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Potentiality of *Plastanoxus westwoodi* (Kieffer) (Hymenoptera: Bethylidae) against flat grain beetle, *Cryptolestes pusillus* (Schoenherr) (Coleoptera: Cucujidae)

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ABSTRACT: ***Plastanoxus westwoodi*** **(Kieffer), an ectoparasitoid of the larvae and pupae of flat grain beetle, *Cryptolestes pusillus* (Schoenherr), was evaluated experimentally by infesting 625g kibbled wheat in a plastic container with 100 pairs of the beetles and at 35 days after introducing 0, 5, 10, 20, 30, 40 and 50 mated females of the parasitoids. Samples taken 180 days after the parasitoid was introduced showed *P. westwoodi* had reduced the population growth of the beetle by at least 43.08% even when only 5 mated females were introduced and by 81.31% when 50 mated females were introduced. The pest emergence was very high in the control container. Minimum pest emergence and maximum parasitism were achieved by introducing 50 mated females per container.**

KEY WORDS: Biological control, *Cryptolestes pusillus,* parasitism, *Plastanoxus westwoodi*, suppression.

INTRODUCTION

Pest management in stored commodities is facing many obstacles such as restrictions on the use of certain chemical pesticides and pesticide resistance in pest populations (Philips *et al*., 2000). The use of insect parasitoids and predators to control stored product insect pests has many advantages over traditional chemical control methods. These natural enemies leave no harmful chemical residues. To date, 58 species of predators and parasitoids of 79 stored product insect pests have been studied (Scholler, 1998). Many of these species are widely distributed geographically, because they are being transported along with stored products.

The effect of releases of insect parasitoids and predators into warehouse situations to suppress or eliminate residual or active population of various stored product insect pests has been studied by several workers (Le Cato *et al*., 1977; Brower and Press, 1992; Flinn *et al*., 1996; Islam and Kabir, 1995; Ahmed and Khatun, 1996; Biswas *et al*., 2004; Schmale *et al*., 2006).

The flat grain beetle, *Cryptolestes pusillus* (Schoenherr) (Coleoptera: Cucujidae), is a serious cosmopolitan pest of stored product commodities. There are four distinct larval instars, one pre-pupal and one pupal stage in *C. pusillus*. The total developmental period takes 30-34 days for egg to adult emergence at 30 ± 0.5°C and 70% RH (Ahmed *et al*., 1994). It virtually feeds on all kinds of stored grains and milled cereal products and causes immense damage to stored wheat, flour and other stored commodities in all the tropical and subtropical countries of the world including Bangladesh (Dhaliwal, 1976; Hossain *et al*., 1986; Kirkpatrick and Cagle, 1978). The damage is caused both by the larval and adult stages (Cotton, 1963).

A number of bethylid parasitoids have been found in the storage ecosystem on stored product insect pests. *Plastanoxus westwoodi* (Kieffer) (Hymenoptera: Bethylidae) is a primary ectoparasitoid and lays eggs on the mature larvae, pre-pupae and pupae of *C. pusillus.* This parasitoid prefers the 4^{th} instar or mature host larva for parasitization and may play a vital role in the control of the insect pests. As a biological control tool, the potentiality of a parasitoid depends on its parasitising ability on the target pest and the dosage of release. No information is available on the potentiality of *P. westwoodi* against *C. pusillus*. The present research is aimed to establish the potentiality of the parasitoid in reducing or eliminating *C. pusillus* populations attacking different stored commodities.

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MATERIALS AND METHODS

Cryptolestes pusillus and the parasitoid *P. westwoodi* were collected from the stock cultures maintained in the Control Temperature (CT) room (30 ± 0.5°C), Integrated Pest Management (IPM) Laboratory, Institute of Biological Sciences, Rajshahi University, Bangladesh. To determine the parasitizing ability of *P. westwoodi*, 500g fresh kibbled wheat and 125g of whole wheat flour were taken in a round plastic container (22cm in height and 13cm in diameter). Two hundred agile mated females of *C. pusillus* were released into the container. Then the container was covered with fine meshed cloth and tightly fastened with a rubber band for proper ventilation. After 35 days, a huge number of 1st, 2nd, 3rd and 4th instar larvae, pre-pupae, pupae and adult progeny of *C. pusillus* were produced inside the containers. At this time, *P. westwoodi* was released into the containers @ 5, 10, 20, 30, 40 and 50 healthy mated female parasitoids separately. The 7th container was kept as control (without parasitoid). All the containers were kept in the laboratory for 180 days. The experiments were conducted during June-November 2005 at 27°–30° ± 1ºC and 70 ± 5 % RH. All the treatments were replicated 3 times.

The data on the percentage suppression of the pest, parasitism, host and parasitoid emergence and progeny production per female of the parasitoid were subjected to statistical analysis. Test results were analyzed statistically using linear regression and correlation. The percentage parasitism was determined according to the formula of Islam and Kabir (1995).

$$\text{Percentage of parasitism} = \frac{P.\ westwoodi}{C.\ pusillus + P.\ westwoodi} \times 100$$

RESULTS AND DISCUSSION

The efficacy of *P. westwoodi* against *C. pusillus* was 81.31% @ 50 mated female parasitoids and 43.08% @ 5 mated female parasitoids (Table 1). The percentage of suppression was positively correlated with the number of *P. westwoodi* introduced ($Y = 41.082 + 0.8183x$, $r = 0.995$) into the host population. The per cent suppression was significantly ($P \leq 0.01$, $F = 285.95$) affected by the number of parasitoids released. From the present results, it is evident that the per cent suppression gradually increased with an increase in the numbers of parasitoids released.

The progeny production by *P. westwoodi* is depicted in Table 1. The results showed an inverse correlation among the different introduction levels of the parasitoid ($Y = 175.32 - 0.8396x$, $r = -0.466$). The total parasitoid progeny production was significantly ($P \leq 0.01$, $F = 354.98$) affected by the number of parasitoids released. Odjo and Gaspar (1994) observed that *Dinarmus basalis* reduced 93% adult population of *Callosobruchus maculatus*. Press *et al.* (1984) recorded that *Anisopteromalus calandrae*

Table 1. Effect of release of *P. westwoodi* on mean per cent suppression, per cent parasitism and host emergence of *C. pusillus*

No. of parasitoids released	Total no. of parasitoid produced (Mean ± SE)	%		Progeny/ female (Mean ± SE)	Host emerged (Mean ± SE)	% Parasitism	% suppression (Mean ± SE)
		Male	Female				
5	173.58^{b} ± 8.17	42.33	57.67	34.71 ± 4.72	113.85 ± 2.29	60.39 ± 4.75	43.08^{f} ± 4.88
10	127.92^{e} ± 9.42	34.10	65.90	12.79 ± 1.63	98.26 ± 3.69	56.56 ± 2.35	50.87^{e} ± 3.69
20	205.26^{a} ± 7.45	32.45	67.55	10.26 ± 2.03	83.18 ± 2.54	71.16 ± 7.03	58.41^{d} ± 4.27
30	153.47^{c} ± 5.13	43.54	56.46	5.11 ± 1.19	68.95 ± 2.98	69.00 ± 2.39	65.53^{cd} ± 3.97
40	139.81^{d} ± 6.69	45.37	54.63	3.49 ± 1.72	51.75 ± 1.96	72.98 ± 7.03	74.13^{b} ± 5.09
50	121.74^{e} ± 2.98	51.25	48.75	2.43 ± 0.88	37.37 ± 3.08	76.51 ± 2.39	81.31^{a} ± 4.54
0 (Control)	--	--	--	--	1359 ± 92.87	--	--

Means within a column followed by the same letter indicate no significant difference at $P \leq 0.01$ by DMRT.

suppressed rice weevil (*Sitophilus oryzae*) population in wheat debris by about 95.3% at the release rate of 30, 40 and 50 pairs and 50% at the rate of 5 pairs. Islam and Kabir (1995) found that *D. basalis* suppressed 98% of *C. chinensis* population (ca 600 hosts) @ 50 pairs and 70% @ 5 pairs. These results are comparable with the results of the present investigation. Ahmed and Kabir (1995) found that 53% of *S. oryzae* and 54% of *Rhizopertha dominica* were suppressed by *A. calandrae* at the release rate of 20 mated female parasitoids.

Press *et al.* (1984) reported that single release of 50 pairs of *A. calandrae* suppressed 95.3% of residual populations of *S. oryzae* in wheat while Ahmed and Kabir (1995) reported 32.8% and 34.3% suppression of *S. oryzae* and *R. dominica,* respectively. Augmentative release of *Choetospila elegans* (Westwood) was observed to be very effective for suppressing *R. dominica* populations (Flinn *et al*. 1996). In field studies conducted by Flinn *et al*. (1996) to assess the effectiveness of *C. elegans* in controlling *R. dominica* populations in 1993 and 1994, the population suppression of *R. dominica* was 98% and 91%. The present findings are in agreement with those results. Schmale *et al*. (2006) observed that on small-scale farms in Colombia, bean weevil *Acanthoscelides obtectus* (Say) was controlled by *D. basalis* by 88-97%.

The number of progeny produced per female was minimum (2.43 ± 0.88) @ 50 mated females and it was maximum @ 5 mated females (34.71 ± 4.72). It was evident that progeny production gradually decreased with an increase in the number of parasitoids released. Female progeny production was highest (67.55%) when 20 female parasitoids were introduced (Table 1). The present result is similar to that of Press *et al.* (1984) who reported that the lowest number of progeny per female was at higher introduction levels and the highest number of progeny at lower level of introduction of the parasitoid, *D. basalis*. The reduction in progeny production at higher parasitoid release rate could have been due to superparasitism and higher mortality at immature stage.

Per cent parasitism was maximum (76.51 ± 2.39%) at the level of 50 mated females per container and minimum (56.56 ± 2.35%) at 10 mated females per container (Table 1). Per cent parasitism increased with increasing parasitoid density ($Y = 57.547 + 0.3956x$, $r = 0.895$) and it was significant ($P \leq 0.01$). The host emergence was very high in the control container (1359 ± 92.87) whereas the minimum host emergence (37.37 ± 3.08) was achieved by introducing 50 mated females (Table 1). The host emergence decreased with increasing density of parasitoids.

The present experiment advocates the suitability and efficacy of the parasitoid *P. westwoodi* to check the population of *C. pusillus*. It can be concluded that the population of *C. pusillus* could be suppressed by the parasitoid, *P. westwoodi* in grain storages and this parasitoid can be a strong component in an Integrated Pest Management (IPM) system.

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REFERENCES

Ahmed, K. N., Khatun, M. and Hannan, M. A. 1994. Notes on the life history of the flat grain beetle *Cryptolestes pusillus* (Schon.) (Coleoptera: Cucujidae). *Journal of Asiatic Society of Bangladesh Science*, **20**: 83-86.

Ahmed, K. N. and Kabir, S. M. H. 1995. Role of the ectoparasite, *Anisopteromalus calandrae* (Howard) (Hymenoptera: Pteromalidae) in the suppression of *Sitophilus oryzae* and *Rhyzopertha dominica*. *Entomon,* **20**: 175-182.

Ahmed, K. N. and Khatun, M. 1996. The biology of the ectoparasite *Plastanoxus westwoodi* (Kieffer) (Hymenoptera: Bethylidae) parasitizing flat grain beetle *Cryptolestes pusillus* (Schon.). *Bangladesh Journal of Scientific and Industrial Research*, **31**: 105-109.

Ahmed, K. S. 1996. Studies on the ectoparasitoid, *Anisopteromalus calandrae* (How.) (Hymenoptera: Pteromalidae) as a biocontrol agent against the lesser grain borer, *Rhyzopertha dominica* (Fab.) in Saudi Arabia. *Journal of Stored Product Research*, **32**: 137-140.

Biswas, L., Islam, W. and Mondal, K. A M. S. H. 2004. Potentiality of *Anisopteromalus calandrae* (Howard) and *Choetospila elegans* (Westwood) against the rice weevil, *Sitiphilus oryzae* (Linnaeus). *Journal of Biological Control*, **18**: 141-145.

Brower, J. H. and Press, J. W. 1992. Suppression of residual populations of stored-product pests in empty corn bins by releasing the predator *Xylocoris flavipes* (Reuter). *Biological Control,* **2**: 66-72.

Cotton, R. T. 1963. *Pests of stored grain and grain products*. Burgess Co., 318p.

Dhaliwal, G. S. 1976. Intensity of insect infestation under rural storage conditions in Punjab. *Entomologist's Newsletter*, **6**: 49-50

Flinn, P. W., Hagstrum, D. W. and Mc Gaughey, W. H. 1996. Suppression of beetles in stored wheat by augmentative releases of parasitic wasps. *Environmental Entomology*, **25**: 505-511.

Hossain, M., Verner, P. H. and Rezaur, R. 1986. Taxonomic descriptions of the mature larvae of six species of *Cryptolestes* (Coleoptera: Cucujidae). *Bangladesh Journal of Zoology*, **14**: 139-148.

Islam, W. and Kabir, S. M. H. 1995. Biological control potential of *Dinarmus basalis* (Rond.) (Hymenoptera: Pteromalidae), a larval-pupal ectoparasitoid of the pulse beetle *Callosobruchus chinensis* (L.). *Crop Protection*, **14**: 439-443.

Kirkpatrick, R. L. and Cagle, A. 1978. Controlling insects in bulk wheat by infrared radiation. *Journal of Kansas Entomological Society*, **51**: 386-376.

Le Cato, G. L., Collins, J. W. and Arbogast, R. T. 1977. Reduction of residual populations of stored product insects by *Xylocoris flavipes* (Hemiptera: Anthocoridae). *Journal of Kansas Entomological Society*, **50**: 84-88.

Odjo, T. A. A. and Gaspar, C. 1994. Biological control of *Callosobruchus maculatus* F. (Coleoptera: Bruchidae) using *Dinarmus basalis* Rond. (Hymenoptera: Pteromalidae). *Mededelingen Faculteit L and bouwkundige en Toegepaste Biologische Wetenschappen Universite it Gent* (Belgium), **59**: 451-456.

Phillips, T. W., Berberet, R. C. and Cuperus, G. W. 2000. Post-harvest integrated pest management, pp. 2690-2701. In: Francis, F. J. (Ed.), *Encyclopedia of Food Science and Technology*, 2nd ed. Wiley, New York.

Press, J. W., Cline, L. D. and Flaherty, B. R. 1984. Suppression of residual populations of the rice weevil, *Sitophilus oryzae* by the parasitic wasp, *Anisopteromalus calandrae*. *Journal of Georgia Entomological Society*, **19**: 110-113.

Schmale, I., Wackers, F. L., Cardona, C. and Dorn, S. 2006. Biological control of the bean weevil, *Acanthoscelides obtectus* (Say) (Col.: Bruchidae), by the native parasitoid *Dinarmus basalis* (Rondani) (Hym.: Pteromalidae) on small-scale farms in Colombia. *Journal of Stored Product Research*, **42**: 31-41.

Scholler, M. 1998. Biologische Bekampfung vorratschadlicher Artropoden mit Rauberm und Parasitoiden-Sammelbericht und Bibliographie, pp. 85-189. In: Reichmuth, Ch. (Ed.), 100 Jahre Pflanzenschutzforschung. Wichtige Arbeitsschwerpunkte im Vorratsschutz. Mitteilungen aus der Biologischen Bundesanstalt fur Land-und Forstwirtschaft, Heft 342. Parey, Berlin.

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