Rearing earwig *Chelisoches morio* (Fabricius) on a variety of artificial diets

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**Abstract.** Black earwig (*Chelisoches morio* (Fabr.) (Dermaptera: Chelisochidae), is an effective predator of various important pests of crops such as mealybugs, beetles, and stem borers. Earwig mass rearing is considered simple, but it requires a long time to reach the optimal life stages for field releases. The type of artificial food given has at least an influence of lifespan so this study was conducted to determine the types of food that can shorten life cycle of earwig. Feeding trials consisted of combination between mealybugs and dog food, mealybugs and fish and mealybugs with cornmeal. Each treatment had five replications. The results shown that the lifespan of black earwig was 52 days (mealybug + dog food), 62 days (mealybug + fish material), and 67 days (mealybug + cornmeal) respectively. It is suggested that a better artificial food is to shorten lifespan and therefore it is considered to use earwig mass rearing.

1. **Introduction**

Biological control is defined as the use of living organisms aims to reduce population of plant pest and disease under economical threshold and to replace at least prevalent hazardous chemical use. In the integrated pest and disease management perspective, biological control agent is a fundamental component to keep in ecological balance of pest and disease population in ecosystem under economic threshold level [1]. One of important biological control agent is a predator and of many predator species, *Chelisoches morio* Fabr. (earwig insect: Dermaptera) is a promising predator with a significant role in agro-ecosystem [2].

Earwig is known as *cocopet* (Indonesia name) which has many various colors. In this study, black earwig was focused. Earwig has a structure-shaped like claws (pincers) on the last segment of its abdomen. The pincers are used to catch the prey and to protect its-self from predators. The pincers also are utilized to facilitate copulation. Cocopet is a typical polyphagous insect, killing many species. Number of earwigs were used to control mealybugs, coconut palm beetles [2], corn stem borer [3], and sugarcane stem borer [4].

Earwig is an aggressive predator and for mass production it is easily developed in Lab scale [2]. Generally, the procedure of biocontrol agent prior to being released in the ecosystem, scale up in the Lab scale is necessary. An issue of predator development is short lifespan that can affect to predation performance in nature. The preliminary study of earwig development was undertaken to analyses...
preference and it resulted that feeding trial with fish and cornmeal shown to have significant influence of its lifespan [5-7]. In addition, the past experiment suggested that individual has a low survival and proliferated rate once the food is given without prey (mealybug). It was indicated that feeding trial with prey is an important component of food ingredient [8]. Therefore, development of earwig in the lab scale would focus on food ingredient to boost the proliferation and would assess its stadia, egg production by per female, food consumption per individual and and the number of preys killed.

2. Materials and methods
This experiment was carried out at Laboratory of Plant Pest and Disease Department, Faculty of Agriculture, Universitas Hasanuddin from April to June 2018.

2.1. Research methodology
This study was arranged according to a Completely Randomized Design that was repeated five times with three treatments in the forms of (1) a combination of mealybug and dog food; (2) a combination of mealybug and fish feed; (3) combination of mealy bug and cornmeal. This experiment was following the Chelisoches manual production compiled by Marcela Navasero and Mario Navasero [9].

2.2. Breeding media preparation
The container used was a clear jar with a height of 10 cm and a diameter of 12 cm. The containers were filled with a mixture of soil + sand in a ratio of 1: 1 then topped with cocopet. The medium was filled as high as 3-5 cm and then moistened using a water-filled hand sprayer.

Lid of plastic bottle with a height of 1.3 cm and a diameter of 3 cm was used as a food plate. The lids were placed parallelly. A 4 cm long coconut fiber was placed on the edge of container. The coconut fiber was a shelter. Each container was used for a pair of male and female earwigs.

2.3. Feeding method
Three types of artificial food including dog food, fish material, and commercial cornmeal were ground separately and then weighed to achieve 3 g per each food trial. The artificial food was then placed into a lid of water bottle with reverse position before it was laid into a main container. A total of 15 mealybug nymphs collected and placed together with artificial food trials into a lid with reverse position.

2.4. Observation parameters
Every egg was calculated after spawned. The female adult made a hole to lay the eggs. Every egg was counted. C. morio male adult was split from female adult and the male was transferred to a separate container. Three days after egg hatch, the female adult was transferred to another container to avoid behavior of anthropophagus. The period from when the egg was laid until the eggs hatch was recorded.

The nymphs from instar 1 to IV were fed and once the egg hatched, the nymph was observed by using a light microscope. Every three days the nymph was assessed the antenna segments developed for instar status. Artificial food and mealybugs were measured and renewed every three days. The parameters including (a) instar stadia; (b) the number of eggs laid per adult; (c) the ability of the C. morio on consuming artificial food and preying on mealybug.

3. Results
The dog food with mealybug treatment shown to have the shortest lifespan overall breeding time among all treatment (52 days), followed by fish food with mealybug treatment (66.4 days), and the cornmeal with mealybug treatment (67.4 days) (table 1). The breeding time for mealybug + dog food...
treatment was significantly shorter than the breeding times in mealybug + fish food and mealybug + cornmeal treatments. However, no significant difference in the number of days needed from egg to instar 4 between mealybug + fish food and mealybug + cornmeal treatments.

Table 1. The amount of breeding time of *C. morio* based on dietary variations

| Treatment                  | Breeding Stages (days) | Total (days) |
|----------------------------|------------------------|--------------|
|                            | Egg | Instar 1 | Instar 2 | Instar 3 | Instar 4 |              |
| Mealybug + dog food        | 6.0^a | 10.6^a | 11.8^a | 10.0^a | 13.6^ab | 52.0^a     |
| Mealybug + fish food       | 8.0^ab | 12.8^ab | 14.0^ab | 13.8^ab | 17.8^b | 66.4^b     |
| Mealybug + cornmeal        | 9.2^b | 15.2^b | 15.8^b | 15.2^b | 12.0^a | 67.4^b     |

Numbers followed by different letters in the same column are significantly different according to the BNJ Test level of 5%.

The average number of eggs laid by a *C. morio* female adult was not significant difference among other treatments (figure 1). The highest average number of eggs laid was on the trial of mealybug + dog food while the lowest average number of eggs was in the mealybug + fish food treatment.

![Figure 1. The average numbers of eggs laid by a *C. morio* female fed on different food](image)

The amounts of artificial food consumed by an individual can be seen in figure 2. The treatment of mealybug + fish food was more preferred than mealybug + cornmeal, but not significantly different from mealybug + dog food.
The numbers of mealybugs preyed by a *C. morio* individual were different amongst the food treatments (figure 3). The largest number (210 nymphs) of mealybugs consumed was on the mealybug + cornmeal treatment and significantly higher than those consumed on mealybug + dog food treatment (190 nymphs) but was not significantly different from those consumed on the mealybug + fish food treatment (206 nymphs).

4. Discussion
Once the eggs altogether are laid, the increase of aggressive behavior of female occurs. The female protects and keeps the eggs until hatch by re-arranging egg position, maintaining egg moisture, and providing food for initial nymph instar [10]. One female adult has capable of spawning the eggs with...
four times which affects to the increase of generation population and sex ratio [11]. In this study, the finding indicates that, in one adult, number of eggs were successfully produced about 45 eggs in one time. The combination of dog food and mealybugs (prey) seems to have a more significant impact of the increase of lifespan with 52 days than other food trials. Also, this food trial increases the fitness of female adult to lay eggs. The main factor affecting to variation of food preference of earwig is highly likely nutrition composition. Food dog riches in high protein content, mineral and carbohydrate to support egg production of of C. morio [5]. In contrast to cornmeal mixed with mealybugs, source of protein is only supplied from the mealybugs. Mealybug is a favorite prey of earwig during mating due to less active colony, small body and abundant colony [12].

5. Conclusion
Among the combination of artificial food in this study, the combination of dog food with mealybugs was the most appropriate combination used to breed the C. morio. The dog food and mealybug diet shown that the C. morio took 52 days to fix its lifespan in the dog food + mealybug treatment. With a short breeding time, the release of the predators to the field can be done as early as possible to suppress pest population. Even though the earwigs fed on mealybug cornmeal diet consumed more mealybug nymphs than those on the other treatments, the mealybug + dog food is still better because it significantly shortened the lifespan and stimulated the female adult to spawn many more eggs.

References
[1] Holmes L, Mandjiny S and Upadhyay D 2016 Biological control of agriculture insect pest Euro. Sci. J. 216-225
[2] Rismansyah E A 2014 Chelisoches morio: Predator Pengendali Hama Kumbang Janur Kelapa (Pontianak: Balai Proteksi Tanaman Perkebunan)
[3] Boupha B D, Jamjanya T, Khlibsuwan W and Siri N 2006 Monitoring of insect pests, natural Enemies of sweet corn and study on control methods in Khon Khaen University Khon Khaen Agri. 34 1-11
[4] Kurniata L S and Korowi K T 2005 Overview of natural enemies of sugarcane moth stem borers at Ramu Sugar Estate Proceedings of the 79th Annual Congress of South African Sugar Technologists' Association 79 368-376
[5] Navasero M and Navasero V 2010 Biology of the black earwig Chelisoches morio (Fabricius) (Chelisochidae, Dermaptera) Philipp. Ent. 24 122-136
[6] Navasero M and Navasero V 2008 Development, prey consumption and mass production of Chelisoches morio Fabr. (Chelisochidae, Dermaptera) Philipp. Ent. 22 202
[7] Prasaja G Y, Tris H R and Edy S 2014 Preferensi dan respons fungsional Chelisoches morio terhadap larva Brontispa longissima di laboratorium Balai Proteksi Tanaman Perkebunan Pontianak J. Perkebunan & Lahan Tropika 4
[8] Marucci E P 1955 Notes on the predatory habits and life cycle of two Hawaiian Earwigs. Proceedings of Hawaiian Ent. Soc. 15 565-569
[9] Navasero M M and Navasero M V 2015 Chelisoches Production, National Crop Protection Center - Crop Protection Cluster (Laguna: University of the Philippines Los Baños) p13
[10] Suksen K 2007 Biological study of coconut Hispine Beetle, Brontispa longissima Gestro (Coleoptera: Hispidae) and its natural enemies Thesis (Bangkok: Kasetsart University)
[11] Kamimura Y 2003 Effects of repeated mating and polyandry on the fecundity, fertility and maternal behaviour of female Earwig, Euborellia plebeja Ani. Behaviour 65 205-214
[12] Harun R, Singh M, Forde G M and Danquah M K 2010 Bioprocess engineering of microalgae to produce a variety of consumer products Renew. and Sus. Energy Reviews 14 1037–1047