

# New records of the genus *Cladonia* (Lecanorales, Ascomycota) for the Canary Islands

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## Abstract

*Cladonia glauca* Flörke is reported for the first time on the island of La Palma, and *C. dimorpha* S. Hammer and *Cladonia polydactyla* (Flörke) Spreng. on the island of Tenerife, engrossing the list of species of this genus in the area, along with other species for which distribution is expanding.

**Key words:** Cladoniaceae, chorology, Macaronesia, new records.

## Resumen

### **Nuevas citas del género *Cladonia* (Lecanorales, Ascomycota) para las Islas Canarias**

Se aportan las primeras citas de *Cladonia glauca* Flörke para la isla de La Palma y *C. dimorpha* S. Hammer y *Cladonia polydactyla* (Flörke) Spreng. para la isla de Tenerife, junto con otras especies para las que se amplía distribución.

**Palabras clave:** Cladoniaceae, corología, Macaronesia, nuevas citas.

The genus *Cladonia* is one of the most important genera of terrestrial macrolichens (Athi, 2000). There has been a prolonged dispute regarding the classification of the species within the genus and their clustering, due to their substantial phenotypic variation, which renders species delimitation arduous (Stenroos et al., 2002). However, many of the previous questions raised for this group have been resolved by the latest phylogeny of the family Cladoniaceae by Stenroos et al. (2019).

The understanding of the *Cladonia* genus in the Canary Islands remains insufficient, according to Pérez-Vargas et al. (2015). Main citations for this genus on the islands belong to Etayo & Burgaz (1997), Sicilia et al. (2009) and Pérez-Vargas et al. (2015). However, a complete database of records of various organisms, including all lichens, is currently available for the Canary Islands (BIOTA, 2023). A total of 62 species of *Cladonia* have been reported in the Canary Islands, of whom La Palma and La Gomera with a total of 37 species, exhibit the highest number of species in this genus. Databases of this type are of most importance, as knowledge of the distribution of species is crucial for the assessment of extinction risks used in the classification of threat categories (Otte et al., 2002). The objective of this research is to report some new records for the Canary Islands.

The specimens were collected in April and May 2023 from five localities in the Canary Islands (Table 1), two localities in Tenerife and the remaining four in the island of La Palma. More information of collection localities and habitat characteristics are provided in Table 1.

**Table 1.** Collection locality codes with coordinates and habitat characteristics. (TNF) Tenerife island; (LP) La Palma island.

**Tabla 1.** Códigos de las localidades de recolección junto con las coordenadas y las características del hábitat. (TNF) isla de Tenerife; (LP) isla de La Palma.

| Locality code | Coordinates              | Habitat characteristics   |
|---------------|--------------------------|---|
| 1TNF          | 28.420093,<br>-16.379804 | Tenerife, Santa Cruz de Tenerife, Pinar las Raíces, 972m, soils of basalt and basic agglomerates, on slopes of pine forest. |
| 2TNF          | 28.320045,<br>-16.831978 | Tenerife, Buenavista, Parque Rural de Teno, 938 m, basaltic soil with laurisilva vegetation.                                |
| 1LP           | 28.783203,<br>-17.807978 | La Palma, Los Sauces, Mirador Espigón Atravesado (Los Tilos), 750 m, basaltic soil with laurisilva vegetation.              |
| 2LP           | 28.763950,<br>-17.826529 | La Palma, San Andrés, Nacientes Marcos y Cordero, 1351 m, basaltic soil with laurisilva vegetation.                         |
| 3LP           | 28.646931,<br>-17.825111 | La Palma, Santa Cruz de Tenerife, Pista Hilera de la Cumbre, 1400 m, basaltic pyroclastic soil with laurisilva vegetation.  |

The specimens were examined morphologically with a Nikon SMZ1000 stereomicroscope and identified using the current keys for the genus *Cladonia* (Burgaz & Ahti, 2009; Burgaz *et al.*, 2020). A description of the specimens is not included because they correspond to those that can be found in the keys used. The secondary metabolites of each specimen were analysed by thin layer chromatography (TLC) according to the standardised method (White & James, 1985; Orange *et al.*, 2001) using solvents A and C. The material was deposited at MACB and MA-Lichen Herbarium in Madrid and has also been sent to TFC-Lich in Tenerife. The symbol (\*) denotes a new record in Tenerife, and (#) those in La Palma.

A total of 16 species of *Cladonia* were identified on both islands, 12 species on Tenerife and 12 species on La Palma.

#### ***Cladonia cervicornis*** (Ach.) Flot.

Studied material: 2TNF (27273 MA-Lichen. 121772, 121771 MACB), 3LP (27274 MA-Lichen. 122084 MACB).

Chemical composition: corresponds to the common chemotype described for the species Pd+ red, K–, KC–, C–, UV–, containing fumarprotocetraric acid.

Observations: it is a very common species. Widespread in the Canary Islands and Macaronesia (Sicilia *et al.*, 2009). The distribution of this species on the islands of Tenerife and La Palma is extensive.

#### ***Cladonia cyathomorpha*** Stirt. ex Walt. Watson

Studied material: 2LP (27275 MA-Lichen. 121781 MACB).

Chemical composition: our specimen corresponds to the common chemotype described for the species Pd+ red, K–, KC–, C–, UV–, containing fumarprotocetraric acid.

Observations: the morphology of most of the specimens studied is somewhat anomalous, which could lead to confusion with *C. humilis* or *C. pyxidata*, but the presence of big primary thallus together with big scyphose podetia covered with convex and dispersed granules was used for identification. This species has only been reported from the island of La Palma (Pérez-Vargas *et al.*, 2015), but is very common in the Macaronesian region (Burgaz *et al.*, 2020). The distribution of this species on the island of La Palma is extensive.

\* ***Cladonia dimorpha*** S. Hammer (Figure 1a)

Studied material: 2TNF (27276 MA-Lichen. 121775 MACB), 2LP (26904 MA-Lichen. 27277 MACB).

Chemical composition: our specimens correspond to the common chemotype described for the species Pd+ red, K-, KC-, C-, UV-, containing fumarprotocetraric acid. Some specimens containing trace amounts of atranorin have also been found.

Observations: young specimens lacking the split, flattened and branched marginal proliferations, may be mistaken for *C. pyxidata*, due to the presence of some flat plates inside the podetia. *C. dimorpha* has been found on the islands of La Gomera and La Palma (Sicilia *et al.*, 2009), as well as in the Azores islands (Pino-Bodas *et al.*, 2017) and south-western Europe, although its original distribution is western North America (Burgaz *et al.*, 2020). The new records represent an extension of its known distribution in La Palma. New for the island of Tenerife.

***Cladonia fimbriata*** (L.) Fr.

Studied material: 1TNF (27278 MA-Lichen. 122079 MACB), 2LP (27279 MA-Lichen. 122086 MACB).

Chemical composition: our specimens correspond to the common chemotype described for the species Pd+ red, K-, KC-, C-, UV-, containing fumarprotocetraric acid.

Observations: it was known from La Gomera, La Palma and Tenerife (Pérez-Vargas *et al.*, 2015). The range of the species is extended in Tenerife and La Palma.

***Cladonia foliacea*** (Huds.) Willd.

Studied material: 2TNF (27280 MA-Lichen. 122083 MACB).

Chemical composition: the specimen collected to the commonest chemotype Pd+ red, K-, KC+ yellow, C, UV-, containing fumarprotocetraric and usnic acids.

Observations: our specimen matches the standard described for this species. However, it is worth mentioning that a new morphology is considered. The species *C. convoluta* (Lam.) Anders was the subject of a species delimitation problem (Pino-Bodas *et al.*, 2010), and recognised as *C. foliacea* morph. *convoluta*. It is widespread throughout the islands (Sicilia *et al.*, 2009). The range of the species is extended to the Tenerife Island.

***Cladonia furcata*** (Huds.) Schrad.

Studied material: 2TNF (27281 MA-Lichen. 121774 MACB), 1LP (27282 MA-Lichen. 121777 MACB), 2LP (27283 MA-Lichen. 121783 MACB).

Chemical composition: it corresponds to the commonest chemotype Pd+ red, K-, KC-, C-, UV-, containing fumarprotocetraric acid and traces of physodalic in some cases.

Observations: this species can be mistaken with *C. rangiformis*, but the discontinuous algal layer and chemical composition of the latter make it easy to separate them. It is widespread throughout the islands (Sicilia *et al.*, 2009). The range of the species is extended to Tenerife and La Palma.

# *Cladonia glauca* Flörke (Figure 1b)

Studied material: 3LP (27284 MA-Lichen. 122088 MACB).

Chemical composition: our specimen corresponds to the chemotype Pd–, K–, KC–, C–, UV+ white only, containing squamatic and traces of barbatic acids.

Observations: this species was found on the bark of *Pinus canariensis*. It shares similarities with *C. subulata*, but the latter can be distinguished by the lack of a longitudinal groove on the podetia, as well as the occasional slight branching at the tips of the podetia. It may be mistaken for *C. cenotea* (Ach.) Schaer, however, *C. glauca* podetia are less open and do not create actual funnels. Previously known in the Canary Islands only from a single site on the island of La Gomera (Sicilia *et al.*, 2009). New for the island of La Palma.

*Cladonia humilis* (With.) J.R. Laundon

Studied material: 2TNF (27285 MA-Lichen. 122081 MACB), 1LP (27286 MA-Lichen. 121778, 121779 MACB), 2LP (27287 MA-Lichen. 121785 MACB), 3LP (27288 MA-Lichen. 121786 MACB).

Chemical composition: our specimen corresponds with the chemotype Pd+ red, K+ yellow, KC–, C–, UV– containing atranorin and fumarprotocetraric acid.

Observations: some specimens can create confusion and misidentification due to incomplete development or variable morphological traits that resemble other scyphose species, such as *C. cyathomorpha* or *C. pyxidata*. It is distributed in La Gomera, La Palma and Tenerife, and is widespread in the Macaronesian región (Pérez-Vargas *et al.*, 2015). The range of the species is extended to Tenerife and La Palma.

\* *Cladonia polydactyla* (Flörke) Spreng. (Figure 1c)

Studied material: 1TNF (27289 MA-Lichen. 122080 MACB).

Chemical composition: our specimen corresponds to the chemotype Pd+ red, K+ yellow, KC–, C–, UV–, containing thamnolic and traces of barbatic acids.

Observations: it can be confused with *C. macilenta* Hoffm. if the specimens are not well developed, but they contain additionally didymic acid. This species is known from the islands of La Palma, La Gomera and Gran Canaria, and is widespread in the Macaronesian region (van den Boom *et al.*, 2015). New for the island of Tenerife Island.

*Cladonia pyxidata* (L.) Hoffm.

Studied material: 1TNF (27290 MA-Lichen. 121766 MACB), 2TNF (27291 MA-Lichen. 121773 MACB), 1LP (27292 MA-Lichen. 121776 MACB), 2LP (27293 MA-Lichen. 121780 MACB).

Chemical composition: our specimens belong to the chemotype Pd+ red, K–, KC–, C–, UV–, containing fumarprotocetraric acid.

Observations: this species is highly polymorphic and is thought to be a group of species (Burgaz *et al.*, 2020), so specimens can often be confused with other species such as *C. chlorophaea* (Flörke ex Sommerf.) Spreng., *C. humilis* or *C. cyathomorpha*. It is a species that is widely distributed throughout most of the Canary Islands and is widespread in the Macaronesian region (Pérez-Vargas *et al.*, 2015). The range of the species is extended to Tenerife and La Palma.

*Cladonia ramulosa* (With.) J.R. Laundon

Studied material: 2TNF (27294 MA-Lichen. 121769, 121770 MACB).

Chemical composition: our specimens correspond to the chemotype described for the species Pd+ red, K–, KC–, C–, UV–, containing fumarprotocetraric acid.

Observations: this species has a considerable morphological variability and can be occasionally mistaken with other scyphose species within the genus, including *C. phyllophora*. However, *C. phyllophora* can be differentiated by its necrotic podetia base. It was found on several islands and is widespread in the Macaronesian region (Pérez-Vargas *et al.*, 2015). The new records represent an extension of its known distribution in Tenerife

***Cladonia rangiformis*** Hoffm.

Studied material: 1TNF (27295 MA-Lichen. 121767 MACB), 2TNF (27296 MA-Lichen. 121768 MACB), 1LP (27297 MA-Lichen. 122090 MACB), 2LP (27298 MA-Lichen. 121782 MACB), 3LP (27299 MA-Lichen. 121787 MACB).

Chemical composition: the specimens studied correspond with two chemotypes: i) Pd–, K+ yellow, KC–, C–, UV–, containing atranorina and rangiformic acid, the most frequent chemotype, and ii) Pd+ red, K+ yellow, KC–, C–, UV–, containing atranorin, fumarprotocetraric and rangiformic acids.

Observations: this species can be confused with *C. furcata*, but the continuous algal layer of *C. furcata* makes it easier to identify. It is widely distributed throughout the islands and is widespread in the Macaronesian region (Pérez-Vargas *et al.*, 2015). The new records represent an extension of its known distribution in La Palma and Tenerife

***Cladonia squamosa*** (Scop.) Hoffm.

Studied material: 1LP (27300 MA-Lichen. 122089 MACB).

Chemical composition: our specimen corresponds with the chemotype Pd–, K–, KC–, C–, UV+ white, containing squamatic acid.

Observations: it is widespread on most Canary Islands (Sicilia *et al.*, 2009). The new records represent an extension of its known distribution in La Palma

***Cladonia subturgida*** Samp. (Figure 1 d)

Studied material: 1TNF (27301MA-Lichen. 122077, 122078 MACB), 2LP (27302 MA-Lichen. 122085 MACB).

Chemical composition: our specimens correspond with the chemotype Pd–, K+ yellow, KC–, C–, UV–, containing atranorin and protolichesterinic acid.

Observations: this species has been synonymized with *C. iberica* Burgaz & Ahti (Pino-Bodas *et al.*, 2012), previously reported only from La Gomera and La Palma (Étayo & Burgaz, 1997; Pérez-Vargas *et al.*, 2015). The new records represent an extension of its known distribution in La Palma and Tenerife.

***Cladonia subulata*** (L.) Weber ex F.H. Wigg.

Studied material: 2TNF (27303 MA-Lichen. 122082 MACB).

Chemical composition: our specimen corresponds to the chemotype described for the species Pd+ red, K–, KC–, C–, UV–, containing fumarprotocetraric acid.

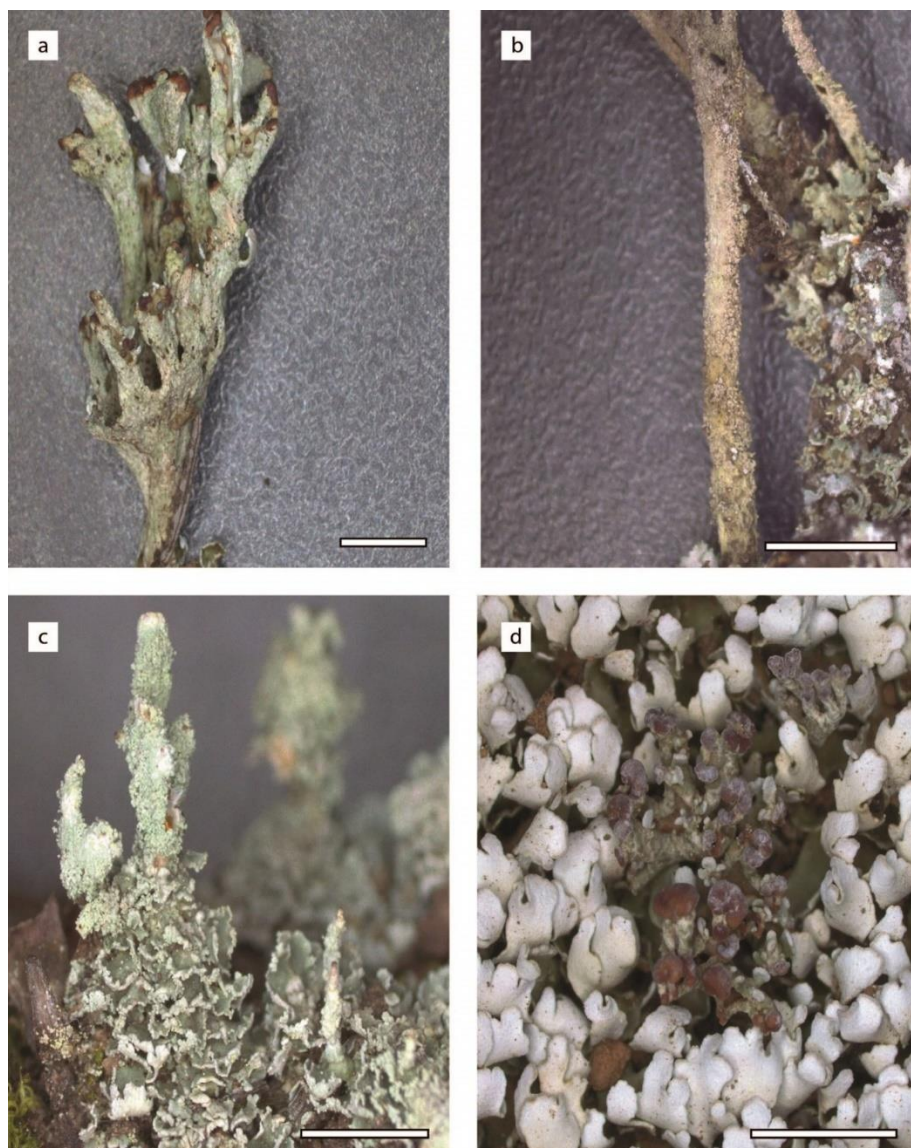
Observations: this species and *C. fimbriata* some times are morphologically variable and may be confused, but *C. fimbriata* possesses wider and deeper scyphi, which facilitate species identification. It was previously found in El Hierro, La Palma, La Gomera and Tenerife (van den Boom *et al.*, 2015). The new records represent an extension of its known distribution in Tenerife.

***Cladonia verticillata*** (Hoffm.) Schaer.

Studied material: 2LP (27304 MA-Lichen. 121784 MACB).

Chemical composition: our specimen corresponds to the common chemotype described for the species Pd+ red, K-, KC-, C-, UV-, containing fumarprotocetraric acid.

Observations: this species may be misidentified with *C. cervicornis* if it lacks the characteristic central proliferations. It is widespread on several islands (Sicilia *et al.*, 2009). The new records represent an extension of its known distribution in La Palma.



**Figure 1.** a) *Cladonia dimorpha* MACB121775; b) *C. glauca* MACB122088; c) *C. polydactyla* MACB122080; d) *C. suburgida* MACB122078. Scale bar 0.5 cm.

**Figura 1.** a) *Cladonia dimorpha*; b) *C. glauca*; c) *C. polydactyla*; d) *C. suburgida*. Barra de escala 0,5 cm.

**Conflict of interest**

None

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## References

- Athi, T. (2000). *Cladoniaceae. Flora Neotropical Monograph*. New York Botanical Garden. Bronx, New York, 78, 1–363.
- BIOTA (2023). Banco de datos de biodiversidad de Canarias. Gobierno de Canarias. <https://www.biodiversidadcanarias.es/>
- Burgaz, A. R. & Athi, T. (2009). *Cladoniaceae. Flora Liquenológica Ibérica*, vol. 4. Sociedad Española de Liquenología (SEL), Madrid.
- Burgaz, A. R., Athi, T. & Pino-Bodas, R. (2020). *Mediterranean Cladoniaceae*. Sociedad Española de Liquenología (SEL), Madrid.
- Etayo, J. & Burgaz, A. R. (1997). Contribution to the lichen-forming fungi from the Canary Islands III. The genus *Cladonia*. *Annalen des Naturhistorischen Museums in Wien. Serie B für Botanik und Zoologie*, 99b, 721–725.
- Orange, A., James, P.W. & White, F.J. (2001). *Microchemical methods for the identification of lichens*. British Lichen Society, London.
- Otte, V., Esslinger, T. L. & Litterski, B. (2002). Biogeographical research on European species of the lichen genus *Physconia*. *Journal of Biogeography*, 29(9), 1125–1141.
- Pérez-Vargas I., González-Montelongo C., Hernández Padrón C. & Pérez de Paz P. L. (2015). Contribution to the knowledge of the genus *Cladonia* in Macaronesia. *Botanica Complutensis*, 39, 31–35. [https://doi.org/10.5209/rev\\_BOCM.2015.v39.49131](https://doi.org/10.5209/rev_BOCM.2015.v39.49131)
- Pino-Bodas, R., Athi, T. & Stenroos, S. (2017). Cladoniaceae of the Azores. *Herzogia* 30(2), 445–462. <https://doi.org/10.13158/heaia.30.2.2017.445>
- Pino-Bodas, R., Martín, M.P., Steinar, J. & Burgaz, A.R. (2010). Insight into *Cladonia convoluta*-*C. foliacea* (Ascomycotina) complex and related species revealed through morphological, biochemical and phylogenetic analyses. *Systematics and Biodiversity*, 8(4), 575–586.
- Pino-Bodas, R., Martín, M. P. & Burgaz, A. R. (2012). *Cladonia suburgida* and *C. iberica* (Cladoniaceae) form a single, morphologically and chemically polymorphic species. *Mycological Progress*, 11, 269–278.
- Sicilia, D., Hernandez, C. & Burgaz, A. R. (2009). The genus *Cladonia* in Garajonay National Park, La Gomera, Canary Islands. *Cryptogamie Mycologie*, 30(3), 305–316.
- Stenroos, S., Hyvönen, J., Myllys, L., Thell, A. & Athi, T. (2002). Phylogeny of the genus *Cladonia* s.l. (Cladoniaceae, Ascomycetes) inferred from molecular, morphological, and chemical data. *Cladistics*, 18, 237–278. <https://doi.org/10.1111/j.1096-0031.2002.tb00151.x>
- Stenroos, S., Pino-Bodas, R., Hyvönen, J., Lumbsch, H.T. & Athi, T. (2019). Phylogeny of the family Cladoniaceae (Lecanoromycetes, Ascomycota) based on sequences of multiple loci. *Cladistics*, 35, 351–384. <https://doi.org/10.1111/cla.12363>
- van den Boom, P. P., Clerc, P. & Ertz, D. (2015). New records of lichens and lichenicolous fungi from La Gomera (Canary Islands, Spain), including the new species: *Usnea boomiana* P. Clerc. *Candollea*, 70(2), 165–177.
- White, F.J. & James, P. (1985) *A new guide to microchemical techniques for the identification of lichen substances*. British Lichen Society Bulletin, London.