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# An updated checklist of the Chironomidae of Corsica with an outline of their altitudinal and geographical distribution [Diptera]

by Joël MOUBAYED-BREIL* & Patrick ASHE**

* Biodiversity, Marine and Freshwater Ecology, 10 rue des Fenouils, F - 34070 Montpellier, France
jm.aquabiol@neuf.fr Corresponding author

** 33 Shelton Drive, Terenure, Dublin 12, Ireland
patrick.ashe@upcmail.ie

Keywords: Chironomidae, Corsica, altitudinal distribution, wetlands, Tyrrhenian elements, conservation.

Investigations in Corsica enabled us to generate an updated checklist with numerous new records of Chironomidae (Diptera) based on material collected from 1968 to 1998 and recently in 2012. The material (from 42 sites) was collected in a wide range of habitats (freshwater, brackish and marine) in four altitudinal zones extending from the high mountains to the coastline. A definitive list of 368 species, with 319 named, is included in this paper which updates and complements previous data on the chironomid fauna of Corsica. This list includes 177 new records for Corsica, 7 queried species and 42 undescribed species as well as one new genus. The present study is apparently the first one which includes detailed altitudinal data (for four defined zones), extending from sea-level to the high mountains, for the chironomid fauna of a single defined geographical area. The total number of species includes Holarctic, Palaearctic, Pantropical, Afrotropical, Mediterranean, and Tyrrhenian elements. The 42 undescribed species (11.4%) consist mainly of Tyrrhenian elements most of which (32) are currently endemic to Corsica. Whether or not there are any truly endemic chironomid species present in Corsica is unproven due to insufficient knowledge from the western Mediterranean and other parts of the Tyrrhenian subregion (including adjoining islands). The low frequency, rarity and importance of these undescribed species and the high rate of endemism among other aquatic groups deserve greater recognition in Corsica, which needs a robust implemented conservation plan of action for the preservation and protection of aquatic and semi-aquatic habitats.

## Inventaire actualisé et distribution altitudinale et biogéographique des espèces de Chironomidae de Corse (Diptera)

Mots-clés : Chironomidae, Corse, distribution altitudinale, zones humides, éléments Tyrrhéniens, conservation.

Des récoltes de Diptères Chironomidae en Corse nous ont permis d'établir une liste de nouvelles citations à partir d'un matériel collecté entre 1968 et 1998, et récemment en 2012. Les sites prospectés (au nombre de 42) se répartissent altitudinalement dans quatre zones qui couvrent une large gamme d'habitats (eaux douce, saumâtre et marine) étendus depuis la haute montagne jusqu'à la côte. Une liste définitive de 368 espèces, comprenant 319 espèces valides, complémente les données antérieures sur les Chironomidae connus de Corse. Elle se compose de 177 nouvelles citations pour la Corse, 7 probables et 42 espèces nouvelles

pour la science dont un nouveau genre. La distribution altitudinale détaillée des espèces, dans 4 zones étendues entre le littoral marin et la haute montagne, constitue la première du genre qui porte sur une seule et unique aire géographique. Les espèces recensées appartiennent à des éléments connus des régions holarctique, paléarctique, afrotropicale, méditerranéenne et tyrrhénienne. Les 42 espèces non décrites correspondent principalement à des éléments tyrrhéniens (taux estimé à près de 11,4 %) dont une grande partie est endémique à la Corse. La présence encore non prouvée de Chironomidés endémiques en Corse provient de l'insuffisance des données sur l'Ouest Méditerranéen et sur les autres sous-régions tyrrhéniennes y compris les îles avoisinantes. Compte tenu de leur faible fréquence, leur rareté, leur intérêt patrimonial et leur fort taux d'endémisme par rapport à d'autres organismes aquatiques, les espèces nouvelles pour la science méritent une attention particulière et une plus grande considération en Corse. Des mesures de protection et de préservation basées sur un plan de conservation durable des habitats aquatiques et subaquatiques sont nécessaires.

# 1. Introduction

Corsica is the most mountainous island in the Mediterranean where a single chain of mountains dominates and comprises two-thirds of the island: Monte Cinto is the highest peak at 2706 m and there are several other summits of more than 2300 m. Almost the entire territory of this well preserved island includes areas in need of conservation and protection against any intervention which may detrimentally alter its unique habitats or its faunal and floral diversity. About 20 % of the island is covered by woodland mainly composed of scrubland (mattoral, at low altitude), monospecific and mixed forests (at higher altitude). The complexity of hydrographic and physiographic characteristics of catchments (with deep sinuous gorges) when combined with the semi-arid nature and extreme density of forest cover means that many aquatic habitats and wetland areas are very inaccessible and difficult to reach. In Corsica the most biogeographically important habitats (e.g. cold stenothermic streams, glacial lakes, moraines, moorland, peat bogs) are located at higher and middle altitudes. The coastline is noted for its red cliffs (some more than 600 m high), headlands, sandy and gravely beaches and wetlands areas including numerous estuaries, lagoons and coastal ponds. Corsica is usually divided into three major ecological zones based on altitude: **(1)** below 600 m, a coastal lowland characterized by dense woodlands and shrub; **(2)** 600-1800 m, a temperate mountain area which varies in elevation and exposure and supports a mixed diverse forest of oak, pine, etc.; **(3)** 1800-2700 m, a high alpine zone, includes small glaciers, glacial lakes and sparse vegetation.

According to GIUDICELLI et al. (1985), ORSINI (1986), GAGNEUR & CHAOUI-BOUDGHANE (1991), LOUNACI et al. (2000), MOUBAYED et al. (2000), MOUBAYED-BREIL & ASHE (2011), MOUBAYED-BREIL et al. (2012a), river basins located in the Mediterranean region (including islands) have in common some of the following main characteristics summarised below:

- presence of temporary springs and streams at both high and low altitude;
- short travel distance of flowing waters;
- rhithral with deep, sinuous and winding gorges;
- potamal zone moderately short and often strongly polluted;
- violent flooding in spring and autumn;
- very long period of low water levels (with drought for 3 to 6 months);
- in general, habitats of both mountain and lowland zones of rivers are deeply affected by hydrous stress (especially temporary springs and streams);

- presence of dense scrubland occurring usually in the driest areas near the coastline.

In many areas of the Mediterranean Region, vast wetlands, scrublands, forests, seascapes and landscapes are significantly altered and degraded due to human activity, development and disturbance (e.g. construction, tourism, logging, overgrazing, farming, major fires, etc.).

From both an environmental and a biogeographical point of view Corsica differs in general from other neighbouring Mediterranean areas located in southern Europe (continental France, Italian and Iberian Peninsula) by the following factors:

- accentuated Mediterranean climate;

- important flooding events during scarce storms;

- presence of deep and sinuous gorges with emergence of underground water;

- mattoral (scrubland) and arid vegetation occurring near the seacoast where exposure to wind and salt spray are frequent (especially at lower altitude) and reaches the entire island in every season;

- long dry period followed by heavy (hard) rains and storms even during the summer period;

- fewer benthic invertebrates per sample;

- presence of cold and stenothermic species at low altitude.

Corsica differs from the other Mediterranean islands by the following factors:

- its unique geomorphologic history including orogenesis of the mountain chain during the Tertiary period (Oligo-Miocene) which created the conditions of isolation and formation of habitats in the high and middle altitude zones;

- the important chain of mountains, with a line of peaks reaching over 2000 m, which extends from the north to the south of the island (separating the eastern and western provinces);

- the short distance separating the island from the continental mainland of both Italy and France;

- landscapes characterized by a local typology of basins extending from high mountain habitats to lowlands areas located near the coastline;

- a moderately long snow period which extends over 4 months per year;

- emergence of underground water in the potamal part of rivers including helocrenes and limnocrenes through the wetlands areas of the coastline;

- basins of rivers with wooded deep gorges providing favourable environmental conditions for aquatic invertebrates (shade, cold stenothermic water, enriched litter, etc.);

- coastline wetland with numerous lagoons, pools and coastal ponds directly connected to the potamal section of rivers which is well extended throughout estuaries;

- a well structured forest covering the majority of the upper and middle altitude streams providing beneficial shading and privileged refuges for aquatic habitats and niches;

- a dense scrubland biome covers a large part of the wetlands in lowland areas (including rhithral, potamal, ponds, lagoons, estuaries);

- many river basins are clustered together and separated from one another by short distances;

- the majority of rivers and streams, between their source and the estuary, flow for relatively short distances.

Corsica and Sardinia belong to the Hercynian geological formation that was fragmented during the Oligo-Miocene causing a short migration southwards of the Corsico-Sardinian microplate (ALVAREZ 1976, ORSINI et al. 1980). These two islands are separated by only 15 km and drifted away from the southern European continent (coastline of Italy, continental France and Iberian Peninsula) during the late Miocene. Despite the short distance separating Corsica from the continental mainland (only 80 km from Italy), this island is indisputably one of the most biologically diverse areas in the Mediterranean Basin where endemism is high based on both floristic and faunal community data.

According to CONTANDRIOPOULOS (1962, 1990), GAMISANS & JEANMONOD (1993), GAMISANS (1999), GAMISANS & MARZOCCH (1996), MÉDAIL & QUÉZEL (1997), MÉDAIL & VERLAQUE (1997), MÉDAIL et al. (1998) Corsica comprises 2,325 indigenous plant taxa, of which 316 are endemic or subendemic representing 39% of the mountain flora and 13.6% of the total island flora. In Sardinia, with about 2,300 indigenous plant species and subspecies, 11% of the total flora is endemic. Among aquatic mountain invertebrates GIUDICELLI (1975) reported 89 endemic species (mainly insects) based partly on data of VAILLANT (1955), CONSIGLIO (1957, 1963), ANGELIER (1959), BENAZZI (1961), BERNARDI (1961), CODREANU (1961), BERTHÉLEMY (1967). In addition, endemic mountain species belonging to specific aquatic invertebrate groups such as the Turbellaria (Tricladida), Ephemeroptera, Plecoptera, Coleoptera, Diptera (some families), represent about 49% of the known species, which is dominated by Tyrrhenian faunal elements (GIUDICELLI 1975). The high mountain streams and wetland areas in particular represent an area of high endemism for numerous plants, several aquatic insect groups and some vertebrates according to VAILLANT (1955), CONSIGLIO (1957, 1963), ANGELIER (1959), BENAZZI (1961), BERNARDI (1961), CODREANU (1961), CONTANDRIOPOULOS (1962, 1990), GIUDICELLI (1975), ILLIES & coll. (1978), BERTHÉLEMY (1979), LA GRECA (1990), CHEYLAN (1992), GAMISANS (1999), GAMISANS & JEANMONOD (1993), GAMISANS & MARZOCCH (1996), MÉDAIL & QUÉZEL (1997), MÉDAIL & VERLAQUE (1997), MÉDAIL et al. (1998), PARADIS (2011). Overall biodiversity and levels of endemism generally increase with increasing altitude (BLONDEL et al. 2010) as is found on Corsica.

In more recent decades there has been an increased interest devoted to island studies on Chironomidae, or which includes island data, in the Mediterranean, e.g. Corsica (SERRA-TOSIO & LAVILLE 1991, LAVILLE & LANGTON 2002), Sardinia and Sicily (ROSSARO 1988) and Balearic Islands (Fauna Europaea, SÆTHER & SPIES 2011) and in the eastern Atlantic, e.g. Canary Islands (MALMQVIST et al. 1993, ARMITAGE et al. 1995), Madeira (HUGHES & MURRAY 2000, MURRAY & HUGHES 2000), Azores (MURRAY et al. 2004, RAPOSEIRO et al. 2009).

LAVILLE & LANGTON (2002) compiled the previous Corsican checklist which consisted of 158 species (including 25 unnamed or undescribed species) based on material collected in 33 sites mostly rheophilic habitats located in middle and low mountain springs, streams and rivers.

Investigations in Corsica enabled us to generate a new checklist of the Chironomidae based on previously published data and on material collected between 1968 and 1998, and recently in 2012. The material was collected in a wide range of aquatic habitats located throughout the island including the high mountains, areas of intermediate and lower altitude and the coastal zone. The distribution of species is tabulated based on four altitudinal zones:

- **Zone 1** (sea level, includes brackish and marine habitats, lagoons, estuaries, lower potamal of rivers and temporary pools);

- **Zone 2** (0-500 m, coastal ponds, potamal and hyporhithral of rivers);

- **Zone 3** (500-1000 m, permanent and temporary streams, reservoirs, lakes);

- **Zone 4** (above 1000 m, springs, streams, pozzines, glacial lakes).

A checklist of 368 species is provided in this paper, which updates and complements those of SERRA-TOSIO & LAVILLE (1991) and LAVILLE & LANGTON (2002) on the chironomid fauna of Corsica. This list includes 177 named species recorded from Corsica for the first time as well as 42 unnamed or undescribed species. The list consists mainly of freshwater species encountered in zones 2 to 4 but also includes some brackish and marine species inhabiting the coastline in zone 1. The altitudinal distribution of species within Corsica is discussed and the chironomid fauna is compared with that of adjoining islands and areas (especially the Tyrrhenian faunistic province).

## 2. Material and methods

In this paper, the examined material is based on previous large collections kindly presented to the senior author by: Dr. J. Giudicelli in 1968-1979; Dr. Y. Brouquet in 1988; Dr. B. Roché in 1997 and Dr. P.P. Lenck-Santini in 1995-1996. A total of more than 300 samples, in freshwater, marine and brackish habitats, were collected by the senior author in 1995 and more recently in 2012. The period of collecting corresponds mainly to the three favourable seasons related to peaks of emergence of aquatic insects during the spring, summer and autumn. The latter material was collected using some standard methods: Surber net for the benthos (for larvae and pupae); Brundin drift nets for pharates, pupae and drifting pupal exuviae; troubleau net for individuals floating on the surface of the water; sweep net supplemented by other techniques for collecting flying imagines (e.g. light trap). In marine and brackish habitats drift nets towed behind a boat were used to collect exuviae and adults on the surface. The samples were fixed in six to eight-percent formaldehyde for later identification and analysis. Identification of species is mainly based on the male adult, male pharates and pupal exuviae but also included associated forth stage larvae encountered in the same habitats. In compiling the present checklist about 60,000 specimens (adult males, male and female pharates and immature stages) have been examined firstly on binocular microscope and partly sorted out with some selected and slide mounted for further microscopic investigation and identification. The spelling, authorship and dates of chironomid taxa in Table I for the smaller subfamilies (Buchonomyiinae to Prodiamesinae) are based on ASHE & O'CONNOR (2009), for the Orthocladiinae on ASHE & O'CONNOR (2012) and for the Chironominae on SÆTHER & SPIES (2011).

Table I. Pp 32-39. List and distribution of species in the four major altitudinal zones of Corsica. Altitude of zones: Zone 1 (marine and brackish habitats, sea level); Zone 2, below 500 m; Zone 3, between 500 and 1000 m; Zone 4, above 1000 m. P = previous record; **?** = queried record; * = new record for Corsica; ** = undescribed species. Abundance of species: (+) = rare, density less than 10 individuals; + = frequent, 10 to 30; ++ = abundant, 30 to 100; +++ = very abundant, density more than 100.

Tableau I. Pp 32-39. Liste des espèces et leur répartition dans les 4 zones altitudinales de Corse. Altitude des zones : Zone 1 (habitats marins et saumâtres, 0 m) ; Zone 2, inférieure à 500 m ; Zone 3, comprise entre 500 et 1000 m ; Zone 4, supérieure à 1000 m. P = citation antérieure ; **?** = citation probable ; * = citation nouvelle pour la Corse ; ** espèce non décrite. Abondance des espèces : (+) = rare, densité inférieure à 10 individus ; + = peu abondante, 10 à 30 ; ++ = abondante, 30 à 100 ; +++ = très abondante, densité supérieure à 100.

| List of species | Record | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| **Subfamily Buchonomyinae:** 1 genus, 1 species | | | | | |
| *Buchonomyia thienemanni* Fittkau, 1955 | P | | ++ | | |
| **Subfamily Podonominae:** 1 genus, 1 species | | | | | |
| *Paraboreochlus minutissimus* (Strobl, 1895) | P | | | (+) | ++ |
| **Subfamily Tanypodinae:** 19 genera, 37 species | | | | | |
| *Ablabesmyia* (*Ablabesmyia*) *longistyla* Fittkau, 1962 | * | (+) | | | |
| *A.* (*Ab.*) *monilis* (Linnaeus, 1758) | * | + | + | | |
| *Apsectrotanypus trifascipennis* (Zetterstedt, 1838) | * | (+) | (+) | | |
| *Arctopelopia griseipennis* (Wulp, 1859) | * | (+) | (+) | | |
| *Arctopelopia* sp. 1 (south of France, Moubayed-Breil, 2008) | ** | | (+) | | |
| *Clinotanypus* (*Clinotanypus*) *nervosus* (Meigen, 1818) | * | (+) | | | |
| *Conchapelopia hittmairorum* Michiels & Spies, 2002 | P | | + | (+) | |
| *C. pallidula* (Meigen, 1818) | P | | + | + | |
| *C. triannulata* (Goetghebuer, 1921) | * | | | (+) | (+) |
| *C. viator* (Kieffer, 1911) | P | | (+) | | |
| *Hayesomyia tripunctata* (Goetghebuer, 1922) | P | | (+) | | |
| *H.* Pe nov. (sensu Laville & Langton, 2002) | **P | | | + | |
| *Larsia atrocincta* (Goetghebuer, 1942) | P | | + | (+) | |
| *Macropelopia nebulosa* (Meigen, 1804) | * | (+) | + | + | |
| *M. notata* (Meigen, 1818) | * | | (+) | | |
| *Monopelopia tenuicalcar* (Kieffer, 1918) | P | (+) | (+) | | |
| *Natarsia puctata* (Fabricius, 1805) | P | | (+) | (+) | |
| *Nilotanypus dubius* (Meigen, 1804) | P | | + | ++ | + |
| *Paramerina cingulata* (Walker, 1856) | P | | + | ++ | |
| *P. divisa* (Walker, 1856) | * | | (+) | (+) | |
| *P.* "spec. Griechenland" (sensu Fittkau, 1962) | **P | | (+) | (+) | |
| *Procladius* (*Holotanypus*) *choreus* (Meigen, 1804) | P | ++ | ++ | ++ | + |
| *P.* (*Ht.*) *culiciformis* (Linnaeus, 1767) | * | (+) | (+) | | |
| *P.* (*Ht.*) *sagittalis* (Kieffer, 1909) | * | (+) | (+) | | + |
| *P.* (*Ht.*) *signatus* (Zetterstedt, 1850) | * | | | (+) | |
| *P.* (*Psilotanypus*) *lugens* Kieffer, 1915 | * | (+) | (+) | | |
| *Rheopelopia maculipennis* (Zetterstedt, 1838) | P | (+) | (+) | | |
| *R. ornata* (Meigen, 1838) | P | | (+) | | |
| *Tanypus* (*Tanypus*) *puctipennis* (Meigen, 1818) | * | (+) | (+) | | |
| *Telopelopia fascigera* (Verneaux, 1970) | * | (+) | (+) | | |
| *Thienemannimyia laeta* (Meigen, 1818) | P | (+) | (+) | | |
| *T. lentiginosa* (Fries, 1823) | P | (+) | (+) | | |
| *T. northumbrica* (Edwards, 1929) | * | | (+) | | |
| *T.* sp.1 | ** | | | (+) | |
| *Trissopelopia longimana* (Staeger, 1839) | P | + | + | | |
| *Zavrelimyia barbatipes* (Kieffer, 1911) | P | | | (+) | + |
| *Z. melanura* (Meigen, 1804) | * | (+) | (+) | | |
| **Subfamily Telmatogetoninae:** 2 genera, 2 species | | | | | |
| *Telmatogeton japonicus* Tokunaga, 1933 | * | (+) | | | |
| *Thalassomya frauenfeldi* Schiner, 1856 | P | + | | | |
| **Subfamily Diamesinae:** 6 genera, 21 species | | | | | |
| *Boreoheptagyia cinctipes* (Edwards, 1928) | P | | | | (+) |
| *B. dasyops* Serra-Tosio, 1989 | * | | | (+) | (+) |
| *B. legeri* (Goetghebuer, 1933) | P | | + | + | (+) |
| *B.* sp. 3 (sensu Serra-Tosio, 1989, **?** = *B. legeri* Goet., 1933) | **?** P | | + | (+) | |
| *Diamesa aberrata* Lundbeck, 1898 | * | | | | (+) |
| *D. cinerella* Meigen, 1835 | * | | | | (+) |

| List of species | Record | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| *D. insignipes* Kieffer, 1908 | * | | | + | (+) |
| *D. latitarsis* (Goetghebuer, 1921) | P | | | | ++ |
| *D. macronyx* (Kieffer, 1918) | P | | | | (+) |
| *D. tonsa* (Haliday, 1856) | P | | | + | (+) |
| *D. veletensis* Serra-Tosio, 1971 | * | | | | (+) |
| *D. zernyi* Edwards, 1933 | * | | | + | + |
| *Potthastia gaedii* (Meigen, 1838) | P | ++ | +++ | ++ | (+) |
| *P. longimanus* Kieffer, 1922 | * | | (+) | | |
| *P. montium* (Edwards, 1929) | P | | + | (+) | |
| *Pseudodiamesa (Pseudodiamesa) branickii* (Nowicki, 1873) | P | | | | ++ |
| *P. (Pd.) nivosa* (Goetghebuer, 1928) | * | | | | (+) |
| *Sympotthastia zavreli* Pagast, 1947 | * | ++ | ++ | | |
| *S.* sp. 1 | ** | | (+) | | |
| *Syndiamesa nigra* Rossaro, 1980 | * | | | | (+) |
| *S.* sp. 1 (near *edwardsi* (Pagast, 1947)) | **?** * | | | | (+) |
| **Subfamily Prodiamesinae:** 2 genera, 2 species | | | | | |
| *Odontomesa fulva* (Kieffer, 1919) | * | | | + | + |
| *Prodiamesa olivacea* (Meigen, 1818) | P | + | + | + | |
| **Subfamily Orthocladiinae:** 39 genera, 184 species | | | | | |
| *Acricotopus lucens* (Zetterstedt, 1850) | * | (+) | (+) | | |
| *Brillia bifida* (Kieffer, 1909) | P | + | +++ | + | (+) |
| *B. longifurca* Kieffer, 1921 | P | | | + | + |
| *Bryophaenocladius aestivus* (Brundin, 1947) | * | | | + | + |
| *B. flexidens* (Brundin, 1947) | * | | + | | |
| *B. illimbatus* (Edwards, 1929) | * | | | (+) | (+) |
| *B. muscicola* (Kieffer, 1906) | * | | (+) | | |
| *B. nidorum* (Edwards, 1929) | * | | | + | + |
| *B. scanicus* (Brundin, 1947) | * | | | + | + |
| *B. subvernalis* (Edwards, 1929) | * | | | + | + |
| *B. tuberculatus* (Edwards, 1929) | * | | + | | |
| *Camptocladius stercorarius* (De Geer, 1776) | * | | (+) | | |
| *Cardiocladius capucinus* (Zetterstedt, 1850) | P | + | + | | |
| *C. fuscus* Kieffer, 1924 | P | | | (+) | (+) |
| *Chaetocladius* (*Chaetocladius*) *algericus* Moubayed, 1989 | P | | | (+) | (+) |
| *C.* (*Cc.*) *laminatus* Brundin, 1947 | * | | (+) | (+) | |
| *C.* (*Cc.*) *melaleucus* (Meigen, 1818) | P | (+) | (+) | + | + |
| *C.* (*Cc.*) *perennis* (Meigen, 1830) | * | | | (+) | + |
| *C.* (*Cc.*) *suecicus* (Kieffer, 1916) | * | | | | (+) |
| *Clunio* sp. 1 (near *mediterraneus* Neumann, 1971) | ** | ++ | | | |
| *Clunio* sp. 2 | ** | + | | | |
| *Corynoneura carriana* Edwards, 1924 | P | | | | + |
| *C. celtica* Edwards, 1924 | P | (+) | + | + | |
| *C. gratias* Schlee, 1936 | P | (+) | + | | |
| *C. lacustris* Edwards, 1924 | P | | + | + | |
| *C. lobata* Edwards, 1924 | P | | + | + | (+) |
| *C. scutellata* Winnertz, 1846 | * | (+) | (+) | | |
| *C.* Pe 2a (sensu Langton, 1991) | **P | | (+) | (+) | |
| *Corynoneurella paludosa* Brundin, 1949 | P | (+) | (+) | | |
| *Cricotopus* (*Cricotopus*) *albiforceps* (Kieffer, 1916) | P | | + | + | |
| *C.* (*Cr.*) *annulator* Goetghebuer, 1927 | P | (+) | + | + | |
| *C.* (*Cr.*) *beckeri* Hirvenoja, 1973 | P | + | ++ | ++ | |
| *C.* (*Cr.*) *bicinctus* (Meigen, 1818) | P | + | ++ | | |

| List of species | Record | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| *C.* (*Cr.*) *caducus* Hirvenoja, 1973 | * | ++ | + | | |
| *C.* (*Cr.*) *curtus* Hirvenoja, 1973 | P | (+) | (+) | | |
| *C.* (*Cr.*) *ephippium* (Zetterstedt, 1838) | P | (+) | + | | |
| *C.* (*Cr.*) *levantinus occidentalis* Moubayed-Breil &Ashe, 2011 | * | | (+) | (+) | |
| *C.* (*Cr.*) *pulchripes* Verrall, 1912 | P | ++ | +++ | | |
| *C.* (*Cr.*) *similis* Goetghebuer, 1921 | P | (+) | ++ | | |
| *C.* (*Cr.*) *tremulus* (Linnaeus, 1758) | P | (+) | ++ | (+) | |
| *C.* (*Cr.*) *triannulatus* (Macquart, 1826) | * | (+) | | | |
| *C.* (*Cr.*) *trifascia* Edwards, 1929 | P | + | + | | |
| *C.* (*Cr.*) *vierriensis* Goetghebuer, 1935 | * | (+) | + | | |
| *C.* (*Isocladius*) *intersectus* (Staeger, 1839) | * | (+) | (+) | | |
| *C.* (*Is.*) *sylvestris* (Fabricius, 1794) | * | ++ | + | | |
| *C.* (*Is.*) *tricinctus* (Meigen, 1818) | * | (+) | (+) | | |
| *Eukiefferiella bedmari* Vilchez-Quero & Laville, 1987 | P | | + | + | |
| *E. brehmi* Gowin, 1943 | * | | (+) | (+) | |
| *E. brevicalcar* (Kieffer, 1911) | P | | + | ++ | ++ |
| *E. claripennis* (Lundbeck, 1898) | P | (+) | ++ | +++ | + |
| *E. clypeata* (Thienemann, 1919) | P | + | ++ | + | |
| *E. coerulescens* (Kieffer, 1926) | P | | (+) | + | (+) |
| *E. cyanea* Thienemann, 1936 | P | | + | + | (+) |
| *E. devonica* (Edwards, 1929) | P | (+) | ++ | ++ | + |
| *E. dittmari* Lehmann, 1972 | P | | + | + | |
| *E. fittkaui* Lehmann, 1972 | * | | | | (+) |
| *E. fuldensis* Lehmann, 1972 | P | | (+) | + | + |
| *E. ilkleyensis* (Edwards, 1929) | P | | + | + | + |
| *E. lobifera* Goetghebuer, 1934 | P | | | | (+) |
| *E. minor* (Edwards, 1929) | * | | | | + |
| *E. pseudomontana* Goetghebuer, 1935 | P | | + | ++ | ++ |
| *E. similis* Goetghebuer, 1939 | P | | (+) | + | ++ |
| *E. tirolensis* Goetghebuer, 1938 | P | | + | ++ | + |
| *E.* sp. 1 | ** | | | (+) | (+) |
| *E.* Pe nov. (sensu Laville & Langton, 2002) | **P | | (+) | (+) | |
| *Gymnometriocnemus* (*Gy.*) *terrestris* (Krüg., Thi. & Gowin, 1941) | * | | (+) | | |
| *Halocladius* (*Halocladius*) *mediterraneus* Hirvenoja, 1973 | * | (+) | (+) | | |
| *H.* (*Ha.*) *variabilis* (Staeger, 1839) | * | + | | | |
| *H.* (*Ha.*) *varians* (Staeger, 1839) | * | +++ | | | |
| *H.* (*Ha.*) sp. 1 (known from Madeira and continental France) | ** | +++ | | | |
| *Heleniella ornaticollis* (Edwards, 1929) | P | | | (+) | (+) |
| *H. serratosioi* Ringe, 1976 | P | | + | ++ | ++ |
| *Heterotrissocladius marcidus* (Walker, 1856) | * | | (+) | (+) | |
| *Hydrobaenus conformis* (Holmgren, 1869) | * | | (+) | | |
| *H. distylus* (Potthast, 1914) | * | | (+) | | |
| *Krenosmittia boreoalpina* (Goetghebuer, 1944) | * | | | | (+) |
| *K. camptophleps* (Edwards, 1929) | P | (+) | + | ++ | ++ |
| *K. hispanica* (Wülker, 1957) | P | | + | | |
| *Limnophyes bidumus* Sæther, 1990 | * | | | | (+) |
| *L. gelasinus* Sæther, 1990 | * | | | + | + |
| *L. gurgicola* (Edwards, 1929) | * | | | (+) | |
| *L. madeirae* Sæther, 1990 | * | | (+) | (+) | |
| *L. minimus* (Meigen, 1818) | P | | + | + | |
| *L. natalensis* (Kieffer, 1914) | * | (+) | (+) | | |

| List of species | Record | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| *L. ninae* Sæther, 1975 | P | | (+) | (+) | |
| *L. pentaplastus* (Kieffer, 1921) | P | | + | + | ++ |
| *L. pumilio* (Holmgren, 1869) | * | (+) | + | | |
| *L.* sp. 1 | ** | | | | + |
| *L.* sp. 2 (= L. sp. 3 Lebanon, Moubayed & Laville, 1983) | ** | | | (+) | |
| *L.* sp. 3 | ** | | | | (+) |
| *Metriocnemus* (*Metriocnemus*) *eurynotus* (Holmgren, 1883) | * | | | | (+) |
| *M.* (*Me.*) *fuscipes* (Meigen, 1818) | * | | | (+) | (+) |
| *M.* (*Me.*) *hirticollis* (Staeger, 1839) | * | | (+) | + | (+) |
| *Nanocladius* (*Nanocladius*) *balticus* (Palmén, 1959) | P | | + | | |
| *N.* (*Na.*) *dichromus* (Kieffer, 1906) | P | | + | | |
| *N.* (*Na.*) *parvulus* (Kieffer, 1909) | * | | + | | |
| *N.* (*Na.*) *rectinervis* (Kieffer, 1911) | P | | + | + | |
| *Orthocladius* (*Eudactylocladius*) *fuscimanus* (Kieffer, 1908) | P | | + | ++ | + |
| *O.* (*Euorthocladius*) *ashei* Soponis, 1990 | P | | +++ | +++ | + |
| *O.* (*Eo.*) *calvus* Pinder, 1985 | * | (+) | + | | |
| *O.* (*Eo.*) *luteipes* Goetghebuer, 1938 | P | | (+) | + | |
| *O.* (*Eo.*) *rivicola* Kieffer, 1911 | P | | + | + | |
| *O.* (*Eo.*) *rivulorum* Kieffer, 1909 | P | | ++ | + | + |
| *O.* (*Eo.*) *saxosus* (Tokunaga, 1939) | P | | (+) | (+) | + |
| *O.* (*Eo.*) sp. 1 | ** | | + | (+) | |
| *O.* (*Mesorthocladius*) *frigidus* (Zetterstedt, 1838) | P | | + | +++ | ++ |
| *O.* (*Mo.*) *vaillanti* Langton & Cranston, 1991 | P | | (+) | (+) | |
| *O.* (*Orthocladius*) *carlatus* (Roback, 1957) | P | | (+) | | |
| *O.* (*Or.*) *glabripennis* (Goetghebuer, 1921) | * | | ++ | (+) | |
| *O.* (*Or.*) *oblidens* (Walker, 1856) | P | | + | + | |
| *O.* (*Or.*) *pedestris* Kieffer, 1909 | P | | + | + | |
| *O.* (*Or.*) *rivinus* Potthast, 1914 | * | (+) | + | | |
| *O.* (*Or.*) *rubicundus* (Meigen, 1818) | P | | + | + | + |
| *O.* (*Or.*) sp. 1 | ** | + | (+) | (+) | |
| *O.* (*Or.*) sp. 2 | ** | | | (+) | (+) |
| *O.* (*Symposiocladius*) *lignicola* Kieffer, 1914 | P | | + | ++ | + |
| *O.* (*Sp.*) *ruffoi* Rossaro & Prato, 1991 | P | | (+) | (+) | |
| *O.* (*Sp.*) sp. 1 (known from Eastern Pyrenees) | ** | | (+) | (+) | |
| *Paracricotopus niger* (Kieffer, 1913) | P | | + | ++ | + |
| *Parakiefferiella bathophila* (Kieffer, 1912) | * | | + | (+) | |
| *P. coronata* (Edwards, 1929) | * | | (+) | (+) | |
| *Parametriocnemus boreoalpinus* Gowin & Thienemann, 1942 | * | | | (+) | (+) |
| *P. stylatus* (Spärck, 1923) | P | (+) | ++ | ++ | + |
| *P. valescurensis* Moubayed & Langton, 1999 | * | | | (+) | (+) |
| *P.* sp. 1 | ** | | | (+) | (+) |
| *Paraphaenocladius impensus impensus* (Walker, 1856) | * | | (+) | (+) | (+) |
| *P. pseudirritus* Strenzke, 1950 | * | | | (+) | (+) |
| *Paratrichocladius micans* (Kieffer, 1918) | P | (+) | ++ | + | |
| *P. osellai* Rossaro, 1990 | P | | + | + | |
| *P. rufiventris* (Meigen, 1830) | P | | + | + | |
| *P. skirwithensis* (Edwards, 1929) | * | | (+) | | |
| *P.* sp. 1 | ** | | | + | |
| *Paratrissocladius excerptus excerptus* (Walker, 1856) | P | | (+) | + | + |
| *Parorthocladius nudipennis* (Kieffer, 1908) | P | | | + | + |
| *Psectrocladius* (*Allopsectrocladius*) *obvius* (Walker, 1856) | * | | (+) | + | (+) |
| *P.* (*Al.*) *platypus* (Edwards, 1929) | * | (+) | (+) | | |

| List of species | Record | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| *P.* (*Psectrocladius*) *barbimanus* (Edwards, 1929) | * | | | + | + |
| *P.* (*Ps.*) *limbatellus* (Holmgren, 1869) | * | | + | + | + |
| *P.* (*Ps.*) *octomaculatus* Wülker, 1956 | * | | | + | |
| *P.* (*Ps.*) *oxyura* Langton, 1985 | * | | + | | |
| *P.* (*Ps.*) *sordidellus* (Zetterstedt, 1838) | * | (+) | + | | |
| *P.* (*Ps.*) sp. 1 | ** | | | | + |
| *P.* (*Ps.*) sp. 2 | ** | | | | (+) |
| *Pseudorthocladius* (*Pseudorthocladius*) *berthelemyi* Moub., 1989 | P | | | + | + |
| *P.* (*Pt.*) *curtistylus* (Goetghebuer, 1921) | * | | | + | + |
| *Pseudosmittia angusta* (Edwards, 1929) | * | | (+) | | |
| *P. danconai* (Marcuzzi, 1947) | * | | (+) | | |
| *P. gracilis* (Goetghebuer, 1913) | * | | (+) | | |
| *P. holsata* Thienemann & Stenzke, 1940 | * | | | (+) | (+) |
| *P. trilobata* (Edwards, 1929) | * | | (+) | | |
| *P.* sp. 1 | ** | (+) | (+) | | |
| *P.* sp. 2 | ** | | | (+) | (+) |
| *Rheocricotopus* (*Psilocricotopus*) *atripes* (Kieffer, 1913) | P | + | ++ | | |
| *R.* (*Pc.*) *chalybeatus chalybeatus* (Edwards, 1929) | P | | + | + | |
| *R.* (*Pc.*) *glabricollis* (Meigen, 1830) | * | | + | (+) | |
| *R.* (*Pc.*) sp. 1 | ** | | | (+) | (+) |
| *R.* (*Rheocricotopus*) *effusus* (Walker, 1856) | P | | (+) | + | + |
| *R.* (*Rh.*) *fuscipes* (Kieffer, 1909) | P | | ++ | + | |
| *R.* (*Rh.*) sp. 1 (known from eastern Pyrenees) | ** | | | (+) | (+) |
| *Smittia aterrima* (Meigen, 1818) | * | | (+) | (+) | |
| *S. foliosa* (Kieffer, 1921) | * | | (+) | (+) | |
| *S. nudipennis* (Goetghebuer, 1913) | * | | (+) | (+) | |
| *S. pratorum* (Goetghebuer, 1927) | * | | (+) | (+) | |
| *S. vesparum* (Goetghebuer, 1921) | * | (+) | (+) | | |
| *S.* sp. 1 | ** | | | | (+) |
| *S.* sp. 2 | ** | | | (+) | |
| *Symbiocladius* (*Symbiocladius*) sp. 1 | ** | | | (+) | |
| *Synorthocladius semivirens* (Kieffer, 1909) | P | + | +++ | ++ | + |
| *Thalassosmittia thalassophila* Bequaert & Goetghebuer, 1914 | * | ++ | | | |
| *Thienemannia gracilis* Kieffer, 1909 | P | | | + | + |
| *T.* sp. 1 | ** | | | | (+) |
| *Thienemanniella acuticornis* (Kieffer, 1912) | * | | | + | + |
| *T. clavicornis* (Kieffer, 1911) | * | | + | + | |
| *T. obscura* Brundin, 1947 | * | | | + | |
| *T. vittata* (Edwards, 1924) | * | ++ | ++ | (+) | |
| *T.* sp. 1 (= *T.* Pe 2a Langton, 1991 **?** = *T. majuscula* Edwards, 1924) | **?** P | + | + | | |
| *T.* sp. 2 | ** | | | + | (+) |
| *T.* Pe 3 (sensu Langton, 1991) | **P | | (+) | (+) | |
| *T.* Pe nov. (sensu Laville & Langton, 2002) | **P | | | (+) | |
| *Tvetenia bavarica* (Goetghebuer, 1934) | * | | | | (+) |
| *T. calvescens* (Edwards, 1929) | P | | ++ | +++ | + |
| *T. discoloripes* (Goetghebuer & Thienemann, 1936) | P | | (+) | (+) | |
| *T. verralli* (Edwards, 1929) | P | (+) | + | + | |
| Orthocladiinae, new genus sp. 1 | ** | | (+) | | |

| List of species | Record | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| **Subfamily Chironominae:** 28 genera, 120 species | | | | | |
| **Chironomini:** 16 genera, 56 species | | | | | |
| *Chironomus* (*Chironomus*) *annularius* Meigen, 1818 | * | (+) | (+) | | |
| *C.* (*Ch.*) *anthracinus* Zetterstedt, 1860 | * | | | + | |
| *C.* (*Ch.*) *aprilinus* Meigen, 1818 | * | ++ | | | |
| *C.* (*Ch.*) *bernensis* Kloetzli, 1973 | * | | + | | |
| *C.* (*Ch.*) *dorsalis* Andersen, 1949 (sensu Sæther & Spies, 2011) | * | + | | | |
| *C.* (*Ch.*) *luridus* Strenzke, 1959 | P | (+) | + | | |
| *C.* (*Ch.*) *piger* Strenzke, 1956 | P | | + | | |
| *C.* (*Ch.*) *plumosus* (Linnaeus, 1758) | * | (+) | + | | |
| *C.* (*Ch.*) *riparius* Meigen, 1804 | * | + | +++ | | |
| *C.* (*Ch.*) *salinarius* Kieffer, 1915 | * | + | | | |
| *C.* (*Ch.*) sp. 1 (near *longistylus* Goetghebuer, 1921) | **?** * | | | ++ | ++ |
| *Cladopelma virescens* (Meigen, 1818) | * | (+) | (+) | | |
| *Cryptochironomus rostratus* Kieffer, 1921 | P | | + | | |
| *C. supplicans* (Meigen, 1830) | * | | + | + | |
| *Dicrotendipes fusconotatus* (Kieffer, 1922) | * | (+) | (+) | | |
| *D. nervosus* (Staeger, 1839) | * | | (+) | | |
| *D. notatus* (Meigen, 1818) | * | | | (+) | (+) |
| *D. pallidicornis* (Goetghebuer, 1934) | * | | + | + | |
| *D. septemmaculatus* (Becker, 1908)] | * | | (+) | + | |
| *Endochironomus tendens* (Fabricius, 1775) | * | (+) | (+) | | |
| *Harnischia curtilamellata* (Malloch, 1915) | * | | | (+) | |
| *H. fuscimanus* Kieffer, 1921 | * | (+) | (+) | | |
| *Kiefferulus* (*Kiefferulus*) *tendipediformis* (Goetghebuer, 1921) | * | ++ | ++ | | |
| *Microchironomus tener* (Kieffer, 1918) | * | (+) | (+) | | |
| *Microtendipes britteni* (Edwards, 1929) | P | | (+) | | |
| *M. chloris* (Meigen, 1818) | P | | (+) | + | |
| *M. diffinis* (Edwards, 1929) | P | | (+) | | |
| *M. pedellus* (De Geer, 1776) | * | | + | (+) | |
| *M. rydalensis* (Edwards, 1929) | P | (+) | + | | |
| *Parachironomus frequens* (Johannsen, 1905) | * | | (+) | (+) | |
| *P. parilis* (Walker, 1856) | * | | (+) | (+) | |
| *P.* sp. 1 | ** | | | (+) | (+) |
| *Paracladopelma camptolabis* (Kieffer, 1913) | * | + | + | | |
| *P. mikianum* (Goetghebuer, 1937) | P | | (+) | (+) | |
| *P. nigritulum* (Goetghebuer, 1942) | * | (+) | (+) | | |
| *Paratendipes albimanus* (Meigen, 1818) | P | (+) | (+) | (+) | |
| *P. nudisquama* (Edwards, 1929) | * | + | + | | |
| *Phaenopsetra flavipes* (Meigen, 1818) | * | (+) | (+) | | |
| *Polypedilum* (*Pentapedilum*) *nubens* (Edwards, 1929) | P | | + | (+) | |
| *P.* (*Pe.*) *sordens* (Wulp, 1874) | P | + | + | | |
| *P.* (*Pe.*) *tritum* (Walker, 1856) | * | (+) | (+) | | |
| *P.* (*Polypedilum*) *albicorne* (Meigen, 1838) | P | | + | ++ | ++ |
| *P.* (*Po.*) *amoenum* Goetghebuer, 1930 | * | | | + | + |
| *P.* (*Po.*) *laetum* (Meigen, 1818) | P | | | (+) | (+) |
| *P.* (*Po.*) *nubeculosum* (Meigen, 1804) | * | | (+) | + | + |
| *P.* (*Po.*) *nubifer* (Skuse, 1889) | * | (+) | (+) | | |
| *P.* (*Po.*) *pedestre* (Meigen, 1830) | P | + | + | | |
| *P.* (*Tripodura*) *aegyptium* Kieffer, 1925 | * | (+) | + | | |
| *P.* (*Tr.*) *bicrenatum* Kieffer, 1921 | P | | (+) | (+) | (+) |

| List of species | Record | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| *P.* (*Tr.*) *scalaenum* (Schrank, 1803) | * | (+) | (+) | | |
| *P.* (*Tr.*) sp. 1 | ** | | (+) | | |
| *P.* (*Uresipedilum*) *convictum* (Walker, 1856) | P | + | ++ | | |
| *P.* (*Ur.*) *cultellatum* Goetghebuer, 1931 | * | | (+) | (+) | |
| *Stenochironomus* (*Stenochironomus*) *gibbus* (Fabricius, 1794) | P | (+) | (+) | | |
| *Stictochironomus maculipennis* (Meigen, 1818) | P | | (+) | (+) | |
| *S. pictulus* (Meigen, 1830) | * | | (+) | (+) | |
| **Tanytarsini:** 12 genera, 64 species | | | | | |
| *Cladotanytarsus* (*Cladotanytarsus*) *atridorsum* Kieffer, 1924 | * | | | + | + |
| *C.* (*Cl.*) *lepidocalcar* Krüger, 1938 | * | | ++ | (+) | |
| *C.* (*Cl.*) *mancus* (Walker, 1856) | * | (+) | + | | |
| *Lithotanytarsus emarginatus* (Goetghebuer, 1933) | * | | | | (+) |
| *Micropsectra apposita* (Walker, 1856) | * | | (+) | + | + |
| *M. atrofasciata* (Kieffer, 1911) | P | | (+) | | |
| *M. auvergnensis* Reiss, 1969 | * | | | | (+) |
| *M. contracta* Reiss, 1965 | * | ++ | ++ | | |
| *M. junci* (Meigen, 1818) | * | | | | + |
| *M. lindrothi* Goetghebuer, 1931 | * | | | + | + |
| *M. notescens* (Walker, 1856) | P | + | ++ | + | + |
| *M. pallidula* (Meigen, 1830) | P | | | + | + |
| *M. radialis* Goetghebuer, 1939 | P | | + | + | + |
| *M. recurvata* Goetghebuer, 1928 | * | | | (+) | |
| *M. roseiventris* (Kieffer, 1909) | * | | | | + |
| *M. schrankelae* Stur & Ekrem, 2006 | * | | + | + | |
| *M. sofiae* Stur & Ekrem, 2006 | * | | + | | |
| *M.* sp. 1 | ** | | | (+) | (+) |
| *M.* sp. 2 (near *nohedensis* (Moubayed & Langton, 1996)) | ** | | | (+) | + |
| *M.* Pe 3 (Langton, 1991; **?** = *attenuata* Reiss or *bodanica* Reiss) | **?** P | | (+) | | |
| *Neozavrelia cuneipennis* (Edwards, 1929) | * | | (+) | | |
| *N.* sp. 1 (near *fuldensis* Fittkau, 1954) | **?** * | | (+) | | |
| *N.* Pe 1 (sensu Langton, 1991) | **?** P | | (+) | | |
| *Paratanytarsus corsicanus* Moubayed-Breil, Ashe & Langton, 2012 | P | | | (+) | (+) |
| *P. dissimilis* (Johannsen, 1905) | * | (+) | + | | |
| *P. inopertus* (Walker, 1856) | * | | (+) | | |
| *P. laetipes* (Zetterstedt, 1850) | * | (+) | (+) | | |
| *Rheotanytarsus curtistylus* (Goetghebuer, 1921) | P | | + | (+) | |
| *R. dactylophoreus* Moubayed-Breil, Langton & Ashe, 2012 | P | | (+) | + | + |
| *R. distinctissimus* (Brundin, 1947) | P | | (+) | + | |
| *R. muscicola* Thienemann, 1929 | * | (+) | (+) | | |
| *R. nigricauda* Fittkau, 1960 | P | | + | | |
| *R. pentapoda* (Kieffer, 1909) | P | (+) | + | | |
| *R. reissi* Lehmann, 1970 | P | | (+) | (+) | |
| *R. rhenanus* Klink, 1983 | P | | (+) | | |
| *R. ringei* Lehmann, 1970 | P | | (+) | | |
| *R.* sp. 1 | ** | | | (+) | (+) |
| *Stempellina bausei* (Kieffer, 1911) | P | (+) | (+) | (+) | |
| *Stempellinella brevis* (Edwards, 1929) | P | | + | + | + |
| *S. flavidula* (Edwards, 1929) | P | | + | + | + |
| *Tanytarsus bathophilus* Kieffer, 1911 | * | | (+) | ++ | +++ |
| *T. brundini* Lindeberg, 1963 | P | (+) | (+) | | |
| *T. chinyensis* Goetghebuer, 1934 | * | (+) | + | (+) | |
| *T. debilis* (Meigen, 1830) | * | + | (+) | | |

| List of species | Record | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
|---|---|---|---|---|---|
| *T. ejuncidus* (Walker, 1856) | * | + | (+) | | |
| *T. eminulus* (Walker, 1856) | P | | + | + | + |
| *T. formosanus* Kieffer, 1912 | * | + | | | |
| *T. gregarius* Kieffer, 1909 | * | | (+) | (+) | (+) |
| *T. heusdensis* Goetghebuer, 1923 | P | | + | + | + |
| *T. longitarsis* Kieffer, 1911 | * | (+) | (+) | | |
| *T. medius* Reiss & Fittkau, 1971 | * | (+) | (+) | | |
| *T. mendax* Kieffer, 1925 | * | + | + | | |
| *T. occultus* Brundin, 1949 | * | | (+) | | |
| *T. pallidicornis* (Walker, 1856) | * | | (+) | (+) | |
| *T. recurvatus* Brundin, 1947 | * | | | + | |
| *T. signatus* (Wulp, 1859) | * | | | (+) | |
| *T. usmaensis* Pagast, 1931 | P | | (+) | (+) | |
| *T.* sp. 1 | ** | (+) | (+) | | |
| *Virgatanytarsus arduennensis* (Goetghebuer, 1922) | P | | + | + | + |
| *V. triangularis* (Goetghebuer, 1928) | P | (+) | (+) | (+) | |
| *V.* sp. 1 (= sp. 1, France, Moubayed, 2008) | ** | | | (+) | |
| *V.* sp. 2 | ** | | (+) | | |
| *Zavrelia pentatoma* Kieffer & Bause, 1913 | * | (+) | + | + | + |
| *Zavreliella marmorata* (Wulp, 1859) | * | (+) | (+) | | |

Total genera = 98; Total species = 368, including 177 new records (*) and 42 undescribed species (**)

# 3. Prospected sites

The present investigation was carried out on 42 sites throughout Corsica which includes a wide range of habitats, i.e. springs (helocrenes and limnocrenes), temporary and permanent streams and pools, lakes and reservoirs, rhithral, potamal and estuaries of rivers, lagoons, coastal ponds and swamps. The 42 sampled sites are located in the four major physiographic and biogeographic zones delimited by altitude (Fig. 1) and defined as follows:

**- Zone 1**. Sea level including lagoons, sea shores (rocky shores and beaches), coastal ponds, temporary pools, helocrenes and limnocrenes and estuaries which consist of three subzones: (a) marine littoral zone (salinity = 34-35 g/L); (b) brackish habitats (salinity between 3 and 5 g/L); (c) lower part of the potamal of rivers (salinity < 1 g/L);

**- Zone 2**. Below 500 m, including: habitats located in rivers (potamal, rhithral, reservoirs), permanent and temporary streams, springs and pools at low altitude, coastal swamps and ponds;

**- Zone 3**. Between 500 and 1000 m, including: permanent and temporary streams, waterfalls, lakes, reservoirs;

**- Zone 4**. Over 1000 m, including habitats at high altitude: glacial lakes, springs, streams, waterfalls, pools, pozzines (acidic mountain bogs and pools), reservoirs.


Figure 1. The four major physiographic and altitudinal zones of Corsica. Zone 1, sea level, coastal marine and brackish habitats; Zone 2, altitude below 500 m; Zone 3, 500 to 1000 m; Zone 4, above 1000 m.

Figure 1. Représentation altitudinale des quatre zones physiographiques majeures de Corse. Zone 1, habitats côtiers, marins et saumâtres ; Zone 2, altitude inférieure à 500 m ; Zone 3, altitude comprise entre 500 et 1000 m ; Zone 4, altitude supérieure à 1000 m.

**Location and characteristics of sites, from north to south:**

**1,** Luri & Alessandro streams: seashore, estuaries, potamal, rhithral at Castiglione & Piazza (0-100 m);

**2,** Pietracorbara stream, near Cap Corse: seashore, estuary, potamal, rhithral at Pietracorbara (0-300 m);

**3,** Ostriconi stream: seashore, estuary, lagoons, pools, potamal, limnocrenes at Ogliastro (coastline area, 0-50 m);

**4,** Lozari and Regino rivers: seashore, estuaries, potamal, pools, lagoons, limnocrenes at Lozari (coastline area);

**5,** Griggione, Miomo and Poretto streams, north of Bastia: seashore, estuaries, potamal, rhithral, helocrenes (0-300 m);

**6,** Marsolino River Basin: potamal, rhithral, pools, helocrenes (10-250 m);

**7,** Biguglia Natural Reserve (coastline area): pond, stream, swamps, pools, seashore and estuary, south of Bastia;

**8**, Fium Alto stream: rhithral at Taglio-Isolaccio (40-60 m);

**9,** Tavignano River: rhithral, Sainte Lucie (450 m);

**10**, Tavignano River: downstream and pools (50 m);

**11**, Tavignano River: potamal, pools (30-60 m);

**12,** Tavignano River Basin: coastal wetland and ponds at Aléria (0-10 m);

**13,** Fium'Orbo and Regolo streams: rhithral at Ghisoni (650 m) and Prunelli-di-Fium'Orbo (450 m);

**14**, Fium'Orbo: estuary, potamal and surrounding coastal ponds and pools at Ghisonaccia (0-20 m);

**15**, Solenzara River: potamal, pools at Solenzara (0-430 m); upstream at Col de Bavella (1200 m);

**16,** Taravo River (upper basin): rhithral, waterfall and helocrenes at Col de Verde (1300-1500 m);

**17,** Taravo River: springs, rhithral and pozzines (acidic mountain bogs and pools) at Zicavo, (750 m);

**18**, Travo River: spring, rhithral, waterfall and helocrenes near Chisa (600-650 m);

**19**, Restonica River (upper basin): springs, waterfall and ruisselets (altitude 1900 m);

**20**, Restonica River (upper basin): upstream areas, moraines and the outflow of the glacial Capitellu Lake, the deepest glacial lake in Corsica (42 m maximum depth, altitude 1930 m);

**21**, Restonica River (upper basin): upstream areas, moraines and the inflow and outflow of the glacial Melu Lake (1710-1750 m);

**22**, Restonica River: upstream and gorges (1100-1800 m);

**23**, Restonica River: rhithral at Corte (430 m);

**24,** Restonica River: middle and downstream of the Restonica River (200-350 m);

**25**, Golo River (upper basin): pozzines (acidic mountain bogs and pools), moraines, moorland, helocrenes, rhithral, inflow and outflow of the glacial Ninu Lake (1700-1900 m);

**26,** Golo River (upper basin): upstream and tributaries at Vergio (850-1650 m);

**27**, Golo River: outflow and inflow of Calacuccia Lake (790-800 m);

**28**, Golo River, at Prunelli-di-Casacconi: rhithral, waterfall (820-850 m);

**29**, Fango River (down basin): potamal, coastal ponds, pools, limnocrenes, estuary at Galéria (0-15 m);

**30,** Fango River (upper basin): upper stream areas (rhithral, helocrenes) of Montestremo, Canne, Cavicchia, Tassi and Force streams at Manso (300-1700 m);

**31**, Scandola Natural Reserve: seashore and cliffs, Elbo stream, pools, helocrenes, estuary (0-10 m);

**32,** Taoulade stream: potamal, pools, reservoir, rhithral, helocrenes, estuary at Galéria (0-250 m);

**33**, Bussaglia stream: rhithral, upstream and helocrenes at Serriera (200-520 m);

**34**, Bussaglia stream: potamal, pools, helocrenes, seashore and estuary at Bussaglia (0-20 m);

**35**, Porto River: seashore, estuary, potamal, pools at Porto (0-20 m); rhithral (50-150 m);

**36,** Prunelli River (upper basin): springs, waterfall and rhithral (800-1300 m);

**37,** Prunelli River basin: Tolla Lake (700-725 m);

**38**, Gravona River basin: potamal, swamp and estuary at Ajaccio (coastline areas);

**39**, Rizzanese River: springs, rhithral at Zonza (700-800 m);

**40,** Rizzanese River: springs, rhithral and pools at Quenza (700-800 m);

**41,** Fiumicicoli stream, a tributary of the Rizzanese River: rhithral at Sainte Lucie de Tallano (450 m);

**42,** Stabiacco and Piscia streams: potamal, rhithral, at Porto-Vecchio (10-100 m).

Mean value of conductivity (Cd) in the water surface within the four zones is as follows:

- Zone 1, connected subzone between the estuary and potamal section of rivers, Cd = 120-140 µS/cm;

- Zone 2, potamal and hyporhithral, 80-90 µS/cm;

- Zone 3, metarhithral section of cold streams, Cd = 40-60 µS/cm;

- Zone 4 (high altitude aquatic habitats), epirhithral section, springs, pozzines, ruisselets, Cd = 30-40 µS/cm. Highest conductivity value (Cd = 180-190 µS/cm) were recorded in some sites associated with emergence of underground water.

Undersampled areas are mainly located in high mountain streams and lakes (zone 4) but also in low and middle stream and river basins (zones 1 and 2) located in the north at Cap Corse and in the south around Porto-Vecchio, Propriano, Sartène and Bonifacio.

## 4. Faunal results and remarks

The status of some of the 25 unidentified or unnamed chironomid species listed in LAVILLE & LANGTON (2002) has now become cleared and it was important to resolve all these problems before deciding which of these names to include or exclude from Table I. This was a necessary task in order to produce a definitive checklist and an accurate total of the number of Corsican species. The form of each name below is the same as given in table 4 of LAVILLE & LANGTON (2002).

(**1**) *Conchapelopia* Pe 1 Langton 91. This pupal morphotype is now identifiable as *Conchapelopia hittmairorum* Michiels & Spies.

(**2**) *Hayesomyia* Pe nov. This pupal morphotype was figured in LAVILLE & LANGTON (2002: 62, figs 2a-c). It does not match any of the other Tanypodinae pupal exuviae so far known from Corsica and it therefore included as a separate distinct taxon in Table I.

(**3**) *Paramerina* spec. Griechenland Fittkau. The distinctive pupal morphotype is widespread in the Mediterranean region but the adult male is not described. Included in Table I.

(**4**) *Thienemannimyia laeta*/*lentiginosa*. LAVILLE & LANGTON (2002) were not able to identify the pupal exuviae to species but both species are now known from Corsica.

(**5**) *Boreoheptagyia* sp. 3 Serra-Tosio. The larva was described and keyed out separately in SERRA-TOSIO (1989) but it appears to be closely related to or may be identical to *B. legeri* (Goethghebuer). Further investigation of the range of intraspecific variation in the larvae of *B. legeri* will resolve whether or not the two are synonymous. Included as a valid taxon in Table I.

(**6**) *Corynoneura* Pe 2a Langton 91. This morphotype was described in LANGTON (1991) but its specific identity has not been established. Included in Table I as a separate taxon.

(**7**) *Eukiefferiella minor*/*fittkaui*. LAVILLE & LANGTON (2002) were not able to identify the pupal exuviae to species but both species are now known from Corsica.

(**8**) *Eukiefferiella* Pe nov. The pupal exuviae, with only one large anal macroseta on each lobe, was figured in LAVILLE & LANGTON (2002: 63, figs 3b, c). The pupal exuviae of "*E.* Pe nov." is not the same as *Eukiefferiella* sp. 1 and both are listed in Table I.

(**9**) *Limnophyes* sp. This pupal type is not described or associated with any morphotype in LANGTON (1991). It is therefore not possible to say whether or not this species is identical with any of the other twelve Corsican *Limnophyes* species listed in Table I. Since its status cannot be resolved it is excluded from Table I.

(**10**) *Orthocladius* (*s. str.*) cf. *carlatus*. In LAVILLE & LANGTON (2002) the identification of this species was uncertain but the occurrence of *O.* (*Or.*) *carlatus* (Roback) in Corsica is confirmed.

(**11**) *Parametriocnemus* Pe 1 Langton 91. In the remarks on *P. valescurensis* in MOUBAYED & LANGTON (1999) it states that it resembles the pupal exuviae of *P.* Pe 1 as described in LANGTON (1991). Based on new data we can confirm that the two pupal types are identical. *Parametriocnemus* sp. 1 in Table I is an undescribed species.

(**12**) *Thienemanniella* Pe 2a Langton 91. In LANGTON & VISSER (2003) this pupal morphotype is queried as possibly being the species *T. majuscula* (Edwards). Included as a separate taxon in Table I under the name *Thienemanniella* sp. 1.

(**13**) *Thienemanniella* Pe 2b Langton 91. In LANGTON & VISSER (2003) this pupal morphotype is identified as belonging to either *T. clavicornis* (Kieffer), *T. flavescens* (Edwards) or *T. obscura* Brundin. Since *T. clavicornis* is now known from Corsica we treat "*T.* Pe 2b Langton 91" in Table I as a tentative queried synonym of the former.

(**14**) *Thienemanniella* Pe 3 Langton 91. There is no morphotype "*T.* Pe 3" described in LANGTON (1991) but this morphotype is mentioned in LANGTON & VISSER (2003) based on three specimens collected and donated by Laville and Casas, but no locality or reference for these specimens is cited. This morphotype is included in Table I as a separate taxon.

(**15**) *Thienemanniella* Pe 4 Langton 91. In LANGTON & VISSER (2003) there is a comment that "*T.* Pe 4" keys out in the genus *Corynoneurella*. This genus has only one described European species, *C. paludosa* Brundin, which is known from Corsica. In addition, we treat "*T.* Pe 4" as a tentative synonym of the former because the single specimen of "*T.* Pe 4" was found at the same site as 23 specimens of *C. paludosa* (LAVILLE & LANGTON 2002, table 4).

(**16**) *Thienemanniella* Pe nov. This pupal type was figured in LAVILLE & LANGTON (2002: 63, fig. 3a). It does not match any of the other known Corsican *Thienemanniella* species and is therefore included in Table I.

(**17**) *Chironomus* (*s. str.*) ? *riparius* Mg. In LAVILLE & LANGTON (2002) the identification of this species was queried but its occurrence in Corsica is now confirmed.

(**18**) *Phaenopsectra* Pe 1 Langton 91. In LANGTON & VISSER (2003) the morphotype *Phaenopsectra* Pe 1 in LANGTON (1991) has been identified as *P. flavipes* (Meigen, 1818).

(**19**) *Polypedilum* Pe nov. Its placement in LAVILLE & LANGTON (2002, table 4) indicates that it belongs in the subgenus *Polypedilum*. It was not described or associated with any morphotype in LANGTON (1991) and its identity cannot be established. It is therefore excluded from Table I.

(**20**) *Polypedilum* ? *convictum* var. This taxon of the subgenus *Uresipedilum* was not described or associated with any morphotype in LANGTON (1991) and its identity is unknown. Since its status cannot be resolved it is excluded from Table I.

(**21**) *Micropsectra* Pe 3 Langton 91. The morphotype *Micropsectra* Pe 3 described in LANGTON (1991) has been identified in LANGTON & VISSER (2003) as belonging to either *M. attenuata* Reiss or *M. bodanica* Reiss neither of which is known from Corsica. The pupal exuviae of *Mi-*

*cropsectra* Pe 3 Langton 91 do not match any of the other known Corsican *Micropsectra* species and is therefore included in Table I.

(**22**) *Neozavelia* Pe 1 Langton 91. In LANGTON & VISSER (2003) the morphotype "*N.* Pe 1" of LANGTON (1991) has been identified as belonging to one of four species: *N. bernensis* Reiss, *N. fuldensis* Fittkau, *N. improvisa* Fittkau or *N. luteola* Goetghebuer. Included in Table I. The pupal exuviae of *Neozavelia* Pe 1 Langton 91 is not the same species as *Neozavelia* sp. 1 (near *fuldensis* Fittkau, 1954) in Table I.

(**23**) *Rheotanytarsus* sp A n. sp. This taxon has recently been described as a new species, *R. dactylophoreus* Moubayed-Breil, Langton & Ashe (MOUBAYED-BREIL et al. 2012c).

(**24**) *Rheotanytarsus* Pe 1 nov. It was not described or associated with any morphotype in LANGTON (1991) and its identity cannot be established. It is therefore excluded from Table I.

(**25**) *Virgatanytarsus* Pe 1 Langton 91. The morphotype *Virgatanytarsus* Pe 1 described in LANGTON (1991) is queried in LANGTON & VISSER (2003) as possibly belonging to one of three species: *V. albisutus* (Santos-Abreu), *V. arduennensis* (Goetghebuer) or *V. triangularis* (Goetghebuer). Since both *V. arduennensis* and *V. triangularis* are already known from Corsica it is likely that "*V.* Pe 1" is identical to one of these species. Excluded from Table I.

The new inventory of the Chironomidae of Corsica confirms the presence of 368 species belonging to 98 genera (Table I). The list includes 177 new records for Corsica, 7 queried species and 42 undescribed species (one of which belongs to an undescribed orthoclad genus). The figure of 368 species includes 319 valid named species based on compiled data of 142 previously known named species: from EDWARDS (1928), VAILLANT (1955), ANGELIER (1959), SERRA-TOSIO & LAVILLE (1991) and LAVILLE & LANGTON (2002), combined with the listed 177 new records given in the current paper. Two of the listed species in Table I have recently been described based on Corsican material from 1997: *Paratanytarsus corsicanus* (MOUBAYED-BREIL et al. 2012b) is only known from Corsica and *Rheotanytarsus dactylophoreus* (MOUBAYED-BREIL et al. 2012c) is a pyreneocorsican species.

The total diversity of the chironomid fauna of Corsica, compared to those listed from other neighbouring areas, is based on numbers extracted from published sources including the last version of chironomid data in Fauna Europaea (SÆTHER & SPIES 2011). The figure of 368 from Corsica represents almost 52-53% of the 700-710 species recorded in continental France (SERRA-TOSIO & LAVILLE 1991, LAVILLE & SERRA-TOSIO 1996, MOUBAYED et al. 2000, DELETTRE 2001, MOUBAYED-BREIL 2008) but about 68% of the total species (528) reported from Italy (ROSSARO 1988, FERRARESE 1993, PASINI & FERRARESE 1998, SÆTHER & SPIES 2011) and about 10% more than the circa 330 known from Morocco (AZZOUZI et al. 1992, KETTANI et al. 2001).

## 5. Altitudinal distribution and ecology

The immature stages of Chironomidae occur in almost every conceivable type of freshwater habitat from the tropics to the polar regions and from coastal brackish and marine habitats (down to 30 metres) to high altitude snow fields and glaciers (over 5,000 metres). The majority of species are associated with aquatic, semi-aquatic or moist habitats but terrestrial and fully marine species are commonly found. Habitats include flowing water (e.g. cold and hot springs, underground water, glacial meltwater, waterfalls, thin water films on vertical surfaces, trickles, brooks, streams, rivers); standing water (e.g. glacial and non-glacial lakes, reservoirs, saline

lakes, ponds, pools, bogs, temporary water bodies, phytotelmata – plant held water), marine habitats (littoral zone and coastal areas down to 30 metres, brackish water in estuaries, lagoons and pounds) and terrestrial habitats (woodland, tillage and grassland soils rich in organic matter, rotting wood, fungi, cow dung). In freshwater aquatic systems (rivers, lakes, etc.), chironomids frequently dominate the ecosystem in both total animal diversity (often 50 to 70% or more of all the species) and total animal biomass (often 50 to 70% or more) (ASHE & O'CONNOR 2012: 13). The high productivity and ubiquitous occurrence of chironomids means that they are of major importance as a food source for a wide range of aquatic and terrestrial predators including small and large invertebrates (crustaceans, spiders, other insects, etc.) and vertebrates (fish, birds, bats, etc.).

The present study is apparently the first time that detailed altitudinal data, extending from at sea-level to the high mountains, has been investigated for the chironomid fauna of a single defined geographical area. The distribution of all species and the altitudinal zone in which they are found is detailed in Table I. The ratio (**genera:species**) by subfamily of the listed 98 genera and 368 species (in Table I-II) is as follows:- Buchonomyinae (**1:1**), Podonominae (**1:1**), Tanypodinae (**19:37**), Telmatogetoninae (**2:2**), Diamesinae (**6:21**), Prodiamesinae (**2:2**), Orthocladiinae (**39:184**) and Chironominae (**28:120**) with the two tribes of the latter subfamily represented by the Chironomini (**16:56**) and Tanytarsini (**12:64**).

Table II summarizes chironomid distribution data giving the number and percentage of species found for each subfamily (and for all subfamilies combined) for each zone. The current data for the smaller subfamilies shows that Buchonomyinae are restricted to zone 2, the Podonominae to zones 3 and 4, the Telmatogetoninae (being primarily marine) to zone 1 while the Prodiamesinae occur in all four zones. For the remaining subfamilies the most interesting figures are the percentages. Based on percentage the Tanypodinae and Chironominae are most diverse in Zones 1 and 2 but decline with increasing altitude from zones 3 to 4. The Diamesinae, as expected, show a significant increase in diversity with increasing altitude. The Orthocladiinae in general show an increase in percentage diversity with altitude and the figures for zones 3 and 4 are the same but are likely to be higher with more intensive sampling in zone 4. The Chironominae show a decline with increasing altitude but when the two tribes are separated the percentages are quite different. The Chironomini show a significant decline with increasing altitude from zone 1 to 4 while in the Tanytarsini the percentages are comparable for all four zones though greater sampling in zone 4 is likely to produce a higher figure for the latter tribe (which includes many cool-adapted species). The variation in altitudinal distribution and percentage representation of the different subfamilies in Corsica is in line with expectations and "is a reflection of the adaptations of the major subfamilies to prevailing environmental conditions (oxygen concentration, water temperature, climate, altitude, current speed in flowing water, etc.)" (ASHE et al. 1987: 55).

The highest species richness is recorded in zone 2 (258 species, 70.1%) and zone 3 (199 species, 54.5%) where aquatic habitats are located respectively below 500 m (zone 2) and between 500 and 1000 m (zone 3) (Table II). These two zones include the potamal and hyporhithral sections of streams and rivers which are mostly surrounded by dense scrubland extending from the foothills to the inflow of estuaries. The lowest diversity of species is encountered in the coastal area (zone 1: 120 species, 32.6%) and the high mountain area (zone 4: 131 species, 35.6%). The lower number of species in coastal areas (zone 1) is partly related to reduced ecological quality of habitats which have been mainly altered by human activities and pollution. Diversity in the high mountains (zone 4) is lower than expected which is mostly related to a combination of

poorly explored areas, more limited knowledge on the chironomid fauna of high altitude wetlands, the lower number of sites investigated and the difficulty of accessing different areas. The altitudinal, typological and ecological zonation of Chironomidae in Corsica could be used as a model for other similar studies.

| **Subfamilies of Chironomidae (98 genera: 368 species)** | **Zone 1** | **Zone 2** | **Zone 3** | **Zone 4** |
|---|---|---|---|---|
| Buchonomyinae (**1:1**) | | **1** (0.4%) | | |
| Podonominae (**1:1**) | | | **1** (0.5%) | **1** (0.8%) |
| Tanypodinae (**19:37**) | **18** (15.0%) | **30** (11.6%) | **15** (7.5%) | **5** (3.8%) |
| Telmatogetoninae (**2:2**) | **2** (1.7%) | | | |
| Diamesinae (**6:21**) | **2** (1.7%) | **7** (2.7%) | **8** (4.0%) | **16** (12.2%) |
| Prodiamesinae (**2:2**) | **1** (0.8%) | **1** (0.4%) | **2** (1.0%) | **1** (0.8%) |
| Orthocladiinae (**39:184**) | **50** (41.7%) | **125** (48.4%) | **117** (58.8%) | **77** (58.8%) |
| Chironominae (**28:120**) | **47** (39.2%) | **94** (36.4%) | **56** (28.1%) | **31** (23.7%) |
| Total Number of species | **120** | **258** | **199** | **131** |
| Total Percentage (%) | **100%** | **100%** | **100%** | **100%** |
| | | | | |
| [ Chironominae-Chironomini (16:56) ] | 27 (22.5%) | 46 (17.8%) | 23 (11.6%) | 8 (6.1%) |
| [ Chironominae-Tanytarsini (12:64) ] | 20 (16.7%) | 48 (18.6%) | 33 (16.5%) | 23 (17.6%) |

| Number of species | **120** | **258** | **199** | **131** |
|---|---|---|---|---|
| Percentage (%) of 368 | 32.6% | 70.1% | 54.5% | 35.6% |

| Undescribed species (** = 42) | **6** | **16** | **28** | **19** |
|---|---|---|---|---|
| Percentage (%) of 368 | 1.6% | 4.3% | 7.6% | 5.2% |

Table II. Distribution of subfamilies and species (number and percentage) of Chironomidae in the four altitudinal zones of Corsica.

Tableau II. Répartition des Chironomidae par sous-familles et espèces (nombre et pourcentage) dans les quatre zones altitudinales en Corse.

Cold stenothermic and crenophilous species are mostly confined to middle and high mountain areas where habitats are characterized by: (a) supplies of cold water from glaciers; (b) the long period of snow melt; (c) presence of glacial lakes, helocrenes, pozzines and ruisselets; and (d) rhithral with deep and winding gorges (maintaining low variation of temperature and beneficial fresh environmental characteristics). Associated species encountered in these two zones mainly belong to crenobiontic forms (Diamesinae and crenophilous orthoclads) restricted to the spring area: *Boreoheptagyia cinctipes, Diamesa aberrata, D. latitarsis, D. macronyx, Pseudodiamesa* (*Pd.*) *branickii, P.* (*Pd.*) *nivosa, Chaetocladius* (*Cc.*) *laminatus, C.* (*Cc.*) *suecicus, Parametriocnemus boreoalpinus, Lithotanytarsus emarginatus, Micropsectra recurvata, M. roseiventris, M.* sp. 1 and *M.* sp. 2.

Interstitial, hygropetric and madicolous species occur in some streams with helocrenes where there is emergence of underground water, e.g. *Arctopelopia griseipennis, A.* sp. 1, *Bryophaenocladius aestivus, B. muscicola, B. nidorum, B. subvernalis, Heleniella ornaticollis, Krenosmittia camptophleps, K. hispanica, K. boreoalpina, Orthocladius* (*Mo.*) *frigidus, Parametriocnemus*

*boreoalpinus, Paraphaenocladius impensus impensus, Rheocricotopus* (*Rh.*) *effusus, R.* (*Pc.*) sp. 1, *Thienemannia gracilis* and *T.* sp. 1.

Thermophilous species are mainly reported from exposed habitats generally affected by hydrous stress such as those located near the coastline in lowland streams and wetland areas: estuaries, lagoons, pools, coastal ponds and the potamal of rivers (zones 1 and 2). Associated species in these areas are: *Ablabesmyia* (*Ab.*) *longistyla, A.* (*Ab.*) *monilis, Procladius* (*Ht.*) *choreus, Potthastia gaedii, Sympotthastia zavreli, Brillia bifida, Corynoneura celtica, C. gratias, C. lacustris, Cricotopus* (*Cr.*) *bicinctus, C.* (*Cr.*) *trifascia, C.* (*Cr.*) *vierriensis, C.* (*Is.*) *sylvestris, C.* (*Is.*) *trianulatus, Eukiefferiella claripennis, E. clypeata, Halocladius* (*Ha.*) *varians, Chironomus* (*Ch.*) *riparius, C.* (*Ch.*) *salinarius, Micropsectra pallidula, Paratanytarsus dissimilis, P. inopertus, Tanytarsus ejuncidus, T. gregarius* and *Virgatanytarsus arduennensis.*

Marine and brackish species occur in habitats of zone 1 located around the coastline and extended to the seashore (salinity between 3 and 35 g/L) and to lagoons and tidal sections of river estuaries which receive freshwater input (salinity < 500 mg/L). Species encountered in these habitats which are strictly marine or halobiontic include: *Telmatogeton japonicus, Thalassomya frauenfeldi, Halocladius* (*Ha.*) *mediterraneus, H.* (*Ha.*) *varians, H.* (*Ha.*) *variabilis, Clunio* sp. 1, *C.* sp. 2, *Thalassosmittia thalassophila, Chironomus* (*Ch.*) *salinarius* and *Tanytarsus formosanus*. However, other species (found also in freshwater) which occur here, that are tolerant of low to moderate saline conditions, include: *Cricotopus* (*Cr.*) *caducus, C.* (*Cr.*) *pulchripes, C.* (*Cr.*) *trifascia, C.* (*Is.*) *sylvestris, Chironomus* (*Ch.*) *aprilinus, Micropsectra contracta, M. pallidula* and *Paratanytarsus dissimilis.*

Species recorded from lakes, ponds and reservoirs at low, middle or high altitude include: *Apsectrotanypus trifascipennis, Psectrocladius* (*Ps.*) *barbimanus, P.* (*Ps.*) sp. 1, *P.* (*Ps.*) sp. 2, *Paratanytarsus corsicanus, Stempellina bausei, Tanytarsus bathophilus, T. gregarius, T. signatus* and *Zavrelia pentatoma.*

Abundance of species is detailed in Table I: (+) = rare (density is less than 10 individuals); + = frequent (10 to 30 individuals); ++ = abundant (30 to 100 individuals); +++ = very abundant (greater than 100 individuals). The most abundant species in Zone 1 include: - *Clunio* sp. 1, *Cricotopus* (*Cr.*) *caducus, C.* (*Is.*) *sylvestris, Halocladius* (*Ha.*) *varians, H.* (*Ha.*) sp. 1, *Thalassosmittia thalassophila, Chironomus* (*Ch.*) *aprilinus, C.* (*Ch.*) *salinus, Tanytatsus ejuncidus* and *T. gregarius*; in Zone 2 include: - *Buchonomyia thienemanni, Potthastia gaedii, Brillia bifida, Cricotopus* (*Cr.*) *pulchripes, Orthocladius* (*Eo.*) *ashei, Synorthocladius semivirens* and *Chironomus* (*Ch.*) *riparius*; in Zone 3 include: - *Nilotanypus dubius, Paramerina cingulata, Eukiefferiella claripennis, Orthocladius* (*Eo.*) *ashei, O.* (*Mo.*) *frigidus* and *Tvetenia calvescens,* and in Zone 4 include: - *Chaetocladius melaleucus, C. perennis, Paraboreochlus minutissimus, Diamesa latitarsis, Pseudodiamesa* (*Pd.*) *nivosa, Eukiefferiella similis, Limnophyes pentaplastus* and *Tanytarsus bathophilus.*

## 6. Chironomidae of some islands

Islands in the Mediterranean and the eastern Atlantic represent an ideal area for zoogeographical investigation and comparison because the majority of chironomid species which exist are described and the ecology and immature stages of a significant proportion are known. Our understanding of diversity on some of the islands has greatly progressed during the last few decades to the point that on some of them 70 to 80% of the chironomid species which exist are

known and listed. This is especially true of the fauna of some eastern Atlantic islands (e.g. Azores, Canary Islands, Madeira) which are quite well investigated (MALMQVIST et al. 1993, ARMITAGE et al. 1995, NILSSON et al. 1998; HUGHES & MURRAY 2000, MURRAY & HUGHES 2000, MURRAY et al. 2004, RAPOSEIRO et al. 2009) but have a more restricted fauna due in part to their isolation, small surface area and less diverse habitats. Chironomidae from Corsica's neighbouring islands (i.e. Sardinia, Sicily, Balearics) located in the western Mediterranean are still little known due to insufficient investigation of freshwater, marine, brackish and terrestrial habitats.

We summarize the known chironomid fauna of these islands (Table III) based on data in the literature and in Fauna Europaea (SÆTHER & SPIES 2011). The high number of species occurring in Corsica is in sharp contrast to the very low figures for the neighbouring islands of Sardinia, Sicily and the Balearics. Particularly significant is the characteristic chironomid fauna in zone 4 which highlights the importance of the extensive Corsican high mountain chain which extends from 1000 m to 2300-2700 m. The high mountain streams and wetland areas in particular represent an area of high endemism for numerous plants, several aquatic insect groups and some vertebrates and it is likely that some chironomid species evolved in Corsica and subsequently spread to at least other adjoining regions including neighbouring islands and the surrounding continental mainland of Europe and North Africa. The high rate of endemism is some groups, combined with floristic and faunal affinities between Corsica, Sardinia, Sicily and Balearics, appears to be the result of their Tertiary geographical isolation which became a regional hot-spot for evolution and speciation.

| Islands | Corsica | Sardinia | Sicily | Balearics | Canary Islands | Madeira | Azores |
|---|---|---|---|---|---|---|---|
| Number of species | 368 | 31 | 41 | 61 | 68 | 75 | 44 |

Table III. Number of species of Chironomidae known from Corsica, some neighbouring western Mediterranean islands (Sardinia, Sicily, Balearics) and from some eastern Atlantic islands (Canary Islands, Madeira, Azores).

Tableau III. Diversité spécifique des Chironomidae connus de Corse et de quelques îles voisines situées dans le W-Méditerranéen (Sardaigne, Sicile, Baléares) et l'E-Atlantique (Canaries, Madère, Açores).

## 7. Discussion (Tyrrhenian elements and conservation)

According to FURON (1950, 1972), JEANNEL (1956), ALVAREZ (1976), MÉDAIL & QUÉZEL (1997), MOUBAYED-BREIL et al. (2012a, 2012b) the Tyrrhenian province includes the Balearic Islands (except for the Pithyuses), Corsica, Sardinia, Sicily and the coastal mainland of south-west Italy, southern France and south-east Spain. Knowledge of the Chironomidae fauna of this subregion of the western Mediterranean, except for Corsica and the Eastern Pyrenees, is still limited.

The total number of chironomid species currently known from Corsica is 368 which includes 319 named species, 7 queried species and 42 undescribed or unnamed species. The figure of 319 named species is composed of widespread Holarctic and Palaearctic species, some Pantropical and Afrotropical species as well as more localized Mediterranean and Tyrrhenian elements. The figure of 368 includes 177 new records of named species given in the current paper which more

than doubles the previous total list of species (both named and unnamed) from published sources including LAVILLE & LANGTON (2002) and Fauna Europaea (SÆTHER & SPIES 2011).

Corsican species commonly encountered in the Mediterranean Region include: *Paramerina* "spec. Griechenland", *Cricotopus* (*Cr.*) *beckeri, Eukiefferiella bedmari, Krenosmittia hispanica, Chaetocladius* (*Cc.*) *algericus, Parametriocnemus valescurensis, Paratrichocladius micans, Pseudorthocladius* (*Pt.*) *berthelemyi, Polypedilum* (*Po.*) *amoenum, Dicrotendipes fusconotatus, D. septemmaculatus* and *Tanytarsus formosanus*.

The 42 undescribed species from Corsica represents 11.4% of the fauna and is composed mainly of Tyrrhenian and Mediterranean faunal elements. However, some of these Tyrrhenian species are pyreneocorsican and are also known from the eastern Pyrenees (e.g. *Rheocricotopus* (*Rh.*) sp. 1, Orthocladiinae genus sp. 1 and *Virgatanytarsus* sp. 1) and some may be alpinocorsican and could also occur in the French and/or Italian Alps.

Some of the other undescribed Corsican species are likely to occur elsewhere in the Tyrrhenian subregion. However, others (e.g., *Sympotthastia* sp. 1, *Orthocladius (Eo.)* sp. 1, *Parametriocnemus sp.* 1, *Psectrocladius (Ps.)* sp. 1, *Rheocricotopus (Pc.)* sp. 1, *Smittia* sp. 1, *Thienaemannia* sp. 1, *Parachironomus* sp. 1, *Virgatanytarsus* sp. 2) are currently endemic to Corsica and have not so far been found in the well studied wetland areas of southern continental France (Eastern Pyrenees, Var and Maritime Alps departments). Of these 42 species, 32 occur in very low numbers (less than 10 individuals) and in low frequency within the 42 prospected sites in Corsica and therefore are quite rare and mostly occur at high altitude. Most may yet be found in the Eastern Pyrenees and elsewhere at least within the Tyrrhenian subregion and the western Mediterranean with more intensive sampling.

The zonal distribution and percentage of the new undescribed species is given in Table II: - Zone 1 with 6 new species (1.6%); Zone 2 with 16 (4.3%); Zone 3 with 28 (7.6%) and Zone 4 with 19 (5.2%). The highest numbers and percentages reported from zones 3 and 4 are believed to be related to the Tertiary geographical isolation of middle and high mountain areas which created the conditions for evolution and speciation. The majority of these mountain species are associated with springs (including helocrenes), pozzines, cold glacial lakes and the uppermost sections of streams which provide refuges and niches for each of the new species. The majority of these species are found in the middle and high mountain areas (altitude over 500 m) where geographical isolation and the habitats of the mountain chain are believed to favour evolution and speciation. Whether or not there are any truly endemic chironomid species in Corsica is unproven but if any are eventually proven to be endemic the rate of endemism is likely to be very low.

The lower number of undescribed species recorded in zones 1 and 2 (1.6% and 4.3% respectively) is partly related to the fact that lowland areas in the region are better investigated but is also linked to endangered lowland areas (including potamal, estuaries, lagoons, pools, helocrenes and coastal ponds) where many habitats are at risk due to human activities (large scale developments, construction, tourism, pollution, etc.). Unfortunately, the biological quality of both water and sediment in wetland areas and the lower reaches of coastal rivers are being seriously damaged by the impact of organic and chemical pollution similar to what is happening in many countries around the Mediterranean Basin. According to MOUBAYED-BREIL et al. (2012b) coastal aquatic ecosystems in southern France have been heavily affected by toxic chemical pollutants such as HAP's and PCB's during the last four decades. 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 diversity of aquatic invertebrates in coastal habitats by 30 to 50% (in Chironomidae) and up to 50% in other groups. The vulnerability of species occurring in the most threatened areas (potamal, marine and brackish habitats, helocrenes, coastal ponds and lagoons) merits greater attention throughout Corsica and neighbouring islands where plans for the conservation of rare and bio-indicator species are implanted by local authorities.

The lower than expected numbers of new species from the high mountains (zone 4: 19 new species, 5.2%) compared to the middle mountain area (zone 3: 28, 7.6%) is due to the fact that the high mountains regions are poorly explored because of the difficulty of accessing different areas and this is reflected in the lower number of sites investigated. In addition, the biology and ecology of habitats located in these high mountain areas have not been intensively studied and deserve greater consideration.

It is not possible at the present time to do detailed zoogeographical comparisons between the chironomid fauna of Corsica and neighbouring islands and other areas of the western Mediterranean due to the lack of other detailed surveys and comprehensive investigations. Future studies are necessary to determine the exact relationships and affinities of the Corsican fauna. Whether or not there are any truly endemic chironomid species present on the island is unproven but if there are any they will be few in number and occur at higher altitude.

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