INTRODUCTION

West Lombok Regency is one of the regencies in West Nusa Tenggara Province, with an area of 1,053.92 km². It has fertile soil and abundant water reserves that have the potential to be utilized properly. Vegetable crops are one of the many potentials of West Lombok Regency in agriculture, with a harvest area of 507 ha in 2021. One type of vegetable crop that has become the main commodity is kale. Lingsar sub-district is the highest producer of kale, with a kale production of 6381 quintals in 2021 compared to other sub-districts in the West Lombok region [1].

Vegetables are agricultural commodities that are very important in supporting the economy and the nutritional needs of families. Many factors, including pests, influence the growth and development of vegetables. Pests found in agricultural land, especially vegetable crops, generally come from the Orthoptera, the largest insect order with more than 20,000 species spread throughout the world. Most of the Orthoptera are fairly large insects, with enlarged hind legs used for jumping and many species have stridulatory apparatus for song production [2]. An example of the order Orthoptera, which is most commonly found as an agricultural pest, is the grasshopper group (locusts and grasshoppers).

Grasshoppers play an important role in ecosystems by triggering plant growth, and being involved in nutrient cycles and food chains [3]. Most species of grasshoppers act as herbivores and are a good source of protein for other animals such as amphibians, small reptiles, birds, and small mammals [4]. Not only for animals, some species of grasshoppers, such as Valanga nigricornis Burm and Nomadacris succincta L. are consumed by the community, as in Java (Indonesia). Communities living in and around forests use grasshoppers as an alternative protein source to fight malnutrition and increase the consumption of nutritious food [5].

Grasshoppers are very different from other pests because their populations can grow quickly and, in some species, can form large swarms that can cause damage in a fairly short time [6]. If the population density of grasshoppers increases, it will certainly affect crop yields which has an impact on reducing and even failing to harvest a certain agricultural commodity, so controlling the locust population becomes very important. In Lombok, studies on the diversity of grasshopper species in the vegetable area have not been carried out. Therefore, the availability of initial data is needed for the management of preventing damage to vegetable fields in the future that certain types of grasshoppers may cause.

KEYWORDS: Grasshopper, Diversity, Vegetables

RESEARCH METHODS

A sampling of grasshoppers was carried out in the vegetable field of Bug-Bug Village, Lingsar District, West Lombok, based on the vegetable age category, namely 1 to 3 months. Grasshopper samples were caught using the sweeping net in the morning (07.00-10.30) around the edge and middle of the vegetable field. It is found that there are eight types of grasshoppers in 2 sub-orders and three families (Acrididae (6 species), Pyrgomorphidae (1 species), Tettigoniidae (1 species)). Atractomorpha crenulata and Oxya japonica were grasshopper species with the highest relative abundances of 42% and 29%, respectively. The analysis showed that the diversity index (H') of grasshoppers found in the research location was 1.5445.

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The samples obtained were sorted and preserved. Large-sized grasshoppers were preserved by injecting a preservative of 5% formalin, while small grasshoppers were put into bottles or jars containing a mixture of 5% formalin and detergent. Diversity data were analyzed using the Shannon-Wienner index [11]:

$$H' = \sum_{i=1}^{s} Pi \ln P_i$$

Where, $H'$ = Diversity Index; $Pi$ = Proportional abundance

Calculation of relative abundance refers to Krebs (2014):

$$KR = (ni/N) \times 100\%$$

Where, $ni$ = the number of individuals of the $i$-th type; $N$ = total number of individuals

**Results and Discussion**

**Species Composition and Diversity Index**

Grasshopper is a dominant herbivore, which has diversified into grassland, desert, semi-aquatic, alpine, and tropical forest habitats and exhibits diverse morphological, ecological, and behavioral diversity [12]. The grasshoppers found in the vegetable fields of Bug Bug Village consisted of 8 species belonging to 2 sub-orders, namely Caelifera (two families: Acrididae; Pyrgomorphidae) and Ensifera (Tettigoniidae) (Table 1). They have rather short antennae with a maximum of 30 segments. Sound or sound is produced by rubbing the hind legs against the wings. Meanwhile, Ensifera has antennae that are longer than its body and are divided into many segments (up to 500). Species that can sing or produce sounds produce sound by rubbing their wings forward [2]. The number of grasshoppers found in this study was more than those found in the rice field ecosystem, namely three species [13], four species in the Prakoso & Kurniawan corn agroecosystem (2021), and seven species in the plantation forest ecosystem. species [14]. However, the number of this species is much lower [15], who studied the diversity of grasshoppers in several agricultural areas including ecoton areas, post-harvest rice farming, post-harvest maize farming, mixed farming, vegetable farming and savanna, which is as much as 26 species belonging to 4 families.

Family Acrididae (Suborder Caelifera) is a family that has the most members found in the research location, namely six species, namely Aiolopus thalassinus subsp. Tamulus (Fabricius, 1798), Gastrimargus marmoratus (Thunberg, 1815), Oxya japonica (Thunberg, 1815), Phlaeoba fumosa (Serville, 1838), Stenocatantops splendens (Thunberg, 1815), Valanga nigricornis (Burmeister, 1838) (Table 1). Grasshoppers from the family Acrididae are one of the most diverse lineages of the order Orthoptera with 6,700 valid species distributed worldwide [11]. *Acrididae* are commonly known astrue grasshoppers and are pests of agricultural, forest, vegetable, garden, and fruit crops [16].

Not all types of grasshoppers obtained were found in all ages of vegetables. Two species of grasshoppers *Oxya japonica* (Thunberg, 1815) and *Atractomorpha crenulata* (Fabricius, 1793) were found in all data collections (three vegetable age categories). The species *O. japonica* is also one of the grasshoppers found abundantly in rice fields in...
Sleman Yogyakarta (Yudharta et al., 2021). It is suspected that this species is a permanent pest in vegetable fields adjacent to rice farms. It is supported by the external appearance of an appropriate color so that predators disguise it. These two types of grasshoppers have the characteristics of movement in the form of a jump that is not too active and far. Both types of grasshoppers are commonly found in green leafy vegetables. Meanwhile, two species, *Aiolopus thalassinus subsp. Tamulus* (Fabricius, 1798) and *Gastrimargus marmoratus* (Thunberg, 1815) were only found in 1 age range of vegetables (2 months of age) (Table 1). Both of these species are usually found living to camouflage themselves in open ground with little grass vegetation growing near vegetable beds or the underside of vegetables which have a slightly green and brownish color following the appearance of their body morphology.

The grasshopper diversity index ($H'$) was 1.5445 (Table 2). This index is higher than $H'$ in the vegetable farming area in the Dompu area, Sumbawa island, by 1.25 (Leksono et al., 2022), forest ecosystems (0.6307), and maize agroecosystems (0.5335) in Karanggayam District, Kebumen [17], and only slightly different from the diversity of grasshoppers in the three forests in Surabaya, namely 1.53 [18]. The diversity of grasshopper species was positively influenced by plant diversity, but the relationship was sometimes inconsistent [4]. For some grasshopper species, habitat appears to be influenced by the presence of shrubs and tree cover as important factors providing shelter, laying eggs, and food sources (Zografou et al., 2009). In addition, factors such as land height also have an effect. Orthopterans with the highest diversity and evenness values are found at an altitude of 150-250 meters above sea level, while the lowest diversity and evenness values are in the range of 360°. – 450 masl [19].

### Table 1. Distribution and Diversity Index of Grasshoppers in Vegetable Fields Research Locations

<table>
<thead>
<tr>
<th>Species</th>
<th>Sub-Order</th>
<th>Family</th>
<th>Vegetable Age (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aiolopus thalassinus subsp. Tamulus</em> (Fabricius, 1798)</td>
<td>Caelifera</td>
<td>Acrididae</td>
<td>1 2 3</td>
</tr>
<tr>
<td><em>Gastrimargus marmoratus</em> (Thunberg, 1815)</td>
<td>Caelifera</td>
<td>Acrididae</td>
<td>- + -</td>
</tr>
<tr>
<td><em>Oxya japonica</em> (Thunberg, 1815)</td>
<td>Caelifera</td>
<td>Acrididae</td>
<td>+ + +</td>
</tr>
<tr>
<td><em>Phlaeoba fumosa Serville</em>, (1838)</td>
<td>Caelifera</td>
<td>Acridantops</td>
<td>( + +</td>
</tr>
<tr>
<td><em>Splendenscatantops</em> (Thunberg, 1815)</td>
<td>Caelifera</td>
<td>Acrididae</td>
<td>- + +</td>
</tr>
<tr>
<td><em>Valanga nigricornis</em> (Burmeister, 1838)</td>
<td>Caelifera</td>
<td>Acrididae</td>
<td>+ + -</td>
</tr>
<tr>
<td><em>Atractomorpha crenulata</em> (Fabricius, 1793)</td>
<td>Caelifera</td>
<td>Pyrgomorphidae</td>
<td>+ + +</td>
</tr>
<tr>
<td><em>Maculatus</em> (Le Guillou, 1841)</td>
<td>Ensifera</td>
<td>Tettigoniidae</td>
<td>+ - +</td>
</tr>
</tbody>
</table>

Conocephalus present/found: - = absent/not found

### Table 2. Grasshopper Diversity Index at the study site

<table>
<thead>
<tr>
<th>Species</th>
<th>Total</th>
<th>Ln Pi</th>
<th>Pi LnPi</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Oxya japonica</em> (Thunberg, 1815)</td>
<td>22</td>
<td>0.2895</td>
<td>-1.2397</td>
</tr>
<tr>
<td><em>Valanga nigricornis</em> (Burmeister, 1838)</td>
<td>5</td>
<td>0.0658</td>
<td>-2.7213</td>
</tr>
<tr>
<td><em>Atractomorpha crenulata</em> (Fabricius, 1793)</td>
<td>32</td>
<td>0.4211</td>
<td>-0.8650</td>
</tr>
<tr>
<td><em>Conocephalus maculatus</em> (Le Guillou, 1841)</td>
<td>6</td>
<td>0.0789</td>
<td>-2.5390</td>
</tr>
<tr>
<td><em>Stenocatantops splendens</em> (Thunberg, 1815)</td>
<td>3</td>
<td>0.0395</td>
<td>-3.2321</td>
</tr>
<tr>
<td><em>Phlaeoba fumosa</em> (Serville, 1838)</td>
<td>6</td>
<td>0.0789</td>
<td>-2.5390</td>
</tr>
<tr>
<td><em>Gastrimargus marmoratus</em> (Thunberg, 1815)</td>
<td>1</td>
<td>0.0132</td>
<td>-4.3307</td>
</tr>
<tr>
<td><em>Aiolopus thalassinus subsp. Tamulus</em> (Fabricius, 1798)</td>
<td>1</td>
<td>0.0132</td>
<td>-4.3307</td>
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</tbody>
</table>

$H'$ 1.5445

### Relative Abundance of Species

The relative abundance of the types of grasshoppers found was quite varied. Variations in the abundance of grasshoppers could be influenced by many factors such as environmental factors, including altitude, temperature, and soil moisture and composition [4]. Variation Abundance and diversity of grasshopper species formed along with the elevation gradient of land use highest relative abundance was the *A. crenulata* (Fabricius, 1793).
at 42%, followed by *O. japonica* (Thunberg, 1815) (29%). The high abundance of these two species is related to the distribution of species, where these two species are always found in three age categories of vegetables. *Oxya japonica* (Rice grasshopper) is one of the main pests inhabiting wild rice (*Oryza rufipogon*) and lowland rice (*Oryza sativa*) in South China which can cause a decrease in rice yields [20]. Meanwhile, the grasshopper type *Atractomorpha crenulata* has a great hidden potential to turn into a major pest if its population is not monitored and controlled below the damage threshold level [21]. *A. crenulata* also played a role as pathogenicity of two parasites namely *Leidyana subramanii* and *Retractocephalus dhawanii* [22]. Meanwhile, the lowest relative abundance was found in two species, namely *G. marmoratus* (Thunberg, 1815) and *A. thalassinus* subsp. *Tamulus* (Fabricius, 1798) of 1%, which shows the same pattern with the relationship of species distribution (Figure 2).

![Figure 2. Relative abundance of locust species found during the study](image)

**CONCLUSION**

There were eight species of grasshoppers (order *Orthoptera*) in the vegetable fields of Bug Bug Village, which were covered in two suborders, namely *Caelifera* and *Ensifera*, with a diversity index of 1.5445. The most abundant species in relative abundance are *A. crenulata* (family *Pyrgomorphidae*) and *O. japonica* (Acrididae) which are part of the suborder *Caelifera* and species that have a low abundance from the family *Acrididae* are *G. marmoratus* and *A. thalassinus* subsp. guest.

**REFERENCES**


Biodiversity Research.


