The Palaearctic species of *Pristaulacus* Kieffer, 1900 (Hymenoptera, Aulacidae): remarks on taxonomy, systematic, and biogeography

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Abstract: Taxonomic, systematic, and biogeography knowledge on the Palaearctic species of *Pristaulacus* Kieffer 1900 is summarized. Twenty-one valid species are recognized. The most important morphological characters taken into consideration are: shape, cuticular sculpture, and pubescence of head; index length/width of antennomeres; shape, sculpture and cuticular processes of mesosoma, especially of pronotum and mesonotum; number and shape of teeth on claw; shape and sculpture of metasoma; ovipositor length compared with wing and antenna length; and colour pattern (e.g., the dark spots on fore wing, and the colour of hind tarsus). Several characters of the genital capsule of the male were proved to be very useful for species identification, e.g., the shape of the paramere, volsella, cuspis, and digitus. Based on analysis of twenty-five morphological characters, eight species groups are recognized. The critical revision of the chorological data, including many new records, introduced relevant changes of the geographical distribution pattern of most species. Twelve species are restricted to the western part of the Palaearctic Region and eight species are restricted to its eastern part; only one species, *P. gibbator*, has a wider distribution, including both western and eastern parts of the Palaearctics.

Key words: taxonomy, systematic, biogeography, *Pristaulacus*, Palaearctic Region.
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Introduction

The family Aulacidae includes 182 living species, currently placed in 3 genera: *Aulacus* Jurine 1807, with 65 species, *Pristaulacus* Kieffer 1900, with 115 species, and *Panaulix* Benoit 1984, with 2 species. They are found in all zoogeographic regions, Antarctica excluded. Based on available catalogues and revisions (Kieffer 1912, Hedicke 1939, Oehlke 1983, Konishi 1990, Smith 2001, Turrisi 2007), only 27 species are known for the Palaearctic Region, 6 *Aulacus* and 21 *Pristaulacus*.

Aulacidae (Fig. 1) are parasitoids of wood-boring Hymenoptera (Xiphydriidae) and Coleoptera (mostly Cerambycidae and Buprestidae) employing a koinobiont endophagous strategy (Jennings & Austin 2004). Due to this particular biology, aulacids are not easily observed in their natural habitats and they are not frequently collected by most of the usual collecting methods. As consequence, many species are known from a few specimens or only one. Notwithstanding some recent contributions (Turrisi 1999, 2000, 2004, 2005, 2006, 2007; Turrisi & Pilato 2004), their taxonomy, systematics, biogeography and biological traits are unsatisfactorily known.

In this contribution the knowledge on taxonomy, systematic and biogeography of Palaearctic *Pristaulacus* deriving from a recently published revisionary study (Turrisi 2007), are summarized.

A brief history of previous studies on the Palaearctic *Pristaulacus*

Kriechbaumer (1878a, b) was the first to give a comprehensive taxonomic treatment of the European Aulacidae, although now out of date and of little use. Another detailed contribution was provided by Schletterer (1889), although without relevant taxonomical improvements. The world Aulacidae were first catalogued by Hedicke (1939) and more recently by Smith (2001). The latter paper is an excellent updated catalogue of species, including data on taxonomy, geographical distribution, hosts, and literature.

The knowledge of Palaearctic *Pristaulacus* is derived mainly from a few taxonomic revisions e.g. Kieffer (1912), Oehlke (1983), Konishi (1990), and Turrisi (2007) and from other short papers including descriptions

of single species or faunistic reports on restricted, mostly European, areas. The monograph by KIEFFER (1912) is a very important attempt to give a comprehensive synopsis of world species, although it is of little use for the taxonomy of the group, since many of the treated species are synonyms, the generic assessment is not adequate, and several important diagnostic characters were overlooked; moreover, it nearly lacks iconography of diagnostic features. The contributions by OEHLKE (1983) and KONISHI (1990) are excellent taxonomic revisions using modern concepts, the first one treating the European species, the latter treating the Japanese species. The recent monograph by TURRISI (2007) represents the first attempt to revise the Palaearctic species based on type material, with detailed redescriptions, and additions to taxonomy and distribution.

Species	Distribution
P. barbeyi (FERRIÈRE 1933)	Algeria, Morocco (*), Greece (*), Turkey (*)
P. boninensis KONISHI 1989	Japan: Hahajima Island (Ogasawara Islands)
P. chlapowskii KIEFFER 1900	France, Czech Republic, Hungary, Bulgaria (*), Russia, Italy
P. compressus (SPINOLA 1808)	Spain, France, Austria, Germany, Switzerland, Italy, Czech Republic, Slovakia, Poland, Romania, Bulgaria, Hungary, Yugoslavia, Russia, Ukraine, Iraq (*), Morocco, Turkey, Syria (*), Lebanon (*)
P. comptipennis ENDERLEIN 1912	China (*), Japan (Iriomote-jima Island, Okinawa-hontô Island), Taiwan
P. edoardoi TURRISI 2007	Crete Island (*), Greece (*)
P. galitae (GRIBODO 1879)	Spain, Canary Islands (Tenerife), France, Germany, Austria, Czech Republic, Slovakia, Bulgaria, Hungary, Romania, European Russia, Ukraine, Italy, Sardinia, Sicily, Yugoslavia, Croatia (*), Greece (*), Crete Island (*) Rhodos Island (*), Turkey (*), Morocco, Algeria, Tunisia including Galita Island
P. gibbator (THUNBERG 1822)	Sweden, Germany, Austria (*), Poland, Russia (*) (including Siberia)
P. gloriator (FABRICIUS 1804)	Czech Republic, Slovakia, Germany, Hungary, Austria, Romania, European and central Russia, Italy, Yugoslavia Albania, Greece (*), Turkey, Iran
P. insularis KONISHI 1990	Japan (Honshu, Mikura-jima Island, Hachijô-jima Island, Chikuzen-okino-shima Island, Yaku-shima Island, Amami-ôshima Island)
P. intermedius UCHIDA 1932	China, Japan (Hokkaido, Honshu, Shikoku, Kyushu)
P. kostylevi (ALEKSEYEV 1986)	Russia (Primorski Krai)
P. lindae TURRISI 2000	Sicily (Italy)
P. longicornis KIEFFER 1911	China (unknown if Palaearctic or Oriental)
P. morawitzi (SEMENOW 1892)	Turkmenistan
P. mourguesi MANEVAL 1935	France, Croatia (*), Hungary, Greece (*)
P. paglianoi TURRISI 2007	Morocco (*), Tunisia (*)
P. patrati (AUDINET-SERVILLE 1833)	Spain, France, Austria, Germany, Hungary, Switzerland
P. proximus KIEFFER 1906	Spain
P. rufipilosus UCHIDA 1932	Japan (Hokkaido, Honshu, Shikoku)
P. ryukyuensis KONISHI 1990	Japan (Amami-ôshima Island, Okinawa-hontô Island)

(*) New records from TURRISI (2007).

Fig. 1. *Pristaulacus edoardoi* Turrisi 2007, holotype ♀ (Greece: Crete Island).

Materials and methods

About 450 specimens from many museums and private collections were examined, including all the relevant type material. Specimens were studied under a stereo-microscope and SEM. The nomenclature for morphology follows Crosskey (1951), Gauld & Bolton (1996), and Snodgrass (1941). Terminology for surface sculpturing follows Harris (1979).

Characters taken into consideration for taxonomy

The morphological characters useful for taxonomical purposes are briefly listed as follows:

Head

Shape and sculpture; occipital margin (straight; more or less concave; medially grooved); length and shape of temple; shape and width of occipital carina (very narrow, less than 0.2x diameter of an ocellus; moderately wide or very wide, lamelliform, 0.5-1.5x diameter of an ocellus); index length/width of antennomeres (A3–A5 and last antennomere); setal position, length, and density.

Mesosoma
Shape and sculpture; shape and teeth of lateroventral margin (rounded or angulated anteriorly; without or with 1 or 2 teeth); shape and sculpture of prescutum; shape of anterior margin of mesoscutum (rounded; acute; acute and upward directed); shape of notaulus; vein 2-rs+m of fore wing (short or long); length of spurs of tibiae; index length/width of hind basitarsus; index length of hind basitarsus/length of hind tarsomeres 2-5; number of teeth on inner margin of claw (2, 3, or 4); setal position, length, and density.

Metasoma
Shape and sculpture; shape and length of petiole (short and stout or long and slender); length of ovipositor; genital capsule of the male (e.g., shape of paramere, volsella, cuspis, and digitus) (Fig. 2); setal position, length, and density.

Colour pattern
Wings (colour, absence or presence, number, and position of dark brown spots); legs, especially hind tibia; metasoma; setae.

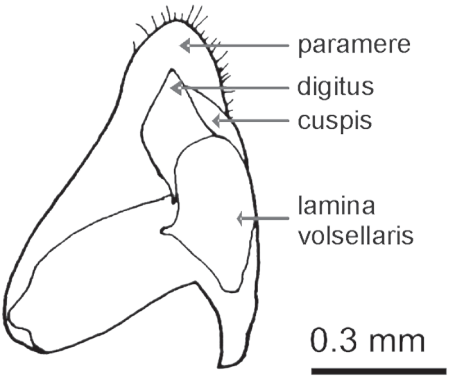

Fig. 2. Genital capsule of *Pristaulacus galitae* (GRIBODO 1879) (medial view) showing the main features.

Results
Twenty-five morphological characters were selected (Tab. 2) to perform a handmade cladogram (Fig. 3), based upon a parsimony criterion. To assume the hypothetical ancestral state of the characters, all species were compared with fossil species and with the *Aulacus* ground-plan, a genus of Aulacidae which shows the highest number of presumable ancestral states (TURRISI 2004). Based on the proposed cladogram, eight phyletic lines (or species groups) are recognized.

Phylogenetic relationships
The higher phylogeny of Evanioidea, including Aulacidae, was examined by JENNINGS & AUSTIN (2000), but no comprehensive studies on the generic assessment were performed so far. A preliminary analysis of the extant genera of Aulacidae (TURRISI 2004; TURRISI & JENNINGS, unpubl.) demonstrated that the most basal clade is represented by the genus *Aulacus*, having the higher number of plesiomorphic characters. The other two recognized genera, *Pristaulacus* and *Panaulix*, appear to be more specialized, with the higher number of derived characters.

The most basal group is the *P. barbeyi* group (Mediterranean and eastern Palaearctic; 2 species), with the highest number of plesiomorphic characters. This group is mainly characterized by three features:
1) presence of two teeth on the inner margin of claws; 2) stout and short petiole (about as long as wide); 3) ovoidal shape of metasoma (in lateral view).

The other seven groups have three or four inner teeth on the claws, elongate and slender petiole (at least 2.0x longer than wide), and metasoma pyriform (in lateral view).

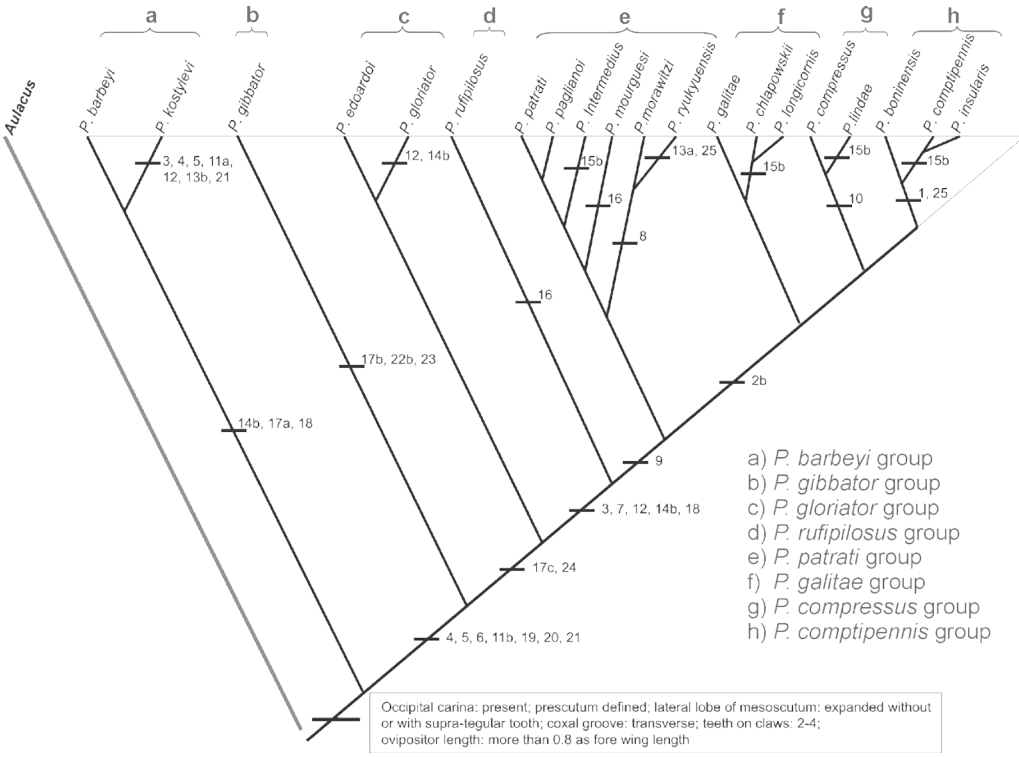

Fig. 3. Handmade cladogram of Palaearctic *Pristaulacus*.

The *P. gibbator* group (Eurasian; 1 species) is mainly characterized by three exclusive characters: 1) presence of three teeth on the inner margin of the claws; 2) wings hyaline, yellowish, without brown spots; 3) a very long ovipositor, 2.0x longer than fore wing length.

All the remaining groups are characterized by the presence of four inner teeth on the claws, by dark spots on the wings, and by a long ovipositor (1.1–1.7x longer than fore wing length). Among these, the *P. gloriator* group (European, 2 species) appears to be basal, due to the presence of carinulae on the frons (absent in all the remaining groups), the lateroventral margin of pronotum rounded (angulated in the remaining groups), without tooth (with one or two teeth in the other groups, with one exception, see below), and a long 2-rs+m vein in the fore wings (short in the other groups). The *P. rufipilosus* group (eastern Palaearctic, 1 species) has the lateroventral margin of the pronotum without a tooth, and a long hind basitarsus (1.6x longer than tarsomeres 2-5). The remaining groups are characterised by the presence of one or two teeth on the lateroventral margin of the pronotum, and a shorter basitarsus (1.1–1.2x longer than tarsomeres 2-5); among these, the comprehensive *P. patrati* group (mainly European, 2 species from eastern Palaearctic, out of a total of 6 species), as the other above mentioned groups, retained a narrow occipital carina (width: 0.2x or less diameter of an ocellus). The remaining groups have a more or less wide, occipital carina, at least 0.5x wide as diameter of an ocellus. The *P. galitae* group (western Palaearctic, 1 species from China out of a total of 3 species) has a moderately wide occipital carina (width: about 0.5x diameter of an ocellus). The *P. compressus* group (western Palaearctic; 2 species), has a wider occipital carina, 1.0–1.2x diameter of an ocellus, and it is the only group with an additional tooth on the lateroventral margin of the pronotum. The *P. comptipennis* group (eastern Palaearctic; 3 species), is characterized by the following exclusive features: the presence of a more or less deep and wide median groove on the hind margin of head, occipital carina interrupted, and entirely black or blackish metasoma (always bicoloured, red and black, in all the other groups).

	Character	Presumable ancestral state (*Aulacus*)	Derived state/s
	Head		
1)	Hind margin (dorsal view)	straight or weakly concave	deeply grooved in middle
2)	Occipital carina	absent	present: a) narrow (less than 0.2x diameter of an ocellus), blackish; b) large (0.5–1.0x diameter of an ocellus), brownish
3)	Sculpture of frons	present, more or less developed	absent
4)	Occipital area	sculptured	polished
5)	Apex of last antennomere (♀)	acute	rounded
6)	Shape of last antennomere (♀)	cylindrical	dorsoventrally compressed
	Mesosoma		
7)	Lateroventral margin of pronotum	rounded	angulate
8)	Pronotum	narrow	1arge
9)	Tooth A of pronotum	absent	present
10)	Tooth B of pronotum	absent	present
11)	Propleuron	coarsely sculptured	a) weakly striolate; b) polished
12)	Sculpture of mesoscutum	weak	coarse
13)	Anterior margin of mesoscutum (lateral view)	rounded	a) acute; b) lamelliform, upward directed
14)	Margin of lateral lobe of mesoscutum	not expanded	a) expanded without supra-tegular tooth; b) expanded with supra–tegular tooth
15)	Length/width hind basitarsus	7.0	a) 7.8–10.0; b) 11.1–14.0
16)	Hind basitarsus length/hind tarsomeres 2–5 length	1.0–1.2	1.5–1.6
17)	Number and shape of teeth on inner margin of claw	only one very small basal tooth	a) two far from apex, first small or very small; b) three moderately large and spaced from each other; c) four narrow
18)	Vein 2-rs+m (*)	long	short
	Metasoma		
19)	Shape (lateral view) (♀)	ovoidal	pyriform
20)	Petiole	stout (length/width: 1.0–1.1)	slender (length/width: 2.0–4.5)
21)	Sculpture on petiole base	present	absent
22)	Ovipositor length/ fore wing length (♀)	0.7–0.8	a) 1.1–1.8; b) 2.0
	Colour		
23)	Fore wing	hyaline, whitish	hyaline, yellowish
24)	Dark spot of fore wing	absent	present
25)	Metasoma	black and red	entirely black or blackish

Table 2. Characters used for the handmade cladogram of Fig. 3.
(*) The length of this vein is variable within some species, but it is possible to ascribe to the different type on the basis of the index length vein 2-rs+m/length vein RS+M (short: < 0.5; long: > 0.5).

Remarks on biogeography

The knowledge of the geographical distribution of the Palaearctic species of *Pristaulacus* is in most cases too incomplete for a subdivision into different chorological categories; thus, it is not possible to provide a biogeographical analysis of this fauna. However, based on available chorological data (Turrisi 2007), it can be pointed out that the western and the eastern parts of the Palaearctic Region have different *Pristaulacus* species (Tab. 1), with the only exception represented by *P. gibbator* which has a quite wider distribution than previously stated, extending from northern and central Europe east to Siberia. Moreover, *P. barbeyi*, previously known from Algeria only (type locality), is also present in southern Europe and Turkey; *P. comptipennis*, previously known only for some islands of the eastern Palaearctic and Oriental regions, was newly recorded for China. Three species are currently known from only their type locality, e.g., *P. kostylevi*, *P. morawitzi*, and *P. longicornis*, and no new data were added, although a wider distribution can be hypothesized. The Aulacidae of the Mediterranean countries (especially of northern Africa) and of central and eastern Asia (especially China and Russia) still remain poorly known, and the recent discovery of several new species (Turrisi 2000, 2005, 2007, He et al. 2002, Sun & Sheng 2007) seems to confirm this assumption, suggesting the need for more research for a better knowledge of the fauna from those areas.

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