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Beyond the Grove: Climate-Driven Dispersal of *Bactrocera oleae* into Adjacent Forest Habitats in Mediterranean Landscapes

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Abstract The olive fly (*Bactrocera oleae*) is a significant pest in olive cultivation areas, jeopardizing both productivity and quality. Conventional pest management has concentrated on grove perimeters, frequently neglecting the influence of surrounding non-agricultural ecosystems. As climate change escalates, resulting in heightened temperature extremes and modified ecosystem dynamics, comprehending the impact of these environmental conditions on pest behavior is essential. Agroecological methods, which emphasize ecological linkages across landscape types, offer promising insights for sustainable pest management. Mediterranean areas such as Lesvos Island, Greece, include mosaic landscapes of olive trees and neighbouring forests, creating a complex ecological matrix. This work investigates the dispersal of *B. oleae* outside its conventional agricultural environment into pine woods and examines how microclimatic variations in these regions may influence its mobility and survival, especially under the stress of elevated summer temperatures linked to climate change.

Keywords: *Bactrocera oleae*, climate change, agroecology, Mediterranean, pest ecology

1. Introduction

The olive fly, *Bactrocera oleae*, poses a significant threat to olive production, particularly in the Mediterranean region. This pest affects not only the yield of olives but also the quality of olive products. Historically, pest management has focused solely on olive groves, often neglecting the ecological dynamics of adjacent non-agricultural habitats. Recent studies highlight the importance of recognizing these boundaries to understand pest behavior, influenced by surrounding ecosystems, especially concerning climate change that intensifies pest pressures (Ponti et al., 2014; Daane & Johnson, 2010; Stavrianakis et al., 2025).

Climate change is expected to alter environmental conditions, including temperature variability, impacting pest dynamics. Evidence suggests that the dispersal behavior of *B. oleae* can be affected by microclimatic conditions in surrounding habitats, including pine forests. Research indicates that increased summer temperatures drive changes in pest populations and foraging behaviors, underscoring the need for integrated pest management strategies that consider these landscape variations (Ponti et al., 2014). Changes in climate and habitat may enhance the pest's survival, particularly given its interactions with various environmental factors and food sources in adjacent non-agricultural areas (Wang et al., 2021).

Agroecological approaches offer a framework to understand the intricate interactions between the olive fruit fly and its ecosystem. These methodologies emphasize the need to grasp the relationship between *B. oleae* and its surrounding environment, particularly the role of plant diversity—both host and non-host species—in pest dynamics (Guo et al., 2019). The presence of diverse tree species can facilitate the presence of olive flies or mitigate their impact by stabilizing pest populations through ecological interactions (Guo et al., 2019; Petrovskii et al., 2014). Additionally, research on olfactory cues from different olive cultivars shows that certain characteristics influence the ovipositional preferences and behavioral responses of *B. oleae*, with implications for pest management (Pavlidi et al., 2017; Malheiro et al., 2016).

2. Materials and Methods

The study was conducted in central Lesvos, where olive groves are about extensive pine forests. The area experiences Mediterranean climatic conditions, with hot, dry summers and mild, wet winters. The forest flora is dominated by *Pinus brutia*, *Quercus coccifera*, *Arbutus unedo*, *Juniperous oxycedrus*, *Cistus salviifolius*, *Sarcopoterium spinosum and Calicotome villosa*.

During the summer and autumn of 2024, McPhail traps baited with a solution of 2% diammonium phosphate, were placed at four locations: in the olive grove (5 traps), at the borders (3 traps), 100 m inside the forest (3 traps), and 300 m (3 traps) inside the adjacent pine forest. Traps were inspected weekly, and temperature sensors were placed in the same points as the traps, to assess fine-scale thermal variation across the sampling gradient. Hourly measurements of temperature were recorded during the study period. Trap catches were compared across distances using ANOVA. Correlation between fly abundance and temperature was assessed using Pearson's correlation.

3. Results

Fly presence was consistent inside grove, at the borders and at 100 m into the pine forest. Traps at 300 m recorded negligible fly activity, suggesting a threshold of dispersal or survival. The pattern was stable across both summer and autumn sampling.

Microclimatic analysis revealed that forested areas maintained lower temperatures than the olive grove, particularly during the summer months, with differences averaging 2.5–3.5°C. Specifically, forest exhibited 29-34% more hours with temperature under 23ºC than the olive grove, and 16-19% less hours over 31ºC. These cooler conditions may reduce thermal stress for olive flies during peak heat events.

Periods of extreme heat coincided with increased fly activity in the border to 100 m forest range, suggesting a behavioral shift possibly driven by thermal refuge-seeking. Statistical analysis showed a significant negative correlation ($r = -0.62$, $p < 0.05$) between fly captures and temperature at the grove edge, supporting the refuge hypothesis.

4. Discussion

These findings suggest the possibility that pine forests near olive groves are not passive barriers but can be active components of the pest's ecological range, especially under climate stress. The forest interior, up to 100 m, may provide a microhabitat allowing *B. oleae* to find shelter during high-temperature periods. As climate change increases the frequency and intensity of heatwaves in the Mediterranean, such thermal refuges could play a more prominent role in pest survival and population dynamics. On the other hand, the absence of olive fly presence in more than 300 m depth in the forest, suggests that at this scale, it can act as a natural barrier.

This challenges conventional pest control approaches that treat non-agricultural areas as irrelevant or strictly exclusionary. Instead, an agroecological perspective that recognizes cross-habitat interactions can enhance integrated pest management (IPM) strategies. It also highlights the necessity of sustainable management of olive groves, to enhance the presence of natural enemies that can suppress olive fly populations, particularly under conditions of landscape complexity and climate stress.

The preliminary results from Lesvos highlight the importance of landscape context in pest ecology. Pine forests bordering olive groves can facilitate olive fly movement and survival, or create a natural barrier, depending on their depth. These insights support the need for IPM strategies that incorporate landscape structure and microclimate buffering—key components of agroecology. Future work will expand the temporal scale of sampling, incorporate host plant availability, and integrate remote sensing to refine pest risk models under evolving climate conditions.

References

Daane, K. and Johnson, M. (2010), Olive fruit fly: managing an ancient pest in modern times. *Annual Review of Entomology*, **55**(1), 151-169.

Guo, Q., Fei, S., Potter, K., Liebhold, A. and Wen, J. (2019), Tree diversity regulates forest pest invasion. *Proceedings of the National Academy of Sciences*, **116**(15), 7382-7386.

Lichtenberg, E., Kennedy, C., Kremen, C., Batáry, P., Berendse, F., Bommarco, R. and Crowder, D. (2017), A global synthesis of the effects of diversified farming systems on arthropod diversity within fields and across agricultural landscapes. *Global Change Biology*, **23**(11), 4946-4957.

Malheiro, R., Casal, S., Cunha, S., Baptista, P. and Pereira, J. (2016), Identification of leaf volatiles from olive (olea europaea) and their possible role in the ovipositional preferences of olive fly, bactrocera oleae (rossi) (diptera: tephritidae). *Phytochemistry*, **121**, 11-19.

Pavlidi, N., Gioti, A., Wybouw, N., Dermauw, W., Ben-Yosef, M., Yuval, B. and Vontas, J. (2017), Transcriptomic responses of the olive fruit fly bactrocera oleae and its symbiont candidatus erwinia dacicola to olive feeding. *Scientific Reports*, **7**(1).

Perrot, T., Rusch, A., Coux, C., Gaba, S. and Bretagnolle, V. (2021), Proportion of grassland at landscape scale drives natural pest control services in agricultural landscapes. *Frontiers in Ecology and Evolution*, **9**.

Petrovskii, S., Petrovskaya, N. and Bearup, D. (2014), Multiscale approach to pest insect monitoring: random walks, pattern formation, synchronization, and networks. *Physics of Life Reviews*, **11**(3), 467-525.

Ponti, L., Gutierrez, A., Ruti, P. and Dell'Aquila, A. (2014), Fine-scale ecological and economic assessment of climate change on olive in the mediterranean basin reveals winners and losers. *Proceedings of the National Academy of Sciences*, **111**(15), 5598-5603.

Stavrianakis, G., Sentas, E., Zafeirelli, S., Tscheulin, T. and Kizos, T. (2025), Utilizing Olive Fly Ecology Towards Sustainable Pest Management. *Biology*, **14**(2), 125.

Wang, C., Wang, R., Yu, C., Xiao-peng, D., Sun, W., Li, Q. and Wan, J. (2021), Risk assessment of insect pest expansion in alpine ecosystems under climate change. *Pest Management Science*, **77**(7), 3165-3178.