Great Basin Naturalist

Volume 40 | Number 3 Article 12

9-30-1980

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OBSERVATIONS ON SEASONAL VARIATION IN DESERT ARTHROPODS IN CENTRAL NEVADA

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ABSTRACT — Pitfall and Malaise trap collections from terrestrial arthropod populations in central Nevada were analyzed for four trapping periods during the 1978 growing season. Mites (Acarina) and ants (Formicidae) were the taxa represented by the largest numbers of individuals in pitfall trap collections throughout the season; Malaise collections were composed mainly of aerial taxa (largely Diptera and Hymenoptera). Peak arthropod abundance was recorded during mid-June. Collection diversities for both trapping methods were generally low due to the abundance of a few taxa. Evidence for spatial heterogeneity in arthropod populations was meager; temporal heterogeneity in these populations, however, was more apparent.

Within shrub desert communities invertebrate animals constitute a major part of the biotic matrix (Fautin 1946), forming an important food resource for many consumer species. Spatial and temporal variation in such a resource base can affect the foraging patterns of individual consumers (Gill and Wolf 1977, MacArthur and Pianka 1966) as well as their intra- and interspecific ecological relationships (Wiens 1976).

Commonly, investigations of arthropod populations are limited to faunistic inventories (e.g., Allred et al. 1965, Beck and Allred 1968), or to broad scale comparisons (e.g., Allred 1973, Allred and Gertsch 1976, Gertsch and Allred 1965). The present report represents a preliminary analysis of one part of an ongoing investigation of lizard ecology in the Great Basin Desert. Here I will deal with the arthropod food base at a single location, focusing upon the relative success of two sampling schemes, seasonal changes in arthropod abundance and diversity, and the apparent degree of local spatial and temporal heterogeneity in arthropod populations.

Study Site and Methods

The research site is in Fairview Valley, Nevada, a relatively flat basin ranging in elevation from 1370 to 1500 m. Vegetation within the valley is dominated by *Atriplex confertifolia*, *Sarcobatus baileyi*, and *Oryzopsis hymenoides* and generally typifies the shadscale zone common to much of interior Nevada (Billings 1949). Average monthly temperatures for the site vary from about 0 C to just over 23 C; average monthly precipitation varies from about .5 cm to just over 1.5 cm; mean growing season is 142 days.

Data were analyzed from an insect sampling plot established approximately 9.6 km N of Frenchman, Churchill County, where 49 pitfall traps were arrayed along cardinal compass directions at intervals of 5 m (Fig. 1). Traps were randomly located with respect to the vegetation; the total linear distance of each line was 120 m. Each pitfall trap measures 98 mm in diameter by 144 mm in depth; a funnel insert prevents escape of arthropods once captured. A Malaise trap (Townes 1972) was placed at approximately the center of the two lines (Fig. 1).

Malaise and pitfall traps were opened for a period of 48 hours, followed by a closed period of generally equal duration. This schedule was maintained from 13 May to 24 August 1978 and yielded a new sample at roughly four-day intervals. Each trap contained a standardized amount of 5 percent formaldehyde solution. The captures of each "arm" of the pitfall traplines for each trapping period were combined. Thus, each of the N-, S-, and W-arm samples contained the contents of 12 traps, and the E-arm sample contained those of 13 traps. Contents of Malaise trap samples were maintained separately.

To examine the major seasonal patterns in the prospective arthropod food base, samples were analyzed for four trapping periods designated 13 May, 12 June, 14 July, and 12

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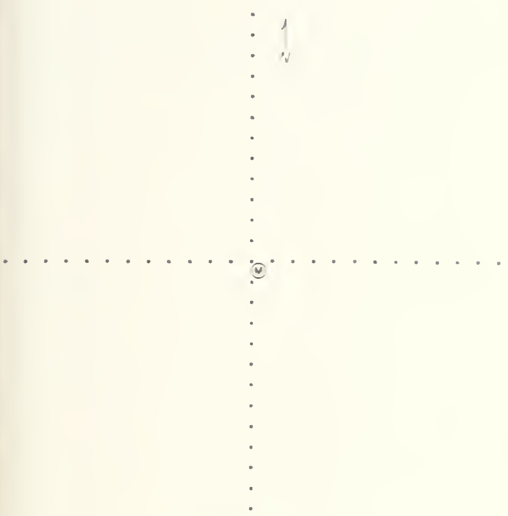

Fig. 1. Pitfall and Malaise trap placements. Dots represent pitfall traps; *M* represents Malaise trap.

August. These spanned the major part of the surface-active season for lizards in 1978. Arachnids caught were identified to the ordinal level; insects caught were identified to family or superfamily where practicable, using Borror, DeLong, and Triplehorn (1976), Borror and White (1970), and Chu (1949). Samples from each arm of the pitfall trapping grid were analyzed separately, as were Malaise samples. Total counts of identified groups were then determined for each sample. Arthropod diversity within a sample was assessed using $B = 1/\Sigma p_i^2$, where p_i equals the proportion of individuals in category *i* (MacArthur 1972). The relative degrees of spatial and temporal heterogeneity were assessed using a similarity index, S, where

$$S = 1 - \frac{1}{2}(\Sigma |p_{x,i} - p_{y,i}|) \quad ,$$

and $p_{x,i}$ and $p_{y,i}$ are the proportions of samples x and y in category *i* (Schoener 1970).

RESULTS

Trapping success.— For the four trapping periods analyzed, the two methods employed amassed a total catch of 7176 arthropods. The vast majority of these, 6117, were collected along pitfall traplines; 1059 arthropods were collected by Malaise trapping. On a per-trapping period basis, Malaise trapping yielded an average of 265 captures. This is a substantially lower capture rate (up to 50 percent lower) than when these traps are used in forested habitats (Matthews and Matthews 1971). Pitfall traps also yielded a higher number of captures per trapping period, averaging 382 per trapline arm, or just over 1500 captures per trapping grid. However, capture rates for the two methods are not directly comparable due to the greater "at risk" area for pitfall traps.

The composition of collections obtained by the two methods also differed substantially. Pitfall collections were dominated by mites (Acarina), which comprised almost half the total collection. These were followed, in order of numerical importance, by Hymenoptera (the vast majority of which were ants), Coleoptera, and Diptera. In all, largely or completely terrestrial forms comprised approximately 88 percent of the arthropods collected. Malaise trap collections, by contrast, were dominated by Diptera, which formed over 70 percent of the total collection. Hymenoptera, Homoptera, Lepidoptera, and Coleoptera combined to form just over one-quarter of the total collection (Table 1). These data are consistent with those from Malaise traps used in forested areas in which Diptera, Hymenoptera, Hemiptera (including Homoptera), and Lepidoptera constitute at least 90 percent of each collection (Matthews and Matthews 1971).

Seasonal changes in abundance and diversity.— Arthropod abundance appeared to peak during mid-June, approximately 1.5 months after the last of the spring rains. Numbers of arthropods declined rapidly thereafter to moderate levels. This seasonal trend is closely reflected in collections from pitfall traps but not from Malaise trapping (Fig. 2A). The low number of captures on 12 June may reflect an actual decrease in aerial insects, but it is more likely that this is a reflection of local changes in wind conditions, to which this technique is highly susceptible (Matthews and Matthews 1971). This interpretation is strengthened by the observation that aerial insects occurred in approximately equal numbers in the 12 June and 14 July Malaise samples.

TABLE 1. Summary of arthropods collected in pitfall and Malaise trap samples.

Taxa		Pitfall trap		Malaise trap	
		Number of specimens	Relative abundance	Number of specimens	Relative abundance
Acarina		3051	0.4988	1	0.0009
Araneida		104	0.0170	6	0.0057
Scorpionida		16	0.0026		
Solpugida		2	0.0003		
Coleoptera	Anthribidae	30	0.0049	2	0.0019
	Buprestidae	17	0.0028	1	0.0009
Carabidae		5	0.0008		
	Curculionidae	2	0.0003	2	0.0019
	Dascillidae			1	0.0009
	Histeridae	5	0.0008		
	Leiodidae	2	0.0003		
	Melyridae	244	0.0399		
	Nitidulidae	1	0.0002		
	Pedilidae	1	0.0002		
	Staphylinidae	3	0.0005	4	0.0038
	Tenebrionidae	243	0.0397	29	0.0274
Collembola	Sminthuridae	38	0.0062		
	Poduridae	7	0.0011		
Diptera	Anthomyiidae	24	0.0039	3	0.0028
	Bibionidae	1	0.0002		
	Bombyliidae	3	0.0005	5	0.0047
	Calliphoridae	1	0.0002		
	Cecidomyiidae	37	0.0060	197	0.1860
	Chironomidae			5	0.0047
	Conopidae			1	0.0009
	Dolichopodidae	18	0.0029		
	Empididae	1	0.0002		
	Lauxaniidae			4	0.0038
	Muscidae	8	0.0013	11	0.0104
	Mycetophilidae	4	0.0007	3	0.0028
	Pipunculidae			9	0.0085
	Psychodidae	1	0.0002		
	Ptychopteridae			1	0.0009
	Sarcophagidae	1	0.0002		
	Sciaridae	3	0.0005		
	Simuliidae	45	0.0074	41	0.0387
	Syrphidae	1	0.0002	203	0.1917
	Tachinidae	18	0.0029	21	0.0198
	Therevidae	1	0.0002	1	0.0009
	Tipulidae			1	0.0009
	Xylophagidae			3	0.0028
	Acalypterate muscoids	42	0.0069	248	0.2342
	Diptera larvae	2	0.0003		
Hemiptera	Lygaeidae	84	0.0137	3	0.0028
	Miridae	18	0.0029	4	0.0038
	Nabidae	2	0.0003		
	Pentatomidae	2	0.0003		
	Tingidae	1	0.0002	1	0.0009
Homoptera	Aphididae	10	0.0016	60	0.0567
	Cercopidae	5	0.0008		
	Cicadellidae	102	0.0167	11	0.0104
	Coccoidea	2	0.0003		
	Nymph/larvae	1	0.0002		

Table 1 continued.

		Pitfall trap		Malaise trap	
Hymenoptera	Andrenidae	6	0.0010		
	Apidae	21	0.0034	1	0.0009
	Braconidae			13	0.0123
	Chalcidoidea	51	0.0083	87	0.0822
	Chrysididae	6	0.0010		
	Dryinidae	2	0.0003		
	Formicidae	1577	0.2578	13	0.0123
	Halictidae	66	0.0108	5	0.0047
	Ichneumonidae	1	0.0002	1	0.0009
	Mutillidae	5	0.0008		
	Pompilidae	4	0.0007	2	0.0019
	Sphecidae	46	0.0075	3	0.0028
Lepidoptera	Cosmopterygidae	19	0.0031	38	0.0359
	Lycaenidae	1	0.0002		
	Pyralidae	5	0.0008	4	0.0038
	Unidentified larvae	12	0.0020		
Neuroptera	Chrysopidae			1	0.0009
	Coniopterygidae	3	0.0005	1	0.0009
	Hemerobiidae	18	0.0029	1	0.0009
	Myrmeleontidae	17	0.0028		
	Unidentified larvae	3	0.0005		
Orthoptera	Acrididae	2	0.0003		
	Blattidae	2	0.0003		
	Gryllacrididae	18	0.0029	1	0.0009
	Mantidae	1	0.0002		
Thysanoptera	Heterothripidae	4	0.0007	6	0.0057
	Phlaeothripidae	7	0.0011		
	Thripidae	9	0.0015		
	Unidentified larva (campodeiform)	1	0.0002		
Isopoda		1	0.0002		

Among the major arthropod groups occurring in seasonal samples, mites most closely follow the general trend. It is quite likely, in fact, that mite populations are the major factor underlying the observed seasonal pattern. The much greater abundance of mites tends to mask other groups, such as the Hymenoptera, Diptera, and Coleoptera, which tend to remain at low to moderate levels of abundance throughout the season (Fig. 2B).

Diversity values based on pitfall trapping and Malaise trapping, respectively, were substantially different from one another during all trapping periods of the 1978 season (Fig. 3). Among pitfall samples arthropod diversity is generally low due to the high abundance of both mites and ants (see Table 1). The trend toward increasing diversity reflects the relative decrease in mite abundance in late season samples. Among Malaise samples diversity values reflect, in part, the lower total catch afforded by this method. Trapping dates with the highest diversity values, 12 June and 12 August, had catches that were approximately 28 and 8 percent, respectively, of the catches for the remaining trapping periods. These samples contained fewer taxa more equitably represented, yielding greater apparent diversity. It is likely that the values for 12 June and 12 August Malaise samples are inordinately high due to the sensitivities of the technique mentioned earlier. Nevertheless, that there should be relatively greater diversity of aerial insects seems reasonable, if for no other reason than their greater mobility.

Spatial and temporal heterogeneity of arthropods.— As mentioned above, spatial and temporal variation in arthropod abundance may affect not only characteristics of individual consumer behavior, but also the ecological relationships within and between species. As an approach to spatial variation on a relatively small scale (minimum area effect of the

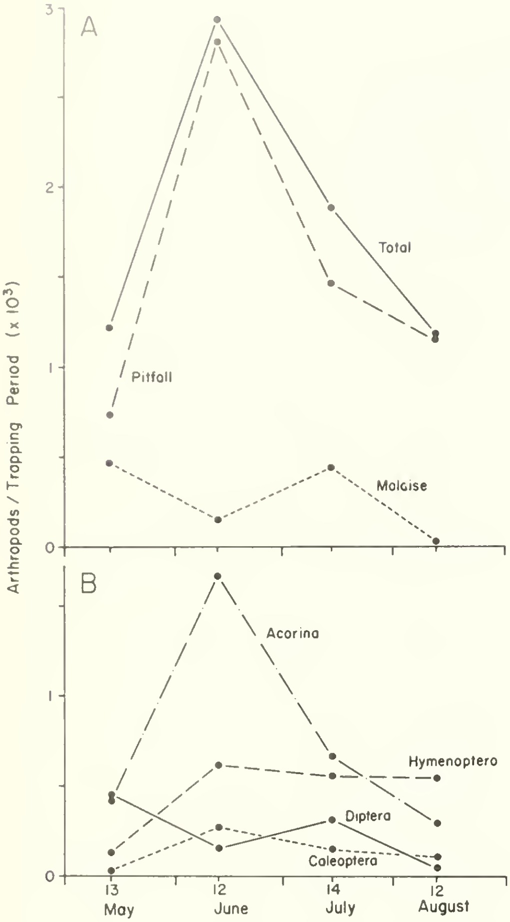

Fig. 2. Seasonal changes in arthropod abundance: a, as reflected by pitfall and Malaise trap samples; b, seasonal changes in the major taxa of these samples.

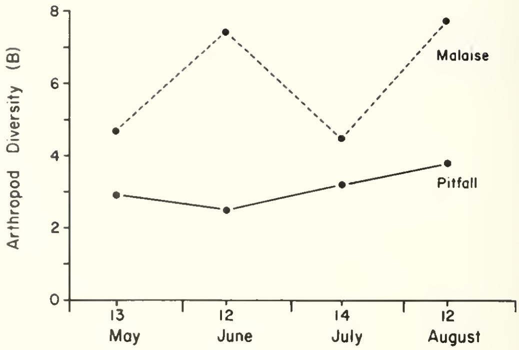

Fig. 3. Seasonal changes in arthropod diversity as reflected in pitfall and Malaise trap samples. Pitfall diversities represent the average diversity for the four grid arms at each sampling date.

trapping grid is probably on the order of 1.4 ha), I calculated similarity values for all possible combinations of grid arms for each trapping period. An average similarity value ($\bar{S}$) was then obtained as a measure of the overall spatial heterogeneity over the trapping grid. Immediately apparent from this analysis is the high degree of similarity (low heterogeneity) between grid arms at all trapping periods (range = .730–.893, Fig. 4). Yet, there does appear to be a trend toward increasing arthropod patchiness with decreasing abundance levels. The trend is not statistically significant, however, based upon these data.

Though evidence for spatial variation in arthropod numbers during 1978 is meager, temporal variation is much more apparent. Average similarity values, based upon all possible comparisons of each grid arm over all trapping dates, were substantially lower than for spatial variation: N-arm = .621; E-arm = .648; W-arm = .672; S-arm = .692. These data indicate a substantial change in the arthropod fauna throughout the active season over a relatively small area. Comparisons of Malaise trap collections support this interpretation ($\bar{S}$ = .384), but, as mentioned above, the collections for two of the dates may be suspect.

Discussion

Desert habitats are characterized by both cyclic and unpredictable climatic changes on micro- as well as macrogeographic scales (Cloudsley-Thompson 1968, Logan 1968). As a result, these habitats are typified by periods of pulsed production. It is particularly noteworthy that in the first four months of 1978 Fairview Valley received 255 percent greater than normal rainfall; average temperatures between April and August were below normal (U.S. Weather Bureau data). Such a combination of climatic events may have provided for a longer than normal production pulse, resulting in a marked increase in arthropod abundance throughout the season. The numerical dominance by mites and ants of col-

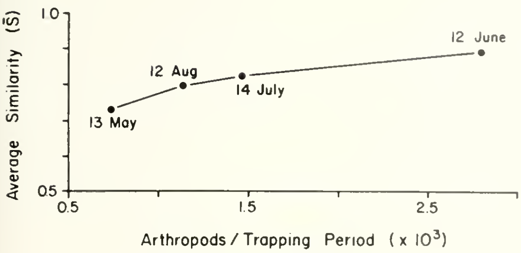

Fig. 4. Spatial heterogeneity of arthropods as reflected in the average similarity, S̄, between pitfall trap grid arms at each sample date.

lections spanning the entire season seems to argue for this possibility. Moreover, it has been suggested that at extremely high population levels habitat patchiness will be reduced and localized areas may even become uniform in their species distributions (Wiens 1976). Indeed, this seems to be what occurred in 1978. If this hypothesis is correct, then arthropod patchiness would be predicted to be more apparent during dry years when abundance levels are low. The data to test this prediction have been gathered (for 1979, a substantially drier year) but have not yet been analyzed.

Finally, it is clear from these analyses that to effectively monitor arthropod populations no single methodology is sufficient. The combination of pitfall and Malaise trapping provides a reasonable balance of terrestrial and aerial forms from desert habitats. Nevertheless, specific situations and goals will ultimately determine the techniques to be used.

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