

An Unusual Encounter with Biting Mites (family: Pyemotidae) at a Wildlife Rescue Center

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ABSTRACT: In October, 2015, a non-profit wildlife rescue and rehabilitation center in Northern California contacted the Marin/Sonoma Mosquito and Vector Control District to report an outbreak of pruritic rashes affecting animal care volunteers and staff. This report describes the investigation of this outbreak by district and public health staff to identify the etiology of the rash and the source of the infestation. Straw itch mites (*Pyemotes* sp.) were identified as the likely cause of the outbreak, which affected approximately 20 individuals.

INTRODUCTION

Microscopic, soft-bodied mites of the family Pyemotidae have sometimes been considered beneficial insects for their role as generalist parasites on stored product pests such as moths and beetles. However, their value as biological control agents is diminished by the pain and suffering that the bites of some species can inflict on humans who come into contact with infested products (Coleman et al. 2015, Moser 1975).

Pyemotid mites inject a toxin in their bites that paralyzes arthropods and can cause a blistering rash in humans (Booth 1952, Moser 1975). The resulting pruritic dermatitis has been referred to straw, grain, or hay itch, depending on the type of material involved. These outbreaks of dermatitis have occurred primarily amongst agricultural workers who handle the material infested with the various insect hosts of *Pyemotes* mites (Booth and Jones 1952, Walker and Landis 1994). However, these mites also have attacked people in less predictable situations, including in a store inside a shopping mall where decorative wheat was sold (Betz et al. 1982) and in a house with seasonally-infested furniture (Fine and Scott 1965).

This report recounts the investigation of an itch mite biting incident in a wildlife rescue and rehabilitation facility in Northern California.

MATERIALS AND METHODS

In mid-October, 2015, the Marin/Sonoma Mosquito and Vector Control District ("the District") received a report that 18-19 people working for or volunteering at a local wildlife rescue and rehabilitation center had been experiencing a severe dermatitis of uncertain origin. Onset of symptoms was around October 12, and the timing had coincided with the death of a pair of young mountain lions kept on-site. An abundance of fleas had since been observed in the vicinity of the mountain lion enclosure, and the wildlife facility director requested assistance from the District in assessing if the fleas presented a health risk and whether the dermatitis was caused by the fleas. On-site inspections were conducted by the District on October 21, 23 and 27, 2015.

Wearing Tyvek® suits and rubber boots, the District's scientific programs manager and the wildlife facility director surveyed the

mountain lion enclosure for fleas using a flannel flag. Fleas were observed and collected from the enclosure and brought back to the District laboratory.

The wildlife center director also indicated that a number of affected staff had recently worked in a wolf-dog hybrid enclosure located much closer to the main building, which housed the hospital, administrative offices, and a converted garage being used as the animal food preparation room ("the garage"). As the wolf-dog hybrids were held in quarantine while being treated for fleas, this enclosure was swept for ticks, fleas and mites using a flannel flag, and for chiggers using plexiglass-acrylic squares (per Loomis 1956). No biting arthropods were found in this enclosure.

Sticky traps were placed by wildlife facility staff in and around several occupied animal pens, left out for a week, and then retrieved for examination by District staff.

Several samples of materials found around the facility were collected and taken back to the District laboratory for inspection. These samples included: mulch that had arrived on-site around the inception date of the biting incidents, straw stored under tarps outdoors, dust and detritus left in an empty straw storage shed, various types of seeds, nuts and dried animal chow stored in the garage, and spider webs collected from the garage floor. Additionally, swabs were taken from a variety of surfaces in several other rooms, including animal examination rooms in the main building. Each swab was obtained by wetting a paper towel with 70% isopropyl alcohol, wiping a surface with the paper towel, then sealing the towel into an individually labeled zip-top plastic bag.

While standing at the central L-shaped food preparation table in the garage taking samples of animal food the author felt an intense pruritic sensation on her torso. Swabs were taken from the skin onto an alcohol-soaked paper towel using the method described above and preserved for further analysis. Although a Tyvek® suit was not worn at the time of this collection, the author was wearing clothing sprayed earlier with a pyrethrin-based repellent and exposed skin areas (face, neck and arms) had been treated with DEET.

The District rodent specialist conducted a thorough inspection of the main building. The objectives of this inspection were to assess whether a rodent infestation existed that could be producing rat mites, as well as to identify conditions present that might facilitate rodent presence.

Wildlife center staff and contractors on site were interviewed. Staff were asked about whether or not they had experienced bites, and the location and nature of their work activities.

All specimens collected on site were brought to the District laboratory. In order to isolate microscopic arthropods from samples, animal feed and other dry samples were soaked in 70% isopropyl alcohol, and paper towel swabs were flushed using a squirt bottle of alcohol. The resultant alcohol used for the wash was then examined under a dissecting scope. Sticky traps and spider webs were examined directly under the dissecting scope. After candidate biting arthropods were isolated and tentatively identified at the District laboratory, samples were submitted to the California Department of Public Health (CDPH) for confirmation of identifications.

Shortly after the initial inspection was conducted on October 21, the author was contacted by the infectious disease doctor coordinating worker's compensation cases for the wildlife facility. Observations of symptomatic trends and the disease capacity of potential biting arthropods were discussed. This avenue of communication was maintained throughout the investigation.

RESULTS

The swabs taken from the author's abdomen (Fig. 1) contained several non-gravid, female biting mites belonging to the family Pyemotidae (*Pyemotes* sp.), commonly referred to as straw itch mites (Fig. 2). Identification to genus was confirmed by Denise Bonilla via the CPDH. District entomologist Eric Engh further identified the mites as belonging to the *ventricosus* group, based on morphological features using published keys and descriptions (Cross et al. 1981, Walter et al. 2009). It has been suggested that straw itch is only caused by *Pyemotes tritici* (Moser 1975), but there have since been cases of *Pyemotes herfsi* causing a similar dermatitis (Broce et al. 2006, Zaborski 2008). Definitive identification to species was not feasible using available references.



Figure 1. Photo of the author's bites, obtained while collecting samples at the wildlife rescue center.



Figure 2. A *Pyemotes* mite swabbed from the author's torso.

Pyemotes mites were collected in large numbers (> 100) from swabs taken from the countertop in a central L-shaped table in the garage (Fig. 3), the spider webs on the floor beneath this table, and in small numbers (< 10) from swabs of various other surfaces in the same room. No itch mites were collected from the mulch, the straw or straw storage areas, or any of the animal feeds, with the exception of a single *Pyemotes* found in a container of sunflower seeds. However, as these seeds had been stored, uncovered, directly beneath the animal food preparation table, it is likely that this mite simply fell from the heavily infested countertop into the seeds. Other mites found in these samples appeared to be predatory mites, grain or mold mites, and were unlikely to have played a significant role in the severe biting incidents experienced by wildlife center personnel.

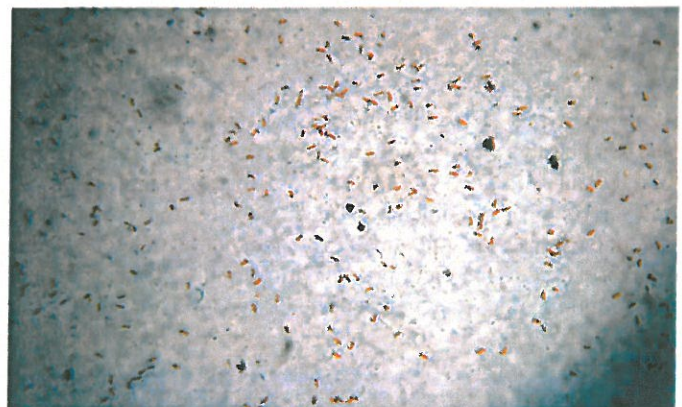


Figure 3. *Pyemotes* mites from a countertop swab in the wildlife center garage/animal feed preparation area. Image has been enhanced for visibility.

Interviews with facility staff revealed that all personnel that had experienced severe bites had spent significant time working in the animal food preparation area in the garage. Several of these staff members, unprompted, displayed their assemblage of bites to the author. Many appeared to have bites numbering in the hundreds, and nearly all of these were located on the front, back, and sides of the torso (Fig. 4). Many bites displayed an area of hyperpigmentation flaring out from each bite site, commonly known as the “comet sign” (Corazza et al. 2014). Several affected employees reported that they had experienced fever and sleeplessness, and some had been prescribed prednisone, which they said was effective in alleviating itching. However, they still reported obtaining new bites every day they were on site. Other employees who worked in the main building in administrative roles or who had done laundry in the garage but did not work with the animal feeds on the central table, had not received bites. Landscape workers and gardeners who worked exclusively outside also did not report any unusual bites.

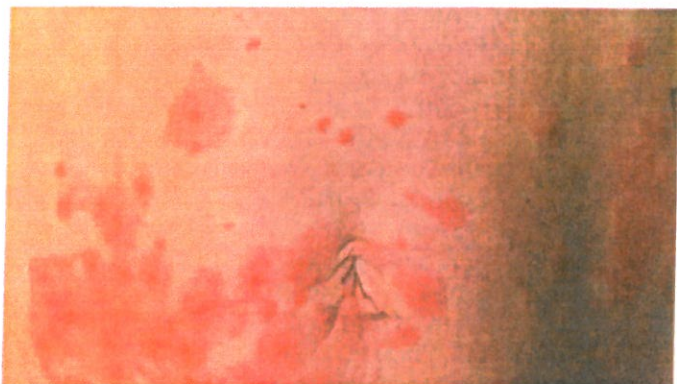


Figure 4. Photo of skin lesions of straw itch mite dermatitis on abdomen of wildlife center staff member.

Cat fleas (*Ctenocephalides felis*) were identified from the mountain lion enclosure collections. However, the flea infestation was limited to the immediate area in and around the lion enclosure; fleas were especially abundant in the straw bedding inside the area where the lions slept. The lion enclosure was located at the far edge of the facility, several minutes' walk from the area around main building, and few staff members had worked in this area. Additionally, the concentration of bites almost exclusively on the torso and back did not match the typical biting habits of fleas.

The District rodent specialist found a few rodent droppings, rub marks, and other signs suggesting a previous rat infestation, but no obvious evidence of current rodent activity. Wildlife facility staff confirmed they had dealt with a serious rat issue in the past. Recommendations for pruning, sanitation, and structural repairs were given to the wildlife facility maintenance manager to prevent a recurrence of rat issues.

Discussions with the coordinating physician confirmed that the appearance, abundance, and location of bites were similar in all of the facility's worker's compensation cases. Also of note was that no patient reported any secondary biting exposures (i.e. their spouses, partners, and children had not been affected). All

arthropod findings from on-site investigations were shared with the coordinating physician. In early November, it was reported back to the author that biopsy results from wildlife facility patients were consistent with arthropod bites.

DISCUSSION

As straw itch mites can parasitize a variety of insects, a concerted effort was made to identify infested materials. Although some animal feeds did contain stored product insects, including Anobiid beetles in partially shelled walnuts and in a container of “turkey/pheasant” food and more beetles and psocids in the stored straw, none of these insects were observed hosting *Pyemotes*. Many of the animal foodstuffs used by the wildlife center had been donated by the public, which meant they had arrived in various levels of freshness or decay, and prior storage conditions were largely unknown. Based on the large concentration of mites on the countertop, we speculate that a *Pyemotes*-infested animal feed or bedding material had been processed on the table, which led to the dispersal of itch mites around that area (perhaps repeatedly). As wildlife center staff and volunteers leaned over the counter to measure and prepare other feeds, they were exposed to the biting mites remaining on the countertop, a method inadvertently replicated by the investigator, with similar results.

Cases in the literature cite environmental sources of entomological itch mite hosts aside from stored hay or grains, including wood (wood-boring beetles), wooden furniture and wood flooring (Dermestid beetles), Pin oak trees (oak leaf gall midges), and periodical cicada hatches (Broce et al. 2006, Corazza et al. 2014, Del Giudice et al. 2008, Zaborski 2008). Although the garage floor was cement, and there were no pin oak trees or cicadas present, several stacks of cut wood were kept on site at the wildlife center, and some wood was stored in bins in the garage. Although samples of the wood were not examined in the laboratory, there did not seem to be any direct connection to the location of the stored wood and where the *Pyemotes* were abundant. Additionally, the wood had been present in the garage for at least several weeks before the biting began, without incident. Nonetheless, without closer examination it could not be ruled out as a potential source. The L-shaped food preparation table containing the greatest density of *Pyemotes* mites was constructed of treated, pressed wood, and could potentially have housed furniture beetles, although none were observed during the time spent working in close proximity to the table and countertop.

Straw itch is characterized by often hundreds of tiny red welts, each with a central vesicle, with the bites usually densely concentrated on the trunk of the body (Fine and Scott 1965). The mites are microscopic and patients usually never see what bit them. Additionally, in several published accounts, the entomologists investigating the cases often experienced these bites themselves, a characteristic dubbed “the sign of the infected investigators” (Bellido-Blasco et al. 2009). Despite the lack of identified host insect or infested plant material, *Pyemotes* were collected both from the body of the bitten author and in the working environment common to all affected parties. Circumstances of the current

investigation closely match straw itch case descriptions from the literature.

Working from the hypothesis that *Pyemotes* mites had been the cause of the outbreak, but unable to identify the host insect or source material, the District recommended general sanitation and control measures for the wildlife center, including:

- Thoroughly wet and wipe down surfaces in the garage with Lysol, alcohol, or another cleaning disinfectant. Tyvek® suits, gloves, and dust masks are recommended for cleaning.
- Maintain an ongoing cleaning protocol to regularly wipe down work surfaces with disinfectant.
- Remove wood from garage that is not actively being used.
- Avoid clutter and unnecessary storage in work areas.
- Visually screen donated animal feed; discard any in poor condition or infested with insects.
- Upon acceptance of donated animal feed, freeze the feed for at least 48-h before use.
- Store all animal feed in sealed containers.
- When purchasing new equipment, try to select models made of easily cleanable materials.
- Enact rodent exclusion and environmental management recommendations.
- Work with a licensed, private pest control operator to resolve flea issues in the lion enclosure. This should involve physical removal of the infested animal bedding material. Until the flea population has been reduced, limit staff access to the affected area.

A follow-up facility inspection was conducted on February 4, 2016. All moldy or insect-infested materials had been removed from the garage, and a new sanitation regimen enacted. In addition, several appliances and items of furniture, including the central L-shaped table, had been replaced by stainless steel items. A tree potentially providing rodent access to the building had been pruned and other entry points sealed. No mites were detected, and no further biting incidents have been reported.

This investigation of an arthropod biting outbreak benefited from a multi-disciplinary approach. Communication with affected individuals, consultation with the medical community, on-site observations and laboratory examination of samples were all key components leading to a satisfactory resolution. Many of the wildlife center staff had been initially convinced that fleas were the cause of their bites. Others harbored vague suspicions about mulch delivered around the same time or of other innocuous conditions such as fruit fly larvae present in the kitchen. Speaking with facility staff both focused our search and mitigated their fears. Similarly, the treating physicians, when presented with what might have been flea bites, had valid concerns about the potential for flea-borne diseases. The information they provided on the bite patterns helped narrow the list of candidate arthropods. The subsequent assignment of causality to *Pyemotes* mites, which do not vector human disease, in turn helped inform medical treatment decisions made by the physicians. The quick response and references offered by CDPH biologists were critical in facilitating a timely and appropriate response to this local outbreak.

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