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Three Species of Ectoparasite Mites (Acari: Pterygosomatidae) Infested Geckos in Indonesia

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Limited data is hitherto available on the diversity and dispersal of parasitic mites of geckos in Indonesia. Here, we collected three species of geckos, namely *Cosymbotus platyurus*, *Hemidactylus frenatus*, and *H. garnotii* throughout Indonesia to study the distribution and diversity of its parasitic mites. We conducted detail morphological analysis of the mites using whole mount polyvinyl lactophenol and scanning electron microscope preparation. Three species of ectoparasite mites from genus Geckobia were identified in a total of 221 individuals out of 448 geckos collected from 25 sites in Indonesia. Two species were *G. glebosum* and *G. bataviensis*, and the other one was designated as *Geckobia* sp 1. Based on our result, the three mites species were spread randomly and live sympatrically. The *G. bataviensis* mite showed the widest distribution, because it was found in almost all gecko collection sites, hence the most cosmopolitan mites. We also found that *C. platyurus* gecko had the lowest mite prevalence which might due to the fact that it has the least number of skin folds, an important site for mite protection. This result implies that further research on the relationship of anatomy of gecko skin with chelicera and claw structure of mites is necessary in the future.

Keywords: *Cosymbotus*, *Geckobia*, *Hemidactylus*, infestation, prevalence

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INTRODUCTION

Due to its plasticity and relatively small body size, mites are able to adapt to various kind of habitats including land, water, as well as colonize plants and animals (Fain 1994). Almost all land vertebrates and invertebrates are infested by mites (Walter & Proctor 1999) either as a temporary or permanent symbiont with commensalism, mutualism, and parasitism relation. Most species of mites are ectoparasites and the rest are endoparasites such as mites in the respiratory tracts of birds and mammals (Fain 1994). Reptiles, e.g. turtles, snakes, lizards, and geckos, interact with various kinds of mites, both as ectoparasites or endoparasites (Walter & Proctor 1999).

Mites in the Family of Pterygosomatidae live as ectoparasite in geckos and lizards of Gekkonidae (Bochkov & Mironov 2000; Walter & Shaw 2002), such as *Geckobia* (Montgomery 1966), which are known as blood sucker parasites (Schmäschke 1997). *Geckobia* are also known as ectoparasites in *Hemidactylus* geckos in Southeast Asia (Krantz 1978). *Cosymbotus platyurus* and *H. frenatus* geckos could be infested by several species of *Geckobia* (Bertrand *et al*. 1999). The *H. mabouia* geckos are host of *G. hemidactyli* mites in Puerto Rico (Rivera *et al.* 2003), while *Gehyra oceanica* geckos in Polynesia are host of *G. carcinoides* mites (Bertrand & Ineich 1989).

Geckos have a wide distribution especially in tropical areas and are easy to spread to form a new group. *Hemidactylus frenatus*, *C. platyurus*, and *H. garnotii* geckos are distributed in various areas in Indonesia, such as Sumatra, Java, Borneo, Sulawesi, and Nusa Tenggara (de Rooij 1915).

Previous characterization of ectoparasitic mites of geckos in Bogor revealed that *Geckobia* mites infested *C. platyurus*, *H. frenatus,* and *H. garnotii* (Soleha 2006). Earlier, Vitzthum (1926) reported that *G. bataviensis* was found in *H. frenatus* in Batavia (Jakarta). However, there is no report for the characterization and distribution of ectoparasitic mites infesting geckos *C. platyurus*, *H. frenatus,* and *H. garnotii* throughout Indonesia. Therefore, we aimed to study (i) the diversity and distribution of ectoparasitic mites infesting three species of geckos: *C. platyurus*, *H. frenatus* and *H. garnotii* in Indonesia; and (ii) the prevalence and intensity of mite infestation in the three mentioned gecko species.

MATERIALS AND METHODS

Collection of Geckos and Ectoparasitic Mites. Geckos were collected from various regions

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in Indonesia (Sumatra, Java, Borneo, Sulawesi, Mollucas, Papua, Nusa Tenggara) between 2007-2010. Geckos were preserved in 70% ethanol and were stored separately based on species and collection sites. Mites that attached to each gecko were collected using needle from various gecko body parts, i.e. head, ear, armpit (fore and hind), body, thigh (fore and hind), tail, fore fingers, and hind fingers. The mites were then stored separately in 70% ethanol.

Mites Slide Preparations. Preserved mites in 70% ethanol were cleared with lactophenol for 24 hours. Subsequently, mites were placed on objective glass and covered with adhesive polyvinyl lactophenol.

Scanning Electron Microscopy (SEM). Preserved mites in 70% ethanol were further prepared for SEM analysis conducted in the Laboratory of Electron Microscopy, Indonesian Institute of Science (LIPI) Cibinong.

Identification of Geckos and Ectoparasitic Mites. Ectoparasitic mites were identified based on Krantz (1978) and Lawrence (1936). Geckos were identified based on de Rooij (1915).

Data Analysis. The occurrence of mites in geckos body was analysed based on (i) prevalence value (percentage of geckos infested by mites), and (ii) intensity of infestation (average number of mites infested each gecko) (Barton & Richard 1996).

RESULTS

Inventarization of Ectoparasitic Mites that Infested Geckos. A total of 448 geckos from 25 locations in Indonesia were succesfully collected and identified as *C. platyurus*, *H. frenatus*, and *H. garnotii*. The distribution of these geckos in these 25 locations varied; *C. platyurus* was found in 18 collection sites (178 individuals), *H. frenatus* in 16 collection sites (84 individuals), and *H. garnotii* in 18 collection sites (186 individuals) (Table 1).

Out of 448 geckos, 221 individuals were infested by mites. These mites were called "the red mites" due to its reddish color. Table 1 listed the number of each geckos species that were infested by mites in 25 collection sites throughout Indonesia. Interestingly,

Table 1. Distribution of three geckos species and the number of geckos infested by mites in 25 collection sites throughout Indonesia

Collection sites	*Cosymbotus platyurus*		*Hemidactylus frenatus*		*Hemidactylus garnotii*		Three geckos species	
	Collected	Infested	Collected	Infested	Collected	Infested	Collected	Infested
Sumatra								
Aceh	3	0	0	0	15	12	18	12
Padang Sidempuan	8	7	0	0	15	12	23	19
Bengkulu	8	0	2	1	0	0	10	1
Palembang	13	0	8	2	5	5	26	7
Java								
Serang	3	0	6	4	4	3	13	7
Serpong	9	1	7	6	4	4	20	11
Pekalongan	37	9	0	0	12	11	49	20
Tuban	16	2	1	0	1	1	18	3
Lamongan	11	0	5	5	7	5	23	10
Borneo								
Pontianak	7	0	6	0	0	0	13	0
Kotawaringin Barat	0	0	15	6	3	1	18	7
Palangkaraya	5	0	3	1	5	2	13	3
Sangatta	0	0	9	5	19	18	27	24
Sulawesi								
Manado	7	0	6	5	0	0	13	5
Gorontalo	0	0	0	0	11	10	11	10
Makassar	2	0	7	5	0	0	9	5
Kolaka	10	0	2	0	0	0	12	0
Nusa Tenggara								
Denpasar	7	3	3	3	0	0	10	6
Mataram	13	3	0	0	2	2	15	5
Kupang	2	1	1	0	0	0	3	1
Mollucas								
Pulau Kisar	0	0	0	0	12	10	12	10
Masohi	0	0	0	0	27	20	27	20
Pulau Seram	17	1	0	0	23	18	40	19
Ambon	0	0	3	3	4	3	7	6
Papua								
Biak	0	0	0	0	18	10	18	10
Total	178	27	84	46	186	148	448	221

Table 1 showed that only geckos from Pontianak and Kolaka were not infested by mites in this study.

Characterization of Ectoparasite Mites in Geckos. The number of mites that infested *C. platyurus*, *H. frenatus*, and *H. garnotii* were 110, 553, and 1,831 individuals, respectively (Table 2). All mites were classified as members of Family Pterygosomatidae for having these characteristics: body consisted of three tagmata (gnathosoma, podosoma, and opisthosoma); no segmentation in opisthosoma; gnathosoma with chelicera, palp, stigmata, and peritreme; palp with claw; setae in their body with various form and size; tenent hair.

The genus characters were the existence of dorsal scutum; mouth in the dorsal anterior of the gnathosoma; coxa with rigid seta (spur); fused coxae of leg 1 and 2, fused coxae of leg 3 and 4; all limbs were pointed to the outer region; variety of setae at tarsus 1; body length was slightly longer or the same with the width. Based on these charcteristics, all mites were classified in the genus *Geckobia*.

An observation on the body shape, gnathosoma, scutum, leg, and also types and distribution of dorsal setae showed that *Geckobia* found in this study can be classified into three species: *Geckobia* species 1 or G1 (Figure 1), *Geckobia* species 2 or G2 (Figure 2), and *Geckobia* species 3 or G3 (Figure 3). Among total number of mites found in 221 infested geckos, we found 676, 206, and 1,612 individuals for G1, G2, and G3 mites, respectively.

Description of *Geckobia* Species 1 (G1). Body shape: round and pointed at posterior end, ± 0.5 mm both length and width; small dorsal scutum with short setae in rare distribution; posterior scutum with longer setae compared to dorsal scutum setae (Figure 1a). Gnathosoma with four segmented palps, the first segment attached to body wall, the first free segment with long slender setae, palpal tibia with long setae, claw in palpal tarsus with hairs in palm arrangement (Figure 1b); short setae in ventral body, rare scattered setae in posterior gnathosoma and coxa; legs are shorter than body, clawed tarsus with hairs in palm arrangement; anterior coxae (1 & 2) with 2 spurs, posterior coxae (3 & 4) with 1 spur (Figure 1c).

Description of *Geckobia* Species 2 (G2). Body shape: almost triangle, narrow at anterior end, widen at posterior end, ± 0.3 mm length and ± 0.4 mm width (Figure 2a); gnathosoma with four segment palps, the first segment attached to body wall, hair-

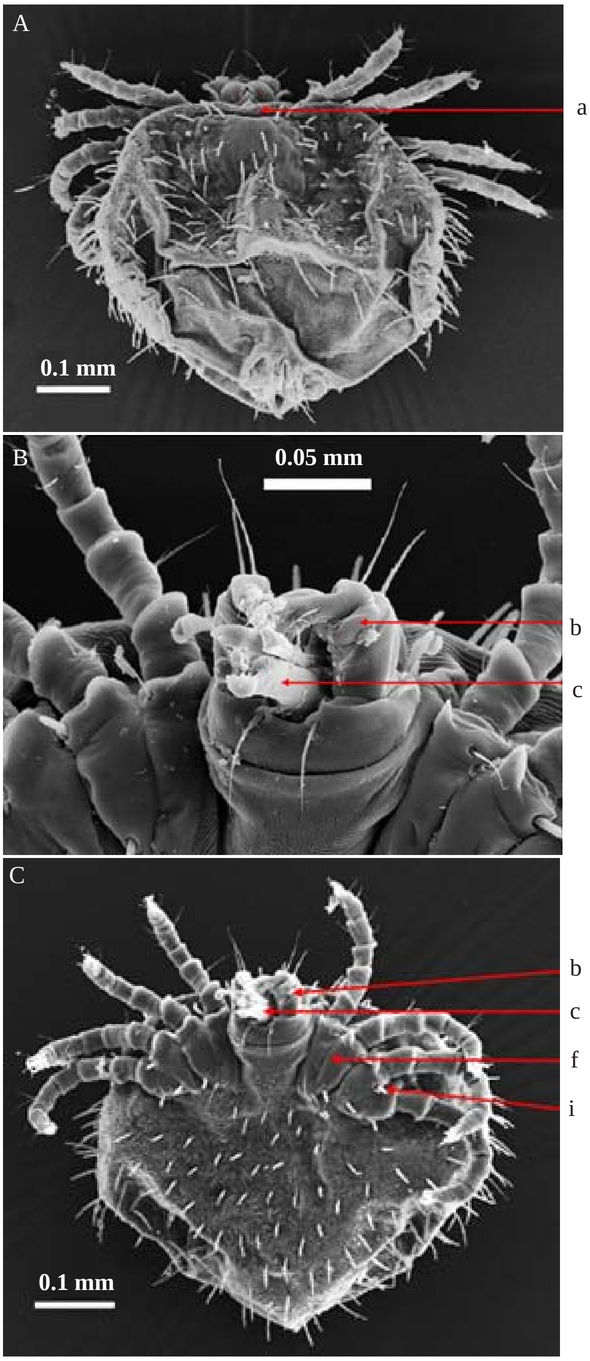

Figure 1. *Geckobia* species 1 (G1): (A) body: dorsal position, (B) gnathosoma: ventral position, (C) body: ventral position; a = dorsal scutum, b = palp, c = chelicera, f = coxa, i = spur coxa.

Table 2. Total number of collected geckos and the number of mites that were found in 25 collection sites throughout Indonesia

Species	Number of geckos		Number of mites			
	Collected	Infested	G1	G2	G3	Total
C. platyurus	178	27	32	11	67	110
H. frenatus	84	46	119	41	393	553
H. garnotii	186	148	525	154	1,152	1,831
All spesies	448	221	676	206	1,612	2,494

G1: *Geckobia* Species 1, G2: *Geckobia* Species 2, G3: *Geckobia* Species 3.

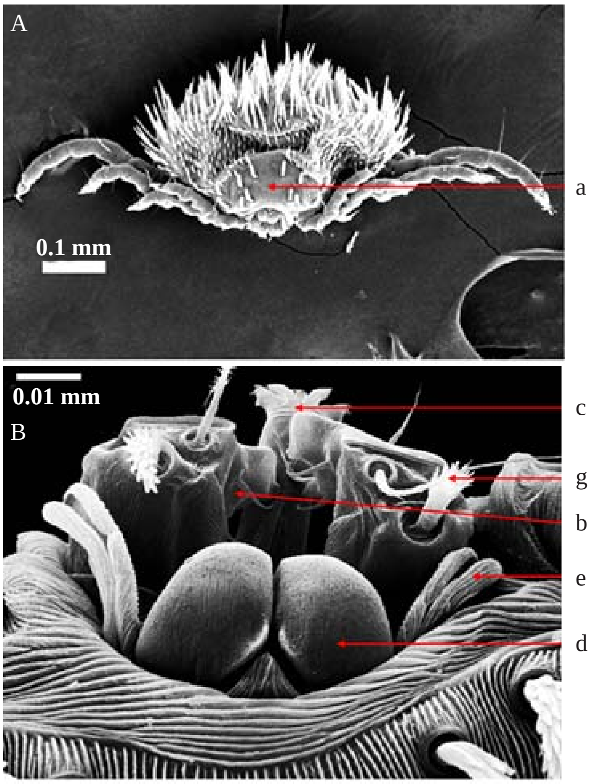

Figure 2. *Geckobia* species 2 (G2): (A) body: dorsal position, (B) gnathosoma: dorsal position; a = dorsal scutum, b = palp, c = chelisera, d = base of chelicera, e = peritreme, g = spur.

like rigid setae (spur) at the first free segment, palpal tibia with broom-like thick setae and claw with hairs at the end of palp (palpal tarsus) (Figure 2b). Dorsal scutum was larger in anterior compared to the posterior with 12-14 spurs; short, thick and dense arrangement setae at posterior scutum; long, thick, and dense setae at posterodorsal body; the leg 4 was twice longer than the leg 1, tarsus with claw and hairs.

Description of *Geckobia* Species 3 (G3). Body shape: round, anterior part is narrower than the posterior end , i.e. ± 0.5 mm length, ± 0.4 mm width, wide dorsal scutum with rare pilose (long and serrated) setae; long and dense setae at posterior scutum (Figure 3a); gnathosoma with four segmented palps, the first segment was attached to the body wall, short and thick setae at the first free segment, two long and slender setae at palpal tibia, claw and hair at the end of palp (palpal tarsus) with one spur at the tip of tarsus (Figure 3b), shorter and sparse setae at ventral body; four legs with palm arrangement hairs of claws, two spurs at coxa except coxa 1 of the leg 1, the leg 4 was not longer than the other three legs (Figure 3c).

The different characteristics among G1, G2, and G3 were body shape and length, the shape of dorsal scutum and the distribution of setae at the body, and the ratio of leg 4 to the other legs (Table 3). A

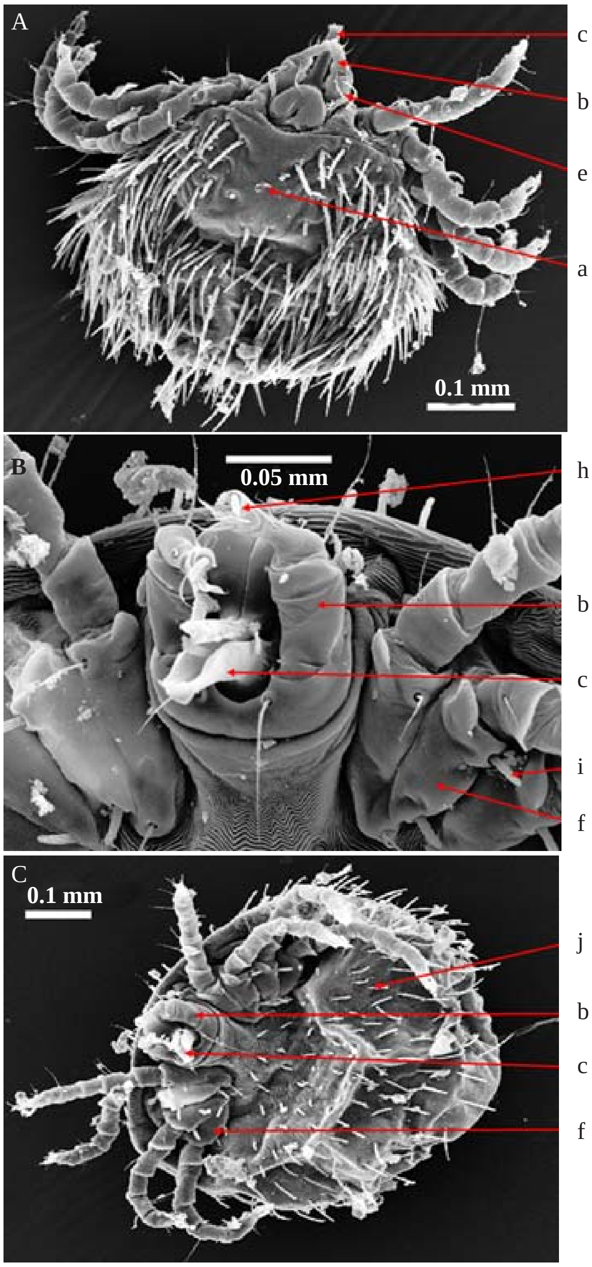

Figure 3. *Geckobia* species 3 (G3): (a) body: dorsal position, (B) gnathosoma: ventral position, (C) body: ventral position; a = dorsal scutum, b = palp, c = chelicera, e = peritreme, f = coxa, h = spur palpal tarsus, i = spur coxa, j = ventral setae.

comparison of G2 to the database of *Geckobia* (Bertrand *et al.* 1999) revealed its similar characteristics with *G. glebosum*. Those characters are: triangle body shape, 0.3-0.42 mm length and 0.4-0.55 mm in width; large dorsal scutum with spur; twice longer of leg 4 than leg 1 (Table 3, Figure 2 & 4). Meanwhile, G3 showed similar characteristics with *G. bataviensis* (Vitzthum 1929) because of their resemblance in the rounded shape and 0.4-0.5 mm length and 0.35-0.4 mm width body size; wide dorsal scutum, longer dorsal setae than those at the ventral; similar length of the four legs (0.32 mm) (Table 3, Figure 3 & 4).

Table 3. Comparison of mites characteristics *Geckobia* G1, G2, G3, *Geckobia glebosum* (Bertrand *et al*. 1999) and *G. bataviensis* (Vitzthum 1926)

Character	G1	G2	G3	*Geckobia glebosum* (Bertrand *et al*. 1999)	*G. bataviensis* (Vitzthum 1926)
Body shape	Round and pointed to posterior; 0.5 mm length and, width	Triangle; ± 0.3 mm length, ± 0.4 mm width	Rounded to posterior; length 0.5 mm, width 0.4 mm	Almost triangle; 0.35-0.42 mm length, 0.40-0.55 mm width	Rounded in posterior; 0.40 mm length 0.35 mm width
Dorsal scutum	Small; short and rare setae	Large hump with 12-14 spur	Wide; pilosa seta	Large in anterior end, cover with short and dense setae	Wide; shorter and stronger seta than the posterior part
Setae at posterior scutum	Long and rare	Short, highly dense posterodorsal setae long and dense	Long and dense	Longer and denser than the scutum setae	All dorsal seta is longer and slimmer than scutum seta, anal seta is longer
Ventral setae	Short and rare	not available	Shorter than dorsal setae and rare	not available	Similar to or shorter than dorsal setae
Palp	First free segment: long and slender setae, palpal tarsus without spur	Spur at the first free segment, thick setae at palpal tibia	First segment with long and slender setae; spur at palpal tarsus	Tibia and tarsus are equipped with very long hairs	Long and slender seta in the first segment
Legs	Shorter than body; coxa with short and stiff spur	Leg 4 twice longer than leg 1	Leg 4 is not longer than leg 1, coxa with short and stiff spur	Leg 4 is twice longer than the leg 1	Relatively same of length of the four pairs of legs; short and stiff spur in coxa

G1: *Geckobia* Species 1, G2: *Geckobia* Species 2, G3: *Geckobia* Species 3.

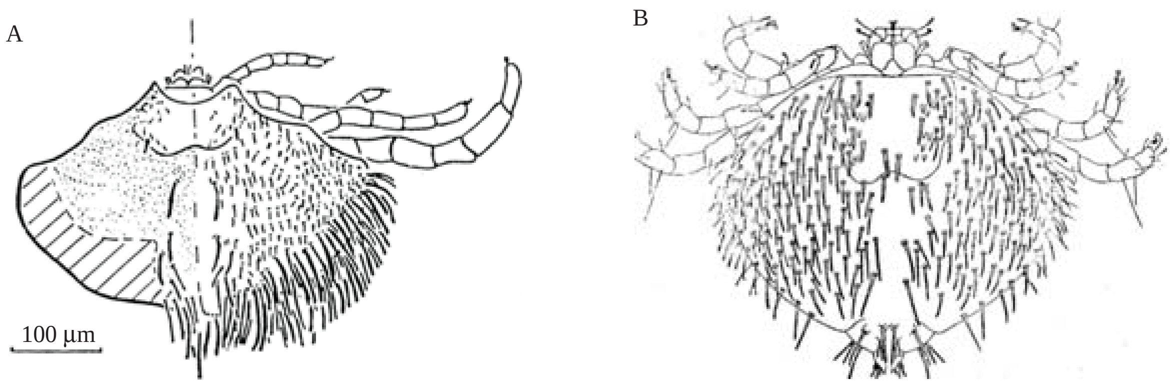

Figure 4. Schematic morphology of: (A) *Geckobia glebosum (*Bertrand *et al.* 1999), (B) *Geckobia bataviensis* (Vitzthum 1926).

Prevalence and Intensity of Mites Infestation in Geckos. Based on the number of each gecko species succesfully collected, *H. garnotii* had the highest mites infestation (Table 4). Prevalence value of 100% was found in *H. frenatus* from Lamongan, Denpasar and Kisar Island, as well as in *H. garnotii* from Palembang, Serpong, Tuban, and Mataram.

The highest intensity of G1 mites infestation was 18 mites per geckos in *H. garnotii* geckos from Mataram (Table 4). The highest intensity of *G. glebosum* mites infestation was 9 mites per geckos, found in geckos from Sangatta. The highest intensity of *G. bataviensis* mite infestation was in *H. frenatus* from Denpasar with 63.5 mites per geckos.

Table 4. Prevalence and intensity of mites infestation in three gecko species from 25 collection sites throughout Indonesia

Collection sites	Pre-valence (%)	*Cosymbotus platyurus* Number of mites and intensity				Pre-valence (%)	*Hemidactylus frenatus* Number of mites and intensity				Pre-valence (%)	*Hemidactylus garnotii* Number of mites and intensity			
		G1	G.glb	G.btv	Total		G1	G.glb	G.btv	Total		G1	G.glb	G.btv	Total
Aceh	0.00	-	-	-	-	*	-	-	-	-	80.00	-	25 (3.6)	97 (10.8)	122 (10.2)
Padang Sidempuan	87.50	12 (2.0)	1 (1.0)	13 (2.6)	26 (3.7)	*	-	-	-	-	80.00	44 (6.3)	44 (7.3)	45 (9.0)	133 (11.1)
Bengkulu	0.00	-	-	-	-	50.00	-	-	1 (1.0)	1 (1.0)	*	-	-	-	-
Palembang	0.00	-	-	-	-	25.00	-	1 (1.0)	1 (1.0)	2 (1.0)	100.00	3 (3.0)	1 (1.0)	13 (4.3)	17 (3.4)
Serang	0.00	-	-	-	-	66.67	17 (4.3)	-	18 (6.0)	35 (8.8)	75.00	17 (5.7)	-	24 (12.0)	41 (13.7)
Serpong	11.1	-	-	1 (1.0)	1 (1.0)	85.71	45 (9.0)	11 (5.5)	85 (17.0)	141 (23.5)	100.00	8 (2.7)	4 (1.3)	13 (4.3)	25 (6.3)
Pekalongan	24.32	14 (4.7)	9 (2.3)	39 (4.9)	62 (6.9)	*	-	-	-	-	91.67	83 (16.6)	21 (3.0)	97 (16.2)	201 (18.3)
Tuban	12.50	6 (3.0)	-	-	6 (3.0)	0.00	-	-	-	-	100.00	6 (6.0)	-	-	6 (6.0)
Lamongan	9.09	-	-	1 (1.0)	1 (1.0)	100.00	-	1 (1.0)	34 (8.5)	35 (7.0)	71.43	31 (10.3)	-	27 (5.4)	58 (11.6)
Pontianak	0.00	-	-	-	-	0.00	-	-	-	-	*	-	-	-	-
Kotawaringin Barat	*	-	-	-	-	40.00	22 (3.7)	-	8 (2.0)	30 (5.0)	33.33	4 (4.0)	-	-	4 (4.0)
Palangkaraya	0.00	-	-	-	-	33.33	3 (3.0)	-	14 (14.0)	17 (17.0)	40.00	7 (7.0)	-	17 (8.5)	24 (12.0)
Sangatta	*	-	-	-	-	55.56	21 (7.0)	27 (9.0)	15 (3.8)	63 (12.6)	94.74	90 (6.9)	20 (3.3)	204(14.6)	314 (16.5)
Manado	0.00	-	-	-	-	83.33	-	-	33 (6.6)	33 (6.6)	*	-	-	-	-
Gorontalo	*	-	-	-	-	*	-	-	-	-	90.91	52 (7.4)	16 (3.2)	73(9.1)	141 (14.1)
Makassar	0.00	-	-	-	-	71.43	-	1 (1.0)	36 (9.0)	37 (7.4)	*	-	-	-	-
Kolaka	0.00	-	-	-	-	0.00	-	-	-	-	*	-	-	-	-
Denpasar	42.86	-	-	7 (2.3)	7 (2.3)	100.00	4 (4.0)	-	127 (63.5)	131 (43.7)	*	-	-	-	-
Mataram	23.08	-	-	4 (1.3)	4 (1.3)	*	-	-	-	-	100.00	36 (18.0)	-	47 (47.0)	83 (41.5)
Kupang	50.00		1 (1.0)		1 (1.0)	0.00	-	-	-	-	*	-	-	-	-
Masohi	*	-	-	-	-	*	-	-	-	-	74.07	69 (4.6)	9 (1.5)	90 (6.9)	168 (8.4)
Pulau Seram	5.88			2 (2.0)	2 (2.0)	*	-	-	-	-	78.26	19 (2.7)	6 (3.0)	142 (7.9)	167 (9.3)
Pulau Kisar	*	-	-	-	-	*	-	-	-	-	83.33	55 (9.8)	8 (4.0)	177 (17.7)	240 (24.0)
Ambon	*	-	-	-	-	100.00	7 (3.5)	-	21 (7.0)	28 (9.3)	75.00	1 (1.0)	-	17 (8.5)	18 (6.0)
Biak	*	-	-	-	-	*	-	-	-	-	55.56	-	-	69 (6.9)	69 (6.9)
Average	14.80	11 (3.2)	4 (1.4)	10 (2.2)	12 (2.7)	50.69	24 (4.9)	6 (3.5)	13 (11.6)	46 (11.9)	79.07	33 (7.0)	10 (3.1)	64 (11.8)	102 (12.4)

* = samples of particular species of gecko not available, - = samples of particular type/species of mite not found, G1: *Geckobia* Species 1, G.glb = *Geckobia glebosum*, G.btv= *Geckobia bataviensis.*

DISCUSSION

Identified Mites of Geckos in Indonesia: *Geckobia glebosum* and *G. bataviensis*. This study is the first one in identifying mites on geckos in 25 collection sites throughout Indonesia. Based on general characteristics, all observed mites were classified as Pterygosomatidae according to Krantz (1978). Further, genus level characteristics showed the existence of dorsal scutum, gnathosoma, coxa with rigid setae (spur) with setae distributed on the body. According to Lawrence (1936) these characters belong to the member of genus *Geckobia*. Moreover, fused coxae 1 and 2 (anterior coxae), and fused coxae 3 and 4 (posterior coxae), variation setae at tarsus and distinct body size also emphasized that these mites were from the genus *Geckobia* (Montgomery 1966). Earlier study of *C. platyurus*, *H. frenatus* and *H. garnotii* geckos in Bogor also mentioned that these geckos were infested by *Geckobia* mites (Soleha 2006). *Geckobia* mites were also previously found in other geckos and lizards (Bauer *et al.* 1990). Bertrand *et al.* (1999) made a list of *Geckobia* mites infested geckos, i.e. *C. platyurus* gecko was infested by *G. clelandi*, *G. cosymboty*, and *G. glebosum; H. frenatus* gecko was infested by *G. andoharonomaitsoensis*, *G. bataviensis*, *G. nepali*, *G. cosymboty*, *G. ifanadianaensis*, *G. philippinensis*, *G. himalayensis*, and *G. samanbavijinensis*.

On the basis of body shape, gnathosoma, scutum, leg, as well as the type of and distribution of setae, the G2 and G3, but not G1, mites revealed a similarity to the known mites species listed above. G2 mites in geckos from Indonesia were identified as *G. glebosum* based on the body shape, scutum and leg 4 length (Bertrand *et al*. 1999) (Table 3). Therefore, we determined G2 as *G. glebosum*, which is consistent with the report from Bertrand *et al*. (1999) who reported that *G. glebosum* is one of mites infesting *C. platyurus*.

This study identified G3 mites as *G. bataviensis* as described by Vitzthum (1926), due to the similar characteristics of body shape, dorsal scutum, ventral seta and legs between these two mites species (Table 3). Vitzthum (1926) identified mites found on *H. frenatus* from Batavia (currently Jakarta) as *G. bataviensis* mites.

Another approach that one can seek in identifying or grouping the ectoparasite mites is based on the chaetotaxy. Chaetotaxy is defined as the pattern of position of setae at the podomer (segments of the body) including the legs (Jack 1964). Chaetotaxy in legs of mites determines the pattern of setae in tibia, genu, femur and trochanter. However, in some cases, leg chaetotaxy is only able to determine up to group level (Jack 1964).

Sympatric and Random Distribution of Three Geckos Species. Based on 25 collection sites in Indonesia, we found 178 individual of *C. platyurus*, 84 individual of *H. frenatus*, and 186 individual of *H. garnotii* distribute in 18, 16, and 18 collection sites. After de Rooij (1915) publication, this study reports the vast area distribution of geckos in Indonesia and reveals their sympatric and random distribution. Previously, de Rooij (1915) mentioned that *H. garnotii* was distributed in western part of Indonesia (Sumatra, Java, and Borneo). However, we also found *H. garnotii* gecko in collection sites in Gorontalo, Kisar Island, Masohi, and Biak (eastern Indonesia), which was the only gecko species found in those locations. After almost 100 years since de Rooij (1915) report, here we report that the distribution of *H. garnotii* gecko in Indonesia shows an increasing distribution. *Hemidactylus garnotii* distributed in Indochina and the tropical Pacific, including Papua (Bansal & Karanth 2010). There is possibility that *H. garnotii* found in eastern part of Indonesia came from the tropical Pasific (East Papua) then spread to West Papua.

Cosymbatus platyurus and *H. frenatus* geckos were distributed in Sumatra, Java, Borneo, and Nusa Tenggara (de Rooij 1915). Bauer *et al.* (2010) mentioned that *C. platyurus* and *H. frenatus* originated from India and spread throughout Southeast Asia. This is in agreement with Cook and Richard (1999) who described that gecko can easily spread and form a new group. Groups of gecko migrated between islands through human activity (Jesus *et al.* 2001). Human activity leads to vegetation changes and trigger migration of Geckonidae species (Menke 2003). In Florida, acceleration in the population of invasive *H. garnotii* could replace the native species (*H. tursicus*) (Meshaka 2000). The existence of *H. garnotii* in eastern Indonesia probably was part of this phenomenon, where arrival of *H. garnotii* abolished the number of native geckos.

Sympatric and Random Distribution of Ectoparasitic Mites Infested Geckos in Indonesia. The distribution pattern of ectoparasite mites is following to the wider distribution of the three geckos as the host. Further, sexual activity increases the risk for gecko to be infected by mites (Brown *et al.* 1995). Geckos infested by mites through physical contact with host such as during mating behaviour, fighting or living on the same nest (Rivera *et al.* 2003). Infestation of *C. platyurus*, *H. frenatus*, *H. garnotii* geckos by mites (Table 1) showed random distribution of mites in each collection sites. This might be due to the fact that they were only found in 8, 12, and 18 locations, respectively. The average number of mites on each gecko are 2.7, 11.9, and 12.4 for *C. platyurus*, *H. frenatus*, and *H. garnotii*, respectively (Table 4). We reached a similar finding with Soleha (2006); the number of mites infested *C. platyurus* was the lowest. However, we obtained different result with regard to which gecko species is infected by the highest number of mites. We found that *H. garnotii* gecko had the most mites, while Soleha (2006) found that *H. frenatus* had the highest number of mites.

Three species of *Geckobia* can infest all three species of the observed gecko. This shows that G1, *G. glebosum*, and *G. bataviensis* mites were not specific ectoparasites for certain species of geckos. Based on host species, G1 mites had infested with the highest infestation intensity of 7.0 (16 locations) to *H. garnotii*. *Geckobia glebosum* mites had infested *H. frenatus* with the highest infestation intensity of 3.5 (5 locations) and *G. bataviensis* mites had infested *H. garnotii* with the highest infestation intensity of 11.8 (16 locations). These three species of mites were able to infest the three species of observed gecko. This is consistent with Bertrand *et al.*(1999) which mentioned that a species of mites can infest different species of geckos.

Bertrand and Ineich (1989) reported that three species of *Geckobia* mites *G. gehirae*, *G. blanci*, and *G. carcinoides* infested *Gehyra oceanica* gecko in French Polynesia. Interestingly, he found that *G. carcinoides* mites infestation on *G. oceanica* gecko was relatively high on every stage of mites life cycle and was found in every observing sites, meaning that *G. carcinoides* mites from Polynesia are cosmopolitant. On the other hand, in our study there was no species of mites found in every collection sites. The G1, G2 (*G. glebosum*), and G3 (*G. bataviensis*) mites was found in 17, 13, and 21 collection sites, respectively. Therefore, it can be concluded that distribution of *G. bataviensis* is the highest because it can be found in almost all collection sites.

Low Prevalence and Intensity of Mites Infestation in *C. platyurus* Gecko. Prevalence is a percentage of geckos infested by mites, while infestation intensity is a number of mites that invest every gecko individual. *Hemidactylus frenatus* showed 100% prevalence of mites infestation which originated from Lamongan, Denpasar and Ambon. It means that 100% *H. frenatus* gecko from those area were infested by mites. A total of 100% prevalence also occurred in the same genus of gecko *H. garnotii* in Palembang, Serpong, Tuban and Mataram. At most collection sites, intensity of G1, *G. glebosum* and *G. bataviensis* mites infestation on *H. garnotii* gecko was the highest. Highest average prevalence and intensity of mites infestation in Indonesia (79.07% and 12.4) also came from *H. garnotii*. Thus, from 25 collection sites in Indonesia, more mites infested *H. garnotii* than *H. frenatus* and *C. platyurus*. The third gecko observed in this study, *C. platyrus*, showed the lowest prevalence and intensity infestation of either G1, *G. glebosum* and *G. bataviensis* in every collection site. The result is consistent with report from Soleha (2006) that prevalence for *C. platyurus* gecko was the lowest compare to the other two gecko species in Bogor.

However, in this study we found that 100% or high gecko prevalance of mites infestation is not always followed by high infestation intensity (Table 4). This antagonistic result between prevalence and infestation intensity of mites is congruent with the result of Ruiz-Fons *et al*. (2006) who reported that louse infested deer had a prevalence of 41.3% with infestation intensity of 13.9, while wild boar had prevalence of 31% with infestation intensity of 13.6. This means a high prevalence does not always positively correlate with infestation intensity. Furthermore, an examinination of the pattern of *Eutrombicula* mites parasitism on three species of *Tropidurus* lizard (Carvalho *et al*. 2006) showed that infestation prevalence of mites on *T. itamber* lizard was 88.2% with infestation intensity 36.67 while on *T. oreadeus* lizard was 87.6% with infestation intensity of 15.38. These findings were again pointing out that prevalence does not always positively correlate with infestation intensity, as similarly shown by Ruiz-Fons *et al.* (2006).

High number of skin fold on *H. garnotii* gecko (de Rooij 1915) might give protection for ectoparasite mites as observed in this study. Further research will be needed to seek the relationship of skin morphology and anatomy of gecko with chelicera and claw structure of mites for their attachment on gecko.

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