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Morphological Identification Warehouse Pests as a Teaching Media for Plant Protection Practicals

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ABSTRACT
The purpose of the study was to determine the warehouse pest type bruchus that attacks green bean commodities in storage areas at the Kolakan market in Jombang Regency. The research period began in May - September 2023, located at the Agricultural Laboratory of the Faculty of Agriculture, KH University. A. Wahab Hasbullah Jombang. Mung bean seed samples were taken from the storage warehouse at the Kolakan Market in Jombang Regency. The research method used is the descriptive method used to identify warehouse pests that attack green bean seeds. While this type of research is qualitative. It is known that Callosobruchus maculatus is a warehouse pest that can complete its life cycle actively in green bean storage areas. Its distribution is higher in food ingredients in storage areas. This is expected to be used as a teaching medium in the identification of warehouse pest morphology in the practical of Plant Protection.

***Keywords**: identification; Instructional media; Warehouse Pests; Mung Beans*

INTRODUCTION
Mung beans*(Phaseolus radiates L)* are one of the foodstuffs that are widely consumsed by the public. These types of beans contain 21,78% proteins, 61,92% carbohydrates, 0,64% fats (Maryam, 2015). The nutrional content is quite high, making mung beans have a high level of ned in the community (Fanindya, 2018).

Based on data from the Directorate General of Food Crops (2021), mung bean production in Indonesia tends to decline. Indonesia's mung bean production decreased by 11,453 tons in 2020-2021, and its productivity decreased by 61 tons/ha. This figure is not in line with the increase in Indonesia's population which increases by 2.1% every year so that Indonesia's mung bean production is unable to meet the needs of the Indonesian people (Riry, et al., 2020). One of the factors causing the decline in mung bean production is the quality and quantity of mung bean for seed and consumption. Mung beans provided as seeds nationally are still low at around 12 percent (Directorate General of Food Crops, 2021). In addition, pest attacks during storage in warehouses are the cause of the decline in mung bean production. One of the warehouse pests that attack the mung bean commodity is the bean weevil *Callosobruchus maculatus.*

Callosobruchus maculatus or mung bean weevil is a cosmopolitan pest and is a major pest of legumes (Radha and Susheela, 2014). *Callosobruchus maculatus* beetles damage crops during the storage process (Soutgate, 1979). The larvae will make burrows in the seeds and live inside the seeds until they become pupae. Mung bean damage caused by *C. maculatus* reached 20-50% in India (Allotey and Oyewo, 2004). The characteristics of the texture of mung bean seeds that are easily brittle and also contain a lot of carbohydrates and proteins, become the choice of pests to place their eggs and then as food availability for larvae, until heavy damage to the seeds (Radha and Susheela *et al*., 2014). Research on *C. chinensis* species, the damage caused by its attack on susceptible mung bean genotypes ranges from 80-90%, and resistant genotypes range from.4%-14.3% (Gai, 1993).

Based on the above, it is necessary to know the characteristics of the pests that attack, to be part of the efforts to control the attacks carried out, so as to reduce the decline in the quality and quantity of mung bean production. Exploration, isolation, and identification are carried out to obtain insects that act as warehouse pests in mung bean commodities. In the Basic Plant Protection course in the

Agroecotechnology study program at the Faculty of Agriculture, KH. A. Wahab Hasbullah University (UNWAHA), the course learning outcomes include applying pest identification based on the type of attack symptoms caused to plants and crops. Therefore, as part of the achievement of identification, it is applied in the practicum in the Basic Plant Protection course.

Based on the above, this paper is related to the Morphological Identification of Mung Bean *Warehouse* Pests as a Teaching Medium for Basic Plant Protection. The purpose of the study was to determine the type of bruchus warehouse pests that attacked the mung bean commodity in the storage area at the Kolakan market in Jombang Regency. It is expected to be used as a teaching medium in the morphological identification of warehouse pests in the practicum of Basic Plant Protection

METHOD

The research is done at May - September 2023, was at the Agriculture Laboratory of the Faculty of Agriculture UNWAHA. Mung bean seed samples were taken from a storage warehouse in Kolakan Market, Jombang Regency. Tools and materials used in this study were pest propagation jars, jars for feed sterilization, cameras, microscopes, mung beans, cotton, alcohol, distilled water, tweezers, and stationery. Materials for identification from the journal Beck and Blumber (2011).

This research uses a descriptive method to identify Warehouse pests that attack mung bean seeds. In addition, testing was also carried out on the morphology of these pests with the hope of being able to be used as teaching media in the Plant Protection practical.

The propagation of *C. maculatus* pests was carried out at the Laboratory of the Faculty of Agriculture, UNWAHA. The pests used must be identified first and are the brunchus type (visible from the abdomen). Propagation is carried out on pests that come from storage warehouses and use pest propagation jars. Green beans used as feed must be sterilized first.

Pest propagation is done by randomly infesting male and female imago in jars containing 250 g of feed. Investment is carried out for 2 weeks/14 days. The surface of the jar was covered using chiffon cloth to maintain air circulation. Imago used in the study were 0-24 hours old. The results of the cross (F1) were then observed microscopically by observing the morphology of the pest. Imago that have been identified are then placed in 2 different containers.

Observation Parameters Morphological characteristics of each stadia of *C. maculatus*, namely egg, larva, pupa, imago. Then the morphological characteristics of the body of *C. maculatus,* namely body shape, head, mouth, antennae, and legs, and the period of each stadia.

RESULT AND DISCUSSION

Results

Based on observations of the morphology of bruchus type warehouse pests on mung bean seeds, it is known that the eggs are transparent white and oval in shape. The size is 0.74 mm long and 0.38 mm wide. Eggs are attached to mung bean seeds and hatch about 4-5 days after being laid on the bean surface. Observations showed that the eggs were randomly scattered on the mung beans. There are 1 to 2 eggs in one seed (Figure 1). It were placed randomly on mung bean seeds, with a zig-zag position. The larvae are white with a *scarabaeiform* shape or curved like the letter "C". The larvae cannot move so they have no other choice but to eat. However, it was difficult to find the larvae in the seeds during observation. This is due to the fact that the larvae grow and develop inside the seeds, making it difficult to observe their growth inside the seeds.

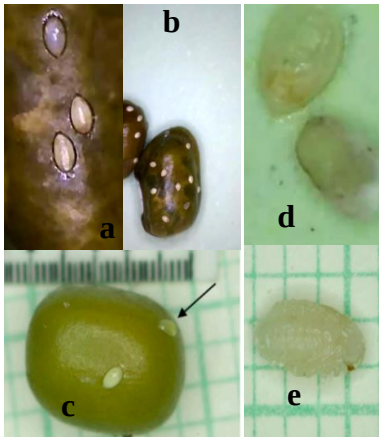

Figure 1. The appearance of eggs from observations (a) oval egg shape and transparent white color, (b) eggs laid irregularly on mung bean seeds at 100x magnification with a digital microscope, (c) the appearance of pale green pupae at 50x magnification with a digital microscope (Fauziah, 2024). Reference photos of eggs (c) and pupae (e) from observations of Beck and Blumer (2011).

The pupae is known to be pale green in color on the forewings and the abdomen is white, with a length of 3.88 mm and a width of 1.76 mm. the pupa stadia period ranges from 6 - 7 days. While the Imago of the insects tested, based on the results of observations known to have several phases of growth, in Figure 2 shows the *insect* after the pupa phase changes to the imago form. The -1 phase has a clear brown color with an almost perfect body shape. In the 2nd phase has a slightly dark brown color, where there has been a change in the head is perfectly formed. The antennae have begun to elongate and the shape of the legs can already be seen clearly with a microscope. In the 3rd phase, the body as a whole is already dark brown in color. In addition, in this phase the body shape is already sturdy. In the 4th phase, the body shape begins to have significant changes. The abdomen begins to have a brownish-black color. The head begins to be black and the antennae are perfectly shaped. The elytra has started to grow to a small size with a transparent color but still not too perfect.

Figure 2. Appearance of the tested insect imago; a) 1st phase, b), 2nd phase, c), 3rd phase, d), 4th phase under a 100x magnification digital microscope (Fauziah, 2024).

The results of visual observations showed differences between male and female imago insects (Figure 3).

Figure 3. Cross-section of the tested insects; a) Male, and b) female with 50x magnification. (Fauziah, 2024)

Based on observations of the sex of these pests, shown in table 1.

Table 1. Morphological observation results of *C. maculatus* pests based on gender.

No.	Morphology	Male	Females
1.	Body shape	Oval	Oval more larger than the male insect
2.	Head shape	Somewhat tapered	Somewhat tapered
3.	Mouth shape	Biters and chewers	Biters and chewers
4	Leg shape	Walking and digging	Walking and digging
5	Antenna shape	Serrate	Serrate
6	Eye shape	Compound Eyes	Compound Eyes
7	Color of abdomen	Light brown	Dark metallic in color and larger
8	Color of elyptra	Slight yellowish brown	Brown yellowish, there are black spots
9.	Head color	Black	Black
10	The pattern of the elyptra	Slight yellowish brown	Slight yellowish brown with black spots/patterns

Furthermore, the elyptra of the female species are metallic in color and speckled. The size of the female is larger than the male and there is a black color on the sides with white longitudinal lines on the abdomen. The head of the tested insect has a slightly tapered shape with a black color. The mouthparts show a biting - chewing type (a). On the head there is a pair of compound eyes (b) and a pair of antennae located on the right and left of the head (Figure 4).

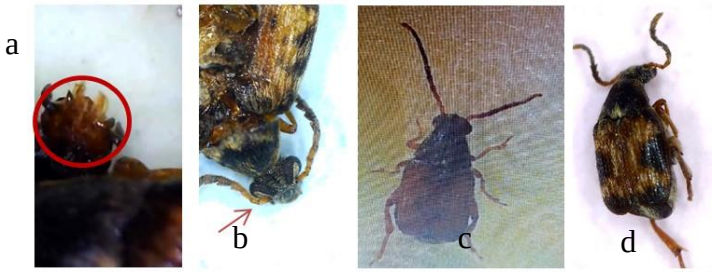

Figure 4. Cross-section of the head of the tested insect at 50x magnification (Fauziah, 2024); (a) mouth type, (b) compound eyes of the insect, (c) antenna, (d) insect body from the research of Nafisah (2019).

The parts of the insect's legs are shown in Figure 5.

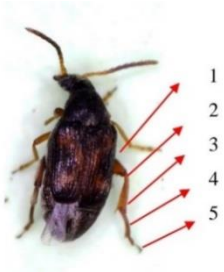

Figure 5. Parts of the legs of the insects tested (Fauziah, 2024), 1.) Coxa, leg segment located at the base of the foot, near the chest (prothorax), 2.) Trochanter, a small segment following the coxa. 3.) Femur, the largest segment of the leg. 4.) Tibia, the same length as the femur but slimmer. 5.) Tarsus (plural tarsi), located at the end of the tibia. Composed of 1-5 segments, at the end of which there are 1 or 2 nails, on the nails there is a cushion-like structure called pulvullus or arolium.

Discussion

Biogeographically, *Callosobruchus maculatus* is a species originating from the African continent. This pest then spread to tropical and subtropical regions of the world (Garima *et al*., 2021). This pest is often called a seed-boring beetle that attacks legumes in storage. *Callosobruchus maculatus* is a pest that can reproduce quickly and takes 30-35 days to complete its life cycle (Devi and Devi, 2014). The life span of the larvae in the seeds is between 9 - 11 days. In the observations of Devi and Devi (2014), it also shows that *C.maculatus* larvae growth and developed in seeds until they become imago. Meanwhile, according to Kardiyono (2012), the egg stage ranges from 4 - 5 days at 28°C. One female imago is able to lay a total of 100 eggs during her lifetime (Hill, 2003; Bailey, 2007).

According to Kardiyono (2012) the larval stage ranges from 9 - 11 days at a temperature of 30°C and RH 95-100%. Meanwhile, according to Umar and Turaki (2014) the larvae obtain food from the beans for 2-6 weeks and then develop into pupae. *Callosobruchus maculatus* larvae use their mouths to chew their food. Its larvae cannot move between seeds, so the larvae have no other choice but to eat, grow and develop in the seeds chosen by their parents, therefore the oviposition behavior of females is very important in determining the survival of offspring (Mitchell, 1975; Fatima *et al*., 2016).

Callosobruchus maculatus larvae generally develop in dried pea seeds. The larval mouthparts are biters and chewers. It has a *Labrum* (upper lip), *Mandibles* (a pair of jaws for chewing/grabbing food), *Maxillae* (a pair of jaws for holding, grasping, smelling, tasting and also holding food), *Hypopharynx* (tongue), and *Labium* (lower lip that functions to hold food and also as a sense of taste). Larvae chew food near the surface of the bean and do not eat (leave) the thin surface layer of the bean. The chewing forms a small hole in the bean. Damage caused by *C. maculatus* larvae can cause seed death (Drees and Jackman, 1999).

During the pupal period, the pest is inside the seed. The larvae continue to dig and make burrows serves as a place for the exit of the imago (Hill, 2003; Bailey, 2007; Nafisah, 2019). Insect antennae are *serrate-shaped* which functions as a sensory tool to determine the presence of food, direction of travel, mates, danger and establish relationships with each other. This is evidenced by the research of Hu *et al*, (2009) that male and female imago *C.maculatus* both have *serrate-shaped* antennae. The antenna segments of it have the same length. The base segment of the antenna is reddish yellow and the rest is darker (Hagstarum *et al*., 2012). Male and female pests can be distinguished through their appearance. The part that shows the most difference is the tip that covers the abdomen of the pest. In females this part is larger and darker while in males it is smaller and striped than female. The body size of female is larger than male.

Callosobruchus maculatus lives well at 32°C and 90% humidity. Under these conditions, the imago appears at the age of 3-4 weeks after egg laying. The imago of this pest has a short lifespan of only about 7 and in laboratory conditions can last up to 14 days (Nafisah, 2019). It pests during the imago phase also do not require food or water *(*Fatimah *et al*., 2016). The size of the imago of this pest ranges from 2-4 mm and It has a slightly pointed head and the elytra is slightly yellowish brown. This pest also has *spines* on the outside and inside of the hind limb femur (Nafisah, 2019).

Callosobruchus maculatus have limited flying ability, so that it pests have actually been present since they were still in the field but can only breed well during storage. It also does not like light and requires little oxygen. Its life cycle is active between grain storage places, therefore its spread is higher in foodstuffs in storage from one place to another. The identification test of these insect pests is expected to help students understand the morphology of warehouse pests. Therefore, it can stimulate students' curiosity about the role of warehouse pests, so that the emergence of new creations and innovations related to the science material studied (Susanti, et al., 2024), and determine the appropriate control for warehouse pest attacks in storage.

Conclusion

Callosobruchus maculatus is one of the insect pests that attacks green beans stored in warehouses. The pest has a life cycle in the egg, larva, pupa, and imago phases. In addition, it has different male and female sex characteristics. The identification test of the morphology and cycle of the insect pest is expected to help students understand the morphology of warehouse pests, so that they can determine the right control for warehouse pest attacks in storage areas.

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