The Effects of Feral Animals on Soil Mites Recovered from Catalina Ironwood Groves (Lyonothamnus floribundus) on Santa Catalina Island, California

Stephen G. Bennett
Orange County Vector Control District
Garden Grove, CA 92643

Abstract - Several plant communities on Santa Catalina Island have been altered by trampling and over-grazing from such animals as goats and pigs. The soil beneath selected groves of Lyonothamnus floribundus floribundus was sampled in order to determine what impact feral animals may have on populations of soil inhabiting mites. Marked decreases in diversity and abundance of species were noted in heavily disturbed areas. A depauperate soil fauna may result in a decrease in nutrients for plant growth and development. A preliminary checklist of soil mites from Santa Catalina Island is appended.

Introduction

Santa Catalina Island is one of eight southern California Channel Islands and is 34 km long, 13 km wide and encompasses an area of 194 sq. km. It lies approximately 32 km off the coast of California and is parallel to the mainland in a northwest/southeast direction. The highest elevation is 632 m on Mt. Orizaba and the average annual rainfall is approximately 29 cm (Miller 1985). The human population of the island is approximately 3,000, with the majority residing in the city of Avalon. Eighty six percent of the island is under the protection of the Santa Catalina Island Conservancy as a natural area and includes most of the islands’ interior. Astigate, Prostigmatite, Meso-stigmatic, and Cryptostigmatic soil mites were collected once a month from February 1984 to February 1985 at six localities on the island. All specimens were recovered from leaf litter in groves of Catalina ironwood trees (Lyonothamnus floribundus floribundus). Ironwood groves are scattered about the island in isolated pockets usually situated on steep north facing slopes where the microclimate tends to be cooler throughout the year (Fig. 1). Lyonothamnus f. floribundus is a relict species from the Pleistocene, now extinct on the mainland, and is considered an endemic subspecies of Santa Catalina Island. A related subspecies occurs on some of the other California Islands (Philbrick 1980).

Since the introduction of goats, pigs, deer and bison to Santa Catalina Island, several plant communities have been altered by trampling and over-grazing. Some rare endemic plants have become endangered or have disappeared completely because of the activity of these feral animals (Coblentz 1980). The soil in several ironwood groves has been extensively damaged by goats and pigs and in some cases has eroded away, exposing the hard mineral layer beneath the thick litter and humus layer (Fig. 2). Little is known about the effects of such disturbance on the soil flora and fauna, particularly in the fragile environment of an island. The effects of trampling and over-grazing are obvious when observed on a macroscopic level. Stripped branches, short cropped grasses, turned soil, a lack of seedlings, trails and, in extreme cases, gulley erosion and a complete lack of vegetation are all to apparent. One must ask, however, what happens to the animals inhabiting the soil under these conditions. Soil mites, in particular, are partly responsible for the breakdown of organic matter in the soil (leaf litter, twigs, fungi, bacteria, etc.), stimulation of microfloral growth, transport of fungal spores through the soil and mineral recycling (Coleman 1970; Crossley 1977; Engelmann 1961; Mitchell & Parkinson 1976; Wooley 1960). In addition, the predator-prey relationships keep a balance in
Figure 2. Soil damage by feral goats in Lyonothamnus floribundus floribundus grove in Gallagher’s Canyon, Santa Catalina Island. Arrows indicate areas where hard mineral layer is exposed.

Figure 3. Map of Santa Catalina Island showing six localities of Lyonothamnus floribundus floribundus groves sampled for soil mites. 1) Bulrush Canyon; 2) Big Geiger’s Cove; 3) Blackjack Mountain; 4) White’s Valley; 5) Toyon Canyon; 6) and Gallagher’s Canyon. Map modified from Rente & Weissman (1981).

Materials and Methods
A total of six groves of Lyonothamnus f. floribundus was sampled: 1) Bulrush Canyon; 2) Big Geiger’s Cove; 3) Blackjack Mountain; 4) White’s Valley (Swain’s Canyon; see Menke 1985); 5) Toyon Canyon and 6) Gallagher’s Canyon. Survey areas are indicated on the map in Figure 3. Soil samples were collected with a piece of PVC pipe, 7.6 cm in diameter and 5.0 cm deep. This cylinder fit inside a slightly larger piece of pipe that was fashioned with a wooden dowel handle to aid in forcing the pipe into the soil and a plastic plunger for pushing the soil-filled sleeve into a plastic bag. Each sample represented approximately 230 cm$^3$. Two random samples were taken from each

the arthropod populations and add to the organic matter with their carcasses. The end result is the production of nutrients which ultimately are utilized by plants for growth and development. An imbalance in the soil mite populations may result in an imbalance in nutrient levels.

This study was initiated for four reasons: 1) to inventory the species of mites inhabiting the soil within groves of Lyonothamnus f. floribundus during the course of a year; 2) to monitor seasonal changes in the mite populations; 3) compare diversity and abundance of mites from “disturbed” and “undisturbed” soil and 4) determine if soil mites could serve as indicator species for accessing the condition of soil in selected sites on Santa Catalina Island.
grove, usually once a month, along two transect lines; one through the center of the grove and one near the edge. In addition, temperatures at the surface and at 5 cm below were recorded at each sample site every month and the general appearance of the soil was noted prior to sampling. Plastic bags containing the soil samples were kept cool until extraction of the mites with a Tullgren Funnel (Krantz, 1978). Specimens were sorted and counted using a Wild M5 stereomicroscope and representative specimens were mounted on microscope slides in Polyanin Alcohol-Lactic Acid (PVA-L) mounting media. Specimens were identified using a Zeiss Phase Contrast microscope at 1,000 x magnification. Classification of mites to the family level follows that of Krantz (1978). Taxonomic keys from Krantz (1978) and McDaniel (1979) also were utilized. The Blackjack Mountain site was used since it had been fenced off for several years, therefore excluding feral animals (except for an occasional deer). The soil in this grove was loose and thick, secondary growth of small trees and shrubs was evident and grasses grew tall and thick. Hypothetically, the soil fauna at Blackjack should represent “undisturbed” conditions in which a “normal” mite population should exist. Abundance and diversity of species found at Blackjack could then be compared to other unfenced sites. The other five ironwood groves were all unfenced.

The White’s Valley site had very little damage until January 1985 (Fig. 4) and the soil conditions were very much like those at Blackjack. Groves at Big Geiger’s Cove, Toyon, Gallagher’s and Bulrush canyons had varying degrees of damage. It should be noted that because of extensive rock outcroppings on the edges of the Bulrush Canyon site, only one transect line was maintained through the center of the grove. Some data are lacking for certain months (September and November) because of an inability to travel to the island. Data for other months are lacking for selected localities as a result of transportation problems on the island, lack of time or loss of specimens to accidental exposure to heat.

Results and Discussion

A total of 9,397 mite specimens was recovered from 90 soil samples collected between February 1984 and February 1985: 3,015 from White’s Valley; 1,862 from Blackjack; 1,272 from Gallagher’s Canyon; 974 from Toyon Canyon; 1,326 from Big Geiger’s Cove and 948 from Bulrush Canyon. The study sites at White’s Valley and Blackjack, respectively, had little or no goat and pig damage and had thick litter and humus layers (>15 cm) along most of the transects. Consequently, these two groves yielded the greatest number of individuals. Sites with the fewest individuals were also the most heavily damaged by feral animals (Toyon and Gallagher’s canyons and Big Geiger’s Cove, respectively.) Although the total for Bulrush Canyon is lower than Toyon Canyon, only one transect was sampled from the center of the grove (two transects in all other groves). Except for February 1985, monthly samples from Bulrush were always greater than Toyon. The Toyon Canyon site was constantly being “rooted” by pigs, particularly along the edges of the grove and had several compacted trails running through the center. The Gallagher’s Canyon site was primarily trampled by goats and most of the soil was absent except in the center of the grove where it was compacted. The general trends in the mite populations of...
the six study sites during the year are illustrated in Figures 5-7. The greatest numbers of individuals were obtained during the months of December, January, February, and April, corresponding to the rainy season. Evans & co-authors (1961) obtained similar results for soil mites in the British Isles at a depth of 0-6.5 cm and noted a close connection with the reproductive cycles of some of the Cryptostigmata. Samples during these four months were taken within 1-5 days following rainfall with substantial increases in mite numbers occurring in areas without animal trails or pig damage. Notable exceptions are White’s Valley in January, Bulrush in February and Blackjack in February (1985). White’s Valley is particularly interesting because in the interval between December and January, pigs rooted through the ironwood grove along both transects, turning over most of the soil within the grove. During a month when mite populations would be expected to be high, they were unusually low. The edge of the grove sustained the most damage and the number of mites was lower than any other sample taken in January, including Toyon Canyon. February 1985 samples from White’s Valley indicated some recovery of the mite population on the edge of the grove, but little had changed in the center. The February sample from Bulrush Canyon also was lower than expected. The sample was taken along a deer trail where the leaf litter, although thick, had been compressed by the weight of the animals. The fenced grove at Blackjack appeared to be unaffected by feral animals, yet the February sample from the center was lower than expected. This particular sample was taken from relatively rocky soil at

![Diagram](image-url)
Figure 7. Monthly number of soil mites recovered from Big Geiger's Cove and Bulrush Canyon Lyotothamnus floribundus floribundus groves on Santa Catalina Island.

the base of an ironwood tree and probably contributed to the decrease in number of mites. Similar results were obtained from Geiger's Cove in January (Fig. 7). Under these conditions small rocks and gravel were present with the litter and humus in the soil sampler. Decreased humus would mean fewer mites in the sample. As the dry season progressed from May to October, mite populations decreased and at most localities reached their lowest point by mid-summer, particularly the edges of the groves which tended to have fewer mites each month than the centers. The edges of the groves had less leaf litter and humus, less shade because of the lack of canopy cover, and therefore greater exposure to heat, cold, wind and dessication. All these factors could effectively decrease mite populations (at least to the sampling depth of 5 cm). In most instances greater numbers of species and individuals were recovered from the centers of the groves which were insulated from such harsh environmental conditions. When a pig turns up the soil while foraging for food along the edge of an ironwood grove, the existing mite fauna faces exposure to more extreme temperatures, increased evaporation, and decreased shelter within the interstitial spaces between soil particles. In areas such as Toyon Canyon where pigs continuously damage the soil, it seems the mite fauna has little time to recover. The comparison of the disturbed soil at Toyon and the undisturbed at White's Valley is well illustrated in Figure 5. Both groves show the normal seasonal fluctuations, however, the number of mites recovered is considerably lower at Toyon.

Species diversity in both disturbed and
undisturbed groves followed the same seasonal trend, with the greatest diversity occurring during the winter and early spring and the least occurring in the summer and autumn months. Figure 8 summarizes the average number of species recovered from 250 cm² of soil. Data from all groves are combined into the two categories, disturbed and undisturbed, in addition to data from center and edge transects.

The number of mite species consistently was higher in undisturbed soil samples. Increases occurred in both soil types after periods of rainfall in the spring and winter, corresponding to increases in numbers of populations of mites that recover occasional damage from goats and pigs (Figs. 9-10), although recovery of population density may take longer. In groves such as Toyon Canyon, where pig damage is constant, mite populations and reproductive potential may be reduced.

Fewer larval and nymphal mites are present, and certain dominant genera of Cryptostigmata (Eucheretia, Opilla, Kartoeremaeus, Cunaxa) comprised 58-59% of the total, the Prostigmata, 31-33% and the Mesostigmata, 7-10% at both localities. The Astigmata, primarily seed feeders, were not common in any sample (1-2% total) and appeared to be unaffected by soil disturbance. Astigmata from the British Isles were found to be uncommon in forest soils but occurred in large numbers in arable soil and pastureland at a depth of 7.5 cm (Evans et al. 1961). Most of the Astigmata recovered from ironwood groves were found along the edge transects or in disturbed soil with little or no humus. The oribatid species (Cryptostigmata) comprised 58-59% of the total, the Prostigmata, 31-33% and the Mesostigmata, 7-10% at both localities. However, at the Toyon site the total number of mites from each suborder was, respectively, 57, 56, and 76% less than White's Valley. Cryptostigmata genera that were present in undisturbed samples from White's Valley and Blackjack but not found at Toyon Canyon included *Hermaniella*, *Propelops* and *Canisia*. Prostigmata genera included *Cryptognathus* (Cryptognathidae), *Fenarimol* (Smirididae) and *Buchholzia* (Chelisidae). Mesostigmata genera included *Galeodes* (Phytoseiidae), and *Epigynus* (Ameroseiidae). Other species that occurred in substantially reduced numbers in disturbed soil samples included *Eobrachychthonius*, *Poecilobothrius*, *Cryptostigmata*, *Ophochthonius*, *Kartoveremaeus*, *Haplochthonius*, *Sphaerochthonius*, *Opiella* and *Chamobates* (Cryptostigmata); *Cunaxa* and *Nanorchestidae* (Prostigmata); and *Ologamasididae*, *Achaeidae* and *Zerconidae* (Mesostigmata). Two cryptostigmat genera, *Aphelacarus* and *Tecephonous* seemed to be enhanced by soil disturbance, occurring in higher numbers at the Toyon site. *Aphelacarus* is most common in sandy soils, sandy humus or sandy moss and because it was ubiquitous in samples, it could be called an "indicator" species. Lindquist (1979) also mentioned the potential use of soil biota and of the effects of human activity on agricultural and forest ecosystems. Except for *Sphaerochthonius*...
and *Fossaria*, all of the mites mentioned above were present all year around in undisturbed soil samples and followed the established seasonal trend, reaching their greatest density during December, January and February.

These preliminary findings suggest that certain species of soil mites within the ironwood groves are sensitive to the changes in soil temperature, moisture and density associated with the feeding activities of goats, pigs, and deer. Species that are absent or occur in low numbers under these conditions may be an indication of poor soil quality even if the litter and humus layers superficially appear to be normal. The presence of other genera such as *Aphelacarus* or *Tectocepheus* may serve the same function. These "indicator species" may be useful tools for evaluating the condition of soil prior to the transplantation of seedling trees, for determining which ironwood groves have been affected the most (and the least) by feral animals and for monitoring soil quality after a grove has been fenced off and feral animals excluded. Recovery of a balanced soil fauna could be a good indication of normal decomposition and nutrient production within an ironwood grove. Future studies concerning the recovery of mite populations at the Toyon Canyon site are planned in addition to a more extensive analysis of data regarding "indicator species" from the other five localities mentioned in this paper.

Appendix 1 provides a preliminary inventory of the soil mites from *Lyonothamnus floribundus* groves on Santa Catalina Island.

**Acknowledgments**

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**Literature Cited**


Appendix 1: Preliminary checklist of soil mites from Santa Catalina Island.

Preliminary studies of the mites recovered from soil in groves of Catalina ironwood trees (Lyonothamnus floribundus floribundus) have thus far revealed a total of 62 families, 79 genera and 87 species within 4 orders: Astigmata [2 families, 2 genera, 2 species]; Mesostigmata [10, 16 and 17 respectively]; Prostigmata [23, 29 and 32 respectively]; and Cryptostigmata [27, 32 and 36 respectively] (Table 1). A total of 9,397 specimens were examined. Little is known about the mite fauna of the California Islands and very few records have been published. Poweder & Loomis (1962) recorded the tombulid mites, Eutrombicula belkini and Kayella lacerata, from East Anacapa Island and Bennett (1987) reported on several species of ectoparasitic mites on vertebrates from Santa Catalina Island which included larvae of Euschoengastia ambocalis and E. numerosa recovered from soil samples in L. f. floribundus groves.

The systematic of some of the groups is poorly known and as a result many of the species listed may represent new taxa. They will be the subjects of other studies as will the mites from other plant communities and soil types. The systematic literature used in compiling this checklist is included at the end of the Appendix.

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Author (date) = literature used for identifications
All other identifications from Krantz (1978) and McDaniel (1979)

Systematic Literature


