ISSN 0972- 1800

BIONOTES

VOLUME 23, NO. 1 **QUARTERLY** **JANUARY - MARCH, 2021**

Date of Publication: 12th April, 2021

BIONOTES

A Quarterly Newsletter for Research Notes and News
On Any Aspect Related with Life Forms

BIONOTES articles are abstracted/indexed/available in the Indian Science Abstracts, INSDOC; Zoological Record; **Thomson Reuters (U.S.A); CAB International (U.K.); The Natural History Museum Library & Archives, London: Library Naturkundemuseum, Erfurt (Germany)** etc. and online databases.

Publication Policy
Information, statements or findings published are the views of its author/ source only.

Manuscripts
Please E-mail to petersmetacek@gmail.com.

Guidelines for Authors
BIONOTES publishes short notes on any aspect of biology. Usually submissions are reviewed by one or two reviewers.
Kindly submit a manuscript after studying the format used in this journal (http://www.entosocindia.org/).
Editor reserves the right to reject articles that do not adhere to our format. Please provide a contact telephone number. Authors will be provided with a pdf file of their publication.

Address for Correspondence
Butterfly Research Centre, Bhimtal, Uttarakhand 263 136, India. Phone: +91 8938896403.
Email: butterflyresearchcentre@gmail.com

From Volume 21
Published by the Entomological Society of India (ESI), New Delhi (Nodal Officer: V.V. Ramamurthy, ESI, New Delhi)
And
Butterfly Research Centre, Bhimtal
Executive Editor: Peter Smetacek
Assistant Editor: Shristee Panthee
Butterfly Research Trust, Bhimtal

Published by Dr. R.K. Varshney, A Biologists Confrerie, Raj Bhawan, Manik Chowk, Aligarh (up to volume 20 (2018)) R.N.I. Registration No. 71669/99.

Cover Photo by Parixit Kafley of *Balinta octonotata*

TABLE OF CONTENTS

SHELTER BUILDING BEHAVIOUR OF *HASORA CHROMUS* (CRAMER, 1780) LARVAE (INSECTA: LEPIDOPTERA: HESPERIIDAE)

RAJESH CHAUDHARY
Department of Biomedical Science, Acharya Narendra Dev College, University of Delhi, Govindpuri, Kalkaji, New Delhi-110019, India.
rajeshchaudhary@andc.du.ac.in

Reviewer: Peter Smetacek

Abstract
Larvae of many lepidopterans, including those belonging to the family Hesperiidae, construct leaf shelters. It has been indicated that these shelters confer protection to larvae from predators and harsh environmental conditions. The repertoire of shelter architectures constructed by given genera or species of Hesperiidae is fairly predictable. Thus, shelter building behaviour can also be important from the perspective of evolution. The present study provides an insight into shelter building behaviour of larvae of Common Banded Awl, *Hasora chromus* (Cramer), including various designs of shelter that larvae can make, and the role of shelters protection from predators. *H. chromus* larvae were found to construct at least four broad architectural types of shelters by folding and tying leaves. The shelters function as a barrier for arthropod predators (including wasps and spiders), and also effective in protecting larvae from avian predators too.
Keywords: Common Banded Awl, *Hasora chromus,* Hesperiidae, Larva, Ecobiology, Shelter-building, Predation, Protection.

Introduction

Larvae of lepidopterans have devised several ways to protect themselves from predators as well as environmental conditions such as solar heat, dislodgement due to shaking or wind blow (Greeney et al., 2015). Their protective strategies include chemical, physiological, morphological, and behavioural defences association with other organisms and avoiding encounters with predators by constructing shelters (Greeney et al., 2015). The latter strategy, *i.e.* shelter making, is widely utilized by larvae of Hesperiidae (Greeney et al., 2003). The larvae of this butterfly family construct shelters with a diverse array of architecture through precisely executed actions, including cutting, rolling, folding and tying a portion or whole of a leaf or several leaves together (Greeney et al., 2003, 2015; Greeney 2009). Within Hesperiidae, the range of shelter architecture made by larvae of a species is largely predictable, and this may be important from the point of view of phylogeny of this group of butterflies (Greeney et al., 2003, 2010; Greeney 2009). However, studies on shelter building behaviour, architectural details of shelter and its protective values (protection from predators and harsh environment) for larvae have not received much attention, particularly for Indian hesperids. In the present communication, these aforementioned aspects have been reported for Common Banded Awl (*Hasora chromus* Cramer, 1780), a common hesperid butterfly found in most parts of India. *Hasora chromus* lays eggs singly or in groups of 2-3 eggs on nascent leaves of its host plant. There are five larval instars, live in self-constructed leaf shelters (Jenkinson, 2010; Devika Rani et al., 2020). In this observational study, the shelter building behaviour of *H. chromus* was monitored in the natural conditions on the larval host plant *Millettia pinnata* (L.)- a tree planted along roads in many Indian cities.

Material and Methods

Eight *Millettia pinnata* trees growing along the roadsides and parks (in North-West Delhi, India) and infested with the larvae of Common Banded Awl (*Hasora chromus*) were monitored in the year 2020 from the second week of August to the first week of September. For observations related to predation and shelter building activities, the crown of two of these trees was accessed from the third and fourth floor (height of approximately 10-14 meters) of a residential building and observed for 12 days, i.e. the fourth week of August to the first week of September. During this period, the infested trees had the highest population of IVth and Vth instar larvae. Therefore, in the present study, observations on predation and shelter building activities pertain mainly to these two larval stages. Trees were observed between 9:00 a.m. to 5:00 p.m., cumulatively for 3.5-4 hours per day. Visible portions of the tree crown within 4 to 6 meters from the observer (covering about half of the crown area of trees) were chosen for making observations. The events were photographed and filmed using a Digital SLR camera (Nikon) fitted with an 80-400 mm zoom telephoto lens. The larval instars (Fig. 1) were identified based on their morphological features visible while they were engaged in feeding or constructing shelters (Devika Rani et al., 2020; Jenkinson, 2010).

Results and Discussion

Infestation of trees

M. pinnata is a middle-sized tree and a preferred larval host plant of *H. chromus* (Suryanarayana et al., 2015; Karmakar et al., 2018; Nitin, 2018; Devika Rani, 2020). In the study area, all the trees under observation had renewed their leaves and borne flowers in March-April. These trees had a second flush of new leaves and flowers during the rainy season, i.e. last week of July-September (in the same year). During this period (i.e. rainy season), the oviposition activity of *H. chromus* gradually increased with its peak during the second to fourth week of August (as determined by the numbers of egg-laying females). Eggs were laid on nascent buds of leaves (Fig. 1). The ovipositioning activity was higher in the morning and evening hours. During cloudy days, high ovipositioning was observed throughout the day. The maximum number of larvae (IVth and Vth instars) feed on leaves were observed during the fourth week of August to the first week of September.

Shelter architecture and feeding activity of larvae

During the fourth week of August to the first week of September, about 120 larval shelters were securitized. About 80 per cent of these were constructed /occupied by Vth Instar and most of the rest by IVth instar larvae. A few shelters, however, were occupied by IInd/IIIrd instars as well. Based on architecture, shelters could be classified as *a)* constructed from one leaflet and *b)* constructed by tying two leaflets together.

Three architectural subtypes were observed in shelters constructed from one leaflet:

i) Those in which the opposite margins of leaflets were brought together and tied with the help of silk (Figs. 2A, 2 B), *ii)* those in which a furrow was made by tying two sides of the blade in the middle of the leaflet (Fig. 2C), and *iii)* shelters in which a portion of the leaflet was cut from margin towards midrib and the resulting leaf flap was folded and glued (Fig. 2D). The 'ii' subtype was seen only on three occasions and was constructed by younger larval instars (II/ III instars). The subtypes 'i' and 'iii' observed in the present study may correspond respectively to the 'Type 2' and 'Type 6' shelters according to the classification of larval shelters given by Greeney et al. (2003). Accordingly, subtype 'ii' observed here may correspond to 'Type 2' shelter (Greeney et al., 2003).

In the shelters formed by two leaflets, the surfaces of two neighbouring or touching leaflets were brought together, and their margins were tied to each other (Figs. 2E-H). This architecture of shelter may correspond to ‘Type 4’ shelter of Greeney et al. (2003).

Larvae were found to spend most of the time inside the pockets of the shelters. They fed in bouts by chewing the margins of shelter leaflets or nearby leaflets by extending a part of their body out of the shelter (Figs. 2B, 2F-H, 3A-C). Only new leaves, i.e. those that emerged during the rainy season, were utilized for feeding or making shelters. Tough and mature leaves borne during March-April, however, remained unexploited. This might reflect the preference of larvae for tender leaves and the inability to fold or cut leaflets with hard leaf blades (Greeney *et al*., 2010).

The larvae abandoned their shelters once the shelter was consumed to the level that it could no more accommodate the body of larvae (Figs. 2E, 3D). To search for a suitable leaflet for the construction of a new shelter, larvae crawled on leaf petiole, rachis and twigs. The searching process sometimes took more than 5 minutes, exposing larvae to potential predators (Figure 3E-F). Since larvae can consume a shelter in less than a day’s time, they require constructing several shelters during the larval stage (Jenkinson, 2010).

Shelter construction

About 20 shelter construction events were witnessed during the period of observation. The shelters were constructed with leaves that had emerged in the rainy season. Old and tough leaves offspring were not utilized. In a typical one leaf shelter, the process followed is 1) after settling to the new leaflet, the larvae swing a quarter to one-third portion of their anterior body in left and right repeatedly, 2) while swinging, the larvae touched their head on the one side of the leaf surface and then to the other side, 3) while the left and right movement of the body was under progress, there appeared a thin silken thread linking those two points of leaves which were repeatedly touched by head of the larvae, 4) larvae continued to swing their anterior part of the body to the left and right along the silk thread, which gradually thickened and shortened, 5) shortening of the thread was concurrent with the folding of the leaflet and brought the two sides of leaflet blade in close contact (or brought the surface of two leaflets in close contact if the shelter was being constructed from two neighbouring leaflets). The silken thread thus seemed to function as pulling rope and fastener. The process of fastening the leaf was performed at 3-4 points along the length of the leaflet to make a stable cavity. The cavity formed by the folding of the leaflet (or tying two leaflets) was also worked on from inside (as indicated by the rapid head movement of larvae while inside the cavity), possibly for proper sealing and to provide strength to the cavity. Figure 4 provides a sequential snapshot of various steps during the construction of a typical one leaf shelter by a V^{th} instar larva. The entire process of construction of a shelter may take over 30 minutes.

Larvae of lepidopterans are known to produce silk from their labial glands (Sehnal et al. 2008). Leaf shelter-building larvae generate the force required to pull or roll leaves by fixing several strands of overstretched silk to opposite points on a leaf (Fitzgerald et al., 1991, 1994, Greeney et al., 2010). The elastic properties (or contraction) of silk provide force to pull the two points and bring them together to make a leaf fold (Fitzgerald et al., 1991, 1994). Folding of the leaf by larvae might be constrained by certain properties of leaves such as structure, hardness and texture (Greeney et al., 2010), for instance, the force generated by silk may not be adequate to fold tough older leaves. Thus, in addition to chemical and nutritional characteristics, other leaf properties such as its toughness and structure may also affect preference for one host plant over another by shelter making lepidopterans (Greeney et al., 2010).

Value of shelter as protection from predators

The potential functions of shelter are- protection of larvae from predators, dislodgement due to shaking of leaves by a sudden gush of wind, heavy rain, and cover from direct sunlight (Greeney et al., 2015; Loeffler 1996; Baer et al., 2020; Abarca et al., 2011, 2014). In the present study, observations related to the predation of IVth and Vth instar larvae by various predators were made. A list of predators frequently observed attacking or feeding on the larvae of *H. chromus* is provided in Table 1 and Fig. 5. A properly sealed leaf-shelter of *H. chromus* camouflages well with the background and functions as a protective shield around the larvae. Larvae were found to extend a part of their body outside the shelter to feed. Any sudden shake to the twig bearing shelter or sharp sound (such as clicking of the camera at about 1meter distance from the shelter) caused feeding larva to retract completely inside the shelter. However, on several occasions, feeding larvae did not retract even when a wasp or other insects landed or hovered within 2-3 inches from the shelter. Birds were found to be the most successful of all the predators in searching and extracting larvae from shelters (Fig. 5). Of all the birds given in Table 1, Jungle Babblers were found to be the most efficient in predation. About ten raiding events, each lasting for nearly 15 minutes by a flock of 4-5 Jungle Babblers, were witnessed. The flock could extract and consume about 10-15 larvae during each raiding event. Birds were found to feed on larvae as well as on pupae. The decline of raiding events by birds was found to be coincident with the decrease in the number of shelters (with larvae) in the first week of September.

Wasps, though not observed to extract larvae from the shelter, did make attempts to penetrate the shelter (Fig. 5K). Larvae looking for new leaflet for making a shelter or those in the process of making shelter were frequently found to be killed and consumed by wasps (Fig. 5J). Spiders were not found to kill or feed on larvae. However, on several occasions, spiders were found to follow movements of feeding or those larvae wandering in search of new leaflet for making shelter (Figs. 5H, I).

Whether shelters confer any protection to *H. chromus* larvae from predators?

1. There is an indication from the present study that shelter can act as a barrier to prevent arthropod predators from reaching larvae hiding inside the cavity of shelters. However, the protection conferred by the shelter may not be absolute. Similar observations have also been made by other workers (Abarca et al., 2014; Loeffler, 1996; Jones et al., 2002).

2. Though birds were found to the most successful predators, camouflaging of shelter with background could deceive birds, as in many cases, birds were unable to find shelters located within their close view. Also, on a few occasions, birds attacked empty shelters indicating that birds use leaf folds as visual cues to locate shelters (Murakami 1999).

Therefore, it may be concluded from the present study that- under natural conditions, shelter building behaviour can increase the chances of survival of IVth and Vth instar larvae of *H. chromus* larvae.

Acknowledgement

The author acknowledges Principal, Acharya Narendra Dev College, New Delhi and colleagues for their encouragement and support during the study.

References

Abarca, M. & K. Boege. 2011. Fitness costs and benefits of shelter building and leaf trenching behaviour in a pyralid caterpillar. *Ecological Entomology,* 36: 564–573.

Abarca M., K. Boege & A. Zaldívar-Riverón. 2014, Shelter-building behavior and natural history of two pyralid caterpillars feeding on *Piper stipulaceum. Journal of Insect Science* 14: 39.

Baer, C.S. & R.J. Marquis. 2020. Between predators and parasitoids: Complex interactions among shelter traits, predation and parasitism in a shelter-building caterpillar community. *Functional Ecology*, 34: 2186-2198.

Devika Rani D., K.S. Jagadesh & D. Jemla Naik. 2020. Biology of the Common Banded Awl, *Hasora chromus* Cramer (Lepidoptera: Hesperiidae) on *Pongamia pinnata* at Bengaluru. *Journal of Pharmacognosy and Phytochemistry*, 9: 2086-2089.

Fitzgerald, T.D. & K.L. Clark. 1994. Analysis of leaf-rolling behavior of *Caloptilia serotinella* (Lepidoptera: Gracillariidae). *Journal of Insect Behavior*, **7**: 859-872.

Fitzgerald, T.D., K.L. Clark, R. Vanderpool & C. Phillips. 1991. Leaf shelter-building caterpillars harness forces generated by axial retraction of stretched and wetted silk. *Journal of Insect Behavior*, 4: 21-32.

Greeney, H. F., & M.T. Jones. 2003.Shelter building in the Hesperiidae: A classification scheme for larval shelters. *Journal of Research on the Lepidoptera*, 37: 27-36.

Greeney, H. F. 2009. A revised classification scheme for larval Hesperiid shelters, with comments on shelter diversity in the Pyrginae. *Journal of Research on the Lepidoptera*, 41: 53-59.

Greeney, H. F., T. R. Walla & R.L. Lynch. 2010. Architectural changes in larval leaf shelters of *Noctuana haematospila* (Lepidoptera: Hesperiidae) between host plant species with different leaf thicknesses. *Zoologia*, 27: 65–69.

Greeney, H. F., L.A. Dyer & A.M. Smilanich. 2015. Feeding by lepidopteran larvae is dangerous: A review of caterpillars' chemical, physiological, morphological, and behavioural defences against natural enemies. *Journal of Agriculture and Environmental Sciences*, 4: 54-57.

Jenkinson W. 2010. Life history notes on the Chrome Awl, *Hasora chromus* (Cramer, [1780]) Lepidoptera: Hesperiidae. *Metamorphosis Australia*, 58. http://www.boic.org.au/files/ChromeAwl.pdf.

Jones, M.T., I. Castellanos & M. R. Weiss. 2002. Do leaf shelters always protect caterpillars from invertebrate predators? *Ecological Entomology*, 27:753-757.

Karmakar, T. et al. 2018. Early stages and larval host plants of some Northeastern Indian butterflies. *Journal of Threatened Taxa*, 10: 11780–11799.

Loeffler, C.C. 1996. Caterpillar leaf folding as a defense against predation and dislodgment: staged encounters using *dichomeris* (Gelechiidae) larvae on Goldenrods. *Journal of the Lepidopterist Society*, 50: 245-260.

Murakami, M.1999. Effect of avian predation on survival of leaf-rolling lepidopterous larvae. *Population Ecology*, 41:135-138.

Nitin, R., V.C. Balakrishnan, P. V. Churi, S. Kalesh, S. Prakash & K. Kunte. 2018. Larval host plants of the butterflies of the Western Ghats, India. *Journal of Threatened Taxa*, 10: 11495–11550.

Suryanarayana K., P. Harinath, P. Meerabai, M. V. Reddy & S.P. Venkata Ramana. 2015. Life cycle of the Common Banded Awl *Hasorachromus* (Cramer) (Lepidoptera: Rhopalocera: Hesperiidae) from southern Andhra Pradesh. *Cibtech Journal of Zoology*, 4: 45-51.

Sehnal, F. & T. Sutherland. 2008. Silks produced by insect labial glands. *Prion*, 2: 145–153.

Table 1**.** Predators observed attacking or searching into *Hasora chromus* shelters.

Birds	Arthropods
House Crow (*Corvus splendens*) Red-vented Bulbul (*Pycnonotus cafer*) Jungle Babbler (*Turdoides striata*) Common Myna (*Acridotheres tristis*) Oriental White-eye (*Zosterops palpebrosus*) Rufous Treepie (*Dendrocitta vagabunda*) Brown-headed Barbet (*Megalaima zeylanica*)	Yellow Paper Wasp (Genus: *Polistes*) Spiders (Order: Araneae)

Fig. 1: Larval stages

Fig. 3: Feeding

Fig. 2: Shelter architectures

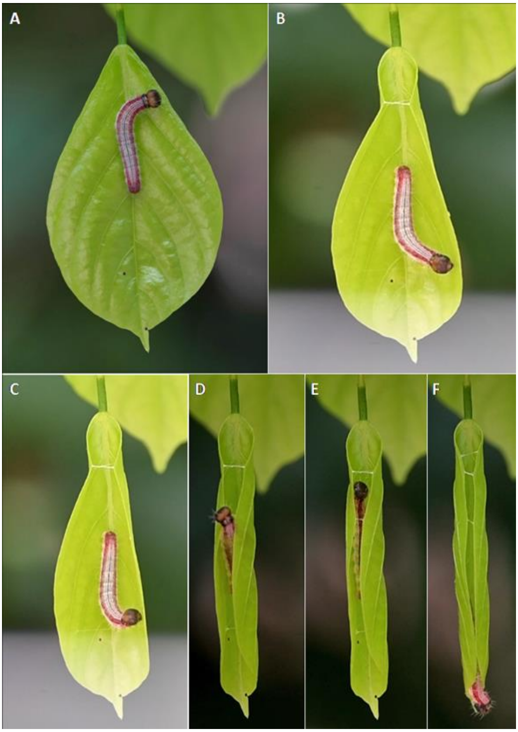

Fig. 4: Shelter making

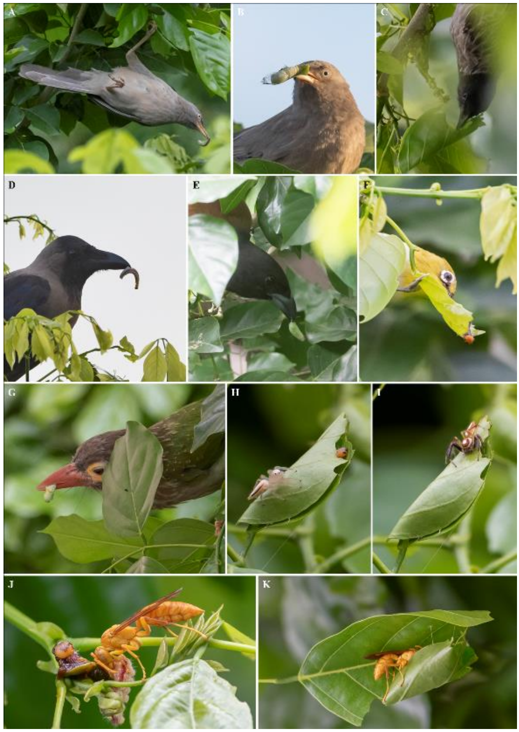

Fig. 5: Predators