

COMPARATIVE ARTHROPOD PROJECT

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Abstract (T.Gr.)

We sampled arthropods with sweep nets in four different Costa Rican habitats. We looked at the associations between insect populations and the various forest types, specifically evaluating arthropod abundances and diversity. We also compared these two parameters at different sites within the forest types. We found significant insect population associations both within and between forest types. These results suggest that habitat types affect insect diversity.

Introduction (T.Go., V.V.)

We examined arthropod communities in four major tropical preserves of Costa Rica which differed in physical and biological characteristics. These were lowland dry forest (Palo Verde), Pacific lowland moist forest (Corcovado), cloud forest (Monteverde), and Atlantic lowland rainforest (La Selva). We assumed that these preserves differ in resources, and we studied the dependence of arthropod abundance on preserve characteristics. We looked at the differences in arthropod abundance between different sites within each preserve. Within any site, organisms utilize numerous niches. Diversity of organisms is generally dependent on the number of available niches. We compared the numbers of orders (an indication of diversity) in the different sites at a preserve, and in similar sites in different preserves. We also looked at the number of individuals within each order in the different sites in each preserve to see if a particular site was more suitable for an order. As orders of arthropods may not always be indicative of ecological trophic levels we compared herbivorous orders in different environments at each site to see if particular sites were more suitable to herbivores.

Methods (T.Gr.)

We sampled insects at four sites in Costa Rica: Palo Verde on 11 January 1991, Corcovado on 25 January 1991, Monteverde on 2 February 1991, and La Selva on 8 February 1991. In all sites we sampled 25-m transects, with at least two one replicates of each habitat type. Each transect was one sweep length (approximately 100cm) in width.

In Palo Verde we sampled six transects total: four on the Toledo Trail and two on the access road. It was a bright day of 91°F. Both areas had a few emergent trees, with dense scrubby undergrowth; the canopy over the road was significantly more open.

We took seven terrestrial transects at Corcovado: two on the Pavo Trail, two on the air

strip, and three on the beach. The Pavo Trail ran through secondary growth and was dominated by heliconias. The air strip consisted of grasses and low shrubs and was in the direct sun. The beach transects were sandy dunes spotted with small leguminous trees. The temperature was 85°F. We also collected aquatic samples from the Rio Claro in Corcovado. We completed two transects, overturning rocks to find sedimentary insects and scanning for swimming insects.

In Monteverde, we took six transects in the bullpen: three in random directions in the grass and three on the south edge. The open grass contained a few trees and vines. The edge bordered on secondary forest. There was a heavy mist and rain, and a temperature of 55°F. We also attempted to collect aquatic samples in Monteverde but were unable to do so because the stream was too deep, the water was too dirty, and there weren't enough areas to sample.

In La Selva, we took a total of six transects. All were on the Sendero Holdridge by the successional plots; three were on the edge of primary forest and three were on the edge of secondary forest. The primary transects had dense vegetation, patchy sunlight, and a temperature of 85°F. The secondary forest, however, was sparse in vegetation and the sun had given way to clouds. We also tried aquatic sampling in the Rio Salto in La Selva, and again were unable to do so because we could not find an area that was suitable for sampling.

We compared data within each site and between sites. We will discuss these parameters further in the results section.

Results (V.V.)

The number of individuals of each order collected in similar habitats across preserves were compared using Mann Whitney U tests (see Table 1). The number of individuals (Mean +/-sd) collected from each order in each site is reported in Table 2. We also compared the number of orders and the total number of individuals within each order and across each order between different sampling sites (habitat) within a preserve (see Table 3).

Repeated pairwise Mann Whitney U tests were used instead of a multiple comparison test because we had no way to evaluate between group differences if our tests had been significant.

Discussion (G.Y., L.T.)

Comparison of the total number of orders represented at sites of similar types of vegetation located in different preserves could reveal the effects of different climatic factors, such as elevation, temperature, and/or humidity, on arthropod diversity in those sites. The lack of a significant difference in number of orders present at the airstrip and bullpen suggests that the differences in elevation and mean annual temperature between these two sites of grass dominated vegetation does not affect the number of insect orders present. Mean annual precipitation is much lower in the secondary forest along the Toledo Trail than along the Whittaker Plots, and

significantly more orders are represented at the latter site. These points suggest that in lowland tropical forest, increasing precipitation increases the number of orders present. Unfortunately, isolated climatic factors such as elevation, temperature, and humidity only represent a few of many actual differences between sites of similar vegetation in different preserves, we have not considered other possible differences carefully enough to claim that our two above mentioned conclusions are strong ones.

Comparison of the total number of orders represented at different sites within the same preserve can reveal differences in the ability of different vegetation types in similar climatic conditions to support arthropods. In Palo Verde, Corcovado, and Monteverde, different vegetation types within each preserve did not affect the number of orders present. But in La Selva, primary forest supported significantly more insect orders than secondary forest. Perhaps primary forest contains a greater diversity of plant species, and thus more niches to support more insect orders, compared to secondary forest which may be dominated by a less diverse group of early successional plant species. Note however that the primary forest sites contained a more dense shrub layer, which may have resulted in our capturing a greater number of insect orders there.

Comparison of the total number of individuals represented at different sites within the same preserve can reveal the ability of different vegetation types, under similar climatic conditions, to support different total numbers of individuals. In Palo Verde and Corcovado, different vegetation types within each forest did not affect the number of individuals present. In Monteverde, the edge of the bullpen supports more individuals than the bullpen itself, possibly because of a greater diversity of plant species present in the shrub layer at the edge of the bullpen, which possibly provides a more varied substrate supporting a greater total number of arthropods. In La Selva, primary forest contains more individuals than secondary forest, possibly for the aforementioned reason that primary forest contains a greater diversity of plant species and thus could support a greater total number of individuals.

It seems that the most telling set of comparisons were those that focused on the number of individuals within an order that were found at each site. This presents a picture of how the different orders divide up an environment and what aspects of a habitat appeal to which order.

In Corcovado, there was a clear pattern between the three field sites: secondary forest (Pavo Trail), airstrip, and beach edge. For most orders, it appears that the beach was the least hospitable habitat. Only Dipterans were moderately successful there, and this was probably due to the fact that many of them are scavengers and could take advantage of the dead organic matter washed up on shore. The low density of vegetation may have made it undesirable for any other order. It appears that the secondary forest was generally the best habitat. This is probably due to its complex structure which creates a larger number of niches for the orders to fill. This did not show up in total numbers of individuals because those orders that do survive on the airstrip and the beach encounter less competition from other orders and have very high numbers.

There was much less of a trend in site preference at Monteverde and La Selva. At Monteverde greater numbers of Orthopterans and Homopterans were found in the bull pen than along the edge of the forest. This makes sense for Orthopterans since much of their diet is grasses. Also, 100% of our sampling in the bullpen was within good Orthopteran habitat, where as Orthopterans would only occur in the lower portion of edge vegetation. It is possible that Homopterans were less abundant at the edge because a lot of the vegetation there was emergent. This would provide little greenery for them to feed on when compared to the grassy bull pen and possibly higher exposure to predators. There was little significant difference in the distribution of all the other orders. In some cases this could be attributed to very low numbers. However, for such arthropods as Homopterans and Dipterans, this shows their orders' ability to cover a range of niches.

At La Selva there was a similar trend in that most of the orders had little significant difference in the number of individuals distributed between the primary forest and the secondary forest. The Lepidopterans, Hemipterans, Homopterans, and Coleopterans had a significantly higher number of individuals in the primary forest. The primary forest did appear to be more lush in this area which may result in more niches for these orders. However, we were doing our sampling at the edges of these forests which may have changed the structure of these areas.

We have been able to make some suggestions for the interpretation of our data, but there is a general weakness of the study. Our classification of arthropods was by orders which is purely taxonomic. These groupings are so general that they can cover many ecological niches and so make it hard to extrapolate trends found in them to such parameters as niche distribution in a site. Therefore, we would suggest an improvement in the study would be focusing on ecological classification instead of taxonomic. We did some of this by looking at the distribution of total numbers of herbivores at the different preserves. At Palo Verde there was no significant difference

in their distribution, probably due to the fact that both sites of sampling were done in secondary forest. At Corcovado, higher numbers of herbivores were found in the secondary forest and airstrip when compared to the beach. In these habitats there is generally greater diversity in vegetation, as well as a greater biomass of vegetation. At Monteverde, the increased number of herbivores found in the bullpen, again, probably reflects the fact that there was less edible vegetation at the edge. Similarly at La Selva, we found the greater number of herbivores at the edge of the primary forest where the vegetation appeared more lush. With these classifications it is easier to draw conclusions about what kind of niches a site offers and which organisms would be able to utilize them. With improvements a comparative study such as this one could provide useful knowledge about the diversity and distribution of Costa Rica's arthropods, a vital element in the entire tropics' ecosystem.

Table 1 Comparison of numbers of orders of arthropods represented in similar sites of different preserves.

Sites	Preserves compared	Results
Grassy fields	Corcovado (airstrip) vs. Monteverde (bullpen)	No statistically significant difference (MWU, $p > 0.05$)
2° Forest	Palo Verde (Toledo Trail) vs. Corcovado (Pavo Trail) vs. La Selva (Holdridge Trail)	La Selva > Palo Verde (MWU=12; $n_1 = 4$, $n_2 = 3$; $p < 0.05$) No other statistically significant differences

Table 2 Mean individuals of each order at each sampling site.

Preserve	Site	De	I	Homo	Nemi	Col	Lep	Hym	Neur
Palo Verde	Toledo Trail	0	0	1.25 +1.63	5.30 +3.80	6.10 +2.50	1.30 + .83	1.13 +4.00	0
(1/11/91)	Road	0	0	1.50 +1.50	2.50 + .50	28.00 +4.00	0	8.00 +3.00	0
Corcovado	Pavo Trail	0	0	27.50 +17.50	4.00 +1.00	20.00 +2.00	5.50 +1.50	24.00 +14.00	0
(1/25/91)	Air Strip	0	0	14.00 +2.00	15.00 +5.00	10.50 +2.90	12.50 + .50	4.00 +1.00	0
	Beach	0	0	4.00 +2.80	0	7.00 +4.00	0.30 + .47	5.30 +6.00	0
Monteverde	Bull-pen	0.30 + .47	1.00 + .82	17.00 +8.60	0.67 +0.47	2.30 +0.94	1.30 +1.25	1.67 + .47	0.30 +0.49
(2/2/91)	Edge of bullpen	0	1.30 +1.20	3.00 + .82	1.00 +0	2.30 + .47	1.67 +1.70	3.00 +1.40	0
La Selva	Primary Forest	0	2.00 +1.40	9.30 +1.25	3.30 +1.70	10.30 + .94	6.30 + .47	23.00 +7.30	0
(2/8/91)	Secondary Forest	.0	67 + .94	2.30 + .47	0	3.00 +1.40	3.00 +1.40	14.00 +4.30	0

(Table 2 continued)

Preserve		Dip	Od	Ar	Orth	Eph	Tr	Th
Palo Verde (1/11/91)	Toledo	8.00	.50	11.00	4.50	0	0	0
	Trail	+5.40	+.86	+4.60	+1.50			
	Road	4.00	0	6.00	1.50	0	0	0
		+1.00		+3.00	+1.50			
Corcovado (1/25/91)	Pavo	15.00	0	21.00	25.00	0	0	0
	Trail	+0.50		+1.00	+2.50			
	Air	6.00	0	8.50	12.00	0	0	0
	Strip	+2.00		+4.50	+3.00			
	Beach	10.60	0	0	.66	0	0	0
		+7.50			+.94			
Monteverde (2/2/91)	Bull-	8.30	0	0	47.00	0	0	0
	pen	+5.20			+11.90			
	Edge of	9.60	0	0	5.00	0	0	0
	Bullpen	+4.60			+.86			
La Selva (2/8/91)	Primary	14.00	0	9.30	14.00	0	0	.30
	Forest	+4.30		+.47	+4.10			+.47
	Secondary	11.00	0	12.00	9.30	0	0	0
	Forest	+2.90		+6.50	+4.10			

Order Abbreviations

De: Dermaptera Lep: Lepidoptera Ar: Aranoe
I: Isopod Hym: Hymenoptera Orth: Orthoptera
Homo: Homopteran Neur: Neuroptera Eph: Ephemeroptera
Hemi: Hemipteran Dip: Diptera Tr: Trichoptera
Col: Coleopteran Od: Odonata Th: Thysanura

Table 3 Comparisons of Arthropods at Sites in Different Preserves (Jan-Feb 1991, Costa Rica).

Preserve	Site	#. of Orders	Total #of Ind.	#. of ind. in each order	#. of herbivores
Palo Verde 1-12-91	Road, (R) Toledo trail(T)	No significant difference	No significant difference	No significant difference	No significant difference
Corcovado 1-25-91	Airstrip (A) Pavo Trail(P) Beach (B)	No significant difference	No significant difference	Ortho:P>A>B (p<.05) Hemi:A>P>B (p<.05) Homo:A,P>B (p<.05) Cole:P>A>B (p<.05) Dip:P>B>A (p<.05) Hym:P,A>B (p<.05) Lep:No sig. difference	P>B(P<0.1 test does not allow lower p)
Monteverde 2-2-91	Bullpen (BP) Edge of Pen(E)	No significant difference	E>BP(p<.05)	Orth:BP>E (p<.05) Homo:PB>E (p<.05) others: No sig. difference	BE>E (p<.05)
La Selva 2-9-91	1° Forest (1°) 2°Forest (2°)	1°>2° (p<.05)	1°>2° (p<.05)	Hemi:1°>2° (p<.05) Homo:1°>2° (p<.05) Cole:1°>2° (p<.05) Lepid:1°>2° (p<.05) Others: No sign. difference	1°>2°(p<.05)