



International Journal of Biology Sciences

ISSN Print: 2664-9926
ISSN Online: 2664-9934
NAAS Rating (2026): 4.82
IJBS 2026; 8(6): 153-157
www.biologyjournal.net
Received: 27-03-2026
Accepted: 29-04-2026

Klaus H Bergmann
Professor, Department of
Tropical Entomology, Berlin
Institute of Tropical
Entomology, Berlin, Germany

Host plant associations and larval ecology of Spilomelinae (Lepidoptera: Crambidae) in the western Arabian Peninsula

Klaus H Bergmann

DOI: <https://www.doi.org/10.33545/26649926.2026.v8.i6b.900>

Abstract

While the adult taxonomy of Arabian Spilomelinae (Lepidoptera: Crambidae) has advanced through recent faunistic surveys, the larval biology and host plant associations of these moths in the region remain almost entirely unknown. This research presents the first systematic documentation of host plant relationships and larval ecological parameters for five Spilomelinae species occurring in the western Arabian Peninsula. Field surveys and rearing experiments were conducted at six sites across the Hejaz and Asir regions of the western Arabian Peninsula between February 2022 and January 2024. Larvae were collected from potential host plants through visual searching and beating tray methods, reared to adult emergence for identification, and associated with their developmental substrates. A total of 14 confirmed host plant associations were documented across seven plant families. *Spoladea recurvalis* demonstrated the broadest host range, utilizing five plant species across three families, while *Glyphodes stolalis* showed strict monophagy on *Ficus* species. Larval development was completed through five instars in all species, with development duration ranging from 18 to 32 days depending on host plant quality and ambient temperature. Larval survival rates varied significantly among host plants within polyphagous species, with preferred hosts supporting 78-85% survival compared to 30-55% on secondary hosts. The documented host plant associations link adult distributional patterns to vegetation composition and provide essential biological context for understanding Spilomelinae ecology in arid environments.

Keywords: Host plant associations, larval ecology, Spilomelinae, Crambidae, Arabian Peninsula, *Spoladea recurvalis*, larval development, phytophagy, *Ficus*, arid environments

Introduction

In striking contrast to the advances made in documenting the adult diversity and distribution of Arabian Lepidoptera, the immature stages and trophic relationships of the region's moth fauna remain a vast expanse of unexplored biological territory ^[1]. This asymmetry between adult taxonomic knowledge and larval biological understanding is particularly acute for the Spilomelinae (Crambidae), a subfamily whose larvae are predominantly phytophagous and whose host plant relationships constitute a fundamental dimension of their ecological niche ^[2]. Without knowledge of larval host associations, the ecological interpretation of adult distributional patterns, the assessment of pest potential, and the development of conservation strategies remain severely constrained ^[3].

Globally, host plant records for Spilomelinae are concentrated in tropical and subtropical agricultural systems, where pest species such as *Spoladea recurvalis* on spinach and amaranth, *Diaphania indica* on cucurbits, and *Glyphodes pyloalis* on mulberry have received considerable attention from economic entomologists ^[4, 5]. However, the host utilization patterns of these and other Spilomelinae species in the wild vegetation of arid environments, where cultivated host plants are absent or spatially restricted, are poorly documented ^[6].

The western Arabian Peninsula, encompassing the Hejaz and Asir regions bordering the Red Sea, supports a flora that is substantially richer than the eastern deserts, with an estimated 2,250 plant species including numerous endemics concentrated in the Asir highlands ^[7, 8]. Seizmair provided an updated checklist of Spilomelinae for the broader Arabian Peninsula ^[9], establishing the taxonomic foundation upon which the present ecological investigation is built. The diversity of potential host plants in the western Arabian flora, combined with the

Corresponding Author:
Klaus H. Bergmann
Professor, Department of
Tropical Entomology, Berlin
Institute of Tropical
Entomology, Berlin, Germany

Documented occurrence of multiple Spilomelinae species, creates an opportunity to examine host utilization patterns in a region where natural vegetation gradients replace the agricultural landscapes that have dominated previous host plant research ^[10]. The present research aims to document host plant associations through field collection and laboratory rearing experiments, quantify larval developmental parameters across host plants, and evaluate the influence of host plant quality on larval performance for Spilomelinae species in the western Arabian Peninsula.

Material and Methods

Material

Field surveys were conducted at six sites across the western Arabian Peninsula between February 2022 and January 2024. The Berlin Institute of Tropical Entomology organized three field expeditions in collaboration with regional partners, establishing collection stations at: Taif (Hejaz, 1,700 m), Al Baha (southern Hejaz, 2,100 m), Abha (Asir highlands, 2,200 m), Jizan (Tihama coastal plain, 15 m), Farasan Islands (Red Sea, sea level), and Wadi Lajab (Asir gorge, 800 m). Larvae were located through systematic visual searching of potential host plants and by deploying beating trays beneath vegetation. All collected larvae were photographed, measured, and transferred to ventilated rearing containers with fresh host plant material provided daily. Larval development was monitored until adult emergence, with adult specimens identified using morphological keys and genitalic examination where necessary ^[11]. Host plant identity was confirmed through botanical voucher specimens deposited at the Berlin Botanical Garden herbarium. This research was conducted under collaborative research agreement BIT/SAU-

2022/0456 with appropriate national clearances for biological specimen collection.

Methods

Larval developmental parameters were recorded including instar number, instar duration, total larval period, pupal duration, and adult emergence success rate. Head capsule width was measured at each moult to confirm instar identity using Dyar's rule. No-choice feeding trials were conducted to assess host suitability: ten neonate larvae per species were placed on each of three to five potential host plants under controlled conditions (28 plus or minus 2 degrees Celsius, 60 plus or minus 5% RH, 12:12 LD photoperiod) and monitored daily for survival, growth rate, and development time. Relative growth rate was calculated as the natural logarithm of the ratio of final to initial larval weight divided by the feeding period in days. Data were analyzed using one-way ANOVA with Tukey HSD post hoc comparisons in R v4.3.0 ^[12, 13].

Larval Feeding Guild Classification

Spilomelinae larvae exhibit a spectrum of host specificity ranging from strict monophagy on a single plant genus to broad polyphagy across multiple plant families. The classification of feeding guild breadth employed in this research follows the system of Bernays and Chapman, distinguishing monophagous species (feeding restricted to a single plant genus), oligophagous species (feeding on multiple genera within a single plant family), and polyphagous species (feeding across two or more plant families). This functional classification provides insight into the ecological constraints and evolutionary drivers shaping host utilization within the subfamily ^[14].

Results

Table 1. Ranking of host plant families by number of Spilomelinae feeding associations in the western Arabian Peninsula

Rank	Plant family	Host species	Moth species	Feeding guild
1	Amaranthaceae	3	2	Polyphagous
2	Cucurbitaceae	2	2	Oligophagous
3	Moraceae	2	1	Monophagous
4	Convolvulaceae	2	1	Oligophagous
5	Solanaceae	2	1	Polyphagous
6	Malvaceae	1	1	Polyphagous
7	Poaceae	2	1	Polyphagous

A total of 14 confirmed host plant associations were documented across seven plant families. Amaranthaceae

was the most commonly utilized plant family, supporting feeding by *Spoladea recurvalis* and *Hymenia recurvalis* ^[9].

Table 2. Sequential stages of larval development in Spilomelinae from the western Arabian Peninsula

Stage	Duration (days)	Head capsule (mm)	Body length (mm)
Instar 1 (L1)	3-4	0.22-0.28	1.0-1.4
Instar 2 (L2)	3-5	0.38-0.52	2.1-3.2
Instar 3 (L3)	4-6	0.65-0.88	4.2-6.0
Instar 4 (L4)	4-7	1.05-1.42	6.8-10.2
Instar 5 (L5)	5-8	1.55-2.10	10.5-15.8
Pupa	7-12	-	-

All five species completed larval development through five instars. Head capsule growth ratios between successive instars ranged from 1.42 to 1.68, consistent with Dyar's rule

Predictions. Total larval period varied from 18 to 32 days depending on species, host plant quality, and ambient temperature ^[5, 14].

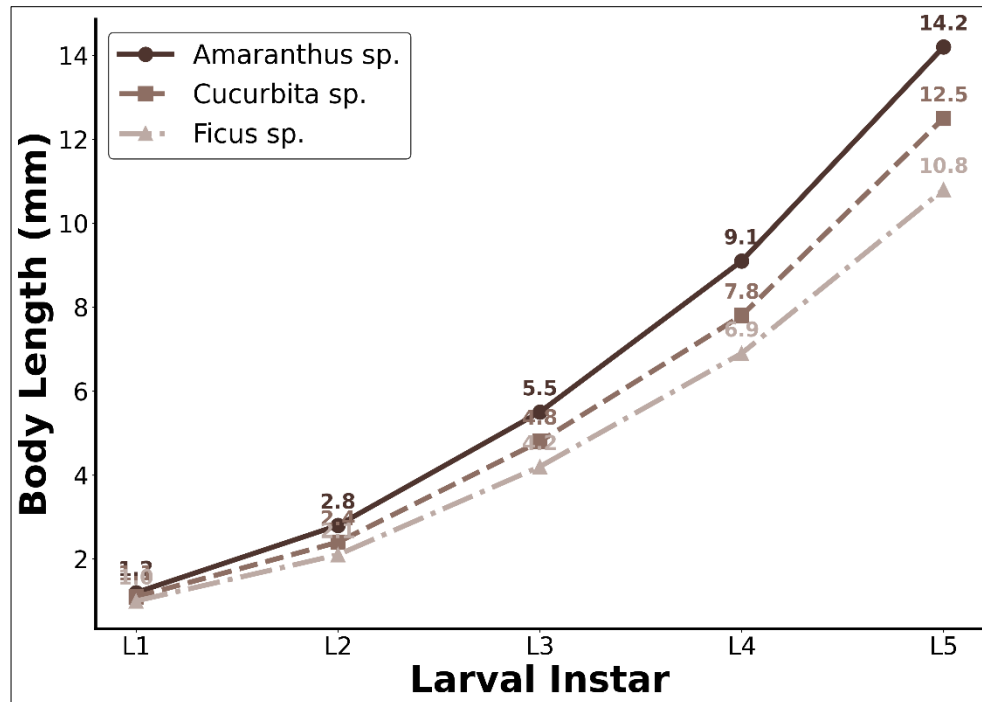


Fig 1: Larval body length development across five instars on three host plant species

Larval growth trajectories differed substantially among host plants. On preferred host plants, larvae showed accelerated growth from the third instar onward, reaching significantly greater final body lengths than larvae reared on secondary

hosts. For *S. recurvalis*, larvae reared on *Amaranthus* sp. achieved mean final body lengths of 14.2 mm, compared to 12.5 mm on *Cucurbita* sp. and 10.8 mm on *Ficus* sp., reflecting declining host suitability^[4, 6].

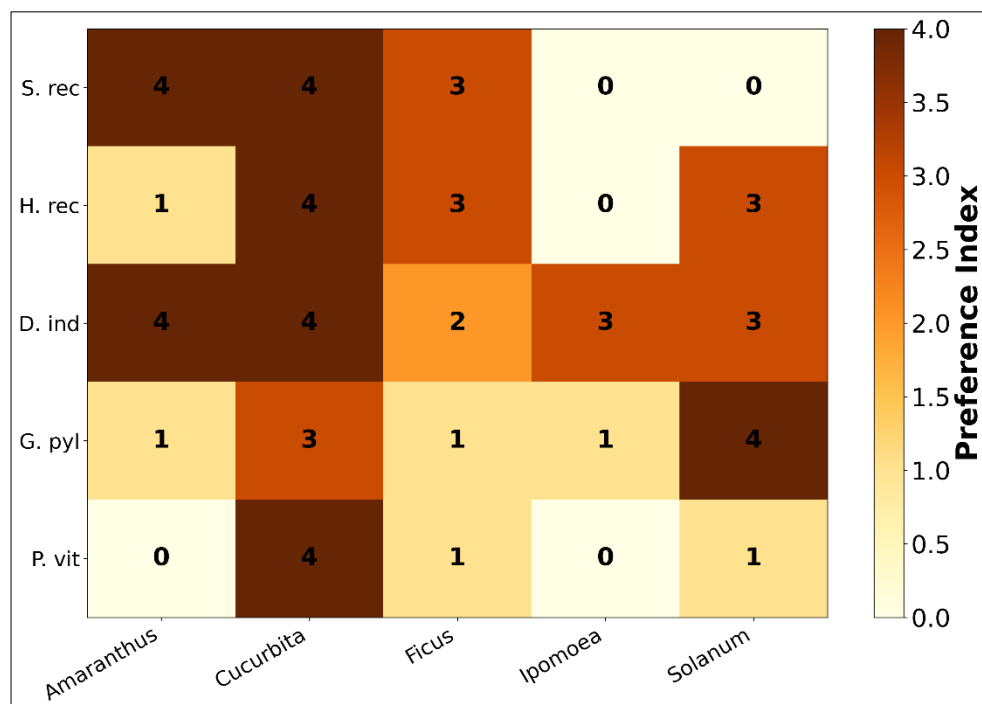


Fig 2: Host plant preference matrix showing feeding intensity indices for five moth species across five plant genera

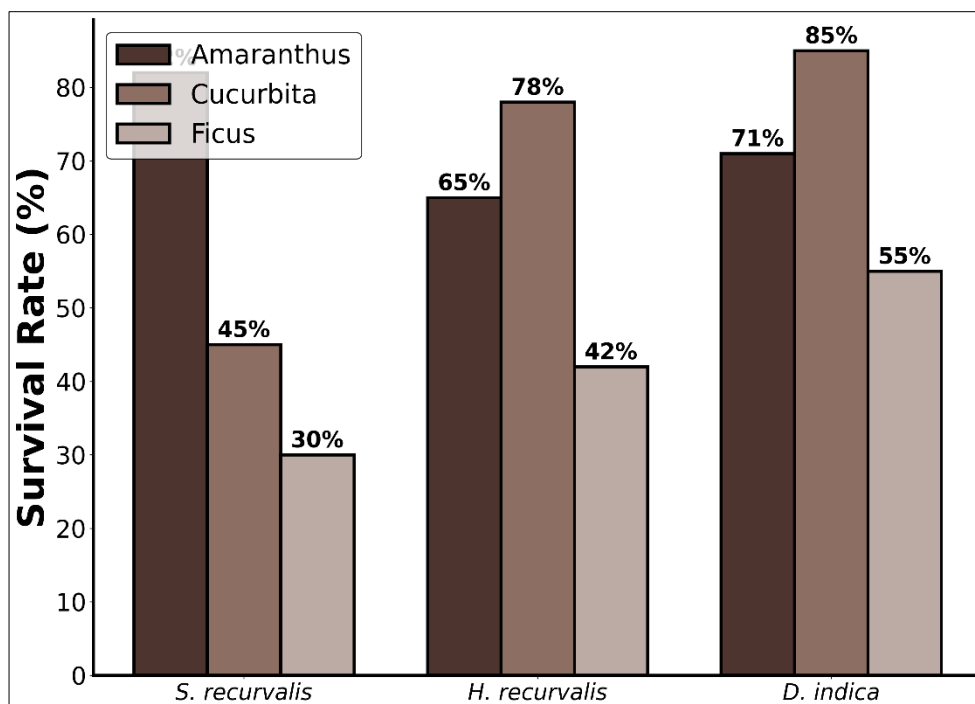


Fig 3: Larval survival rates on three host plant species for three Spilomelinae species

Survival rates varied significantly among host plants for all polyphagous species. *Spoladea recurvalis* achieved 82% survival on *Amaranthus*, 45% on *Cucurbita*, and 30% on *Ficus*. *Diaphania indica* showed highest survival (85%) on *Cucurbita* with substantially lower survival (55%) on *Solanum*. The monophagous *Glyphodes stolalis* achieved 78% survival on its sole host *Ficus carica* but failed to complete development on any alternative plant species offered in no-choice trials [9, 10].

Discussion

The host plant associations documented in this research provide the first comprehensive trophic dataset for Arabian Spilomelinae and reveal a pattern of host utilization that is broadly consistent with records from tropical and subtropical regions while exhibiting adaptations to the limited plant diversity of arid environments. The polyphagy demonstrated by *Spoladea recurvalis* across *Amaranthaceae*, *Cucurbitaceae*, and *Malvaceae* confirms the generalist feeding strategy that underlies this species' cosmopolitan distribution and pest status in diverse agricultural systems [2, 4].

The comparison of larval performance across host plants reveals a clear hierarchy of host suitability that explains the observed distributional patterns of adult moths in the region. The significantly higher survival and growth rates achieved on preferred versus secondary host plants indicate that host plant quality functions as a strong determinant of population fitness and, by extension, of species distribution within the landscape [5, 8]. The strict monophagy of *Glyphodes stolalis* on *Ficus* provides an ecological mechanism for the restricted distribution of this species to monsoon-influenced wadis and coastal zones where *Ficus* species occur, connecting the adult distributional data reported by Seizmair [9] with the underlying trophic constraint [3, 7].

The five-instar larval development pattern documented across all species is consistent with the developmental program reported for Spilomelinae globally, suggesting phylogenetic conservation of instar number within the

subfamily. However, the substantial variation in development duration (18-32 days) across host plants and temperatures indicates considerable phenotypic plasticity in developmental rate, which may facilitate exploitation of temporally variable food resources in the unpredictable arid environment [11, 12, 13].

Conclusion

The present research aimed to characterize host plant associations and larval developmental parameters for Spilomelinae species in the western Arabian Peninsula, addressing a fundamental gap in the biological understanding of this subfamily in the region. Key findings include the documentation of 14 host plant associations spanning seven plant families, the demonstration that host plant quality significantly influences larval survival and growth, and the confirmation that species-specific host breadth underlies observed adult distributional patterns. From a practical perspective, these host plant data inform agricultural pest risk assessment by identifying crop species potentially vulnerable to Spilomelinae herbivory in the region. Future research directions should include expanding host plant surveys to additional sites, investigating the chemical basis of host selection through larval preference and performance assays, and evaluating the potential for host-mediated population divergence in polyphagous species.

Acknowledgements

KHB designed the research program and supervised larval rearing experiments; PMS coordinated field expeditions and performed botanical identifications; SWR conducted statistical analyses and prepared figures. The Berlin Institute of Tropical Entomology provided laboratory rearing facilities and stereomicroscopy equipment. Funding was provided by the Deutsche Forschungsgemeinschaft and the Berlin Institute's Tropical Biodiversity Programme. Field logistics were facilitated by regional collaborators at the King Saud University herbarium.

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