Contributions to the knowledge of the Lepidoptera species diversity in an urban park setting of Bucharest, Romania, with considerations on the species dynamics in the city over the last century

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Summary: We present the results of a multi-year study (1970, 1974-1982) of the Lepidoptera fauna of a Bucharest urban park and its adjacent areas. We used various sampling methods including ultraviolet light attraction, diurnal netting of specimens, daytime inspection of city lights and rearing of immature stages. We recorded 320 specimens, representing 170 species, distributed in 13 superfamilies. The Noctuoidea had the highest representation with 42% of the species, followed by the Pyraloidea and Geometroidea with 15% and 11%, respectively. The majority of the encountered species were generalist feeders on multiple genera of grasses, herbs and trees. We compared and corroborated our findings with those of Székely (2015). This suggests an almost 50% reduction in the species richness within Bucharest over the past 100 years.

Sumar: Prezentăm rezultatele unui studiu multi anual (1970, 1974-1982) al faunei lepidopterologice dintr-un parc urban din Bucureşti şi din vecinătatea acestuia. Colectarea materialului a fost efectuat prin metode variate: atracţie la lumina ultravioletă, captarea cu fileul entomologic, inspecţia diurnă a surselor citadine de lumină, creşterea adulţilor din stadiile imature. În acest fel am inregistrat 320 de specimene reprezentând 170 de specii, distribuite în 13 suprafamilii. Suprafamilia Noctuoidea a fost cel mai bine reprezentată, cu 42% din speciile întâlnite, urmată Pyraloidea şi Geometroidea cu respectiv 15% si 11% din specii. Majoritatea speciilor întâlnite au fost ierbovore generaliste în multiple genuri de arbori, plante ierbacee şi ierburi. În final, am comparat si coroborat rezultatele acestui studiu cu cele ale lui Székely (2015). Aceasta coroborare sugerează o reducere cu aproape 50% a biodivesităţii lepidopterlogice a oraşului în ultimii 100 de ani.

Key words: city ecology, lepidoptera of Romania, urban biodiversity, urban insects.

Introduction

During the last 100 years, increased worldwide urbanization has resulted in a sharp decline of wildlife habitats. A recent study by McKinney from 2002 documented this continuous rise in human agglomeration. Numerous animal groups that once thrived in undisturbed wildlife areas have been forced to adapt to anthropogenic structures and conditions such as high rise buildings, paved surfaces, busy traffic, artificial lighting, and increased levels of air, noise and light pollution. As a result, remnants of the primordial ecosystems such as urban parks and verdant areas with local flora within urban lots have become important for the survival of organisms and maintenance of urban species diversity. While some synanthropic city dwellers like bats, birds and other insectivores are viewed favorably and tolerated, even protected in some areas (Tóth-Ronkay 2015), others (rats, mice, pigeons) are viewed as pests and human disease risks and have been the targets of eradication measures [e.g. "The program of general insect and rodent control in the municipality of Piatra Neamţ" (Romania) 2014, www.pigeoncontrolresourcecenter, 2009)].

Among city-dwelling arthropods, Lepidoptera also have a dualist acceptance status. On one hand, colorful, day flying butterflies are admired as symbols of beauty and frailty and consequently, enjoy a degree of human protection. Moths, being more cryptic in their coloration and behavior, are largely unnoticed and remain less impacted by the general public. On the other hand, Lepidopteran larvae cause a sense of aversion in many humans, are often lumped into a generic "pest" category and destroyed, when found. Occasionally, some moth species experience a surge in population, causing extensive agricultural and forestry damage, triggering eradication measures, like the Gypsy moth or Codling moth control actions.

Moth species richness, along with that of other invertebrates, peaks in small urban centers due to increased habitat niches created by moderate habitat fragmentation (McKinney 2008). The introduction of exotic floral species by humans adds more new niches and attracts more exotic species. An example is the sporadic encounter of larvae of *Daphnis nerii* (Linnaeus, 1758) in Romania. Pre-imaginal stages of this hawkmoth species, native to the Mediterranean region, have been found on its food source, leaves

of *Nerium oleander* L. and reared to the imaginal stage in various Romanian cities (P.-Gorj 1964; Brătășanu 1978 personal communications). The *oleander* is a commonly encountered potted exotic plant in Romania that is being kept outdoors in the summer and indoors in the winter.

The niche-creating advantage is gradually lost with the increasing size and density of urban sprawl. This comes with further fragmentation and critical diminution of botanical habitats leading to the eventual elimination of certain host plants and implicitly of the moth specialists depending on them as food sources (Shuey *et al.* 2012).

It has been shown that there is a strong correlation between a moth's body size and its feeding habits (Neiminen *et al.* 1999; Hambäck *et al.* 2007). The guild of specialist feeders tends to be smaller in size while that of generalist feeders tends to be larger. Body size has also been shown to impact the dispersal rate of moth species (Neiminen *et al.* 1999). Larger-bodied moths have stronger flying capabilities and an increased ability to find an adequate habitat in the context of increasing woodland lot fragmentation. Corridors of vegetation along streets and between construction sites may help this dispersal especially if associated with native trees, shrubs and flowers. However, some native plants are considered "weeds" by city planners and ignored in the urban landscape in favor of exotic, showier plant species. The widespread practice of urban landscaping with turf-grass lawns and non-native ornamental bushes, trees and flowers, along with the maintenance efforts they require, has the net effect of excluding native plant communities from the area and reducing or annihilating wildlife habitats (Hostetler *et al.* 2010). This process of native plant community fragmentation without communication corridors may lead to the situation where a specialist herbivore species would survive in a certain urban park, but may die out in other urban areas.

Bucharest is a sprawling urban center situated in the southern plain of Romania, north of the Danube River. It covers an area of 228 km^2 and has a population density of 7,360 people per km^2. It has a wet temperate continental climate with warm summers and moderately cold winters. The mean temperature is 23°C in summer and -3°C in winter. This plain was once covered by extensive woods, the Vlăsia Forest. Over the centuries, this forest was cut for agriculture and city building purposes. Several fragments of it remain in and around Bucharest as the Băneasa, Andronache, Pasărea, and Ștefănești forests along with several parks within the perimeter of the city.

One of these fragments, Petrașcu Park, is situated on Basarabia Boulevard. It is a small area on the south side of the boulevard surrounded by many apartment buildings. Across the boulevard is the Parcul Național with the National Arena, another semi-natural area with a lake and more wooded lots. The entire area is highly developed, but there are sizable wooded spaces in the two parks, around the buildings, along the boulevard and the side streets. In the latter half of the last century, the grounds of these areas were not mowed which allowed grass and herb species to complete their natural, year-round cycles. Recently, Petrașcu Park has undergone further reduction as a result of the addition of several recreational areas and of an extensive network of paved alleys. The trees which grew there included oaks (*Quercus* spp.), maples (*Acer* spp.), chestnuts (*Aesculus* spp.), linden (*Tilia* spp.), elms (*Ulmus* spp.), poplars (*Populus* spp.), willows (*Salix* spp.) and ashes (*Fraxinus* spp.). Several species of shrubs such as lilacs (*Syringa* spp.), elderberries (*Sambucus* spp.), wild cherries (*Prunus* spp.) and forsythias (*Forsythia* spp.) were also present. Flowering plants included chicories (*Cichorium* spp.), nettles (*Urtica* spp.), wild carrots (*Daucus* spp.), thistles (*Cirsium* spp.), fleabane (*Erigeron* spp.) and other members of the Asteraceae as well as Malvaceae and Geraniaceae families. Additionally, there were many plots of ornamental flowers around the buildings with roses, petunias, dahlias, peonies, geraniums etc.

Materials and methods

From 1978 to 1982, a 160 W ultraviolet (UV) tanning reflector lamp was used to attract moths during sampling sessions. Sampling was conducted within a second floor apartment, on a table facing the park, behind open windows to allow free access to the attracted insects. Attracted moths came to rest on a white sheet that was hung behind the lamp. The sheet and the room walls were continuously inspected for resting specimens. Because the interest of this study was primarily to record the species diversity from the area, sampling was not performed to estimate the population sizes of the different species. Rather, only specimens needed for the checklist were retained, resulting in the collection of a small number of the individuals of a given species. Turning the light off before dawn ensured that the majority of the attracted moths not retained for the study would fly away through the open window around sunrise. The individuals which were retained were placed in jars containing ammonium carbonate powder until they became obtunded. Large specimens were subsequently injected with liquid ammonia between the thorax and the abdomen using a 27 gauge hypodermic needle for quick dispatch. Smaller specimens were kept in a refrigerator freezer for several hours. Sampling was performed at irregular intervals depending on the outside temperature, weather conditions, and availability of the UV lamp.

UV light-aided sampling occurred from 1978 to 1982, during the months of April through October. During this period, as well as in other years (1970 and 1974 through 1977), the first author also searched for

moths during the day. Specimens resting on walls under building lights were collected in the same city area, but not necessarily in the park. Occasionally, butterflies and moths were collected during the day on flowers and on plant leaves. Rarely, eggs, larvae and pupae were collected and reared to adulthood.

A yearly species/session coefficient was established by dividing the number of species sampled during a year by the number of collecting events during that year. This allowed for a comparison of the efficiency of the collecting process during the study years.

We followed Rice and White (2015), with some modifications, in defining the feeding niches associated with the various species:

1. tree specialists feeding on one or two genera within the same family;

2. tree generalists feeding on three or more genera within the same family or on two or more families;

3. grass and herb specialists feeding on one or two genera within the same family of grasses or herbs;

4. grass and herb generalists feeding on three or more genera of the same family or on two or more families;

5. broad generalists feeding on multiple genera of grasses, herbs and trees;

6. other specialists feeding on household animal and plant products (keratin and cereals) as well as on dead leaves, beeswax, lichens and mosses, or with carnivorous feeding habits.

Feeding habits were established according to various comprehensive works on European Lepidoptera: Die Palpenmotten (Lepidoptera, Gelechiidae) Mitteleuropas (Elsner *et al.* 1999), Noctuidae Europeae vols 1-12 (Fibiger ed. 1990-2010), Die Bombyces und Sphinges der Westpalaearktis (de Freina and Witt 1987), The Geometrid Moths of Europe vols 1-5 (Hausmann ed. 2001-2015), Wir bestimmen Schmetterlinge vol 1 (Koch 1966) and vol 4 Koch 1976), A Guide to the Microlepidoptera of Europe (Parenti 2000), Die Noctuiden Rumäniens (Rákosy 1996), Die Torticiden (Lepidoptera, Tortricidae) Mitteleuropas (Razowski 2001), Die Zünslerfalter (Pyraloidea) Mitteleuropas (Slamka 1995). We followed the taxonomic numbering from "The Lepidoptera of Europe—A Distributional Checklist" (Karsholt and Razowski 1996) but adopted the changes made to the classification of the Noctuoidea superfamily by Lafontaine and Fibiger in 2006. We checked the regional distribution of the recorded species in the "Catalogue of the Lepidoptera of Romania" (Rákosy *et al.* 2003).

Results

One hundred twenty-nine sampling sessions were conducted over 10 years (1970 and 1974-1982). During this time, 170 species of Lepidoptera were recorded from 320 voucher specimens, distributed in 13 superfamilies (Table 1). Seventy-two species (42%) belonged to Noctuoidea, followed by Pyraloidea and Geometroidea with 26 (15%) and 18 (11%) species, respectively. The remaining 54 species (32%) represented the other 10 superfamilies (Table 1).

Table 1. Superfamily distribution of the Lepidoptera from Petraşcu park, Bucharest.

Superfamily	Number of species	Percentage
NOCTUOIDEA	72	42
PYRALOIDEA	26	15
GEOMETROIDEA	18	11
TORTRICOIDEA	13	8
PAPILIONOIDEA	13	8
GELECHIOIDEA	10	6
YPONOMEUTOIDEA	5	3
BOMBYCOIDEA	4	2
TINEOIDEA	3	1
PTEROPHOROIDEA	2	1
LASIOCAMPOIDEA	2	1
COSSOIDEA	1	1
HEPIALOIDEA	1	1

Table 2 shows the number of species and specimens arranged by the sampling years. According to the species/session ratio, the most productive years were 1981 and 1982, with respective coefficients of 2.8 and 2.2. Table 3 illustrates the number of species and specimens segregated by monthly encounters. The greatest species richness occurred during the May-September interval.

There was no light source used during the period of 1970-1977 and only 14 species were recorded (Table 2). Individuals were sampled only during the day from plant material and when they were found resting on walls. Once a light was introduced in 1978, the number of recorded species increased and each year brought in new species that were not previously encountered (Table 4). The peak year was 1981, with 74 new species (43% of the sampled material).

We identified 113 species of generalist and 35 species of specialist feeders (Table 5). In the generalist guild, we identified 32 herbivore species feeding on different genera of trees, 65 species on different genera of grasses and herbs, and a group of 16 species of broad feeders on trees, grasses, and herbs. The specialist herbivores were equally divided between tree feeders and grasses and herbs feeders, with 17 and 18 species, respectively. A further group of 20 species was comprised of moths feeding on household products derived from processed vegetable and animal material (e.g. flour, grains, wool etc.), beeswax, dead leaves, mosses, lichens and included the carnivorous *Calymma communinacula* (Denis and Schiffermüller, 1775). We could not find reliable food plant references for *Ematheudes punctella* (Treitschke, 1833) and *Chrysocrambus linetella* (Fabricius, 1781).

Table 2. Yearly occurrence of the Lepidoptera species and specimens from Petraşcu Park.

Year	Species	Sessions	Yearly species/sampling session coefficient	Specimens
1970	5	5	1	11
1974	2	2	1	2
1975	3	3	1	3
1976	3	3	1	3
1977	1	1	1	1
1978	19	17	1.1	23
1979	30	21	1.4	37
1980	21	18	1.1	21
1981	89	36	2.4	139
1982	51	23	2.2	80

Table 3. Monthly occurence of the Lepidoptera species and specimens from Petraşcu Park.

Month	Species	Specimens	Sessions
February	1	2	2
March	1	1	1
April	7	10	7
May	20	23	13
June	85	151	25
July	24	29	23
August	29	31	28
September	35	54	16
October	7	17	12
November	2	2	2

Table 4. Numbers of new, previously unrecorded species encountered in each year of the study.

Year	New species	Percentage
1970	4	3
1974	2	1
1975	2	1
1976	2	1
1977	1	1
1978	15	9
1979	27	16
1980	19	11
1981	74	43
1982	24	14

Table 5. Feeding guilds distribution of the Lepidoptera recorded from Petraşcu Park..

Generalist herbivores			Specialist herbivores		Other specialists	Unknown
113 (66%)			35 (21%)		20 (12%)	2 (1%)
Trees	Grasses and herbs	Trees, grasses and herbs	Trees	Grasses and herbs	Keratin, cereals, beeswax, leaf detritus	
32	65	16	17	18	20	2

One hundred thirty-five of the recorded species (79%) were found only during one year of the study period. Of the species that were collected during multiple years (not necessarily consecutive), 31 species were recorded during two years, five during three years and two during four years. Except for the commonly occurring and widespread *Pieris rapae* (Linnaeus, 1758) and *Polyommatus icarus* (Rottemburg, 1775) which were observed year after year, no other species was recorded during more than 4 years (Table 6).

Of the ten most frequently encountered species (Table 7), eight are broadly polyphagous on various combinations of trees, grasses and herbs with at least one (*Noctua pronuba* Linnaeus, 1758) being also a strong migrator. The other two species are more restricted feeders but of widespread occurrence: the widely occurring *Hypsopygia costalis* (Fabricius, 1775), a specialist on clover hay, and *Aedia funesta* (Esper, 1786) which feeds on the cosmopolitan perennials *Convolvulus arvensis* L. and *Calystegia sepium* (L.) R. Br.

Table 6. Yearly occurrence of the Lepidoptera species and specimens from Petrașcu Park.

Two year encounters					
No.	Species	No.	Species	No.	Species
1	*Epicallima formosella*	12	*Ematheudes punctella*	23	*Hoplodrina ambigua*
2	*Pandemis heparana*	13	*Agriphila tristella*	24	*Chilodes maritima*
3	*Zeuzera pyrina*	14	*Pediasia contaminella*	25	*Atethmia centrago*
4	*Tortrix viridana*	15	*Hypomecis roboraria*	26	*Aetheria dysodea*
5	*Bactra furfurana*	16	*Xanthorhoe fluctuata*	27	*Orthosia miniosa*
6	*Lobesia botrana*	17	*Scliopterix libatrix*	28	*Axylia putris*
7	*Aphomia zelleri*	18	*Catocala elocata*	29	*Ochropleura plecta*
8	*Hypsopygia costalis*	19	*Aedia funesta*	30	*Noctua fimbriata*
9	*Sciota rhenellla*	20	*Acronicta aceris*	31	*Rhyacia simulans*
10	*Glyptoteles leucacrinella*	21	*Platyperigea aspersa*		
11	*Plodia interpunctella*	22	*Caradrina selini*		
Three year encounters					
No.	Species	No.	Species	No.	Species
1	*Acleris forsskaleana*	3	*Homeosoma nebulella*	5	*Limantria dispar*
2	*Lamoria anella*	4	*Apamea monoglypha*		
Four year encounters					
No.	Species	No.	Species	No.	Species
1	*Xanthia gilvago*	2	*Noctua pronuba*		

Discussion

Seventy-two out of the 170 total Lepidoptera species recorded during this study (42%), represent the Noctuoidea superfamily. Generally, these moths are large-bodied and large-winged, characteristics that appear to favor spatial dispersal, as they confer a strong flying ability with the potential to cover extended areas in search of a suitable habitat (Sekar 2012). On the other hand, these same characteristics may make them more vulnerable to predators like birds, bats, and others.

As expected, the generalist feeders were most commonly encountered with 113 recorded species. Among these, the grass and herbs feeders had a preponderance of 2:1 over the tree feeders. We hypothesize that this may be due to the fact that by not being mowed, the park mimicked a semi-natural environment allowing grasses and herbs to complete their annual development cycle thus favoring the local herbivorous populations. The majority of grass and herb feeding species were representatives of Noctuoidea. Their polyphagous nature and strong flying capabilities confer these species the mobility and versatility necessary to reach and exploit different city habitats and to move from areas where vegetation is being destroyed to other, more hospitable places. Several species from this guild are recognized as strong migrators: *Noctua fimbriata* (Schreber, 1759), *N. pronuba, Xestia c-nigrum* (Linnaeus, 1758), *Peridroma saucia* (Hübner, 1808), *Agrotis ipsilon* (Hufnagel, 1766). From this group, *Xanthia gilvago* (Denis and Schiffermüller, 1775), *Apamaea monoglypha* (Hufnagel, 1766), *N. pronuba* and *Lymantria dispar* (Linnaeus, 1758) were encountered in three and four different years during the study suggesting established and persistent populations in the area. The guild of generalist feeders also included the most abundantly encountered species during the study with *Acleris forsskaleana* (Linnaeus, 1758), *Aphomia zelleri* (Joannis, 1932), and *Lamoria anella* (Denis and Schiffermüller, 1775) being the most sampled organisms. Four species of strong flying generalists from Sphingidae were recorded: *Agrius convolvuli* (Linnaeus, 1758), *Macroglossum stellatarum* (Linnaeus, 1758), *Hyles livornica* (Esper, 1779), and *Proserpinus proserpina* (Pallas, 1772). All but *P. proserpina* are herbaceous plant generalists as larvae and common visitors of city flower beds as adults. *P. proserpina* is a rather unexpected urban visitor, as it prefers most meadows and heaths where its *Epilobium* spp. and *Lythrum* spp. food plants grow.

On two occasions pupae of *P. rapae* were reared to adulthood. Adult individuals were a very common species in the park and were not sampled otherwise.

We encountered a number of 35 species of specialist feeders on either trees or grasses and herbs. Nearly half of this guild (16 species) was comprised of relatively weak flying representatives of Tortricoidea, Pyraloidea, Gelechioidea, Yponomeutoidea, and Pterophoroidea superfamilies. 14 species were members of Noctuoidea, consisting of a combination

of heavy-bodied species such as *Catocala elocata* (Esper, 1787), *Cosmia trapezina* (Linnaeus, 1758), *Xanthia ocellaris* (Borkhausen, 1792), *Mythimna obsoleta* (Hübner, 1803), with other, more slender-bodied individuals like *Chilodes maritima* (Tauscher, 1806), *Oligia latruncula* (Denis and Schiffermüller, 1775), and *Nycteola asiatica* (Krulikovsky, 1904). From this group of specialist feeders, the majority were encountered during only one year. *Bactra furfurana* (Haworth, 1811), *Agriphila tristella* (Denis and Schiffermüller, 1775), *Pediasia contaminella* (Hübner, 1796), *A. funesta,* and *Scoliopteryx libatrix* (Linnaeus, 1758) were encountered during two years of the study. No representative of this group was recorded in more than two years. This suggests the possibility of a temporary presence of a local population followed by subsequent thinning or extinction of that population.

The balance of species for the guild of specialists was completed by the Papilionoidea superfamily with *Iphiclides podalirius* (Linnaeus, 1758), *Aporia crataegi* (Linnaeus, 1758), and *Colias croceus* (Fourcroy, 1785) as examples. These were widespread species, commonly found nectaring on wild as well as cultivated flowers.

Another well represented category was that of the detritivores—feeders on leaf litter and on dry animal and vegetable products. We encountered 20 species from this guild that included cosmopolitan species such as *Tineola bisselliella* (Hummel, 1823), *Tinea pellionella* (Linnaeus, 1758), *Oegoconia quadripuncta* (Haworth, 1828), *Achroia grisella* (Fabricius, 1794), *Galleria mellonella* (Linnaeus, 1758), *Pyralis farinalis* (Linnaeus, 1758), *H. costalis*, *Plodia interpunctella* (Hübner, 1813), and *Ephestia kuehniella* (Zeller, 1879). These species have adapted to feed on dry cereals, beeswax, and animal wool, including people's clothes, permitting them to thrive in human habitats. This niche that they evolved to fill has rendered them cosmopolitan and made them less dependent on wild habitats. As such, they are less likely to be a measure of the health of a natural ecosystem.

Another group in this guild was the decaying leaves feeders: *Idaea rusticata* (Denis and Schiffermüller, 1775), *I. seriata* (Schrank, 1802), *I. dimidiata* (Hufnagel, 1767), *I. aversata* (Linnaeus, 1758), and *I. deversaria* (Herrich-Schäffer, 1847). These are weak fliers that responded sporadically to light attraction.

The 320 specimens of the 170 Lepidoptera species recorded during 129 sampling sessions over 10 years represent an overall species/session coefficient of 1.3. This illustrates the relative paucity of the urban Lepidoptera explaining the reluctance of lepidopterists to investigate the low-yield city fauna. The specimen number is artificially low in the present study since we deliberately did not retain all the individuals of the encountered species.

There is a documented decline in the Lepidopteran fauna of Bucharest over the last century (Székely 2015) with a contraction from 516 species at the beginning of the twentieth century to 157 species in 2015. According to Székely, the 516 species recorded at the beginning of the last century included 389 "Macrolepidoptera" (post-Lasiocampoid assemblages) and 127 "Microlepidoptera" (pre-Lasiocampoid assemblages). In his 2015 list of the Bucharest Lepidoptera, Székely records 157 species. Of these, 153 are "Macrolepidoptera" and four are Cossoidea and Hepialoidea, traditionally placed in the "Microlepidoptera" group. Along the same criteria, this study documents the presence of 61 species of "Microlepidoptera" and 109 species of "Macrolepidoptera" in the city. For a more meaningful comparison of the results of these two studies, we took into account only the "Macrolepidoptera" species of both sources.

Table 8 summarizes the comparison between these two studies, showing that of the 153 species listed by Székely and the 109 species listed in this paper, 61 are present in both studies (Fig. 1). In other words, 92 species are present only in Székely's study and 48 only in our study. The 61 common species added to these yield a total number of 201 species of "Macrolepidoptera" recorded in Bucharest in the latter part of the twentieth and beginning of the twenty-first centuries. This

Table 7. The 10 most frequently recorded species during the study time.

Species	Number of specimens
Acleris forsskaleana	12
Aphomia zelleri	9
Lamoria anella	9
Hoplodrina ambigua	8
Noctua pronuba	7
Xanthia gilvago	7
Aedia funesta	7
Paradrina selini	5
Hyphantria cunea	5
Hypsopygia costalis	5

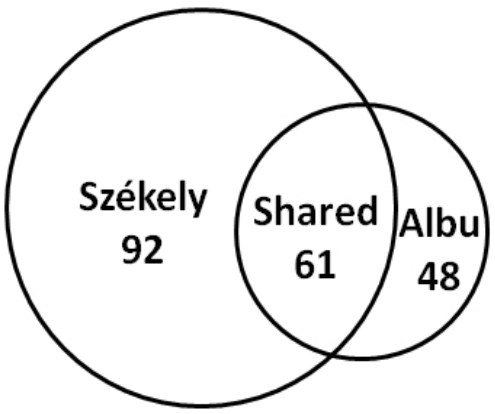

Fig 1. „Macrolepidoptera" species recorded by Székely's 2015 study and the present study. The large and small circles represent species exclusive to Székely, and Albu, respectively. Union indicates shared species recorded in both studies.

Table 8. Comparison between the number of species of the post Lasiocampoid superfamilies recorded by Székely (2015) and by this study in Bucharest. Also emphasized is the number of species recorded in both studies.

Superfamilies	Székely Macrolepidoptera species	Common Macrolepidoptera species	Albu Macrolepidoptera species
LASIOCAMPOIDEA	4	1	2
BOMBYCOIDEA	10	2	4
PAPILIONOIDEA	28	12	13
DREPANOIDEA	3	0	0
GEOMETROIDEA	22	6	18
NOCTUOIDEA	86	40	72
TOTAL	153	61	109

suggests a loss of 188 species over 100 years, or a 48% reduction in urban species richness. Both studies have the inherent limitation of being unable to explore many of the city's ecological niches that can support fluctuating populations of different species, so the actual number of recorded species is most likely underestimated. To this one must add the serendipity of the sampling act. As an example, the reader is reminded that in this study, the most productive years were the last 4 (1979-1982), especially 1981, when 43% of the records were obtained. Had we missed that year, the number of recorded species would have been much smaller. Since each year brought many new, previously unrecorded species, it is reasonable to presume that the number of recorded species would have been higher had we continued the investigation beyond 1982. Further studies will likely discover other Lepidoptera species in Bucharest, as the city is largely under-sampled. Collectors usually choose species-rich hotspots in the countryside and ignore the city "desert" (A.P.-Gorj personal communication).

Further confusing the issue are the complex dynamics of populations and species. Populations can contract or expand. An example of the former is *Saturnia pyri* (Denis and Schiffermüller, 1775), a common species in Bucharest at the beginning of the twentieth century and now in sharp decline in the city (Székely, 2015). The opposite is true for *Colias erate* (Esper, 1805) which was first recorded in and around Bucharest in 1960 and has since then undergone a sharp populational increase with a significant expansion towards Central Europe (Székely 2015). According to the same author, other species have disappeared altogether from the city, *e.g. Saturnia spini* (Denis and Schiffermüller, 1775), *Nymphalis xanthomelas* (Esper, 1781), or have established themselves as new, like *Aedia leucomelas* (Linnaeus, 1758) and *Chrysodeixis chalcites* (Esper, 1789). These changes show the complex dynamics of the urban ecosystems caused by the expansion and contraction of vegetated areas, oscillations in plant species, variable presence of predators, pesticide usage, and continuously changing microhabitat patterns including the creation and destruction of heat islands and impervious surfaces (Raupp *et al*. 2010).

The halving of the Lepidopteran fauna of Bucharest over the last 100 years is a worrisome event similar to a trend documented in other urban agglomerations like San Francisco where it is estimated that 43% of the indigenous butterfly fauna has disappeared from the city due to habitat loss (Connor *et al.* 2002).

Dated checklists have their importance in sampling and recording the local fauna at various intervals. They are a useful tool in making city planners aware of the changes in the urban environment. They stress the importance of understanding the city as a new type of ecosystem. From this understanding derives the importance of establishing, maintaining and preserving healthy floral and dendrological habitats in city parks with dispersal corridors between them. In order to make this urban ecosystem viable and sustainable, a heightened awareness needs to be elicited for the maintaining of the local plant mix in these city parks and preserves.

Acknowledgements

We would like to thank Ms. Ruoxi Chen for assisting with constructing the diagram illustrated in Figure 1 and Mr. Alexander Albu for reviewing the manuscript and making many helpful recommendations for improvement.

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Received: 07.05.2016
Accepted: 04.02.2017
Published online: 30.03.2017
Published:
Online article number: ER20201604

Appendix 1. The Lepidoptera species recorded by this study from Petraşcu Park and their feeding guild affinities. The asterisk sign marks the species encountered also in Székely's 2015 study. K & R number is the Karsholt and Razowski European checklist number. B G = broad generalist; G+H G = grass and herbs generalist; G+H S = grass and herbs specialist; O S = other specialist; T G = tree generalist; T S = tree specialist; U = unknown.

No.	K & R number	Species	Feeding guild
1	63	*Triodia sylvina*	G+H G
2	669	*Tineola bisselliella*	O S
3	671	*Tinea pellionella*	O S
4	704	*Monopis obviella*	O S
5	1347	*Yponomeuta evonymella*	T S
6	1348	*Yponomeuta padella*	T S
7	1349	*Yponomeuta malinellus*	T S
8	1352	*Yponomeuta rorrella*	T S
9	1408	*Paraswammerdamia lutarea*	T G
10	1730	*Agonopterix alstromeriana*	G+H S
11	2310	*Epicallima formosella*	O S
12	2476	*Coleophora fuscocuprella*	T G
13	2716	*Coleophora asteris*	G+H S
14	2941	*Oegoconia quadripuncta*	O S
15	3264	*Isophrictis anthemidella*	G+H S
16	3280	*Metzneria metzneriella*	G+H G
17	3419	*Teleiodes luculella*	T G
18	3430	*Teleiodes proximella*	T G
19	3868	*Helcystogramma triannulella*	G+H S
20	4176	*Zeuzera pyrina*	T G
21	4370	*Tortrix viridana*	T G
22	4372	*Ailemma loeflingiana*	T G
23	4375	*Acleris forsskaleana*	T G
24	4522	*Pseudargyrotoza conwagana*	T G
25	4557	*Archips podana*	T G
26	4564	*Choristoneura hebenstreitella*	T G
27	4580	*Pandemis heparana*	B G
28	4581	*Pandemis dumetana*	B G
29	4656	*Bactra furfurana*	G+H S
30	4713	*Hedya salicella*	T S
31	4791	*Lobesia botrana*	G+H G
32	4987	*Gypsonoma sociana*	T S
33	5144	*Cydia pomonella*	T G
34	5545	*Hellinsia osteodactylus*	G+H G
35	5552	*Emmelina monodactyla*	G+H G
36	5574	*Aphomia zelleri*	B G
37	5578	*Lamoria anella*	B G
38	5587	*Achroia grisella*	O S
39	5589	*Galleria mellonella*	O S
40	5627	*Pyralis farinalis*	O S
41	5652	*Hypsopygia costalis*	O S
42	5658	*Orthopygia glaucinalis*	O S
43	5661	*Endotricha flammealis*	T G
44	5724	*Sciota rhenella*	T S
45	5869	*Acrobasis consociella*	T S
46	5878	*Glyptoteles leucacrinella*	O S
47	6072	*Homoeosoma sinuella*	G+H G
48	6079	*Homoeosoma nebulella*	G+H G
49	6102	*Plodia interpunctella*	O S
50	6105	*Ephestia kuehniella*	O S
51	6145	*Ematheudes punctella*	U
52	6243	*Crambus pascuella*	G+H S
53	6258	*Agriphila tristella*	G+H S
54	6266	*Agriphila selasella*	G+H G
55	6344	*Chrysocrambus linetella*	U
56	6364	*Pediasia contaminella*	G+H S
57	6416	*Elophila nymphaeata*	G+H G
58	6423	*Cataclysta lemnata*	G+H G
59	6531	*Udea ferrugalis*	G+H G
60	6667	*Pleuroptya ruralis*	B G
61	6719	*Nomophila noctuella*	B G
62	6743	*Malacosoma neustria**	T G
63	6780	*Odonestis pruni*	T G
64	6828	*Agrius convolvuli**	G+H G
65	6843	*Macroglossum stellatarum**	G+H G
66	6849	*Proserpinus proserpina*	G+H G
67	6860	*Hyles livornica*	G+H G
68	6958	*Iphiclides podalirius**	T S
69	6993	*Aporia crataegi**	T S
70	6995	*Pieris brassicae**	G+H S
71	6998	*Pieris rapae**	G+H G
72	7000	*Pieris napi**	G+H G
73	7015	*Colias croceus**	G+H S
74	7093	*Everes argiades**	G+H G
75	7127	*Plebejus argus**	G+H G
76	7145	*Aricia agestis**	G+H G
77	7163	*Polyommatus icarus**	G+H G
78	7243	*Vanessa atalanta**	G+H S
79	7245	*Vanessa cardui**	G+H G
80	7307	*Pararge aegeria*	G+H G
81	7632	*Ennomos autumnaria*	T G
82	7635	*Ennomos fuscantaria*	T G
83	7663	*Colotois pennaria**	T G
84	7699	*Erannis defoliaria**	B G
85	7754	*Peribatodes rhomboidaria**	T G
86	7783	*Hypomecis roboraria**	T G
87	7826	*Cabera exanthemata*	T G
88	7953	*Alsophila aescularia*	T G

No.	K & R number	Species	Feeding guild
89	7982	*Chlorissa viridata**	B G
90	8042	*Scopula nigropunctata*	B G
91	8059	*Scopula marginepunctata*	G+H G
92	8107	*Idaea rusticata*	O S
93	8140	*Idaea humiliata*	G+H G
94	8155	*Idaea seriata*	O S
95	8161	*Idaea dimidiata*	O S
96	8184	*Idaea aversata*	O S
97	8188	*Idaea deversaria*	O S
98	8256	*Xanthorhoe fluctuata**	G+H G
99	8708	*Furcula furcula*	T G
100	8849	*Polypogon tentacularia*	G+H G
101	8984	*Scoliopteryx libatrix**	TS
102	8877	*Catocala elocata**	TS
103	8904	*Dysgonia algira**	T G
104	8958	*Aedia funesta**	G+H S
105	8959	*Aedia leucomelas**	G+H S
106	8965	*Tyta luctuosa**	G+H S
107	10568	*Spilosoma urticae*	G+H G
108	10570	*Hyphantria cunea**	B G
109	10598	*Arctia caja*	G+H G
110	10376	*Lymantria dispar**	T G
111	10444	*Nycteola asiatica*	TS
112	10451	*Pseudoips prasinana**	T G
113	8778	*Acronicta aceris*	T G
114	8787	*Acronicta rumicis**	T G
115	8810	*Cryphia raptricula*	O S
116	9051	*Macdunnoughia confusa**	G+H G
117	9056	*Autographa gamma**	G+H G
118	9093	*Abrostola triplasia*	G+H G
119	9097	*Emmelia trabealis**	G+H G
120	9118	*Deltote bankiana*	G+H G
121	9122	*Pseudeustrotia candidula*	G+H G
122	9132	*Calymma communimacula*	O S
123	9199	*Cucullia umbratica**	G+H G
124	9307	*Amphipyra pyramidea**	B G
125	9308	*Amphipyra berbera*	B G
126	9370	*Helicoverpa armigera**	B G
127	9423	*Platyperigea aspersa**	G+H G
128	9424	*Platyperigea kadenii**	G+H G
129	9430	*Caradrina selini*	G+H G
130	9454	*Hoplodrina ambigua*	G+H G
131	9471	*Chilodes maritima*	G+H S
132	9501	*Trachea atriplicis**	G+H G
133	9505	*Phlogophora meticulosa**	T G
134	9537	*Apterogenum ypsillon*	TS
135	9550	*Cosmia trapezina*	TS
136	9552	*Atethmia centrago*	TS
137	9560	*Xanthia gilvago*	T G
138	9561	*Xanthia ocellaris*	TS
139	9596	*Eupsilia transversa**	B G
140	9748	*Apamea monoglypha*	G+H G
141	9771	*Apamea sordens*	G+H G
142	9781	*Oligia versicolor*	G+H G
143	9782	*Oligia latruncula**	G+H S
144	9789	*Mesapamea secalis*	G+H G
145	9801	*Luperina testacea*	G+H G
146	9917	*Lacanobia oleracea**	G+H G
147	9920	*Lacanobia suasa**	G+H G
148	9927	*Aetheria dysodea*	G+H S
149	9987	*Mamestra brassicae**	G+H G
150	10002	*Mythimna albipuncta**	G+H G
151	10003	*Mythimna vitellina**	G+H G
152	10007	*Mythimna pallens**	G+H G
153	10010	*Mythimna obsoleta*	G+H S
154	10022	*Mythimna l-album*	G+H G
155	10037	*Orthosia incerta*	B G
156	10039	*Orthosia cruda**	T G
157	10041	*Orthosia miniosa*	T G
158	10054	*Egira conspicillaris**	G+H G
159	10082	*Axylia putris**	G+H G
160	10086	*Ochropleura plecta**	G+H G
161	10096	*Noctua pronuba**	G+H G
162	10100	*Noctua fimbriata**	B G
163	10139	*Rhyacia simulans**	G+H G
164	10199	*Xestia c-nigrum**	G+H G
165	10212	*Xestia xanthographa*	G+H G
166	10238	*Peridroma saucia**	G+H G
167	10273	*Euxoa temera*	G+H G
168	10346	*Agrotis ipsilon**	G+H G
169	10348	*Agrotis exclamationis**	G+H G
170	10351	*Agrotis segetum**	G+H G