

Three new species of *Parmotrema* containing salazinic acid from the coast of São Paulo State, southeastern Brazil

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Abstract — During a survey of *Parmeliaceae* species in natural ecosystems and urbanized coastal areas of São Paulo State, southeastern Brazil, three new salazinic acid-containing *Parmotrema* species were discovered namely, *P. anchietanum*, *P. asperum* and *P. hypermaculatum*.

Key words — *Parmotrema cetratum*, *Parmotrema despectum*, *Parmotrema expansum*, *Parmotrema permaculatum*, *Parmotrema ruptum*

Introduction

The genus *Parmotrema* A.Massal. is characterized by broad rotund lobe apices, absence of pseudocyphellae, frequent occurrence of marginal cilia, naked lower margins, simple rhizinae, and thick-walled, ellipsoid ascospores (Brodo et al. 2001, Nash & Elix 2004). More than three hundred species are known worldwide (Nash & Elix 2004), 93 of which occur in Brazil (Marcelli 2004).

This study describes three new species of *Parmotrema* containing salazinic acid. These were discovered by the authors during an investigation of the large lobed species of *Parmeliaceae* on the coast of São Paulo State in Brazil (Benatti 2005), for the most part situated between the municipalities of Ubatuba (23°02'S, 45°04'W) and Itanhaém (24°11'S, 46°47'W). This region included urbanized areas, rocky shores, and mangrove and restinga forests as the predominant vegetation types.

All three species are saxicolous, collected from rocky coastal areas growing fully exposed to sunlight. Two of the new species produce soredia, while the third lacks vegetative propagules.

Although we have included sufficient specific descriptive information about the three new taxa, more detailed morphological and chemical comparisons with other similar species can be found in Benatti (2005).

Materials and methods

Specimens were distinguished by morphological characters using standard stereoscopic and light microscopes. Anatomical sections, including those of apothecia and pycnidia, were made with a razor blade by hand. The chemical constituents were checked by spot tests with potassium hydroxide (K), sodium hypochlorite (C) and para-phenylenediamine (P), and also examined under UV light (360 nm). Chemical constituents were identified by thin-layer chromatography (TLC) using solvent C (Bungartz 2001), high performance liquid chromatography (HPLC) (Elix et al. 2003) and comparison with authentic samples.

Since we have encountered problems dealing with the many morphological terms present in the literature, we specify here that in our concept lacinules represent adventitious, ribbon-like secondary outgrowths from the primary lobe margins. Lobules are similar, but short and rounded.

For each new species diagnosis refers exclusively to holotype characters and the English descriptions and comments to all the material studied.

The species

Parmotrema anchietanum Marcelli, Benatti & Elix, sp. nov.

Fig. 1

MB 511104

DESCRIPTIO: *Thallus* sublaciniatus, 12.0 cm latus, cinereus, albidus. *Lobi* angustati, 1.0–3.0 (–5.5) mm lati, parce maculati, apicibus subtruncatis, lacinulis marginalibus abundantibus, magnitudine 0.2–3.2 × 0.2–1.0 mm, margine ciliato, cilia simplicia, frequentia et regulariter distributa, 0.2–1.6 mm longa; soralia capitata, submarginalia, ad pustulas ephemeris oriunda, in soredia subgranulata caducis erumpentia; subtus niger, ambitum versus castaneus, nudus vel rhizinosus, rhizinae simplices vel furcatae, frequenter agglutinata; medulla albida; apothecia ignota; conidiomata frequentia, conidia brevifiliformia, 6.5–11.0 × 1.0 μm; atranorinam, chloroatranorinam, acidum salazinicum et acidum consalazinicum continens.

HOLOTYPE—Brazil, São Paulo State, Município Ubatuba, Anchieta Island, Saco Grande, rocky shore, 23°02'S, 45°04'W, 2 m alt., saxicolous, leg. A.A. Spielmann, L.S. Canêz & D.F. Peralta 557b, 23-XI-2003 (SP, isotypes in B and NY).

THALLUS up to 16 cm in diameter, coriaceous, saxicolous, light gray darkening in the herbarium, sublaciniate to weakly laciniate; LOBES usually irregularly

branched, occasionally becoming subdichotomous, 1.0–3.0 (–5.5) mm wide, younger lobes imbricate but soon becoming very crowded, adnate to weakly ascending, loosely attached; UPPER SURFACE continuous then irregularly cracked, smooth to partially rugose, APICES almost flat to subconcave, subtruncate to truncate, MARGINS crenate to irregularly dissected, weakly ascending, subundulate, lacinulate, ciliate; MACULAE weak at the center to distinct in the younger parts, punctiform to linear but never reticulate, laminal, sometimes developing into cracks; LACINULES short, regularly distributed at the lobe margins and apices, abundant, usually simple, more rarely furcate or irregular, flat, $0.2\text{--}3.2 \times 0.2\text{--}1.0$ mm, truncate or acute, frequently mixed with small, irregular adventitious lobules, underside concolorous with the lower margin; CILIA black, simple, $0.20\text{--}1.60 \times \text{ca. } 0.05$ mm, frequent along the margins. MEDULLA white, pigments absent, but sometimes with reddish parts due the hydrolysis and oxidation of the salazinic acid. SORALIA capitate to irregular, originating from pustules (see below), infrequently coalescing, often exposing the lower cortex when eroded; SOREDIA subgranular to granular, \pm coarse. PUSTULES submarginal or subapical on the lobes or subapical at the lacinulae, also frequently appearing on thalline ridges, ephemeral and soon bursting into soredia. ISIDIA absent. LOWER SURFACE black, shiny, smooth to subpapillate; MARGIN brown, shiny, smooth to subpapillate, 1.0–3.0 mm wide, usually naked to partially rhizinate; RHIZINES black even at the margin, simple, furcate or rarely irregular, $0.20\text{--}1.40$ (–3.60) $\times 0.05\text{--}0.10$ mm, frequent to dense in some parts, frequently becoming agglutinated, scattered. APOTHECIA absent. PYCNIDIA submarginal and common, sometimes on the lacinulae, with black ostioles; CONIDIA short filiform, $6.5\text{--}11.0 \times \text{ca. } 1.0$ μm .

SPOT TESTS: upper cortex K+ yellow, UV–; medulla K+ yellow→red, C–, KC similar to K but weaker due to the C, P+ yellow, UV–.

TLC/HPLC: cortical atranorin (minor), chloroatranorin (minor); medullary salazinic acid (major), consalazinic acid (minor).

PARATYPES — Brazil, São Paulo State, Municipality of Ubatuba, Anchieta Island, Saco Grande rocky shore, 23°02'S, 45°04'W, 2 m alt., saxicolous, leg. A.A. Spielmann, L.S. Canêz & D.F. Peralta 557a, 23-XI-2003 (S); idem, over granite on the rocky shore in the shade, 23°02'S, 45°04'W, 2 m alt., leg. L.S. Canêz & A.A. Spielmann 607b, 23-XI-2003 (SP); idem, over granite on the rocky shore, 23°02'S, 45°04'W, 2 m alt., leg. L.S. Canêz & A.A. Spielmann 620, 23-XI-2003 (SP).

COMMENTS— This species is characterized by the sublaciniate lobes with lacinulate margins, somewhat resembling large specimens of *Parmelinopsis* or *Bulbothrix*, or even small specimens of *Parmotrema reticulatum* (Taylor) M. Choisy.

Parmotrema anchietanum is further characterized by the pale gray upper cortex, the ciliate margins and formation of pustular soralia, especially at the

subapical parts of the lobes and lacinules. Although maculae are apparent in parts of the upper cortex, especially in the young, peripheral lobes, they are much less prominent than those observed in species formerly accommodated in *Canomaculina* or *Rimelia*. Indeed, the maculae are barely visible in the central parts of the thallus because of the very pale gray colour of the cortex.

Unlike other sorediate *Parmotrema* species, which commonly have a cream or white coloured margin below the soralia, this species has an entirely brown lower margin.

The lower surface of *P. anchietanum* is only partially nude at the margins due to an irregular pattern of rhizine distribution, some lobes having completely nude lower margins, while others are rhizinate close to the edges, or even entirely rhizinate. The majority of rhizines are simple, but they are mixed with a few furcate or irregularly branched ones, and are frequently agglutinated at the initial stages. The species formerly attributed to *Canomaculina* and *Rimelia* have dimorphic or squarrosely branched rhizines, respectively, but these were not observed in *P. anchietanum*. This species has a very smooth and shiny lower cortex, with a few papillate parts and is sometimes randomly cracked.

The development of small, marginal lacinules is quite common in *P. anchietanum*. The soralia are most common in the subapical region of the lacinules, more rarely occurring submarginally or on thalline ridges. They originate from foam-like, ephemeral pustules, which soon burst and form caducous soredia, frequently exposing the upper part of the lower cortex. Sometimes these soredia have a weakly yellowish tinge, possibly due to hydrolysis and oxidation of salazinic acid, since no pigment was found in the medulla.

Some specimens exhibited traces of unidentified fatty acids (or other substances) in TLC, substances that were also observed in some specimens of *P. asperum* collected at the same locality (see below).

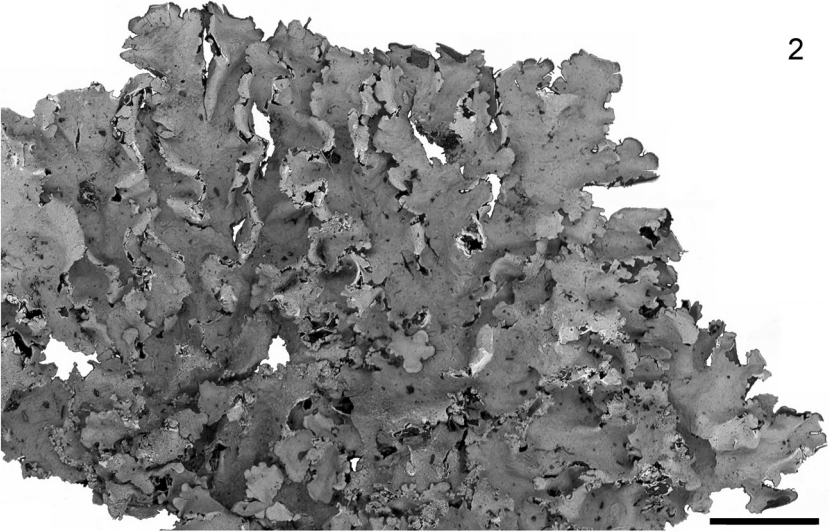
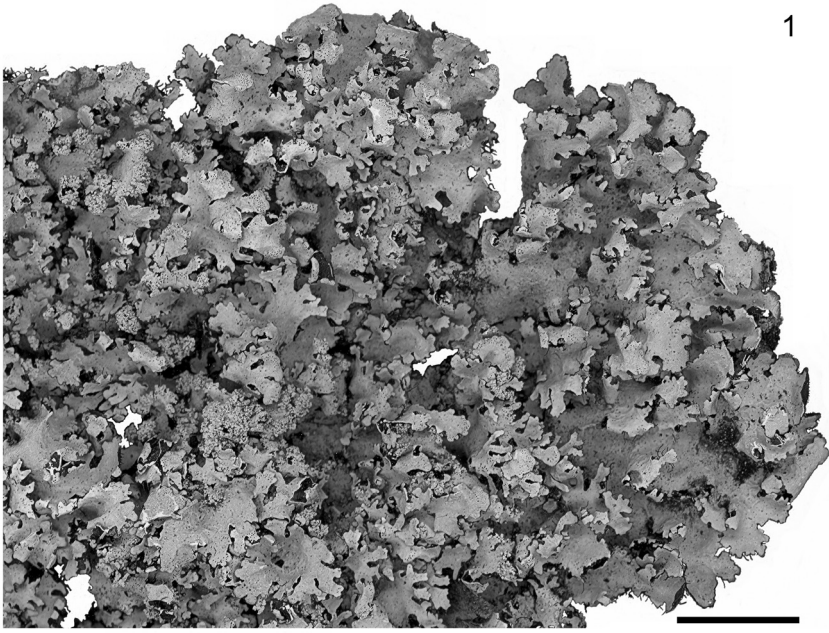
This species is named after Anchieta Island, the only known collection locality on the northern coast of São Paulo State, Brazil.

***Parmotrema asperum* Benatti, Marcelli & Elix, sp. nov.**

Fig. 2

MB 511105

DESCRIPTIO: *Thallus sublobatus, fragmentatus, 11.0 cm latus, lactineocinereus. Lobi angusti, (1.0–) 2.0–6.5 mm lati, dense maculati, apicibus subrotundatis vel subtruncatis, lacinulis marginalibus satis irregulariter formantes, 0.2–2.2 × 0.2–0.9 mm, margine ciliatis, cilia simplicia et irregulariter distributa, 0.2–0.8 (–1.3) mm longa; soralia capitata, subapicalia, ad pustulas ephemeris oriunda, in soredia granulata et agglutinata incompleta erumpentia; subtus niger, ambito castaneus nudus vel pro parte modice rhizinatus, rhizinae simplices vel furcatae, aliquando agglutinatae; medulla albida; apothecia ignota; conidiomata frequentia, conidia brevia filiformes, 6.5–11.0 × 1.0 μm; atranorinam, chloroatranorinam, acidum salazinicum, acidum consalazinicum et acidum divaricaticum continens.*



Figures 1-2. 1. *Parmotrema anchietanum* (part of the holotype).
2. *Parmotrema asperum* (part of the holotype).
Bars = 10 mm.

HOLOTYPE—Brazil, São Paulo State, Município de Ubatuba, Ilha Anchieta, Saco Grande rocky shore, 23°02'S, 45°04'W, 2 m alt., saxicolous, leg. A.A. Spielmann, L.S. Canêz & D.F. Peralta 587a, 23-XI-2003 (SP, isotypes in US and S).

THALUS fragile, up to 11 cm in diameter, coriaceous, saxicolous, milky gray becoming darker in the herbarium, lobate; LOBES (1.0–) 2.0–6.5 mm wide, irregularly branched, younger lobes overlapping laterally, then becoming crowded, adnate to weakly ascending, loosely attached; UPPER SURFACE continuous, then irregularly cracked, smooth to ±rugose, APICES ±flat to subconcave, subrotund to subtruncate or irregular, MARGIN crenate to irregularly dissected, ±ascending, subundulate, sublacinulate, irregularly ciliate; MACULAE distinct, linear to somewhat reticulate, denser at the center, laminal, sometimes forming cracks; LACINULES short and irregularly spreading at the apices and lobe margins, frequently intermixed with small irregular lobules, simple or irregular, flat, 0.2–2.2 × 0.2–0.9 mm, truncate or acute, underside concolorous with the lower margin; CILIA black, simple, 0.2–0.8 (–1.3) × ca. 0.05 mm, absent on some young lobes, but frequent to irregular on mature lobes. MEDULLA white, pigments absent, but ±reddish spotted due to hydrolysis and oxidation of salazinic acid. SORALIA capitate to irregular, originating from pustules (see below), ±coalescing, frequently agglutinated due to incomplete eruption of the pustules, SOREDIA granular, coarse, agglutinated. PUSTULES subapical on the lobes or lacinules, sometimes also developing on thalline ridges, ephemeral and soon breaking down into soredia, but often incompletely so. ISIDIA absent. LOWER surface black, shiny, smooth to rugose and papillate, MARGIN shiny, brown, smooth to subpapillate, 1.0–3.0 mm wide, naked to partially rhizinate; RHIZINES black even when growing at the margin, simple, furcate or ±irregular, 0.20–1.70 (–2.80) × 0.05–0.10 mm, scattered but frequent to dense in some parts, ±becoming agglutinated. APOTHECIA absent. PYCNIDIA common, submarginal and on the lacinules, with black ostioles; CONIDIA short filiform, 6.5–11.0 × ca. 1.0 µm.

SPOT TESTS: upper cortex K+ yellow, UV–; medulla K+ yellow→red, C–, KC similar to K but paler, P+ yellow, UV–.

TLC/HPLC: cortical atranorin (minor) and chloroatranorin (minor); medullary salazinic acid (major), consalazinic acid (minor), and divaricatic acid (trace).

PARATYPES — Brazil, São Paulo State, Municipality of Ubatuba, Anchieta Island, Saco Grande rocky shore, 23°02'S, 45°04'W, 2 m alt., saxicolous, leg. A.A. Spielmann, L.S. Canêz & D.F. Peralta 561 (B), 609 (SP), 613, 23-XI-2003; idem, 23°02'S, 45°04'W, 2 m alt., over granite in a shaded place on the rocky shore, leg. L.S. Canêz & A.A. Spielmann 607, 23-XI-2003 (SP).

COMMENTS— The habit and maculation of *Parmotrema asperum* resembles that of *P. reticulatum*, and it has narrower and less rounded lobes than species of the *P. cristiferum* (Taylor) Hale group. This species has a characteristic milky

gray colour due to the strongly maculate upper cortex, and the margins are frequently irregularly lacinulate and ciliate.

Both *P. anchietanum* and *P. asperum* differ from the other salazinic acid containing *Parmotrema* species by producing pustular, subapical soralia on the lobes, lacinules, and thalline ridges. Like *P. anchietanum*, the margins of the lower surface of *P. asperum* are brown and in part naked, in part rhizinate with mainly simple rhizines. The surface below the soralia is also brown.

In contrast to *P. asperum*, *P. anchietanum* has a darker gray upper cortex, an alternative disposition and ontogeny of the pustular soralia, and more uniformly ciliate margins. The two species also differ in the nature of the lobes and lacinules. Thus the thallus of *P. asperum* has broader, subrotund lobes with typically short, irregular, unevenly distributed, adventitious marginal lacinules and lobules which are more common on older lobes whereas *P. anchietanum* has narrower, sublaciniate lobes with more regularly distributed marginal lacinules which are distinctly linear. Furthermore, *P. anchietanum* has poorly developed, punctiform maculae which are, for the most part, restricted to the very young lobes, whereas in *P. asperum* and *P. hypermaculatum* (see below), the maculae are often large and dense all over the upper surface where the irregularly dispersed algal cells give rise to small greenish spots scattered over the upper cortex.

The soralia of *P. asperum* are subapical and apical on the lobes and lacinules, but are less common on the thalline ridges. Coarse or granular 78–223 (–305) μm soredia originate from pustules, which only partially burst open, such that the soredia remain agglutinated instead of being shed. The soredia in *P. anchietanum* are finer (52–137 μm) due to the more complete breakdown of the pustules. As a consequence the soredia are often completely shed thus exposing the black upper side of the lower cortex. Also, the soralia of *P. anchietanum* only rarely reach the extremities of the lobes and lacinules, leaving a small but constant esorediate area at the apices.

The specimens of *P. asperum* contained traces of divaricatic acid, which may have originated from sorediate *Dirinaria* species growing nearby. The soredia from such species are often washed on to adjacent lichens. Although some specimens of *P. anchietanum* showed a similar faint spot in TLC, no substances other than the salazinic and consalazinic acids were detected by HPLC.

This species is named after the very granular, agglutinated soredia, which derive from rough soralia following the incomplete breakdown of the pustules, giving the thallus a characteristic, coarse appearance.

***Parmotrema hypermaculatum* Marcelli, Benatti & Elix, sp. nov.**

Fig. 3

MB 511106

DIAGNOSIS: *Species thallo similis Parmotremati expanso, sed subcoriaceus non fragilis, ciliis plerumque simplicibus, superne cortex dense maculatus, medulla acidum protocetraricum continens, sporis ellipsoideis minoribus (10.0–14.0 \times 6.5–9.0 μm) episporio 1.0 μm et conidiis filiformibus majoribus plerumque 9.0–14.0 \times 1.0 μm differt.*

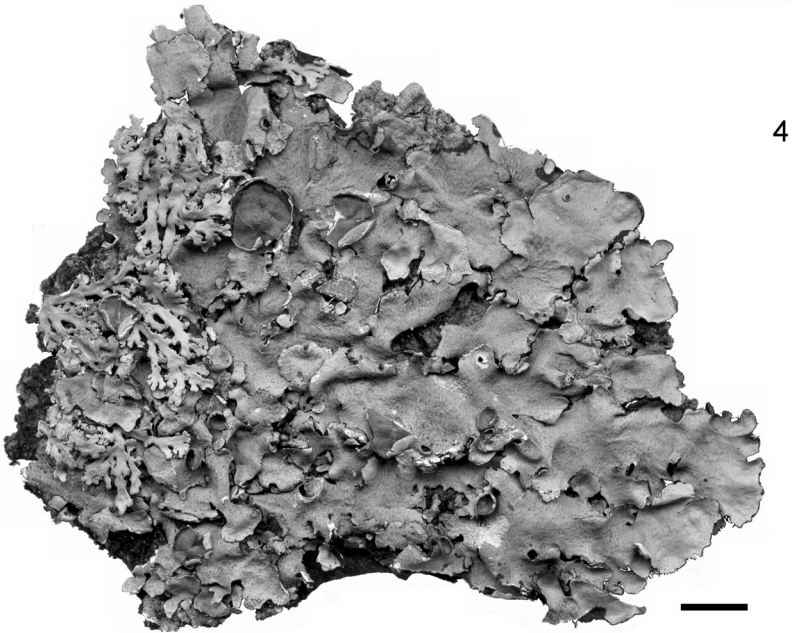
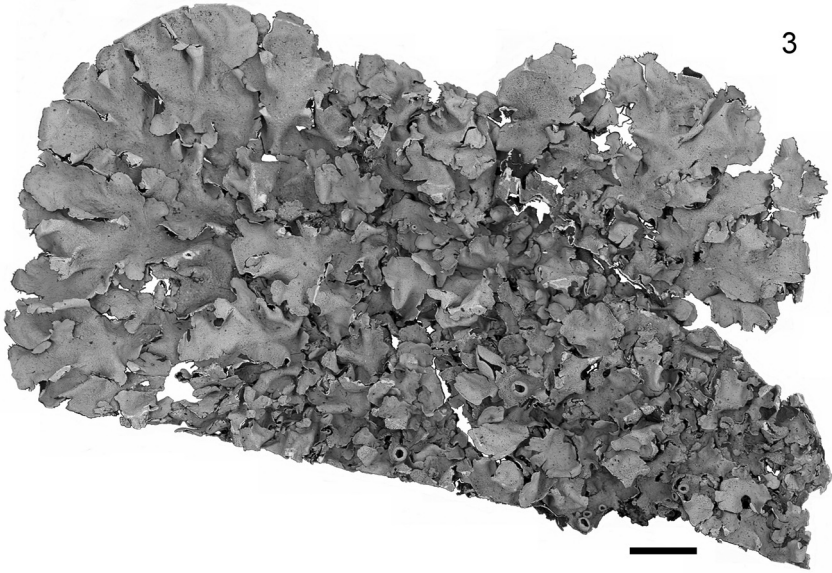
HOLOTYPE—Brazil, São Paulo State, Município Itanhaém, Cibratel quarter, rocky shore between Praia dos Sonhos and Praia de Itanhaém, 24°11'S, 46°47'W, 25 m alt., on the leeward side of a small grass-covered granitic rock, leg. M.P. Marcelli 4198, 10-I-1989 (SP, isotypes in CANB and G).

THALLUS up to 19 cm in diameter, subcoriaceous, saxicolous, grayish becoming darker gray on storage, lobate; LOBES (2.0–)4.0–11.0 mm wide, irregularly branched, overlapping laterally and crowded at the thallus center, adnate to weakly ascending, loosely attached; UPPER SURFACE smooth to scrobiculate, continuous, becoming irregularly cracked to almost rimose-reticulate in some parts, APICES slightly revolute, subrounded to irregular, MARGIN smooth to highly incised and crenate, weakly ascending or mostly ±flat, irregularly dissected and sublacinulate in older parts, ciliate; MACULAE laminal and amphithecial, usually distinct, but faint in young apothecia, linear to reticulate, very dense, often developing into cracks; LACINULES short and irregular in size and shape, unevenly dispersed at the apices and along the margins of older lobes, admixed with some small, irregular adventitious lobules, simple or irregularly branched, flat, 0.5–2.3 × 0.4–1.7 mm, apices truncate or rarely acute, underside concolorous with the lower margin; CILIA black, usually simple, rarely furcate or irregularly branched, 0.2–2.6 × 0.05–0.15 mm, sparse to frequent along the margins; MEDULLA white, pigments absent, but sometimes reddish spotted due to hydrolysis and oxidation of salazinic acid. SORALIA, PUSTULES and ISIDIA absent. LOWER SURFACE black, shiny, smooth to subrugose, subvenate or subpapillate; MARGIN shiny, brown, smooth, rugose to papillate, 1.0–5.0 mm wide, naked, cream coloured or variegated under fertile lobes; RHIZINES black, simple, furcate or irregularly branched, 0.2–2.2 (–3.4) × 0.05–0.15 mm, frequent to dense, scattered. APOTHECIA submarginal and common, concave to urceolate, becoming ±flat and sometimes distorted when old, 0.5–7.6 mm wide, substipitate, margins smooth, eciliate; amphithecium and stipe smooth, turning rugose when older; DISC brown, epruinose, imperforate, ±incised when old; ASCOSPORES ellipsoid, 10.0–14.0 × 6.5–9.0 μm, episore ca. 1.0 μm wide; PYCNIDIA submarginal and common, abundant on lobules or lacinules, with black ostioles; CONIDIA filiform (7.0–) 9.0–14.0 × ca. 1.0 μm.

SPOT TESTS: upper cortex K+ yellow, UV–; medulla K+ yellow→red, C–, KC similar to K but paler, P+ yellow, UV–.

TLC/HPLC: cortical atranorin (minor) and chloroatranorin (minor); medullary salazinic acid (major), consalazinic acid (minor), and protocetraric acid (trace).

PARATYPE — Brazil, São Paulo State, Municipality of Itanhaém, Cibratel quarter, rocky shore between Praia dos Sonhos and Praia de Itanhaém, 24°11'S, 46°47'W, 10 m alt., on steep granitic rock near the sea, leg. M.P. Marcelli, M.M. Marcelli & M.M. Marcelli 6224, 03-IV-1989 (SP).



Figures 3-4. 3. *Parmotrema hypermaculatum* (part of the holotype).

4. *Parmotrema ruptum* (holotype).

Bars = 10 mm.

Table 1. A comparison of *P. hypermaculatum* with the lectotype of *P. ruptum* and the holotype of *P. expansum*.

	<i>P. EXPANSUM</i>	<i>P. RUPTUM</i>	<i>P. HYPERMACULATUM</i>
Lobe width (mm)	6–10	4–6	4–11
Maculae	effigurate (!, S)	reticulate	markedly reticulate
Cilia (mm)	often furcate 0.5–1.2	simple 0.2–0.5 (!)	usually simple 0.2–2.6
Apothecium	imperforate (S)	imperforate	imperforate
Ascospore size (µm)	17.5–21×10–14 (!)	10–12.5×6.0–7.5 (S)	10–14×6.5–9
Conidia size (µm)	6–9 × 0.5	10–12.5 × 1 (S)	9–14 × 1
Medullary acids	salazinic*	salazinic*	salazinic (major), consalazinic (minor), protocetraric (trace)

(*) Data from literature. (!) Differs significantly from original description. (S) A.A. Spielmann personal communication.

COMMENTS – *Parmotrema hypermaculatum* is a saxicolous species that lacks vegetative propagules and has a very densely reticulate-maculate upper cortex that sometimes becomes irregularly cracked without becoming reticulate-rimose. The maculae often become so enlarged that they restrict the grayish-green colored areas with algae to small, scattered spots. The margins are moderately ciliate. The apothecia are imperforate, shortly stipitate, and have an eciliate thalline exciple, which is smooth when young but becomes rugose and incised with age.

According to Hale (1977), *Parmotrema expansum* Hale, a very similar species, is distinguished by its subimbricate lobes, frequently furcate cilia and an upper cortex that becomes somewhat rimose-reticulate in the central parts due to the agglomeration of age-dependent cracks, thus more closely resembling those species formerly placed in *Rimelia*. In addition the ascospores of *P. expansum* are considerably larger than those of *P. hypermaculatum* (17.5–21.0 × 10.0–14.0 µm vs. 10.0–14.0 × 6.5–9.0 µm) and the conidia somewhat shorter (6.0–9.0 × 1.0 µm vs. 7.0–14.0 × 1.0 µm).

Lynge's description of *Parmelia rupta* [*Parmotrema ruptum* (Lynge) Hale] (Lynge 1914) cites only one corticolous specimen (lectotype in S!, Fig. 4), which differs from *P. hypermaculatum* by having much narrower lobes (4–6 mm vs. 4–11 mm wide), shorter (0.5–1.0 mm vs. 0.2–2.6 mm long), simple cilia and

small subglobose spores (9.0–11.0 × 5.5–8.0 μm vs. 10.0–14.0 × 6.5–9.0 μm). Hale (1960) commented that Lyngé's specimen was very similar to *Parmotrema cetratum* (Ach.) Hale, apart from the nude lower margins. We confirmed this to be the case with the type resembling a small, weakly reticulate, weakly cracked, elacinulate specimen of *P. cetratum* with nude lower margins. No medullary substance other than salazinic acid is reported for *P. ruptum*.

The original descriptions of *P. ruptum* and *P. expansum* recorded significant differences in lobe width, cilia ramification and ascospore size (Lyngé 1914, Hale 1977). Following a comparison of the lectotype of *P. ruptum* with the holotype of *P. expansum*, we consider that these differences are indeed, significant. Thus, the cortex of *P. ruptum* is maculate in a reticulate pattern, whereas *P. expansum* has typical, effigurate maculae (A.A. Spielmann, pers. comm.) which do not resemble *Rimelia*. Consequently, we do not accept these names as synonyms as recommended by Hale & DePriest (1999), but consider them to be similar, possibly related species from this very complicated, salazinic acid containing group (Table 1).

Parmotrema permaculatum (Hale) Kurok. is a further species that resembles *P. hypermaculatum*, but it is corticolous, has a more coriaceous thallus, and sessile, perforate apothecia. Moreover, the lobes of *P. permaculatum* are broader (8–15 mm vs. 4–11 mm wide), the ascospores somewhat larger (13.0–16.0 × 8.0–10.0 μm vs. 10–14 × 6.5–9 μm), and lacinules and lobules are absent (Hale 1971, Kurokawa 2001).

According to Kurokawa (2001), *P. despectum* Kurok. has a very coriaceous thallus with a weakly maculate upper cortex, sparse to rare cilia, ±perforate apothecia with a ± rugose amphithecium. Despite some morphological and ascospore similarities with *P. hypermaculatum*, *P. despectum* has a more regular pattern of lobule formation along the margins, with more rounded lobules, while *P. hypermaculatum* has irregular, truncate lobules or lacinules which are scattered and spread irregularly along the margins.

Although Benatti (2005) mentioned caperatic acid detected in TLC, this substance was not confirmed in HPLC analysis.

This species name (*hypermaculatum*) refers to the strong, often dense, reticulate pattern of maculae developed over the entire upper cortex.

Additional comments on other related species containing salazinic acid such as *Parmotrema eurysacum* (Hue) Hale and *P. mantiqueirensis* Hale can be found in Benatti (2005).

A more detailed overview of the many problems regarding the salazinic acid-containing group of *Parmotrema* species without vegetative propagules can be found in Spielmann (2005).

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