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Insect biodiversity and environmental health: A case study of *Abgrallaspis azadirachti* (armoured scale insect)

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Abstract
Insect biodiversity is an essential component of terrestrial and agricultural ecosystems, contributing significantly to environmental stability, ecosystem functioning, and sustainable development. Insects perform indispensable ecological roles, including pollination, decomposition, nutrient cycling, biological control, and maintenance of food webs, thereby supporting environmental quality and agricultural productivity. However, increasing anthropogenic pressures such as habitat loss, climate change, pollution, invasive species, and indiscriminate pesticide use have accelerated the decline of insect diversity worldwide. These changes not only disrupt ecosystem services but also influence crop health, biodiversity conservation, and the interconnected health of humans, animals, and the environment. Understanding insect diversity through taxonomy and ecological assessment is fundamental for effective biodiversity conservation and environmental management. Accurate species identification provides the basis for monitoring ecosystem changes, detecting invasive species, and developing sustainable pest management strategies. Within this context, *Abgrallaspis azadirachti* (Armoured Scale Insect), a species associated with neem (*Azadirachta indica*), serves as an important example for understanding insect diversity, host specificity, and ecological interactions in natural and managed ecosystems. Although armoured scale insects are often recognized for their economic significance, they also contribute valuable information for biodiversity documentation, ecological monitoring, and studies on species distribution under changing environmental conditions.

Keywords: Insect biodiversity, environmental health, *Abgrallaspis azadirachti*, biodiversity, conservation, ecosystem health

Introduction

Insect biodiversity represents one of the most important components of terrestrial biological diversity. Insects occur in almost all terrestrial habitats and interact closely with plants and other components of ecosystems. Their abundance, distribution and behaviour are influenced by environmental conditions, availability of host plants, temperature, humidity and habitat characteristics. Consequently, detailed studies of individual insect species can contribute to a better understanding of ecological processes and environmental changes. Among the less conspicuous insects associated with plants are armoured scale insects. These insects possess specialized piercing and sucking mouthparts and remain closely associated with their host plants. Their populations can occur on leaves, twigs and other plant surfaces, where feeding activity may influence plant condition. Because of their close association with vegetation, scale insects provide useful subjects for studying plant–insect relationships.

Abgrallaspis azadirachti Ojha is an armoured scale insect originally described from neem (*Azadirachta indica*) in northern India. Ojha (2005) [10] described the species from material collected from leaves of neem at Kudhi village near Shikohabad, Firozabad, Uttar Pradesh. The original publication reported its distribution mainly from northern India and emphasized the economic and medicinal importance of its perennial host plant.

The association of *Abgrallaspis azadirachti* with neem is ecologically significant. Neem is a widely distributed perennial tree and occurs in agricultural areas, gardens, roadsides, institutional campuses and other human-influenced habitats. Therefore, an insect closely associated with neem can potentially be observed across a variety of environmental conditions.

The biology of *azadirachti* is particularly interesting because of the behaviour of its first-stage crawler. The crawler is the mobile stage responsible for locating a suitable place on the host plant before becoming established. A recent behavioural study reported that *Abgrallaspis azadirachti* crawlers are affected by environmental factors including temperature and humidity and exhibit phototactic and geotropic responses.

Recent work conducted at Agra has also examined the dispersal pattern of *Abgrallaspis azadirachti*. The study reported that most crawlers remained associated with their maternal host tree, while some crawlers were dispersed by wind to nearby areas. Crawlers were recorded from October to December, with the highest movement reported in December. These observations demonstrate that the species has an ecological relationship with both its host plant and the surrounding physical environment. Wind, temperature and humidity may influence the movement and establishment of crawlers, while the condition and distribution of neem trees influence the availability of suitable habitat.

The environmental-health perspective of the present study is therefore based on the concept that changes in insect abundance, distribution and behaviour can provide information about ecological conditions. The purpose is not to regard *Abgrallaspis azadirachti* alone as a definitive pollution indicator but to examine how its population and behaviour can contribute to an understanding of plant health

and environmental variation. The present research paper therefore provides a focused case study of *Abgrallaspis azadirachti*, emphasizing its biodiversity significance, host association, dispersal, environmental relationships and potential application in ecological monitoring.

Objectives

The objectives of the study were:

1. To document the ecological significance of *Abgrallaspis azadirachti*.
2. To study its association with neem (*Azadirachta indica*).
3. To examine the dispersal behaviour of its crawler stage.
4. To assess the relationship between *Abgrallaspis azadirachti* and host-plant health.
5. To examine the possible influence of temperature, humidity and wind on its distribution.
6. To evaluate the significance of *Abgrallaspis azadirachti* in local insect biodiversity.
7. To discuss its potential application in environmental-health monitoring.
8. To identify areas requiring further ecological and field-based research.

Materials and Methods

Study organism

The study organism was *Abgrallaspis azadirachti* Ojha, an armoured scale insect belonging to the family Diaspididae. The species was originally described from neem leaves collected at Kudhi village near Shikohabad, Firozabad, Uttar Pradesh. The present paper deliberately considers *Abgrallaspis azadirachti* as the focal organism throughout the ecological discussion.

Study area

The ecological observations considered in this study are primarily related to the Agra–Firozabad region of Uttar Pradesh, India. This region provides suitable conditions for studying the association between *Abgrallaspis azadirachti* and neem because neem trees occur commonly in both managed and semi-natural environments. The original description was based on material collected near Shikohabad, whereas subsequent behavioural and dispersal observations have been conducted in Agra.

Field observation

For field assessment, neem trees should be selected from different locations representing contrasting environmental conditions. Selected trees can be examined at regular intervals for the presence and intensity of *Abgrallaspis azadirachti* infestation.

The following observations can be recorded:

- number of infested leaves;
- number of scales per leaf;
- distribution on upper and lower leaf surfaces;
- infestation of twigs;
- presence of crawler stages;
- movement of crawlers;
- visible symptoms on affected plant parts;
- seasonal changes in infestation.

Observation of crawler behaviour

Crawler behaviour can be studied by marking infested portions of neem plants and observing crawler movement at regular intervals.

Behavioural parameters may include:

- direction of movement
- movement towards or away from light
- response to gravity
- movement on different plant surfaces
- time taken to settle
- response to temperature
- response to humidity

A laboratory or controlled-environment experiment may additionally be used to compare crawler behaviour under different temperature and humidity conditions.

Dispersal observation

Dispersal can be examined by placing suitable collection surfaces at predetermined distances around an infested neem tree. Greased plates or comparable collection surfaces may be used for detecting wind-borne crawlers. The number of crawlers collected at different distances and during different months can then be compared.

Recent Agra observations used greased plates around infested trees and reported crawler movement during October–December, with a maximum of five crawlers recorded during a 48-hour observation period.

Environmental observations

The following environmental parameters should be recorded simultaneously:

- air temperature
- relative humidity
- wind direction
- wind velocity
- rainfall
- soil moisture
- canopy condition
- degree of sunlight
- seasonal variation

Recording these variables is important because insect movement and establishment can be influenced by microclimatic conditions.

Results

Occurrence and host association

Abgrallaspis azadirachti was originally described from neem (*Azadirachta indica*) in the Shikohabad–Firozabad region of Uttar Pradesh. The original publication specifically reported its occurrence on leaves of neem and described its distribution as mainly northern Indian.

This close association with neem makes the species particularly suitable for examining plant–insect relationships in northern India.

Morphological characteristics

The species is an armoured scale insect associated primarily with plant surfaces. Published descriptions include morphological observations of the adult female, while recent work has examined the first-stage crawler. The crawler is a small, mobile developmental stage. Published observations describe the *Abgrallaspis azadirachti* crawler as yellow-green, with a broad and relatively flat body and long fine caudal setae.

Crawler behaviour

The crawler represents the principal mobile phase of the insect's development. Following emergence, it actively searches for a suitable location on the host plant and subsequently becomes established. Recent behavioural observations indicate that crawler movement is influenced by substrate, temperature and humidity. Phototactic and geotropic responses have also been reported. These behavioural characteristics are ecologically important because successful establishment depends on the ability of crawlers to locate appropriate plant surfaces.

Dispersal

Recent observations from Agra indicate that dispersal occurs principally during the crawler stage. Most crawlers were reported to remain on their maternal host tree, while some were capable of movement to nearby plants through wind-assisted dispersal. Crawler movement was reported from October to December, with the highest activity observed during December. During one 48-hour observation period, a maximum of five crawlers were trapped on the collection surfaces. These observations suggest that seasonal environmental conditions may influence dispersal intensity.

Distribution on the host plant

Field observations reported that infested areas of neem leaves and twigs could remain heavily affected while crawlers showed limited movement from established locations during observation periods. This indicates that once the insect becomes established on a suitable plant surface, the subsequent population may remain closely associated with that location.

Relationship with environmental factors

Temperature and humidity appear to be important environmental variables influencing crawler behaviour. Wind is particularly relevant to dispersal because mobile crawlers can be transported away from their maternal host tree. Thus, the observed distribution of *Abgrallaspis azadirachti* may be understood as the combined result of:

Host availability + crawler behaviour + temperature + humidity + wind movement + seasonal conditions.

Discussion

Ecological importance of *Abgrallaspis azadirachti*

The ecological significance of *Abgrallaspis azadirachti* is closely related to its association with neem. The original description established its occurrence on neem in Uttar Pradesh, providing an important record for the insect biodiversity of the region. Because neem is a perennial tree capable of growing under a variety of environmental conditions, it provides a relatively stable habitat for studying insect–plant interactions. The study of *azadirachti* is therefore relevant not only to entomology but also to biodiversity assessment, plant health and ecological monitoring.

Importance of the crawler stage

The crawler is particularly important in the ecology of *Abgrallaspis azadirachti*. It is the mobile stage capable of locating new feeding sites.

Once a suitable location is identified, the crawler settles and its mobility decreases substantially. The ability of crawlers to respond to environmental stimuli therefore directly influences colonization and distribution. The documented phototactic and geotropic responses suggest that environmental orientation mechanisms may contribute to successful establishment on the host plant.

Environmental factors and population distribution

Temperature and humidity can influence insect development and movement. The observations available for *Abgrallaspis azadirachti* indicate that these factors affect crawler behaviour.

Wind is another important environmental factor. Recent observations from Agra indicate that wind can transport crawlers from an infested neem tree to nearby plants. This creates an ecological connection between meteorological conditions and insect distribution. The seasonal observation of crawler activity between October and December further suggests that population monitoring should be conducted throughout the year rather than during a single sampling period.

Relationship with plant health

The close association between *Abgrallaspis azadirachti* and neem means that infestation can be considered an important aspect of plant-health assessment. Monitoring the density and distribution of scales can help identify heavily affected plant portions. However, plant health is influenced by many environmental and biological factors. Therefore, the effects specifically attributable to *Abgrallaspis azadirachti* should be determined through controlled experiments rather than assumed from visual symptoms alone.

Significance for insect biodiversity

Small, sedentary or inconspicuous insects can easily be overlooked during conventional biodiversity surveys. *Abgrallaspis azadirachti* demonstrates the importance of including specialized plant-associated insects in biodiversity studies. A biodiversity assessment based only on easily visible insects may underestimate the diversity and ecological complexity associated with perennial plants such as neem. Consequently, systematic examination of leaves, twigs and other plant surfaces can improve the documentation of local insect biodiversity.

Conclusion

The present case study demonstrates the ecological importance of *Abgrallaspis azadirachti* as a specialized armoured scale insect associated with neem (*Azadirachta indica*). The species was originally described from neem leaves at Kudhi village near Shikohabad, Firozabad, Uttar Pradesh, establishing an important record in the insect biodiversity of northern India.

The available observations indicate that the crawler stage is particularly important in the life cycle and distribution of *Abgrallaspis azadirachti*. Crawlers actively search for suitable locations on the host plant and respond to environmental factors such as temperature, humidity, light and gravity. Recent observations from Agra further indicate that wind contributes to crawler dispersal and that seasonal movement occurs particularly during October–December,

The close relationship between *Abgrallaspis azadirachti*, neem and environmental conditions makes this insect a valuable subject for ecological investigation. Monitoring its abundance, distribution and crawler behaviour may

contribute to understanding local plant health and environmental variation. Nevertheless, further systematic research is required to establish quantitative relationships between *Abgrallaspis azadirachti* and environmental-health parameters. Future studies should involve multiple locations, larger sample sizes, seasonal observations and simultaneous measurement of temperature, humidity, wind, soil characteristics and plant-health parameters.

In conclusion, *Abgrallaspis azadirachti* represents an important and relatively specialized component of neem-associated insect biodiversity, and its study can contribute to a broader understanding of insect–plant relationships and environmental ecology. Long-term monitoring of this species may provide useful baseline information for biodiversity conservation, plant-health assessment and ecological research in northern India.

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