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The lichen genus *Cladonia* in Monte Ceceri (Tuscany, Central Italy)

Abstract

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Cladonia is a widespread genus of lichenized Ascomycetes whose knowledge is fragmentary in Italy. There, many records are dispersed in floristic studies, while specific research targeted on this lichen group is almost missing. As a first contribution to the knowledge of the *Cladonia* biota of Tuscany, the annotated list of the species recorded in Monte Ceceri (Fiesole, province of Florence) is reported. Eleven species are listed; among them, *C. ciliata* likely became extinct since the only historical record, while *C. peziziformis* and *C. rei* are reported for the first time from Tuscany. Similarly to other areas recently studied in northern Italy, also in Monte Ceceri the occurrence of *Cladonia*-rich terricolous lichen communities is related to the persistence of fragments of open dry habitats, which are threatened by vegetation encroachment. This case study is a first step towards a better knowledge of terricolous lichen communities of lowlands of central Italy, which provides information useful for the conservation of these overlooked organisms.

Key words: Diversity, floristics, habitat loss, open dry habitats.

Introduction

Cladonia (Hill.) P. Browne is a cosmopolitan genus of lichenized Ascomycetes which includes over 500 taxa worldwide (Gheza 2018a). In Tuscany, as in most of the other Italian regions, no research specifically focused on *Cladonia* has taken place in the past. As it happens in most of the other Mediterranean countries (Burgaz & al. 2017), also here records of Cladoniaceae are included in general floristic or ecological papers. Furthermore, in spite of it being one of the lichenologically best studied regions of Italy (Nimis 2016), *Cladonia* species are still overlooked there, as demonstrated by recent findings (e.g. *C. pseudopityrea*, recently reported by Ravera & al. 2019). The main problem related to this poor knowledge is that it may hamper effective conservation of lichens.

Terricolous *Cladonia* species at low altitudes in southern Europe are known to form species-rich communities mainly in open dry habitats, both in continental and submediterranean-thyrrhenian climates (Gheza & al. 2018, 2019, 2020a, 2020b). Such habitats are threatened in Europe (AA.VV. 2016), and this adds up to the poor basic knowledge in

threatening these lichens. For these reasons, research focused on *Cladonia* lichens should be recommended to take place in such habitats at first instance.

As a first contribution devoted to genus *Cladonia* in Tuscany, we provide an annotated list of the species recorded in Monte Ceceri (Fiesole, province of Florence). This locality, which once hosted wide areas characterized by open dry habitats, was occasionally visited by lichenologists in the past, but only fragmentary and very concise information is available about *Cladonia* lichens in their papers (Steiner 1911; Sbarbaro 1956) or in herbaria (GZU). Therefore, it seemed a very suitable site where starting floristic research on genus *Cladonia* in Tuscany.

Materials and methods

Study area

The study area is located in the A.N.P.I.L. (Natural Protected Area of Local Interest) of Monte Ceceri, which is a hill located in Fiesole, near Florence (Northern Apennine of Tuscany, Central Italy). The A.N.P.I.L. covers 44 hectares, ranging from 220 to 410 m a.s.l. This is a well-known historical locality, since at the top of this hill took place in 1506 the first flight attempt ever known, by means of the flying machine invented and built by Leonardo da Vinci, an event that is commemorated by a monument placed there. The site is very popular for this reason and for recreational activities (e.g. running, trekking, climbing), also due to its proximity to a densely populated area.

The climate is temperate with an annual mean temperature of 13.0 °C and a mean annual precipitation of 878 mm. The highest temperatures are reached in July (mean of 28.7 °C), while the lowest in January (mean of 7 °C). The driest month is July, with a mean precipitation of 39 mm, while the wettest is November, with a mean of 113 mm (climatic data retrieved from: <https://it.climate-data.org>).

The substrate of this area is characterized by a sandstone called “Pietra Serena”, a part of the Macigno Formation, composed mainly by oligomiocenic sandstones (Fazzuoli & al. 1985). Since the Etruscan period (15th century B.C.) until the beginning of the 20th century A.D., the area has been subjected to intense extracting activity, as Pietra Serena has been largely used to build monuments in the province of Florence. This activity led to an almost complete disappearance of wooded vegetation, fostering the occurrence of open habitats (Fig. 1a) which lasted on pioneer substrates thank to the frequent disturbance. But then, after the decommissioning of the quarries, a reforestation project started in 1929 (Gatteschi & Meli 1998) led to the reforestation of the whole area through the plantation of mainly Maritime Pine (*Pinus pinaster* Aiton), Mediterranean Cypress (*Cupressus sempervirens* L.) and Holm Oak (*Quercus ilex* L.). These species still dominate the wood vegetation occurring in the area, with an understory composed mainly of species belonging to the Mediterranean maquis, such as Myrtle (*Myrtus communis* L.), Mediterranean Buckthorn (*Rhamnus alaternus* L.) and Strawberry Tree (*Arbutus unedo* L.). This reforestation project led to a huge loss of open areas, which are nowadays almost missing and still remain only in small fragments, chiefly around the abandoned quarries (Fig. 1b). Unfortunately, at the best of our knowledge, no historical information about the vegetation composition of such open habitats occurring in the past is available.

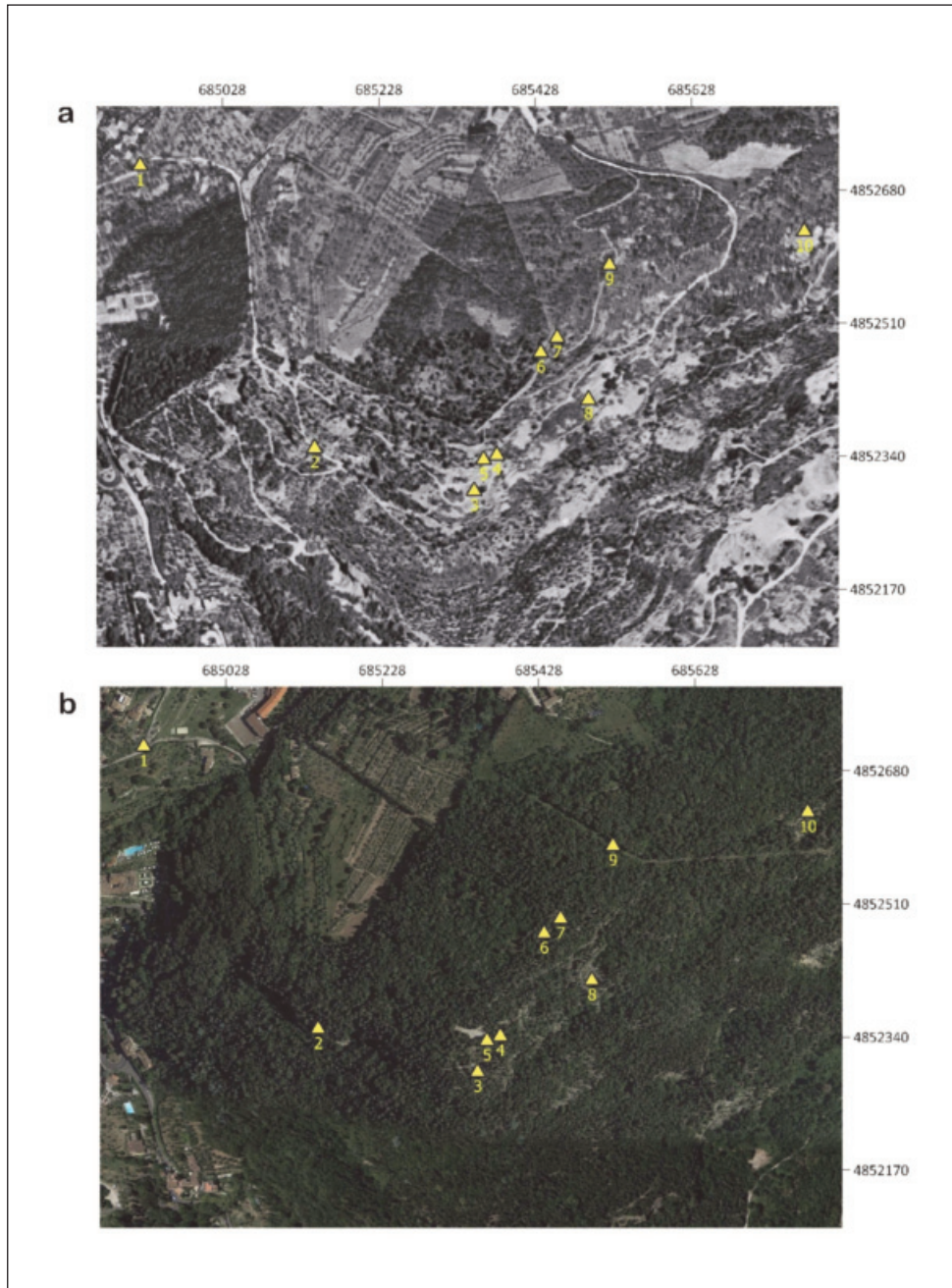


Fig. 1. The study area in 1954 (a) and 2015 (b). The sampling sites are indicated by means of triangles and numbered as in the text. It can be easily seen that the reforestation activity has led to the loss of almost every open area once occurring in Monte Ceceri. Ortophotos reworked from (a) GAI-IGMI flight 1954, Italian Military Geographical Institute, and (b) Google Maps 2015.

Sampling sites

The survey was carried out exploring the main trails of the well-developed trail network of Monte Ceceri. The occurrence of *Cladonia* lichens was carefully checked especially in open habitats, e.g. clearings near the trails, but also along the trails in wooded areas.

The ten sites listed below are those in which fragments of open habitats suitable for terricolous *Cladonia* species still occur on Monte Ceceri (Fig. 1). Coordinates are given in the UTM WGS84 system.

1. Crossroads between Via Mari, Via Monte Ceceri and Via degli Scalpellini in the outskirts of Fiesole, 32T 684923.4852711, 352 m a.s.l.; stone wall at the edge of the road, near to the city park.
2. Trail between the school of Fiesole and the Piazzale di Leonardo, 32T 685146.4852350, 345 m a.s.l.; small clearings at the edge of the trail within the wood.
3. Cava Fratelli Sarti below the Piazzale di Leonardo, 32T 685350.4852295, 394 m a.s.l.; wide clearing crossed by the trail and overhang by the low cliff of the abandoned quarry, with small patches of dry grassland.
4. Trail between Cava Fratelli Sarti and the hilltop Piazzale di Leonardo, 32T 685379.4852341, 392 m a.s.l.; small clearing at the edge of the trail within the wood.
5. Piazzale di Leonardo, 32T 685362.4852335, 397 m a.s.l.; clearing at the top of a low cliff.
6. Trail between Piazzale di Leonardo and Parco dei Pini, 32T 685435.4852472, 396 m a.s.l.; rock outcrop at the edge of the path, with small clearings.
7. Trail between Piazzale di Leonardo and Parco dei Pini, 32T 685456.4852491, 395 m a.s.l.; small clearings at the edge of the trail within the wood.
8. Trail between site 10 and Piazzale di Leonardo, 32T 685496.4852412, 371 m a.s.l.; wide clearing crossed by the trail and overhang by a low cliff, with small patches of dry grassland and exposed rock outcrops.
9. High voltage line, 32T 685523.4852584, 391 m a.s.l.; open vegetation beneath a high voltage line near its crossing with the main trail.
10. Climbing rocky wall, 32T 685772.4852627, 333 m a.s.l.; wide clearing at the top of a former quarry cliff now used for climbing, with small patches of dry grassland.

Species identification and nomenclature

Easily recognizable species – *Cladonia foliacea*, *C. furcata*, *C. pyxidata*, *C. rangiformis* – were identified in the field. Only specimens which needed to be checked in the laboratory for morphology and chemistry were collected and identified with the keys by Burgaz & al. (2017) and Gheza (2018a). The specimens are stored in the first author's personal herbarium.

Nomenclature follows Nimis & Martellos (2020). The name *C. foliacea* (Huds.) Willd. is used also for specimens morphologically attributable to *C. convoluta* (Lam.) Anders, since recent research proved the identity of the two taxa (Pino-Bodas & al. 2018).

Results

The annotated list of the recorded taxa is reported hereinafter. Literature citations and herbarium specimens referred to the study area are also included, to the best of our knowledge. Table 1 gives a synopsis of the *Cladonia* biota of each surveyed site.

Table 1. Synopsis of the *Cladonia* species recorded in the 10 sites with open dry habitats surveyed on Monte Ceceri.

Sites	1	2	3	4	5	6	7	8	9	10	N. of sites where the species was found
<i>Cladonia chlorophaea</i>	.	+	+	+	3
<i>Cladonia coniocraea</i>	.	+	1
<i>Cladonia foliacea</i>	.	.	+	.	+	+	+	+	+	+	7
<i>Cladonia furcata</i>	.	+	.	.	.	+	+	+	+	+	6
<i>Cladonia peziziformis</i>	.	.	.	+	+	2
<i>Cladonia pyxidata</i>	+	+	+	.	.	+	+	+	.	+	7
<i>Cladonia ramulosa</i>	.	.	+	1
<i>Cladonia rangiformis</i>	.	.	+	.	+	+	+	+	+	+	7
<i>Cladonia rei</i>	.	.	+	1
N. of species per site	1	4	6	2	2	4	4	4	3	5	

Cladonia chlorophaea (Sommerf.) Spreng.

Sites 2, 3, 4. On soil.

It is a very common species in all of Italy (Nimis 1993, 2016).

Cladonia ciliata Stirt.

Reported by Sbarbaro (1956) from “Monte Ceceri (leg. Corradi)” as “*Cladonia tenuis* (Flk.) Harm.”. Not recorded during this survey.

Cladonia coniocraea (Flörke) Spreng.

Site 2. On soil.

It is a very common species in all of Italy, but it is found mainly as lignicolous or epiphytic, rather than terricolous (Nimis 1993, 2016).

Cladonia fimbriata (L.) Fr.

Near sites 2, 3, 4, 6, 7. On bark of *Pinus* and *Quercus*.

This was the only *Cladonia* species recorded as epiphytic in the woods of Monte Ceceri.

Cladonia foliacea (Huds.) Willd.

Sites 3, 5, 6, 7, 8, 9, 10. On soil, only one specimen on a stump. Some specimens with very large primary squamules bore fertile podetia; such podetia were 1.5-2 cm tall, of irregular shape, tipped by light brown apothecia.

This species was already reported from Monte Ceceri by Steiner (1911) as “*C. foliacea* var. *convoluta*”. Fertile specimens of this species are uncommon, and had been reported previously in Tuscany only from three sites by Baroni (1894a, b) as “*C. endiviaefolia*”. It is common in Tuscany (Nimis 1993, 2016).

Cladonia furcata (Huds.) Schrad.

Sites 2, 6, 7, 8, 9, 10. On soil.

Common in Tuscany (Nimis 1993, 2016).

Cladonia peziziformis (With.) J.R.Laundon

Sites 4, 10. On soil. Only sterile specimens were found.

One fertile specimen from Monte Ceceri, collected by prof. Josef Poelt in 1962, labelled as “*Cladonia capitata* (Michx.) Ach.”, previously unpublished, is preserved in GZU.

Reported for the first time from Tuscany. This is the only site currently known for this species from peninsular Italy.

Cladonia pyxidata (L.) Hoffm.

Sites 1, 2, 3, 6, 7, 8, 10. On soil and plant debris.

Steiner (1911) reported *Cladonia pocillum* (as “*C. pyxidata* var. *pocillum*”) from Monte Ceceri, but that was probably *C. pyxidata* instead, since *C. pocillum* is typical of calcareous soils. However, Kotelko & Piercey Normore (2010) showed that the two taxa belong to the same species, therefore we report also this record under *C. pyxidata*. Both taxa are common in Tuscany (Nimis 1993, 2016).

Cladonia ramulosa (With.) J.R.Laundon

Site 3. On soil.

This species was already reported from Tuscany, but only from few localities (Savi 1825, Nimis & al. 1990, Benesperi 2001), therefore its record from Monte Ceceri is still interesting, since it is surely uncommon in the region.

Cladonia rangiformis Hoffm.

Sites 3, 5, 6, 7, 8, 9, 10. On soil.

Common in Tuscany (Nimis 1993, 2016).

Cladonia rei Schaer.

Site 3. On soil.

Reported for the first time from Tuscany.

Discussion and conclusions

This *Cladonia* survey in Monte Ceceri led to recording ten species. Among them, nine were terricolous and occurred only in residual fragments of open dry habitats. One species recorded only historically, *C. ciliata*, was not found, while two other species, *C. peziziformis* and *C. rei*, are reported for the first time from Tuscany.

The loss of *C. ciliata* could be hypothetically due to increased air pollution, which is reported by Ravera & al. (2016) as a major threat to this species. However, also habitat loss may have negatively impacted the species, being one of the main drivers of biodiversity loss for terricolous lichens in lowland open dry habitats (Gheza & al. 2020b), due to vas-

cular plant encroachment. Unfortunately, data useful to unambiguously infer the reasons of the loss of this species are virtually missing.

C. peziziformis is a rare species that was reported recently in Italy only from sites hosting well-preserved open dry habitats in the western Po Plain (Gheza 2018b, 2020; Gheza & al. 2019, 2020b). The fertile specimen preserved in GZU was collected on Monte Ceceri in 1962, when open areas still dominated the landscape. In the present survey, only few sterile thalli were observed, and this species is likely to become extinct very soon in the area, as soon as the last fragments of open habitats are lost (Gheza 2020). On the other hand, the finding of *C. rei* in Tuscany widens furtherly its Italian range: rarely reported in the past, this species has been increasingly found in recent times in both continental (Gheza 2018b, 2020) and Mediterranean (Burgaz & al. 2019; Gheza & al. 2020a) areas of Italy, and it is probably widespread in the whole Country.

This case study should alert towards the conservation needs of overlooked taxa such as terricolous lichens. The finding of two species previously unreported from Tuscany in an area next to the hinterland of Florence highlights the poor knowledge of *Cladonia* lichens in the region. The local extinction of one species (*C. ciliata*) and the impending extinction of another one (*C. peziziformis*), both likely due to the loss of open dry habitats, emphasize the lack of proper management. These elements strongly support the need of accurate floristic exploration, that is indispensable for setting up effective conservation measures.

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Disclosure of interest

The authors report no conflict of interest.

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