New records of German Scelionidae (Hymenoptera: Platygastroidea) from the collection of the State Museum of Natural History Stuttgart

Jessica Awad[‡], Cristina Vasiliţa[§], Sophie Wenz[|], Hamdow Alkarrat[|], Olaf Zimmermann[¶], Claus Zebitz[|], Lars Krogmann[‡]

‡ State Museum of Natural History, Stuttgart, Germany
§ Alexandru Ioan Cuza University, Iasi, Romania
| Institute of Phytomedicine, University of Hohenheim, Stuttgart, Germany
¶ Center for Agricultural Technology Augustenberg, Karlsruhe, Germany

Corresponding author: Jessica Awad (platygastrinae@gmail.com)

Academic editor: Stefan Schmidt

Abstract

Background

Scelionid wasps are arthropod egg parasitoids, many of which are relevant to global biosecurity. However, the scelionid fauna of Germany has not received much attention from professional taxonomists.

New information

Eleven species and four genera are recorded for the first time from Germany, including species of interest to agriculture and biological control. First genus records include *Baryconus* Förster, *Macroteleia* Westwood, *Paratelenomus* Dodd and *Probaryconus* Kieffer. First species records include *B. europaeus* (Kieffer), *Idris nigroclavatus* (Kieffer), *Idris semiflavus* (Kieffer), *M. bicolora* Kieffer, *M. pannonica* Szabo, *Paratelenomus saccharalis* (Dodd), *Trimorus varicornis* (Walker), *Trissolcus basalis* (Wollaston), *Trissolcus belenus* (Walker), *Trissolcus colemani* (Crawford) and *Trissolcus flavipes* (Thompson). COI barcodes are identified for the first time from *B. europaeus* and *M. bicolora*. Each species is illustrated and updated world distributions are provided. Implications for agriculture are discussed.

Keywords

parasitoid wasps; DNA barcoding; *Trissolcus*; *Paratelenomus*; dark taxa

Introduction

Platygastroidea is the third largest superfamily of Hymenoptera in terms of the number of described species, exceeded only by Ichneumonoidea and Chalcidoidea. The current number of valid species is ca. 6,500, with a worldwide estimate of about 10,000 (Hymenoptera Online 2020, Masner 1993, Johnson 2011). At the time of writing, the superfamily comprises two extant families, Scelionidae and Platygastridae (Talamas and Buffington 2015, Popovici et al. 2017).

In the 19th century, several notable experts published on German Platygastroidea. The earliest was Christian Gottfried Nees von Esenbeck, who described dozens of species in *Sparasion*, *Scelio*, *Platygaster* and *Teleas* (Nees von Esenbeck 1834). Julius Theodor Christian Ratzeburg described species of *Platygaster* and *Teleas* associated with forest pests (Ratzeburg 1852). Soon after, Arnold Förster published his "Hymenopterologische Studien", establishing 26 platygastroid genera, many of which remain valid today (Förster 1856). In the early 20th century, Jean-Jacques Kieffer described numerous genera and species from central Europe, including German material (Kieffer 1926).

Since Kieffer, there has not been much research on the Platygastroidea of Germany. The most recent catalogue of German insects (Dathe et al. 2001) lists 136 platygastroid species, including 56 Scelionidae. However, these numbers are certainly low. The section was based on a relatively short reference list and many common European taxa were not included. Thus, Platygastroidea has been identified as a priority for research within the German Barcode of Life III: Dark Taxa project (Hausmann et al. 2020). Dark taxa are insect groups, mainly in Hymenoptera and Diptera, which pose a taxonomic impediment to biodiversity studies. Such taxa are abundant and diverse in insect monitoring projects, but a lack of usable diagnostic literature makes species identification difficult to impossible.

Scelionid wasps parasitise the eggs of arthropods, including many invasive or noxious pest species (Austin et al. 2005). Thus, their accurate identification is critical to agricultural research, especially in the context of the global plant trade. For example, the brown marmorated stink bug, *Halyomorpha halys* Stål, 1855, is an invasive species in Europe and North America. Its most effective natural enemy, *Trissolcus japonicus* (Ashmead, 1904), has been detected or established as an adventive species throughout the introduced range (Talamas et al. 2015, Abram et al. 2019, Stahl et al. 2019). Most recently, *T. japonicus* was detected in Germany (Dieckhoff et al. 2021). Similarly, *Paratelenomus saccharalis* (Dodd, 1914) has followed the kudzu bug, *Megacopta cribraria* (Fabricius, 1798), from the Palearctic into North America (Gardner et al. 2013).

The current work represents a first update to the German platygastroid fauna within the German Barcode of Life (GBOL) III initiative. As these findings occurred within the first several months of the project, further discoveries are expected over the next three years. Identification of Platygastridae is still underway, as the state of taxonomic disarray in this group is more severe.

Materials and methods

We examined recent and historical collections of Scelionidae at the State Museum of Natural History Stuttgart (SMNS). Recent material was collected for earlier stages of the GBOL project or for long-term insect monitoring programmes, generally by Malaise trap. Recently-collected specimens were preserved in 96% ethanol. Specimens collected for the GBOL project had DNA extracted non-destructively with the DNeasy Blood & Tissue Extraction Kit from Qiagen following the updated protocol provided by Cruaud et al. (2019). COI barcodes were amplified by PCR with the LCO1490/HCO2198 primers (Folmer et al. 1994). Barcode sequences are available at GenBank accession numbers MW829349–MW829358.

Illustrations were created with a Keyence imaging system. Adobe Photoshop was used for image processing and plate construction.

Taxon treatments

Baryconus europaeus (Kieffer, 1908)

Nomenclature

Hoploteleia europaea Kieffer, 1908

Hoploteleia graeffei Kieffer, 1908

Baryconus graeffei (Kieffer): Kieffer, 1926

Baryconus europaeus (Kieffer): Bin, 1974

Materials

a. scientificName: ***Baryconus europaeus*** (Kieffer, 1908); country: Germany; stateProvince: Baden-Württemberg; municipality: Markgröningen; locality: Entomological Society of Stuttgart property in the Rotenacker; verbatimLocality: EVS-Vereinsgrundstück am Rotenacker; verbatimElevation: 280 m; samplingProtocol: sweep net; year: 2009; month: 8; day: 4; individualCount: 3; sex: female; recordedBy: L. Krogmann; identifiedBy: Cristina Vasilita; type: PhysicalObject; bibliographicCitation: ***Baryconus europaeus*** (SMNS_Hym_Sce_001093, 1094, 1095); institutionCode: SMNS; basisOfRecord: PreservedSpecimen; occurrenceID: C4668E50-41F7-5A5D-89ED-9BAE733CCDD9

b. scientificName: ***Baryconus europaeus*** (Kieffer, 1908); country: Germany; stateProvince: Baden-Württemberg; municipality: Tübingen; verbatimCoordinates: 48.504317° N,

8.9956° E; samplingProtocol: Malaise trap; year: 2014; month: 7; day: 17–31; individualCount: 1; sex: female; recordedBy: T. Kothe, M. Engelhardt, C. König; associatedSequences: GenBank: MW829358; identifiedBy: Cristina Vasilita; type: PhysicalObject; bibliographicCitation: Baryconus europaeus (SMNS_Hym_Sce_000715); institutionCode: SMNS; basisOfRecord: PreservedSpecimen; occurrenceID: E0B2195F-16AB-5DE6-898D-D73DE6BAD59D

Distribution

Baryconus europaeus (Fig. 1) was described from Italy and has also been recorded from Croatia, Cyprus, France, India, Japan, Morocco, Portugal, Russia, Spain, Turkey and UAE (Popovici et al. 2013). It is expected in Romania (Spiridon et al. 2019). We here provide the first genus and species record for Germany and the first identified barcode for *Baryconus europaeus.* Identification is based on Popovici et al. (2013).

Idris nigroclavatus (Kieffer, 1908)

Nomenclature

Acolus nigroclavatus Kieffer, 1908

Acolus striativentris Kieffer, 1909

Acolus coxalis Kieffer, 1912

Idris coxalis (Kieffer): Szabo, 1965

Idris striativentris (Kieffer): Kozlov, 1978

Idris nigroclavatus (Kieffer): Huggert, 1979

Material

a. scientificName: *Idris nigroclavatus* (Kieffer, 1908); country: Germany; stateProvince: Baden-Württemberg; municipality: Markgröningen; locality: Rotenacker Forest east; samplingProtocol: sieve; year: 2019; month: 4; day: 2; habitat: maple, forest edge; individualCount: 2; sex: female; recordedBy: J. Reibnitz; identifiedBy: Cristina Vasilita; type: PhysicalObject; bibliographicCitation: *Idris nigroclavatus* (SMNS_Hym_Sce_001098, 1099); institutionCode: SMNS; basisOfRecord: PreservedSpecimen; occurrenceID: 253FCA94-2ADB-5D6D-9410-F681F0F0B6FE

Distribution

Idris nigroclavatus (Fig. 2) was described from Italy and has also been recorded from Austria, Bosnia and Herzegovina, Bulgaria, Croatia, France, Hungary, Spain and Sweden (Huggert 1979, Kononova and Kozlov 2001). We here provide the first species record for Germany. Identification is based on Huggert (1979).

Idris semiflavus (Kieffer, 1908)

Nomenclature

Acolus semiflavus Kieffer, 1908

Idris semiflavus (Kieffer): Huggert, 1979

Materials

a. scientificName: ***Idris semiflavus*** (Kieffer, 1908); country: Germany; stateProvince: Baden-Württemberg; municipality: Weil am Rhein; verbatimCoordinates: 47.579614° N, 7.606160° E; samplingProtocol: suction sampler; year: 2020; month: 7; day: 14; habitat: ruderal area dominated by ***Ailanthus altissima***; individualCount: 1; sex: female; recordedBy: O. Zimmermann, S. Wenz, M. Renninger, A. Reißig; associatedSequences: Genbank: MZ334547; identifiedBy: Klaus Schrameyer; type: PhysicalObject; bibliographicCitation: ***Idris semiflavus*** (SMNS_Hym_Sce_001147); institutionCode: SMNS; basisOfRecord: PreservedSpecimen; occurrenceID: 2CD206F2-0205-5FDC-B509-7E1384C444FB

b. scientificName: ***Idris semiflavus*** (Kieffer, 1908); country: Germany; stateProvince: Baden-Württemberg; municipality: Weil am Rhein; verbatimCoordinates: 47.586876° N, 7.619260° E; samplingProtocol: suction sampler; year: 2020; month: 7; day: 14; habitat: ruderal area dominated by ***Paulownia*** sp.; individualCount: 1; sex: female; recordedBy: O. Zimmermann, S. Wenz, M. Renninger, A. Reißig; associatedSequences: Genbank: MZ334548; identifiedBy: Klaus Schrameyer; type: PhysicalObject; bibliographicCitation: ***Idris semiflavus*** (SMNS_Hym_Sce_001148); institutionCode: SMNS; basisOfRecord: PreservedSpecimen; occurrenceID: 61B33A93-EBF5-5963-BF10-38D05CF70DDE

c. scientificName: ***Idris semiflavus*** (Kieffer, 1908); country: Germany; stateProvince: Baden-Württemberg; municipality: Konstanz; samplingEffort: suction sampler; year: 2020; month: 8; day: 7; habitat: ruderal area near apple production; individualCount: 1; sex: female; recordedBy: O. Zimmermann, M. Trautmann; associatedSequences: Genbank: MZ334549; identifiedBy: Klaus Schrameyer; type: Physical Object; bibliographicCitation: Idris semiflavus (SMNS_Hym_Sce_001149); institutionCode: SMNS; basisOfRecord: PreservedSpecimen; occurrenceID: 55306283-665A-5473-88A4-59DD7AD9592D

Distribution

Idris semiflavus (Fig. 3) was described from France and has been recorded from Egypt, Hungary, Italy, Mongolia, Spain and Switzerland (Huggert 1979). We here provide the first species record for Germany. Identification is based on Huggert (1979) .

Macroteleia bicolora Kieffer, 1908

Nomenclature

Macroteleia bicolora Kieffer, 1908

Macroteleia bicolor (Kieffer): Kozlov, 1978

Material

a. scientificName: *Macroteleia bicolora* Kieffer, 1908; country: Germany; stateProvince: Baden-Württemberg; municipality: Emmendingen; verbatimCoordinates: 48.128533° N, 7.738301° E; samplingProtocol: Malaise trap; year: 2017; month: 8; day: 2–16; individualCount: 2; sex: female; recordedBy: Patricia Gut; associatedSequences: GenBank: MW829349, 829350; identifiedBy: Cristina Vasilita; bibliographicCitation: *Macroteleia bicolora* (SMNS_HYM_Sce_000729, 000731); institutionCode: SMNS; basisOfRecord: PreservedSpecimen; occurrenceID: 5C75BE1E-F962-56CF-9215-7F897C2C6D49

Distribution

Macroteleia bicolora (Fig. 4) was described from Italy and has also been recorded from Denmark, Kazakhstan, Russia, Ukraine and the United Kingdom (Kozlov 1987, Notton et al. 2014). We here provide the first genus and species record for Germany and the first identified barcode for *Macroteleia bicolora.* Identification is based on Kozlov (1987).

Macroteleia pannonica Szabo, 1966

Nomenclature

Macroteleia pannonica Szabo, 1966

Material

a. scientificName: *Macroteleia pannonica* Szabo, 1966; country: Germany; stateProvince: Hessen; municipality: Hersfeld-Rotenburg; locality: Rockensüß, Eschkopf; verbatimElevation: 339 m; samplingProtocol: Malaise trap; year: 2012; verbatimEventDate: 25 Jul.–15 Aug. 2012; individualCount: 1; sex: female; recordedBy: H.-J. Flügel; identifiedBy: Cristina Vasilita; bibliographicCitation: *Macroteleia pannonica* (SMNS_Hym_Sce_000159); institutionCode: SMNS; basisOfRecord: PreservedSpecimen; occurrenceID: 2F7A5A03-CAB7-59EB-A2AB-8A11F8B4E8C6

Distribution

Macroteleia pannonica (Fig. 5) was described from Hungary and has also been recorded from Romania (Fabritius and Popovici 2007, Kononova and Kozlov 2008). We here provide the first genus and species record for Germany. Identification is based on Kononova and Kozlov (2008).

Paratelenomus saccharalis (Dodd, 1914)

Nomenclature

Telenomus saccharalis Dodd, 1914

Liophanurus saccharalis (Dodd): Kieffer, 1926

Paratelenomus saccharalis (Dodd): Johnson, 1988

Materials

a. scientificName: *Paratelenomus saccharalis* (Dodd, 1914); country: Germany; stateProvince: Baden-Württemberg; municipality: Markgröningen; locality: Entomological Society of Stuttgart property in the Rotenacker; verbatimLocality: EVS-Vereinsgrundstück am Rotenacker; verbatimElevation: 280 m; samplingProtocol: sweep net; year: 2009; month: 8; day: 4; individualCount: 1; sex: male; recordedBy: L. Krogmann; identifiedBy: Cristina Vasilita; bibliographicCitation: *Paratelenomus saccharalis* (SMNS_Hym_Sce_001096); institutionCode: SMNS; occurrenceID: D3CB0351-B728-5300-BEFB-E148A725B20A

b. scientificName: *Paratelenomus saccharalis* (Dodd, 1914); country: Germany; stateProvince: Baden-Württemberg; municipality: Tübingen; locality: Wurmlingen, Gegental; verbatimElevation: 377 m; verbatimCoordinates: 48.513233° N, 8.991767° E; samplingProtocol: Malaise trap; year: 2014; month: 5; day: 13–23; individualCount: 1; sex: female; recordedBy: T. Kothe, M. Englehardt, Ch. König; associatedSequences: GenBank: MW829355; identifiedBy: Jessica Awad; bibliographicCitation: *Paratelenomus saccharalis* (SMNS_HYM_Pla_000305); institutionCode: SMNS; occurrenceID: 2F11F650-E658-5A48-816D-B88940C5FA83

Distribution

Paratelenomus saccharalis (Fig. 6) was described from Indonesia and has also been recorded from Australia, Austria, Bangladesh, Benin, China, Ghana, India, Ivory Coast, Italy, Japan, Kenya, Malaysia, Moldova, Nigeria, Philippines, Romania, Rwanda, Somalia, South Africa, South Korea, Taiwan, Thailand, Uganda, USA, Zambia and Zimbabwe (Johnson 1996). We here provide the first genus and species record for Germany. Identification is based on Johnson (1996).

Probaryconus Kieffer, 1908

Nomenclature

Procacus Kieffer, 1910

Neurocacus Kieffer, 1913

Amblyconus Kieffer, 1913

Urundia Risbec, 1957

Material

a. scientificName: *Probaryconus* Kieffer, 1908; country: Germany; stateProvince: Baden-Württemberg; municipality: Tübingen; locality: Wurmlingen, Gegental; verbatimElevation: 377 m; verbatimCoordinates: 48°30.794' N, 8°59.506' E; samplingProtocol: Malaise trap; year: 2014; month: 5; day: 13–23; individualCount: 2; sex: female; recordedBy: T. Kothe, M. Englehardt, Ch. König; identifiedBy: Cristina Vasilita; bibliographicCitation: *Probaryconus* sp. (SMNS_Hym_Sce_000344, 000345); institutionCode: SMNS; occurrenceID: 86AC8672-260E-5069-9B51-50DFC8168736

Distribution

Probaryconus (Fig. 7) was described from France and has also been recorded from Australia, Azerbaijan, Belize, Benin, Botswana, Brazil, Bulgaria, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, Egypt, France, French Guiana, Ghana, Hungary, India, Indonesia, Ivory Coast, Kenya, Kyrgyzstan, Jamaica, Madagascar, Malaysia, Mexico, Moldova, New Caledonia, Nigeria, Panama, Papua New Guinea, Paraguay, Peru, Puerto Rico, Romania, Slovakia, South Africa, Thailand, Trinidad and Tobago, Turkey, Ukraine, USA, Venezuela and the Virgin Islands (Hymenoptera Online 2020, Kieffer 1926, Kozlov 1987). We here provide the first genus record for Germany. Identification is based on Kozlov (1987) and Talamas et al. (2011).

Trimorus varicornis (Walker, 1836)

Nomenclature

Teleas varicornis Walker, 1836

Teleas metabus Walker, 1836

Prosacantha minor Thomson, 1859

Prosacantha grandis Thomson, 1859

Prosacantha variicornis (Walker): Marshall, 1873

Prosacantha metabus (Walker): Marshall, 1873

Prosacantha varicornis (Walker): Walker, 1874

Prosacantha spinosa Szepligeti, 1901

Pentacantha variicornis (Walker): Kieffer, 1908

Pentacantha minor (Thomson): Kieffer, 1908

Pentacantha grandis (Thomson): Kieffer, 1908

Pentacantha rufimanus Kieffer, 1908

Pentacantha varicornis (Walker): Kieffer, 1913

Hoplogryon metabus (Walker): Kieffer, 1926

Propentacantha varicornis (Walker): Kieffer, 1926

Propentacantha minor (Thomson): Kieffer, 1926

Propentacantha grandis (Thomson): Kieffer, 1926

Propentacantha spinosa (Szepligeti): Kieffer, 1926

Propentacantha rufimanus (Kieffer): Kieffer, 1926

Trisacantha varicornis (Walker): Szabo, 1957

Trimorus grandis (Thomson): Sundholm, 1967

Trimorus minor (Thomson): Sundholm, 1967

Material

a. scientificName: *Trimorus varicornis* (Walker, 1836); country: Germany; stateProvince: Baden-Württemberg; municipality: Klettgau; locality: Jestett; verbatimLocality: Flachshof BF1N; year: 1996; month: 6; day: 3; individualCount: 1; sex: female; recordedBy: M. Hermann; identifiedBy: Cristina Vasilita; bibliographicCitation: *Trimorus varicornis* (SMNS_Hym_Sce_001100); institutionCode: SMNS; occurrenceID: 1025F3DA-54B8-5161-963B-629FF22B5A54

Distribution

Trimorus varicornis (Fig. 8) was described from Ireland and has also been recorded from Bulgaria, Croatia, Denmark, Finland, France, Italy, Romania, Russia, Sweden, Switzerland, Ukraine and the United Kingdom (Fabritius and Popovici 2007, Hymenoptera Online 2020, Kononova and Kozlov 2001). We here provide the first species record for Germany. Identification is based on Kozlov (1987).

Trissolcus basalis (Wollaston, 1858)

Nomenclature

Telenomus basalis Wollaston, 1858

Telenomus maderensis Wollaston, 1858

Telenomus megacephalus Ashmead, 1894

Telenomus megalocephalus Schulz, 1906

Telenomus piceipes Dodd, 1920

Liophanurus megacephalus (Ashmead): Kieffer, 1926

Microphanurus africanus Fouts, 1934

Microphanurus basalis (Wollaston): Nixon, 1935

Microphanurus sulmo Nixon, 1938

Asolcus basalis (Wollaston): Delucchi, 1961

Trissolcus maderensis (Wollaston): Masner, 1965

Trissolcus piceipes (Dodd): Masner, 1965

Trissolcus sulmo (Nixon): Masner, 1965

Asolcus sulmo (Nixon): Voegele, 1969

Trissolcus africanus (Fouts): Bin, 1974

Asolcus lodosi Szabo, 1981

Trissolcus megacephalus (Ashmead): Johnson, 1983

Trissolcus lodosi (Szabo): Kononova, 2014

Material

a. scientificName: ***Trissolcus basalis*** (Wollaston, 1858); country: Germany; stateProvince: Baden-Württemberg; municipality: Freiburg; locality: Emmendingen; verbatimCoordinates: 48.128533° N, 7.738301° E; samplingProtocol: Malaise trap; year: 2017; month: 10; day: 11–25; individualCount: 2; sex: female; recordedBy: Patricia Gut; associatedSequences: GenBank: MW829356, MW829357; identifiedBy: Cristina Vasilita; bibliographicCitation: ***Trissolcus basalis*** (SMNS_Hym_Sce_000805, 000806); institutionCode: SMNS; occurrenceID: CC7028D4-C77E-5C85-859D-EB904564DA7A

Distribution

Trissolcus basalis (Fig. 9) was described from Portugal and has also been recorded from Australia, Brazil, China, Cyprus, France, Hungary, Iran, Israel, Italy, Jordan, Montenegro, Montserrat, South Africa, Spain, Tonga, Turkey, USA, Vanuatu and Zimbabwe Talamas et al. (2017). We here provide the first species record for Germany. Identification is based on Talamas et al. (2017).

Trissolcus belenus (Walker, 1836)

Nomenclature

Telenomus belenus Walker, 1836

Telenomus arminon Walker, 1836

Telenomus nigrita Thomson, 1860

Telenomus frontalis Thomson, 1860

Telenomus grandis Thomson, 1860

Telenomus nigripes Thomson, 1860

Telenomus ovulorum Thomson, 1860

Teleas pentatomae Rondani, 1877

Telenomus nigritus Thomson: Dalla Torre, 1898

Telenomus pentatomae (Rondani): Dalla Torre, 1898

Allophanurus arminon (Walker): Kieffer, 1912

Aphanurus belenus (Walker): Kieffer, 1912

Aphanurus frontalis (Thomson): Kieffer, 1912

Aphanurus grandis (Thomson): Kieffer, 1912

Aphanurus nigrita (Thomson): Kieffer, 1912

Aphanurus nigripes (Thomson): Kieffer, 1912

Liophanurus pentatomae (Rondani): Kieffer, 1912

Allophanurus arminon (Walker): Kieffer, 1926

Microphanurus belenus (Walker): Kieffer, 1926

Microphanurus frontalis (Thomson): Kieffer, 1926

Microphanurus grandis (Thomson): Kieffer, 1926

Microphanurus nigripes (Thomson): Kieffer, 1926

Microphanurus nigritus (Thomson): Kieffer, 1926

Asolcus grandis (Thomson): Masner, 1959

Trissolcus grandis (Thomson): Viktorov, 1967

Asolcus nixomartini Javahery, 1968

Asolcus silwoodensis Javahery, 1968

Trissolcus pentatomae (Rondani): Bin, 1974

Trissolcus belenus (Walker): Fergusson, 1978

Trissolcus nigripes (Thomson): Fergusson, 1978

Trissolcus nixomartini (Javahery): Fergusson, 1978

Trissolcus silwoodensis (Javahery): Fergusson, 1978

Trissolcus arminon (Walker): Fergusson, 1983

Trissolcus ovulorum (Thomson): Tortorici et al., 2019

Materials

a. scientificName: ***Trissolcus belenus*** (Walker, 1836); country: Germany; stateProvince: Baden-Württemberg; municipality: Hartheim Breisach; samplingProtocol: reared; year: 1971; month: 6; day: 14; habitat: ex. Heteroptera Eier [from Heteroptera eggs]; individualCount: 12; sex: female; recordedBy: Gauss; identifiedBy: Cristina Vasilita; institutionCode: SMNS; occurrenceID: 6E5CCEC1-6D48-5D8B-BBCB-98D54040DB22

b. scientificName: ***Trissolcus belenus*** (Walker, 1836); country: Germany; stateProvince: Baden-Württemberg; municipality: Tübingen; verbatimCoordinates: 48.504317° N, 8.9956° E; samplingProtocol: Malaise trap; year: 2014; month: 7; day: 17–31; individualCount: 3; sex: female; recordedBy: T. Kothe, M. Englehardt, Ch. König; associatedSequences: GenBank: MW829354, MW829353; identifiedBy: Cristina Vasilita; bibliographicCitation: *Trissolcus belenus* (SMNS_Hym_Sce_000713, 000716, 000719); institutionCode: SMNS; occurrenceID: 4CCCCE6C-BB08-5B7C-B253-9418F530F220

Distribution

Trissolcus belenus (Fig. 10) was described from the UK and has also been recorded from China, France, Iran, Italy, Morocco, Portugal, Russia, Sweden, Switzerland and Tanzania (Tortorici et al. 2019). We here provide the first species record for Germany. Identification is based on Tortorici et al. 2019.

Trissolcus colemani (Crawford, 1912)

Nomenclature

Telenomus colemani Crawford, 1912

Microphanurus djadetshko Ryakhovskii, 1959

Microphanurus pseudoturesis Ryakhovskii, 1959

Microphanurus rossicus Ryakhovskii, 1959

Asolcus nigribasalis Voegele, 1962

Asolcus djadetschko (Ryakhovskii): Viktorov, 1964

Asolcus pseudoturesis (Ryakhovskii): Viktorov, 1964

Asolcus bennisi Voegele, 1964

Trissolcus djadetschko (Ryakhovskii): Viktorov, 1967

Trissolcus pseudoturesis (Ryakhovskii): Viktorov, 1967

Trissolcus waloffae Javahery, 1968

Trissolcus bennisi (Voegele): Kozlov & Le, 1977

Trissolcus nigribasalis (Voegele): Kozlov & Le, 1977

Trissolcus crypticus Clarke, 1993

Materials

a. scientificName: ***Trissolcus colemani*** (Crawford, 1912); country: Germany; stateProvince: Baden-Württemberg; locality: Bopserwald; samplingProtocol: reared; year: 1932; month: 7; day: 12; habitat: aus Wanzeneiern [from bug eggs]; individualCount: 7; sex: 1 male, 6 females; recordedBy: Fischer; identifiedBy: Cristina Vasilita; institutionCode: SMNS; occurrenceID: D0F7D9B0-2B70-5B98-B560-F7005C824641

b. scientificName: ***Trissolcus colemani*** (Crawford, 1912); country: Germany; stateProvince: Baden-Württemberg; municipality: Bahlingen; verbatimCoordinates: 48.128533° N, 7.738301° E; samplingProtocol: Malaise trap; year: 2017; month: 9; day: 13–27; individualCount: 2; sex: female; recordedBy: Patricia Gut; associatedSequences: GenBank: MW829352, MW829351; identifiedBy: Cristina Vasilita; bibliographicCitation: *Trissolcus colemani* (SMNS_Hym_Sce_000796, 000797); institutionCode: SMNS; occurrenceID: 973D7C3F-7863-54B1-861F-01B07DCEFE85

c. scientificName: ***Trissolcus colemani*** (Crawford, 1912); country: Germany; stateProvince: Baden-Württemberg; municipality: Tübingen; locality: Steinenberg; verbatimElevation: 460–490 m; year: 2019; month: 7; day: 1–2; individualCount: 1; sex: male; recordedBy: University of Hohenheim insect summer course; identifiedBy: Cristina Vasilita; bibliographicCitation: *Trissolcus belenus* (SMNS_Hym_Sce_001097); institutionCode: SMNS; occurrenceID: B8083A90-6D10-5C93-8333-6CAFBC6C1D7A

Distribution

Trissolcus colemani (Fig. 11) was described from India and has also been recorded from China, France, Greece, India, Iran, Italy, Morocco, Pakistan, Russia, Sweden,

Ukraine and the United Kindgom (Tortorici et al. 2019). We here provide the first species record for Germany. Identification is based on Tortorici et al. (2019).

Trissolcus flavipes (Thompson, 1860)

Nomenclature

Telenomus flavipes Thomson, 1860

Aphanurus flavipes (Thomson): Kieffer, 1912

Microphanurus flavipes (Thomson): Kieffer, 1926

Trissolcus circus Kozlov & Le, 1976

Trissolcus crassus Kononova, 2014

Materials

a. scientificName: *Trissolcus flavipes* (Thompson, 1860); country: Germany; stateProvince: Hessen; municipality: Vogelsbergkreis; locality: Ober-Moos; verbatimLocality: Windwurffläche, SNR 5121a; verbatimElevation: 473 m; samplingProtocol: Malaise trap; year: 2012; verbatimEventDate: 29 May–18 Jun. 2012; individualCount: 2; sex: female; recordedBy: H.-J. Flügel; identifiedBy: Cristina Vasilita; bibliographicCitation: *Trissolcus flavipes* (SMNS_Hym_Sce_000188, 000190); institutionCode: SMNS; occurrenceID: A870371E-26D4-55BC-A982-7AC64A8758D9

b. scientificName: *Trissolcus flavipes* (Thompson, 1860); country: Germany; stateProvince: Mecklenburg-Vorpommern; municipality: Insel Rügen; locality: Kniepow; verbatimElevation: 50 m; samplingProtocol: Malaise trap; year: 2014; month: 8; day: 3–9; individualCount: 1; sex: female; recordedBy: F. Koch; identifiedBy: Cristina Vasilita; bibliographicCitation: *Trissolcus flavipes* (SMNS_Hym_Sce_000236); institutionCode: SMNS; occurrenceID: 6D5C91D9-F466-5BD0-8BFE-AD9A49743193

Distribution

Trissolcus flavipes (Fig. 12) was described from Sweden and has also been recorded from Austria, Denmark, France, Hungary, Japan, Moldova, Romania, Russia, Sweden, Thailand, Ukraine and the United Kingdom (Talamas et al. 2017). We here provide the first species record for Germany. Identification is based on Talamas et al. (2017).

Discussion

Of the two families of Platygastroidea, Scelionidae is better resolved. High-quality revisions and keys are available for many genera of Scelionidae, due to careful attention from professional taxonomists, as well as data regarding ecological and biological aspects. Platygastridae has been somewhat more neglected and, in large genera, such as *Platygaster* Latreille and *Synopeas* Förster, better diagnostic tools are needed

for accurate species identification. This is the case with some genera of Scelionidae as well, such as *Gryon* Haliday and *Telenomus* Haliday. For example, one-hundred-year-old specimens of *Telenomus* still remain unidentified in the collection of SMNS. As taxonomic issues are resolved, it will become possible to accurately identify material for barcode reference libraries.

Baryconus europaeus and *Macroteleia bicolora* are here barcoded for the first time. A comparison with existing records in BOLD Systems (https://www.boldsystems.org/) showed no matches to identified material. For the *M. bicolora* sequences, the highest match (93.62%) was to unidentified specimens from Gabon. The *B. europaeus* sequence was most similar (97.63%) to unidentified specimens from South Africa. As expected, all *Trissolcus* sequences matched well (at least 99%) with appropriately identified material.

Based on preliminary data, several species of *Probaryconus* are found in Germany, but their nomenclature is uncertain, due to the aforementioned taxonomic impediment. Historical *Trissolcus* specimens remained unidentified in the SMNS collection for 50 to almost 100 years. The oldest of these, *T. colemani*, was reared from hemipteran eggs in 1932 (Fig. 11). A series of *T. belenus* from 1971 are preserved along with host material (Fig. 10). It is no surprise that these specimens were never identified, since *T. belenus* was largely overlooked for nearly two centuries before it was properly examined and keyed by Tortorici et al. (2019).

In addition to the newly-recorded species, *Trissolcus* species already known from Germany, such as *T. cultratus* (Mayr), *T. semistriatus* (Nees von Esenbeck) and *T. scutellaris* (Thomson), have been repeatedly detected at various locations in Baden-Württemberg. The last checklist of German Scelionidae (Dathe et al. 2001) also includes *T. choaspes* (Nixon), *T. discolor* (Ratzeburg) and *T. rufiventris* (Mayr). *Trissolcus choaspes* is now a junior synonym of *T. scutellaris* (Thomson) (Talamas et al. 2017). The taxonomic status of *Trissolcus discolor* is unverifiable, as there is no known type material and some authors even debate whether *T. discolor* should be placed in *Telenomus* rather than *Trissolcus* (Kononova 2014). As for *T. rufiventris*, it was not found, which we think is an intriguing matter considering the number of *Trissolcus* specimens examined by C.V. at SMNS.

Our results emphasise that much remains to be discovered regarding parasitoid ecosystem services in Germany. Many of the newly-recorded species parasitise the eggs of stink bugs which pose a threat to vegetable and fruit production. As wasp species differ in their host preference and biological control efficacy, accurate identification is an important factor in agroecological studies (Scaccini et al. 2020). The effect of the scelionid species assemblage on local pest populations merits further attention, especially in the context of organic or sustainable food systems.

Acknowledgements

The research was supported by the Bundesministerium für Bildung und Forschung, Berlin, Germany, project "German Barcode of Life III: Dark Taxa" (FKZ 16LI1901B). We thank Tanja Schweizer, Michael Haas and the GBOL staff for their assistance. We also thank Sebastian Görn for helping to interpret old German specimen labels.

References

- Abram P, Talamas E, Acheampong S, Mason P, Gariepy T (2019) First detection of the samurai wasp, *Trissolcus japonicus* (Ashmead) (Hymenoptera, Scelionidae), in Canada. Journal of Hymenoptera Research 68: 29-36. https://doi.org/10.3897/jhr.68.32203
- Austin AD, Johnson NF, Dowton M (2005) Systematics, evolution, and biology of scelionid and platygastrid wasps. Annual Review of Entomology 50 (1): 553-582. https://doi.org/10.1146/annurev.ento.50.071803.130500
- Cruaud A, Nidelet S, Arnal P, Weber A, Fusu L, Gumovsky A, Huber J, Polaszek A, Rasplus J-Y (2019) Optimised DNA extraction and library preparation for minute arthropods: application to target enrichment in chalcid wasps used for biocontrol. Molecular Ecology Resources 19: 702-710. https://doi.org/10.1111/1755-0998.13006
- Dathe HH, Taeger A, Blank SM (2001) Entomofauna Germanica, Band 4. Entomologische Nachrichten und Berichte (Dresden), Beiheft 7: 1-178.
- Dieckhoff C, Wenz S, Renninger M, Reißig A, Rauleder H, Zebitz CPW, Reetz J, Zimmermann O (2021) Add Germany to the list - Adventive population of *Trissolcus japonicus* (Ashmead) (Hymenoptera: Scelionidae) emerges in Germany. Insects 12 (5): 414. https://doi.org/10.3390/insects12050414
- Fabritius K, Popovici O (2007) A catalogue of Scelionidae from Romania (Hymenoptera, Platygastroidea). Entomologica Romanica 12: 133-161.
- Folmer O, Black M, Hoeh W, Lutz R, Vrijenhoek R (1994) DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Molecular Marine Biology and Biotechnology 3 (5): 294-299.
- Förster A (1856) Hymenopterologische Studien. II. Heft. Chalcidiae und Proctotrupii. Ernst ter Meer, Aachen, 152 pp. [In German].
- Gardner W, Blount J, Golec J, Jones W, Hu XP, Talamas E, Evans R, Dong X, Ray C, Buntin GD, Gerardo N, Couret J (2013) Discovery of *Paratelenomus saccharalis* (Dodd) (Hymenoptera: Platygastridae), an egg parasitoid of *Megacopta cribraria* F. (Hemiptera: Plataspidae) in its expanded North American range. Journal of Entomological Science 48 (4): 355-359. https://doi.org/10.18474/0749-8004-48.4.355
- Hausmann A, Krogmann L, Peters RS, Rduch V, Schmidt S (2020) GBOL III: Dark Taxa. iBOL Barcode Bulletin 10: 1.
- Huggert L (1979) Revision of the west Palaearctic species of the genus *Idris* Förster s.l. (Hymenoptera: Proctotrupoidea: Scelionidae). Entomologica Scandinavica, Suppl. 12 URL: http://zoobank.org/e8e5738b-008a-463e-aaab-cb4a4c15a72c
- Hymenoptera Online (2020) https://mbd-db.osu.edu/hol/

- Johnson N (1996) Revision of world species of *Paratelenomus* Dodd (Hymenoptera: Scelionidae). The Canadian Entomologist 128 (2): 273-291. https://doi.org/10.4039/ent128273-2
- Johnson NF (2011) A collaborative, integrated and electronic future for taxonomy. Invertebrate Systematics 25: 471-475. https://doi.org/10.1071/IS11052
- Kieffer JJ (1926) Das Tierreich. 48. Hymenoptera: Scelionidae. Walter de Gruyter & Co., Berlin/Leipzig, 885 pp. [In German].
- Kononova SV, Kozlov MA (2001) Scelionidae from Palearctic (Hymenoptera, Scelionidae). Subfamily Teleasinae, Baeinae. Akademperiodika, Kiev, 438 pp.
- Kononova SV, Kozlov MA (2008) Scelionidae of the Palearctic (Hymenoptera, Scelionidae). Subfamily Scelioninae. Tovarishchestvo Nauchnykh Izdanii KMK, Saint Petersburg, 489 pp.
- Kononova SV (2014) Egg-parasitoids of the genus *Trissolcus* (Hymenoptera, Scelionidae, Telenominae) from the Palaearctic fauna (the *flavipes* morphological group). 1. New species of the genus *Trissolcus*. Entomological Review 94 (7): 1019-1030. https://doi.org/10.1134/S0013873814070112
- Kozlov MA (1987) Superfamily Proctotrupoidea. In: Medvedev GS (Ed.) Determination of Insects of the European Portion of the USSR. 3, part 2. Brill, Leiden.
- Masner L (1993) Superfamily Platygastroidea. In: Goulet H, Huber JT (Eds) Hymenoptera of the World: An Identification Guide to Families. Agriculture Canada, Ottawa.
- Nees von Esenbeck CG (1834) Hymenopterorum Ichneumonibus Affinium Monographiae, Genera Europaea et Species Illustrantes. Volumen Secundum, Pteromalinorum, Codrinorum et Dryineorum. J.G. Cottae, Stuttgart, 448 pp. [In Latin].
- Notton D, Popovici O, Van Achterberg C, De Rond J, Burn J (2014) Parasitoid wasps new to Britain (Hymenoptera: Platygastridae, Eurytomidae, Braconidae & Bethylidae). European Journal of Taxonomy 99: 1-20. https://doi.org/10.5852/ejt.2014.99
- Popovici OA, Masner L, Notton D, Popovici M (2013) A review of Western Palaearctic *Amblyscelio* and *Baryconus* (Hymenoptera: Platygastroidea, Platygastridae). Zootaxa 3599 (4): 325-342. URL: http://zoobank.org/ec10501f-a56e-4b1e-a1cb-0f509cbb1050
- Popovici OA, Vilhelmsen L, Masner L, Mikó I, Johnson N (2017) Maxillolabial complex in scelionids (Hymenoptera: Platygastroidea): morphology and phylogenetic implications. Insect Systematics & Evolution 48 (4): 315-439. https://doi.org/10.1163/1876312x-48022156
- Ratzeburg JTC (1852) Die Ichneumonen der Forstinsecten in forslicher und entomologischer Beziehung. Band 3. Nicolai'schen Buchhandlung, Berlin, 272 pp. [In German].
- Scaccini D, Falagiarda M, Tortorici F, Martinez-Sañudo I, Tirello P, Reyes-Domínguez Y, Gallmetzer A, Tavella L, Zandigiacomo P, Duso C, Pozzebon A (2020) An Insight into the Role of Trissolcus mitsukurii as Biological Control Agent of Halyomorpha halys in Northeastern Italy. Insects 11 (5): 1-16. https://doi.org/10.3390/insects11050306
- Spiridon AG, Viciriuc M, Vasilita C, Pintilioaie A, Popovici O (2019) Two genera of platygastroids (Hymenoptera: Platygastroidea) new to the Romanian fauna. Travaux du Museum National d'Histoire Naturelle "Grigore Antipa" 62 (2): 213-220. https://doi.org/10.3897/travaux.62.e38298
- Stahl J, Totorici F, Pontini M, Bon M-, Hoelmer K, Marazzi C, Tavella L, Haye T (2019) First discovery of adventive populations of *Trissolcus japonicus* in Europe. Journal of Pest Science 92: 371-379. https://doi.org/10.1007/s10340-018-1061-2

- Talamas E, Buffington M (2015) Fossil Platygastroidea in the National Museum of Natural History, Smithsonian Institution. Journal of Hymenoptera Research 47: 1-52. https://doi.org/10.3897/JHR.47.5730
- Talamas E, Herlihy M, Dieckhoff C, Hoelmer K, Buffington M, Bon M, Weber D (2015) *Trissolcus japonicus* (Ashmead) (Hymenoptera: Scelionidae) emerges in North America. Journal of Hymenoptera Research 43: 119-128. https://doi.org/10.3897/JHR.43.4661
- Talamas E, Buffington M, Hoelmer K (2017) Revision of Palearctic *Trissolcus* Ashmead (Hymenoptera, Scelionidae). Journal of Hymenoptera Research 56: 3-185. https://doi.org/10.3897/jhr.56.10158
- Talamas EJ, Masner L, Johnson NF (2011) Revision of the Paridris nephta species group (Hymenoptera, Platygastroidea, Platygastridae. ZooKeys 133: 49-94. https://doi.org/10.3897/zookeys.133.1613
- Tortorici F, Talamas E, Moraglio S, Pansa M, Asadi-Farfar M, Tavella L, Caleca V (2019) A morphological, biological and molecular approach reveals four cryptic species of *Trissolcus* Ashmead (Hymenoptera, Scelionidae), egg parasitoids of Pentatomidae (Hemiptera). Journal of Hymenoptera Research 73: 153-200. https://doi.org/10.3897/jhr.73.39052

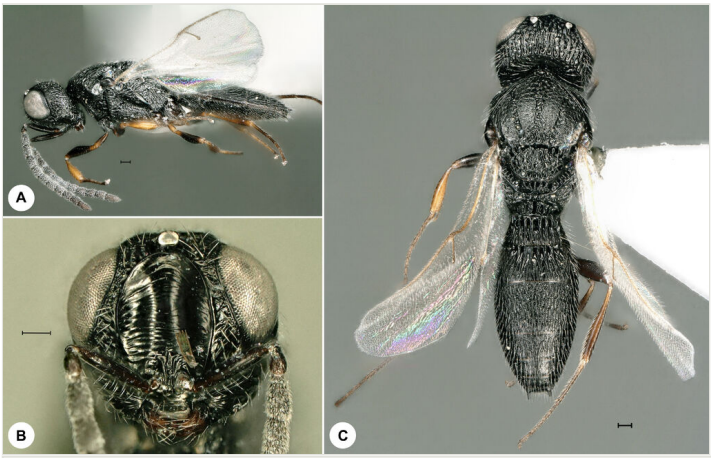

Figure 1.

Baryconus europaeus (Kieffer), female, SMNS_Hym_Sce_1093. **A.** Lateral habitus; **B.** Head, frontal view; **C.** Dorsal habitus. Scale bar = 100 µm.

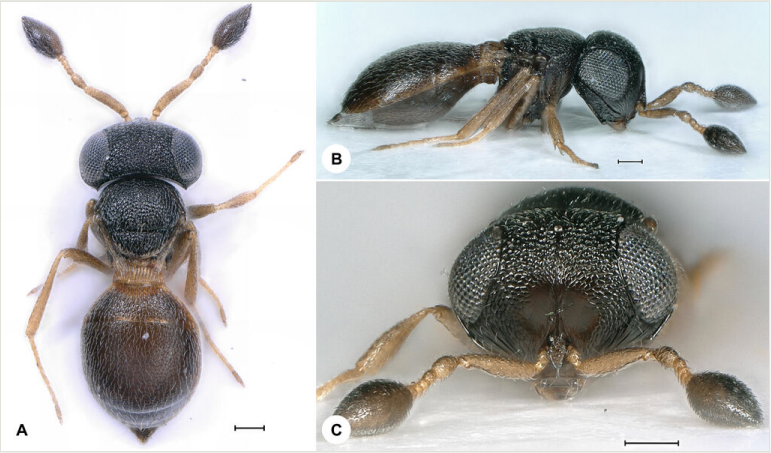

Figure 2.

Idris nigroclavatus (Kieffer), female, SMNS_Hym_Sce_001098. **A.** Dorsal habitus; **B.** Lateral habitus; **C.** Head, frontal view. Scale bar = 100 µm.

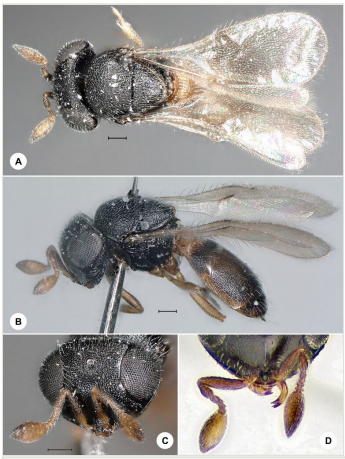

Figure 3.

Idris semiflavus (Kieffer), female, SMNS_Hym_Sce_001149. **A.** Dorsal habitus; **B.** Lateral habitus; **C.** Head, frontal view; **D.** Clava and mandible. Scale bar = 100 µm.

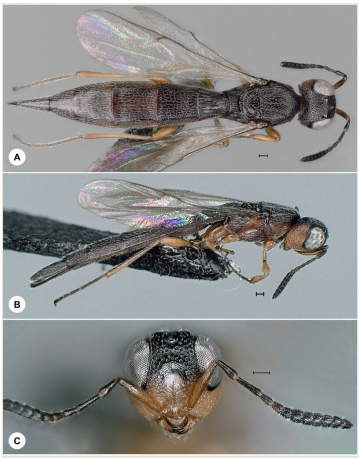

Figure 4.

Macroteleia bicolora Kieffer, female, SMNS_Hym_Sce_000731. **A.** Dorsal habitus; **B.** Lateral habitus; **C.** Head, frontal view. Scale bar = 100 µm.

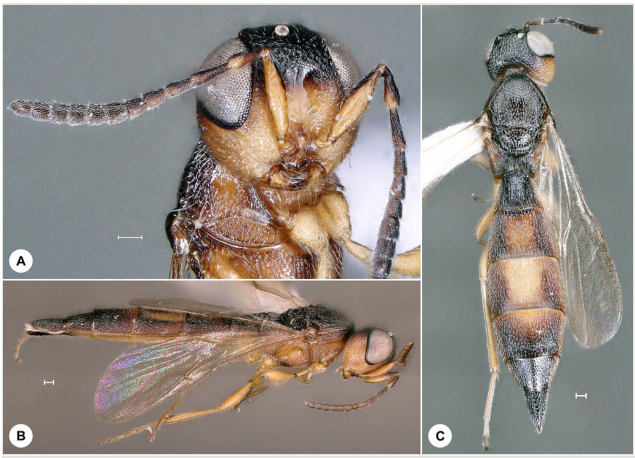

Figure 5.

Macroteleia pannonica Szabo, female, SMNS_Hym_Sce_000159. **A.** Ventral head; **B.** Lateral habitus; **C.** Dorsal habitus. Scale bar = 100 µm.

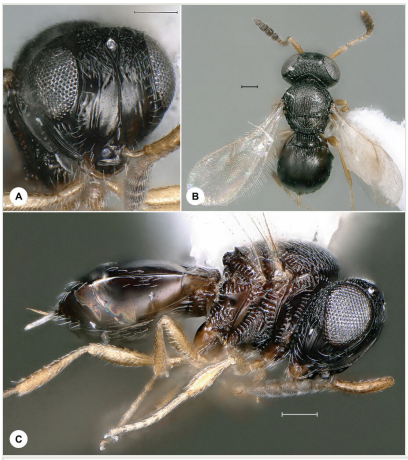

Figure 6.

Paratelenomus saccharalis (Dodd), female, SMNS_Hym_000305. **A.** Head, frontal view; **B.** Dorsal habitus; **C.** Lateral habitus. Scale bar = 100 µm.

Figure 7.

Probaryconus Kieffer, female, SMNS_Hym_Sce_000344. **A.** Dorsal habitus; **B.** Lateral habitus. Scale bar = 100 µm.

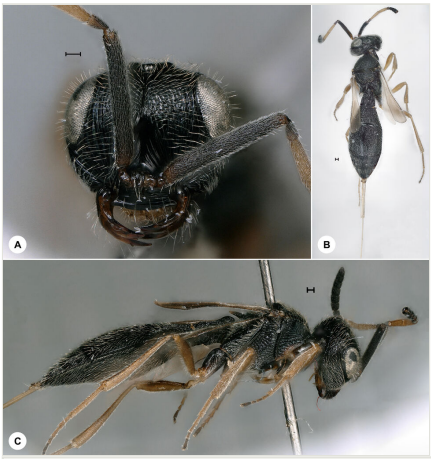

Figure 8.

Trimorus varicornis (Walker), female, SMNS_Hym_Sce_001100. **A.** Head, frontal view; **B.** Dorsal habitus; **C.** Lateral habitus. Scale bar = 100 µm.

Figure 9.

Trissolcus basalis (Wollaston), female. **A.** Lateral habitus, SMNS_Hym_Sce_000806; **B.** Dorsal habitus, SMNS_Hym_Sce_000805; **C.** Head, frontal view, SMNS_Hym_Sce_000806. Scale bar = 500 µm.

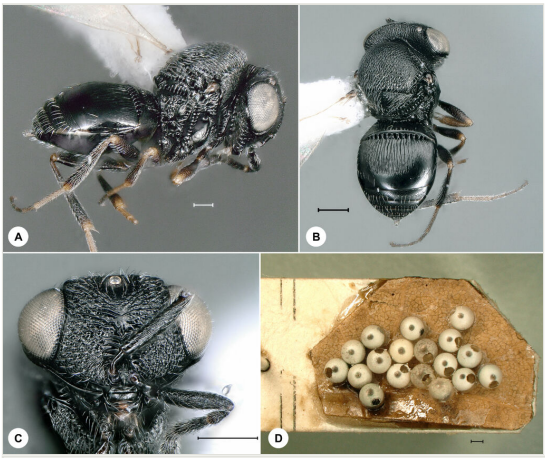

Figure 10.

Trissolcus belenus (Walker), female. **A.** Lateral habitus, SMNS_Hym_Sce_000719 (scale bar = 100 µm); **B.** Dorsal habitus, SMNS_Hym_Sce_000719 (scale bar = 200 µm); **C.** Head, frontal view, SMNS_Hym_Sce_000719 (scale bar = 200 µm); **D.** Preserved host material (scale bar = 500 µm).

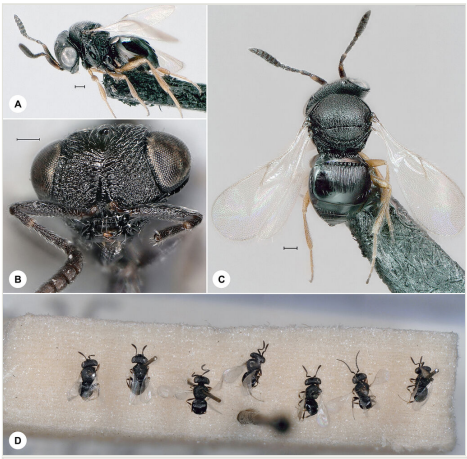

Figure 11.

Trissolcus colemani (Crawford), female. **A.** Lateral habitus, SMNS_Hym_Sce_000796; **B.** Head, frontal view; **C.** Dorsal habitus, SMNS_Hym_Sce_000797; **D.** Historical mounting method. Scale bar = 100 µm.

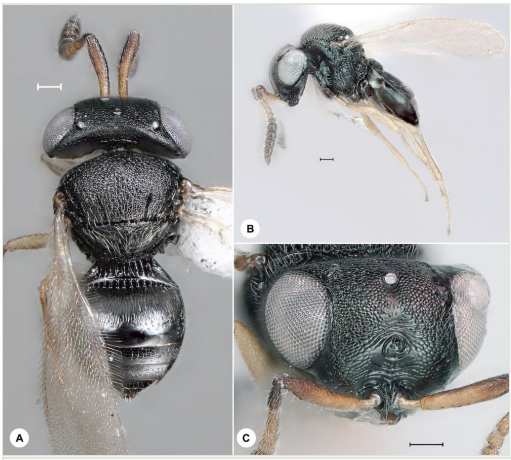

Figure 12.

Trissolcus flavipes (Thompson), female, SMNS_Hym_Sce_000188. **A.** Dorsal habitus; **B.** Lateral habitus; **C.** Head, frontal view. Scale bar = 100 µm.