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Colour morph distribution of the *Gasteracantha cancriformis* (Linnaeus, 1758) in Honduras

Distribución de los patrones de color de la araña orbicular espinosa *Gasteracantha cancriformis* (Linnaeus, 1758) (Arachnida: Araneidae) en Honduras

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Abstract

The colour variation in organisms offers critical insights into phenotypic plasticity and evolutionary processes. The Spiny-backed Orb-weaver Spider *Gasteracantha cancriformis* (Linnaeus, 1758), widely distributed across the Americas, exhibits remarkable colour polymorphism. This study presents the first formal documentation of *G. cancriformis* in Honduras, addressing significant Wallacean shortfalls in Central America. Using citizen science data from iNaturalist and ecological niche modelling, we mapped the distribution of *G. cancriformis* and identified four colour morphs, including a red variant representing a color morph previously unknown to science. In addition, a higher habitat suitability was observed in Honduran rainforests regions. Our findings are congruent with three previously documented Central American morphs, but the discovery of a unique red morph underscores regional diversification.

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This work highlights the value of citizen science platforms for biodiversity research and emphasizes the need for expanded arachnological studies in Central America to elucidate evolutionary drivers of phenotypic diversity in this and other species of spiders.

Keywords: Central America, polychromatism, six-spined spider, Wallacean shortfall.

Resumen

La variación de color en los organismos ofrece información clave sobre la plasticidad fenotípica y los procesos evolutivos. La araña orbicular espinosa *Gasteracantha cancriformis* (Linnaeus, 1758), ampliamente distribuida en el continente americano, exhibe un notable polimorfismo cromático. Este estudio presenta la primera documentación formal de *G. cancriformis* en Honduras, abordando importantes vacíos wallaceanos de información en Centroamérica. Mediante el uso de datos de ciencia ciudadana provenientes de iNaturalist y modelación de nicho ecológico, se cartografió su distribución y se identificaron cuatro morfos de color, incluyendo una nueva variante roja. Además, se observó una mayor idoneidad del hábitat en regiones de bosques lluviosos de Honduras. Nuestros resultados concuerdan con tres morfos previamente documentados para Centroamérica; sin embargo, el hallazgo de un morfo rojo único resalta procesos de diversificación regional. Este trabajo subraya el valor de las plataformas de ciencia ciudadana para la investigación en biodiversidad y enfatiza la necesidad de ampliar los estudios aracnológicos en Centroamérica con el fin de dilucidar los factores evolutivos que impulsan la diversidad fenotípica.

Palabras clave: Centroamérica, policromatismo, araña de seis espinas, déficit wallaceano.

INTRODUCTION

Discrete color variation within populations of a single species represents one of the most conspicuous forms of phenotypic plasticity, as evidenced by the sustained interest it has attracted from researchers over the years (e.g., Svensson & Abbott, 2005; McKinnon & Pierotti, 2010; Salgado-Roa et al., 2024). This phenomenon has been reported across a wide range of organisms, including lizards (Stuart-Fox et al., 2021), birds (Galeotti et al., 2003), and spiders (Salgado-Roa et al., 2024). In some cases, color polymorphism may also vary geographically between populations. For example, Van der Geer (2019) reported that mainland populations of the Polynesian rat *Rattus exulans* (Peale, 1848) in Southeast Asia showed no color polymorphism, whereas island populations exhibited three distinct color patterns.

Variation in colour pattern has been linked to several evolutionary advantages, especially in widely distributed species. For example, different colour morphs of *Timema* spp. walking sticks (Phasmatodea) occupy different substrates (e.g., stem and leaves), reducing the chance of predation (Nosil et al., 2018; Villoutreix et al., 2023). Anderson & Dodson (2014) found that the prey capture rate of colour morphs of the crab spider *Misumenoides formosipes* (Walckenaer, 1837) is correlated with the color of the substrate. However, colour variation does not always present a clear selective advantage. For example, in the Coconut Crab *Birgus lastro* (Leach, 1767), the presence of different colour morphs seems to be more related to a neutral process of evolution, such as genetic drift rather than selective pressures (Caro et al. 2019). Therefore, we still need to improve our understanding of the presence of different colour morphs and the evolutionary processes related to their origin and maintenance.

In spiders, variation in color patterns appears to be common in several taxa, including Araneidae and Theridiidae (e.g., Oxford, 2005; Croucher et al., 2012; Cotoras et al., 2017). Among spiders exhibiting color polymorphism, the spiny-backed orb-weaver *Gasteracantha cancriformis* (Linnaeus, 1758) stands out for presenting at least 20 color morphs across its distribution, which ranges from the southern United States through Central America to South America (Chamberland et al., 2020; Salgado-Roa et al., 2022, 2024). Some of these color morphs appear to be geographically restricted, whereas others—such as the white and yellow morphs are widely distributed, suggesting genetic connectivity among populations or the persistence of ancestral polymorphism (Chamberland et al., 2020; Salgado-Roa et al., 2024). Previous studies suggest that coloration in *G. cancriformis* does not provide an advantage in prey capture, but may function as an aposematic signal directed at visually oriented predators (Gawryszwski & Mota, 2012; Ximenes & Gawryszwski, 2020). In addition, *Gasteracantha* species show a developmental shift in habitat preference: cryptic juveniles occur mainly in shaded habitats, whereas brightly colored adults are typically found in more open environments (Edmunds & Edmunds, 1986). Moreover, another important characteristic that varies among *G. cancriformis* populations is the number of spines on the abdomen. For instance, in some populations specimens have six and eight spines, while in others they can have four spines (Levi 1996). Therefore, the presence of colour morphs and spine variation in the spider *G. cancriformis* may be related to different environmental factors, such as those related to the type of predator.

Gasteracantha cancriformis shows a wide distribution, from the southern United States to northern Argentina, including the Caribbean and the Galápagos (Levi 1996, World Spider Catalog 2026) and has been introduced in Hawai'i (World Spider Catalog 2026). Despite this, the Wallacean shortfall (*sensu* Lomolino 2004) persists for this species, especially for Central America (World Spider Catalog 2026).

Aiming to reduce this gap in knowledge about *G. cancriformis* distribution, we recorded the presence of this species in Honduras for the first time, producing a map with the suitable sites in the country and illustrations of the distribution of its colour morphs.

MATERIALS AND METHODS

Field sampling was carried out in Honduras in April 2023 and from January to August 2024. Sampling was conducted in rainforest habitats and adjacent vegetation types where orb-weaving spiders are commonly found. Surveys were performed during the day between 10:00 and 14:00 h by two researchers using the active search method. Specimens were collected directly by hand or with the aid of forceps while inspecting vegetation and webs.

Collected specimens were preserved in 80% ethanol. The habitus and epigyne of one specimen were photographed using Olympus ZS and Leica M125 stereomicroscopes. The distributional map was prepared using QGIS version 23.22.6.

Specimens were identified using the taxonomic literature for the species, particularly the revision of the genus *Gasteracantha* by Levi (1996). The identification and classification of color morphs followed the criteria proposed by Chamberland et al. (2020) and Salgado-Roa et al. (2022).

The specimens examined are deposited in the arachnological collection of the Instituto Butantan, São Paulo, Brazil (IBSP; curator: A. D. Brescovit), and in the first author's personal collection of arachnids and myriapods located in Santa Ana, Francisco Morazán, Honduras (AMC-R).

In addition to field collections (ca. 8 new records obtained during this study), we compiled occurrence data from the citizen science platform iNaturalist (https://www.inaturalist.org), obtaining more than 500 additional records collected between 2015 and 2026. These records were carefully reviewed, and duplicated observations as well as records with photographs that were not sufficiently clear to confirm the species identity were removed during the data filtering process.

Potential distribution of the species was modeled using MaxEnt (Maximum Entropy Modeling). The model was built using georeferenced occurrence records together with bioclimatic variables commonly used in ecological niche modeling. Climatic variables were obtained from the WorldClim database (version 2.1), including temperature and precipitation variables.

RESULTS

Order Araneae Clerck, 1757
Family Araneidae Clerck, 1757
Genus *Gasteracantha* Sundevall, 1833
Gasteracantha cancriformis (Linnaeus, 1758)

Diagnosis.— Following Levi (1996), the species is characteristic and easily differentiated by the presence of a body bearing six to eight spines (Fig. 1A–B); males are smaller than females (Levi 1996). The female differs from other species of the genus by the epigyne having a posterior median knob in ventral view and a posteriorly separated subtriangular median plate dorsally, joining the knob ventrally (Fig. 1C). Males differ from congeners by the palp having an almost circular median apophysis and a median process bearing a distal knob (see Levi 1996).

Material examined.— Honduras, Bay Islands department. Iguana Station, 16.103341, -86.898954; 30 m.s.n.m, 1♀; April 17, 2024. col. AM Cubas-Rodríguez (AMCR-Ara-101); Atlántida department. Barras de Cuero y Salado Wildlife Refuge, 15.778639029232915, -87.13273774001736; 1 m.s.n.m. 4♀; September 7, 2023. AM Cubas-Rodríguez, in the backyard of a house (AMCR-Ara-102); Francisco Morazán department. Tegucigalpa, “Santa Ana”. 13.929599711837174, -87.27285860596687; 1422 m.s.n.m; 1♀; June

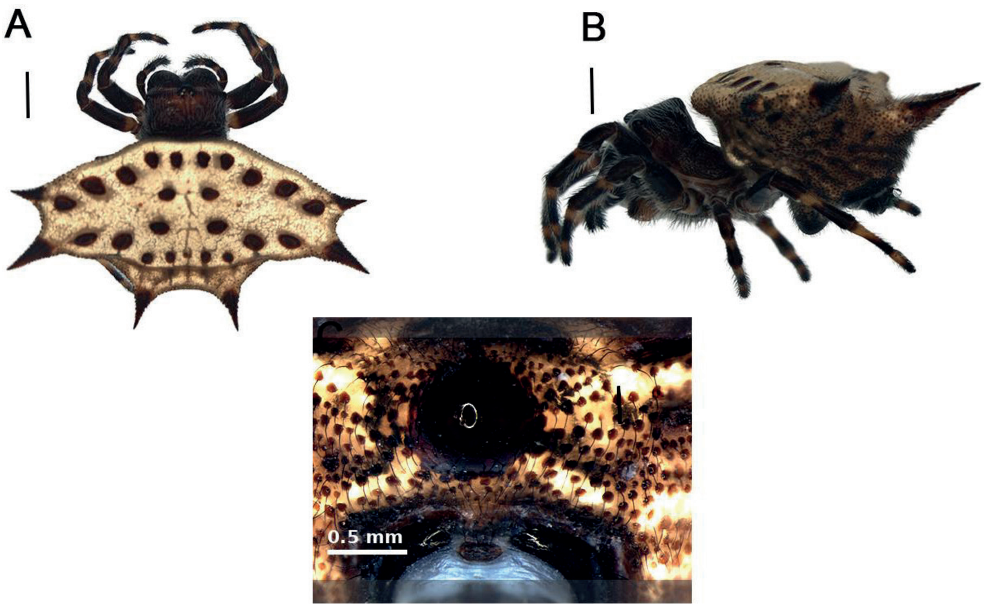

Figure 1. *Gasteracantha cancriformis* (Linnaeus, 1758), female. (A) Habitus, dorsal view. (B) Same specimen, lateral view. (C) Epigynum, ventral view. Scale bars: A–B = 5 mm; C = 0.5 mm.

Figura 1. *Gasteracantha cancriformis* (Linnaeus, 1758), hembra. (A) Hábito, vista dorsal. (B) Mismo ejemplar, vista lateral. (C) Epigino, vista ventral. Escalas: A–B = 5 mm; C = 0,5 mm.

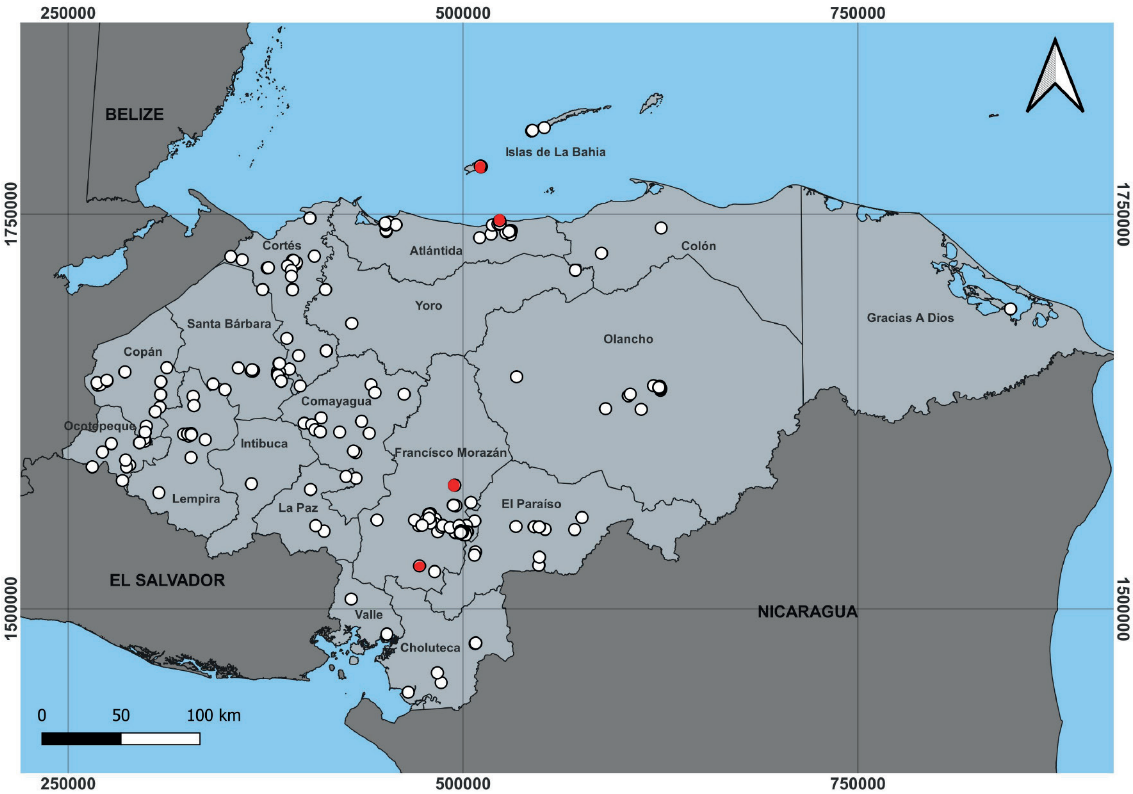

Figure 2. Distribution of *Gasteracantha cancriformis* on Honduras. The red circles represent the material collected; the white circles represent the records extracted from iNaturalist.

Figura 2. Distribución de *Gasteracantha cancriformis* en Honduras. Los círculos rojos representan el material colectado, mientras que los círculos blancos representan los registros extraídos de iNaturalist.

14, 2023, AM Cubas-Rodríguez, in the vegetation surrounding the building (AMCR-Ara-103). 2♀ 1 immature, Campus UNAH, 2020-2021, AM Cubas-Rodríguez col. (IBSP 325862).

Distribution.— North America, Central America, Caribbean, South America, introduced to Hawai'i (World Spider Catalog 2026). In Honduras this species is very common in all departments of the country (Fig. 2).

Colour morphs distributed in Honduras. A total of 559 georeferenced records were compiled for the species in Honduras. Of these, 551 records were obtained from the citizen science platform iNaturalist, while eight records correspond to specimens collected during field surveys conducted in this study. Most of the available records correspond to adult females. Four colour morphs of *Gasteracantha cancriformis* were documented in Honduras (white, yellow, red, and orange) (Fig. 3). The white morph was the most widely distributed, occurring in all 18 departments of the country (100%). The yellow morph was recorded in 15 of the 18 departments (83.3%), being absent only from Gracias a Dios, Intibucá, and La Paz (Fig. 3).

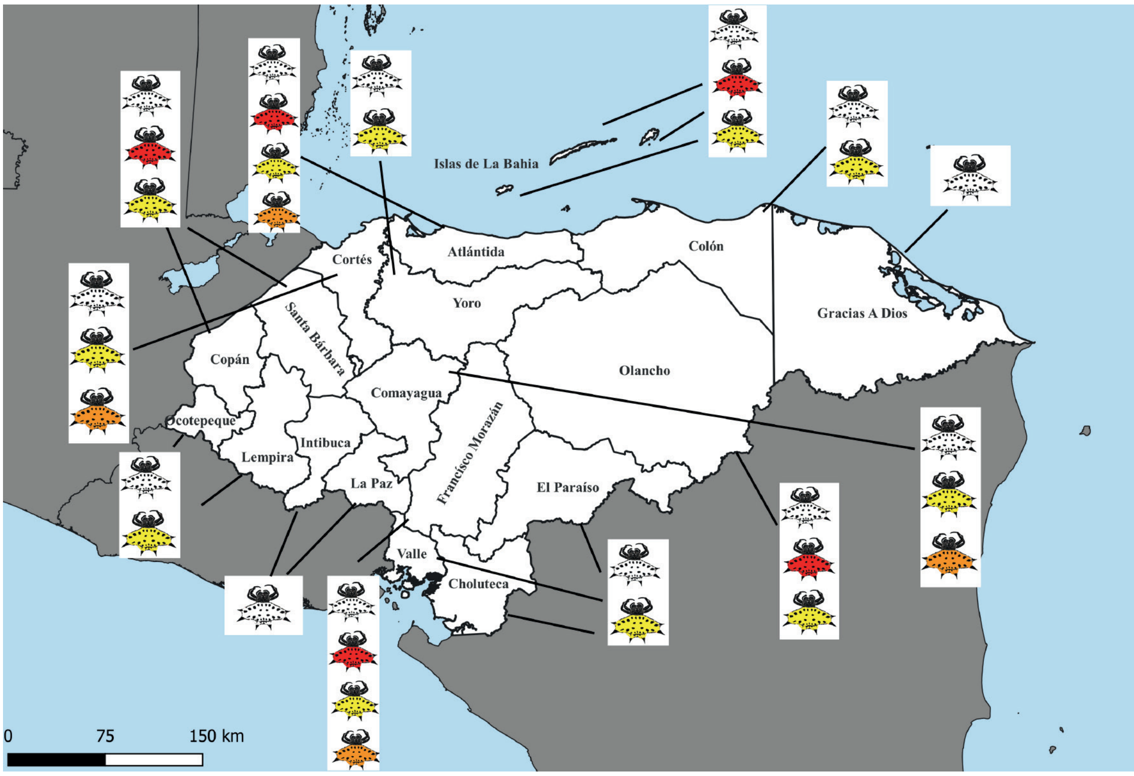

Figure 3. Distribution of *Gasteracantha cancriformis* colour patterns by departments in Honduras.

Figura 3. Presencia de patrones de color de *Gasteracantha cancriformis* encontrados en los departamentos de Honduras.

The MaxEnt model predicted a heterogeneous distribution of habitat suitability for *Gasteracantha cancriformis* across Honduras (Fig. 4). The highest suitability values were concentrated mainly in western and central Honduras, particularly across mountainous areas, with additional areas of high suitability occurring in parts of the southern and northern regions. In contrast, lower suitability was predicted across much of eastern Honduras, especially in the lowland areas. These results provide a spatial representation of the areas with greater potential suitability for *G. cancriformis* in Honduras (Fig. 4).

The red morph was less common and was recorded in six departments (33.3%): Francisco Morazán, Olancho, Islas de la Bahía, Copán, Santa Bárbara, and Atlántida. The orange morph showed the most restricted distribution, occurring in only four departments (22.2%): Francisco Morazán, Comayagua, Atlántida, and Cortés (Fig. 3).

The presence of all four colour morphs was confirmed in only two departments, Francisco Morazán and Atlántida (Fig. 3).

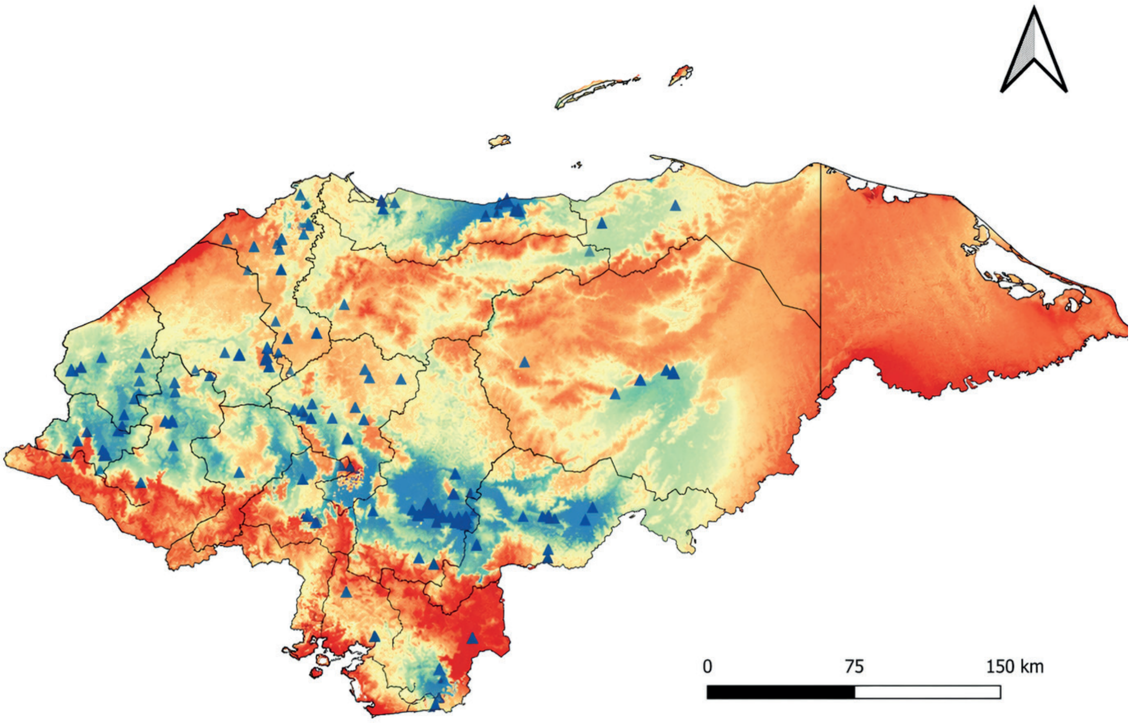

Figure 4. Potential distribution map of *Gasteracantha cancriformis* in Honduras. Colours represent habitat suitability, from low (red) to high (blue, green). Blue triangles indicate presence records used as input for the model.

Figura 4. Mapa de distribución potencial de *Gasteracantha cancriformis* en Honduras. Los colores representan la idoneidad del hábitat, desde baja (rojo) hasta alta (azul, verde). Los triángulos azules indican los registros de presencia utilizados como entrada para el modelo.

DISCUSSION

In this study we assessed the distribution of *G. cancriformis* colour morphs in Honduras. This is the first time that *G. cancriformis* has been recorded in the scientific literature for this country, which is a surprise since it is a species widely distributed across the American continent (Salgado-Roa et al. 2022; World Spider Catalog 2026). This situation is explained by the lack of arachnological studies in Honduras (Cubas-Rodriguez & Brescovit 2024a). Fortunately, on the citizen science platform iNaturalist, there are a large number of observations of *G. cancriformis*. Previous studies have shown that these data can be used as long as the specimens have morphological characteristics that are easy to distinguish (Hazzi & Hormiga 2021; Armas & Cubas-Rodriguez 2023; Cubas-Rodriguez & Brescovit 2024b).

Gasteracantha cancriformis is widely distributed across Honduras, with rainforest habitats representing areas of higher environmental suitability for the species (Fig. 4). Rainforests may benefit an orbweb spider like *G. cancriformis*, due to constant activity of food resources (e.g. flying insects) throughout the year (Hernández-Ortiz et al. 2022; van Dijk et al. 2024), un-

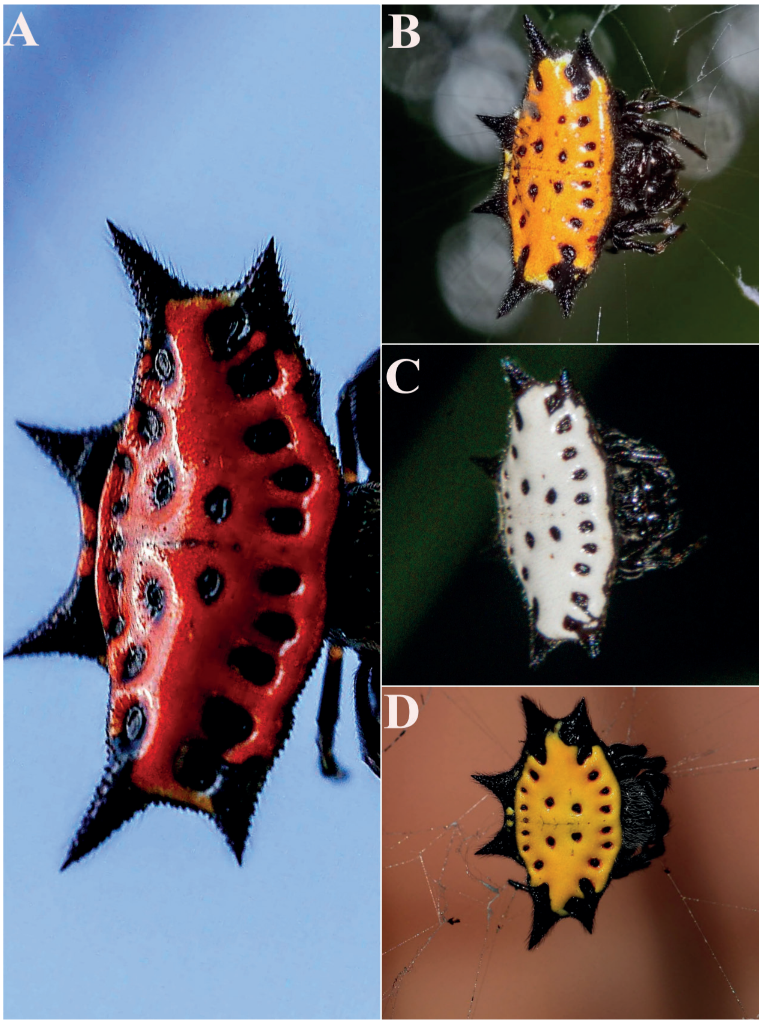

Figure 5. Color pattern variation in *Gasteracantha* orb-weaver spiders from Honduras. (A) Newly recorded colour morph (red form). (B) Orange morph with black spotting. (C) White morph with black spotting. (D) Yellow morph with black spotting. These variations illustrate the intraspecific diversity of dorsal abdominal coloration observed in Honduran populations.

Figura 5. Variación de patrones de color en arañas del género *Gasteracantha* en Honduras. (A) Nuevo morfo de color registrado (forma roja). (B) Morfo naranja con manchas negras. (C) Morfo blanco con manchas negras. (D) Morfo amarillo con manchas negras. Estas variaciones ilustran la diversidad intraespecífica en la coloración dorsal del abdomen observada en poblaciones de Honduras.

like dry forest where the insect activity is markedly seasonal (Silva et al. 2021; Bezerra-Gusmão et al. 2022). However, these results should be interpreted with caution, as our findings indicated low suitability for the department of Gracias a Dios. Therefore, we cannot rule out that the obtained results may have been a reflection of the lack of records for certain regions of Honduras.

Our results indicated the presence of four colour variations of *G. cancriformis* females in Honduras. Despite reports of multiple morphs in Central America, no regionally focused systematic assessment has been conducted to evaluate their distribution and consistency.

Salgado-Roa et al. (2022) documented nearly 20 colour variations across the Americas, including six morphs in Central America. Our findings align with three of the variations reported; however, this study documents a new red colour morph (Fig. 5), primarily found in the Honduran departments of Francisco Morazán, Olancho, Islas de la Bahía, Atlántida, Copán, and Santa Bárbara. To the best of our knowledge, this colour morph has not been recorded in any other country.

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