DOI: 10.1111/epp.13008

EPPO STANDARD ON DIAGNOSTICS

PM 7/156 (1) *Aromia bungii*

Specific scope: This Standard describes a diagnostic protocol for *Aromia bungii*.[1] This Standard should be used in conjunction with PM 7/76 Use of EPPO diagnostic protocols.

Specific approval and amendment: First approved in 2023–12. Authors and contributors are given in the Acknowledgements section.

1 | INTRODUCTION

Aromia bungii also known as red necked longhorn beetle is native to East Asia. It is recorded in China, North Korea, South Korea, Mongolia and Vietnam (EPPO, 2022). It has been recently introduced into Japan where it was first detected in 2012 (Tamura & Shoda-Kagaya, 2022) and into Europe where established populations have been present in Italy since 2010 (Garonna et al., 2013) and in Germany since 2011 (Burmeister et al., 2012). The species has also been intercepted in the United Kingdom in 2008 (Reid & Cannon, 2010) and a single adult specimen was found in Spain in 2018 (Otero & Cobo, 2018) without evidence of establishment (EPPO, 2019).

Aromia bungii is an oligophagous wood borer of *Prunus* species. In its native area of distribution, the main hosts are *Prunus armeniaca* (apricot), *P. persica* (peach), *P. domestica* (plum) and *P. avium* (cherry). Other confirmed hosts are *P. americana*, *P. grayana*, *P. japonica*, *P. mume*, *P. pseudocerasus*, *P. salicina* and *P. yedoensis*. Other tree species have been reported as potential hosts for *A. bungii*, such as *Diospyros kaki*, *D. lotus*, *D. virginiana* and *Punica granatum* but these records are unconfirmed (EFSA, 2019).

Further details on the biology of *A. bungii* are available in Russo et al. (2020), in the EPPO Datasheet (EPPO, 2022) as well as in the EFSA Pest Survey Card (EFSA, 2019).

Figure 1 shows the diagnostic procedure for *A. bungii*.

2 | IDENTITY

Name: *Aromia bungii* (Faldermann, 1835).

[1]Use of brand names of chemicals or equipment in these EPPO Standards implies no approval of them to the exclusion of others that may also be suitable.

Other scientific names: *Cerambyx bungii* Faldermann, 1835; *Aromia bungi* (Faldermann, 1835); *Aromia cyanicornis* Guérin-Méneville, 1844; *Callichroma bungii* (Faldermann, 1835); *Callichroma ruficolle* Redtenbacher, 1868; *Aromia cyanicornis* ab. *puncticollis* Plavilstshikov, 1940; *Aromia bungii* m. *brunnea* Podaný, 1971.

Taxonomic position: Insecta, Coleoptera, Cerambycidae, Cerambycinae, Callichromatini.

EPPO Code: AROMBU.

Phytosanitary categorization: EPPO A2 (2021); EU A1 Quarantine pest (Annex II B).

3 | DETECTION

In the field, infestations can be detected by the accumulation of larval frass, by the presence of exit holes on the trunk, and by the presence of the adults. Traps are also being used in some EPPO countries to monitor *A. bungii* (EFSA, 2019; Garonna et al., 2013). In any case, as symptoms are not specific, the confirmation requires sampling and identification of adults or preimaginal stages.

Additional information on the detection of *A. bungii* is included in the EPPO datasheet on pests recommended for regulation (EPPO, 2022) and in Pest Risk Analysis for *A. bungii* (EPPO, 2014).

3.1 | Detection in plants

3.1.1 | Period for detection

The best time of the year to detect the symptoms caused by the beetle is between the end of winter and the beginning of summer. Adults have a diurnal activity (Figure 2a,b), they can be observed mainly in summer.

Exit holes remain visible on trunks and branches for a long time and can be observed all year long (Figure 2c).

3.1.2 | Signs of presence

3.1.2.1 | *Senescent and decaying-looking trees (Figure 2d)*

Aromia bungii larvae bore into both the sapwood and heartwood of main trunks and branches, weakening

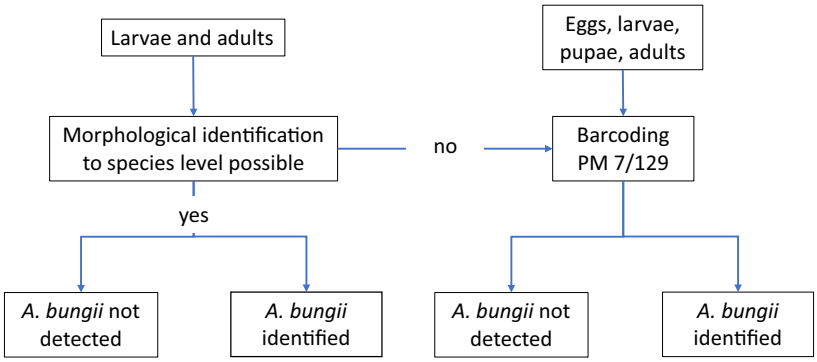

FIGURE 1 Diagnostic procedure for *Aromia bungii*. This flow diagram is intended to provide an overview of the diagnostic process and may not cover all possible scenarios.

trees and occasionally killing them (Duffy, 1968; Gressitt, 1942). It is reported that the larvae mainly tunnel the subcortical area beneath the bark and the sapwood and less commonly in the heartwood, leading to loss of fruit production and weakening of the trees (EPPO, 2013).

3.1.2.2 | *Frass accumulation (Figure 2e,f)*

The first symptoms that can be detected in field conditions are accumulations of larval frass at the base of tree trunks (although some may be seen on the bark or near the crown in upper branches) (Xu et al., 2017; Zou et al., 2019). Larvae excrete frass out of their galleries almost every day (Gressitt, 1942; Liu et al., 1999). Young larvae start excreting frass about 2 weeks after hatching. Frass has a reddish appearance and the volume produced increases with the age and size of the larvae. This sign is difficult to detect at the beginning of infestation but becomes easier at later stages. There may be several larvae in the main stem or branches.

This sign is not specific for *A. bungii* and is also produced by other species such as *Cossus cossus* (Linnaeus, 1758) (Lepidoptera: Cossidae) or *Capnodis tenebrionis* (Linnaeus, 1758) (Coleoptera: Buprestidae) that are common pests of *Prunus* spp. in Europe.

3.1.2.3 | *Exit holes (Figure 2c)*

Exit holes are located on the trunk or the main branches and have an oval shape (roughly 6–10 × 10–16 mm in size). They show that the first generation has completed its development, but younger living larvae can still be present in the wood, which will emerge 1 or 2 years later. This sign is not specific and collection of larvae (Figure 2g,h) followed by identification is required to confirm the presence of *A. bungii*.

3.1.2.4 | *Adults (Figure 2a,b)*

Adults can be easily observed in field conditions because of their diurnal activity, their large size (20–40 mm), and often shiny coloration with a combination of red pronotum and black elytra (note that the pronotum can also be black on the specimens of the var. *cyanicornis*).

3.1.2.5 | *Eggs*

Eggs are laid in crevices on the surface of the bark and may be visible externally. Unlike other Cerambycidae species, there are no oviposition scars.

3.1.3 | Sampling

If suspicious signs (frass and/or exit holes) are found, especially on host plants (*Prunus* trees), destructive sampling of the plant is required, including the removal of the bark to reveal young larvae and tunnels, and/or cutting through the trunk or branches to reveal deeper galleries (Ostojá-Starzewski, 2016). Larvae should be collected for identification. For morphological analysis, larvae should be boiled in water for approximately 1 min and then preserved in 70% ethanol. For molecular analyses, they should be immersed directly in 96% ethanol.

3.2 | Detection in wood packaging material and wood

Wood packaging material (pallets, crates, dunnage, etc.) is probably the main introduction pathway of *A. bungii* (EPPO, 2014). Wood or wooden products of *Prunus* species which are large enough to sustain live larvae until adult emergence are also other possible pathways for entry. In those commodities, frass accumulation and exit holes are signs of infestation. Living adults may hitch-hike in imported commodities but this is probably only occasional.

3.3 | Molecular detection in frass

Two real-time PCR tests (one based on a TaqMan probe and the other one on SybrGreen) and a LAMP test allowing the detection of *A. bungii* DNA in frass have been developed (Rizzo et al., 2020, 2021). More validation data and experience in EPPO diagnostic laboratories are required before they can be recommended in this protocol. DNA barcoding cannot be reliably applied to frass

FIGURE 2 Symptoms of *Aromia bungii*. (a) Adult on a branch; (b) Galleries in cross-section and an adult; (c) Exit holes; (d) Decaying tree; (e) Frass on branches; (f) Frass at base of trunk; (g) Base of an attacked tree, bark removed to sample larvae; (h) Larvae under bark. Photos courtesy: (a, d) Haye T, CABI (CH), (b, f–h) Maspero M, Centro MiRT (IT), (c) Bayerische Landesanstalt für Landwirtschaft (LfL) (DE), (e) Benchi D, Plant Health Service of Campania Region (IT).

material, due to possible binding of primers on the DNA of other organisms that rapidly colonize frass material, such as fungi, nematodes, and other arthropods.

3.4 | Trapping

It is well known that longhorn beetles are attracted by food liquids, but this is mainly effective for wood borers that feed on dead or decaying wood, and less or not effective for many other species, especially those (such as *A. bungii*) that attack living trees (Schmeelk et al., 2016). The use of bottle traps lured with fermenting liquids, fruit juice and vinegar has been reported to monitor *A. bungii*, but the efficacy of these baits was very poor (EFSA, 2019).

Recent research has been conducted in Japan and China (Fukaya et al., 2017; Xu et al., 2017; Yasui et al., 2019; Zou et al., 2019) on the efficacy of the identified pheromone of *A. bungii* ((E)-2-cis-6,7-epoxynonenal) and has opened interesting monitoring and control scenarios (i.e., mass trapping) where outbreaks of the pests are recorded. In Lombardia (Italy), promising results were obtained in 2022 and 2023 using this pheromone in cross vane traps during monitoring activity (A. Bianchi, personal communication).

4 | IDENTIFICATION

The genus *Aromia* Audinet-Serville, 1834 is mainly found in the Palaearctic region with an expansion in the Oriental region. It includes only four species: *Aromia bungii* Faldermann, 1835 (Korean Peninsula and China, introduced to Japan, Italy and Germany), *Aromia moschata* (Linnaeus, 1758) (Europe, Siberia, Central Asia, Caucasus, Turkey, Iran, Middle East, North Africa) *Aromia orientalis* Plavilstshikov, 1933 (Eastern Siberia, Far East Russia, Mongolia, Korean Peninsula, Japan, China) and *Aromia malayana* Hayashi, 1977 (Malaysia) (Özdikmen, 2014; Tavakilian & Chevillotte, 2018). *Aromia orientalis* is sometimes considered as a subspecies of *A. moschata* (Danilevsky, 2009). Very little information is available on *A. malayana* apart from its original description (Hayashi, 1977), it seems to be very close to *A. moschata*. The genus *Aromia* used to include the species *A. japonica*, which is now considered to be a junior synonym of *Chloridolum thaliodes* Bates, 1884 (Bentanachs et al., 2011). All other published names in combination with the genus *Aromia* are considered synonyms or subspecies of the four valid *Aromia* species (Löbl & Smetana, 2010).

4.1 | Morphological identification of *A. bungii*

Identification of *A. bungii* by morphological examination is quite straightforward for adult specimens. The habitus of adults displays characters that are unique compared to other longhorn beetle species present in Europe. The morphological identification of larvae is possible, especially in the case of fully developed larvae found on *Prunus* host plants, but it is recommended to confirm the identification of larvae with molecular tests in case of any doubts.

There are no adequate keys for the identification of eggs and pupae. Molecular tests can be applied to all life stages including those for which morphological identification to species level is not possible. Additionally, in cases where adult specimens are damaged, molecular tests may provide further relevant information about their identity.

4.1.1 | Adult

For a key to the families of Coleoptera see Lawrence et al. (1999a). For a key to the subfamilies and genera (including *Aromia*) of Cerambycidae in Europe, see Bense (1995), Villiers (1978) and Berger (2012); in China, see Hua et al. (1993). For a key to the Callichromatini tribe and to the *Aromia* species in the Palearctic, see Plavilstshikov (1934). Available descriptions of the genus *Aromia* in the European literature must be used with caution since they may use criteria (especially criteria related to the colouration) that do not work for *A. bungii*. It is therefore advised to refer to the diagnostic criteria presented in this protocol.

Description

Adults are 20–40 mm long. They have shiny smooth black elytra and usually the dorsal region of the prothorax is red except for the anterior and posterior margins that are black (Figure 3a,b), though there is a colour variant *A. bungii* var. *cyanicornis* that is entirely black (Figure 3c) (Yiu, 2009). The pronotum bears four swellings on the disc and is strongly spined laterally. Antennae and legs are steel bluish to black (Hua et al., 2009) (Figure 4c,l). Antennae are longer than the body in males (Figure 3a) and equal to the length of the body in females (Figure 3b). The first article of the antennae is furrowed on the outer surface, the following articles, from the third one onwards, are tri-carinated along their length (Figure 4l). Legs are long and robust, especially the hind pair. Hind tibiae are distinctly flattened at the sides (Figure 4c).

A key to the species of the genus *Aromia* is provided in Appendix 1.

Possible confusion with other native and exotic Cerambycidae

In Europe, the only native species of the genus *Aromia* is *A. moschata* (Figure 3d–h). It can be easily differentiated from *A. bungii* by the two fine, longitudinal carinae on the elytra and the sculptured, rugose elytral disc.

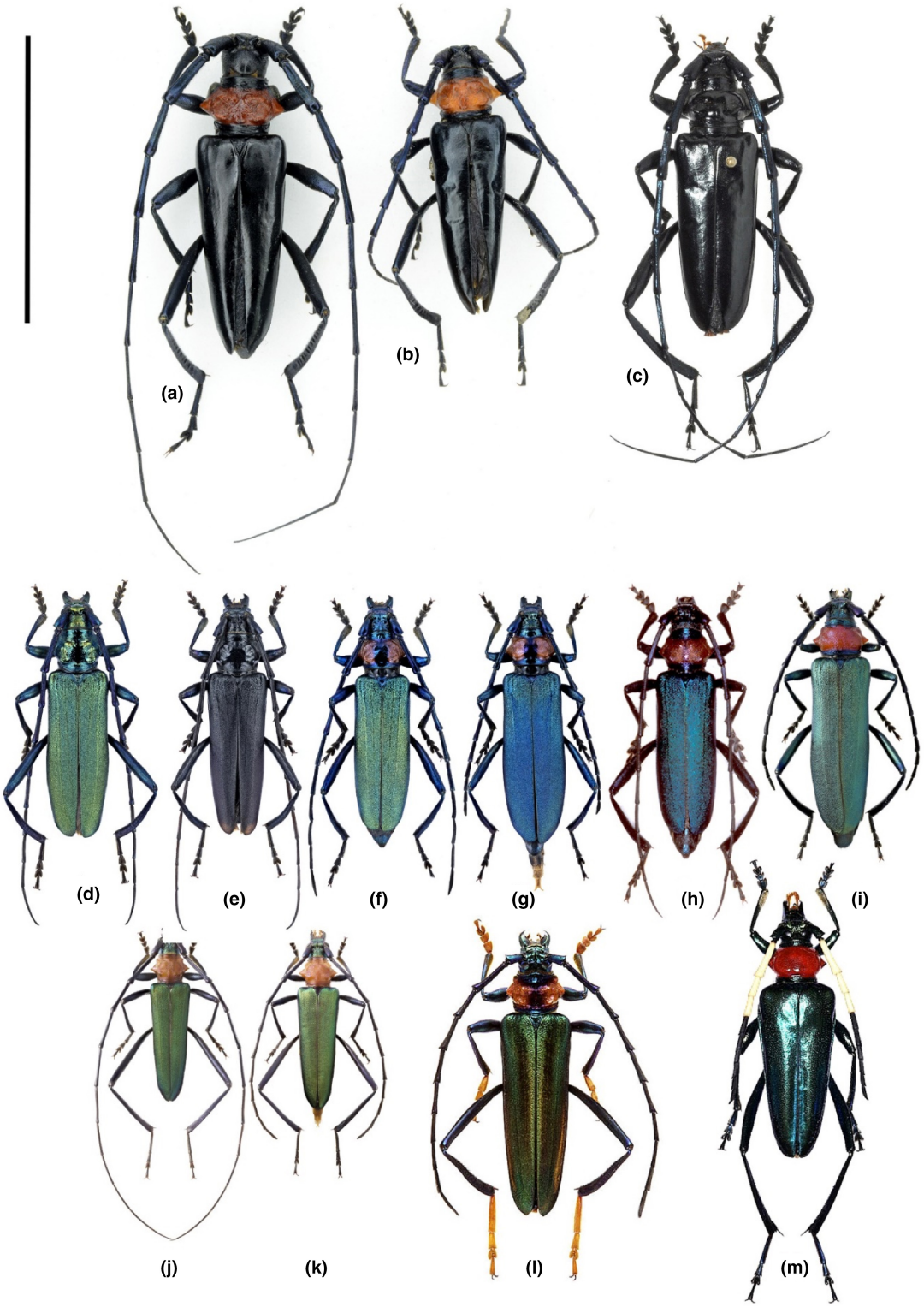

FIGURE 3 *Aromia bungii* and look-alike species (scale bar: 3 cm). (a, b) *Aromia bungii*, male (a) and female (b); (c) *Aromia bungii* var. *cyanicornis*, male entirely black; (d, e) *Aromia moschata*, males, two colouration variants; (f–h) *Aromia moschata* subsp. *ambrosiaca*, different colouration variants, male (f), female (g), male (h); (i) *Aromia orientalis*, female; (j, k) *Chloridolum sieversi*, male (j) and female (k); (l) *Aphrodisium faldermannii*, male; (m) *Pachyteria ruficollis*. Photo courtesy: (a, b) Chartois M (INRAE, FR), (c) Haller P (entomologist, CH), (d–h) Hoskovec M (Institute of Organic Chemistry and Biochemistry, CZ), (i–k) Makarov K, Moscow State Pedagogical University (RU); (l) Bourdon P, entomologist (FR), (m) Jacquot P, entomologist (FR).

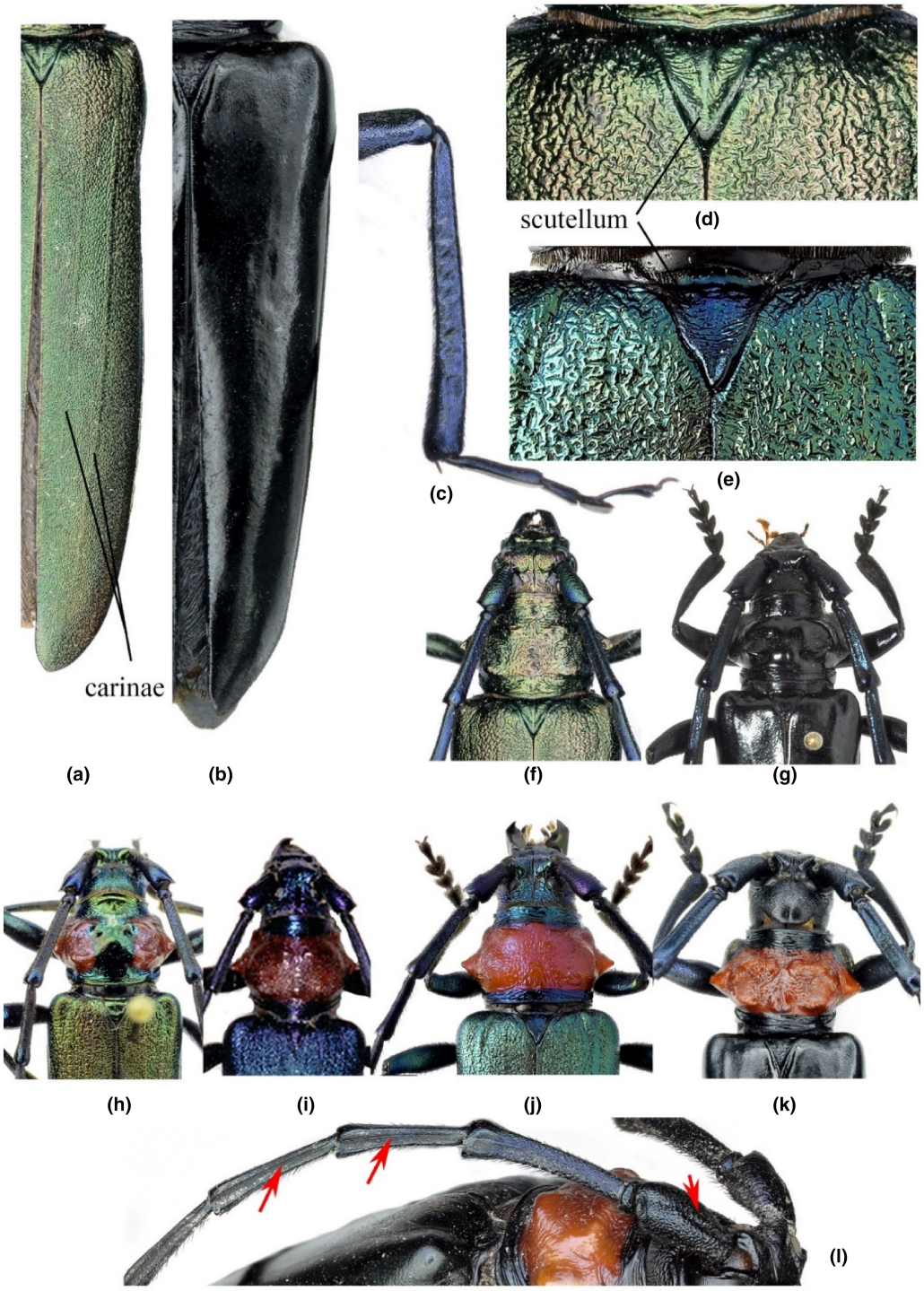

FIGURE 4 (a) *Aromia moschata*, female, elytra with two carinae and disc sculptured, rugose; (b) *Aromia bungii*, male, elytra entirely smooth; (c) *Aromia bungii*, flattened tibiae; (d) *Aromia moschata*, female, scutellum concolourous; (e) *Aromia orientalis*, female, scutellum darker than elytra; (f) *Aromia moschata*, female, head and pronotum; (g) *Aromia bungii* var. *cyanicornis*, male head and pronotum; (h, i) *Aromia moschata* subsp. *ambrosiaca*, male, head and pronotum; (j) *Aromia orientalis*, female, head and pronotum; (k) *Aromia bungii*, male, head and pronotum; (l) *Aromia bungii*, female, basal part of antennae, arrows showing furrow on article 1 and carinae on articles 4–5. Photos courtesy: (a–d, f, h, k) Chartois M, INRAE (FR), (e, j) Makarov K, (g) Haller P, entomologist, (CH), (i) Hoskovec M, entomologist (CZ), (l) Mouttet R, ANSES (FR).

A. moschata is also usually smaller (13–35 mm) than *A. bungii* and often presents a pronotum that is concolorous with the elytra (Figure 3d,e). In Southern Europe, the subspecies *A. moschata* subsp. *ambrosiaca* (Figure 3f–h) is more likely to be confused with *A. bungii* due to its pronotum that is more or less extensively red. However, some

differences are found in the aspect of the elytra (sculptured disc and longitudinal carinae) as well as in the general greenish/bluish metallic coloration of the body.

Apart from *A. moschata*, there is a limited risk of confusion with other species of Cerambycidae in Europe. However, several other species from Asia might be confused with *A. bungii*:

Aromia orientalis (Figure 3i) was described as a race of *A. moschata* from East Siberia with red pronotum and short antennae (Danilevsky, 2009). It can be distinguished from *A. bungii* by the elytral disc that is granular and shows two fine, longitudinal carinae.

Aromia malayana is reported from Malaysia only. Adults differ from *A. bungii* by the colour of elytra that is dark violet with slight greenish tint and the elytral disc that is granular and shows two fine, longitudinal carinae.

Chloridolum sieversi (Ganglbauer, 1886) (Figure 3j,k) is a member of the Callichromatini tribe from North-East Asia that inhabits deciduous forests and is ecologically associated with the Manchurian walnut (*Juglans mandshurica*) (Cherepanov, 1988a). It can be distinguished from *A. bungii* by the colour of the elytra that is bluish-green with metallic sheen and the pronotum that is entirely yellowish-red. In *A. bungii*, the pronotum is red or entirely black in var. *cyanicornis*. It is also significantly smaller (9–14 mm).

Aphrodisium faldermannii (Saunders, 1853) (Figure 3l) is a member of the Callichromatini tribe that is present in Russia, Korean Peninsula, China, Thailand and Vietnam. It can be distinguished from *A. bungii* by the yellow tarsi whereas they are black in *A. bungii*.

Pachyteria ruficollis Waterhouse, 1878 (Figure 3m) is a member of the Callichromatini tribe that is present in Borneo. It can be distinguished from *A. bungii* by the yellow colour of antennomeres 3–5.

4.1.2 | Larva

For a key to the families of Coleoptera larvae see Stehr (1987) and Lawrence et al. (1999b). The main features used for diagnostics of cerambycid larvae are presented in Figure 5.

Description

Newly hatched larvae are 2–2.5 mm long; mature larvae are 42–52 mm. There are two distinct morphological types (Garonna, 2012) similar to the case of *A. moschata* (Duffy, 1968), designated as larval types 'a' and 'b'. The 'a' forms are usually around 50 mm long and 10 mm wide when mature and show the broadest body area across the prothorax, with body segments narrowing towards the abdominal apex (Figure 5a,b). The 'b' forms, which are the final larval forms, are rather shorter (around 30–45 mm long), cylindrical and compact (Garonna, 2012) (Figure 5c,d). Form 'a' larvae show strong and very prominent mandibles in which the basal part is as dark as the apical part (Figure 6a). The 'b' forms show shorter mandibles with basal parts whitish and separated from a darker apical part by a deep transverse incision (Figure 6b). The head has a medial frontal line distinct along whole length (Figure 7a) as well as one hyaline stemma near each antennal base (Figure 8a) (which can be less visible on the 'b' form). Larvae have fully developed legs, with sharp claws (Figure 5g). The pronotum has short rust coloured hairs more concentrated on the lateral sides and a disc forming two transverse fields (Figure 5e). The abdomen has well developed non-sclerotized locomotory ampullae on segments I–VII (Figure 5a). The dorsal ampullae are characterized by a shallow median longitudinal furrow, an anterior transverse furrow which is quite straight and a posterior transverse furrow which is more or less bilobed, their extremities being joined by a pair of deep lateral furrows (Figure 5i).

A simplified key for late instar larvae of *A. bungii* is provided in Appendix 1.

Possible confusion with other Cerambycidae

Species identification of larvae may be difficult, and they can be confused with those of some other longhorn beetles present in Europe. The closest larvae are those of the species *A. moschata* for which no reliable morphological criteria are known to differentiate them from *A. bungii* larvae but both species have different host plants. *A. moschata* also present the two larval types 'a' and 'b'. In the absence of information relative to the host plants, it is not possible to separate the two species. When the host plant is known, it should be possible to make an identification because the host ranges of the two species do not overlap. However, it is recommended to confirm results (especially in case of new outbreaks) by molecular methods.

In Europe, several other species of Cerambycidae are known to develop on *Prunus* species. This is the case for example for *Aegomorphus clavipes* (Schrank, 1781), *Morimus asper* (Sulzer, 1776), *Saperda scalaris* (Linnaeus, 1758) or *Niphona picticornis* Mulsant, 1839, which belong to the subfamily Lamiinae. Their larvae can be distinguished from *Aromia bungii* by the absence of segmented legs, the shape of the clypeus that is more or less trapezoidal, filling the entire space between dorsal mandibular articulations (Figure 9b) and the shape of the mandibles which are not rounded and present a distinct apex and more or less distinct dorsal angle (Figure 10b). This is also the case of some species belonging to the subfamily Cerambycinae, such as *Cerambyx scopolii* Fueßlins, 1775 which can be distinguished from *Aromia bungii* by the presence of three stemmata (Figure 8b), *Xylotrechus arvicola* (Olivier, 1800) which does not have

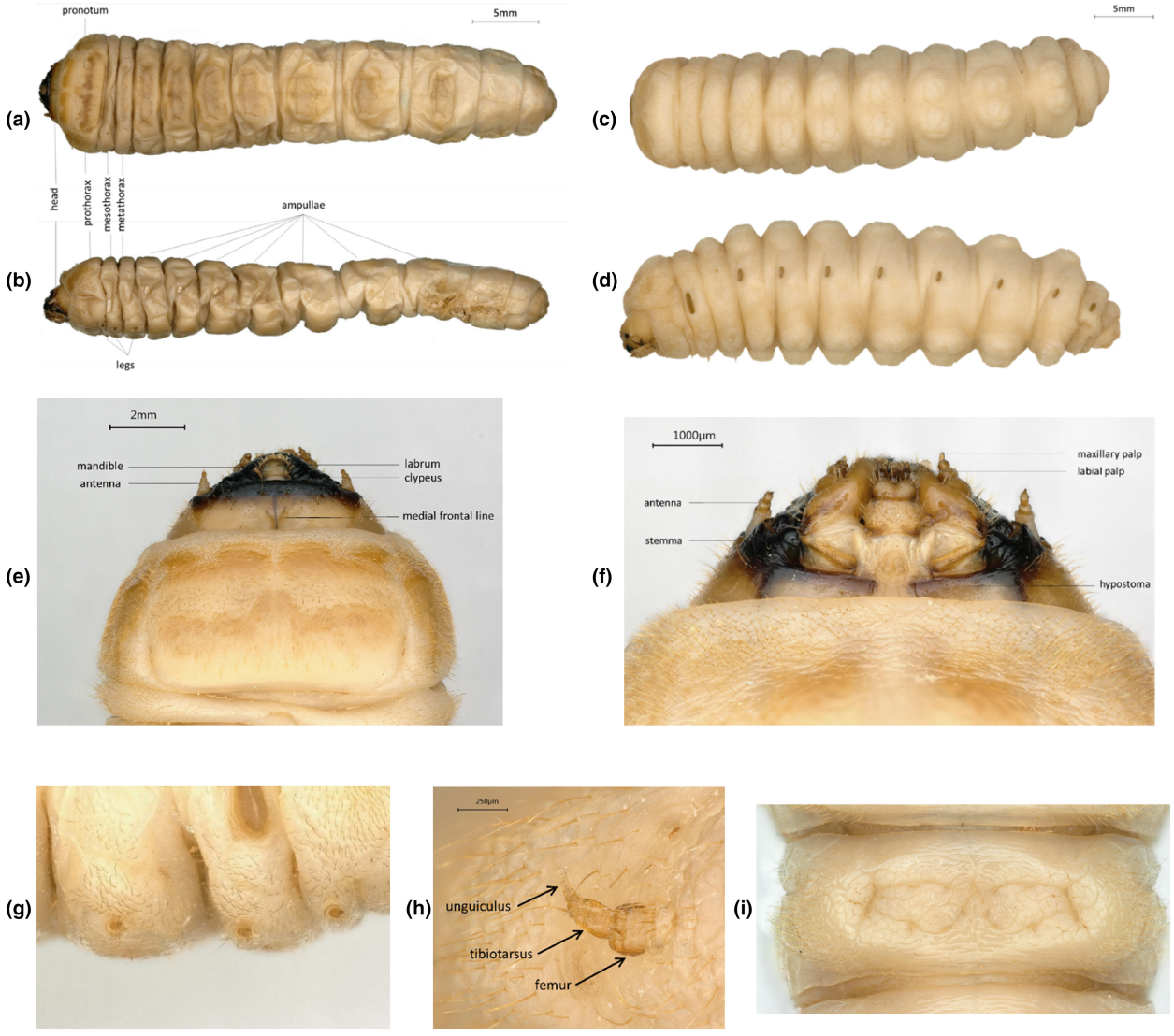

FIGURE 5 Morphological characters of *Aromia bungii* larvae (a) form a, dorsal view; (b) form a, lateral view; (c) form b, dorsal view; (d) form b, lateral view; (e) head and pronotal shield of form a, dorsal view; (f) head of form a, ventral view; (g) thorax, lateral view of legs; (h) details of a leg; (i) details of the dorsal ampullae. Photos courtesy: Mouttet R, ANSES (FR).

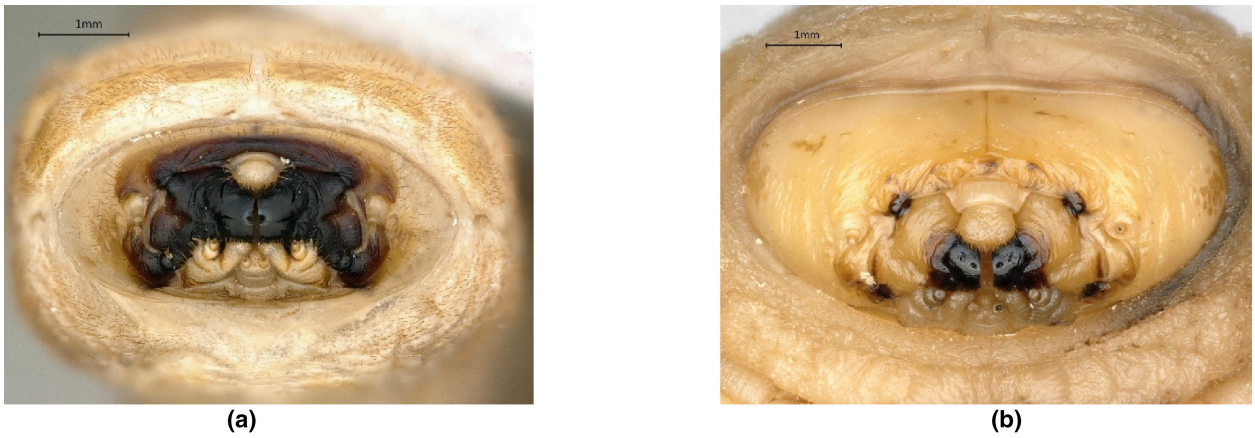

FIGURE 6 (a) Mandibles fully black (*Aromia bungii* form a), frontal view; (b) mandibles pale in their basal part (*Aromia bungii* form b), frontal view. Photos courtesy: Mouttet R, ANSES (FR).

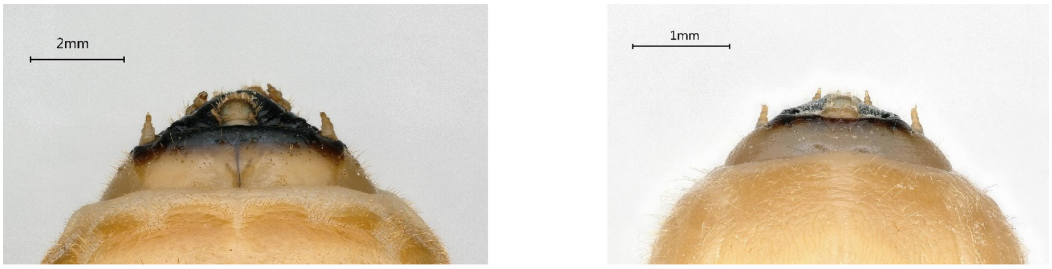

FIGURE 7 (a) Medial frontal line distinct along whole length (*Aromia bungii*), dorsal view; (b) medial frontal line indistinct or hardly visible (*Pyrrhidium sanguineum*), dorsal view. Photos courtesy: Mouttet R, ANSES (FR).

FIGURE 8 (a) One stemma present on each side (*Aromia bungii*), lateral view; (b) three stemmata present on each side (*Cerambyx scopolii*), lateral view. Photos courtesy: Mouttet R, ANSES (FR).

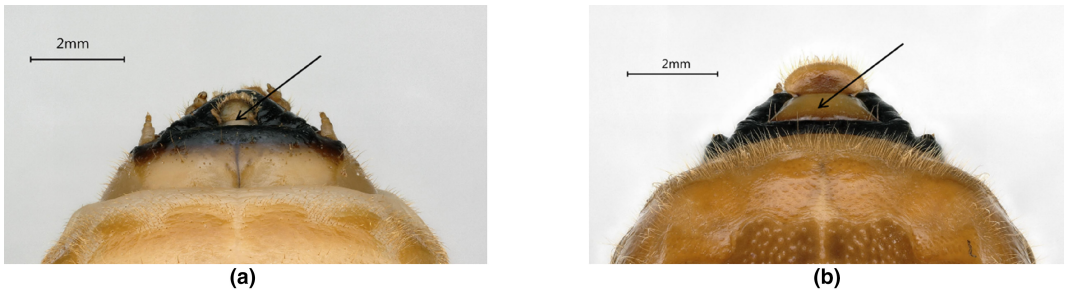

FIGURE 9 (a) Clypeus narrow in sub-family Cerambycinae (*Aromia bungii*), dorsal view; (b) clypeus trapezoidal in sub-family Lamiinae (*Morimus asper*), dorsal view. Photos courtesy: Mouttet R, ANSES (FR).

FIGURE 10 (a) Mandibles short, apically rounded in sub-family Cerambycinae (*Aromia bungii*), frontal view; (b) mandibles not rounded with distinct apex in sub-family Lamiinae (*Morimus asper*), frontal view. Photos courtesy: Mouttet R, ANSES (FR).

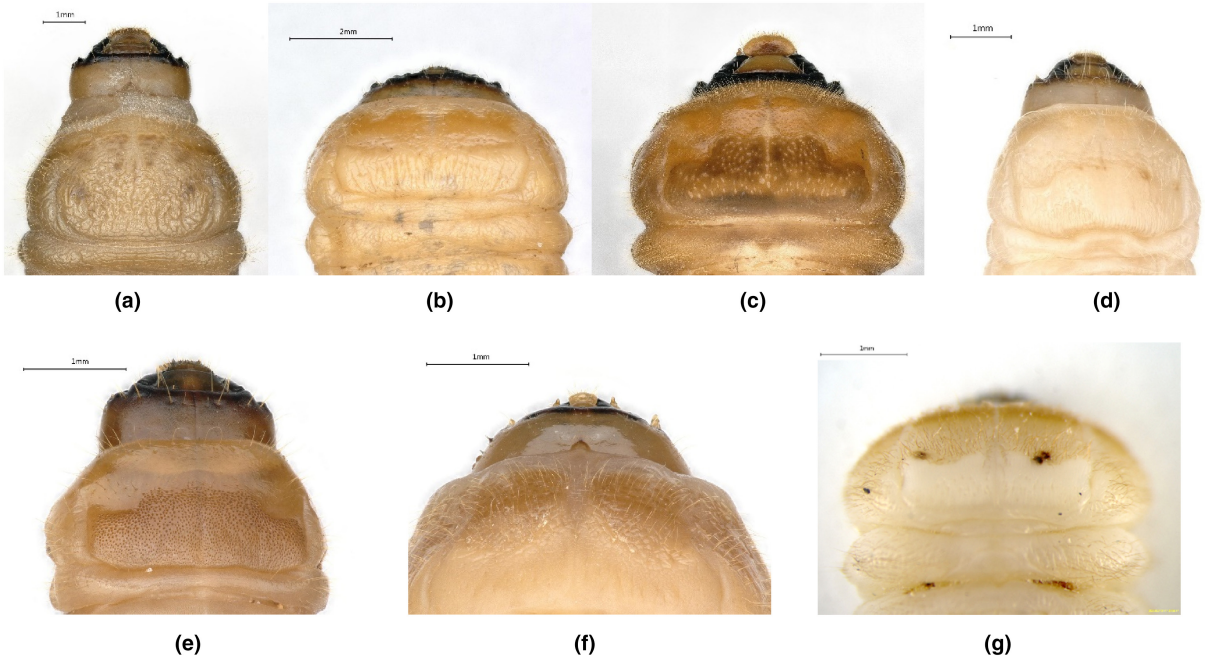

FIGURE 11 Pronotal shields (a) *Aegomorphus clavipes*, dorsal view; (b) *Cerambyx scopolii*, dorsal view; (c) *Morimus asper*, dorsal view; (d) *Niphona picticornis*, dorsal view; (e) *Saperda scalaris*, dorsal view; (f) *Xylotrechus arvicola*, dorsal view; (g) *Purpuricenus kaehleri*, dorsal view. Photos courtesy: (a–f) Mouttet R, ANSES (FR), (g) Zugno M, Regione Lombardia Plant Protection Service (IT).

segmented legs unlike *A. bungii* or *Purpuricenus kaehleri* (Linnaeus, 1758) which has a hypostoma that is coarsely striate. The shape of the pronotal shields (Figure 11) as well dorsal ampullae are also criteria useful for diagnostics that can complement the criteria presented in the key in Appendix 1.

4.2 | Molecular identification

A protocol for DNA barcoding based on COI described in Appendix 1 of PM 7/129(2) *DNA barcoding as an identification tool for a number of regulated pests*: DNA barcoding Arthropods (EPPO, 2021) allows the identification of *Aromia bungii*. Guidance for sequence analysis is given in appendices 7 and 8 of PM 7/129 (EPPO, 2021).

Other molecular tests exist, based on real time PCR (Rizzo et al., 2020) or LAMP (Rizzo et al., 2021). More validation data and experience in EPPO diagnostic laboratories are required before they can be recommended in this protocol.

5 | REFERENCE MATERIAL

Reference material is available from the EURL for Insects and Mites reference collection at ANSES-Laboratoire de la santé des végétaux, Unité entomologie et plantes invasives, 755 avenue du Campus Agropolis, 34988 Montferrier-sur-Lez Cedex, France.

Reference sequences of *Aromia bungii* originating from China and Italy are available in EPPO-Q-bank: https://qbank.eppo.int/arthropods/.

6 | REPORTING AND DOCUMENTATION

Guidelines on reporting and documentation are given in EPPO Standard PM 7/77 (1) *Documentation and reporting on a diagnosis*.

7 | PERFORMANCE CHARACTERISTICS

When performance characteristics are available, these are provided with the description of the test. Validation data are also available in the EPPO Database on Diagnostic Expertise (http://dc.eppo.int), and it is recommended to consult this database as additional information may be available there (e.g. more detailed information on analytical specificity, full validation reports, etc.).

8 | FURTHER INFORMATION

Further information on this protocol can be obtained from the EURL for insects and mites, ANSES – Laboratoire de la santé des végétaux, Unité entomologie

et plantes invasives, 755 avenue du Campus Agropolis, 34988 Montferrier-Sur-Lez Cedex, France. e-mail: eurl-insects-mites@anses.fr.

9 | FEEDBACK ON THIS DIAGNOSTIC PROTOCOL

If you have any feedback concerning this Diagnostic Protocol, or any of the tests included, or if you can provide additional validation data for tests included in this protocol that you wish to share please contact diagnostics@eppo.int.

10 | PROTOCOL REVISION

An annual review process is in place to identify the need for revision of diagnostic protocols. Protocols identified as needing revision are marked as such on the EPPO website.

When errata and corrigenda are in press, this will also be marked on the website.

ACKNOWLEDGEMENTS

The first draft of this protocol was written by Mouttet R (ANSES, FR), Streito JC (INRAE, FR), Rousse P (ANSES, FR) and Zugno M (Regione Lombardia Plant Protection Service, IT). The authors would like to thank the Plant Health Protection Services of the regions Lombardia and Campania (Italy) (including inspectors, agents and technicians) for providing valuable biological material in particular to Cavagna B, Ciampitti M, Bianchi A, Corsi N, Matarrese A, Porro V and Venegoni D for technical and field support. The authors are also grateful to all the people who have given permission to use their photographs to illustrate this protocol. The protocol was reviewed by the Panel on Diagnostics in Entomology.

REFERENCES

Bense U (1995) *Longhorn beetles. Illustrated key to the Cerambycidae and Vesperidae of Europe*. Weikersheim, Germany: Margraf Verlag.

Bentanachs J, Niisato T, Ohbayashi N (2011) Synonymic Notes on *Callichromatine* Species (Coleoptera, Cerambycidae, Cerambycinae) Described from Japan. *Elytra, Tokyo, New Series* 1, 125-129.

Berger P (2012) Coléoptères Cerambycidae de la faune de France continentale et de Corse: actualisation de l'ouvrage d'André Villiers, 1978. Association Roussillonnaise d'Entomologie.

Burmeister EG, Hendrich L & Balke M (2012) Der asiatische Moschusbock *Aromia bungii* (Faldermann, 1835) – Erstfund für Deutschland (Coleoptera: Cerambycidae). *Nachrichtenblatt der Bayerischen Entomologen*, 61, 29–31.

Cherepanov AI (1988a) *Cerambycidae of Northern Asia, Vol. 2, Cerambycinae, Part I*. New Delhi: Amerind.

Cherepanov AI (1988b) *Cerambycidae of Northern Asia. Vol. 2: Cerambycinae. Part 2*. New Delhi: Amerind.

Danilevsky ML (2009) Species group taxa of longhorned beetles (Coleoptera, Cerambycidae) described by NN Plavilstshikov and their types preserved in the Zoological Museum of the Moscow State University and in the Zoological Institute of the Russian Academy of Sciences. *St. Petersburg. Entomological review* 89, 689–720.

Duffy EAJ (1953) *A monograph of the immature stages of British and imported timber beetles (Cerambycidae)*. London: British Museum (Natural History).

Duffy EAJ (1968) *A monograph of the immature stages of oriental timber beetles (Cerambycidae)*. London: British Museum (Natural History).

EPPO (2013) 2013/050 Update on the situation of *Aromia bungii* in Campania (IT). – EPPO Reporting Service no. 03 – 2013

EPPO (2014) Report of a Pest Risk Analysis for *Aromia bungii*. Available online: https://www.eppo.int/ACTIVITIES/plant_quarantine/pra_activities (accessed: 2021/03/31)

EPPO (2019) New data on quarantine pests and pests of the EPPO Alert List. EPPO Reporting Service no. 08 – 2019. Available at: https://gd.eppo.int/reporting/article-6584 (last accessed: 2023-11-03)

EPPO (2021) EPPO Standards PM 7/129 (2) DNA barcoding as an identification tool for a number of regulated pests. *EPPO Bulletin* 46, 501-537.

EPPO (2022) *Aromia bungii*. EPPO datasheets on pests recommended for regulation. Available online. https://gd.eppo.int

European Food Safety Authority (EFSA). de la Peña E, Schrader G, Vos S (2019). Pest survey card on *Aromia bungii*. EFSA Supporting Publications, 2019: EN-1731, 25pp.

Fukaya M, Kiriyama S & Yasui H (2017) Mate-location flight of the red-necked longicorn beetle, *Aromia bungii* (Coleoptera: Cerambycidae): an invasive pest lethal to Rosaceae trees. *Applied Entomology and Zoology*, 52, 559–565.

Garonna AP (2012) *Aromia bungii*: un nuovo fitofago delle drupacee in Campania. – Seminario- workshop: Nuovi pericolosi insetti di recente introduzione in Campania, 27th November 2012. Available online: http://www.agricoltura.regione.campania.it/difesa/files/aromia_garonna.pdf (accessed: 02/02/2023).

Garonna AP, Nugnes F, Epinosa B, Griffo R & Benchi D (2013) *Aromia bungii*, nuovo tarlo asiatico ritrovato in Campania. *Informatore Agrario* 69, 60–62.

Gressitt JL (1942) *Destructive Long-Horned Beetle borers at Canton, China*. Special Publication 1. Lingnan Natural History Survey and Museum, Lingnan University, Canton, China: 1–60.

Hayashi M (1977) Study on Cerambycidae from West Malaysia. *Osaka Jonan Women's Junior College*, 12, 93–128.

Hua L, Nara H & Yu C (1993) *Longicorn-beetles of Hainan & Guangdong*. Muh-sheng Museum of Entomology (Taiwan), 320pp.

Hua L, Nara H, Samuelson GA, Lingafelter SW (2009) *Iconography of Chinese Longicorn Beetles (1406 species) in Color*. Sun Yat-sen University Press (Guangzhou), 474pp.

Lawrence JF, Hastings AM, Dallwitz MJ, Paine TA & Zurcher EJ (1999a) 'Beetles of the World: A Key and Information System for Families and Subfamilies.' CD-ROM, Version 1.0 for MS-Windows. (CSIRO Publishing: Melbourne.).

Lawrence JF, Hastings AM, Dallwitz MJ, Paine TA & Zurcher EJ (1999b) 'Beetle Larvae of the World: Descriptions, Illustrations, Identification, and Information Retrieval for Families and Sub-families.' CD-ROM, Version 1.1 for MS-Windows. (CSIRO Publishing: Melbourne.)

Liu Q, Wang Y. & Zhou J (1999) Biology of RNL's boring trunk and expelling frasss. *Journal of China agricultural University* 4, 87–91. (abstract)

Löbl I & Smetana A (2010) *Catalogue of palaearctic coleoptera*. Vol. 6. Chrysomeloidea. Apollo Books. 924pp.

Lompe A (2012) Die Käfer Europas. Gattung *Aromia*. Available online at https://coleonet.de/coleo/texte/aromia.htm. (accessed: 13/03/2023).

Ostojá-Starzewski JC (2016) Red-necked longhorn beetle *Aromia bungii* (revised May 2017 by C. Malumphy (Fera), D. Eyre and

H. Anderson (Defra)). Available online at: https://planthealthportal.defra.gov.uk/plant-health-api/api/pests/26575/notices/6690/documents/4196/document (accessed: 29/07/2022).
Otero JC & Cobo F (2018) Primer cita de *Aromia bungii* (Faldermann, 1835) (Coleoptera, Cerambycidae) una nueva especie alóctona en el NW de la Península Ibérica. *Boletín de la Asociación española de Entomología* 42, 437–441.
Özdikmen H (2014) A synopsis of Turkish Callichromatini (Coleoptera: Cerambycidae: Cerambycinae). *Munis Entomology and Zoology* 9, 554–563.
Plavilstshikov NN (1934). *Bestimmungs-Tabellen der europaïschen Coleopteren. 112. Heft. Cerambycidae. III. Teil. Cerambycinae: Cerambycini III.(Callichromina, Rosaliina, Callidiina)*. Troppau, Edmund Reitter Verlag, 230 pp.
Reid S & Cannon R (2010) *Psacothea hilaris* (Coleoptera: Cerambycidae) and other exotic longhorn beetles. *Fera News on Line*, 5.
Rizzo D, Taddei A, Da Lio D, Nugnes F, Barra E, Stefani L, Bartolini L, Griffo RV, Spigno P, Cozzolino L, Rossi E & Garonna AP (2020) Identification of the red-necked longhorn beetle *Aromia bungii* (Faldermann, 1835) (Coleoptera: Cerambycidae) with real-time PCR on frass. *Sustainability*, 12, 6041.
Rizzo D, Luchi N, Da Lio D, Bartolini L, Nugnes F, Cappellini G, Bruscoli T, Salemi C, Griffo RV, Garonna AP & Rossi E (2021) Development of a loop-mediated isothermal amplification (LAMP) assay for the identification of the invasive wood borer *Aromia bungii* (Coleoptera: Cerambycidae) from frass. *3 Biotech* 11, 85.
Russo E, Nugnes F, Vicinanza F, Garonna AP & Bernardo U (2020) Biological and molecular characterization of *Aromia bungii* (Faldermann, 1835)(Coleoptera: Cerambycidae), an emerging pest of stone fruits in Europe. *Scientific Reports* 10, 7112.
Schmeelk TC, Millar JG & Hanks LM (2016) Influence of trap height and bait type on abundance and species diversity of cerambycid beetles captured in forests of east-central Illinois. *Journal of Economic Entomology* 109(4), 1750-1757.
Stehr FW (1987) *Immature insects (No. 595.7039 I-33i)*. Dubuque, US: Kendall/Hunt Publishing.
Švácha P & Danilevsky ML (1987) Cerambycoid larvae of Europe and Soviet Union (Coleoptera, Cerambycoidea). Part II. *Acta Universitatis Carolinae – Biologica* 31, 121–284.
Tamura S & Shoda-Kagaya E (2022) Genetic Differences among Established Populations of *Aromia bungii* (Faldermann, 1835) (Coleoptera: Cerambycidae) in Japan: Suggestion of Multiple Introductions. *Insects*, 13(2), 217.
Tavakilian G & Chevillotte H (2018) Titan: base de données internationales sur les Cerambycidae ou Longicornes. Version 4.0, 15/10/2018 ed.: IRD/MNHN/GBif. Available online at: http://titan.gbif.fr/. Accessed: 29/07/2022.
Villiers A (1978) *Faune des Coléoptères de France*. I Cerambycidae. Editions Lechevalier, Paris.
Xu T, Yasui H, Teale SA, Fujiwara-Tsujii N, Wickham JD, Fukaya M, Hansen L, Kiriyama S, Hao D, Nakano A, Zhang L, Watanabe T, Toloro M & Millar JG (2017) Identification of a male-produced sexaggregation pheromone for a highly invasive cerambycid beetle, *Aromia bungii*, *Scientific Reports*, 7, 7330.
Yasui H, Fujiwara-Tsujii N, Yasuda T, Fukaya M, Kiriyama S, Nakano A, Watanabe T & Mori K (2019) Electroantennographic responses and field attraction of an emerging invader, the red-necked longicorn beetle *Aromia bungii* (Coleoptera: Cerambycidae), to the chiral and racemic forms of its male-produced aggregation-sex pheromone. *Applied Entomology and Zoology*, 54, 109–114.
Yiu V (2009) *Longhorn Beetles of Hong Kong. Insect Fauna of Hong Kong, Fascicle 1*. Hong Kong Entomological Society, Hong Kong, 149 pp.
Zou Y, Hansen L, Xu T, Teale SA, Hao D & Millar JG (2019) Optimizing pheromone-based lures for the invasive red-necked longhorn beetle, *Aromia bungii*. *Journal of Pest Science* 92, 1217–1225.

How to cite this article: EPPO (2024) PM 7/156 (1) *Aromia bungii*. *EPPO Bulletin*, 54, 124–136. Available from: https://doi.org/10.1111/epp.13008

APPENDIX 1 - KEYS TO ADULTS AND TO LATE INSTARS LARVAE BASED ON MORPHOLOGY

KEY TO THE ADULTS OF THE GENUS *AROMIA*

Adapted from Plavilstshikov (1934) and Lompe (2012).

1	Elytra with two distinct, at least in the basal half, fine longitudinal carinae (Figure 4a). Elytral disc sculptured, rugose (Figure 4a)	2
1′	Elytra without two fine longitudinal carinae (Figure 4b). Elytral disc almost smooth (Figure 4b)	5
2	Part of the pronotum more or less extensively red (Figure 4h–j)	3
2′	Pronotum and elytra about the same colour (Figure 4f). Colour very variable, shiny metallic, green, copper, blue, violet to black	4
3	Scutellum distinctly darker than elytra (Figure 4e). Russian Far East, Mongolia, Japan, China and Korean peninsula	*Aromia orientalis*
3′	Scutellum about the same colour as elytra (Figure 4d). Southern Europe	*Aromia moschata* subsp. *ambrosiaca*
4	Frons densely punctured. Europe, Siberia, Central Asia, Caucasus, Turkey, Iran, Middle East, North Africa	*Aromia moschata* (other subspecies)
4′	Frons with scarce fine punctures. Malaysia	*Aromia malayana*
5	Elytra black, pronotum red except for anterior and posterior margins (Figure 4k)	*Aromia bungii*
5′	Elytra, as well as pronotum, black (Figure 4g). Asia	*Aromia bungii* var. *cyanicornis*

KEY FOR THE IDENTIFICATION OF *AROMIA BUNGII* LATE INSTAR LARVAE

Adapted from Villiers (1978), Duffy (1953), Duffy (1968), Švácha and Danilevsky (1987), Cherepanov (1988a, 1988b).

1	Clypeus more or less trapezoidal, filling entire space between dorsal mandibular articulations (Figure 9b). Mandibles not rounded, with distinct apex and more or less distinct dorsal angle (Figure 10b)	Other subfamilies
1′	Clypeus very narrow, with only slender basal arms reaching to mandibular articulations (Figure 9a). Mandibular apex and dorsal angle more or less lacking; mandibles short, apically rounded, spoon-like (Figure 10a)	Cerambycinae 2
2	More than one pair of stemmata present (Figure 8b)	Other genera
2′	One pair of main stemmata present or stemmata indistinct (Figure 8a)	3
3	Ampullae of abdominal segments 3–5 deeply bilobed and strongly protuberant. Mandibles never pale in their basal part	Other genera
3′	Ampullae of abdominal segments not strongly protuberant (Figure 5b). In case mandibles are pale in their basal part (Figure 6b), ampullae can appear somewhat protuberant (Figure 5d)	4
4	Legs absent or legs vestigial in form of unsegmented papillae	Other genera
4′	Legs present and distinctly segmented (Figure 5g)	5
5	Hypostoma with front margin distinctly tuberculate or coarsely striate	Other genera
5′	Hypostoma with front margin smooth (Figure 5f)	6
6	Legs minute, never as long as maxillary palpi, but, if nearly so, then tibiotarsus transverse	Other genera
6′	Legs moderately long (Figure 5g), about as long as maxillary palpi, with tibiotarsus quadrate to elongate (Figure 5h)	7
7	Head with medial frontal line distinct along whole length (Figure 7a) If mandibles fully black, pronotal shield as in Figure 5e	*Aromia* sp. 8
7′	Head with median frontal line indistinct or hardly visible (Figure 7b) and/or pronotal shield different. Mandibles never pale in their basal part	Other genera
8	On *Salix*, *Populus*, *Alnus*, *Acer*	*Aromia moschata*
8′	On *Prunus*	*Aromia bungii* Optional: for the distinction of the form a and b, see the note below

Note: Form a: Mandibles fully black without a longitudinal impression on outer face (Figure 6a). Form b: Mandibles pale in their basal part with a deep longitudinal impression on outer face (Figure 6b).