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A new species of *Marmara* (Lepidoptera: Gracillariidae: Marmarinae), with an Annotated List of Known Hostplants for the Genus

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Abstract

Larvae of the New World gracillariid moth genus *Marmara* are primarily stem/bark miners, with some species mining in leaves or fruits. We describe a new species, *M. viburnella* Eiseman & Davis, which feeds on *Viburnum*, initially mining the leaves but completing development as a stem miner. The type series is from Nantucket Island, Massachusetts, with observations of leaf mines indicating the species is widespread in the eastern USA. Combining previously published data, our own observations, and other sources, we present a list of known *Marmara* hostplants, many of which represent undescribed species.

Key words: *Ageniaspis*, *Quadrastichus*, barkminer, leafminer, stem miner, *Viburnum*

Introduction

The genus *Marmara* Clemens (Lepidoptera: Gracillariidae: Marmarinae) includes 19 described North American species and five from South America. Larvae of most species are stem miners, typically in bark of woody plants, with a few mining instead (or additionally) in leaves or fruits. When mature, larvae of all the leaf and fruit feeders, and most of the stem feeders, molt to a non-feeding final instar that cuts a transverse semicircular slit at the end of the mine and wanders for some distance before spinning a cocoon. This cocoon may be spun on a leaf, in a bark crevice, or in leaf litter, and is adorned with numerous pearly globules or "bubbles" extruded from the anus (Wagner *et al.* 2000). A few stem-mining species instead cut a much larger, lateral, semicircular flap at the end of the mine and spin an unadorned cocoon on the underside of this flap, causing the overlying stem tissues to buckle over the cocoon (Braun 1915; Vinal 1917; De Gryse 1943; Fitzgerald 1973; Wagner *et al.* 2000).

One *Marmara* species from the southwestern USA and all of the South American species were described by E. Meyrick without knowledge of larval biology, although adults reared from cacao pods were subsequently determined as *M. isortha* (Meyrick) (Bondar 1939). *Marmara gulosa* Guillén & Davis is polyphagous, mining in peels, shoots, and occasionally leaves in California and Arizona (Guillén *et al.* 2001; Neff 2002; Semet 2010). Known hosts include an array of cultivated plants as well as some native species, although there has yet to be a focused effort to assess its host range on natives. As far as is known, the remaining described species each feed on plants of one genus or two closely related genera. *Marmara smilacisella* (Chambers) mines leaves of *Smilax* L. (Smilacaceae), *M. arbutiella* Busck mines leaves and occasionally green stems of *Arbutus* L. (Ericaceae), and the rest are apparently exclusively stem miners (Wagner *et al.* 2000; Guillén *et al.* 2001). A table of the host and tissue specificity of described *Marmara* species was presented by Guillén *et al.* (2001), and one additional species has been described since then (Davis *et al.* 2011).

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Here we describe a new species that is intermediate in habits, with young larvae mining in leaves and later instars feeding in stems. The cocoon is spun under a bark flap cut at the mine terminus but is sometimes adorned with pearly bubbles. In the hope of stimulating further investigation of this genus, we present an annotated list of known and suspected *Marmara* host plants assembled from the literature and our own observations (Table 1).

Materials and methods

In June 2016, CSE and JAB spent several hours on Nantucket Island (Massachusetts, USA) searching *Viburnum dentatum* L. (Adoxaceae) plants for *Marmara* bark flaps, either gently peeling them off or using a knife to cut off stem portions that included the flaps. These were collected in plastic vials, which were checked daily for emerging adults. Adult moths were pinned, spread, and double mounted by JAB. After CSE described the external characters, the specimens were sent to DRD for dissection and illustrations, and were deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (USNM). Parasitoids were preserved in 95% ethanol. Encyrtids were examined by R. L. Zuparko, Department of Entomology, California Academy of Sciences, San Francisco, and deposited in the Essig Museum of Entomology, University of California, Berkeley. Eulophids were examined by C. Hansson, Department of Zoology, Lund University, Sweden, and deposited in the Natural History Museum, London.

We have followed Stevens (2016) for higher taxonomy of plants. Otherwise, plant taxonomy follows USDA, NRCS (2016), and literature records have been brought into agreement with this classification without comment except in ambiguous cases.

Marmara viburnella Eiseman & Davis, sp. nov.

Figs. 1–11

Adult (Figs. 1, 10, 11). Wingspan ~6 mm.

Head: Vestiture smooth; frons and vertex silvery white; back of head blackish. Eyes red in live specimens. Maxillary palpus white with prominent black tip; haustellum white; labial palpus with first two segments black (one specimen with inner surfaces white) and third segment white with a black ventral spot. Antenna dusky, paler beneath; pedicel with black scales (conspicuously elongated in female).

Thorax: Shining blackish above, pale golden beneath. Forewing shining blackish with silvery markings: a broad transverse fascia in the basal ¼, gradually broadening dorsally; at ½, opposing dorsal and costal spots, separate (1 specimen) or narrowly joined in the middle (2 specimens); at ¾, a prominent costal spot (extending to middle of wing) and a smaller, opposing dorsal spot; a fainter costal spot of similar size at apex, mottled with blackish scales; fringe white. Hindwing dusky, slightly paler than forewing. Coxae white with black scales distally. Fore femur mostly black, with variable amounts of white proximally, laterally, and posteriorly; fore tibia mostly black, with variable amounts of white proximally, distally, and posteriorly; fore tarsus white with black bands anteriorly. Middle femur mostly black (including spurs); middle tibia black with a broad, white central band, more or less interrupted centrally with black scales; middle tarsus white with a few black scales. Hind femur white with a broad black band distally; hind tibia black with two broad white bands, contiguous with the white proximal and distal spurs; hind tarsus white with a broad black band proximally and a few black scales distally.

Abdomen: Shining blackish dorsally; ventrally silvery with intersegmental boundaries black; anal tuft silvery (concolorous with abdomen in female).

Male genitalia (Figs. 2A–B): Uncus absent. Tegumen a slender, dorsal arched band. Vinculum a moderately broad ventral band with anterior margin slightly curved caudally; anterior margin reflexed medially to form slender triangular lobe. Gnathos membranous and poorly defined. Valva separated nearly from base into three distinct lobes: a relatively short, slender, costal lobe bearing a dense comb of 18–20 short, stout spines; an elongate, slender, more lateral cucullar lobe that expands abruptly to form a setose, triangular distal lobe; and the largest, most ventral, valvular lobe that gradually broadens apically to a nearly truncate, inwardly curved apex. Phallus short, acute, with greatly inflated phallobase, approximately equal in length to distal, tubular portion of phallus.

FIGURE 1. *Marmara viburnella* holotype male.

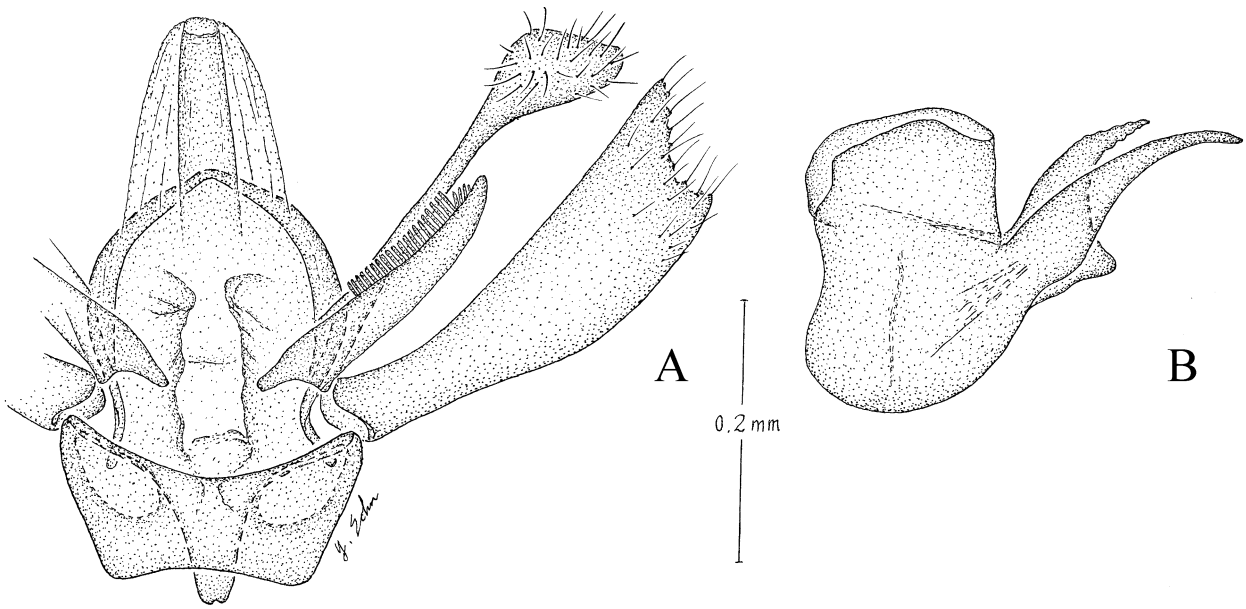

FIGURE 2. *Marmara viburnella* male genitalia. 2a, Genital capsule with valvae, ventral view. 2b, Phallus, lateral view.

Female genitalia: Not examined. The abdomen is now missing from the single female specimen.

Larva. Early instar as in Fig. 3; immature stages otherwise not examined.

Cocoon. An oblong envelope of white silk, approximately 5–6 mm long and 2–3 mm wide, spun on the underside of a semicircular bark flap cut by the larva at the end of the mine; unadorned or with a cluster of 1–12 or so pearly bubbles near each end (Figs. 4–6).

Type material. *Holotype:* ♂, UNITED STATES: Massachusetts: Nantucket Co.: Nantucket State Forest, 11.vi.2016, em. 2.vii.2016, C. S. Eiseman & J. A. Blyth, ex *Viburnum dentatum*, #CSE2692, slide USNM 34733, digital image captured (USNM 01325414).

Paratypes: Same collection data as holotype, 1 ♂, em. 24.vi.2016, #CSE2625 (USNM); Nantucket, Lost Farm, 1 ♀, 12.vi.2016, em. 27.vi.2016, C. Eiseman, ex *Viburnum dentatum*, #CSE2642 (USNM).

FIGURES 3–11. *Marmara viburnella*. 3, early instar larva; 4, bark flap cut by the larva, under which the cocoon is spun; 5, cocoon of male paratype, with pupal exuviae protruding from right end; 6, cocoon with numerous pearly bubbles, found in Illinois; 7, the first documented leaf mine, from Tuckernuck Island, September 2011; 8, mine tract departing the leaf blade, visible as a brown line in the petiole and twig; 9, bark mine; 10, holotype male; 11, paratype male.

Distribution. Eastern United States and southeastern Canada. Adults have only been reared from cocoons collected on Nantucket Island, Massachusetts, but we have observed larval mines in mainland Massachusetts (Berkshire, Bristol, and Plymouth Counties), Connecticut (Hartford), Illinois (near Effingham), Louisiana (4 mi NE of Slidell), Maryland (Baltimore; Wilson 2014), North Carolina (Durham), Rhode Island (Block Island), Vermont (Mt. Mansfield), and Quebec (Gatineau Park).

Etymology. The specific name is derived from the genus of the host plant, *Viburnum* L.

Diagnosis. The forewing pattern is similar to that of several described *Marmara* species possessing darkly banded forewings, but *M. viburnella* is clearly distinct when larval biology is taken into account. No other species is known both to mine leaves and to pupate under a bark flap cut by the larva at the end of the mine. Further, each of the six species that is reported to pupate under a bark flap, in addition to using hosts belonging to other plant orders, has an adult with distinctly different forewing coloration: the wings of *M. auratella* Braun are "bronzy brown, with an almost golden luster under brilliant illumination" (Braun 1915); those of *M. elotella* (Busck) and the three ash feeders are predominantly white (Busck 1909; Fitzgerald 1973); and those of *M. fasciella* (Chambers) are banded with approximately equal parts white and pale brown (Chambers 1875).

The male genitalia of *M. viburnella* are most similar to that of *M. fulgidella* (Clemens) in possessing a greatly inflated phallobase and inwardly curved apex of the valvular lobes. The forewing pattern of *M. fulgidella* is distinct in possessing much broader white fascia.

Host plants. Adults have been reared from *Viburnum dentatum* L. (Adoxaceae). We have found leaf mines of the new species on *V. lantanoides* Michx., *V. nudum* L. var. *cassinoides* (L.) Torr. & A. Gray, and *V. rafinesquianum* Schult.

Biology. In Massachusetts, adults emerge in June and early July and deposit eggs on the upper surfaces of leaves of *Viburnum*, one egg per leaf, typically over a prominent vein. The sap-feeding larvae hatch in early July and form meandering linear leaf mines, less than 1 mm wide (Figs. 7–8). The mine is at first epidermal and may appear whitish or like a tiny, shining snail trail, difficult to discern. Before long the mine deepens and becomes pale brown in color, with a very fine, central frass line visible under magnification. Eventually the mine enters the leaf midrib, either directly or by a side vein, and proceeds down the petiole and into the stem. We have found apparently occupied leaf mines in Massachusetts as late as 8 August, and have found completed leaf mines, with larvae already feeding in stems, as early as 19 July in Massachusetts and 30 June in Illinois. Once in the stem, the larva quickly tunnels deeper in the bark, and the mine (Fig. 9) usually is not externally visible for more than a few cm. Based on the known life histories of other bark-mining *Marmara* species, we presume that the larvae overwinter partially grown and finish feeding in the spring. The depth of the bark mine appears to vary throughout development; we have found fragmentary epidermal and deeper bark mines of various sizes, but much of the feeding evidently takes place in the cortex and is not visible on the surface. The mature larva cuts a semicircular flap in the bark (Fig. 4) and spins its cocoon on the underside of this (Fig. 6). Although we have found mines extending to within a few cm of the base of the stem, the pupation site tends to be well over 1 m aboveground, on a branch or a portion of the main stem that is less than 1 cm thick and has relatively smooth bark. Upon emergence of the adult (Figs. 10–11), the pupa is thrust through the cocoon near one end (Fig. 5).

Parasitoids. Four *Quadrastichus* Girault adults (Hymenoptera: Eulophidae: Tetrastichinae) emerged from one cocoon. No keys exist for the identification of North American species in this genus, and there are likely numerous undescribed species in addition to the ten known from this continent (C. Hansson, *in litt*.). Six *Ageniaspis* Dahlbom adults (Encyrtidae: Encyrtinae) emerged from another cocoon, and another 23 emerged from two or more cocoons that were not isolated in separate rearing vials. They do not match any of the species recorded from northeastern North America (R. Zuparko, *in litt*.).

Other Associates. We found several different arthropods hiding under bark flaps created by larvae of *Marmara viburnella*. These included two elongate-bodied springtails (Entomobryomorpha), *Anurophorus* cf. *septentrionalis* Palissa (Isotomidae) and *Entomobrya nivalis* (L.) (Entomobryidae), as well as two beetles (Coleoptera), *Contacyphon* Des Gozis sp. (Scirtidae) and *Neapion* Alonso-Zarazaga sp. (Brentidae).

Remarks. The successful rearing of *Marmara viburnella* followed five years of investigation and failed attempts, during which the larval biology was gradually pieced together. The first known leaf mine on *Viburnum dentatum* was found on Tuckernuck Island by CSE on 10 September 2011 during a survey of leaf-mining and gall-forming insects of Nantucket County, Massachusetts, USA. Additional mines were found on Nantucket Island in August 2012, and since they were observed to proceed down the petioles and into the twigs, several twigs with

mined leaves were collected in resealable plastic bags. A single larva appeared in one of the bags, and photographs were shown to DRD and DLW, who agreed that it appeared to be an early instar *Marmara*. In June 2013, additional searching of *V. dentatum* by CSE and JAB revealed a few old bark mines, but no bark flaps were found and it was presumed that this species exits the mine to pupate after overwintering in the stem or roots. In late July 2014, *V. dentatum* plants with leaf mines were marked with pink flagging, and in December, five of these were dug, potted, and kept in an unheated shed over the winter, inside large sleeves of fine-meshed cloth. On 3 March 2015, the plants were brought indoors, and they were checked daily until June for emerging adults. No moths emerged, but on 30 June, CSE and JAB discovered leaf and stem mines with two associated bark flaps on *V. dentatum* west of Effingham, Illinois. Thus, in June 2016 CSE and JAB were newly motivated to search for bark flaps on Nantucket Island, and succeeded in collecting approximately 30 that appeared fresh (rejecting numerous others that were from previous years) scattered over five different sites.

The leaf mine of *Marmara viburnella* is easily distinguished from other mines occurring on *Viburnum*, as no other insect produces a mine that proceeds down the petiole and into the stem. The only other known linear mine on *Viburnum* is one found by CSE and JAB on *V. edule* (Michx.) Raf. in Washington. This mine was tightly coiled at the beginning, arcing back and forth in an area bounded by two lateral veins; eventually it crossed a vein and stretched out into a typical linear mine. The larva exited through a slit in the upper epidermis at the end of the mine. Frass was deposited in beaded strips along the sides (not in a thin central line as in *M. viburnella*), an arrangement characteristic of Agromyzidae (Diptera). We presume this mine to be the work of *Liriomyza charada* Lonsdale, which has been reared from *V. edule* in Alberta (Lonsdale 2017). The two other known *Viburnum* miners are both moths that form blotch mines. *Phyllonorycter viburnella* (Braun) (Gracillariidae), which like *M. viburnella* is common on *V. dentatum* on Nantucket Island, forms an underside tentiform mine in which pupation takes place (Braun 1923). *Coleophora viburniella* Clemens (Coleophoridae) feeds from a portable case, producing full-depth mines that contain no frass. It is recorded from *V. nudum* L. var. *cassinoides* (L.) Torr. & A. Gray (McDunnough 1942), *V. prunifolium* L. (Clemens 1861), and *V. rufidulum* Raf. (Covell 1999), and we have found larvae on *V. dentatum* in Vermont.

It is conceivable that *Marmara* mines on *Viburnum* species other than *V. dentatum* represent moths distinct from *M. viburnella*, but at this point we have no reason to suspect so. In Berkshire County, Massachusetts, we have found mines on *V. lantanoides* in the immediate vicinity of mines on *V. dentatum*.

Discussion

Among the described *Marmara* species with known life histories, *M. viburnella* is unique in its habit of beginning as a leafminer and completing development as a stem miner. *Marmara arbutiella* is normally a leafminer, occasionally mining in the stem and rarely mining through the stem from one leaf to another (Wagner *et al.* 2000). *Marmara gulosa* may mine stems, leaves, or fruits of its various hosts (Guillén *et al.* 2001). As far as is known, each of the other described species is found in a single plant tissue (stem, leaf, or fruit). However, our observations of leaf mines throughout the USA have revealed that life histories like that of *M. viburnella* are found on a number of plants unrelated to *Viburnum* (Table 1). Specifically, confirmed or possible *Marmara* mines leading from the leaf blade to the stem occur on Anacardiaceae (*Malosma* Nutt. ex Abrams, *Rhus* L.), Asteraceae (*Lactuca* L.), Ericaceae (*Arctostaphylos* Adans.), Rosaceae (*Heteromeles* M. Roem.), Salicaceae (*Populus* L. and *Salix* L.), and Symplocaceae (*Symplocos* Jacq.).

In Table 1 we have collected records of *Marmara* mines, or suspected *Marmara* mines, on North American plants belonging to 115 genera in 50 families. Records from 49 genera in 28 families have been attributed to the polyphagous species *M. gulosa*, although few of these have been confirmed by rearing or barcoding. Host plant records from 79 genera in 40 families represent the 19 other described North American species plus an unknown number of undescribed species—these records are from outside the known geographic distribution of *M. gulosa*, or else involve species that have been reared and are known to be undescribed. Apart from *M. auratella*, which has been reared from two genera of Asteraceae, and *M. oregonensis* Fitzgerald, which has been reared from two genera of Pinaceae, every other species is monophagous as far as is known (mines on both *Castanea* Mill. and *Quercus* L. have been attributed to *M. fulgidella*, but this species has apparently only been reared from the latter host). Conversely, three described species have been reared from a single host, *Fraxinus pennsylvanica* Marshall

(Oleaceae), and two from *Malus pumila* Mill. (Rosaceae). Several other plant genera host *Marmara* species that differ sufficiently in geography or larval habit that we suspect multiple moth species are involved. Given all this, it seems likely that undescribed *Marmara* species far outnumber those that have been named. DRD currently recognizes (and has illustrated) approximately ten new species for North America, most of which have not been reared; the rest of us have reared adults that surely represent more than a dozen further species.

It should be noted that mines of other insects can superficially resemble those of *Marmara*; thus some qualifying statements (e.g. "moth genus not confirmed") are entered into the "Other notes" field in Table 1. Larvae of the gracillariid genera *Phyllocnistis* Zeller (Phyllocnistinae) and *Metriochroa* Busck (Oecophyllembiinae), like *Marmara*, are sap feeders throughout development. Their leaf mines are similarly long and linear, without granular frass, but in these genera pupation always takes place at the end of the mine, whereas all known leaf-mining *Marmara* species vacate their mines before spinning cocoons (Kawahara *et al.* 2017). A few agromyzid flies also produce epidermal linear leaf mines easily mistaken for those of Gracillariidae. These include *Phytomyza opacae* Kulp, which mines in leaves of evergreen *Ilex* L. species (Aquifoliaceae) (its puparium is formed within the leaf but is often difficult to detect, as it is formed about 1 cm beyond the apparent end of the mine), and the polyphagous *Liriomyza schmidti* (Aldrich), which occurs from Florida to Argentina. An unknown agromyzid forms epidermal mines on *Gelsemium sempervirens* (L.) W.T. Aiton (Gelsemiaceae) in the southeastern USA; we had considered these as possible *Marmara* mines until one was found with a dead larva inside. The lack of a head capsule easily distinguishes an agromyzid larva from that of a gracillariid, and when a visible frass trail is present, it tends to alternate along the sides of agromyzid mines rather than forming a central line as in gracillariid mines.

A wide variety of Lepidoptera, Diptera, Coleoptera, and Hymenoptera feed in stems. Many of these form galleries partially or entirely in the pith, rather than mining exclusively in the outer tissues as in *Marmara*. We are unaware of any beetles or sawflies that form stem mines resembling those of *Marmara*. Among flies, some Agromyzidae form externally visible stem mines on herbaceous plants. Most of these are species of *Ophiomyia* Braschnikov, which pupate at the ends of their mines. Occasional members of other agromyzid genera form stem mines and exit to pupate; as with leaf mines, the frass pattern helps to distinguish these from lepidopteran stem mines. Species of *Phytobia* Lioy (Agromyzidae) feed in the cambium of woody plants but their mines are not externally visible (Spencer & Steyskal 1986).

Apart from *Marmara*, the moths most likely to be responsible for externally visible stem mines in North America are Nepticulidae. Species of *Acalyptris* Meyrick form stem mines on Cyperaceae and Fabaceae (Frohne 1939; Wagner 1987), and as far as is known all species of *Zimmermannia* Hering mine in bark of woody plants, the known hosts being in Fagaceae (we report a possible *Zimmermannia* mine on *Betula* L.(Betulaceae) in Table 1, and one European species feeds on *Ulmus* L. (Ulmaceae)) (van Nieukerken *et al.* 2016). On *Prosopis velutina* Wooton (Fabaceae) in Arizona, we have found bark mines resembling those of *Z. bosquella* (Chambers) on *Quercus*, each beginning with a compact spiral. None of these nepticulid mines has been reported to exceed 10 cm in length, whereas *Marmara* stem mines typically measure at least several dm.

The other nepticuloid family, Opostegidae, also includes stem miners. The only Nearctic species with a known life history is *Opostegoides scioterma* (Meyrick), which forms cambium mines on *Ribes* L. (Grossulariaceae) that are not externally visible (Grossenbacher 1910). Young larvae of the European species of *Pseudopostega* Kozlov, which are found on Lamiaceae, produce externally visible mines before tunneling deeper into the stems (E. van Nieukerken *in litt.*). In Massachusetts we have found similar mines on *Lycopus* L., sometimes extending into the leaf blades, that may likewise be attributable to *Pseudopostega*. Numerous leaf mines on *Monarda* L. photographed by C. Vispo (*in litt.*) in Connecticut are similar in appearance and invariably involve the petioles; these are evidently likewise extensions of stem mines and are likely produced by the same or a related insect.

A few moths in other families are known to produce stem mines. *Cydia pseudotsugae* (Evans) (Tortricidae) forms a mine in the bark of *Pseudotsuga menziesii* (Mirb.) Franco (Pinaceae) up to 9 dm long, pupating under a semicircular bark flap as in some *Marmara* but several cm back from the end of the mine (Evans 1969). The European species *Leucoptera spartifoliella* (Hübner) (Lyonetiidae) has been introduced in western North America, where it forms stem mines on *Cytisus* Desf. and *Genista* L. (Fabaceae). The larvae exit their mines to spin conspicuous, elongate white cocoons on the stems (Powell & Opler 2009; Pitkin *et al*. 2016).

Finally, some gracillariids other than *Marmara* may mine stems. An introduced leaf-mining moth in the southern USA, *Caloptilia triadicae* Davis, has been observed to mine petioles and stems of *Triadica sebifera* (L.) Small (Euphorbiaceae) when population densities are high (M. Fox & J. Schneider, *in litt*.). Powell & Opler (2009)

TABLE 1. Host plants from which *Marmara* adults have been reared or on which presumed *Marmara* mines have been found. Literature records are supplemented with our own observations of leaf, stem, and fruit mines. When there is doubt about a mine being attributable to a *Marmara* species, we have indicated this in the "Other notes" column. Most host records for the polyphagous species *M. gulosa* have not been confirmed by rearing; those that definitely have been are indicated in the "Other notes" column. The "Pupation site" field is left blank for hosts not confirmed by rearing, as it is possible that larvae are not able to complete development on these hosts. The few exceptions to this are empty mines we have found with clear terminal exit slits associated with larval exuviae.

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Adoxaceae	*Viburnum dentatum* L.	leaf to stem	internal	Nantucket Co., MA	mines also found in Berkshire, Bristol, & Plymouth Cos., MA; Hartford Co., CT; Effingham Co., IL	*M. viburnella* Eiseman & Davis	C. S. Eiseman & J. A. Blyth
Adoxaceae	*Viburnum lantanoides* Michx.	leaf to stem		Berkshire & Hampshire Cos., MA; Lamoille Co., VT		*M. viburnella* Eiseman & Davis	C. S. Eiseman
Adoxaceae	*Viburnum nudum* L. var. *cassinoides* (L.) Torr. & A. Gray	leaf to stem		Berkshire Co., MA		*M. viburnella* Eiseman & Davis	C. S. Eiseman
Adoxaceae	*Viburnum rafinesquianum* Schult.	leaf to stem		Durham Co., NC		*M. viburnella* Eiseman & Davis	T. S. Feldman
Altingiaceae	*Liquidambar styraciflua* L.	stem		Scotland Co., NC	moth genus not confirmed		T. S. Feldman
Amaranthaceae	*Amaranthus hybridus* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Amaranthaceae	*Chenopodium murale* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Amaranthaceae	*Chenopodium standleyanum* Aellen	stem	external	Payne Co., OK	identity of insect uncertain; exit slit same as in *Marmara* mines, but larval exuviae not found		M. W. Palmer
Anacardiaceae	*Malosma laurina* (Nutt.) Nutt. ex Abrams	leaf, possibly into stem (per Mallory 2013)		Santa Catalina Island & Santa Barbara Co., CA			Powell 2012; D. L. Wagner & J. A. Powell
Anacardiaceae	*Rhus ovata* S. Watson	leaf to stem		San Diego Co., CA			C. S. Eiseman & J. A. Blyth
Anacardiaceae	*Rhus trilobata* Nutt.	stem	internal in exfoliating bark	Mohave Co., AZ	stem pustule former		D. L. Wagner
Anacardiaceae	*Rhus virens* Lindh. ex A. Gray	leaf to stem		Cochise Co., AZ			C. S. Eiseman & J. A. Blyth
Anacardiaceae	*Schinus terebinthifolius* Raddi	stem	external	FL		*M. habecki* Davis	Davis *et al.* 2011

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Apocynaceae	*Apocynum* L.	leaf blade	external	Durham Co., NC	adult female reared (in USNM)		T. S. Feldman
Apocynaceae	*Apocynum cannabinum* L.	stem	external	near Cincinnati, OH	mines found in OK (MWP)	*M. apocynella* Braun	Braun 1915
Apocynaceae	*Apocynum cannabinum* L.	stem, sometimes entering petiole and leaf midrib		Payne Co., OK			M. W. Palmer
Apocynaceae	*Nerium oleander* L.	shoots and occasionally leaves	external	Riverside Co., CA	adults reared (paratypes)	*M. gulosa* Guillén & Davis	Atkins 1961; Guillén *et al.* 2001
Apocynaceae	*Trachelospermum jasminoides* (Lindl.) Lem.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Aquifoliaceae	*Ilex verticillata* (L.) A. Gray	stem		Windham Co., CT	elongate mine in green bark of lower stems of young plants		D. L. Wagner
Araceae	unspecified			Heredia Province, Costa Rica	"*Marmara* from this area are especially prevalent on the monocot families Araceae and Heliconiaceae."		Guillén *et al.* 2001
Araceae	*Colocasia esculenta* (L.) Schott	leaf blade and sometimes petiole	external	Payne Co., OK	adult female reared (in USNM)		M. W. Palmer
Araceae	*Monstera* Adans.	leaf mine		Guanacaste Province, Costa Rica	no adults reared; taxonomic identity uncertain		D. L. Wagner & R. Espinoza
Asteraceae	*Dahlia* Cav.	stem	internal	Cincinnati, OH		*M. auratella* Braun	Braun 1922
Asteraceae	*Helianthus* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Asteraceae	*Lactuca* L.	stems and leaves	external	Payne Co., OK	leaf mines were in basal rosettes, ultimately leading down petiole and apparently into crown of plant		M. W. Palmer
Asteraceae	*Rudbeckia laciniata* L. 'Golden Glow'	stem	internal	Cincinnati, OH		*M. auratella* Braun	Braun 1915
Begoniaceae	*Begonia* L.	leaf mine	external; often on upper surface of mined leaf	Guanacaste Province, Costa Rica			D. L. Wagner & R. Espinoza
Betulaceae	*Alnus rhombifolia* Nutt.	stem		Monterey Co., CA	adult reared		Turner & Turner 2012c

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Betulaceae	*Betula papyrifera* Marshall	stem		New England	elongate serpentine mine in bole; possibly *Zimmermannia* (Nepticulidae)		D. L. Wagner
Betulaceae	*Betula populifolia* Marshall	stem	internal under pitched bark flap	Windham Co., CT	adult reared		D. L. Wagner & R. Wagner
Betulaceae	*Corylus americana* Walter	stem		Nantucket, MA	moth genus not confirmed		C. S. Eiseman & J. A. Blyth
Betulaceae	*Ostrya virginiana* (Mill.) K. Koch	stem	internal under bark flap at mine terminus	Tolland Co., CT; MA	adult reared		D. L. Wagner & V. Wagner; C. S. Eiseman
Bignoniaceae	*Campsis radicans* (L.) Seem. ex Bureau	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Bignoniaceae	*Catalpa speciosa* (Warder) Warder ex Engelm.	stem		Payne Co., OK	moth genus not confirmed (but certainly Gracillariidae)		M. W. Palmer
Bignoniaceae	*Chilopsis linearis* (Cav.) Sweet [“desert willow”]	shoots and leaves		Riverside Co., CA		*M. gulosa* Guillén & Davis	Atkins 1971
Bignoniaceae	× *Chitalpa tashkentensis* Ellis & Wisura [“chitalpa”]	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Boraginaceae	*Cordia sebestena* L.	stem		Monroe Co., FL	single mine in new shoot; perhaps incidental; identity uncertain		D. L. Wagner
Burseraceae	*Bursera ?simaruba* (L.) Sarg.	stem		Guanacaste Province, Costa Rica			D. L. Wagner
Buxaceae	*Pachysandra terminalis* Siebold & Zucc.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Cactaceae	*Opuntia* Mill.	stem (pad)	external	southern TX	mines found in AZ & FL (DLW)	*M. opuntiella* Busck	Busck 1907
Cactaceae	*Opuntia engelmannii* Salm-Dyck ex Engelm.	stem (pad)	external	Cameron Co., TX	adults reared	*M. opuntiella* Busck	D. L. Wagner
Celastraceae	*Euonymus atropurpureus* Jacq.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Clusiaceae	*Clusia* L.			Guanacaste Province, Costa Rica			D. L. Wagner & R. Espinoza
Convolvulaceae	*Ipomoea hederacea* Jacq.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Convolvulaceae	*Ipomoea purpurea* (L.) Roth	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Cornaceae	*Cornus amomum* Mill.	stem		MA	mines fairly short; identity of insect uncertain		C. S. Eiseman
Cornaceae	*Cornus sericea* L. ssp. *occidentalis* (Torr. & A. Gray) Fosberg	stem		Monterey Co. & Plumas Co., CA; Clackamas Co., OR	elongate serpentine mine in new shoots; adults reared		Turner & Turner 2012b; D. L. Wagner
Cornaceae	*Nyssa* L. (ornamental)	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Cornaceae	*Nyssa sylvatica* Marshall	stem		Nantucket, MA; Scotland Co., NC	moth genus not confirmed		C. S. Eiseman; T. S. Feldman
Crassulaceae	*Dudleya* Britton & Rose	leaf		CA: Santa Cruz Island	adults reared		D. L. Wagner
Cucurbitaceae	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	fruit		Riverside Co., CA		*M. gulosa* Guillén & Davis	Atkins 1971
Cucurbitaceae	*Cucurbita* L. (gourd, pumpkin, squash)	fruit		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Cyclanthaceae	*Cyclanthus* Poit. ex A.Rich.			Alajuela Province, Costa Rica			D. L. Wagner & R. Espinoza
Ericaceae	*Arbutus arizonica* (A. Gray) Sarg.	stem	internal; in exfoliating bark	Cochise Co., AZ	stem pustule		D. L. Wagner
Ericaceae	*Arbutus menziesii* Pursh	leaf (occasionally in green stems, per Wagner *et al.* 2000)	external	northern CA; Seattle, WA	mines found in BC (Gilmore 2013) and OR (CSE & JAB)	*M. arbutiella* Busck	Busck 1904; J. A. DeBenedictis; D. L. Wagner
Ericaceae	*Arbutus unedo* L.	leaf		Pacific Northwest		*M. arbutiella* Busck	Wagner *et al.* 2000
Ericaceae	*Arctostaphylos* Adans.	leaf	external	Cochise Co., AZ			D. L. Wagner & R. S. Wielgus
Ericaceae	*Arctostaphylos andersonii* A. Gray	leaf	external	Santa Cruz Mountains, CA	DLW believes the *Arctostaphylos* feeder is a different species, consistently smaller than *M. arbutiella*	*M. arbutiella* Busck	Guillén *et al.* 2001
Ericaceae	*Arctostaphylos patula* Greene	leaf	external	El Dorado Co. & Lassen Co., CA	adults reared; see above	*M. arbutiella* Busck	Gates *et al.* 2002; D. L. Wagner

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Ericaceae	*Arctostaphylos pungens* Kunth	leaf to stem		Cochise Co., AZ			C. S. Eiseman & J. A. Blyth
Ericaceae	*Gaultheria shallon* Pursh	leaf		Galiano Island, BC			Simon 2016
Ericaceae	*Oxydendrum arboreum* (L.) DC.	leaf		Hocking Co., OH; Wake Co., NC	numerous mines found on upper leaf surface; one on lower surface		C. S. Eiseman, J. A. Blyth, T. S. Feldman
Ericaceae	*Vaccinium angustifolium* Aiton	presumably in bark of shoots		Chittenden Co., VT	mines never seen; two adults issued from *Caloptilia* collection		D. L. Wagner
Ericaceae	*Vaccinium corymbosum* L.	stem		Windham Co., CT			D. L. Wagner
Euphorbiaceae	*Euphorbia pulcherrima* Willd. ex Klotzsch	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Euphorbiaceae	*Triadica sebifera* (L.) Small	stem		New Orleans, LA; Hidalgo Co., TX	mines on sucker shoots from Rio Grande Valley (1986) appeared to belong to a *Marmara*		D. L. Wagner
Fabaceae	*Caesalpinia bonduc* (L.) Roxb. [as *Guilandina bonducella*]	stem	external	Palm Beach Co., FL	mines found in Broward & Monroe Cos. (DLW)	*M. guilandinella* Busck	Busck 1900
Fabaceae	*Canavalia ?rosea* (Sw.) DC.	stem	external	Broward Co., FL	mines in green stems		D. L. Wagner
Fabaceae	*Prosopis* L.	stem		Pinal Co., AZ; Tulare Co., CA		*M. gulosa* Guillén & Davis	Gibson *et al.* 1997; Neff 2002
Fabaceae	*Senna marilandica* (L.) Link	stem	external	Payne Co., OK			M. W. Palmer
Fabaceae	*Sophora secundiflora* (Ortega) Lag. ex DC.	leaf		Edwards Co., TX	moth genus not confirmed; mines usually on lower leaf surface		C. S. Eiseman & J. A. Blyth
Fabaceae	*Vigna unguiculata* (L.) Walp.	stem, petiole		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Fabaceae	*Wisteria frutescens* (L.) Poir.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Fagaceae	*Castanea* Mill.	stem		eastern US	unclear whether record is based on rearing or Busck (1913, below)	*M. fulgidella* (Clemens)	Ely 1917
Fagaceae	*Castanea dentata* (Marshall) Borkh. ["chestnut"]	stem	internal under pitched bark flap	Windham Co., CT; Falls Church, VA	not reared; found less commonly than mines on oak in same area (VA)		Busck 1913; D. L. Wagner
Fagaceae	*Fagus grandifolia* Ehrh.	stem		Hampshire Co., MA	moth genus not confirmed		C. S. Eiseman

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Fagaceae	*Quercus* L. ["oak"]	stem	external	Falls Church, VA		*M. fulgidella* (Clemens)	Busck 1913
Fagaceae	*Quercus alba* L.	stem	internal under pitched bark flap	Tolland Co., CT	reared		D. L. Wagner & L. Mehrhoff
Fagaceae	*Quercus kelloggii* Newberry	stem	presumably external	El Dorado Co. & Shasta Co., CA			D. L. Wagner
Fagaceae	*Quercus prinus* L. [probably = *Q. montana* Willd.]	stem		eastern USA	origin of record unclear; possibly derives from Busck's (1913) references to "chestnut" and "oak" ("chestnut oak" being a common name for *Q. prinus*)	*M. fulgidella* (Clemens)	Forbes 1923
Garryaceae	*Garrya* Douglas ex Lindl.	not specified	not specified	Monterey Co., CA	adult reared		Turner & Turner 2012c
Garryaceae	*Garrya wrightii* Torr.	leaf	external	Cochise Co., Pinal Co., & Santa Cruz Co., AZ	adults reared		C. S. Eiseman & J. A. Blyth; D. L. Wagner
Hamamelidaceae	*Hamamelis virginiana* L.	stem		Hocking Co., OH	moth genus not confirmed		C. S. Eiseman & J. A. Blyth
Heliconiaceae	unspecified			Heredia Province, Costa Rica	"*Marmara* from this area are especially prevalent on the monocot families Araceae and Heliconiaceae."		Guillén *et al.* 2001
Hydrangeaceae	*Deutzia gracilis* Siebold & Zucc.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Hydrangeaceae	*Hydrangea* L. (cultivated)	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Iteaceae	*Itea japonica* Oliv.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Juglandaceae	*Carya texana* Buckley	leaf		Payne Co., OK	moth genus not confirmed, but certainly Gracillariidae		M. W. Palmer
Juglandaceae	*Juglans* L. (cultivated walnut)	stem and husk		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Lauraceae	*Laurus nobilis* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Lauraceae	*Persea americana* Mill.	shoots and fruit	external	Orange Co., CA	adult reared (paratype)	*M. gulosa* Guillén & Davis	Guillén *et al.* 2001
Lauraceae	*Umbellularia californica* (Hook. & Arn.) Nutt.	leaf	external	Los Angeles Co., CA	adults reared		D. L. Wagner, Donahue, & Frack

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Lauraceae	*Umbellularia californica* (Hook. & Arn.) Nutt.	leaf		southern CA			Guillén *et al.* 2001
Lauraceae	*Umbellularia californica* (Hook. & Arn.) Nutt.	stem	not specified	Monterey Co., CA	adult reared		Turner & Turner 2011b
Lythraceae	*Punica granatum* L.	fruit		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Magnoliaceae	*Magnolia* × *soulangeana* Thiéb.-Bern.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Malvaceae	*Abutilon theophrasti* Medik.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Malvaceae	*Gossypium barbadense* L.	stem		Pinal Co., AZ		*M. gulosa* Guillén & Davis	Gibson *et al.* 1997
Malvaceae	*Gossypium hirsutum* L.	boll, stem	external	CA, AZ	adults reared (paratypes)	*M. gulosa* Guillén & Davis	Atkins 1971, Guillén *et al.* 2001
Malvaceae	*Hibiscus* L.	not specified	not specified	eastern US?	"an undescribed species . . . of the dark group"		Forbes 1923
Malvaceae	*Hibiscus* L. (ornamental)	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Malvaceae	*Malva parviflora* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Malvaceae	*Melochia pyramidata* L.	stem	external	Cameron Co., TX	adult reared		D. L. Wagner
Malvaceae	*Theobroma cacao* L.	pods	external	Brazil		*M. isortha* (Meyrick)	Bondar 1939
Malvaceae	*Tilia americana* L.	stem		Hampshire Co., MA	moth genus not confirmed		C. S. Eiseman
Malvaceae	*Waltheria indica* L.	stem	external	Key Largo, FL	moth genus not confirmed		D. L. Wagner
Moraceae	*Ficus carica* L.	stem, fruit		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Moraceae	*Morus alba* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Moraceae	*Morus rubra* L.	stem	external	Payne Co., OK	adults reared (in USNM)		M. W. Palmer
Myricaceae	*Morella californica* (Cham.) Wilbur	leaf	not specified	Mendocino Co., CA	Turner & Turner (2012c) report rearing *Marmara* from "*Myrica*" in Monterey Co., probably the same host		Gates *et al.* 2002; D. L. Wagner
Myricaceae	*Morella cerifera* (L.) Small	leaf		Houston Co., TX	single mine; probably incidental		D. L. Wagner

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Nyctaginaceae	*Bougainvillea spectabilis* Willd. [as *B. brasiliensis*]	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Nyctaginaceae	*Pisonia aculeata* L.			Key Largo, FL	not confirmed as *Marmara*		D. L. Wagner, D. R. Davis & Parks
Oleaceae	*Forsythia* Vahl (ornamental)	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Oleaceae	*Fraxinus americana* L.	main stem and branches (periderm)	internal	NY, OH	mines found in CT, MA, NC, VT; also on *Fraxinus* sp. in TX (CSE; TSF; DLW)	*M. fraxinicola* Braun	Braun 1922; Fitzgerald 1973
Oleaceae	*Fraxinus latifolia* Benth.	stem	external	Shasta Co., CA			D. L. Wagner
Oleaceae	*Fraxinus pennsylvanica* Marshall	lower stem and root collar (periderm)	internal	Onondaga Co., NY	mines found in VT (DLW)	*M. basidendroca* Fitzgerald	Fitzgerald 1973
Oleaceae	*Fraxinus pennsylvanica* Marshall	usually higher in stem (initially in periderm, then in cortex)	internal	Onondaga Co., NY	mines found in VT (DLW)	*M. corticola Fitzgerald*	Fitzgerald 1973
Oleaceae	*Fraxinus pennsylvanica* Marshall	main stem and branches (periderm)	internal	Onondaga Co., NY	mines found in VT (DLW)	*M. fraxinicola* Braun	Fitzgerald 1973
Oleaceae	*Fraxinus uhdei* (Wenzig) Lingelsh.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Oleaceae	*Jasminum fluminense* Vell.	stem		Miami-Dade Co., FL	not confirmed as *Marmara*		D. L. Wagner & D. R. Davis
Oleaceae	*Olea europaea* L.	fruit		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Pinaceae	*Abies balsamea* (L.) Mill.	stem		ON	mines and larvae similar to *M. fasciella*; adults not reared		De Gryse 1943
Pinaceae	*Abies grandis* (Douglas ex D. Don) Lindl.	stem	external	BC, OR	univoltine	*M. oregonensis* Fitzgerald	Fitzgerald 1975
Pinaceae	*Abies procera* Rehder	stem	external	OR	adult reared; cocoons found in needles of Christmas tree	*M. oregonensis* Fitzgerald	D. L. Wagner
Pinaceae	*Pinus monticola* Douglas ex D. Don	stem		BC	mines and larvae similar to *M. fasciella*; adults not reared		De Gryse 1943
Pinaceae	*Pinus strobus* L.	stem	internal	eastern Canada & US	univoltine	*M. fasciella* (Chambers)	De Gryse 1943
Pinaceae	*Pseudotsuga menziesii* (Mirb.) Franco	stem	external	BC, OR, CA	univoltine	*M. oregonensis* Fitzgerald	Fitzgerald 1975; D. L. Wagner

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Pinaceae	*Tsuga canadensis* (L.) Carrière ["hemlock"]	stem	internal	MA	not reared, but forms "the same characteristic cocoon as *M. elotella*"		Vinal 1917
Pinaceae	*Tsuga heterophylla* (Raf.) Sarg.	stem		Pacific Northwest			Fitzgerald 1975
Plantaginaceae	*Penstemon parryi* (A. Gray) A. Gray	leaf	external	Pima Co., AZ	adults reared		D. L. Wagner
Plumbaginaceae	*Plumbago scandens* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Portulacaceae	*Portulaca oleracea* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Rhamnaceae	*Berchemia scandens* (Hill) K. Koch	stem	external	Reelfoot Lake, TN; Harris Co. & Houston Co., TX			C. S. Eiseman & J. A. Blyth; D. L. Wagner
Rhamnaceae	*Ceanothus* L.	not specified	not specified	Monterey Co., CA	adult reared		Turner & Turner 2012c
Rhamnaceae	*Ceanothus ?arboreus* Greene	stem	in exfoliating bark	Contra Costa Co., CA	stem pustule; adult reared		D. L. Wagner
Rhamnaceae	*Ceanothus fendleri* A. Gray	stem	in exfoliating bark	Cochise Co., AZ	stem pustule		D. L. Wagner
Rhamnaceae	*Ceanothus greggii* A. Gray	leaf		CA	insect identification tentative		Gates *et al*. 2002
Rhamnaceae	*Ceanothus greggii* A. Gray	stem	in exfoliating bark	Mohave Co., AZ	stem pustule		D. L. Wagner
Rhamnaceae	*Ceanothus ?integerrimus* Hook. & Arn.	stem		Shasta Co., CA	elongate serpentine mine		D. L. Wagner
Rhamnaceae	*Ceanothus leucodermis* Greene	stem	in exfoliating bark	San Diego Co. & San Mateo Co., CA	stem pustule		D. L. Wagner
Rhamnaceae	*Ceanothus sanguineus* Pursh	stem		Douglas Co., OR	moth genus not confirmed, but certainly Gracillariidae; yellow larvae feeding in late October		C. S. Eiseman & J. A. Blyth
Rhamnaceae	*Ceanothus sorediatus* Hook. & Arn.	stem	in exfoliating bark	Contra Costa Co., CA	stem pustule; adult reared		D. L. Wagner
Rhamnaceae	*Ceanothus spinosus* Nutt.	stem	in exfoliating bark	Santa Barbara Co., CA	stem pustule		D. L. Wagner & J. A. Powell

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Rhamnaceae	*Ceanothus thyrsiflorus* Eschsch.	stem	both internal (pustule former) and external	Alameda Co. & Marin Co., CA	perhaps two species involved, one forming a pustule and the other a serpentine mine		D. L. Wagner
Rhamnaceae	*Colubrina arborescens* (Mill.) Sarg.	stem	external	Miami-Dade Co., FL	elongate mine in green bark		D. L. Wagner & D. R. Davis
Rhamnaceae	*Colubrina asiatica* (L.) Brongn.	stem	external	Key Largo, FL	elongate mine in green bark		D. L. Wagner
Rhamnaceae	*Frangula californica* (Eschsch.) A. Gray	stem		southern CA			Guillén *et al.* 2001
Rhamnaceae	*Frangula purshiana* (DC.) A. Gray	stem	external	Alameda Co., Marin Co., & Plumas Co., CA	serpentine mine in green bark; adults reared		Gates *et al.* 2002; D. L. Wagner
Rhamnaceae	*Gouania lupuloides* (L.) Urb.	stem	external	Key Largo, FL	serpentine mine		D. L. Wagner, D. R. Davis & Parks
Rhamnaceae	*Ziziphus obtusifolia* (Hook. ex Torr. & A. Gray) A. Gray	stem	external	Cameron Co., TX	serpentine mine		D. L. Wagner
Rosaceae	*Cercocarpus montanus* Raf.	stem	internal (pustule former) and external	Imperial Co., Monterey Co., Shasta Co., & Stanislaus Co., CA	pustule mine (DLW); adults reared		Gates *et al.* 2002; D. L. Wagner
Rosaceae	*Heteromeles arbutifolia* (Lindl.) M. Roem.	leaf to stem		northern CA			C. S. Eiseman & J. A. Blyth
Rosaceae	*Heteromeles arbutifolia* (Lindl.) M. Roem.	stem		southern CA			Guillén *et al.* 2001
Rosaceae	*Heteromeles arbutifolia* (Lindl.) M. Roem.	stem mine at base of previous year's growth	in exfoliating bark	Alameda Co., Contra Costa Co., El Dorado Co., & Los Angeles Co., CA	elongate pustule mine extending over 6-9" of shoot; adults reared		D. L. Wagner
Rosaceae	*Malus* Mill. spp. (apple)	fruit		Tulare Co., CA	"incidental"	*M. gulosa* Guillén & Davis	Neff 2002
Rosaceae	*Malus pumila* Mill. ["apple"]	fruit	not specified; likely external	Benton Co., OR	mines found in San Luis Obispo Co., CA (DLW)	*M. pomonella* Busck	Busck 1915
Rosaceae	*Malus pumila* Mill. ["apple"]	stem	internal	MA	mines found in CT (DLW)	*M. elotella* (Busck)	Vinal 1917
Rosaceae	*Photinia* Lindl. (ornamental)	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Rosaceae	*Prunus* L. spp. (cultivated apricot, cherry, plum)	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Rosaceae	*Prunus caroliniana* Aiton	stem	in exfoliating bark	Harris Co., TX	stem pustule in new shoots		D. L. Wagner
Rosaceae	*Prunus dulcis* (Mill.) D.A. Webb ["almond"]	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Rosaceae	*Prunus ilicifolia* (Nutt. ex Hook. & Arn.) D. Dietr.	stem		southern CA			Guillén *et al.* 2001
Rosaceae	*Prunus laurocerasus* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Rosaceae	*Prunus pensylvanica* L. f.	stem		Windham Co., CT			D. L. Wagner
Rosaceae	*Prunus persica* (L.) Batsch var. *nucipersica* (Suckow) C.K. Schneid. ["nectarine"]	stem and fruit		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Rosaceae	*Prunus persica* (L.) Batsch var. *persica* ["peach"]	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Rosaceae	*Prunus serotina* Ehrh.	stem	not specified; likely external	Falls Church, VA	mines found in CT, MA, MI, NC (CSE; TSF; DLW)	*M. serotinella* Busck	Busck 1915
Rosaceae	*Rosa* L. (ornamental)	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Rosaceae	*Rosa californica* Cham. & Schltdl.	stem	external	Contra Costa Co. & Plumas Co., CA	adult reared		D. L. Wagner
Rosaceae	*Rubus* L.	stem	external	Alameda Co. & San Luis Obispo Co., CA	adult reared		D. L. Wagner & J. A. Powell
Rosaceae	*Rubus armeniacus* Focke [as *Rubus procerus*]	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Rosaceae	*Rubus ursinus* Cham. & Schltdl.	stem	external	Alameda Co., Monterey Co,. & San Mateo Co., CA	elongate serpentine mine; adults reared		De Benedictis *et al*. 1990; Turner & Turner 2012a; D. L. Wagner

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Rosaceae	*Rubus vitifolius* Cham. & Schltdl.	stem	external	Alameda Co. & Contra Costa Co., CA	elongate serpentine mine; adults reared		D. L. Wagner
Rubiaceae	*Chiococca alba* (L.) Hitchc.	leaf	external	Key Largo, FL; Cameron Co., TX	narrow, twisting tract begins on lower side and finishes near upper surface; adults reared		D. L. Wagner
Rubiaceae	*Chiococca parvifolia* Wullschl. ex Griseb.	leaf	external	No Name Key, FL	narrow, twisting tract begins on lower side and finishes near upper surface; adult reared		D. L. Wagner
Rubiaceae	*Erithalis fruticosa* L.	leaf	external	Key Largo, FL	narrow, twisting tract begins on lower side and finishes near upper surface; adult reared		D. L Wagner, D. R. Davis & Parks
Rutaceae	*Citrus ×aurantiifolia* (Christm.) Swingle (pro sp.) [medica × sp.] (lime)	fruit		San Joaquin Valley, CA		*M. gulosa* Guillén & Davis	Neff 2002 [cited in Semet 2010]
Rutaceae	*Citrus ×limon* (L.) Burm. f. (pro sp.) [*medica* × *aurantifolia*] (lemon)	fruit and green shoots		southwestern US		*M. gulosa* Guillén & Davis	Atkins 1971
Rutaceae	*Citrus maxima* (Burm. f.) Merr. (pomelo)	fruit		San Joaquin Valley, CA		*M. gulosa* Guillén & Davis	Neff 2002 [cited in Semet 2010]
Rutaceae	*Citrus ×paradisi* Macfad. (pro sp.) [*maxima* × *sinensis*] (grapefruit)	fruit and green shoots	external	Riverside Co., CA	adults reared (holotype and paratypes)	*M. gulosa* Guillén & Davis	Atkins 1961; Guillén *et al.* 2001
Rutaceae	*Citrus reticulata* Blanco (tangerine)	fruit and green shoots		Riverside Co., CA		*M. gulosa* Guillén & Davis	Atkins 1971
Rutaceae	*Citrus ×sinensis* (L.) Osbeck (pro sp.) [maxima × reticulata] (Valencia orange, navel oranges)	fruit and green shoots		southern CA		*M. gulosa* Guillén & Davis	Atkins 1971; Neff 2002 [cited in Semet 2010]
Rutaceae	*Citrus ×tangelo* J.W. Ingram & H.E. Moore (Minneola tangelo)	green shoots		Pinal Co., AZ		*M. gulosa* Guillén & Davis	Gibson *et al.* 1997
Rutaceae	*Poncirus trifoliata* (L.) Raf.	stem	external	Bexar Co., TX			D. L. Wagner & C. T. Maier

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Rutaceae	*Zanthoxylum fagara* (L.) Sarg.	stem	external	Collier Co. & Monroe Co., FL			D. L. Wagner & D. R. Davis
Salicaceae	*Populus* L.	stem	external	Plumas Co. & Shasta Co., CA	found together with mines on *Salix* at both locations; adults reared from one or both hosts		D. L. Wagner
Salicaceae	*Populus* L. (ornamental)	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Salicaceae	*Populus* L. ["poplar"]	stem		MA, RI			Vinal 1917; D. L. Wagner
Salicaceae	*Populus grandidentata* Michx.	stem		Cheboygan Co., MI			D. L. Wagner
Salicaceae	*Populus tremuloides* Michx.	stem	external	Chittenden Co., VT	adults reared	*M. salictella* Clemens?	D. L. Wagner
Salicaceae	*Populus trichocarpa* Torr. & A.Gray ex. Hook.	leaf to stem		Josephine Co., OR	moth genus not confirmed, but certainly Gracillariidae; single example found		C. S. Eiseman & J. A. Blyth
Salicaceae	*Salix* L.	stem; some leaf to stem examples observed	external	Mendocino Co., Monterey Co., Plumas Co., & Shasta Co., CA	adults reared		D. L. Wagner
Salicaceae	*Salix* L. ["yellow willow"]	stem	external	eastern US		*M. salictella* Clemens	Clemens 1863
Salicaceae	*Salix lasiolepis* Benth.	stem	external	Contra Costa Co., CA	adults reared (paratypes)	*M. gulosa* Guillén & Davis	Guillén *et al.* 2001
Salicaceae	*Salix lasiolepis* Benth.	stem		Monterey Co. & San Mateo Co., CA	adult reared; wrong climate for *M. gulosa*?		Turner & Turner 2011a; D. L. Wagner
Salicaceae	*Salix nigra* Marshall	stem		Cameron Co. & Harris Co., TX		*M. salictella* Clemens	D. L. Wagner
Salicaceae	*Salix purpurea* L.	stem		Nantucket, MA		*M. salictella* Clemens	C. S. Eiseman & J. A. Blyth
Sapindaceae	*Acer floridanum* (Chapm.) Pax	stem		Durham Co. & Scotland Co., NC	moth genus not confirmed		T. S. Feldman
Sapindaceae	*Acer macrophyllum* Pursh	stem		southern CA			Guillén *et al.* 2001
Sapindaceae	*Acer negundo* L.	stem	external	Baltimore, MD; Harris Co., TX			D. L. Wagner; Wilson 2015
Sapindaceae	*Acer palmatum* Thunb.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Sapindaceae	*Acer pseudoplatanus* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Sapindaceae	*Acer rubrum* L.	stem		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Sapindaceae	*Acer rubrum* L.	stem	external	Windham Co., CT; MA; Scotland Co., NC	CT mines were subcortical in boles of young trees; more visible in years after mine was active		C. S. Eiseman; T. S. Feldman; D. L. Wagner
Sapindaceae	*Sapindus saponaria* L. var. *drummondii* (Hook. & Arn.) L.D. Benson	leaf		Payne Co., OK	moth genus not confirmed; single example found, with larva parasitized by a eulophid		M. W. Palmer
Sapindaceae	*Sapindus saponaria* L. var. *saponaria*	fruit	external	Key Largo, FL	larva mined entire rind of fruit		D. L. Wagner, D. R. Davis & Parks
Simaroubaceae	*Simarouba glauca* DC.	stem	external	Miami-Dade Co., FL	in new growth		D. L. Wagner, D. R. Davis & Dickel
Smilacaceae	*Smilax* L.	leaf		Colbert Co., AL; Alachua Co., FL; Porter Co., IN; Baltimore, MD; Hocking Co., OH	larvae collected in OH in November overwintered in their mines, with fresh mining observed in April, suggesting this species is bivoltine (CSE)	*M. smilacisella* (Chambers)	Carr 2014; C. S. Eiseman & J. A. Blyth; T. S. Feldman; Wilson 2016
Smilacaceae	*Smilax bona-nox* L.	leaf	external	Scotland Co., NC; Payne Co., OK	adult female reared from OK (in USNM)	*M. smilacisella* (Chambers)	T. S. Feldman; M. W. Palmer
Smilacaceae	*Smilax glabra*	leaf	mines aborted	southern KY	*Smilax glabra* Roxb. is an Asian species that does not occur in North America; it is likely that another species was intended	*M. smilacisella* (Chambers)	Chambers 1875
Smilacaceae	*Smilax glauca* Walter	leaf		Scotland Co., NC		*M. smilacisella* (Chambers)	Needham *et al.* 1928; T. S. Feldman
Smilacaceae	*Smilax laurifolia* L.	leaf		Moore Co. & Scotland Co., NC		*M. smilacisella* (Chambers)	T. S. Feldman
Smilacaceae	*Smilax rotundifolia* L.	leaf	external	Scotland Co., NC; Houston Co., TX	adult reared	*M. smilacisella* (Chambers)	T. S. Feldman; D. L. Wagner

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TABLE 1. (Continued)

Plant family	Plant species	Part of plant mined	Pupation site	Location	Other notes	*Marmara* species, if known	Reference or observer
Smilacaceae	*Smilax smallii* Morong	leaf		Scotland Co., NC		*M. smilacisella* (Chambers)	T. S. Feldman
Smilacaceae	*Smilax tamnoides* L. [as *S. hispida* Muhl.]	leaf	external	Cincinnati, OH		*M. smilacisella* (Chambers)	Braun 1909
Solanaceae	*Capsicum annuum* L.	stem, fruit		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Solanaceae	*Datura inoxia* Mill. [as *Datura meteloides*]	leaf		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Solanaceae	*Nicotiana glauca* Graham	leaves and stems		southern CA (including Los Angeles Co.)			Guillén *et al.* 2001; P. A. Opler
Solanaceae	*Solanum erianthum* D. Don	stem	external	Collier Co., FL			D. L. Wagner
Solanaceae	*Solanum melongena* L.	fruit		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002
Solanaceae	*Solanum xanti* A. Gray	stem	external	Los Angeles Co., CA			D. L. Wagner
Symplocaceae	*Symplocos tinctoria* (L.) L'Hér.	leaf to stem		Scotland Co., NC; Berkeley Co., SC			C. S. Eiseman; T. S. Feldman
Ulmaceae	*Ulmus* L. ["elm"]	stem	internal?	VA	adult resembles *M. elotella*		Forbes 1923
Ulmaceae	*Ulmus americana* L.	stem	internal; under pitched bark flap	Windham Co., CT; central NY; Chittenden Co., VT; Brazoria Co., TX	adults reared		Fitzgerald & Simeone 1971; D. L. Wagner
Vitaceae	*Vitis vinifera* L. 'Red Globe'	fruit	external	Tulare Co., CA	adult reared; "spilling over" from adjacent cotton field	*M. gulosa* Guillén & Davis	Haines 2010
Vitaceae	*Vitis vinifera* L. 'Thompson Seedless' and 'Flame'	stem		Pinal Co., AZ		*M. gulosa* Guillén & Davis	Gibson *et al.* 1997
Vitaceae	*Vitis* L. spp. (cultivated grape)	stem, petiole, fruit		Tulare Co., CA		*M. gulosa* Guillén & Davis	Neff 2002

report a coastal California *Phyllocnistis* species on *Salix* L. (Salicaceae) whose mines sometimes extend from leaf to leaf along the stems. In Europe, the *Salix* feeder *P. ramulicola* Langmaid & Corley forms a very *Marmara*-like stem mine, up to 30 cm long, only entering a leaf blade to spin its cocoon, which is done along the leaf margin adjacent to the petiole (Langmaid & Corley 2007). In light of these examples, empty stem mines can only confidently be attributed to *Marmara* when they terminate in the characteristic bark flap or if larval exuviae can be removed and examined from the mine—the head capsule of *Marmara* is sufficiently diagnostic as to allow certain identification.

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