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NOTES ON THE BEHAVIOR AND DISTRIBUTION OF THE DAY-FLYING MOTH,
HETERUSIA ATALANTATA (GUENÉE, [1858]) (LEPIDOPTERA, GEOMETRIDAE, LARENTIINAE),
WITH SPECIAL REFERENCE TO MEXICO.

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ABSTRACT. Collecting and observation of the diurnal geometrid, *Heterusia atalantata* (Guenée, [1858]), in Natura Park, Veracruz by the first coauthor led to an interest in the distribution and behavior of this species in Mexico. Records from the literature and several Mexican collections as well as the McGuire Center for Lepidoptera and Biodiversity in Florida have resulted in these notes on the distribution, altitudinal occurrences and behavior of this species.

Additional key words: inchworm, diurnal, neotropics

Moths of the family Geometridae are cosmopolitan; however, a large majority of them are found in the neotropics (Heppner 1991, Scoble 1995). Even though most species are nocturnal and attracted to lights, some are day-flying and active during the morning mainly inside the canopy of humid forests or in open areas when conditions are misty and cloudy (Powell & Opler 2009). Very rarely are they seen in sunny open spots or in the afternoon along open spaces (Hernández-Baz unpublished)

The richness of Geometridae is substantial. More than 20,000 species have been described worldwide, and some 1,400 species are from America north of Mexico (Munroe 1982, Powell & Opler 2009). Even though there is no checklist for Mexican species, Heppner (2002) has estimated that there should be between 2,500–3,000 Geometridae in the country. Hernández-Baz & Iglesias (2001) reported 350 species in the state of Veracruz.

The genus *Heterusia* Hübner 1831 was originally described with *Heterusia conduplicaria* Hübner 1831, as type species. The syntypes were collected in Rio de Janeiro, Brazil. The genus is exclusive to the Americas (Druce 1898; Parsons et al. 1999) and includes 87 species (Scoble, 1999), with only three species previously recorded from Mexico: *Heterusia atalantata* (Guenée, [1858]); *Heterusia discordata* (Guenée,

[1858]); and *Heterusia substriata* Dyar, 1910, according to the information gathered in the database “Polilla” attached to the base collection Semarnat/Cites/CP-0026-Ver/05 (CPFHB) (Hernández-Baz 2012).

Besides being a day-flying moth, not much is known about the life history, behavior, natural enemies, or trophic relationships of *H. atalantata* (BAMONA 2015). Its known overall distribution is based on isolated visual records and a small number of specimens deposited in insect collections. As part of the larger project “Inventory of the lepidopterans of the state of Veracruz, Mexico” we have focused on a detailed study of the moths found in protected areas of Mexico. One such protected area is Parque Natura, located in the central mountains of the state of Veracruz, in the Xalapa municipality (96°53'39.82 N 19°30'42.26 W) with an altitude between 1289 and 1331 m. The predominant vegetation of this protected area is a secondary forest arisen in abandoned lands that were used once in agriculture (*Acahual maduro*) with scattered coffee plantations and some native mature trees of Mountain Cloud Forests (GDV 2001, Sánchez & Gándara 2011). This park is the site of the first author's observations on the behavior of *Heterusia atalantata*.

Most day-flying moths are not well understood, and this is particularly true for most Mexican Lepidoptera. Even though a large amount of the information is based

on published articles and books, as well as information on specimen labels held in insect collections, detailed notes about these dayflying creatures are uncommon. Works like that of Beebe & Fleming (1951) who studied migration of dayflying moths in Portachuelo Pass located in the Henri Pittier National Park, Venezuela, are rare (Sandoval et al. 2008). Thus, the main objective of this work is to provide information about the dayflying *Heterusia atalantata* (Guenée), including details on its geographic distribution and natural history.

MATERIALS AND METHODS

The information presented herein comes from four main sources:

a) Specimens collected by the first author (FHB) in Parque Natura, Veracruz, Mexico. They were collected from 08:00 to 17:00 hrs using a traditional butterfly net from 21 to 25 May, 2015. Once collected, the specimens were killed inside a tightly closed glass jar charged with Ethyl Acetate ($C_4H_8O_2$) to minimize scale loss. Once in Xalapa, the specimens were pinned, spread and dried with techniques described by Steyskal et al. (1986). In addition, photographs were taken of each specimen collected, both in the field and also in the laboratory after being pinned and mounted. The camera used was a Sony Cyber Shot (10 megapixels). The identification of the specimens was first done by use of the keys in Triplehorn and Johnson (2005) and later compared with identified specimens at the Museum of Natural History (Museo de Historia Natural) in the City of México (MHNCM). The specimens were later deposited in the Lepidoptera collection in the School of Biology, Universidad Veracruzana, Xalapa, Veracruz. They were registered as DF-CC-276-13 by the Secretary for Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales - SEMARNAT) of Mexico. All information from the collected specimens was included in the database "Polilla" (Hernández-Baz 2012). Specimens were collected under the permit for scientific collecting, license FAUT-0194. (SEMARNAT).

b) Records from specimens in the following insect collections: Natural History Museum of the City of Mexico (MHNCM); National Collection of Insects, Biology Institute of the National University of Mexico (CNIIBUNAM); Lepidoptera Collection of the Biology School of Universidad Veracruzana (UV-FBX-CL); Entomology Collection of the Tropical Biology Station Los Tuxtlas, of Universidad Nacional Autónoma de México (EBTLT-CE); a private Lepidoptera Collection (SEMARNAT / CITES/CP-0026-VER/05) in Xalapa, Veracruz, México (CPFHB); and the McGuire Center for Lepidoptera and Biodiversity, Florida Museum of

Natural History, Gainesville, Florida (MGCL).

c) Literature and online sources. Pertinent literature was reviewed in the libraries of the Biology Institute and Tropical Biology Station Los Tuxtlas, from the National Autonomous University of Mexico; Biology School, Universidad Veracruzana; Madden Library, Fresno State; and Natural History Museum of the City of Mexico. The obtained data were corroborated and searched in numerous scientific information systems such as BioOne, Wiley Interscience; Blackwell Publishing, Ebscohost, Isi-Thompson Scientific, Latin Index; and Biodiversity Library.

d) Map Generation: All records (data from bibliography and collections) were georeferenced by means of the Mexican National Institute of Statistics, Geography and Computer Science catalogue of names and the 1:250000 topographic map of Mexico 1:250 (INEGI 2012). For the Americas data, we used information obtained in <http://www.google.com/earth/>. The information taken from the "Polilla" database was converted into sexagesimal data for inclusion in a geographical information system for the Arc View 2.0 program (Esri 1998).

RESULTS AND DISCUSSION

Label data from Mexican specimens examined:

DISTRITO FEDERAL: May, MHNCM, code number 10616, 2 specimens, Col. Roberto Müller (Díaz 2004). **GUERRERO:** Cacahuamilpa, 20 July 1956, Kent Wilson leg. **NUEVO LEÓN:** Linares, Porfirio Díaz, -99.58252 N. La. / 24.82906 W. Long., Cat. 494701, ID 917412, recorded 4-i-2014, Juan Cruzado Cortes (GBIF 2015); Monterrey, -99.58274 N. Lat. / 24.82839 W. Long., Cat. 581730, ID 1024418, recorded 19-iii-2014, Juan Cruzado Cortes (GBIF 2015); Monterrey, -99-90912 N. La. / 24.92953 W. Long., Cat. 624857, ID 1024180606, recorded 13-iv-2014, Juan Cruzado Cortes (GBIF 2015); Linares, -99.58291 N. La. / 24.82885 W. Long., Cat. 612914, ID 1024180527, recorded 3-iv-2014, Juan Cruzado Cortes (GBIF 2015); Monterrey, -100.26295 N. La. / 25.55762 W. Long., Cat 280714, ID 456182, recorded 13-ix-2006, Carlos Velazco; Santa Rosa Canyon, Km 28, route 5 S of Linares, 17 July 1988, C. L. Smith leg.; 4 km. NE of Santiago, Predela Cueva, 14 July 1974, Kate Bozy & E.C. Olson leg.; Cola de Caballo, 610 M elev., moist forest, 3 Sept. 1973, Station 1973-64, Lee D. & Jacqueline Y. Miller leg.; ditto, in malaise trap, 18-20 June 1975, H. V. Weems leg.; Highway 60, 9 miles E of Iturbide, 15 Aug. 1967, J. Scott leg. **PUEBLA:** 10 Km. South of Petalalcingo (4 Km. S Chita), 3-6 July 1992, Hans Muhle leg. **QUERETARO:** Cadereyta de Montes, -99.80419 N. La. / 20.68639 W. Long., Cat. 798815, ID 1434649,

recorded 23-vii-2014, José Belem Hernández Díaz (GBIF 2015); SAN LUIS POTOSI: Cd. Valles, 14 Oct. 1976, leg. E. C. Knudson. TAMAULIPAS: Ciudad Victoria, -99.17161 N. La. / 23.05056 W. Long., Cat. 605370, ID 1061812, recorded 29-iii-2014, Juan Cruzado Cortes (GBIF 2015); San Fernando, -98.14546 N. La. / 24.84622 W. Long., Cat. 1064804, ID 1088895865, recorded 2-xi-2014, Juntal (GBIF 2015); Miquihuana Road la Meca, -99.60275 N. La. / 23.59958 W Long., Cat 1256240, ID 2337534, recorded 4-viii-2008 Diana Terry Hibbitts (GBIF 2015). 0.8 miles NW Gomez Farias, 280 – 700 M elev., moist forest, 20 Feb. 1969, Station 40, Acc. 1969-4, L.D. & J.Y. Miller leg.; 26 Km. South of Cd. Victoria, highway 85, 16 Oct. 1984, leg. H. D. Baggett. VERACRUZ: Xalapa: Parque Natura, 96°53'39.82 N. Lat; 19°30'42.26 W. Long, 1290 m collecting time: 08:00- 10:00 hrs. 2015-v-21 day-flying, 4 ♂, 1 ♀, F. Hernández-Baz (UV-FBX-CL); Coatepec, 3 km al Sur Palacio Municipal. 1180 m, 2015-v-22, 19° 26' 54"W / 96° 57' 25"N. Collecting time: 09:00 hrs. Day-flying. 1 ♂, F. Hernández-Baz. (UV-FBX-CL); Xico: 1 km al norte cascada Texolo. 1300 m. 2015-v-23, 19° 25' 12"W / 97° 00' 30"N. Cloud forest, collecting time: 10:00 hrs. Day-flying, 2 ♂ F. Hernández-Baz. (UV-FBX-CL); Teocelo: km 1, road Teocelo-Xico. 1138 m. 2015-v-24, N 19° 23' 39" W. / 96° 58' 44" N. Cloud forest. Collecting time: 10:00 hrs. Day-flying. 1 ♂, F. Hernández-Baz. (UV-FBX-CL). Presidio, 1 July 1955 and 1 July 1965, leg. H. L. King.

Species Distribution

Heterusia atalantata (Guenée) (Geometridae: Larentiinae) (Fig. 1a-d) was originally described [as *Scordylia atalantata* (Guenée, 1857) based on five specimens (2 ♂♂, 3 ♀♀) from Brazil. Its general recognized distribution extends from the southern Rio Grande Valley of Texas, U.S.A., through Mexico, Central America and South America to Southern Brazil (Guenée [1858]; Druce 1891-1900; Beebe & Fleming 1951; Knudson & Bordelon 2008) (Fig. 2).

Druce (1891–1900) mentioned the species from: México [Tamaulipas State (Ciudad Victoria), Veracruz State (Atoyac, Orizaba), Guerrero State (Venta de Zopilote)]; Guatemala [San Gerónimo]; Panama [Vera Paz State]; Costa Rica; Colombia [Bogotá]; Venezuela; and Brazil. Díaz (2005) adds the Mexican locality of Distrito Federal (D. F.) based on two specimens deposited in the Roberto Müller Collection (MHNCM). There are five specimens deposited in the National Collection of Insects of the Institute of Biology, UNAM (CNIIBUNAM). These specimens came from three different localities within the city of Mexico, Distrito Federal (D.F.): Botanical Gardens of the UNAM, Xochimilco, and el Ajusco. The latter is

located above 3000 meters and should be considered the highest recorded altitude for *H. atalantata*. Records of the species were known within the states of Nuevo Leon, Tamaulipas and Queretaro (GBIF 2015).

In the Lepidoptera Collection of the Biology School of Universidad Veracruzana in Xalapa (UV-FBX-CL) there are nine specimens of *H. atalantata*. Five of them were collected at Parque Natura, Xalapa, Veracruz; one male from Coatepec; two males from Xico; and one male from Teocelo. These localities are found along the Mountainous Cloud Forest of the State of Veracruz, México except for the Parque Natura which was in the acahual and coffee plantations previously described.

A total of 35 specimens have been located and found from Mexico, while seven have been reported from other countries in the Americas. Nine of the Mexican specimens are held in the McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, Gainesville, Florida (MGCL). Five of them were collected in Nuevo León State, two from Tamaulipas, and one each from the states of Guerrero, Puebla and Veracruz.

As our obtained data indicate, *H. atalantata* populations have a preference for mountain cloud forests and all collecting sites coincide with mountainous regions of Mexico. The collecting sites of the species we have studied are in the plateaus of the states of Nuevo Leon and Queretaro and continue to Tamaulipas and Veracruz within the Eastern Sierra Madre mountains and extend from there to the transversal volcanic belt that goes from Orizaba, Veracruz, to Puebla (Fig. 2). Specimens collected from Central and South American countries come also from sites located in wet and cloud forests.

A geographical distribution similar to *H. atalantata* was found for the species *Apeplopora mecrida* (Druce) (Erebidae: Euchromiina) in Mexico (Hernández-Baz et al. 2012). It appeared that both species are using the mountainous regions of Mexico as a biological corridor *sensu* Halffter (1964, 1987) and their populations are found South East by the Southern Sierra Madre entering Guatemala through the Chucumanes Sierra (Hernández-Baz et al. 2012) and then into the localities of San Gerónimo and Vera Paz [as reported by Druce (1891-1900)]. Altitudinally, the range of distribution of the species extends from 2,000 to 3,000 m.

In the Henri Pittier National Park, located along the North Central region of the Northern Cordillera of Venezuela, 126 species of day-flying moths, including 8 Geometridae were collected (Beebe & Fleming 1951; Sandoval et al. 2008). Among those, specimens of *H. atalantata* were found flying through Portachuelo Pass (1,100 m) from May to July, a reduced time frame

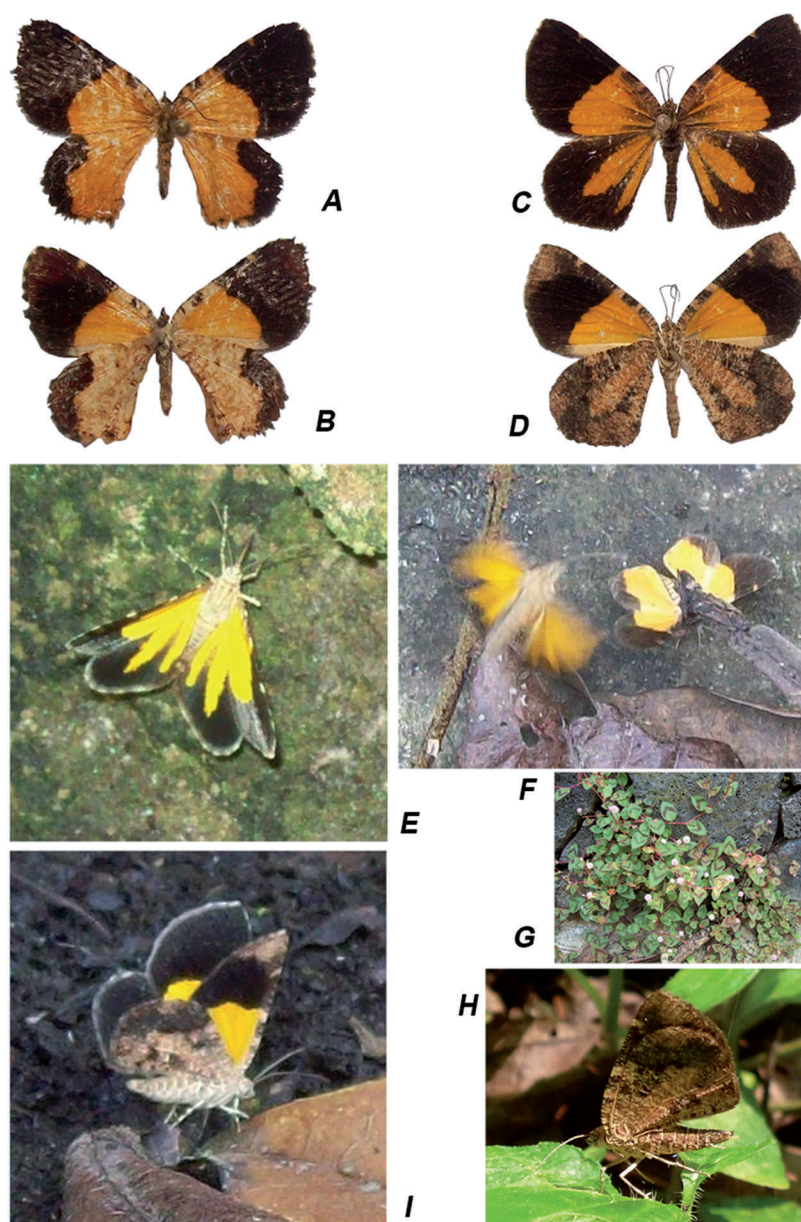


FIG. 1. **A)** *Heterusia atalantata* ♂ dorsal view; **B)** *H. atalantata* ♂ ventral view; **C)** *H. atalantata* ♀ dorsal view; **D)** *H. atalantata* ♀ ventral view. (Both ♂ and ♀ specimens were deposited in the Lepidoptera Collection of the Biology School, Universidad Veracruzana, México) (UV-FBX-CL); **E)** *H. atalantata* ♂ perched on wet rock (notice the extended proboscis); **F)** *H. atalantata* ♂ fluttering around and above a ♀; **G)** *Polygonum capitatum* (Polygonaceae), plant; **H)** Imago of *H. atalantata* perched on a low plant along the undergrowth of Parque Natura, Veracruz, Mexico; **I)** *H. atalantata* ♂ sipping salts from the ground.

contrasted to the flight season in Mexico, which is longer and extends from March to August (Beebe & Fleming 1951).

Biology and Behavior

The life history of *H. atalantata* is basically unknown (BAMONA 2015). Unfortunately, labels from collected specimens held in insect collections surveyed provided us with little information. Besides, published sources

referring to this species do not include many biological details. In relation to the flying behavior of the species, it has been reported that it flies only after 07:30 hrs, in Portachuelo Pass, Rancho Grande, Venezuela (Beebe & Fleming 1951). In Parque Natura, Veracruz, Mexico, some individuals were found flying as early as 08:00 hrs, above a stone wall bordering the ecotone of oak trees (Fagaceae) and grasses (Poaceae). Adults were active

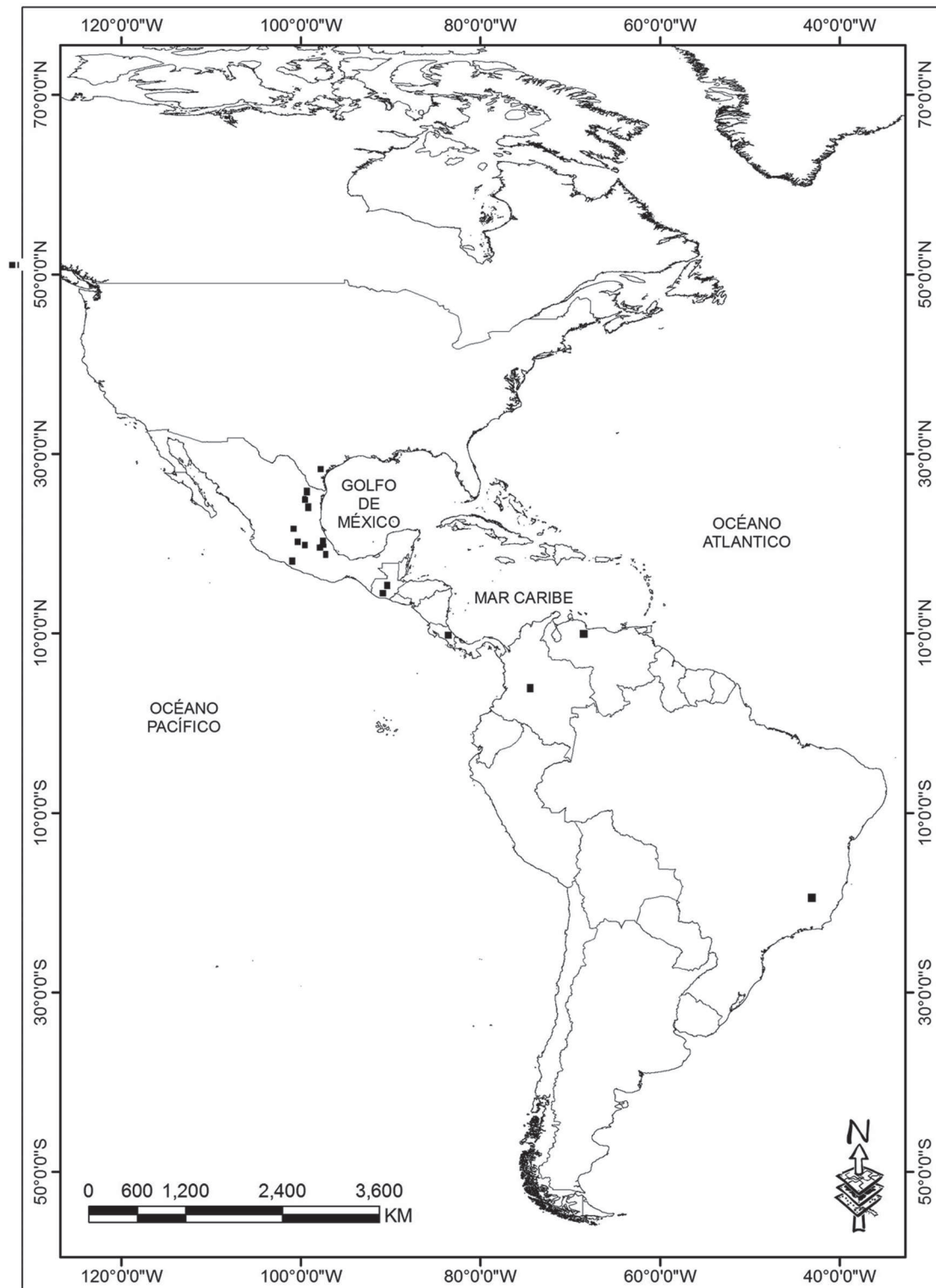


FIG. 2. Distribution of *Heterusia atalantata* in the Americas, with special reference to Mexico. These data come from specimens reported and collected from 1889-2008. Source: Data Base "Polilla".

from 08:00 to 11:20 hrs. Females settled on rocks and lifted their abdomens while males approached closer and fluttered above and around them. No copulation was observed. Most of the time, males settled on wet rocks or on the ground to sip water. Most males also settled on inflorescences of *Polygonum capitatum* Buch.-Ham. Ex D. Don (Polygonaceae) from 10:00 to 11:00 hrs (Figs. 1e-i).

When the sun was at its highest around noon (~12:00 hrs), males and females abandoned the ecotone and flew into the forest, perhaps looking for a more humid environment, where they perched on the reverse of leaves until 17:00 hrs. Then they fluttered along open areas, avoiding direct light exposure. In the Barranca de Teocelo (Veracruz, México), isolated individuals of *H. atalantata* have been observed flying in the humid and shadowy areas from 09:00 to 17:00 hrs. We could deduce then that *H. atalantata* is strongly associated with the high humidity levels provided by the cloud forests found between 1,100 and 2,800 m altitude ranges in the Americas where the species lives.

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