EPIZOOTIOLOGY, TREATMENT AND CONTROL OF TROPICAL RAT-MITE INFESTATION IN A BREEDING COLONY OF SWISS MICE UNDER TEMPERATE CLIMATE OF NILGIRIS HILL - INDIA

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ABSTRACT

Ectoparasites are a cause of concern to laboratory mice colonies maintained for research, as they cause severe annoyance to the host, affecting colony production, besides transmitting zoonotic diseases. Tropical rat-mite (Ornithonyssus bacoti) is an obligate, blood-feeding parasite with an extensive host range, but common in wild rodents. There are ample records regarding the existence of this parasite in rodent breeding colonies in many countries in the world. This paper describes the epizootiology, treatment and control of rat-mite infestation in a breeding mice colony at Pasteur Institute in Nilgiris hill in India. Incidentally, it is the first report on the epizootiology of this parasite in a temperate climate in India. This mite was discovered following the complaint received from the personnel working in the mice colony about the development of insect-bite like lesions on the skin, along with intense itching. The mice were also found to be infested with mites. The infested mice were hyperactive, as evidenced by their grooming activities. The mites were also present in mice cages and racks. The mites were identified as Ornithonyssus bacoti on the basis of morphological characteristics, magnified under a simple microscope. The mice in the colony were dipped in a solution of Butox vet® (Deltamethrin, 12.5% suspension, Intervet, Mumbai, India). The animals completely recovered after a single treatment, and did not show any side effect during the observation period of six months. The treated animals did not express any short term or long term side effects, including toxic effect. There was no untoward skin reaction, abnormality in behavior, and colony production. The mites started disappearing from the cages and racks after a single treatment of Butox vet® spray, and were observed in abundance in a sluggish state in the environment, e.g., floor and walls of the shelter room. There was no recurrence of the parasite in animal cages and shelter during the observation period of six months. It is concluded that Butox vet® was an effective and safe acaricide in the eradication of tropical rat mites from the rodents as well as its environment.

KEY WORDS

Deltamethrin, Nilgiris Hill, Ornithonyssus bacoti, Swiss mice, Treatment

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INTRODUCTION

The mesostigate mite, Ornithonyssus bacoti (O. bacoti), a tropical rat-mite is prevalent worldwide and is commonly found in wild rat or mice populations and small mammals, like hamsters and gerbils (Beck 2008; Watson, 2008). It also exists in mice colonies, and laboratory facilities, housing the rodents (Cole et al., 2005). It is an obligate, blood-feeding parasite with an extensive host range (Hill et al., 2005).

O. bacoti is frequently confused with red bird-mites (Dermanyssus gallinae) or nordic bird-mites (Ornithonyssus sylviarum), all of which belong to the family of Macronyssidae and possess similar morphologic features. An exact differential diagnosis is necessary, especially in view of possible epizoonoses, for determination of the origin or reservoir of the parasites.

Certain morphologic structures, e.g., hairiness, caudally pointed scutum (dorsal plate), typical shape of the anal plate with a cranial anus, allow the differentiation of the tropical rat-mite from other mite species. Proximity to rodents or other infested animals (Figure-1 & Figure-2) is the prime source of rat-mite infestation in humans leading to pruritic dermatoses (Beck and Pfister, 2004; Beck and Fölster-Holst, 2009).

Rodents act as reservoir of this hematophagous parasite, and feeds upon humans or other mammals and birds, when rodent is unavailable (Beck and Fölster-Holst, 2009). Its zoonotic potential to transmit painful diseases like bartonellosis and rickettsia cannot be ruled out, as O. bacoti have been found to harbor these pathogens (Reeves et al., 2007).

O. bacoti infestation has been reported from many countries across the world, but it was detected only once in India in the semi-arid state of Haryana (Ram et al., 1986). The control of O. bacoti is somewhat different due to the nature of this parasite, which is more likely to be found in the environment of its host, viz., in the cages, in the litter, or in corners, or cracks of the living area, than on the hosts' skin itself (Baumstark et al., 2007; Beck and Pfister, 2004; Beck 2008; Beck and Fölster-Holst, 2009). Environmental treatment with pyrethroids has been found to be effective in successful eradication of this parasite (Cole et al., 2005; Hill et al., 2005; Watson, 2008).

This paper reports occurrence of O. bacoti infestation in a random bred Swiss mice colony under temperate climatic condition of Nilgiris Hill in India, and its treatment and control protocol. To our knowledge, there is no report available in literature regarding the incidence of O. bacoti infestation in laboratory mice in a temperate climate in India, and also its treatment schedule with Butox vet®. This is the first report of its kind.
CASE PROFILE

Laboratory Animal Division of Pasteur institute of India, Coonoor maintains a random bred conventionally reared Swiss mice colony at Coonoor, located in Nilgiris hill in India as per the guidelines of committee for the purpose of control and supervision of experiments on animal (CPCSEA), the national control authority for animal breeding and experimentation.

The climatic condition of the place is temperate. The animals are maintained in groups (polygamous, 1 Male, 2 Females) in cages of 29 cm (L) x 22 cm (B) x 14 cm (H) dimensions. They are provided with commercial pellet feed and germ free drinking water.

The personnel working in the mice colony suddenly complained us regarding the development of insect-bite like lesions on the skin, along with intense itching. We inspected the mice reared in the colony and found that they were infested with mites. The infested mice were hyperactive as evidenced by their grooming activities. The skin lesions of the personnel resembled rat-mite dermatitis (Beck and Fölster-Holst, 2009; Rahdar and Vazirianzadeh, 2009).

Careful search for the source of insects revealed the presence of mites in mice cages and racks. The mice colony is routinely screened for ectoparasites as a part of regular health monitoring programme, but mites or any other ectoparasite were never detected till the sudden appearance of this case.

LABORATORY TEST

The samples of mites were collected from the cages as well as from the clothing of personnel working in the animal house. Scotch tape, approximately 25mm x 150mm in size, was applied directly on the surface of the cages or to the clothing of personnel working in the mice colony to trap the mites. The trapped mites in the scotch tape were...
fixed on a microscope slide and examined thoroughly and systematically under 10x and 40x magnification. The observations were recorded.

**DIAGNOSIS**

The mites were identified by their morphological similarities to *O. bacoti* as per available literature. Observation under 10 x objectives of a light microscope (Nikon) revealed that the dimension of the mite was 1.13 mm x 0.63 mm. It was an engorged female hairy mite, red in colour. The blood was visible in the abdomen of the mite. The body was oval and elongated. Arrows indicate, from top to bottom: the chelicera, pedipalp and setae on the cuticle. The chelicera was pointed (Figure-3). The observed mites showed the typical shape of anal plate with cranial anus and caudally pointed dorsal scutum of *O. bacoti*. Alexander (1984) had observed that the male mite was shorter in length (0.89 mm) than the female mite (1.4 mm). The starving mite is grayish in colour and very active, while the well-fed mite is engorged, red in colour, and sluggish in movement. A mite from the clinical sample obtained in our study was observed under microscope, and was found to be a female mite, and conformed to the observations of Alexander (1984), Watson (2008), and Rahdar and Vazirianzadeh (2009).

**TREATMENT**

Butox vet® (Deltamethrin, 12.5% suspension, Intervet, Mumbai, India) was used as a dip for the entire mice colony. A solution of 50 ppm of deltamethrin (4 ml/litre of sterile distilled water) was prepared and the animals were dipped in the solution for a brief period (2-3 seconds) making sure that all body parts were immersed, and then shifted to fresh sterile cages. The newborn pups were forbidden from dipping, to avoid toxicity. Precautionary measures were taken to avoid direct contact of the personnel to the acaricidal substance during treatment. After the dip, the animals were shifted to fresh sterile cages.

Deltamethrin (C22H19Br2NO3), a pyrethroid compound (Figure-4), is available commercially as Butox vet®.
(Intervet, Mumbai, India) and commonly used to treat ectoparasite infestations of domestic and pet animals. Pyrethroid, not necessarily kills, but paralyses the insects by interfering with normal production and conduction of nerve signals in the nervous system (Narahashi, 1982).

![Figure-4. Chemical structure of Deltamethrin (C22H19Br2NO3)](image)

The animals completely recovered after a single treatment. Observation over a period of six months form the date of treatment, did not reveal any short term or long term side effects, including toxic effect. There was no untoward skin reaction, and abnormality in behavior and colony production.

Pyrethroids are less toxic to mammals compared to the insects due to the higher body temperature of the mammals, larger body size and decreased sensitivity of the ion channel sites (Johnson et al., 2010). It dislodges the mite from skin surface, without harming the host.

Acute toxicity study by oral route in rats suggested a LD₅₀ of 30mg/ kg body weight (oily vehicle) to ≥ 5000 mg/ kg body weight (aqueous vehicle) and by dermal application a LD₅₀ ≥ 2000 mg/ kg in rabbits have been described (Johnson et al., 2010). In chronic toxicity study, mice fed with 0, 1, 5, 25, or 100 mg/ kg/ day for a period of 24 months did not reveal any observable adverse effect even at 100 mg/ kg/ day (Johnson et al., 2010). Compared to the toxic level of the compound, the concentration of 50 ppm used as single dip in our study was a negligible quantity to show any toxic effect.

CONTROL

The mites started disappearing from the cages and racks soon after treatment with a single spray of Butox vet® (50 ppm), and were observed in abundance on the floor and walls of the room in a sluggish state. The animal cages were dipped in hot water (80°C), washed with water containing teepol (50 ml/ 50 Litre), rinsed, dried and autoclaved. Racks were steam washed and animal shelters were mopped with 1:20 diluted Lysol. The animal cages, racks, and shelter remained completely free from mites during the observation period of six months.

Hill et al. (2005) used successfully 7.4% permethrin (another synthetic pyrethroid)-impregnated cotton ball along with environmental treatment of sustained-release pyrethrin for 5 consecutive weeks in mice cages to eliminate O. bacoti infestation from a colony of mutagenized and transgenic mice. Visual inspection of the macroenvironment, microenvironment, and colony for 38 days confirmed that the treatment was effective against the mites. Further, there was no treatment related toxicities or adverse effects on colony production.

Cole et al. (2005) successfully eliminated the mites with the use of permethrin impregnated cotton balls in the mouse cages for 8 weeks, the surrounding structures with
pyrethrin spray, and an adjacent rabbit colony with organic pyrethrin dust at weekly interval, and noticed that the mites did not reappear even 3 years after treatment.

Watson (2008) used permethrin for eight weeks in combination with sustained-release deltamethrin 0.06%, fan-sprayed the floors and base boards monthly for three treatments, timed to precede cage sanitation with success.

Permanent eradication of this mite needs coordinated and sustained effort to eliminate the mites from the environment. These mites are hunger-resistant, and can survive for several months without feeding on hosts (Baker, 1998).

As the colony of mice under investigation was a small colony of around 500 mice during the period of the infestation, it was relatively easy to treat individual animals. However, in case of large colonies, when treating individual animals is not feasible, spray of the same concentration might prove effective.

EPIZOOTIOLOGY

This mesostigmatid mite (O. bacoti) is a rapid blood sucker and has a nonselective host range. They are on the host only during feeding and spend much of their life cycle in the surrounding environment. If it does not find a suitable rodent host, it will feed upon humans causing rat-mite dermatitis with or without puritic papules on the skin (Rahdar and Vazirianzadeh, 2009; Mark et al., 2011). Infestation with tropical rat-mites often occurs with very close bodily contact between human and infested animal, thus children with pets are vulnerable. Some times, people who have no pets in their home and no other contact with animals are also infested with tropical rat-mite. In such cases, wild rodents could be a reservoir for the mites.

The mites have a large radius of action. They are active at night, and are entirely capable after a blood meal, that lasts maximally 20 minutes, to leave their preferential hosts and enter buildings and living quarters, thus making it difficult to detect the parasites on the skin of the human patient (Beck and Pfister, 2004; Beck and Fölster-Holst, 2009).

The primarily consulted physician will therefore usually consider cutaneous lesions to be a result of allergies, fungal, or bacterial infections. Suspicion of a parasitic cause only dawns after unsuccessful symptomatic treatments or after finding mites in the living or working environment (Ram et al., 1986).

CLINICAL IMPLICATION

O. bacoti infestation in a colony of Swiss mice, confirmed by microscopical studies, was successfully treated with a single dip of Butox vet® (Deltamethrin, 12.5%).

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