The Journal of Plant Protection Sciences, **3**(2) : 14-19, December, 2011

Biology of *Dichromia sagitta* (Fabricius) (Noctuidae: Lepidoptera), a serious pest of Indian ipecac, *Tylophora indica*

[1]Nilesh Suresh Gole and [2]Bijan Kumar Das

[1]Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

[2]All India Co-ordinated Research Project on MAP & Betelvine, Directorate of Research, BCKV, Kalyani, Nadia -741235, West Bengal, India, E-mail: bkdas1963@rediffmail.com

A B S T R A C T

Indian ipecac, *Tylophora indica* (Burm. f.) Merr. commonly known as dumvel or antomul, is an important medicinal plant in the family Asclepiadaceae, indigenous to India. In West Bengal, we observed the herb to be heavily infested by a defoliator pest, *Dichromia sagitta* (Fabricius) (Noctuidae: Lepidoptera). A study was conducted in the field and laboratory of All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine (AICRP on MAPB) at Bidhan Chandra Krishi Viswavidyalaya (BCKV), Kalyani, Nadia, West Bengal during 2010-2011 on seasonality, extent of damage and biologoy of *D. sagitta* on *T. indica.* The larvae were active almost throughout the year, fed voraciously on leaves and flowers causing extensive damage to *T. indica* during June and December. Eggs were laid singly or in batch of 2-3 on younger leaves (mostly on under surface) or on young shoot tips. Life cycle was completed in 41-46 days during January- February and 26-32 days during June-July. There were several overlapping generations in a year. Descriptions of different life stages have been made. Adaptive behaviour of *D. sagitta* and its interaction with toxic host plant have been discussed critically.

Keywords: *Indian ipecac, Tylophora indica*, *Dichromia sagitta*, biology

Introduction

Indian ipecac, *Tylophora indica* (Burm. f.) Merr. commonly known as antomul or dumvel is an important medicinal plant of the family Asclepiadaceae, indigenous to India. *T. indica* contains many alkaloids namely, tylophorine, tylophorinine, tylophorinidine, septicine and isotylocrebrine (Govindachari 2002; Ratnagiriswaran & Venkatachalam 1935), of which last one has anticancerous property (Chandrasekhar *et al.* 2006). Traditionally the leaves and roots of *T. indica* are used as herbal medicine and also as substitute for ipecacuanha. Tylophorine has strong anti inflammatory, immunomodularory (Gopalakrishnan *et al.* 1979; 1981), anti-tumor (Donaldson *et al.* 1968), anti-amoebic (Bhutani *et al.* 1985) properties, and alcoholic and aqueous extracts of leaves have hepatoprotective activity (Gujrati *et al.* 2007).

In West Bengal, this herb was heavily infested by *Dichromia sagitta* (Fabricius) belonging to superfamily Noctuoidea, family Noctuidae and tribe Hypeninae. In the current literature, the insect is also well known as *Hypena sagitta* **(**Fabricius) and *Dichromia orosia* (Cramer). However, thorough review of literature has revealed that the correct and valid name should be *Dichromia sagitta* (Fabricius 1775) (Lödl 1993; 1993a; 1994).

Devaiah *et al.* (1983) recorded a semilooper, *D. orosia* (Cramer) *(=D. sagitta*) as an important pest of *Tylophora indica* plant. In 1893, Hampson (1893) also noted *T. asthmatica Wight & Arn. (= T. indica*) as the larval host of this insect. Later, he (Hampson 1895) also recorded the insect from Myanmar (Burma), China in addition to India and Ceylon. Sridhar & Rani (2010) found this insect at Bangalore feeding on *T. indica*. A study was conducted during 2010-

2011 on population abundance, seasonality, extent of damage and biology of *D. sagitta* on *T. indica* at Kalyani, Nadia, West Bengal .

Materials and Methods

The biology and behaviour of *Dicromia sagitta* were studied in the experimental field of AICRP on MAPB and also on plants maintained in the laboratory. Eggs of insect pests were collected from the field, and after hatching the larvae were provided with the leaves of host plant and kept in the Petri dish individually. Every day the fresh leaves were given. The observations were taken daily on the duration of different immature stages, as well as on the morphology of different stages. The full grown larvae were also collected from the field and in the laboratory allowed them for pupation separately. After pupa is formed, they were kept in glass jar for adult rearing. The longevity of adults was observed by keeping the freshly emerged adults in large cages providing dilute honey and larval food plants. Different stages of *D. sagitta* were observed under stereo-microscope. And external morphological characters were studied and measurements were taken from both freshly killed and preserved specimens. In the field, direct observations were made on egg laying, feeding behaviour and nature and symptoms of damage caused by the insects.

Observations on the seasonal incidence of these pests were made on five plants selected randomly from each plot (total five plots) and the number of larvae on these plants were counted 15 days interval. The presence of eggs or pupae was also noted in the field throughout. To note the damage caused by the larvae, total damaged and healthy leaves were counted and percentage leaf damage was calculated month wise.

Results and Discussion

During the study period, only the incidence of *Dicromia sagitta* was observed on *T. indica*.

Symptom of damage

The newly hatched larvae started feeding on green matter of lower surface of young leaf, leaving the epidermis intact and showed the blotching appearance. The Voracious feeding later instars defoliated the plants leaving only the midribs and veins. In the scarcity of leaves, they also gnaw the green tissues of midribs and veins and even the stem. During flowering season, the larvae were found to feed on flowers also. Larvae are very agile. Two larvae are sufficient to completely defoliate one plant. The denuded plants suffer heavily. At least one month is required for regeneration of new leaves.

Biology

The observations on durations of various life stages of *D. sagitta* during June - July, 2010 and January - February, 2011 are given in Table 1.

Egg: Flatly spherical, light yellowish green, 0.7mm in diameter. Eggs are laid singly or in batch of 2-3 on younger leaves (mostly on under surface) or on young shoot tips. Egg period was 4-5 days.

Larva (Fig. 1a): There were five larval instars. The larvae are very agile in nature. Final instar larva is yellowish green in colour. It is a semilooper, abdominal prolegs absent on Abd 3, present on Abd 4th, 5th, 6th & 10th segments; three pairs of thoracic legs. Body is with simple setae of various lengths over head and trunk regions. All setal bases in head region are with black pinacula, but thoracic and abdominal segments bear black small and large chalazas (elevated and conical pinacula) of various size. The basal part of the setae is black and distal part is whitish. On each side of the head capsule, there

is a group of six stemmata. Prothoracic shields concolour with the body, containing six setae on each side (XD1, XD2, D1, D2, SD1 & SD2). Anal shield is also concolorous with the ground. The prolegs are long, outer side is black, tapering at the apex. The crochets of prolegs are of uniordinal (of one length) and mesoseries (arranged in a longitudinal row). Spiracles are horizontally elliptical (0.3mm x 0.16mm) and present on prothorax and abdominal segments 1 - 8. Body length and breadth of final instar larva are 24-28mm and 2.8-3.0 mm (average of five larvae) respectively. Total larval period ranges from 27-30 days during January-February, and 15-18 days during June-July (Table 1).

Pupa (Fig. 1b): Stout, deep reddish brown with dorsal black markings on abdominal segments. Size: 12-13.3 mm x 3.5-4.5mm. Pupal period is 9-11 days during January-February, and 7-10 days during June-July. Pupation takes place on the leaves in loosely spun silken cocoon or open on the debris.

Adult (Fig. 1c): Fore wing grey with apical area suffused with fuscous black; a large medial sub-triangular black patch not reaching the inner margin. Hind wing yellowish orange with apical area black, abdomen metal yellowish orange, adult wing span 25-35mm. Adult longevity is 10-12 days during January-February, and 7-8 days during June-July. Life cycle was completed in 41-46 days in January-February and 26-32 days in June-July. In the field, there are several overlapping generations in a year.

Population abundance, seasonality and extent of damage

The larval populations in 12 months varied from 0.01 to 2.1 larvae/plant. Low levels of populations were noted during July, August, November, February, March and April. Medium level of populations (0.4-0.6 larvae/plant) was noticed in September, October, January and May, while higher levels of populations were found in December (1.9 larvae/plant) and June (2.1 larvae/plant). Leaf damage was between 0.3% and 97 % during the period of observation. Leaf damage was highest (97%) in June, 2011 followed by 95% in December, 2010. During these two months the experimental plots were almost completely defoliated by the larvae of *D. sagitta*. Comparatively, low level of leaf damage was noticed in July, January, March, April and May while medium level was in August to November, and February. The larvae were active almost throughout the year with a very low population in April and highest population in June. It caused complete defoliation of the plant twice in a year, in June and December.

In Gujarat, the pest remained active throughout the year and maximum damage was observed during June-August and late December-January (Anon 2010). However, in Bangalore, Sridhar and Rani (2010) observed that *D. sagitta* on this plant caused up to 70 % defoliation of *T. indica* and occurrence of the pest was observed mainly during August-December, coinciding with the flowering period.

Shivananda and Rani (2001) recorded *D. quadralis* Walker, 1858 (=*Hypena quadralis* (Walker) on *T. indica.* Surprisingly, B. J. Rani published another paper (Sridhar & Rani 2010) recording *D. sagitta* from Bangalore on *T. indica,* but in this paper, they had not mentioned their previous related work of Shivananda and Rani (2001) where information on related insect occurring on same host *T. indica* was available. Therefore, record of *D. quadralis* on *T. indica* needs verification.

Though, *D. sagitta* was generally known as a monophagous insect and specialist on *Tylophora indica,* Robinson *et al*. (2010) in their Database of the World's Lepidopteran Host Plants, mentioned *Wattakaka volubilis* (L. f.) Stap f. as a host of *D.*

sagitta in India. This plant also belongs to *T. indica*'s family, i.e. Asclepiadaceae.

The antifeedant activities of tylophorine against polyphagous pests like *Spilosoma obliqua* (Lepidoptera: Arctiidae) (Tripathi *et al.* 1990) and *Spodoptera litura* (Lepidoptera: Noctuidae) (Verma *et al.* 1986) have been demonstrated. However, *D. sagitta* has adapted and specialized on toxic plant *T. indica*. Likewise, the larvae of Troidini (Papilionidae: Lepidoptera) feed almost exclusively on *Aristolochia* species. They sequester the major secondary metabolites of these plants, aristolochic acids (Klitzke & Brown 2000) for better development (Pinto *et al.* 2009), as well as to acquire chemical defense against predators which is carried over to the adult stage (Rauscher & Feeny 1980). Troidines are frequently cited in the literature as classic examples of coevolutions with their host-plants *Aristolochia* (Aristolochiaceae) (Weintraub 1995), earning them the name "Aristolochia swallowtails" (Brown *et al*. 1981). The features of this association agree with most of the premises of the co-evolutionary hypothesis (Ehrlich & Raven 1964).

However, in case of *D. sagitta,* the mechanism of adaptation on or evolutionary relationship with *T. indica* having toxic chemicals has yet not been investigated. And, it is also not known whether the toxic chemicals are essential for increasing its fitness level. One interesting thing is that so far no natural enemy has been recorded feeding on this insect.

Literature Cited

Anonymous. 2010 Newsletter. Directorate of Medicinal and Aromatic Plant Research, ICAR, Anand, Gujarat. **11:** 3-4.

Bhutani KK Sharma GL Sarin AN Kaur R Kumar V Atal CK. 1985 In vitro amoebicidal and bactericidal activities in medicinal plants. *Indian Journal of Pharmaceutical Sciences* **47**: 65-67.

Brown KS Damman AJ Feeny P. 1981 Troidine swallowtails (Lepidoptera: Papilionidae) in southeastern Brazil: natural history and foodplant relationships. *The Journal of Research on the Lepidoptera* **19**: 199–226.

Chandrasekhar T Hussain TM Ramagopal G Rao JVS. 2006 Somatic Embryogenesis of *Tylophora indica* (Burm.f.) Merril., an Important Medicinal Plant. *International Journal of Applied Science and Engineering* **4**: 33-40.

Devaiah MC Gouda RR Kotikal YK Yelshetty S.1983 A noctuid defoliator pest, *Dichromia orosia* Cramer (Noctuidae: Lepidoptera) of *Tylophora indica* (Burm.f.) Merril., a medicinal plant. *Journal of the Bombay Natural History Society* **80**: 659.

Donaldson GR Atkinson MR Murray AW. 1968 Inhibition of protein synthesis in Ehrlich ascetes- tumor cells by the pheanthrene alkaloids tylophorine, tylocrebrine and cryptopleurine. *Biochemical and Biophysical Research Communications* **31**: 104-09.

Ehrlich PR Raven PH. 1964 Butterflies and plants: a study in coevolution. *Evolution* **18**: 586-608.

Fabricius JC. 1775 Systema Entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus. Officina Libraria Kortii, Flensburgi et Lipsiae. [xxx] + 832 pp.

Gopalakrishnan C Shankaranarayan D Kameswaran L Natarajan S. 1979 Pharmacological investigations of tylophorine, the major alkaloid of *Tylophora indica*. *The Indian Journal of Medical Research* **69**: 513-20.

Gopalakrishnan C Shankaranayana D Nizamudin SK Kameswaran L. 1981 Effect of Tylophorine a major alkaloid of *Tylophora indica* on immunopthological and inflammatory reactions. *The Indian Journal of Medical Research* **71**: 940-48.

Govindachari TR. 2002 Five decades in the study of natural products. *Proceedings of the Indian Academy of Sciences (Chemical Science)* **114**(3): 175-95.

Gujrati V Patel N Rao VN Nandakumar K Gouda TS Shalam MD Kumar SM. 2007 Hepatoprotective activity of alcoholic and aqueous extract of leaves of *Tylophora indica* in rats. *Indian Journal of Pharmacology* **39**: 43-47.

Hampson GF. 1893 *Illustration of Typical Specimens of Lepidoptera Heterocera in the Collection of the British Museum.* Part IX-*The Macrolepidoptera Heterocera of Ceylon,* British Museum (Natural History), London.182pp.

Hampson GF. 1895 *The Fauna of British India including Ceylon and Burma.* Vol. III- *Moths,* Taylor and Francis, London, 546pp.

Klitzke CF Brown KS. 2000 The occurrence of aristolochic acids in neotropical troidine swallowtails (Lepidoptera: Papilionidae). *Chemoecology* **10**: 99-102.

Lödl M. 1993 Notes on the synonymy of the genera *Hypena* Schrank, 1802, *Dichromia Guenée*, 1854 and *Harita* Moore, 1882 (Lepidoptera: Noctuidae: Hypeninae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* **45**(1/2): 11-14.

Lödl M. 1993 Remarks on the classification of the genera *Hypena* Schrank, 1802*, Dichromia Guenée*, 1854 *and Harita* Moore, 1882 (Lepidoptera: Noctuidae). *Nota Lepidopterologica* **16**(3/4): 241-50.

Lödl M. 1994 Revision der Gattung *Hypena* Schrank, 1802 s.l., der Äthiopischen und Madagassischen Region, Teil 1. (Insecta: Lepidoptera: Noctuidae: Hypeninae). *Annalen des Naturhistorischen Museums in Wien* **96** B: 373-590.

Pinto CF Troncoso AJ Urzúa A Niemeyer HM. 2009 Aristolochic acids affect the feeding behaviour and development of *Battus polydamas archidamas* larvae (Lepidoptera: Papilionidae: Troidini). *European Journal of Entomology* **106**: 357-61.

Ratnagiriswaran AN Venkatachalam K. 1935 The chemical examination of *Tylophora asthmatica* and isolation of the alkaloids tylophorine and tylophorinine. *The Indian Journal of Medical Research* **22:** 433-41.

Rausher MD Feeny P. 1980 Herbivory, plant density and plant reproductive success: the effects of *Battus philenor* on *Aristolochia reticulata*. *Ecology* **61**: 905-17.

Robinson GS Ackery PR Kitching IJ Beccaloni GW Hernández LM. 2010 *HOSTS - a Database of the World's Lepidopteran Hostplants*. Natural History Museum, London.

Shivananda TN Rani BJ. 2001 Record of *Hypena quadralis* (Walker) on *Tylophora indica* - a medicinal plant. *Insect Environment* **6:** 151.

Sridhar V Rani BJ. 2010 Occurrence and Biology of Semilooper, *Hypena sagitta* (Fabricius) (= *Dichromia orosia* Cramer) (Lepidoptera: Noctuidae) on *Tylophora indica* (Burm. f.) Merr. *Pest Management in Horticultural Ecosystem* **16**: 78-79.

Tripathi AK Singh D Jain DC. 1990 Persistency of tylophorine as an insect antifeedant against *Spilosoma obliqua* Walker. *Phytotherapy Research* **4**: 144 - 47.

Verma GS Ramakrishnan V Mulchandani NB Chadha MS. 1986 Insect feeding deterrents from the medicinal plant *Tylophora asthmatica*. *Entomologia Experimentalis Applicata* **40**: 99-105.

Weintraub JD. 1995 Host plant association patterns and phylogeny in the tribe Troidini (Lepidoptera: Papilionidae), pp 307–16. In *Swallowtail Butterflies: Their Ecology and Evolutionary Biology* (Eds Scriber JM Tsubaki Y Lederhouse RC) Scientific Publishers, Gainesville, FL.

Table 1.

Duration of various life stages of *Dicromia sagitta*

Life Stage		Duration (Days)	
		Jan - Feb'11	June - July'10
Egg		5	4
Larva	1st instar	4-5	
	2nd instar	4-5	
	3rd instar	5-6	
	4th instar	6 - 7	
	5th instar	7 - 9	
Total larval period		27-30	15-18
Pupa		9 -11	7-10
Adult longevity		10-12	7-8

a- Full grown larva

b- Cocoon

c- Adult

Fig. 1 (a-c) Life stages of *Dichromia sagitta* on *Tylophora indica*