WildMetro Insect Survey 2004

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Introduction

Sampling for arthropods, primarily insects, was performed during June and July 2004 in six New York City parks, including several sites in the largest park. The specimens were identified at least to species, and some groups were identified to subfamily or genus and sorted by morphospecies. The nature of the sampling strategy in 2004 does not enable either statistically significant conclusions or in-depth comparison with the results obtained in 2003. However, the closer identifications lay the groundwork for piecing together the trophic ecology of the Metropolitan area's natural areas.

Methods

Sampling largely followed the same methods as in 2003 (Hayden 2003), except that the linen sheet spread on the ground for beating was replaced by a hand-held canvas sheet of 1 m^2 and that an aspirator was used in conjunction with forceps. Most specimens were preserved in vials of 70% ethanol, but some were in isopropyl.

The sampling covered several more sites than 2003, but each site was sampled only once.

Sites, in order of code:

BPS, BPB: Bloomingdale Park. Sweep and beat, 29 July 2004, B. Bains.

FPS: Forest Park, Plot #2. Sweep, 2 July 2004. B. Bains.

FPNSS: Forest Park, Plot #2, Northeast to Southeast Corner. Sweep, 2 July 2004. B. Bains.

HAS: Hart Island, Bronx. Sweep, 16 June 2004, B. Bains.

HRS: High Rock Park. Sweep, 26 July 2004. B. Bains.

IPS: Inwood Park, Manhattan. Sweep, 14 July 2004, B. Bains.

PHUS, PHUB: Underneath and around "Big Red" oak tree, Hunter's Island, Pelham Bay Park. GPS: 18T 0602190, 4525901. Sweep, 1 July 2004. B. Bains.

POFS, POFB: Field near large white oak tree, northeast of playing fields and south of Veterans' Memorial, South Zone of Pelham Bay Park. GPS: 18T 0599260, 4523005. Sweep and beat, 15 June 2004. J. Hayden

POGS, POGB: Field dominated by Tripsacum dactyloides "gama grass," behind Orchard Beach and south of Parking Lot complex, North Zone of Pelham Bay Park. GPS: 18T 0601312, 4524339. Sweep and beat, 14 June 2004. J. Hayden & al.

POOS, POOB: Underneath large white oak tree, northeast of playing fields and south of Veterans' Memorial, South Zone of Pelham Bay Park. GPS: near 18T 0599260, 4523005. Sweep and beat, 15 June 2004. J. Hayden & al.

POPS, POPB: European Poplar stand, on north side of trail leading from Rodman's Neck parking lot to Orchard Beach, southern (right-hand) branch of trail, 25 paces shoreward of fork; Pelham Bay Park. Sweep and beat, 14 June 2004. J. Hayden & al.

PSGS: Field with much Tripsacum dactyloides "gama grass," facing breakwater shore in far southeastern corner of Southern Zone, Pelham Bay Park. Sweep, 15 June 2004. B. Bains & al.

PWFS, PWFB: "Wet field," surrounded by low trees and shrubs, off east end of north side of the trail along southern perimeter of South Zone, Pelham Bay Park (about where forest gives way to more open space, but

inland from the Phragmites thicket). GPS: 18T 0599800, 4522706. Sweep and beat, 15 June 2004. B. Bains & al.

Date	Sites	Methods
14 June 2004	Pelham Bay Park: North Zone gama grass; Euro. Poplar stand	sweep and beat
15 June	P.B.P.: South Zone Oak-field, Old Oak, gama grass, wet field	sweep and beat
16 June	Hart Island	sweep
1 July	P.B.P.: Hunter's Island: Big Red Oak	sweep and beat
2 July	Forest Park, Plot #2	sweep
14 July	Inwood Park	sweep
26 July	High Rock Park	sweep
29 July	Bloomingdale Park	sweep and beat

Identification:

Identifications were done as the previous year: specimens immersed in 70% alcohol were examined by binocular microscope under fiber-optic halogen light and against a black or white background. The specimens preserved in isopropyl were noticeably more brittle and often lacked appendages, which sometimes impeded or prevented diagnosis. Poor lighting also impeded the preliminary identifications; this was remedied by using the fiber-optic light.

Specimens were identified to family where possible except most Lepidoptera (entirely larval), Psocodea, Thysanoptera, Crustacea: Oniscoidea, and Arachnida (Araneae, Opiliones). For Diptera, Heteroptera, and Hymenoptera (Ichneumonoidea: Braconidae, Ichneumonidae; and Apoidea: Colletidae, Halictidae), specimens were identified to genus or subfamily using keys (see *References*), assigned to morphospecies, and these compared across sites. In a few doubtful cases, specimens were compared with material in the Cornell University Insect Collection.

For other taxa, morphospecies were assigned within each site but not compared among sites. Ceratopogonidae, Chironomidae, and Culicidae (all in the last identified as *Culex*) were too fragmentary to assign to morphospecies. Some morphospecies that were not assignable to family were recognized (as, for example, "Diptera undet. sp. 1," "…sp. 3"). (Simple lack of determination was marked as "x" in the database.) Morphospecies are listed as numbers ("sp. 1"), but for the labels, "1 sp." or "# spp." after the family indicates so many species, listed below.

"Sp. 1," "sp. 2," etc. signify particular morphospecies and are equivalent to "[genus] 1," [genus] 2." In a few cases with the Hymenoptera, a new number sequence begins where something is keyed to a significant lower rank (new column in spreadsheet). E.g., what would have been "Phygadeuontinae sp. 5" became "[Phygadeuontinae:] *Gelis* sp. 1" when it was keyed to *Gelis*. The "fams/site" reports the totals of families or next highest category (order), including undetermined specimens from different orders but not including cases where the undetermined may belong to an already listed family (e.g., Heteroptera undet. nymphs).

The "subfamily" category is optional: almost everything in theory is classified in some subfamily, but it matters for our purposes only where something was classified only as far as subfamily (Ichneumonoidea), or in some cases where subfamilies are especially distinct in biology, ecology, or gross morphology: e.g., chrysomelid subfamilies; Conopidae: Myopinae; Gryllidae: Oecanthinae.

Analysis:

Families and morphospecies were summed for each site. Scoring was conservative: where the number of species was uncertain, the least number was included, and larvae or nymphs that were of the same family as recorded adults in the sample were not counted, since it was possible that the immatures were of the same species as the adults (regardless of appearances).

I did not count the total number of morphospecies across all families because I did not critically examine all specimens across sites, as I did for Diptera, Ichneumonoidea and Heteroptera.

An accumulation curve was created for species of the taxa for which specimens were compared among sites: all Diptera, Heteroptera, Ichneumonoidea and Apoidea, minus those for which species comparisons were impossible: Ceratopogonidae, Chironomidae, Culicidae, and Heteroptera nymphs (Miridae, Nabidae, and fam. indet.). Samples from the P.B.P. Orchard Beach gama grass field were

included, despite some being unidentified because specimens were lost. Beating samples were not included because these never presented more than two species for the taxa considered. New species as a percentage of all species in a sample were also plotted through time.

Family-site records: Families (or higher taxa if specimens could not be identified further) were totalled for four sites in Pelham Bay Park: The Orchard Beach gama grass field, the Orchard Beach stand of European Poplar, the field near the Old Oak in the South Zone, and the foliage under and around the Old Oak. These were compared with the results from these sites taken in 2003 by the Jaccard Index, which is the percentage overlap (the set of shared records divided by the total records in the two sets: formally, (overlap) / (set 1 total + set 2 total – overlap).

Results

Complete identifications were not possible for several taxa. The Diptera samples from Orchard Beach Gama Grass field, after being identified to genus were either dried out and pinned (in J. Hayden Collection) or lost; the drying prevented confident identification with other morphospecies.

Table 1. Numbers of morphospecies and families, by site and sampling method.

site	spp/site sweep	spp/site beating	total spp	families/site sweep	families/site beating	total families
pogs/b	43	4	47	28	4	32
pops/b	72	3	75	35	2	37
pofs/b	50	3	53	28	3	31
poos/b	24	13	37	22	11	33
psgs	27	--	27	19	--	19
pwfs/b	36	6	42	25	5	30
has	52	--	52	32	--	32
phus/b	54	3	57	33	3	36
fps	21	--	21	15	--	15
fpnss	29	--	29	19	--	19
ips	30	--	30	26	--	26
hrs	16	--	16	14	--	14
bps/b	27	6	33	16	5	21
average	**37.00**	**5.43**	**39.92**	**24.00**	**4.71**	**26.54**
stand. dev.	**15.50**	**3.33**	**15.85**	**6.80**	**2.76**	**7.68**

The total number of families (or taxa that could not be identified to family), with all sites pooled, was 89. See the accompanying Excel file for accumulation plots (absolute and relative) of morphospecies.

Family-site records: 118 records were made in 2004 of families occurring at one of the four Pelham Bay sites of interest. The number in 2003 was 206, and the Jaccard Index was 33.9%.

Of the total families or higher groups recorded in 2004, 14 were not recorded in 2003: Anobiidae, Bostrichidae, Buprestidae, Cleridae, Conopidae, Endomychidae, Eulophidae, Mantidae, Psilidae, Psychodidae, Ptilodactylidae, Staphylinidae, Tenthredinidae and Vespidae.

Discussion

The total of 89 families (or supra-familial taxa) found in 2004 compares with the 125 families found in 2003. However, sampling in 2003 was more extensive: it included 24 instances of sampling at 6 sites in Pelham Bay Park, over a period of 8 months in July and August; sites were sampled between 3 and 5 times. This year, the time interval was 6 weeks in June and July, and 12 sites were sampled once each; 6 of these sites were the same as those in 2003 (but the samples were taken two weeks earlier), and an additional one was also in Pelham Bay Park (the gama grass field in the South Zone). While the greater sampling in 2003 (24 versus 12 instances) explains that year's higher total for families, the disparity in sampling regimes makes comparison between the years difficult.

Since each site was sampled once, statistically significant comparisons between the diversity of sites is impossible. The variety of factors that may interfere with sampling (e.g., weather, equipment failure, time limits) necessitate that sampling be repeated several times to distribute evenly and reduce those sources of error. Hence, differences in sample diversity in Table 1 may be more easily explained by compromised sampling than by differences in actual diversity in the environment.

The slope of the species-accumulation curve ("accmln gph" in accompanying Excel file) generally decreases through time (and sites), though it does not seem to level off. Given a model equation for accumulation and a rate of increase, it would be possible to estimate the percent of species in the environment that have been sampled (given the time or effort) or the additional time or effort needed to sample some desired percentage of the species in the environment. For example, if the amount of effort is set at the number of sites (13), the percentage *x* of species sampled out of the environment may be $x = 1 - 1/e^{13r}$ or, alternatively, $x = 13 / (13 + r)$. If the rate of increase r = 0.293 (where the equations coincide), both yield values of x = 97.9%, but if r = 0.1, x = 73% or x = 99%. The discrepancy between these accumulation-functions and the still unknown quantity of the rate of increase (low values of which, however realistic, induce the greatest differences in model behavior) preclude confident estimation of how efficiently the sampling achieved its goal.

More importantly, since the sites were sampled only once and in sequence through the summer, the curves of species accumulation and relative new species do not apply to point sites or habitats, but only to the metropolitan area considered as a whole. The City includes a range of habitats that may be expected to differ partially in species composition, and the overturn of insect fauna through the season should also present new species. The accumulation curve would therefore be expected to approach a non-horizontal asymptote—that is, to be following an ever-increasing number of species. While these problems present even more sources of error, it may be remarked that the presence of a clear, decreasing curve in the accumulation graph suggests that the overlap of habitats in species composition is low, and that several species persisted through the duration of the sampling season.

The relative new species plot scales new species to sample sizes (which varied widely between 0 and 1: standard deviation, 0.19), and it is expected to decline gradually (but not continuously) as new species are exhausted. This plot does not begin at 1 (100%) because several voucher specimens from the first site were lost or damaged. Though these had been identified to family or genus, they could not be compared to other specimens and assigned to morphospecies. The resulting gaps were not counted as new species. The plot does decline, though all fitted trendlines have low correlation values (less than R = 0.35). The main lesson gained from rescaling to sample sizes is that sample sizes varied widely: some days yielded many species in total, while others, few.

The rather small Jaccard Index of shared family-site records for the four Pelham Bay sites between 2003 and 2004 is partly explained by the weaker sampling done in 2004, which yielded just more than half the families. The earlier timing of the samples (all of 2004's samples from Pelham Bay were taken in June) may explain the difference further. Ten families (or higher groups) appeared in this set of samples that did not appear in 2004; of these, two are doubtful identifications (Anthribidae and Nyssonidae). Of the 14 families not recorded in 2003, the presence of none is surprising. Interesting records should be sought at the genus and species levels, but I do not have the expertise to assess that.

It was suggested in 2003 that using aspirators would more effectively capture fast-moving insects. In 2003, the average number of morphospecies per beating-site was 7.1; these were obtained with forceps and a bedsheet. In 2004, the average was 5.4 morphospecies per beating-site, using aspirator and hand-held sheet. One explanation for the smaller samples may be the smaller area of the hand-held sheet.

The identification to lower taxonomic ranks allowed, in some cases, anomalous (and so possibly non-native) specimens to be highlighted.

The eremnine weevil from Hunter's Island is almost certainly a worn specimen of *Cyrtepistomus castaneus* Roelofs, the introduced Asiatic oak weevil. Further research is needed to determine whether it occurs in densities sufficient to damage the oak trees at the site.

Two species of tephritid flies identified as *Urophora* were found in the Orchard Beach European Poplar stand and in the P.B.P. South-Zone gama grass field; these may be beneficial weed-controllers.

Unusually large male and female specimens of a dung fly (Sepsidae: Sepsinae) were found in Forest Park; only specimens from the Neotropics in the Cornell University Insect Collection were as large.

A large eriopterine crane fly species, which ran in the key to *Neocladura*, was taken in the Orchard Beach Poplar stand and in Bloomingdale Park. Its large size and mottled wings distinguish it from all other Nearctic Eriopterinae available for examination.

Diptera undet. sp. 1 appeared to be closest to Lauxaniidae but did not fit exactly; its occurrence in Forest and Inwood Parks would make it worthy of investigation.

Ecological information about Diptera is heavily indebted to the accounts by various authors in the *Manual of Nearctic Diptera*. Information about other taxa relies mostly on Borror, Triplehorn & Johnson. Other references are given below.

Recommendations

More sampling effort is needed: thirteen sites is insufficient for generating statistical confidence that any given site (much less several sites) has been intensively sampled. Confident comparisons of the sites would also be preliminary: as it stands, variation in the small samples can easily be explained as arising by chance. Assessments of the impact of urbanization on insect fauna would be inappropriate, if based on such small samples.

These data and the voucher specimens should be evaluated by taxonomic or faunistic experts to determine if unusual new genus or species records, or unusual absences of records, exist. In addition, the ecological interactions of the arthropods may be pieced together. Many of the taxa identified to genus (Diptera, Heteroptera, Ichneumonoidea, Apoidea) may include host-specific or environment-specific species. For exmple, alysiine braconid wasps are parasitoids of the "higher" flies (which comprise the majority of the dipteran species), and pipunculid flies are parasitoids of leafhoppers. Combined with plant occurrence information, the beginnings of a tritrophic ecological framework (plants—herbivores—predators/parasitoids) may be seen.

Future sampling should either improve the approach taken toward beating samples (make it more extensive, intensive, or hire someone with more experience) or forgo beating, because it seems to yield too little for the time invested. Other sampling methods should be tried. In particular, Pollard Walks should be made routine to count butterflies, Odonata and other conspicuous groups. This regimen has been widely tested and refined into a rigorous method, and it furthermore requires neither equipment (besides binoculars) nor voucher specimens. Butterflies and odonates, though smaller in diversity than (for example) Diptera, are usually better-studied and so present opportunities for integrating findings with those of other surveys outside the Metropolitan area(s).

Despite the uncertainties surrounding the comparisons of sites, seasons and years, a wealth of insect diversity clearly exists among the Metropolitan area's parks. While the rate of accumulation of species records does decline with increased effort, a plateau was not reached in the extensive approach of 2004. This taxonomic diversity suggests that, at least in some places, a correspondingly wide diversity of ecological interactions exists.

The greatest impediments to this study were expertise in identification and recognition of the species' ecological roles and significance. The current capacity of taxonomic and ecological expertise is insufficient and can only be increased by training students. To this end, the great variety of arthropod morphology, behavior, and ecology found in the New York City area should be taken advantage of for the instruction of the many local students.

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References

Borror, D.J., C.A. Triplehorn, and N.F. Johnson. *An Introduction to the Study of Insects*, sixth edition. New York: Harcourt-Brace, 1989.

Hayden, J.E. 2003. Insect Diversity in Pelham Bay Park, 2003. *WildMetro: Research*. <http://www.wildmetro.org/insect03.htm>

Hymenoptera of the World: an identification guide to families. H. Goulet and J.T. Huber, eds. Ottawa: Agriculture Canada Research Branch pub. no. 1894/E, 1993.

Manual of Nearctic Diptera, vol. 1. J.F. McAlpine et al., coordinators. Ottawa: Biosystematics Research Institute, Agriculture Canada, Monograph no. 27, 1981.

Manual of Nearctic Diptera, vol. 2. J.F. McAlpine et al., coordinators. Ottawa: Biosystematics Research Centre, Agriculture Canada, Monograph no. 28, 1987.

Michener, C.D., R.J. McGinley, and B.N. Danforth. *The Bee Genera of North and Central America.* Washington, D.C.: Smithsonian Institution Press, 1994.

Slater, James A. and Richard M. Baranowski. *How to Know the True Bugs.* Dubuque: Wm. C. Brown, Pictured Key Nature Series, 1978. (Reputedly the best in the series.)