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TROPILAELAPS MITES AS AN EMERGING THREAT TO APICULTURE: A REVIEW OF BIOLOGY AND INFESTATION DYNAMICS

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Abstract. *Tropilaelaps mites are brood-associated ectoparasites of honey bees whose expanding distribution has increased concern for apiculture and agricultural pollination. This narrative literature review examines taxonomy, host associations, feeding biology, geographical expansion, diagnosis and integrated management, with particular emphasis on Tropilaelaps mercedesae and implications for European preparedness. Targeted searches of publicly accessible scholarly sources and authoritative bee-health material were undertaken in October 2026; foundational taxonomic publications were considered alongside recent experimental studies and dated epidemiological updates. Four species are recognised, but T. mercedesae and T. clareae are the principal species known to reproduce on Apis mellifera. A close dependence on developing brood supports rapid population growth while limiting the usefulness of adult-bee sampling alone. Recent evidence nevertheless shows that short-term survival outside living brood and phoretic transport should not be dismissed. Brood examination, sticky-board monitoring and molecular tools provide complementary information, although reported sensitivities depend on protocol and infestation intensity. A 2024 field trial demonstrated sustained suppression following queen-caging-induced brood interruption, but no treatment established complete elimination of mites. Published observations of establishment in western Russia and Georgia, together with subsequent Caucasus updates and emerging reports from Türkiye, strengthen the case for regional vigilance; peer-reviewed records, preprints and official notifications must remain distinct. Evidence supports risk-based surveillance, rapid laboratory confirmation and coordinated biosecurity rather than direct transfer of Varroa treatment schedules. Research priorities include survival during broodless periods, validated low-infestation diagnostics, treatment thresholds, acaricide susceptibility and climate-dependent establishment. This review reports no original field or experimental data.*

Keywords: *Tropilaelaps mercedesae; Apis mellifera; brood parasites; surveillance; biosecurity; integrated pest management.*

INTRODUCTION

Honey bee health is relevant to agriculture through colony productivity and the pollination services supplied to cultivated and wild plants. Parasitic mites connect individual bee injury with colony-level demographic losses and movement-mediated disease risk. Although *Varroa destructor* has dominated research and management in many regions, *Tropilaelaps* merits separate attention because its host use, dispersal phase and dependence on brood differ substantially (DE GUZMAN et al., 2017; CHANTAWANNAKUL et al., 2018).

The importance of *Tropilaelaps* is not explained by the simple claim that it is universally more dangerous than *Varroa*. Outcomes vary with mite species, brood availability, host defences, viral infection, season and husbandry. Nevertheless, rapid reproduction and severe damage in susceptible *Apis mellifera* colonies make delayed detection consequential. Recent synthesis has highlighted both its westward expansion and unresolved questions concerning diagnosis and control (ESMAEILY et al., 2026).

For European agriculture, the relevant question is how evidence from endemic regions can inform preparedness without assuming identical conditions in a new region. Published

reports from western Russia and Georgia challenge an exclusively tropical interpretation of the risk, while international movement of bees may connect distant production systems (BRANDORF et al., 2024; JANASHIA et al., 2024). This review therefore critically links mite biology with detection, management and surveillance needs, including their potential relevance to Romanian apiculture. It does not claim a Romanian occurrence or establish national pest-free status.

MATERIAL AND METHODS

This article is a targeted narrative literature review, not a systematic review or meta-analysis. Public web searches were performed on 23 October 2026 using combinations of *Tropilaelaps*, mercedesae, biology, brood, survival, detection, deformed wing virus, control and geographical distribution. Sources were located through scholarly publisher websites, PubMed Central and the websites of the World Organisation for Animal Health (WOAH), the European Union Reference Laboratory for Bee Health (EURL/ANSES) and APIMONDIA. No exhaustive subscription-database search or formal screening flow diagram was undertaken.

Priority was given to recent primary research concerning *A. mellifera*, supported by older taxonomic and methodological studies where necessary. Relevant topics were species identification, host associations, life history, pathology, surveillance sensitivity, experimental management and spread. Broad reviews were used to identify context and additional references. Primary full texts were inspected where accessible; some bibliographic and contextual evidence was obtained from abstracts and references within accessible articles. This accessibility limitation was retained rather than implying uniform full-text appraisal.

Information was organised by biological and operational theme. Quantitative findings are attributed to their original studies and are not pooled, because protocols, colonies, regions and outcomes differ. Particular attention was given to separating mite detection from viable infestation, treatment suppression from eradication, and confirmed distribution from suspected or preliminary occurrence. The September 2026 Türkiye report is explicitly identified as a preprint. Dated institutional statements are interpreted according to their publication dates rather than treated as continuously updated databases.

No specimens, photographs, interviews or new colony measurements were collected for this review. Tables are original textual syntheses of the cited literature; none represents original experimental data. The selected set is purposive and may overrepresent English-language and open-access research. Consequently, conclusions describe the evidence examined and do not constitute a comprehensive prevalence assessment or a veterinary treatment protocol.

RESULTS AND DISCUSSION

Taxonomic resolution and host associations

Anderson and Morgan (2007) resolved genetic and morphological diversity within *Tropilaelaps* into four recognised species: *T. clareae*, *T. mercedesae*, *T. koenigerum* and *T. thaii*. This distinction matters because historical references to *T. clareae* may precede recognition of *T. mercedesae*. An older name therefore cannot automatically be mapped onto a modern species without checking geography, host association and identification methods.

The principal managed-host concern is that *T. mercedesae* and *T. clareae* reproduce on *A. mellifera*. Native associations involve giant Asian honey bees, including *Apis dorsata* and related species. The presence of a mite on an adult bee should not be equated with a demonstrated reproductive host association. Species-level attribution is strengthened by molecular identification, especially in new localities or morphologically variable populations (ANDERSON & MORGAN, 2007; MOHAMADZADE NAMIN et al., 2024).

Adults are small, elongated and reddish-brown, with a body longer than wide, unlike the broader outline of *V. destructor*. Their rapid movement across comb surfaces is useful for suspicion but not a sufficient species-level diagnosis. Morphological examination and, where necessary, PCR and sequencing should confirm suspect material. Standardised identification reduces the risk of confusing harmless hive-associated mites, *Varroa* and *Tropilaelaps* (ANDERSON & ROBERTS, 2013; WOAH, 2018).

Brood dependence, feeding and molecular biology

The reproductive phase occurs in brood cells. Females enter near capping, reproduce during bee development and emerge with the developing host before entering another reproductive cycle. A short interval outside sealed cells reduces exposure to treatments acting mainly on dispersing mites. Because larvae and pupae provide the feeding resource, the presence and age structure of brood are central to interpreting population growth (DE GUZMAN et al., 2017; TOKACH et al., 2024).

Brood feeding includes more than damage to late pupae. Phokasem and colleagues demonstrated feeding on pre- and post-capped brood, which broadens the susceptible developmental window. Thus, removing only sealed brood is not necessarily equivalent to removing all suitable food resources. Feeding-related injuries and their relationship to colony condition have also been examined in field colonies (PHOKASEM et al., 2019; LING et al., 2023).

Feeding terminology should be evidence-specific. HAN et al. (2024) investigated stage-dependent diets in ectoparasitic mites and provided support for haemolymph feeding during reproduction, including *Tropilaelaps*. Findings concerning the fat-body diet of dispersing *Varroa* should not simply be transferred to *Tropilaelaps*. Likewise, the assumption that attaching to an adult bee proves feeding on that adult is not supported by attachment observations alone.

New molecular resources help move beyond descriptive biology. WEI ET AL. (2024) identified 4,422 proteins across post-embryonic stages of *T. mercedesae*, including 2,189 with significant developmental differences. These data support investigation of development and candidate biological targets. They do not by themselves validate a safe acaricide, establish field efficacy or show that a proposed molecular intervention is ready for use in colonies.

Survival outside brood and pathways of dispersal

A traditional rationale for brood interruption is the limited survival of *Tropilaelaps* without developing bees. That dependence remains important, but an absolute rule that every mite dies within a fixed short interval would oversimplify the evidence. Survival estimates depend on temperature, substrate, mite condition and access to alternative tissues; laboratory endpoints are not equivalent to successful establishment after transport (DE GUZMAN et al., 2017; ESMAEILY et al., 2026).

GILL et al. (2025) reported survival beyond 96 hours on live adult *A. mellifera*, beyond 144 hours on decomposing pupae and up to 168 hours on decomposing adults under their in vitro conditions. These findings support a wider short-term survival window than commonly assumed, but do not demonstrate sustained reproduction without brood or prove the mechanism of feeding. They are relevant to evaluating transport pathways, not a stand-alone estimate of the risk of any particular consignment.

Direct evidence of dispersal complements laboratory survival. TOKACH et al. (2025) recovered *T. mercedesae* from adult bees leaving colonies, with detection associated with elevated brood infestation. Phoresy therefore provides a plausible route between colonies even when the adult bee is not a suitable long-term feeding host. Movement of live bees, brood and infested colony material should be evaluated separately from unsubstantiated assumptions that distance or a brief broodless journey guarantees safety.

Pathology, viruses and colony-level effects

Infested brood may show feeding wounds, abnormal development and mortality, while affected colonies can present irregular brood patterns, weakened populations and deformed newly emerged workers. Such signs overlap with other bee-health problems; they are grounds for investigation rather than species-specific proof. Colony losses arise from interactions among parasite burden, host condition and associated pathogens, not from a single visible sign (WOAH, 2018; LING et al., 2023).

Viral associations add a second layer of injury. In Palawan, DE GUZMAN et al. (2020) identified *T. mercedesae* and found higher levels of deformed wing virus variants in mite-infested pupae than in uninfested pupae. Such results connect infestation with viral load, but a correlation does not by itself quantify transmission efficiency or distinguish every possible route. The broader review by ESMAEILY et al. (2026) similarly identifies mite–virus interactions as important but incompletely resolved.

For synthesis, three evidence levels should be kept distinct: detection of viral RNA in a mite, association of infestation with higher infection in bees, and experimental demonstration of transmission or replication. Failure to separate these levels can exaggerate mechanistic certainty. Surveillance should therefore combine parasite identification with investigation of clinical and virological context when appropriate, while avoiding the inference that every deformity is attributable to *Tropilaelaps*.

Geographical expansion and the European context

BRANDORF et al. (2024) documented established *T. mercedesae* populations in the Krasnodar region of western Russia, including local overwintering and genetic confirmation. JANASHIA et al. (2024) reported its presence in Georgia. These records challenge the assumption that a temperate location alone prevents establishment. They do not identify a universal climatic boundary, demonstrate the source of every incursion or establish country-wide prevalence.

Genetic work across Asian populations provides complementary evidence about diversity and regional relationships, but phylogenetic similarity is not equivalent to a traced movement event. MOHAMADZADE NAMIN et al. (2024) supports interpretation of geographic variation while also illustrating why molecular identification is valuable. Distribution maps should retain the distinction between a locality record, an established local population and a systematically surveyed national distribution.

An EURL update dated 15 December 2025 summarised reports from Abkhazia and Dagestan and treated an additional Georgian regional suspicion cautiously. The note explicitly warned that available information came from limited research or informal feedback rather than comprehensive surveillance. Such evidence supports vigilance but does not permit reliable estimation of regional prevalence (FRANCO et al., 2025).

The evidence concerning Türkiye changed during 2026. Franco and Duquesne (2026) described the Artvin observation as suspected and not officially confirmed at the time of their August note. A September preprint subsequently reported morphological and molecular identification in Artvin (ÖZKIRIM et al., 2026), while Apimondia issued a regional preparedness call on 16 October 2026. The preprint is preliminary research, and Apimondia is a stakeholder organisation rather than the national notifying authority. Neither should be misrepresented as a verified official notification (Apimondia, 2026).

For Romania, the defensible inference is a preparedness priority, not a finding of infestation. Veterinary surveillance, traceability of bee movements and diagnostic readiness should be strengthened on the basis of regional risk. A claim that the mite is present, absent or

officially eradicated nationally requires current competent-authority evidence and falls outside what this review establishes.

Diagnostic performance and interpretation

Brood examination, mite-fall collection and molecular testing target different components of infestation. Adult-bee methods developed for *Varroa* may underperform because relatively few *Tropilaelaps* are present on adults at a sampling moment. GILL et al. (2024) found that careful uncapping with tweezers and sticky traps improved detection compared with several existing approaches. Sugar rolling performed better than alcohol washing in that study, but this relative result should not be interpreted as universal high sensitivity.

TOKACH et al. (2026) compared five monitoring approaches and found bottom-board sticky traps and worker-brood uncapping more sensitive than adult-bee alcohol washing or powdered sugar shaking. This agrees with brood-associated biology, while showing that methods cannot be judged solely by familiarity or convenience. Published diagnostic rankings should be accompanied by the sampling effort and infestation context used to obtain them.

UZUNOV et al. (2025) described rapid brood decapping using wax strips and observation of surfacing mites. It offers a practical compromise between time demands and brood examination. However, a result obtained with one developmental stage, observation period or operator should not be assumed to apply unchanged in other conditions. Reduced labour is valuable only if the resulting sensitivity is sufficient for the purpose, particularly early incursion detection.

SCHOUTEN et al. (2026) tested six methods in 27 infested colonies across six Papua New Guinea apiaries. The reported sensitivities are summarised in Table 1. eDNA performed especially well, but a positive DNA signal does not alone prove that viable mites remain in a colony. Persistence of DNA, contamination control, analytical specificity and confirmatory sampling must be considered before converting a molecular result into an epidemiological conclusion.

Diagnostic surveillance and routine burden monitoring are different tasks. A beekeeper managing an established pest may need a practical count, whereas an authority seeking an early incursion requires a high probability of detecting very low infestation. Repeated tests and complementary methods can be useful, but published point estimates should not be treated as universal constants or pooled across heterogeneous protocols. No negative single inspection proves pest freedom (ANDERSON & ROBERTS, 2013; SCHOUTEN et al., 2026).

Table 1

Study-specific sensitivity of *Tropilaelaps mercedesae* detection

Method	**Reported sensitivity**	**Interpretation**
eDNA swab	100%	DNA signal; viability requires separate assessment
Sticky mat + acaricide	92%	24 h; distinct from natural mite fall
Worker-brood uncapping	70%	Actual effort averaged 126 cells per colony
Rapid brood uncapping	63%	Single-strip result
Alcohol wash	41%	Adult-bee sampling
Bump test	33%	Protocol-specific rapid screen

Source: SCHOUTEN et al. (2026), 27 infested colonies in six apiaries; sticky mats were evaluable in 26 colonies. Percentages are rounded study estimates, not universal assay characteristics. The projected sensitivity for a 200-cell protocol was not substituted for observed uncapping performance.

Integrated management: evidence and limitations

Brood interruption has a strong biological rationale: it removes or reduces access to feeding and reproductive hosts while limiting shelter within sealed cells. Nevertheless, its effectiveness depends on how completely suitable brood is interrupted, when the intervention occurs and whether reinfestation follows. ROBERTS et al. (2020) and TOKACH et al. (2024) support its management value without establishing that every brood-break protocol eradicates the pest.

TOKACH et al. (2024) studied 51 *A. mellifera* colonies in Thailand using untreated controls, a brood break, brood break plus formic acid, and brood break plus oxalic acid. Queens in brood-break groups were caged for 24 days. Model estimates of worker-brood infestation at day 60 were 15.25% for controls, 0.10% for brood break, 0 for brood break plus formic acid and 0.11% for brood break plus oxalic acid. The zero estimate refers to that brood endpoint, not absence of mites throughout the colony: mites were still found by other assessments, and the study did not establish complete elimination.

Adding either acid did not significantly improve the final infestation outcome over brood interruption alone in that experiment. Colonies receiving brood break plus formic acid had lower adult populations at day 60, illustrating the need to assess colony safety as well as mite reduction. These are study-specific findings, not treatment instructions for Romanian apiaries. They should not be converted into an assumed efficacy percentage by comparing unrelated endpoints (TOKACH et al., 2024).

PETTIS et al. (2017) provides evidence for formic acid and cultural control in northern Thailand, and SANKOVITZ et al. (2025) extends recent investigation to formic acid and thermal remediation. These studies justify continued evaluation, not automatic adoption across climates. Temperature, colony strength, brood status, product formulation and approved indications affect suitability. A product authorised against *Varroa* in one country is not thereby authorised against *Tropilaelaps* elsewhere.

An integrated strategy therefore links accurate diagnosis, assessment of colony demography, appropriately validated biotechnical measures, veterinary-supervised use of legally permitted products and post-intervention monitoring. Chemical-only assumptions are weakened by the brief exposed phase and potential variation in susceptibility. Low mite counts after treatment should trigger follow-up rather than an unqualified declaration of eradication (DE GUZMAN et al., 2017; ESMAEILY et al., 2026).

Table 2

Worker-brood infestation after experimental management

Treatment group	Day 60 estimate	Critical qualification
Untreated control	15.25%	Model estimate; initial estimate 0.40%
Brood break	0.10%	Queens caged for 24 days
Brood break + formic acid	0%	No mites in this brood endpoint; not colony eradication
Brood break + oxalic acid	0.11%	No significant advantage over brood break alone

Source: TOKACH et al. (2024). Values are model estimates for the percentage of infested worker-brood cells, not measured treatment efficacy percentages. No management group established complete elimination of mites across assessments. No doses or product-use recommendations are proposed here.

Evidence gaps and priorities for preparedness

Key biological gaps concern overwintering, survival mechanisms outside living brood and the conditions that permit establishment after movement. Laboratory survival data,

observations of local overwintering and phoretic recovery answer different questions and should be connected without collapsing them into a single survival estimate. Experiments should distinguish environmental tolerance from successful reproduction and subsequent colony-to-colony spread (GILL et al., 2025; BRANDORF et al., 2024).

Operational priorities include validation of low-infestation diagnostics, inter-laboratory comparison of molecular assays, costs under local conditions and treatment thresholds tied to meaningful colony outcomes. Standardised recording should include sample size, brood stage, inspection duration, intervention history and the basis for defining an infested colony. eDNA and rapid brood examination are promising, but their advantages need independent testing in different beekeeping systems (GILL et al., 2024; SCHOUTEN et al., 2026).

The present review is limited by purposive source selection, incomplete access to some primary texts and a rapidly changing geographical situation. It does not calculate pooled diagnostic sensitivity, regional prevalence or economic losses. Its main contribution is an evidence-based separation of what is established, what is promising and what remains uncertain. For agricultural preparedness, this distinction is more useful than presenting all reports or experimental interventions as equally mature evidence.

CONCLUSIONS

Tropilaelaps, particularly *T. mercedesae*, is an important emerging concern for *A. mellifera* health and apicultural resilience. Taxonomic accuracy and brood-associated biology are essential for interpreting both historical reports and present management evidence.

Detection should not rely on adult-bee sampling alone. Brood examination, sticky-board methods and validated molecular tools provide complementary evidence; their performance remains protocol- and infestation-dependent.

Brood interruption can strongly suppress infestation, while evidence for specific chemical or thermal interventions must be interpreted in relation to colony safety, climate, reinfestation and local authorisation. Suppression and failure to detect mites are not synonymous with eradication.

Westward expansion supports risk-based surveillance and regional cooperation. Reports from Türkiye must be described according to their date and evidence status. This review makes no claim of occurrence in Romania and identifies diagnostic readiness, traceability and timely official investigation as priorities for preparedness.

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