SCIENTIFIC NOTE

Natural Enemies and Competitors of *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae) in Colombia

ALEX E. BUSTILLO, REINALDO CÁRDENAS AND FRANCISCO J. POSADA

Disciplina de Entomología, Centro Nacional de Investigaciones de Café, Cenicafé, Chinchiná, Caldas, Colombia
e-mail: alex.bustillo@cafedecolombia.com

Neotropical Entomology 31(4):635-639 (2002)

Inimigos Naturais e Competidores da Broca-do-Café *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae) na Colômbia

RESUMO - O objetivo desta pesquisa foi levantar e registrar os inimigos naturais e competidores da broca-do-café, *Hypothenemus hampei* (Ferrari), na região cafeeira colombiana. Apesar da recente introdução da broca do café na Colômbia, foram registrados 25 inimigos naturais, incluindo o fungo *Beauveria bassiana*. Com exceção do fungo, os outros organismos são registros novos de inimigos naturais da broca-do-café, o que demonstra o pouco conhecimento existente sobre esses agentes de controle natural e sobre os competidores que podem contribuir para manter as populações da praga em equilíbrio. O grupo com maior número de inimigos naturais foi o dos predadores, seguido pelos competidores, fungos, bactérias e protozoários. Somente uma vespa parasitóide foi registrada atacando os adultos da broca-do-café.

PALAVRAS-CHAVE: *Beauveria bassiana*, entomopatógeno, parasitóide, predador

ABSTRACT - The objective of this research was to survey and record the natural enemies and competitors of the Coffee Berry Borer (CBB) *Hypothenemus hampei* (Ferrari) in the Colombian coffee region. Despite the recently introduction of CBB to Colombia, 25 natural enemies were recorded, including *Beauveria bassiana*. Except for this fungus, the other organisms are new records of natural enemies of CBB. This emphasizes the little knowledge about these natural control agents and competitors that can help to keep the CBB population under control. The predators were the group with higher number of natural enemies followed by the competitors, fungi, bacteria and protozoans. Only one parasitoid wasp was recorded attacking CBB adults.

KEY WORDS: *Beauveria bassiana*, Coffee Berry Borer, entomopathogen, parasitoid, predator

The coffee berry borer (CBB), *Hypothenemus hampei* (Ferrari), is the most important insect pest in the coffee producing areas (Le Pelley 1968). This insect, originated in Africa, was introduced to the American continent early in the 20th century without the natural enemies present in its original habitat. Several biological agents regulate the populations of the coffee berry borer in Africa: the parasitoids, *Cephalonomia stephanoderis* Betrem (Hymenoptera: Bethylidae), *Prorops nasuta* Waterston (Hymenoptera: Bethylidae), *Heterospilus coffeicola* Schenedeken (Hymenoptera: Braconidae), *Phymastichus coffea* La Salle (Hymenoptera: Eulophidae); and the fungus *Beauveria bassiana* (Balsamo) Vuillemin (Hempel 1934, Ticheler 1963, Koch 1973, Moore & Prior 1988, La Salle 1990, Vega *et al*. 1999). Except for *B. bassiana*, the other natural enemies are not present in areas where *H. hampei* arrived, such as Colombia. However, the presence of new natural enemy was evaluated in different coffee areas of Colombia, where the CBB has been established for over 12 years.

There is not much literature on the natural beneficial fauna attacking the CBB populations in their original habitat. However, *B. bassiana* is the most frequently recorded mortality factor in African countries, as well as in those countries where the borer had spread (Villacorta 1984, Benassi 1995, Bustillo *et al.* 1998). The first records are dated back to the 1930's in the Belgian Congo (Pascalet 1939, Steyaert 1935). The incidence of *B. bassiana* on *H. hampei* differs from one country to another. For example, in Ivory Coast and Kenya the infections have been low (Ticheler 1963, Murphy & Moore 1990), although disease incidence has been higher in Cameroon, Honduras, Mexico and Ecuador (Pascalet 1939, Tronconi *et al.* 1986, Klein-Koch *et al.* 1988, Barrera *et al.* 1990). In Colombia, *B. bassiana* was found for the first time in 1989, infecting *H. hampei* in coffee plantations just after its detection in

Ancuyá (Nariño) (Vélez & Benavides 1990). After several years of introduction to borer-infested coffee plantations, *B. bassiana* has become the main mortality factor of *H. hampei* (Bustillo *et al.* 1998)

Little information is available concerning the parasitoids affecting CBB in the Western Hemisphere. In Brazil, Benassi (1995) found a non-described species of *Cephalonomia* parasitizing the borer, while Perez-Lachaud and Hardy (1999) found a new species described as *Cephalonomia hyalinipennis*, in Mexico. This paper reports the results of a survey of natural enemies and competitors of *H. hampei* in different coffee regions of Colombia.

The survey of the CBB natural enemies and competitors was carried out between 1990 and 1998 in different coffee plantation sites in Colombia, mainly in Antioquia, Caldas, Risaralda, Huila, Quindío, Nariño and Valle del Cauca. During the visits to coffee fields, infested berries of different ages were randomly collected from the ground and from the tree canopy. These berries were deposited in collecting bags and taken to the laboratory for examination. About 2000 berries were collected from the different places surveyed during eight years as well as during occasional visits to coffee farms. Field observations were also made on borer predation by other insects, as well as the presence of other insect competitors for space and / or food inside the tunnels made by the borer in the coffee berry, especially in those found on the branches.

In the laboratory, 30% of the material was dissected and had the content observed while the rest of the samples were put in glass containers in order to detect beneficial insects emergence from the berries.

The borer samples suspected of being infected by microorganisms were disinfected superficially with sodium hypochlorite (0.5%), and then placed in Petri dishes containing culture media. Nutrient agar was used to isolate bacteria. In the case of fungi, the insects were put in a moist-chamber for sporulation and further isolation of the microorganism, which was done using the Sabouraud-dextrose-agar medium. To confirm the identification of these organisms, culture samples were subjected to Koch´s postulates and samples were sent to specialists for proper identification. In some cases, the gut content of dying insects was examined to determine the presence of protozoa, nematodes or other organisms.

After observing predatory activity on CBB in the field, predators were put into boxes (15 cm x 25 cm) containing coffee berries infested with different stages of CBB (eggs, larvae, pupae and adults). Observations were also made on organisms found inside the tunnels of the infested coffee berries in order to determine whether or not they were competing for the insect's niche. The unknown insects were sent to taxonomists from the International Institute of Entomology (IIE) in London for identification.

A list of new natural enemies made up of seven entomopathogens (fungi, bacteria, and protozoan), one insect parasitoid and ten predators is presented. In addition, three insects were recorded competing for the borer space and food. The importance of these agents is discussed below.

Entomopathogens. Five species of fungi infecting adults CBB are reported. The most frequently found species was *B. bassiana,* which infects *H. hampei* possibly through inoculum produced by infections of other insect species occurring naturally on coffee and green banana plantations. Before CBB introduction into coffee plantations of the Colombian coffee region, *Xyloxandrus morigerus* Blanchard (Coleoptera: Scolytidae), *Hypothenemus obscurus* (Fichhoff) (Coleoptera: Scolytidae), *Metamasius hemipterus sericeus* (Olivier) (Coleoptera: Curculionidae) and *Cosmopolites sordidus* (Germar) (Coleoptera: Curculionidae) on green banana, had already been reported as infected with *B. bassiana*.

One species recorded for the first time on *H. hampei* was *Hirsutella eleutheratorum* (Nex ex Gray) Petch. This fungus is characterized by the long brown filamentous stroma emerging from the body of the insect. Although it has been found at various sites, the levels of infection were low and apparently require high environmental humidity for its manifestation (Posada *et al*. 1993).

Metarhizium anisopliae (Metsch.) Sorokin was found only on *H. hampei* adults associated with infested berries collected from the soil at northeastern Antioquia in Vegachi, at an altitude of 1,600 m. This is also a new record under field conditions (Cárdenas 1995).

Infections due to *Fusarium oxysporum* have been frequently observed on *H. hampei* in several regions (Quindío, Risaralda, Caldas, and Huila). The fungus appears on the borer's body as a white dusty mycelium with slight pink or yellow shades (Pérez *et al*. 1996). This species has been recorded infecting several insect species (Hasan & Vago 1972, Nayak & Srivastava 1978, Balaraman *et al*. 1979, Bai & Chen 1991). Apparently *F. oxysporum* is saprophytic or a weak pathogen, which under laboratory and field conditions does not cause high mortality. This fungus has been recorded as an important plant pathogen. *F. oxysporum* f. sp. *dianthi* causes vascular wilt in carnations (Arbeláez 1993) and *F. oxysporum* f. sp. *cubense* is responsible for the wilting in banana known as Panamá disease (Ploetz *et al*. 1992).

Paecilomyces lilacinus (Thom.) Samson was isolated from *H. hampei*-infested berries collected from the soil. This fungus was found for the first time in natural conditions infecting coffee berry borer adults, emerging from berries fallen on the ground (Bustillo *et al*. 1999). Its pathogenicity *in vitro* against *H. hampei* has been demonstrated by Posada *et al*. (1998). A related species, *P. farinosus* (Holm ex SF Gray), was recorded infecting *H. hampei* in Togo and Ivory Coast (Vega *et al*. 1999).

Infections caused by bacteria such as *Bacillus* sp. and *Serratia* sp. were found, although their presence, characterized by a dark color of the beetle's integument and internal septicemia, was not very common. In the case of *Serratia* sp., host larvae show a distinct pinkish coloration.

The microsporidian *Mattesia* sp. was observed only once, while examining the adult borer's intestines coming from a population of laboratory-reared insects, kept at Cenicafé. Individuals of this host, affected by these protozoa, are

relatively inactive and their reproduction is reduced or show inability to breed. In the available literature there are no records of this pathology on *H. hampei*. However, it is important to take them into consideration when assessing mortality factors in laboratory-reared colonies.

Nematodes. No entomopathogenic nematodes were detected during this study.

Parasitoids. Only one parasitoid species was found in coffee plantations of the San José del Nus in northern Antioquia. A. K. Walker, of the IIE in London, tentatively identified it as being in a genus close to *Cryptoxilos* sp. (Hymenoptera: Braconidae) and it is likely a new species that remain without identification. It is true that this parasitoid is normally associated to other insects such as *Hypothenemus* spp., which are native to the area and that has moved to *H. hampei* upon its arrival in this habitat (Cárdenas 1995). The behavior of this wasp is as follow: the endoparasitoid enters the coffee berries and attacks the *H. hampei* adult. It lays an egg in the body of the borer, which hatches and the feeding action of the larva kills the adult borer. Upon completing the larval development, the parasitoid abandons the borer's body and forms a grayish silky layer that covers the entrance tunnel on the berry, apparently for the purpose of protecting the entrance from potential enemies. It then pupates behind the cadaver of the *H. hampei* adult. Many green berries infested with *H. hampei* with signs of parasitoid attack were collected for adult emergence. Attempts to rear the parasitoid under laboratory conditions were unsuccessful.

Predators. Three important families were observed: Formicidae (Hymenoptera), Anthocoridae (Hemiptera) and Cucujidae (Coleoptera). In the first family, seven genera of Formicidae were abundant and the number of species varied according to the region and the CBB control practices used. Ants were abundant at sites where no insecticides are used for borer control. They prey by invading infested berries and carrying off the immature stages to their nests. The genera recorded as predators were: *Solenopsis, Pheidole, Wasmannia, Paratrechina, Crematogaster, Brachymyrmex* and *Prenolepis*. The ant *Crematogaster curvispinosus* preying on immature stages of the borer has been reported in Brazil (Benassi 1995). In the case of Anthocoridae, one unknown and two identified genera (*Calliodes* and *Scoloposcelis*) were recorded. Nymphs and adults of these insects get inside the bored berries and feed on immature stages of the borer. The Cucujidae species *Cathartus quadricollis* (Guérin-Méneville) was observed in the tunnels of infested berries and was believed to exert a predatory action against *H. hampei*. However, tests to prove this action under laboratory conditions were negative.

Competitors. Competition between populations of CBB and other insects was found in infested fallen berries and in those found in the aerial part of the tree. This kind of competition is mainly due to a great variety of organisms that once invading the infested berries in the soil, can cause the rotting of the berry and some can compete for space and food with the borer.

Several competitors were observed especially in infested berries found on the ground. The borer is expelled by the rotting of the fruit caused by fungi or bacteria, or by the invasion of nematodes and mites. It is also common to observe the presence of five groups of immature stages of *Neosilba* sp. (Diptera: Lonchaeidae), sciarid fly (Diptera: Sciaridae), pyralid larva (Lepidoptera: Pyralidae) and specimens of Coleoptera (Staphylinidae and Nitidulidae) within the empty tunnels made by the borer in the fallen berries.

On the aerial part of the coffee trees, the borer-infested berries are frequently invaded by the fly *Neosilba* sp., whose adults lay eggs in the tunnel made by the borer. Invasion by fly larvae causes rotting of the endosperm, which expels out the progeny (eggs and larvae) of the borer. An unidentified species of sciarid fly that was found only in the northwest area of Antioquia, causes the same effect. In dry infested berries, the presence of a pyralid larva was also detected.

Sponagel (1994) reported only one case of antagonism occurring in coffee plantations in Ecuador, wherein the ant *Azteca* sp., did not prey on the borer but competed with *H. hampei* for space inside the berry. Under field conditions, it was also found that dried coffee berries attacked by CBB were colonized by *Araecerus fasciculatus* (DeGeer) (Coleoptera: Anthribidae).

Acknowledgments

The authors would like to acknowledge to Harry C. Evans from CABI Bioscience in Ascot, England, for identifying several species of entomopathogens (*Hirsutella, Fusarium, Paecilomyces*). Thanks are also extended to the following taxonomists: A.K. Walker, I.M. White, G.M. Stonedahl and A. Polaszek of the International Institute of Entomology (IIE) in London, for insect identifications. Likewise, to the contribution of several colleagues: Sergio Montoya, Anibal Arcila and Lorena Ruiz for collecting field material; to the anonymous reviewers and to Carmenza Góngora B., for their critics and comments and to Roberto Alves and Angela Jaramillo for translating the abstract into Portuguese.

Literature Cited

Arbeláez, G. 1993. Las enfermedades vasculares del clavel en Colombia y en el mundo. Agron. Colomb. 10: 12-18.

Bai, F.Y. & Q.T. Chen. 1991. *Fusarium* species on some insects from China. Acta Mycol. Sinica 10: 120-128.

Balaraman, K., V.S. Bheema Rao & P.K. Rajagopalan. 1979. Isolation of *Metarhizium anisopliae, Beauveria tenella* and *Fusarium oxysporum* (Deuteromycetes) and their pathogenicity to *Culex fatigans* and *Anopheles stephensi*. Indian J. Medical Res. 70: 718-722.

Barrera, J.F., D. Moore, Y.J. Abraham, S.T. Murphy & C. Prior. 1990. Biological control of the coffee berry borer, *Hypothenemus hampei*, in Mexico and

possibilities for further action, p.391-396. Brighton Crop Protection Conf. - Pests and Diseases - 1990.

Benassi, V.L.R.M. 1995. Levantamento dos inimigos naturais da broca do café *Hypothenemus hampei* (Ferr.) (Coleoptera: Scolytidae) no norte do Espirito Santo. An. Soc. Entomol. Brasil 24: 635-638.

Bustillo, A.E., M.G. Bernal, P. Benavides & B. Chaves. 1999. Dynamics of *Beauveria bassiana* and *Metarhizium anisopliae* infecting *Hypothenemus hampei* (Coleoptera: Scolytidae) populations emerging from fallen coffee berries. Fla. Entomol. 82: 491-498.

Bustillo, A.E., R. Cárdenas, D. Villalba, P. Benavides, J. Orozco & F.J. Posada. 1998. Manejo integrado de la broca del café, *Hypothenemus hampei* (Ferrari) en Colombia. Chinchiná, Cenicafé, 134p.

Cárdenas, R. 1995. Manejo de insectos que se alimentan del cafeto *Coffea arabica* L. (Rubiales: Rubiaceae) en Colombia, p.86-90. In Memorias del XXII Congreso Sociedad Colombiana de Entomología SOCOLEN, Santafé de Bogotá, julio 26-28.

Hasan, S. & C. Vago. 1972. The pathogenicity of *Fusarium oxysporum* to mosquito larvae. J. Invertebr. Pathol. 20: 268-271.

Hempel, A. 1934. A *Prorops nasuta* Waterston no Brasil. Arq. Inst. Biol. 5: 197-212.

Klein-Koch, C., O. Espinoza, A.Tandazo, P. Cisneros & D. Delgado. 1988. Factores naturales de regulación y control biológico de la broca del café (*Hypothenemus hampei*). Sanid. Veg. 3: 5-30.

Koch, V.J.M. 1973. Abondance de *Hypothenemus hampei* (Ferr.), scolyte des graines de café, en fonction de sa plante-hôte et de son parasite *Cephalonomia stephanoderis* Betrem, en Côte d'Ivoire. Mededelingen Landbouwhogeschool, Wageningen, 84p.

La Salle, J. 1990. A new genus and species of Tetrastichinae (Hymenoptera: Eulophidae) parasitic on the coffee berry borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae). Bull. Entomol. Res. 80: 7-10.

Le Pelley, R.H. 1968. Pests of coffee. Longmans, Green and Co. Ltd., London, 590p.

Moore, D. & C. Prior. 1988. Present status of biological control of the coffee berry borer *Hypothenemus hampei*, p. 1119-1123. In Proc. Brighton Crop Protection Conf. - Pests and Diseases 3.

Murphy, S.T & D. Moore. 1990. Biological control of the coffee berry borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae): previous programmes and possibilities for the future. Biocontrol News Inf. 11: 107-117.

Nayak, K. & R.P. Srivastava. 1978. Occurrence of a new fungal disease on green horned caterpillar of rice. Curr. Sci. 47: 380-381.

Pascalet, P. 1939. La lutte biologique contre *Stephanoderis hampei* ou scolyte du cafeier au Cameroun. Rev. Bot. Appl. Agric. Trop. 49: 753-764.

Pérez, E.J., F.J. Posada & M.T. González. 1996. Patogenicidad de un aislamiento de *Fusarium* sp., encontrado infectando la broca del café, *Hypothenemus hampei*. Rev. Colomb. Entomol. 22: 177-181.

Perez-Lachaud, G. & I. Hardy. 1999. Reproductive biology of *Cephalonomia hyalinipennis* (Hymenoptera: Bethylidae), a native parasitoid of the coffee berry borer, *Hypothenemus hampei* (Coleoptera: Scolytidae), in Chiapas, Mexico. Biol. Control 14: 152-158.

Ploetz, R.C., J.R. Braunworth, S. Hasty, B. Gantotti, C.T. Chizala, D.L.N. Banda, D.W. Makina & A.G. Channer. 1992. *Fusarium* wilt of banana (Panamá disease) in Malawi. Fruits 47: 503-509.

Posada, F.J., A.E. Bustillo & G. Saldarriaga. 1993. Primer registro del ataque de *Hirsutella eleutheratorum* sobre la broca del café en Colombia. Rev. Cenicafé 44: 155-158.

Posada, F.J., P. Marin & M. Pérez. 1998. *Paecilomyces lilacinus*, enemigo natural de adultos de *Hypothenemus hampei*. Rev. Cenicafé 49: 72-77.

Sponagel, K.W. 1994. La broca del café *Hypothenemus hampei* en plantaciones de café robusta en la Amazonía Ecuatoriana. Agrarwissenschaften, Wissenschaftlicher Fachverlag, Giessen, 185p.

Steyaert, R.L. 1935. Un ennemi natural du *Stephanoderis*, le *Beauveria bassiana* (Bals.) Vuill. Etude des facteurs ambiants requissant sa pullulation. Bruselas, Institute de Etudes Agronomiques du Congo Belge, 46p. (Serie Scientifique No.2).

Ticheler, J.H.G. 1963. Estudio analítico de la epidemiología del escolítido de los granos de café, *Stephanoderis hampei* Ferr., en Costa de Marfim. Rev. Cenicafé 14: 223-294.

Tronconi, N.M., R.A. Argucia & R.J. Muñoz. 1986. Evaluación de la eficiencia de *Beauveria bassiana* (Balsamo) Vuillemin en el control de la broca del fruto del cafeto (*Hypothenemus hampei* (Ferr. 1867), p.167-174. IV Seminario de Investigación Cafetera IHCAFE,

Tegucigalpa, D.C. 9-11. Julio, 1986.

Vega, F.E., G. Mercadier, A. Damon & A. Kirk. 1999. Natural enemies of the coffee berry borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae) in Togo and Cote d¨Ivoire, and other insects associated with coffee beans. Afr. Entomol. 7: 243-248.

Vélez, P.E. & M. Benavides. 1990. Registro e identificación de *Beauveria bassiana* en *Hypothenemus hampei* en Ancuya, departamento de Nariño, Colombia. Rev. Cenicafé 41: 50-58.

Villacorta, A. 1984. Ocorrência de *Beauveria* sp. infectando a broca-do-café, *Hypothenemus hampei* (Ferrari, 1867) (Coleoptera: Scolytidae) em lavouras no estado do Paraná. An. Soc. Entomol. Brasil 13: 177-178.

Received 17/09/01. Accepted 01/10/02.