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Intraguild predation of eggs by predaceous ladybirds, *Propylea dissecta* and *Menochilus sexmaculatus*

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Abstract: Ladybird beetles belonging to family Coccinellidae of the largest order Coleoptera are considered to be the economically important insects. They have immense potential to be used as biocontrol agents of several phytophagous pests, viz. aphids, scale insects, mealy-bugs and other soft bodied insects and acarines. Apart from attacking the aphid infestation, they are also known to attack immature stages of other heterospecific ladybirds. We performed laboratory experiments to quantify the incidence of intraguild predation of eggs by two co-occurring ladybird species, *Propylea dissecta* and *Menochilus sexmaculatus*. These experiments revealed that all predatory stages preyed upon heterospecific eggs, however, differently. First instars and adult females of *M. sexmaculatus* significantly consumed more number of P. dissecta eggs than vice versa. Both first instar and adult female of *P. dissecta* showed reluctance in consuming heterospecific eggs, which wasn't the case with the similar predatory stages of *M. sexmaculatus*. Our results reveal that *M. sexmaculatus* is more voracious than *P. dissecta* and showed no reluctance in consuming heterospecific eggs. Hence, we conclude that *M. sexmaculatus* could act as intraguild predator in the absence of natural prey, i.e., aphids, and can easily attack heterospecific eggs, which could be the reason for its successful establishment and cosmopolitan distribution.

Keywords: *Propylea dissecta* • *Menochilus sexmaculatus* Coccinellidae • heterospecific eggs • intraguild predation

Introduction

Ladybird beetles or ladybirds (Coccinellidae: Coleoptera) are economically important insects, as most of them are predators of several phytophagous pests, *viz*. aphids, scale insects, mealy-bugs and other soft bodied insects and acarines. They have successfully used as biocontrol agents of numerous phytophagous pests, especially scale insects (Omkar and Pervez, 2003). Eggs are considered highly nutritious first food consumed by newly hatched instars of ladybirds (Omkar et al., 2006). Apart from attacking aphids and other insect pests, they attack immature stages of other heterospecific ladybirds (Omkar et al., 2002), especially eggs and immature stages of heterospecifics (Omkar et al., 2004, 2005). In phidophagous systems where a few predators compete for a single available prey then the interactions that are likely to occur is known as intraguild predation (IGP) (Lucas, 2005). IGP is defined by Lucas et al. (1998) as predatory interactions between predators within a guild.

Ladybirds can be effective biocontrol agents of numerous native and exotic pests in the normal conditions (Symondson et al., 2002). However, IGP could negatively interfere and may slow down the outcome of biocontrol (Snyder and Wise, 1999).

Due to lack of external protection, the eggs of ladybirds can be easily victimized to IGP (Polis et al., 1989). However, Hemptinne et al. (2000) found that eggs of certain ladybirds have some alkaloids that may reduce the probability of IGP. Ladybirds, *Coleomegilla maculata* (de Geer) and *Harmonia axyridis* (Pallas) can easily develop from first instars to adults by feeding on *Chrysoperla carnea* eggs, However, seven spot ladybird *Coccinella septempunctata* L. could not (Phoofolo and Obrycki 1998). This shows that IGP of eggs in ladybirds varies amongst ladybirds. Ladybirds usually attack immobile and poorly defended vulnerable life stages, especially eggs (Lucas, 2005; Hemptinne et al., 2011; Michaud & Grant, 2004). These eggs could also be proved to be a highly nutritious in terms of quality and palatability (Gagné et al., 2002; Omkar et al., 2006). Certain studies indicated that ladybird larvae fed on conspecific (Pervez et al., 2006; Roy et al., 2007) or heterospecific eggs (De Clercq et al., 2005; Michaud & Jyoti, 2008) perform better than when fed on aphids, however vice-versa has also been reported (Rieder et al., 2008; Sloggett et al., 2009; Sloggett and Davis, 2010).

Both *Propylea dissecta* (Mulsant) and *Menochilus sexmaculatus* (Fabricius) are locally abundant ladybirds and can be found in the agricultural fields of North India preying on numerous aphid pests (Omkar and Pervez, 2004; Pervez and Omkar, 2004a). *Propylea dissecta* can easily be reared in the laboratory and could be used as important aphid biocontrol agent (Pervez and Omkar, 2004b). The present study is a step to identify the incidence of intraguild predation of eggs in these to ladybird species.

Materials and Methods

Stock culture

Adults *Menochilus sexmaculatus* and *Propylea dissecta* were collected from agricultural fields near around of Kashipur (29º2104´N, 78º9619´E), and reared in laboratory and paired in plastic Petri dishes (9.0cm diameter × 2.0cm height) under constant conditions (27 ± 2ºC; 65 ± 5% RH; 14L: 10D) in B.O.D. Incubator (*REMI*, Remi Instruments). They were feed on *ad libitum* supply of aphids, *Aphis gossypii* and *Aphis craccivora*. Eggs were collected daily and stored in under the hatching temperature for the purpose the experiments. All experiments were performed in plastic Petri dishes (2.0cm height × 9.0cm diameter).

Experimental Design

Ten eggs (10-hour-old) of *M. sexmaculatus* were arranged in single straight line in a plastic Petri dish (2.0cm height × 9.0cm diameter). Thereafter, 1-day-old first instar of *P. dissecta* was released in the Petri dish and allowed to consume the eggs. After 24 hours, the first instar was removed from the Petri dish and the number of remaining eggs was counted to determine the number of eggs consumed by the first instar larva. The experiment was replicated ten times (n =10). The same experiment was repeated using *M. sexmaculatus*. The same experiment was repeated to second instar larvae, third instar larvae, and fourth instar larvae, male and female *M. sexmaculatus* and *P. dissecta*. The data on egg consumption was subjected to t-test using the statistical software, MINITAB -13.0. The data were further subjected to Two-way ANOVA using (i) species and (ii) stage as dependent variables and IGP as independent variables.

Results

The first instar of *P. dissecta* significantly preferred eggs of *M. sexmaculatus*. Similarly, first instar of *M. sexmaculatus* significantly preferred eggs of *P. dissecta* ($t = 2.17$; $p = 0.02$) (Table1; Fig. 1). The second instar of *P. dissecta* did not significantly prefer the eggs of *M. sexmaculatus* after 24 hours of exposure, and similarly, second instar of *M. sexmaculatus* did not significantly prefer the eggs of *P. dissecta* ($t = 1.03$; $P = 0.15$). The third instar of *P. dissecta* did not significantly prefer the eggs of *M. sexmaculatus* after 24 hours of exposure, and similarly, third instar of *M. sexmaculatus* did not significantly prefer the eggs of *P. dissecta* (t = 0.42;

P = 0.33). The fourth instar of *P. dissecta* did not significantly prefer the eggs of *M. sexmaculatus* after 24 hours of exposure, and similarly, fourth instar of *M. sexmaculatus* did not significantly prefer the eggs of *P. dissecta* (t=0.29; P =0.38). Adult male of *P. dissecta* did not significantly prefer the eggs of *M. sexmaculatus* after 24 hours exposure, and similarly, adult male of *M. sexmaculatus* did not significantly prefer the eggs of *P. dissecta* (t = 1.23; P = 0.11). Adult female of *P. dissecta* significantly prefer the eggs of *M. sexmaculatus* after 24 hours exposure, and similarly, adult male of *M. sexmaculatus* significantly prefer the eggs of *P. dissecta* (t = 2.84; p = 0.54). Two Way ANOVA revealed a significant main effect of 'stage' on the cannibalism (F = 31.92; P<0.001; d.f. = 1). The main effect of 'species' was not statistically significant (F = 1.41; P = 0.237; d.f. = 1) Interaction between 'species' and 'stage', however, was found to be statistically significant (F = 4.65; P<0.01; d.f. = 1, 119).

Table 1 Data showing the number of eggs consumed by different predatory stages of ladybirds, *Propylea dissecta* and *Menochilus sexmaculatus.*

S. No.	Predatory stage	*Propylea dissecta*	*Menochilus sexmaculatus*	T-value
1	First instar	2.10 ± 1.31 a	3.50 ± 1.04 b	2.17; P < 0.01
2	Second instar	5.00 ± 1.62 a	6.00 ± 1.25 a	1.03; P = 0.15
3	Third instar	8.80 ± 1.27 a	8.50 ± 1.23 a	0.42; P = 0.33
4	Fourth instar	6.90 ± 1.34 a	6.60 ± 1.62 a	0.29; P = 0.38
5	Adult male	9.00 ± 1.19 a	8.20 ± 1.21 a	1.23; P = 0.11
6	Adult female	3.90± 1.31 a	6.20 ± 1.37 b	2.84; P < 0.01

Data are Mean ± S.D Different letters on the same rows means that the data is statistically significant

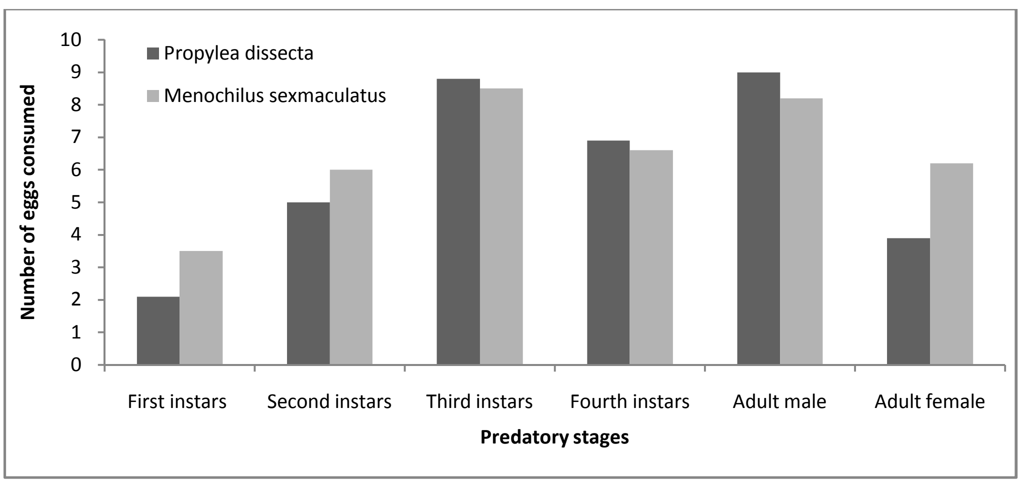

Figure 1 Figure showing egg predation by heterospecific ladybirds.

Discussion

The results reveal that albeit first instars of both *P. dissecta* and *M. sexmaculatus* were attacking and consuming heterospecific eggs, the former ate significantly lesser eggs of the latter. This is so because the eyes and sensory organs are less developed in first instars. After hatching, the first instars were very hungry and hence, they could not distinguish between the conspecific and heterospecific eggs. So they feed on heterospecific eggs. Ladybird larvae, especially the neonates, have poorly developed eyes and do not appear to use visual stimuli in prey recognition (Dixon, 2000). Older larvae, viz. second, third and fourth instars alongwith and adult male of both *P. dissecta* and *M.*

sexmaculatus showed similar intraguild predation habits as egg consumption did not vary significantly.

Two way ANOVA revealed that there was a significant main effect of stage on cannibalism. This shows that all larval instars along with adult male and female behaved differently in terms of egg predation. That is, in terms of magnitude these predatory stages differently indulged in egg predation. However, the main effect of 'species' did not vary significantly, which reveals that both *P. dissecta* and *M. sexmaculatus* approached similarly towards egg predation. Nevertheless, our results reveal that *M. sexmaculatus* is more voracious than *P. dissecta* and showed no reluctance in consuming heterospecific eggs. Hence, we conclude that *M. sexmaculatus* could act as intraguild predator in the absence of natural prey, i.e., aphids, and can easily attack heterospecific eggs, which could be the reason for its successful establishment and cosmopolitan distribution.

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References

De Clercq P, Bonte M, van Speybroeck K, Bolckmans K and Deforce K (2005) Development and reproduction of *Adalia bipunctata* (Coleoptera: Coccinellidae) on eggs of *Ephestia kuehniella* (Lepidoptera: Phycitidae) and pollen. *Pest Manag. Sci.* 61: 1129-1132.

Dixon AFG (2000) Insect predator-prey dynamics. Ladybird beetles and biological control. *Cambridge,* Cambridge University Press. pp. 257.

Gagné I, Coderre D and Mauffette Y (2002) Egg cannibalism by *Coleomegilla maculata lengi* neonates: preference even in the presence of essential prey. *Ecol. Entomol*. 27: 285-291.

Hemptinne JL, Magro A, Saladin C and Dixon AFG (2011) Role of intraguild predation in aphidophagous guilds. *J. Appl. Entomol*. 13: 161-170.

Hemptinne JL, Lognay G, Gauthier C and Dixon AFG (2000) Role of surface chemical signals in egg cannibalism and intraguild predation in ladybirds (Coleoptera: Coccinellidae). *Chemoecology* 10: 123-128.

Lucas E (2005) Intraguild predation among aphidophagous predators. *Eur. J. Entomol*. 102: 351-364.

Lucas E, Coderre D and Brodeur J (1998) Intraguild predation among three aphid predators: Characterization and influence of extra-guild prey density. *Ecology* 79: 1084-1092.

Michaud JP and Grant AK (2004) Adaptive significance of sibling egg cannibalism in Coccinellidae: comparative evidence from three species. *Ann. Entomol. Soc. Am*. 97: 710-719.

Michaud JP and Jyoti JL (2008) Dietary complementation across life stages in the polyphagous lady beetle *Coleomegilla maculata*. *Entomol. Exp. Appl*. 126: 40-45.

Omkar and Pervez A (2003) Ecology and biocontrol potential of a scale-predator, *Chilocorus nigritus. Biocontrol Sci. Techn.* 13(4): 379-390.

Omkar and Pervez A (2004) Predaceous coccinellids in India: Predator-prey catalogue. *Oriental Insects* 38: 27-61.

Omkar, Mishra G and Pervez A (2002) Intraguild predation by ladybeetles: An ultimate survival strategy or an aid to advanced aphid biocontrol? *Prof. S.B. Singh Commemoration Volume of ZSI*. pp. 77-90.

Omkar, Pervez A and Gupta AK (2004) Role of surface chemicals in egg cannibalism and intraguild predation by neonates of two aphidophagous ladybirds, *Propylea dissecta* and *Coccinella transversalis*. *J. Appl. Ent.* 128: 691-695.

Omkar, Pervez A and Gupta AK (2005) Attack, escape and predation rates of the larvae of two aphidophagous ladybirds during conspecific and heterospecific interactions. *Biocontrol Sci. Techn.* 13(3): 295-305.

Omkar, Pervez A and Gupta AK (2006) Why do neonates of aphidophagous ladybird beetles preferentially consume conspecific eggs in presence of aphids? *Biocontrol Sci. Techn.* 16: 233-243.

Pervez A, Gupta AK and Omkar (2006) Larval cannibalism in aphidophagous ladybirds: influencing factors, benefits and costs. *Biol. Contr*. 38: 307-313.

Pervez A and Omkar (2004a) Prey Dependent life attributes of an aphidophagous ladybird beetle, *Propylea dissecta* (Mulsant). *Biocontrol Sci. Techn.* 14(4): 385-396.

Pervez A and Omkar (2004b) Temperature dependent life attributes of an aphidophagous temperature dependent life attributes of an aphidophagous ladybird, *Propylea dissecta* (Mulsant). *Biocontrol Sci. Techn.* 14(6): 587-594.

Phoofolo W and Obrycki J (1998) Potential for intraguild predation and competition among predatory Coccinellidae and Chrysopidae. *Entomol. Exp. Appl.* 89: 47-55.

Polis GA, Myers CA and Holt RD (1989) The ecology and evolution of intraguild predation: potential competitors that eat each other. *Annu. Rev. Ecol. Syst* 20: 297-330.

Rieder JP, Newbold TAS, Sato S, Yasuda H and Evans EW (2008) Intraguild predation and variation in egg defence between sympatric and allopatric populations of two species of ladybird beetles. *Ecol. Entomol*. 33: 53-58.

Roy HE, Rudge H, Goldrick L and Hawkins D (2007) Eat or be eaten: prevalence and impact of egg cannibalism on two spot ladybirds, *Adalia bipunctata*. *Entomol. Exp. Appl*. 125: 33-38.

Sloggett JJ and Davis AJ (2010) Eating chemically defended prey: alkaloid metabolism in an invasive ladybird predator of other ladybirds (Coleoptera: Coccinellidae). *J. Exp. Biol*. 213: 237-241.

Sloggett JJ, Haynes KF and Obrycki JJ (2009) Hidden costs to an invasive intraguild predator from chemically defended native prey. *Oikos* 118: 1396-1404.

Snyder WE and Wise DH (1999) Predator interference and the establishment of generalist predator populations for biocontrol. *Biol. Contr*. 15: 283-292.

Symondson WOC, Sunderland KD and Greenstone MH (2002) Can generalist predators be effective biocontrol agents? *Annu. Rev. Entomol*. 47: 561-594.

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