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Scanning Electron Microscope Studies on Ornamentation of Egg Chorion of *Capissa vagesa* (Moore, 1859) (Erebidae) and *Trabala vishnou* (Lefèbvre, 1827) (Lasiocampidae) (Ditrysia: Lepidoptera) from India

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ABSTRACT

The eggs of *Capissa vagesa* (Moore, 1859) and *Trabala vishnou* (Lefèbvre, 1827) from the families Erebidae and Lasiocampidae were examined and characterized under scanning electron microscope. Significant morphological traits on the eggshells of both analyzed species are presented in current study. Descriptions and comparative morphological assessments for both species of these moths are provided, in addition to the structural complexity of the eggs uncovered throughout the course of this study. This study showed that ultrastructural egg chorion features investigated in the current study i.e., shape of Micropylar rosette, polygonal cells, number of micropyles and aeropyles have high taxonomic significance at specific and generic levels, and these sort of investigations must be expanded to improve and elevate the morphological depiction at levels of earlier life stages in various moth families.

Key words: Aeropyles, micropylar rosette, micropylar pit, micropyles, polygonal cells.

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INTRODUCTION

Invertebrates such as insects, spiders, mollusks, and crustaceans have long used eggs as a mechanism of reproduction. Lepidopterans, like most other insects, are oviparous, or "egg-bearers" (Gullan & Cranston, 2004). Many species deposit their eggs individually, in widely dispersed clumps, or in masses, while others lay them in masses covered with a hardened fluid from the female's abdominal glands (Holland, 1898, 1903).

In Lepidoptera, the eggs are usually oval, spherical, dome-like, disc-like, conical, cuboid or irregular in shapes (Peterson, 1964). The chorion may have a simple and basic structure, or may have a reticulate patterned surface with divisions and transverse or longitudinal ridges along with other parts of chorion i.e., polygonal cells, micropylar rosette and micropyles. The chorion is the outer protective layer of the egg and secreted by the ovarian follicle cells along with the surface sculpturing (polygonal cells) of the chorion which usually reflects the outline or imprints of these cells. The egg shell typically has tiny minute grooves or holes (airspaces, air-pores, or aeropyles) that can only be seen using an electron microscope's high magnification and resolution capabilities. These air-pores allow for the exchange of oxygen (O_2) and carbon dioxide (CO_2) between the environment and embryo with very little water loss. The egg's anterior pole is slightly flattened, resulting in a tiny medial chamber with a minute hole known as a micropyle (Evans, 1932).

The chorion is secreted around the whole egg while it is inside the ovary, so it becomes obligatory to have amenity for permitting the upcoming entry of sperm through it. The small openings which allow the sperm to enter and fertilize the ovum are termed as micropyles. These small funnel shaped pores which run and pass right through the chorion are usually located near the anterior pole of the egg (Salked, 1975).

The micropylar zone is found on the upper anterior section of globular, conical, or cylindrical eggs, as well as on the outside perimeter or rim of flattened or lenticular eggs (Holland, 1898, 1903). This area is protected by a unique arrangement known as micropylar rosette. The number of micropyles ranges from 1 to 20 in Lepidoptera (Hinton, 1981).

There are several methodologies for analyzing taxonomic characteristics, such as morpho-taxonomy, molecular taxonomy, behavioral taxonomy, and ecological taxonomy, among others. The current effort is precise advantage in terms of improving and elevating the morphological characteristics of various moths. These scanning electron microscopic studies will build up the morphological representation of the external surface characteristics of the eggshell i.e., chorion and reveal both traditional and mutable features, thus serve in learning various facets of biological diversity. Such studies will surely provide valuable tools to disclose the eggshell sculpturing in various lepidopteran families at species and generic levels in order to segregate them at much earlier stages of their life histories which can prove beneficial in case of pests as earlier identification of pests through eggs on economically important plants will help scientists and farmers in building a proper and more suitable pest management program.

MATERIALS AND METHODS

Collection and identification The tours were conducted in Sainj and Shalwad localities of the district Kullu in Himachal Pradesh to collect the adults as well as eggs of moths in September 2020. The adult specimens were stretched, preserved and identified.

Material examined

Capissa vagesa, Himachal Pradesh: Sainj, 2 eggs and *Trabala vishnou,* Himachal Pradesh: Shalwad, 3 eggs

Taxonomy and distribution

Genus: *Capissa* Moore, 1878

Capissa Moore, 1878; *Proc. zool. Soc. Lond.,* 1878: 19; Moore, 1882, *Lepid. Ceylon,* 2 (1): 56, 134; Singh, Singh & Joshi, 2014, *Rec. Zool. Survey India. Occ. Pap.,* 367: 27.

Type species. *Lithosia vagesa* Moore, 1859

Distribution. India: Assam, Kashmir, Sikkim, North-West Himalayas; Nepal, Myanmar.

Remarks. Genus *Capissa* Moore, 1878 is a monotypic tiger moth genus of the family Erebidae. It was formerly considered a synonym of the genus *Eilema* Hübner, 1819. This genus was firstly reported by Frederic Moore in 1878. The adult form usually found from North West Himalayas and Nepal has the legs with black bands at joints and the eastern form of this moth has wholly black legs.

Species: *Capissa vagesa* (Moore, 1859)

Lithosia vagesa Moore, 1859; in Horsfield & Moore, *Cat. Lep. Ins. Mus. Nat. East India Hous*e 2: 304.

Capissa vagesa; Kirti, Singh & Joshi, 2014, Ann. Zool. 64 (1): 46; Singh, Singh & Joshi, 2014, Rec. Zool. Survey India. Occ. Pap 367: 27, 134.

Ilema vagesa; Hampson, 1900, Cat. Lep. Phalaenae Br. Mus. 2: 144, f. 91.

Eilema vagesa; Kishida, 1993, Tinea 13: 37, pl. 40, f. 15.

Eilema vegesa; Kishida, 1994, Tinea 14: 69.

Type locality. Sikkim (India)

Distribution. The species is distributed throughout Indian Himalayas, Nepal and Myanmar.

Remarks. The monotypic status of this genus has been updated recently as Kirti et al (2014) described a new species, *Capissa alba* sp. nov., from Jammu and Kashmir region of Indian Himalayas. During the present study, the ultrastructure details of the eggs of *Capissa vagesa* (Moore, 1859) have been studied for the first time.

Genus: *Trabala Walker, 1856*

Walker, 1856, *List Spec. Lepid. Insects Colln. Br. Mus.,* 7: 1785; Moore, 1883, *Lepid. Ceylon,* 2: 146; Hampson, 1892, *Moths India,* 1: 421; Holloway, 1987, *Moths Borneo,* 3: 49; Zolotuhin, Treadaway, & Witt, 1997, *Lasiocampidae Philippines,* 17: 139; Zolotuhin and Witt, 2000, *Lasiocampidae Vietnam,* 3(11): 48; Zolotuhin & Pinratana, 2005, *Lasiocampidae Thailand,* 4: 41; Youqiao and Chunsheng, 2006, *Fauna Sinica,* 47: 333-334; Sujata, Kaleka, & Singh, 2019, *Ann. Entomol.*, 37(1): 19-27.

Amydona Walker, 1855, *List Spec. Lepid. Insects Colln. Br. Mus.,* 6: 1387.

Type species. *Amydona prasina* Walker, 1855

Distribution. Oriental and Palearctic regions.

Remarks. This genus was established as an objective replacement name for *Amydona* Walker and the type species of this genus was designated by Moore in 1883. Earlier genus *Trabala* Walker was treated in the family Bombycidae, however, Moore in 1883 placed it as a distinct genus in the family Lasiocampidae. (Hampson, 1892; Holloway, 1987; Zolotuhin, Treadaway & Witt, 1997; Zolotuhin & Witt, 2000; Zolotuhin & Pinratana, 2005; Youqiao & Chunsheng, 2006, as well as, in this present study the same nomenclature has been followed. (Sujata et al*,* 2019) described three species of this genus from North-West India. Presently, this genus is represented by twenty-eight species from Oriental and Palearctic regions.

Species: *Trabala vishnou* (Lefèbvre, 1827)

Gastropacha vishnou Lefèbvre, 1827, Zool. J. 3: 207.

Trabala vishnou Lefèbvre: Moore, 1883, *Lepid. Ceylon,* 2: 146; Zolotuhin & Witt, 2000, *Lasiocampidae Vietnam,* 3 (11): 48; Zolotuhin & Pinratana, 2005, *Lasiocampidae Thailand,* 4: 42-44; Youqiao and Chunsheng, 2006, *Fauna Sinica,* 47: 336-338;

Zolotuhin & Ihle, 2008, *Lasiocampidae Laos,* 20(4): 3; Hauenstein et al., 2011, *Lasiocampidae Bhutan;* 67: 29; Sujata et al, 2019, *Ann. Entomol.*, 37(1): 24-26.

Trabala vishnu Hampson, 1892, *Moths India,* 1: 421-422.

Type locality. Unknown

Distribution. Throughout India; Cambodia; Central and Southern China; Malaysia; Myanmar; Nepal; North- East Pakistan; Sri Lanka; Taiwan; Thailand; Vietnam.

Remarks. In India, Nepal, and Southern China, the current species is a serious polyphagous pest of orchards and ornamental plants. Barringtonia (Lecythidaceae), Lagerstroemia (Lythraceae), Shorea (Dipterocarpaceae), and Schleichera are all known defoliators (Sapindaceae). During the present study, the ultrastructure details of the eggs of *Trabala vishnou* (Lefèbvre, 1827) have been studied for the first time

Scanning electron microscopy studies

After collection of adults from vertical sheet light traps, the freshly laid eggs by the gravid female moths are hand-picked with the help of fine forceps and brushes. The collected eggs were then preserved in glass vials containing 70% alcohol and glycerol at a ratio of 8:2. The vials were marked with proper reference numbers and field data such as name of locality, collector's name, and date of collection.

To prepare samples for scanning electron microscopy studies, the following procedure was adopted:

The sample substance i.e., the eggs were fixed in 2.5% glutaraldehyde for a minimum duration of one hour. Then, the material was shifted into phosphate-buffered saline (PBS) at pH 7.4 and rinsed repeatedly for a minimum period of 15 min.

The eggs were dehydrated by maneuvering a succession of graded ethyl alcohol (in 50% alcohol for 15 min, followed by 70% and 90% alcohol for 15 min each and 3 changes in 100% alcohol for 10 min each).

After proper dehydration and drying of sample material in air it was mounted on aluminium stubs with double-sided adhesive carbon tape and sputter coated with a mixture of gold and platinum.

The sputtered samples of the eggs were observed and studied through a scanning Electron Microscope (JEOL) JSM-6510LV available in the Sophisticated Instrumentation Centre of Punjabi University, Patiala. The sample material was scanned under this microscope to assess the chorion, micropylar region, the arrangement of micropylar rosettes, aeropyles and other external ultra-structures present on the eggshell.

The eggs were classified according to the nomenclature systems proposed by (Doring, 1955; Peterson, 1964). The terminology used by Salked, 1975; Zolotuhin & Kurshakov, 2009; Korycinska, 2012 and Dolinskaya, 2019 was been followed in this study.

RESULTS

Capissa vagesa **(Moore, 1859)**

Egg shape: In this species, the eggs are spherical in shape with 0.826mm length and 0.6mm width (Fig. 1a).

Egg chorion: The exo-chorion of the egg is smooth and very lightly sculptured with a plain surface area. It has very fine, thin and almost faded lines all over the surface. It forms an intricate, exquisite patterned polygonal cell arrangement comprising majorly of hexagonal and heptagonal shaped polygons. These polygonal cells are without any raised or thick boundaries and are joined by imaginary lines connecting at each corner with an aeropylar opening. No depressions, groves, pits, or rough texture are observed on the egg surface. After the transition area, the exo-chorion shows smooth and texture-free surface up to the basal area of the egg (Fig. 1b).

Aeropyles: Air cavities are present on each corner of the polygonal cells on general exo-chorionic surface area except micropylar and basal regions of the egg. The aeropyles are very minute, rounded and without any distinct boundaries on the exo-chorionic surface and present at each corner of the hexagonal and heptagonal cells. The number of aeropyles is in accordance with the shape and size of the polygonal cells and their number ranges from 6-7 (Fig. 1c).

Micropylar region: In this species, the micropylar region is very prominent and clearly visible in the center at the anterior pole of the egg. The micropylar region consists of micropylar openings and micropylar rosettes with primary and secondary petaloid cells (Fig. 1d).

Micropylar rosette: The micropylar rosette is composed of 9 to 11 primary petaloid cells and only one petaloid cell is smaller in size than others forming asymmetric arrangement in the rosette. The primary cells surround the micropylar pit and are observed with very fine and slightly raised boundaries in side view. The boundaries of these cells are fused with each other up to 2/3rd of their length from where the curves start forming. The internal area of these cells is slightly textured. The primary cells are further surrounded by a row of secondary petal shaped cells, which seem fading to form the transitional zone i.e., to demarcate the end of the micropylar region (Fig. 1e).

Micropyles: These openings are present at the center of the micropylar rosette. In this study, it has been revealed that the number of micropylar openings always depends on the number of primary cells that surround the micropylar pit **(**Fig. 1f).

In the eggs having 9 primary petal shaped cells, the micropylar pit plus-shaped and 4 micropyles are present, each at the corner end of plus sign. Whereas, in the eggs having 11 primary petal-shaped cells, the micropylar pit is star-shaped and has 5 micropylar openings, each present at the corner end of the star. In both cases, the micropylar pit is somewhat depressed and present at the center of the rosette having minute rounded micropylar holes. No sign of prominent thick boundaries is seen (Fig. 1f).

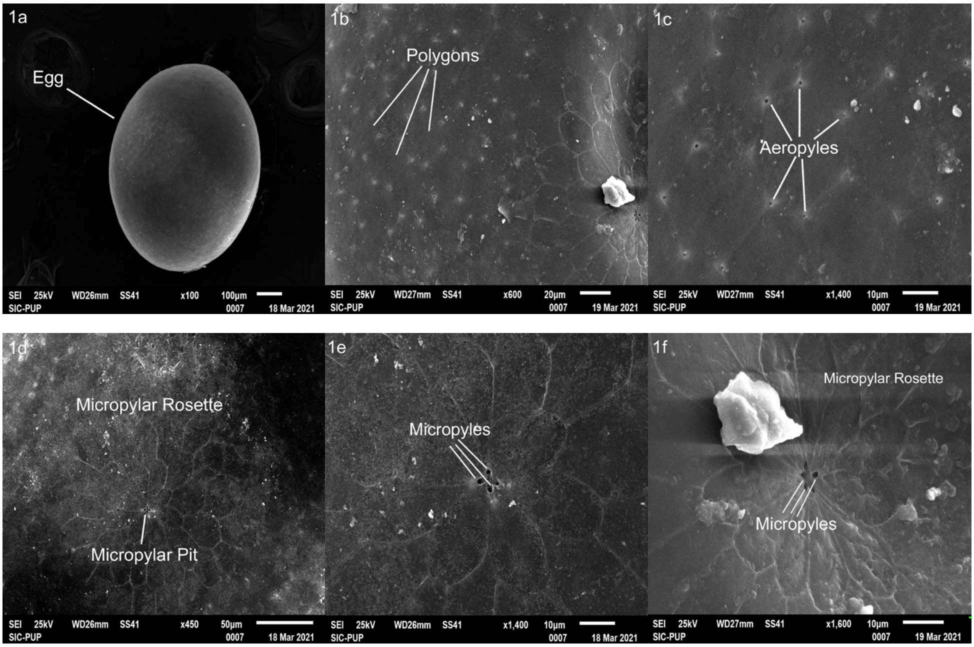

Figure 1. SEM of *Capissa vagesa* (Moore, 1859). a) dorsal view (egg), b) egg chorion, c) aeropyles, d-f) micropylar rosette).

Trabala vishnou **(Lefèbvre, 1827)**

*Egg shape***:** In this species, the eggs are oval with 2.418mm length and 1.860mm width. Eggs are covered with complexly threaded flagellate hairs of the female moth's abdomen i.e., anal tuft. These hairs form a nest-like covering at the base or posterior pole of the egg and cover half of the egg surface toward its anterior pole. The general surface of the egg is with a highly sculptured pattern, which is visible under magnification SEM (Fig. 2a).

Hair-tufts: The female abdominal hairs present on the base are straight and flagellated with pointed tip endings in structure and aligned in an irregular fashion of crisscrossing. These are part of the anal tuft and function as a protective layer for egg from harsh and unfavorable environmental conditions (Fig. 2b).

Egg chorion: The chorion is highly sculptured and patterned with pentagonal, hexagonal and heptagonal cells all over the egg surface. These polygonal cells are with very thick and uniform boundaries. These boundaries are slightly raised above the egg surface area and form crater-like depression in the center of each polygonal cell. The aeropylar openings are present on thick boundaries of each polygonal cell circumscribing the polygonal crater and their number varies as per the shape of the cell (Fig. 2c).

Aeropyles: The aeropylar openings vary in number according to the shape of the polygonal cells. Aeropyles are present at the corners of each polygon. In heptagonal cells 7 aeropyles are present and their number in hexagonal and pentagonal cells is 6 and 5 respectively (Fig. 2d).

The structure of the aeropyles is simple having tiny holes with minutely visible bordering depression at the center of thick boundaries of polygonal cells, which further led to the aeropylar canals under the chorion layer (Fig. 2d).

Micropylar region: While examining the anterior pole of the egg under a scanning electron microscope, no usual area was revealed as in the earlier studied egg. No distinct micropylar region is present at the anterior end of the egg; rather it is a smooth surface showing no signs of micropylar region and its other important parts such as prominent micropylar rosette and openings. It shows no distinct structure which can be compared to a micropylar region of a lepidopteran egg (Fig. 2e).

Even all the sculptured cells and their thick boundaries become quite smooth the anterior pole of the egg. The aeropyles are also absent in the upper 1/3rd part of egg toward anterior end (Fig. 2e).

Micropyles: As discussed above, no unique structure is present at the anterior pole of the egg in this species. On thorough examination, only two prominent, deep and nearly round openings are observed almost in the center of the assumed micropylar region at the anterior pole of the egg. These two small openings are present one cell apart from each other, in the center of the craters formed on the chorion surface, circumscribed by thick and raised uniform boundaries. These openings are clearly distinct from the aeropylar openings. These points are sufficient to prove their identity as micropylar openings (Fig. 2f).

These two openings are bigger and not fully round or circular in their shape as observed in aeropyles.

These openings are present in the centre of depression or crater of the cells surrounded by thick boundaries. Whereas, in the case of aeropyles, it is clearly observed that the aeropylar openings are present on the thick boundaries of the cells and a total 5-7 per cell at each corner. This is not the case with these two micropylar openings.

Therefore, leaving aside all the important structures of a micropylar region that are expected to be present in the lepidopteran eggs, it has been concluded that the eggs of this species possess only a smooth micropylar plate and have only two micropylar openings adjacent to this plate for aiding entrance to sperms for fertilization.

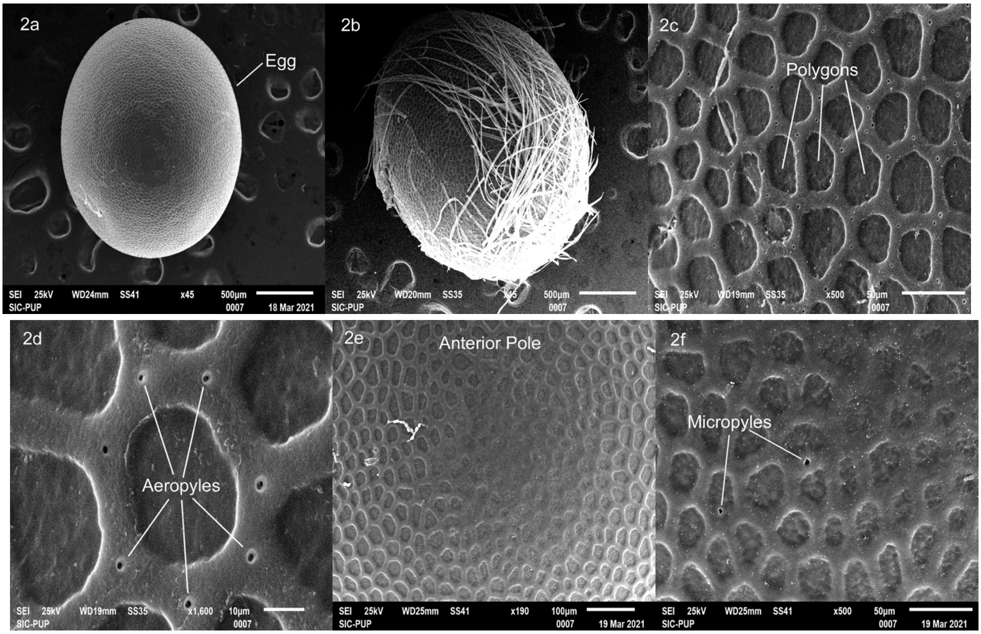

Figure 2. SEM of *Trabala vishnou* (Lefèbvre, 1827) a) dorsal view (egg), b) lateral view (egg with hairs), c) chorion, d) aeropyles, e) micropylar region, f) Micropyles.

CONCLUSIONS AND DISCUSSION

The egg shape, anatomy of the egg chorion, and distinct chorion patterns in two species of moths, *Capissa vagesa* (Moore, 1859) and *Trabala vishnou* (Lefèbvre, 1827), were explored and studied using a scanning electron microscope in this study. In both the studied species, the exterior morphology or ultrastructure of the egg's chorion is unique in terms of chorion sculpturing, the number of primary cells forming the micropylar area, shapes of polygonal cells, number of micropylar and aeropylar apertures present on the chorion surface.

An attempt has also been made to summarize the ultrastructural details of the eggs of these two species under study for comparison purposes in this paper as (Table 1.).

Table 1. Comparative account of important ultrastructural egg characters between studied species.

Species	Egg features								
	Egg Shape	Chorion Texture	Shape of Polygons	Number of Aeropyles (per polygonal cell)	Number of Micropyles	Primary Petaloid Cells (PPC)	Secondary Petaloid Cells (SPC)	Shape of Micropylar Pit	Egg hairs or Setae
Capissa vagesa (Moore, 1859)	Spherical	Very lightly sculptured	Hexagonal & Heptagonal	6-7	4-5	8+1, 10+1 Petaloid	Present	Plus & Star Shaped	-
Trabala vishnou (Lefèbvre, 1827)	Oval	Highly sculptured	Pentagonal, Hexagonal & Heptagonal	5-7	2	-	-	-	Present

The eggs of *Capissa vagesa* (Moore, 1859), revealed the general pattern of egg chorion as found in other representatives of family Erebidae as investigated by (Doring, 1955; Peterson, 1963) by light microscopy. The egg shape of this moth is observed as spherical when seen dorsally which resembles to the eggs of other species referable to the family Erebidae.

In *Trabala vishnou* (Lefèbvre, 1827), its egg chorion unveils altogether unusual observations compared to other eggs of lappet moths (Zolotuhin & Kurshakov, 2009). Usually, a Lasiocampid egg shell shows a full-fledged micropylar structure with other important parts such as micropylar pit with micropyles and micropylar rosette at the anterior top of the egg (Zolotuhin & Kurshakov, 2009). But in the present species i.e., *Trabala vishnou* (Lefèbvre, 1827), its egg showed no distinct micropylar region at the top anterior end. Three egg samples have been investigated under a scanning electron microscope. Only two tiny holes i.e., micropyles, have been observed at the anterior pole and observed no other micropylar structure. The egg chorions of this species have been scanned and investigated for the first time.

Kawaguchi, Banno, Koga, Kawarabata, & Doira (1996) and Wolf, Murphy, Reid, & Garraway (2000) concluded that the number of micropylar openings present in the center of a micropylar rosette in the eggs has a fixed relationship with the shape of the micropylar pit. They observed that in eggs having a star-shaped micropylar pit, the number of micropyles is usually 5-6 and in case of eggs with a cross or plus-shaped micropylar pit, they are usually 4 in number. According to which the total number of primary petaloid cells also varies in its number and formation. In the present study, the same has been observed in *Capissa vagesa* (Moore, 1859) of family Erebidae.

It has been observed that the egg with a micropylar rosette of 9 petaloid cells with a cross or plus-shaped micropylar pit, possesses 4 micropylar openings at each corner of the cross and the other egg with a micropylar rosette of 11 petaloid cells with a star-shaped micropylar pit, have 5 micropylar openings at each corner of the star. This is in accordance with the earlier observations made by (Wolf et al*,* 2000) in the case of *Utetheisa ornatrix* (Linnaeus, 1758) referable to family Erebidae and (Kawaguchi et al*,* 1996) in case of *Bombyx mandarina* (Moore, 1872) of the family Bombycidae.

As far as the information about aeropylar openings present on the egg chorion in lepidopteran eggs is concerned, quite limited studies are there (Fehrenbach, Dittrich & Zissler, 1987) attempted to count the number of aeropyles present on egg chorions in two Noctuid species, namely *Heliothis virescens* (Fabricius, 1777) and *Spodoptera littoralis* (Boisduval, 1833). They recorded 50 aeropyles per egg in *Heliothis virescens* (Fabricius, 1777) and 400 aeropyles per egg in *Spodoptera littoralis* (Boisduval, 1833). In this study, an attempt has been made to examine the number as well as shape of aeropylar openings in the species being studied. The number of aeropyles per polygonal cell present on the egg chorion has been recorded and revealed variance in their number in these two species of moths under study, the number of aeropyles per polygonal cell observed in the eggs of *Capissa vagesa* (Moore, 1859) are 6-7 which were minute faded circles in shape whereas, on the egg chorion in case of

Trabala vishnou (Lefèbvre, 1827), they were limited to approximately 5-7 deep and thick round circles per polygonal cell.

For identification and distinction of discrete species, superficial morphological traits as coloration, ornamentation of the head, thorax, and abdomen, wing maculation, wing venation, male and female genitalic characters are traditionally used. Arbogast et al (1980) described the ultrastructural and morphological details of chorionic sculpturing of the eggs in 10 species of stored product moths referable to families Pyralidae, Gelechiidae and Tineidae. They discussed about pattern of sinuous ridges or carinae and cells, structure of aeropyles and texture of chorion on cell discs and also formulated a taxonomic key for identification of eggs on the basis of these characters. Likewise, based on the current findings, it is easy to assume that the ultrastructural traits are likewise noteworthy, and that they can authenticate and reinforce the morpho-taxonomy.

Korycinska (2012) studied and illustrated the eggs of seven economically important species of moths i.e., *Autographa gamma* (Linnaeus, 1758), *Helicoverpa armigera* (Hübner, 1808), *Lacanobia oleracea* (Linnaeus, 1758), *Mamestra brassicae* (Linnaeus, 1758), *Spodoptera exigua* (Hübner, 1808), *Spodoptera littoralis* (Boisduval, 1833), *Spodoptera litura* (Fabricius, 1775) of family Noctuidae. He also formulated a taxonomic key for identification of these species for their easy quarantine and management during trades. It confirms the importance of this study not only for morphological identification purposes but also in sector of pest management for early detection of important pest species through means of egg characters.

With naked eyes, it is difficult to distinguish between closely related species based on morphological traits such as form, size, color, and texture of the eggs. That is why, for adequate distinction, additional well-founded taxonomic features must be included. Ultrastructure examinations on many characteristics such as shape, chorion texture and pattern, and other structural details of eggs of these two species of ditrysian moths were carried out for this purpose. Further examination of such traits appearing on the eggs of other moth species is required. These findings will add important facts and details to moth taxonomy and phylogenetic studies, as well as be useful for the delimitation of closely related species.

From India, Kumar et al (2002) compiled the fine ultrastructural details of chorion and shell layers of the eggs of a snout moth species namely *Diaphania pulverulentalis* Hampson, 1896 of family Pyralidae. They observed recognizable crisscross net-like pattern of rectangular and pentagonal cells on the chorion. They also recorded asymmetrical micropylar rosette with 8 dissimilar petal-fashioned cells and 15-18 ring-shaped aeropylar openings per egg. Kumar, Rajadurai, Babu, & Kariappa (2003) investigated the ultrastructural details of chorion of the eggs of a lepidopteran pest of Mulberry i.e., *Amata passalis* (Fabricus, 1781) of family Amatidae The eggshell structure of the pest species revealed highly adorned chorion structure with micropylar rosette of 15-19 petal-shaped primary cells. The general chorion surface was seen with a reticulate pattern of pentagonal and hexagonal cells and each cell mounted with 3-6 aeropyles of 0.36±0.008mm diameter. Kumar, Kariappa, Babu, & Dandin (2007) examined the surface ultrastructure of the eggshell of Eri silkworm *Samia ricini* (Boisduval, 1854) of family Saturniidae by using scanning electron microscope and studied the chorion characters such as micropyles, micropylar rosette, micropylar canals, shell imprints and aeropyles.

At last, in support of our study we like to conclude that, a precise benefaction, in terms of improving and elevating the morphological personation of various moth families, has been carried in the current work. An attempt has been made to engrave these egg structures to identify these moth species. It is worth repeating that SEM inspections of these moth eggshells will show them to be an advanced method. Such studies can aid in the differentiation of distinct taxa at the family, genus, and species levels, as well as in the resolution of species complexes. As a result, this study will undoubtedly provide a firm basis and provide a viable paradigm for future researchers undertaking similar studies on Indian moths.

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