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27	423	TEE	Blego - Sedionoto, Vivi Filia Elvira	Essential Ecological Risk F infection in Rural Areas Ku
28	433	TEE	Rusfina Widayati	The Use of AHP within G Development Planning Pol
29	441	TEE	sifriyani sifriyani, Idris Mandang, Fidia Deny Tisna Amijaya	GIS Mapping Based on Sp Health Services and Popula Outbreak in Kalimantan
30	444	TEE	Nurul Novalia Kartika	Effect of UVA, UVC, UVA Degrading Synthetic Dyes
31	446	TEE	Risa Farrid Christianti, Azhari S.N. Azhari Mail	Computational Intelligent A Fusion for UAV Detection Opportunities
32	450	TEE	Joan Angelina Widians, Annisa Chitra Adinda, Anindita Septiarini Septiarini Mail	Diagnose Digestive Diseas Medicinal Plants as an Alte
33	451	TEE	Indah Trisnawati, Mukhammad Muryono, Iska Desmawati Mail	Pollinator-friendly plants f conservation on agroforest
34	453	TEE	Devita Grecia Naftalia Simorangkir	Photocatalyst Effect of Var to Degrade Variations in C Compounds (Methylene Bl
35	456	TEE	Nurul Puspita Palupi, agus sarjono, abdul hanif	Soil Quality Index Analysi Plantation
36	458	TEE	Ade Kurniawan	Design of a Waste Power F Types as a Source of Renew
37	459	TEE	Encik Akhmad Syaifudin	Esponse of Shallots (Alliu On The Trichokompos Fer

Essential Ecological Risk Factors of *Strongyloides stercoralis* infection in Rural Areas Kutai Kertanegara, Indonesia

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Abstract

Strongyloides stercoralis infections are still challenge in public health problem especially in developing countries where have ecological risk factors. In rural areas of Kutai Kertanegara regency have high risk of ecological factors of the prevalence *S. stercoralis* infections, A cross-sectional study was

performed among 426 participants from rural community of Muarakaman District and Marangkayu Districts, Kutai Kertanegara Regency. In this study would show the infection rates, correlation analysis between environmental risk factors and prevalence of hookworm infection with statistical analysis. We performed a cross-sectional study among 426 participants from rural community of Muarakaman District and Marangkayu Districts, Kutai Kertanegara Regency East Kalimantan Province, Indonesia. In this study used two diagnostic methods: Kato Katz and Koga agar plate culture/KAP culture for diagnosing of Strongyloides infections. Pearson chi-square analysis was used for study correlation between ecological risk factors with *S stercoralis* infection. *S stercoralis* infections were found in this study; 34 (8.0%), Ecological risk factors have significant correlation and high odd ratio of prevalence of *S. strercoralis* infections. Essential ecological risk factors of the infections should use for preventing program of reduction prevalence of *S stercoralis* infections.

Keywords: *S. stercoralis,* Ecological factors, Rural areas, Kutai Kertanegara

Introduction

The prevalence of strongyloidiasis is of serious public health concern globally. Strongyloidiasis is prevalent in poor rural community in tropical and subtropical areas in many developing country. They are transmitted through in protected contact with soil are endemic in tropical and temperate regions. The prevalence of hookworm infection and strongyloidiasis was estimated in 2010 that 438.9 million people were infected with hookworm and 100 million with strongyloides. Almost 70% of these infections occur in Asia. (Wardell et al 2017; Pullan, et al, 2014, WHO, 2011 (Bethony et al. 2006).

Strongyloidiasis is transmitted through in protected contact with soil are endemic in tropical and temperate regions. Human acquire the strongyloidiasis through direct skin contact with infective third stage larvae where the soil was contaminated by human feces penetrate the intact human skin and eventually reach small intestine (Forrer et al. 2016). Strongyloidiasis are found among poor people with poor environmental

sanitation and where the climate is warm and humid (Bannon et al., 1995; Hall et al., 1994). Factors affecting difference in distribution of strongyloidiasis may include good hygiene practices among population, availability of sewerage system and the length of rainy season. Ecological factors have contributed for transmission of diseases as well as growth and development of the worms (Anamnart, et al, 2013; Prasit et al, 2016).

Ecological factors especially long rainy season may affect the decrease in prevalence of strongyloides stercoralis infection but not for hookworm infection. Prevalence of strongyloidiasis in south Thailand is lower than other parts of the country, in contrast, prevalence of hookworm infection is still high in the south. It is possibly because the failure in the control of hookworm infection due to 10 months long rainy season in southern Thailand contrasted with 4 months long rainy season in other parts (Anamnart et al., 2015). The study in Cambodia reported the lower prevalence of strongyloidiasis in area with heavy rainfall than in low rainfall area. Moreover, high amount of soil organic carbon content affect to the lower prevalence of strongyloidiasis (Khieu et al., 2014). Epidemiology study of hookworm infection and strongyloidiasis in Southern Laos showed 56.1% and 41% respectively where was heavy

rainfall and poor sanitation. In this study Baerman and Kato-Katz techniques were used for detecting them (Vonghachack Y et al, 2015).

In rural Kutai Kertanegara Regency, Indonesia has ecological risk factors of prevalence of strongyloidiasis that important to exploration association both of them. We perform a cross-sectional study in rural community in Muarakiaman and Marangkayu district to analysis of geography, texture of soil, humidity, hookworm and strongyloides in pet, vegetation, elevation, volume rain, amount days of rain yearly, temperature and quality of soil as clay content, organic carbon of soil and pH of soil then was correlated with prevalence of hookworm infection and strongyloidiasis.

Methodology

Ethical consideration

The study protocol was approved by the Ethical Clearance committee on human right related to research involving human subjects, Walailak University HE: number WUEc-18-034-01.

Study Setting and Population

The study was carried out in rural area of Muarakaman District and Marangkayu District Kutai Kertanegara Regency, Indonesia. This research is a community based, was conducted during July 2018 to September 2019 and second study on January to September 2021. Total of number participant is 426 participants that were counted by equal number of participants who joined and sent stool samples.

Field Procedures

We collected third stool sample of participant, for collecting stool samples, the first day were requested to head of house hold and member of house hold for requesting stool sample, second day in the morning would start to collect stool samples, were brought to biomedical laboratory, school of Public Health Mulawarman University for diagnosis samples. Others day was done observation ecological condition of houses surrounding village.

Laboratory Procedures

Agar plate culture and Kato Katz technique

Agar plate culture was done as described by Koga et al., 1991. Briefly, a few grams of stool was placed at the center of nutrient agar and kept at room

temperature for five days. Tracks from larva crawling and larvae or adult worms were observed. If positive, 10 ml of 10% formalin was added to agar surface for 5-10 minutes and transferred to centrifuged tube. Centrifugation at 2,500 rpm for 5 minutes and supernatant was discarded. The sediment will be examined for hookworm and *S. stercoralis* larvae or adult worm.
For Kato-katz thick smear, 50 mg of stool was placed on slide and covered with a cellophane paper soaked in glycerin solution for 24 hours. The stool was spread out using rubber stick. After 30 minutes was examined and counted for eggs

Risk Factors Data

Demographic data and personal hygiene of participants were collected by questionnaire, and sanitation facilities each house hold of participants were collected by observation, while environmental data was collected consist such as vegetation, elevation of soil, kind of pets, kind of soil around houses, length of rainy season, humidity and temperature per year. Quality of soil as organic carbon content, clay content and pH were diagnosed by soil laboratory Mulawarman University. Vegetation and kind of soil around houses were collected by observation form, kind of pet will be

collected by questioner and observation, and length of rainy season, humidity and temperature per year will collected from Central Bureau of Statistics (https://www.bps.go.id) and Central Bureau of meteorology, climatology and Geophysical of Indonesia (https://www.bmkg.go.id).

Data Analysis

The prevalence of hookworm infection and *S. stercoralis* infection was stratified according to demographic data, sanitation facilities and personal hygiene, environmental data, and reported by descriptive statistic. Statistical analysis was performed by Chi-square using SPSS verse 21. The correlation analysis chi-square to evaluate association of *S. stercoralis* infection with demographic data, sanitation facilities, personal hygiene, and environmental risk factors and the level of significance was considered as $P<0.05$ and the analysis of risk estimate by odds ratio Chi-Square with confidence interval 95%.

Results

Study Sample

A total of 426 individuals participated in this study. The age ranged between 2 and 70 years from 28 villages, with detail 12 villages from Muarakaman District and 16 villages from Marangkayu District, East Kalimantan Province Indonesia. Among 28 villages collected each village 10-15 household with 2 to 3 participant each household, in enrolled we would collect 336 household and 592 participants. In this study collected 296 household and 426 participants. Males (60%) were dominant in the sample study. The age distribution of sample was 2 to 12(53.5%) and 13 and above (46.5%) Main occupation of the sample consist as farmer (32.9%), at home (25.8%), at school (38.0%) and others (3.3%).Results and Discussion.

Results

Study sample

A total of 213 individuals participated in this study. The age ranged between 2 and 70 years from 28 villages, with detail 12 villages from Muarakaman district and 16 villages from Marangkayu district, East Kalimantan province Indonesia. Among 28 villages collected each village 10-15 household with 2 to 3 participant each

household, in enrolled we would collect 168 household and 296 participants. In this study collected 148 household and 213 participants. Males (60%) were dominant in the sample study. The age distribution of sample was 2 to 12(53.5%) and 13 and above (46.5%) Main occupation of the sample consist as farmer (32.9%), at home (25.8%), at school (38.0%) and others (3.3%).

Parasitological findings

Prevalence hookworm infection and *strongyloides stercoralis* infection were diagnosed by Kato Katz technique and APC method showed of 426 tested samples from community have 186 (43.7%)cases found positive with hookworm infection and 34 (8.0%) cases found positive with *strongyloides* infection and co-infection 30 (7.0%). Detail data of prevalence of hookworm, *strongyloides stercoralis* and co-infection were explained below::

Ecology Factors and *S. stercoralis* infection in East Kalimantan Province

The results statistical analysis between ecological risk factors with *S. stercoralis* infection

showed several of ecological risk factors have correlated significant with *S. stercoralis* ($p<0.05$) such as district, organic carbon content in soil, texture of soil, humidity, temperature, elevation, number day of rainfall, rainfall volume, and *S. stercoralis* infection in dog. While pH of soil, clay content in soil, and dry or wet soil surrounding house vegetation, village areas, and having cat and dog and strongyloides infection in cat. have not significant correlated with prevalence of *S. stercoralis* infection in Kutai Kertanegara Regency.

Ecological risk factors which were highest association/correlation *S. stercoralis* infection were organic carbon content in soil ($p= 0.000$) and live together with human infected with *S. stercoralis* $p=0.000$. The category of ecological risk factors which had percentage of positive *S. stercoralis* infection more than 9% and with significant correlation such as elevation from above sea (<41.6m), volume of rainfall (<3549 mm3), number day of rainfall (<164days), humidity (<65.4%), temperature(<28.6 0C), organic carbon content in soil(<2.47%), texture of soil (sandy soil with organic material), district (Murangkayu District), and *S. stercoralis* infection in dog. Live together with human infected with S. stercoralis was highest percentage of *S. stercoralis* infection (84.2%) and highest significant correlation with p-value= 0.000.

Odd Ratio (OR) Ecological risk factor of *S. stercoralis*

Result analysis of estimating risk between environmental risk factor with *S.stercoralis* infection by chi-square odds ratio analysis had showed several environmental risk factors with OR> 1, but the odds ratio had deferent each others of infection. Analysis OR in district explained that Marangkayu District (2.66 (1.28-5.54)) is higher risk than Muarakaman (0.64 (0.54-0.77)) district for *S.stercoralis* infection. Marangkayu district where have temperature (<28.6 ^{0}C), humidity (<65.4), number day of rainfall (<164 days), and rainfall volume (3549-4000 mm3) is higher OR=2.66 (1.28-5.54).Organic carbon content in soil <2.47% was higher OR than 2.47-4.04% was 2.56 (1.38-4.71) and 0.52 (0.45-0.65) respectively. Elevation with category 41.6-50 m, has higher OR than < 41.6m with OR=2.72 (1.30-5.66) and OR=0.63 (0.53-0.76) respectively.and texture of soil with category sandy soil with organic material was higher OR than non-sandy soil with OR= 2.05 (0.98-4.29) and 0.77 (0.66-0.92) respectively. Occupation, drinking water, and personal hygiene especially usual wash foot after soil contact, usual un-cook vegetable and wash hand after soil contact were high risk of *S. stercoralis* infection were 2.08 (0.99-4.35),

1.99 (1.08-3.69) 1.26 (1.01-1.58) 1.27 (0.98-1.63), and 1.27 (1.02-1.58) respectively. Having dog infected with S. stercoralis infection high risk of *S. stercoralis* infection in participants, the statistical analysis showed OR=4.42 (1.14-17.15). Participants whose infected cat by *S. stercoralis* 14 (8.9%) while participants whose infected dog by *S. stercoralis* 32 (9.9%), analysis pearsonX^2 *S. stercoralis* infection in human has correlation significant with infected dog by *S. stercoralis* (p = 0.009). the correlation did not significant with infected cat by *S. stercoralis* (*p* = 0.607). Having dog infected with *S. stercoralis* infection high risk of *S. stercoralis* infection in participants, the statistical analysis showed OR=4.42 (1.14-17.15). Live together human infected *S. stercoralis* was high risk of *S. stercoralis* infection with OR=16.74(4.36-64.22). Participants who have infected dog by *S. stercoralis* high risk with *S. stercoralis* with OR=4.42 (1.14-17.15).

Discussion

The prevalence of hookworm infection in Muarakaman District is higher than in marangkayu district was 61.1% and 38.9% respectively, while the prevalence *Strongyloides stercoralis*, Marangkayu District (11.9%) is higher than Muarakaman District (3.2%). Prevalence of co-infection was showed in

Marangkayu District (10.2%) where is higher than Muarakaman District (3.2%). The study similar with south Thailand study where hookworm infection higher than *S. stercoralis* (Anamnart, et al., 2015). Deference of ecological factor between Muarakaman District and Marangkayu District should be affected the higher hookworm infection and lower of *S. stercoralis* in Muarakaman district such as vegetation surrounding area of villages and geographical location where Muarakaman District be located surrounding palm plantation and river area. Similar study in Manufahi District, Timor Leste where is rural area with prevalence of hookworm infection was 62.8%.(Nerry SV, et al 2015)

The results statistical analysis between environmental risk factors with hookworm and S. stercoralis co-infection showed several of environmental factors have correlated significant with hookworm and S. stercoralis co-infection such as district, organic carbon content in soil, texture of soil, humidity, temperature, elevation, number day of rainfall, rainfall volume, and hookworm and *S. stercoralis* co-infection in dog. While pH of soil, clay content in soil, and dry or wet soil surrounding house vegetation, village areas, and having cat and dog and strongyloides infection in cat. have not significant correlated with prevalence of hookworm

and S. stercoralis co-infection in East Kalimantan Province.

Environmental risk factors which the higher association/correlation hookworm and *S. stercoralis* co-infection were organic carbon content in soil (p=0.000) and live together with human infected with hookworm and *S. stercoralis* co-infection (p=0.000). The category of environmental risk factors which had percentage of positive *S. stercoralis* infection more than 9% and with significant correlation such as elevation from above sea (<41.6m), volume of rainfall (<3549 mm3), number day of rainfall (<164days),humidity (<65.4%), temperature(<28.6 0C), organic carbon content in soil(<2.47%), texture of soil (sandy soil with organic material), district (Murangkayu District), and *S. stercoralis* infection in dog. Live together with human infected with S. stercoralis was highest percentage of S. stercoralis infection (82.4%) and highest significant correlation with p value= 0.000. District, organic carbon content in soil, humidity, temperature, elevation, number day of rainfall, rainfall volume, and *S. stercoralis* infection in dog have high significant with hookworm, *S. stercoralis* and co-infection that due to the variables have contribution for surviving of parasitic larvae of hookworm and *S. stercoralis* then potential increase

for penetration the larvae to human via soil contact and pet contact. In this study had showed that quality of soil and climatology such as humidity, temperature have correlation with survive of hookworm and *S. stercoralis* and heavy rainfall effected for reducing and increasing of distribution hookworm and *S. stercoralis*. In general condition soil surrounding houses more than 80% covering with soil where close the location with plantation and forest that have high position for contamination from plantation and forest. And in addition personal hygiene and sanitation facilities still not save for protection skin from larvae hookworm and *S. stercoralis* also in file rice and palm or rubber plantation. (Anamnart, W et al, 2010). In poor countries with tropical climate, where have environmental condition favorable for transmission hookworm and *S.stercoralis* infection the prevalence still high (Jongwutiwes s et al, 1999).

S.stercoralis infection and co-infection no significant correlated with clay content, texture, vegetation and village areas although the prevalence co-infection still high in several environmental factor. Collaboration many environmental risk factors could support the survival of larvae the worms. Environmental factors of hookworm and *S. stercoralis* infection in Kutai Kertanegara Regency,

Indonesia has similar with south Thailand including long rainy season, temperature and several geography area, then the prevalence of hookworm infection in East Kalimantan Province (44.1%) is higher than in south Thailand but equal for *S.stercoralis* infection, (Anamnart, et al., 2015). In contrast quote by epidemiology study of S.stercoralis infection Southern Laos showed was 41% where has heavy rainfall and poor sanitation. (Vonghachack et al, 2015).

Analysis OR in district explained that Muarakaman District high risk for hookworm infection, in contrast Marangkayu District high risk for S. stercoralis and co-infection. Village areas had high risk for hookworm is buffer area (OR=2.54) while *S. stercoralis* and co-infection were higher in surrounding rubber and palm plantation where closed with buffer areas Buffer areas of river or sea were highest environmental risk factor hookworm infection with OR 2.54.

Temperature in category <28.6 0C become high risk factor for *S. stercoralis* and co-infection high with OR=2.66 and OR=2.32 respectively while hookworm infection has high risk in temperature category >28.50C-29 0C, while humidity category <65.4 65.4-66 high risk for *S. stercoralis* and co-infection with OR=2.66 and OR=2.32 respectively ,

but humidity category 65.4-66 high risk for hookworm infection with OR= 1.84. Elevation from above sea in category <41.6m is high risk hookworm infection while S. stercoralis and co-infectio were high risk in elevation 41.6-50m. Organic carbon content <2.47% was higher risk for *S. stercoralis* and co-infection, organic carbon content in soil 2.47-4.04% was high risk for hookworm infection. Organic carbon content >2.47% become protective environmental risk factor for S. stercoralis and co-infection. The study was similar with study in Cambodia reported the higher of hookworm infection and the lower prevalence of S.stercoralis infection in area with heavy rainfall than in low rainfall area. Cambodian study also explained that high amount of soil organic carbon content affect to the lower prevalence of *S. stercoralis* infection (Khieuet al., 2014), equal with study in East Kalimantan which organic carbon soil more in became have effected for reducing *S. stercoralis* but did not for hookworm infection,

Rainy season with rainfall in category number day of rainfall <164 days yearly was high risk for hookworm infection while *S. stercoralis* and co-infection still high risk in rainfall 164-174 days. Volume rainfall in category <3459 was higher risk for hookworm infection and the volume rainfall

3459-4000mm3 was higher risk for *S. stercoralis* and co-infection. Supporting environmental factor against survival of hookworm and *S. stercoralis* . When communities defecated in rubber or palm plantation could be spread in village or rice field that condition was caused elevation plantation is higher than village and rice field elevation, run of water from plantation or forest when rainfall maybe bring the eggs or larvae hookworm and *S.stercoralis* from hill to village and field rice. Potential infected together via field rice and rubber and palm plantations adult communities also for children when they were playing around houses.

Having dog was risk factor for hookworm, *S. stercoralis* and Co-infection, but highest risk factor for *S. stercoralis* (OR=4.42), This research has similarly condition with Cambodian research that dogs in rural Cambodian villages largely kept as guard dogs and allowed to roam freely, especially during the day. The dogs are also allowed inside the house and around rice and vegetable fields and ponds. At night-time, the dogs then often stay in or around the house. Dogs, therefore, pose a serious zoonotic risk as they have the potential to transmit zoonotic parasites through their close association with household members as well as through heavy contamination of the environment, including soil,

fresh produce and waterways, with eggs or larvae of hookworm and S. stercoralis, in our observation sew behavior of cats almost all day and night stayed around houses and rare contact with ponds and did not stay around rice and vegetable fields, behavior of dog is higher potential risk of zoonotic deseases of hookworm and *S. stercoralis* than behavior of cat (Schar F, et al, 2014 and Strkolcova G, et al 2017). Behavior of cat defecation make un-save survive of the egg or larvae of *S. stercoralis*

In the study was showed that live together with human infected with hookworm/S. stercoralis/Co-infection high risk for them but higher for *S. stercoralis* (OR=16.74) and co-infection (OR=14.78) than hookworm infection (OR= 1.37). In this study showed participants who positive *S. stercoralis* infection has live together with other positive *S. stercoralis* infection through one household or neighbor where live close were dominant, same as environmental risk factor, personal hygiene and sanitation facilities became caused together infection.

Ecological risk factors have significant correlation with high prevalence of *S. stercoralis* such as district, humidity, temperature, volume and amount day of rain organic carbon of soil, texture of soil and elevation, the ecological risk factors make

survive of infective larvae of *S. stercoralis* infection had explained with Garcia (2007) that a significant increase the prevalence of *S. stercoralis* infection with environmental conditions. Changing environmental conditions, specifically deforestation and subsequent silting of locally river, have caused periodic flooding with deposition on layer of sandy loam topsoil could increase soil moisture, and supporting by low quality of sanitation facilities and hygiene personal to add the increasing of *S. stercoralis* infection. These conditions, all of which are conducive to *S. stercoralis* transmissions, have allowed *S. strercoralis* infection to re-emerge as an important human pathogen in this area (Forrer, et al 2018).

Conclusions

Ecological risk factors have significant correlation and high odd ratio of prevalence of hookworm , *S. stercoralis* and co- infection such as district, humidity, temperature, volume and amount day of rain organic carbon of soil, elevation, having dog and addition of risk factor is supported by low hygiene and sanitation, and live together with human infected by infected by hookworm infection and/or S stercoralis infection in rural area of Kutai

Kertanegara Regency. Essential environmental risk factors of the infections should use for preventing program of reduction prevalence hookworm and *S stercoralis* infection.

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Tables and Figures

Table 1 Prevalence of Hookworm, *Strongyloides stercoralis* and Co-infection among Communities in Kutai Kertanegara Regency

Infections	Muarakaman District		Marangkayu District		
	Positive	Negative	Positive	Negative	P
Hookworm	116 (61.1%)	74 (38.9%)	70 (37.6%)	166 (70.3%)	1
S. stercoralis	6 (3.2%)	184 (96.8%)	28 (11.9%)	208 (88.1%)	3
Co-infection	6 (3.2%)	184 (96.8%)	24 (10.2%)	212 (89.8%)	3

Table 2 Environmental Factors and *S. stercoralis* Infection in Kutai Kertanegara Regency

Variable	Category	S. stercoralis	
		Negative n (%)	Positive n (%)
District	Muarakaman	184 (96.8)	6 (3.2)
	Marangkayu	208 (88.1)	28 (11.9)
Organic carbon content in soil	<2.47%	156 (85.7)	26(14.3)
	2.47-4.04%	236 (96.7)	8 (3.3)
pH soil	<5.85	190 (93.1)	14 (6.9)
	5.85-6.92	202 (91.0)	20 (9.0)
Clay content in soil	<18.5	178 (92.7)	14 (7.3)
	18.5-42.50	214 (91.5)	20 (8.5)
Temperature	<28.6 ^{0}C	208 (88.1)	28 (11.9)
	28.6 -29.5^{0}C	184 (96.8)	6 (3.2)
Humidity	<65.4	208 (88.1)	28 (11.9)
	65.4-66	184 (96.8)	6 (3.2)
Number day of rainfall	<164	184 (96.8)	6 (3.2)
	164-174	208 (88.1)	28 (11.9)
Rainfall volume	<3549 mm^3	184 (96.8)	6 (3.2)
	3549-4000 mm^3	208 (88.1)	28 (11.9)
Elevation from above of sea	<41.6m	188 (96.9)	6 (3.1)
	41.6-50m	204 (87.9)	28 (12.1)

Texture of soil	Sandy soil with organic material	250 (89.9)	28 (10.1)
	Non-sandy soil with organic material	142 (95.9	6 (4.1)
Vegetation	Surrounding palm plantation and/or rubber plantation	310 (92.8)	24 (7.2)
	Surrounding rice field	82 (89.1)	10 (10.9)
Village areas	Buffer river/sea	308 (92.8)	24 (7.2)
	Hill area	84 (89.4)	10 (10.6)
Dry or wet soil surrounding house	Dry soil	308 (91.1)	30 (8.9)
	Wet soil	84 (95.5)	4 (4.5)
Having cat	Not having cat	150 (93.8)	10 (6.3)
	Having cat	242 (91.0)	24 (9.0)
Having dog	Not having dog	8 (100)	0 (0.0)
	Having dog	384 (91.9)	34 (8.1)
S. stercoralis in cat	Negative	248 (92.5)	20 (7.5)
	Positive	144 (91.1)	14 (8.9)
S. stercoralis in dog	Negative	102 (98.1)	2 (1.9)
	Positive	290 (90.1	32 (9.9)
Live together with human infected with *S. stercoralis*	No	386 (99.5)	2 (0.5)
	Yes	6 (15.8)	32 (84.2)

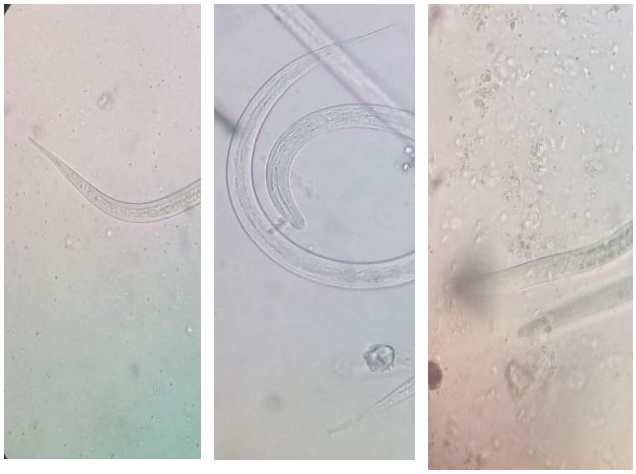
Table 3 Essential Risk Factors of *S. stercoralis* in Kutai Kertanegara Regency

Essential risk factors	**Category**	***S. stercoralis***		
		Negative n (%)	**Positive n(%)**	
District	Muarakaman	184 (96.8)	6 (3.2)	0.6
	Marangkayu	208 (88.1)	28 (11.9)	2.6
Organic carbon content	<2.47%	156 (85.7)	26 (14.3)	2.5

in soil	2.47-4.04%	236 (96.7)	8 (3.3)	0.5
Temperature	<28.6 ^{0}C	208 (88.1)	28 (11.9)	2.6
	28.6 -29.5^{0}C	184 (96.8)	6 (3.2)	0.6
Humidity	<65.4	208 (88.1)	28 (11.9)	2.6
	65.4-66	184 (96.8)	6 (3.2)	0.6
Number day of rainfall	<164	184 (96.8)	6 (3.2)	0.6
	164-174	208 (88.1)	28 (11.9)	2.6
Rainfall volume	<3549 mm^3	184 (96.8)	6 (3.2)	0.6
	3549-4000 mm^3	208 (88.1)	28 (11.9)	2.6
Elevation from above of sea	<41.6m	188 (96.9)	6 (3.1)	0.6
	41.6-50m	204 (87.9)	28 (12.1)	2.7
Texture of soil	Sandy soil with organic material	250 (89.9)	28(10.1)	2.0
	Non-sandy soil with organic material	142 (95.9	6 (4.1)	0.7
S. stercoralis in dog	Negative	102 (98.1)	2 (1.9)	0.7
	Positive	290 (90.1)	32 (9.9)	4.4
Occupation	Non farmer	248 (89.9)	28 (10.1)	2.0
	Farmer	144 (92)	6 (4.0)	0.7
Live together with human infected with *S. stercoralis*	No	386 (99.5)	2 (0.5)	0.1
	Yes	6 (15.8)	32 (84.2)	16

Figures

Figures. Modified agar plate techniques. (a; *Strongyloides stercoralis* filariform larva (L3), b; *Strongyloides stercoralis* filariform larva (L3) ,c) *Strongyloides stercoralis* rhaditiform larva (L2). Microscopic observation under low power (x10).



a b c