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Larval redescription of *Eurythyrea aurata* (Pallas, 1776) (Coleoptera: Buprestidae) based on microphotography and scanning electron microscopy

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Abstract. The larva of *Eurythyrea aurata* was first described by Volkovitsh (1975) and Bílý (1999). Both authors referred to this species by comparing it to other species in the genus. In this manuscript, the last instar larva of *Eurythyrea aurata* is thoroughly recharacterized using microphotographs and SEM images to illustrate the different body parts, including mouthparts, thorax, and abdomen. In addition, efforts have been made to establish relationships between these morphological characters and larval biology.

Keywords: *Eurythyrea aurata*, larval redescription, microphotography, scanning electron microscopy, sensilla.

Introduction

The genus *Eurythyrea* Dejean, 1833 (Coleoptera: Buprestidae) is a small group of metallic wood-boring beetles, comprising 11 described species distributed across the entire Palearctic region. Within Europe, four species are currently known (Bílý 2002): *Eurythyrea aurata* (Pallas, 1776), *E. austriaca* (Linnaeus, 1767), *E. micans* (Fabricius, 1792), and *E. quercus* (Herbst, 1780). In Romania, only the last three have been recorded to date.

Species in the genus *Eurythyrea* are monophagous or oligophagous, with larvae that develop in the stems of physiologically weakened or recently dead trees. Consequently, they are strictly dependent on decaying or deadwood microhabitats (Jonsell 2004, Kajtoch et al. 2022), typically within coniferous, broadleaf, or riparian forests. This obligate saproxylic association—common to many other deadwood-dependent species—renders them highly vulnerable to habitat disturbance (Speight 1989, Fowles et al. 1999).

At the European level, saproxylic insects are among the most threatened insect groups (Berg et al. 1994, Read 2000, Alexander 2004, Davies et al. 2008). Their decline is primarily linked to habitat loss resulting from intensive forest management practices (McGee et al. 1999, Hale et al. 1999, Fridman & Walheim 2000, Larsson & Danell 2001, Siitonen 1994, Davies et al. 2008) and, in the case of riparian forests, agricultural expansion.

Due to the widespread decline in old-growth trees, many saproxylic beetles, including *Eurythyrea* species, are now included in national and international Red Lists (Jonsell 2004). In France (Auvergne-Rhône-Alpes region), *E. micans* is considered Near Threatened (Dodelin & Calmont 2021). In Italy, all the species of the genus are listed as Critically Endangered (Audisio et al. 2014). According to Prokhorov (2009, 2019), *E. aurata* and *E. quercus* in Ukraine require protection. In Romania, all three known *Eurythyrea* species are included in the national Red List of invertebrates (Ruicănescu 2021). Among them, *E. aurata* is the most widely distributed, occurring across Hungary, Serbia, Montenegro, Albania, North Macedonia, Greece, Bulgaria, Romania, Ukraine, Georgia, Azerbaijan, and the Russian Federation (GBIF 2025) (Fig. 1).

Figure 1. Distribution of *Eurythyrea aurata* (GBIF 2025).

Although *E. aurata* has a wide distribution range, its populations are relatively isolated. In Romania, the species was previously known only from the Danube Delta (Negru 1968, Serafim & Ruicănescu 1995). However, we have recently recorded this species further downstream along the Danube, in Comasca (Giurgiu County), in the southern part of the country (personal observation). In Romania, *E. aurata* is considered a rare and localized species that requires targeted conservation measures. A deep understanding of the species' ecology and biology is crucial for formulating these strategies (Sitar et al. 2024). Special attention must be paid to the larval stage, as insects are typically most vulnerable at this phase of their development (Johnson et al. 2007). Accurate knowledge of larval morphology can provide important insights into the species' biology and habitat requirements, serving as a basis for designing effective conservation and management plans for both the species and its ecological niche (Sitar et al. 2021).

Morphology and biology of *Eurythyrea aurata*

The adult *Eurythyrea aurata* measures between 16 and 22 mm in length, with females typically larger than males. The body is elongate-oval, displaying a metallic golden-green coloration with coppery-red lateral margins. The elytra bear 10 visible striae, and the scutellum is approximately twice as wide as it is long (Fig. 2).

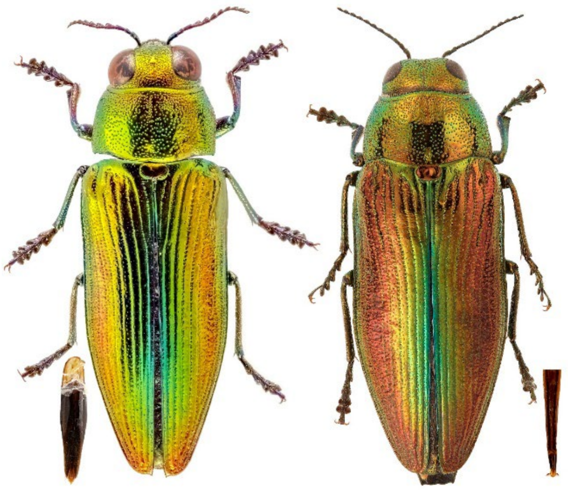

Figure 2. *Eurythyrea aurata* – adults: left – male (Comasca, 8.06.2021 M. Teodorescu leg.), right female (C. A. Rosetti, 7.06.2018, I. Tăuşan leg).

The species is monophagous in its larval stage, developing in different poplar species. Larvae colonize weakened or declining trees, acting as secondary invaders rather than primary pathogens. After hatching, the larva bores into the trunk and settles in the cambial zone, feeding on vascular tissues during its initial development.

The larval period lasts 3–4 years, during which the larva continues to feed and grow beneath the bark. In the final instar, it tunnels deep into the wood and then ascends nearly vertically toward the bark, leaving a thin cap of wood at the surface to facilitate adult emergence.

A notable anatomical feature is the prognathous head of the larva (with forward-facing mandibles), which contrasts with the orthognathous head of the adult (mandibles positioned at a 90° angle). This morphological shift reflects the larva's burrowing role and the adult's above-ground life cycle.

Adults are typically active from June to August. Males are usually acrodendric (occupying the upper canopy), while females descend to the trunks of host trees to oviposit.

The larval morphology of *E. aurata* was first described by Volkovitsh (1975), primarily in the context of comparative studies with *E. quercus*. The original description, published in Russian, included highly detailed illustrations of diagnostic features.

Later, Bílý (1999) provided a key for identifying the larvae of Central European buprestids, including all three *Eurythyrea* species in the region. His guide remains a key reference for comparative morphology within the genus.

In this study, we present a comprehensive redescription of the last instar larva of *Eurythyrea aurata*, using high-resolution photomicrography and scanning electron microscopy (SEM). We provide detailed images and descriptions of key morphological structures, including the head, thorax, abdomen, appendages, and spiracles, to clarify species-level diagnostic traits and support future taxonomic and ecological research on this threatened saproxylic beetle.

Materials and methods

The specimens under examination consist of twelve larvae obtained on 17 March 2024 from a log of *Populus alba*, which had been cut down for firewood, found in the Danube Plain adjacent to Comasca, Giurgiu. The larvae were found in tunnels approximately 10 cm below the bark surface.

The final instar larvae were immersed in a fixative composed of 4 parts xylene, 6 parts refined commercial isopropyl alcohol, 5 parts glacial acetic acid, and 4 parts dioxane. This solution guarantees that the larvae maintain their original colouration and do not turn black (Viedma 1970). The remaining larvae were stored in absolute ethanol. The microphotographic images were captured using a Canon EOS 7D camera fitted with a Canon MP-E 65 mm lens and macro extension tubes. The entire apparatus is attached to a Wemacro automatic slider. For the processing of the images, the HeliconFocus® 8.2.1 software application was used.

Samples, including various body parts, cephalic components, and oral structures, were meticulously prepared for scanning electron microscopy (SEM) analysis using the turbomolecular pumped coater Quorum Q150T ES, housed within the Integrated Electron Microscopy Laboratory (LIME) of the National Institute for Research and Development of Isotopic and Molecular Technologies (INCDTIM) located in Cluj-Napoca, Romania, and subsequently examined using the Hitachi SU8230 SEM (LIME-INCDTIM, Cluj-Napoca, Romania).

The terminology used for the head appendage structures follows Pshtiwan & Wand (2021). On the larval body of *Eurythyrea aurata*, four distinct types of sensilla were identified. Their nomenclature and presumed functional roles were adopted from Seena et al. (2023) and are illustrated in Fig. 3. In addition, the interpretation of sensillar morphology and function follows the descriptions provided by Pshtiwan & Wand (2021), Seena et al. (2023), and Sitar et al. (2021, 2025).

Results

Description of the last instar larva

The larva of *Eurythyrea aurata* is apodous and eucephalous, belonging to the typical Buprestoid type (Volkovitsh 1979), and is distinguished by its elongated and slender form. The epicranium is retracted within the prothorax, rendering only the peristome and the mouthparts visible. All three thoracic segments display a flattened and dilated morphology, being broader than the abdominal segments. The prothorax is notably larger and wider (approximately 6 mm) compared to the meso- and metathorax. The terminal abdominal segment does not terminate in two chitinized appendages. The measured length of the final instar larva is approximately 40 mm. In its living state, the larva presents a white coloration with delicate cream tones. The peristome and mouthparts are present in various shades of brown. At the same time, the mandibles are distinctly black (Fig. 4). Sclerotization is superficial, with the presence of semi-sclerotised plaques on the dorsal and ventral surfaces, particularly within the thoracic and first abdominal segments. A reversed Y-shaped groove is present on the dorsal prothoracic plate. In contrast, an I-shaped groove is found on the ventral plate (Fig. 4). The entire body tegument is adorned with microscopic microspinulae.

Head

The head capsule has a pale white coloration, is membranous, and has minimal chitinization, except for the peristome and mouthparts, which are significantly chitinized and have a dark brown to black hue (Fig. 5). The peristome is comprised of the epistome (dorsal), hypostome (ventral), and the pleurostomes (lateral). This ring-shaped peristome supports the antennae and mouthparts.

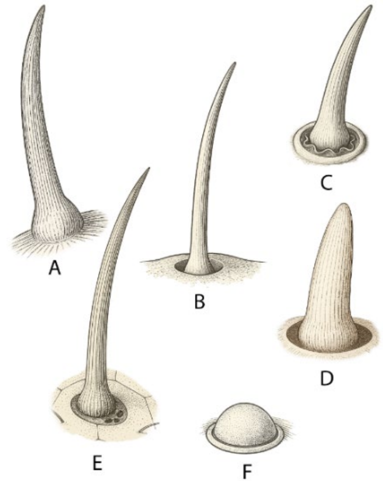

Figure 3. Schematic representation of major types of sensilla present in larva of *Eurythyrea aurata*. A – Sensillum chaeticum (1); B – Sensillum chaeticum (2); C – Sensillum basiconicum (1); D – Sensillum basiconicum (2); E – Trichoid sensillum; F – Campaniform sensillum.

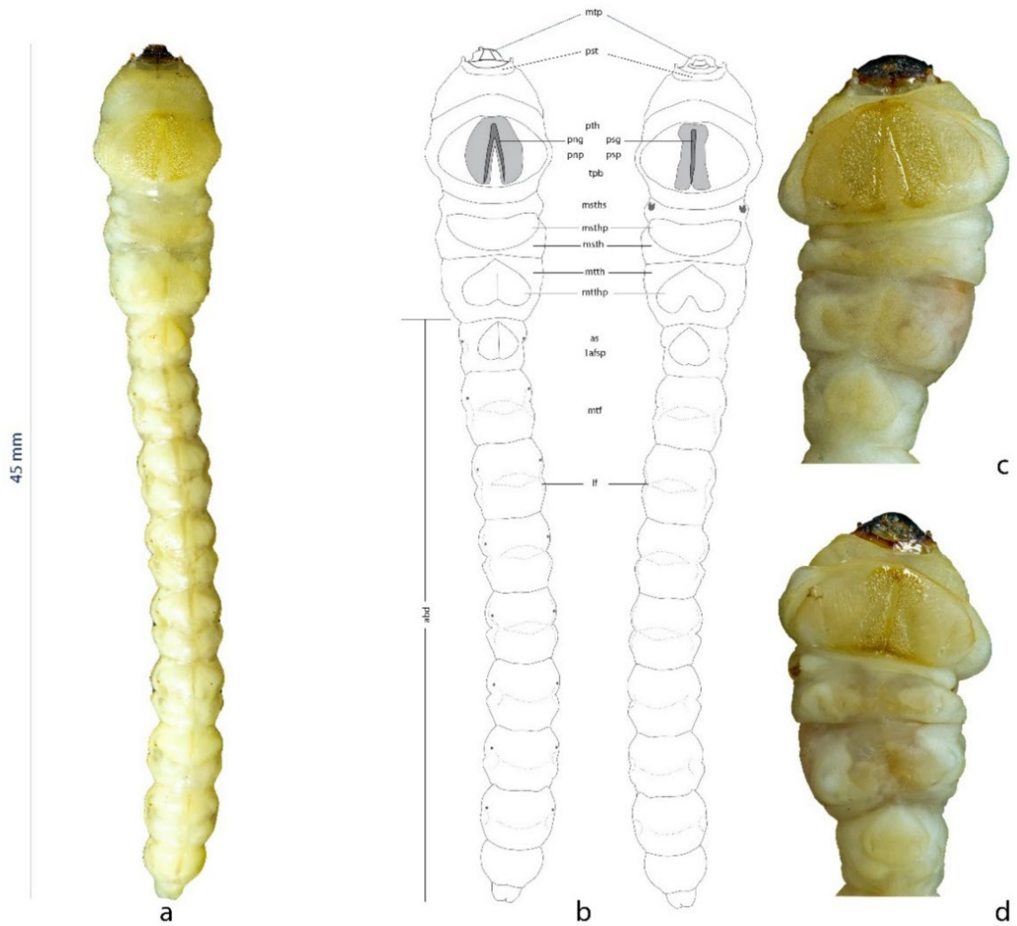

Figure 4. Larva of *Eurythyrea aurata* – a. Habitus; b. Habitus dorsal and ventral (scheme); c. Details of the head and thorax dorsal; d. Details of the head and thorax ventral. Abbreviations: 1afsp – first abdominal segment's plates (dorsal and ventral), abd – abdomen, as – abdominal spiracles on segments I-VIII, lf – lateral fold of abdominal segment II–VII (dorsal and ventral), msth – mesothorax, msthp – dorsal and ventral plates of the mesothorax, msths – mesothoracic spiracles, mtf – median, transversal fold on the abdominal segments II–VIII, mtp – mouth parts, mtth – metathorax, mtthp – dorsal and ventral plates of the metathorax, png – pronotal groove, pnp – pronotal plate, psg – prosternal groove, psp – prosternal plate, pst – peristome, tpb – stronger chitinized areas of the pronotal and prosternal plates covered with tubercles.

Figure 5. Larva of *Eurythyrea aurata* – Cephalic capsule in dorsal view.

Antenna

The antenna is short, consisting of two segments known as antennomeres. The basal antennomere is cylindrical and features a cluster of bristles at its apex, within which the apical antennomere is inserted. The apical antennomere ends in a cup-like structure. Inside this concave structure, there are some sensilla basiconica. Additionally, a long trichoid sensillum is attached to the inner top side. (Fig. 6).

The labro-clypeal complex

The strongly sclerotised epistome serves as a support structure for connections to the mandibles and the anteclypeus. The epistome is horizontally oriented, three times as wide as it is long, with a concave front edge. The anteclypeus and labrum are placed in the middle of this concavity, while the epistomal condyles are located on each side. The mandibles are articulated in these epistomal condyles. Externally, there are four trichoid sensilla present. The surface of the epistome is predominantly smooth, except for the rough microstructure found in the side depressions above the mandibular condyles. The epistome is brown, with a darker shade along the front edge (Fig. 7).

The exposed section of the labrum is characterised by a transverse, rounded rectangle shape and is dark brown in colour. Its dorsal surface presents two sets of three trichoid sensilla each. On the ventral (inner) side of the labrum, there are additional sets of three trichoid sensilla on each side, while thick bristles form a brush-like arrangement along the edges and on the ventral side (Fig. 8).

The mandibles are pyramidal-shaped, with an incisive (cutting) edge featuring three teeth that project into the inner region through three carinae. The smooth masticatory (inner) surface contrasts with the granular, abrasive microstructure present on the outer surface. Additionally, each mandible has two trichoid sensilla at its base on the outer surface, which serve as a tactile function. These mandibles serve two purposes: tunneling into wood and shredding it as a food source. (Fig. 9).

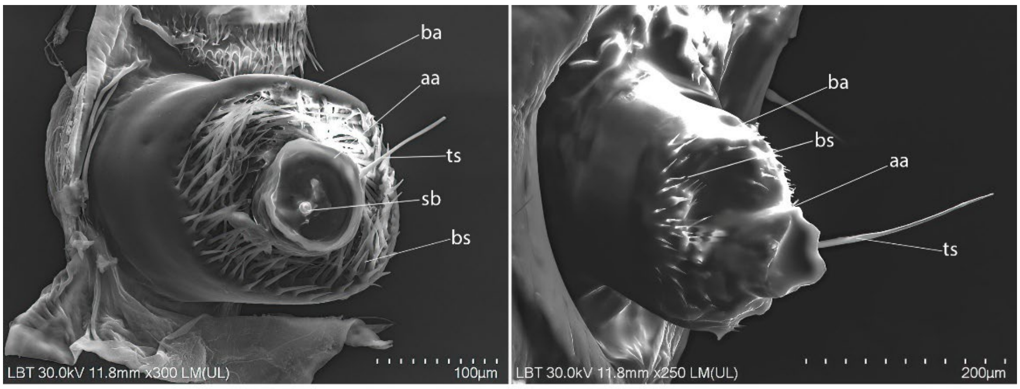

Figure 6. Larva of *Eurythyrea aurata* – SEM pictures of the antennal structure: A – frontal view; B – lateral view. Abbreviations: ant – antenna, bs – brush of bristles, sb – sensilla basiconica, ts – trichoid sensillum.

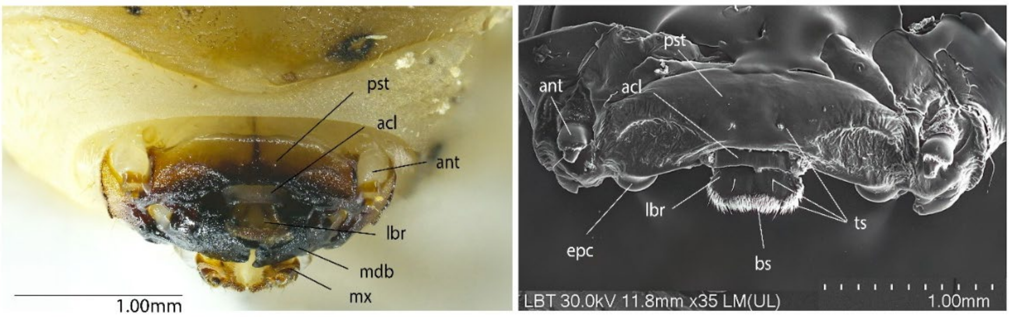

Figure 7. Larva of *Eurythyrea aurata* – The labro-clypeal complex: A. microphotography; B. SEM slide. Abbreviations: acl – anteclypeus, ant – antenna, bs – brush of bristles, epc – epistomal condyle, lbr – labrum, mdb – mandible, mx – maxilla, pst – peristome, ts – trichoid sensilla.

Figure 8. Larva of *Eurythyrea aurata* – The position of the bristles and sensilla on the inner surface of the labrum.

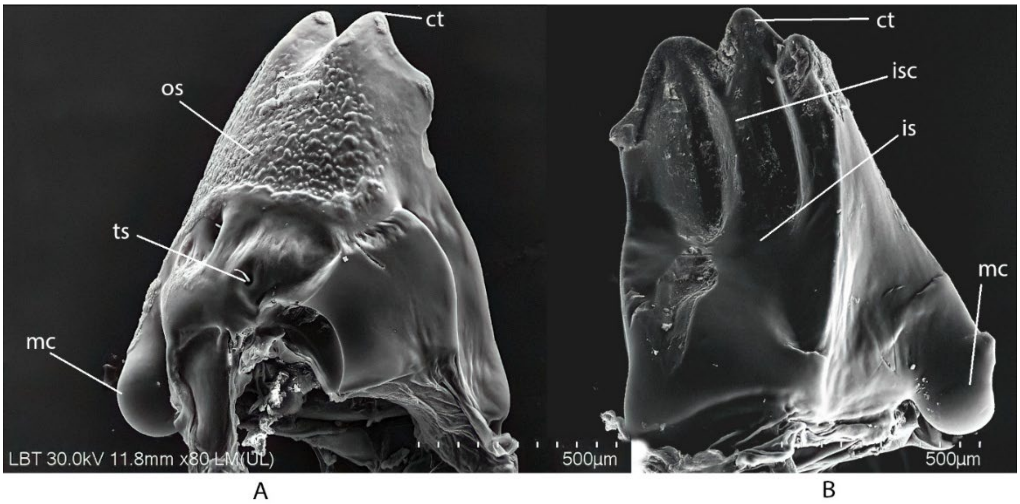

Figure 9. Larva of *Eurythyrea aurata* – The SEM pictures of the mandible: A. outer view; B. inner view. Abbreviations: ct – cutting edge teeth, is – inner surface, isc – inner surface carinae, mc – mandibular condyle, os – outer surface, ts – trichoid sensillum.

The labio-maxillary complex

The maxillae and labium are connected in the hypostome, together forming the labio-maxillary complex.

The hypostome is horizontally orientated, and the anterior edge has a deeper concavity compared to the epistome. Its central area has a smooth surface, while the sides show rough ripples. On either side of the midline are two trichoid sensilla. The hypostome appears pale brown, with a darker shade along the front edge. Inserted within the concavity of the hypostome, both maxillae cardo and, in the middle, the labium's submentum are inserted. There is a pair of trichoid sensilla positioned on the cardo, as well as two additional sensilla on the submentum. (Fig. 10).

The maxilla is biramous. Their basal articles (cardo) have fused with the basal article of the labium (submentum). The stipes is trapezoidal shaped, with the biarticulated maxillary palpus attached externally. On the internal side, it is attached to the mala, formed by the union of lacinia and galea (see Figure 10). Atop the mala, a cluster of trichoid sensilla is present. The stipes and mala are provided internally with a series of hairs and setae, which are longer and thicker toward the distal end. The primary function of the maxillae is to direct the crushed wood towards the mouth opening. The maxillary palpus consists of two segments. The basal segment is cylindrical, with a trichoid sensillum situated on its outer margin. The distal segment is bluntly conical, with a fossette on the inner side bearing a sensilla basiconica (Fig. 11).

The anterior margin of the labium is divided into two lobes. Both the edges and inner surface are lined with clusters of bristles. Additionally, there are two smaller lobes on the outer surface, also adorned with bristles, and two trichoid sensilla located on the lateral sides.

The entire labio-maxillary complex is equipped with various types of sensilla serving multiple sensory functions, likely including tactile, kinaesthetic, positional, thermal, olfactory, and gustatory perceptions (Seena et al. 2023). Bristle brushes found in both the labrum and labium consist of specialized microspinulae designed to capture wood particles, which are then transported by the maxillae to the mouth for ingestion (Fig. 12).

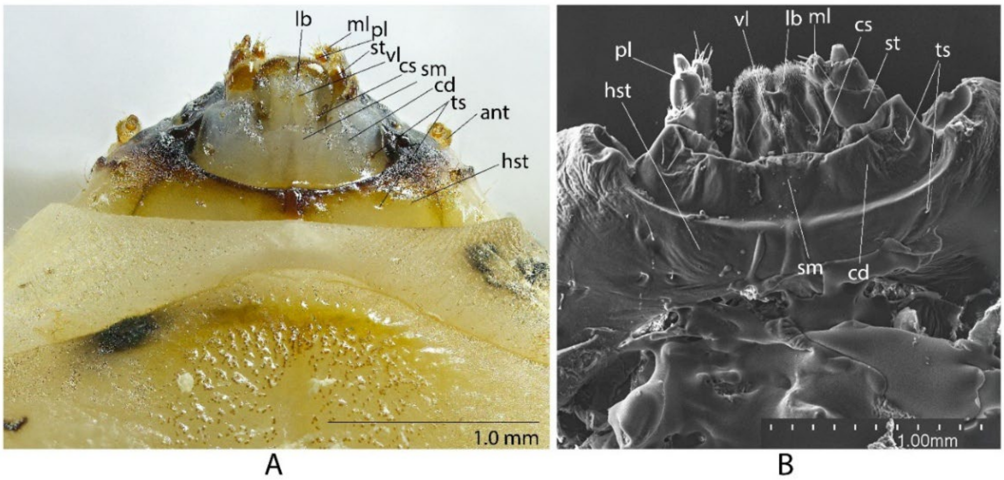

Figure 10. Larva of *Eurythyrea aurata* – the labio-maxillary complex: A – microphotography; B – SEM photography. Abbreviations: ant – antenna, cd – cardo, cs – campaniform sensillum, hst – hypostome, lb – labium, ml – mala, pl – maxillary palpus, sm – submentum, st – stipes, ts – trichoid sensilla, vl – ventral lobes of the labium.

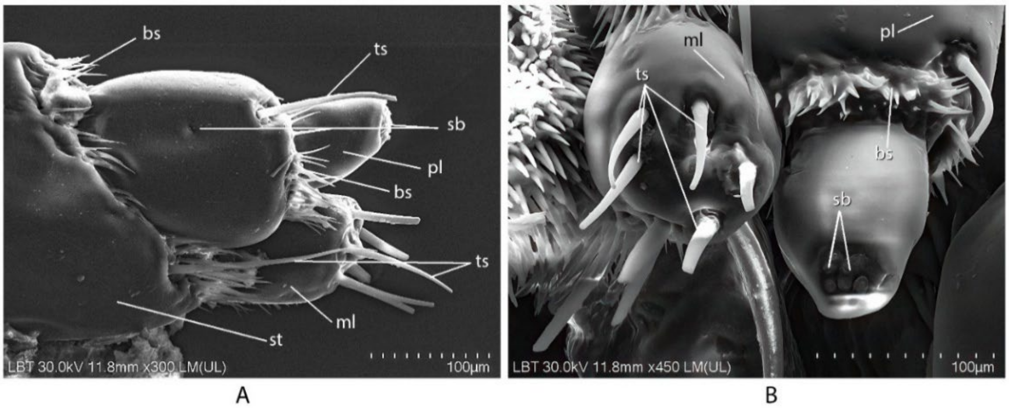

Figure 11. Larva of *Eurythyrea aurata* – maxilla in SEM: A – lateral view; B – frontal view. Abbreviations: bs – brush of bristles, ml – mala, pl – maxillary palpus, sb – sensilla basiconica, st – stipes, ts – trichoid sensilla.

Figure 12. Larva of *Eurythyrea aurata*: the mouthparts in frontal view (SEM). Abbreviations: bs – brush of bristles, cd – cardo, ef – epipharynx, hs – hypostome, lb – labium, lbr – labrum, md – mandibles, mx – maxilla, oo – oral opening, ml – mala, pl – maxillary palpus, sb – sensilla basiconica, sm – submentum, st – stipes, ts – trichoid sensilla, vl – ventral lobes of the labium.

Thorax

The width of the prothorax is nearly double its length and is 1.2 times wider than that of both the mesothorax and metathorax.

Prothoracic plates. The prothoracic plates are low-chitinized; the dorsal plate is oval-transversal in shape and is distinguished by two longitudinal grooves that create a reversed Y-shaped pattern. Surrounding these grooves is a region adorned with sizable, heavily chitinized tuberised microspinulae. External to this region, as well as between the two grooves, are sections covered with delicate and densely packed microspinulae, alongside scattered trichoid sensilla (Fig. 13).

The ventral prothoracic plate is transversely oval and features a solitary longitudinal median groove. This groove is bordered by a narrower region adorned with heavily chitinized tubercles, along with broad sections covered in microspinulae and occasional trichoid sensilla distributed on both sides (Fig. 14). The microspinulae and tuberised microspinulae provide adequate traction on the larval body within its tunnel, preventing falls in vertical sections and promoting smooth locomotion. The trichoid sensilla inform the larva about the temperature of the close environment.

Both the mesothorax and metathorax are provided with dorsal and ventral plates, the former being highly transversal in the mesothorax and heart-shaped in the metathorax. These plates are densely covered with small tuberised microspinulae.

The mesothoracic spiracles. There are only two thoracic spiracles located laterally between the prothorax and mesothorax. These spiracles are kidney-shaped and measure 0.7 mm in length. Their surface is characterised by multiple chitinized, radially arranged anastomosed trabeculae that function to filter air and prevent the penetration of small wood particles and fungal spores. (Fig. 15).

Abdomen

The abdomen consists of ten visible segments. All of them, except the last two, are spool-shaped. The ninth segment is short and oval, and the tenth segment is small and round conical. The first segment is slightly smaller than the next seven, and is the only one with heart-shaped semi-sclerotised dorsal and ventral plates.

The abdominal spiracles. There are eight sets of abdominal spiracles located on the sides. The abdominal spiracle has a similar shape and structure, except that its surface area is approximately half that of the mesothoracic spiracle (Fig. 16).

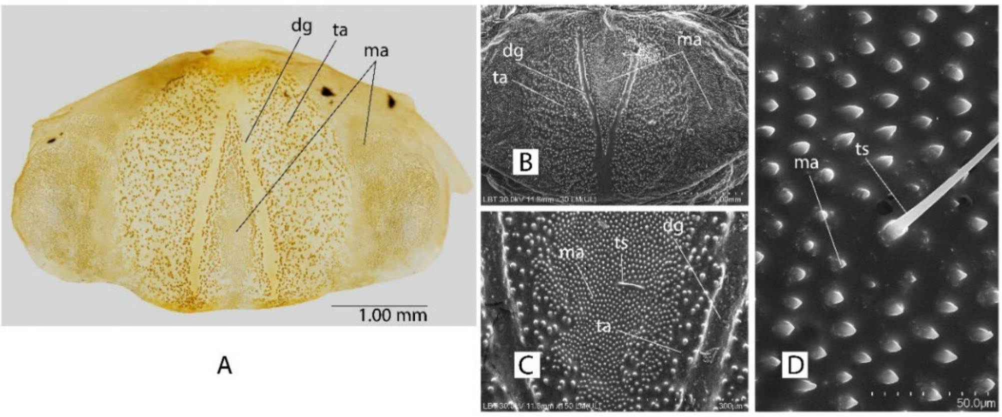

Figure 13. Larva of *Eurythyrea aurata*: A – dorsal protoracic plate (microphotography); B – the same (SEM); c – detailed structure of the space between the 2 branches of the reversed Y-shaped groves (SEM); d – details of the microspinulae (SEM). Abbreviations: dg – reversed Y-shaped dorsal grooves, ma – area covered with microspinulae, ta – area covered with tuberised microspinulae, ts – trichoid sensillum.

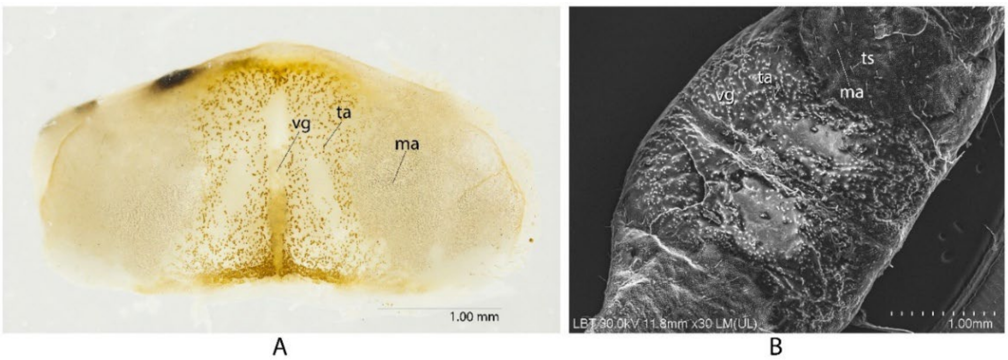

Figure 14. Larva of *Eurythyrea aurata*: A – ventral protoracic plate (microphotography); B – the same (SEM). Abbreviations: ma – area covered with microspinulae, ta – area covered with tuberised microspinulae, ts – trichoid sensillum, vg – ventral groove.

Figure 15. Larva of *Eurythyrea aurata*: The mesothoracic spiracle: A – microphotography, B – SEM photography, C: detail. Abbreviation: at – anastomosed chitinised trabeculae.

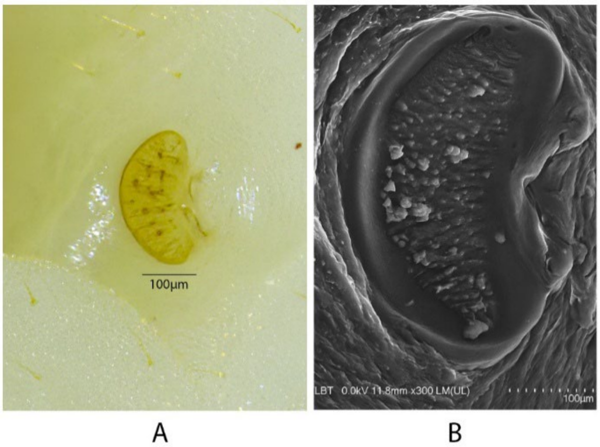

Figure 16. Larva of *Eurythyrea aurata*: abdominal spiracle: A – microphotography; B – SEM photography.

Discussion

In the present study, we redescribe the larva of *Eurythyrea aurata* using scanning electron microscopy (SEM) and present new morphological details for several previously undescribed structures.

Although the larval morphology of *Eurythyrea* species was first documented by Volkovitsh (1975) and Bílý (1999), their illustrations were limited to camera lucida drawings. However, detailed as they are, such renderings cannot match the resolution and structural clarity provided by SEM. Recent advances in SEM accessibility and resolution have significantly expanded its role in insect taxonomy, enabling researchers to detect fine-scale surface features that remain invisible under optical systems. Over the past decade, SEM has been increasingly applied to describe and redescribe developmental stages in Coleoptera and other insect groups (Kownacki et al. 2015), adding depth to the comparative framework of morphological studies.

Recent investigations employing SEM (Faucheux et al. 2020, 2025, Sitar et al. 2021, 2025) highlight its importance for understanding functional morphology and the relationships between structural traits and ecological roles and behaviours. For *E. aurata*, such detailed structural analysis can inform targeted conservation planning by clarifying habitat requirements, feeding adaptations, and behavioural traits, ultimately strengthening species-specific management strategies.

The larva of *E. aurata* shows clear specialisations for a saproxylic lifestyle within *Populus alba* sapwood. The robust, tridentate mandibles (Fig. 9) and brush-like setal arrays on the labrum, labium, and maxillae (Figs. 8, 10–12) form an efficient system for processing wood fragments, adapted for both excavation and ingestion of fibrous tissues. The maxillary brushes likely act as particle filters and conveyors, directing wood fragments toward the oral opening (Fig. 12).

Complex sensilla types—trichoid, basiconica, and campaniform—are strategically distributed on the antennae (Fig. 6), mouthparts (Figs. 8, 10–12), and thoracic plates (Figs. 13–14). These structures are likely involved in multimodal environmental sensing, enabling larvae to detect temperature, humidity, wood density, and orientation within their galleries. The flattened thoracic plates and microspinulae (Figs. 13–14) enhance traction and anchoring within the tunnel, preventing slippage, while the prognathous head supports forward excavation in confined spaces.

The mandibles expose a pronounced incisive edge, in contrast with a smooth internal masticatory surface (Fig. 9). This characteristic is apparently atypical for a wood-boring larva; however, our personal observations of larvae in their natural environment reveal that they operate their mandibles in an alternating fashion rather than simultaneously. Consequently, the incisive edge of one mandible presses against the smooth surface of the opposite mandible, facilitating the fragmentation of wood into smaller particles that are subsequently ingested.

Together, these features indicate behavioural adaptations for efficient burrowing, precise navigation, and optimal exploitation of microhabitat resources in decaying *P. alba* stems. SEM imaging provides critical detail on these functional traits that may not be discernible with optical microscopy alone.

Detailed SEM-based descriptions of such adaptive features can also improve larval-based species identification when adult material is absent. Accurate identification is particularly important for *E. aurata*, a species of conservation concern, as it enables the design of site-specific habitat management strategies. Understanding the distribution and function of sensilla, the microstructure of cuticular plates, and the configuration of the feeding apparatus helps predict how the species interacts with its environment and how it may respond to changes in microhabitat conditions (Nowińska & Kóbor 2025).

From a conservation standpoint, the larval stage provides valuable insight into species–habitat relationships. Host and microhabitat specificity, as seen in the association with *P. alba*, is a critical factor for *E. aurata* persistence. Such specificity has direct implications for forest management, as the availability of suitable host trees and the maintenance of decaying wood substrates are essential for sustaining populations.

Globally, riparian forests have been subject to severe anthropogenic pressures. Historic land-use change has led to widespread clearance for agriculture (Décamps et al. 1988, Nilsson & Berggren 2000, Dincă et al. 2025), compounded by river regulation and dam construction (de Araújo et al. 2018, Dincă et al. 2025). These pressures have resulted in significant reductions of suitable habitats, with direct negative effects on *E. micans* in western Europe and *E. aurata* in eastern regions.

While SEM was once considered a specialised and less accessible method, it is now widely available. Its integration with traditional optical microscopy offers a complementary approach that could become standard practice in morphological taxonomy and the description of new species.

This study is limited by its focus on final instar larvae from a single species. Future research should include comparative SEM analyses of larvae of *E. aurata, E. quercus*, and *E. austriaca* to elucidate interspecific differences in morphology and functional adaptations. Examination of earlier instars and pupae may also yield valuable information for species conservation and habitat management.

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