Sexual Dimorphism of *Leptocorisa oratorius* Fabricius (Hemiptera: Alydidae) from Special Region of Yogyakarta

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ABSTRACT

Sexual dimorphism (SD) is a common phenomenon in animals, especially in invertebrates and poikilothermic vertebrates, which can cause body size differences of males and females in a species. Rice ear bugs [*Leptocorisa oratorius* Fabricius (Hemiptera: Alydidae)] are a significant rice pest in Indonesia, and the data about sexual dimorphism of this species is little known. This research aims to describe the sexual dimorphism of rice ear bugs. The study was conducted by sampling on the suburbs area's paddy fields in Yogyakarta with a purposive sampling method, followed by the dissection and analysis of 22 morphometric descriptors. Results have shown a significant sexual dimorphism on the antennae length, tarsus length, and prothorax length. Male *L.oratorius* generally have longer antennae length, tarsus length, and prothorax length than females. There are no significant differences between male and female descriptors, but some female descriptors are bigger than males. There is a possibility that mating selection pressure was driven by the sexual dimorphism of *L. oratorius*.

Keywords: *Morphometry, Rice ear bug, Sexual dimorphism.*

1. INTRODUCTION

Rice ear bug or *Leptocorisa oratorius* Fabricius (Hemiptera: Alydidae) is a common pest species in Asia's lowland rice crops, capable of causing damage in the grain forming stage rice plants [1]. The attack of this bug may cause partially filled or unfilled rice grains, usually with dark brown spots as remnants of stylet penetration [2]. Between 1997 and 2003, crop loss caused by *L.oratorius* in Indonesia was estimated at around 29,325 hectares [3]. The ability to survive on minimal food supply, delay egg-laying, high spreading capability, and live on other host plants made this insect a dominant species on the flowering and late stage of rice plant growth [4].

Adult *L.oratorius* generally have a brown color 18-18.5 mm long with brown spots on the ventrolateral side of the abdomen, while nymphs are small and green colored. When disturbed, adult *L.oratorius* will fly and leave a specific odor produced by glands near the abdomen. *L.oratorius* is a diurnal organism living in environments with temperatures ranging from 25.30-26.75°C and relative humidity of 73.75-74.92%, with a lifespan of 23-61 days for males and 35-80 days for females. All instars of the species consume the liquid inside rice grains during the grain forming stage, which causes damage to reduction to rice yield [3,5]. Females often laid 200-300 white-colored eggs in batches of 10- 20 on upper leaf surfaces, which became darker upon hatching. Nymphs undergo five instars in 25-30 days before maturing into adults [1]. *L.oratorius* is a diurnal species, with peak daily activity around 06:00- 07:00 and 15:00 or 17:00, usually avoiding hot periods of the day [5,6]. Peak population occurs during rice crops' flowering stage, especially during warm weather [1].

Sexual dimorphism (SD) is a phenomenon of differences in morphology of each sex in the same species, common on insects, with predominantly sized females, often with more instars than their male counterparts [7]. SD in female insects is reflected in the broader thorax and wider abdomen, while males tend to have longer abdomens due to intense reproductive selection [8]. SD is mainly influenced by ecological mechanisms. Different morphs of males and females of the population might offer specific roles or adaptations according to their ecological conditions and competition on limited resources [9].

One of the methods to know and determine SD is morphometrics. Morphometrics is a type of form measurement and analysis that can be used to identify characteristic variations and express hypothetical relationships between each dimension. It consists of measuring the shape, ratio, and size of the organism's body parts. Body size is related to the eco-geography of an organism [10]. SD is a phenomenon of differences in morphology of each sex in the same species, common on insects, with predominantly sized females, often with more instars than their male counterparts [7]. Sexual dimorphism in female insects is reflected in the broader thorax and wider abdomen, while males tend to have longer abdomens due to intense reproductive selection [8]. Sexual dimorphism is mainly influenced by ecological mechanisms. Different morphs of males and females of the population might offer specific roles or adaptations according to their environmental conditions and competition on limited resources [9]. The morphometrics method is a valuable tool to analyze allometry of the body size and shape, which influences sexual dimorphism [8,10].

Previous research suggested differences in body shape and length of *L.oratorius*, usually correlated to their function in nature [11]. Generally, females are stronger fliers than males, and it is known that variations in the shape and apex of the left and right forewing of *L.oratorius* are prominent [12]. There are variations between the head capsule of *L.oratorius*, particularly on the labrum, vertex, compound eye indentation, and the insert of antennal joints [13]. Research in morphological variations between sexes was seldom done, so this research aimed to explore the specific morphological variants of body shape and sizes between the males and females of the *L.oratorius* species and the correlation to their function.

2. METHODS

2.1. Research and Collection Site

This research was conducted in the Laboratory of Entomology, Universitas Gadjah Mada, Special Region of Yogyakarta, from November 2019 to March 2020. Data were collected from paddy fields in a suburbs area through 06.00 to 08.00 a.m. The paddy fields were located at Sumberadi Village, Mlati, Sleman District (145 MASL) and Sinduharjo Village, Ngaglik, Sleman District (230 MASL). All the paddy fields had been becoming generative phase, especially at grain formation (*masak susu*, red).

2.2. Specimen Collection

Specimens were collected with purposive method sampling. A total of 80 individuals were collected, comprising males and females. Specimen sexing is done by comparing genital plates at the end of the abdomen; females generally have a pointed genital plate while males have blunted genital plate [12]. Environmental parameters, such as air humidity, light intensity, and air temperature, were recorded.

2.3. Specimen Preparation

Collected specimens were transported to the Laboratory of Entomology, Faculty of Biology, Universitas Gadjah Mada for sex determination. Sex determination is conducted based on previous research from Bendoy et al [12]. After that, specimens were euthanized using ethyl acetate and dissected using a dissection kit. Parts of the body (e.g., wings, antenna, and legs) were separated from the body. Each specimen was then kept in a PCR tube with added water desiccant (silicon dioxide). If the measurement was impossible on the same day, measurements were performed two days maximum after storage. The specimens were stored in the refrigerator.

2.4. Specimen Measurement

There were 22 descriptors used in this research (Table 1). Each sample is photographed using a camera with a millimeter block background. All photos were stored on the computer. Measurements were performed using ImageJ, and the data were saved in a collective datasheet.

2.5. Data Analysis

Data analysis was performed after measurement using IBM SPSS 20. The data was inputted into this program. Analysis was performed using a t-test to know the possibility of a significant difference between males and females in each descriptor.

3. RESULT AND DISCUSSION

Morphometry is a standard method that allows the summarization of numerical morphological data and expresses the dimensional relationship between each data.

Table 1. T-test analysis on male and female L. oratorius population morphometry.

Descriptor	Descriptor Value (mm)		t-value
	Male	Female	
Body Length (B.L)	16.736±3.980	15.024±6.423	1.433
Body Width (B.W)	2.766±0.669	2.850±0.689	-0.566
Body Height (B.H)	2.253±0.602	2.337±0.634	-0.608
Antennae Length (An.L)	17.685±4.321	13.716±6.497	3.218*
Mouthpart Length (M.L)	5.116±1.232	4.431±2.089	1.789
Left Forewing Length (Lf.L)	12.167±2.902	10.968±4.698	1.374
Right Forewing Length (Rf.L)	11.923±2.861	11.519±3.943	0.524
Left Hindwing Length (Lh.L)	8.149±2.046	7.673±2.964	0.835
Right Hindwing Length (Rh.L)	8.149±1.955	7.890±2.705	0.490
Left Forewing Width (Lf.W)	2.491±0.608	2.582±0.627	-0.659
Right Forewing Width (Rf.W)	2.478±0.606	2.427±0.834	0.313
Left Hindwing Width (Lh.W)	2.138±0.542	2.163±0.639	-0.184
Right Hindwing Width (Rh.W)	2.132±0.531	2.093±0.725	0.280
Femur Length (F.L)	4.815±1.269	4.561±1.151	0.939
Tibia Length (Ti.L)	4.480±1.093	4.147±1.000	1.420
Tarsus Length (Tar.L)	2.359±0.807	1.995±0.701	2.154*
Prothorax Leg Length (Pro. Leg L)	12.154±3.023	10.163±4.357	2.375*
Mesothorax Leg Length (Mes. Leg L)	12.325±3.015	11.663±2.848	1.009
Metathorax Leg Length (Met. Leg L)	18.286±4.447	17.369±4.169	0.952
Head Length (h.L)	2.371±0.562	2.408±0.593	-0.286
Abdomen Length (Ab.L)	9.403±2.227	9.327±2.729	0.136
Thorax Length (Th. L)	5.017±1.243	4.646±1.614	1.151

Note : * mean significantly difference (α = 0.05)

This method is beneficial in Entomology, where morphological variation is often difficult to analyze by normal means [10]. This research is focused on the sexual dimorphism between the males and females of the *L.oratorius* species, sampled in semi-urban rice fields in the Special Region of Yogyakarta. A total of 40 specimens of each sex were sampled from exact locations.

T-tests were conducted to analyze the significant difference between the body part lengths of each sex, in which we obtained the mean length and standard deviation of each descriptor. The resulting analysis is summarized in (Table 1.), with the following parameters significantly more prominent in males: antennae length (17.685±4.321 mm), tarsus length (2.359±0.807 mm), and prothorax leg length (12.154±3.023 mm). According to this, we postulate some possibilities about this phenomenon.

Sexual dimorphism is commonly found in various animal taxa, often causing exaggerated sexual selective traits such as ornamentation and weapons. Sexual dimorphism is often conditionally expressed since many of its features are phenotypically plastic. Some factors that affect this phenomenon are nutrition, genetics, niche, sexual selections, and competitions. These aspects affect individuals regardless of their sex, making it possible to produce different traits even in the same sex. Larval or juvenile access to nutrition will affect the regulation of the structure of sexual selections. Evolution is one of the earliest factors influencing this phenomenon. Sexual dimorphism can be raised from monomorphism. This evolution doesn't happen independently in one sex but correlates indirectly with other sex. Genetic correlation value that is higher than 1 is difficult for establishing sexual dimorphism. On the other hand, the value that is lower than one is likely causing sexual dimorphism where a character will eventually confine in one sex. Males and females niche also contributed to this phenomenon where the more prominent individual is likely to be selected as a parent for parental care. Body dimension measurements, including length, width, and height, do not differ significantly. However, a trend is found, with the highest mean body length found on male specimens (16.736+3.980 mm) while female specimens have the most increased body width (2.850+0.689 mm) and body height (2.337+0.634 mm). This trend shows that sampled male specimens on average have longer, slender bodies, while females are short and stout-bodied, though the difference is not apparent and significant. A longer body length is assumed to help males position themselves better during mating. In contrast, wider bodies, especially around the abdomen in females, could help with accumulating a more significant number of eggs. A larger body can also give an individual and its pair an advantage because a larger dimension can benefit from lower competition. Sexual selection allows more prominent individuals to have a higher chance to mate for having more enormous fecundity than smaller ones. Competitions between individuals also cause larger ones to have more access to courtship action. Wing sizes between species vary, but no significant differences are observed. Males, on average, have longer wings but have less width than females, which can be influenced by allometry and ratio of growth of the species, which is longer in males due to longer body length than females [8,10,14–16].

These possibilities can be linked to our result, where males tend to have a more prominent size than females. One of the possible outcomes of this possibility is males have a larger body to facilitate male-to-male combat where this interaction can be found in the *Riptortu*s genus. Larger hindlegs (metathorax leg) on males are used as weapons for combat, where an individual uses it for kicking and squeezing its competitor. This interaction is already observed in *Riptortus pedestris*, in the form of the specialized spined hind femur of the Alydinae subfamily. In contrast, the Mycrelitrinae subfamily with *L.oratorius* as its member does not have this hind femur modification [17–19]. The lack of hind leg modification may also suggest the lack of direct male-to-male confrontation during the mating process, though more data is necessary to validate this hypothesis.

From the data, it can be inferred that males have significantly longer antenna, tarsus, and prothorax leg length. Longer antennae can also result from population adaptation or a form of sexual dimorphism where this body part is used to detect the opposite sex. This is suggested to be true in males since a closely related species, *Leptocorisa chinensis,* is reported to produce various semi-chemicals in both sexes but only attract males (Leal et al., 1996). This could also correlate to the assumption that attracted males would need longer legs to stride over gaps and surfaces, which coincides with the size-grain hypothesis [20]. These adaptations are proposed to aid the mobility of the males, especially in mating seasons. Longer antennae of the males could also indicate a population with fewer females, thus increasing competition for males to have longer antennae. Also, longer antennae could result from an adaptation where higher antennae scales can be helpful for mating [21]. This large body allows the male to travel more considerable distances to find mates. This activity also correlates with a slenderer body to allow minor air friction, thus extending the travel range [22].

This research focuses on how different sexes may affect the morphology of *L.oratorius* and could provide data and a basic understanding of the dimorphism between the sexes of *L.oratorius* found in Indonesia. Improvements in further study with larger data sets may be required to express a more complete relation in the sexual dimorphism of *L.oratorius.*

This study has shown that sexual dimorphism indeed occurs in between *L.oratorius* sexes. Results show that males of the species have longer antennae, tarsus, and prothorax leg lengths than females. The difference is assumed to be related to the mating selection pressure of the species related to the chemicals released to attract males during mating, which causes the males to develop longer prothorax leg and tarsus to aid in locomotion and antennae to assistance in locating females during mating.

AUTHORS' CONTRIBUTIONS

Concept and field coordinator (FT) performed experiment/data collection (FT, EL, APN, RAA), data analysis and interpretation (EL, APN, FT), primary author (FT, EL, APN), principal investigator (RCH).

ACKNOWLEDGMENTS

We offer thanks and appreciation to the Laboratory of Entomology, Faculty of Biology, Universitas Gadjah Mada for providing the equipment necessary for this study. We also would like to thank all farmers who collaborated in offering paddy fields as the collection site of the specimens.

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