Studies on the biology of *Deanolis sublimbalis* Snellen (Lepidoptera, Pyralidae) and its natural enemies on mango in Papua New Guinea

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Abstract: Untersuchungen zur Biologie und den natürlichen Feinden von *Deanolis sublimbalis* SNELLEN (Lepidoptera, Pyralidae) an Mango in Papua New Guinea.

An vier Standorten in der Central Province von Papua Neuguinea wurde *D. sublimbalis* untersucht. Eier wurden fast immer am Fruchtstiel unter vertrockneten Blütenblättern abgelegt, meist zu 2-4. Eiablage auf die Früchte war sehr selten. Larven wurden in den Früchten von *Mangifera indica, M. minor* und *M. odorata* gefunden, nie an den anderen Anacardiaceen *Spondias* spp. und *Anacardium occidentale* oder den Myrtaceen *Syzygium* spp. Im Labor entwickelten sich in Früchten von *A. occidentale* (Cashew-Baum) nur 5 % der Larven zur Imago. Präpuppen und Puppen wurden nur unter der Rinde der Mangobäume gefunden oder in tiefen Rissen der Rinde. Parasitoide oder Pathogene der Eier oder Larven wurden nicht festgestellt. Die Prädatoren, wie die Weberameise *Oecophylla smaragdina* (F.), spielten bei *D. sublimbalis* keine Rolle.

Key words: Mango, PNG, *Deanolis sublimbalis*, Eiablage, Diapause, Wirtspflanzen, natürliche Feinde

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Deanolis sublimbalis SNELLEN (Lepidoptera: Pyralidae), the red banded mango caterpillar (RMBC), is a Southeast Asian insect species. It is now widely distributed throughout this region (India, Burma, Thailand, China, Brunei, Philippines, Indonesia, and Papua New Guinea) and was recently detected for the first time on mainland Australia, but so far has not been recorded in Pakistan, Nepal, and Malaysia (WATERHOUSE 1998). In Papua New Guinea (PNG) it is nowadays widely distributed throughout the mainland and islands (WATERHOUSE 1998). Although infestation levels of 40 – 50 % were recorded in the Philippines (TIPON 1979), very little is known about the biology of this pest, and there are only few references in the literature, the results differing significantly (WATERHOUSE 1998). Due to the contradictory opinions on the biology published, the following study was undertaken to obtain the basic information required for the development of an appropriate management technique for this pest. In particular, the fundamental data to clarify in the course of this study were: 1. life history and behaviour of RMBC, especially when mango is out of season. 2. search for other host plants of RMBC. 3. search for natural enemies of RMBC.

Material and methods

The Central Province of Papua New Guinea (PNG), has an average annual rainfall of 1,000 to 1,200 mm. The rainy season starts usually by the end of November and lasts until April. The flowering of mango starts in July, and fruits are harvested from October through until the mid of December. Field studies took place at four orchards in the coastal lowland zone of the Central Province, 25 to 120 km away from Pt. Moresby (Launakalana, Laloki, Tahira and a mango plantation of the Pacific Adventist University, PAU). The main mango variety grown in all areas was 'Kensington Pride', and no insecticides were used in the plantations during and before the study period, i.e. 2000 to early 2003. Studies in the laboratory were conducted at Port Moresby.

Oviposition. Fruits, leaves and twigs were regularly checked for oviposition sites and number of eggs laid during the 2001 season at Laloki, PAU and Tahira.

Pupation sites. The upper layer of soil (5 cm) and the litter under two randomly chosen heavily infested trees at Tahira and one at Laloki were checked on a monthly basis from October to December 2001 during mango fruiting for the presence of pre-pupae and pupae of RMBC. At each sampling time, ten m^2 around each tree were randomly chosen by placing a frame (1 x 1 m) on the ground. The covered area was then searched for pupae of Lepidoptera. No pupae were found.

Emergence. Fruits both on the tree or fallen to the ground were visually inspected for the presence of boreholes. Those with boreholes were examined for the presence of lepidopteran pupae. If found, pupae were taken into the laboratory to allow emergence of adults. Sampling was done during the 2001 mango season at Laloki, PAU and Tahira. Trees: During the 2002 mango season the bark on the trunk and branches of infested trees at Tahira and Laloki were regularly checked for the presence of pre-pupae and pupae of RMBC. The pupal stages were collected and taken into the laboratory where they were treated to allow emergence of adults.

Behaviour during mango off-season. To study the behaviour during the period when there is no mango fruit on the trees, the bark on the trunk of infested trees at Tahira and Laloki were examined towards the end of the 2002 mango season for the presence of pre-pupae and pupae of RMBC. In total 100 pupation sites were located and marked, and again visited during off-season in March 2003 to check the cocoons for emergence holes of adult moths. In addition, 100 prepupae and pupae were collected towards the end of the mango season 2002 and taken into the laboratory where they were placed on a layer of sawdust in plastic vials (3.5 x 10cm) closed with insect gauze to determine emergence of adults during off-season.

Host plants. Fruits of the following trees growing around Pt. Moresby were regularly monitored for boreholes and the presence of RBMC larvae during their fruiting seasons: *Spondias* spp. (umbrella apple, yellow and purple mombins) (Anacardiaceae), *Anacardium occidentale* L. (cashew) (Anacardiaceae), and *Syzygium* spp. (water apples, like *S. carolinense*) (Myrtaceae). In addition, trees of *Mangifera minor* and *M. odorata* were visited to confirm earlier findings that these species are hosts for RBMC (WATERHOUSE 1998). To determine the suitability of the fruits *Anacardium occidentale* and *Syzygium* spp. as alternative hosts for RMBC, field collected 1^{st}- and 2^{nd} instars of RBMC (100 per plant) were placed into boxes (12 x 6 cm) (5 larvae in each box) and provided with fruits of the test plants to allow emergence of adults.

Natural enemies of RMBC.

Parasitoids: To identify larval/pupal parasitoids of RBMC, larvae were collected in the field and kept singly in transparent plastic vials closed with insect gauze (10 x 3.5 cm) in the laboratory at an average temperature of 24^o C and 60 – 70 % relative humidity, to observe emergence of parasitoids. RBMC-eggs were collected in the field and singly kept in the laboratory (24^o C, 60 – 70 % RH) in glass vials (1 x 5cm) until emergence of the larvae, to test for egg-parasitoids.

Pathogens: To identify bacteria, fungi or viruses attacking RBMC, field collected larvae were kept in the laboratory using the same method as described for larval/pupal parasitoids and regularly checked for typical signs of viruses and bacteria attacks or the presence of fungal spores/mycelium.

Predators: Predators were collected using the beating method and pitfall traps at Launakalana and PAU. In addition, visual observations were made when visiting the study sites. The detailed results are presented and discussed in KRULL & BASEDOW (in prep.).

Results

Oviposition. In total, 156 egg laying sites were found and their location on the trees and the number of eggs were recorded. The eggs were laid in small crevices (preferably dried anthraknose spots) on the peduncle, on non fruiting vegetative branches close to the fruit, or on the fruit itself. Marble sized fruit were preferred sites for oviposition, while only a few eggs were recorded on mature fruits. No eggs were recorded on the leaves. As Table 1 shows the majority of the eggs (69.9 %) were laid at the peduncle at the base of the fruit under dried sepals. Uncovered eggs laid at the same spot accounted for 17.9 %, while only a few were found at the other spots. Eggs were preferably laid in groups of two, although single egg-laying and bigger egg masses (up to 14 eggs) were also recorded. RBMC larvae usually enter the fruit through one borehole, which is typically made into the lower half of the fruit. Boreholes close to the peduncle are not caused by RBMC but by another caterpillar, probably *Cryptoblabes* sp. (Lep., Pyralidae).

Pupation sites. Pre-pupae and pupae of RMBC were found in the bark on the trunks of every RBMC infested tree examined at both locations studied. To pupate, the larvae bore deep into the bark (1-2 cm) and

close the entrance hole with chewed bark particles, which left them completely invisible. Other pupation sites were deep crevices in the bark. The identification was simple, since many of them were found in the pre-pupal stage, during which the larvae turn bluish. No pre-pupae or pupae of RMBC or of any other lepidopteran species were found in the surface layer of soil, litter or in the fruit, at either location.

Behaviour during mango off-season. When the pupation sites were visited again in March 2003, no holes in the cocoons were visible. This indicates that none of the pupae had emerged as adult moths. Out of the 100 pupae taken into laboratory, no adult moth emerged during the off-season of mango.

Table 1: Oviposition sites of *Deanolis sublimbalis* on mango

Oviposition Site	No. of egg masses recorded	%
Base of peduncle covered with dried sepals	109	69.78
Base of peduncle (uncovered)	29	18.59
Peduncle	9	5.77
Non-fruiting vegetative branch	6	3.85
Fruit	3	1.92
Total	156	100

Determination of host plants other than *Mangifera*

Field search. No larvae of RMBC were found in the fruits of *Spondias* spp., *Anacardium occidentale* and *Syzygium* spp. Fruits of the species *Mangifera minor* and *M. odorata* were found to be attacked by RBMC.

Laboratory trials (feeding study). All larvae fed with fruits of *Syzygium* spp. (water apples) did not complete metamorphosis and died within the larval stage. Five out of hundred larvae supplied with cashew as a diet completed the larval stage and pupated, while all larvae survived on the Mango species tested.

Natural enemies of *D. sublimbalis* in PNG.

Parasitoids. In total 1355 larvae and 923 eggs were collected and no parasitoids emerged from these.

Pathogens. In total 547 larvae were collected in the field and kept in the laboratory to be observed for possible attack by pathogens. No signs of microbial infections were recorded in the larvae.

Predators. The most abundant predator on the trees was the weaver ant *Oecophylla smaragdina* (F.) (average 0.5 to 0.8 per m²), but it was not found feeding on eggs or larvae of RMBC. Also Coccinellidae were not observed feeding on RBMC-eggs (KRULL & BASEDOW, in prep.).

Discussion

Concerning oviposition the findings of FENNER (1987) and GOLEZ (1991) have been confirmed. Our observation that marble sized fruits are preferred sites for oviposition has to be related to the fact that RMBC synchronises with its host plant. In contrast to reports by SENGUPTA & BEHURA (1957) in India, and GOLEZ (1991) in the Philippines, in our study the pupation sites turned out to be exclusively in the bark of mango tree trunks. These observations are supported by the recent results of SUJATHA & ZAHERUDDEEN (2002) from India. Since RMBC is monophagous on mango, as our study shows, it is safe to assume that the end of the diapause, when pupating in the bark, is initiated by physiological changes within the mango tree itself. Like GOLEZ (1991), who did not record any larval parasitoids in the Philippines, we did not find any parasitoids. The only record comes from PNG, where one single *Carcelia* sp. (Tachinidae) was reared (WATERHOUSE 1998). In the control of RBMC and fruit borers in general, larvae bore into the fruit immediately after hatching, and in this concealed habitat they are less susceptible to parasitization. Since no egg parasitoids were recorded in this study, it can be stated that parasitization of eggs is seldom and if, only at random. The low incidence can be related to the following reasons: The oviposition site under dried sepals might not have been located by hymenopteran parasitoids, or the parasitoids might not have identified the eggs as potential hosts. Furthermore, RMBC is an introduced species in PNG and no endemic parasitoids may have established themselves yet on this pest. The ineffectiveness of the weaver ant *Oecophylla smaragdina*, the most frequent predator, can be related to a different activity period. According to HÖLLDOBLER & WILSON

(1990) *O. smaragdina* is mostly diurnal while RMBC movement is probably nocturnal, as no larval movements were observed during the day.

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