The Great Lakes Entomologist

Volume 34
Number 1 - Spring/Summer 2001 *Number 1 - Spring/Summer 2001*
Article 8

April 2001

Invertebrate Terrestrial Diversity Along a Gravel Road on Barrie Island, Ontario, Canada

Austine Luce
Coastal Carolina University

Mary Crowe
Coastal Carolina University

INVERTEBRATE TERRESTRIAL DIVERSITY ALONG A GRAVEL ROAD ON BARRIE ISLAND, ONTARIO, CANADA

Austine Luce and Mary Crowe

ABSTRACT

Although roads have been a part of our landscape for hundreds of years, their impact on the plant and animal populations has only recently been studied. We examined the effect a gravel road had on terrestrial arthropod diversity in the Barrie Islands, Canada. Over a ten-week period during the summer of 1999 we systematically sampled ground and aerial terrestrial arthropods at 5, 10 and 15 m from a 250 m stretch of road. We collected nearly 5,000 insects the majority of which were Coleoptera, Diptera and Hymenoptera. We collected over 2,000 non-insect invertebrates that included representatives from the classes Gastropoda, Annelida, Arachnida, Crustacea, and Diplopoda. There were significantly more individuals at 5 m from the road than at 10 or 15 m. Our results show that invertebrate diversity indices were similar at 5, 10 and 15 m distances from the road. The similar diversity indices may reflect the level to which we keyed out invertebrates (Order) and had we keyed specimens to Family might have found greater differences. Another possibility is that over time invertebrate populations return to pre-disturbance levels along roads that experience limited vehicular traffic.

Roads have been an integral part of our landscape for hundreds of years and American's love of the automobile has lead to an increased density of roads. Because there are 6.2 million km of roads in the United States (Forman and Alexander 1998), there is a growing interest in examining how roads may affect plant and animal populations. The placement of a road automatically results in habitat fragmentation but roads may also have other ecological effects. Factors that influence how much impact a road has on the local habitat are: corridor width, connectivity and usage intensity. Roads and their associated vehicular traffic and construction contribute to local pollution (Przybylski 1979), habitat destruction and isolation (Spellerberg 1998) as well as direct mortality of numerous animals (Case 1978). Most studies examining the impact roads have had on natural populations have focused on bird and small mammal populations (Hodson 1962, Ferris 1979, Adams 1984, Reijnen et al., 1995, Forman and Alexander 1998).

Few studies have examined the effect roads have had on invertebrate community structure or behavior. Munguira and Thomas (1992) found that road verges supported a wide range of butterfly and burnet species, and that roads did not appear to substantially increase mortality nor did they hinder

---

[1]Department of Biology, Coastal Carolina University, P.O. Box 261954, Conway, S.C. 29528.

dispersal. In fact, road verges can be home to beneficial insect populations (Free et al. 1975). Roads do appear to hinder movement of snails (Baur and Baur 1990), carabid beetles (Mader 1984) and some species of butterflies (Dennis 1986). Roads may also lead to higher earthworm mortality. The vibrations from passing cars causes earthworms to leave their burrows making them more susceptible to crow predation (Tabor 1974). The purpose of this study was to examine the effect an established gravel road has on terrestrial arthropod diversity in the Barrie Islands, Canada. We were interested in determining whether arthropod diversity was lower or higher in areas immediately adjacent to the road vs. 15 m away.

MATERIALS AND METHODS

Study site. The study was conducted on Barrie Island in Northern Ontario, Canada. Barrie Island is a sparsely populated island located on Lake Huron. The forested gravel road (6m in width) has been in place for over 15 years and incurs minimal traffic.

We collected data twice a week for a ten-week period from 1 June 1 to 15 August 1999 at ten sites along a 250 m stretch of the forested gravel road. Five sites were on one side of the road and five sites were on the other side of the road. Each site was located 25 m from the prior site and we staggered sites on both sides of the road so that sites on a given side of the road were separated by 50 m. At each site three permanent plots were established at 5, 10, and 15 m from the road.

At each site we assessed invertebrate diversity using pitfall traps and vegetative sweeps. To construct the pitfall traps we dug holes 30 cm deep and placed 1.17 l coffee cans in them. When the cans were flush with the ground we placed Vaseline around the edges to keep anything from crawling out and a tablespoon of clear dish soap at the bottom to help trap anything that fell in. Twice each week the cans were left uncovered for a 24–hr period upon which time we collected the contents of the can. Immediately following the collection, we covered the cans until the next sampling period.

Sweep nets were used to capture invertebrates found above the ground at each site on Fridays and Sundays, the days we collected from the pitfall traps. We held the sweep nets 1 m from the ground and made five circular passes of the air and vegetation at each site. Every effort was made to conduct the sweeps with the same range of motion and constant speed. The general weather conditions, time, and temperature were recorded at each sampling. We took the invertebrates collected from the pitfall traps and sweep nets to the lab for identification. We keyed out insects to order and other invertebrates to class.

Using an ANOVA we examined the effect distance from road (5, 10 and 15 m) had on the abudance of specimens in the pitfall and sweep samples. We computed Shannon-Weaver diversity indexes for each the pitfall and sweep samples (Brower et al. 1998).

RESULTS

Pitfall traps. We collected over 2,500 insects in our pitfall traps and over 1,000 non-insect terrestrial invertebrates in our pitfall traps over the 10–week period. The pitfall traps located 5m from the road contained the greatest numbers both insects and non-insect terrestrial invertebrates ($F = 4.56$, d.f. = 2, $P < .01$; Table 1). There were no differences between distances

Table 1. Average number (standard deviation) of invertebrate specimens captured using pitfall and sweep net sampling methods.

	Sampling technique	
Distance from road	pitfall trap	sweep net
5 m	217.4 ± (113.37)	102.7 ± (42.56)
10 m	133.9 ± (43.52)	70.9 ± (11.85)
15 m	123.0 ± (52.84)	88.1 ± (17.03)

with respect to the insect Orders present in the pitfall traps (Table 2). Hymenoptera (ants) made up the majority of the insects found in our pitfall traps. For the following orders, we found at least one individual present in our samples but total numbers represent less than 1% of the total sample: Ephemeroptera, Mecoptera, Dermaptera, Odonata and Siphonaptera. The Shannon-Weaver diversity indices were 1.79, 1.58 and 1.49 for 5 m, 10 m and 15 m distances, respectively.

Five non-insect terrestrial classes were present in our pitfall traps (Table 3). Spiders made up an overwhelming majority of our samples while Crustaceans placed a distant second. Some of the individuals in our non-insect samples were smashed during collection and while samples were transported to the lab. Although we could isolate a given individual specimen (body plus legs) we were unable to determine to what class it belonged (Tables 3 and 5).

Sweep nets. As with the pitfall traps the greatest numbers of insects and non-insect invertebrates were collected 5 m from the road ($F = 3.38$, d.f. = 2, $P < .04$); Table 1). We collected over 2,400 insects and 1,200 non-insect terrestrial invertebrates while sweeping the vegetation surrounding the pitfall traps. The Shannon-Weaver diversity indices were 0.54, 0.42 and 1.15 for 5 m, 10 m and 15 m distances respectively. The lower Shannon values for the sweep net samples are probably a result of fewer insect orders found in the sweep nets vs. the pitfall traps. The majority of sweep net samples appeared to be mosquitoes (Diptera) (Table 4).

As in the pitfall samples, spiders made up the majority of non-insect invertebrate specimens in our sweep net samples (Table 5). Two of the classes (Gastropoda and Diplopoda) found in the pitfall traps were missing from the sweep net samples. This is not surprising given that organisms found in the classes Gastropoda and Diplopoda are mostly ground dwelling animals.

DISCUSSION

Our data suggest that invertebrate community composition was not influenced by the presence of a road. The types of insects and non-insect terrestrial invertebrates found at sites 5 m from the road's edge were not different from those 15 m from the road. The failure to document any impact of the road on diversity is likely a result of our keying out samples only to the level of order for the insects and class for non-insects. Had we been able to key samples to the level of families we might have found differences.

Contrary to our expectations, we found more invertebrates closer to the road rather than further away. Przybylski (1979) found twice as many Diptera and Hymenoptera at sites greater than 50 m from the road versus sites within 50 m of the road. However, in his study there were higher numbers of Aphididae at the sites within in 50 m of the road versus those between 50 and 100 m of the road. The road we chose to study was a gravel

Table 2. Percent abundance of insect orders collected in pitfall traps at different distances from the road.

Distance from road (m)	Total # of individuals	Dictyoptera	Orthoptera	Hemiptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera
5	1,014	<1	2.2	1.4	20.0	2.2	10.2	63.5
10	795	<1	1.2	1.6	25.6	2.5	11.7	56.4
15	716	2.1	2.6	<1	31.3	<1	12.0	50.0

Table 3. Percent abundance of non-insect terrestrial invertebrates collected in pitfall traps at different distances from the road traps.

Distance from road (m)	Total # of individuals	Gastropoda	Annelida	Arachnida	Crustacea	Diplopoda	Unidentifiable
5	581	2.6	1	72.2	20.6	<1	3.2
10	277	8.7	3.6	70.4	10.8	1.8	4.7
15	260	6.5	6.1	71.9	6.9	1.1	7.3

Table 4. Percent abundance of insect orders collected in sweep nets at the different distances from the road.

Distance from road (m)	Total # of individuals	Hemiptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera
5	981	8.1	11.7	2.1	48.3	28.1
10	657	5.9	11.5	3.3	64.1	14.0
15	817	8.7	10.5	2.7	62.5	15.3

Table 5. Percent abundance of non-insect terrestrial invertebrates collected in sweep nets at the different distances from the road.

Distance from road (m)	Total # of individuals	Annelida	Crustacea	Arachnida	Unidentifiable
5	496	<1	4.2	90.5	3.2
10	332	1.2	2.1	90.4	6.3
15	436	<1	2.0	91.8	5.2

road that had very limited vehicular traffic. Because of limited road use by the population on Barrie Island, our study site may act like a natural gap rather than roads that experience more traffic or that are made of other materials. It would be interesting to repeat the study along a section of the road that experiences more traffic.

ACKNOWLEDGMENTS

This study was part of Austine Luce's senior thesis. We would like to thank Leisha Rottering for help in entering data on the computer and Barrie High School students for helping us in the field.

LITERATURE CITED

Adams, L. W. 1984. Small mammal use of an interstate highway median strip. J. Appl. Ecol. 21: 175–178.

Baur, A. and B. Baur. 1990. Are roads barriers to dispersal in the land snail *Arianta arbustorum*? Can. J. Zool. 68: 613–617.

Brower, J. E., J. H. Zar, and L. N. von Ende. 1998. Field and laboratory methods for general ecology. 4th edition. McGraw-Hill, New York, New York.

Case, R. M. 1978. Interstate highway road-killed animals: a data source for biologists. Wildl. Soc. Bull. 6: 8–13.

Dennis, R. L. H. 1986. Motorways and cross-movements. An insect 'mental map' of the M56 in Cheshire. Bull. Am. Ento. Soc. 45: 228–243.

Ferris, C. R. 1979. Effects of interstate 95 on breeding birds in northern Maine. J. Wildl. Manage 43: 421–427.

Free, J. B., D. Gennard, J. H. Stevenson and I. Williams. 1975. Beneficial insects present on a motorway verge. Biol. Cons. 8: 61–72.

Forman R. T. T. and L. E. Alexander. 1998. Roads and their major ecological effects. Ann. Rev. Ecol. Syst. 29: 207–31.

Hodson, N. L. 1962. Some notes on the causes of bird road casualties. Bird Study 6: 168–173.

Mader, H. J. 1984. Animal habitat isolation by roads and agricultural fields. Biol. Cons. 29: 81–96.

Munguira, M. L. and J. A. Thomas. 1992. Use of road verges by butterfly and burnet populations and the effect of roads on adult dispersal and mortality. J. Appl. Ecol. 29: 316–329.

Przybylski, Z. 1979. The effects of automobile exhaust gases on the arthropods of cultivated plants, meadows and orchards. Environ. Pollut. 19: 157–161.

Reijnen, R., R. Foppen, C. Terbraak and J. Thissen. 1995. The effects of car traffic on breeding bird populations in woodland. III. Reduction of density in relation to the proximity of main roads. J. Appl. Ecol. 32: 187–202.

Spellerberg, I. F. 1998. Ecological effects of roads and traffic: a literature review. Global Ecol. And Biogeography Letters 7: 317–333.

Tabor, R. 1974. Earthworms, crows, vibrations and motorways. New Scientist 62: 482–483.