Neem, the wonder tree, under attack: a new major pest

Azadirachta indica A. Juss. (Meliaceae), popularly known as neem, is a well-recognized tree. It is widely distributed and has multiple beneficial properties. Its Sanskrit name, 'arishtha' means 'reliever of sickness' and it is considered as the 'kalpavriksh of kalyuga'. It is a medium-sized tree with a straight trunk and dense crown of foliage of pinnate leaves. A native of South Asia, it is now naturalized in semi-arid, arid, tropical and subtropical areas throughout Asia, Africa, Middle East, Central and South America, the Caribbean, Florida and Arizona[1].

Neem provides shade, ornamental look, shelterbelt, fuel wood and construction material, and also helps in degraded land reclamation and soil conservation activities[1–3]. It is used to cure malaria, and bacterial, viral, fungal and helminth infections[4–6] and in storing food grains[7–9]. The traditional knowledge of its uses received scientific recognition in the mid 20th century[9]. Observations that locusts settled on the neem tree but did not feed on it, led to numerous studies which aided the identification of around 200 compounds responsible for various insecticidal and medicinal properties, the most known amongst them are azadirachtin and nimbin[10].

Despite its insecticidal properties, neem in the Indian subcontinent is known to be infested by insect pests such as scale insects *Palvinaria maxima* and *Aspidotus orientalis*, lepidopteran *Helopeltis theivora*[1,11] and geometrid moth *Ascostis selenaria*[12]. Minor defoliating agents are acridid grasshopper *Orthacris simulans*, fire ants *Solenopsis* spp. and *Latoia lepida* (Cram), coleopteran *Cryptocephalus ovulum* and lepidopteran *Laspeyresia aurantiana* and *Cleora cornaria*[11].

In November 2009, mature neem trees in the village of Bhauli, Bakshi ka Talab, Lucknow, started defoliating and soon consumed the entire leaves (Figure 1 *a*). This attracted the attention of researchers, as it had hitherto not been observed[13,14]. Observations revealed a lepidopteran to be the cause of this. The same phenomenon reoccurred in 2010. Similar defoliation was also observed on neem trees around Sultanpur, Pratapgarh and Faizabad districts in Uttar Pradesh. The increasing spread of this defoliating insect on a tree believed to be invincible, led to studies about its identity, previous records, status as an occasional pest and life history.

The pest was then identified as *C. cornaria* (Lepidoptera: Geometridae), previously a minor pest of neem[11]. No information is available on the life-history traits of this pest so far. The present study aims to understand its basic biology owing to its potential as a major pest of neem. We also need to identify the cause for the conversion of this minor pest into a major one in areas around Lucknow, and to reclassify it as a major pest.

Late larval stages of the pest were collected from infested neem trees in Bhauli, between 9 and 22 November 2009, and were reared in plastic petri dishes (9.0 × 2.0 cm) on daily *ad libitum* supply of neem leaves, till they pupated in the moist soil provided. Newly emerged adults were placed in 2000 ml plastic beakers covered with muslin cloth held by rubber bands. Cotton soaked with honey was provided for feeding and muslin cloth strips hung inside worked as oviposition sites.

Ten adult pairs were observed for daily oviposition, egg viability, pre-oviposition, oviposition and post-oviposition periods. Hundred first instars (ten in a petri dish with *ad libitum* neem leaves) were separated and observed till adult emergence. Fifth instars on becoming sluggish were transferred to plastic petri dishes containing moist soil for pupation. Duration of each stage and number surviving were observed. Length of all stages was also measured.

Bright green eggs bearing indentations were laid singly as well as in abstract clusters. These indentations resembled a corn-cob arrangement when viewed

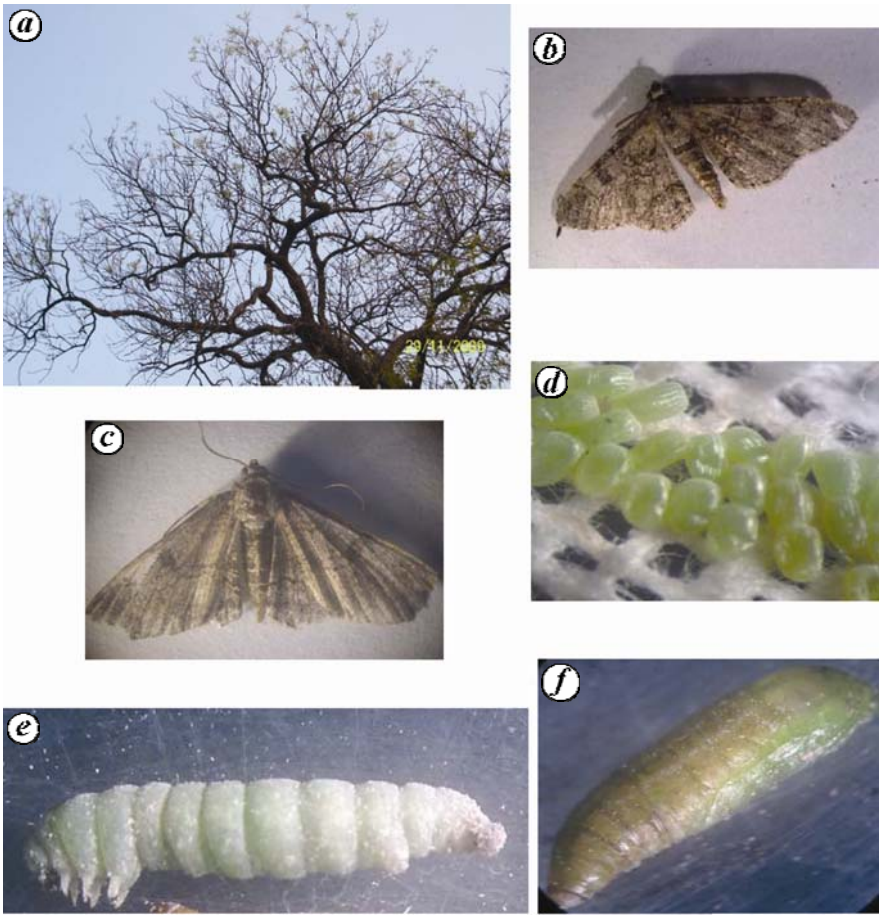

Figure 1. Photographs depicting (***a***) tree infested by *Cleora cornaria*, (***b***) adult male, (***c***) adult female, (***d***) eggs, (***e***) fifth instar and (***f***) pupa of *C. cornaria*.

under the microscope (Figure 1 *d*). Eggs became greenish-grey prior to hatching, which took place after an incubation period of 4.10 ± 0.23 days (range 3–5 days).

Newly hatched first instars (1.5–2.5 mm long) were bright green and showed semilooper movements. They were usually found clumped on the edges of neem leaves feeding in a frenzied manner, skimming of the epidermal layer of the leaves from between the veins. First-instar duration was 3.25 ± 0.12 days (range 2–4 days). Second instar was also green and 7–9 mm in size, with a duration of 2.85 ± 0.15 days (range 2–4 days). Third instars were similar to the second instar in shape and structure, but grew to 1.2–2.0 cm and had an instar duration of 3.00 ± 0.09 days (range 2–4 days). They moved around actively in search of food and cut leaves rhythmically in semi-circles. Fourth instar was also green with a duration of 3.30 ± 0.12 days (range 3–4 days). Fifth instar was the largest (4.2–5.3 cm), fed voraciously and developed in 4–5 days (4.50 ± 0.13 days; Figure 1 *e*). It became sluggish, stopped feeding and began to burrow into moist soil to form pre-pupa. Pre-pupa was green in colour and showed flicking movements on being disturbed (1–2 days; 1.20 ± 0.08 days). Immobility of pre-pupa followed by browning marked the start of pupal stage (Figure 1 *f*). Pupal stage lasted for 13–15 days (13.90 ± 0.28 days). Adults eclosed from the pupa and were creamish in colour with brown patterns on the wings (Figure 1 *b* and *c*). They mated for 1–2 min after 2–3 days of emergence and laid eggs within 24 h of mating. They mated a maximum of three times in their lifetime. Males survived for 5.80 ± 0.20 days (range 5–7 days), while the female longevity was 8.60 ± 0.45 days (range 8–11 days). A female laid 527.10 ± 25.30 eggs in her lifetime with an average of 126.50 ± 21.68 eggs per day for up to 3.5 ± 0.27 days. About 95.41 ± 0.59% eggs were found viable.

The results indicate *C. cornaria* to be a fast-growing insect with a voracious appetite. Genus *Cleora* has been previously found to cause major damage in mangroves in Thailand[15] and Kenya[16]. It has also been reported as pest in tea gardens[17] and teak plantations[18] in India. In view of previously reported tendency of the genus to be a major pest of many trees and the increased incidence of its species *C. cornaria* on neem, we should consider revising its status from a minor to that of a potential major pest.

1. National Research Council, *Neem: A Tree for Solving Global Problems*, National Academy Press, Washington, DC, 1992, p. 139.
2. Anon., *Bois For. Trop*., 1988, **217**, 33–47.
3. Chaturvedi, A. N., *UP For. Bull*., 1988, p. 50.
4. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, Council of Scientific and Industrial Research, New Delhi, 1956, p. 33.
5. Ketkar, C. M., Final Technical Report, Khadi and Village Industries Commission, Directorate of Non-Edible Oils and Soap Industry, Hyderabad, 1976, p. 279.
6. Luscombe, D. K. and Taha, S. A., *J. Pharmacol*., 1974, **26**, 110–111.
7. Ahmed, S. and Grainge, M., *Ecol. Bot*. 1986, **40**, 201–209.
8. Jotwani, M. G. and Srivastava, K. P., *Pesticides*, 1981, **15**, 19–23.
9. Moges, Y., Sub-report No. 4, FARM Africa/SOS, Sahel, 2004.
10. Siddiqui, S., *Curr. Sci*., 1942, **11**, 278–279.
11. Tewari, D. N., *Monograph on Neem*, International Book Distributor, Dehra Dun, 1992, p. 236.
12. Beeson, C. F. C., *The Ecology and Control of the Forest Insects of Indian and the Neighboring Countries*, Government of India Press, New Delhi, 1953, 2nd edn, p. 767.
13. *Daily News Activist*, 4 February 2010.
14. *Hindustan Times*, 5 February 2010.
15. Piyakarnchana, T., *J. Sci. Soc. Thailand*, 1981, **7**, 33–36.
16. Mwangi, J. G., Eastern Arc Mountains Information Source; 2004; http://www.easternarc.org/html/NewPestK.html
17. Das, S., Mukopadhyay, A. and Roy, S., *J. Biopestic*. 2010, **3**, 016–019.
18. Nair, K. S. S., *Tropical Forest Insect Pests: Ecology, Impact and Management*. Cambridge University Press, 2007, p. 404.

ACKNOWLEDGEMENTS. We thank Dr Sushila Joshi, Division of Entomology, Indian Agricultural Research Institute, New Delhi for identification of the insect and the Department of Higher Education, Govt of Uttar Pradesh, Lucknow for providing a grant under the Centre of Excellence programme.

Received 29 April 2011; revised accepted 2 March 2012

GEETANJALI MISHRA
OMKAR*

Centre of Excellence in Biocontrol of Insect Pests,
Department of Zoology,
University of Lucknow,
Lucknow 226 007, India
**For correspondence.*
e-mail: omkaar55@hotmail.com

Egg-laying trends in black redstart (*Phoenicurus ochruros* Gmelin)

Since the mid-1970s, temperature has increased due to climate change[1] and this change is already affecting many plants and animals on the globe[2]. Most of these changes are as expected for the warming temperature[3]. According to Parmesan[4], advance in spring events has been registered in all continents, except the Antarctic. For instance[5], two frog species in their northern range limit in the United Kingdom spawned two to three weeks earlier in 1994 than in 1978. According to Najmanova and Adamík[6], among the studies on vertebrates, birds play the main role in our understanding of the responses of animals to climate change.

During the last 40 years birds have shown significant changes in their phenology, demographic factors, etc. For example, changes in population dynamics[7], brood size[8,9], egg dimensions[10], earlier arrival[11,12], etc. Numerous studies have demonstrated advances in laying dates of birds in the last several decades. Crick *et al*.[13] reported that 51 of 65 species showed a trend towards earlier nesting between 1971 and 1995. According to these authors, mean advancement in the 20 species in which the trend was most marked was 8 days (range: from 4 to 18 days). Furthermore, coefficient of variation for Blackcap (*Sylvia atricapilla*) indicates a 12-day shift toward