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Anthrenus (*Anthrenus*) *mumbaiensis* sp. nov. from India and a morphometric examination of *Anthrenus* (*Anthrenus*) *festivus* (Coleoptera, Dermestidae, Anthrenini)

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Abstract

All examples of *Anthrenus* (*Anthrenus*) *festivus* were borrowed from the Natural History Museum, London for dissection to provide good images of external and internal features. Images of habitus, ventrites and antennae are presented along with aedeagus and sternite IX. The purpose of this was to provide clear information for future comparative taxonomic studies. During the examination of the specimens, a new species was discovered that had been collected in Bombay (Mumbai) in the late 19th century. Images of external and internal features of the holotype (male) and paratype (female) are provided. The new species is named *Anthrenus* (*Anthrenus*) *mumbaiensis* after the location of collection. Collection data from the study specimens, Andreas Herrmann's private collection, the literature, and verifiable images on iNaturalist were used to generate a distribution map. The map showed that *A. festivus* is found mainly in coastal regions of the western Mediterranean.

Key words: Dissection, genitalia, aedeagus, sternite IX, distribution

Introduction

The Dermestidae Latreille, 1804 contains over 1800 species (Háva 2023) and within the Dermestidae over 250 species belong to the polytypic (Kadej 2018) genus *Anthrenus* Geoffroy, 1762. Many of these species have poor descriptions by today's standards with access to many publication options and modern imagery techniques. From the 18th until the end of the 20th century, the only way to be sure of a species being described was to consult the holotype. It is reasonable now, when a new species is described, to expect the publication to carry clear images of the various elements of the specimen used to define the species without the need to resort to holotype examination.

Beal (1998) was really the first to demonstrate the importance of dissecting the male genitalia of *Anthrenus* species to confirm identification. Since then, Kadej *et al*. (2007) carried out an important study on the difficult Palaearctic *Anthrenus pimpinellae* (Fabricius, 1775) complex and showed through dissection that it consists of more species than previously thought. The work by Kadej *et al*. (2007) has subsequently been supplemented by Kadej & Háva (2011) and Holloway (2019, 2020, 2021), Holloway & Bakaloudis (2010), and Holloway *et al.* (2020). The significance of several of these studies has been to demonstrate that dissection of runs of specimens is essential to be sure of the number of species present.

There are many species, such as *Anthrenus festivus* Erichson, 1846, that are abundant, considered relatively easy to identify, and which were described long ago so that good images of the genitalia are not available. This has two consequences: the assumption that all species resembling *festivus* are indeed *festivus*, and should a worker come across a potential new species resembling *festivus* there are no images available for comparative purposes. The Natural History Museum, London (NHML), holds over 30 specimens of *A. festivus* offering the opportunity to produce clear images of various habitus and genitalia features to facilitate future taxonomic work on *Anthrenus*.

During the dissection of the NHML *A. festivus*, a new species was discovered: *A. mumbaiensis*.

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Materials and methods

Specimens of *A. festivus* from NHML were macerated in a solution of 2% acetic acid for five days to allow their removal from staging prior to dissection. Dissection was carried out under a Brunel BMSL zoom stereo LED microscope and involved detaching the abdomen from the rest of the insect using two entomological pins. The soft tergites were then peeled away from the harder ventrites to expose the genitalia. For males, the aedeagus was detached from the ring sclerite, and then sternite IX was detached from the ring sclerite and the aedeagus. Females were similarly dissected to confirm sex, but no further examination of female genitalia was carried out. Images of male and female habitus, both upper and under sides, were captured at ×20 magnification using a Canon EOS 2000D camera mounted on the BMSL microscope. Images of aedeagi and (male) sternite IX were captured at ×200 magnification for measurement using a Canon EOS 1300D camera mounted on a Brunel monocular SP28 microscope. After dissection, all body parts were mounted on card. The antennae were teased out (where possible) and images were taken at ×200 magnification through the SP28 microscope. All images were fed through Helicon Focus Pro version 6.8.0 focus-stacking software. Habitus measurements were made using a micrometre fitted into an eyepiece of the BSML microscope. Aedeagi, sternite IX, and antennae were measured using DsCap.Ink Software version 3.90. Measurements taken:

- Body length (BL): distance from anterior margin of pronotum to the apex of the elytra
- Body width (BW): maximum distance across the elytra
- Antennal club length (AL): length of the last three antennomeres
- Antennal club width (AW): maximum width across the terminal antennomere
- Paramere length (PL): distance from the anterior end of the parameres to the apex of the parameres
- Sternite IX length (SL): distance from the tip of one anterior horn to the tip of the posterior lobe

The data for the distribution map were derived from the data labels on the NHML specimens, Andreas Herrmann's private collection (AHEC), and literature. The distribution maps were generated using SimpleMappr (Shorthouse 2010).

Results

Anthrenus (*Anthrenus*) *mumbaiensis* sp. nov. (Figures 1–3)

Specimen examined. New record (holotype) for *Anthrenus mumbaiensis* **sp. nov.** India, Mumbai (approx. 19.1N, 72.9E). Labelled Bombay, 1893, Pascoe leg. Holotype ♂ NHML, London. Paratype ♀ NHML, London.

Holotype habitus (Figure 1A) (BL = 2.25 mm, BW/BL = 0.756), and paratype habitus (Figure 1B) (BL = 2.5 mm, BW/BL = 0.74). Ventrites (Figure 1C). The male (holotype) was brittle and the antennae difficult to display without damage, so Figure 1D shows a female antenna.

Anthrenus mumbaiensis has a single ocellus on the vertex, typical of Dermestidae (except Dermestinae) and a notch on the inner margin of the eye, typical of *Anthrenus* subgenus *Anthrenus*. *Anthrenus mumbaiensis* is coated in broad orange and white scales on a background of black scales. Each elytron has three clear white spots of scales close to the outer margin: sub-basally, just past mid-point, and sub-apically. In addition, there are two further clear white spots of scales close to the elytral suture: sub-apically and mid-point. The elytral suture carries orange scales as a thin band from the elytral apex to the mid-point white spot and from there to the scutellum region the orange scales form a broader band admixed with white scales, with orange and white scales fanning out left and right from the scutellum. Otherwise, orange scales are randomly scattered across the elytra on a background of black scales. The pronotum carries two patches of white scales at the anterior margin of the pronotum directly behind each eye. More white patches occur along the outer margins admixed with orange scale and at approximately halfway along the outer margin orange and white scales form a loose band across the pronotum. The middle of posterior margin of the pronotum carries another patch of white scales bordered anteriorly by orange scales.

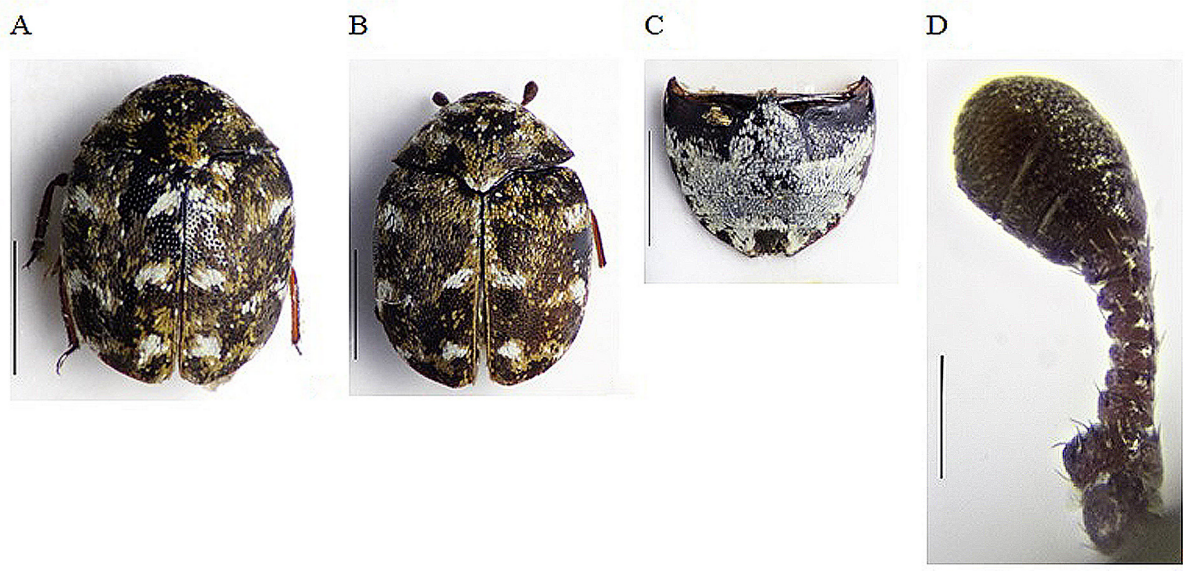

FIGURE 1. *Anthrenus* (*Anthrenus*) *mumbaiensis* **sp. nov.** Holloway, 2023: habitus: dorsal aspect A: male and B: female, C: ventrites, D: antenna (female).

FIGURE 2. *Anthrenus* (*Anthrenus*) *mumbaiensis* **sp. nov.** Holloway, 2023: aedeagus: A dorsal and B ventral aspect, C: sternite IX.

The ventrites (Figure 1C) are coated in white scales with small patches of black scales at the outer margins of the 2nd to 5th sternites. There is a large, square patch of black scales in the centre of the 5th sternite. There is no black patch of scales (maybe one or two scales) on the outer margin of the 1st sternite.

The female antennae (Figure 1D) remained attached and intact during dissection. One of the male antennal clubs snapped off but remains associated with the dissected specimen. ♂ AL = 189 µm, AW = 145 µm. ♀ AL = 162 µm, AW = 126 µm. All antennomeres are dark red. All components of the legs are also red.

Figures 2A and 2B shows the dorsal aspect and ventral aspect of the aedeagus, respectively. The anterior halves of the parameres are slim with the outer and inner margins converging slightly. The posterior halves of the parameres are broad, flat and knife-shaped. The outer margins curve smoothly round to pointed tips, and from the tips the inner margins are convex. The dorsal surfaces (Figure 2A) of the posterior halves of the parameres carry some scattered, relatively short setae. On the ventral surfaces (Figure 2B), the paramere tips carry long, inward pointing, pubescence. These pubescent setae continue for a short way down the inner margins of the parameres. The pubescence is concentrated on the ventral surface although visible between the parameres in Figure 2A. The median lobe falls short of the paramere tips. The median lobe narrows gradually from the base towards the tip. Close to the tip, the margins converge more noticeably to meet at a sharp tip. PL = 425 µm.

Figure 2C shows sternite IX. The sternite was damaged during dissection and one anterior horn became detached. The outer margins of the posterior lobe are covered in short, spikey setae, many of which are curved at the tip. The tip of the posterior lobe forms a flattened curve with a small central nipple. Moving towards the anterior horns the outer margins converge slightly to form a slight neck before expanding to form the anterior horns. SL = 500 µm.

Figure 3 shows the collection location of *A. mumbaiensis*. *Anthrenus mumbaiensis* is only known from two specimens, both from Mumbai.

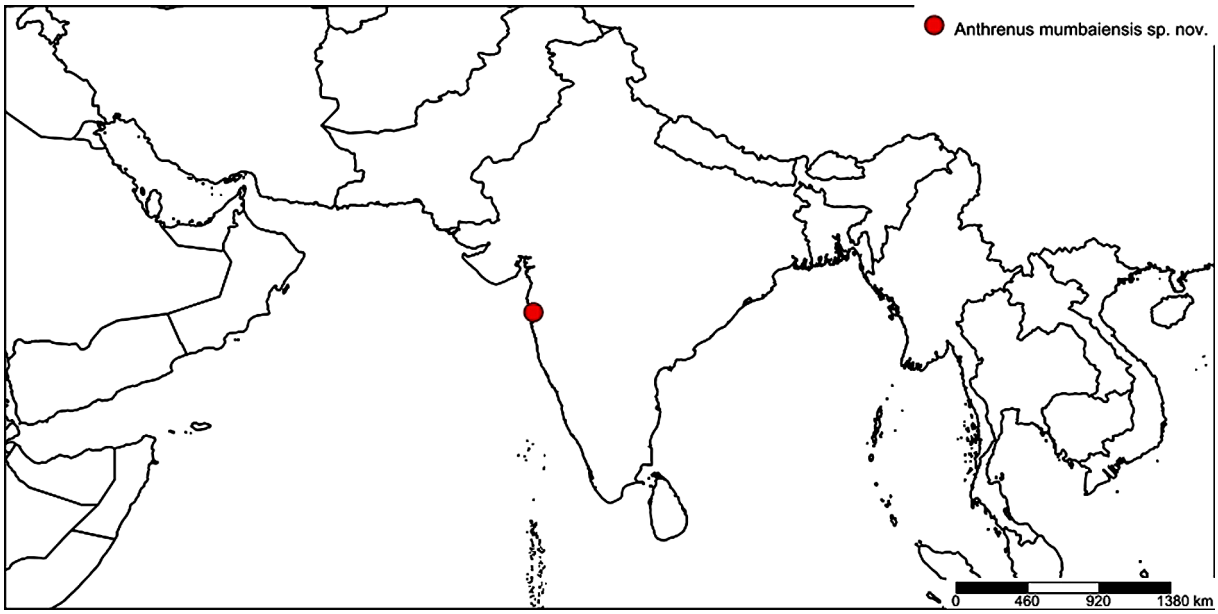

FIGURE 3. *Anthrenus* (*Anthrenus*) *mumbaiensis* **sp. nov.** Holloway, 2023: collection location

Anthrenus (*Anthrenus*) *festivus* Erichson, 1846 (Figures 4–6)

A total of 34 *A. festivus* were dissected (27♂♂ and 7♀♀). Examples of *A. festivus* habitus (dorsal aspect) (Figure 4A), ventrites (Figure 4B), and antenna (Figure 4C) are illustrated. All data were normally distributed and homoscedastic. Male BL = 2.417 ± 0.122 mm (mean ± standard deviation); female BL = 2.529 ± 0.115 mm. Male BL was significantly smaller than female BL (t_{31} = 2.17, p = 0.038). 95 % of male BL would be expected to fall between 2.17–2.67 mm (study sample minimum and maximum = 2.05 mm and 2.65 mm, respectively). 95% of female BL would be expected to fall between 2.25 mm and 2.81 mm (study sample minimum and maximum = 2.40 mm and 2.70 mm, respectively). Body width/body length (BW/BL) was calculated as a measure of body shape. Male BW/BL = 0.722 ± 0.016; female BW/BL = 0.709 ± 0.004. Male BW/BL differed marginally but significantly from female BW/BL (t_{31} = 2.08, p = 0.46) indicating that males had a slightly rounder profile than females. 95%

of male BW/BL would be expected to fall between 0.689–0.755 (study sample minimum and maximum = 0.688 and 0.750, respectively). 95% of female BW/BL would be expected to fall between 0.700 and 0.718 (study sample minimum and maximum = 0.703 and 0.714, respectively). Figure 4C shows a typical example of an *A. festivus* antenna. For the antenna shown in Figure 4C, AL = 161 µm and AW = 121 µm, AL/AW = 1.33.

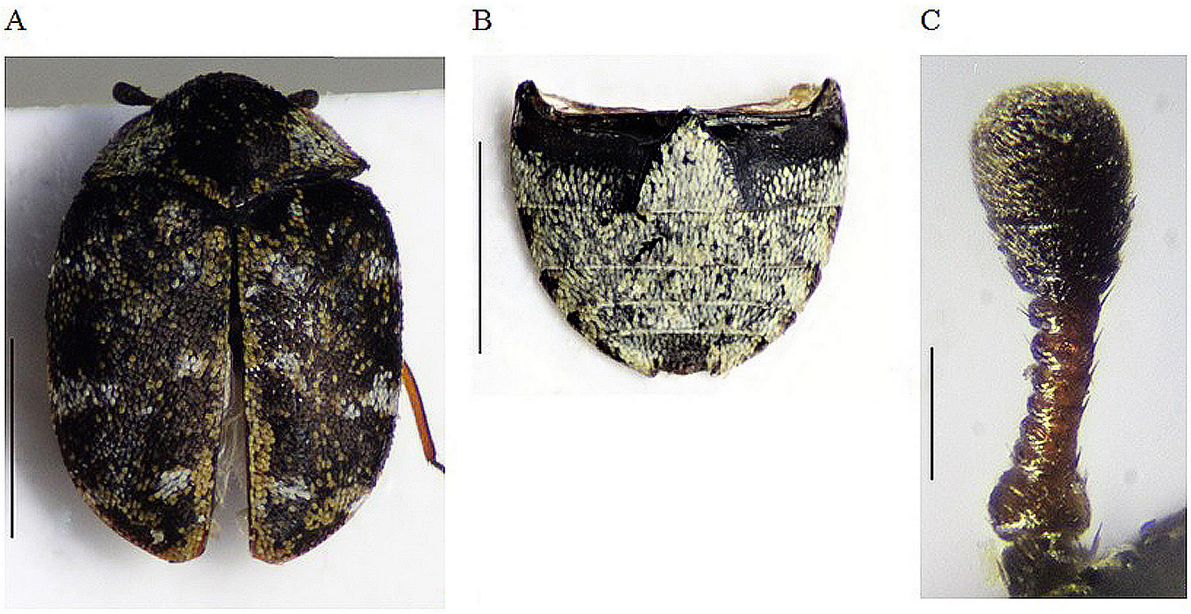

FIGURE 4. *Anthrenus* (*Anthrenus*) *festivus* Erichson, 1846: A: habitus (dorsal aspect), B: ventrites, C: antenna

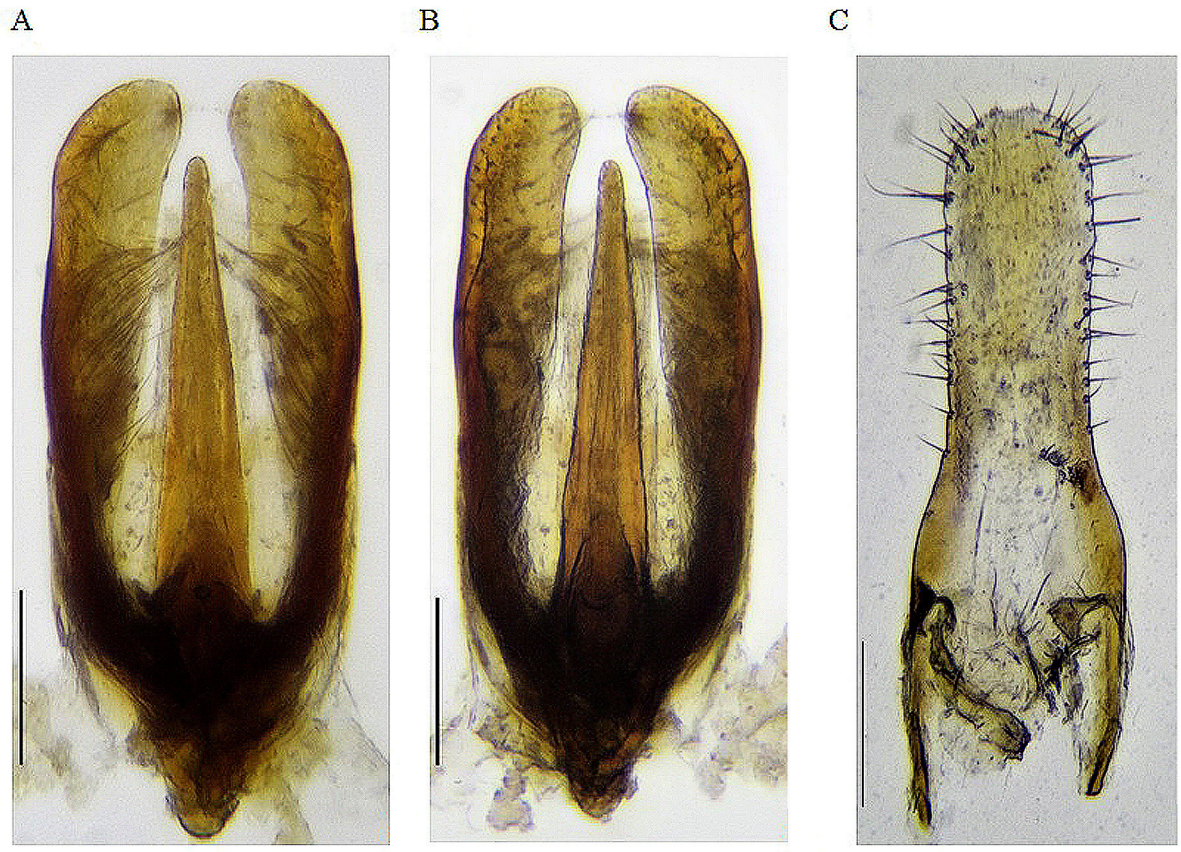

FIGURE 5. *Anthrenus* (*Anthrenus*) *festivus* Erichson, 1846: aedeagus: A dorsal and B ventral aspect, C: sternite IX

Figure 5A and 5B show an *A. festivus* aedeagus dorsal and ventral aspect, respectively. The example in Figures 5A and 5B shows slight sinuosity in the outer margin of the parameres, but this is not evident in all specimens. The parameres have very blunt, rounded tips and are slightly concave immediately round the tip along the inner margins. The surfaces of the parameres are covered in long, fine, forward pointing hairs. These hairs are located principally on the dorsal surface. At the tip of the parameres on the ventral surface, there are a few inward pointing hairs. The median lobe narrows steadily from the base to a blunt tip that falls short of the tips of the parameres. PL in the example shown in Figures 5A and 5B is 356 µm. Figure 5C shows an example of male *A. festivus* sternite IX. The posterior lobe is broad and parallel sided to an evenly rounded end with a small notch at the very tip. The entire length of the margin of the posterior lobe displays long, spikey setae, except across the notch which is bare. The setae at the posterior end are slightly shorter and more numerous with a few emerging from the surface of the lobe as well as the margin. One of the anterior pointing horns is slightly damaged. SL = 439 µm.

Figure 6 shows *A. festivus* distribution. *Anthrenus festivus* is distributed around western Mediterranean only and is principally coastal. The countries shaded grey are those listed as containing *A. festivus* in the World Catalogue (Háva 2023). Three countries: Germany, Switzerland, and Austria are hatched indicating dubious records resulting in their inclusion in the World Catalogue.

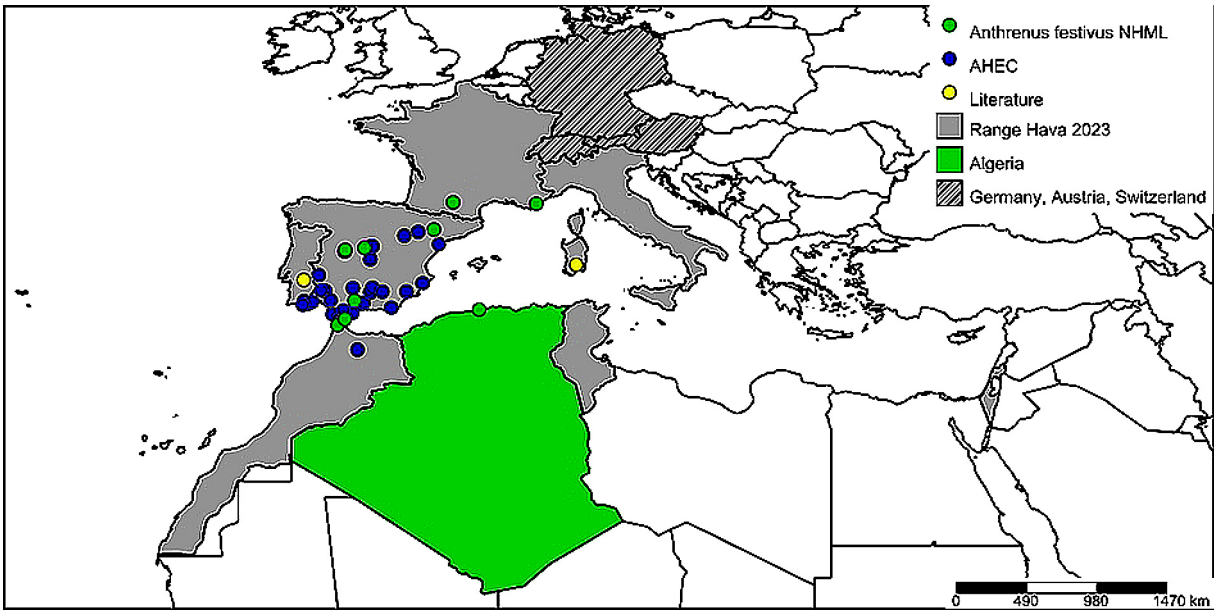

FIGURE 6. Distributions of *Anthrenus* (*Anthrenus*) *festivus* Erichson, 1846. Countries infilled grey: distribution according to Háva (2023). Countries hatched: records claimed but later rejected. Country infilled green (Algeria): data from NHML but no more precise location provided. Collection locations of *A. festivus* in NHML green dots, AHEC blue dots, published literature yellow dots.

Differential diagnosis

The two specimens of *A. mumbaiensis* were found in the NHML in the *A. festivus* collection. The external appearance of *A. mumbaiensis* very closely resembles that of *A. festivus*. Figures 1A and 1B suggest that *A. mumbaiensis* is brighter than *A. festivus* and this might be true for many Spanish *A. festivus* (according to the specimens held by NHML). However, several of the *A. festivus* from Algeria and Southern France held by NHML were brighter than those from Spain with larger white spots and more bright orange scales. *Anthrenus mumbaiensis* differs from *A. festivus* in the distribution of colour on the prothorax. The lateral sections of the prothorax in *A. festivus* are covered in white and yellow scales (Figure 4A). The white and yellow pronotal scales in *A. mumbaiensis* are more extensive but patchy in nature (Figures 1A and 1B) and form loose bands across the anterior margin and across the middle of the pronotum. Both specimens of *A. mumbaiensis* have a clear patch of white scales on the middle part of the posterior margin that protrudes to cover the scutellum. *Anthrenus mumbaiensis* is distributed (Figure 3) so far away from *A. festivus* (Figure 6), and the fact that there are no other similar species of *Anthrenus* known from India (Andreas Herrmann pers. comm.) leaves little scope for confusion. Furthermore, *A. festivus* is not known as

a synanthropic or pest species, so the chance of accidental human transport from western Mediterranean to India is remote.

Etymology

The species name, *mumbaiensis*, refers to the location of collection.

Discussion

The initial purpose of the study was to produce clear illustrations of a species that is considered easy to recognise and common where it occurs. Many species of Dermestidae are poorly described and don't provide the taxonomist with good clear guidance for comparative purposes. As far as the author is aware, this is the first time that an image of sternite IX has been provided for *A. festivus*. The aedeagus has been illustrated elsewhere (Herrmann 2023), but in low resolution. The reason for describing common species like this is that cryptic species could be 'hidden' within common species. This belief comes from studies on the Palaearctic *Anthrenus pimpinellae* complex where two new species have been discovered, *A. chikatunovi* Holloway, 2020 (Holloway, 2020) and *A. corona* Holloway, 2021 (Holloway, 2021), by trawling though specimens labelled *A. pimpinellae*. In other cases, subspecies have been inappropriately assigned which, again, makes the correct taxonomy difficult to unravel (Holloway *et al*. 2020). It was chance that *A. mumbaiensis* was discovered hidden amongst specimens of *A. festivus*, but its discovery reinforces the point being made here.

Anthrenus festivus is quite a small *Anthrenus* species. The size range found here was a body length of 2.05 mm for the smallest male up to 2.70 mm for the largest female. Females were slightly but statistically significantly larger than males, which is not unusual for *Anthrenus*. Herrmann (2023) also provides a size range for the species of 1.6 mm–2.9 mm. The data presented here fit well with the upper value but nothing under 2 mm was found.

Both Háva (2023) and Herrmann (2023) provide information on the distribution of *A. festivus*. Háva's (2023) distribution is shown in grey (Figure 6), including the countries hatched. *Anthrenus festivus* is clearly distributed around western Mediterranean, and any records away from this region would require expert confirmation. The Israel record is far removed from the focus of the *A. festivus* distribution and is likely to be a misidentification. The German record (Kock 1974) has been declared a hoax (Kohler 1995) and the Swiss record has been declared a misidentification (Chittaro & Sanchez 2019). By virtue of these cases and distance from western Mediterranean, the Austrian record must also be brought into question. Furthermore, the source of this record could not be found in the literature. No records are claimed from mainland Italy (included here by virtue of Sardinian and Sicilian records), nor from France north of the coastal regions.

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