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Life history and description of the larval stage of *Aphodius lusitanicus* ERICHSON, 1848 (*Coleoptera*: *Scarabaeoidea*: *Aphodiinae*)*

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Abstract. The larvae of *Aphodius lusitanicus* ERICHSON, an endemic Iberian species are described and illustrated. The life history of this species was studied on the Mediterranean coast of the Iberian Peninsula in 1993 and 1994. *A. lusitanicus* was reared from adult to larvae and to adult in an environmental chamber of the laboratory at 22:16C (Light:Dark), relative humidity 80% and photoperiod of 16: 8 hours (Light:Dark). Adult activity began in late winter, lasting till early summer and a new period of activity including mating and oviposition was observed in autumn. The description of *A. lusitanicus* kleptoparasitizing a nest of geotrupid *Thorectes valencianus* BARAUD, is for the first time offered for this species.

Key words: *Scarabaeoidea*, *Aphodiinae*, larva, description, mediterranean ecosystem, Iberian Peninsula.

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I. INTRODUCTION

The subgenus *Ammoecius* MULSANT is distributed in the occidental Palearctic Region, the southern part of the Etiopian Region and the Nearctic Region (BARAUD 1971; DELLACASA 1983). Nine of the thirty species known live in Europe, three of them are Iberian endemics: *Aphodius frigidus* BRISOUT 1866, *A. lusitanicus* ERICHSON 1848 and *A. mariani* BÁGUENA 1930 (BARAUD 1971 and 1992).

In this paper we continue our investigation aiming at descriptions of the larva of the *Aphodiinae* species (GALANTE 1990; VERDÚ & GALANTE in press) especially the species living exclusively in the Iberian Peninsula, e. g. *A. lusitanicus*.

This species has been recorded, though infrequently, from different localities of the Iberian Peninsula and the Balearic Islands (BÁGUENA 1967; COMPTE 1975; RUANO-MARCO et al. 1988).

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A. lusitanicus was captured in Alicante during a study of the biology and ecology of dung beetles in the Spanish Levant. In that area it is well established in rabbit latrines.

Generally, larval stages of *Aphodiinae* are not taken into account in ecological studies and such biological aspects as the kleptoparasitic behaviour (BRUSSARD 1987; CHAPMAN 1869 and 1870; KLEMPERER 1980; HAMMOND 1976; HOWDEN 1955; MARTÍN-PIERA & LOBO 1993; ROUGON & ROUGON 1980 and 1983) may go unnoticed.

Without descriptions of the larval stages it is not possible to make a complete study of the dynamics of coprophagous communities. *A. lusitanicus* was found together with *A. elevatus* (OLIVIER) in rabbit latrines in the Alicante study area. The aims of this work were : 1) to describe the third larval stage of *A. lusitanicus*, 2) to study the biology of this species, 3) to check if kleptoparasitic behaviour occurs in this species. This would enable future identification of this species, allowing the separation of its larvae from the larvae of *A. elevatus* living together with them in rabbit latrines in the Alicante region (unpublished data).

The voucher specimens of adults and larvae of *A. lusitanicus* are stored in the entomological collection of E. GALANTE in the Departamento de Ciencias Ambientales y Recursos Naturales, Universidad de Alicante, Spain.

A c k n o w l e d g m e n t s. We thank K. BURKE for checking the early English version of the manuscript.

II. MATERIAL AND METHODS

A biological study was carried out in different localities of the Alicante province during 1993 and 1994 (Table I). The weather of this region is very dry and warm; during the study period the air and soil temperatures and relative humidity of the air were measured (Table II).

Table I

Sampling sites and geographic coordinates U.T.M.

Sampling sites	U.T.M
Font Roja (Alcoy)	30SYH18
Sª de la Carrasqueta	30SYH17
Sª del Cid	30SXH95
Sª del Cabeçó	30SYH26
Cabezó de la Sal	30SXH74
Algueña	30SXH74
El Reconco (Sª de Onil)	30SXH97
Sª de Salinas	30SXH86
Sª del Reclot	30SXH74

First dung-baited pit-fall traps (LUMBRERAS et al. 1990, MENA et al. 1989) were used to monitor the activity of adult *A. lusitanicus*. Also sampling of adults and larvae of this species was undertaken directly in rabbit latrines and the soil under them was examined in order to check possible kleptoparasitic habits.

The live specimens collected were kept in cylindrical plastic breeding cages (20 cm high, 10 cm in dia.) inside an environmental chamber (at a temperature of 22:16C - Light:Dark -, relative humidity 80% and photoperiod 16: 8 hours - Light:Dark -); rabbit droppings were provided as food.

Table II

Air and soil temperatures (T) and relative humidity of the air (R.H.) in the study area

	MONTHS		
	Mar.-Apr.-May	June-July-Aug.	Sep.-Oct.-Nov.
Average air T (C)	26.82	38.40	23.00
Average soil T (C)	20.70	32.67	21.35
Average R.H. (%)	23.23	8.81	57.60

Larvae were preserved in KAAD's solution (CARNE 1951) for later examination and description. Ten LIII larvae fixed on 4th January 1994 were utilised to describe the larval morphology of *A. lusitanicus*. These larvae were obtained in the laboratory from adults collected in the Font Roja Natural Park, Alcoy (Alicante) on February 26th 1993.

III. RESULTS AND DISCUSSION

Description of *A. lusitanicus* larvae

The description of larvae was carried out using RITCHER's (1966) and KIM & LUMARET's (1988) anatomical designations.

Body arched (C-shaped) at the level of the 5th abdominal segment (Fig. 1). Small size: body length 7.8-8.7 (8.2) mm; thorax width 1.2-1.9 (1.4) mm. Body with well-developed hairs.

Head light yellowish brown with a darker area at the antennal union. The mandibles dark brown with black anterior edge.

Head capsule (Fig. 2) – cranium bearing one long seta on each side, on the anterior frontal angle (AA), a similar one on the external frontal part (EFS), one very short seta in the anterior frontal region (AFS) with microsensilla on the base, one seta externally at the back of the frontal region (EPFS) and another one inside the frontal region (IPFS).

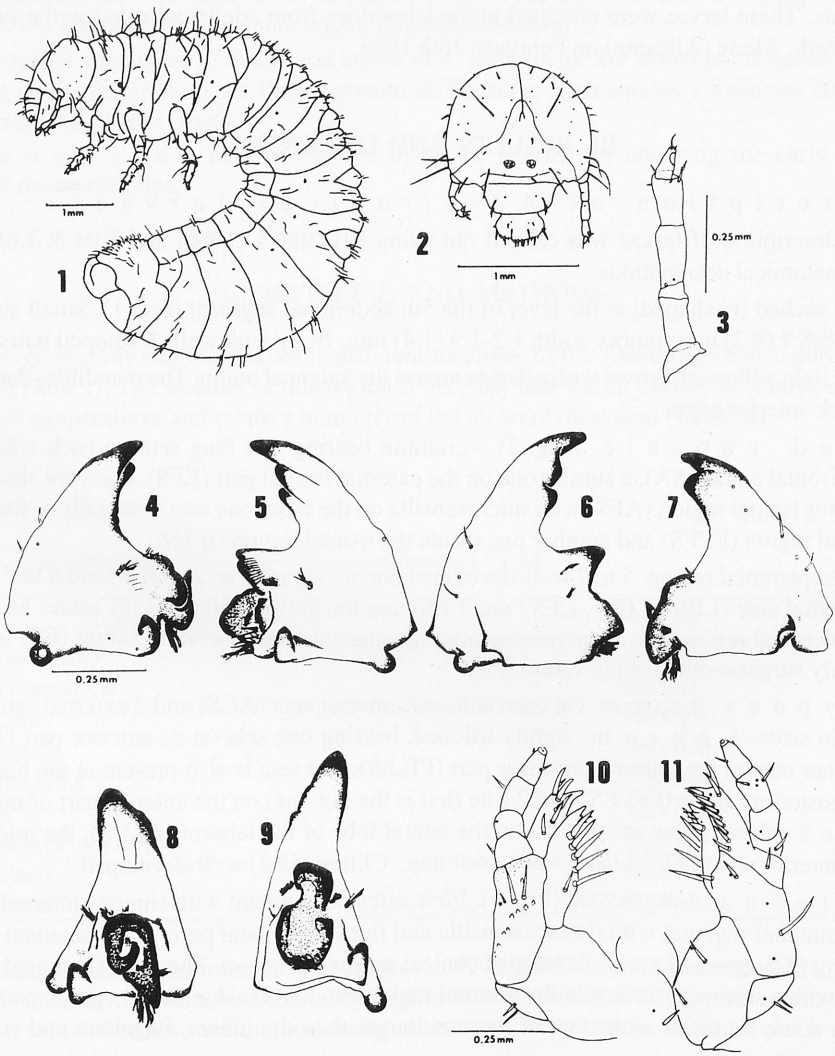
In the epicranial region, 5 to 7 well-developed dorsoepicranial setae (DES) and 6 to 7 setae on each external side (LES); LES1, LES2 and LES3 are the best-developed LES setae. At the back of the epicranial region 3 to 4 microsetae (ms) are present. The epicranial suture (ES) is present and clearly surpasses the frontal suture (FS).

Clypeus transverse. On each side one anterior seta (ACS) and 2 external setae (ECS) varying in sizes. Labrum lightly trilobed, bearing one seta on its anterior part (AILSbS) and another one on the internal posterior part (PILbS); one seta is also present at the back of the lateral- posterior region (PPLLS) and 2 (the first is the big one) on the anterior part of that region (APLLS); 2 anterior setae are present on the lateral lobe of the labrum (ALLS); the middle lobe bears 4 anterior setae (ACLS) and a posterior one. Clithra (CLI) well-developed.

Antenna 4-segmented (Fig. 3). First antennal segment with sinuous internal margin; second antennal segment with 5 macrosensilla and thickened distal part. Third antennal segment with a ring of 5 setae and a well-developed conical sensory structure. The fourth antennal segment is short, with a sensorial surface in the internal region extended to dorsal and ventral parts; apical end with some sensorial setae, one of them is longer than the others, flagellate and is a whips shaped.

Mandibles (Figs 4-9) asymmetrical, right mandible slightly shorter than the left, with 3 dorso-external setae and one microsensillum between 2 posterior setae. Left mandible with S1, S2 and S3 teeth clearly separated from each other by a shallow groove. Right mandible with S1 and S2 teeth fused; S3 tooth isolated by a groove.

M a x i l l a (Figs 10,11) bears both separate galea and lacinia. Galea in dorsal view with 2 external (EGS) and 4 internal setae (IDGS); in ventral view with a comb of 9 to 10 internal setae (IVGS). Lacinia with a terminal trilobed uncus; 2 microsetae on the bases of the lobes. The dorsal part of the lacinia bears an internal row of 5 setae (IDLAS) and a short and central seta on its base (BDLAS). Stipe with a row of 7 to 11 (8) stridulatory teeth (SD), 1 or 2 of them on the base of the palpifer (PF); 2 fore setae varying in size (ASTS), with a small external microseta (ASTSm).



Figs 1-11. *Aphodius lusitanicus* ERICHSON: 1 – third-stage larva, left lateral view; 2 – head, dorsal view; 3 – antenna; 4 – right mandible, ventral view; 5 – left mandible, ventral view; 6 – right mandible, dorsal view; 7 – left mandible, dorsal view; 8 – right mandible, molar view; 9 – left mandible, molar view; 10 – left maxilla, dorsal view; 11 – left maxilla, ventral view.

Maxillary palpus 4-segmented, the first joint (palpifer) with a seta in the ventral part; the second with a thickened apical part and with 2 microsensilla in the dorsal and ventral region, respectively; the third joint also thickened in its apical part, with 2 setae and 2 microsensilla in the ventral part; the fourth joint tapering distally with 2 dorsal setae and a ring of 8 short microsetae at its distal end.

H y p o p h a r y n x (Fig. 12) with well-developed, asymmetrical oncyli covered in part by tegument extensions which also cover the back of the right oncyli. Glossa with 2 pairs of macrosensilla and 15 to 19 (17) microsensilla (MIS) arranged in a curved row anterior to the oncyli. Posterior region of glossa with 9 to 13 (10) setae (PLGlS) arranged in an arc; lateral lobe of the glossa with 3 setae (LLGlS).

E p i p h a r y n x (Fig. 13) with anterior epitorma (ETA) slightly broadened at the apical end which is situated in the central pedial area (PE); short pternotormae (PT); the left is narrower and prolonged. Mesophoba (MPH) with 3 pairs of macrosensilla covered by direct back expansions of tegument, better developed on the lateral sides. Dexiophoba better developed than laeophoba. Protophoba (PPH) with expansions of tegument accompanied by 15 to 18 (17) sensilla. Haptomerum with 1 pair of macrosensilla. Acroparia with 4 setae. Chaetoparia with one small seta on each side, on the base of the pternotormae. Clithrum well-developed.

T h o r a x. Prescutum bears 9 pronounced setae; scutum with 1 pair of long setae in the dorsal region; scutellum bears 2 pairs of dorsal setae and 3 pleural ones. Maximum width of prothoracic spiracle (Fig. 14) 0,051 mm (52.2 µ). Respiratory plate (RSP) with a maximum of 6 to 8 holes. Legs (Fig. 15) well-developed, with the prothoracic pair shorter; distal part of tarsal claws curved, bearing 2 very short setae on the ventral part. Trochanter with 4 to 5 macrosensilla in the anterior region. Apical part of the femur thickened and triangular in shape.

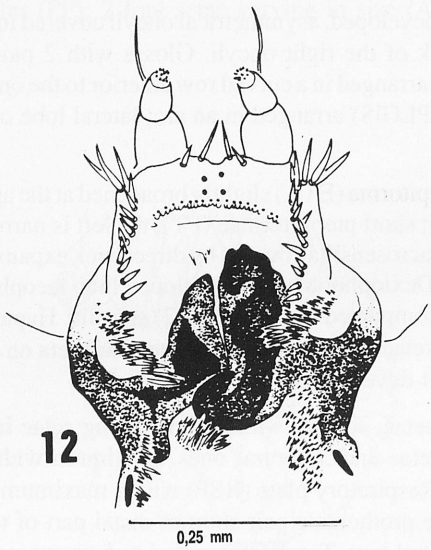
A b d o m e n. Scutum with a transverse row of 5 to 6 setae and two more in both pleural region of the scutellum. Scutellum with 3-4 short setae nearly the same size. Postscutellum with 6 to 7 setae. Superior anal lobe (Fig. 16) with a deep slit (LAL); external angles of the ventral anal lobe (VAL) slightly extended towards the superior anal lobe. Raster (Fig. 17) without palidium. Anal setae (T) 34 to 54 (48) in number.

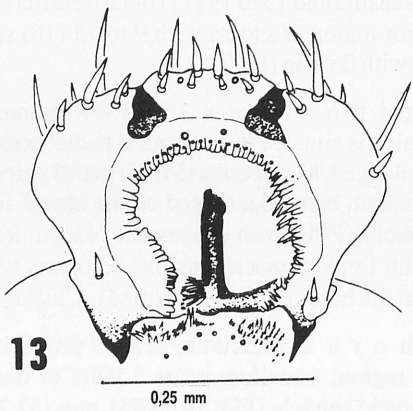
B i o l o g y o f *A. l u s i t a n i c u s*

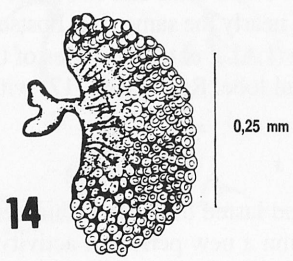
Adults' activity began in late winter (February) and lasted until early summer (June) with a maximum in the April-May period (Fig. 18). In autumn a new period of activity was observed including mating and egg-laying in September-October. The larval development period took place in autumn and winter (from mid-September to early April).

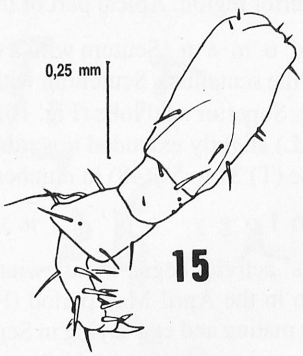
Utilization by *A. lusitanicus* of the brood mass of *Thorectes valencianus* BARAUD was observed. The adults of this *Aphodius* actively sought out the dung buried by *Th. valencianus* and laid theirs eggs on the brood mass; after hatching, the larvae ate brood mass (*Th. valencianus*) and interfered with larval development of the host larvae. According to ROUGON & ROUGON (1980, 1983 and 1991), kleptoparasitism in *Aphodiinae* is an adaptation to survive in droppings in warm and dry regions; these species take advantage of the rapid burial of dung by larger dung beetles. In the Alicante region the weather is dry and warm from spring to autumn (Figs 19A, 19B), the ground is very hot in this period (Table II) and rabbit droppings dry quickly. Normally the rabbit droppings are the only dung present in the study area; sheep dung is occasionally present in some localities.

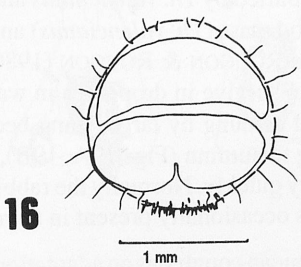
Probably kleptoparasitism is frequent in this Mediterranean country as an adaptation to climatic conditions. In addition to *A. lusitanicus* some other dung beetle species were found inside *Th. valencianus* brood masses. Adults of *Aphodius ibericus* HAROLD and *Onthophagus punctatus* (ILLIGER) were collected in these subterranean dung reserves, but no larvae were observed.

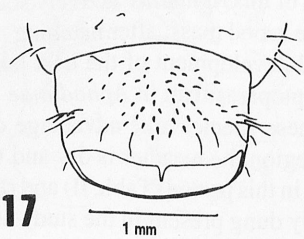












Figs 12-17. *Aphodius lusitanicus* ERICHSON: 12 – hypopharynx; 13 – epipharynx; 14 – thoracic spiracle; 15 – left prothoracic leg, dorsal view; 16 – caudal view of last abdominal segment; 17 – raster.

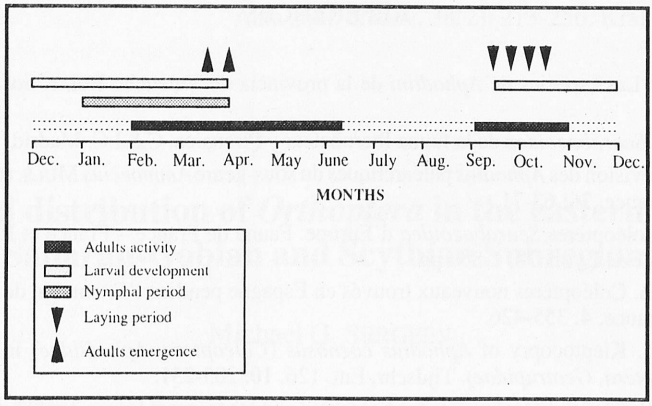


Fig. 18. Life history of *A. lusitanicus* ERICHSON.

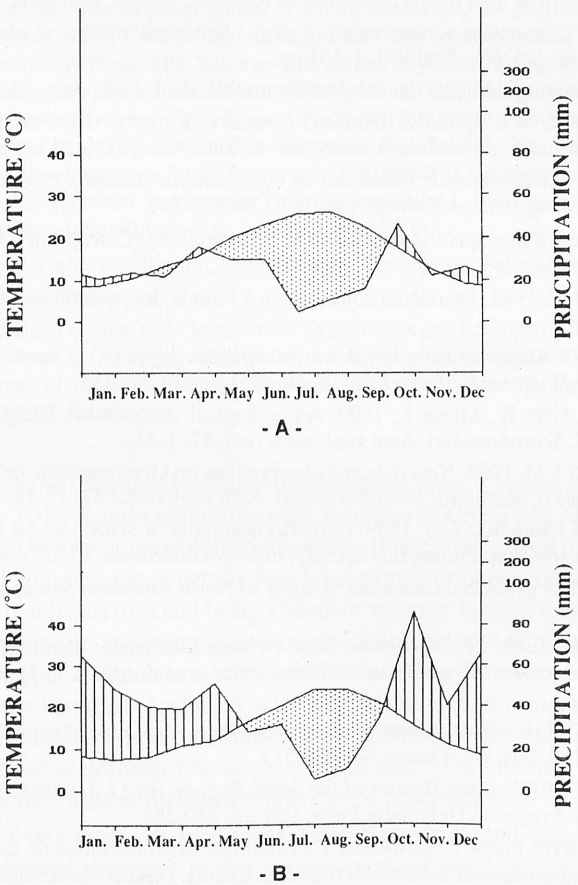


Fig. 19. Ombrothermic diagrams: the driest locality (A: Pinoso) and the wettest locality (B: Alcoy) in the study area. Data provided by the National Institute of Meteorology, Spain.

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