Figure 16: Thamnosma montana

season probably started sometime in March. Numerous other species were flowering at the same time as milk-vetch (Appendix 1), and insects were usually quite active, as long as it was not too cold or windy. Three species were notable for the wide array of different insects visiting their flowers: Phacelia and Xylorhiza, with 13 each, and Salazaria, with 11 (Appendix 3).

Results (lab)

Pollen reference slides were made for fourteen of the species flowering during the course of the study (Appendix 4). Despite repeated attempts, no successful slides were made for the Cryptantha specimens. The plants were mostly past flowering and all the anthers investigated seemed to be without pollen. Each pollen sample was scored as to size, shape, aperture features, surface ornamentation, and over-all appearance (terminology follows Kremp 1965). Lane Mountain milk-vetch pollen was found to be similar to other Astragalus pollen (Ferguson and Skvarla 1981). The grains are prolate to spheroidal, with three short colpi (short slit-like apertures), a relatively smooth exterior (at 400X magnification), and approximately 20 microns in diameter.

Eleven specimens of Anthidium dammersi, four specimens of Anthophora and three syrphids were collected for species identification and pollen load analysis (Appendix 5). Pollen slides were made from all Anthidium specimens except for one collected in alcohol during the early stages of the study. Usually a single slide was made from each bee, but two slides were made for two specimens, representing different parts of the insect's body (face and underneath). Four slides were made from Anthophora specimens and one from the syrphids. The insects collected will become part of the permanent collection at the Entomology Museum of the University of California, Riverside.

Figure 17: Anthophora on Salazaria mexicana

Pollen recovered from Anthidium was primarily Phacelia or milk-vetch, with an occasional few composite (Asteraceae) grains (Appendix 5). In the 11 Anthidium slides, Phacelia pollen was detected in nine (82%), while milk-vetch was seen in seven (64%). Five slides (46%) had a few scattered composite grains, probably Xylorhiza, judging from size. Phacelia pollen was abundant on legs, thorax (both dorsal and ventral surfaces), abdomen, and only a minor component of pollen collected from the face and mouthparts. In contrast, milk-vetch was abundant in pollen collected on the face and mouthparts and only a minor component or lacking from pollen collected from other areas of the body. In one female bee, the pollen sample from the scopae (abdominal hairs) was entirely Phacelia, while another female's scopal load was entirely milk-vetch with the inclusion of a few scattered composite grains. No other flower species were recognized in the pollen samples made from the Anthidium specimens.

Pollen samples from the minor visitors to milk-vetch provided limited information. The two samples from the one specimen of Anthophora collected on milk-vetch was primarily Phacelia, a little milk-vetch, and traces of composite and what appeared to be Thamnosma and Ephedra. A specimen collected on Salazaria had very little pollen and only Salazaria was seen. None of the syrphid flies were collected on milk-vetch, and microscopic examination revealed that they carried little pollen on their bodies. The one slide that contained pollen had only a single unidentified grain, reminiscent of Gilia, but at twice the size.

Figure 18: Delphinium parishii

Discussion

Although this season's total precipitation was not too far from average, this was not a good year for Lane Mountain milk-vetch. The erratic precipitation and relatively warm winter, coupled with last year's drought, resulted in fewer, less robust milk-vetch plants with an earlier and shorter flowering season. Consequently, it meant that finding suitable research plants was difficult and sample sizes were too small for statistical analysis.

Anthidium bees were the major pollinator of Lane Mountain milk-vetch. No other insect visited as often nor was so focused on milk-vetch flowers. The second most common visitor seen in this study was Eupeodes, a common syrphid fly, who also visited just about every other flower in the vicinity. Although they do collect nectar, pollen is also a major component of these flies' diet (Stelleman 1978) and the fact that they visit so many different flowers limits their usefulness as a pollinator (Faegri and van der Pijl 1979). Lane Mountain milk-vetch appears to be used as an occasional resource by Syrphid flies, Sphinx moths (both of which visit a number of species) and Anthophora bees (who mostly utilized Thamnosma and Salazaria in the study site). There may be more than one species of Anthophora that occasionally visit milk-vetch. In flight, the bees look very similar and precise identification often requires capturing the animal.

Figure 19: Phacelia distans

Although Lane Mountain milk-vetch is primarily pollinated by Anthidium bees, other species visit the flowers and probably affect some pollination, albeit in a less efficient manner. If there were no Anthidium, one or more of these species would most likely increase their visitation in order to make use of the resources now utilized by Anthidium.

Since male and female Anthidium bees have different foraging behaviors, it can be hypothesized that they differ in their relative effectiveness at pollinating milk-vetch. A male bee sets up his territory near an individual milk-vetch and keeps returning to the same plant, this would tend to limit out-crossing. In contrast, the persistent mating behavior of the male Anthidium bees drives female bees away and promotes out-crossing. The female bees tend to visit fewer flowers per plant and thus, are more likely to spread pollen between individual plants.

The data in this study are not sufficient to determine the degree of selfing versus out-crossing pollination in Lane Mountain milk-vetch. Bees would need to be marked and then observed to see if they routinely foraged on a single plant or if they tended to visited multiple individuals.

Anthidium dammersi is not dependent on Lane Mountain milk-vetch. The bees have been reported visiting Dalea (now Psorothamnus, Hickman 1993) fremontii, D. fremontii var. sandersii, Phacelia distans, and Astragalus lentiginosus var. fremontii. (Grigarick and Stange 1968, Krombein et al 1979). In this study, both observations and pollen load analysis indicate that Phacelia distans is an important resource for Anthidium bees. The scopal loads of female Anthidium were essentially pure milk-vetch or Phacelia pollen. Both plants have pollen similar in size, shape, and ornamentation and both are collected as food for larval Anthidium. It appears, therefore, that the bees use Phacelia and the legumes for nest provisions (pollen), as well as a source of nectar.

The different architecture of Phacelia and milk-vetch flowers could explain the different abundance of the two pollen species on the bee's bodies. Milk-vetch anthers are hidden within the keel petals of the specialized legume flowers and are less likely to come in contact with a bee's legs, thorax or abdomen. Probing behavior and pollen consumption by the bee would tend to deposit milk-vetch pollen on face and mouthparts. Phacelia flowers are like open bowls, presenting anthers in the center. Any insect landing on a Phacelia flower would most likely pick up pollen on the legs and underside of the thorax and abdomen.

Phacelia, Psorothamnus, and Astragalus species are widespread (Munz 1974), so it is not surprising that Anthidium is more widely distributed than Lane Mountain milk-vetch. The reported range for the bee includes both the Mojave and Colorado deserts in California and Nevada, and probably Arizona, as well (Grigarick and Stange 1968, Krombein et al 1979). Although three other Anthidium species were noted, A. dammersi was not collected during recent arthropod surveys on Edwards Air Force Base (Pratt 2000).

Anthidium dammersi appears most closely related to A. emarginatum, a more widespread species most commonly associated with Phacelia (Grigarick and Stange 1968, Krombein et al 1979).

The inclusion of small amounts of composite pollen in some of the samples does not necessarily indicate that the insect visited that particular species' flowers. Insects, such as syrphid flies, that visit many different species tend to contaminate flowers with the "wrong" pollen. Because many insects visit Phacelia, it is particularly susceptible to contamination. In addition, because pollen is small and dust-like, the chance of contamination during specimen preparation or when the pinned insects are transported cannot be discounted. Without additional evidence from observations or larger pollen loads, it would be premature to assert that Anthidium visits composite flowers.

In the current study, four different pollinators were observed visiting Lane Mountain milk-vetch, but only one appeared to be significant. Literature reports of Astragalus flower visitors do not often specify the important pollinator species. Insects reported visiting Astragalus include bumblebees

(Bombus), honeybees (Apis melifera), other bees (Andrena, Anthophora, Emphoropsis, Megachile, Osmia, and Psithyris), bee-flies (Bombylidae), and butterflies (Lycaedes, Plebejus) (Karron 1987, Sugden 1985, USFWS 1998, Yamamoto 1985 in USFWS 1998).

For the species other than milk-vetch, the data presented in the plants and flower visitor table (Appendix 3) must be viewed with the following considerations. The data was not collected in a rigorous manner, but mostly based on a limited number of observations while doing other things. There were few to no pollinator records for some species because they had already finished flowering (Pholistoma, Lomatium), were mostly past flowering (Amsinkia, Erodium), or were not flowering at the same time as milk-vetch (Ambrosia, Stephanomeria, Tetradymia). Some species were just starting to flower at the end of the study (Erigonium, Mirabilis), and others were not very common in the study site (Camissonia, Chaenactis, Mentzelia, Dicheleostemma, Sclerocactus).

The relative numbers of pollinators visiting a particular species may, to some extent, be an artifact of the number of plants in flower in the study site. Because much of the non-milk-vetch data was collected in a less rigorous manner, conclusions must be viewed with some reservations. Species that were rare in the site tended to generate fewer pollination records. For plants like Chaenactis, with its easily accessible resources, the actual number of flower visitors would certainly be higher if more plants had been observed.