Unexpected diversity in the relictual European spiders of the genus *Pimoa* (Araneae, Pimoidae)

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Abstract

Pimoidae is a small family of araneoid spiders, hitherto represented in Europe by two species with disjunct distribution in the Alps and in the Cantabrian Mountains of northern Spain. Here we report the description of two additional European species of *Pimoa*, discovered within the range of the only former alpine species *P. rupicola*: *P. graphitica* sp. nov. and *P. delphinica* sp. nov. The new species are distinguished from the latter by genitalic characters as well as by molecular characters. Based on the re-examination of old and recent abundant material collected in caves and other subterranean habitats, we revise the distribution patterns of the genus *Pimoa* in the Alps and outline the species distribution ranges. Molecular data suggest the existence of gene flow between populations of the two new species when in sympatry. The different species probably originated in the alpine region as a result of range contractions following dramatic climatic changes in the Alps since the mid Miocene. We interpreted the present-day overlapping distribution in light of a possible postglacial expansion. Finally, we provide insights on the natural history and life cycles of the new species and discuss their phylogenetic relationships within Pimoidae.

Running title: Two new European species of *Pimoa*

Introduction

The combination of topographical, geological and glacial factors contribute significantly to the faunistic importance of the Western alpine districts (Schmid and Kissling 2000). Moreover, the particular biogeographical frame in which the area is located, straddling the border between the Mediterranean, alpine and continental zones, makes it an important biodiversity hot-spot in Europe (e.g., Minelli *et al.* 2006; Nagy *et al.* 2012; Villemant *et al.* 2015).

Such peculiarities also mirror an extraordinary subterranean biodiversity, which has been investigated since the 19th century (Lessona 1878; Fairmaire 1882; Gestro 1885). The Western Alps contain more than 2,500 caves developed in carbonate and non-carbonate substrates (AGSP 2016), plus more than 2,000 artificial hypogean habitats such as bunkers and abandoned mines (Isaia *et al.* 2011a). The arachnid fauna of these caves is particularly well known, thanks to the works by numerous authors (e.g., Brignoli 1971; 1972; 1985; Arnò and Lana, 2005; Isaia *et al.* 2007a; 2011b). Yet, as we realized while conducting a phylogeographic study on alpine pimoids (Mammola *et al.* 2015a), there are still surprises in store.

Pimoidae currently includes four genera and thirty-eight extant species of araneoid spiders, distributed in Western North America, Southern Europe and Asia (World Spider Catalog, 2016), although new species remain undescribed (Hormiga, unpublished data). Among Pimoidae, *Pimoa* Chamberlin & Ivie, 1943 is the most species-rich genus. After the first revision of the genus (Hormiga 1994), which included 22 species, five more species have been recently described, including three from China (Griswold *et al.* 1999; Xu and Li 2007; 2009), one from India (Trotta 2009) and one from California (Hormiga and Lew 2014).

In Europe, pimoids are represented by *P. rupicola* (Simon, 1884), reported from Italy and France and *P. breuili* (Fage, 1931), from Spain. More specifically, *P. rupicola* ranges from the Graian to the Maritime Alps and Var, down to the Ligurian and Tusco-Emilian Apennine (Brignoli 1971; 1972; 1985; Thaler 1976; Le Peru 2007; Isaia *et al.* 2011b) while *P. breuili* is known from about ten localities in Cordillera Cantabrica (Hormiga 1994).

During extensive biospeleological surveys carried out in caves and other subterranean

habitats in the Western Italian Alps (Mammola *et al.* 2015a), we collected numerous specimens of *Pimoa* spiders within the alpine range of the genus, from the Graian Alps down to the Ligurian sea (approximately 200 km from the northernmost and the southernmost localities). The morphological examination of this material, as well as the study of old material stored in private collections and Museums, led to the identification of two undescribed species, occurring within the former range of *P. rupicola.*
In this paper we describe and illustrate *P. graphitica* sp. nov. and *P. delphinica* sp. nov., we summarize their phylogenetic affinities and provide insights into their ecology, distribution and natural history.

Materials and Methods

Molecular analyses

New sequences for the mitochondrial cytochrome *c* oxidase subunit I gene (hereinafter *cox1*) and the nuclear internal transcribed spacer 2 region (hereinafter *ITS-2*) of two adult individuals of *P. delphinica* sp. nov., two co-occurring juveniles of doubtful identification and one *P. breuili* were obtained following the protocols described in Mammola *et al.* (2015a). All *Pimoa* sequences of the *cox1* available in GenBank® were downloaded, along with those of the species *Nanoa enana* Hormiga, Buckle & Scharff, 2005, which was used to root the inferred trees (Dimitrov *et al.* 2012).

Sequences were edited and managed using Geneious R9 (http://www.geneious.com, Kearse *et al.* 2012). The alignment of the *cox1* sequences was trivial, as they showed no evidence of indel mutations or stop codons. The *ITS-2* sequences were aligned with the online version of MAFFT v. 7 using the global homology algorithm (G-INS-i). Indels were coded as presence/absence characters according to Simmons and Ochoterena (2000) simple coding, as implemented in SeqState (Müller 2005).

We explored the best partitioning schemes and substitution models simultaneously using PartitionFinder v.1.0.1 (Lanfear *et al.*, 2012) under a Bayesian information criterion (BIC). Maximum Likelihood (ML) analysis was conducted in RAxML v.7.4.2 (Stamatakis 2006). We inferred the best ML tree and bootstrap support automatically determining a sufficient number of bootstrap replicates, using the MRE convergence criteria. Bayesian (BI) analysis was conducted in MrBayes v.3.2 (Ronquist *et al.* 2012) with two independent runs of 20 million generations with four Markov chains (one cold, three heated), sampling every 1,000 generations. The chain convergence (ASDSF), the correct mixing (EES) and the number of generation to discard as burn-in were monitored with Tracer v.1.6 (Rambaut *et al.* 2014). The first 25% of trees in each run were discarded as burn-in. Parsimony analysis was conducted with TNT v.1.1 using 1,000 iterations of Wagner trees followed by tree bisection and reconnection (TBR) branch swapping and clade support assessed with 1,000 Jackknife resampling replicates (removal probability 36%).

Coalescent clusters in the *cox1* data partition were identified using the splits R package (Ezard *et al.* 2014) and the ultrametric tree obtained with BEAST 1.8.2 (Drummond et al. 2012) under a constant coalescent tree prior following Monaghan *et al.* (2009) and lognormal relaxed clock arbitrarily fixed to 1. Once coalescent clusters were identified, single representatives of each coalescent group were used to estimate divergence times in the *cox1* gene. Due to the lack of fossil information, we relied on external substitution rates for spiders available in the literature (Bidegaray-Batista and Arnedo 2011). We define a speciation birth-death (BD) tree prior and a strict clock, because the distribution of the standard deviation of the *ucld* parameter included zero in the preliminary analyses. The mean rate was set to 0.0125 with standard deviation 0.005 (0.005-0.02). Independent TrN evolutionary models with gamma heterogeneity were specified for each codon position, as suggested by PartitionFinder. Three independent chains were run remotely on CIPRES cyber-infrastructure. Chain convergence and mixing were assessed with Tracer (Rambaut *et al.* 2014) and the parameter and tree files were analyzed with the accompanying programs LogCombiner and TreeAnnotator.

ITS-2 allele networks were constructed using the statistical parsimony method (Templeton *et al.* 1992), with a connection limit of 95% as implemented in TCS v.1.21 and with the help of PopArt (online at: http://popart.otago.ac.nz).

Between and within species uncorrected genetic distances were calculated in MEGA v.7 (Kumar *et al.* 2016).

Morphological methods

Morphological methods are described in detail in Hormiga (2000; 2002). Taxonomic descriptions follow the format of Hormiga (1994) and Hormiga and Lew (2014). Specimens were examined and illustrated using a Leica M205A stereoscopic microscope equipped with a Leica DFC425 camera and LAS software or with a camera lucida. Further details were studied using a Leica DMRM compound microscope with a camera lucida. Single images were combined with Helicon Focus (version 5.3; www.heliconsoft.com) software from Helicon Soft Ltd., to increase depth of field. Left structures are depicted unless otherwise stated. Most setae and macrosetae are not depicted in the final palp and epigynum drawings. All morphological measurements are in millimetres. The position of the metatarsal trichobothrium I (TmI) is expressed according to Denis (1949a; i.e., the distance between the proximal end of the leg article and the trichobothrial base divided by the total length of the leg article). Female genitalia were excised using carbon steel breakable blades mounted on a cotton applicator wood stick (with the cotton end removed). Whenever possible, epigynal plugs were removed after treating the dissected epigynum with a KOH solution for ca. five minutes and transferring it to distilled water. Epigyna and palps were transferred to methyl salicylate (Holm 1979) for examination under the microscope. Label data are reported verbatim.

The type series is preserved in 70% ethanol and deposited at Museo Civico di Scienze Naturali "E. Caffi" di Bergamo (MSNB). Additional paratypes are stored at the George Washington University (Gustavo Hormiga laboratory; GH). Unless otherwise stated, all re-examined material is stored in the collection of Marco Isaia (Department of Life Science and Systems Biology, University of Turin). Material is listed in geographical order (north to south). For hypogean localities we report the speleological cadastre code in square brackets [cave number, regional code, provincial code], when available/applicable.

The following abbreviations are used: ALE = anterior lateral eyes; AER = anterior eye row; AME = anterior median eyes; PCS = pimoid cymbial sclerite; Pdp = male pedipalp; PME = posterior median eyes; PLE = posterior lateral eyes; TmI = position of metatarsus I trichobothrium.

Results

Molecular data

The new sequences obtained in the present study are available in GenBank® (KX018995-KX019004).

Specimen and sequence information are summarized in Supplementary Materials. Sequences of the *ITS-2* of the two analyzed specimen of *Pimoa delphinica* sp. nov. showed evidence of two alleles of different length. The two alleles were phased by eye. Only unique sequences were used for downstream analyses (i.e. single mtDNA haplotypes and *ITS-2* alleles). PartitionFinder selected three by-codon partitions as the best partitioning scheme, with the following models: HKY+ gamma, TrN+ invariants and F81+gamma and invariants for the first, second and third partition, respectively. There were 96 most parsimonious tree of 1,270 steps. All inference methods recovered similar topologies with different levels of resolution (Fig. 1). The European species were supported (PP>95% or BS>75) as monophyletic in the model-based analyses but not among the 96 most parsimonious trees, but no support for alternative topologies was recovered. All analyses supported *P. graphitica* sp. nov. and *P. delphinica* sp. nov. as sister species and *P. rupicola* as their sister group.

Uncorrected genetic distances for *cox1* are summarized in Table I. The *cox1* p-distance between *P. breulli* and the Alpine species was 14.2, 14.1 and 13.8% for *P. rupicola*, *P. graphitica* sp. nov. and *P. delphinica* sp. nov., respectively. Genetic divergences between *P. rupicola*, *P. graphitica* sp. nov. and *P. delphinica* sp. nov. were 0.113 and 0.117, respectively. The distance between *P. graphitica* sp. nov. and *P. delphinica* sp. nov. was instead 0.069. The within-divergence in *P. rupicola* and *P. graphitica* sp. nov. was 0.01 and 0.009, respectively. The average uncorrected genetic distance between *Pimoa* spider *cox1* available in Genebank was 15.3%.

The estimated time of the split according to the *cox1* of *P. rupicola* was 6.1 Ma (95% HPD

= 13.2-2.5 Ma) and the split between *P. graphitica* sp. nov. and *P. delphinica* at 2.6 Ma (95% HPD = 5.8-1 Ma).

The uncorrected genetic distances for *ITS-2* were generally low: about 0.14 between *P. breuili* and the Alpine taxa, 0.16 between *P. rupicola* and the other alpine taxa and 0.24, between *P. graphitica* sp. nov. and *P. delphinica* sp. nov. Because of the low level of variability, an allele network was preferred over the use of phylogenetic inference methods to represent population affinities. The application of the statistical parsimony approach with a connection limit of 8 steps (95% probability of no homoplasy), resulted in three independent networks corresponding to the three nominal species (Fig. 2). The networks revealed a clear geographic structure in the relationships of the alleles. One of the alleles of *P. delphinica* sp. nov. individuals was more closely related to those found in individuals of *P. graphitica* sp. nov. co-occurring in the same caves, suggesting interspecific gene flow (i.e., hybridization).

Discussion

Phylogeography

Molecular data support the existence of three separate evolutionary lineages within the Alpine *Pimoa* (see Fig. 1). The level of genetic divergence in the *cox1* barcode between *P. rupicola* and the two new species (~14%) falls within the range found in other nominal *Pimoa* species (average 16%, maximum 20%, minimum 10%). On the other hand, although showing clear morphological diagnostic characters (see Taxonomy), *P. graphitica* sp. nov. and *P. delphinica* sp. nov. are characterized by lower genetic divergences in the *cox1* (7%) than the average values for other species. It should be noted, however, that some of the nominal species most likely include cryptic or overlooked lineages that may actually constitutes different species. For example, genetic divergences within *P. reinformis* and *P. curvata* show similar values to those reported for the two new species here described (Wang *et al.* 2008). Nuclear data indicate that *P. graphitica* sp. nov. and *P. delphinica* sp. nov. sharing the same caves show evidence of interspecific gene flow. Although our sample size is low (n=2), in all cases we found clearly distinct mtDNA lineages corresponding to each species, but mixed nuclear alleles in *P. delphinica* sp. nov., which suggests an unidirectional introgression of males of *P. graphitica* sp. nov. into females of *P. delphinica* sp. nov.

Although only based on the *cox1* information, time estimates for the divergence of the species are in agreement with those reported in Mammola et al. (2015a) and indicate that the origin of the extant species of alpine *Pimoa* traces back to the middle to late Miocene, and was probably driven by the dramatic climatic changes undergone by the region during those ages. The two new species diverged much later: time estimates are compatible with an isolation of the ancestral populations during the earlier glacial cycles. The present day pattern of overlapping distributions may be the result of postglacial expansion of *P graphitica* sp. nov. into the once isolated *P. delphinica* sp. nov. localities. Accordingly, the interspecific gene flow between the two species would be relatively recent, which seems to be supported by the fact that two clearly different alleles with no evidence of recombination are still present in the hybrid individuals.

More data will be required to determine the degree of overlapping in the distribution of the two new species and to measure the extent and directionality of the introgression.

Natural history

Pimoa graphitica sp. nov., *P. delphinica* sp. nov. and *P. rupicola* mainly occur in the twilight zone of natural caves or artificial subterranean habitats such as mines, bunkers, blockhouses, cellars and ruined buildings. In such habitats, populations may be locally very abundant. In addition, specimens were occasionally collected in alpine screes, boulder fields, under big rocks and other superficial (= shallow) subterranean habitats (SSH *sensu* Culver and Pipan 2009; 2014). Several specimens (especially males and immatures) of both *P. graphitica* sp. nov. and *P. rupicola* were also collected in pitfall traps placed in the leaf litter of broad-leaved woods at mid altitudes (600-1300 m a.s.l.).

The life cycle is very similar in both *P. graphitica* sp. nov. and *P. delphinica* sp. nov.: males reach the adult stage at the beginning of summer (June), while females and immatures are present all year. We observed deposition of cocoons in June-July. The cocoon is spherical [diameter 8-11 mm (n=3)] and lacks a stalk. Like in *P. edenticulata* Hormiga, 1994, the cocoon is suspended beneath the female web and covered with debris (Hormiga 1994). In *P. graphitica* sp. nov. it contains 90-110 eggs (n=3). Cocoons are usually guarded by females (Fig. 3). First instar spiderlings remain within the cocoon, presumably feeding on the yolk (see Foelix 1996). Subsequently, sibling spiderlings emerge from the cocoon and cluster together in a spherical group near the cocoon.

P. graphitica sp. nov. shows a general preference for the medium alpine montane belt, from 500 up to 1,500m a.s.l. (mean: 1,082m; n=65), and inhabits cavities characterized by mean annual temperature values ranging from 4 to 11 °C (mean: 8.6°C; n=65) (see also Isaia *et al.* 2007a). Exceptionally, we recorded the species at 2,375 m a.s.l., in military bunkers (Tour Real Blockhouse, Pontechianale, CN).

P. delphinica sp. nov. was mainly collected in wild caves and military bunkers at an altitude ranging from 1,230 to 2,242 a.s.l. (mean: 1,753m; n=7), and inhabits sites characterized by mean annual temperature values ranging from 2 to 8 °C (mean: 5.5°C; n=7).

Both species are able to maintain permanent subterranean populations but seem somewhat related to the outer environment. Accordingly, they do not show particular adaptations to the hypogean life (i.e. troglomorphic traits; *sensu* Christiansen 1962). Following the classical biospeleological nomenclature (Sket 2008) both species can be regarded as troglophiles, as already observed by Brignoli (1971; 1972; 1985) and Thaler (1976) for *P. rupicola*. All alpine species of European *Pimoa* usually inhabit the outermost section of caves (the so-called epigean/hypogean ecotone or twilight zone; Prous *et al.* 2004; 2015), where they are generally found on cave walls or among rocky blocks on the ground, hanging on horizontal sheet webs (see web examples in Hormiga 1994: fig. 3, 4, 5, 6, 7, 8; Isaia *et al.* 2011b: fig. 2.23).

During recent speleological investigations, two of us (MI and SM) have recorded several invertebrates as prey items of *P. graphitica* sp. nov., including flies (*Limonia* spp.), millepedes (Diplopoda), geophilomorph centipedes (Chilopoda) and small-sized earthworms (Oligochaeta). In few occasions we have also observed gastropoda (*Oxychilus* sp.) wrapped in webs, but we have never observed active feeding.

P. graphitica sp. nov. is usually found in syntopy with similarly sized troglophile orb-weaving spiders, such as *Meta menardi* (Latreille, 1804) and *Metellina merianae* (Scopoli, 1763) (Araneae, Tetragnathidae) and, at least in three hypogean sites, with *Meta bourneti* Simon, 1922 (Arnò and Lana 2005; Isaia *et al.* 2011b; Mammola and Isaia 2014). There, they often share similar micro-habitats, which may result in a hypothetical niche overlap (Mammola *et al.*, submitted).

Distribution

The known distribution of *Pimoa graphitica* sp. nov., *P. delphinica* sp. nov. and *P. rupicola* is reported in Fig. 4. *P. graphitica* sp. nov. has to be regarded as steno-endemic Western Alpine species. The known distribution of *P. graphitica* sp. nov. is centered in the Graian Alps, where the species is continuously distributed from Valli di Lanzo (Province of Torino), all along the Cottian Alps down to the river Stura di Demonte (Province of Cuneo), marking the geographical border with Maritime Alps. The only French record of *P. graphitica* sp. nov. refers to rocky debris near Château Queyras (R. Bosmans leg.). The northernmost known locality inhabited by the species is the Pugnetto hypogean complex, well known among biospeleologists for the presence of several steno-endemic elements with point-like distribution such as *Troglohyphantes bornensis* Isaia & Pantini, 2008 (Araneae, Linyphiidae) and *Dellabeffaella roccae* (Capra, 1924) (Coleoptera, Cholevidae) (Isaia and Pantini 2008; Isaia *et al.* 2011b; Mammola *et al.* 2015b). The cave Grotta della Chiesa di Valloriate [1056 Pi/CN] and the cave Buco dell'Aria Calda [1102 Pi/CN], at the very southern section of Cottian Alps, mark the southern border of the distribution of this species. This area represents the observed geographical limit that separates *P. graphitica* sp. nov. (Cottian Alps) from *P. rupicola* (Maritime Alps and Apennines). It is worth noting that the two species have never been recorded in syntopy within the same hypogean habitat. Given their peculiar geographical position, Maritime Alps are regarded by biogeographers as a biodiversity hot-spot (Villemant *et al.* 2015). In our case, the climatic peculiarity of the area (low continentality, namely reduced mean annual temperature range and high precipitations) as well as its complex geological and glacial history seem to represent the most important factors in determining the segregation of the two species (Mammola *et al.* 2015a).

South of the southern border of the Cottian Alps down to the Ligurian Alps, we only recorded *P. rupicola*. Additional records are reported in literature for France (Alpes Maritimes and Var; Le Peru 2007) and from the Tuscan Apennine (Tuscany; Brignoli 1971; Thaler 1976; Hormiga 1994). Our record from Central Apennines (Lazio) extends the range of *P. rupicola* of nearly 300 km southward.

P. delphinica sp. nov. has to be regarded as steno-endemic Italian species with a restricted Western Alpine distribution. Its distribution range appears like a small enclave within the range of *P. graphitica* sp. nov. To date, the species was recorded only in seven nearby localities, in the Varaita and Bellino valleys. We hypothesize that the distribution of this species stretches from the Bellino valley westward to the adjacent French valleys. Additional faunistic investigations are needed to confirm this hypothesis. The presence of immatures of *P. graphitica* sp. nov. (identified by using genetic data) was also detected in two sites inhabited by *P. delphinica* sp. nov. ([1041 Pi/CN] Buco delle Ciauie di Casteldelfino and [1017 Pi/CN] Buco dei Drai). On the contrary, the co-occurrence of adults of the two species was never documented.

Taxonomy

Family Pimoidae Wunderlich

Genus *Pimoa* Chamberlin & Ivie

Type species *Labulla hespera* Gertsch & Ivie, 1936 (by subsequent designation by Chamberlin & Ivie 1943: 9)

Pimoa graphitica Mammola, Hormiga & Isaia, sp. nov.

Louisfagea rupicola Brignoli, 1971: 162, f. 40-43 (#@)
Pimoa sp. Jocqué & Dippenaar-Schoeman, 2006: 211, f. 82 a-f (#@)
Pimoa rupicola Isaia *et al.,* 2011b: 118, f. 2.21A-C, 2.22-23 (#@) (misidentification)

(Figs 5, 6, 7*A-B*, 8*A-C*, 10*B*, *E*)

Material examined

Holotype male. Italy, Piemonte, Cottian Alps, Chisone valley, Perosa Argentina, Hamlet of Pons, Abandoned graphite mine, 44° 57' 44.6" N, 7° 10' 53.9" E, hand collected, 11.vi.2015, M. Isaia, S. Mammola and J. Dejanaz leg. (MSNB).

Paratypes. 2# and 2@: same as holotype (MSNB); 1@: Chisone valley, Inverso Pinasca, Fornaisa, Abandoned graphite mine, 44° 55' 19.7" N, 7° 14' 12.3" E, hand collected, 11.vi.2015, M. Isaia, S. Mammola and J. Dejanaz leg. (MSNB); 1#, 1@: Chisone valley, S. Germano Chisone, Hamlet of Tornini, Abandoned graphite mine, 44° 54' 29.6" N, 7° 11' 55.2" E, hand collected, 11.vi.2015, M. Isaia, S. Mammola and J. Dejanaz leg.; 1#, 1@: same locality, 20.ix.2014, M. Isaia and S. Mammola leg. (GH1857); 1@: Pramollo

Valley, S. Germano Chisone, Abandoned graphite mine of Bonousso-1, 44° 54' 03.1", N 7° 13' 01.3" E, hand collected, 6.v.2015, S. Mammola, G. Marangoni and E. Piano leg. (MSNB); 1@: same locality, hand collected, 11.vi.2015, M. Isaia, S. Mammola and J. Dejanaz leg. (MSNB).

Etymology

The species was firstly identified studying material collected in abandoned graphite mines of Chisone and Pramollo Valleys (Cottian Alps, Italy). The species epithet is an adjective referring both to the localities of the type series and to the metallic grey coloration of the abdomen (Figs. 5*F*, *G*).

Diagnosis

Morphologically *Pimoa graphitica* sp. nov. is most similar to *P. rupicola* and *P. delphinica* sp. nov. Males of *P. graphitica* sp. nov. can be easily distinguished from those of the latter two species by the shape of the PCS, especially in ventral and ectal views. In *P. rupicola* the PCS bears an acute, falciform apophysis (Fig. 11; see also Hormiga 1994: fig. 15, 16), less pointed in *P. delphinica* sp. nov (Figs. 9, 10*F*) absent in *P. graphitica* sp. nov. (Figs. 7*A-B*, 10*E*). In addition, *P. graphitica* sp. nov. has a small cluster of (ca. six) cymbial cuspules (Figs. 6*A-B*, 7*A-B*), adjacent to the PCS-cymbium connection, which is absent in *P. rupicola* (Fig. 11) or restricted to one or two (or no) isolated cuspules in *P. delphinica* sp. nov. (Figs. 7*C-D,* 9*A-B*). The median apophysis of *P. rupicola* (Fig. 11*A-B*, *D*) is longer and thinner than that of *P*. *graphitica* sp. nov. (Fig. 6*A-B*) and *P. delphinica* sp. nov. (Fig. 9*B-C*). Females are best diagnosed by a caudal view of the epigynum, although differences across these three *Pimoa* species can be subtle and the relevant features are often occluded by hard epigynal plugs that are difficult to remove. In caudal view the epigyna of *P. graphitica* sp. nov. (Figs. 5*B*, 8*B*, 10*B*), *P. rupicola* (Fig. 10*C-D*) and *P. delphinica* sp. nov. (Figs. 8*E*, 10*A*) differ in the shape of both the epigynal septum that connects the dorsal and ventral epigynal plates and the openings on either side. The mid region of the septum is narrowest in *P. delphinica* sp. nov. and *P. graphitica* sp. nov., but these two can be differentiated by the longitudinally narrower openings of the former species. The mid region of the septum of *P. rupicola* is wider than in the other two species.

Description

Male (holotype). Total length 7.18. Cephalothorax 3.43 long, 2.81 wide, 2.87 high.

Sternum 1.81 long, 1.62 wide. Abdomen 4.84 long, 2.50 wide. AER diameter 1.06. PER diameter 1.12. AME diameter 0.17. PLE 1.09, PME 1.09, ALE 1.09 times one AME diameter. AME separation 0.18 times their diameter, PME separation 0.5 times their diameter. PME-PLE separation 0.72 times one PME diameter, AME-ALE separation 0.58 times one ALE diameter. Clypeus height 2.90 times one AME diameter. Carapace with deep longitudinal fovea (Fig. 5*F*). Chelicerae with three prolateral and two retrolateral teeth; 18 cheliceral stridulating files; striae subtle, scaly. Legs uniform, light brown. Leg measurements as in Table II. Femur I 2.81 times length of cephalothorax. TmI: 0.60. Metatarsus IV trichobothrium present (medial). Pedipalp as in Figs. 6, 7*A*-*B*, 10E. Pedipalpal tibia with five lateral trichobothria (Fig. 7*A*-*B*).

Female (paratype from Bonousso-1, San Germano Chisone). Total length 8.59. Cephalothorax 3.75 long, 2.65 wide, 2.43 high. Sternum 1.75 long, 1.87 wide. Abdomen 5.93 long, 4.06 wide. AER diameter 1.00. PER diameter 1.06. AME diameter 0.15. PLE 1, PME 1, ALE 1 times one AME diameter. AME separation 0.4 times their diameter, PME separation 0.8 times their diameter. PME-PLE separation 1.2 times one PME diameter, AME-ALE separation 1 times one ALE diameter. Clypeus height 2.6 times one AME diameter. Carapace with deep longitudinal fovea. Cheliceral teeth, stridulating files and legs like in male. Leg measurements as in Table II. Femur I 2.05 times the length of cephalothorax. TmI: 0.60. Metatarsus IV trichobothrium present (medial). Epigynum as in Figs. 5*A*-*C*, 8*A*-*B*, 10*B*. Vulva as in Figs. 5*D*-*E*, 8*C*.

Additional material examined

Original data

ITALY, Piemonte: Gran Bosco di Salbertrand, Salbertrand, 18.ix.2000, G. Della Beffa leg. 1# (MSNB); Devejs, in screes and boulder fields, Gravere, 13.vi.2014, S. Mammola & E. Piano leg. 2# 2@; Miniera Argentifera di Rouget, Gravere, 19.ii.2016, M. Isaia & S. Mammola leg. 4@; [1597 Pi/TO] Balma Fumarella, Gravere, 11.v.2012, M. Isaia & S. Mammola leg. 1@; [1569 Pi/TO] Grotta della Testa di Napoleone, Borgone di Susa, 05.xii.2011, M. Isaia & S. Mammola leg. 1@; [1616 Pi/TO] Grotta delle Meta Inferiore e Superiore, Borgone di Susa, 04.v.2012, M. Isaia & S. Mammola leg. 1@; Barmarola, in a ruined building, Coazze, 20.ii.2011, M. Isaia & R. Galindo leg. 1@; Miniera di Garida, Giaveno, 20.ii.2011, M. Isaia 2@; [1620 Pi/TO] Boira dal Farfujet (=Balma dei Folletti), Novalesa, 23.i.2015, M. Isaia, E. Piano & D. Giuliano leg. 2@; Bonousso-1, abandoned graphite mine, S. Germano Chisone, 6.v.2015, S. Mammola, G. Marangoni & E. Piano leg. 1@; same locality, 06.v-11.vi.2015, pitfall trap, 1juv; Tornini mine, Pramollo, 11.vi.2015, M. Isaia,

S. Mammola & J. Dejanaz leg. 2# 1@; Fortino a ovest della Balma di Rio Martino, Opera 372 Rocca di Granè, Crissolo, 13.xi.2014, M. Isaia, S. Mammola & M. Paschetta leg. 7@; [1009 Pi/CN] Buco di Valenza, Crissolo, 13.ix.1995, E. Lana leg. 1@; same locality, 13.xi.2014, M. Isaia, S. Mammola & M. Paschetta leg. 4@; [1250 Pi/CN] Grotta delle Pimoa, Oncino 18.vi.2015, M. Isaia & S. Mammola leg. 2@; Private cellar in Chianale, Pontechianale, 28.vi.2012, S. Mammola leg. 1@; Tour Real blockhouse, Pontechianale, 29.vii.2014, S. Mammola leg. 2@; [1041 Pi/CN] Buco delle Ciauie di Casteldelfino, Casteldelfino, 16.vii.2015, M. Isaia & S. Mammola leg. 1 juv (PK717; sequenced); [1017 Pi/CN] Buco del Drai (=Pertus dal Drai), Sampeyre, 16.vii.2015, M. Isaia & S. Mammola leg. 1 juv (PK718; sequenced); [1195 Pi/CN] Grotta e forra della Marmorera, Busca, 18.vi.15, M. Isaia & S. Mammola leg. 5@; [1122 Pi/CN] Grotta dello Scoiattolo, Valgrana, 21.xi.2005, M. Isaia leg. 1@ (GH1859), same locality, 13.i.2015, M. Isaia, S. Mammola & M. Paschetta leg. 3# 3@; [1102 Pi/CN] Buco dell'Aria Calda, Vignolo, 03.x.2014, M. Isaia, S. Mammola & M. Paschetta leg. 2@; [n.c. Pi/CN] Barmo Scuro, Roccabruna, 14.vii.2014, M. Isaia & R. Galindo leg. 2@; [n.c. Pi/CN] Balma Castlas, Roccabruna, 25.vii.2015, M. Isaia & R. Galindo leg. 1# 1@; [1056 Pi/CN] Grotta della Chiesa di Valloriate, Valloriate, 13.i.2015, M. Isaia, S. Mammola & M. Paschetta leg. 2@; Miniera di Barite, Pontebernardo, 28.ix.2003, E. Lana leg. 1@.

Re-examined material

Former literature records (sub *P. rupicola*) are here revised and assigned to *P. graphitica* on the base of morphological examination. The identification of juveniles is based on the identification of adults occurring in the same locality.

<u>FRANCE, Hautes Alpes:</u> rocky debris near Château Queyras, 09.viii.1980, Bosmans R. leg. 2# 6@ (Jocqué and Dippenaar-Schoeman 2006 sub *Pimoa* sp.); <u>ITALY, Piemonte:</u> [1563 Pi/TO] La Büra, Gravere, 26.x.2002, E. Lana leg. 1@ (Lana *et al.* 2003; Arnò and Lana 2005), same locality, 19.xii.2006, M. Isaia leg. 1@ (Isaia et al. 2011b); [1620 Pi/TO] Boira dal Farfujet (=Balma dei Folletti), Novalesa, 11.viii.2002, E. Lana leg. 1@ (Isaia et al. 2011b); [1666 Pi/TO] Balma di Sant'Antonio, Chiomonte, 16.viii.2001, E. Lana leg. 1@; 18.xii.2006, E. Lana leg. 1juv (Lana *et al.* 2002; Arnò and Lana 2005; Isaia et al. 2011b); Buco di Romean (=Grand Pertus), Chiomonte, 21.x.2007, M. Isaia and R. Galindo leg. 1@ 1juv (Isaia *et al.* 2011b); Miniera della Colletta, Giaveno, VII.2001, E Lana leg. 2# 2@ 3juv (Lana *et al.* 2001; 2002; Arnò and Lana 2005); 15.vii.2001, E. Lana leg. 1@ (Isaia *et al.* 2011b); Ex miniera di pirite dei Giai, Giaveno, 12.iii.2000, E. Lana leg. 4@ 4juv (Arnò and Lana 2005); Cave di Marra, Villarfocchiardo, 22.iv.2008, M. Isaia and M. Motta leg. 2juv (Isaia *et al.* 2011b); Ex miniera di S. Pietro Val Lemina, S. Pietro, 23.xi.2000, E. Lana leg. 1@ 1juv (Isaia *et al.* 2011b); Prospetto di miniera di Boccetto, Perrero, 21.ii.2007, M. Isaia leg. 1@ (Isaia *et al.* 2011b); [1591 Pi/TO] Tana del diavolo, Roure, 11.xi.2006, M. Isaia leg. 1@ (Isaia *et al.* 2011b); [1621 Pi/TO] Tuna dal Diau (=Grotta di Chiabrano), Perrero, 2010, M. Isaia leg. 1@ (Isaia *et al.* 2011a); Fortino militare presso Bout du Col, Prali, 20.vii.2006, M. Isaia leg. 1@ (Isaia *et al.* 2011b); Galleria Gianfranco, Miniere di talco di Fontane, Prali, 2010, M. Isaia leg. 2# (Isaia *et al.* 2011a); Galleria Gianna, Miniere di talco di Fontane, Prali, 30.viii.2009, M. Isaia leg. 1@ (Isaia *et al*, 2011a); Galleria Santa Barbara, Miniere di talco di Fontane, Prali, 2010, M. Isaia and M. Paschetta leg. 1@ (Isaia *et al.* 2011b); Galleria Paola, Miniere di talco

di Fontane, Prali, 20.vii.2006, M. Isaia leg. 1@ (Isaia *et al.* 2011b); [1623 Pi/TO] Grotticella 4, Cavour, 15.vi.2006, E. Lana leg. 1@ 3juv (Isaia *et al.* 2011b); [n.c. Pi/CN] Il Fringuello, Crissolo, 21. XII.2001, E. Lana leg. 1@ 2juv (Arnò and Lana 2005), same locality, 16.vi.2002, T. Pascutto leg. 6@ (Isaia *et al.* 2011b); [1001 Pi/CN] Grotta di Rio Martino, Crissolo, 02.iv.2000, E. Lana leg. 1juv; 08.x.2000, T. Pascutto and S. Bugalla leg. 3@ 1juv; VI.2006, M. Isaia leg. 2# 2juv (Isaia *et al.* 2011b); [1250 Pi/CN] Grotta delle Pimoa, Oncino, 27.viii.2000, E. Lana leg. 2# 2juv (Lana *et al.* 2001; Lana 2005; Arnò and Lana 2005); Fortino a ovest della Balma di Rio Martino, Opera 372 Rocca di Granè, Crissolo, 21.xii.02, C. Arnò and E. Lana leg. 1# 1@ 7juv (Arnò and Lana 2005), same locality, 10.vi.2006, M. Isaia leg. 1#, 7juv (Isaia et al. 2011b); [1062 Pi/CN] Tana del Tasso, Sanfront, 01.v.2000, E. Lana leg. 3@ 5juv (Lana *et al.,* 2001; Arnò and Lana 2005); [1251 Pi/CN] Pertui de l'Oustanetto, Ostana, E. Lana leg. 1#, 4juv (Lana *et al.* 2002; Lana 2005; Arnò and Lana 2005); Miniera della Quagna, Monterosso Grana, 21.xi.2006, M. Isaia leg. 1@ 4juv (Isaia *et al.* 2011b); [1010 Pi/CN] Grotta delle Fornaci, Rossana, 13.viii.1995, G. Cormotti and A. Baldan leg. 1# (Isaia *et al.* 2007b; MSNB); [1024 Pi/CN] Grotta dei Partigiani, Rossana, 05.viii.2000, E. Lana leg. 1@ (Lana 2001; Arnò and Lana 2005); 03.ii.2007, M. Isaia and E. Lana leg. 5 juv (Isaia *et al.* 2011b); [1035 Pi/CN] Buco della Lausiera, Acceglio, 15.viii.2000, E. Lana leg. 1@ (Isaia *et al.* 2011b); [1040 Pi/CN] Pozzo fessura di Greguri, Acceglio, 08.x.2006, E. Lana leg. 1@, 1juv (Isaia *et al.* 2011b); [1200 Pi/CN] Buco 2 della Lausiera, Acceglio, 15.viii.2000, E. Lana leg. 1@ (Lana *et al.* 2001; Lana 2005; Arnò and Lana 2005); [1203 Pi/CN] Grotta 3 di Saretto, Acceglio, 17.iii.2000, E. Lana leg. 4@ 2juv (Arnò and Lana 2005); Pertus del Chargiòu (=Buco del Caricatore), Acceglio, 13.x.2003, E. Lana leg. 1@ 1juv (Arnò and Lana 2005); Sotterranei dei forti N e S del bivio di Elva, Opera 319-320, Stroppo, 16.iv.2000, E. Lana leg. 5@ 2juv; 26.xi.2000, E. Lana and C. Arnò leg. 1@, 3juv 11.iv.2006, M. Isaia leg. 1@, 2 juv (Isaia *et al.* 2011b); [1195 Pi/CN] Grotta e forra della Marmorera, Busca, 12.viii.2000, E. Lana leg. 2# 1@ (Arnò and Lana 2005); [1188 Pi/CN] Pertus del Bec, Pradleves, 13.x.1999, E. Lana leg. 1@ (Arnò and Lana 2005); [1015 Pi/CN] Buco della Mena'd Mariot, Bernezzo, 14.v.2000, E. Lana leg. 1@ (Arnò and Lana 2005).

Verified citations

List of the former records (sub *P. rupicola* or otherwise specified) now assigned to *Pimoa graphitica* sp. nov. on the basis of examination of fresh material collected at the same locality (see original material and re-examined material).

<u>ITALY, Piemonte:</u> [1597 Pi/TO] Balma Fumarella (Isaia *et al.* 2011b); Giaveno, Torino, (Thaler 1976 sub *Louisfagea rupicola*; Hormiga 1994); Ex miniera di S. Pietro Val Lemina, S. Pietro Val Lemina (Arnò and Lana 2005); [1591 Pi/TO] Tana del Diavolo, Roure (Lana *et al.* 2003; Arnò and Lana 2005); [1621 Pi/TO] Tuna dal Diau (=Grotta di Chiabrano), Perrero (Arnò and Lana 2005); [1538 Pi/TO] Ghieisa d'la Tana, Angrogna, (Isaia *et al.* 2011b); [1001 Pi/CN] Grotta di Rio Martino, Crissolo (Brignoli 1975; 1985 sub *Louisfagea rupicola;* Lana *et al.* 2001; Lana 2001; Arnò and Lana 2005); [1148 Pi/CN] Buco del Maestro, Paesana (Lana *et al.* 2001; Lana 2005; Arnò and Lana 2005); [1024 Pi/CN] Grotta dei Partigiani, Rossana (Brignoli 1975; 1985 sub *Louisfagea rupicola*); [1248 Pi/CN] Grotta della cava Nord di Rossana (Lana *et al.* 2003; Lana 2005; Arnò and Lana 2005); Sotterranei dei forti N e S del bivio di Elva, Opera 319-320, Stroppo

(Arnò and Lana 2005); [n.c. Pi/CN] Barmo Scuro, Roccabruna (Isaia *et al.* 2011b); [1195 Pi/CN] Grotta e forra della Marmorera, Busca (Morisi, 1969 sub *Labulla ripicola* (*sic*!)*;* Morisi, 1971 sub *Louisfagea rupicola;* Brignoli 1971; 1972 sub *Louisfagea rupicola;* Casale 1971 sub *Lonisfagella r.* (*sic*!)*;* Arnò and Lana 2005; Lana *et al.* 2003; Lana 2005; Isaia *et al.* 2011b); [1122 Pi/CN] Grotta dello Scoiattolo, Valgrana (Isaia *et al.* 2011b); [1056 Pi/CN] Grotta della Chiesa di Valloriate, Valloriate (Isaia *et al.* 2011b).

Unverified citations

Former records (sub *Pimoa rupicola* or otherwise specified) that we were not able to verify, likely to be assigned to *P. graphitica* sp. nov. on the basis of geography.

<u>ITALY, Piemonte:</u> [1501 Pi/TO] Grotta del Pugnetto (=Borna Maggiore del Pugnetto), Mezzenile (Isaia *et al.* 2011b); Ex miniera di Cudine, Corio (Isaia *et al.* 2011b); [1532 Pi/TO] Le Voute sup., Bussoleno (Isaia *et al.* 2011b); Sotterranei del Forte Serre Marie, Fenestrelle (Brignoli 1975; 1985 sub *Louisfagea rupicola*; Arnò and Lana 2005); [1579 Pi/TO] Fessura de l'Enfer, Exilles (Isaia *et al.* 2011b); Bagnolo Piemonte, Saluzzo (Thaler 1976 sub *Louisfagea rupicola*; Hormiga 1994); [1265 Pi/CN] Pertus d'la Tundo, Isasca (Isaia *et al.* 2011b); [1205 Pi/CN] Tana della Volpe di Dronero, Dronero (Lana *et al.* 2002; Lana 2005; Arnò and Lana 2005); [1242 Pi/CN] Abissotto della Fauniera, Demonte (Isaia *et al.* 2011b); Miniera di Carbone di Monfieis, Demonte (Lana 2005).

Misidentifications

As far as we are concerned, the first individuals of *Pimoa graphitica* sp. nov. were collected by Augusto Vigna Taglianti in the hypogean locality of Grotta e Forra della Marmorera [1195 Pi/CN], municipality of Busca, Province of Cuneo [28.viii.1969, leg. 2# 1juv; Morisi, 1969 sub *Labulla ripicola* (*Sic*!)]. The same material was later examined by Brignoli (1971). Although no locality is specified, the illustration provided (Brignoli 1971: p. 162, f. 40-43) likely depicts the material collected by Vigna Taglianti in 1969 given that all other localities provided by Brignoli (1971) are likely assigned to *P. rupicola* on the basis of geography. Further citations of Vigna Taglianti's material appear in Morisi (1971), Casale (1971), Lana *et al.* (2003), Arnò and Lana (2005), Lana (2005) and Isaia *et al.* (2011b). Unfortunately, we were not able to re-examine this material, but we collected several specimens in the same locality and identified them as *P. graphitica* sp. nov.

Similarly, we re-assigned to *P. graphitica* sp. nov. part of the material examined by Hormiga (1994).

The so far unidentified species illustrated by Jocqué and Dippenaar-Schoeman (2006: p. 211, f. 82 a-f sub *Pimoa* sp.) on material collected by Robert Bosmans in Queyras

(France), is now assigned to *Pimoa graphitica* sp. nov.

Finally, the male and female illustrated in Isaia *et al.* (2011b: p. 118, f 2.21 A-C; p. 119, f. 2.23 sub *P. rupicola*) are in fact *Pimoa graphitica* sp. nov.

Pimoa delphinica **Mammola, Hormiga & Isaia, sp. nov.**

(Figs. 7*C-D*, 8*D-F*, 9, 10*A*, *F*)

Material examined

Holotype male. Italy, Piemonte, Cottian Alps, Varaita Valley, Casteldelfino, Military bunker, 44° 35' 2.28" N, 7° 4' 32.8" E, hand collected, 16.vii.2015, M. Isaia and S. Mammola leg. (MSNB).

Paratypes. 3#, 1@: same as holotype (MSNB); 1# 1@: Varaita valley, Casteldelfino, Buco delle Ciauie di Casteldelfino [1041 Pi/CN], 44° 34' 52.0" N, 7° 04' 20.9" E, hand collected, 16.vii.2015, M. Isaia and S. Mammola leg. (MSNB); 1# 1@: same locality, same collection data (GH1900); 5@: Varaita valley, Sampeyre, Buco del Drai (=Pertus dal Drai) [1017 Pi/CN], 44° 36' 48.2" N, 7° 13' 22.8" E, hand collected, 16.vii.2015, M. Isaia and S. Mammola leg. (MSNB).

Etymology

The species was first identified from specimens collected in the municipality of Casteldelfino (Varaita Valley, Piedmont, Italy), an area that was formerly included in the province of Dauphiné (Delfinato) of the French *ancien régime,* before to the French revolution. The species epithet is an adjective referring to this historical region. Moreover, the shape of the PCS falciform apophysis in frontal view recalls the shape of the dorsal fin of a dolphin (PCS in Fig. 7*C*).

Diagnosis

Pimoa delphinica sp. nov. is most similar to *P. rupicola*. Males of the new species can be easily distinguished from *P. rupicola* by the shape of the PCS, especially in ventral and ectal views. In *P. rupicola* the PCS bears an acute, falciform apophysis (Fig. 11; see also Hormiga 1994: fig. 15, 16, 36), less pointed in ectal view (Figs. 7*D*, 9*A-B*) and more pronounced in ventral view (Figs. 7*C*, 10*F*) in *P. delphinica* sp. nov.; this process is absent in *P. graphitica* sp. nov. (Figs. 6, 7*A-B*). For female diagnosis see the relevant section under *P. graphitica* sp. nov.

Description

Male (holotype). Total length 7.09. Cephalothorax 2.65 long, 2.34 wide, 2.18 high. Sternum 1.56 long, 1.65 wide. Abdomen 4.06 long, 1.93 wide. AER diameter 0.84. PER diameter 0.96. AME diameter 0.15. PLE 1, PME 1, ALE 1 time one AME diameter. AME separation 0.4 times their diameter, PME separation 0.6 times their diameter. PME-PLE separation 0.8 times one PME diameter, AME-ALE separation 0.7 times one ALE diameter. Clypeus height 3 times one AME diameter. Carapace with deep longitudinal fovea. Chelicerae with three prolateral and two retrolateral teeth; 17 cheliceral stridulating files; striae subtle, scaly. Legs uniform, light brown. Leg measurements as in Table II. Femur I 2.82 times length of cephalothorax. TmI: 0.60. Metatarsus IV trichobothrium present (medial). Pedipalp as in Figs. 7*C-D*, 9, 10*F*. Pedipalpal tibia with five lateral trichobothria (Fig. 7*C -D*).

Female (paratype from Buco delle Ciuaie di Casteldelfino [1041 Pi/CN]). Total length 10.62. Cephalothorax 4.21 long, 2.81 wide, 2.87 high. Sternum 2.00 long, 1.87 wide. Abdomen 7.18 long, 5.00 wide. AER diameter 0.87. PER diameter 0.96. AME diameter 0.12. PLE 1, PME 1, ALE 1 times one AME diameter. AME separation 0.5 times their diameter, PME separation 0.75 times their diameter. PME-PLE separation 1 time one PME diameter, AME-ALE separation 1.25 times one ALE diameter. Clypeus height 3.75 times one AME diameter. Carapace with deep longitudinal fovea. Cheliceral teeth, stridulating files and legs like in male. Leg as described in Table II. Femur I 2.02 times the length of cephalothorax. TmI: 0.60. Metatarsus IV trichobothrium present (medial). Epigynum as in Figs. 8*D-E*, 10*A*. Vulva as in Fig. 8*F*.

Additional material examined

Original data

<u>ITALY, Piemonte:</u> Meire Rua, Becetto, Sampeyre, 10.xii.2006, G. Gardini leg. 1@ (<u>GH0743</u>; GHandDD DNA sequence voucher); same locality, 1.ix.2007, G. Gardini leg. 2# 1@ (A. Trotta private collection); same locality, 2.xi.2010, G. Gardini leg. 1@ (A. Trotta private collection); same locality, 01.i.2012, G. Gardini leg. 1@ (A. Trotta private collection); [1017 Pi/CN] Buco del Drai (= Pertus dal Drai), Sampeyre, 01-20.viii.2003,

G. Gardini leg. 1@ 3juv. (A. Trotta private collection); same locality, 03.ix.2005, G. Gardini leg. 3@ 3juv. (A. Trotta private collection); same locality, 01.x.2006, G. Gardini leg. 5@ (A. Trotta private collection); same locality, 16.viii. 2015, M. Isaia & S. Mammola leg. 5@ 3juv.; Sotterranei del forte sotto Rocca Senghi, Opera 12 Grange Cruset, Bellino, 29.vi.2012, S. Mammola leg. 1@; same locality, 03.viii.2015, S. Mammola & G. Marangoni leg. 2# 2@; [n.c. Pi/TO] Unknown cave near Rocca Senghi, 29.vi.2012, S. Mammola leg. 1@, same locality, 03.viii.2015, S. Mammola & G. Marangoni leg. 1# 1@; [1023 Pi/CN] Caverna sotto Rocca Senghi, Bellino, 28.vii.2014, S. Mammola leg. 1@.

Re-examined material

Former records (sub *P. rupicola*) are here revised and assigned to *P. delphinica* sp. nov. on the basis of morphological examination. The identification of juveniles is based on the identification of adults occurring at the same locality.

<u>ITALY, Piemonte:</u> Meire Rua (1,600 m a.s.l., Becetto), Sempeyre, 20.vii-16.viii.2001, pitfall trap, G. Gardini leg. 1# 4@ (Isaia *et al.* 2007b; MSNB); [1017 Pi/CN] Buco del Drai (= Pertus dal Drai), Sampeyre, 25.viii.2001 E. Lana leg. 1@ (Lana *et al.* 2002; Lana 2005; Arnò and Lana 2005); [1041 Pi/CN] Buco delle Ciauie di Casteldelfino, 29.viii.2004, E. Lana leg. 1# 1juv. (Lana 2005; Isaia *et al.* 2011b; GH1860)

Verified citations

List of the former records (sub *P. rupicola*) now assigned to *Pimoa delphinica* sp.nov. on the basis of examination of fresh material collected at the same locality (see original material).

<u>ITALY, Piemonte:</u> Sotterranei del forte sotto Rocca Senghi, Opera 12 Grange Cruset, Bellino (Arnò and Lana 2005; Isaia *et al.* 2011b).

Unverified citations

Former records of *Pimoa rupicola* that we were not able to corroborate, likely identified as *P. delphinica* sp. nov. on the basis of geography.

<u>ITALY, Piemonte:</u> Miniera di Casteldelfino, Casteldelfino (Isaia *et al.*, 2011b); [1158 Pi/CN] Buco del Nebin 1, Sampeyre (Isaia *et al.*, 2011b); [1159 Pi/CN] Buco del Nebin 2, Sampeyre (Isaia *et al.*, 2011b).

Misidentification

As far as we are concerned, the first specimens of *Pimoa delphinica* sp. nov. were collected by Giulio Gardini in pitfall traps near Meire Rua, hamlet of Becetto, municipality of Sampeyre (20.vii-16.viii.2001, leg. 1# 4@). This material was identified as *P. rupicola* in

Isaia *et al.* (2007b). Additional specimens were collected by Enrico Lana in the cave Buco del Drai (=Pertus dal Drai) [1017 Pi/CN] in the nearby of the previous locality (25.viii.2001, leg. 1@ 3juv; sub *P. rupicola* in Lana *et al.* 2002, Arnò and Lana 2005; Isaia *et al.* 2011b). Further material was later collected by Enrico Lana in a cave near Casteldelfino (Buco delle Ciauie di Casteldelfino [1041 Pi/CN]; sub *P. rupicola* in Lana 2005; Isaia *et al.* 2011b) and in a military bunker near S. Anna di Bellino (sub *P. rupicola* in Arnò and Lana 2005; Isaia *et al.* 2011b).

***Pimoa rupicola* (Simon, 1884)**

Labulla rupicola Simon, 1884: 264 (#@)

For nomenclatural history and taxonomic references see World Spider Catalog (2016)

(Figs. 10*C-D*, 11)

Material examined

Original data

FRANCE, Alpes Marittimes: Tende, 30.vi-11.viii.2007, K. Wolf-Schwenninger leg. 1# 1@; ITALY, Piemonte: [3303 Pi/CN] Grotta Beppe Bessone (= Lo Zucco), Frabosa Soprana, 22.v.2015, M. Isaia and S. Mammola leg. 1@; [113 Pi/CN] Tana di Camplass, Roburent, M. Isaia and S. Mammola leg. 2@ 5 juv; Liguria: Molini di Triora, 19.vii.2001, Museo Caffi BG leg. 1# (MSNB); Inferno stream, San Lorenzo al Mare, 03.vi.2006, R. Fabbri leg. 1@ (MSNB); [619 Li/IM] Sgarbu du Ventu, Pieve di Teco, 27.xii.2014, M. Isaia and S. Mammola 8@ (GH1858); same locality, 9.xii.2015, M. Isaia and S. Mammola 6@; [104 Li/IM] Tana di Bertrand, Badalucco, 27.xii.2014, M. Isaia and S. Mammola leg. 1@; Ponte dell'Isola, Tanarello valley, 15.ix.1985, MSS trap, D. Vailati leg. 1@ (MSNB); Passo Cento Croci, Varese Ligure, IV-VIII.1991, pitfall trap, R. Cerbina and M. Valle leg. 1@ (MSNB); Marina di Andorra, Andorra (SV), 2.vi.2006, R. Fabri leg. 1@ (MSNB); Varazze (Savona), IV.1956, unknown leg. 1@ (MSNB); Emilia Romagna: Tarsogno, Tornolo, 23.vi.1992, G. Buttarelli, P. Pantini and M. Valle leg. 1@ (MSNB); Grotta 1 di Cà Boschetti, Borgo Rivola, 02.vi.2012, F. Papi leg. 1@ (MSNB); Mugnano, Sasso Marconi, 17.v.2014, A. Cherubini leg. 1@ (Alba Cherubini personal collection); Pietrapazza (National Park Foreste Casentinesi), Santa Sofia, VI.1997, Bertozzi M. leg. 1# (MSNB); Corniolo (National Park Foreste Casentinesi), Santa Sofia, 26.viii.1997, Bertozzi M. leg. 1# (MSNB); La Quercia, Prignano sulla Secchia, 05-18.vii.2006, pitfall trap, R. Fabbri R. leg. 1@ (MSNB); Toscana: Badia Valle, Marradi, 12.i.1998, A. Usvelli leg. 1 juv.; same locality, 30.ix.2002, A. Usvelli leg. 1@ (MSNB); Lazio: Pezze della Macchia, Campo Buffone, 31.vii.2009, F. La Casella leg. 2# 1@; SCI Bosco Pago, Vacone (Rieti), 06.vi-2.vii.2013, pitfall traps, R. Fabbri leg. 3# 1@ (MSNB); 509 La Pozzo Cornetto, Vallepietra, 01.x.2003, F. Papi leg 1@ (MSNB); SAN MARINO: Monte Cucco (380 m a.s.l.), Castle of San

Marino, 25.v-12.vii.2010, pitfall traps, R. Fabbri leg. 2#; same locality, 11.viii-17.xi.2919, pitfall trap, R. Fabbri leg. 1@; same locality, 12.vii-11.viii.2010, pitfall trap, R. Fabbri leg. 1#1@ (MSNB); fosso di Canepa (300 m a.s.l.), Mulini, Castle of San Marino, 25.v-13.vii.2010, pitfall trap, R. Fabbri leg. 3# 1@ (MSNB); same locality, 13.vii-25.viii.2010, pitfall trap, R. Fabbri leg. 1# 1juv (MSNB).

Re-examined material

FRANCE, Alpes Maritimes: Forêt de Châtaignier, Tende, M. Isaia and M. Paschetta leg. (www.gbif.org); Cagnes, Berland leg. 1# 3@ (GH1861) (Hormiga 1994); Menton, 22.iii.1915, 1# 8@ (Museum National d'Histoire Naturelle de Paris) (Hormiga 1994); ITALY, Piemonte: Entracque, 1989, G. Buttarelli and M. Valle leg. 1@ (Isaia *et al.* 2007b; MSNB); Vallone del Bousset, Entracque, 21.ix.2008, M. Isaia, M. Paschetta and Vinals leg. 1# (Isaia *et al.* 2015; GH1901); pathway to Pian del Valasco, Valdieri, 23.ix.2009, M. Isaia and M. Paschetta leg. 2@ (Isaia *et al.* 2015); Pian del Valasco, Valdieri, 29.vi.2009, 1@ (Isaia *et al.* 2015); Natural Reserve of Rocca San Giovanni-Saben, 22.ix.2009, M. Paschetta leg. 1@ (Isaia *et al.* 2015); Palanfrè, Vernante, 09.ix.2011, M. Isaia and M. Paschetta 1@ (Isaia *et al.* 2015); same locality, 11.viii.2011, M. Isaia and M. Paschetta 1# (Isaia *et al.* 2015); same locality, 13.x.2011, M. Isaia and M. Paschetta 1# 1@ (Isaia *et al.* 2015); same locality, 13.x.2011, A. Chiarle and M. Stassi leg. 1#, 2 juv (Isaia *et al.* 2014; 2015); 1153 Pi/CN] Grotta di Andonno, Valdieri, 26.xi.2000, E. Lana and C. Arnò leg. 1@ 1juv (Arnò and Lana 2005, Isaia *et al.* 2011b); Sotterranei del forte di Tetti Cialombard, Opera 9 Andonno, Valdieri, 16.iv.2000, E. Lana leg. 1# (Isaia *et al.* 2011b); Pian della Casa, Alpi Marittime Natural park, 21.viii-20.ix.2008, pitfall trap, M. Isaia and M. Paschetta leg. 1@ (Paschetta *et al.* 2013); [1128 Pi/CN] Pozzo di Montevecchio, Limone Piemonte, 19.xi.2006, E. Lana leg. 1# 1juv (Isaia *et al.* 2011b); [1166 Pi/CN] Grotta di Tetto Verna, Vernante, 25.vi.2006, E. Lana leg. 1# (Isaia *et al.* 2011b); Sotterranei del forte (A) di Vernante, Opera 11 Tetto Ruinas, Vernante, 26.iv.2003, C. Arnò and E. Lana leg. 1@ (Isaia *et al.* 2011b); [197 Pi/CN] Abisso Artesinera, Frabosa Sottana, 07.v.1995, E. Lana leg. 2@ (Arnò and Lana 2005); 28.vi.2008, M. Isaia and E. Lana leg. 3 juv (Isaia *et al.* 2011b); [697 Pi/CN] Grotta del Sorso, Torre Mondovì, 30.iv.2006, E. Lana leg. 1@ (Isaia *et al.* 2011b); 18 Pi/CN] Grotta dell'Orso, Ponte di Nava, 25.x.2008, M. Isaia leg. 1@ (Isaia *et al.* 2011b); Liguria: [n.c. Li/IM] Tana Rossa, Margheria dei Boschi, 07.ix.1971, J. Wunderlich leg. 1# (Hormiga 1994); Lombardia: beech forest near Albergo Colletta, Santa Margherita di Staffora, 31.vii.2001-19.ix.2001, P. Pantini leg. 2@ (Isaia *et al.* 2007b).

Verified citations

List of the former records of *P. rupicola* verified on the basis of our recent collection of fresh material at the same localities (see original or re-examined material).

ITALY, Piemonte: [113 Pi/CN] Tana di Camplass, Roburent (Isaia *et al.* 2011b); [118 Pi/CN] Grotta dell'Orso (=Caverna del Poggio), Ormea (Brignoli 1985 sub *Louisfagea rupicola*; Bologna and Vigna Taglianti 1985 sub *L. r.*; Hormiga 1994; Arnò and Lana 2005); FRANCE, Alpes Maritimes: Menton (Simon 1884 sub *Labulla rupicola*).

Unverified citations

Former records of *Pimoa rupicola* assigned on the basis of geography.

ITALY, Piemonte: Ovada (Thaler 1976 sub *Louisfagea rupicola*); [1130 Pi/CN] Grotta G-4 di Costa Lausea, Vernante (Lana *et al.*, 2003; Arnò and Lana 2005; Isaia *et al.* 2011b); [1131 Pi/CN] Grotta G-5 di Costa Lausea (=Grotta delle Ossa), Vernante (Lana *et al.* 2003; Lana 2005; Arnò and Lana 2005, Isaia *et al.* 2011b); [1233 Pi/CN] Grotta G-7 della Lausea (=Grotta dei Vecchietti), Vernante (Lana *et al.* 2003; Arnò and Lana 2005; Isaia *et al.* 2011b); Caverna del Comando di Limone Piemonte (Isaia *et al.* 2011b); [112 Pi/CN] Tana delle Fontanelle (=Tana di S. Luigi), Roburent (Isaia *et al.* 2011b); [181 Pi/CN] Garbo della Donna Selvaggia (=Caverna della Donna), Garessio (Lana *et al.* 2002; Lana 2005; Arnò and Lana 2005); 273 Pi/CN] Pozzo del Villaretto, Garessio (Isaia *et al.* 2011b); Ormea-Viozene (Thaler 1976 sub *Louisfagea rupicola*); Isola Perosa, Ormea (Hormiga 1994); Liguria: San Remo (Bertaku 1890 sub *Labulla rupicola;* Brignoli 1971 sub *Louisfagea r.*); Bordighera (Jackson 1929 sub *Labulla rupicola;* Brignoli 1971 sub *Louisfagea r.*); Consevola river, Altare (Brignoli 1971 sub *Louisfagea rupicola*); Varazze (Brignoli 1971 sub *Louisfagea rupicola*); [66 Li/SP] Grotta di Cassana, Borghetto Vara (Brignoli 1971; 1972 sub *Louisfagea rupicola*); [n.c. Li/IM] Grotta P 39, Pian Cavallo (Brignoli 1975; 1985 sub *Louisfagea rupicola*); Conca Giavetti, Massimino-Bagnasco (Thaler 1976 sub *Louisfagea rupicola*; Hormiga 1994); Murialdo (Thaler 1976 sub *Louisfagea rupicola*); Giusvalla (Thaler 1976 sub *Louisfagea rupicola*); [n.c. Li/IM] Tana Rossa, Margheria dei Boschi (Brignoli 1985 sub *Louisfagea rupicola;* Hormiga 1994); [618 Li/IM] Tana da Valle, Borgomaro (Brignoli 1985 sub *Louisfagea rupicola*); [714 Li/IM] Voragine di Ciaura (Brignoli 1975; 1985 sub *Louisfagea rupicola*); [n.c. Li/SV] Tana da Bordaira, Bardiato (Brignoli 1979; 1985 sub *Louisfagea rupicola*); Toscana: Montemignaio-Pratomagno (Thaler 1976 sub *Louisfagea rupicola*); Passo di Cerreto (Thaler 1976 sub *Louisfagea rupicola;* Hormiga 1994); Grondola-Pontremoli (Thaler 1976 sub *Louisfagea rupicola*); Turrite Secca, Castelnuovo (Thaler 1976 sub *Louisfagea rupicola*); Fornovolasco (Brignoli 1971 sub *Louisfagea rupicola*); FRANCE, Alpes Maritimes: Gorbio (Simon 1929 sub *Labulla rupicola*); Nice (Simon 1929 sub *Labulla rupicola*); Monaco (Simon 1929 sub *Labulla rupicola*); Sospel (Simon 1929 sub *Labulla rupicola*); Les Mèsces (Maurer and Thaler 1988 sub *Louisfagea rupicola*); Gias des Pasteurs (Maurer and Thaler 1988 sub *Louisfagea rupicola*); Mount Mengiabo, Sospel (Simon 1884 sub *Labulla rupicola*); Saint Martin Lantosque (Simon 1884 sub *Labulla rupicola*); Saint Martin Vésubie (Simon 1929 sub *Labulla rupicola*); Var: Var (Simon 1884; 1829 sub *Labulla rupicola*; Denis 1949b sub *L. r.*).

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Supplementary Materials: Specimens analyses in the present study with geographic and sequence information; *cox1* accession #: GeneBank accession code; *cox1* haplo: *cox1* haplotypes arbitrarily named with one of the sequences; GMYC: GMYC clusters; *ITS2* Accession #: GeneBank accession code, *ITS2* alleles: arbitrarily named after one of the sequences; Locality #: locality number as seen in Fig. 2.

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Table and Figure captions

Table I. Pairwise p-distances of *cox1* gene between and within (bolded values on the diagonal of the matrix) nominal and unidentified species.

Table II. Leg measurements (mm) of *Pimoa graphitica* sp. nov. (male holotype and female paratype) and *Pimoa delphinica* sp. nov. (male holotype and female paratype).

Figure 1. Bayesian tree*.* White circles indicate independent GMYC clusters, which were collapsed. Circles on internal nodes denote support values as follow: upper left: Bayesian posterior probabilities (PP); upper right: maximum likelihood bootstraps (BS), bottom: parsimony jackknifing (JS). Filled box: PP>95% or BS>75 or JS>0.75. Grey boxes: clades recovered with support values below former thresholds. Empty sectors: clades not recovered. The tree was rooted using *Nanoa enana* Hormiga, Buckle & Scharff, 2005 (Pimoidae).

Figure 2. Statistical parsimony networks for the Alpine *Pimoa ITS2* alleles (Alleles network 1: *P. rupicola*; Alleles network 2: *P. delphinica* sp. nov.; Alleles network 3: *P. graphitica* sp. nov.). Allele names and locality numbers as listed in Supplementary Materials. The size of each circle is proportional to the number of sampled individuals with each allele (see scale above the legend). Unsampled and/or extinct alleles are represented by small black circles.

Figure 3. Female and cocoon of *Pimoa graphitica* sp. nov. (A-C) and *Pimoa delphinica* sp. nov. (D). A, graphite mine of Pons, Perosa Argentina; B, Grotta e Forra della Marmorera, Busca; C, Grotta delle *Pimoa*, Oncino; D) Pertus d'le Ciauie, Casteldelfino.

Figure 4. Range of distribution of *Pimoa graphitica* sp. nov., *P. delphinica* sp. nov. and *P. rupicola*.

Figure 5. A-E, *Pimoa graphitica* sp. nov., female from Italy, Province of Torino, Vallone di

Pramollo, Hamlet of Tornini (GH1857). A, Epigynum, ventral. B, Epigynum, caudal. C, Epigynum, lateral. D, Epigynum (cleared), anterior. E, Epigynum (cleared), anterodorsal (arrow points to copulatory opening). F, Habitus, dorsal. G, Habitus, lateral. Scale bars: A-E, 0.2 mm; F-G, 2.0 mm.

Figure 6. A-D, *Pimoa graphitica* sp. nov., male from Italy, Province of Torino, Vallone di Pramollo, Hamlet of Tornini (GH1857). A, B, Palp, ectal (arrow points to median apophysis). C, Palp, mesal. D, Palp, dorsal. Scale bars: 0.5 mm. Abbreviations: C = conductor; CDP = cymbial denticulate process; E = embolus; MA = median apophysis; PCS = pimoid cymbial sclerite; PEP = pimoid embolic process; T = tegulum.

Figure 7. A-B, *Pimoa graphitica* sp. nov., male from Italy, Province of Torino, Vallone di Pramollo, Hamlet of Tornini (GH1857); C-D, *Pimoa delphinica* sp. nov., male from Italy Province of Cuneo, Varaita valley, Casteldelfino (GH1900). A, C, Palp, ventral (arrow up points to embolus; arrow down points to pimoid embolic process; arrow right points to alveolar sclerite). B, D, Palp, ectal. D, Palp, dorsal. Scale bars: 0.5 mm. Abbreviations: C = conductor; CDP = cymbial denticulate process; E = embolus; MA = median apophysis; P = paracymbium; PCS = pimoid cymbial sclerite; PEP = pimoid embolic process; T = tegulum.

Figure 8. A-C, *Pimoa graphitica* sp. nov., female from Italy, Province of Torino, Vallone di Pramollo, Hamlet of Tornini (GH1857); D-F, *Pimoa delphinica* sp. nov., female from Italy Piemonte, Cottian Alps, Varaita valley, near Casteldelfino (GH1900). A, D, Epigynum, ventral. B, E, Epigynum, caudal. C, F, Epigynum (cleared), dorsal (arrow points to copulatory opening). Scale bars: 0.5 mm. Abbreviations: CD = copulatory duct; FD = fertilization duct; S = spermatheca.

Figure 9. A-D, *Pimoa delphinica* sp. nov., male from Italy, Province of Cuneo, Varaita valley, Casteldelfino (GH1860). A, B, Palp, ectal. C, Palp, mesal. D, Palp, dorsal (arrows in B and C point to median apophysis). Scale bars: 0.5 mm. Abbreviations: C = conductor; CDP = cymbial denticulate process; E = embolus; MA = median apophysis; PCS = pimoid cymbial sclerite; PEP = pimoid embolic process; T = tegulum.

Figure 10. A, F, *Pimoa delphinica* sp. nov.; B, E, *Pimoa graphitica* sp. nov. C, D, *Pimoa*

rupicola. A, Female from Italy, Province of Cuneo, Varaita valley, Sampeyre (GH0743), epigynum, caudal. B, Female from Italy, Piemonte, Valgrana Valley, Valgrana (GH1859), epigynum, caudal. C, Female from Italy, Province of Imperia, Pieve di Teco (GH1858), epigynum, caudal. D, Female from France, Alps Maritimes (GH1861), epigynum, caudal (note epigynal plugs). E, Male from Italy, Province of Torino, Vallone di Pramollo, Hamlet of Tornini (GH1857), male palp, ventral. F, Male from Italy, Province of Cuneo, Varaita valley, Casteldelfino (GH1860), male palp, ventral. Scale bars: A-D, F, 0.2 mm; E, 0.5 mm.

Figure 11. A-D, *Pimoa rupicola*, male from Italy, Province of Cuneo, Vallone del Bousset, Entracque (GH1901). A, B, Palp, ectal (arrow points to median apophysis). C, Palp, mesal (note that the distal part of lower branch of PEP is broken off). D, Palp, ventral (arrow up points to median apophysis, left pointing arrow points to paracymbium). Scale bars: 0.5 mm. Abbreviations: C = conductor; CDP = cymbial denticulate process; E = embolus; PCS = pimoid cymbial sclerite; PEP = pimoid embolic process; T = tegulum.

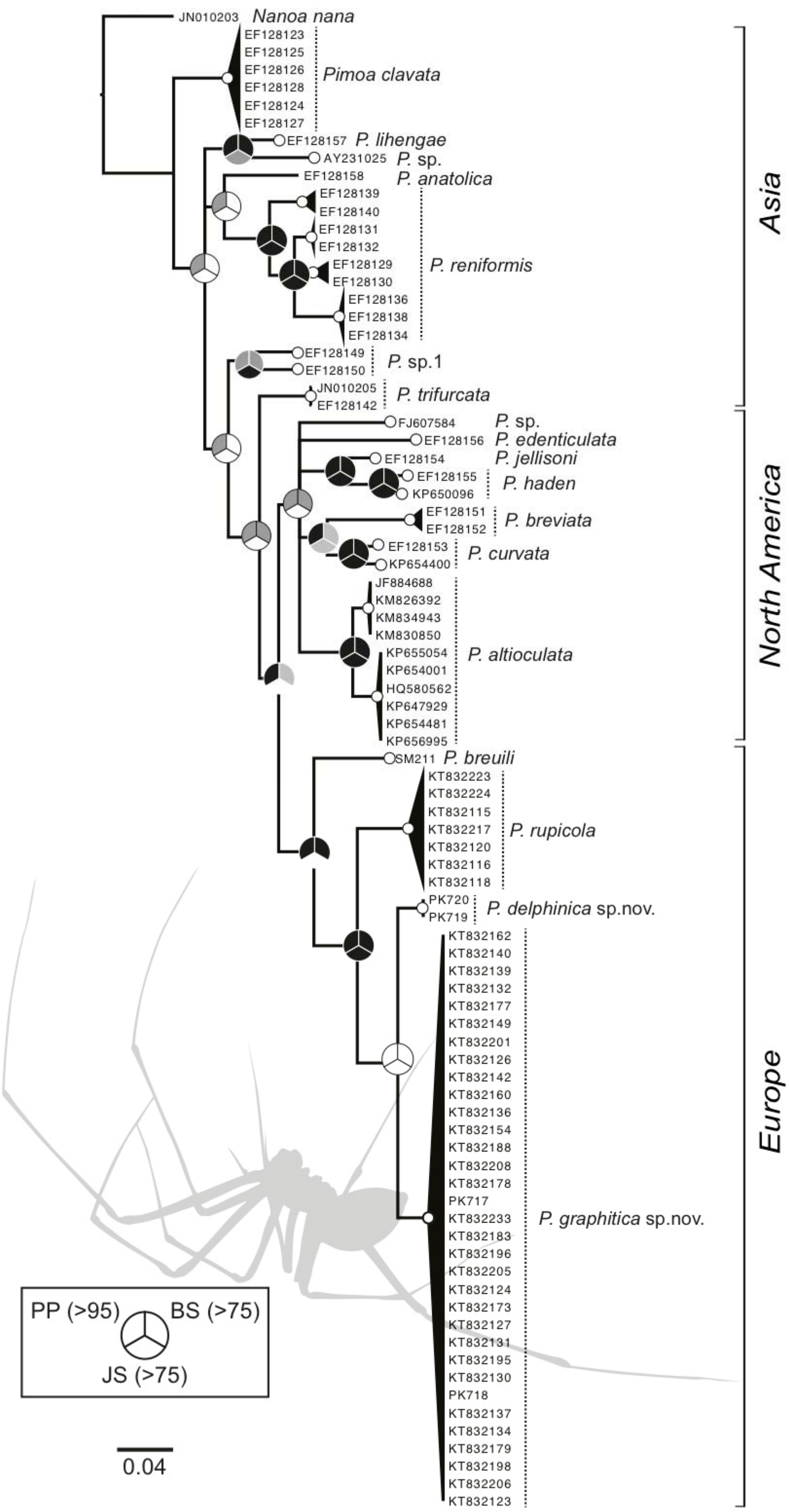
Table 1

Nanoa nana	**na**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. clavata	0,177	**0,028**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pimoa [sp1]	0,180	0,158	**na**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pimoa sp. [x131]	0,197	0,174	0,160	**na**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. lihengae	0,194	0,156	0,162	0,146	**na**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. anatolica	0,192	0,157	0,160	0,168	0,158	**na**	-	-	-	-	-	-	-	-	-	-	-	-	-
P. trifurcata	0,179	0,153	0,131	0,138	0,156	0,144	**0,000**	-	-	-	-	-	-	-	-	-	-	-	-
P. reniformis	0,196	0,155	0,153	0,164	0,164	0,155	0,131	**0,077**	-	-	-	-	-	-	-	-	-	-	-
P. jellisoni	0,188	0,164	0,156	0,144	0,160	0,166	0,138	0,164	**na**	-	-	-	-	-	-	-	-	-	-
P. haden	0,204	0,164	0,166	0,161	0,169	0,157	0,132	0,166	0,101	**0,054**	-	-	-	-	-	-	-	-	-
P. breviata	0,209	0,191	0,174	0,177	0,201	0,174	0,145	0,163	0,130	0,150	**0,025**	-	-	-	-	-	-	-	-
P. curvata	0,179	0,169	0,151	0,171	0,172	0,171	0,126	0,158	0,133	0,129	0,120	**0,065**	-	-	-	-	-	-	-
P. altioculata	0,193	0,174	0,158	0,173	0,188	0,178	0,142	0,170	0,134	0,150	0,140	0,129	**0,028**	-	-	-	-	-	-
Pimoa sp. [TAB]	0,200	0,181	0,151	0,176	0,192	0,162	0,140	0,155	0,138	0,165	0,161	0,147	0,139	**na**	-	-	-	-	-
P. edenticulata	0,201	0,177	0,175	0,174	0,199	0,177	0,145	0,161	0,138	0,149	0,150	0,140	0,149	0,153	**na**	-	-	-	-
P. breuili	0,190	0,173	0,160	0,185	0,186	0,145	0,129	0,172	0,149	0,151	0,156	0,162	0,168	0,173	0,160	**na**	-	-	-
P. rupicola	0,205	0,185	0,175	0,182	0,182	0,178	0,151	0,166	0,139	0,160	0,147	0,155	0,161	0,159	0,161	0,146	**0,012**	-	-
P. delphinica sp.nov.	0,190	0,188	0,178	0,181	0,202	0,174	0,145	0,169	0,149	0,163	0,164	0,154	0,160	0,155	0,145	0,145	0,113	**0,000**	-
P. graphitica sp.nov.	0,200	0,187	0,171	0,165	0,185	0,172	0,157	0,173	0,136	0,160	0,169	0,151	0,154	0,153	0,145	0,155	0,117	0,069	**0,009**

Table 2

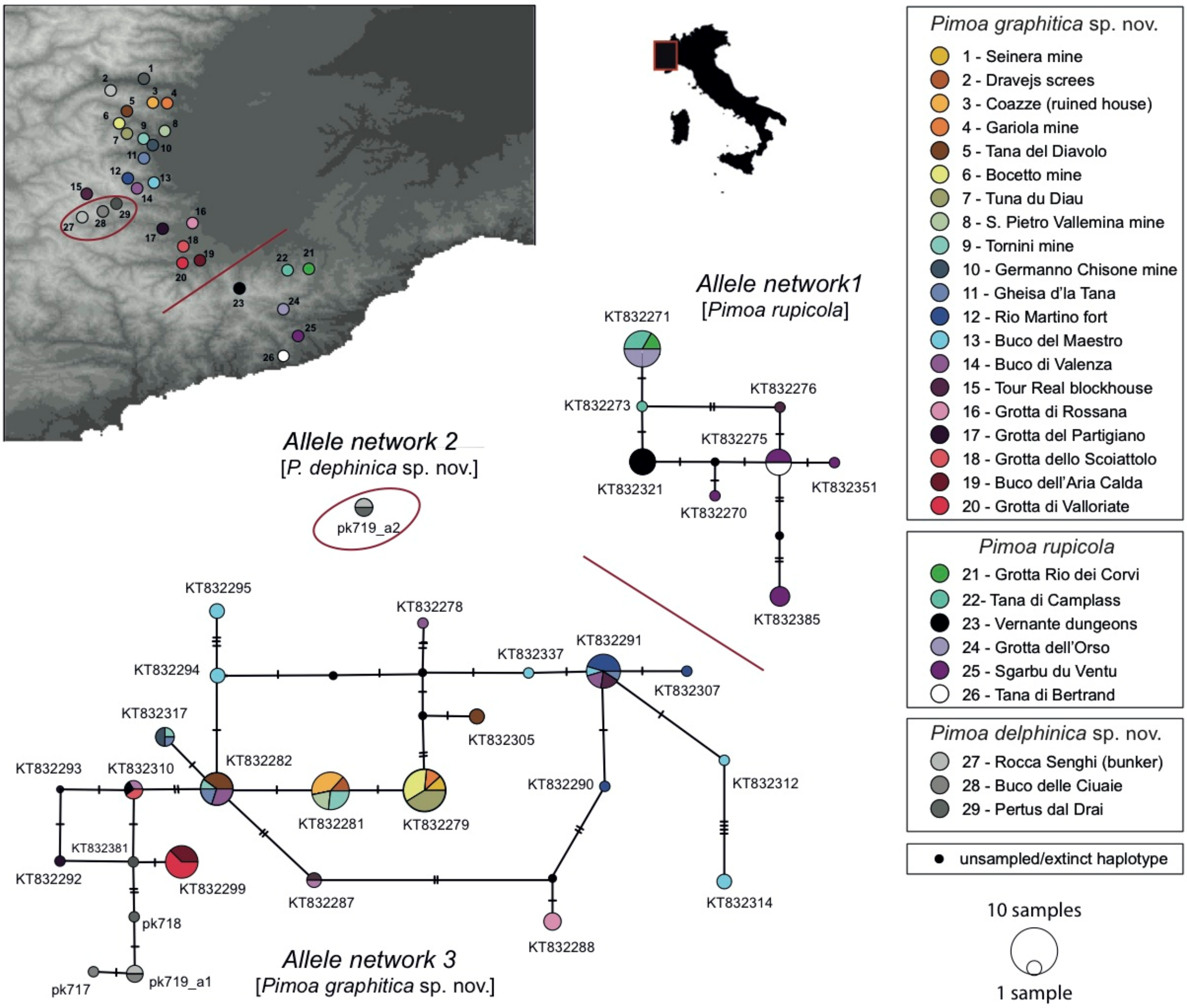
	Trochanter	Femur	Patella	Tibia	Metatarsus	Tartus	Total
Pimoa graphitica sp. nov. Holotype male (Perosa Argentina, TO, Italy)							
I	0,63	9,69	1,41	9,69	10,34	3,69	35,44
II	0,63	8,59	1,41	9,25	10,00	2,88	32,75
III	0,56	6,25	1,00	6,25	7,19	2,13	23,38
IV	0,63	8,75	1,09	8,34	9,38	2,78	30,97
Pdp	0,31	1,19	0,41	0,41	-	0,88 (Cy)	3,19
Pimoa graphitica sp. nov. Paratype female (S. Germano Chisone, TO, Italy)							
I	0,47	7,69	1,31	7,75	8,34	2,97	28,53
II	0,53	6,88	1,16	6,56	6,88	2,5	24,5
III	0,44	5,00	0,84	4,56	4,88	1,69	17,41
IV	0,56	7,19	0,94	6,38	6,38	2,34	24,34
Pdp	-	1,25	0,47	0,88	-	1,69	4,28
Pimoa delphinica sp. nov. Holotype male (Casteldelfino, CN, Italy)							
I	0,53	7,50	1,09	7,81	9,97	3,06	29,97
II	0,47	6,38	0,94	6,72	8,13	2,19	24,81
III	0,44	5,00	0,94	4,69	5,38	1,88	18,31
IV	0,44	5,84	0,94	6,25	7,19	2,38	23,03
Pdp	0,24	0,94	0,41	0,34	-	0,91 (Cy)	2,83
Pimoa delphinica sp. nov. Paratype female (Casteldelfino, CN, Italy)							
I	0,63	8,53	1,47	8,59	8,75	3,38	31,34
II	0,50	7,88	1,25	7,50	7,81	2,81	27,75
III	0,56	5,81	1,06	4,81	5,56	1,72	19,53
IV	0,69	7,19	1,38	7,19	7,31	2,69	26,44
Pdp	0,31	1,50	0,47	0,94	-	1,88	3,22

Figure 1



1142

1143 **Figure 2**


Pimoa graphitica sp. nov.
1 - Seinera mine
2 - Dravejs screes
3 - Coazze (ruined house)
4 - Gariola mine
5 - Tana del Diavolo
6 - Bocetto mine
7 - Tuna du Diau
8 - S. Pietro Vallemina mine
9 - Tornini mine
10 - Germanno Chisone mine
11 - Gheisa d'la Tana
12 - Rio Martino fort
13 - Buco del Maestro
14 - Buco di Valenza
15 - Tour Real blockhouse
16 - Grotta di Rossana
17 - Grotta del Partigiano
18 - Grotta dello Scoiattolo
19 - Buco dell'Aria Calda
20 - Grotta di Valloriate
Pimoa rupicola
21 - Grotta Rio dei Corvi
22- Tana di Camplass
23 - Vernante dungeons
24 - Grotta dell'Orso
25 - Sgarbu du Ventu
26 - Tana di Bertrand
Pimoa delphinica sp. nov.
27 - Rocca Senghi (bunker)
28 - Buco delle Ciuaie
29 - Pertus dal Drai
unsampled/extinct haplotype
10 samples
1 sample
Allele network1
[Pimoa rupicola]
KT832271
KT832273
KT832276
KT832275
KT832321
KT832270
KT832351
KT832385
Allele network 2
[P. dephinica sp. nov.]
pk719_a2
Allele network 3
[Pimoa graphitica sp. nov.]
KT832295
KT832278
KT832294
KT832337
KT832291
KT832307
KT832317
KT832305
KT832293
KT832310
KT832282
KT832290
KT832312
KT832281
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KT832381
KT832292
KT832299
KT832287
KT832314
pk718
KT832288
pk717
pk719_a1

Figure 3

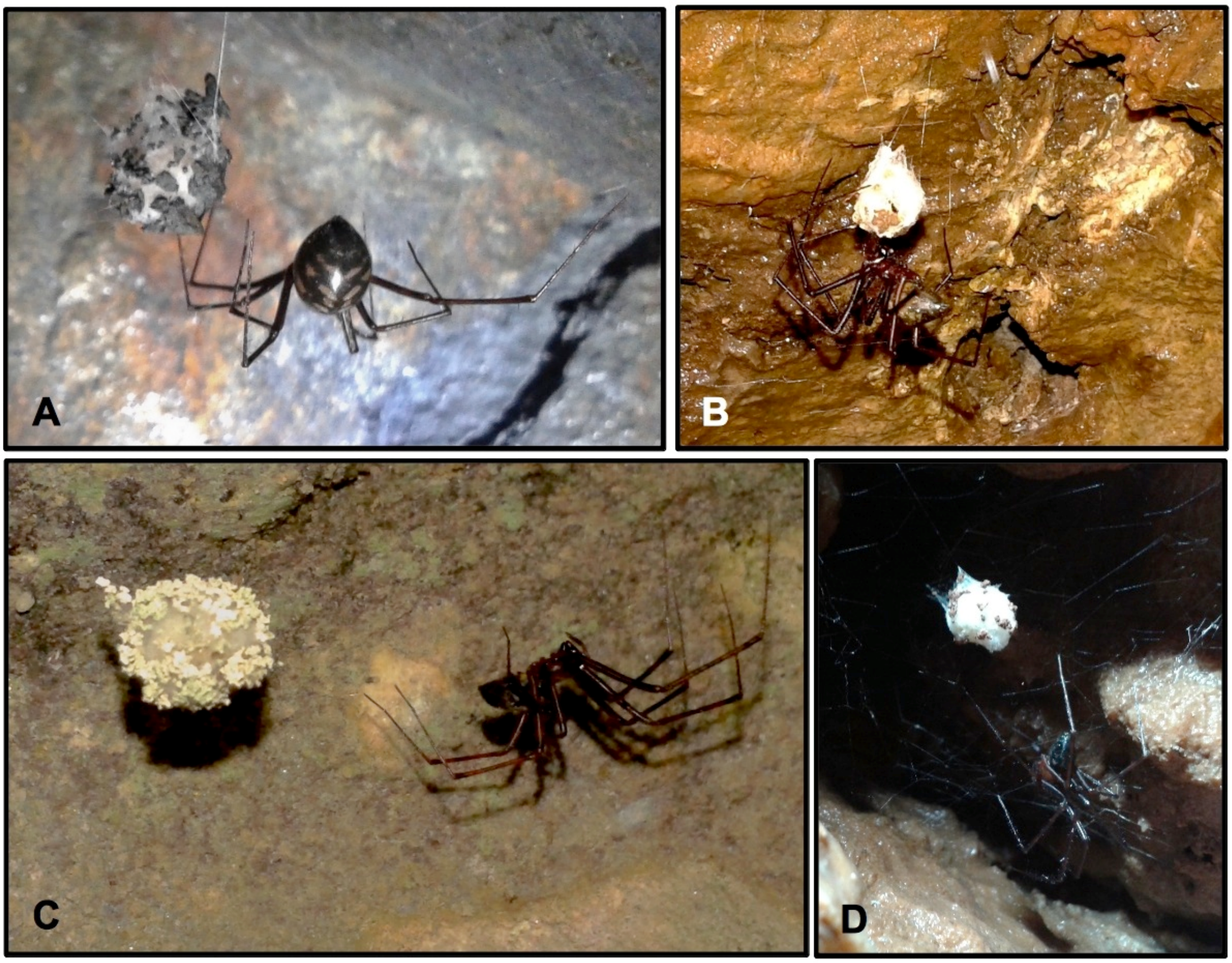


Figure 4

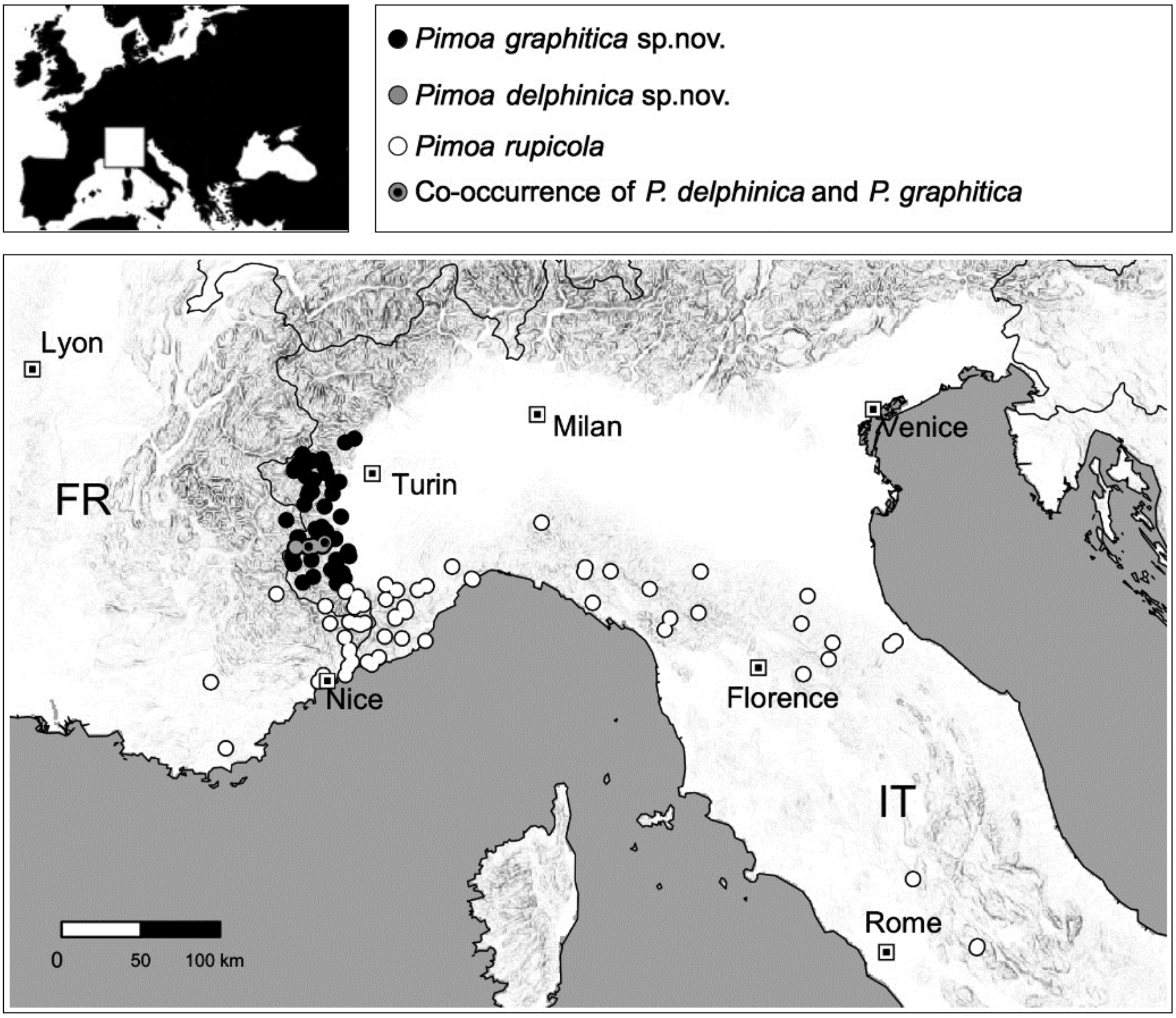
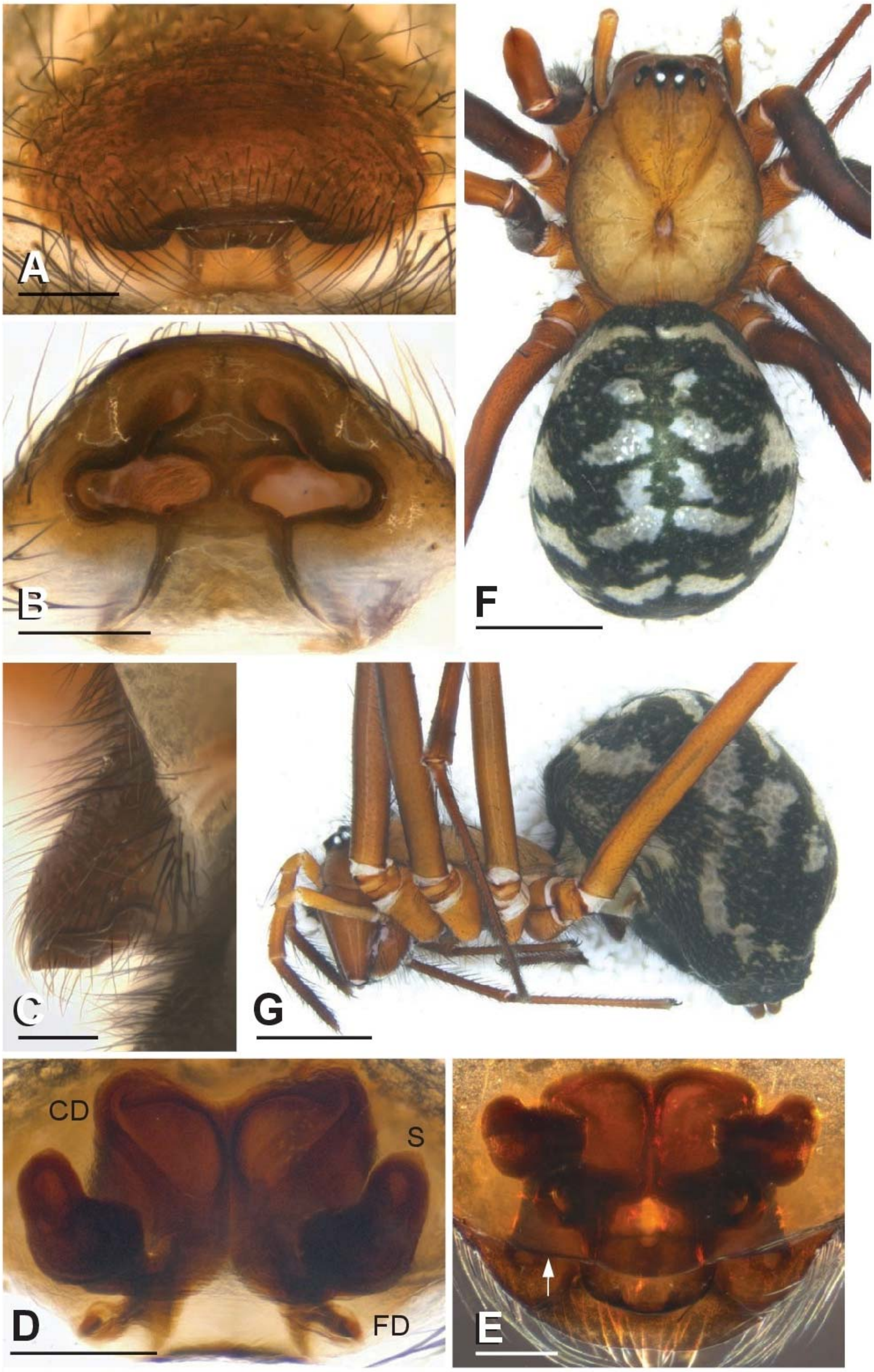


Figure 5



1176

1177 **Figure 6**

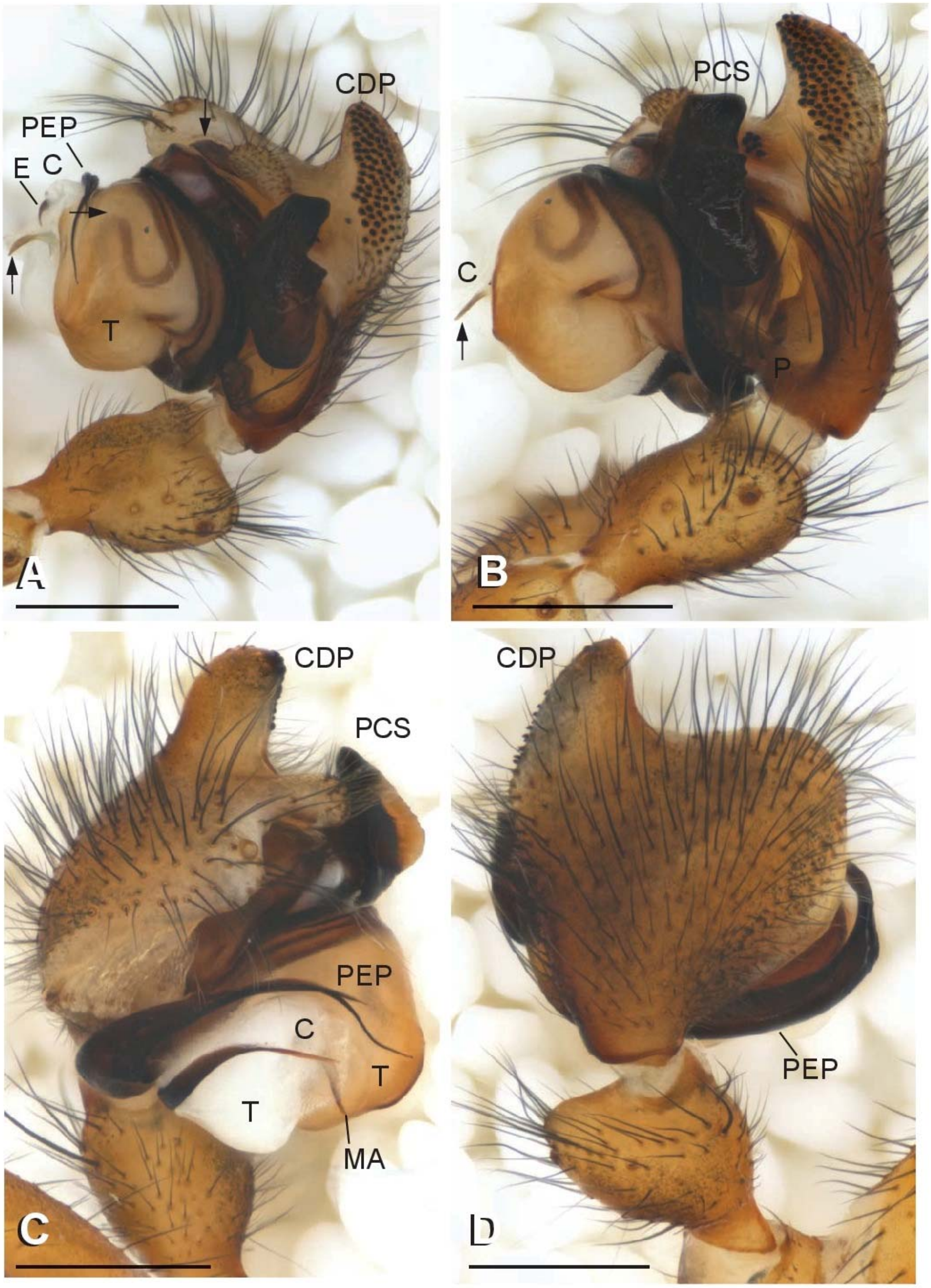


Figure 7

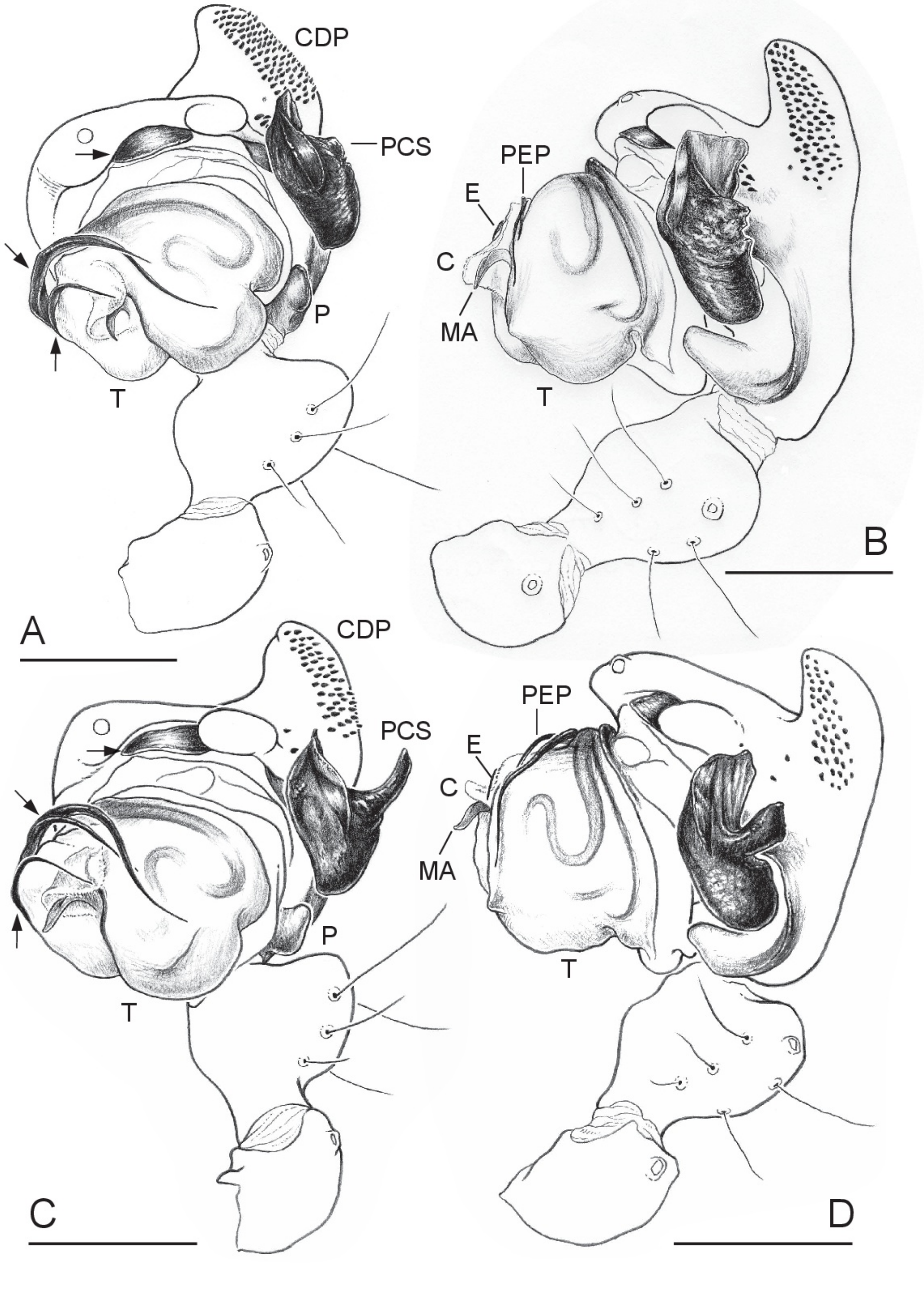


Figure 8

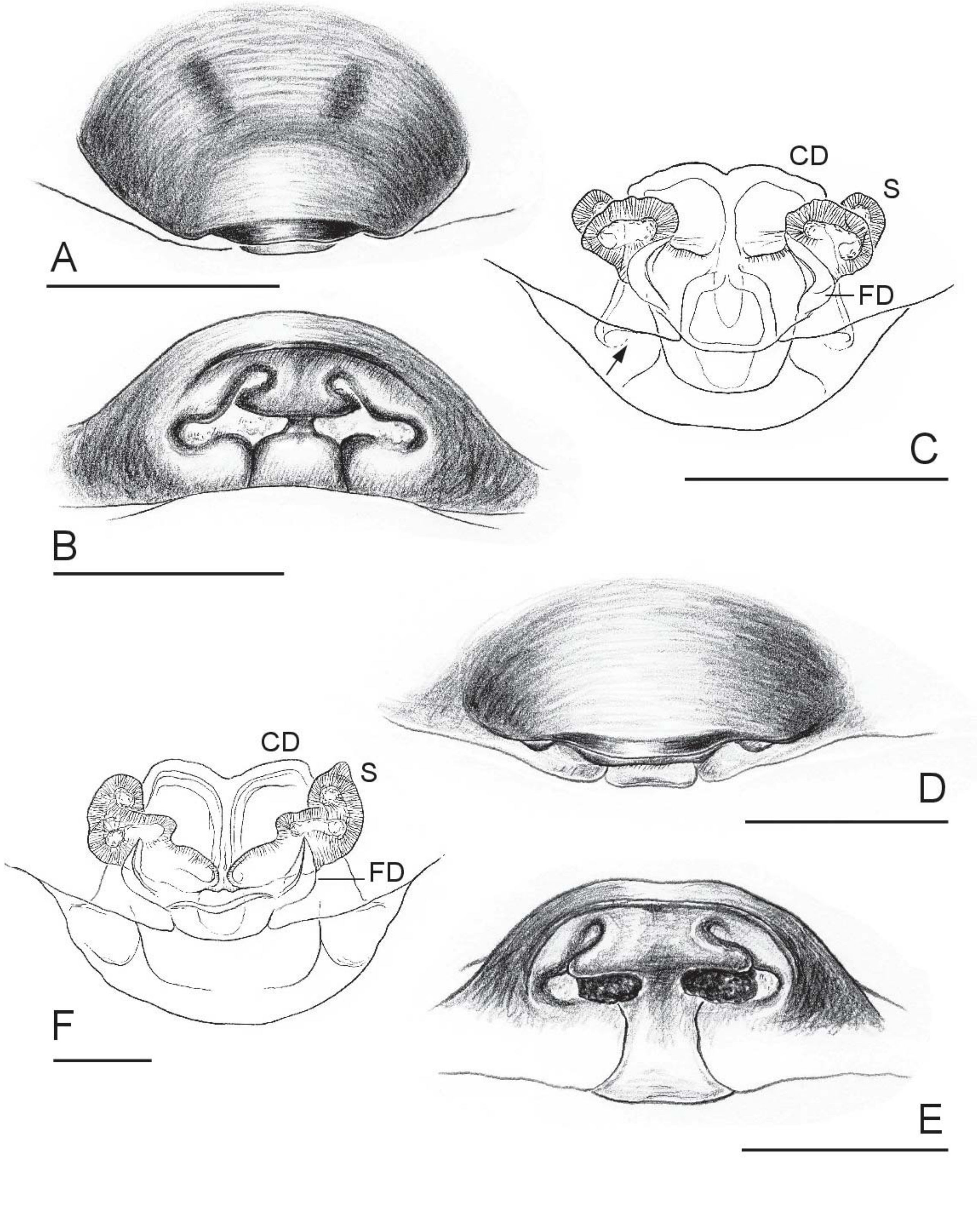


Figure 9

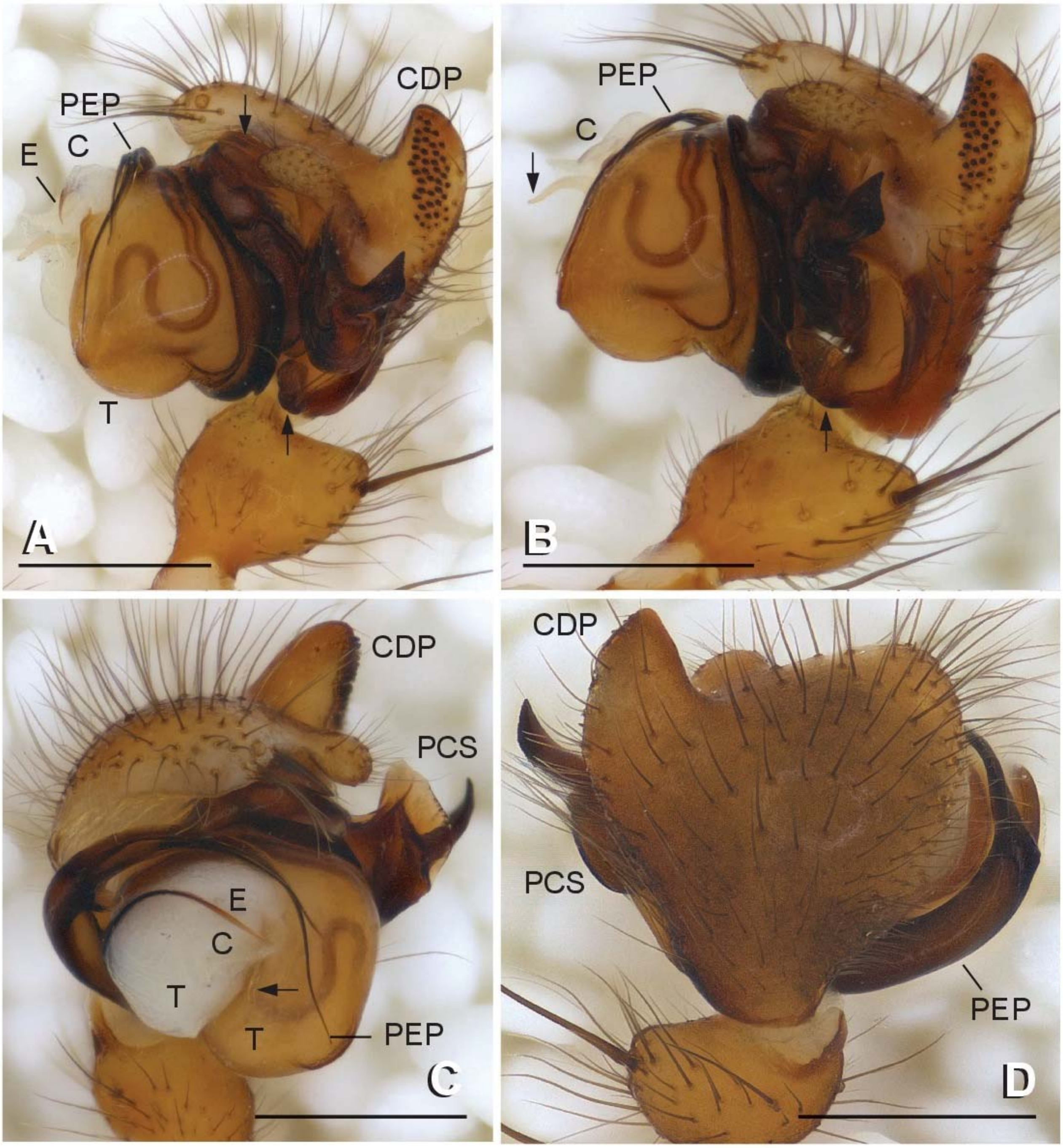
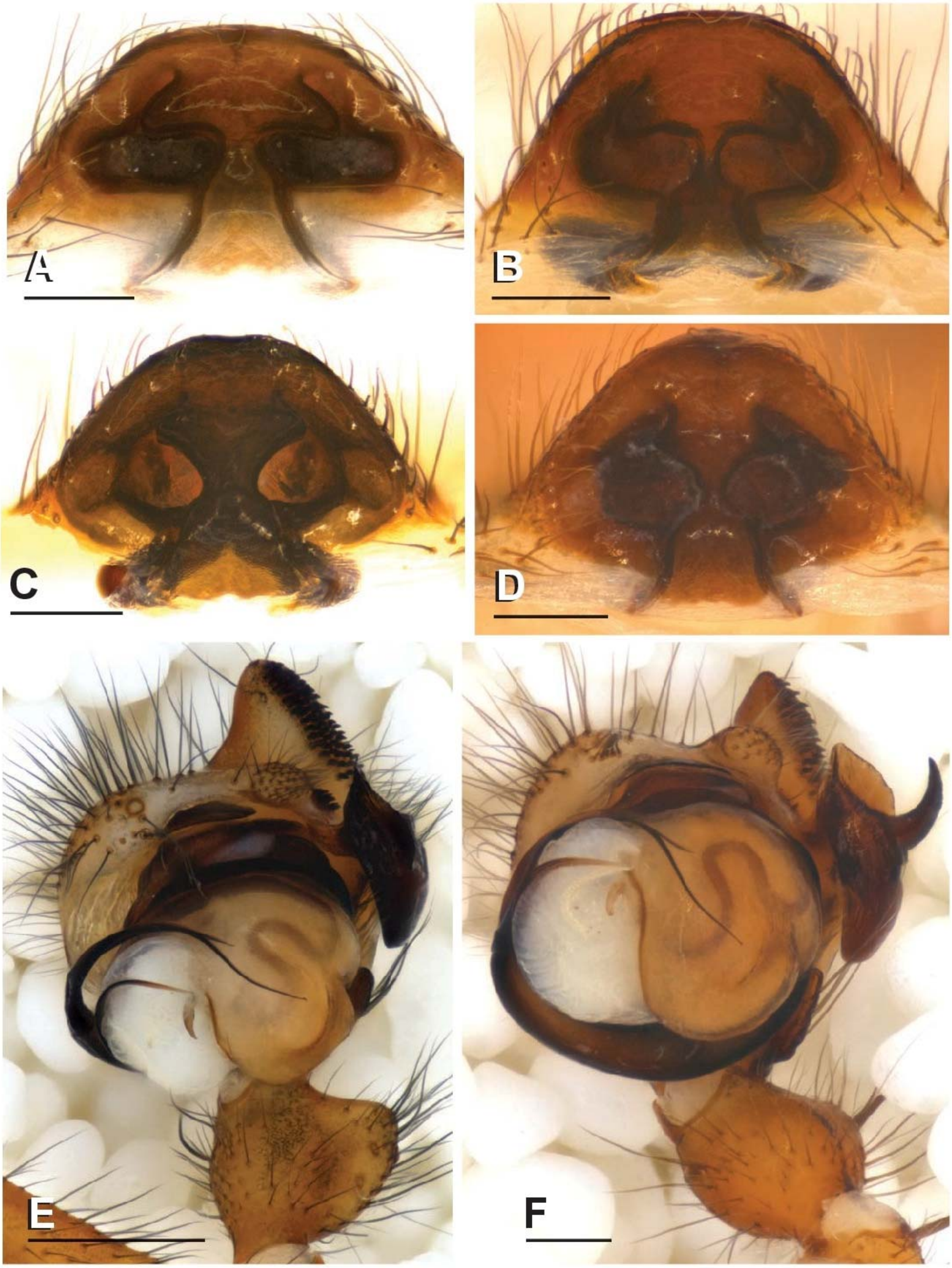


Figure 10



1194

Figure 11