Journal of Agricultural Sciences Research

ISSN 2764-0973 vol. 5, n. 7, 2025

ARTICLE 8

Data de Aceite: 03/12/2025

TROPHIC INTERACTIONS IN THE PLANT-PEST-NATURAL ENEMY RELATIONSHIP, CASE STUDY: *ANASTREPHA SPP.* AND FIVE HOST FRUITS

María de Jesús García Ramírez
Faculty of Agricultural Sciences. Autonomous University of Campeche. Escárcega, Campeche.
ORCID: 0000 -0002- 2707- 8081

Marvel del Carmen Valencia Gutiérrez
Faculty of Chemical and Biological Sciences. Autonomous University of Campeche. Campeche, Campeche .
ORCID 0000- 0002- 3671- 0296

Magnolia del Rosario López Méndez
Faculty of Humanities. Autonomous University of Campeche. Campeche, Campeche.
ORCID: 0000-0002-7919-894X

Carlos Alberto Bautista Félix
State Committee for the Promotion and Protection of Livestock in the State of Campeche. Av. Héroes de Nacozari. Campeche, Campeche

All content published in this journal is licensed under the Creative Commons Attribution 4.0 International License (CC BY 4.0).

Abstract: The objective of this study was to investigate the trophic interaction of *Anastrepha and* Schiner species (Diptera: Tephritidae) in backyards in the southeastern part of the state of Campeche, Mexico. Five fruit species were sampled: *Citrus aurantium* L. 1753 (Rutaceae), *Citrus sinensis,* Osbeck, (Rutaceae), *Psidium guajava* L. (Myrtaceae), *Talissia olivaeformis* H.B.K. (Sapindaceae), and *Zuelannia guidonea* (Sw.) Britton and Millsp (Flacourtiaceae), infested with larvae of *Anastrepha spp.* The fruits were transported to the entomology laboratory of the Faculty of Agricultural Sciences of the Autonomous University of Campeche, where they were dissected and third-instar larvae were extracted. The flies obtained were identified as: A. *ludens* (Loew) 1873, A. *obliqua* (Macquart) 1835, A. *striata* (Schiner) 1868, A. *fraterculus* (Wiedemann) 1830, and A. *zuelaniae* (Stone) 1942. The average larval infestation rates per kg of fruit ranged from 126 to 4783. Five genera of parasitoids were identified: *Diachasmimorpha longicaudata* (Ashmead) (Hymenoptera: Braconidae), *Doryctobracon areolatus* (Szépligeti), 1911 (Hymenoptera: Braconidae), *Aganaspis pelleranoi* (Bréthes), (Hymenoptera: Figitidae), *Opius bellus* (Gaham) 1930, (Hymenoptera: Braconidae), *Odontosema spp.* and *Odontosema anastrephae* (Hymenoptera: Figitidae) (Borgmeier), 1935. Parasitism rates fluctuated on average between 3.0 and 18.2%.

Keywords: Anastrepha spp, backyard, hosts, parasitoids

INTRODUCTION

Due to its proximity to the Gulf of Mexico and the Caribbean Sea, the state of Campeche in Mexico has a wide variety of microclimates and native vegetation, conditions conducive to the proliferation of *Anastrepha* species, some of which are considered a phytosanitary problem with economic losses in fruit growing in tropical and subtropical regions (Hernández, 1992, Aluja 1994), and other species that do not have an economic impact but carry out their biological cycle in commercial and wild fruits.

In addition to the above, there are other insects such as hymenoptera that act as natural enemies, regulating populations of *Anastrepha spp*, which are generally ignored, as are their benefits and impact on the environment.

In rural communities in the state of Campeche, there are backyard gardens that resemble the ecosystems to which they belong in terms of structure and function (Montemayor et al., 2007). Fruit trees are an important factor within these systems and are potential hosts for species of the genus *Anastrepha*. Until 2008, ten species of fruit flies were known to exist in Campeche, but all were captured using a trapping system and a food attractant (García et al., 2008; Tuchuc et al., 2008). It was not until studies conducted directly with fruit were published that mention was made of the interaction of hymenopteran parasitoids of the families Braconidae and Figitidae associated with *Anastrepha* species (García et al., 2009 and 2010). Therefore, the objective of this study was to determine the interaction that exists between *Anastrepha* species *and* their parasitoids present directly in fruits collected from backyard gardens, as well as to determine the relative abundance of economically and non-economically important species of these tephritids.

MATERIALS AND METHOD

This study was carried out in the southeastern region of the state of Campeche in Mexico (18° 29´ N and 90° 55´ W, with an altitude of 42.6 m, and a warm subhumid climate with rainfall in summer). The collections were carried out in three rural locations in the municipality of Francisco, Escárcega in Campeche, Mexico. Fruit sampling was conducted weekly from June to September 2021 and 2022, the period in which the highest infestation of fruit flies in backyards is reported (García et al., 2012). The fruits collected were: *Citrus aurantum* L. 1753 (Rutaceae) (bitter orange), *Citrus sinensis,* Osbeck, (Rutaceae) (sweet orange), *Psidium guajava* L. (Myrtaceae) (guava), *Talissia olivaeformis* H.B.K. (Sapindaceae) (guava), and *Zuelannia guidonea* (Sw.) Britton and Millsp, (Flacourtiaceae) (permentina); species commonly found in backyards in the region.

Nine houses with backyard orchards were visited where there were trees bearing fruit at an advanced stage of ripeness. These were collected both from the trees and from the ground. They were transported in separate 10-liter plastic buckets according to species collected to the laboratory of the Faculty of Agricultural Sciences of the Autonomous University of Campeche. In the laboratory, the fruits were weighed and dissected to extract third-stage larvae of *Anastrepha spp.* These were quantified and placed in 5 x 10 cm Petri dishes with sterilized soil in groups of 50 from each fruit collected. After 10 days, the estimated pupation time, the boxes were checked to count the pupae, which were separated individually into 5 x 5 cm plastic containers. The biological material was kept in the laboratory at room temperature (32 ± °C) and checked daily to record the emergence of adult flies (males and females) and/or possible parasitoids. When the adults emerged (flies or parasitoid), they were placed in 4 cm amber glass vials with 70% alcohol and subsequently identified, following the keys of Zuchii (2000) and Korytkowski (2008) for fruit flies; the parasitoids were identified using the keys of Wharton (1988). For data analysis, the infestation index, relative abundance, and parasitism index of the material obtained were determined using the formulas used by Nuñez *et al.*, 2004, and Schliserman and Ovruski, 2004

% Infestation = Number of third-stage larvae/kg of fruit collected X 100.

Relative abundance = Total number of insects of a species/Total number of emerged insects X 100.

Specimens and plant samples were deposited in the entomological collection and herbarium of the Faculty of Agricultural Sciences and the Center for Sustainable Development of the Autonomous University of Campeche.

RESULTS AND DISCUSSION

A total of 888 third-instar larvae were obtained from *C. aurantum*, from which 456 adults emerged, maintaining a sex ratio of 1:1. The most abundant species was *A. ludens* (Loew) 1873, interacting with A. *obliqua* (Macquart) 1835, in a ratio of 67-77% and 22-33%, respectively, while infestation rates remained similar in both sampling periods per fly species (Table 1). Schliserman and Ovruski, in 2004, put forward the theory that when the relative abundance ratio of a species in a host has a difference of 70% or more, it is a plant that is serving as

a refuge for the secondary pest due to the unavailability of its preferred host. In addition to the above, data show that in the state of Campeche, the main species found in mango orchards is A. *obliqua* (García *et al.*, 2008, Tucuch *et al.*, 2008), however, during the collection of biological material for the preparation of this document, mango trees were observed in the backyard, but there were no fruits available; this is , which suggests that A. *obliqua* uses C. *aurantum* as a reservoir in low populations to remain present until its preferred host is available.

In *C. sinensis*, 45 third-stage larvae were recovered, with 11 adults of *A. ludens* emerging in a 1:1 sex ratio and a similar infestation rate in both periods. Table 1 shows a clear difference in the preference of *A. ludens* for *C. aurantium* fruit, with higher infestation rates compared to *C. sinensis*, but in the latter, the interaction of *Diachasmimorpha longicaudata* (Ashmead), (Hymenoptera: Braconidae), was observed in both periods with parasitism rates of 6.25% and 30.27%, respectively. This wasp is known to be one of the exotic parasitoids that have been released until its establishment (Ovrusky et al., 2000), and although there is no data indicating that these releases are carried out in the state of Campeche, the results indicate that the wasp is naturally present in the backyard. Supporting the above in sour oranges, although to a lesser extent, the interaction of two wasps, *Doryctobracon areolatus* (Szépligeti), (Hymenoptera: Braconidae) and D. *longicaudata,* was also found. These insects have previously been reported as parasitoids of *Anastrepha spp.* (López et al., 1999) but which had not been reported in the state of Campeche recovered from fruits of the Rutacea family in backyard gardens.

From the fruits of *P. guajava*, 1,742 larvae were obtained, from which 1,068 adults emerged in a sex ratio of 1:1. The species recovered were: *A. fraterculus* (Wiedemann) 1830, and A. *striata* (Schiner) 1868 in proportions of 79% and 30%, respectively, in both periods, maintaining the infestation index between 2530 and 2899 (Table 1). A study conducted by García *et al.* (2009) reports that the relative abundance of fly species in guava fruit was 80% and 20%, with A. *striata* being the most abundant species during two years of sampling. They mention that A. *fraterculus* is a species that is becoming the main pest in guava cultivation in the state of Campeche and, over time, is displacing A. *striata,* considered the main pest of these fruits.

Aluja *et al*. (2000) mention that, in the state of Veracruz in Mexico, *A. striata* and *A. fraterculus* are present in wild guava fruits, alternating their relative abundance per crop cycle. They propose the theory of species regulation, whereby the secondary pest regulates the primary pest, preventing it from becoming a phytosanitary problem and spreading to commercial crops. In the present study, based on two years of results, no alternation of *Anastrepha* species was observed, but there are indications to support the theory of displacement of a primary pest by a secondary one. The interaction of two species of hymenoptera, *Aganaspis pelleranoi* (Bréthes) (Hymenoptera: Figitidae) and D. *areolatus,* was also found, with a level of parasitism between 7 and 12% respectively. The data corroborate the findings reported by (García *et al.*, 2009) for the state of Campeche and (Hernández *et al.*, 2006) for the state of Yucatán regarding the "plant-phytophagous-parasitoid" relationship, with a similar percentage of parasitism.

In fruits of *T. olivaeformis*, 1,980 third-stage larvae were obtained, from which 1,648 adult flies of the species *A. fraterculus* and *A. ludens* emerged in abundance ratios of 99 to 1%, respectively, while infestation rates remained similar and the sex ratio remained 1:1 in both sampling periods. The interaction of two species of hymenoptera, *D. areolatus* and *Opius bellus* (Gaham) 1930, (Hymenoptera: Braconidae), was also found. This species is reported for the first time in this document in *T. olivaeformis* fruits in the state of Campeche in backyard gardens. Guagliomi (1966), in a sampling in Venezuela, reports having recovered species of *Anastrepha spp.* in guaya fruits, but the species of flies was never determined. It was not until García *et al.* (2010) reported finding A. *fraterculus* and A. *ludens* in these fruits in a ratio of 99 to 1%, respectively, which is similar to the present study. These same authors also mention the interaction with D. *areolatus;* this parasitoid has been linked to A. *fraterculus* in several studies (López *et al.*, 1999; Schliserman and Ovruski, 2004; Hernández *et al.*, 2006). In the case of Z. *guidonea*, a total of 1,169 third-stage larvae were obtained with the emergence of 731 adult flies. The sex ratio was 1.4 males per 1 female in both sampling periods. In the 2021 sampling period, the species found were A. *fraterculus,* A. *ludens*, and A. *zuelaniae* (Stone) 1942, with relative abundance proportions of 6.6, 6.8, and 86.5%, respectively, and an infestation index of 3091. In the second sampling period in 2022, the only species found was A. *zuelaniae* with an infestation index of 830, considerably lower than in the first sampling. Regarding the presence of hymenoptera interaction in 2021, three species were found: *Odontosema spp.*, *Odontosema anastrephae* (Borgmeier),

Host	Kg fruit	% of infestation	*Anastrephas spp* (A. R. %)	% Parasitism	Parasitoids
C. aurantum	114	775	*A. ludens* 72.1 *A. obliqua* 27.7	7.4	*D. longicaudata*
C. sinensis	37	126	*A. ludens* 100.0	18.2	*D. longicaudata* *D. aerolatus*
P. guajava	64	2714	*A. striata* 20.6 *A. fraterculus* 79.3	9.7	*A. pellenanoi* *D. aerolatus*
T. olivaeformis	41	4783	*A. fraterculus* 98.3 *A. ludens* 1.3	3.0	*D. aerolatus* *O. bellus*
Z. guidonea	57	1960	*A. fraterculus* 6.6 *A. ludens* 6.8 *A. zuelaniae* 86.5	17.4	*Odontosema spp* *O. anastrephae* *A. pelleranoi*

Table 1.- Average variables of: % larval infestation per fruit, relative abundance per *Anastrepha* species, and % of parasitoids emerged in different hosts

1935 (Hymenoptera: Figitidae), and A. *pelleranoi.* In 2022, the interaction of two hymenoptera was observed: D. *areolatus* and A. *pelleranoi.* Regarding the presence of *Anastrepha* species found in permentina, several authors mention only the relationship of A. *zuelaniae* associated with *Z. guidonea* fruits (Norrbom and Kim 1988; Foote *et al.*, 1993), which coincides with the present work in 2015. there is also a report mentioning A. *fraterculus* and A. *striata* in permentina fruit, interacting with D. *areolatus* and O. *anastrephae* (García et al., 2010), which is similar to the findings of the present study in 2021. In general, based on the results of both periods, it could be thought that A. *zuelaniae* is taking over its host as the primary pest in the state of Campeche, while *A. fraterculus* could be defined as a secondary pest present in permentina fruit; A. *ludens* uses the host as a reservoir, but to substantiate these claims, further research in backyard gardens is needed to corroborate the theory. (Table 1).

CONCLUSION

This study determined that backyard gardens in southeastern Campeche, Mexico, are conducive to the interaction of *Anastrepha* species and their hosts and parasitoids, both those of economic importance and those that do not pose a phytosanitary threat. It is recommended to monitor wild plants in particular and to study the biology and habits of parasitoids, which are possible candidates as biological control agents. A total of 313 kg of fruit was collected from backyard gardens of the species C. *aurantium, C. sinensis, P. guajava. T. olivaeformis, and Z. guidonea,* yielding 5,824 third-instar larvae, from which 3,914 adults emerged belonging to five species: *A. ludens, A. obliqua, A. striata, A. fraterculus, and A. zuelaniae.* The percentages of larval infestation per kg of fruit averaged between 126 and 4,783. A total of 264 parasitoids were also obtained, corresponding to five genera: D. *longicaudata, D. areolatus, O. bellus, A. pellaranoi, Odontosema anastrephae, Odontosema spp.* (Table 1). The average parasitism rates ranged between 3.0 and 18.2.

References

Aluja, M. 1994. Biomomics and management of Anastrepha. *Annual Review of Entomology*, 39: 155–178.

Aluja, M., Piñero, J., Jácome I. and F. Díaz-Fleischer. 2000. Behavior of Flies in the Genus *Toxotrypana* (Trypetinae: Toxotripanini). In: M. Aluja, y A. L. Norrbom. (Eds.). Fruit Flies (Tephritidae) Phylogeny and Evolution of Behavior. CRC. USA. ISBN: 0-8493-1275-2. *Memorias de las Convención Nacional de Entomología*. Lima. Perú.

Foote, R. H., Blanc, F. L. and A. L. Norrbom. 1993. *Handbook of the Fruit Flies (Diptera: Tephritidae) of America North of Mexico*. Comstock Publishing Associates, Ithaca. Xii. 571 pp.

García, R. M. J., Maldonado-Arrollo, M., López-Martínez, V., Encalada-Mena, L. y J. J. Vargas-Magaña. 2008. *Atracción de Anastrepha spp. a trampas cebadas con frutos naturales en Campeche, México*. 7a Reunión de grupo de trabajo en moscas de la fruta del hemisferio occidental. Mazatlán, Sinaloa, México.

García, R. M. J., Gómez, R. E., López, B. J. M., Médina, M. V. y M. L. Encalada. 2009. Incidencia de Parasitoides en larvas de *Anastrepha* spp. en frutos de *Psidium guajava*, en Campeche, México. In: Estrada, V. E., Equihua, M. A., Chaires, G. P., Acuña, S. J., Padilla, R. R. y Mendoza, E. A. Entomología Mexicana. Vol. 9.

García, R. M. J., Medina-Hernández, R. E., López-Martínez, V., Vázquez-López, M., Duarte, U. I. E. and H. Delfín-González. 2010a. *Talisia Olivaeformis* (Sapindaceae) and *Zuelania guidonia* (Flacourtiaceae): New Host Records for *Anastrepha spp*. (Diptera:Tephritidae) in México. *Florida Entomologist*, 93(4): 633–634.

García, R. M. J., Medina, H. R. E., Baeza, G. J. M., López, M. V., Vázquez, L. M. and M. L. Encalada. 2010. Incidence of parasitoids of *Anasthepha* spp., in backyard ochards in the southe of Campeche, Mexico. *8th international symposium on fruit flies of economic importance*. Valencia (Spain). 26 sept-1 oct.2010. Editorial Universitat politecnica de Valencia. 342 pp.

García, R. M. J., López, M. V., Bolivar, F. N., Valencia, G. M. y M. L. Encalada. 2012. *Interacciones tróficas de Anastrepha spp. y sus parasitoides en dos hospederos silvestres, en el sureste del estado de Campeche, México*. In: C. E. Ruiz, y B. J. Coronado. Recursos Naturales. Universidad de Tamaulipas. 1ª ed.

Gliessman, S. R. 1987. Species interactions and community ecology in low external-impact agriculture. *American Journal of Alternative Agriculture*, 2: 160–165.

Guagliumi, P. 1966. Insetti e aracnidi delle piante comuni del Venezuela segnalatinel periodo 1938-1963. *Relaz. Monogr. Agr. Subtrop. Trop. (N.S.)*, 86: 392 pp.

Hernández, O. V. 1992. *El género Anastrepha Schiner en México (Diptera. Tephritidae). Taxonomía, Distribución y sus Plantas Huéspedes*. Instituto de Ecología Publ. 33. Xalapa, México. 162 pp.

Hernández, O., Delfin, G. H., Escalante T. A. and S. P. Manrrique. 2006. Fruit flies (Diptera: Tephritidae) reared from different hosts in Yucatán, México. *Florida Entomologist*. 89(4) 508–515.

Korytkowski, C. A. 2008. Manual para la identificación de moscas de la fruta del género *Anastrepha* Schiner, 1868. Universidad de Panamá. 145 pp.

López, M., Aluja, M. and J. Sivinski. 1999. Hymenopterous larval-pupal and pupal parasitoids of *Anastrepha* flies (Diptera: Tephritidae) in Mexico. *Biological Control*, 15: 119–129.

Montemayor, M. M. C., Estrada, P. C., Packardiii, J. M., Treviño, G. E. J. y M. H. Villaón. 2007. *El traspatio un recurso local en los servicios de "turismo rural familiar" alternativa de desarrollo sustentable municipal - caso: San Carlos, Tamaulipas, México*, Revista de investigación en turismo y desarrollo local.

Norrbom, A. L. and K. C. Kim. 1988. *A List of the Reported Host Plants of the Species of Anastrepha (Diptera: Tephritidae)*. U.S. Dep. Agric., APHIS, PPQ, APHIS. 81-52.

Nuñez, B. L., Gómez, R. S., Guarin, G. y G. León. 2004. Moscas de las frutas (Diptera:Tephritidae) y parasitoides asociados a *Psidium guajava* y Coffea arabica L. en tres municipios de la Provincia de Vélez (Santander, Colombia). Parte 1: Índices de infestación y daño por moscas de la frutas. *Corpoica*, 1(5): 5–11.

Ovruski, S. M., Aluja, M., Sivinski, L. and R. A. Wharton. 2000. Hymenopteran parasitoids on fruit – infesting tephritidae (Diptera) in Latin America and the southern United States: diversity, distribution, taxonomic status and their use in fruit fly biological control. *Integrated Pest Management Review*, 5: 81–107

Schliserman, P. y S. Ovruski. 2004. Incidencia de moscas de la fruta de importancia económica sobre *Citrus aurantium* (Rutaceae) en Tucumán, Argentina. *Manejo Integrado de Plagas y Agroecología (Costa Rica)*, 72: 44–53.

Tucuch, C. F. M., Chi, Q. G., y C. F. Orona. 2008. Dinámica poblacional de adultos de la mosca mexicana de la fruta *Anastrepha* sp. (Diptera: Tephritidae) en Campeche, México. *Agriccultura Técnica. México*, 34: 341–347.

Wharton, R. A., Ovruski, S. M. and F. E. Gilstrap. 1998. Neotropical Eucoilidae (Cynipoidea) associated with fruit infesting Tephritidae, with new records from Argentina, Bolivia and Costa Rica. *Journal of Hymenoptera Research*, 7(1): 102–115.

Zucchi, R. A. 2000. Taxonomía. Pp. 13–24. In: A. Malavasi and R. A. Zucchi. (Eds.). *Moscas-das-frutas de importancia economica no Brasil: Conhecimento básico e aplicado*. Riberao Preto, SP, BR, Holos, Editora Ltda-ME.