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STUDIES ON BIOLOGY OF *CATOPSILIA POMONA* (FABRICIUS), THE COMMON EMIGRANT AND *C. PYRANTHE* (LINNAEUS), THE MOTTLED EMIGRANT (LEPIDOPTERA : PIERIDAE) FROM PUNJAB

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The gross morphology and duration of various life history stages has been recorded of two species of genus *Catopsilia* Hübner viz.. *pomona* (Fabricius) and *pyranthe* (Linnaeus). The larval and oviposition behaviour of both has been studied in details. Some nectar food plants of adults have also been recorded. *Sturnus vulgaris* (Linnaeus)(Sturnidae), *Hypsitetes madagascariensis* (Muller) (Pycnonotidae) and *Turdoides caudatus* (Dumont) (Timaliidae) have been recorded as bird predators of *C. pomona.*

Key words : Behaviour, *Catopsilia Pomona*, *Catopsilia pyranthe*, life history stages, Pieridae.

INTRODUCTION

The genus *Catopsilia* Hübner is represented by four species *viz. pomona* Fabricius, *pyranthe* Linnaeus, *florella* Fabricius and *scylla* Linnaeus from India (Varshney, 1993). The former two species are present throughout India (Evans, 1932) and during present studies both these species are found to be present in dry, moist and as well as foothills areas of Punjab. Wynter-blyth (1957) has recorded *Cassia fistula* (Linnaeus), *Cassia siamea* (Lamk), *Cassia tora* (Linnaeus), *Butea frondos* (Koen) and *Bauhinia racemosa* (Lamk) as larval host plants of *pomona*, and *Cassia tora, Cassia auriculata, Cassia occidentalis* as larval host plants of *pyranthe* Linn. During the course of present studies, the life cycle of *pomona* is studied on *Cassia siamea* Lamk. (Caesalpiniaceae) and life cycle of *pyranthe* is studied on *Cassia occidentalis* Linnaeus, *Cassia fistula* Linnaeus, *Cassia tora* Linnaeus (Caesalpiniaceae). The life history and behaviour of both the species is being described in details. Besides this, *Cosmos sulphureus* Cav., *Bidens pilosa* Linnaeus, *Zinnia elegans* Jacq., *Cosmos bipinnatus* Cav. (Compositae); *Cheiranthus cheiri* Linnaeus (Cruciferae); *Coccinia cordifolia* Linn. (Cucurbitaceae); *Lantana camara* Linnaeus, *Stachytarpheta urticaefolia* Sims. (Verhenaceae); *Murraya paniculata* Linnaeus, *Murraya paniculata* Linnaeus (Rutaceae); *Poinciana pulcherrima* Linnaeus (Caesalpiniaceae); *Russelia coccinea* Wetts., *Salvia coccinea* Juss. (Labiatae); *Quisqualis indica* Linnaeus (Cambrotaceae); *Sylibum marijanum* Schlecht. and Cham., *Russelia equisetiformis* Schlecht. & Cham. (Scorophulariaceae) *and Oxalis latifolia* Auct. (Oxalidaceae) have been recorded as nectar food plants of *Pomona* and *Zinnia elegans* Jacq. (Compositae); *Mathiola incana* R.Br. in Ait. (Cruciferae); *Poinoiana pulcherrima* Linnaeus, *Cassia fistula* Linn. (Caesalpiniaceae); *Lantana camara* Linnaeus (Verbenaceae); *Sylibum marijanum, Limonium suworowii* Kuntze (Plumbaginaceae) have been recorded the nectar food plants of *pyranthe*. The detailed account of the various life history aspects of these species is as follows.

MATERIALS AND METHODS

The eggs and different larval instars brought from field were kept in circular transparent containers, each measuring (10 cm in diameter and 4.5 cm deep). Subsequently, the later instars were shifted to relatively larger transparent containers (12x7 cm, 15x20 cm and 18x23 cm) furnished with fresh clippings of the food plants. The mature larvae nearing pupation were then shifted to still bigger rearing containers (18.5 cm in diameter and 12.5 cm deep) for pupation. The freshly emerged adults were transferred to the insect breeding cages of varied sizes and furnished with an artificial diet consisting of 10% sugar solution to record their longevity. The rearing boxes were carefully examined twice a day in order to make observations on different life history aspects. The rearing boxes were cleaned at regular intervals by removing the faecal matter, dead insect stages and waste host food plant clippings etc. for keeping proper hygienic conditions. The fresh host plant cuttings were provided to the larvae for their proper development and also to minimize the mortality rate due to starvation etc. The gross morphology, colouration and measurements of the egg, different larval instars and the pupae were recorded with the help of occulometer, taking a mean of 05 specimens of each stage.

OBSERVATIONS

***Catopsilia pomona* (Fabricius)**
(Figs.1-6)

***Life-history stages and developmental time* : Eggs (Fig. 3) :** Length 1.26 ± 0.08 mm, width 4.52 ± 0.35 mm (at 20x X10), singly laid, spindle shaped, whitish-yellow, slightly turned to one side near micropyle, latter distinct, number of ridges and furrows 8 to 9 and 9 to 10 respectively, transverse striae present on egg surface, all ridges reach upto micropylar end, latter turns yellowish-brown, first instar movements traceable from outside chorion.

***Incubation period* :** 1.78 ± 0.21 days.

Larva : Number of instars : 5

First instar

***Head* :** Width 1.26 ± 0.85, hypognathous, light brown, shinning, distinct, globular, stemmata and sutures well pronounced, long primary setae present.
***Body* :** Length 6.0 ± 1.0 mm, width 1.42 ± 0.29 mm, pale yellowish, cylindrical, well segmented, each segment further annulated, though number of annuli not distinct, later turns green, mid-dorsal stripe indistinct, yellow lateral stripes also indistinct, throughout length of body, spiracles conspicuous, setae long, , in each annulus present band.

Second instar

***Head* :** Width 1.3 ± 0.18 mm, as above, except colour of head greenish brown.
***Body* :** Length 13 ± 1.58 mm, width 1.25 ± 0.03 mm, as above, except 8th to 10th abdominal segments turn blackish comparatively, six annuli segment distinct, inter-

segmental and interannular septa visible, black pinnaculi bearing small primary and secondary setae, conspicuous.

Third instar

Head : Width 2.44 ± 0.13 mm; as above, except turns yellowish-green; secondary setae present along with primary ones.
Body : Length 18.4 ± 2.88 mm, width 3.18 ± 0.29 mm, as above, except neck visible during feeding, A8 to A10 less widened comparatively, body setosed, whitish-yellow lateral stripe present, an additional broad black smoky lateral stripe appear above it, formed of grouping of pinacula, both run throughout body length, legs hairy with transparent whitish hairs.

Fourth instar (Fig. 4)

Head : Width 2.78 ± 0.25 mm; as above, pinnaculi distinct.
Body : Length 24 ± 4.18 mm, width 2.98 ± 0.31 mm, as above, except a typical bifid patterned spot present dorsally on 10th abdominal segment, pinnaculi of setae black and distinct.

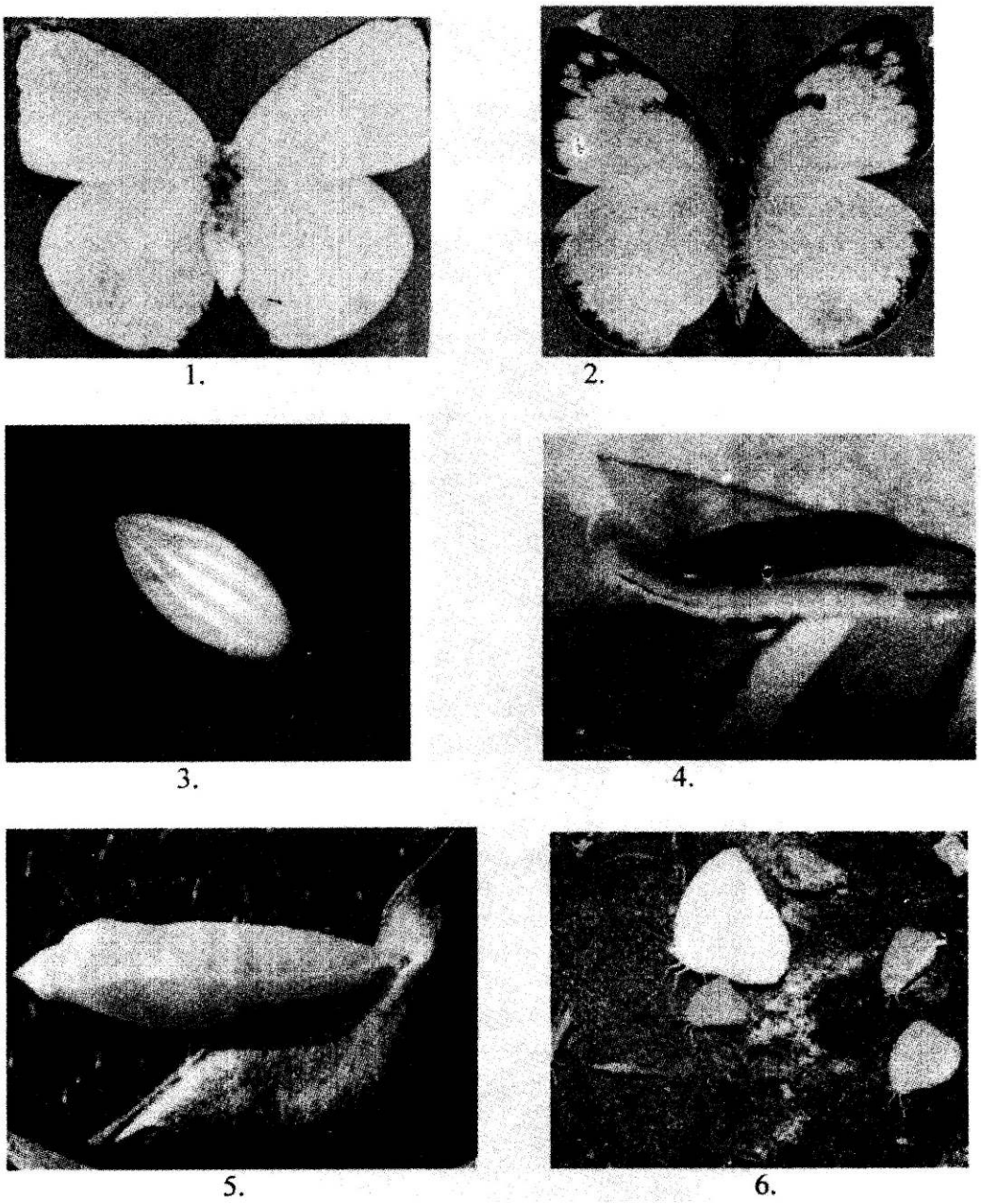
Fifth instar

Head : Width 3.02 ± 0.37 mm, as above.
Body : Length 28.6 ± 4.36 mm, width 4.36 ± 0.41 mm, as above, except whitish-yellowish lateral stripe turns deep yellowish, smoky black lateral stripe get diminish in 8th to 10th abdominal segments.

Pupa (Fig. 5) : Length 25.0 ± 1.0 mm, width 6.9 ± 0.74 mm; light greenish, later turns yellowish brown; attached upside down from upper petridish (under laboratory conditions) or from twig (in wild), camouflage with surroundings in wild, tapering at both ends, anterior end black and turncated; width maximum in wing region, yellow mid-dorsal and lateral stripes distinct throughout length of pupa, spiracles and abdominal segmentation well defined; supported by girdle, latter wrapped around 2nd/ 3rd abdominal segment arising from substratum, additional support provided by attached caudal end through silken threads, in rare instances girdle absent, head and body excuviae of fifth instar attached to caudal end, case becomes transparent on ripening, wings, head, antennae, eyes, mouth parts visible from outside pupal case.

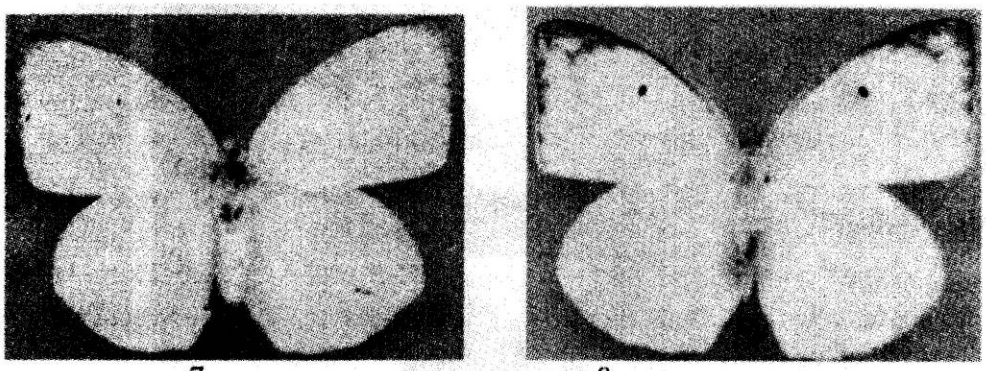
Oviposition behaviour : *Catopsilia pomona* (Fabricius) lays her eggs on *C siamea* Lamk (Caesalpiniaceae), which is quite common in Punjab. Many tree present at the Punjabi University, Patiala Campus, itself. The butterfly lays her eggs during the months of February to May and mid-July to October. The salient features of oviposition are : i) the eggs are laid on the fresh tender leaves. ii) the eggs are deposited singly. iii) the eggs are laid on the margins or the undersurface of the leaf. iv) the egg laying is quite frequent and the single leaf may be selected for oviposition by same/ different individuals v) in peak season, a single female may deposit, as many as, 20 to 22 eggs within a period of 20 seconds.

Larval behaviour : In different instars, the larva takes 5 to 8.45 hours to moult. In first instar, larva after feeding on egg shell move to feed on fresh and tender leaves. The feeding symptoms are of two types *i.e.* either making minute circular holes on the leaf or



Figs. 1-6 : Explanation for *Catopsilia pomona* (Fabricius). **1.** Adult (Male); **2.** Adult (Female); **3.** Egg; **4.** Last instar larva; **5.** Pupa; **6.** Mud-puddling behaviour.

feeding from and along margins of the leaf. However, midrib of the leaf remains intact. The second instar larvae feed only on apical portion of the leaf. The third instar caterpillar feeding on the leaves makes relatively bigger holes. The fourth instar caterpillar consumes the whole leaf but without midrib. The fully fed larva take rest along the mid-dorsal line of the leaf, with the head facing towards the stem. In some rare cases, it has also been seen that the larva of first three instar stages also rest along mid-ventral line of the leaf. The larva may restore to intraspecific cannibalistic behaviour in the



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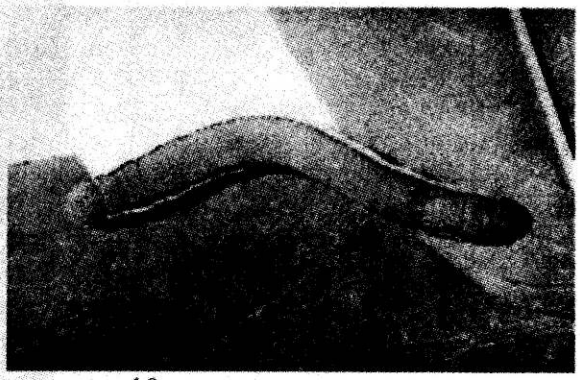

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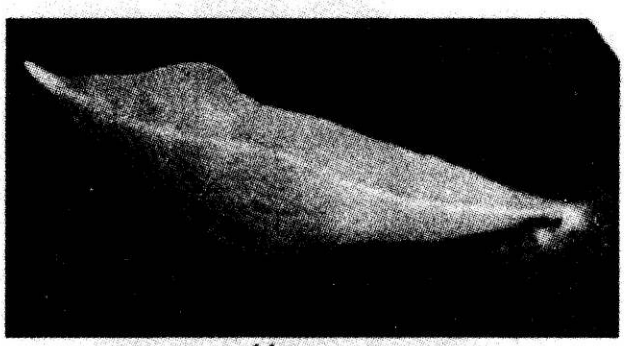

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***Figs.* 7-11** : Explanation for *Catopsilia pyranthe* (Linnaeus). **7.** Adult (Male); **8.** Adult (Female); **9.** Egg; **10.** Last instar larva; **11.** Pupa.

scarcity of the food plants, as has been seen in captivity. The third instar larva consumed the first instar within a period of 8.5 minutes, as seen in the laboratory (29.4^{0}C).

Pupation : The prepupation occurs in early morning or late evening hours in nature with upside down posture. The larva is attached to the substratum at the anterior and caudal ends of the body. The prepupation period lasts for 10 to 12 hours. During its later stages, colour of the fifth instar larva changes to dark green and light green along dorsal and ventral regions, respectively. The ateral stripes being yellowish and white on first

two abdominal segments and rest of body segments respectively.

Eclosion : The eclosion generally occurs in early morning or late evening hours in nature. It takes nearly 45-60 minutes for the adult to come out of the pupae and to become active.

Field observations

Mating behaviour : For mating, the adult males fly in search of females at height of 6 to 16 fts above the ground level. The female is always chased by a group comprising 3 to 8 males per group. The species is a powerful flier and makes a series of upward and downward curves. The determined male faces the same rejection/ acceptance behaviour in a particular territory. Owing to territorial behaviour and severe competition, most of the males are seen with their wings broken in nature. The duration of a pair in copula varies from 1.25 to 1.40 hours. The male is active flight partner.

Mud-puddling behaviour **(Fig. 6)** : The species has been seen to puddle on wet bricks, on moist soil, on cow dung and on moist sand. The number of puddling adults varied from 1 to 4 at different localities, mentioned in the parenthesis. However, it seems appropriate to mention here that a congregertion of 10 to 12 adults involved in puddling on moist soil along a water source were noticed at Madhopur (Gurdaspur).The puddling adults probe the soil with fast movements of their proboscis while remaining stationary in rows. The abdomen was slightly raised at ground level. It need hardly be emphasized that the puddling adults were all males and could easily be identified due to sexual dimorphism.

Predatism : During many field surveys, it has been observed that the species is highly prone to be attacked by the predators. The chief bird predators of adult *C. pomona* are : *Sturnus vulgaris* (Linnaeus)(Sturnidae), *Hypsitetes madagascariensis* (Muller) (Pycnonotidae) and *Turdoides caudatus* (Dumont) (Timaliidae). Out of these, the former predates upon the adults just within the twinkling of an eye. As such, except wings, the entire body is consumed by the predators. In addition to Aves, the adults are also predated upon by arthropods such as grasshoppers, praying mantids and spiders. These arthropods hide themselves amongst camouflaged surroundings and attack the adult butterflies, as and when, they come for nectar sucking on different species of plants during sunshine hours. It is note worthy to record that though the adult butterfly visits the nectar source just for 3 to 6 seconds, yet is promptly pounced upon by the predators, as if the latter is waiting for his/ her arrival. It takes about 16 to 30 minutes for a spider to kill the adult by sucking its body fluids.

Remarks : Owing to vast availability of the host plant, *C. siamea* (Lamk), the species is relatively more common. In fact, the common host plant is availabale along road sides at many places in various districts of Punjab. Like wet areas, the population built up of this species is increasing in the dry zone areas due to the availability of more number of host plants because of the aforestation drive undertaken in recent past.

***Catopsilia pyranthe* (Linnaeus)**
(Figs. 7-11)

***Life-history stages and developmental time* : Egg (Fig. 9)** : Length 1.38 ± 0.10mm, width 4.44 ± 0.87mm, same as that of *Catoposilia pomona*, except that more spindose comparatively, shinning dirty-whitish, all ridges not reaching upto micropyle, later turn yellowish-white before hatching.

Incubation period : 2.8 ± 0.57 days. It has also been noted that hatching normally takes place during early morning hours, except in the month of March when it occurs in the afternoon.

Larva : Number of instars : 5

First instar

Head : Width 0.74 ± 0.11 mm; hypognathous, distinct, globular, light greenish, later turns yellowish-green, non retractible, nearly equal in width to body, stemmata and cephalic sutures conspicuous, primary setae long with distinct pinnaculi.
Body : Length 5.4 ± 0.54 mm, width 1.08 ± 0.16 mm, cylindrical, uniformly widened, whitish-green, later becomes greenish; well segmented, each segment further annulated (6-7 annuli/ segment), intersegmental and interannular septa/ furrow well defined, mid-dorsal stripe well-defined, long setae with black pinnaculi present in transverse bands (one band/ annulus), spiracles clearly visible laterally.

Second instar

Head : Width 1.46 ± 0.11 mm, as above, except slightly less widened than body.
Body : Length 11 ± 0.10 mm, width 2 ± 0.15 mm, as above, in addition a yellow stripe appears laterally, just above legs, running throughout length, mid-dorsal stripe wanting, 8th to 10th abdominal segments less widened that rest of segments.

Third instar

Head : Width 3.34 ± 0.31 mm, as above, except secondary setae present besides primary setae.
Body : Length 19.6 ± 1.51 mm; width 3.7 ± 0.67 mm, as above, except a smoky black lateral stripe present just above yellowish lateral stripe throughout length, formed of pinaculi, both aforesaid lateral stripes wanting in 8th and 10th abdominal segments, latter demarcated from rest segments, bifid caudo-dorsally.

Fourth instar (Fig. 10)

Head : Width 4.16 ± 0.32 mm, as above, except as wide as body.
Body : Length 38.4 ± 2.71 mm, width 4.14 ± 0.12 mm; as above, except that smoky black lateral stripe further widened, light brownish spiracles distinct laterally.

Fifth instar

Head : Width 4.2 ± 0.12 mm, as above.
Body : Length 38.4 ± 2.70 mm, width 4.24 ± 0.04 mm, as above, except that interannular septa/ furrows turned wavy or wrinkled.

***Pupa* (Fig. 11) :** Length 23.8 ± 2.77 mm, width 6.65 ± 0.54 mm; similar to *C. pomona*, except that thoracic region being yellowish; caudal end being black; anterior end blunt, dorsally raised, not as pointed as in case of *C. pomona*; mid-dorsal stripe wanting; pupal dimorphism present, female pupae little bit more lengthened than male, former also having two black spots, latter present one on either side of raised yellowish portion of mid-dorsal thoracic region.

***Oviposition behaviour* :** The ovipositional behaviour of *C. pyranthe* (Linnaeus) can be observed uninterruptedly from March to October every year in the state of Punjab. From March to August, the eggs are laid on two egg laying host plants *i.e. Cassia occidentalis* Linnaeus and *C. fistula* Linnaeus (Caesalpiniaceae) simultaneously. However, it has also been observed during the months of March (29.4^{0}C), April (35.6^{0}C) and May (40.9^{0}C), that the maximum number of eggs were laid on the former plant, whereas, the latter is preferred for oviposition in June (45.1^{0}C), July (40.9^{0}C) and August (35.9^{0}C) every year. With drying and withering of the leaves of these two plants, the butterfly switches on to still another egg laying host *i.e. C. tora* (Linnaeus), in the month of September and October. In all cases, the eggs are generally laid on the tender leaves of the plants of shorter height. The frequency of egg laying is generally more pronounced during clearer sunny weather conditions rather than cloudy ones. The eggs are deposited on either side of the leaf near the corners, preferably on the undersurface of the leaf. As many as, 2 to 9 eggs may be laid on a single leaf. In a period of 12 to 14 seconds, a female may deposit 3 to 5 eggs.

During the survey work, it has also been noted that though common grasses are no longer the larval host plants of the species under reference, yet under certain unavoidable conditions, the females have been seen to deposit their eggs there, as well. It is clearly a case of oviposition mistake as the first instar larvae fail to feed on grass blades and died.

***Larval behaviour* :** The different larval instars feed upon the leaves and produce varied feeding symptoms. The first instar caterpillars feed on the young leaves and make holes either along midrib or consume apical edges of the leaf as a whole or do the both. The second instar caterpillars though consume the tender leaves but make bigger holes between the edges and mid-rib of the leaf. Contrary to this, the third instar caterpillars feed along the margins in the apical half of the leaf, whereas, the fourth instar initiates feeding at the proximal end of the leaf and extend their feeding along the margins leaving aside area around midrib. As usual, the fifth instar larva is relatively more voracious and consumes the fresh leaf as a whole or leave the midrib of the older leaves intact. The green coloured larvae rest and camouflage themselves with the upper surface of the leaves, with their heads towards the petiole.

***Pupation* :** Pupation takes place as in *Catopsilia pomona*. The prepupal period varies from 10 to 12 hours.

***Eclosion* :** Eclosion takes place in morning hours. It takes nearly 0.50 to 1.30 hours for the adult to come out of the pupae and to become active.

Field observations

***Mating behaviour* :** The adults fly at a height of 3 to 8 ft above the ground level, at a moderate speed. The mating pairs can be seen during pre-monsoon, monsoon and post-

monsoon periods when the population is reasonably quite abundant. The mating behaviour is almost the same as that of *C. pomona*, except that instead of many males following a female, the latter is chased by 1 or 2 males only. Under normal circumstances, when a pair in copula detaches itself, the male walks upwards and the female downwards on the same twig. The former flies prior to the latter. As such, there is no specific territorial behaviour observed in this species. The copulation lasts for 2.19 to 3.35 hours.

Mud puddling : The males in a small group of 2 to 4 individuals were seen puddling on the moist site around after noon at 11.32 PM and 1 PM at Punjabi University, Patiala Campus and Rose gardens, Bathinda respectively in the month of August.

Remarks : *C. pyranthe* is available throughout the year in varying numbers in almost all the areas of Punjab. Contrary to many, the present species ensures its presence felt in high numbers even during the hottest periods (June and July) of the year. It appears as if the species has many overlapping generations in the year.

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