

## **Biology of *Aphanogmus fijiensis* (Ferriere) (Hymenoptera: Cera- phronidae) a hyperparasite of *Diaphania indica* (Saunders) (Lepidoptera: Pyralidae) through *Apanteles taragamae* Viereck (Hymenoptera: Braconidae)\***

CLEMENT PETER and B V DAVID

Department of Entomology, Fredrick Institute of Plant Protection and Toxicology,  
Padappai 601 301, India

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**Abstract.** Studies were conducted on the hyperparasite *Aphanogmus fijiensis* (Ferriere) (Hymenoptera: Ceraphronidae) to determine its biology through *Apanteles taragamae* Viereck (Hymenoptera: Braconidae). *Aphanogmus fijiensis* is a gregarious ectoparasite and developed on the prepupal and pupal stages of *Apanteles taragamae* present inside the host cocoon. Mean development time from egg to adult was 12.28 days at  $26.43 \pm 2.53^\circ\text{C}$ . There is no preoviposition period; the host is paralysed before oviposition, freshly formed to 3-day old cocoons are preferred for oviposition and mean longevity for both sexes was 4.86 days.

**Keywords.** *Aphanogmus fijiensis*; hyperparasite; biology.

### **1. Introduction**

*Apanteles taragamae* Viereck is a gregarious endoparasite and was recorded for the first time from *Diaphania indica* Saunders on snake gourd from Sri Lanka (Wilkinson 1931). In 1948, Bhatnagar listed 13 hosts of *A. taragamae*. During the studies on biological control of *D. indica* at Padappai, it was observed that *A. taragamae* was the major parasite of this insect pest. Even though parasitism of *D. indica* during certain months was as high as 80%, the pest was not completely controlled. It was observed that the cocoons of *A. taragamae* were attacked by the hyperparasite, *Aphanogmus fijiensis* (Ferriere). This species was originally described as *Calliceras fijiensis*, a hyperparasite of *Tirathaba* sp. through *Apanteles tirathabae* Wlk. (Ferriere 1933). It has also been recorded as a hyperparasite of *Microgaster curticornis* Granger (Williams 1951). Later it was reported as a parasite of *Cremastus (Trathala) flavo-orbitalis* (Cameron) in Fiji (Hinckley 1963). *Ceraphron* sp. near *fijiensis* was also recorded as a hyperparasite of the coconut pest, *Artona catoxantha* Hampson through *Apanteles artonae* Roh. from Malaya (Lever 1964). This is the first record of *A. fijiensis* as a hyperparasite of *D. indica* through *A. taragamae*. Hence, in the present investigation the biology of this hyperparasite was studied.

### **2. Materials and methods**

To study the biology of the secondary parasite it was essential to maintain a culture

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of the primary parasite. The following procedure was followed to rear *A. taragamae* in the laboratory.

### 2.1 Rearing of stock culture of primary parasite

Twenty-five third-instar *Diaphania* larvae were released on a bouquet of *Coccinia* leaves inserted into a glass vial (6 × 1.5 cm) and placed inside a plastic jar (12 × 10 cm). Three mated *A. taragamae* females were released into each jar. The larvae were exposed to the parasite for 12 h. At the end of this period the parasites were removed from the jar and the larvae allowed to feed on the leaves. The leaves were changed periodically until the parasite larvae completed their development inside the host larvae and the cocoons were formed. These cocoons were collected from the rearing jars and placed in specimen tubes.

### 2.2 Biology of hyperparasite

Freshly formed *A. taragamae* cocoons were exposed to *A. fijiensis* adults in glass specimen tubes for 1 h. After this the adults were separated from the cocoons and after 12 h the cocoons were dissected at periodic intervals of 6 h until hatching of the hyperparasite eggs was observed. After the incubation period, the cocoons were dissected every 24 h and the development of the larval stage was observed, measured and drawn. To establish the larval period the parasitized host cocoons were dissected at periodic intervals using a Carl Zeiss Zoom Citoval-2-Stereo-microscope. The parasite larvae were measured with a calibrated ocular micrometer and drawn using a camera lucida attached to a Carl Zeiss Laboval 4 Compound microscope. The prepupal and pupal periods were also recorded. The rearing was done at  $26.43 \pm 2.53^\circ\text{C}$  and 65-80% RH.

The preoviposition and oviposition periods were determined by exposing freshly formed primary parasite cocoons to the hyperparasite at regular intervals of 24 h beginning with the day of emergence. The cocoons were dissected after each exposure and the number of parasitized cocoons as well as the number of eggs laid per cocoon counted. The host cocoons were exposed continuously until the female died. Adult longevity was determined by feeding honey solution to freshly emerged males and females. The age of the host cocoons preferred for oviposition was determined by exposing 0-5-day old *A. taragamae* cocoons to *A. fijiensis* adults for 12 h. After exposure the cocoons were placed in glass specimen tubes. The development time for each age group was recorded.

The stock culture of *A. fijiensis* was maintained in the insectary by rearing it on *A. taragamae* cocoons. The cocoons were exposed for 6 h after which the adults were separated from the cocoons. The exposed cocoons were placed in glass specimen tubes until the adults emerged.

## 3. Results and discussion

### 3.1 Immature stages

3.1a *Egg*: The egg is opaque, shining white with minute punctate markings on

the chorion. It is spindle shaped and pointed at one end and slightly rounded at the other end (figure 1A). The length averaged 0.19 and 0.05 mm wide (table 1).

3.1b *Larva*: The larva passes through 3 stages. The freshly hatched larva is white and translucent and remains attached to the spot where the egg was deposited (figure 1B,C). The head is rounded and the body has 12 segments. The length of the freshly hatched larva averages 0.26 mm and the width 0.125 mm. The second instar larva is very similar to the first instar but is larger and has 13 segments. The body is translucent, smooth and globular (figure 1D,E). The size of larvae of this instar averaged 0.56 mm in length and 0.30 mm in width. The third instar larva has a curved body, broad at the anterior region and tapering to the posterior. It is translucent white at first and then turns opaque. The head is almost embedded in the broad anterior region. The entire surface of the body is covered with small tubercles. These are absent on the last segment which is smooth and rounded (figure 1F). The length of full grown larva averaged 1.27 mm and width at the middle was 0.54 mm.

The mandible is simple, pointed and well sclerotized (figure 1H). At the beginning of the first instar it measured 0.02 mm in length and 0.012 mm in width at the base. The size increases to 0.05 mm in length and 0.03 mm in width at the end of the

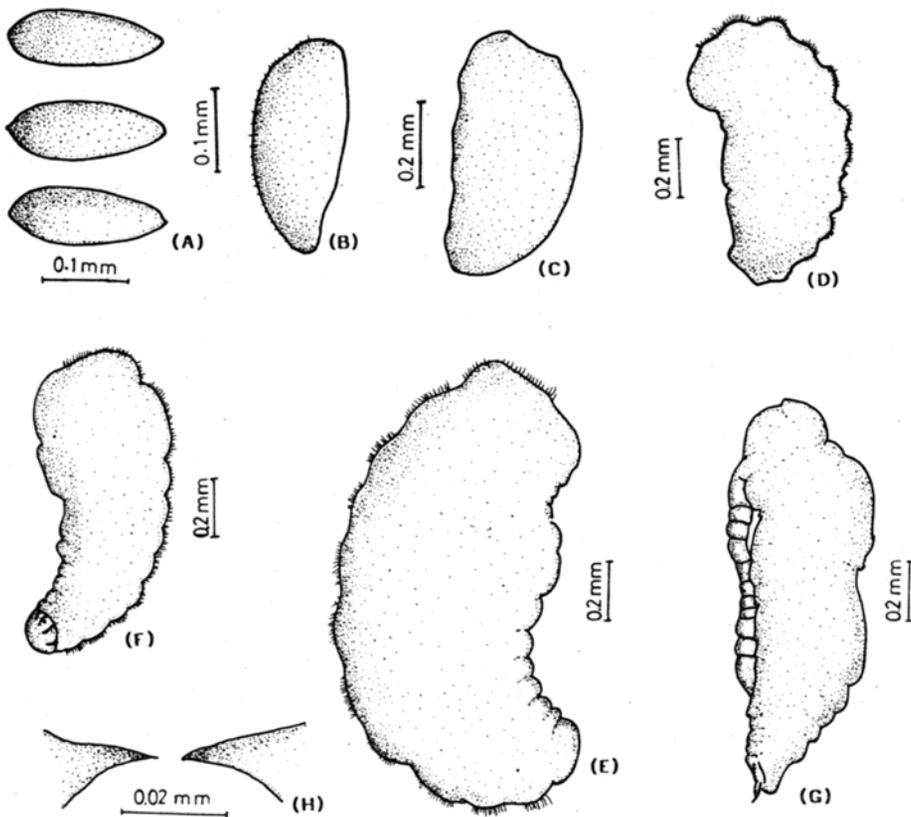


Figure 1. Developmental stages of *A. fijiensis*. A. Egg. B, C. I instar larva. D, E. II instar larva. F. III instar larva. G. Pupa. H. Mandibles.

**Table 1.** Mean size and duration of immature *A. fijiensis* reared at  $26.43 \pm 2.53^\circ\text{C}$ .

Stage	n	Length (mm)	Width (mm)	Duration (h)
		$\bar{X} \pm \text{SEM}$	$\bar{X} \pm \text{SEM}$	
Egg	25	$0.19 \pm 0.12$	$0.05 \pm 0.02$	24–36
I instar	20	$0.26 \pm 0.04$	$0.12 \pm 0.04$	1–2
II instar	18	$0.56 \pm 0.03$	$0.30 \pm 0.04$	2
III instar	15	$1.27 \pm 0.10$	$0.54 \pm 0.03$	1–2
Prepupa	12	$1.17 \pm 0.34$	$0.56 \pm 0.27$	1
Pupa	12	$1.19 \pm 0.27$	$0.45 \pm 0.52$	4–7

third instar. The shape of the mandibles is similar at all stages of larval development.

3.1c *Pupa*: The freshly formed pupa, bright white at first, gradually turns dirty white. The appendages such as antennae, legs and wing pads are pressed to the body (figure 1G). The length of the pupa averaged 1.19 mm and the width at the thoracic region averaged 0.45 mm.

### 3.2 Life history

*A. fijiensis* develops as gregarious ectoparasite on the pupa of *A. taragamae* inside the cocoon. The eggs are laid on the body of the host through the host cocoon. The egg period ranges from 24–36 h and the larva on hatching commences feeding at the point where it was laid. It continues to feed for 4–6 days. At the end of this period the host is entirely consumed and only the full grown larvae of the hyperparasite remain inside the host cocoon. The larvae discharge the meconium and enter the prepupal stage. The meconium which remains attached to the posterior end of the larva is smooth, spherical and dark brown. The prepupal stage lasts about a day after which it turns into pupa.

The pupal period ranges from 4–7 days. The total life cycle of *A. fijiensis* from egg to adult studied with 60 cocoon masses exposed to this hyperparasite averaged 12.28 days (range 11–15 days).

### 3.3 Adult

3.3a *Oviposition*: The females commence oviposition on the day of emergence. There is no preoviposition period and oviposition continue as long as the females live. The female has a long concealed ovipositor. During oviposition the ovipositor is extended at an acute angle to the body to probe the cocoon as if stinging it. Then the region behind the ovipositor enlarges and the egg is forced through the ovipositor. Oviposition lasts 30–60 s after which the female moves around rapidly and stops frequently to drum the cocoon with its antennae.

The eggs are laid on the body of the host which is generally in the prepupal stage. There is no specific site for oviposition but the eggs are distributed on different parts of the body. The number of eggs found in each cocoon averaged 6.30 (range 3–22 eggs/host) and out of these an average of 5.25 individuals (range 4–11) completed development.

3.3b *Host paralysis*: The ovipositing female paralyzes the host in the prepupal stage. The prepupa in the unexposed cocoon develops into a pupa within one day, while the prepupa in the exposed cocoon remains in the same stage without further development. It is therefore apparent that before oviposition the female paralyzes the host in the cocoon.

3.3c *Host age preferred for oviposition*: An experiment was conducted to determine the stage of the host preferred by *A. fijiensis* for oviposition. Cocoons of *A. taragamae* of different age groups (ranging from freshly formed to 4-day old) were exposed to adults of *A. fijiensis*. The study indicated that cocoons up to 3 days old were acceptable for oviposition and development.

In 4-day old cocoons the pupa of the host is fully developed and not suitable for the development of *A. fijiensis*. No hyperparasites emerged from 4-day old cocoons whereas adults of *A. taragamae* emerged after 1 to 2 days. The size of the hyperparasite adults emerging from 3-day old cocoons is smaller than those from 1 and 2-day old cocoons; in addition, the date of emergence of adults is extended by one day (i.e. 14 days for 3-day old cocoons). Similarly, the size of adults emerging from hosts parasitised as freshly formed cocoons is reduced and the date of emergence is delayed by one day.

3.3d *Longevity*: When kept in tubes and fed on 20% honey solution the adult life span averaged 4.86 days (maximum 9 days and minimum 2 days) for both sexes. Without food under similar conditions the adults survived only two days.

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### References

- Bhatnagar S P 1948 Studies on *Apanteles* Forster (Vipionidae: Parasitic Hymenoptera) from India; *Indian J. Entomol.* **10** 133–203
- Ferriere C 1933 Chalcidoid and Proctotrupoid parasites of pests of the coconut palm; *Stylops* **2** 97–108
- Hinckley A D 1963 The rice leaf-folder, *Susumia exigua* (Butler) in Fiji; *J. Econ. Entomol.* **56** 112–113
- Lever R J A W 1964 Notes on some parasites and hyperparasites and predators of coconut pests in Malaya; *Plant Prot. Bull. FAO* **12** 42–43
- Wilkinson D S 1931 Four new species of Ichneumonoidea; *Bull. Entomol. Res.* **22** 393–397
- Williams T R 1951 The bionomics and morphology of *Brenthia leptocosma* Meyrick (Lep. Glyphipterygidae); *Bull. Entomol. Res.* **41** 629–635