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POTENCY OF INTRAGUILD PREDATION TO DISRUPT THE OPTIMUM FUNCTIONS OF PREDATORY ARTHROPODS: AN ECOLOGICAL PERSPECTIVE

POTENSI INTRAGUILD PREDATION UNTUK MENGGANGGU FUNGSI OPTIMAL DARI ARTROPODA PREDATOR : SEBUAH TINJAUAN EKOLOGIS

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ABSTRACT

Some empirical studies have revealed the ecological consequence of interspecific relationships among predatory arthropods that is the disruption of natural functions of indigenous species of predators on their preys, i.e. phytophagous arthropods. In relation to many efforts on the utilization of introduced species of natural enemies, particularly predatory arthropods, the effects of Intraguild Predation (IGP) on key predators should be considered carefully to optimize their potency. In addition, understanding the impact of biological traits of each species of predatory arthropods on their ability to adapt from being predated by other species might be important to predict their composition and possibilities for being exist in ecosystem.

Key words : biological control, interspecific relationship, intraguild predation, natural enemy

INTISARI

Beberapa kajian empiris membuktikan adanya konsekuensi ekologis akibat hubungan antar spesies artropoda predator yaitu gangguan alamiah pada fungsi pemangsaan predator asli pada mangsanya, yaitu artropoda fitofaga. Dalam kaitannya dengan usaha-usaha untuk memanfaatkan artropoda predator, misalnya melalui upaya pemasukan agensia musuh alami, pengaruh Intraguild Predation (IGP) pada predator-predator kunci harus diperhitungkan secara hati-hati untuk mengoptimalkan potensi mereka. Selanjutnya, pemahaman terhadap pengaruh sifat-sifat biologis dari masing-masing spesies artropoda predator dan kemampuannya untuk beradaptasi terhadap kemungkinan dimangsa oleh spesies lain menjadi penting, yaitu untuk memperkirakan komposisi dan kemungkinan keberadaan spesies-spesies tersebut di ekosistem.

Kata kunci :*pengendalian hayati, hubungan interspesies, intraguild predation, musuh alami*

INTRODUCTION

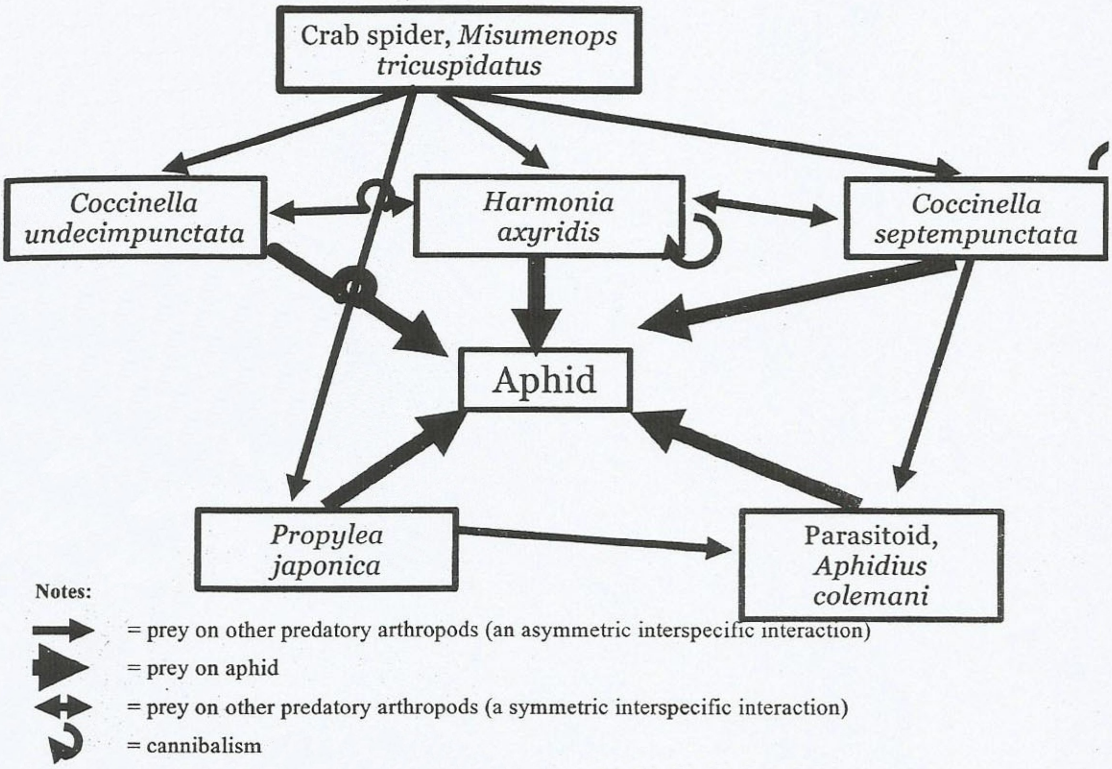
Intraguild predation (IGP) is the killing and eating of species that use similar resources and are thus potentially an intraguild competition (Polis and Holt, 1992). This phenomenon has been revealed to perturb the effectiveness of biological control by predatory arthropods on phytophagous insects through competition and/or predation mechanisms (e.g. Rosenheim et al., 1993; Holt and Polis, 1997; Rosenheim, 1998; Finke and Denno, 2003; Snyder and Ives, 2003). Impacts of intraguild predation on the inferior species of predators are including (1) decrement of the performance of active stage of predators (i.e. larval stage) (e.g. Lucas et al., 1998; Yasuda and Ohnuma, 1999; Hindayana et al., 2000; Putra and Yasuda, unpublished data) and (2) alteration of specific behaviors, e.g. avoidance of the patches which are attended by potential competitors or predators for laying eggs (Taylor et al., 1998; Takizawa et al., 2000; Agarwala et al., 2003; Putra and Yasuda, 2005). In addition, if intraguild predation occurs, the nature of food web will become more knotty since the generalist predators feed on a wide range of preys, either on phytophagous or on other predatory arthropods (Polis et al., 1989; Polis and Holt, 1992), which in turn might change the composition of both phytophagous and predatory arthropods in a given habitat. Therefore, studies to understand the emergence impacts of intraguild predation in structuring arthropod community might be needed to predict the population dynamics of phytophagous insects and the effectiveness of biological control by natural enemies as well.

The purpose of this review is to discuss the impacts of intraguild predation on the possibilities of composition shift of predatory arthropods, which will also dampen the optimum role of key predators on phytophagous insects. The effect of biological traits of predator such as body size, voraciousness, and mobility to determine the strength of intraguild predation (Lucas et al., 1998; Hindayana et al., 2000; Felix and Soares, 2004) will also be discussed in relation with the performance of key predators in controlling phytophagous population.

Nature and Mechanism of Intraguild Predation. Intraguild predation is a natural phenomenon that occurs at a wide range of animal species and/or habitat (Polis et al., 1989; Hunter et al., 2002; Baber and Babbitt, 2003; Snyder and Ives, 2003; Hickerson et al., 2005; Lucas, 2005; Armsby and Tisch, 2006) in the frame of prey-predator relationship (Holt and Polis, 1997). Empirical evidences provided by Polis (1991) from his elegant study in the Coachella Valley desert, and notes of Polis and Strong (1994) showed that species in food webs are generally drastically lumped together; means that they potent to interact each others in a highly complex relationship, as also shown, for example in an aphid-aphidophagous system (*Figure 1*). Furthermore, Sih et al. (1998) explained that natural communities typically have multiple predators feeding on most prey. Those statements then suggest an assumption that they might involve in either intra- or interspecific relationships that ranged from weak to strong, and as a consequence, will determine their potential role in controlling the abundance of phytophagous insects.

Intraguild predation which takes place via a combination of competition and /or predation mechanisms (Polis and Holt, 1992), are strengthening the impact on population

Figure 1. A simplified diagram of interspecific interactions among predatory arthropods in aphidophagous system. Based on Yasuda and Ohnuma, 1999; Takizawa et al., 2000; Yasuda et al., 2000; Yasuda and Kimura, 2001; Felix and Soares, 2004.



dynamics in more complex way than when competition or predation occurs alone. The magnitude of interactions will be strongly influenced by biological traits of each species, i.e. body size (related to the age of each opponent), aggressiveness (viz. mobility or foraging behavior), hunger level, and food range.Body size might be the most important factor that influences the strength of interaction (Lucas et al., 1998; Felix and Soares, 2004; Lucas, 2005). For example, the olderstage of coccinelid larva, *Coleomegilla maculata* or lacewing larva, *Chrysoperla rufilabris* would kill the younger larvae of opponents (Lucas et al., 1998), but not vice versa. Furthermore, many evidences also showed the significant effect of aggressiveness of species to influence the outcome of IGP. The more mobile arthropods might usually win the confrontation (Lucas et al., 1998; Meyhofer and Hindayana, 2000; McGregor and Gillespie, 2005), although in some cases are not always as such (e.g. Hindayana et al., 2000). In addition, some empirical evidences revealed the interdependency of those traits influence the final outcome of interaction. For example, Hindayana et al. (2000) showed that although larvae of the low-mobile hoverfly, *Episyrphus balteatus* has higher potency to be an intraguild prey (IG_{prey}), the older larva -

were able to exert a sticky-fluid to reduce the detrimental impacts of predation by its potential predator, the high mobile coccinellid, *Coccinella septempunctata*. Thus, in ecological sense, intraguild predation should be realized as a highly complex interaction among species, and might involve plenty of both intrinsic and extrinsic factors.

Ecological consequences of intraguild predation on key predators. As shown in several studies IGP might reduce the potency of key predators in controlling the number of phytophagous insects due to biological activities curtailment, such as oviposition preference, and foraging behavior of both larval and adults due to the increment of risk of being predated. Regarding to the role of key predators to control phytophagous insect population in a given habitat, negative effects of IGP on the success of biological control might be prevalent, as have been proven in several different environments (Snyder and Wise, 1999; Finke and Denno, 2003; Finke and Denno, 2004).

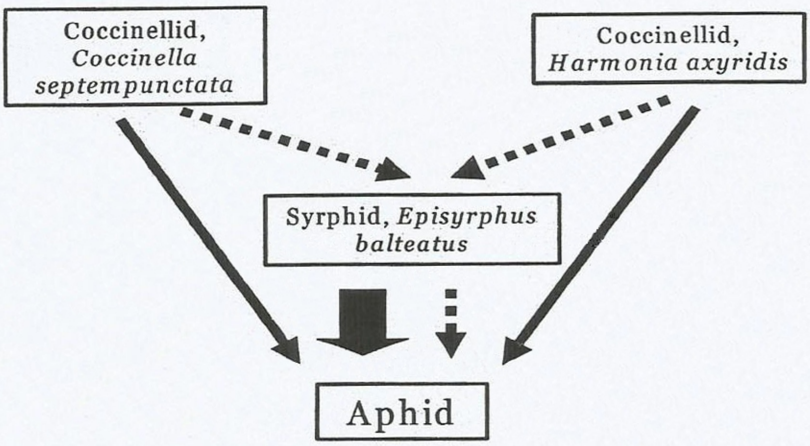
Furthermore, intraguild predation is well studied in the environments, where the introduced ones overcome the native species (Elliott et al., 1996; Brown and Miller, 1998; Lucas et al., 2002; Evans, 2004; Kajita et al., 2006). Thus, impacts of intraguild predation on particular habitats could be outlined as the relationship between introduced and native species. The problems might emerge if key predators play important roles on the suppression of phytophagous population. *Figure 2* shows the mechanism on how intraguild predation determines the suppression rate of prey (i.e. phytophagous arthropods) by key predators due to the disturbance by invading species. The potency of predatory hoverfly larvae was shown to be higher than the potency of coccinelids by foraging and consuming aphids much more efficient (Gilbert, 1993; Tenhumberg, 1995; Michaud and Belliure, 2001). However, it is shown that the coccinellids, by its higher mobility and tendency to attack the others reduces the feeding rate of syrphid larvae by attacking the larvae, or reducing the oviposition preference of the adult in patches attended by coccinelid larvae (Putra and Yasuda, 2005). High mobility, strength and high voraciousness of coccinellids would be the significant factors, which enhance their potency as the superior predator over the others (Lucas et al., 1998; Meyhofer and Hindayana, 2000; Felix and Soares, 2004; Lucas, 2004; McGregor and Gillespie, 2005; Putra and Yasuda, 2005).

In relation with the rapid implement of biological control efforts, such as introduction of new species of biological control agents into particular habitats, the detrimental impacts of intraguild predation should also be considered carefully to optimize the control power of key predators on key pests. In addition, introducing new species of biological control agents into particular ecosystem should be preceded by thorough ecological studies to predict the possibilities of emergence impacts of interspecific interaction with native species, from which two ecological consequences might be took place, i.e. (1) habitat displacement of native predatory species by the introduced ones, and (2) disturbance of the composition of predatory species in given habitats.

Several studies have been revealed a habitat displacement by the introduced predators to the indigenous species (e.g. Elliot et al., 1996; Brown and Miller, 1998; Evans, 2004). For example, a study which was reported by Brown and Miller (1998) showed that two-exotic species of ladybird, *Coccinella septempunctata* and *Harmonia axyridis* became the dominant species in apple orchards of Eastern West Virginia after a displacement process during 13 years from 1983 to 1996. Those reports have shown mechanisms which caused habitat displacement, i.e. (1) decrement of survivorship of native species due to interspecific interaction, and (2) alteration of the dynamics of dispersal and habitat use across the landscape.

Furthermore, habitat displacement, or in other sense is also termed as population shifting, might change the composition of predatory arthropods in particular habitat. Downing and Leibold (2002) revealed that the composition of species within richness levels can have equally or more marked effects on ecosystems than average effects of richness *per se*. Thus, from the ecological point of view, intraguild predation might elicit the change of community structure of arthropods, or in other meaning, it might change the ecosystem functioning of food web provided by native species of arthropods, including key predators. Ecological risks, for example the shifting of arthropods composition then should be considered carefully to restrain an environmental shock, because, however, arthropods might have a specific role in the whole mechanism of trophic interaction among organisms.

Figure 2. A simplified diagram of reduction of the suppression rate of the syrphid larva, *Episyrphus balteatus* on aphid when intraguild predator, the coccinellids occur in the same patches. Note that the thickest arrow shows the optimum feeding rate of the syrphid larvae on aphid, while the dotted-short arrow shows the feeding rate when the two coccinellids occur in the same place. In addition, the long-thin arrows show the normal feeding rate of the two coccinellids on aphid, while the dotted-long arrows show the possibility of predation by the two coccinellids on the syrphid. Based on Gilbert, 1993; Tenhumberg, 1995; Hindayana et al., 2000; Michaud and Belliure, 2001; Putra and Yasuda, 2005 (in part).



CONCLUSIONS

In ecological point of view, intraguild predation has various impacts on both predatory and phytophagy arthropods. On the inferior predators, intraguild predation might reduce the optimum potency of predators on their native preys by decreasing their survivorship and numerical or aggregative responses. In addition, introducing new species of biological control agents to control the fast growing population of phytophagous arthropods in particular habitat should be preceded by thorough studies to ensure that such organisms might not disturb the stability of ecosystem fun' tions, e.g. predation by native predators on its preys.

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