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Observations on the pioneer white butterfly, *Belenois aurota* (Lepidoptera: Pieridae) in Ker (*Capparis decidua*) plant in Arid region of India

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Abstract

The pioneer white butterfly, *Belenois aurota* Fabricius, 1793 (Lepidoptera: Pieridae), has found to be emerging as a major pest of ker (*Capparis decidua*) plant in arid region of India and causes over 70% damage to wild and cultivated ker plants. During the survey of pest incidence, the maximum incidence (86.67%) was observed in first fortnight of December and it was reduced to 11.67% in first fortnight of September in subsequent year. The average numbers of insects ranged between 1.33 to 10.33 larvae per branch of plant. Adults of this small butterfly were blacks and whites in color with black markings on both upper and under sides broader, the white spots on black apical area of fore wing often sub-obsolete above. Eggs were laid in batches on young shoots or new branches and were 1.74 mm in length, 1.55 mm in width and yellow in color when first laid. The length and width of 1st instar larvae were 2.05 mm and 0.47 mm, respectively and feed on branches gregariously. There were total of five instars. Pupae were 18.84 mm long and 4.92 mm wide. Adult females had a body length of 13.23 mm and a wingspan of 41.65 mm. Bodies of males were 11.54 mm long and their wingspan measured 38.72 mm.

Key words: *Belenois aurota*; *Capparis deciduas*; incidence; morphological characterization

Introduction

Capparis decidua (Forsk.) Edgew (Capparidaceae), locally known as ker, is a drought resistant plant growing in dry regions of India as dense tufts. It is a small much branched tree or shrub of arid regions in Africa, Middle East and southern Asia, including the Thar Desert. It bears a mass of slender, leafless branches, the small caduceus leaves being found only on young shoots. It rarely exceeds a height of 5 meters. The new flush of leaves appears in November–January. Red conspicuous flowers appear in March to April and August–September and ripe by May and October. The pink fleshy berries are readily eaten by birds. It coppices well and produces root suckers freely. It is extremely drought-resistant and tolerates some frost (Burdak, 1982). This is a very useful plant in its marginal habitat. Their spicy fruit are used for preparing vegetables, curry and fine pickles and can attract helpful insectivores and is also used in folk medicine and herbalism. *C. decidua* can be used in landscape gardening, afforestation and reforestation in semi desert and desert areas; it provides assistance against soil erosion (Kaul, 1963). The green immature fruits are considered antihelminthic and laxative and are employed in the treatment of asthma, constipation, coughs, hysteria and other psychological problems (Ghazanfar, 1994).

There are 30 species in the genus *Belenois*, distributed variously across Africa, Arabia, the Indian subcontinent, south-east Asia and Australia (Chandra, 1985; Kunte, 2006; Ghosh and Saha, 2016). *Belenois aurota* Fabricius, 1793 has a wide distribution range extending across sub-Saharan Africa (including Madagascar) and Arabia to the Indian subcontinent, and also occurs in north of the Himalayas in Turkmenia and Tajikistan. *B. aurota* has been reported from India, but basic information on damage, incidence, morphomatric analysis and its molecular data is lacking (Woodhall, 2005; Kunte, 2006; Nimbalkar *et al.*, 2011). As per the existing primary literature scan and to our knowledge, the pest status of *B. aurota* has not been reported, and therefore, we believe that this would be of first study of such kind where all the comprehensive information is available at one place. Furthermore, proper management strategies of an emerging pest are largely based on better understanding of their damage, incidence and morphometric analysis. The

information reported in this study would be helpful for biological studies of this pest species.

Material and Methods

Species identification and morphometric measurements

The dried and pinned adult specimens were sent to Insect Biosystematic Section, Division of Entomology, Indian Agricultural Research Institute, New Delhi for taxonomical identification. The average linear measurements of various body parts of male and female adults were obtained under a binocular microscope (Radical Instruments, Ambala, Haryana, India) using Jenoptic Pro 2.8.0 software. Twenty insects (10 males and 10 females) were used for observation and measurements. The larvae were reared under laboratory conditions (temperature at 28 ± 2 ^{o}C with a relative humidity of 60 ± 5 %) for measurement of different stages. The terminology used to denote different parts of the body were according to Haldhar (2012), Haldhar and Singh (2014) and Haldhar *et al.* (2015). The illustrations were scanned at 600 dpi black and white, and mounted onto plates by Adobec Photoshopc 8.0.

Incidence and symptoms

Twenty ker plants were selected randomly in each of 3 replicates at the Experimental Farm of the Central Institute for Arid Horticulture (CIAH) (N 28° 06' E 73° 21'). Incidence of infestation observed on each plant and numbers of larvae per branch was recorded 15 days interval from September 2013 to March 2014 and September 2014 to March 2015. The sampling was done by visual observation and manual counting. Average incidence was calculated as the percentage of whole plants infested by *B. aurota*. Average numbers of larvae per branch was calculated from numbers recorded for 10 randomly selected ker plants with 3 replications.

Statistical analysis

Before statistical analysis, data were transformed as necessary to achieve normal distribution. The data on incidence and numbers of insects were analyzed by 1-way ANOVA using SPSS software (O'Connor, 2000). When significant differences were detected, means were compared by using Turkey's honest significant difference (HSD) tests for paired comparisons at a probability level of 5%.

Results

Incidence and symptoms

For the first time, pioneer white butterfly was observed on ker plant in the hot arid region of north-western India, (*i.e.*, Thar Desert) and identified as *B. aurota*. During the present study, the average incidence of butterfly larvae on plants ranged between 11.67 and 86.67 per cent (Table 1 & Fig. 1). The incidence and the numbers were higher in winter months (November to January) and the maximum incidence of 85.00 and 86.67 per cent was recorded in first fort night of December and the minimum 11.67 and 13.33 per cent in first fortnight of September during 2013-14 and 2014-15, respectively. Thus the highest mean number of this butterfly species per branch was recorded in first fortnight of December (10 & 10.33/ branch) and the lowest was in second fort night of March (1.33 & 1.67/ branch) during 2013-14 and 2014-15, respectively (Table 1). Due to attack by this pest, the growth of ker plants was suppressed and new branches and leaves wilted and dry. On hatching, clusters of young larvae feed gregariously by initially scraping the surface of the branches and leaf. Later instars disburse and move on to other branches and leaves and feed voraciously, producing large irregular holes and may leave only the veins. High infestation causes severe defoliation. This larvae quickly skeletonised branches and leaves as they attack in clusters in early stages.

Morphometric measurements

Data on linear measurements of *B. aurota* have been presented in Tables 2 and 3 and Fig. 2. This butterfly was typically characterized as males white, front wings black tipped with white spots, white margin to hind wings and female similar but the black markings on both upper and under sides broader, the white spots on black apical area of fore wing often sub-obsolete above. The adult females had a body length of 13.23 mm and a wingspan of 41.65 mm. The male body length and wingspan were 11.54 mm and 38.72 mm, respectively. Antennae in both sexes black sparsely sprinkled with white dots. The lengths of male and female antennae were 10.54 mm and 11.40 mm, respectively. The female length of fore wing, hind wing, head, thorax, abdomen, proboscis, fore, middle and hind legs were 19.23, 16.32, 1.65, 4.83, 9.15, 8.95, 6.53, 7.44 and 8.02 mm, respectively. The male width of fore wing, hind wing, head, thorax and abdomen were 10.31, 11.15, 2.48, 2.36 and 2.16 mm, respectively. Eggs were laid in batches on branches or young shoots. They were 1.74 mm in length, 1.55 mm in width, and yellow in color when first laid. When hatched, the 1st larval instar was olive colour with a distinct glossy jet-black head. The length and width of 1st instar larvae were 2.05 and 0.47 mm, respectively. The lengths of 2nd, 3rd, and 4th instar larvae were 5.12, 12.27, and 18.60 mm, respectively. The 5th instar larvae were 24.71 mm long, 3.93 mm wide, and long, cylindrical, broader towards the head, slightly tomentose on back, hairy on the sides. Pupae were 18.84 mm long, 4.92 mm wide, and transparent, pale cream-colour. In front of pupa a longish tubercle with a black mark on each side, a lateral line of pale plum-colour on which is a longitudinal line of yellow round dots and a transverse row of dots on each segment.

Discussion

To our knowledge this is the first report of *B. aurota* as pest damage, incidence, morphomatric analysis and its DNA barcoding evidence of ker from World. The incidence and the numbers were higher in winter months (November to January) as compare to other seasons and the maximum incidence was recorded in first fort night of December and the minimum in first fort night of September. Chandra *et al.* (2000), Wynter-Blyth (1957) and Ghosh and Saha (2016) reported that the host *Capparis aphylla,* C. *sepiaria,* C. *heyneana*, *Cadaba indica* and *Maerua arenaria* of pioneer white butterfly *A. aurota.* This butterfly was typically characterized as males white, front wings black tipped with white spots, white margin to hind wings and female similar but the black markings on both upper and under sides broader, the white spots on black apical area of fore wing often sub-obsolete above. Sharma (2014) and D'Abrera (1982) described the morphomatric of *A. aurota* as adult upperside male pure white with black apex in the forewing and black outer margins in both wings. Black area with white spots, elongated in the forewing and rounded in the hindwing. Female similar to male, but with thicker and broader veins, apex and outer margins. Underside male spots in the apex, yellowish in the forewing and yellow with black veins in hindwing. Wingspan 50-60 mm. It is distributed throughout India except Assam. It is also found in Afghanistan, Africa, a few Mediterranean countries, Bhutan, Pakistan, Saudi Arabia, Iran, Asia Minor, Madagascar, Myanmar and Australia (Kunte, 2006; Chandra, 1985; Ghosh and Saha, 2016).

In published literature no incidence and linear morphomatric details given on *B. aurota* could be found; and the first incidence and linear morphomatric study of *B. aurota* is described herein. This butterfly was damaging economically important parts of plant, such as leaves and branches. Therefore, management practices needs to be developed and implemented to minimize the losses caused by this pest.

Table 1. Percent infestation and number of larvae per branch of butterfly, *Belenois aurota* on *Capparis decidua* during 2013-14 and 2014-15

Sampling month	Mean incidence (%)[a,b]		Mean no. of *B. aurota* larvae per branch[b]	
	2013-14	2014-15	2013-14	2014-15
September-I*	11.67 (19.88)^{a}	13.33 (21.33)^{a}	2.33^{ab}	2.67^{bc}
September-II	16.67 (24.04)^{ab}	18.33 (25.30)^{ab}	2.67^{bc}	3.00^{c}
October-I	28.33 (32.13)^{c}	30.00 (33.15)^{c}	4.67^{def}	5.00^{efg}
October-II	43.33 (41.15)^{d}	45.00 (42.10)^{d}	5.67^{f}	6.00^{g}
Nov-I	53.33 (46.89)^{e}	55.00 (47.86)^{ef}	7.33^{g}	7.67^{h}
Nov-II	65.00 (53.74)^{fg}	66.67 (54.73)^{g}	7.33^{g}	7.33^{h}
Dec-I	85.00 (67.38)^{h}	86.67 (68.64)^{i}	10.00^{h}	10.33^{i}
Dec-II	81.67 (64.67)^{h}	85.00 (67.38)^{i}	7.67^{g}	8.00^{h}
Jan-I	73.33 (58.91)^{g}	76.67 (61.12)^{h}	5.33^{ef}	5.67^{fg}
Jan-II	61.67 (51.73)^{f}	63.33 (52.72)^{fg}	5.00^{def}	5.33^{efg}
Feb-I	60.00 (50.77)^{ef}	60.00 (50.77)^{ef}	4.33^{cde}	4.67^{def}
Feb-II	45.00 (42.10)^{d}	48.33 (44.02)^{de}	4.00^{cd}	4.33^{de}
March-I	21.67 (27.70)^{bc}	23.33 (28.77)^{bc}	3.33^{bc}	3.67^{cd}
March-II	15.00 (22.59)^{a}	16.67 (24.04)^{ab}	1.33^{a}	1.67^{ab}
CD	4.45	4.93	1.18	1.25

* I means first fortnight of month and II means second fortnight of month.

[a] Parentheses contain the angular transformation value.

[b] Values followed by different letters are significantly different (Tukey's HSD test, $P < 0.05$).

Table 2. Linear morphometric measurements of different life stages of the butterfly, *Belenois aurota*

Life stage	Length (mm) Mean* ± SE	Width (mm) Mean* ± SE
Egg	1.74±0.012	1.55±0.007
1st instar larva	2.05±0.010	0.47±0.004
2nd instar larva	5.12±0.020	1.05±0.010

Life stage	Length (mm) Mean* ± SE	Width (mm) Mean* ± SE
3rd instar larva	12.27±0.024	1.94±0.013
4th instar larva	18.60±0.032	2.83±0.025
5th instar larva	24.71±0.037	3.93±0.020
Pupa	18.84±0.032	4.92±0.014
Adult female with wingspan	13.23±0.020	41.65±0.090
Adult male with wingspan	11.54±0.028	38.72±0.061

* Mean of ten specimens.

Table 3. Linear morphometric measurements of various traits of adult males and females of butterfly, *Belenois aurota* infesting *Capparis decidua*

Body parts measured (mm)	Male	Female
	Mean ± SE	Mean ± SE
Length of fore wing	18.33±0.040	19.23±0.023
Width of fore wing	10.31±0.021	12.01±0.016
Length of hind wing	14.15±0.019	16.32±0.015
Width of hind wing	11.15±0.022	12.30±0.027
Length of head	1.46±0.007	1.65±0.007
Width of head	2.48±0.009	2.75±0.008
Length of thorax	4.10±0.010	4.83±0.012
Width of thorax	2.36±0.006	2.83±0.013
Length of abdomen	8.45±0.009	9.15±0.011
Width of abdomen	2.16±0.005	2.65±0.008
Length of proboscis	7.74±0.013	8.95±0.006
Length of antenna	10.54±0.020	11.40±0.013
Length of fore leg	5.59±0.013	6.53±0.010
Length of middle leg	6.71±0.017	7.44±0.010
Length of hind leg	7.11±0.015	8.02±0.013

Figure 1. Damage symptoms of *Belenois aurota* on ker (*Capparis decidua)* during the winter season at the ICAR-Central Institute for Arid Horticulture, Bikaner, India.

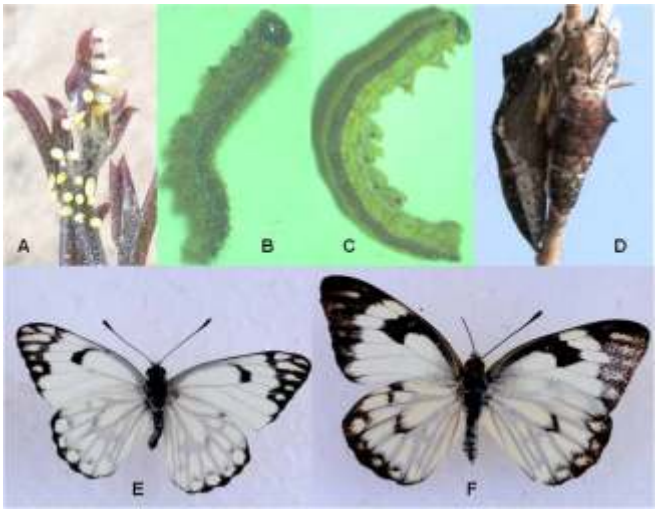

Figure 2. Different developmental stages of *Belenois aurota*. A, eggs; B, 1st instar larvae; C, 5th instar larva; D, pupae; E, adult male; F, adult female.

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