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First report of *Colotis amata* (Lepidoptera: Pieridae) on *Salvadora persica* (Capparales: Salvadoraceae) in Rajasthan, India: incidence and morphometric analysis

S. M. Haldhar*, R. Bhargava, R. S. Singh, H. Krishna, and S. K. Sharma

Abstract

An infestation of the small salmon Arab, *Colotis amata* (F.) (Lepidoptera: Pieridae), on pilu (*Salvadora persica* L.; Capparales: Salvadoraceae) plants was first noticed in 2012 at the Experimental Farm of the Central Institute for Arid Horticulture and other fields of Bikaner District, Rajasthan, India. The maximum incidence (80%) was observed on 18 Dec and the minimum (13%) on 4 Sep. The average numbers of insects ranged between 6.2 and 22.3 larvae per 3 leaves. Adults of this small butterfly were salmon-pink in color. Eggs were laid singly on leaves or young shoots and were 0.58–0.72 mm in length, 0.38–0.43 mm in width, and white in color when first laid, later developing red blotches. The length and width of 1st instar larvae were 1.98–2.29 mm and 0.36–0.48 mm, respectively. The lengths of 2nd, 3rd, and 4th instars were 5.04 mm, 9.77 mm, and 14.27 mm, respectively. The 5th instars were 19.30 mm long and 3.33 mm wide. Pupae were 14.10 mm long and 5.73 mm wide and laterally compressed. Adults were salmon-pink in color, and females had a body length of 9.71 mm and a wingspan of 33.62 mm. Bodies of males were 7.59 mm long and their wingspan measured 25.67 mm. The lengths of male and female antennae were 4.63 mm and 5.46 mm, respectively.

Key Words: small salmon Arab; pilu; morphometric characters

Resumen

Se observó por primera vez en 2012 una infestación de la pequeña salmón árabe, *Colotis amata* (F.) (Lepidoptera: Pieridae), sobre plantas de Pílu (*Salvadora persica* L.; Capparales: Salvadoraceae) en la Granja Experimental del Instituto Central para Zonas Áridas y Horticultura otros campos de Bikaner Distrito, Rajasthan, India. La incidencia máxima (80%) fue observada en el 18 de diciembre y el mínimo (13%) en el 04 de septiembre. El promedio del número de insectos vario entre 6.2 y 22.3 larvas por 3 hojas. Los adultos de esta pequeña mariposa son amarillos y de color blanco. Los huevos se ponen individualmente en las hojas o brotes jóvenes y fueron 0.58 a 0.72 mm de longitud, 0.38-0.43 mm de ancho, y de color blanco cuando acaban de ser puestos y luego desarrollan manchas rojas. La longitud y anchura de las larvas del primer instar fueron 1.98 a 2.29 mm y 0.36 a 0.48 mm, respectivamente. La longitud de las larvas del segundo, tercero y cuarto instar fuer 5.04 mm, 9.77 mm y 14.27 mm, respectivamente. Las larvas del quinto estadio fueron 19.30 mm de longitud y 3.33 mm de ancho. Las pupas fueron 14.10 mm de longitud y 5.73 mm de ancho y comprimido lateralmente. Los adultos fueron del color rosa-salmón y las hembras tenían una longitud de 9.71 mm y una envergadura de 33.62 mm. El cuerpo de los machos fue 7.59 mm de largo y su envergadura mide 25.67 mm. La longitud de las antenas masculinos y femeninos fueron 4.63 mm y 5.46 mm, respectivamente.

Palabras Clave: pequeño salmón árabe; Pílu; incidencia; caracteres morfométricos

The genus *Salvadora* belongs to the family Salvadoraceae. It comprises 3 genera (i.e., *Azima*, *Dobera*, and *Salvadora*) and 10 species distributed mainly in the tropical and subtropical regions of Africa and Asia (Mabberley 2008). On the Indian subcontinent, this family is represented by only 1 genus with 2 species, namely *Salvadora persica* L. and *Salvadora oleoides* Decne. (Qureshi 1972; Stewart 1972; Perveen & Qaiser 1996). *Salvadora persica*, or pilu, is a medium-sized tree or shrub with a crooked trunk, seldom more than 0.3 m in diameter. It has a pleasant fragrance as well as a warm and pungent taste. Fruits have a sweet, agreeable, aromatic, and slightly sour flavor. They can be eaten raw, cooked, or dried and stored when dried. Fruits with or without seeds are said to contain 1.7–1.9% sugars when ripe, and delicious drinks can be made from them. *Salvadora persica* is a popular chewing

stick commonly known as “miswak” and is one of the most popular medicinal plants throughout the Indian subcontinent as well as other parts of Asia and the Middle East (Ezmirly et al. 1978; Almas 2002; Al-Otaibi et al. 2003, 2004; Sofrata et al. 2007). When *S. persica* occurs on river terraces, it is a preferred host of *Cistanche tubulosa* (Schenk) R. Wight (Lamiales: Orobanchaceae), an obligate phanerogamic root parasitic plant (Sher et al. 2010). Furthermore, defoliating larvae of several beetles and of *Colotis ephyia* (Klug) (Lepidoptera: Pieridae) often attack the tree, and the mite *Eriophyes* sp. causes leaf galls (Kumar et al. 2012). The genus *Colotis* comprises 40 species, 39 of which are primarily or entirely Afrotropical in distribution. The majority of species have pure white uppersides, with prominent orange, yellow, or crimson tips of the forewings. *Colotis amata* is distributed across Africa from Sen-

Table 1. Mean percentage of *Salvadora persica* plants infested by the small salmon Arab, *Colotis amata*, and mean number of larvae per 3 leaves of plant in 2012–2013 at the Experimental Farm of the ICAR Central Institute for Arid Horticulture, Bikaner District, Rajasthan, India.

Sampling date	Mean incidence (%) ^{a,b}	Mean no. of larvae per 3 leaves ^b
4 Sep 2012	13.33 (21.14) a	6.20 a
19 Sep 2012	16.67 (23.85) a	7.63 a
4 Oct 2012	30.00 (32.99) b	10.37 b
19 Oct 2012	36.67 (37.21) bc	11.93 bc
3 Nov 2012	56.67 (48.83) de	13.33 cd
18 Nov 2012	60.00 (50.83) de	16.30 ef
3 Dec 2012	70.00 (56.98) efg	18.30 gh
18 Dec 2012	80.00 (63.90) g	22.30 i
2 Jan 2013	66.67 (54.76) ef	19.00 hi
17 Jan 2013	63.33 (52.75) ef	16.77 fg
01 Feb 2013	46.67 (43.06) cd	12.80 cd
16 Feb 2013	36.67 (37.21) bc	10.80 bc

^aParentheses contain the angular transformation value.
^bValues followed by different letters are significantly different (Tukey's HSD test, $P < 0.05$).

egal to Ethiopia, and south to Namibia, South Africa, and Madagascar. It is also found in Arabia and is widespread on the Indian subcontinent including Sri Lanka. An infestation with small salmon Arab has not been reported on pilu. Here, we report new information on the incidence of *C. amata* on pilu, including its morphological characteristics and taxonomic identification.

Materials and Methods

Twenty pilu plants were selected randomly in each of 3 replicates at the Experimental Farm of the Central Institute for Arid Horticulture (CIAH) (28°06'N, 73°21'E). Incidence of infestation observed on each plant and numbers of larvae per 3 leaves (top, middle, and lower leaves) were recorded from Sep 2012 to Feb 2013. The sampling was done by visual observation and manual counting. Average incidence was calculated as the percentage of whole plants infested with *C. amata*. Average numbers of larvae per 3 leaves were calculated from numbers recorded for 10 randomly selected pilu plants with 3 replications. Ten insect specimens (eggs, larvae, pupae, and male and female adults) were used for observation and measurements. The larvae and adults were reared under laboratory conditions (temperature of 28 ± 2 °C, relative humidity of $60 \pm 5\%$, photoperiod of 12:12 h L:D) for measurement of different stages. The average linear measurements of various body parts of insect specimens (length and width of eggs, larvae, pupae, and male and female adults) were taken under a binocular microscope (Radical Instruments, Ambala, Haryana, India) using Jenoptic Pro 2.8.0 software. The terminology used to denote different parts of the body was according to Haldhar (2012) and Haldhar & Singh (2014). The butterfly samples collected from the CIAH farm and other fields were preserved in 70% alcohol and deposited at the Insect Biosystematic Section, Division of Entomology, Indian Agricultural Research Institute, New Delhi, India, for taxonomic identification.



Fig. 1. Aggregation of *Colotis amata* on a pilu plant (*Salvadora persica*) during the winter season at the ICAR Central Institute for Arid Horticulture, Bikaner, India.

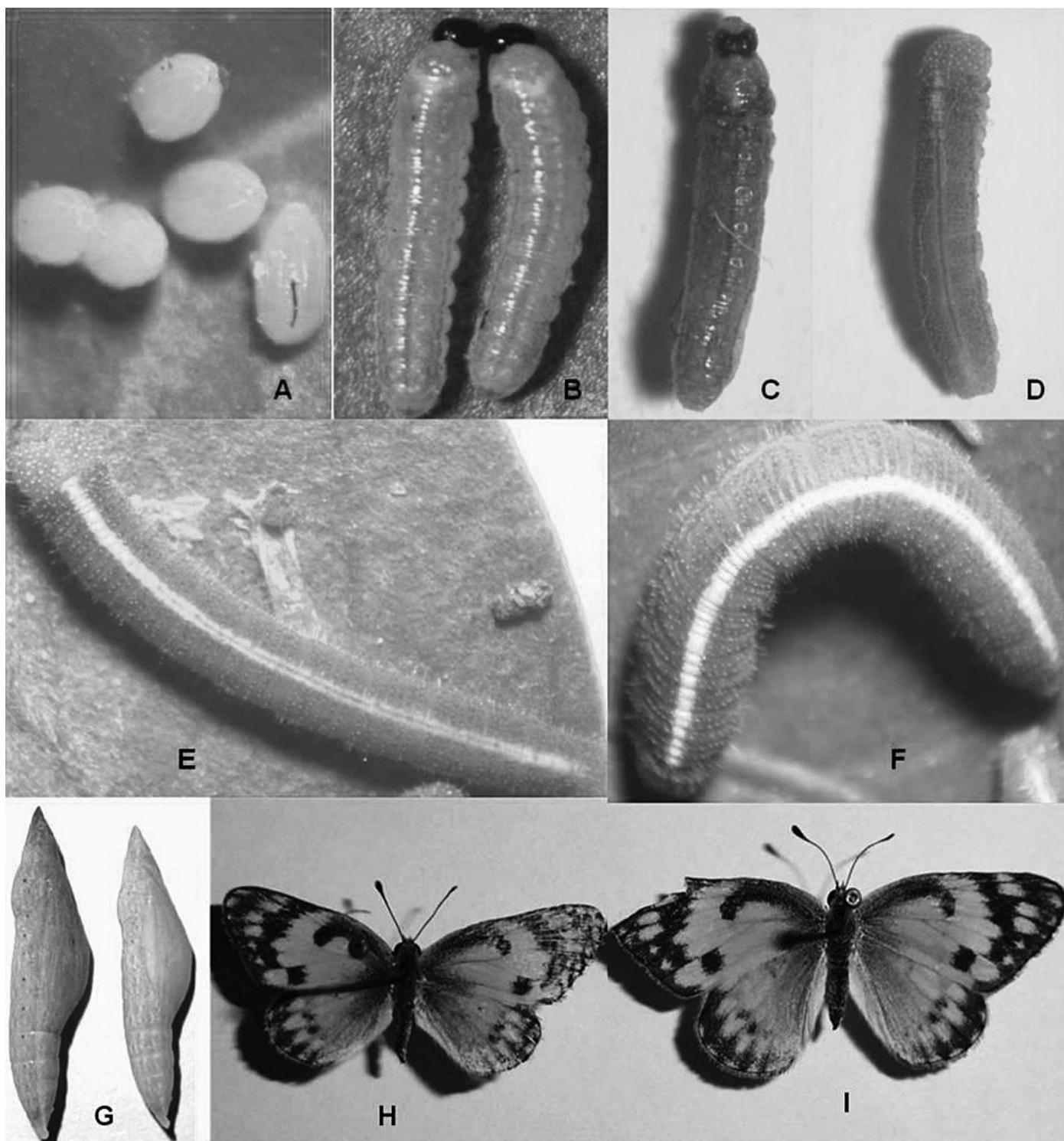


Fig. 2. Different developmental stages of *Colotis amata*. A, eggs; B, 1st instars; C, 2nd instar; D, 3rd instar; E, 4th instar; F, 5th instar; G, pupae; H, adult male; I, adult female.

Before statistical analysis, data were transformed as necessary to achieve normal distribution by using Statistical Package for the Social Sciences (SPSS) software. The data on incidence and numbers of insects were analyzed by 1-way analysis of variance (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

The butterflies observed on pilu plants were identified as *C. amata*. Damaging effects were recorded from Sep 2012 to Feb 2013. The percentage of plants infested with larvae of *C. amata* ranged from 13–80%, with the maximum incidence recorded on 18 Dec and the minimum on 4 Sep. The maximum average number of larvae (22.3 per

Table 2. Mean ($\pm$ SEM) linear morphometric measurements of different life stages of the small salmon Arab, *Colotis amata*.

Life stage	Length (mm) ^a	Width (mm) ^a
Egg	0.62 $\pm$ 0.009	0.41 $\pm$ 0.007
1st instar	2.15 $\pm$ 0.023	0.42 $\pm$ 0.012
2nd instar	5.04 $\pm$ 0.027	1.15 $\pm$ 0.022
3rd instar	9.77 $\pm$ 0.022	1.96 $\pm$ 0.011
4th instar	14.27 $\pm$ 0.052	2.27 $\pm$ 0.021
5th instar	19.30 $\pm$ 0.100	3.33 $\pm$ 0.012
Pupa	14.10 $\pm$ 0.046	5.73 $\pm$ 0.020
Adult female with wing expansion	9.71 $\pm$ 0.007	33.62 $\pm$ 0.031
Adult male with wing expansion	7.59 $\pm$ 0.021	25.67 $\pm$ 0.035
Female antenna	5.46 $\pm$ 0.016	not applicable
Male antenna	4.63 $\pm$ 0.017	not applicable

^aMean of ten specimens.

3 leaves) was recorded on 18 Dec and the minimum (6.2 per 3 leaves) on 4 Sep, followed by 7.6 larvae per 3 leaves on 19 Sep (Table 1). Larvae damaged the new leaves, old leaves, and new or top branches of the pilu plants (Fig. 1). Due to attack by this pest, the growth of pilu plants was suppressed, and new branches and leaves wilted. The data on linear measurements of the small salmon Arab are presented in Table 2 and Fig. 2. Eggs were laid singly on leaves or young shoots. They were 0.58–0.72 mm in length, 0.38–0.43 mm in width, and white in color when first laid, later developing red blotches. The 1st larval instar was greenish yellow with a black head. The length and width of 1st instars were 1.98–2.29 mm and 0.36–0.48 mm, respectively. The lengths of 2nd, 3rd, and 4th instars were 5.04, 9.77, and 14.27 mm, respectively. The 5th instars were 19.30 mm long, 3.33 mm wide, and light greenish in color with a white stripe on the dorsal surface of the body. Pupae were 14.10 mm long, 5.73 mm wide, and laterally compressed. They had a moderately high dorso-thoracic keel and a pointed but short cephalic projection, slightly up-curved distally. Adults had a salmon-pink color, and females had a body length of 9.71 mm and a wingspan of 33.62 mm (Fig. 2). The male body length and wingspan were 7.59 mm and 25.67 mm, respectively. The costa on the forewing was black and thickly overlaid with grayish or pinkish scales. The lengths of male and female antennae were 4.63 mm and 5.46 mm, respectively.

Discussion

Colotis amata infestations were observed on pilu plants in the hot arid region (Thar Desert) of northwestern India. To our knowledge, this is the first report of *C. amata* on *S. persica*. The incidence and the numbers were higher in Dec than during other months and lowest in Sep. The higher population and incidence may be due to the low temperature and high relative humidity. The larvae were found to be aggregated on the leaves of the plants. Eggs were laid singly on leaves or young shoots. First instars were greenish yellow with black head. Final instars were light greenish with a white stripe on the dorsal surface of body. When temperature was low, both sexes commonly basked on the foliage of bushes, with their wings either half open or almost fully outspread. In West Africa, this species is a common butterfly of the Sahel (Larsen 2005). The flying capacity of *Colotis* species is very low and weak. Both sexes are frequently found feeding on flowers and spend much of their time flying around in the vicinity of their larval host plant

(*S. persica*), resting periodically on the ground (Pringle et al. 1994). In Delhi, India, females of *Colotis vestalis* (Butler) were noted ovipositing single eggs on or near old leaves of the host plant, whereas females of *C. amata* laid eggs in large clusters on fresh leaves of the same trees. These observations pertained to 2 species of the plant genus *Salvadora* (Larsen 1988). *Colotis amata* damages economically important parts of the plant, such as leaves, flowers, and top branches. Therefore, management practices need to be developed and implemented to minimize the losses caused by this pest.

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