A contribution to an understanding of the biology and early stage morphology of *Casilda consecraria* (Staudinger, 1871) (Insecta: Lepidoptera: Geometridae)

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KEY WORDS
Sterrhinae, Rhodometrini, Ichneumonidae, Braconidae, central Spain, chaetotaxy, parasitoids.

ABSTRACT
Data are presented on the biology of *Casilda consecraria* (Staudinger, 1871) from central Spain (Madrid), in addition to original morphological data of the ovum, larva (L1-L2, L4-L5) and pupa. Larval data include 2nd larval instar chaetotaxy. A brief comparison of the biological and morphological characters is made with *Rhodometra sacraria* (Linnaeus, 1767) which belongs to the same tribe, the Rhodometrini Agenjo, 1952. Additional data are included on larval parasitoids (Hymenoptera: Ichneumonidae; Braconidae).

MOTS CLÉS
Sterrhinae, Rhodometrini, Ichneumonidae, Braconidae, centre de l'Espagne, chétotaxie, parasitoides.

RÉSUMÉ
Contribution à la compréhension de la biologie et à la morphologie des premiers stades de Casilda consecraria *(Staudinger, 1871) (Insecta: Lepidoptera: Geometridae).*
Des données sur la biologie de *Casilda consecraria* (Staudinger, 1871) du centre de l'Espagne (Madrid) sont présentées, ainsi que des données originales sur l'œuf, la larve (L1-L2, L4-L5) et la chrysalide. Les données larvaires comprennent le chétotaxie du 2e stade. Les caractères biologiques et morphologiques sont brièvement comparés avec *Rhodometra sacraria* (Linnaeus, 1767) qui appartient à la même tribu, les *Rhodometrini* Agenjo, 1952. Des données supplémentaires concernent les larves de parasitoïdes (Hymenoptera: Ichneumonidae; Braconidae).

INTRODUCTION

The tribe Rhodometrini Agenjo, 1952 contains 16 species in three genera (*Rhodometra* Meyrick, 1892, *Casilda* Agenjo, 1952, *Ochodontia* Lederer, 1853) with a distributional focus on the Afrotropical Region (Scoble 1999; Hausmann 2004). There are three species documented from the Mediterranean Basin: *Rhodometra sacraria* (Linnaeus, 1767), *Casilda consecraria* (Staudinger, 1871) and *C. anthophilaria* (Hübner, 1813), the latter species is allopatric with *C. consecraria*, this taxon being found no further west than SE Italy (Hausmann 2004). Of the two species being found in the Iberian Peninsula, *R. sacraria* is an important migrant or divagant (Eitschberger *et al.* 1991), it being an *r*-strategist, reaching northern Europe (Skule & Svendsen 1984; Grosser & Meier 1986; Johanson 1993); on the other hand, *C. consecraria* is a stenotypic taxon (strategy-*k*) that is limited distribution-wise to halophytic habitats in the SW Paleartic until west-central Asia (Sutton 1963; Raineri 1992; Viidalepp 1996; Parenzan 1998; Hausmann 2004).

In Madrid, *C. consecraria* is a permanent resident, the imago flying between February and September in three generations, although data from the summer months are much more limited (Hausmann 2004). The larvae is monophagous in *Limonium dichotomum* (Cav.) Kunze (Plumbaginaeceae), feeding on both the leaves and on the flowers (King & Viejo Montesinos 2010); imagines are diurnal, but not exclusively so (King 2002; Hausmann 2004), they are also attracted to artificial light (Romera 2004 unpublished thesis); they visit flowers of *Limonium dichotomum* flowers in the hottest part of the day (King 2013 unpublished thesis); on being disturbed, they take flight and tend to hide amongst low vegetation resting in a tectiform position (Hausmann 2004).

Although Singh (1951) diagnosed the subfamily Sterrhinae according to larval characters (included were 11 species from the Indo-tropics), he did not deal with any taxon in the tribe Rhodometrini, to date, morphological detail is limited to *R. sacraria* (Skule 1980; Häuser 2001; Gómez de Aizpúrua *et al.* 2006) which includes descriptions of all the early stages (not including the chaetotaxy), whilst detail about *C. consecraria* includes brief morphological detail of the L5 larva and the pupa with no information on the egg stage (Gómez de Aizpúrua *et al.* 2005).

Objectives

This paper aims to add to that biological data already known on *C. consecraria* courtesy of observations in captivity and in the wild state, as well as to describe the ovum and oviposition strategy adopted; in addition, each larval instar is to be described in terms of general morphology and chaetotaxy from captive-bred stock; data will also be provided on the hitherto undescribed pupa and pupation strategy. Additional data are provided on the hymenopterous parasitoids obtained (Hymenoptera: Icheumonidae; Braconidae).

MATERIAL AND METHODS

Study area

The localities which formed the basis for the collection of imagines and of larvae in the Tagus Valley (Madrid; 590-600 m) included: Cerros de Vallecas (Madrid municipality) (40°21'21.1N, 003°40'42.6W); Ciempozuelos (Cerros de Palomera) (40°09'09.1N, 003°36'27.1W); El Regajal (Aranjuez municipality) (40°0'16.87"N, 3°36'12.85"W); La Ponderosa (Chinchón municipality) (40°8'52.38"N, 3°26'3.48"W); Los Santos de la Humosa (40°29'56.44"N, 3°15'30.36"W) and Valdemoro (La Cañada) (40°11'15.11"N, 3°39'31.57"W).

The Miocenic and Triassic gypsyperous soils are relatively frequent in the Iberian Peninsula in the Tagus and Ebro basins, and the South-East Peninsula (Ferrandis *et al.* 2005). The climate is Meso-Mediterranean, with important drought conditions from June to September. The little rain that falls does so in the spring (March to May), and in the autumn (September to November). In winter, conditions of thermic inversion tend to prevail (Izco 1984). The general lack of precipitation and the corresponding aridity ensures that the influence of the gypsum soils is a constant, with a consequential effect on the vegetation which is generally understood to be included in the botanic order Gypsophiletalia.

Data collection: collecting larvae

Larvae were collected in localities in the Tagus valley. Initial larval collection took place as from August 2001, with an intensive field study occurring January 2004 until May 2006, September 2007 until July 2008 (King & Viejo Montesinos 2010). *Casilda consecraria* larvae were obtained exposed on their food-plant, *Limonium dichotomum*, either on the flowers or amongst the leaves, as described in King & Viejo Montesinos (2010) in areas of halophytic influence. Rearing out of larvae (and subsequent pupae) took place in plastic containers of various sizes ensuring that excess humidity did not build up which is invariably fatal for the larvae (Stehr 1987). Pupae were left *in situ* in order for emergence of adults to occur.

Obtaining ova

Friedrich (1986) describes the simple process in order for ova to be obtained *ex* female (whether bred out *ex* larva or obtained *ex* larva in the field) in the case of the geometrids, which do not necessarily need either the presence of the food-plant or flowers to enable feeding and laying to occur. Nevertheless, contact with plant material (stems, flowers, roots) does facilitate the process. In the case of *C. consecraria*, ova were laid on the flowers, stems and leaves of *Limonium dichotomum*, as well as on the sides of the container (King & Viejo Montesinos 2016).

Obtaining parasitoids

Shaw (1997) indicates how to breed out parasitoids (Hymenoptera: Ichneumonidae; Braconidae) *ex ovo*, *ex larva* (including *ex* pre pupal phase) or *ex pupa* in captive conditions, which includes the importance of associating the correct host-parasitoid, and

so avoiding erroneous or improbable relations which can only slow up future studies. In the same way, it should be established in which larval instar (L1-L5) the parasitoid attack occurred (or at least when it was noted) (Shaw & Huddleston 1991). When breeding out larvae (whether obtained directly from the field or bred out *ex* female) in captivity, whether a larva has been parasitised, the first sign is the wasp's cocoon being found, for example, in the whereabouts of a moribund larva, or if the larva has already pupated, within the host's cocoon, or if the wasp has exited the host; one finds the host's exuvium whilst the wasp larva is seeking out its own place in which to pupate (Shaw 1997). In all of these cases, it is imperative that all events associated with the parasitisation of the host are kept: cocoon (individual or *en masse*) (Hymenoptera) (with host remains) being appropriately labelled which would include (date of host capture in wild, date of finding of "parasitisation event", host food-plant, emergence date of parasitoid itself). All material thus obtained was sent to Mark R. Shaw, National Museum of Scotland (NMS), for identification.

A collection of larvae (Coll. GEK) was maintained (including those that perished after field collection or those bred out under captive conditions) in 70% ethanol (in *Eppendorf* vials with appropriate data). A collection of imagines (Coll. GEK, MNHN), was also maintained which were either reared out *ex larvae* or collected in Madrid (2000-2011). In those cases where it was necessary to verify identification of ostensible *C. consecraria* which can be confused with *R. sacraria*, at least in the summer generations, as both species fly sympatrically in the study area, slides were made of the genitalia apparatus according to standard procedures (Robinson 1976) and maintained at the Universidad Autónoma de Madrid (UAM).

SEM images of larvae (*ex* female or field-collected as appropriate, see captions) were obtained with material mounted on *stubs* with adhesive carbon discs and these were then subject to being bathed in gold using a *Quorum Q150TS*; the images themselves were taken with a SEM model Amray 1810 (10 kV). Images were taken either at the Universidad de Concepción (Chile) (2010) or at the Universidad Autónoma de Madrid (2011).

Terminology related to chaetotaxy as in Hinton (1946) and Dugdale (1961). Hausmann (2004) was consulted for differences in habitus between *C. consecraria* and *R. sacraria* as well as that related to the reproductive apparatus in male and female.

Abbreviations

A1-A10	abdominal segments;
L1-L5	refers to the larval instars;
T1-T3	thoracic segments.

Private collections

Coll. GEK	Gareth Edward King, Madrid.

Institutional collections

MNHN	Muséum national d'Histoire naturelle, Paris;
NMS	National Museum of Scotland, Edinburgh;
UAM	Universidad Autónoma de Madrid.

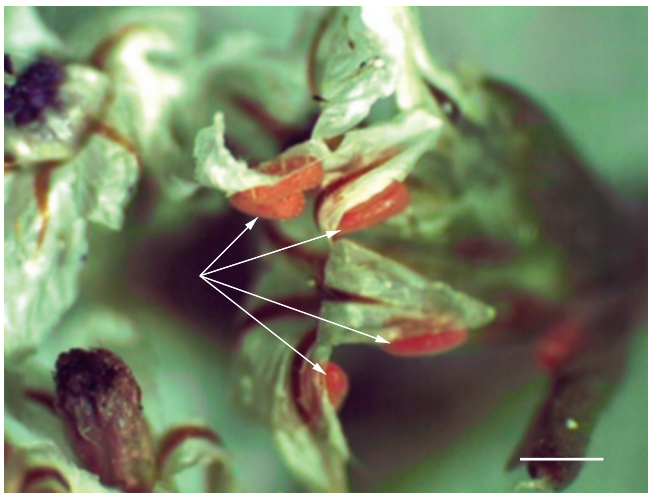

Fig. 1. — *Casilda consecraria* (Staudinger, 1871) ova: *ex* ♀ Los Santos de la Humosa, 26.VIII.2007 in *Limonium dichotomum* (Cav.) Kunze (Plumbaginaceae) flowers. Scale bar: 1.1 mm.

RESULTS

Family Geometridae Leach, 1815
Subfamily Sterrhinae Meyrick, 1892
Tribe Rhodometrini Agenjo, 1952
Genus *Casilda* Agenjo, 1952

Casilda consecraria (Staudinger, 1871)

Sterrha anthophilaria consecraria Staudinger *in* Staudinger & Wocke, 1871: 176.

Casilda consecraria – Agenjo 1952: 180.

Material. — The localities prospected resulted in the finding of 209 larvae (initial collection date: 25.VIII.2001, Ciempozuelos; final collection date:19.IX.2010, Cerros de Vallecas). Larvae were collected between the first generation in May (moths begin to fly from mid-February) (15 = 13.9%) and November with the majority being taken in the month of September (67 larvae = 32.1%) and the least in November (three larvae: 12.XI.2005; Valdemoro). The third generation would appear to be the most important with 110 (= 52.5%) larvae taken in the months from September to November.

Ovum and oviposition

Ovum (Fig. 1)

♀ Ciempozuelos, 26.IV.2008 (n = 1). Oviposited with axis parallel to substrate, laid individually, or in small groups on the stems or flowers of the food-plant or on the walls of the container; ♀ (n = 2) (Ciempozuelos, 13.VI.2010) oviposited individually on *Limonium dichotomum* leaves. Incubation: 7-11 days (n = 3, ♀).

On being laid the ovum is creamy-white becoming vermillion after two days; ovum is elongated ovoid-shaped with flattish poles (n = 1) (Fig. 2); surface is relatively smooth with barely perceptible rhomboid-shaped cells; micropyle surrounded by five irregular-shaped primary cells, the two upper cells larger than the three lower cells; eight secondary cells irregular in shape and size (Fig. 3).

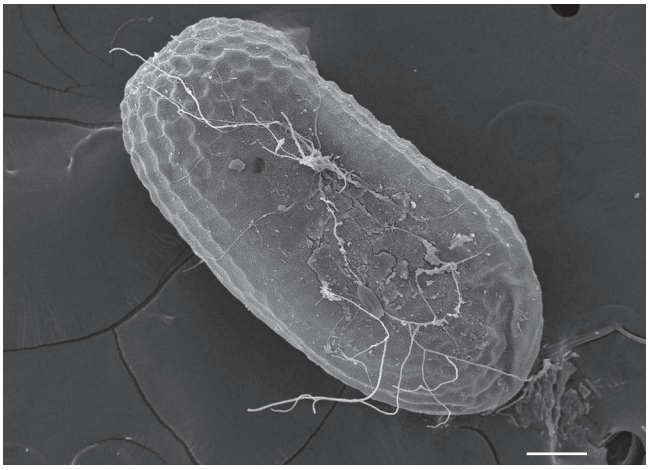

Fig. 2. — *Casilda consecraria* (Staudinger, 1871) ovum: *ex* ♀ 13.VI.2010, Ciempozuelos, Madrid; lateral view. Scale bar: 100 µm.

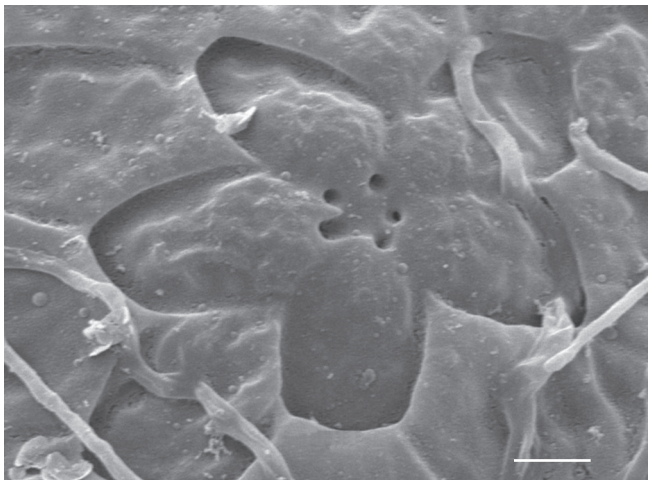

Fig. 3. — *Casilda consecraria* (Staudinger, 1871) ovum: ex ♀ 13.VI.2010, Ciempozuelos micropyle; primary cells. Scale bar: 5 µm.

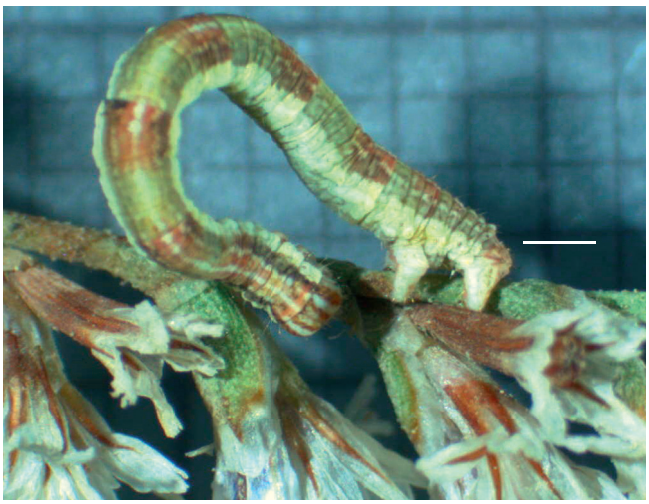

Fig. 4. — *Casilda consecraria* (Staudinger, 1871) larva L5: morph 2; Cerros de Vallecas (Madrid municipal area); 19.IX.2010; latero-ventral view; in *Limonium dichotomum* (Cav.) Kunze (Plumbaginaceae) . Scale bar: 1 mm.

Larval morphology

L1. (1st instar): 2.2 mm (n = 3): *ex* ♀ Ciempozuelos, 13.VI.2010 (eclosion: 21.VI.2010; description: 22.VI.2010): dorsal line greenish-white on an overall reddish cuticle; ventrally with reddish line.

L2. 5 mm (n = 3): dorsal line bluish-white; dorsally reddish-ochre; laterally bluish-white; ventrally reddish-ochre; cephalic capsule: bluish-white with epicranial suture reddish-ochre with lateral stripes same colour.

L3. Description not available.

L4. 14.5 mm (n = 1): (descriptions: Cerros de Vallecas: 19.IX.2010, 26.IX.2010) dorsally greenish-grey; urite A2 two evident black spots; A3-A5 with yellowish spots; dorsal line yellowish-white; cephalic capsule: bluish-white, lateral stripes reddish-ochre; laterally yellowish-white with pro-legs same colour, evident black spots A3-A5; ventrally greyish-green; thoracic legs greenish-white.

L5. 16.6 mm (n = 10) (Fig. 4): The fully-grown larvae is variable with five morphs established. Morph 1: incomplete dorsal line creamy with small black dots urites A2-A5; series of black dots A3-A5 in dorsal line margin; alongside dorsal line parallel runs an incomplete chestnut ochre line; cephalic capsule whiter than the previous instar with wider lateral cephalic lines which at the same time are a continuation of the blackish corporal margins; thoracic region: T1 same as evident chestnut ochre that borders dorsal line; laterally larva bluish-white with wider black dots A3-A5; ventrally several black lines give mottled appearance (wider A3-A5) on a bluish-white background, spiracles black. Morph 2 (Fig. 4): overall greenish; dorsal line greenish-white; dorsally reddish-ochre shapes alternate with others greyish-green T1-T3; abdominal region: A1-A10: greenish-white; line that runs along dorsal region greenish-ochre, A1-A2 somewhat paler; laterally as well as ventrally larva same greyish-green tone. Morph 3: overall mostly reddish with evident reddish-ochre rings urites A2-A10; dorsally larva chestnut ochre, dorsal line whitish interrupted by dark ochre spots within segmental interstices; bordering dorsal region runs an uninterrupted greyish-ochre line; cephalic capsule reddish-rose with lateral lines which at the same time are a continuation of the greyish-ochre line; frons reddish-ochre; laterally larva greyish-cream; ventrally violet-grey. Morph 4: overall greyish-ochre; uninterrupted dorsal line creamy A5-A10, then, until A1 interrupted, then uninterrupted T1-T3; dorsal region reddish-ochre; line that runs dorsally uninterrupted same tone reddish-ochre bordered by grey line; laterally, greyish-cream tone with irregular lines; ventrally bluish-grey gives mottled appearance; pro-legs both anal and abdominal same tone as laterally; thoracic legs: pinkish; cephalic capsule as with morph 3. Morph 5: overall dark green; evident reddish-ochre spots A2-A10 dorsal region these at the same time emphasise yellowish-white dorsal line which fades out in rest of dorsal region, although more evident in T1-T3; laterally and dorsally larva greenish-yellow tone.

Chaetotaxy

Larva

L2: ± 5 mm (n = 2) (*ex* ♀ Ciempozuelos, VI.2004): Head: Hypognathous; *stemmata* 1-6 (Fig. 5A, B) form a "semi-

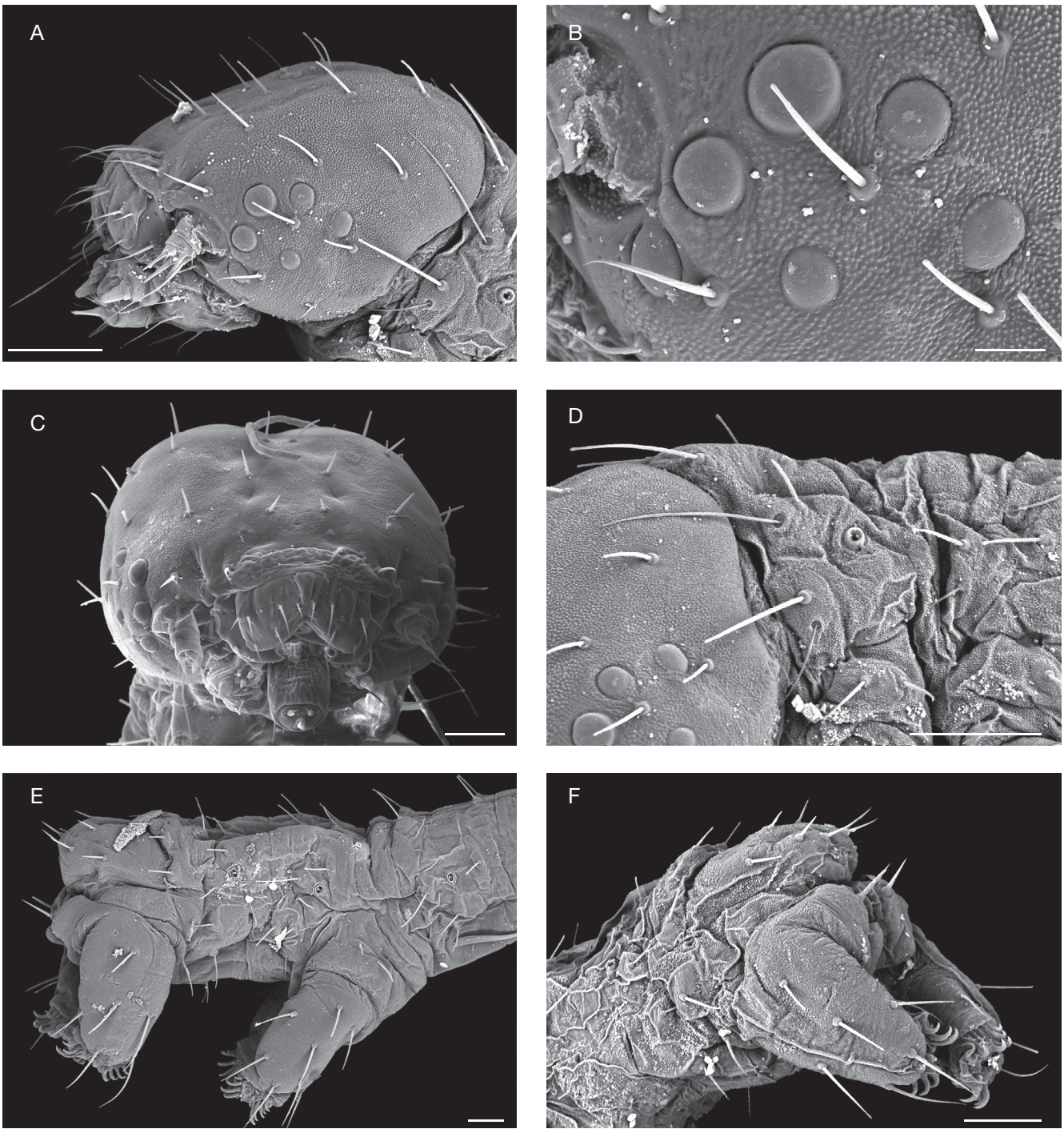

Fig. 5. — *Casilda consecraria* (Staudinger, 1871) L2, *ex* ♀ VI.2004, Ciempozuelos: **A**, cephalic capsule lateral view, T1: corresponding setae; **B**, cephalic capsule lateral view, ocelli: ocellar setae; **C**, capsule lateral view, ocelli: ocellar setae; **D**, cephalic capsule, T1, lateral view: corresponding setae; **E**, A6-A10: corresponding setae on abdominal pro-legs; anal shield and anal pro-leg; **F**, corresponding setae on anal shield and anal pro-leg; latero-ventral aspect. Scale bars: A, C-F, 100 µm; B, 25.5 µm.

circle"; ocellus 2 and 6 positioned at 50% of an ocellus one from another; ocellus 1 positioned one-and-a-half ocelli from ocellus 2; ocellus 5 positioned what is worth three ocelli from ocellus 1 and 6; two ocelli from ocelli 2-4; ocellus 3 is the largest at 25% more than the others and at 50% larger than ocellus 5; seta O2 positioned at 50% of an ocellus from ocellus 1; O1 positioned at 50% of an ocellus from ocellus 2 (25% larger); O3 positioned at four ocelli from ocellus 5; SO2 positioned at 50% of an ocellus from ocellus 6; SO3 positioned in a descending line below (Fig. 5C) setae A1, A2, A3 form a "triangle" with A2 and A3 at the same level; A1 positioned at two ocelli from ocelli 3 and 4; L1, P1, P2 form a "triangle" with L1; labrum (Fig. 5C): setae "short": LR2, LR5 longer at 20% longer than LR6

Table 1. — *Rhodometra sacraria* (Linnaeus, 1767) and *Casilda consecraria* (Staudinger, 1871) larva: early stages: comparative biological and morphological characters.

Stage	*Rhodometra sacraria* (Linnaeus, 1767)	*Casilda consecraria* (Staudinger, 1871)
Ovum	Laid with axis parallel to substrate; Laid individually; walls of container or roots of *Polygonum aviculare* L., 1753 (Polygonaceae); On being laid are intense yellow which changes to rose pink after a few days; Incubation period: 4-12 days (n = 3; ♀) (King, data in captivity ♀ 2007-2009) (King 2013 unpublished thesis).	Laid with axis parallel to substrate (Fig. 1); Laid individually or in groups of variable number; on stalks, flowers of leaves of *Limonium dichotomum* or walls of container (Fig. 1); On being laid are creamy-white which changes to intense pink after two days (Fig. 1); Incubation: 7-11 days (n = 3, ♀) (King 2013 unpublished thesis).
L1	Transluscent reddish; two reddish lines run semi-laterally; dorsal line transluscent reddish (n = 4).	Dorsal line greenish-white on reddish background; runs centrally reddish line (n = 3).
L2 cephalic capsule	Pale green; epicranial suture reddish-brown (n = 3).	Bluish-white; epicranial suture reddish-ochre; lateral stripes reddish-ochre (n = 3).
L2 dorsal line	Greyish-green (n = 4)	Bluish-white (n = 3)
L4	Tone greyer; dorsal region ochre; dorsal line pale ochre bordered in darker ochre; sub-dorsal lines much darker ochre; lateral-ventrally greyish; thoracic legs greyish-white; abdominal pro-legs with reddish forms hardly perceptible (n = 1).	Dorsally greyish-green; A2 two black spots evident; A3-A5 yellowish spots; dorsal line yellowish-white; cephalic capsule bluish-white, lateral lines reddish-ochre; laterally yellowish-white abdominal pro-legs same tone, black spots evident A3-A5; ventrally greyish-green; thoracic legs greenish-white (n = 1).
L5	Four morphs established: commonest: overall lemon-green dorsal region with reddish spots (n = 7) (King 2013 unpublished thesis).	Five morphs established: two commonest: overall reddish-pink and reddish-ochre (n = 10) (Fig. 4).
Pupa/cocoon	Cocoon is a flimsy structure of yellowish-orange silken threads; pupa much paler yellowish; overall yellowish-green (Patočka 2003); opaque cuticle through which can be discerned the pharate imago.	Pupal cuticle seems to be more "substantial" as is cocoon (see *Results*) (Fig. 7).
Food-plant	Oligophagous in the polygonales (Polygonaceae) (Skule 1980; Bacallado *et al.* 2006; Huertas Dionisio 2007).	Monophagous in *Limonium dichotomum* (King 2002; King & Romera 2004; Gómez de Aizpúrua *et al.* 2005; King & Viejo Montesinos 2010).

Table 2. — Chaetotaxy: comparisons with larvae of *Scopula* Schrank, 1802 (Singh 1951) and *Casilda consecraria* (Staudinger, 1871) (tribe: Rhodometrini Agenjo, 1952).

Character	*Scopula* Schrank, 1802 (Singh 1951)	*Casilda consecraria* (Staudinger, 1871)
Cephalic capsule	Granular; vertex almost rounded; O2 in proximity to ocellus 1; O1 very near to ocellus 3 (seems to be between ocelli 3, 4).	Granular; vertex almost rounded; O2 in proximity to ocellus 1; O1 very near to ocellus 2 (Fig. 5B).
Urites	Lengthened abdomen, cuticle granular; setae are "short" and not very prominent at base; A1-A9; SD1 anterior to spiracle A1-A7; L1 posterior to spiracle and below it A1-A5, urites A6-A8 it is positioned at same level; anal shield (A10) is rounded, L1 next to L2 (SD1 according to Dugdale 1961), D1, L3 in a row.	Lengthened abdomen; cuticle relatively smooth; setae are not "short", for example, SV 1-3 (A6); A1-A9; SD1 anterior to spiracle A1-A7; L1 posterior to spiracle and below it A1-A5; urites A6-A8 it is positioned at same level; anal shield (A10) is rounded, L2 (SD1) much more lateral on anal shield rather than "near to" (Fig. 5E, F).
Spiracles	Spiracles oval-shaped; A6 is "bigger" than that in T1; A7, A8 are of different sizes.	Spiracles oval-shaped; A6 is slightly "bigger" than that in T1; A7, A8 are of same size.

the shortest of these setae. Thoracic region: T1 (Fig. 5D): XD1, XD2, SD1 25% longer than SD2, thread-like, motile, positioned in "open" pinnacle, L2, L1 (thread-like, 25% shorter than SD1) these setae positioned anteriorly to spiracle; setae SV2, SV1, V1. Abdominal region: A6 (Fig. 5E): D1, D2; SD1, L1, L2 (same length) form a "triangle" around spiracle; L3, L4 positioned anteriorly: seven setae positioned anteriorly on abdominal pro-leg;V1; A7: D1, D2; SD1, L1, L2, form a "triangle" around spiracle; L3, SV1,V1; A8: D2, SD1 (positioned in pinnacle), L1, L3, SV1 (positioned in pinnacle), V1; A9: setae in descending line: D2, SD1, L1, SV1 (longest by 25%); A10: anal shield "rectangular" form: D1, setae D2 on apex; PP1 porrect in anal region; L1, SD1 "thickset, pronounced" not as "long" in comparison with D2; six setae positioned anteriorly in anal pro-leg, 50% longer than setae in anterior zone of A10 (Fig. 5E, F); crochets (Fig. 6) completely broken mesoseries (Dugdale 1961).

Pupa (Fig. 7)
Cocoon (not shown) of dense greyish-white silk spun in amongst plant matter or between leaves of *Limonium* (in captive conditions); ♀ 7 mm (n = 1) overall pale olive-ochre; A1-A3 light greenish-olive; A4-A10 pale ochre; pterotecas greenish-ochre overlap A5; cephalic capsule prominent; spiracles dark ochre; cremaster: eight hooks; D2 somewhat longer with laterals wrapped around forming a "knot" (Fig. 8).

PARASITOIDS
The hymenopterous parasitoids obtained *ex larvae* (evidently collected in field: 2004-2008) are detailed below, data is also included on a case of pseudo-hyper-parasitisation (Shaw pers. comm.). There were three species recorded (one braconid and two ichneumonids):
– *Homolobus truncator* Say, 1828 (Braconidae: Homolobinae) MRS det. deposited NMS; Shaw 2010): eight cases: (VII (1), IX (6), X (1)] in IX-X.2005 there were 4/31 larvae (12.9%). Cocoons of this braconid are noted alongside the moribund L5 larva in its cocoon.
– *Alcima orbitale* (Gravenhorst, 1829) (Ichneumonidae: Campopleginae) (MRS det. deposited NMS): documented in late spring-summer months attacking L4 larvae; 14 attacks V (4), VI (4), VII (6); V-VII.2004, 9/45 larvae (20%); May-June (2008) 2/7 (40.8%).
– *Campoletis* sp. (Ichneumonidae: Campopleginae) (MRS *det.* deposited NMS): six cases *ex pre-pupae* (L5) with cocoons found inside host's cocoon (May, June, July, September) (VII.2004-V.2006).
– *Neochrysocharis albiscapus* Erdos, 1954 (Eulophidae: Entedoninae) (R. Askew det. deposited NMS): *Alcima orbitale* larva is parasitised as it emerges from *C. consecraria* larva. One case: 19.VI.2004: cocoon in *Limonium*. (*C. consecraria*-*A. orbitale*-*N. albiscapus*) (MRS pers. comm.: II.2012). (Example of pseudo-hyper-parasitisation as the larva of *C. consecraria* is not directly attacked; *A. orbitale* larva emerges from L5 host larva before it itself is attacked Shaw *et al.* 2009).

DISCUSSION

In terms of phenology, an important quantity of larvae were taken in September-November, the majority pupated in captivity to emerge the following year, however a partial third generation in the wild state does occur as is suggested with those larvae taken 09.IX.2004; one imago emerged 03.X.2004 (Coll. GEK) and 18.IX.2004 two emergences took place 15.X.2004 and 07.XI.2004 (Coll. GEK). In September 2010 (26.IX.2010, Cerros de Vallecas), ova were found having been laid on the flowers of *Limonium dichotomum* with neonates eclosing 01.X.2010 (King 2013 unpublished thesis).

With reference to larval ethology, the *C. consecraria* larva is invariably taken exposed on *Limonium*, either on the flowers or the stems or leaflets, so in this way, it is unlike *R. sacraria* which is usually taken on the ground immediately beneath knotweed mats (*Polygonum aviculare* L.) (King & Viejo Montesinos 2014), neither species sit with the body pressed against the substrate, and both seem relatively active rather than in a state of quiescence (King 2013). One aspect of larval behaviour which is unusual in a cryptic insect (Zalucki *et al.*

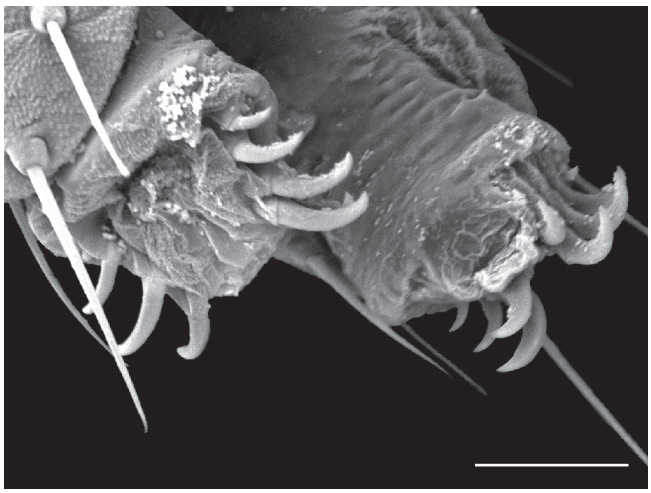

FIG. 6. — *Casilda consecraria* (Staudinger, 1871) L2: A10 crochets; anal pro-legs *ex* ♀ VI.2004, Ciempozuelos. Scale bar: 50 µm.

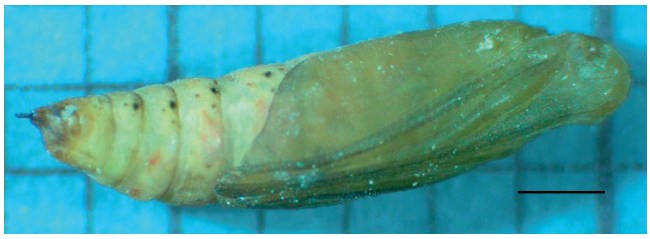

FIG. 7. — *Casilda consecraria* (Staudinger, 1871): ♀ pupa latero-ventral view, diagnostic characteristics; larva IX.2010; Cerros de Vallecas, Madrid municipality. Scale bar: 1 mm.

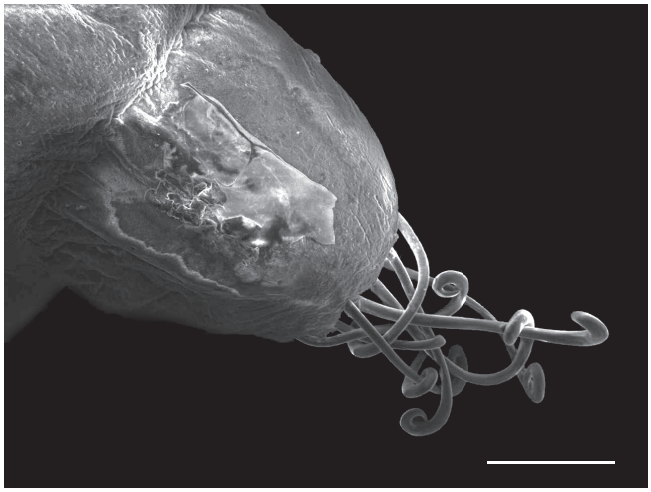

FIG. 8. — *Casilda consecraria* (Staudinger, 1871): anal field and corresponding hooks; cremaster ventral view; larva IX.2010; Cerros de Vallecas, Madrid municipality. Scale bar: 100 µm.

2002), is the fact that the larva of *C. consecraria* typically (in all instars which were collected in the field) "jumps" off the substrate falling on to the ground beneath the plant (King 2013), that it does this would seem to make it more vulnerable to depredation, to other kinds of predators distinct to those which caused it to react initially. Gross (1993) pointed out that this type of behaviour as a response to the presence of a predator, is frequent amongst insects, on the other hand, other larvae allow themselves to drop suspended by a silken thread which facilitates a return to the plant (Sugiura & Yamazaki 2006) which at the same time becomes a strategy which is taken advantage of by parasitic hymenopterans (Icheumonidae, Braconidae) which use the thread in order to locate their larval host (Yeargan & Braman 1986, 1989). In this way, if *C. consecraria* larvae do not spin a silken "safety line" back on to the plant this cannot be picked up as a cue by erstwhile predators.

The information provided on egg positioning is a first for *C. consecraria* with data known for *R. sacraria* (Skule 1980; Grosser & Meier 1986) (Table 1), the only other species in the tribe Rhodometrini which is relatively well-known. Both taxa oviposit individually with the ovum axis parallel to substrate, additionally, on being laid and the subsequent colour changes to the ovum are also similar. Peterson (1962) working with Nearctic sterrhine species also noted a brighter egg colour. The structure of the chorion in *C. consecraria* as described in this paper is the first for a taxon in this tribe. Although Salkeld (1983) did not correlate ova of the tribes Sterrhini Meyrick, 1892 and Scopulini Duponchel, 1845, it would seem to be the case that this first description of a Rhodometrine ova (Figs 2, 3) fits in with the general structure alluded to by this author of the ova of the Scopulini, as it does with the only Scopuline ova included in a recent paper of the ova of six Sterrhine taxa (King & Viejo Montesinos 2016).

In this paper original detail has been included at a general morphological level of larval instars L1-L5 (not L3) of *Casilda consecraria* which had only been illustrated in the final instar (Gómez de Aizpúrua *et al.* 2005), additionally, this species can now be compared with *R. sacraria* (Table 1) (Skule 1980; Grosser & Meier 1986). Furthermore, of the two species, it must noticed that in the fifth instar there is a pronounced polychroism (Table 1) which could be related to the major substrate against which the larvae would be taken: "bright green" polygonales in the case of *R. sacraria* and "rose-pink" *Limonium dichotomum* flowers regarding *C. consecraria*. This has not been documented formally in any Sterrhine larva, although Bocaz *et al.* (2003) analysed morphological variation in the Neo-tropical ennomine *Syncirsodes primata* (Walker, 1862).

The *C. consecraria* L2 larva has been described in terms of its chaetotaxy with data which are new for Science, as well as being the first for the tribe Rhodometrini, although unpublished data are available for L5, rather than L2 *R. sacraria* (King 2013); secondary setae appear as from L3 (Dugdale 1961).

Singh (1951) included *Scopula* Schrank, 1802 in the Sterrhinae larvae (genera: *Problepsis* Lederer, 1853, *Scopula* and *Idaea* Treitschke, 1825) he analysed, which might serve as a valid comparison for our purposes (Table 2).

According to Hassenfuss (1963), the length and breadth of the setae in the proximity of the *stemmata* (Fig. 5A, C, D) are associated with those strategies that larvae adopt in their particular milieu, which in the case of *C. consecraria* might be "shorter" as they are not "ground-dwellers", unlike *Idaea* larvae (Hausmann 2004; King & Viejo Montesinos 2012). It could be concluded that the "slender" setae of the two species in the Rhodometrini for which there are data (King 2013) is indeed related to the strategies which they adopt, although *R. sacraria* larvae are "ground-dwellers" in the widest sense (King & Viejo Montesinos 2014).

In terms of the parasitoids recorded *ex C. consecraria*, the life cycle of *Homolobus truncator* Say, 1828 (Braconidae; Homolobinae) includes the wasp larva emerging from the quiescent larval host in the pre-pupal phase within the host's cocoon, the braconid larva then constructing its own cocoon alongside the moribund host, in this way, it takes advantage of the silken shelter that is constructed by the host larva (Shaw 2010).

Other Geometrid taxa that are attacked by *H. truncator* include *Xanthorhoe fluctuata iberaria* Staudinger, 1901 and *Rhodometra sacraria* (Linnaeus, 1767), as well as *Calophasia platyptera* (Esper, 1788) (Noctuidae) (Shaw 2010). These taxa also feed exposed on the host plant.

The campoplegine (Ichneumonidae) taxa attacking *C. consecraria*: *Campoletis* sp. and *Alcima orbitale* (Gravenhorst, 1829) share a recognised synapomorphy of the Campopleginae which is the deposition of the host larva's cuticle on the cocoon of the Ichneumonid once the parasitoid larva has emerged from the erstwhile host (Gauld 1988; Bueno dos Reis Fernandes *et al.* 2010). *Campoletis* sp. emerge as larvae once the host has pupated within its own cocoon and then pupate within the host's cocoon. *Campoletis* attacks the second generation of *C. consecraria* at the height of the summer (Shaw *et al.* 2009). *Campoletis* are recognized as attacking "exposed" larvae as is the case with *C. consecraria* on *Limonium dichotomum* (Aubert 1978).

A. orbitale attacks the larval host in the late spring/summer months only; in 2004 (V-VII) nine parasitisation cases were registered *ex* 45 larvae (20%), in 2005 1 case/11 larvae (V-VI) (9.9%), in 2006 (2/3 larvae V (66%) and additionally in 2008 (2/7 larvae = 40.8%). Of the 63 *C. consecraria* larvae taken in 2005 from May until November, it would seem that *A. orbitale* did not play an important role, so it must have used other larval hosts (Shaw *et al.* 2009), nevertheless, the following year with only three larvae found, parasitisation levels were high, as was the case in 2008. *Casilda consecraria* larvae feed in the exposed parts of their host plant, so as a consequence, *A. orbitale* larvae emerge in an exposed fashion pupating and depositing their own cocoon on the dorsal side of the leaf, in this way, the parasitoid has a competitive advantage in terms of shorter development times, both in the host and as a cocoon, due to exposure to full sun (Shaw *et al.* 2009). This is corroborated by emergence data in captivity with an average of only 7.8 days (n = 10) in the pupal stage. Shaw *et al.* (2009) suggest that high rates of "hyperparasitisation" experienced by *A. orbitale* can be explained

by the exposure of the larva as it emerges from its host, although the present study did not document more than one case: *Neochrysocharis albiscapus* Erdos, 1954 (Eulophidae: Entedoninae).

It should be pointed out that according to Shaw *et al.* (2009), the host range of *A. orbitale* is limited to the Zygaenidae, in Spain, however, the taxa attacked *ex larvae* is much wider including the subfamily Satyrinae (Nymphalidae) and Geometridae. One interesting example of the latter family is that involving *R. sacraria*. *R. sacraria* "shares" two parasitoids with *C. consecraria*: *A. orbitale* and *H. truncator*. Of 201 *R. sacraria* larvae collected in various localities in Madrid 2006-2010, in August 2006, *A. orbitale* was obtained *ex larva* of the 16 larvae collected 17.VIII.2006 (King, obs. pers.).

A. orbitale's hosts can be seen as being larvae that are found at soil level beneath their respective food plants, at least during daylight hours that crawl upwards onto the plant itself at night; the satyrine nymphalid *Maniola jurtina* (Linnaeus, 1758) would seem to be an example of this (*ex larva* in Poaceae: 18.IV.2009, Tres Cantos; GEK leg., MRS det., NMS dep.) (with the notable exception of *C. consecraria* that feed exposed on *Limonium dichotomum*). Turlings *et al.* (1993) and Shaw & Aeschlimann (1994) suggest that the female limits its host search to those hosts in a particular herbal stratum, in the case of *A. orbitale*, this actively ekes out at soil level, or in the proximity, in low plants, taking advantage of those host larvae of a similar shape and size, rather than that they should be close taxonomically. García Barros (1989) cited *Hipparchia statilinus* (Hufnagel, 1766) (Satyrinae), whose larva is found from September until May when it may serve as a larval host for *A. orbitale*.

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