Behavioural and feeding observations of some Anthrenus Geoffroy, 1767 species (Coleoptera, Dermestidae) and identification using final larval instar cases

ISSN: 1989-6581

www.aegaweb.com/arquivos_entomoloxicos

Holloway *et al.* (2024)
ARQUIVOS ENTOMOLÓXICOS, **28**: 261-268

ARTIGO / ARTÍCULO / ARTICLE

Behavioural and feeding observations of some *Anthrenus* Geoffroy, 1767 species (Coleoptera, Dermestidae) and identification using final larval instar cases

Graham J. Holloway [1], Ivan Cañada Luna [2] & Amanda Callaghan [1]

[1] Cole Museum of Zoology, School of Biological Sciences, HLS Building, University of Reading, Whiteknights, Reading RG6 6EX, UK. e-mail: g.j.holloway@reading.ac.uk

[2] Living Systems Institute, University of Exeter, Stocker Road, Exeter, Devon, EX4 4QD. e-mail: ic375@exeter.ac.uk

Abstract: *Anthrenus amandae* Holloway, 2019, *A. angustefasciatus* Ganglbauer, 1904, and *A. isabellinus* Küster, 1848 are Dermestidae (Coleoptera) belonging to the Palaearctic *A. pimpinellae* (Fabricius, 1775) complex. All three species were collected from Mallorca. The distributions of the three species were habitat specific with *A. angustefasciatus* only found in acidic environments dominated by conifers. *Anthrenus amandae* and *A. isabellinus* were found in agricultural or cultivated environments. All three species were able to breed on bird feathers. The resulting final larval instar cases are described to facilitate species identification in the absence of adults.
Key words: Coleoptera, Dermestidae, *Anthrenus pimpinellae* complex, keratin feeding, distribution, niche partitioning, Mallorca, Spain.

Resumen: Observaciones de comportamiento y alimentación de algunas especies de *Anthrenus* Geoffroy, 1767 (Coleoptera, Dermestidae) e identificación mediante exuvias larvarias de último estadio. *Anthrenus amandae* Holloway, 2019, *A. angustefasciatus* Ganglbauer, 1904 y *A. isabellinus* Küster, 1848 son Dermestidae (Coleoptera) pertenecientes al complejo paleártico de *A. pimpinellae* (Fabricius, 1775). Las tres especies fueron recolectadas en Mallorca. Las distribuciones de las tres especies fueron específicas de hábitat, encontrándose *A. angustefasciatus* sólo en ambientes ácidos dominados por coníferas. *Anthrenus amandae* y *A. isabellinus* se encontraron en ambientes agrícolas o cultivados. Las tres especies fueron capaces de reproducirse en plumas de aves. Se describen las exuvias larvarias de último estadio para facilitar la identificación de las especies en ausencia de adultos.
Palabras clave: Coleoptera, Dermestidae, complejo de *Anthrenus pimpinellae*, alimentación con queratina, distribución, reparto de nicho, Mallorca, España.

Recibido: *6 de junio de 2024*
Aceptado: *10 de junio de 2024*
Publicado on-line: *18 de junio de 2024*

Introduction

The Dermestidae are a poorly studied family of beetles and our knowledge of the species that can be found on Mallorca is sketchy. HOLLOWAY *et al.* (2024) provided a list of species of Dermestidae definitively known to occur on Mallorca. Included in this list are five *Anthrenus* Geoffroy, 1767 species, four of which belong to the *Anthrenus pimpinellae* (Fabricius, 1775) complex: *A. amandae* Holloway, 2019, *A. angustefasciatus* Ganglbauer, 1904, *A. isabellinus* Küster, 1848, and *A. munroi* Hinton, 1945. All these species are covered in dark, white/cream and orange/yellow scales, with most of the white scales concentrated in a white fascia crossing the elytra (see Fig. 1). With no evidence to suggest otherwise, HOLLOWAY *et al.* (2024) commented that *A. amandae* could be endemic to Mallorca. *Anthrenus angustefasciatus* has a western European distribution extending from north-west Europe into Iberia and north-west Africa (HOLLOWAY & HERRMANN, in press), *A. isabellinus* is distributed around the Mediterranean (HOLLOWAY *et al.*, 2023) although data from parts of north Africa are sparse, and *A.*

munroi is believed to have a distribution similar to *A. isabellinus* but perhaps extends further to the east (HÁVA, 2024). Little is known about the ecology of these species, but it is thought that feathers are an important larval food. For example, *Anthrenus pimpinellae* is known as the bird nest carpet beetle and *A. nipponensis* Kalík & Ohbayashi, 1985, an eastern Palaearctic species of the *A. pimpinellae* complex, commonly breeds on feathers in the wild (YOKOYAMA, 1929, in HINTON, 1945; HOLLOWAY & FOSTER, 2022). Knowledge of the behaviours of these species of Dermestidae in the wild is very limited, and in many cases nothing is known at all. The purpose of the current study was twofold:

- to establish whether the Mallorcan *A. pimpinellae* complex species were able to breed on feathers, and
- whether it was possible to distinguish among them using the final larval instar case following adult eclosion.

For most species of *Anthrenus*, it is not known how to identify them using larval characteristics (although see HINTON, 1945; PEACOCK, 1993). An ability to identify *Anthrenus* species at breeding sites using larval remains in the absence of adults would facilitate the gathering of information on breeding behaviours under field conditions.

Methods

During May 2023, specimens of *A. amandae*, *A. angustefasciatus*, and *A. isabellinus* (Fig. 1) were collected from the field in Mallorca (no *A. munroi* were found). They were separated by species using external colour pattern (HOLLOWAY & CAÑADA LUNA, 2022) and presented with feathers as a breeding substrate. Between 20 and 25 unsexed specimens of each species were placed on common wood pigeon *Columbus palumba* L. feathers in 7x7x5 cm plastic containers. The insects were kept at 21°±2°C in ambient light and humidity conditions. Larvae were inspected weekly until adult eclosion.

Images of dorsal and lateral aspects of the larval cases were captured at x10 magnification using a Canon EOS 2000D camera mounted on the BMSL microscope. Images of the head capsule were captured at x30 magnification. Images of the hastisetae were captured at x200 magnification using a Canon EOS 1300D camera mounted on a Brunel monocular SP28 microscope. All images were fed through Helicon Focus Pro version 8 focus-stacking software. After imaging, all larval cases were mounted on card along with the emergent adult.

The distribution map was generated using SimpleMappr (Shorthouse, 2010). Scale bars were added using ImageJ 1.53M (Schneider *et al.*, 2012).

Results

Field observations

Anthrenus angustefasciatus were found at Alcanada (39.837, 3.169), Son Real (39.744, 3.186), and Lluc Monastery (39.823, 2.886) (Fig. 2). At Alcanada, *A. angustefasciatus* were only found on narrow-leaved cistus (*Cistus monspeliensis* L.) (Fig. 3). The distribution of *A. angustefasciatus* was unevenly distributed across the *C. monspeliensis*, with some patches of *C. monspeliensis* bearing several *A. angustefasciatus* and stretches along the path with plenty of *C. monspeliensis* having no *A. angustefasciatus*. Groups of *A. angustefasciatus* were always found close to large pine trees. No other species of Dermestidae were found. The situation was the same in Son Real away from the Finca (old homestead building), only *A. angustefasciatus* was found, always on *C. monspeliensis* and always associated with a large conifer. *Anthrenus amandae* and *A. isabellinus* were also found at Son Real but only in the vicinity of the Finca. All three species were found at Lluc, mostly on fennel (*Foeniculum vulgare* Mill.). On the roadside in the agricultural landscape between Pollensa and Port Pollensa (39.89, 3.05, Fig. 2) only *A. amandae* and *A. isabellinus* were found, mostly on wild carrot (*Daucus carota* L.).

Laboratory observations

All three species laid eggs on the feathers, producing larvae within three weeks, which all pupated between mid-September and mid-November 2023. Pupation occurred within the final larval case. Adults emerged from the pupal case but remained quiescent in the final larval case (Fig. 4a). The adults emerged mostly over a period extending from mid-January to mid-April. To emerge from the final larval instar case, the adult beetle turned itself laterally across the larval case to split weak sutures in the larval head capsule (Fig. 4b). Having done this, the adult was able to work itself free from the larval case. The thin pupal case can be seen wedged in the posterior end of the dorsal suture.

The appearance of the final instar case varied among the three species (Figs. 5-7). The dorsal surface of *A. amandae* (Fig. 5a) is honey/pale brown coloured, with patches of slightly darker brown on the first three segments and single pale brown stripes across the dorsal surfaces of the rest of the segments. The dorsal surface is largely devoid of hastisetae (except for some along the dorsal suture and large clumps of long hastisetae on segments 9-11). The larva has a long tail consisting of a few dark setae, in Fig. 5a six setae. Laterally, there is a sharp, broad line of black hastisetae running the length of the larval case (Fig. 5b), There are many, evenly spaced hastisetae on the ventral side of the larval case. The head (Fig. 5c) is the same pale brown as the rest of the larval case. The sutures in the head capsule that are split open by the adult during eclosion can be seen, one vertical down the face from the vertex which bifurcates just above the centre of the face. On segments 9-11 are tufts of long, arrow-headed hastisetae (Fig. 5d) emanating from just above the lateral line of hastisetae, and partly hidden under the previous segment (the hastisetae on segment 9 are partly hidden under segment 8, and so on). The heads of the hastisetae consist of four components pressed together to form a pointed unit at the end of a fragile, segmented stem.

The dorsal surface of *A. angustefasciatus* (Fig. 6a) is pale yellow with dark brown patches on each segment. The larva is very hirsute, bearing copious numbers of long, black hastisetae, which are longest at the posterior end of the larval case. The larva has a tail, much shorter than *A. amandae* (Fig. 5a) but consisting of more setae. Laterally (Fig. 6b), there is a band of black setae from the 5th segment to the tail, but not as clean, sharp, and therefore not as obvious as on *A. amandae* (Fig 5b). The head capsule (Fig. 6c) is honey coloured, or pale brown, contrasting with the pale yellow of the body of the larval case. There are two large, dark brown patches on the upper part of the head, one each lateral margin. The arrow-headed hastisetae towards the posterior end of the larval case (Fig. 6d) are small compared with *A. amandae* (Fig. 5d).

The dorsal surface of *A. isabellinus* (Fig. 7a) is pale yellow with discrete and obvious brown spots on the first three segments, one spot on each side of the dorsal suture. The surface is hirsute, bearing many long hastisetae, but not as dense and long as *A. angustefasciatus* especially towards the head. The larval case bears a short tail, much shorter than *A. amandae*, but about the same length and thickness as *A. angustefasciatus*. Laterally (Fig. 7b), there is no black band of hastisetae, instead the lateral margin is paler than the rest of the body and extends along all segments. The head capsule (Fig. 7c) is brown (darker than *A. angustefasciatus*), contrasting with the pale-yellow body. As with *A. angustefasciatus*, the head capsule bears two large, dark brown spots on the upper half of the head capsule, one on each lateral margin. The arrow headed hastisetae (Fig. 7d) are very small indeed, very much smaller than *A. angustefasciatus* let alone *A. amandae*, with none extending to 100 μm in length.

Discussion

The ecology and life history of species of Dermestidae is rarely reported in the literature, unless they are economic or cultural pests (HINTON, 1945). *Anthrenus pimpinellae* is referred to as the bird-nest beetle, so there is a general assumption that this species can breed in bird nests, probably utilizing feathers. We know now much more about the number of species in the Palaearctic *A. pimpinellae* complex and how to differentiate them (HOLLOWAY & CAÑADA LUNA, 2022). For example, *A.*

pimpinellae has been confused with *A. amandae* (HÁVA & HERRMANN, 2019, 2020; HOLLOWAY *et al.* 2023) and *A. isabellinus* (HOLLOWAY *et al.*, 2020, 2021, 2023), so we cannot be sure which species was being referred to that feeds on feathers. YOKOYAMA (1929, in HINTON, 1945) stated that *A. pimpinellae* from Japan feed on feathers. We now know that *A. pimpinellae* does not occur in Japan and it is likely that Yokoyama was referring to *A. nipponensis* (HOLLOWAY & FOSTER, 2022). It transpires that all three of the species studied here are capable of breeding on feathers.

Studies on the taxonomy and faunistics of *Anthrenus* focus almost exclusively on adults. The major exception to this is KADEJ (2018) who conducted a detailed examination of the larvae of several species of *Anthrenus* from different subgenera, again for taxonomic purposes. The identification of UK *Anthrenus* using a microscope and key has been provided by PEACOCK (1993). As far as we know, this is the first study of the larvae of *A. amandae*, *A. angustefasciatus*, and *A. isabellinus* with the provision of images that might be of value for identification in the absence of a microscope.

The appearances of the larval cases differ considerably among *A. amandae*, *A. angustefasciatus*, and *A. isabellinus*, and offer scope for identification when larval remains rather than adults are found. This type of information would be valuable when assessing food stuffs and breeding opportunities under field conditions.

The authors are not aware of any studies on the behaviour of non-pest species of *Anthrenus* under field conditions, other than some flowers on which adults can be found (e.g., BEAL, 1998; HOLLOWAY, 2019; HOLLOWAY & BAKALOUDIS, 2020). *Anthrenus* are found almost exclusively on white flowers, or flowers with white in them, although they can be found also on fennel (current study) and yellow parsnip *Pastinaca sativa* (*A. verbasci* pers. obs. Amanda Callaghan). In Mallorcan coastal habitats, *A. angustefasciatus* was found on narrow-leaved cistus (Fig. 1) close to large conifers in the absence of *A. amandae* and *A. isabellinus*.

Large trees offer more nesting opportunities for birds, so it is not unreasonable to suggest that *A. angustefasciatus* specializes on nests of birds associated with pines, e.g., Coal tit *Periparus ater* (Linnaeus, 1758) (NEUMANN *et al.*, 2016) or is adapted to living and breeding in the acidified conditions conifers produce. All sites where *A. angustefasciatus* were collected were dominated by conifer trees. If this is the case, neither *A. amandae* nor *A. isabellinus* target conifer breeding bird species, or they are adapted to higher pH conditions. Both *A. amandae* and *A. isabellinus* were found in pastoral and agricultural habitats, including Son Real but only around the fields and pastoral components of the Finca, and at Lluc in the cultivated monastery garden. Although they all breed on feathers there is clear evidence of niche partitioning in adult distribution (MARTÍN-VEGA & BAZ, 2012; KELLER *et al.*, 2019; SATO *et al.*, 2019). The likelihood of niche partitioning is further supported by inter-specific variation in the structure of the defensive hastisetae (Figs. 5d, 6d, 7d). The longest hastisetae in *A. amandae* were arrow-headed and concentrated around the posterior end of the larva. In *A. angustefasciatus* and *A. isabellinus*, the arrow-headed hastisetae were much shorter than the other hastisetae, particularly so in *A. isabellinus*. These adaptive features suggest that the larvae were encountering different types of predators, parasites, parasitoids, or competitors in their respective habitats.

Acknowledgements

We are grateful to the editors for processing and reviewing the text so efficiently.

References

BEAL JR, R.S. 1998. Taxonomy and biology of Nearctic species of Anthrenus (Coleoptera: Dermestidae). *Transactions of the American Entomological Society*, **124:** 271-332.

HÁVA, J. 2024. *Dermestidae World (Coleoptera).* Available from: http://dermestidae.wz.cz/world-dermestidae/ [Last accessed: 1st June 2024].

HÁVA, J. & HERRMANN, A. 2019. New faunistic records and remarks on Dermestidae (Coleoptera)-Part 19. *Natura Somogyiensis*, **33**: 27-36.

HÁVA, J. & HERRMANN, A. 2020. New faunistic records and remarks on Dermestidae (Coleoptera)-Part 20. *Natura Somogyiensis*, **34**: 9-19.

HINTON, H.A. 1945. *A Monograph of the Beetles Associated with Stored Products. Vol. 1.* British Museum (Natural History), London. viii + 443 pp.

HOLLOWAY, G.J. 2019. *Anthrenus* (s. str.) *amandae* (Coleoptera: Dermestidae): a new species from Mallorca, Spain. *Zootaxa*, **4543**(4): 595-599.

HOLLOWAY, G.J. & BAKALOUDIS, D.E. 2019. New distributional record of *Anthrenus dorsatus* Mulsant & Rey, 1868 (Coleoptera, Dermestidae), Thessaloniki, Greece. *Check List*, **15**(6): 1077-1081.

HOLLOWAY, G.J., BAKALOUDIS, D.E., BARCLAY, M.V., FOSTER, C.W., KADEJ, M., CALLAGHAN, A. & PAXTON, R.J. 2020. Revision of taxonomic status of *Anthrenus pimpinellae isabellinus* (Coleoptera: Dermestidae). *European Journal of Entomology*, **117**: 481-489.

HOLLOWAY, G.J., BAKALOUDIS, D.E. & FOSTER, C.W. 2021. *Anthrenus dorsatus* new to the United States and a comparison with *Anthrenus pimpinellae* ssp. *pimpinellae* (Coleoptera: Dermestidae). *Journal of the Kansas Entomological Society*, **93(2)**: 153-163.

HOLLOWAY, G.J. & CAÑADA LUNA, I. 2022. A morphometric analysis of *Anthrenus munroi* Hinton, 1943, and a key for citizen scientists to the Western European species in the *Anthrenus pimpinellae* complex (Coleoptera: Dermestidae). *Entomologist's Monthly Magazine*, **158**(4): 289-298.

HOLLOWAY, G.J., EVANS, J., SAUNDERS, K.S., TILLEY, B.L. & CALLAGHAN, A. 2024. Some Dermestidae (Coleoptera) of Mallorca (Balearic Islands, Spain). *Arquivos Entomolóxicos*, **28**: 207-212.

HOLLOWAY, G.J. & FOSTER, C.W. 2022. Distribution, morphology and phenology of *Anthrenus nipponensis* Kalik & Ohbayashi (Coleoptera: Dermestidae). *Entomologist's Monthly Magazine*, **158**(3): 215-224.

HOLLOWAY, G.J. & HERRMANN, A. (in press). *Anthrenus canadalunai* (Coleoptera: Dermestidae) sp. nov. from Turkey and a comparison with *Anthrenus angustefasciatus* and *Anthrenus mroczkowskii*. *Annales Zoologici*.

HOLLOWAY, G.J., MACLURE, C.J. & FOSTER, C.W. 2023. Palaearctic distributions of *Anthrenus pimpinellae* (Fabricius) and *Anthrenus isabellinus* Küster (Coleoptera: Dermestidae). *Entomologist's Monthly Magazine*, **159**: 239–244.

KADEJ, M. 2018. *Contribution to knowledge of the immature stages of Dermestidae with special emphasis on the larval morphology of the genus Anthrenus Geoffroy, 1762 (Megatominae: Anthrenini).* Polish Entomological Monographs, 16. Polish Entomological Society, Poznań, Poland. 180 pp.

KELLER, M.L., HOWARD, D.R. & HALL, C.L. 2019. Spatiotemporal niche partitioning in a specious silphid community (Coleoptera: Silphidae, *Nicrophorus*). *The Science of Nature*, **106**(11): article number 57 [12 pp.].

MARTÍN-VEGA, D. & BAZ, A. 2012. Spatiotemporal distribution of necrophagous beetles (Coleoptera: Dermestidae, Silphidae) assemblages in natural habitats of central Spain. *Annals of the Entomological Society of America*, **105**(1): 44-53.

NEUMANN, J.L., GRIFFITHS, G.H., HOODLESS, A. & HOLLOWAY, G.J. 2016. The heterogeneity of wooded-agricultural landscape mosaics influences Woodland bird community assemblages. *Landscape Ecology*, **31**: 1833-1848.

PEACOCK, E.R. 1993. *Adults and larvae of hide, larder and carpet beetles and their relatives (Coleoptera: Dermestidae) and of derodontid beetles (Coleoptera: Derodontidae)*. Handbooks for the Identification of British Insects, Vol. 5, Part 3. Natural History Museum, London. 144 pp.

SATO, H., NASU, Y., MURAHAMA, S., MATSUMURO, H. & UEDA, K. 2019. Differences in the niches of keratin/chitin feeding moths (Lepidoptera: Tineidae) in bird nests in central Japan. *European Journal of Entomology*, **116**: 442-449.

SCHNEIDER, C.A., RASBAND, W.S. & ELICEIRI, K.W. 2012. NIH Image to ImageJ: 25 years of image analysis. *Nature Methods*, **9**: 671–675.

YOKOYAMA, K. 1929. On *Anthrenus pimpinellae* F., an imported species? *Insect World, Gifu*, **33**: 183-186. [In Japanese].

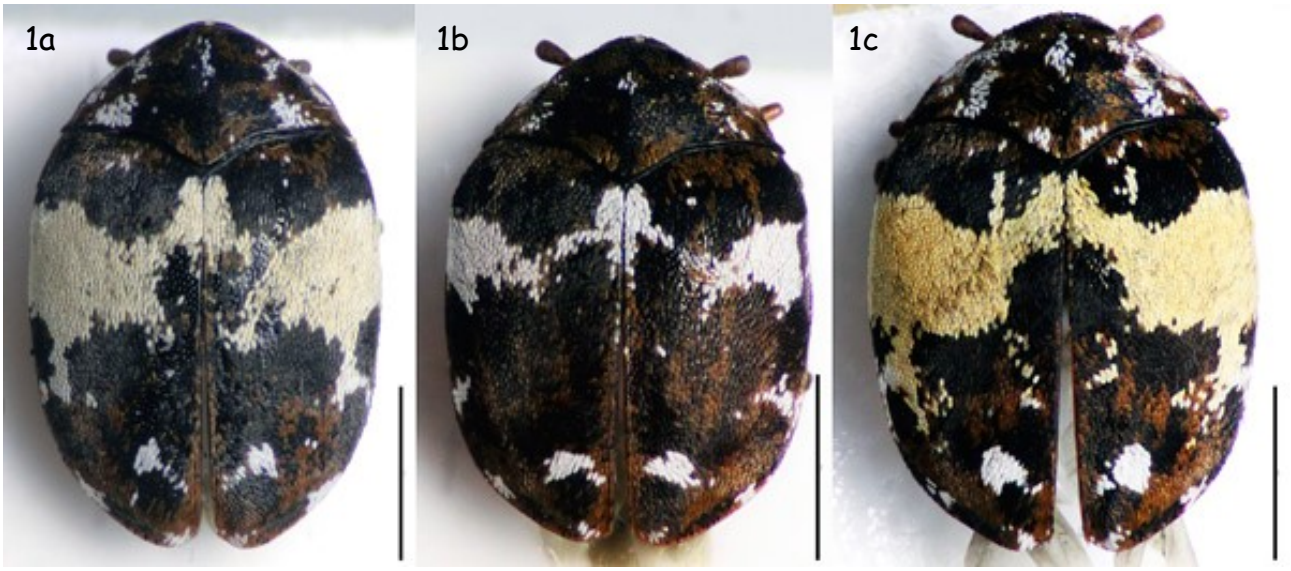

Fig. 1.- Dorsal aspect. **1a.-** *Anthrenus amandae*. **1b.-** *Anthrenus angustefasciatus*. **1c.-** *Anthrenus isabellinus*. Scale bar = 1 mm in all cases.

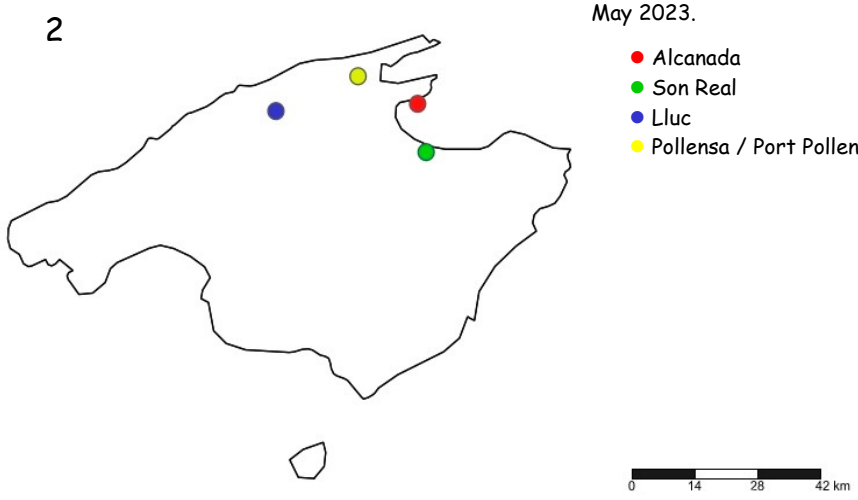

Fig. 2.- Location of collection sites, Mallorca, May 2023.

Fig. 3.- *Anthrenus angustefasciatus* on *Cistus monspeliensis*, Alcanada, Mallorca.

Fig. 4.- *Anthrenus amandae*. **4a**.– Quiescent in final larval instar case. **4b**.– Rotation in final larval instar case to split sutures in head capsule to facilitate eclosion.
Scale bars = 1 mm in both cases.

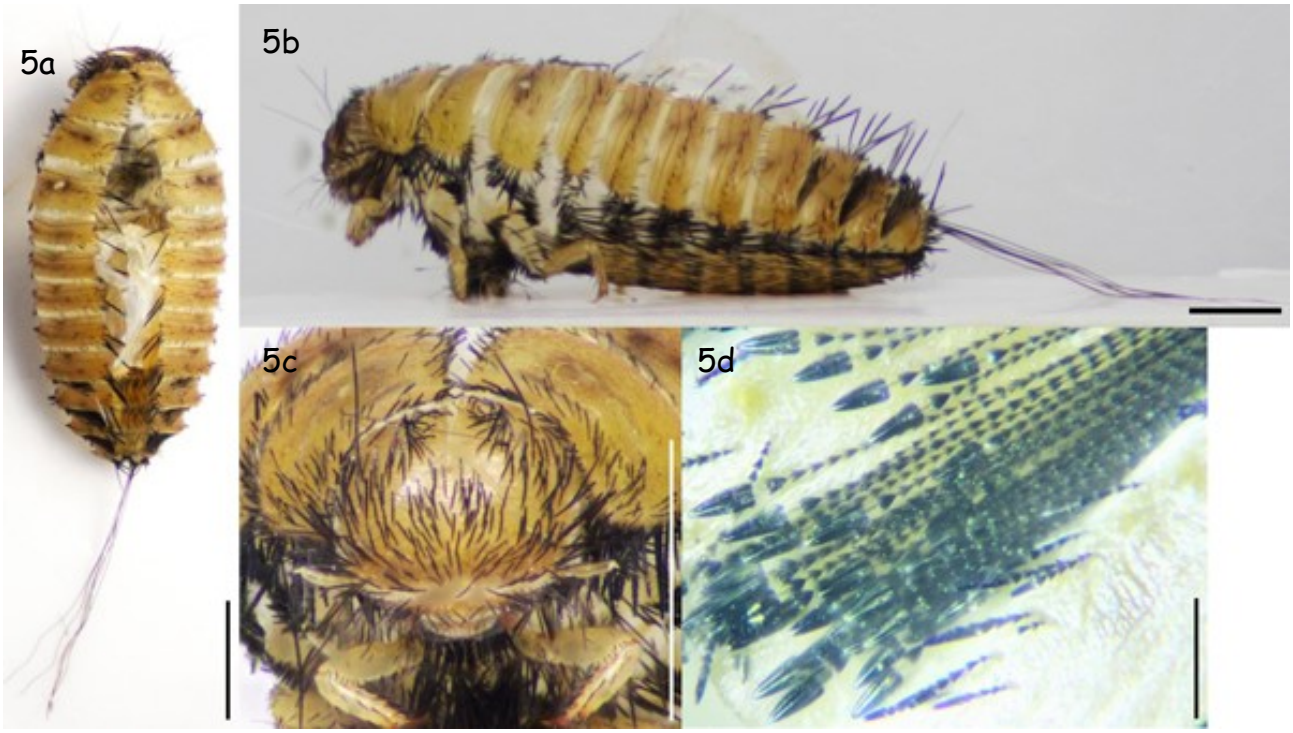

Fig. 5.- *Anthrenus amandae* final larval instar case. **5a**.– Dorsal aspect (scale bar = 1 mm). **5b.-** Lateral aspect (scale bar = 1 mm). **5c.-** Head capsule (scale bar = 1 mm). **5d.-** Arrow-headed hastisetae on terminal segments (scale bar = 100 μm).

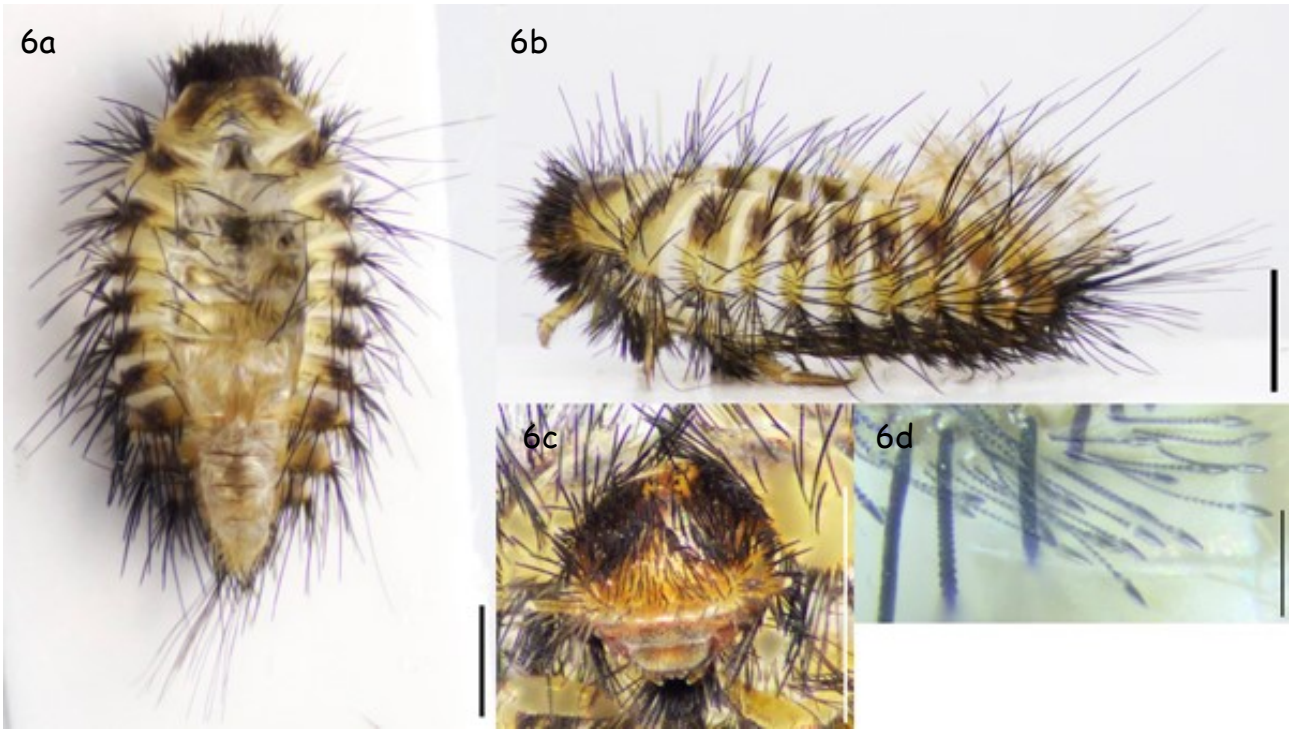

Fig. 6.- *Anthrenus angustefasciatus* final larval instar case. **6a.-** Dorsal aspect (scale bar = 1 mm). **6b.-** Lateral aspect (scale bar = 1 mm). **6c.-** Head capsule (scale bar = 1 mm). **6d.-** Arrow-headed hastisetae on terminal segments (scale bar = 100 μm).

Fig. 7.- *Anthrenus isabellinus* final larval instar case. **7a.-** Dorsal aspect (scale bar = 1 mm). **7b.-** Lateral aspect (scale bar = 1 mm). **7c.-** Head capsule (scale bar = 1 mm). **7d.-** Arrow-headed hastisetae on terminal segments (scale bar = 100 μm).