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Faunistic composition and larval community structure of Trichoptera in the Avia River Basin (Ourense, NW Spain)

Estudio faunístico y estructura de la comunidad larvaria de Trichoptera de la cuenca del río Avia (Ourense, NO España)

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Abstract

The fauna of Trichoptera larvae in the Avia River Basin and their ecological preferences were analysed in this study. We sampled ten sites with different types of substrate that were characterised *in situ* according to the predominant material type: macrophytes, moss and hard substrates (pebbles, cobbles and sand). Hierarchical clustering was used to test for significant differences in locations regarding the diversity and the abundance among material types, and a canonical correspondence analysis was used to test for significant differences in physico and chemical variables and species among sampling sites. We found that species such as *Rhyacophila munda* were related to high mineralization values as other authors express, whereas others, such as *Micrasema* sp. "gr. *moestum*" and *Tinodes foedellus* were found in high oxygen levels.

Keywords: river, macroinvertebrates, Trichoptera, Avia river, ecology.

Resumen

En este trabajo se estudió la fauna de larvas de Trichoptera en la Cuenca del río Avia y sus preferencias ecológicas. Se seleccionaron 10 estaciones de muestreo con diferentes sustratos: macrófitos, musgos, y sustratos duros (cantos, gravas y arena). Se realizó un análisis de análisis de agrupamiento jerárquico para comprobar las diferencias entre las estaciones muestreadas debido a su diversidad y la abundancia de individuos en los diferentes sustratos. También se realizó un análisis de correspondencias canónicas para comprobar si existían diferencias significativas debidas a las diferentes condiciones físico-químicas y a las muestras biológicas en las estaciones. Encontramos que algunas especies, como *Rhyacophila munda*, estaban relacionadas con altos valores de mineralización o que otras, como *Micrasema* sp. "gr. *moestum*" y *Tinodes foedellus*, preferían niveles elevados de oxígeno disuelto.

Palabras clave: río, macroinvertebrados, Trichoptera, río Avia, ecología.

INTRODUCTION

Fluvial ecosystems are of special interest because of their high biological diversity. Communities of aquatic organisms have developed adaptations that allow them to prosper and survive in these environments which, at the same time, make them very vulnerable to human alterations (Tavzes *et al.,* 2006). In this sense, human activities cause alterations in the physico chemical composition of water and hydromorphology that result in changes the structure of communities living in this environment. It becomes an important task to carry out taxonomic and ecological studies to know the relationships between species and the environment to better manage these waterbodies.

The use of aquatic macroinvertebrates and, in particular those of the Order Trichoptera, have been probed of importance to study the effects on water quality changes. Trichoptera is one of the most important groups of macroinvertebrates in terms of richness and abundance. There are 13,574 described species worldwide (Morse, 2011), although it is estimated that only 20-25% of the species in this group have been discovered (De Moor & Ivanov, 2008).

The main objective of this study was to stablish a faunistic inventory of Trichoptera larvae of Avia River Basin, and to identify the relationships between species and the environment (i.e. physico-chemical conditions). The Trichoptera species found in this study were compared with the faunistic information provided by González (1988), González *et al*. (1992) and Martín *et al.* (2014).

METHODS

Study site and sampling design

The study area is located in the Avia River Basin, a tributary of the Miño River, located in the north western part of the Ourense province in Galicia (Spain) (Fig. 1: taken from Río-Barja *et al*., 1996). It is surrounded by a set of massive mountain ranges forming the border with the Pontevedra and Lugo provinces. Along its course, it is fed by numerous tributaries forming a river basin of 643 Km^2 area. The geology is mainly composed by schist in the eastern part of the basin and granite in the western part, the eastern part of the river is made of schistose substrate and mainly on granite substrate in the west.

Samples were taken seasonally during an annual cycle (from March 1999 to November 1999) in ten different sites (Fig. 2) (A1-A10). Several physico and chemical parameters were recorded *in situ*, including water temperature, dissolved oxygen, pH, conductivity, and total dissolved solids. Other measures as habitat parameters were also measured, such as width, depth, stream velocity, altitude and distance from the source. Multihabitat samples were taken using a kick net (500 µm mesh) along 10 m and during ten minutes, and were fixed in the field with 4% formaldehyde. Larvae of Trichoptera were sorted and identified in the laboratory using reference works including Vieira-Lanero (2000), for larvae from Galicia, or Zamora-Muñoz *et al.* (1995), for the rest of the Peninsula. Identified specimens were preserved in 70º alcohol and deposited in the scientific collection of the Laboratory of Aquatic Entomology at the Vigo University.

Table 1. Names and location of the sampling sites in the Avia River Basin.
Tabla.1. Localización de las estaciones de muestreo en la cuenca del río Avia.

Nombre de la Estación	Código	Río	Coordenadas U.T.M
El río	A1	Oseira	29TNH8505
Subirol	A2	Lovagueira	29T NH6505
Campinas	A3	Viñao	29T NH7005
Leiro	A4	Avia	29T NG7090
Carballiño	A5	Arenteiro	29T NH7500
Gabián	A6	Lodeiros	29T NH6500
Beariz	A7	Doade	29T NH6000
Amiudal	A8	Couso	29T NG6095
Avión	A9	Valdeiras	29T NG6090
Pazos de Arenteiro	A10	Avia	29T NG7090

Identified Trichoptera larvae were analysed considering presence/absence and semi-quantitative data. The Jaccard similarity coefficient (Jaccard, 1902) was applied on the presence/absence data and a dendrogram was obtained as a graphic expression through the cluster analysis method of the SPSS 12.0 software. Species richness and the Shannon-Wiener index using semi-quantitative data were calculated for each site.

A correspondence analysis (CA) was performed on the semi-quantitative data. Species were aggregated and grouped according to habitats to assess their preferences: moss, macrophytes, and hard substrate. Physico-chemical parameters were used as average values after applying a Dixon Test eliminating possible extreme values. Finally, a Canonical Correspondence Analysis (CCA) was applied to relate physico-chemical parameters with semi-quantitative data. CANOCO 4.0 software was used in all multivariate analyses (Lepš & Šmilauer, 2003). In order to simplify the analyses and obtain a clearer representation, those species that were only represented by three or fewer individuals were eliminated.

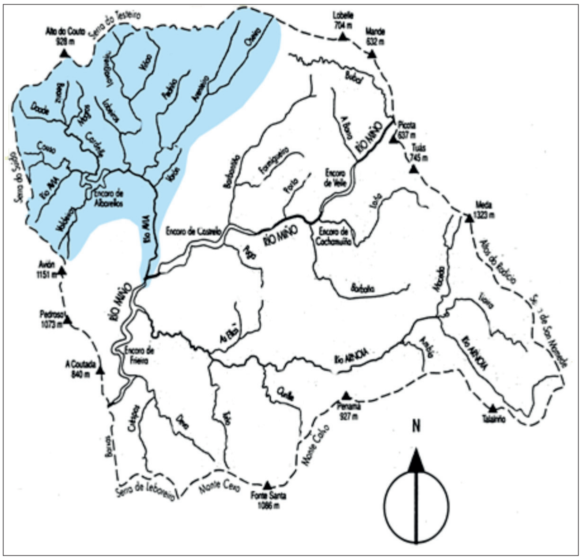

Figure 1. River Miño Basin among Os Peares and Frieira (taken from Río-Barja *et al*., 1996; in blue, Avia River Basin).
Figura 1. Cuenca del río Miño en su tramo de Os Peares a Frieira (extraído de Río-Barja *et al*., 1996; en azul la cuenca del río Avia).

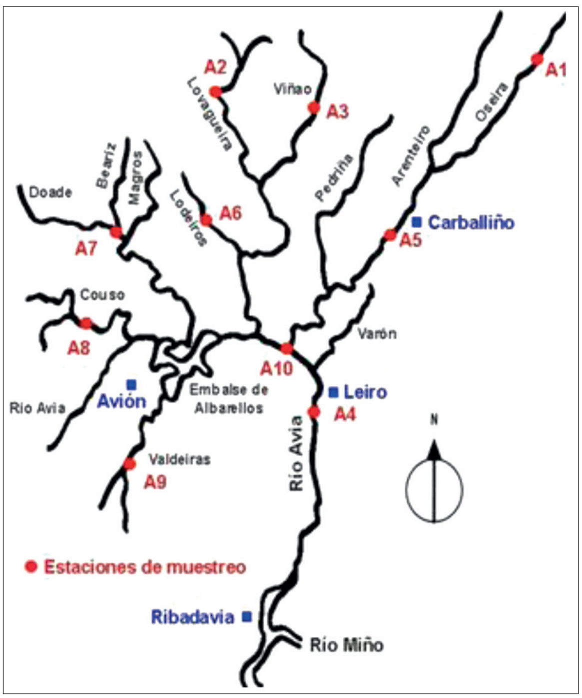

Figure 2. Sampling sites located in the Avia River Basin (A1-A10).
Figura 2. Localización de las diez estaciones de muestreo en la Cuenca del río Avia (A1-A10).

RESULTS

A total of 5,632 larvae corresponding to 67 Trichoptera species and 17 families were identified. Seven species constitute new records for the province of Ourense: *Rhyacophila laufferi* Navás, 1918; *Rhyacophila obelix* Malicky, 1979; *Agapetus fuscipes* Curtis, 1834*;* *Oxyethira frici* Klapálek, 1891; *Hydropsyche tibialis* McLachlan, 1884; *H. urgorrii* González & Malicky, 1980 and *Polycentropus flavomaculatus* (Pictet, 1834). Rhyacophilidae, with ten species, was the richest family followed by Hydropsychidae and Leptoceridae, with seven species each, and by Polycentropodidae and Limnephilidae, with six species each (see annex). Site A4 and A5 had the lowest richness whereas A7 and A8 the highest (Fig. 3). In Avia river basin locations, the value for diversity of Shannon-Wiener index had good values in the majority of the stations being lower in sites like A5 and A10 in coincidence with their lower wealth already commented. These stations are stronger and more disturbed (Fig. 3).

Regarding the figure 4, Rhyacophilidae was the most abundant family (15%), followed by Limnephilidae (11%) and Hydropsychidae (11%) due to the type of running waters where these families and the species are very common.

The dendrogram with the Jaccard similarity coefficient (Fig. 5) showed that there is one of the stations of the river, A10, that it is apart from the others due to the lack of fauna. The explanation is related with the presence of diffuse pollution that causes the disturbance and the low quality of water and consequently the reduction of species

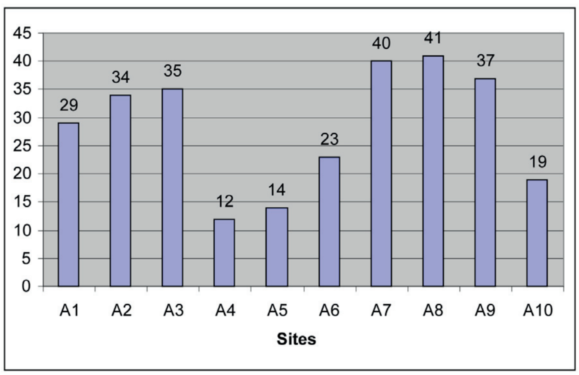

Figure 3. Species richness in each station and diversity according Shannon Wiener index.
Figura 3. Riqueza específica en cada una de las estaciones y diversidad según el índice de Shannon Wiener.

of macroinvertebrates (including Trichoptera order). Other stations as A8 and A9 appeared very close in the figure possibly because the faunistic composition is quite similar and both are located in the most pristine parts of the upper part of the streams. Nevertheless, station A1 is quite different from the others and this could be explained maybe by the different geological composition. Finally, the other stations are more similar among them with more similar faunistic composition.

The CA explained 70.3% of the variance in the axis I and 29.7% in the axis II (Fig. 6). Five taxa were associated with the hard substrate *Plectronemia laetabilis* McLachlan, 1880; *Polycentropus kingi* McLachlan, 1881*; Sericostoma sp.*; *Lepidostoma hirtum* (Fabricius,1775); *Beraea alva* Malicky, 1975; *Chaetopteryx lusitanica* Malicky, 1974 and *Potamophylax cingulatus* (Stephens, 1837) were associated with the macrophyte substrate, whereas *Micrasema servatum* (Navás, 1918), *M. longulum* McLachlan, 1876*, Hydropsyche tibialis, Philopotamus perversus* McLachlan, 1884 and *P. montanus* (Donovan, 1813) were associated with mosses.

The CCA found that silica, oxygen, potassium and pH were the main variables that explained Trichoptera variability among sites (Fig. 7). The right quadrant expresses a mineralization gradient (i.e., conductivity, silica, pH, calcium, potassium, lead, magnesium). *Rhyacophila munda* McLachlan, 1862 appeared strongly associated with

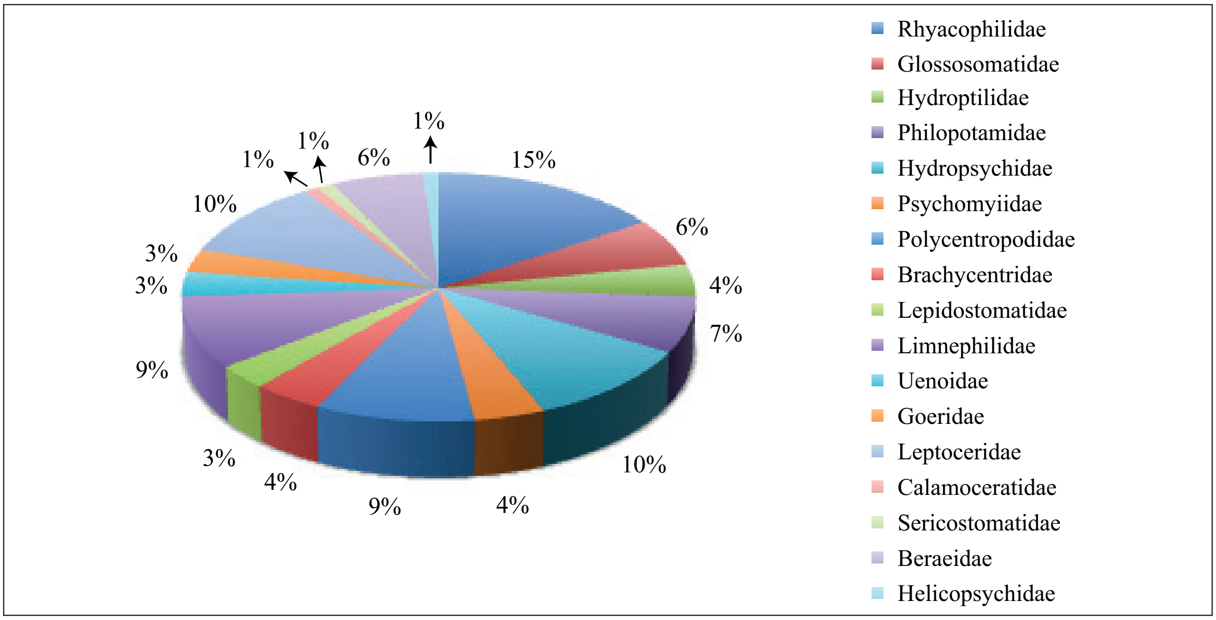

Figure 4. Percentage of the most abundant species captured organized by family at each sampling station.
Figura 4. Porcentaje de las especies más abundantes de cada familia en las diferentes estaciones de muestreo.

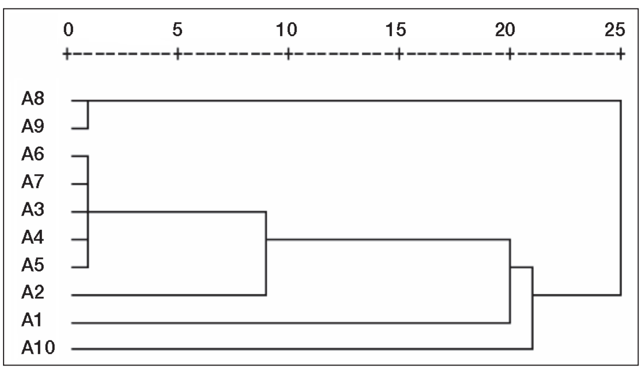

Figure 5. Similarity coefficient among stations (table 1).
Figura 5. Afinidad faunística entre las estaciones de la cuenca (tabla 1).

high concentrations of silica and potassium. At the same time, the species from *Thremma* genus appear attached to granitic rocks and they depend on diatoms and periphyton (Vieira-Lanero, 2000). This could explain their correlation with the silex gradient in the CCA.

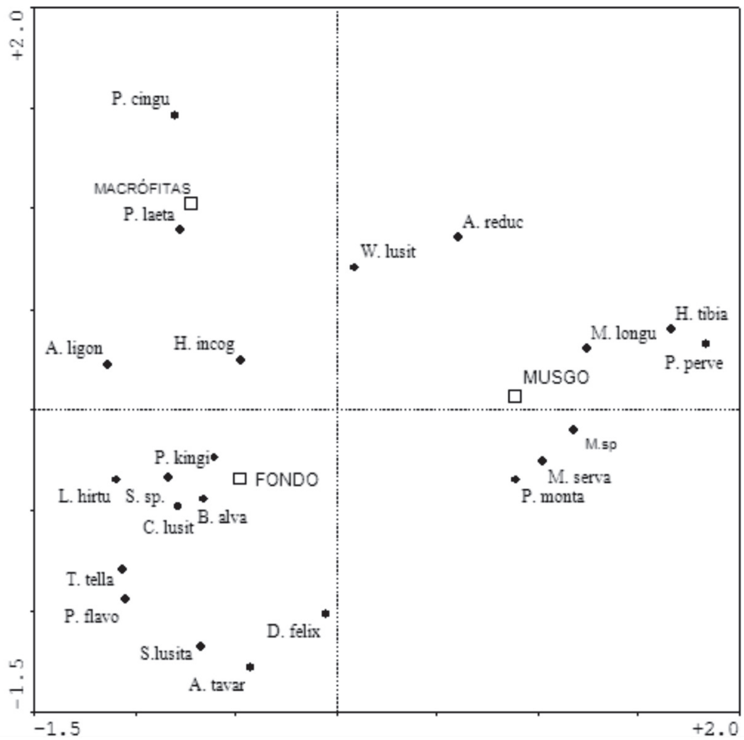

Figure 6. Correspondence analysis of species of Trichoptera (full names in Annex) among different microhabitats.
Figura 6. Análisis de correspondencias de las especies de Trichoptera (nombres completos en Anexo) en los distintos microhábitats.

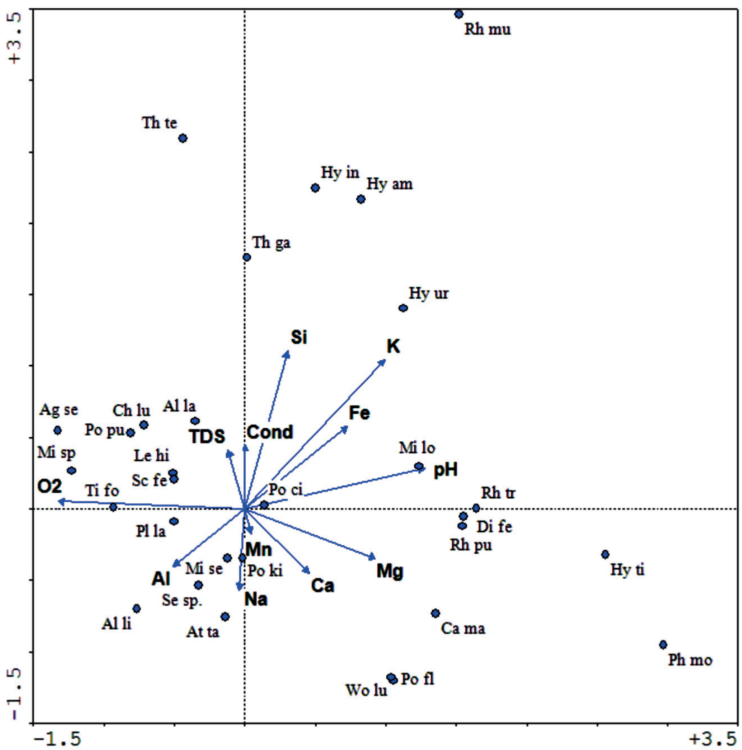

Figure 7. Canonical Correspondence Analysis. Species and Environmental parameters representation (full names in Annex).
Figura 7. Análisis de Correspondencias Canónicas. Representación de las especies y las variables ambientales (nombres completos en Anexo).

At the same time, species as *Micrasema* sp. "gr. *moestum*" and *Tinodes foedellus* McLachlan, 1884, clearly appeared link to oxygen gradation, this could be explained due to the specific ecology requirements of these species that can live in the interphase air-water (Vieira-Lanero, 2000), so they are very sensitives to oxygen concentration changes in the habitat.

DISCUSSION

In accordance with other authors, Rhyacophilidae, Limnephilidae and Hydropsychidae families were the richest and most abundant families in the study area (Vieira-Lanero, 2000).

Regarding the relationship among stations in general, and taking into account the previous analyses carried out, it can be said that there is a homogeneity (Fig. 5) between the different sampling stations when we refer to the physico-chemical characteristics (except in specific cases) and the variables do not discriminate the distribution of the species in the case of this study but there is some dispersion in the results of CCA with some species more influenced by parameters as siliceous, oxygen, pH and potassium (Fig. 7) , since the bulk of species will be concentrated around the average of the variables.

About the substrates, *Polycentropus kingi* is associated with the hard substrate also underlined in other works by Casado *et al.* (1990). In relation to the moss substrate, for the family Brachycentridae there is a strong association of the three species of the genus *Micrasema* to this substrate, *Micrasema longulum, M. servatum* and *M. sp*. "gr. *moestum*" sharing the habitat and living together in many localities as some authors highlight (Vieira-Lanero, 2000, González, 1988). Our data agree with Vieira-Lanero (2000) that places it between mosses and roots. To a lesser extent, *Philopotamus perversus* has been found in moss, although other authors place it in mountainous areas (Terra, 1981, González, 1988). In our study *Plectronemia laetabilis* and *Potamophylax cingulatus* are associated also with macrophytes, in this case, the bibliographic data contrast with the results obtained in our analysis, since Vieira-Lanero (2000) places these species mostly on gravel substrates. In turn, the species *Micrasema sp*. "gr. *moestum"* and *Tinodes foedellus* appear clearly associated with the oxygen gradient, this can be explained by the ecology of these species that live in the air-water interface (Vieira-Lanero, 2000).

Regarding the species *Wormaldia* sp., *Adicella reducta* (McLachlan, 1865) and *Hydropsyche incognita* Pitsch, 19193, they appeared related to the three biotopes mentioned in the study.

Finally, the CCA results it is clear that there is a mineralization gradient in the river basin that influences the abundance and diversity distribution of larvae of Trichoptera studied.

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Annex: Faunistic Inventory.

Abbreviations: 1. S.lusita; 2. P.monta; 3. P.perve; 4. W.lusit; 5. H.incog; 6. H.tibia; 7. P.laeta; 8. P.flavo; 9. M.longu; 10. M.serva; 11. M.s; 12. L.hirtu; 13. C.lusit; 14. P.cingu; 15. A.ligo; 16. T.tella; 17. A.tavar; 18. A.reduc; 19. S.s; 20. B.alva.

Anexo: Inventario faunístico.

Abreviaturas: 1. S.lusita; 2. P.monta; 3. P.perve; 4. W.lusit; 5. H.incog; 6. H.tibia; 7. P.laeta; 8. P.flavo; 9. M.longu; 10. M.serva; 11. M.s; 12. L.hirtu; 13. C.lusit; 14. P.cingu; 15. A.ligo; 16. T.tella; 17. A.tavar; 18. A.reduc; 19. S.s; 20. B.alva.

Familia RHYACOPHILIDAE

Genus *Rhyacophila* Pictet, 1834

R. adjuncta McLachlan, 1884

R. laufferi Navas, 1918

R. lusitanica McLachlan, 1884

R. melpomene Malicky, 1976

R. meridionalis E. Pictet, 1865

R. munda McLachlan, 1862

R. obelix Malicky, 1979

R. pulchra Schmid, 1952

R. relicta McLachlan, 1879

R. tristis Pictet, 1834

Family GLOSSOSOMATIDAE Wallengren, 1891

Subfamily AGAPETINAE Martynov, 1913

Genus *Agapetus* Curtis, 1834

A. fuscipes Curtis, 1834

A. segovicus Schmid, 1952

Genus *Synagapetus* McLachlan, 1879

S. lusitanicus Malicky, 1980[1]

Subfamily GLOSSOSOMATINAE Wallengren, 1891

Tribu Glossosomatini Wallengren, 1891

Genus *Glossosoma* Curtis, 1834

G. privatum McLachlan, 1884

Family HYDROPTILIDAE Stephens, 1836

Subfamily HYDROPTILINAE Stephens, 1836

Tribu Hydroptilini Stephens, 1836

Genus *Hydroptila* Dalman, 1819

H. vectis Curtis, 1834

Genus *Oxyethira* Eaton, 1873

O. frici Klapalek, 1891

Subfamily PTILOCOLEPINAE Martynov, 1924

Genus *Ptilocolepus* Kolenati, 1848

P. extensus McLachlan, 1884

Family PHILOPOTAMIDAE Stephens, 1829

Subfamily PHILOPOTAMINAE Stephens, 1829

Genus *Philopotamus* Stephens, 1829

P. amphilectus McLachlan, 1884

P. montanus Donovan, 18132[2]

P. perversus McLachlan, 1884[3]

Genus *Wormaldia* McLachlan, 1865

W. lusitanica González & Botosaneanu, 1983[4]

Subfamily Chimarrinae Cambur, 1842

Genus *Chimarra* Stephens, 1829

C. marginata (Linnaeus, 1767)

Family HYDROPSYCHIDAE Curtis, 1835

Subfamily DIPLECTRONINAE Ulmer, 1951

Genus *Diplectrona* Westwood, 1840

D. felix McLachlan, 1878

Subfamily HYDROPSYCHINAE Curtis, 1835

Genus *Hydropsyche* Pictet, 1834

H. ambigua Schmid, 1952

H. exocellata Dufôur, 1841

H. incognita Pitsch, 1993[5]

H. siltalai Dölhler, 1963

H. tibialis McLachlan, 1884[6]

H. urgorrii González & Malicky, 1980

Family PSYCHOMYIIDAE Walter, 1852

Subfamily PSYCHOMYIINAE Walter, 1852

Genus *Psychomyia* Latreille, 1829

P. pusilla (Fabricius, 1781)

Genus *Lype* McLachlan, 1878

L. auripilis McLachlan, 1884

Genus *Tinotes* Curtis, 1834

T. foedella McLachlan, 1884

Family POLYCENTROPODIDAE Ulmer, 1903

Subfamily Polycentropodinae Ulmer, 1903

Genus *Plectronecmia* Stephens, 1836

P. laetabilis McLachlan, 1880[7]

Genus *Polycentropus* Curtis, 1835

P. corniger McLachlan, 1884

P. flavomaculatus (Pictet, 1834)[8]

P. intricatus Morton, 1910

P. kingi McLachlan, 1881

Family BRACHYCENTRIDAE Ulmer, 1903

Genus *Micrasema* McLachlan, 1876
M. longulum McLachlan, 1876[9]
M. servatum (Navás, 1918)[10]
M. sp. "gr.*moestum*" Vieira-Lanero, 2000[11]
Family LEPIDOSTOMATIDAE Ulmer, 1903
Subfamily LEPIDOSTOMATINAE Ulemr, 1903
Genus *Lepidostoma* Rambur, 1842
L. hirtum (Fabricius, 1775)[12]
Subfamily THELIOPSYCHINAE Schmid, 1955
Genus *Crunoecia* McLachlan, 1876
C. irrorata (Curtis, 1834)
Family LIMNEPHILIDAE Kolenati, 1848
Subfamily Limnephilinae Kolenati, 1848
Tribu Limnephilini Kolenati, 1848
Genus *Limnephilus* Leach, 1815
L. guadarramicus Schmid, 1955
Tribu Chaetopterygini Hagen, 1858
Genus *Chaetopteryx* Stephens, 1829
C. lusitanica Malicky, 1974[13]
Tribu Stenophylacini Schmid, 1955
Genus *Potamophylax* Wallengren, 1891
P. cingulatus (Stephens, 1837)[14]
Genus *Halesus* Stephens, 1836
H. radiatus (Curtis, 1834)
Genus *Stenophylax* Kolenati, 1848
S. sequax (McLachlan, 1875)
Genus *Allogamus* Schmid, 1955
A. ligonifer (McLachlan, 1876)[15]
A. laureatus (Navás, 1918)
Family UENOIDAE Iwata, 1927
Subfamily Thremmatidae Martynov, 1935
Genus *Thremma* McLachlan, 1876
T. gallicum McLachlan, 1880
T. tellae González, 1978[16]
Family GOERIDAE Ulmer, 1903
Subfamily Goerinae Ulmer, 1903
Genus *Silo* Curtis, 1830
S. graellsii E. Pictet, 1865
Subfamily Larcasinae Navas, 1917
Genus *Larcasia* Navas, 1917
L. partita Navás, 1917
Family LEPTOCERIDAE Leach, 1815
Subfamily Leptocerinae Leach. 1815
Tribu Athripsodini Morse & Wallace, 1976
Genus *Athripsodes* Billberg, 1820
A. albifrons (Linnaeus, 1758)
A. braueri (E. Pictet, 1865)
A. tavaresi (Navás, 1916)[17]
Tribu Mystacidini Burmeister, 1839
Genys *Mystacides* Berthold, 1827
M. azureus (Linnaeus, 1761)
Tribu Triaenodini Morse, 1981
Genus *Adicella* McLachlan, 1877
A. meridionalis Morton, 1906
A. reducta (McLachlan, 1865)[18]
Genus *Triaenodes* McLachlan, 1865
T. ochreellus McLachlan, 1877
Family CALAMOCERATIDAE Ulmer, 1905
Subfamily Calamoceratinae Ulmer, 1905
Genus *Calamoceras* Brauer, 1865
C. marsupus Brauer, 1865
Superfamily SERICOSTOMATOIDEA Stephens, 1836
Family SERICOSTOMATIDAE Stephens, 1836
Genus *Sericostoma* Latreille, 1825[19]
Genus *Schizopelex* McLachlan, 1876
S. festiva (Rambur, 1842)
Family BERAEIDAE Wallengren, 1891
Genus *Beraea* Stephens, 1833
B. alva Malicky, 1975[20]
B. malahiguerra Schmid, 1952
B. malatebrera Schmid, 1952
B. terrai Malicky, 1975
Family HELICOPSYCHIDAE Ulmer, 1906
Genus *Helycopsyche* von Siebold, 1856
H. lusitanica McLachlan, 1884