

# Parasitoids of the African wild silkworm, *Gonometa postica* (Lepidoptera: Lasiocampidae) in the Mwingi forests, Kenya

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## Keywords

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## Abstract

*Gonometa postica* Walker produces silk of high quality, but it is affected by parasitoids attack. A study on the parasitism of *G. postica* larvae and pupae on host and non-host plants were undertaken for the first and second generations, corresponding to the long (March–May) and short (October–December) rainy seasons in 2006 at six field sites, three each in the Imba and Mumoni forests of Mwingi, eastern Kenya. All freshly spun cocoons of *G. postica* were sampled at each site from a total of 100 trees of host plants and other non-host plants where they have migrated before pupation. The cocoons were kept individually in fine net-sealed plastic vials to determine percentage parasitism. Two dipterans and four hymenopteran larval–pupal parasitoids were identified from the two forests. The most common parasitoids were *Palexorista* sp. (Diptera: Tachinidae) and *Goryphus* sp. (Hymenoptera: Ichneumonidae) with parasitism ranging from 1.8 to 32.7% and 2.2 to 7.5%, respectively. Parasitism varied significantly according to host or non-host plants, seasons and sites. This study indicates that, of the six parasitoid species recovered, only two had a significant impact in reducing the quality of the cocoons.

## Introduction

*Gonometa postica* Walker (Lepidoptera: Lasiocampidae) is currently the species being utilized for commercial wild silk production in Mwingi, Kenya (Kioko et al. 2007; Fening et al. 2008). It produces high-quality silk, comparable to that of the domesticated silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) (Kioko et al. 2000; Raina and Kioko 2000; McGeoch 2002; Veldtman et al. 2007; Ngoka et al. 2008).

One of the factors that limit commercial silk production is attack of parasitoids, which causes a significant reduction in the abundance of cocoons (Hartland-Rowe 1992; Ngoka 2003; Veldtman et al. 2004; Kioko et al. 2007). Also exit holes left in cocoons by adult parasitoids render them unsuitable for degumming and spoil the continuity of silk filament during reeling (Kioko 1998; Veldtman et al. 2004).

The studies by Kioko (1998) and Ngoka (2003) provided general information on the natural enemies

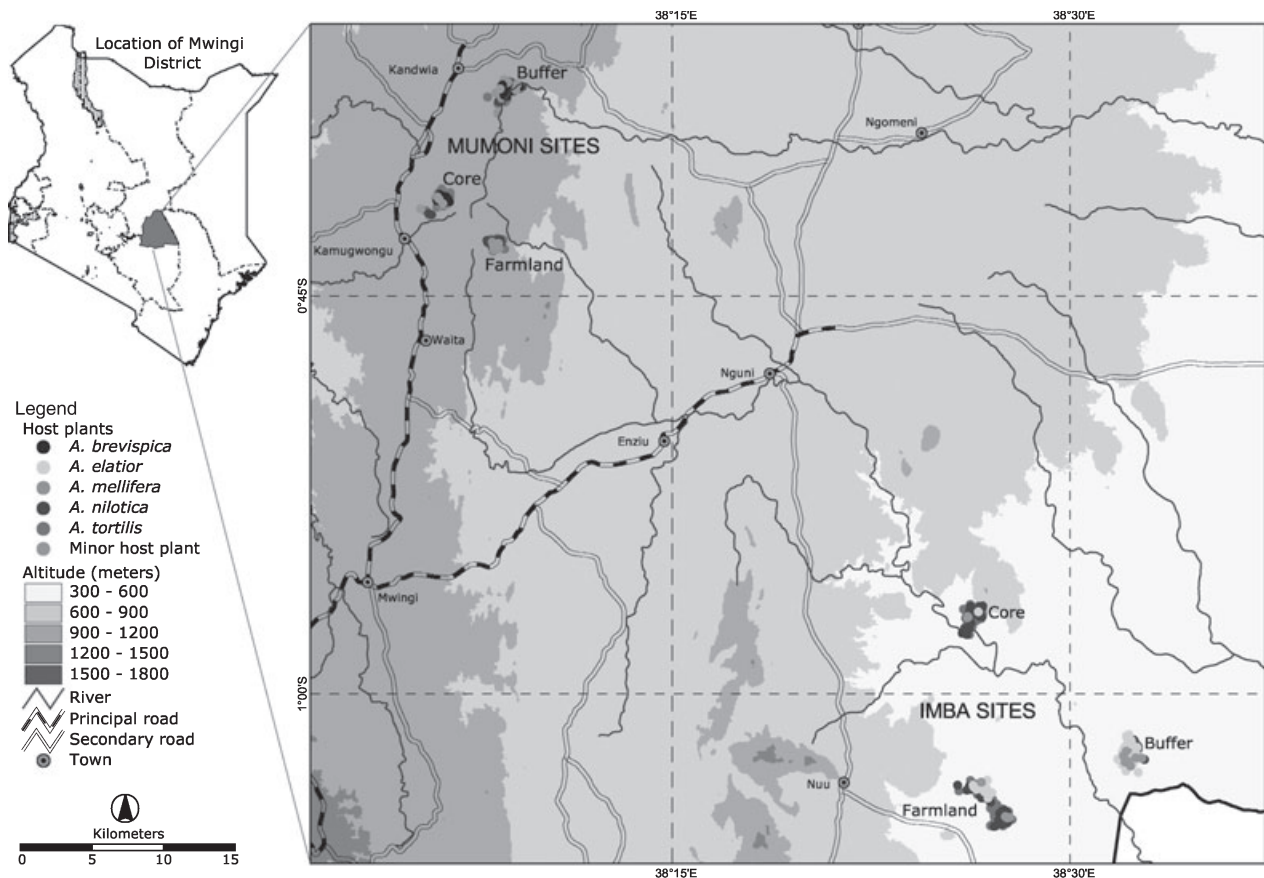
and parasitism rates of the different stages of *G. postica* in Kenya.

The current study focuses on the larval–pupal parasitoids of *G. postica* in the Imba and Mumoni forests of Mwingi, Kenya. This study seeks to assess the impact of parasitoids on the quality of *G. postica* cocoons in the Imba and Mumoni forests of Mwingi, Kenya.

## Materials and Methods

### Study sites

The study was carried out in 2006 in the Imba and Mumoni forests of Mwingi district in eastern Kenya (fig. 1), during the long rains of March–May and short rains between October and December corresponding to, respectively, the first and second generations of wild silkworms. In each forest, three sites were selected [i.e. site 1 (0°51'S, 38°22'E), site 2 (0°50'S, 38°22'E) and site 3 (0°50'S, 38°23'E) in the Imba forest, and site



**Fig. 1** Map of Kenya showing the study sites in Mumoni and Imba forests of Mwingi. Source: Fening et al. (2008).

1 (0°36'S, 38°1'E), site 2 (0°34'S, 38°2'E) and site 3 (0°32'S, 38°0'E) in the Mumoni forest]. Distances between sites within a forest were > 1 km. The sites were chosen systematically to reflect the different forest zones (Fening et al. 2008) and the availability of 40 or more *G. postica* cocoons per site was a prerequisite for selection (Veldtman et al. 2007).

#### Parasitism rates of *G. postica*

In each forest, three sites were selected. One hundred host and other non-host plants of *G. postica* were randomly sampled in each site and all trees were inspected for presence of *G. postica* cocoons. Non-host plants were referred to plants that *G. postica* larvae do not feed on but are used for pupation (Veldtman et al. 2004; Fening et al. 2008). Thus, *G. postica* cocoons were normally seen on both host and non-host plants. The cocoons were kept individually in plastic vials (13 × 11 cm) covered with a fine mesh (400 micron), labelled and kept until adult moth or parasitoid emerges. The sex ratio of the parasitoids was computed as the proportion of

females. The identification of dipteran parasitoids was carried out using Crosskey (1984) keys to the genera of Tachinidae at the Biosystematics unit of the International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya and voucher specimens were kept in their insect museum and the National Museum of Kenya. The Hymenopteran parasitoids were sent to Gerard Delvare of the Agricultural Research Centre for International Development (CIRAD) in France for their identification.

Sampling was done weekly from the three sites at each forest during the study period. The percentage parasitism ( $P_i$ ) for each parasitoid species was calculated for the actual stage(s) of the host attacked using the formula proposed by van Driesche (1983):

$$P_i = \frac{\sum_{t=0}^T P_{it}}{\sum_{t=0}^T d_{it}}$$

where  $d_{it}$  is the number of the susceptible hosts in stage  $i$  at week  $t$ ,  $P_{it}$  is the number of parasitised hosts  $i$

at time  $t$ , and  $T$  is total weeks. For each species, parasitism was averaged across host plant species for determination of the key parasitoids in each forest. In addition, parasitism of the key species was calculated for the different host and non-host plants in the two forest sites. Dead cocoons of *G. postica* were dissected to determine unsuccessful parasitism if any.

### Data analysis

The percentage parasitism of the different species of parasitoids on the different host and non-host plants was compared between the two generations within each forest by using Mann–Whitney  $U$ -test ( $\alpha = 0.05$ , SAS Institute Inc. 2001). Kruskal–Wallis test ( $\alpha = 0.05$ ) was used to compare the parasitism among the different species of parasitoids and host plants within each generation. When the Kruskal–Wallis test showed significant differences ( $P = 0.05$ ), multiple comparisons was conducted using the Nemenyi test ( $\alpha = 0.05$ , Zar 1999).

## Results

### Diversity of parasitoids and parasitism of *G. postica*

Two dipteran (the tachinids *Palexorista* sp. and *Pimelomyia semitestacea* Villeneuve) and four hymenopteran (the ichneumonids *Pimpla (Apechtis)* sp., and *Goryphus* sp., the eurytomid *Eurytoma tolidpepra* Delvare, and the chalcidid *Brachymeria* nr. *albicus* Klug) parasitoids were identified from the two forests. Five species of parasitoids (*Pimpla* sp.,

*E. tolidpepra*, *P. semitestacea*, *Palexorista* sp. and *Goryphus* sp.) were collected in the Imba forest and three (*Palexorista* sp., *Goryphus* sp. and *Brachymeria* sp.) in the Mumoni forest (table 1). All the parasitoids identified in this study were found to attack the mature larvae of *G. postica* but emerged from the pupal stage (enclosed in a silken cocoon), thus referring to them as larval–pupal parasitoids.

In the Imba forest, *Palexorista* sp. was the predominant species for both generations followed by *Goryphus* sp. (d.f. = 1,  $\chi^2 = 9$ ,  $P < 0.005$ ; d.f. = 4,  $\chi^2 = 12.70$ ,  $P < 0.025$ ) (table 1). Parasitism by *Palexorista* sp. was significantly higher (d.f. = 1,  $\chi^2 = 9$ ,  $P < 0.005$ ) for the first than that of the second generation in Imba. In the Mumoni forest, parasitism of *Goryphus* sp. on *G. postica* was significantly higher (d.f. = 2,  $\chi^2 = 7.20$ ,  $P < 0.05$ ) than that of *Brachymeria* sp. for the second generation.

Parasitism by *Palexorista* sp. was significantly higher (d.f. = 3,  $\chi^2 = 8.775$ ,  $P < 0.05$ ) on *A. tortilis* than on the non-host plants for the second generation cocoons in Imba (table 2). In the Imba forest, parasitism of *G. postica* by *Palexorista* sp. was significantly higher (d.f. = 1,  $\chi^2 = 9$ ,  $P < 0.005$ ) for the first than that of second generation for cocoons collected from all host and non-host plants. In Mumoni, *Palexorista* sp. was only obtained from cocoons collected from *A. tortilis* and was similar for both generations (d.f. = 1,  $\chi^2 = 3$ ,  $P > 0.05$ ).

For the first generation cocoons in Imba forest, parasitism by *Goryphus* sp. was significantly higher (d.f. = 2,  $\chi^2 = 7.20$ ,  $P < 0.05$ ) on *A. tortilis* than on *A. elatior* (table 3). In the Imba forest, parasitism of

**Table 1** Mean ( $\pm$  SE) percentage parasitism of *G. postica* larvae in Imba and Mumoni forest of Mwingi by different parasitoids, first and second generations, corresponding to the long and short rainy seasons, 2006

Order	Family	Species	Mean parasitism* (%) $\pm$ SEM			
			Imba forest		Mumoni forest	
			First generation	Second generation	First generation	Second generation
Diptera						
	Tachinidae	<i>Palexorista</i> sp.	32.65 $\pm$ 5.48 aA	8.37 $\pm$ 0.88 bA	4.17 $\pm$ 1.15 aA	1.80 $\pm$ 0.32 bAB
		<i>Pimelomyia semitestacea</i>	0.00 $\pm$ 0.00	2.53 $\pm$ 0.66 AB	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Hymenoptera						
	Ichneumonidae	<i>Goryphus</i> sp.	2.96 $\pm$ 0.14 aB	4.33 $\pm$ 0.85 aAB	2.15 $\pm$ 0.63 aA	7.50 $\pm$ 1.86 aA
		<i>Pimpla (Apechtis)</i> sp.	0.00 $\pm$ 0.00	0.27 $\pm$ 0.06 B	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
	Eurytomidae	<i>Eurytoma tolidpepra</i>	0.00 $\pm$ 0.00	1.48 $\pm$ 0.16 AB	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
	Chalcididae	<i>Brachymeria</i> nr. <i>albicus</i>	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.49 $\pm$ 0.14 B

Means within a column followed by the same capital letter (Kruskal–Wallis test) and within a row and forest followed by the same lower case letter (Mann–Whitney  $U$ -test) are not significant at  $P = 0.05$ .

\*Mean parasitism (%) was calculated from cocoons collected from all three sites and all host plants in Imba and Mumoni forests of Mwingi.

Host plant species	Mean parasitism (%) ± SEM			
	Imba forest		Mumoni forest	
	First generation	Second generation	First generation	Second generation
<i>A. tortilis</i>	27.90 ± 5.67 aA	9.73 ± 1.28 bA	5.77 ± 0.58 a	6.28 ± 1.08 a
<i>A. nilotica</i>	28.33 ± 6.01 aA	5.87 ± 0.83 bAB	0.00 ± 0.00	0.00 ± 0.00
<i>A. elatior</i>	23.70 ± 2.54 aA	6.70 ± 1.81 bAB	–	–
Non-host plants	50.67 ± 3.31 aA	2.77 ± 0.28 bB	0.00 ± 0.00	0.00 ± 0.00

Means within a column followed by the same capital letter (Kruskal–Wallis test) and within a row and forest followed by the same lower case letter (Mann–Whitney *U*-test) are not significant at  $P = 0.05$ .

Host plant species	Mean parasitism (%) ± SEM			
	Imba forest		Mumoni forest	
	First generation	Second generation	First generation	Second generation
<i>A. tortilis</i>	6.20 ± 1.19 aA	8.93 ± 2.14 aA	1.73 ± 0.48 aA	5.53 ± 0.55 aA
<i>A. nilotica</i>	0.00 ± 0.00	1.10 ± 0.10 B	0.00 ± 0.00	0.00 ± 0.00
<i>A. elatior</i>	0.70 ± 0.13 aB	3.00 ± 0.46 aAB	–	–
Non-host plants	1.97 ± 0.48 AB	0.00 ± 0.00	1.13 ± 0.30 aA	9.53 ± 0.87 aA

Means within a column followed by the same capital letter (Kruskal–Wallis test) and within a row and forest followed by the same lower case letter (Mann–Whitney *U*-test) are not significant at  $P = 0.05$ .

the second generation cocoons by *Goryphus* sp. was significantly higher (d.f. = 2,  $\chi^2 = 7.20$ ,  $P < 0.05$ ) on *A. tortilis* than on *A. nilotica*.

## Discussion

Most parasitoid species (except *E. tolidepepra*) recorded in this study have been reported by previous workers in Southern Africa (Hartland-Rowe 1992; Veldtman et al. 2004; Veldtman and McGeoch, 2004). Okelo (1972) identified the ichneumonid, *Pimpla mahalensis* (Gribodo) as a larval parasitoid of *Gonometa podocarpi* Aurivillius in East Africa. *Goryphus* sp. was reported in Kenya by Raina and Kioko (2000) to attack *G. postica* and emerged from field-collected cocoons. *Palexorista* sp. is among the key parasitoids of *G. postica* recorded in both forests, and *P. semitestacea* was the third most important parasitoid from the present study. Earlier studies by Cuthbertson and Munro (1941), Taylor (1961), Crosskey (1984), Hartland-Rowe (1992), Peigler (1994) and Veldtman et al. (2004) described *P. semitestacea* and *Palexorista* sp. as the two most important dipteran parasitoids attacking *G. postica* and *G. rufobrunnea* larvae in Southern Africa.

**Table 2** Mean ( $\pm$  SE) percentage parasitism of *G. postica* larvae by *Palexorista* sp. in Imba and Mumoni forests of Mwingi, first and second generations, corresponding to the long and short rainy seasons, 2006

**Table 3** Mean ( $\pm$  SE) percentage parasitism of *G. postica* larvae by *Goryphus* sp. in Imba and Mumoni forests of Mwingi, first and second generations, corresponding to the long and short rainy seasons, 2006

The current work has shown that generally parasitism of *G. postica* by *Palexorista* sp. and *Goryphus* sp. is widespread on *A. tortilis* than some of the host and non-host plants. This observation might be due to the fact that *A. tortilis* is the most abundant host plant of *G. postica* in the two forests and harbours greater population of *G. postica* larvae and pupae (Fening et al. 2008).

Parasitism by *Palexorista* sp. was high on *A. tortilis* and low on the non-host plants during the second generation in Imba. Thus, by pupating on non-host plants, the larvae very likely escaped parasitism, which indicates that parasitoids either attack the larvae before they move to the non-host plants or the non-host plant disrupts the searching ability of the parasitoids (Guildford 1992; Veldtman et al. 2007).

The current study recorded a parasitism of 0.3–32.7% from field-collected cocoons of *G. postica*. Earlier work by Hartland-Rowe (1992) in South Africa has shown that larval parasitoids caused 30% mortality in late larval instars of *G. rufobrunnea*. A similar study also established that larval parasitoids of *G. postica* and *G. rufobrunnea* resulted in a median parasitism of about 30% at the sampled locations in South Africa (Veldtman et al. 2004).



Finally, this study has identified six parasitoids of *G. postica* in the forests of Mwingi, eastern Kenya and only two of them had a significant impact in reducing the quality of *G. postica* cocoons. As these key parasitoids were recovered in both forests and generations, their possible role in regulating the natural population of *G. postica* may be vital, as attacked larvae although pupate, fail to enclose. The results obtained from this study offer baseline information on the key parasitoids, which is a prerequisite for devising any management programme so as to boost the quality of cocoons.

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