BIOLOGICAL CONTROL

Effect of Time of Permanence of Host Fruits in the Field on Natural Parasitism of *Anastrepha* spp. (Diptera: Tephritidae)

ELEN L. AGUIAR-MENEZES[1] AND EURIPEDES B. MENEZES[2]

[1]*Embrapa Agrobiologia, BR 465, km 7, C. postal 74505, 23890-000, Seropédica, RJ*
[2]*Universidade Federal Rural do Rio de Janeiro, CIMP "CRG", BR 465, km 7, 23890-000, Seropédica, RJ*

Neotropical Entomology 31(4):589-595 (2002)

Efeito do Tempo de Permanência de Frutos Hospedeiros no Campo no Parasitismo Natural de *Anastrepha* spp. (Diptera: Tephritidae)

RESUMO - Este trabalho avaliou a influência do tempo de permanência do fruto no campo, após sua queda, no parasitismo natural de *Anastrepha* spp. Em fevereiro/2000, três árvores de serigüela (*Spondias purpurea* L.) e três goiabeiras (*Psidium guajava* L.) foram selecionadas na Universidade Federal Rural do Rio de Janeiro. Foram coletados 250 frutos infestados por árvore, cinqüenta dos quais foram levados diretamente para o laboratório para obtenção de pupas de Tephritidae (frutos sem exposição no campo - tempo zero). Os demais frutos foram divididos em quatro amostras colocadas em bandejas plásticas com areia, dispostas sob a copa das árvores. Após cada dois dias, os frutos de uma bandeja eram levados para o laboratório. Em serigüela, foram obtidas 1123 moscas do gênero *Anastrepha* [*A. obliqua* (Macquart) e *A. fraterculus* (Wiedemann)] e 1880 parasitóides Hymenoptera (Braconidae, Figitidae e Pteromalidae). Em goiaba, foram obtidos 4714 adultos de *Anastrepha* spp. (*A. obliqua, A. fraterculus* e *A. sororcula* Zucchi) e 383 parasitóides Hymenoptera (Braconidae, Figitidae e Pteromalidae). A mais alta percentagem de parasitismo causada pelos Braconidae (67,2% em serigüela e 6,4% em goiaba) foi registrada no tempo zero, sugerindo ter preferência em procurar por suas larvas hospedeiras em frutos ainda presos à planta. A maior percentagem de parasitismo causada pelos Figitidae (2,8% em serigüela e 4,7% em goiaba) ocorreu aos seis dias de permanência dos frutos no campo. Para os Pteromalidae, registrou-se a maior percentagem de parasitismo em frutos que permaneceram no campo por oito dias (2,4% em serigüela e 1,9% em goiaba).

PALAVRAS-CHAVE: Mosca-das-frutas, percentagem de parasitismo, Braconidae, Figitidae, Pteromalidae

ABSTRACT - The present work evaluated the influence of time of permanence of the fruit in the field after its abscission on natural parasitism of *Anastrepha* spp. In February 2000, three trees of Spanish prune (*Spondias purpurea* L.) and three guava tree (*Psidium guajava* L.) were selected in the Universidade Federal Rural do Rio de Janeiro, State of Rio de Janeiro, Brazil. Sampling consisted of 250 infested fruits collected per tree. Fifty of them were taken immediately to the laboratory in order to obtain Tephritidae pupae (0-day exposure). The remaining fruits were divided in four batches and placed in plastic trays on a layer of sand, underneath the tree canopy. Every other day, the fruits of one tray were transported to the laboratory (2, 4, 6 and 8 days exposure). A total of 1,123 flies of the genus *Anastrepha* [*A. obliqua* (Macquart) and *A. fraterculus* (Wiedemann)] and 1,880 Hymenopteran parasitoids (Braconidae, Figitidae and Pteromalidae) were recovered from Spanish prune. From guava, 4,714 adults of *Anastrepha* spp. (*A. obliqua, A. fraterculus* and *A. sororcula* Zucchi) and 383 Hymenopteran parasitoids (Braconidae, Figitidae and Pteromalidae) were obtained. The highest percent parasitism by Braconidae (67.2% in Spanish prune and 6.4% in guava) was recorded on fruits of 0-day, suggesting that they would prefer the larvae in the fruits while on the tree. For Figitidae the higher percent parasitism (2.8% in Spanish prune and 4.7% in guava) occurred on fruits present for six days in the field and for Pteromalidae in fruits present for eight days (2.4% in Spanish prune and 1.9% in guava).

KEY WORDS: Fruit fly, percent parasitism, Braconidae, Figitidae, Pteromalidae

Flies in the genus *Anastrepha* Schiner are serious pests of commercially grown fruits in the tropical and subtropical regions of the New World. Insecticide bait sprays targeted at tephritid pests continue to be the most widely used control method in Brazil. However, with the increased public concerns over the risk of pesticides use to both the environment and human health as well as over conservation of biodiversity in the agro-ecosystems, biological control tactics are now receiving greater attention by producers and researchers. Several studies have suggested that augmentative releases of parasitoids have great potential for reducing tephritid pest population (Wong & Ramadan 1987, Knipling 1992, Wong *et al*. 1992). For example, the augmentative release of *Diachasmimorpha longicaudata* (Ashmead) is an outstanding success in the biological control of Caribbean fruit fly, *Anastrepha suspensa* (Loew) in Florida (Baranowski *et al.* 1993, Sivinski 1996). This exotic Old-world opiine was recently introduced in Brazil and has been released in an attempt to control *Anastrepha* spp. populations in some regions of this country (Nascimento *et al.* 1998, Carvalho *et al.* 1999).

Foraging over fallen fruits should be taken into account in order to have a close estimate of the impact of parasitoids on fruit fly population levels since several studies showed that females of *D. longicaudata* are commonly observed attacking fruit fly larvae in rotting fruits on the ground, using the odors from fungal fermentation to locate the hosts (Greany *et al.* 1977, Leyva *et al.* 1991, Messing & Jang 1992, Purcell *et al.* 1994). For example, in Hawaii, parasitism levels of only 1% to 3% of *Bactrocera dorsalis* (Hendel) (Tephritidae) by *D. longicaudata* were reported in tree-collected fruits or combined with ground-collected fruit samples (Wong *et al.* 1984, Vargas *et al.* 1993). On the other hand, Purcell *et al.* (1994) observed that this parasitoid accounted for up to 24% of parasitism of *B. dorsalis* in guava fruits that remained on the ground for 6-10 days after abscission. They concluded that the impact of this parasitoid on tephritid population is usually underestimated by sampling ripe guava from the tree or freshly fallen fruits on the ground.

In this context, the present work aimed to determine the effect of the time of permanence of fruits in the field after their abscission on parasitism of *Anastrepha* spp. by native species. The overall goal was to provide preliminary information on the native community of fruit fly parasitoids present in the study area, such as parasitoid diversity, host searching behavioral pattern and percent parasitism. As far as we are aware of, no biological control of tephritid pests has been attempted in this area; thus, the results should reflect the natural status of the fruit fly parasitoids.

Materials and Methods

Samplings were carried out on three Spanish prune trees (*Spondias purpurea* L.) and three guava trees (*Psidium guajava* L. cv. 'Guanabara') in the Universidade Federal Rural do Rio de Janeiro (UFRuralRJ), in Seropédica, in February 2000. The city of Seropédica is located in Southeast Brazil at 22º 46'S latitude, 43º 41'W longitude and 33 m of altitude. The climate is defined as humid-warm, with mean annual temperature of 22.7ºC and 1200 mm rainfall concentrated in the summer (FIDERJ 1976). In the study period, there was an abundance of fully ripe fruits in the canopy of the sampled trees. The ground underneath the tree canopy was cleared of extraneous fruits, leaves and debris. Afterwards, the branches were gently shaken to dislodge fully ripe fruits. These fruits constituted the samples and were assumed to be ready to drop of their own accord (natural abscission) and, hence, had completed their time of exposure to parasitoids foraging in that portion of the tree canopy. Samples of 250 fruits each were collected per tree: 50 were immediately transferred to the laboratory, whereas 200 remained in the field and were divided into four batches of 50 fruits each. Each batch was placed on a 2-cm layer of slightly moistened sand inside a 40 cm x 30 cm x 6 cm plastic tray with the bottom perforated and covered with organdy. As fruits continued to naturally fall from the trees during the period of the experiment, the sampled fruits were identified with a thumbtack introduced into the scar of the fruit pedicel. For each tree, four trays were placed at ground level under the respective canopies, placing one tray per quadrant. To avoid predation by ants, the trays were placed on top of aluminum cans (9 cm tall x 7 cm in diameter), with their base immersed in a water-detergent solution held in plastic bowls. The trays were inspected daily when the fruits not belonging to the samples were discarded and the sand was remoistened. Every other day, the fruits of one of the four trays were transported to the laboratory of the "Centro Integrado de Manejo de Pragas Cincinnato Rory Gonçalves" (CIMP CRG) at the UFRuralRJ. Therefore, each sampling day represented a different treatment: two, four, six and eight days of permanence of the fruits in the field after abscission. In the laboratory, the thumbtacks were removed and the fruits placed in plastic sieves, which in turn, were placed on top of five-liter plastic buckets with a 15-cm layer of sand (pupation substrate) at the bottom. Sand from the trays and the buckets was sifted to remove larvae and/or pupae, which were counted and transferred into 250-ml plastic cups with a 2-cm layer of slightly moistened sand. The cups were placed in 2-liter plastic containers with screened lids to hold the flies and parasitoids after emergence. These containers were kept at room-environmental conditions and inspected every other day to ascertain if the sand needed to be remoistened.

The 50-fruit samples that were taken directly to the laboratory represented the treatment 0-day of exposure (i.e.; fruits without field exposition after abscission). In the laboratory, these samples were processed as previously described.

Fly and parasitoid emergence was checked every day for a period of 30 days after pupation. The adults of both insect types were maintained alive for two to three days to achieve their full coloration; after that, they were killed and preserved in 70% ethanol for further identification. The species of *Anastrepha* and their parasitoids were identified based on available taxonomic keys and descriptions (Canal Daza *et al.* 1994, Guimarães 1998, Canal & Zucchi 2000, Zucchi 2000). Some specimens were sent to Jorge A. Guimarães (Escola Superior de Agricultura Luiz de Queirós, Piracicaba, State of São Paulo, Brazil) and to the Systematic

Entomology Laboratory, USDA-ARS, Beltsville, MD, USA) to confirm the identifications. Voucher specimens of fruit flies and their parasitoids were placed in the entomological collection of the CIMP CRG and the U.S. National Collection.

Percent parasitism was based on the number of emerging adult flies and parasitoids. Data on differences among times of permanence of the host fruits in the field were compared using analysis of variance (ANOVA) and Fisher's test (α = 0.05). Means were separated by Tukey's test ($P \leq 0.05$). Regression analysis by orthogonal polynomials was used to determine the functional relationship between time of permanence of the fruits in the field and percent parasitism. The statistical tests were performed with the STATDISK program (Password Inc. 1998).

Results and Discussion

A total of 4,427 puparies of Tephritidae was recovered from the Spanish prune fruits, from which 1,123 fruit flies and 1,880 hymenopteran parasitoids emerged. All flies belonged to the genus *Anastrepha* and two species were identified: *A. obliqua* (Macquart) and *A. fraterculus* (Wiedemann). The first species was more abundant, representing 83% of all specimens recovered. Five parasitoid species were obtained in association with these fly species: *Doryctobracon areolatus* (Szépligeti), *Utetes* (*Bracanastrepha*) *anastrephae* (Viereck) and *Opius bellus* Gahan (Braconidae: Opiinae), *Odontosema anastrephae* Borgmeier (Figitidae: Eucoilinae), *Spalangia endius* Walker and *Pachycrepoideus vindemmiae* Rondani (Pteromalidae). This is the first record of *O. anastrephae* in the state of Rio de Janeiro (Aguiar-Menezes & Menezes 2000).

From the guava fruits, 8,016 puparies of Tephritidae were obtained, from which emerged 4,714 adults of *Anastrepha* and 383 hymenopteran parasitoids. *A. fraterculus* accounted for 55% of all flies recovered, 38% were *A. sororcula* Zucchi and 7% *A. obliqua*. The species of parasitoids were: *O. anastrephae, Aganaspis pelleranoi* (Brèthes) (Figitidae: Eucoilinae), *D. areolatus* (Braconidae: Opiinae) and *P. vindemmiae* (Pteromalidae).

The remaining 1,424 and 2,919 puparies of Tephritidae, which were respectively obtained from the Spanish prune and guava fruits, did not result in emergence of adults 30 days after pupation. Although these were not dissected to verify if any live or dead pupa or adult of fly or parasitoid remained within the puparies.

Most parasitoid specimens were Braconidae (Opiinae): ca. 97% and 73% in Spanish prune and guava, respectively. They were recovered from all treatments and were the only ones collected from 0-day and 2-day field-exposed fruits (Tables 1 and 2). The highest percent parasitism by braconids was in the 0-day samples (67.2% in Spanish prune and 6.4% in guava), and declined gradually in fruits with two to eight days of permanence in the field after abscission (Figs. 1A and 1D).

Table 1. Mean percent parasitism of *Anastrepha* spp. by Hymenoptera in samples of Spanish prune (*S. purpurea*) fruits collected after five different periods of field-exposure on the ground (treatments) in Seropédica County, State of Rio de Janeiro, Brazil, in February 2000.

Treatment (day)	Mean percent parasitism					
	Braconidae			Figitidae	Pteromalidae	
	D. areolatus	*U. anastrephae*	*O. bellus*	*O. anastrephae*	*S. endius*	*P. vindemmiae*
0	40.8 a	23.3 a	3.1 a	0 b	0 b	0 b
2	38.2 a	20.6 a	3.0 a	0 b	0 b	0 b
4	37.9 a	20.0 a	2.1 ab	2.2 a	1.0 a	0 b
6	37.4 a	21.6 a	1.4 b	2.8 a	0.5 ab	1.2 a
8	26.9 b	16.7 a	1.5 b	0 b	0 b	2.4 a

Means within a column followed by the same letter are not significantly different by the Tukey's test ($P \leq 0.05$).

.

Table 2. Mean percent parasitism of *Anastrepha* spp. by Hymenoptera in samples of guava (*P. guajava*) fruits collected after five different periods of field-exposure on the ground (treatments) in Seropédica County, State of Rio de Janeiro, Brazil, in February 2000.

Treatment (day)	Mean percent parasitism			
	Braconidae	Figitidae		Pteromalidae
	D. areolatus	*A. pelleranoi*	*O. anastrephae*	*P. vindemmiae*
0	6.4 a	0 b	0 b	0 b
2	5.9 a	0 b	0 b	0 b
4	5.2 b	2.4 a	0.5 b	0.7 bc
6	4.8 b	3.7 a	1.0 a	1.1 ab
8	3.9 c	1.6 ab	0 b	1.9 a

Means within a column followed by the same letter are not significantly different by the Tukey's test ($P \leq 0.05$).

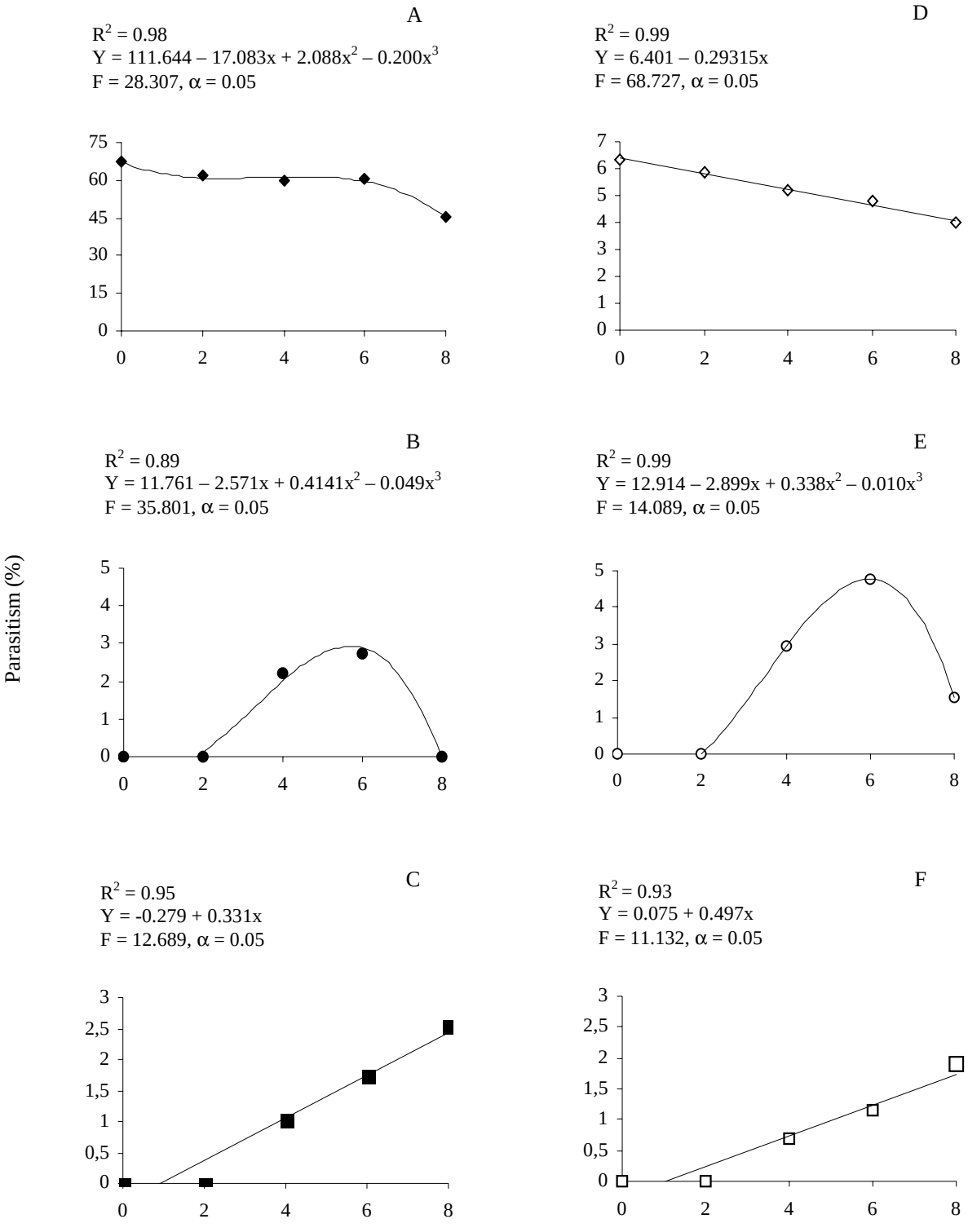

Figure 1. Relationship between the mean percent parasitism of *Anastrepha* spp. by Braconidae, Figitidae and Pteromalidae in Spanish prune (*S. purpurea*) (A, B and C, respectively) and guava (*P. guajava*) (D, E and F, respectively) fruit samples collected after five different periods of field-exposure on the ground in Seropédica County, State of Rio de Janeiro, Brazil, in February 2000.

The highest percent parasitism by *D. areolatus* occurred particularly in fruits that were taken directly to the laboratory (i.e., without exposition in the field after abscission) (Tables 1 and 2); however, this parasitism level did not differ significantly from those recorded in Spanish prunes exposed for two to six days in the field, and in guavas exposed for two days. For *U. anastrephae*, there were no significant differences in percent parasitism among the times of field exposure of Spanish prunes, but the parasitism levels by *O. bellus* were significantly higher in that fruit species exposed for zero to four days. These results suggest that the three species of Braconidae have a preference for attacking their host larvae developing in fruits hung on the tree. A similar behavioral pattern was described by Pemberton & Willard (1918) for *Diachasmimorpha* (= *Diachasma*) *tryoni* (Cameron), whose females oviposited in the host larvae in fruits after they had fallen to the ground and with equal success attacked larvae in fruits before downfall; however, the highest parasitism occurred while the fruits were still on the tree.

Females of *D. longicaudata*, which was recently introduced in Brazil (Nascimento *et al.* 1998, Carvalho *et al.* 1999), prefer to attack fruit fly larvae in ground-rotting fruits (Greany *et al.* 1977, Leyva *et al.* 1991, Messing & Jang 1992, Purcell *et al.* 1994). Therefore, it seems that there will be less chance of competition between this exotic opiine and the native opiines present in the study area once they showed preference for searching host larvae in fruits that were still on the tree. Thus, it is possible that the use of augmentative releases of *D. longicaudata* may lead to additional mortality of pest tephritids and could be a viable alternative control method.

In the present study, the diversity of parasitoid species increased when the fruits remained for four or more days on the ground. In addition to Braconidae, species of Figitidae and Pteromalidae were found in older fruit samples (Tables 1 and 2). Similar results were obtained by Salles (1996) who collected braconids and figitids from fallen fruits on the ground but recovered only braconids from tree-harvested fruits.

The highest parasitism levels by Figitidae (Eucoilinae) were recorded from fruits, which had remained for six days on the ground: 2.8% in Spanish prune and 4.7% in guava (Figs. 1B and 1E). However, the percent parasitism by *O. anastrephae* in Spanish prune did not differ significantly from that found in fruits of four days of permanence in the field (Table 1), and by *A. pelleranoi* in guava exposed for four and eight days in the field (Table 2). Fruits that remained for more than four days in the field after abscission had crevices and holes, which probably favored parasitism by Eucoilinae since the females generally enter wounds previously existent in fruits to search for host larvae within the pulp (Ovruski 1994). It was also verified that all specimens of *A. pelleranoi* were recovered from guava samples, and 66.7% of the specimens of *O. anastrephae* were recovered from Spanish prune and the remainder from guava. In contrast, Wharton *et al.* (1998) collected 74% of all specimens of *O. anastrephae* from guava, and López *et al.* (1999) found both eucoiline species almost exclusively in guavas [*P. guajava, P. sartorianum* (Berg.) Ndzu., and *P. guineense* Sw.]. According to Guimarães *et al.* (1999, 2000), both these eucoilines search for their host larvae in different fruit species; however, they attack the larvae most frequently in fruits of Myrtaceae.

The highest percent parasitism by Pteromalidae was recorded in fruits that had remained on the ground for eight days: 2.4% in Spanish prune and 1.9% in guava (Figs. 1C and 1F), and caused by *P. vindemmiae* in particular (Tables 1 and 2). In this sampling day, most larvae had already pupated, and this might have allowed a more effective action of this pteromalid because it is a pupal parasitoid of Diptera, including Tephritidae (Ovruski *et al.* 2000). However, the highest percent parasitism by the pupal parasitoid *S. endius* occurred in Spanish prune fruits exposed for four days in the field, when few pupae were recovered from the trays, but this rate did not significantly differ from that found in six-day field exposed fruits (Table 1).

In Brazil, orchard sanitation by removing fallen fruits from the ground is a cultural practice technically recommended for the control of fruit flies in commercial orchards and is commonly used by growers. Thus, from a practical standpoint, our results indicate that this practice reduces or hinders the possibility of parasitism by parasitoids that search for host larvae most frequently in abscised fruits (e.g. *A. pelleranoi*). In this case, the efficiency of *D. longicaudata* should be also affected. Because the commercial orchards are usually attacked by fruit flies that come from surrounding wild vegetation (Puzzi & Orlando 1965, Bateman 1972, Herrera & Viña 1977, Malavasi & Morgante 1981), parasitoid releases could be concentrated in these marginal areas, and still be compatible with the strategies of fruit fly management adopted by growers.

Acknowledgments

The authors would like to acknowledge the "Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ)" (Project # E-26/150.471/97) and the "Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)" (Project # 523495/96-0) for the scholarships granted to the first and second authors. Acknowledgements are also extended to Dr. E. Eric Grissel (Systematic Entomology Laboratory, USDA-ARS, Beltsville, MD) for identifying the Pteromalidae species as well as to Dr. John Sivinski (Center for Medical, Agricultural and Veterinary Entomology, USDA-ARS, Gainesville, FL) for kindly reading the manuscript and providing valuable criticisms. Approved for publication by the Head of Research and Development of Embrapa Agrobiologia as manuscript number 232/2001.

Literature Cited

Aguiar-Menezes, E.L. & E.B. Menezes. 2000. Rio de Janeiro, p. 259-263. In A. Malavasi & R.A. Zucchi (eds.), Moscas-das-frutas de importância econômica no Brasil; conhecimento básico e aplicado. Ribeirão Preto, Holos, 327p.

Baranowski, R., H. Glenn & J. Sivinski. 1993. Biological control of the Caribbean fruit fly (Diptera: Tephritidae). Fla. Entomol. 76: 245-251.

Bateman, M.A. 1972. The ecology of fruit flies. Annu. Rev. Entomol. 17: 493-518.

Canal Daza, N.A., R.A. Zucchi, N.M. Silva & F.L. Leonel Jr. 1994. Reconocimiento de las espécies de parasitoides (Hym.: Braconidae) de moscas de las frutas (Dip.: Tephritidae) en dos municipios del estado de Amazonas, Brasil. Bol. Mus. Ent. Univ. Valle 2: 1-7.

Canal, N.A. & R.A. Zucchi. 2000. Parasitóides - Braconidae, p. 119-126. In A. Malavasi & R.A. Zucchi (eds.), Moscas-das-frutas de importância econômica no Brasil; conhecimento básico e aplicado. Ribeirão Preto, Holos, 327p.

Carvalho, R.S., A.S. Nascimento & W.J.R. Matrangolo. 1999. Inseto exótico controla moscas-das-frutas. Lavoura 3: 40-43.

FIDERJ. 1976. Indicadores climatológicos: sistema de informação para o planejamento estadual. Rio de Janeiro, FIDERJ/SECPLAN. 54p.

Greany, P.D., J.L. Tumlinson, D.L. Chambers & G.M. Boush. 1977. Chemically mediated host finding by *Biosteres* (*Opius*) *longicaudatus*, a parasitoid of tephritid fruit fly larvae. J. Chem. Ecol. 3: 189-195.

Guimarães, J.A. 1998. Espécies de Eucoilinae (Hymenoptera: Figitidae) parasitóides de larvas frugívoras (Diptera: Tephritidae e Lonchaeidae) no Brasil. Tese de mestrado, ESALQ/USP, Piracicaba, 86p.

Guimarães, J.A., N.B. Diaz & R.A. Zucchi. 2000. Parasitóides – Figitidae (Eucoilinae), p. 127-134. In A. Malavasi, R.A. Zucchi (eds.), Moscas-das-frutas de importância econômica no Brasil; conhecimento básico e aplicado. Ribeirão Preto, Holos, 327p.

Guimarães, J.A., R.A. Zucchi, N.B. Diaz, M.F. Souza Filho & M.A. Uchôa F. 1999. Espécies de Eucoilinae (Hymenoptera: Cynipoidea: Figitidae) parasitóides de larvas frugíforas (Diptera: Tephritidae e Lonchaeidae) no Brasil. An. Soc. Entomol. Brasil 28: 263-273.

Herrera, J.M. & L.E. Viñas. 1977. "Moscas de la fruta" (Dipt.: Tephritidae) en mangos de Chulucanas, Piura. Rev. Peru. Entomol. 20: 107-114.

Knipling, E.F. 1992. Principles of insect parasitism analyzed from new perspectives, pratical implications for regulating insect populations by biological means. USDA-ARS, Agriculture Handbook No. 693.

Leyva, J.L., H.W. Browning & F.E. Gilstrap. 1991. Effect of host fruit species, size, and color on parasitization of *Anastrepha ludens* (Diptera: Tephritidae) by *Diachasmimorpha longicaudata* (Hymenoptera: Braconidae). Environ. Entomol. 20: 1469-1474.

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

Malavasi, A. & J.S. Morgante. 1981. Adult and larval population fluctuation of *Anastrepha fraterculus* and its relationship to host availability. Environ. Entomol. 10: 275-278.

Messing, R.H. & E.B. Jang. 1992. Response of the fruit fly parasitoid *Diachasmimorpha longicaudata* (Hymenoptera: Braconidae) to host-fruit stimuli. Environ. Entomol. 21: 1189-1195.

Nascimento, A.S., R.S. Carvalho, W.J.R. Matrangolo & J.U.V. Luna. 1998. Situação atual do controle biológico de moscas-das-frutas com parasitóides no Brasil. Informativo SBF 17: 12-15.

Ovruski, S.M. 1994. Comportamiento en la detección del huésped de *Aganaspis pelleranoi* (Hymenoptera: Eucoilidae) parasitóide de larvas de *Ceratitis capitata* (Diptera: Tephritidae). Rev. Soc. Entomol. Argentina 53: 121-127.

Ovruski, S., M. Aluja, J. Sivinski & R. Wharton. 2000. Hymenopteran parasitoids on fruit-infesting Tephritidae (Diptera) in Latin America and southern United States: diversity, distribution, taxonomic status and their use in fruit fly biological control. Int. Pest Manage. Rev. 5: 81-107.

Pemberton, C.E. & H.F. Willard. 1918. A contribution to the biology of fruit-fly parasites in Hawaii. J. Agric. Res. 15: 419-465.

Purcell, M.F., C.G. Jackson, J.P. Long & M. Batchelor. 1994. Influence of guava ripening on parasitism of the Oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae), by *Diachasmimorpha longicaudata* (Ashmead) (Hymenoptera: Braconidae) and other parasitoids. Biol. Control 4: 396-403.

Puzzi, D. & A. Orlando. 1965. Estudos sobre a ecologia das "moscas das frutas" (Trypetidae) no estado de São Paulo, visando o controle racional da praga. Arq. Inst. Biol. 32: 9-22.

Salles, L.A.B. 1996. Parasitismo de *Anastrepha fraterculus* (Wied.) (Diptera: Tephritdae) por Hymenoptera, na região de Pelotas, RS. Pesq. Agropec. Bras. 31: 769-774.

Sivinski, J. 1996. The past and potential of biological control of fruit flies, p. 369-375. In B.A. McPheron & G.J. Steck (eds.), Fruit fly pests, a world assessment of their biology and management. Delray Beach, St. Lucie Press, 586p.

Vargas, R.I., J.D. Stark, G.K. Uchida & M. Purcell. 1993. Opiine parasitoids (Hymenoptera: Braconidae) of Oriental fruit fly (Diptera: Tephritidae) on Kauai island, Hawaii: islandwide relative abundance and parasitism rates in wild and orchards guava habitats. Environ. Entomol. 22: 246-253.

Wharton, R.A., S.M. Ovruski & F.E. Gilstrap. 1998. Neotropical Eucoilidae (Cynipoidea) associated with fruit-infesting Tephritidae, with new records from Argentina, Bolivia and Costa Rica. J. Hym. Res. 7: 102-115.

Wong, T.T.Y. & M.M. Ramadan. 1987. Parasitization of the Mediterranean and Oriental fruit flies (Diptera: Tephritidae) in the Kula area of Maui, Hawaii. J. Econ. Entomol. 80: 77-80.

Wong, T.T.Y., M.M. Ramadan, J.C. Herr & D.O. McInnis. 1992. Suppression of a Mediterranean fruit fly population with concurrent parasitoid and sterile fly releases in Kula, Maui, Hawaii. J. Econ. Entomol. 85: 1671-1681.

Wong, T.T.Y., N. Mochizuki & J.I. Nishimoto. 1984. Seasonal abundance of parasitoids of the Mediterranean and Oriental fruit flies in the Kula area of Maui, Hawaii. Environ. Entomol. 13: 140-145.

Zucchi, R.A. 2000. Taxonomia, p. 13-24. In A. Malavasi & R.A. Zucchi (eds.), Moscas-das-frutas de importância econômica no Brasil; conhecimento básico e aplicado. Ribeirão Preto, Holos, 327p.

Received 24/12/01. Accepted 27/10/02.