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Short communication

First record of *Hyperphyscia coralloides* (L.) Scutari growing on PET plastic within a fruit crops plot and its implications

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Abstract

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In a fruit crop located in the Lujan district (Buenos Aires province, Argentina), we exposed plastic bottles to the environment for three years. We explored microplastics' presence on thalli. Out of the potential five lichen species only one grew: *Hyperphyscia coralloides*. Microplastic particles were observed on the thalli. The present work represents the first record of *H. coralloides* growing on PET plastic. Considering the largest thalli size recorded, the results of the growth rate are similar in an average to those recorded for fruticose species. Finally, our results suggest that the contact of *H. coralloides* with microplastics may be a potential pathway for the incorporation of microplastics into ecosystems.

Keywords

forest plantings, organic matter, soil texture, steppe soils, water content

Introduction

More than 400 million tonnes of plastic are produced globally per year, and it is predicted that this number will double by 2045 (Bergmann et al., 2022). Plastic waste is a major environmental concern, since it accumulates at an alarming rate, harming to many species and even threatening human health (Sharma and Chatterjee, 2017). Interestingly, some living organisms can have positive relationships with these materials. For instance, some fungi and bacteria, feed on plastic waste (Anani and Adetunji, 2021). Fungi and lichens are able to grow on/colonize plastic substrates (Cano and Bago 2005; Upadhyay et al., 2020). Loopi et al. (2021) have even shown that lichens are able to accumulate microplastics (size range 1–5,000 µm). The intimate interplay between organisms and plastics, either through ingestion or accumulation, may result in an increase in the flux of plastic materials into ecosys

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tems through the processes of bioaccumulation and biomagnification.

In the present work, we experimentally explore and discuss the relationship between a particular lichen community and polyethylene terephthalate (PET) bottles.

Materials and methods

The study area corresponded to a fruit and vegetable plot in the experimental fields of the National University of Luján, Luján, Buenos Aires, Argentina (34.58°S, 59.08°W). The plot consists of European plum, *Prunus domestica* L., in a 10 × 14 arrangement (47 m × 61 m). In March 2020 a total of twenty 600 mL plastic bottles (polyethylene terephthalate, PET) were randomly suspended from trees (1 per tree) at an approximate height of 1.5 m. We recorded the lichen species with a foliose morphotype growing on the bark of the trees from which the bottles were suspended. The identification of lichen thalli was based on the collection deposited at the National University of Luján. In October 2022, the bottles were collected, and their surface was explored using a Zeiss STEMI 2000C stereoscopic microscope in order to record: (1) species that had formed thalli and, (2) number of thalli per bottle. Each thallus was photographed and measured (larger radius) using ImageJ® software. Fragments of plastic bottles with thalli were cut and observed using an epifluorescence microscope. PET microplastics emitted autofluorescence at ~495–500 nm (green-cyan colours). Each fragment was examined for autofluorescence with a Zeiss® Axioplan microscope equipped with a filter set for blue light excitation (BP 450–490 nm, FT 510 nm, LP 520 nm). Results are presented as mean ± standard deviation (SD).

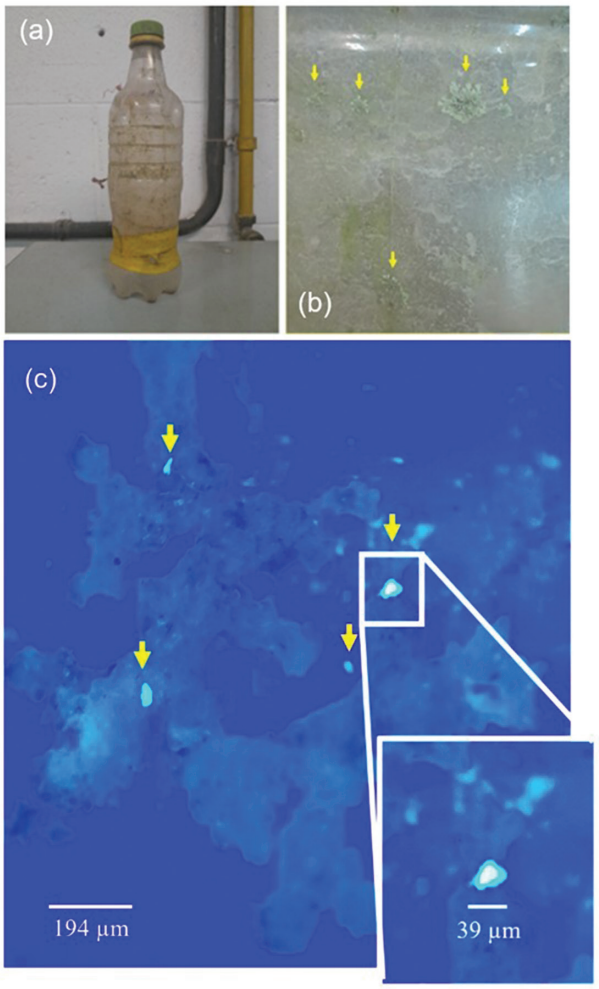

Fig. 1. Plastic bottle collected (a). All collected bottles showed thalli of *H. coralloides* growing on their surfaces (b). Photograph of a thallus of *H. coralloides* on a plastic bottle fragment exposed to a blue light filter and microplastic fragments of PET can be clearly seen on the surface of the thallus (c)

Results

Five foliose lichen species were identified on tree bark: *Hyperphyscia coralloides* (L.) Scutari, *Punctelia semansiana* (Culb. and C. Culb.) Krog, *Canoparmelia austroamericana* Adler, *Flavoparmelia exornata* (Zalilbr.) Hale and *Hypotrachyna bonariensis* (Adler & Elix) Divakar, A. Crespo, Sipman, Elix & Lumbsch. As regards the bottles, every one of them had lichen thalli growing on their surface. All the thalli recorded (n = 527) belonged to the species *H. coralloides*. We observed 26.35 (±6.64) thalli per bottle. The size of thalli per bottle was 2.98 mm (±4.22 mm): with a maximum of 15 mm and a detectable minimum of 1.2 mm. Autofluorescent PET microplastic particles (1 µm–5,000 µm) were found on the recorded thalli (Fig. 1).

Discussion

Various lichen species have been described growing on plastic substrates (e.g., Upadhyay et al., 2020). However, the present work represents the first evidence of the species *H. coralloides* growing on plastic substrates. Though there is no information on lichens' growing behaviour on PET bottles, it is remarkable that in 2.5 years only one species colonized this substrate. Lücking and Bernecker-Lücking (2002), for instance, have recorded 109 lichens species growing on polyethylene (PE) within a time period of 2 years. The richer lichen community of the study area (Costa Rica's rainforest) could be a key factor determining the wider variety of species colonizing this substrate. Besides, if we consider the largest thallus size recorded in our experiment (15 mm), it can be inferred that they grew at a rate of 6 mm yr^{-1}. This value, though obtained in the time lapse of only 2.5 years, is remarkable. To the best of our knowledge, prior to this paper there is no information on the growth rates of the other foliose lichens species recorded in the study area but, when analysing related species, the growth rates are variable and depend on conditions of each study. For example, in the review by Armstrong and Bradwell et al. (2011) it is stated that *Flavoparmelia caperata* (L.) Hale has variable growth rates ranging from 0.46 mm yr^{-1} to 11.20 mm yr^{-1}. Besides, the growth

rate recorded for *H. coralloides* is similar to that of species of the genus *Ramalina* (1–5 mm yr^{-1}, Lumbsch and Elix, 1988). The growth rate of *H. coralloides* is unusually high compared to the growth rates of other foliose lichen species. Finally, we have documented the presence of microplastics on the surface of *H. coralloides* thalli. The work by Loopi et al. (2021) represents the first evidence of lichens' capacity to accumulate microplastics. The fact that *H. coralloides* grows on such a common plastic substrate (PET bottles) and that it can interact with microplastics constitutes a potential pathway for microplastic incorporation into local food webs.

To sum up, based on the results presented here, we propose the species *H. coralloides* as an interesting model when exploring the mechanisms involved in the growth of lichens on plastic substrates and its role in the incorporation of microplastics into ecosystems.

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