



## Description of *Diaspidiotus aetnensis* sp. n. (Hemiptera: Coccoomorpha: Diaspididae) living on endemic birch in Sicily (Italy), with a key to *Diaspidiotus* species recorded on Betulaceae

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### Abstract

The adult female of a new species of armoured scale insect, *Diaspidiotus aetnensis* Nucifora, Watson and Mazzeo sp. n. (Hemiptera: Coccoomorpha: Diaspididae), is described and illustrated. It was collected in Sicily on the endemic birch, *Betula aetnensis* Raf. (Betulaceae). We provide supplementary notes on *Diaspidiotus alni* (Marchal), *D. wuenni* (Lindinger) and *D. lenticularis* (Lindinger), and a key to the *Diaspidiotus* species recorded on Betulaceae worldwide.

**Key words:** armoured scale, *Betula aetnensis*, *Betula pendula*, diaspidid, Mount Etna, *Genista aetnensis*

### Introduction

An endemic Sicilian birch, *Betula aetnensis* Raf. is restricted to the western and northeastern slopes of Mount Etna between 1,300 and 2,100 m a.s.l., with just two populations inside the Etna Regional Park (Poli 1965; 1982). For a long time it was considered to be a subspecies of *B. pendula* Roth, which is present in other Italian regions as well as in other sites in Sicily (Strano 2010). However, it is thought that *B. aetnensis* became confined to favorable habitats on Mount Etna, where it differentiated into a new species as a result of genetic isolation (Mazzeo *et al.* 2016).

Fifty-four species of armoured scale insect (Hemiptera: Coccoomorpha: Diaspididae) have been recorded living on members of the plant family Betulaceae (García Morales *et al.* 2016); 28 of these feed on species of *Betula*, of which nine belong to the genus *Diaspidiotus* Berlese (*in* Berlese & Leonardi 1896). The only other diaspidid species that has been recorded on birch trees in Italy is *Chionaspis salicis* Linnaeus (1758) on *Betula pubescens* Ehrh. (as *B. alba* L. in Matile Ferrero & Pellizzari 2002).

Periodical observations of the Sicilian scale insect fauna over the last 20 years (Mazzeo *et al.* 2016) have resulted in collections of an undescribed armoured scale insect from *Betula aetnensis*. The adult female is here described and illustrated. Some new data of *Diaspidiotus lenticularis* (Lindinger 1912) are also reported.

### Materials and methods

Adult females were slide-mounted in Canada balsam using the method described in Watson (2002). They were examined using a compound Nikon Labophot microscope at magnifications between 40 and 1000x. The specimens were compared with descriptions, illustrations, and keys to known species of the genus *Diaspidiotus* and other allied Diaspidiotinae genera (Ferris 1942; Lupo 1948; Balachowsky 1950; Schmutterer 1959; Zahradník 1972; Kosztarab & Kozár 1978; Danzig 1993; Miller & Davidson 2005) facilitated by information in the ScaleNet database online (García Morales *et al.* 2016). In the following description, measurements are given in micrometres (µm). Measurements and frequencies for the holotype are followed by the range taken from all the adult female specimens in the slide-mounted type series.

Type material is deposited at the following institutions: Dipartimento di Agricoltura, Alimentazione e Ambiente, University of Catania, Italy (Di3A UNICT); The Natural History Museum, London, U.K. (BMNH); and the Muséum nationale d'histoire naturelle, Paris, France (MNHN).

## Taxonomy

### *Diaspidiotus aetnensis* Nucifora, Watson and Mazzeo sp. n.

(Figs 1 and 2)

**Material examined.** All the specimens are mounted individually on slides, and were collected by S. Nucifora.

**Holotype.** Adult female mounted in Canada balsam: right label: on *Betula / aetnensis* Raf. / Sicily, ITALY / Mt. Etna, eastern slope / (on branch) / 8.iii.2016 / S. Nucifora leg.; left label: *Diaspidiotus / aetnensis* / HOLOTYPE / Nucifora, Watson / & Mazzeo / Di3A-UNICT. The geographic coordinates, as shown on label on the back of the slide, are: Lat. N 37°47'02.0" / Lon. E 15°03'34.7" / 1625 m a.s.l. Specimen deposited at Di3A UNICT.

**Paratypes.** Nineteen adult females, all from: ITALY, Sicily, Mt. Etna, eastern slope (Municipality of Sant'Alfio), on bark of *B. aetnensis*. Specimens deposited at Di3A UNICT: 7 adult females, 8.iii.2016; 1 adult female, 24.vii.2010; 1 adult female, 2.x.1997. Specimens deposited at BMNH: 1 adult female, 8.iii.2016; 2 adult females, 24.vii.2010; 1 adult female, 11.vii.2009; 1 adult female (with its second-instar exuviae), 14.vii.2005. Specimens deposited at MNHN: 2 adult females, 23.iii.2014; 1 adult female, 24.vii.2010; 2 adult females, 11.vii.2009.

**Other material examined**, all from ITALY, Sicily, Mt. Etna, eastern slope (Municipality of Sant'Alfio), on bark of *B. aetnensis*, deposited at Di3A UNICT: 3 adult females, 10.iii.2019; 2 adult females, 18.ix.2011; 1 adult female, 24.vii.2010; 2 adult females, 11.vii.2009.

**Description of adult female.** *Appearance in life:* scale cover of adult female subcircular, diameter 0.9–1.9 mm (usually 1.2–1.6 mm), almost flat; in large specimens, scale cover is more irregular in outline. Central area of cover (over exuviae) opaque sandy brown, being darker towards the centre and whitish toward the outer edge. Exuviae central to subcentral; first-instar exuviae pale yellow, second-instar exuviae yellowish. Ventral scale extremely thin, white and fragile, remaining on plant surface when scale cover and insect are removed. Exposed adult female yellow, rather flat, pygidium darker and flatter than rest of body. Scale cover of second-instar male similar to that of female but oval, measuring 0.6–0.8 mm x 0.4–0.6 mm, whitish to sandy brown by exuviae but fading to white at margins; exuviae yellow, situated at widest part of scale cover; ventral scale similar to that of female.

*Slide-mounted adult female* (Fig. 1): young adult female egg-shaped or pyriform, becoming almost circular at maturity due to expansion of cephalothorax, with lateral abdominal lobes sometimes extending posteriorly on either side of pygidium. Body measurements (n=20): 640 (576–1239) long, maximum width 545 (477–1162).

**Pygidium** broadly rounded; posterior margin with 3 pairs of lobes; median lobes ( $L_1$ ) well developed, slightly convergent, each lobe broad, rounded, slightly protruding with 1 notch on external lateral margin. Second lobes ( $L_2$ ) poorly developed, merging with margin; third lobes ( $L_3$ ) even less developed but always visible, tooth shaped.  $L_1$  typically each with 2 paraphyses extending from the basal corners, anteromesal and anteromesad, these generally most evident on the ventral surface. Each side of pygidium with 2 additional pairs of paraphyses, each short, spindle-shaped and thickened towards inner end, visible on both surfaces: a medium-sized paraphysis (PL1) originating lateral to anterolateral basal corner of  $L_1$ , paired with a slightly smaller paraphysis (PL2) of similar shape, originating just mesad of anteromesad base of  $L_2$ ; small third and fourth paraphyses (PL3 and PL4) forming a pair, situated between  $L_2$  and  $L_3$ , with smallest paraphysis (PL4) originating just mesad of anteromesad base of  $L_3$ . All four paraphyses curved, tending to touch proximal ends, each pair forming an arch framing a marginal crypt, there being 2 marginal crypts on each side of pygidium. Ventral sclerotizations present on each side of pygidium:  $L_1$  with fusiform sclerosis originating at  $L_1$  anteromesad base, broader than PL1; far smaller, teardrop-shaped sclerosis originating on the outside basal corner of  $L_1$ . With a large wing-shaped sclerotised thickening, arising from mesad basal margins of  $L_1$  and  $L_2$ , with anterolateral end forming a point directed towards distal end of perigenital apophysis. Perigenital apophyses with basal and distal portions strong and central section thin. Dorsal apophyses present on each side of pygidium: mediobasal apophysis usually with a central break dividing

it into two parts, but sometimes entire, moderately strongly sclerotised; latero-basal apophysis more strongly sclerotised, a bit wider laterally and curved towards base of pygidium. Plates: absent from between  $L_1$ ; lateral plates underdeveloped, not much evident, spine-shaped or fringed; with 2 plates between  $L_1$  and  $L_2$ , the one adjacent to  $L_1$  plug-shaped, the other notched on the outside margin; with 2 plates present between  $L_2$  and  $L_3$ , the one adjacent to  $L_2$  similar to an inverted drop, having a wide base and pointed tip, and with other plate notched on the outside margin. Dorsal ducts: space between  $L_1$  containing a median duct with oval orifice on margin and long glandular tube extending to level of anal opening; each side of pygidium with 15–26 dorsal ducts, all of similar length to median duct, with orifices arranged as follows: usually 3 (sometimes 2, rarely 4) in intersegmental crypt between  $L_1$  and  $L_2$ ; only 1 in intersegmental crypt between  $L_2$  and  $L_3$ ; with a marginal orifice mesad to second crypt, overlapping base of ventral bristles on  $L_2$ ; usually with 4–9 orifices in an oblique line starting from submargin near  $L_3$ , leading anteriorly towards latero-basal apophysis but not reaching that level; plus 5–10 orifices forming a second, outer row, typically forming an arc beginning with 2 orifices in marginal area of segment VI and continuing with 3–8 orifices in an oblique row to the latero-basal apophysis; also with 1 (sometimes 2 or 3) orifices on the submargin of segment V. Segment IV sometimes with 1–4 dorsal submarginal ducts (Fig. 2). Anal opening: small, slightly longer than wide, located at proximal end of a furrow beginning between  $L_1$ , widening anteriorly until same width as anal opening; two short parallel scleroses bracket the anal opening and extend a short distance anteriorly beyond it. Perivulvar pores: usually absent, but sometimes 1–3 pores present on each side. Ventral microducts: each side of pygidium with 3 clusters of microducts in marginal and submarginal areas; with about 10 ducts on segment VI, about 6 on segment V and about 4 on segment IV.

**Prepygidium** (free abdominal segments anterior to pygidium): cuticle membranous, with segment margins somewhat expanded laterally. Dorsal ducts absent from prepygidial segments. Ventral microducts: a few submarginal or submedian microducts on prepygidial area, mostly on segment II.

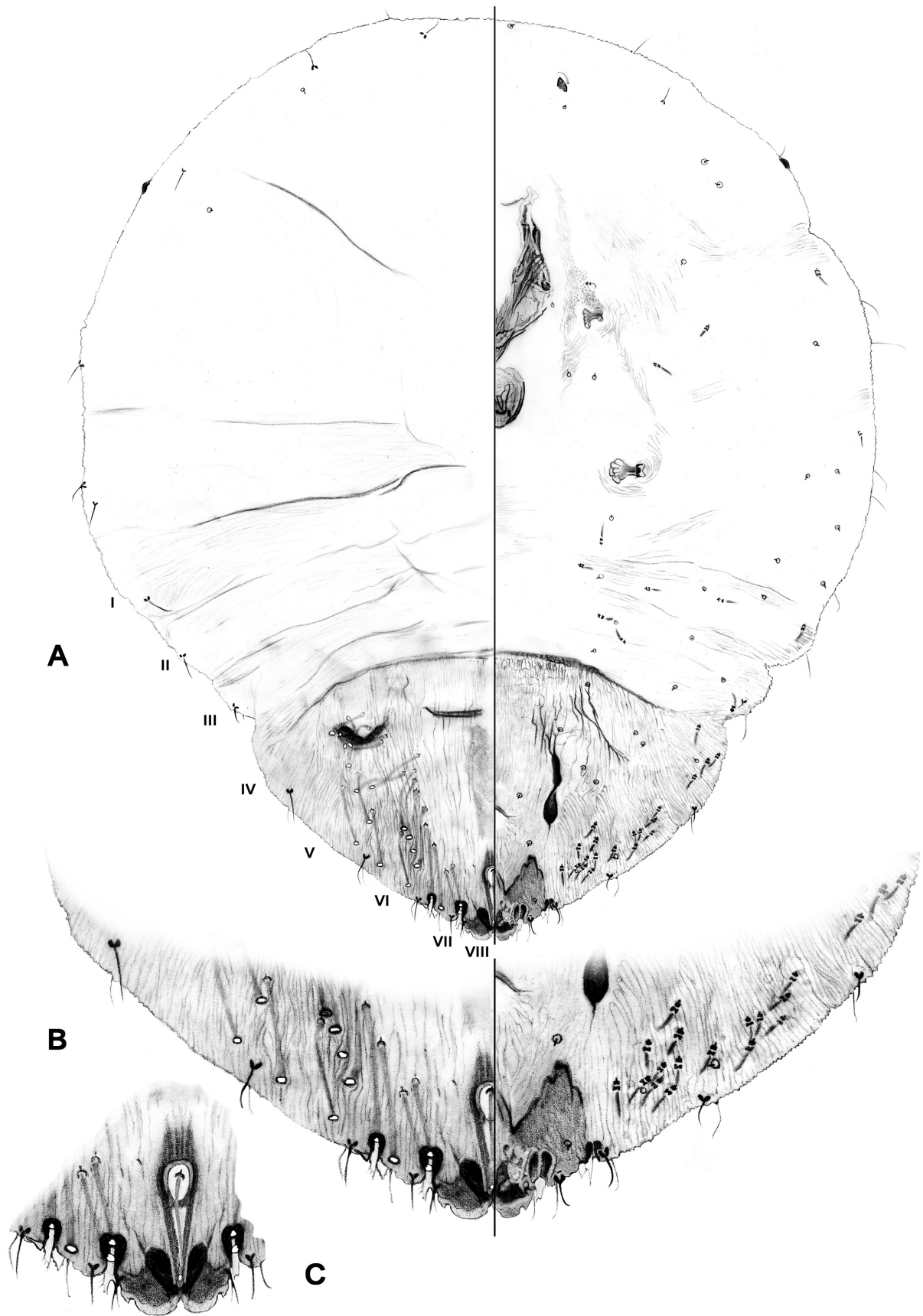
**Cephalothorax** (prosoma): cuticle not thickened; cuticle just anterior to anterior spiracle with characteristic sculpture, with plaques that always end with a small ventral gland. Prothorax with marginal tubercle on each side. Setae along margin each long and slender with pointed apex. Margins of thoracic segments slightly lobed in young adult female and, exceptionally, expanding to project laterally to pygidium in post-reproductive female. Spiracles not associated with pores. Ventral microducts: present in submedian and submarginal areas of metathorax. Antennae: each bearing 1 conspicuous seta.

**Etymology.** The species epithet *aetnensis* is formed by combining the Latinised name of the mountain, “Etna”, with the Latin ending “-ensis”, meaning “from”.

**Comments.** Of the 58 species of Diaspididae reported on Betulaceae, 14 (24%) belong to the genus *Diaspidiotus* Berlese. These *Diaspidiotus* species are mostly polyphagous, with hosts belonging to 47 plant families and with preferences for Salicaceae, Fabaceae, Fagaceae, Rosaceae, Juglandaceae, Moraceae and Oleaceae (García Morales *et al.* 2016). Of the 28 species of Diaspididae reported on *Betula*, nine (32%) belong to *Diaspidiotus*. The latter species all have perivulvar pores; *D. aetnensis* sp. n. is an exception, as it usually lacks them. Other Palaearctic *Diaspidiotus* species that lack perivulvar pores are: *D. alni* (Marchal 1909), *D. distinctus* (Leonardi 1900), and *D. wuenni* (Lindinger 1923), but they have not been collected on *Betula*. *Diaspidiotus alni* is known on species of *Alnus*, *Carpinus* (Betulaceae), *Fagus*, *Quercus* (Fagaceae) and *Populus* (Salicaceae); *D. distinctus* on species of *Corylus* (Betulaceae), *Gonocytisus* (Fabaceae) and *Quercus* (Fagaceae); and *D. wuenni* feeds on species of *Alnus* (Betulaceae), *Castanea* and *Quercus* (Fagaceae). Among the latter *Diaspidiotus* species, *D. alni* and *D. wuenni* seem to be closest morphologically to *D. aetnensis*.

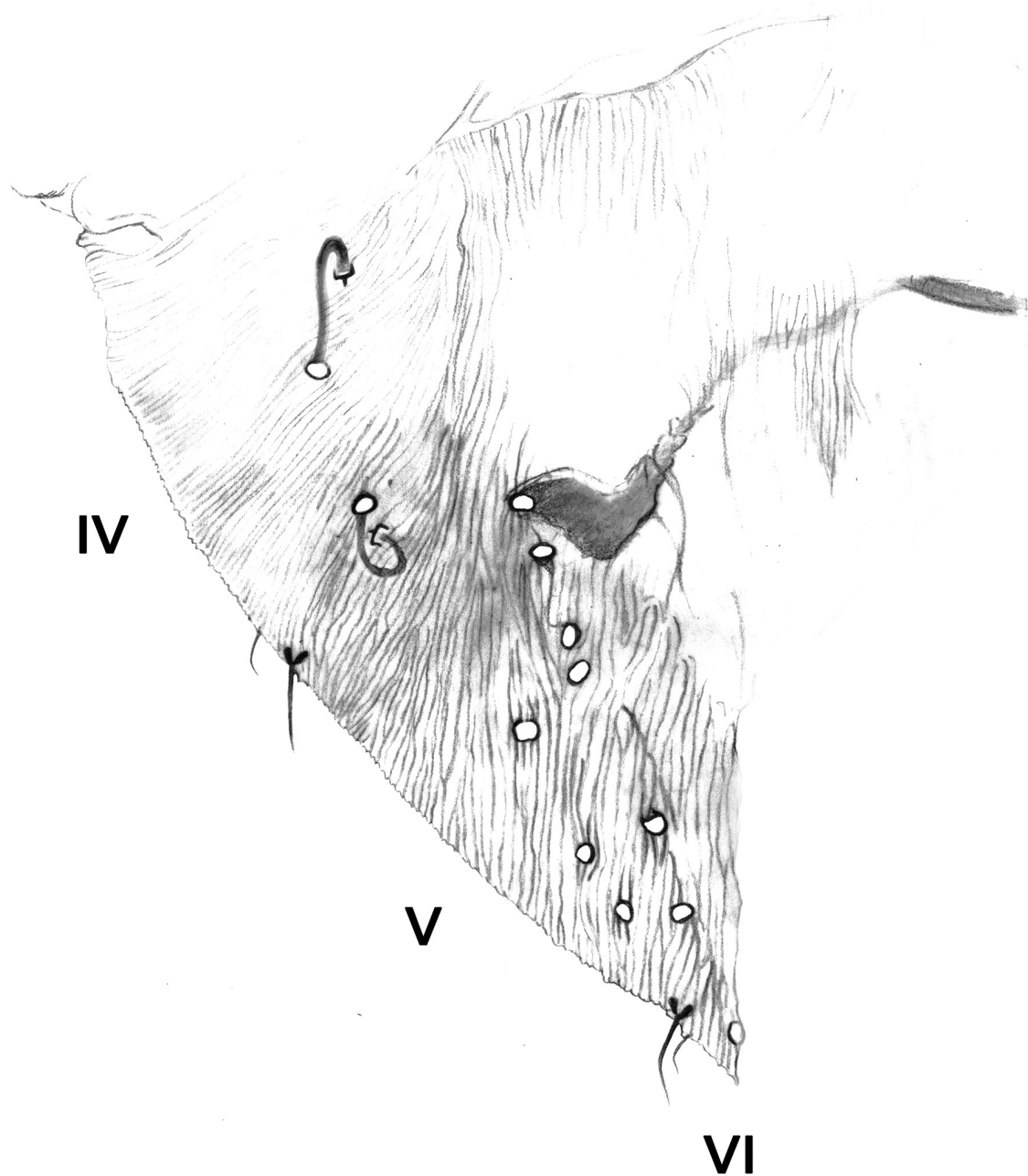
*Diaspidiotus aetnensis* sp. n. has a body outline and pygidial morphology very similar to *D. alni*, especially the median lobes ( $L_1$ ) and the paraphyses between segments VI, VII, and VIII, but differs as follows (condition in *D. alni* in brackets): pygidial margin with plates developed (plates reduced or absent); segment IV with dorsal ducts, especially in larger individuals (without ducts); and pygidium with about 45 (31–54) dorsal ducts (fewer than 32 ducts).

Both *D. aetnensis* sp. n. and *D. lenticularis* occur on *Betula*, and sometimes *D. lenticularis* also lacks perivulvar pores. *Diaspidiotus aetnensis* sp. n. differs as follows (condition in *D. lenticularis* in brackets): prepygidial macroducts absent (present). We have collected *D. lenticularis* on the bark of *B. pendula* Roth (= *B. alba* L.) in the Nebrodi Mountains in Sicily, and in Italy (Lazio, in Caldara di Manziana), but never on *B. aetnensis*.



**FIGURE 1.** *Diaspidiotus aetnensis* Nucifora, Watson and Mazzeo **sp. n.**, adult female; showing features of the dorsum on the left side and those of the venter on the right. A) habitus, B) pygidium, C) detail of dorsal pygidial margin showing duct between median lobes.

*Diaspidiotus aetnensis* **sp. n.** resembles *D. wuenni* in having similar plates and in the number of dorsal ducts, but differs in having segment IV with dorsal ducts, especially in larger individuals (*D. wuenni* without ducts); the shape and proportions of the marginal paraphyses situated between segments VIII and VII, in relation to the size of a median lobe ( $L_1$ ) are also different between these species.



**FIGURE 2.** Pygidial detail of an adult female *Diaspidiotus aetnensis* Nucifora, Watson and Mazzeo **sp. n.**, to show dorsal marginal, submarginal and submedian areas of abdominal segments IV, V and VI; note that segment IV has 2 dorsal macroducts.

Specimens of *D. aetnensis* **sp. n.** were usually found on the bark of the trunk and branches; more rarely, they were found on exposed roots, but were never observed feeding on the leaves. In the same location in the eastern slope of the volcano, we found *Diaspidiotus lenticularis* on *Genista aetnensis* (Biv.) DC. (a new host association), growing amongst the Etna birches.

#### Key to adult females of *Diaspidiotus* species recorded on Betulaceae

- 1 (0) Prosoma with 1 or 2 constrictions on each side . . . . . 2

-	Prosoma without any constrictions . . . . .	3
2 (1)	Prosoma with 1 constriction on each side; prepygidial dorsal ducts present . . . . .	<i>Diaspidiotus ostreaeformis</i> (Curtis)
-	Prosoma with 2 constrictions on each side; prepygidial dorsal ducts absent . . . . .	<i>Diaspidiotus juglansregiae</i> (Comstock)
3 (1)	Pygidial plates reduced or absent . . . . .	4
-	Pygidial plates relatively well developed . . . . .	6
4 (3)	Perivulvar pores present; second lobes ( $L_2$ ) well developed . . . . .	<i>Diaspidiotus lenticularis</i> (Lindinger)
-	Perivulvar pores absent; second lobes ( $L_2$ ) reduced or absent . . . . .	5
5 (4)	Median lobes ( $L_1$ ) with 1 dorsal duct present between them . . . . .	<i>Diaspidiotus alni</i> (Marchal)
-	Median lobes ( $L_1$ ) without dorsal duct between them . . . . .	<i>Diaspidiotus distinctus</i> (Leonardi)
6 (3)	Perivulvar pores numbering 0–3 in total per side . . . . .	7
-	Perivulvar pores numbering more than 3 in total per side . . . . .	8
7 (6)	Pygidium with marginal crypt between $L_1$ and $L_2$ containing 3 duct orifices, with another duct orifice anterior to this group . . . . .	<i>Diaspidiotus wuenni</i> (Lindinger)
-	Pygidium with marginal crypt between $L_1$ and $L_2$ containing 2 or 3 duct orifices, without any additional duct orifice anterior to this group . . . . .	<i>Diaspidiotus aetnensis</i> Nucifora, Watson and Mazzeo <b>sp. n.</b>
8 (6)	Median lobes ( $L_1$ ) without dorsal ducts between them . . . . .	9
-	Median lobes ( $L_1$ ) with 1 dorsal duct present between them . . . . .	11
9 (8)	Prepygidial dorsal ducts present in marginal or submarginal areas . . . . .	<i>Diaspidiotus aesculi</i> (Johnson)
-	Prepygidial dorsal ducts absent from both marginal and submarginal areas . . . . .	10
10 (9)	Pygidial segment VI margins bearing numerous long, simple plates . . . . .	<i>Diaspidiotus uvae</i> (Comstock)
-	Pygidial segment VI margins without long, simple plates, but sometimes with short, spine-like plates . . . . .	<i>Diaspidiotus osborni</i> (Newell & Cockerell)
11 (8)	Prepygidial dorsal ducts present in marginal or submarginal areas . . . . .	12
-	Prepygidial dorsal ducts absent from both marginal and submarginal areas . . . . .	14
12 (11)	Pygidial segments IV and V with dorsal ducts . . . . .	<i>Diaspidiotus gigas</i> (Thiem and Gerneck)
-	Pygidial segments IV and V without any dorsal ducts . . . . .	13
13 (12)	Space between median lobes ( $L_1$ ) containing 2 narrow plates . . . . .	<i>Diaspidiotus zonatus</i> (Frauenfeld)
-	Space between median lobes ( $L_1$ ) containing only 1 narrow plate . . . . .	<i>Diaspidiotus ancylus</i> (Putnam)
14 (11)	$L_3$ well developed; with 2 fringed plates between $L_1$ and $L_2$ . . . . .	<i>Diaspidiotus pyri</i> (Lichtenstein)
-	$L_3$ absent or much reduced; fringed plates absent from between $L_1$ and $L_2$ . . . . .	<i>Diaspidiotus forbesi</i> (Johnson)

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