Exercise 5B
Behavior & Population Dispersion

Parts of this lab adapted from *General Ecology Labs*, Dr. Chris Brown, Tennessee Technological University and *Ecology on Campus*, Dr. Robert Kingsolver, Bellarmine University.

Lab Exercise 5B: Dispersion of Isopods in an Artificial Habitat

Research Question

Do terrestrial isopods seek out conspecifics when selecting a habitat, or do they disperse to partition resources more evenly by avoiding habitat spaces occupied by others?

Preparation

Terrestrial isopods include "pill bugs" (genus *Armadillium),* which roll into a ball when threatened, and the flatter and less flexible "sow bugs" (genus *Oniscus).* These arthropods are widely distributed, and are easily collected from leaf litter, under rocks and logs, or in lumber piles around buildings in most of North America. They can also be obtained from laboratory supply companies. Isopods feed on decaying organic material and are not difficult to handle or maintain in the laboratory. Use a covered container with some air exchange, such as a terrarium, plastic food container with perforated lid, or plastic shoe box. You might find a spoon and a small paintbrush handy to "sweep" them up and transport them from one place to another. It is very important to keep damp leaf mold or moistened paper toweling in their habitat at all times, because isopods use gills for respiration, and require high humidity.

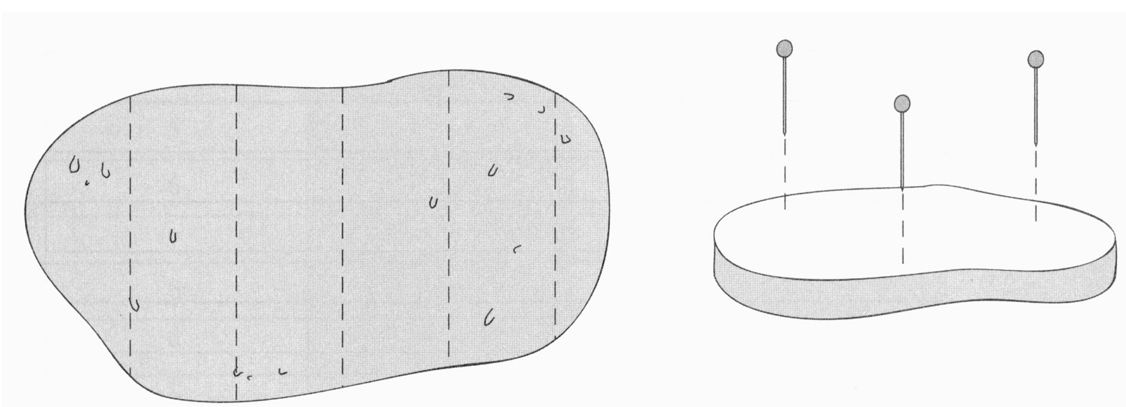

Figure 5.5 Slice potatoes and insert pins to make isopod shelters.

Materials (per laboratory team)

Plastic sweater box or other box-shaped container with a flat bottom, about 30 x 50 cm
5 medium potatoes
3-4 inch paring knife
60 map pins (with round heads, about 5 mm diameter) 20-30 live terrestrial isopods
Cutting board or cutting surface on lab bench

Procedure

1. Prepare "resource islands" from potatoes. First, cross-section a potato with parallel cuts evenly spaced 1 cm apart. You should get four or five round sections from each potato. Discard the ends, and cut more potatoes until you have 20 sections of approximately equal size and thickness. Then insert three map pins in a triangle formation on the bottom of each potato slice, so that the potato slice will stand on the map pins like a three-legged stool (Figure 3.5). The pins should leave about _ cm of space for the isopods to crawl underneath.

2. Arrange the 20 potato slices, pinheads down, in the bottom of the sweater box. Distribute the potato slices uniformly, with space separating each one. You now have an artificial habitat with 20 resource islands suitable for isopod colonization.

3. Release 20-30 isopods into the box. Take a few minutes to observe their behavior. How do they react to the box edges? to the potato "islands"? to one another?

4. Leave the isopods overnight. The underside of the potato slice islands provide a dark, humid microclimate that is preferred by isopods. They also feed on the potatoes. If lights are left on in the room, all isopods should select one of the potato slices to hide under.

5. After the isopods have had time to adjust to their habitat (12-48 hrs), count the number of isopods underneath each potato slice. You will need to pick up each "habitat island," because the isopods often invert themselves and cling to the potato. Record 0 if there are none in that sample. The 20 numbers you record should sum to the number of isopods you released into the box.

6. Complete the Data Table and calculation page at the end of this chapter. The mean number of isopods per potato slice ($\bar{x}$) is the ecological density, and the variance/mean ratio provides an index of aggregation for the captive isopod population.

Data Analysis

1. Enter your 20 counts of organisms per sampling unit (x_i) in the second column of Table 3.2.
2. Calculate a mean ($\bar{x}$) by summing all the counts and dividing by the sample size (n = 20).
3. Subtract the mean from each data value to obtain the deviation from the average (d_j).
4. Square each deviation $(d^2)_i$. (Note that this step takes care of the negative signs.)
5. Add up all the squared deviations (Σd^2).
6. Divide the sum of d^2 values by (sample size - 1) to calculate the sample variance (S^2).
7. Finally, divide the variance by the mean ($\bar{x}$) to compute the variance/mean ratio ($S^2/\bar{x}$).
8. By comparing the variance of your 20 potato islands with the mean, you will determine whether the plants you sampled are aggregated, random, or uniformly dispersed. Refer to the Introduction, and to the **index of dispersion** you learned in Exercise 3B, to interpret this ratio.

Table 5.2 Potato Islands

Sample number (i)	No. of organisms in sample i (x_i)		Deviations (d_i)		Squared deviations $(d^2)_i$
1		$-\bar{x}$ =		^2 =	
2		$-\bar{x}$ =		^2 =	
3		$-\bar{x}$ =		^2 =	
4		$-\bar{x}$ =		^2 =	
5		$-\bar{x}$ =		^2 =	
6		$-\bar{x}$ =		^2 =	
7		$-\bar{x}$ =		^2 =	
8		$-\bar{x}$ =		^2 =	
9		$-\bar{x}$ =		^2 =	
10		$-\bar{x}$ =		^2 =	
11		$-\bar{x}$ =		^2 =	
12		$-\bar{x}$ =		^2 =	
13		$-\bar{x}$ =		^2 =	
14		$-\bar{x}$ =		^2 =	
15		$-\bar{x}$ =		^2 =	
16		$-\bar{x}$ =		^2 =	
17		$-\bar{x}$ =		^2 =	
18		$-\bar{x}$ =		^2 =	
19		$-\bar{x}$ =		^2 =	
n = 20		$-\bar{x}$ =		^2 =	
Total # organisms $\Sigma(x_i)$ =		**Sum of Squared Deviations** $\Sigma(d^2)_i$ =			
Mean $\Sigma(x_i)/n$ =		**Sample Variance** $s^2 = \Sigma(d^2)_i/(n-1)$ =			
	Variance/Mean $(s^2/\bar{x})$ =				

Statistical Analysis of Data

As described above and in Exercise 3B, if the organisms (in this case, the isopods) are distributed randomly, their counts per sample should follow a Poisson distribution and the sample variance should approximately equal the sample mean. Thus, since the **Index of Dispersion (*I*) = $s^2/\bar{x}$**, if the distribution is random, then *I* = 1. Conversely, if the distribution is *not* random (i.e., uniform or aggregated), then *I* ≠ 1.
It may not be obvious, but this is another example of **categorical** (nominal qualitative) **data**. Is the distribution random, uniform, or aggregated? So, once again, we can utilize a **chi-square test**. If we have hypothesized that environmental and/or social factors will result in uniform or aggregated distribution, then our *null hypothesis* is that such factors are *not* significant and dispersion of individuals is random.
Therefore, our statistics should test the null hypothesis that *I* = 1.

In Exercise 5A, we used Pearson's Chi-Square Test of Goodness of Fit. For this exercise, we'll use the **Chi-Square Test of Independence**.

For this version of chi-square, $\chi^2 = (\Sigma d^2_i)/\bar{x}$; with **degrees of freedom (*df*) = n–1**, and n being the number of samples (in our case, number of potato islands). So, if we counted isopods on twenty islands, n=20 and *df*=19.

Combining the equations for s^2, *I*, and χ^2, we can simplify to get $\chi^2 = I * df$.
So take your value for *I* calculated in Table 5.2, multiply by your *df*, and compare your **calculated χ^2** to the **critical χ^2** value in the **Table 5.4 Critical values of chi-square** for your *df* and a significance level (α) of 0.05. If the calculated χ^2 is greater than the critical χ^2 value, you may reject the null hypothesis in favor of a non-random dispersion.

Table 5.3 Chi-square test of isopod dispersion index

I	*df*	calculated χ^2 value	critical χ^2 value	Hypothesis supported
				Random / Uniform / Aggregated

Discussion

1. Based on the variance/mean ratio and chi-square test, what can you conclude about the spatial pattern of your population? How might you explain this pattern, given observations you made as you were sampling?

2. Would you expect another organism from the same biological community to exhibit a similar index of dispersion? Is spatial pattern a property of the organism, or of its habitat?

Table 5.4: Critical values of chi-square

Degrees of freedom (*df*)	Significance level (α) .99	.975	.95	.9	.1	.05	.025	.01
1	-------	0.001	0.004	0.016	2.706	3.841	5.024	6.635
2	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210
3	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345
4	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277
5	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086
6	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812
7	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475
8	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090
9	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666
10	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209
11	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725
12	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217
13	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688
14	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141
15	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578
16	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000
17	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409
18	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805
19	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191
20	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566
21	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932
22	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289
23	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638
24	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980
25	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314
26	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642
27	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963
28	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278
29	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588
30	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892
40	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691
50	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154
60	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379
70	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425
80	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329
100	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116
1000	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807