On the presence of *Cissites maculata* (Coleoptera: Meloidae) in Mexico

Sobre la presencia de *Cissites maculata* (Coleoptera: Meloidae) en México

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**Abstract.** The presumed sympatry and validity of morphological diagnostic characters used to separate the only 2 described species of *Cissites* (Coleoptera: Meloidae), *C. maculata* (Swederus) and *C. auriculata* Champion, are assessed. Morphological diagnostic features between both species (head shape, antennae length, thorax shape, first metatarsal segment length, and elytral coloration) are constant over their entire geographic distribution, without the existence of intermediate morphs. Regional sympatry between these species was found in central Mexico, confirming the presence of *C. maculata* in Central America and Mexico, whereas *C. auriculata*, widely distributed in Central America, has not colonized South America. Sequences of the mitochondrial gene cytochrome oxidase were obtained from single Mexican specimens of each species. Divergence between the sequences is considerably high (14.5%), suggesting separation of both species as a result of an ancient cladogenetic event.

Key words: Nemognathinae, Mexico, South America, sympatry, COI.

**Resumen.** Se investiga la probable simpatría y validez de los caracteres morfológicos diagnósticos empleados para distinguir a las 2 únicas especies de *Cissites* (Coleoptera: Meloidae), *C. maculata* (Swederus) y *C. auriculata* Champion. Los caracteres morfológicos diagnósticos de ambas especies (forma de la cabeza, longitud antenal, forma del tórax, longitud del primer segmento del metatarso y color de élitros) son constantes a lo largo de toda su distribución geográfica, sin existencia de formas intermedias. Se encontró simpatría regional entre ambas especies en el centro de México, confirmando la presencia de *C. maculata* en América Central, mientras que *C. auriculata*, ampliamente distribuida en América Central, no ha colonizado América del Sur. Las secuencias del gen mitocondrial cito-cromoxidasa, obtenidas a partir de un ejemplar mexicano de cada especie, muestran una divergencia considerablemente alta (14.5%), por lo que la separación entre ambas especies sería consecuencia de un evento cladogenético muy antiguo.

Palabras clave: Nemognathinae, México, América del Sur, simpatría, COI.

**Introduction**

Beetles of the subfamily Nemognathinae (Coleoptera: Meloidae) are represented in the Americas by species classified in 2 tribes: Horini and Nemognathini (Pinto and Bologna, 1999). American Nemognathini are represented by about 130 species grouped in 8 genera, whereas the New World fauna of Horini only has 2 species, both in the genus *Cissites* Latreille, 1804: *C. maculata* (Swederus, 1787) and *C. auriculata* Champion, 1892. According to literature, the geographic distribution of the New World species of *Cissites* appears to be mostly parapatric. *Cissites maculata* occurs from northern Argentina and Brazil to Panama and the Antilles (Selander and Bouseman, 1960; Genaro, 1996), with questionable isolated records in Costa Rica, Nicaragua, Mexico (Champion, 1892; Enns, 1958), and southern United States (Champion, 1892; Enns, 1958; Werner et al., 1966). The geographic range of *C. auriculata* extends from Costa Rica to northern Mexico and southern United States (Champion, 1892; Enns, 1958; Maes, 1989; Lewis, 2004; Maes and Huether, 2007; García-París et al. 2007, 2009). Records of *C. auriculata* from the Antilles (Champion, 1892; Leng and Mutchler, 1914; Blackwelder, 1945) require confirmation according to Enns (1958) and Selander and Bouseman (1960). This last species was introduced in Hawaii, apparently without success (Bianchi, 1962; Pinto and Bologna, 1999).

Since the discovery and description of *C. auriculata* (Champion, 1892), all previous records of *C. maculata* (Swederus, 1787) located north of Panama have been questioned or discarded. Rejection of records previous to
Champion (1892) was based in objective reasons, because at that time only *C. maculata* was known, and consequently all subsequently revised material certainly corresponded to *C. auriculata*. This is apparently the case of Dugès’ (1869, 1889) records of *C. maculata* from Colima, which were transferred to *C. auriculata* by Champion (1892). In other cases, however, rejection was made only based on the implicit assumption that both species would not occur sympatrically. As a result, records of *C. maculata* within the geographic area of *C. auriculata* would be treated as erroneously labeled or accidentally introduced (Werner et al., 1966). Such were considered, for example, the Mexican records of *C. maculata* of Champion (1892) from Morelia (Michoacán), or Enns’ (1958) records from Arizona. Those uncertainties led Garcia-Paris et al. (2007) to conclude that *C. maculata* probably had to be excluded from the Mexican fauna of Meloidae. With this large amount of possible erroneous historical identifications or labeling mistakes it is easy to believe that *C. maculata* and *C. auriculata* are easy to confuse with each other; however, despite a common general facies, and considerable sexual and intrapopulational variability, the specific characters reported by Champion (1892) have not been challenged for consistent species identification.

In order to shed light on the geographic distribution and presumable sympathy between *C. maculata* and *C. auriculata*, we revised 2 large series of *Cissites* from Mexico and Venezuela. Our objectives were to determine the validity of morphological diagnostic characters used to separate *C. maculata* and *C. auriculata*, to document the existence of regional sympathy between the 2 taxa in Mexico, and to determine mitochondrial differentiation level between single Mexican specimens of each taxon.

### Materials and methods

Adult specimens of *Cissites* are nowadays difficult to find in the field; most old collections consist of isolated specimens found casually wandering on wood houses (Champion, 1892). Recent collections are mostly made at light, and large series from a given locality are generally unavailable. Fortunately, 2 large series of *Cissites*, including multiple localities, but also a number of specimens from single localities, were available for study in scientific collections. These series are the basis for our work. One series contains 65 specimens from Mexico, which are held at the Colección Nacional de Insectos, Instituto de Biología (CNIN-IBUNAM), and the Estación de Biología de Chamela (EBCH-UNAM), both administrated by the Universidad Nacional Autónoma de México. A second series consists of 171 specimens from Venezuela, Colombia and Peru, held at the collection of the Museo del Instituto de Zoología Agrícola de la Universidad Nacional de Venezuela (Maracay) (MIZA). Five additional specimens from Ecuador, French Guiana, Dominican Republic, and Trinidad and Tobago, were examined in the collection of Marco Bologna at the Università degli Studi, Roma Tre (Italy) (MAB) (Appendix).

External morphology was studied under a stereomicroscope. Habitus and morphological details were photographed with a Nikkon digital camera. For morphological descriptions we follow Enns (1958).

A 658 bp fragment of the cytochrome oxidase I mitochondrial DNA gene, was generated for 2 specimens of *Cissites* following Alcobendas et al. (2008) procedures (HF586634 *C. auriculata* y HF586635 *C. maculata*). These specimens, each morphologically assignable to *C. maculata* and *C. auriculata* following Champion’s (1892) criteria, were obtained from nocturnal inspection of building lights in Estación de Biología de Los Tuxtlas (Veracruz) and Estación de Biología de Chamela (Jalisco) respectively, both administrated by the Instituto de Biología (UNAM). These 2 specimens were the only individuals found after 8 and 3 visits made to Chamela and Los Tuxtlas regions during 3 years and 2 years, respectively (including settings of UV light traps).

### Results

#### Morphological diagnostic characters.

Adult specimens of *Cissites* are easily identified as such among Neotropical and Nearctic Coleoptera based on their characteristic habitus. Large size, buprestoid shape, orange-red coloration spotted with large irregular black dots, large prothorax, large wide head, with oversized black mandibles in males, give to *Cissites* an unmistakably appearance (Figs. 1-4).

According to Champion (1892), the 2 species currently included in *Cissites* are diagnosed by differences in head shape, antennae length, thorax shape, first metatarsal segment length, and to a lesser extent, elytral coloration. Champion’s (1892) description of *C. auriculata* is precise, and allows a readily and accurate identification of specimens of both sexes; however, individual variation is extreme in Mexican samples. This is particularly evident in male head and prothorax shape, which seems to vary in relation to specimen size. Large males of *C. auriculata* show marked bumps in head temples, strong and robust prominent mandibles, and a much more robust and subcylindrical prothorax (Figs. 2, 4). A similar variation pattern occurs within *C. maculata* (Figs. 1, 3), in which larger males present the anterior portion of the pronotum wider than the base, as already indicated by Champion (1892). Specimens with reduced black elytral pattern,
or totally black, were reported amongst normal colored specimens of *C. maculata* (Perty, 1830; Pic, 1929; Betrem, 1932).

Champion’s (1892) diagnostic characters were checked in our examined specimens. The head in *C. maculata* is flattened or broadly depressed frontally, while it is narrowly and more deeply incised in *C. auriculata*. Antennae are comparatively shorter in *C. maculata* than in *C. auriculata*, both in males and females. Thorax strongly transverse (length / width ratio= 0.61, n= 10) and with anterior angles raised in *C. maculata*, while it is less transverse, almost subquadrate (in some specimens it actually looks longer than wide at naked eye) (length / width ratio= 0.76, n= 12) and with anterior angles deflexed in *C. auriculata* (Figs. 3, 4). First metatarsal segment clearly shorter than the following articles together in *C. maculata* (first segment vs. 2 to 4 segments length ratio= 0.68, n= 10), subequal or slightly shorter in *C. auriculata* (first segment vs. 2 to 4 segments length ratio= 0.96, n= 11). Coloration pattern is quite similar in specimens of both species, but

Figure 1. Habitus of selected specimens of *C. maculata*. A, male (Los Tuxtlas, Veracruz, Mexico); B, female (Los Tuxtlas, Veracruz, Mexico); C, specimen showing a color variant (Cerro Aracamuni, T. F. Amazonas, Venezuela).
in *C. maculata* the spots on central areas of the elytra are generally smaller (Figs. 1c, d) disappearing completely in some specimens. In contrast, in *C. auriculata* medial elytral spots are larger, and, following Champion’s (1892) terminology, the antemedial juxta-sutural spots are fused along the suture forming a transverse large black patch (Figs. 2a, c). Individual variation across Champion’s (1892) diagnostic characters is minimal, and allows separation of

**Figure 2.** Habitus of selected specimens of *C. auriculata*. A, male (Playa Azul, Veracruz, Mexico); B, female (Chamela, Jalisco, Mexico); C, male (Valle de Bravo, Estado de México, Mexico).
all specimens into 2 specific groups, which correspond to the species currently accepted.

Sympatry between *Cissites maculata* and *C. auriculata*. All specimens from Colombia, Ecuador, Guyane Française, Peru, Dominican Republic, Trinidad and Tobago, and Venezuela share the diagnostic characters described for *C. maculata*, showing the typical variation reported for the species (Perty, 1830; Champion, 1892). Most of our Mexican specimens examined (51), share the diagnostic features described for *C. auriculata*, encompassing the individual variation already mentioned for the species (Champion, 1892); however, 13 specimens from the state of Veracruz (Los Tuxtlas), and 1 from the state of Puebla (Jicotepec de Juárez) are unambiguously assignable to *C. maculata*, including specimens without the medial elytral dots, like those described by Perty (1830).

The specimen of *C. maculata* from Jicotepec de Juárez is located north from any currently known Mexican continental population of the species, including the questioned records of *C. maculata* from Morelia (Champion, 1892), that Enns (1984), reported erroneously as “Morelos”. Populations of *C. maculata* from Jicotepec de Juárez and Los Tuxtlas are in close proximity to localities where *C. auriculata* is present, including some in Veracruz (Tierra Blanca, Plan

**Figure 3.** Morphological details of *C. maculata* (Los Tuxtlas, Veracruz, Mexico). Male: A, lateral view, head and thorax; B, frontal view, head; C, dorsal view, thorax and head. Female: D, lateral view, head and thorax; E, frontal view, head; F, dorsal view, thorax and head.
del Río), and more distantly, in Puebla (Tehuacán). In any case, Jicotepec de Juárez and Los Tuxtlas are deeply nested inside the geographic range of *C. auriculata*. Consequently, the implicit hypothesis of lack of sympatry between *C. maculata* and *C. auriculata*, used to question former localities of *C. maculata* located north of Panamá, should be disregarded. We therefore revalidate former Champion’s (1892) records of *C. maculata* in Chontales (Nicaragua) and Morelia (Mexico). Based on habitat differences, and lack of presence along geographically intermediate localities, we agree with Werner et al. (1966) and treated records of *C. maculata* from Arizona (Enns, 1984) as the result of a possible man made introduction.

We had also the opportunity to study the 2 specimens upon which Dugès (1869, 1889) reported the presence of *C. maculata* in Colima (Mexico), and, in agreement with Champion (1892), we conclude that they actually belong to *C. auriculata*.

**Mitochondrial differentiation.** Uncorrected genetic divergence between the specimen assigned to *C. maculata* from Los Tuxtlas (Veracruz) and the one assigned to *C. auriculata* from Chamela (Jalisco) exceeds 14.5%. This divergence is considerably higher than any intraspecific distance recorded for Meloidae, and is of the same magnitude than divergences found for the same COI fragment across genera from the tribe Mylabrini (15.0-
17.4%) (unpublished data based on 4 genera: Actenodia, Croscherichia, Hycleus, and Mylabris).

**Adult activity and phenology.** Data presented in labels of specimens of *C. maculata* from Venezuela show that adult specimens are active throughout the year. The maximum number of specimens captured per collecting event was normally one, but 2 specimens were collected in 12 occasions, and 3 in 3 occasions. Indications of capture methods report the use of mercury lamps and unspecified lights.

Fifty four specimens of *C. maculata* were collected in the nearby localities of El Limón and Maracay, in the state of Aragua, Venezuela, between 1952 and 1987 (with 1 additional record from 1996). The Museo de Zoología Agrícola is located in Maracay, where highly active entomologists have been collecting material along the period indicated. This large species is easily spotted and generally collected always when found, so it is probable that all specimens of *Cissites* found by MIZA researchers were kept in the collection. Counting all specimens captured along the period 1952-1987 in El Limón and Maracay, we obtained a collecting rate of 1.5 specimens of *C. maculata* per year. The maximum number of specimens captured per collecting event was 3 (1 occasion), and 2 (1 occasion also). These figures of per year collection rate and maximum number of specimens captured per event, are an additional indication of the rarity of the species even in highly favorable areas. The specimens collected in Maracay and El Limón were distributed along the year, with a maximum in September and a minimum in March, as follows: I (4 specimens), II (4), III (1), IV (2), V (4), VI (3), VII (2), VIII (4), IX (11), X (6), XI (10), XII (3).

The 15 specimens of *C. maculata* collected at Los Tuxtlas (Veracruz, Mexico) were found from January to July, with almost half of the records obtained in June (7 specimens). Adult specimens of *C. auriculata* are active all the year in the Mexican territory during most of the year, though there are no records for March, October and December. Eleven records from Chamela (1976-1982) show activity as follows: II (2), IV (3), V (3), VII (3), but this pattern may reflect taxonomist’s preferred collecting periods for other taxa.

**Discussion**

Morphological diagnostic features between *C. maculata* and *C. auriculata* are constant and expressed over large geographic areas, without any sign for the existence of intermediate morphs. Cytochrome oxidase sequence divergence between *C. maculata* and *C. auriculata* is deep, suggesting that the split amongst them was the result of an ancient cladogenetic event. Lack of intermediate morphs and deep mitochondrial divergence indicate that *C. maculata* and *C. auriculata* have been separated as independent species for a long period of time. Current sympatry in Mexico could be a consequence of relatively recent colonization events, resulting from *C. maculata* dispersals into the range of *C. auriculata*, that occurred once the speciation process was concluded. Evidence of regional sympatry of *C. maculata* and *C. auriculata* in central Mexico, allows to reconsider all previous “questionable” reports of *C. maculata* in Central America and Mexico, while the study of large series of Venezuelan material, confirms Champion’s (1892) opinion that *C. auriculata* has not colonized South America.

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Colima: 2 specimens (Colección E. Dugès). D-785 [CNIN-IBUNAM].

Guerrero: 20-XI-1979, 1 specimen (A. Ibarra leg.) [CNIN-IBUNAM]; 20-I-1981, 1 specimen (J. Bueno leg.) [CNIN-IBUNAM]; 1 specimen [CNIN-IBUNAM].

Jalisco: 17-VI-1994, 1 specimen (G. Nogueira leg.) [EBCH]; 4 specimens, nocturna (H. Brailovsky leg.) [CNIN-IBUNAM].


Michoacán: 1971, 1 specimen (L. Marsch leg.) (Col. J. Hendrichs S.) (Ex Sonn) [CNIN-IBUNAM].

Morelos: 2.5 km N, 96º54.703' O: 21-IX-1998, 1 specimen (S. Zaragoza leg.) [CNIN-IBUNAM].

Oaxaca: Dominguillo, 760 m,17º38.907' N, 99º02.475' O: 12-VII-1996, 2 specimens, trampa de luz (F. A. Noguera et al. leg.) [CNIN-IBUNAM].


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Appendix. Material examined.


Colima: 2 specimens (Colección E. Dugès, 807, D-785) [CNIN-IBUNAM].


Michoacán: Playa Azul: 13-VIII-1971, 1 specimen (L. Marsch leg.) (Col. J. Hendrichs S.) (Ex Col. J. Hendrichs) [CNIN-IBUNAM].

San Nicolás, Km. 84 Carretera Barra de Navidad - Puerto Vallarta: 14-IX-1980, 1 specimen (E. Ramírez leg.); 7-VI-1991, 1 specimen (E. Ramírez leg.) [EBCH].

Estado de México: Valle de Bravo: 20-XI-1981, 1 specimen (W. Sohn) [CNIN-IBUNAM].

Michoacán: Playa Azul: 13-VIII-1971, 1 specimen (L. Marsch leg.) (Col. J. Hendrichs S.) (Ex Col. J. Hendrichs) [CNIN-IBUNAM].

Morelos: 2.5 km N, 4 km O Huautla, Estación CEAMISH, 940 m, 18º27.671' N, 99º02.475' O: 12-VII-1996, 2 specimens, trampa de luz (F. A. Noguera et al. leg.) [EBCH]; Tepoz. [Tepoztlán]: 17-VII-1965, 1 specimen [CNIN-IBUNAM]; Tepoz. [Tepoztlán]: 22-VIII-1965, 1 specimen [CNIN-IBUNAM].


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