

# **New records and additions to the database on the geographical distribution of some threatened chironomid species from continental France [Diptera, Chironomidae]**

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A list of 164 species (Table I) of Chironomidae (Diptera) from continental France is provided based on recent investigations conducted between 2010 and 2015. This list includes 62 new records, 52 undescribed taxa and additional data on 50 previously recorded species. The chironomid fauna of continental France is currently estimated to comprise 792 species including 740 valid named species and 52 undescribed species. The local geographical distribution of the listed species is given based on thirteen major biogeographic regions and subregions of France (Corsica not included, Fig. 1). Assessment based on results obtained during the last three decades (1975-2010) of the chironomid fauna of continental France revealed a high number of threatened (51%) or undetected species (25%) mainly reported from five ecological zones delimited by the Mediterranean coastal ecosystem. New records and new undescribed taxa in particular are almost exclusively encountered in preserved or protected zones (National or Regional Parks, Nature Reserves) mainly located in both mountain and lowland areas, which include pristine isolated aquatic refugia. Communities confined to mountain streams and lowland karstic springs consist of endangered and threatened species including new undescribed taxa, which are mostly represented by less than 3 specimens (with some based on one single specimen). The most endangered wetland areas are delimited by the Mediterranean subregions, which include the Var and Maritimes Alps departments to the east and the Eastern Pyrenees to the west. In the present paper, threatened species represent 158 (96%) of 164 listed species, which includes all (100%) of both the 62 new records and the 52 undescribed species. River basins and wetland areas located below 1000 m have high wildlife potential and are hotspots of diversity. Their biological and ecological quality is now strongly affected by a combination of repetitive catastrophic floods and the disastrous negative effects of various human activities which include: ecotourism, camping, canyoning, modification of habitats and exposure of wetland landscapes to eutrophication and toxic chemical pollutants including PCBs, HPAs, heavy metals and pesticides (selective pest-control agents, anti-mosquitos solution Bti).

**Nouvelles citations de Chironomidae pour la faune de France continentale et données complémentaires sur la distribution de certaines espèces menacées [Diptera, Chironomidae]**

Mots-clés: Diptera, Chironomidae, France continentale, inventaire 2015 réactualisé, conservation.

Une liste de 164 espèces (Tableau I) de Chironomidae (Diptera) est fournie sur la base de récentes investigations menées entre 2010 et 2015. L'inventaire 2016 se compose de 62 nouvelles citations, 52 espèces non

décrites et des données complémentaires sur 50 espèces citées antérieurement. Une mise à jour de la faune de France basée sur des récentes données de la littérature nous permet d'établir une liste réactualisée 2015 qui s'évalue à 792 espèces dont 740 espèces valides et 52 non décrites. La distribution géographique des espèces est représentée dans treize régions et sous-régions biogéographiques majeures de France (Corse non comprise, Fig. 1).

Un bilan faunistique sur les Chironomidae connus de France continentale, basé sur des données antérieures obtenues au cours des trois dernières décennies, révèle un grand nombre d'espèces menacées ou non recensées qui sont principalement répertoriées dans cinq zones écologiques délimitées par l'écosystème méditerranéen côtier. Sur un total de 556 espèces répertoriées depuis plus de 3 décennies (1975-2005), 137 (25 %) n'ont pas été retrouvées, et 419 (75 %) ont été recensées entre 2005 et 2015, dont 213 (51 %) correspondent à des espèces menacées. Les habitats aquatiques les plus affectés par les activités humaines (écotourisme, camping, canyoning, modification des habitats, traitement anti-moustiques par le Bti, usage de pesticides, pollution, etc.) et l'impact des crues accidentelles sont délimités par l'écosystème méditerranéen côtier.

Une grande partie des espèces encore non-décrites et des nouvelles citations pour la France a été répertoriée dans des zones humides préservées appartenant à des territoires ou espaces naturels protégés (parcs régionaux ou nationaux, réserve naturelles) qui couvrent des habitats refuges de grande valeur biogéographique. Ces derniers correspondent pour la plupart à d'anciennes enclaves glaciaires relictuelles qui se répartissent tant en haute et moyenne montagne qu'en basse altitude. Les cours d'eau de moyenne et de basse montagne et tout particulièrement les ruisseaux à régime de soutien karstique que délimite l'écosystème méditerranéen se caractérisent par des spécificités écologiques et faunistiques originales qui sont parfois atypiques par rapport au contexte régional. Les sources karstiques et leurs ruisselets hébergent, le plus souvent, des espèces à distribution locale restreinte ainsi que des endémiques de grande valeur patrimoniale. Leur communauté se caractérise, en l'occurrence, par l'originalité de certaines espèces dont l'appartenance à des lignées génétiques autochtones et relictuelles mérite d'être soulignée. Ce sont essentiellement des formes crénobiontes ou sténothermes d'eau froide comprenant parfois des espèces encore non décrites qui sont connues pour leur grande fragilité et leur très faible représentativité numérique (taxons souvent capturés avec moins de 3 individus, parfois 1 seul : l'holotype).

Dans le présent travail, une forte représentativité des espèces menacées est constatée sur les 164 espèces listées. Parmi elles, nous citons : - la totalité (100 %) des nouvelles citations (62 sur 62) et des espèces non décrites (52 sur 52) ; - 96 % (158 espèces) de la richesse spécifique totale. Les étendues de zones humides situées en dessous de 1000 m couvrent des habitats de grande valeur écologique et biogéographique. Tout particulièrement, les sources situées tant en haute altitude qu'en moyenne ou en basse montagne correspondent à de véritables réserves naturelles qui sont assimilées à des hot-spots de diversité et d'endémisme. Actuellement, leur qualité biologique et écologique est profondément affectée par les crues catastrophiques répétitives et les conséquences désastreuses occasionnées par les activités humaines qui touchent en particulier les sous-régions méditerranéennes situées au Sud-Est et au Sud-Ouest de la France.

## 1. Introduction

Based on published faunal data (1989 to 2008) on the Chironomidae of continental France (SERRA-TOSIO & LAVILLE 1989, 1991, LAVILLE & SERRA-TOSIO 1996, GARCIA & LAVILLE 2000, MOUBAYED et al. 2000, VALA et al. 2000, DELETTRE 2001, MOUBAYED-BREIL 2008) a total number of **666** known chironomid species were recorded. More recently (between 2012 and 2016), **12** new species have been described from continental France (LANGTON 2012, MOUBAYED-BREIL & ASHE 2011, 2014, 2015a, 2015b, MOUBAYED-BREIL & LOUNACI 2013, MOUBAYED-BREIL 2012a, 2012b, 2012c, 2015a, 2015b, 2016): *Cricotopus levantinus occidentalis* Moubayed-Breil & Ashe, 2011; *Metriocnemus malliarus* Langton, 2012; *Orthocladius* (*Eu-*

*orthocladius*) *kabylianus* Moubayed-Breil & Lounaci, 2013; *Pseudosmittia withersi* Langton, 2012; *Stygocladus multisetosus* Moubayed-Breil, Ashe & Langton, 2012; *Paratanytarsus oconori* Moubayed-Breil, Ashe & Langton, 2012; *Rheotanytarsus dactylophoreus* Moubayed-Breil, Langton & Ashe, 2012; *Thienemannia valespira* Moubayed-Breil & Ashe, 2014; *Trissocladus orsinii* Moubayed-Breil & Ashe, 2015; *Paratanytarsus fontinalis* Moubayed-Breil & Ashe, 2015; *Rheocricotopus (Psilocricotopus) meridionalis* Moubayed-Breil, 2016; *Rheocricotopus (Psc.) thomasi* Moubayed-Breil, 2016. Consequently, these 12 new species increased the total number of valid named species to 678 (666 + 12). In the current study, the total number of known chironomid species from continental France is estimated to be 739 including the 678 previously updated species and the listed 62 new records in Table I. Currently, 792 species are known from continental France including 740 named species and 52 undescribed species.

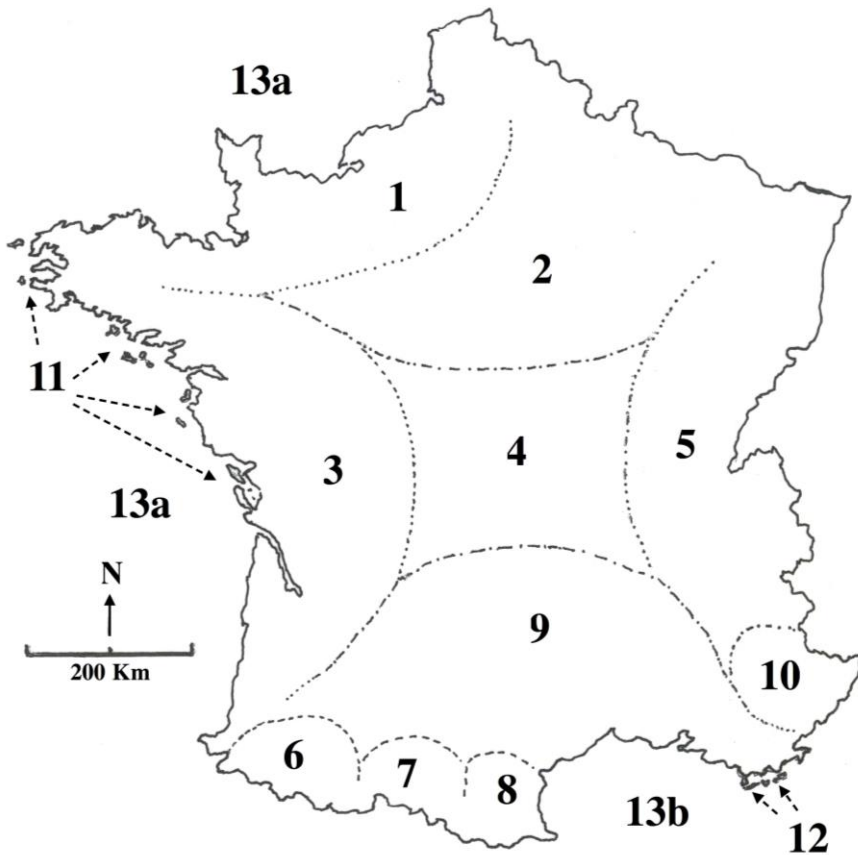


Figure 1. The thirteen major biogeographic regions and subregions of continental France in the present study.

Figure 1. Les treize régions et sous-régions majeures de France continentale selon la présente étude.

## 2. Methods and sampling sites

The collection sites, collecting methods and both geographical and typological data of some sampling habitats throughout continental France have been detailed in a previous paper (MOUBAYED-BREIL 2008) where ten regions and subregions of France were defined. In this paper up to thirteen regions and subregions have been investigated between 2005 and 2015, including three additional sites (11-13) as illustrated in Figure 1. The thirteen sampled sites extend from high mountain areas (located above 1000 m) to middle and lowland areas (located below 1000 m) including: springs, permanent and temporary streams and pools, peat pits, rhithral and potamal of rivers, estuaries and estuarine zones, lakes, ponds, lagoon and the marine littoral zones (supralittoral, midlittoral and sublittoral).

Geographical distribution of the ten previously prospected regions provided by MOUBAYED-BREIL (2008) includes habitats located along the upper basins (subregion a) and those delimited by the down basins (subregion b):

- two in Northern France (1a, 1b; 2a, 2b),
- three in Central France (3a, 3b western part, Atlantic area; 4a, 4b central part, Auvergne; 5a, 5b, eastern part, Alps),
- five in Southern France (6a, 6b, Western Pyrenees; 7a, 7b, Central Pyrenees; 8a, 8b, Eastern Pyrenees; 9a, 9b, South Central France; 10a, 10b, Maritime Alps).

Some published papers on the biogeographical divisions of continental France include informative maps, which distinguish areas located above and below 1000 m, are given by SERRA-TOSIO & LAVILLE (1991), LAVILLE & SERRA-TOSIO (1996), MOUBAYED et al. (2000), MOUBAYED-BREIL (2008). Those delimited by both the Atlantic and the Mediterranean coastal ecosystem respectively consist of:

- zone **13** of the Limnofauna Europaea (ILLIES & coll. 1978) includes subregions **A, B, C, D, E** (SERRA-TOSIO & LAVILLE 1991, LAVILLE & SERRA-TOSIO 1996);
- three coastal biogeographic zones (MOUBAYED et al. 2000);
- subregions **1** to **10** (MOUBAYED-BREIL 2008).

The three recently investigated additional regions and subregions include marine, brackish and freshwater habitats located along the coastline of some small continental islands (Fig. 1). Among them, two (**11** and **12**) belong to continental insular areas and one belongs to marine habitats of the marine littoral zone (**13**). Subregion **11**, NW-France includes the Channels Islands (Ste-Anne, Guernsey, Jersey, Bréhat, etc.), and Atlantic islands (Ouessant, Molène, Groix, Belle-Île, Noirmoutier, Yeu, Ré, Oléron). Mediterranean islands are: Hyères Islands (Porquerolles, Port-Cros, Levant), Lérins Islands, etc. (subregion **12**, E-France). Marine littoral zone includes marine habitats extended along: the Atlantic coasts, **13a**; the Mediterranean coasts, **13b**.

## 3. Faunal results and local distribution of species

A list and local geographical distribution throughout continental France of 164 species is provided in Table I, which include 62 new records and 52 new undescribed species. The number of species by subfamily of the listed 164 species in Table I is as follows:

- Buchonomyinae: 1 species;

- Tanypodinae: 7 species;
- Diamesinae: 6 species;
- Orthocladiinae: 87 species;
- Chironominae: 63 species including the two tribes (Chironomini: 25 species; Tanytarsini: 38 species).

Known distribution in the thirteen major biogeographic regions and subregions of continental France (Fig. 1) for each of the 164 species is given in the right hand column of Table I. The 164 species summarized in Table I include 62 new records (\*) for continental France and 52 new undescribed species (\*\*). The remaining 50 species are considered as representing the second or third records for some regions or subregions. Biogeographical regions or subregions located in the Atlantic and Mediterranean coastal ecosystems (regions 3, 6, 7, 8b, 9a, 9b, 9c, 10) have been more intensively investigated compared to the poorly explored remaining areas of continental France (regions 1, 2, 4 and 5).

Based on recent faunal data on the Chironomidae of continental France, a total of 678 species were listed in the literature (SERRA-TOSIO & LAVILLE 1989, 1991, LAVILLE & SERRA-TOSIO 1996, GARCIA & LAVILLE 2000, MOUBAYED et al. 2000, VALA et al. 2000, DELETTRE 2001, MOUBAYED-BREIL 2008) including a previous list of 666 species plus 12 recently described new species. An updated checklist of 792 species of Chironomidae is provided in this paper for continental France, of which 739 (678 + 61) are valid named species and 52 are new undescribed species.

Among the 164 listed species a high number of rare and threatened species (\*\*\*) are represented:

- 158 (= 96%) of the total number of 164 species;
- 62 (= 100%) of the 62 new records;
- 52 (= 100%) of the 52 new undescribed species.

In general, the most affected wetlands areas are delimited by the Mediterranean coastal ecosystem where habitats are significantly degraded and impacted by numerous perturbation factors (tourism, new development and infrastructure, camping, modification of habitats, canyoning, repetitive floods, etc.) and obviously exposure to eutrophication and toxic chemical pollutants including PCBs, HPAs, heavy metals and pesticides (selective pest-control agents, anti-mosquitos solution Bti).

A list of 556 species were compiled for the chironomid fauna of the Mediterranean coastal ecosystem of continental France, based on material collected during the last three decades (MOUBAYED-BREIL & ASHE 2016). Assessment since 2005 based on more recent investigations revealed a high number of undetected species (137 i. e. 25%), which were previously recorded. Between 2005 and 2015, only 419 species (75%) have been rediscovered out of the 556 previously listed species from this endangered area, where 213 (51% of 419) are considered as threatened species.

The number of species listed as “threatened” or “undetected” indicates an urgent necessity for large-scale investigations to provide more detailed comparative assessments in order to implement conservation measures, including the incorporation and protection of additional pristine habitats into national parks and nature reserves.

New records and new undescribed taxa in particular are often encountered in preserved or protected local areas (National or Regional Parks, Nature Reserves) mainly occurring in the upper and middle basin of rivers. Mountain helocrenes and streams, karstic springs and estuarine zones, located in particular along the Mediterranean coastline (both eastern and western parts), mostly consist of sensitive and vulnerable habitats, which harbour wildlife potential, highly divergent genetic lineages and hotspots of global significance. Stenothermic and crenobiontic species are restricted in general to karstic springs and cold streams where spatial distribution is significantly correlated with long-term isolation into cumulative microrefugia caused by the impact of human activities including aridity and forest fragmentation of wetlands areas. Moreover, diversity patterns of local communities is strongly linked to some local environmental conditions (regularity of thermal regime of underground water, enriched canopy coverage, strong seasonal variability of hydrological conditions maintained by repetitive flooding and drying, high level of mineralization of water-courses, etc.). This highlights the importance of some Mediterranean mountain range in the preservation and persistence of autochthonous relic species, which appear as cold enclaves throughout the Mediterranean coastal ecosystem (MYERS et al. 2000, MOUBAYED-BREIL 2008, GIUDICELLI & OLIVARI 2010, MOUBAYED-BREIL & ASHE 2013, 2015b, 2015c, 2016). The biological and ecological quality of many lotic and lentic habitats is now strongly affected and threatened by recurring and increasing alternating flood/drought events associated with increasingly greater risk of human activities. Such endangered communities, are generally composed of biogeographical representative and bio-indicator elements, which deserve greater attention, protection and consideration.

#### 4. Remarks

##### - *Buchonomyia thienemanni*

Very abundant in the middle and lower basins of rivers and streams located in south central France (subregions 4a, 4b, 9a, rivers: Allier, Alagnon, Sioule, Lot, Aveyron, etc.), this emblematic species has become less widespread and rare throughout basins delimited by the coastal Mediterranean ecosystem of southern France (subregions 8b, 9b and 10b, rivers: Tech, Agout, Vidourle, Gardon, Argens, Var, Roya, Tinée, etc.). Previously reported in the years 1980's as a threatened species in some river basins located in both south western and south eastern France (Massane, Agly, Aude, Hérault, Argens, Var, Tinée, Vésubie, etc.), this species has not been detected in the same rivers during the last two decades. Modification of habitats, construction of numerous hydroelectric stations, accidental flooding and impact of human activities (camping, tourism, excessive construction, pollution, etc.) on the quality of water are believed to represent the most significant degrading factors causing the decline and loss of *B. thienemanni* from this endangered area.

##### - *Brillia* sp. 1

Only one single male pupal exuviae of *Brillia* sp. 1 was collected. It belongs to a new morphotype, which keys nearer *B. longifurca* (Kieffer, 1909) rather than to *B. bifida* Kieffer, 1921 on the basis of the following characters:

- thoracic horn linear and parallel sided in its  $\frac{3}{4}$  basal part, narrowed and pointed apically;
- anal lobe nearly circular.

This pupal exuviae probably belongs to *B. pudorosa*, which has been collected as well in the same locality (Tardit, Saison River, middle basin; W-Pyrenees, zone 6b).

- *Bryophaenocladius simus*

*B. simus* is keyed and the male hypopygium is figured in LANGTON & PINDER (2007). Nevertheless, some additional taxonomic characters of the male adult are provided as follows: squama with 10 setae; anal tergite bearing 16 setae; anal point 43 µm long, 37 µm wide at base, 17 µm wide in the middle; inferior volsella with two distinct lobes, dorsal lobe is hyaline and larger, ventral lobe tubercle-like and sclerotized, blackish and bearing numerous stout setae; gonostylus 87 µm long, 35-38 µm maximum width, bearing two crista dorsalis (the first is very large, dome-like, covers almost the entire anterior-dorsal part; the second is triangular, tooth-like, blackish and located ventrally on proximal part; megaseta 12 µm long, 6 µm wide, spatulate distally. One single male adult of *B. simus* was recently collected in a spider's web by M. H. Breil in the Eastern Pyrenees (littoral coastline). Consequently, its geographical distribution, previously restricted to England and Ireland (ASHE & O'CONNOR 2012), is now extended to southern France.

- *Cricotopus (Paratrichocladus) gayi* and *C. (Ptc.) lanzavecchiai*

The former genus *Paratrichocladus* has recently been reduced to a subgenus of *Cricotopus* (CRANSTON & KROSCHE 2015). Both *C. (Ptc.) gayi* and *C. (Ptc.) lanzavecchiai* are uncommon and rare species throughout the upper and middle basins of rivers located in southern France (regions 9 and 10). While *C. (Ptc.) gayi* is mostly recorded in lowland river stretches of subregion 9b, *C. (Ptc.) lanzavecchiai* is more widespread in both the upper and middle basins situated towards the Italian border.

- *Eukiefferiella brulini*

A recently described new species (MOUBAYED-BREIL & ASHE 2015) from the coastal Mediterranean ecosystem of continental France. *E. brulini* and *E. ancyla* Svensson, 1986 are considered by the latter cited authors as sister species based on their behaviour life cycle as commensal species on the river limpet *Ancylus fluviatilis* O. F. Müller, 1774. While *E. ancyla* is widespread in both northern and central Europe (SÆTHER & SPIES 2013), *E. brulini* seems to be confined to the middle and lower basins located in southern Europe and delimited by the coastal ecosystem. The known distribution of *E. ancyla* throughout Europe has been based mainly on the pupal exuviae (SVENSSON 1986, LANGTON 1991) in which the anal lobe is lacking an apical seta. However, an accurate identification based not only on the pupal exuviae characters, but also on material composed of adults and immature stages (male, female, pharate, larva) is necessary to confirm the presence or absence of either of these *Eukiefferiella* species. Care must be taken with identifications of some species, which are based solely on pupal exuviae, particularly in large genera such as *Eukiefferiella*, *Orthocladus* and *Paratanytarsus* where unrecognised sibling species may exist and in such cases it is essential to obtain reared material or pharate material of at least the adult male and its associated pupal exuviae. All records of *E. ancyla* (based exclusively on pupal exuviae characters) from central and southern Europe need to be carefully reviewed based on associated adult male and pupal exuviae.

- *Euryhopsis fuscipropes*

This species is described only as male adult from the type locality in China (SÆTHER & WANG 1993). Its first record as both new genus and new citation for Europe is reported by MOUBAYED-BREIL (2008) based on one single male pharate adult collected in the rhithral of the Saison River (Western Pyrenees, zone 6b).

- ***Orthocladius (Orthocladius) spp.***

Material consisting of male and female adult pharates of *Orthocladius (Or.)* spp. were recently obtained from continental France and Corsica, which includes a few new species based on some distinctive characters in the male adult and pupal exuviae. Their pupal exuviae in particular bear dense black chitinous rings on tergites and sternites resembling those of *O. rubicundus* (Meigen, 1818) and *O. pedestris* Kieffer, 1909. A description of these new species is in preparation. *Orthocladius* sp. 1, occurring exclusively in karstic springs in southern France (zones 9a, 9b), is closely related to *O. carlatus* from which it can be distinguished by the following characters:

- in the adult (shape of superior and inferior volsella; virga consisting of 3 distinct spines, median one is much larger than the 2 laterals; form of the gonostylus);

- in the pupal exuviae (shape of the thoracic horn, swollen basally, narrowed apically; absence of black chitinous rings on the lateral area of sternites I-III; presence of conspicuous blackish granulation on posteromedian area of segment I).

- ***Rheocricotopus thomasi, Trissocladius orsinii, Paratanytarsus oconnori and Rheotanytarsus dactylophoreus***

All four species are reported from both Corsica and the Eastern Pyrenees (MOUBAYED-BREIL & ASHE 2012, 2015a, MOUBAYED-BREIL et al. 2013, MOUBAYED-BREIL 2016). These species are considered biogeographically to represent a pyrenocorsican element, which includes the new Orthoclaadiinae genus 1 and species (see below).

- **Orthoclaadiinae 1, new genus and species**

Orthoclaadiinae 1, a new genus and species, is currently known only as pupal exuviae. One pupal exuviae was collected in 1984 in the Eastern Pyrenees but no additional material has been collected there since this date. A few pupal exuviae of this new genus were reported in some river basins located in northern and western Corsica (MOUBAYED-BREIL & ASHE 2011). In recent investigations throughout Corsica and south eastern France (MOUBAYED-BREIL & ASHE 2015a, MOUBAYED-BREIL & ASHE 2016) up to 50 pupal exuviae were collected but no associated pharate adult material has yet been found. More recently (in May-June 2015) a few male adults of a new genus of Orthoclaadiinae, obtained from the same locality as the pupal exuviae of Orthoclaadiinae genus 1 - these adult males may be the unknown males of Orthoclaadiinae genus 1. A description of the male adult and the pupal exuviae of this new genus and species is in preparation.

- ***Micropsectra roseiventris***

Large samples of male pharate adults, including several *Micropsectra* species, were collected in high mountain springs in the Eastern Pyrenees. *M. roseiventris* in particular was separated from other related *Micropsectra* species based on the description given by REISS (1974) except that lateral teeth on the margin of the anal tergite is a variable feature and may be present or absent. However, the description of REISS (1974) can be supplemented by the main following distinguishing characters:

- in the male adults: anal tergite with tubercule distinctly visible in lateral view; anal point spatulate distally and forked apically; lamellar setae on median volsella very long, lanceolate, sharply pointed with curved needle-like distal part;

- in the pupal exuviae: the median patch on tergite III is large and consists of conspicuous spines, anal comb of segment VIII with 9-11 spines. In continental France, *M. roseiventris* oc-



curs exclusively in high mountain springs and peat bogs located in the Eastern Pyrenees (zone 8a).

**- Species known only from one single area or locality**

Previously undetected and threatened species are increasingly reported from pristine protected habitats of the Mediterranean coastal ecosystem of continental France (MOUBAYED-BREIL & ASHE 2016). The following species including both new records and undescribed species are often represented by less than 3-5 specimens, and sometimes even by only one single individual. Moreover, these latter species, hitherto recorded from only one single area or locality, are therefore all considered as threatened throughout the five ecological zones of the Mediterranean coastal ecosystem where the habitats are strongly affected by combined repetitive floods and disastrous effects of human activities:

- *Arctopelopia* sp. 1 (Lot middle river basin, South central France; zone 9a);
- *Guttipeloplia guttipennis* (limnocrenes; S-France, zone 9b);
- *Macropeloplia fittkaui* (Roya River, upper basin, Col of Tende; Maritime Alps, zone 10a);
- *Procladius* sp. 1 (= *P.* sp, known from Norway, in FITTKAU & MURRAY 1985); pupal exuviae easily recognized on the basis of thoracic horn characters; Lake Gorg Estelat, a high mountain lake; E-Pyrenees, zone 8a);
- *Potthastia pastoris* (Hérault River, middle basin; Hérault, zone 9a);
- *P.* sp. 1 (near *montium*; potamal of rivers located in the Pyrenees; zones 6b, 7b, 8b);
- *Pseudokiefferiella* sp. 1 (Alemany springs, altitude 2000 m, Mantet Nat. Res.; E-Pyrenees, zone 8a);
- *Cricotopus (Cricotopus) beckeri* (Massane and Roya Rivers, middle and down basins; E-Pyrenees, zone 8b; Maritime Alps, zone 10b);
- *C. (Cr.) polaris* (basaltic helocrenes; volcanic area of Auvergne, Central France, zone 4a);
- *C. (Cr.)* sp. 1 (near *nevadensis* Vilchez-Quero, 1992; middle basin of streams; rhithral; Maritime Alps, zone 10a);
- *Eukiefferiella bedmari* (Roya River, middle basin; Maritime Alps, zone 10b);
- *E. brulini* (rhithral of Mediterranean rivers located below 1000 m; zones 9a, 9b, 10b);
- *Eurynemus crassipes* (Guiel stream, rhithral; NW-France, zone 1a);
- *Georthocladius (Georthocladius) luteicornis* (Ariège River, rhithral; Central Pyrenees, zone 7a);
- *Limnophyes inanispatina* (temporary basaltic pools, Roque-Haute, Nat. Res.; S-France, zone 9b);
- *L. roquehautensis* (temporary basaltic pools, Roque-Haute, Nat. Res.; S-France, zone 9b);
- *Mollerella calcarella* (new record for continental France, Guiel stream, NW France ; zone 1) ;
- *Orthocladius kabylianus* (Argens River, rhithral; SE-France, Var dept, zone 9a);
- *O. (Eudactylocladius)* sp. 1 (Tech River, upper basin, Prats-de-Mollo Nat. Res.; E-Pyrenees, zone 8a);
- *O. marchettii* (Argens River, rhithral; SE-France, Var dept, zone 9b);

- *O. (Or.)* sp. 2 and *O. (Or.)* sp. 3 (rhithral below 1000 m; E and W-Pyrenees, zones 6b, 7b, 8b);
- *O. (Or.)* sp. 4 (Saison River, rhithral and gorges; W-Pyrenees, zone 6b);
- *Parachaeotcladius* sp. 1 (near *abnobaesus*; high mountain areas, Prats-De-Mollo Nat. Res.; E-Pyrenees, zone 8a);
- *Parakiefferiella* sp. 1 (helocrenes and peat bogs at 2000 m, Mantet Nat. Res.; E-Pyrenees, zone 8a);
- *Parametriocnemus* sp. 1 (Malière stream, rhithral; SE-France, zone 9a);
- *P.* sp. 2 (karstic helocrenes and rhithral; S-France, zone 8b);
- *P.* sp. 3 (Enfer stream, cold pristine basaltic helocrenes; Auvergne, Central France, zone 4a);
- *Pseudorthocladius (Pseudorthocladius) cristagus* (Enfer stream, basaltic helocrenes, volcanic area of Auvergne; Central France, zone 4a);
- *Rheocricotopus (Psilocricotopus) meridionalis* and *R. (Psc.) thomasi* (both are cold stenothermic species occurring in mountain helocrenes and pristine streams; *R. meridionalis* is considered as a Mediterranean element while geographical occurrence for *R. thomasi* is currently restricted to the Tyrrhenian province);
- *R. (Psc.) tirolus* (Massane River, rhithral, Massane Nat. Res.; E-Pyrenees, zone 8b);
- *R. (Rheocricotopus)* sp. 1 (mountain helocrenes and rhithral of shaded pristine streams in: Eastern Pyrenees, Mantet Nat. Res., zone 6a; Western Pyrenees, Soule Valley, Kakuetta gorges, zone 8a);
- *Stilocladius montanus* (Roya River, upper basin; Maritime Alps, SE-France, zone 10a);
- *Stygocladius multisetosus* (known from karstic helocrenes in Algeria; basaltic helocrenes in S-France, zone 9b);
- *Trissocladius orsini* (known from Corsica; mountain springs and streams, W and E-Pyrenees, zones 6a, 7a, 8a);
- *Chironomus (Chironomus) vallenduuki*, a new replacement name for *C. uliginosus* Keyl, 1960, in ASHE & O'CONNOR (2015); Argens River, lentic habitats, zone 9b; Porquerolles and Port-Cros Islands, pools, zone 9c;
- *Demicryptochironomus (Demicryptochironomus) vulneratus* (Massane River, middle stream; E-Pyrenees, zone 8b);
- *D. (Irmakia) neglectus* (Ariège River, middle and down basins; SW-France, zone 7b);
- *Polypedilum (Cerobregma) lotensis* (Lot River, hyporhithral; Auvergne, zone 4b);
- *P. (C.) saetheri* (Sioule River, hyporhithral; Auvergne, zone 4b);
- *P. (Tripodura) moubayedbreili*, a new replacement name for *P. elongatum* Albu, 1980, in ASHE & O'CONNOR (2015); Nohèdes River, rhithral, Nohèdes Nat. Res.; E-Pyrenees, zone 8b;
- *Pseudochironomus prasinatus* (Pavin volcanic lake, littoral zone; Auvergne, Central France, zone 4a);
- *Micropsectra chionophila* and *M. nana* (Gavet stream and Poursollet Lake, moorland and peat bogs; High Alps, zone 5a);

- *M. clastrieri* and *M. seguyi* (Roya River, upper basin, pristine peat bogs; Maritime Alps, SE-France, zone 10a);
- *M. nohedensis* (upper basins of rivers, peat bogs at high altitude; E-Pyrenees, zone 8a);
- *Neozavrelia bernensis* (pristine peat bogs at high altitude; High Alpes, zone 5a);
- *Neozavrelia* sp. 1 (karstic springs and streams; S-France, zone 9b);
- *Rheotanytarsus procerus* (known from N-Africa, Morocco, first record for Europe; springs and rhithral, Port-Cros island; SE-France, zone 9c);
- *Tanytarsus cretensis* (Petit-Rhône, potamal; S-France, zone 9b);
- *Virgatanytarsus albisutus* (known from Morocco, Italy, Sardinia and Greece; Port-Cros Island, SE-France, zone 9c).

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Table I. List and geographical distribution of species. P = Previous record; ?=queried record; \* = New record; \*\* = Rare, threatened, represented only by 1-3 individuals; \*\*\* = Undescribed species.

Tableau I. Liste des espèces et leur distribution géographique. P = Citation déjà connue ; ?=citation probable ; \* = Espèce nouvelle pour la France; \*\* = Rare, menacée, représentée seulement par 1-3 individus; \*\*\* = Espèce non décrite.

Total species, the **164** species includes: - **52** undescribed species (\*\*\*); - **62** new records (\*); - **158** threatened species (\*\*). Current total number of known valid species from continental France = **740**.

CHIRONOMIDAE – LIST OF SPECIES	RECORD	DISTRIBUTION
<b>Subfamily Buchonomyinae: 1 species</b>		
<i>Buchonomyia thienemanni</i> Fittkau, 1955**	P	8b; 9a; 9b; 10
<b>Subfamily Tanypodinae: 7 species</b>		
<i>Arctopelopia</i> sp. 1 (S-Central France, Lot River)**	***	9a
<i>Guttipelopia guttipennis</i> (van der Wulp, 1861)**	P	9b
<i>Krenopelopia binotata</i> (Wiedemann, 1817)**	P	8b; 9b
<i>Labrundinia longipalpis</i> (Goetghebuer, 1921)**	*	1; 2; 9a
<i>Macropelopia fittkai</i> Ferrarese & Ceretti 1987**	*	10a
<i>Procladius</i> sp. 1 (= <i>P.</i> sp. in FITTKAU & MURRAY 1985, E-Pyrenees)**	***	8a
<i>Zavrelimyia berberi</i> Fittkau, 1962**	*	9c; 10
<b>Subfamily Diamesinae: 6 species</b>		
<i>Boreoheptagvia rugosa</i> Saunders, 1930)**	P	8b; 10
<i>Pothastia pastoris</i> (Edwards, 1933)**	P	9a
<i>P.</i> sp. 1 (near <i>montium</i> ; potamal of rivers, Pyrenees)**	***	6b; 7b; 8b
<i>Pseudokiefferiella</i> sp. 1 (Alemany springs, altitude 2000 m, E-Pyrenees)**	***	8a
<i>Sympothastia zavreli</i> Pagast, 1947**	P	5b; 8b; 9a; 10b
<i>S. spinifera</i> Serra-Tosio, 1969**	P	
<b>Subfamily Orthoclaadiinae: 87 species</b>		
<i>Acamptocladus reissi</i> Cranston & Sæther, 1982**	*	9a; 9b; 10
<i>Brillia pudorosa</i> Cobo, Gonzales & Vieira-Lanero, 1995**	P	3a; 6b
<i>B.</i> sp. 1 (Saison River, middle basin, W-Pyrenees)**	***	6b
<i>Bryophaenocladus furcatus</i> (Kieffer, 1916)**	*	1; 2; 3; 4; 6; 8; 9; 10
<i>B. inconstans</i> (Brundin, 1947)**	*	4; 9a; 10
<i>B. simus</i> (Edwards, 1929)**	*	8b
<i>B.</i> sp. 1 (karstic springs, southern France)**	***	9a; 9b
<i>B.</i> sp. 2 (rhithral, Mantet River, altitude 750 m, E-Pyrenees)**	***	8b
<i>B.</i> sp. 3 (Soques springs, Mantet River basin, altitude 1790 m E-Pyrenees)**	***	8a
<i>Chaetocladus (Chaetocladus) algericus</i> Moubayed, 1989**	P	9b; 10
<i>Clunio marinus</i> Haliday, 1855 (Atlantic coasts)	P	13a
<i>C. mediterraneus</i> Neumann, 1971 (Mediterranean coasts)	P	13b
<i>C.</i> sp. 1 (Mediterranean coasts)**	***	13b
<i>C.</i> sp. 2 (Mediterranean coasts)**	***	13b
<i>Corynoneura celtica</i> Edwards, 1924**	P	8b; 9a; 9b; 10
<i>Cricotopus (Cr.) beckeri</i> Hirvenoja, 1973**	P	8b; 10b
<i>C. (Cr.) ephippium</i> (Zetterstedt, 1838)**	*	9a; 9b; 9c

CHIRONOMIDAE – LIST OF SPECIES	RECORD	DISTRIBUTION
<i>C. (Cr.) levantinus</i> ssp. <i>occidentalis</i> Moubayed-Breil & Ashe, 2011**	P	9b; 10
<i>C. (Cr.) polaris</i> Kieffer, 1926**	*	4a
<i>C. (Cr.)</i> sp. 1 (near <i>nevadensis</i> Casas & Vilchez-Quero, 1992)**	***	10a
<i>C. (Paratrichocladius) gavi</i> Serra-Tosio, 1969 (Alps, Maritimes Alps)**	P	5a; 10a
<i>C. (Ptc.) lanzavecchiai</i> Rossaro, 1990**	P	9a; 10a; 10b
<i>Eukiefferiella bedmari</i> Vilchez-Quero & Laville, 1988**	P	10b
<i>E. brulini</i> Moubayed-Breil & Ashe, 2015**	*	8b; 9a; 9b; 10a; 10b
<i>Eurycnemus crassipes</i> (Meigen, 1810)**	P	1a
<i>Euryhopsis fuscipropes</i> Sæther & Wang, 1993**	P	6b; 8b
<i>Georthocladius (Georthocladius) luteicornis</i> (Goetghebuer, 1941)**	P	7a
<i>G. (Ge.)</i> sp. 1 (Tech River, upper basin, E-Pyrenees)**	***	8a
<i>Gymnometriocnemus (Gymno.) subnudus</i> (Edwards, 1929)**	*	9a; 9b
<i>Halocladius (Halocladius) mediterraneus</i> Hirvenoja, 1973**	*	13b
<i>Heleniella</i> sp. 1, near <i>ornaticollis</i> (Edwards, 1929); High Alps**	*	5a
<i>Heterotrissocladius brundini</i> Sæther & Schnell, 1988**	*	6; 7; 8a; 8b; 10
<i>Hydrosmittia</i> sp. 1 (central & W-Pyrenees)**	***	6; 7
<i>Krenosmittia hispanica</i> Wülker, 1957**	P	8a; 8b
<i>Limnophyes angelicae</i> Sæther, 1990 **	*	6; 7; 8a; 8b
<i>L. inanispatina</i> Langton & Moubayed, 2001**	P	9b
<i>L. madeirae</i> Sæther, 1990 **	*	8b; 9b; 9c
<i>L. roquehautensis</i> Langton & Moubayed, 2001**	P	9b
<i>L.</i> sp. 1 (Roya River, upper basin, SE-France)**	***	10a
<i>Metriocnemus (Metriocnemus) wangi</i> Sæther, 1995**	*	1; 2; 4; 9a
<i>Mollerella calcarella</i> Sæther & Ekrem, 1999**	*	1
<i>Orthocladius (Eudactylocladius) sp. 1</i> (mountain springs, E-Pyrenees)**	***	8a
<i>Orthocladius (Euorthocladius) kabylianus</i> Moubayed-Breil & Lounaci, 2013**	*	9a
<i>O. (Mesorthocladius) sp. 1</i> (cold mountain streams, W-Pyrenees)**	***	6b
<i>O. (Orthocladius) carlatus</i> (Roback, 1957)**	P	8; 9; 10
<i>O. (Or.) marchettii</i> Rossaro & Prato, 1991**	*	9b; 9c; 10
<i>O. (Or.)</i> sp. 1, near <i>carlatus</i> (Roback, 1957); karstic springs, S-France**	***	9a; 9b
<i>O. (Or.)</i> sp. 2 (springs, high mountain, E and W-Pyrenees)**	***	6a, 7a, 8a
<i>O. (Or.)</i> sp. 3 (springs and mountain streams, E and W-Pyrenees)**	***	6b, 7b, 8b
<i>O. (Or.)</i> sp. 4 (springs and mountain streams, W-Pyrenees)**	***	6b
<i>O. (Symposiocladius) holsatus</i> Goetghebuer, 1937**	P	7b; 8b; 9b
<i>Parachaeotocladius</i> sp. 1, near <i>abnobaevus</i> (Wülker, 1959); E-Pyrenees)**	***	8a
<i>Parakiefferiella</i> sp. 1 (high mountain springs, E-Pyrenees)**	***	8a
<i>P.</i> sp. 2 (Notre Dame stream, Port-Cros Island, SE-France)**	***	8a
<i>Parametriocnemus</i> sp. 1 (SE France, cold pristine stream at low altitude)**	***	9a
<i>P.</i> sp. 2 (helocrenes and rhithral at low altitude, SW-France)**	***	8b
<i>P.</i> sp. 3 (cold pristine stream, volcanic area of Auvergne, Central France)**	***	4a
<i>Propsilocerus jacuticus</i> (Zvereva, 1950)**	*	9b; 9c; ?10b
<i>Pseudorthocladius (Pseudorthocladius) berthelemyi</i> Moubayed, 1990**	P	8a; 9a; 10
<i>P. (Pso.) cristagus</i> Stur & Sæther, 2004**	*	4a
<i>Pseudorthocladius (Pso.)</i> sp. 1 (E-Pyrenees)**	***	8b
<i>Pseudosmittia obtusa</i> Strenzke, 1960**	*	9b; 9c; 10
<i>P. simplex</i> Strenzke & Thienemann, 1942**	*	8b; 9b
<i>P.</i> sp. 1 (wet meadows, N-France)**	***	2a
<i>Rheocricotopus (Psilocricotopus) meridionalis</i> Moubayed-Breil, 2016**	*	9a; 9b; 10
<i>R. (Psc.)</i> cf. <i>subacutus</i> Caspers & Reiss, 1989**	*	9a; 9b
<i>R. (Psc.) thomasi</i> Moubayed-Breil, 2016 (pyreneocorsican element)**	*	?8a; 8b
<i>R. (Psc.) tirolus</i> Lehmann, 1969**	P	8b
<i>R. (Rheocricotopus) sp. 1</i> (mountain helocrenes and streams, Pyrenees)**	***	6a; 8a
<i>Smittia abruzzae</i> Rossaro & Lencioni, 2000	*	9b; 9c
<i>S. alpilonga</i> Rossaro & Lencioni, 2000**	*	9c

CHIRONOMIDAE – LIST OF SPECIES	RECORD	DISTRIBUTION
<i>S. aquatilis</i> (Goetghebuer, 1921)**	P	8b; 9b
<i>S. macrura</i> Goetghebuer, 1932**	*	8b; 9b
<i>S. stercoraria</i> Rossaro & Lencioni, 2000**	*	9a; 9b; 9c
<i>S. thalassicola</i> Goetghebuer, 1943**	P	9b; 9c; 10
<i>S. sp. 1</i> (wet litter and moss, high mountain springs, E-Pyrenees)**	***	9c; 10
<i>S. sp. 2</i> (wet litter and moss, high mountain springs, E-Pyrenees)**	***	8a; 8b
<i>S. sp. 3</i> (wet litter and moss, high mountain springs, E-Pyrenees)**	***	8a
<i>S. sp. 4</i> (pools and wet meadow at Porquerolles Island; zone 9c, SE-France)**	***	9c
<i>S. sp. 5</i> (wet meadows, N-France)**	***	2a
<i>Stilocladius montanus</i> Rossaro, 1979**	*	10a
<i>Stygocladius multisetosus</i> Moubayed-Breil, Ashe & Langton, 2012**	P	9b
<i>Thienemannia valespira</i> Moubayed-Breil & Ashe, 2013**	P	5; 6a; 7a; 8a; 10
<i>Tokunagaia excellens</i> (Brundin, 1956)**	*	8a; 10a
<i>Trissocladius orsinii</i> Moubayed-Breil & Ashe, 2015**	P	8a
Orthoclaudiinae -1, new genus and species (also known from Corsica)**	***	8; 10
Orthoclaudiinae -2, new genus and species (high mountain springs)**	***	10
<b>Subfamily Chironominae 63 species</b>		
<b>Chironomini: 25 species</b>		
<i>Baeotendipes noctivagus</i> (Kieffer, 1911)**	*	3b; 6b; 8b; 9b; 9c
<i>Chironomus</i> ( <i>Chironomus</i> ) <i>nudiventris</i> Ryser, Scholl & Wülker, 1983**	*	2; 3; 9a
<i>Ch.</i> ( <i>Chironomus</i> ) <i>valenduuki</i> , Ashe & O'Connor, 2015**	*	9b; 9c
<i>Cryptochironomus</i> ( <i>Cryptochironomus</i> ) <i>psittacinus</i> (Meigen, 1830)**	*	2b; 3; 4; 9b
<i>Crc.</i> ( <i>Crc.</i> ) <i>redeckeii</i> (Kruseman, 1933)**	*	2; 3; 9b
<i>Cryptotendipes holsatus</i> Lenz, 1959**	*	3; 4
<i>Crt. nigronitens</i> (Edwards, 1929)**	*	3; 9b
<i>Demicryptochironomus</i> ( <i>Demicryptochironomus</i> ) <i>vulneratus</i> (Zetterstedt, 1838)**	P	8b
<i>D. (Irmakia) neglectus</i> Reiss, 1988**	P	7b
<i>Dicrotendipes septemmaculatus</i> (Becker, 1908)**	*	9b
<i>Fleuria lacustris</i> Kieffer, 1924**	*	3; 9a; 9b
<i>Glyptotendipes</i> ( <i>Caulochironomus</i> ) <i>foliicola</i> Kieffer, 1918**	*	2; 3; 4; 9a; 9b
<i>G. (Cl.) imbecilis</i> (Walker, 1856)**	*	9a; 9b
<i>G. (Gl.) salinus</i> Michailova, 1987**	*	9b; 9c
<i>Nilothauma brayi</i> (Goetghebuer, 1921)**	*	4; 5; 9b
<i>Phaenopsectra punctipes</i> (Wiedemann, 1817)**	P	9b
<i>Polypedilum</i> ( <i>Cerobregma</i> ) <i>lotensis</i> Moubayed-Breil, 2007**	P	4a
<i>P. (C.) saetheri</i> Moubayed-Breil, 2007**	P	4a
<i>P. (Tripodura) moubayedbreili</i> Ashe & O'Connor, 2015**	*	8b
<i>Pseudochironomus prasinatus</i> (Staeger, 1839)**	P	4a
<i>Stenochironomus sp. 1</i> **	***	8b
<i>Stictochironomus crassiforceps</i> (Kieffer, 1921)**	*	3; 9a
<i>S. rosenscholdi</i> (Zetterstedt, 1838)**	*	9a; 9b
<i>Tribelos intextum</i> (Walker, 1856)**	P	3; 9a
<i>Zavreliella marmorata</i> (Van der Wulp, 1859)**	P	8b; 9a; 9b
<b>Tanytarsini: 38 species</b>		
<i>Constempellina brevicosta</i> (Edwards, 1937)**	P	5b; 9a
<i>C. sp. 1</i> **	***	1b; 2
<i>Micropectra attenuata</i> Reiss, 1969**	*	8a; 8b; 9a; 9b
<i>M. chionophila</i> (Edwards, 1933)**	*	5a
<i>M. clastrieri</i> Reiss, 1969**	P	10a
<i>M. nana</i> (Meigen, 1818)**	P	10a
<i>M. nohedensis</i> (Moubayed & Langton, 1996)**	P	8a
<i>M. roseiventris</i> (Kieffer, 1909)**	P	8a
<i>M. seguyi</i> Casas & Laville, 1990**	*	5a
<i>M. uliginosa</i> (Reiss, 1969)**	P	8a

CHIRONOMIDAE – LIST OF SPECIES	RECORD	DISTRIBUTION
<i>M. sp. 1</i> (springs, high altitude, SW-France, E-Pyrenees)**	***	8a
<i>M. sp. 2</i> (rhithral, high mountain stream, SW-France, E-Pyrenees)**	***	8a
<i>M. sp. 3</i> (mountain karstic springs, SW-France, E-Pyrenees)**	***	8a
<i>M. sp. 4</i> (mountain springs, SW-France, E-Pyrenees)**	***	8a
<i>M. sp. 5</i> (rhithral, high mountain stream, SW-France, E-Pyrenees)**	***	8a
<i>M. sp. 6</i> (karstic springs and streams, SE-France)**	***	9a
<i>M. sp. 7</i> (near <i>roseiventris</i> (Kieffer, 1909), S-France)	***	8a; 8b; 9a
<i>Neozavrelia bernensis</i> Reiss, 1968**	*	5a
<i>N. sp. 1</i> (karstic springs and streams, S-France)**	***	9b
<i>Paratanytarsus fontinalis</i> Moubayed-Breil & Ashe, 2015**	P	9a
<i>P. mediterraneus</i> Reiss & Säwedal, 1981**	*	9a; 9b; 9c
<i>P. navigi</i> (Goetghebuer, 1933)**	*	2; 4; 9a
<i>P. oconnori</i> Moubayed-Breil, Ashe & Langton, 2012**	P	9b; 9c
<i>P. sp. 1</i> (karstic limnocrenes, SW-France)**	***	8b; 9b
<i>P. sp. 2</i> (karstic limnocrenes, SW-France)**	***	8b
<i>Rheotanytarsus procerus</i> Reiss, 1991**	*	9c
<i>R. sp. 1</i> (potamal, S-France)**	***	9b
<i>Tanytarsus aberrans</i> Lindeberg, 1970	*	2; 3; 9a; 9b
<i>T. debilis</i> (Meigen, 1830)	P	8b; 9a; 9b; 10
<i>T. cretensis</i> Reiss, 1987**	P	9b
<i>T. excavatus</i> Edwards, 1929	*	9b; 10
<i>T. smolandicus</i> Brundin, 1947**	*	9a; 9b
<i>T. striatulus</i> Lindeberg, 1976**	*	8b; 9b
<i>T. telmaticus</i> Lindeberg, 1959**	*	2; 9b
<i>Virgatanytarsus albisutus</i> (Santos Abreu, 1918)**	*	9c
<i>V. sp. 1</i> (Karstic springs, S-France)**	***	8a
<i>V. sp. 2</i> (Karstic springs, SW-France)**	***	8a
<i>V. sp. 3</i> (irrigation channels, SE-France)**	***	9b