

# Current situation of stonefly fauna (Insecta : Plecoptera) in the Iberian Peninsula and the Balearic Islands

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## Current situation of stonefly fauna (Insecta: Plecoptera) in the Iberian Peninsula and the Balearic Islands

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According to the literature available on the order Plecoptera in the Iberian Peninsula and the Balearic Islands, this group is represented at present by 136 species and subspecies. The growth of this number since 1841 to the present is described. The different species are grouped by geographical area, reflecting species richness of each zone, taking into account the scarcity of studies in a large part of Iberian geography. In addition, the state of conservation of these taxa is discussed, analyzing the principal causes that can endanger or have endangered representatives of this group.

Keywords: Plecoptera, Iberian Peninsula, Geographic Distribution, Conservation Status.

### BACKGROUND

Plecoptera in the Iberian Peninsula is a relatively well-known insect group at the species and subspecies level. Nevertheless, knowledge of the precise distribution of each taxon remains incomplete.

The first data known on the species of this order in the Iberian Peninsula were collected in the last century by BRULLE, PICTET, RAMBUR and ROSENHAUER (SÁNCHEZ-ORTEGA & ALBA-TERCEDOR, 1987). No further work was done until the end of the 19th century and the beginning of the 20th century, when new entomological studies were made, for example, by BOLÍVAR, KLAPALEK, BOHIGAS, LESTAGE, SCHOENEMUND and, above all, the Jesuit priest Longinos NAVÁS, a prolific naturalist whose work was interrupted by his natural death during the Spanish Civil War. The number of Iberian taxa rose from 11 before 1900 to 48 by 1930, considering only currently accepted taxa (Fig. 1).

New works did not begin until the middle of the 20th century, when Spain recovered from the Civil War (roughly coinciding with World War II for the rest of Europe), a conflict in which many zoologists disappeared.

In the 1950s and 1960s, 55 new taxa were described by such authors as DESPAX, ILLIES, and especially Jacques AUBERT, who reviewed specimens in different collections, including that of NAVÁS (now in the Museum of Zoology in Barcelona) and the small collection of the Spanish Institute of Entomology (today joined to the National Museum of Natural Sciences), as well as specimens collected during three large expeditions around the Iberian Peninsula, these constituting the mainstay of present knowledge of Iberian Plecoptera.

Since the 1970s Plecoptera studies have reached a new zenith, as part of the expansion of Spanish entomology in general (MARTÍN ALBALADEJO, 1994). From 1972 to 1984, 19 new taxa were recorded in Spain by authors such as BERTHÉLEMY, BAENA, GONZÁLEZ DEL TANÁGO, PUIG, THEISCHINGER, WHYTTON DE TERRA, and ZWICK.

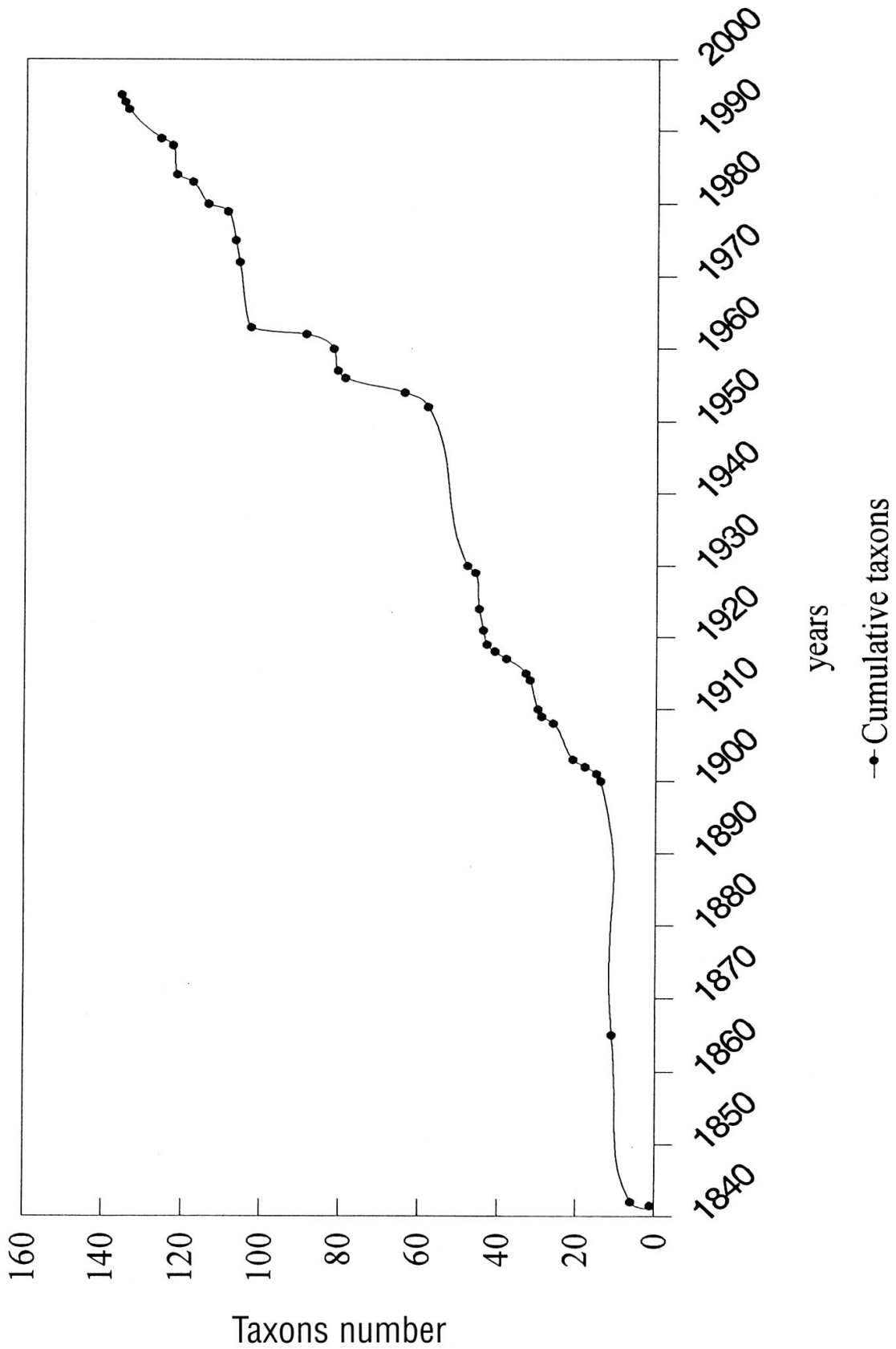


Fig. 1. Historical evolution of the number of Plecoptera species known in the Iberian Peninsula and the Balearic Islands.

In 1987, SÁNCHEZ-ORTEGA & ALBA-TERCEDOR compiled a faunistic list and bibliography for Plecoptera of the Iberian Peninsula (edited by the Spanish Limnology Association), reporting a total of 122 species and subspecies.

Since this date, various entomologists from Spain (ALBA-TERCEDOR, MEMBIELA, PARDO, ROPERO, SÁNCHEZ-ORTEGA, and TIERNO) as well as from other European countries (VINÇON and ZWICK) (see Appendix III) have cited and described for the first time 14 new species and subspecies, raising the total number to 136 at present, though the validity of some taxa and some citations remain to be confirmed. This number will soon be increased by at least 7 species, which at present await the publication of their record or description (VINÇON, pers. com.).

In fact, the validity of many recent works related to fluvial environments - either from ecological (community structure) or applied (biological water quality) standpoints - is at least questionable, and frequently useless from a faunistic viewpoint, because there is no compendium on Iberian Plecoptera that enables the correct identification of Iberian taxa, and thus specimens are frequently identified without adequate faunistic knowledge, often only on the basis of nymphs, or at times even with keys from other European countries.

#### SPATIAL DISTRIBUTION OF IBERIAN AND BALEARIC PLECOPTERA

The species distributions are usually limited by a combination of biogeographical, ecological and historical factors (SABIO GONZÁLEZ, 1993), which also may not coincide in all the marginal areas of its distribution (ODLAND, 1987, HENGEVELD, 1990, in ANTÚNEZ & MENDOZA, 1992). In particular, benthic macroinvertebrates are distributed according to physico-chemical characteristics of the entire river basin, as well as other factors which depend on the geologic and morphometric structure as well as human activity.

The studies on freshwater macroinvertebrate community distribution in the Iberian Peninsula are generally quite restricted, while areas such as south-central Portugal and the Guadiana Basin are hardly studied at all (ALBA-TERCEDOR *et al.*, 1992).

For an overall approximation of the distribution of the Iberian Plecoptera, we grouped the different species by river basins (taken from REAL GIMÉNEZ, 1991), and by mountain systems, as shown in Figs 2 and 3, and in Appendices I and II. The river basin is a geographic unit for taxa directly or indirectly linked to freshwater environments (REAL GIMÉNEZ, 1991) and the mountain systems are propitious habitats for insects dependent on swift-flowing and clean waters.

Figs 2 and 3 represent an uneven distribution of the number of species or subspecies of Plecoptera in the Iberian Peninsula, which, though these might partly reflect the different intensity with which the various areas have been studied, traces a clear decline in diversity with a descent in latitude. Thus, the zone of the Pyrenees, the Cantabrian and Galician Mountains present values far above those of other systems such as the Sierra Morena or the Betic Systems. Similarly, the general preference of these insects for clean, oxygenated waters (ZWICK, 1981), typical of high areas, explains the scarcity of Plecoptera in depressions compared with mountains. Consistent with the latitude trend, we find maximum species diversity in the northern basins (of Ebro, Miño, Duero, and the Cantabrian Cordillera), as opposed to poorer diversity in the southern basins, especially those of the southeastern zone (basins of Júcar and Segura).

This phenomenon of diminishing species richness with descent in latitude is found in other animal groups of holarctic origin, as in the case of the Urodela (REAL,

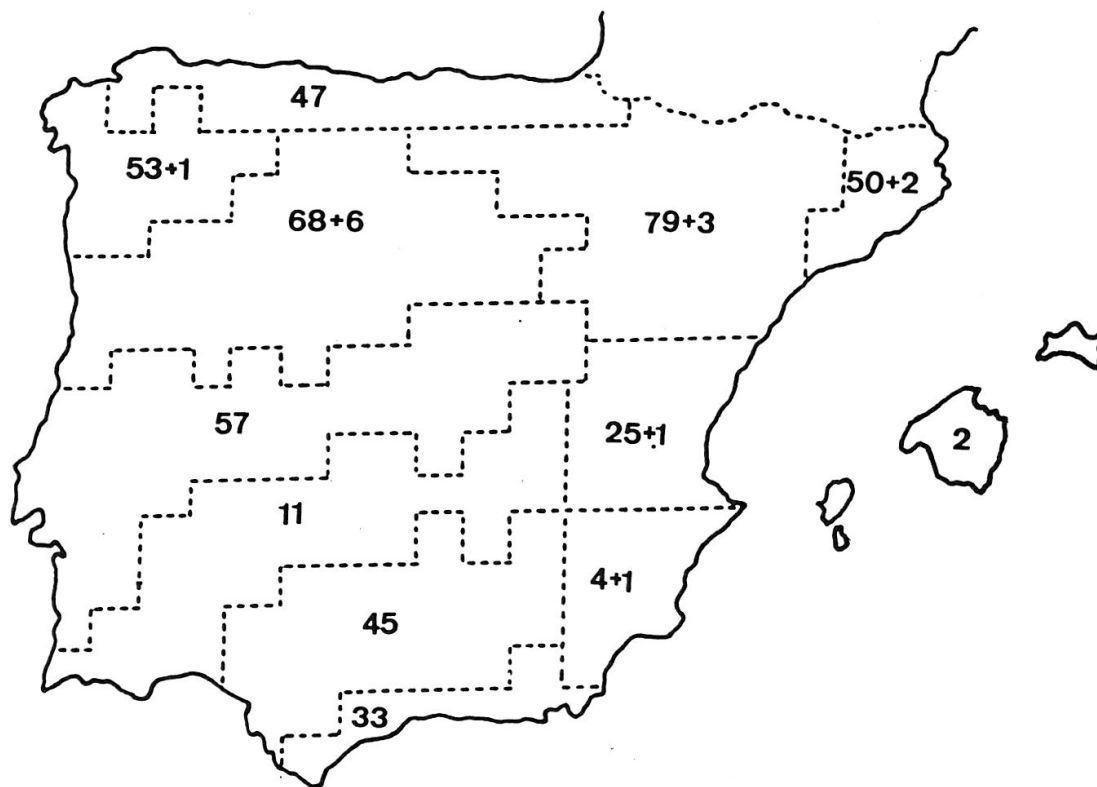


Fig. 2. Plecoptera species distribution by basins in the Iberian Peninsula and the Balearic Islands.

1992), and this pattern was translated by SABIO GONZÁLEZ (1993) as a separation of two large geographic areas, according to the composition of its macroinvertebrates: the northeastern region (Galicia, Basque Country, Pyrenees, and the Duero and Tajo Basins), rich in Plecoptera and Trichoptera, with a high number of endemic species, especially at the headwaters of rivers; and the southeastern region, with a scarcity of representatives of the two previous groups and greater abundance of Diptera and Ephemeroptera. To explain a similar distribution in Trichoptera, GONZÁLEZ *et al.* (1987) identified as determining factors of the greater species richness of the Iberian north and west the frequent rains and a geomorphology conducive to suitable streams.

The differential distribution of Plecoptera species in the Iberian Peninsula is due fundamentally to influences of neighboring areas as well as speciation phenomena. The peninsular effect defined by SIMPSON (1964), as the decrease in species richness from the isthmus to the end of the peninsula, due to a high rate of extinction and a low rate of immigration (REAL, 1992), is perfectly applicable to the distribution of this order of insects. In addition, speciation accounts for the large number of endemic Iberian Plecoptera. This speciation resulted from the isolation, after glacial periods, of populations with low dispersion capacity (BRITAIN, 1990). Undoubtedly, the role of the Iberian Peninsula as a refuge and/or dispersion zone at different times boosted the faunistic richness, not only in Plecoptera taxa, but in many other groups, which also have a high number of endemic species. Thus, in the Iberian Peninsula and the Balearic Islands the proportion of endemic taxa is more than 50% for Plecoptera, about 33% in Trichoptera (GONZÁLEZ *et al.*, 1987), and 35 to 40% in Ephemeroptera (ALBA-TERCEDOR, pers. com.).

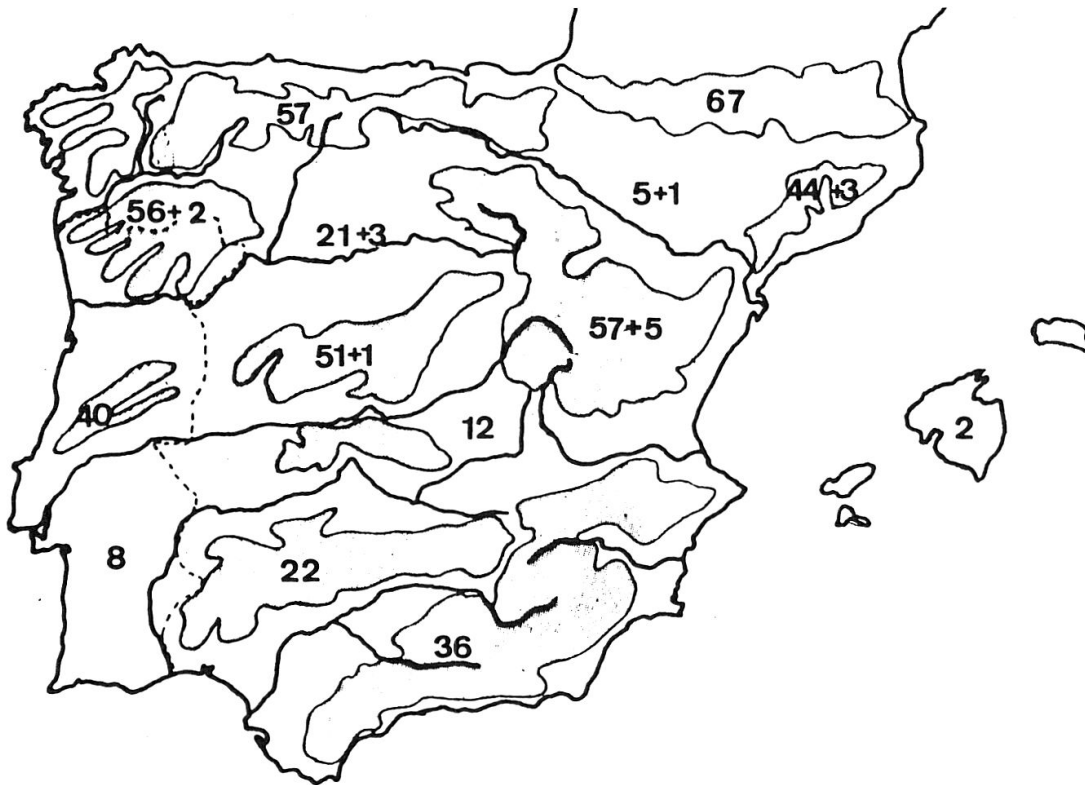


Fig. 3. Plecoptera species distribution by mountain systems in the Iberian Peninsula and the Balearic Islands.

The families of Plecoptera inhabiting the Iberian Peninsula stem from a holarctic line (AUBERT, 1949), probably with a Siberian origin (ILLIES, 1965), which colonized the peninsula despite the Pyrenees standing as a formidable barrier (ZWICK, 1981). Nevertheless, the cooling of the glacial period encouraged the spread of more northern elements towards the south (ZWICK, 1981), and those that remained isolated after the receding of the ice constituted speciation nuclei. Among the basic types of distribution proposed by ILLIES (1965) for the families of Plecoptera, the 7 families present in the Iberian Peninsula are included within the actogaecic-neotropical (Perlidae) and the holarctic (the remaining families) types. The peculiarities of the species distributions can be accounted for, according to RAUSER (1962), by the long isolation (closed off by the Pyrenees), the fluctuations of the distribution areas with the glaciations, the later colonization of the south (an explanation for the lower number of species that arrived and shorter time for diversification), and the existence of the Hesperian Massif in the northeast of the Peninsula as an evolutionary refuge and ancient nucleus for speciation. This massif has been used in a hypothesis to explain the concentration of endemic Trichoptera taxa in this area (GONZÁLEZ *et al.*, 1987).

#### CURRENT SITUATION OF RISK FOR THE IBERIAN PLECOPTERA (TABLE 1)

Due to the limited knowledge about Plecoptera outside highly restricted areas, this group, like others, has been overlooked by conservationists, which in Spain, as in the rest of the world, have focused on raising public and governmental awareness concerning the danger of extinction among impressive vertebrates or attractive

Tab. 1. Situation of Plecoptera in the Iberian Peninsula and Balearic Islands with regard to threat.

ENDANGERED SPECIES (R.D.B. 1; UICN EN)	
<i>Marthamea selysii</i>	<i>Marthamea vitripennis</i>
<i>Leuctra balearica</i>	<i>Leuctra besucheti</i>
<i>Leuctra bidula</i>	<i>Leuctra estrela</i>
<i>Leuctra wilmae</i>	
SPECIES IN DANGER OF DISAPPEARANCE IN THE IBERIAN PENINSULA	
<i>Dictyogenus ventralis</i>	<i>Isoperla moselyi</i>
<i>Eoperla ochracea</i>	<i>Nemoura rifensis</i>
<i>Leuctra digitata</i>	<i>Leuctra gallica</i>
<i>Tyrrhenoleuctra tangerina</i>	
VULNERABLE SPECIES (R.D.B. 2; UICN W)	
<i>a. Global</i>	
<i>Isoperla acicularis guadarramica</i>	<i>Brachyptera vera vera</i>
<i>Brachyptera vera cordubensis</i>	<i>Rhabdiopteryx christinae</i>
<i>b. In the Iberian Peninsula</i>	
<i>Perlodes dispar</i>	<i>Capnopsis schilleri</i>
<i>Leuctra alticola</i>	<i>Leuctra franzi paenibetica</i>
RARE SPECIES (R.D.B. 3)	
LEST RISK (UICN LR)	
<i>a. Global</i>	
<i>Isoperla acicularis acicularis</i>	<i>Chloroperla acuta</i>
<i>b. In the Iberian Peninsula</i>	
<i>Xanthoperla apicalis</i>	<i>Taeniopteryx nebulosa</i>
<i>Brachyptera seticornis</i>	<i>Leuctra kempnyi</i>
INSUFFICIENT DATA (UICN DD)	
<i>Amphinemura hibernatarii</i>	<i>Protonemura brevistyla</i>
<i>Protonemura culmenis</i>	<i>Nemoura cambrica</i>
<i>Capnioneura brachyptera</i>	<i>Capnioneura petitpierrae</i>
<i>Leuctra berthelemyi</i>	<i>Leuctra clerguae</i>
<i>Leuctra gallaeca</i>	<i>Leuctra hexacantoides</i>
<i>Leuctra leptogaster</i>	<i>Leuctra mortoni</i>
<i>Leuctra pseudocylindrica</i>	<i>Leuctra rauscheri</i>
<i>Leuctra thomasi</i>	
ENDEMIC SPECIES (RDB 5J)	
<i>Guadalgenus franzi</i>	<i>Isoperla acicularis acicularis</i>
<i>Isoperla acicularis cantabrica</i>	<i>Isoperla acicularis guadarramica</i>
<i>Isoperla bipartita</i>	<i>Isoperla curtata</i>
<i>Isoperla moselyi</i>	<i>Isoperla nevada</i>
<i>Isoperla pallida</i>	<i>Isoperla viridinervis</i>
<i>Perla madritensis</i>	<i>Chloroperla acuta</i>
<i>Chloroperla breviata</i>	<i>Chloroperla nevada</i>
<i>Siphonoperla baetica</i>	<i>Brachyptera arcuata</i>
<i>Brachyptera vera vera</i>	<i>Brachyptera vera cordubensis</i>
<i>Rhabdiopteryx christinae</i>	<i>Rhabdiopteryx thienemanni</i>
<i>Amphinemura guadarramensis</i>	<i>Amphinemura hibernatarii</i>
<i>Protonemura alcazaba</i>	<i>Protonemura beatensis beatensis</i>
<i>Protonemura culmenis</i>	<i>Protonemura globosa</i>
<i>Protonemura hiberiaca</i>	<i>Protonemura hispanica</i>
<i>Protonemura intricata iberiaca</i>	<i>Protonemura navacerrada</i>
<i>Protonemura pyrenaica pyrenaica</i>	<i>Protonemura pyrenaica asturica</i>
<i>Protonemura tuberculata</i>	<i>Protonemura vandeli</i>
<i>Nemoura ceciliae</i>	<i>Nemoura linguata</i>

Tab. 1. (Suite)

<i>Nemoura moselyi</i>	<i>Capnioneura brachyptera</i>
<i>Capnioneura gelesae</i>	<i>Capnioneura libera</i>
<i>Leuctra alosi</i>	<i>Leuctra alticola</i>
<i>Leuctra andalusiaca</i>	<i>Leuctra auriensis</i>
<i>Leuctra balearica</i>	<i>Leuctra berthelemyi</i>
<i>Leuctra besucheti</i>	<i>Leuctra bidula</i>
<i>Leuctra cazorlana</i>	<i>Leuctra clerguae</i>
<i>Leuctra espanoli</i>	<i>Leuctra estrela</i>
<i>Leuctra franzi franzi</i>	<i>Leuctra gallaeca</i>
<i>Leuctra hexacantoides</i>	<i>Leuctra hiberiaca</i>
<i>Leuctra hispanica</i>	<i>Leuctra iliberis</i>
<i>Leuctra illiesi</i>	<i>Leuctra lamellosa</i>
<i>Leuctra lusitanica</i>	<i>Leuctra madritensis</i>
<i>Leuctra pseudocylindrica</i>	<i>Leuctra stupeningi</i>
<i>Leuctra thomasi</i>	<i>Leuctra wilmae</i>
<i>Tyrrhenoleuctra minuta</i>	<i>Pachyleuctra benllochi</i>
<i>Pachyleuctra bertrandi</i>	

insects and other invertebrates (ALBA-TERCEDOR, 1994). In fact, only 15 Plecoptera species, in the USA and Australia, appear on the list of the IUCN (International Union for the Conservation of Nature) for 1994. In addition, this group, together with other arthropods, despite constituting the majority of diversity and biomass of natural systems, are practically ignored in environmental-impact studies required by the EU prior to beginning many projects and public works (BARRIENTOS & RODRÍGUEZ, 1994).

Nevertheless, it is highly useful to establish the state of Plecoptera, and others aquatic insect groups, since they reflect water quality in rivers, which in general is rapidly deteriorating in developed and developing countries. Previous studies on the state of this group have been carried out in different European countries (CLAESSENS, 1981 in Netherlands; COSTELLO, 1988 in Ireland; RAVIZZA & NICOLAI, 1983 in Italy; AUBERT, 1984 in Switzerland; BRATTON, 1990 in Great Britain).

In the Iberian Peninsula, no Plecoptera appears on any official national list of protected species. Up to now, only the regional government of Madrid, in Spain, has published a list of regionally protected species, including 3 Plecoptera (*Leuctra madritensis*, *Brachyptera arcuata*, and *Marthamea vitripennis*), catalogued as being sensitive to habitat disturbance (VIEJO MONTESINOS & SÁNCHEZ CUMPLIDO, 1994). Also in Spain, a list soon to be released by the Andalusian Regional Government will include 16 protected species (TIERNO & SÁNCHEZ-ORTEGA, 1996).

To determine the potential state of risk of a species, we apply the criteria of the Red Data Book (RDB; SHIRT, 1987), as done by BRATTON (1990) for British Ephemeroptera and Plecoptera, and those adopted by the IUCN in Gland, Switzerland in 1994, the last one currently being used nationally (Spanish Association of Entomology) and regionally (regional government of Andalusia) to compile lists of endangered species.

To categorize a species, we must consider the geographic level concerned. For example, we find species which, on a continental scale, are not included in any of the categories of risk (quite the contrary, these species can have a wide distribution), while on a peninsular or regional scale these same species might be extremely localized and seriously endangered (TIERNO & SÁNCHEZ-ORTEGA, 1996; IUCN, 1994). For this reason, we have considered a category not provided for in either of



the two systems commonly used (species in danger of disappearance from the Iberian Peninsula), and within the categories considered, we can differentiate between species globally and locally at risk, respectively (Tab. 1).

Gaps in information on the geographic distribution of many species hampers an accurate designation within either of the two categories mentioned above. Lacking the data necessary to apply criteria according to a grid distribution, we assign categories tentatively, taking into account that these lists should be constantly re-evaluated in light of ongoing research.

In any case, the present work provides a departure point: not only for future research, but also for current management of natural resources in the Iberian Peninsula. The following represents our evaluation of the state of Iberian Plecoptera.

#### *Extinct species*

We know of no species or subspecies of the Iberian fauna of Plecoptera which is definitively extinct.

#### *Endangered species (RDB 1; IUCN EN)*

Seven species are endangered (Tab. 1), of which four are endemic to the Iberian Peninsula and Balearic Islands. Five species were captured in very specific areas and in extremely low numbers. The reduction of their habitats and populations, perhaps being already at critical levels, could result in extinction.

The situation with *Marthamea selysii* and *M. vitripennis* is different, since these are species distributed throughout the center and south of Europe, but, being species of the lower reaches of rivers, they can be considered to be in danger of extinction in their entire distribution area (ZWICK, 1984).

#### *Species in danger of disappearance from the Iberian Peninsula*

These include taxa which extend across the southern side of the Pyrenees and whose Iberian populations are in danger of disappearance. It should be noted that *Iso-perla moseyi* is listed in this category because it also appears in the French Pyrenees.

This category includes a total of 9 species (Tab. 1), which are either extremely localized and scantily represented in the Iberian Peninsula and/or occupy habitats which are being drastically reduced and, if the reduction continues, could lead to disappearance, as occurred with *Dictyogenus ventralis* and *Eoperla ochracea*.

#### *Vulnerable species (RDB 2; IUCN VU)*

Taxa which may become endangered in the near future are considered vulnerable. These are distributed in relatively localized areas, and their small populations can be further decreased by environmental disturbance.

Eight Iberian taxa fit in this category (Tab. 1), among which we can distinguish two subcategories: taxa vulnerable to disappearance from the Iberian Peninsula (which may or may not be on endangered species lists in other countries), and taxa vulnerable to complete extinction (inhabiting only the Iberian Peninsula).

#### *Rare species (RDB 3)*

This category covers species which are known only in small populations or which have relatively restricted distributions. While neither being in danger of

extinction nor vulnerable, their limited numbers represent a certain risk on the Iberian Peninsula.

Although, for the above categories, it is relatively easy to compare the criteria of the RDB and of the IUCN, the same does not apply in this case. We can include all the species of low abundance and, or with restricted distributions which we considered to be species at less risk (IUCN LR), and species rarely captured, which are probably distributed in broader geographical areas than currently known and which we consider to be species with inadequate data (IUCN DD). As more data become available, the shifting of species from one category to another can be done with relative ease.

#### *Endemic species (RDB 5)*

This category represents 69 taxa which are exclusive to the Iberian Peninsula (Andorra, Spain, and Portugal) and the Balearic Islands, as well as species endemic to the Pyrenees (both the French and Spanish) which have been captured on the southern (Spanish and Andorran) side of the mountains (Tab. 1). This category excludes species known only in the French Pyrenees or which are found in other regions of France or Europe in general.

This category is used by the RDB, but not by the IUCN. We use the category because a limited distribution implies a certain degree of risk.

#### PRINCIPAL CAUSES OF RISK FOR PLECOPTERA POPULATIONS

Plecoptera, placing specific requirements on the environment and being highly sensitive to pollution, are commonly used as bioindicators of water quality (WARD, 1992). The reduction in the populations of many species, as in other aquatic macroinvertebrates, is fundamentally due to habitat destruction, both by pollution and other threats (FOSTER, 1989; BRATTON, 1990). Human activity is especially intense in middle to low stretches of river basins, where most human populations, industry, agriculture and animal husbandry are concentrated, in which populations of Plecoptera may have disappeared completely without ever having been studied (ALBA-TERCEDOR, 1994).

In these last zones, one of the main factors affecting the Iberian populations of Plecoptera (as well as other aquatic macroinvertebrates) is chemical pollution caused by both inorganic and organic substances, though in our case the latter is the primary cause of the alterations. Organic pollution is usually caused by dumping of residues from different industries (chemicals), agriculture (insecticides, and fertilizers), animal raising and fisheries (waste), and towns (sewage), which contribute greatly to the eutrophization of rivers and lakes and to the abrupt impoverishment in the aquatic fauna. In fact, downstream of urban, industrial and tourist centres, biological water quality is invariably very low (ALBA-TERCEDOR *et al.*, 1992).

In addition to pollution are the physical alterations caused primarily by dredging and various types of construction such as dams, water channels, and roads. Dams and reservoirs, especially, affect rivers by drastically altering the flow rates and volumes, thereby diminishing oxygen concentration, temperature, sediment composition, etc. (WARD & STANFORD, 1979). Finally, thermal contamination, caused by refrigeration of electric plants and industrial installation, can raise the water temperature of a river and thereby impoverish the fluvial fauna.

Most Plecoptera in the Iberian Peninsula and Balearic Islands survive in mountain systems at medium to high altitudes, associated with the headwaters of the river

basins. In these zones, the principal risk factors for fluvial fauna are, on the one hand, the construction of dams, reservoirs and water channels which interrupt or interfere with natural water flow, and, on the other hand, the construction of small electric plants and pollution from tourist complexes (camping sites, ski stations, etc.) which alter natural water quality. The latter set of risks is exacerbated by the rampant forest fires of recent years (many set intentionally), especially in summer, which leave the beds of mountain rivers and streams smothered in ashes.

#### CONCLUSION

For certain insect groups the species in the greatest danger of extinction in Europe are those endemic to the Iberian Peninsula and some Mediterranean islands, such as the Balearic Islands (FOSTER, 1989). This situation reflects the need for a higher degree of conservation of Spanish rivers, which should be considered to be natural ecosystems, and not simply used for extracting drinking water and dumping our waste.

Without a doubt, the best way to maintain populations of Plecoptera is to conserve their habitats. This principle, common to the conservation of all species (LUMARET, 1994), is especially urgent in the case of stoneflies, given their high sensitivity to environmental pollution. Therefore we conclude, as did RAVIZZA & NICOLAI (1983), that the extinction of Spanish Plecoptera is more than a simple disappearance, as the study of this insect group contributes to a broader understanding of the natural web of life in relation to human activity.

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#### REFERENCES

- ALBA-TERCEDOR, J. 1994. El entomólogo y los problemas de degradación de los sistemas acuáticos. In: JIMÉNEZ-PEYDRÓ & MARCOS-GARCÍA (Eds.), *Environmental Management and Arthropod Conservation*, pp. 131-138. Asociación Española de Entomología.
- ALBA-TERCEDOR, J., GONZÁLEZ, G. & PUIG, M. A. 1992. Present level of knowledge regarding fluvial macroinvertebrate communities in Spain. *Limnética* 8: 231-241.
- ANTÚNEZ, A. & MENDOZA, M. 1992. Factores que determinan el área de distribución geográfica de las especies: conceptos, modelos y métodos de análisis. In: VARGAS, REAL & ANTÚNEZ (Eds.), *Objetivos y Métodos Biogeográficos. Aplicaciones en Herpetología*. pp. 51-72. Asociación Herpetológica Española. Monografías de Herpetología n.º 2.
- AUBERT, J. 1949. La répartition des Plécoptères dans le monde. *Mitt. Schweiz. Ent. Ges.* 22(3): 361.
- AUBERT, J. 1984. L'Atlas des Plécoptères de Suisse - Influence de la pollution. *Annls Limnol.* 20(1-2): 17-20.
- BARRIENTOS, J. A. & RODRÍGUEZ, R. 1994. Los artópodos y los estudios de impacto o Gulliver en el país de Liliput. In: JIMÉNEZ-PEYDRÓ & MARCOS-GARCÍA (Eds.), *Environmental Management and Arthropod Conservation*, pp. 115-130. Asociación Española de Entomología.
- BRATTON, J. H. 1990. A review of the scarcer Ephemeroptera and Plecoptera of Great Britain. Research & survey in nature conservation. N° 29. Nature Conservancy Council 1990. 40 pp.
- BRITAIN, J. E. 1990. Life history strategies in Ephemeroptera and Plecoptera. In: CAMPBELL, I. (Ed.), *Mayflies and Stoneflies: Life history and biology*, pp. 1-12. Kluwer Academic Publishers.
- CLAESSENS, E. E. C. M. 1981. The stoneflies (Plecoptera) of the Netherlands. *Nieuwsbrief European Invertebrate Survey- Nederland.* 10: 73-77.
- COSTELLO, M. J. 1988. A review of the distribution of stoneflies (Insecta, Plecoptera) in Ireland. *Proc. Royal Irish Acad.* 88B: 1-22.
- FOSTER, G. N. 1989. Conserving Insects of Aquatic and Wetland Habitats, with Special Reference to Beetles. In: COLLINS & THOMAS (Eds.), *The Conservation of Insects and their Habitats*, pp. 236-262. 15th Symposium of the Royal Entomological Society of London.

- GONZÁLEZ, M. A., GARCÍA DE JALON, D. & DA TERRA, L. W. 1987. Faunistic studies on Iberian Trichoptera: a historical survey and present state of knowledge. In: BOURNAUD & TACHET (Eds.), *Proceedings of the 5th International Symposium on Trichoptera*, pp. 85-90. Dr W. Junk Publishers, Dordrecht, The Netherlands.
- HENGEVELD, R. 1990. *Dynamic biogeography*. Cambridge University Press. Cambridge .
- ILLIES, J. 1965. Phylogeny and Zoogeography of the Plecoptera. *Ann. Rev. Entomol.* 10:117-140.
- LUMARET, J. P. 1994. La conservation de l'entomofaune dans les aires naturelles protégées. In: JIMÉNEZ-PEYDRÓ & MARCOS-GARCÍA (Eds.), *Environmental Management and Arthropod Conservation*, pp. 57-65. Asociación Española de Entomología.
- MARTÍN ALBALADEJO, C. 1994. *Bibliografía entomológica de autores españoles (1758-1990)*. Documentos Fauna Ibérica 1. RAMOS, M. A. (Ed.). Museo Nacional de Ciencias Naturales. CISIC. 821 pp.
- ODLAND, A. 1987. On the ecology of *Thelypteris limbosperma* in W. Norway. The distribution in relation to climatic factors. *Nord J. Bot.* 7: 325-337.
- RAUSER, J. 1962. Zur Verbreitungsgeschichte einer Insektendauergruppe (Plecoptera) in Europa. *Práce Brnen. zálk. CSAV.* 34(8): 281-284.
- RAVIZZA, C. & NICOLAI, P. 1983. I Plecotteri minacciati di estinzione nella regione italiana. *Boll. Soc. ent. ital.* 115 (4-7): 70-78.
- REAL GIMÉNEZ, R. 1991. *Modelo de distribución de los anfibios en las cuencas fluviales de Europa a tres escalas geográficas*. Tesis Doctoral. Univ. Málaga. 374 pp.
- REAL, R. 1992. Las tendencias geográficas de la riqueza específica. In: VARGAS, REAL & ANTÚNEZ (Eds.), *Objetivos y Métodos Biogeográficos. Aplicaciones en Herpetología*. pp. 85-94. Asociación Herpetológica Española. Monografías de Herpetología n.º 2.
- SABIO GONZÁLEZ, B. 1993. Influencia de la Biogeografía en la estructuración de las comunidades béticas fluviales en la Península Ibérica. *Actas VI Congreso Español de Limnología (Granada, mayo de 1993)*: 323-330.
- SÁNCHEZ-ORTEGA, A. & ALBA-TERCEDOR, J. 1987. *Lista faunística y bibliográfica de los Plecópteros (Plecoptera) de la Península Ibérica*. Listas de la flora y fauna de las aguas continentales de la Península Ibérica. Asoc. Esp. Limnol. Publicación n.º 4. 133 pp.
- SHIRT, D. B. 1987. *British Red Data Books: 2, Insects*. Peteborough, Nature Conservancy Council.
- SIMPSON, G. G. 1964. Species density of North America recent mammals. *Syst. Zool.* 13: 57-73.
- TIERNO, J. M. & SÁNCHEZ-ORTEGA, A. 1996. Revisión de la distribución y el estado de conservación de la fauna de Plecópteros (Insecta: Plecoptera) de los sistemas montañosos andaluces, con especial referencia a Sierra Nevada. *Actas de la 1a Conferencia Internacional Sierra Nevada. Conservación y Desarrollo Sostenible*. J. CHACÓN & J.L. ROSÚA (Eds). 3: 69-74.
- UICN, 1994. *Categorías de las Listas Rojas de la UICN*. Comisión de Supervivencia de Especies de la UICN. 22 pp.
- VIEJO MONTESINOS, J. L. & SÁNCHEZ CUMPLIDO, C. 1994. Leyes y normas que protegen a los insectos en España. *Quercus* 96: 13-17.
- WARD, J. V. 1992. *Aquatic Insect Ecology. 1. Biology and Habitat*. John Wiley & Sons, Inc. 438 pp.
- WARD, J. V. & STANFORD, J. A. 1979. Ecological factors controlling stream zoobenthos with emphasis on thermal modification of regulated streams. In: WARD, J. V. & STANFORD (Eds.), *The Ecology of Regulated Stream*. Plenum. New-York
- ZWICK, P. 1981. Das Mittelmeergebiet als glaziales refugium für Plecoptera. *Acta entomol. Jugoslav.* 17(1-2): 107-111.
- ZWICK, P. 1984. *Marthamea beraudi* (NAVAS) and its European congeners (Plecoptera: Perlidae). *Annl. Limnol.* 20(1-2): 129-139.

Appendix 1. Distribution, by mountain systems, of Iberian species and subspecies of Plecoptera (Pi: Pyrenees; Cc: Cantabrian Cordillera; Ca: Coastal Catalanian Cordillera; Ga: Galician Massif; Di: Iberian Depression; Si: Iberian System; Sn: Northern Subplateau and Coastal Douro; Ss: Southern Subplateau; Sc: Central System; EB: Sierra Estrela and Beira; Sm: Sierra Morena; Sb: Betic System; Ba: Balearic Islands; EP: Extremadura, Central and Southern Portugal and Algarve).

	Pi	Cc	Ca	Ga	Di	Si	Sn	Ss	Sc	EB	Sm	Sb	BA	EP
<i>Arcynopteryx compacta</i>	X	X	X			X								
<i>Dictyogenus ventralis</i>						X		X	X?					
<i>Guadalgenus franzi</i>				X		X			X	X	X			
<i>Perlodes dispar</i>				X						X				
<i>Perlodes intricata</i>	X					X?								
<i>Perlodes microcephalus</i>	X	X	X	X		X	X	X	X			X		
<i>Hemimelaena flaviventris</i>		X	X	X		X	X		X	X	X	X		X
<i>Isoperla a. acicularis</i>	X		X											
<i>Isoperla a. cantabrica</i>		X		X										
<i>Isoperla a. guadarramica</i>									X					
<i>Isoperla bipartita</i>				X							X			
<i>Isoperla curta</i>		X		X		X			X	X	X			
<i>Isoperla grammatica</i>	X	X	X	X		X		X	X	X	X	X		X
<i>Isoperla moselyi</i>	X													
<i>Isoperla nevada</i>												X		
<i>Isoperla pallida</i>									X		X			
<i>Isoperla viridinervis</i>	X													
<i>Dinocras cephalotes</i>	X	X	X	X		X	X	X	X			X		
<i>Eoperla ochracea</i>			X			X	X					X		
<i>Marthamea selysii</i>				X		X		X				X		
<i>Marthamea vitripennis</i>			X		X	X		X						
<i>Perla bipunctata</i>	X	X					X							
<i>Perla burmeisteriana</i>		X				X			X					
<i>Perla grandis</i>	X	X	X			X						X		
<i>Perla madritensis</i>	X	X		X		X		X	X	X				
<i>Perla marginata</i>	X	X	X	X		X	X		X			X		X
<i>Chloroperla acuta</i>				X										
<i>Chloroperla breviata</i>	X	X	X											
<i>Chloroperla nevada</i>				X						X		X		
<i>Chloroperla tripunctata</i>	X	X		X		X			X	X				
<i>Siphonoperla baetica</i>														
<i>Siphonoperla torrentium</i>	X	X	X	X		X			X	X		X		
<i>Xantoperla apicalis</i>	X		X?			X								
<i>Taeniopteryx hubaulti</i>	X													
<i>Taeniopteryx nebulosa</i>	X				X	X								
<i>Taeniopteryx schoemundi</i>		X	X	X		X	X		X					
<i>Brachyptera arcuata</i>		X	X?	X		X			X	X				
<i>Brachyptera auberti</i>						X			X	X	X	X		
<i>Brachyptera braueri</i>		X	X		X?	X	X	X	X	X	X	X		
<i>Brachyptera monilicornis</i>		X		X		X	X		X	X	X			
<i>Brachyptera risi</i>	X	X	X			X								
<i>Brachyptera seticornis</i>	X			X?										
<i>Brachyptera trifasciata</i>					X	X		X						
<i>Brachyptera vera vera</i>							X		X					
<i>Brachyptera v. cordubensis</i>											X			
<i>Rhabdiopteryx christinae</i>						X						X		X
<i>Rhabdiopteryx thienemanni</i>				X?			X		X	X	X			
<i>Amphinemura hibernatarii</i>				X										
<i>Amphinemura standfussi</i>	X													
<i>Amphinemura sulcicollis</i>	X	X	X	X		X								
<i>Amphinemura guadarramensis</i>				X		X?			X	X	X			X
<i>Amphinemura triangularis</i>		X	X			X						X		
<i>Protonemura alcazaba</i>												X		X
<i>Protonemura brevistyla</i>	X													
<i>Protonemura b. beatensis</i>	X	X	X	X		X?			X	X	X			X
<i>Protonemura culmenis</i>	X													
<i>Protonemura globosa</i>				X						X				
<i>Protonemura hiberiaca</i>		X		X		X								
<i>Protonemura hispanica</i>		X		X					X	X				
<i>Protonemura intricata</i>	X	X	X	X		X	X		X	X				
<i>Protonemura meyeri</i>	X	X	X	X		X	X		X		X	X		
<i>Protonemura navacerrada</i>		X		X		X			X	X				
<i>Protonemura praecox</i>	X	X	X	X										
<i>Protonemura p. pyrenaica</i>	X		X											
<i>Protonemura p. asturica</i>		X	X	X		X			X	X				

SITUATION OF PLECOPTERA IN THE IBERIAN PENINSULA

	Pi	Cc	Ca	Ga	Di	Si	Sn	Ss	Sc	EB	Sm	Sb	BA	EP
<i>Protonemura risi spinulosa</i>	X	X	X											
<i>Protonemura tuberculata</i>	X		X?											
<i>Protonemura vandeli</i>	X		X			X?								
<i>Nemoura cambrica</i>	X								X					
<i>Nemoura ceciliae</i>		X		X		X			X	X				
<i>Nemoura cinerea</i>	X	X	X	X		X			X	X	X	X		X
<i>Nemoura erratica</i>	X					X								
<i>Nemoura fulviceps</i>	X		X	X		X	X	X	X	X	X	X		
<i>Nemoura lacustris</i>	X	X	X	X		X		X	X	X	X	X		
<i>Nemoura linguata</i>	X		X											
<i>Nemoura moselyi</i>	X	X												
<i>Nemoura rifensis</i>												X		
<i>Nemoura uncinata</i>	X	X	X			X			X					
<i>Nemurella pictetii</i>	X	X	X											
<i>Capnia bifrons</i>		X	X			X	X?		X	X				
<i>Capnia nigra</i>	X	X			X	X			X	X		X		
<i>Capnia vidua</i>	X		X											
<i>Capnioneura brachyptera</i>	X													
<i>Capnioneura gelesae</i>											X			
<i>Capnioneura libera</i>				X					X	X				
<i>Capnioneura mitis</i>	X	X	X	X		X	X		X	X	X	X		
<i>Capnioneura petitpierrae</i>											X	X		
<i>Capnopsis schilleri</i>										X	X	X		
<i>Leuctra alosi</i>	X	X	X	X		X	X		X	X				
<i>Leuctra alticola</i>	X													
<i>Leuctra andalusiaca</i>												X		
<i>Leuctra auriensis</i>				X										
<i>Leuctra aurita</i>	X	X	X	X		X								
<i>Leuctra balearica</i>													X	
<i>Leuctra besucheti</i>				X		X?								
<i>Leuctra berthelemyi</i>	X													
<i>Leuctra bidula</i>												X		
<i>Leuctra castillana</i>	X	X	X	X		X	X		X	X				
<i>Leuctra cazorlana</i>												X		
<i>Leuctra clerguae</i>	X													
<i>Leuctra despaxi</i>		X	X	X		X				X				
<i>Leuctra digitata</i>			X											
<i>Leuctra espanoli</i>	X	X												
<i>Leuctra estrela</i>										X				
<i>Leuctra franzi franzi</i>		X		X		X			X					
<i>Leuctra franzi paenibetica</i>												X		
<i>Leuctra fusca</i>	X	X	X	X		X	X		X			X		
<i>Leuctra gallaeca</i>				X										
<i>Leuctra gallica</i>										X				
<i>Leuctra geniculata</i>	X	X	X	X		X	X?	X	X		X	X		
<i>Leuctra hexacanthoides</i>	X													
<i>Leuctra hiberiaca</i>				X					X	X				
<i>Leuctra hippopus</i>	X	X	X	X		X	X		X	X				
<i>Leuctra hispanica</i>		X	X	X		X			X	X				
<i>Leuctra iliberis</i>												X		
<i>Leuctra illiesi</i>		X		X					X	X	X			
<i>Leuctra inermis</i>	X	X	X	X		X			X	X		X		
<i>Leuctra kempnyi</i>	X													
<i>Leuctra lamellosa</i>	X	X				X								
<i>Leuctra leptogaster</i>	X	X	X											
<i>Leuctra lusitanica</i>				X			X?			X				
<i>Leuctra madritensis</i>		X	X	X		X	X		X	X				
<i>Leuctra major</i>	X	X	X			X			X					
<i>Leuctra maroccana</i>				X		X	X		X			X		X
<i>Leuctra mortoni</i>	X													
<i>Leuctra occitana</i>									X					
<i>Leuctra pseudocylindrica</i>	X													
<i>Leuctra rauscheri</i>	X													
<i>Leuctra stupeningi</i>				X					X	X				
<i>Leuctra thomasi</i>	X													
<i>Leuctra wilmae</i>		X												
<i>Pachyleuctra benllochi</i>	X													
<i>Pachyleuctra bertrndi</i>	X													
<i>Tyrrhenoleuctra minuta</i>											X	X	X	
<i>Tyrrhenoleuctra tangerina</i>												X		

Appendix II. Distribution, by basins, of the Iberian species and subspecies of Plecoptera. (Mi: Miño Basin; CC: Cantabrian River Basins; Eb: Ebro Basin; Cat: Northeastern Mediterranean Basin; Du: Duero Basin; Ta: Tajo Basin; Gu: Gadiana Basin; Ju: Júcar Basin; Se: Segura Basin; Guq: Guadalquivir Basin; SA: Southern Mediterranean Basin; Ba: Balearic Islands).

	Mi	CC	Eb	Cat	Du	Ta	Gu	Ju	Se	Guq	SA	Ba
Arcynopteryx compacta		X	X	X	X?							
Dictyogenus ventralis					X	X		X				
Guadalgenus franzi					X	X				X		
Perlodes dispar	X				X							
Perlodes intricata			X	X	X?							
Perlodes microcephalus	X	X	X	X	X	X		X		X	X	
Hemimelaena flaviventris	X		X		X	X	X			X	X	
Isoperla a. acicularis			X	X								
Isoperla a. cantabrica	X	X			X?							
Isoperla a. gadarramica					X	X						
Isoperla bipartita	X									X		
Isoperla curtata	X	X	X?		X	X	X			X	X	
Isoperla grammatica	X	X	X	X	X	X	X	X		X	X	
Isoperla moselyi			X									
Isoperla nevada										X	X	
Isoperla pallida						X	X			X		
Isoperla viridinervis			X	X								
Dinocras cephalotes	X	X	X	X	X					X	X	
Eoperla ochracea			X			X		X		X	X	
Marthamea selysii	X		X			X		X	X	X		
Marthamea vitripennis			X			X	X					
Perla bipunctata		X	X		X							
Perla burmeisteriana		X	X		X	X						
Perla grandis	X	X	X	X	X	X				X	X	
Perla madritensis	X	X	X		X	X						
Perla marginata	X	X	X	X	X	X	X	X	X	X	X	
Chloroperla acuta	X				X							
Chloroperla breviata		X	X	X								
Chloroperla nevada	X				X					X	X	
Chloroperla tripunctata	X	X	X	X	X	X		X				
Siphonoperla baetica										X	X	
Siphonoperla torrentium	X	X	X	X	X	X		X		X		
Xantoperla apicalis			X	X				X				
Taeniopteryx hubaulti			X									
Taeniopteryx nebulosa			X	X				X				
Taeniopteryx schoemundi	X			X	X	X						
Brachyptera arcuata	X	X	X		X	X						
Brachyptera auberti					X	X				X	X	
Brachyptera braueri			X	X	X	X						
Brachyptera monilicornis			X		X					X		
Brachyptera risi		X	X	X	X							
Brachyptera seticornis			X	X	X?							
Brachyptera trifasciata			X			X						
Brachyptera vera vera					X							
Brachyptera vera cordubensis										X		
Rhabdiopteryx christinae						X		X		X	X	
Rhabdiopteryx thienemanni					X	X				X		
Amphinemura hibernatarii	X											
Amphinemura standfussi			X									
Amphinemura sulcicollis	X?	X	X	X	X	X						
Amphinemura gadarramensis	X				X	X	X			X		
Amphinemura triangularis		X	X	X	X					X	X	
Protonemura alcazaba						X	X			X	X	
Protonemura brevistyla			X	X								
Protonemura b. beatensis	X	X	X	X	X?							
Protonemura culmenis			X									
Protonemura globosa	X				X	X						
Protonemura hiberiaca	X		X		X							
Protonemura hispanica	X	X			X	X						
Protonemura intricata	X	X	X	X	X	X		X				
Protonemura meyeri	X	X	X	X	X	X		X		X	X	
Protonemura navacerrada	X		X		X	X						
Protonemura praecox	X	X		X								
Protonemura p. pyrenaica			X	X								
Protonemura p. asturica	X	X	X	X	X	X						
Protonemura risi spinulosa		X	X	X	X							
Protonemura tuberculata			X									

SITUATION OF PLECOPTERA IN THE IBERIAN PENINSULA

	Mi	CC	Eb	Cat	Du	Ta	Gu	Ju	Se	Guq	SA	Ba
<i>Protonemura vandeli</i>			X	X	X?							
<i>Nemoura cambrica</i>		X		X		X						
<i>Nemoura ceciliae</i>	X				X							
<i>Nemoura cinerea</i>	X	X	X	X	X	X		X		X	X	
<i>Nemoura erratica</i>			X	X	X							
<i>Nemoura fulviceps</i>	X		X	X	X	X	X	X	X	X		
<i>Nemoura lacustris</i>	X	X	X	X	X	X	X	X	X?	X	X	
<i>Nemoura linguata</i>			X	X								
<i>Nemoura moselyi</i>		X	X									
<i>Nemoura rifensis</i>										X		
<i>Nemoura uncinata</i>		X	X	X	X	X						
<i>Nemurella pictetii</i>		X	X	X								
<i>Capnia bifrons</i>				X	X	X						
<i>Capnia nigra</i>			X	X	X			X		X	X	
<i>Capnia vidua</i>			X?	X?								
<i>Capnioneura brachyptera</i>			X									
<i>Capnioneura gelesae</i>										X		
<i>Capnioneura libera</i>	X				X	X						
<i>Capnioneura mitis</i>	X	X	X	X	X	X				X	X	
<i>Capnioneura petitpierrae</i>										X	X	
<i>Capnopsis schilleri</i>					X					X	X	
<i>Leuctra alosi</i>	X	X	X	X	X	X						
<i>Leuctra alticola</i>			X									
<i>Leuctra andalusiaca</i>										X	X	
<i>Leuctra auriensis</i>	X											
<i>Leuctra aurita</i>	X	X	X	X	X							
<i>Leuctra balearica</i>												X
<i>Leuctra besucheti</i>	X		X									
<i>Leuctra berthelemyi</i>			X									
<i>Leuctra bidula</i>											X	
<i>Leuctra castillana</i>	X		X	X	X	X		X				
<i>Leuctra cazorlana</i>										X	X	
<i>Leuctra clerguae</i>			X									
<i>Leuctra despaxi</i>	X	X		X	X							
<i>Leuctra digitata</i>			X	X								
<i>Leuctra espanoli</i>		X	X		X							
<i>Leuctra estrela</i>					X							
<i>Leuctra franzi franzi</i>	X	X			X	X						
<i>Leuctra franzi paenibetica</i>										X	X	
<i>Leuctra fusca</i>	X	X	X	X	X	X		X		X	X	
<i>Leuctra gallaeca</i>	X											
<i>Leuctra gallica</i>					X							
<i>Leuctra geniculata</i>	X	X	X	X	X	X	X	X		X	X	
<i>Leuctra hexacanthoides</i>			X									
<i>Leuctra hiberiaca</i>	X				X	X						
<i>Leuctra hippopus</i>	X	X	X	X	X	X		X				
<i>Leuctra hispanica</i>	X	X	X		X	X		X				
<i>Leuctra iliberis</i>										X	X	
<i>Leuctra illiesi</i>					X	X				X		
<i>Leuctra inermis</i>	X	X	X	X	X	X		X		X	X	
<i>Leuctra kempnyi</i>			X									
<i>Leuctra lamellosa</i>		X	X		X							
<i>Leuctra leptogaster</i>		X	X	X								
<i>Leuctra lusitanica</i>	X				X							
<i>Leuctra madritensis</i>	X	X	X		X	X		X				
<i>Leuctra major</i>		X	X	X	X	X		X				
<i>Leuctra maroccana</i>	X				X	X		X?		X	X	
<i>Leuctra mortoni</i>			X									
<i>Leuctra occitana</i>					X							
<i>Leuctra pseudocylindrica</i>			X									
<i>Leuctra rauscheri</i>			X									
<i>Leuctra stupeningi</i>	X				X	X						
<i>Leuctra thomasi</i>			X									
<i>Leuctra wilmae</i>		X										
<i>Pachyleuctra benllochi</i>			X	X								
<i>Pachyleuctra bertrandi</i>			X?	X?								
<i>Tyrrhenoleuctra minuta</i>									X	X	X	X
<i>Tyrrhenoleuctra tangerina</i>									X	X		



Appendix III. Bibliography used for Appendices I and II but not included in SANCHEZ-ORTEGA & ALBA-TERCEDOR, 1987.

- ALBA-TERCEDOR, J., ZAMORA-MUÑOZ, C., SÁNCHEZ-ORTEGA, A. & GUIASOLA, I. 1991. Mayflies and stoneflies from the rio Monachil (Sierra Nevada, Spain) (Ephemeroptera and Plecoptera). In: ALBA-TERCEDOR & SÁNCHEZ-ORTEGA (Eds.), *Overview and Strategies of Ephemeroptera and Plecoptera*, pp. 529-538. Sandhill Crane Press, Gainesville.
- CASADO, C., MONTES, C., GARCÍA DE JALÓN, D. & SORIANO, O. 1990. Contribución al estudio faunístico del bentos fluvial del rio Lozoya (Sierra de Guadarrama, España). *Limnética* 6: 87-100.
- CORTÉS, R. M. V. 1989. *Biotipología de ecosistemas lóticos do nordeste de Portugal*. Universidad de Trás-os-Montes e Alto Douro. Vila Real, 305 pp.
- CORTÉS, R. M. V. & MONZÓN, A. 1991. Biological assessment of water quality in northern Portugal using a method combining species tolerance and diversity along the longitudinal axis. *Limnética* 7: 123-132.
- CORTÉS, R. M. V., TJARDA DE, K. & SIMOES GRAÇA, M. A. 1986. Estudio de un río de montaña de una zona granítica del norte de Portugal. *Limnética* 2: 197-204.
- GALLARDO MANYECO, A. 1990. Distribución de los Plecópteros en el río Guadiamar (Sevilla). *Ecología* 4: 333-337.
- GARCIA AVILÉS, J. 1990. *Insectos acuáticos de Baleares (Odonata, Ephemeroptera, Heteroptera, Plecoptera y Coleoptera)*. Tesis Doctoral. Universidad Complutense de Madrid. 690 pp.
- GONZÁLEZ DEL TÁNAGO, M. & GARCÍA DE JALÓN, D. 1987. Clasificación de los rios de Málaga según las comunidades de macrobentos. *Actas IV Congreso español de Limnología (Sevilla, mayo de 1987)*: 251-259.
- LATORRE MACARRÓN, E. 1987. *La fauna de artrópodos acuáticos del río Razón*. Tesis doctoral. Universidad de Madrid. 160 pp.
- MADRID VINUESA, F. 1990. *Factores físico-químicos y comunidades de macroinvertebrados de la cabecera del río Genil (Sierra Nevada) aguas arriba de Granada. Estudio de la calidad biológica de las aguas*. Memoria de Licenciatura. Universidad de Granada.
- MALO, J. & PUIG, M. A. 1993. Efecto de las fluctuaciones sobre la estabilidad de la comunidad de macroinvertebrados de un tramo permanente de un cauce mediterráneo (rio Matarraña, cuenca del Ebro). *Actas VI Congreso Español de Limnología (Granada, mayo de 1993)*: 347-354.
- MEMBIELA IGLESIA, P. 1988. Descripción de las larvas de último estadio de *Protonemura globosa* BERTHÉLEMY & TERRA, 1980 (Plecoptera, Nemouridae). *Boletín Asoc. esp. Entom.* 12: 93-98.
- MEMBIELA IGLESIA, P. 1988. *Los Plecópteros de Galicia: estudio faunístico y ecológico*. Tesis Doctoral. Universidad de Santiago de Compostela. Departamento de Biología Animal. 399 pp.
- MEMBIELA, P. 1989. Two new species of *Leuctra* of the Iberian Peninsula (Insecta, Plecoptera). *Aquatic Insects* 11(2): 81-87.
- MEMBIELA IGLESIA, P. 1990. Contribución al conocimiento de las larvas del último estadio de las especies ibéricas del grupo *braueri* del género *Leuctra* (Plecoptera, Leuctridae). *Boletín. Asoc. esp. Ent.* 14: 175-180.
- MEMBIELA IGLESIA, P. 1990. Contribución al conocimiento faunístico de los Plecópteros de Galicia (Plecoptera). *Boletín. Asoc. esp. Ent.* 14: 89-103.
- MEMBIELA IGLESIA, P. 1990. Dos individuos anómalos en Plecoptera. *Scientia gerundensis* 16(1): 129-132.
- MEMBIELA, P. 1990. Las larvas del género *Perla* (Plecoptera, Perlidae) en la Península Ibérica. *Misc. Zool.* 14: 65-68.
- MEMBIELA, P. 1990. Los Plecópteros de Galicia (España): Distribución altitudinal y períodos de vuelo. *Limnética* 6: 131-136.
- MEMBIELA, P. 1990. The mating calls of *Perla madritensis* RAMBUR, 1842 (Plecoptera, Perlidae). *Aquatic Insects* 12(4): 223-226.
- MEMBIELA IGLESIA, P. 1991. The Stonefly of Galicia (NW Iberian Peninsula): a ecological study (Plecoptera). In: ALBA-TERCEDOR & SÁNCHEZ-ORTEGA (Eds.). *Overview and Strategies of Ephemeroptera and Plecoptera*, pp. 403-413. Sandhill Crane Press, Gainesville.
- MEMBIELA IGLESIA, P. 1992. Las larvas del último estadio de las especies ibéricas del subgrupo *aurita* del género *Leuctra* STEPHENS, 1836 (Plecoptera, Leuctridae). *Boletín. Asoc. esp. Ent.* 16: 63-70.
- MEMBIELA, 1996. Inventario dos Plecópteros de Galicia (Insecta: Plecoptera). Cadernos da área de Ciências Biológicas (Inventarios). In press.
- MIRANDA BRAGA, A. 1987. Utilización de macroinvertebrados bentónicos como indicadores biológicos de la calidad del agua en el río Viao-Piloña (Asturias). *Limnética* 3: 141-150.
- MONZÓN, A., CORTÉS, R. M. V., DE KOE, T. & MELO DE CARVALHO, L. M. 1990. Técnica de análisis directa de gradiente en la ordenación de las comunidades de macrobentos en la cuenca del rio Tua. *Scientia gerundensis* 16(1): 133-146.

- PARDO, I. 1989. New data on the genus *Amphinemura* Ris (Plecoptera: Nemouridae) from the Iberian Peninsula, with a description of a new species. *Aquatic Insects* 11(4): 209-216.
- PARDO, I. 1992. *Estudio comparado de la macrofauna bentónica (ambientes lóticos) de los ríos Louro y Tea (Pontevedra)*. Tesis doctoral. Universidad de Santiago de Compostela. 443 pp.
- PARDO, I., EIROA, E. & NOVOA, F. 1991. Contribution to the Stonefly Fauna of Galicia. In: ALBA-TERCEDOR & SÁNCHEZ-ORTEGA (Eds). *Overview and Strategies of Ephemeroptera and Plecoptera*, pp. 325-327. Sandhill Crane Press, Gainesville.
- PARDO, I. & ZWICK, P. 1993. Contribution to the knowledge of Mediterranean *Leuctra* (Plecoptera: Leuctridae). *Mitt. Schweiz. Ent. Ges.* 66: 417-434.
- PICAZO MUÑOZ, J. 1995. *Caracterización y calidad de las aguas de los cauces de la cuenca del Río Guadiana Menor. Aspectos físico-químicos y macroinvertebrados acuáticos*. Tesis doctoral. Universidad de Granada. 256 pp.
- PONS, L. 1988. The genus *Tyrrhenoleuctra* (Insecta, Plecoptera) in Minorca (Spain). *Misc. Zool* 10: 380-382.
- PRESA, Y., LUIS, E. & DE SOTO, J. 1987. Análisis de las comunidades de macroinvertebrados en la cuenca del río Orbigo, León. *Actas IV Congreso Español de Limnología (Sevilla, mayo de 1987)*: 203-213.
- PRESA, Y., LUIS, E., SOTO, J. & POSTIGO, M. 1990. Caracterización de la fauna de macroinvertebrados bentónicos en la cuenca del río Orbigo (León). *Scientia gerundensis* 16(1): 195-202.
- PUIG, M. A. 1993. Relaciones tróficas de la comunidad de macroinvertebrados en el río Matarraña (cuenca del Ebro). *Actas VI Congreso Español de Limnología (Granada, mayo de 1993)*: 355-362.
- PUIG, M. A., FERRERAS-ROMERO, M. & GARCÍA-ROJAS, A. 1990. Morphological variability of *Thyrrhenoleuctra minuta* (KLAPALEK, 1903) in Spain. In: CAMPBELL, I. C. (ed.). *Mayflies and Stoneflies: Life histories and biology*, pp. 357-360. Kluwer Academic Publishers.
- PUIG, M. A., GONZÁLEZ, G. & RECASENS, L. 1987. Modelos de distribución de Plecópteros, Ephemeropteros, Tricópteros y Simúlidos en el Río Ter. *Limnética* 3: 125-132.
- PUJANTE MORA, A. M. 1993. *Macroinvertebrados y calidad de aguas de los ríos de la comunidad Valenciana*. Tesis Doctoral. Universitat de Valencia. 239 pp.
- ROCA, J. R. & DEL CASTILLO, M. 1993. Tipology of the pyrenean springs based on their biological communities. *Actas VI Congreso Español de Limnología (Granada, mayo de 1993)*: 283-289.
- RODRÍGUEZ, S. E., FERNÁNDEZ-ALAEZ, C., FERNÁNDEZ-ALAEZ, M. & BÉCARES, E. 1994. Caracterización de las comunidades de macroinvertebrados de la cuenca alta del río Cares (NO España). *Limnética* 10(1): 93-100.
- ROPERO-MONTERO, J. M., PEÑA, M. P. & SÁNCHEZ-ORTEGA, A. 1996. Composición y fenología de la fauna de Plecópteros (Insecta, Plecoptera) del sur de la provincia de Cádiz. *Boletín. Asoc. esp. Ent.*, in press.
- ROPERO-MONTERO, J. M. & SÁNCHEZ-ORTEGA, A. 1992. Descripción de la ninfa madura de *Leuctra cazorlana* AUBERT, 1962 (Plecoptera, Leuctridae). *Boletín. Asoc. esp. Ent.* 16: 43-49.
- SÁNCHEZ-ORTEGA, A. 1992. Ginandromorfismo en el género *Protonemura* (Insecta: Plecoptera). *Actas do V Congresso Ibérico de Entomología. Lisboa, noviembre de 1992. Bolm Soc. port. Ent.* 1(3): 113-117.
- SÁNCHEZ-ORTEGA, A. & ALBA-TERCEDOR, J. 1988. Description and life cycle of *Leuctra iliberis* sp.n. from Southern Spain (Plecoptera, Leuctridae). *Aquatic Insects* 10(2): 117-123.
- SÁNCHEZ-ORTEGA, A. & ALBA-TERCEDOR, J. 1988. Sobre las ninfas de *Isoperla nevada* AUBERT, 1952 y *Nemoura fulviceps* KLAPALEK, 1902 en Sierra Nevada (Insecta: Plecoptera). *Boletín Asoc. esp. Ent.* 12: 233-238.
- SÁNCHEZ-ORTEGA, A. & ALBA-TERCEDOR, J. 1989. Características de fenología y distribución de las especies de Plecópteros de Sierra Nevada (Insecta: Plecoptera). *Boletín. Asoc. esp. Ent.* 13: 213-230.
- SÁNCHEZ-ORTEGA, A. & ALBA-TERCEDOR, J. 1990. Life cycles of some species of Plecoptera in Sierra Nevada (South of Spain). In: CAMPBELL, I. C. (Ed.). *Mayflies and Stoneflies: Life histories and biology*, pp. 43-52. Kluwer Academic Publishers.
- SÁNCHEZ-ORTEGA, A. & ALBA-TERCEDOR, J. 1990. Los Plecópteros de Sierra Nevada (Granada, España). *Zool. baetica* 1: 77-146.
- SÁNCHEZ-ORTEGA, A. & ALBA-TERCEDOR, J. 1991. The life cycle of *Perla marginata* and *Dinocras cephalotes* in Sierra Nevada (Granada, Spain) (Plecoptera, Perlidae). In: ALBA-TERCEDOR & SÁNCHEZ-ORTEGA (Eds), *Overview and Strategies of Ephemeroptera and Plecoptera*, pp. 493-501. Sandhill Crane Press, Gainesville.
- SÁNCHEZ-ORTEGA, A., PEÑA-CUENCA, M. P. & ROPEROMONTERO, J. M. 1990. Sobre la distribución de *Leuctra iliberis* SÁNCHEZ-ORTEGA Y ALBA-TERCEDOR, 1988 (Plecoptera, Leuctridae). *Boletín Asoc. esp. Ent.* 14: 269.

- SÁNCHEZ-ORTEGA, A. & ROPERO-MONTERO, J. M. 1990. Nuevos datos sobre la distribución de *Rhabdiopteryx christinae* THEISCHINGER, 1975 (Plecoptera, Taeniopterygidae) en la Península Ibérica. *Eos* 66(2): 229-230.
- SÁNCHEZ-ORTEGA, A. & ROPERO-MONTERO, J.M. 1993. *Leuctra franzi paenibetica* n. ssp. del sur de la Península Ibérica. (Insecta: Plecoptera). *Graellsia* 49: 119-121.
- SÁNCHEZ-ORTEGA, A., ROPERO-MONTERO, J. M. AND PEÑA-CUENCA, M. P. 1991. Adult Morphology of *Siphonoperla* species in the Iberian Peninsula. In: ALBA-TERCEDOR & SÁNCHEZ-ORTEGA (Eds), *Overview and Strategies of Ephemeroptera and Plecoptera*, pp. 217-219. Sandhill Crane Press, Gainesville.
- SOLER, G. & PUIG, M.A. 1993. Similitud y diferencias de las pautas de colonización de tramos permanentes y temporales de un río mediterráneo (R. Matarraña, cuenca del Ebro). *Actas VI Congreso Espanol de Limnología (Granada, mayo de 1993)*: 363-372.
- TIERNO, J. M., PÉREZ, T. & SÁNCHEZ-ORTEGA, A. 1996. Composición faunística y fenología de los Plecópteros (Insecta: Plecoptera) de la Serranía de Ronda (Málaga). *Boletín Asoc. esp. Ent.*, in press.
- TIERNO, J. M. & SÁNCHEZ-ORTEGA, A. 1995. Contribución al conocimiento de la fauna de Plecópteros (Insecta: Plecoptera) de Extremadura. *Zool. Baetica* 6: 149-156.
- TIERNO DE FIGUEROA, J. M. & SÁNCHEZ-ORTEGA, A. 1996. Nuevas citas de Plecópteros (Insecta: Plecoptera) en el Pirineo español. *Boletín Asoc. esp. Ent.*, in press.
- TIERNO DE FIGUEROA, J. M. & SÁNCHEZ-ORTEGA, A. 1996. Confirmación de la presencia de *Leuctra alticola* DESPAX, 1929 en España (Plecoptera: Leuctridae). *Boletín Asoc. esp. Ent.*, in press.
- TIERNO, J. M. & SÁNCHEZ-ORTEGA, A. 1996. Revisión de la distribución y el estado de conservación de la fauna de Plecópteros (Insecta, Plecoptera) de los sistemas montañosos andaluces, con especial referencia a Sierra Nevada. *I Conferencia Internacional Sierra Nevada: Conservación y Desarrollo Sostenible (Granada, marzo 1996)*. J. CHACÓN & J.L. ROSÚA (Eds). 3: 69-74.
- TIERNO, J. M., SÁNCHEZ-ORTEGA, A. & PICAZO-MUÑOZ, J. 1994. Sobre la distribución espacial y temporal de *Isoperla nevada* AUBERT, 1952 (Insecta: Plecoptera). *Zool. baetica* 5: 107-112.
- VIDAL LÓPEZ, M. & MEMBIELA IGLESIA, P. 1993. Algunos factores abióticos de la distribución de los Efemerópteros y Plecópteros (Insecta) en las sierras Segundera, Cabrera y Teleno (NW Península Ibérica). *Limnética* 9: 99-106.
- VINÇON, G. & PARDO, I. 1994. Contribution to the knowledge of Pyrenean Stoneflies: *Leuctra joani* sp. n. y *L. clerguae* sp. n. (Insecta. Plecoptera). *Aquatic Insects* 16(4): 205-212.
- ZAMORA-MUÑOZ, C. 1992. *Macroinvertebrados acuáticos, caracterización y calidad de las aguas de los cauces de la cuenca alta del río Genil*. Tesis doctoral. Universidad de Granada. 255+109 pp.
- ZAMORA-MUÑOZ, C. & ALBA-TERCEDOR, J. 1992. *Caracterización y calidad de las aguas del río Monachil. factores físico-químicos y comunidades de macroinvertebrados acuáticos*. Universidad de Granada. 171 pp.
- ZAMORA-MUÑOZ, C., SÁNCHEZ-ORTEGA, A. & ALBA-TERCEDOR, J. 1993. Physico-chemical factors that determine the distribution of Mayflies and Stoneflies in a high-mountain stream in Southern Europe (Sierra Nevada, Southern Spain). *Aquatic Insects* 15(1): 11-20.
- ZWICK, P. 1984. *Marthamea beraudi* (NAVAS) and its European congeners (Plecoptera: Perlidae). *Annls. Limnol* 20 (1-2): 129-139.
- ZWICK, P. & VINÇON, G. 1993. Contribution to the knowledge of Pyrenean Stoneflies (Insecta: Plecoptera). *Annls. Limnol* 29: 47-57.