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Cotesia rubecula Feeding Strategy as a Biocontrol Parasitoid: A Review

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Abstract
Indonesian citizens rely on the agricultural sector to meet their daily needs because Indonesia is an agricultural country. Agricultural land, which is planted with monoculture crops, is a good condition for the development of pests, especially insect pests. To eradicate insect pests, farmers often choose insecticides that have a negative impact on the farmers themselves, on the environment, and on insects that are not parasitic to plants. Therefore, pest control with natural enemies needs to be done in order to preserve the environment and reduce the use of insecticides. Parasitoid organisms have great potential as biocontrol, one of which is Cotesia rubecula, which can be used as a biocontrol for the cabbage pest Pieris rapae. The feeding strategy of Cotesia rubecula can be used as a biocontrol agent for environmentally sound pest control. Besides that, Cotesia rubecula also helps pollinate cabbage plants.

INTRODUCTION

Indonesia is an agrarian country where most of the population relies on the agricultural sector to meet their needs, especially basic needs. Agricultural land is processed and planted with rice plants then accompanied by secondary crops. They can be consumed directly the harvest and sold for economic resources for farmers.

Agricultural land which is planted with one type of plant (monoculture). This is a good condition for the development of pests, especially insects (Fataar et al., 2019). Therefore, it is very necessary to control insect pests so as not to harm farmers as a source of food for the community.

Insects are species that have a lot of diversity in each class of living things. There are benefits and there are disadvantages. About 400,000 insect species are herbivorous/phytophagous insects that damage crops on agricultural land. This species is called insect pests (Amrullah, 2019).

Farmers using insecticides through spraying often do insect pest control. Using insecticides not only benefits farmers but also has a negative impact on health and the environment (Girsang in (Jasrani et al., 2016)). Insecticide is one type of pesticide that can cause chronic poisoning in farmers. This is because it can enter through the skin, respiratory tract and digestive tract of farmers (Yuantari et al., 2015). Another example, the insecticide profenofos interferes with the metabolism and physiology of red tilapia as aquatic biota (Adharini et al., 2017).

Insect pest control that has been widely carried out in Indonesia is in the form of biological control (biocontrol). This aims to realize Integrated Pest Management (IPM)

which is environmentally sound (Amrullah, 2019). Using biocontrol in controlling insect pests is more environmentally friendly by utilizing parasitoids (Fataar et al., 2019).

Parasitoids are insects that parasitize other parasitic insects and can be used as biocontrol agents. Using parasitoids has the potential to be developed along with the increasing public awareness of environmental sustainability, namely the adoption of a sustainable agricultural system. Parasitoid larvae develop in their host insect bodies and directly take food from the hemolymph and host tissues until the imago phase (Siekmann et al., 2004). This causes the death of the host (Foottit and Adler in (Amrullah, 2019)).

Biocontrol/biological control is an effort to control pathogens biologically. For example, efforts to control insects that become pests for plants use parasitoid insects. Using biocontrol can reduce the negative effects of using pesticides, including on farmers, water bodies and can kill other beneficial insects, such as insects that help pollinate. Thus, the use of biocontrol includes efforts to preserve the environment (Danial in (Amrullah, 2019)).

Insects or insect pests originating from the Order Lepidoptera, Hemiptera and Diptera, one biocontrol is *Cotesia rubecula Marshall*. *Cotesia rubecula* belongs to the class Insecta and the Order Hymenoptera. Species in the order of Hymenoptera, are often used in agriculture to control plant parasitic insects (Hidayat and Sosromarsono in (Jasrani et al., 2016)). *Cotesia rubecula* is a parasitoid of the white cabbage butterfly Pieris rapae L. (Lepidoptera: Pieridae) which feeds on cabbage plants in the eastern United States and southeastern Canada (Herlihy et al., 2012). Insect pests that attack vegetable crops in West Lombok are Thrips and Aphis species while their natural enemies are ants, crickets, Vespidae and others (Murdan and Sarjan in (Amrullah, 2019)).

Biocontrol Parasitoids

Parasitoids are a group of insects that live freely in the adult phase, but parasitize other insects during the immature phase (Quicke in (Lia, 2019)). Parasitoids are organisms that spend most of their life history depending on a single host organism and cause the death of the host. This is because the parasitoid develops and takes food from the tissues of the host's body.

We have shown insecticides used by farmers to eradicate insect pests to leave harmful residues, such as chemical residues found in shallot bulbs in Alahan Panjang, West Sumatra (Nelly, 2015), if consumed, it will have a negative impact on health. The active chemicals found as diazinon, propenophos, dimethoate (organophosphate) and cypermethrin (pyrethroid), with a value of 0.067-2006 mg/kg (ppm). It included these values in the highest category (Reflinaldon in (Nelly, 2015)). These effects need to be controlled so as not to damage health and the environment. Alternative control by using natural enemies of insect pests as parasitoids. This control is called biocontrol, or biological control.

Biocontrol is an effort to use parasitoid insects in overcoming insects that become pests for plants on agricultural land (Amrullah, 2019). Some examples of biocontrol include Diadegma sp. (Ichneumonidae) and Apanteles sp. (Braconidae) is a family Hymenoptera found in vegetables in West Sumatra (Yaherwandi in (Jasrani et al., 2016)), biocontrol Carabidae, crickets, wandering beetles, Lycosidae, Tetragnathidae, Oxyopidae, Salticidae, Coccinellidae, dragonflies, praying worms, shield ladybugs, Andrallus, Vespidae , Loxoscelidae, and Tettigonidae for Thrips and Aphis in West Lombok (Murdan and Sarjan in (Amrullah, 2019)) and families Scelionidae, Trichogrammatidae, Chalcididae, Braconidae in the Antirogo rice fields, Jember Regency (Lia, 2019).

We can use parasitoids as biocontrol agents because they attack insect pests from eggs, larvae, and pupae. The pupa leaves the host's body and, after the imago, it lives in nature freely (Kartohardjono in (Jasrani et al., 2016)). In addition, parasitoids help pollination by taking nectar as food and do not damage crops in agricultural areas, because they carried their host larvae to the edge of the field.

Most of the parasitoids as biocontrol agents for agricultural insect pests are of the Order Hymenoptera and help pollinate plants (Hidayat and Sosromarsono in (Jasrani et al., 2016)). Two families of this order that have the potential as biocontrol agents for insect pests are

Ichneumonidae and Braconidae, especially as parasitoids of eggs and larvae of insects, Lepidoptera, Hemiptera, and Diptera (Goulet and Hubner in (Lia, 2019)). In the identification of parasitoids at the Entomology Laboratory of the Zoology Division of LIPI, four Hymenoptera species were obtained, namely Adialythus ambiguus, Aphidius matricariae, Praon absinthi (Braconidae) and Psyllaephagus pilossus (Encyrtidae) (Maharani et al., 2020).

Parasitoids are parasitic insects against other parasitic insects and are used as one of the biocontrol agents. Parasitoids looking for hosts pay attention to fitness, odor and morphology of potential hosts (Maharani et al., 2020). Parasitoid larvae develop to feed on hemolymph and host tissues. The host larva continues to live during the development of the parasitoid, but dies as soon as the parasitoid larva leaves it.

Using parasitoids has the potential to be developed in line with increasing public awareness of environmental sustainability, namely by adopting a good agricultural system (Good Agricultural Practices) through the Integrated Pest Management (IPM) program to improve the quality and sustainability of production and preserving the environment (Ditlintanhor in (Nelly, 2015)).

Environmental conditions influence parasotoid life cycle. The species thrives in high-temperature environments rather than low-temperature environments (Nelly in (Jasrani et al., 2016)). Thus, the population increases more in the lowlands than in the highlands (Riyanto in (Jasrani et al., 2016)).

Efforts to use parasitoids as biocontrol agents in Indonesia have also been carried out in biological pest control, for example, the use of parasitoids to control pests on soybeans by (Buchori et al., 2008), sugarcane by (Aristya et al., 2020), rice by (Lia, 2019), and vegetables by (Murdan & Sarjan, 2018)

Cotesia rubecula Marshall

Cotesia rubecula is a parasitoid wasp of the large wasp family Braconidae of the Order Hymenoptera. The body is black, mature with a body length of less than 1/4 inch, has long antennae and extends approximately the length of the body. The classification is as follows.

Kingdom : Animalia
Phylum : Arthropoda
Class : Insecta
Order : Hymenoptera
Family : Braconidae
Genus : Cotesia
Species : *Cotesia rubecula*

Cotesia rubecula was used as a biocontrol parasitoid for cabbage plants. *Cotesia rubecula* is a biocontrol for Lepidoptera, Hemiptera and Diptera pests. The specific insect pest is Pieris rapae L (Fataar, 2019). They carried larvae of insect pests to the edge of the land so that they do not damage crops in agricultural areas and even help pollinate crops.

Research for *Cotesia rubecula* uses a chamber or glass chamber to see its feeding behavior, we can also use it for research on other insects. Besides the chamber also uses a Y tube. Then on one side is given food with the smell of nectar and on the other side is given colored food. Then he will choose food with a smell. This proves that *Cotesia rubecula* relies more on the sense of smell than the sense of sight (Fataar et al., 2019).

Cotesia rubecula is not commonly found, only found in some areas of the world, such as North America, Colombia, Canada, China and Yugoslavia (Herlihy et al., 2012). Meanwhile, in Indonesia, Cotesia erionotae was found in Natar and Tanjung Bintang Subdistricts (Flora Pasaru et al., 2017), and Cotesia flavipes in Binjai, Medan (Siregar, 2015)

Cotesia rubecula has no interspecies status, as does *Apis cerana*. *Cotesia rubecula* Females are proovigenic and some are synovigenic. Proovigenic females inject eggs only into host larvae that are almost fully mature and ready to hatch, while syngeneic females inject eggs into host larvae that are not at the same level of maturity, even some eggs are not fertilized, so they cannot hatch (Siekmann et al., 2004), the female wasp stings and lays between 20 and 50 eggs in the host instar

Cotesia rubecula parasitized cabbage caterpillars attacks the first and second instars of *Pieris rapae*, but kills the larvae as the fourth instar (Le Masurier and Waage in (Herlihy, 2013)). The host larval defense mechanism can sometimes kill the eggs. Otherwise, the host does

not die until the *Cotesia rubecula* larvae leave the host's body. Its nature is to parasitize the host from eggs to larvae. When it is an adult, it will become a symbiont to mark the area. Adult *Cotesia rubecula* and its symbionts coexist with their host. The population increases in late summer and is related to the growth of the host species.

The decision to forage for food rather than a host depends on factors such as energy state, experience in searching for food, number of eggs, distance to food sources and abundance of food (Jervis in (Siekmann et al., 2004)). The smell of nectar and host for *Cotesia rubecula* is almost the same, so it will visit both in almost equal portions. If in a state of hunger, then he prefers nectar over the host (Siekmann et al., 2004). *Cotesia rubecula* often forages in agricultural areas because host plants and food sources are separated spatially (host plants and nectar-producing plants at a certain distance, perhaps only on the outskirts of the field). The way parasitic wasps find flowers has practical implications for conservation of biological control in agriculture.

The feeding strategy of *Cotesia rubecula*

The feeding strategy of *Cotesia rubecula* is the same as that of common parasitoids, namely using the sense of smell for volatiles produced by plants that are parasitized by their hosts (Maharani et al., 2020). The host population will increase if sufficient food sources are available. The host larva then feeds on the cabbage and its body coated with the volatile compounds produced by the cabbage. Volatile compounds in the host larva's body carried by the wind attracted *Cotesia rubecula*, then *Cotesia rubecula* imago came to mark the place so that they lived side by side. The volatile cabbage plant is used by *Cotesia rubecula* to find hosts and recognize food (Cusumano et al., 2019).

Pieris rapae is said to be its specific host. The specificity of the host for parasitoids causes parasitoids to be used for biocontrol. If we smell a gray flower of cabbage, then it is attracted to the flower, as well as a yellow flower is smelled of cabbage because the sense of smell is more functional than the sense of sight. Thus, the togetherness of the host with *Cotesia. rubecula* imago and the presence of a distinctive smell from the host became a strategy for him in foraging.

CONCLUSION

The feeding strategy of *Cotesia rubecula* is to coexist with its host as Pieris rapae larvae and the presence of a distinctive odor from the host. As a parasitoid against insect pests, *Cotesia rubecula* can be used as a biocontrol agent for environmentally sound pest control, so that environmental sustainability is maintained.

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