A new species of the genus *Mexicantha* from Guerrero, Mexico (Lepidoptera: Saturniidae, Hemileucinae)

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Abstract: A new species of the genus *Mexicantha* Naumann, Nässig & Nogueira, 2012 (Lepidoptera: Saturniidae, Hemileucinae) is described from Guerrero, Mexico: ***M. arellanoi* sp. n.** The species is described, male holotype and female paratype and the male genitalia structures are figured. The holotype will be deposited in the IBUNAM collection at the Universidad Nacional Autónoma de México. The new taxon is compared to the two other known species of the genus, *M. oaxacana* Naumann, Nässig & Nogueira, 2012, and *M. garciorum* (Brechlin & Meister, 2012); an update about new collecting data for those two species is given, and the hitherto unknown male of *M. garciorum* is described. The monophyly of the genus *Mexicantha* is shown on basis of general and male genitalia morphology and COI barcode.

Keywords: *Mexicantha*, new species, new records, unknown male, Guerrero, Oaxaca.

Eine neue Art der Gattung *Mexicantha* aus Guerrero, Mexiko (Lepidoptera: Saturniidae, Hemileucinae)

Zusammenfassung: Eine neue Art der Gattung *Mexicantha* Naumann, Nässig & Nogueira, 2012 (Lepidoptera: Saturniidae, Hemileucinae) wird aus Guerrero, Mexiko beschrieben: ***M. arellanoi* sp. n.** Die Art wird beschrieben, männlicher Holotypus und weiblicher Paratypus sowie die männlichen Genitalstrukturen werden abgebildet. Der Holotypus wird in der IBUNAM-Sammlung an der Universidad Nacional Autónoma de México deponiert. Die neue Art wird verglichen mit den beiden anderen bisher bekannten Arten der Gattung, *M. oaxacana* Naumann, Nässig & Nogueira, 2012, und *M. garciorum* (Brechlin & Meister, 2012), eine Fortschreibung der bisher bekannten Funddaten dieser beiden Arten wird aufgeführt, und das bisher unbekannte Männchen von *M. garciorum* wird beschrieben. Die Monophylie der Gattung *Mexicantha* wird auf Basis der äußeren und der männlichen Genitalmorphologie sowie mit Hilfe des COI-Barcodes untermauert.

Una nueva especie del género *Mexicantha* de Guerrero, México (Lepidoptera: Saturniidae, Hemileucinae)

Resumen: Se describe una nueva especie del género *Mexicantha* Naumann, Nässig & Nogueira, 2012 (Lepidoptera: Saturniidae, Hemileucinae) de Guerrero, México: ***M. arellanoi* sp. n.** Se describe el especie y se ilustran el holotipo macho, el paratipo hembra y las estructuras genitales macho. El holotipo macho pasará a la colección IBUNAM de la Universidad Nacional Autónoma de México. Se compara el nuevo taxón con las dos demás especies conocidas del género, *M. oaxacana* Naumann, Nässig & Nogueira, 2012, y *M. garciorum* (Brechlin & Meister, 2012). Los datos de recogida de estas dos especies son actualizados y se describe el macho de *M. garciorum*, desconocido hasta la fecha. La característica monofilética del género *Mexicantha* se muestra basándose en la morfología general, de los genitales macho y en los códigos de barras COI.

Introduction

The genus *Mexicantha* was described only recently for two endemic species from Oaxaca, Mexico. At the time of description of the genus there were only the male gender of the typus generis and the female gender of the second species known, both only from two respectively one specimens in total. Since publication some efforts were undertaken to get additional knowledge about the genus and to find some more specimens to get better ideas of distribution and variability.

Within the last two years further ♂♂ of *M. oaxacana* Naumann, Nässig & Nogueira, 2012 were collected from near the type locality at Cerro del Vidrio, Oaxaca, and an additional ♂ was found near the type locality of *M. garciorum* (Brechlin & Meister, 2012), at San José del Pacifico, also Oaxaca, about 100 km east of Cerro del Vidrio, where both species occur syntopically. Details of collecting data are mentioned below. The conspecifity of specimens of *M. oaxacana* from the type locality and the new record east of San José del Pacifico is easily determinable by external characters, but it was verified both by genitalic dissection and by DNA barcoding results. The ♀ of *M. oaxacana* remains unknown.

A small series of both sexes of *M. garciorum* was collected in 2012 and 2013 ca. 30 km southeast of the type locality of the species. The formerly unknown ♂ is figured and shortly described here for the first time.

In June and July 2013 some specimens of another species were collected at three sites in the state of Guerrero, about 300 km further west of the westernmost known distribution of *M. oaxacana,* which at once could be assigned to the genus *Mexicantha* by their external habitus, but differed by their lighter colour and much larger size from the two other representatives. The specific status was proven by genitalic dissection and analysis of the DNA barcode, and the species is described as new to science below. For the distribution of the taxa, see the map.

The analysis of mitochondrial DNA (so-called barcode of the COI = cytochrome-*c* oxidase, subunit I, gene), conducted by BOLD in Canada, followed standard procedures as described, e.g., in Vaglia et al. (2008), and the resulting Neighbor Joining tree, computed with the software MEGA5, is figured (Fig. 10) and shows the separate standing of *Mexicantha* as genus on one side, and on the other side the well-separated three species known so far in this genus.

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The COI barcode sequence data used here will soon be published in BOLD and within a foreseeable time also in GenBank.

Abbreviations

GP [no.] genitalia preparation [no.].

IBUNAM Instituto de Biología (Colección Nacional de Insectos), Universidad Nacional Autónoma de México, Ciudad México (Mexico City, Mexico).

SMFL Senckenberg-Museum, Frankfurt am Main, Lepidoptera collection (Germany).

SNB collection and work of the author Stefan Naumann, Berlin (Germany).

Description of a third *Mexicantha* species

Mexicantha arellanoi sp. n.

(Figs. 1, 2, 7)

Holotype ♂: Mexico, Guerrero, 60 km W Chilpancingo, near Omiltemi, 1950 m, 1. vi. 2013, leg. local collector, received from H. J. Arellano Garcia, coll. Stefan Naumann; barcode SNB 5159 (Fig. 1). – The holotype will be donated to the IBUNAM collection at the Universidad Nacional Autónoma de México, Instituto de Biología, in Ciudad México.

Paratypes (4 ♂♂, 1 ♀, all from Mexico, Guerrero): 3 ♂♂, same locality data as holotype, 1. & 2. vi. 2013, 1 of these with dissection no. 2315/14 Naumann and 2 of these with barcode SNB 5157, 5158. 1 ♀, 20 km W Chilpancingo, 2450 m, 3. vi. 2013, barcode SNB 5156 (Fig. 2). 1 ♂, Filo de Caballos, 17.3906° N, 99.5024° W, 2200 m, vii. 2013, leg. local collector, received ix. 2013 from H. J. Arellano Garcia. – One of the ♂ paratypes will be deposited in SMFL, Frankfurt am Main, Germany; the other specimens remain in the author's collection which will be deposited within the Rainer Seegers Foundation in ZMHU (Museum für Naturkunde), Berlin.

Etymology: The new species is named in honour of the author's friend Hector José Arellano Garcia in recognition of his efforts to increase the knowledge on this interesting genus.

Description

Male (Fig. 1): Ground colour light ochreous to reddish brown. Antennae quadrupectinate up to the last 2 or 3 segments, 9.4–10.0 mm long, with 34 segments in total, longest dorsal rami 1.3 mm, longest ventral ones 1.1 mm. Length of forewing, measured from basis to apex, 25–29 mm (holotype 28 mm) and thereby much larger than ♂♂ of the two other *Mexicantha* species. Forewing homogenous in ground colour; the only markings are the discoidal patch bordered with small dark brown spots similar to ♂♂ of *M. oaxacana*, but more hinted, and the almost straight postmedian line with basally ochreous and marginal darker portion which ends apically in the tip of the apex. The basal and median part of the hindwing somewhat reddish, postmedian area in ground colour. A hindwing ocellus, the bent postmedian line and a basal shade in the postmedian area are more or less slightly indicated in reddish violet colour. The outer margin with a row of fringes in ground colour. Head, thorax with legs and abdomen completely in ground colour, the ventral side of the wings somewhat lighter, more ochreous, only markings on both fore- and hindwings are a central round white spot surrounded by a ring of reddish violet scales, and an undulated postmedian line of same colour.

Some of the specimens were already moulded and thereby have small defects; collecting took place under very hard weather conditions, and unfortunately the material could not be saved in completely dry conditions. Fungus contamination was probably also the reason for limited success in the DNA barcoding process where only 2 of 5 samples gave results.

Male genitalia (Fig. 7): Uncus simple, rounded, with some dorsal incurvations, rougher than in *M. oaxacana*. Valves with large dorsal lobe and bent inner spine, which is much longer and rounder than in *M. oaxacana* and *M. garciorum*. As in the other representatives of the genus, the lateral arms of the transtilla are fused with the inner margin of the valves, the sclorotized arms are much longer and with a rough margin on their dorsal end. Juxta processes broadly based, symmetric, saccus long; the complete structure is about 1.4 times larger than in *M. oaxacana*. Phallus 2 mm long, broader than in *M. oaxacana*. Generally the genitalia structures fall completely into the generic description of the genus *Mexicantha*.

Female (Fig. 2): Aside of some sexual dimorphic characters completely similar to the ♂♂. The only known ♀ differs from the ♂♂ by the filiform antenna (only the left one incompletely conserved, this part 6.8 mm in length with 23 segments), its larger size (forewing length 32 mm), and a larger abdomen. It is of the same ground colour and has the same ornamentation on both dorsal and ventral side. The apical tip of the forewing is bent a little wider outward than in ♂♂.

Distribution: *M. arellanoi* sp. n. is known so far only from a small remote mountain area around Chilpancingo in the State of Guerrero, southern Mexico, which belongs geographically to the western part of the Sierra Madre del Sur. It was found at different localities at altitudes from 1950 to 2450 m in the months of June and July.

Discussion

It is interesting to find a third new species of a genus described only recently within such a short period since the first *Mexicantha* specimens became known to science. Obviously members of the genus quite rarely come to lights as otherwise more specimens should have been found earlier, and evidently they occur only within a short flight period each year at their different known localities.

mtDNA COI barcodes

When describing *M. oaxacana* as new species, the authors indicated that at that time the mtDNA COI barcode of *M. garciorum* was not yet publically available to show the status as different species of those two taxa also in a Neighbor Joining barcode tree, but that there were enough morphological differences to interprete them as

different species. With knowledge of more material and the ♂♂ of *M. garciorum* this handling as two different species is now clearly supported, as well as with the new taxon *M. arellanoi* from Guerrero described here.

The present set of available barcode data for the genus *Mexicantha* and its probable closest relatives is now sufficient to suggest a better based view of the group (Fig. 10), as compared to Naumann et al. (2012).

- Based on the barcode data, the three different species of *Mexicantha* are, each for itself, rather homogeneous (low intraspecific variability in the barcode, Tab. 1; average distance within species between 0% and 0.4%) and clearly separate from one another (Tab. 2), with average distances between species counting for 4.4%, 7.7% and 9.4%, respectively. All three species show 100% in the bootstrap test (Fig. 10).

Tab. 1: Estimates of average evolutionary divergence over sequence pairs within genera (data base as in Fig. 10), analysed with MEGA5 software. The number of base substitutions per site from averaging over all sequence pairs within each group (species within *Mexicantha,* others on genus level) are shown. Standard error estimates are shown under "S.D.". The single specimen of *Cinommata* is not included here, as it is not possible to estimate evolutionary distances for a singleton.

Species	Distance	S.D.
M. garciorum	0.000	0.000
M. oaxacana	0.004	0.002
M. arellanoi	0.000	0.000
Automerella	0.067	0.009
Catacantha	0.057	0.008
Hylesiopsis festiva	0.027	0.007

For the barcode analysis of the sistergroup relationships between *Mexicantha* and related genera, some specimens and species of the following closely related Hemileucinae genera (compare Lemaire 2002) were used as outgroups for *Mexicantha* in Fig. 10 and tables:

1. 2 specimens of *Hylesiopsis festiva* Bouvier, 1929 (the only member of *Hylesiopsis* presently analysed);
2. 5 specimens of 3 species of the genus *Automerella* Michener, 1949 (only a part of the available material);
3. 12 specimens of ca. 4 species of the genus *Catacantha* Bouvier, 1930 (only a part of the available material); and finally
4. the only available (and incomplete) barcode sequence data of *Cinommata bistrigata* Butler, 1882, a species which turned out to be also somewhere in the group of genera related to the above. We do not have fresh material presently to get better sequence data.

The analysis of COI barcode shows that the relationships within this group of genera are much less clear (as might generally be expected for COI barcode analyses at higher taxonomic levels above the genus: Wilson 2010). In any case, the sequence similarity percentage between *Mexicantha* and other genera is over 10% (Tab. 2). For example, the bootstrap results for the forking between *Mexicantha* and *Hylesiopsis festiva* and further between these two and *Automerella* are only 20% and 45%, respectively, which means that these forkings might quite as well be different. This should be studied on basis of further characters (e.g., morphology, other DNA sequence data, etc.), as suggested by, e.g., Dayrat (2005) or Schlick-Steiner et al. (2010).

Further distribution data

In addition to the type locality, ***M. oaxacana*** ♂♂ were meanwhile found also at following localities in Oaxaca: Cerro del Vidrio, plateau near pass, 1980 m, 20. v. 2012, 2 ♂♂, one with barcode SNB 4961; and a singleton (Fig. 4) at Dos de Mayo, 30 km SE San José del Pacifico, 1700 m, vii. 2012, with barcode SNB 4975 (all specimens in the author's collection). Generally *M. oaxacana* shows little more variation in its colour than known before from the two type specimens; the specimen from Dos de Mayo is of same colour, but the 2 ♂♂ from Cerro del Vidrio are little lighter, more ochreous.

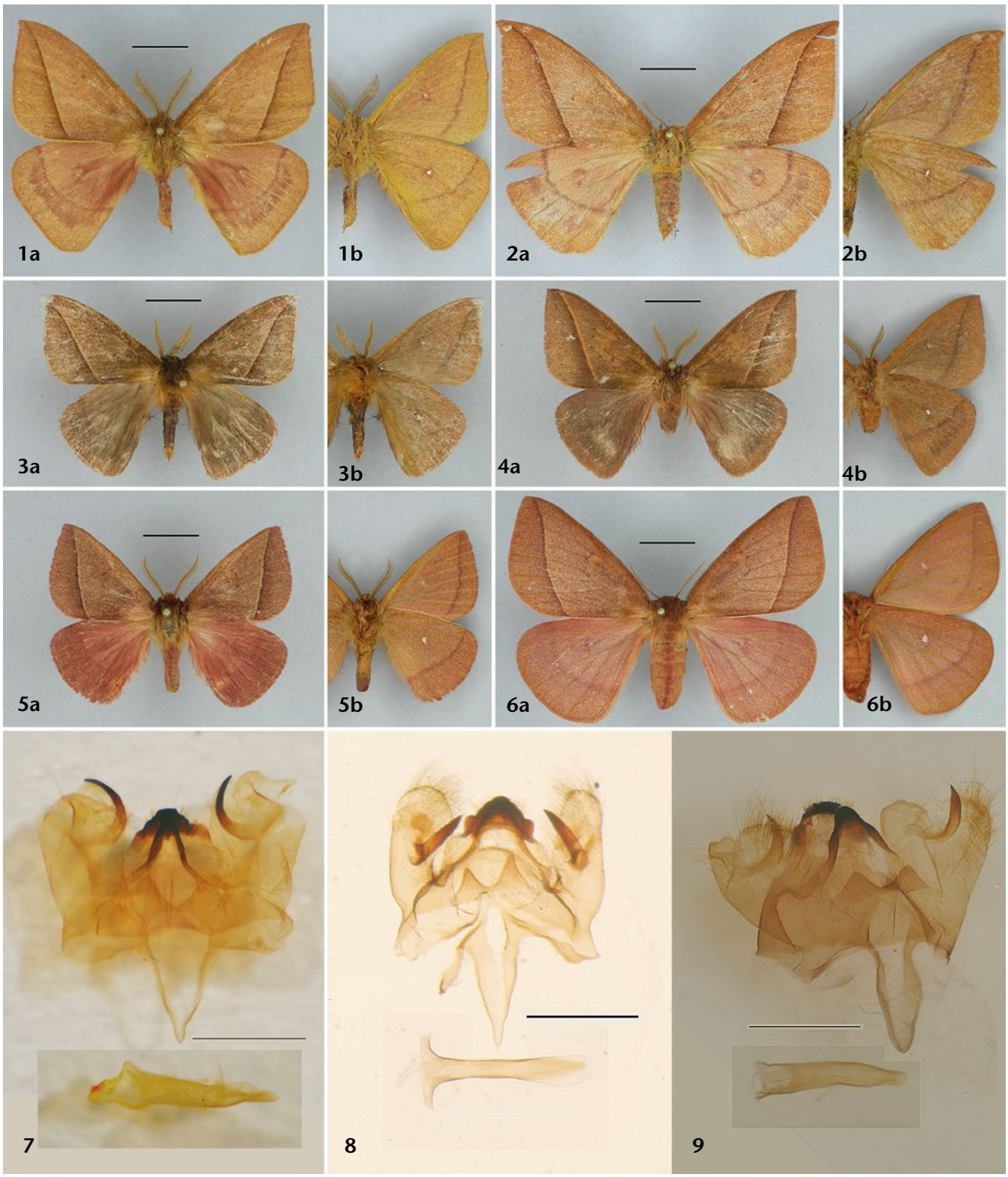
M. garciorum, described from some cabañas at San José del Pacifico, was collected in a series of 10 ♂♂ (Fig. 5) and 8 ♀♀ (Fig. 6) at and around Dos de Mayo at 1650 m altitude in vii. 2012 and at 1700 m altitude in vi. 2013, with barcodes SNB 4958, 4959 (♂♂) and 4960 (♀) (specimens in the author's collection, 1 pair deposited in coll. Carlos G. C. Mielke, Curitiba, Brazil) and was found there to occur syntopically with *M. oaxacana*.

Further notes on *Mexicantha garciorum*

Brechlin & Meister (2012) mention a forewing length of 27 mm for their ♀ holotype of *M. garciorum* which is within the normal variability of size of that taxon; the additional ♀♀ have a forewing length of 24–29 mm. The so far unknown ♂ of *M. garciorum* (Fig. 5) shows the same

Tab. 2: Estimates of evolutionary divergence over sequence pairs between groups (data base as in Fig. 10), analysed with MEGA5 software. The number of base substitutions per site from averaging over all sequence pairs between groups are shown. Standard error estimates are shown above the diagonal (light grey background, in square brackets).

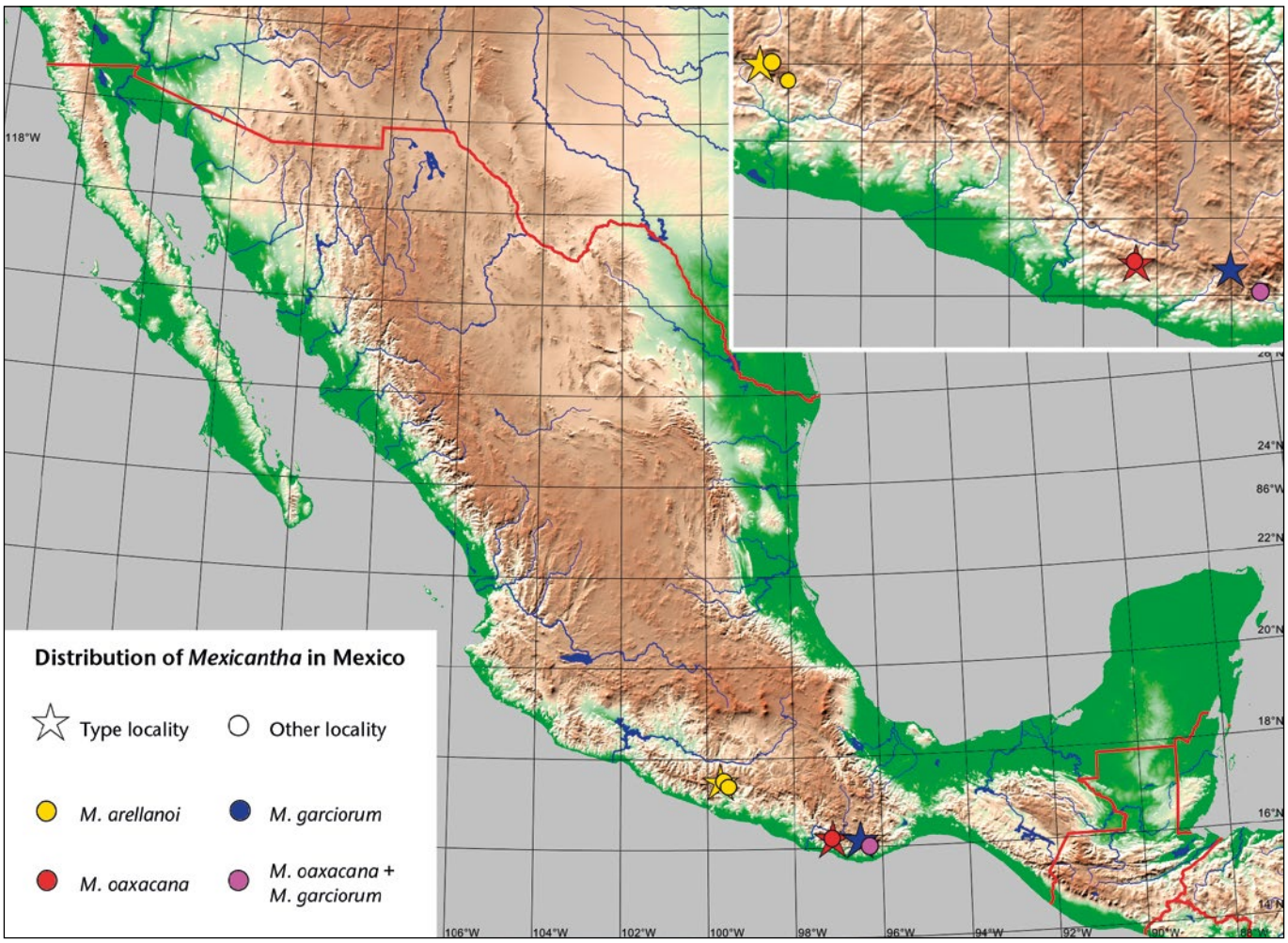
	M. garciorum	*Automerella*	*M. oaxacana*	*M. arellanoi*	*Catacantha*	*Hyles. festiva*	*Cinommata*
M. garciorum	–	[0.015]	[0.014]	[0.012]	[0.014]	[0.018]	[0.029]
Automerella	0.118	–	[0.015]	[0.013]	[0.015]	[0.018]	[0.030]
M. oaxacana	0.094	0.115	–	[0.009]	[0.016]	[0.019]	[0.033]
M. arellanoi	0.077	0.103	0.044	–	[0.015]	[0.018]	[0.032]
Catacantha	0.107	0.127	0.118	0.108	–	[0.018]	[0.026]
Hylesiopsis festiva	0.129	0.148	0.135	0.126	0.142	–	[0.033]
Cinommata	0.154	0.185	0.184	0.171	0.159	0.183	–



Figs. 1–6: *Mexicantha* specimens, **a** = dorsal view, **b** = ventral view, all from Mexico. Specimens figured approximately to the same scale, 1 scalebar = 10 mm. — **Fig. 1:** *M. arellanoi* n. sp., holotype ♂, Guerrero, ex CSNB in IBUNAM. **Fig. 2:** *M. arellanoi* n. sp. paratype ♀, Guerrero, CSNB. — **Fig. 3:** *M. oaxacana*, paratype ♂, Oaxaca, SMFL. **Fig. 4:** *M. oaxacana*, ♂, Oaxaca, CSNB. — **Fig. 5:** *M. garciorum*, ♂, Oaxaca, CSNB. **Fig. 6:** *M. garciorum*, ♀, Oaxaca, CSNB. — **Figs. 7–9:** ♂ genitalia of *Mexicantha* specimens. Scalebars = 1 mm; approximately to the same scale. — **Fig. 7:** *M. arellanoi* n. sp., GP 2315/14 Naumann, paratype. **Fig. 8:** *M. oaxacana*, GP 1961/05 W. A. Nässig (scan: W. Eckweiler), holotype. **Fig. 9:** *M. garciorum*, GP 2331/14 Naumann.

reddish brown colour as the ♀, sometimes even more vivid. The forewing has a length of 21–23 mm, its outer margin is rounded as in the ♀ and differs much from the quite straight forewing margins of *M. oaxacana* and *M. arellanoi* sp. n. As mentioned already by Naumann et al. (2012), *M. garciorum* differs from *M. oaxacana* (and also from the third species described here) by the different discoidal patch and the forewing postmedian line which ends in the costal margin (near to the apical tip in *M. oaxacana* and *M. arellanoi* sp. n.). These characters are shared also by the ♂♂ of *M. garciorum*.

The preimaginal instars of all three taxa remain unknown.



Map: Distribution of the three known species of *Mexicantha* in Mexico. Inset map: enlarged details. — Maps produced with MapCreator 2.0 Personal Edition (W. A. Nässig).

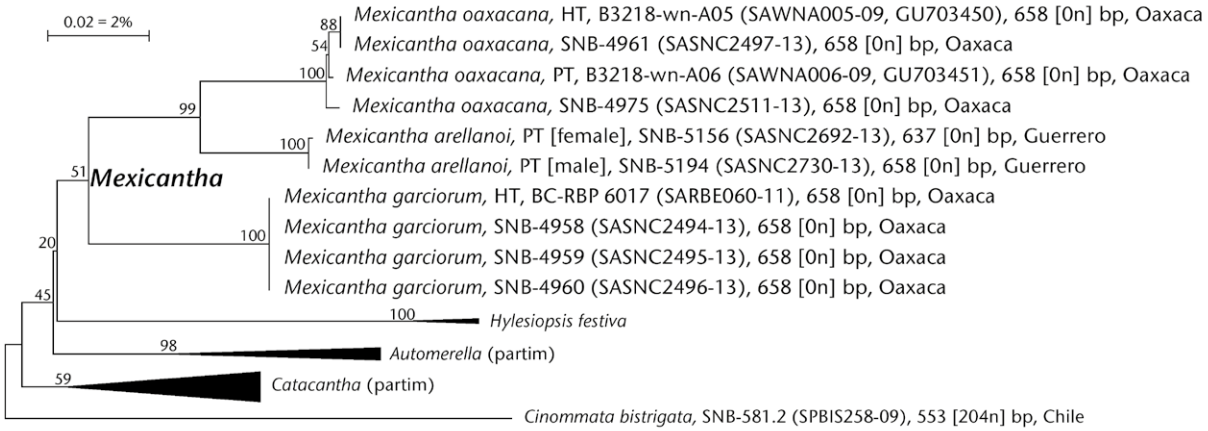


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Fig. 10: Possible evolutionary relationships of taxa according to the COI Neighbor Joining tree (Saitou & Nei 1987), calculated with MEGA5 software (Tamura et al. 2011). The optimal tree with the sum of branch length = 0.62601727 is shown. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (2000 replicates) are shown next to the branches (Felsenstein 1985). The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. The evolutionary distances were computed using the Maximum Composite Likelihood method (Tamura et al. 2004) and are in the units of the number of base substitutions per site. The rate variation among sites was modelled with a gamma distribution (shape parameter = 3). The differences in the composition bias among sequences were considered in evolutionary comparisons (Tamura & Kumar 2002). The analysis involved 29 nucleotide sequences (= specimens). Codon positions included were 1st+2nd+3rd+Noncoding. All ambiguous positions were removed for each sequence pair. There were a total of 654 positions (base pairs) in the final dataset.

Checklist of the genus *Mexicantha*

Mexicantha Naumann, Nässig & Nogueira, 2012

garciorum (Brechlin & Meister, 2012) [*Automeris*]

oaxacana Naumann, Nässig & Nogueira, 2012

arellanoi sp. n.

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