



A study on the life history of plain tiger *Danaus chrysippus* linnaeus (Lepidoptera: Nymphalidae) in West Bengal

Tirthankar Dalui¹, Soumik Chowdhury¹, Subhankar Kumar Sarkar²

¹ Department of Zoology, Barasat College, Kolkata, West Bengal, India

² Department of Zoology, Entomology Laboratory, University of Kalyani, Nadia, West Bengal, India

Abstract

Plain tiger or African Monarch or *Danaus chrysippus* is a one of the well distributed species of Monarch butterfly in the Indian subcontinent. Apart from India, *Danaus chrysippus* can be found in large numbers in Africa, southern Europe, Saudi Arabia, tropical Asia, Australia, and New Zealand. *Danaus chrysippus* feeds on different species of Milkweed of the genus *Asclepias*. Larvae of plain tiger feed on milkweed host plants that contain poisons that they may isolate and store in their bodies. These toxins are then transferred to the pupa and adult butterfly. A study was carried out to investigate the details of different developmental stages with morphometric study of *D. chrysippus* in both field and laboratory conditions. The study was conducted from June to September in 2019 at a private orchard in Barasat, West Bengal. Freshly laid eggs were collected from the field. After the emergence of adults, male and females were transferred to large cylindrical container and feed them with honey solution. For morphometric study five healthy larval samples of *Danaus chrysippus* were selected. Observations were recorded on the duration and detailed observations on eggs and larva of each instar, pupa and adults were made. The result revealed that the length of the first, second, third, fourth and fifth instar larva varied from 4.4 to 4.8 mm, 8.5 to 8.8 mm, 13.9 to 14.2 mm, 20.8 to 21.5 mm and 29.8 to 30.2 mm respectively. While the width varied from 1 to 1.3 mm, 1.6 to 1.8 mm, 2.7 to 3 mm, 3.3 to 3.6 mm and 5.4 to 5.7 mm respectively. It is evident that total life cycle of plain tiger was completed in between 30 to 33 days with an average of 31.4 ± 1.14 days.

Keywords: *Danaus chrysippus* linnaeus, lepidoptera, nymphalidae

Introduction

Butterflies have a close relationship with plants and provide human society an economic and ecological advantages. Butterflies, both as adults and larvae, are reliant on vegetation and engage in intricate feeding associations with green plants. The larvae feed primarily on plant foliage and are typically host specific. An ideal habitat for butterflies should include mating sites, nectar sources and larval food plants. The diversity of butterflies for particular habitats is associated with the availability of larval host plants and adult nectar plants (Ilse, 1956) ^[5]. Many flowering plants serve as nectar sources for butterflies, resulting in a diverse array of butterfly species (Harish, 1996) ^[4]. The African Queen butterfly, *Danaus chrysippus* (Linnaeus, 1758) ^[6], is a member of the Nymphalidae family comprises over 7000 species worldwide (Francke, 1989) ^[3]. Africa, southern Europe, Saudi Arabia, tropical Asia, Australia, and New Zealand are among the regions where *Danaus chrysippus* can be found in large numbers (Kheloufi *et al.*, 2019) ^[6]. Due to warmer weather, *Danaus chrysippus* has expanded its range significantly in North African coastal regions, and from there it has colonised in the parts of Spain's south coast as well as Corsica, Sardinia, and Sicily, as well as Italy and Malta. (Burton, 2001) ^[2]. This multivoltine species thrives in open, occasionally deteriorated, habitats surrounding gardens or cultivated areas (Perković, 2006) ^[7]. *Danaus chrysippus* feeds on different species of milkweed of the genus *Asclepias*. *Danaus chrysippus* is usually found as a host in two popular species, *Calotropis gigantea* and *Calotropis procera*. As a defence against predation, *D. chrysippus* larvae feed on milkweed host plants that contain poisons that they may isolate and store in their bodies. These toxins are then transferred to the pupa and adult butterfly. Most ecologists and conservationists believe that our current understanding of the exact requirements of Indian butterflies is woefully inadequate, and that the life histories of most Indian butterflies are still unknown. As a result, efforts are being made to study the life history of the plain tiger *Danaus chrysippus* Linnaeus (Lepidoptera: Nymphalidae) found in Barasat region, West Bengal. The present experiment was carried out to investigate the details of different developmental stages with morphometric study of *D. chrysippus* in both field and laboratory conditions.

Methodology

Adult butterflies obtained nectar from wide range of plants. The flowering of the available host plants varied depending on the season and the habitat range of butterfly. It is also a fact that certain plants do not flower throughout the year. *Danaus* primarily consume plants which is commonly called milkweed under the genus

Asclepias. To study the life history of plain tiger; a study was conducted from June to September in 2019 at a private orchard in Barasat, West Bengal. This experimental site is situated at 23°N latitude and 89°E longitude with an average altitude of 9.75 m above sea level. The field experiment was conducted during the flowering season of milkweed trees. The life history study was conducted both in field and laboratory conditions. Freshly laid eggs were collected from the field. The parts of plants on which the eggs were laid, was also collected without causing any damage. The date and time of collections were noted. Butterflies are usually day active mostly during 7 am to 4pm. Therefore, the survey was made during these time span of the day to record the oviposition behaviour and collection of samples. In the laboratory eggs were inserted in petridish of 10 cm diameter. To provide moist condition, the inside of each of these petridishes was lined with blotting paper. After hatching freshly emerged larva was collected and kept in plastic jars containing fresh leaves of *Asclepias* as food. Food was changed at regular intervals. The mouth of the jar was covered by a clean cloth and securely tied with rubber band. This rearing produced the opportunity for observing the larval activity and development of larvae and pupae. The number moultings and the number of larval instars produced were noted. After the emergence of adults, male and females were transferred to large cylindrical container and feed them with honey solution. For morphometric study five healthy larval samples of *Danaus chrysippus* were selected. Observations were recorded on the duration and detailed observations on eggs and larva of each instar, pupa and adults were made. Measurement on length and width of larva, pupa and adult with total developmental periods were recorded. The wing span of adults were also recorded. During this observation several meteorological parameters like average relative humidity, average temperature and rainfall were also recorded.

Results and Discussions

Table 1: Measurement of length (mm) of different developmental stages from five samples of Plain tiger.

Length	S-I	S-II	S-III	S-IV	S-V	Length (mm)		
						AVG±SD	Max	Min
EGG	1.2	1.5	0.9	1.3	1.1	1.2±0.22	1.5	0.9
Instar-I	4.8	4.4	4.5	4.5	4.7	4.5±0.16	4.8	4.4
Instar-II	8.7	8.8	8.5	8.8	8.6	8.6±0.13	8.8	8.5
Instar-III	14.1	14.2	13.9	14.1	14.2	14.1±0.12	14.2	13.9
Instar-IV	21.2	21.5	20.8	20.9	21	21±0.27	21.5	20.8
Instar-V	30.2	30.2	30.1	30	29.8	30±0.16	30.2	29.8
Prepupa	19.8	20.2	20	20.1	19.9	20±0.15	20.2	19.8
Pupa	17.5	17.6	17.5	17.4	17.3	17.4±0.11	17.6	17.3
Adult	23.2	23.3	23.1	22.9	22.8	23±0.20	23.3	22.8

Table 2: Measurement of Width (mm) of different developmental stages from five samples of Plain tiger.

WIDTH	S-I	S-II	S-III	S-IV	S-V	WIDTH (mm)		
						AVG±SD	Max	Min
EGG	1	0.8	1.1	1.2	0.8	0.9±0.17	1.2	0.8
Instar-I	1	1	1.1	1.2	1.3	1.1±0.13	1.3	1
Instar-II	1.6	1.6	1.8	1.7	1.8	1.7±0.1	1.8	1.6
Instar-III	2.8	2.7	2.7	2.8	3	2.8±0.12	3	2.7
Instar-IV	3.5	3.6	3.5	3.4	3.3	3.4±0.11	3.6	3.3
Instar-V	5.5	5.7	5.4	5.6	5.4	5.5±0.13	5.7	5.4
Prepupa	6.8	6.7	6.9	6.7	6.9	6.8±0.1	6.9	6.7
Pupa	7.6	7.5	7.7	7.9	7.6	7.6±0.15	7.9	7.5
Adult	80	75.6	75.8	75.4	75.6	76.48±1.9 (wing span)	80	75.4

Table 3: Duration (days) of different developmental stages from five samples of Plain tiger.

Days	S-I	S-II	S-III	S-IV	S-V	DAYS		
						AVG±SD	Max	Min
EGG	3	4	3	4	3	3.4±0.54	4	3
Instar-I	1	1	2	2	2	1.6±0.54	2	1
Instar-II	2	2	2	2	1	1.8±0.44	2	1
Instar-III	2	2	2	1	3	2.0±0.70	3	1
Instar-IV	1	1	1	2	2	1.4±0.54	2	1
Instar-V	3	3	2	2	2	2.4±0.54	3	2
Prepupa	2	2	2	1	2	1.8±0.44	2	1
Pupa	7	7	7	8	8	7.4±0.54	8	7
Adult	11	9	9	9	10	9.6±0.89	11	9
Total	32	31	30	31	33	31.4±1.14	33	30

Table 4: Detail of duration and measurement of different life stages of Plain tiger in 2019

Stages	Days			Length (mm)			Width (mm)		
	Max	Min	AVG±SD	Max	Min	AVG±SD	Max	Min	AVG±SD
Egg	4	3	3.4±0.54	1.5	0.9	1.2±0.22	1.2	0.8	0.9±0.17
I instar larva	2	1	1.6±0.54	4.8	4.4	4.5±0.16	1.3	1	1.1±0.13
II instar larva	2	1	1.8 ±0.44	8.8	8.5	8.6±0.13	1.8	1.6	1.7±0.1
III instar larva	3	1	2.0±0.70	14.2	13.9	14.1±0.12	3	2.7	2.8±0.12
IV instar larva	2	1	1.4±0.54	21.5	20.8	21±0.27	3.6	3.3	3.4±0.11
V instar larva	3	2	2.4±0.54	30.2	29.8	30±0.16	5.7	5.4	5.5±0.13
Prepupa	2	1	1.8±0.44	20.2	19.8	20±0.15	6.9	6.7	6.8±0.1
Pupa	8	7	7.4±0.54	17.6	17.3	17.4±0.11	7.9	7.5	7.6±0.15
Adult	11	9	9.6±0.89	23.3	22.8	23±0.20	80	75.4	76.48±1.9 (wingspan)
Total life cycle	33	30	31.4±1.14						

**Fig 1:** Instar larva**Fig 2:** Cocoon

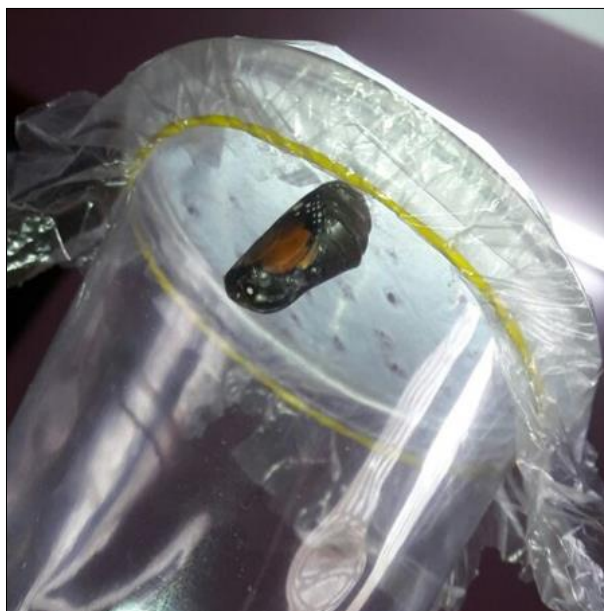


Fig 3: Pupa Inside the cocoon



Fig 4: Adult *Danaus chrysippus*

Egg: The newly laid egg is dome in shape and has longitudinal ridges that run the entire length. The freshly laid eggs are white in colour, but they turn creamy white after a day. The eggs were 0.9-1.5 mm in length and 0.8-1.2 mm in width. The mean length and width of five samples were 1.2 ± 0.22 mm and 0.9 ± 0.17 mm respectively. The incubation period was varied from 3-4 days after which the larvae were hatched out. The larva swallowed its eggshell after emerging from the egg. During the present studies, larva of plain tiger was observed to moulted four times and thus passed through five larval instars in average of 12-13 days.

Instar I: It grew for two days, reaching a length of 4.4 to 4.8 mm and a width of 1-1.3 mm. The mean length and width of first instar larvae were found to be 4.5 ± 0.16 mm and 1.1 ± 0.13 mm respectively. It was yellow in colour and had fluffy feathers on its body and head. The head was black in colour and had two black horns on it. There were distinct yellow lines that ran longitudinally along the dorsal part of the body. The 1st instar larvae were lasted for 1 to 2 days with mean of 1.6 ± 0.54 days.

Instar II: It lasted for 1 to 2 days and was 8.5 to 8.8 mm in length and 1.6 to 1.8 mm in width. The mean length and width of second instar larvae were found to be 8.6 ± 0.13 mm and 1.7 ± 0.1 mm respectively. Body colour is green with two forked horns on head. Anal spines were black. There were distinct longitudinal yellow lines on the dorsal side of the body, as well as a pair of narrower yellow lines on each lateral side.

Instar III: It was measured 13.9 to 14.2 mm in length with an average of 14.1 ± 0.12 mm and 2.7 to 3 mm in width with an average of 2.8 ± 0.12 mm. The head was hairy and black, with white marks on it. The dorsal and lateral yellow lines on the body were well-marked. The two dorsal yellow lines were extended up to the black

anal spines. Other characters remained unchanged from the previous instar. It lasted for 1 to 3 days with an average of 2.0 ± 0.70 days.

Instar IV: It was 20.8 to 21.5 mm long with an average of 21 ± 0.27 mm and 3.3 to 3.6 mm width with an average of 3.4 ± 0.11 mm. It lasted for 1 to 2 days with an average of 1.4 ± 0.54 days. The horns on the head turned reddish brown and the width of the head increased. The white marks on the head turned cream in colour and triangular in shape. Dorsally, the anal spines turned orange. Other characters remained unchanged from the previous instar.

Instar V: It reached a final length of 29.8 to 30.2 mm with an average of 30 ± 0.16 mm and a width 5.4 to 5.7 mm with mean of 5.5 ± 0.13 mm after 2-3 days of growth. The width of the head increased. There was a black tip on the orange anal spine. The entire body was covered in hair. It was rough on the dorsal side and soft on the ventral side, with a light green colour. Three pairs of orange and dark blue to green coloured dots were visible on the dorsal yellow pair of lines. Other characters remained unchanged from the previous instar.

Pupa: The fifth instar larva stopped feeding and sat motionless during the pre-pupal period. The pre-pupal period lasted with an average of 1.8 ± 0.44 days. The duration of the pupal period was 7 to 8 days. Pupa was measured between 17.3 to 17.6 mm in length with an average of 17.4 ± 0.11 mm and 7.5 to 7.9 mm in width with an average of 7.6 ± 0.15 mm. The colour of the pupa was bright green. Later it was changed to pale brown in colour. Its front was wider than its back, which was marked with a yellowish green colour. A projection with red and cream linear markings had been present on the dorsal side. Cream spots with a crimson border were found on the dorsal side, while red spots with a yellow border were seen on the lateral sides.

Adult: The wingspan was measured between 75.4 to 80 mm with an average of 76.48 ± 1.9 mm. The fore wings of both sexes have orange tips with black marginal borders. The sub-apical portion contains white band of elongated spots. On both sides of the hind wing, there are four small black disc like spots found. On the underside of the male's hind wing is a pouch containing scent scales, and on the upper side is a patch of scent scales. Thorax is black in colour with white spots. In both wings, the upper side is reddish brown with black borders. There was a black apex in the fore wing. The costa and apex of the forewing have a variable number of white spots. The underside is a dull orange colour. The upper half of the forewing is dark brown, and the hindwing has six black spots. The significant difference between males and females was the presence of spots on the hind wings. The males had four black spots on their hind wings, while the females only had three.

Conclusion

Studies were undertaken on the life cycle of plain tiger during 2019 revealed that the average duration of first to fifth instar larvae was 1.6 ± 0.54 , 1.8 ± 0.44 , 2.0 ± 0.70 , 1.4 ± 0.54 and 2.4 ± 0.54 days, respectively. The length of the first, second, third, fourth and fifth instar larva varied from 4.4 to 4.8 mm, 8.5 to 8.8 mm, 13.9 to 14.2 mm, 20.8 to 21.5 mm and 29.8 to 30.2 mm with an average of 4.5 ± 0.16 , 8.6 ± 0.13 , 14.1 ± 0.12 , 21 ± 0.27 and 30 ± 0.16 mm respectively. While the width varied from 1 to 1.3 mm, 1.6 to 1.8 mm, 2.7 to 3 mm, 3.3 to 3.6 mm and 5.4 to 5.7 mm with an average of 1.1 ± 0.13 , 1.7 ± 0.1 , 2.8 ± 0.12 , 3.4 ± 0.11 and 5.5 ± 0.13 mm respectively. In the pre-pupal stage, the full-grown larva of the fifth instar became sluggish and stopped feeding. Larvae pupate underside of the leaves and branches. Duration of larval, pre-pupal and pupal was found 10.5 ± 0.54 , 1.8 ± 0.44 , 7.4 ± 0.54 days, respectively. The life span of adult was 9.6 ± 0.89 . It is evident that total life cycle of plain tiger was completed in between 30 to 33 days with an average of 31.4 ± 1.14 days. According to Swailem and Ismail (1972)^[11], Wadnerkar *et al.* (1979)^[12], Sharma and Verma (2005)^[9], and Ramana *et al.* (2005), the development from egg to adult took 26 to 37 days. Ramana *et al.* (1988) reported the duration of larval, pre-pupal and pupal period were 12.5 ± 0.2 , 1.5 ± 0.1 , 9.8 ± 0.3 days, respectively. According to Sharma and Verma (2005)^[9], it was 7.20 ± 0.44 , 1.3 ± 0.1 , 7.40 ± 0.54 days respectively. According to Wadnerkar *et al.* (1979)^[12], the duration of larval, pre-pupal and pupal period was 19.1 ± 0.4 , 2.4 ± 0.1 , 14.6 ± 0.7 days, respectively. Variation in subspecies, hosts, and climates could be the main causes of these differences (Smith *et al.* 1988)^[10]. Swailem and Ismail (1972)^[11] and Sharma and Verma (2005)^[9], both observed the pupal colour in pale green. However, Ramana *et al.* (1998)^[8] and Braby (2000)^[1] found only green colour during the pupal period. The greening hormone in the larval head was responsible for the colour variation in pupa (Smith *et al.* 1988)^[10].

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