Research Article / Artículo de Investigación

First report of the fruit-piercing moth, *Gonodonta nutrix* Stoll, 1780 (Lepidoptera: Erebidae) in Colombia, with notes on its morphology and biology

Primer reporte de la polilla perforadora de frutos, *Gonodonta nutrix* Stoll, 1780 (Lepidoptera: Erebidae) en Colombia, con notas sobre su morfología y biología

Takumasa Kondo[1*], Yenifer Campos-Patiño[1], Rubilma Tarazona-Velásquez[1], Carlos E. Sarmiento[2], Erika Valentina Vergara-Navarro[3]

[1]*Corporación Colombiana de Investigación Agropecuaria (Agrosavia), Centro de Investigación Palmira, Palmira, Valle del Cauca, Colombia.* [2]*Universidad Nacional de Colombia -Sede Bogotá - Instituto de Ciencias Naturales - Laboratorio de Sistemática y Biología Comparada de Insectos, Bogota, Colombia.* [3]*Corporación Colombiana de Investigación Agropecuaria (Agrosavia), Centro de Investigación Tibaitata, Cundinamarca, Mosquera, Colombia.* ✉ *tkondo@agrosavia.co**

ZooBank: urn:lsid:zoobank.org:pub:9A9875F1-1827-42B7-B973-BC9C8266C68B
https://doi.org/10.35249/rche.50.4.24.11

Abstract. In February 2023, an outbreak of lepidopteran larvae was observed on a soursop grove (*Annona muricata* L.; Magnoliales: Annonaceae) at the Agrosavia Palmira Research Station in Valle del Cauca, Colombia. The adult moth was identified as *Gonodonta nutrix* Stoll (Lepidoptera: Erebidae), a species found from North to South America. The larvae of *G. nutrix* typically target plants in the Solanaceae family, especially *Brunfelsia americana* L. and *Solanum lycopersicum* L. (tomato), as well as species within the genus *Annona* L. (Annonaceae). The moths can damage the skin of these fruits and occasionally harm citrus fruits with their mouthparts. This study presents information on the morphology and biology of *G. nutrix*, including life-cycle data and a life table. The larvae were found to be parasitized by a braconid parasitoid from the genus *Glyptapanteles* Ashmead, 1904 (Hymenoptera: Braconidae: Microgastrinae). Future research is needed to quantify the level of parasitization by *Glyptapanteles* sp. on *G. nutrix* and to assess its potential as a biological control agent. Additionally, we provide information on the geographical distribution of *G. nutrix* in Colombia and the New World, drawing on scientific literature, GBIF data, and citizen science contributions. An examination of entomological collections from six Colombian museums revealed a specimen dating back to 1978, however, this is the first written record of *G. nutrix* in Colombia.

Key words: *Annona* spp.; biology; Braconidae; insect pest; percentage of emergence.

Resumen. En febrero de 2023, se observó un brote de larvas de lepidópteros en un huerto de guanábana (*Annona muricata* L.; Magnoliales: Annonaceae) en Agrosavia, Centro de Investigación Palmira, Valle del Cauca, Colombia. La polilla adulta fue identificada como *Gonodonta nutrix* Stoll (Lepidoptera: Erebidae), una especie que se encuentra desde América del Norte hasta América del Sur. Las larvas de *G. nutrix* suelen atacar plantas de la familia Solanaceae, especialmente *Brunfelsia americana* L. y *Solanum lycopersicum* L. (tomate), así como especies del género *Annona* L. (Annonaceae). Las polillas pueden dañar la piel de estas frutas y, ocasionalmente, dañar cítricos con su aparato bucal. Este

Received 12 October 2024 / Accepted 5 November 2024 / Published online 29 November 2024
Responsible Editor: José Mondaca E.

estudio presenta información sobre la morfología y biología de *G. nutrix*, incluidos datos del ciclo vital y una tabla de vida. Se encontró que las larvas estaban parasitadas por un parasitoide bracónido del género *Glyptapanteles* Ashmead, 1904 (Hymenoptera: Braconidae: Microgastrinae). Se necesitan investigaciones futuras para cuantificar el nivel de parasitación de *Glyptapanteles* sp. sobre *G. nutrix* y evaluar su potencial como agente de control biológico. Además, se proporciona información sobre la distribución geográfica de *G. nutrix* en Colombia y el Nuevo Mundo, basándonos en literatura científica, datos de GBIF y contribuciones de ciencia ciudadana. Una examinación de colecciones entomológicas de seis museos colombianos reveló un espécimen que data de 1978, sin embargo, este es el primer registro escrito de *G. nutrix* en Colombia.

Palabras clave: *Annona* spp.; biología; Braconidae; insecto plaga; porcentaje de emergencia.

Introduction

Moths of the Neotropical genus *Gonodonta* Hübner, 1818 (Lepidoptera: Erebidae) have a proboscis modified for piercing, and some species have been observed feeding on *Citrus* spp., *Annona* spp. and other fruits (Todd 1959). Using both light microscopy and SEM methods, Zaspel *et al*. (2011) classified the mouthparts of *G. nutrix* in a category they termed "primary piercing of thick-skinned fruit; secondary piercing of hard-skinned fruit" based on a morphological examination of the structures associated with the proboscis of fruit-piercing, blood-feeding, and tear-feeding representative adult moth species of the subfamily Calpinae Boisduval, 1840 (Lepidoptera: Erebidae). The mouthparts of moths in this category can pierce the intact rind of thick-skinned fruit, *e.g*., oranges and grapefruit, as well as all softer-skinned fruits, but are not capable of piercing hard-skinned fruits such as longan, *Dimocarpus longan* Lour. and lychee, *Litchi chinensis* Sonn. (Sapindales: Sapindaceae) (Zaspel *et al*. 2011).

Both immature stages and adult moths of the genus *Gonodonta* are known to cause damage to fruit crops. In Minas Gerais, Brazil, larvae of three *Gonodonta* species, namely *Gonodonta bidens* Geyer, 1832, *G. nutrix* Stoll, 1780 and *G. pyrgo* Cramer, 1777 were reported causing an 85% infestation level and 30% average defoliation in groves of sugar apple, *Annona squamosa* L., and atemoya, *Annona* × *atemoya* Mabb. (Silva *et al*. 2017). In Nayarit, Mexico, Hernández Fuentes *et al*. (2015) reported *G. pyrgo* causing infestations of up to 46 larvae per tree and 40% of defoliation in some sites, with total defoliation of young soursop trees up to two-years old, weakening the trees and delaying their development. In Florida, USA, damage caused by moths of *G. nutrix* on orange fruits has been reported as ranging from 20% to 100%; the immature stages feed on the young leaves of pond apple, *Annona glabra* (L.), a plant that grows along canals adjacent to citrus groves (King and Thompson 1958). The first- and second-instar larvae of *G. nutrix* feed superficially on the leaf epidermis of young leaves, and the last three instars feed on leaves and young shoots which often become skeletonized (King and Thompson 1958).

In Panama, *G. incurva* (Sepp, 1840) is known to feed on *Piper duckei* C. DC. (Piperaceae) (Chang 2018). In Venezuela, injury to mango fruits has been reported to be caused by the adults of various moth species, including *G. pyrgo*, *G. clotilda* Stoll, 1790, and *Gonodonta* sp. (Angeles and Requena 1966). In Louisiana (USA), 100% losses caused by *G. pyrgo* were reported in orange, tangerine, grapefruit, and lemon groves (Todd 1959). Damage by adults of *G. pyrgo* has been reported on mango, soursop and citrus fruits in Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Nicaragua, Venezuela (Angulo and Jana 1983), Panama, USA (Todd 1959), and Ecuador (Galapagos Islands) (Roque-Albelo and Landry 2012).

At the end of June 2022, larvae of unidentified moth species were observed causing leaf-feeding damage to a cherimoya tree, *Annona cherimola* Mill. at the premises of the Corporación Colombiana de Investigación Agropecuaria [Colombian Corporation for Agricultural Research] at Palmira. In February 2023, a population outbreak of the same caterpillars occurred in an orchard of soursop, *Annona muricata* L. (Annonaceae), located at the same research center, approximately 500 m away from the cherimoya orchard, and causing damage and losses to foliage, especially young leaves. The damage appeared to match that caused by *G. nutrix* in Florida (USA), as reported by King and Thompson (1958); the young larvae (first and second instars) feed on the leaf epidermis causing skeletonization of the leaves and later larval stages feed on the entire leaf and shoots. However, the population outbreak at Palmira did not last for long since the manager of the orchard treated the insects with a fumigation of Sáfermix ®, a product made from a mixture of the fungi *Beauveria bassiana* (Bals.-Criv.) Vuill., *Metarhizium anisopliae* (Metchnikoff) Sorokin, *Lecanicillium lecanii* R. Zare & W. Gams and the bacteria *Bacillus thuringiensis* Berliner. As a result of this treatment the moth population declined and afterwards the larvae of this moth species were only observed sporadically in small numbers.

Soursop, *A. muricata*, is native to the Antilles and northern South America (Morton 1987) and is currently distributed throughout the tropical regions of the world, including the Caribbean (Bahamas, Bermuda, Cuba, Dominican Republic, Grenada, Puerto Rico, St. Vincent), Brazil, Costa Rica, Colombia, Ecuador, Mexico, and Venezuela (Gajalakshmi *et al*. 2012; Coria-Téllez *et al*. 2018; Santos *et al*. 2023). The soursop tree is normally evergreen, with low branches and bushy foliage, reaching a height of 7 to 9 m; the flowers are triangular-conical shaped with a short, thick stalk, and born singly on the trunk or branches; the fruit is heart-shaped, with a prickly skin and can weigh 4.5 up to 6.8 kg; the pulp is creamy and granular, with black seeds surrounded by white, juicy edible flesh (Morton 1987; Kobayashi *et al*. 2023). According to the Colombian Horticultural Association (Asohofrucol), the total area planted with soursop in Colombia in 2019 reached 5,000 hectares, and according to the latest National Agricultural Census, an average of 40,000 tons of soursop are produced each year, with international sales of the fruit that reach 1 million US$ (Agronegocios 2019). Thus any insect that damage this crop may inflict economic losses.

The primary objectives of this study were to identify the moth pest of soursop at the species level, characterize its development and survival, describe its morphological features, and document its natural enemies. Following species identification, a secondary aim was to collect data on the distribution of this species in Colombia and the rest of the New World, drawing from scientific literature, GBIF, citizen science contributions, and entomological collections in Colombian museums.

Materials and Methods

Host plant and study site

Insect samples were collected in a soursop, *A. muricata*, orchard planted located at the Corporación Colombiana de Investigación Agropecuaria [Colombian Corporation for Agricultural Research], - Agrosavia, Palmira Research Station, located in the municipality of Palmira, Valle del Cauca, Colombia, 03°30’55.8’’N, 76°18’49.7’’W, 1000 m a.s.l. The orchard was planted with two varieties, namely Agrosavia Tesoro and Agrosavia Fecunda.

Insect sampling and rearing of moths and their parasitoids

In the soursop orchard described above, plants were visually inspected for the presence of healthy lepidopteran larvae and larvae with symptoms of parasitoid infestation, *i.e.*,

unhealthy-looking caterpillars and the presence of small puparia on their skin, once a week from January to March 2023. The larvae were kept in Darnel® plastic containers 17 cm x 17 cm x 10 cm, with a mesh lid to allow airflow and a wet paper towel in the bottom of the container to prevent desiccation of the plant material. Young leaves to feed the larvae were changed every other day until pupation. Once the adult moths emerged, they were moved to a glasshouse and put in an insect mesh cage, 1 m x 80 cm x 80 cm, with a potted soursop plantlet to allow them to copulate and oviposit. The emerged parasitoids were kept alive for 24 hours and then put into properly labeled 4 mL vials filled with 70% EtOH. Some of the moths were killed in a kill jar containing ethyl acetate for pinning and identification.

Specimens were collected under a permit framework for collecting specimens of wild species of the biological diversity for non-commercial scientific research purposes (resolution No. 1466, Autoridad Nacional de Licencias Ambientales – ANLA) [Colombian National Authority Environmental Permits].

Adult moths were pinned, and their wings spread following the method described by Upton and Mantle (1991). Labels include the collecting data (locality where the larvae were collected, date when the moth was killed, and name of collector). Moths and their parasitoids were identified to the family level using the keys of Triplehorn and Johnson (2005). Noctuid moths were identified to the subfamily level using the keys by Kirti and Dar (2013). The identification of *Gonodonta* species was based on adult wing venation utilizing keys from Todd (1959), along with larval characteristics described by King and Thompson (1958). Species identification of Lepidoptera was conducted by the first author through direct observation of specimens collected in this study, as well as photographs of *Gonodonta* spp. provided by collaborators (see Acknowledgment section). In this way, the moth found on soursop at Palmira was confirmed as *G. nutrix*. In addition to the specimens collected during this study, data on *Gonodonta* spp. were obtained from five insect collections in Colombia (see depositories below).

The wasps were critical point dried to avoid the collapse of the wasp specimens during dry mounting. A variation of the method described by Gordh and Hall (1979) was applied as follows: the wasps were dehydrated in 96% ethanol for 48 hours and then placed in a small Petri dish with a minimum amount of ethanol in a refrigerator at -30 °C until complete evaporation and subsequently were mounted on triangular points following standard entomology parameters (Triplehorn and Johnson 2005). The wasps were identified by Carlos Sarmiento to the subfamily and genus level using the keys of Arias-Penna *et al*. (2019), Wharton *et al*. (1997), Fernández-Triana (2019), and Whitfield *et al*. (2002).

Repositories

CBUMAG: Centro de Colecciones Biológicas Universidad del Magdalena. Universidad del Magdalena, Santa Marta, Magdalena, Colombia (Roberto Guerrero y Emira García).

CTNI: Colección Taxonómica Nacional de Insectos "Luis María Murillo", Corporación Colombiana de Investigación Agropecuaria [AGROSAVIA], Mosquera, Cundinamarca, Colombia.

LEUA: Laboratorio de Entomología Universidad de la Amazonia. Universidad de la Amazonia, Florencia, Caquetá, Colombia (Jean Alexander Gamboa).

MEFLG: Museo Entomológico Francisco Luis Gallego. Universidad Nacional de Colombia, Bogotá, Cundinamarca, Colombia (Jhon Alveiro Quiroz).

UNAB: Museo Entomológico Facultad de Agronomía, Universidad Nacional de Colombia, Sede Bogotá, Bogotá, Cundinamarca, Colombia.

ICN-MHN-En: Colección de Entomología, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Cundinamarca, Colombia. (Braconid wasps).

Life history studies

Soursop branches about 30 cm long with leaves infested with lepidopteran eggs were cut with garden scissors in the field. For the life history study a total of 58 lepidopteran eggs were collected on February 25th, 2024. Gathering of the data began on the day of collection of the eggs (day 1) but it was not known when eggs were laid and hence the exact duration of the egg stage from oviposition to hatching could not be determined. Adult moths lay eggs singly or in groups, mainly on the lower side of leaves (abaxial surface), but some are laid also on the upper side (adaxial surface). A leaf disk was cut around each egg with a scapel, put on the surface of a young soursop leaf and placed inside a plastic container, 17 cm x 17 cm x 10 cm, with a wet paper towel in the bottom of the container to prevent desiccation of the plant material and a mesh lid to allow airflow.

Observations were carried out daily, and once the eggs had hatched, tender soursop shoots were provided as food for the caterpillars every two days until pupation. Once the adults emerged, they were moved to a 1 m x 80 cm x 80 cm mesh cage, with a potted soursop plantlet to allow them to copulate and oviposit. On each side of the cage, gauze pads soaked with a mixture of water, honey, and a nutritional supplement (SUSTAGEN®) were hung as a food source for the moths. The duration of each life stage of *G. nutrix* was studied under glasshouse conditions, at an average temperature of 26.9 °C and relative humidity (RH) of 68.2 % and natural light regime, approx. 12:12 (L: D) hr, for which data were measured using a Data logger (CEM, DT 171, Data logger). The number of living individuals was recorded daily for each of the stages, *i.e.* egg, larva (all five-instars combined), pupa and adult. The survival of *G. nutrix* was followed during its whole life cycle, starting from an initial population composed of the total number of eggs collected in the field on day 1 until the death of the last adult. An age-specific life table, often referred to as a horizontal or cohort life table was used since this type of life table is commonly used to analyze the outcomes of a specific cohort, making it particularly suitable for studying individuals from a single generation (Henderson 2021; Vázquez *et al*. 2003). We implemented the approach outlined by Richards *et al*. (1960) for assessing mortality within a generation of a population. This technique relies on the premise of a singular recruitment event and a stable mortality rate, making it relevant solely for stages that exhibit a distinct peak in abundance. By estimating the population survival curve over time after the initial population and projecting it to the point at which the entire population dies, one can estimate the population at any point in time as well as the probability of the mortality of the population. A population facing consistent mortality can be described as: $Y_t = N_0 \emptyset^t$, where Yt represents the population at time t, N_0 denotes the peak population (ideally the number that hatched), and ø signifies the portion of the population surviving to the end of a time unit (*e.g.*, a day), indicating the survival rate per time unit. Consequently: $logY_t = \log N_0 + tlog\emptyset''$ (Richards *et al*. 1960).

Distribution map

The distribution map was created with the ArcGis – ArcMap version 10.8. software (Esri 2011). Coordinates and/or collecting localities for each data point were extracted from iNaturalist (http://www.inaturalist.org), GBIF (https://www.gbif.org/) and published literature. Because of the characteristic color patterns on the wings of the adult stage, and body of the larvae, and its common association with Annonaceae, it was possible to identify these insects on the citizen science platforms and thus utilize their distribution records. For the countries recorded in published literature that lack coordinates, a point in the middle of the country was arbitrarily selected.

The photos and illustrations of Figs. 1 and 2 were produced by T. Kondo, except for the photos of the egg and first-instar larva by Y. Campos Patiño. The photos of Fig. 4 were taken by Y. Campos Patiño.

Results and Discussion

Taxonomic notes

In Colombia, *G. pyrgo* was hitherto the only species of the genus reported from *Annona* spp. (Pinzón-García *et al*. 2016). With the discovery of *G. nutrix*, the species of *Gonodonta* that may be found on soursop in Colombia is increased to two species. *Gonodonta nutrix* (Figs. 1A-D) and *G. pyrgo* (Figs. 1E-H) can be differentiated from all other species in the genus by having the costal margin of the forewings distinctly lighter in color than the median part of wings, usually white or white suffused with other colors; other *Gonodonta* species have the costal margin of the forewings not distinctly lighter in color than median part of the wings (Todd 1959). Further, both *G. nutrix* and *G. pyrgo* have the tornus [= posterior corner of the wing] of the forewing produced, forming a tooth, and the apex of second palpal segment is tufted ventrally, appearing wider at apex than at the middle (Todd 1959).

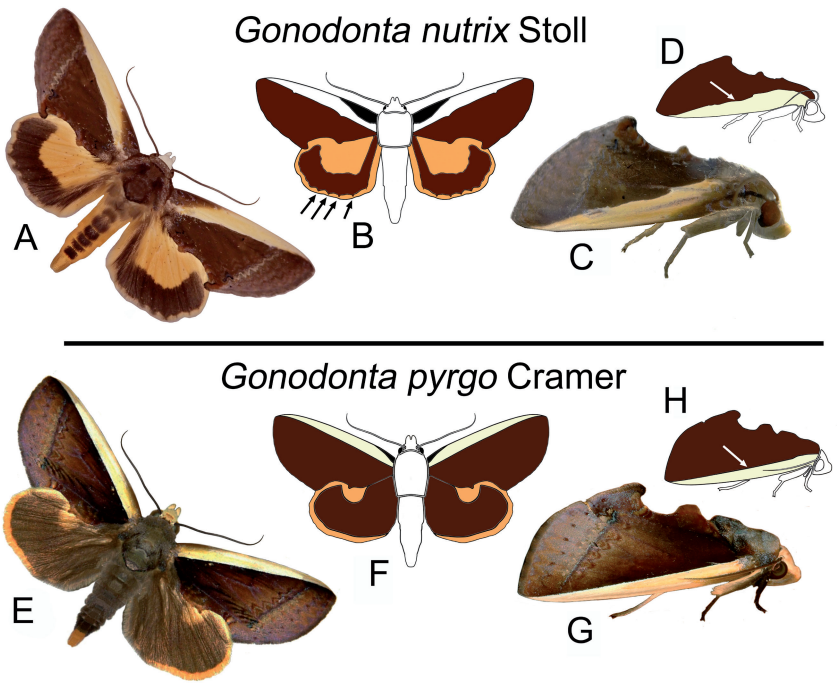

Figure 1. Comparison of *Gonodonta nutrix* and *G. pyrgo*, two common species on soursop in Colombia. **A.** Adult *G. nutrix* with extended wings. **B.** Illustration of adult of *G. nutrix* emphasizing the characteristic color patterns of the wings. Note brown veins interrupting fringe (arrows). **C.** Lateral view of adult of *G. nutrix*. **D.** Illustration of the lateral view of adult of *G. nutrix* showing an undulated inner margin of the white costal streak of the forewing. **E.** Adult of *G. pyrgo* with extended wings. **F.** Illustration of adult of *G. pyrgo* emphasizing the characteristic color patterns of the wings. **G.** Lateral view of adult of *G. pyrgo*. **H.** Illustration of the lateral view of adult of *G. pyrgo* showing a straight inner margin of the white costal streak of the forewing. / **Figura 1.** Comparación de *Gonodonta nutrix* y *G. pyrgo*, dos especies comunes en guanábana en Colombia. **A.** Adulto de *G. nutrix* con alas extendidas. **B.** Ilustración de un adulto de *G. nutrix* que enfatiza los patrones de color característicos de las alas. Nótese las venas marrones que interrumpen el borde (flechas). **C.** Vista lateral de un adulto de *G. nutrix*. **D.** Ilustración de la vista lateral de un adulto de *G. nutrix* que muestra el margen interno ondulado de la línea costal blanca del ala anterior. **E.** Adulto de *G. pyrgo* con alas extendidas. **F.** Ilustración de un adulto de *G. pyrgo* que enfatiza los patrones de color característicos de las alas. **G.** Vista lateral de un adulto de *G. pyrgo*. **H.** Ilustración de la vista lateral de un adulto de *G. pyrgo* que muestra el margen interno recto de la línea costal blanca del ala anterior.

Gonodonta nutrix can be differentiated from *G. pyrgo* by having the following combination of features (character states of *G. pyrgo* in parenthesis): 1) inner margin of the white costal streak of the forewing irregular basally (Figs. 1C, D) [inner margin of white costal streak of forewing straight (Figs. 1G, H)]; 2) with a large pale (often orange or yellow cream) area on the hindwings which is about twice the width of the dark area of wing (Figs. 1A, B) [pale (often light brown, orange or yellow cream) area of hindwing small, about equal in width to dark area of wing (Figs. 1E, F)]; and 3) fringe of hindwing interrupted with brown at veins (Figs. 1A, B) [fringe unicolorous (uninterrupted with brown at veins) (Figs. 1E, F)] (Todd 1959).

Morphological characteristics and behavior of *Gonodonta nutrix*

King and Thompson (1958) described the eggs and larvae as follows, with additional observations from this study noted in square brackets [ ]. Eggs are round, translucent, about two millimeters [2.0-2.5 mm] wide and laid singly [or in groups of up to eight eggs], usually on the undersides of young and old leaves (Fig. 2B: egg). The larvae are smooth skinned, with three pairs of thoracic legs, each with a single claw, with a pair of prolegs on each of the fifth, sixth, seventh, and tenth abdominal segments (Figs. 2A, B) (King and Thompson 1958). Newly hatched larvae (first instar) are creamy yellow, translucent, with dark spots on each segment, and with a brown head (Fig. 2B: L1). Second-instar larvae are black, with fewer yellow spots compared with later instars, and lack white stripes (Fig. 2B: L2); third-instar larvae are black, with faint white stripes on each abdominal and thoracic segment, with yellow spots on the basal part of the abdominal segments on the lateral margins, with larger dorsal yellow markings on the area around the first abdominal segments and smaller markings on the dorsal areas on the segments that bear the prolegs (Fig. 2B: L3); fourth-instar larvae have yellow markings near the base on the lateral margins and dorsally on all abdominal segments, with numerous white stripes (Fig. 2B: L4); fifth-instar larvae have yellow markings basally on the lateral margins and dorsally on all abdominal segments, the white stripes are incomplete, present mostly dorsally, with small patches of white between the yellow markings and on the thoracic segments (Fig. 2: L5). Fully-grown larvae [fifth instar] measure about 2.5 cm when fully extended; they have two pronounced humps when at rest, one includes the first three abdominal segments and the other on the eighth and ninth segments; the head and body has a black background color, and each abdominal segment has four large orange spots and several small white dots (Figs. 2A, B).

The mature larvae usually form their pupal case by webbing together pieces of leaves (Fig. 2C and inset), which are usually attached to branches and the tree trunk (King and Thompson 1958). In the USA (Florida), adult moths have been observed to be active during the night from around 8:30 p.m. to 3:30 a.m. (King and Thompson 1958). No night observations were made during the present study.

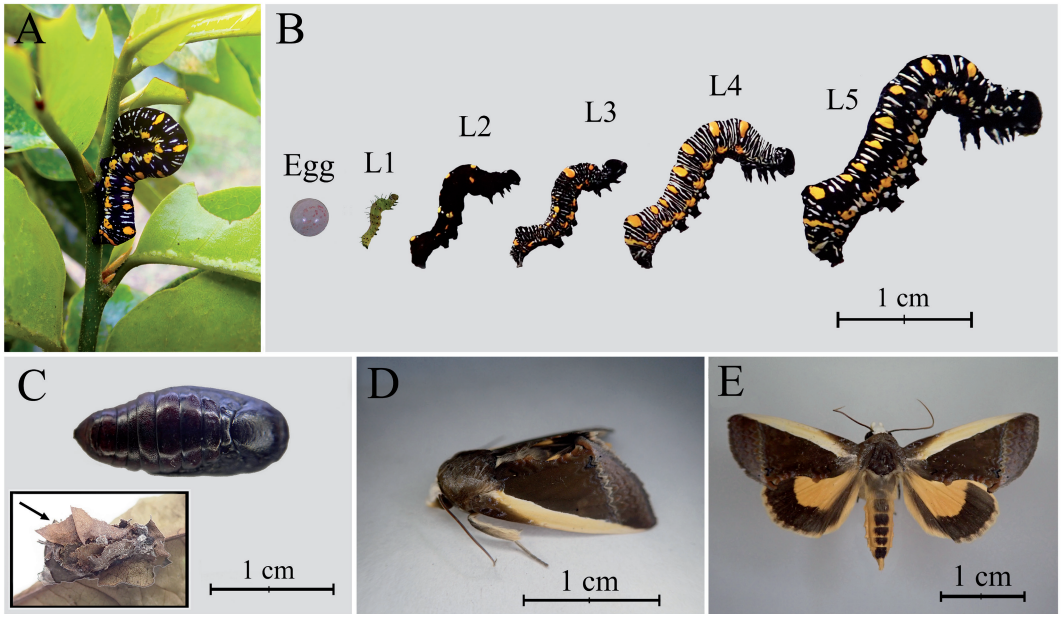

Figure 2. *Gonodonta nutrix*. **A.** Fifth-instar larva and damage to soursop leaves. **B.** Relative size of egg and the five larval instars. **C.** Pupa. Inset. Pupa rolled in a leaf. **D.** Adult female in lateral view. **E.** Adult female with spread wings. L1 = first-instar larva; L2 = second-instar larva; L3 = third-instar larva; L4 = fourth-instar larva; L5 = fifth-instar larva. / **Figura 2.** *Gonodonta nutrix*. **A.** Larva de quinto estadio y daño en hojas de guanábana. **B.** Tamaño relativo del huevo y de los cinco estadios larvarios. **C.** Pupa. Recuadro. Pupa enrollada en una hoja. **D.** Hembra adulta en vista lateral. **E.** Hembra adulta con las alas extendidas. L1 = larva de primer estadio; L2 = larva de segundo estadio; L3 = larva de tercer estadio; L4 = larva de cuarto estadio; L5 = larva de quinto estadio.

Life history and life table of *Gonodonta nutrix*

This species goes through an egg stage, five larval instars, a pupal stage, and adult stage (Fig. 2). Eggs deposited by the adult moths kept in captivity were not fertile, hence we only study the partial life cycle of *G. nutrix* based on eggs of unknown age collected in the soursop field. However, we can infer that the eggs used in the present study belonged to the same cohort since all eggs hatched by day two. Of the 58 eggs observed, only 34 hatched, 24 individuals reached the pupal stage and 23 reached the adult stage during 59 days until the last adult died. A life table showing a summary of the mortality and survival rates at each stage is shown in Tab. 1. A high mortality rate was observed in the egg stage; 41% of the eggs were non-viable on day 3, since they became dried, discolored and/or deformed. After this, mortality decreased, with 40% of the population reaching the adult stage. In the closely related species, *G. pyrgo*, the egg stage lasts 2.5 days (S.E. ± 0.18) (Pinzón-García *et al*. 2016) which greatly contrasts with the observations carried out in Florida (USA) by King and Thompson (1958) for *G. nutrix* who reported that the egg stage lasts about two weeks. This seems likely to be an error, perhaps they meant to write "days" instead of "weeks". Life cycle studies on other erebid species have reported an egg duration of less than a week, *e.g.*, 3-4 days in *Eudocima phalonia* (Linnaeus, 1763) (Leroy *et al*. 2021), 5 days in *Cosmosoma auge* (Linnaeus, 1767) (León-Finalé and Barro 2014), 4.1 days in *Zale phaeograpta* Hampson, 1913 (Vázquez *et al*. 2014), and 4.0-6.5 days in *Spilarctia obliqua* (Walker, 1855) (Veeranna 2020).

In the present study, the larval stage (all five larval instars combined) lasted 16 (Standard error (S.E.) ± 1.30) days. The pupal stage lasted 14 (S.E. ± 0.39) days; this coincides with the observations made by King and Thompson (1958) but differs from the duration of the pupal

stage of *G. pyrgo* which was reported to last 7.5 (S.E. ± 0.30) days (Pinzón-García *et al*. 2026). The adult moths of *G. nutrix* (both sexes) lived for 6 (S.E. ± 1.37) days. *Gonodonta nutrix* lived from egg to adult 37 (S.E. ± 1.05) days. This contrasts with the life cycle of *G. pyrgo* that lasts 26 (S.E. ± 2.11) days from egg to adult (Pinzón-García *et al*. 2026). Caged adult females of *G. nutrix* laid a total of 20 eggs, but were non-viable, hence a second generation could not be continued to be studied.

Table 1. Life table of *Gonodonta nutrix* from field collected eggs to the adult stage. / **Tabla 1.** Tabla de vida de *Gonodonta nutrix* desde huevos recolectados en el campo hasta el estado adulto.

Stage	Number of individuals that progressed to the next life stage (N_x)	Proportion of survivors (l_x)	Standardized number of dead individuals (d_x)	Mortality rate by stage (q_x)	Mortality rate (%)
Initial population (field-collected eggs)	58	1.00	24	0.41	41%
Egg (hatched eggs)	34	0.59	4	0.12	12%
Larva (all instars)	30	0.52	6	0.20	20%
Pupa	24	0.41	1	0.04	4%
Adult	23	0.40	23	1.00	100%

Proportion of survivors by stage x. $l_x = N_x/N_0$
Total number of deaths during a stage x. $d_x = N_x - N_{x+1}$
Specific mortality rate for stage x. $q_x = d_x/N_x$

A negative logarithmic behavior was observed between the number of living individuals and the days of observation where the percentage of individuals decreased until reaching its death as adults (Fig. 3). The estimated survival curve derived from these data reveals a logarithmic pattern, showing a decline in survival from the egg to the larval stage, followed by a gradual decrease that stabilizes over time.

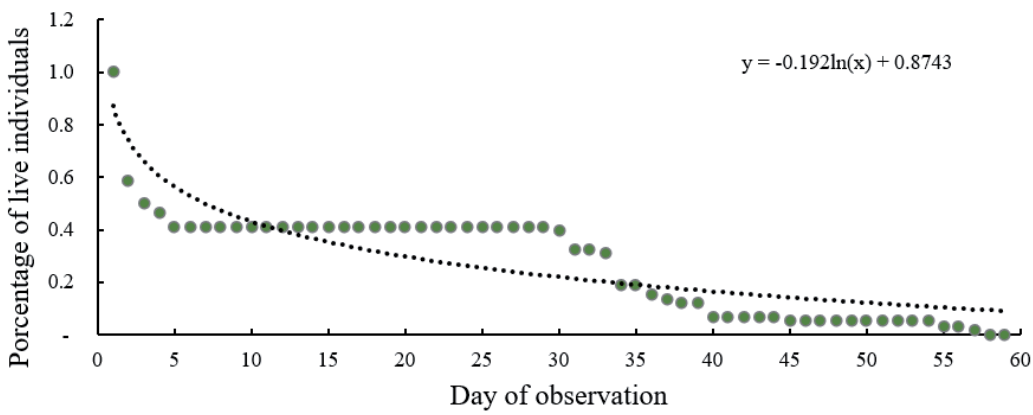

Figure 3. Survival curve of *Gonodonta nutrix* recorded since day 1 of observation until the death of the last adult (day 59). The green dots represent the total number of living individuals in each day of observation, the dotted black line indicates the trend of the recorded data. / **Figura 3.** Curva de supervivencia de *Gonodonta nutrix* registrada desde el día 1 de observación hasta la muerte del último adulto (día 59). Los puntos verdes representan el número total de individuos vivos en cada día de observación, la línea negra punteada indica la tendencia de los datos registrados.

Natural enemies of *Gonodonta nutrix*

Known natural enemies of *G. nutrix* include *Lydellohoughia* sp. (Diptera: Tachinidae), *Parapanteles aletiae* (Riley, 1881) (Hymenoptera: Braconidae: Microgastrinae), *Euplectrus platyhypenae* Howard, 1885 (Hymenoptera: Eulophidae) and *Trichogramma minutum* Riley, 1871 (Hymenoptera: Trichogrammatidae) (Bruner *et al*. 1945; Cochereau 1973). The parasitoid larvae that emerged from the larvae of *G. nutrix* studied by us produced numerous small cocoons that remained attached to the parasitized moth larvae (Fig. 4A). The adult parasitoid was identified as a species of the genus *Glyptapanteles* Ashmead, 1904 (Hymenoptera: Braconidae: Microgastrinae) (Fig. 4B).

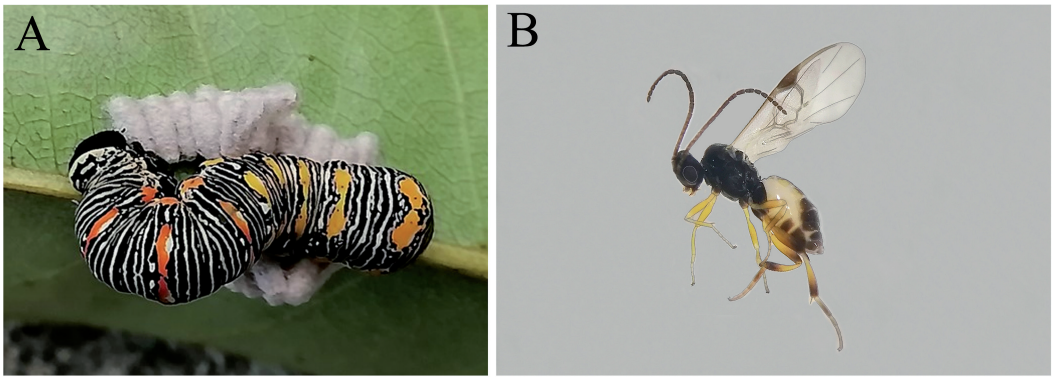

Figure 4. A. Fourth-instar larva of *G. nutrix* with the cocoons of just-emerged braconid larvae. **B.** Adult of *Glyptapanteles* sp. (Hymenoptera: Braconidae: Micrograstrinae). / **Figura 4. A.** Larva de cuarto estadio de *G. nutrix* con capullos de larvas de bracónidos recién emergidas. **B.** Adulto de *Glyptapanteles* sp. (Hymenoptera: Braconidae: Micrograstrinae).

In Florida (USA), larvae of two species of fruit piercing moths, namely, *G. nutrix* and *G. unica*, feed on the tender leaves of *Annona* spp., however, these species do not cause significant damage there because they were heavily parasitized by a species of braconid wasp (Peña and Crane 2006). Further studies are needed in order to determine if the braconid parasitoid identified in the present study is the same species as that reported from Florida by Peña and Crane (2006).

Material studied. *Glyptapanteles* sp. (Hymenoptera: Braconidae: Microgastrinae) (ex. Lepidoptera: Erebidae). COLOMBIA: Valle, Palmira, Agrosavia, C.I. Palmira, 03°30′56″ N, 76°19′02″ W, 1000 m a.s.l., 9.v.2023, coll. Y. Campos Patiño, reared in the laboratory, 10 specimens (5 males + 5 females) (CTNI, Catalogue No. 10146). *Glyptapanteles* sp. (Hymenoptera: Braconidae: Microgastrinae). **COLOMBIA:** Valle del Cauca, Palmira, Agrosavia, C.I. Palmira, 9.v.2023, coll. Y. Campos Patiño, parasitoid of *Gonodonta nutrix*, 90% Ethanol, 3 specimens, PGN 001 (ICN-Ent); Same data, except: 70% Ethanol, 9 specimens PGN 002 (ICN-Ent).

***Gonodonta nutrix* Stoll, 1780 (Lepidoptera: Erebidae). COLOMBIA:** Cundinamarca, San Juan de Río Seco, Vda. Honduras, Fca. Buenos Aires, 04°47′31′′N, 74°40′56′′W, 1250 m a.s.l., 29.i.2002, coll. J. Olaya, Jama [insect net], Follaje [folliage], *G. nutrix*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6705); Meta, San Martín, Reserva El Caduceo, 400 m a.s.l., 03°46′N, 73°35′W, 23.x.2012, coll. A. Gómez, Jama [insect net], *G. nutrix*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6706); Valle del Cauca, Ginebra, 27.xii.1978, coll. B. de Gutiérrez,

Masticador follaje guanábana [soursop leaf chewer], *Annona muricata* (Annonaceae)-guanábana [soursop], *G. nutrix*, det. T. Kondo, 1 specimen (CTNI, Catalogue No. 10137); Magdalena, Cienaga, vi.1986, coll. F. Posada, Masticador en follaje de [leaf chewer] *Annona muricata* (Anonaceae)-guanábana, *Annona muricata* (Anonaceae)-guanábana [soursop], *G. nutrix*, det. Robert W. Poole, xi.1991, Departamento de Agricultura de los Estados Unidos (USDA) (USA), 1 specimen (CTNI, Catalogue No. 7607).

***Gonodonta pyrgo* (Cramer, 1777) (Lepidoptera: Erebidae): COLOMBIA:** Cundinamarca, Bogotá D.C., Modelia, Parque Modelia central, N 04°40′09′′N, 74°07′11′′W, 2548 m a.s.l., 10.iv.2024, coll. L. Sanchez, Jama [insect net], *G. pyrgo*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6704); Boyacá, Siachoque, Vda. Tocavita, 05°36′24.2′′N, 73°15′01.6′′W, 2798 m a.s.l., 1.vi.2024, coll. K. Benavidez, Manual, *G. pyrgo*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6704); Cundinamarca, Bogotá, Univ. Nacional de Colombia, Zona invernaderos, 04°38′08.5′′N, 74°05′22.2′′W, 2556 m a.s.l., 28.x.2016, coll. L. Carvajal, Jama [insect net], En pastizal [in grassland], *G. pyrgo*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6704); Cundinamarca, Puli, Vda. Paramon, Fca. Los Cauchos, 04°41′50.9′′N, 74°42′00′′W, 1210 m a.s.l., 1.xii.2019, coll. J. Delgado, Jama [insect net], Plantación de frutales [fruit orchard], *G. pyrgo*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6704); Cundinamarca, Granada, Prov. Sumapaz, Vda. San Raimundo, 04°31′06′′N, 74°20′50′′W, 1800 m a.s.l., 30.iv.2016, coll. C. Velasquez, Manual, *G. pyrgo*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6704); Cundinamarca, Fusagasugá, Vda. Piamonte, 04°27′45.8′′N, 74°27′50.1′′W, 1470 m a.s.l., 28.xii.2018, coll. G. Forde, Jama [insect net], 1 specimen (UNAB, Catalogue No. 6704); Cundinamarca, La Calera, El Triunfo, 04°46′00′′N, 73°58′53′′W, 10.xi.2012, coll. J. Bonnet, Trampa de luz [light trap], *G. pyrgo*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6704); Cundinamarca, Bogotá, Barrio Venecia, 04°35′N, 74°08′W, 2566 m a.s.l., 8.xi.2014, coll. O. Ladino, *G. pyrgo*, det. T. Kondo, 1 specimen (UNAB, Catalogue No. 6704); Cundinamarca, Mosquera, 2.iii.1979, coll. N. Ruíz, Trampa de luz [light trap], *G. pyrgo*, det. T. Kondo, 1 specimen (CTNI, Catalogue No. 3390); Cundinamarca, Mosquera, 19.iv.1979, coll. I. Zenner, Trampa de luz [light trap], *G. pyrgo*, det. T. Kondo, 1 specimen (CTNI, Catalogue No. 3390); Valle del Cauca, Cerrito, 16.ii.1984, coll. B. de Gutiérrez, Follaje guanabana [soursop folliage] *Annona muricata* (Annonaceae)-guanabana [soursop], *G. pyrgo*, det. T. Kondo, 7 specimens (CTNI, Catalogue No. 10136).

Geographical distribution of *Gonodonta nutrix*

Based on a literature review and records from citizen science reports, the world distribution of *G. nutrix* is restricted to the Nearctic and the Neotropical regions (Fig. 5). The species is known from the USA in North America; Barbados, Cuba, Dominican Republic, Guadeloupe, Mexico, Panama, Salvador, and Saint Lucia in Central America; Bolivia, Brazil, French Guiana, Paraguay, Surinam, and Venezuela in South America (Tab. 2). Based on data from museum specimens at CTNI and UNAB, and information from citizen science reports (iNaturalist), *G. nutrix* is distributed in Colombia in the departments of Cundinamarca, Magdalena, Meta, Sucre, and Valle del Cauca.

The earliest collection of *G. nutrix* found in Colombia is a pinned specimen of an unidentified *Gonodonta* species in the CTNI (catalogue No. 10137). The collecting data for this specimen are as follows: "Colombia, Valle del Cauca, Ginebra, 27.xii.1978, coll. B. de Gutiérrez, Masticador follaje guanabana, *Annona muricata* (Annonaceae)-guanabana". In this study, we identified it as *G. nutrix*.

Table 2. Distribution of *Gonodonta nutrix* in the New World, based on published literature, GBIF, citizen science reports, including the number of observations. / **Tabla 2.** Distribución de *Gonodonta nutrix* en el Nuevo Mundo, basada en literatura publicada, GBIF, informes de ciencia ciudadana, incluyendo el número de observaciones.

Country	References	Citizen science (No. Observations)
North America		
USA	Peña and Crane (2006), King and Thompson (1958), Todd (1959)	4 observations (GBIF 2024), 54 observations (iNaturalist 2024)
Central America		
Barbados	Peña and Bennett (1995)	---
Costa Rica		10 observations (GBIF 2024), 1 observation (iNaturalist 2024)
Cuba	Todd (1959)	---
Dominican Republic	Perez-Gelabert (2015)	---
French Guiana		3 observations (GBIF 2024)
Mexico	Todd (1959)	1 observation (iNaturalist 2024)
Nicaragua		1 observation (iNaturalist 2024)
Guadeloupe	Touroult *et al*. (2021)	6 observations (GBIF 2024)
Panama	Todd (1959)	---
Puerto Rico		3 observations (iNaturalist 2024)
Salvador	Todd (1959)	---
Saint Lucia	Todd (1959)	---
South America		
Bolivia	Todd (1959)	---
Brazil	Silva *et al*. (2017), Todd (1959)	6 observations (iNaturalist 2024)
Colombia		6 observations (iNaturalist 2024)
Ecuador		2 observations (iNaturalist 2024)
French Guiana	Silvain and Lalanne-Cassou (1986), Todd (1959)	1 observation (iNaturalist 2024)
Paraguay	Todd (1959)	---
Surinam	Todd (1959), Zaspel and Branham (2008)	---
Venezuela	Todd (1959)	---

The records gathered from citizen science have proven to be a good source of information on the geographical distribution and dispersal of species that can be easily identified by well defined external characteristics of the immatures stages and adults, as in the case of *G. nutrix*. Of the 21 countries herein recorded, five come from iNaturalist reports.

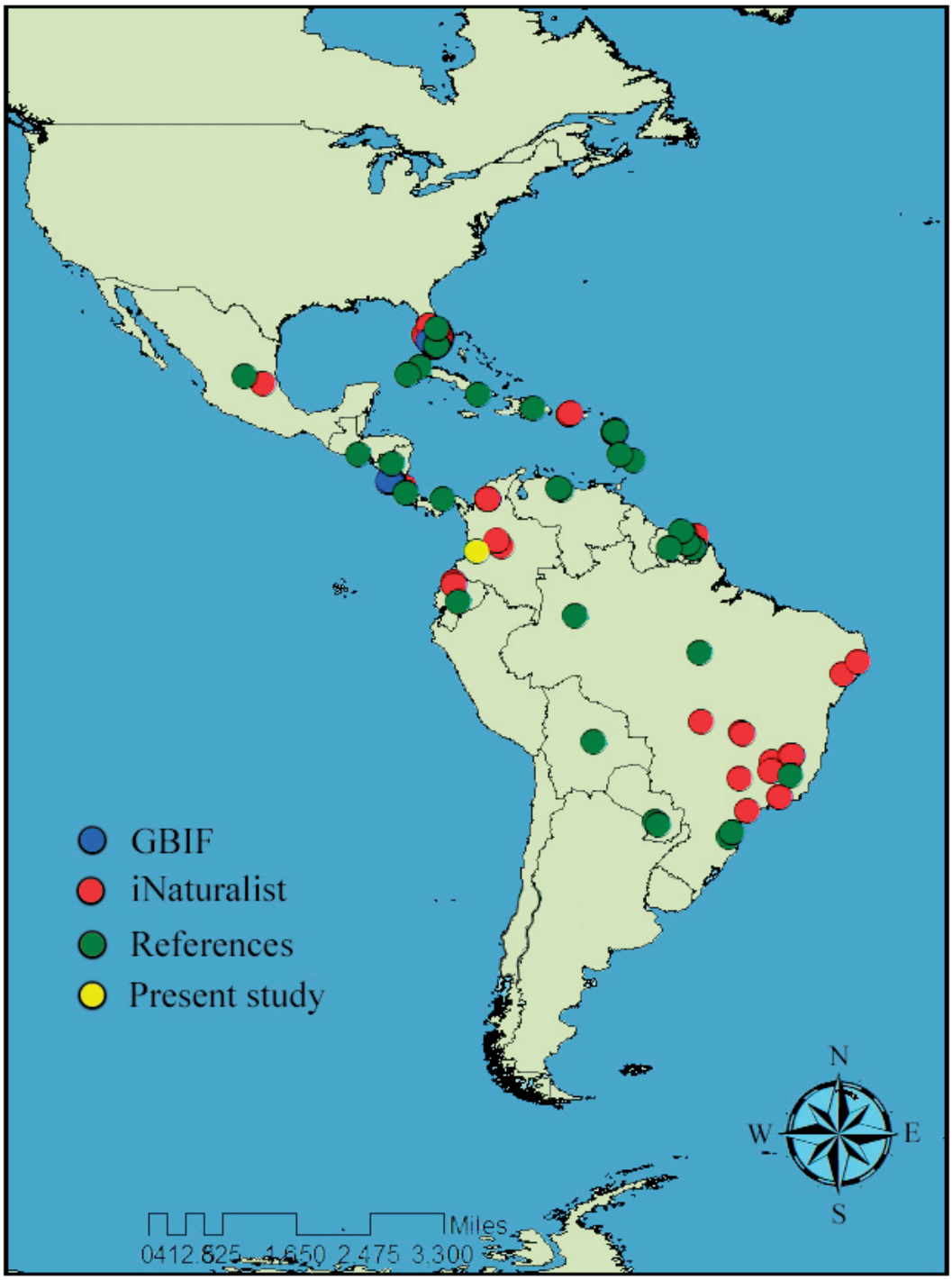

Figure 5. Distribution map of *Gonodonta nutrix* in the New World. / **Figura 5.** Mapa de distribución de *Gonodonta nutrix* en el Nuevo Mundo.

Conclusions

To date, 11 species of *Gonodonta* have been reported in Colombia: *G. biarmata biarmata* Guenée, 1852, *G. bidens miranda* Raymundo, 1908, *G. correcta* Walker, 1857, *G. fulvangula* Geyer, 1832, *G. fulvidens* Felder and Rogenhofer, 1874, *G. holosericea* Guenée, 1852, *G. latimacula* Guenée, 1852, *G. lincus* Cramer, 1775, *G. primulina* Druce, 1887, *G. pyrgo*, and *G. sinaldus* Guenée, 1852 (Thöny and Piñas 2015). Among these, *G. pyrgo* was previously the only species of the genus associated with *Annona* spp. in Colombia (Pinzón-García *et al*. 2016).

We could not find any previous records of *G. nutrix* in Colombia, and it is not listed in the recent field guide of Colombian moths by Bernal and Martínez (2024). Therefore, we consider this the first written report of *G. nutrix* in Colombia. Both the larvae and adults of this species can damage fruit crops.

Gonodonta nutrix is present in several South American countries, including Colombia and its neighbors, but it has not been reported in Argentina, Chile, Guyana, Peru, or Uruguay. Future research is necessary to accurately assess the duration of the egg stage (from oviposition) and to identify natural enemies that might regulate populations of *G. nutrix*. Additionally, understanding the role of braconid wasps in controlling this species in the field could inform their potential use for biological control in management programs.

Acknowledgments

The authors thank the Corporación Colombiana de Investigación Agropecuaria – Agrosavia for the partial financial support of this study. Many thanks to Diana Carolina Arias-Pena (Unaffiliated Entomologist, Bogotá, Cundinamarca, Colombia) for confirming the identification of the braconid wasp. To the Universidad Nacional de Colombia for the logistic support for the braconid identification. Special thanks to Penny J. Gullan (Australian National University, Canberra, Australia) and to Daniel Carrillo (Department of Entomology and Nematology, University of Florida – IFAS, Homestead, Florida, USA) for reviewing the manuscript. Thanks to Hubert Thöny (Reserva Serra Bonita, Camacan, Bahia, Brazil) for confirming the identification of *Gonodonta* species. Thanks to Leidy Paola Moreno Caicedo (Master Researcher, Agrosavia) for providing access to the soursop orchard and information on the agronomic management of the orchard and to Victor Balanta (Research Assistant, Agrosavia) for support in data collection during the experiments.

Author Contributions

TK: Conceptualization, investigation, methodology, writing - original draft preparation, resources, reviewing and editing, supervision, visualization. **YCP:** Data curation, investigation, reviewing and editing, visualization. **RTV:** Data curation, formal analysis, investigation, methodology, reviewing and editing, visualization. **CES:** Data curation, investigation, writing - review & editing, visualization. **EVVN:** Data curation, investigation, writing - review & editing.

Literature Cited

Agronegocios (2019) Cultivos de guanábana para producción suman casi 5.000 hectáreas. https://www.agronegocios.co/agricultura/cultivos-de-guanabana-para-produccion-suman-casi-5-000-hectareas-2857876. Accessed on: 20 October 2024.

Angeles, N. and Requena, J. (1966) Moth injury of mangoes in Venezuela. *Plant Protection Bulletin F.A.O.*, *14*: 86-87.

Angulo, O.A. and Jana, S.C. (1983) Catalogo crítico, ilustrado y claves de Catocalinae y Ophiderinae para Chile (Lepidoptera: Noctuidae). *Gayana, 45*: 3-26.

Arias-Penna, D.C., Whitfield, J.B., Janzen, D.H., Hallwachs, W., Dyer, L.A., Smith, M.A., Hebert, P.D.N. and Fernández-Triana, J.L. (2019) A species-level taxonomic review and host associations of *Glyptapanteles* (Hymenoptera, Braconidae, Microgastrinae) with an emphasis on 136 new reared species from Costa Rica and Ecuador. *ZooKeys*, *890*: 1-685. https://doi.org/10.3897/zookeys.890.35786.

Bernal, R. and Martínez, B. (2024) *Polillas de Colombia-Guía de campo. Editorial Panamericana*. Formas e impresos, Bogotá, Colombia. 669 pp.

Bruner, S.C., Scaramuzza, L.C. and Otero, A.R. (1945) Catálogo de los insectos que atacan a las plantas económicas de Cuba. *Boletín de la Estación Experimental Agronómica*, *63*: 1-246.

Cochereau, P. (1973) Controle biologique naturel des papillons piqueurs de fruits. *Fruits*, *28*(5): 367-375.

Coria-Téllez, A.V., Montalvo-Gónzalez, E., Yahia, E.M. and Obledo-Vázquez, E.N. (2018) *Annona muricata*: A comprehensive review on its traditional medicinal uses, phytochemicals, pharmacological activities, mechanisms of action and toxicity. *Arabian Journal of Chemistry*, *11*(5): 662-691. https://doi.org/10.1016/j.arabjc.2016.01.004

Chang, P.E.C. (2018) Panama moths: notes on the life history of *Gonodonta incurva* (Sepp, [1840]) (Erebidae, Calpinae). *International Journal of Avian & Wildlife Biology*, *3*(6): 405-407.

ESRI (2011) ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.

Fernandez-Triana, J. (2019) Revision of the North American species of *Promicrogaster* (Hymenoptera, Braconidae, Microgastrinae), with an updated key to all described species in North and Meso America. *Journal of Hymenoptera Research*, *70*: 89-112.

Gajalakshmi, S., Vijayalakshmi, S. and Devi, R.V. (2012) Phytochemical and pharmacological properties of *Annona muricata*: a review. *International Journal of Pharmacy and Pharmaceutical Sciences*, *4*(2): 3-6.

GBIF.org. (2024) GBIF Occurrence download https://www.gbif.org/occurrence/search?q=gonodonta%20nutrix. Accessed on: 20 July 2024.

Gordh, G. and Hall, J.C. (1979) A critical point drier used as a method of mounting insects from alcohol. *Entomological News*, *90*(1): 57-59.

Henderson, P.A. (2021) Southwood's ecological methods. Oxford University Press. 528 pp.

Hernández Fuentes, L.M., Valdez Carrasco, J.M., Urías López, M.A. and Gómez Jaimes, R. (2015) Identification, damage and population fluctuation of *Gonodonta pyrgo* (Lepidoptera: Noctuidae) in *Annona muricata*. *Revista Mexicana de Ciencias Agrícolas*, *6*(5): 1001-1012.

iNaturalist (2024) Citrus Fruitpiercer (*Gonodonta nutrix*). Observations available from: https://www.inaturalist.org/observations?taxon_id=334074. Accessed on: 20 July 2024.

King, J.R. and Thompson, W.L. (1958) Fruit piercing moth, *Gonodonta nutrix* (Cramer), attacks oranges in Florida. *Florida Entomologist*, *41*(2): 61-65.

Kirti, J.S. Dar, M.A. (2013) Keys for the identification and segregation of noctuid subfamilies. *Insect Environment*, *19*(3): 176-179.

Kobayashi, S., Kondo, T., Rojas, D.A. and Kobayashi, N. (2023) *Verduras y frutas para todos: enciclopedia didáctica y visual*. Corporación Colombiana de Investigación Agropecuaria -AGROSAVIA, Colombia. 569 pp. https://doi.org/10.21930/agrosavia.nbook.7406368

León-Finalé, G. and Barro, A. (2014) Immature stages and life cycle of the wasp moth, Cosmosoma auge (Lepidoptera: Erebidae: Arctiinae) under laboratory conditions. *Psyche: A Journal of Entomology*, *2014*(1): 328030. http://dx.doi.org/10.1155/2014/328030

Leroy, L., Mille, C. and Fogliani, B. (2021) The common fruit-piercing moth in the Pacific region: a survey of the current state of a significant worldwide economic pest, *Eudocima phalonia* (Lepidoptera: Erebidae), with a focus on New Caledonia. *Insects*, *12*(2): 117. https://doi.org/10.3390/insects12020117

Morton, J.F. (1987) Soursop. Pp. 75–80. *In*: Fruits of warm climates NewCROP, New Crop Resource Online Program, Center for New Crops & Plant Products, Purdue University.

Peña, E.J. and Bennett, F.D. (1995) Arthropods associated with *Annona* spp. in the neotropics. *Florida Entomologist*, *78*(2): 329-349.

Peña, J.E. and Crane, J.H. (2006) Insect/mite management in *Annona* spp. ENY-834 (IG166), Department of Entomology and Nematology, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Florida, USA. https://doi.org/10.32473/edis-ig166-2006

Perez-Gelabert, D.E. (2015) Entomofauna de la Reserva Científica Ébano Verde, Cordillera Central, República Dominicana. *Novitates Caribaea*, *8*: 61-81.

Pinzón-García, J.M., Hernández-Fuentes, L.M., Luna-Esquivel, G., Isiordia-Aquino, N. and Ortiz-Catón, M. (2016) Biología y hábitos de *Gonodonta pyrgo* Cramer en *Annona muricata*. *Southwestern Entomologist*, *41*(1): 251-258. https://doi.org/10.3958/059.041.0122

Richards, O.W., Waloff, N. and Spradbery, J.P. (1960) The measurement of mortality in an insect population in which recruitment and mortality widely overlap. *Oikos*, *11*(2): 306-310.

Roque-Albelo, L. and Landry, B. (2016) CDF Checklist of Galapagos Butterflies and Moths. Charles Darwin Research Station, Puerto Ayora, Ecuador, 32 pp. Available at: https://datazone.darwinfoundation.org/en/checklist/?species=7211. Accessed on: 24 July 2024.

Santos, I.L., Rodrigues, A.M.D.C., Amante, E.R. and Silva, L.H.M.D. (2023) Soursop (*Annona muricata*) properties and perspectives for integral valorization. *Foods*, *12*(7): 1-20. https://doi.org/10.3390/foods12071448

Silva, J.F., Alvarenga, C.D., Giustolin, T.A. and Sa, L.P. (2017) *Gonodonta* species (Lepidoptera: Erebidae) defoliating sugar apple and *Atemoya* fruits in the semiarid region of Minas Gerais. *Revista Brasileira de Fruticultura*, *39*: 1-3. https://doi.org/10.1590/0100-29452017370

Silvain, J.-F. and Lalanne-Cassou, B. (1986) Liste preliminaire des Lépidoptères Noctuidae de Guyane française. Centre ORS-TOM-Cayenne. INRA. Antilles-Guyane et Muséum National d'histoire naturelle.

Thöny, H. and Piñas, F. (2015) Remarks, corrections, comments and additions to Vol. 23 and 25 of the 'Mariposas del Ecuador' on the genus *Gonodonta* Hübner, 1818 (Noctuoidea, Erebidae, Ophiderinae). *Tropical Lepidoptera Research*, *25*(1): 15-21.

Todd, E.L. (1959) *The fruit-piercing moths of the genus* Gonodonta *Hübner (Lepidoptera, Noctuidae).* Technical bulletin No. 1201. US Department of Agriculture. Washington, D.C., USA. 69 pp.

Touroult, J,. Poirier, E. and Jourdan, T. (2021) Inventaire entomologique de la Réserve Biologique Dirigée Nord Grande Terre, Guadeloupe, 2020. *Rapport de la Société entomologique Antilles-Guyane*, *2*: 1-34.

Triplehorn, C.A. and Johnson, N. (2005) Borror and DeLong´s introduction to the study of insects. Seventh Edition. Thomson Brooks/Cole, Belmont, USA. 864 pp.

Upton, M.S. and Mantle, B.L. (1991) *Methods for Collecting, Preserving and Studying Insects*. Miscellaneous Publication, Australian Entomological Society, Brisbane, Australia. 86 pp.

Vázquez, E., Camaño, F., Silvi, J. and Roca, A. (2003) La tabla de vida: una técnica para resumir la mortalidad y la sobrevivencia. *Boletín Epidemiol/OPS*, *24*: 6-10.

Vázquez, Y.M., Martínez, A.M., Valdez, J.-M., Figueroa, J.I., Rebollar, Á., Chavarrieta, J.M., Sánchez, J.A., Viñuela, E. and Pineda, S. (2014) Life history, diagnosis, and parasitoids of *Zale phaeograpta* (Lepidoptera: Erebidae). *Annals of the Entomological Society of America*, *107*(1): 170-177. https://doi.org/10.1603/an13093

Veeranna, R. (2020) Biology of bihar hairy caterpillar, *Spilarctia obliqua* Walker (Erebidae: Lepidoptera) underlaboratory condition on sunflower. *Journal of Farm Sciences*, *33*(02): 284-287. https://doi.org/10.61475/jfm.v33i02.274

Wharton, R.A., Marsh, P.M. and Sharkey, M.J. (1997) *Manual of the New World genera of the family Braconidae (Hymenoptera)*. The International Society of Hymenopterists, Washington D.C., USA. 439 pp.

Whitfield, J., Benzing, A. and Ponce, F. (2002) Review of the *Glyptapanteles* species (Hymenoptera, Braconidae, Microgastrinae) attacking noctuids in field crops in the Neotropical region, with descriptions of two new species from the Ecuadorian Andes. *Journal of Hymenoptera Research*, *11*(1): 152-165.

Zaspel, J.M. and Branham, M.A. (2008) World checklist of tribe Calpini (Lepidoptera: Noctuidae: Calpinae). *Insecta Mundi*, *47*: 1-15.

Zaspel, J.M., Weller, S.J. and Branham, M.A. (2011) A comparative survey of proboscis morphology and associated structures in fruit-piercing, tear-feeding, and blood-feeding moths in Calpinae (Lepidoptera: Erebidae). *Zoomorphology*, *130*(3): 203-225. https://doi.org/10.1007/s00435-011-0132-1.