TROPICAL LEPIDOPTERA, 9 (Suppl. 2): 33-41

PARASITIZATION BIOLOGY OF A NEW SPECIES OF BRACONIDAE (HYMENOPTERA) FEEDING ON LARVAE OF COSTA RICAN DRY FOREST SKIPPERS (LEPIDOPTERA: HESPERIIDAE: PYRGINAE)

DANIEL H. JANZEN[1], MICHAEL J. SHARKEY[2], AND JOHN M. BURNS[3]

[1]Dept. of Biology, University of Pennsylvania, Philadelphia, Pennsylvania 19104, USA (djanzen@sas.upenn.edu)
[2]Dept. of Entomology, University of Kentucky, Lexington, Kentucky 40546-0091, USA (msharkey@ca.uky.edu)
[3]Dept. of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0127, USA (burnsj@nmnh.si.edu)

ABSTRACT.– The black and red medium-sized parasitoid wasp *Bassus brooksi* Sharkey **n. sp.** (Braconidae) is described from wild-caught specimens from dry forest habitats ranging from northern Mexico to the northwestern Costa Rican coastal plain, and from specimens reared from the Area de Conservacion Guanacaste, Costa Rica. The wasp larvae develop in the caterpillars of a relatively unrelated array of at least 24 species of pyrgine Hesperiidae. These hosts live in the broken shade and sun of forest edges while feeding on a variety of herbs, vines, and low woody plants. Oviposition occurs in an early to middle instar caterpillar, and a single wasp larva emerges from a penultimate or ultimate instar caterpillar to spin its large elongate white cocoon in the caterpillar's shelter next to the empty skin and head capsule of the caterpillar. *Bassus brooksi* is distinctive in not attacking any grass-feeding Hesperiidae caterpillars (Hesperiinae) in this same habitat, and in apparently ignoring many species of sympatric pyrgine hesperiids as well as all other taxa of caterpillars. *Bassus brooksi* is closely related to *Bassus spiracularis*, which ranges over much of North America, is broadly sympatric with *B. brooksi* in northern Mexico, and has been reared only from pyrgine hesperiid caterpillars. These are the only two species of agathidine braconids known to attack butterfly larvae. It is hoped that publication of this information in a lepidopterological journal will stimulate the recording of these parasitoids when they are encountered while studying caterpillars.

KEY WORDS: Agathidinae, *Aguna*, *Anaea*, *Antigonus*, *Astraptes*, *Atarnes*, *Bassus*, ***Bassus brooksi*** n. sp., behavior, *Bungalotis*, *Cabares*, *Calliades*, Canada, *Carrhenes*, Central America, *Cephise*, Chalcididae, Chiapas, *Chioides*, *Chiomara*, *Cogia*, El Salvador, *Epargyreus*, *Erynnis*, *Gesta*, *Gorgythion*, Guanacaste, Hesperiinae, Honduras, hyperparasite, Ichneumonidae, immatures, Jalisco, Malvaceae, *Memphis*, Mesoamerica, Mexico, Morelos, *Mylon*, *Narcosius*, *Nascus*, Nayarit, Neotropical, Nymphalidae, Oaxaca, *Ocyba*, parasitoid, *Pellicia*, Perilampidae, *Polyctor*, *Polygonus*, *Polythrix*, Pyrginae, Pyrrhopyginae, Sinaloa, *Sostrata*, *Spathilepia*, *Staphylus*, *Systasea*, Tamaulipas, taxonomy, Texas, *Thessia*, *Timochares*, *Timochreon*, USA, *Urbanus*, Veracruz, *Xenophanes*.

The Area de Conservacion Guanacaste (ACG) is 88,000 ha of dry forests and associated wetter ecosystems conserved for ecosystem and biodiversity services in northwestern Costa Rica (Janzen, 1988a, b, 1993). As part of its Biodiversity Development, the ACG is conducting a thorough inventory of its biodiversity so as to set up that biodiversity for non-damaging use (e.g., Janzen, 1996a,b). Such inventory encounters undescribed species and simultaneously reveals a sketchy outline of their natural history (e.g., Burns, 1996; Dangerfield *et al.*, 1996; Gauld and Janzen, 1994; Sharkey and Janzen, 1995; Woodley and Janzen, 1995). Here we name one of these species, the previously undescribed *Bassus brooksi* Sharkey **n. sp.**, so that it and its natural history can be included in the greater global taxonomic understanding of braconid parasitoids (e.g., Sharkey, 1985, 1988; Burns and Janzen, 1999), and so that ecological papers can refer to it (e.g., Camargo, 1999).

This new species has been commonly collected in two distinct ways. Since the mid-1980's, I. D. Gauld and co-workers have conducted a Malaise trap inventory of the parasitoid wasp fauna of the ACG (e.g., Gauld and Janzen, 1985; Janzen and Gauld, 1997) and have frequently captured specimens of *Bassus brooksi*. Also, *Bassus brooksi* larvae frequently emerge from wild-caught skipper caterpillars reared in captivity as part of the ongoing biodiversity inventory (Janzen and Hallwachs, 1998). Here we describe the natural history of the interaction of this distinctive parasite with its hesperiid host caterpillars in a journal about Lepidoptera, with the intent that others will add to this story through their caterpillar rearings.

Bassus brooksi Sharkey, new sp.

Holotype: ♀. Length: 11.6mm.

Description.– *COLOR*: Black except reddish orange as follows: posterior orbit of eye; metapleuron, propodeum except anterior third; first metasomal median tergite, and anterior margin of second; wings infuscate. *HEAD*: Antenna with 53 flagellomeres; distance between lateral ocellus and eye = 0.35mm; distance between lateral ocelli = 0.23mm; temple not bulging laterally in dorsal view; length of malar space = 0.32mm; largest diameter of eye = 0.82mm; gena rounded posteroventrally with a well developed flange posterior to mandible; frons with prominent median ridge between antennal insertions; frons with deep depressions between antennal insertions and ocelli; antennal depressions shallow. *MESOSOMA*: propleuron evenly convex, lacking angulate protuberance; notaulus deeply impressed, complete, and smooth; posterior semicircular depression of scutellum absent; posterior transverse ridge of scutellum absent; sternaulus complete from posterior margin of mesopleuron to epicnemium, carinate and deep posteriorly, lacunate (sculpture composed of large punctures), shallow, and diffused anteriorly (Fig. 2); epicnemial carina very prominent and curled posteriorly especially in ventral area (Fig. 2); metapleuron rugose in ventral third, mostly smooth in dorsal two thirds, with weak sparse punctures and very weak coriarious (leather-like) sculpture; propodeum with pair of median longitudinal diverging carinae with some carinae between them; lateral areas weakly coriarious with rugosities on all margins; propodeal spiracles very large and ovate (Fig. 1); hind coxal cavities separated from metasomal cavity (insertion) by wide sclerite. *LEGS*: Foretibia lacking spines and pegs; midtibia with 6 apical spines/pegs and 5 preapical spines/pegs; hind tibia with 10 apical spines/pegs; ratio of hind femur length:width = 0.38; hind femur smooth ventrally and punctate on all other surfaces; all tarsal claws with large quadrate basal lobes. *WINGS*: All veins wide and thick; second submarginal cell small and triangular; 2CU vein of hind wing long and well pigmented but tubular only at extreme base. *METASOMA*: Ratio of length to apical width of first median tergite (T1) = 1.12; T1 with well developed pair of

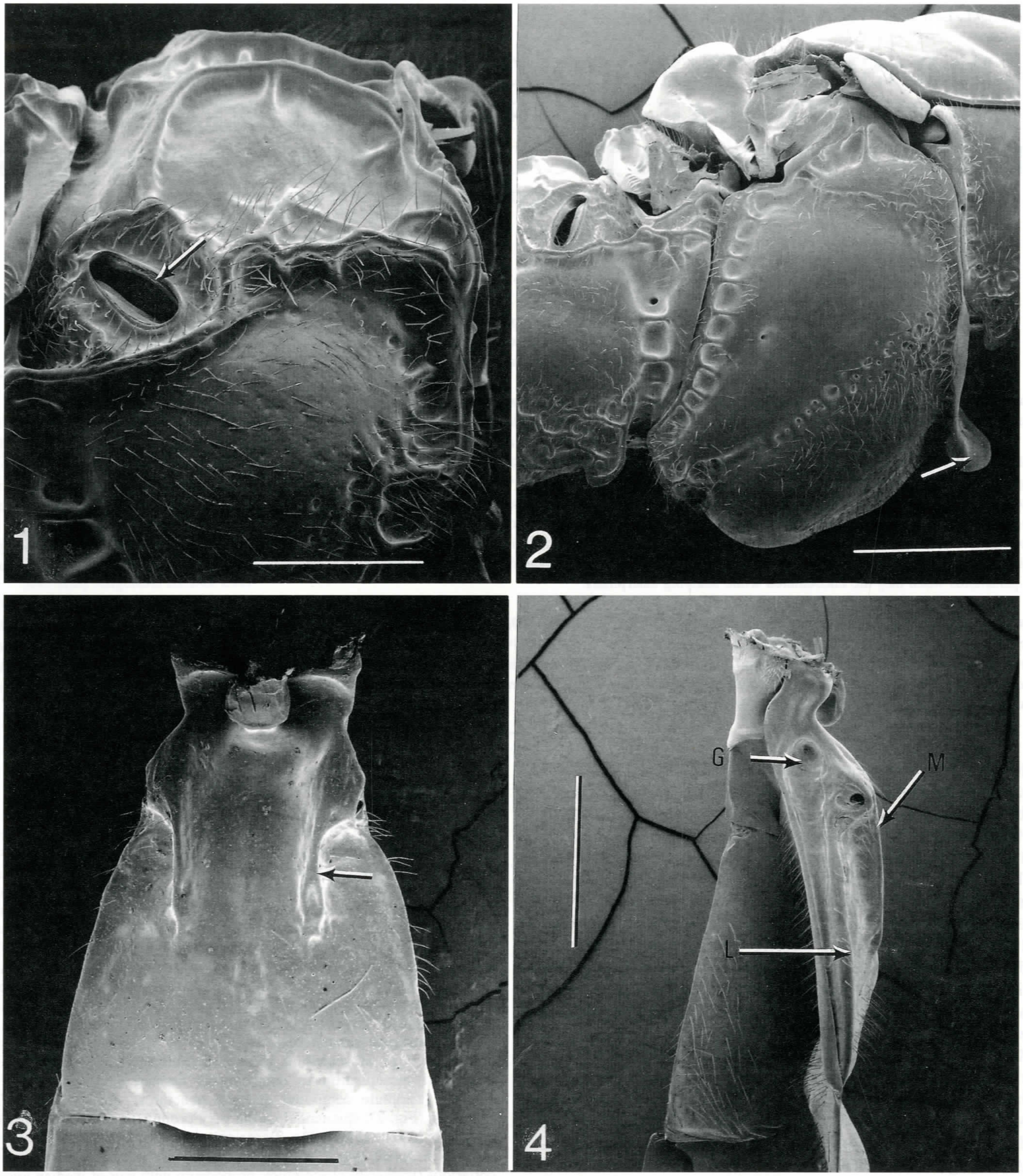

Fig. 1-4. Morphology of *Bassus brooksi*: **1)** Lateral view of metapleuron and propodeum, showing large propodeal spiracle. Scale bar = 500 μm. **2)** Lateral view of mesosoma showing large, curved epicnemial carina. Scale bar = 1000 μm. **3)** Dorsal view of first metasomal median tergite, showing medial longitudinal carinae. Scale bar = 860 μm. **4)** Lateral view of first metasomal segment. G = lateral groove, the base of which is the laterope. L = lateral longitudinal carina. M = median longitudinal carina. Scale bar = 920 μm.

median longitudinal carinae and well developed pair of lateral longitudinal carinae (Fig. 3, 4); lateral precurrent groove running from laterope to posterior margin of T1 (Fig. 4); T1 mostly smooth with very weak coriarious sculpture especially medially and some rugosities medially, T2+3 smooth with 3 very weak, transverse grooves; ratio of length of ovipositor to length of metasoma = 1.16.

VARIATION: Specimens from more northern latitudes (e.g., northern Mexico) are generally smaller. Total length varies from 8.0-12.5mm. Males from all localities are slightly smaller than females. Propodeum may be entirely black; first metasomal median tergite may be entirely black; hind femur may be entirely reddish orange (especially in Mexican specimens);

hind coxa rarely mostly black; antenna with 43 to 57 flagellomeres; coriarious sculpture can be much reduced; propodeum usually with a complete transverse carina anteriorly. Most specimens from Sinaloa and Nayarit are mostly reddish orange on the metanotum and scutellum, the entire metasoma, and the hind leg except the trochanter.

Etymology.– This parasitoid is named in honor of Daniel R. Brooks (despite his zeal for tapeworms) whose enthusiasm for biodiversity development of the Area de Conservacion Guanacaste is exemplary.

Material examined.– The following museum collections were consulted:

AEI = American Entomological Institute, Gainesville, Florida.
CAS = California Academy of Sciences, San Francisco, California.
BM = The Natural History Museum, London, England.
CNC = Canadian National Collection, Ottawa, Canada.
EL = Michigan State University Collection, East Lansing, Michigan.
INBIO = Instituto Nacional de Biodiversidad, San Jose, Costa Rica.
USNM = National Museum of Natural History, Smithsonian Institution, Washington, DC.
FSCA = Florida State Collection of Arthropods, Gainesville, Florida.
TAMU = Texas A&M University, College Station, Texas.
UK = University of Kentucky Insect Collection, Lexington, Kentucky.
UW = University of Wyoming Insect Collection, Laramie, Wyoming.

Holotype ♀.– 95-SRNP-6824 in Janzen and Hallwachs Caterpillar Rearing Database (Janzen and Hallwachs, 1998); Sector Junquillal, Area de Conservacion Guanacaste, Guanacaste Province, Costa Rica; 2m elevation, Lambert Coordinates north 327650, east 351900. 25 Aug 1995. Reared from a larva of *Carrhenes fuscescens* (Mabille) (Hesperiidae) (INBIO).

Paratypes ("wild caught adults").– **Mexico**: *Chiapas*: 1♀, El Zapotal, 2 mi S. Tuxtla Gutierrez, 11 Jul 1957 (CNC). 1♀, Municipio Angel Albino Corzo, along Rio Custepec below Finca Gadow, alt. 853m, 12 Sep 1972, D. & J. Breedlove (CAS). *Jalisco*: 2♀, 2♂, Guadalajara (no further data) (USNM). 1♀, 16 km N. Autlan, 7 Jul 1984, Carroll, Schaffner, Friedlander (TAMU). 1♀, Las Cabanas, 7 mi SW. Mazamitla, 1910m, 20 Oct 1988 (CAS). 1♂, Puerto de Mazos, 8 mi SW. Autlan 1035m, 18 Oct 1988, E. Ross & P. Buickrood (CAS). *Morelos*: 1♀, 1♂, Tepotzlan, 26 Sep 1957, R. & K. Dreisbach (EL). 1♂, Xautepec, 19 Aug 1956, R. & K. Dreisbach (USNM). 2♀, Yautepec, 31 Jul 1963, Parker and Stangė (USNM). *Nayarit*: 1♀, Acponeta, 8 Aug 1964, W. R. M. Mason (CNC). 1♂, 5 mi NW. Chaplilla (SW. Tepic), 1180m, 13 Oct 1988, E. Ross & P. Buickrood (CAS). 1♀, 10 mi N. of Tepic, 15 Aug 1957, J. A. Chemsak and B. J. Rannells (CNC). *Oaxaca*: 1♂, Oaxaca (no more data) (USNM). 1♀, Palomares, 5-21 Sep 1961, R. & K. Dreisbach (EL). 2♀, 27 mi SW. Salina Cruz, 14 Jul 1987, R. Wharton (TAMU). 1♀, 19 mi S. San Miguel, Suchixtepec, 17 Jul 1985, Woolley & Zolnerwich (TAMU). *Sinaloa*: 1♀, 2♂, 20 mi E. Concordia, 3000 ft, 9-12 Aug 1964, W. R. M. Mason (CNC). 1♀, 7 mi E. Concordia, 14 Aug 1970, J. A. Chemsak (CNC). 1♀, Copala, 15 Aug 1960, P. Arnaud, E. Ross, D. Rentz (CAS). 1♀, 20 mi E. Villa Union, 235m, 19 Aug 1964, E. I. Schlinger (USNM). *Tamaulipas*: 1♀, c.a. Gómez Farías, 25 May 1990, E. Ruíz (TAMU). *Veracruz*: 1♀, Mocambo, Nov 1960, N. L. & H. K. Krauss (USNM). 1♀, Orizaba, 12-22 Aug 1961, R. & K. Dreisbach (EL). 1♀, S. Lucrecia, Crawford (no further data) (FSCA). 1♀, Valles, 8 Aug 1954, Dreisbach (EL). **El Salvador**: 1♀, Quetzaltepeque, 17 Jun 1963, D. Cavagnaro & M. Irwin (USNM); 1♀, 9 Aug 1961, M. Irwin (USNM). **Costa Rica**: *Guanacaste*: 1♀, S. Cañas, 26-31 Jan 1989, F. D. Parker (UW). 1♀, 14 km S. Cañas, 7-10 Oct 1989, F. D. Parker (UW). 1♀, Estacion Experimental Enrique Jimenez Nuñez, 20 km SW. Cañas, malaise trap, 5-17 Nov 1991, A. Menke (USNM). 2♀, Santa Rosa Park, scrub forest (7 year) open site, 300 m, 13 Jun-3 Jul 1985, Gauld & Janzen (UK); 1♀, 14 Sep-5 Oct 1985, Gauld & Janzen (BM); 1♀, scrub forest (7 year) closed site, 300m, 26 Oct-16 Nov 1985, Gauld & Janzen (BM). 1♀, Santa Rosa Park, Dry Hill, 28 Aug 1977 (AEI). 1♀, Los Almendros, P. N. Guanacaste, LN 334800 369800, 11-30 Jun 1993, E. Lopez (INBIO). 1, LN 334800 369800, 7-26 Jan 1993, E. Lopez (INBIO). 1♀, Finca Jenny, 300m, 31 km N. Liberia, Nov 1988, GNP Biodiversity Survey, W85°34' 27", N10°51'55" (INBIO). 1, Ref. Nac. Fauna Silvestre Rafael Lucas Rodriguez, Palo Verde, LN 259000 388400, 10m, Mar 1991, U. Chavarria (INBIO). **Honduras**: *La Paz*: 1♀, La Paz, 23 Jun 1979 (CNC). **USA**: *Texas*: 1♀, Sutton Co., 7 mi E. Llano R. on US 290, 24 Aug 1974, H. Greenbaum (TAMU).

Paratype reared adults: 99♂, 138♀ (INBIO) (see Table 2).

Range.– Widespread in Mexico, south to Costa Rica (Fig. 5), always in lowland dry forest.

Taxonomic remarks.– *Bassus brooksi* is very similar to *Bassus spiracularis* Muesebeck, the only previously known agathidine parasitoid of Hesperiidae (Marsh, 1979; Shenefelt, 1970). *Bassus brooksi* and *Bassus spiracularis* are of a similar size and have distinctive elongate propodeal spiracles. They also share a peculiar similarity in the shape of the carinae on the first metasomal median tergite (Fig. 3). Besides a number of minor and rather superficial differences such as coloration (the metasomata of *Bassus spiracularis* are entirely reddish orange while the metasomata of *Bassus brooksi* are usually black except for the first segment which is reddish orange), the most obvious characteristic that distinguishes the two species is the enlarged epicnemial carina of *Bassus brooksi* (Fig. 2). We have encountered no specimens that are morphologically intermediate for this character. Based on the shared derived states of the enlarged spiracles, the configuration of the carinae of the first tergite, and the use of Hesperiidae as hosts (see below), the two appear to be sister species.

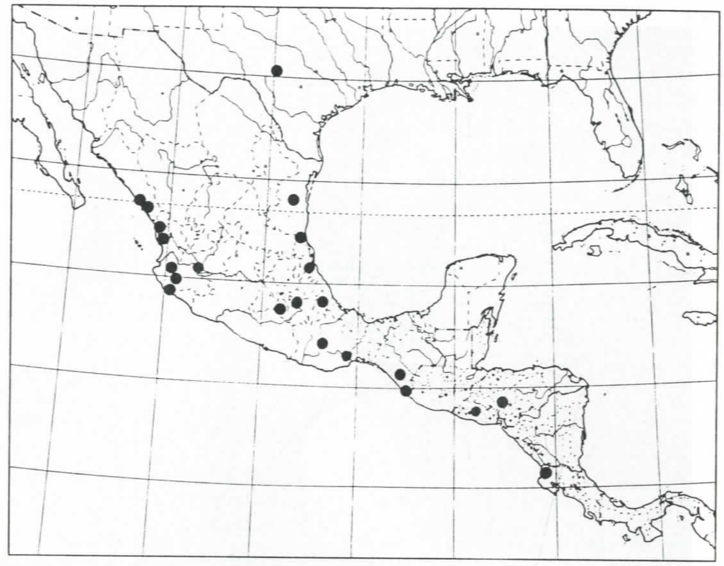

Fig. 5. Geographic distribution of *Bassus brooksi*.

Bassus spiracularis is widespread all over the USA, from Washington to New York in the north, and Arizona to Florida in the south. There are also several records from southern Ontario, Canada, and from northern and western Mexico (e.g., Nuevo Leon, Sinaloa). *Bassus brooksi* and *Bassus spiracularis* are widely sympatric in northern Mexico.

Natural History of *Bassus brooksi*

The genus *Bassus* contains about 250 described species of 0.3-2 cm long black, red, and/or yellow agathidine Braconidae, distributed worldwide. Like all agathidines, they are parasitoids of the larvae of macrolepidoptera (Sharkey, 1992). Until this study began, *Bassus spiracularis* was the only agathidine known to parasitize hesperiid larvae (Shenefelt, 1970). In the USA, *Bassus spiracularis* has been reared from larvae of the hesperiids *Cogia outis* (Skinner), *Systasea pulverulenta* (R. Felder), *Gesta gesta* (Herrich-Schäffer), and *Erynnis zarucco* (Lucas), but no details of these rearings were published. No agathidines are known to attack Hesperiidae in the Old World tropics (A. Walker, pers. comm.). *Bassus spiracularis* and *Bassus brooksi* are also the only agathidine Braconidae known to parasitize the larvae of butterflies. It may be significant that Hesperiidae caterpillars are the only butterfly larvae that consistently spend most of their non-feeding time "hidden" inside of leaf and silk structures (except for a few nymphalid genera such as *Memphis* and *Anaea*, the larvae of which also construct silk and leaf roll shelters). However, other genera and species of agathidines are not noted for being parasitoids of Lepidoptera larvae living in shelters.

The following natural history of *Bassus brooksi* is based on more than five hundred rearings of this wasp from wild-caught hesperiid caterpillars found in the lowland dry forests of the ACG between

Fig. 6. Last instar larva of *Urbanus esmeraldus* (Butler) (Hesperiidae), a frequent host of the wasp *Bassus brooksi* (Braconidae) in the dry forests of the Area de Conservacion Guanacaste (voucher 90-SRNP-1906, Janzen and Hallwachs, 1998).

Fig. 7. Above: cocoon of the wasp *Bassus brooksi* (Braconidae) spun in the larval shelter of *Urbanus esmeraldus* (Hesperiidae), after the wasp larva had exited from the penultimate instar caterpillar; the caterpillar head capsule and larval skin rests in its usual place on the end of the cocoon. Below: adult normal-sized and normal-colored female *Bassus brooksi* (vouchers 93-SRNP-6648, 93-SRNP-6207, respectively, Janzen and Hallwachs, 1998).

1978 and 1996 (Table 1). This wasp is a specialist on a small subset of the species of pyrgine hesperiids in the ACG and parasitizes no other species of Lepidoptera larvae (based on about 75,000 rearing records, Janzen and Hallwachs, 1998). Three subfamilies of Hesperiidae occur in the study area. No *Bassus* (or other Agathidinae) emerged from 1136 wild-caught caterpillars of seven species of Pyrrhopyginae, or 2246 wild-caught caterpillars of at least 43 species of Hesperiinae. All of the hesperiines feed on monocots, but these monocots are thoroughly interspersed with the pyrgine food plants, which are dicots (Table 1). Members of other subfamilies of Braconidae do attack almost all of the species in all three hesperiid subfamilies in the ACG.

By the close of 1996, 11,426 wild-caught caterpillars in 153 species of pyrgine hesperiids reared from the study area have yielded 24 species of hosts for *Bassus brooksi* (Table 1). About ten of these — *Epargyreus* spp., certain *Urbanus* spp. (Fig. 6), *Astraptes anaphus annetta* Evans, *Cabares potrillo* (Lucas), *Antigonus erosus* (Hübner), *Gesta gesta* — are sustaining the *Bassus brooksi* population. The rest of the records appear to be "incidental" or at least very low frequency. *Bassus brooksi* is unambiguously a specialist on a small set of pyrgine hesperiid larvae living on broad-leaved dicot herbs, shrubs, saplings, and vines in mixed sun-shade habitats at heights less than about 1m above the ground.

Bassus brooksi is not using the larvae of "forest" pyrgines living just a few tens of meters away (e.g., *"Polythrix" caunus* (Herrich-Schäffer), *Narcosius*, *Calliades*, *Bungalotis*, *Nascus*, *Cephise*, *Ocyba*, *Polyctor*, *Atarnes*, *Mylon*, etc.). In a detailed study of the interaction between *Bassus brooksi* and *Epargyreus* spp. larvae in the ACG dry forests, Camargo (1999) found a significantly greater frequency of attack on *Epargyreus* caterpillars in sunny than in deeply shady sites. However, there are many species of common yet totally unattacked pyrgine hesperiid caterpillars that live in exactly the same habitat as do the species used by *Bassus brooksi* (e.g., *Urbanus simplicius* (Stoll), *Urbanus doryssus* (Swainson), *Urbanus albimargo* (Mabille), *Astraptes fulgerator azul* (Reakirt), *Pellicia arina* Evans, *Pellicia dimidiata* Herrich-Schäffer, *Staphylus* spp., *Gorgythion* spp., *Sostrata*

TABLE 1. Hesperiid species parasitized by *Bassus brooksi* in the tropical dry forests of the Area de Conservacion Guanacaste, northwestern Costa Rica (see Janzen and Hallwachs (1998) for individual rearing records).

Hesperiidae species	Food plant species[1]	Family	Number of rearings	% *Bassus brooksi*
Aguna asander	*Bauhinia ungulata*	Fabaceae	337	<1
Antigonus erosus	*Guazuma ulmifolia*	Sterculiaceae	265	25
Astraptes alector hopfferi	*Platymiscium parviflorum*	Fabaceae	200	7
Astraptes anaphus annetta	*Stizolobium pruriens*	Fabaceae	193	25
	Canavalia brasiliensis	Fabaceae	8	25
	Phaseolus lunatus	Fabaceae	5	60
Cabares potrillo	*Priva lappulacea*	Verbenaceae	88	17
Carrhenes canescens	*Malvaviscus arboreus*	Malvaceae	38	11
Carrhenes calidius	*Byttneria catalpaefolia*	Sterculiaceae	5	20
Carrhenes fuscescens	*Byttneria aculeata*	Sterculiaceae	50	16
Chioides catillus albius	*Galactia striata*	Fabaceae	17	18
	Rhynchosia reticulata	Fabaceae	67	3
	other Fabaceae vines	Fabaceae	37	0
Cogia eluina	*Senna pallida*	Fabaceae	100	1
	Cassia obtusifolia	Fabaceae	1	0
Epargyreus sp. 1	*Calopogonium galactioides*	Fabaceae	89	3
Epargyreus sp. 2	*Dioclea megacarpa*	Fabaceae	3	33
Epargyreus sp. 3	*Gliricidia sepium*	Fabaceae	586	17
Epargyreus sp. 4	*Machaerium biovulatum*	Fabaceae	173	12
Gesta gesta	*Indigofera costaricensis*	Fabaceae	309	35
Polygonus leo	*Lonchocarpus orotinus*	Fabaceae	74	1
	other *Lonchocarpus* spp.	Fabaceae	419	0
"*Polythrix*"[2] "*asine*"[3]	*Gliricidia sepium*	Fabaceae	51	2
	Lonchocarpus costaricensis	Fabaceae	18	6
	other Fabaceae spp. (trees)	Fabaceae	358	0
Spathilepia clonius	*Pachyrrhizus erosus*	Fabaceae	30	7
	other Fabaceae spp. (vines)	Fabaceae	76	0
Thessia jalapus	*Pithecellobium furcatum* .	Fabaceae	31	3
	other Fabaceae spp.	Fabaceae	11	0
Urbanus belli	Asteraceae	Asteraceae	72	1
Urbanus dorantes	*Desmodium* spp.	Fabaceae	83	18
Urbanus esta	*Desmodium* spp.	Fabaceae	56	4
	Centrosema spp.	Fabaceae	3	0
Urbanus "*proteus* group"[4]	*Centrosema* spp	Fabaceae	168	22
	Desmodium spp.	Fabaceae	160	30
Xenophanes tryxus	*Malvaviscus arboreus*	Malvaceae	50	6
	other Malvaceae (herbs)	Malvaceae	301	0

1. These are the sole food plants that have been encountered in the dry forests of the ACG for the species of Hesperiidae in this table.
2. "*Polythrix*" is a polyphyletic genus that currently (but incorrectly) includes *Polythrix asine* (Hewitson) and *Polythrix mexicanus* Freeman; these species are closely related to each other (Burns, 1997).
3. This is an undifferentiable mix of "*Polythrix*" *asine* (usually) and "*Polythrix*" *mexicanus* (rarely).
4. This is an undifferentiable mix of *Urbanus proteus* (Linnaeus), *Urbanus esta* Evans, *Urbanus esmeraldus*, and *Urbanus evona* Evans.

bifasciata nordica Evans, *Timochreon satyrus* (Felder & Felder), *Timochares trifasciata* (Hewiston), *Chiomara georgina* (Reakirt), etc.). Perhaps the most enigmatic are those species (Table 1) that have just a few rearing records (e.g., *Polygonus leo* (Gmelin), *Aguna asander* (Hewitson), *Urbanus belli* (Hayward), *Astraptes alector hopfferi* (Plötz), and *Cogia eluina* Godman & Salvin, as well as *Xenophanes tryxus* (Stoll) when it feeds on herbaceous Malvaceae, rather than on woody Malvaceae), which demonstrates that the wasp can develop in these caterpillars, yet they are only rarely used by *Bassus brooksi*. This occurs even though the caterpillars are extremely common and on food plants that grow side by side with food plants of pyrgines that are heavily parasitized by *Bassus brooksi*.

Mixed sun-shade habitats at ground level are today characteristic of the commonplace edges of roadsides and of fields and pastures, and young secondary succession in tropical old fields and pastures. However, these habitats would originally have occurred in much scarcer and less contiguous landslides, watercourse edges, and large new tree falls. *Bassus brooksi* is currently living in a world where conspecific density, host density, and host distribution on food plants are very different from those of its pre-human history in Mesoamerica. This is because the food plants of their caterpillars are plants of open, sunny, and young second-growth vegetation. Today this habitat is the dominant habitat, but during most of the evolution of this wasp it would have been a fragmented and scarce habitat.

The wasp's choice of habitats, micro-habitats, and hosts is probably in great part guided and triggered by traits that had their evolution and their function in that very different pre-human circumstance. Only further detailed ecological and behavioral study can perhaps determine whether the non-hosts are ignored, rejected, resistant, or more simply, never encountered by the wasp. The wasp searches diurnally, flitting through the foliage and running across leaves. It does not come to light at night. Nothing is known of its mating behavior. The sex ratio of reared adults is 99 males to 138 females, but this distortion from 50:50 could reflect nothing more than that male offspring have lower survival capacity when subjected to the rigors and semi-starvation of the host when reared in captivity. The strong female biased sex ratio among the wild-caught paratypes (see above) could be either a distortion stemming from the capture process or a real biological bias.

Bassus brooksi oviposits in pyrgine hesperiid larvae at least as early as the second instar, as evidenced by 36 rearings from wild-caught caterpillars collected in the second instar. Furthermore, in seven cases a caterpillar collected in what was believed at the moment of collection to be the first instar also proved to contain a *Bassus brooksi*. However, corroboration is required to be certain that this wasp can oviposit in a first instar larva since it is possible that these "first" instar larvae were in fact second instars (very small hesperiid larvae can be incorrectly placed to instar in the field). We do not know if the wasp may also oviposit in later instars, but assume that it probably does. The few observations of other species of *Bassus* indicate that only early-instar larvae are attacked by members of this genus (Dondale, 1954; Nickels *et al.*, 1950).

Whatever the instar or caterpillar species, the wasp larva waits until its host caterpillar is either a full-sized penultimate instar or a full-sized last instar, before accelerating its feeding and development and consuming the internal contents of the caterpillar. It then emerges from the empty caterpillar to spin its cream-colored ovoid cocoon of strong silk next to the larva's skin and head capsule (Fig. 7). The silk wasp cocoon sticks to the hesperiid silk and the leaf surface.

If the hesperiid is a small species, such as *Gesta gesta*, *Cabares potrillo*, or *Antigonus erosus*, and therefore has a relatively small last instar larva, the wasp larva emerges from the full-sized last-instar caterpillar (about 10% of the time, it emerges from *Antigonus erosus* at the end of the penultimate stage). In effect, the wasp larva is emerging from a pre-pupal or nearly pre-pupal caterpillar that has accumulated all the reserves that it will accumulate and has stopped feeding, and has spun as much of a cocoon or silk/leaf pupal shelter as it would have had there been no parasitoid inside. The wasp larva is effectively spinning its cocoon inside the "cocoon" or pupal nest of the caterpillar, just as is the case with all other species of *Bassus* and other Agathidinae Braconidae reared to date in the ACG (these are parasitoids of Noctuidae, Pyralidae, and Gelechiidae). And, in this situation, there is no outstanding change in the behavior of the host caterpillar when parasitized.

Caterpillar consumption by the larva of *Bassus brooksi* may involve a distinctive change in caterpillar behavior about the time of the parasitoid's emergence from the caterpillar if the emergence is from the penultimate larval instar. When *Bassus brooksi* is parasitizing skippers that have large last instar larvae, such as species of *Epargyreus*, *Astraptes*, and *Urbanus*, the wasp larva induces the penultimate instar caterpillar to construct a substantial leaf and silk shelter, as if the caterpillar were going to pupate. Then, the wasp larva consumes the caterpillar and emerges to spin its cocoon inside this shelter, which is often more substantial than the normal resting shelter constructed by penultimate instar hesperiid larvae. However, this wasp/caterpillar-instar relationship is not 100% reliable. In about 5% of the cases, the wasp larva waits until the large caterpillar has molted and grown to full size as an ultimate instar before consuming it and emerging to spin its own cocoon as described in the previous paragraph. When the wasp is emerging from a penultimate instar larva, that larva can appear to be a prepupa waiting to pupate, and the resultant wasp cocoon may be recorded by the unsuspecting observer as a Lepidoptera cocoon.

Not all *Bassus brooksi* larvae that have emerged and spun cocoons produce adults. Under ordinary rearing circumstances (each caterpillar in its own plastic bag with food plants changed every 2-4 days), about 30% die from diseases or developmental failure in their cocoons, or after spinning mishaps. If the larva falls out of the hesperiid pupal nest onto a smooth surface (glass, plastic), it often cannot successfully spin its own cocoon and dies of unknown causes, often without pupating. However, if it falls into frass and litter in the rearing container, sometimes it can successfully spin its own cocoon.

In slightly more than 500 rearings, two hyperparasites have eclosed. In one case a Perilampidae wasp eclosed from the *Bassus brooksi* cocoon (93-SRNP-7821), and in the other a Chalcididae wasp eclosed from a wild-caught *Bassus brooksi* cocoon (95-SRNP-7088). The latter case of hyperparasitization probably occurred through oviposition by the hyperparasite into the braconid cocoon in nature. A low frequency such as 1 perilampid out of 500 parasitized caterpillars is not abnormal, considering that of 9,237 parasitized larvae to date from about 75,000 wild-caught larvae, only 137 of them had perilampids in them (Janzen and Hallwachs, 1998).

The frequency of parasitoids and hyperparasitoids of *Bassus brooksi* prepupae and pupae in the wild cannot be estimated from this study because reared hesperiid larvae are not exposed to them. When a caterpillar is captured to rear, it is removed from parasitoid attack, so that any frequencies of attack such as those presented in Table 1 are always minimal estimates. Equally complicating is the fact that for those species from which *Bassus brooksi* larvae emerge from the penultimate instar, larvae captured as last instar larvae should not "count" in determining percentages of parasitism. If this adjustment is made for the figures in Table 1, the percent parasitism for the *Epargyreus* spp. and *Urbanus* spp. increases by about 30%.

Each of the species of caterpillars parasitized by *Bassus brooksi* is also parasitized by a few species of other Braconidae, Ichneumonidae and/or Tachinidae (Janzen and Hallwachs, 1998). Nothing is known of the specific interactions of these parasitoids with *Bassus brooksi* larvae. However, since some of these other parasitoids kill the caterpillar before the end of the appropriate instar for *Bassus brooksi* development, they presumably consume the *Bassus* larva in the process. Alternatively, *Bassus brooksi* consumes its caterpillars before some of the other parasitoids begin their caterpillar-killing development, and therefore presumably consumes the larvae of other parasitoids. As high as 30% of the individuals of the species of caterpillars that are attacked by *Bassus brooksi* die "of disease," and some of this mortality may be due to aborted parasitism by *Bassus brooksi* through death of the wasp larva before emergence from the caterpillar cadaver.

Bassus brooksi pupates for 7-10 days between the date of cocoon spinning and emergence of the adult wasp from the cocoon. In more than 300 successful rearings of this wasp, there has not been a single case of a wasp (or its larva or pupa) remaining dormant in the cocoon (or in a dormant hesperiid larva). The rearing containers are glass bottles or plastic bags suspended from a clothesline, at ambient temperatures in a rearing barn; internal conditions of the rearing containers range from very wet to very dry (Janzen, 1993). There is thus no hint of egg, larval, or pupal dormancy in *Bassus brooksi* (despite the 5-6 month dry season (Janzen, 1987a, 1993) in the study area, a time when virtually no hesperiid caterpillars are in the habitat).

To date, the preliminary, though extensive, rearing of hesperiid larvae caught in the wetter eastern end of the ACG (cloud forest, rain forest, and various degrees of intergrades with dry forest) has yielded no *Bassus brooksi*; and there is as yet no reason to expect that this wasp is passing the dry season by migrating to this wetter area, as do many other organisms (Janzen, 1987a,b, 1988c). We suspect that the adult wasps seclude themselves in locally moist areas rather than make a long-distance migration. This impression is reinforced by the fact that there are no records of wild-caught *Bassus brooksi* from rain forest habitats (Fig. 5).

The time from oviposition in a second instar hesperiid larva to emergence of an adult wasp ranges from 4-8 weeks (the variation is generated by the different growth rates of different species of hesperiids). This means that about four successive generations of wasps and hesperiid larvae probably occur during the six month rainy season (May-December) in the ACG dry forests. It is certain that hesperiid hosts are continuously available, albeit at highly variable densities, throughout the rainy season.

During the six-month dry season, it is very likely that the population of *Bassus brooksi* survives as potentially active (but reproductively dormant) adults, perhaps augmented by the occasional new offspring of a female wasp that finds one of the very rare (low density) dry season hesperiid caterpillars. The wasp population probably declines through adult mortality during this non-reproductive period. It is therefore likely to be at its annual low when the rains begin and the first generation of hesperiid hosts occurs. In contrast, it is probably at its highest during the last half of the rainy season, thereby contributing to the overall parasitization and predation pressure that appears to result in the bulk of Lepidoptera having their heaviest reproductive period in dry forest during the first half of the rainy season (Janzen, 1987a,b, 1988c). However, it should also be noted that Hesperiidae are among the very few higher taxa with easily "findable" larval generations during the second half of the rainy season in the ACG dry forest. This implies that hesperiids have not fully responded – whether evolutionarily or serendipitously – to this general increase in parasitoid and predatory density as the rainy season progresses.

ACKNOWLEDGMENTS

This study and the larger caterpillar/host/parasitoid inventory in which it is embedded has been supported by NSF grants BSR 90-24770, DEB 93-06296, and DEB-94-00829, and DEB-97-05072 to DHJ, as well as financial, administrative, and logistic support from INBio, the government of Costa Rica, the Area de Conservacion Guanacaste, CONICIT of Costa Rica, Keidanren of Japan, and the Children's Rainforest Japan. Support for MJS was provided by Kentucky Agricultural Experiment Station Project No. 98-08-17. Many individuals have supported the development of all stages of the project in a multitude of ways. We wish to specially thank H. Kidono, W. Hallwachs, C. Camargo, A. Masis, R. Robbins, A. Venables, E. Klafter, D. Harvey, I. Gauld, S.Ward, P. Southgate, and N. Zamora for contributions to the taxonomic and data-processing aspects of the *Bassus*, the Hesperiidae, and their host plants; I. Gauld, M. Wood, N. Woodley, S. Shaw, J. Whitfield, D. Quicke, C. Darling, and D. Carmean for parasitoid identifications; and R. Moraga, G. Sihezar, G. Pereira, L. Rios, M. Pereira, O. Espinosa, E. Cantillano, M. Pereira, R. Franco, H. Ramirez, F. Chavarria, M. M. Chavarria, E. Olson, C. Moraga, P. Rios, C. Cano, D. Garcia, F. Quesada, E. Araya, E. Guadamuz, R. Espinosa, R. Blanco, A. Guadamuz, and D. Perez for caterpillar and parasitoid hunting and husbandry.

LITERATURE CITED

Burns, J. M.

1996. Genitalia and the proper genus: *Codatractus* gets *mysie* and *uvydixa* —in a compact *cyda* group—as well as a *hyster*ectomy, while *Cephise* gets part of *Polythrix* (Hesperiidae: Pyrginae). *J. Lepid. Soc.* (Los Angeles), 50:173-216.

1997. Presidential address 1996: On the beauties, uses, variation, and handling of genitalia. *J. Lepid. Soc.* (Los Angeles), 51:1-8.

Burns, J. M., and D. H. Janzen

1999. Larval food plants of pyrgine Hesperiidae (Lepidoptera) in the tropical lowland dry forest of the Area de Conservacion Guanacaste, northwestern Costa Rica. [in prep.]

Burns, J. M., A. Masis, and D. H. Janzen

1999. The *Epargyreus* (Hesperiidae) species complex in the Area de Conservacion Guanacaste in northwestern Costa Rica. [in prep.]

Camargo, C.

1999. Inter-habitat variation in host use by the parasitoid wasp *Bassus brooksi* (Agathidinae, Braconidae) when parasitizing a butterfly caterpillar *Epargyreus* spp. (Hesperiidae) in a Costa Rican dry forest. [in prep.]

Dangerfield, P. C., J. B. Whitfield, M. J. Sharkey, D. H. Janzen, and I. Mercado

1996. *Hansonia*, a new genus of cardiochiline Braconidae (Hymenoptera) from Costa Rica, with notes on its biology. *Proc. Ent. Soc. Washington*, 98:592-596.

Dondale, C. D.

1954. Biology of *Agathis laticinctus* (Cress.) (Hymenoptera: Braconidae), a parasite of the eye-spotted bud moth, in Nova Scotia. *Can. Ent.* (Ottawa), 86:40-44.

Gauld, I. D., and D. H. Janzen

1994. The classification, evolution and biology of the Costa Rican species of *Cryptophion* (Hymenoptera: Ichneumonidae). *Zool. J. Linn. Soc.* (London), 110:297-324.

Janzen, D. H.

1987a. How moths pass the dry season in a Costa Rican dry forest. *Insect Sci. Appl.* (Nairobi), 8:489-500.

1987b. When, and when not to leave. *Oikos* (Lund), 49:241-243.

1988a. Ecological characterization of a Costa Rican dry forest caterpillar fauna. *Biotropica* (Baltimore), 20:120-135.

1988b. Guanacaste National Park: Tropical ecological and biocultural restoration. *In* J. J. Cairns (ed.), *Rehabilitating Damaged Ecosystems*. Vol. II: 143-192. Boca Raton: CRC Press.

1988c. The migrant moths of Guanacaste. *Orion Nat. Qtr.* (San Francisco), 7:38-41.

1993. Caterpillar seasonality in a Costa Rican dry forest. *In* N. E. Stamp and T. M. Casey (eds.), *Caterpillars: Ecological and Evolutionary Constraints on Foraging*, 448-477. New York: Chapman and Hall.

1996a. On the importance of systematic biology in biodiversity development. *ASC Newsl.* (Washington), 24:17, 23-28.

1996b. Prioritization of major groups of taxa for the All Taxa Biodiversity Inventory (ATBI) of the Guanacaste Conservation Area in northwestern Costa Rica, a biodiversity development project. *ASC Newsl.* (Washington), 24:45, 49-56.

Janzen, D. H., and I. D. Gauld

1997. Patterns of use of large moth caterpillars (Lepidoptera: Saturniidae and Sphingidae) by ichneumonid parasitoids (Hymenoptera) in Costa Rican dry forest. *In* A. D. Watt, N. E. Stork, and M. D. Hunter (eds.), *Forests and Insects*, 251-271. London: Chapman and Hall.

Janzen, D. H., and W. Hallwachs

1998. *Janzen and Hallwachs Caterpillar Rearing Database*. Filemaker Pro 4.0 database (accessible through Netscape and other web browsers). <http://janzen.sas.upenn.edu/index.html>.

Marsh, P. M.

1979. Family Braconidae. *In* K. V. Krombein, P. D. Hurd, D. R. Smith, and B. D. Burks (eds.), *Catalog of Hymenoptera in America north of Mexico*. Vol. 1. Washington: Smithson. Inst. Pr. 1198pp.

Nickels, C. B., W. C. Pierce, and C. C. Pinkney

1950. Parasites of the pecan nut casebearer in Texas. *Tech. Bull. Texas Dept. Agric.* (Austin), 1011:1-21.

Sharkey, M. J.

1985. Notes on the genera *Bassus* Fabricius and *Agathis* Latreille, with a description of *Bassus arthurellus* n. sp. (Hymenoptera: Braconidae). *Can. Ent.* (Ottawa), 117:1497-1502.

1988. A taxonomic revision of *Alabagrus* (Hymenoptera: Braconidae). *Bull. Br. Mus. (Nat. Hist.) Ent. Ser.* (London), 57:311-437.

1992. Cladistics and tribal classification of the Agathidinae (Hymenoptera: Braconidae). *J. Nat. Hist.* (London), 26:425-447.

Sharkey, M. J., and D. H. Janzen

1995. Review of the world species of *Sigalaphus* (Hymenoptera: Braconidae: Sigalaphinae) and biology of *Sigalaphus romeroi*, new species. *J. Hymen. Res.* (Washington), 4:99-109.

Shenefelt, R. D.

1970. Braconidae 3. Agathidinae. In *Hymenopterorum Catalogus*, 6:307-428. Leiden: E. J. Brill.

Woodley, N. E., and D. H. Janzen

1995. A new species of *Melanagromyza* (Diptera: Agromyzidae) mining leaves of *Bromelia pinguin* (Bromeliaceae) in a dry forest in Costa Rica. *J. Nat. Hist.* (London), 29:1329-1337.

TABLE 2. Paratype specimens of *Bassus brooksi* reared from hesperiid larvae within the dry forests of the Area de Conservacion (ACG), northwestern Costa Rica. Detailed data for each record is in the Janzen and Hallwachs Caterpillar Rearing Database at http://janzen.sas.upenn.edu/index.html

MALES:

Rearing event voucher number	Wasp eclosion date	Host collection Lambert coordinates		Hesperiidae species
92-SRNP-5558		314500	357850	Antigonus erosus
92-SRNP-5602		313100	359900	Antigonus erosus
92-SRNP-5912		313800	359800	Antigonus erosus
93-SRNP-5707	09/27/93	313800	359800	Antigonus erosus
93-SRNP-6205	10/14/93	314800	360500	Antigonus erosus
93-SRNP-6211	10/09/93	314800	360500	Antigonus erosus
93-SRNP-6213	10/20/93	314800	360500	Antigonus erosus
93-SRNP-6520	10/17/93	305500	361600	Antigonus erosus
93-SRNP-6697.1	11/23/93	313400	358900	Antigonus erosus
93-SRNP-6750	11/19/93	305500	361600	Antigonus erosus
96-SRNP-8494	08/26/96	313100	359900	Astraptes alector hopfferi
94-SRNP-7302	09/19/94	307250	365650	Astraptes anaphus annetta
94-SRNP-7304	09/25/94	307250	365650	Astraptes anaphus annetta
96-SRNP-9890	09/24/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10192	09/29/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10203	09/28/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10207	09/28/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10208	10/06/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10213	10/13/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10214	10/01/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10396	10/03/96	313400	358900	Astraptes anaphus annetta
96-SRNP-10400	10/16/96	313400	358900	Astraptes anaphus annetta
96-SRNP-10403	10/16/96	313400	358900	Astraptes anaphus annetta
96-SRNP-10421	10/18/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10646	10/11/96	305100	365900	Astraptes anaphus annetta
96-SRNP-11870	12/01/96	312300	361050	Astraptes anaphus annetta
93-SRNP-3448	07/25/93	313400	358900	Cabares potrillo
93-SRNP-3449	07/22/93	313400	358900	Cabares potrillo
93-SRNP-3481	07/21/93	313400	358900	Cabares potrillo
93-SRNP-3494	07/23/93	313400	358900	Cabares potrillo
93-SRNP-5123	09/09/93	313400	358900	Cabares potrillo
95-SRNP-6003	07/17/95	313000	359900	Cabares potrillo
95-SRNP-6013	07/15/95	313000	359900	Cabares potrillo
95-SRNP-6808	09/02/95	327650	351900	Carrhenes fuscescens
95-SRNP-6837	08/24/95	327650	351900	Carrhenes fuscescens
93-SRNP-7577		313400	358900	Chioides catillus albius
92-SRNP-5680	11/07/92	317200	360850	Epargyreus
92-SRNP-5795	11/25/92	315500	360200	Epargyreus
92-SRNP-5946		312150	357200	Epargyreus
93-SRNP-3633		320050	365300	Epargyreus
93-SRNP-4294	08/12/93	313400	358900	Epargyreus
93-SRNP-4443	09/01/93	311700	356600	Epargyreus
93-SRNP-4477	08/16/93	310250	356600	Epargyreus
94-SRNP-6604	09/08/94	321150	364600	Epargyreus
95-SRNP-4680	07/12/95	315500	360200	Epargyreus
95-SRNP-4800	07/13/95	312450	359800	Epargyreus
95-SRNP-5059	07/18/95	317600	364250	Epargyreus
95-SRNP-5061	07/15/95	317600	364250	Epargyreus
95-SRNP-5065	07/19/95	317600	364250	Epargyreus
95-SRNP-5086	07/16/95	312650	357250	Epargyreus
95-SRNP-5097	07/26/95	320400	347200	Epargyreus
95-SRNP-5126	07/24/95	312650	357250	Epargyreus
95-SRNP-5138	07/24/95	312650	357250	Epargyreus
95-SRNP-5146	07/31/95	311800	359600	Epargyreus
95-SRNP-5158	08/09/95	313400	358900	Epargyreus
95-SRNP-5162	08/09/95	317600	364250	Epargyreus
95-SRNP-5164	08/09/95	317600	364250	Epargyreus
95-SRNP-5198	08/16/95	317800	362600	Epargyreus
95-SRNP-5216	08/03/95	313800	359800	Epargyreus
96-SRNP-10051	10/08/96	318600	375150	Epargyreus
93-SRNP-3923	08/02/93	310250	356600	Gesta gesta
93-SRNP-5161	09/15/93	313400	358900	Gesta gesta
93-SRNP-5163	09/07/93	313400	358900	Gesta gesta
93-SRNP-5165	09/19/93	313400	358900	Gesta gesta
93-SRNP-5258	09/21/93	313400	358900	Gesta gesta
93-SRNP-5270	09/19/93	313400	358900	Gesta gesta
93-SRNP-5279	09/15/93	313400	358900	Gesta gesta
93-SRNP-5309	09/22/93	313400	358900	Gesta gesta
93-SRNP-5322	09/22/93	313400	358900	Gesta gesta
93-SRNP-5324	09/22/93	313400	358900	Gesta gesta
93-SRNP-5326	09/23/93	313400	358900	Gesta gesta
93-SRNP-5356	09/24/93	313400	358900	Gesta gesta
93-SRNP-5363	09/23/93	313400	358900	Gesta gesta
93-SRNP-5365	09/21/93	313400	358900	Gesta gesta
93-SRNP-5392	09/24/93	313400	358900	Gesta gesta
93-SRNP-5397	09/28/93	313400	358900	Gesta gesta
93-SRNP-5401	09/25/93	313400	358900	Gesta gesta
93-SRNP-5420	09/20/93	313400	358900	Gesta gesta
93-SRNP-5438	09/19/93	313400	358900	Gesta gesta
93-SRNP-5444	09/18/93	313400	358900	Gesta gesta
93-SRNP-5455	09/21/93	313400	358900	Gesta gesta
93-SRNP-5459	09/23/93	313400	358900	Gesta gesta
93-SRNP-5462	09/28/93	313400	358900	Gesta gesta
93-SRNP-5470	09/20/93	313400	358900	Gesta gesta
93-SRNP-5471	09/18/93	313400	358900	Gesta gesta
96-SRNP-10545	10/08/96	312300	361050	Gesta gesta
96-SRNP-10547	10/08/96	312300	361050	Gesta gesta
95-SRNP-9998	10/26/95	334900	364100	Thessia jalapus
92-SRNP-4837	09/01/92	315500	360200	Urbanus dorantes
92-SRNP-5199		315500	360200	Urbanus "proteus group"
92-SRNP-5411	10/18/92	315500	360200	Urbanus "proteus group"
93-SRNP-1101	06/05/93	317200	360850	Urbanus "proteus group"
93-SRNP-6299	10/16/93	315500	360200	Urbanus "proteus group"
93-SRNP-6797	11/02/93	315500	360200	Urbanus "proteus group"
93-SRNP-7383	11/18/93	313800	359800	Urbanus "proteus group"
93-SRNP-7421	11/22/93	315500	360200	Urbanus "proteus group"
93-SRNP-7594	11/26/93	313400	358900	Urbanus "proteus group"
94-SRNP-9739	11/20/94	313800	359800	Urbanus "proteus group"
94-SRNP-9742	11/22/94	313800	359800	Urbanus "proteus group"

FEMALES:

Rearing event voucher number	Wasp eclosion date	Host collection Lambert coordinates		Hesperiidae species
96-SRNP-4858		312300	361050	Aguna asander
92-SRNP-5329		320050	365300	Antigonus erosus
92-SRNP-5561	11/06/92	314500	357850	Antigonus erosus
92-SRNP-5562		314500	357850	Antigonus erosus
92-SRNP-5562.1		314500	357850	Antigonus erosus
92-SRNP-5563	11/19/92	314500	357850	Antigonus erosus
92-SRNP-5564	11/23/92	314500	357850	Antigonus erosus
92-SRNP-5874	11/20/92	313800	359800	Antigonus erosus
92-SRNP-5901	01/05/93	313800	359800	Antigonus erosus
92-SRNP-5911	12/09/92	313800	359800	Antigonus erosus
92-SRNP-5913		313800	359800	Antigonus erosus
93-SRNP-3902	09/10/93	315500	360200	Antigonus erosus
93-SRNP-3935	08/13/93	309450	355300	Antigonus erosus
93-SRNP-4327	08/23/93	309500	353200	Antigonus erosus
93-SRNP-5559	09/19/93	313800	359800	Antigonus erosus
93-SRNP-5563	10/02/93	313800	359800	Antigonus erosus
93-SRNP-5564	09/28/93	313800	359800	Antigonus erosus
93-SRNP-5722	10/04/93	313400	358900	Antigonus erosus
93-SRNP-5870	10/05/93	313800	359800	Antigonus erosus
93-SRNP-6097	10/11/93	313800	359800	Antigonus erosus
93-SRNP-6207	10/28/93	314800	360500	Antigonus erosus
93-SRNP-6208	10/29/93	314800	360500	Antigonus erosus
93-SRNP-6214	10/14/94	314800	360500	Antigonus erosus
93-SRNP-6215	10/28/93	314800	360500	Antigonus erosus
93-SRNP-6379		313400	358900	Antigonus erosus
93-SRNP-6658	11/09/93	313800	359800	Antigonus erosus
93-SRNP-7211		313400	358900	Antigonus erosus
93-SRNP-7815	01/06/94	313800	359800	Antigonus erosus
94-SRNP-7530	10/30/94	307250	365650	Antigonus erosus
95-SRNP-9335	10/10/95	313800	359800	Antigonus erosus
96-SRNP-8765	09/12/96	313400	358900	Astraptes alector hopfferi
94-SRNP-7307	09/28/94	307250	365650	Astraptes anaphus annetta
94-SRNP-7317	09/28/94	307250	365650	Astraptes anaphus annetta
94-SRNP-7322	09/27/94	307250	365650	Astraptes anaphus annetta
94-SRNP-7325	09/26/94	307250	365650	Astraptes anaphus annetta
96-SRNP-9420	09/17/96	305100	365900	Astraptes anaphus annetta
96-SRNP-9894	10/05/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10195	09/28/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10196	09/28/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10202	10/09/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10209	09/29/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10210	10/01/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10212	09/29/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10218	09/29/96	305100	365900	Astraptes anaphus annetta
96-SRNP-10398	10/16/96	313400	358900	Astraptes anaphus annetta
96-SRNP-10422	10/15/96	305100	365900	Astraptes anaphus annetta
96-SRNP-11868	11/25/96	312300	361050	Astraptes anaphus annetta
93-SRNP-3452	07/26/93	313400	358900	Cabares potrillo
95-SRNP-4959	07/18/95	314500	357850	Cabares potrillo
95-SRNP-4991	07/17/95	313000	359900	Cabares potrillo
95-SRNP-6005	07/17/95	313000	359900	Cabares potrillo
93-SRNP-5718	09/21/93	313400	358900	Carrhenes canescens
93-SRNP-5726	09/28/93	313800	359800	Carrhenes canescens
95-SRNP-6810	09/14/95	327650	351900	Carrhenes fuscescens
95-SRNP-6811	10/10/95	327650	351900	Carrhenes fuscescens
95-SRNP-6815	09/18/95	327650	351900	Carrhenes fuscescens
93-SRNP-7063	11/15/93	318500	359850	Chioides catillus albius
93-SRNP-4821	09/15/93	307250	365650	Cogia eluina
92-SRNP-5761	09/23/92	315500	360200	Epargyreus
92-SRNP-5799	11/23/92	315500	360200	Epargyreus
92-SRNP-5803		315500	360200	Epargyreus
93-SRNP-3634	07/24/93	320050	365300	Epargyreus
95-SRNP-4674	07/08/95	315500	360200	Epargyreus
95-SRNP-4681	07/09/95	315500	360200	Epargyreus
95-SRNP-5018	07/09/95	313800	359800	Epargyreus
95-SRNP-5058	07/16/95	312650	357250	Epargyreus
95-SRNP-5060	07/14/95	317600	364250	Epargyreus
95-SRNP-5062	07/18/95	317600	364250	Epargyreus
95-SRNP-5069	07/20/95	317600	364250	Epargyreus
95-SRNP-5070	07/20/95	317600	364250	Epargyreus
95-SRNP-5073	07/19/95	317600	364250	Epargyreus
95-SRNP-5108	08/07/95	313800	359800	Epargyreus

FEMALES:

Rearing event voucher number	Wasp eclosion date	Host collection Lambert coordinates		Hesperiidae species
95-SRNP-5127	08/05/95	312650	357250	Epargyreus
95-SRNP-5134	07/23/95	312650	357250	Epargyreus
95-SRNP-5137	08/06/95	312650	357250	Epargyreus
95-SRNP-5140	07/29/95	312650	357250	Epargyreus
95-SRNP-5181	08/03/95	312450	359800	Epargyreus
95-SRNP-5186	08/13/95	312450	359800	Epargyreus
95-SRNP-5195	08/18/95	317800	362600	Epargyreus
95-SRNP-5205	08/12/95	312450	359800	Epargyreus
95-SRNP-5208		312450	359800	Epargyreus
93-SRNP-5140	09/15/93	313400	358900	Gesta gesta
93-SRNP-5151	09/09/93	313400	358900	Gesta gesta
93-SRNP-5154	09/19/93	313400	358900	Gesta gesta
93-SRNP-5237	09/15/93	313400	358900	Gesta gesta
93-SRNP-5245	09/27/93	313400	358900	Gesta gesta
93-SRNP-5252	09/14/93	313400	358900	Gesta gesta
93-SRNP-5255	09/15/93	313400	358900	Gesta gesta
93-SRNP-5256	09/29/93	313400	358900	Gesta gesta
93-SRNP-5261	09/18/93	313400	358900	Gesta gesta
93-SRNP-5262	09/14/93	313400	358900	Gesta gesta
93-SRNP-5267	09/28/93	313400	358900	Gesta gesta
93-SRNP-5268	09/15/93	313400	358900	Gesta gesta
93-SRNP-5284	09/17/93	313400	358900	Gesta gesta
93-SRNP-5301	09/15/93	313400	358900	Gesta gesta
93-SRNP-5306	09/17/93	313400	358900	Gesta gesta
93-SRNP-5318	11/11/93	313400	358900	Gesta gesta
93-SRNP-5347	09/18/93	313400	358900	Gesta gesta
93-SRNP-5366	09/24/93	313400	358900	Gesta gesta
93-SRNP-5370	09/28/93	313400	358900	Gesta gesta
93-SRNP-5402	09/25/93	313400	358900	Gesta gesta
93-SRNP-5406	09/24/93	313400	358900	Gesta gesta
93-SRNP-5422	09/22/93	313400	358900	Gesta gesta
93-SRNP-5426		313400	358900	Gesta gesta
93-SRNP-5428	09/29/93	313400	358900	Gesta gesta
93-SRNP-5454	09/17/93	313400	358900	Gesta gesta
93-SRNP-5464	09/24/93	313400	358900	Gesta gesta
93-SRNP-5469	10/03/93	313400	358900	Gesta gesta
93-SRNP-5474	10/01/93	313400	358900	Gesta gesta
93-SRNP-5475	09/24/93	313400	358900	Gesta gesta
93-SRNP-5479	09/23/93	313400	358900	Gesta gesta
93-SRNP-5484	09/29/93	313400	358900	Gesta gesta
93-SRNP-6646		313400	358900	Gesta gesta
92-SRNP-5359	10/24/92	315500	360200	Urbanus "proteus group"
92-SRNP-5392		315500	360200	Urbanus "proteus group"
92-SRNP-5407	11/01/92	315500	360200	Urbanus "proteus group"
92-SRNP-5409	10/27/92	315500	360200	Urbanus "proteus group"
93-SRNP-1100	06/07/93	317200	360850	Urbanus "proteus group"
93-SRNP-1887	06/28/93	313800	359800	Urbanus "proteus group"
93-SRNP-3512		313800	359800	Urbanus "proteus group"
93-SRNP-3515		313800	359800	Urbanus "proteus group"
93-SRNP-3546	07/25/93	314500	357850	Urbanus "proteus group"
93-SRNP-3554		313800	359800	Urbanus "proteus group"
93-SRNP-3630	08/03/93	313800	359800	Urbanus "proteus group"
93-SRNP-3654	08/04/93	315500	360200	Urbanus "proteus group"
93-SRNP-5702	09/25/93	313800	359800	Urbanus "proteus group"
93-SRNP-6194	10/03/93	320050	365300	Urbanus "proteus group"
93-SRNP-6648	10/23/93	314650	361300	Urbanus "proteus group"
93-SRNP-6700	10/28/93	313800	359800	Urbanus "proteus group"
93-SRNP-6800	11/02/93	315500	360200	Urbanus "proteus group"
93-SRNP-6858	10/29/93	315500	360200	Urbanus "proteus group"
93-SRNP-7012	11/14/93	315500	360200	Urbanus "proteus group"
93-SRNP-7014	11/08/93	317200	360850	Urbanus "proteus group"
93-SRNP-7411	11/19/93	313100	359900	Urbanus "proteus group"
93-SRNP-7731	12/08/93	315500	360200	Urbanus "proteus group"
95-SRNP-9570	10/23/95	318500	359850	Urbanus "proteus group"
93-SRNP-5344		313400	358900	Xenophanes tryxus
95-SRNP-11256	12/12/95	313400	358900	Xenophanes tryxus