

Long-Term Studies of Ground-Dwelling Arthropod Biodiversity at Bandelier National Monument

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Introduction

This annual report summarizes recent results of an on-going long-term monitoring study of ground-dwelling arthropods at Bandelier National Monument that was initiated in 1992. Interannual variation in abundance is notoriously high in arthropod populations so that long-term monitoring is necessary to detect changes that may be due to climate or land use shifts. Studies of mountain ground-dwelling arthropods in the U.S. have been few, especially at the community level. The Bandelier study was designed to describe patterns of these communities across an elevation gradient and to associate those changes with large-scale weather patterns, such as El Niño Southern Oscillation (ENSO), which has a strong impact on the southwestern U.S. From long-term study we gain baseline data to compare with responses to abnormally dry (La Niña) or wet (El Niño) years and to detect possible time lags in responses.

In areas with high topographic variation, such as the southwestern U.S., mountains provide elevational gradients without change in latitude, so that elevational effects may be studied more clearly. The gradient extends from lower elevations, which are dry and warm to high elevations, which are cooler and receive more precipitation. These abiotic differences produce obvious changes in plant species and cover. The ENSO cycle can be thought of as a natural “treatment” applied across the gradient.

If arthropods respond over a short period to ENSO events, we expect to see one of two likely patterns. The first is that lowland species would be less affected by drought conditions because they already live at the dry end of the gradient. Species at high elevations, which generally do not experience dry conditions, might be more strongly and negatively affected. The second is that lowland species may experience more negative conditions when their habitats become even drier, while montane species are more buffered against the severity of the drought. The purpose of our research project was to determine if data on a group of organisms living across such an elevation gradient supported one of the above predictions, or perhaps some other pattern.

Methods

This research was conducted at Bandelier National Monument, in the Jemez Mountains of north-central New Mexico. Three study sites were established across an elevation gradient from approximately 6000 ft elevation at the base of the mountains, to approximately 9500 ft elevation near the summits of the mountains. Piñon pine (*Pinus edulis*) and one-seed juniper (*Juniperus monosperma*) made up the dominant vegetation at the low-elevation site, ponderosa pine (*Pinus ponderosa*) was dominant at the mid-elevation site and several mixed conifer species, such as Douglas-fir (*Pseudotsuga menziesii*), Engelmann spruce (*Picea engelmannii*), white fir (*Abies concolor*), ponderosa pine and quaking aspen (*Populus tremuloides*), dominated at the high-elevation site.

We installed permanent pitfall traps to capture ground-dwelling arthropods, and to gather information on species composition and relative abundances at a site in each of the three elevation zones. Five replicate sets of traps were located at each of the three sites. Each of the five sets of traps consisted of six individual replicate traps positioned a line, approximately 5 m apart, for a total of 30 traps at each site (An additional mixed-conifer site (Site F) was

established in 1993 to be used for an experimental prescribed burn to examine the effects of fire on the Jemez Mountain salamander.). The replicate lines were placed at least 200 m apart. Each trap consisted of a steel can 8 cm in diameter buried in the ground with the can opening even with the ground. A plastic cup half full of propylene glycol was placed in each can and a small wooden cover was positioned about 5 cm above each trap to protect the trap from sunlight and precipitation. All traps were left open continuously year-round. Arthropods were collected from all of the traps in April, June, August and October. Trap samples were sorted and tabulated to the species level. All data were pooled for a given year.

Only arthropod taxa that are known to be ground-surface active, and appropriately sampled by pitfall traps, were tabulated. We call these “target” taxa. Other taxa that are not appropriately sampled by pitfall traps, or “non-target” taxa, were not tabulated. Of the target taxa, only those groups that were represented by large numbers of individuals were used for analysis in this particular study. Those taxonomic groups included the following: 1) spiders (Araneae; predators), 2) bristletails (Microcoryphia; detritivores), 3) crickets (Orthoptera: Gryllidae, Rhaphidophoridae, Stenopelmaticidae; omnivores), darkling beetles (Coleoptera: Tenebrionidae; detritivores), and ground beetles (Coleoptera: Carabidae; predators).

Results

Accomplishments for 2000

All arthropod pitfall trap samples collected during 2000 were sorted, target taxa identified, and count data for each taxon/pitfall trap were recorded. The data were entered into a Microsoft Excel file (filename: xbandcomb00) on a floppy disk included with this report. Hard-copy output of the Excel data file is also provided with this report as Appendix 1. The results of the 2000 data are presented in this report along with selected data from 1992-1999 for comparison. Beginning with this report we present the data in annual rather than seasonal summaries, because the dataset is so large. Seasonal data are still available from the Excel files. The species list for all target taxa is included as Appendix 2 (and is Excel file bandspp). Several taxonomic changes have occurred over the course of this study; current names are linked to old ones in the species lists. The major sources we used for determining current taxonomic status included 1) Ross Arnett, *American Insects*, 2) Entomological Information Service, *Nomina Insecta Nearctica*, 3) Norman I. Platnick, *Advances in Spider Taxonomy*, and 4) original descriptive literature and correspondence with expert taxonomists.

Ground-dwelling Arthropods

The year 2000 was characterized by La Niña (drought) conditions. Weather data for 1999-2000 were available from stations from the three elevations of interest: Firetower, representing piñon-juniper at 6500 ft elevation; Los Alamos TA-6 Tower, representing ponderosa pine at 7424 ft; and Cerro, representing mixed-conifer at 9,000 ft (Figure 1). Data for earlier years are contained in our earlier annual reports.

Arthropod numbers were high when this study began in 1992, which was an El Niño year (Figure 2). Numbers declined at all sites in the drought of 1994-1995, stayed low from 1996-

1998. Abundances began to recover in 1999-2000, although they were much lower than had been seen in 1992-1993. Arthropod species numbers have also declined since 1992-1993 (Figure 3), although they have been relatively steady since then. Much of the decline may be due to El Niño effects, but part may also be due to an artifact of identification. Dick Fagerlund (in 1994) and Sandra Brantley (in 1997) began to identify specimens, so some of the changes seen over time may be the results of slightly different identification procedures. Taxon names also change over time as more information is gathered about them. (Changes in taxon names are tracked through the notes field in the species list file.) We will be looking more closely at reconciling species or morphospecies determinations over the next year. The numbers of species collected at the sites varied by year but less so than abundance levels. Not every species was collected every year, making long-term studies of particular importance in characterizing biodiversity at the sites. While richness and abundance fluctuate seasonally and annually, the dominant species tend to remain dominant. Species are well known to respond independently to environmental factors, so that responses of one species are not necessarily indicative of the responses of others.

Spiders were widely distributed throughout the sites (Figure 4), with high numbers at the PJ site in summer 1992, although by summer 1993 through autumn 1994 more spiders were collected at the mixed conifer (MC) site. The drought in 1995 reduced numbers at all sites. Numbers have been increasing more rapidly at the MC site, are relatively steady at the PP site and are most variable at the PJ site. Most of the abundance at the MC site comes from wolf spiders, especially *Pardosa mackenziana*. Ground spiders (Gnaphosidae) appear to dominate the PP zone.

Bristletail insects were collected primarily at the PJ site, where moderate to high precipitation and warm weather were very favorable for their populations. By 1995 bristletails were not collected at all and they made only a weak comeback by the time of the droughts in 1999 and 2000 (Figure 5).

Cricket abundance data (Figure 6) included field crickets, camel crickets and Jerusalem crickets. The species are rather restricted by habitat: Jerusalem crickets (*Stenopelmatus fuscus*), field crickets (*Gryllus* sp.) and one camel cricket (*Ceuthophilus pallidus*) are found primarily at the PJ site; field crickets and the other camel cricket (*C. utahensis*) are found at ponderosa pine (PP) site; and *C. utahensis* is found primarily at the MC site. For 2000 cricket abundance showed the same patterns as in 1999: highest abundance at MC, next highest at PP and lowest at PJ. This is the pattern seen for 1993, 1994 and 1996 as well. It is interesting that the drought in 1995 reduced abundance to a level similar to PJ for all sites. The big increase in PP crickets in 1997 reminds us that there are plenty of ecological patterns that we cannot explain.

Ground beetles (Family Carabidae) are well known indicators of moisture conditions in a variety of habitats. The arid southwest has relatively few species (but this is still a large family) away from riparian or other moist habitats. At the Bandelier sites most individuals were found at the MC site (Figure 7). Numbers declined in 1995 and 1998 at all sites. Perhaps widespread drought conditions affect species at all elevations. As shown with the crickets (Figure 6), the carabids at MC recovered more quickly than at the other two sites.

The rove beetles (Family Staphylinidae) are a large family with broad feeding habits ranging from predation to detritivory to fungivory. Many are small in size and their identification below subfamily is difficult for some groups (e.g., the aleocharines). Taxonomic difficulty of course does not stop them from being important members of the ground arthropod community. At the Bandelier sites they are collected from PP and MC; the PJ site may be too dry. They are generally associated with cover of grass or litter. We report on abundance from 1998-2000 (Figure 8) and hope to include these beetles in future reports. For the three years shown abundance declined in PP but increased in MC. We do not know whether this is part of a larger pattern or not.

Darkling beetles (Family Tenebrionidae) have been present in low but consistent numbers over the course of this study, even during the drought years (Figure 9). These beetles and the spiders are abundant at PJ, while many of the other taxa we report on are more abundant at higher elevations. These beetles seem to be relatively unaffected by short-term environmental changes; for example, compare their numbers for 1995 with crickets (Figure 8) or spiders (Figure 4).

Ant abundance (Figure 10) for the MC site showed that numbers were usually greatest on lines B and D, although numbers on all lines were down during the 1995 drought. Because of a miscommunication we do not have the ant data for 1998-1999, but the specimens have been retained and can be counted. The very high number of ants collected on line D in 1994 was probably due to a colony entrance near the pitfall trap. Abundance data from this trapping method should be used cautiously because establishment or decline of colonies near traps can greatly affect captures. Pitfall traps are primarily used to capture solitary wandering arthropods. For the data through 1995 we reported that lines E and F were similar, even though line F was the site of a prescribed burn. However, since 1996 the data are less similar, perhaps showing us something about the transient dynamics of ant populations at the burn site. In 2000 abundance declined on all lines to 1995 levels or below.

Ant species (see Appendix 3 for name codes and Appendix 4 for data) collected at MC during 2000 were:

Camponotus modoc Wheeler
C. pennsylvanicus De Geer
Formica hewitti Wheeler
F. laeviceps Creighton
F. neorufibarbis Emery
F. occulta Francoeur
F. podzolica Francoeur
Lasius niger (Linnaeus)
Leptothorax muscorum Nylander
Monomorium cyaneum Wheeler
Myrmica lobifrons Pergande
Tapinoma sessile (Say)

Nine years of arthropod data from pitfall traps have revealed habitat preferences of species from the three vegetation zones and have shown that abundances vary greatly from one year to another. Species richness patterns show that a few species dominate a given vegetation zone and

that there are many rare species. The PJ site seems to differ more from PP and MC than the two higher sites do from each other. Separating the effects of precipitation from other sources of variation is only possible with a long-term dataset and with the completion of 10 years of data we expect to detect effects of elevation and precipitation on ground-dwelling arthropod communities. In the meantime we have characterized the arthropods from each vegetation zone, documented rare species and even uncovered a few undescribed species. Species and trophic groups exhibit independent distribution and response patterns to environmental variation. It appears that both wet and dry years influence abundance but dry years have the greater impact. The value of this dataset is not only in the number of years covered but in the number of species tracked, in documenting arthropods from forests of a semi-arid region, and in the inclusion of invertebrate data for conservation/management planning.

Notes

Once again there were a few unusual findings in the BNM samples for the year 2000. Dick Fagerlund noticed an “inordinate” number of flies (Phoridae; *Megaselia* sp.) found in the PP samples for August. Sandra Brantley also found many phorid flies in samples from the same time in the Sacramento Mountains.

An undescribed species of *Tachinus* (Coleoptera: Staphylinidae) was found in the June MC samples. There are four species of *Tachinus* in NM: *T. lanei*, *T. angustatus* (Sangre de Cristo Mts.), *T. nearcticus* (Sacramento Mts.), and *T. mexicanus* (Coronado National Forest). This specimen, a female, is markedly different from the others. Dick has sent it to Dr. J.M. Campbell, who is a specialist in Staphylinidae at the Canada Department of Agriculture and who revised the genus *Tachinus* a number of years ago.

Dick identified the ants collected from the PJ and PP sites in August and October to see how species at these sites compare with MC.

Piñon-Juniper

Camponotus ocreatus

Crematogaster cerasi

Dorymyrmex insanus

Formica fusca

Liometopum apiculatum

Myrmecocystus mandax

M. mexicanus

Pogonomyrmex occidentalis

Ponderosa Pine

Camponotus modoc

Lasius niger

Myrmica lobifrons

The staphylinid or rove beetles were represented by a number of species, mostly in the subfamily Aleocharinae. *Tachyporus jocosus* was found but this is a relatively common species. Some species that have been found in previous years such as *Pseudopsis callosa*, *Lordithon arizonensis* and *Carphacis nepigonensis* were not collected this year. Oddly enough no ptiliid or feather-winged beetles from the genus *Acrotrichus* were either

All species of lithobiomorph centipedes should be lumped into the species *Nadabius mesenchinus* as Dick explained in a previous e-mail. There is no current revision of the group available and the old descriptions almost certainly contain a number of synonymies.

So far only one parajulid millipede species (*Oriulus medianus*) continues to occur in the pitfall samples, although there are other published records for at least two other species.

Dick also identified two mollusks this year: a snail (Polygyridae; *Ashmunella ashmuni*) and a slug (Limacidae; *Deroderus laeve*). The slug species was the same one as occurred in pitfalls from Brian Jacobs study.

Sandra identified yet another ground spider (Family Gnaphosidae) not seen in the Bandelier pitfalls until this year. *Herpyllus hesperolus* Chamberlin is a widespread species in North America. During this project we have already collected about three dozen gnaphosid species.