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Construction of the nest of *Amazilia rutila* De Lattre (Trochillidae) and its anti- predatory defensive strategy in a medium deciduous forest in Campeche, Mexico

Introduction

The construction of nests by birds is a natural behavior, its size and composition varies depending on the species, and the selection of materials is opportunistic (Deeming, Mainwaring, 2015). In some cases, birds select fresh leaves of plants that have antimicrobial properties or that allow the abatement of ectoparasites in their nests (Dubiec, Mazgajski, 2013). As for the selection of habitats, birds that nest in the soil to achieve reproductive success tend to look for sites with heterogeneous vegetation and dense foliage, which also helps them counteract predation (Martin et al., 1997). But nests with reproductive success depend on factors such as the availability of food and the presence of other individuals of the same species (Danchin et al., 2004).

In the case of hummingbirds, reproductive success can be affected by the isolation and fragmentation of vegetation, resulting in the reduction of their populations (Feinsinger et al., 1987). However, predation in nests is common in ecosystems, being the main factors that cause reproductive failure, affecting population density and affecting abundance at the community level (Angelstam, 1986; Martin, 1988; Buler, Hamilton, 2000; Jokimäki, Huhta, 2000). In this sense, hummingbirds are used as indicator species of disturbance in tropical ecosystems; for example, in the Yucatan Peninsula (YP), Mexico, the diversity of hummingbirds is related to a greater abundance of tree species (Navarro et al., 2016). In the YP there are 12 species of hummingbirds, among these the cinnamon hummingbird *Amazilia rutila* De Lattre (Trochillidae), which is distributed in the Pacific slope from the northeast of Mexico to Costa Rica and the Atlantic slope in the portion north and east of the YP and in Belize; this species is found from tropical forests, urban areas, bushes to savannas (BirdLife International,

2016). In the Official Mexican Standard (DOF-2010) and the BirdLife International (2016) it is categorised as Least Concern (LC).

In general, hummingbirds are considered as flags because of their diversification of plumage colours and flight capabilities (Sánchez-Jasso, Cebrián-Abellán, 2015; Medina- van Berkum et al., 2016), these species function as symbols to attract governmental and non-governmental support, as well as a flag for the implementation of conservation programs (Noss, 1990; Andelman, Fagan, 2000; Carignan, Villard, 2002; Caro et al., 2004; Isasi-Catalá, 2011). With the aim of contributing to the knowledge of the biology and reproductive strategies of *A. rutila*, the architecture, dimensions and vegetative materials of plants used for the construction of their nests and the hosts used as possible adaptations to counteract predation are described.

Material and methods

Study area

The first nest of *Amazilia rutila* was located in the Native Flora Conservation Unit of the Yucatan Peninsula (NFCUYP) at the Instituto Tecnológico de Chiná in Campeche, Mexico (19°46′10.44″ N, 90°30′16.24″ W) (Cetzal-Ix et al., 2017) (Fig. 1–2). The second nest was located at the residential farms Cholul (RFC), Campeche, Mexico (19°42′56.44″ N, 90°23′6.59″ W) 14.3 km southeast of the NFCUYP in Chiná, Campeche, Mexico (Fig. 3). Both sites have medium deciduous forest (Pérez et al., 2017) with a sub humid warm climate (Aw) and an annual precipitation of 1141 mm (García, 1988). However, RFC site has a vegetation disturbed by agriculture and livestock, restricted to agro-crops, citrus and pasture (Fig. 2–3).

Observations and identification of materials for the construction of the nest

Observations of behavioral activities in the hummingbird nests were made at time intervals of 12 to 23 minutes during each hour, between 8:00 a.m. to 1:00 p.m. (diurnal) and 8:00 p.m. to 12:00 p.m. (nocturnal) during 16 days, of 14 from March to April 1, 2019. The characterisation of the nests was made according to Hansell (2000) and with a millimeter precision Vernier. In the Laboratory of Agroecosystems and Conservation of Biodiversity, the identification of the host plants and the materials used for the construction of the nest was made, through specialised literature and illustrated guides of flora of the Yucatan Peninsula (Yucatán) (Carnevali et al., 2010; Cetzal-Ix et al., 2017).

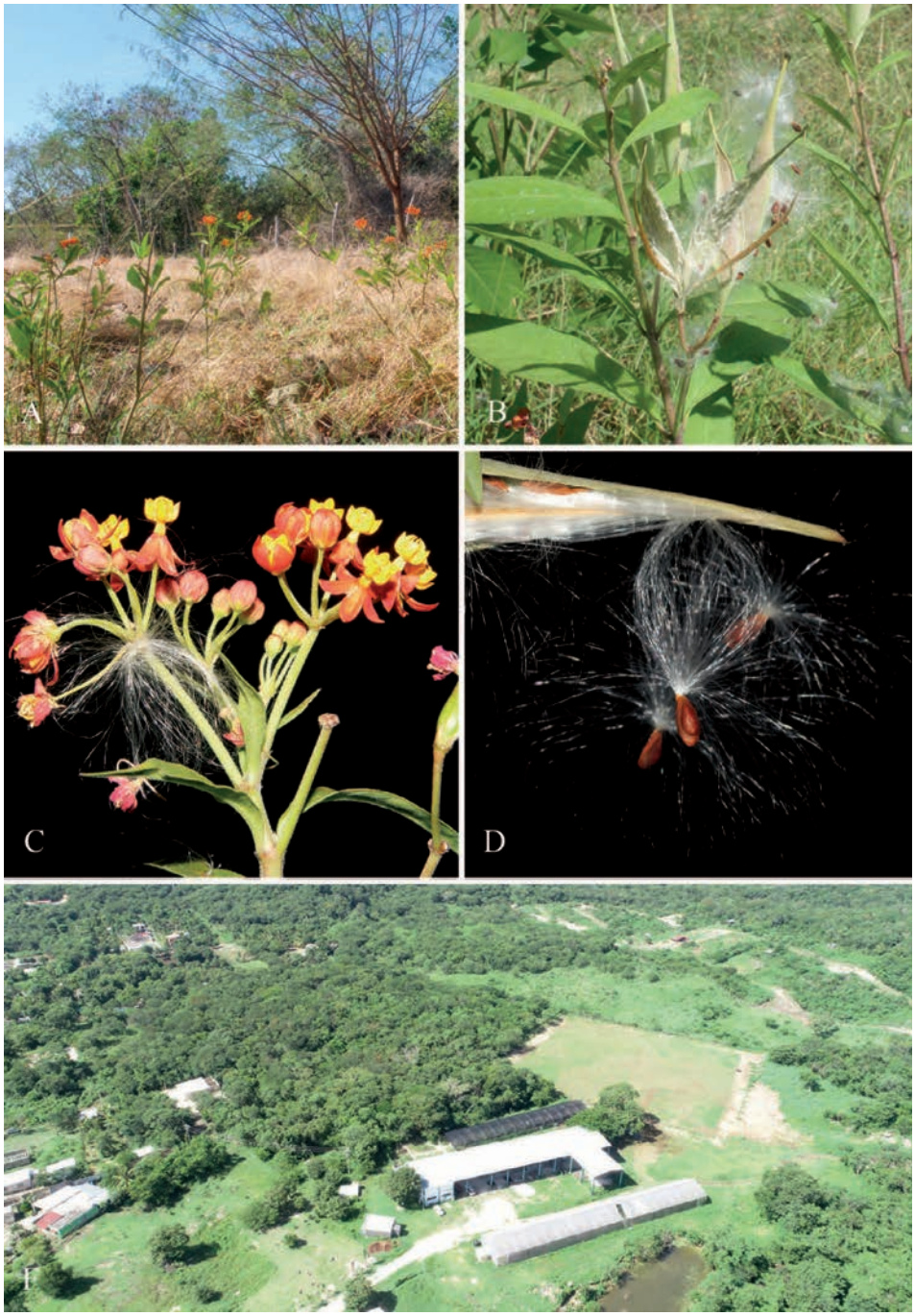

Fig. 1. Plant material for nest and study area: A – *Asclepias curassavica* L.; B – seeds; C – flowers and seeds; D – pappus with seeds; E – Native Flora Conservation Unit of the Yucatan Peninsula (NFCUYP) at the Instituto Tecnológico de Chiná in Campeche, Mexico (Photo. W. Cetzal-Ix)

Results and discussion

The nest of hummingbird located in the NFCUYP presented a female of *A. rutila* with two eggs, one hatched (and the brood was not found) and the other did not hatch after 16 days of observation, due to the abandonment of the adult female (Fig. 1). On the other hand, the hummingbird nest located in RFC presented an adult individual and a juvenile chick. Regarding the sizes of nest, both presented a concave cup-shaped symmetric shape, but differed in their sizes (Fig. 3); the NFCUYP nest has an external length of 61.27 mm, a cup diameter of 24.62 mm, an internal diameter of 23 × 23 mm and a depth of 19.76 mm. The RFC nest had an external length of 52.49 mm, a cup diameter of 40.89 mm, an internal diameter of 23.37 × 26.07 mm and a depth of 27.94 mm.

The main vegetative material identified for the construction of the nests in both locations, were made from pappus from *Asclepias curassavica* L. (Apocynaceae) (Fig. 2A–D). The pappus is a thin and cottony filament that possesses the seeds for the dispersion (Toro, Briones, 1995). Approximately between 10 and 14 m away from the host plants of the nests, respectively, *A. curassavica* was observed growing as a herbaceous from 0.5 to 1 m in height, in disturbed sites and without vegetation. In addition, we observed in both nests the presence of lichens in the lateral parts of the same and covered with cobweb, which gives them greater rigidity and support. The web possibly belongs to *Peucetia viridans* Hentz, which was registered in the same host plants, in both sites (Fig. 1E).

In the NFCUYP, the identified plant-host where the hummingbird nest was found was Chaya bush *Cnidoscolus acotinifolius* (Mill.) I.M. Johnst. (Euphorbiaceae), known in the YP as "Chaya de monte" which are shrubs with abundant white latex, trichomes in the form of sharp hairs and thorns (Fig. 1). This species is native to the YP and is widely distributed in the northern portion of the region, mainly in deciduous and medium-sized sub-deciduous forest (Carnevali et al., 2010). The nest in the host plant was found 1.45 m above the ground, at 37.76 mm in diameter of the main branch, 12.50 mm in diameter of the support branch, placed 10 branches of the host plant, 45 cm away from the stem of the host plant; the percentage of coverage of the leaves that provide the nest was 80% and with a percentage of 70% visibility, based on the criteria of observations indicated by Ralph et al. (1996). Stinging trichomes and the latex that possesses *C. acotinifolius* have been reported to act as defensive mechanisms for the plant (Torres-González, García-Guzmán, 2014). In this sense, they can also represent a defense and protection mechanism for the nests of *A. rutila*, particularly during periods of drought (January to May) when the greatest loss of leaves (40–60%) occurs in the low and medium deciduous and sub caducifolious forests, respectively.

The nest registered in RFC, was found in a mango tree *Mangifera indica* L., a species cultivated and used for agriculture in tropical areas, the nest was observed at

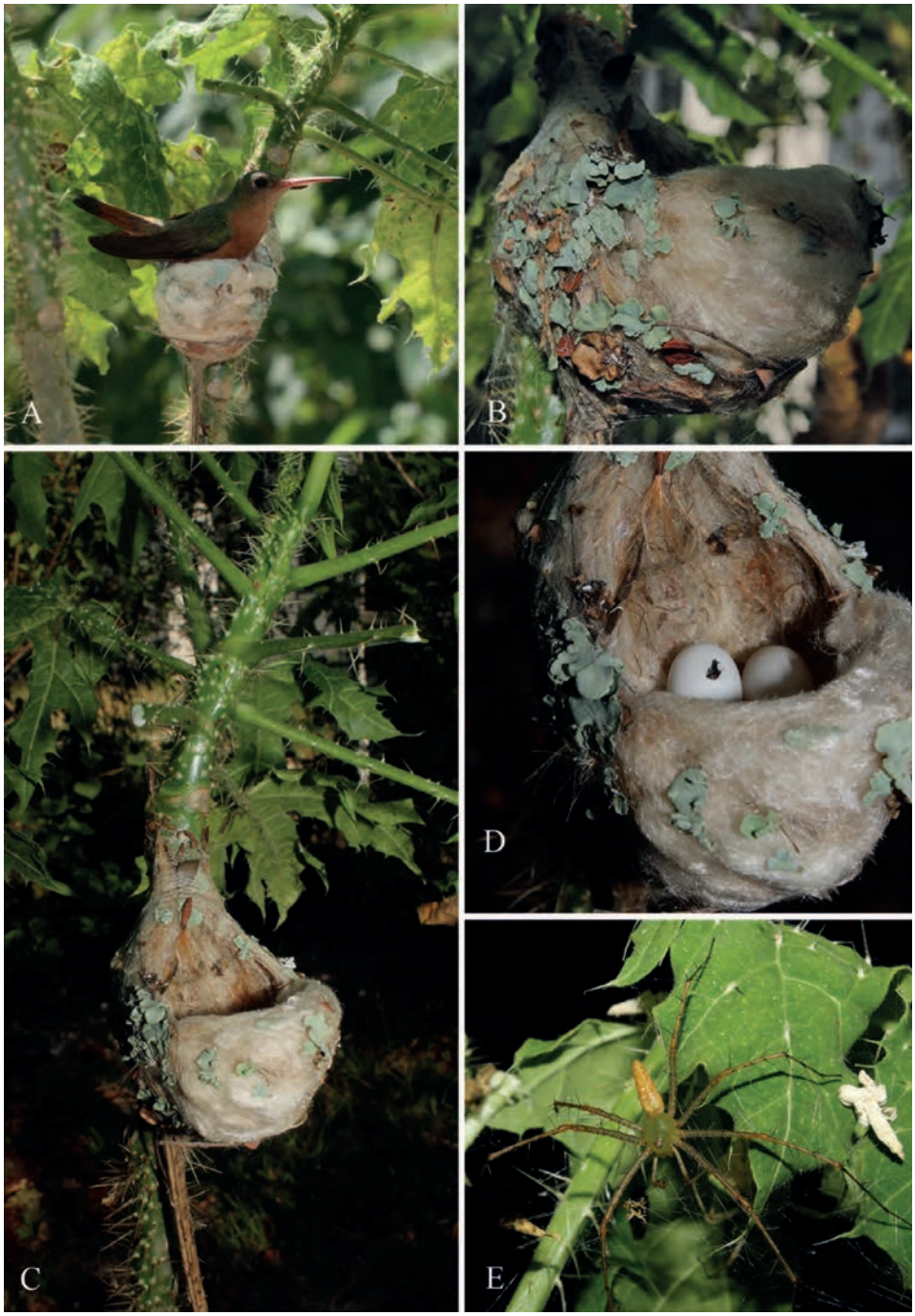

Fig. 2. Cinnamon hummingbird and host plant: A – *Amazilia rutila* De Lattre in nest; B – nest, C – nest in *Cnidoscolus aconitifolius* (Mill.) I.M. Johnst.; D – nest eggs; E – *Peucetia viridans* Hentz in *C. aconitifolius* (Photo. H.M.J. López-Castilla)

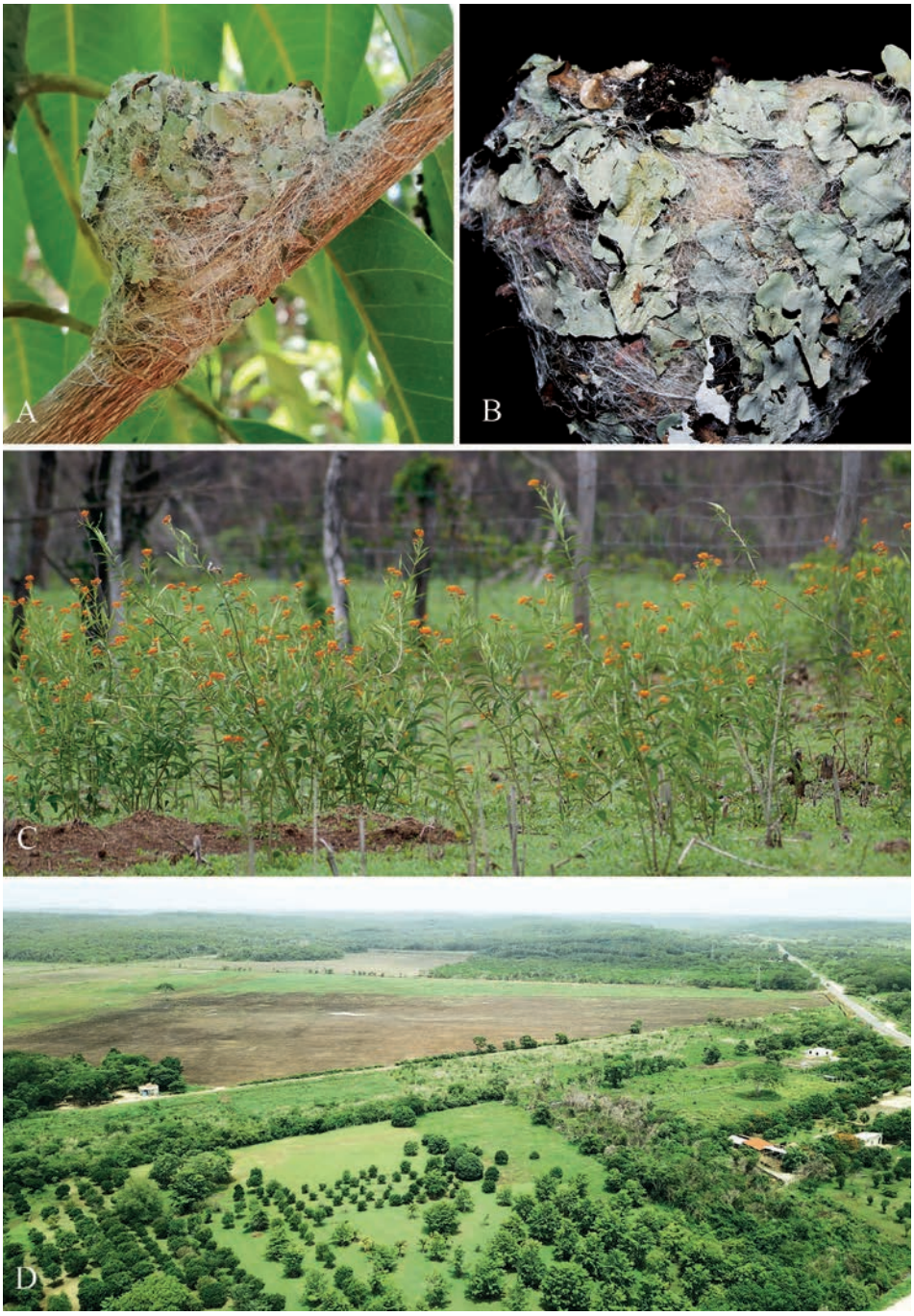

Fig. 3. Nest and study area: A – nest on *Mangifera indica* L.; B – nest with lichen and cobwebs; C – plants of *Asclepias curassavica* L. near the nest; D – Residential farms Cholul (RFC) in Chiná, Campeche, Mexico (Photo. H.M.J. López-Castilla)

1.70 meters from the ground, at 37.76 mm in diameter of the main branch, 12.50 mm in diameter of the support branch, placed 10 branches of the host plant, 45 cm away from the stem of the host plant; the percentage of coverage of the leaves that provide the nest was 80% and with a percentage of 70% visibility. The mango tree is widely cultivated in the YP and they do not lose their foliage during the seasons of the year, therefore, they do not expose the hummingbird nests. These dimensions and data on host plants can be considered for further studies on nesting patterns in hummingbirds.

Different species of birds use a wide variety of materials for the construction of their nests, from dry grasses (Mainwaring et al., 2014) or dry leaves of *Pinus patula* Schltdl. & Cham. (Pinaceae) (Morales-Rozo et al., 2009) to cigarette butts in urban species as *Haemorhous mexicanus* Müll. and *Passer domesticus* L. (Suárez- Rodríguez et al., 2013). In some hummingbirds, recorded is the use of branches and dry leaves of *Calea urticifolia* (Mill.) DC. (Asteraceae) for the construction of the nest (Ortiz-Pulido et al., 1998), which are decorated with lichens of the genus *Parmotrema* sp. (García, Botero, 2013) or mosses such as *Ancistrodes genuflexa* (C. Müll.) Cros. and *Weymouthia cochlearifolia* (Schwägr.) Dixon (Meteoriaceae) (Torres-Dowdall et al., 2007). Generally, the materials used for the construction of the nest are adhered with cobwebs (Ortiz-Pulido et al., 1998; García, Botero, 2013). Although plant materials for nest construction are described in some bird species, information on various groups of birds is still scarce (Deeming, Mainwaring, 2015; Biddle et al., 2018; Wesołowski, Wierzcholska, 2018). As well as the identity of the plant species used and if they are selected for some function in the nest, as for example by their antimicrobial properties to counteract ectoparasites (Dubiec, Mazgajski, 2013). For example, in *Amazilia violiceps* Gould we reported the use of dry branches of plants (not determined species plants) for the construction of the outer part of the nest and whitish fibers of the fruit of *Ceiba aesculifolia* (Kunth) Britt. & Baker f. tree for the inner part of the nest; interwoven with cobwebs of possibly *Nephila* sp. (DeSucre-Medrano et al., 2016).

On the other hand, *Amazilia cyanocephala* Lesson records the use of small grasses, small pieces of leaves and flowers of *Mimosa* sp.; likewise, scales of the stems of the fern *Alsophila firma* (Baker) D.S. Conant, *Cyathea bicrenata* Liebm. and *Cyathea* aff. *fulva*) (Cyatheaceae); seeds of *Tillandsia deppeana* Steud. (Bromeliaceae) and horse hairs. The nests are decorated with pieces of liverworts *Calypogeia* spp. (Calypogeiaceae) and adhered with the cobweb of *Peucetia viridans* (Ornelas-Rodríguez, 2010). This same species of spider was identified in *Amazilia rutila*, with which it also adheres the materials to the nest. Previous studies identified as host plants of hummingbird nests species represent species like *Phyllostachys* Siebold & Zucc. (Poaceae) (Ornelas-Rodríguez, 2010), *Heliocarpus terebinthinaceus* (DC.) Hochr. (Malyaceae) (DeSucre-Medrano et al., 2016) and *Citrus limon* (L.) Osbeck (Rutaceae) (García, Botero, 2013). The knowledge of nesting species of the genus *Amazilia* is far from complete

(Ornelas-Rodríguez, 1995). Although *A. rutila* is permanently resident in the YP, its reproductive habits, composition and structure of its nests have not yet been fully studied.

Conclusion

The cinnamon hummingbird individuals located at the two sites of Campeche were selective-opportunistic with the vegetative materials used for the construction of their nests, because they collect plants that are close to where they establish their nests within their habitat. On the other hand, they select exclusively the pappus from the seeds of *Asclepias curassavica* for the construction of the nest walls, and provide rigidity and support with lichen and cobwebs of *Peucetia viridans* that are also living in the same host plant. The selection of the host plant occurs selectively and opportunistically for periods of drought when the eggs in the nests are mostly exposed to predation. The location of materials for the construction of the nest and host plants can help understand the composition and architecture of nests for the survival of tropical bird species.

Conflict of interest

The authors declare no conflict of interest related to this article.

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Abstract

The Yucatan peninsula (YP) is part of a biogeographical area characterised by its diversity of flora and fauna, among which are the birds, mainly hummingbirds, which are indicators of the state of conservation of the ecosystems. In birds, the site establishment and construction of nest plays a fundamental role for reproduction and survival rate, the selection of materials occurs opportunistically, but birds tend to use fresh leaves of plants with antimicrobial properties or that allow the depletion of ectoparasites in their nests. In this sense, for the first time we recorded for the cinnamon hummingbird (*Amazilia rutila* De Lattre), the materials used for the construction of its nest and the site of establishment of the nest in the host plants in two sites of a medium sub-deciduous forest in, Mexico. We recorded the construction of nests of *A. rutila* in two locations in Campeche; in the first site the nest was found in a chaya bush *Cnidoscolus aconitifolius* (Mill.) I.M. Johnst. (Euphorbiaceae); most possibly as an anti-predatory strategy for trichomes in the form of sharp hairs and spines that the plants possess in their stems and leaves. In the second site, the nest was found in a mango tree *Mangifera indica* L. (Anacardiaceae). The main vegetative material identified for the construction of the nests in both locations, were made from *pappus* (thin and cottony filament that possess the seeds for the dispersion) from *Asclepias curassavica* L. (Apocynaceae).

Key words: *Asclepias curassavica*, *Cnidoscolus aconitifolius*, hummingbird, *Mangifera indica*, Yucatan peninsula

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Budowa gniazda *Amazilia rutila* De Lattre (Trochillidae) i jego anty-drapieżna strategia obronna w lasach liściastych w Campeche w Meksyku

Streszczenie

Półwysep Jukatan (YP) jest częścią obszaru biogeograficznego charakteryzującego się różnorodnością flory i fauny. Wśród fauny licznie występują ptaki, głównie kolibry, będące wskaźnikami stanu zachowania ekosystemów. Dla ptaków zakładanie i budowa gniazda odgrywa podstawową rolę w rozmnażaniu i przeżywalności. Wybór materiałów na gniazda odbywa się oportunistycznie, ale ptaki zwykle używają świeżych liści, o właściwościach przeciwdrobnoustrojowych lub pozwalających na odstraszenie pasożytów zewnętrznych z ich gniazd. W tym kontekście, dla kolibra cynamonowego (*Amazilia rutila* De Lattre) po raz pierwszy opisaliśmy materiały użyte do budowy gniazda oraz miejsce założenia gniazda w roślinach żywicielskich, w dwóch lokalizacjach lasu liściastego w Meksyku. Obserwowaliśmy budowę gniazd *A. rutila* w dwóch lokalizacjach w Campeche. W pierwszym miejscu gniazdo znaleziono w zaroślach Chaya *Cnidoscolus aconitifolius* (Mill.) I.M. Johnst. (Euphorbiaceae); ostre włoski i kolce, które mają rośliny z tego rodzaju na swoich łodygach i liściach, najprawdopodobniej występują tu jako anty-drapieżna strategia dla włosieni. W drugim miejscu gniazdo znaleziono na drzewie mango *Mangifera indica* L. (Anacardiaceae). Główny materiał roślinny zidentyfikowany do budowy gniazd w obu lokalizacjach został wykonany z puchu – *pappus* (cienkiego i bawełnianego filamentu służącego do dyspersji nasion) z *Asclepias curassavica* L. (Apocynaceae).

Słowa kluczowe: *Asclepias curassavica*, *Cnidoscolus aconitifolius*, koliber, *Mangifera indica*, Półwysep Jukatan

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