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ASPECTS OF LARVAL MORPHOLOGY AND LARVAL AND ADULT KEYS TO THE RICE STEM BORERS (INSECTA : LEPIDOPTERA) AND A NEW RECORD OF A RICE STEM BORER NIPHADOSES GILVIBERBIS (ZELL.) FROM PAKISTAN*

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Abstract. Aspects of larval morphology with reference to chaetotaxy of rice stem borer species of lower Sind, Pakistan, are investigated and keys to the larvae and adults are formulated to help identify these devastating insects. A new record of a rice stem borer species *Niphadoses gilviberbis* (Zell.) from lower Sind, Pakistan, is also presented.

Introduction

Rice stem borers ought to be identified at larval stage and in the absence of any authentic larval key it is impossible to identify correctly the larvae and consequently the study of relative infestation due to different borer species is almost impossible. In Pakistan, the earlier workers probably confused the larvae of *Chilo suppressalis* (Walk.) with those of *Tryporyza insertulas* (Walk.). Therefore it is not surprising that in a recent RCD symposium on rice at Islamabad,[1] some of the local workers altogether denied the presence of *C. suppressalis* in Pakistan, although Hampson[11] had recorded it from Sind and Fletcher[5] from Landhi, Larkana, Sukkur and Mirpurkhas in Sind and Lyallpur in the Punjab.

Several authorities in the past have attempted to identify the larval characters of different rice stem borers mostly on the basis of colour, and at best on caudal appendages and spiracles, and rarely upon setae (Fletcher;[3, 4] Shiraki;[29] Fletcher and Ghosh;[6] Kawada;[19] Fracker;[9] Sugiyama;[30] ssac and Rao;[16] Issac and Venkatraman;[17] Gardner[10]; Krishnamurti and Usman;[22] Williams;[34] Kawada and Hattori;[20] Fukaya and Hattori;[7, 8] Kodoma,[21] Nishida and Torii.[26] Since these characters generally vary from instar to instar and since also there are infraspecific variations, in the present work chaetotaxy has been considered the most authentic, reliable and consistent character, for it is neither eliminated nor changed in the preservatives (Peterson).[27]

In the above light, and taking into account Kapur's suggestion that, "the larval setae should be named, described and mapped along a uniform style at least for the common species of the rice stem borers", efforts are made presently to study in detail the chaetotaxy of the four major rice stem borer species of lower Sind, viz, *C. suppressalis*, *T. incertulas*, *T. innotata* (Walk.) and *Sesamia inferens* (Walk.). Among earlier workers only Krishnamurti and Usman[22] and Williams[34] followed Hinton's[13] system of nomenclature for the larvae of one or the other borer species they studied. With the help of this and other morphological studies such as structural variation of the mandibles and the arrangement of crochets a larval key is made to help correct identification of these devastating insects.

On the other hand *Niphadoses gilviberbis* (Zell.) appears so similar to *T. innotata* (Kapur[23]) that the earlier workers probably could not distinguish the two (Husain.[14, 15] Stewart;[31] Aziz *et. al.*;[2] Moiz;[25] Haq;[12] Pirzada *et. al.*;[28] Javed and Ahmed[18] and Ahmad).[1] During the present studies, however, after working on adult external and internal morphology of all representative species of rice stem borers in lower Sind, *N. gilviberbis* is differentiated from *T. innotata* and thus a new borer species has been recorded for the first time from this region and a key to the adults is presented to help resolve this confusion.

Material and Methods

Rice stem borer larvae were collected from paddy fields of lower Sind throughout the crop season 1975-77. The collected larvae were either introduced into the stems of potted rice plants or preserved in 70% alcohol.

External morphology of the live and preserved larvae with special reference to chaetotaxy was studied for the construction of a working larval key. The larvae in the potted plants were marked with the help of the above key and were later reared to adult for final identification of the species with the help of keys given by Kapur (1967) and Nishida and Torii (1970), and the present key to the adults.

For chaetotoxy setae are named according to the nomenclature given by Fracker (1915; revised, 1930). A hypothetical setal map is presented in Fig. 1 to help locate the setae correctly.

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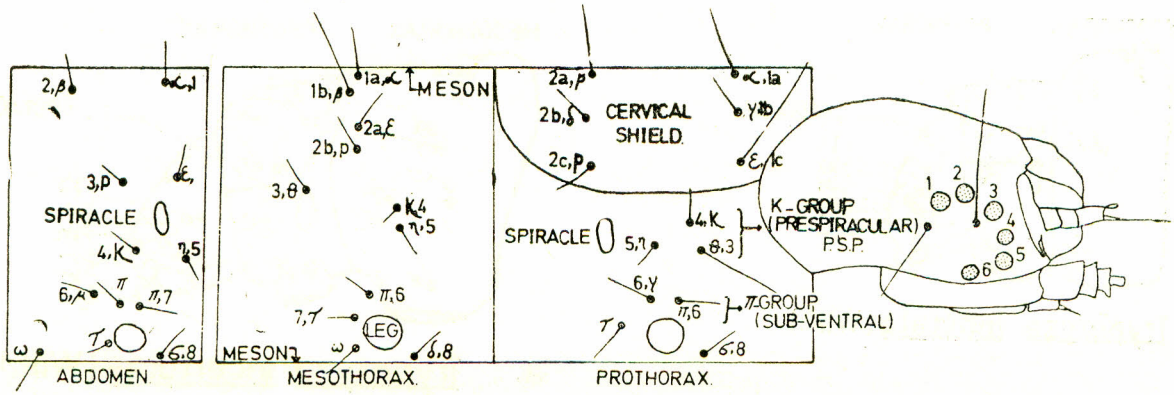


Fig. 1. A hypothetical setal map.

Results

Larval morphology of Sesamia inferens (Walk.). (Pink stem borer) (Fig. 2a-c).

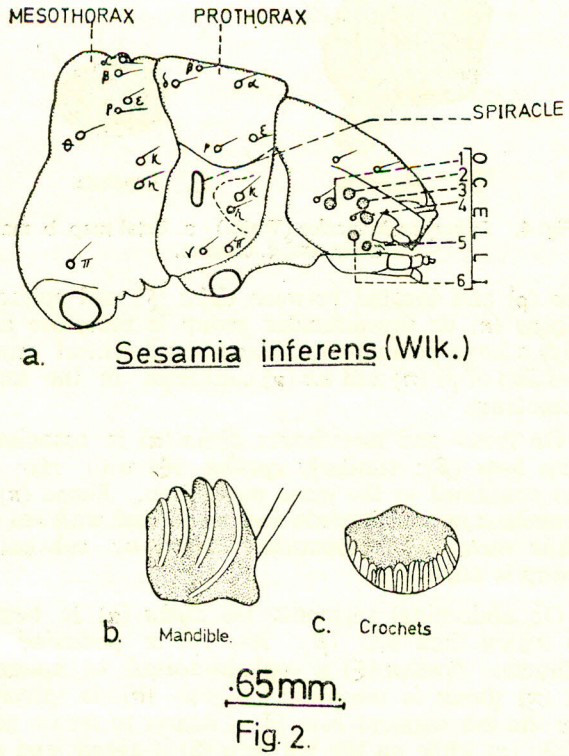


Fig. 2. *Sesamia inferens* (Walk.)

Coloration and other external features. Larvae pink with a distinct orange red head, cervical and anal plates dark brown, a pair of caudal appendages, abdominal prolegs more or less elongated with the first two pairs slightly reduced.

Larval period (in days): 31-38

Chaetotaxy. The larva of *S. inferens* possesses only primary setae. The *beta* (β) of prothorax is closer to *meson* than the *alpha* (α), the *epsilon* (ϵ) is close to *rho* (ρ) and located between the *delta* (δ) and the spiracle. The *kappa* (pre-spiracular) group consists of *Kappa*(κ) and *eta* (η) both contained in the same pinaculum. The *pi* (subventral) group consists of *pi* (π) and *nu* (ν) not contained in the same pinaculum. On meso- and metathorax, *alpha* (α) is associated with *beta* (β), *epsilon* (ϵ) with *rho* (ρ), *kappa* (κ) with *eta* (η) while *theta* (θ) is separate and the *pi* group is unisetose on abdominal segments 1 to 6 and 8, *alpha* (α) is nearer to *meson* than *beta* (β), *rho* (ρ) is dorsad to spiracle, *epsilon* (ϵ) is cephalo-dorsal to spiracle, *kappa* (κ) and *eta* (η) are remote, and *pi* group is unisetose. On 7th and 8th abdominal segments the pi group is bisetose and consists of pi (π) and Nu (ν). Sigma (σ) is present on abdominal segments.

Prolegs. The first two pairs of prolegs are slightly reduced.

Crochets. Crochets are uniordinal and arranged in a mesopenellipse. The gap at the ends of the crochets is greater than one third the projected circumference of the circle.

Mandibles. Mandibles with five teeth, three outer ones very short, 4th smaller and the 5th rudimentary.

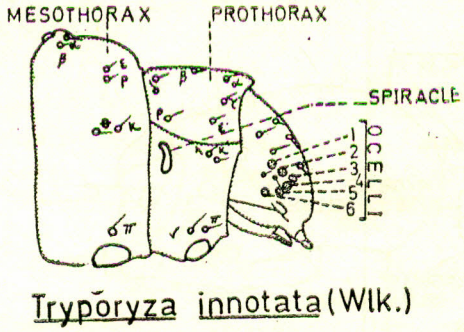
Ocelli. Ocellus 2 is at equal distance from ocelli 1 and 3, ocellus 5 is out of the semicircle formed by all other ocelli. The distance between ocelli 4 and 6 is distinctly larger than the distance between ocelli 1 and 2. There are two ocellar bristles, one arising posteriad to ocellus 1 and the other posteriad to the ocellus 4.

Larval morphology of Tryporyza innotata (Walk.) (White stem borer) (Fig. 3a-c).

Coloration and other external features. Larvae milky white, prothoracic shield well divided, no distinctive coloration of the anal plate, caudal appendages absent, abdominal prolegs reduced.

Larval period (in days) : 19-31.

Chaetotaxy. The larvae of *T. innotata* possesses only primary setae. *Beta* (β) of prothorax is closer



Tryporyza innotata (Wlk.)

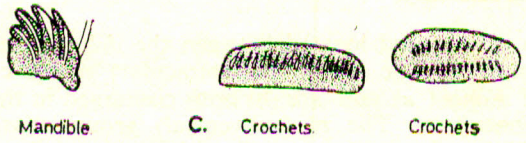


Fig. 3. *Tryporyza innotata* (Walk.) a. Setal map, b. mandible, and c. crochet.

to meson than *alpha* (α); *gamma* (γ) is present. *Epsilon* (ϵ) and *rho* (ρ) are remote and later located between *delta* (δ) and the spiracle. *Kappa* (κ) or pre-spiracular group consists of *kappa* (κ) and *eta* (η) contained in the same pinaculum. *Pi* (subventral) group consists of *pi* (π) and *nu* (ν) not contained in the same pinaculum.

On meso- and metathorax *alpha* (α) is associated with *beta* (β), *epsilon* (ϵ) with *rho* (ρ), *kappa* (κ) close to *theta* while *eta* (η) is absent and *pi* (π) group is unisetose.

All abdominal segments are similar to those of *T. incertulas*.

Crochets. Crochets of abdominal prolegs are in uniordinal circle while those on anal prolegs form a biordinal meso-series.

Mandibles. Mandibles with 5 teeth. The first 4 are prominent, while the 5th is the smallest.

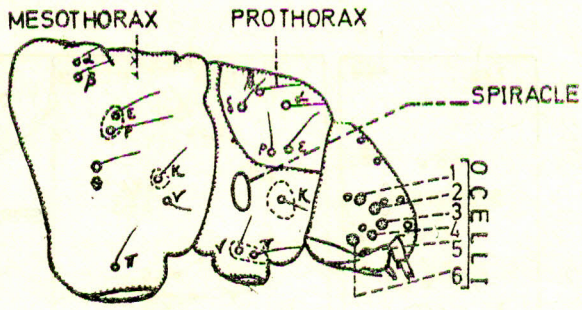
Ocelli. Arrangements of ocelli is similar to those of *T. incertulas* but the two ocellar bristles arise from postero-ventrad to ocellus 1 and posteriad to ocellus 2, respectively.

Larval morphology of Tryporyza incertulas (Walk.)
(Yellow stem borer Fig. 4a-c)

Coloration and other external features. Larvae yellowish brown with a distinct orange yellow head, prothoracic shield dark brown, no distinctive coloration of the anal plate, caudal appendages absent, abdominal prolegs moderate.

Larval period (in days): 12-27.

Chaetotaxy. The larvae of *T. incertulas* possesses only primary setae. *Beta* (β) of prothorax is closer to *meson* than *alpha* (α). *Epsilon* (ϵ) is very close to



a. Tryporyza incertulas (Wlk.)

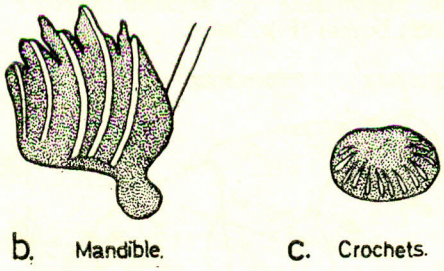


Fig. 4. *Iryporyza incertulas* (Walk.) a. Setal map, b. mandible, and c. crochet.

rho (ρ) and located between *delta* (δ) and spiracle. *Kappa* (κ) or prespiracular group is unisetose and with a large pinaculum. *Pi* (π) or subventral group consists of *pi* (π) and *nu* (ν) contained in the same pinaculum.

On meso- and metathorax *alpha* (α) is associated with *beta* (β); similarly *epsilon* (ϵ) with *rho* (ρ) but contained in the same pinaculum. *Kappa* (κ) is contained in a pinaculum and associated with *eta* (η) while *theta* (θ) is separate. *Pi* (π) or subventral group is unisetose.

On abdominal segments 1-6 *alpha* (α) is nearer to *meson* than *beta* (β). *Rho* (ρ) is posteriad to spiracle. *Epsilon* (ϵ) is cephalo-dorsad to spiracle. *Pi* (π) group is unisetose. *Sigma* (σ) is present. On the 8th segment *beta* (β) is nearer to *meson* than *alpha* (α) while on the 9th *beta* (β) is absent and *rho* (ρ) is closely associated with *epsilon*.

Crochets. Crochets are uniordinal and arranged in meso-penellipse.

Mandibles. Mandibles with five teeth. The outer 4 are sharp, the 2nd and 3rd longer while the 5th is truncated but distinct.

Ocelli. Ocellus 2 is nearer to ocellus 3 than to ocellus 1. Ocellus 5 is out of the semicircle formed by other ones. The distance between 4th and 6th ocelli is slightly larger than that between ocelli

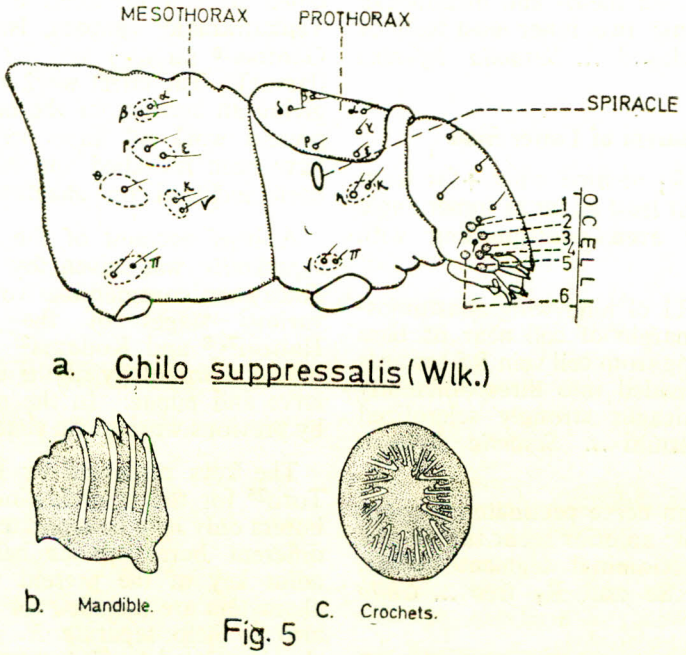


Fig. 5. *Chilo supressalis* (Walk) a. Setal map, b. mandible and c. crochet.

1 and 2. There are two ocellar bristles, one arising posteriad to ocellus 1 and the other posteriad to ocellus 4.

Larval morphology of Chilo supressalis (Walk.)
(Striped stem borer Fig. 5a-c)

Coloration and other external features. Larvae with five grey-brown dorsal longitudinal stripes; ventral surface pale yellow, body sparsely covered with five hairs.

Larval period (in days): 30-36

Chaetotaxy. The larva of *Chilo supressalis* possess only primary setae. *Beta* (β) of prothorax is closer to *meson* than *alpha* (α). *Gamma* (γ) is present. *Epsilon* (ϵ) and *rho* (ρ) are remote and later located between *delta* (δ) and spiracle. *Kappa* (κ) or pre-spiracular group consists of *kappa* (κ) and *eta* (η) contained in same pinaculum. *Pi* (π) or subventral group consists of *pi* (π) and *nu* (ν) contained in same pinaculum.

On meso- and metathorax *alpha* (α) is associated with *beta* (β) contained in same pinaculum. *Epsilon* (ϵ) with *rho* (ρ) contained in same pinaculum, *kappa* (κ) with *eta* (η) contained in the same pinaculum while theta is separate with large pinaculum, *pi* (π) group bisetose.

On the abdominal segment 1-8 *alpha* (α) is nearer to *meson* than *beta* (β), *epsilon* (ϵ) is cephalo-dorsad to spiracle while *kappa* (κ) is close to *eta* (η) ventrad to spiracle. *Pi* group is unisetose. On the 9th abdominal segment *beta* (β) is absent and *epsilon* (ϵ) is associated with *rho* (ρ) contained in the same pinaculum, while the *kappa* (*k*) group is unisetose.

Crochets. Crochets are biordinal circle.

Mandibles. Mandibles with 6 teeth, 4 inner large and sharp, while the last are two small and blunt.

Ocelli. Ocellus 2 is between ocellus 1 and 3. Ocellus 5 is out of the semicircle formed by all other ocelli. Ocellus 3 and 4 are very close. There are two ocellar bristles, one arising postero-ventrad to ocellus 1 with the other posteriad to ocellus 3.

Larval Key to Rice Stem Borers of Lower Sind

1. Crochets of abdominal prolegs uniordinal; mandibles with 5 teeth; all setae on meso- and metathorax not contained in pinacula. *Pi* (π) group on meso- and metathorax unisetose ...2

   Crochets of abdominal prolegs biordinal circle; mandibles with 6 teeth, 4 inner large and sharp, last two small and blunt; all setae on meso- and metathorax contained in pinacula, *pi* (π) group on meso- and metathorax bisetose ... *Chilo supressalis* (Walk.).

2. Crochets of anal prolegs uniordinal like abdominal prolegs and arranged in a meso-penellipse ...3
   Crochets of anal prolegs forming a biordinal meso-series unlike abdominal prolegs ... *Tryporyza innotata* (Walk.).

3. On prothorax *kappa* (κ) and *eta* (η) not contained in same pinaculum; on meso- and metathorax *epsilon* (ϵ) associated with *rho* (ρ) and both contained in the same pinaculum and *kappa* (κ) also contained in a pinaculum, all teeth of mendibles well developed ... *Tryporyza incerturlas* (Walk.).
   On prothorax *kappa* (κ) and *eta* (η) contained in

the same pinaculum, on meso- and metathorax pinacula entirely absent; two inner most teeth of mandibles less developed ... *Sesamia inferens* (Walk.).

Adult Key to Rice Stem Borers of Lower Sind

1. Delicate insects; Sc+R_1 of hind wing, + far from upper margin of cell, at least as far as upper angle and approaching or even anastomosing with R_5 ... 2.

   Stout insects, Sc — R1 of hind wing anastomosing with the upper margin of cell near its base and thereafter diverging from cell vein R5 towards wing apex; harpes divided into three differently sclerotized parts, aedeagus strongly sclerotized with groups of cornuti ... *Sesamia inferens* (Walk.).

2. Hind wing with median nerve pectinate on upper side; proboscis present; anterior scent tuft on the venter of the 7th abdominal segment absent, forewing with veins Sc and R_1 free ... *Chilo suppressalis* (Walk.).

   Hind wing with median nerve not pectinate on upper side, proboscis absent; anterior scent tuft on venter of 7th abdominal segment present, forewing with veins Sc and R_1 anastomosed or vein Sc and not running straight ... 3.

3. Labial palpus with apical segment less than one third length of second segment; forewing with Sc and R_1 invariably anastomosed, male genitalia with dorsal thickening of tegumen Y-shaped; anterior scent tuft 1.5 times as long as broad at base ... *Niphadoses gilviberbis* (Zeller).

   Labial palpus with apical segment more than one half the length of the second segment; forewing with Sc curved towards R_1 but not touching it, tegumen without dorsal thickening, anterior scent tuft 3 times as long as broad at base.

4. Forewing bright yellowish brown with a clear single spot in centre; subteguminal process with bifid sclerotized hooks ... *Tryporyza incertulas* (Walk.).

   Forewing bright and silvery without any spot; subteguminal process with single sclerotized hook ... *T. innotata* (Walker).

Discussion

Although Walker,[33] Fletcher,[3] Martin[24] and Nishida & Torii[26] gave some details of the immature stages of *T. incertulas*, a comparative morphological account and detailed setal map of the caterpillar was not available before the present work. The same thing could also be said about *T. innotata*, for Van Der Goot[32] presented only a general description of the immature stages.

Fletcher and Ghosh[6] gave a brief account of the larvae and pupae of *Sesamia inferens*. More detailed descriptions were, however, given by Issac and Venkatraman[17] (pupae), Isaac and Rao[16] (larvae), Gardner[10] (larvae) and Krishnamurti & Usman[22] (larvae). The latest work available is by Williams[34] giving an account of the larvae and pupae. In the present work all these previously noted characters have been restudied and additional information has been included on chaetotaxy.

A brief account of the larvae and pupae of *C. supressalis* was given by Fletcher and Ghosh.[6] Since then considerable work has been done on the various stages of the species. Fukaya and Hattori[7, 8] and Kodoma[21] gave a detailed account of the morphology of the different structures of the larve and pupae. In the present work the gap left by previous workers on chaetotaxy has been filled.

The keys presented by Kapur[23] and Nishida & Torii[26] for the identification of the adult rice stem borers only help to separate the families to which the different borer species belong. Therefore, in the adlut key of the present work, additional specific characters are included for correct identification and also to help separate *N. gilviberbis* which is very closely related to *T. innotata* with which probably it has been confused to-date in this region.

In connection with the larval key the above authors did not utilize the setal characters. Therefore in the present work, besides, a detailed description of the larval morphology and chaetotaxy has been included.

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