The diversity of ectoparasites on some type of rats

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Abstract. The rats were parasitized by ectoparasitic arthropods which have a close relationship with rats as their specific host. In the rat's body found various types of ectoparasites such as ticks, mites, fleas, and ticks at the same time and is known as polyparasit. This research aims at obtaining data about the diversity of ectoparasites on different types of rats and their habitat. The rats caught in the house habitat, forest, field, and sewer. The caught rats were put into a cloth bag, labeled, then taken to laboratory to be identified by using key rodent identification. Then, the researcher did the collection and identification. The results showed that There were 87 rats caught from all the habitats. The four rat species trapped from four habitats were Rattus rattus diardii, R. tiomanicus, R. argentiventer, and R. norvegicus. The total number of 2548 ectoparasites were collected from the rats of Hoplopluera pacifica, Polyplax spinulosa, Xenopsylla cheopis, Laelaps nutalli Hirst and L. echidninus. The diversity index of ectoparasites on the bodies of R. tanezumi was predominant (0.525). Statistical analysis with t-tests (α = 5%) of all index diversity between male and female rodents infested with ectoparasites was not significantly different.

1. Introduction
Rats play an important role as pests in agricultural and urban environments that cause economic losses. Rats and ectoparasites can be causing problems for human and animal health [1,2]. Ectoparasitic arthropods in rats are vectors such as pes/pestilence, leptospirosis, scrub typhus, murine typhus and babesiosis which can cause death in humans and animals [2], so they are always a concern of researchers widely. Research results on ectoparasites have been widely reported from the tropics such as Thailand [3], India [4], Malaysia [5], and Myanmar [6]. In Indonesia, research on rat ectoparasites was carried out [7–9].

Ectoparasites of rats based on where they live are located on the outer surface of the host body, including in holes in the skin or outer ear space [10]. Ectoparasites have host specifications, preferred hosts, or preferred hosts. Although ectoparasites choose certain hosts for their survival, this does not mean that there are only ectoparasites in their bodies. [11] revealed that ectoparasites in rats were classified into four main groups namely, Ixodide (tick), Mesostigmata (mites), Phthiraptera (lice), and Siphonaptera (fleas). [10] showed that mites and ticks like and settle in the back and abdomen, ticks on the neck, mite larvae in the ear space and the base of the tail, whereas fleas are distributed throughout the body, except the tail.

Diversity can indicate host specifications for species and ectoparasites tolerance to their host
This information is useful, both for controlling ectoparasites as infectious diseases or pests and as a collection of references for science. Research into the diversity of ectoparasites in rats and their habitats in Indonesian regions is rare. Therefore, researchers are trying to uncover data about the diversity of ectoparasites in various types of rats in different habitats.

2. Methodology
This research was conducted from August 2013 to January 2015. Catching rats was carried out in four different habitats, namely houses, forests, rice fields, and sewers. Locations of rat sampling in West Java, namely Bogor (Dramaga) and Subang (Sukamandi). Identification of the type of rat was carried out at the Pest Vertebrate Laboratory, Plant Protection Department, Faculty of Agriculture, Bogor Agricultural University. Identification of ectoparasite morphology was carried out at the Insect Biosystematics Laboratory, Plant Protection Department, Faculty of Agriculture, Institut Pertanian Bogor and Entomology Laboratory, Zoology Research Center for Biology-LIPI Cibinong Bogor.

2.1 Rat catching method
Rats are caught using live traps with dried fish bait, chicken bones, and sweet potatoes. Live rat traps were installed in the afternoon at 15.00–17.30 WIB and then taken the next day at 06.00–08.00 WIB. The rats taken were put into a cloth bag 30 cm x 40 cm, then labeled (date, habitat, and location code), then taken to the laboratory for processing.

2.2 Rat identification
Identification of rats by observing and measuring the qualitative and quantitative characters of rat morphology. The reference used is the description key developed [12–14].

2.3 Sampling of ectoparasites
Rats in cloth bags were turned off using chloroform. Dead rats were combed body hair on a white tray, then examined the ears, nose, and base of the tail. Ectoparasites dropped on the tray are taken with tweezers, while ectoparasites stick to the ears, nose, and base of the tail scraped with needles or tweezers. Ectoparasites were put into tubes containing 70% alcohol and labeled (location code and host number).

2.4 Identification of ectoparasites
The ectoparasite identification process was carried out under an OLYMPUS CX21 microscope compound with a Dino-eye AM4234 camera connected directly to the computer. Identification refers to the identification key book: [15–18].

2.5 Calculation of ectoparasites prevalence
Prevalence is calculated using the following formula:

\[
\text{Prevalence} = \frac{\text{Number of rat attacked}}{\text{Number of rat samples examined}} \times 100 \%
\]

2.6 Data analysis
Analysis of diversity of ectoparasites using the Shannon-Weaver diversity index formula [19]. Similarity analysis to determine differences or similarities in variations in the composition of ectoparasites between rat was done by comparing the quantity and diversity of ectoparasites of each group of mice using the t-test (α = 0.05).
3. Results and discussion

3.1 Rat and ectoparasites species

During the study, 87 rats from 4 habitats (house, rice field, forest, and sewer) were captured. Rat species caught were identified as *Rattus tanezumi*, *R. argentiventer*, *R. tiomanicus*, and *R. norvegicus*. The percentage of ectoparasite infestation (table 1).

*R. tanezumi* were captured 26 tails consisting of 10 males and 16 females. Male rats (90%) were relatively more ectoparasites infested compared with female rats (86.7%). [20] who reported an average level of ectoparasite infestation in *R. rattus diardii* around 63.3% with a rate of infestation of fleas in home habitats as much as 96.2%. *R. argentiventer* were caught as many as 20 tails (5 males and 15 females). The percentage of ectoparasites infested male rats (80%) was lower when compared to female rats (86.7%). The percentage of ectoparasite infestations in *R. argentiventer* in this study was higher when compared with those reported [20]. [20] reported that the percentage of mite infestations was 22.6% and ticks were 6.45%. Percentage of ectoparasite infestation in male and female *R. argentiventer* is not too different, this can occur because both sexes of these mice have nearly the same range.

*R. tiomanicus* are trapped in two different habitats, namely in the rice field and forest habitat. In the field, 8 tails (5 males and 3 females) were captured with infestation rates of 60% and 66.7%, respectively. *R. tiomanicus* was captured 22 tails in forest habitats (11 males and 11 females) with successive infestation rates of 54.5% and 27.3% lower than tree rats caught in rice field habitat. [9] reported that host behavior, age, and sex influence the parasitic infestation patterns. Rat mobility plays an important role and determines parasitic infestation patterns. *R. tiomanicus* is known to have a wider habitat than other mice.

*R. norvegicus* was captured 11 tails (2 male and 9 female). All types of rat caught are still considered adults. The percentage of ectoparasites infested male rats (100%) was higher than female rats (77.8%). The percentage of ectoparasite infestation in *R. norvegicus* is quite high, this is in line with what was reported by [20] where the percentage of ectoparasite infestations in the body of *R. norvegicus* was 71% with the percentage of infestations of *P. spinulosa* species reaching 97.26%.

Table 1. Distribution of four rat species and percentage of rats infested with ectoparasite in four rat fishing habitats.

| Rat type         | Gender | Number of a rat caught | Percentage of ectoparasites infested (%) |
|------------------|--------|------------------------|-----------------------------------------|
|                  |        | Home Rice Fields Forest Sewer | Home Rice Fields Forest Sewer |
| *R. tanezumi*    | Male   | 10 0 0 0 90 0 0 0   |                                        |
|                  | Female | 15 1 0 0 86.7 100 0 0 |
| *R. argentiventer* | Male   | 0 5 0 0 0 80 0 0   |                                        |
|                  | Female | 0 15 0 0 0 86.7 0 0 |
| *R. tiomanicus*  | Male   | 0 5 11 0 0 60 54.5 0 |
|                  | Female | 0 3 11 0 0 66.7 27.3 0 |
| *R. norvegicus*  | Male   | 0 0 0 2 0 0 0 100 |
|                  | Female | 0 0 0 9 0 0 0 77.8 |

3.2 Number of ectoparasites

The results showed that as many as 5 species of ectoparasites infested four species of a rat was captured in different habitats namely, 1) *Hoplopleura pacifica*, 2) *Polyplax spinulosa*, 3) *Xenopsylla cheopis*, 4) *Laelaps echidninus*, and 5) *Laelaps nuttalli* (table 2).
Table 2. Ectoparasites that infest four rat species in different habitats.

| Ordo        | Family           | Ectoparasites                  |
|-------------|------------------|--------------------------------|
| Phthiraptera| Hoplopleuridae   | Hoplopleura pasifica           |
|             | Palyplacidae     | Polyplax spinulosa             |
| Siphonaptera| Pulicidae        | Xenopsylla cheopis             |
| Acarina     | Laelapidae       | L. echidninus                  |
|             |                  | L. nutalli                    |

The number of ectoparasites was 2548 (table 3). *H. pacifica* in male and female rats were found in 1001 and 382 (1383 individuals). *P. spinulosa* were 685 individuals (155 males and 530 females), *L. echidninus* were 290 individuals (91 males and 199 females), *L. nuttalli* were 174 individuals (61 males and 113 females), and *X. cheopis* were 16 individuals (9 males and 7 females). [9] reported that there were three groups of ectoparasites in the body of the rat consisting of Anoplura, Siphonaptera, and Mesostigmata. [20] reported that there were at least 10 species of ectoparasites that could be found in the body of rat which included; *X. cheopis, P. spinulosa, H. pacifica, L. nuttalli, L. echidninus, O. bacoti, A. indica, L. deliense, W. oudemansi* and Amblyomma sp. The ten ectoparasites are members of four groups of ectoparasites, namely Anoplura, Siphonaptera, Mesostigmata, and Ixodida.

Table 3. The number of individuals of each ectoparasite species infesting rat.

| Rat type       | Gender | Number of individual species of ectoparasites |
|----------------|--------|-----------------------------------------------|
|                |        | *H. pacifica* | *P. spinulosa* | *X. cheopis* | *L. nuttalli* | *L. echidninus* | Sub Total |
| *R. tanezumi*  | Male   | 922          | 143            | 4             | 3             | 67             | 1139      |
|                | Female | 224          | 490            | 5             | 17            | 142            | 878       |
| *R. argentiventer* | Male | 16           | 5              | 0             | 39            | 13             | 73        |
|                | Female | 140          | 32             | 0             | 54            | 41             | 267       |
| *R. tiomanicus* | Male   | 45           | 6              | 5             | 15            | 11             | 82        |
|                | Female | 8            | 0              | 2             | 7             | 11             | 28        |
| *R. norvegicus* | Male   | 18           | 1              | 0             | 4             | 0              | 23        |
|                | Female | 10           | 8              | 0             | 35            | 5              | 58        |
| Total          | Male   | 1001         | 155            | 9             | 61            | 91             | 1317      |
|                | Female | 382          | 530            | 7             | 113           | 199            | 1231      |

*H* = Hoplopleura, *P* = Polyplax, *X* = Xenopsylla, dan *L* = Laelaps.

3.3 Diversity Index of ectoparasites on some type of rats

Female *Rattus tanezumi* in home habitats have a relatively higher diversity index (0.525) when compared to male rats (0.275). [10], reported the same thing in *R. rattus diardii* in home habitats with a diversity index value in female rats that were 1.75 relatively higher than in male rats that were 1.48. *R. tanezumi* females were caught at a paddy habitat with a diversity index value of 0.079 (table 4). *R. argentiventer* has a diversity index in female rats 0.523 and males 0.503. *R. tiomanicus* at forest habitat shows a different diversity index (index of salvation in male rats is higher than female) compared to the three rats species (*R. tanezumi, R. argentiventer, and R. norvegicus*) other. The highest diversity index value occurs in male rats (0.463) compared to female rats (0.217). *R. tiomanicus* female sex caught in paddy habitat has a higher index (0.446) when compared to male rats (0.341). *R. norvegicus* showed a higher diversity index value in female rats (0.474) than male rats (0.275). [20] namely the ectoparasite index (*X. cheopis*) in the body of *R. norvegicus* in urban areas around 0.32 with a prevalence value of 32%.
Table 4. Diversity index of ectoparasites on some type of rats.

| Rat type       | Gender | Diversity Index | Home | Rice Fields | Forest | Sewer |
|---------------|--------|----------------|------|-------------|--------|-------|
| *R. tanezumi* | Male   | 0.275ª         | -    | -           | -      | -     |
|               | Female | 0.525ª         | 0.079ª | -           | -      | -     |
| *R. argentiventer* | Male | -              | 0.503ª | -           | -      | -     |
|               | Female | -              | 0.523ª | -           | -      | -     |
| *R. tiomanicus* | Male | -              | 0.341ª | 0.463ª      | -      | -     |
|               | Female | -              | 0.446ª | 0.217ª      | -      | -     |
| *R. norvegicus* | Male | -              | -    | -           | 0.275ª | -     |
|               | Female | -              | -    | -           | 0.474ª | -     |

Numbers followed by the same letter (a) in the same column mean significantly different comparison variety based T-test, α = 0.05.

T-test results at 5% level showed that the quantity of each ectoparasite species in the body of a rat by sex did not show any significant difference (p > 0.05). These results indicate that the individual distribution of each type of ectoparasite in *R. tanezumi*, *R. argentiventer*, *R. tiomanicus*, and *R. norvegicus* is relatively evenly distributed. This is in line with the results of research [10] who reported that Chi square test results at the level (α = 0.05) on the ectoparasite diversity index in *R. tanezumi* home mice and *R. exulans* polynasia rats were not significantly different. These results show that the spread of individual ectoparasites in each of the *R. rattus diardii*, *R. argentiventer*, *R. tiomanicus* and *R. norvegicus* mice caught in four capture habitats (houses, rice fields, sewers, and forests) is relatively evenly distributed.

4. Conclusion

Ectoparasites that infest rat *R. tanezumi*, *R. argentiventer*, *R. tiomanicus*, and *R. norvegicus* are ectoparasites of the species *H. pacifica* (F. Hoplopleuridae), *P. spinulosa* (F. Polyplacidae), *X. cheopis* (F. Pulicidae), *L. nuttalli* and *L. echidninus* (F. Laelapidae).

Based on the sex of the rat, the highest prevalence of ectoparasite infestation (100%) in male *R. norvegicus* and the lowest was found in male *R. tiomanicus* (56.3%). In female rats, the highest prevalence of infestation occurred in *R. tanezumi* (87.5%) and the lowest in *R. tiomanicus* (35.7%). The highest ectoparasite diversity index value in female *R. tanezumi* was 0.525. Based on the results of the t-test, all diversity indices in the four rat species were not significantly different.

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