the lobe surface); lower surface with a narrow, erhizinate, 0.5–1 mm wide area, overall blackened throughout or with a very narrow, dark brown margin; rhizines short, stout, black, mostly simple; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Etymology. Named for its long, conspicuously erect cilia.

Ecology and distribution. Endemic to the Galapagos, known only from the type.

Notes. At first glance similar to *P. cristiferum*, although its equally broad lobes are abundantly ciliate, with long, stout and slender cilia. The species is further distinguished by a lower surface that is almost entirely blackened throughout and only in a narrow part along the lower lobe edge might not be pitch black, but dark brown. Generally, the black to deep brown pigmentation of the lower side extends all the way to the margin and is therefore visible from above – the lobes appearing delimited by a distinct black to dark brown edge.

Parmotrema flavescens (Kremp.) Hale, *Phytologia* 28(4): 336. 1974. (Fig. 3A–D)

Type: Brazil, Glaziou, A.F.M. 1833 (M – holotype, H – isotype, fide Hale 1965).

Thallus saxicolous; upper surface pale greenish yellow, dull to ±shiny, emaculate, but especially the older parts frequently with conspicuous, ±reticulate cracks; abundantly isidiate; isidia both marginal and laminal, cylindrical and simple to abundantly branched, becoming coralloid, brown to blackened at their tip and frequently ciliate; lobes moderate-sized, 2–8 mm wide, rotund, axils rounded, forming ±indistinct loops, margins sparsely to densely ciliate; cilia short and slender, 0.5–2.5 mm long, black, mostly simple, very rarely branched; lower surface with a deep brown, erhizinate, ~2–5 mm wide margin, soon blackened and densely rhizinate towards the center; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with usnic acid [P–, K–, KC± dirty yellowish brown, C–, UV–]; medulla with salazinic and gyrophoric acid [P+ strongly yellow, K+ yellow, quickly turning blood-red, C+/KC+ pale pink (C and KC reactions are evanescent and must be examined under continuous observation); UV–].

Ecology and distribution. Africa (Müller Argoviensis 1880), Central America (Hue 1899; Hale 1965; Tenorio et al. 2002), South America (Hale 1965). In South America most reports are from Brazil (Krempelhuber 1869, 1876; Nylander 1885; Zahlbruckner 1909; Hale 1965; Fleig & Riquelme 1991; Fleig 1997; Ribeiro 1998; Eliasaro 2001; Benatti & Marcelli 2009; Donha 2005; Spielmann 2009). New for Galapagos and Ecuador; moderately common; most specimens found in the transition zone and humid zone of several islands, generally growing on sunny, wind- and rain-exposed rock surfaces (boulders, outcrops and cliffs).

Notes. The morphology of saxicolous *P. flavescens* is extremely similar to its corticolous counterpart, *P. nyasense*. Apart from inhabiting different substrates, the

two species also differ by their chemistry. Both share gyrophoric acid within their medulla, but *P. flavescens* additionally contains salazinic acid.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: inside the crater of Cerro Laguna at E side of island, on W-exposed slope, 1°16′11.80″S, 90°23′17″W, 245 m alt., transition zone, dense forest of *Prosopis juliflora*, *Clerodendrum molle*, very few *Bursera graveolens* and some *Jasminocereus thouarsii* in the upper part among lava outcrops and boulders, *Ramalina usnea/anceps* hanging in curtains from *Clerodendrum* twigs, on W-exposed slope of basalt outcrop, sunny, wind- and rain-exposed, 20-Jan-2011, Bungartz, F. 9973 (CDS 47342); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, cliff at NE side of trail (Mirador), 1°17′4.298″S, 90°26′36.60″W, 365 m alt., transition zone, ~10 m high lava cliff within dense scrub of *Clerodendrum molle*, *Croton scouleri* and *Macraea laricifolia*, one single *Acacia rorudiana* on top of cliff, on slope of basalt cliff, sunny, wind- and rain-exposed, 25-Jan-2011, Yánez-Ayabaca, A. 2135 (CDS 48509); Bungartz, F. 10219 (CDS 47638), 6607 (CDS 34827). ISLA SANTIAGO: along the trail from Bucanero to Jaboncillos, ~200 m below the summit, Cerro Gavilan, 0°12′9″S, 90°47′3″W, 796 m alt., upper transition zone; open *Psidium galapageium* forest with *Zanthoxylum fagara*, dense understory of *Clerodendrum molle*, *Tournefortia pubescens* and others, on E-exposed front to overhang of basalt boulder on top of cliff, sunny, wind- and rain-exposed, 23-Mar-2006, Bungartz, F. 4743 (CDS 28854); summit of Cerro Gavilan, inner N- and NE-exposed crater rim, 0°12′20″S, 90°47′3″W, 840 m alt., humid zone, N- and NE-exposed, steep basalt cliffs of crater rim with ferns (*Pityrograma calomelanos* var. *calomelanos*, *Polypodium tridens*, *Doryopteris palmata*, *Adiantum concinnum*, *Blechnum polypodioides*) growing in crevices, on lava rock, 23-Mar-2006, Aptroot, A. 65730 (CDS 32322). ISLA ISABELA, VOLCÁN ALCEDO: outer E-exposed slope just below the crater rim, 0°25′17″S, 91°5′8″W, 1077 m alt., humid zone, basalt outcrops, SE-exposed slope with scattered shrubs of *Tournefortia rufo-sericea*, *Opuntia insularis*, *Lantana peduncularis* and occasional trees of *Zanthoxylum fagara* among basalt rubble, on lava rock, 08-Mar-2006, Aptroot, A. 65174 (CDS 31758); VOLCÁN DARWIN: southwestern slope, above Tagus Cove, 0°13′59″S, 91°20′8″W, 597 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri* and *Macraea laricifolia* shrubs, few *Chiococca alba* and *Scalesia microcephala*, on rocks among lava boulders and outcrops, slope (45°) AA-lava, sunny, wind- and rain-exposed, 16-Nov-2007, Bungartz, F. 7791 (CDS 38300); VOLCÁN SIERRA NEGRA: top of eastern crater rim, 0°48′22.30″S, 91°5′15.80″W, 991 m alt., humid zone, W-exposed slope of inner crater rim with *Psidium guajava* shrubs, ferns, grasses, and scattered basalt rocks, on NW-exposed front of basalt boulder, semi-shaded, wind- and rain-sheltered, 08-Sep-2007, Bungartz, F. 6813 (CDS 36244), 6795 (CDS 36214); trail to Volcán Chico, along Sierra Negra crater, 0°48′41.70″S, 91°5′15.1″W, 987 m alt., humid zone, *Psidium guajava* shrubland with *Pteridium arachnoideum* on the ground, slope 25° SW, on basalt rocks at the side of the trail, 14-Aug-2008, Clerc, P. 08-164 (CDS 40018); Herrera-Campos, M.A. 10574 (CDS 40311).

Parmotrema grayanum (Hue) Hale, Phytologia 28: 336. 1974. (Fig. 13C–D)

Type: India, Tamil Nadu: Nilgiri Mountains [as 'Nilgherries'], Coonoor, Gray, M.C. 1893 (P – holotype, fide Hale 1965).

Thallus saxicolous; upper surface white to whitish gray, dull to ±shiny, epruinose, emaculate, occasionally cracked, but not forming a distinctly reticulate pattern; abundantly sorediate; soralia marginal, linear to labriform (±crescent-shaped), or subcapitate; soredia ±granular, typically discolored by a dark gray tinge, pale inside; lobes moderate-sized, 5–7(–10) mm wide, rotund, axils incised, margins sparsely ciliate; cilia short and slender, 0.1–2.5 mm long, black, mostly simple, very rarely branched; lower surface often blackened throughout or becoming dark brown towards the margin or, especially below the soredia, often mottled white, typically with a distinct, 1–2(–2.5) mm wide, erhizinate marginal zone; rhizines short, stout, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with protolichesterinic acid [P–, K–, KC–, C–, UV–].

Ecology and distribution. Africa, Asia, Oceania, North and South America (Hale 1965; Swinscow & Krog 1988; Chen et al. 2005; Jungbluth 2006). New for Ecuador; from the Galapagos previously reported only online (Bungartz et al. 2016); only rarely found, on exposed rock, in the transition zone and humid zone.

Notes. This saxicolous species closely resembles both *P. praesorediosum* and *P. mordenii* but it is distinctly ciliate along its lobe margin and does contain protolichesterinic acid in its medulla.

Specimens examined from Ecuador, Galápagos. ISLA SANTIAGO: along the trail from Bucanero to Jaboncillos, ~3 km SE of Bucanero, 0°10′52″S, 90°48′33″W, 362 m alt., transition zone, open woodland of large *Bursera graveolens* and smaller *Psidium galapageium* trees, grassland and basalt boulders in between, on lava rock, 22-Mar-2006, Aptroot, A. 65409 (CDS 31995). ISLA ISABELA, VOLCÁN ALCEDO: upper NNW-exposed slope inside the crater, 0°27′27″S, 91°7′23″W, 1055 m alt., humid zone, open vegetation with *Adianthus concinnum*, and scattered shrubs of *Tournefortia rufo-sericea* among basalt rocks, on NE-exposed slope (85°) of basalt boulder, sunny, wind- and rain-exposed, 05-Mar-2006, Bungartz, F. 4088 (CDS 28052); VOLCÁN CERRO AZUL: outer SE-exposed slope and crater rim, 0°27′29″S, 91°7′19″W, 1089 m alt., humid zone, tortoise pasture with scattered trees (*Tournefortia rufo-sericea*, *Zanthoxylum fagara*), on lava rock, 05-Mar-2006, Aptroot, A. 65115 A (CDS 31697); outer, lower, densely vegetated slopes of the crater rim, 0°57′9.096″S, 91°24′23.19″W, 1470 m alt., high altitude transition zone, dense grassy pasture with abundant Low Rattlebox (*Crotalaria pumila*), few, large basalt boulders, scarce *Tournefortia rufo-sericea* scrub and sparse Guayabillo trees (*Psidium galapageium*), on top of rocky outcrop in pasture, semi-shaded, 05-May-2012, Spielmann, A.A. 10531 (CDS 51888); Spielmann, A.A. 10530 (CDS 51887).

Parmotrema hypotropum (Nyl.) Hale, Phytologia 28(4): 337. 1974. (Fig. 13C–D)

Type: USA [at the time of the collection still part of MEXICO], Texas, Comancharies, Berlandier, J.L. 2093 & Trécul, A. (P – holotype, H – isotype, fide Hale 1965).

Thallus corticolous; upper surface white to whitish gray, dull to shiny, epruinose, densely and very finely

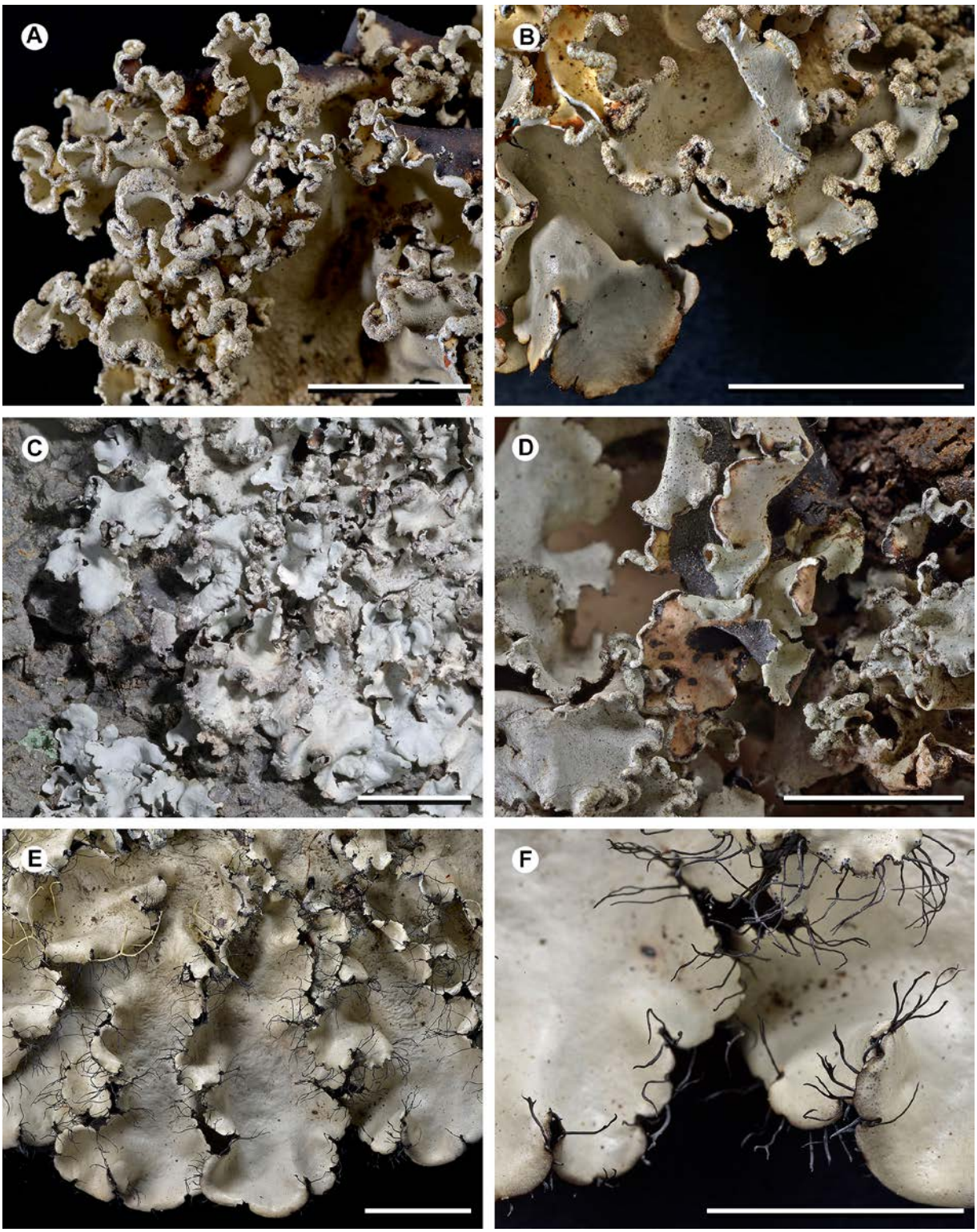

Figure 13. Sorediate *Parmotrema* species with a gray, emaculate surface (cortex with atranorin, medulla K–, P–). A – *P. cooperi*, overview of the thallus (Aptroot, A. 65659, CDS 32250); B – *P. cooperi*, close-up of the lobe margins with labriform soralia, mottled white below (Aptroot, A. 65659, CDS 32250); C – *P. grayanum*, overview of the thallus growing on rock (Bungartz, F. 4088, CDS 28052); D – *P. grayanum*, close-up of the lobe margins with labriform soralia, mottled white below (Spielmann, A. 10530, CDS 51887). E – *P. rampoddense*, thallus overview (Bungartz, F. 10220, CDS 47639); F – *P. rampoddense*, close-up of the lobes with long cilia (Bungartz, F. 10220, CDS 47639). Scales: A–F = 5 mm.

maculate, the maculae effigurate, typically not cracked; abundantly sorediate; soralia initially marginal, labriform to crescent-shaped, often merging and becoming subcapitate, rarely ±marginal and then ±convex-capitate; soredia farinose, surface often discolored by a ±grayish tinge, pale inside; lobes moderate-sized, 2–7 mm wide, rotund, axils ±rounded, margins sparsely to abundantly ciliate; cilia short and slender, 0.3–1.5 mm long, black, mostly simple, very rarely branched; lower surface often blackened throughout or becoming dark brown towards the margin or, especially below the soredia, often mottled white, typically with a distinct, 1–2 mm

wide, erhizinate marginal zone; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with norstictic, connorstictic and stictic acid [P+ yellow, K+ yellow, soon turning orange (crystals), KC–, C–, UV–].

Ecology and distribution. North America (Culberson 1973; Egan et al 2016); in South America only known from the Galapagos, first reported by Weber (1986) and subsequently by Elix & McCarthy (1998). A corticolous species found only on a few islands; all specimens collected in the dry zone, all on *Bursera graveolens*.

Notes. Abundantly maculate specimens of *P. hypotropum* may resemble those of *P. reticulatum* or *P. clavuliferum*, although its maculae are effigurate and generally much less conspicuous, forming a finer pattern that typically does not break into distinct cracks. The species further differs by its medullary chemistry (with stictic and norstictic instead of salazinic acid). Unlike *P. clavuliferum*, the soralia of *P. hypotropum* do not develop at the tip of elongate, laciniate lobes (clavulae); they are instead initially lining the lobe margins and resemble more closely the linear marginal soralia of *P. reticulatum*. However, as observed in *P. clavuliferum*, the surface below soredia of *P. hypotropum* is typically 'mottled', i.e., large patches of white, unpigmented areas are splotched among the otherwise uniformly deep brown to soon-blackened lower side.

Specimens examined from Ecuador, Galápagos. ISLA ESPAÑOLA: along S-coast of the island, SE of Punta Suárez, ~500 m inland from coast, 1°22′56.60″S, 89°43′8.40″W, 133 m alt., dry zone, lava cliff with *Cordia lutea*, *Ipomoea habeliana*, and frew trees of *Bursera graveolens*, on branch of *Bursera graveolens*, sunny, 10-Nov-2010, Yánez-Ayabaca, A. 1622 (CDS 45511); trail from Bahía Manzanillo on the N-coast of the island to the highest point, dry zone, open shrubland of *Cordia lutea* and *Prosopis juliflora* with few *Opuntia megasperma* var. *orientalis* and grass in the understory, on branch of *Cordia lutea*, 11-Nov-2010, Yánez-Ayabaca, A. 1703 (CDS 45586). ISLA SAN CRISTÓBAL: Pan de Azúcar, inland from Bahía Sardinas at the NW-coast of the island, 0°43′12″S, 89°21′14″W, 143 m alt., dry zone, NE-exposed slope on hill of consolidated tuff with low vegetation of herbs, on branches of *Bursera graveolens*, semi-shaded, wind- and rain-sheltered, 24-Apr-2007, Bungartz, F. 6456 (CDS 34673). ISLA SANTA FÉ: cerca la playita y el barranco en la costa norte de la isla, 0°48′12.80″S, 90°2′35.20″W, 26 m alt., zona seca, bosque abierto con arbustos y árboles dominantes en la zona como: *Bursera graveolens* y *Opuntia echios* var. *barringtonensis*, sobre *Bursera graveolens*, 25-Oct-2007, Nugra, F. 477 (CDS 37038), 475 (CDS 37036); lava flow at the N-coast of the island, 0°48′6.200″S, 90°2′39.77″W, 42 m alt., dry zone, S-exposed side of lava flow with scarce vegetation (shrubs of *Croton scouleri*, *Cordia lutea*, few *Bursera graveolens* trees, and *Opuntia echios* var. *barringtonensis*), on branches of *Bursera graveolens*, semi-shaded, ±wind- and rain-sheltered, 25-Oct-2007, Bungartz, F. 7268 (CDS 37752); 15-Feb-1964, Weber, W.A. & Orr, R.T. 210 (L-40415, COLO 190167).

Parmotrema internexum (Nyl.) Hale ex DePriest & B.W. Hale, Mycotaxon 67: 204. 1998. (Fig. 6A)

Type: Brazil, São Paulo: Serra near to Santos, 1844, Weddel s.n., (H-NYL35210 – holotype, fide Fleig 1997).

Thallus corticolous; upper surface whitish gray to ivory, shiny to ±dull, epruinose, emaculate, but occasionally in parts irregularly cracked; abundantly isidiate; isidia initially marginal but soon spreading across the thallus surface and, where eroded, frequently leaving distinct circular scars, cylindrical, simple to sparsely branched, brown at their tip or concolorous with the thallus surface, eciliate; lobes broad, small to moderate-sized, 0.7–6(–8) mm wide, ±rotund, axils incised, margins sparsely ciliate; cilia short and slender, 0.2–1(–1.5) mm long, black, mostly simple, very rarely branched; lower surface with a broad, deep brown, erhizinate, ~1–3 mm wide margin, blackening and densely rhizinate towards the thallus center; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with stictic, constictic and cryptostictic acid, and norlobaridone [P+ slowly orange, K+ yellow, KC+ rosé, turning orange, C+ rosé, turning orange, UV–].

Ecology and distribution. Africa, North and South America (Dodge 1959; Hale 1979; Fleig 1997; Eliasaro & Donha 2003; Spielmann & Marcelli 2009; Benatti & Marcelli 2010). New for Ecuador; from the Galapagos previously reported only online in Bungartz et al. (2016) and mentioned by Miquel & Bungartz (2017) as habitat and food for the endemic micro-mollusk *Pupisoma galapagorum* Pilsbry, 1934. So far only a single specimen has been collected, in the humid zone, on the small native tree *Zanthoxylum fagara*.

Notes. This isidiate corticolous species has only been found once in the Galapagos; due to the presence of norlobaridone it has a very distinctive KC+/C+ medullary spot test reaction: initially rosé, soon turning orange.

Specimens examined from Ecuador, Galápagos. ISLA SANTIAGO: Jaboncillos dentro, 0°12′18″S, 90°47′4″W, 814 m alt., humid zone, S-exposed, steep basalt cliffs of crater rim with ferns growing in crevices (*Pityrograma calomelanos* var. *calomelanos*, *Polypodium tridens*, *Doryopteris palmata*, *Adiantum concinnum*, *Blechnum polypodioides*), on *Zanthoxylum fagara*, 24-Mar-2006, Aptroot, A. 65545 (CDS 32134).

Parmotrema lacteum Marcelli & Spielmann, in Marcelli, Jungbluth, Benatti, Spielmann, Canêz, Cunha & Martins, Biblthca Lichenol. 96: 215. 2007. (Fig. 9A)

Type: Brazil, Rio Grande do Sul: Boqueirão do Leão, Spielmann, A.A. 1307 & Sulzbacher, M.A. (SP – holotype!).

Thallus corticolous; upper surface white to whitish gray, dull to shiny, epruinose, densely reticulate-maculate, typically cracked; abundantly isidiate; isidia marginal and laminal, cylindrical, sparsely branched to distinctly

coralloid, often clustered (caespitose) and apically breaking apart into soredia, the isidia located along the lobe margin typically longer and more elaborate, often with a brown to blackened tip, frequently ciliate (thus appearing 'tufted'); lobes small to moderate-sized, 0.3–4(–5) mm wide, ±angular, axils rounded but not forming conspicuous loops, margins sparsely to abundantly ciliate; cilia short and slender, 0.2–0.8(–1) mm long, black, mostly simple, very rarely branched; lower surface black, gradually becoming dark brown towards the margin, lacking a distinctly erhizinate zone, the marginal rhizines not much shorter than the central ones; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Ecology and distribution. Africa (Cape Province), Brazil (Marcelli et al. 2007; Spielmann 2009). New for Galapagos and previously not reported from Ecuador; a single historical specimen has been collected on *Bursera* by Weber on Floreana Island, followed by an additional recent collection, also on *Bursera*, in the transition zone, at Mina Granillo Rojo, on Santa Cruz Island.

Notes. *Parmotrema lacteum* is one of several isidiate species with a gray, distinctly reticulate-maculate surface, and salazinic acid in its medulla. The species is unusual because of its unique isidia that typically form clusters breaking apart into irregular soredia. Specimens then look 'peppered' with granular soredia.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: along trail from Black Beach to Cruz farm, on bark of *Bursera*, 25-Apr-1976, Weber, W.A. s.n. (CDS 10850). ISLA SANTA CRUZ: above Mina Granillo Rojo, on the N side of the island, 0°37′4.40″S, 90°21′57″W, 600 m alt., transition zone, upper transition zone with *Bursera graveolens*, *Psidium galapageium*, *Scalesia pedunculata* and *Opuntia echios*, N-exposed, very little slope, on bark of *Bursera graveolens*, 07-Aug-2008, Clerc, P. 08-30 (CDS 39884).

Parmotrema latissimum (Fée) Hale, Phytologia 28: 337. 1974. (Fig. 1D)

Type: Jamaica [State or Province and exact locality, and collector unknown], s.c., (G – lectotype!, designated by Hale 1965).

Thallus corticolous, rarely saxicolous; upper surface whitish gray to ivory, shiny to ±dull, epruinose, emaculate, not cracked, but older parts ±wrinkled; lacking vegetative propagules; lobes moderate-sized to large, 4–12 mm wide, ±rotund, eciliate, distinctly delimited along the lobe edge by a conspicuous black rim; lower surface with a broad, pale to deep brown erhizinate, ~3–5(–7) mm wide margin, blackening and sparsely rhizinate towards the thallus center; rhizines short, stout, black, mostly simple, rarely sparsely branched, often clustered in groups, with erhizinate areas in between; medulla white. Apothecia absent, or rare to moderately abundant, 0.5–9 mm in diam., with a cupulate thalline margin, disc pale brown, deeply concave, imperforate; asci clavate, *Lecanora*-type, ascospores 8/ascus, simple, broadly ellipsoid, (25.7–)27.8–34.1(–34.7) × (14.9–)15.7–17.3(–17.8) µm (n = 25), very thick-walled (~2–3 µm thick). Pycnidia not observed in the Galapagos (the lectotype according to Spielmann 2009 has abundant, conspicuous pycnidia with a black ostiole and sublageniform conidia, 6–8 × ~1.0 µm).

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Ecology and distribution. Asia (Hale 1965; Divakar & Upreti 2005), North, Central and South America (Hale 1965; Fleig & Riquelme 1991; Egan et al. 2016); cited from continental Ecuador by Cevallos Solórzano (2012). From Galapagos previously reported only online (Bungartz et al. 2016); only one recent and one historical specimen collected, both from the transition zone of San Cristóbal Island.

Notes. In Galapagos, *P. latissimum* is one of only three species found without vegetative propagules. Superficially it is most similar to *P. mesotropum*, which also has broad, rotund lobes, typically growing on bark, but that species lacks salazinic acid and medullary spot test reactions are all negative. Most specimens of *P. latissimum* are corticolous and thus easily distinguished from the exclusively saxicolous *P. eborinum*. *Parmotrema eborinum* generally has much smaller lobes (see description) that are densely lobulate; its medulla contains protocetraric instead of salazinic acid.

Specimens examined from Ecuador, Galápagos. ISLA SAN CRISTÓBAL: Cerro Mundo, at the top of the rock cliffs on the S side close to the summit, 0°53′19.5″S, 89°34′24.30″W, 282 m alt., transition zone, with *Bursera graveolens*, *Croton scouleri* and *Jasminocereus thouarsii*, slope 15° S, on bark of *Bursera*, 25-Aug-2008, Clerc, P. 08-402 (CDS 40256); near Tortugueria Cerro Colorado, 0°54′56″S, 89°26′18″W, 130 m alt., transition zone, on bark of *Hippomane*, 02-Jun-2005, Aptroot, A. 63420 (CDS 30175); S-slope of Cerro Mundo, shortly below the top; NE of Puerto Baquerizo Moreno and ~2.5 km NW of El Progreso, 0°53′21.80″S, 89°34′25.5″W, 228 m alt., transition zone, at bottom of SE-exposed basalt cliffs in dense forest of *Bursera graveolens*, *Zanthoxylum fagara*, *Piscidia carthagenensis* and *Croton scouleri*, on dead twig, semi-shaded, wind- and rain-sheltered, 25-Aug-2008, Bungartz, F. 8684 (CDS 41330).

Parmotrema lawreyi Bungartz & Spielmann, sp. nov. (Fig. 4D)

MycoBank MB 832664

Diagnosis: Differs from *P. dominicanum* by the presence of coralloid to cauliflower-like isidia that rupture to release soredia.

Type: Ecuador. Galápagos: Isla San Cristóbal, northwestern foothills of Media Luna, inland from the NW-coast, 0°43′41″S, 89°18′44″W, 75 m alt., dry zone, open woodland of *Cordia lutea* and *Bursera graveolens*, on NE-exposed trunk of *Bursera graveolens* (~20 cm in diam.), semi-shaded, ±wind- and rain-sheltered, 22-Apr-2007, Bungartz, F. 6187 (CDS 34399 – holotype!).

Thallus corticolous; upper surface pale greenish yellow, dull, emaculate, smooth, not wrinkled, occasionally

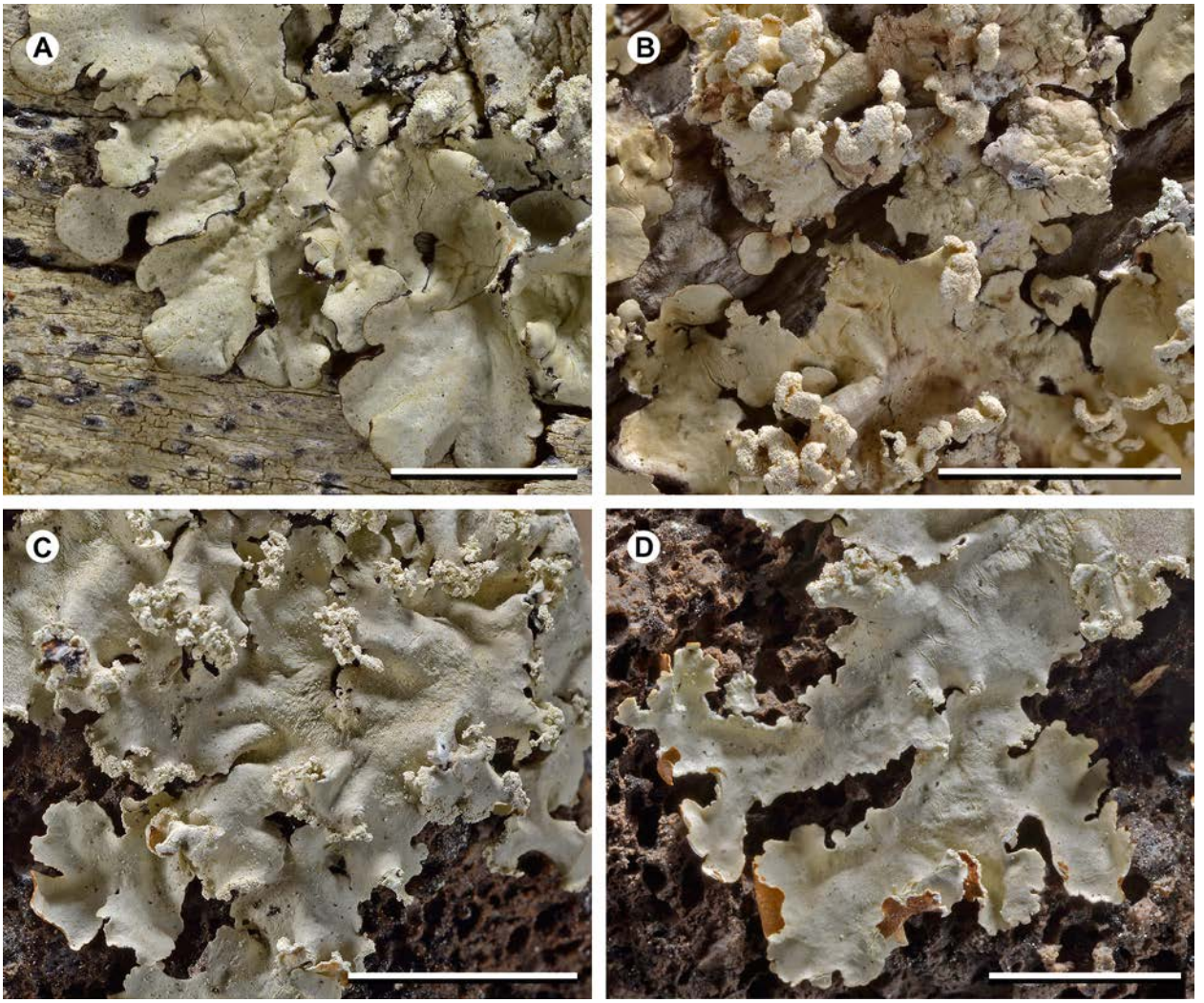

Figure 14. Sorediate *Parmotrema* species with gray, emaculate surface (cortex with atranorin, medulla K–, P–). A – *P. praesorediosum*, overview of thallus growing on wood (Yánez-Ayabaca, A. 2004, CDS 48354); B – *P. praesorediosum*, close-up of thallus lobes with marginal subcapitate soralia (Bungartz, F. 4597, CDS 28684); C – *P. soredioaliphaticum*, overview of thallus growing on rock, lobes with marginal, ±cauliflower-like soralia (Bungartz, F. 7340, CDS 37827); D – *P. soredioaliphaticum*, angular lobes with granular soredia (Bungartz, F. 7340, CDS 37827). Scales: A–D = 5 mm.

cracked, but not forming a distinctly reticulate pattern; pustulate-isidiate, rupturing into soralia; isidia submarginal to laminal, very variable, initially cylindrical to dactyliform (constricted at their base, apically tapering), sometimes ±flattened and almost squamulose-lobulate, with age increasingly branched, becoming coralloid to cauliflower-shaped and then rupturing into coarse, granular, ±pseudocorticate soredia; lobes moderate-sized, (3–)7–10 mm wide, rotund, axils incised, margins eciliate (very rarely with few cilia); cilia, if present, stout, short, 0.3–.05 mm long, black, mostly simple, rarely branched; lower surface with a erhizinate, ~1–2(–2.5) mm wide, deep brown margin, moderately to densely rhizinate and blackened towards the center; rhizines short, stout, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with both usnic acid and atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with protocetraric acid only [P+ yellow turning orange, K+ dirty yellowish brown, KC–, C–, UV–].

Etymology. Named in honor of our good friend and colleague James D. Lawrey, to whom this publication is dedicated on the occasion of his 70th birthday.

Ecology and distribution. Endemic to the Galapagos; known from a few collections in the dry zone of Floreana, San Cristobal and Volcán Alcedo; all specimens collected on bark of *Bursera graveolens*, both in sunny, exposed and ±shaded and sheltered habitats.

Notes. The pustular, initially cylindrical isidia that soon develop into large, cauliflower-shaped clusters, breaking apart into coarse granular soredia, distinguish this species from the much more common *P. dominicanum*.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, 1°15′42.27″S, 90°26′31″W, 197 m alt., dry zone, open forest of *Bursera graveolens* and some *Prosopis juliflora* on W-exposed slope, dry herbaceous vegetation and small boulder field, on S-exposed trunk of *Bursera graveolens* (~25 cm in diam.), sunny, wind- and rain-exposed, 14-Jan-2011, Bungartz, F. 9621 (CDS 46900). ISLA SAN CRISTÓBAL: near Rosa Blanca, inland from the

SE-coast of the island, 0°49′9″S, 89°21′48″W, 12 m alt., dry zone, open *Bursera graveolens* woodland with *Mentzelia aspera* and *Scalesia incensa* shrubs on lava flow, on trunk of *Bursera* (~10 cm in diam.), semi-shaded, ±wind- and rain-sheltered, 23-Apr-2007, Bungartz, F. 6396 (CDS 34611); ISLA ISABELA, VOLCÁN ALCEDO: along the trail going up the E-slope, basalt rubble field to the SE side of the trail and the barranco, 0°24′6″S, 91°2′53″W, 530 m alt., dry zone, basalt rubble field with scattered vegetation (*Bursera graveolens*, *Zanthoxylum fagara*, *Pisonia floribunda*, *Senna pistaciifolia*), on *Bursera*, 10-Mar-2006, Aptroot, A. 64917 (CDS 31496).

Parmotrema marcellianum Spielmann & Bungartz, sp. nov. (Fig. 10E–F)

MycoBank MB 832665

Diagnosis: Similar to *Parmotrema clavuliferum* but exclusively saxicolous, clavulae white below, but speckled with black, lobes abundantly ciliate and generally much smaller, their lower side lacking a distinct erhizinate margin; unlike fertile *P. herrei* with shorter, simple cilia, and reproducing with soredia.

Type: Ecuador. Galápagos: Isla Floreana, Cerro Ventanas, top and upper slope at southern point of the ridge, 1°16′25.89″S, 90°25′42.20″W, 424 m alt., transition zone, lower transition zone; low vegetation of *Lecocarpus pinnatifidus* and some *Macraea laricifolia* shrubs, much open ground with small lava pebbles, overgrowing pebbles on the ground, sunny, wind- and rain-exposed, 18-Jan-2011, Bungartz, F. 9881 (CDS 47219 – holotype! CGMS – isotype!).

Thallus saxicolous; upper surface white to whitish gray, dull to shiny, epruinose, densely reticulate-maculate, often cracked; abundantly sorediate; soralia capitate, conspicuously stalked, at the tip of distinct, short to elongate, laciniate lobes (clavulae); soredia ±granular, surface creamy white, typically not discolored; lobes small, narrow, 0.5–2(–2.5) mm wide, ±angular, abundantly ciliate; cilia short and slender, 0.3–1 mm long, black, mostly simple, very rarely branched; lower surface blackened throughout or strongly dark brown at the very edge of the lobes, the rhizines growing all the way to the edge of the lobe, lacking a distinct deep brown erhizinate lower margin, the lower cortex occasionally in parts mottled white (especially below the clavulae); rhizines, where present, long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia not observed among Galapagos specimens. Pycnidia immersed, globose; ostiole brownish black; conidia filiform, (9.0–)10.0–12.0 µm ~1 µm (n = 14).

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Etymology. Named in honor of our colleague and good friend Marcelo Pinto Marcelli, in recognition of his work on the lichen family Parmeliaceae.

Ecology and distribution. Endemic to the Galapagos; apparently rare, few collections from Floreana and Isabela Island (Volcán Darwin and Volcán Sierra Negra); from the dry zone through the transition zone and humid zone into the high altitude dry zone; all specimens from exposed rock surfaces (pebbles, small rocks and boulders).

Notes. *Parmotrema marcellianum* is overall very similar to *P. clavuliferum* but is exclusively saxicolous, more conspicuously ciliate, and has much smaller lobes. The species generally lacks an erhizinate zone along its lower lobe margin, and the underside is almost entirely blackened throughout; only rarely is the immediate edge of the lower side of the lobes very dark brown, and sometimes the *clavulae* have whitish flecks below (unlike those of *P. clavuliferum*, which are generally white below). The new species is similar in overall appearance to *P. herrei* (Zahlbr.) Spielmann & Marcelli, but that species presents much longer and branched cilia and it is regularly found with apothecia and lacks vegetative propagules (Marcelli et al. 2011).

Specimens examined from Ecuador, Galápagos. ISLA ISABELA, VOLCÁN DARWIN: ~1.5 km from the southwestern crater rim, 0°12′20.5″S, 91°18′52.77″W, 1280 m alt., high altitude dry zone, on basalt outcrop bare of vegetation, exposed rock, 14-Nov-2007, Ertz, D. 11870 A (CDS 37229), 11879 (CDS 37238); southwestern slope, above Tagus Cove, 0°13′59″S, 91°20′8″W, 597 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri* and *Macraea laricifolia* shrubs, few *Chiococca alba* and *Scalesia microcephala*, among lava boulders and outcrops, on small basalt rock partially shaded by overhang, semi-shaded, ±wind- and rain-sheltered, 16-Nov-2007, Bungartz, F. 7810 (CDS 38319); VOLCÁN SIERRA NEGRA: top of eastern crater rim, 0°48′22.30″S, 91°5′15.80″W, 991 m alt., humid zone, W-exposed slope of inner crater rim with *Psidium guajava* shrubs, ferns, grasses, and scattered basalt rocks, on top of basalt boulder under a shrub, semi-shaded, wind- and rain-sheltered, 08-Sep-2007, Bungartz, F. 6791 (CDS 36210); trail to Volcán Chico, along Sierra Negra crater, 0°48′41.70″S, 91°5′15.1″W, 987 m alt., humid zone, *Psidium guajava* shrubland with *Pteridium arachnoideum* on the ground, slope 25° SW, on basaltic rocks along the side of the trail, 14-Aug-2008, Clerc, P. 08-163 (CDS 40017).

Parmotrema mellissii (C.W. Dodge) Hale, Phytologia 28: 337. 1974. (Fig. 6B–D)

Type: Saint Helena [exact locality unknown], Melliss, J.C. 23 (K – holotype, US – isotype, fide Hale 1965, and Fleig 1997).

Thallus corticolous; upper surface whitish gray to ivory, occasionally with large, mottled-black patches, dull, epruinose, emaculate, but occasionally in parts irregularly cracked; sparsely to abundantly isidiate; isidia marginal, cylindrical, simple to sparsely or abundantly branched (coralloid) and then clustered (caespitose), brown to blackened at their tip and frequently ciliate (having a 'tufted' appearance); lobes broad, moderate-sized, 0.7–5(–7) mm wide, ±rotund, axils incised, margins abundantly ciliate; cilia long and slender, 0.5–5(–8) mm long, black, mostly simple, very rarely branched; lower surface black, with a distinctly erhizinate, 0.5–2.5 mm wide, dark brown to black marginal zone; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia absent or rare, 0.3–7 mm in diam., with a cupulate thalline margin that is typically speckled by abundant isidia, disc dark brown, deeply concave, imperforate; asci clavate, *Lecanora*-type, ascospores 8/ascus, simple, broadly ellipsoid, (14.9–)16.0–21.3(–22.3) × (9.4–)11.0–14.1(–14.9) µm (n = 15), thick-walled (~1 µm thick). *Pycnidia* not observed.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with alectoronic and α-collatolic acid [P–, K–, KC+ rosé, quickly orange, C–, UV+ greenish blue].

Ecology and distribution. Oceania, Asia, Africa, North, Central and South America (Hale 1965; Awasthi 1976; Swinscow & Krog 1988; Malcolm & Galloway 1997; Louwhoff & Elix 1999; Kurokawa & Lai 2001; Kantvilas et al. 2002; Spielmann & Marcelli 2009; Marcelli & Benatti 2011). Previously reported from Galapagos only online (Bungartz et al. 2016); relatively rare, most collections from the humid zone, few from the upper transition zone; on sunny, wind- and rain-exposed rock or bark.

Notes. Well developed thalli of *P. mellissii* have repeatedly branched, coralloid isidia. These isidia are usually abundantly ciliate and thus ±'tufted'. Isidia of *P. neosubcrinitum* and *P. ultralucens* are typically not as elaborately branched, more densely clustered, but typically also abundantly ciliate. Of these similar species only *P. mellissii* contains alectoronic acid, with a medulla that reacts KC+ rosé, quickly turning orange, also displaying UV+ greenish blue fluorescence. In Galapagos only *P. rampoddense* has a similar secondary chemistry. Its medulla also contains both α-collatolic and alectoronic acid, but *P. rampoddense* is sorediate and *P. mellissii* is isidiate.

Specimens examined from Ecuador, Galápagos. ISLA SANTA CRUZ: along the trail from Media Luna to El Puntudo, near a small stream crossing the trail, 0°39′4″S, 90°20′5″W, 690 m alt., humid zone, forest of *Cinchona pubescens*, occasionally with *Miconia robinsoniana*, *Pteridium arachnoideum*, and *Lycopodium* sp., on *Cinchona*, 28-Feb-2006, Aptroot, A. 64657 (CDS 31231); near Puntudo, 0°38′41″S, 90°20′13″W, 750 m alt., humid zone, on lava rock, 27-May-2005, Aptroot, A. 63209 (CDS 29941); near the CDRS field-weather station below the summit of Cerro Crocker, 0°38′35″S, 90°19′42″W, 830 m alt., humid zone, much overgrown with dead *Cinchona pubescens* trees, N-exposed slope, on trunks and twigs of dead *Cinchona pubescens* trees, 28-Dec-2005, Bungartz, F. 3319 (CDS 26974); on the North side of the island, along the dirt road to the ash quarry Mina Granillo Rojo, 0°36′56″S, 90°22′3″W, 570 m alt., lower transition zone, dry semi-deciduous forest with *Bursera graveolens* and *Zanthoxylum fagara*, on branches of *Bursera graveolens*, sunny, wind- and rain-exposed, 23-Feb-2006, Bungartz, F. 3917 (CDS 27799). ISLA SANTIAGO: along the trail from Bucanero to Jaboncillos, ~200 m below the summit, Cerro Gavilan, 0°12′9″S, 90°47′3″W, 796 m alt., upper transition zone; open *Psidium galapageium* forest with *Zanthoxylum fagara*, dense understory of *Clerodendrum molle*, *Tournefortia pubescens* and others, on E-exposed front to overhang of basalt boulder on top of cliff, sunny, wind- and rain-exposed, 23-Mar-2006, Bungartz, F. 4744 (CDS 28855); summit of Cerro Gavilan, inner N- and NE-exposed crater rim, 0°12′20″S, 90°47′3″W, 840 m alt., humid zone, N- and NE-exposed, steep basalt cliffs of crater rim with ferns growing in crevices (*Pityrograma calomelanos* var. *calomelanos*, *Polypodium tridens*, *Doryopteris palmata*, *Adiantum concinnum*, *Blechnum polypodioides*), on SE-exposed front of basalt cliff, sunny, wind- and rain-exposed, 23-Mar-2006, Bungartz, F. 4754 A (CDS 28886); Aptroot, A. 65741 (CDS 32333). ISLA ISABELA, VOLCÁN ALCEDO: outer E-exposed slope just below the crater rim, 0°25′17″S, 91°5′8″W, 1077 m alt., humid zone, basalt outcrops, SE-exposed slope with scattered shrubs of *Tournefortia rufo-sericea*, *Opuntia insularis*, *Lantana peduncularis* and occasional trees of *Zanthoxylum fagara* among basalt rubble, on E-exposed front of basalt outcrop, sunny, wind- and rain-exposed, 08-Mar-2006, Bungartz, F. 4301 (CDS 28374), 4303 (CDS 28376); Aptroot, A. 65175 (CDS 31759); VOLCÁN SIERRA NEGRA: El Mango, on the E side of the dirt road, 0°53′1.7″S, 91°0′50.77″W, 162 m alt., lower transition zone; basalt lava outcrop with scattered vegetation (*Polypodium* sp., *Pityrogramma calomelanos*, *Darwiniothamnus tenuifolia*), on dead twigs of shrub, sunny, wind- and rain-exposed, 15-Aug-2008, Bungartz, F. 8218 (CDS 40864); Herrera-Campos, M.A. 10592 (CDS 40329).

Parmotrema cf. ***mesotropum*** (Müll. Arg.) Hale, Phytologia 28(4): 337. 1974. (Fig. 1E)

Type: Paraguay, Distrito Capital: Asunción, Balanso, R. s.n. (G – lectotype, fide Hale 1965).

Thallus corticolous; upper surface whitish gray to ivory, dull to shiny, epruinose, emaculate, typically not cracked; lacking vegetative propagules; lobes moderate-sized to large, 5–10 mm wide, rotund, axils incised, margins eciliate; lower surface with a very broad, distinct, pale brown, 3–6 mm wide, erhizinate marginal zone, the brown pigmentation becoming darker and eventually black towards the thallus center; rhizines short, slender, initially pale brown, darkening and eventually black towards the thallus center, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with an unidentified substance (pale spot at R_f 30 in solvent C) [P–, K–, KC–, C–, UV–].

Ecology and distribution. Asia, North, Central and South America (Hale 1965; Divakar & Upreti 2005; Egan et al. 2016; Torres 2018). New for Ecuador and the Galapagos; only a single specimen known (from Volcán Darwin, Isabela).

Notes. The single specimen is here identified with some hesitation as *P.* cf. *mesotropum*. It is sterile and lacks both soredia and apothecia; unlike *P. mesotropum* s.str., this specimen does not contain caperatic and protolichesterinic acid, but instead we observed only a pale unidentified spot at R_f 30 in solvent C.

Specimens examined from Ecuador, Galápagos. ISLA ISABELA, VOLCÁN DARWIN: southwestern foothills, above Tagus Cove (1st campsite), 0°14′50″S, 91°21′29.89″W, 67 m alt., dry zone, open *Bursera graveolens* forest with *Waltheria ovata* and *Macraea laricifolia*, few *Acacia rorudiana* and *Cordia lutea*, along small lava flow, on twigs of *Acacia rorudiana*, sunny, wind- and rain-exposed, 11-Nov-2007, Bungartz, F. 7372 (CDS 37859).

Parmotrema mordenii (Hale) Hale, Phytologia 28(4): 337. 1974. (Fig. 12A–B)

Type: Dominica. Saint Joseph: North of Coulibistri, ~30 m alt., Hale, M.E. 35649 (US – holotype, BM – isotype, UPS – isotype, fide Hale 1971).

Thallus saxicolous; upper surface white to whitish gray, dull to ±shiny, epruinose, emaculate, occasionally cracked, but not forming a distinctly reticulate pattern; abundantly sorediate; soralia marginal, linear to ±subcapitate or almost coralloid ('subfatiscent'); soredia ±granular, ±concolorous or slightly paler than the thallus surface, sometimes with a faint brownish tinge, pale inside; lobes moderate-sized, 5–7(–10) mm wide, rotund, axils incised, margins eciliate; lower surface with an erhizinate, ~1–2(–2.5) mm wide, deep brown margin, moderately to densely rhizinate and blackened towards the center; rhizines short, stout, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with atranorin, praesorediosic and protopraesorediosic acid [P+ yellow, K+ yellow, KC–, C–, UV–].

Ecology and distribution. Africa, North, Central and South America (Hale 1971; Winnem 1975; Spielmann & Marcelli 2009; Egan et al. 2016). New for Galapagos; moderately common, from the coastal zone through the dry zone and transition zone into the humid zone, most abundant in the transition zone; exclusively saxicolous; mostly at sunny, wind- and rain-exposed sites, less frequently in ±shaded and sheltered habitats.

Notes. *Parmotrema mordenii* is the only species known from the Galapagos that contains atranorin in its medulla. It is superficially very similar to *P. praesorediosum*, which, however, is mostly corticolous or lignicolous and only rarely grows on rock. The two species are best distinguished by their chemistry: both contain praesorediosic and protopraesorediosic acid within their medulla; however, *Parmotrema mordenii* contains atranorin not only in its cortex but also in its medulla, which therefore reacts P+/K+ yellow. Medullary spot test reactions of *P. praesorediosum* are all negative. Morphologically, distinguishing the two species is difficult. *Parmotrema praesorediosum* has soralia that are more distinctly crescent-shaped, whereas they are linear to subcapitate in *P. mordenii*, or, if unusually well developed, even coralloid (Hale 1971 then uses the term 'subfatiscent').

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: along trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, at Laguna Seca, 1°15′30.80″S, 90°26′26.60″W, 206 m alt., dry zone, very open *Bursera graveolens* forest over SE-exposed lava flow with *Prosopis juliflora*, on the front of a lava rock, sunny, wind- and rain-exposed, 14-Jan-2011, Yánez-Ayabaca, A. 1881 (CDS 48236); at the base of Cerro Comunista, 1°17′22.89″S, 90°28′22.39″W, 158 m alt., dry zone, dense low forest of *Croton scouleri*, *Waltheria ovata* and *Castela galapageia* with occasional trees of *Acacia rorudiana* and *Bursera graveolens*, at top of basalt rock, sunny, 16-Jan-2011, Yánez-Ayabaca, A. 1961 (CDS 48311); caldera of Cerro Pajas, trail at the end of road leading up to crater rim, 1°17′54.27″S, 90°27′22.5″W, humid zone, forest, on basalt pebble lying on the ground, semi-shaded, wind- and rain-sheltered, 02-Jan-2010, Hillmann, G. GAL-149 (CDS 44841); lower S-slope of Cerro Ventanas, 1°16′36.10″S, 90°25′41.10″W, 295 m alt., transition zone, open shrubland of *Macraea laricifolia* and some lower *Waltheria ovata* shrubs in between, on top of basalt rock, sunny, wind- and rain-exposed, 18-Jan-2011, Yánez-Ayabaca, A. 2020 (CDS 48370), 2021 (CDS 48371); Bungartz, F. 9861 (CDS 47199), 9854 (CDS 47192); Pampa Larga, S of Cerro Asilo de la Paz, 1°19′38.70″S, 90°27′11.6″W, 249 m alt., transition zone, herbaceous vegetation with dominant *Phyla strigulosa*, occasional grasses and other herbs, few small shrubs of *Geoffroea spinosa*, at top of small basalt rock lying on the ground, sunny, wind- and rain-exposed, 13-Jan-2011, Bungartz, F. 9427 (CDS 46714), 9432 (CDS 46719); trail from La Primavera Farm to La Corona and Arco de la Reina, southeastern part of the island, 1°19′21.60″S, 90°24′45.89″W, 219 m alt., transition zone, very dense scrub of *Clerodendrum molle* with some *Croton scouleri*, *Waltheria ovata*, few *Prosopis juliflora* and occasional trees of *Geoffroea spinosa* in flat area on generally SE-exposed, moderately inclined slope with few boulders, at top of basalt rock, sunny, wind- and rain-exposed, 24-Jan-2011, Yánez-Ayabaca, A. 2091 (CDS 48437); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, 1°16′57.27″S, 90°26′41.10″W, 310 m alt., transition zone, open shrubland of *Croton scouleri*, *Zanthoxylum fagara*, *Macraea laricifolia*, *Waltheria ovata* and lava rocks; *Ramalina usnea/anceps* forming long curtains hanging from branches, on top of small basalt rock, sunny, wind- and rain-exposed, 14-Jan-2011, Bungartz, F. 9576 (CDS 46855). ISLA PINTA: N-exposed slope of highest point of the island, at crater rim, 0°35′6″N, 90°45′10″W, 620 m alt., humid zone, dense vegetation of ferns and low shrubs, on SE-exposed front of basalt cliff, sunny, wind- and rain-exposed, 26-Feb-2007, Bungartz, F. 5753 (CDS 33408). ISLA PINZÓN: lower N-slopedry zone, 15-Feb-1964, Cavagnaro, D. s.n. (L-44017, COLO 190177). ISLA SAN CRISTÓBAL: Cerro Colorado, enclosure for *Calandrinia galapagosa* near the viewpoint on the top, 0°54′58″S, 89°26′5″W, 130 m alt., transition zone, open scrubland with *Croton scouleri*, *Macraea laricifolia*, *Calandrinia galapagosa*, *Lecocarpus darwinii* and few trees of *Piscidia carthagenensis* among lava boulders on SE-exposed slope of cinder cone, on E-exposed slope of small rock of soft and weathered tuff, sunny, wind- and rain-exposed, 29-Apr-2007, Bungartz, F. 6722 (CDS 34966). ISLA SANTA CRUZ: Puerto Ayora, cliff N of the town, 0°43′59″S, 90°18′45″W, 20 m alt., dry zone, on lava rock, 11-Feb-2006, Aptroot, A. 63716 (CDS 30271); near begin of road to Baltra, 0°44′34″S, 90°18′45″W, 25 m alt., dry zone, on lava rock, 26-May-2005, Aptroot, A. 63092 (CDS 29822). ISLA SANTIAGO: at the W-coast of the island in Bahía Ladilla, 0°18′8″S, 90°49′56″W, 10 m alt., coastal zone, S-exposed coastal lava cliff and boulders, on S-exposed slope of basalt boulder, sunny, wind- and rain-exposed, 22-Jul-2006, Bungartz, F. 5408 (CDS 29624), 5368 (CDS 29584); SE of James Bay, 0°16′45″S, 90°50′0″W, 40 m alt., dry zone, open *Bursera* forest on a lava flow, on rock, 26-Apr-1971, Pike, L.H. 2581 (OSC 101816); 0°13′50″S, 90°50′50″W, 15 m alt., dry zone, open *Bursera* forest on S-facing slope of red cinder cone next to sea and nearly surrounded by recent lava flow, on rock, 28-Apr-1971, Pike, L.H. ID14-3 (OSC 98702). ISLA ISABELA, VOLCÁN ALCEDO: outer SE-exposed slope and crater rim, 0°27′29″S, 91°7′19″W, 1089 m alt., humid zone, tortoise pasture with scattered trees (*Tournefortia rufo-sericea*, *Zanthoxylum fagara*), on lava rock, 05-Mar-2006, Aptroot, A. 65115 B (CDS 36579); along the trail going up the E-slope, at the NW side of the trail, 0°24′2″S, 91°2′36″W, 410 m alt., dry zone, basalt boulders and outcrops at the NW-exposed slope of the barranco, *Bursera graveolens* and *Zanthoxylum fagara* growing in between, on E-exposed front of basalt boulder, semi-shaded, wind- and rain-sheltered, 09-Mar-2006, Bungartz, F.

Figure 15. Sorediate *Parmotrema* species with gray, emaculate surface (cortex with atranorin, medulla with salazinic acid). A – *P. cristiferum*, overview of thallus growing on rock (Bungartz, F. 4261, CDS 28332); B – *P. cristiferum* close-up of lobes with labriform soralia (Bungartz, F. 4261, CDS 28332); C – *P. cristiferum*, close-up of upturned lobe exposing mottled white lower surface (Bungartz, F. 9582, CDS 46861); D – *P. cristiferum*, close-up of specimen with few, short cilia (most specimens typically eciliate but a very few have sparse, short cilia) (Aptroot, A. 65271, CDS 31857); E – *P. erectociliatum*, overview of thallus (Weber, W.A. 403, L-40540, COLO 192658 – holotype); F – *P. erectociliatum*, close-up of lobes with marginal soralia and abundant cilia which are typically upturned-erect (±perpendicular to lobe surface) (Weber, W.A. 403, L-40540, COLO 192658 – holotype). Scales: l A–F = 5 mm.

4397 (CDS 28482); VOLCÁN CERRO AZUL: along the trail from Caleta Iguana to the first Caseta del Parque, 0°59′13.6″S, 91°25′39.27″W, 300 m alt., transition zone, open *Psidium guajava* forest, with *Zanthoxylum fagara*, *Tournefortia rufo-sericea*, and *Darwiniothamnus lancifolius*, on top of basaltic rock, sunny, 02-May-2012, Spielmann, A.A. 10372 (CDS 51728); lower crater slopes above the first Caseta del Parque; within the cloud layer, 0°58′36.77″S, 91°25′26.19″W, 456 m alt., humid zone, open Guajava forest, with sparse *Psidium guajava* shrubs, few larger *Zanthoxylum fagara* trees, and *Tournefortia rufo-sericea* scrub, on front of basaltic rock, sunny, wind- and rain-exposed, 03-May-2012, Spielmann, A.A. 10441 (CDS 51797); wide,

open ditch between two lava ridges to the West above Cerro Verde, 0°57′9.40″S, 91°24′31.5″W, 1436 m alt., humid zone, small, shaded woodland of *Tournefortia rufo-sericea*, *Cordia leucophlyctis* and *Psidium galapageium*, inside encañada, semi-shaded, on slope and front of rock, 06-May-2012, Spielmann, A.A. 10565 (CDS 51934); VOLCÁN DARWIN: southwestern foothills, above Tagus Cove, 0°14′50″S, 91°21′29.89″W, 67 m alt., dry zone, open *Bursera graveolens* forest with *Waltheria ovata* and *Macraea laricifolia*, few *Acacia rorudiana* and *Cordia lutea*, along small lava flow, on exposed basalt rock, 11-Nov-2007, Ertz, D. 11758 B (CDS 56245); southwestern slope, above Tagus Cove, 0°13′59″S, 91°20′8″W, 597 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri* and *Macraea laricifolia* shrubs, few *Chiococca alba* and *Scalesia microcephala*, among lava boulders and outcrops, on NW-exposed slope of basalt boulder, semi-shaded, wind- and rain-exposed, 16-Nov-2007, Bungartz, F. 7787 (CDS 38296). VOLCÁN SIERRA NEGRA: close to Volcán Chico, along the trail, 0°46′57.77″S, 91°5′59.39″W, 944 m alt., transition zone, dry and rocky area (young lava), with cacti and *Macraea laricifolia*, slope 40° NE, on basaltic rocks, 14-Aug-2008, Clerc, P. 08-153 (CDS 40007); El Mango, on the E side of the dirt road, 0°53′1.7″S, 91°0′50.77″W, 162 m alt., lower transition zone; basalt lava outcrop with scattered vegetation (*Polypodium* sp., *Pityrogramma calomelanos*, *Darwiniothamnus tenuifolia*), N-exposed slope, on top of basalt lava outcrop, sunny, wind- and rain-exposed, 15-Aug-2008, Bungartz, F. 8194 (CDS 40840).

Parmotrema neosubcrinitum C.H. Ribeiro & Marcelli, in Marcelli & Ribeiro, Mitt. Inst. Allg. Bot. Hamburg 30–32: 147. 2002. (Fig. 8A–B)

Type: Brazil, São Paulo: Campos do Jordão, 1420 m alt, in *Podocarpus* forest, 11-Dec-1995, Ribeiro, C.H. 939 (SP – holotype, B – isotype, H – isotype, fide Marcelli & Ribeiro 2002).

Thallus corticolous; upper surface whitish gray to ivory, shiny to ±dull, epruinose, emaculate, but occasionally in parts irregularly cracked; abundantly isidiate; isidia marginal to submarginal, cylindrical, simple to sparsely branched, occasionally closely clustered (caespitose), brown to blackened at their tip and frequently ciliate (having a 'tufted' appearance); lobes broad, small to moderate-sized, 0.7–6(–8) mm wide, ±rotund, axils incised, margins abundantly ciliate; cilia moderately long and slender, 0.5–2.5(–5) mm long, black, mostly simple, very rarely branched; lower surface blackened throughout or with a narrow, deep brown, erhizinate, ~1–1.5 mm wide margin, blackening and densely rhizinate towards the thallus center; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Ecology and distribution. Previously known only from Brazil (Marcelli & Ribeiro 2002). New for Galapagos and Ecuador; currently known from a single specimen collected on plant debris below a boulder in the transition zone of San Cristóbal Island.

Notes. This species differs from *P. crinitum* by its chemistry (salazinic instead of stictic acid). Whereas in Galapagos *P. crinitum* is among the most common isidiate *Parmotrema* species, *P. neosubcrinitum* has only been found once.

Specimens examined from Ecuador, Galápagos. ISLA SAN CRISTÓBAL: Cerro Partido along trail from entrance to Cerro Pelado to El Ripioso, 0°51′23″S, 89°27′37″W, 376 m alt., transition zone, rocky SW-exposed slope of hill with *Jasminocereus thouarsii*, *Clerodendrum molle* var. *glabrescens*, *Psidium galapageium*, Bromeliaceae and ferns growing in rock crevices, on plant debris, below S-exposed front of basalt boulder, semi-shaded, wind- and rain-sheltered, 28-Apr-2007, Bungartz, F. 6593 (CDS 34813).

Parmotrema nyasense (C.W. Dodge) R.S. Egan, Bibliotheca Lichenologica 110: 383. 2016. (Fig. 2A–B)

Type: Malawi [State or Province, and exact locality unknown], Vernay Nyasaland Expedition of 1946, Nchisis Mt., 1400 m, on dry rocks in *Brachystegia*-woodland, 24-Jul-1946, Brass, L.J. 16922 (FH – holotype, NY – isotype, fide Egan et al. 2016).

Thallus corticolous, rarely saxicolous; upper surface pale greenish yellow, dull to ±shiny, emaculate, typically not cracked; abundantly isidiate; isidia mostly marginal and laminal, cylindrical to dactyliform (i.e., ±constricted at their base, tapering at the apex), brown to blackened at their tip and frequently ciliate; lobes small to moderate-sized, 2–6 mm wide, rotund, axils forming loops, margins abundantly ciliate; cilia short and slender, 0.3–1.5 mm long, black, mostly simple, very rarely branched; lower surface with a deep brown, erhizinate, ~1–2 mm wide margin, soon blackened and densely rhizinate towards the center; rhizines long, slender, black, mostly simple, very rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with usnic acid [P–, K–, KC± dirty yellowish brown, C–, UV–]; medulla with gyrophoric acid, and an unknown terpenoid [P–, K–, C+/KC+ pale pink (C and KC reactions are evanescent and must be examined under continuous observation); UV–].

Ecology and distribution. Neotropics from Mexico to Paraguay, Africa, Asia (Hale 1965; Nash & Elix 2002; Divakar & Upreti 2005; Marcelli & Canêz 2008; Egan et al. 2016). Previously reported from the Galapagos as *P. aberrans*, *P. neotropicum*, *P. flavescens* and/or *P. xanthinum* (see doubtful and incorrect reports). A rare species, found in the transition zone of Pinzón and Volcán Darwin, and the high altitude transition zone of Volcán Darwin, on exposed rock and trunk of the endemic cactus *Jasminocereus thouarsii*.

Notes. A corticolous, or rarely saxicolous, isidiate species with a strikingly pale yellow thallus and conspicuous, slender marginal cilia which are dark-tipped and apically often ciliate. In Galapagos this species has previously been confused with the superficially similar *P. xanthinum* (Müll. Arg.) Hale, a species lacking gyrophoric acid and distinguished also by much broader lobes and eciliate isidia. A detailed discussion can be found in Egan et al. (2016).

Specimens examined from Ecuador, Galápagos. ISLA PINZÓN: transition zone, 07-Feb-1964, Weber, W.A. 307 (L-40757, COLO 188442). ISLA ISABELA, VOLCÁN DARWIN: ~1.5 km from the southwestern crater rim, 0°12′20.5″S, 91°18′52.77″W, 1280 m alt., high altitude transition zone, basalt outcrop for the most part bare of vegetation, on SW-exposed front of basalt outcrop, sunny, wind- and rain-exposed, 14-Nov-2007, Bungartz, F. 7604 (CDS 38100); Ertz, D. 11894 (CDS 37253); southwestern slope, above Tagus Cove, 0°13′25.60″S, 91°19′13.80″W, 900 m alt., transition zone, top of lava flow of weathered AA-lava with scarce vegetation (*Jasminocereus thouarsii*, *Dodonaea viscosa*, *Chiococca alba*, *Macraea laricifolia*), on NE-exposed base of *Jasminocereus*, semi-shaded, wind- and rain-sheltered, 15-Nov-2007, Bungartz, F. 7766 (CDS 38274); 0°13′43.27″S, 91°19′47.27″W, 724 m alt., transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Dodonaea viscosa*, *Croton scouleri*, *Cordia revoluta* and *Jasminocereus thouarsii*), on trunk of *Jasminocereus thouarsii*, 12-Nov-2007, Ertz, D. 11781 (CDS 37140).

Parmotrema praesorediosum (Nyl.) Hale, Phytologia 28: 338. 1974. (Fig. 14A–B)

Type: Singapur [State or Province, and exact locality unknown], 30-Nov-1879, Almquist, E. s.n. (H-NYL 35547 – holotype, S – isotype, fide Fleig 1997).

Thallus corticolous, lignicolous, rarely saxicolous; upper surface white to whitish gray, dull to ±shiny, epruinose, emaculate, occasionally cracked, but not forming a distinctly reticulate pattern; abundantly sorediate; soralia marginal, linear to labriform (±crescent-shaped), or subcapitate; soredia ±granular, ±concolorous or slightly paler than the thallus, their surface often discolored by a dark gray tinge, pale inside; lobes moderate-sized, 5–7(–10) mm wide, rotund, axils incised, margins eciliate; lower surface with an erhizinate, ~1–2(–2.5) mm wide, deep brown margin, moderately to densely rhizinate and blackened towards the center; rhizines short, stout, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with ±caperatic, praesorediosic and protopraesorediosic acid [P–, K–, KC–, C–, UV–].

Ecology and distribution. Oceania, Africa, Asia, North, Central and South America (Hale 1965; Swinscow & Krog 1988; Marcelli 1992; Elix 1994; Louwhoff & Elix 1999; Divakar & Upreti 2005; Jungbluth 2006; Spielmann & Marcelli 2009; Marcelli & Benatti 2010; Benatti & Marcelli 2010; Egan et al. 2016). First reported from Galapagos by Weber (1986), subsequently by Elix & McCarthy (1998) and online (Bungartz et al. 2016) A common species in the Galapagos from the coastal zone all the way into the humid zone, most frequently encountered in the dry zone; typically on bark, rarely on rock, most frequently on *Bursera graveolens*, occasionally on other, mostly native or endemic trees and shrubs.

Notes. Differences from the morphologically similar *P. mordenii* have been discussed under that species.

Specimens examined from Ecuador, Galápagos. ISLA ESPAÑOLA: along S-coast of the island, SE of Punta Suárez, 60 m inland from coast, 1°22′58.39″S, 89°43′15.4″W, 113 m alt., dry zone, *Cordia lutea* shrubland with *Prosopis juliflora*, on branches of *Cordia lutea*, sunny, 10-Nov-2010, Yánez-Ayabaca, A. 1610 (CDS 45499), 1612 (CDS 45501); Bungartz, F. 8951 (CDS 45769), 8950 (CDS 45768); trail from Bahía Manzanillo on the N-coast of the island to the highest point, 1°22′18.69″S, 89°42′7.40″W, 125 m alt., dry zone, *Cordia lutea* shrubland with some *Prosopis juliflora* shrubs at bottom of basalt outcrop, on twigs of *Cordia lutea*, sunny, wind- and rain-exposed, 11-Nov-2010, Bungartz, F. 9151 (CDS 45969); Yánez-Ayabaca, A. 1676 (CDS 45559); at the base of Cerro Comunista, 1°17′22.89″S, 90°28′22.39″W, 158 m alt., dry zone, dense low forest of *Croton scouleri*, *Waltheria ovata* and *Castela galapageia* with occasional trees of *Acacia rorudiana* and *Bursera graveolens*, on branch of *Acacia rorudiana*, sunny, 16-Jan-2011, Yánez-Ayabaca, A. 1960 (CDS 48310); Bungartz, F. 9735 (CDS 47052), Bungartz, F. 9714 (CDS 47031); lower S-slope of Cerro Ventanas, 1°16′36.10″S, 90°25′41.10″W, 295 m alt., transition zone, open shrubland of *Macraea laricifolia* and some lower *Waltheria ovata* shrubs in between, on fallen branch, 18-Jan-2011, Yánez-Ayabaca, A. 2027 (CDS 48377); Bungartz, F. 9841 (CDS 47179), 9840 (CDS 47178); SW of La Gigante and N of Playa de los Perros at E-coast of the island, a bit inland from the coast, inside the crater of a small volcano, 1°16′37.77″S, 90°21′28″W, 74 m alt., coastal zone, open vegetation of *Cordia lutea* shrubs and trees, with *Prosopis juliflora*, *Castela galapageia*, *Vallesia glabra*, *Parkinsonia aculeata*, *Lycium minimum*, on trunk of *Cordia lutea*, sunny, wind- and rain-exposed, 17-Jan-2011, Yánez-Ayabaca, A. 2004 (CDS 48354); W of dirt road to water tank, off the main dirt road to the highlands, 1°16′56.10″S, 90°28′50.89″W, 67 m alt., dry zone, dense *Prosopis juliflora* shrubland with some *Castela galapageia* and few trees of *Bursera graveolens*, on branch of *Zanthoxylum fagara*, sunny, wind- and rain-sheltered, 12-Jan-2011, Yánez-Ayabaca, A. 1783 (CDS 48065); Bungartz, F. 9413 (CDS 46700). ISLA PINTA: along the trail up to the summit, ~1 km inland from the S-coast, 0°33′8″N, 90°44′29″W, 54 m alt., dry zone, open vegetation of *Bursera graveolens*, *Croton scouleri*, *Castela galapageia*, and *Opuntia galapageia* among lava blocks, on trunk of *Bursera graveolens*, SE-exposed, sunny, wind- and rain-exposed, 25-Feb-2007, Bungartz, F. 5653 (CDS 33288), 5671 (CDS 33306). ISLA PINZÓN: in the valley on the W-slope of the highest mountain, 0°36′41″S, 90°40′11″W, 310 m alt., dry zone, dry zone vegetation with *Prosopis juliflora*, *Alternanthera filifolia*, *Maytenus octogona*, and *Croton scouleri*, on basalt, 16-Feb-2006, Aptroot, A. 64091 (CDS 30652); lower N-slope, 300 m alt., transition zone, on *Croton*, 15-Feb-1964, Cavagnaro, D. s.n. (L-40499, COLO 192824). ISLA SAN CRISTÓBAL: along the trail from Galapagera at the NW-coast of the island to Media Luna, 0°42′41″S, 89°18′15″W, 33 m alt., dry zone, open woodland of *Piscidia carthagenensis*, *Bursera graveolens*, and *Gossypium darwinii* shrubs, on branches of *Bursera graveolens*, E-exposed, semi-shaded, wind- and rain-exposed, 22-Apr-2007, Bungartz, F. 6317 (CDS 34532); along trail from Bahía Sardinas at the NW-coast of the island to Cerro Pan de Azúcar, 0°42′28″S, 89°21′29″W, 13 m alt., dry zone, open woodland of *Bursera graveolens* and *Piscidia carthagenensis* with dense understory of *Scutia spicata*, *Gossypium darwinii* and *Waltheria ovata*, on upper side of *Bursera graveolens* branch, sunny, wind- and rain-exposed, 24-Apr-2007, Bungartz, F. 6475 (CDS 34692); Cerro Colorado, enclosure for *Calandrinia galapagosa* near the viewpoint on the top, 0°54′58″S, 89°26′5″W, 130 m alt., transition zone, open scrubland with *Croton scouleri*, *Macraea laricifolia*, *Calandrinia galapagosa*, *Lecocarpus darwinii* and few trees of *Piscidia carthagenensis* among lava boulders on SE-exposed slope of cinder cone, on SE-exposed

front of soft and weathered tuff outcrop, sunny, wind- and rain-exposed, 29-Apr-2007, Bungartz, F. 6711 (CDS 34955); near Rosa Blanca, inland from the SE-coast of the island, 0°49′9″S, 89°21′48″W, 12 m alt., dry zone, open *Bursera graveolens* woodland with *Mentzelia aspera* and *Scalesia incensa* shrubs on lava flow, on trunk of *Bursera graveolens*, W-exposed, sunny, wind- and rain-exposed, 23-Apr-2007, Bungartz, F. 6401 (CDS 34616); northern foothills of Pan de Azúcar, 0°43′5″S, 89°21′17″W, 72 m alt., dry zone, dense woodland of *Bursera graveolens*, *Piscidia carthagenensis*, with *Scutia spicata*, *Malvastrum* sp. and *Mentzelia aspera* in the understory, on branches of *Piscidia carthagenensis*, E-exposed, semi-shaded, ±wind- and rain-sheltered, 24-Apr-2007, Bungartz, F. 6470 (CDS 34687). ISLA SANTA CRUZ: along old trail to Bellavista, on *Acacia* sp., 29-Apr-1976, Weber, W.A. s.n. (CDS 10865); along the trail from Puerto Ayora to Bahía Tortuga, 0°44′48″S, 90°19′14″W, 28 m alt., dry zone, decidous forest in dry zone; with *Bursera graveolens*, *Acacia rorudiana*, and *Opuntia echios* over basalt, on twigs of *Bursera graveolens*, sunny, wind- and rain-exposed, SW-exposed, 05-Jan-2006, Bungartz, F. 3349 (CDS 27016); E side of island, trail from parking lot to El Garrapatero beach, N side of trail, 0°41′26.69″S, 90°13′19.10″W, 6m alt., dry zone, open deciduous forest of *Bursera graveolens*, *Cordia lutea*, *Opuntia echios* with *Castela galapageia* and *Alternanthera echinocephala* and others in the understory, on *Bursera graveolens*, 16-Jun-2010, Spielmann, A.A. 8180 (CDS 45317), 8189 (CDS 45324);, 8190 (CDS 45325); Garrapatero Bay, site 4, 0°41′19″S, 90°13′22″W, on twig, 26-Jul-2000, LeDee, O.E. OEL-00-05 (CDS 39143); on the North side of the island, along the dirt road to the ash quarry Mina Granillo Negro, 0°34′22″S, 90°19′55″W, 27 m alt., dry zone, dry deciduous lowland forest (*Bursera graveolens*, *Heliotropium* sp., *Acacia* sp., *Zanthoxylum fagara*), on *Bursera*, 23-Feb-2006, Aptroot, A. 64483 (CDS 31055); Puerto Ayora, near begin of road to Baltra, 0°44′34″S, 90°18′45″W, 25 m alt., dry zone, on shrub, 26-May-2005, Aptroot, A. 63079 (CDS 29807); vicinity of Academy Bay, barranca along old trail, on tree, 15-Feb-1964, Weber, W.A. s.n. (L-40621, COLO 192534); barranca behind Research Station, dry zone, 15-Feb-1964, Weber, W.A. s.n. (L-40542, COLO 192683); between Darwin Station and first barranca, dry zone, on *Acacia*, 29-Jan-1964, Schuster, R.O. s.n. (L-40046, COLO 189423); waste deposit along road to Baltra; 0°35′0″S, 90°21′17″W, 300 m alt., transition zone, on *Bursera graveolens*, 28-May-2005, Aptroot, A. 63231 (CDS 29966). ISLA SANTA FÉ: lava flow at the N-coast of the island, 0°48′2.798″S, 90°2′38.39″W, 26 m alt., dry zone, open scrubland of *Croton scouleri* with some *Bursera graveolens* trees, and *Opuntia echios* var. *barringtonensis* on NE-exposed side of lava flow, on top of inclined branch of *Bursera graveolens*, sunny, wind- and rain-exposed, 25-Oct-2007, Bungartz, F. 7277 (CDS 37761). ISLA SANTIAGO: 1/4 mi S of James Bay, 0°14′30″S, 90°51′30″W, 7m alt., dry zone, open *Bursera* forest on consolidated ash, on *Bursera* twigs, 25-Apr-1971, Pike, L.H. 2521 (OSC 101703); along the trail from Bucanero to Jaboncillos, ~1 km below the summit, Cerro Gavilan, 0°11′45″S, 90°47′20″W, 680 m alt., transition zone, open *Psidium galapageium* forest with *Zanthoxylum fagara*, *Blainvillea dichotoma*, *Mentzelia aspera* and *Senna obtusifolia*, basalt boulders and outcrops in between, on top of basalt boulder, sunny, wind- and rain-exposed, 22-Mar-2006, Bungartz, F. 4697 (CDS 28784); ~3 km SE of Bucanero, 0°10′52″S, 90°48′33″W, 362 m alt., transition zone, open woodland of large *Bursera graveolens* and smaller *Psidium galapageium* trees, grassland and basalt boulders in between, on *Erythrina*, 22-Mar-2006, Aptroot, A. 65376 (CDS 31962); Bungartz, F. 4597 (CDS 28684); along the trail from the caseta in La Central to La Bomba (at the coast), halfway down to the coast, 0°12′54″S, 90°43′21″W, 293 m alt., dry zone, open woodland of *Bursera graveolens* and *Opuntia galapageia* with shrubs of *Castela galapageia* and *Clerodendrum molle* among basalt boulders and rocks, on twigs of *Clerodendrum molle*, semi-shaded, wind- and rain-sheltered, 25-Mar-2006, Bungartz, F. 4932 (CDS 29136); ~5 km inland from the E-coast, ±at the same latitude as Bahía Sullivan, 0°16′52″S, 90°37′17″W, 175 m alt., dry zone, rubble of older lava with very scarce vegetation of few *Bursera graveolens* trees, *Macraea laricifolia*, and *Mentzelia aspera*, on basalt boulder, near the ground, S-exposed, 16-Jul-2006, Bungartz, F. 5056 (CDS 29269); en el parte sureste de la isla, 0°16′38.39″S, 90°38′23.80″W, 163 m alt., zona seca, bosque de *Bursera graveolens* y pocos árboles de *Scalesia atractyloides*, sobre lava jovén, sobre *Bursera graveolens* muerto, 20-Jul-2006, Nugra, F. 123 (CDS 32777). ISLA ISABELA, VOLCÁN ALCEDO: cerca las fumarolas, 0°26′22.89″S, 91°8′35.20″W, 900 m alt., zona de transición, con árboles de *Trema micrantha*, con muy poca vegetación, los árboles existentes carecen de hojas, es una zona casi sin vida, sobre las ramas de *Trema micrantha*, 01-Dec-2006, Nugra, F. 160 (CDS 32814); in the crater near fumaroles, 0°27′9″S, 91°7′33″W, 780 m alt., transition zone, among sulphur-influenced boulders, on twigs, 07-Mar-2006, Aptroot, A. 65116 (CDS 31698); VOLCÁN CERRO AZUL: along the first few meters of the path from the Caseta del Parque to Caleta Iguana, 0°58′44.20″S, 91°26′46.27″W, 12 m alt., dry zone, dense scrubland of mostly *Clerodendrum molle*, some *Gossypium darwinii* and *Croton scouleri*, very sparse *Bursera graveolens* trees, on twigs, sunny, wind/rain-exposed, 09-May-2012, Bungartz, F. 10510 (CDS 52522); VOLCÁN DARWIN: southwestern slope, above Tagus Cove, 0°14′15.4″S, 91°20′40.27″W, 351 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri*, *Macraea laricifolia* and *Waltheria ovata*, few trees of *Acacia rorudiana*, on top of inclined *Zanthoxylum fagara* branch, semi-shaded, wind- and rain-sheltered, 16-Nov-2007, Bungartz, F. 7891 (CDS 38400); VOLCÁN SIERRA NEGRA: close to Volcán Chico, along the trail, 0°46′57.77″S, 91°5′59.39″W, 944 m alt., transition zone, dry and rocky area (young lava), with cacti and *Macraea laricifolia*, slope 40° NE, on basaltic rocks, 14-Aug-2008, Clerc, P. 08-154 (CDS 40008); 0°48′53.20″S, 91°5′18.39″W, 982 m alt., humid zone, *Psidium guajava* shrubland with *Pteridium arachnoideum* on the ground, slope 25° NW, on branches of *Psidium guajava*, 14-Aug-2008, Herrera-Campos, M.A. 10575 (CDS 40312); Velasco, 0°49′57.77″S, 91°11′11″W, 650 m alt., humid zone, on rock, 25-Jan-2006, Jaramillo, P. 2834 (CDS 38781).

Parmotrema pustulotinctum Spielmann & Bungartz, sp. nov. (Fig. 7C–D)

MycoBank MB 832666

Diagnosis: Differs from *P. tinctorum* by the coarse, pustulate isidia, leaving distinct circular scars when breaking off the thallus surface.

Type: Ecuador. Galápagos: Isla Santiago, along the trail from Bucanero to Jaboncillos, ~3 km SE of Bucanero, 0°10′52″S, 90°48′33″W, 362 m alt., transition zone, open woodland of large *Bursera graveolens* and smaller *Psidium galapageium* trees, grassland and basalt boulders in between, N-exposed, on vertical front of basalt boulder, sunny, wind- and rain-exposed, 22-Mar-2006, Bungartz, F. 4624 (CDS 28711 – holotype!).

Thallus corticolous, lignicolous, less frequently saxicolous; upper surface whitish gray to ivory, dull, not shiny, epruinose, emaculate, not cracked, but soon conspicuously wrinkled, gnarled granular; abundantly isidiate; isidia

laminal, irregularly granular-globose, pustulate, developing from the very irregular central surface and where eroded leaving conspicuous circular scars, isidia not dark-tipped, but concolorous with the thallus, eciliate; lobes broad, moderate-sized to large, 0.6–10(–11) mm wide, ±rotund, axils incised, margins eciliate; lower surface with a broad, pale to deep brown, erhizinate, ~3–5 mm wide margin, blackening and sparsely rhizinate towards the thallus center; rhizines short, stout, pale to dark brown or black, mostly simple, rarely sparsely branched, often growing in clusters; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with lecanoric acid [P–, K–, C+/KC+ bright red (C and KC reactions are evanescent and must be examined under continuous observation); UV–].

Etymology. Named for its pustulate isidia that are distinctly different from the otherwise similar *P. tinctorum*.

Ecology and distribution. Currently known only from the type and presumably endemic, collected on an exposed vertical boulder in the transition zone of Santiago Island.

Notes. The dull surface of this species, soon becoming conspicuously gnarled, developing into granular-globose isidia that break apart into pustulate soredia, is very characteristic. These pustules do not resemble the cylindrical isidia of *P. tinctorum*, with which *P. pustulotinctum* shares the same chemistry. Throughout the Neotropics, *P. tinctorum* may be considered one of the most common species in the genus; the name, however, has nevertheless often been applied far too widely. Some of the morphological variation previously included within *P. tinctorum* has already been distinguished as distinctly different. Marcelli et al. (2007), for example, described a new species as *P. eitenii* Marcelli & Benatti. It is not isidiate but forms marginal soralia with granular soredia. Although the soredia of *P. eitenii* are coarse, they are ontogenetically clearly distinct from the pustulate structures characteristic of *P. pustulotinctum*. These structures are initially globose isidia, which secondarily break apart. Occasionally the whole structure breaks off, leaving distinct circular scars. These circular scars can also be observed in *P. internexum*, which, however, has much finer, dark-tipped isidia and a different chemistry.

Parmotrema rampoddense (Nyl.) Hale, Phytologia 28: 338. 1974. (Fig. 13E–F)

Type: Sri Lanka, Central Province: Ramboda, Almquist, E. s.n. (H-NYL 35555 – holotype, S – isotype, fide Hale 1965).

Thallus saxicolous; upper surface whitish gray to ivory, dull to ±shiny, epruinose, emaculate, occasionally cracked, but not forming a distinctly reticulate pattern; abundantly sorediate; soralia marginal, linear to labriform (±crescent-shaped), or subcapitate; soredia ±granular, typically discolored by a dark gray tinge, pale inside; lobes moderate-sized to large, 5–8(–12) mm wide, rotund, axils incised, margins abundantly ciliate; cilia long and slender, 0.6–5 mm long, black, mostly simple, very rarely branched; lower surface with a broad erhizinate, ~2–5 mm wide, deep brown zone (not mottled white), moderately to densely rhizinate and blackened towards the center; rhizines long, slender, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with atranorin, alectoronic, α-collatolic and β-alectoronic acid [P–, K–, KC+ rosé, quickly turning orange, C–, UV+ greenish blue].

Ecology and distribution. Oceania, Asia, Africa, North, Central and South America (Hale 1965; Winnem 1975; Awasthi 1976; Elix 1994; Louwhoff & Elix 1999; Kurokawa & Lai 2001; Brodo et al. 2001; Spielmann & Marcelli 2009; Egan et al. 2016). Previously reported from continental Ecuador (Cevallos Solórzano 2012); new for Galapagos, where the species has been found on exposed lava flows, boulders and cliffs of the dry zone and transition zone.

Notes. *Parmotrema rampoddense* is morphologically similar to *P. sorediiferum* (Hale 1986); the two species are most reliably distinguished by their spores, which are larger in *P. sorediiferum* (22–24 µm) than in *P. rampoddense* (10–12 µm). All Galapagos material is sterile, but the specimens generally have the longer cilia characteristic of *P. rampoddense* (3–6 mm) in comparison with those typical for *P. sorediiferum* (2–4 mm). Additionally, it seems that *P. sorediiferum* occasionally forms sorediate pustules (Kukwa et al. 2012), which were not observed in any of the specimens here.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, cliff at NE side of trail (Mirador), 1°17′4.298″S, 90°26′36.60″W, 365 m alt., transition zone, ~10 m high lava cliff within dense scrub of *Clerodendrum molle*, *Croton scouleri* and *Macraea laricifolia*, one single *Acacia rorudiana* on top of cliff, on top of basalt cliff, sunny, wind- and rain-exposed, 25-Jan-2011, Bungartz, F. 10220 (CDS 47639). ISLA ISABELA, VOLCÁN DARWIN: southwestern slope, above Tagus Cove, 0°13′59″S, 91°20′8″W, 597 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri* and *Macraea laricifolia* shrubs, few *Chiococca alba* and *Scalesia microcephala*, among lava boulders and outcrops, on NW-exposed slope of basalt boulder, semi-shaded, wind- and rain-exposed, 16-Nov-2007, Bungartz, F. 7786 (CDS 38295); 0°13′43.27″S, 91°19′47.27″W, 724 m alt., transition zone, on SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Dodonaea viscosa*, *Croton scouleri*, *Cordia revoluta* and *Jasminocereus thouarsii*), 12-Nov-2007, Ertz, D. 11817 (CDS 37176).

Parmotrema reticulatum (Taylor) M. Choisy, Bull. mens. Soc. linn. Soc. Bot. Lyon 21: 148. 1952. (Fig. 11A–B)

Type: Ireland, Kerry: near Dunkerron, on rocks, common, Taylor, T. s.n. (FH – lectotype!, BM – isolectotype!, designated by Hale & Fletcher 1990).

Thallus corticolous or saxicolous; upper surface white to whitish gray, dull to shiny, epruinose or pruinose,

densely reticulate-maculate, often cracked; abundantly sorediate; soralia marginal, sublinear to linear along the lobes, rarely subcapitate, but not distinctly capitate; soredia farinose, surface creamy white, typically not discolored; lobes small to moderate-sized, 2–5 mm wide, ±angular, abundantly ciliate; cilia short and slender, 0.3–1.5 mm long, black, mostly simple, very rarely branched; lower surface often blackened throughout or becoming dark brown towards the margin, but typically lacking an erhizinate marginal zone, the rhizines extending all the way to the edge of the lobe; sorediate lobes typically blackened and densely rhizinate below; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Ecology and distribution. The species is often considered pantropical to almost pan-temperate (Elix 1994; Egan et al. 2016). However, following a more narrowly delimited species concept (Benatti & Marcelli 2008; Spielmann 2009), the species may turn out to have a more restricted distribution, especially if, as we here suggest, *Parmotrema clavuliferum*, *P. herrei* and *P. marcellianum* are recognized as separate.

From Galapagos, *P. reticulatum* was first reported by Weber (1986), subsequently by Elix & McCarthy (1998) and online (Bungartz et al. 2016). A common species, from the dry zone throughout the transition zone and humid zone into the high-altitude dry zone; most common in the humid zone, both on a variety of endemic, native and introduced trees, and on rock (small boulders, outcrops), both at sunny, exposed and ±shaded and sheltered sites.

Notes. As discussed above, *P. reticulatum* is most similar to *P. clavuliferum*, with which it shares the same chemistry and a gray, reticulate-maculate surface, but lacks distinct clavulae.

Specimens examined from Ecuador, Galápagos. ISLA ESPAÑOLA: trail from Bahía Manzanillo on the N-coast of the island to the highest point, 1°21′24.89″S, 89°41′57″W, 24 m alt., dry zone, boulder field of weathered AA-lava with scarce vegetation of *Ipomoea habeliana*, one *Bursera* tree and few *Cordia lutea* shrubs, on branches of *Bursera graveolens*, sunny, wind- and rain-exposed, 11-Nov-2010, Bungartz, F. 9022 (CDS 45840), 9023 (CDS 45841); Yánez-Ayabaca, A. 1640 (CDS 45523). ISLA FLOREANA: trail from Black Beach to highlands, on bark of *Bursera*, 25-Apr-1976, Weber, W.A. s.n. (L-62918, COLO 294603); trail from La Primavera Farm to La Corona and Arco de la Reina, southeastern part of the island, 1°19′21.60″S, 90°24′45.89″W, 219 m alt., transition zone, very dense scrub of *Clerodendrum molle* with some *Croton scouleri*, *Waltheria ovata*, few *Prosopis juliflora* and occasional trees of *Geoffroea spinosa* in flat area on generally SE-exposed, moderately inclined slope with few boulders, on branch of *Clerodendrum molle*, semi-shaded, wind- and rain-sheltered, 24-Jan-2011, Bungartz, F. 10125 (CDS 47520). ISLA PINZÓN: summit areatransition zone, on *Croton*, 15-Feb-1964, Weber, W.A. s.n. (L-40517, COLO 192297). ISLA SAN CRISTÓBAL: bordering lake at El Junco, humid zone, steep slope bordering lake, on rock, 21-May-1976, Lanier, J. s.n. (L-63747, COLO 298432). ISLA SANTA CRUZ: base of El Puntudo, humid zone, summit grassland, on sides of lava tube opening, 16-Jun-1972, Weber, W.A. s.n. (L-55398, COLO 256024); El Puntudo, 0°38′32.10″S, 90°20′4.596″W, 694 m alt., zona húmeda, bosque de *Scalesia penduculata* con árboles invasores *Cinchona pubescens*, sobre *Cinchona pubescens*, exposición NE, 01-Aug-2007, Nugra, F. 422 (CDS 36170); La Piramide, Salazaca, 0°42′0″S, 90°20′0″W, 850 m alt., humid zone, on rock, 30-Apr-1990, Sánchez-Pinto, L. 5057 (108619, B 60 0173264); Maternidad, two craters along road above Santa Rosa (= Los Gemelos), east crater, N rim, 500 m alt., humid zone, on exposed lava, 17-Jun-1976, Sipman, H.J.M. s.n. (L-63483, COLO 297953); Media Luna, cerca del camino al Puntudo, 0°39′43.27″S, 90°19′29.89″W, 558 m alt., zona húmeda, bosque de *Scalesia pedunculata*, con especies introducidas, dominante la *Cinchona pubescens* mayor a 5m de alto, sobre *Psidium guajava*, 07-Jul-2006, Nugra, F. 83 (CDS 32737); summit of the island between El Puntudo and Cerro Crocker, 700 m alt., humid zone, on top of small rock outcrops, 16-Apr-1976, Weber, W.A. s.n. (L-63060, COLO 296966), s.n. (L-63057, COLO 296969); vicinity of Academy Bay, above Horneman farm, humid zone, on *Zanthoxylum fagara*, 15-Feb-1964, Weber, W.A. s.n. (L-40511, COLO 192290). ISLA SANTIAGO: above recent James Bay lava flow, 0°13′30″S, 90°48′15″W, 320 m alt., transition zone, *Psidium* forest with understory of *Psychotria*, on shrubs, 27-Apr-1971, Pike, L.H. 2625 (OSC 101702); along trail to summit above James Bay lava flow, 0°13′0″S, 90°47′30″W, 680 m alt., humid zone, dense stand of *Zanthoxylum*, *Croton*, *Psychotria*, 03-May-1971, Pike, L.H. ID21-8 (OSC 101759); summit of Cerro Gavilan, inner N- and NE-exposed crater rim, 0°12′20″S, 90°47′3″W, 840 m alt., humid zone, N- and NE-exposed, steep basalt cliffs of crater rim with ferns (*Pityrograma calomelanos* var. *calomelanos*, *Polypodium tridens*, *Doryopteris palmata*, *Adiantum concinnum*, *Blechnum polypodioides*) growing in crevices, on lava, 23-Mar-2006, Aptroot, A. 65703 (CDS 32295). ISLA ISABELA, VOLCÁN ALCEDO: along the trail going up the E-slope, basalt rubble field to the SE side of the trail and the barranco, 0°24′6″S, 91°2′53″W, 530 m alt., dry zone, basalt rubble field with scattered vegetation (*Bursera graveolens*, *Zanthoxylum fagara*, *Pisonia floribunda*, *Senna pistaciifolia*), on *Bursera*, 10-Mar-2006, Aptroot, A. 64918 (CDS 31497); along the crater rim near the hut, 0°26′33″S, 91°5′31″W, 1100 m alt., humid zone, *Pteridium arachnoideum* and *Stachytarpheta cayennensis*, scattered low shrubs of *Tournefortia rufo-sericea* and outcrops of basalt tuff in between, on *Zanthoxylum*, 07-Mar-2006, Aptroot, A. 65221 (CDS 31807), 65272 (CDS 31858); upper NNW-exposed slope inside the crater, 0°27′27″S, 91°7′23″W, 1055 m alt., humid zone, open vegetation with *Adianthus concinnum*, and scattered shrubs of *Tournefortia rufo-sericea* among basalt rocks, on basalt, 05-Mar-2006, Aptroot, A. 64891 (CDS 31468); VOLCÁN CERRO AZUL: along the trail from Caleta Iguana to the first Caseta del Parque, 0°59′12.1″S, 91°25′35.77″W, 276 m alt., transition zone, isolated tree close to a *Psidium guajava* forest, on twigs and branches, semi-shaded, 02-May-2012, Spielmann, A.A. 10377 (CDS 51731); ash fields below the highest peak with GPS station, 0°55′52.77″S, 91°24′28.5″W, 1649 m alt., high altitude dry zone, dense *Tournefortia rufo-sericea* scrub along the flanks of the peak, on trunk of old *Zanthoxylum*, shaded, 05-May-2012, Spielmann, A.A. 10508 (CDS 51864), 10509 (CDS 51865); lower crater slopes above the first Caseta del Parque; below the cloud layer, 0°58′39.20″S, 91°25′25.80″W, 434 m alt., transition zone, open Guajava forest, with sparse *Psidium guajava* shrubs,

few larger *Zanthoxylum fagara* trees, and *Tournefortia rufo-sericea* scrub, on twigs and trunk of isolated *Zanthoxylum* in a field with *Psidium guajava*, sunny, 03-May-2012, Spielmann, A.A. 10417 (CDS 51772), 10418 (CDS 51773); within the cloud layer, 0°57′55.60″S, 91°25′1.899″W, 767 m alt., humid zone, open pasture with some *Tournefortia rufo-sericea* scrub, and occasional large clusters of *Cladonia confusa* on the ground, on branches and twigs of shrubs, sunny, 03-May-2012, Spielmann, A.A. 10465 (CDS 51821), 10437 (CDS 51793); middle crater slopes above the first Caseta del Parque; within the cloud layer, 0°57′58.27″S, 91°24′40.60″W, 863 m alt., humid zone, open, windswept pasture of strongly grazed sedges (*Cyperus anderssonii*), grasses and few ferns; no trees or shrubs, on WNW-exposed front of basaltic boulder, sunny, 03-May-2012, Spielmann, A.A. 10468 (CDS 51824); outer, lower, densely vegetated slopes of the crater rim, 0°57′9.096″S, 91°24′23.19″W, 1470 m alt., high altitude transition zone, dense grassy pasture with abundant Low Rattlebox (*Crotalaria pumila*), few, large basalt boulders, scarce *Tournefortia rufo-sericea* scrub and sparse Guayabillo trees (*Psidium galapageium*), on trunk of isolated tree, ±3m high, in pasture, sunny, 06-May-2012, Spielmann, A.A. 10532 (CDS 51889); 0°57′1″S, 91°24′18.80″W, 1512 m alt., high altitude transition zone, dense grassy pasture with abundant Low Rattlebox (*Crotalaria pumila*), scarce *Tournefortia rufo-sericea* scrub and sparse *Psidium galapageium* trees, on trunk of dead but still upright tree, sunny, 05-May-2012, Spielmann, A.A. 10523 (CDS 51880), 10524 (CDS 51881), 10525 (CDS 51882); path from the first Caseta del Parque to Caleta Iguana at the coast, approx. half of the way, abandonned farm 'La Lima', 0°59′1.100″S, 91°26′17.10″W, 198 m alt., transition zone, dense, shaded woodland of large, predominantly introduced fruit trees, *Citrus* spp. (Lima, Limón, Naranja), *Carica papaya*, but also some natives like *Croton scouleri*, and *Pisonia floribunda*, on main branches of dead standing trunk, semi-shaded, 08-May-2012, Nugra, F. 1134 (CDS 52486); steep outer slopes of the volcano above Cerro Verde, 0°57′28.5″S, 91°24′29.10″W, 1238 m alt., humid zone, dense pasture with scarce *Tournefortia rufo-sericea* scrub, very few *Zanthoxylum fagara* and *Psidium galapageium* trees, on slope of basalt rock, 07-May-2012, Nugra, F. 1086 (CDS 52249); Spielmann, A.A. 10601 (CDS 51968); on bark, 07-May-2012, Spielmann, A.A. 10600 (CDS 51966); steep outer slopes of the volcano above Cerro Verde, 0°57′28.5″S, 91°24′29.10″W, 1238 m alt., humid zone, dense pasture with scarce *Tournefortia rufo-sericea* scrub, very few *Zanthoxylum fagara* and *Psidium galapageium* trees, on branches of *Psidium galapageium*, sunny, wind/rain-exposed, S-facing, 07-May-2012, Bungartz, F. 10409 (CDS 52379); Nugra, F. 1089 (CDS 52252), 1093 (CDS 52256); Spielmann, A.A. 10584 (CDS 51952), 10590 (CDS 51957), 10575 (CDS 51944), 10583 (CDS 55058); uppermost crater slopes of blackened volcanic ash fields along the crater rim, 0°56′20.39″S, 91°24′13.30″W, 1614 m alt., high altitude dry zone, open black volcanic ash fields bare of vegetation with inspersed patches of vegetation of (*Opuntia* spp.), very few *Tournefortia rufo-sericea* shrubs and occasional *Iochroma ellipticum* trees, on branches and trunk of isolated *Iochroma ellipticum* tree near the crater border, sunny, wind- and rain-exposed, 05-May-2012, Spielmann, A.A. 10494 (CDS 51850); wide, open ditch between two lava ridges to the West above Cerro Verde, 0°57′9.40″S, 91°24′31.5″W, 1436 m alt., humid zone, near small, shaded woodland of *Tournefortia rufo-sericea*, *Cordia leucophlyctis* and *Psidium galapageium*, growing on *Opuntia insularis*, 06-May-2012, Spielmann, A.A. 10550 (CDS 51908); VOLCÁN DARWIN: southwestern crater rim, 0°12′11.5″S, 91°18′41.27″W, 1286 m alt., high altitude dry zone, open forest of *Scalesia microcephala*, few trees of *Zanthoxylum fagara*, *Cordia revoluta* and *Croton scouleri* shrubs, many young *Scalesia* in the understory, on *Zanthoxylum fagara*, 13-Nov-2007, Ertz, D. 11835 A (CDS 38901); southwestern slope, above Tagus Cove, 0°13′26.60″S, 91°19′17.10″W, 890 m alt., transition zone, dense scrubland of *Croton scouleri* with *Dodonaea viscosa*, *Macraea laricifolia*, *Cordia revoluta* and some *Scalesia microcephala* and *Opuntia insularis*, on *Croton scouleri* twig, sunny, wind- and rain-exposed, 15-Nov-2007, Bungartz, F. 7783 (CDS 38292); 0°13′57.89″S, 91°20′5.096″W, 613 m alt., transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Croton scouleri*, *Dodonaea viscosa*, *Scalesia microcephala*, *Cordia revoluta* and *Opuntia insularis*), on branches of *Croton scouleri*, sunny, wind- and rain-exposed, 12-Nov-2007, Bungartz, F. 7392 (CDS 37879); 0°13′43.27″S, 91°19′47.27″W, 724 m alt., transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Dodonaea viscosa*, *Croton scouleri*, *Cordia revoluta* and *Jasminocereus thouarsii*), on branches and twigs of large *Cordia revoluta* shrub, sunny, wind- and rain-exposed, 12-Nov-2007, Bungartz, F. 7489 (CDS 37976), 7437 (CDS 37924); VOLCÁN SIERRA NEGRA: Volcán Santo Tomás, borde del cráter, 0°50′0″S, 91°2′0″W, 01-Feb-1994, Follmann, G. 35308 (108741, B-Koeln 60 0173578).

Parmotrema saxoisidiatum Spielmann & Bungartz, sp. nov. (Fig. 9B–C)

MycoBank MB 832667

Diagnosis: Differs from *P. subisidiosum* by its smaller, ±angular, flattened and closely appressed lobes with simple, cylindrical, mostly unbranched isidia; the thalli growing on rock, not bark.

Type: Ecuador. Galápagos: Isla Floreana, trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, cliff at NE side of trail (Mirador), 1°17′4.298″S, 90°26′36.60″W, 365 m alt., transition zone, ~10 m high lava cliff within dense scrub of *Clerodendrum molle*, *Croton scouleri* and *Macraea laricifolia*, and one single *Acacia rorudiana* tree, on top of the basalt cliff, sunny, wind- and rain-exposed, 25-Jan-2011, Bungartz, F. 10207 (CDS 47626 – holotype!).

Thallus saxicolous; upper surface white to whitish gray, dull to shiny, epruinose, densely reticulate-maculate, rarely becoming cracked; abundantly isidiate; isidia marginal and laminal, cylindrical, mostly simple to sparsely branched, occasionally clustered, typically longer along the lobe margin, commonly with a brown to blackened tip, eciliate; lobes small to moderate-sized, 0.3–4(–5) mm wide, ±angular, axils rounded, but not forming conspicuous loops, margins sparsely to abundantly ciliate; cilia short and slender, 0.2–0.5(–0.7) mm long, black, mostly simple, very rarely branched; lower surface black, gradually becoming dark brown towards the margin, lacking a distinctly erhizinate zone, the marginal rhizines not much shorter than the central ones; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Etymology. Named for its saxicolous substrate and its isidia.

Ecology and distribution. Currently known only from the type and presumably endemic, collected on top of a basalt cliff in the transition zone of Floreana Island.

Notes. In Galapagos, *P. saxoisidiatum* is not easily confused with any other reticulate-maculate species that contains salazinic acid in its medulla. In Galapagos the only other isidiate, reticulate-maculate species containing salazinic acid is *Parmotrema subisidiosum*. It is much more common and more abundant, and also grows on bark, not on rock. The species can be distinguished from *P. saxoisidiatum* by larger, rotund, undulating lobes that are abundantly ciliate, and isidia that are soon conspicuously coralloid. In South America, two other species that resemble *P. saxoisidiatum* have recently been described: *Parmotrema anchietanum* Marcelli, Benatti & Elix and *P. asperum* Benatti, Marcelli & Elix (Benatti et al. 2008). Both species also have reticular maculae, contain salazinic acid within their medulla, and are also saxicolous. However, unlike *P. saxoisidiatum*, these two species are sorediate species, not isidiate.

Parmotrema soredioaliphaticum Estrabou & Adler, Mycotaxon 66: 134. 1998. (Fig. 14C–D)

Type: Argentina, Córdoba: Departamento Sobremonte, Cerro Colorado, 30°08′S, 63°54′W, on rock, Nov-1996, Estrabou s.n., (BAFC 37878 – holotype, Estrabou Herbarium 1500 – isotype, fide Estrabou & Adler 1998).

Thallus saxicolous; upper surface whitish gray to ivory, dull, epruinose, emaculate, occasionally cracked, but not forming a distinctly reticulate pattern; abundantly sorediate; soralia submarginal, forming conspicuous cauliflower-like outgrowths; soredia ±granular, ±concolorous or slightly paler than the thallus, pale inside; lobes small to moderate-sized, 1–5(–6) mm wide, ±angular, axils incised, margins eciliate; lower surface with an erhizinate, ~1–2(–2.5) mm wide, pale brown margin, moderately to densely rhizinate and blackened towards the center; rhizines short, stout, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with fatty acids [P–, K–, KC–, C–, UV–].

Ecology and distribution. Argentina, Brazil (Estrabou & Adler 1998; Canêz 2005). New for Galapagos and Ecuador; currently only two specimens known, both from the same locality (Volcán Darwin, above Tagus Cove), one from a ±shaded and sheltered basalt ledge, the other from an exposed basalt rock.

Notes. The cauliflower-like submarginal soralia of this saxicolous species with angular lobes are quite conspicuous and in the Galapagos *P. soredioaliphaticum* is thus not easily confused with any other species. *Parmotrema mordenii* and *P. praesorediosum* typically have ±linear to crescent-shaped marginal soralia, which occasionally may become subcapitate, but not distinctly cauliflower-like. *Parmotrema dilatatum* and *P. weberi* can have similar cauliflower-like soredia, but these originate from abundant lobules, which are absent from *P. soredioaliphaticum*. All these species are clearly distinguished by their chemistry, with *P. soredioaliphaticum* containing only fatty acids in its medulla.

Specimens examined from Ecuador, Galápagos. ISLA ISABELA, VOLCÁN DARWIN: southwestern foothills, above Tagus Cove, 0°14′50″S, 91°21′29.89″W, 67 m alt., dry zone, open *Bursera graveolens* forest with *Waltheria ovata* and *Macraea laricifolia*, few *Acacia rorudiana* and *Cordia lutea*, along small lava flow, on ledge of basalt boulder, semi-shaded and wind- and rain-sheltered by overhang, 11-Nov-2007, Bungartz, F. 7340 (CDS 37827); on exposed basalt rock, 11-Nov-2007, Ertz, D. 11758 A (CDS 38916).

Parmotrema subisidiosum (Müll. Arg.) Hale, Phytologia 28(4): 339. 1974. (Fig. 9D–F)

Type: Tanzania, Lushoto District: West Usambara Mountains, Bumba Mavumbi [original label data: Africa, Bumba: Usambara], Holst 8772 p.p., (G – lectotype!, designated by Hale & Fletcher 1990).

Thallus corticolous or saxicolous; upper surface white to whitish gray, dull to shiny, epruinose or pruinose, densely reticulate-maculate, sometimes becoming cracked; abundantly isidiate; isidia marginal, cylindrical, soon coralloid, i.e., densely to loosely and elaborately branched, typically with a brown tip, ciliate or eciliate, but along the lobe margin closely intermingled with the abundant cilia (see comments below); lobes moderate-sized, 3–9 mm wide, ±rotund, axils incised, margins abundantly ciliate; cilia short and slender, 0.3–2.5 mm long, black, mostly simple, very rarely branched; lower surface black, gradually becoming dark brown towards the margin, the rhizines there becoming increasingly sparse and shortened, but rarely entirely missing and typically not developing into a distinctly erhizinate zone; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV–].

Ecology and distribution. Africa, North, Central and South America (Dodge 1959; Krog & Swinscow 1981; Hale & Fletcher 1990; Brodo et al. 2001; Spielmann 2009; Egan et al. 2016). From Galapagos previously only reported online (Bungartz et al. 2016). A common species, mostly growing in the transition zone and humid zone, rarely in the lower or high altitude dry zone; mostly on bark (mostly native and endemic trees, shrubs and cacti; occasionally on introduced *Cedrela*), rarely on rock, one specimen on soil; typically at sunny, wind- and rain-exposed sites.

Notes. The Galapagos material of *P. subisidiosum* is somewhat heterogeneous in that some specimens form distinctly ciliate isidia, whereas others have cilia and isidia closely intermingled, the cilia forming along the lobe margin, being closely interspersed but not necessarily

emerging directly from the isidia. These differences appear subtle but may be sufficiently distinct to recognize two separate morphotypes. It remains doubtful, however, whether this variation justifies recognizing these morphotypes as separate taxa.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: along trail from Black Beach to Cruz farm, on bark of *Bursera*, 25-Apr-1976, Weber, W.A. s.n. (QCA); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, cliff at NE side of trail (Mirador), 1°17′4.298″S, 90°26′36.60″W, 365 m alt., transition zone, ~10 m high lava cliff within dense scrub of *Clerodendrum molle*, *Croton scouleri* and *Macraea laricifolia*, one single *Acacia rorudiana* on top of cliff, on top of basalt cliff, sunny, wind- and rain-exposed, 25-Jan-2011, Yánez-Ayabaca, A. 2132 (CDS 48505). ISLA PINTA: on the western cliff, W of Las Pampas, 0°34′51.70″N, 90°46′25.89″W, 411 m alt., transition zone, W-exposed forest of *Zanthoxylum fagara*, *Croton scouleri*, *Cordia lutea* and *Pisonia floribunda*, on SSW-exposed stem of *Croton scouleri*, semi-shaded, 01-Feb-2008, Nugra, F. 624 (CDS 39002); plateau on top of the western cliff, W of Las Pampas, 0°34′52.60″N, 90°46′29.19″W, 425 m alt., transition zone, W-exposed forest of *Zanthoxylum fagara*, *Croton scouleri*, and *Pisonia floribunda*, on branches and base of dead standing trunk, sunny, 01-Feb-2008, Nugra, F. 648 (CDS 39026), 642 (CDS 39020). ISLA PINZÓN: along the trail going up from Playa Escondida, SW-slope of the top, 0°36′36″S, 90°40′11″W, 310 m alt., dry transition zone with *Prosopis juliflora*, *Opuntia galapageia* ssp. *macrocarpa*, *Croton scouleri*, *Cordia lutea*, *Scalesia baurii* ssp. *baurii*, on trunk of *Opuntia galapageia* ssp. *macrocarpa* (~30 cm in diam.), sunny, wind- and rain-exposed, 16-Feb-2006, Bungartz, F. 3590 (CDS 27403). ISLA SAN CRISTÓBAL, Cerro Partido along trail from entrance to Cerro Pelado to El Ripioso, 0°51′23″S, 89°27′37″W, 376 m alt., transition zone, rocky SW-exposed slope of hill with *Jasminocereus thouarsii*, *Clerodendrum molle* var. *glabrescens*, *Psidium galapageium*, Bromeliaceae and ferns growing in rock crevices, on twigs of *Psidium galapageium*, S-exposed, sunny, wind- and rain-exposed, 28-Apr-2007, Bungartz, F. 6590 (CDS 34810), 6603 (CDS 34823); slope of Cerro Tortuga, ~4 km inland from the NW-coast, 0°44′51″S, 89°23′25″W, 155 m alt., dry zone, rocky S-exposed slope with few *Bursera graveolens*, *Piscidia carthagenensis*, *Zanthoxylum fagara*, and *Mentzelia aspera* in the understory, in SE-exposed cavity under large basalt boulder, shaded, wind- and rain-sheltered, 25-Apr-2007, Bungartz, F. 6566 (CDS 34784). ISLA SANTA CRUZ: above Mina Granillo Rojo, on the N side of the island, 0°37′4.40″S, 90°21′57″W, 600 m alt., transition zone, on bark, 07-Aug-2008, Clerc, P. 08-93 B (CDS 54953); off the dirt road to Mina Granillo Rojo, on the N side of the island, 0°37′2″S, 90°22′6″W, 294 m alt., transition zone, deciduous forest of *Zanthoxylum fagara*, *Psidium galapageium*, *Pisonia floribunda* and few *Bursera graveolens* and *Cedrela odorata*, on twigs of *Zanthoxylum fagara*, sunny, wind- and rain-exposed, 21-Jun-2006, Bungartz, F. 4960 B (CDS 29173); on the North side of the island, along the dirt road to the ash quarry Mina Granillo Rojo, 0°36′56″S, 90°22′3″W, 570 m alt., lower transition zone, dry semi-deciduous forest with *Bursera graveolens* and *Zanthoxylum fagara*, on *Bursera*, 23-Feb-2006, Aptroot, A. 64573 (CDS 31145); saddle between Puntudo and Mt. Crocker, 0°38′41″S, 90°19′57″W, humid zone, on exposed rock, 18-Apr-1976, Weber, W.A. 35 (CDS 10838); Steve Divine's Farm at the end of Tortoise Road, off the main road to Baltra, Tortoise Territory, 0°40′8″S, 90°24′17″W, 364 m alt., humid zone, agricultural area, open farmland with *Cedrela odorata*, *Persea americana*, *Citrus* sp., on wood, 23-Feb-2006, Aptroot, A. 64524 (CDS 31096); saddle between Puntudo and Mt. Crocker, humid zone, on exposed rock, 18-Apr-1976, Weber, W.A. s.n. (35) (QCA). ISLA SANTIAGO: along the trail from the caseta in La Central to La Bomba (at the coast), ~2.5 km NE of the caseta, 0°13′41″S, 90°44′9″W, 528 m alt., transition zone, open woodland of *Psidium galapageium*, *Zanthoxylum fagara*, *Bursera graveolens*, *Trema micrantha* and *Opuntia galapageia* with shrubs of *Clerodendrum molle* in between, on trunk of *Bursera graveolens* (~30 cm in diam.), NW-exposed, semi-shaded, wind- and rain-sheltered, 25-Mar-2006, Bungartz, F. 4888 (CDS 29092); ~1 km NE of the caseta and on the W side of the trail, 0°14′10″S, 90°44′41″W, 664 m alt., transition zone, vertical, SE-exposed cliff face with ferns growing in crevices (*Blechnum polypodioides* and *Pityrograma calomelanos* var. *calomelanos*), on S-exposed top of flat basalt boulder at the bottom of the cliff, semi-shaded, wind- and rain-exposed, 25-Mar-2006, Bungartz, F. 4853 (CDS 29049). ISLA ISABELA, VOLCÁN ALCEDO: al lado este del cumbre, 0°26′54.77″S, 91°5′22.10″W, 950 m alt., zona húmeda, bosque abierto, sobre *Tournefortia rufo-sericea*, 30-Dec-2006, Nugra, F. 170 A (CDS 32824); outer SE-exposed slope and crater rim, 0°27′29″S, 91°7′19″W, 1089 m alt., humid zone, tortoise pasture with scattered trees (*Tournefortia rufo-sericea*, *Zanthoxylum fagara*), on wood, 05-Mar-2006, Aptroot, A. 65093 (CDS 31675); Bungartz, F. 4030 (CDS 27960), 4019 (CDS 27949); ~100 m below the crater rim, 0°25′36″S, 91°5′12″W, 1146 m alt., humid zone, disturbed by former grazing of goats, *Pteridium arachnoideum* and *Stachytarpheta cayennensis*, scattered low shrubs of *Tournefortia rufo-sericea* and outcrops of basalt tuff in between, conglomerated basalt tuff partially covered by soil, on E-exposed slope of basalt outcrop, shaded, wind- and rain-sheltered, 06-Mar-2006, Bungartz, F. 4136 (CDS 28167), 4169 (CDS 28200); ~2.5 km below the crater rim, 0°26′20″S, 91°4′35″W, 784 m alt., transition zone, bare basalt outcrop, ±bare of vascular plant vegetation, with some *Psidium galapageium* growing below, on E-exposed front of basalt outcrop, sunny, wind- and rain-exposed, 07-Mar-2006, Bungartz, F. 4284 (CDS 28356); upper NNW-exposed slope inside the crater, 0°27′27″S, 91°7′23″W, 1055 m alt., humid zone, open vegetation with *Adianthus concinnum* and scattered shrubs of *Tournefortia rufo-sericea* among basalt rocks, on branches and twigs of *Tournefortia rufo-sericea*, NW-exposed, sunny, wind- and rain-exposed, 05-Mar-2006, Bungartz, F. 4084 (CDS 28048); VOLCÁN CERRO AZUL: large lava ridge to the West above Cerro Verde, 0°57′7.40″S, 91°24′31″W, 1467 m alt., high altitude transition zone, large liverworts on open soil, sparse grasses, some Low Rattlebox (*Crotalaria pumila*), sedges (*Cyperus anderssonii*), ferns, few *Opuntia* spp. and *Tournefortia rufo-sericea* scrub, rocky outcrop formation, sunny, on soil, 06-May-2012, Spielmann, A.A. 10543 (CDS 51901); lower crater slopes above the first Caseta del Parque; below the cloud layer, 0°58′39.20″S, 91°25′25.80″W, 434 m alt., transition zone, open Guajava forest, with sparse *Psidium guajava* shrubs, few larger *Zanthoxylum fagara* trees, and *Tournefortia rufo-sericea* scrub, on twigs and trunk of isolated *Zanthoxylum* in a field with *Psidium guajava*, 03-May-2012, Spielmann, A.A. 10435 (CDS 51791), 10429 (CDS 51784); 0°57′55.60″S, 91°25′1.899″W, 767 m alt., humid zone, open pasture with some *Tournefortia rufo-sericea* scrub, and occasionally large clusters of *Cladonia confusa* on the ground, on top of rock, sunny, 03-May-2012, Spielmann, A.A. 10455 (CDS 51811); within the cloud layer, 0°58′36.77″S, 91°25′26.19″W, 456 m alt., humid zone, open Guajava forest, with sparse *Psidium guajava* shrubs, few larger *Zanthoxylum fagara* trees and *Tournefortia rufo-sericea* scrub, on front of basaltic rock, sunny, wind- and rain-exposed, 03-May-2012,

Spielmann, A.A. 10439 (CDS 51795); uppermost crater slopes of blackened volcanic ash fields along the crater rim, 0°56′20.39″S, 91°24′13.30″W, 1614 m alt., high altitude dry zone, open black volcanic ash fields bare of vegetation with inspersed patches of vegetation (*Opuntia* spp.), very few *Tournefortia rufo-sericea* shrubs and occasional *Iochroma ellipticum* trees, on branches and trunk of isolated *Iochroma* near the crater border, sunny, wind- and rain-exposed, 05-May-2012, Spielmann, A.A. 10475 (CDS 51831), 10492 (CDS 51848), 10493 (CDS 51849), 10479 (CDS 51835); wide open ditch between two lava ridges to the West above Cerro Verde, 0°57′9.40″S, 91°24′31.5″W, 1436 m alt., humid zone, near small, shaded woodland of *Tournefortia rufo-sericea*, *Cordia leucophlyctis* and *Psidium galapageium*, growing on *Opuntia insularis*, 06-May-2012, Spielmann, A.A. 10545 (CDS 51903); VOLCÁN DARWIN: ~200 m from the southwestern crater rim, 0°12′17.19″S, 91°18′45.20″W, 1304 m alt., high altitude dry zone, open forest of *Scalesia microcephala*, few trees of *Zanthoxylum fagara*, *Cordia revoluta* and *Croton scouleri* shrubs, many young *Scalesia* in the understory, on trunk of *Zanthoxylum fagara* (~10 cm in diam.), semi-shaded, wind- and rain-sheltered, 13-Nov-2007, Bungartz, F. 7528 (CDS 38019); Ertz, D. 11849 A (CDS 38889); 0°12′11.5″S, 91°18′41.27″W, 1286 m alt., high altitude dry zone, open forest of *Scalesia microcephala*, few trees of *Zanthoxylum fagara*, *Cordia revoluta* and *Croton scouleri* shrubs, many young *Scalesia* in the understory, on stem of *Croton scouleri* (~4 cm in diam.), sunny, wind- and rain-exposed, 13-Nov-2007, Bungartz, F. 7497 (CDS 37988); southwestern slope, above Tagus Cove, 0°13′27.60″S, 91°19′21.19″W, 860 m alt., transition zone, open scrubland of *Dodonaea viscosa*, *Croton scouleri*, *Macraea laricifolia*, *Scalesia microcephala*, few *Opuntia insularis* and dry grasses in the understory, on dead shrub, 15-Nov-2007, Ertz, D. 11949 (CDS 37308); 0°13′43.27″S, 91°19′47.27″W, 724 m alt., transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Dodonaea viscosa*, *Croton scouleri*, *Cordia revoluta* and *Jasminocereus thouarsii*), on S-exposed front of basalt boulder, sunny, wind- and rain-exposed, 12-Nov-2007, Bungartz, F. 7475 (CDS 37962), 7456 (CDS 37943), 7476 (CDS 37963); VOLCÁN SIERRA NEGRA: along dirt road from Puerto Villamil to crater of Sierra Negra, farmland, 0°51′39.89″S, 91°1′41.60″W, 330 m alt., humid zone, *Cedrela odorata* and *Psidium guajava* trees along road bordering a pasture, on S-exposed trunk of *Cedrela odorata*, sunny, wind- and rain-exposed, 09-Sep-2007, Bungartz, F. 6919 (CDS 36418); mirador El Mango, SE side of island, 0°53′1.399″S, 91°0′48.39″W, 161 m alt., transition zone, rocky open area with shrubs of *Psidium guajava*, ferns and *Stereocaulon* covering the ground, on exposed basaltic rocks, 15-Aug-2008, Herrera-Campos, M.A. 10610 (CDS 40347); near parking place at start of foot path to the crater, 0°49′47.5″S, 91°5′19.80″W, 939 m alt., humid zone, open grazed woodland of shrubby *Psidium guajava*, on rotting wood of old overhanging fence post (~10 cm in diam.), NE-exposed, semi-shaded, wind- and rain-sheltered, 08-Sep-2007, Bungartz, F. 6816 (CDS 36247), 6841 (CDS 36289), 6809 (CDS 36240); trail climbing up to Sierra Negra crater, 0°49′41.39″S, 91°5′30.10″W, 967 m alt., humid zone, *Psidium guajava* shrubland with *Pteridium arachnoideum* on the ground, slope 25° SE, on dead branches with mosses on the ground, 14-Aug-2008, Herrera-Campos, M.A. 10553 (CDS 40289); trail to Volcán Chico, along Sierra Negra crater, 0°49′4.798″S, 91°5′18.30″W, 980 m alt., humid zone, *Psidium guajava* shrubland with *Pteridium arachnoideum* on the ground, slope 25° SW, on branches of *Psidium guajava*, 14-Aug-2008, Clerc, P. 08-160 (CDS 40014); Truong, C. 1282 (CDS 39593); 0°48′53.20″S, 91°5′18.39″W, 982 m alt., humid zone, *Psidium guajava* shrubland with *Pteridium arachnoideum* on the ground, slope 25° NW, on branches of *Psidium guajava*, 14-Aug-2008, Herrera-Campos, M.A. 10568 (CDS 40305), Herrera-Campos, M.A. 10570 (CDS 40307).

Parmotrema tinctorum (Despr. ex Nyl.) Hale, Phytologia 28: 339. 1974. (Fig. 7A–B)

Type: Spain. Canary Islands, Despréaux, J.M. s.n. (H-NYL 35365 – holotype, fide Fleig 1997).

Thallus corticolous, lignicolous, less frequently saxicolous; upper surface whitish gray to ivory, shiny to ±dull, epruinose, emaculate, not cracked; abundantly isidiate; isidia laminal, irregularly spread across the thallus surface, cylindrical, simple to sparsely branched, brown to blackened at their tip, eciliate; lobes broad, moderate-sized to large, 0.8–10(–14) mm wide, ±rotund, axils incised, margins eciliate; lower surface with a broad, pale to deep brown, erhizinate, ~4–6 mm wide margin, blackening and sparsely rhizinate towards the thallus center; rhizines short, stout, black, mostly simple, rarely sparsely branched, often growing in clusters; medulla white. Apothecia often absent, but occasionally observed, 0.2–9 mm in diam., with a cupulate thalline margin, disc dark brown, deeply concave, imperforate; asci clavate, *Lecanora*-type, ascospores 8/ascus, simple, broadly ellipsoid, (12.9–)13.6–15.3(–15.8) × (6.4–)6.8–8.0(–8.4)µm (n = 25), thick-walled (~1 µm thick). *Pycnidia* not observed among the Galapagos specimens; *conidia* according to Swinscow & Krog (1988) filiform, 12–16 µm long.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with lecanoric acid [P–, K–, C+/KC+ bright red (C and KC reactions are evanescent and must be examined under continuous observation); UV–].

Ecology and distribution. Cosmopolitan; reported from Oceania, Asia, Africa, Europe, North, Central and South America (Hale 1965; Awasthi 1976; Swinscow & Krog 1988; Purvis et al. 1992; Elix 1994; Malcolm & Galloway 1997; Louwhoff & Elix 1999; Kurokawa & Lai 2001; Benatti & Marcelli 2009; Spielmann & Marcelli 2009; Egan et al. 2016), including continental Ecuador (Cevallos Solórzano 2012). First reported from the Galapagos by Dodge (1936), subsequently by Weber (1966, 1981, 1986), Elix & McCarthy (1998) and online (Bungartz et al. 2016). Possibly the most common species of *Parmotrema* in the Galapagos; from the coastal zone all the way to the high-altitude dry zone, most common in the dry zone and transition zone, followed by the humid zone; most frequently on bark of native trees (*Bursera*, *Cordia*, *Piscidia*, *Pisonia*, *Erythrina*, *Zanthoxylum*) and shrubs (*Clerodendrum*, *Croton*), occasionally on wood or cacti (*Jasminocereus*, *Opuntia*), also in mangroves (*Conocarpus*, *Hippomane*), rarely on introduced trees of the agricultural areas (*Cedrela*), common also on rock; mostly at sunny and exposed, less frequently ±shaded and sheltered sites.

Notes. For differences from the similar *P. endosulphureum* and the exclusively saxicolous *P. pustulotinctum*, refer to the descriptions of these species.

Specimens examined from Ecuador, Galápagos. ISLA ESPAÑOLA: along S-coast of the island, SE of Punta Suárez, 60 m inland from coast, 1°22′58.39″S, 89°43′15.4″W, 113 m alt., dry zone, *Cordia lutea* shrubland with *Prosopis juliflora*, on branches of *Cordia lutea*, sunny, 10-Nov-2010, Yánez-Ayabaca, A. 1607 (CDS 45496), 1609 (CDS 45498); ~500 m inland from coast, 1°22′56.60″S, 89°43′8.40″W, 133 m alt., dry zone, lava cliff with *Cordia lutea*, *Ipomoea habeliana*, and frew trees of *Bursera graveolens*, on top of basalt cliff, sunny, wind- and rain-exposed, 10-Nov-2010, Bungartz, F. 8935 (CDS 45753); on bark, 10-Nov-2010, Bungartz, F. 8958 (CDS 45776); 30 m inland from coast, 1°22′59.77″S, 89°43′17.10″W, 109 m alt., dry zone, *Cordia lutea* shrubland with *Prosopis juliflora* and opening, on branch of *Cordia lutea*, 10-Nov-2010, Yánez-Ayabaca, A. 1603 (CDS 45491); 1°21′24.89″S, 89°41′57″W, 24 m alt., dry zone, boulder field of weathered AA-lava with scarce vegetation of *Ipomoea habeliana*, one *Bursera* tree and few *Cordia lutea* shrubs, on branch of *Bursera graveolens*, sunny, 11-Nov-2010, Yánez-Ayabaca, A. 1636 (CDS 45519), 1652 (CDS 45535); 1°21′40.60″S, 89°41′56.60″W, 48 m alt., dry zone, open scrub of *Cordia lutea* and *Prosopis juliflora* with grasses and few trees of *Bursera graveolens* over weathered lava boulders, on trunk of *Bursera graveolens*, sunny, 11-Nov-2010, Yánez-Ayabaca, A. 1664 (CDS 45547), 1666 (CDS 45549), 1669 (CDS 45552), 1670 (CDS 45553), 1698 A (CDS 45581), 1702 (CDS 45585); 1°21′40.60″S, 89°41′56.60″W, 48 m alt., dry zone, open scrub of *Cordia lutea* and *Prosopis juliflora* with grasses and few trees of *Bursera graveolens* over weathered lava boulders, on W-exposed side of *Bursera graveolens* branch (~10 cm in diam.), semi-shaded, wind- and rain-exposed, 11-Nov-2010, Bungartz, F. 9064 (CDS 45882); on twigs of *Cordia lutea*, sunny, wind- and rain-exposed, 11-Nov-2010, Bungartz, F. 9152 (CDS 45970); 1°22′11.19″S, 89°42′58″W, 113 m alt., dry zone, open shrubland of *Cordia lutea* and *Prosopis juliflora* with few *Opuntia megasperma* var. *orientalis* and grass in the understory, SE-exposed upper side of cactus pad, semi-shaded, wind- and rain-sheltered, on cactus, 11-Nov-2010, Bungartz, F. 9160 (CDS 45978); 1°22′18.69″S, 89°42′7.40″W, 125 m alt., dry zone, *Cordia lutea* shrubland with some *Prosopis juliflora* shrubs at bottom of a basalt outcrop, on branch of *Prosopis juliflora*, sunny, 11-Nov-2010, Yánez-Ayabaca, A. 1679 (CDS 45562); 1°22′18.69″S, 89°42′7.40″W, 130 m alt., dry zone, basalt outcrop among *Cordia lutea* shrubland, on top of basalt cliff, sunny, wind- and rain-exposed, 11-Nov-2010, Bungartz, F. 9110 (CDS 45928); along trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, at Laguna Seca, 1°15′30.80″S, 90°26′26.60″W, 206 m alt., dry zone, very open *Bursera graveolens* forest over SE-exposed lava flow with *Prosopis juliflora*, on SW-exposed trunk/branch of *Bursera* (~15 cm in diam.), sunny, wind- and rain-exposed, 14-Jan-2011, Bungartz, F. 9528 (CDS 46811); on trunk of *Prosopis juliflora*, sunny, wind- and rain-exposed, 14-Jan-2011, Yánez-Ayabaca, A. 1885 (CDS 48240); at the base of Cerro Comunista, 1°17′22.89″S, 90°28′22.39″W, 158 m alt., dry zone, dense low forest of *Croton scouleri*, *Waltheria ovata* and *Castela galapageia* with occasional trees of *Acacia rorudiana* and *Bursera graveolens*, on branch of *Acacia rorudiana*, sunny, 16-Jan-2011, Yánez-Ayabaca, A. 1959 (CDS 48309), 1965 (CDS 48315); Cerro Pajas, inside the crater, 1°17′49.27″S, 90°27′23″W, 379 m alt., humid zone, *Scalesia pedunculata* forest with *Croton scouleri*, *Tournefortia rufo-sericea*, *Zanthoxylum fagara*, *Macraea laricifolia*, *Chiococca alba* and ferns in the understory, on branch of *Zanthoxylum fagara*, semi-shaded, 12-Jan-2011, Yánez-Ayabaca, A. 1745 (CDS 48023); inside the crater of Cerro Laguna at E side of island, on W-exposed slope, 1°16′11.80″S, 90°23′17″W, 245 m alt., transition zone, dense forest of *Prosopis juliflora*, *Clerodendrum molle*, very few *Bursera graveolens* and some *Jasminocereus thouarsii* in the upper part among lava outcrops and boulders; *Ramalina usnea/anceps* hanging in curtains from *Clerodendrum* twigs, on twigs of *Clerodendrum molle*, sunny, wind- and rain-exposed, 20-Jan-2011, Bungartz, F. 9954 B (CDS 55161); Pampa Larga, S of Cerro Asilo de la Paz, 1°19′38.70″S, 90°27′11.6″W, 249 m alt., transition zone, herbaceous vegetation with dominant *Phyla strigulosa*, occasional grasses and other herbs, few small shrubs of *Geoffroea spinosa*, on top of basalt rock, sunny, 13-Jan-2011, Yánez-Ayabaca, A. 1813 (CDS 48104); plain between the two hills Cerro de los Chanchos and Cerro de los Burros, 1°16′40.27″S, 90°24′12.4″W, 311 m alt., transition zone, open herbaceous area surrounded by dense forest of *Clerodendrum molle* and *Croton scouleri*, some rocks and boulders on the ground, on top of basalt boulder, sunny, wind- and rain-exposed, 21-Jan-2011, Bungartz, F. 9995 (CDS 47364); SW of La Gigante and N of Playa de los Perros at E-coast of the island, a bit inland from the coast, inside the crater of a small volcano, 1°16′37.77″S, 90°21′28″W, 74 m alt., coastal zone, open vegetation of *Cordia lutea* shrubs and trees, with *Prosopis juliflora*, *Castela galapageia*, *Vallesia glabra*, *Parkinsonia aculeata*, *Lycium minimum*, dry branch, sunny, wind- and rain-sheltered, on wood, 17-Jan-2011, Yánez-Ayabaca, A. 2002 (CDS 48352); 1°16′45.70″S, 90°21′37.39″W, 67 m alt., dry zone, very open vegetation of *Cordia lutea* with some *Vallesia glabra*, *Prosopis juliflora*, *Parkinsonia aculeata* on NE-exposed slope with some lava boulders and rocks, on dry branch of *Cordia lutea*, sunny, wind- and rain-exposed, 17-Jan-2011, Yánez-Ayabaca, A. 2011 (CDS 48361); trail from La Primavera Farm to La Corona and Arco de la Reina, southeastern part of the island, 1°19′21.60″S, 90°24′45.89″W, 219 m alt., transition zone, very dense scrub of *Clerodendrum molle* with some *Croton scouleri*, *Waltheria ovata*, few *Prosopis juliflora* and occasional trees of *Geoffroea spinosa* in flat area on generally SE-exposed, moderately inclined slope with few boulders, on branch of *Clerodendrum molle*, sunny, wind- and rain-exposed, 24-Jan-2011, Yánez-Ayabaca, A. 2096 (CDS 48452); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, cliff at NE side of trail (Mirador), 1°17′4.298″S, 90°26′36.60″W, 365 m alt., transition zone, ~10 m high lava cliff within dense scrub of *Clerodendrum molle*, *Croton scouleri* and *Macraea laricifolia*, one single *Acacia rorudiana* on top of cliff, on S-exposed front of basalt cliff, sunny, wind- and rain-exposed, 25-Jan-2011, Bungartz, F. 10189 (CDS 47608); 01-Jan-1934, Taylor, W.R. 868 D (FH 197224). ISLA PINTA: along the trail up to the summit from the S-coast, 0°34′15″N, 90°45′2″W, 289 m alt., transition zone, open woodland of *Zanthoxylum fagara*, *Pisonia floribunda*, and few *Trema micrantha*; grasses, *Justicia galapagana*, and *Alternanthera filifolia* in the understory, on upper side of bent *Pisonia floribunda* trunk (~15 cm in diam.), NW-exposed, sunny, wind- and rain-exposed, 27-Feb-2007, Bungartz, F. 5893 (CDS 33570); plateau on top of the western cliff, W of Las Pampas, 0°34′52.60″N, 90°46′29.19″W, 425 m alt., transition zone, W-exposed forest of *Zanthoxylum fagara*, *Croton scouleri*, and *Pisonia floribunda*, on SSW-exposed slope of basalt boulder, sunny, wind- and rain-exposed, 01-Feb-2008, Nugra, F. 643 (CDS 39021); along the trail going up from Playa Escondida, 0°36′10″S, 90°40′1″W, 254 m alt., dry zone, dry zone vegetation with *Prosopis juliflora*, *Alternanthera filifolia*, *Maytenus octogona*, and *Croton scouleri*, dead branches lying on the ground, sunny, wind- and rain-exposed, on wood, 16-Feb-2006, Bungartz, F. 3637 (CDS 27455); N- to W-facing cliff above a crater, 0°36′29″S, 90°40′14″W, 318 m alt., dry transition zone with *Cordia lutea*, *Croton scouleri*, and at the bottom of the cliff also *Scalesia baurii* ssp. *baurii*, on top

of large boulder of conglomerated volcanic tuff, sunny, wind- and rain-exposed, 16-Feb-2006, Bungartz, F. 3656 (CDS 27474), Aptroot, A. 64008 (CDS 30569); SW-slope of the top, 0°36′36″S, 90°40′11″W, 310 m alt., dry transition zone with *Prosopis juliflora*, *Opuntia galapageia* ssp. *macrocarpa*, *Croton scouleri*, *Cordia lutea*, *Scalesia baurii* ssp. *baurii*, on trunk of *Opuntia galapageia* ssp. *macrocarpa*, ~30 cm in diam., sunny, wind- and rain-exposed, on cactus, 16-Feb-2006, Bungartz, F. 3591 (CDS 27404); nesting area for tortoises, 0°36′44.39″S, 90°40′12.5″W, 303 m alt., lower transition zone, on 2.50 m high *Opuntia galapageia* var. *macrocarpa*, on cactus, 25-Nov-2005, Guézou, A. 206 A (CDS 39124); 300 m alt., transition zone, 07-Feb-1964, Cavagnaro, D. s.n. (L-40153, COLO 189285); 370 m alt., transition zone, 15-Aug-1905, Stewart, A. (350) 449 (FH 197360), (349) 442 (FH 197361). ISLA SAN CRISTÓBAL: Cerro Colorado, enclosure for *Calandrinia galapagosa* near the viewpoint on the top, 0°54′58″S, 89°26′5″W, 130 m alt., transition zone, open scrubland of mostly *Croton scouleri*, *Waltheria ovata*, and *Macraea laricifolia* on W-exposed cinder cone, on stems and branches of *Croton scouleri*, sunny, wind- and rain-exposed, 29-Apr-2007, Bungartz, F. 6752 (CDS 35003); 0°54′58.39″S, 89°26′4.700″W, 132 m alt., transition zone, on bark of *Psidium guajava*, 15-May-2006, Jaramillo, P. 2894 (CDS 38812), 2876 B (CDS 38790), 2886 A (CDS 38802), 2889 A (CDS 38808); Cerro Partido along trail from entrance to Cerro Pelado to El Ripioso, 0°51′23″S, 89°27′37″W, 376 m alt., transition zone, rocky SW-exposed slope of hill with *Jasminocereus thouarsii*, *Clerodendrum molle* var. *glabrescens*, *Psidium galapageium*, Bromeliaceae and ferns growing in rock crevices, on W-exposed front of basalt boulder, shaded, wind- and rain-sheltered, 28-Apr-2007, Bungartz, F. 6595 (CDS 34815); on S-exposed slope (30°) of basalt boulder, sunny, wind- and rain-exposed, 28-Apr-2007, Bungartz, F. 6598 (CDS 34818); crest of Cerro Tortuga, ~4 km inland from the NW-coast, 0°44′54″S, 89°23′32″W, 116 m alt., dry zone, open *Piscidia carthagenensis* woodland with few *Bursera graveolens* and dense understory of *Croton scouleri*, *Cordia lutea*, and *Mentzelia aspera* on rocky SE-exposed slope of hill, on trunk of *Bursera graveolens* (~15 cm in diam.), SW-exposed, sunny, wind- and rain-exposed, 25-Apr-2007, Bungartz, F. 6517 (CDS 34735); E of La Lobería, 0°55′56.5″S, 89°36′30.05″W, 20 m alt., coastal zone, on bark of *Piscidia carthagenensis*, 17-May-2006, Jaramillo, P. 3000 C (CDS 38832); from Punta Tortuga ~3 km inland close to Cerro Tortuga, 0°44′39″S, 89°23′32″W, 79 m alt., dry zone, dense woodland of *Bursera graveolens*, *Piscidia carthagenensis*, with *Scutia spicata* and *Croton scouleri* in the understory at edge of young lava flow, on trunk of *Bursera graveolens* (~15 cm in diam.), SE-exposed, semi-shaded, wind- and rain-sheltered, 25-Apr-2007, Bungartz, F. 6511 (CDS 34728); northwestern foothills of Media Luna, inland from the NW-coast, 0°43′41″S, 89°18′44″W, 75 m alt., dry zone, open woodland of *Cordia lutea* and *Bursera graveolens*, on top of inclined branch of *Bursera graveolens*, semi-shaded, wind- and rain-sheltered, 22-Apr-2007, Bungartz, F. 6215 (CDS 34427); top of dead branch of *Cordia lutea* (~20 cm in diam.), sunny, wind- and rain-exposed, on wood, 22-Apr-2007, Bungartz, F. 6227 (CDS 34439); road leading out of Wreck Bay, on *Bursera*, 20-May-1976, Lanier, J. s.n. (L-63706, COLO 298473); sector of the 'Gotera de agua', trail to Cerro Pelado, 0°51′34.60″S, 89°27′35.20″W, 389 m alt., transition zone, with *Bursera graveolens*, *Zanthoxylum fagara* and Lantana camara invading the understory, slope 15° N, on basalt lava, 23-Aug-2008, Herrera-Campos, M.A. GAL-446 (CDS 43337); slope of Cerro Tortuga, ~4 km inland from the NW-coast, 0°44′51″S, 89°23′25″W, 155 m alt., dry zone, rocky S-exposed slope with few *Bursera graveolens*, *Piscidia carthagenensis*, *Zanthoxylum fagara*, and *Mentzelia aspera* in the understory, on trunk of *Piscidia carthagenensis* (~20 cm in diam.), ESE-exposed, semi-shaded, wind- and rain-sheltered, 25-Apr-2007, Bungartz, F. 6580 (CDS 34798); SW foothills of Media Luna, inland from the NW-coast of the island along the trail from Galapagera to Media Luna; bottom of small crater to the NW of Media Luna, 0°43′53″S, 89°18′57″W, 124 m alt., upper dry zone; woodland of *Piscidia carthagenensis*, *Cordia lutea*, *Zanthoxylum fagara*, *Croton scouleri* and few *Bursera graveolens*, trunk of *Bursera graveolens* (~10 cm in diam.), on S-exposed, semi-shaded, ±wind- and rain-sheltered, 22-Apr-2007, Bungartz, F. 6236 (CDS 34448); trail to Cerro Mundo from the border of the National Park, NE of Puerto Baquerizo Moreno, 0°53′33.39″S, 89°34′42.5″W, 157 m alt., transition zone, dry bed of periodical stream with lava boulders, abundant *Hippomane mancinella* and few *Bursera graveolens* trees, on top of dead *Hippomane mancinella* branch, semi-shaded, wind- and rain-sheltered, 25-Aug-2008, Bungartz, F. 8664 (CDS 41310); 0.25 mi N of Darwin Research Station, Academy Baydry zone, cactus forest, on *Bursera*, 27-Jan-1964, Weber, W.A. s.n. (L-39132, COLO 186062); 1/4 mile north of Darwin Research Station, Academy Baydry zone, cactus forest, on *Bursera*, 27-Jan-1964, Weber, W.A. s.n. (FH 197180). ISLA SANTA CRUZ: along the road from Bellavista to El Garrapatero, ~4 km W from the campsite of the National Park, 0°40′38″S, 90°14′54″W, 159 m alt., dry zone, decidous dry lowland forest, *Bursera graveolens*, *Acacia rorudiana*, *Opuntia echios*, *Tournefortia rufo-sericea*, *Croton scouleri*, *Erythrina velutina*, *Piscidia carthagenensis*, *Passiflora suberosa*, and *Pisonia floribunda*, on trunk of *Erythrina velutina* (~25 cm in diam.), sunny, wind- and rain-exposed, 14-Feb-2006, Bungartz, F. 3573 (CDS 27372); along the trail from Puerto Ayora to Bahía Tortuga, 0°44′48″S, 90°19′14″W, 28 m alt., dry zone, decidous forest; with *Bursera graveolens*, *Acacia rorudiana*, and *Opuntia echios*; over basalt, on trunk of *Bursera*, sunny, wind- and rain-exposed, SW-exposed, 05-Jan-2006, Bungartz, F. 3335 (CDS 27002), 3336 (CDS 27003), 3343 (CDS 27010); at base of barranco on old trail to Bella Vista, 20 m alt., dry zone, on bark of *Bursera*, 11-Apr-1976, Weber, W.A. (QCA); base of barranco near seismic station, 20 m alt., dry zone, on bark of *Bursera*, 11-Apr-1976, Weber, W.A. s.n. (CDS 10814); coastal cliffs E of Puerto Ayora near Charles Darwin Research Station (CDRS), 0°44′45″S, 90°17′39″W, 20 m alt., coastal zone, on coastal lava, 31-May-2005, Aptroot, A. 63407 (CDS 30162); E side of island, along road from Cascajo to El Garrapatero, 0°40′22.10″S, 90°14′41.70″W, 137 m alt., lower transition zone, open mixed forest of *Bursera graveolens*, *Pisonia floribunda*, *Piscidia carthagenensis*, *Psidium galapageium*, *Erythrina velutina* with an understory of *Plumbago scandens*, *Alternanthera halmifolia*, *Bastardia viscosa*, *Zanthoxylum fagara*, on bark of *Erythrina velutina*, 16-Jun-2010, Spielmann, A.A. 8198 (CDS 45386), 8199 (CDS 45387), 8194 (CDS 45388); Nugra, F. 869 (CDS 44962), 920 (CDS 44965); on rock, Nugra, F. 895 (CDS 44966); E side of island, trail from parking lot to El Garrapatero beach, N side of trail, 0°41′26.69″S, 90°13′19.10″W, 6m alt., dry zone, open deciduous forest of *Bursera graveolens*, *Cordia lutea*, *Opuntia echios* with *Castela galapageia* and *Alternanthera echinocephala* and others in the understory, on bark of *Bursera*, 16-Jun-2010, Spielmann, A.A. 8191 (CDS 45326), 8192 (CDS 45327), 8193 (CDS 45328), 8196 (CDS 45330); Yánez-Ayabaca, A. 1499 (CDS 44931); Garrapatero Bay, site 11, 0°41′39″S, 90°13′25″W, on bark, 26-Jul-2000, LeDee, O.E. OEL-00-04 (CDS 43843); Puerto Ayora, near Charles Darwin Research Station (CDRS), 0°44′32″S, 90°18′10″W, 5m alt., coastal zone, 24-May-2005, Aptroot, A. 63025 (CDS 29753); summit of the island between El Puntudo and Cerro Crocker, 700 m alt., humid zone, on top

of small rock outcrops, 16-Apr-1976, Weber, W.A. s.n. (L-63351, COLO 297070); vicinity of Academy Bay, 5m alt., coastal zone, on bark, 28-Jan-1964, Schuster, R.O. s.n. (L-40135, COLO 189426), s.n. (L-40132, COLO 189421); 120 m alt., transition zone, on bark of *Pisonia floribunda*, 15-Feb-1964, Itow, S. s.n. (L-44004, COLO 192143); along shore E of Research Station, coastal zone, aerohaline belt, 15-Feb-1964, Weber, W.A. s.n. (L-40997, COLO 190371), s.n. (L-40997, FH 197179); at seismic station, dry zone, on bark, 29-Jan-1964, Schuster, R.O. s.n. (L-40129, COLO 189436), s.n. (L-40131, COLO 189420), s.n. (L-40134, COLO 189425), s.n. (L-40133, COLO 189444); Weber, W.A. s.n. (L-40202, COLO 189973); barranca along old trail, on bark, 15-Feb-1964, Weber, W.A. 415 A (L-40620, COLO 192533); Bellavista trail, 90 m alt., dry zone, bark, on bark, 04-Feb-1964, Schuster, R.O. s.n. (L-40137A, COLO 189428); between dormitories and first barranca, dry zone, 29-Jan-1964, Schuster, R.O. s.n. (L-40136, COLO 189427); first barranca along the old trail to Bellavista, dry zone, on rock, 15-Feb-1964, Weber, W.A. s.n. (L-40280, COLO 192975); near Bellavista on old trail, transition zone, 04-Feb-1964, Schuster, R.O. s.n. (L-40138, COLO 189429); top of first barranca, Bella Vista trail, dry zone, 04-Feb-1964, Schuster, R.O. s.n. (L-40130, COLO 189419); transition zone, on rock, 27-Mar-1971, Higgins, A. s.n. (FH 197178). ISLA SANTIAGO: 5–6 km al NO de Bahía Sullivan, desde el Cerro Inn, 0°16′42″S, 90°37′26″W, 142 m alt., zona seca, tallo de *Bursera graveolens*, sobre corteza, 15-Jul-2005, Simbaña, W. 544 (CDS 32380); above recent James Bay lava flow, 0°13′30″S, 90°48′15″W, 320 m alt., transition zone, *Psidium* forest with understory of *Psychotria*, on shrubs, 27-Apr-1971, Pike, L.H. 2632 (OSC 101711); along the trail from Bucanero to Jaboncillos, ~1 km below the summit, Cerro Gavilan, 0°11′45″S, 90°47′20″W, 680 m alt., transition zone, open *Psidium galapageium* forest with *Zanthoxylum fagara*, *Blainvillea dichotoma*, *Mentzelia aspera* and *Senna obtusifolia*, basalt boulders and outcrops in between, on trunk of *Bursera graveolens* (~40 cm in diam.), E-exposed, sunny, wind- and rain-exposed, 22-Mar-2006, Bungartz, F. 4677 (CDS 28764); ~3 km SE of Bucanero, 0°10′52″S, 90°48′33″W, 362 m alt., transition zone, open woodland of large *Bursera graveolens* and smaller *Psidium galapageium* trees, grassland and basalt boulders in between, on bark of *Erythrina*, 22-Mar-2006, Aptroot, A. 65375 (CDS 31961); Bungartz, F. 4635 (CDS 28722); along the trail from the caseta in La Central to La Bomba (at the coast), cerro ~1 km NE of the caseta and on the W side of the trail, 0°14′10″S, 90°44′41″W, 664 m alt., transition zone, vertical, SE-exposed cliff face with ferns (*Blechnum polypodioides* and *Pityrograma calomelanos* var. *calomelanos*) growing in crevices, on SE-exposed front of cliff of conglomerated basalt tuff, semi-shaded, wind- and rain-sheltered, 25-Mar-2006, Bungartz, F. 4856 (CDS 29052); ~200 m S of Cerro Gavilan, W-exposed slope, 0°12′30″S, 90°47′6″W, 832 m alt., humid zone, open woodland of *Psidium galapageium*, *Zanthoxylum fagara* and few *Iochroma ellipticum* and *Scalesia pedunculata* with dense scrub of *Tournefortia rufo-sericea* in between, on SE-exposed steep slope of basalt boulder, sunny, wind- and rain-exposed, 24-Mar-2006, Bungartz, F. 4824 (CDS 28991); ~7 km inland from the E-coast, ±at the same latitude as Bahía Sullivan, 0°17′4″S, 90°38′18″W, 192 m alt., dry zone, scrubland of *Castela galapageia* and *Macraea laricifolia* with occasional trees, mostly *Bursera graveolens* and few *Pisonia floribunda*, on trunk of *Bursera* (~30 cm in diam.), NE-exposed, semi-shaded, wind- and rain-exposed, 17-Jul-2006, Bungartz, F. 5169 (CDS 29382), 5084 (CDS 29297); Cerro Gavilan, directly below the summit at the NE-exposed slope, 0°12′19″S, 90°47′6″W, 828 m alt., humid zone, formerly with scrub or forest, disturbed by former grazing therefore shrubs and trees missing; artificial pampa with *Solanum americanum*, *Portulaca oleraceum*, *Senna occidentalis*, *Borreria laevis*, and grasses, basalt boulders and outcrops, on edge of basalt boulder, W-exposed, sunny, wind- and rain-exposed, 22-Mar-2006, Bungartz, F. 4714 (CDS 28812); on wood, 22-Mar-2006, Bungartz, F. 4717 (CDS 28815); near James Bay, 0°14′0″S, 90°51′0″W, on trunk of *Bursera*, 27-Apr-1971, Pike, L.H. 2595 (OSC 101709); Santiago Bay, on cactus, 15-Feb-1964, Dawson, E.Y. s.n. (L-41031, COLO 192953); summit of Cerro Gavilan, inner N- and NE-exposed crater rim, 0°12′20″S, 90°47′3″W, 840 m alt., humid zone, N- and NE-exposed, steep basalt cliffs of crater rim with ferns (*Pityrograma calomelanos* var. *calomelanos*, *Polypodium tridens*, *Doryopteris palmata*, *Adiantum concinnum*, *Blechnum polypodioides*) growing in crevices, on top of basalt boulder on top of cliff, sunny, wind- and rain-exposed, 23-Mar-2006, Bungartz, F. 4790 (CDS 28922); 0°13′50″S, 90°50′50″W, 15 m alt., dry zone, open *Bursera* forest on S-facing slope of red cinder cone next to sea and nearly surrounded by recent lava flow, on bark of *Bursera*, 28-Apr-1971, Pike, L.H. 2658 (OSC 101710). ISLA WOLF: on wood, 15-Feb-1964, Cavagnaro, D. s.n. (L-40371, COLO 190148). ISLA ISABELA, VOLCÁN ALCEDO: along the trail going up the E-slope, basalt rubble field to the SE side of the trail and the barranco, 0°24′3″S, 91°2′35″W, 434 m alt., dry zone, basalt rubble field with scattered vegetation (*Bursera graveolens*, *Zanthoxylum fagara*, *Pisonia floribunda*, *Senna pistaciifolia*), on trunk of *Bursera graveolens*, semi-shaded, wind- and rain-exposed, 09-Mar-2006, Bungartz, F. 4404 (CDS 28489); 0°24′6″S, 91°2′53″W, 530 m alt., dry zone, basalt rubble field with scattered vegetation (*Bursera graveolens*, *Zanthoxylum fagara*, *Pisonia floribunda*, *Senna pistaciifolia*), on bark of *Bursera*, 10-Mar-2006, Aptroot, A. 64906 (CDS 31484); eastern part of rim, Volcán Alcedo, humid zone, humid rocky ridges, 09-Jul-1972, De Roy, T. s.n. (L-55445, COLO 255978); on the crater rim near the hut, 0°26′33″S, 91°5′31″W, 1100 m alt., humid zone, *Pteridium arachnoideum* and *Stachytarpheta cayennensis*, scattered low shrubs of *Tournefortia rufo-sericea* and outcrops of basalt tuff in between, on lava, 07-Mar-2006, Aptroot, A. 65250 (CDS 31836); outer E-exposed slope just below the crater rim, 0°25′17″S, 91°5′8″W, 1077 m alt., humid zone, basalt outcrops, SE-exposed slope with scattered shrubs of *Tournefortia rufo-sericea*, *Opuntia insularis*, *Lantana peduncularis* and occasional trees of *Zanthoxylum fagara* among basalt rubble, on N-exposed front of basalt outcrop, sunny, wind- and rain-exposed, 08-Mar-2006, Bungartz, F. 4295 (CDS 28368); Aptroot, A. 65162 (CDS 31745); ~2.5 km below the crater rim, 0°26′20″S, 91°4′35″W, 784 m alt., transition zone, bare basalt outcrop, ±bare of vascular plant vegetation, with some *Psidium galapageium* growing below, on E-exposed front of basalt outcrop, sunny, wind- and rain-exposed, 07-Mar-2006, Bungartz, F. 4285 (CDS 28357); plain at the base of the outer E-exposed slope, along the trail going up to the rim, 0°24′47″S, 91°4′12″W, 768 m alt., transition zone, very open *Psidium galapageium* stand with occasional *Croton scouleri* and *Zanthoxylum fagara*, grassland and open soil in between, *Zanthoxylum fagara*, on the side and underside of inclined trunk, shaded, wind- and rain-sheltered, 08-Mar-2006, Bungartz, F. 4312 (CDS 28386); atop basalt cliffs south of Caleta Iguana, 0°58′51.70″S, 91°26′52″W, 10 m alt., coastal zone, low woodland of large Manzanillo (*Hippomane manzinella*) trees immediately above the cliffs, on branches, semi-shaded, 09-May-2012, Spielmann, A.A. 10748 (CDS 52152), 10749 (CDS 52153); 0°58′53.20″S, 91°26′52.77″W, 8m alt., coastal zone, *Hippomane mancinella* forest on top of cliff of moderately young, roughened basalt lava, on scar of *Hippomane mancinella*, 08-May-2012, Bungartz, F. 10550 (CDS 52561); Iguana Cove, on the side of the cliff above the cove,

20-Mar-1906, Stewart, A. s.n. (L-56312, COLO 263360), (343) 439 (FH 197359); 02-May-1906, Anonymous 5616 (FH 197362); ~1.5 km from the southwestern crater rim, 0°12′20.5″S, 91°18′52.77″W, 1280 m alt., high altitude dry zone, basalt outcrop for the most part bare of vegetation, on SE-exposed basalt outcrop, sunny, wind- and rain-exposed, 14-Nov-2007, Bungartz, F. 7589 (CDS 38085); Ertz, D. 11889 (CDS 37248); VOLCÁN DARWIN: southwestern slope, above Tagus Cove, 0°13′28.19″S, 91°19′17.89″W, 872 m alt., transition zone, top of lava flow in open scrubland of *Croton scouleri* and *Dodonaea viscosa* with *Cordia revoluta* and some *Opuntia insularis*, on SW-exposed slope of lava flow, sunny, wind- and rain-exposed, 15-Nov-2007, Bungartz, F. 7750 (CDS 38256); 0°14′15.4″S, 91°20′40.27″W, 351 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri*, *Macraea laricifolia* and *Waltheria ovata*, few trees of *Acacia rorudiana*, on top of inclined *Zanthoxylum fagara* branch, semi-shaded, wind- and rain-sheltered, 16-Nov-2007, Bungartz, F. 7890 (CDS 38399); 0°13′43.27″S, 91°19′47.27″W, 724 m alt., transition zone, SW-exposed lava flow of weathered AA-lava with scarce vegetation (*Macraea laricifolia*, *Dodonaea viscosa*, *Croton scouleri*, *Cordia revoluta* and *Jasminocereus thouarsii*), stem and branches of *Jasminocereus thouarsii*, sunny, wind- and rain-exposed, on cactus, 12-Nov-2007, Bungartz, F. 7443 (CDS 37930), 7451 (CDS 37938); along dirt road from Puerto Villamil to crater of Sierra Negra, 0°55′12.4″S, 90°59′38.20″W, 30 m alt., dry zone, top of old lava flow with scattered vegetation (*Bursera graveolens*, *Opuntia echios*, and *Waltheria ovata*), on S-exposed trunk of *Bursera graveolens*, sunny, wind- and rain-exposed, 10-Sep-2007, Bungartz, F. 7000 (CDS 36504); 09-Sep-2007, Bungartz, F. 6922 (CDS 36421); along the beach W of Puerto Villamil, dirt road to el Muro de las Lagrimas, SE side of the island, 0°57′24.89″S, 90°59′10.69″W, 3m alt., coastal zone, behind the beach, flat, on branches of *Conocarpus erectus*, facing the beach (exposed), 17-Aug-2008, Herrera-Campos, M.A. 10733 (CDS 40471); area around the Muro de las Lagrimas, ~5 km W of Puerto Villamil, 0°57′54.27″S, 91°0′48.77″W, 81 m alt., dry zone, open *Bursera graveolens* forest on NNE-exposed slope with *Opuntia echios*, *Scalesia affinis* and *Lantana peduncularis*, on E-exposed branch of *Bursera graveolens*, sunny, wind- and rain-exposed, 17-Aug-2008, Bungartz, F. 8420 (CDS 41066); Cerro Orchilla W of Puerto Villamil, close to the top, 0°57′45.60″S, 91°0′25.30″W, 98 m alt., dry zone, vegetation with *Bursera graveolens* and *Opuntia echios*, slope 45°, on basalt lava, 17-Aug-2008, Herrera-Campos, M.A. GAL-420 (CDS 43311); El Mango, on the E side of the dirt road, 0°53′1.7″S, 91°0′50.77″W, 162 m alt., lower transition zone; basalt lava outcrop with scattered vegetation (*Polypodium* sp., *Pityrogramma calomelanos*, *Darwiniothamnus tenuifolia*), on NW-exposed front of basalt outcrop, semi-shaded, wind- and rain-sheltered, 15-Aug-2008, Bungartz, F. 8212 (CDS 40858); on dead twigs of shrub, sunny, wind- and rain-exposed, 15-Aug-2008, Bungartz, F. 8215 (CDS 40861); 0°53′1.399″S, 91°0′48.39″W, 161 m alt., transition zone, rocky area (open) with shrubs of *Psidium guajava*, ferns and *Stereocaulon* covering the ground, on exposed basaltic rocks, 15-Aug-2008, Herrera-Campos, M.A. 10585 (CDS 40322), 10595 (CDS 40332), 10599 (CDS 40336), 10609 (CDS 40346); on twigs, 15-Aug-2008, Herrera-Campos, M.A. 10617 (CDS 40354), 10590 (CDS 40327); Muro de las Lagrimas W of Puerto Villamil, small hill above the wall, 0°57′54.77″S, 91°0′47.10″W, 81 m alt., dry zone, vegetation with *Bursera graveolens* and *Opuntia echios*, slope 45° N, on bark of *Bursera*, 17-Aug-2008, Herrera-Campos, M.A. 10750 (CDS 40489); trail to Volcán Chico, along Sierra Negra crater, 0°48′41.70″S, 91°5′15.1″W, 987 m alt., humid zone, *Psidium guajava* shrubland with *Pteridium arachnoideum* on the ground, slope 25° SW, on basaltic rocks at the side of the trail, 14-Aug-2008, Herrera-Campos, M.A. 10576 (CDS 40313).

Parmotrema ultralucens (Krog) Hale, Phytologia 28: 339. 1974. (Fig. 8C–D)

Type: USA, Georgia: Harris County, Dowdell's Knob, on rock, 1965, Krog, H. s.n. (O – holotype!, BM – isotype!).

Thallus corticolous; upper surface whitish gray to ivory, ±dull, epruinose, emaculate, but occasionally in parts irregularly cracked; abundantly isidiate; isidia marginal to submarginal, cylindrical, simple to sparsely branched, often grouped (±clustered), brown to blackened at their tip and rarely sparsely ciliate ('spiked' by short tapering black cilia); lobes broad, moderate-sized, 0.8–6(–9) mm wide, ±rotund, axils incised, margins sparsely to abundantly ciliate; cilia short and slender, 0.1–1(–1.5) mm long, black, mostly simple, very rarely branched; lower surface black, with a broad, distinctly dark brown, erhizinate marginal zone, 0.5–6 mm wide; rhizines long, slender, black, mostly simple, rarely sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV± yellow]; medulla with lichexanthone and salazinic acid [P+ deep yellow, K+ yellow, soon turning blood-red, KC–, C–, UV+ bright yellow].

Ecology and distribution. Africa, Asia, Azores, Oceania, North, Central and South America (Krog 1974; Swinscow & Krog 1988; Elix 1994; Louwhoff & Elix 1999; Kurokawa & Lai 2001; Elix et al. 2002; Chen et al. 2003; Spielmann 2009; Marcelli & Benatti 2010; Egan et al. 2016). First reported by Weber (1986), subsequently by Elix & McCarthy (1998) and online (Bungartz et al. 2016). In the Galapagos a moderately common species and apparently restricted to dry environments (zones: dry, transition, high-altitude dry); mostly on bark on native trees (*Bursera*), scrub (*Croton*) and cacti (*Opuntia*), less frequently on rock; mostly at sunny and exposed, less frequently ±shaded and sheltered sites.

Notes. Superficially very similar to both *P. crinitum* and *P. neosubcrinitum*, which both also contain salazinic acid and occasionally have tufted, caespitose, ciliate isidia. This species can easily be distinguished by its conspicuously UV+ bright yellow medullary reaction (due to the presence of lichexanthone). The species can further be confused with *P. mellissii*, which occasionally has tufted, caespitose, ciliate isidia but does not contain salazinic acid in its medulla and instead has alectoronic acid, which reacts UV+ bright greenish blue, not yellow.

Specimens examined from Ecuador, Galápagos. ISLA FLOREANA: along rim trail of Cerro Pajas, northeastern part of rim, 1°17′40.20″S, 90°27′17.30″W, 504 m alt., humid zone, low dense vegetation of *Zanthoxylum fagara*, *Scalesia pedunculata*, *Macraea laricifolia*, *Croton scouleri* and ferns (*Polypodium tridens*) over lava boulders; bryophytes hanging in curtains from trees, on slope of basalt cliff, semi-shaded, wind- and rain-sheltered, 26-Jan-2011, Bungartz, F. 10274 (CDS 47693);

lower S-slope of Cerro Ventanas, 1°16′36.10″S, 90°25′41.10″W, 295 m alt., transition zone, open shrubland of *Macraea laricifolia* and some lower *Waltheria ovata* shrubs in between, on top of basalt rock, sunny, wind- and rain-exposed, 18-Jan-2011, Yánez-Ayabaca, A. 2017 (CDS 48367); near Wittmer Farm, Asilo de la Paz, in the lower slope of Cerro Asilo de la Paz, 1°18′54.27″S, 90°27′15.30″W, 352 m alt., transition zone, young *Scalesia pedunculata* forest with *Zanthoxylum fagara*, *Croton scouleri*, *Macraea laricifolia*, *Chiococca alba* and some small lava boulders on NW-exposed slope, on top of lava boulder, sunny, wind- and rain-exposed, 13-Jan-2011, Yánez-Ayabaca, A. 1838 (CDS 48189); trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, cliff at NE side of trail (Mirador), 1°17′4.298″S, 90°26′36.60″W, 365 m alt., transition zone, ~10 m high lava cliff within dense scrub of *Clerodendrum molle*, *Croton scouleri* and *Macraea laricifolia*, one single *Acacia rorudiana* on top of cliff, on top of basalt cliff, sunny, wind- and rain-exposed, 25-Jan-2011, Bungartz, F. 10195 (CDS 47614); Yánez-Ayabaca, A. 2130 (CDS 48503). ISLA PINTA: along the trail up to the summit from the S-coast, 0°34′3″N, 90°44′56″W, 233 m alt., transition zone, open woodland with *Bursera graveolens*, *Zanthoxylum fagara*, *Pisonia floribunda*, *Croton scouleri*, and few *Opuntia galapageia* among old lava flows; in between *Alternanthera filifolia* and grasses, on upper side of inclined branch of *Bursera*, semi-shaded, wind- and rain-sheltered, 28-Feb-2007, Bungartz, F. 5972 (CDS 33650); plateau on top of the western cliff, W of Las Pampas, 0°34′52.60″N, 90°46′29.19″W, 425 m alt., transition zone, W-exposed forest of *Zanthoxylum fagara*, *Croton scouleri*, and *Pisonia floribunda*, on top of basalt boulder, sunny, wind- and rain-exposed, 01-Feb-2008, Nugra, F. 644 (CDS 39022). ISLA PINZÓN: summit, transition zone, on bark of *Croton*, 15-Feb-1964, Cavagnaro, D. 304 (L-40491, COLO 192818), s.n. (L-40494, COLO 193117); Weber, W.A. s.n. (L-40519, COLO 192299). ISLA SAN CRISTÓBAL: Cerro Partido along trail from entrance to Cerro Pelado to El Ripioso, 0°51′23″S, 89°27′37″W, 376 m alt., transition zone, rocky SW-exposed slope of hill with *Jasminocereus thouarsii*, *Clerodendrum molle* var. *glabrescens*, *Psidium galapageium*, Bromeliaceae and ferns growing in rock crevices, on branches of *Clerodendrum molle* var. *glabrescens*, S-exposed, semi-shaded; wind- and rain-sheltered, 28-Apr-2007, Bungartz, F. 6583 (CDS 34803); on S-exposed slope (20°) of basalt boulder, sunny, wind- and rain-exposed, 28-Apr-2007, Bungartz, F. 6610 (CDS 34830); NW-slope of Cerro Colorado, close to the lighthouse, 0°54′53.5″S, 89°26′1.7″W, 141 m alt., upper dry zone; dense shrubland of *Croton scouleri*, *Macraea laricifolia*, few *Psidium galapageium* shrubs, on trunk of *Bursera graveolens* (~20 cm in diam.), semi-shaded, wind- and rain-exposed, 24-Aug-2008, Bungartz, F. 8609 (CDS 41255); rim of crater to the NW of Media Luna, inland from the NW-coast, 0°43′51″S, 89°18′55″W, 149 m alt., lower transition zone; basalt cliffs of inner and outer crater rim with scarce vegetation, on S-exposed overhang of cliff on top of crater rim, shaded, wind- and rain-sheltered, 22-Apr-2007, Bungartz, F. 6303 (CDS 34515); ISLA SAN CRISTÓBAL: slope of Cerro Tortuga, ~4 km inland from the NW-coast, 0°44′51″S, 89°23′25″W, 155 m alt., dry zone, rocky S-exposed slope with few *Bursera graveolens*, *Piscidia carthagenensis*, *Zanthoxylum fagara*, and *Mentzelia aspera* in the understory, on trunk of *Piscidia carthagenensis* (~20 cm in diam.), ESE-exposed, semi-shaded, wind- and rain-sheltered, 25-Apr-2007, Bungartz, F. 6579 (CDS 34797); SW foothills of Media Luna, inland from the NW-coast of the island along the trail from Galapagera to Media Luna; bottom of small crater to the NW of Media Luna, 0°43′53″S, 89°18′57″W, 124 m alt., upper dry zone; woodland of *Piscidia carthagenensis*, *Cordia lutea*, *Zanthoxylum fagara*, *Croton scouleri* and few *Bursera graveolens*, on trunk of *Bursera* (~10 cm in diam.), S-exposed, semi-shaded, ±wind- and rain-sheltered, 22-Apr-2007, Bungartz, F. 6238 (CDS 34450); trail to Cerro Mundo from the border of the National Park, NE of Puerto Baquerizo Moreno, 0°53′33.39″S, 89°34′42.5″W, 157 m alt., transition zone, dry bed of periodical stream with lava boulders, abundant *Hippomane mancinella* and few *Bursera graveolens* trees, on N-exposed trunk of *Bursera graveolens* (~10 cm in diam.), sunny, wind- and rain-exposed, 25-Aug-2008, Bungartz, F. 8673 (CDS 41319). ISLA SANTA CRUZ: E side of island, along road from Cascajo to El Garrapatero, 0°40′22.10″S, 90°14′41.70″W, 137 m alt., lower transition zone, open mixed forest of *Bursera graveolens*, *Pisonia floribunda*, *Piscidia carthagenensis*, *Psidium galapageium*, *Erythrina velutina* with an understory of *Plumbago scandens*, *Alternanthera halmifolia*, *Bastardia viscosa*, *Zanthoxylum fagara*, on bark of *Erythrina*, 16-Jun-2010, Spielmann, A.A. 8201 (CDS 45373); near lava tube outside Puerto Ayora along Bellavista road, 0°43′55″S, 90°19′44″W, 95 m alt., dry zone vegetation with *Bursera graveolens* and *Zanthoxylum fagara*, on lava, 25-Feb-2006, Aptroot, A. 64625 (CDS 31198); near Los Gemelos craters, 0°36′31″S, 90°22′4″W, 350 m alt., humid zone, on lava, 31-May-2005, Aptroot, A. 63377 (CDS 30123); on the North side of the island, along the dirt road to the ash quarry Mina Granillo Rojo, 0°36′56″S, 90°22′3″W, 570 m alt., lower transition zone; dry semi-deciduous forest with *Bursera graveolens* and *Zanthoxylum fagara*, on branches of *Bursera*, sunny, wind- and rain-exposed, 23-Feb-2006, Bungartz, F. 3913 (CDS 27795); vicinity of Academy Bay, barranca along old trail, on tree, 15-Feb-1964, Weber, W.A. 415 C (L-40620, COLO 192533), 170 (L-40292, COLO 193499). ISLA SANTIAGO: Cerro Gavilan, directly below the summit at the NE-exposed slope, 0°12′19″S, 90°47′6″W, 828 m alt., humid zone, formerly with scrub or forest, disturbed by former grazing therefore shrubs and trees missing; artificial pampa with *Solanum americanum*, *Portulaca oleraceum*, *Senna occidentalis*, *Borreria laevis*, and grasses, basalt boulders and outcrops, on W-exposed slope of basalt boulder, sunny, wind- and rain-exposed, 22-Mar-2006, Bungartz, F. 4702 (CDS 28800); E of salt lake at James Bay, 0°14′25″S, 90°48′50″W, 170 m alt., transition zone, *Bursera-Psidium* forest on pahoehoe lava flow, on rock, 30-Apr-1971, Pike, L.H. ID16-6 (OSC 101760); 08-Aug-1905, Stewart, A. 6059 C (FH 197441). ISLA ISABELA, VOLCÁN CERRO AZUL: lower crater slopes above the first Caseta del Parque; within the cloud layer, 0°58′36.77″S, 91°25′26.19″W, 456 m alt., humid zone, open Guajava forest, with sparse *Psidium guajava* shrubs, few larger *Zanthoxylum fagara* trees, and *Tournefortia rufo-sericea* scrub, on front of basaltic rock, in sunny, wind- and rain-exposed, 03-May-2012, Spielmann, A.A. 10440 (CDS 51796); 0°58′52.39″S, 91°26′41″W, 74 m alt., dry zone, shaded forest of huge Manzanillo (*Hippomane manzinella*) trees, some *Zanthoxylum fagara* scrub, shrubs of *Clerodendrum molle* and *Psidium galapageium*, on tree trunk, semi-shaded, 09-May-2012, Spielmann, A.A. 10721 (CDS 52124), 10725 (CDS 52128); middle crater slopes above the first Caseta del Parque; within the cloud layer, 0°57′58.27″S, 91°24′40.60″W, 863 m alt., humid zone, open, windswept pasture of strongly grazed sedges (*Cyperus anderssonii*), grasses and few ferns; no trees or shrubs, on WNW-exposed front of basaltic boulder, sunnyon, 03-May-2012, Spielmann, A.A. 10467 (CDS 51823); wide, open ditch between two lava ridges to the West above Cerro Verde, 0°57′9.40″S, 91°24′31.5″W, 1436 m alt., humid zone, near small, shaded woodland of *Tournefortia rufo-sericea*, *Cordia leucophlyctis* and *Psidium galapageium*, growing on *Opuntia insularis*, on cactus, 06-May-2012, Spielmann, A.A. 10549 (CDS 51907); VOLCÁN DARWIN: ~200 m from the

southwestern crater rim, 0°12′17.19″S, 91°18′45.20″W, 1304 m alt., high altitude dry zone, open forest of *Scalesia microcephala*, few trees of *Zanthoxylum fagara*, *Cordia revoluta* and *Croton scouleri* shrubs, many young *Scalesia* in the understory, on shrub, 13-Nov-2007, Ertz, D. 11837 (CDS 37196); southwestern slope, above Tagus Cove, 0°13′28.19″S, 91°19′17.89″W, 872 m alt., transition zone, base of lava flow in open scrubland of *Croton scouleri* and *Dodonaea viscosa* with *Cordia revoluta* and some *Opuntia insularis*, on SE-exposed stem of large and old *Cordia revoluta* shrub, semi-shaded, wind- and rain-exposed, 15-Nov-2007, Bungartz, F. 7755 (CDS 38261); 0°13′59″S, 91°20′8″W, 597 m alt., dry zone, open *Bursera graveolens* forest with *Croton scouleri* and *Macraea laricifolia* shrubs, few *Chiococca alba* and *Scalesia microcephala*, among lava boulders and outcrops, slope (45°), on AA-lava, sunny, wind- and rain-exposed, 16-Nov-2007, Bungartz, F. 7792 (CDS 38301), 7802 (CDS 38311); El Mango, on the E side of the dirt road, 0°53′1.7″S, 91°0′50.77″W, 162 m alt., lower transition zone; basalt lava outcrop with scattered vegetation (*Polypodium* sp., *Pityrogramma calomelanos*, *Darwiniothamnus tenuifolia*), on dead twigs of shrub, sunny, wind- and rain-exposed, 15-Aug-2008, Bungartz, F. 8217 (CDS 40863).

Parmotrema virescens Hale, Mycotaxon 25(1): 90. 1986. (Fig. 4E–F)

Type: Venezuela, Táchira: Páramo de Tamá, El Cobre Chiquito, 2700 m., 28-Mar-1975, Hale, H.E. 45557 & López, M. (US – holotype, MERF – isotype, fide Hale 1986).

Thallus saxicolous; upper surface pale greenish yellow, dull to ±shiny, mostly emaculate, but typically distinctly wrinkled, in older thallus parts these wrinkles often breaking into reticulate cracks; abundantly sorediate; soralia marginal, ±convex-capitate; soredia farinose to ±granular, initially concolorous with the thallus surface, but often discolored by a ±brownish tinge, pale inside; lobes small to moderate-sized, 2–5 mm wide, rotund, axils incised, margins eciliate to sparsely or abundantly ciliate; cilia stout, short, 0.5–1 mm long, black, mostly simple, rarely branched; lower surface with an erhizinate, ~1–2 mm wide margin, this margin either deep brown or, more often, pitch black (like the whole lower surface), the black pigmentation frequently visible from above, delimiting the lobe edge with a conspicuous black rim, the lower side of the thallus often as conspicuously wrinkled as the upper surface and densely rhizinate towards the center; rhizines short, stout, black, simple to sparsely branched; medulla white. Apothecia and pycnidia not observed among the Galapagos specimens.

Chemistry. Cortex with both usnic acid and atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with protocetraric acid [P+ yellow turning orange, K+ dirty yellowish brown, KC–, C–, UV–].

Ecology and distribution. Previously reported from Ecuador and Venezuela (Hale 1986). New for Galapagos; the only two specimens known were both collected on exposed basalt at El Mango, in the lower transition zone of Volcán Sierra Negra, on Isabela Island; the site is unusually exposed, barren, open gravel, the ground in large parts covered by the endemic *Stereocaulon azulense*.

Notes. At a cursory glance the saxicolous yellowish *P. virescens* could be mistaken for the similarly colored *P. flavescens*, which also grows on rock. However, the two species are otherwise not easily confused. *Parmotrema virescens* is sorediate, while *P. flavescens* is isidiate. These species also differ in their chemistry: *P. virescens* contains protocetraric, *P. flavescens* stictic and norstictic acid. Like *P. virescens*, the corticolous *P. dominicanum* also contains protocetraric acid, but it occasionally also contains traces of echinocarpic acid and its medulla reacts KC+ rosé to faintly orange.

Specimens examined from Ecuador, Galápagos. ISLA ISABELA, VOLCÁN SIERRA NEGRA: El Mango, on the E side of the dirt road, 0°53′1.7″S, 91°0′50.77″W, 162 m alt., lower transition zone; basalt lava outcrop with scattered vegetation (*Polypodium* sp., *Pityrogramma calomelanos*, *Darwiniothamnus tenuifolia*), on N-exposed front of basalt outcrop, sunny, wind- and rain-exposed, 15-Aug-2008, Bungartz, F. 8211 (CDS 40857); mirador El Mango, SE side of island, 0°53′1.399″S, 91°0′48.39″W, 161 m alt., transition zone, rocky open area with shrubs of *Psidium guajava*, ferns and *Stereocaulon* covering the ground, on exposed basaltic rocks, 15-Aug-2008, Herrera-Campos, M.A. 10587 (CDS 40324).

Parmotrema weberi Hale ex Spielmann & Bungartz, sp. nov. (Fig. 12E–F)

MycoBank MB 832668

Diagnosis: Differs from *P. dilatatum* by the presence of caperatic instead of echinocarpic acid; currently known only from the Galapagos.

Type: Ecuador. Galápagos: Isla Floreana, trail from Black Beach to highlands, transition zone, 25-Apr-1976, Weber, W.A. s.n. (L-62899, COLO 294622 – holotype! originally selected by M.E. Hale).

Thallus saxicolous; upper surface whitish gray to bright white, shiny, epruinose, emaculate, not cracked; densely lobulate, lobules breaking apart into cauliflower-like soralia with granular coarse soredia; lobes small to moderate-sized, 2–7 mm wide, ±rotund, eciliate, distinctly delimited along the lobe edge by a conspicuous black rim; lower surface with a ±narrow, deep brown erhizinate, ~1–2.5 mm wide margin, blackening and rhizinate towards the thallus center; rhizines short, stout, black, mostly simple, rarely sparsely branched; medulla white. Apothecia very rarely observed (on a few, non-sorediate specimens only, cited separately below), 0.3–7 mm in diam., with a cupulate thalline margin, disc dark brown, deeply concave, imperforate; asci clavate, *Lecanora*-type, ascospores 8/ascus, simple, broadly ellipsoid, (9.9–)10.6–12.8(–12.9) × (5.9–)6.5–7.9(–7.1) µm (n = 25), thick-walled (~1.5 µm thick). Pycnidia immersed, flask-shaped to globose; ostiole brownish black; conidia sublageniform, 6.0–7.5 × ~1.0–1.5 µm (n = 12).

Chemistry. Cortex with atranorin [P+ yellow, K+ yellow, KC–, C–, UV–]; medulla with protocetraric and caperatic acid [P+ yellow turning orange, K+ dirty yellowish brown, KC–, C–, UV–].

Etymology. Named in honor of William A. Weber, outstanding pioneer in the exploration of the Galapagos

lichen biota. A formal validation of this species name is long overdue. Mason Hale first used this name, annotating several specimens already in 1977, also selecting the holotype here designated by us. Bill Weber celebrated his 100th birthday on November 16, 2018. We wish him all the best and apologize for this now much-belated birthday gift.

Ecology and distribution. Endemic to the Galapagos; a common, exclusively saxicolous species throughout the coastal, dry, and transition zones; both at sunny and exposed and at ±shaded and sheltered sites; fertile specimens are rare.

Notes. Hale already annotated several specimens collected by Weber with this new name, apparently being aware that the chemistry does not match that of the very similar *P. dilatatum*. Although both substances are polyketides and both originate from the acetyl-polymalonyl pathway, they are biosynthetically nevertheless not closely related (J.A Elix, pers. com.). Therefore, we here formalize Mason Hale's discovery of the new species. Hale at the time did not provide a formal description, but the type is clearly labeled with the name '*Parmotrema weberi*' in his own handwriting.

Specimens examined from Ecuador, Galápagos [typical morphotype with soredia, lacking apothecia]. ISLA ESPAÑOLA: along S-coast of the island, SE of Punta Suárez, ~500 m inland from coast, 1°22′56.60″S, 89°43′8.40″W, 133 m alt., dry zone, lava cliff with *Cordia lutea*, *Ipomoea habeliana*, and frew trees of *Bursera graveolens*, on slope of lava outcrop, sunny, 10-Nov-2010, Yánez-Ayabaca, A. 1624 (CDS 45513), 1626 (CDS 45514); N of Punta Cevallos, inland from coast, 1°23′3.700″S, 89°37′44.77″W, 20 m alt., dry zone, SE-exposed basalt cliff with some *Cordia lutea* shrubs, on SW-exposed slope of rock, sunny, 09-Nov-2010, Yánez-Ayabaca, A. 1571 (CDS 45453), 1570 (CDS 45452); trail from Bahía Manzanillo on the N-coast of the island to the highest point, 1°21′24.89″S, 89°41′57″W, 24 m alt., dry zone, boulder field of weathered AA-lava with scarce vegetation of *Ipomoea habeliana*, one *Bursera* tree and few *Cordia lutea* shrubs, on slope of lava boulder, sunny, 11-Nov-2010, Yánez-Ayabaca, A. 1659 (CDS 45542); ISLA FLOREANA: trail going to Post Office Bay off the dirt road between highlands and Puerto Velasco Ibarra, 1°15′42.27″S, 90°26′31″W, 197 m alt., dry zone, open forest of *Bursera graveolens* and some *Prosopis juliflora* on W-exposed slope, dry herbaceous vegetation and small boulder field, on top of small basalt rock, sunny, wind- and rain-exposed, 14-Jan-2011, Bungartz, F. 9612 (CDS 46891), semi-shaded, on rock, 14-Jan-2011, Yánez-Ayabaca, A. 1916 (CDS 48271). ISLA PINTA: along the trail up to the summit from the S-coast, 0°34′3″N, 90°44′56″W, 233 m alt., transition zone, open woodland with *Bursera graveolens*, *Zanthoxylum fagara*, *Pisonia floribunda*, *Croton scouleri*, and few *Opuntia galapageia* among old lava flows; in between *Alternanthera filifolia* and grasses, on top of AA-lava flow, sunny, wind- and rain-exposed, 28-Feb-2007, Bungartz, F. 5979 (CDS 33657). ISLA SAN CRISTÓBAL: Cerro Colorado, fenced off area, 0°54′58.39″S, 89°26′4.700″W, 132 m alt., transition zone, on *Psidium guajava*, 15-May-2006, Jaramillo, P. 2880 A (CDS 38797); from Punta Tortuga ~3 km inland close to Cerro Tortuga, 0°44′39″S, 89°23′32″W, 79 m alt., dry zone, young basalt lava flow of bare AA-lava, on W-exposed vertical part of lava flow, semi-shaded, ±wind- and rain-sheltered, 25-Apr-2007, Bungartz, F. 6500 (CDS 34717); S of Punta Pit at the NE-coast of the island, 0°43′27″S, 89°15′6″W, 113 m alt., dry zone, on top of crater rim, open scrubland with *Cordia lutea* and abundant *Mentzelia aspera* as ground cover, on top of basalt boulder, sunny, wind- and rain-exposed, 20-Apr-2007, Bungartz, F. 6105 (CDS 33784); saddle between the two summits of Cerro Tortuga, 0°44′52″S, 89°23′27″W, 140 m alt., dry zone, open *Piscidia carthagenensis* woodland with understory of *Cordia lutea*, on top of basalt boulder, sunny, wind- and rain-exposed, 25-Apr-2007, Bungartz, F. 6550 (CDS 34768). ISLA SANTA CRUZ: along shore E of Puerto Ayora near Charles Darwin Research Station (CDRS), 0°44′45″S, 90°17′39″W, 20 m alt., coastal zone, on coastal lava, 29-May-2005, Aptroot, A. 63289 (CDS 30029); cliffs about 1 km east of Puerto Ayora, about 100 m from the sea, 0°44′37″S, 90°17′47″W, 15 m alt., dry zone, dry zone vegetation with *Opuntia*, *Jasminocereus* and *Croton*, S-exposed, on small outcrops of lava rocks, 09-Aug-2008, Clerc, P. 08-64 (CDS 39918); coastal cliffs E of Puerto Ayora near Charles Darwin Research Station, 0°44′45″S, 90°17′39″W, 20 m alt., coastal zone, on coastal lava, 31-May-2005, Aptroot, A. 63406 (CDS 30161); E side of island, trail from parking lot to El Garrapatero beach, N side of trail, 0°41′26.69″S, 90°13′19.10″W, 6m alt., dry zone, open deciduous forest of *Bursera graveolens*, *Cordia lutea*, *Opuntia echios* with *Castela galapageia* and *Alternanthera echinocephala* and others in the understory, slightly shaded, on rock, 16-Jun-2010, Spielmann, A.A. 8181 (CDS 45316), 8204 (CDS 45332), 8185 (CDS 45323); vicinity of Academy Bay, along shore E of Research Station, coastal zone, on rock, 15-Feb-1964, Weber, W.A. s.n. (L-40873, COLO 190379); barranca E of Darwin Station, coastal zone, on rocks just above high tide mark, 15-Feb-1964, Weber, W.A. field no. 117 (B-40057, COLO 188253). ISLA SANTA FÉ: cerca la playita y el barranco en la costa norte de la isla, 0°48′12.80″S, 90°2′35.20″W, 26 m alt., zona seca, bosque abierto con arbustos y árboles dominantes en la zona, como *Bursera graveolens* y *Opuntia echios* var. *barringtonensis*, sobre roca de lava basáltica, 25-Oct-2007, Nugra, F. 487 (CDS 37048); lava flow at the N-coast of the island, 0°48′2.798″S, 90°2′38.39″W, 26 m alt., dry zone, open scrubland of *Croton scouleri* with some *Bursera graveolens* trees, and *Opuntia echios* var. *barringtonensis* on NE-exposed side of lava flow, on exposed basalt lava, 25-Oct-2007, Jonitz, H. 14 (CDS 44614); on top of lava flow at the N-coast of the island, 0°48′12.4″S, 90°2′34.5″W, 13 m alt., coastal zone, open scrubland of partly dead shrubs (*Croton scouleri*, *Cordia lutea*), few shrubby *Bursera graveolens*, and *Opuntia echios* var. *barringtonensis* among lava rocks, on S-exposed slope of basalt boulder, sunny, wind- and rain-exposed, 25-Oct-2007, Bungartz, F. 7185 (CDS 37669); top of flat basalt boulder, sunny, wind- and rain-exposed, 25-Oct-2007, Bungartz, F. 7227 (CDS 37711); on S-exposed front of basalt boulder, sunny, wind- and rain-exposed, 25-Oct-2007, Bungartz, F. 7250 (CDS 37734). ISLA SANTIAGO: at the W-coast of the island in Bahía Ladilla, 0°18′8″S, 90°49′56″W, 10 m alt., coastal zone, S-exposed coastal lava cliff and boulders, on E-exposed basalt cliff face, sunny, wind- and rain-exposed, 22-Jul-2006, Bungartz, F. 5386 (CDS 29602); ~5 km inland from the E-coast, ±at the same latitude as Bahía Sullivan, 0°16′37″S, 90°37′24″W, 163 m alt., dry zone, on SE-exposed slope of lava boulders, small basalt rock, near the ground SE-expose, sunny, wind- and rain-exposed, 18-Jul-2006, Bungartz, F. 5199 (CDS 29412); 0°16′35″S, 90°37′23″W, 172 m alt., dry zone, plateau of lava flows and boulders with scarce vegetation (*Bursera graveolens*, *Castela galapageia*, *Mentzelia aspera*), on S-exposed steep slope of basalt boulder, near the g0round, 18-Jul-2006, Bungartz, F. 5226 (CDS 29441); on SE-exposed overhang (100°) of small basalt rock, shaded, wind- and rain-sheltered, 18-Jul-2006, Bungartz, F. 5231 (CDS 29446); ~7 km inland from the E-coast, ±at the same latitude as Bahía Sullivan, 0°17′1″S, 90°38′24″W,

183 m alt., dry zone, SE-exposed slope of lava flow, on top of basalt boulder, sunny, wind- and rain-exposed, 17-Jul-2006, Bungartz, F. 5150 (CDS 29363). ISLOTE GARDNER POR ESPAÑOLA: SW-part of the island, 1°20′46.39″S, 89°38′54″W, 7m alt., coastal zone, boulder field of weathered AA-lava with the vine *Ipomoea habeliana* and few shrubs of *Bursera graveolens*, *Prosopis juliflora* and *Croton scouleri*, on S-exposed front of basalt boulder, sunny, wind- and rain-exposed, 12-Nov-2010, Bungartz, F. 9168 (CDS 45986); on front of lava boulder, sunny, 12-Nov-2010, Yánez-Ayabaca, A. 1708 (CDS 45591); on top of lava boulder, sunny, 12-Nov-2010, Yánez-Ayabaca, A. 1729 (CDS 45594). ISLA ISABELA, VOLCÁN ALCEDO: ~100 m inland from the shore a little N of Islote Cowley, 0°24′4″S, 91°0′1″W, 45 m alt., coastal zone, plain with small pebbles of lava tuff, mostly open, occasional groups of small *Bursera graveolens* trees, shrubs of *Scalesia affinis*, *Cordia lutea*, *Scutia spicata* var. *pauciflora*, on lava, 11-Mar-2006, Aptroot, A. 64738 (CDS 31313).

Specimens examined from Ecuador, Galápagos [morphotype with apothecia, lacking soredia]. ISLA ESPAÑOLA: along S-coast of the island, SE of Punta Suárez, ~500 m inland from coast, 1°22′56.60″S, 89°43′8.40″W, 133 m alt., dry zone, lava cliff with *Cordia lutea*, *Ipomoea habeliana*, and frew trees of *Bursera graveolens*, on top of basalt outcrop, sunny, wind- and rain-exposed, 10-Nov-2010, Bungartz, F. 8932 (CDS 45750); on top of basalt cliff, sunny, wind- and rain-exposed, 10-Nov-2010, Bungartz, F. 8934 (CDS 45752); trail from Bahía Manzanillo on the N-coast of the island to the highest point, 1°22′18.69″S, 89°42′7.40″W, 130 m alt., dry zone, basalt outcrop among *Cordia lutea* shrubland, on S-exposed top of basalt cliff, sunny, wind- and rain-exposed, 11-Nov-2010, Bungartz, F. 9106 (CDS 45924). ISLA SAN CRISTÓBAL: Cerro Colorado, enclosure for *Calandrinia galapagosa* near the viewpoint on the top, 0°54′58″S, 89°26′5″W, 130 m alt., transition zone, open scrubland with *Croton scouleri*, *Macraea laricifolia*, *Calandrinia galapagosa*, *Lecocarpus darwinii* and few trees of *Piscidia carthagenensis* among lava boulders on SE-exposed slope of cinder cone, on S-exposed slope (80°) of soft and weathered tuff outcrop, sunny, wind- and rain-exposed, 29-Apr-2007, Bungartz, F. 6740 (CDS 34984), 6688 (CDS 34932).

Specimens examined from Ecuador, Galápagos [morphotype without apothecia or soredia]. ISLA ESPAÑOLA: trail from Bahía Manzanillo on the N-coast of the island to the highest point, 1°21′24.89″S, 89°41′57″W, 24 m alt., dry zone, boulder field of weathered AA-lava with scarce vegetation of *Ipomoea habeliana*, one *Bursera* tree and few *Cordia lutea* shrubs, on S-exposed front of basalt boulder, sunny, wind- and rain-exposed, 11-Nov-2010, Bungartz, F. 8991 (CDS 45809).

Key to the species

1 Thallus lacking vegetative propagules (isidia, soredia, pustules, etc.); eciliate; cortex K+ yellow, C–, KC–, P+ yellow, with atranorin (all Galapagos species that form only apothecia lack cilia and contain atranorin within their cortex) 2

Thallus with vegetative propagules (isidia, soredia, pustules or others); ciliate or eciliate; cortex with atranorin and/or usnic acid 5

2(1) Upper surface conspicuously rugose towards the center; medullary spot tests all negative, K–, C–, KC–, P– [with an unidentified substance (pale spot at Rf 30 in solvent C)] . . . . . ***P.*** cf. ***mesotropum***

Upper surface smooth or slightly rugose in the center; medullary spot tests positive with K and P 3

3 Ascospores small, 11–14 × 5–7 µm; medulla K± dirty yellow to yellowish brown, P+ yellow, quickly turning deeply orange (protocetraric acid) 4

Ascospores larger, 27–35 × 15–17 µm; medulla K+ yellow turning blood-red, P+ strongly yellow, but not turning orange (salazinic acid) . . . . . ***P. latissimum***

4 Medulla KC± rosé to faintly orange (echinocarpic acid) . . . . . ***P. eborinum***

Medulla KC– (caperatic acid) . . . . . ***P. weberi***

5(1) Thallus isidiate, rarely pustulate (i.e., isidia breaking apart, leaving distinct scars or transitioning into granular soredia) 6

Thallus distinctly sorediate, never isidiate 21

6 Thallus surface pale greenish yellow; cortex KC+ dirty yellowish brown (usnic acid) 7

Thallus surface pale to dark gray, whitish gray, ivory or bright white (the ivory-colored *P. internexum* contains norlobaridone in its medulla and herbarium specimens with age turn ±dull yellowish); cortex K+ yellow, KC– (atranorin) 11

7 Isidia cylindrical to coralloid, becoming cauliflower-like and then rupturing into granular pseudocorticate soredia . . . . . ***P. lawreyi***

Isidia globular to cylindrical, sometimes branched, but not cauliflower-like, not pustulate, not rupturing 8

8 Medulla C+/KC+ pale pink (with gyrophoric acid); thallus margin abundantly ciliate; isidia sparsely to abundantly ciliate 9

Medulla C–/KC– (gyrophoric acid absent); thallus margin with few or no cilia; isidia not ciliate 10

9 Medulla K+ yellow, soon blood-red, P+ strongly yellow (salazinic and gyrophoric acid); growing on rock . . . . . ***P. flavescens***

Medulla K–, P– (gyrophoric acid only); typically growing on bark, rarely on rock . . . . . ***P. nyasense***

10 Lobes broad, rotund, undulating; axils incised; margins not lobulate, typically lacking cilia (very rarely sparsely ciliate); on bark of trees and shrubs . . . . ***P. conformatum***

Lobes elongate, angular, flattened; axils ±rounded, forming in distinct loops; margins in parts lobulate, sparsely ciliate; on cactus pads of *Opuntia* . . . ***P. cactacearum***

11(6) Medulla with a distinctly yellow or pale salmon-yellow pigment (check carefully: pigmentation can occasionally be very pale, almost indistinct!), C+/KC+ distinctly yellow (gyrophoric and secalonic acid) . . . . . ***P. endosulphureum***

Medulla white, not pigmented, the C/KC-reaction varies, either C–/KC– or C+/KC+ rosé or pinkish, sometime turning orange, but not distinctly yellow (secalonic acid absent) 12

12 Cilia absent 13

Cilia present (check carefully: in some species cilia can be very sparse) 14

13 Isidia coarse, short, stout, globular to gnarled, concolorous with the thallus surface, ±pustulate, leaving conspicuous circular scars after breaking off; lobe surface

dull; a rare species known from a single locality in the Galapagos . . . . . ***P. pustulotinctum***

Isidia fine, cylindrical, typically dark-tipped, not leaving scars; lobe surface smooth; a widely distributed, common and abundant species . . . . . ***P. tinctorum***

14 Thallus surface distinctly reticulate-maculate, often becoming deeply cracked along the maculae 15

Thallus surface smooth, emaculate or with few, indistinct maculae that do not form a reticulate pattern (although the surface of some species can occasionally become cracked) 17

15 Isidia apically breaking apart into soredia . . . ***P. lacteum***

Isidia not breaking apart into soredia 16

16 Growing on bark; lobes large, rotund, undulating; isidia initially cylindrical, soon coralloid, sparsely to abundantly ciliate; a common and often abundant species . . . . . ***P. subisidiosum***

Growing on rock; lobes moderate-sized, ±angular, flattened & appressed; isidia cylindrical, mostly simple to sparsely branched, eciliate; a rare species . . . . . ***P. saxoisidiatum***

17 Medulla UV+ bright yellow (lichexanthone) or UV+ bright greenish blue (alectoronic acid) 18

Medulla UV– 19

18 Medulla UV+ bright yellow (lichexanthone) . . . . . ***P. ultralucens***

Medulla UV+ bright greenish blue (alectoronic acid) . . . . . ***P. mellissii***

19 Medulla K+ yellow, quickly turning blood-red (salazinic acid) . . . . . ***P. neosubcrinitum***

Medulla K+ yellow, not turning red (other substances) 20

20 Medulla C–/KC– (stictic acid only); very common and abundant species, on bark or rock . . . . . ***P. crinitum***

Medulla C+/KC+ rosé, turning orange (norlobaridone and stictic acid; thallus with prolonged storage in the herbarium fading to dull yellowish); rare species, on bark . . . . . ***P. internexum***

21(5) Thallus surface pale greenish yellow; cortex with both usnic acid and atranorin 22

Thallus surface pale to dark gray, whitish gray, ivory or bright white; cortex only containing atranorin, no usnic acid 23

22 Lobes sparsely to abundantly ciliate; soredia initially concolorous with the thallus surface, but often brownish discolored; growing on rock . . . . . ***P. virescens***

Lobes eciliate (or very rarely with few cilia); soredia concolorous with the thallus surface; growing on bark . . . . . ***P. dominicanum***

23 Thallus surface distinctly reticulate-maculate, often becoming deeply cracked along the maculae 24

Thallus surface smooth, emaculate or with few, indistinct maculae that do not form a reticulate pattern (although the surface of some species can occasionally become cracked) 27

24 Medulla K+ yellow, slowly turning orange (crystals; norstictic acid) . . . . . ***P. hypotropum***

Medulla K+ yellow, quickly turning blood-red (no crystals; salazinic acid) 25

25 Soredia crescent-shaped, along broadly rotund lobe margins . . . . . ***P. reticulatum***

Soredia capitate, distinctly stalked, i.e., forming at the tips of distinctly elongated, lacinulate lobes (clavulae)* 26

26 Lobes narrow, generally less than 2(–2.5) mm wide; lower side of the lobes blackened throughout, rarely with a narrow, dark brown margin, rhizinate throughout, lacking a distinct erhizinate marginal zone; clavulae mostly blackened below, rarely with few, white flecks; thalli exclusively saxicolous . . . . . ***P. marcellianum***

Lobes broad; typically 2–6(–10) mm wide; lower side of the lobes blackened throughout or at least in parts with a ±broad deep brown margin that in parts typically appears mottled white and is then typically erhizinate; clavulae typically white below; thalli mostly corticolous, very rarely saxicolous . . . . . ***P. clavuliferum***

27(23) Medulla K–, P– 28

Medulla K± dirty yellowish brown to K+ yellow, or K+ yellow to soon blood-red, P+ yellow to orange or orange-red 32

28 Medulla KC+ pink or KC+ rosé, quickly turning orange 29

Medulla C–/KC– 30

29 Medulla C+/KC+ bright red (lecanoric acid), UV– . . . . . ***P. cooperi***

Medulla C–/KC+ rosé, quickly turning orange, UV+ greenish-blue (alectoronic acid) . . . . . ***P. rampoddense***

30 Lobe margins ciliate . . . . . ***P. grayanum***

Lobe margins lacking cilia 31

31 Soredia marginal, crescent-shaped; cortex with atranorin, medulla with ±caperatic, praesorediosic and protopraesorediosic acid . . . . . ***P. praesorediosum***

Soredia submarginal, cauliflower-like; cortex with atranorin, medulla with fatty acids only . . . . . ***P. soredioaliphaticum***

32 Medulla K+ yellow, quickly turning blood-red (salazinic acid) 33

Medulla K+ yellow to dirty yellowish brown, not turning red 34

33 Cilia abundant, erect (i.e., mostly turned upwards and thus perpendicular to the lobe edge), elongate, mostly simple, very rarely sparsely branched . . . . . ***P. erectociliatum***

Cilia absent or very sparse, if present short, simple to sparsely branched . . . . . ***P. cristiferum***

34(32) Lobe margins broad, wavy, not lobulate, lined by ±labriform to ±capitate soralia; medulla K+/P+ yellow (atranorin) . . . . . ***P. mordenii***

Lobe margins conspicuously minutely lobulate; lobules breaking apart into granular soredia, medulla K+ dirty brownish yellow, P+ deep yellow-orange (protocetraric acid) 35

35 Medulla C+/KC+ rosé to ±orange (echinocarpic acid) . . . . . ***P. dilatatum***

Medulla C–/KC– (caperatic acid) . . . . . ***P. weberi***

(some broad-lobed specimens have capitate soredia on relatively short stalks; they could be considered a ±intermediate morphotype of *P. clavuliferum* and *P. reticulatum*, but these specimens are overall more similar to *P. clavuliferum* and are here not treated separately).

Doubtful and incorrect reports

Parmotrema bangii (Vain.) Hale

Erroneously reported online (Bungartz et al. 2016), based on a specimen collected on the continent (Ecuador, Azuay, Cuenca, along northern river bank of Rio Tomebamba, between Calle Presidente Borrero and Calle Manuel Vega, 2°52′60″S, 78°58′60″W, 2450 m alt., 13-Nov-2006, Bungartz, F. 5493).

Parmotrema peralbidum (Hale) Hale

All specimens cited by Weber (1986) that we examined were based on misidentification of *Canoparmelia raunkiaeri* (Vain.) Elix & Hale.

Parmotrema soyauxii (Müll. Arg.) Hale

Elix & McCarthy (1989) include this species in their checklist despite Weber's (1986: 490) having previously expressed doubts as to whether the original report was correct: '... Reported by Dodge (1936). The specimen was not found at FH or MO. This Dodge determination is not to be accepted ...'. During our survey we did not collect any specimens and found no historical material in B, NM, FH, COLO or OSC. Therefore, we agree with Weber that the original report should be considered erroneous.

Parmotrema xanthinum (Müll. Arg.) Hale

First reported from the Galapagos by Weber (1986) and subsequently by Elix & McCarthy (1998). Most if not all records belong to *Parmotrema nyasense*.

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