LICHEN BIODIVERSITY ON ANTHROPO-HISTORIC SUBSTRATA IN ISTANBUL (TURKEY)

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Abstract. *The vicinity of two castles, The Anadolu Fortress and The Rumeli Fortress, in the Asian and the European sides of Istanbul (Turkey) were visited on dates between 15.06.2008-29.07.2008 for the purpose of detecting lichens surviving directly on the old man-made substrates. Lichens were taken photographs in the field and identified at genus or species level. Sixteen lichen taxa were reported under several anthropological impacts in the city.*

Keywords: *Lichens, biodiversity, anthropic, Istanbul.*

Rezumat. Biodiversitatea lichenilor pe un substrat antropo-istoric din Istanbul (Turcia). *Împrejurimile a două castele, Fortareata Anadolu şi Fortareata Rumeli, localizate în partea Asiatică, respectiv în partea Europeană a oraşului Istanbul (Turcia), au fost cercetate între 15.06.2008 – 29.07.2008, în scopul de a detecta prezenta lichenilor supravieţuind direct pe substarte vechi, produse de om. Lichenii au fost fotografiaţi pe teren şi identificaţi la nivel de gen şi specie. Au fost identificaţi saizeci taxoni de licheni, prezenţi sub impactul antropic divers al oraşului.*

Cuvinte cheie: *licheni, biodiversitate, antropic, Istanbul.*

INTRODUCTION

Lichens are often used as biomonitors of environmental quality and bioindicators of air pollutants such as SO_2 and trace metals, in suburban industrial regions and urban parts of the cities with intense human activities, in many papers on this subject (BRANQUINHO et al., 1999; NIMIS et al., 2000; GARTY, 2001; GARTY et al., 2001; BARGAGLI et al., 2002; ZSCHAU et al., 2003). These slow-growing (1 mm/a year!) and long-living organisms are able to absorb pollutants directly from the atmosphere at their surface and accumulate in their tissues, because they have no cuticle layer and lack a well developed root system unlike the higher plants, so they can reflect levels of pollution (NASH III, 1996; GARTY 2001). In addition, biomonitoring methods can assess the anthropogenic effects on organisms, for instance influences of heavy metals on lichen physiology (BROWN & BECKETT, 1983; TARHANEN, 1998). So, lichens can be regarded as suitable indicators for the degree of anthropogenous influences on the landscape so called "hemeroby" (MAYER & TÜRK**,** 2002).

Lichens as terrestrial cryptogamic organisms with a wide ecological amplitude are able to colonize on a variety of substrata. They are mainly separated into 3 according to substrate type and called respectively as saxicolous (on rock), terricolous (soil) and epiphytic (on tree) lichens. The saxicolous lichens grow on siliceous or calcareous rocks and stones and also on man-made substrates such as walls, concrete, cement, marble etc. In the cosmopolitan cities, on anthropic substrates, such as city walls, mosques, towers, ruins and monuments, some species of lichens may be recognized in time. These historic constructions in general have calcareous character. Many lichen species morphologically named as "fruticose" and "foliose" are not able to survive in urban areas, since they are highly sensitive to pollutants. On the other hand, crustose species those with less surface area, are not as vulnerable and are more capable of growing on man-made substrata.

There is a number of recent papers about biomonitoring with lichens in Turkey (AKCIN et al., 2001; TUNCEL & KARAKAS 2001; ÇİÇEK & KOPARAL, 2003; UĞUR et al., 2003; ASLAN *et al.,* 2004; DEMIRBAŞ, 2004; KARABULUT et al., 2004; TUNCEL et al., 2004, YENISOY-KARAKAŞ & TUNCEL, 2004; MENDIL et al., 20005; TUZEN *et al*., 2005; ASLAN et al*.,* 2006). However, the use of lichens for other anthropic aspects is very limited. Only one paper refers to lichens on historic places in Istanbul province (GÖKMEN et al., 2006; 2007). The present study points out the lichen diversity on two historic sites in Istanbul (Fig.1). It is also searched that they were suitable substrates for which species of lichens. Anthropic impacts were determined with respect to presence and amount of the lichen species.

The Study Area

Istanbul has become the biggest and the most crowded city of Europe and always had a great geopolitical importance, since it is the only city in the world which spreads over two continents; lying at a point where Asia and Europe are separated by a narrow sea way -the Bosphorus with an area of 7▪500 km^2 (Fig.1). The population is about 12 to15 millions and around 2 millions tourists visit Istanbul every year▪ It has a history of over 2,500 years. It is under Mediterranean climate. In the north of Istanbul Bosphorus, The Anadolu Fortress (Anadolu Hisarı) and The Rumeli Fortress (Rumeli Hisarı) are two castles situated opposite to each other at the both side of the Bosphorus:

1. The Anadolu Fortress is situated on the Asian shore of the Bosphorus, the sole outlet of the Black Sea, and it was built by Sultan Bayezid in 1390-91. Next to it there is a stream running into the sea. Together with the Rumeli Fortress on the opposite side, it ensured full control over the traffic in the Bosphorus. It is located at the geographic coordinates 41° 04' 54-55" N and 29° 04' 01-02" E. (Fig. 2i);

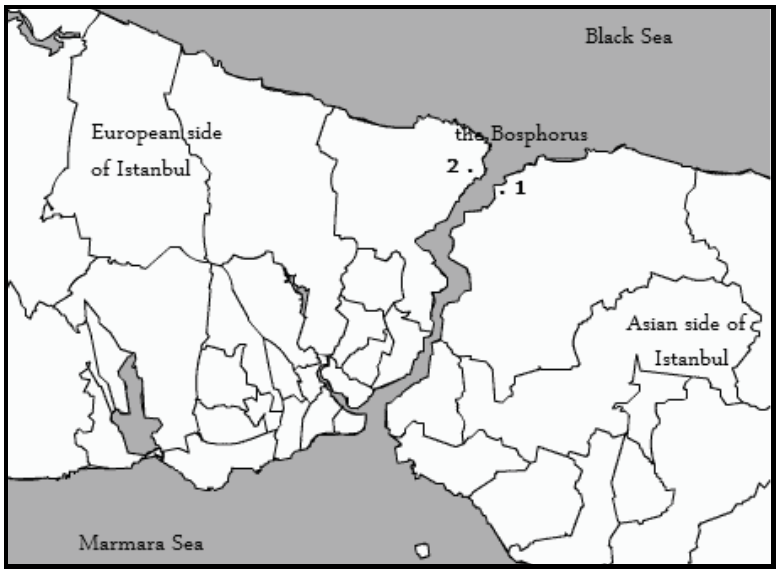

Fig. 1. Study area indicated with numbers. 1. The Anadolu Fortress 2. The Rumeli Fortress.
Fig. 1. Suprafața studiată indicată cu numere: 1. Fortareața Anadolu; 2. Fortareața Rumeli.

2. The Rumeli Fortress was built on the European shore before the siege in 1453 opposite an earlier Turkish fortress on the other shore to prevent any reinforcements and help to the city from the Black Sea. The fortress was completed in the amazingly short time of four months in 1452. This largest and strongest fortress of the Middle Ages lost its importance after the fall of the city. The Rumeli Fortress is a fine example of classic Turkish military architecture. It was restored in the 1950's and turned into a museum. During the annual Istanbul Festival of Arts, the interior of the fortress is used as an amphitheater. It is located at the geographic coordinates 41° 05' 02-09" N and 29° 03' 19-23" E. www.istanbul.gov.tr.

MATERIALS AND METHODS

In order to keep lichens in their natural habitats not to cause damage in historic places, the saxicolous lichen material was not collected, but only was taken photographs in the localities by Burçak Gökmen. Information about the substrates such as aspect and elevation was recorded as well as appearances of lichens (color etc.) Determinations were made following standard identification methods by Gülşah Çobanoğlu with the aid of flora books (PURVIS et al., 1992; WIRTH, 1995). The data for the substrata (age, constriction) and the list of lichen taxa were given in the results.

RESULTS

List of 16 lichen taxa were given in alphabetical order together with locality information followed by these abbreviations: AF for The Anadolu Fortress, RF for The Rumeli Fortress. The situations of the localities are all at the sea level.

The nomenclature follows the Index Fungorum at the web site http://www.indexfungorum.org. The abbreviations of author names were given according to BRUMMITT & POWELL (1992).

List of Taxa:

1. *Acarospora fuscata* (NYL.) ARNOLD RF
2. *Aspicilia calcarea* (L.) KÖRB. AF, RF (Fig. 2a)
3. *Aspicilia cinerea* (L.) KÖRB. RF
4. *Aspicilia contorta* (HOFFM.) KREMP. RF (Fig. 2b)
5. *Caloplaca citrina* (HOFFM.) TH. FR. AF, RF (Fig. 2c)
6. *Caloplaca flavescens* (HUDS.) J. R. LAUNDON AF, RF (Fig. 2d)
7. *Caloplaca saxicola* (HOFFM.) NORDIN AF, RF (Fig. 2e,f)
8. *Caloplaca* sp. RF
9. *Candelariella aurella* (HOFFM.) ZAHLBR. RF
10. *Collema crispum* (L.) WEBER ex F. H. WIGG. RF (Fig. 2g)
11. *Lecanora albescens* (HOFFM.) MÜLL. ARG. AF
12. *Lecanora dispersa* (PERS.) RÖHL AF, RF (Fig. 2h)
13. *Lobothallia radiosa* (HOFFM.) HAFELLNER RF

14. *Protoparmeliopsis muralis* (SCHREB.) M. CHOISY RF
15. *Verrucaria muralis* ACH. RF
16. *Verrucaria nigrescens* PERS. RF

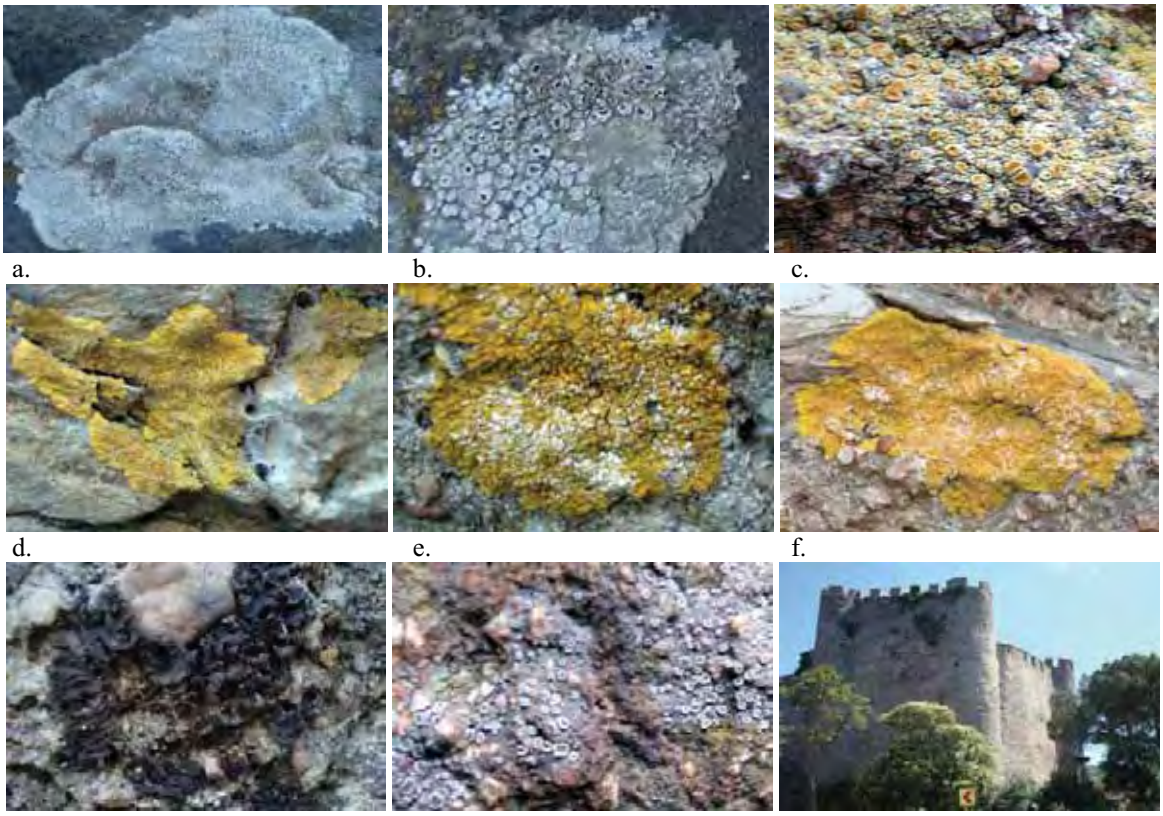

Fig. 2. a. *Aspicilia calcarea* b. *Aspicilia contorta* c. *Caloplaca citrina* d. *Caloplaca flavescens* e. f. *Caloplaca saxicola* g. *Collema crispum* h. *Lecanora dispersa* i. The Anadolu Fortress.

DISCUSSIONS

The walls of the fortresses, providing anthropic substrata for lichens, are not very rich in the sense of species number compared to natural habitats. Among 16 identified lichen taxa in the study area, the most often genera are *Aspicilia, Caloplaca*, *Candelariella, Collema, Lecanora, Verrucaria*. The crustose and placodioid type of calcareous lichens are dominated. Among these, *Caloplaca saxicola*, *Caloplaca flavescens, Lobothallia radiosa and Protoparmeliopsis muralis* are placodioid that is rosette-forming crustose species. The crustose lichens are less sensitive to environmental effects e.g. pollution compared to foliose and fruticose species those with larger surface area. Orange colored *Caloplaca* species and white-gray colored *Aspicilia* species are common in the both localities. These species are often present on seaside rocks exposed to waves as well. *Caloplaca saxicola* is the most wide-spread species in the area. The mentioned lichens have green algal partner. Only one cyanolichen (with cyanobacteria), and one single foliose genus at the same time, *Collema* was detected on the shaded and wet surfaces of the old stone walls. Cyanolichens have been distinguished as more vulnerable to air pollution (NASH III, 1996). 17 similar lichen taxa are previously reported from many historic places in Istanbul (GÖKMEN et al, 2006; 2007).

The calcareous habitat around these two castles had become suitable substrata for some lichen taxa most of which are rather cosmopolite as well as mosses. The western aspects of substrates which are exposed to sunlight and winds coming from sea had a rather more lichen cover. However, several anthropic-resourced reasons may be estimated for the low number of lichen species, from air pollution to mechanic effects, besides natural causes. The lichen growing sites of the historic constructions are mainly protected parts from human impacts, such as bottoms and tops of walls or undersides of stones.

Lichens developed in very little amounts on side-surfaces of cleaned parts of the walls. It is a fact that many crustose lichens can grow only in millimeters per a year (NASH III, 1996). Since these old man-made constructions are often cared or renovated, some lichens are probably disappearing or disturbing every year. So the present lichens survive again probably after every periodic care. On the other hand, the fortresses are open to tourists and always exposed to human impacts. Variety and distribution lichen species may be a predictor for future increasing effects of hemeroby in the region.

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