Biology of the Common Castor Butterfly Ariadne merione merione Cramer (Lepidoptera: Nymphalidae) reported from Jammu region of J & K State

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Abstract
Biology of common castor butterfly was studied under the field and laboratory conditions during the year 2013. Field studies indicated that Ariadne merione merione Cramer was in continuous flight and reproduction, with highest densities of early and adult stages occurring during June–September, the time of the entire North-West monsoon. Mating which usually takes place once, twice, or thrice, is observed on the same day or a day after emergence. Female starts laying eggs on the same day or a day after mating. Fresh eggs of common castor butterfly were collected from the host plants. Fresh eggs were transported and kept in the laboratory for rearing. Hatched larvae were individually reared on leaves of common castor, R. communis for studying the morphology and life history of the butterfly. The complete life cycle from egg to adult took 22-32 days and usually has 8-9 generations per year. The biology and developmental periods are mainly dependent on the climate, location and plant species on which it feeds.

Keywords: Common castor, Ariadne merione merione, Biology, Life history.

1. Introduction
Ariadne merione merione also known as common castor butterfly is a brownish orange butterfly with black wavy lines. In females, these wavy lines are broader in the form of distinct bands. The larvae of this butterfly feed exclusively on leaves of castor plant, R. communis. Castor butterflies are often found flying gracefully as if sailing through the air among the castor plants or any dense vegetation. They are fond of resting on leaves at the top canopy, keeping the wings slowly moving sideways and are always nearer to host plants. They are found throughout the year, more densely populated during the rainy and summer season. The summer season butterfly has a wider wingspan as compared to rainy season species. R. communis is the host plant of the Common Castor butterfly (A. merione merione). It is an important non-edible oilseed crop belonging to family Euphorbiaceae. It is cultivated around the world primarily because of the commercial importance of its oil in pharmaceutical industries and employed in landscaping because of its handsome, giant, 12-lobed, palmate (fanlike) leaves. Its fruits are attractive but often are removed before they mature because the poison ricin gets concentrated in their beanlike seeds. It is also the host plant of Eri silkmoth (Samia cynthia ricini), and the Castor Semi-Looper moth (Achaea janata). It is also used as a food plant by the larvae of some other species of Lepidoptera including Hypercompe hambletoni and the Nutmeg (Discestra trifolli). The common castor butterfly is a specific pest of the castor seed plant, Ricinus communis (Nayar et al., 1976) [12] and the larvae also feed on the stinging nettles, Tragia involucrata and T. pluenetti (Euphorbiaceae) (Kunte, 2000) [9].

We plan to study the biology of the common castor butterfly A. merione merione Cramer (Lepidoptera: Nymphalidae) reported from Jammu region of J&K State during 2013. The butterfly was found throughout the year in the field, however, only a few larvae and pupae were observed during winter season. Both the common castor butterfly and its host plant are common in Jammu region. Attack of the pest in the field is noticed by the defoliated leaves. The observations were recorded both in field as well as in the laboratory. The site was selected to conduct the study was decided in the Jammu University campus at Jammu, (J&K) India. The detailed field observations were made at 12 sites in order to observe the flight activity of the adults, abundance of adults, the period of copulation and oviposition. After oviposition, the leaves with eggs are transported to laboratory and detailed observations were made like the
time of each moult, morphological characters, body measurements of each instar, prepupal behavior of the final instar, pupal particulars and the time of adult eclosion were recorded in the laboratory from egg hatched to the emergence of adult. Fresh leaves were supplied daily as food to larvae. The biology of the A. merione merione was done first time in the Jammu region of J&K State.

1. Objectives
(1) To understand the processes of scientific investigation and conduct and communicate about such investigations.
(2) To observe the dramatic changes throughout the life cycle of common castor butterfly.
(3) To explain the adaptations which enable them to survive in their environment.
(4) To study the complete description of the adults, eggs caterpillar and pupa including their size and time of each moult.
(5) To become aware of the roles that butterflies play in our world.

2. Material and Methods

2.1 Chemical
Ethyl acetate was used to kill the adult specimens. Adult specimens are collected to dissect the male and female genitalia for differentiate between male and female specimens. Other materials that can be used as killing agents in insect’s bottles are carbon tetrachloride, cyanide or chloroform, ethyl acetate is least dangerous of the four to use.

2.2 Instruments
Stereomicroscope to study the minute structure of eggs, larvae and adults. Camera for photographic record of eggs, larvae and adults. The study was conducted during the year 2013 in the Jammu University campus at Jammu, (J&K) India. The natural plant community of the campus was considered for the distribution and reproductive activity of the common castor butterfly, A. merione merione Cramer. Adult butterflies were seen mostly near the larval host plant, R. communis Linnaeus. Once located detailed observations were made at 12 sites in order to observe the flight activity and abundance of adults, the period of copulation and oviposition, following which fresh eggs were collected to study the life history and the duration of early stages. After oviposition, the leaves with egg were collected in Petridishes (15 cm x 2.5 cm depth) and brought to the laboratory. The pieces of the leaves with the egg were then placed in a smaller Petridish (10 cm x 1.5 cm depth) the inside of which was lined with moistened blotter to prevent the leaves from drying. Ten samples were placed in a cage covered with wire mesh. The eggs were then examined at 6h intervals daily for recording time to eclosion. Fresh leaves were supplied daily as food to larvae. The time of each moult was noted. The morphological characters, body measurements of each instar were recorded daily. The prepupal behavior of the final instar, pupal particulars and the time of adult eclosion were also recorded.

To determine the developmental success of each of the early stages, a number of eggs were placed in Petridishes in each month and the number of larvae hatched, pupae formed and the adult’s eclosed were recorded. To record the different early stages on the natural host plant, one plant at each of the 12 study sites was thoroughly studied at 10 day intervals each month and the early stages found were enumerated and pooled for each month.

3. Results and Discussions

3.1 Adult stage (Fig. 1 A)
Both male and female adults were nearly identical, characterized by their brownish orange wings bearing black wavy lines. The present authors has not observed mating in the caged adults. However, mating pairs were caught from the field and kept in the rearing cages for observations but unfortunately they could not survive in the caged conditions. It has been observed in the field. Mating took place end to end and lasted for 80 minutes. Mating of butterflies was observed to take place during flight mostly in the late morning hours (11 am to 2 pm). As the butterflies could not mate and oviposit in captivity therefore freshly laid eggs were systematically collected from the field and brought to the laboratory. Adult females lay eggs singly or in small groups of 2 to 5 one at a time on the under surface of leaves. Adults were found feeding on spoiled flowers of Lantana camara, overripe, fallen and damaged fruits of Annona squamosa, Syzygium cumini and Artocarpus heterophyllus, and the sap oozing from wounds in the tree trunks of Citrus aurantifolia.

3.2 Egg stage (Fig. 1 B & C)
Gravid females lay eggs singly on the under surface of the leaves of the castor plant. Females spread their wings during egg laying, depositing 1 to clutches of 15. There was no bias for the age of the leaf. During one survey old leaves had 1–8 and young tender leaves 1–4 eggs. Eggs were round, measuring 1-1.5 mm in diameter at the broadest region (Table 3) and 1.0-2.0 mm in height. At oviposition they were white, the color changing to light brown before hatching. When first laid eggs appeared soft in texture, but within 6 –10 seconds they became hairy. The maximum egg duration was 3-4 days during pre-Monsoon (May-June) and the minimum of 2-3 days was during Post Monsoon period (Oct-Nov) (Table 2). Soon after hatching, larvae ate their egg-shells. Each larva passed through five distinct instars over a period of 13 – 18 days.

3.3 Larval stage (Fig. 1 D & I)
Instar I The first instar immediately after emergence started feeding on empty egg shells and then epidermis of leaflets. The freshly hatched larva was cream colored, later turning brownish green with three brown colored horizontal bands on dorsal side. Body was somewhat rectangular in shape, but slightly narrowing posteriorly. Head very minute, and brown. Average length of the larva measured between 2-4 mm (Table 3). The duration of the first instar varied from 2-3 days during Pre Monsoon (May-June) to 3-4 days during Post Monsoon (Oct-Nov)) (Table 2).

Instar II Whitish green spines with branched ends appeared over the entire body. Head was brown with a pair of brown horns. There were no changes in other characters seen in instar I. The average length of the larva measured 6-8 mm (Table 3) and the duration of instar period was 2-3 days during Pre Monsoon (May-June) and 3-4 days during Post Monsoon (Oct-Nov) (Table 2).

Instar III Dorsally they had a yellowish green broad stripe with brown edge longitudinal to the body. The body spines present on the three brown horizontal bands were also brown. Head was 1mm in size, blackish brown with white markings. The head horns were 0.80 – 1.00 (0.90 ± 0.08) mm long and...
branched. Legs were clearly visible. The larva did not move much, but moved its head continuously when disturbed. There were no changes in other characters from previous instar. Average length of the larva measured between 8-16 mm (Table 3). The duration of the third instar varied from 3-4 days during Pre Monsoon (May-June) to 2-4 days during Post Monsoon (Oct-Nov) (Table 2).

**Instar IV** Body became green in color. The dorsal stripe turned brown with yellowish cream edges. The three black horizontal bands began to disappear. Head was blackish brown in color, square shaped and measured 1.00 – 2.00 (1.53 ± 0.41) mm in diameter. There were three triangular white markings on the head. The head horns were reddish brown in color and measured 2 mm in length. Segmentation was clear. Body spines were green, arranged in four lines on each side of the body on all the segments. Legs were green. The average length of larva measured between 17-26 mm (Table 3). Duration of larval period was 2-4 days during Pre Monsoon (May-June) to 2-3 days during Post Monsoon (Oct-Nov) (Table 2).

**Instar V** The fifth instar when fully matured turned green with clear segmentations. The dorsal stripe changed to orange with black edges showing numerous small white to cream colored spots. The dorsal three horizontal bands disappeared completely. Head was 2.00 - 3.00 (2.56 ± 0.41) mm in diameter. It had prominent white triangular markings with black borders two present above and one below. The horns became orange, with black tips, and measured 3.00 – 4.00 (3.60 ± 0.43) mm in length. Light and dark green crossed lines developed on both lateral sides of the body. The color of spines changed to brown with black tips and with yellow to orange colored spots at their base. The average length of larvae measured between 27-40 mm (Table 3). Duration of larval period was 2-3 days during Pre Monsoon (May-June) to 3-5 days during Post Monsoon (Oct-Nov) (Table 2).

### 3.4 Pupa (Fig. J)

The fifth instar when fully grown stopped feeding, turned brown and its lateral crossed lines changed to brown and white. The larva became lethargic and slightly shrunk before entering into the pupal stage. This stage called as prepupal stage lasted for 8-10 hours and finally formed pupa. The body contracted and the larva attached itself to the substratum with its posterior end hanging downwards. Average length of the pupa measured between 28-29 mm in length (Table 3) and 3 mm in width. The duration of the pupal stage varied from 6-7 days during Pre Monsoon (May-June) to 7-11 days during Post Monsoon (Oct-Nov) (Table 3). The pupal stage lasted for 5-7 days. The brown color changed to black with pupal maturation until adult eclosion. The anterior end was narrow. At the broadest point both lateral sides were curved inwards, between which two pointed projections appeared on dorsal side. Average pupal weight was 202.3 mg. Hatching success varied between 50 and 100%, being highest during June to September. Both larval and pupal development success varied between 60 and 100%. The three early stages and adults could be found under natural conditions throughout the year. However, the period of June to September provided the highest frequency of all stages, with peak numbers in July (Table 1a and 1b). Rainfall appears to be the most important factor promoting higher reproduction rates in *A. merione merione* Cramer as is the case for both *Catopsilia crocata* (Christopher & Mathavan, 1986) [5] and *Catopsilia pyranthe* (Atluri et al., 2004a) [2]. Precipitation during the North - West monsoon likely had its influence on reproduction via the host plant. During this season, the host plant had its greatest fresh growth, a resource needed by the larvae for better performance due to the likely higher levels of nitrogen and water content. Although the host plant was available throughout the year, leaf quality in terms of nitrogen and water content might have varied through the year. Few other species noted at the study biotope also reproduced throughout year, but at a higher rate during different periods: *Pachliopta aristolochiae* April to May, and October to November (Atluri et al., 2004b) [3], *Papilio polytes* August to February (Atluri et al., 2002) [1], *Graphium agamemnon* August to December (Venkata ramana et al., 2003a) [17], *Eurema hecabe* September to November (Venkata ramana et al., 2003b), *Europa core* November to January (Venkata ramana et al., 2001). For most of India, Wynter - Blyth (1957) [19] rated spring as the most favorable period, followed by post monsoon and South – West monsoon. In the Northern Western Ghats, Kunte (1997) [8] observed highest flight activity during late monsoon (August to September) and early winter (October to November). These differences in the phenology of butterflies suggest that different species respond differently to the prevailing environmental seasonality and exhibit different life history patterns. Even different species of a genus may behave differently as observed by Jones and Rienks (1987) in the three species of the tropical *Eurema* they studied.

The total development time from egg laying to adult eclosion was determined as 22-32 days, thus permitting a maximum of 8 to 9 overlapping broods per year. This behavior is in line with the expectation of tropical butterflies to have a short life cycle, and multiple broods over the year (Owen, 1971) [10]. Since temperature influences instar duration and the overall development time (Mathavan & Pandian, 1975; Palanichamy et al., 1982; Pathak & Pizvi, 2003; Braby, 2003) [11, 15, 4], the brood number in other parts of *A. merione merione* distribution may vary from our records depending on the prevailing temperatures. As no temperature extremes occur at Jammu, especially at the Jammu University site, the duration of life cycle did not vary much over the overlapping seasons. Adult feeding on the damaged and ripened fruit helps them obtain proteins and carbon sources (Levey & Del Rio, 2001) [19], with such nutrient uptake improving egg productivity (Fischer et al., 2004) [6].

**Table 1a:** Hatching, larval and pupal development success of *A. merione merione* Cramer in the laboratory.

<table>
<thead>
<tr>
<th>Life cycle stage</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs incubated</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Larvae hatched</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Pupae formed</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Adult emerged</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
### Table 1b: Hatching, larval and pupal development success of *A. merione merione* Cramer in the laboratory.

<table>
<thead>
<tr>
<th>Life cycle stage</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs incubated</td>
<td>12</td>
<td>9</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Larvae hatched</td>
<td>12</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Pupae formed</td>
<td>12</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Adult emerged</td>
<td>11</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 2: Duration of different stages of *A. merione merione* Cramer during different seasons of the year on *R. communis*.

<table>
<thead>
<tr>
<th>Season</th>
<th>Egg (Days)</th>
<th>1st Instar (Days)</th>
<th>2nd Instar (Days)</th>
<th>3rd Instar (Days)</th>
<th>4th Instar (Days)</th>
<th>5th Instar (Days)</th>
<th>Pupa (Days)</th>
<th>Total life cycle duration (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Monsoon (May-June)</td>
<td>3-4</td>
<td>2-3</td>
<td>2-3</td>
<td>3-4</td>
<td>2-4</td>
<td>2-3</td>
<td>6-7</td>
<td>20-28</td>
</tr>
<tr>
<td>Post Monsoon (Oct-Nov)</td>
<td>2-3</td>
<td>3-4</td>
<td>3-4</td>
<td>2-4</td>
<td>2-3</td>
<td>3-5</td>
<td>7-11</td>
<td>22-32</td>
</tr>
</tbody>
</table>

### Table 3: Morphometric measurement of different stages of *A. merione merione* Cramer during different seasons of the year on *R. communis*.

<table>
<thead>
<tr>
<th>Egg</th>
<th>1st Instar</th>
<th>2nd Instar</th>
<th>3rd Instar</th>
<th>4th Instar</th>
<th>5th Instar</th>
<th>Pupa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1.5 mm</td>
<td>2-4</td>
<td>6-8</td>
<td>8-16</td>
<td>17-26</td>
<td>27-40</td>
<td>28-29</td>
</tr>
<tr>
<td>2-4 mm</td>
<td>6-8</td>
<td>8-16</td>
<td>17-26</td>
<td>27-40</td>
<td>28-29</td>
<td></td>
</tr>
</tbody>
</table>
Fig 1: Photographs of the sequential stages in the life history of *Ariadne merione merione* Cramer. (A) Adult pairing (B) Freshly laid eggs (C) Eggs before hatching (D) Newly hatched larvae (E) Instar I (F) Instar II (G) Instar III (H) Instar IV (I) Instar V (J) Pupa (K) Host Plant (L) Host plant leaf eaten by larvae.
4. Acknowledgement
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5. References