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Brief comparison between the Diptera fauna at a native forest edge and at a nearby house backyard, in Wellington, New Zealand.

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ABSTRACT

The New Zealand environment underwent extensive anthropogenic environmental change. Although habitat modification is a known factor leading to the displacement or elimination of indigenous species, many invertebrates may be able to exploit anthropic environments. In this short investigation we compared the Diptera fauna collected in adult traps set c. 150 m apart, at the edge of native forest and at a house yard. Considerably more specimens and species were collected in the native forest, and there was some indication that of shift in species assemblage in the yard. However, despite the clearance of native forest to give way to settlements, the fauna in the anthropic habitat was still made up mostly by indigenous species.

Keywords: biodiversity, exotic, indigenous, light traps, urban

INTRODUCTION

The New Zealand environment has suffered dramatic changes since the arrival of humans c.800 years ago (Higham et al. 1999; McGlone and Wilmshurst 1999; Derraik and Slaney 2007). According to some estimates native forests and woodlands for instance, have been reduced from approximately 78% to 23% of the country's land area (King 1990). Most of the mid-altitudes and lowlands are now free hold land (Derraik et al. 2001), as they have the greatest agricultural value and, as a result, are often highly modified (Watt 1979).

Such modified habitats may still harbour high biodiversity, particularly amongst the invertebrate fauna (e.g. Crisp et al. 1998). In New Zealand, Young & Mitchell (1994) and Davies-Colley et al. (2000) suggested that 50 m and 40 m wide respectively, edge buffer zone are necessary for the conservation of indigenous species. Disturbed forest edge habitats not only have a considerably different microclimate to the forest interior, but they also function as staging areas which can facilitate the invasion of the surrounding landscape by exotic species (Center et al. 1995). In this short investigation we aimed to obtain an insight into the assemblages of adult Diptera species from two disturbed habitats: the edge of a native forest and a nearby house backyard.

METHODS

Sampling was carried out in late summer 2002 in two different sites in the suburb of Wilton, Wellington City, New Zealand (lat 41°16'S, long174°45'E). Adult Diptera were sampled at two localities: c.5 to 10 m from the edge of forest at Otari-Wilton's Bush (a 90 ha urban native coniferous-broadleaved forest), and c.150 m away in the front and back yards of a house.

Two CO_2-baited light traps were set overnight at each site, being placed against tree trunks for shade and protection. Sampling was carried out over three nights, under dry and relatively windless conditions, as insect catches by adult traps decrease with rainfall and increasing wind speed (Strickman et al. 1995; Southwood and Henderson 2000). Traps were set up at least one hour before sunset and collected at least one hour after sunrise. Note that the type of traps adopted aimed to target in particular the Culicidae fauna as part of a wide-ranging research project into the ecology of mosquitoes in New Zealand (Derraik 2006).

Specimens were identified using a range of taxonomic guides, viz Marshall (1896), Edwards (1923), Tonnoir and Edwards (1927), Collin (1928), and McAlpine et al. (1981). Names of taxa and their ranks were brought up to date following Evenhuis (1989). Some identifications were conservative due to damaged specimens and consequent lost of key characters. Note that we have used Matile (1989) in recognising the Keroplatidae as a family separate from the Sciaridae, although some authors do not agree (e.g. Vockeroth 1981).

Non-metric multidimensional scaling (MDS) ordinations (based on Bray-Curtis dissimilarity measures) were carried out using PRIMER-E (Plymouth Marine Laboratory, UK) to compare the assemblages of taxa between the two disturbed habitats (forest edge and backyard), and were run from 30 random restarts. One-way analyses of similarities (ANOSIM) were used to test whether the taxon assemblages were statistically different from each other. It should be highlighted that the R statistic given by ANOSIM provides a useful comparative measure of the degree of separation of sites, and according to (Clarke and Warwick 2001) the value of the R statistic as important as its statistical significance if not more so. Note that if R = 1, within-site replicates are significantly more similar to each other in comparison to any replicates from other sites (Clarke and Warwick 2001).

RESULTS

The 12 traps yielded a total of 102 adult Diptera specimens, which equated to 8 different families (Cecidomyiidae, Chironomidae, Chloropidae, Culicidae, Keroplatidae, Mycetophilidae, Stratiomyidae and Tipulidae), and approximately 23 taxa (Table 1). Out of the total number of specimens 85% (87) which were collected at the forest edge with the remaining 15% (15) recorded at the house backyard. Three families (Chironomidae, Keroplastidae and

Mycetophilidae) and 15 taxa were only found at the native forest edge, while two families (Chloropidae and Stratiomyidae) and four taxa were restricted in this study to the house yard (Table 1).

The MDS ordination gave an indication that the taxon assemblages between the two sites were indeed distinct (Figure 1). The samples taken at that native forest edge were clearly clustered together, while all but one of the samples recorded at the house yard were scattered away from the above cluster (Figure 1). The ANOSIM provided however, a low global R (0.144), and also a non-significant result with $P = 0.071$, which would indicate nearly similar taxon assemblages between the two habitats.

DISCUSSION

Based on the considerably richer taxa recorded at the forest edge (Table 1) and the likely distinct assemblage of taxa between the two habitats (Figure 1), there was indication that the edge of the native forest was a considerably more favourable habitat for indigenous invertebrates. Note that the non-significant result and low R from the ANOSIM were a likely result of the low replication and, most importantly, of the species-poor samples with many rare taxa. The numerous rare taxa meant that within-site samples tended to be as different from each other as they were to those in the other site.

The relatively high indigenous taxon diversity at the forest edge, even though expected, was a relevant finding as the edge habitat in question was highly modified with a very open understorey, and composed mostly by adult trees with numerous walking tracks through it. This highlights that even highly disturbed native habitats can still harbour numerous native dipteran species, and probably other invertebrate groups as well, which seems to imply the importance of urban fragments of native forest habitats for invertebrate biodiversity. Moreover, the overall the presence of some native dipterans in the open and highly disturbed habitat at the house backyard do indicate that many indigenous invertebrates are resilient and capable of exploiting the new habitats created by anthropogenic environmental change.

It should also be highlighted that there are considerable taxonomic impediments for New Zealand Diptera, which meant that many of the identifications here and in a previous related study were indicative (Heath and Derraik 2005). The New Zealand Diptera fauna is not only incompletely known, but there is also a lack of up-to-date revisions for many groups (Macfarlane and Andrew 2000).

Considerably more research is needed before we can adequately understand the patterns of invertebrate biodiversity in urban habitats in New Zealand. It has been suggested that even highly fragmented and disturbed patches of native habitat may be of particular relevance for biodiversity protection, particularly in lowlands and urban environments where pristine habitats are scarce (Crisp et al. 1998; Derraik et al. 2005). This study, although brief, seems to add further evidence to support the above hypothesis.

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REFERENCES

Center TD, Frank JH, Dray FA. 1995. Biological invasions - stemming the tide in Florida. Florida Entomol 78:45-55.

Clarke KR, Warwick RM. 2001. Change in marine communities: an approach to statistical analysis and interpretation, 2nd Ed. PRIMER-E Ltd., Plymouth.

Crisp PN, Dickinson KJM and Gibbs GW. 1998. Does native invertebrate diversity reflect native plant diversity? A case study from New Zealand and implications for conservation. Biol Cons 83:209-220.

Davies-Colley RJ, Payne GW, van Elswijk M. 2000. Microclimate gradients across a forest edge. N Z J Ecol 24:111-121.

Derraik JGB. 2006. Mosquitoes and public health in New Zealand – ecological studies, the threat posed by exotic species and the impact of anthropogenic environmental change. [PhD thesis] Department of Public Health, Wellington School of Medicine and Health Sciences, University of Otago, Wellington.

Derraik JGB, Barratt BIP, Sirvid P, MacFarlane RP, Patrick BH, Early J, Eyles AC, Johns PM, Fraser PM, Barker GM, Henderson R, Dale J, Harvey MS, Fenwick G, McLellan ID, Dickinson KJM, Closs GP. 2001. Invertebrate survey of a modified native shrubland, Brookdale Covenant, Rock and Pillar Range, Otago, New Zealand. N Z J Zool 28:273-290.

Derraik JGB, Rufaut CG, Closs G, Dickinson KJM. 2005. Ground invertebrate fauna associated with native shrubs and exotic pasture in a modified rural landscape, Otago, New Zealand. N Z J Ecol 29:129-135.

Derraik JGB, Slaney D. 2007. Anthropogenic environmental change, mosquito-borne diseases and human health in New Zealand. EcoHealth 4:72-81

Edwards F. 1923. A preliminary revision of the crane-flies of New Zealand (Anisopodidae, Tanyderidae, Tipulidae). Trans Proc N Z Inst 54:265-352.

Evenhuis NL (ed.). 1989. Catalog of the Diptera of the Australasian and Oceanian regions. Bishop Museum Press and EJ Brill, Honolulu.

Heath ACG, Derraik JGB. 2005. Adult Diptera trapped at two heights in two native forests and an urban environment in New Zealand. The Weta 29:22-32.

Higham T, Anderson AJ, Jacomb C. 1999. Dating the first New Zealanders: the chronology of Wairau Bar. Antiquity 73:420-427.

King CM. 1990. The handbook of New Zealand mammals. Oxford University Press, Auckland.

Macfarlane RP, Andrew IG. 2000. New Zealand Diptera identification, diversity and biogeography: a summary. Rec Canterbury Museum 15:33-72.

McAlpine JF, Peterson BV, Shewell GE, Teskey HJ, Vockeroth JR, Wood DM ed. 1981. Manual of Nearctic Diptera, Vol. 1, Monograph No. 27. Ottawa, Research Branch Agriculture Canada.

Marshall P. 1896. New Zealand Diptera: No. 1. Trans Proc N Z Inst 28:216-250.

Matile L. 1989. Family Keroplatidae. In: Catalog of the Diptera of the Australasian and Oceanian Regions (ed. Evenhuis NL), Bishop Museum Press and EJ. Brill, Honolulu, p 128-133.

McGlone MS, Wilmshurst JM. 1999. Dating initial Maori environmental impact in New Zealand. Quaternary International 59:5-16.

Southwood TRE, Henderson PA. 2000. Ecological Methods, 3rd Ed, Blackwell Science, Oxford.

Strickman D, Wirtz R, Lawyer P, Glick J, Stockwell S, Perich M. 1995. Meteorological effects on the biting activity of *Leptoconops americanus* (Diptera, Ceratopogonidae). J Am Mosq Control Assoc 11:15-20.

Tonnoir AL, Edwards FW. 1927. New Zealand fungus gnats (Diptera, Mycetophilidae). Trans Proc N Z Inst 57: 747-878.

Vockeroth JR. 1981. Mycetophilidae. In: Manual of Nearctic Diptera, Volume II, Monograph No. 27 (eds McAlpine JF, Peterson BV, Shewell GE, Teskey HJ, Vockeroth JR, Wood DM). Research Branch, Agriculture Canada, Quebec, p 223-246.

Watt JC. 1979 New Zealand Invertebrates. In: A vanishing heritage: the problem of endangered species and their habitat, Nature Conservation Council**,** Wellington, p 140-146.

Young A, Mitchell N. 1994. Microclimate and vegetation edge effects in a fragmented podocarp-broadleaf forest in New Zealand. Biol Cons 67:63-72.

Table 1. List of adult Diptera recorded in CO_2-baited light traps set overnight at a native forest edge and at a nearby house backyard, in Wellington. Note that n = 6 for each site. Species origins are indicated by nat (native) and exo (exotic). The numbers of specimens collected for each species are indicated, with the number in brackets indicating the number of traps in which a particular taxon was recorded if it happened more than once.

Family	Species	Origin	Native Forest Edge	Backyard
Cecidomyiidae	*Campylomyza* sp.	nat?	5 (2)	2
	Diadiplosis/Zeuxdiplosis sp.	?	34 (2)	4 (3)
Chironomidae	*Chironomus zealandicus* Hudson	nat	2	-
	?*Harrisius pallidus* Freeman	nat	2 (2)	-
	damaged	?	1	-
Chloropidae	*Oscinosoma* nr. *huttoni*	nat	-	1
Culicidae	*Culex (Culex) pervigilans* Bergroth	nat	1 (1)	-
	Ochlerotatus (Finlaya) notoscriptus Skuse	exo	3 (2)	1 (2)
Keroplatidae	*Chiasmoneura (Prochiasmoneura) fenestrata* Edwards	nat	3	-
	Macrocera unipunctata Tonnoir	nat	1	-
Mycetophilidae	*Mycetophila* ?*grandis* Tonnoir	nat	1	-
	Mycetophila ?*fagi* Marshall	nat	1	-
Stratiomyidae	*Exaireta spinigera* Wiedemann	exo?	-	1
Tipulidae	*Amphineurus horni*	nat	2 (2)	-
	Amphineurus ?*hudsoni* Edwards	nat	8 (3)	-
	Anisopus notatus Hutton	nat	2	-
	Dicranomyia sp.	?	-	3
	Limonia (Zelandoglochina) nr. *flavidipennis* Edwards	nat	16 (5)	3
	?*Gynoplistia sp.*	?	1	-
	Limnophilella ?*delicatula* Hudson	nat	1	-
	Leptotarsus (Chlorotipula) nr. *holochlorus* Nowicki	nat	-	1
	Molophilus (Molophilus) nr. *infantulus* Edwards	nat	1	-
	Molophilus ?*variegatus* Edwards	nat	3 (2)	-
	Dolichopeza ?*parvicauda* Edwards	nat	2	-

Figure 1. Two-dimensional MDS ordination for the taxon assemblages recorded at a native forest edge (gray triangles) and at a nearby house backyard (black circles).