Rapid assessment of the diversity of "vehiculicolous" lichens on a thirty year old Ford Bronco truck in central Puerto Rico

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Lichens occur on a wide range of substrata, including man-made materials such as concrete and even glass, metal, plastic, rubber, and textiles (Nylander, 1879; Brightman and Seaward, 1977; Green and Snelgar, 1977; Bailey, 1974; Sipman, 1994; Schroeter and Sancho, 1996; Lücking, 1998; Stolley, 2000; Brodo et al., 2001; Upreti and Dixit, 2002; Payne and Henderson, 2005; Kossowska and Węgrzyn, 2009). Lichens growing on buildings, monuments, and gravestones can have deteriorating effects on the substrate (Dobson, 1997; Edwards et al., 1999; Aptroot and James, 2002; Ariño et al., 2002). On the other hand, lichens have also been promoted as artwork on buildings, through the "Lichens for Skyscrapers Project" by Elisabeth Demaray in New York (Eveleth, 2011), also dubbed "lichaffiti." The fact that lichens can grow on artificial substrata has been used for experimental approaches to study early stages of lichenization, lichen growth, and community formation on surfaces such as microscope slides and plastic leaves (Sanders, 2005; Sanders and Lücking, 2002; Lücking and Bernecker-Lücking, 2002, 2005). One of the earliest reports of lichens on unusual substrata is a letter mentioning lichens on glass by Bouteille (1874; no pun intended regarding the

Fig. 1. Rapid assessment of lichen diversity on an abandoned Ford Bronco truck in Ciales, Puerto Rico. A, Front of car covered with lichens. B, Lichen community structure in detail, showing feeding traces of a snail. C, International expert team including Ricardo Miranda (Oregon), Rosa Emilia Pérez (Mexico), Bibiana Moncada (Colombia) and André Aptroot (Netherlands) assessing the driver door (with Paul Kirika from Kenya to the right). D, Discovery of an additional species below the side window (with María de los Ángeles Herrera-Campos from Mexico). E, Thorsten Lumbsch (Field Museum, Chicago) deciding to collect the door after a new species was discovered on the side mirror (to the right André Aptroot and in the background Edier Soto from Colombia). F, Thorsten and Field Museum postdoc Ekaphan Kraichak (Thailand) with one of the largest lichen samples ever collected. All photographs by Robert Lücking.

Table 1. Lichen taxa found on an abandoned Ford Bronco truck in Ciales, Puerto Rico, as by rapid assessment of a team of twenty international specialists. The mean species richness discovered per specialist amounts to 2.0. New records for Puerto Rico are marked with an *asterisk.

Species

Byssoloma chlorinum (Vain.) Zahlbr.
Byssoloma leucoblepharum (Nyl.) Vain.
Byssoloma subdiscordans (Nyl.) P. James
Byssoloma tricholomum (Mont.) Zahlbr.
**Calenia depressa* Müll. Arg.
**Calopadia editiae* Vězda ex Chaves & Lücking
Canoparmelia texana (Tuck.) Elix & Hale
Coccocarpia palmícola (Spreng.) Arv. & D. J. Galloway
Coenogonium sp.
Crocodia aurata (Ach.) Link
Cryptothecia striata G. Thor
Cryptothecia sp.
Echinoplaca sp.
**Gyalideopsis capitata* Sérus.
**Gyalideopsis vainioi* Kalb & Vězda
Herpothallon rubrocinctum (Ehrenb.) Aptroot, Lücking & G. Thor
**Heterodermia japonica* (M. Satô) Swinscow & Krog
Heterodermia speciosa (Wulfen) Trevis.
Heterodermia tremulans (Müll. Arg.) W. L. Culb.
Hypotrachyna minarum (Vain.) Krog & Swinscow
**Hypotrachyna rockii* (Zahlbr.) Hale
Hypotrachyna sp.
Leptogium cyanescens (Pers.) Körb.
Leptogium phyllocarpum (Pers.) Mont.
**Lyromma dolichobellum* Cavalc.
Parmotrema austrosinense (Zahlbr.) Hale
Parmotrema reticulatum (Taylor) M. Choisy
Parmotrema tinctorum (Despr. ex Nyl.) Hale
Physcia atrostriata Moberg
Physcia sorediosa (Vain.) Lynge
**Porina atrocoerulea* Müll. Arg.
Porina distans Vězda & Vivant
Pyxine caesiopruinosa (Tuck.) Imshaug
Pyxine subcinerea Stirt.
Tapellaria epiphylla (Müll. Arg.) R. Sant.
Tapellaria nana (Fée) R. Sant.
Tapellariopsis sp. nov.
Trichothelium argenteum Lücking & L. I. Ferraro
Trichothelium epiphyllum Müll. Arg.
**Trichothelium montanum* Lücking

author's surname!).

Since cars include a mixture of materials suitable for lichen growth, such as metal, glass, plastic, and rubber, they make a potentially available substrate of considerable dimension and diversity, provided they are not moving or regularly cleaned and the environmental conditions are favorable. A few reports exist for lichens growing on cars (Brightman and Seaward, 1977; Arvidsson, 1982-83; Malcolm and Galloway, 1996; Gray, 1999; Pedley, 2000; Malcolm and Malcolm, 2000; Brodo et al., 2001; Tucker, 2001; Bennett, 2002), with the record being 21 species identified on an old Lada car in southern England (Gray, 1999). However, the phenomenon does not appear to have been investigated in any systematic manner.

Here we report an extraordinary diversity of lichens growing on a thirty year old Ford Bronco truck in the municipality of Ciales, in central Puerto Rico (Fig. 1). According to the owner, the truck was left abandoned in a forest for about ten years and then brought to its current location in a rural area along road PR-149. We established a rapid assessment protocol to facilitate species inventories of car-dwelling lichens. To that end, we assembled a team of twenty international specialists, fifteen of whom were sent into the field to retrieve the data by positioning them strategically in different points around the car and reporting species back to a data recording team for a period of 30 minutes (Fig. 1). We also took samples back to the laboratory where five other colleagues analyzed specimens in more detail. Sampling included the entire driver-side car door with rear mirror still attached to it. To provide accurate terminology, we coined the term "vehiculicolous" for car-dwelling lichens, from the Latin *vehiculum*, meaning carriage,

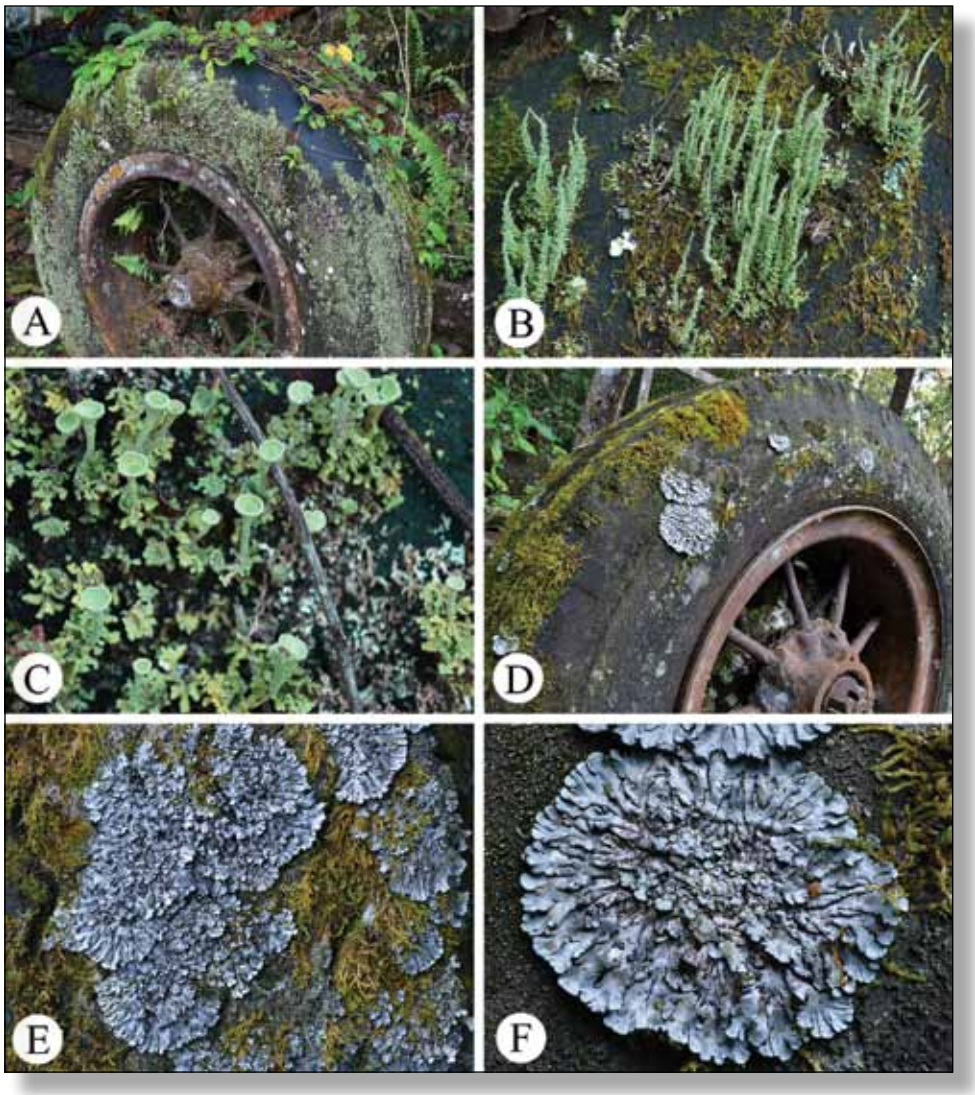

Fig. 2. A second site with one abandoned tractor and two trailers covered with lichens. A, Trailer tire covered with Cladonia. B and C, Selected Cladonia species (Cladonia corymbosula and C. subsquamosa). D, Trailer tire covered with bryophytes and Coccocarpia erythroxyli. E and F, Coccocarpia erythroxyli thalli in close-up. All photographs by Robert Lücking.

wagon, or cart. This term is entirely new as it does not yet exist in Google (we checked!).

The rapid assessment revealed a total of 40 species, nine of which are new records for Puerto Rico (Table 1). This diversity represents nearly twice the number of the previous record of 21 species on a Lada car (Gray, 1999). About one third of the taxa were lichens usually growing on leaves (Lücking, 2008), represented by few, small thalli, such as in the genera *Byssoloma*, *Calenia*, *Calopadia*, *Tapellaria*, and *Trichothelium*. Other species were opportunistic taxa usually growing on bark, wood, and rock under favorable conditions, such as *Cryptothecia*, whereas others are also common in urban environments (Physciaceae). We even detected at least one thallus completely grazed by snails, indicating that these are viable biological communities.

We hypothesize that cars undergo specific succession once abandoned and depending on environmental conditions: the smooth surface at first attracts small foliicolous lichens and taxa found primarily on smooth bark or bamboo, which may establish within 1–3 years after abandonment, as suggested by the experiments by Lücking and Bernecker-Lücking (2002, 2005). Similar to very old leaves, these communities then facilitate the growth of larger lichens such as Collemataceae, Parmeliaceae, and Physciaceae, as well as fast-growing crusts such as *Cryptothecia* and *Herpothallon*. Remarkably, lichens that usually grow at least partially endoperidermally on bark, including many Graphidaceae, Pyrenulaceae, and Trypetheliaceae, were not detected on the car. The largest lichens were about 50 mm across, which would correspond to about eight to twelve years of growth assuming an average radial growth rate of 2-3 mm per year. This would be consistent with the information that the car was left abandoned for about ten years in the forest and a few more years at its current roadside location.

The comparatively high species richness found on the car supports the notion of a latitudinal diversity gradient, compared to much lower numbers reported from cars in North America and Europe, with between one and 21 species (Brightman and Seaward, 1977; Arvidsson, 1982-83; Malcolm and Galloway, 1996; Gray, 1999; Pedley, 2000; Brodo et al., 2001; Tucker, 2001; Bennett, 2002). However, compared to other reports of high small-scale lichen diversity in the tropics, the number of 40 species is moderate. For instance, Lücking and Matzer (2001) listed 50 species from a single leaf, Lücking (1998) 63 species from a small plastic sign, and Aptroot (1997) 173 species from a single tree. It is possible that the car featured even more species before it was brought to its current roadside location. To assess its relative species richness, one would have to compare the lichen diversity in the location where the car had been abandoned originally.

In addition to our rapid assessment of the Ford Bronco truck, we also visited a second site with abandoned farm tractors and trailers, in the Río Abajo State Forest between the municipalities of Utuado and Arecibo. This area is dominated by moist, evergreen to semi-evergreen broadleaf forest on karst limestone. The studied vehicles, left abandoned in the backyard of the administrative building of the reserve, exhibited a different assembly of lichen species mainly growing on the large rubber tires and on the metal frames. We observed a clear difference between objects in this case: while one trailer had its tire covered with different species of *Cladonia*, mostly *C. subsquamosa* Kremp. and *C. corymbosula* Nyl., the other was preferred by a community of bryophytes

and *Coccocarpia* species, in particular *C. erythroxyli* (Spreng.) Swinscow and Krog (Fig. 2). It is unclear whether this difference is caused by rubber composition or rather represents different successional stages. Since especially *Cladonia* species are comparatively substrate-specific (Ahti, 2000), the former seems more likely, suggesting that the tire covered with these lichens provided a more acidic substrate.

Our observations suggest that car-dwelling ("vehiculicolous") lichens are a rather frequent phenomenon if conditions for such growth are suitable, as also indicated by the anecdotal notes summarized by Tucker (2001). We propose a more systematic inventory of such lichens using the protocol implemented here or an adaptation thereof. Thus far, very little is known about possible preferences of lichens for car make and model, paint color and quality, and the different materials offered by a car surface (metal, fiberglass, glass, plastic, rubber). Is a light-colored Volkswagen Beetles more susceptible to lichen growth than a dark Cadillac limousine? What about a red Ferrari GT versus a yellow Porsche Carrera?

Lichen succession as function of time of abandonment, and correlation with lichens on natural substrata in the environment where the car was abandoned, are topics that deserve further investigation. It would also be interesting to explore the possible function of lichens in the biological deterioration of cars and other artificial materials. An assemblage of old cars of various makes, models and colors covered with lichens would also make a truly eye-catching tourist attraction while serving as outreach object for public education about lichens and their importance.

Abandonment does not seem to be required for lichens to grow on vehicles. According to Tucker (2001) and other, unpublished observations particularly in Europe, lichens are occasionally growing on cars that are still operating, and not infrequently by lichenologists, who sometimes drive old cars in the field and, for obvious reasons, do not clean them meticulously (or not at all). When these cars are used for mapping projects, it poses the dilemma whether or not the species present on the car should be recorded from all visited localities, apart from the notion that such a situation bears the possibility of dispersing lichen species into areas where they do not occur naturally. That cars are important dispersal agents has been shown in a recent study on plant seeds (Ansong and Pickering, 2013).

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Rhizocarpon sp. patterns. Courtesy of T. Wheeler.