Life Cycle and Ethological Notes on Burca braco braco (Herrich-Schäffer, 1865) (Hesperiidae: Pyrginae)

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LIFE CYCLE AND ETHOLOGICAL NOTES ON *BURCA BRACO BRACO* (HERRICH-SCHÄFFER, 1865) (HESPERIIDAE: PYRGINAE)

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ABSTRACT. In this study, we describe for the first time the immature stages of a *Burca* species: eggs, five larval instars, prepupa, and pupa. Morphometric measurements for each stage are given. Based on the measures of head width and growth rates, we recognize the possible presence of non-typical individuals with more than five instars. We describe four larval shelters types that are associated with specific instars. Each individual constructs three to four shelters during its larval development. We also report notes on feeding patterns and oviposition.

Additional keywords: *Burca*, *Croton*, Hesperiidae, skippers, larval shelters, immature stages

The genus *Burca* (Hesperiidae: Pyrginae: Carcharodini) was described by Bell & Comstock (1948). These butterflies are dark brown to blackish brown with the forewing rounded along the outer margin and with the hindwing margin angular. Male secondary characters are variable and palpal coloration is a useful character for species determination (Smith et al. 1994). *Burca* is closely related to *Nisoniades*, *Noctuana* and *Staphyllus* (Warren et al. 2008). *Burca* is restricted to Cuba, the Bahamas, and Hispaniola, where it is represented by five species endemic to the West Indies (Bell & Comstock 1948, Smith et al. 1994).

Prior knowledge concerning the natural history of *Burca* species is limited to data on geographic distribution and nectar sources (Alayo & Hernández 1987, Smith et al. 1994). Recently published were the first records of host plants; *Burca b. braco* caterpillars feed on *Croton lucidus* (Euphorbiaceae) (Núñez 2001) and *C. glabellus* (Lauranzón et al. 2013), while *Burca c. concolor* uses *C. sagraeanus* and *C. origanifolius* (Fernández 2004). Immature stages and their behavior, however remain undescribed. Knowledge of the natural history in lepidopterans is necessary for ecological studies (Young 1972). In this paper, we describe *Burca b. braco* immature stages and provide ethological notes related to larval shelter construction, oviposition behavior, and additional nectar sources.

MATERIALS AND METHODS

Field observations of immature specimens were conducted at Piedra Alta (23010' N and 81059' W) and Boca de Canasí (23009' N, 81046' W). Both places are close to Cuba's northern coastline and are located at 45 and 65 km E from Havana City respectively. Habitats at Piedra Alta were a characteristic dry coastal scrubland, while a microphyllous evergreen forest predominated at Boca de Canasí (Capote & Berazaín 1984). Both habitats supported abundant *Croton lucidus*. Field observations were taken between 09:00 and 16:00 hours.

One hundred and fifty-eight eggs were collected from host plants, 39 from September to November 2000, and 119 from March 2006 to April 2007. Each egg was placed alone in a Petri plate. We measured the perpendicular base diameters (d1 and d2) and height (h) with an ocular micrometer coupled to a stereoscope (error=50 µm). To describe the array of the egg's vertical ridges were placed into three categories: (i) complete ridges (CR), with one extreme on base and the other on micropyle, (ii) incomplete ridges with one extreme on basis and the other interrupted (IRB), and (iii) incomplete ridges with one extreme on micropyle and the other interrupted (IRM).

Ninety-seven caterpillars were maintained in captivity, 54 reared from eggs and the others collected as larvae in nature. Larvae were provided with fresh *C. lucidus* leaves and cleaned every day to remove fecal pellets, leftovers and head capsules. Head width (HW) was measured for every larva and in every instar, while body length (L) was measured only for first and second instars. Both measurements were taken with the micrometer described above. For chaetotaxy of first instar, five individuals were sacrificed and photographed

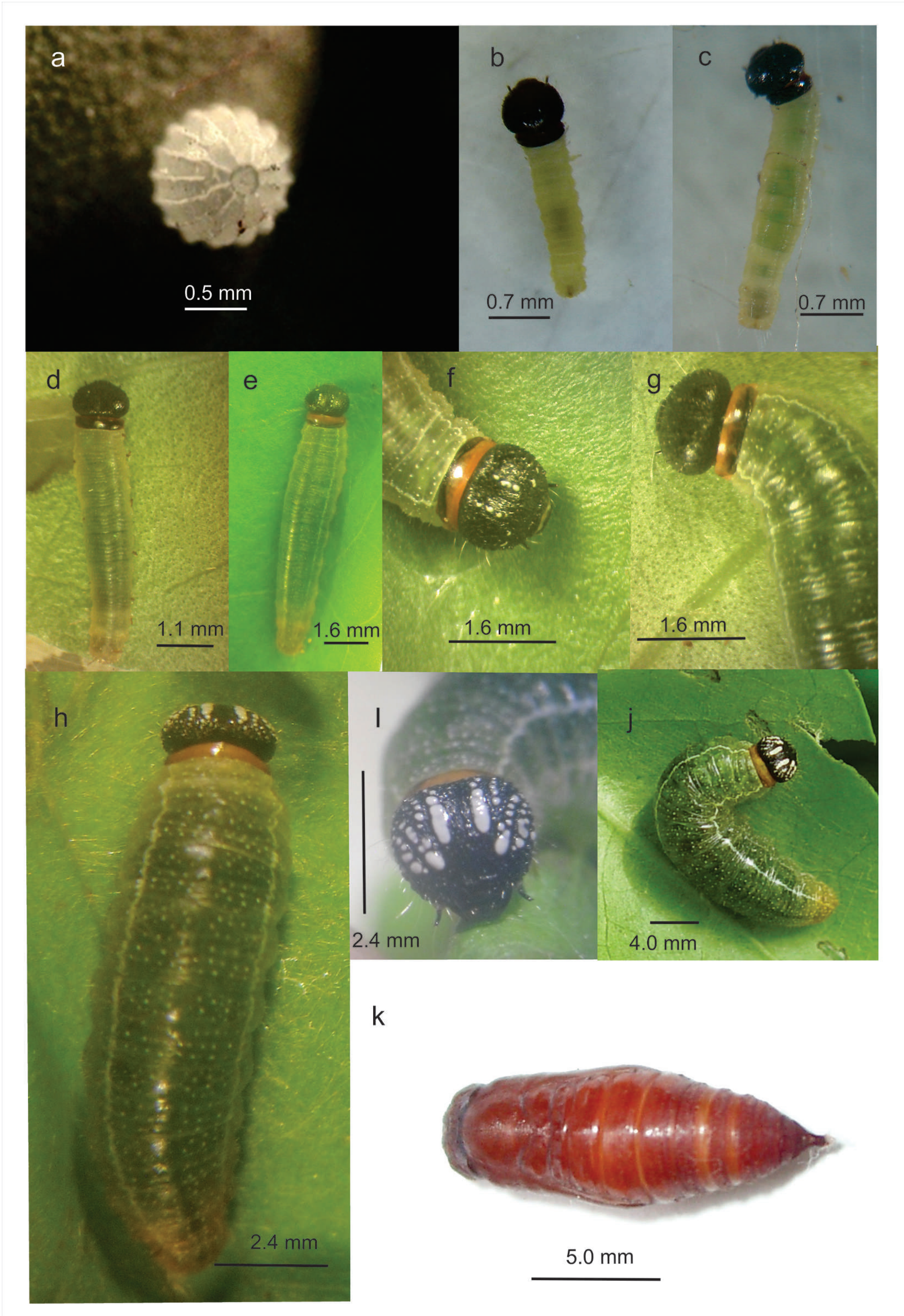

FIG. 1. Immature stages of *Burca braco braco*. (**a**) Egg in upper view, (**b**) upper view of first instar just after eclosion, (**c**) same as (**b**) but after eating, (**d**) upper view of second instar, (**e**) upper view of third instar, (**f**) detail of the head of third instar with typical white spots, (**g**) same as (**f**) but without white spots , (**h**) upper view of fourth instar, (**i**) detail of the head of fourth instar, (**j**) upper view of fifth instar, (**k**) pupa.

by a scanning electron microscope and by a Zeiss AxioCam MRc 5 video camera attached to a Carl Zeiss Discovery stereomicroscope. We follow Hinton's (1946) and Stehr's (1987) terminology for setae. Descriptions of larval shelters were referenced by collection time in nature, after Greeney (2009).

Pupae were obtained from larvae reared in captivity. They were maintained in a 5-liter container to assure that adults could extend their wings after emergence. We measured the major thoracic width of pupa in dorsal view (MTW) and the body length of pupa (LP) from vertex to cremaster. Both measurements were taken with a slide gauge (error=0.05 mm). We also measured the weight of pupae with a scale (error=0.001 g).

RESULTS

Life cycle and description of immature stages

Eggs: Eggs are light green when laid, and then change to light gray or light orange. Infertile eggs are recognizable because they are transparent white. Vertical ridges are white. Eggs are vertical with flattened base and micropyle (Fig. 1a). Base diameters are very similar and larger than height (Table 1), so the egg form is hemispherical. There is a large variation in number of ridges, and also in the three categories CR, IRB and IRM (Table 2). Egg duration was recorded in two cases: 5 and 6 days.

We could not rear any larva from the first to the last instar. However, we did determine that *Burca b. braco* larvae have five instars based on all measurements of HW (Fig 2). The head is rounded, robust, heart shaped and wider than the prothorax in all instars (Figs. 1b–j). The head is widest at the mid region in a frontal view. The body is tapering and slim in the first instar. In subsequent instars, the body becomes larger and more robust, changing proportions between the head and body.

First instar (Figs. 1b, c): At birth L=2.31 ± 0.27 mm (min 1.85, max 3.00 mm, N=49). HW=0.70 ± 0.05 mm (min 0.60, max 0.80 mm, N=56). The body is yellowish-white and the head is glossy black (Fig. 1b). Prothorax is dorsally reddish-brown and ventrolaterally light red. The mouth parts are beige. The first pair of legs are light red, while the second and third pair of legs and prolegs have the same coloration as the body. The tarsi are black. Primary setae are tiny, hair-like or Y shape (Fig. 3). None of our first instar larvae would feed in captivity so we were unable to note any changes in coloration following feeding. However, we collected two first instar larvae in nature with dull green bodies and that were slightly larger: 3.50 and 4.25 mm, respectively (Fig. 1c).

Second instar (Fig. 1d): Similar to the two individuals mentioned above but with the coloration

TABLE 1. Eggs morphometric means of *Burca braco braco* (d1 and d2=base diameters and h=height)

	N	X	SD	Min	Max
d1 (mm)	158	1.08	0.06	0.90	1.20
d2 (mm)	158	1.06	0.07	0.85	1.20
h (mm)	117	0.89	0.08	0.75	1.05

TABLE 2. Number of vertical ridges and their categories (CR=complete, IRB=incomplete with one extreme on base, IRM= incomplete with one extreme on micropyle) arraying eggs of *Burca braco braco* . Number of eggs analyzed = 70.

	Mode	Min	Max
CR	6	3	10
IRB	11	6	16
IRM	5	1	6
Total	21	17	25

TABLE 3. Substrate surfaces used in shelters constructed by different instars of *Burca braco braco* .

Surface/Instars	1st	2nd & 3rd	4th & 5th
Upper-leaf	1	11	6
Under-leaf	15	14	6
Two leaves joined	0	0	11

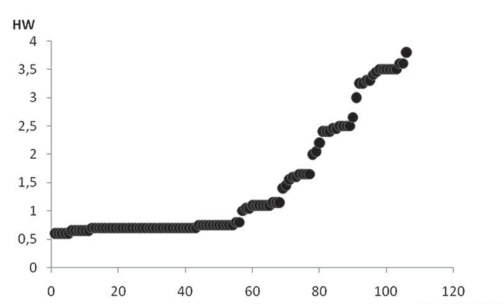

FIG. 2. Dispersion of measurements of head width of *Burca braco braco* caterpillars.

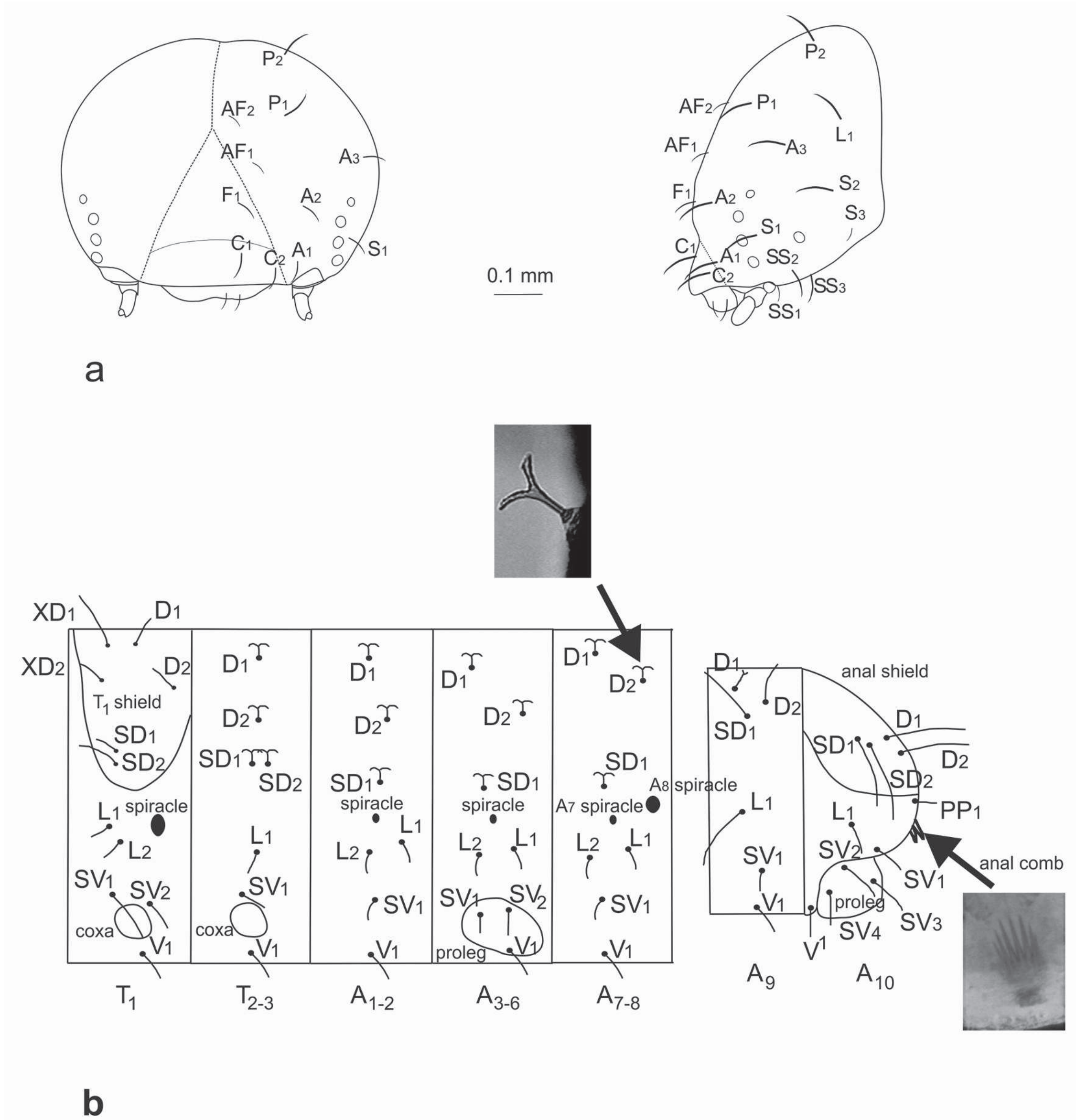

FIG. 3. Chaetotaxy of first instar of *Burca braco braco*. (**a**) Head scheme in frontal view (left) and lateral view (right), and (**b**) segments of the body scheme with details of "Y" shape setae and anal comb: T=Thoraxic segment, A=Abdominal segment.

darker. There are no changes in coloration of the head and prothorax. L=3.97 ± 0.49 mm (min 3.40, max 4.25, N=3). HW=1.10 ± 0.05 mm (min 1.00, max 1.15 mm, N=12).

Third instar (Figs. 1e–g): The body is olive green with the last three abdominal segments dark orange. The prothorax is orange and the head is black with two lines of tiny white elliptical spots (Figs 1e, f), rarely absent (Fig. 1g). There are two slight white longitudinal lines at both sides of the dorsal region from mesothorax to the end of the body. HW=1.58 ± 0.09 mm (min 1.40, max 1.65 mm, N=9).

Fourth instar (Figs. 1h, i): The head has a great number of elliptical or sub-rectangular white spots on the vertex. These sometimes reach the epicranial notch dorsally and the genae ventrally. These spots are arrayed in five to seven lines. The internal spot lines run parallel to the ecdysial cleavage line, while most external lines are perpendicular to the frontoclypeus. Major spots are placed in the internal lines, and in every line the largest spot is the lowest. The number of points by line differs between individuals. Even in the same individual, the arrays of spots from left and right sides of the head are different (Fig. 1i). The rest of head is black while the

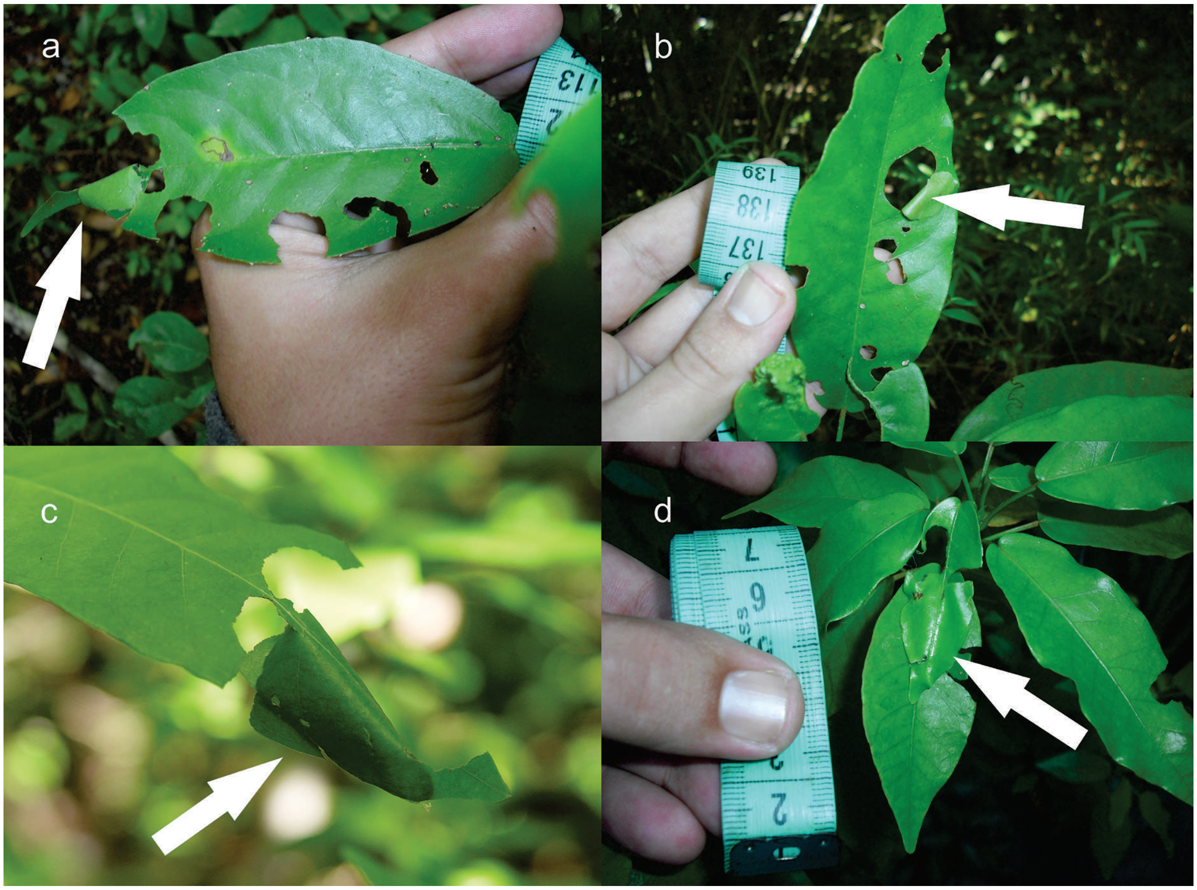

FIG. 4. Larval shelters of *Burca braco braco*. (**a**) Usual shelters type 5 for second and third instars, (**b**) non-usual shelters type 3 of a third instar, (**c**) usual shelters type 5 for fourth and fifth instars, (**d**) usual shelters type 2 for fourth and fifth instars. Shelter classification of Greeney (2009).

prothorax is orange. The color of the body is similar to the third instar but is lighter. In the dorsal region of the three last abdominal segments color changes gradually from orange-green to orange-brown at the end of the body. The two longitudinal white lines are more conspicuous than in third instar. Except for the mid-dorsal line and prothorax, the body is uniformly covered by a large number of short white setae. The base of the setae are also white, giving the body the appearance of being covered with tiny white dots. HW=2.39 ± 0.19 mm (min 2.00, max 2.65 mm, N=13).

Fifth instar (Fig 1j): Not very different from the fourth instar. The body color is lighter. Longitudinal lines and head spots are more conspicuous. The mandibles are black, while the labrum varies from yellowish brown to reddish brown, sometimes both. Antennae are light gray and yellowish on base. Maxillary palpi are light gray too, but with the extremes and setae reddish brown. There are more setae on body than in the fourth instar, but they are so short that the body looks bald. There is a dark green mid dorsal line. Legs are light greenish brown with tarsi reddish brown. Spiracles are elliptical and orange but paler than the last abdominal segments, except the bigger thoracic spiracles, which have the same color of prothorax. Prolegs are very pale, almost transparent. When larvae become prepupa (N=3), they transform to the orange-brown coloration gradually from last abdominal segment toward the mesothorax. At that point, the body clarifies from yellowish green to pale yellow. The prothorax transform the orange coloration to pale orange, while the head changes from black to dull brown. Head spots become more inconspicuous and gain coloration like bronze. HW=3.38 ± 0.18 mm (min 3.00, max 3.80 mm, N=13).

Pupa (Fig. 1k): We never observed pupae in the field. They are greenish brown in the first hours. When the cuticle hardens it becomes bright reddish brown, just prior to ecolsion it becomes dull dark brown. The labrum and the large pronounced edge of the thoracic spiracle are black. Although the body appears bald, the thorax

Fig. 5. Usual way of laying eggs for *Burca braco braco*, singly and in upper-surface of leaves of *Croton lucidus*.

and abdomen are actually covered by tiny white setae. The frontoclypeus and eyes are covered by tiny white setae as well, but a little longer that mentioned above. The only conspicuous setae are the large white ones on the cremaster. The wings pads totally cover the first two thoracic segments, mostly the third one, and the first three abdominal segments. Frontoclypeus and vertex are noticeably wrinkled while the rest of the body is quite smooth. LP=15.37 ± 0.77 mm (min 14.00 mm, max 16.1 mm, N=7). MTW was measured in two individuals: 5.13 and 5.35 mm, respectively. Weight measured in these two individuals was 256 and 199 mg, respectively.

Ethology

After eclosion, the larva eats the upper half of egg shell. All instars of *Burca b. braco* feed on *Croton lucidus*. Larvae construct shelters with sections of a leaf or complete leaves of the host plant modified with silk and cuts. We never observed larvae outside their shelters. These structures have been never damaged by feeding activity. On the other hand, the rest of the substrate leaf (or leaves) of shelter and/or very nearby leaves show some damage attributed to feeding activity. Architecture of shelters varies between instars. First to third instars inhabit type 5 shelters (N=40) with the two cuts in the same margin (Fig. 4a). Unlike second and third instars, first instar shelters are rarely folded to upper-leaf surface (Table 3). Larvae of second and third instars seldom construct circular type 3 shelters (N=1) (Fig. 4b). Fourth and fifth instars construct either type 5 shelters (N=12) with cuts in opposite margins (Fig. 4c) or type 2 (N=11) (two leaves joined) shelters (Fig. 4d). Sometimes we observed close to an occupied shelter, other recently abandoned shelters used by previous instars. We never found shelters with feces accumulations. In captivity, larvae could not construct shelters as they do in nature. When they are disturbed, they react bending laterally their body to cover the head with the abdomen, or vomiting, or attacking with their mandibles.

We observed females laying eggs twice. The vast majority of the eggs observed (167) were laid singly (164) and on the upper-leaf surface (165) (Fig. 5). Adults typically fly no more than 3 m from the ground and move quite rapidly between shrubs. In resting position, they extend their two pairs of wings in the same horizontal plane of the body. We recorded four nectar sources: *Croton lucidus* (Euphorbiaceae), *Duranta erecta* (Verbenaceae), *Morinda royoc* (Rubiaceae) and *Chiococca alba* (Rubiaceae).

Discussion

The typical five instars of larval development of *Burca b. braco* (see Fig. 1) are similar to the records of most Pyrginae (Scudder 1889, Moss 1949, Torres 1998). However, according to our data the presence of non-typical individuals with more than five instars is possible (see Fig. 2). The intra-specific variations in number of instars, even with the existence of a typical number, are quite normal in Lepidoptera (Knopf & Habeck 1976, Otazo et al. 1984, Farr 2002, Holland 2003, Barro 2006). If some of our individuals are non-typical in the number of instars, our estimated HW and especially their variances, are biased. We can expect that bias is larger in major instars, and logically the first instar estimation of HW is not biased.

The descriptions of immature stages of *Burca b. braco* are the first ones for the genus. Immature morphology, color patterns, form and disposition of setae (see Fig. 1 and 3) are similar to other Pyrginae species (Scudder 1889, Moss 1949, Stehr 1987). The complex and irregular design of white spots in the head of fourth and fifth instars is unknown for other Pyrginae in the literature we reviewed (Moss 1949, Janzen 2017) (see Fig. 1i). Most ethological records in this paper are similar to those for other skippers, especially Pyrginae. Several hesperiids eat the upper half of egg shell at birth (Heitzman 1965, Young 1985, Stehr 1987, Torres 1998). Construction of larval shelters is distinctive of Hesperiidae (Moss 1949, Stehr 1987, Scoble 1992), and possibly it is the most diverse family in construction patterns of larval shelters (Greeney & Jones 2003). Pyrginae and Eudaminae may be the subfamilies with more diversity because their larvae change the pattern of construction between instars (Moss 1949, Lind et al. 2001, Greeney & Jones 2003, Greeney 2009). Larvae of *Burca b. braco* construct four to five shelters during their lifetime and of two to four different types (see Table 3 and Fig. 4) based on the classification of Greeney (2009). It seems to be usual that first instar shelters are different from second and third instars because the shelters differ in which leaf surfaces are folded, even if they belong to the same type (see Table 3). Since we never saw larvae outside their shelters, we expect that they are nocturnal or display low rates of activity. Hesperiid caterpillars are considered nocturnal by several authors (Scott 1986, Stehr 1987, Smith et al. 1994). It could be that *Burca b. braco* larvae do not walk far away outside their shelter. It is likely that larvae spend all their lifetime in the same host plant. A similar case was experimentally demonstrated on larvae of *Epargyreus clarus* (Eudaminae) which feed closely to their shelter and spend more than 95% of daytime inside it (Lind et al. 2001).

Except *Croton lucidus*, all nectar sources reported here are new to *Burca b. braco* and also to the genus. *Morinda royoc* and *Chiococca alba* are also the first Rubiaceae nectar sources for the genus (Smith et al. 1994). Other *Croton* species have been also reported as nectar sources for *B. concolor* and *B. stillmani* (Smith et al. 1994). *Burca concolor concolor* known hostplants also belong to *Croton*; *C. sagraeanus* and *C. origanifolius* (Fernández 2004), so it is probable that *Croton*, with a large number of species in the area, is the host genus of all *Burca* species. The inclination in related lepidopterans to use related plants is well known (Gilbert & Singer 1975), so if our suspicion is true, then immature of other species of *Burca* should be described in the near future by looking for them on *Croton*.

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