Euscorpius

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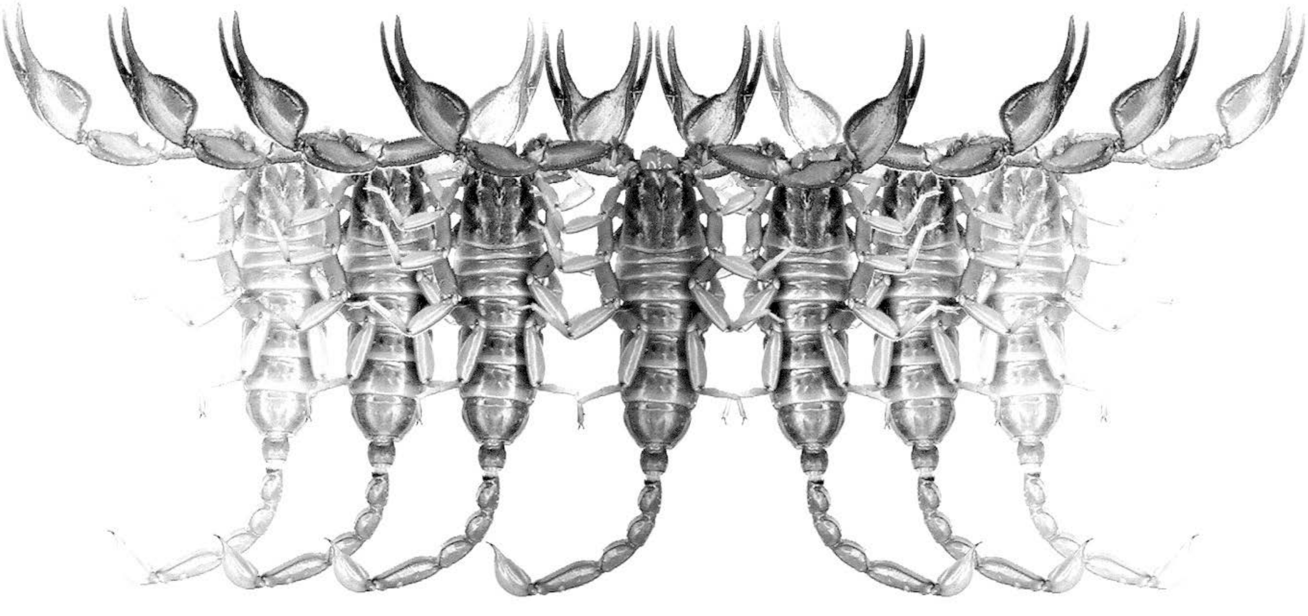

Reconsideration of the Taxonomy of *Euscorpius tergestinus* (Scorpiones: Euscorpiidae)

Gioele Tropea

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Occasional Publications in Scorpiology

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The name ***Euscorpius*** Thorell, 1876 refers to the most common genus of scorpions in the Mediterranean region and southern Europe (family Euscorpiidae).

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Reconsideration of the taxonomy of *Euscorpius tergestinus* (Scorpiones: Euscorpiidae)

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Summary

After the revision of Fet & Soleglad (2002), *Euscorpius tergestinus* (C. L. Koch, 1837) was considered a polymorphic species widespread from France to Croatia. In this study, we reconsidered the taxonomy of *E. tergestinus* s.str. based on morphological and genetic evidence, its range, and its original description. *Euscorpius aquilejensis* (C. L. Koch, 1837), **stat. nov.**, previously synonymous with *E. tergestinus*, is elevated to species status herein. A preliminary phylogenetic analysis based on available GenBank *16S rDNA* data shows a separate, basal position of *E. aquilejensis* and some other *Euscorpius* species, which implies that the subgenus *Euscorpius* s.str. is paraphyletic.

Introduction

The genus *Euscorpius* Thorell, 1876 (Euscorpiidae) is one of the most studied taxa of scorpions. However, because of its complicated taxonomy, the situation of this genus is still unresolved, especially in the Balkans and Turkey, but also in Italy and neighboring countries. Di Caporiacco (1950) published the largest review of the genus, focused mostly on Italian populations. He recognized the main, traditional four species: *E. italicus* (Herbst, 1800), *E. flavicaudis* (De Geer, 1778), *E. carpathicus* (Linnaeus, 1767), and *E. germanus* (C. L. Koch, 1837). Di Caporiacco (1950) also recognized a great number of their subspecies (among them, *E. carpathicus aquilejensis* and *E. c. tergestinus*) based on patellar trichobothria number, pectinal teeth number, and metasomal carination. Fet & Soleglad (2002) revised a large portion of the subgenus *Euscorpius*, moving all the subspecies that were reported from France to Croatia with the external trichobothria series of the patella *eb* = 4 and *em* = 4 in synonymy with *E. tergestinus*. These included: *E. carpathicus apuanus* Di Caporiacco, 1950, *E. c. aquilejensis* (C. L. Koch, 1837), *E. c. concinnus* (C. L. Koch, 1837), *E. c. corsicanus* Di Caporiacco, 1950, *E. c. oglasae* Di Caporiacco, 1950, *E. c. niciensis* (C. L. Koch, 1841), and *E. c. tergestinus* (C. L. Koch, 1837). Subsequently, Vignoli et al. (2005, 2007) elevated to species status *E. concinnus* and *E. oglasae*, respectively. After Fet & Soleglad (2002), *E. tergestinus* was considered a polymorphic species with range that included France, Italy, Slovenia, Croatia, and southern Austria (Fet & Soleglad 2002; Salomone et al., 2006; Vignoli & Salomone, 2008).

In this study, we reconsidered the taxonomic situation of *E. tergestinus* s.str., based on its morphology and original description. The range of *E. tergestinus* s.str. is restricted to the extreme northeastern part of Italy, near the border with Slovenia, and part of the Balkans, including the populations considered introduced in Austria and Czech Republic. *E. tergestinus* (C. L. Koch, 1837), s.str., is here separated from another valid taxon, *E. aquilejensis* (C. L. Koch, 1837), **stat. nov.,** previously a synonym of *E. tergestinus*, which is for the first time elevated to species rank. Further, *E. carpathicus picenus* Di Caporiacco, 1950, previously a synonym of *E. tergestinus*, is here moved to synonymy with *E. aquilejensis.*

In addition, a preliminary phylogenetic analysis based on available GenBank *16S rDNA* data shows a separate, basal position of *E. aquilejensis* and some other *Euscorpius* species, which implies that the subgenus *Euscorpius* s.str. is paraphyletic.

Materials and Methods

Material examined

A total of 136 specimens of *Euscorpius* from Italy, Slovenia, Croatia, Austria, and Czech Republic have been examined: ***Euscorpius aquilejensis*** (C. L. Koch, 1837), **stat. nov. - Croatia:** 1 ♂, 2 ♀♀, Rovinj, 6-1983, D. Devetak leg. (UL); 1 ♂, Mali Losinj (Lussino), Losinj Island, 9-1968, K. Bilek leg. (NHMW 11746); **Slovenia:** 1 ♂, Osp, Koper, 1994, B. Toskan leg. (NHMW 21319); **Italy:** 1 ♂, Battaglia Terme, Monte Croce, abandoned cave, under stones, Colli Euganei, Padua, 30-09-2012 Devincenzo & Guarento leg. (GTC); 4 ♂♂, 2 ♀♀, Rome, Latium, 2012, G. Tropea leg. (GTC); 2 ♀♀, Celano, L'Aquila, Abruzzo, 29-06-2011, G. Tropea leg. (GTC); 1 ♂, Duino Aurisina, Trieste, Friuli-Venezia Giulia, 15-09-2012, C.M. Legittimo leg. (GTC); 1 ♂, 1 ♀, Bergamo, Lombardy, 01-09-1979 (MZUF 5682, 5683); 2 ♀♀, Trieste, Friuli-Venezia Giulia, 1937 (MZUF 5926, 5927); 2 ♀♀, Marcellise, San Martino Buon Albergo, Verona, Veneto, 1880, De Betta leg. (MZUF 5934, 5935); 1 ♂, 1 ♀, Nabresina, Trieste, Friuli-Venezia Giulia, 13-08-1880, Caroti leg. (MZUF 6133, 6134); 1 ♂, 1 ♀, Udine, Friuli-Venezia Giulia, 1878, Marinoni leg. (MZUF 6264, 6265); 1 ♀, Treviso, Veneto, 1879, (MZUF 6266); 1 ♂, Aquileia, Udine, Friuli-Venezia Giulia, 1978, Marinoni leg. (MZUF 6269; **neotype** designated herein, see below); 1 ♀, Friuli-Venezia Giulia, 1976, Marinoni leg. (MZUF 6270); 2 ♀♀, Trieste, Val Rosandra near Italian-Slovenian border, Bagnoli di Rosandra, 200 m, Friuli-Venezia Giulia, 30-8-1997, M. Calcagno & S. Cianfanelli leg. (MZUF Coll. 1150); 2 ♀♀, Valle Salinello (Gorges), Abruzzo, 20-09-1979, M. Zapparoli leg. (MZUR 31,32); 2 ♂♂, Gubbio, Perugia, Umbria, 19-05-1974, W. Rossi leg. (MZUR 33-34); 1 ♂, 1 ♀, via Fabio S., Trieste, Friuli-Venezia Giulia, 05-2003, Baratto leg. (MSNT); 1 ♀, Vicolo del Castagneto, n° 69, Trieste, Friuli-Venezia Giulia, 08-05-2002, L. Saetti leg. (MSNT); 1 ♀, Via dell'Istria, Trieste, Friuli-Venezia Giulia, 10-01-2001, A. Colla leg. (MSNT); 1 ♀, lapidary garden, traps in the park, Trieste, 28-08-1994, 02-10-1994, Gruppo Entomologico Museo of Trieste leg. (MSNT); 1 ♂, Trieste (MSNT); 1 ♀, Pindemonte 8, Trieste, Friuli-Venezia Giulia, 11-2003, Scala leg. (MSNT); 1 ♀, Trieste, Karst, Ceroglie, Grotta of Mt. Querceto, 11-12-2001, A. Colla leg. (MSNT); 1 ♀, Malchina, Trieste, Friuli-Venezia Giulia, 10-2003, A. Quadracci leg. (MSNT); 3 ♂♂, 1 ♀, Venice, Veneto (MSNV); 2 ♀♀, Venice, Giardino Biennale, Veneto, 08-1992, Hansen leg. (MSNV); 1 ♂, 1 ♀, Valdagno, Vicenza, Veneto, 21-05-1965, Matiello leg. (MSNV); 1♂, 2 ♀♀, Città della Pieve, 508 m, Perugia, 2010, C.M. Legittimo leg. (GTC); 1 ♀, Mirano (in house), Venice, Veneto, G.V. Zolo leg (MSNV); 1 ♀, Roncavezzari, Follina, under stone, Treviso, Veneto, 17-04-1971, Paoletti leg. (MSNV); 1 ♀, in the woods of the convent of Caramanico, Chieti, Abruzzo, 4-8-1878, G. Cavanna leg. (MSNG 6861); 1 ♀, Avellana, Marche, 15-07-1878 (MSNG 6863).

E. tergestinus (C. L. Koch, 1837), **s.str. – Austria:** 1 ♀, Zirknitz, Carinthia, 08-1880, Caroti leg. (MZUF 6262); 1 ♂, Wienerstr. 5, Krems, 10-1946, Strouhal leg. (NHMW 1936); 1 ♂, Mödling, Wien, 06-1952, JMB (NHMW 2126); 1 ♀, Krems, 1951, Adametz leg. (NHMW 1935); **Croatia:** 1 ♂, 1 ♀, Ucka, Istria, 14-08-1968, A. Valle & R. Bianchi leg. (MSNB 6963, 6971); 2 ♂♂, 4 ♀♀, Lovran Draga, 14-08-1968, A. Valle & R. Bianchi leg. (MSNB 6990, 6992-6995, 6998); 3 ♂♂, 3 ♀♀, Sukosan, 2012 (GTC 238-243); 1 ♀, Capocesto (MZUF 6032); 1 ♂, 2 ♀♀, Istria, Stossich leg. (MZUF 6236-6238); 1 ♀, Veljun, Slunj, 1976-1980, Bognolo leg. (MSNT); 1 ♂, 1 ♀, near Pola, Istria, 16,26-04-1931 (MSNT); 1 ♀, Mt. Maggiore, refuge, 16-06-1933, Muller leg. (MSNT); 1 ♂, Ugljan (Ugliano) Island, 08-1926, Muller leg. (MSNT); 1 ♂, 1 ♀, Jablanac, 07-04-1965, Paoletti leg. (MSNV); 2 ♀♀, Pag Island, 2001 (VFPC); 2 ♂♂, Pakostane, Zadar (VFPC); 1 ♂, 1 ♀, Bormeno, 06-1913, Muller leg. (MSNT); 1 ♀, Losinj (Lussino) Island, 08-1929, Lana leg. (MSNT); 1 ♀, Lake of Tusa, 06-1930, Muller leg. (MSNT); **Italy:** 1 ♂, 3 ♀♀, Aurisina, Friuli-Venezia Giulia, 14-09-1963, A. Valle & R. Bianchi leg. (MSNB 2123, 2124, 2126, 2313); 1 ♀, Villa Opicina, Trieste, Friuli-Venezia Giulia, 10-08-68, A. Valle & R. Bianchi leg. (MSNB 6989); 1 ♀, Samatorza, Duino Aurisina, Trieste, Friuli-Venezia Giulia, 15-09-2012, C.M. Legittimo leg. (GTC 234); 1 ♀, Karst of Trieste, Trieste, Friuli-Venezia Giulia, 11-06-1933 (MZUF 5821); 1 ♀, Nabresina, Trieste, Friuli-Venezia Giulia, 08-1979, Paolucci leg. (MZUF 6275); 2 ♂♂, Trieste, Basovizza, Hotel Pesek, 380 m, Friuli-Venezia Giulia, 6-12-2005, A. Quadracci leg. (MSNT); 1 ♂, Trieste, Basovizza, Hotel Pesek, 480 m, Friuli-Venezia Giulia, 16-9-2005, A. Quadracci leg. (MSNT); 1 ♂, Sito 1L-UTM VL15, Karst of Trieste, Moccò, S. Dorligo della Valle, Trieste, 100 m, 15-10-2005, A. Quadracci leg. (MSNT); 11 ♂♂, 4 ♀♀, Sito 1B-UTM VL15, Karst of Trieste, Moccò, S. Dorligo della Valle, Trieste, 100 m, Friuli-Venezia Giulia, 16-9-2005, A. Quadracci leg. (MSNT); 1 ♂, Sito 2L-UTM, Trieste, Basovizza, Hotel Pesek, 450 m, Friuli-Venezia Giulia, 16-9-2005, A. Quadracci leg. (MSNT sc4001; **neotype,** designated here, see below); 2 ♂♂, Sito 1V-UTM, Trieste, Basovizza, 380 m, Friuli-Venezia Giulia, 06-11-2005, A. Quadracci leg. (MSNT); 1 ♂, 5 ♀♀, Doberdò, Gorizia, Friuli-Venezia Giulia, 20-03, 09-08-1991, Ratti leg. (MSNV); **Slovenia:** 1 ♂, 1 ♀, Skocjan, Divaca, 1953, det. J. Hadži (UL); **Czech Republic:** 2 ex., Nebrich, 24-04-1969, Pfleger leg. (MSNB 12911, 12912).

Further 21 specimens from Italy, France, and Spain were studied for comparison: **Spain:** *E. balearicus* Di Caporiacco, 1950: 2 ♀♀, Puerto de Soller, Mallorca, Balearic Islands, 10-1933, C. Alzona leg. (MSNG 2847, 2848); 1 ♀, Mallorca, Balearic Islands, 16-10-1984, Rallo leg. (MSNV); **France:** *E. carpathicus corsicanus* Di Caporiacco, 1950: 1 ♀, Corsica (MZUF 5981); 1 ♀, Sarteano, Corsica, 05-1878, G. B. Toscanelli leg. (MZUF 5980); *E. carpathicus niciensis* (C. L. Koch, 1837): 1 ♂, Alpes-Maritimes, Esterel, Agay, 1915 (MZUF 5911); **Italy:** *E. oglasae* Di Caporiacco, 1950: 1

♂, 1 ♀, Montecristo Island, Tuscany, 1879, G.B. Toscanelli leg. (MZUF 5974, 5975); *E. sp.*: 1 ♂, 1 ♀, Almese, Turin, Piedmont, 13-09-1964, A. Valle & G. Dugone leg. (MSNB 2535, 2559); 2 ♀♀, Borgo San Dalmazzo, Cuneo, Piedmont, summer 1956, A. Vigna leg. (MSNB 4462, 4464); *E. carpathicus apuanus* Di Caporiacco, 1950: 1 ♀, Tuscany, Massa, Apuan Alps, Mt. Tambura, 1450 m, under stones, 30-05-1882, Del Prete leg. (MZUF 5929); 1 ♀, Tuscany, Massa, Alta Valle di Magra, Bardono, 24-10-1879, Del Prete leg. (MZUF 5929); 1 ♂, Tuscany, Lucca, Castelnuovo di Garfagnana, 11-1876, Cte. Carli leg. (MZUF 5929); 2 ♂♂, 4 ♀♀, Tuscany, Lucca, Apuan Alps, Mt. Corchia, Lucca, Pietrasanta, Vallecchia, 500 m, 08-1875, Del Prete leg. (MZUF 5938, 5946, 5951, 5952, 5957, 5963).

Phylogenetic analysis

Fifteen mitochondrial *16S rDNA* sequences have been extracted from GenBank database: *E. aquilejensis* stat. nov.: DQ989951, DQ989952, DQ989953; *E. Tergestinus* s.str.: AJ298065, AJ298066; comparison group - *E. balearicus* Di Caporiacco, 1950: *E. carpathicus* s.str. (Linnaeus, 1767): AY172338; *E. concinnus* (C.L. Koch, 1837): DQ989929, DQ989931, DQ989935; *E. sicanus* (C. L. Koch, 1837): DQ989927; AJ309209; *E. italicus* (Herbst, 1800): DQ989956; *E. flavicaudis* (De Geer, 1778): DQ989957; *E. tauricus* (C.L. Koch, 1837): AY193822 (Gantenbein et al., 2001; Huber et al., 2001; Fet, 2002; Salomone et al., 2006). The sequences were aligned using Clustal X 1.81 (Thompson et al., 1997) and verified by eye. The evolutionary history was inferred ad phyolgenetic tree built using the Neighbor-Joining method (Saitou & Nei, 1987). The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1000 replicates) are shown next to the clades (Felsenstein, 1985). The evolutionary distances were computed using the number of differences method (Nei & Kumar, 2000) and are in the units of the number of base differences per sequence using MEGA 5 (Tamura et al., 2011). Estimates of evolutionary divergence between sequences (genetic distance) were calculated using method of Tamura & Nei (1993), the rate variation among sites was modeled with a gamma distribution with MEGA 5 (Tamura et al., 2011).

Abbreviations

Abbreviations: *V*: trichobothria on pedipalp chela manus ventral surface; *Pv*: trichobothria on patella ventral surface; *Pe*: trichobothria on pedipalp patella external surface; *et*: external terminal; *est*: external subterminal; *em*: external medium; *esb*: external suprabasal; eb_a: external basal *a*; *eb*: external basal; *db*: dorsal basal trichobothrium on fixed finger; *Dp*: pectinal teeth number; *L*: length; *H*: height; *Lchel*: chela length; *Wchel*; chela width; *Lcar*: carapace length; *Wcar*: carapace width; *Lfem*: femur length; *Lpat*: patella length; *Lmet*: metasoma length; *CarA/CarP %*: average ratio of distances from center of median eyes to anterior and posterior margins of the carapace; *DPS*: dorsal patellar spur; *DD*: distal denticle; *MD*: median denticles; *OD*: outer denticles; *ID*: inner denticles; *IAD*: inner accessory denticles; MZUF: Museo Zoologico dell'Università di Firenze "La Specola", Florence, Italy; GTC: private collection of Gioele Tropea, Rome, Italy; MSNB: Museo Civico di Scienze Naturali "E. Caffi", Bergamo, Italy; MZUR: Museo di Zoologia "Charles Darwin" dell 'Università di Roma "La Sapienza", Rome, Italy; MSNV: Museo di Storia Naturale di Venezia, Italy; VFPC: Private collection of Victor Fet, Huntington, West Virginia, USA; MSNT: Museo Civico di Storia Naturale di Trieste, Trieste, Italy; UL: University of Ljubljana, Ljubljana, Slovenia; MSNG: Museo Civico di Storia Naturale "Giacomo Doria", Genoa, Italy; NHMW, Naturhistorisches Museum Wien, Vienna, Austria.

Terminology and conventions

The trichobothrial notation follows Vachon (1974). The morphological measurements are given in millimeters (mm) following Sissom et al. (1990). The morphological nomenclature follows Stahnke (1970), Hjelle (1990) and Sissom (1990); the chela carinae and denticles configuration follow Soleglad & Sissom (2001), and sternum terminology follows Soleglad & Fet (2003); description and terminology of hemispermatophore follows Soleglad & Sissom (2001) and Fet & Soleglad (2002).

Taxonomy

Family Euscorpiidae Laurie, 1896
Genus *Euscorpius* Thorell, 1876
Subgenus *Euscorpius* Thorell, 1876

Euscorpius tergestinus (C. L. Koch, 1837), s.str.

Scorpius tergestinus C. L. Koch, 1837: 106, pl. CVII-CVIII, Fig. 247-248, surroundings of Trieste, Italy (leg. Wagner).

Syntypes (male and female), formerly in J. Sturm's collection in Nuremberg (Birula, 1917), now are presumed lost (Fet & Sissom, 2000).

Neotype from Osp, Slovenia, assigned in Fet & Soleglad (2002) is not valid due to misidentification, since it does not correspond to the original description (see below). A new neotype is designated according to ICZN Article 75 as it is required for the purposes of clarifying the taxonomic status of specific populations.

Figure 1: *Euscorpius tergestinus* s.str., male, dorsal and ventral views.

Neotype: male, Basovizza, Trieste, Friuli-Venezia Giulia, Italy (MSNT); label as: SC N° 4001 Sito 2L-UTM: Trieste, Basovizza, Hotel Pesek, 450 m a.s.l., 16-9-2005, leg. A. Quadracci.

***Synonyms*:**

Scorpius tergestinus var. *austriacus* Ferrari, 1872: 657-658. Syntypes: 2 specimens (NHMW 1901), Krems, Austria, 30 June 1873 (leg. J. Ferrari).

Euscorpius carpathicus mesotrichus Hadži, 1929: 36-38, Fig. 5-6; a junior primary homonym of *E. italicus mesotrichus* Hadži, 1929 (Capra, 1939: 202; Di Caporiacco, 1950: 181; Fet, 1997: 248); synonymized by Di Caporiacco (1950: 181) with *E. carpathicus tergestinus* (C. L. Koch, 1837). Syntypes: 2 males, 7 females (depository unknown), southern Slovenia. Not *E. "mesotrichus" sensu* Kinzelbach (1975), as stated by Fet & Sissom (2000), misidentification.

***Diagnosis*:** A medium *Euscorpius* species, total length 27-38 mm. Color of adults light brown-reddish with carapace and pedipalps darker, reddish. With more or less expressed reticulations or marbling on carapace, metasoma and chelicerae. Trichobothria *db* on the base of the fixed finger in line with the trichobothria *eb* or *esb* or slightly moved, *esb* proximal to *eb*. The number of trichobothria on the pedipalp manus ventral surface is 4 (3 *V* + *Et* 1); the number of trichobothria on the pedipalp patella ventral surface usually is 10/11 (10 in 50% and 11 in 41.56% of examined pedipalps); the number of trichobothria on pedipalp patella external surface is: *eb* = 4, eb_a = 4, *esb* = 2, *em* = 4, *est* = 4, *et* = 7-8 (series *et* = 7 in 35.06% and *et* = 8 in 61.04% of examined pedipalps). The pectinal teeth count usually is 9 in males (in 81.58% of pectines examined) and 7 to 8 in females (7 in 32.05% and 8 in 56.41% of pectines examined). The telson vesicle in males is more swollen than in females: average *L/H* ratio of the vesicle is 1.85 (min. 1.79, max. 1.94) in males and 2.15 (min. 1.95, max 2.28) in females. Chela with a strong notch on fixed finger and scalloping of the movable finger in adult males, obsolete in females; *Lchel/Wchel* ratio is 2.42 in males and 2.52 in females. Dorsal patellar spur medium developed. Femur usually shorter than patella or as long as it; *Lfem/Lpat* ratio is 0.97. Average ratio *Lcar/Wcar* is 0.965; average value of the length from center of median eyes to anterior margin of the carapace is 43.21% of the carapace length. Average value of the length from center of median eyes to posterior margin of the carapace is 56.79% of the carapace length. Average ratio of *Lmet/Lcar* is 2.88 in males and 2.72 in females.

Figure 2: *Euscorpius tergestinus* s.str., female, dorsal and ventral views.

Description of the neotype (MSNT SC 4001, male)

***Coloration*:** Whole color light brown-orange with carapace darker, very light reticulations or marbling on carapace and metasoma, tergites outline lighter, yellowish; sternites very pale brown-whitish; pectines and genital operculum whitish; chelicerae yellowish with dark reticulation or marbling and teeth apical portion darker; telson yellow with longitudinal dark line and dark reddish tip of the aculeus; all carinae of pedipalp dark reddish/brown blackish.

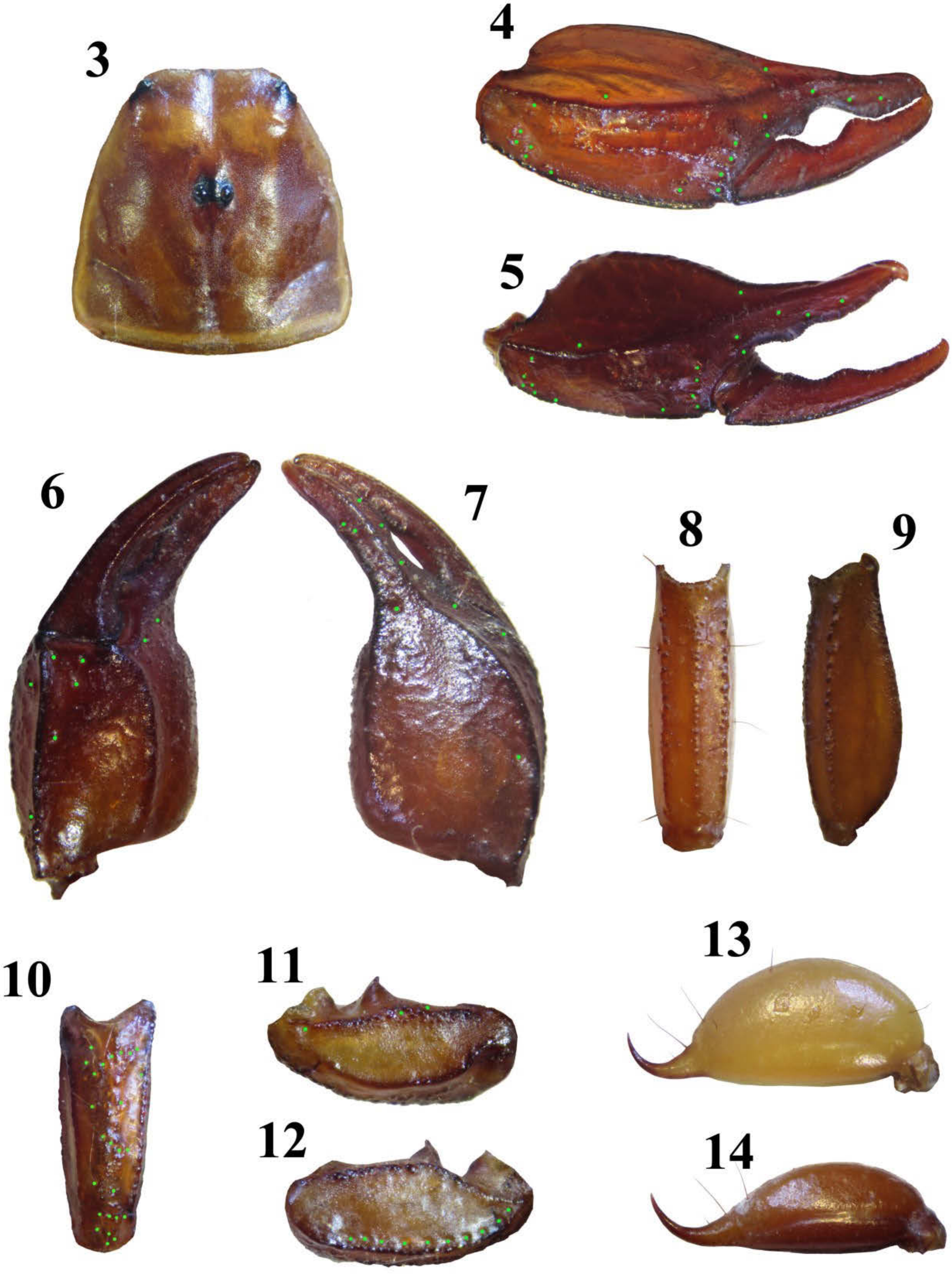
***Carapace*:** Length 4.02, posterior width 4.08; very fine granulation on whole surface, especially on reticulations; anterior edge straight; deep posterior lateral furrows, less accentuated anterior median and especially posterior median furrows; two pairs of lateral eyes and two median eyes; length from center of median eyes to anterior margin is 43.28% of carapace length; length from center of median eyes to posterior margin is 56.72% of the carapace length.

***Mesosoma*:** Tergites very finely granulated with outline lighter; sternites smooth very finely punctate with spiracles very small, oval shaped and inclined to about 45° downwards towards outside, area of overlap between sternites paler.

***Metasoma*:** Dorsal carinae of segment I formed by little visible granules to lightly rough, on II-IV granulated, spaced and lightly irregular on segments II and III; dorsolateral carinae on segments I-IV absent or obsolete; rounded with scattered granulation on segment V; ventrolateral carinae absent on segment I, smooth on segments II-IV, serrulate and spaced on segment V; ventromedian carina absent on segments I-III, obsolete on segment IV, finely serrulate on segment V; very fine granulation present on intercarinal spaces, especially on segment V and on dorsal and lateral surfaces, punctated on ventral surface.

***Telson*:** Vesicle highly swollen; very lightly rough, with ventral setae of different sizes, especially in surround of the vesicle/aculeus juncture; telson height 1.92; telson length 4.46; vesicle length 3.54; vesicle width 1.56; *L/H* ratio of the vesicle 1.84.

Pectines: tooth count 9-9; middle lamellae count 5-6; several microsetae on marginal lamellae, middle lamellae and fulcra.



Figures 3–14: *Euscorpius tergestinus* s.str. **3.** Carapace. **4.** External view of the chela of adult male. **5.** External view of the chela of adult female. **6.** Ventral view of the chela. **7.** Dorsal view of the chela. **8.** Ventral view of the metasomal segment V. **9.** Lateral view of the metasomal segment V. **10.** External view of pedipalp patella. **11.** Dorsal view of pedipalp patella. **12.** Ventral view of pedipalp patella. **13.** Telson of adult male. **14.** Telson of adult female.

Genital operculum**:** Partially divided with genital papillae protruding; a few microsetae present.

Sternum**:** pentagonal shape, type 2; length approximately equal to width, deep posterior emargination.

Pedipalps**:** Coxa and trochanter with tuberculate carinae. Femur: dorsal internal carinae tuberculate; dorsal external carinae formed by tubercles, slightly serrulate and spaced; external median carinae serrulate, less marked proximally; anterior median formed by almost conical tubercles, of which three bear a macroseta each; intercarinal spaces granulated, with larger granules near carinae. Patella: dorsal internal carinae tuberculate to slightly crenulate; dorsal external carinae lightly crenulate to rough; ventral external carinae crenulate; ventral internal carinae tuberculate to lightly serrulate; dorsal intercarinal surface with uniform small granules; ventral intercarinal surface with few scattered minute granules, especially near to ventral internal carinae. Dorsal patellar spur well developed. Chelal carina *D1* is distinctly strong, dark and rough; *D4* is rounded smooth to rough and dark; *V1* is distinctly strong, dark and rough to lightly crenulate; *V3* rounded, dark and lightly granulated; external carina granulated; intercarinal tegument rough to granulated by very minute scattered granules except between carinae *D4* and *V3*. Chela finger dentition: *MD* form a straight line of very small denticles closely spaced with a *DD* on the distal tip; *OD* formed of 7 denticles on movable finger and 6 denticles on fixed finger, immediately outside of *MD*, the terminal denticle is not very pronounced; *ID* formed of 7 denticles on movable finger and 6 denticles on fixed finger, spaced from *MD*, the terminal denticle is little pronounced; *IAD* formed of 4 denticles on movable finger and 3 on fixed finger; *L/W* ratio of the chela 2.367; *Lfem/Lpat* ratio is 0.946.

Trichobothria**:** Chela: trichobothria series *V* standard: *V* = 4-4 (3 *V*+ *Et*1). Patella: ventral (*Pv*): 10-10; patella external (*Pe*): *et* = 8-8, *est* = 4-4, *em* = 4-4, *esb* = 2-2, eb_a = 4-4, *eb* = 4-4. Femur: trichobothrium *d* situated lightly decentralized and very lightly proximal to *i, e* distal to both, situated on dorsal external carina, but most on dorsal surface.

Legs**:** Legs with two pedal spurs; no tarsal spur; ventral row of tarsus III with a total of 11 stout spinules (including the ventral distal spinules pair) of increasing size from proximal to distal, distally ending with a pair of spinules; 3 flanking pairs of tarsal setae adjacent to the ventral spinules row. Granulation present above leg femora, mostly ventrally, formed by spaced tubercles.

Chelicerae**:** smooth, with dark marbling, with darker apical portion of denticles; the dorsal distal denticle is smaller than the ventral distal denticle; ventral edge is smooth with brush-like setae on the inner part; dorsal edge has five denticles: one large distal, two medium subdistal, one large median and a small basal; fixed finger has four denticles: one distal, one subdistal, one median and one basal; the median and the basal are in a fork arrangement; the internal surface has brush-like setae.

Trichobothrial and pectinal teeth count variation**:** The variation observed in 77 studied specimens (38 males, 39 females) is as follows: pectinal teeth in males: 8-8 (2/38), 8-9 (5/38), 9-9 (26/38), 9-10 (5/38); females: 7-7 (9/39), 8-7 (7/39), 8-8 (17/39), 8-9 (3/39), 9-9 (3/39); pedipalp patella trichobothria *Pv*: 9-9 (2/77), 9-10 (3/77), 10-10 (29/77), 10-11 (14/77), 11-11 (23/77), 10-12 (2/77), 11-12 (4/77); pedipalp patella trichobothria *Pe*: *et* = 6-7 (2/77), 7-7 (21/77), 6-8 (1/77), 7-8 (12/77), 8-8 (40/77), 8-9 (1/77); *est* = 3-4 (3/77), 4-4 (72/77), 4-5 (2/77); *em* = 3-4 (1/77), 4-4 (76/77); *esb*= 2-2 (77/77); eb_a = 3-4 (2/77), 4-4 (75/77); *eb* = 4-4 (77/77).

Hemispermatophore**:** Well developed lamina with well visible basal constriction, tapered distally; truncal flexure present and well developed; capsular lobe complex well developed, with acuminate process; ental channel spinose distally, exhibiting 7 delicate spinules.

Distribution**:** Slovenia, Croatia, Italy (extreme northeast); introduced in Austria and Czech Republic.

Genus *Euscorpius* Thorell, 1876

Euscorpius aquilejensis (C. L. Koch, 1837), stat. nov.

Scorpius aquilejensis C. L. Koch, 1837: 101-103, pl. CV, Fig. 244.
Holotype (male; presumed lost), surroundings of Trieste, Italy (leg. Wagner).
The neotype is designated here according to ICZN Article 75 as it is required for the purposes of clarifying the taxonomic status of specific populations.

Neotype: male, Aquileia, Udine, Friuli-Venezia Giulia, Italy, 1978, leg. Marinoni (MZUF 6269).

Notes:

(1) Fet & Soleglad (2002) assigned a neotype for *E. tergestinus* from Osp, in Slovenia (NHMW), near the border with Italy. We found, however, that this specimen belongs to the species *E. aquilejensis* stat. nov. as evidenced by all the trichobothrial series, the pectinal teeth count and the measurements reported in Fet & Soleglad (2002). Also the pictures of specimens of *E. tergestinus* from Strunjan and Osp in Slovenia show clearly the typical diagnostic characters of *E. aquilejensis* stat. nov. Thus the Osp neotype is declared invalid herein according to Article 75 of the *ICZN*.

(2) The populations considered as *E. tergestinus* in Vignoli et al. (2005, 2007), Salomone et al. (2006), Tro-

Figure 15: *Euscorpius aquilejensis* stat. nov., male, dorsal and ventral views.

pea (2012) and Tropea et al. (2012) belong to *E. aquilejensis*.

Synonyms:

Euscorpius carpathicus picenus Di Caporiacco, 1950: 194, **syn. nov**.

Lectotype (designated by Fet & Soleglad, 2002): ♂ (MZUF 132-5856), Avellana, Pesaro e Urbino, Marche, Italy, 15-7-1880, G. Cavanna leg.. **Paralectotypes**: 5 ♂♂, 8 ♀♀ (MZUF 31/5838-5843, 132/5853-5855, 5857, 5859, 5860), same label as lectotype; 2 ♂♂, 3 ♀♀, 2 juv. (MZUF 161/5850-5851, 162/5864-5867, 163/5987), Caramanico, Pescara, Abruzzo, Italy, 1878, G. Cavanna leg.; 1 ♀ (MZUF 180/5852), Teramo, Abruzzo, Italy, 5-9-1904; 1 ♂, 2 ♀♀ (MZUF 84/5861-5863), Vallombrosa, Reggello, Firenze, Tuscany, Italy, Giachetti leg., 1 ♂ (MZUF 93/5849), San Marino, 7-7-1878, G. Cavanna leg..

References:

Scorpius aquilejensis: C. L. Koch, 1837: 101-103, pl. CV, fig. 244; C. L. Koch, 1850: 86.

Scorpio (Scorpius) aquilejensis: Gervais, 1844: 68.

Euscorpius carpathicus aquilejensis: Di Caporiacco, 1950: 198, 200; Lacroix, 1991: 19; Fet & Sissom, 2000: 361; Fet & Soleglad, 2002: 16, 24; Vignoli et al., 2005: 97–113; Vignoli & Salomone, 2008: 502–514.

Diagnosis: A medium-large *Euscorpius* species, total length 29-41 mm. Color of adults yellowish-ivory to light brown-reddish with carapace and pedipalps darker, reddish. Without reticulations or marblings on all body parts, especially on chelicerae. Slender appearance with carapace, metasoma and all segments of the pedipalps elongated. Trichobothria *db* and *dsb* are located much more distally than the base of the fixed finger; trichobothrium *db* is distal to *eb* and *esb*; and trichobothrium *esb* is distal to *eb*. The number of trichobothria on the pedipalp manus ventral surface is 4 (3 *V* + *Et* 1); the number of trichobothria on the pedipalp patella ventral surface usually is 9 (in 91.38% of examined pedipalps); the number of trichobothria on pedipalp patella external surface is: *et* = 6 (in 93.04% of examined pedipalps), *est* = 4, *em* = 4, *esb* = 2, eb_a = 4, *eb* =

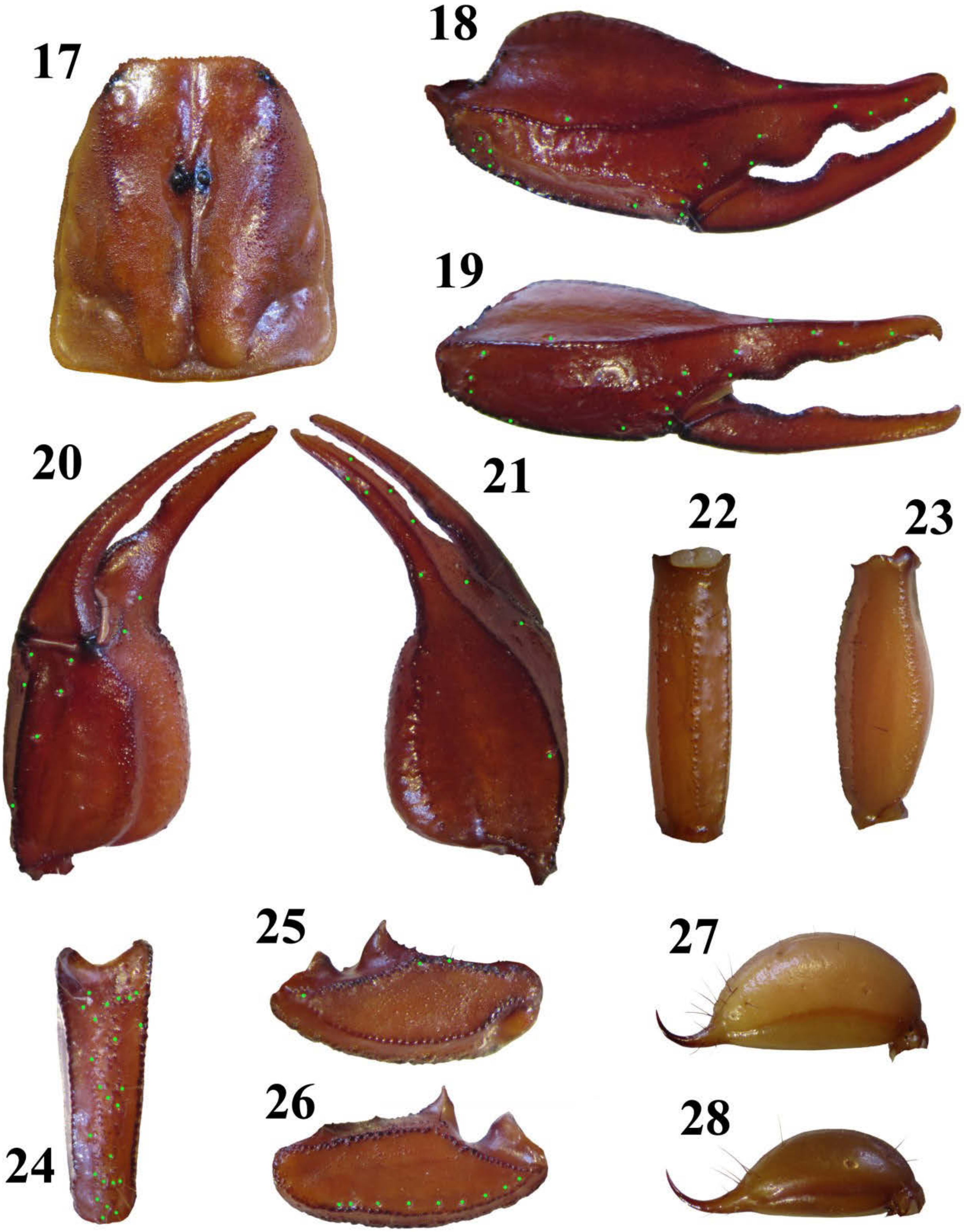
Figure 16: *Euscorpius aquilejensis* stat. nov., female, dorsal and ventral views.

4. The pectinal teeth count usually is 8 in males (in 89.13% of pectines examined) and 7 in females (in 85.71% of pectines examined). The telson vesicle in males is more swollen than in females: average *L/H* ratio of the vesicle is 1.73 (min. 1.67, max. 1.91) in male and 1.96 (min. 1.83, max 2.12) in females. Chela with a notch on fixed finger and scalloping of the movable finger in adult males, obsolete in females; *Lchel/Wchel* ratio is 2.79 in males and 2.89 in females. Dorsal patellar spur very developed. Femur longer than patella; *Lfem/Lpat* ratio is 1.05. Average ratio *Lcar/Wcar* is 1.10; average value of the length from center of median eyes to anterior margin of the carapace is 38.88% of the carapace length. Average value of the length from center of median eyes to posterior margin of the carapace is 61.12% of the carapace length. Average ratio of *Lmet/ Lcar* is 2.53 in males and 2.31 in females.

Description of the neotype (MZUF 6269, male)

Coloration: Whole color light orange-brown without reticulations or marblings, carapace and chelae darker, reddish, tergites outline lighter; sternites pale brownish with outline very lighter; pectines and genital operculum whitish/very light brownish; chelicerae yellow without reticulation or marbling and with teeth apical portion darker; telson yellow with longitudinal dark line and dark reddish tip aculeus; internal carinae of pedipalp femur blackish; chelal digital and ventro-external carinae red-blackish; dorsal carinae of metasoma dark brown.

Carapace: Length 5.16, posterior width 4.56; fine granulation on whole surface but it becomes gradually larger toward the lateral area, especially in anterior lateral area; anterior edge straight and granulate; deep an-



Figures 17–28: *Euscorpius aquilejensis* **stat. nov. 17.** Carapace. **18.** External view of the chela of adult male. **19.** External view of the chela of adult female. **20.** Ventral view of the chela. **21.** Dorsal view of the chela. **22.** Ventral view of the metasomal segment V. **23.** Lateral view of the metasomal segment V. **24.** External view of pedipalp patella. **25.** Dorsal view of pedipalp patella. **26.** Ventral view of pedipalp patella. **27.** Telson of adult male. **28.** Telson of adult female.

terior median, posterior median and posterior lateral furrows, the latter two combine to form two protuberances with rounded posterior margin; two pairs of lateral eyes, anterior eye larger; median eyes and tubercle quite small, situated anterior of middle; length from center of median eyes to anterior margin is 38.95% of carapace length; length from center of median eyes to posterior margin is 61.05% of the carapace length.

Mesosoma: Tergites very finely granulated with lighter outline; sternites smooth with spiracles very small, oval shaped and inclined to about 45° downwards towards outside, area of overlap between sternites paler.

Metasoma: Dorsal carinae of segments I-IV finely granulated; dorsolateral carinae of segment I finely granulated, obsolete on segments II-IV, rounded with scattered fine granulation on segment V; ventrolateral carinae absent on segment I, smooth to slightly rough on segments II-IV, finely serrulate on segment V; ventromedian carina absent on segments I-III, obsolete on segment IV, finely serrulate on segment V; very fine granulation present on intercarinal spaces, especially on segment I and on dorsal and lateral surfaces.

Telson: Vesicle highly swollen; slightly rough, with ventral setae of different sizes, especially near the vesicle/aculeus juncture; telson height 2.27; telson length 5.10; vesicle length 3.90; vesicle width 2.10; *L/H* ratio of the vesicle 1.72

Pectines: tooth count 8-8; middle lamellae count 4-4; several microsetae on marginal lamellae, middle lamellae and fulcra.

Genital operculum: Partially divided with genital papillae protruding; a few microsetae present.

Sternum: pentagonal shape, type 2; length approximately equal to width, deep posterior emargination.

Pedipalps: Coxa and trochanter with strong granulation. Femur: dorsal internal carinae tuberculate; dorsal external carinae formed by tubercles, slightly serrulate; external median carinae serrulate, anterior median formed by almost conical tubercles, of which three are larger, each with a macroseta; intercarinal spaces uniformly granulated. Patella: dorsal internal carinae tuberculate; dorsal external and ventral external carinae crenulate; ventral internal carinae from serrulate to tuberculate; dorsal intercarinal surface with granules of increasing size from proximal to distal area; ventral intercarinal surface with scattered minutes granules to a few bigger granules near to ventral internal carinae. Dorsal patellar spur very developed. Chela carina *D1* is distinctly strong, dark and slightly crenulate; *D4* is rounded, smooth to granular; *V1* is distinctly strong, dark and rough to crenulate; *V3* rounded and granulated; external carina granulated; intercarinal tegument rough to granulated with scattered very minute granules except between carinae *D4* and *V3*. Chela finger dentition: MD form a straight line of very small denticles closely spaced with a DD on the distal tip; OD formed of 7 denticles on movable finger and 6 denticles on fixed finger, immediately outside of MD, the terminal denticle is not very pronounced; ID formed of 7 denticles on movable finger and 7 denticles on fixed finger, spaced from MD, the terminal two denticles are little pronounced; IAD on both movable and fixed finger formed of 4 small denticles; *L/W* ratio of the chela 2.85; *Lfem/Lpat* ratio is 1.04.

Trichobothria: Chela: trichobothria series *V* standard: *V* = 4-4 (3 *V*+ *Et*1). Patella: ventral (*Pv*): 9-9; Patella external (*Pe*): *et* = 6-6, *est* = 4-4, *em* = 4-4, *esb* = 2-2, eb_a = 4-4, *eb* = 4-4. Femur: trichobothrium *d* situated slightly decentralized and proximal to *i* and *e*, *e* slightly distal to both, situated on dorsal external carina, but most on dorsal surface.

Legs: Legs with two pedal spurs; no tarsal spur; ventral row of tarsus III with a total of 9 stout spinules, of increasing size from proximal to distal, ending with a decentralized spinule instead of a spinule pair; 3 flanking pairs of tarsal setae adjacent to the ventral spinules row. Granulation present on leg femora, mostly ventrally; on the dorsal surface of leg femora I it is weakly marked.

***Chelicerae**:* smooth, without marbling, with darker teeth; the dorsal distal denticle is smaller than the ventral distal denticle; ventral edge is smooth with brush-like setae on the inner part; dorsal edge has five denticles: one large distal, two medium subdistal, one large median and a small basal; fixed finger has four denticles: one distal, one subdistal, one median and one basal; the median and the basal are in a fork arrangement; the internal surface has brush-like setae.

***Trichobothrial and pectinal teeth count variation*:** The variation observed in 58 studied specimens (23 males, 35 females) is as follows: pectinal teeth in males: 7-8 (4/23), 8-8 (18/23), 8-9 (1/23); females: 6-6 (1/35), 6-7 (7/35), 7-7 (26/35), 7-8 (1/35); pedipalp patella trichobothria *Pv*: 8-8 (1/58), 8-9 (4/58), 9-9 (49/58), 9-10 (4/58); pedipalp patella trichobothria *Pe*: *et* = 2-6 (1/58), 5-6 (4/58), 6-6 (49/58), 6-7 (4/58); *est* = 4-1 (1/58), 4-4 (57/58); *em* = 4-1 (1/58), 4-2 (1/58), 4-3 (1/58), 4-4 (55/58); *esb*= 2-1 (1/58), 2-2 (57/58); eb_a = 4-4 (58/58); eb = 4-4 (58/58).

Hemispermatophore: Well developed lamina with well visible basal constriction, tapered distally; truncal flexure present and well developed; capsular lobe complex well developed, with acuminate process; ental channel spinose distally, exhibiting 7 delicate spinules.

***Distribution*:** Italy (northern and central), San Marino, Vatican City State, Slovenia (west), Croatia (northwest).

		E. aquilejensis **Aquileia, Udine,** **Friuli, Italy,** **MZUF 6269** **Neotype**	***E. aquilejensis*** **Trieste,** **Friuli, Italy,** **MSNT**	***E. tergestinus*** **Bassovizza, Trieste,** **Friuli, Italy,** **MSNT SC 4001** **Neotype**	***E. tergestinus*** **Aurisina, Trieste,** **Friuli, Italy,** **MSNB 2123**
Gender		Male	Female	Male	Female
Pv		9-9	9-9	10-10	11-11
Pe		6-6,4-4,4-4,2-2,4-4,4-4	6-6,4-4,4-4,2-2,4-4,4-4	8-8,4-4,4-4,2-2,4-4,4-4	8-8,4-4,4-4,2-2,4-4,4-4
Dp		8-8	6-7	9-9	8-8
Total	**Length**	32.36	37.82	29.77	31.5
Carapace	**Length**	5.16	5.28	4.02	4.50
	Post. width	4.56	4.60	4.08	4.62
Metasoma	**Length**	12.74	11.98	12.17	12.06
Segment I	**Length**	1.56	1.56	1.56	1.50
	Width	1.68	1.68	1.62	1.62
Segment II	**Length**	1.92	1.80	1.91	1.86
	Width	1.50	1.46	1.35	1.38
Segment III	**Length**	2.16	2.02	2.10	2.10
	Width	1.44	1.41	1.32	1.32
Segment IV	**Length**	2.57	2.40	2.52	2.52
	Width	1.38	1.38	1.26	1.26
Segment V	**Length**	4.53	4.20	4.08	4.08
	Width	1.33	1.35	1.26	3.46
Telson	**Length**	5.10	4.56	4.46	3.84
Vesicle	**Length**	3.90	3.15	3.54	2.70
	Width	2.10	1.68	1.56	1.26
	Height	2.27	1.56	1.92	1.26
Aculeus	**Length**	1.20	1.41	0.92	1.14
Femur	**Length**	4.74	4.74	3.29	3.72
	Width	1.68	1.68	1.37	1.50
Patella	**Length**	4.56	4.68	3.48	3.84
	Width	1.80	1.86	1.38	1.50
Chela	**Length**	9.24	9.36	6.96	7.56
	Width	3.24	3.12	2.94	3
Mov. finger	**Length**	5.58	5.46	4.02	4.38
Ratio	**Lcar/Lfer**	1.102	1.114	1.276	1.209
	CarA/CarP %	38.95-61.05	39.39-60.61	43.28-56.72	42.66-57.14
	Lfer/Lpat	1.039	1.013	0.946	0.969
	Lchel/Wchel	2.852	3.000	2.367	2.520
	Lmet/Lcar	2.469	2.269	3.027	2.680

Table 1: Measurements (mm) and morphometric ratios of *E. aquilejensis* **stat. nov.** and *E. tergestinus* s.str.

		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	*E. concinnus* (Mugello)		0.000	0.006	0.013	0.012	0.014	0.018	0.025	0.016	0.026	0.026	0.026	0.024	0.035	0.027
2	*E. concinnus* (Bologna)	0.000		0.006	0.013	0.012	0.014	0.018	0.025	0.016	0.026	0.026	0.026	0.024	0.035	0.027
3	*E. concinnus* (Volterra)	0.011	0.011		0.014	0.013	0.014	0.018	0.023	0.016	0.024	0.024	0.024	0.025	0.036	0.026
4	*E. tergestinus* (Austria)	0.035	0.035	0.039		0.004	0.014	0.018	0.024	0.014	0.025	0.025	0.025	0.027	0.034	0.024
5	*E. tergestinus* (Slovenia)	0.034	0.034	0.038	0.003		0.014	0.017	0.024	0.015	0.025	0.025	0.024	0.027	0.034	0.024
6	*E. carpathicus* s.str.	0.038	0.038	0.042	0.046	0.042		0.015	0.020	0.012	0.020	0.020	0.022	0.026	0.029	0.023
7	*E. italicus*	0.067	0.067	0.062	0.063	0.059	0.050		0.015	0.012	0.020	0.020	0.018	0.025	0.026	0.022
8	*E. balearicus*	0.102	0.102	0.095	0.100	0.096	0.077	0.052		0.017	0.023	0.023	0.021	0.028	0.027	0.023
9	*E. sicanus* complex (Puglia)	0.047	0.047	0.051	0.043	0.046	0.033	0.036	0.062		0.020	0.020	0.018	0.025	0.026	0.025
10	*E. aquilejensis* (Sistiana)	0.103	0.103	0.096	0.101	0.097	0.073	0.076	0.090	0.076		0.000	0.005	0.029	0.033	0.030
11	*E. aquilejensis* (Rome)	0.103	0.103	0.096	0.101	0.097	0.073	0.076	0.090	0.076	0.000		0.005	0.029	0.033	0.030
12	*E. aquilejensis* (Siena)	0.103	0.103	0.096	0.101	0.097	0.083	0.066	0.080	0.066	0.007	0.007		0.028	0.032	0.031
13	*E. germanus*	0.099	0.099	0.104	0.120	0.115	0.107	0.110	0.121	0.110	0.128	0.128	0.126		0.030	0.042
14	*E. flavicaudis*	0.165	0.165	0.170	0.152	0.157	0.138	0.121	0.127	0.126	0.154	0.154	0.153	0.141		0.034
15	*E. tauricus*	0.131	0.131	0.124	0.109	0.105	0.101	0.100	0.105	0.119	0.145	0.145	0.146	0.185	0.151	

Table 2: Estimates of evolutionary divergence between 15 mitochondrial *16S rDNA* sequences. The number of base substitutions per site is shown. Standard error estimates are shown above the diagonal and were obtained by a bootstrap procedure (1000 replicates). Analyses were conducted using the Tamura-Nei (1993) model. The rate variation among sites was modeled with a gamma distribution.

Discussion

Di Caporiacco (1950) studied several specimens of "*E. carpathicus*" from the environs of Trieste, confirming the presence of two distinct forms. One was a "mesotrichous" form, with a number of trichobothria on the pedipalp patella ventral surface normally 9, total number of trichobothria on pedipalp patella external surface 24, with 7 pectinal teeth in females and 8 in males. Another was a "polytrichous" form, with a number of trichobothria on the pedipalp patella ventral surface normally 10 to 11, total number of trichobothria on pedipalp patella external surface 25 to 26, with 8 pectinal teeth in females and 9 to 10 in males. According to Di Caporiacco (1950), the "mesotrichous" form was identifiable as *Scorpius aquilejensis* of C. L. Koch, while the "polytrichous" form corresponded to *S. tergestinus*. Scherabon (1987) reported the presence of a population of *Euscorpius carpathicus* in Austria, with a *Pv* = 10-12 and total *Pe* = 25-26, which agrees with Di Caporiacco's "polytrichous" form. According to Huber et al. (2001), the Austrian populations were introduced and correspond to the Slovenian clade. Kovarik & Fet (2003) reported a population of *E. tergestinus* from Nebrich, in the Czech Republic, which correspond with Austrian specimens studied by Scherabon (1987). We checked some specimens from Nebrich and Austria, and they appear related to the form considered *E. tergestinus* s.str. in this study. Fet & Soleglad (2002) elevated *E. tergestinus* to species status and moved in synonymy with it all the Italian forms that have trichobothria on the pedipalp patella external surface *em* = 4, eb_a = 4, and *eb* = 4, including *E. c. aquilejensis*. However, these characteristics alone are not enough to identify this species; further trichobothrial series and other morphological characters should be considered, which circumscribe well some populations such as *E. c. tergestinus* and *E. c. aquilejensis*, the latter elevated herein at species status, *E. aquilejensis* stat. nov.

Data of Scherabon (1987), Huber et al. (2001), and especially Di Caporiacco (1950) are in agreement with those of the present study. The presence of two totally separate forms is evident. The form considered until now as *E. tergestinus* found in most of Italy has a trichobothrial number on the pedipalp patella ventral surface 9, a total trichobothrial number on the pedipalp patella external surface 24 (*et* = 6, *em* = 4, *eb* = 4), with a pectinal teeth count 7 in females and 8 in males. These values are only higher in the northeast of Italy and Balkans; however, the increase of these characters is not gradual as would be expected from a population of the same species. In fact, both forms are found in northeastern Italy near Trieste: "mesotrichous" specimens, with low pectinal teeth count and more long-limbed, and "polytrichous" specimens with higher pectinal teeth count and more stocky. However, there are no forms showing mixed or intermediate morphology. Furthermore, measurements and proportions of the specimens studied highlighted morphological characters already evident to the naked eye, among which the elongated fingers of chela already mentioned by C.L. Koch (1837) in "mesotrichous" specimens; they all have more slender appearance because of segments of pedipalps and carapace relatively longer than in "polytrichous" form (see comparison section below) and in the most of *Euscorpius* species. The fact that a set of characters so fundamental is well fixed among the populations and there are no intermediate forms in the area of sympatry reinforces the fact that there are two well distinct species.

It is notable that both *Scorpius aquilejensis* and *Scorpius tergestinus* were described by C.L. Koch (1837) in the same work and both from the vicinity of Trieste, an Italian city next to the modern border with Slovenia. The specific epithets given by Koch derive from the Latin names of Trieste (*"Tergeste"*) and, probably, Aquileia (a neighboring town and district in Friuli-Venezia Giulia). We confirm that geographic ranges of these two taxa overlap in this transitional region. C.L. Koch clearly saw them as two distinct species; and his keen eye for *Euscorpius* has been confirmed several times in recent years by elevation of his "old" taxa to species rank. *Scorpius aquilejensis* was described based on a male with yellowish coloration, with 8 trichobothria ("dimples" [Grübchen], i.e. trichobothrial areolae) on the pedipalp patella ventral surface, 9 pectinal teeth, and elongated fingers of chela. At the same time, *S. tergestinus* was described as reddish-rust colored form, with 10 trichobothria (dimples) on the pedipalp patella ventral surface with 8 and 9 pectinal teeth and small chelae. Particularly light/yellowish specimens of *E. aquilejensis* stat. nov. are found throughout its range, while specimens with 8-8 trichobothria on the pedipalp patella ventral surface and 9-9 pectinal teeth count are very rare. However, it is also true that none of the 77 specimens considered *E. tergestinus* s.str. according to this study showed 8-8 trichobothria on the pedipalp patella ventral surface. This also refers to 72 specimens of *E. c. tergestinus* studied by Di Caporiacco (1950). Probably the only specimen studied by Koch was anomalous, or he was not able to see well all the trichobothria, since that he himself wrote "the dimples of the outer edge of the ventral surface are individually small and difficult to see". Furthermore, all specimens of *E. aquilejensis* stat. nov. clearly have elongated chelae fingers compared to more stocky chelae of *E. tergestinus* s.str., as described by C. L. Koch. Therefore, and also in agreement with Di Caporiacco, in this paper the "mesotrichous" form with more slender appearance, *Pv* = 9, and *Dp* = 7-7 in females and 8-8 in males is considered to be the Koch's *Scorpius aquilejensis*, elevated to species status herein, *E. aquilejensis* **stat. nov**. At the

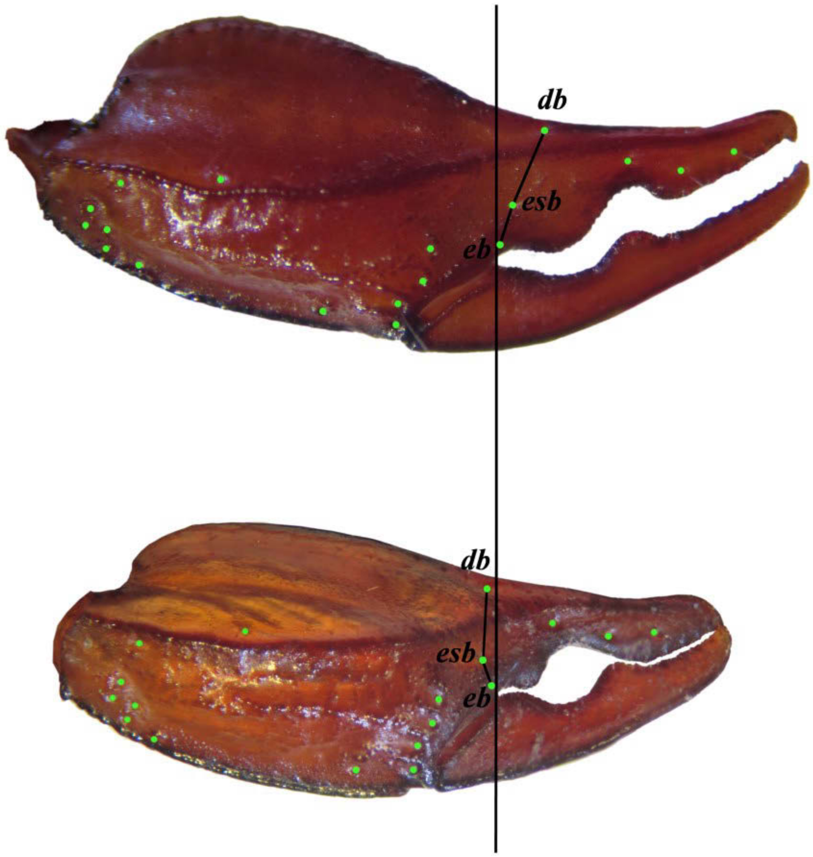


Figure 29: Comparison between chelae of adult males of *E. aquilejensis* (above) and *E. tergestinus* (below). Note the position of the trichobothria *db*, *esb* and *eb*: in *E. aquilejensis*, *db* is always distal to *eb* and *esb*, and *esb* is distal to *eb*, while in *E. tergestinus*, *db* occurs in a much more basal position and is generally in line with *eb* or slightly moved, and *eb* is usually distal to *esb*.

same time, the "polytrichous" form with more stocky appearance, *Pv* = 10-11, and *Dp* = 8-8 in females and 9-9 in males is considered to be Koch's original *Scorpius tergestinus*, addressed as *E. tergestinus* s.str. in this paper.

After this morphological evidence was discovered, we conducted a pilot molecular survey, extrapolating *16S rDNA* data available from the GenBank database (the results are presented in Fig. 32 and Table 2). We confirmed that *E. aquilejensis* stat. nov. (from three populations, Friuli-Venezia Giulia, Tuscany and Lazio; Salomone et al., 2006) and *E. tergestinus* s.str. (from Slovenia and Austria; Huber et al., 2001) are clearly separated into two well distinct and strongly supported clades (see phylogenetic tree on Fig. 32). *E. tergestinus* s.str. specimens from Austria and Slovenia form a clade relatively closer to *E. concinnus,* although well separated from the latter by genetic distance of 3.4-3.8%. At the same time, *E. aquilejensis* stat. nov. shows a very high relative genetic distance from the populations of the subgenus *Euscorpius* s.str., placed in a basal position between the phylogenetic clades of *E. italicus* (subgenus *Polytrichobothrius*) and *E. flavicaudis* (subgenus *Tetratrichobothrius*). The divergence between *E. aquilejensis* and *E. tergestinus* s.str. is 9.7%, and 10.3% between *E. aquilejensis* and *E. concinnus*, while with the other populations examined in this study the ranges is 7.3% to 15.4%. This is a very high divergence value, higher than that between *E. italicus* and *E. tergestinus* s.str. which is 5.9-6.3%. Very interesting also is the fact that even some other species considered part of the subgenus *Euscorpius,* i.e. *E. balearicus* and *E. tauricus,* are located in a basal position with divergence > 6 % from the populations of the subgenus *Euscorpius* s.str. clustering around type species *E. carpathicus*, but are well separated from *E. aquilejensis* stat. nov. with a divergence of 9% and 14.5%, respectively. The phylogenetic tree and the estimates of evolutionary divergence (genetic distance) between sequences suggest a long history of independent evolution. We see that subgenus *Polytrichobothrius* (represented here by its type species *E. italicus*) is phylogenetically closer to the part of subgenus *Euscorpius* s.str. clustering around type species *E. carpathicus*. On the other hand, both these clades are distant from *E. aquilejensis* stat. nov., *E. balearicus* and *E. tauricus.* Therefore, this traditional nominotypic subgenus *Euscorpius* s.str. appears to be paraphyletic.

Salomone et al. (2006) showed the unusual position of *E. aquilejensis* for the first time considering it as *E. tergestinus* based, in part, on the incorrect neotype assigned in Fet & Soleglad (2002). However, they did not comment on the incongruence of these data com-

Figure 30: *E. aquilejensis* **stat. nov.** has a particularly elongated carapace compared to other *Euscorpius* species, usually longer than wide (average ratio *Lcar/Wcar* is 1.10); its posterior part is on average 61.12% of the total length of carapace, so the median eyes are in a more distal position. At the same time, *E. tergestinus* has the carapace more stocky, with its length usually less or equal to the width (average ratio Lcar/Wcar is 0.965) and its posterior part is on average 56.79% of the total length of carapace.

pared with those of other studies and did not address the paraphyletic status of the subgenus *Euscorpius* at the time. Until now, the genetic data of *E. aquilejensis* stat. nov. and *E. tergestinus* populations have never been compared, although they have been published separately (in Gantenbein et al. 2001; Huber et al. 2001; Salomone et al., 2006), because of the choice of the nomenclature used for the forms considered. In fact, the populations analyzed before Fet & Soleglad (2002) have simply been considered part of *E. carpathicus* without the subspecific status but only based on the provenance of the specimens. At the same time, the populations analyzed after Fet & Soleglad (2002) (with *eb*=4 and *em*=4 from France to Croatia) have been considered *E. tergestinus*, creating a confusion. Nevertheless, through studying various forms and their distribution and a careful examination of literature it was possible to clarify the identity of *E. tergestinus* s.str. and *E. aquilejensis* stat. nov.

Although previously not recognized, *E. tergestinus* s.str. and *E. aquilejensis* stat. nov., as we demonstrate here, are far from “cryptic species”. They are two very separate species with a surprisingly high genetic distance of 9.7%, and a very distant position in the preliminary phylogenetic tree, *E. aquilejensis* being in a very basal position. Especially notable on Fig. 32 is position of subgenus *Polytrichobothrius* and several other species, including *E. sicanus* complex, between *E. tergestinus* s.str. and *E. aquilejensis*, suggesting a long-lasting history of independent evolution of these taxa. The divergence among *E. tergestinus* and *E. aquilejensis* is much higher than that between subgenus *Polytrichobothrius* (represented here by its type species *E. italicus*) and subgenus *Euscorpius* s.str. (represented here by its type species *E. carpathicus*) (i.e. 5 %). It seems clear that *E. aquilejensis* stat. nov. does not fall in the subgenus *Euscorpius* s.str., therefore in this paper we do not assign it to any subgenus.

Comparison of *E. aquilejensis* stat. nov. and *E. tergestinus* s.str.

The morphological division among *E. aquilejensis* stat. nov. and *E. tergestinus* s.str. is clear, as these two species differ in several characters:

(1) *E. aquilejensis* has lower trichobothrial count with *Pv* = 9 and *Pe-et* = 6 compared to *Pv* = 10 to 11 and *Pe-et* = 7 to 8 in *E. tergestinus*;

(2) *E. aquilejensis* has lower pectinal teeth count with *Dp* 7 in females and 8 in males, while *E. tergestinus* has *Dp* 7 to 8 in females (7 in 32.05% and 8 in 56.41% of pectines examined) and 9 in males;

(3) *E. aquilejensis* has general habitus more slender, with all segments of the pedipalps and the carapace proportionally longer than in *E. tergestinus*;

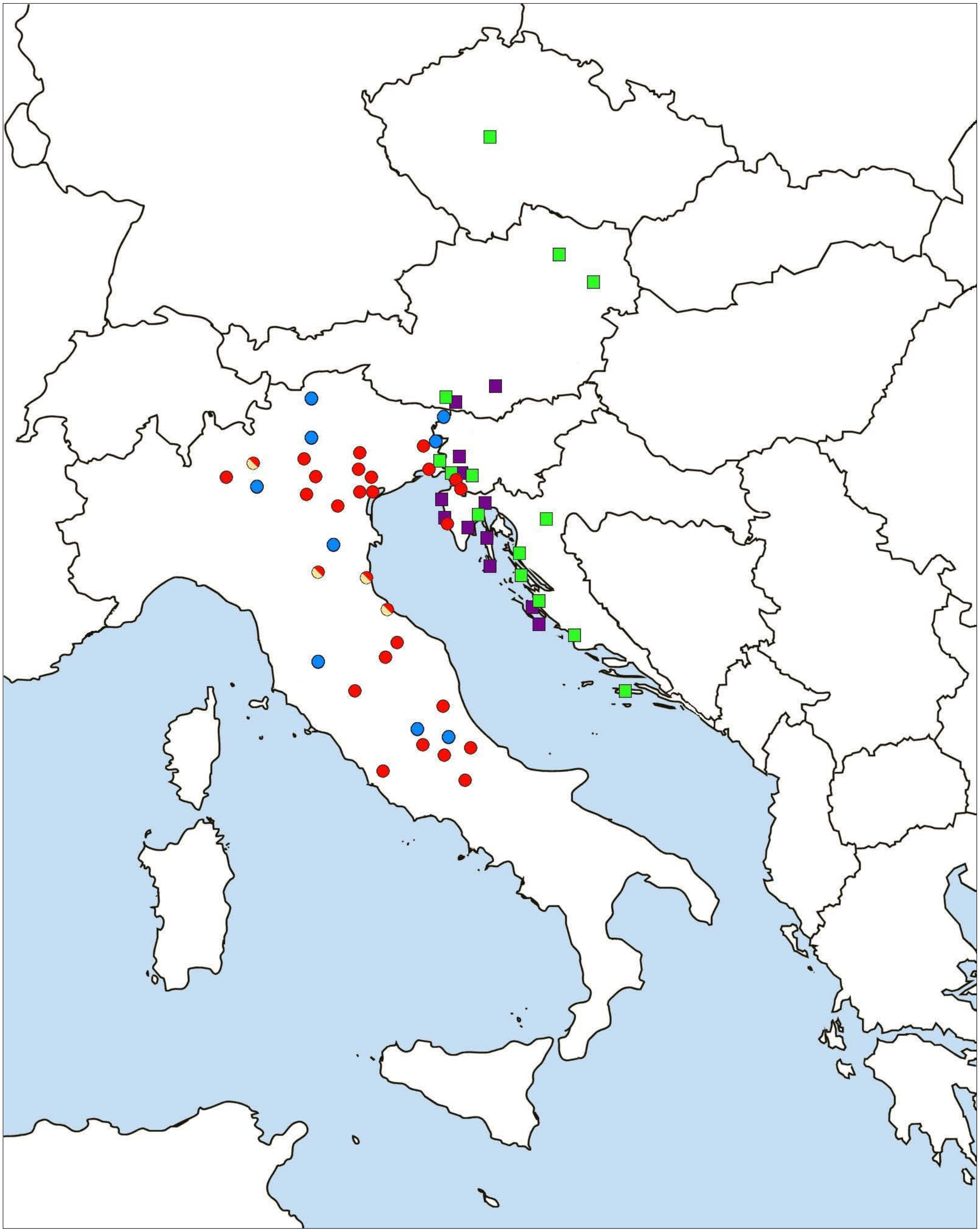


Figure 31: Map of the distribution of *E. aquilejensis* (*red circles*, specimens examined in this study; *blue circles*, records from other studies; *yellow and red circles*, identifications from photographs) and *E. tergestinus* (*green squares*, specimens examined in this study; *purple squares*, records from other studies). Note that the two species are sympatric only in the vicinity of the border between Italy and Slovenia, mainly in the area around Trieste, where there are no Alps to hinder the dispersal but only the Trieste Karst formation, few hundred meters high.

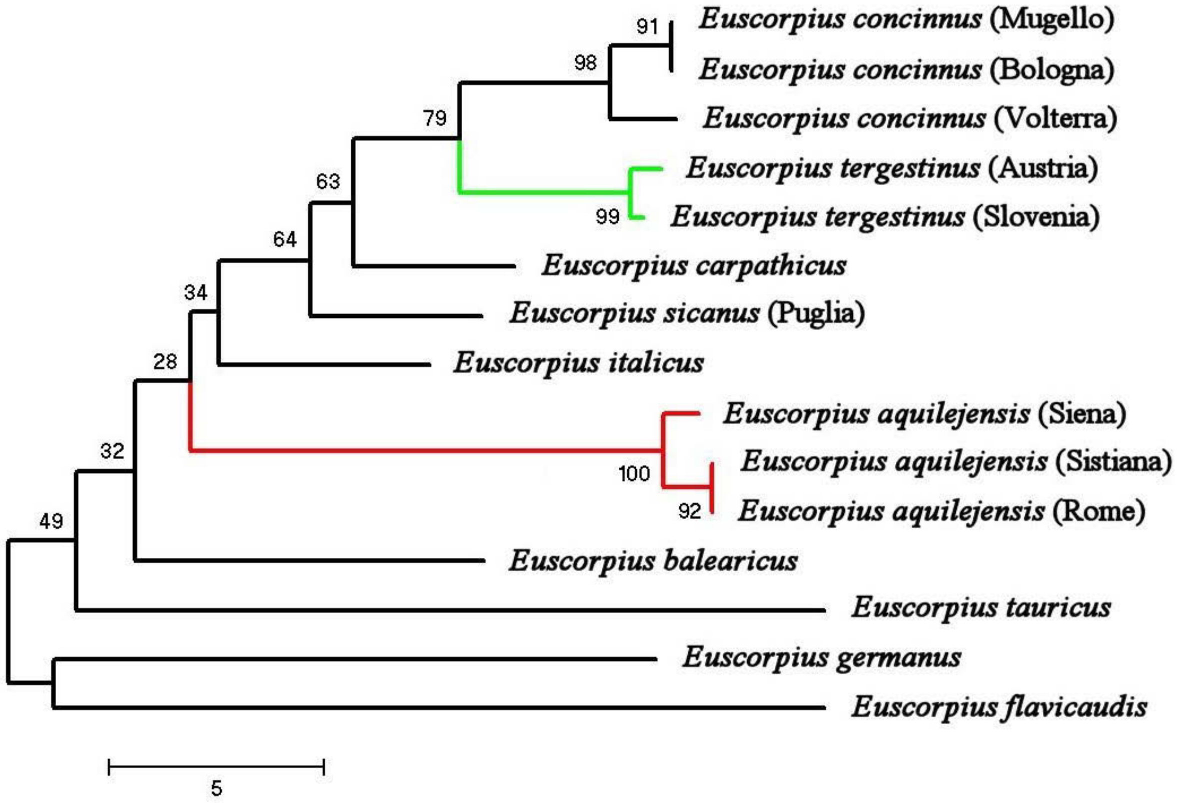


Figure 32: Preliminary Neighbor Joining (NJ) phylogenetic tree showing that *E. aquilejensis* stat. nov. and *E. tergestinus* s.str. are clearly separated into two well distinct and strongly supported clades. Note that *E. aquilejensis*, as well as *E. balearicus* and *E. tauricus* are located in a basal position to *E. italicus* (subgenus *Polytrichobothrius*), which implies that they are not part of the subgenus *Euscorpius* s.str. and thus the latter is paraphyletic. The evolutionary history was inferred using the Neighbor Joining method (Saitou & Nei, 1987). The optimal tree with the sum of branch length = 106.18359375 is shown. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1000 replicates) are shown next to the branches (Felsenstein, 1985). The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. The evolutionary distances were computed using the number of differences method (Nei & Kumar, 2000) and are in the units of the number of base differences per sequence. The analysis involved 15 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There were a total of 292 positions in the final dataset. Evolutionary analyses were conducted in MEGA5 (Tamura et al., 2011).

(4) in *E. aquilejensis*, because of the elongated chela and more proximal position of the base of fixed finger, the trichobothria *db* and *dsb* occur in more distal position than in *E. tergestinus*, which has the trichobothrium *db* in basal position and *dsb* more proximally;

(5) in *E. aquilejensis*, trichobothrium *db* on fixed finger is always distal to *eb* and *esb*, and *esb* is distal to *eb*, while in *E. tergestinus*, *db* occurs in more basal position than in *E. aquilejensis* and is generally in line with *eb* or *esb* or slightly moved; and *eb* is usually distal to *esb* (Fig. 29);

(6) *E. aquilejensis* has a proportionally longer pedipalp femur that is usually longer than pedipalp patella, while *E. tergestinus* has a more stocky femur which is usually shorter than patella or as long as it;

(7) *E. aquilejensis* has a particularly elongated carapace compared with other *Euscorpius* species; in fact it usually is longer than wide (average ratio *Lcar/Wcar* is 1.10) and its posterior part is on average 61.12% of the total length of carapace, so the eyes occur in more distal position, while *E. tergestinus* has more stocky carapace, with its length usually less or equal to width (average ratio *Lcar/Wcar* is 0.965), its posterior part is on average 56.79% of the total length of carapace (Fig. 30);

(8) *E. aquilejensis* has an average ratio of *Lmet/Lcar* 2.53 in males and 2.31 in females while *E. tergestinus* has an average ratio of *Lmet/Lcar* 2.88 in males and 2.72 in females.

(9) *E. aquilejensis* has more granulated body, which is most visible on the carapace that is granulated over whole surface but granules become gradually larger toward the lateral area, especially in anterior lateral area;

(10) *E. aquilejensis* never has reticulation or marbling, and its chelicerae are always uniformly yellow with dark teeth apical portion, while *E. tergestinus* often has more or less accentuated reticulation or marbling on carapace, metasoma and especially on chelicerae.

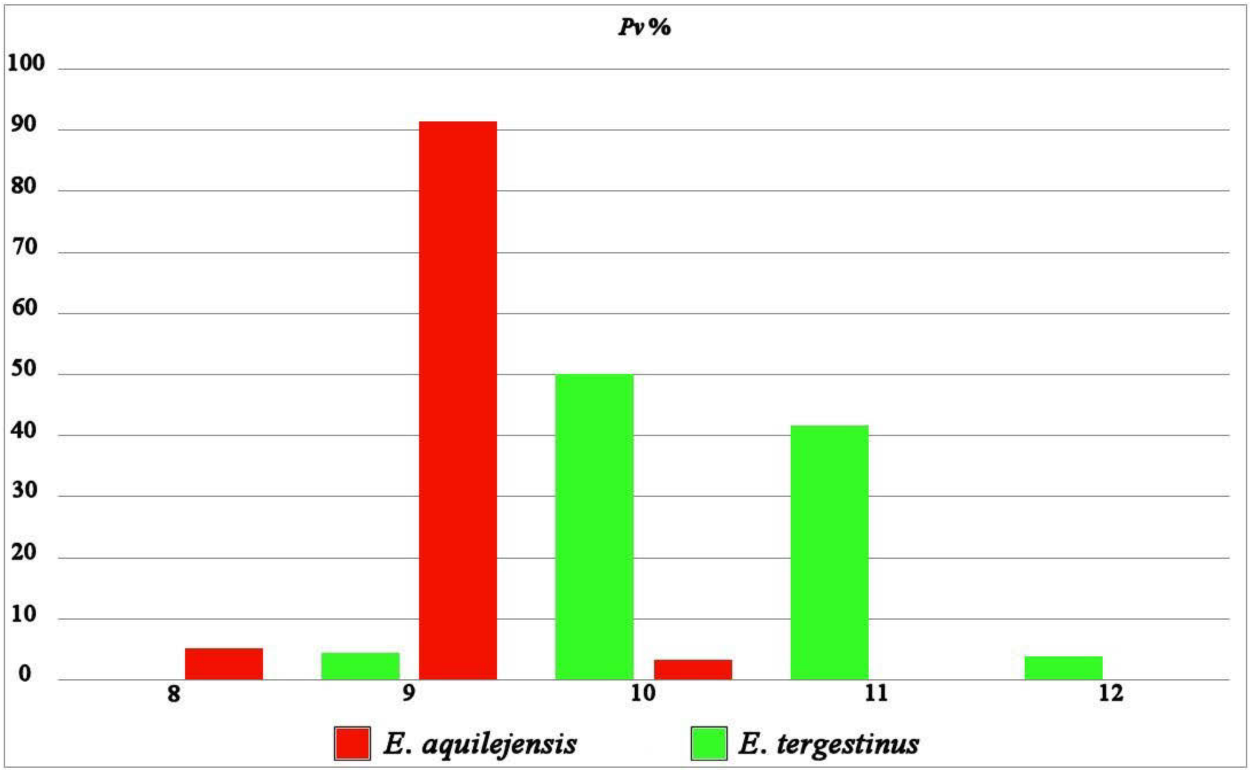


Figure 33: Distribution of trichobothria (%) on the ventral surface of the patella (*Pv*) depending on the species. *E. aquilejensis*, red; *E. tergestinus*, green.

In addition, there are further minor differences like other granulation and the various carinae more accentuated in *E. aquilejensis*. Position of some trichobothria, such as those in the outer part of the patella, because of the elongated shape of patella, forms a more acute angle with its longitudinal axis; this is most observable in the series *Pe-esb*, while in *E. tergestinus* they are more "compressed", with the series *Pe-esb* sometimes almost paired. Often, *E. aquilejensis* has stout spinule series on tarsus ending with a decentralized distal spinule instead of a pair of spinules, while in *E. tergestinus* it always ends with a distal pair of spinules.

Distribution

Italy is a peninsula with the northern part connected to the mainland, but the mountain range of the Alps creates a natural barrier to biological dispersal, although in areas near the sea the Alps become lower, and in the area of Trieste the Karst formations create an easy passage for scorpion dispersal. This would explain the fact that the range of some species abundant in Italy (e.g. *E. germanus* and *E. aquilejensis* stat. nov.) extends slightly beyond the Italian border and, vice versa, species abundant in Slovenia and Croatia are found slightly within of Italian territory, in the Trieste area (e.g. *E. gamma* and *E. tergestinus* s.str.). The range of *E. tergestinus* s.str. is restricted here to Slovenia, Croatia, the extreme northeast of Italy near the border with Slovenia, and introduced populations in Austria and Czech Republic. There is no ecological information on this form, but it probably is less synanthropic than *E. aquilejensis*, although it also was found in human constructions. The distribution range of *E. aquilejensis* stat. nov. includes western Slovenia, northwestern Croatia, and mainly northern and central Italy in the eastern half of the Apennine Mountains up to Abruzzo in a continuous way, with some populations in central-eastern Tuscany, and a few scattered populations near the border between Abruzzo and Lazio and in Rome city. The latter is probably an introduced population since it is restricted only to the urban area, in moist cellars and garages, while is never found in natural environments around the city, which are occupied by other species (*E. italicus*, *E. flavicaudis*, and *E. concinnus*; Tropea, unpublished data). This would also explain the fact that the same haplotype occurs in Sistiana and Rome, two localities separated by about 600 km (Salomone et al., 2006). This species is mostly synanthropic, found in human structures throughout its range (including Trieste), therefore possible casual introductions by part of the humans are likely, as has been already described for *E. flavicaudis* and *E. italicus* (Fet et al., 2005) and *E. tergestinus* (Huber et al., 2001). In natural environments

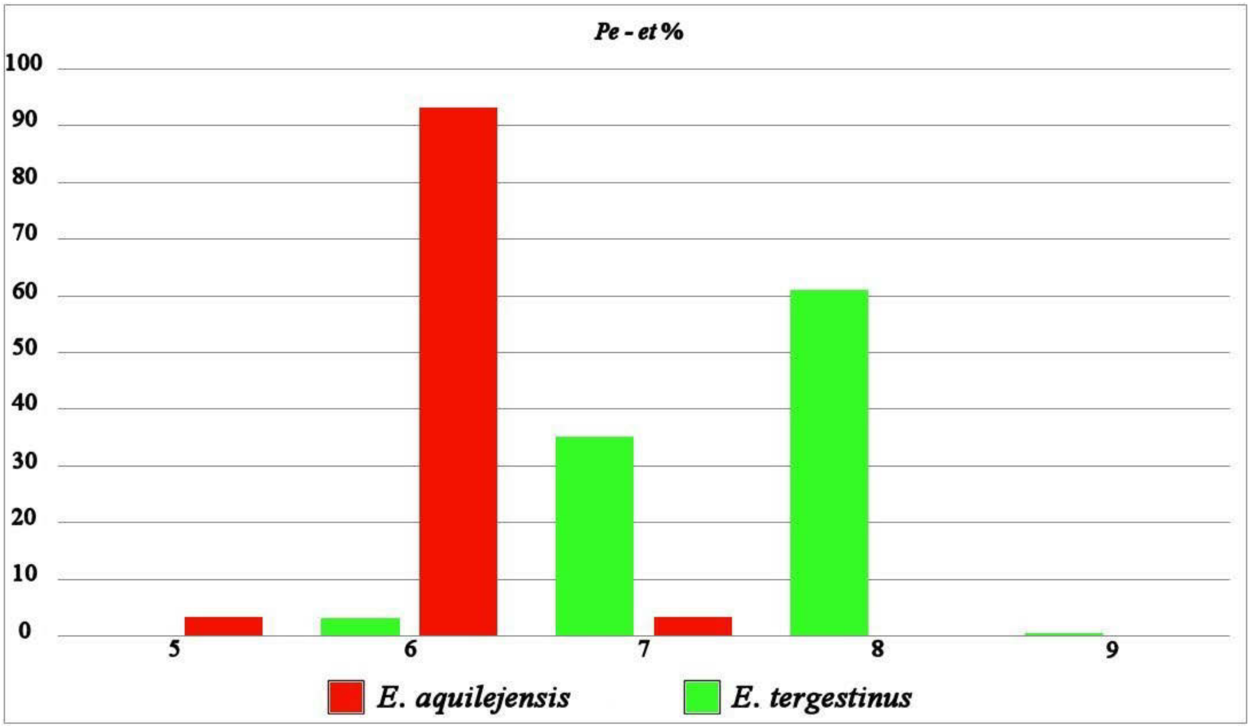


Figure 34: Distribution of trichobothria (%) in the series *et* on the external surface of the patella (*Pe*) depending on the species. *E. aquilejensis*, red; *E. tergestinus*, green.

E. aquilejensis is often found in lapidicolous and calcareous habitats, and in natural and artificial caves. Further genetic studies should be conducted for the populations to the east of the Apennines to understand the intraspecific divergence of this species.

Conclusions

The taxonomy of genus *Euscorpius* is still unresolved as it seems to include more taxa that have yet to be clarified and described. Its subgeneric composition is also unclear. Three old subgenera introduced by Birula (*Euscorpius* Thorell, 1876; *Polytrichobothrius* Birula, 1917; *Tetratrichobothrius* Birula, 1917) with the more recent addition of *Alpiscorpius* Gantenbein et al., 1999, are not sufficient to explain the revealed phylogenetic position of some populations. As can be seen from our preliminary phylogeny, such isolated taxa as *E. aquilejensis* stat. nov., *E. balearicus* and *E. tauricus* do not fall within the subgenus *Euscorpius* s.str, which appears to be paraphyletic. Further studies are required to clarify the position subgeneric taxonomy of these and other possible species.

While it is clear that the area of Trieste in northeastern Italy is the meeting point of two clearly distant species, *Euscorpius aquilejensis* and *E. tergestinus*, the situation surrounding these two species is not completely resolved. In fact, in the Balkans there are unnamed forms that require further investigation (under preparation), as well as in Italy there are known forms which could be elevated to species status or synonymized with other forms in the near future (under preparation). For instance, *E. carpathicus picenus* Di Caporiacco, 1950, syn. nov., is herein moved in synonymy with *E. aquilejensis*. However, all other forms currently synonymous with *E. tergestinus* (i.e. *E. c. apuanus, E. c. niciensis* and *E. c. corsicanus*) are not recognized as its synonyms due to different morhology (most evident in the case of *E. c. niciensis,* which is relatively close to *E. concinnus*); further studies are required for a correct taxonomic assignment of these forms (under preparation).

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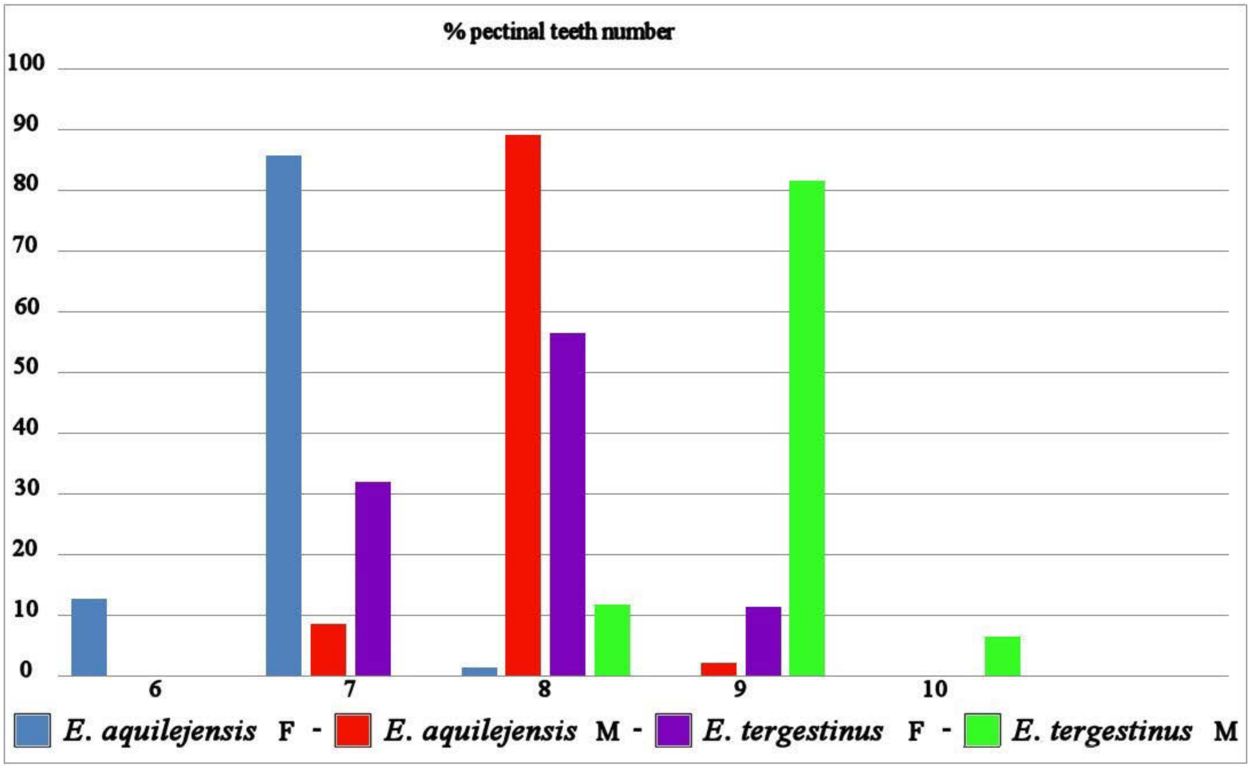

Figure 35: Distribution of the number of pectinal teeth (%) according to the species and gender. *E. aquilejensis* females, blue; *E. aquilejensis* males, red; *E. tergestinus* females, purple; *E. tergestinus* males, green.

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