

A NEW SPECIES OF *ADHEMARIUS OITICICA* (LEPIDOPTERA:  
SPHINGIDAE) FROM MEXICO

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**Abstract.**—*Adhemarius mexicanus*, new species, is described from the Sierra Madre Oriental mountains, Mexico. A key to males of the *A. donysa* species group (*A. donysa*, *A. dariensis*, *A. mexicanus*, *A. globifer*, and *A. blanchardorum*) is presented, and specific characters are discussed.

**Key Words:** *Adhemarius blanchardorum*, *Adhemarius dariensis*, *Adhemarius donysa*, *Adhemarius globifer*, *Adhemarius mexicanus*, distribution, Mexico

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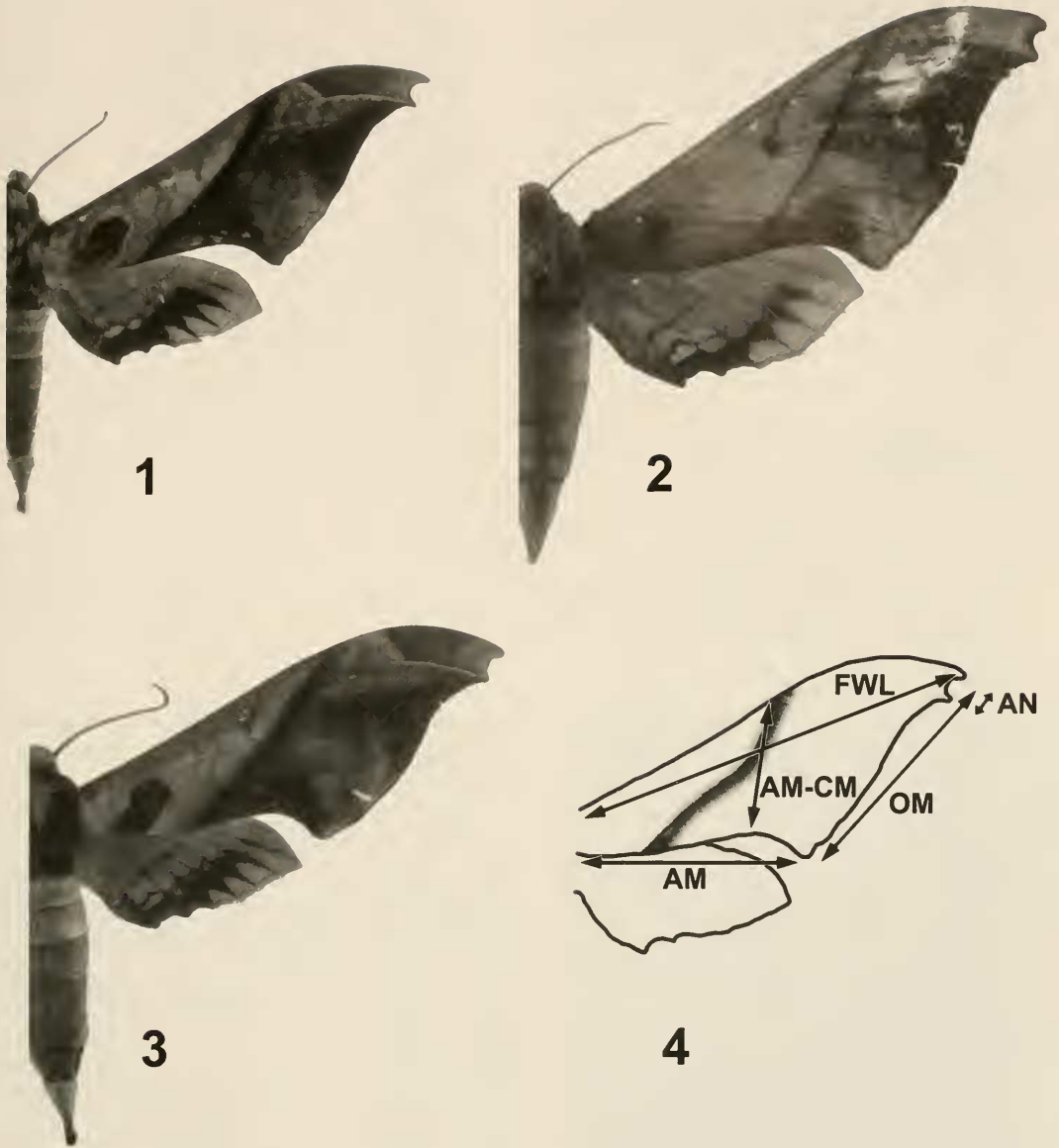
The taxonomy of the species that are closely related to *Adhemarius donysa* (Druce) has been problematic. D'Abrera ([1987]), who illustrated *A. globifer* (Dyar) and the types of *A. dariensis* (Rothschild and Jordan) and *A. donysa*, suggested that all three of these taxa might be synonymous. He also overlooked the most recently described species, *A. blanchardorum* (Hodges 1985). In contrast, Carcasson and Heppner (1996) treated *A. globifer* and *A. donysa* as separate species, with *dariensis* as a subspecies of the latter. Recently, Cadiou and Hodges (1998) reviewed the species of *Adhemarius* from North and Central America, with special reference to the *donysa* group. They concluded that there were four species, and undertook a thorough review of the names and previous taxonomic confusion. For several years, we had recognized four species in Mexico. The identities of three were clear following Cadiou and Hodges' paper: *A. donysa*, *A. dariensis*, and *A. globifer* (*A. blanchardorum* has not yet been found in Mexico). However, with regard to *A. dariensis*, Cadiou and Hodges

(1998) wrote "Specimens from Veracruz and farther north tend to have more elongate forewings, with a narrower apex, than do specimens from Chiapas and farther south . . . we have not found clear characters to subdivide this taxon." We believe that these northern populations correspond to what we considered was the fourth species found in Mexico. After close examination of the external morphology and genitalia of a quite large series of specimens, we have concluded that it is indeed a hitherto undescribed species.

***Adhemarius mexicanus* Balcázar and  
Beutelspacher, new species**  
(Figs. 1–2, 5–6, 9)

**Description.**—Forewing length: ♂ 43–51 mm ( $\bar{x}$  = 47.8,  $n$  = 31); ♀ 49–52 ( $\bar{x}$  = 50.3,  $n$  = 4).

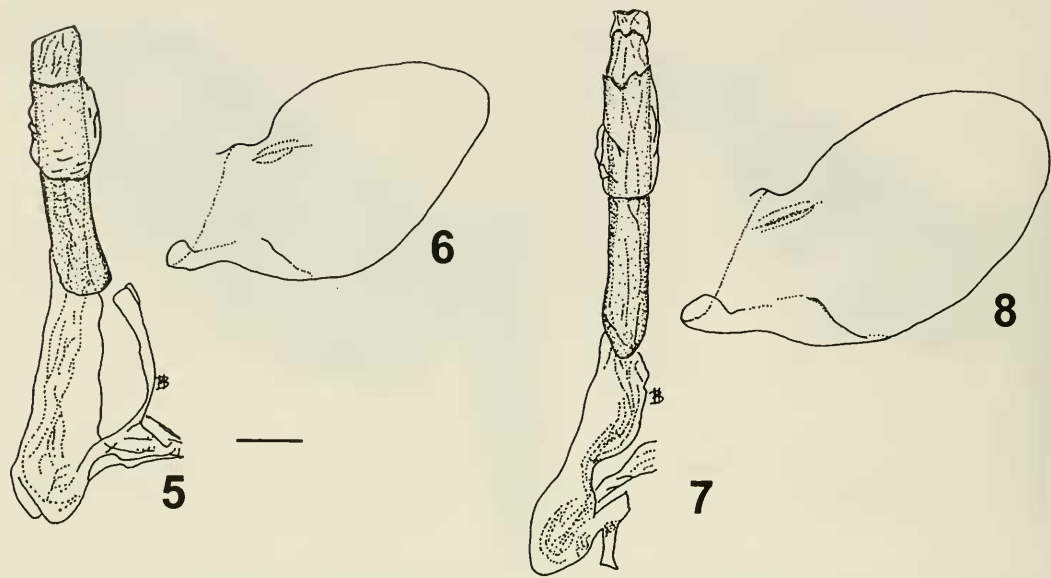
**Male (Fig. 1).**—**Head:** Gray; labial palp ventrally orange, especially basal segments (distal one can be greenish); zone from base of antenna to vertex greenish brown. **Thorax:** Dorsally pale yellowish gray; dark areas greenish brown. Legs with coxae and



Figs. 1-4. Habitus of *Adhemarius* species. 1-2, *A. mexicanus*. 1, Holotype ♂ (forewing length: 48 mm). 2, Paratype ♀ (forewing length: 61 mm), Mexico, Veracruz, Las Minas, 15 Oct 1972, C. Beutelspacher. 3, *A. dariensis* ♂ (forewing length: 53 mm), Mexico, Chiapas, Rancho Nuevo, San Cristóbal de las Casas, 19-22 Oct 1992, C. Beutelspacher. 4, Measurements used for the PCA analysis (AM = anal margin length; AM-CM = length from the concave area at the anal margin to the interception of the postmedial line with costal margin; AN = width of the apex notch; FWL = forewing length; OM = outer margin length).

trochanters yellowish green; femora, tibiae, and tarsi greenish brown. *Abdomen*: Greenish brown followed by pale yellowish gray then pale grayish green, with a faint medial line on segments 2-6. *Forewing*: Narrow and very elongate. Apex produced; very

narrow; external margin almost straight (can be slightly wavy, but not crenulate); tornus very acute. Forewing dorsally gray green; extreme base yellowish gray; lunule dark greenish brown; median line clearly oblique; posterior margin just beyond me-



Figs. 5-8. Male genitalia of *Adhemarius* species. 5-6. *Adhemarius mexicanus*. 5, Aedeagus. 6, Right valva. 7-8. *A. dariensis*. 7, Aedeagus. 8, Right valva (scale line = 1 mm).

dial line greenish gray (with a lighter patch near costa); discocellular vein well outlined. Dark submarginal area both basally and distally convex, with maximal width at M2, merging smoothly into wing pattern. Forewing ventrally pale yellowish green; anal angle with the same color as rest of wing; basal area red; discocellular vein clearly outlined. *Hindwing*: Base red becoming paler toward outer margin; dark mark in anal area dark greenish brown immediately preceded and followed by pale yellowish gray or green; median line slightly oblique; antemarginal black pattern well marked and extending distad along veins, almost reaching posterior margin. Medial line curved basad when reaching costal margin. *Male genitalia* (Figs. 5-6): Valva elongate, not broadly rounded to apex; costal margin with a small lobe not followed by a sharp angle. Sacculus very poorly developed; lacking setae.

*Female* (Fig. 2).—Similar to male, but larger. Forewing pattern less contrasting, and with a pinkish cast. *Female genitalia* (Fig. 9): Base of ductus bursae broad, about two-thirds width of ostium bursae.

Signum narrowly arrow shaped; inwardly directed cones evenly graduated from short to very short.

*Types*.—Holotype: ♂; MEXICO: Oaxaca, Santiago Comaltepec, La Esperanza, Sierra de Juárez, 17°37'45"N, 96°22'5"W, 1600, 28 Mar 1984 (coll. M. García). Paratypes: MEXICO: same locality as holotype, 26 Mar 1976 (coll. ND)—♂; 27 Mar 1976 (coll. ND)—♂; 30 Mar 1976 (coll. A. Díaz Francés)—♂; 22 Mar 1977 (coll. A. Díaz Francés)—2 ♂; 28 Mar 1984 (coll. A. Ibarra)—2 ♂; (coll. H. Delfín)—3 ♂; (coll. V. Hernández)—2 ♂; 29 Mar 1984 (coll. A. Ibarra)—2 ♂; (coll. H. Delfín)—1 ♂; Puebla, Xicotepec, Dos Caminos, 20°14'35"N, 97°58'12"W, 29 Jun 1976 (coll. ND)—1 ♂; Villa Juárez, 19°52'0"N, 97°47'0"W, 3 Apr 1954 (coll. G. Pérez H.)—1 ♂; 1 May 1954 (coll. C. Márquez M.)—1 ♂; Jul-Aug 1960 (coll. ND)—2 ♂; Sep-Oct 1960 (coll. ND)—1 ♀, 1 ♂; 22 Oct 1960 (coll. ND)—1 ♂; 26 Sep 1961 (coll. C. Márquez M.)—1 ♂; Xicotepec, 20°16'32"N, 97°57'37"W, 1150, 18 Aug 1978 (coll. R. Boue)—1 ♂; 20 Sep 1980 (coll. R. Boue)—1 ♂ 11 Oct 1980 (coll. R. Boue)—1 ♀; 4 Jul 1981

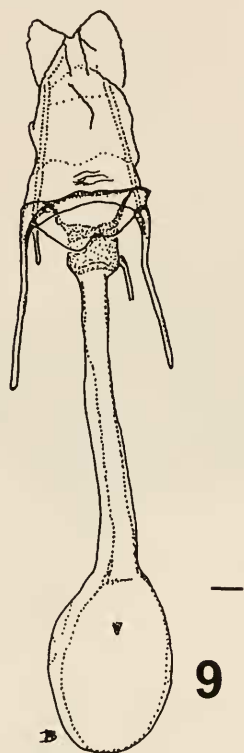


Fig. 9. Female genitalia of *Adhemarius mexicanus* (scale line = 1 mm).

(coll. C. Beutelspacher B.)—1 ♂; 10 Apr 1985 (coll. C. Beutelspacher B.)—1 ♂.

Other specimens studied.—MEXICO: Oaxaca, San Juan Lachao, Sierra Madre del Sur, ±20 mi Norte de San Gabriel Mixtepec, 16°9'24"N, 97°7'36"W, 10 Jul 1991 (coll. ND)—1 ♂; Querétaro, Landa de Matamoros, Km 8 carr. Agua Zarca -Neblinas, 21°15'14"N, 99°4'58"W, 1150, 22 Jul 1998 (coll. Oliver & Ibarra)—1 ♂; Veracruz, Las Minas, Las Minas, 19°41'27"N, 97°8'48"W, 1,480 m, 28 Sep 1972 (coll. C. Beutelspacher B.)—1 ♂; 15 Oct 1972 (coll. C. Beutelspacher B.)—1 ♀; Xalapa, Xalapa, 19°32'24"N, 96°55'39"W, 1,460 m, 14 Sep 1984 (coll. J. Peña M.)—1 ♂.

Deposition of types.—The holotype and 25 paratypes are in the Colección Nacional de Insectos (CNIN), Universidad Nacional Autónoma de México. One paratype male will be deposited in each of the following institutions: National Museum of Natural

History, Smithsonian Institution, Washington, DC, The Natural History Museum, London, American Museum of Natural History, New York, and Muséum national d'Histoire naturelle, Paris.

Etymology.—This new species is named after the country in which it is found.

Distribution.—Fig. 10.

Flight period.—*A. mexicanus* has been collected from March to October.

KEY TO THE MALES OF THE *ADHEMARIUS* *DONYSA* GROUP

Adult males of the *Adhemarius donysa* group of species can be identified using the following key. Additional characters to separate *A. mexicanus* and *A. dariensis* are discussed in the next section. The key can also be used for females, except for *A. mexicanus* and *A. dariensis*, as discussed below.

1. Antemarginal black pattern of hindwing upper side well marked and extending distad along veins, almost reaching posterior margin; discocellular vein of forewing upper side well outlined, forewing external margin almost straight; . . . . . 2
- Antemarginal black pattern of hindwing upper side not extending distad along veins; discocellular vein of forewing upper side not clearly outlined; forewing external margin crenulate near torus . . . . . 4
- 2(1). Forewing broad; forewing apex little produced; median line of forewing upper side little oblique; medial line of hindwing under side straight . . . . . *Adhemarius donysa*
- Forewing narrow; forewing apex produced; median line of forewing upper side clearly oblique; medial line of hindwing under side curved basad when reaching costal margin . . . . . 3
- 3(2). Forewing external margin almost straight, apex very narrow (Fig. 1); dorsally usually gray green; forewing length usually less than 51 mm . . . . . *Adhemarius mexicanus*
- Forewing external margin outwardly convex, apex not very narrow (Fig. 3); dorsally usually gray brown; forewing length usually 52 mm or more . . . . . *Adhemarius dariensis*
- 4(1). Forewing dorsally gray green; dark submarginal area of forewing upper side generally narrower, indented distally at M2 and at M3; dark submarginal area of forewing upper side sharply delimited basally . . . . . *Adhemarius blanchardorum*



Fig. 10. Known distribution of *Adhemarius mexicanus* (dots) and *A. dariensis* (squares) in Mexico.

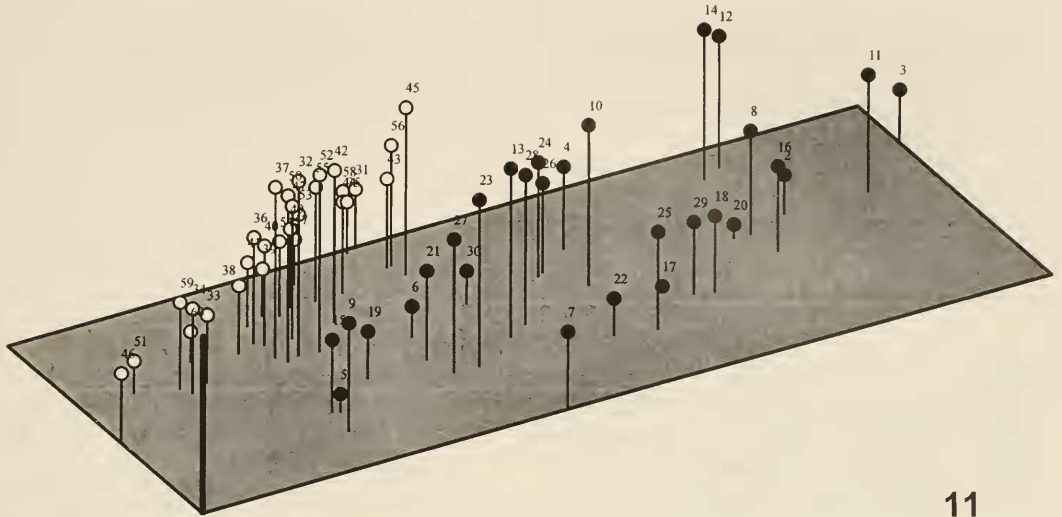
Forewing dorsally gray brown; dark submarginal area of forewing upper side globally convex, with maximal width at M2; dark submarginal area of forewing upper side merging smoothly into wing pattern

..... *Adhemarius globifer*

**Discussion.**—Several characters can be used to separate males of *Adhemarius mexicanus* from those of *A. dariensis*. *Adhemarius mexicanus* is a smaller (in most specimens, the forewing is less than 50 mm), a more slender species, with more elongate wings, an almost straight forewing external margin, a very narrow apex and a very acute tornus (Fig. 1). In contrast, *A. dariensis* is a larger (forewing is usually more than 55 mm), a more robust species, with broader forewings and apex, an outwardly convex external margin, and a more rounded tornus (Fig. 3). In *A. mexicanus*, the forewing pattern is more contrasting, and the ground color is greenish in fresh

specimens, turning yellowish in old ones; while in *A. dariensis*, the ground color is brownish turning orange in old specimens, with a less contrasting wing pattern. *Adhemarius mexicanus* has a costal light gray patch next to the distal margin of the postmedial line that makes the zigzag postmedial lines very clear; this patch is missing in *A. dariensis*. The hindwings are usually uniformly red in *A. dariensis*, whereas in most specimens of *A. mexicanus* they turn yellowish toward the outer margin. The valva of *A. dariensis* is more rounded, and the sacculus, although poorly developed, is better developed (Fig. 8) than in *A. mexicanus*, which in addition has a less rounded valva. The aedeagus is long (longer than the bulbus ejaculatorius) in *A. dariensis* (Fig. 7) and short (subequal than the bulbus ejaculatorius) in *A. mexicanus* (Fig. 5) (I. Kitching, personal communication, uses the term





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Fig. 11. Principal component analysis of 30 specimens of *Adhemarius mexicanus* and 30 specimens of *A. dariensis*. Three-dimensional graph with the projection of the specimens onto the first three components. This representation expresses 96% of the variation of five characters studied.

cuticular simplex instead of bulbus ejaculatorius, but both terms are obscure).

On the basis of a limited number of females, we suggest the following diagnostic characters. The same characters of forewing apex, tornus, red hindwing color, and ro-

business that separate the males also serve to separate the females. In *A. dariensis*, the forewing is divided into a light basal area and a darker distal area, separated by the medial line; in *A. mexicanus*, the basal and distal areas are less contrasting, and have a pinkish cast. No diagnostic characters were identified in the female genitalia.

Table 1. Summary of the data used in the PCA analysis: 30 male specimens of each species were measured. FWL = forewing length; OM = forewing outer margin length; AM-CM = forewing length from the concave area at the anal margin to the interception of the postmedial line with costal margin; AM = anal margin length; AN = width of the apex notch.

		<i>A. dariensis</i>	<i>A. mexicanus</i>
FWL	$\bar{x}$	51.1	47.8
	Min	42	43
	Max	57	51
OM	$\bar{x}$	30.2	27
	Min	26	24
	Max	35	30
AM-CM	$\bar{x}$	19.3	17.1
	Min	17	15
	Max	22	19
AM	$\bar{x}$	28.6	27.4
	Min	25	25
	Max	33	30
AN	$\bar{x}$	3.4	2
	Min	3	2
	Max	4	2

To analyze the apparent overlap in the external appearance of some specimens of both species, we conducted a principal component analysis (PCA). Five measurements were used: forewing length (FWL), forewing outer margin (termen) length (OM), forewing length from the concave area at the anal margin to the interception of the postmedial line with costal margin (AM-CM), anal margin length (AM), and width of the apex notch (AN) (Fig. 4). We measured 30 males from Mexico north of the Isthmus of Tehuantepec and 30 males from Chiapas and Costa Rica. The data are summarized in Table 1 (The data are available on request from the senior author). All measurements were standardized and analyzed using NTSysPc version 2.02c (Rohlf 1989). The first three components extracted account for 96% of the variation observed

Table 2. Eigenvectors, corresponding eigenvalues, and percentage of variation explained for 30 male *Adhemarius mexicanus* and 30 *A. dariensis* studied.

i	Eigenvalue	Percent	Cumulative
1	3.97187564	79.4375	79.4375
2	0.57496201	11.4992	90.9368
3	0.23571324	4.7143	95.6510
4	0.12598810	2.5198	98.1708
5	0.09146101	1.8292	100.0000

(Table 2). The loadings of each variable are shown in Table 3. There are two distinct clouds of specimens on the three-dimensional graph (Fig. 11), a very compact group comprising the specimens from North of the Isthmus of Tehuantepec, (*A. mexicanus*) and a more dispersed group comprising the remaining specimens (*A. dariensis*). Although the two clouds are very close, there is no overlap. Based on the few character measured, the external differences between *A. mexicanus* and *A. dariensis* seem to be largely a matter of scale, with *A. mexicanus* being a smaller species than *A. dariensis*. The same pattern appears to be true for the females, but we did not have a sufficiently large number for an analysis. We expect that knowledge of immature stages will help clarify status of taxa.

This new species seems to be closely associated with cloud forest ("bosque mesófilo") sensu Rzedowski (1978) in the states of Veracruz, Hidalgo, Querétaro, Puebla, and Oaxaca, and at altitudes between 1,150 and 1,600 m a.s.l. (Fig. 10). This cloud forest is well known for its relictual and endemic taxa (Llorente & Escalante 1992). We have one specimen from the Sierra Madre del Sur province on the Pacific slope in Oaxaca, again from an area with cloud forest. However, more specimens are needed from that area to confirm its presence there. The few specimens of *A. dariensis* that we have seen from Mexico were all collected at altitudes between 1,900 and 2,400 m, and never at lower altitudes, in the state of Chiapas. Furthermore, the specimens illustrated as *A. dar-*

Table 3. Correlations (loadings) between principal components and the five variables analyzed.

	1	2	3
FWL	0.9348	0.1786	0.1134
OM	0.9615	-0.0747	0.0323
AM-CM	0.9286	-0.0207	0.2981
AM	0.8344	0.4516	-0.2967
AN	0.7843	-0.5772	-0.2120

*iensis* by Cadiou and Hodges (1998: figs. 3–4) are actually *A. mexicanus*

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