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## An annotated checklist of lichens reported from New York City since 1968<sup>1</sup>

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**Abstract.** New York City is the largest urban area in the USA. The growth of this vast and densely populated region has drastically reshaped the landscape and biodiversity over the past 400 years. Lichens are one component of biodiversity that respond to urbanization in unique ways, many of which are still not well understood. The aims of this study were to review the historical literature on lichen diversity in New York City, discuss the changes in diversity through time, and compile an annotated checklist of lichen species currently in New York City. Since the first publication on lichen diversity in New York City was published almost 200 years ago by John Torrey, six publications have reported the lichen species occurring in the vicinity of New York City, or some subset of the city. There appears to be a general trend in decreasing diversity from the earliest publication to 1968, when the fewest species are reported. Since 1968 there has been an increase in the number of species reported. Targeted surveys of sites studied in 1968 showed that the species in those areas have indeed increased. The annotated checklist is comprised of 103 taxa in 55 genera that have been reported from New York City since 1968. The majority of species are crustose (57 species), and only one cyanolichen has been reported. Future studies on how the lichen diversity continues to change as air quality and climate change, and how horticulture throughout the city influences the lichen diversity, hold great promise for furthering the knowledge of how organisms respond to complex, heterogeneous urban environments.

Key words: Air quality, Clean Air Act, recolonization, urban biodiversity, urban ecology

URBAN LICHENS. Lichens are an important component of urban biodiversity. They add to the total species richness of cities and are easily observable indicators of air quality (Brodo *et al.* 2001). For much of the 20th century, lichens were nearly absent from many city centers because of their sensitivity to air pollution (Rose and Hawksworth 1981, Seaward and Letrouit-Galinou 1991, Munzi *et al.* 2007). Beginning in the late 20th century lichens started recolonizing cities and increasing in diversity and abundance from Tokyo to Paris, and Cincinnati to London (Rose and Hawksworth 1981, Seaward and Letrouit-Galinou 1991, Washburn and Culley 2006, Ohmura *et al.* 2012). A more complex relationship between lichen diversity and urban areas is emerging as studies show that air quality is the major driver of lichen community composition, while human population density is not (Munzi *et al.* 2007, McMullin *et al.* 2016), and some urban areas can harbor surpris-

ingly high lichen diversity (McMullin *et al.* 2014). As air quality continues to improve in many cities, the trend in increasing urban lichen diversity may continue. It is essential that the current diversity in urban areas is documented so comparisons will be possible in the coming decades.

HISTORY OF LICHEN RESEARCH IN NEW YORK CITY. Literature on the lichen diversity occurring in New York City is relatively sparse. The literature that does exist is inconsistent in its geographic study extent, and, because there are large time gaps between most studies, inconsistent taxonomically. Unfortunately, the voucher specimens for all the early studies are missing, thus it is not possible to precisely update the taxonomy and identifications. The collections from the 19th century were likely lost either during the many moves of the Lyceum of Natural History in New York City (now the New York Academy of Sciences), or in the fire of 1866 when all the organization's collections were destroyed (Barnhart 1917). Despite these limitations for comparing studies, there is still much we can learn from the available literature.

There were two reports of New York City lichens published in the 19th century. The first publication that reported on the lichens of New York City was by John Torrey (1819). At the end of his list of vascular plants growing within a 30-mile radius of town hall, he included a section on cryptogams in which he reported 61 species of lichens (Torrey 1819). He also stated that the list is

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certainly incomplete, and did not include any specific localities for the species reported. The next study on the lichens of New York City was published only five years later (Halsey 1824). Halsey (1824) focused his manuscript only on lichens and extended the radius around town hall to 50 miles, along with a handful of species that were reported from upstate New York and western Massachusetts. One hundred ninety-one species were reported, though, again, there was no indication of where each species was observed. Halsey (1824) did not cite Torrey (1819), but they certainly knew each other. Not only were they clearly contemporaries and belonged to the same scientific organizations in New York City, but Halsey (1824) did make one mention of Torrey in his manuscript under *Pyrenula enteroleuca* in which he wrote, “specimens of this common lichen were sent by Dr. Torrey to Professor Sprengel of Halle, and by him determined to be a new species of *Pyrenula*, under the name here adopted” (p. 10). Thus, together, John Torrey and Abraham Halsey laid the first foundation of our knowledge of lichen diversity in New York City.

There were no further publications on lichen diversity in New York City until the 20th century. The first study was published by Wood (1914), a graduate student at The New York Botanical Garden (NYBG). Wood (1914) further extended the radius of his study area to 100 miles around City Hall, which spanned from Philadelphia to Connecticut. Luckily, Wood (1914) indicated specific localities where species were found, so that it is clear he reported 51 species within the five boroughs of New York City. Following Wood’s publication there was another long period without any research activities in this area, which was not broken until 1968, when Irwin Brodo published his dissertation on the lichens of Long Island. As part of his dissertation, he surveyed three sites in Kings and Queens counties where he found only eight species (Brodo 1968). The next study of city lichens also focused on Kings and Queens counties and reported 18 species (Delendick 1994). This potentially shows a significant increase in diversity from 1968, especially because Delendick (1994) did not focus on parks and large green spaces, while Brodo (1968) only visited large parks, which should host higher diversity than the streets. Ten years later, a small flora of Highline Park was published where five lichens were included (Stalter 2004). The most recent publication is a flora of Freshkills Park on

Staten Island, where 17 species are reported (Allen and Howe 2016). Based on the 20th century literature there seemed to be a general trend of decreasing lichen diversity until the 1960s, from which point the diversity has increased. However, again, with the currently available literature it is difficult to draw firm conclusions on trends in New York City lichen diversity.

**AIR QUALITY IN NEW YORK CITY.** The air quality in New York City has changed drastically over the last century. Air pollution was not monitored in the eastern USA until 1928 (Center for Chemical and Process Safety [CCPS] 2006). Once air quality monitoring began it was discovered that the particulate matter in the air was so concentrated that year that it blocked 20–50% of the sunlight in New York City (CCPS 2006). The 1950s and 1960s were clearly the low point in New York City air quality as multiple extreme smog events led to the deaths of hundreds of people in 1953, 1963, and 1966 (CCPS 2006). Since the implementation of the Clean Air Act and subsequent related legislation the air quality throughout the USA has improved dramatically, especially SO<sub>2</sub> emissions (Smith *et al.* 2011). More recent regulations in New York City that reduce the amount of SO<sub>2</sub> containing fuels that can be burned have further improved the situation, leading to a 95% decrease in SO<sub>2</sub> concentrations in the past six years (Kheirbek *et al.* 2017). Projections for future air quality in New York City are positive, as fossil fuel-based energy and transportation are replaced by cleaner sources of energy (Kheirbek *et al.* 2017). Continued improvement in air quality in New York City has the potential to allow more lichen species to recolonize and flourish in the urban environment. Although the original community that occupied the area before urbanization may never recover, a novel urban lichen community will likely replace it.

**RATIONALE AND SUMMARY OF STUDY.** Here I present a list of all lichen species reported from New York City since 1968. I compiled this list from the literature, herbarium records, and surveys I conducted from 2013–2017. Studies of the total lichen diversity for the five boroughs have been published at roughly 100-year intervals (Halsey 1824, Wood 1914); thus, it is certainly time to add a list from the 21st century. Furthermore, because John Torrey (1819) was the first to publish a report of lichens from New York City, it is most fitting to publish this list in celebration of the 150th anniversary

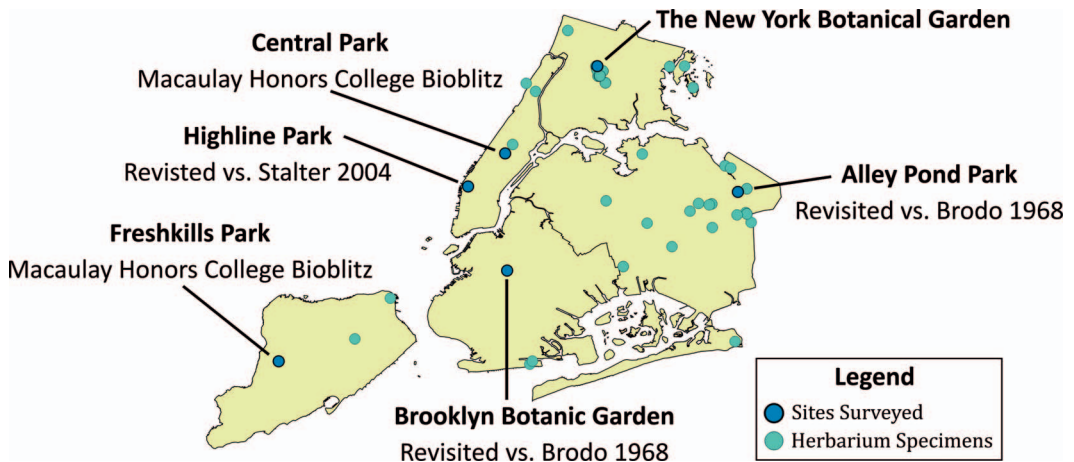


FIG. 1. Map of the five boroughs of New York City showing all sites sampled for this project and mapping all referenced herbarium specimens.

sary of the Torrey Botanical Society. The reason that I set 1968 as the starting year for this study is because it is when the reported lichen diversity was the lowest (Brodo 1968). The conclusion that the lichen diversity has only improved in New York City since the 1968 is based on the available literature, trends in air pollution, and discussions with lichenologists who have lived in New York over the past few decades (Harris, pers. comm.). Thus, all species reported since then have a high likelihood of continuing to inhabit the study area at present.

**Methods.** Data for this annotated checklist were drawn from original surveys, herbarium records, and published literature (Fig. 1). Surveys were conducted between 2013 and 2017 and voucher specimens or photos were taken at each site. Two sites, Central Park and Freshkills Park, were surveyed as part of the Macaulay Honors College BioBlitzes over a two day period. Alley Pond Park and Brooklyn Botanic Gardens were surveyed for four hours each to directly compare diversity reported by Brodo (1968). Highline Park was visited three times for a total of six hours to search for the lichens reported by Stalter (2004) before major renovations took place at the park. Surveys of lichens at The New York Botanical Garden were mostly conducted in the Thain Family Forest at various points throughout the survey time period. Herbarium records were extracted from the database for The New York Botanical Garden (NYBG) herbarium along with the Consortium of North American Lichen Herbaria website by searching for all lichens collected in Bronx, New

York, Richmond, Kings, and Queens counties. A selected subset of these specimens was examined, but as multiple lichenologists have already confirmed identifications, a complete examination of specimens was not required. An exhaustive survey of the literature was conducted to find all published articles on lichen diversity in New York City using Web of Science, Recent Literature on Lichens, Google Scholar, and Biodiversity Heritage Library using the search terms “lichen” and “New York.”

**Results.** A total of 103 taxa in 55 genera have been reported from New York City since 1968. Most of the species are crustose (57 spp.), followed by foliose (28 spp.), then fruticose (13 spp., all in *Cladonia*). Five taxa were only identifiable to genus. The most diverse genus in the city is *Cladonia*, with 16 species, followed by *Lepraria* and *Phaeophyscia*, each with five species. Only one cyanolichen has been reported, *Collema bachmanianum*, and only from a single specimen. The majority of the records are from the Bronx, especially from the grounds of NYBG. While NYBG may host higher diversity than some areas because it is a larger green space, the total number of species only reported from the grounds of NYBG may be due to abundance of lichenologists rather than the lichens.

Three areas were surveyed to determine if the lichen diversity has changed since originally reported. The first was Highline Park, which was surveyed by Stalter (2004) while naturally regenerating vegetation dominated the train tracks before major renovations took place. Stalter (2004) reported five lichen species, none of which was relocated during my three surveys

Table 1. Comparison of lichen diversity in three parks in New York City at different time points. Highline Park original species reported by Stalter (2004), Alley Pond Park and Brooklyn Botanic Garden by Brodo (1968). “X” indicates a species presence.

| Species                          | Highline Park |           | Alley Pond Park |      | Brooklyn Botanic Garden |      |
|----------------------------------|---------------|-----------|-----------------|------|-------------------------|------|
|                                  | 2004          | 2016–2017 | 1968            | 2017 | 1968                    | 2017 |
| <i>Acarospora fuscata</i>        |               |           |                 |      |                         | X    |
| <i>Amandinea</i> sp.             |               |           |                 | X    |                         | X    |
| <i>Candelaria concolor</i>       |               |           |                 | X    |                         | X    |
| <i>Cladonia caespiticia</i>      |               |           | X               |      |                         |      |
| <i>Cladonia chlorophaea</i>      |               |           | X               |      |                         |      |
| <i>Cladonia coniocraea</i>       |               |           | X               |      |                         |      |
| <i>Cladonia mateocyatha</i>      | X             |           |                 |      |                         |      |
| <i>Cladonia polycarpoides</i>    |               |           | X               |      |                         |      |
| <i>Cladonia ramulosa</i>         |               |           | X               |      |                         |      |
| <i>Cladonia</i> sp.              |               |           |                 | X    |                         | X    |
| <i>Flavoparmelia caperata</i>    |               |           |                 | X    |                         | X    |
| <i>Lecanora</i> sp.              | X             |           |                 |      |                         |      |
| <i>Lecanora strobilina</i>       |               |           |                 | X    |                         |      |
| <i>Leiomonis erratica</i>        |               |           | X               |      |                         |      |
| <i>Lepraria finkii</i>           |               |           |                 |      |                         | X    |
| <i>Lepraria</i> sp.              |               |           |                 | X    |                         | X    |
| <i>Myriolecis dispersa</i>       |               |           |                 |      | X                       | X    |
| <i>Parmotrema hypotropum</i>     |               |           |                 |      |                         | X    |
| <i>Phaeophyscia adiasstola</i>   |               |           |                 | X    |                         | X    |
| <i>Phaeophyscia pusilloides</i>  |               |           |                 | X    |                         | X    |
| <i>Phaeophyscia rubropulchra</i> |               |           |                 | X    |                         | X    |
| <i>Phaeophyscia insignis</i>     | X             |           |                 |      |                         |      |
| <i>Physcia millegrana</i>        |               |           |                 | X    |                         | X    |
| <i>Physcia stellaris</i>         |               |           |                 |      |                         | X    |
| <i>Porpidia albocaerulescens</i> |               |           |                 |      |                         | X    |
| <i>Punctelia caseana</i>         |               |           |                 | X    |                         | X    |
| <i>Punctelia rudecta</i>         |               |           |                 | X    |                         | X    |
| <i>Rinodina freyi</i>            | X             |           |                 |      |                         |      |
| <i>Sarcogne clavus</i>           |               |           |                 |      |                         | X    |
| <i>Squamulea subsoluta</i>       |               |           |                 | X    |                         |      |
| <i>Trapelia coarctata</i>        |               |           | X               |      |                         |      |
| <i>Trapelia placodioides</i>     |               |           |                 | X    |                         | X    |
| <i>Xanthoria parietina</i>       | X             |           |                 |      |                         |      |
| <i>Xanthocarpia feracissima</i>  |               | X         |                 |      |                         | X    |
| <i>Xanthoparmelia plittii</i>    |               |           |                 | X    |                         | X    |

in 2016 and 2017. Instead, I found only one species, *Xanthocarpia feracissima*, growing on cement (Table 1). The other two areas that were surveyed were Brooklyn Botanic Garden and Alley Pond Park, which were originally surveyed by Brodo (1968). Brodo (1968) reported a single species from Brooklyn Botanic Garden, while I found 21 species during my survey (Table 1). At Alley Pond Park, Brodo (1968) reported seven species while I found 15 (Table 1).

**Annotated Checklist.** The species are listed alphabetically. For each species either a voucher specimen is listed by collector and collector number, an article is cited that references the species, an observation is cited, or some combination of the three, always listed in that order.

Observations are indicated with the last name of the observer followed by “obs.” Observation site acronyms are as follows: Alley Pond Park (APP), Brooklyn Botanical Garden (BBG), Central Park (CP), Highline Park (HP), and The New York Botanical Garden (NYBG) unless otherwise fully written out. New York City distributions are given as the counties where the taxa have been observed.

*Acarospora fuscata* (Schrad.) Arnold

Description: Nash *et al.* 2007. Substrate: Rocks, especially sandstone monuments and cement mortar. North American Distribution: Cosmopolitan. NYC Distribution: Richmond, Brooklyn, and New York.

Notes: While this minute brown species can be easily overlooked, it is somewhat common on less disturbed rock surfaces and crevices.



Selected voucher and observations: *Amtoft 152, 209* (NY); Allen obs. CP, BBG.

*Amandinea* M.Choisy ex Scheid. & H.Mayrhofer

Description: Scheidegger 1993. Substrate: Variable. North American Distribution: Cosmopolitan. NYC Distribution: All counties.

Notes: This observation is most likely one of the three common species of this genus found in New York City, *Amandinea milliaria*, *A. polyspora*, or *A. punctata*, all three of which are likely underreported for the city.

Selected voucher and observations: Allen obs. APP, BBG.

*Amandinea milliaria* (Tuck.) P.May & Sheard

Description: Sheard and May 1997. Substrate: Most frequent on smooth bark. North American Distribution: Atlantic and Gulf coastal plain and Great Lakes. NYC Distribution: Richmond.

Selected voucher and observations: *Allen 4480, 4482* (NY).

*Amandinea polyspora* (Willey) E.Lay & P.May

Description: Sheard and May 1997. Substrate: Bark. North American Distribution: Eastern North America to Minnesota and Iowa. NYC Distribution: Bronx and Richmond.

Selected voucher and observations: *Allen 4486* (NY); *Amtoft 110, 117, 144* (NY); *Howe 378, 382, 436* (NY).

*Amandinea punctata* (Hoffm.) Coppins & Scheid.

Description: Sheard and May 1997. Substrate: Bark and rarely rock, only reported from bark and lignum in NYC. North American Distribution: Cosmopolitan. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 224, 299, 300* (NY); *Harris s.n.* (NY).

*Anisomeridium* sp. (Müll.Arg.) M.Choisy

Description: Nash *et al.* 2002. Substrate: Wood and rocks, only observed on rock in NYC. North American Distribution: Cosmopolitan. NYC Distribution: Richmond.

Selected voucher and observations: *Howe 376* (NY).

*Anisomeridium polypori* (Ellis & Everh.) M.E.Barr

Description: Harris 1973, Aptroot 1999. Substrate: Bark, polypores, and rock, but only reported from bark in NYC. North American Distribution: Cosmopolitan. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 239* (NY).

*Bacidia circumspecta* (Nyl. ex Vain.) Malmé

Description: Nash *et al.* 2004. Substrate: Bark, reported from old stump in NYC. North American Distribution: Cosmopolitan. NYC Distribution: Bronx.

Selected voucher and observations: *Buck s.n.* (NY).

*Bacidina* sp.

Description: Nash *et al.* 2004. Substrate: Various, reported from cement and stone in NYC. North American Distribution: Cosmopolitan. NYC Distribution: Bronx.

Selected voucher and observations: *Harris 13289, 13295* (NY).

*Bacidina egenula* (Nyl.) Vězda

Description: Nash *et al.* 2004. Substrate: Various rocks and anthropogenic materials. North American Distribution: Most commonly observed in eastern North American and Great Plains, with scattered reports from the Southwest. NYC Distribution: Bronx.

Selected voucher and observations: *Aptroot 50614* (NY).

*Buellia curtisii* (Tuck.) Imshaug

Description: Nash *et al.* 2007. Substrate: Bark. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 345* (NY).

*Candelaria concolor* (Dicks.) Stein

Description: Nash *et al.* 2002. Substrate: Bark or rock. North American Distribution: Widespread. NYC Distribution: All counties.

Notes: This species is a well-documented nitrophile and does very well in the city. Some of the largest populations of this species can be observed on the bases of trees throughout Central Park. However, no special trip is required for its observation as it occurs abundantly on street trees throughout the city.

Selected voucher and observations: *Allen 4411* (NY); *Amtoft 44, 49* (NY); Allen obs. APP, BBG, CP, NYBG.

*Candelariella aurella* (Hoffm.) Zahlbr.

Description: Nash *et al.* 2004. Substrate: Calcium rich rock, especially mortar and concrete.

North American Distribution: Widespread. NYC Distribution: Bronx, Kings, and Queens.

Selected voucher and observations: *Amtoft 226* (NY); Reported in Delendick 1994.

*Chromofulvea dialyta* (Nyl.) Marbach

Description: Marbach 2000. Substrate: Bark. North American Distribution: Mostly northeastern North America and Great Lakes with scattered occurrences reported from the West. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 183* (NY).

*Chrysothrix caesia* (Körb.) Ertz & Tehler

Description: Harris and Ladd 2005. Substrate: Branches and twigs. North American Distribution: Temperate eastern North America. NYC Distribution: Bronx, Kings, and Queens.

Selected voucher and observations: *Amtoft 31, 54, 60* (NY); reported in Delendick 1994.

*Cladonia* sp.

Description: Nash *et al.* 2002. Substrate: Soil, rock, moss, and bark, especially at the base of trees. North American Distribution: Cosmopolitan except in arid regions. NYC Distribution: All counties.

Notes: Sterile squamules of *Cladonia* not confidently identifiable to species are commonly found throughout the city. Only rarely are podetia produced.

Selected voucher and observations: Reported in Delendick 1994; Allen obs. APP, BBG, CP, NYBG.

*Cladonia apodocarpa* Robbins

Description: Brodo *et al.* 2001. Substrate: Soil and humus. North American Distribution: Mostly eastern North America. NYC Distribution: Kings.

Selected voucher and observations: Reported in Delendick 1994.

*Cladonia caespiticia* (Pers.) Flörke

Description: Hinds and Hinds 2007. Substrate: Soil, humus, and bases of trees. North American Distribution: Eastern North America and Great Plains. NYC Distribution: Queens.

Selected voucher and observations: Reported in Brodo 1968.

*Cladonia chlorophaea* (Flörke ex Sommerf.) Spreng. *s.lat.*

Description: Hinds and Hinds 2007. Substrate: Soil, humus, moss, rotting wood, and the bases of

trees. North American Distribution: Cosmopolitan. NYC Distribution: Kings and Queens.

Selected voucher and observations: Reported in Brodo 1968 and Delendick 1994.

*Cladonia coniocraea* (Flörke) Spreng.

Description: Hinds and Hinds 2007. Substrate: Rotting wood and the bases of trees. North American Distribution: Temperate and boreal areas. NYC Distribution: Queens.

Selected voucher and observations: Reported in Brodo 1968.

*Cladonia cristatella* Tuck.

Description: Hinds and Hinds 2007. Substrate: Soil, rotting wood, and the bases of trees. North American Distribution: Eastern North America. NYC Distribution: Bronx and Kings.

Selected voucher and observations: *Ahti 42002* (NY); *Harris 13554, s.n.* (NY); reported in Delendick 1994.

*Cladonia grayi* G.Merr. ex Sandst.

Description: Hinds and Hinds 2007. Substrate: Soil, humus, moss, rotting wood, and the bases of trees. North American Distribution: Mostly eastern temperate North America. NYC Distribution: Queens.

Selected voucher and observations: *Delendick s.n.* (NY).

*Cladonia macilenta* var. *bacillaris* (Genth) Schaer.

Description: Hinds and Hinds 2007. Substrate: Soil, rotting logs, and bases of trees. North American Distribution: Cosmopolitan. NYC Distribution: Bronx.

Selected voucher and observations: *Harris s.n.* (NY).

*Cladonia mateocyatha* Robbins

Description: Hinds and Hinds 2007. Substrate: Soil and thin soil over rocks. North American Distribution: Eastern North America. NYC Distribution: New York.

Notes: Originally reported from Highline Park but further surveys suggest it is likely now extirpated.

Selected voucher and observations: Reported in Stalter 2004.

*Cladonia petrophila* R.C.Harris

Description: Hinds and Hinds 2007. Substrate: Noncalcareous rock or thin soil over rock. North American Distribution: Eastern North America and Great Lakes. NYC Distribution: Bronx.

Selected voucher and observations: *Harris 13294* (NY).

*Cladonia pleurota* (Flörke) Schaer.

Description: Hinds and Hinds 2007. Substrate: Soil and thin soil over rocks. North American Distribution: Cosmopolitan. NYC Distribution: Bronx.

Selected voucher and observations: *Harris 13286* (NY); *Majestyk 2649* (DUKE); *Prince s.n.* (NY).

*Cladonia polycarpoides* Nyl.

Description: Hinds and Hinds 2007. Substrate: Soil and thin soil over rocks. North American Distribution: Eastern North America. NYC Distribution: Bronx and Queens.

Selected voucher and observations: *Harris s.n.* (NY); reported in Brodo 1968 and Delendick 1994.

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

Description: Hinds and Hinds 2007. Substrate: Rotting wood and soil. North American Distribution: Temperate and southern boreal regions. NYC Distribution: Queens.

Notes: Originally reported as *Cladonia pityrea* (Flörke) Fr. by Brodo (1968) and Delendick (1994), but the taxonomy of this species was corrected by Laundon (1984) to *C. ramulosa*.

Selected voucher and observations: Reported in Brodo 1968 and Delendick 1994.

*Cladonia strepsilis* (Ach.) Grognot

Description: Hinds and Hinds 2007. Substrate: Soil. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Harris 13293* (NY); *Majestyk 2647* (DUKE).

*Coenogonium pineti* (Ach.) Lücking & Lumbsch

Description: Smith *et al.* 2009. Substrate: Bark. North American Distribution: Widespread in temperate areas. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 51* (NY).

*Collema bachmanianum* (Fink) Degel.

Description: Hinds and Hinds 2007. Substrate: Calcareous soil. North American Distribution: Temperate and arctic regions. NYC Distribution: Bronx.

Notes: This is the only cyanolichen that has been reported from NYC since Wood (1914).

Selected voucher and observations: *Aptroot 50610* (NY).

*Dermatocarpon luridum* (With.) J.R.Laundon

Description: Hinds and Hinds 2007. Substrate: Rocks along streams and lakes, often right at the edge of the water line where it is sometimes submerged. North American Distribution: Temperate to arctic regions. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 280* (NY).

*Diploschistes muscorum* (Scop.) R.Sant.

Description: Nash *et al.* 2002. Substrate: Soil, moss, or parasitic on other lichens when young. North American Distribution: Cosmopolitan. NYC Distribution: Bronx.

Selected voucher and observations: *Aptroot 50606* (NY).

*Endocarpon pallidulum* (Nyl.) Nyl.

Description: Nash *et al.* 2002. Substrate: Limestone, reported from cement and bark in NYC. North American Distribution: Eastern and southwestern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 180, 287, 310* (NY); *Aptroot 50622* (NY).

*Flavoparmelia baltimorensis* (Gyeln. & Főriss)

Hale

Description: Hinds and Hinds 2007, Fig. 2B. Substrate: Rock. North American Distribution: Eastern and southwestern North America. NYC Distribution: Bronx and New York.

Selected voucher and observations: *Amtoft 69* (NY); Allen obs. CP.

*Flavoparmelia caperata* (L.) Hale

Description: Hinds and Hinds 2007. Substrate: Usually on bark, but occasionally on rocks. North American Distribution: Temperate regions. NYC Distribution: All counties.

Notes: This is one of the most abundant species in NYC and is easily observable on street trees and in parks.

Selected voucher and observations: *Allen 4484* (NY); *Amtoft 208, 252* (NY); *Harris s.n.* (NY); *Majestyk 2643* (DUKE); Allen obs. APP, BBG, CP, NYBG.

*Flavopunctelia soledica* (Nyl.) Hale

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Widespread. NYC Distribution: Bronx and New York.

Selected voucher and observations: *Aptroot 50612* (NY); Allen obs. CP.



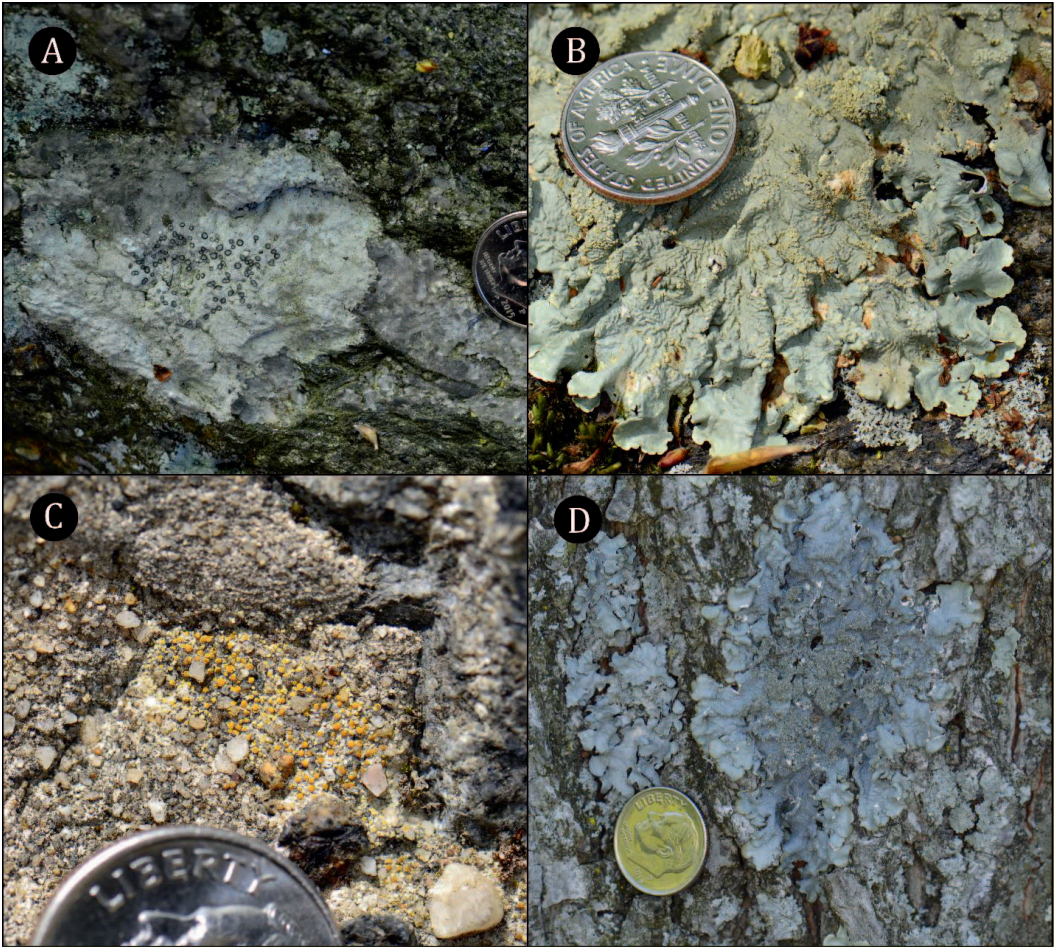


FIG. 2. Selected species observed at The New York Botanical Garden. (A) *Porpidia albocaerulscens*. (B) *Flavoparmelia baltimorensis*. (C) *Xanthocarpia feracissima*. (D) *Punctelia rudecta*.

*Hyperphyscia adglutinata* (Flörke) H. Mayrhofer & Poelt

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Widespread from eastern to southwestern North America. NYC Distribution: Kings.

Selected voucher and observations: *Clarke s.n.* (NY).

*Hypotrachyna livida* (Taylor) Hale

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Eastern North America and Mexico. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 326* (NY).

*Lecania croatica* (Zahlbr.) Kotlov

Description: Harris and Lendemer 2010. Substrate: Bark. North American Distribution: Eastern North America, Great Lakes, and Ozarks. NYC Distribution: Bronx.

Selected voucher and observations: *Aptroot 50627* (NY).

*Lecanora* sp.

Description: Brodo *et al.* 2001. Substrate: Various. North American Distribution: Cosmopolitan. NYC Distribution: All counties.

Notes: Species of *Lecanora* are common and widespread in the city. Many species are not identifiable beyond the genus without microscopy.

Selected voucher and observations: Reported in Stalter 2004.

*Lecanora caesiorubella* Ach.

Description: Nash *et al.* 2004. Substrate: Bark. North American Distribution: Widespread. NYC Distribution: Kings.

Selected voucher and observations: Reported in Delendick 1994.

*Lecanora strobilina* (Spreng.) Kief.

Description: Nash *et al.* 2004. Substrate: Mostly on pine cone scales and twigs, occasionally on bark. North American Distribution: Eastern and southwestern North America. NYC Distribution: New York, Queens, and Richmond.

Selected voucher and observations: *Allen 4491* (NY); *Howe 383, 384* (NY); Allen obs. APP, CP.

*Lecanora thysanophora* R.C.Harris

Description: Harris *et al.* 2000. Substrate: Bark. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Selected vouchers and observations: *Majestyk 2650* (DUKE).

*Lecidea cyrtidia* Tuck.

Description: Harris 1997. Substrate: Non-calcareous rocks. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Aptroot 50629* (NY).

*Lecidea plebeja* Nyl.

Description: Thomson 1984. Substrate: Wood. North American Distribution: Eastern North America, Great Lakes, and arctic. NYC Distribution: Bronx.

Selected voucher and observations: *Harris s.n.* (NY).

*Leimonis erratica* (Körb.) R.C. Harris & Lendemer

Description: Harris 2009. Substrate: Non-calcareous rock. North American Distribution: Almost exclusively eastern North America with scattered occurrences in other parts of the country. NYC Distribution: Bronx and Richmond.

Selected voucher and observations: *Allen 4416* (NY); *Aptroot 50615, 50619* (NY); *Buck s.n.* (NY); *Howe 383, 384* (NY); Reported in Brodo 1968.

*Lepraria* sp.

Description: Lendemer 2013. Substrate: Various. North American Distribution: Widespread. NYC Distribution: All counties.

Notes: This genus is common and widespread in the city and can usually be found on sheltered boulders and the bases of trees. Confident identification to species usually requires chemical tests.

Selected voucher and observations: Allen obs. APP, BBG, CP, NYBG.

*Lepraria caesiella* R.C.Harris

Description: Lendemer 2013. Substrate: Most commonly on bark, but also on non-calcareous rock. North American Distribution: Eastern North America, Great Lakes, and Ozarks. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 342, 343* (NY); *Harris 13284* (NY).

*Lepraria cryophila* Lendemer

Description: Lendemer 2013. Substrate: Non-calcareous rock. North American Distribution: Eastern North America, especially Appalachia. NYC Distribution: Bronx.

Selected voucher and observations: *Harris 13284* (NY).

*Lepraria finkii* (B.de Lesd.) R.C.Harris

Description: Lendemer 2013. Substrate: Various. North American Distribution: Widespread. NYC Distribution: All counties.

Notes: This species is highly tolerant of the conditions in New York City. Lendemer (2013) even noted that it is found in every borough.

Selected voucher and observations: *Amtoft 294, 309, 322* (NY); *Scott s.n.* (NY); *Dicker s.n.* (NY); Allen obs. BBG, CP.

*Lepraria hodkinsoniana* Lendemer

Description: Lendemer 2013. Substrate: Bark. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 320* (NY).

*Lepraria neglecta* (Nyl.) Erichsen

Description: Lendemer 2013. Substrate: Various. North American Distribution: Widespread. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 99, 103, 135* (NY); *Aptroot 50620* (NY).

*Micarea micrococca* (Körb.) Gams ex Coppins

Description: Barton and Lendemer 2014. Substrate: Bark and lignum. North American Distribution: Northeast and Southwest North America. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 339* (NY).

*Micarea peliocarpa* (Anzi) Coppins & R.Sant.

Description: Harris and Ladd 2005. Substrate: Moss over rock, siliceous rock, and occasionally lignum. North American Distribution: Eastern North America, Great Lakes, and Ozarks. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 137* (NY); *Aptroot 50611, 50617* (NY).

*Micarea prasina* Fr.

Description: Barton and Lendemer 2014. Substrate: Decaying hardwoods and live conifers. North American Distribution: Eastern North America, Great Lakes, Ozarks, and scattered records from western North America. NYC Distribution: Bronx and New York.

Selected voucher and observations: *Amtoft 207* (NY); Allen obs. CP.

*Myelochroa aurulenta* (Tuck.) Elix & Hale

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Eastern and southwestern North America. NYC Distribution: New York and Queens.

Selected voucher and observations: Allen obs. APP, CP.

*Myriolecis dispersa* (Pers.) Śliwa, X.Zhao & Lumbsch

Description: Nash *et al.* 2004. Substrate: Rocks, mostly calcareous and siliceous, cement, and many other anthropogenic substrates. North American Distribution: Cosmopolitan. NYC Distribution: All counties.

Notes: This species is common and abundant throughout the city on mortar and cement. It has likely been overlooked in some areas because of its minute size.

Selected voucher and observations: *Allen 4415* (NY); reported in Brodo 1968, Delendick 1994; Allen obs. BBG, CP.

*Parmelia sulcata* Taylor

Description: Hinds and Hinds 2007. Substrate: Bark and wood. North American Distribution:

Widespread throughout. NYC Distribution: Bronx, Kings, New York, and Queens.

Selected voucher and observations: *Buck s.n.* (NY); *Delendick s.n.* (NY); Allen obs. CP.

*Parmotrema hypotropum* (Nyl.) Hale

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Eastern and southwestern USA and Mexico. NYC Distribution: Bronx, Kings, and New York.

Selected voucher and observations: *Harris s.n.* (NY); Allen obs. BBG, CP, NYBG

*Phaeocalicium polyporaeum* (Nyl.) Tibell

Description: Nash *et al.* 2004. Substrate: Upper surface of *Trichaptum bififormis* and very rarely *Trametes versicolor*. North American Distribution: Almost exclusively eastern North America, Great Lakes, and Ozarks. NYC Distribution: Bronx and Richmond.

Notes: This species is likely underreported for the city due to its small size and unique microhabitat. However, *P. polyporaeum* is also unlikely to be common because dead wood that hosts the shelf fungi that this lichen grows on is sparse in the usually highly manicured urban environment.

Selected voucher and observations: *Allen 4485* (NY); *Buck s.n.* (NY); *Howe 384* (NY).

*Phaeophyscia adiastrata* (Essl.) Essl.

Description: Hinds and Hinds 2007. Substrate: Bark and rock. North American Distribution: Eastern North America. NYC Distribution: Bronx, Kings, New York, and Queens.

Selected voucher and observations: *Amtoft 48, 155, 179, 268, 279* (NY); *Aptroot 50626* (NY); Allen obs. APP, BBG, CP.

*Phaeophyscia insignis* (Mereschk.) Moberg

Description: Hinds and Hinds 2007. Substrate: Bark and rocks. North American Distribution: Primarily midwestern, Ozark, and Appalachian. NYC Distribution: New York.

Notes: During recent surveys I was unable to relocate this species.

Selected voucher and observations: Reported in Stalter 2004.

*Phaeophyscia orbicularis* (Neck.) Moberg

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Widespread. NYC Distribution: Kings and Queens.



Selected voucher and observations: Reported in Delendick 1994.

*Phaeophyscia pusilloides* (Zahlbr.) Essl.

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Almost exclusively eastern North America. NYC Distribution: Kings, New York, Queens, and Richmond.

Selected voucher and observations: *Allen 4412* (NY); Allen obs. APP, BBG, CP.

*Phaeophyscia rubropulchra* (Degel.) Essl.

Description: Hinds and Hinds 2007. Substrate: Bark and occasionally rock. North American Distribution: Eastern North America. NYC Distribution: Bronx, Kings, New York, and Queens.

Selected voucher and observations: *Amtoft 6, 15, 267* (NY); *Harris s.n.* (NY); Allen obs. APP, BBG, CP.

*Physcia adscendens* H.Olivier

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Widespread except southeastern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 74* (NY).

*Physcia millegrana* Degel.

Description: Hinds and Hinds 2007. Substrate: Bark and less frequently rocks. North American Distribution: Eastern North America and central California. NYC Distribution: All counties.

Notes: This species is one of the most common and abundant lichens in the city. It is easily observable on street trees and in parks on trees and surrounding rocks.

Selected voucher and observations: *Allen 4410, 4489* (NY); *Amtoft 16, 21, 82* (NY); *Delendick s.n.* (NY); *Harris 13555* (NY); *Howe 438* (NY); *Majestyk 2645* (DUKE); Allen obs. APP, BBG, CP, NYBG.

*Physcia stellaris* (L.) Nyl.

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Widespread. NYC Distribution: Bronx, Kings, New York, and Queens.

Notes: This species was once described to me as "the killer lichen" by a gardener in New York City. However, there is no evidence that this species harms the plants that it grows on.

Selected voucher and observations: *Allen 4679* (NY); *Amtoft 71, 93, 356* (NY); *Aptroot 50602*

(NY); *Buck s.n.* (NY); reported in Delendick 1994; Allen obs. BBG, CP.

*Physcia thomsoniana* Essl.

Description: Esslinger 2017. Substrate: Non-calcareous rock and occasionally bark. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 352* (NY); *Aptroot 50608* (NY).

*Physciella chloantha* (Ach.) Essl.

Description: Hinds and Hinds 2007. Substrate: Bark and wood, occasionally on rocks under trees. North American Distribution: Widespread in temperate areas. NYC Distribution: Bronx, New York, and Richmond.

Selected voucher and observations: *Allen 4488* (NY); *Amtoft 124, 211* (NY); Allen obs. CP.

*Placynthiella icmalea* (Ach.) Coppins & P.James

Description: Nash *et al.* 2004. Substrate: Various forms of dead, rotting wood, debris, humus, and rocks. North American Distribution: Widespread. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 27* (NY); *Harris s.n.* (NY).

*Placynthiella uliginosa* (Schrad.) Coppins & P.James

Description: Nash *et al.* 2004. Substrate: Soil and dead bark and wood. North American Distribution: Widespread. NYC Distribution: Bronx.

Selected voucher and observations: *Buck 35565* (NY).

*Porpidia albocaerulescens* (Wulfen) Hertel & Knoph

Description: Harris and Ladd 2005, Fig. 2A. Substrate: Rocks. North American Distribution: Eastern North America. NYC Distribution: Bronx and Kings.

Selected voucher and observations: Allen obs. BBG, NYBG.

*Porpidia subsimplex* (H.Magn.) Fryday

Description: Harris and Ladd 2005 (as *P. tahawasiana*). Substrate: rock. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Harris 13282, 13287, s.n.* (NY).

*Punctelia caseana* Lendemer & Hodkinson

Description: Lendemer and Hodkinson 2010. Substrate: Bark. North American Distribution: Mostly eastern North America with a few records from the Southwest. NYC Distribution: All counties.

Selected voucher and observations: *Allen 4681* (NY); *Amtoft 167* (NY); Allen obs. APP, BBG, CP.

*Punctelia rudecta* (Ach.) Krog

Description: Hinds and Hinds 2007, Fig. 2D. Substrate: Bark. North American Distribution: Common in eastern North America and occurs in the Great Plains and Southwest. NYC Distribution: All counties.

Selected voucher and observations: *Allen 4683* (NY); *Amtoft 323* (NY); Allen obs. APP, BBG, CP.

*Pyrrhospora varians* (Ach.) R.C.Harris

Description: Harris and Ladd 2005. Substrate: Twigs and branches. North American Distribution: Widespread in eastern North America. NYC Distribution: Bronx and Richmond.

Selected voucher and observations: *Allen 4483* (NY); *Aptroot 50607* (NY); *Howe 379* (NY).

*Pyxine subcinerea* Stirt.

Description: Amtoft 2002. Substrate: Bark. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Notes: Amtoft (2002) suggested that this species may have been introduced to New York on horticultural material, and that monitoring should be conducted to determine the continued status of the species. There have been no further reports of the species, so it either continues to be rare, or if Amtoft's original hypothesis is correct, it could have subsequently died after being brought in on horticultural plants.

Selected voucher and observations: *Amtoft 15, 174, 210* (NY).

*Rinodina cana* (Arnold) Arnold

Description: Sheard 2010. Substrate: Rocks, including granite and sandstone. North American Distribution: Eastern North America to the eastern edge of the prairies. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 349* (NY).

*Rinodina freyi* H.Magn.

Description: Sheard 2010. Substrate: bark of deciduous trees. North American Distribution: Widespread. NYC Distribution: New York.

Notes: Searches at the Highline Park did not result in relocation of this species. Presumed extirpated.

Selected voucher and observations: Reported in Stalter 2004.

*Sarcogyne clavus* (DC.) Kremp.

Description: Nash *et al.* 2007. Substrate: Rocks. North American Distribution: Widespread. NYC Distribution: Bronx, Kings, and New York.

Notes: This species is relatively easy to observe on granite rock outcrops in Central Park.

Selected voucher and observations: *Harris 132823* (NY); Allen obs. BBG, CP.

*Scoliosporum umbrinum* (Ach.) Arnold

Description: Nash *et al.* 2004. Substrate: Rock. North American Distribution: Eastern and southwestern North America, Great Lakes, Ozarks, and Plains. NYC Distribution: Bronx.

Selected voucher and observations: *Aptroot 50618* (NY).

*Segestria lectissima* Fr.

Description: Harris and Ladd 2005. Substrate: Rock. North American Distribution: Eastern North America and on record from coastal California. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 138* (NY).

*Squamulea subsoluta* (Nyl.) Frödén, Arup & Søchting

Description: Nash *et al.* 2007. Substrate: Non-calcareous rock. North American Distribution: Cosmopolitan. NYC Distribution: Queens and Richmond.

Selected voucher and observations: *Allen 4413* (NY); Allen obs. APP.

*Strigula jamesii* (Swinscow) R.C.Harris

Description: Harris and Ladd 2005. Substrate: Bark. North American Distribution: Eastern North America and Ozarks. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft 1* (NY).

*Thelocarpon laureri* (Flot.) Nyl.

Description: Harris and Ladd 2005. Substrate: Conifer lignum and occasionally rocks. North American Distribution: Eastern North America, Great Lakes, and Ozarks. NYC Distribution: Bronx.



Selected voucher and observations: *Amtoft* 172, 182, 286, 327 (NY).

*Trapelia coarctata* (Turner) M.Choisy

Description: Nash *et al.* 2004. Substrate: Siliceous rocks. North American Distribution: Eastern and western North America. NYC Distribution: Bronx.

Selected voucher and observations: *Aptroot* 50627 (NY).

*Trapelia glebulosa* (Sm.) J.R.Laundon

Description: Harris and Ladd 2005. Substrate: Pebbles and rock fragments. North American Distribution: Eastern North America, Great Lakes, Ozarks, and west coast. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft* 2, 4, 133 (NY); *Aptroot* 50616 (NY); *Buck s.n.* (NY).

*Trapelia obtegens* (Th.Fr.) Hertel

Description: Smith *et al.* 2009. Substrate: On siliceous rocks. North American Distribution: Northeastern North America, Great Lakes, and California. NYC Distribution: Bronx.

Selected voucher and observations: *Aptroot* 50604 (NY).

*Trapelia placodioides* Coppins & P.James

Description: Harris and Ladd 2005. Substrate: Siliceous rocks. North American Distribution: Eastern North America, Great Lakes, Ozarks, and scattered records from western North America. NYC Distribution: Bronx, Kings, New York, and Queens.

Selected voucher and observations: *Amtoft* 13, 43, 199 (NY); Allen obs. APP, BBG, CP.

*Trapeliopsis flexuosa* (Fr.) Coppins & P.James

Description: Harris and Ladd 2005. Substrate: Lignum. North American Distribution: Widespread. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft* 128, 196, 261 (NY); *Harris* 13285, 13297 (NY).

*Verrucaria* sp.

Description: Harris and Ladd 2005. Substrate: Mostly on rocks. North American Distribution: Widespread. NYC Distribution: Bronx and Richmond.

Selected voucher and observations: *Amtoft* 248, 290 (NY).

*Verrucaria calkinsiana* Servit

Description: Nash *et al.* 2007. Substrate: Rock. North American Distribution: Mostly eastern

North America and Great Lakes. NYC Distribution: Bronx.

Selected voucher and observations: *Harris* 13292 (NY).

*Verrucaria* cf. *elaeina* Borrer

Description: Orange 2000. Substrate: Various rocks, including bricks. North American Distribution: Southwestern North America. NYC Distribution: Richmond.

Notes: This record is from one poorly developed specimen on brick. Richard Harris determined that the most similar, described species to this specimen is *V. elaeina*, but the determination remains preliminary.

Selected voucher and observations: *Allen* 4481 (NY).

*Willeya diffractella* (Tuck.) Müll.Arg.

Description: Thomson 1991. Substrate: Calcareous rocks. North American Distribution: Eastern North America. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft* 340 (NY); *Aptroot* 50634 (NY).

*Xanthocarpia crenulatella* (Nyl.) Frödén, Arup & Söchting

Description: Nash *et al.* 2007. Substrate: Calcareous rocks, mortar, and cement. North American Distribution: Cosmopolitan in temperate areas. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft* 61, 129, 204 (NY).

*Xanthocarpia feracissima* (H.Magn.) Frödén, Arup & Söchting

Description: Magnusson 1953, Fig. 2C. Substrate: Rock, especially cement. North American Distribution: Widespread. NYC Distribution: All counties.

Notes: This one of the most abundant species growing in NYC, which is unsurprising given its primary substrate is cement and it is easily observable on many sidewalks.

Selected voucher and observations: *Allen* 4414 (NY); *Aptroot* 50621 (NY); *Harris s.n.*

(NY); reported in Delendick 1994; Allen obs. BBG, CP, HP.

*Xanthomendoza fallax* Arnold

Description: Hinds and Hinds 2007. Substrate: Bark. North American Distribution: Widespread, especially abundant in western North America. NYC Distribution: Queens.

Selected voucher and observations: Reported in Delendick 1994.

*Xanthoparmelia conspersa* (Ach.) Hale

Description: Hinds and Hinds 2007. Substrate: Rock. North American Distribution: Widespread. NYC Distribution: Bronx.

Selected voucher and observations: *Amtoft* 274, 275, 334 (NY).

*Xanthoparmelia cumberlandia* (Gyeln.) Hale

Description: Hinds and Hinds 2007. Substrate: Rock. North American Distribution: Widespread. NYC Distribution: Bronx.

Selected voucher and observations: *Aptroot* 50636 (NY).

*Xanthoparmelia plittii* (Gyeln.) Hale

Description: Hinds and Hinds 2007. Substrate: Rock. North American Distribution: Widespread. NYC Distribution: Bronx, Kings, New York, and Queens.

Selected voucher and observations: *Amtoft* 219 (NY); *Majestyk* 2646 (DUKE); Allen obs. APP, BBG, CP.

*Xanthoria parietina* (L.) Th.Fr.

Description: Hinds and Hinds 2007. Substrate: Bark and rocks. North American Distribution: Mostly found in oceanic and maritime climates, but also occurring in scattered records in other parts of temperate North America. NYC Distribution: Kings and New York.

Selected voucher and observations: Reported in Stalter 2004; Howe obs. Brooklyn Bridge Park 2016.

**Conclusion.** The checklist compiled here of 103 taxa reported from New York City since 1968 is the first attempt at a comprehensive checklist for New York City lichens in over 100 years (Wood 1914). The number of species is surprisingly high, given the well-established sensitivity of lichens to air pollution and the very low number of species reported from Kings and Queens counties in the 1960s (Brodo 1968). There is the possibility that some of the species reported here were brought in on horticultural material and later died, and thus do not have established populations (Amtoft 2002). This is especially possible for species found on the grounds at The New York Botanical Garden where there is a great deal of horticultural activity. Despite this potential caveat for some species, it is clear that the lichen diversity and abundance has

increased since the 1960s. Two of the strongest evidences of the increase in lichens in New York City are the direct comparisons of surveys as Brooklyn Botanic Garden and Alley Pond Park, which show a clear increase (20 and 8 species increase, respectively; Brodo 1968), and the current abundance of *Flavoparmelia caperata* throughout the city, when it could not survive in the city limits in the recent past (Brodo 1961). Continued studies of the lichen diversity in New York City are needed to determine if other species occur there, whether or not all species here have established self-sustaining populations, and to document how the lichen communities change as air quality and climate continue to change.

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