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BIOLOGY OF FEW BUTTERFLY SPECIES OF AGRICULTURE ECOSYSTEMS OF ARID REGIONS OF KARNATAKA, INDIA

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ABSTRACT: Agriculture ecosystems have provided congenial habitat for various butterfly species. The Papilionidae and Nymphalidae family member's most of their life cycle is depended on natural plant communities amidst agriculture ecosystems. To record few butterflies viz., *Papilio polytes, Graphium agamemnon, Ariadne merione* and *Junonia hierta,* agriculture ecosystems were selected randomly and visited frequently by adapting five-hundred-meter length line transects during 2014 to 2016. Study sites were visited during 0800 to 1700 hours and recorded the ovipositing behaviour of gravid female of these butterfly species by following standard methods. Eggs along with the host plant leaves / shoot / twigs were collected in a sterilized Petri dish and brought to the laboratory for further studies. Eggs were maintained under sterilized laboratory conditions till hatching. Newly hatched larvae were fed with their preferred host plants foliage and reared by following standard methods. *P. polytes* and *G. agamemnon* and *A. merione* and *J. hierta* developmental stages included egg, larva, pupa and adult and these stages have showed significant variation (F=21.35; P>0.01). Further, all the four species had four moults and five instars in their larval stage. However, including larval period, pupal duration was also varied considerably among these species. Further, overall life cycle completed in 43, 32.5 to 40, 21 to 30 and 21 to 29 days by *P. polytes, G. Agamemnon, A. merione* and *J. hierta* respectively. Thus, time taken to complete the developmental stages viz., egg, larva, pupa and imago in the life cycle of Papilionidae and Nymphalidae family members exhibited significant variations under laboratory conditions. This kind of observations are essential to know the life cycle duration and in turn help undertake measures to protect these species under man-made habitats like agriculture ecosystems where human interference is maximum.

KEYWORDS: Developmental stages, Life cycle, butterfly species, agriculture ecosystem

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1. INTRODUCTION

Insects have unrivalled supremacy among all living animals and they are largest faunal components on this planet earth (Tiple et al., 2011). The agriculture ecosystems have provided suitable habitat for different insect species in general and butterflies in particular (Liu, 2006). Butterflies biology includes life cycle with different stages which becomes essential factors, very much important in order to study them at their preferred habitats. Petersen (1977) have observed different generations of butterfly species and recorded the variations between populations which are directly influenced by the local environment. Clark and Dickson (1977) have reported the life history of South African butterflies. Beebe et al. (1960) have studied the life history of Heliconiine butterflies at Trinidad, West India. Later, Pollard (1991) has conducted the life cycle study of white admiral butterfly, *Limenitis camila* in England. The larvae were used as keys for identification of families and subfamilies (Scott, 2001). The life cycle duration of *Catopsilia pomona* butterflies varied considerably during different seasons (Choudhary and Agarwal, 2013). In temperate regions, butterfly species breed once in a year or twice in a year and that shows their multivoltine or univoltine or bivoltine characters. However, many butterfly species occur almost throughout the year in tropics (Owen et al., 1972). Further, egg to egg stage of *Dannus chrysippus* in tropical Africa and its generation is very short and completed within a month without undergoing diapauses (Owen et al., 1972). Kawahara (2006) has observed the life history of *Libythea celtis* that varied between 22 to 25 days but, *Libythea geoffroyi* life cycle was in between 20 and 22 days at Ithaca, Japan. Life cycle of several species of butterflies which commonly occur amidst agriculture ecosystems is scanty in India (Tiple et al., 2011). Although reports are available on life histories of few butterfly species studied by Beebe et al. (1960), Barrose (2000), Mcneely and Singer (2001), Janz et al. (2005), Pooreten and Pooreten (2013), Bala et al. (2014) and others. Still there is a lacuna of understanding the early stages of many butterfly species (Chaturvedi, 1999; Smetacek, 1996 and Kunte, 2000). The complete knowledge on biology of native butterfly species is very much required for their conservation and it has to be addressed critically (Dennis et al., 2003) in the years to come. Further, De-Morais and Brown (1991) have studied the larval food plants in southeastern Brazil. Devries (1985) has recorded the host plant of butterflies in Costa Rica. Fleishman et al. (1999) have recorded the butterfly's communities in agriculture habitats in Great Basin, USA. Flick et al. (2012) have studied butterfly species richness in agricultural landscapes in eastern Ontario, Canada. Study on the duration of life cycle in general and larval stage in particular is very essential. Moreover, morphology of different stages viz., egg, larva, pupa in the life cycle of butterflies is necessary. Because, breeding places, depended plant communities are important to know the survival status of butterflies. The flora on the margin of agriculture fields provides a suitable habitat for pollinating insects. Therefore, life cycle studies of butterflies have necessitated knowing about their strategies followed during different developmental stages at heterogeneous habitats of agriculture ecosystems. Because, butterflies at intensively farmed landscapes are facing stress due to decline of host plants and nectar plants (Pywell et al., 2011). New (1990) and New et al. (1995) have emphasized the need of conservation and management of butterflies very long back. Kevan and Viana (2003) have rightly predicted the decline of global pollinators in general and butterflies in particular. Thus, knowledge about butterfly species biology that includes different stages of their life cycle, duration, host plants and nectar plants on which they depend are essential factors to understand their survival. Since, reports on such study especially amidst agriculture ecosystems are fragmentary hence the present investigation was undertaken.

2. MATERIALS AND METHODS

The natural plant communities in and around intensively cultivated agriculture ecosystems were frequently visited to search butterfly food plants and larval host plants by adapting line transect method (LTM) as per Pollard (1988). Butterfly species which belong to Papilionidae family viz., *Papilio polytes* and *Graphium agamemnon* and Nymphalidae family viz., *Ariadne merione* and *Junonia hierta* were considered during the present study. Five hundred meter length line transect (LT) was fixed randomly at different agriculture ecosystems and visited during 0800 to 1700 hours to record reproductive activity of butterflies as per Rayalu et al. (2012). The ovipositing activity of gravid female butterflies were observed on their host plants as per Atluri et al. (2004), Ramana et al. (2004), Garraway et al. (2008), Atluri et al. (2010), Ramana et al. (2011) and Harinath et al. (2012). After egg laying, leaves / shoot on which the eggs were laid have collected in a sterilized Petri dish with a size 15 cm × 2.5 cm depth and brought to the laboratory for further studies as per Ramana et al. (2011) and Rayalu et al. 2012).The leaf or shoot with an egg was placed in a small Petri dish with a size 10 cm × 1.5 cm depth lined with wet muslin cloth to prevent leaf wilting and kept in ant proof, clean iron tray covered with small wire mesh. The eggs were observed every six to eight hours time intervals to record hatching as per Barua and Slowik (2007), Tara and Sharma (2009), Atluri et al. (2010), Naidu and Ramana (2010), Rayalu et al. (2012). The newly hatched larvae were transferred to Petri dish which was lined with muslin cloth as per Rayalu et al. (2012). Every day, larvae were provided with fresh leaves after cleaning the Petri dish with the help of camel brush as per Naidu and Ramana et al.(2004 and 2011) and Rayalu et al.(2012). The growing larvae were observed regularly to note the morphological characters appeared. Care was taken to provide sufficient place for their normal activity and recorded such activities with the help of digital camera, Nikon DSLR D3100, 16 Mega Pixels with 18-55 lenses. Larval host plant twigs along with leaves were collected and brought to the laboratory for identification. Larval host plants were identified with the help of herbarium and taxonomic keys as described by Gamble (1967). Further, identified foraging plants were grouped into trees, shrubs, herbs and climbers from where they have been collected i.e., at cultivable and non-cultivable lands were complied and statistically analyzed by following standard methods as per Saha (1992).

3. RESULTS AND DISCUSSION

The developmental stages of Papilionidae family members (e.g. *Papilio polytes* and *Graphium agamemnon*) and Nymphalidae family members (e.g. *Ariadne merione* and *Junonia hierta*) are presented in Table 1.

Development of *Papiliopolytes*:

The common Mormon, *P. polytes* more preferred *Citrus limnos* for oviposition (Plate 1a). Other commonly preferred host plants of the Rutaceae family members were *C. aurantifolia, C. grandis, Murraya koenigii, Zanthoxylum rhetsa and Aegle marmelos* for oviposition by *P. polytes*. The detailed report of larval plans of *P. polytes* will be published elsewhere. Female *P. polytes* laid eggs on the stalk of young tender shoots, and the ovipositing activity was high during 9000 to 1230 hours. Eggs were pale yellow in colour and laid more than two on the upper surface of tender leaf. Sometimes, single egg was laid at the base of young leaves stalk and even at the developing buds or leaves of plants namely *C. aurantifolia, C. grandis, C. limon, M. koenigii, Z. rhetsa* and *A. marmelos.* The egg development was completed within three to four days (Plate 1b). The larval stage included five instars and four moults. Larva is very small and blackish snuff in color with white patches on posterior segments of its body. The abdomen is narrow and tapering at its end. Newly hatched larva feeds on young tender leaves of Rutaceae family members and completed first instar in two to three days (Plate 1c). The dorsal surface of the second instar larva looks rough with dark snuff color. There are three white bands present on its body surface. The head bears two yellow colored antennae. The anal part of the body bears two yellow spiny structures. The second instar stage was completed within three to four days (Plate 1d). The third instar larva was comparatively big in size and it was pale green in color with white patches. Third instar was completed in three to four days. During this stage, larva feed voraciously on tender leaves as well as old leaves and increased its body length and size predominantly (Plate 1e). During fourth instar, larval body clearly differentiated into dark green colored dorsal surface and brown colored ventral surface. The dark green colored dorsal surface has four brown colored lines with clearly differentiable segments. First line present on the head portion which is incomplete with the appearance of two dark spots at the end on either sides of the body. The second line appears in between the thoracic and abdomen with clear demarcation between two regions. The other two lines appeared in between third and fourth, fourth and fifth segments in the abdomen and they are incomplete dorsally (Plate 1f). After completing fourth instar within three to four days, larva entered into fifth instar stage. Externally, the morphological features of fifth instar larva didn’t show much difference compared to fourth instar larva excepting body size. The larva completes fifth instar within three to four days (Plate 1g) (Table 1). After completing five instars, larva stopped feeding and moved towards stalk of the leaf and entered into pupal stage by hanging upside down within two days. The larva spun a thread around its body and attached to stem with the help of last abdominal segments and developed a pupal case. The pupa was dark green in color during early stage and later changed to brown color. By completing 14 to 18 days of pupal stage, pupa changes into imago. The adult butterfly emerged from pupal case (Plate 1h). Thus, *P. polytes* completed its egg, larva and pupa stages in its life cycle within 43 days (Table 1).

Development of *Graphium agamemnon*:

The Tailed Jay, *G. agamemnon* preferred *Polyalthia longifolia* as its main host plant and shown oviposition activities during 8000 to 1100 hours. The female preferred lower surface of the young tender leaf of *P. longifolia* and sometimes *Annona reticulate, A. squamosa, Michelia champaca* and *Miliusa tomentosa* which belongs to the families Annonaceae and Magnoliaceae for oviposition. Detailed larval plants of *G. agamemnon* will be published elsewhere. Around two to three eggs were laid on a single leaf and the egg lying activity was very fast and done by fast movement of abdominal tip. Eggs are round in appearance with dark white soft surfaces and sometimes they have shining outer coat. After three to four days of embryonic development, egg hatch into tiny larva (Plate 2b). The larval stages include five instars and four moults. Newly hatched larva is very small in size and has dark brown in color with dark brown spiny structures on its lateral sides. The larva starts feeding on young tender leaves soon after hatching and completed its first instar within three days (Plate 2c). Morphologically, second instar larva was similar to that of first instar larva excepting the body size. During this stage, larva developed a pale green spots with white border on its abdomen. There are many clearly visible dark black colored horns like structures appeared on the surface of abdomen. The head is yellow in color with two horns on its dorsal surface. Two horn like structures appeared on the next segments. The first horn is small in size, the second horn is in the subsequent segment and it is little bigger in size. The last segment bears two prominent horns with hairy out growths. Second instar was completed within three to four days (Plate 2d). There was no much variations appeared morphologically on third instar larva compared to first and second instars excepting the body size. The head is dark black in color and each segment of the body is clearly visible during this stage. The green spots with white margins are prominently visible in this stage. Third instar was completed within three to four days (Plate 2e). Morphologically, fourth instar larva is similar to that of previous instars excepting the body size. However, the larva becomes pale green in color and developed spines over the body surface which was not there at the posterior end. The body segments are clearly visible and differentiated into dorsal pale green and ventral white color. Bluish colored eye shaped spots with green shadings appeared on lateral sides of third thoracic segment. The larva voraciously fed on the leaves of *P. longifolia*. The fourth instar stage was completed within three to four days (Plate 2f). The external morphological features in fifth instar larva didn’t show much variation. But, it appeared like fourth instar larva except its body size. However, the larva appears green in color. The larva completed fifth instar stage within three to four days (Plate 2g). At the end of fifth instar, larva stopped feeding and transformed into pupa through metamorphosis by hanging upside down on twig of *P. longifolia*. The larva transformed to pupa within 13-15 days. The larva spun threads like structure around its body and attached to the twig with the help of last abdominal segments and developed a pupal case. The pupa color varied from green to dark brown and after 13 to 15 days of pupation, pupa transformed into imago. Imago emerges from the pupal case (Plate 2h) and thus in 32.5 to 40 days *G. agamemnon* completed egg, larva and pupa stages in its life cycle (Table 1).

Development of *Ariadne merione*:

A. merione has selected *Ricinis communis* as its main host plant to complete its life cycle amidst agriculture ecosystem. Female *A. merione* showed its ovipositing activities during 9000 to 0130 hours by resting under surface of leaf by spreading its wings and deposited eggs slowly on both tender and matured leaves of *R. communis.* The eggs are laid in clutches and in each clutch around two to eight eggs were laid. Eggs are round in appearance with white colored soft surfaces. Later, eggs developed hair like structures over the surface with in few seconds after oviposition and color changed to light brown. After two to three days of incubation, egg hatched into a larva (Plate 3b). The larval stage includes five instars and four moults. The newly hatched larva is very small in size with greenish brown color along with bands all over the dorsal surface. The larva feeds egg shell first soon after hatching and then starts feeding the lower epidermal layer of tender leaves of *R. communis*. The head is dark brown in color with a prominent segmented antenna. The first instar stage was completed within two to three days (Plate 3c) and entered into second instar stage. Second instar larva was morphologically similar to that of first instar larva excepting its body size. The segmented bristles are present all over the body prominently. It feeds on both tender and matured leaves of *R. communis* and grown well and complete the second instar larval stage within two to three days (Plate 3d). During third larval instar, body colour changed to green and developed yellowish brown strips on the body segments at dorsal longitudinal axis. Spines appeared on the body which is green to brown color. Third instar larva is not very active, but completed its stage within three to four days (Plate 3e). In fourth instar, body color completely changed from green to dark green with prominent spines. The yellow strips appeared longitudinally on dorsal surface of the body, but turns to brown color on lateral surface. The body segments are clearly visible with green colored legs. The fourth instar stage was completed within three to four days (Plate 3f) and entered into fifth instar. During this stage, larva has dark green colored body with dark black head. The body developed dark orange colored bands on dorsal surface with dark brown margin. Numerous white spots have appeared over dark dorsal surface of the body. The spine like projections is developed on the body surface, which are changed into brown color with black tips and yellow spots on their base. The fifth instar stage was completed within three to four days (Plate 3g), larva stopped feeding, hanged upside down over the leaf surface and finally entered into pupation. Larva transform into pupa within two days. The pupa color varied from green to dark brown. The anterior surface of the pupa folds towards inner side and formed a pointed projection at the middle. The pupa changed its body color into black after two to three days that indicated its complete maturation. Finally, pupa transformed into imago by taking five to seven days and emerged as an adult butterflies (Plate 3h). *A. merione* completed egg, larva and pupa stages in its life cycle within 21 to 30 days (Table 1).

Development of *Junonia hierta*:

J. hierta did selected *Barleria prionitis* as its main host plant to complete its life cycle amidst agriculture ecosystem. It showed its ovipositing activity during 8000 to 1230 hours. Gravid female laid eight to ten eggs on leaf buds, at tender leaf base, young flower bud, on sepals and also on seed coats of Acanthaceae family members such as *B. involucrate* including *B. prionitis*. Detailed report on larval plants of *J. hierta* will be published elsewhere. Eggs are white in color with ovoid in appearance (Plate 4a). Egg surface has shiny surface with ornamented margins along with ridges which are present all along the length of egg from anterior yellow spot. Egg completed its development in three days and egg hatched into larva (Plate 4b). Larval stage includes five instars and four moults. The newly hatched larva was very small in size with dark black colored body. The larva feeds on pupal case as a first food soon after hatching. The larva possesses black tiny spines which run in four lines along the dorsal longitudinal axis of the body. The first larval instar stage was completed within three to four days (Plate 4c). Second instar larva was morphologically almost similar to that of first instar larva excepting the body size. Head is dark black in color and clearly demarcated with yellow margins from other body segments. The abdominal legs were dark black in color, with yellow tips. The second instar completed within two to three days (Plate 4d) and entered to third instar. Morphologically, third instar larva was similar to first and second instars excepting the body size. Spines are prominent with white shading at their base on the larval body surface along with a dark blue colored dots have appeared at the base of each spine. Third instar larva has completed its stage within two to three days (Plate 4e) and entered into fourth instr. Further, fourth instar larva was similar to that of previous instars excepting its body size. There are three rows of white spots developed on the dorsal surface and fourth instar has completed within two to three days (Plate 4f). During fifth instar, larva showed prominent spines on the body surface with black head which was clearly demarked by yellow band. The body segments were clearly visible with yellow spots on the lateral surface and completed fifth instar within four to five days (Plate 4g), underwent pupation by moving onto the twig to hang upside down. The pupa was chocolate to dark black in color with small spine like structures appeared all along its body. Spines on their central axis were prominent with small spines on their lateral sides. After four to six days of pupation, pupa transformed into imago and emerged as an adult butterfly (Plate 4h). Thus, *J. hierta* has completed egg, larva and pupa stages in its life cycle within 21 to 29 days (Table 1).

Comparative note of life cycle of butterfly species amidst agriculture ecosystem:

The life cycle of *P. polytes*, *G. agamemnon*, *A. merione* and *J. hierta* is given in Table 1 and Plates 1to 4. *P. polytes* and *G. agamemnon* belong to Papilionidae family and *A. merione* and *J. hierta* belong to Nymphalidae family. The developmental stages include egg, larva, pupa and adult of these species showed significant variation (F=21.35; P>0.01) with respect to developmental duration (Table 1). This clearly indicated that life cycle stages *viz*., egg, larva and pupa development duration significantly differed among Papilionidae and Nymphalidae family members. The egg stage *P. polytesa* and *G. agamemnon* (Family: Papilionidae) completed in three to four days whereas *A. merione* and *J. hierta* (Family: Nymphalidae) completed in two days only (Table 1). Interestingly, all the four species showed four moults and five instars in their larval stage. However, larval duration also varied considerably among these species. *P. polytes* and *G. agamemnon* completed their larval stage in 14 to 19 days with an average of three to four days for each instars, whereas *A. merione* required 13 to 18 days with an average two to three days to complete for first three instars but, in fourth and fifth instars, the period was three to four days. The larval duration of *J. hierta* was two to three days for first to fourth instars but, it was four to five days in fifth instar (Table 1). Further, pupal duration also varied considerably among these species. The pupal duration of *P. polytes, G. agamemnon, A. merione and J. hierta* was respectively 14 to 19, 13 to 15 and four to six days (Table 1). Further, overall duration required to complete the life cycle was 43, 32,5 to 40, 21 to 30 and 21 to 29 days for *P. polytes*, *G. agamemnon*, *A. merione* and *J. hierta* respectively (Table 1). Thus, developmental stages *viz.*, egg, larva, pupa and imago in the life cycle of Papilionidae and Nymphalidae family members exhibited significant variations. Interestingly, all the four butterfly species used innumerable plants which belong to more than 19 families amidst agriculture ecosystems (Santhosh and Basavarajappa, 2016). Detailed report on host plants, larval plants and nectar plants will be published elsewhere.

DISCUSSION

Lepidopteron insect's life cycle is variously modified due their diversified life style. Developmental stages such as egg, larva, pupa of *P. polytes* and *G. agamemnon* (Family: Papilionidae) and *A. merione* and *J. hierta* (Family: Nymphalidae) was not alike. In general, Papilionidae family members (e.g. *P. polytes* and *G. agamemnon*) took more duration (40 to 43 days) to complete their life cycle compared to Nymphalidae family members (e.g. *A. merione* and *J. hierta*). Time spent in each and every stage of their life cycle was varied considerably. Among lepidopteron insects, life cycle duration is species specific and it is well exhibited by Papilionidae and Nymphalidae family members amidst arid agriculture ecosystems. Atluri et al. (2011) have recorded similar type of observations amidst coastal Andhra, Visakhapatnam. The life cycle duration of Papilionidae family members such as *P. demoleus, P. polytes* and *G. agamemnon* and *G. doson* was 31 to 39, 35 to 40, 29 to 35 and 31 to 36 days respectively under laboratory conditions

Reddy and Bai (1984) have also reported the developmental duration of Papilionidae family members such as *P. polytes* (28 to 31 days), *P. hector* (39 to 44 days), *G. agamemnon* (33 to 40 days) and *G. doson* (33 to 38 days). Moreover, Ramana et al. (2004) have reported the life cycle duration of *P. aristolochia* for 40 to 44 days. *Pachliopta hector* and *P. aristolochia* life cycle duration was studied by Barua and Slowik (2007). Both species have completed their life cycle in 39 to 47 and 30 days respectively (Barua and Slowik, 2007). Further, Garraway *et al*. (2008) have recorded *Papilio homerus* life cycle and it was completed in 84 days. Similarly, Tara and Sharma (2009) have reported the life cycle duration of *Papilio polytesromulus* for 26 to 28 days. In the present investigation, life cycle duration of *P. polytes* was within 43 days and *G. agamemnon* was 32.5 to 40 days. Since, abiotic and biotic factors playing a major role and influence the life cycle stages of butterfly species (Choudhry and Agarwala, 2013). Moreover, butterfly species showed variations in their life cycle stages between populations which were directly influenced by the local environment (Petersen,1977). Perhaps, local ecological conditions at ovipositing sites and on the host plants of larva and pupa stages might have interfered and brought significant variation in developmental duration of egg, larva and pupa of *A. merione, J. hierta, A. merione* and *J. hierta*. All these observations suggested that, life cycle duration among butterfly species is species specific character but, it is influenced by prevailed ecological conditions of that ecosystem. Thus, our results are on par with the previous researchers. Further, Bell (1909 and 1927) has published the reports pertaining to egg and larval stages of 238 butterfly species in India. Indian butterfly species passes through five instars in nine days at 32^0C (Mathavan and Pandian, 1975). However, during the present study, *P. polytes* and *G. agamemnon* (Family: Papilionidae) and *A. merione*and *J. hierta* (Family: Nymphalidae) larval duration was more than nine days. Interestingly, abiotic and biotic factors played a major role which influences the life cycle stages of all these butterfly species (Choudhry and Agarwal, 2013). Similarly, Atluri et al. (2004) have reported from natural environmental conditions of coastal Andhra Pradesh. But, during the present study the development of *A. merione* life cycle duration was 21 to 30 days and *J. hierta* was 21 to 29 days respectively under laboratory conditions. Moreover, larval food plants also influence the developmental duration of lepidopteron insects. Rizvi and Ali (2009) have reported the development response of Cabbage butterfly, *Pieris brassicae* to different food plants during its larval stage and observed variation in their developmental duration under both laboratory and natural conditions. When *P. brassicae* fed with Cabbage plant foliage, it has completed the life cycle in 33.1 ± 1.95 days and when it was fed with yellow Sarson plant foliage, it has completed its development in 37.87 ± 1.93 days (Rizvi and Ali 2007). Since, herbs, shrubs, trees belong to more than 20 to 24 plant families were used by *P. polytes, G. agamemnon, A. merione* and *J. hierta* amidst agriculture ecosystems of Chamarajanagar District of Karnataka (Santhosh, 2016). Many plants grow as weeds on the margins of cultivable lands where few plant species were grown as mixed plantation crops for commercial purpose

(Santhosh, 2016). Of all, many plant species were used for oviposition, some plants were used for food by growing larva and certain plants were used as nectar plants by adults (Santhosh and Basavarajappa, 2016). Hence, to complete their life cycle successfully, *P. polytes, G. agamemnon, A. merione* and *J. hierta* might have depended on diversified flora under agriculture ecosystem (Santhosh and Basavarajappa, 2016). Floral calendar prepared from this diversified flora amidst agriculture ecosystems revealed the interaction between available flora and local butterfly fauna during different seasons (Santhosh and Basavarajappa, 2016). This indicated the importance of diversified flora for the successful completion of life cycle by butterfly species under natural conditions. Barua and Slowik (2007) have observed the distribution of butterfly species in relation to egg laying and larva stages which was depended on the larval food plants and adult butterfly nectar plants distribution. Besides local ecological conditions, host plants also interfere with larval duration in butterfly species. Such type of observations was presented elsewhere. Thus, understanding the earlier stages of butterfly species, plant species used for oviposition, larval host plants and nectar plants preferred by butterfly species during different life cycle stages under natural conditions is very essential. It could help understand their home range, their plant preference and status in the given ecosystem so as to restore local butterfly species.

4. CONCLUSION

P. polytes, G. agamemnon, A. merione and *J. hierta* are Polyphagus insects, did exhibit specific developmental duration under laboratory conditions despite their common floral preference. These species biology is indirectly supported by diversified flora that is not properly taken care amidst agriculture ecosystems. Present study highlighted the necessity to study the biology of local butterfly fauna to understand the importance of local floral diversity which is under brink at many agriculture ecosystems of India.

CONFLICT OF INTEREST

The authors have no conflict of interest.

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SUPPLEMENTARY FILES

Table 1. Life cycle of few butterfly species at agriculture ecosystems of Karnataka, India

Sl. No.	Stage		Butterfly species			
			P. polytes	***G. agamemnon***	***A. merione***	***J. hierta***
1.	Oviposited on		*Citrus aurantifolia, C. grandis, C. limon, Murraya koenigii, Zantho xylumrhetsa and Aegle marmelos*	*Annona reticulate, A. squamosa, Michelia champaca, Milius atomentosa* and *Polyalthia longifolia*	*Ricinis communis*	*Barleria prionitis, B. involucrate* and *B. prionitis*
2.	Egg		3-4	3-4	2-3	3
3.	Larva	1st instar	2-3	2-3	2-3	2-3
		2nd instar	3-4	3-4	2-3	2-3
		3rd instar	3-4	3-4	3-4	2-3
		4th instar	3-4	3-4	3-4	2-3
		5th instar	3-4	3-4	3-4	4-5
		Total	14-19	14-19	13-18	12-19
4.	Pupa		14-18	13-15	5-7	4-6
5.	Adult (in Days)		4-5	4-5	4-5	4-5
Total			31-41	30-38	22-28	19-28
'F' value			21.35 S			

Note: Value is significant at 0.01% level

SUPPLEMENTARY FILES

a. Adult · b. Egg · c. 1st Instar · d. 2nd Instar · e. 3rd Instar · f. 4th Instar · g. 5th Instar · h. Pupa

Plate 1. Life cycle *of Papilio polytes* on *Citrus limon* plant

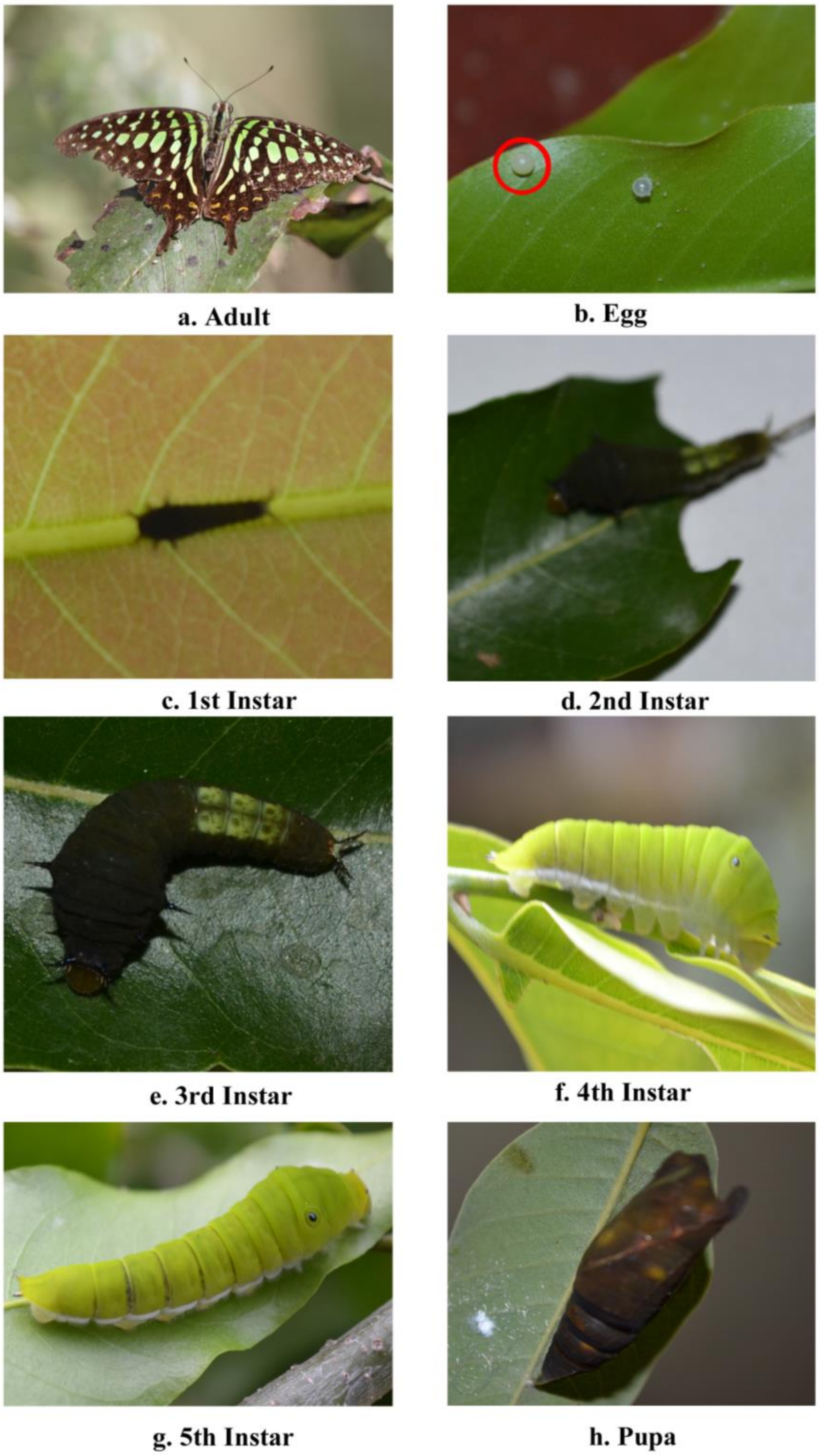

Plate 2. Life cycle *of Graphium agamemnon* on *Polyalthia longifolia* plant

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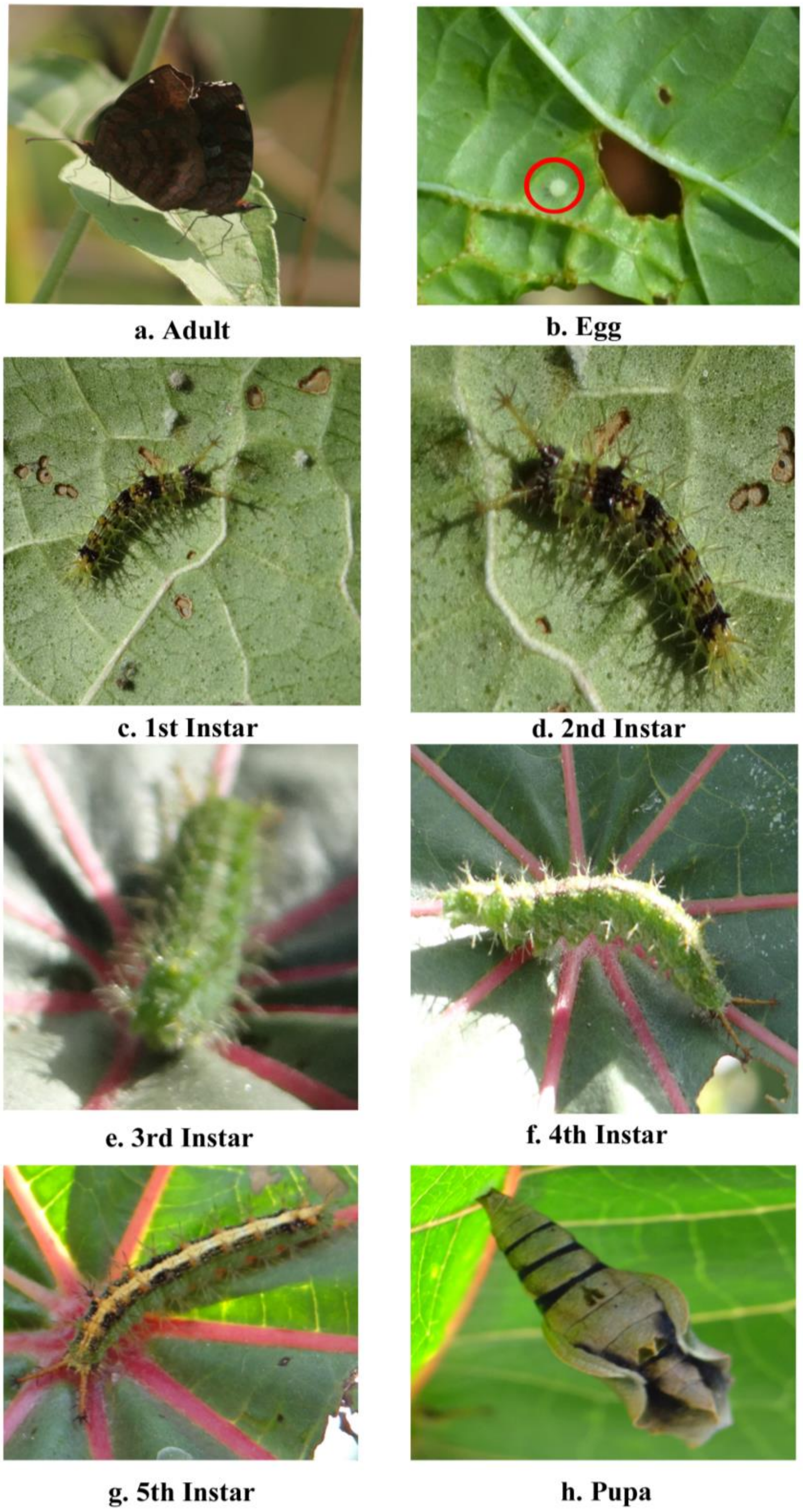

Plate 3. Life cycle of *Ariadne merione* on *Ricinus communis* plant

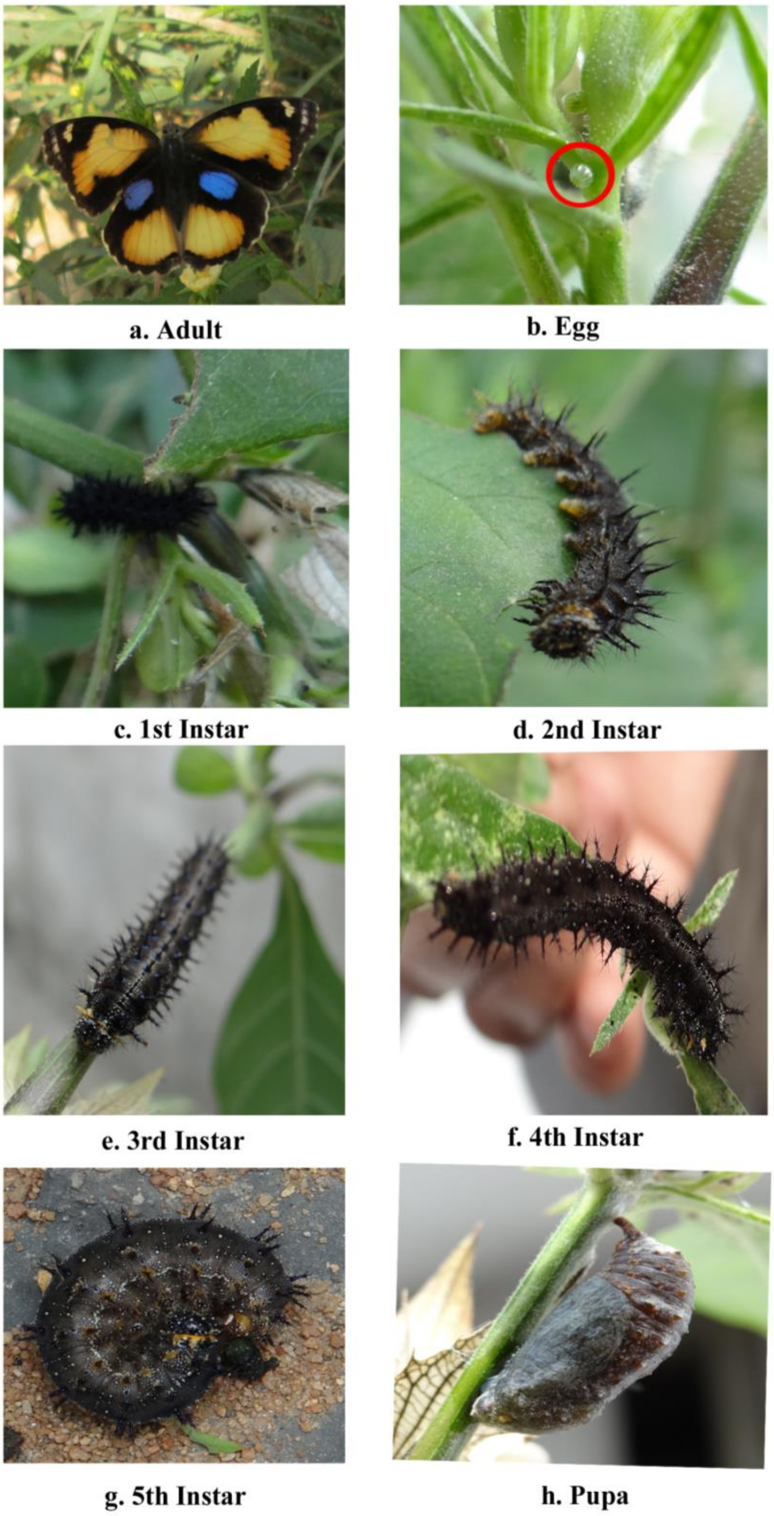

Plate 4. Life cycle *of Junonia hierta* on *Barleria prionitis* plant