THESIS

MORPHOMETRY VARIATION OF MALE AND FEMALE *Ascaris suum* AT PEGIRIAN SLAUGHTERHOUSE SURABAYA

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Morphometry Variation of Male and Female *Ascaris suum* at Pegirian Slaughterhouse Surabaya

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Supervisor	Co- Supervisor

DECLARATION

Hereby, I declare that in this thesis entitled :

MORPHOMETRY VARIATION OF MALE AND FEMALE *Ascaris suum* AT PEGIRIAN SLAUGHTERHOUSE SURABAYA

There is no other work ever published to obtain a college degree in a certain college and to my knowledge there is also no work or opinion ever written or published by others, except those in writing reffered to this paper and mentioned in the references.

Surabaya 30th November 2015

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MORPHOMETRY VARIATION OF MALE AND FEMALE *Ascaris suum* AT PEGIRIAN SLAUGHTERHOUSE SURABAYA

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ABSTRACT

Ascaris suum is a parasite nematode that causes infection in swines with high prevalence rates in host populations and usually associated with liver damages called "milk spots" caused by larvae migration, resulting in organ condemnation. The study of morphology has had an important emphasis by developing statistical shape analysis. This study aimed to determine the variation of female and male *Ascaris suum* morphometry in Pegirian Slaughterhouse Surabaya. This study used three region which is the main supplier of swine at Pegirian Slaughterhouse Surabaya. This study used 12 *swine* in each region and took all of *Ascaris suum* that had been found in small intestine. The observations of *Ascaris suum* morphometry were done after measured each of worm in ; Wet Weight (WW), diameter (D), and Total Length (TL). Based on the data analysis, morphometry measurement between male and female *Ascaris suum* in each region have significant different. The variation of morphometry affected by sex, not region. It can be seen from the size of WW, D, and TL that had significant difference ($p < 0.05$) for each sex. Region does not given an affected on morphometry variation of male and female *Ascaris suum.*

Key word: morphometry, nematode, *Ascaris suum*, slaughterhouse, pigs

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Surabaya, November 2015

Author

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ABBREVIATIONS AND SYMBOLIC MEANING

e.g.	: Exempli gratia (for example)
%	: Percent
cm	: Centimeter
et al	: Et alii
ml	: Mililiter
mm	: Milimeter
mg	: Milligram
NaCl	: Natrium Chlorida
FAO	: Food and Agriculture Organization of the United Nations

CHAPTER 1 INTRODUCTION

1.1 Background

The role of livestock in human life is very essential, beside as a source of foods, other parts of the livestock can be used are skin, feces, and bones. One of the livestock that is also popular in tropical areas such as Indonesia is a pig. Pigs are highly efficient meat source, so pigs have a high economic value as livestock. In fact, pigs can be fed well, using only kitchen scraps from a family's household (FAO, 2009). Other advantages why pork meat became popular for human consumption is it very rich in vitamin B6, B12, thiamine, niacin, riboflavin and pantothenic acid, and also it a source of iron that is easily absorbed than other meat sources. Pork meat also have a high mineral content of phosphorus, selenium, sodium, zinc, potassium and copper.

According Murtidjo (1993), the increasing of population, the demand for meat consumption will increase too. The importance of the meat production in the swine industry is reflected in some figures: From 1977 to 1998, world pork meat production had nearly doubled in 20 years (1977: 42.9 million tons of pork, 1998: 83.6 million tons of pork, data from FAO review, RDA Cameron, 2000) and since then pork meat production increased further till today, particularly in countries of Asia, e.g., in China (Mehlhorn, 2008). To meet these needs, it will require livestock development efforts and prevention of disease in livestock. Disease prevention efforts are intended to keep the animals healthy.

One of the diseases infecting pig is helminthiasis, infected pigs became weak, low appetite, and ultimately can make meat production decrease. One of the worms that can infect pig is *Ascaris suum* (*A. suum*). *Ascaris suum* is a very common parasite of pigs. Swine ascariasis interferes with health and performance of swines while resulting in reduced feed to gain ratios and liver condemnation incurring economic losses (Stewart *et al*., 1988). Weaners and fattening pigs are often infected with *A. suum* (Mehlhorn, 2008).

Post mortem inspection, the liver shows varying degrees of fibrosis, which may localized in the form of "milk spots", these are usually whitish in colour but may become haemorrhagic, indicating a more recent nature (Soulsby, 1986). "Milk spots" caused by larvae migration, resulting in organ condemnation. Its importance is related both to the sometimes very significant lesions caused by larvae during migration through the liver and lungs, and to the effects of adult worms in the small intestine. In the liver, the traveling larva causes intra lobular necrosis and a granulation reaction known as "milk spots." In the ordinary moderate infections, adults have no defined pathogenesis. In heavy infection, there is experimental evidence of reduction in growth rate, diarrhea, and ill thriving. Intestinal obstruction is rare (Mehlhorn, 2008).

Adult *A. suum* is the largest nematode occurring in pigs, very stout, white; (Ballweber, 2001). There are have three prominent lips surrounding the mouth (Baker, 2007). Morphology of *A. suum* generally been described other than by Ballweber (20011), Baker (2007), Cameron (1958), Ma'arif (1995), Soulsby (1986), Noble,W. and Noble, G. (1989), and Griffiths (1978). Acording Soulsby (1986) and Griffiths (1978), male length of *A. suum* 15 – 25 cm and for female 40 cm. *Ascaris suum* include in phylum Nemathelminthes and class Nematode.

Include in gastro-intestinal nematodes (Over, *et al*. 1992) which means these worms live in the human digestive tract. When existing infestations of *A. suum* excess, it is not rare that worms will be pushed to other areas outside of the main predilection. This worm has a body that is symmetrical from tip to tip of the anterior posterior (Ma'arif, 1995), which distinguishes with other nematodes in pigs. Over, *et al*. (1992) said if a more or less cosmopolitan nematode fauna in pigs consists of the ascaroid: *Ascaris suum*, the trichostrongylid: *Hyostrongylus rubidus*, the strongylids: *Oesophagostomum dentatum* and *Oe. quadrispinulatum*, the spiruroids: *Ascarops strongylina* and *Physocephalus sexalatus*, the rhabditoid: *Strongyloides ransomi*, the trichurid: *Trichuris suis* and the *acanthocephalan* (not a nematode) *Macracanthorhynchus hirudinaceus*. *M. hirudinaceus* (adults resemble *A. suum*), a common parasite of pigs (Mehlhorn, 2008). *M. hirudinaceus* derived from the phylum Acanthocephala, have a morphology similar to *A. suum*, but the differences seen in body color, often pale reddish (Griffiths, 1978) and in posterior part, *M. hirudinaceus* has a hooked proboscis which serves to attached their body into a final host (Mehlhorn, 2008).

In order to meet consumer demand for pork in Surabaya, Pegirian slaughterhouse Surabaya provide facilities and services for slaughtering . Various pig farmers areas in Java supply it to this slaughterhouses, to meet the high demand, pigs also had to came from Bali (Heru, 2015). By doing so, it can be observed the *A. suum* in Pegirian Slaughterhose Surabaya is based on the origin of the pigs.

Based on this, the writer wants to do a research about morphometry variation of male and female *A. suum* in Pegirian Slaughterhouse, Surabaya. The results of this study are expected to be known whether there is a difference in the ratio between male and female morphometry of *A. suum* those found in Pegirian Slaughterhouse Surabaya.

1.2 Problem Formulation

1) How is the size of male and female *A. suum* in Pegirian Slaughterhouse Surabaya?
2) Is there any different between male and female *A. suum* in Pegirian Slaughterhouse Surabaya based on the measuring of the body?

1.3 Theoretical Base

Ascaris suum, is the species that cosmopolitan in distribution (Soulsby, 1986). The impact of the infections with gastro-intestinal helminths on the production of pigs will be considerable as some of the nematodes can cause severe problems including clinical diseases.

Ascaris suum occurring in percentage's of 5–85% are mainly of importance in piglets and young pigs (Over, *et al*., 1992). With typical prevalence rates of 50% to 75%, this worm it's more common in growing pigs than in mature pigs.

Larvae stage, *A. suum* can cause "milk spot", in adult stage, adult worm also compete with the host fot nutrients and they may occlude and rupture the small intestine and also migrate into the common bile duct and occlude it, cause icterus (Baker, 2007).

Although now recognized as a separated species, the large roundworm of humans, *A. lumbricoides*, was once though to represent human infectious with *A. suum* (Baker, 2007).

Research on morphometry in the field of veterinary and biology have been carried out. Neither the statement regarding bigger then a male from female (Andersson, 1994). The direction of reviews these differences, that is whether the males or females are larger, varies from one group to another (Koehl, 1996).

1.4 Aims of The Research

1) To add information data that regarding the size of the *A. suum* more specific to the area of Surabaya
2) Analyze differences in male and female *A. suum* variations quantitatively

1.5 Outcomes of the Research

The results of this research will give some scientific information about appropriate size of *A. suum* male and female in Pegirian Slaughterhouse, Surabaya and as reference for the next research about the reason of the morphometric difference between *A. suum* male and female.

1.6 Hypothesis of Research

Found a significant difference in the measurement of worms *A. suum* females and males on both morphological measurements.

CHAPTER 2 LITERATURE REVIEW

2.1 Morphometry

Comparison of anatomical characters between organisms has been a core element in comparative biology for centuries. Historically, taxonomic classification and understanding of biological diversity have been based mainly on morphological descriptions (Adams, *et al*. 2004).

In the early twentieth century, comparative biology entered a transition from the description field and quantitative science, where morphological analysis had a similar revolution of quantification (Bookstein, 1998).

Based on this quantitative mathematical revolution, the study of morphology has had an important emphasis by developing statistical shape analysis. This made possible the combination of multivariate statistical methods and new ways to visualize a structure (Adams and Funk, 1997) (Dryden, *et al*. 1998).

One of the most interesting sources of phenotypic variation in animals and plants has been sexual dimorphism, the study of which continues to be an important area of research in evolutionary biology.

Sexual differences in morphological characters are a common phenomenon in many animal taxa, and their most conspicuous aspect is body size (Gannon and Racz, 2006).

The direction of these differences, that is whether males or females are larger, varies from one group to another (Koehl, 1996). Females are generally larger than males, and this gives them adaptive advantages such as greater fecundity and better parental care (Andersson, 1994) (Muller, *et al*. 1997).

Sexual dimorphism is of interest in entomological studies since frequently the differences between sexes are not obvious or the individuals are very small; thus, finding discriminating characters allows easy determination of sexes (Benitez, 2013).

Existing methods for measuring nematode size and shape vary in their accessibility, assumptions on nematode morphology, throughput, and interpretability of measured values.

*According Lee (2011), these methods were developed for use with pre-existing mounted quantitative samples and the study of latitudinal variation in body-size.There is***selection of species for analysis:**The species should have a wide latitudinal distribution, at least 10 degrees of latitude;The species should be sufficiently abundant in at least three sites across its range; Sufficiently abundant is defined as minimum of 10 adult individuals.

However, ideally there should be 20 adult individuals 10 male and 10 female allowing differences between the sexes to be examined.

2.2 Ascariasis in Swine

2.2.1Classification of *Ascarissuum*

Kingdom : Animalia

Filum : Nematoda

Kelas : Secernentea

Order : Ascaridida

Famili : Ascarididae

Genus : Ascaris

Spesies : *Ascarissuum* (Roberts *et al*., 2005)

2.2.2 Morphology of *Ascarissuum*

Ascarissuum has cylindrical body shape (Cameron, 1958), symmetric bilateral and non segmented (Ma'arif, 1995).The exterior is covered with a tough resistant cuticle which is flexible, but not extensible, and is transversely striated; this straction has no connection with any internal segmentation as in the annelids (Cameron, 1958).

A.suum body coveredby creamcolored thick cuticule and sometimes reddish. *A.suum*'s mouth is completed with three lips, one dorsal and two located in subventral equipped with small papillae in lateral section with a row of teeth on the inside. Female worms are longer and larger than the male worms(Ma'arif, 1995).

The male of *A. suum* measure 15-25 cm (Soulsby, 1986) with the average until 32 cm (Noble and Noble, 1989) by about 3 mm. the tail of male is usually without well-developed caudal alae, but it usually bears numerous caudal papillae.

The spicules of the male are about 2mm long and stout, there are a large number of precloacal papillae (Soulsby, 1986).

Adult females may be 40 cm long, diameter 5 – 6 mm, and lay 200.000 until 1.6 million eggs per day (Griffiths, 1978) (Levine, 1990). Vulva lies in anterior mid-body (third the length of the body from the anterior tip), vagina leads backward, and there are two uterus (Levine, 1990).

2.2.3 Life Cycle of *Ascarissuum*

These worms can live more than one year, it can produce 73 million eggs during her lifetime (Noble and Noble, 1982). And for the life cycle (Figure 2.1 and figure 2.2), pigs get infected with *A. suum* when they take up eggs from the environment in which an infective stage larva had developed (Figure 2.2 A). The larva emerging from the egg is not a second-stage larva (L2) as was previously presumed but rather a third-stage larva (L3) covered by a loosened second-stage cuticle (Fagerholm et al., 2000) (Figure 2.2 B). The larvae of Ascaris complete two moults within the egg. After oral intake, hatching is induced by the altering chemical and physical factors of the new environment.

The larvae inside the egg get stimulated to secrete proteinases and chitinases, which presumably help them degrading the different layers of the eggshell from the inside out (Geng et al., 2002; Hinck and Ivey, 1976). When the larvae get out of the egg, they start their hepatothracheal migration by penetrating the wall of the caecum and upper part of the colon (Murrell et al., 1997). Then, the L3s are transported through the mesenterial blood veins to the liver where they get stuck in the capillaries and destroy liver tissue in order to get to the efferent blood vessels (Douvres*et al*., 1969; Murrell *et al*., 1997).

The blood stream carries the larvae to the next capillary system, which is the lung, where they penetrate the alveoli, move up the respiratory tree, and eventually get swallowed again. From 8 days onwards, the L3's finally return to the small intestine where they start their first ecdysis inside the host to reach the L4 stage by day 14 post infection (Figure 2.2 C). After about 6 weeks, the worms have reached maturity (Figure 2.2 D) and adult females can begin to excrete fertilized eggs (Figure 2.2 E) (Vlaminck, J. 2013)

Figure 2.1 Male and female *Ascarissuum* (Junquera, 2015)

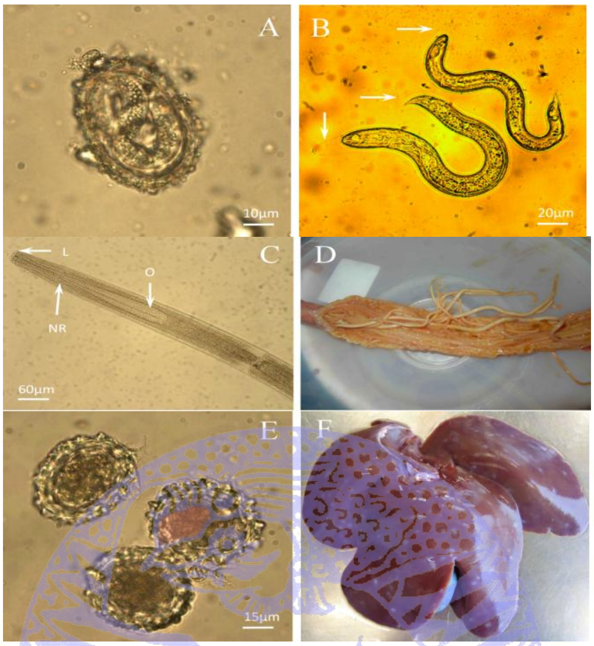

Figure 2.2 Development of *A.suum*, (A) infective stage larva (B) third-stage larva (C) L4 stage (D) worms have reached maturity (E) fertilized eggs (F) milk spot (Vlaminck, 2013)

2.2.4 Diagnostic

Diagnosis of chronic infestation (more than two months) can often be made by identifying eggs (Griffiths, 1978) using fecal flotation examinations (Ballweber, 2001) or by finding grossly visible ascarids in the small intestine (Figure 2.1).

Since ascarids have some mobility, they sometimes can be found in the stomach or in the major bile and pancreatic ducts at necropsy. Obstruction of the bile duct sometimes leads to marked generalized icterus.

Ascarids may not be present in animals recently "dewormed" but scarring in the liver or hemorrhages in the lung may still be apparent.Adult worms may be vomited up and occasional case of obstructive jaundice and intestinal obstruction or rupture occur (Radostits*et al,* 2000)

Diagnosis of acute infestations (less than two months) requires postmortem examination of a few typical pigs that have died or been sacrificed. Fecal flotations are not reliable during the first 6-8 weeks following infestation (prepatent period). Postmortem examination also permits the evaluation of concurrent diseases, including other sources of parasitism or causes of pneumonia. Diagnosis of early infestations is by observation of typical liver and lung lesions with confirmation by histopathology (Iowa State University, 2014).

Figure 2.3 Milk Spot on pig liver (Mehlhorn, 2008)

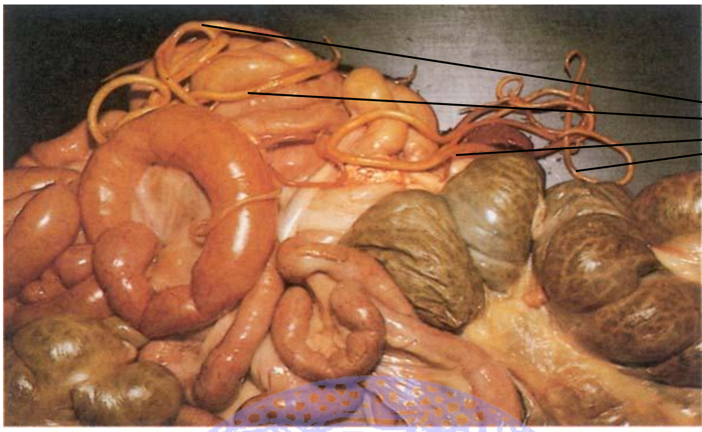

Figure 2.4 Ascariasis. Numerous round worms in the intestine of a market pig. (Herenda, 2000)

2.2.5 The Degree of Severity of *Ascarissuum*infection

Parasite control required routine inspection of the endoparasites, especially the type and degree of infestation that can be done together with routine physical examination (Subronto and Tjahajati, 2001). The presence of parasitic worms can be known through stool examination, which found the worm eggs, the more worm the more worm eggs.

Changes in swine instestine worm population can be followed by counting of eggs per gram of feces (TTGF) on a regular basis .TTGF inspection is directly proportional to the number of adult female worms present in the digestive tract (Robert and Kusumamihardja 1981 in 1992). One adult *A.suum* female lay eggs on average 200.000 eggs per day, and during his life can spawn 23 billion eggs (Dunn, 1978). the severity of infestation depends on the number of worms that infect. Weight loss will occur on 300 adult infection or equal to 1800 TTGF (Kusumamihardja, 1992). Light infestations have TTGF number 50-500, infestations are having TTGF 500-2000 and heavy infestations have TTGF number over 2000 (Taazona in Kusumamihardja, 1992).

CHAPTER 3 MATERIALS AND METHODS

3.1 Research Location and Date

This research conducted in June - August 2015. Located in the Pegirian Slaughterhouse Surabaya and Laboratory of Parasitology - Faculty of Veterinary Medicine Universitas Airlangga, Surabaya.

3.2 Experimental Design

Experimental design for this study using purposive sampling method. This research begins with determining the main regional supplier of pigs to Pegirian slaughterhouse Surabaya, there are from Blitar, Tulungagung, and Malang.

Sampling had done by removing the contents of pig intestines, then take *A. suum* in it, put it into physiological saline 0.9 % NaCl and immediately took it to Laboratory of Parasitology - Faculty of Veterinary Medicine Universitas Airlangga, Surabaya.

3.3 Materials of Research

3.3.1 Research Materials

This research uses *A. suum* worms from swine small intestine which was taken from Pegirian Slaughterhouse, Surabaya. Other materials are physiological saline NaCl 0.9%, and formaline 1 %, alcohol 70%, and liquid soap.

3.3.2 Research Equipments

The equipments for this research: scissors, petri dish 14 cm, plastic tray 34 cm, tweezers, ruler 30 cm, stationery, notes, tape, digital vernier caliper, digital scales, stereomicroscope, plastic 1L, plastic bag, plastic bucket, gloves, mask, and tissue.

3.4 Research Method

Asaris suum which have been taken from the small intestine of pigs were positive ascariasis placed in different plastic bag which had previously been filled by NaCl 0.9%. Then immediately taken to the Laboratory of Parasitology at the Airlangga University to do the measurement of the length and width by using a vernier caliper with an accuracy of 0.1 mm. Morphological characters of sample *A. suum* measured using vernier caliper and ruler, includes: Total Length (TL), Diameter (D), and Wet Weight (WW). When the sample has been collected, wipe samples from the rest of the intestinal contents, and then start doing weight measurement using digital scales and then recorded. Then followed by measuring the length and width of the sample by using a vernier caliper and a ruler. Sample placed on plastic tray, then position it such that the sample can be measured in length and width and then proceed with data collection.

3.5 Data Analysis

Using Chi Square Test to determine the composition of males and females in each regions. To know morphometry male or female in each regions using One Way Anova. To determine the morphometry based on sex in each area using Independent T Test. And to see the correlation between morphology measurements of female and male *A. suum* with wet weight, diameter, total length, individual, and regions using Decission Tree Regression analysis.

3.6 Research Flow Chart

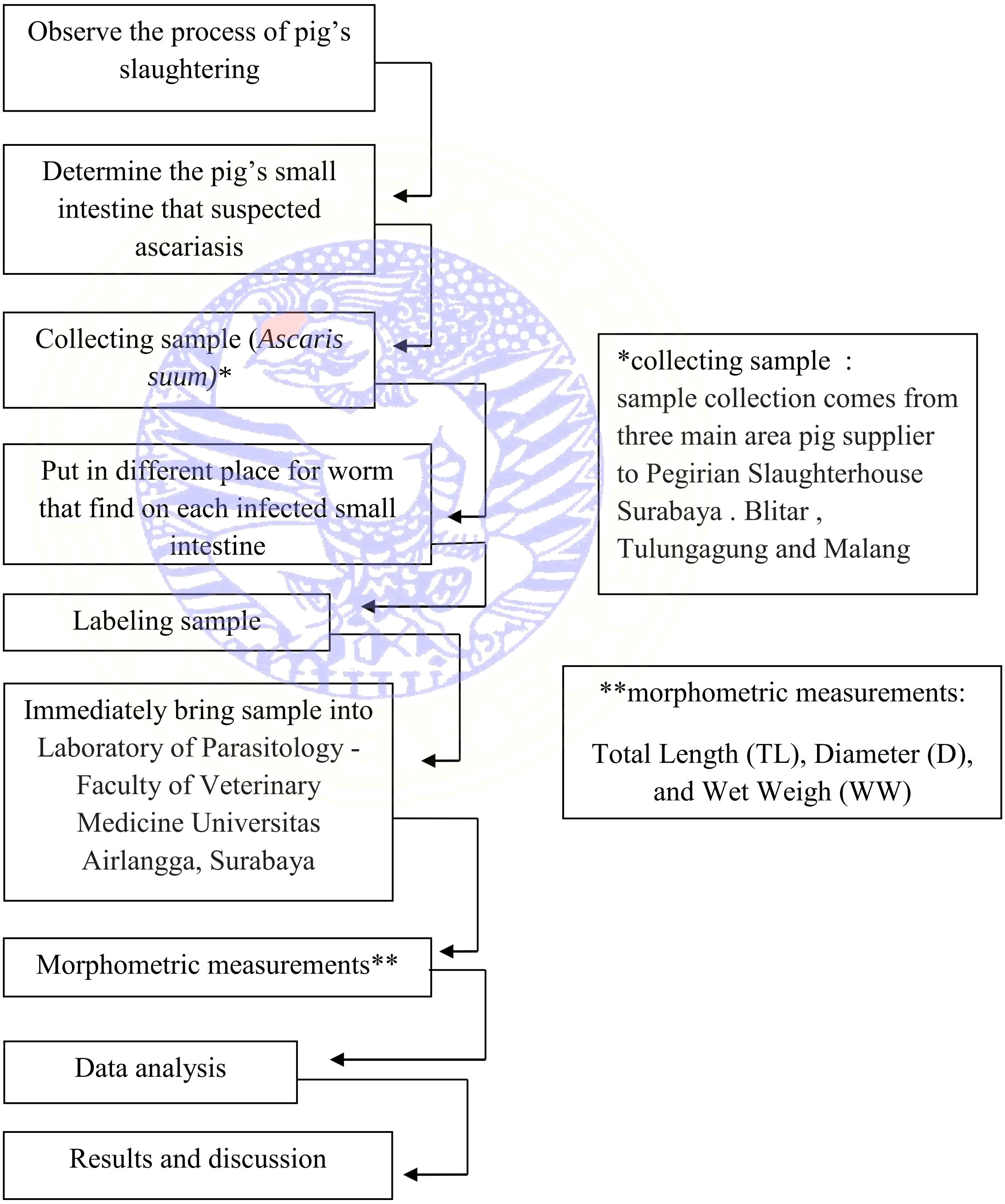

Figure 3.1 Research flow chart.

CHAPTER 4 RESEARCH RESULTS

The results's test of morphometric variation of male and female *Ascaris suum* at Pegirian Slaughterhouse Surabaya are:

4.1 Morphometry of *Ascaris suum*

Morphometric analysis on *A suum* conducted on 12 pigs from every region of the main suppliers of pigs at Pegirian slaughterhouse Surabaya (Blitar, Tulungagung, and Malang) and took 69 *A. suum*, 40 females and 29 males. Morphometric measurements are carried out on each sex, male and female. Correlation measurement of morphology male and female in each region was significantly different ($P < 0.05$). *Ascaris suum* females and males measurement in Blitar results presented in Table 4.1, *A. suum* females and males measurement in Tulungagung results presented in Table 4.2, and for *A. suum* females and males measurement in Malang result presented in Table 4.3 and for the whole analysis can be seen in Appendix 2, Appendix 3, and Appendix 4.

Figure 4.1 Male and female *Ascaris suum* that had been found at Pegirian Slaughterhouse Surabaya

Table 4.1 *Ascaris suum* females and males measurement in Blitar

	Sex	Mean ± Std. Dev
Wet Weight (WW) (gram)	Female	3.5457 ± 1.55339
	Male	1.2420 ± 0.67555
Diameter (D) (mm)	Female	4.4100 ± 0.64325
	Male	3.0040 ± 0.75821
Total Length (TL) (cm)	Female	26.9857 ± 2.97162
	Male	15.4400 ± 7.21616

From the table it show that WW, D, and TL of females and males *A. suum* in Blitar were significantly different ($p<0.05$).

Table 4.2 *Ascaris suum* females and males measurement in Tulungagung

	Sex	Mean ± Std. Dev
Wet Weight (WW) (gram)	Female	4.2300 ± 1.79690
	Male	1.3938 ± 0.38124
Diameter (D) (mm)	Female	4.4485 ± 0.83074
	Male	3.1800 ± 0.29612
Total Length (TL) (cm)	Female	29.7546 ± 4.99883
	Male	20.4375 ± 2.85254

From the table it show that WW, D, and TL of females and males *A. suum* in Tulungagung were significantly different ($p < 0.05$).

Table 4.3 *Ascaris suum* females and males measurement in Malang

	Sex	Mean ± Std. Dev
Wet Weight (WW) (gram)	Female	3.4623 ± 1.17642
	Male	1.1988 ± 0.37234
Diameter (D) (mm)	Female	4.3338 ± 0.64053
	Male	3.0431 ± 0.35681
Total Length (TL) (cm)	Female	26.1615 ± 3.50251
	Male	19.0813 ± 2.82164

From the table it show that WW, D, and TL of females and males *A. suum* in Malang were significantly different ($p < 0.05$).

For the measurement data about morphometric variation of females *A. suum* between regions (Blitar, Tulungagung, and Malang) can be seen in table 4.4. The measurement data about morphometry variation of males *A. suum* between regions (Blitar, Tulungagung, and Malang) can be seen in table 4.5, and for the whole analysis can be seen in Appendix 5 and Appendix 6.

Table 4.4 Morphometric variation of females *A. suum* between regions (Blitar , Tulungagung and Malang)

		Sum of Squares	df	Mean Square	F	Sig.
Wet Weigh (WW) (gram)	Between Groups	4.652	2	2.326	.992	.380
	Within Groups	86.723	37	2.344		
	Total	91.375	39			
Diameter (D) (mm)	Between Groups	.089	2	.044	.088	.916
	Within Groups	18.584	37	.502		
	Total	18.672	39			
Total Length (TL) (cm)	Between Groups	92.520	2	46.260	3.046	.060
	Within Groups	561.867	37	15.186		
	Total	654.387	39			

From the table, it show that the measurement data about morphometry variation of females *A . suum* between the three regions were not significantly different ($p > 0.05$).

Table 4.5 Morphometric variation of males *A. suum* between regions (Blitar , Tulungagung and Malang)

		Sum of Squares	df	Mean Square	F	Sig.
Wet Weigh (WW) (gram)	Between Groups	.205	2	.102	.541	.589
	Within Groups	4.922	26	.189		
	Total	5.127	28			
Diameter (D) (mm)	Between Groups	.130	2	.065	.349	.708
	Within Groups	4.823	26	.186		
	Total	4.953	28			
Total Length (TL) (cm)	Between Groups	79.143	2	39.571	2.675	.088
	Within Groups	384.675	26	14.795		
	Total	463.818	28			

From the table, it show that the measurement data about morphometry variation of males *A. suum* between the three regions were not significantly different ($p > 0.05$).

4.2 Composition Females and Males Among Regions

For composition, the number of males and females *A. suum* among regions in getting the results that have been specified in Appendix 7 that *A. suum* composition of males and females among regions was not significantly different.

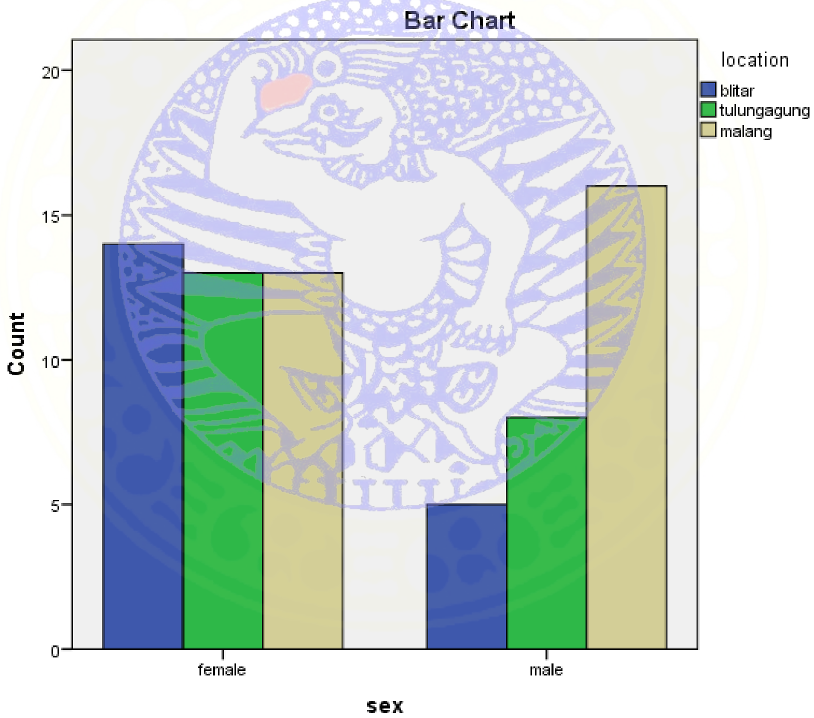

Figure 4.2 The bar chart of composition of male and female *Ascaris suum* among regions

4.3 Decission Tree Regression Analysis

To see the correlation between morphology measurements of female and male *A. suum* with wet weight, diameter, total length, individual, and regions use Decission Tree Regression analysis.

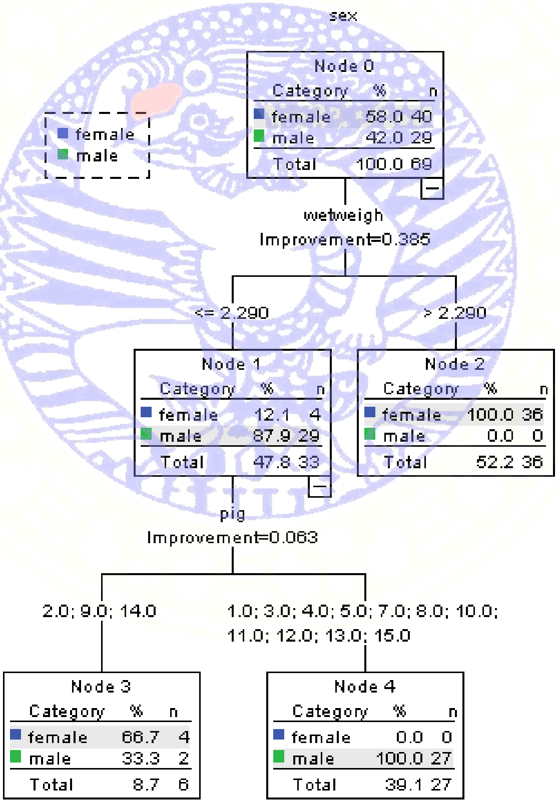

Figure 4.3 Diagram of decision tree regression analysis

From the figure it can be seen that the wet weight is a major factor to determine the morphometric variation of both sex of *A. suum*. Of the total samples (69 samples), worms that weighs above 2,290 with a percentage of 100 % or as much as 36 tails are owned by female worms, while worms with a weight of less than 2,290 is dominated by male worms by 87.9 % or as much as 29 worms. This meant that all male worms have a weight under 2,290. But as much as 12.1 % or as much as 4 female worms have a weight under 2,290 too. In the diagram can be seen that there are three pigs (2.0, 9.0, and 14.0) were infected with *A. suum* females with a wet weight of under 2,290 at 66.7 % .

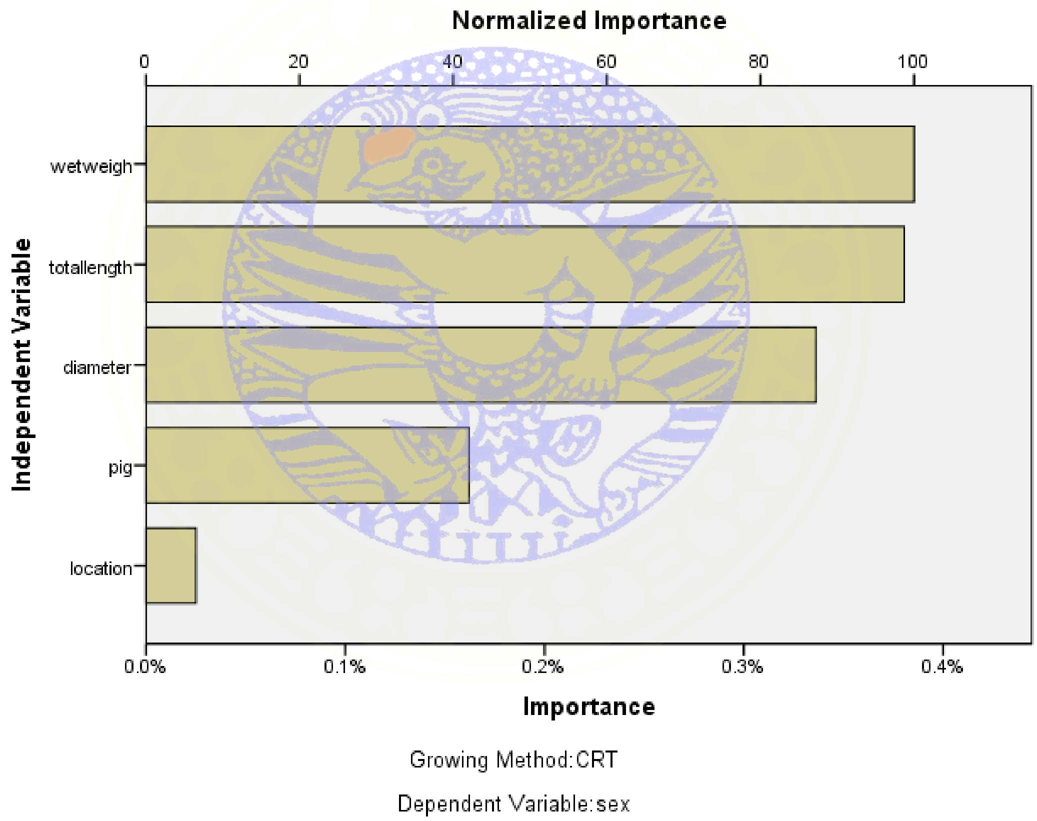

Figure 4.4 Graph of correlation between sex and independent variable

From the graph above it can be seen that the wet weight is a determinant of the morphometric variation that occurs in females and males of *A. suum* were found in Pegirian Slaughterhouse Surabaya. While the next determinants can be seen from the total length, diameter, condition of each individual pig, then is an locations where the pigs came from.

CHAPTER 5 DISCUSSION

5.1 Morphometry of *Ascaris suum*

Ascaris suum were found in Pegirian Slaughterhous Surabaya has a total length (TL) for female 26.9857 ± 2.97162, 29.7546 ± 4.99883, and 26.1615 ± 3.50251 for female. And for male has a total length 15.4400 ± 7.21616, 20.4375 ± 2.85254, and 19.0813 ± 2.82164. Alba, *et al* (2009) found *A. suum* females with a total length ranging from 15.6 cm – 29.5 cm and 11.4 cm – 18.6 cm for males in Quezon City Slaughterhouse, Manila. Simirlarly with Soulsby (1986) and Griffiths (1978) in his book states that the male of *A. suum* measure 15 cm - 25 cm , and for the size of female mentions that adult female may be 40 cm long. Even Schmidt and Roberts (2009) once stated in his book that the length of males *A. suum* 15cm – 31 cm and for the females 20 cm – 49 cm. Thus in general comparison of *A. suum* body size range is not so different from or even close to the research that has been done before.

But for the size of the worm itself can depend on nutrients that derived from the host. For the result in Tulungagung, the total length of both males and females is higher than Blitar and Malang. Assuming that the area is a rural location, Tulungagung have a large agricultural area, and the results of the farm can be used as an adjunct to feed pigs. It is also related to the presence of the other parasites that are in the same location with *A. suum*, also as well as high and low population of *A. suum* that located in the small intestine of the infected pigs. This situation is also influenced by the pressure of the body of *A. suum* itself. Harpur and Popkin (1965) said, in *A. suum* the pressure can average from 70 mm Hg to 120 mm Hg and vary up to 210 mm Hg and order of magnitude higher than the pressure in body fluids of animals with hydrostatic skeletons in other phyla. Limitations imposed by this high internal pressure determine many features of nematode morphology and physiology, such as how they eat, defecate, copulate, and lay eggs (Schmidt and Roberts, 2009).

Positive correlation results to morphometry of males and females *A. suum* is a natural thing happened on the nematode. According to Maarif (1995), the female worms are longer and larger than the male worms . It is in because the body of *A. suum* females must be able to acomodate thousand hundreds of eggs when fertile. Beside that, most nematodes are dioecious and show considerable sexual dimorphism, female are usually larger than male (Schmidt and Roberts, 2009).

5.2 Composition Males and Females of *A. suum*

Based on the results of morphometric comparison between the individual males and females of *A. suum* found no significant difference ($p > 0.05$). It shows that *A. suum* including a group of nematodes that there is have a sexual dimorphism in the individual. Sexual dimorphism usually attends dioecious forms, with females growing larger then males (Schmidt and Roberts, 2009). The main morphological differences that can be found is the formation of spicules (male copulation organ) (Soulsby, 1986) located in the posterior part of the body near the anus , while the female copulation organ, vulva, is lies in anterior mid-body (third the length of the body from the anterior tip) (Levine, 1990).

The composition of males and females *A. suum* among regions was not significantly different. That distribution is sometimes influenced by host diet, physiological condition, and the presence of other helmints (Schmidt and Roberts, 2009). However, in the result can be seen that composition of females larger than a males in each regions. the presence and the number of female *A. suum* are very necessary to notice. As has been written in many literature, *A. suum* utery may contain up to 27 milion eggs at time with 200.000 being laid per day. Some species of nematodes tend to wander if no males are present within host, including *A. suum* . Female *A. suum* cease producing eggs if they are transferred to a host without any male worms, and they readily resume when a male is transferred to join them (Jungersen, *et al.* 1997). Female *A. suum* tend to wander and seeking a constriction to squeeze the eggs through. For the example constriction in bile duct, this may result in dire consequences to the host if the female selected that lace for exploration (Schmidt and Roberts, 2009).

Besides a female *A. suum* can produce eggs and can squeeze through without having at fertilization by the male, the size of the females also need to be taken into consideration. In the previous discussion, it was mentioned that the size of the females larger than the males. And can be seen from the data that has been taken, the number of females higher than a males. The absence of males cause females had to wander to squirm through the coiled tail of male. The overcrowding in small intestine lumen may also lead to *A. suum* wandering. The wandering activity of adult like this can cause various serious reactions. Downstream wandering leads to the appendix which can be clogged or penetrated, or to the anus with an attendant surprise for an unsuspecting host. Upstream wandering leads to pancreas and bile duct can cause multiple abcesses in liver. If worms reaching stomach and aggravated with stomach acid can cause nausea. And if the vomited worms leads to esophagus and may crawl to the trachea, can cause lung damage.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

From the results of this study concluded:

1) The regions did not influence to the size of the males and females *Ascaris suum* .
2) Variations of males and females *Ascaris suum* morphometry influenced by sex, not the location of the regions . It was seen from the size of data wet wight, diameter, and total length that highly significant ($p < 0.05$) in the different sexes.

6.2 Recommendations

1) The research may be continued by looking at the correlation between morphometric of *Ascaris suum* that were found with the body size of the infected pigs.
2) The region of the studies need to be expanded to obtain data and ecology information that more accurate and more complete .

SUMMARY

Gheby Indira., research with title "Morphometry Variation of Male and Female *Ascaris suum* at Pegirian Slaughterhouse Surabaya" under the supervision of Prof.Dr. Setiawan Koesdarto, drh., M.Sc. as the first supervisor, Handijatno, drh., MS., Ph. D. as the co-supervisor, Prof. Dr. Nunuk Dyah Retno L, drh., M. S.as the coordinator of examiners.

The aims of this research was to find out thedifferences in male and female *A. suum* variations quantitativelyand this research was expected to be used as a reference to knowing thethe size of the *A. suum* more specific to the area of Surabayaas a literature to study about morhometry of nematodes.

All *A.suum* will be taken for morphometryy measurements. This morphometry measurements is mainly determine the morphology of *A. suum* quantitatively by measure the Wet Weight (WW), Diameter (D), and Total Length (TL).

A. *suum* that will be used in this study are divided into 3 groups by its areas which is the main supplier pigs into Pegirian Slaughterhouse Surabaya.

Data that has been obtained will be processed with SPSS program version 21 by computer. The software used for data analysis is Statistical

Program for Social Science (SPSS) 21 for Windows byUsing Chi Square Test to determine the composition of males and females in each regions . To know morphometry male or female in each regions using One Way Anova . To determine the morphometry based on sexin each area using Independent T Test. And to see the correlation between morphology measurements offemale and male*A. suum* with wet weight , diameter , total length, individual , and regions using Decission Tree analysis..

Based on the data analysis, morphometry measurement between male and female *Ascaris suum* in each region have significant different. The variation of morphometry affected by sex, not region. It can be seen from the size of WW, D, and TL that had significant difference ($p < 0.05$) for each sex. Region does not given an affected on morphometry variation of male and female *Ascaris suum.*

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APPENDIX 1 . Measurement Result of Morphology Males and Females *A. suum* at Pegirian Slaughterhouse Surabaya

Blitar				
No.	Wet Weigh (gram)	Diameter (mm)	Total Length (cm)	M or F
1a	1.4	3.47	19	M
1b	6.12	5.32	32.4	F
2a	2.43	3.93	24.3	F
2b	2.64	3.81	25.7	F
2c	1.89	3.86	24	F
3a	0.42	2.05	10	M
3b	1.03	2.59	5.7	M
4	3.39	4.45	27.7	F
5	3.89	4.66	27.9	F
6	7.69	6.16	33.7	F
7	3.4	4.49	27.3	F
8a	2.93	4.23	26	F
8b	2.62	4.12	24.2	F
9	3.77	4.35	27.1	F
10	3.38	4.41	27.8	F
11	2.27	4	22.6	M
12	1.09	2.91	19.9	M
13	2.73	4.09	23.7	F
14	2.76	3.86	26	F

Tulungagung				
No.	Wet Weight (gram)	Diameter (mm)	Total Length (cm)	M or F
1	5.42	5.29	31.5	F
2a	3.16	4.1	28.7	F
2b	1.44	3.48	19.2	F
3	6.73	5.67	32.1	F
4a	3.36	4.42	29.11	F
4b	3.8	4.5	27.6	F
4c	4.99	5.03	31.4	F
4d	1.68	3.54	23	M
4e	1.71	3.42	22.8	M
4f	0.94	3.1	16.3	M
5a	7.48	5.26	39.8	F
5b	1.23	2.93	21.6	M
5c	1.93	3.58	22.6	M
5d	1.21	3.02	20.6	M
6	6.28	5.24	36.4	F
7	2.6	3.13	26.1	F
8	1.56	3.07	20.8	M
9	3.67	4.48	30.2	F
10	2.94	3.25	28	F
11	3.12	3.98	26.7	F
12	0.89	2.78	15.8	M

Malang				
No.	Wet Weigh (gram)	Diameter (mm)	Total Length (cm)	M or F
1a	3.98	4.3	29.8	F
1b	4.06	4.6	27.7	F
1c	1.16	3.1	18.5	M
2a	3.9	5.1	26.2	F
2b	3.28	4.3	27.3	F
3	2.32	3.8	25.7	F
4	1.23	3	21.3	M
5	3.61	4.3	28.1	F
6	3.85	4.4	29.7	F
7a	4.73	4.9	27	F
7b	5.4	5.4	28.5	F
7c	1.69	3.6	22.5	M
8a	0.86	2.8	16.3	M
8b	1.5	3.1	20.7	M
8c	1.58	3.3	20.6	M
8d	1.48	3.2	20.8	M
9a	2.08	3.6	20	F
9b	0.99	2.9	17.3	M
9c	4.27	4.6	28	F
10a	0.69	2.5	17.2	M
10b	2.31	4	23.7	F
11	1.83	3.7	25	M

12	1.5	3.5	19.9	M
13a	1.35	3.2	20.2	M
13b	0.76	2.5	16.7	M
14a	1.01	2.9	18.7	M
14b	1.22	3	18.4	F
15a	0.82	2.9	14.2	M
15b	0.73	2.7	15.4	M

APPENDIX 2. Measurement Result of Females and Males *A. suum* in Blitar

T-Test

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
wetweigh	Equal variances assumed	.006	2.30371	.72801
	Equal variances not assumed	.000	2.30371	.51345
diameter	Equal variances assumed	.001	1.40600	.35014
	Equal variances not assumed	.010	1.40600	.38017
totallength	Equal variances assumed	.000	11.54571	2.27125
	Equal variances not assumed	.021	11.54571	3.32346

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
wetweigh	Equal variances assumed	.76775	3.83968
	Equal variances not assumed	1.21476	3.39267
diameter	Equal variances assumed	.66727	2.14473
	Equal variances not assumed	.48280	2.32920
totallength	Equal variances assumed	6.75380	16.33763
	Equal variances not assumed	2.70499	20.38644

APPENDIX 3. Measurement Result of Females and Males *A. suum* in Tulungagung

T-Test

Group Statistics

	sex	N	Mean	Std. Deviation	Std. Error Mean
wetweigh	female	13	4.2300	1.79690	.49837
	male	8	1.3938	.38124	.13479
diameter	female	13	4.4485	.83074	.23041
	male	8	3.1800	.29612	.10469
totallength	female	13	29.7546	4.99883	1.38643
	male	8	20.4375	2.85254	1.00852

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
wetweigh	Equal variances assumed	13.417	.002	4.363	19
	Equal variances not assumed			5.494	13.694
diameter	Equal variances assumed	6.213	.022	4.126	19
	Equal variances not assumed			5.012	16.277

totallength	Equal variances assumed	1.050	.318	4.785	19
	Equal variances not assumed			5.435	18.959

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
wetweigh	Equal variances assumed	.000	2.83625	.65007
	Equal variances not assumed	.000	2.83625	.51628
diameter	Equal variances assumed	.001	1.26846	.30747
	Equal variances not assumed	.000	1.26846	.25308
totallength	Equal variances assumed	.000	9.31712	1.94733
	Equal variances not assumed	.000	9.31712	1.71444

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
wetweigh	Equal variances assumed	1.47564	4.19686
	Equal variances not assumed	1.72662	3.94588
diameter	Equal variances assumed	.62493	1.91200
	Equal variances not assumed	.73271	1.80422

totallength	Equal variances assumed	5.24131	13.39292
	Equal variances not assumed	5.72823	12.90600

APPENDIX 4. Measurement Result of Females and Males *A. suum* in Malang

T-Test

Group Statistics

	sex	N	Mean	Std. Deviation	Std. Error Mean
wetweigh	female	13	3.4623	1.17642	.32628
	male	16	1.1988	.37234	.09309
diameter	female	13	4.3338	.64053	.17765
	male	16	3.0431	.35681	.08920
totallength	female	13	26.1615	3.50251	.97142
	male	16	19.0813	2.82164	.70541

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
wetweigh	Equal variances assumed	13.229	.001	7.287	27
	Equal variances not assumed			6.671	13.959
diameter	Equal variances assumed	2.233	.147	6.871	27

	Equal variances not assumed			6.493	17.904
totallength	Equal variances assumed	.181	.674	6.034	27
	Equal variances not assumed			5.898	22.898

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
wetweigh	Equal variances assumed	.000	2.26356	.31064
	Equal variances not assumed	.000	2.26356	.33930
diameter	Equal variances assumed	.000	1.29072	.18784
	Equal variances not assumed	.000	1.29072	.19879
totallength	Equal variances assumed	.000	7.08029	1.17339
	Equal variances not assumed	.000	7.08029	1.20053

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
wetweigh	Equal variances assumed	1.62618	2.90094
	Equal variances not assumed	1.53563	2.99148

diameter	Equal variances assumed	.90530	1.67614
	Equal variances not assumed	.87292	1.70852
totallength	Equal variances assumed	4.67268	9.48790
	Equal variances not assumed	4.59620	9.56437

APPENDIX 5. Morphometric variation of females *A. suum* between regions (Blitar , Tulungagung and Malang)

Oneway

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Wetweigh	Between Groups	4.652	2	2.326	.992	.380
	Within Groups	86.723	37	2.344		
	Total	91.375	39			
Diameter	Between Groups	.089	2	.044	.088	.916
	Within Groups	18.584	37	.502		
	Total	18.672	39			
Totallength	Between Groups	92.520	2	46.260	3.046	.060
	Within Groups	561.867	37	15.186		
	Total	654.387	39			

APPENDIX 6. Morphometric variation of males *A. suum* between regions (Blitar , Tulungagung and Malang)

Oneway

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
wetweigh	Between Groups	.205	2	.102	.541	.589
	Within Groups	4.922	26	.189		
	Total	5.127	28			
diameter	Between Groups	.130	2	.065	.349	.708
	Within Groups	4.823	26	.186		
	Total	4.953	28			
totallength	Between Groups	79.143	2	39.571	2.675	.088
	Within Groups	384.675	26	14.795		
	Total	463.818	28			

APPENDIX 7. Composition Females and Males Among Regions

Crosstabs

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
sex * location	69	98.6%	1	1.4%	70	100.0%

sex * location Crosstabulation

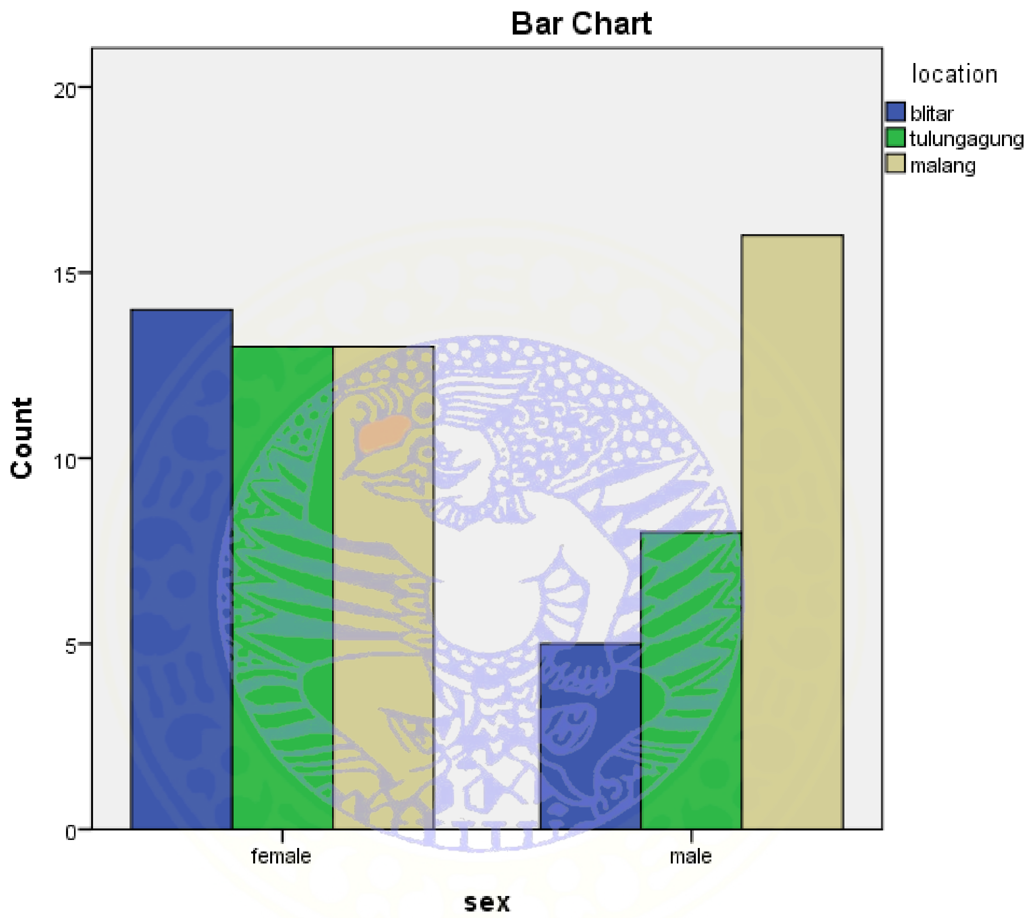
			location			Total
			blitar	tulungagung	malang	
sex	female	Count	14	13	13	40
		Expected Count	11.0	12.2	16.8	40.0
		% within sex	35.0%	32.5%	32.5%	100.0%
		% within location	73.7%	61.9%	44.8%	58.0%
		% of Total	20.3%	18.8%	18.8%	58.0%
	male	Count	5	8	16	29
		Expected Count	8.0	8.8	12.2	29.0
		% within sex	17.2%	27.6%	55.2%	100.0%
		% within location	26.3%	38.1%	55.2%	42.0%
		% of Total	7.2%	11.6%	23.2%	42.0%
Total		Count	19	21	29	69
		Expected Count	19.0	21.0	29.0	69.0

	% within sex	27.5%	30.4%	42.0%	100.0%
	% within location	100.0%	100.0%	100.0%	100.0%
	% of Total	27.5%	30.4%	42.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.115[a]	2	.128
Likelihood Ratio	4.191	2	.123
Linear-by-Linear Association	4.014	1	.045
N of Valid Cases	69		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.99.


Bar Chart
location
blitar
tulungagung
malang
Count
20
15
10
5
0
female
male
sex

APPENDIX 8. Decission Tree Analysis

Classification Tree

Warnings

The table of scores is not displayed because the growing method is not CHAID or Exhaustive CHAID.
The table of profits is not displayed because profits are not defined.
Gain summary Tables are not displayed because profits are undefined.
Target category gains tables are not displayed because target categories are undefined.

Model Summary

Specifications	Growing Method	CRT
	Dependent Variable	sex
	Independent Variables	pig, location, wetweigh, diameter, totallength
	Validation	None
	Maximum Tree Depth	5
	Minimum Cases in Parent Node	10
	Minimum Cases in Child Node	5
Results	Independent Variables Included	wetweigh, totallength, diameter, pig, location
	Number of Nodes	5
	Number of Terminal Nodes	3

Depth	2

Prior Probabilities

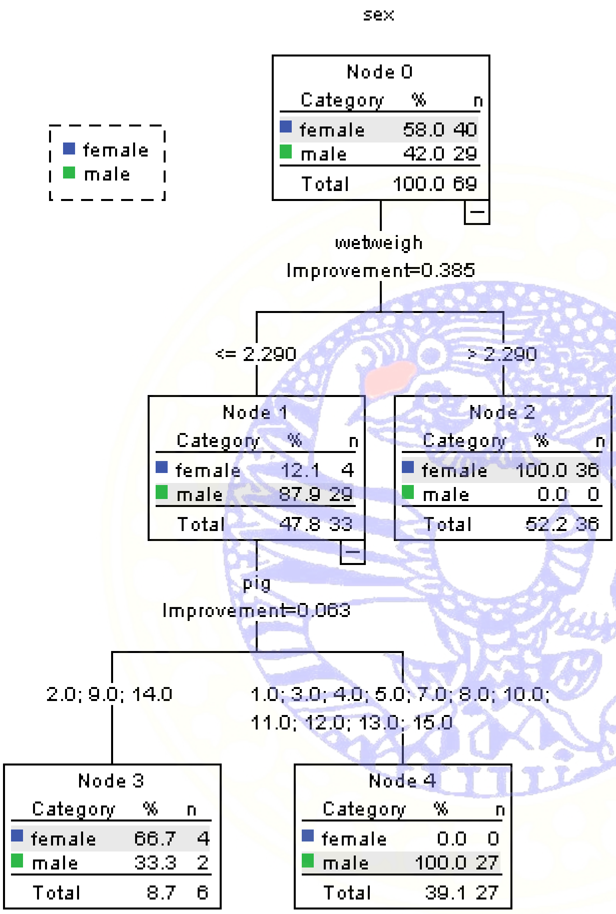
sex	Prior Probability
female	.580
male	.420

Priors are obtained from the training sample

Misclassification Costs

Observed	Predicted	
	female	male
female	.000	1.000
male	1.000	.000

Dependent Variable: sex



Tree Table

Node	female		male		Total	
	N	Percent	N	Percent	N	Percent
0	40	58.0%	29	42.0%	69	100.0%
1	4	12.1%	29	87.9%	33	47.8%
2	36	100.0%	0	0.0%	36	52.2%
3	4	66.7%	2	33.3%	6	8.7%

4	0	0.0%	27	100.0%	27	39.1%

Tree Table

Node	Predicted Category	Parent Node	Primary Independent Variable		
			Variable	Improvement	Split Values
0	female				
1	male	0	wetweigh	.385	<= 2.290
2	female	0	wetweigh	.385	> 2.290
3	female	1	pig	.063	2.0; 9.0; 14.0
4	male	1	pig	.063	1.0; 3.0; 4.0; 5.0; 7.0; 8.0; 10.0; 11.0; 12.0; 13.0; 15.0

Growing Method: CRT

Dependent Variable: sex

Risk

Estimate	Std. Error
.029	.020

Growing Method: CRT

Dependent Variable: sex

Classification

Observed	Predicted		
	female	male	Percent Correct
female	40	0	100.0%
male	2	27	93.1%
Overall Percentage	60.9%	39.1%	97.1%

Growing Method: CRT

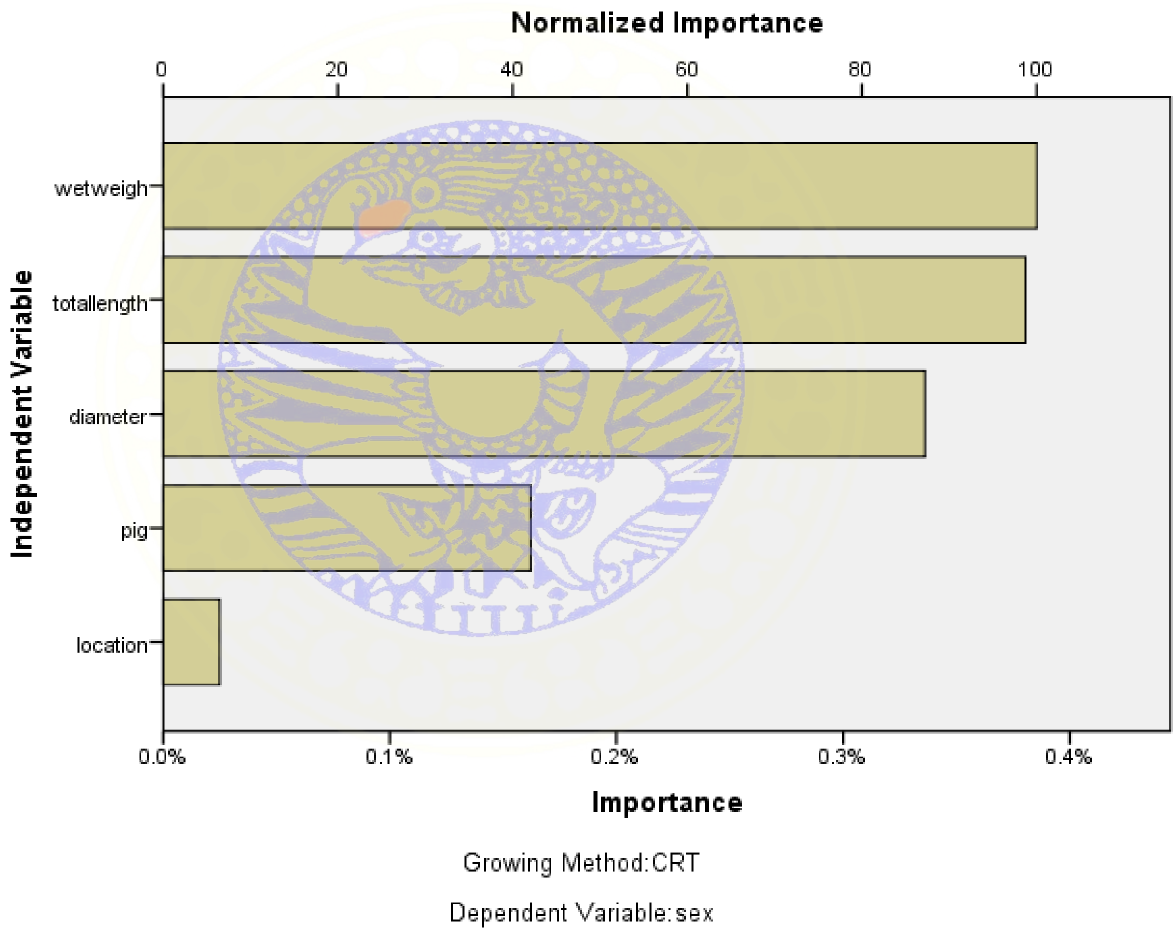
Dependent Variable: sex

Independent Variable Importance

Independent Variable	Importance	Normalized Importance
wetweigh	.385	100.0%
totallength	.381	98.7%
diameter	.336	87.2%
pig	.162	42.1%
location	.025	6.5%

Growing Method: CRT

Dependent Variable: sex



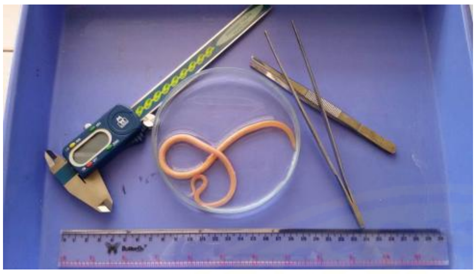
APPENDIX 9. Research Documentation

Pig skin scrapping by the slaughterhouse officer

Removing the content of pig visceras, include a small intestines

Taking *A. suum* and put it into a plastic bag containing a physiological fluid

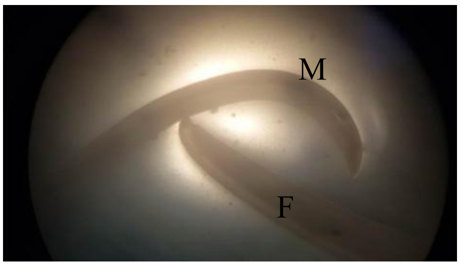
Organize and inspect the intestine that containing *A. suum*



Some tools and materials for morphometry examination of *A. suum*

Morphometry examination of male and female *A. suum* by using a ruler

Examination of the wet weight (WW) *A. suum* ; A. Male *A. suum* , B. female *A. suum*



Male (M) and female (F) *A. suum*. A. differences in body size between males and females . B. the posterior part of the male and female *A. suum* viewed using stereomicroscope