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Co-occurrence of ectoparasites on wild rodents in Sipora Island, Mentawai, Indonesia with the zoonotic potential review

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Abstract. *Mairawita, Mursyid A, Dahelmi, Diniyati F, Lidia D, Putri N, Arifa MM, Jefrial, Maulana RM. 2023. Co-occurrence of ectoparasites on wild rodents in Sipora Island, Mentawai, Indonesia with the zoonotic potential review. Biodiversitas 24: 6369-6376.* A complex interaction between human existence and synanthropic rodents can facilitate the spillover of zoonotic diseases. This research provides valuable data regarding Rodentia species distribution, ectoparasites, and the potential for zoonotic transmission. In linked habitats, rodents were collected systematically using 70 live traps over 3 days. A total of 54 Rodentia individuals were assessed, belonging to 7 species: *Mus musculus, Rattus tanezumi, R. tiomanicus, R. rattus, R. argentiventer, R. norvegicus*, and *Leopoldamys siporanus*. Additionally, 7 species of ectoparasites (mites, ticks, and fleas) were identified, including *Laelaps echidninus*, *Leptotrombidium delicense*, *Haemaphysalis longicornis*, *Ornithonyssus bacoti*, *Culicoides* sp., *Hoplopleura pasifica*, and *Polyplax spinulosa*. Various ectoparasites infested all the captured rats. *Laelaps echidninus* showed the highest prevalence and relative abundance in plantation habitats (81.25% and 68.81) and human dwellings (72.73% and 89.73). Spearman correlation analysis revealed a strong positive correlation between prevalence-abundance of species ectoparasite (ρ. 0.955; p-value <0.01), while positive correlations between habitat types-prevalence (ρ. 0.439; p-value <0.01) and habitat types-abundance of species ectoparasite (ρ. 0.426; p-value <0.01). Negative correlations between ectoparasites species-prevalence (ρ. -0.273; p-value <0.05) and ectoparasites species-abundance of species ectoparasites (ρ. -0.309; p-value <0.05). These findings emphasize the need to assess zoonotic risks and take effective control measures in island regions for public health and conservation.

Keywords: Ectoparasites, Mentawai, prevalence, Rodentia, synanthropic, zoonotic

INTRODUCTION

Rodents are highly adaptable to habitats such as forests, plantations, and human dwellings. Although rodents are ecologically essential, their presence in human dwellings and plantation environments often brings disadvantages to some extent, especially regarding health. Their ability to adapt and thrive in diverse environments plays a crucial ecological role but often adversely affects wildlife and human well-being (Farid et al. 2021). Rodents have long been recognized as one of the wildlife responsible for causing zoonotic diseases such as rat bite fever and leptospirosis. This disease transmission is exacerbated by forest conversions into human dwellings and plantations, increasing the frequency of human-rodent interaction. The most notable interaction is between humans and the cosmopolitan and invasive species, *Rattus norvegicus*, which hosts various ectoparasites that cause zoonotic diseases (Gravinatti et al. 2020; Awoniyi et al. 2022). Ectoparasites are highly adaptive species, sometimes host-specific and infectious. Ectoparasites are a vector that can transmit pathogenic agents such as bacteria, viruses, worms, and protozoa to other animals and humans (Zendehfili et al. 2015; Farid et al. 2021). The prevalence of ectoparasites is closely linked to host species, behavioral sex, age, and other environmental factors. In addition, the behavior of various temporary ectoparasite species and harvesters has implications for the intensity of ectoparasite movement. This will trigger a high potential for spillover to other interacting species, especially in commensal species, including humans (Zendehfili et al. 2015). These patterns are predicted to be more severe in restricted regions like the Mentawai Islands.

The Mentawai islands were isolated from mainland Asia in the middle Pleistocene or approximately 500 thousand years ago (Verstappen 1975; Gillespie and Clague 2009; Yuliana and Razi 2022). Due to geographical isolation, the Mentawai islands host several endemic rodents, such as *Maxomys pagensis*, *Chiropodomys karlkoopmanii*, *Leopoldamys siporanus*, and *Rattus lugens* (Nowak and Paradiso 1983). The Mentawai Islands continue to develop, especially in Sipora Island; after it was appointed as the capital of the regency in 2005, triggered an increase in human population, especially North Sipora Sub-district, with a growth rate of 2.6% in 2018-2019 (BPS 2023). This is directly proportional to the increasing human need for natural resources, which triggers land conversion and deforestation for office areas, human dwellings, and plantations. This phenomenon alters rodent species demography (Casula et al. 2017; Klimant et al. 2017; Benedek et al. 2021; Shilereyo et al. 2023). In addition, human activities and land conversion increase the dispersal rate of Rodentia groups, especially synanthropic species (Hornok et al.

2015; Gravinatti et al. 2020; Awoniyi et al. 2022; Trogu et al. 2023). A case study on small mammal abundance in Slovakia mentioned that their abundance was significantly higher in urban areas than in suburban (Klimant et al. 2017). Increasing rodent populations contribute to an increase in ectoparasitic species and will be higher in commensal rodents (Gómez-Rodríguez et al. 2015; Wale et al. 2023). Furthermore, investigating Rodentia and ectoparasites' ecology is vital to understanding potential zoonotic risk. Calculation of prevalence values, abundance of ectoparasite species, rodent, and habitat type can be used as indicators to see the dynamics of the relationship between ectoparasite and host ecology. These indicators are expected to provide an understanding of the interactions between Rodentia and ectoparasites in their environment so that they can be used to mitigate zoonotic diseases in the islands.

MATERIALS AND METHODS

Study area

The research was conducted in the Mapaddegat Village (02° 0.3' 31.54" S 99° 34' 14.35") and Goisooinan Village (02° 0.3' 42.45" S 99° 38' 58.96"), northern district of the Sipora Island, Mentawai, with the altitude range of 2-38 meters above sea level (masl) (Figure 1).

Two habitat types were selected, which were around human dwellings and plantations. The two habitats were chosen because they were interconnected, allowing rodent species to move between habitats and interact with other organisms. Residential areas are houses, offices, yards, and gardens; plantation areas are community cultivation areas in coconut, sago, paddy fields, cocoa, and banana plantations.

Trapping and identification of small mammals

Data collection of rodents and ectoparasites was conducted in August 2023 following studies conducted by Alonso et al. (2020) and Torre et al. (2023). We placed small mammal traps with dimensions of 28 x 17 x 12 cm^3 for single traps and 34 x 20 x 15 cm^3 for multiple traps proportionally on the transect lines in each habitat type. We deployed 70 traps, consisting of 60 single and 10 multiple traps for three nights, using roasted coconut coated with peanut butter as the bait. Trap settings were done from 3:00 to 5:30 pm. Trap checking and rat sample collection were done from 6:00 to 8:00 am. The captured rats were then put into a 30 x 20 cm^2 cloth bag and labeled accordingly (the date, location code, and habitat type were noted). Rodentia identification refers to Nowak and Paradiso (1983) and Phillipps and Phillipps (2010) and Payne (2000)

Sampling and identification of ectoparasites

The collection of ectoparasites refers to the Research Center for Disease Vectors and Reservoirs (B2P2VRP) (rat) data collection field guide (2015) and has been adapted to the research of Alonso et al. (2020). Vertebrae dislocation was performed on 54 rats, followed by sweeping on a tray. We carefully examined the nose, ears, and base of the tail areas to check the presence of ectoparasites. Tweezers and brushes were used to detach the ectoparasites from the host. Subsequently, the ectoparasites were collected and then preserved with 70% alcohol in 2.5 mL tubes. The ectoparasite identification procedure was carried out by modifying the methods of Thille et al. (2019), Baker (2007), and Krantz (1978). Each ectoparasite acquired will be identified utilizing the reference materials authored by Thille et al. (2019), and Krantz (1978). The identification process will involve using a microscope to observe essential characteristics. Subsequently, the observed traits will be compared with the content of the already available ectoparasite identification guidebooks.

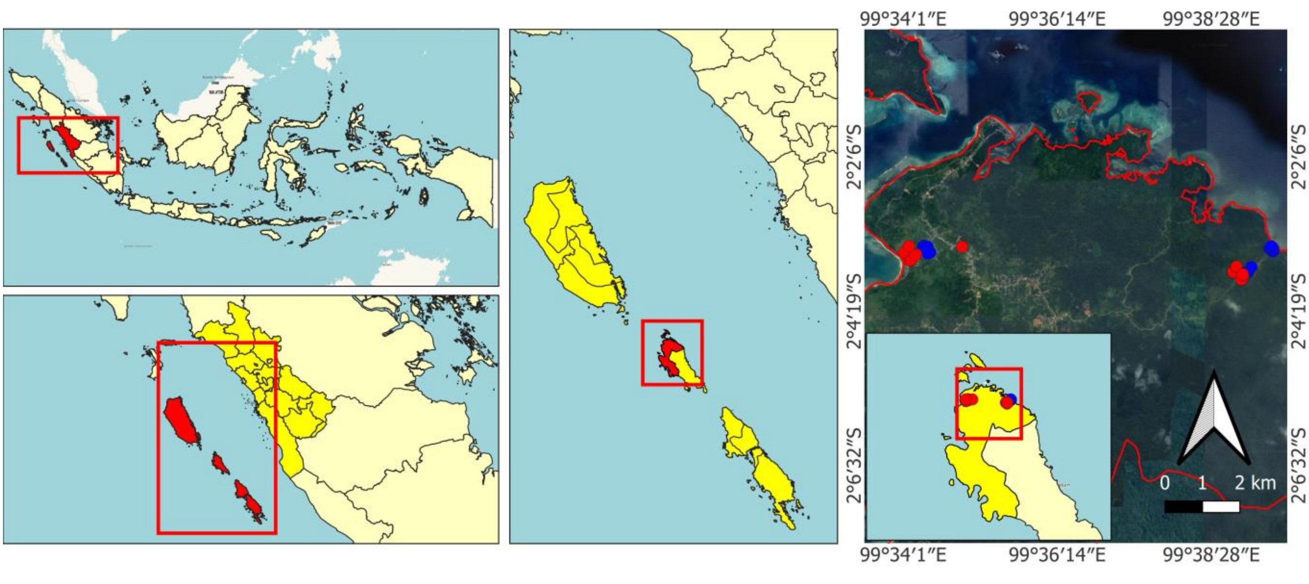

Figure 1. The map of the study areas is in northern Sipora Island, the outrage areas are residential. Red circles are trapping sites located in plantation habitats, blue circles are trapping sites located in residential areas

Data analysis

We recorded the number of ectoparasites found on each collected rodent to assess how ectoparasites are distributed among the various rodent species we observed. Subsequently, we calculated ectoparasite prevalence to determine the percentage of individual rodents exposed to ectoparasites within each species. Next, we used the Spearman correlation test, a non-parametric statistical test, to assess if there is a correlation between the distribution of ectoparasites among rodent species and several other variables we observed. These variables include rodent species parameters, ectoparasite species, ectoparasite prevalence, ectoparasite abundance, and other variables such as habitat type and rodent sex. We utilized the SPSS statistical software version 23 to analyze this data. Therefore, this analysis aims to understand how ectoparasites are distributed among various rodent species and whether certain factors, such as habitat type or rodent sex, correlate with this ectoparasite distribution. The correlation test parameters used are as follows Habitat Types (HBT); Ectoparasites Species (ECS); Individual Ectoparasites Number (IEN); Prevalence (PVL); Abundance of Species Ectoparasite (ABE); Rodent Species Name (RSN); Sex Rodent Code (SRC), and Abundance of Species Rodent (ABR).

RESULTS AND DISCUSSION

Rat and mouse community

A total of 54 individual rats and mice from 7 species were captured. These species include *Mus musculus, Rattus tanezumi, R. tiomanicus, R. rattus, R. argentiventer, R. norvegicus,* and *L. siporanus* (Figure 2). Of the 7 species, only *L. siporanus* is known to be endemic to Mentawai islands, while the rest are synanthropic and cosmopolite species (Nowak and Paradiso 1983). *Rattus tanezumi*, *R. tiomanicus*, *R. argentiventer*, and *R. norvegicu*s were found in both habitats in this study (human dwelling and plantation). *Mus musculus* were only found in human-dwelling habitats, while *R. rattus* and *L. siporanus* species were only found in plantation habitats.

In addition to the Rodentia species' environmental adaptability, the high number of individuals of some rat species in this study is also related to the behavioral patterns of each species. The Rattus group tends to favor relatively open habitats and is rich in food sources. On the other hand, the study area of settlements and plantations that are interconnected increases the flexibility of the distribution of each Rodentia species (Nowak and Paradiso 1983; Phillipps and Phillipps 2010). Furthermore, disturbance levels often increase and decrease the abundance of certain species (Casula et al. 2017; Klimant et al. 2017; Gravinatti et al. 2020; Awoniyi et al. 2022; Shilereyo et al. 2023).

Ectoparasites community

A total of 441 individual ectoparasites were collected and belonged to 2 classes (Arachnida and Insecta), 7 families, and Genus and 7 species belonging to ticks, mites, and flies (Table 1). These species consist of *Culicoides* sp., *Haemaphysalis longicornis*, *Hoplopleura pasifica*, *Laelaps echidninus*, *Leptotrombidium deliense*, *Ornithonyssus bacoti*, and *Polyplax spinulosa*.

The mite *L. echidninus* was the most common ectoparasite with 296 individuals and was distributed in all rat species. In both habitat types, the mite species *L. deliense* was found on 3 Rodentia species, i.e., *R. tiomanicus*, *R. tanezumi*, *and R. argentiventer*. A total of 32 individual *P. spinulosa* species were documented in *M. musculus*, *R. tanezumi*, *R. tiomanicus*, *R. rattus*, and *R. norvegicus*. The species *O. bacoti* (4 individuals) and *Culicoides* sp. (1 individual) were the least abundant in this study.

Prevalence and abundance ectoparasites

Many species have been identified in the arachnids and insects, each demonstrating varying prevalence and abundance across two distinct regions, MR1 and MR2. Within the category of mites, the species *L. echidninus* of the Laepaidae family holds substantial prevalence in both MR1 and MR2, accounting for 72.73% and 81.25%, respectively (Table 2). Moreover, it exhibits a marked abundance, representing 69.73% in MR1 and 68.81% in MR2. Another mite species, *L. deliense* from the Trombiculidae family, demonstrates a comparatively lower prevalence, comprising 9.09% in MR1 and 15.63% in MR2. Although less prevalent, it displays a relatively higher relative abundance of 24.41% in MR2. The tick species *H. longicornis*, classified under Ixiodidae, displays relatively modest prevalence in both regions, contributing 4.55% and 9.38% in MR1 and MR2, respectively. However, its abundance remains minimal, representing only 0.01% in MR1 and 0.13% in MR2. Among the Macronyssidae mites, *O. bacoti* exhibits prevalence solely in MR1, accounting for 4.55%, with an abundance of 0.03%, thereby contributing to a relative abundance of 2.37%.

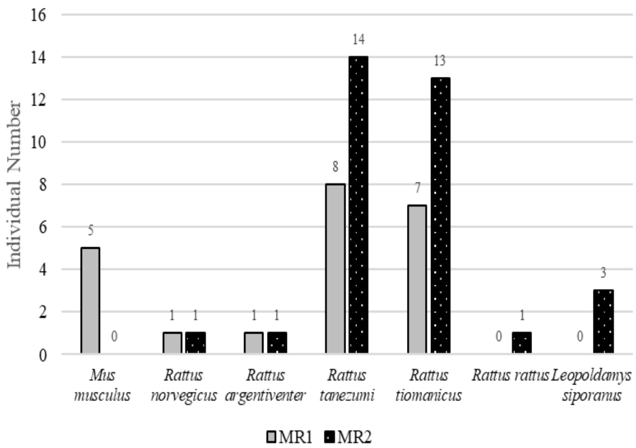

Figure 2. Individual numbers of rodent species were collected. MR1: Human dwelling, MR2: Plantation

Table 1. Species abundance of ectoparasites in individual rodents trapped in this study

Ordo/Family/Species	*M. musculus*		*R. tanezumi*		*R. tiomanicus*		*R. rattus*		*R. argentiventer*		*R. norvegicus*		*L. siporanus*		Total
	MR1	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**	
Arachnida															
Laelapidae (Mites)															
Laelaps echidninus	23		23	60	22	112		2	18		7			29	296
Trombiculidae (Mites)															
Leptotrombidium deliense			9	18	15	53				3					98
Ixiodidae (Tick)															
Haemaphysalis longicornis				1	1	1								2	5
Macronyssidae (Mites)															
Ornithonyssus bacoti			4												4
Insecta															
Ceratopogonidae (Flies)															
Culicoides sp.					1										1
Hoplopleuridae															
Hoplopleura pasifica					5										5
Polyplacidae															
Polyplax spinulosa	4		10	9	2	3		1				3			32
Total	27		46	88	46	169		3	18	3	7	3		31	441

Note: MR1: Human dwelling, MR2: Plantation

Table 2. Species of ectoparasites, prevalence, abundance and relative abundance

Ordo/Family/Species	Prevalence (%)		Abundance		Relative abundance (%)	
	MR1	**MR2**	**MR1**	**MR2**	**MR1**	**MR2**
Arachnida						
Laepaidae (Mites)						
Laelaps echidninus	72.73	81.25	0.82	6.34	69.73	68.81
Trombiculidae (Mites)						
Leptotrombidium deliense	9.09	15.63	0.17	2.25	14.25	24.41
Ixiodidae (Ticks)						
Haemaphysalis longicornis	4.55	9.38	0.01	0.13	0.59	1.36
Macronyssidae (Mites)						
Ornithonyssus bacoti	4.55		0.03		2.37	
Insecta						
Ceratopogonidae (Fleas)						
Culicoides sp.	4.55		0.01		0.59	
Hoplopleuridae (Fleas)						
Hoplopleura pasifica	22.73		0.03		2.97	
Polyplacidae (Fleas)						
Polyplax spinulosa	27.27	15.63	0.11	0.50	9.50	5.42

Note: MR1: Human dwelling, MR2: Plantation

In contrast, the flea species *H. pasifica*, belonging to the Hoplopleuridae family, boasts significant prevalence exclusively in MR1, representing 22.73%, with an abundance of 0.03%, contributing to a relative abundance of 2.97%. *Polyplax spinulosa*, a flea species categorized under the Polyplacidae family, appears in both regions with a prevalence of 27.27% in MR1 and 15.63% in MR2. Its corresponding abundances are 0.11% and 0.50%, leading to relative abundances of 9.50% and 5.42% in MR1 and MR2, respectively. These insights shed light on the prevalence and distribution of various arachnid and insect species across distinct regions, illuminating intriguing differences in their relative prevalence and abundance.

The results of the Spearman correlation statistical test between several test parameters, namely HBT, ECS, IEN, PVL, ABE, RDS, SRC, and ABR, obtained the correlation coefficient value between HBT-PVL, HBT-ABE, IEN-ABE, PVL-ABE with a significant positive correlation value (sign. 0.01) and IEN-ABE (p-value 0.05) (Table 3). While the correlation test between ECS-PVL and ECS-ABE has a negative significance value (p-value 0.01). Furthermore, several other test parameters did not show significant results. The correlation test results between Habitat Types and Prevalence (HBT-PVL) showed a positive correlation with a moderate correlation coefficient of 0.439**, indicating a tendency to increase prevalence values in habitat changes, in this case, plantations. These results also show that ectoparasite prevalence values are higher in plantation habitats compared to residential habitats. Also in line with the results of the correlation test between Habitat Type and Ectoparasite

Abundance (HBT-ABE) showing a moderate correlation value of 0.426** (p-value 0.01) and Individual Ectoparasites Number with Ectoparasite Abundance (IEN-ABE) with a low correlation coefficient of 0.252* (p-value 0.05).

Discussion

Laelaps echidninus belongs to the family Laelapidae, a type of mite commonly found in small mammals, especially among rodents (Lareschi and Velazco 2013; Savchenko et al. 2021). *Laelaps echidninus* is classified as a parasite commonly found in mice (Setiati et al. 2021) and is known as an ectoparasitic species with the term gamasid and, in some cases, is a vector of diseases (Engelbrecht et al. 2014; Yuan et al. 2023). This type of ectoparasite is common in urban areas and plantations (Abdel-Rahman 2020; Setiati et al. 2021), which aligns with this study. Correspondingly, *L. echidninus* is one of the most widespread ectoparasites in the tropics and is distributed worldwide (Nemati et al. 2016; Kaminskienė et al. 2023; Yang et al. 2023). In addition to the cases of disease caused by *L. echidninus* species in humans, the finding of *L. echidninus* species in the endemic rat species *L. siporanus* is an essential aspect of ecological and conservation studies. This finding also suggests a high potential for spillover between rat species on Sipora Island caused by the introduction of cosmopolitan alien species, which increases the potential for interactions with native island species. Moreover, 98 *L. deliense* individuals were collected in each rodent species, which displayed different average burdens.

Leptotrombidium sp. larvae have specific habitat requirements and are abundant in forests with shrubs and long grass plants (Lv et al. 2018; Xiang and Guo 2021; Chen et al. 2022). The abundance of *Leptotrombidium* sp. larvae is higher in habitats with shrubs and grasses (Kuo et al. 2015; Huang et al. 2017; Xiao et al. 2018), and this is in line with the condition of the study, which is mixed with shrubs. The relatively high abundance of *L. delisense* indicates the increased interaction of this ectoparasitic species in the human environment. All three host species are synanthropic rodents, leading to a high chance of zoonosis, and this is concerning because *L. deliense* is known to carry *Rickettsia tsutsugamushi*, a bacterium that causes scrub typhus (Candasamy et al. 2016; Latif et al. 2017; Bal et al. 2019; Sadanandane et al. 2021). The onset of scrub typhus is characterized by clinical symptoms such as fever, headache, myalgia (muscle pain), cough, and gastrointestinal symptoms. The severity of symptoms varies widely, depending on the body's susceptibility, the bacterial strain's virulence, or both (Peng et al. 2017; Chaisiri et al. 2019; Yang et al. 2020).

The tick *P. spinulosa* was one of the 7 species with the highest abundance. The presence of *P. spinulosa* species in several mouse species indicates a high level of adaptation to various host species. The discovery of *P. spinulosa* species in several Rodentia species is in line with studies reported by Abdel-Azeem (2008), Pakdad et al. (2012), and Chakma et al. (2017), who noted that the same species infects rodents (Rodentia). Ticks are notorious vectors of numerous pathogenic organisms (Madinah et al. 2013). They are vectors of zoonotic pathogens such as bubonic plague and can transmit tularemia and bartonellosis to humans (Bowman et al. 2003).

Species *O. bacoti* was only found in the host *R. tanezumi* in a relatively small number of individuals; it is known as tropical rat mites, are blood-sucking meso-stigmatized mites that can infect research rat colonies through wild rodent vectors (Bauer et al. 2016; Bhuyan 2016; Clancy et al. 2022) and are only found on the rat during periods of feeding (Otto et al. 2015). *Ornithonyssus bacoti* has been identified in a wide range of wild rodent mammals worldwide, in temperate and tropical climates. Although it does not usually cause clinical signs, it can cause severe symptoms and, in some cases, cause anemia, alopecia, itching, and decreased reproductive performance (Brito-Casillas et al. 2018; Dumitrache et al. 2023).

Table 3. Spearman's correlation test

		HBT	ECS	IEN	PVL	ABE	RDS	SRC	ABR
HBT	Correlation Coefficient	1	-0.055	-0.008	.439**	.426**	0.134	0.204	0.095
	Sig. (2-tailed)	.	0.657	0.95	0	0	0.279	0.097	0.444
ECS	Correlation Coefficient	-0.055	1	0.089	-.273*	-.309*	0.134	0.157	0.1
	Sig. (2-tailed)	0.657	.	0.475	0.026	0.011	0.279	0.204	0.419
IEN	Correlation Coefficient	-0.008	0.089	1	0.104	.252*	-0.12	-0.041	-0.014
	Sig. (2-tailed)	0.95	0.475	.	0.404	0.039	0.332	0.74	0.913
PVL	Correlation Coefficient	.439**	-.273*	0.104	1	.955**	0.031	-0.076	0.186
	Sig. (2-tailed)	0	0.026	0.404	.	0	0.805	0.54	0.132
ABE	Correlation Coefficient	.426**	-.309*	.252*	.955**	1	0.017	-0.091	0.169
	Sig. (2-tailed)	0	0.011	0.039	0	.	0.891	0.462	0.171
RDS	Correlation Coefficient	0.134	0.134	-0.12	0.031	0.017	1	0.003	0.117
	Sig. (2-tailed)	0.279	0.279	0.332	0.805	0.891	.	0.979	0.347
SRC	Correlation Coefficient	0.204	0.157	-0.041	-0.076	-0.091	0.003	1	0.039
	Sig. (2-tailed)	0.097	0.204	0.74	0.54	0.462	0.979	.	0.755
ABR	Correlation Coefficient	0.095	0.1	-0.014	0.186	0.169	0.117	0.039	1
	Sig. (2-tailed)	0.444	0.419	0.913	0.132	0.171	0.347	0.755	.

Note: HBT: Habitat Types, ECS: Ectoparasites Species, IEN: Individual Ectoparasites Number, PVL: Prevalence, ABE: Abundance of Species Ectoparasite, RDS: Rodent Species Name, SRC: Sex Rodent Code, ABR: Abundance of Species Rodent. **: Correlation is significant at the 0.01 level (2-tailed), *: Correlation is significant at the 0.05 level (2-tailed)

In this study, only one individual of the species *Colicoides* sp. was found on the host species *Rattus tiomanicus*. *Colicoides* sp. is a blood-feeding insect typically associated with livestock such as chickens, cows, buffaloes, sheep, goats, and humans (Sick et al. 2019). Furthermore, no reports of *Colicoides* sp. have been found in rats. This ectoparasite species is found in various habitats, depending on the species (Ayllón et al. 2019; Sick et al. 2019). These tiny insects, belonging to the *Culicoides* genus, are crucial in the medical and veterinary field as they act as vectors for several viruses, protozoa, and nematodes. This includes Bluetongue, African horse sickness, and Schmallenberg (Rasmussen et al. 2012).

Host species, especially synanthropic rodent species, correlate highly with habitat disturbance and human dispersal (Gravinatti et al. 2020; Awoniyi 2022; Trogu et al. 2023). This is a very important factor, considering that some Rodentia species in this study were also found and known as hosts of several ectoparasite types (Guo et al. 2016; Speer et al. 2022). The study aligns with Smith et al. (2023) in South Africa; habitat type significantly affects the type of Rodentia *Gerbilliscus leucogaster*; related to that, the host species found have good adaptation to the environment, such as *R. tanezumi* and *R. tioamaicus* found in both habitat types (Gebrezgiher et al. 2023). This emphasizes the importance of habitat management and mitigation related to the spread of vectors of various diseases.

A significant correlation value was also found in the PVL-ABE parameter with a perfect correlation coefficient of 0.955** (p-value 0.01). This correlation value illustrates a significant positive relationship to the increase in prevalence as the value of ectoparasite abundance increases. In other words, the rise in prevalence is directly related to the increase in ectoparasite abundance proportionally, especially in this study's Laelapidae and Trombiculidae families. Some other parameters that affect ectoparasite abundance are the number/abundance of individuals of certain rodent species, considering that some synanthropic rodent species are known to be natural hosts of some ectoparasites. Land use changes substantially impact rodent species communities and ectoparasites' prevalence, potentially elevating the risk of disease transmission. Alterations in land use, like deforestation, urban development, or expansion of agricultural areas, can modify the availability of habitats and resources for various rodent species. Consequently, this can influence the composition of the rodent community within the region (Klimant et al. 2017; Benedek et al. 2021; Shilereyo et al. 2023). In line with that, synanthropic species such as Norway rats (*R. norvegicus*) are infected more by mites, especially the Trombiculidae group (Guo et al. 2016; López-Pérez et al. 2022; Gebrezgiher et al. 2023). In some cases, land use changes may favor certain rodent species more adaptable to the new environmental conditions. These favored species may experience increased population densities and resource availability, attracting more ectoparasites. Studies of mite infections in Southeast China suggest a relatively high prevalence of this group of mites in *R. tanezumi* species. In some instances, the prevalence of fleas group ectoparasites was higher in *R. tanezumi* and *R. tiomanicus* (Sepe et al. 2020; Islam et al. 2021). In addition, several other environmental factors, such as elevation and sex, also influence (Guo et al. 2016; Gebrezgiher et al. 2023). The abundance of ectoparasites acts as disease vectors or reservoir hosts for specific pathogens; when ectoparasite abundance increases, the potential for spillover to other individuals will increase.

These results indicate that the more ectoparasite species found, the lower the percentage prevalence value, meaning that a specific species infects the host and is closely related to the Rodentia species (host). This is also supported by the negative correlation between ectoparasite species and ectoparasite abundance, indicating that the more varied the ectoparasite species, the lower the ectoparasite abundance. The dynamics of competition between ectoparasites that infect host species affect their abundance. We acknowledge the limitations of the sample size in the statistical test, but these findings align with several previous ectoparasite studies. Some ectoparasite species are found in certain rodentia groups; mites and fleas are common, while thickets are rare in synanthropic rat species (Hornok et al. 2015; López-Pérez et al. 2022; Trogu et al. 2023). This could suggest that various ectoparasite species may influence the spread of disease among their host populations (Smith et al. 2023). Correspondingly, the study by Seyoum et al. (2015) confirmed that the prevalence of each ectoparasite is highly dependent on the host species. Studies of ectoparasites on small mammals in Portugal confirmed the dominance of prevalence in one rodent species (Carrilho et al. 2023; Setiati et al. 2023). Host species that are volant and carry ectoparasites are considered more dangerous due to the combination of mobility and disease transmission factors. Their ability to fly allows them to spread ectoparasites over a larger area, potentially leading to a broader spread of disease. Furthermore, their increased mobility also leads to higher levels of exposure, as volant hosts may interact more frequently with humans and other animals, increasing the risk of ectoparasite and disease transmission. Finally, these hosts may have a significant ecological role, increasing the potential for widespread disease transmission and more effective environmental impact (Ahmad et al. 2020; Fajri and Armaini 2021).

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