DESCRIPTIONS OF IMMATURE STAGES OF *Mythimna venalba* (MOORE) (LEPIDOPTERA: NOCTUIDAE)

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ABSTRACT

An outbreak of the cutworm *Mythimna venalba* (Moore) had caused a huge loss to rice farmers in 2011 in Peninsular Malaysia. This is due to the late identification of the larvae, which appears to be one of the rice pests. This study presents the morphological descriptions of immature stages of *M. venalba* including the larval chaetotaxy in detail. The larvae of *M. venalba* were collected from several rice fields in Peninsular Malaysia, and they were reared and maintained in the laboratory to establish a colony. Ten specimens of egg, larva, pupa and adult from the colony were selected and observed for morphological descriptions and larval chaetotaxy. The external morphology of the eggs, larvae, pupae, and adults was described and illustrated. Important taxonomic structures of the larvae were discussed. The absence of G2 seta in the cranial chaetotaxy and the L1 seta situated just slightly anterior to SD1 on the A9 segment of the abdominal chaetotaxy are good characters to distinguish *M. venalba* from other *Mythimna* species.

Keywords: Cutworm, Hadeninae, larval chaetotaxy, morphological descriptions, rice pest

ABSTRAK

Satu letusan ulat pangkas *Mythimna venalba* (Moore) telah menyebabkan kerugian yang besar kepada petani di Semenanjung Malaysia pada tahun 2011. Ini berpunca dari pengecaman larva yang lambat ke atas salah satu perosak padi ini. Mengambil kira faktor ini, kajian ini membentangkan perihalan morfologi *M. venalba* pada peringkat tidak matang termasuk kaetotaksi larva secara terperinci. Larva-larva telah dikutip dari beberapa sawah padi di Semenanjung Malaysia dan telah dipelihara di makmal untuk membentuk koloni makmal. Sepuluh spesimen telur, larva, pupa dan dewasa telah dipilih dari koloni dan telah diperhati untuk perihalan morfologi dan kaetotaksi larva. Morfologi luaran bagi telur, larva, pupa dan dewasa telah diterangkan dan diilustrasi. Struktur taksonomi penting pada larva juga dibincangkan. Ketiadaan seta G2 pada kaetotaksi kranium dan seta L1 yang berada sedikit

anterior dari seta SD1 pada segmen A9 bagi kaetotaksi abdomen adalah ciri-ciri yang baik untuk membezakan *M. venalba* dari spesies *Mythimna* yang lain.

Kata kunci: Ulat pangkas, Hadeninae, kaetotaksi larva, perihalan morfologi, perosak padi

INTRODUCTION

Rice is one of the main crops grown in Asian countries as it is a staple food for the people of the region (FAO 2020). Based on a report by the Food and Agriculture Organization (FAO), the average of Malaysia's rice yield in 2020 is 2.58 tonnes per hectare, which is lower than the average yield in 2019. Insect pests are still one of the causes of the reduction of rice yield, where losses are reported up to 28% annually (Mondal et al. 2017).

Rice has been attacked by many insect pests, especially pests from the order Lepidoptera (Bhatt et al. 2018). Stem borers, leaf folders, rice caseworms, armyworms and cutworms are the key lepidopteran pests of rice (Jamil et al. 2021; Pathak & Khan 1994; Yaakop et al. 2020). Many studies have been conducted on the major species of lepidopteran pests, including their taxonomy, ecology and biology (Bhatt et al. 2018; Pathak & Khan 1994; Shepard et al. 1995). However, there are many species of armyworms and cutworms are still under studied, such as *Mythimna venalba* (Moore). This species is reported as one of the rice cutworms that occurs in Southeast Asia (Barrion & Litsinger 1994; Bhatt et al. 2018; Pathak & Khan 1994).

Cutworms also feed gregariously on the leaves and stems of rice plants like the armyworms, which in severe case the rice plants will be left cut off at ground level (Shepard et al. 1995). Compare to other major lepidopteran pests, such as rice stem borers and leaf folders, the pattern of their infestation occurred with the sudden advent of the larvae in large numbers and severe loss occurs before the larvae are detected (Assefa & Ayalew 2019).

Due to the sudden damage caused by these cutworms and armyworms larvae, early identification of the larvae will avoid further damage to the crops. Therefore, detail morphological descriptions at immature stages could provide rapid field identification of the larvae, and early control measures can be taken to prevent future outbreaks (Timm et al. 2007). Although *M. venalba* has been reported by many authors as a pest of rice (Barrion & Litsinger 1994; Holloway 1986; Pathak & Khan 1994), details of its immature stages are still lacking. Yoshimatsu (1994) had described in detail only the morphology of adult *M. venalba*. Holloway (1986) only provided the illustration of the adult male genitalia of this species. Sevastopulo (1945) had briefly described the immature stages of this species, but he did not provide any illustration. To fill the gap related to the recognition of this species, the objectives of this study were to describe and illustrate the immature stages of *M. venalba* including its larval chaetotaxy.

MATERIALS AND METHODS

Study Area

The larvae of *M. venalba* were collected from seven rice fields in five states in Peninsular Malaysia. The sampling sites were as follows: Kg. Padang Malau, Beseri, Perlis (6°33'N,100°13'E), Pokok Sena, Kota Setar, Kedah (6°9' N,100°32'E), Kg. Parit Rawi, Seberang Perak (4°8'N,100°53'E), Parit 7B, Seberang Perak (4°4'N,101°5'E), and Parit Hj.

Kassim, Bagan Serai (5°1'N,100°32'E) in Perak, Kg. Mampas, Terachi, Negeri Sembilan (2°44'N,102°9'E) and Kg. Jelapang, Setiu, Terengganu (5°25'N,102° 50'E).

Sampling Period

Samplings were conducted from January until September 2012, at the stage of rice between 30 to 70 days after sowing. Live samples of larvae collected were bought to laboratory for further examination.

Establishment of Laboratory Colony

The colony of *M. venalba* was established from 158 larvae collected in the fields, and were reared and maintained under ambient laboratory conditions at 26-28 °C, 60-70% relative humidity and 12 h L:12 h D photoperiod (Ghafoor 2011). New emergence adults were placed in 44 x 28 cm cage with potted rice plants. Adults were given access to 10% honey solution on a small cotton ball. Daily observation was done to look for eggs. A group of 60 newly laid eggs were transferred to a new cage for establishing a new colony of *M. venalba*. Larvae were fed with rice plants and were changed every two days. Pupae were then collected every day, and transferred to a new 44 x 28 cm cage, with host plant for new adults to emerge. The steps were repeated to maintain the colony.

Identification of Species

The species was confirmed by sequencing the mitochondrial cytochrome oxidase subunit 1 (*COI*) gene, the DNA barcoding region of the larvae. The *COI* gene sequence obtained was blast in the Barcode of Life Data Systems (BOLD) to search for any similarity with the reference databases. The result hit 97.2% similarity with other Lepidoptera species from the family Noctuidae, reported as *Leucania venalba* (Sequence ID: ANICL088-10). Besides that, the species identification was also done by examining the male genitalia of the adult. The male genitalia was also compared with the illustration of *M. venalba* by Holloway (1986) and Yoshimatsu (1994). Both data had confirmed the cutworm species collected from the field as a *M. venalba*.

Morphological Descriptions

Ten individuals for each stage were taken for measurement. Measurements were taken with measurement tool in QuickPHOTO MICRO 2.3 software with Olympus E330-ADU1X camera attached to Olympus SZX10 stereo microscope (Olympus, Japan). The standard error was determined in Minitab Software version 2018. The morphology of egg, larva of every instar, pupa and adult were examined and photographs were also taken with the previous mentioned software and camera.

Larval Chaetotaxy

The techniques employed were adopted from Gilligan et al. (2011) with some modifications. A small incision was made at the ventral mid-line near the larva head under a RZ Series stereo microscope (Meiji Techno, Japan). The larvae were heated in 10% potassium hydroxide (KOH) for 20 minutes, and then placed in ethanol where the incision extended to full length of the body. The head capsule was carefully removed with micro scissors and forceps. The larval integument was cleaned with 5% acetic acid. The cleaned skin was stained lightly with acid fuschin. Then, the skin was left to dehydrate with a series of ethanol concentration: 70% ethanol for 20 minutes and 100% ethanol for one hour. The skin and head capsule were mounted in Canada balsam. The slide photos were taken using the same previous mentioned software and camera. Drawing of the setal map was produced using Adobe Illustrator C3. Discussion on the

chaetotaxy was followed Hinton's terminologies (1946) and the positions of the setae were referred with Beck (2000).

RESULTS

Morphology of *M. venalba* At All Immature Stages

The life cycle of *Mythimna venalba* includes four life stages, viz, egg, larva (six instars of larval development), pupa and adult. It was completed in about 40 days from the egg stage until the adult dies. The larva of *M. venalba* shows general characteristics of Noctuidae and Hadeninae larva. The most distinct characteristics to indicate the larvae of subfamily Hadeninae is the reticulated head, and generally the colour of the larva body is dull and marked with longitudinal stripes. The specific descriptions at all life stages of *M. venalba* are described below:

***Eggs* (Figures 1A–1B):**

Eggs rounded, 0.63–0.70 mm in diameter (mean = 0.65 mm±0.64), smooth surface, translucent yellow, gradually becoming black towards egg eclosion. Eggs were laid in small groups of seven to 60, found in folded and withered leaves.

Duration: 0 – 1st day.

Figure 1. Eggs of *Mythimna venalba* (Moore). (A) Dorsal view of early eggs; (B) A pair of egg near eclosion

***First instar* (Figure 2A):**

Cephalic capsule width 0.31–0.33 mm (mean = 0.33 mm±0.002). Cephalic capsule light brown with light brown bristles. Six stemmata, on the lower posterior region of the epicranium, 1–4 and 6, arranged in a semicircle and 5 on the ventral region, near base of antenna. Prothoracic shield distinct, light brown. Body greyish after eclosion, becoming greenish after feeding. Prothoracic plate trapezoidal, distinct, light brown, sclerotized; anal shield concolourous as body. Thoracic and abdominal legs indistinct at this stage.

Duration: 2nd – 4th day.

***Second instar* (Figure 2B):**

Cephalic capsule width 0.42–0.49 mm (mean = 0.46 mm±0.006). Cephalic capsule brown. Body greenish grey; longitudinal stripes starting to appear at this stage, mid-dorsal white longitudinal stripe, a pair sub-dorsal white longitudinal stripes, lateral dark brown stripe along spiracle line. Prothoracic shield concolourous as body on anterior ½, brown on posterior ½;

anal shield concolourous as body. Thoracic legs light brown, abdominal legs same colour as body.
Duration: 5^{th} – 6^{th} day.

***Third instar* (Figure 2C):**
Cephalic capsule width 0.69–0.79 mm (mean = 0.74 mm±0.01). Cephalic capsule similar to previous instar. Body dark green; pale, thin, poorly defined white longitudinal stripes along body, conspicuous mid-dorsal white longitudinal stripe, a pair sub-dorsal white longitudinal stripes, lateral dark brown stripe along spiracle line, darker than previous instar. Prothoracic shield concolourous as body, with three white longitudinal stripes; anal shield concolourous as body. Thoracic legs light brown, abdominal legs same colour as body.
Duration: 7^{th} – 8^{th} day.

***Fourth instar* (Figure 2D):**
Cephalic capsule width 1.06–1.30 mm (mean = 1.16 mm±0.025). Cephalic capsule similar as previous instar. Body greenish; pale, thin, poorly defined white longitudinal stripes along body, conspicuous mid-dorsal white longitudinal stripe, a pair sub-dorsal white longitudinal stripes, lateral dark brown stripe along spiracle line, more prominent than previous instar. Prothoracic and anal shields similar as previous instar. Thoracic legs light brown, abdominal legs same colour as body.
Duration: 9^{th} – 11^{th} day.

***Fifth instar* (Figure 2E):**
Cephalic capsule width 1.77–2.21 mm (mean = 1.97 mm±0.041). Cephalic capsule brown, head starting reticulated, dark arches starting outlining adfrontal area. Body yellowish green; pale, thin, poorly defined white longitudinal stripes along body, conspicuous mid-dorsal white longitudinal stripe, a pair sub-dorsal white longitudinal stripes, conspicuous lateral dark brown stripe along spiracle line. Prothoracic and anal shields similar as previous instar. Thoracic legs light brown, abdominal legs same colour as body.
Duration: 12th – 16^{th} day.

***Sixth instar* (Figures 2F–2H):**
Cephalic capsule width 2.60–2.76 mm (mean = 2.69 mm±0.014). Cephalic capsule brown, conspicuous reticulated head and dark arches outlined adfrontal area (Figure 2G). Body yellowish brown; conspicuous mid-dorsal white longitudinal stripe, a pair sub-dorsal brown longitudinal stripes with minute dots along the stripes, prominent lateral dark brown stripe above spiracles line, white stripe along spiracles line, yellowish stripe below spiracles line (Figure 2H). Prothoracic shield slightly darker than body, with three white longitudinal stripes; anal shield concolourous as body. Thoracic and abdominal legs light brown; abdominal legs with a sequence of crochets, in semicircle, uniserial, and unidiordinal. After development is complete, the larvae body shortens, swollen, turns yellow towards pupation.
Duration: 17^{th} – 23^{rd} day.

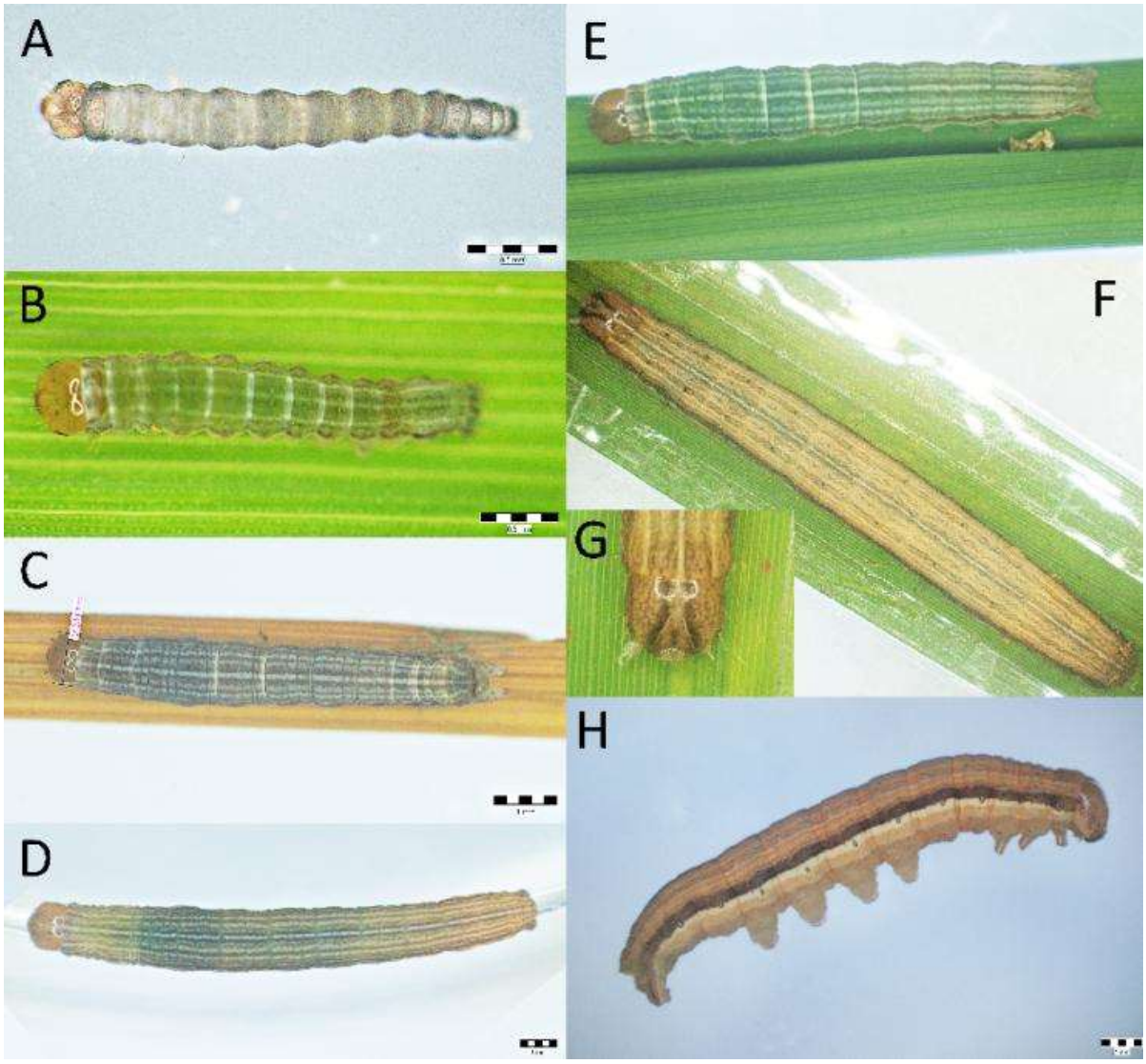

Figure 2. Developmental stages of *Mythimna venalba* (Moore) larva. (A) First instar larva; (B) Second instar larva; (C) Third instar larva; (D) Fourth instar larva; (E) Fifth instar larva; (F) Dorsal view of sixth instar larva; (G) Dark arches outlined adfrontal area; (H) Lateral view of sixth instar larva

***Pupa* (Figures 3A–3C):**
Length of pupa 14.30–15.50 mm (mean = 14.98 mm±0.015). Pupa obtect. Dark mahogany colour, darker dorsally. Appendages do not extend beyond posterior ventral margin of fourth abdominal segment. Labial palps exposed. Two short cremaster at caudal.
Durations: 24^{th} – 32^{nd} day.

***Adult* (Figures 4A–4D):**
Well-described of the adult by Yoshimatsu (1994). There are no distinct characteristics to separate male and female moth, sometimes the orangish cucullus can be easily seen protruding from the last segment of male abdomen.
Durations: 33^{rd} day – 40^{th} day.

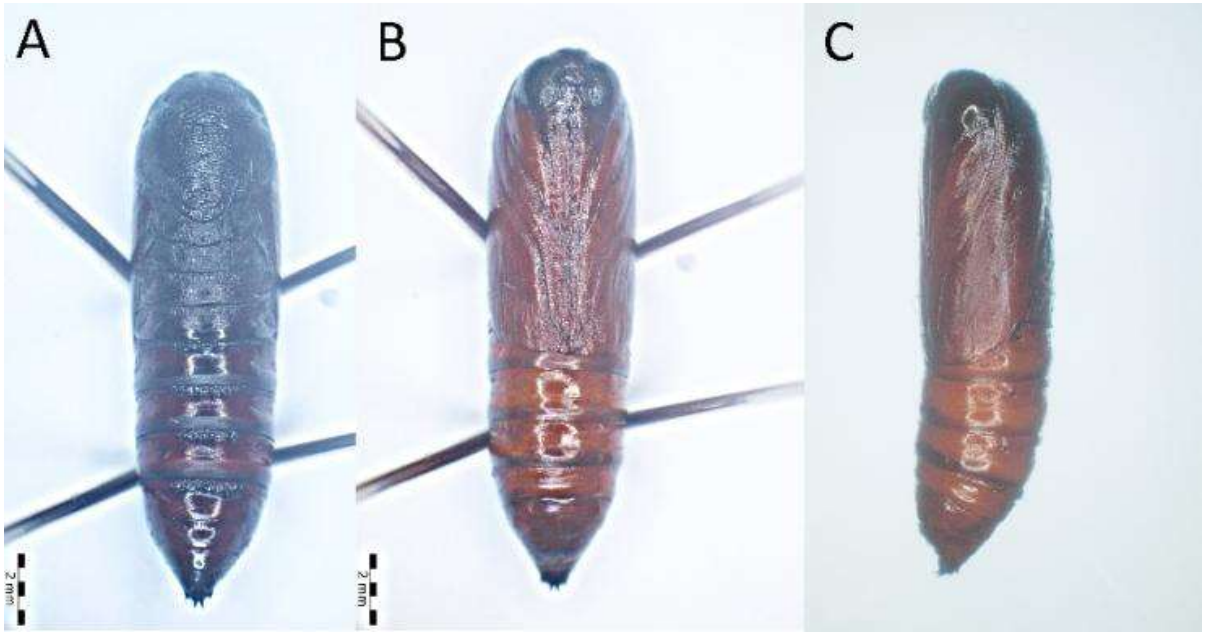

Figure 3. *Mythimna venalba* (Moore) pupa. (A) Dorsal view of pupa, colour darker than ventral; (B) Ventral view of pupa; (C) Lateral view of pupa

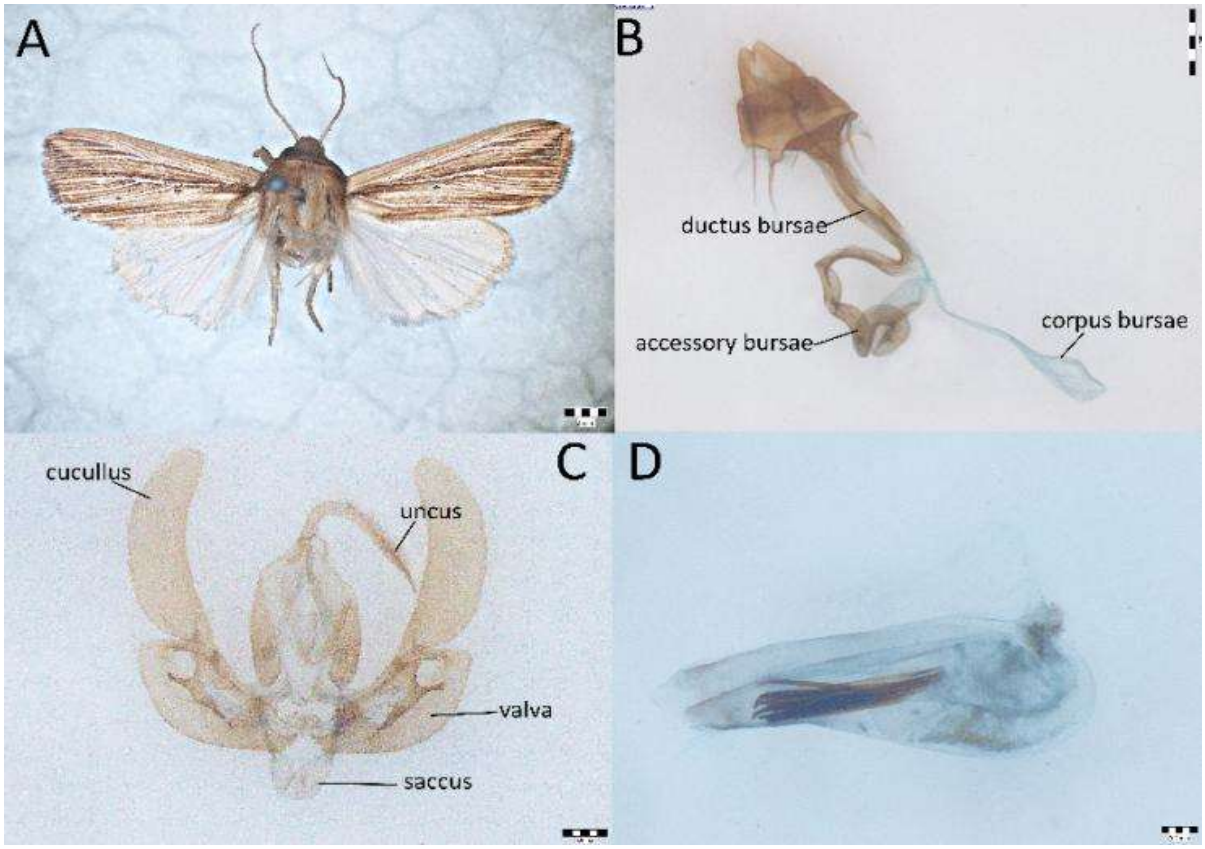

Figure 4. *Mythimna venalba* (Moore) adult. (A) Male, dorsal habitus; (B) Female genitalia (C) Male genitalia; (D) Aedeagus

Larval Chaetotaxy of *M. venalba* (Distributions of the setae are listed in Table 1)
***Cranial chaetotaxy* (Figures 5-6)**
Anterior group seta, A1 ventral to A2. A2 the closest to adfrontal suture in this group. A3 lateral, far dorsal to A2, and very close to second ocellus. Aa behind, slightly dorsal to A2, between A2 and A3. There are three setae and one puncture in ommatal group. O1 the most ventral, next to fourth ocellus. O2 more or less in the same line, posterior to the first ocellus. O3 far posterior at sixth ocellus. Oa lies next to sixth ocellus. For subommatal group, SO1 ventral to fifth ocellus. SO2 situated next to fifth ocellus, dorsal to SO1. SO3 posterior to SO2. SOa situated just above SO1. L1 far lateral to P1. La somewhat behind, dorsal to L1. In posteriordorsal group, P1 near to adfrontal suture. P2 far dorsal to P1, close to epicranial suture. Pa slightly lateroventral to P1. Pb ventral to P2, closer to epicranial suture than P2. F1 of frontal group situated side by side with Fa on frons. There are two setae of adfrontal group, AF1 and AF2. AF1 ventral to AF2. AF2 very close to epicranial suture. AFa just below AF2. C1 situated side by side with C2 on clypeal, C1 on the right from frontal view. There are two groups of minute seta, vertical and genal group. Vertical setae situated far posterior of the head in slight curve pattern. V1 the most dorsal, followed by V2. Va ventral, same line with V2. V3 the most ventral in the group. G1 slightly ventral to Ga.

Table 1. Distribution tactile and microscopic setae on the head, thorax and abdomen of *Mythimna venalba* (Moore)

Setae group	Setae	Presence of setae
Anterior (A)	A1	+
	A2	+
	A3	+
	Pore Aa	+
Ommatal (O)	O1	+
	O2	+
	O3	+
	Pore Oa	+
Subommatal (SO)	SO1	+
	SO2	+
	SO3	+
	Pore SOa	+
Lateral (L)	L1	+
	Pore La	+
Posteriodorsal (P)	P1	+
	P2	+
	Pore Pa	+
	Pore Pb	+
Vertical (V)	V1	+
	V2	+
	V3	+
	Pore Va	+
Genal (G)	G1	+
	G2	–
	Pore Ga	+
Frontal (F)	F1	+
	Pore Fa	+
Adfrontal (AF)	AF1	+
	AF2	+
	Pore AFa	+
Clypeal (C)	C1	+
	C2	+

Prothorax		
Tactile setae		
	XD1	+
	XD2	+
Dorsal	D1	+
	D2	+
Subdorsal	SD1	+
	SD2	+
Lateral	L1	+
	L2	+
	L3	−
Subventral	SV1	+
	SV2	+
Ventral	V1	+
Proprioceptor setae	MXD1	+
	MV2	+
	MV3	+
Meso- and Metathorax		
Tactile setae		
Dorsal	D1	+
	D2	+
Subdorsal	SD1	+
	SD2	+
Lateral	L1	+
	L2	+
	L3	+
Subventral	SV1	+
	SV2	−
Ventral	V1	+
Proprioceptor setae	MD1	
	MD2	
	MSD1	
	MV2	
	MV3	
Abdomen 1-9		
Tactile setae		
Dorsal	D1	+
	D2	+
Subdorsal	SD1	+
	SD2	+α
Lateral	L1	+
	L2	+ α
	L3	+α
Subventral	SV1	+
	SV2	+β
	SV3	+τ
Ventral	V1	+
Proprioceptor setae	MD1	+
	MV3	+

+ = Present on all segments
− = Absent on all segments
+α = Absent on A9 only
+β = Absent on A1, A7, A8 and A9
+τ = Absent on A7, A8 and A9

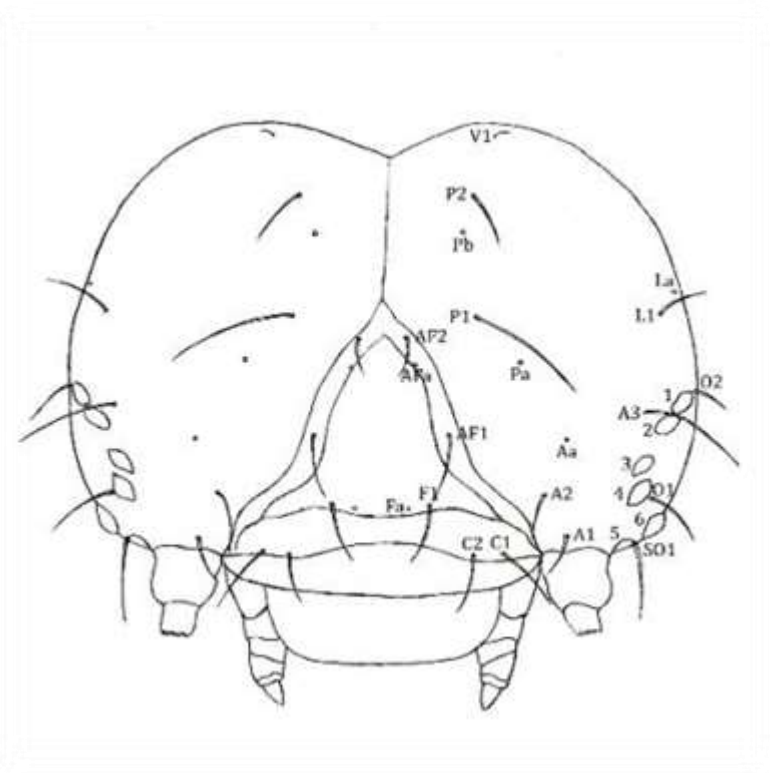

Figure 5. A setal map of *Mythimna venalba* (Moore) cranial, frontal view

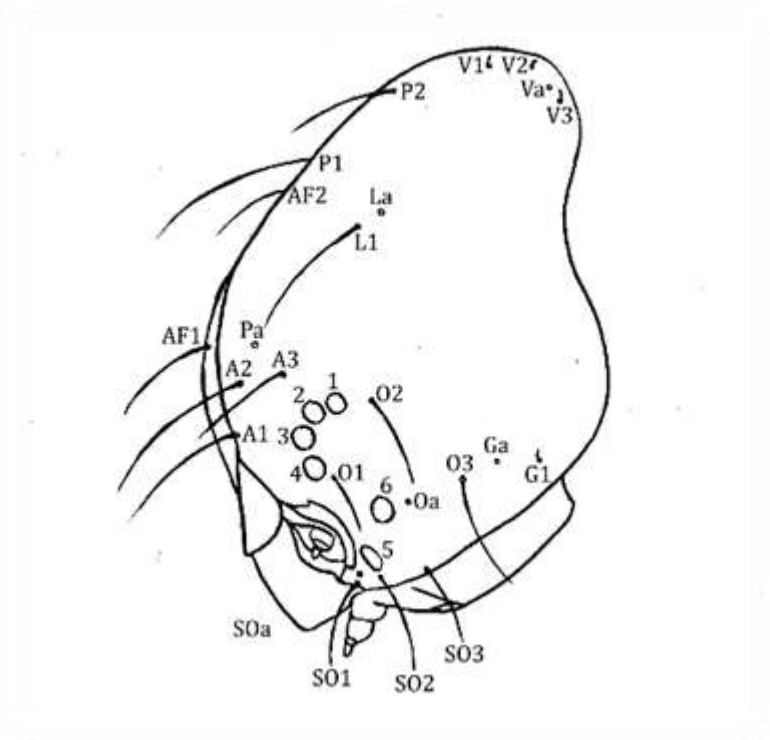

Figure 6. A setal map of *Mythimna venalba* (Moore) cranial, lateral view

Thoracic and Abdominal Chaetotaxy (Figure 7)

Thoracic segments

- **Prothorax (T1):**

On the anterior edge of prothoracic plate, XD1 nearer to midlongitudinal line. XD2 closer to lateral edge. D1 and D2 situated at the posterior of the plate. D1 posterodorsal to XD1. D2 posterodorsal to XD2. There are three punctures on prothoracic plate. XDa caudad from XD1. XDb posterodorsal to D1. XDc in the same line with XD2. For subdorsal group, SD1 near midlateral margin of the plate. SD2 posterior to SD1, adjoin of posterolateral angle of the plate. L1 and L2 lie in prespiracular position. L2 corresponds to SD1, ventrally close to L1. Subventral group unisetose with two setae, SV1 and SV2. SV1 posteroventral to SV2. V1 unisetose. There are three microscopic setae, MXD1, MV2 and MV3. MXD1 situated posterodorsal to D1, very close to the edge of prothoracic plate. MV2 anterodorsal to MV3, where MV2 in front of thoracic legs. MV3 very near to coxa.

- **Mesothorax (T2) and metathorax (T3):**

Two setae in dorsal group, D1 and D2. D1 near to midlongitudinal line. D2 somewhat posteroventral to D1. SD2 situated slightly posteroventral to D2. SD1 ventral to SD2 but slightly anterior. Lateral group comprises L1, L2 and L3 setae, which arranged in slightly curve pattern. L1 situated anterolateral, slightly ventral to L3. Distance between L1 and L3 more or less equivalent to SD1 and SD2. L2 the most anterior, ventral to L1. L3 the most posterior in the group. SV1 unisetose, lies in the same line with D1 and D2, very close to thoracic legs shield. V1 unisetose, caudad to truelegs. Microscopic seta, MD1 situated slightly anteroventral to D2. MSD1 and MSD2 situated closely to each other, anteroventral to SD2. MV2 the most anterior, somewhat anteroventral to MV2. MV3 very close to coxa.

Abdominal segments

- **Abdomen I (A1):**

Seta D1 lies close to midlongitudinal line. D2 slightly posteroventral, slanting line with D1. SD1 situated just above spiracle. SD2 prespiracular. Lateral group characterized by three setae, L1, L2 and L3. L1 situated posterior to spiracle. L2 ventral to spiracle. L3 posteroventral to L2, and in a great distance from L2. SV1 lies posteroventral to SV3, in the middle of L3 and SV3. SV3 anterodorsal to SV1. Seta V1 situated below SV1. The microscopic seta, MD1 situated the most anterior of the segment, in the same line with D2 laterally. MV3 very close to anterior edge of A1, between setae SV1 and SV3.

- **Abdomen II (A2):**

D1 lies close to midlongitudinal line. D2 slightly posteroventral, slanting line with D1. Lateral group characterized by three setae, L1, L2 and L3. L1 lies posterior to spiracle. L2 ventral to spiracle. L3 posteroventral and in a great distance from L2. There are three setae in subventral group, SV1, SV2 and SV3. SV1 situated posteroventral to SV3, and in the middle of L3 and SV3. SV3 anterodorsal to SV1. SV2 ventrally in the middle of SV1 and SV3. V1 lies below SV1. Two groups of microscopic seta, MD1 situated most anterior of the segment, in the same line with D2 laterally. MV3 very close to anterior edge of A1, between SV1 and SV3.

- **Abdomen III to IV (A3-A6):**

Segments A3 to A6 bear abdominal legs. Dorsal group of these four segments have two setae, D1 and D2. D1 lies close to midlongitudinal line. D2 somewhat posteroventral, slanting line with D1. SD1 lies just above spiracle. SD2 prespiracular. There are three setae of lateral group. L1 situated posterior to spiracle. L2 ventral to spiracle. L3 posteroventral to L2, and in a great distance from L2. Subventral group consists of three setae, SV1, SV2 and SV3. All subventral

group setae situated on the abdominal legs of every segment. SV3 most dorsal on abdominal legs, SV2 anteroventral to SV3. SV1 the closest to planta base of abdominal legs. V1 situated close to margin on midventral line. Microscopic seta, MD1 the most anterior and very close to the margin of every segment, slightly dorsal to D2. MV3 situated before abdominal legs, very close to coxa.

- **Abdomen VII (A7):**

D1 lies closest to mid-longitudinal line. D2 lies slightly posteroventral, in slanting line with D1. Subdorsal group comprises by two setae, SD1 and SD2. SD1 lies just spiracle. SD2 prespiracular. Lateral group possesses three setae, L1, L2 and L3. L1 posteroventral to spiracle. L2 anteroventral to L1, and just below spiracle. L3 the most ventral seta in the group, somewhat posterior to L2. SV1 of SV group situated posteroventral to L3. V1 very near to midventral line. Microscopic seta, MD1 the most anterior and very close to the margin. MV3 anterodorsal to V1 and somewhat close to anterior margin of A7.

- **Abdomen VIII (A8):**

D1 and D2 more or less in a horizontal line. SD1 situated above spiracle. SD2 prespiracular. Lateral group comprises by three setae, L1, L2 and L3. L1 posteroventral to spiracle. L2 anteroventral to L1. L3 the most ventral seta in lateral group, somewhat posterior to L2. SV1 posteroventral L3. V1 very near to midventral line. Microscopic seta, MD1 most anterior and very close to the margin. MV3 anterodorsal to V1 and somewhat close to anterior margin of A8.

- **Abdomen IX (A9):**

A9 segment is lacking of spiracle. D1 somewhat anteroventral to D2. Subdorsal group possesses one seta only, SD1. SD1 posteroventral to D1. Only one group in lateral group, L1 situated ventral and in the same line with SD1 vertically. SV1 situated ventral to L1. The most ventral seta, V1 close to midventral line. Microscopic seta, MD1 most anterior and very close to margin of A9. MV3 anterodorsal to V1 and somewhat close to anterior margin of A9.

- **Abdomen X (A10):**

A10 is the last abdominal segment and bears an anal plate. The anal plate has four setae for two groups, dorsal and subdorsal group. D1 somewhat anteroventral to D2. SD1 more or less posterodorsal to SD1. There are two groups of seta on anal legs, lateral and subventral group. L1 anterolateral to L3. L2 situated between L1 and L3. SV1 posterolateral to L2. SV2 in the middle of L1 and L3, but slightly at the back of anal leg. SV3 lateral to L1, slightly behind leg.

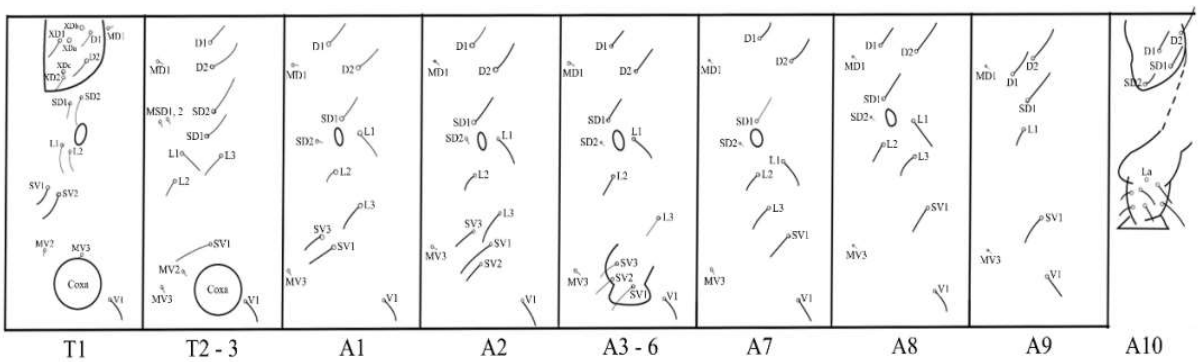

Figure 7. Setal map of thoracic and abdominal segments of *M. venalba* (Moore)

The larva of *Mythimna venalba* (Moore) shows general characteristics of larva from family Noctuidae and subfamily Hadeninae. According to Godfrey (1972), the larvae under subfamily Hadeninae are very similar to each other and they are lacking larval characteristics to distinguish them, especially the genera *Aletia*, *Mythimna* and *Pseudaletia*. The most distinct characteristics to indicate larva of subfamily Hadeninae is the reticulated head while larvae under those three genera have the dark arches or coronal stripes outlining the adfrontal area of the head. The body is cylindrical and stout, and generally the colour of the body is dull and marked with longitudinal stripes (Stehr 1987). For *M. venalba,* the longitudinal stripes on the body can be seen as early as second instar when they start feeding on the leaves. However, towards the late instar, there are minute black dots along the sub-dorsal stripes, which can determine that the larva is in its final stage. The larva body will look more wrinkled, shortens, swollen and yellowish towards pupation. This is due to the secretions by the moulting fluid glands from the outer and inner layers of cuticle before pupation (Kaleka et al. 2019).

The pupa of *M. venalba* also shows the general characteristics of noctuid pupae. The appendages on the pupa do not extend beyond the posterior ventral margin of the fourth abdominal segment. However, caudal setae and spines give the most valuable diagnostic characteristics to determine pupa at genus level. The caudal has two short cremaster, somewhat hooked which indicates that the larva falls under subfamily Hadeninae (Gardner 1948; Mosher 1916). The adult morphology of *M. venalba* was described, explained and discussed in detail by Yoshimatsu (1994). There is no difference between male and female moth, but sometimes the orangish cucullus can be easily seen protruding from the last segment of the body of male moth.

The cranial chaetotaxy of *M. venalba* follows the general cranial chaetotaxy of noctuid larvae as referred with Beck (2000). G2 seta from genal group is absent for *M. venalba.* The absence of G2 seta is corresponding with the head chaetotaxy by Beck (2000). The P2 seta is distinctly far from the apex of adfrontal suture. When compared with other noctuid larva, *Spodoptera exigua* (Hübner) that is an armyworm, the P2 seta is side by side the apex of adfrontal suture (Piao & Fan 2011), and the distance between P1 and P2 is closer. The position of P2 seta can be used to distinguish the cutworm and armyworm.

The distributions of all body setae of *M. venalba* generally correspond with general chaetotaxy of noctuid larvae (Beck 2000). There are few characteristics that are variable in *M. venalba.* L3 seta in the prothorax or T1 segment is absent, but Hinton (1946) found L3 setae on the prothorax of other noctuid larvae. Nevertheless, the chaetotaxy of T1 for *M. venalba* is identical with *Helicoverpa armigera* (Hübner) (Noctuidae) where the L3 seta was absent as well (Singh & Goel 1987). The SV2 seta on mesothorax (T2) and metathorax (T3) is also absent. This can be supported by the absence of SV2 seta in T2 and T3 in some species of noctuid larva (Peterson 1962). For some abdominal segment of this species, the absence of subventral group seta, SV2 on segments A1, A7, A8 and A9 and SV3 seta on segments A7, A8 and A9 are also similar with common setae distributions of noctuid (Beck 2009). The absence of proprioceptor seta, MD2 on T2 and T3 is also a general character of noctuid larvae (Hinton 1946). Singh and Goel (1987) had treated SD2 seta of A1 to A8 segments as MSD2 microscopic seta because of its function is other than tactile. However, Mukerji and Singh (1951) and Beck (2009) treated MSD2 seta of A1 to A8 segments as SD2 for noctuid larvae because of its identical position with SD2 according to Hinton (1946). Therefore, MSD2 was treated as SD2 seta for *M. venalba* in its chaetotaxy. According to Hinton, A10 segment has little taxonomic value and he cannot find solution for the homotypy of all the setae, so he did

not describe this segment in his work. The A10 segment of *M. venalba* follows the common setal positions for A10 segment of noctuid larvae that have homoideous crochets.

Based on description by Ripley (1923), Gardner (1967), Godfrey (1972), and Singh and Goel (1987), it is clearly shown that the species of this study falls under the family Noctuidae and subfamily Hadeninae based from its setae distributions. The positions of setae L1 and L2 that lie prespiracular in prothorax, where L2 is ventrad from L1 indicate the larva is from family Noctuidae. There are one and three SV setae on each A1 and A2 segments respectively. Both characters indicate the larva belongs to the subfamily Hadeninae. The distance between L1 and L3 setae of T2 or T3 segment might be obviously nearer to either one for Hadeninae larva. The three prothoracic punctures; XDa, XDb and XDc give taxon for subfamily level of the larva as well. The position of XDb puncture is posterodorsal and slightly dorsad from XDa.

The chaetotaxy work on Hadeninae larva especially under genus *Mythimna* and subgenus *Leucania* is still lacking. Ripley (1923) had discussed in detail the cranial and body chaetotaxy of *Mythimna* (*Pseudaletia*) *unipuncta* (Haworth), Kumar (2010) had only discussed the cranial chaetotaxy of *Mythimna* (*Acantholeucania*) *loreyi* Duponchel and recently Madruga et al. (2019) had discuss in detail the chaetotaxy of *Mythimna* (*Pseudaletia*) *sequax* Franclemont. Since the scarcity of information and works on the abdominal chaetotaxy of other species of *Mythimna* (*Leucania*), different characteristic of chaetotaxy between species were observed from previous works by Ripley (1923) and Madruga et al. (2019) for *Mythimna* larvae. From this study, we managed to identify the possible characteristic to differentiate *M. venalba* with *M. unipuncta* and *M. sequax*. The most distinct characteristic is the variable positions of L1 seta in A9 segment for all three species. For *M. unipuncta*, the L1 is situated most anterior (near the anterior margin of A9 beyond SD1) and slightly ventrad from SD1. For *M. sequax*, the L1 is situated anterior to and more ventrad from SD1, but posterior to D1. For *M. venalba*, the L1 seta is situated just slightly anterior from SD1. It can be concluded that the position of L1 seta among the three species might provide taxon for specific level under subfamily Hadeninae.

CONCLUSION

The absence of G2 seta in the cranial chaetotaxy and the L1 seta that is situated just slightly anterior to SD1 on the A9 segment of the abdominal chaetotaxy are good characters to distinguish *M. venalba* from other *Mythimna* species. Detail morphological descriptions of *M. venalba* at all immature stages including the illustrations provided here contribute information of the species in identification process. The descriptions and illustrations will help in early field identification, especially during field pests monitoring, before it is being identified with more precise identification methods such as molecular techniques.

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