STUDIES ON THE IMMATURE STAGES OF *OXYA VELOX* (FABRICIUS) A RICE GRASSHOPPER FROM DISTRICT JAMSHORO, SINDH, PAKISTAN

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Abstract

Grasshoppers are polyphagous insect pest. They cause considerable damage to many precious crops. Amongst these pest species *Oxya* is reported as severe pest to rice in many countries of world including Pakistan. The immature stages of *Oxya velox* (F.) has been studied in this paper. *Oxya* comprises on sixth nymphal instars. These hoppers appear to be more epidemic than the adults, because they have no functional wings and are unable to fly and all the time they eat; hence cause more damage than the adult. In addition to this, morphological description of various nymphal instars, identification key and measurements of different body parts are also provided. This will, hopefully be useful in plants protection.

Introduction

Rice is the world most important food crop second to wheat, feeding over 2 billion people in Asia alone (Karim and Riazuddin 1999). The rice plant is vulnerable to many insects from its sowing to harvest. Amongst the pests *Oxya* species (mostly called small grasshopper) are reported as sporadic pest of rice in all developmental stages i.e. seeding, tillering, stem elongation etc. Grasshopper at times, occurs in very large numbers. They have great mobility so they migrate from one place to another. Many grasshoppers' species are occasionally found in shady fields but rarely cause significant damage other than along field borders (Irshad, 1977; Zafar; 1986). They chew angular holes in leaves causing an injury similar to that caused by leaf-fodder or Armyworm. Grasshoppers are polyphagous insect pest. The hoppers are seen to be more epidemic than the adults, because they have no functional wings, so are enable to fly and all the times they eat, hence cause more damage than the adults.

Although, there is bulk of publications available on the food preference, plant selection, distribution pattern, status of this pest and other grasshoppers (Srodgram 1935; Dempster 1963; Uvarov 1966, 1977; Thakur 1984; Aziz and Aziz, 1985; Inayatullah *et al.,* 1986; Mohan and Manoharan 1987; Shen *et al.,* 1988; Premchand 1995, Lanjar *et al.,* 2002 and Riffat and Wagan 2010) but there are several aspects regarding the biology of *Oxya* species are less known. It is, therefore, felt necessary to examine the immature stages of this pest. Actually the basic knowledge about the biology of pest species provides authentic information for its control. The results of such study will be instrumental in understanding and devising the population management strategies to adopt control measures at appropriate time.

Materials and Methods

Collection of samples: The nymphs of *O.velox* were collected from the agriculture fields of rice, fodder crops and their surrounding vegetation of grasses with the help of traditional insect hand-net (8.89 cms in diameter and 50.8 cms in length) as well as by hand picking. The collection was made during the year 2011 in the months (May-October) from various localities of Jamshoro (Map. I). The collected material was transferred into polythene bags and taken to the laboratory for further study.

Killing and preservation of samples: The method was adopted from Vickery and Kevan (1983). The collected material brought in to the laboratory and was killed by means of potassium cyanide in standard entomological killing bottles. The specimens were not left too longer in this medium because the color changed particularly that of green specimens. Pinning of the specimens was made within few hours. As the specimens were flexible there was a little danger of losing any part through the necessary manipulation, further the parts could be stretched as desired. Mounting was done according to the following standard entomological. The insect pins were inserted on the pronotum posterior to transverse sulcus slightly to the right of median dorsal carina. The posterior legs were bent beneath the body to minimize the possibility of breaking and to occupy the least amount of storage space.

The abdomen was so set that it dropped below the wings and not obscured by the hind legs as several taxonomic characters are found on the terminal end and these were not to be hidden till the specimens were dried thoroughly. The body parts had to be supported with extra pins so that it can dry in the desired position and also special attention was paid to the antennae, wings and legs in order to display important taxonomic

characters. Dust and other extraneous matter were removed with the help of a dry camel hairbrush. The fully dried specimens were removed from stretching boards and were stored in standard entomological boxes with labels showing locality, date of collection and collector name. Naphthalene balls were placed in boxes to prevent the attack of ants and other insect.

Identification & measurements of hopper: Identification of hopper was carried out under the stereoscopic dissecting binocular microscope. The body parts of the hopers were measured with vernier caliper except first and second instars and antennae of other instars .The first and second instar hopper and antennae were measured by ocular squire graph and segment of an antenna were counted under microscopic. All the measurements are given in millimeter (mm).

Results

Key to the nymphal instars of *Oxya velox* (F.)

1. Elytron and wing rudiments, when present directed downward ……..……..2
   --Elytron and wing-rudiments turned upward…….. …….……..…..5

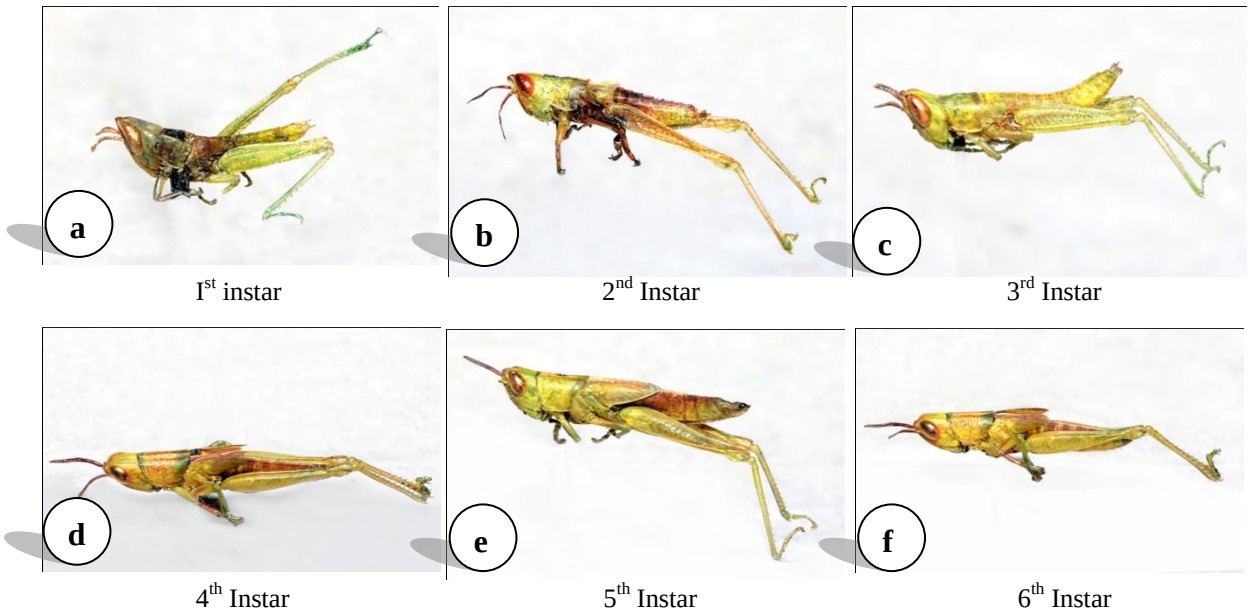
2. Elytron and wing rudiments not developed, ♂antennal length 2.25±0.10mm with 2.25±2.47 segments (Fig.1 a)……..……**First instar**
   --Elytron and wing rudiments evident, ♂antennal length2.46±0.01 mm with usually 2.60± 0.14 segments…….....3

3. ♂Antennal length usually 2.36±0.014 mm with 2.65 segments, elytron and wing rudiments faintly marked directed downwards. (Fig.1 b)
   ……....**Second instar**
   --♂Antennal length 2.46±0.14 mm with 2.72 segments ……..….....4

4. Elytron-and-wing-rudiments directed downward, slightly back, smooth to weak rugose (Fig.1 c)……..**Third instar**

   --♂Antennal length 2.66mm with 2.8±0.14 segments, elytron-and-wing-rudiments directed downward and noticeably back, conspicuously rugose (Fig1.d)
   ……..……**Fourth instar**

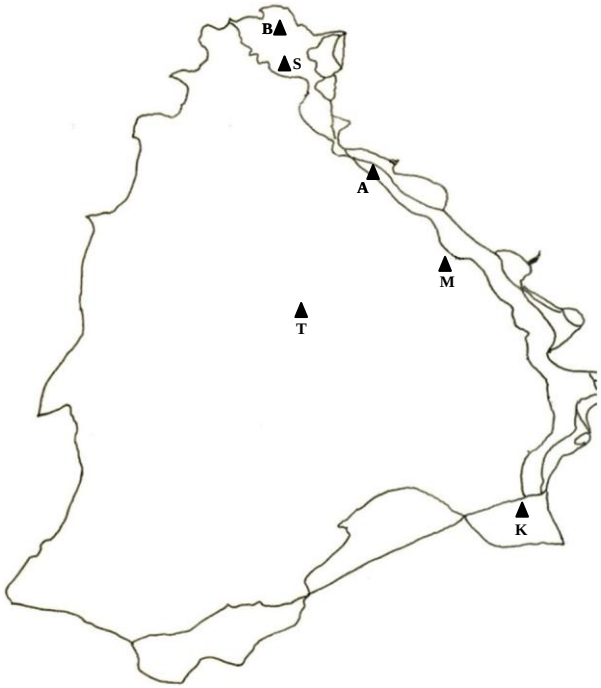
5. Elytron and wing-rudiments not extending beyond first abdominal Segment (Fig1.e)…….…….……**Fifth instar**
6. Elytron and wing-rudiments extending well beyond first abdominal Segment (Fig1.f)……..…… ……..……**Sixth instar**



Ist instar | 2nd Instar | 3rd Instar

4th Instar | 5th Instar | 6th Instar

Fig. 1 (a-f) showing the different nymphal stages of *Oxya velox*



Map of district Jamshoro Showing Surveyed areas during present study

B=Bhan Saeedabad; S=Sehwan; A=Amri; M=Manjhand; T=Thano Bula Khan; K=Kotri

Morphological description of hopper stages

First stage nymph: Body coloration light green pale, pronotum dark at posterior end. Head triangular, a little raised above pronotum, upper margin appears slightly curved in profile, vertex slightly produced and angular terminally. Compound eyes grayish in colour and speckled with brown pigments, elongate, oval, large sized, and prominently developed. Two small pits, one on either side of median carinae, Frontal carinae widely apart and somewhat divergent posterior, lateral and sub–colour carinae indistinctly developed. Pronotum broad and highly developed and overlies mesonotum dorsally and laterally; posterior–lateral areas of mesonotum exposed as small triangles. Median carinae conspicuous on pronotum faint on meso-and meta-nota. Pronotum transversally sulcated by four furrows, equally developed not reaching lateral margin; second sulcus shortest and fourth indistinct on dorsal aspect but developed on lateral sides. Tegminal and wing rudiments produced as margins of meso-and meta-nota. Pro-and mesolegs small having characteristic blackish spot frequently distributed on femora, tibia and tarsi bearing bluish appearance. Abdominal short, light greenish on dorsal side and polish on ventral aspect. Cerci well developed and bearing numerous setae on its surface

Second stage nymph: Coloration as in first instar. Head deflected down words when seen in profile rather cute, vertex produced interiorly. Two white spots, one on each side, at junction of edges of vertex with compounds eyes. Compound eyes of bigger size appear somewhat separated from above. Two greenish lateral ocelli, a whitish median ocellus. Frontal carina bearing row dark pigmented spots along. Frons and clypeus bear numerous minute spots. Tips of maxillary palpi and antennae greenish, antennal tips light brown. A white dorsal median band running from the vertex to tip of abdomen. Pronotum well developed and having three distinct transverse sulci, anterior margin convex and posterior concave. Hind margins of all thoracic segments bear dark spots. Terminal and wing rudiments pushed postero-laterally acquire folded appearance. Femora robust; tarsi and tibia spines of all legs bear a light green pigmentation, tibiae black tipped. On various parts of legs, there are ridges stripes and blackish spots present. Abdomen short, paler than rest of body, dark pigmentation on anterior sterna; cerci elongated, pointed distally and bear a paler pigmentation and numerous minute hairs.

Third stage nymph: General coloration mostly as first and 2nd instars except two pale divergent bands appear behind vertex which runs antero-posteriorly; mesonotum with pale patches on dorsum. Fifth and eighth segments of abdomen bear pale patches on dorsal side; ventral of body whitish–pale with a tinge of gray on thoracic sterna and a few on anterior abdominal sterna. Frons bears numerous black spots, frontal carinae convergent and originated below vertex and strongly marked, carinae gradually diverge while approaching epistomal structure. Maxillary palpi with grayish pigmentation. White spots noticed on vertex .Sterna greenish with pigmentation towards tips. Pronotum grows in size and acquires more intense green pigmentation; sulci

well- developed; of all nota, mesontoum being shortest in size. Both meso-and meta-nota bear black spots on their posterior margins. The pro and mesolegs slender, metalegs rather stoutly built, pretarsi of all legs acquire an intense green pigmentation. Abdomen medium sized and bearing pale coloration on lateral sides. Cerci tipped with yellowish brown in coloration.

Fourth stage nymph: General body color become pale white, divergent bands observed behind vertex in third instar disappear; white patches on pronotum, metanotum and abdominal terga assume shape of a continuous line of black spots on either side of white median carina in female hoppers. Mostly femora trochanto-femoral joints and anterior part bear dark green pigmentation, in female hoppers. Head conspicuous, frons convex and lower part of face externally deflected, face thickly punctuated with small black spots in both sexes; puncation closely approximated in female hoppers; eyes with regularly distributed longitudinal brown stripes in female and male .Antennae bear darker pigmentation on proximal and distal ends .Median ocellus are colorless but shiny, lateral ocelli brownish and a little above origin of antennae. Meta-tergum fairly and sub-rectangular. In female hoppers wing rudiments lie over tegminal rudiments. All legs bear terminally black tipped claws, setae on all tibiae tipped blackish. Abdomen elongated, cerci and genitalia well formed; cerci and associated structures is of pale coloration and bearing numerous minutes hairs like third instar.

Fifth stage nymph: Female coloration deep green on frontal, dorsal and lateral sides of thorax and abdomen, on fronto-lateral parts of the head and legs. Thorax, wings, tegminal rudiments and legs in female with green pigmentation; male comparatively lighter in color. Head conspicuous, frons and lower facial areas extremely deflected, eyes bearing unequally distributed dark brown pigmentation and regular stripes. Antennae greenish in both sexes. Pronotum well- developed and saddle – shaped. Anterior margin smooth and posterior distinctly angulated, posterior angle more acute in female hoppers. Meta-legs strongly developed. Abdomen short and stumpy, sexes distinct, ovipositor valves well- developed, cerci acutely pointed, terminal parts of abdomen bear numerous white hair, dorsal band on abdomen of female attenuated, but guarded by indistinct, dorsal dark margins, dorsal band in male represented by a white line. Cerci elongated and genitalia well developed.

Sixth stage nymph: Hoppers of light green pale color, white band on dorsal side of body guarded by dark borders throughout its length in the hoppers;these borders disappear in female hopper. Head medium –sized, from downwardly stopping and distinctly convex. Basic dusky coloration of eyes marked with regularly arranged longitudinal stripes, five of these closely spaced and located towards anterior side and lie behind last one and widely spaced on anterior dorsal end. Each compound eye bearing on elongated brown spot in it. Lateral ocelli lined with brown, running between each of these are lateral carina, vertex angulated with light gray or brown, particularly in case of male hoppers. Pronotum well-developed, anterior margin straight or only slightly concave, posterior margin regularly angulated in male. It is interesting to note that female tibia joints in both female and male hoppers and posterior end of abdomen only in male hoppers acquire a brownish pigmentation. Abdomen and laterally compressed with under surface having some grayish deep green colour of body. Male and female genitalia completely differentiate in this stage.

Measurement of different body parts of various instars of both sexes has been discussed in (Table. 1 a-b)

Table 1. Morphometric mean used to distinguish various instars of *O. velox*

a. Male (n=10)

Parameter (mm)	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar	6th Instar
Antennal segment	2.25±2.470	2.60±0.149	2.72±0.126	2.80±0.149	3.12±0.12	3.6±0.149
Antennal length	2.25±0.108	2.36±0.014	2.46±0.014	2.66±0.149	2.96±0.01	2.70±0.149
Distance between compound eyes	0.66±0.107	1.06±0.014	0.62±0.014	0.73±0.115	0.77±0.01	0.78±0.011
Length of head	1.05±0.010	1.7±0.014	2.15±0.108	2.2±0.149	2.46±0.01	2.5±0.01
Length of pronotum	1.76±0.014	2.2±0.140	2.3±0.149	2.6±0.149	2.84±0.11	2.9±0.140
Length of tegmina	0.52±0.001	1.57±0.001	1.75±0.012	3.675±0.001	9.97±0.015	11.37±0.094
Length of femur	1.48±0.131	2.83±0.115	3.16±0.014	4.65±0.149	7.04±0.09	8.16±0.107
Total body length	6.66±0.014	7.8±0.149	9.21±0.144	9.55±0.149	9.87±0.01	10.12±0.14

b. Female (n=10)

Parameter (mm)	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar	6th Instar
Antennal segment	2.35±2.57	2.70±1.14	2.82±0.22	2.9±1.14	3.33±0.22	3.8±0.15
Antennal length	2.35±0.28	2.46±1.0	2.56±0.11	2.76±0.24	2.80±012	2.91±0.15
Distance between compound eyes	0.84±0.10	0.86±0.13	0.88±0.12	0.91±0.2	0.97±0.1	1.08±0.11
Length of head	1.15±0.11	1.86±0.11	2.25±0.11	2.34±0.15	2.56±0.11	2.61±0.11
Length of pronotum	1.86±0.11	2.30±0.15	2.71±0.15	2.80±0.151	2.95±0.21	3.10±0.151
Length of tegmina	0.62±0.011	1.67±0.01	2.89±0.112	3.57±0.011	9.93±0.115	11.57±0.01
Length of femur	1.58±0.231	2.93±0.215	4.75±0.159	5.75±0.159	7.14±0.19	8.26±0.197
Total body length	7.76±0.114	8.8±0.151	9.65±0.11	9.75±0.159	10.21±0.254	11.12±0.24

Discussions

The study has been principally concerned with the developmental stages of *O. velox* this pest cause significant damage other than along field borders (Irshad 1977, Zafar 1986). As has been noted by Uvarov (1966) reliable description and identification keys for nymphal instars are particularly needed for ecological studies in which it is essential to distinguish between species in mixed population from their earliest instars. Most of the available descriptions are based on color patterns of nymphs. However, recent workers are tending to rely on certain morphological characters and those of wing and elytra rudiments and posterior abdominal structures have been used with success. These characters were found satisfactory for *O. velox* should also be useful for instars identification of the other Pakistani grasshopper. There are a number of methods used to determine the number of nymphal instars in grasshoppers. Uvarov (1966) noted that most of the available descriptions of instars are base on color pattern. During the collection trip it was also observed that the apparently complete absence of adults and the presence of only first nymphal instars in June suggest that *O. velox* were hatched in June. Moreover, it appears that *O.velox* over-winters slowly in the egg stage.

Ramsey (1964) in his revision of the moult number in orthoptera concludes that the nymphal instars in the Acrididae range from four to nine, with five and six instars occurring most frequently. In recording the instars number, the figure given always excludes the moult of the vermiform larva or nymph when the embryonic cuticle is cast off. This is the only known character that enables the number of nymphal instars in these species to be determined from examination of an adult. For those species lacking eye stripes other methods have been used, for example the number of antennal segments and changes occurring to the wings, elytra and genitalia (Carothers 1923 and Burnett 1951) In addition, measurements of dimensions of the head, pronotum and meso- and met thoracic legs have also been used by Richards and Waloff (1954) who also determined the number of instars by rearing nymphs. *O. velox* pass through seven hopper stages (seventh stage only occurring in female) but we don't report the seventh stage during this stage it might be due to feeding habits or effect of temperature on insect during the development. Furthermore, in this study the methods used in determining the numbers of instars is base on measurement of different body parameters.

The nymphs eat newly germinated rice seedlings and cause them to wither. Adult grasshoppers feed on the leaves and shoots and sometimes cut the earheads. If the emerging inflorescence is attacked, the resulting grains become chaffy. In the month of August and September heavy defoliation can be caused by their attack. This pest is a severe pest of rice but also effect the berseem, maize, sorghum, rice, bajra and sugarcane. When there is serious infestation the plant may be completely defoliated. The nymphs and adults feed on rice leaves and nurseries. Adults feed at the bases of maturing earheads causing them to dry up. Our field survey showed that it appeared on rice three weeks after transplanting, when crop was at stage of vegetative growth up to second week of July there is insignificant population of hopper as well as adult but later on it significantly increased in numbers and the nymphs attained peak population in the second week of September and proved to be very injurious to the crop.

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