Ethiop. J. Biol. Sci. **10(2): 213-221, 2011**
 ISSN: 1819-8678

SHORT COMMUNICATION

INCIDENCE AND COMPOSITION OF CERATITID FRUIT FLIES IN WILD COFFEE, *COFFEA ARABICA* L. SOUTHWESTERN ETHIOPIA

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ABSTRACT: Incidence and composition of fruit flies were studied at afromontane rainforests of southwestern Ethiopia: Yayu, Berhane-kontir and Bonga forest which are located in Illubabor, Benchi- Maji and Kefa zones, respectively. Based on ecological descriptions of forest coffee population, each forest locality was stratified into three forest sites and sixteen trees were systematically selected for assessment of fruit fly berry infestation. The result of the study showed that *Ceratitis fasciventris* (Bezzi) and *Ceratitis anonae* Graham are new records for Ethiopia. *Ceratitis fasciventris*, *Trirhithrum coffeae* and *C. anonae* were collected from all the study areas and accounted 85.26, 13.68 and 1.06% of the overall fruit fly population recovered, respectively. Fruit fly incidence on ripen coffee berry ranged from 43.65% to 61.57 % (Yayu), 66.33% to 76.13% (Berhane-Kontir) and 79.77% to 85.1% (Bonga). A statistically significant difference ($P<0.05$) was observed in fruit flies incidence among the three sites. To promote the highly desired forest *C. arabica*, which still remains as a purely organic product in the country and fetches maximum premium coffee, the implication on the embryo death of the host during the infestation of fruit flies of ripen coffee berries, possible taints and off-flavours in coffee liquor quality should be studied across agro-ecological zones of coffee growing areas.

Key words/phrases: Afromontane rainforest, Fruit flies, Incidence, Wild *Coffea arabica* L.

INTRODUCTION

Despite the existence of enormous genetic diversity and suitable natural conditions for coffee production in Ethiopia, the productivity of the crop both in quantity and quality is incredibly low as compared to other countries (CSA, 2006). Insect pests are among key biotic factors that accounts for low production and quality of the crop (Mesfin Amaha, 1989; Million Abebe, 1987, 2000; Chemeda Abedeta, 2008). Coffee insect pests can cause high

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yield losses and/or affect the cup quality individually or in combination (Nyambo and Masaba, 1997). Coffee berry borer, *Hypothenemus hampei* Ferrai, African coffee leaf miner, *Leucoptera meyricki* (Ghesq), *L. coffeana* (Wash), Neotropical coffee leaf miner, *L. coffeela* (Guer), Antestia bugs, *Antestiopesis* spp. White stem borer, *Anthores leuconotus* (Pase), *Xylotrechus quadvipes* chvrolat, Citrus mealy bug, *Planococcus citri* (Risso), Kenya mealy bug, *P. kenyae* and Green coffee scales, *Coccus* spp are among the key pests which cause serious economic damage to coffee berries. These insect pests are known to be distributed in coffee production areas in South America, Asia and Africa including Ethiopia (Le Pelley, 1966; Nyambo and Masaba, 1997).

Ceratitid fruit flies are emerging as insect pests of coffee. They feed on pulp of ripen coffee berries affect the coffee quality. The tephritid, *Ceratitis* spp. presently contain 94 recognized species (De Meyer, 1996, 1998, 2000; De Meyer and Copeland, 2005; De Mayer and Freidberg, 2006). The Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), infests numerous species of wild plants (Copeland *et al*., 2002), including *Coffea arabica* without injuring the beans (Mukiama and Muraya, 1994). Likewise, *Ceratitis rosa* Karch, *C. fasciventris* (Bezzi), *C. anonae* Ghraham, and *C. cosyra* (Walker) infest numerous essential cultivated fruits including *C. arabica* (Mukiama and Muraya, 1994). The fruit fly, *Trirhithrum coffeae* Bezzi, is suspected to be a vector of bacterium that it transmits to the pulp causing an undesirable flavour known as “in liquored coffee”. Furthermore, pre-mature berry fall occasionally happened due to fruit fly infestation (Crowe, 2004). Even though fruit flies in general economically important pests in Ethiopia, but information regarding the magnitude of their infestation on coffee and their diversity is not well investigated. Presence of three species of fruit flies namely, *Ceratitis rosa* Karsch, *Trirhithrium coffeae* and *C. capitata* on *C. arabica* was reported from cultivated coffee in Ethiopia (Esayas Mindesil, 2005). In the current study area of Afromontane rain forest of south western Ethiopia, no any information is currently available with regard to infestation by fruit flies, their species composition and natural enemies associated with the flies. It is apparent that such information are essential to device means of conserving the diverse genetic pool of forest coffee and the associate or co-evolved fauna and pave the ways for sustainable use of these genetic resources in the country and beyond. Hence, this project was initiated to generate pedestal information on species composition and incidence of fruit flies in forest coffee ecosystems of southwestern Ethiopia.

MATERIALS AND METHODS

Study sites

The study was conducted in three Forest Coffee Populations (FCPs) namely, Yayu (PI), Berhane-Kontir (PII) and Bonga (PIII) (Table 1). The entire sites are positioned in southwestern part of Ethiopia. Plots were geo-referenced and described using GPS for coordinates and altitude. Clinometer and compass were used to record the slope and direction of study sites, respectively. Laboratory based experiments were conducted at Jimma Agricultural Research Center (JARC) (Table 1).

Table 1. Description of the study sites in montane rainforests of southwestern Ethiopia.

Forest coffee Population	Forest site	Elevation (m)	Co-ordinates		Slope (%)	Aspect or Direction
			Latitude(N)	Longitude (E)		
Yayu (PI)	Yayu-1 (SI)	1493	08^0 24' 11"	$035^0$47' 44"	10	East
	Yayu-2 (SII)	1491	08^0 23' 98"	035^0 47' 40"	16	West
	Yayu-3 (SIII)	1496	08^0 23' 10"	035^0 47' 62"	20	West
Berhane-Kontir (PII)	Beko I (SI)	1051	07^0 07'43"	035^0 26' 16"	15	North
	Beko II (SII)	1084	07^0 07' 16"	035^0 26' 29"	13	N-East
	Beko III (SIII)	1134	07^0 06' 52"	035^0 26' 33"	20	East
Bonga (PIII)	Alemgano-1(SI)	I744	07^0 20' 01"	035^0 13' 39"	5	East
	Alemgano -2 (SII)	1739	07^0 20' 31"	035^0 13' 32"	10	East
	Yabito (SIII)	1894	07^0 19' 04"	'$035^0$03' 31"	8	N-West
	JARC*	1753	07^0 47' 03"	036^0 00'00"	-	-

* Laboratory based experiment

Experimental tree selection

A reconnaissance survey was carried out to get general information about each forest population site prior to the actual experiment. Uniformity in age coffee trees (5-7 years old), general growth performance and field features (slope and direction) were taken in to considerations in choosing experimental plots. Three sites (SI, SII and SIII) were selected per location based on these criteria. Sixteen trees were systematically selected following methodology developed by Paterson (2006) from each sub-sites during

coffee berry ripening stages. The selected trees were stratified into three canopy layers (top, middle and bottom) and a pair of branches from each layer was selected randomly and tagged for berry damage assessment.

Berry damage assessment

For fruit fly prevalence assessments on ripen coffee berries, three hundred fully grown and ripen berries were sampled from top, middle and bottom canopy layer (100 berries per canopy), mixed and kept in a plastic bag. The collected berries were dissected on the same day by removing the skin with a scalpel. The number of fruit fly larvae in the mucilage and between the beans was counted. Percentage of berries with fruit fly infestation was calculated by sorting infested and non-infested berries. Data were collected twice weekly during the entire harvesting period that lasted 2 months.

Determination of fruit fly species and their parasitiods

Samples of 300 ripen coffee berries were collected from selected trees of each study site and kept independently in Perspex cylindrical cages of 30 x 15 cm in the JARC, entomology laboratory intended for adult emergence. The cages were maintained on bench top within the insectary and a layer of sterilized sand was spread at the bottom of the cage to a depth of 2 cm for larvae to pupate. Daily emerged adults and parasitiods were collected, counted, pined and preserved for one month duration. Mean daily maximum, minimum, and average temperatures were 27.76 ^{0}C, 22.45 ^{0}C and 24.35 ^{0}C, respectively. Mean maximum, minimum, and average relative humidities were 59.65 %, 46.04 % and 55.30 %, respectively. Fruit flies and their parasitiods were identified at International Center for Insect Physiology and Ecology (ICIPE), Nairobi, Kenya.

Data analysis

The Statistical Package for Social Science (SPSS), software programme version 13 was used for analysis of non-parametric data (SPSS, 1999). Two-way analysis of variance (ANOVA) was used for analysis of the parametric data and means were separated using Tukey's standardized test when significant differences were found between treatments. All count data were subjected to Arcsine transformation before executing data analyses.

RESULTS AND DISCUSSION

Results

Fruit flies incidences varied within and among the FCPs. It ranged from 31.3 - 69.0, 61.7 - 79.7 and 78.0 - 88.0 % at Yayu, Berhane-Kontir and

Bonga FCPs, respectively. The mean incidences were 51.12, 71.08 and 82.73 %, respectively. A statistically significant difference ($P<0.05$) was observed in percentage incidence of coffee fruit fly among the FCPs (Table 2). The number of fruit fly larvae per berry ranged from 1 to 9 for Yayu and Berhane-Kontir, where as it was 1 to 7 for Bonga. The mean number of larvae per infested berry was 1.26, 1.44 and 1.76 for Yayu, Berhane-Kontir and Bonga, respectively. Among ripen coffee berries investigated, 98 % of Yayu, 99.5 of Berhane-Kontir and 98.97 % of Bonga contained 0 to 5 larvae per berry. In most cases, differences between sub-sites in each plantation for fruit fly incidence larval population were insignificant ($P>0.05$).

Table 2. Average fruit fly larvae density per infested coffee berry and % incidence in wild Arabica coffee populations of southwestern Ethiopia.

Forest populations	Forest sites	Average fruit fly (Mean ± SE)	% Incidence (Mean ± SE)
Yayu	SI	1.34 ± 0.082 b	61.57 ± 12.94 bc
	SII	1.39 ± 0.105 ab	51.15 ± 12.52 ab
	SIII	1.05 ± 0.090 b	43.65 ± 17.47 a
Berhane-Kontir (PII)	SI	1.35± 0.069 ab	70.77 ± 2.12 c
	SII	1.66 ± 0.077 ab	76.13 ± 6.15 cd
	SIII	1.30 ± 0.073 b	66.33 ± 5.16 c
Bonga (PIII)	SI	1.90 ± 0.076 a	85.10 ± 2.83 d
	SII	1.83 ± 0.082 a	79.77± 2.12 cd
	SIII	1.54 ± 0.062 ab	83.33 ± 5.87 d

Means followed by same letter (s) in the column are not significantly different according to Turkey's test at 0.05 probability level.

Fruit fly species encountered included *C. anonae* (Graham), *C. fasciventris* (Bezzi) and *T. coffeae* Bezzi (Table 3). *Ceratitis fasciventris* was the dominant species and accounted for 85.26 % of the species composition of fruit flies, followed by *T. coffeae* (13.68 %) and *C. anonae* (1.06 %) across the study sites. The abundance of fruit fly species varied with forest coffee sites (Table 3). Larvae of fruit flies collected from all forest coffee populations were parasitized by the parasitoid *Psyttalia sp*. (Hymenoptera: Braconidae). Another Braconid of the Opiinae sub-family was also recorded from fruit fly larva.

Table 3. Fruit flies species composition in forest coffee ecosystems of south western Ethiopia

Forest populations	Fruit fly species composition (Mean ± SE)		
	Ceratitis anonae	*Ceratitis fasciventris*	*Trirhithrum coffeae*
Yayu	1.11 ± 0.975	86.27 ± 10.317	12.62± 3.601
Berhane-Kontir	1.11 ± 1.923	84.74 ± 1.731	14.15 ± 3.624
Bonga	0.96 ± 0.835	84.77 ± 6.860	14.27 ± 1.855
Mean	1.06 ± 1.244	85.26 ± 9.636	13.68 ± 5.027

Discussion

The mean incidence of fruit flies was 68.1% along FCPs, suggesting that wild coffee are hosts of several species of fruit flies. Earlier studies indicated incidence 55.2 to 58.1 in cultivated coffee (Esayas Mindesil, 2005). Abasa (1973) also reported that even though seasonal emergence and infestation varied in a coffee plantation at Ruiru, Kenya; fruit flies caused up to 85 % infestation during the peak season. On the other hand, there is controversial report on implication of coffee fruit flies on final coffee quality but pre-mature berry fall occasionally happened due to infestation and there is also a possibility that the pest may use the crop as reservoir host (Mukiama and Muraya, 1994; Crowe, 2004).

Fruit fly species composition varied within and among FCPs. *Ceratitis fasciventris* was the dominant followed by *T. coffeae* and *C. anonae*. This agrees with reports of Copeland *et al.* (2006) who reported the prevalence of the three species of fruit flies in coffee elsewhere. On the other hand, Esayas Mindesil (2005) recorded three species of Tephritids fruit flies, *viz*. *C. rosa*, *T. coffeae* and *C. capitata* infesting Arabica coffee with percent composition of 84.67, 14.43 and 0.9, respectively. The most probable reason for the variation with current findings could be the revision of the sub-genus *Ceratitis* (*Pterandrus*) Bezzi (Diptera: Tephritidae) by De Meyer and Freidberg (2006) *C. fasciventris* used to be categorized under *C. rosa* as sub-species. Mekuria Tadesse *et al.* (1995) reported more than three species of fruit flies infesting coffee berries in Ethiopia. According to these authors, *C. rosa* and *T. coffeae* were the dominant species. Survey conducted in Kenya by Mukiama and Muraya (1994) also showed the prevalence of *C. capitata, C. rosa* and *T. coffeae* on coffee.

Fruit fly parasitiods, *Pysttalia* sp. and unidentified species under the Opiine sub-family reared from all coffee areas. In Ethiopia, Million Abebe and Bayisa Mormane (1986) recovered *Opius* sp. nr. *africanus* and *Opius* sp. nr. *Desideratus* from *C. Rosa*. In general, the level of incidence caused by fruit flies varied among and within FCP and the highest incidence of fruit flies was observed in Bonga followed by Berhane-Kontir and Yayu in that order. The abundance of fruit fly species varied with forest coffee sites, but *C. fasciventris* was the most dominant among all the species reported. To promote the highly desired forest *C. arabica*, which still remains as a purely organic product in the country and fetches maximum premium coffee, the implication on the embryo death of the host during the infestation of fruit flies of ripen coffee berries, possible taints and off-flavours in coffee liquor quality should be studied across agro ecological zones of coffee-growing areas.

ACKNOWLEDGEMENTS

The authors would like to thank Jimma Agricultural Research Center for its continued help and facilitation, and the International Center for Insect Physiology and Ecology (ICIPE), Nairobi/Kenya for technical and material support during insect identification. Center for Development Research (ZEF) based at Bonn University/Germany is highly acknowledged for financial support.

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