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Density Identification of Rats and Fleas (Xenopsylla cheopis) as the Biological Vector of Plague at the Central Market of Gorontalo City

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ABSTRACT

Rat are a reservoir for bubonic plague, as well as a host for ectoparasites of the flea type (Xenopsylla cheopis) as the main biological vector that contributes to the transmission of bubonic plague. Traditional markets are one of the places where rats can be found in quite high numbers. This study aims to determine the density of rats and the presence of fleas (Xenopsylla cheopis) in rats at the Gorontalo City Central Market.

The type of research used in this research is descriptive quantitative. The samples were rats caught using mouse traps which were spread at 10 points for 3 days and fleas (Xenopsylla cheopis) that lived on rats. The data is presented using tables and then analyzed descriptively

The results showed that the density of rats at the Gorontalo City Central Market was 60%, meaning that it was classified as high density (exceeding the Environmental Health Quality Standards according to Permenkes No. 50 of 2017, namely > 5%). The density of fleas (Xenopsylla cheopis) at the Gorontalo City Central Market is 0.116, meaning that it does not have the potential to transmit bubonic plague (under the Environmental Health Quality Standard according to Permenkes No.50 of 2017, namely <1). It is suggested to market managers be able to control the rat vector using physical control in the form of setting traps and chemical control in the form of administering rat poison, as well as improving the environment around the market to reduce the rat population.

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1. INTRODUCTION

Aspects of human well-being and aspects of disease are influenced by environmental factors. In many cases of disease, the tendency to worsen certain physical and biological environmental conditions caused by humans, in fact, creates a habitat for certain animals or organisms to breed. Rats are known as cosmopolitan animals, which occupy almost all habitats (1). In general, rats are animals that control the surface of the earth after humans. Rat (Rodentia) are the largest order (40%) of the class of mammals with the highest number of species (Nurul, 2021). The high rat population can have an impact on losses in various areas of human life. Judging from the aesthetic value, the presence of rats will describe environmental conditions that are dirty, dirty and indicate poor environmental hygiene (Dewi, T. 2015). Rats are members of rodents that bring many losses and have a negative impact on human life. Rats can transmit disease, disease can be caused by various disease agents such as viruses, rickettsiae, bacteria, protozoa, fungi, and worms which can be transmitted directly through skin contact or rodent bites or indirectly through ectoparasites such as fleas, fleas, mites, and ticks (4).

According to Riyanto (2019) diseases caused by vectors are a health problem that generally occurs in the world. Based on WHO data (2020) vector-borne diseases account for more than 17% of all infectious diseases.

Deaths caused by vectors occur around 700,000 each year. One type of vector that transmits the disease is the rat (5).

Transmission of diseases caused by rats can occur through bites made by rats or through vector bites attached to the rat's body. The type of vector that generally sticks to rat is called flea. Various types of infectious diseases are transmitted through ectoparasites belonging to the arthropods, ectoparasites as vectors that cause zoonotic diseases are fatal to humans. Several types of diseases that can be transmitted by ectoparasites in rat include bubonic plague, murine typhus, bush fever (Scrub typhus), and Q fever (4).

Vectors and disease-carrying animals in Indonesia have been identified, especially those related to tropical infectious diseases, both endemic and potential epidemic infectious diseases. Considering the diversity of tropical diseases which are vector-borne and zoonotic diseases, efforts to control vectors and disease-carrying animals are an integral part of efforts to combat vector-borne diseases, including zoonotic diseases that have the potential to attack humans, which require Standard Health Quality Standards. Environmental and Health Requirements (6). Infected flea bites, Xenopsylla cheopis, are the most common source of exposure that results in disease in humans worldwide. Xenopsylla cheopis rat flea is the most important vector in the transmission of bubonic plague and also murine typhus (5). Plague is one of the e-emerging diseases, namely diseases that can reappear at any time so that they have the potential to cause Extraordinary Events (KLB) (7).

One of the places where rats can be found in high numbers is traditional markets. Traditional market conditions generally do not meet health requirements, such as unclean sanitation, poor lighting, goods piling up, and poor waste management. If the market does not meet the requirements of a healthy market, rats have a great opportunity to breed. The existence of rats with high density can indirectly affect the presence of ectoparasites (1). The market is synonymous with a dirty and smelly place caused by trash that is scattered everywhere (8).

In a research by Frye (2015), 133 Norwegian rats were imprisoned in Manhattan, New York, for 10 months. With an average of 17 species per person, the Norwegian rat serves as a home to the tropical rat mite (Ornithonyssus bacoti), the spiny rat mite (Laelaps echidnina Berlese), Laelaps nuttalli, the spiny rat mite (Polyplax spinulosa), and the Oriental rat tick (Xenopsylla cheopis). 4.10 times the flea index (9).

Research conducted by Manyullei, Birawida, & Suleman (2019) di at Soekarno Hatta Seaport. Based on the results of the study, several types of rats were found, namely Rattus tanezumi (75.00%) and Rattus norvegicus (25.00%). From the results of the study, it was found that 12 rats caught were all found to have ectoparasites of the type of flea Xenopsylla cheopis 7 tails, fleas 1 tail, and mites 2 tails (10).

Based on preliminary observations, it can be seen that the sanitation in the Gorontalo city central market is not good, there is a lot of garbage in the market halls and garbage piled up next to the trash bins so that it can trigger the presence of rats. Garbage that is in the market is transported every day, but the provision of trash bins is still lacking, while the waste generated from the market is very large. During interviews with traders and visitors at the market, it can be seen that many rats roam around both in the morning and at night. Visitors and traders feel uncomfortable with the existence of these rats, because there is rat droppings and the goods they sell are damaged or eaten by rats. The existence of rats as reservoir hosts results in a risk of spreading the disease. Parasites that ride on rats will certainly have an impact on public health, especially among people who live in slum settlements. Efforts to determine the type of parasite in rat can be one of the control measures to reduce the density of rat and minimize the risk of exposure to diseases caused by these vectors.

2. METHODOLOGY

This research was carried out from January to February 2023 at the Gorontalo City Central Market which is located on Jalan Budi Utomo, Waste U1 Village, South City District, Gorontalo City. The type of research used in this study was descriptive quantitative which described the presence of rats and Xenopsylla cheopis fleas that cause disease in rats. The variables in this study were rat density and Xenopsylla cheopis flea index. Calculation Formula:

$$\text{Rat Density Index} = \frac{Number\ Positive\ Trap}{Number\ Traps\ installed} \text{X } 100\%$$

$$\text{Special Flea Index} = \frac{\text{Number of Xenopsylla cheopis obtained}}{The\ number\ of\ rats\ examined} \text{X } 100\%$$

Rat density is the number of rat caught by traps spread over 10 points for 3 days, which is the result of calculations using the rat density formula while the Xenopsylla cheopis flea index is the number of fleas obtained from sweeping the bodies of caught rats obtained using the flea index formula special. The population in this study were all ectoparasites and rats in the Gorontalo City Central Market. The samples were rats caught using mouse traps which were spread at 10 points for 3 days, and Xenopsylla cheopis fleas that lived on rats.

2.1. Tools and materials

The tools used in this study were mouse traps and microscopes, label paper, stationery, petri dishes, tweezers, cotton and tissue. The materials used in this study were chloroform, alcohol, gloves, masks, white plastic, cloth bags and rats.

2.2. Sampling

Rat were caught using live mouse traps, namely wire traps measuring 21x12x10 cm spread at several points where rats were indicated by using corn bait, salted fish and cakes. The arrest was made at the Gorontalo City Central Market. Traps will be set in the afternoon at 17.00 WITA - finished then monitored the next day at 07.00 - finished. The caught mouse is put into a cloth bag along with the labeled trap, then recorded (date, habitat, and location code). Rat that have been tagged/tagged are then killed (mechanically or using cotton that has been treated with chloroform and put in a sack, then wait a few minutes until the rats don't move anymore). Some rats had to be killed by dislocking them because they didn't work with chloform. Do a sweep of the rats using a special comb for fleas, so that it is easy to get Flea ectoparasites (Xenopsylla cheopis). Slides of Xenopsylla cheopis flea preparations were observed under a binocular microscope with magnifications of 4 x 10 and 10 x 10 and identified using an identification book for rodent-borne diseases (rats).

3. RESULTS

3.1. Rat Density

Based on the results of installing rat traps which were carried out for 3 (three) days at the Gorontalo City Central Market, 18 rats were obtained consisting of 12 Rats (Rattus norvegicus) and 6 head Rats (Rattus rattus). Of the 18 rats caught, 2 rats were positive for Xenopsylla cheopis fleas.

Table 1. Location Distribution of Rats Found at Central Market in Gorontalo City

No.	Trap location	Number of caught mouse
1.	Location point number 3	3
2.	Location point number 4	2
3.	Location point number 5	3
4.	Location point number 6	3
5.	Location point number 7	3
6.	Location point number 8	2
7.	Location point number 10	2

From table 1 it can be seen that at location points 3, 5, 6 and 7 each found 3 rats while at locations 4, 8 and 10 each only found 2 rats.

Rat density at the Gorontalo City Central Market can be calculated using the rat density index formula as follows:

$$\text{Rat Density Index} = \frac{\text{Total Positive Trap}}{Total\ Traps\ installed} \text{X } 100\%$$

$$= \frac{18}{30} X\ 100\ \%$$

$$= 60\ \%$$

The results of the calculation of the Rat Density Index at the Gorontalo City Central Market is 60%. This means that the density of rats at the Gorontalo City Central Market is included in the high density category based on Permenkes No. 50 of 2017 concerning Environmental Health Quality Standards and Health Requirements for vectors and disease-carrying animals and their control.

The relative density of rats in the Central Market of Gorontalo City can be found by dividing the number of rats caught that were installed during a certain period of time. The relative density of rats is usually called trap success, because the success of this capture can describe the relative density of the rat population in a place. The following is the relative density of rats in the Sentra Market, Gorotalo City, which can be seen in the table below:

Table 2. Success Trap in the Central Market Area of Gorontalo City

Execution time	Bait Type	Number of traps installed	Caught Mouse	Length of day of arrest	Succes Trap	Explanation
Day I	Corn	10	5	1	50%	high density
Day II	Salted fish	10	7	1	70%	high density

Day III	Cake	10	6	1	60%	high density
Total for 3 days		30	18	3	60%	high density

Table 2 shows that overall the trap success in this study was 20%. On the first day of the arrest, 5 rats (50%) were caught from the 10 traps that were installed, on the second day there were 7 rats (70%) caught from the 10 traps that were installed while on the third day there were 6 rats (60%) caught. The highest rat catching success was on the second day, namely 7 rats (70%). The following is the formula for calculating the trap success of rat density at the Gorontalo City Central Market:

Succes Trap = $\frac{A}{BXC} X\ 100\%$

= $\frac{18}{10X\ 3} X\ 100\%$

= $0{,}6\ (60\%)$

Description: A→ The number of rats that entered the trap

B→ Number of traps set

C→ Length of day of Arrest

Based on research results and calculations, the formula shows that the total success trap for the installed traps is 0.6 (60%). This means that the success of catching rats in the central market of the city of Gorontalo was successful based on Permenkes No. 50 of 2017 concerning Environmental Health Quality Standards and Health Requirements for vectors and disease-carrying animals and their control.

3.2. Density of Fleas (*Xenopsylla cheopis*)

The following table shows the density of fleas (Xenopsylla cheopis) found in rats at the Central Market in Gorontalo City.

Table 3. Catches of Flea Ectoparasites (Xenopsylla cheopis)

The number of rats examined	*Number of Fleas (Xenopsylla cheopis)*	Other Types of Ectoparasites (fleas, mites)	Density of Fleas (Xenopsylla cheopis)	Explanation
18	2	13	0,116	<1 (Meets Environmental Health Quality Standards, Permenkes No. 50 of 2017

Based on table 3, it can be seen that from the 18 rats caught, 15 types of ectoparasites were found, including 2 Xenopsylla cheopis fleas and 13 other types of ectoparasites such as fleas and mites. Two (2) Xenopsylla cheopis fleas were found in the Goth rat (Rattus norvegicus). For the other 13 types of ectoparasites, 8 ectoparasites were found in the rat species (Rattus norvegicus) and the other 5 were found in the house mouse species (Rattus rattus). The following is the formula for calculating the density of flea (Xenopsylla cheopis):

Special Flea Index = $\frac{\text{Number of cheopis Xenopsylls obtained}}{The\ number\ of\ rats\ examined} \text{X } 100\%$

= $\frac{2}{18}$

= $0{,}116$

4. DISCUSSION

4.1. Rat Density

Poor environmental sanitation in the central market area of Gorontalo City supports rat breeding. Piles of garbage and dirty puddles are places that rats like, because of the availability of food sources. Poor environmental sanitation plays a major role in rat density in an area. The movement and development of rats are determined by the source of food, water, and hiding places

This research was conducted for three days and the traps were set in the afternoon at 17.00 WITA - finished and then monitored the next day at 07.00 WITA - finished. In this study, on the first day, 5 rats were obtained from 10 traps installed, on the second day 7 rats were obtained from 10 traps installed and on the third day 6 rats were obtained from 10 traps installed, so that the total number of rats caught was 18 mouse tail. Based on the results of the study it was known that there were 18 rats of different types caught during 3 days of trapping. Of the 18 rats, there were 6 types of house rats (Rattus rattus) and 12 rats of the brown rat type

(Rattus norvegicus). It can be seen that the rat that was caught the most was the brown rat (Rattus norvegicus).

Rodents are generally considered pests because they cause economic losses and transmit diseases that are transmitted by rodents (11). Because of their ticks, droppings and bites, rodents are well-known hosts and vectors for zoonotic infections and can transmit illness. Rattus rattus and Rattus norvegicus have coexisted with people for thousands of years. It's considered that Asia is where R. rattus and R. norvegicus first appeared. nonetheless, both species are now widespread throughout the planet (12).

Based on the results of the study for 3 days of trapping with a total of 10 traps per day, in general, the calculation of success traps per day on traps obtained values ranging from 0.5 to 0.7. With the Total Success trap on the installed trap, it is 0.6 (60%). This Success Trap is used as an estimate of the relative density in an area. An area is said to have a high rate density if the success of catching is more than 7%. This means that the density of rats in the Central Market area of Gorontalo City is high. This can be caused by poor environmental sanitation in the central market area.

The success rate of catching rats is influenced by the quality of the traps, the right bait, and the relatively high density of rats. The quality of the trap can affect the success of catching rats because it will become a barrier when the rat enters the trap. If the quality of the trap is not good, it can cause the rats that are caught to break the trap and escape (13).

During the research, many traps were found in closed conditions and the bait inside was lost, and even broken traps were found. This is most likely caused by the size of the trap is not suitable for rats or the hook is not strong enough. The accuracy of bait selection can also affect the success of catching rats. The baits used in this study were salted fish, corn, and cakes. The mouse's favorite bait is salted fish. This can be seen when the trap is put in salted fish, there are 7 rats caught compared to when the bait is cake and corn, the number of rats caught is less.

Salted fish bait has a higher success in trapping rats, according to a study by Haidar et al (2022), rats prefer salted fish bait over other baits. This is allegedly due to the pungent smell of salted fish (14).The sense of smell of rats is very well developed, this is shown when the rats carry out activities that move their heads and sniff the air when they smell food (15).

The accuracy of laying the position of the trap can also affect the success of catching rats. Traps are placed in places that are thought to be rat trails or places where rats frequent. The behavior of the rat themselves can also affect the success of catching rat. Rat have a cunning nature. In addition, the behavior of rats appear during the day even though humans are present. These conditions indicate a high level of rat population in the area because rats have limited mobility. Rat never pass through open areas especially during the day unless conditions are urgent because rat instincts are more active at night (16).

Rat belong to Kingdom Animalia, class Mammalia, which are wild animals that are very often in contact with humans. Rat are detrimental to humans, especially in agriculture, construction, and health. Rats have the potential to harm public health because they act as intermediaries for diseases, including the plague and leptospirosis. Plague is a disease caused by the bacterium Yersinia pestis whose vector is the flea Xenopsylla cheopis which lives as an ectoparasite in rat. While leptocirrosis is caused by Leptospira germs found in rat urine which can be at risk of entering the body if there are wounds on the skin, the habit of walking barefoot, contact with rat or rat urine and contact with other animal tissues infected with Leptospira such as Xenopsylla cheopis fleas (17).

The high rat population in the Central Market area of Gorontalo City poses a risk to the health of the people around the market. Therefore it is necessary to do control efforts. Control is an effort to reduce or eliminate risk factors for disease and/or health problems (6).

4.2. Density of Fleas (Xenopsylla cheopis)

Fleas are small insects (2-10 mm) belonging to the order Siphonaptera which contains more than 2500 known species arranged in 238 genera. Unlike other insects, fleas are flattened laterally, wingless, and able to jump more than 100 times their body length (18). Rat and fleas interact as transient obligate ectoparasites. In this interaction, adult fleas always live attached to the surface of the host's body, while the immature stage grows independently of the host. The evolution of flea and host interactions appears to be related to host environmental factors, host factors, such as flea habitat (hair, feathers, hair) physiological adaptation and ability to spread, isolation, and specifications (10).

Based on the results of the study, out of 18 rats caught, 16 rats were positive for ectoparasites. Two ectoparasites of the type Xenopsylia cheopis were found and 13 other types of ectoparasites. The discovery of various kinds of ectoparasites, which are ectoparasites that are often found in rats.

The flea density on the body of rats is commonly referred to as the General Index of Fleas, which is to determine the average investment density of the fleas found divided by the total number of rats caught in surveillance programs in the health sector, the general flea index and the special flea index are often used. This value, together with knowledge of the distribution of hosts, vectors, and their habitat, can predict the risk of humans contracting rat-based diseases, such as the plague in an area. It has been agreed that the general index of fleas is higher than 2 and the specific index of fleas is higher than 1 for Xenopsylla cheopis in rats with the

potential to transmit plague to humans (10).Transmission of the bubonic plague is caused by fleas that move from the bodies of rat. The contact relationship that often occurs between rats and humans causes the fleas in the rat's body to also move from one rat's body to another and the fleas will move again from the rat's body to humans to transmit bubonic plague (19).

Rat flea Yersinia pestis is one of several zoonotic bacterial infections for which Xenopsylla cheopis is a significant vector. Highly fatal diseases known as Y. pestis, or plague-causing agents, are spread by the bite of infected fleas (20). Some of the deadliest pandemics in recorded human history have their roots in the bubonic plague (21).

Infected flea bites, especially Xenopsylla cheopis, are the most common source of exposure that results in disease in humans worldwide. As well as being a reservoir for bubonic plague, rat are also hosts for fleas that carry Rickettsia bacteria. Fleas are a type of arthropod that has long been known to be a vector for the deadly bubonic plague and can cause epidemics. According to research, the transmission of bubonic plague always involves human factors, rats, fleas, and Yersinia pestis bacteria (5). The capacity of Yersinia pestis to adapt and act swiftly in response to the various ambient temperatures experienced in its mammalian and tick hosts is a key factor in determining the pathogen's effectiveness (22). According to Liu, Feng, Li, and Qiu (2019) the bacterium Yersinia pestis, which causes the bubonic plague, is a zoonotic illness that is extremely infectious (23). When an infected flea bites a human, the bubonic plague is transmitted. If untreated, the disease can cause major sickness and up to 55% of people to die (24). Although in the Central Market of Gorontalo City the density of Xenopsylla cheopis fleas still meets environmental health quality standards according to Permenkes No. 50 of 2017, but control is still needed.

5. CONCLUSION

Based on the results of research that has been done on the Density Analysis of Rats and Fleas (Xenopsylla cheopis) at the Central Market of Gorontalo City, it can be concluded that the density of rats at the Central Market of Gorontalo City exceeds the quality standard value of 60%, meaning that the density of rats at the Central Market of Gorontalo City is classified as Density while the flea density of Xenopsylla cheopis in the central market of Gorontalo city still meets the Environmental Health Quality Standards, namely <1 and does not have the potential to transmit bubonic plague.

6. RECOMMENDATION

It is hoped that with the results of this study, market managers can control the rat vector by means of physical control in the form of setting traps and chemical control once a month in the form of administering rat poison to reduce the rat population, even though the market building has been renovated, because the cause of the rat density is not only the the building is dirty but depends on the cleanliness of the market environment, in addition to that the relevant health agencies can carry out efforts to control rat populations on a regular and integrated basis and the need for environmental sanitation education to the local community in the context of rat control.

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