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Scientific Note

March to the North: *Ceratitis capitata* (Wiedemann, 1824) (Diptera, Tephritidae) reaches Manaus, state of Amazonas, Brazil

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Abstract. Since its detection in Brazil in 1901, the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann, 1824) has continuously extended its occurrence in Brazil. The last Brazilian states in the North region of the country without records of the Mediterranean fruit fly were invaded in the current decade - Acre and Roraima in 2017 and Amapá in 2022 - leaving only the state of Amazonas to complete the spread of the Mediterranean fruit fly in all Brazilian states. In the state of Amazonas, the Mediterranean fruit fly was detected in a mango fruit purchased at a commercial establishment. This record is an alert to phytosanitary agents to establish strategies to monitor the occurrence of this pest in the state. We also discuss the first records of *C. capitata* in each Brazilian state, establishing the chronological order of these records in Brazil from 1901 to 2024.

Keywords: Mediterranean fruit fly, medfly, first record, invasive species, mango.

Ceratitis capitata (Wiedemann, 1824), commonly known as the Mediterranean fruit fly or medfly, originated from the Afrotropical region. Since its description in 1824, therefore 200 years ago, it has spread widely in Africa, Europe, Western Asia (Middle East), Central and South America, Western Australia, and the Hawaiian Islands (Liquido et al. 2020). Among the invasive Tephritidae species, *C. capitata* is the one that has invaded most countries (61), occurring in six of the eight biogeographic regions (Trombik et al. 2022). Headrick & Goeden (1996) summarized the history of medfly invasions and eradications. Invasions have been well documented in several parts of the world, therefore, *C. capitata* has been an ideal model for studies of biological invasions (Diamantidis et al. 2011). In South America, the medfly was first recorded in Brazil (Ihering 1901). According to Headrick & Goeden (1996), the medfly was registered in Argentina in 1905. The Mediterranean fruit fly is also established in Bolivia, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela (GISD 2024).

Along with its capacity to adapt to various parts of the world, *C. capitata* is a polyphagous species, whose larvae develop in fruits from 419 host species, distributed in 175 genera and 68 families (Liquido et al. 2020), considered one of the main pests of fruit growing regions worldwide. In Brazil, *C. capitata* larvae develop in 117 species of fruit trees in 31 families of which three families have more than 10 species attacked by the medfly, namely, Myrtaceae (26), Rutaceae (20) and Rosaceae (11) (Zucchi & Moraes 2024). The Mediterranean fruit fly is not considered a quarantine pest in Brazil; however, it is a restrictive pest for some countries (South Korea, the United States, Indonesia, Japan, and Malaysia) (IBRAF 2014).

After detection in the state of São Paulo (Ihering 1901), the medfly was recorded in six other Brazilian states, namely, Bahia (Bondar 1925), Rio de Janeiro (Lima 1926), Rio Grande do Sul (Carvalho 1940), Santa Catarina (Lima 1942), Minas Gerais (Schlottfeldt 1944), and Paraná (Vellozo et al. 1949). Until the 1980s, the Recôncavo Baiano, in the state of Bahia, was the northernmost point of *C. capitata* distribution in Brazil (Nascimento & Zucchi 1981). However, 10 years later, *C. capitata* was detected further north in the state of Maranhão (Morgante 1991) and five years later, it was detected in the state of Rondônia, which was the first record of the medfly in the Brazilian Amazon (Ronchi-Teles & Silva 1996).

From the 1990s onwards, records of *C. capitata* in Brazil increased significantly, due to the increase of fruit fly surveys in several Brazilian regions. Thus, *C. capitata* occurrence was detected in several Brazilian states. Among these, detection in the state of Rio Grande do Norte revealed the invasive capacity of the Mediterranean fruit fly. Until 1993, there was no published record of *C. capitata* in that state, despite intense surveys carried out in the area free of the cucurbit fly *Anastrepha grandis* (Macquart, 1846) (Araujo et al. 2000). However, seven years later, *C. capitata* was the predominant fruit fly species in the region, attacking several hosts (Araujo et al. 2000). Therefore, in a short time, *C. capitata* was adapted to the region climate adversities and competed with native species of the *Anastrepha* Schiner, 1868. The Mediterranean fruit fly has also adapted to native fruits (Lima 1926), including some fruits from the Atlantic Forest (Uramoto et al. 2023). Until the beginning of the 2020s, no fruit native to the Brazilian Amazon region was associated to this pest (Silva et al. 2011), indicating that the invasion of *C. capitata* in this region was recent. However, less than a decade later, the medfly was already attacking native fruits from the Brazilian Amazon (Araújo et al. 2016; Castilho et al. 2019; Silva et al. 2019). In general, *C. capitata* has been collected more commonly in urban areas than the *Anastrepha* species (Haji et al. 1991; Veloso et al. 2000).

By the end of the 20th century, *C. capitata* had been recorded in 15 of the 26 Brazilian states. Therefore, it took a century to invade half of the national territory; nevertheless, the rest of the territory was invaded in less than a quarter of a century (Tab. 1). By 2015, *C. capitata* had been detected in 20 states, that is, there were no records in four states in the North region (Acre, Amapá, Amazonas, and Roraima), in one state in the Central-western region (Mato Grosso), and another in the Northeastern region (Sergipe) (Zucchi 2015). In the last seven years, *C. capitata* has been detected in Acre (Adaime et al. 2017), Amapá (Costa et al. 2022), and Roraima (Trassato et al. 2017) (Tab. 1). Therefore, in the North region, only in the state of Amazonas there was no record of the Mediterranean fruit fly.

The lack or scarcity of records in some states is directly related to the neglect of fruit fly studies. This fact is most evident in the state of Sergipe, as until 2020, there were no samplings of fruit flies in that state, with the exception of an occasional collection of *A. fraterculus* (Malavasi et al. 1980). On the other hand, records of *C. capitata* in Acre and Roraima indicate a recent expansion in *C. capitata* distribution in the Brazilian Amazon. In a fruit fly survey in the states of Acre (Thomazini et al. 2003) and Roraima (Marsaro Júnior et al. 2009), *C. capitata* was not collected. The first records in these two states were detected in the 21st century (Adaime et al. 2017; Trassato et al. 2017, respectively), therefore, less than five years ago. The most recent detection was in the state of Amapá, but apparently *C. capitata* is not established in that state (Costa et al. 2022). In Amapá, the Mediterranean fruit fly was obtained in guava fruit purchased at a commercial establishment, and some specimens were also collected in Jackson-type traps baited with trimedlure. Costa et al. (2022) discussed the assumptions for the non-establishment of the pest in Amapá, and they traced the historical timeline of the Mediterranean fruit fly invasion in the Brazilian Amazon.

Table 1. First records of *Ceratitis capitata* in the 26 Brazilian states (1901-2024)*

States	References
North region	
Acre	Adaime et al. (2017)
Amapá	Costa et al. (2022)
Amazonas	**This publication**
Pará	Silva et al. (1998)
Rondônia	Ronchi-Teles & Silva (1996)
Roraima	Trassato et al. (2017)
Tocantins	Bomfim et al. (2007)
Northeast region	
Alagoas	Gonçalves et al. (2006)
Bahia	Bondar (1925)
Ceará	Sales & Gonçalves (2000)
Maranhão	Morgante (1991)
Paraíba	Lopes et al. (2007)
Pernambuco	Haji et al. (1991)
Piauí	Feitosa et al. (2007)
Rio Grande do Norte	Azevedo Júnior et al. (1998)
Sergipe	Barreto et al. (2020)
Central-West region	
Goiás	Veloso et al. (2000)
Mato Grosso	Silva et al. (2019)
Mato Grosso do Sul	Uchôa & Zucchi (2000)
Southeast region	
Espírito Santo	Martins & Alves (1988)
Minas Gerais	Schlottfeldt (1944)
Rio de Janeiro	Lima (1926)
São Paulo	Ihering (1901)
South region	
Paraná	Vellozo et al. (1949)
Rio Grande do Sul	Carvalho (1940)
Santa Catarina	Lima (1942)

*Records in abstracts of scientific events and theses were not considered.

Based on records compiled until 2023, *C. capitata* did not occur in the state of Amazonas (Silva et al. 2023), but those authors warned about the need to remain vigilant, as according to Zucchi (2015), this pest was advancing to the North region. However, in January 2024, six males and one female of *C. capitata* were obtained from a single mango fruit (*Mangifera indica* cv. Tommy Atkins), purchased at a commercial establishment in Manaus. The mango fruits were purchased on January 28, 2024, and four larvae were found in one of them on the next day. The infested mango (Fig. 1) was kept in a cage with sand in a natural environment at the Agricultural Entomology and Acarology Laboratory of the "Universidade Federal do Amazonas" (UFAM). Adults (Fig. 2) emerged between February 8 and 15, 2024. The voucher specimens (in 70% ethanol) are deposited at the Agricultural Entomology and Acarology Collection, UFAM, Coroado I, Manaus, Amazonas State, Brazil. This is the first record of the Mediterranean fruit fly in the state of Amazonas.

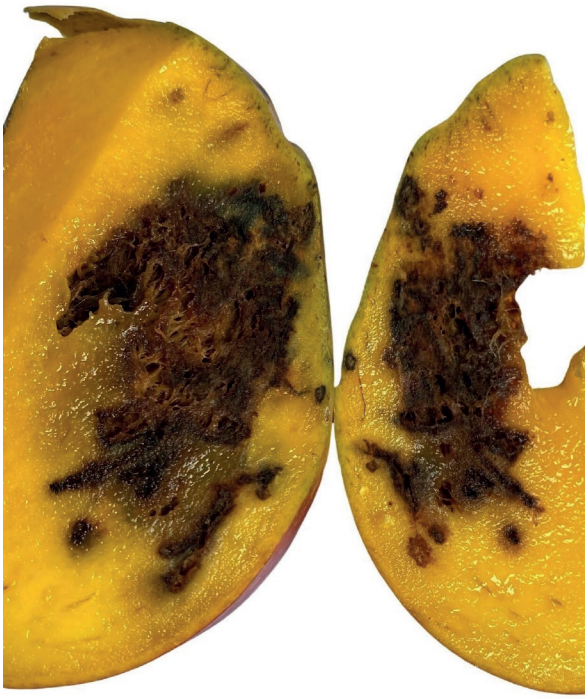

Figure 1. Mango damaged by Mediterranean fruit fly.

Figure 2. *Ceratitis capitata*: male (above); female (below).

This record is a warning to agricultural defense agents to investigate the possibility of entry of *C. capitata* into the states of Amazonas from fruits acquired from other Brazilian states for sale in Manaus and adjacent cities. This has already been clearly proven in the state of Amapá, where the introduction of *C. capitata* occurred due to the commercialization of guava fruits from the state of São Paulo (Costa et al. 2022). Therefore, it is recommended to carry out surveys using fruit sampling and traps (McPhail and Jackson types) at strategic points in the state of Amazonas, prioritizing interstate roads, ports, airports, and commercial establishments (grocery stores, markets, and supermarkets). In addition, efforts to collect native fruits are necessary to detect possible establishment of *C. capitata* in that state. This monitoring is important to verify whether the Mediterranean fruit fly will establish in the state of Amazonas, or this record is an accidental occurrence in the state, as it was observed in the state of Amapá.

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Authors' Contributions

ANSA, NMS, RAZ, RA: Conceptualization, Formal Analysis; ANSA, NMS, FCCS: Methodology, Investigation, Resources; RAZ: Writing - original draft; RAZ, ANSA, NMS, RA: Writing - review & editing.

Conflict of Interest Statement

The authors declare no competing interests.

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