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Research Article

HADENE TRIFOLII (HUFNAGEL), A NEW EMERGING PEST OF SAFFRON (*CROCUS SATIVUS*) FROM KASHMIR VALLEY

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ABSTRACT
A new emerging pest, *Hadene trifolii* (Hufnagel) of Saffron (*Crocus sativus*) is reported from the Kashmir valley for the first time. Biology and the taxonomy of the pest are detailed. The immature stages of the pest were collected in saffron fields and reared in the biosystematics laboratory of Sheri Kashmir University of Agricultural Science and Technology (SKUAST-K). Adults were collected with the help of light traps and dissected to study their genital structures.

Keywords: *Saffron, Pest, Hadene trifolii, Kashmir Valley*

INTRODUCTION
Saffron (*Crocus sativus*) originating from the Arabic word ‘zafaran’ meaning yellow, is a fascinating spice steeped in rich history (Caiola and Canini, 2010). It is used as a culinary condiment, dye, perfume and as a medicinal herb (Zeinab and Zahra, 2011; Katariya, 2011). Saffron is cultivated in Iran, India, Greece, Spain, Italy, Morocco and other countries. Iran is the largest producer of saffron accounting for more than 65% of the global saffron production, while India, which produces 7.0 tones, ranks third after Spain (Kafi and Showket, 2006).
The Jammu and Kashmir and Himachal Pradesh states are major saffron growing regions in India. Saffron is believed to have been introduced inthe Kashmir valley by the Persian migrants (Kafi *et al.,* 2006). The plateaus of Pampore known as "Saffron Town of Kashmir" (India), has been cultivating saffron since 750 A.D (Amjad *et al.,* 2010). Various districts of Kashmir valley contribute varyingly towards the cultivation of saffron. The area under saffron cultivation in Pulwama district accounts for 78.91 per cent followed by Budgam (12.27 per cent), Srinagar (7.32 per cent), Doda (1.5 per cent) (Vigneshwara, 2013).
Kashmir despite being one of the oldest historical saffron producing areas is facing a rapid decline of this industry. The total area under saffron cultivation in Kashmir has shown a decrease of 114% in area and 184% in production in just a short span of 12 years (Mir, 1992; Zargar, 2011; Amjad *et al.,* 2013). Saffron once the chief crop of Kashmiri farmers is currently suffering on several counts, especially those relating to productivity as well as post-harvest management. The saffron industry is running in loss on account of low saffron productivity and unorganized market. The main reasons responsible for this trend are lack of good-quality corm, poor soil fertility, irrigation, diseases, infestation by rodents and increased urbanization on saffron land. During the present study besides the above mentioned reasons of saffron decline from Kashmir valley one unnoticed potential insect pest larvae i.e. *Hadene trifolii* (Hufnagel) were found actively damaging and destroying the cash crop during the harvesting stage. It was also observed that for the management of this potential pest proper cleaning; regular monitoring of the crop for pest presence, collection and killing of all damaging larvae needs to be done.

MATERIALS AND METHODS
The present study was carried out during the years 2009-2012 from different saffron producing districts of Jammu and Kashmir. The insect pests were collected from the cash crop of Kashmir and brought to laboratory for rearing. The adult moths were collected and killed in killing agents after their emergence from the pupae. After killing, pinned and properly stretched specimens were preserved in insect wooden cabinets with appropriate data labels. Standard procedures used by Common, (1970), Robinson (1976); Zimmerman, (1978) were followed for the preparation of wing and genitalia slides. For taxonomic study forewing and hindwing of each species were detached from the body of an adult by simply giving upward

jerk followed by dipping into 70% alcohol for 1-2 minutes, then placing in sodium hypochlorite for 10-20 minutes depending upon the size of the insect for descaling, then transferring the wings into glacial acetic acid for 10 minutes, later on into carbo-xylol for 15 minutes and mounted finally on a glass slides in DPX mountant.

Male and female genitalia were dissected out. The genitalia were dipped overnight or boiled for 20-30 minutes with 10% KOH solution to get the musculature sufficiently relaxed. Later on KOH was removed by washing in distilled water for 2 or 3 times.

The dissection was performed within a cavity block, with the help of fine forceps and needles under an Olympus SZX7 binocular stereoscope microscope. The dissected parts were transferred to acetic acid glacial in another cavity block for 10-15 minutes and finally transferred to carbo-xylol for 15 minutes. After clearing they were mounted finally on a slide in DPX mountant and covered with cover slip. The drawing of wings was done on camera lucida attached to binocular microscope. The photographs of male and female genitalia (Plate) and other parts were taken by the help of Olympus digital camera (CAMEDIA C-7070).

The collected materials have been deposited in Department of Zoology and Environmental Sciences, Punjabi University Patiala for future reference.

List of Abbreviations Used: 1A: First anal vein; 2A: Second anal vein; AED: Aedeagus; AMP: Ampulla; ANT. APO: Anterior apophyses; CRN: Cornuti; CRP.BU: Corpus bursae; CU: Cucullus; Cu1: First anterior cubital vein; Cu2: Second anterior cubital vein; DIV: Diverticulum; DU. BU: Ductus bursae; DU. EJ: Ductus ejaculatorius; HRP: Harpe; JX: Juxta; M1: First median vein; M2: Second median vein; M3: Third median vein; PAP.A: Papilla analis; PO.APO: Posterior apophyses; R1: First radial vein; R2: Second radial vein; R3: Third radial vein; R4: Fourth radial vein; R5: Fifth radial vein; Sc + R1: Stalk of subcostal and first radial vein; SIG: Signum; TG: Tegumen; UN: Uncus; VES: Vesica; VIN: Vinculum.

RESULTS AND DISCUSSION

Results

Hadenatrifolii (Hufnagel, 1767)

Plate 1 and II

Material Examined: Budgam: Doodpather, 2870m, 17♂♂, 4.vi.2009, 4.ix.2009, 15.vi.2010, 20.vi.2012; Kralpather, 2340m, 1♀, 22.vi.2012; Yousmarg, 2600m, 10♀♀, 13♂♂, 21.v.2009, 19.vi.2009, 19.vi.2012.

Distribution: Kashmir (India, Himachal Pradesh); Europe; Campbellpur; Eurasia; North America; Mexico; Virginia; Iran; Azerbaijan; Greece; Spain; Argentina; USA; China and Japan.

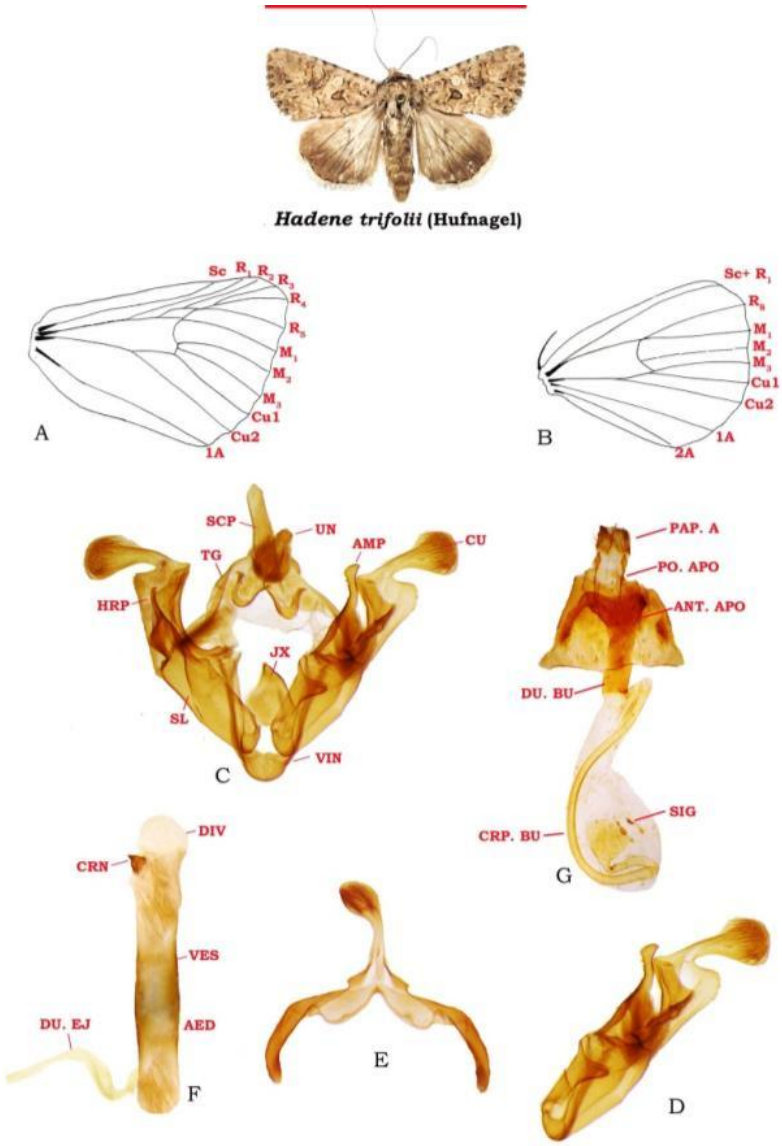
Description: Head and body grayish brown; antennae ciliate, short, pectinate in male; forewing moderately narrow, distally dilated rectangular, dark brown; brownish black costal strigulae present; basal, antemedial, postmedial lines black, irregularly zigzagged; a pale irregularly waved submarginal line with a w-mark at centre; discal cell and bullet shaped basal patch brownish black; reniform, orbicular and subreniform stigmata dark yellowish brown; hindwing dark grayish brown, paler at base, veins and discal spot brownish black.

Male Genitalia: Uncus comma like with a slender neck; tegument broad; scaphium long with w-shaped base; valve asymmetrical, long; sacculus well developed; harpe of right valve long, digitate; left valve ampulla lobe shaped, saw toothed laterally; cucullus round with a narrow neck; corona fringed with dense setae; vinculum u-shaped; saccus wanting; juxta triangular with a broad base; aedeagus cylindrical, straight; vesica granulate at proximal diverticulum; lateral sharp spine like cornuti; ductus ejaculatorious entering from the lateral side.

Female Genitalia: Ovipositor lobes long, triangular, well developed, densely haired; posterior apophyses longer than anterior apophyses; ductus bursae short and broad funnel like, highly sclerotized; corpus bursae elongated, falks like with long neck, membranous; bean shaped 2-4 signum.

Biology: Caterpillars, pupae and moths were reared continuously in a constant temperature laboratory maintained under standard conditions at 25°C. The collection was supplemented with field collected

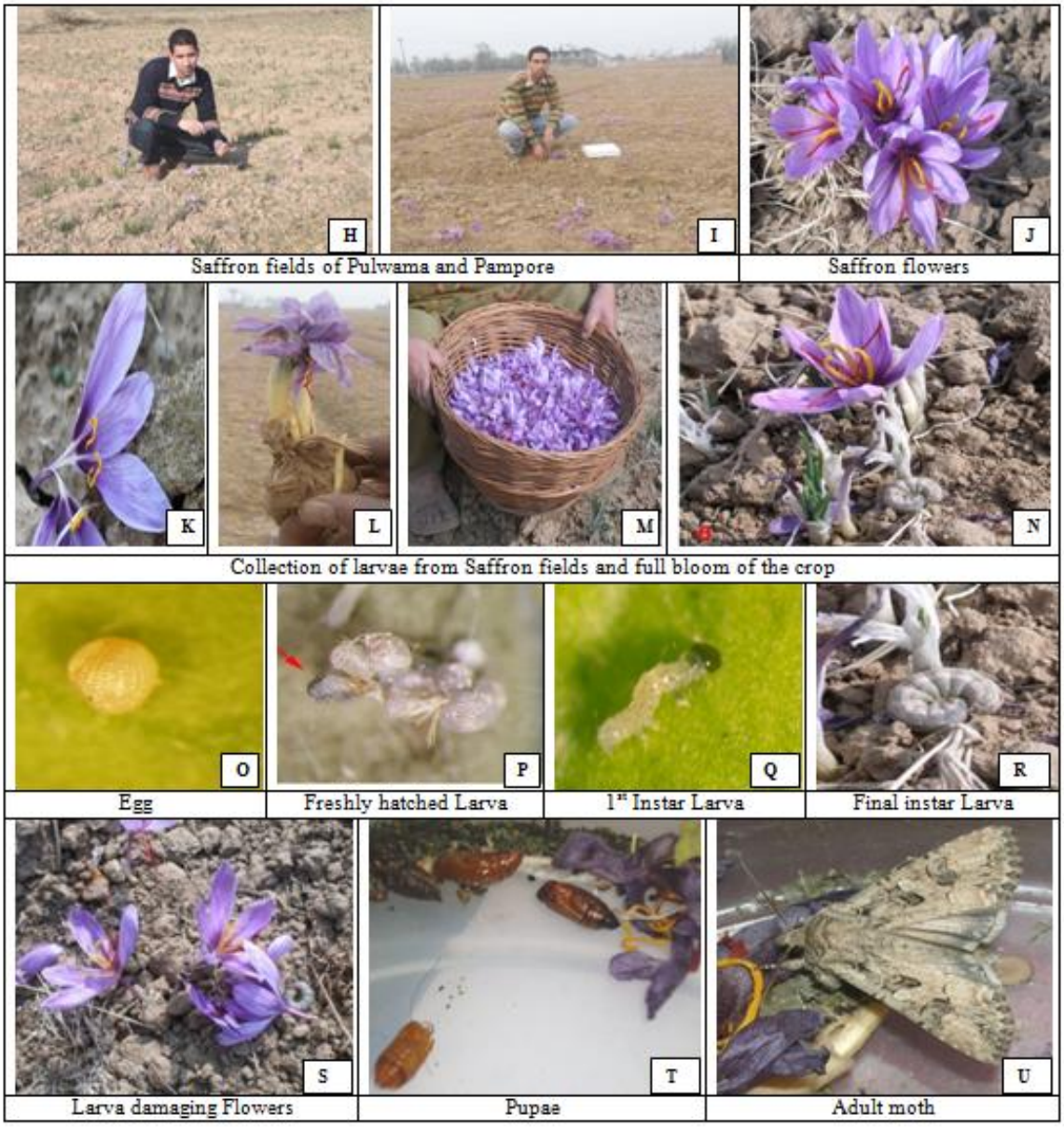
moths, larvae, and pupae as these became available. Out of the large number of larvae only few were able to reach adulthood and few of these were with deformed wings. After the caterpillars had pupated, they were removed and transferred to large sized cages so that emerging moths had adequate room to extend their wings fully.



A. Forewing, B. Hindwing, C. Male genitalia, D. Valva (Left),
E. Uncus with Tegumen (Enlarged), F. Aedeagus,
G. Female genitalia.

Plate 1: Taxonomic Characters; Wing Venation and Genitalic Structures

Eggs: Eggs are globular or spherical in shape ranging from 0.2mm to 1mm in size. The eggs are flat ventrally with vertical ridges on the chorion. Colour of freshly laid eggs varied from greenish-gray to dark brown before hatching. Singly laid in the axils, flower buds, under surface of leaves or on soil surface. In the laboratory at 25°C, incubation takes 4-8 days with the black head capsule visible through the chorion after 3-5 days.



Figures H-N: Seasonal Prevalence of Pest; H-I Saffron Fields of Pulwama and Pampore (Before & After Flowering); J-N Saffron Flower Stages at Harvest; O-U: Biology of Pest; O Egg; P Freshly Hatched Larvae; Q First Instar Larvae; R Final/Fifth Instar Larvae; S Damage to Flowers; T Pupae; U Adult Moth

Larvae: The newly hatched caterpillars are tiny, greenish about 2 mm long, difficult to see on the foliage and with a distinct whitish band**.** Freshly hatched larva feeds on the empty egg shell, gnaw at the epidermal tissue producing a fine netted appearance; later instars feed voraciously on lamina cutting through holes in it. The caterpillars are nocturnal in habit feeds variously at night and dusk, stop all its activities during the day, hides in cracks of the soil. After about 36 days the mature caterpillar attains its maximum size ranging from 35-43 mm long and 3mm broad. Larvae were found active from the middle of August with maximum incidence during the month of September-October. Larvae inflicted varying degree of damage to the host plant flowers. First and second instar larvae fed on the leaves of shoot tips

while as the higher instar larvae fed on the reproductive organs (flowers) of the plant. During the Laboratory rearing of the caterpillars there were color variations among the larvae, early instars were yellowish-green while as final stages were light grayish in color. Larvae molts several times before pupation.

Pupae: The mature caterpillar burrows into the soil to pupate**.** At first pupa is bright green but darkens later, they progressively turn brownish and the last instar achieves a deep brown color and ranges from 17-19mm by 4mm. Pupa is obtect. The time spent as pupae was recorded 18-31 days for larvae reared on host plant in the laboratory under standard conditions.

Adult: The adult has a grayish body; forewing dark brown moderately narrow with brownish black costal strigulae and with a w-mark and a bullet shaped brownish black basal patch. Hindwing dark grayish brown with basal part pale. The veins of hindwing and discal spot are brownish black in colour.

Remarks

This species has been reported for the first time from Kashmir Himalaya. The pest was collected from almost all the saffron growing regions in Kashmir with heaviest infestation rates reported in Pampore region. The larvae are active mostly from second week of August with maximum infestation observed during September and October, coinciding with the harvest season. The larvae inflict heavy economic loses while feeding on the reproductive organs (flowers) of the plant, making them unmarketable.

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