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Study on the life cycle of butterfly species *Danaus chrysippus* (*Nymphalidae*) and *Papilio polytes* (*Papilionidae*) in an agroecosystem

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Abstract
The life cycles of the Plain Tiger (*Danaus chrysippus*) and the Common Mormon (*Papilio polytes*) butterflies were studied under laboratory conditions from January 2024 to December 2024. Most butterfly species depend on specific host plants within the ecosystem. Eggs collected from the agroecosystem were maintained under sterile conditions until hatching. Newly emerged larvae were fed their preferred host plants and reared using conventional rearing techniques. Both butterfly species underwent four moults and five instars during larval development. The duration of the life cycle varied between the two species, indicating that both species identity and family characteristics influence the developmental timing. The developmental stages from egg to adult showed notable differences between the two species under laboratory conditions. Such observations are essential for understanding life cycle duration, which in turn supports conservation and management measures for these species.

Keywords: Butterfly species, *Danaus chrysippus*, *Papilio polytes*, life cycle, agroecosystem

Introduction

Butterflies are a diverse group of insects belonging to the order *Lepidoptera*. They play a significant role in pollination, and many species depend on specific host plants for survival, forming essential ecological relationships. In addition, butterflies occupy a crucial position in the food chain and serve as bio-indicators of environmental quality, making them an important component of global biodiversity (Kanagaraj *et al*., 2018) [7]. Declines in butterfly populations can directly affect agricultural systems (Devkar & Chati, 2025) [4]. Understanding butterfly biology requires knowledge of their life cycle, which consists of several distinct stages that are vital for studying their ecological interactions. Petersen (1997) documented variations between butterfly populations influenced by local environmental conditions and identified the occurrence of multiple generations within species.

The family *Nymphalidae* comprises more than 7,000 species worldwide (Francke, 1989) [5] of which 521 species have been recorded in India (Kehimkar, 2008) [8]. *Danaus chrysippus*, commonly known as the Plain Tiger, is one of the widely distributed species in this family. According to Kheloufi *et al*. (2019) [9], *D. chrysippus* occurs abundantly in Africa, southern Europe, Saudi Arabia, tropical Asia, Australia, and New Zealand. In Tamil Nadu, 97 species of *Nymphalidae* have been reported (Appavu Pavendhan *et al*., 2024) [14].

Papilio polytes is a common swallowtail butterfly belonging to the family *Papilionidae*, characterized by the distinct tail-like extensions on its hind wings (Islam *et al*., 2017) [6]. Globally, approximately 570 species of *Papilionidae* have been reported (Yan *et al*., 2024), of which 89 species occur in India (Smetacek & Varshney, 2015) [17]. Tamil Nadu supports 19 species within this family (Appavu Pavendhan *et al*., 2024) [14]. Papilionid butterflies are holometabolous, undergoing complete metamorphosis with distinct egg, larval, pupal, and adult stages. They maintain complex feeding interactions with green plants throughout their life cycle, as both larvae and adults primarily rely on foliage and floral resources (Nagalakshmi *et al*., 2017) [10]. *P. polytes* is tropical to subtropical in distribution and occurs from Southeast Asia to the southwestern islands of Japan (Corbet & Pendlebury, 1992; Nakayama *et al*., 2003; Nakayama & Honda, 2004) [2, 11, 12].

The present study was carried out to enhance understanding of butterfly biology and morphometrics in agroecosystems, with a particular focus on the life cycle and morphometric characteristics of *Danaus chrysippus* and *Papilio polytes*.

Materials and Methods

Adult butterflies use a variety of plants to obtain nectar. The season and the butterfly's habitat range influence the availability of flowering host plants. *Danaus chrysippus* (Linnaeus, 1758) primarily consumes plants in the genus *Asclepias*, commonly known as milkweeds. Plants belonging to the family Rutaceae serve as host plants for the northern subspecies of *Papilio polytes* (Linnaeus, 1758), while Fabaceae species are used by the southern subspecies.

From January 2024 to December 2024, agroecosystems in the Cuddalore district were regularly surveyed to study the life histories of two butterfly species: *Papilio polytes* and *Danaus chrysippus*. The flowering season coincided with the field experiment. Both field and laboratory conditions were used for the life-history observations. Freshly laid eggs were collected from the field, along with the portion of the host plant on which they were deposited, without causing any damage and transported to the laboratory and kept in sterilized Petri dishes for further study. They were maintained under sterile conditions until hatching. Blotting paper was used to line the dishes to maintain humidity. The date and time of each collection were recorded. Since butterflies are generally diurnal and remain most active between 6:00 a.m. and 5:00 p.m., surveys were conducted during this period to collect samples and observe oviposition behaviour.

After hatching, newly emerged larvae were transferred to plastic containers with fresh leaves of the host plant, which were replaced periodically. This rearing process enabled observation of larval and pupal behaviour and development. The number of larval instars and the number of moults were recorded. After emergence, adults were transferred to a cylindrical container and provided with a honey solution for feeding.

Results and Discussion

Plain Tiger Butterfly (*Danaus chrysippus*)

Egg Stage

The freshly laid egg is dome-shaped and has longitudinal ridges. Upon laying, the eggs are white but transition to a cream colour within a day. Each egg measures about 1.00 mm in length and 0.80-0.90 mm in width. The eggs hatch after an incubation period of 4 days. Immediately after emerging, the larva consumes its eggshell and then it undergoes five instars over a duration of 6 to 9 days. According to Rao *et al*. (2016), *D. chrysippus* has a three-day egg period in its life cycle.

Larval Stage (Instars I-V)

This stage lasts about two days. The larva reaches a length of 4-5 mm and a width of 1.10-1.20 mm. The body is yellow and covered with tiny hairs on both the head and body. The head is black and broad, bearing a pair of black horns. Longitudinal yellow lines are present on the dorsal side of the body. This instar lasts 1-2 days, during which the larva grows to 7.0-10.0 mm in length and 1.50-2.00 mm in width. The body becomes entirely green, and the head becomes square-shaped and black. The anal spines are black. Prominent yellow longitudinal lines appear on the dorsal side, along with a pair of narrower yellow lines on each lateral side. Both the body and head exhibit a rough, hairy texture. Over the course of 1-2 days, the larva grows to 11.00-16.00 mm in length and 2.00-2.50 mm in width. The head has two forked horns, is black and hairy, and bears white patterns. Distinct yellow stripes occur dorsally and laterally, with the dorsal pair extending to the black anal spines. The body appears clearly segmented. Other characteristics remain similar to the previous instar. This stage lasts about one day, with the larva growing to 14.00-21.00 mm in length and 2.50-3.00 mm in width. The entire head, including the horns, turns reddish-brown. The head's white patterns shift to a cream colour, becoming distinct and triangular. On the dorsal side, the anal spines turn orange. Other traits remain unchanged from the previous instar. After two days of growth, the larva reaches a final size of 27.00-35.00 mm in length and 4.10-5.10 mm in width. The orange anal spines develop black tips. The larva has a green body with two forked horns on its head. Two smaller yellow lines occur on each lateral side of the body, along with prominent longitudinal yellow lines along the dorsal side. The total life cycle duration (30-33 days; mean: 31.4 ± 1.14 days) closely matched earlier reports. Larval instars showed progressive morphological changes suited to feeding on *Asclepias* species, with body lengths ranging from 4.4 mm (first instar) to 30.2 mm (fifth instar) (Dalui *et al*., 2022) [3]. Additionally, *D. chrysippus* larval development takes seven to eight days, according to Rao *et al*. (2016). Previous studies have documented considerable variation in developmental durations for *D. chrysippus*. Wadnerkar *et al*. (1979) recorded longer larval (19.1 days) and pupal (14.6 days) periods, while Swailem and Ismail (1972) observed a total developmental time of 26-37 days.

The pupal stage lasts 6 to 9 days. *D. chrysippus* pupae have a life cycle of 7-8 days, according to Rao *et al*. (2016). The pupa measures 1-5.00-17.00 mm in length and 7.00-8.00 mm in width at its widest point. It is initially vivid green in colour, later turning a light brownish shade. A yellowish-green marking is present on its back, and the anterior region is wider than the posterior. On the dorsal side, a protrusion with linear red and cream markings is visible. Cream spots bordered with crimson occur dorsally, while red spots with yellow borders appear along the lateral sides.

The total duration from egg to adult ranges from 16 to 20 days (egg: 4 days; larva: 6-9 days; pupa: 6-9 days). The life cycle of *D. chrysippus* was finished in 17–18 days, according to Rao *et al*. (2016).

In adult butterflies, both sexes have orange tips on their forewings with black edges. Four tiny black disc-like markings are present on each hind wing. The thorax is black with white dots. The upper portion of both wings has black borders and is reddish-brown. The primary difference between males and females is the number of black patches on the hind wings. Males have four patches, whereas females have three.

Common Mormon Butterfly (*Papilio polytes*)

Papilio polytes, commonly known as the Common Mormon butterfly. The life cycle of this species consists of four primary stages: egg, larva, pupa, and adult. The larval stage includes five instars, during which the larva moults and increases gradually in size.

Egg Stage

Female butterflies lay single eggs on either the dorsal or ventral surface of host plant leaves. The eggs are small and spherical. Freshly laid eggs are greenish-yellow in colour. Each egg measures approximately 0.84-2.00 mm in length and 0.65-0.77 mm in width. The eggs hatch after an incubation period of 2–3 days. After hatching, the larvae pass through five growth stages (instars) over a period of 10-12 days.

Larval Stage (Instars I-V)

This stage lasts approximately 1-2 days. The larvae reach a length of 1.00-3.00 mm and a width of 1.00-1.10 mm. They are small and dark yellowish-brown in colour, with two white bands encircling the first and last segments. Small setae are present on the head and lateral sides of the body. The second instar lasts 2-3 days. Larvae grow to a length of 3.00-6.00 mm and a width of 1.50-2.00 mm. They resemble late first-instar larvae but have white markings on the middle and posterior body segments. The body colour becomes darker during this stage. This stage lasts 2-3 days, during which the larvae reach 6.50-11.00 mm in length and 1.70-2.20 mm in width. The larvae appear dark with distinct white furrows on the body segments. The caudal horn becomes thicker and turns white. Over 3-4 days, the larvae grow to 12.00-17.00 mm in length and 2.20-3.10 mm in width. The body becomes greenish with a white streak encircling the abdominal segments. The caudal horn develops into a more pronounced, spike-like projection. The fifth instar lasts 3-4 days. Larvae reach a final size of 18.00-

22.00 mm in length and 2.50-3.20 mm in width. Islam *et al* (2017) [6] *P. polytes* larval development showed a clear morphological progression, with body length growing from 5.2 mm in the first instar to 32.6 mm in the fifth instar. During this stage, the larvae turn light green to pure green. Two prominent dorsal markings appear: one connected to the eyespot and another situated on the abdominal segment. Studies on other *Lepidopteran* species further highlight the influence of larval host plants on developmental duration. Barua and Slowik (2007) [1] documented the life cycle of *Pachliopta hector* and *P. aristolochiae*, demonstrating that growth rates vary with host-plant type. Similarly, Rizvi and Ali (2009) [15], in their investigation of the cabbage butterfly *Pieris brassicae*, reported that larval food plants significantly affect both the duration of developmental stages and the differences observed between laboratory and natural environments. In contrast, the pupal stage lasts approximately 10-12 days. The pupa measures 24.00-26.00 mm in length and 4.50-6.00 mm in width at its widest point. It suspends itself from the stem using a black silk girdle. The pupa is green in colour.

The total duration from egg to adult ranges from 30 to 35 days, Islam *et al*. (2017) [6] reported a similar range of 28-32 days. (egg: 2-3 days; larva: 10-12 days; pupa: 10-12 days; adult lifespan: 10-12 days). Devkar and Chati (2025) [4] reported a life cycle duration of 39-41 days (mean: 40.0 days) for *P. polytes*, consistent with the extended developmental periods characteristic of *Papilionidae*.

The adult butterfly is black in colour. The forewings bear white spots along the margins, while the hindwings feature a white streak near the edge. A tail-like extension is present on the hindwings. Adults possessed a wingspan of 82-86 mm and showed pronounced sexual dimorphism Islam *et al*., 2017) [6].

Table 1: Early Life Stages of *Danaus chrysippus* Butterfly

Stage	Length (mm)			Width (mm)			Duration	
	Min.	Max.	AV±SD	Min.	Max.	AV±S.D	Range	AV±SD
Egg	1.00	1.00	1.00 ± 0.1	0.80	0.90	0.85 ± 0.07	4	4.00 ± 0.00
I	4.00	5.00	4.5 ± 0.70	1.10	1.20	1.2 ± 0.14	2	1.85 ± 0.21
II	7.00	10.0	8.5 ± 2.12	1.50	2.00	1.75 ± 0.35	1-2	1.5 ± 0.70
III	11.00	16.00	13.05 ±3.53	2.00	2.50	2.2 ± 0.28	2	1.65 ± 0.49
IV	14.00	21.00	17.35 ± 4.94	2.50	3.00	2.6 ± 0.14	1	1.1 ± 0.14
V	27.00	35.00	30.50 ± 5.65	4.10	5.10	4.06 ± 0.70	2	1.87 ± 0.17
Total larval period	30.00	35.00	33.95 ± 5.86				6-9	7.5 ± 2.12
Pupa	15.00	17.00	16.01 ± 1.41	7.00	8.00	7.25 ± 0.35	6-9	7.25 ± 1.76

Tab 2: Early Life Stages of *Papilio polytes* Butterfly

Stage	Length (mm)			Width (mm)			Duration	
	Min.	Max.	AV±S.D	Min.	Max.	AV±S.D	Range	AV±S.D
Egg	0.84	1.03	0.93± 0.13	0.65	0.77	0.71 ± 0.08	2-3	2.25 ± 0.35
I	1.00	3.00	2.00 ± 1.41	1.00	1.10	1.05 ± 0.07	1-2	1.62 ± 0.88
II	3.00	6.00	4.5 ± 2.12	1.50	2.00	1.75 ± 0.35	2-3	2.32 ± 0.45
III	6.50	11.00	8.75 ± 3.18	1.70	2.20	1.95 ± 0.35	2-3	2.8 ± 0.42
IV	12.00	17.00	14.5 ± 3.53	2.20	3.10	2.65 ± 0.63	3-4	3.25 ± 0.77
V	18.00	22.00	20.00 ± 2.82	2.50	3.20	2.85 ± 0.49	3-4	3.40 ± 0.84
Total larval period	24.00	26.00	25.00 ± 1.41				10-12	11.00 ± 1.41
Pupa	22.00	28.00	25.00 ± 4.24	4.50	6.00	5.25 ± 1.06	10-12	10.05 ± 0.70

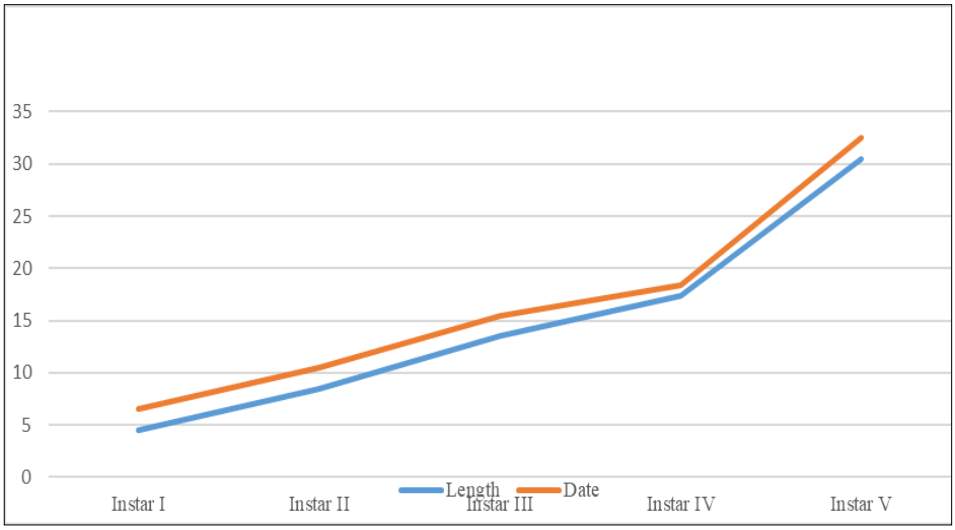

Fig 1: A line graph depicts spending days and length measurements of plain tiger butterfly (*Danaus chrysippus*)

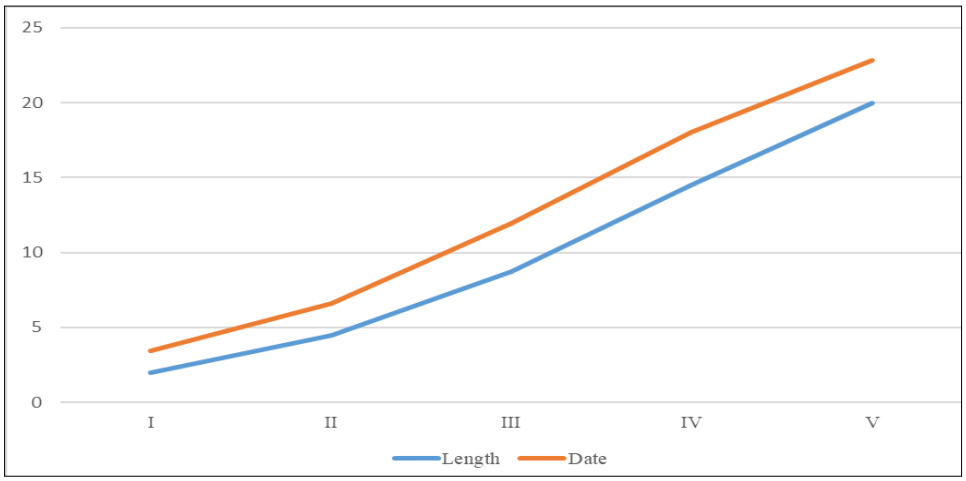

Fig 2: A line graph depicts spending days and length measurements of Common mormone butterfly (*Papilio polytes*)

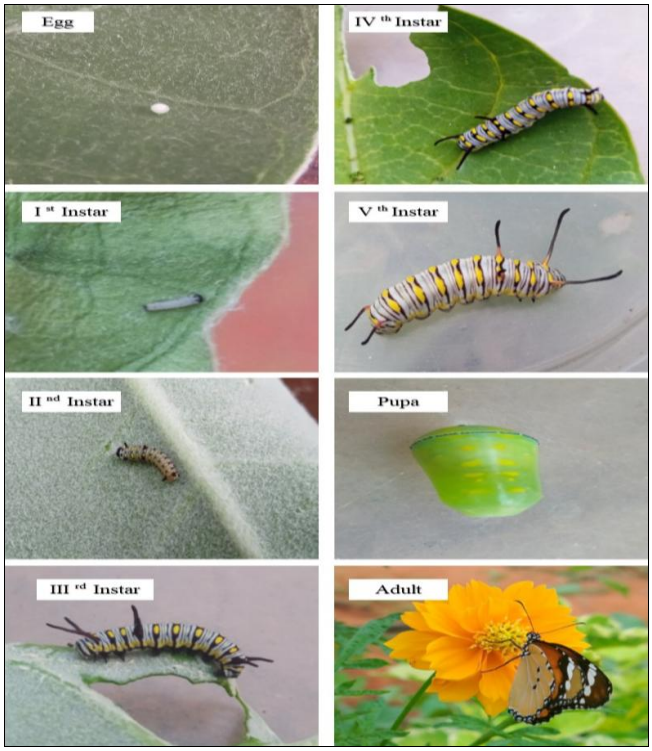

Fig 3: Life cycle of *Danaus chrysippus*

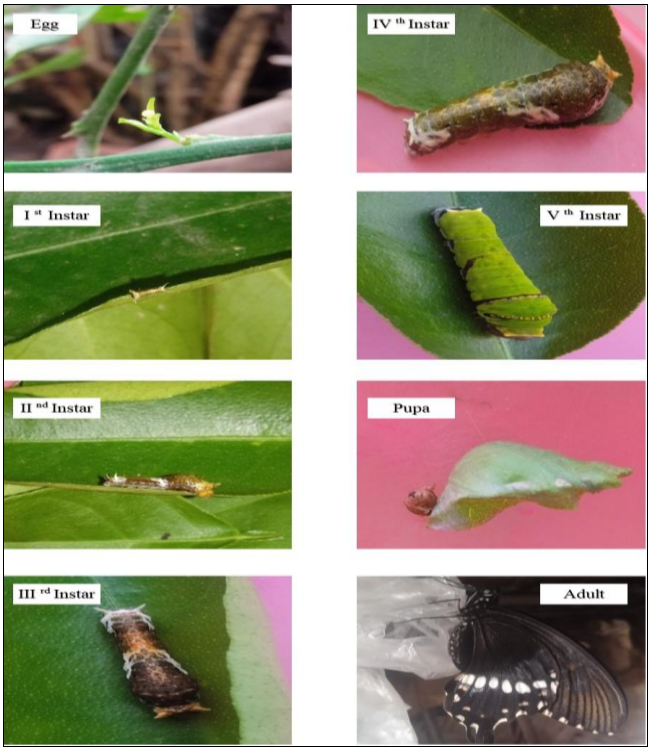

Fig 4: Life cycle of *Papilio polytes*

Conclusion

In Conclusion, the developmental stages from egg to adult of *Papilio polytes* and *Danaus chrysippus* were successfully observed under laboratory conditions. The duration of the life cycle varied between the two species, indicating that both species identity and family characteristics influence the developmental timing. The observed species were more prevalent from March to May and from August to December, which aligns with Owen, (1971) [13] hypothesis that tropical butterflies breed throughout the year, with peak activity occurring during specific seasons.

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