New species of *Paratanytarsus* Thienemann & Bause 1913 (Diptera: Chironomidae) from the Mediterranean Region (Corsica, southern France and Lebanon)

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Three new species of *Paratanytarsus* are described, from Corsica, southern France and Lebanon, based on the adult males and associated pupal exuviae. These descriptions increase the number of western Palaearctic species in the genus to 23. The pupal exuviae of the new species resemble those of *P. bituberculatus* (Edwards). Main diagnostic characters as well as additional illustrations of *P. bituberculatus* are also presented. Characters are given for distinguishing the adult males and the pupal exuviae from other related species. A key to the adult males and pupal exuviae of the described species is provided.

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INTRODUCTION

Worldwide there are currently about 45 valid species of *Paratanytarsus* Thienemann & Bause, which are reported from all zoogeographical regions except the Afrotropical and Antarctica. In the western Palaearctic (Europe, North Africa and the Middle East) there are 20 species in the genus. A partial taxonomic study and revision of the genus, covering most of the Palaearctic region (except Japan), was published by Shilova (1976) and Reiss & Säwedal (1981). Two of the species treated in Reiss & Säwedal (1981) have older available names as indicated in Sæther & Spies (2011) – *P. confusus* Palmén (1960) and *P. intricatus* Goetghebuer (1921) are junior synonyms respectively of *P. dissimilis* Johannsen (1905) and *P. brevicalcar* Kieffer (1909). Since the publication of Reiss & Säwedal (1981) three additional western Palaearctic species are recognised: *P. grimmii* Schneider (1885) (a widespread parthenogenetic species redescribed by Langton et al. (1988) as larva, pupa and adult female), *P. paralaccophilus* Giłka & Paasivirta (2008) (described as adult males from Finland) and *P. praecellens* Giłka (2009) (described as adult males from the United Arab Emirates on the Arabian Peninsula).

In this paper three new species are described based on the adult male and pupal exuviae: *P. corsicanus* sp. nov. from the outflow of Lake Calacuccia in Corsica, *P. curvispinus* sp. nov. from a coastal river in southern Lebanon and *P. oconnori* sp. nov. from temporary pools in southern France (Roque-Haute Domain). Consequently the number of species increases to 23 in the western Palaearctic. A total of five species are recorded from Lebanon and 13 species are reported from Continental France (Laville & Serra-Tosio 1996; Delettre 2001; Moubayed-Breil 2007; Sæther & Spies 2011) but no species of the genus has previously been reported from Corsica.

For each species, remarks on the taxonomic position, ecology and known geographical distribution are given. The

species *P. bituberculatus* appears to be absent from southern France and Lebanon where new sister species may occur.

MATERIAL AND METHODS

The adult, head, thorax, abdomen and anal segment were cleared of musculature in 90% lactic acid which took a minimum of 20-30 minutes - material can be left overnight at room temperature without any detrimental effect or damage. The specimens were checked under a binocular microscope after 20 minutes in lactic acid to determine how the clearing was progressing. When clearing was complete the specimens were washed in two changes of 70% Ethanol to ensure that all traces of lactic acid were removed. Compared to clearing with potassium hydroxide, or other clearing solutions, no deterioration of the typical "original" structure is reported by using lactic acid. More details on the above technique will be given in Moubayed-Breil & Ashe (in prep.). All examined material (adults and pupal exuviae) was mounted in polyvinyl lactophenol. Before the final slide preparation was made the hypopygium was viewed laterally (to draw a side view of the anal point) and ventrally to examine or draw the median volsella before the hypopygium was turned into its permanent dorsal position and covered with a coverslip. If several adult specimens are available the eye on one side should be dissected from the head which ensures that the hairs on the inner margin of eye are more clearly visible. Terminology follows that of Sæther (1980) and Langton & Pinder (2007) for the adult male (except for the types of median volsella setae or lamellae - see Ekrem 2001, 2002, Stur & Ekrem 2006) and Sæther (1980) and Langton (1991) for the pupal exuviae.

RESULTS

Paratanytarsus corsicanus sp. nov.

(Figures 1, 4, 9-15, 19, 23-28, 32)

Type material

Holotype. FRANCE: Corsica, Golo River, outflow of Lake Calacuccia, altitude 790 m, 5.vii.1997 (1 adult male), leg. J. Moubayed-Breil.

Paratypes: same locality, date and collector as holotype, 2 pupal exuviae (1 male, 1 female).

Holotype deposited in the collections of the National Museum of Ireland, Kildare Street, Dublin 2, Ireland. Paratypes in the collection of the senior author.

Etymology

The new species is named after the island of Corsica where the type material was collected.

Diagnosis

Male: AR = 0.94. Mesonotum with a very marked dark scutal mound mediodorsally. Anal tergite without tubercles medially, anal tergite bands abruptly terminated well before base of anal point; anal point dorsally drop-like in shape, broad basally, narrowed medially and spatulate at apex; atypicallly triangle-like in lateral view, crests include a few strong posteriorly directed spines basally and a bunch of point-like spinulae medially. Superior volsella subrectangular to suboval, bearing a finger-like apically rounded digitus of mostly equal width; median volsella triangle-like, uniformly narrowed distally and bearing numerous long bristle-like setae; inferior volsella bearing 2 well spaced setae ventrally.

Pupa: Frontal apotome with indistinct granulation laterally and on base of antennal sheaths. Cephalothorax with a marked granulose scutal hump or mound medially near the thoracic suture; thoracic horn absent; pearl row long, extending past the wing sheath apex and reaching the nose; pair of spine patch on tergite III composed of about 28-30 long spines inserted in a L-shaped line, D5 taeniate.

Description

Male adult and pupal exuviae of *Paratanytarsus corsicanus* sp. nov. are described based on material collected in the outflow of the Lake Calacuccia (altitude 790 m), an artificial reservoir in central Corsica. On the basis of the finger-like digitus on the superior volsella (Reiss & Säwedal 1981), *P. corsicanus* keys near *P. penicillatus* Goetghebuer, *P. setosimanus* (Goetghebuer), *P. austriacus* (Kieffer), *P. baikalensis* (Chernovskii), and *P. tenuis* (Meigen), while the pupa closely resembles *P. bituberculatus*.

Adult male (n = 1) (Figures 1, 4, 9-13)

Large species. Total length 3.90 mm. Wing length 2.30 mm. Coloration in general light brown to dark brown. Head brown with both eyes and pedicel dark brown, antenna dark brown. Thorax dark yellow to medium brown with separated dark brown mesonotal stripes. Mesosternum, scutellum and postnotum brown. Wing yellowish with brownish shading between its base and the arculus. Halteres brownish. Legs dark yellow (all tarsi are missing). Femur of P_1 brownish, darker on distal half; tibia yellowish medially, dark brown basally and apically. Femur of P_2 and P_3 dark brown at tip; tibia dark brown at both base and tip. Abdominal segments brownish to yellowish; anal segment brown with dark brown anal tergite bands; basal inner area of gonocoxite brown.

Head. AR = 0.94. Antenna 13 segmented with distinct division between segments, 1.355 mm long, ultimate flagellomere 655 µm long. Eyes with bare ommatidia; hairs present on anterior inner margin of eyes (Figure 1). Clypeus with 16 setae. Palp segments 1 and 2 only present; length 115 µm and 160 µm, respectively (palp segments 3 to 5 lost). Frontal tubercles strongly projecting. Coronal triangle widely open, bearing 4 small stout setae. Temporal setae 9-10 including 2 inner and 8-9 outer verticals.

Thorax. Mesonotum with a very marked dark scutal mound mediodorsally. Thoracic setae: antepronotals absent; 10 acrostichals nearly reaching antepronotum; 7 dorsocentrals; 2-3 prealars; 8 scutellars. Haltere bearing 4 minute setae in a single row.

Wing. Membrane covered with setae becoming dense in distal quarter. All veins, except M, from base to crossvein RM with dense macrotrichia.

Legs. All tarsi lost. Measurements, in µm, of femur and tibia are given below.

	fe	ti
P_1	1005	1990
P_2	1010	855
P_3	1255	1005

Hypopygium (Figures 4, 9-13). Dorsal and ventral view (Figure 9). Tergite IX subtriangular, lacking tubercles medially, ending with wide-angled margins, bearing 4 setae medio-basally and about 14 setae distally. Anal tergite bands abruptly terminated well before base of anal point (Figure 9). Anal point 35 µm long, maximum width 18-19 µm at base; in dorsal view (Figure 9), anal point drop-like in shape, broad basally, narrowed medially and spatulate at apex, bearing flattened to indistinct crests. In lateral view (Figure 4) the anal point is "atypically" triangular, bent downwards and pointed apically, crests include a few strong posteriorly directed spines basally and a bunch of point-like spinulae medially; 16 setae present on basal "apical" margin including 8 laterally (4 setae on each side), 3 dorsally and 5 ventrally. Sternapodeme with a characteristic horn-like base. Gonocoxite swollen at ventral inner base, which bears dense microtrichia; inner proximal margin with 3 setae, distal one is stouter and much longer than the preceding "two proximals". Superior volsella (Figures 10-11) subrectangular to suboval, 51 µm long and 63 µm wide; with 5 setae dorsally and 2 setae on inner lateral margin, bearing a finger-like, apically rounded, digitus of mostly equal width, broadened at base. Median volsella (Figure 12) 41-43 µm long, triangle-like, uniformly tapering distally, bearing numerous long bristle-like setae; longest setae 55-60 µm long. Inferior volsella (Figures 9, 13), 115 µm long, 41 µm maximum width; wider at base and uniformly narrowed distally; about 11-12 setae present laterodorsally, all stout and curved distally; 2 straight and stout setae of equal length (separated by a distance of 23-24 µm) are located lateroventrally.

Pupal exuviae (n= 2) (Figures 14-15, 19, 23-28, 32)

Total length: 3.60 mm (female) - 3.95 mm (male); abdomen length 2.85 mm (female) - 3.15 mm (male). Colour brown, abdomen brownish, anal segment brown, genital sac brown with whitish tip.

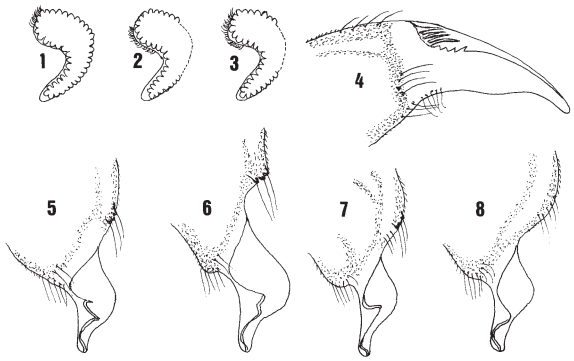
Cephalothorax (Figures 14-15). Frontal tubercles (Figure 14) indistinct to domed and very broad, each with a long bristle 140-155 µm long; frontal apotome with faint granulation apically, a few granules confined to the posterolateral area and warts present on base of antennal sheaths. Thoracic horn absent; three long, bristle-like, precorneal setae (on an inwards projecting eminence). Thoracic suture bearing dense granulation along anterior half and a domed scutal hump or "mound" (Figure 15), which bears minute faint granulation. Posterior thoracic mound large and smoothly rounded. Thorax with 2 long antepronotals; dorsocentrals Dc1-Dc4 in two paired groups widely separated from each other, Dc1-Dc2 and Dc3-Dc4 inserted almost on the same base; lengths of Dc1-Dc2 (115 µm and 140 µm) and Dc3-Dc4 (95 µm and 105 µm). Wing sheath (Figure 19) with long pearl row extended past wing sheath apex and reaching the nose.

Abdomen (Figures 23-28, 32). Armament pattern on tergites III-VII is slightly different in male (Figures 25a, 26a, 27a) and female (Figures 25b, 26b, 27b). Tergite I without shagreen; tergite II largely covered with shagreen; posterior half of tergite III with a pair of spine patches composed of long to medium sized spines, about 28-30 long spines are inserted in a curved line (L-shaped), D5 taeniate; tergites IV and V with a single transverse broadly oval to rounded antero-median patch with different sized spines, longest spines directed posterior (Figures 25-26); lateral longitudinal spine bands present on median part of tergites IV and V; tergite VI bearing an anterior subrectangular patch of short spines medially (Figure 27); tergite VII bearing only one anterior patch composed of minute spines. Lateral setae on abdominal segments I-V: I, with 1 seta; II-V with 4 setae. Lateral filaments "taeniae" on segments VI-VIII: VI-VII (4); VIII (4-5). Anal comb (Figure 28) with 6-7 spines, longest spine 18 µm long. Anal segment (Figure 32a, male and 32b, female) 195 µm long (both male and female), maximum width 315 µm (male), 250 µm (female), bearing a long dorsal taenia; shagreen present only in the anterior part in both male and female, shagreen less intense in the female; apical margin distinctly straight. Genital sac 280 µm long (male), 100 µm long (female). Genital sac of male overreaching tip of anal segment by 110 µm; genital sac of female almost reaching tip of anal lobe; genital sac of male covered with evanescent granulation except in the apical part; genital sac of female bearing granulation apically. Fringe with 32-36 (in male), 33-35 (in female) taeniae.

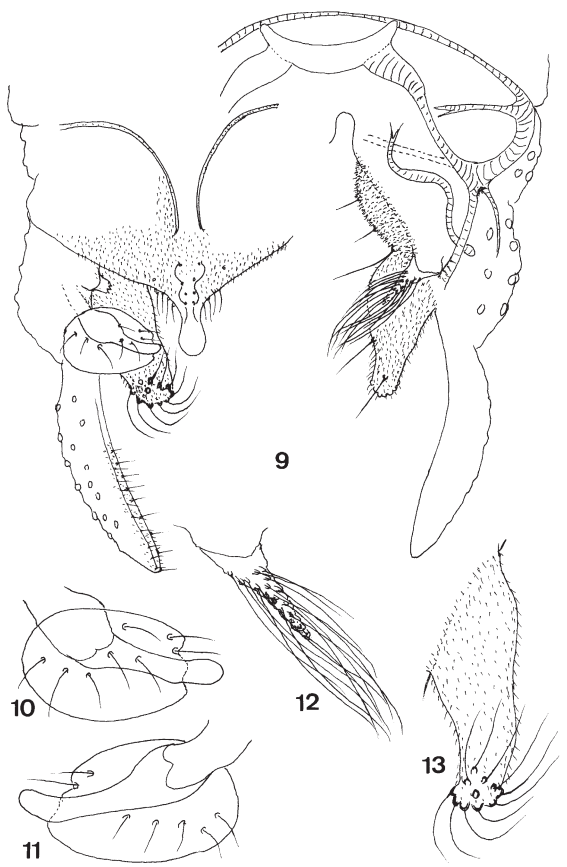
Female adult and larva: Unknown.

Remarks

Within the known *Paratanytarsus* species from Europe and the Mediterranean Region (North Africa and the Near East), male imagines of *P. corsicanus* are easily separated from all other species by the following combination of characters: anal tergite lacking tubercles medially (present in *P. bituberculatus, P. laccophilus, P. mediterraneus, P. penicillatus*); anal tergite bands abruptly end medially (otherwise in many species); anal point with unusual shape in dorsal and lateral view (dorsally:

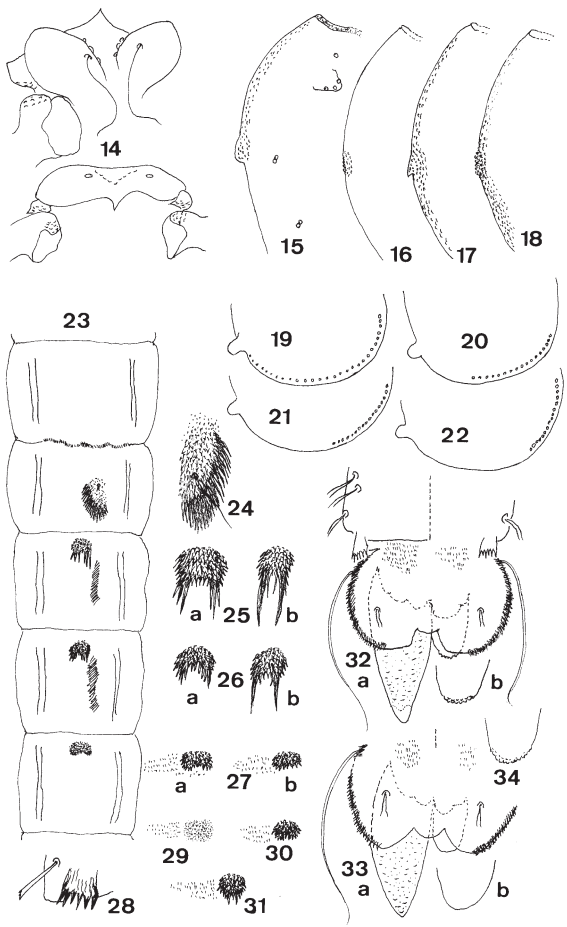


Figures 1-8. *Paratanytarsus* spp. Hairs on inner margin of eyes: (1) *P. corsicanus* sp. nov.; (2) *P. curvispinus* sp. nov.; (3) *P. oconnori* sp. nov.; Anal point in lateral view of: (4) *P. corsicanus* sp. nov.; (5) *P. curvispinus* sp. nov.; (6) *P. oconnori* sp. nov.; (7) *P.* sp. A (near *dissimilis* Johannsen); (8) *P. laccophilus* (Edwards).



Figures 9-13. *Paratanytarsus corsicanus* sp. nov., hypopygium of adult male. Hypopygium, (9) in dorsal (left) and ventral (right) view. Superior volsella, (10) left, (11) right; (12) median volsella; (13) inferior volsella in dorsal view.

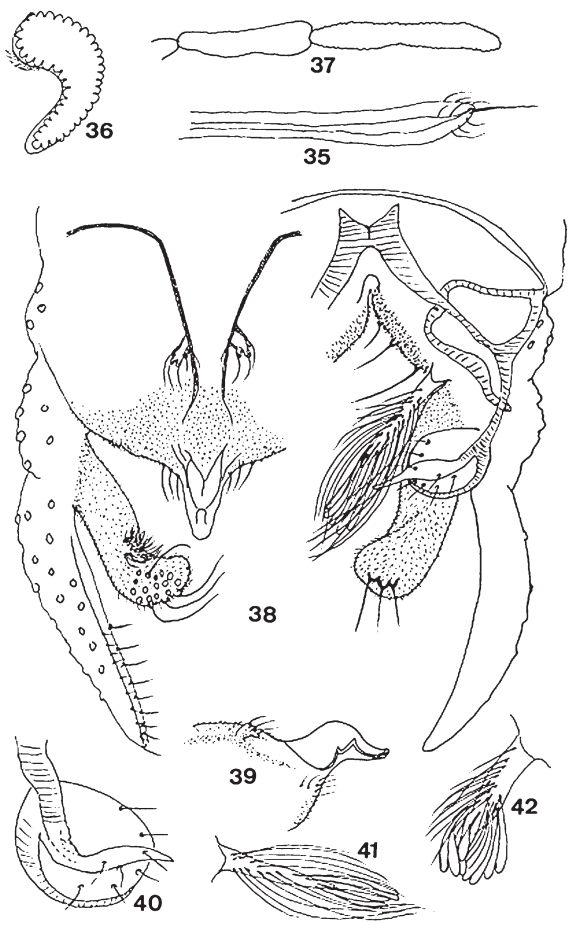
narrowed medially and spatulate apically; laterally: triangular, pointed apically and bearing a flattened crest with spines and points); median volsella triangular and bearing long setae; inferior volsella straight, uniformly tapering distally and bearing 2 long straight and stout setae lateroventrally. However, *P. corsicanus* is closely related to some other species on the basis of the following characters: superior volsella with a finger-like digitus as in *P. penicillatus, P. setosimanus, P. baikalensis*, *P. tenuis* and *P. austriacus*; median volsella bearing long simple



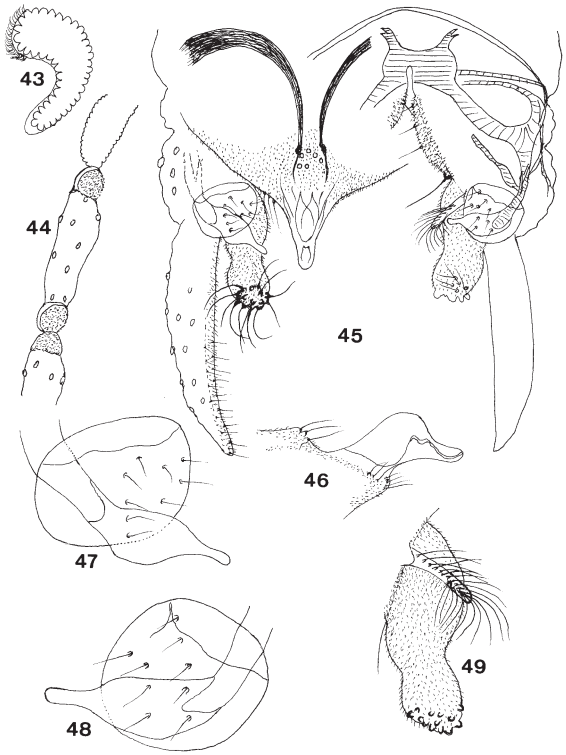
Figures 14-34. *Paratanytarsus* spp., pupal exuviae. Frontal apotome and antennal sheath: (14) *P. corsicanus* sp. nov. Cephalothorax including hump and granulations on thoracic suture of: (15) *P. corsicanus* sp. nov., (16) *P. bituberculatus* (Edwards), (17) *P. curvispinus* sp. nov., (18) *P. oconnori* sp. nov. Apical part of wing sheath of: (19) *P. corsicanus* sp. nov., (20) *P. bituberculatus* (Edwards), (21) *P. curvispinus* sp. nov., (22) *P. oconnori* sp. nov. *Paratanytarsus corsicanus* sp. nov., abdominal segments II-VI, (23). Shape pattern of median patch on tergites III-VI of *P. corsicanus* (24-27; male, a; female, b): (24) tergite III, (25) tergite IV, (26) tergite V, (27) tergite VI. Anal comb of *P. corsicanus*: (28). Median patch on tergite VI of: (29) *P. bituberculatus* (Edwards); (30) *P. curvispinus* sp. nov.; (31) *P. oconnori* sp. nov. Anal segment of male and female in dorsal and ventral view of: *P. corsicanus* sp. nov.: (32; male, a; female, b); *P. bituberculatus* (33; male, a; female, b). Genital sac of female of *P. oconnori* sp. nov. (34).

setae distally as in *P. penicillatus* and *P. setosimanus*. Therefore, the absence of tubercles on the anal tergite, the unusual shape of the anal point in both dorsal and lateral view and the presence of a finger-like digitus on the superior volsella isolates *P. corsicanus* from species with similar male hypopygia.

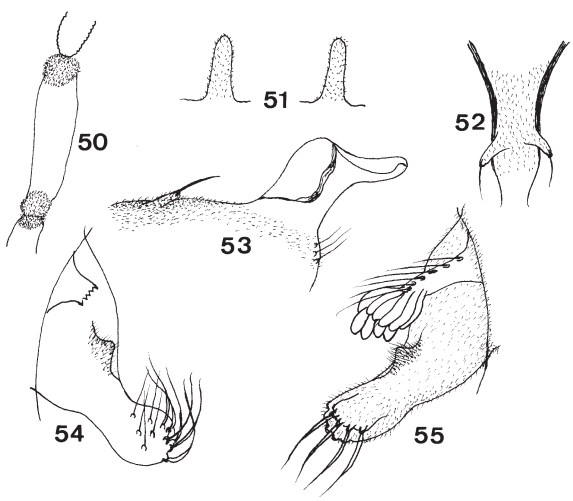
The main features that separate the pupae of *P. corsicanus* from the *bituberculatus*-complex are: scutal hump on thoracic suture broad and bearing granulations; pearl row on the wing sheath extending up to the nose (shorter in *P. bituberculatus*); distribution pattern of armament on tergites (median patch on tergite VI with dark short spines as in figures 27, 30 and 31 in *P. corsicanus*; faint and only composed of points in *P. bituberculatus*); apical margin of anal lobe straight in *P. corsicanus*, while it is rounded in all the other examined species of the *bituberculatus*-complex, including *P. bituberculatus* from Europe (sensu Langton 1991, Figure 132d). Nevertheless,



Figures 35-42. *Paratanytarsus* spp. Adult male of: *P. curvispinus* sp. nov. (35-41); *P. bituberculatus* (Edwards) (42). *Paratanytarsus curvispinus* sp. nov.: (35) last flagellomere of antenna, apical part; (36) hairs on inner margin of eyes; (37) 4th and 5th palpomeres; (38) hypopygium in dorsal (left) and ventral (right) view; (39) anal point in lateral view; (40) superior volsella, left; (41) median volsella, left. *Paratanytarsus bituberculatus* (Edwards) (42) median volsella (right).



Figures 43-49. *Paratanytarsus oconnori* sp. nov., adult male: (43) hairs on inner margin of eyes; (44) 4th palpomere; (45) hypopygium in dorsal (left), ventral (right) view; (46) anal point in lateral view; (47-48), superior volsella, 47 (left), 48 (right); (49) median and inferior volsella (left).



Figures 50-55. *Paratanytarsus bituberculatus* (Edwards), adult male (two specimens from Italy). (50) apical part of 3rd palpomere, 4th palpomere and basal part of 5th palpomere; (51) frontal tubercles; (52) distal part of anal tergite bands; (53) anal point in lateral view; (54) inferior volsella (left) in dorsal view; (55) median and inferior volsella (right) in ventral view.

morphological dimorphism in the shape of both adult male and pupal exuviae is often observed in some *Paratanytarsus* species such as *P. dimorphis* and *P.dissimilis*. In *P. corsicanus* the armament of tergites and shape of anal segments of pupal exuviae show a sexual dimorphism between male and female as in figures 25-27 for the patches of spines on tergites IV-VI and figures 32a-32b for the anal segment: apical spines on tergites IV and V are longer in the female (Figures 25-26); genital sac of male granulated except in the apical part (Figure 32a), genital sac of female only with apical granulation (Figure 32b).

Ecology and geographical distribution

Adult male and pupal exuviae of *Paratanytarsus corsicanus* are recorded only from the outflow of the mountain Corsican Lake Calacuccia (altitude 790 m), where only a few emerged individuals were collected in July 1997. Species emergence presumably occurs mainly in the late spring. Larvae of this species seem to be stenotypically restricted to the profundal zone of Lake Calacuccia.

Several aquatic insect groups of mountain streams in Corsica (Trichoptera, Plecoptera, Diptera, etc.) display high levels of endemism (Giudicelli 1975), e.g. in the Trichoptera there are 30 endemic species (49% of the known species from the island). Despite extensive investigations, *P. corsicanus* has not been found in southern France, Italy, Spain or other western Mediterranean islands. However, the new species represents an additional lentic element to the Tyrrhenian subregion which includes, according to Furon (1950, 1972), the Italian Peninsula, Corsica, Sardinia and Sicily. It is possible that *P. corsicanus* may eventually be found elsewhere within the western Mediterranean subregion including low to middle mountain lakes located to the south in North Africa (Algeria, Morocco) and westwards in the Iberian Peninsula and the Eastern Pyrenees. The lotic chironomid fauna of Corsica has been listed (Laville & Langton 2002). However there is very little data available on the lentic species there and the discovery of a new species from a lake may merely reflect the lack of extensive investigation of standing water habitats throughout the island.

Other associated chironomids from the western Mediterranean include: *Chaetocladius* (*Chaetocladius*) *algericus* Moubayed, *Cricotopus* (*Cricotopus*) *beckeri* Hirvenoja, *C.*(*C.*) *levantinus occidentalis* Moubayed-Breil & Ashe, *Krenosmittia hispanica* Wülker, *Parakiefferiella wuelkeri* Moubayed, *Stempellinella reissi* Casas & Vilchez-Quero, *Pseudorthocladius* (*Pseudorthocladius*) *berthelemyi* Moubayed, *Orthocladius* (*Mesorthocladius*) *vaillanti* Langton & Cranston, *Parametriocnemus valescurensis* Moubayed & Langton, *Rheotanytarsus dactylophoreus* Moubayed-Breil, Langton & Ashe and *Stygocladius multisetosus* Moubayed-Breil, Ashe & Langton.

Paratanytarsus curvispinus sp. nov.

(Figures 2, 5, 17, 21 30, 35-41)

Type material

Holotype. LEBANON: southern Lebanon, Awaly River, altitude 250-350 m, hyporhithral to epipotamal zones, 7.xi.1997 (1 pharate male), leg. J. Moubayed-Breil.

Holotype deposited in the collections of the National Museum of Ireland, Kildare Street, Dublin 2, Ireland.

Etymology

This species is named after the markedly curved spine-like scutal tubercle or hump (from the Latin: *curvus* meaning curved, *spinus* meaning spine) on the thoracic suture of the pupal exuviae. A scutal tubercle is also present on the scutum of the adult. The name *curvispinus* is treated as a noun in apposition.

Diagnosis

Paratanytarsus curvispinus sp. nov. is closely related to *P. bituberculatus* on the basis of both male imagines and pupal exuviae features. Distinguishing characters for the male are: AR = 1.2; hairs present on the anteromedian inner margin of the eyes; Palp 5-segmented, without sensilla clavata; 4th palpomere with cordiform apex and lacking circular patch of microtrichia; thorax with a markedly distinct scutal tubercle mediodorsally; sternapodeme with a characteristic V-like base, bearing two pointed anterior horns; anal point wider at base and progressively narrowed distally, in lateral view crests include 2 sharp points medially, proximal one the smaller; posterior margin of superior volsella rounded; digitus swollen at base, not uniformly tapering apically; median volsella not flattened distally, bearing about five spatulate setae; inferior volsella with distal ¼ swollen and bearing a tuft of short dark setae on distal ¼ inner margin, ventral setiferous lobe with 3 straight stout setae bent downwards. Pupal exuviae characters key to those of *P. bituberculatus* except: pattern and granulation of thoracic suture and scutal hump (hump pointed and granulations extended anteriad and posteriad); shape of median patch on tergite VI only composed of short dark spines.

Description

Adult male (n = 1) (Figures 35-41)

Large species. Total length 4.30 mm. Wing length 1. 55 mm. Head light brown with dark brown eyes, dark brown pedicel and brown flagellum. Thorax medium brown to brown with dark brown mesonotal stripes; mesosternum, scutellum and prosternum brown. Wing brownish. Legs light brown. Abdomen and anal segment brownish, except base of both sternapodeme and gonocoxite, which are dark brown.

Head. AR = 1.2. Antenna with 13 flagellomeres, 1.32 mm long, ultimate flagellomere 720 µm long, bearing one apical stout seta and 8-9 sensilla chaetica (Figure 35). Eyes with bare ommatidia; hairs present on anteromedian inner margin of eyes (Figure 36).

Clypeus with 25 setae in 5 rows (9, 5, 5, 3, 3). Palp 5-segmented, without sensilla clavata; 4th palpomere with cordiform apex and lacking circular patch of microtrichia (Figure 37); length (in µm) of segments: 57, 51, 147, 103, 151. Frontal tubercles well developed. Coronal triangle moderately marked bearing 4 small stout coronals. Temporal setae 12 including 3 inner and 9 outer verticals.

Thorax. Scutum bearing a distinct scutal tubercle mediodorsally. Thoracic setae: antepronotals absent; 21 biserial acrostichals; 10 uniserial dorsocentrals; 2 prealars; 7 scutellars.

Wing. Membrane covered with setae becoming progressively dense in distal ¼; all veins except M, with dense macrotrichia.

Legs. Pulvilli well developed, a little longer than claw. Measurements (in µm) of legs are given below.

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5
P_1	624	675	948	507	442	390	195
P_2	911	779	546	282	338	208	143
P_3	975	1065	611	416	390	247	156

Hypopygium (Figures 38-41). Tergite IX subrectangular to subcircular, ending with a nearly straight apical margin, bearing 8 setae situated mediodorsally on two strongly projecting tubercles, 12 setae present distally. Anal tergite bands regularly thin from base to nearly posterior limit of anal tergite, abruptly bent outwards basally, straight and converged medially and weakly terminated in an outwards arc which ends abruptly close to the base of the anal point. Anal point (Figure 38) 33 µm long, maximum width 26 µm at base, wider at base and progressively narrowed distally, ending with a rounded apex; in lateral view (Figure 39) crests include 2 sharp points medially, proximal one the smaller; 12 setae present basally including 6 laterally (3 on each side) and 6 ventrally. Sternapodeme with a characteristic wide V-like base, bearing two pointed anterior horns. Gonocoxite moderately swollen at ventral inner base, which bears dense microtrichia; inner basal margin bearing 3 stout setae, distal one is stouter and longer than the preceding. Superior volsella (Figures 38, 40) subcircular to suboval bearing 8 setae including 4-5 on inner margin; digitus 41 µm long, swollen at base, not uniformly tapering distally and bearing a pointed apex. Median volsella (Figures 38, 41) 60 µm long, not flattened distally, covered with long bristle-like setae and about 5 spatulate setae apically. Inferior volsella (Figure 38) 135 µm long, nearly straight with distal ¼ swollen, bent and curved upwards; dorsally, a tuft of short dark setae on distal ¼ inner margin and bent inwards, about 18 curved stout setae are located apically; ventral setiferous lobe with 3 stout setae about 53-55 µm long, bent downwards. Gonostylus bearing two longitudinal rows of fine setae on inner margin (about 9 setae on each row).

Pupal exuviae (n = 1) (Figures 17, 21, 30)

Thoracic horn absent. The pupal exuviae of *P. curvispinus* sp. nov. keys to *P. bituberculatus* as do those of *P. corsicanus*. Main distinguishing characters are: thoracic suture (Figure 17) densely covered with granulations on both anterior and posterior half, scutal hump granulate, bent downwards and pointed apically; pearl row on the wing sheath short, not reaching the nose, extending to end of the apical curvature of the wing sheath; postero-median patch of spines on tergite III bearing about 17 long spines on each side, longest spines are inserted in a short rounded row, D5 bristle-like; median patch on tergite VI (Figure 30) subcircular to suboval, bearing dark short spines. Anal lobe with rounded apical margin. Genital sac of male lacking granulations apically.

Female adult and larva: Unknown.

Remarks

P. curvispinus sp. nov. is closely related to *P. bituberculatus* on the basis of both male imagines and pupal exuviae. The following combination of distinguishing features for the male are: posterior margin of superior volsella rounded in *P. curvispinus* (Figure 40), straight in *P. bituberculatus*; digitus swollen at base, not uniformly tapering distally; median volsella short and bearing more than 10 spatulate setae apically in *P. bituberculatus*, while in *P. curvispinus* it has only about 5; ventral setiferous lobe of inferior volsella with 3 stout setae instead of 4 in *P. bituberculatus*. Pupal exuviae of *P. curvispinus* sp. nov. can be easily distinguished from those of the *bituberculatus*-complex on the basis of the following characters: pattern and granulation of thoracic suture (Figure 17, granulations extended anterior and posterior, hump pointed); shape of the median patch on tergite VI (Figure 30).

Ecology and geographical distribution

Paratanytarsus curvispinus is only known from southern Lebanon where it inhabits both the hyporhithral and the epipotamal zones of the Awaly River Basin at an altitude of 250- 350 m. This species represents an additional faunal element for the Levantine subregion.

Paratanytarsus oconnori sp. nov.

(Figures 3, 6, 18, 22, 31, 34, 43-49)

Type material

Holotype. FRANCE: Hérault, Roque-Haute Domain, temporary deep pools, altitude 25-30 m, 21.v.1995 (1 pharate male), leg. J. Moubayed-Breil.

Paratypes: same locality as holotype, 23.iii.1997 (1 male adult and 1 female pupal exuviae), leg. J. Moubayed-Breil (in the collection of the senior author); same locality as holotype, basaltic lake at the cliff, altitude 15 m, 3.viii. 2001 (1 pharate male), leg. J. Moubayed-Breil (in the collection of P. H. Langton). Holotype deposited in the collections of the National Museum of Ireland, Kildare Street, Dublin 2, Ireland.

Etymology

This species is named after our colleague Dr James P. O'Connor who recently retired from the National Museum of Ireland. He continues his research as Emeritus Entomologist in the museum and has to date to his credit 452 publications.

Diagnosis

In general, male adult characters of *P. oconnori* sp. nov. are closely similar to those of both *P. natvigi* Goetghebuer and *P. dissimilis* Johannsen. Distinguishing features for the male are: hairs present on anterior half of inner margin of the eyes; palp without sensilla clavata; 3rd and 4th palpomeres bearing a patch of minute macrotrichia (apically on segment 3, basally and apically on segment 4); thorax with minute scutal tubercle mediodorsally; sternapodeme with a swollen rectangular base, bearing two characteristic nozzle-like horns; anal point wider at base and progressively narrowed distally with rounded apex, in lateral view crests include 2 smooth peaks medially, proximal peak a little higher than the distal one; superior volsella subcircular to subrectangular with rounded posterior margin; digitus wider at base, abruptly tapering medially and ending with a rounded apex; median volsella short, slightly flattened distally, bent downwards, bearing only simple setae, posterior margin with 7-8 setae distinctly bent downwards; inferior volsella with basal half swollen, distal half less swollen, 5 straight and slender setae are present ventrally. Pupal exuviae characters key to those of *P. bituberculatus* but can be easily separated by the following features: thoracic suture with dense granulations only on posterior half, anterior half faintly granulose; scutal hump densely granulose and weakly domed; pearl row on the wing sheath short, not reaching the nose, median patch on tergite VI circular, bearing dark short to medium sized spines, 2 longer spines projecting posteriorly; genital sac of male covered with granulations as in *P. bituberculatus* and *P. corsicanus*, genital sac of female bearing granulations apically as in *P. corsicanus*.

Description

Adult male (n=3) (Figures 43-49)

Large species. Total length 4.60-4.65 mm. Wing length (paratype) 2.30 mm. Dark brown to blackish in general. Head brown to dark brown with both eyes and pedicel blackish. Antenna (partial in holotype and paratype) with dark brown proximal segments. Palpomeres with dark brown segments. Thorax dark brown to blackish with black mesonotal stripes; mesosternum, scutellum and prosternum dark brown. Wing with both membrane and veins medium brown to dark brown. Legs dark brown to blackish. Abdomen and anal segment dark brown to blackish including both sternapodeme gonocoxite and gonostylus; only anal point and IX tergite are brown.

Head. AR not measurable (distal ¼ of last flagellomere missing). Eyes with bare ommatidia; hairs present on anterior half of inner margin of eyes (Figure 43). Clypeus with 23-24 setae located in 5 rows: 3, 3, 5-6, 6, 6. Palp with 5 segments; 3rd and 4th palpomeres (Figure 44) bearing patch of minute microtrichia: apically on segment 3, basally and apically on segment 4; last segment bearing minute sensilla chaetica apically, length (in µm) of palpomeres: 65, 88, 195, 205, 265. Frontal tubercles domed. Coronal triangle well marked bearing 4 small stout coronals. Temporal setae 11 including 2 inner and 9 outer verticals.

Thorax. Scutum bearing a minute scutal tubercle mediodorsally. Thoracic setae: antepronotals absent; 18 biserial acrostichals; 29-31 dorsocentrals often biserial; 0-1 prealars; 2 humerals; 8 uniserial scutellars.

Wing. All veins bearing setae except M; membrane covered with macrotrichia progressively becoming dense in distal ¼.

Legs. Pulvilli moderately developed, a little longer than claw; tibial comb of P_3 semicircular, maximum height 117 µm, maximum width 235 µm, composed of 19-20 short spines with rounded apex, of equal size (about 37-39 µm). Legs (P_1 and P_2 incomplete), measurements, in µm, as follows.

	fe	ti	ta_1	ta_2	ta_3	ta_4	ta_5
P_1	1260	1055					
P_2	1315	1145	675				
P_3	1560	1150	665	405	325	208	156

Hypopygium (Figures 45-49). Tergite IX subtriangular, ending with a quite wide V-like apical margin, bearing 8 setae situated mediodorsally on 2 weakly projecting tubercles, 10 setae present distally. Anal tergite with weakly developed tubercles medially, tergite bands very thick at base, becoming progressively thin from base to median part of anal tergite, parallel side medially and terminated with an outwards arc close to the base of the anal point crests. Anal point in dorsal view (Figure 45) 46 µm long, maximum width 35 µm at base, wider at base and narrowed distally with rounded apex; in lateral view (Figure 46) crests include 2 smooth peaks medially, proximal peak a little higher than the distal; 11-12 setae present basally including 6 laterally (3 on each side) and 4-5 ventrally. Sternapodeme with a swollen rectangular base, bearing two characteristic nozzle-like horns. Gonocoxite moderately swollen at ventral inner base, which bears dense microtrichia; inner basal margin bearing 4 stout setae, distal one is much stouter and longer than the preceding. Superior volsella (Figures 47-48) subcircular to subrectangular with rounded posterior margin; bearing 9 setae including 4 lateroventrally and 5 medially; digitus 48 µm long, maximum width 16 µm, wider at base, abruptly tapering medially and ending with a rounded apex. Median volsella (Figures 45, 49) 55-57 µm long, short and slightly flattened distally, bearing short to medium sized simple setae; posterior margin with 7-8 comb-like setae which are bent downwards. Inferior volsella (Figure 45, 49) 113 µm long, maximum width 41 µm, nearly divided longitudinally into two swollen lobes, basal half wider than distal half; in dorsal view, 12-13 curved stout setae near the apex; in ventral view, presence of 5 slender setae which are

bent inwards. Gonostylus bearing two longitudinal rows of fine setae on inner margin (about 8-9 setae on each row).

Pupal exuviae (n = 3) (Figures 18, 22, 31, 34)
In general pupal exuviae of *P. oconnori* sp. nov. key close to those of other species in the *bituberculatus*-complex and to *P. corsicanus*. Main distinguishing characters are: thoracic suture (Figure 18) covered with dense granulations on posterior half, anterior half with faint granulations; scutal hump densely granulose and weakly domed; pearl row on the wing sheath short (Figure 22), not reaching the nose, extending to end of apical curvature of sheath; postero-median patch of spines on tergite III bearing about 15 long spines on each side, longest spines are inserted in a short rounded row, D5 taeniate; median patch on tergite VI (Figure 31) circular, bearing dark short to medium sized spines, 2 longer spines project posteriad; genital sac of male covered with granulations as in *P. bituberculatus* and *P.corsicanus*, genital sac of female (Figure 34) bearing granulations apically as in *P. corsicanus*.

Female adult and larva: Unknown.

Remarks

Very similar to both *P. natvigi* Goetghebuer and *P. dissimilis*, the male adult of *P. oconnori* sp. nov. is mainly distinguished from other related species on the basis of the legs and hypopygium: tibial comb of P_3 bearing more than 30 smooth spines in *P. dissimilis*, less than 20 smooth spines in *P. oconnori*; anal point in dorsal view uniformly tapering apically in *P. oconnori* (Figure 45), parallel sided to drop-like in *P. dissimilis* (Giłka 2011, Figures 123-124; Palmén 1960, Figure 2); in lateral view presence of 2 smooth peaks in *P. oconnori* (Figures. 6 and 46), presence of only 1 peak in *P.* sp. A (near *dissimilis*) (Figure 7); superior volsella subcircular to subrectangular, bearing a rounded posterior margin; median volsella short, weakly flattened distally, bearing a different combination of simple setae on apical part; inferior volsella wider basally, constricted medially and moderately swollen distally, stout and curved setae present on dorsal apex, 5 slender setae present ventrally, which are bent inwards. Pupal exuviae of *P. oconnori* resembles those of *P. bituberculatus*; it is separated from other related species by the following characters: hump on thoracic suture bearing dense granulation (Figure 18); granulations on thoracic suture extended anteriorly and posteriorly; median patch of spines on tergite VI dark and bearing 2 longer apical spines (Figure 31); only genital sac of female bearing granulations apically (Figure 34).

Ecology and geographical distribution

The species *P. oconnori* is only known from the type locality at Roque-Haute Domain, in southern France, where it was found in pools, lentic springs, a basaltic lake and slow flowing streams. Aquatic plants which occur in these habitats include *Potamogeton, Scirpus, Ranunculus, Juncus, Alisma, Isoetes* and *Marsilea*.

Paratanytarsus bituberculatus (Edwards 1929)

(Figures 16, 20, 29, 33a, 33b, 42, 50-55)
Synonym: *Paratanytarsus atrolineatus* (Goetghebuer 1937)
Imago: Reiss 1968; Langton & Pinder 2007; Giłka (2011).
Pupa: Thienemann 1951; Reiss & Säwedal 1981 (? pupa); Langton 1991; Langton & Visser (2003).

Female adult and larva: Undescribed.

Material examined

FRANCE: Aude, Aude River, epipotamal zone, altitude 50-60 m, 23.iv.1995 (1 male pupal exuviae), leg. J. Moubayed-Breil; Normandy, Valmont River, 5.xi.1997 (1 male pupal exuviae), leg. J. Moubayed-Breil; SPAIN: Andalucía, Sierra Almijara, Barranco de Luna, 21.iii.1999 (1 pharate male), leg. J.J. Casas (in collection of P.H. Langton); IRELAND: Co. Meath, Navan, Randalstown, N855704, leg. D.A. Murray (specimen in National Museum of Ireland), 14.v.1996 (1 male adult); ITALY: Milan, Botanic Garden, 12.viii.1980 (2 pharate males and 1 male pupal exuviae), leg. B. Rossaro.

Diagnostic characters

Only the main distinguishing characters of both adult males and pupal exuviae are given.
Male adult. AR = 1.25-1.35. Palpomere 3 with only one apical patch of microtrichia, palpomere 4 with two patches of microtrichia, basally and distally (Figure 50); frontal tubercles 22-25 µm long (Figure 51), well projecting. Anal tergite (Figure 52) with 2 marked tubercles bearing 2 setae apically (Italian specimen has only one seta on each tubercle); anal point in lateral view with one median well projecting peak bearing a domed proximal margin (Figure 53); superior volsella semi-circular with apical margin nearly straight and bearing a narrowed long digitus; median volsella (Figures 42, 55) short with numerous spatulate setae distally; inferior volsella (Figures 54-55) strongly widened and swollen at base, constricted distally, bearing a triangular lobe medially, setiferous ventral lobe well defined and bearing 4 stout setae (Figure 55).
Pupal exuviae. General shape pattern of abdomen as in Figure 23. Granulations on thoracic suture absent (Figure 16), only scutal hump is faintly granulose; thoracic horn absent; pearl row on wing sheaths short (Figure 20). Pair of spine patches on posterior half of tergite III composed of about 13-15 spines inserted nearly in a L-shaped line, D5 bristle-like or taeniate (taeniate in Italian specimens); point patch on tergite VI (Figure 29) subcircular, not darkened, composed of faint points. Anal lobe (Figures 33a, 33b) with rounded apical margin, genital sac of male with dense granulations including apical part, genital sac of female without granulations.

Remarks and geographical distribution

Reiss & Säwedal (1981: 94) in a key indicate that the pupal exuviae of *P. bituberculatus* has a thoracic horn but in Langtom (1991: 327, Plate 132b) the thoracic horn is regarded as absent in this species and the latter viewpoint is accepted here.

The pupal exuviae of *P. bituberculatus* resemble closely those of *P. corsicanus*, *P. curvispinus* and *P. oconnori*. Main separating characters for *P. bituberculatus* are: thoracic suture (Figure 16) lacking granulations on both anterior and posterior half; thoracic horn absent; scutal hump faintly granulose and not domed (Figure 16); pearl row on the wing sheath (Figure 20), not reaching the nose; median patch on tergite VI (Figure 29) circular, bearing faint to weakly darkened points; genital sac of male covered with granulations (Figure 33a), genital sac of female (Figure 33b) lacking granulations apically. However, some variation in the male imagines and the pupal exuviae *P. bituberculatus* from Italy include: tubercles on anal tergite of male bearing only a single seta; thoracic suture with faint granulations on anterior half; D5 on tergite III taeniate.

DISCUSSION

Associated material composed of pupal exuviae and pharate males belonging to the *bituberculatus*-complex (with pupae that key to *P. bituberculatus* in Langton 1991 and Langton & Visser 2003) described here demonstrates that there is a risk of misidentifying pupal exuviae similar to *P. bituberculatus* as *P. bituberculatus*. Consequently, we believe that populations of *P. bituberculatus* from Europe and neighboring regions include about five new species, which key to *P. bituberculatus* as pupal exuviae. It appears that true *P. bituberculatus* is more a northern element than a widespread species throughout the Palaearctic Region. Therefore, the presence or absence of *P. bituberculatus* from some subregions in Europe and the Mediterranean Region needs to be reviewed and confirmed on the basis of pharate males or adult males, in particular from southern Europe (including Portugal, Spain, France, Italy, Greece) and the Near East. Details on both the taxonomy and biogeography of the *bituberculatus*-complex are given in a separate paper in preparation.

In the *bituberculatus*-complex, based on the morphology of both male adult and pupal exuviae, there appear to be several species groups, one centering on *P. bituberculatus* with several close but distinct sister species and another which includes only *P. corsicanus* sp. nov. Further investigations throughout Europe, North Africa and the Near East are necessary to determine if imaginal and pupal features support each other and enable the creation of species groups within the entire genus.

Paratanytarsus. bituberculatus has been previously accepted as having a widespread distribution throughout the Palaearctic Region including southern Europe, the Near East and North Africa. Our investigations show that several species morphologically similar to *P. bituberculatus*, occur in the Mediterranean Basin region. Two of these, *P. curvispinus* and *P. oconnori*, which we consider members of the *bituberculatus*-complex, are described in this paper. In the light of these new discoveries the geographical distribution of *P. bituberculatus* needs to be reviewed by focusing especially on examining pharate males and adult males. Taxonomic information given in this paper provides additional characters for keying any further related species which fall into the *bituberculatus*-complex. Additional future work needs to be done on both the taxonomic composition and geographical distribution of all members of the *bituberculatus*-complex.

The biological quality of both water and sediment in wetland areas and lower reaches of coastal rivers is seriously damaged by the impact of organic and chemical pollution in many countries around the Mediterranean Basin. Furthermore, despite extensive investigations during the last three decades in southern France and Lebanon, only a few pharate males and pupal exuviae belonging to the *bituberculatus*-complex have been obtained.

Coastal aquatic ecosystems including coastal rivers in southern and western France (Mediterranean and Atlantic coastal areas) have been heavily affected by toxic chemical pollutants such as HAP's and PCB's. The latter products combined with the anti-mosquito solution BTI and the past use of pesticides such as Fipronil and Lindane (which remain in the sediments and take a long time to breakdown) can lower the chironomid diversity in coastal habitats by 30 to 50 % (Moubayed-Breil, personal observation).

Key to related known adult males and pupal exuviae

Adult male

As in most Tanytarsini, variation in the superior and median volsella, and the shape of the anal point, provide good distinguishing characters which are often used as main key features for the identification of species. Details of the median volsella in particular, for accurate observation, are more clearly visible when the hypopygium is temporally mounted ventral side uppermost or if the median volsella is dissected from the rest of the hypopygium.

In the following keys, for the identification of adult males and pupal exuviae, only those species, known from Europe and the Near East, belonging to the *bituberculatus*-complex (*P. bituberculatus*, *P. curvispinus* and *P. oconnori*) and *P. corsicanus* are fully keyed.

Adult males

1. Anal tergite without tubercles medially; Anal tergite bands terminating abruptly, well before base of anal point (Figure 9); Anal point (in dorsal view) broad basally, constricted medially, expanded apically to drop-like apex (Figure 9), (in lateral view) triangular (Figure 4); Superior volsella suboval (Figures 10-11); Digitus long and finger-like, equally broad, with rounded apex (Figures 10-11); Median volsella short, triangular bearing only long bristle-

like setae (Figure 12); Inferior volsella wider at base, straight and uniformly tapering (Figures 9, 13), bearing 2 widely spaced setae ventrally (Figure 9), setiferous ventral lobe absent ..... *P. corsicanus* sp. nov.

- Anal tergite with or without tubercles medially; Anal tergite bands terminating near base of anal point (Figures 38, 45, 52); Anal point (in dorsal view) evenly tapered to rounded apex (Figures 38, 45), (in lateral view) not triangular (Figures 5-6, 39, 46, 53); Superior volsella subcircular, subtriangular or subrectangular; Combination of digitus, median volsella and inferior volsella not as described above 2

2. Anal tergite without tubercles medially ..... other *Paratanytarsus* species [Not keyed]
- Anal tergite with tubercles medially *bituberculatus-complex* 3

3. Median volsella with simple setae (Figures 45, 49); Digitus very broad basally, abruptly constricted medially, and evenly continuing to rounded apex (Figures 47-48); Anal tergite with weakly developed tubercles medially (Figure 45) ..... *P. oconnori* sp. nov.
– Median volsella with spatulate lamellae (Figures 41-42); Digitus not as above, with pointed apex (Figure 40); Anal tergite with very distinct tubercles medially (Figures 38, 52) 4

4. Inferior volsella straight, with a triangular lobe projecting beyond the inner margin (Figure 54, Reiss & Säwedal 1981, Figure 9), ventrally bearing 4 setae on a distinct subapical lobe (Figure 55); Tubercles on anal tergite smaller, usually with 2 setae (rarely 1 seta) (Figure 52); Median volsella, short and broad, not tapering, with simple setae and 10 to 11 spatulate setae distally, simple setae reaching to about one-half length of inferior volsella (Figures 42, 55); Palpomeres 3 (apically) and 4 (basally and apically) with patches of microtrichia (Figure 50) ..... *P. bituberculatus* (Edwards 1929)
– Inferior volsella bent inwards apically, with a distinctive tuft of dark setae on inner margin (Figure 38), ventrally bearing 3 setae but without a distinctive subapical lobe (Figure 38); Tubercles on anal tergite larger, with 4 or 5 setae (Figure 38); Median volsella triangular, tapering towards apex, with both simple setae and about 4 to 6 spatulate setae distally (Figures 38, 41), simple setae almost reaching tip of inferior volsella; Palpomeres 3 and 4 lacking patches of microtrichia (Figure 37) ..... *P. curvispinus* sp. nov.

Pupal exuviae

1. Thoracic horn present; Pearl row on wing sheath present or absent, when present, pearl row is usually short, stopping well before nose; Hump on suture of thorax present or absent; when hump is present, granulations are dense ..... other *Paratanytarsus* species [Not keyed]
- Thoracic horn absent; Pearl row present, either very long or short (Figures 19-22); Hump on thoracic suture present, usually distinct (Figures 15, 17-18), if indistinct, hump is defined by a cluster of granulations (Figure 16) 2

2. Pearl row very long, almost reaching the nose (Figure 19); Median patch on tergite VI consists of short spines (Figure 27); Thoracic hump large, smoothly rounded, domed, with minute faint granulations, only anterior part of suture with dense granulations (Figure 15); D5 on tergite III taeniate (Figure 24); Apical margin of anal lobe straight (Figure 32) ..... *P. corsicanus* sp. nov.
– Pearl row short, stops well before the nose (Figures 20-22); Median patch on tergite VI with dark points or bearing faint short spines (Figures 29-31); Thoracic hump and suture granulations not as described above (Figures 16-18); D5 on tergite III taeniate or bristle-like; Apical margin of anal lobe rounded (Figure 33) (*bituberculatus*-complex) 3

3. Thoracic suture without anterior and posterior granulations, hump weakly domed, indistinct, indicated by a cluster of faint granulations (Figure 16) ..... *P. bituberculatus* (Edwards 1929)
- Thoracic suture with anterior and posterior granulations, hump distinct, pointed or strongly granulose (Figures 17, 18) 4

4. Hump on thoracic suture bent backwards and pointed apically (Figure 17); Median patch on tergite VI composed of dark points (Figure 30); D5 on tergite III bristle-like ..... *P. curvispinus* sp. nov.
- Hump on thoracic suture almost indistinct, strongly granulose (Figure 18); Median patch on tergite VI composed of dark spines (Figure 31); D5 on tergite III taeniate ..... *P. oconnori* sp. nov.

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