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Abstract. Parasitic mite infections are very common on virtually all organisms including tree geckos. This research was aimed to determine the species and prevalence of parasitic mites infecting tree lizards in Purwokerto, Central Java. This research employed a survey method with a purposive random sampling technique. One hundred individuals of tree lizards were obtained from trees in 4 different sub-districts in Purwokerto. The results showed that from 3 species of tree geckos namely, *Hemidactylus platyurus, H. frenatus* and *H. garnotii*, only the last one was not infected by parasitic mites. The prevalence of parasitic mites in *H. garnotii* was 0%, while in *H. frenatus* and *H. platyurus* were 27% and 29%, respectively. The total prevalence of parasitic mites on tree geckos in Purwokerto, Central Java, was 28%. The results showed that there were 5 (five) species of parasitic mites belonging to the genus *Geckobia*, namely *G. keegani, G. gleadovania, G. turkestana, G. simplex* and *G. diversipilis.* The prevalence of *G. gleadovania* in *H. frenatus* geckos was 100%, while in *H. platyurus* geckos, the prevalence of infection by *G. diversipilis* was also 100%. The most infected body part was the trunk where the prevalence was 57%.
Keyword: species, prevalence, tree mites, geckos, Purwokerto

1. Introduction

Mites are members of several groups in the subclass Acari of the class Arachnida. Most mites are tiny, less than 1 mm in length, and have a simple, unsegmented body plan [1]. The diversity of mites (Acari) is enormously huge, indicated by the fact that currently at least 50,000 mite species have been described out of an estimated total of close to one million species. Their high diversity is evidence of their evolutionary success of being adaptable to virtually all environments. Mites live their life in many different ways from free-living to various kinds of symbiotic relationships. They may be parasitic on a diverse range of both invertebrate and vertebrate species including reptiles such as geckos [2].

Geckos are classified into Phylum *Chordata*, Class *Reptilia*, Order *Squamata*, Suborder *Lacertilia*, and Family *Gekkonidae* [3]. Tree geckos have tympanum, sternum and two pairs of legs with special characteristics shown by the presence of digiti with lamellae and claws which help them in better movement on the trees [4]. Several species such as *Gekko gecko, Hemidactylus frenatus, H. garnotii, Cosymbotus platyurus* and *Gehyra mutilata* are known to be well adapted to the human residential environments [5].

The wandering range of the tree geckos is relatively broad and also known to enter the house lizard's territorial area and vice versa. Consequently, this wandering behavior may increase the opportunity for

various parasitic mites to contact and infect them. This increases the possibility to find various species of parasitic mites infecting the tree geckos with high prevalence [4].

Genus *Geckobia* mites infect almost all body surfaces of geckos, such as head, armpits, digiti, thighs, ears, and tail [6]. The mites reside themselves in the geckos' body by gripping the geckos' claws and sticking their mouth into the geckos' body parts. Types of gecko's habitats and behaviors determine the species and prevalence of *Geckobia* mites [2].

Geckos from the Family of Gekkonidae are generally infected by the *Geckobia* ectoparasitic mites. Genus *Geckobia* including *G. hemidactili* is an ectoparasite on *Gehyra oceanica,* which is also known to infect *H. mabouia, G. carcinoides* geckos [6]. Several other studies showed that *G. clelandi, G. cosymbotyi* and *G. glebosum* mites were able to infect *C. platyurus* [7]. However, these studies did not explain the infected group of geckos (house lizards or tree geckos) by ectoparasitic mites and their prevalence.

There were only few studies on tree parasitic mite species and their prevalence of tree geckos in Indonesia. According to [8], the prevalence of parasitic mites on *C. platyurus* and *H. frenatus* geckos in Indonesia is between 14.29% and 100% respectively. These high prevalence values are due to the presence of geckos' lamellae, inter space between claws, and digiti tips which provide protection for the parasitic mites [9]. In addition to protection, these parts are more frequently in contact with the substrate so that the chance of contact with the parasitic mites increases [10-12]. The purpose of this study was to determine the species of parasitic mites infecting the tree geckos and their prevalence in Purwokerto. Purwokerto is a city located in the southern part of Central Java and which is located between 109°17'20''- 109°18'40'' East longitude, 7°10' – 7°30' South latitude with the rainfall of approximately 2.000-4.000 mm/year, humidity of about 52-100% with the monthly average temperature of 26.3° C. Various trees, such as mangos (*Mangifera indica*), rambutan (*Nephelium lappaceum*), Ketapang (*Terminalia catappa*) were well grown in many gardens, front and backyards of the housing areas in the city. This condition presumably is not only appropriate for the growth of various tree mites, but also suitable for the tree geckos [12]. The results of this study are expected to provide important information as a theoretical basis for managing the tree geckos population.

2. Methods

2.1. Time and place of research

The samples of tree geckos were obtained from four districts consisting of South Purwokerto, North Purwokerto, East Purwokerto, and West Purwokerto. There are no different types of trees used as the sampling locations. The trees growing in various yards of houses in the four districts are mango, rambutan, ketapang and duku. Identification of geckos and examination of mites were conducted in the Entomology-Parasitology laboratory, Faculty of Biology, Universitas Jenderal Soedirman. The research was conducted in five months, from May to September 2020. This research used a survey with a random sampling technique. 25 samples of tree geckos were taken from each district. Therefore, 100 individuals of tree geckos were collected from those four districts. The variables observed in this study were species of parasitic mites and their prevalence on the tree geckos. The parameters measured were the number of individuals of each parasitic mite species and the number of tree geckos infected by the parasitic mite species.

2.2. Tree gecko sample collection

Sampling collection was performed at nights when it was not raining. Tree geckos were caught using hands when they were still within reach and using a soap water containing-sprayer when they were out of reach. The caught tree geckos were then put into plastic bags. The temperature and humidity were measured using a thermohygrometer. Tree geckos were anesthetized using ether in a killing bottle and then fixed using alcohol 70%. The identification of tree geckos was conducted using morphological characters as well as morphometric and meristic criteria [3].

2.3. Identification of parasitic mites tree geckos

Parasitic mites in the geckos' body were isolated using a needle or toothpick. Furthermore, the obtained parasitic mites were macerated using KOH solution 10% for 14 days in an Ependorf tube. The mites were then transferred to the glass objects and dropped with Hoyer's solution to preserve the samples. Identification of parasitic mites was conducted using the chaetotaxy principles based on the setae number and location using the determination keys proposed by [3]. In addition to determining the species of parasitic mites, the data obtained were calculated for their prevalence values. The prevalence was calculated by dividing the number of tree geckos infested by the parasitic mites by the total number of individual tree geckos x 100%. The percentage of mite infestation was calculated by dividing the number of tree geckos infested by mites in certain body parts by the number of tree geckos examined [13].

3. Results

The identification results showed that those tree geckos obtained from four districts belong to genus *Hemidactylus*. The characteristics of this genus were the dorsal body colors ranging from whitish gray to blackish brown, long and wide fingers with split or not-split lamellae. The identification results also showed that there were three species of tree geckos: *H. platyurus, H. frenatus* and *H. garnotti*. Those three tree gecko species had obvious morphological differences.

The tree geckos caught in each district in Purwokerto were different. Of 100 tree geckos, 72 individuals were *H. platyurus*, 26 individuals were *H. frenatus* caught in all three districts. Meanwhile, 2 individuals of *H. garnotii* were caught and only found in West Purwokerto district (table 1). The temperature when the samples were taken ranged from 26.3 ºC to 26.9 ºC.

Table 1. Number and species of the captured tree geckos (*Hemidactylus*) in Purwokerto.

Sampling Location	Number and species of tree geckos (*Hemidactylus*)			Total
	H. frenatus	*H. platyurus*	*H. garnotii*	
North Purwokerto	13	12	0	25
East Purwokerto	3	22	0	25
West Purwokerto	8	15	2	25
South Purwokerto	2	23	0	25
Total	26	72	2	100

The parasitic mites obtained on the body of the tree geckos were 156 individuals and all of the mites were identified and classified as the family Pterygosomatidae, genus Geckobia. Based on the chaetotaxy principle, five species of parasitic mite species were identified to belong to *G. keegani, G. gleadovania, G. turkestana, G. simplex* and *G. diversipilis*. The number of each species of the total number of 28 tree gecko individuals infested by parasitic mites with their prevalence is presented in table 2.

Table 2. Prevalence of parasitic mites in tree gecko species in Purwokerto.

Gecko Species	Number of Individuals			Prevalence (%)	Average Prevalence (%)
	Infested	Not infested	Total		
H. frenatus	7	19	26	27	28
H. platyurus	21	51	72	29	
H. garnotii	0	2	2	0	
Total	28	72	100		

The parasitic mites obtained during this research were found to infest all body parts of tree geckos including eyes, ears, femur, digiti, axillary, trunk, and tail. The infestation percentage of parasitic mites in the body parts of tree geckos is presented in table 3.

Table 3. Infestation percentage of parasitic mites in the body parts of tree gecko species in Purwokerto.

Body Part	Number of infested individuals of tree gecko species and their percentage (%)			
	H. frenatus (n=7)	Prevalence	*H. platyurus* (n-21)	Prevalence
Eyes	1	14	7	33
Ears	0	0	1	4
Femur	3	42	5	23
Digiti	5	71	4	19
Axillar	2	28	2	9
Body	1	14	12	57
Trunk	1	14	5	23

Based on the species of parasitic mites, the intensity of *Geckobia diversipilis* reached 100% and was able to infest better on *H. platyurus* than *H. frenatus*. Meanwhile, *G. gleadovania had* the highest intensity on *H. frenatus* compared to that of the other types of parasitic mites in Purwokerto (table 4).

Table 4. Intensity of parasitic mite species on tree gecko species in Purwokerto.

Mite species	Number of individuals of gecko species and their intensity			
	H. frenatus (n = 7)	Intensity	*H. platyurus* (n-21)	Intensity
Geckobia keegani	5	71	16	76
G. gleadovania	7	100	16	76
G. turkestana	0	0	8	38
G. simplex	3	42	8	38
G. diversipilis	5	71	21	100

4. Discussion

H. platyurus tree geckos found in this research had long and broad fingers with webs between the 2nd, 3rd, and 4th fingers as well as a long flattened tail with lateral tufts and ventrolateral folds along the body. These characters were just in accordance with [14]. Meanwhile, we found that *H. frenatus* with the characteristics of long and broad fingers without membranes, yet sometimes there is a proximal membrane on the 3rd, and 4th fingers as well as an elongated round tail with six tubercle sides and no ventrolateral folds along the body, which also described by [15]. Furthermore, we also found *H. garnotii* with a reddish-gray dorsal body, a rounded head with a round snout longer than the distance from the eyes to ear canals and a flattened long tail with serrated edges, which were just in agreement with [16]

Based on table 1, it is assumed that tree fauna species influence the abundance of tree geckos. One factor related to the tree species is the canopy which is related to the abundant number of insects found during this research, which might provide food for the tree geckos [17]. In addition, the average temperature of 26.3 ^{o}C in Purwokerto all year round was in the optimal range for geckos to perform

their activities and thrive as stated by [16] who mentioned that the temperature needed for activities is 19 - 34 ºC.

G. keegani parasitic mites found during this research had a laterally rounded body shape, with little *setae* on their legs. On the tibial part of legs 1 to 4 were found to have 5 *setae*. These mites were found to have no *setae* on their *trochanter* of leg 4. These characters were in accordance with [7]. In contrast to *G. keegani*, *G. gleadovania* has an almost rounded body. This mite was found to have 5 setae on the tibia of leg 1 to 4. These mites had one *seta* on their *trochanter* of leg 4. The *genua* of leg 1 and 4 respectively there was no *seta* found. These characters were also in agreement with [1]. With a narrower body shape than the one found by [5] we found *G. turkestana* having 5 *setae* on the *tibiae* of leg 1 to 4. These mites had one or two *setae* on their *femur* of leg 2 and 3. The *idiosome* of the dorsal part was found to be covered with the relatively dense *setae*, while that of the lateral part was covered with many *setae* as described in [5]. *G. simplex* found in this research had an almost rounded body shape with *setae* on the *tibia* of leg 1 to 4, one *seta* on the femur of leg 2, and 3 *setae* on femur of leg 3. These characteristics were in accordance with [6]. *G. diversipilis* was found to have an almost round body shape like *G. simplex*, but its *setae* on the dorsal *genua* were only on leg 1 and 4 or only found on the *genu* of leg 1. These mites were found to have 3 *setae* on the *femur* of leg 1. No *Seta* was found on the *femur* of leg 3 and there were two *setae* found on the femur of leg 4. In the *genu* of leg 1, there was no *seta*, which were in agreement with [7].

Based on table 2, the prevalence of parasitic mites on both tree geckos was equal, which might be due to the presence of physical contact between geckos including mating, fighting, and living in one adjacent habitat, as stated by [6]. This situation might have caused a better chance for the mites to meet and infest another host that facilitated an increase of mite distribution.

Table 3 figures out that the infestation percentage of parasitic mites in the body of *H. frenatus* was mostly found in the digiti, while that in *H. platyurus* was mostly found in the trunk. The greater the infestation percentage of parasitic mites in the digiti is assumed related to the presence of lamellae and interspace between claws and digiti tips which are parts directly in contact with the substrate when the geckos walk or crawl [5]. Table 3 also informs that parasitic mites can infest all geckos' body parts as stated by [5]. Furthermore, [5] explained that the geckos' ventral part has a thin skin structure which possibly eases mites to access the blood vessels as the mites' food sources. In addition, there is a ventrolateral fold on the ventral side of *H. platyurus* which allows the mites to protect themselves from various frictions.

Table 4 informs that *G. gleadovania* mites have the highest ability to infest all *H. frenatus* geckos as stated by [8]. This finding was proven by the fact that we found the intensity of these parasitic mites could reach 100%. We also examined that *G. diversipilis* was in the second highest infestation intensity found in this research. This probably because *G. diversipilis* has more elongated *chelicerae* that enable this parasitic mite to attach stronger to the host, as stated by [8].

5. Conclusion

In conclusion, 5 species of parasitic mites consisting of *Geckobia keegani, G. gleadovania, G. turkestana, G. simplex* and *G. diversipilis were found* infesting 2 tree geckos in Purwokerto, Central Java, Indonesia. Thus, all well known *Geckobia* in the world were found in Purwokerto. This may be due to the suitability of the environmental condition of this area.

The prevalence of *G. gleadovania* in *H. frenatus geckos* was 100% and that of *G. diversipilis* in *H. platyurus* geckos was also 100% in Purwokerto. The most infected body part of tree geckos was the trunk with the prevalence of 57%. However, whether or not the high prevalences of mites on geckos in this area indicated the potential disruption the balance of the geckos ecosystem as a controller of insect population, further in depth studies are still required.

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