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Redescription of the parasitic wasp *Melittobia sosui* Dahms, 1984 (Hymenoptera: Eulophidae), with records on its new hosts in Vietnam

Переописание паразитической осы *Melittobia sosui* Dahms, 1984 (Hymenoptera: Eulophidae) с заметками о её новых хозяевах во Вьетнаме

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KEY WORDS: association, behavioral ecology, host-parasitoid, *Melittobia sosui,* natural host, Eulophidae.

КЛЮЧЕВЫЕ СЛОВА: ассоциации, экология поведения, хозяин-паразитоид, *Melittobia sosui*, естественный хозяин, Eulophidae.

ABSTRACT. Based on eight female and three male wasp specimens deposited in Kyushu University, Kyushu, Japan and Queensland Museum, Brisbane, Australia, Dahms [1984] has established the parasitoid *Melittobia sosui* Dahms, 1984 without detailed description after he compared external morphological characters of the species with those of the nearly related species *M. assemi* Dahms, 1984 that is known only from India. Here, we, based on more than 2500 specimens of *M. sosui* collected in many provinces of Vietnam, redescribe the species in detail, produce additional different characters between *M. sosui* and *M. assemi*, and record seven new distributional locations in Vietnam for the wasp. Nine new natural hosts of the parasitoid *M. sosui* are presented.

РЕЗЮМЕ. Дамс [Dahms, 1984] установил вид *Melittobia sosui* Dahms, 1984 основываясь на восьми экземплярах самок и трёх самцов, хранящихся в Университете Кюсю, Кюсю, Япония, и Музее Квинсленда, Брисбен, Австралия, без подробного описания, указав отличительные признаки от близкородственного *M. assemi* Dahms, 1984, известного только из Индии. Здесь мы, основываясь на более чем 2500 экземплярах *M. sosui*, собранных во многих провинциях Вьетнама, переописываем этот вид, выделяем дополнительные отличительные признаки между *M. sosui* и *M. assemi* и отмечаем семь новых мест находок во Вьетнаме для этого вида ос. Указаны девять новых естественных хозяев паразитоида *M. sosui*.

Introduction

Melittobia Westwood, 1848 is a genus of parasitic wasps with 12 species known worldwide. Of these 12, five have been recorded for the Oriental region, *Melittobia acasta* (Walker, 1839) (India and Sri Lanka), *M. assemi* Dahms, 1984 (India), *M. clavicornis* (Cameron, 1908) (Malaysia), *M. hawaiiensis* Perkins, 1907 (Indonesia, Malaysia), and *M. sosui* Dahms, 1984 (Taiwan) [Noyes, 2021]. The latter species was identified on the basis of a comparative list of external morphological characters of both sexes between it and the nearly related species *M. assemi* [Dahms, 1984].

Pham *et al*. [2019] recorded the genus *Melittobia* with *M. clavicornis* for the first time from Vietnam and presented its two natural hosts that were solitary sphecid wasps, the blue nest-renting wasp *Chalybion bengalense* (Dahlbom, 1845) and the mud-dauber wasp *Sceliphron madraspatanum* (Fabricius, 1781), both being parasitized as prepupae. Pham *et al.* [2021] recorded the wasp *M. sosui* parasitizing a prepupa of the solitary wasp *Apodynerus troglodytes* (de Saussure, 1856), which was a utilizer of old nests of the mud-dauber wasp *S. madraspatanum* in Bac Ninh province.

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Figs 1–4. Habitat of the sampling and collection of pupae of *D. melanogaster* Meigen: 1 — habitat of a pomelo garden in which pupae of *D. melanogaster* picked up for finding *M. sosui*; 2 — decayed pomelo; 3 — maggot of *D. melanogaster* under a decayed pomelo; 4 — pupa of *D. melanogaster* found in the ground below a decayed pomelo.

Рис. 1–4. Места поиска и сбора коконов *D. melanogaster* Meigen: 1 — сад помело, в котором коконы *D. melanogaster* были собраны для обнаружения *M. sosui*; 2 — разложившийся помело; 3 — личинка *D. melanogaster* под разложившимся помело; 4 — кокон *D. melanogaster*, найденный в земле под разложившимся помело.

In this study, we redescribed *M. sosui* in detail, recorded its new distributional locations and new natural hosts, presented additional different characters in both sexes between *M. assemi* and *M. sosui,* and summarized previously recorded hosts of the parasitoid.

Materials and methods

The sampling was carried out at seven provinces and a city in Vietnam from March 2017 to January 2023, Bac Ninh, Cao Bang, Hoa Binh, Quang Ninh, Thai Binh, Thai Nguyen, Vinh Phuc, and Ha Noi, respectively. Nests of six sphecid wasps *S. madraspatanum*, *S. deforme* (F. Smith, 1856), *S. javanum* (Lepeletier de Saint Fargeau, 1845), *Ch. bengalense*, *Ch. japonicum* (Gribodo, 1882), and *Ch. malignum* (Kohl, 1906) and of four eumenine wasps *Eumenes architechtus* Smith, 1858, *Allorhynchium chinense* (de Saussure, 1862), *Apodynerus troglodytes* (de Saussure, 1856), and *Delta esuriens* (Fabricius, 1787) were collected to find out the parasitoid *M. sosui*. We have also studied several decayed fruits such as rose-apples, Indian jujubes, pomelos (Figs 1–3) contained the pupae of the Oriental fruit fly *Drosophila melanogaster* (Meigen, 1830) (Figs 3–4) in which *M. sosui* possibly parasitized. Trap nests, made of hollow bamboo or reed internodes 0.5–2.0 cm in diameter and 10–30 cm long (Figs 6–7) were used to place in many various habitats in the field (Figs 5–6) to collect nests of tube-nesting wasps for looking the parasitoid *M. sosui*.

Nests of above-mentioned wasps and pupae of flies collected in the field were transferred to the laboratory

Figs 5–7. Habitat of the sampling and collection of cocoons of trap nesting wasps: 5 — habitat of a secondary forest at Vinh Phuc province in which trap nests are put; 6 — trap nests tied to a horizontal branch; 7 — cocoon of *Ch. japonicum* parasitized by *M. sosui*.

Рис. 5–7. Место поиска и сбора коконов ос в ловчих гнездах: 5 —вторичный лес в провинции Виньфук, в котором расставлены ловчие гнезда; 6 — ловчее гнездо, привязанное к горизонтальной ветке; 7 — кокон *Ch. japonicum*, на котором паразитирует *M. sosui*.

of Institute of Ecology and Biological Resources (IEBR) for rearing to take adult wasps *M. sosui* or for dissecting them to find the parasitoid.

All adult wasps of *M. sosui* emerged from experiments or picked up in the laboratory and collected in field trips were put in Ethanol (70%) for the identification. All specimens were studied using a stereoscopic microscope, Nikon SMZ745. Dahms [1984] and Narendran [2007] publications were used for the identification of the wasp. The determination of the species name has also been confirmed by Prof. J. M. Gonzalez, California State University, Fresno, California, USA. Prof. J. M. González, California State University, Fresno, California, USA. Photographic images were taken using a Nikon SMZ800N microscope camera. Information on the taxonomic history and the distribution of *M. sosui* was taken from Dahms [1984] and Noyes [2021]. Morphological terminology used in the text follows Dahms [1984].

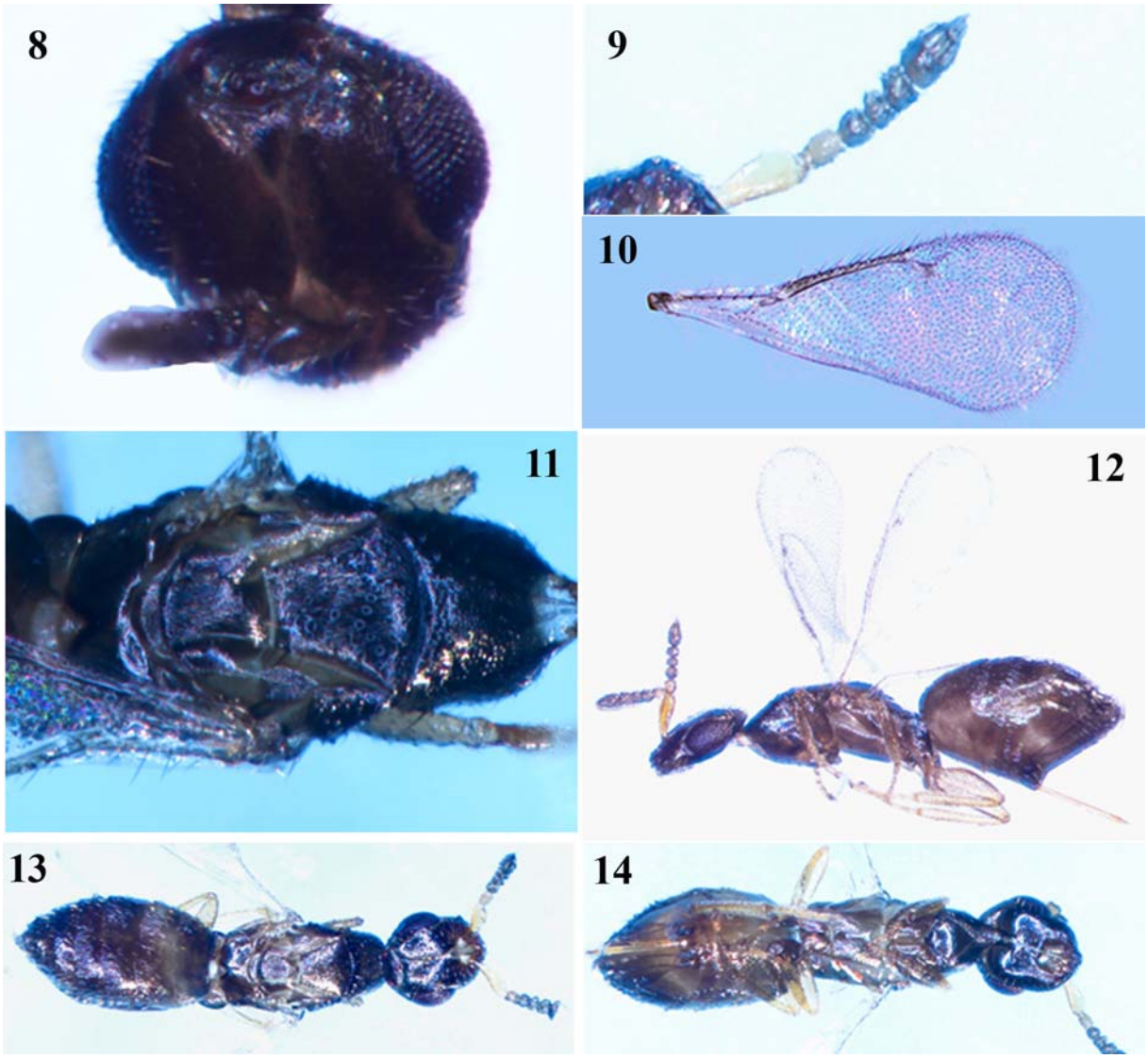
Voucher specimens of *M. sosui* and its hosts examined in the present study are deposited and preserved in IEBR, Vietnam Academy of Science and Technology, Ha Noi, Vietnam.

Results and discussion

Melittobia sosui Dahms, 1984
Figs 8–20.

Melittobia sosui Dahms, 1984: 302, ♂, ♀. Holotype ♂, Japan: Okinawa Isl., Ryuku Arch. (Kyushu University, Kyushu, Japan).

MATERIAL EXAMINED. VIETNAM: Thai Binh: 134♀♀, 4♂♂, Hong Minh, Hung Ha, 14.vi.2022, found in a nest of *Ch. bengalense* (Dahlbom), Coll. P. H. Pham. Ha Noi: 617♀♀, 16♂♂, Co Nhue, Bac



Figs 8–14. *Melittobia sosui* Dahms, female: 8 — head, frontal view; 9 — antenna; 10 — forewing; 11 — mesosoma, dorsal view; 12 — habitus and sting, lateral view; 13 — habitus, dorsal view; 14 — habitus, ventral view.

Рис. 8–14. *Melittobia sosui* Dahms, самка: 8 — голова, вид спереди; 9 — антенна; 10 — переднее крыло; 11 — мезосома, вид сверху; 12 — габитус и жало, вид сбоку; 13 — габитус, вид сверху; 14 — габитус, вид снизу.

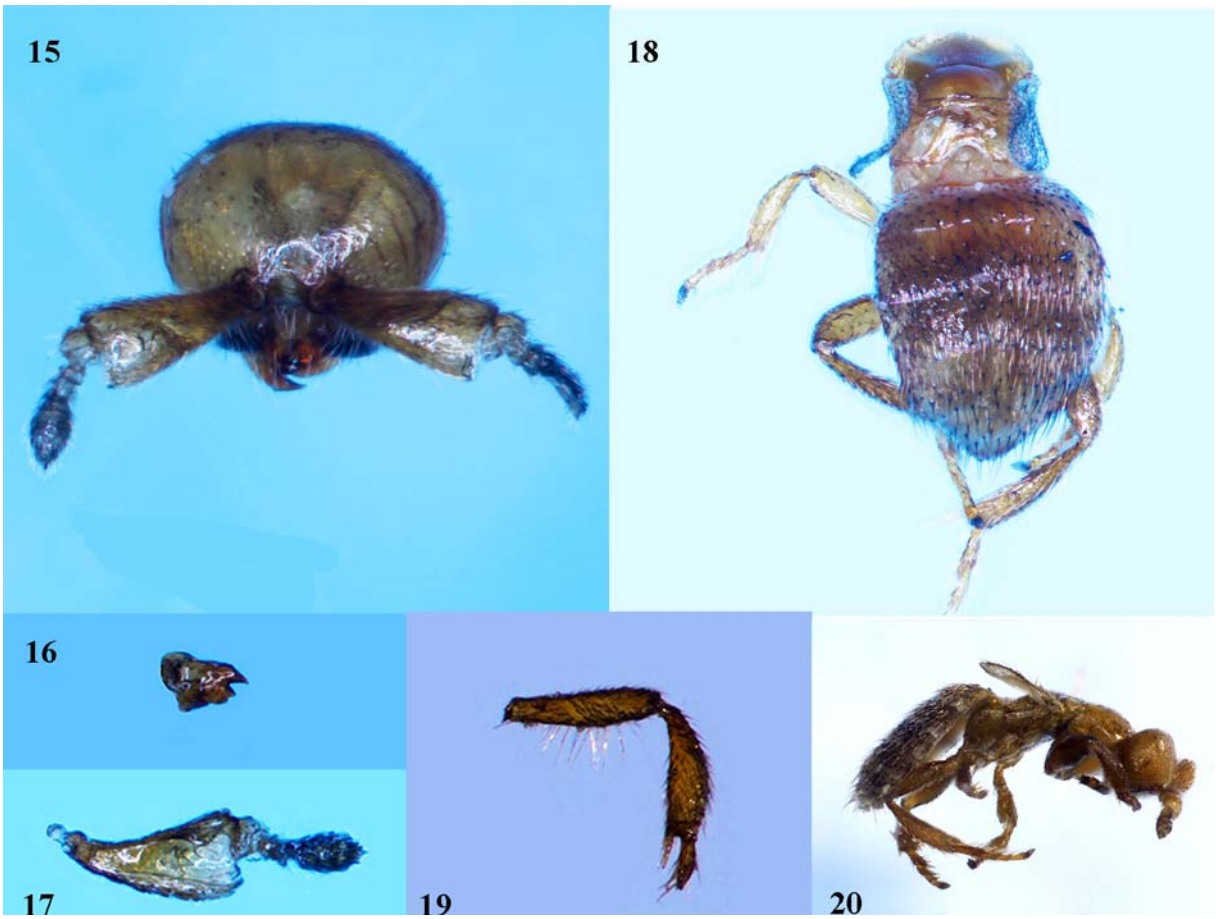
Tu Liem, 4.xii.2021, 1.i.2023, 7.i.2023, emerged from two overwintering nests of *S. madraspatanum* and a pupa of *D. melanogaster,* Coll. P. H. Pham and Khuc Thi Ut; 442♀♀, 34♂♂, Van Hoa, Ba Vi, 8.i.2020, found parasitizing on a prepupa of a nest of *A. chinense* and on a prepupa of a nest of *Ch. japonicum*, Coll. P. H. Pham. Hoa Binh: 217♀♀, 7♂♂, My Tan, Tan Thanh, Luong Son, 20.iii.2019, 27.vi.2019, 26.vii.2019, found in a cocoon of *Ch. malignum* and in a nest of *Megachile disjuncta* (Fabricius, 1781), Coll. P. H. Pham and Khuc Thi Ut; 37♀♀, 3♂♂, Kim Son, Kim Boi, 22.ix.2019, Coll. P. H. Pham; 72♀♀, 2♂♂, Thanh Lap, Luong Son, 2.ix.2020, found in a pupa of *D. melanogaster*, Coll. P. H. Pham; 288♀♀, 10♂♂, Khai Doi, Kim Boi, found in nests of *E. architechtus*, Coll. P. H. Pham. Bac Ninh: 138♀♀, 6♂♂, Tan Hong, Tu Son, 2.iii.2017, 14.ii.2019, found in old nests of *S. madraspatanum* and in a cocoon of *A. troglodytes* put in an old nest of *S. madraspatanum,* Coll. P. H. Pham. Thai Nguyen: 212♀♀, 4♂♂, Phu Luong, 8.ix.2019, 17.vii.2020, found in cocoons of *Isodontia* sp. in trap nests and of *Ch. malignum* in trap nests, P. H. Pham. Vinh Phuc: 2♀♀, Me Linh Station for biodiversity, Ngoc Thach, Me Linh, 31.v.2019, found in a nest of *S. deforme*, P. H. Pham. Quang Ninh: 81♀♀, Hai Ha town, Hai Ha, 24.i.2018, found in a nest of *S. madraspatanum*, Coll. P. H. Pham. Cao Bang: 203♀♀, 6♂♂, Ngoc Dong, Ha Quang, 24.v.2022, found parasitizing a prepupa of *S. javanum*, Coll. P. H. Pham and Khuc Thi Ut.

REDESCRIPTION. Female (Figs 8–14): Body length 1.1–1.2 mm, forewing length 0.8–1.0 mm.

Colour. Brownish black. Following parts yellowish: scape, pedicel, legs except coxae, sting. Ocelli and eyes red-brown.

Head (Figs 8–9, 12–14). Semicircular in frontal view, about 1.1 times as wide as high; deeply vertical groove running around ocelli, then joining eye grooves from hind ocelli; facial grooves converging just below midocellus, then meeting at middle area of eyes as single carina elongating to scrobes; genal-clypeus margin near rounded; anterior margin of clypeus narrowly notched; mandible, about 1.4 times as wide as long, with three teeth on inner margin, first tooth small, long, very sharp, second well defined, third very broad, blunt; eyes with moderately dense, long setae; gena with moderately long setae; antenna covered with long setae, sparsely on scape and pedicel, densely on flagellum, with four articles, second article smallest, forth broadest with a club of three segments; placoid on all flagellomeres, two on first, one on second and third, and four on club; scape broad, conspicuously curved, 3.2 times as wide as long; pedicel longer than wide; length of antennal segments as follows: scape: pedicel: article 1: article 2: article 3: article 4 = 32: 12: 8: 5: 7: 18; maxillary palp about 2.7 times as wide as long.

Mesosoma (Figs 10–14). Pronotum regularly sloped anteriorly, broader than high, about 1.7 time as long as wide, with broad rhombus on ventral surface; mesoscutum flat in profile view, with three lobes, length of posterior margin of mid lobe equivalent to that of anterior margin of mid lobe of scutellum; scutellum conspicuously convex, with mid lobe polish, about 1.9 times as wide as long and sublateral lobes with 3 long setae; propodeum polish, posterior margin small V-shaped at mid area, posterolateral angles obtuse. Forewing uniformly hyaline, 2.4 times as wide as long, with violaceous



Figs 15–20. *Melittobia sosui* Dahms, male: 15 — head, frontal view; 16 — mandible; 17 — antenna, ventral view; 18 — mesosoma and metasoma, dorsal view; 19 — mid leg; 20 — habitus, lateral view.

Рис. 15–20. *Melittobia sosui* Dahms, самец: 15 — голова, вид спереди; 16 — нижняя челюсть; 17 — антенна, вид снизу; 18 — мезосома и метасома, вид сверху; 19 — средняя ножка; 20 — габитус, вид сбоку.

reflections and moderately dense, short pubescence; stigmal vein with uncus, length of stigmal vein equivalent to that of parastigmal vein; submarginal vein with 5 setae of equal length; marginal vein with a series of about 12–15 long setae, length of marginal vein 1.3 times that of submarginal vein and 6.1 times that of stigmal vein; length of submarginal vein 5.1 times that of stigmal vein.

Metasoma (Figs 12–14). With six segments, 1, 2, and 3 of equal length; metasomal tergum 1 0.6 times as wide as long, width of metasomal tergum 1 0.8 times that of metasomal tergum 2; metasomal terga 2 and 3 equal in width; sting straight, rather long, length of sting about 0.5 times that of metasoma. Metasoma with rather dense long setae.

Male (Figs 15–20): Body length 1.1–2.0 mm, forewing length 0.4–0.5 mm.

Colour. Golden brown, except flagellum blackish, mandible red brown.

Head (Figs 15–17, 20). Broad, about 1.3 times as high as wide; eyes and ocelli reduce to small spots; vertex subcircular; genal-clypeal margin rounded; anterior margin of clypeus centrically, narrowly notched, with two laterally, long, small lobes; clypeus deeply impressed, a dense cluster of long setae immediately above impression; mandible 1.2 times as wide as long, with three teeth on inner margin, apical tooth long, broad, sharp, well separated from second, second and third teeth blunt, 2–4 setae sparsely distributed on outer surface; maxillary palp about 2.1 time as wide as long; antenna with five flagellomeres; article 1 smaller than 2 and 3; article 4 variably shaped and closely applied to segment 1 of club; apical flagellomere with a club of three segments; placoid on third segment of club; pedicel conspicuously concave on inner margin and much wider than flagella; scape, 1.9 times as wide as long, broom-shaped, curved, concave on outer margin; ventral surface with deep, broad, longitudinal groove, width of groove about 0.5 times that of scape; anterior margin of groove conspicuously wavy, with glandular area geniculate; posterior margin of groove straight; dorsal surface of scape with long setae; length of antennal segments as follows: scape: pedicel: article 1: article 2: article 3: article 4 = 26: 5: 2: 4: 3: 10. Head with rather long, white setae.

Mesosoma (Figs 18–20). Pronotum sloped regularly anteriorly, 1.5 time as long as wide. Mesoscutum, scutellum, metascutellum polish; mesoscutum and propodeum with sparse setae. Scutellum without grooves, with 3 setae on each side. Fore leg: trochanter with stiff, short setae; tarsi with 2 segments; 1 as long as 2; 2, 3 and 4 fused. Mid leg: trochanter with curved, long setae; femur about 4.2 time as wide as long, with 18–20 setae on the ventral surface, 12 long setae on mid area; length to width of tibia 3.1: 1; tarsi with 3 segments. Fore wing long and narrow, about 4.1 time as wide as long, with its apex acute; marginal to submarginal vein length 1.6: 1.

Metasoma (Figs 18, 20). With seven segments, length of metasomal tergum 1 0.8 times that of metasomal tergum 2, metasomal terga 2 and 3 in equal length. Metasoma with moderately dense, long setae.

DISTRIBUTION. Vietnam: Cao Bang, Ha Noi, Hoa Binh, Quang Ninh, Thai Binh, Thai Nguyen, Vinh Phuc (**new records**), Bac Ninh [Pham et al., 2021]. *Elsewhere*: Japan, Taiwan [Noyes, 2021].

Two externally morphological types of females are presented in *M. sosui*, long wing females as described above and short wing females that are similar to long wing females except their forewings reaching the middle area of the metasoma only. Dahms [1984] produced *M. sosui* as a new species based on comparisons of a few consistently different features between the species and *M. assemi*. He examined eight female wasp specimens of *M. sosui* and showed 2 setae on the left lobe and 3 setae on the right lobe of the scutellum. Possibly, this is a mistake feature observed by Dahms [1984], because more than 2500 specimens examined in the present study, we observed 3 setae on each lobe of the scutellum. On fresh specimens of *M. sosui*, wings were of violaceous reflections. This is not found in dry specimens in this study and is not stated in Dahms' 1984 study. The body length of males markedly varies from 1.1 to 2.0 mm, but only 1.3 mm in Dahms' 1984 study. Because of critical point dried specimens and limit of the number of specimens examined, several features of the species in comparison with *M. assemi* are omitted in Dahms [1984]. Hence, we, here, add some different features between them (Table 1).

HOST. Mathews et al. [2009] recorded seven cultural and natural hosts for *M. sosui* from Japan, Taiwan, and Netherlands, which were distributed in five families and two orders. González et al. [2018] recorded four cultural hosts for *M. sosui* from U.S.A., which were distributed in four families and two orders. Pham et al. [2021] recorded a natural host for the parasitoid from Vietnam. In the present study, we recorded nine new natural hosts for *M. sosui* from Vietnam. Alto-

Table 1. Additional different features between *M. assemi* and *M. sosui*
Таблица 1. Дополнительные отличия между *M. assemi* и *M. sosui*

No.	***M. assemi* (in Dahms [1984])**	***M. sosui* (in this study)**
	Female	
1	5 setae of different length on the submarginal vein of forewing	5 setae of equal length on the submarginal vein of forewing
2	3–4 setae on each submedial lobe of the scutellum	3 setae on each submedial lobe of the scutellum
3	Marginal to stigma vein length 3.4: 1	Marginal to stigma vein length 6.1: 1
4	Submarginal to stigma vein length 3.7: 1	Submarginal to stigma vein length 5.1: 1
5	Length to width of the pronotum 1: 1.5	Length to width of the pronotum 1: 1.7
	Male	
6	Length to width of the mid tibia 3.7: 1	Length to width of the mid tibia 3.1: 1
7	Flagellum 1 as broad as flagella 2 and 3	Flagellum 1 smaller than flagella 2 and 3
8	Flagellum 4 cup-shaped	Flagellum 4 variably shaped
9	Length to width of the fore wing 4.1: 1	Length to width of the fore wing 4.6: 1

Table 2. Hosts and countries recorded for the parasitoid *M. sosui*
Таблица 2. Хозяева и страны, отмеченные для паразитоида *M. sosui*

Host	Country	Reference
DIPTERA **Calliphoridae**: *Calliphora erythrocephala* (Macquart, 1834)*	Netherlands**	Mathews et al. [2009]
HYMENOPTERA **Anthophoridae**: *Xylocopa tranquebarorum* (Swederus, 1787)	Taiwan	Mathews et al. [2009]
HYMENOPTERA **Vespidae**: *Delta flavopictum formosanum* (Zimmermann, 1940), *Symmorphus apiciornatus* (Cameron, 1911), *Discoelius japonicus* Pérez, 1905 **Sphecidae**: *Sceliphron madraspatanum formosanum* van der Vecht, 1968 **Crabronidae**: *Trypoxylon* sp.	Japan	Mathews et al. [2009]
HYMENOPTERA **Apidae**: *Apis mellifera* Lepeletier, 1836* **Megachilidae**: *Megachile rotundata* (Fabricius, 1787)* **Crabronidae**: *Trypoxylon politum* Say, 1837*	U.S.A.**	González et al. [2018]
DIPTERA **Sarcophagidae**: *Sarcophaga bullata* Parker, 1916*		
HYMENOPTERA **Vespidae (Eumeninae)**: *Apodynerus troglodytes*		Pham et al. [2021]
HYMENOPTERA **Megachilidae**: *Megachile disjuncta* **Vespidae (Eumeninae)**: *Allorhynchium chinense*, *Eumenes architechtus* **Sphecidae**: *Isodontia* sp., *Chalybion bengalense*, *Chalybion japonicum, Sceliphron javanum*, *Sceliphron madraspatanum*	Vietnam	This study
DIPTERA **Drosophilidae**: *Drosophila melanogaster*		

NOTES: * — cultural host, ** — country where *M. sosui* has been reared with cultural hosts.
ПРИМЕЧАНИЯ: * — культуральный хозяин, ** — страна, где *M. sosui* выращивался на культуральных хозяевах.

gether, 21 species of natural and cultural hosts are recorded for the parasitoid *M. sosui* (Table 2).

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Competing interests. The authors declare no competing interests.

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