

A review of the European species of *Monochamus* Dejean, 1821 (Coleoptera, Cerambycidae) – with a description of the genitalia characters

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The male and female genitalia characters of the European species of *Monochamus* Dejean, 1821, are described and compared in detail for the first time. The sclerites inside the median phallomer (internal sac) of *M. sutor* (Linnaeus, 1758) and *M. galloprovincialis* (Olivier, 1795) differ from those of all other examined species, and appear to be the best characters to separate *M. sutor* from *M. galloprovincialis*. There are no differences between the male or female genitalia characters of *M. sartor* (Fabricius, 1787) and *M. urussovi* (Fischer von Waldheim, 1805). Thus, *M. urussovi* is regarded as a subspecies of *M. sartor*: *M. sartor urussovi* **nov. stat.** The present results also support that the previously considered subspecies *M. galloprovincialis pistior* (Germar, 1818) is a true junior synonym of *M. galloprovincialis galloprovincialis*. No sclerites occur inside the internal sac of *M. saltuarius* (Gebler, 1830). The internal sac of *M. sartor sartor* (Fabricius, 1787), *M. sartor urussovi* and *M. impluviatus impluviatus* (Motschulsky, 1859) are distinctly different from the other European species of *Monochamus*: there is an elongated tube (terminal segment) inside the internal sac containing two very small and weakly sclerotized plates in *M. sartor sartor* and *M. sartor urussovi* and a larger sclerite in *M. impluviatus impluviatus*. A key to the European species and subspecies of *Monochamus*, incorporating male genitalia characters, is provided.

Key words: Taxonomy, Cerambycidae, Lamiinae, *Monochamus*, genitalia characters, Palearctic Region, Europe.

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Introduction

The main objective of this paper is to provide a detailed morphological description of all genitalia characters in males and females of all European species of *Monochamus* Dejean, 1821, and to find reliable characters for identification. Apart from the very brief descriptions by Pershing & Linit

(1985) and Tomminen & Leppänen (1991), there are no detailed genitalia descriptions available for the genus *Monochamus* describing e.g. the small species-specific sclerites found inside the internal sac in males. Koutroumpa *et al.* (in press) used specimens of *M. sutor* (Linnaeus, 1758) and *M. galloprovincialis* (Olivier, 1795) from central Europe, in a comprehensive genetic and

ecological study incorporating differences in the shape of the sclerites inside the internal sac as an aid to effectively separate males of these two species.

The genitalia characters have been shown to be species-specific in many Cerambycidae species (e.g. Lin *et al.* 2009, Wallin *et al.* 2012, Yamasako & Ohbayashi 2011). All male and female genitalia characters of the six European species of *Monochamus* are herein described and compared in detail for the first time. On the basis of genitalia characters and external morphological characters, we discuss the taxonomy of the European species. Special attention is paid to the question whether or not *M. sartor* (Fabricius, 1787) and *M. urussovi* (Fischer von Waldheim, 1805) are different species. This issue is discussed on the basis of the examination of specimens from the entire geographical range of the two species.

M. galloprovincialis pistor (Germar, 1818) has been considered as a subspecies by many authors (e.g. Sama 1988, 2002, Sláma 1998, Heliövaara *et al.* 2004, Ehnström & Holmer 2007). Morphologically *M. galloprovincialis galloprovincialis* (Olivier, 1795) and *M. galloprovincialis pistor* differ only in the colour of the legs and antennae, and the colour of the pubescence of elytra. *M. galloprovincialis pistor* has black legs and antennae, and elytral pubescence is yellowish to brownish. *M. galloprovincialis galloprovincialis* has reddish legs and antennae, and elytral pubescence is whitish. However, many other authors do not consider it a valid subspecies (e.g. Freude *et al.* 1966, Bílý & Mehl 1989, Cherepanov 1990, Bense 1995, Vives 2000, Böhme 2005. Cesari *et al.* (2005) did not find evidence in their DNA studies that *M. galloprovincialis pistor* should be maintained as a subspecies. Consequently, Sama (2008) referred to Cesari *et al.* (2005) and considered *M. galloprovincialis pistor* as a junior synonym of the nominate species *M. galloprovincialis galloprovincialis*. This consideration was later adopted by both Löbl & Smetana (2010) and Berger (2012). Specimens of both *M. galloprovincialis pistor* from Scandinavia and *M. galloprovincialis galloprovincialis* from SW Europe have been included in our study to see whether or not the genitalia characters differ.

The separation of *M. galloprovincialis* and *M. sutor* in Fennoscandia is difficult when based on the commonly used external characters alone. The characters used are primarily the extent of pubescence on scutellum and lateral part of prothorax, and the colour of the elytral integument. These external characters are highly variable and sometimes even overlapping, especially in regards to old and worn specimens. Thus, proper identification requires very well preserved specimens. Hellrigl (1971) and Lindhe *et al.* (2010) state that *M. galloprovincialis* and *M. sutor* are often misidentified.

A key, incorporating male genitalia characters of the European species and subspecies of *Monochamus* is provided.

Background review of the genus *Monochamus*

Six *Monochamus* species occur in Europe (Breuning 1963, Bense 1995, Sama 2002, Löbl & Smetana 2010, Berger 2012). All species belong to the subgenus *Monochamus* (Löbl & Smetana 2010). *M. galloprovincialis*, *M. saltuarius* (Gebler, 1830) and *M. urussovi* are all widespread in Europe and Asia. *M. sutor sutor* is widely distributed in Europe and also known from Kazakhstan and Russia: West Siberia, while *M. sutor longulus* Pic, 1898, is exclusively found in Asia, distributed from Kazakhstan and Russia: West Siberia and eastwards (Löbl & Smetana 2010). *M. impluviatus impluviatus* Motschulsky, 1859 is recorded from Russia (Central European Territory and North European Territory) and Asia. *M. sartor* is an exclusively European species (Löbl & Smetana 2010). The most widespread and common species in Fennoscandia is *M. sutor* (Bílý & Mehl 1989, Bakke & Kvamme 1992, Ehnström & Axelsson 2002, Heliövaara *et al.* 2004, Ehnström & Holmer 2007, Lindhe *et al.* 2010).

The bionomy of the European species of *Monochamus* have been well studied due to their importance as forest pests. They breed in weakened or recently dead conifer trees and the larvae tunnel deep into the wood. The result is a loss in timber quality (i.e. Hellrigl 1971, 1974, Cherepanov 1990, Ehnström & Axelsson 2002,

Berger 2012).

The genus *Monochamus* has increased in importance as vector for the invasive Pine Wood Nematode (PWN) *Bursaphelenchus xylophilus* (Steiner & Buhrer, 1934), which causes the pine wilt disease in susceptible pine species (e.g. Mamyia 1984, Zhao *et al.* 2010, Ciesla 2011, Vicente *et al.* 2012). PWN is native to North America, but has been accidentally introduced to several Asian countries, and also to Portugal. The pine wilt disease causes high mortality in pine forests in Asia and Europe and thus great economic losses (Vicente *et al.* 2012). Only *Monochamus* spp. has been found to act as vectors of PWN. Amongst the European species, *M. galloprovincialis* has so far been proven to act as vector for PWN, but the other European species may function as vectors if PWN spreads to areas where they occur. *M. alternatus* Hope, 1842 is the main vector in Asia (Zhang *et al.* 2007).

Overview of host trees

The possible misidentification of *M. sutor* versus *M. galloprovincialis* (cf. Hellrigl 1971, Lindhe *et al.* 2010) may be the reason why wrong information on host trees can be found in literature. In Norway Scots pine (*Pinus sylvestris*) is the only verified host tree for *M. galloprovincialis*. We also suspect that beetles may have been found on tree species in which they do not develop. The host tree preferences differ in various parts of the range, as seen in e.g. *M. urussovi*. In Siberia, this species has a host tree preference for *Abies* whereas in Northern Europe it attacks *Picea abies* (Hellrigl 1974, Cherepanov 1990, Bense 1995, Ehnström & Holmer 2007).

Monochamus sutor sutor (Linnaeus, 1758). Develops in *Pinus*, *Picea* and *Abies* (Hellrigl 1971, 1974, Cherepanov 1990, Bense 1995, Böhme 2005, Ehnström & Holmer 2007) and also in deciduous trees (Hellrigl 1971, Cherepanov 1990). Ciesla (2011) recorded *Picea* and *Pinus* as principal hosts.

Monochamus galloprovincialis (Olivier, 1795). Develops predominantly in *Pinus* spp. (Hellrigl 1971, 1974, Cherepanov 1990, Bense

1995, Böhme 2005, Ehnström & Holmer 2007), but also in *Abies*, *Larix* (Hellrigl 1971, 1974) and *Picea* (Ciesla, 2011).

Monochamus urussovi (Fisher von Waldheim, 1805). Develops only in *Picea* in Europe (Bense 1995, Ehnström & Holmer 2007), but in Siberia predominantly in *Abies sibirica* (cf. Hellrigl 1974). In Siberia, *M. urussovi* has also been reported to develop in *Larix*, *Pinus*, *Cedrus* and many different deciduous trees (Hellrigl 1971, Cherepanov 1990, Ciesla 2011).

Monochamus sartor (Fabricius, 1787). Develops predominantly in *Picea* (Hellrigl 1971, 1974, Sama 2002, Böhme 2005), but is also recorded to develop in *Abies* and *Pinus* (Hellrigl 1971, 1974, Bense 1995, Sama 2002, Ciesla 2011).

Monochamus saltuarius (Gebler, 1830). The main host tree is *Picea* (Hellrigl 1974, Bense 1995, Sama 2002, Böhme 2005) but occasionally found in *Pinus* (Bense 1990, Sama 2002). The species is also reported to develop in *Abies*, *Cedrus* and *Larix* (Cherepanov, 1990; Hellrigl, 1971), though this is not firmly documented according to Hellrigl (1971). Ciesla (2011) names *Abies*, *Larix*, *Picea* and *Pinus* as principal hosts.

Monochamus impluviatus impluviatus (Motschulsky, 1859). Develops predominantly in *Larix* (Cherepanov 1990). Ciesla (2011) also includes *Pinus sibirica* as host tree.

Material and methods

The nomenclature follows Löbl & Smetana (2010) and Berger (2012). Measurements included are total body length and width of the examined specimens. In order to evaluate the variation within species, we have also included specimens from Asia.

Genitalia characters. In the present study, we have included the sclerotized parts of the male terminalia: the aedeagus, endophallus with the sclerites inside the median phallomer and the internal sac, tegmen with parameres and median lobe, and tergite VIII. The studies of the female terminalia included tignum, tergite VIII and the spermathecal capsule (see Figures 30–36

for details). The internal sac of the males were embedded in 100% glycerol and photographed using a regular light microscope. This method is described in detail by Wallin *et al.* (2009). We maintain the use of the internal sac (part of the median phallomer), since it has been frequently used in the past. Other parts of the male genitalia and the female genitalia were dry mounted. The terminology used is based on Lin *et al.* (2009) and Yamasako & Ohbayashi (2011).

Abbreviations. CHW = Collection of Henrik Wallin, Uppsala, Sweden; CTK = Collection of Torstein Kvamme, Ås, Norway; CUN = Collection of Ulf Nylander, Gävle, Sweden; CÅL = Collection of Åke Lindelöw, Uppsala, Sweden; GNM = Göteborg Natural History Museum, Gothenburg, Sweden; NHRS = The Swedish Museum of Natural History, Stockholm, Sweden; SLU = Swedish University of Agricultural Sciences, Dept. of Ecology, Uppsala, Sweden; UUZM = Museum of Evolution – Zoology, Uppsala University: formerly Uppsala University, Zoological Museum, Uppsala, Sweden.

Examined material.

Monochamus sutor sutor (Linnaeus, 1758).
Sweden: 1 female, 23.0mm, Ångermanland, Junsele, 1994.VII.10, leg. M. Holmer, CHW; 1 female, 19.5mm, Ångermanland, Junsele, 1994.VII.10, leg. M. Holmer, CHW; 1 female, 21.5mm, Uppland, Knutby, Kamsgård, 1985.V, leg. H. Wallin, CHW; 1 female, 20.5mm, Uppland, Knutby, Kamsgård, 1985.VI.29, leg. H. Wallin, CHW; 1 male, 22.0mm; 1 male, 22.0mm, Norrbotten, Kvikkjokk, 1985.VIII, leg. H. Wallin, CHW; 1 male, 23.0mm, Ångermanland, Junsele, 1994.VII.10, leg. M. Holmer, CHW; 1 male, 22.0mm, Uppland, Knutby, Kamsgård, 1999.VI.13, leg. H. Wallin, CHW; 1 female, 19.8mm, Uppland, Knutby, Kamsgård, 1992.VI.08, leg. H. Wallin, CHW; 1 male, 16.0mm, Uppland, Östfora, Siggeforasjön, 2006.VII.26, leg. H. Wallin, CHW; 1 male, 22.5mm, Uppland, Knutby, Kamsgård, 1986.VII.19, leg. H. Wallin, CHW; 1 male, 18.0mm, Uppland, Knutby, Kamsgård, 1986.VII.19, leg. H. Wallin, CHW; 1 male, 17.0mm, Uppland, Uppsala, 1974.V (reared from larvae found in a trunk of *Picea*), leg. H. Wallin, CHW; 1 male, 18.0mm, Ångermanland, Junsele, 1994.

VII.10, leg. M. Holmer, CHW; 1 female, 22.0mm, Norrbotten, Blåkölen, 1991.VII.04–VIII.03 (collected in a window trap), leg. H. Wallin, CHW; 1 female, 22.5mm, Uppland, Knutby, Kamsgård, 1991.VII.01, leg. H. Wallin, CHW; 1 male, 22.2mm, Uppland, Knutby, Kamsgård, 2009.V.22, leg. H. Wallin, CHW; 1 male, 20.5mm, Jämtland, Östersund, 1991.VII, local collector, CHW; 1 female, 19.0mm, Dalarna, Ludvika 1945.VII.31, leg. E. Wieslander, NHRS, No. NHRS-COLE 6332; 1 male, 19.5mm, Södermanland, Huddinge, leg. M. Carlsson, 1940.VIII.04, NHRS, No. NHRS-COLE 6396; 1 male, 23.0mm, Ångermanland, 1957.X.22, leg. N. Lundqvist, UUZM; 1 male, 16.0mm, Uppland, Ärentuna, 1971.VIII, leg. N. Lundqvist, UUZM; 1 female, 18.0mm, Uppland, Ärentuna, 1970.VII.20, leg. N. Lundqvist, UUZM; **Norway:** 1 male, 22.9mm, VE Sandefjord (EIS 19), 1957, leg. A. Vik, CTK; 1 male, 17.9mm, BØ Drammen, Bragenesåsen (EIS 28), 1985.VI.16, leg. Devegg Ruud, CTK.

Monochamus sutor longulus (Pic, 1898).

Russia: 1 male, 22.5mm, Primorsky Kray, Sikothealin, Mielniechne, 2001.VI.21–VII.02, leg. T. Kvamme, CTK.

Monochamus galloprovincialis (Olivier, 1795) (formerly *Monochamus galloprovincialis pistor* (Germer, 1818)). **Sweden:** 1 male, 19.3mm, Södermanland, Nacka, Erstavik, 1973.VI.26, leg. L. Hole, CHW; 1 female, 19.0mm, Gotska Sandön, 1996.VIII.10, leg. M. Holmer, CHW; 1 male, 23.0mm, Gotska Sandön, 1996.VIII.10, leg. M. Holmer, CHW; 1 male, 23.0mm, Gotska Sandön, 1996.VIII.10, leg. M. Holmer, CHW; 1 male, 23.0mm, Gotska Sandön, 1996.VIII.10, leg. M. Holmer, CHW; 1 male, 23.0mm, Gotska Sandön, 1996.VIII.10, leg. M. Holmer, CHW; 1 male, 22.0mm, Uppland, Gräsö, 1999.VII.10, leg. M. Holmer, CHW; 1 male, 20.0mm, Västergötland, Fristad, 1972.VII, leg. H. Wallin, CHW; 1 female, 22.0mm, Uppland, Stockholm, 1999.IV.03, leg. H. Wallin (reared from a larva), CHW; 1 male, 11.5mm, Småland, Nybro, Fröskelås, 2003.VIII.23, leg. N. Franc, CTK; 1 female, 22.0mm, Gotska Sandön, approx. 1970, leg. N. Höglund, NHRS, No. NHRS-COLE 6374; 1 male, 23.0mm, Gotska Sandön, approx. 1970, leg. N. Höglund, NHRS, No. NHRS-COLE 6369; 1 female, 19.5mm, Tyresö, Brevik, approx. 1960, leg. M. Richter, NHRS, No. NHRS-COLE

6348; 1 female, 21.5mm, Småland, Vindö, 1945. VIII.05, leg. A. Olsson, NHRS No. NHRS-COLE 6358; 1 female, 23.0mm, Gotska Sandön, approx. 1970, NHRS, No. NHRS-COLE 6368; **Norway**: 1 male, 19.5mm, Ø Hvaler, Kirkøy (EIS 12), 1994. VIII.31 (reared 1995.VII.20 from *Pinus*), leg. S. O. Hansen, CTK; 1 female, 22.5mm, Ø Hvaler, Kirkøy (EIS 12), 1994.VIII.31 (reared 1995. VII.20 from *Pinus*), leg. S. O. Hansen, CTK.

Monochamus galloprovincialis (Olivier, 1795) (formerly *Monochamus galloprovincialis galloprovincialis* (Olivier, 1795)). **France**: 1 female, 22.0mm, St André, 1989.VIII.12, local collector, CHW; 1 male, 19.6mm, Le Vans, Adèche, 2004.VII.15, local collector, CHW; 1 male, 18.0mm, Le Vans, Adèche, 2004.VII.15, local collector, CHW; 1 male, 20.6mm, St André, 1989.VII.28, local collector, CHW; 1 male, 22.0 mm, St André, 1989.VII.28, local collector, CHW; 1 male, 23.0mm, Le Vans, Adèche, 2004.VII.15, local collector, CHW; 1 female, 21.5mm, Le Vans, Adèche, 2004.VII.15, local collector, CHW; 1 female, 21.0mm, Le Vans, Adèche, 2004.VII.15, local collector, CHW; 1 female, 16.0mm, Le Vans, Adèche, 2004.VII.15, local collector, CHW; **Croatia**: 1 female, 22.5mm, Kork, 2006.VIII, leg. B. Hracivic, CÅL; **Greece**: 1 male, 18.5mm, Trikala, Katara Pass 1690m, 2001.VII.03, leg. H. Wallin, CHW; 1 male, 21.5mm, Trikala, Katara Pass 1690m, 2001.VII.03, leg. H. Wallin, CHW; 1 female, 18.0mm, St André, local collector 1989. VIII.12, CHW; **Turkey**: 1 female (formerly *M. galloprovincialis tauricola* Pic, 1912), 18.0 mm, Akseki, 2011.VII.02, leg. H. Wallin, CHW; 1 male (formerly *M. galloprovincialis tauricola* Pic, 1912), 20.0mm, NE Korkuteli, 1994.VI.13, leg. U. Nylander, CUN; **Russia**: 1 male, 24.5mm, NW Russia, St Petersburg region, Kingisepp district, Ivanovskoe, 2004.VIII.23, local collector, CHW; 1 male, 21.0mm, Russia, SE Siberia, N. Chita region, Kotar, Mt. Rug, Leprindo lake 1600m, 2002.VII.05, local collector, CHW; **Austria**: 1 male, 17.8mm, Karawanken, Mitterwinkel, Carinthia, 1960.VIII, leg. C. v. Demelt, CHW; 1 male, 17.2mm, Karawanken, S. Ferlach 500m, 1980.VIII, leg. H. Wallin, CHW.

Monochamus sartor sartor (Fabricius, 1787). **Croatia**: 1 male, 25.5mm, Kork, 2006.VIII, leg.

B. Hracivic, CÅL; 1 male, 26.5mm, Kork, 2006. VIII, leg. B. Hracivic, CÅL; 1 female, 22.0 mm, Hiiumaa (Dagö), Jöesun, 1995.VII.24, leg. H. Öunap, CÅL; 1 female, 21.5mm, Hiiumaa (Dagö), Jöesun, 1995.VII.24, leg. H. Öunap, CÅL; **Austria**: 1 male, 23.5mm, Südtirol, Mauls, 1968.VII.0110, leg. K.G. Hellrigl, SLU; 1 male, 26.0mm, Südtirol, Mauls, 1971.VIII.01–15, leg. K. G. Hellrigl, SLU; 1 female, 28.0mm, Südtirol, Mauls, 1971.VIII.01–15, leg. K. G. Hellrigl, SLU; 1 female, 26.5mm, Südtirol, Mauls, 1971. VIII.01–15, leg. K. G. Hellrigl, SLU; 1 male, 31.0mm, Karawanken, S. Ferlach 500m, 1980. VIII.10, leg. H. Wallin, CHW; 1 male, 34.0mm, Karawanken, S. Ferlach 500m, 1980.VIII.10, leg. H. Wallin, CHW; 1 female, 28.2mm, Karawanken, S. Ferlach 500m, 1980.VIII.10, leg. H. Wallin, CHW; **Romania**: 1 female, 24.0mm, Mts. Gurghui, 2009.VIII.08, CHW; 1 male, 27.0 mm, Mts. Gurghui, 2009.VIII.08, local collector, CHW; **France**: 1 female, 28.4mm, Chapelle de Bois, Doubs, 2009.VII.21, local collector, CHW; 1 female, 28.4 mm, Karawanken, S. Ferlach 500m, 1980.VIII, leg. H. Wallin, CHW; **Sweden**: 1 male, 25.5mm, Östergötland, Norrköping, 1996.IV.10 (collected from imported wooden pallets inside a warehouse), leg. H. Wallin, CHW; **Poland**: 1 male, 26.5mm, LZD Krynica odds, 1976.VIII.10, leg. M. Lusscsak, CTK; 1 male, 27.0mm, LZD w. Krynicy lésn, Kopciowa, 1985. IX.05, leg. J. R. Starzyk, CTK; 1 male, 30.0mm, Gorce, GPN, dol. Potoku, Kamienicy 800m, 1985. VIII.15, leg. J. R. Starzyk, CTK; **Estonia**: 1 male, 30.0mm, Dagö (Hiiumaa), Lehtma, 2004.VI.29, leg. Å. Lindelöw, CÅL; 1 male, 27.0mm, Dagö (Hiiumaa), Lehtma, 2004.VI.29, leg. Å. Lindelöw, CÅL; **Lithuania**: 1 male, 30.0mm, Hola Tulra, >100 year old specimen, ex. coll. A. H. Westman, GNM; 1 female, 28.0mm, Hola Tulra, >100 year old specimen, ex. coll. A. H. Westman, GNM; **Germany**: 1 male, 24.0mm, Isohl, Baden-Baden, >100 year old specimen, ex. coll. A. H. Westman, GNM.

Monochamus sartor urussovi (Fisher von Waldheim, 1805) **nov. stat.** (formerly *M. urussovi* (Fisher von Waldheim, 1805)). **Sweden**: 1 male, 26.1mm, Uppland, Bennebol, 1902.VII, leg. G. A. Ringselle, SLU; 1 female, 29.0mm, >200 year

old specimen, labelled "Mus. Payk.", ex. coll. G. Paykull, SLU; 1 female, 25.0mm, labelled "Ups., Lilj." (Uppsala, probably W. Liljeborg), >100 years old specimen, UUZM; 1 female, 26.5 mm, labelled "Sth." (Stockholm), >100 years old specimen, UUZM; 1 male, 26.0mm, >100 years old specimen, ex. coll. Strängnäs läroverk, Bondeska collection, UUZM; 1 female, 30.0mm, >100 years old specimen, ex. coll. Strängnäs läroverk, Bondeska collection, UUZM; 1 female, 23.5mm, >100 years old specimen, ex. coll. Strängnäs läroverk, Bondeska collection, UUZM; 1 male, 24.0mm, >100 years old specimen (labelled "Wadström"), UUZM; 1 male, 26.0mm, >100 years old specimen (labelled "Haeffner collection"), UUZM; 1 male, 25.0mm, >100 years old specimen, ex. coll. Strängnäs läroverk, Bondeska collection, UUZM; 1 female, 24.0mm, >100 years old specimen, ex. coll. Strängnäs läroverk, Bondeska collection, UUZM; 1 male, 33.5mm, >100 years old specimen, ex. coll. Strängnäs läroverk, Bondeska collection, UUZM; 1 male, 27.5mm, >100 years old specimen, ex. coll. Strängnäs läroverk, Bondeska collection, UUZM; 1 male (elytral punctuation and pubescence corresponding to *M. sartor*), 22.5mm, Norrbotten, Lappland, Gällivare, Pålkem, 1943, leg. B. Rapp, CUN; 1 female, 26.5mm, Norrbotten, Lappland, Gällivare, Pålkem, 1944.VII.20, leg. E. Wirén, CUN; 1 male (elytral punctuation and pubescence corresponding to *M. sartor*), 32.0mm, Småland, >100 year old specimen, CUN; 1 male (elytral punctuation and pubescence corresponding to *M. sartor*), 28.0mm, Norrbotten, Lappland, Gällivare, Pålkem, 1943, leg. B. Rapp, CUN; 1 female, 22.0 mm, Överkalix, 1956.VIII, leg. S. Lundberg, CUN; 1 male, 22.0mm, Norrbotten, Gällivare, Vitberget (Lansån), 1955.VIII, leg. S. Lundberg, CUN; 1 male (elytral punctuation and pubescence corresponding to *M. sartor*), 24.0mm, Norrbotten, Kalix, Mjöträsk, 1956.VII.18, leg. S. Lundberg, CUN; 1 female, 30.0mm, Uppland, Gimo, 2012. VIII.06/18 (collected in a window trap), leg. M. Schroeder, SLU; 1 female, 30.0mm, Östergötland, Omberg, ex. coll. Mortonson, >100 year old specimen, GNM; 1 male, 27.0mm, Västergötland, Göteborg, ex. coll. Ekeberg, >100 year old specimen, GNM; 1 male, 26.0mm, Östergötland,

Omberg, ex. coll. Mortonson, >100 year old specimen, GNM; 1 male, 25.0mm, Hälsingland, ex. coll. H. C. Kindberg, >100 year old specimen, GNM; 1 male, 25.0mm, Hälsingland, Delsbo, ex. coll. Rudolphi, >100 year old specimen, GNM; 1 female, 25.0mm, Hälsingland, Delsbo, ex. coll. Rudolphi, >100 year old specimen, GNM; 1 male, 26.0mm, Hälsingland, Delsbo, ex. coll. Rudolphi, >100 year old specimen, GNM; **Finland**: 1 female, 24.0mm, Kivennapa, 1935.VIII.29, leg. E. Kangas, SLU; 1 male, 30.0mm, Valtimo, approx. 1960, leg. M. Pohjola, CUN; **Estonia**: 1 male, 32.0mm, Järvakundi, 1972.VII.15, leg. H. Öunap, CÄL; 1 female, 27.5mm, Kil. Nömme linna ääsu kunnatul, 1989.VI.16, leg. E. Öunap, CÄL; **Ukraine**: 1 male, 31.0mm, Zakarp, Ludyčerná Hora, 1997.VII.24, leg. M. Dvörák, CUN; 1 female, 29.0mm, Zakarp, Ludyčerná Hora, 1997.VII.24, leg. M. Dvörák, CUN; **Russia**: 1 male, 22.0mm, Krasnojarsk (Sweden, Västerbotten, Boliden, Kufors, 1994.V.27: reared from larva collected from imported timber of *Picea*), leg. H. Wallin, CHW; 1 male, 28.2mm, Krasnojarsk (Sweden, Västerbotten, Boliden, Kufors, 1994.V.27: reared from larva collected from imported timber of *Picea*), leg. H. Wallin, CHW; 1 female, 24.0 mm, Krasnojarsk (Sweden, Västerbotten, Boliden, Kufors, 1994.V.27: reared from larva collected from imported timber of *Picea*), leg. H. Wallin, CHW; 1 female 29.0mm, locality data in Russia missing (Sweden, Ångermanland, Örnsköldsvik, 2001.I.15: reared from imported timber from Russia), leg. H. Wallin, CHW; 1 female, 23.0mm, locality data in Russia missing (Sweden, Gästrikland, Gävle 1994.VIII: collected in a electric fly killer at saw mill handling imported timber from Russia), leg. H. Wallin, CHW; 1 male, 30.5mm, Primorsky Kray, Sikothealin, Mielniechne, 2001.VI.21–VII.02, leg. T. Kvamme, CTK; 1 male, 26.0mm, Primorsky Kray, Sikothealin, Mielniechne, 2001. VI.21–VII.02, leg. T. Kvamme, CTK; 1 male, 29.5mm, Amur, approx. 1970, ex. coll. Haglund, NHRS No. 6371, E94; 1 female, 28.0 mm, Amur, approx. 1970, ex. coll. Haglund, NHRS; 1 male, 26.0mm, Leningrad env., Wayjalowo, 1943. VII.20, leg. C. v. Demelt, CUN; 1 female, 30.0mm, Leningrad env., Wayjalowo, 1943.VII.20, leg. C.

v. Demelt, CUN; 1 male, 29.0mm, W. Saian Mts, Cheriomnshki, 1994.VII.09, leg. M. Danilevsky, CUN; 1 female, 31.0mm, W. Saian Mts, Cheriomnshki, 1994.VII.09, leg. M. Danilevsky, CUN; **Japan**: 1 male, 28.5mm, Jozankei, Sapporo Prefecture, 1991, leg. T. Kvamme, CTK; 1 male, 27.5mm, Jozankei, Sapporo Prefecture, 1991, leg. T. Kvamme, CTK; 1 male, 27.5mm, Jozankei, Sapporo Prefecture, 1991, leg. T. Kvamme, CTK; 1 male, 28.5mm, Jozankei, Sapporo Prefecture, 1991, leg. T. Kvamme, CTK; 1 female, 25.0mm, Bokukaido, 1972.VII, ex. coll. K. A. Persson, NHRS; 1 male, 24.0mm, Jozankei, Sapporo, Hokaido, 1984.VII.31, local collector, CUN; 1 male, 25.0mm, Bokukaido, 1972.VII, ex. coll. K. A. Persson, NHRS; 1 female, 27.0mm, 1991, Jozankei, Sapporo Prefecture, Hokkaido, 1991, leg. T. Kvamme, CTK; 1 female, 26.0mm, 1991, Jozankei, Sapporo Prefecture, Hokkaido, 1991, leg. T. Kvamme, CTK; 1 female, 30.0mm, 1991, Jozankei, Sapporo Prefecture, Hokkaido, 1991, leg. T. Kvamme, CTK; 1 female, 29.0mm, 1991, Jozankei, Sapporo Prefecture, Hokkaido, 1991, leg. T. Kvamme, CTK.

Monochamus saltuarius (Gebler, 1830).

Czech Republic: 1 male, 11.9mm, Hlunoká n. Vlt. Poněšice, 2001.IV (reared from larva), leg. V. Némec, CHW; 1 female, 16.4mm, Bohemia, Trěbon, 1975.VII.09, leg. M. Špryál, CHW; **Russia**: 1 male, 15.5mm, Primorsky Kray, Sikothealin, Mielniechae, 2001.VI.21–VII.02, leg. T. Kvamme, CTK; 1 male, 18.4mm, Primorsky Kray, Sikothealin, Mielniechne, 2001.VI.21–VII.02, leg. T. Kvamme, CTK; 1 male, 16.8mm, Primorsky Kray, Sikothealin, Mielniechne, 2001.VI.21–VII.02, leg. T. Kvamme, CTK; 1 male, 15.0mm, Primorsky Kray, Sikothealin, Mielniechne, 2001.VI.21–VII.02, leg. T. Kvamme, CTK.

Monochamus impluviatus impluviatus (Motschulsky, 1859). **Russia**: 1 male, 15.5mm, Amur obl., Tynda, 1988.VII.14, leg. J. Sobota, CUN; 1 female, 16.0mm Amur obl., Tynda, 1988.VII.14, leg. J. Sobota, CUN; 1 male, 13.1mm, Jakutia, Kujdusun, 1988.VI.30, leg. J. Sobota, CUN; 1 male, 13.5mm, Amur obl., Tynda, 1988.VII.14, leg. J. Sobota, CUN; 1 female, 15.0mm, Jakutia, Prjisk Nerskiy, 1988.VI.27, leg. J. Sobota.

Taxonomy

The genus *Monochamus* Dejean, 1821: 106

Type species: *Monochamus sutor* (Linnaeus, 1758), designated by Curtis (1828).

The European species of *Monochamus* spp. vary in size from medium-sized to relatively large (11–35mm). The smallest European species are *M. saltuarius* and *M. impluviatus*, and the largest European species are represented by *M. urussovi* and *M. sartor*. The majority of species are moderately-sized with body tapering to sub-parallel, elytra are elongated approx. 3 to 3.5 x longer than wide. Pronotum medially has more or less distinct, transversal ridges. The base of pronotum is coarsely rugose and has rounded tubercles in some species. The lateral spines of pronotum are acute and have whitish to yellowish pubescence at base in many species. The antennae are long, 2 to 2.5 x longer than body in males and about 1.3 x longer than body in females. Antennae cylindrical with scape robust and apical process with a distinct lateral margin. The males are characterized by having prolonged front legs. Procoxal process about as wide as mesocoxal process, and mesocoxal process not raised. Common key characters used to separate the European species have, so far, predominantly included e.g. the absence or existence of a distinct transverse impression on basal third of elytra, variation in the cover of pubescence on scutellum (i.e. a glabrous, longitudinal median line either absent or covering part of or the entire scutellum), the absence or existence of conspicuous pubescence of apical part of elytra, and the shape and distribution of punctuation on elytra (especially the basal part).

Monochamus sutor sutor (Linnaeus, 1758)

Cerambyx sutor Linnaeus, 1758: 392
 =*Cerambyx atomarius* DeGeer, 1775: 65
 =*Monochamus fuscomaculatus* Petri, 1912: 249
 =*Lamia heinrothi* Cederhjelm, 1798: 88
 =*Monochamus hybridus* Petri, 1912: 249
 =*Monochamus obscurior* Abeille de Perrin, 1869: 42
 =*Lamia pellio* Germar, 1818: 244
 =*Lamia rosenmuelleri* Cederhjelm, 1798: 89

Figures 1, 12, 24, 26, 33A, 35, 36, 45, 51, 52, 63, 64, 79.

A medium-sized species (Figures 1, 12). Basal half of elytra have rough granulation and distinct punctuation, especially towards humeri. Scutellum often with a glabrous, transversal median line reaching from base to apex (visible in well preserved specimens). Elytra covered with a few to numerous yellowish spots, irregularly distributed on the elytra (Figures 1, 12). Elytra in the subspecies *M. sutor longulus* is slightly more elongated and surface glabrous (shining). Lateral part of pronotum with numerous fine hairs (Figure 24), both below and above the lateral spine (visible in well preserved specimens). Antennae long, longer than body with five to six antennomeres in males, and with three to four antennomeres in females. Type locality: "Europe" (country not specified).

Examined males: length 16.0–23.0mm, width 5.5–7.0mm; females: length 19.8–23.0mm, width 4.5–7.0mm.

Male terminalia. *Aedeagus*: 2.3–2.9mm long, relatively stout, and evenly curved towards apex, dorsal ridge as wide as ventral ridge and both ridges rounded at apex (Figures 51, 52). Colour dark brown to black. *Endophallus*: approx. 7.0mm long, and narrowed from median to apical phallomer (Figure 33A). The two brownish and crescent-shaped sclerites at the proximal end of the basal phallomer relatively narrow, and completely folded (Figure 45). *Internal sac* (apical part of median phallomer): the major part consists of a weakly sclerotized structure (approx. 0.5mm long) inside the internal sac (Figures 33A, 35, 36), forming a small "beak-like" structure acutely narrowing anteriorly. Internal sac has surrounding intersegmental membrane with distinct and coarse micro-reticulation. *Tegmen*: 2.9–3.0mm long, base of tegmen extended and curved dorso-ventrally on middle. *Parameres*: elongated, slender and flattened dorso-ventrally, well separated medially along inner margin and often connecting towards apex (Figures 63, 64). Base of inner margin has a distinct extension from each paramere projecting forward forming a "tooth" (Figure 63). Apex evenly rounded along posterior margin with scattered fringes of relatively short, brownish hairs well concentrated at edge of apex. Ventral surface of parameres with

scattered punctures and fine hairs concentrated at apex. No micro-reticulation on parameres. *Tergite VIII*: 1.5–1.8mm long, with brownish pigmentation, posterior margin elongated and narrowly rounded, and covered with short, fine brownish hairs distally towards the posterior margin (Figure 79). Surface has very weak micro-reticulation medially.

There is no difference in the male genitalia characters between the examined specimen of *M. sutor longulus* and *M. sutor sutor*.

Female terminalia. *Tignum*: long, straight shaft which is almost as long as abdomen (Figure 26), mostly straight but sometimes slightly twisted apically, 8.1–9.5mm long, width approx. 0.2mm at the widest point apically. *Tergite VIII*: width of posterior margin approx. 2.0mm, with sparse and relatively long fringes of dark brown hairs laterally (Figure 26), surface dorso-laterally with numerous small granulae, and covered with relatively dense and very fine yellowish pubescence and a few brownish setae, and dorso-medially with more or less weak micro-reticulation and a weak longitudinal impression. The colour is brown. *Spermathecal capsule*: weakly sclerotized, whitish to yellowish, relatively long, widened at base, and weakly curved about 90° towards apex (Figure 26). Apex with an elongated head, 1.2mm long.

***Monochamus galloprovincialis* (Olivier, 1795)**

- Ceranbyx galloprovincialis* Olivier, 1795: 125
- =*Monochamus cinerascens* Motschulsky, 1860: 150
- =*Monochamus heinrothi* Solsky, 1871: 389
- =*Monochamus lignator* Krynicki, 1832: 158
- =*Monohammus nitidior* Abeille de Perrin, 1870: 87
- =*Monohammus parendeli* Théry, 1891: xxiii
- =*Lamia pistor* Germar, 1818: 242
- =*Monochamus sibiricus* Pic, 1908: 5
- =*Monochamus subrifopubens* Pic, 1912: 18
- =*Monochamus tauricola* Pic, 1912: 18
- =*Monochamus unifasciatus* Pic, 1915: 12

Figures 2, 3, 13, 14, 25, 27, 28, 33B, 35, 37, 46, 53, 54, 65, 66, 80.

A medium-sized species (Figures 2, 3, 13, 14). Basal half of elytra has smooth granulation and fine punctuation, especially towards humeri. Scutellum often with a short glabrous, transversal median line only reaching the middle of scutellum

(visible in well preserved specimens). Elytra have a few to numerous yellowish spots often forming a transversal, yellowish or whitish band on the middle of elytra (Figures 2, 3, 13, 14). Lateral part of pronotum with just a few setae (Figure 25) below the lateral spine (visible in well preserved specimens). Antennae longer than body, with five to six antennomeres in males, and with three to four antennomeres in females. Type locality: France (“Gallia”).

Examined males: length 11.5–24.5mm, width 5.0–7.0mm; females: length 16.0–22.0mm, width 5.0–7.0mm.

Male terminalia. *Aedeagus*: 2.3–2.9mm long, relatively stout, evenly curved towards apex, but with base curved backwards, dorsal ridge as wide as ventral ridge, dorsal and ventral ridges rounded at apex (Figures 53, 54). Colour brown. *Endophallus*: approx. 6.5mm long and evenly wide from median to apical phallomer (Figure 33B). The two brownish crescent-shaped sclerites at the proximal end of the basal phallomer are relatively broad, long, and completely folded (Figure 46). *Internal sac* (apical part of median phallomer): the single sclerite embedded inside a fine membrane in the internal sac (Figure 37) consists of a straight shaft (approx. 1.0mm long) anteriorly forming a small “hook” (Figure 35). Internal sac and surrounding intersegmental membrane have weak micro-reticulation. *Tegmen*: 2.9–3.0mm long, base of tegmen extended and curved dorso-ventrally on middle. *Parameres*: elongated, slender and flattened dorso-ventrally, well separated medially along inner margin and towards apex (Figures 65, 66). Base of inner margin has no trace of an extension or “tooth”. Apex evenly rounded along posterior margin with scattered fringes of relatively short, brownish hairs well concentrated at edge of apex. Ventral surface of parameres have dense punctures and fine hairs on the entire surface. Parameres have no micro-reticulation. *Tergite VIII*: 1.5–1.8mm long, with brownish pigmentation, posterior margin elongated and narrowly rounded, and covered with short, fine light brown and white hairs distally towards the posterior margin (Figure 80). Surface has relatively weak micro-reticulation medially.

Female terminalia. *Tignum*: mostly twisted

on the middle (Figures 27, 28), 10.5–11.8mm long, width: approx. 0.3mm at the widest point apically. *Tergite VIII*: posterior margin (width: approx. 2.0mm) with dense and relatively long fringes of dark brown hairs laterally (Figures 27, 28), surface dorso-laterally with numerous small granulae, and covered with relatively dense and very fine yellowish pubescence and a few brownish setae, and dorso-medially mostly with more or less weak micro-reticulation (with a more or less shining area medially), and a weak longitudinal impression. The colour is brown. *Spermathecal capsule*: Weakly sclerotized, whitish to yellowish, relatively long, widened at base, and curved almost 180° towards apex (Figures 27, 28). Apex with an elongated head, 1.4mm long.

Remarks. No difference in the male or female genitalia characters was found between specimens of the former subspecies *M. galloprovincialis pistar* and *M. galloprovincialis galloprovincialis*. The former subspecies *M. galloprovincialis pistar* is the form that occurs in the Scandinavian countries. (Ehnström & Axelsson 2002, Heliövaara *et al.* 2004, Ehnström & Holmer 2007).

Monochamus sartor sartor (Fabricius, 1787)

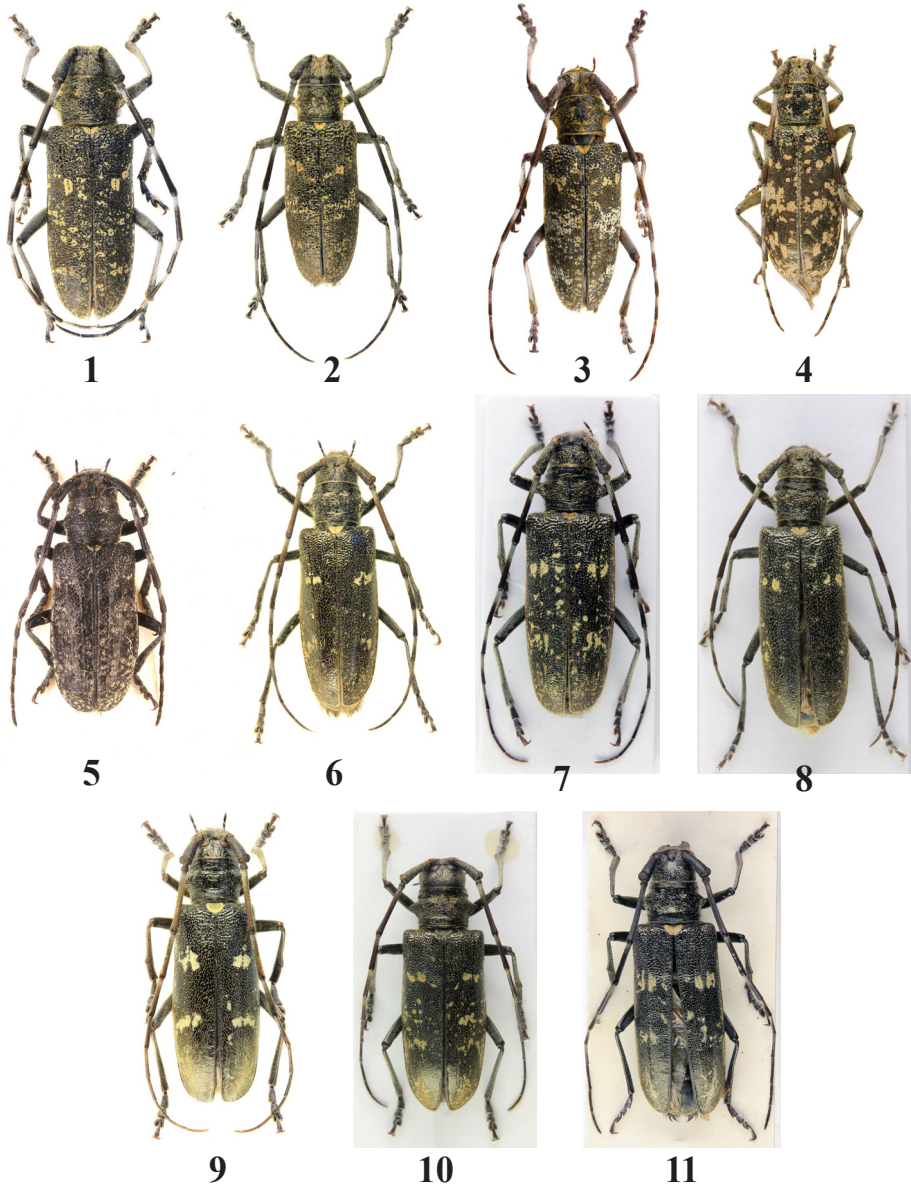
Lamia sartor Fabricius, 1787: 137

=*Monohammus mulsanti* Seidlitz, 1891: 749

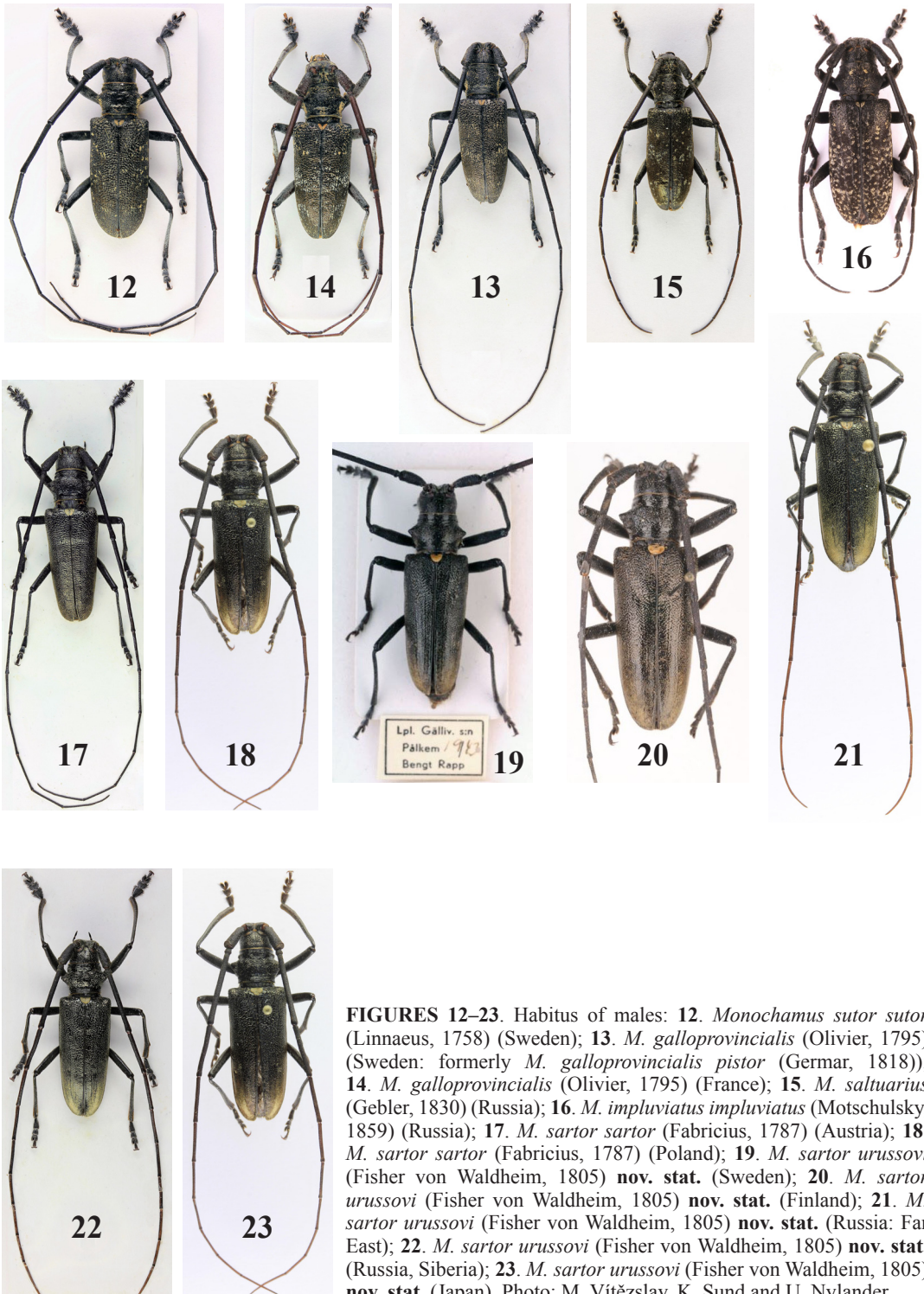
=*Monochamus okenianus* Gistel, 1857: 49

Figures 6, 7, 8, 17, 18, 29, 33C, 34, 39, 40, 43, 48, 55, 56, 67, 68, 69, 70, 81, 82.

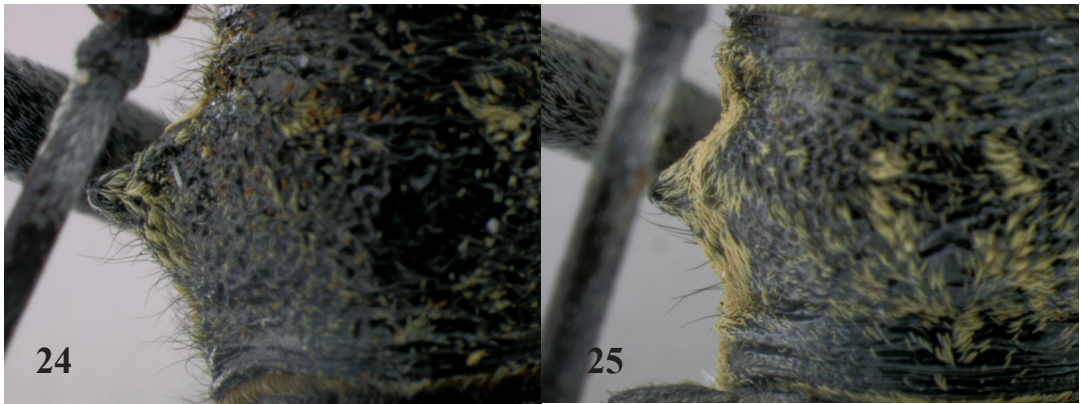
A large and robust species (Figures 6, 7, 8, 17, 18). A distinct elevated area on the middle of basal third of elytra is followed by an impression immediately below the elevation. Basal half of elytra have dense granulation formed by smooth and raised granulae, especially towards humeri. Elytra have fine, sparse punctuation, often surrounded by short, slightly raised longitudinal and transversal carinae forming a fine square-formed pattern towards apices. Apical third has mostly weak, brownish pubescence (sometimes coarser near apices). Exposed integument on elytra shining, sometimes with a slight metallic lustre. Elytra in males sometimes with scattered yellowish spots or maculae (Figure 18). Elytra in females with four conspicuous to distinct whitish to yellowish spots: two above and two



FIGURES 1–11. Habitus of females: **1.** *Monochamus sutor sutor* (Linnaeus, 1758) (Sweden); **2.** *M. galloprovincialis* (Olivier, 1795) (Sweden: formerly *M. galloprovincialis pistor* (Germar, 1818)); **3.** *M. galloprovincialis* (Olivier, 1795) (France); **4.** *M. saltuarius* (Gebler, 1830) (Czech Republic); **5.** *M. impluviatus impluviatus* (Motschulsky, 1859) (Russia); **6.** *M. sartor sartor* (Fabricius, 1787) (Austria); **7.** *M. sartor sartor* (Fabricius, 1787) (France); **8.** *M. sartor sartor* (Romania); **9.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia, Siberia); **10.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia); **11.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Sweden, 40 km NE Uppsala, collected in August 2012). Photo: M. Vítězslav.



FIGURES 12–23. Habitus of males: **12.** *Monochamus sutor sutor* (Linnaeus, 1758) (Sweden); **13.** *M. galloprovincialis* (Olivier, 1795) (Sweden: formerly *M. galloprovincialis pistora* (Germar, 1818)); **14.** *M. galloprovincialis* (Olivier, 1795) (France); **15.** *M. saltuarius* (Gebler, 1830) (Russia); **16.** *M. impluviatus impluviatus* (Motschulsky, 1859) (Russia); **17.** *M. sartor sartor* (Fabricius, 1787) (Austria); **18.** *M. sartor sartor* (Fabricius, 1787) (Poland); **19.** *M. sartor urusovi* (Fisher von Waldheim, 1805) **nov. stat.** (Sweden); **20.** *M. sartor urusovi* (Fisher von Waldheim, 1805) **nov. stat.** (Finland); **21.** *M. sartor urusovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia: Far East); **22.** *M. sartor urusovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia, Siberia); **23.** *M. sartor urusovi* (Fisher von Waldheim, 1805) **nov. stat.** (Japan). Photo: M. Vitězslav, K. Sund and U. Nylander.



FIGURES 24–25. Left lateral spine on pronotum with surrounding pubescence: **24.** *M. sutor sutor* (Linnaeus, 1758); **25.** *M. galloprovincialis* (Olivier, 1795). Photo: M. Vitězslav.

below the middle, and sometimes with small scattered yellowish spots on the elytra (Figures 6, 7, 8). Pronotum in males mostly black (Figures 17), and rarely with very small yellowish spots (Figure 18). Pronotum in females often with two brownish spots above middle and with brownish pubescence laterally (Figure 6, 7, 8). Scutellum completely covered with very dense whitish to yellowish pubescence (Figure 6). Type locality: Germany (Dresden).

Examined males: length 25.5–34.0mm, width 7.0–10.0mm; female: length 24.0–28.4mm, width 7.0–9.0mm.

Male terminalia. *Aedeagus*: 3.8–4.1mm long, stout, weakly curved towards apex, dorsal ridge as wide as ventral ridge, dorsal and ventral ridges almost straight at apex (Figures 55, 56). Colour yellowish to brown. The aedeagus shows very little variability between specimens from different populations. *Endophallus*: approx. 9.0mm long and evenly broad from median to apical phallomer (Figure 33C). The two brownish crescent-shaped sclerites at the proximal end of the basal phallomer broad (broader than in any other European species of *Monochamus*), and only partly folded (Figure 48). The colour is dark brown in mature specimens. Lower part of median phallomer with an elongated micro-reticulated patch on the phallomer membrane (Figures 33C, 43). *Internal sac* (apical part of median phallomer): there is a solid (but not sclerotized) tube, or terminal segment, embedded inside the internal sac (Figures 33C, 39). The

very small sclerotized structure is found inside the apical part of the terminal segment. The small sclerites (approx. 0.1mm long) are “U”-shaped, and show some variability between examined specimens (Figure 34). Surface of the internal sac (phallomer membrane) with very fine micro-reticulation (Figure 40). Colour yellowish to dark brown. *Tegmen*: 3.8–4.8mm long, base of tegmen extended and acutely curved dorso-ventrally on middle. *Parameres*: elongated, slender and flattened dorso-ventrally, well separated medially along inner margin and often connecting towards apex (Figure 67). Base of inner margin with a distinct extension from each paramere projecting forward forming a “tooth” (Figures 67, 69). Apex evenly rounded along posterior margin with fringes of relatively long, brownish hairs well concentrated at edge of apex (often extended to the apical part of ventral surface) (Figure 67). Ventral surface of parameres with scattered punctures and fine hairs (Figure 68). No micro-reticulation on parameres. The shape of the parameres show some variability between examined specimens (Figures 67, 69, 70). *Tergite VIII*: 1.8–2.1mm long, with brownish to black pigmentation, posterior margin slightly elongated and narrowly rounded, and covered with short, brownish hairs (mixed with scattered yellowish setae) distally towards the posterior margin (Figures 81, 82). Surface with very weak micro-reticulation medially. Some variation (similar to *M. saltuarius*) was noted regarding the shape of the posterior margin of

tergite VIII (Figures 81, 82).

Female terminalia. *Tignum*: relatively thick (width: approx. 0.5mm at the widest point apically) and almost straight or only slightly curved, 13.9–14.6mm long (Figure 29). *Tergite VIII*: posterior margin (width: 2.5mm) with relatively long fringes of dark brown hairs laterally (Figure 29), surface dorso-laterally with a few scattered and small granulae, covered with very fine yellowish pubescence and a few brownish setae, and dorso-medially with more or less weak micro-reticulation and a distinct longitudinal impression. The colour is brown. *Spermathecal capsule*: Well sclerotized, yellowish to brownish, relatively long, widened at base, and curved almost 180° towards apex (Figure 29). Apex with an elongated head, 1.5mm long.

Monochamus sartor urussovi (Fisher von Waldheim, 1805) **nov. stat.**

Cerambyx urussovi Fisher von Waldheim, 1805: 12
 =*Monohammus quadrimaculatus* Motschulsky, 1845: 86
 =*Monochamus schaufusi* Pic, 1912: 18

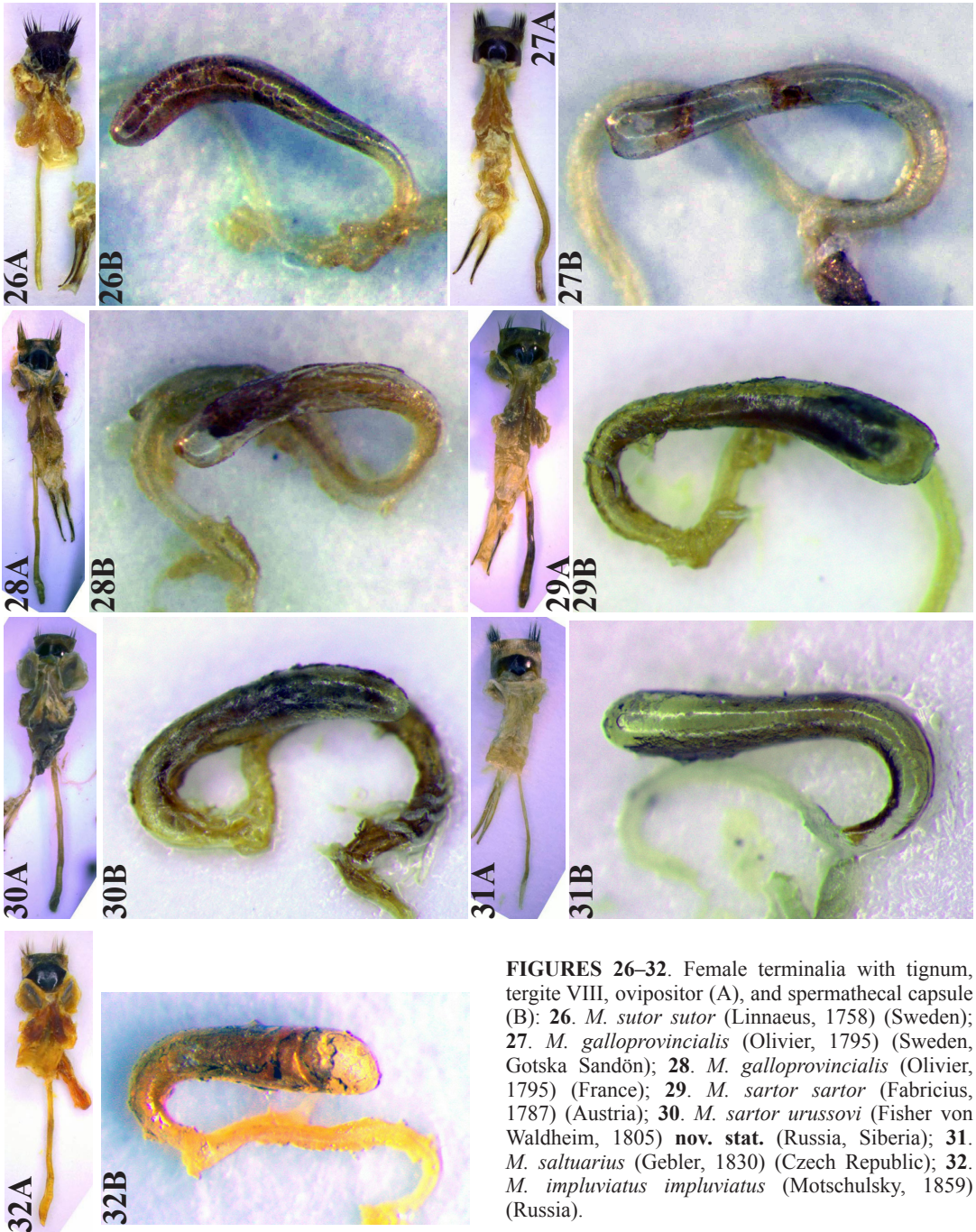
Figures 9, 10, 11, 19, 20, 21, 22, 23, 30, 33C, 34, 41, 42, 43, 49, 57, 58, 71, 72, 73, 74, 83, 84.

A large and robust subspecies, similar in size to *M. sartor sartor* (Figures 9, 10, 11, 19, 20, 21, 22, 23). A distinct elevated area on the middle of basal third of elytra followed by an impression immediately below the elevation. Basal half of elytra with smooth and raised granulation, especially towards humeri. Posterior part of elytra with weak to relatively dense punctuation (sometimes surrounded by short, slightly raised longitudinal and transversal carinae forming a fine square pattern) towards apices. The elytral punctuation in specimens from the far east of Russia and Japan is mostly very weak (anterior part of elytra shining). Exposed integument on elytra shining. Apical third of elytra with weak to dense brownish or yellowish pubescence (coarser near apices). Males from Scandinavia and the Baltic states have weaker, brownish pubescence on apical third of elytra (Figures 19, 20), whereas the corresponding pubescence on specimens from the Far East of Russia and Japan is distinctly yellowish (Figures 22, 23). Elytra in males rarely with small and scattered whitish spots towards

and on epipleuron. Elytra in females with four conspicuous distinct whitish to yellowish spots: two above and two below the middle, sometimes with small scattered yellowish spots on the elytra, at least on epipleuron (Figures 9, 10, 11). Pronotum in males black. Pronotum in females sometimes with two brownish spots above middle and with brownish pubescence laterally (Figure 10). Scutellum completely covered with very dense whitish to yellowish pubescence. Type locality: Russia (Moscow environment).

Examined males: length 22.0–30.5mm, width 7.0–9.0mm; female: length 24.0–30.0mm, width 6.5–9.5mm.

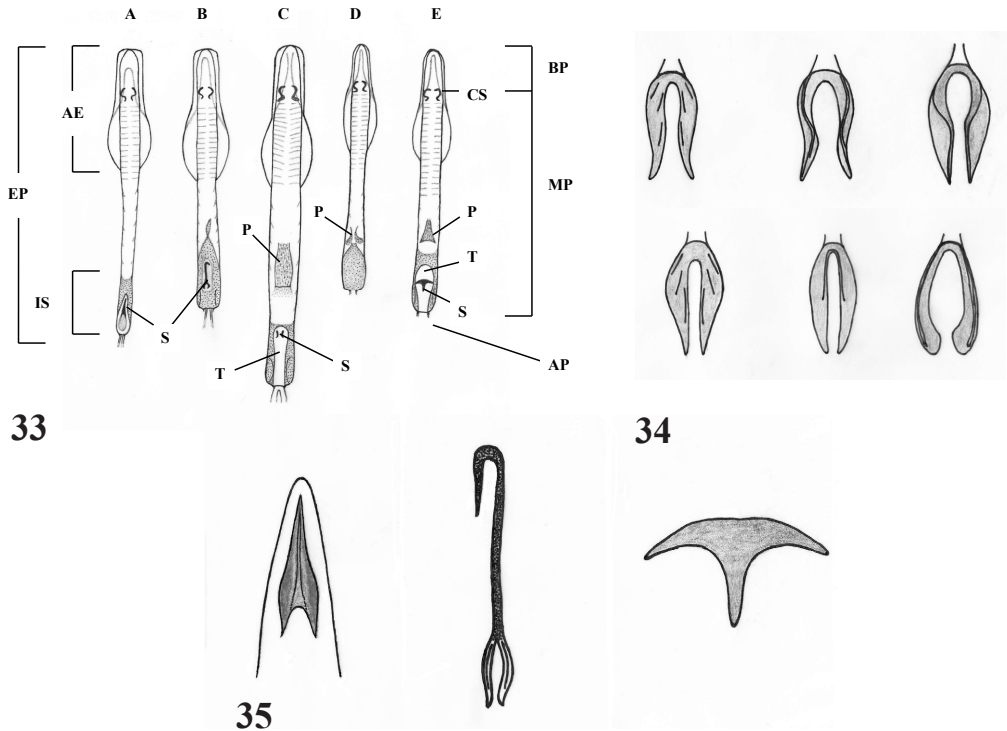
Male terminalia. Aedeagus: 3.5–4.1mm long, stout, weakly curved towards apex, dorsal ridge as wide as ventral ridge, dorsal and ventral ridges almost straight at apex (Figures 57, 58). Colour yellowish to brown. The aedeagus shows very little variability between specimens from different populations with no difference between specimens of *M. sartor sartor* and *M. sartor urussovi*. *Endophallus*: approx. 9.0mm long and evenly broad from median to apical phallomer (Figure 33C). There is no difference in the shape of endophallus between specimens of *M. sartor sartor* and *M. sartor urussovi*. The two brownish crescent-shaped sclerites at the proximal end of the basal phallomer are broad and only partly folded (Figure 49). The colour is yellowish in teneral (newly emerged) specimens (Figure 49). Lower part of median phallomer with an elongated micro-reticulated patch on the phallomer membrane (Figures 33C, 43). There is no difference in the characters of endophallus between specimens of *M. sartor sartor* and *M. sartor urussovi*. *Internal sac* (apical part of median phallomer): there is a solid (but not sclerotized) tube, or terminal segment, embedded inside the internal sac (Figures 33C, 41). The very small sclerotized structure is found inside the apical part of the terminal segment. The small sclerites (approx. 0.1mm long) are “U”-shaped, and show some variability between examined specimens, and the variation involves specimens of both *M. sartor sartor* and *M. sartor urussovi*. (Figure 34). Surface of the internal sac with very fine micro-reticulation (Figure 42), sometimes slightly finer



FIGURES 26–32. Female terminalia with tignum, tergite VIII, ovipositor (A), and spermathecal capsule (B): **26.** *M. sutor sutor* (Linnaeus, 1758) (Sweden); **27.** *M. galloprovincialis* (Olivier, 1795) (Sweden, Gotska Sandön); **28.** *M. galloprovincialis* (Olivier, 1795) (France); **29.** *M. sartor sartor* (Fabricius, 1787) (Austria); **30.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia, Siberia); **31.** *M. saltuarius* (Gebler, 1830) (Czech Republic); **32.** *M. impluviatus impluviatus* (Motschulsky, 1859) (Russia).

than in *M. sartor sartor*. Colour yellowish to dark brown. *Tegmen*: 3.9–4.9mm long, base of tegmen extended and acutely curved dorso-ventrally on middle. *Parameres*: elongated, slender and

flattened dorso-ventrally, well separated medially along inner margin and often connecting towards apex with some variation between examined specimens (Figure 71). Base of inner margin with



FIGURES 33–35. Male terminalia: **33.** Drawings of aedeagus with endophallus (ventral view) of *M. sutor sutor* (Linnaeus, 1758) (A); *M. galloprovincialis* (Olivier, 1795) (B); *M. sartor sartor* (Fabricius, 1787) and *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (C); *M. saltuarius* (Gebler, 1830) (D); and *M. impluviatus impluviatus* (Motschulsky, 1859) (E). AE= aedeagus, EP= endophallus, BP= basal phallomer, MP= median phallomer, AP= apical phallomer, IS= internal sac, CS= crescent shaped sclerites inside basal phallomer, P= patch with elongated microreticulation on the phallomer membrane, S= sclerite inside median phallomer (internal sac), T= a distinct, and more or less solid, tube (terminal segment) inside internal sac; **34.** Drawings of the small sclerites inside the solid tube of *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** from Russia (top row left), Sweden (top row middle), Japan (top row right), and *M. sartor sartor* (Fabricius, 1787) from Austria (bottom row left), Romania (bottom row middle), Poland (bottom row right); **35.** Drawings of sclerites inside internal sac (from left to right) of *M. sutor sutor* (Linnaeus, 1758), *M. galloprovincialis* (Olivier, 1795), and *M. impluviatus impluviatus* (Motschulsky, 1859).

a distinct extension from each paramere projecting forward forming a “tooth” (Figures 71, 73, 74). Apex evenly rounded along posterior margin with fringes of relatively long, brownish hairs well concentrated at edge of apex (often extended to the apical part of ventral surface) (Figure 71). Ventral surface of parameres with scattered punctures and fine hairs (Figure 72). No micro-reticulation on parameres. The shape of the parameres shows some variability between examined specimens (Figures 71, 73, 74). *Tergite VIII*: 1.8–2.1mm long, brownish to black pigmentation, posterior margin slightly elongated and narrowly rounded,

and covered with short, brownish hairs (mixed with scattered yellowish setae) distally towards the posterior margin (Figures 83, 84). Surface with very weak micro-reticulation medially. Some variation (similar to *M. sartor sartor*) was also noted in *M. sartor urussovi*. regarding the shape of the posterior margin of tergite VIII, with the exception of the posterior margin which is notched on the middle (Figure 83) in specimens from Siberia and Japan only.

Female terminalia. *Tignum*: relatively thick (width: approx. 0.5mm at the widest point apically), almost straight but sometimes slightly

twisted apically, 12.5–15.0mm long (Figure 30). It was noted that newly hatched (teneral) specimens had a slightly narrower tignum, and the entire tignum in fully mature specimens is covered with a layer of relatively soft (dark brown) tissue. *Tergite VIII*: posterior margin (width: 2.5mm) with relatively long fringes of dark brown hairs laterally (Figure 30), surface dorso-laterally with a few scattered and small granulae, and covered with very fine yellowish pubescence and a few brownish setae, dorso-medially with more or less weak micro-reticulation and a distinct longitudinal impression. The colour is brown. *Spermathecal capsule*: Well sclerotized, yellowish to brownish, relatively long, widened at base, and curved almost 180° towards apex (Figure 30). Apex with an elongated head, 1.5mm long, similar to *M. sartor sartor*.

Monochamus saltuarius (Gebler, 1830)

Monohammus saltuarius Gebler, 1830: 184

Figures 4, 15, 31, 33D, 38, 47, 59, 60, 75, 76, 85, 86.

A relatively small species (Figures 4, 15). Elytra with dense and smooth granulation concentrated at the basal part of elytra only. Elytral apex with dense pubescence. The apical third of elytra is shining due to no micro-reticulation. Pronotum and elytra covered with large yellowish and white spots often forming a transversal band medially on elytra (Figures 4, 15). Scutellum with a narrow and glabrous, transversal median line (visible in well preserved specimens). Pronotum has elongated, transversal ridges. The lateral spines on pronotum are short and blunt. Head (front view) elongated. Antennae long: longer than body with five to six antennomeres in males, and with three to four antennomeres females. Type locality: Russia, Siberia (Altai, Kolywan).

Examined males: length 11.9–18.4mm, width 4.0–5.5mm; female: length 16.4mm, width 5.5mm.

Male terminalia. *Aedeagus*: 2.0–2.1mm long, relatively slender, evenly curved towards apex, dorsal ridge as wide as ventral ridge, dorsal and ventral ridges rounded at apex (Figures 59, 60). Colour dark brown to black. *Endophallus*: approx. 5.0mm long and evenly broad from

median to apical phallomer (Figure 33D). The two yellow crescent-shaped sclerites at the proximal end of the basal phallomer very fine, twisted and completely folded (Figure 47). Lower part of median phallomer with two rounded micro-reticulated patches on the phallomer membrane (Figure 33D). *Internal sac* (apical part of median phallomer): No sclerites inside internal sac. The surrounding intersegmental membrane with very fine micro-reticulation (Figure 38). *Tegmen*: 2.1–2.5mm long, base of tegmen extended and weakly curved dorso-ventrally on middle. *Parameres*: elongated, slender and flattened dorso-ventrally, weakly separated medially along inner margin and connecting towards apex (Figures 75, 76). Base of inner margin with an extension from each paramere projecting forward forming a small “tooth” (Figure 75). Apex evenly rounded along posterior margin with scattered fringes of short, brownish hairs well concentrated at edge of apex (Figure 75). No micro-reticulation on parameres. Base of tegmen, at lower part of median lobe, extended and strongly curved dorso-ventrally on middle. *Tergite VIII*: 1.0–1.2mm long, with brownish pigmentation, posterior margin slightly elongated (Figure 85) or evenly rounded (Figure 86) and covered with short, very fine brownish hairs distally towards the posterior margin. Surface with very weak micro-reticulation medially.

Female terminalia. *Tignum*: almost straight, 7.2mm long (width: approx. 0.15mm at the widest point apically; Figure 31). *Tergite VIII*: posterior margin (width: approx. 1.5mm) with sparse and relatively long fringes of dark brown hairs laterally (Figure 31), surface dorso-laterally with numerous small granulae, covered with dense and fine yellowish pubescence (the individual hairs twice as long as in any other European species of *Monochamus*) and a few brownish setae, dorso-medially mostly with very weak micro-reticulation (with a more or less shining area medially), and a very weak longitudinal impression. The colour is white to yellowish and brown apically. *Spermathecal capsule*: Weakly sclerotized, whitish to yellowish, relatively long, widened at base, and curved almost 180° towards apex (Figure 31). Apex with an elongated head, 1.2mm long.

Monochamus impluviatus impluviatus

(Motschulsky, 1859).

Monochamus impluviatus Motschulsky, 1859: 571

Figures 5, 16, 32, 33E, 35, 44, 50, 61, 62, 77, 78, 87.

A small species with short and broad elytra (Figures 5, 16). Elytra with dense and smooth granulation concentrated at the basal part of elytra only. Apical third of elytra dull (distinct micro-reticulation). Elytra covered with numerous small, yellowish and whitish irregular spots (Figures 5, 16). Pronotum with short, transversal ridges forming an irregular square-formed pattern. The lateral spines on pronotum short and blunt. Head (front view) broad and square-formed. Scutellum with a narrow and glabrous, transversal median line (visible in well preserved specimens). Antennae short: longer than body with three to four antennomeres in males, and with about one antennomere in females. Type locality: Russia (Siberia).

Examined male: length 15.5mm, width 5.0mm; female: length 15.0mm, width 5.0mm.

Male terminalia. *Aedeagus*: 2.1mm long, relatively broad, weakly curved towards apex, dorsal ridge as wide as ventral ridge, dorsal and ventral ridges rounded at apex with dorsal ridge shorter than ventral ridge at apex (Figures 61, 62). *Endophallus*: approx. 6.0mm long and evenly broad from median to apical phallomer (Figure 33E). Median part of endophallus with a micro-reticulated patch on the phallomer membrane (Figure 33E). The two yellow crescent-shaped sclerites at the proximal end of the basal segment relatively fine (broader than those of *M. saltuarius*), slightly flattened, twisted and partly folded (Figure 50). *Internal sac* (apical part of median phallomer): there is a relatively solid (but not sclerotized) tube, or terminal segment, embedded inside the internal sac (Figures 33E, 44). The very small sclerotized structure is found inside the apical part of the terminal segment. Sclerite inside internal sac and terminal segment (Figure 35) “T”-shaped and approx. 0.3mm long. Internal sac with surrounding intersegmental membrane with very fine micro-reticulation. *Tegmen*: 2.4mm long, base of tegmen, at lower part of median lobe, extended and strongly curved

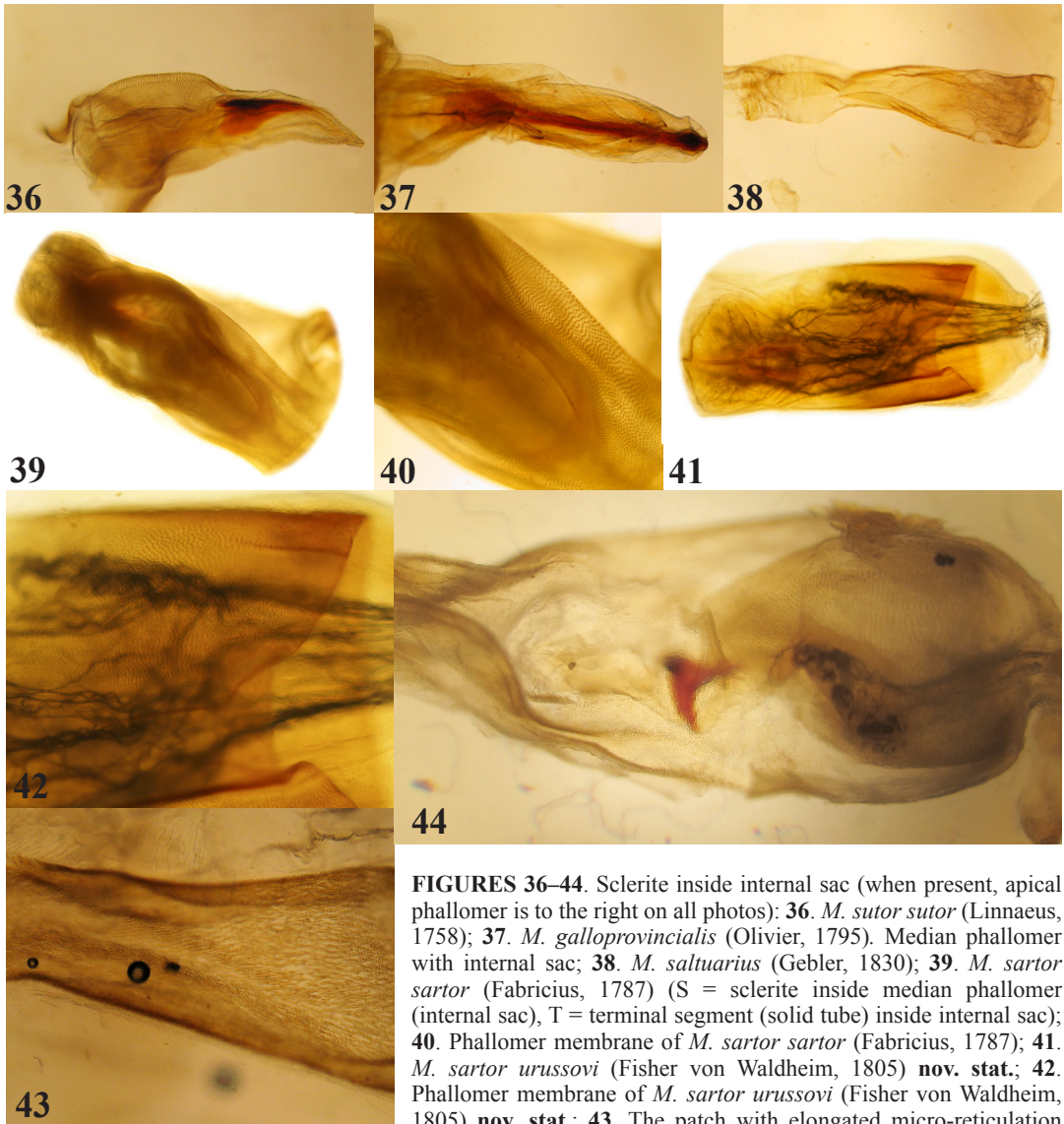
dorso-ventrally on middle. *Parameres*: relatively short and stout, flattened dorso-ventrally, weakly separated medially along inner margin and connecting towards apex (Figures 77, 78). Base of inner margin has an extension from each paramere projecting forward forming a “tooth” (Figure 77). Apex evenly rounded along posterior margin with scattered fringes of short, brownish hairs well concentrated at edge of apex (Figure 77). Parameres dorsally shining (i.e. no micro-reticulation). Distinct punctures and transversal ridges on ventral side of parameres (Figure 78). *Tergite VIII*: 1.2mm long, with brownish pigmentation, posterior margin slightly elongated and narrowly rounded, and covered with short, very fine brownish hairs distally towards the flattened posterior margin (Figure 87). Surface with weak micro-reticulation medially.

Female terminalia. *Tignum*: almost straight, 8.9mm long (width: approx. 0.3mm at the widest point apically: Figure 32). *Tergite VIII*: posterior margin (width: approx. 2.0mm) with sparse and relatively long fringes of dark brown hairs laterally (Figure 32), surface dorso-laterally with numerous small granulae, and sparsely covered with fine yellowish hairs and a few brownish setae, and dorso-medially mostly with weak micro-reticulation (with a more or less shining area medially), and a weak longitudinal impression. The colour is brown. *Spermathecal capsule*: Weakly sclerotized, yellowish, relatively long, widened at base, and curved almost 180° towards apex (Figure 32). Apex with an elongated head, 1.0mm long.

Remarks. Reaches the European part of Ural in the west (Sama 2002). This species has, so far, not been recorded from Western Europe, although it may eventually be imported with timber from Russia.

Discussion

Previous male genitalia descriptions of the genus *Monochamus* have only included the median lobe without detailed descriptions of the remaining parts of the genitalia (Pershing & Linit 1985, Tomminnen & Leppänen 1991). The

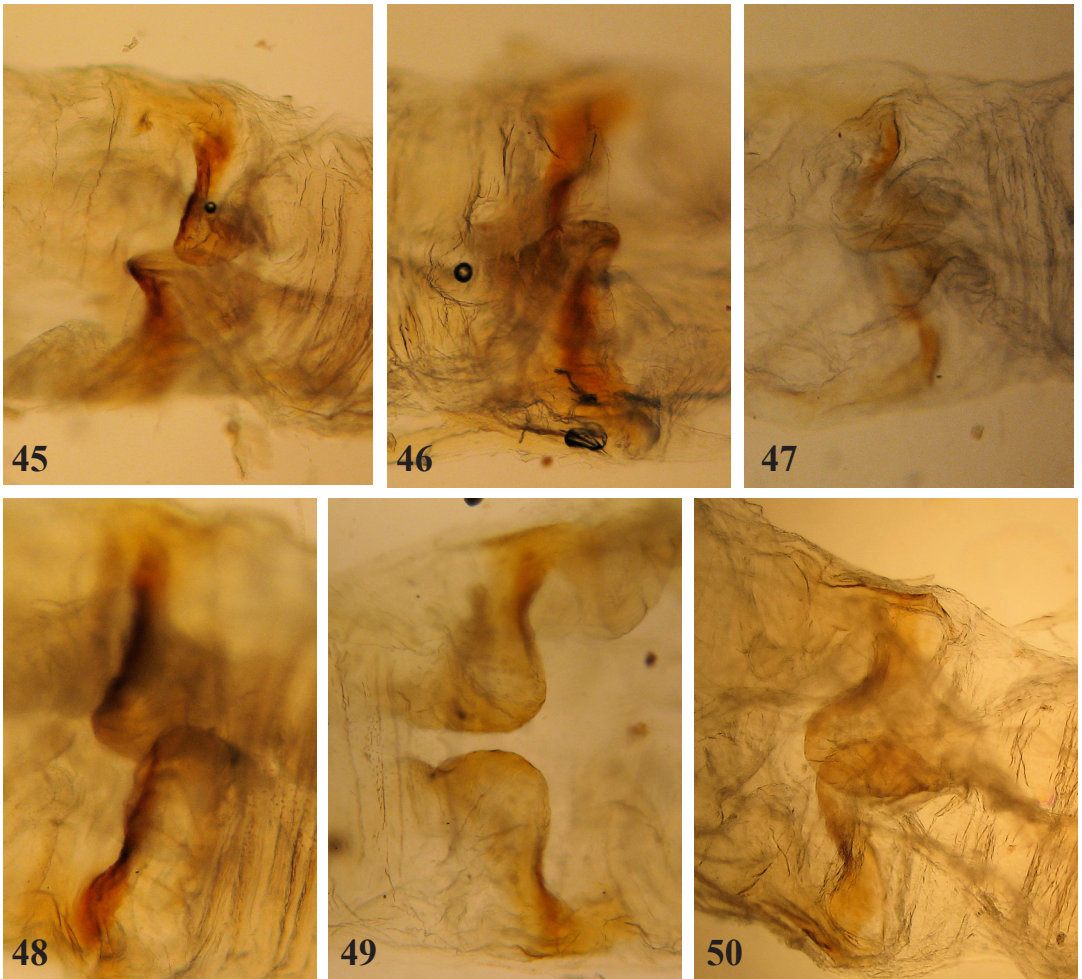


FIGURES 36–44. Sclerite inside internal sac (when present, apical phallomer is to the right on all photos): **36.** *M. sutor sutor* (Linnaeus, 1758); **37.** *M. galloprovincialis* (Olivier, 1795). Median phallomer with internal sac; **38.** *M. saltuarius* (Gebler, 1830); **39.** *M. sartor sartor* (Fabricius, 1787) (S = sclerite inside median phallomer (internal sac), T = terminal segment (solid tube) inside internal sac); **40.** Phallomer membrane of *M. sartor sartor* (Fabricius, 1787); **41.** *M. sartor urusovi* (Fisher von Waldheim, 1805) **nov. stat.**; **42.** Phallomer membrane of *M. sartor urusovi* (Fisher von Waldheim, 1805) **nov. stat.**; **43.** The patch with elongated micro-reticulation on the median phallomer membrane in *M. sartor sartor* (Fabricius, 1787) and *M. urusovi* (Fisher von Waldheim, 1805) **nov. stat.**; **44.** *M. impluviatus impluviatus* (Motschulsky, 1859).

sclerotized structures inside the internal sac, or the endophallus, have not been described before. Both male and female terminalia have, more recently, been thoroughly studied in many other Cerambycid genera, and have been shown to have reliable, species-specific characters (Sama 1985, Lingafelter & Hoebeke 2002, Danilevsky *et al.* 2004, Morati & Huet 2004, Lin *et al.* 2009,

Weigel & Skale 2009, Yamasako & Ohbayashi 2011, Wallin *et al.* 2012).

M. sutor and *M. galloprovincialis* males can easily be separated by the distinct differences in the shape of the sclerites inside the internal sac. In fact, this is the best character to separate the two species especially involving the determination of larger samples with specimens varying in size



FIGURES 45–50. The crescent-shaped sclerites at proximal end of basal phallosome: **45.** *M. sutor sutor* (Linnaeus, 1758); **46.** *M. galloprovincialis* (Olivier, 1795); **47.** *M. saltuarius* (Gebler, 1830); **48.** *M. sartor sartor* (Fabricius, 1787) (Austria); **49.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia, Siberia: a teneral specimen); **50.** *M. impluviatus impluviatus* (Motschulsky, 1859).

and age. Koutroupma *et al.* (in press) managed to successfully separate the two species primarily by using the sclerites inside the internal sac as key characters. In addition, *M. galloprovincialis* is the only studied European species that lacks an extension or “tooth” at the base of the inner margin of the parameres. The external characters such as the shape of the glabrous area on scutellum and the hairs laterally on pronotum require well preserved specimens. The fully developed pattern of yellowish spots on elytra also requires well preserved specimens. Consequently, specimens

of these two species may easily be misidentified (cf. Lindhe *et al.* 2010). A detailed examination of specimens of both *M. galloprovincialis* and *M. sutor* will probably change the knowledge of the geographical distributions of these species e.g. in Sweden. *M. galloprovincialis* has rarely been collected in Norway, but our examination at least confirms the occurrence of this species in Norway.

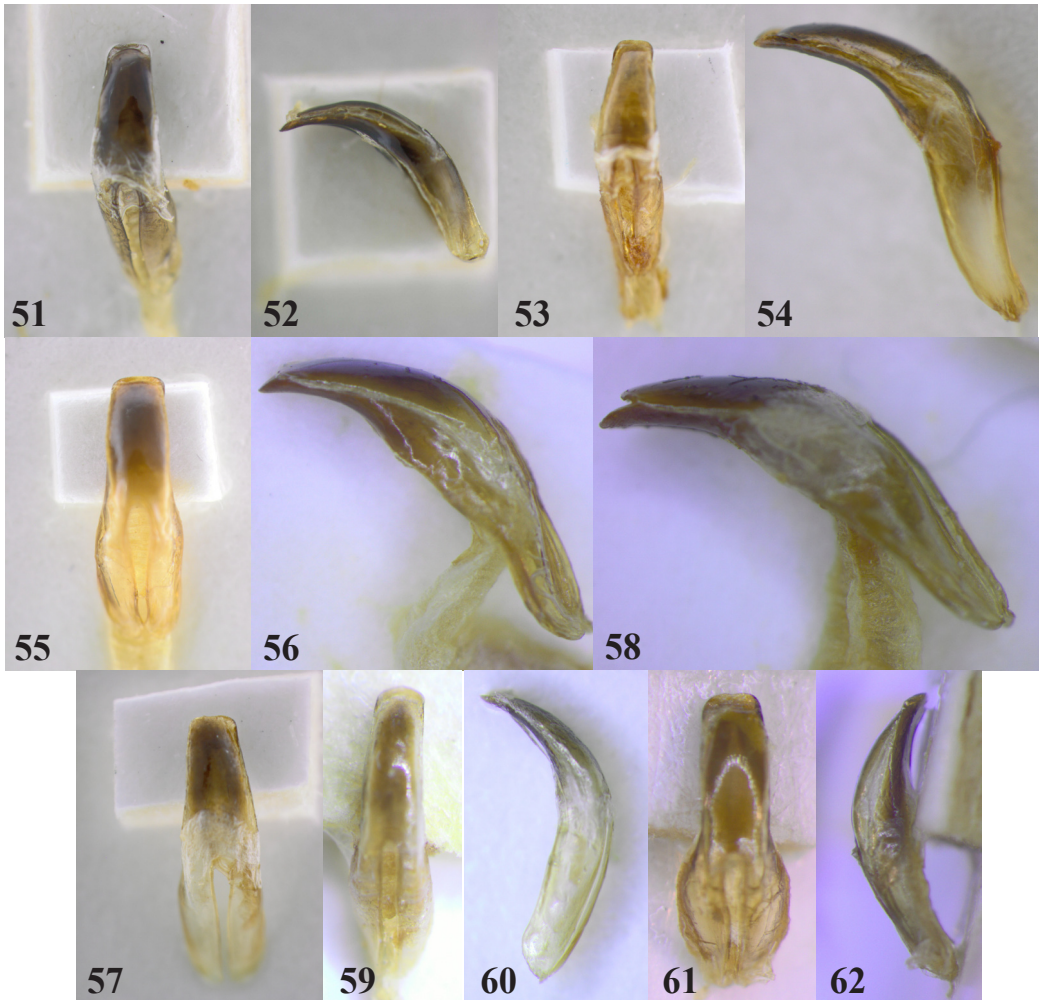
No differences in the male or female genitalia characters in the former subspecies *M. galloprovincialis galloprovincialis* and *M. galloprovincialis pistor* were found. All genitalia

TABLE 1. Key to the European species of *Monochamus*.

1.	Basal third of elytra with a distinctly elevated area medially, followed by an impression immediately below the elevation. Scutellum entirely covered with very dense, whitish or yellowish pubescence. Sclerites inside internal sac very small (0.1mm long), “U-shaped” (Figure 34) and embedded inside a terminal segment (formed as an elongated tube) (Figure 33C)	2
-	Elytra smooth with no trace of an elevated area medially. Scutellum with a narrow and glabrous, transversal median line apically or fully stretched across the scutellum (visible in well preserved specimens). Sclerites inside internal sac (no sclerites in <i>M. saltuarius</i>) larger (0.3–1.0mm long), elongated and varying in shape (Figure 35), internal sac with (Figure 33E) or without a terminal segment (Figures 33A, B & D)	3
2.	Apical third of elytra with only scattered hairs and with punctuation often relatively coarse (surrounded by short, slightly raised longitudinal and transversal carinae forming a fine square formed-pattern). The middle of posterior margin of tergite VIII in males straight	<i>M. sartor sartor</i>
-	Apical third of elytra with relatively dense, brownish to very dense, yellowish (rarely whitish) pubescence forming a longitudinal stripe on each elytron and with punctuation mostly weak. The middle of posterior margin of tergite VIII in males from Europe straight, whereas it is distinctly notched (Figure 83) in specimens from the eastern part of the Palaearctic region (Siberia and Japan)	<i>M. sartor urusovi nov. stat.</i>
3.	Slightly smaller species (average 15mm). Elytra with dense and smooth granulation concentrated at the basal part of elytra only, remaining surface of elytra with fine punctuation (Figures 4, 5, 15, 16)	4
-	Slightly larger species (average 20mm). Elytra with dense and smooth or coarse granulation at the basal part of elytra, remaining surface of elytra with coarse punctuation (Figures 1, 2, 12, 13)	5
4.	Apical third of elytra shining (no micro-reticulation). Pronotum and elytra covered with large yellowish and white spots often forming a transversal band medially on elytra. Pronotum with elongated, transversal ridges. Head (front view) narrow and elongated. Internal sac with no sclerites inside (Figure 38)	<i>M. saltuarius</i>
-	Apical third of elytra dull (distinct micro-reticulation). Elytra covered with numerous small yellowish and whitish irregular spots. Pronotum with short, transversal ridges forming an irregular square-formed pattern. Head (front view) broad and square-formed. A “T-shaped” small sclerite inside internal sac (Figures 35, 44)	<i>M. impluviatus</i>
5.	Basal half of elytra with rough granulation and distinct punctuation (especially towards humeri). Scutellum often with a glabrous, transversal median line reaching from base to apex. Elytra covered with a few to numerous irregular yellowish spots. Lateral part of pronotum with numerous setae, both below and above the lateral spine. Base of inner margin of parameres with a distinct extension projecting forward forming a “tooth” (Figure 63). The two folded sclerites inside internal sac forming a sharp “beak” (Figures 35, 36). Female terminalia with tignum straight (Figure 26) and relatively short (approx. 7.0mm)	<i>M. sutor</i>
-	Basal half of elytra with smooth granulation and fine punctuation, especially towards humeri. Scutellum often with a short glabrous, transversal median line only reaching the middle of scutellum. Elytra covered with a few to numerous yellowish spots often forming a distinct transversal, yellowish or whitish band on the middle of elytra. Lateral part of pronotum with just a few setae below the later spine. Base of inner margin of parameres with no trace of an extension or “tooth” (Figure 65). The sclerite inside internal sac form a straight shaft acutely curved anteriorly (forming a “hook”) (Figures 35, 37). Female terminalia with tignum relatively long (approx. 9.0mm) and often twisted on the middle (Figure 27)	<i>M. galloprovincialis</i>

characters, including the existence of a species-specific sclerite inside the internal sac, are similar, with very little or no variation. Our results support the conclusions by Cesari *et al.* (2005), Sama (2008), Löbl & Smetana (2010) and Koutroumpa *et al.* (in press), that *M. galloprovincialis pistor*

should not be maintained as a subspecies. Löbl & Smetana (2010) state that *M. galloprovincialis* is a highly variable species, which may, in fact, be composed of four subspecies. However, our study could not confirm this for *M. galloprovincialis pistor*, where the external morphological

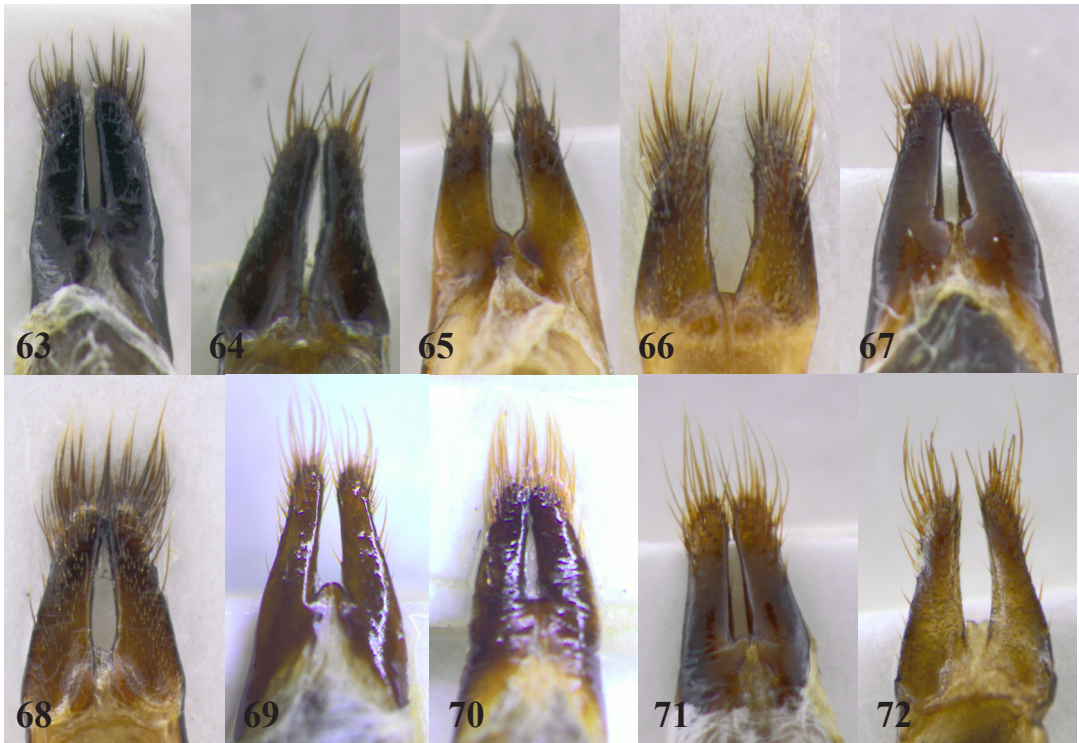


FIGURES 51–62. Aedeagi: **51.** *M. sutor sutor* (Linnaeus, 1758) (dorsal view); **52.** *M. sutor sutor* (Linnaeus, 1758) (lateral view); **53.** *M. galloprovincialis* (Olivier, 1795) (dorsal view); **54.** *M. galloprovincialis* (Olivier, 1795) (lateral view); **55.** *M. sartor sartor* (Fabricius, 1787) (dorsal view); **56.** *M. sartor sartor* (Fabricius, 1787) (lateral view); **57.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (dorsal view); **58.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (lateral view); **59.** *M. saltuarius* (Gebler, 1830) (dorsal view); **60.** *M. saltuarius* (Gebler, 1830) (lateral view); **61.** *M. impluviatus impluviatus* (Motschulsky, 1859) (dorsal view); **62.** *M. impluviatus impluviatus* (Motschulsky, 1859) (lateral view).

differences are weak (mainly colour variation), between this formerly subspecies and the nominate species *M. galloprovincialis galloprovincialis*. Specimens of *M. galloprovincialis* from southern France (type locality of *M. galloprovincialis*) are only characterised by “the reddish-brown appendages, elytral patches of yellowish and ochraceous or grey pubescence” corresponding to specimens also found in Algeria (Sama 2008).

According to Sama (2008) the type locality of *M. galloprovincialis pistor* is Slovenia, and such specimens have blackish antennae and legs corresponding to specimens found in Scandinavia.

Our results confirm that the knowledge of the true distribution of *M. galloprovincialis* in Norway and Sweden is uncertain and needs to be revised based on the present description of genitalia characters. *M. galloprovincialis* is



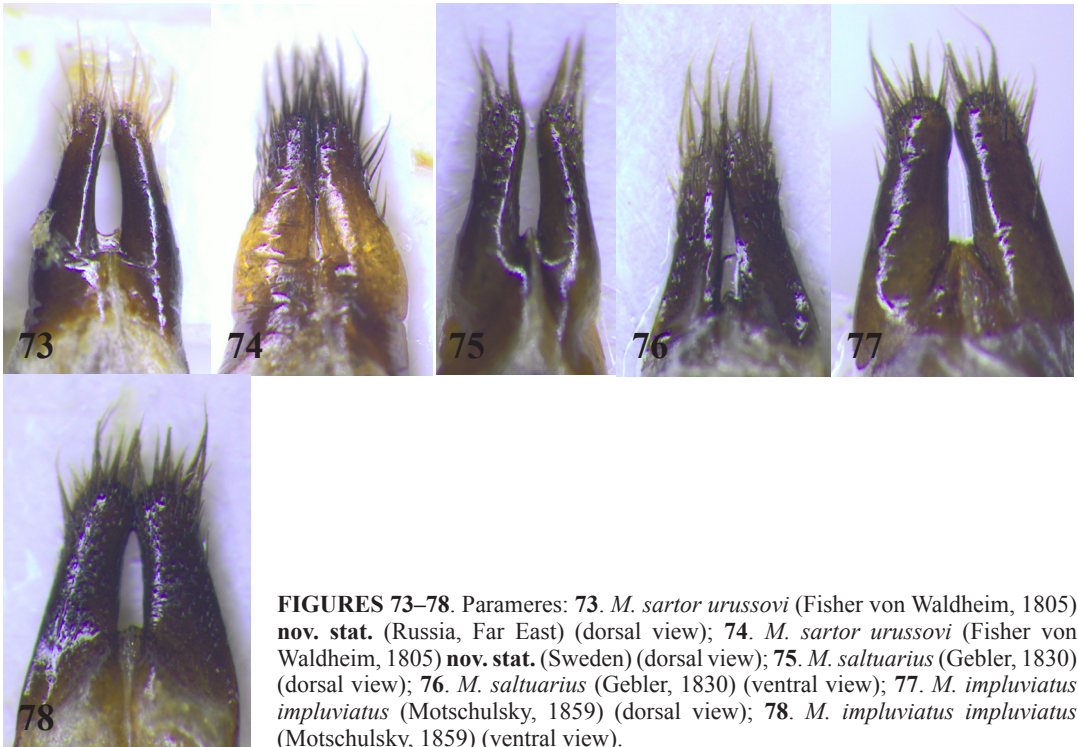
FIGURES 63–72. Parameres: **63.** *M. sutor sutor* (Linnaeus, 1758) (dorsal view (arrow shows the base of inner margin with a distinct extension from each paramere projecting forward forming a “tooth”)); **64.** *M. sutor sutor* (Linnaeus, 1758) (ventral view); **65.** *M. galloprovincialis* (Olivier, 1795) (dorsal view); **66.** *M. galloprovincialis* (Olivier, 1795) (ventral view); **67.** *M. sartor sartor* (Fabricius, 1787) (Austria) (dorsal view); **68.** *M. sartor sartor* (Fabricius, 1787) (Austria) (ventral view); **69.** *M. sartor sartor* (Fabricius, 1787) (Poland) (dorsal view); **70.** *M. sartor sartor* (Fabricius, 1787) (Poland) (dorsal view); **71.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia) (dorsal view); **72.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia) (ventral view).

considered to be found in almost all provinces of Sweden (Ehnström & Holmer 2007, Linde *et al.* 2010). In Norway, only two localities of *M. galloprovincialis* have been confirmed in modern times (after 1950) (Ehnström & Holmer 2007). A male and a female from Norway included in this study: Ø, Hvaler: Kirkøy (EIS 12), 1994 (Leg. S.O. Hansen) are both confirmed to be *M. galloprovincialis*. One male specimen from Norway: BØ, Drammen: Bragenesåsen (EIS 28) has the habitus similar to *M. galloprovincialis*, but the study of the genitalia showed it to be *M. sutor*.

No differences in the male or female genitalia characters of *M. sartor* and *M. urussovi* (Fischer von Waldheim, 1805) were found. We thus regard *M. urussovi* as a subspecies of *M. sartor*:

M. sartor urussovi **nov. stat.** (cf. ICZN 1999). Sláma (2006) had a similar view, since he also considered *M. urussovi* to be a subspecies of *M. sartor*, although he used the invalid name *M. rosenmuelleri* (Cederhjelm, 1798) for *M. urussovi* (cf. Löbl & Smetana, 2010). Cesari *et al.* (2005) found no significant difference in the mitochondrial cytochrome oxidase I (COI) gene between *M. sartor* and *M. urussovi* supporting the present results in that the two species are closely related. However, the study by Cesari *et al.* (2005) only involved specimens of *M. sartor urussovi* from Poland and *M. sartor sartor* from Italy.

M. sartor sartor and *M. sartor urussovi* **nov. stat.** co-exist in the following six European countries: Belarus, Czech Republic, Estonia,

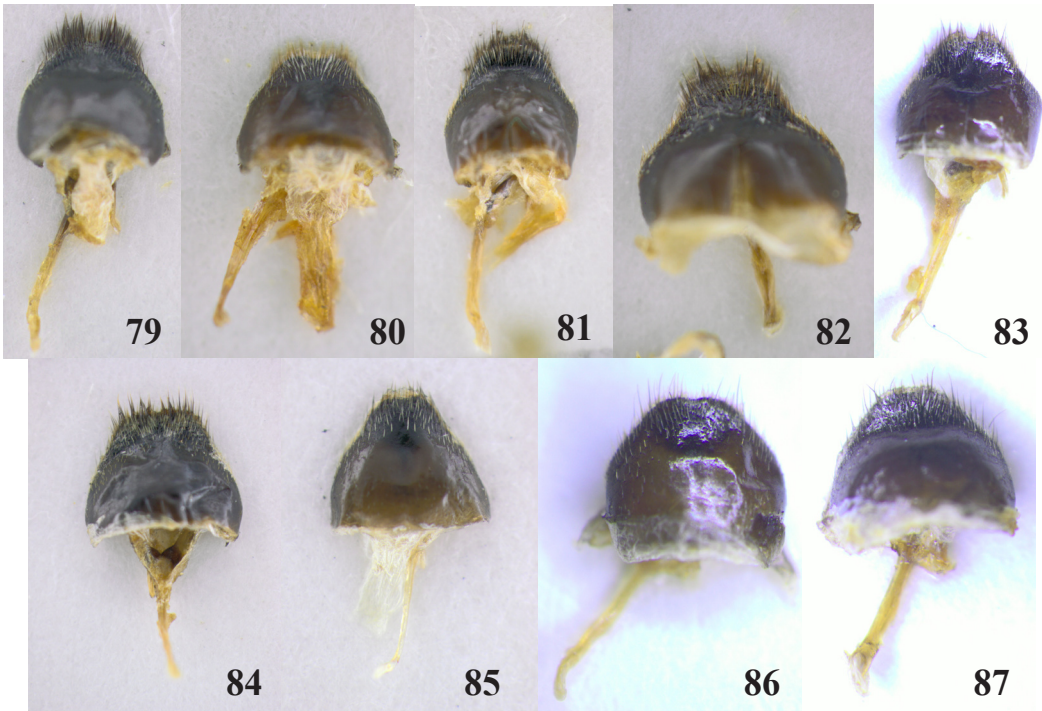


FIGURES 73–78. Parameres: **73.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia, Far East) (dorsal view); **74.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Sweden) (dorsal view); **75.** *M. saltuarius* (Gebler, 1830) (dorsal view); **76.** *M. saltuarius* (Gebler, 1830) (ventral view); **77.** *M. impluviatus impluviatus* (Motschulsky, 1859) (dorsal view); **78.** *M. impluviatus impluviatus* (Motschulsky, 1859) (ventral view).

Latvia, Lithuania and Poland (Löbl & Smetana, 2010). The colour of pubescence and extent of punctuation on the apical third of elytra are the only key characters that have been presented to separate *M. sartor sartor* from *M. sartor urussovi* (e.g. Cherepanov 1990, Bense 1995). However, neither Fabricius (1787) nor Fischer von Waldheim (1805) mention punctuation or granulation in their original descriptions, only the colour of the elytra, and whether or not there are any yellowish maculae. These external characters are highly variable, and overlap, especially when comparing specimens from countries where both species are supposed to occur, or in countries where only *M. sartor urussovi* is recorded. The examined specimens from the isolated population on the island of Hiiumaa (Dagö) in Estonia appear all to be *M. sartor sartor*, and further investigations are needed to clarify whether or not *M. sartor urussovi* also exists on this island. There are specimens identified as *M. sartor sartor* from Belarus and Lithuania that resemble *M. sartor urussovi*, and specimens identified

as *M. sartor urussovi* from Russia (Moscow) resembling *M. sartor sartor* (M. Danilevsky, pers. comm.). Sláma (2006) also found specimens of *M. sartor urussovi* from Ukraine difficult to separate from specimens of *M. sartor sartor* from eastern Slovakia. The latter findings indicate that *M. sartor sartor* and *M. sartor urussovi* co-exist in the same habitat and that there is a zone of contact in these countries. Our conclusion is that a more thorough DNA study, including specimens of *M. sartor urussovi* and *M. sartor sartor* from their whole geographical ranges, is necessary in order to fully understand the genetic relationship and their taxonomic status, particularly considering specimens from the far east of Russia and Japan.

Specimens of *M. sartor urussovi* from the Russian Far East and from Japan differ from European specimens in that the pubescence on the posterior part of elytra of males is distinctly whitish to yellowish, the punctuation is very weak medially, elytral surface is shining, and tergite VIII is notched on the middle of the posterior margin. Thus, it is relatively easy to separate specimens



FIGURES 79–87. Male tergite VIII: **79.** *M. sutor sutor* (Linnaeus, 1758); **80.** *M. galloprovincialis* (Olivier, 1795); **81.** *M. sartor sartor* (Fabricius, 1787) (Austria); **82.** *M. sartor sartor* (Fabricius, 1787) (Austria); **83.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia, Far East); **84.** *M. sartor urussovi* (Fisher von Waldheim, 1805) **nov. stat.** (Russia); **85.** *M. saltuarius* (Gebler, 1830) (Czech Republic); **86.** *M. saltuarius* (Gebler, 1830) (Russia); **87.** *M. impluviatus impluviatus* (Motschulsky, 1859).

of *M. sartor sartor* from Western Europe from *M. sartor urussovi* from the eastern parts of the Palearctic region (Siberia, Russian Far East and Japan). The lack of proper determination has caused some difficulties in the past where e.g. Aurivillius (1917) only included *M. sartor* for Sweden. He also states that the closely related *M. quadrimaculatus* (Motschulsky, 1845) occurs in Finland. The latter species has “weak punctuation on elytra and with dense yellowish pubescence towards elytral apices” (sensu Aurivillius, 1917). *M. quadrimaculatus* is currently regarded as a synonym of *M. urussovi* (Löbl & Smetana 2010). Hellrigl (1971) also wrote that *M. sartor* occurs in Scandinavia. Currently, only *M. urussovi* is reported to occur in the Scandinavian countries (Löbl & Smetana 2010). It was confirmed that all old male specimens of *M. urussovi* preserved at UUZM in Uppsala have punctuation on lateral part of elytra that is weaker than in “typical

M. sartor”, although they lack the very dense yellowish to whitish pubescence on elytral apices found in specimens from Siberia, Russian Far East and Japan. Instead, the pubescence varies from weak to only relatively dense, and is mostly dark or light brown, rarely yellowish (often more distinct in females than in males). Süda & Miländer (1998) only include *M. urussovi* from Estonia, whereas Löbl & Smetana (2010) include both *M. sartor* and *M. urussovi*. The more recently collected specimens we have examined from both Sweden and Estonia show a great variability both in punctuation and pubescence, making some (especially male) specimens difficult to determine (in agreement with findings by Danilevsky (pers. comm.) and Sláma (2006), cf. above)).

A detailed description of the larva of *M. sartor urussovi* is given by Cherepanov (1990), and a description of the larva of *M. sartor sartor* is presented by Svacha (1997). However, none

of these descriptions include any comparison between the two species. According to Danilevsky (pers. comm.) no morphological differences have been found between larvae of *M. sartor* and *M. urussovi*. P. Svacha (pers. comm.) states in an unpublished manuscript that no reliable differences were found between larvae of *M. sartor* and *M. urussovi*, which is in agreement with treating *M. urussovi* as a subspecies, *M. sartor urussovi*.

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