

LIFE HISTORY OF *ATTACUS ATLAS* LINN. (SATURNIIDAE: LEPIDOPTERA) ON *SAPIUM INSEGNE* BENTH. FROM WESTERN GHATS, MAHARASHTRA

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KEY WORDS

Attacus atlas
Sapium insegne, Bivoltine
Pupal diapause

Received on :

05.04.2011

Accepted on :

21.06.2011

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ABSTRACT

Attacus atlas is the largest and beautiful among Saturniid found throughout India and also in Western Ghats region of Kolhapur district, Maharashtra, India. The rearing of the saturniid *Attacus atlas* was done on *Sapium insegne* under laboratory conditions. It completes its one generation within 78 to 100 days with the duration of egg, larval and pupal stages as 8-10, 32-45, 38-45 days respectively. Laboratory rearing and the biology of *A. atlas* indicated that two generations are possible in a year and pupae enter in diapause after second generation in the months of December/ January. Indoor rearing is possible on large scale for commercial silk production by using *Sapium insegne* as a food plant which occurred plenty throughout the forest area of Kolhapur district.

INTRODUCTION

Sericigenous insect have been object of research since many centuries as they produce commercial silk. There are over 1500 sericigenous species belonging to the family Saturniidae. Indian subcontinent contains over 50 species in Saturniidae (Nassig *et al.*, 1996). Jolly *et al.* (1975) reported near about 80 species of silk producing moths from Africa and Asia. According to Lemaire and Minet (1998) Saturniidae is the major family of the superfamily Bombycoidea which includes number of impressive species of Sericigenous Lepidoptera. They are univoltine to multivoltine depending up on the climatic conditions and scattered in both the temperate and tropical region (Regier *et al.*, 2008; Kakati and Chutia, 2009).

The genus *Attacus* Linnaeus of the family Saturniidae, is restricted to the Australasian region and contains 14 known species (Peigler, 1989). Adults of this genus include largest moths. *Attacus atlas* is one of the largest Saturniid which is common in Western Ghats region in Kolhapur district, Maharashtra. Scanty information is available on the various aspects of biology of this species. Nazar (1990) studied life cycle of *Attacus atlas* on clove leaves, *Syzygium aromaticum* L. in greenhouse from Indonesia. In India *A. atlas* is reared for silk on a small scale in North Eastern States of India.

The silk of this moth is secreted as broken strands having greater durability which is used to make the fine decoration in fabrics and is used for ornamentals design. In Taiwan cocoons are used to prepare purses (Jolly *et al.*, 1979; Ghosh and Ghosh, 1995). Detailed published information on the biology, sex dimorphic characters and diapause behavior is lacking.

This species could be utilized in Vanya Silk production by using locally available host plants.

MATERIALS AND METHODS

The biology of *Attacus atlas* was studied for two generations during June – December 2010 under laboratory conditions at 25 to 30°C with varying relative humidity 75 to 80 %. Initially, full grown larvae were collected in July from Amba reserve forest on *Sapium insegne*. Larvae were brought to the laboratory and reared in wooden rearing cages measuring 75 x 75 x 75 cm. Larvae were provided daily fresh leaves of *Sapium insegne* and unused leaves and excreta were removed regularly during the rearing.

Larvae allowed pupating within cages only. Observations were made on the pupal period, adult life span and fecundity. The eggs laid were incubated in Petri dish, the bottom of which was overlaid with moist filter paper. Immediately after hatching, the caterpillars were transferred in the cages and provided with fresh tender leaves of *Sapium insegne*. Observations were made on the larval and pupal development and morphometric measurements were recorded.

RESULTS AND DISCUSSION

The biology of Saturniid, *Attacus atlas* was studied under laboratory conditions. The detailed account of life stages *i.e.* egg, larva, pupa and adult presented in Table 1 and Table 2 and depicted in Fig. 1 to 11.

Oviposition

Table 1: Duration of different stages of *Attacus atlas* (in days)

Stage		Min.	Max.	Mean	SD	SEM
Egg:	Incubation period	8	10	9.2	1.03	0.32
Larval period	I st instar	2	4	2.8	1.03	0.32
	II nd instar	3	6	5.1	1.44	0.45
	III rd instar	8	10	9	1.05	0.33
	IV th instar	7	9	8	1.05	0.33
	V th instar	12	16	15.6	1.26	0.4
Adult	Pupa	38	45	40.5	2.50	0.79
	Male	4	6	4.8	1.03	0.32
	Female	8	10	8.6	0.96	0.30

Figures are mean of 10 samples. SD-Standard deviation SEM-Standard error of mean

Table 2: Morphometric data of *Attacus atlas* L. (in mm)

Stages		Min.	Max.	Mean	SD	SEM
Egg	Length	2.7	3	2.8	0.11	0.03
	Width	2.1	2.7	2.5	0.16	0.05
Larval instar	Body length	8	10	9.1	0.99	0.31
Head capsule	Length	1	1.5	1.3	0.20	0.07
	II	Length	25	28	25.8	1.22
Head capsule	Length	2	2.5	2.4	0.15	0.05
	III	Body length	34	42	40	2.70
Head capsule	Length	3.4	3.6	3.5	0.66	0.02
	IV	Body length	79	82	79.5	1.08
Head capsule	Length	4	4	4	0	0
	V	Body length	88	92	89	1.63
Head capsule	Length	5	6	5.5	0.52	0.16
	Cocoon	Length	55	65	63.88	3.33
		Width	35	38	35.33	1
Pupa	Length	35	40	38.7	6.82	0.26
Adult male	Body length	30	36	35	2.16	0.68
	Wing expanse	210	230	217	9.48	3
Female	Body length	39	40	39.4	0.51	0.16
	Wing expanse	240	250	246	5.16	1.63

Figures are mean of 10 samples. SD-Standard deviation SEM-Standard error of mean

Mated females were kept in cages for egg laying. Egg laying was started on the 3rd and 5th day after emergence. Mated female deposit 170 ± 10 average number of eggs in the period of 8 - 10 days. The unmated female deposited similar number of eggs which were unproductive. *Attacus atlas* therefore conforms to the non parthenogenic nature of the Oriental Saturniidae as both arrhenotokous and thelytokous Saturniids have been reported from other regions of the world (Barlow, 1982). Observations on similar line in *A. mcmulleni* were reported by Veenakumari *et al.* (1992) from Andaman Islands, India.

Egg

The length of egg ranged from 2.7 mm to 3.0 mm with an average of 2.8 mm while the width ranged from 2.1 to 2.7 mm with a mean of 2.5 mm. Eggs were oval, flattened dorsoventrally and dull white in colour. The incubation period of eggs ranged from 8 to 10 days with a mean period of 9.2 days. Nazar (1990) reported incubation period of egg in *Attacus atlas* ranged from 6 to 12 days. In *Attacus mcmulleni*, the eggs measured 2.8 mm in length and 2.4 mm in width and incubation period of 10 to 11 days reported by Veenakumari *et al.* (1992).

Larval development

During the present study in all 4 moults were observed during the larval development with larval period ranged from 32 to

45 days but Nazar (1990) reported total larval duration in *Attacus atlas* reared on clove ranged from 50 to 58 days In Indonesian climate. In *Attacus mcmulleni* 43 days larval period was recorded and larvae pass through 5 moults. Larvae were reared on the leaves *Rhizophora apiculata*, *Rhizophora mucronata*, *Zanthoxylum* sp. and *Vitex glabra* by Veenakumari *et al.*, (1992). *A. atlas* has wide range larval host plants. Palkar (2008) reared on *Embelia acutipetalum* and reported as a new larval host plant of *A. atlas*. Jugale *et al.*, (2010) reported larvae of *A. atlas* as serious pest of *Xylocarpus granatum* Koen. which is critically endangered mangrove species of Maharashtra. However *X. granatum* is a tree type of mangrove plants which can be conserved by making its scientific use in the rearing of *A. atlas* to produce fagara silk.

During the present investigation caterpillars were reared on the leaves of *Sapium insegue* which was earlier reported by Peigler (1989) as a larval host plant of *A. atlas* from South East Asia. During the present study the efforts were to identify the potential food plant of *A. atlas* in which leaves of the *Embelia ribes*, *Holorrhena antidysentrica*, *Terminalia tomentosa*, *Terminalia arjuna*, *Terminalia catappa*, *Ficus carica* and *Sapium insegue* were used but the caterpillars preferred only the leaves of *Sapium insegue*.

First instar

Head black, prothorax has black area on dorsal side between each scolus. Light, brown patch on anal proleg with darker

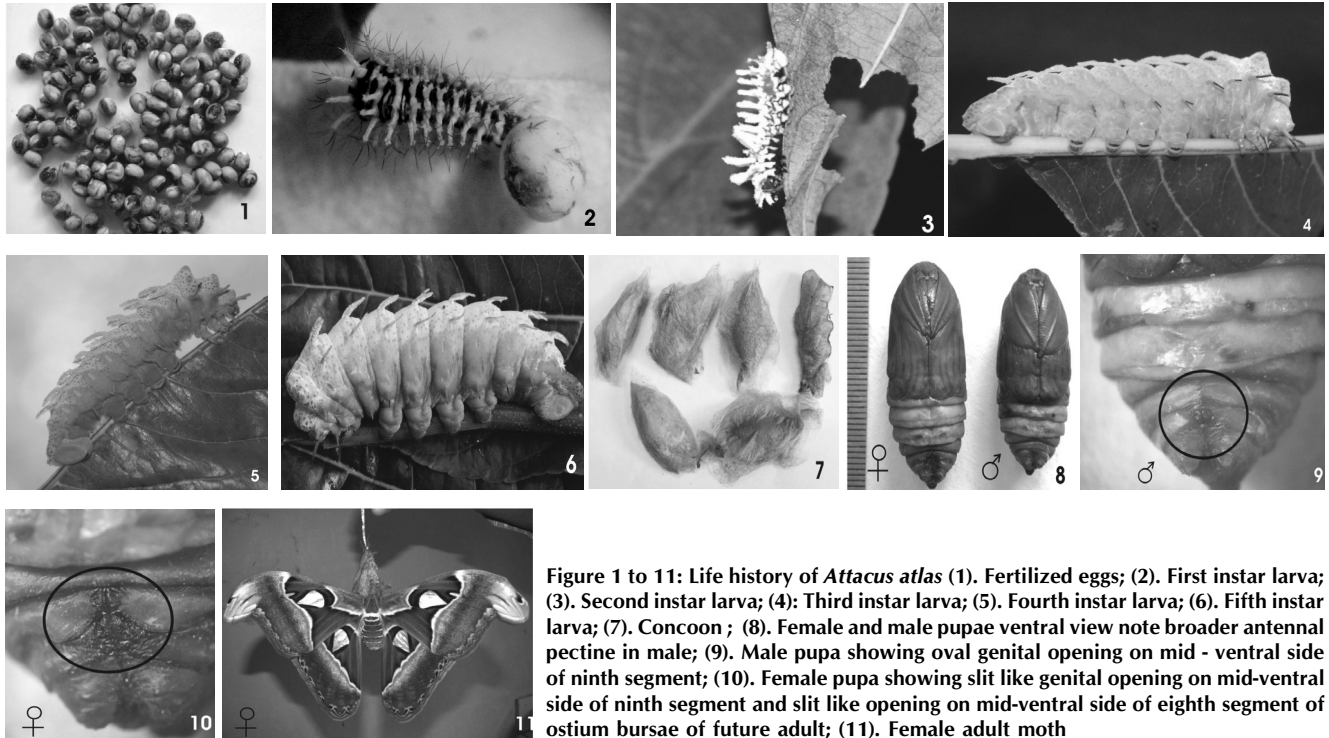


Figure 1 to 11: Life history of *Attacus atlas* (1). Fertilized eggs; (2). First instar larva; (3). Second instar larva; (4). Third instar larva; (5). Fourth instar larva; (6). Fifth instar larva; (7). Cocoon; (8). Female and male pupae ventral view note broader antennal pectine in male; (9). Male pupa showing oval genital opening on mid - ventral side of ninth segment; (10). Female pupa showing slit like genital opening on mid-ventral side of ninth segment and slit like opening on mid-ventral side of eighth segment of ostium bursae of future adult; (11). Female adult moth

margins forming ring. Spiracles are yellow in colour (Peigler, 1989). The duration of first instar ranged from 2 to 4 days with a mean of 2.8 days. The length of first instar ranged from 8 mm to 10 mm with a mean of 9.1 mm. The length of head capsule ranged from 1 mm to 1.5 mm with an average of 1.3 mm. In *A. macmulleni* first instar lasted for 3 days. The length of head capsule has been reported 1.4 mm by Veenakumari *et al.* (1992).

Second instar

Head dark brown, legs black, body covered with white powder; there is lateral deep orange patch on metathorax and segment 8-10. These persist in third and fourth instar also. The average body length of second instar was 25.8 mm and the duration ranged from 3 to 6 days with a mean of 5.1 days. The length of head capsule ranged from 2 mm to 2.5 mm with a mean of 2.4 mm. In *A. mcmulleni*, the second instar lasted for 5 days and it attained the length up to 10 mm. The length of head capsule was 1.9 mm (Veenakumari *et al.*, 1992).

Third instar

All tubercles are shorter and slender; subventral scoli black (Pieglar, 1989). The duration of third instar ranged from 8 to 10 days with an average of 9 days. The mean length of third instar was 40 mm while the mean length head capsule was 3.5 mm. In *A. mcmulleni*, caterpillar attains the length of 20 mm and it lasted for 6 days. The average length of head capsule was 2.5 mm (Veenakumari *et al.*, 1992).

Fourth instar

Head light greenish yellow; prolegs grey; tubercles shorter and thinner than they appear in *Attacus lorquinii*. The length of fourth instar ranged from 79 mm to 82 mm with a mean of 79.5 days and the duration ranged from 7 to 9 days with a mean of 8 days. The length of head capsule was measured to

be 4 mm. In *A. mcmulleni*, 6 days were required for the completion of fourth instar, and the mean length of head capsule was 3.5 mm (Veenakumari *et al.*, 1992).

Fifth instar

Mandibles black; labrum, clypeus and maxillary palpi light greenish; thoracic legs light greenish blue, integument light yellowish green, white dorsally, yellower ventrally; dorsal and subdorsal scoli flattened and concolourous with integument. Head is smooth, glossy, green colour. Larva pale green in colour with brownish speckles. First three segments with dorsal prominence; 4th and 11th segments with long fleshy dorsal and subdorsal blue green spines projecting backwards. On segment 1st to 5th there is series of blue black spines and a similar series of spines present on subdorsal side from segment 1 to 11. These dorsal and subdorsal series of spine project in forward direction. An oval red ring was present on anal segment above the claspers (Hampson, 1892). The length of this instar ranged from 88 mm to 92 mm with a mean of 89 mm. The length of head capsule ranged from 5 mm to 6 mm with a mean of 5.5 mm. The duration of fifth instar ranged from 12 to 16 days with a mean of 15.6 days. In *A. mcmulleni* fifth instar took 8.6 days to transform in to pupa. The body length of full grown fifth instar measured 40 mm and the length of head capsule measured 4.9 mm (Veenakumari *et al.*, 1992).

Cocoon

The full grown caterpillar stops feeding prior to pupation. Caterpillars pupate within papery cocoon in to desiccated leaves. According to Dupont and Scheepmaker (1936), the coloration of cocoons of *A. atlas* varies according to the host plant from brownish black to brownish yellow and whitish. Larvae fed on *citrus medica* L. made a cocoon of pale yellow drying to white whereas caterpillars reared on *Psidium guajava*

made a cocoon of brick red drying to a rather dirty brown (Kitchener, 1961). During the present study caterpillars were reared on *Sapium insegue*, larvae made grayish to light brown cocoons. Hampson (1892) described cocoon which was pale grayish brown and pyriform. Usually cocoons are spinned in a highly variable shape, size, colouration and texture (Peigler, 1989). During the present study, caterpillars spinned oval shaped cocoons with loose flaps of silk on and below the main portion of the cocoon. The length of cocoon ranged from 55 mm to 65 mm with a mean of 63 mm while the width ranged from 35 to 45 mm with a mean of 63.88 mm. The cocoon weight, shell weight and shell ratio is 5.72 g, 5.15 g, 0.76% respectively.

Pupa

Pupae of *A. atlas* are typically lepidopteran obtect type. Pupa is brownish yellow to dark brown. The pupal sex dimorphic characters observed are larger and heavier female pupae than male pupae. The average weight of female pupa was 5.34 g and 4.20 g in male pupa. Antennal covers are wider in male than the females. In female pupa, there are two openings at the ventral posterior side of pupa. The elongated slit like mid ventral side of 8th abdominal segment is the opening of Bursa copulatrix that is ostium bursae and on the mid ventral side of 9th abdominal segment is the female genital opening or gonopores for egg deposition. In male, single oval opening is observed on the mid ventral side of 9th abdominal segment.

A blunt pair of sustentores on ventral side of 10th abdominal segment, cremaster prominent, blunt and rounded (Peigler, 1989). The length of the pupa ranged from 35 to 40 mm with a mean of 38.7 mm. The pupal duration ranged from 35 to 45 days with a mean of 40.5 days. In Indonesian climate, pupal period in *Attacus atlas* ranged from 27 to 31 days. The mean pupal period in *A. mcmulleni* was 25.8 days.

Adult

Immediately after the emergence from the cocoon adults remain in the cocoon for few hours till the wings get spread. The overall description of the morphology of moth matches with the description earlier given by Hampson (1892) and Peigler (1989). Adults are large crepuscular flying moths. Antennae bipectinate in both the sexes. Legs short, hairy without spurs. Head, thorax and abdomen are red brown. The basal segment and abdomen are pale and each segment with pale fringe. Females are usually larger than males. The body length of female ranged from 39 mm to 40 mm with a mean of 39.4 mm. The wing expanse of female ranged from 240 mm to 250 mm with a mean of 246 mm while in male the body length ranged from 30 mm to 36 mm with a mean of 35 mm. The wing expanse in male ranged from 210 to 230 mm with a mean of 217 mm.

ACKNOWLEDGEMENT

Authors are thankful to Department of Biotechnology, New Delhi for financial assistance and Head Department of Zoology, Shivaji University, Kolhapur, Maharashtra for providing necessary facilities.

REFERENCES

- Barlow, H. S. 1982.** An introduction to the moths of South East Asia. Malayan Nature Soc., Kuala Lumpur. ix + 305 pp., 50 col. pls.
- Dupont, F. and Scheepmaker, G. J. 1936.** Uit Java's vlinderleven. Nisser & Co., Batavia. p. 216.
- Ghosh, G. K. and Ghosh, S. 1995.** Indian Textiles. Past and Present. APH Publishing Corporation, 5 Ansari Road, Darya Ganj, New Delhi. p.299.
- Hampson, G. F. 1892.** The Fauna of British India including Ceylon and Burma, 1, xxiii + p. 527, London.
- Jolly, M. S., Chowdhury, S. N. and Sen, S. K. 1975.** Non Mulberry Sericulture in India. Central Silk Board, Bombay.
- Jolly, M. S., Sen, S. K., Sonawalkar, T. N. and Prasad, G. S. 1979.** Non mulberry Silks. Food & Agriculture Organization. United Nations. Serv. Bull. 29. Rome.xvii+ p.178.
- Jugale, S. B., Bhawane, G. P. and Bhosale, L. J. 2010.** Major insect pests of *Xylocarpus granatum* Koen. A critically endangered mangrove species of Maharashtra. *The Bioscan*. 1: 257-268.
- Kakati, L. N. and Chutia, B. C. 2009.** Diversity and ecology of wild sericigenous insects in Nagaland, India. *Tropical Ecology*. 50(1): 137-146.
- Kitchener, H. J. 1961.** A note on Atlas moth- *Attacus atlas*. *Malayan Nat. J.* 15: 107-110.
- Lemaire, C. and Minet, J. 1998.** *The Bombycoidea and Their Relatives*. In N. P. Kristensen (Ed.). Lepidoptera, Moths and Butterflies. Vol. 1: Evolution, Systematics and Biogeography. Walter de Gruyter, Inc. Hawthome.
- Nassig, W. A., Lempe, R. E. J. and Kger, S. 1996.** The Saturniidae of Sumatra (Lepidoptera). *Heterocera Sumatrana*. 10: 3-10.
- Nazar, A. 1990.** The biology of *Attacus atlas* Linn, a pest of Clove leaves. *Pemberitaan Penititian Tanaman Industri*. 16(1): 35- 37.
- Palkar, S. B. 2008.** A new record of host plant *Embelia acutipetalum* of Atlas moth, *Attacus atlas* Linnaeus from Konkan. *J. Bombay Natural History Society*. 105 (3): 357.
- Peigler, R. S. 1989.** *A revision of the Indo-Australian genus Attacus*. Lepidoptera Research Foundation., Inc. Beverly Hills, California. xi+p.167.
- Regier, J. C., Grant, M. C., Mitter, C., Cook, C. P., Peigler, R. S. and Rougerie, R. 2008.** Phylogenetic relationships of wild silk moths (Lepidoptera: Saturniidae) inferred from four protein-coding nuclear genes. *Systematic Entomology*. 10: 1-10.
- Vennakumari, K., Mohanraj, P. and Peigler, R. S. 1992.** The life history of *Attacus mcmulleni* (Saturniidae) from the Andaman Islands, India. *J. Res. on the Lepidoptera*. 31(3-4): 169-179.