Biological Control 60 (2012) 199–206

Contents lists available at SciVerse ScienceDirect

Biological Control

journal homepage: www.elsevier.com/locate/ybcon

Population dynamics of three *Bactrocera* spp. fruit flies (Diptera: Tephritidae) and two introduced natural enemies, *Fopius arisanus* (Sonan) and *Diachasmimorpha longicaudata* (Ashmead) (Hymenoptera: Braconidae), after an invasion by *Bactrocera dorsalis* (Hendel) in Tahiti ☆

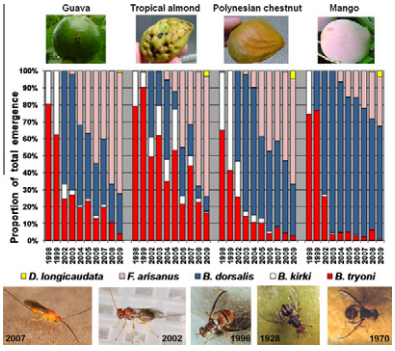
Roger I. Vargas [a,*], Luc Leblanc [b], Rudolph Putoa [c], Jaime C. Piñero [d]

[a] U.S. Pacific Basin Agricultural Research Center, USDA, ARS, 64 Nowelo St., Hilo, HI 96720, USA
[b] Dept. of Plant and Environmental Protection Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii, 3050 Maile Way, Room 310, Honolulu, HI 96822-2271, USA
[c] Service du Developpement Rural, Dept. Protection des Vegetaux, B.P. 100, Papeete, Tahiti 98713, French Polynesia
[d] Cooperative Research and Extension, Lincoln University of Missouri, Allen Hall 212, 900 Chestnut St., Jefferson City, MO 65102, USA

HIGHLIGHTS

- Oriental fruit fly was discovered on Tahiti in 1996. Eradication programs failed.
- *Fopius arisanus* was released in 2002. By 2009, mean parasitism was 65%.
- *Diachasmimorpha longicaudata* was released in 2008, but parasitism has been <5%.
- *Bactrocera dorsalis* has displaced *Bactrocera tryoni* and *Bactrocera kirki* in many host fruits.
- This is the most successful example of fruit fly biocontrol outside of Hawaii.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 19 July 2011
Accepted 21 October 2011
Available online 18 November 2011

Keywords:
Oriental fruit fly
Queensland fruit fly
B. kirki
Classical biological control
Competitive displacement

ABSTRACT

Oriental fruit fly, *Bactrocera dorsalis* (Hendel), invaded French Polynesia in 1996. In 2002 a natural enemy, *Fopius arisanus* (Sonan), was released and established. By 2009 mean (±SD) *F. arisanus* parasitism for fruit flies infesting *Psidium guajava* (common guava), *Inocarpus fagifer* (Polynesian chestnut) and *Terminalia catappa* (tropical almond) fruits on Tahiti Island was 64.8 ± 2.0%. A second parasitoid, *Diachasmimorpha longicaudata* (Ashmead), was released and established in 2008. Although widespread, parasitism rates have not been higher than 10%. From 2003 (parasitoid establishment) to 2009 (present survey) numbers of *B. dorsalis*, *Bactrocera tryoni* (Froggatt), Queensland fruit fly, and *Bactrocera kirki* (Froggatt) emerging (per kg of fruit) declined. For example, for *P. guajava* there was a decline of 92.3%, 96.8%, and 99.6%, respectively. Analysis of co-infestation patterns (1998–2009) of *B. dorsalis*, *B. tryoni*, and *B. kirki*, suggest *B. dorsalis* is now the most abundant species in many common host fruits. Establishment of *F. arisanus* is the most successful example of classical biological control of fruit flies in the Pacific outside of Hawaii and can be introduced if *B. dorsalis* spreads to other French Polynesian islands, as was the recent case when *B. dorsalis* spread to the Marquesas Islands. These studies support *F. arisanus* as a prime biological control candidate for introduction into South America and Africa where *Bactrocera carambolae* Drew and Hancock and *Bactrocera invadens* Drew, Tsuruta, and White, respectively, have become established.

Published by Elsevier Inc.

☆ This article reports the results of research only. Mention of proprietary product does not constitute an endorsement or recommendation by the USDA.

* Corresponding author. Fax: +1 808 959 5470.
E-mail address: Roger.vargas@ars.usda.gov (R.I. Vargas).

1049-9644/$ - see front matter Published by Elsevier Inc.
doi:10.1016/j.biocontrol.2011.10.012

Phytophagous insects of the family Tephritidae, commonly referred to as "true fruit flies", have provided many examples of successful invasions (Duyck et al., 2004). Several *Bactrocera* species are well-documented invaders and rank high on quarantine lists worldwide (Clarke et al., 2005). Superior mobility and dispersive powers, high reproductive rates, and extreme polyphagy are among the common traits of invasive *Bactrocera* species. One such invasive species is oriental fruit fly, *Bactrocera dorsalis* (Hendel). This tephritid fly is considered to be among the five most damaging and aggressive pest fruit flies in the world (Leblanc and Putoa, 2000). It is distributed throughout Asia, from India to Taiwan, but not in Malaysia, Indonesia or the Philippines, and as far north as southern China (Clarke et al., 2005; White and Elson-Harris, 1992). It has been accidentally introduced into the Commonwealth of the Northern Mariana Islands in 1935 (eradicated since 1965), Hawaii in 1945, Guam in 1948 (eradicated since 1965), Nauru in the 1980's (eradicated since 1999), and Tahiti in 1996 (Leblanc and Putoa, 2000).

In addition to *B. dorsalis*, three other economically important *Bactrocera* species have become accidentally established in French Polynesia: *Bactrocera kirki* (Froggatt) in 1928, *Bactrocera tryoni* (Froggatt), Queensland fruit fly, in 1970, and *Bactrocera xanthodes*, Pacific fruit fly, in 1998 (Leblanc and Putoa, 2000). *B. kirki* infests 49 host species in Polynesia, *B. tryoni* 113 species in Australia, and *B. xanthodes* 40 species in Fiji and the Polynesian islands (Secretariat of the Pacific Community Pacific Fruit Fly Web). *B. dorsalis* has been reported in the Society and Marquesas Islands and *B. xanthodes* only in the Austral Islands. Since tephritid fly distribution and abundance are markedly structured by various abiotic (mostly climatic) and biotic (host plants) factors (Duyck et al., 2004), studies in French Polynesia provided a unique opportunity to investigate interspecific competition and displacement among three different invasive *Bactrocera* species that have been introduced successively rather than simultaneously given (1) the sequential nature of these invasions, and (2) the fact that some host plants present in French Polynesia are common to all three fly species.

Circumstantial evidence suggests *B. dorsalis* was introduced into Tahiti Island from Hawaii.

Given its success in Hawaii, *Fopius arisanus*, an egg-pupal parasitoid, was the primary candidate for biological control of *B. dorsalis* in French Polynesia. Also considered for introduction were the larval-pupa parasitoid, *Diachasmimorpha longicaudata* (Ashmead), and early larval parasitoid *Fopius vandenboschi* (van den Bosch and Haramoto, 1951; Ramadan et al., 1992; Vargas et al., 2007). In 2002 a classical biological control program was initiated to introduce *F. arisanus* into French Polynesia from Hawaii. Wasps were released and established on Tahiti, Moorea, Raiatea, Tahaa, and Huahine, in the Society Islands (Vargas et al., 2007). By 2006, *F. arisanus* parasitism of fruit flies infesting guava was 51.9% for Tahiti Island and there was a subsequent decrease in numbers of *B. dorsalis*, *B. tryoni*, and *B. kirki* fruit flies emerging (per kg of fruit) by 75.6%, 79.3%, and 97.9%, respectively (Vargas et al., 2007). The first 5 yr of this study were published, but because this was an ongoing study and we have now collected four more years of data (2006–2009), we felt it important to publish the data set in its entirety to historically document a rare success in biological control of fruit flies (Waterhouse, 1993). Reported here are: (1) competitive interactions among *B. dorsalis*, *B. tryoni*, and *B. kirki* from 1998 to 2009; (2) additional data on establishment of *B. dorsalis* and *F. arisanus* from 2005 to 2009, and (3) impact of release and establishment of a second species of fruit fly parasitoid, *D. longicaudata*, into French Polynesia from Hawaii.

1. Materials and methods

1.1. Fruit fly abundance and their host fruits

Studies were conducted on Tahiti Island (Papeete: 17° 34′ S latitude, 149° 36′ W longitude), the largest of >125 islands and atolls of French Polynesia, spread over 2,500,000 km^2 of the south Pacific Ocean. Fruits from *Psidium guajava* L. (guava), *Inocarpus fagifer* (Parkinson) Fosberg (Polynesian chestnut), *Terminalia catappa* L. (tropical almond), and *Mangifera indica* L. (mango) trees were common along major coastal roadways of Tahiti Island. These four hosts could be collected consistently in relatively large numbers throughout the year (except for the seasonal *M. indica*) and were highly suitable hosts for all three fruit fly species and both parasitoids. Ripe fruits were collected, including ground fruits (particularly for *T. catappa* and *I. fagifer*). Because of the feral nature of the trees, randomized sampling with a fixed sample size could not be carried out. Numbers of collections and fruits sampled are included in tables and figure captions. Infestation by different fruit fly species was summarized to determine fruit fly interactions from 1998 to 2009. Other host fruits were periodically collected in various quantities throughout the year (Vargas et al., 2007), but due to unpredictable fruiting patterns and the scattered nature of trees along roadsides, numbers of fruits sampled varied considerably. Fruit handling procedures were described previously in Vargas et al. (2007).

1.2. Species-specific impact of F. arisanus and D. longicaudata releases

F. arisanus releases were described previously (Vargas et al., 2007). *D. longicaudata* wasps were obtained from a colony maintained for 200 generations at the United States Department of Agricultures (USDA), Agricultural Research Service (ARS), Pacific Basin Agricultural Research Center (PBARC) facility in Honolulu, HI. Five shipments of *D. longicaudata* (of approximately 5000 each for a total of 10,000 surviving wasps) were made between September 2007 and August 2008. Parasitoids were transferred from Faaa International Airport to the Service du Développement Rural Laboratory in Papara, Tahiti. A small laboratory was established at Papara for evaluating parasitism in the field, rearing small numbers of fruit flies, and rearing wasps for augmentative releases. Parasitoids were allowed to emerge from pupae placed inside cubical cages (26 × 26 × 26 cm). Approximately 5000 wasps were held inside each cage until release. Wasps were provided with creamy textured honey (Bradshaws, Sioux Falls, IA) and water. Number of dead parasitoids inside cages after 4 d was recorded in order to estimate the number of wasps released into the field. Generally, cubical cages with approximately 2000 parasitoids were placed under host trees. Cages were opened gently, and parasitoids allowed to disperse to nearby ripe host fruits.

1.3. Data processing and statistical methods

Proportions of adult *B. dorsalis*, *B. tryoni*, and *B. kirki* flies that emerged from sampled fruits were calculated for four host fruits (*P. guajava*, *T. catappa*, *I. fagifer*, and *M. indica*). Emergence data were pooled for ca 200 sampling sites by host species and year (1998–2009) on Tahiti Island. For the four host fruits species collected throughout Tahiti Island, data for numbers of *B. dorsalis*, *B. tryoni*, *B. kirki*, and *F. arisanus* recovered from fruits were pooled by year (1998–2009), and % parasitism and fruit fly emergence per kg host fruit calculated. Because each host species was represented by many fruit collections, each with numerous fruits (total of 2581 samples, 87,352 fruits, and 6964 kg of fruits between 1998

Download English Version:

https://daneshyari.com/en/article/6372978

Download Persian Version:

https://daneshyari.com/article/6372978

Daneshyari.com