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Mosquito population (Culicidae) as potential vector of Japanese encephalitis virus transmission in pigs close to settlements in Kalasey Satu village Minahasa regency

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Abstract
Japanese encephalitis is a zoonotic viral disease that is transmitted by a vector mosquito bite of the *Culex* sp. containing the JE virus. The JE virus belongs to the Flavivirus family that attacks the Central Nervus System and has a severity of 20 - 40. In pigs, this disease can cause abortion and mummification. Pig is an important livestock in the JE virus transmission cycle, because it is the host of the reservoir and is an amplifier. This study aims to determine the *Culex* species which has the potential as a vector of virus transmission in pigs and humans who live close to the settlements. This study obtained the relative abundance (Ra) of *Culex* in pig pens adjacent to settlements. The abundance of *Culex* caught in cages were: *Culex vishnui* (Ra = 27.8); *Cx. gelidus* (Ra = 27,3); *Cx. quinquefasciatus* (18,7); *Cx. tritaeniorhyncus* (Ra = 12,6); *Cx. pseudovishnui* (Ra = 11.1) and *Cx. fuscocephala* (Ra = 2.5%). The temperature and humidity ranges during the exposure of the mosquitoes ranged from 27^0C-30^0C and 60% -64%. *Culex vishnui* and *Culex quinquefasciatus* were most caught between 22.00 pm - 02.00 am. The catch of *Culex* mosquitoes in a cage, explains the activity of mosquitoes in finding food sources. From the research results, it can be concluded that *Culex vishnui* and *Cx. quinquefasciatus* has a high relative abundance category (Ra > 20% - ≤ 30). Thus *Cx. vishnui* and *Cx. quinquefrasciatus* has the potential as a vector for transmission of the Japanese encephalitis virus in pigs and humans who live near the pen.

Keywords: Japanese encephalitis, *Culex*, pig, vector, virus. relative abundance

Introduction
Japanese encephalitis is a zoonotic viral disease that is transmitted by the bite of a vector arthropod, in this case the *Culex* mosquito, which contains the Japanese encephalitis virus. JE virus belongs to the Flavivirus family that attacks the central nervous system. The severity of this disease (CFR) ranges from 20% - 40% [1]. Japanese encephalitis mainly causes a high level of morbidity and mortality in children in Indonesia. In southeast Asian countries and the western Pacific region, this is an important concern, because about 3 billion people live in endemic areas and reported that at least 50,000 cases are suspected of being infected with the JE virus with the death of 10,000 people each year [2].

In addition to attacking humans, this virus can attack livestock groups, such as: horses, donkeys, ungags and pigs. In other animal groups, such as: cows, goats, cats and dogs, the symptoms of the disease are not specific. Several countries indicated that those that act as vectors for the spread of the Japanese encephalitis virus are the types of mosquitoes, including: *Culex tritaeniorhynchus*, *Cx. fuscocephalus*, *Cx. gelidus* and *Cx. quinquefasiatus*. This vector mosquito is widely distributed in Asia, including Japan, Kores, China, India, Thailand, the Philippines, Malaysia, Vietnam, Taiwan and Indonesia [7, 3].

This research was carried out to know the *Culex* mosquito species which have the potential as a vector of JE virus transmission in pigs and humans who live near the pen. This indirectly shows an indicator of the possible threat of the JE virus transmission vector to humans around the pig pen.

Material and Methods
This study is a survey of the abundance of *Culex* as a vector for transmission of the Japanese encephalitis virus in pig pens. The location of the pig pen which is the place to obtain mosquito samples was taken by purposive sampling method, where the sample was taken

according to the research objectives, namely the sample of mosquitoes in a pig pen near the research. Beside, the sampling location was based on the results of preliminary research regarding the high JE antibody reactor [15].

The capture of mosquitoes is carried out by using 2 (two) units of light traps which are installed throughout the night (12 hours) from 18.00 to 06.00. Samples of captured mosquitoes were collected every 2 hours and put in a sample tube so that 6 samples (datas) of mosquitoes were caught in one sampling (1 night). The catch of mosquitoes was repeated 3 times with an interval of 2 weeks.

Mosquito samples were then identified based on morphological characters and separated based on *Culex* mosquito species, using the key of determination [11; 12; 16]. Identification of *Culex* mosquitoes was carried out at the Animal Health Laboratory of the Faculty of Animal Husbandry, Sam Ratulangi University. Most mosquitoes caught show the level of activity of these mosquitoes in looking for food sources (pig blood). Abundance categories used according to [17], namely: (1) Very Low Ra ≤ 1%; (2) Low Ra≥ 1% - 10%; (3) Medium Ra ≥ 10% - 20%; (4) High Ra ≥ 20% - 30% and (5) Very high Ra ≥ 30%.

Result

The research begins with a survey of the location of the pig pen in Kalasey Village, district of Mandolang, Minahasa Regency with Ordinat 10, 27'10.332 "North Latitude and 1240,46'10.5132" East Longitude at an altitude of 12 m asl (above sea level). This location is a complex of small pig pens owned by several nearby breeders. Around the cage there is a water reservoir that flows from higher ground in the southern part of the cage complex. The pond contains tilapia and is planted with water spinach and various vegetation around the cage, such as banana, coconut, papaya and wild plants such as grass. About 50 meters from the location of the pig pen, there is also a broiler chicken stable with a stage with a capacity of 2000.

At the location of the cage, adult mosquitoes were caught. In general, the livestock area has moderate conditions with a temperature range of 20 ^{0}C – 30 ^{0}C and humidity ranging from 59% - 66.5%. This is an ideal condition for the development of mosquitoes as vectors for disease transmission. The livestock system, which is still on the scale of people's farms and semi-intensive, is very supportive for the propagation of vector mosquitoes. Habitats or breeding places for mosquitoes or places where mosquitoes rest, such as: ponds, puddles, drains, damp enclosures and livestock waste, are ideal conditions for mosquito development.

Table 1: Abundance of Adult Female Mosquitoes in Kalasey Village Pig Cages

Jenis	Ulangan	18.00-20.00	20.00-22.00	22.00-24.00	24.00-02.00	02.00-04.00	04.00-06.00	∑	Ra (%)	Ra (%)
Culex	I	3	1	3	4	0	2	13	6,6	
quinquefasciatus	II	1	0	2	4	0	1	8	4,0	18,7
	III	3	2	4	5	1	1	16	8,1	
Culex	I	5	4	3	3	2	1	18	9,1	
gelidus	II	1	2	3	4	2	2	14	7,1	27,3
	III	7	2	6	5	1	1	22	11,1	
Culex	I	5	2	5	3	2	0	17	8,6	
Vishnui	II	2	2	4	5	3	1	17	8,6	27,8
	III	7	4	3	4	3	0	21	10,6	
Culex	I	0	2	2	3	0	0	7	3,5	
Pseudovishnui	II	0	1	2	2	0	0	5	2,5	11,1
	III	1	3	3	2	1	0	10	5,1	
Culex	I	1	2	6	1	0	0	10	5,1	
Tritaeniorhyncus	II	2	1	3	0	1	0	7	3,5	12,6
	III	1	1	5	1	0	0	8	4,0	
Culex	I	0	0	0	1	1	0	2	1,0	
fuscocephala	II	0	0	0	0	1	0	1	0,5	2,5
	III	0	0	1	0	1	0	2	1,0	
Jumlah		39	29	55	47	19	9	198	100	100

This study obtained 198 *Culex* mosquito catches consisting of 6 types, namely: *Culex quinquefasciatus*, *Cx. gelidus*, *Cx vishnui*, *Cx. pseudovishnui*, *Cx. tritaeniorhyncus* and *Cx. fuscocephala*. Table 1, shows that *Cx. vishnui* and *Cx. Gelidus* was most caught, amonunting 55 and 54 respectively, followed by *Cx. quinquefasciatus*, *Cx. tritaeniorhyncus* and *Cx. pseudovishnui* as many as 37, 25 and 22 individuals respectively. Meanwhile, *Cx. Fuscocephala* caught at least, as many as 5 individuals.

Discussion

Analysis of relative abundance (Ra) for each type of mosquito caught, namely *Cx. vishnui* (Ra 27.8%) and *Cx. gelidus* (Ra 27,3%). Based on the abundance category, these two types of mosquitoes are classified as high abundance (Ra ≥20% - 30%). The two mosquitoes were mostly caught at the time of catching at 22.00 - 02.00 am, amount 24. This explains that the two mosquitoes have the highest activity at that time. There is literature that says that the peak activity of Culex mosquitoes is at 24.00 - 02.00 [14]. Foraging activities, namely high livestock blood when the cattle are resting. Foraging activities as well as copulatory activities. Food, namely livestock blood, is a source of food for the development of mosquito eggs or the maturation of mosquito eggs so that they are ready to be placed in breeding places around pig pen, such as puddles, water containers, ponds and water storage tanks.

Culex quinquefasciatus, *Cx tritaeniorhyncus* and *Cx. Pseudovishnui* caught were classified in the category of moderate abundance (Ra ≥ 10% - 20%). Each of these mosquitoes had a relative abundance of 18.7%, 12.6% and 11.1%. While *Cx. fuscocephala* had an abundance of relative lace category (Ra ≥ 1% - 10%) which in this study had an

abundance of 2.5%. Several studies have stated that *Cx. tritaeniorhynchus* is the main vector of transmission of the Japanese encephalitis virus.

The distribution of *Culex* is strongly influenced by the behavior of mosquitoes, bionomic (living system) mosquitoes as a vector which include the availability of resting places, biting behavior and breeding places. Most mosquitoes like to rest in dark, humid places, such as thickets, in rooms or houses and livestock sheds. In selecting prey, *Culex* have zooantrophilic criteria, which like an animal and human blood. The body of pigs emits CO_2 in the process of respiration and has a distinctive aroma and is a favorite smell for mosquitoes. Thus, many mosquitoes are caught at night when the pigs are resting, so that the mosquitoes are free to suck blood from the bodies of pigs.

In this study, *Culex* mosquitoes were the most dominant mosquitoes caught in the pig pen. This is supported by the results of the research, that *Culex* mosquitoes are mostly caught in pig pens which are located very close to residential areas [8]. The results of other studies that were conducted with one arrest stated that *Culex gelidus* and *Culex vishnui* were the 2 types of *Culex* that were caught the most [6]. Some studies say that *Cx. quinquefascitus*, *Cx. fuscocephala* and *Cx. tritaeniorhyncus* is indicated to act as a vector of Japanese encephalitis virus transmission [13, 17, 9]. A study on the prevalence of Japanese encephalitis produced a 100% reactor in pig samples in Kalasey village [15].

Conclusion

From the research results, it was concluded that *Culex vishnui* and *Culex gelidus* had a high abundance category. The two mosquitoes have the potential as vectors for the transmission of the Japanese encephalitis virus in pigs and humans who live near the location of the pig pen.

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