OBSERVATIONS ON DISTRIBUTION AND BIOLOGY OF *AGLAIS CASHMIRENSIS* KOLLAR (INDIAN TORTOISESHELL) (LEPIDOPTERA: NYMPHALIDAE) FROM KASHMIR VALLEY, J&K (INDIA)

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ABSTRACT: Both extensive field and laboratory observations conducted for the first time from April 2008 to November 2011 revealed that *Aglais cashmirensis* (Kollar) commonly called as Indian Tortoiseshell is very commonly distributed species found in diverse habitats like agricultural land, forests, gardens, household lawns, hilly places, open fields, orchids, parks, roads, vegetable gardens, neglected land, etc in Kashmir Valley. Being holometabolous, this Himalayan nymphalid completed its life cycle in 32 to 49 days in which egg stage lasted 4-5, larval 21-30, pre-pupa 1-2, pupa 4-6 and adult 2-6 days respectively The larvae were monophagous feeding on *Urtica dioica* (Urticacae) whereas adults were polyphagous visiting flowers of many families. Except during winter season (December to February), it was active from March to November within an altitudinal range from 1200-3000m. Description on its immature stages, wing venation, flight and distribution with distribution map is being given for the first time from the Kashmir Valley.

KEY WORDS: *Aglais cashmirensis*, Kashmir Valley, field observations, distribution, biology, wing venation.

The nature of vegetation, humidity, sunshine, and availability of water, etc, are factors that determine the survival of a given species in a particular area. Information on such habitat preferences is very useful in developing appropriate conservation strategies for the various species in future. The availability of having such type of data from yet to be fully un-explored but biodiversity rich regions like Kashmir Valley further adds to its importance and justification of such studies. Among insects, butterflies are ecologically very important Mathew and Rahamathulla (1993) and have a wide distribution, are relatively easy to sample and identify, and both as individuals and as species they show important numbers in different ecosystems Blair (1999) and Ricketts et al. (2002). Among all the insects, butterflies are highly sensitive to habitat disturbance Malabika (2011) and are known to respond fast to environmental changes compared to other taxa like birds and vascular plants and have been used commonly as an indicator taxon for ecological research and conservation Kremen (1994) and Thomas et al. (2004). The butterfly diversity is known to be related to the diversity of other faunal groups such as birds and mammals Wilson (1997) and also of vegetation Kunte et al. (1999).

The Indian Tortoise Shell, *Aglais cashmirensis* (Kollar) (Lepidoptera: Nymphalidae) is the commonest Himalayan species found in all kinds of terrains Haribal (1990). It was previously placed in the genus *Vaneesa*, however it has been now placed in the genus *Aglais* Dalman Mandal (1987). The genus is represented by four species in the world in which 3 species namely *Aglais*

cashmirensis Kollar, *A. ladakensis* Moore and *A. urticae* Linnaeus, occur in India including Kashmir Himalayas Varshney (1994). Besides Kashmir, it is distributed in some other parts of India (Fig 18) (like Arunachal Pradesh, Himachal Pradesh, Nagaland, Sikkim, and Western Himalayas), Afghanistan, Bhutan, China, Nepal, Pakistan, and Tibet, Bingham (1905), Evans (1932), Thomas-Glover (1936), Wynter-Blyth (1957), Malik et al. (1972), Haribal (1992), Varshney (1994), Abbas (2002), Joshi et al. (2008), Kehimkar (2008), Greeshma (2010), Naro (2012). Malik et al. (1972) reported it a pest of Knettle grasses occurring from March to October in Kashmir Valley. However, theses authors have not studied the biology of this species. Both *A. ladakensis* and *A. urticae* have been declared as Endangered in the India Varshney (1994). Recently Qureshi et al. (2013) gave a list of 25 host-plants (24 adult and 1 larval) distributed in 13 families which include 10 new records of adult host-plants for *A. cashmirensis* from the Kashmir Valley. Albeit considerable research work has been carried out on many aspects including biology and distribution of butterflies from other regions/parts of India however no serious attention has been paid on these magnificent creatures of Kashmir Valley. Even the details pertaining to current status, distribution, immature stages, hosts, etc of common species like *Aglais cashmirensis* are not fully known, hence this study was undertaken.

STUDY AREA:

The Jammu and Kashmir State is situated in the north of the Indian subcontinent and forms the north western range. Geographically, the state is divided into three regions, viz. Jammu, Kashmir and Ladakh, Qureshi (2007). The administrative capital of the satte is Srinagar (Kashmir) in summer and Jammu (Jammu) in winter. Kashmir commonly called as the Kashmir Valley lies between 33°.20/ and 43°.54/ N Latitude and 73°.55/ and 75°.35/ E Longitude covering an area of 15,948 Sq. Kms with 64% of the total area being mountainous. Politically, the Valley is an important part of the state, accommodating much of its population and economic activity. Being an integral but geographically younger part of the main Himalayan Range, the Valley possess a central position in Asia, and also acts as a doorway in between Palaearctic and Indo-Malayan (=Oriental) region in the Northern India Dar et al. (2002). The Valley is divided into ten administrative districts *viz.*, Anantnag, Bandipora, Baramulla, Budgam, Ganderbal, Kulgam, Kupwara, Pulwama, Shopian, and Srinagar Anonymous (2009) and has four seasons namely Winter (December to February), Spring (March to May), Summer (June to August) and Autumn (September to November). Also called the 'paradise on earth' the Valley possesses a rich and unique floral & faunal wealth including butterflies. In spite being a playground of biodiversity, its biological wealth which provides numerous benefits, directly or indirectly to the people of the region is still fully unexplored and poorly documented.

MATERIALS AND METHODS

The present study was carried out at Entomological Research Laboratory, Department of Zoology, University of Kashmir during the years of 2008-2011 in different areas/localities of Kashmir Valley. Random surveys were conducted in different months/seasons of the year, depending on the prevailing weather conditions and butterfly activity. Only a limited number of adult specimens were collected with the help of traditional insect collecting/butterfly net, killed in killing bottles saturated with ethyl-acetate and identified with the help of

standard references like Evans (1932), Wynter-Blyth (1957), and Haribal (1992). Wing venation was studied as per Borror et al. (1976) with few modifications. Wings were discoloured or bleached by putting in Petri dishes, containing 95% alcohol for 1 to 2 minutes and then were transferred to 10% Hydrochloric acid (HCL) for up to 1 minute. After this they were placed in the mixture of sodium chloride and sodium hypochlorite (having both the chemicals in equal proportion) until the colour was removed. The wings were continuously cleared with a soft brush. They were rinsed in distilled water to remove the excess bleach and dehydrated by running successively increasing concentrations of different grades of alcohol, stained with eosin, cleared twice in xylol (xylene) and mounted in commercially available DPX or Canada balsam and covered with a cover slip and labelled properly. For biological observation, eggs, larvae or pupae along with the parts of host-plant were collected and transferred to rearing cages. Fresh and soft food was provided to larvae and rearing cages were regularly cleaned and continuously monitored Borror et al. (1976) and Bhate (2005) and Harry (2005). The distribution map was prepared using ArcGIS 9.3 software at Eco-informatics lab, Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore. For nomenclature of wings Pajni et al. (2006) was followed whereas that of larva & pupa is as per Talbot (1939) and Kunte (2006).

OBSERVATION AND DISCUSSION

Biology: It completed its life cycle from egg laying to emergence of adult in 31 to 44 days depending upon the climatic conditions in four stages namely egg, larva, pupa and adult. Its monophagous larvae feed on *Urtica dioica* Linn. (Urticacae) which is commonly called 'stinging nettle' or 'bull nettle' and locally as 'Soi' and is highly distributed both at low land and high-altitude areas of Kashmir Valley. Although, its green parts have stinging hairs and can cause painful stings, they are rarely seriously harmful and are mostly avoided by herbivores, so they provide long-term shelter for various insects including larvae of many butterflies. The plant has medicinal properties and its extract of young leaves and inflorescence has anti-diuretic and stomachic properties. The life cycle of this species on this host-plant is described for the first time from Kashmir Valley.

Usually mid-day was found as preferred time for oviposition however it was not a rule because egg laying was observed during late morning hours in the warmest months of June, July and August. The eggs were laid in clusters, usually on the upper areas on the under surface of the leaves. The egg laying was preferred at places were larval host-plants were in abundance and was avoided on isolated plants. The eggs were mostly laid on the centrally located plants, which seemed to avoid the easy attention of predators.

The first instar larvae were visible from the transparent chorion of the egg. The larvae were gregarious however this phenomenon was highest in first and second instars and least in fifth (last) instar. The fourth and fifth instars were seen on adjoining plants like grasses, however we could not notice any larval feeding behavior on these plants. Being in swarms, the first instar with least moving ability feed on the upper tender leaves of the plant and consume nearly most of the plant area and leave network of vein of the leaf.

The web making behavior was seen in first to fourth instars. The larvae excreted pellets of blackish faecal matter. In case of exigencies like danger, external disturbance, etc the second, third and fourth instar larvae secreted a green coloured fluid and also raised their body irregularly and shake their heads.

Eggs: They are laid mostly in groups on the upper portion of the plant. They are brownish to yellowish brown in colour and dome or oval shaped. They eat the egg shell and changed into first instar larvae in 4-6 days.

Larva: There are five larval instars and the total larval period/duration varies from 21 to 30 days. The larvae excreted blackish faecal matter in pellets.

First instar: Head black to brownish black, frons brownish black and shining, vertex and cheeks blackish. Ground colour yellowish to lemonish or greenish yellow, upper side/surface light lemonish or yellowish green and first 5-6 segments more densely coloured. First thoracic segment has a brownish spot on the upper side which is not found in other segments. Thoracic legs are small, blackish, developed and functional. Abdominal legs and anal clasper/legs are light lemonish or colourless, not fully developed and functionless. Mid-dorsal line visible, complete and black to brownish black in colour. All body segments except anal segment covered with small brownish to blackish hairs. Anal segment covered with yellowish hairs. They are slow movers and live in groups, mostly on the upper part of the plant. They eat soft and tender leaves. They also secreted a whitish silken like substance and make cocoon or web like structures in which they live until they change into next instar. The silken web is used as a bridge to move from one place or plant to another while as silken covering seems to provide protection from sunlight, heat, rainfall, winds and enemies (Size 4-6 mm, Duration 3-5 days, Figs. 1, 2).

Second instar: Head more prominent, vertex and frons turn more shining, cheeks brownish black or black and covered with small brownish hairs. Body colour starts changing to black. Hairs on body start growing and increase in size and number. The greenish areas or colouration on the body start disappearing. First segment is smaller than others. The larva comes out of the silken cocoon and starts living mostly in groups or singly. Thoracic legs increase in size and are more blackish, fully developed and functional. Both abdominal and anal legs increase in size. Abdominal legs are lemonish yellow and become fully functional. Anal legs also start functioning and start changing to brownish. The larva becomes quicker and increases in size and shape. Mid-dorsal line becomes more prominent (Size, 9-14 mm, Duration 4-6 days, Fig. 3).

Third instar: Head brownish black, vertex and frons more brownish. Anal legs increase in size, turn brownish and become fully functional. Thoracic legs are blackish, developed and functional. Abdominal legs increase in size and are more yellowish. Head and first thoracic segment are of same size but smaller than other body segments. The larva shows drastic increase in size and becomes more quicker and voracious eater. It starts living singly but can also be seen with other instars, eats nearly any part of the plant and moves freely from one place to another. The larva sticks itself to the object on which it is placed or on which it rests. Hairs on the body increase in size and number. The hairs on the lower side are yellowish and on upper side are black with few yellowish in between (Size 16-22 mm, Duration 5-7 days, Fig. 3).

Fourth instar: Head brownish or blackish brown, smaller than other segments; cheeks and frons complete brownish. Thoracic legs blackish, abdominal legs yellowish and anal legs brownish. All legs are fully functional. Upper side of the body black, ground surface black to brownish black. Mid-dorsal line is prominent

and black. It becomes less quick and eats less as compared to the previous instars (Size 20-26 mm, Duration, 4-6 days, Fig. 4).

Fifth instar: Head blackish brown, cheeks and frons brownish. Thoracic legs blackish, abdominal legs yellowish and anal legs brownish and all legs are fully functional. It is a very slow mover and lives mostly singly. Upper side of the body black, ground surface black to brownish black. Mid-dorsal is prominent and black. It stops feeding during its last larval stages of development and moves to a suitable place usually upper part of the plant where it pupates (Size 26-32 mm, Duration 5-6 days, Fig. 5).

Pre-Pupa: The larva stops feeding and shrinks its size which varies from 18-22 mm. It sticks itself to the substratum with its anal end. The cremaster is whitish. Wing case is light brown to light green (Duration, 1-2 days, Fig. 6).

Pupa: Pupa is variously coloured (brownish, dark brown and greenish brown). When the pupation takes place in dim light the pupa is usually dark brown and if it takes place in bright light the pupa is light brown to greenish brown. Eyes, palpus and antenna are golden brown. Wing case dark brown and spiracles on the wing case golden to golden brown. Pupa is free and hanging. A reddish colorued meconium is ejected (Fig. 12), pupa breaks from lower side and adult comes out. Our findings matched with Dimock (1978) who reported it in the *Vanessa annabella* (Field) (Nymphalidae) from southern California. Immediately after emerging from pupa, the adult can sit on any object even on human hands (Fig. 13) (Size 17-20 mm, Duration 4-6 days, Figs. 7, 8, 9, 10, 11).

Adult/Imago: Antennae black, club elongated, tip creamish brown; Head small, brown; Thorax upper side brownish and covered with silky brownish hairs, underside dull blackish brown covered with dull blackish hairs; Abdomen brownish on upper side and dull creamish on the underside; Forewing upperside with basal part yellow, irrodated with golden scales, marginal area black with light brown colouration in between, rest of wing orange red with various black spots and traces of yellow, cell with a quadrate black bar across the middle, a large black discocellular spot which touches the costal margin, another large but irregular black spot above it towards apex, yellowish bars between these black spots, a large black spot between 1A+2A and Cu1b with some part touching Cu1a, one small black spot between Cu1b and Cu1a, another one between Cu1a and M_3, a whitish spot near apex; underside forewing brown, basal half clouded with dark purplish-brown, the outer margin of the dark portion defined by a highly sinuous jet-black transverse line, most distinct on the hind wing, upperside black, yellow and orange-red colouration represented only by impressions. Hindwing with upperside basal area dusky brown, covered posteriorly with light brown, shining hairs, inner margin light brown and dusted with golden scales, marginal area light brown with an irregular blackish band centered with blue from tornus upto vein R_S and $Sc+R_1$, a light brown submarginal band, a broad red band turning yellow towards costal margin; underside similar to that of forewing. The adults reared under controlled condition lived up to 2 to 6 days (Wing span: 42-60 mm, Figs. 14, 15).

Field Investigations: The present field observations revealed that besides being very common, this butterfly was active from March to November both in groups as well as singly but was most active from May to August. While Wynter-

Blyth (1957) gave its range from low elevation upto 4570m and Haribal (1992) from 900-4800m, the present study observed its altitudinal range from 1200-3000m (meter above sea level). There was no butterfly activity during the months of January, February and December. Among Nymphalidae, it was first to arrive after a very cold winter and was found widely distributed in different habitats like forests, gardens, hilly places, orchids, parks, roads, agricultural land, vegetable gardens and open fields etc in various localities/areas of all the administrative districts of Kashmir Valley (Table 1, Figs. 17, 18).

They mostly took slow to moderate flight and occasionally it was fast, quick and very high. It preferred to fly during mid-days mostly near the ground and was seen taking uneven, zig-zag and discontinuous flight and chasing its own members. At many occasions it was seen chasing other nymphalids like Painted Lady, *Cynthia cardui* (Linnaeus) and Indian Red Admirable, *Vanessa indica* (Herbst) and was itself seen chased by few like the Silver Strip, *Childrena childreni* (Gray) (Nymphalidae). They love to bask in the sun mostly on rocks, stones, open fields, grasses (Fig. 16) etc, by keeping their wings fully or partially open. The adults are difficult to locate when they keep their wings closed, are attracted to rocks, open dusty roads, dead plants, twigs or leaves, moist and damp soil and animal excreta and showed a prominent mud puddling behaviour.

During the present field investigations, the adults were seen visiting plants belonging to various families like Asteraceae (*Taraxacum. officinale*), Compositae (*Tagetus patula*), and Verbenaceae (*Lantana camara*, *Verbena bonariensis*) for nectar sucking and this behavior was highest seen on *T. patula.*

In the field, insects like ants and aphids were seen associated with the larvae on the *Urtica* plant, but no damage to larvae was observed from these organisms. Birds like Common Crow, Indian Mynah, Sparrow, some unidentified hymenopteran, etc were seen acting as predators, devouring both larvae and adults.

CONCLUSION

So far, almost 70% of the country's land area has been surveyed and around 46,000 species of plants and 89,000 species of animals have been described. It is estimated that about 400,000 more species may exist in India which need to be recorded and described. The baseline data on species and genetic diversity, and their macro-and micro-habitats, is inadequate, Anonymous (2007). Inspite of being indicators of environmental quality, important food chain components of various animals and possessing great aesthetic values, the life history of 70% of Indian butterflies is still unknown, Haribal (1992). Further, the information on the biology of butterflies of Kashmir Valley is more dilapidated and still very poorly touched. The present preliminary observations besides adding the knowledge and information on the butterflies of Kashmir Valley, provides the basis for further laboratory and field studies on the biology, ecology, impact of weather and natural enemies, nature of larvae, population dynamics, taxonomy etc of this and other butterfly fauna. Hence such type of studies will be of immense value and great contribution for exploring the biodiversity of this key Himalayan region.

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Table 1. Details of various places where *Aglais cashmirensis* was reported during 2008-2011 in Kashmir Valley.

S.No	Place	District	Latitude	Longitude
1	Achhabal	Anantnag	33.6833	75.2333
2	Aish Muqam	Anantnag	33.8666	75.2833
3	Anantnag	Anantnag	33.7333	75.1500
4	Arau	Anantnag	34.1000	75.2666
5	Banihal Pass	Anantnag	33.5166	75.2166
6	Khanabal	Anantnag	33.7500	75.1333
7	Kulgam	Kulgam	33.6500	75.0166
8	Lidder River	Anantnag	34.0166	75.3166
9	Pahalgam	Anantnag	34.0333	75.3333
10	Qazigund	Anantnag	33.6333	75.1500
11	Budgam	Budgam	34.0166	74.7166
12	Dal Lake	Srinagar	34.1166	74.8666
13	Ajas	Bandipora	34.3333	74.6833
14	Bandipora	Bandipora	34.4166	74.6500
15	Ganderbal	Ganderbal	34.2333	74.7833
16	Gurais	Baramulla	34.6333	74.8333
17	Gushi	Kupwara	34.5166	74.2333
18	Hajan	Bandipora	34.3000	74.6166
19	Handwara	Kupwara	34.4000	74.2833
20	Lolab	Kupwara	34.5000	74.4000
21	Nagin Lake	Srinagar	34.1166	74.8333
22	Pattan	Baramulla	34.1666	74.5666
23	Safapura	Bandipora	34.2500	74.6666
24	Shalimar Garden	Srinagar	34.1500	74.8666
25	Sogam	Kupwara	34.5000	74.3833
26	Sopore	Kupwara	34.3000	74.4666
27	Watlab	Baramulla	34.3666	74.5166
28	Panzgam	Kupwara	34.4833	74.0833
29	Tangdhar	Kupwara	34.4000	73.8666
30	Trehgam	Kupwara	34.5000	74.1333
31	Awantipora	Pulwama	33.9166	75.0166

Figure 1. Bunch of first instar larvae causing damage.

Figure 2. First instar larvae.

Figure 3. Bunch of second and third instar larvae.

Figure 4. Fourth instar larva.

Figure 5. Fifth instar larva.

Figure 6. Pre-pupae.

Figure 7. Pupa.

Figure 8. Pupa is opening for the emergence of adult.

Figure 9. Pupa is ready for opening like a door for the arrival of adult.

Figure 10. Pupa breaks & adult arrives.

Figure 11. Broken pupa after emergence of adult.

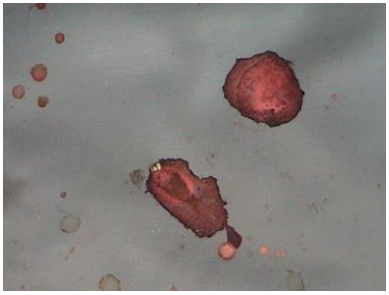

Figure 12. Release of red coloured mecomin before the emergence of adult.

Figure 13. Adult rests on any object like hands after emergence.

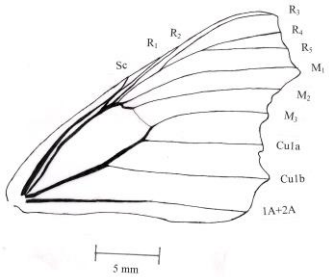

Figure 14. Forewing venation of *Aglais cashmirensis*.

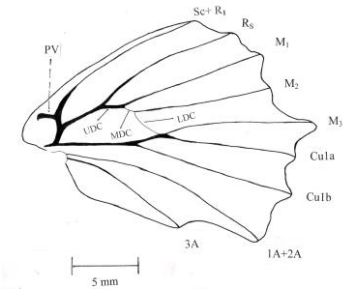

Figure 15. Hindwing venation of *Aglais cashmirensis*.

Figure 16. Adult basking in the sun.

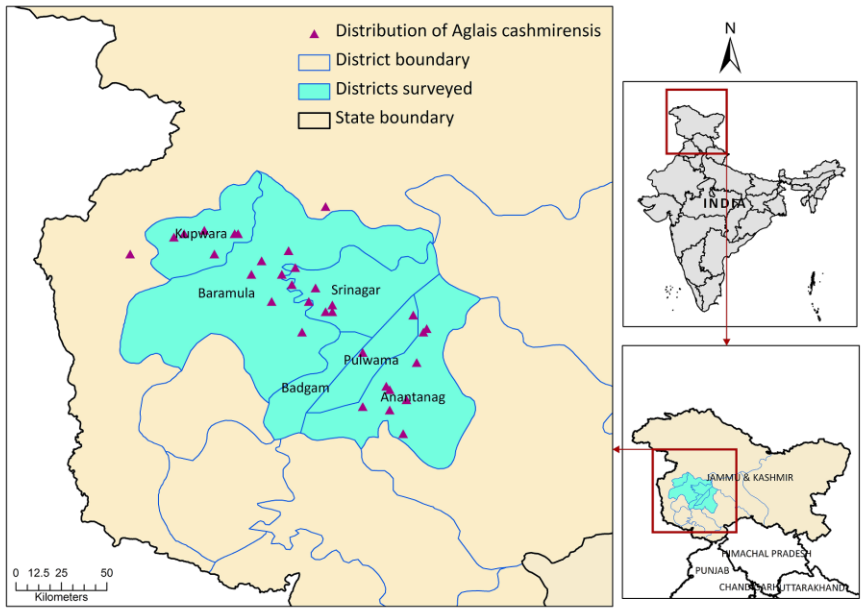

Figure 17. Distribution of *Aglais cashmirensis* in Kashmir Valley.

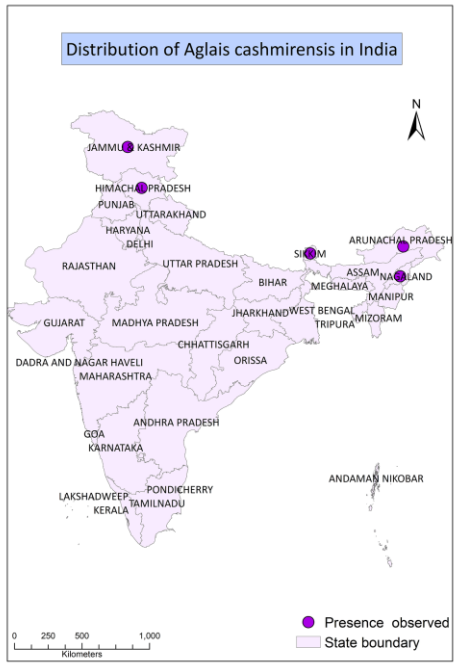

Figure 18. Distribution of *Aglais cashmirensis* in India.