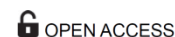


Research Article



The Species Composition of Fruit Flies and Their Parasitoids on Local Red Chilli (*Capsicum annuum* L.) In West Sumatra, Indonesia

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Abstract

Fruit fly infestation remains a major constraint in red chili production in Indonesia, yet the identity of the dominant pest species and the role of parasitoids remain inadequately documented in West Sumatra. This study analyzed the composition, abundance, and distribution of fruit flies and their parasitoids associated with local red chili across altitudinal gradients in West Sumatra. Host-rearing techniques were applied to infested chili fruits collected from 33 locations in Agam, Solok, Tanah Datar, and Padang Pariaman Regencies between October 2024 and March 2025. A total of 210 fruit fly individuals and three parasitoid specimens were recovered. *Atherigona orientalis* dominated the assemblage (86.7%), followed by *Bactrocera dorsalis* (8.6%), *Silba capsicarum* (3.3%), and *Drosophila melanogaster* (1.4%). Parasitoids consisted of *Diachasmimorpha longicaudata* and *Opius* sp., with very low parasitism rates (1.38-1.84%). *A. orientalis* was consistently present across all regencies, altitudinal zones, and chili varieties, indicating high ecological plasticity. These findings demonstrate a shift from the traditionally assumed dominance of *B. dorsalis* toward *A. orientalis* as the primary pest of chili in West Sumatra and highlight the limited contribution of natural enemies under current agroecosystem conditions. Strengthening integrated pest management through habitat manipulation, selective cultivar use, and biological control enhancement is strongly recommended.

Keywords: Altitudinal distribution, *Atherigona orientalis*, *Capsicum annuum*, fruit fly assemblage, parasitoids

1. Introduction

Indonesia is recognized as an agricultural country due to its diverse topography and favorable natural circumstances, which support the production of a wide range of agricultural commodities (Mariyono, 2017; Anwarudin et al., 2019). According to Badan Pusat Statistik (2024), the horticulture sector contributed 1.44% to the national Gross Domestic Product (GDP) in 2022. In West Sumatra province, agriculture is a major pillar of economic growth, contributing 21.71% to the gross regional product (International Labour Organization, 2022) and employing 50.69% of the population (BPS West Sumatra, 2020; Singh & Johari, 2018). Among horticultural commodities, red chilli is one of the most economically important crops (Kate & Laird, 2019). Chilli fruits are widely consumed worldwide and constitute a high-value vegetable crop with diverse uses (Aprilia et al., 2023; Stella & Simamora, 2021). The production of chillies yields lucrative results with an R/C ratio of 2.046, generating approximately 90 million per hectare per planting season (Dinas Kehutanan Sumatra Barat, 2023).

In 2023, Agam Regency produced 42,002 tons of chilli, followed by Solok at 41,168 tons, Tanah Datar at 22,261 tons, and Padang Pariaman at 2,006 tons. Together, these regencies accounted for 50% of the total chilli production among the 19 regencies and cities in West Sumatra (Badan Pusat Statistik, 2024b). Furthermore, this province recorded the highest chilli consumption rate in Indonesia, reaching 0.59 kg per capita per month in 2021 (Lukas et al., 2023).

West Sumatra province harbours 40 fruit fly species, the second-highest diversity among Indonesian provinces, with *Bactrocera* spp. being the most prevalent species (Schutze et al., 2015). Approximately 70% of these species infest horticultural crops, posing a significant threat to vegetable production (Budiyanthi et al., 2019; Hidayat et al., 2023). Under favourable conditions, fruit fly infestation in chilli can reduce yields by 30–90.1% (Hasinu et al., 2020; Jamaluddin et al., 2020). Fruit fly damage results in both quantitative and qualitative losses. Quantitative losses arise from reduced marketable yields, while qualitative losses occur from fruit deterioration, often exacerbated by secondary bacterial infections that cause fruit rot. Larval feeding damages the fruit pulp, accelerating decay and causing premature fruit drop before maturity (Danjuma et al., 2014; Muryati et al., 2017). Consequently, in the five years between 2019 and 2023, West Sumatra's chili productivity has varied, falling by 9.1, 9.45, 9.54, 10.16, and 10.71 tons/ha below the national average yield of 10.56, 11.16, 10.19, 10.05, and 11.33 tons/ha, and falling by roughly half of the potential yield of 22 tons/ha (BPS Sumbar, 2021; Sari et al., 2023).

Numerous studies demonstrate that some parasitoid species effectively control fruit fly populations, especially in areas where these pests pose significant economic risks (Dias et al., 2022). Fruit flies may naturally be harmed by the larval parasitoid

belonging to the Braconidae family (Vargas et al., 2013; Miranda et al., 2015), which is the second-largest family in the Hymenoptera order after Ichneumonidae (Ovruski et al., 2009). Regrettably, West Sumatra province's biological experiments to control fruit flies on red chilli have not been formally explained, and chilli producers are unaware of this. A comprehensive understanding of insect pest and parasitoid assemblages is fundamental for designing biologically based management strategies to control fruit fly infestations in red chilli. Accordingly, this study investigated the species composition of fruit fly parasitoids associated with indigenous red chilli varieties in West Sumatra Province, Indonesia.

2. Materials and Methods

Research Site

This study was conducted at 33 locations between October 2024 and March 2025, with elevations ranging from 15 to 1571 meters, across the four regencies/cities of West Sumatra province (Agam, Solok, Padang Pariaman, and Tanah Datar). Sampling included diverse topographies categorized into lowland (0–600), pre-mountainous (600–1500), low mountain (1500–1800), mid-mountain (1800–2700), high mountain (2700–3300), and sub-alpine (>3300), according to Michael (2019).

Procedures of host fruit rearing

From certain fields, chilli fruits that had indications of fruit fly infection (bitten, bruised, or fallen) were gathered. To enable pupation, fruits were incubated in vented plastic containers filled with wet tissue and sterile sawdust. Until adult emergence, the samples were kept in humid, shaded circumstances for 14 days. Insects that emerged were tagged with the date, variety, and location after being stored in 95% ethanol (Castilho et al., 2019).

Preservation and identification

Fruit flies and parasitoids were kept in a vial bottle with 95% ethanol. The location, research location, and sampling date were listed on the labels of each vial. The identification keys developed by Goulet & Huber (1993); Shaw M. R. & Huddleston (1991); Marinho et al. (2018) were used to identify parasitoids. Fruit fly specimens were identified at the Insect Bioecology Laboratory, Andalas University, using a stereomicroscope and the taxonomic key developed by Suputa (2006), supported by reference images from AQIS (2008) (Astriyani et al., 2016).

Data analysis

The differences in abundance among the study sites and the fluctuations in fruit fly parasitoids during the observation period were analyzed using ANOVA, followed by Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

Fruit flies and their parasitoids across topographies

210 fruit fly specimens and three parasitoid individuals were found by host-rearing in 33 red chilli fields spread over four regencies. The predominant species was *Atherigona orientalis* (86.6%), followed by *Drosophila melanogaster* (0.5%), *Bactrocera dorsalis* (8.6%), and *Silba capsicarum* (4.3%). All topographical zones showed constant presence of *A. orientalis*, indicating excellent ecological flexibility and host plasticity (Table 1). It was especially prevalent in lowland and pre-montane regions, indicating ideal conditions such as moderate humidity and temperature. The range of *B. dorsalis*, on the other

hand, was more constrained and centred on pre-montane areas. Due to their irregular and low frequency of presence, *S. capsicarum* and *D. melanogaster* may be opportunistic pests with little economic value in chilli agroecosystems. Furthermore, only lowland samples in Agam and Padang Pariaman contained the solitary parasitoid species *Diachasmimorpha longicaudata*, which was discovered at a low recovery rate (~1:70). Due to habitat disturbance, pesticide use, or climate restrictions, this low parasitism indicates that there is little natural enemy pressure in the agroecosystems that are in place today. The restricted recovery is consistent with past research showing parasitoids' susceptibility to adverse environmental factors and chemical residues.

Table 1. Association and composition of fruit fly species and parasitoids found on various topographies

Survey location	Topography	Fruit fly species				Parasitoid species
		Ao	Bd	Sc	Dm	DI
Tanah Datar	Lowland					
	Pre-montane	53	6			
Solok	Lower montane	11	3			
	Pre-montane	2				
Agam	Lowland	61		1		1
	Premontane	30	9		8	1
Padang Pariaman	Lowland	25			1	1
	Pre-montane					
Total				210		3

The dominance of *A. orientalis* and *B. dorsalis*, as indicated by the host-rearing technique results, is consistent with their status as invasive and polyphagous species that can displace native Tephritids (White, 1992). In West Sumatra's contaminated indigenous red chili fruit, *A. orientalis* was most frequently found, followed by *B. dorsalis*. This suggested that *A. orientalis* uses red chili as a host plant. In contrast, it is now believed that *B. dorsalis* is the primary insect pest of Southeast Asian horticulture crops (Clarke et al., 2005). These results were consistent with those reported by Herawani et al. (2019). Suputa et al. (2010) found that red pepper attracted more *A. orientalis* flies. According to reports,

Host plant association and species abundance

The host-rearing method's findings (Table 2) indicate statistically significant variations in fruit fly abundance between chilli varieties and regencies. With 182 individuals recorded, or 86.6% of the total, *A. Orientalis* was the most prevalent fruit fly species

A. orientalis is the main pest of bell peppers in Nigeria, causing output losses of up to 93.5% in some types (Ogbalu & Manue, 2014). Additionally, morphological characteristics, including calyx type, size, shape, and colour, as well as the presence or absence of grooves, are linked to variations in infestation levels among cultivars (Ogbalu, 1989). Furthermore, plots treated with NPK chemical fertilizer had a lower proportion of fruit infection than plots treated with chicken droppings as manure, according to Ogbalu (1999). Last but not least, the species can expand quickly due to its short life cycle (21 days), high intrinsic rate of rise (rm) (0.136), and polyphagous feeding (Herawani et al., 2019).

observed in samples grown with *Capsicum annum* variations. This suggests that it is widely distributed and highly correlated with a variety of chilli host species. Almost every chilli variety was found to contain this species, which was most prevalent in the 'Kuhay' variety in Agam (56 individuals) and the 'Akar' variety in Tanah Datar (51 individuals). *D.*

melanogaster and *S. capsicarum* were found at significantly lower frequencies (9 and 1 individuals, respectively), 8.6%, 4.3%, and 0.5%, whereas *B. dorsalis* was the second most frequent species, with 18 individuals. Notably, the parasitoid species *D. longicaudata* was absent from several host fruits and was observed only on two varieties, namely Kuhay and Keriting. Aside from that, Agam shows increased species richness and abundance (all five species were observed), suggesting a possible relationship between fruit fly diversity and region-specific environmental parameters (e.g., elevation, humidity, cropping patterns).

D. longicaudata was the parasitoid most frequently found in the infected fruit. It is believed that low parasitization results from unfriendly agricultural practices and the negative effects of pesticide treatment, which reduce the presence of parasitoids on plants (Overton et al., 2021). The availability of appropriate nutrition is one element that affects parasitoids' development (Bueno et al., 2017). Nonetheless, a notable ecological imbalance in chilli agroecosystems in the investigated locations is evident from the limited recovery of beneficial parasitoids in

our host-rearing investigation. It can be concluded that both biotic and abiotic factors, including host availability and environment, have a significant impact on the effectiveness of parasitoids in controlling fruit fly populations in chili farms. Ovruski et al. (2009) stated that the rainfall influence fruit fly parasitoids' movement, which in turn can alter their presence and parasitism rates. Furthermore, the comparison between pre-montane and lowland areas suggests that topography may have an impact on parasitoid and pest populations. According to earlier studies, microclimatic variability at altitude can have a substantial impact on the variety and abundance of natural enemies as well as pests (Perfecto & Vandermeer, 2002). Seasonality affected fruit fly populations but not parasitoid dynamics, and higher parasitism rates were observed at lower altitudes (Salazar-Mendoza et al., 2021). Moreover, parasitoid efficiency is influenced by chilli types' chemical makeup, specifically capsaicin levels. Increased levels of capsaicin may have a deleterious effect on herbivores and their parasitoids (Koswanudin et al., 2018; Jamal et al., 2021).

Table 2. Abundance and composition of fruit fly parasitoids found on local red chilli in West Sumatra

Survey location	Host chili	Fruit fly species			Parasitoid species	
		Ao	Bd	Sc	Dm	Dl
Tanah Datar	Akar	51	5			
	Rawit	2	1			
	Keriting					
	Kopay					
Solok	Akar	4	3			
	Keriting					
Agam	Kopay	9				
	Keriting	23	8		7	1
	Kuhay	56	1			1
	Akar	5				
Padang Pariaman	Rawit	7	1		1	
	Kuhay	13				
	Keriting	12	1		1	1
	Rawit					
Total		210				3

Note: Ao: *Atherigona orientalis*; Bd: *Bactrocera dorsalis*; Sc: *Silpa capsicarum*; Dm: *Drosophila melanogaster*; Dl: *Diachasmimorpha longicaudata*

4. Conclusion

The previously known *Bactrocera dorsalis* was surpassed by *Atherigona orientalis* as the most prevalent and dominant pest species. The low prevalence of parasitoids, especially *Diachasmimorpha longicaudata*, indicates an ecological imbalance that is probably caused by agrochemical activities and habitat conditions. The results highlight the pressing need for integrated pest management approaches that incorporate habitat modification, selective cultivar usage, and augmentative biological control. Future

studies should investigate landscape-level interventions to maintain natural enemy populations and examine if local cultivars are compatible with parasitoid activity.

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