Mite infestation in Hedgehogs (*Erinaceidae*) in Israel – Characterization and Response to Treatment

Horowitz, I.,[1*] Krupnik, S.,[2] Bourdeau, P.,[3] Landau, U.,[4] Anglister, N.,[1] Alias, R.[1] and Zur, G.[4]

[1] Zoological Center Ramat Gan (Safari) & Israeli Wildlife Hospital, 1 HaZvi Ave., Ramat Gan, P.O. Box 984, Israel.
[2] Veterinary Clinic, 14 Rimon Str., Gealya, Israel.
[3] Veterinary school - Oniris – Atlanpole 44307 , Nantes, France.
[4] Koret School of Veterianry Medicine, The Robert H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, P.O. Box 12, Rehovot, 76100, Israel.

* **Corresponding author:** Dr. Igal Horowitz DVM Dipl. ECZM (Wildlife Population Health), Zoological Center Ramat Gan (Safari) & Israeli Wildlife Hospital, 1 HaZvi Ave., Ramat Gan, P.O. Box 984. Israel. Tel: +972-3-6305318, Mobile: +972- 0544-650000, Fax: 00972-6305303. Email: igal@safari.co.il.

ABSTRACT

Hedgehogs (Fam. *Erinaceidae*) are among the most common mammals in Israel. Their innate sensitivity to external and internal parasites can cause critical damage to their population that could create an imbalance of the ecological environment. Mite are common external parasites of hedgehogs and the current recommended treatment is the use of ivermectin. The hypothesis of this study was that hedgehogs are infested with mites in their normal state and in disease, however with a difference in the severity of infection depending on the hedgehogs' general health condition. The purposes of this study were (a) Investigation and characterization of mites infesting healthy hedgehogs captured in their natural habitat; (b) Characterize the disease caused by mites in clinically affected hedgehogs submitted to a wildlife hospital (IWH) and (c) to assess the success of treatment with ivermectin. Data were collected over a period of one year (July 2011-July 2012) and included skin scrapings, microscopic examinations and fixation of mites for morphologic identification of mites' species. A disease severity scale was devised by the combination of clinical signs and microscopic examination of mites. Seventy hedgehogs were captured in their natural habitat, out of which 65 were not infested with mites and 5 were infested. Mite species were identified as *Sarcoptes scabiei, Caparinia tripilis* and one mite of the family *Laelaptiae*. Ninety three hedgehogs were brought to the Israeli wildlife hospital (IWH), out of which 48 were infested with mites identified as *Sarcoptes scabiei.* Thirty-four of the infested hedgehogs had dermatological signs only, suggesting that mange was not associated with any other internal diseases or injuries. No differences were found in the survival time of hedgehogs for the different degrees of skin disease, but survival rates dropped significantly during the first ten days of hospitalization, regardless of the severity of the dermatological disease. The release of hedgehogs back into the wild was made possible after 80-130 days of hospitalization, when their clinical signs had resolved. The significance of this work was the identification of the mite *Sarcoptes scabiei* as the most common mite species infesting hedgehogs in Israel and emphasizing that this species is a zoonotic parasite. Furthermore, to the best knowledge of the authors, this is the first report to describe the presence of a mite from the *Laelaptidae* family in a hedgehog in Israel. The clinical importance of this study is in realizing that prognosis is not related to the severity of the dermatological disease. The critical days for survival are in the first 10 days of hospitalization.

Keywords: Hedgehog; *Erinaceus concolor; Hemiechinus auritus;* Mites; *Sarcoptes scabiei; Notoedres cati; Caparinia tripilis; Laelapidae;* Mange.

INTRODUCTION

Hedgehogs (*Erinaceidae*) are common mammals in Africa, Asia and Europe (1). Mites are common external parasites of hedgehogs (2). Hedgehogs are very sensitive to external and internal parasites and this may lead to a decline in their population and cause an imbalance of the ecological systems (3).

The mites that affect hedgehogs most commonly are: *Caparinia tripilis*, *Sarcoptes scabiei*, *Notoedres cati* (4, 5, 6). Mite infestation primarily cause dermatological signs. The clinical signs of mange are pruritus, lignification and crusts. The crusts are hard and thick and first visible in areas such as the head, face and legs (7, 8, 9). In severe cases, dermatological changes extend to the rest of the body and cause breakage of the spines from their roots with resultant spine loss and as a result affected hedgehogs often fail to roll up resulting in a loss of their protective ability, hypothermia and behavioral changes (9, 10). In addition, the affected skin is often secondarily infected with bacteria (7).

The current specific recommended treatment of hedgehogs for mites is Ivermectin (11). According to data from the Israeli Wildlife Hospital (IWH), from 2010 there has been significant increase in the number of mange-affected hedgehogs that were brought to the hospital for treatment (Unpublished data, Personal communication: Y. Horowitz).

There is a dearth of studies dealing with external parasites of hedgehogs and especially regarding their prevalence in the wild population in Israel. This study planned to: (a) Examine the prevalence of mites on healthy hedgehogs captured in their natural habitat and (b) characterize of the disease caused by mites in clinically affected hedgehogs submitted to a wildlife hospital (IWH) and (c) assess the efficacy of Ivermectin for treatment.

MATERIALS AND METHODS

Two groups of hedgehogs were included in the study: wild hedgehogs that were captured in open areas in their natural habitat and sick wild hedgehogs that were transported to the IWH by individuals who found them.

The first group of animals was captured between May and September 2011, during the night. All captured animals were returned to their habitat after physical examination, recording their data, which included estimated age, sex, weight, length, and after collecting skin samples, which consisted of skin scrapings from 3 regions from every hedgehog: ears, nose and feet.

Table 1: Scoring system for mites infestation and skin problems

0	No mites, no clinical signs
1	Mites in the absence of clinical sings
2	Mites and appearance of alopecia and/ or itching
3	Mites and itching and/or crusts
4	Mites and generalized skins lesions, crusts and itching

Data from affected hedgehogs that were brought to the IWH between July 2011 and July 2012 were collected. All animals were examined for their general health condition and skin lesions. A scoring system for sick individuals was developed at the IWH (Table 1) and the affected hedgehogs were scored accordingly. The intensity of the infestation as well as the response to treatment was recorded. Skin scrapes were taken from all affected body sites.

All skin samples underwent microscopic fixation and examination for mites and for their further identification. The fixation was performed with Hoyer's medium (Dr. Yuval Gottlib Laboratory, Israel).

Treatment success with Ivermectin (Ivomec®, Merial, Brazil) at a dose of 0.2-0.4 mg/kg body weight, per os (PO) or subcutaneously (SC) every 14 days for 3-5 treatments (8) was assessed weekly and based on the clinical evaluation of the hedgehogs and the detection of mites on microscopic examination. Any animal dying during the course of treatment was recorded in relation to the severity of its disease condition. The treatment period until full recovery was generally between 6 weeks to 3 months.

Statistical methods used to analyze data derived were Kaplan-Meier estimator and the Pearson's test. Analysis was carried out using JMP 7 software (SAS Co.).

Mortality in the graph presented (Graph 1), is represented by a decrease in the percentage of surviving hedgehogs relative to day zero. The recovery was set to the time when the hedgehogs were released back into the wild. Length of time to release was conditioned on the absence of mites on skin scrapings and regrowth of spines and hair coat. In order to properly present the effect of the treatment, only hedgehogs without related diseases were included.

All aspects of the study were approved by the Ethics Committee of the Hebrew University of Jerusalem, Approval

Table 2: Data from the captured hedgehogs from the wild

Species	Males		Females		Total
	Young	Mature	Young	Mature	
Hemiechinus auritus	**2**	**10**	**4**	**9**	**26** (37%)
Erinacceus concolor	**6**	**8**	**7**	**23**	**44*** (63%)
	8 (11.5%)	**18** (26%)	**11** (16.5%)	**32** (46%)	**70**

* p<0.05 (Pearson's test)

No. MD-11-12901-2, and the Israeli Nature and Parks Authority, approval No. 2011/38156.

RESULTS

Seventy hedgehogs were caught in their natural habitats. Most of the hedgehogs (n=44) belonged to the species *Erinaceus concolor* (63%) and 26 (37%) were of the species *Hemiechinus auritus* (Table 2). Sixty five individuals were free of mites and five were infested, and only one had skin lesions.

Sixty-six mites were harvested from the five hedgehogs caught in their natural habitats. Fifty six (85%) were of the species *Sarcoptes scabiei*, nine (14%) *Caparinia tripilis* and one mite belonged to the family *Laelaptidae*. The number of mites found varied widely with 54 *Sarcoptes scabiei* mites isolated from a single one young male (Table 3).

In the second part of the study, ninety-three hedgehogs were brought to the Israeli wildlife hospital during the study period, for various medical reasons. Each hedgehog underwent a physical examination and its health status was evaluated according to the scale from Table 1. Dermatological clinical signs were alopecia, yellow crusts, lichnification and broken spines.

Forty-eight hedgehogs (52%) were infested with mites. The predominant species of mite was *Sarcoptes scabiei* (Figure 1). *Caparinia tripilis* was isolated from one hedgehog only (Figure 2) and a mite from the *Laelaptidae* family was on one hedgehog (Figure 3).

In order to estimate the effectiveness and the impact of Ivermectin treatment, the survival rate of hedgehogs in those animals, which were not experiencing any concomitant disease, was examined. The effect of the treatment with Ivermectin was assessed by survival rate of hedgehogs that dermatologically were only affected with mange.

No significant difference in the hedgehogs' survival was found for the different disease severity degrees. Over all, 19 of 34 hedgehogs survived (55.8%) (Graph 1).

No significant difference in the hedgehogs' survival was found for the different disease severity degrees; however, it was found that survival rates were low especially in the first ten days, possibly as a result of stress caused from the capture.

DISCUSSION

These results indicate that only a small number of wild hedgehogs are infested with mites and those which are infested usually showed dermatological signs without any other medical issues. The presence of infestation with *Caparinia tripilis*, without clinical signs, is not surprising since the parasite has been described in the literature as highly adaptive and living on the hedgehog's skin without causing any clinical signs (4). However clinical signs have been reported in a colony of African pygmy hedgehogs in Korea infected with *Caparinia tripilis,* with clinical signs (12). This discrepancy may be explained due to an increased sensitivity to Caparinia *tripilis* in African Pygmy hedgehogs.

In one wild hedgehog a single hypoaspis mite from the *Laelptidae* family was found. In this family there are various parasites that are defined as obligatory or facultative parasites of vertebrates and insects. Their habitats are sandy soil as well as nests of vertebrates and arthropods. This family has not yet

Table 3: Summary of findings for captured hedgehogs from the wild by species of hedgehog, sex, age, the number of mites found on each hedgehog and the species of mites present.

Species of Hedgehog	Sex	Age	No. of mites found on hedgehog	Species of mites found
E. concolor	Male	Mature	1	*Laelaptidae* spp.
E hemiechinus	Male	Mature	2	*Sarcoptes scabiei*
E. concolor	Male	Mature	6	*Caparinia tripilis*
E. concolor	Male	Mature	3	*Caparinia tripilis*
E. concolor	Male	Young	54	*Sarcoptes scabiei*

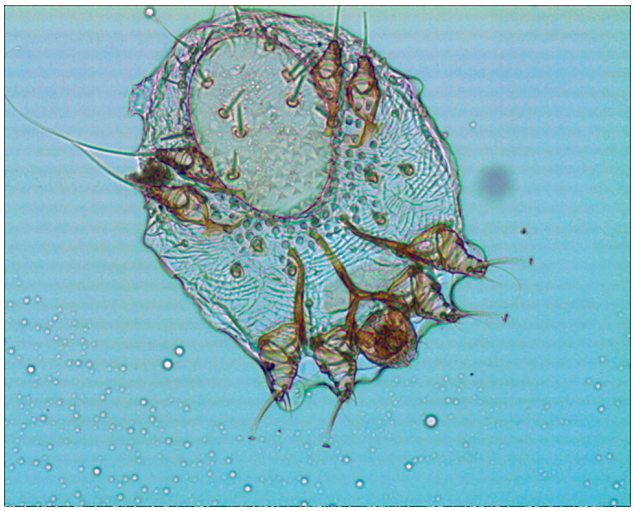


Figure 1: *Sarcoptes scabiei* found on a hedgehog

Figure 2: *Caparinia tripilis* found on a hedgehog

been described in Israel and in fact has not yet been described in hedgehogs at all. The ability to distinguish between different species of mites in this family is difficult, and requires the use a diagnostic tools in addition to morphology (13, 14). The reason for the presence of these mites without clinical signs is unclear.

The affected hedgehogs in the second part of the study, consisting of those presented to the Wildlife Hospital, exhibited clinical signs consistent with those described in the literature (4, 6). According to data from the IWH (not published, Personal communication), in recent years there has been an increase in hedgehogs brought for treatment in general and with mites' infestation in particular. Many reasons can cause

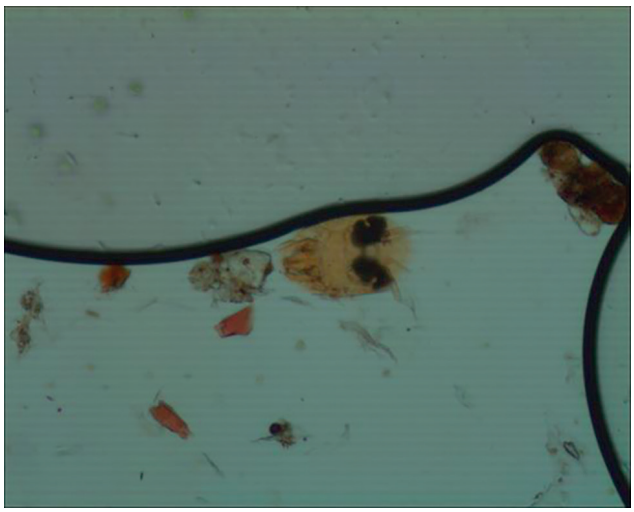
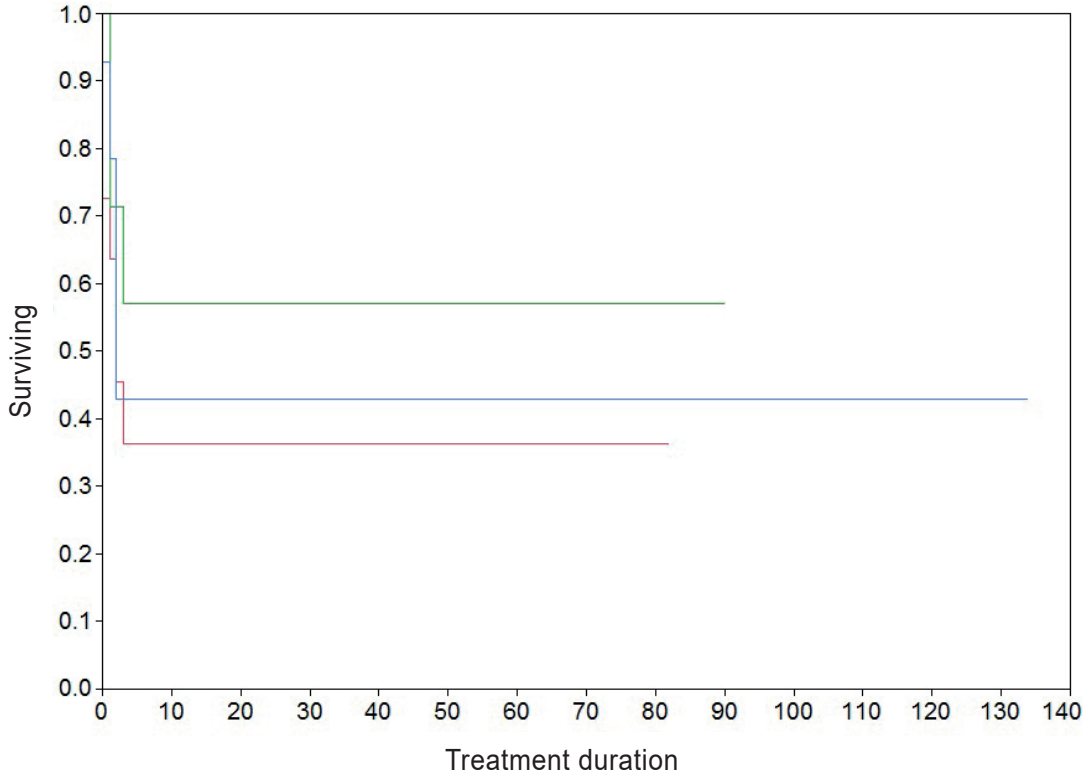


Figure 3: A mite from the *Laelaptidae* family found on one hedgehog.

this increase, including, public awareness for wildlife and for the possibility of available treatments, reduction in the natural habitat of hedgehogs due to increase in urbanization and increase in their proximity to humans. The fact that most of the hedgehogs were infested with *Sarcoptes scabiei* may also be the result of changes in lifestyle, contact to other species or interference with underlying causes resulting in decrease of defense and proliferation of the mites. Furthermore, *Sarcoptes scabiei* with its zoonotic potential could represent a risk for the people who are in close contact with the hedgehogs. Identification of the mites' species as *Sarcoptes scabiei* should raise awareness as this species is zoonotic parasite.

Skin condition and the severity of the skin disease at the clinical level do not appear to predict a failure or the success of the treatment. This result has significant clinical implications. The chances of survival of all hedgehogs are equal at first and the main obstacle is to survive the first ten days. Among all the hedgehogs there was mortality regardless of the severity of the skin disease. At the clinical level it may be stated that a hedgehog which survives the first ten days has a greater chance for recovery. Recovery until release took between 80-130 days, was dependent on re-growth of the spines, as the hedgehogs without spines were unable to curl into a ball and to defend themselves, and therefore were unfit in the wildlife (4).

More recently other treatments other than ivermectin have been described and demonstrated active against *Caparinia tripilis,* such using the combination of moxidectin



Graph 1: Kaplan-Meier curve summarizes the percentage of hedgehogs caught in their natural habitats which surviving during the treatment with ivermectin until healing for the various levels of skin disease.

Red – disease severity 2 (Presence of mites and appearance of alopecia and/or pruritis);
Green – disease severity 3 (Presence of mites with pruritis and/or crusts);
Blue – disease severity 4 (Presence of mites, generalized skin lesions and crusting).

and imidacloprid (16) or the use of oral fluralaner, a recently launched isoxazolin (17).

Concomitant infestations have been described (17) however, it is unknown whether the presence of the two mite species is with or without a synergistic potential having any clinical or other relevance.

In conclusion, the significant findings of this work are additional knowledge about mites infecting hedgehogs and treatment of infected hedgehogs. Identification of the foremost mites' species as *Sarcoptes scabiei* raises awareness and the importance of this species as a zoonotic parasite (18), which must increase our mindfulness for methods of prevention and control of these mites. Regarding treatment, the clinical importance of the prognosis seems to have no connection with the severity of dermatological disease and recovery of the hedgehogs. The critical days in survival are during the first 10 days of treatment with ivermectin.

REFERENCES

1. Arbel, A.: The complete guide for Mammals in Israel. Publisher, Mapa. pp. 52-59, 2008.
2. Romero, C., Sheinberh Waisburd, G., Pineda, J. Heredia, R., Tarto, E. and Cordero, A. M.: Fluralaner as a single dose oral treatment for *Caparinia tripilis* in a pygmy African Hedgehog. Vet. Dermatol. 28:622-e152, 2017.
3. Perelberg, A. Scham, B., Dolev, A., Brenner C. and Kronveld-Schor, N.: A survey of mammals and reptiles on the coastal plain as a means of moving the animal breeding structure, important definitions for conservation and a formulation of a plan for its preservation. Presented to the Department of Environment. Nature Conservation Society, December 2006.
4. Brockie, R.E.: The Hedgehog Mange Mite, *Caparinia tripilis*, in New Zealand. NZ Vet. J. 22: 243-247, 1974.
5. Arlian, L.G.: Biology, Host Relations and Epidemiology of *Sarcoptes scabiei.* Ann. Rev. Entomol. 34: 139-161, 1989.
6. Pantchev, N. and Hofmann, T.: Notoedric Mange Caused by *Notoedres cati* in Pet African Pygmy Hedgehog (*Atelerix Albiventris)*. Vet. Rec. 158: 59-60, 2006.
7. Robinson, I. and Roth, A.: Veterinary Care of the Hedgehog. In Practice. 21:128-137, 1999.

8. Mitchel, M.A. and Tully, T.N.Jr. (Eds): Manual of Exotic Pet Practice. Elsevier Saunders, Missouri, USA. Chapter 16: pp. 443-455, 2009.
9. Fehr, M. and Koestlinger, S.: Ectoparasites in Small Exotic Mammals. Vet. Clin. Exot. Anim. 16: 611-657, 2013.
10. Pfäffle, M.P.: Influence of Parasite on Fitness Parameters of the European Hedgehog (*Erinaceus europaeus)*. Karlsruher Institute for technology, Stuttgart, Germany, Thesis. Ph.D, 2010.
11. Carpenter, J.W.: Exotic Animal Formulary. Third Edition. Elsevier Saunders, Missouri, USA. pp. 364, 2005.
12. Da-Hee,K., Dae-Sung, O., Kyu-Sung, A. and Sung-Shik, S.: An Outbreak of *Caparinia tripilis* in a Colony of African Pygmy Hedgehogs (*Atelerix albiventris*) from Korea. Korean J. Parasitol. 50: 151–156, 2012
13. Zumpt, F.: Notes on parasitic mites. I. Some remarks on the family *Laelaptidae* (*Sensu Vitzthum* 1943) with descriptions of three new species from African rodents. Parasitol. 40:298-303, 1950
14. Beaulieu, F.: Review of the Mite *Geneous Gaeolaelaps* Evans and Till (Acri: *Laelapidae*), and description of a new species from North America, G. Gillespiei sp. Zootaxa. 2158: 33-49. 2009.
15. Romero, C., Sheinber Waisburd, G., Pineda, J., Heredia, R., Yarto, E. and Cordero, A.M.: Fluralaner as a single dose oral treatment for *Caparinia tripilis* in a pygmy African hedgehog. Vet. Dermatol. 28:622-e152, 2017.
16. Kim, K.R., Ahn, K.S., Oh, D.S. and Shin, S.S.: Efficacy of a combination of 10% imidacloprid and 1% moxidectin against *Caparinia tripilis* in African pygmy hedgehog (*Atelerix albiventris*). Parasit. Vectors. doi: 10.1186/1756-3305-5-158.17, 2012.
17. Kuttin, E.S., Beemer, A.M and Gerson, U.: A Dermatitis in a Hedgehog Associated with *Sarcoptes scabiei* and Fungi. Mykosen 20: 51-53, 1977.
18. Estes, S.A., Kummel, B. and Arlian, L.G.: Experimental canine scabies in humans. J. Am. Acad. Derm. 9: 397-401, 1983.