The lichen family Cladoniaceae in Paraíba, Pernambuco and Sergipe, Northeast Brazil

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Abstract. Field and herbarium studies of the lichen family Cladoniaceae in the states of Paraíba, Pernambuco and Sergipe, Northeast Brazil, yielded 22 species, many of them being new reports for the region. The phenolic compounds identified in each species are reported. Cladonia clathrata Ahti & Xavier Filho, Cladonia polita Ahti, Cladonia polyscypha Ahti & Xavier Filho, and Cladonia rugicaulis Ahti are described as new. C. clathrata, C. rhodoleuca Vainio, C. rugicaulis, C. salzmannii Nyl., and C. subminiata Stenroos appear to represent an element confined to northeastern Brazil.

Northeast Brazil, i.e. the states Alagôas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and Sergipe is a large tropical area, which is lichenologically still very poorly known. From Bahia there are some early and more recent (e.g., Britto et al. 1982) records but from Paraíba, for instance, the first lichen records probably date from von Luetzelburg (1923: 231-232), and for most of the states there are apparently no published lichen records at all. However, since about 1960 studies on lichens have been performed in the Federal Universities of Pernambuco, Recife, and of Paraíba, João Pessoa. A. Chaves Batista and his coworkers studied many folicoolous microlichens, but their collections at Recife (URM) also include some macrolichens. From the seventies Lauro Xavier Filho and his coworkers have published many smaller papers on lichens of Paraíba and Pernambuco; their collections are primarily in João
As to the Cladoniaceae, the authors Ahti and Xavier Filho particularly collected specimens of this family in Paraíba in 1987, and Stenroos (together with Sibylle Grundtlehner) joined them on a trip to Sergipe in 1990. Ahti and Stenroos also collected in Pernambuco together with Eugênia Pereira in 1990. These collections are deposited in João Pessoa (JPB) and Helsinki (H). In addition, we have examined the material in Tokyo (TNS) collected by S. Kurokawa and L. Xavier Filho in 1971 and that in Baton Rouge, Louisiana (LSU) collected by Shirley Tucker in 1976.

Our collecting was not exhaustive but because we visited some of the very few areas where species of this family are common and abundant we believe our report includes almost all the species found in the area.

The state of Bahia is excluded from the present study because we have not collected there, although we have examined many specimens from there. It has many more species which are not known elsewhere in the Northeast. One specimen of *Cladonia* was examined from Rio Grande do Norte, but not a single specimen has been seen from the rest of the northeastern states.

As to the earlier records of Cladoniaceae from the area they were mainly published in studies on physiology, antibiotic activity or chemistry of lichens. The identifications are often in need of revision. In many cases we have made an attempt to reidentify the species according to the modern taxonomy, based on recent, largely unpublished studies on neotropical Cladoniaceae by the author Ahti.

**Study area**

The western, mostly interior parts of the Northeast of Brazil belong to the cerrado vegetation province, the central, major part to the caatinga, and the coastal strip to the Atlantic forest (e.g., Lima 1957, F. Carvalho 1978, Eiten & Goodland 1979, F. Carvalho & M. Carvalho 1985).

The cerrado is poor in Cladoniaceae in general, though some 1-3 species can be found in the Distrito Federal, for instance. The northeastern cerrados are apparently so dry (3-5 months of effective dry season and annual precipitation about 800-1000 mm) that the Cladoniaceae cannot exist there.

The caatinga experiences a true semiarid climate, with 6-8 (occasionally even 12) months of dry season, so that the Cladoniaceae are definitely absent in most of this vegetation type. Some other lichens may be abundant, including saxicolous species, especially because rock outcrops and stones are common in this area. However, in Pernambuco, in the moister eastern edge of caatinga called the Agreste formation, some species of Cladoniaceae were recorded.

The 30-50 km wide coastal strip of the study area is included in the Atlantic rainforest. The annual rainfall is 1800-2200 mm, but about two months are fairly dry. The normal mesophytic forest is too shady a habitat for Cladoniaceae, but on road banks and on rotten wood in second-growth forests they can be found. Their major habitat is, however, the so-called tabuleiro vegetation, i.e. sandy coastal hills about 100 m (-300 m in Sergipe) in elevation, covered by open woodlands formed by *Byrsonima cydoniifolia*, *Hancornia speciosa*, *Anacardium occidentale*, *Ou- ratea* spp., *Curatella americana*, etc. Such local cerrado-like woodlands are still well-developed near Santa Rita (ca. 15 km NW of the town) and Alhandra (ca. 30 km S of João Pessoa) in Paraíba, and on Serra do Itabaiana in Mun. Arenas Brancas, Sergipe, which were visited. Fires are common in such woodlands, but the Cladoniaceae flourish at certain postfire stages. In most other places on the tabuleiros the native vegetation has been replaced by vast fields of sugar cane plantations, now grown for production of alcohol (Proálcool) for automobile fuel. The Cladoniaceae are really endangered organisms in the whole region. In the sandy restinga communities near the seashore no Cladoniaceae were observed.
In Paraíba the antimicrobial and antitumoral activity of the Cladoniaceae has been studied extensively (e.g., Silva et al. 1986, Pereira 1989). The extracts of these lichens (especially *Cladonia substellata*; Pereira 1989) have been found to inhibit the Gram positive bacteria and some microfungi (including soil organisms), in particular. In extracts from lichens collected in the dry season the inhibition effects on microorganisms turned out to be highest (Pereira 1989). Being of potential practical interest the conservation of some of the lichen-rich tabuleiro communities is highly desirable.

**Material and methods**

In addition to the field and herbarium work almost all the lichen specimens were subjected to a chemical analysis in Helsinki with thin-layer chromatography (TLC) or in part also with high performance liquid chromatography (HPLC) for the identification of their phenolic products. The HPLC analyses, performed with Dr. Keijo Huovinen, are not considered in detail in this connection. A number of specimens from the area were also analyzed chemically in earlier studies with various methods (see, e.g., Xavier Filho 1973, Carrazzoni & Wanderley 1974, Cavalcanti et al. 1983b, Xavier Filho et al. 1984, Legaz et al. 1987).

**The taxa**

The herbarium symbols follow the standard lists (Salomon 1985, Holmgren et al. 1990). The Brazilian distribution of each species is given with the standard abbreviations of the states (many are new state records!), the following ones being cited: AC (Acre), AM (Amazonas), BA (Bahia), DF (Distrito Federal), ES (Espírito Santo), GO (Goiás), MG (Minas Gerais), MT (Mato Grosso), PA (Pará), PB (Paraíba), PE (Pernambuco), PR (Paraná), RJ (Rio de Janeiro), RN (Rio Grande do Norte), RR (Roraima), RS (Rio Grande do Sul), SC (Santa Catarina), SE (Sergipe), SP (São Paulo).

1. **Cladia aggregata** (Swartz) Nyl.

   Synonyms: *Lichen aggregatus* Swartz, *Cladonia aggregata* (Swartz) Sprengel


   Chemistry: Stictic, constictic, norstictic, and cryptostictic acids. Elsewhere in Brazil and through most of the range of *C. aggregata* a barbatic acid chemotype is dominant. However, the chemotype with the stictic acid group is also known from the Chapada Diamantina region, northern Bahia, which indicates that the Sergipe outlier is probably deriving from the same source.


   Distribution in Brazil: BA, ES, GO, MG, PR, RJ, RS, SE, SP.

   Notes: Although widespread in South America, this species is almost lacking in the tropical lowlands. The Sergipe locality is its northern outpost in eastern Brazil.

2. **Cladina dendroides** (Abb.) Ahti

   Synonyms: *Cladonia sandstedei* f. *dendroides* Abb., *Cladonia dendroides* (Abb.) Ahti

   Description: Ahti (1961).

   Chemistry: Atranorin, fumarprotocetraric and protocetraric acids, and the substance Cph-2. - The report on atranorin and fumarprotocetraric acid of Cladonia sprucei to occur in soil under the lichen in Santa Rita by García-Junceda & Xavier Filho (1986) actually belongs to *C. dendroides*. Besides these compounds Vicente et al. (1984) reported orsellinic acid, orcinol and methyl b-orcinol carboxylate and an unknown compound in this species (as *Cladonia sandstedei*) in Paraíba. However, the latter ones must be degradation products caused by the use of methanol in the mobile phase of the HPLC analysis or the storage
conditions (Huovinen & Ahti 1986: 99, Legaz et
al. 1987: 86). In material collected at Santa Rita
Legaz et al. (1987) and Legaz & Vicente (1989)
reported only atranorin and usnic acid in C.
dendroides in their thorough chemical analyses
(incl. TLC, HPLC). Since no usnic acid has been
found by us in our numerous analyses of this
species, their material may have included some
impurity (e.g., the species is commonly immixed
with Cladonia substellata); the absence of
fumarprotocetraric acid may be also doubtful, as
discussed by the authors themselves.

Specimens examined: Paraíba. Mun. Alhandra,
1962 Tavares 956 (JPB), 1987 Ahti & Xavier
Filho 45685, 45696 (H, JPB); Mun. Santa Rita,
1985 Pereira & Xavier Filho (JPB), 1987 Ahti &
Xavier Filho 45619, 45637 (H, JPB), 45648
(B, H, ICN, JPB, NY, SP, UPS). Pernambuco.
Tabuleiro de Gôiana, 1976, Tucker 16779 (H,
JPB, LSU).

Distribution in Brazil: BA, PB, PE, RJ, SP.

Notes: The recognition of this species by Ahti
(1961) was based on very little material and its
status was uncertain. On the tabuleiros in Paraí-
ba it is one of the most abundant lichens, forming
large colonies up to 15 cm tall. Our field studies
confirm that it is a distinct species, characterized
by a very dense, isotomic top of podetium, but
with several distinct, angular main stems lower
down, rapid disintegration of medullary layer on
stereome (old stems bare), and red slime in
conidiomata. - In earlier studies (Vicente et al.
1984, Xavier Filho et al. 1985) in Paraíba this
species has been referred to as C. sandstedei, a
West Indian species.

3. Cladina rangiferina (L.) Nyl. subsp. abbay-
esii (Ahti) Culb.

Synonyms: Cladina rangiferina var. abbayesii
Ahti

Descriptions: Ahti (1961), Sipman & Cleef
(1979).

Chemistry: Atranorin, fumarprotocetraric acid,
protocetraric acid (tr), Cph-2 (tr).

Specimens examined: Sergipe. Mun. Arenas
Brancas, Ahti et al. 48941 (H, JPB, SP), Stenroos

Distribution in Brazil: AM, BA, MG, RR, SE.

Notes: New to Brazil. This species has been
confused with other taxa, e.g. C. sprucei (Ahti)
Ahti and C. dendroides, in Brazil, but there are
now scattered records from mountains of Minas
Gerais, in particular. Only one scarce colony was
found in the study area.


Description: Vainio (1894).

Chemistry: Fumarprotocetraric acid, protocetra-
ic acid (tr), Cph-2 (tr).

Specimens examined: Pernambuco. S of Gôiana,
1971 Kurokawa & Xavier Filho 8009 (TNS);
Caruaré, 1976 Tucker 16783 (H, LSU).

Distribution in Brazil: AM, MG, PE, RJ, RS, SP.

Notes: A widespread species of road banks in
South America.

5. Cladonia clathrata Ahti & Xavier Filho, sp.
insula (Figs. 1, 2)

A Cladonia rappii A. W. Evans scyphis podetio-
rum clathratis et cortice tomentulato differt.
Acidum fumarprotocetraricum continens.

Primary thallus persistent, squamules 2-6 x 1-4
mm in size. Podetia 2-4.5 cm tall, pale grey to
lilac; scyphose, scyphi proliferating from the
centre, forming 5-8 tiers, which are 3-8 mm
wide, soon perforate and finally strongly clathra-
te when viewed from above; scyphal margins
deeply cleft, with few to 20 broad teeth. Surface
of podetia matt, clearly felty down to the base,
surface of central canal strongly papillate. Pode-
tial wall 200-280 µm thick, with weak cortex 15-
Fig. 1. Cladonia clathrata Ahti & Xavier Filho. Paraiba, Ahti & Xavier Filho 48940 (H). General habit. Bar = 2 cm.

Fig. 2. Cladonia clathrata. Scyphal plate from above. Specimen as in Fig. 1. Bar = 5 mm.
25 \(\mu\)m, medulla 75-100 \(\mu\)m, and stereome 75-125 \(\mu\)m. Conidiomata pyriform, 120-150 x 80-120 \(\mu\)m, constricted at base, sessile or stalked. Hymenial discs brown, no mature spores seen.


Chemistry: Fumarprotocetraric and protocetraric acids and the substance Cph-2, sometimes also Cph-1.


Distribution in Brazil: BA, ES, MG, PB, PE, SE.

Total distribution: Brazil, primarily in Northeast Brazil, particularly on sandy habitats near the coast.

Notes: This is a distinct species, characterized by numerous perforations on the scyphal plates, making the plates clathrate with age, and the felty surface.

6. Cladonia didyma (Fée) Vainio

Descriptions: Vainio (1887), Thomson (1968), Stenroos (1986).

Chemistry: Barbatic acid, 4-0-demethylbarbatic and rhodocladonic (also medullary) acids.


Distribution in Brazil: BA, MG, SC, SE.

Notes: The conspicuous species Cladonia miniatata characterized (besides C. salmonea Stenr.) by its bright red medulla is widespread in tropical America, but in our area it is only represented by

7. Cladonia furfuracea Vainio

Description: Vainio (1894).

Chemistry: Fumarprotocetraric acid, protocetraric acid (tr), Cph-2 (tr).


Distribution in Brazil: AM, BA, MG, MT, PA, PE, PR, RJ, RN, RR, RS, SC, SE, SP.

Notes: The thamnolic acid chemotype, which is also widespread in Brazil, has not been recorded in the study area.


Synonym: Cladonia miniata f. parvipes Vainio

Descriptions: Vainio (1887), Stenroos (1989).

Chemistry: Barbatic, 4-0-demethylbarbatic and rhodocladonic (also medullary) acids.


Distribution in Brazil: BA, MG, SC, SE.
var. parvipes. This variety was actually first reported from Sergipe by Stenroos (1989: fig. 8A), but the specimen was erroneously cited under Santa Catarina. More studies are still required to confirm whether var. parvipes is actually a distinct species. In habit its slender, branchy podetia are quite different from the normally very thick and short podetia of var. miniata.

9. Cladonia pityrophylla Nyl.

Description: Vainio (1894).

Chemistry: Fumarprotocetraric acid, protocetraric acid (tr), Cph-2 (tr).


Distribution in Brazil: AM, BA, DF, MG, MT, PA, PB, PE, PR, RJ, RR, RS, SC, SE, SP.

10. Cladonia polita Ahti, spec. nova (Fig. 3)


Primary thallus persistent, consisting of up to 0.5 cm long, laciniate squamules, which have short, almost terete stalks, below often with ochraceous central streak. Podetia borne marginally on squamules, grey to usually more or less brown, up to 5 cm tall; sowhat branched, branching type irregular anisotomic dichotomy, rarely trichotomy or tetrachotomy; main axes 0.3-0.5 mm thick; axils closed, tips often divided into 2-10 short branchlets. Surface continuously corticate in upper parts, cortex smooth and shiny; soon partly transformed into microsquamules, being finally rather densely squamulose; mature squamules narrow, laciniate and imbricate, up to 4 mm long; esorediate. Podetial wall 200-290 µm, cortex (0)25-40 µm, consisting of large cells, medulla very thin, (0)10-25 µm (incl. the algae), stereome distinctly delimited, very horny, thick, 200-250 µm; inner surface papillate. Conidiomata terminal, 200-250 x 100-150 µm, doliiform, constricted at base, shortly pedicellate, containing red slime, conidia 10 x 1 µm. Hymenial discs brown, aggregated into 0.5 cm wide corymbose heads at podetial tips; spores 12-15 x 3 µm.

Type. Brazil. São Paulo: Ilha do Cardoso, near research center CEPARNIC, 1982 M.P. Marcelli 3710 (SP, holotype; H, isotype).

Chemistry: Squamatic acid.


Distribution in Brazil: PB, PE, PR, RJ, SC, SP.

Taxonomic notes: There are scattered records of this species from the Brazilian coast, from Santa Catarina up to Paraíba.

11. Cladonia polyscypha Ahti & Xavier Filho, spec. nova (Fig. 4)

A Cladonia ramulosa (With.) Laundon differt podetiis tenuissimis (vulgo 0.3-0.8 mm crassis), ramosis, partim abundanter sorediosis, partim corticatis differt. Acidum fumarprotocetraricum continens.

Primary thallus persistent but inconspicuous, consisting of 0.5-2 mm wide, esorediate but granular squamules. Podetia 1-3(3.5) cm tall, very slender and thin, (0.2)0.3-0.8(1.3) mm wide, whitish to greenish-grey, often becoming brownish when sun-exposed, necrotic bases slightly melanotic; unbranched or somewhat branched, either by dichotomy or scyphus formation; tips regularly becoming scyphose but the scyphi stay extremely narrow (0.1-0.2 mm) for a long time.
Fig. 3. Cladonia polita Ahti. Paran, Smith 910207004 (H). Bar = 2 cm.

Fig. 4. Cladonia polycypha Ahti & Xavier Filho. Paraiba, holotype (H). Bar = 2 cm.
until they open up to 1(2) mm wide at the maturity. Surface corticate at base or sometimes up to 1/2 of the podetial length, and regularly inside and outside the fertile scyphi, also often on basal parts of the branchlets; otherwise sorediate, soredia either farinose or immixed with granules or tiny squamules. Podetial wall 160-230 µm, cortex (0)10-25 µm, medulla (with algal layer) 50-75 µm, stereome 100-125 µm, inner surface densely papillulate. Conidiomata common, terminal, globose to pyriform, clearly constricted at base, 80-150 x 100 x 210 µm, conidia 12-10 x 1 µm, slightly arcuate. Hymenial discs brown, no mature spores seen.


Chemistry: Fumarprotocetraric and protocetraric acids and the substance Cph-2.


Distribution in Brazil: MG, PA, PE, RJ, RS, SC, SP, range poorly known.

Notes: This species may resemble C. subradiata but is distinguished by frequent scyphi and much more corticate and often brown podetia. From C. ramulosa it is distinguished by its slender habit caused by thin, relatively tall podetia, which are finely sorediate in part; C. ramulosa is esorediate or has finely granulose (soredioid) structures. At the type locality it was growing side by side with C. subradiata, appearing distinctive.

12. Cladonia ramulosa (With.) Laundon

Synonyms: Cladonia pityrea (Fr.) Floerke, C. anomae a Ahti & P.James


Distribution in Brazil: MG, PA, PE, RJ, RS, SC, SP, range poorly known.

Notes: The present specimens are similar to those of C. polyscypha but the podetial surface is granular-corticate rather than sorediate, the scyphi are wider and the primary thallus well-developed. The specimen JPB 763 was reported as C. “pityrea” in Barros & Xavier Filho (1972).

13. Cladonia rhodoleuca Vainio

Description: Vainio (1887).

Chemistry: Thamnolic and decarboxythamnolic acids.


Distribution in Brazil: MG, PB, PE.

Notes: Cladonia rhodoleuca is very close to C. sphacelata Vainio, and it is still uncertain whether they are distinct species. C. rhodoleuca can be distinguished by its pink colouring in older parts and less squamulose podetia.

14. Cladonia rugicaulis Ahti, spec. nova (Fig. 5)

Cladoniae crispatulae (Nyl.) Ahti (sect. Perviae) affinis sed axes principales podetiorum veteriores crassiores, verruculosobrugulosi, ramuli apicales superficie fibrillosi, ecorticati, medulla crassa et gelatina pycnidiorum hyalina. Acidum thamnolicum continens.
Primary thallus not seen. Podetia 4-8 (11) cm tall, main axes 0.7-1.5 (4) mm thick, greenish to glaucous-grey; richly branched, branching type anisotomic to subisotomic dichotomy (30-50%), trichotomy (20-30%) and tetrachotomy (20-40%); axils closed to open. Surface matt, smooth in the young parts, soon becoming verruculose-rugulose; ecorticate and fibrillose at the apex, lower down weakly but continuously corticate, rarely squamulose (a few small squamules seen in Ahti & Xavier Filho 45684). Podetial wall thick, 250-350 µm, cortex (0)10-20 µm, medulla (225)250-280 µm, stereome 35-50 (80) µm, 1/4-1/3 of the wall thickness, very sharply delimited from the medulla. Conidiomata very shortly cylindrical, 150 x 100 µm, containing hyaline slime. Hymenial discs not seen.


Distribution in Brazil: BA, MG, PB, PE, SE.

Notes: This little known, distinct species has a relatively small range, being apparently confined to northeastern Brazil. It was especially abundant on sandy soil in Sergipe. Though it usually has scyphoid, dilated structures, it may occasionally be extremely similar to C. crispatula (like in Fig. 6), but can always be distinguished by abundant production of barbatic acid (the p-phenylenediamine reaction is usually negative).

15. Cladonia salzmannii Nyl. (Fig. 6)
Description: Vainio (1887). Chemistry: Barbatic acid, 4-O-demethylbarbatic acid (tr). Additional thamnolic and decarboxythamnolic acids may be occasionally present, as well as several minor unknown compounds.


Distribution in Brazil: BA, MG, PB, PE, SE.

Notes: This little known, distinct species has a relatively small range, being apparently confined to northeastern Brazil. It was especially abundant on sandy soil in Sergipe. Though it usually has scyphoid, dilated structures, it may occasionally be extremely similar to C. crispatula (like in Fig. 6), but can always be distinguished by abundant production of barbatic acid (the p-phenylenediamine reaction is usually negative).


Synonyms: Cladonia erythromelaena Müll. Arg., C. miniata var. secundana (Nyl.) Zahlbr., C. miniata var. hypomelaena (Nyl.) Zahlbr.

Description: Stenroos (1989).

Chemistry: Didymic acid, condidymic acid (tr). In its total area C. secundana is chemically very variable (Stenroos 1989). The common major substances, in addition to didymic acid, are barbatic, homosekikaic, and sekikaic acids.

Fig. 5. Cladonia rugicaulis Ahti. Paraiba, Ahti & Xavier Filho 45632 (H). Bar = 2 cm.

Fig. 6. Cladonia salzmannii Nyl. Fertile (left) and sterile (right) podetia. Pernambuco, Kurokawa & Xavier Filho 8004 (TNS). Bar = 2 cm.
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wa & Xavier Filho 8003 (TNS).

Distribution in Brazil: AM, MG, PA, PB, PE, RJ, RR, SC.

Notes: C. secundana is the most widespread member of the so-called C. miniata group in Brazil. It ranges from the Guiana Highland in the north down to SE Brazil.

17. Cladonia subminiata Stenroos

Description: Stenroos (1989).

Chemistry: Usnic and didymic acids are major secondary substances. Accessory minor substances are condidymic, subdidymic, and fumarprotocetraric acids.


Distribution in Brazil: PB, PE, SE.

Notes: One of the most common and widespread species of Cladonia in tropical America.

18. Cladonia subsquamosa Krempelh.

Synonym: Cladonia fimbriata var. chondroides subvar. chlorophaeoides Vainio


Chemistry: Fumarprotocetraric and protocetraric acids and the substance Cph-2.


Distribution in Brazil: AC, AM, BA, DF, MG, MS, PA, PB, PE, PR, RJ, RR, RS, SC, SE, SP.

Notes: Another very common species in tropical America, though not frequent in the study area.
Earlier confused with *C. fimbriata* (L.) Fr. (see Stenroos 1988).

20. **Cladonia substellata** Vainio


Chemistry: Usnic, stictic, cryptostictic and con-
stictic acids. Norstictic and connorstictic acids can be found in this species elsewhere in Brazil. - Usnic acid was reported by Carrazzoni et al. (1976) apparently in this species under the name *Cladonia polia*.


Distribution in Brazil: BA, MG, PB, PE, RS, SE.

Notes: Reported for the area by Ahti (1973). It grows particularly on bare, exposed sands.

21. **Cladonia verticillaris** (Raddi) Fr.

Description: Vainio (1894).

Chemistry: Fumarprotocetraric and protocetra-
ric acids and the substance Cph-2. - Vicente & Xavier Filho (1979) were the first to report fumarprotocetraric acid in Paraibanan material. Legaz et al. (1986) reported that in sunny locations in Paraíba this species produces 1-2.5 times more phenolic lichen substances than in shady places. However, in addition to rather low amounts of fumarprotocetraric acid they (and Xavier et al. 1984) reported orcinol, methyl α-orcinol carbo-
xylate and atranorin, but these substances must be degradation products caused by the macera-
tion of the material in methanol (Huovinen et al. 1990: 227).


Distribution in Brazil: BA, ES, MG, PE, PB, RJ, SP.

Notes: *C. verticillaris* in the sense of Vainio (1894) is a still unclarified collective species, but the Paraiba populations seem to belong to *C. verticillaris* s.str. The lichen forms extensive, showy colonies on the tabuleiros.

22. **Cladonia** sp.

Primary thallus inconspicuous. Podetia 1-1.5 cm tall, simple, smoothly corticate in lower parts, verruculose to granular higher up, scyphose, scyphi rather narrow, tending to have short marginal proliferations, conidiomata and hymenial discs brown.

Chemistry: Fumarprotocetraric acid, protocetra-
rac acid (tr), Cph-2 (tr).


Distribution in Brazil: PB.

Notes: This is almost certainly an undescribed species but it is not described here because of meagre material. It was found scattered in a very young postfire pioneer community on bare sand.

Excluded species

A number of additional species have been repor-
ted from the study area, but because of major recent changes in taxonomic concepts and nomenclature of the neotropical Cladoniaceae the identifications have become outdated. For many of the reports the original material was not available for corrections.
1. **Cladonia crispatula** (Nyl.) Ahti - Reported by Pereira (1989) and others. The reports refer to *C. rugicaulis*.

2. **Cladonia furcata** (Hudson) Schrader - Reported by Xavier Filho & Maríz (1970) from Recife and João Pessoa, but the reports must refer to some other species.

3. **Cladonia macilenta** Hoffm. - Reported from Pernambuco by Barros & Xavier Filho (1972) and Bezerra et al. (1973), the latter report indicating thamnolic, barbatic and didymic acid in the lichen. The reports may refer to *C. didyma*.

4. **Cladina polia** (R. Sant.) W. Weber - See *Cladonia substellata*.

5. **Cladina sandstedei** (Abb.) Ahti - See *C. dendroides*.

6. **Cladina sprucei** (Ahti) Ahti - See *C. dendroides*.

7. **Cladina subtenuis** (Abb.) Hale & Culb. - The report from Pernambuco by Bezerra et al. (1973) - with usnic acid - seems to refer to *Cladonia substellata*.

8. **Cladonia verticillata** (Hoffm.) Schaerer - Reported by Barros & Xavier Filho (1972) and Bezerra et al. (1973) from Pernambuco, probably referring to *C. clathrata*. Carrazzoni & Wanderley (1974) reported evernic acid in Paraíba material of this species. Since evernic acid is not otherwise known in *Cladonia*, their report is doubtful, and the identification of the lichen species must also be incorrect.

**Conclusions**

The Cladoniaceae are relatively infrequent lichens in the Northeast of Brazil. They can tentatively be grouped into the following distribution patterns:

1. Wide temperate-tropical species: 3
2. Wide tropical: 2
3. Wide neotropical: 3
4. NE Brazilian: 5
5. SE to NE Brazilian: 3

The primarily NE Brazilian (with extensions to Espírito Santo and Minas Gerais) species are *Cladonia clathrata*, *C. rhodoleuca*, *C. rugicaulis*, *C. salzmannii*, *C. subminiata*. It is possible that when their ranges will be better known the group should be merged with the SE Brazilian inland element (cf. Frahm 1990: 5). However, three centres of distinctive endemism of flowering plants, viz. Pernambuco, Bahia and and Rio-Espírito Santo have been recognized in the present area of Atlantic coast rain forest (Prance 1978: 61), so that the presence of an endemic lichen element in this area is also possible.

**Parábia** is the state in South America which is closest to West Africa. In light of the plate tectonic history of the continents one could expect that their Cladoniaceae floras would show some similarities. Though West Africa is very poorly known, it seems that these floras have very little in common, however, showing that the later climatic histories of these areas are more important than the continental movements when the distribution patterns of these lichens are explained. There are certainly similarities in the South American and African Cladoniaceae in general, but without a taxonomic revision of the African species, in particular, it is premature to make any far-reaching conclusions.

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(Legends):

Fig. 1. Cladonia clathrata Ahti & Xavier Filho. Paraíba, Ahti & Xavier Filho 48940 (H). General habit. Bar = 2 cm.

Fig. 2. Cladonia clathrata. Scyphal plate from above. Specimen as in Fig. 1. Bar = 5 mm.

Fig. 3. Cladonia polita Ahti. Paran, Smith 910207004 (H). Bar = 2 cm.

Fig. 4. Cladonia polyscypha Ahti & Xavier Filho. Paraíba, holotype (H). Bar = 2 cm.

Fig. 5. Cladonia rugicaulis Ahti. Paraíba, Ahti & Xavier Filho 45632 (H). Bar = 2 cm.

Fig. 6. Cladonia salzmannii Nyl. Fertile (left) and sterile (right) podetia. Pernambuco, Kurokawa & Xavier Filho 8004 (TNS). Bar = 2 cm.