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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.

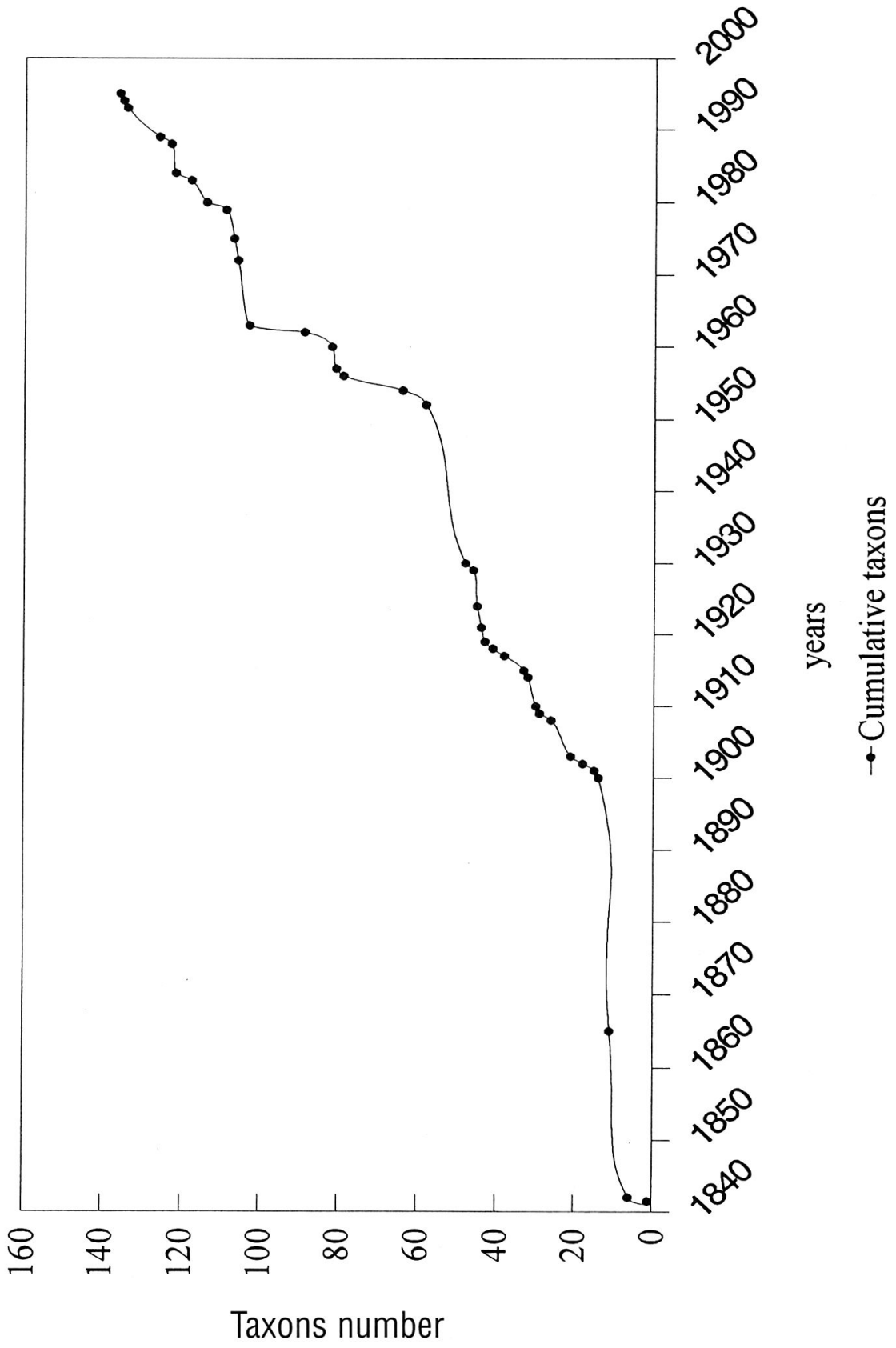

Fig. 1. Historical evolution of the number of Plecoptera species known in the Iberian Peninsula and the Balearic Islands.

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,

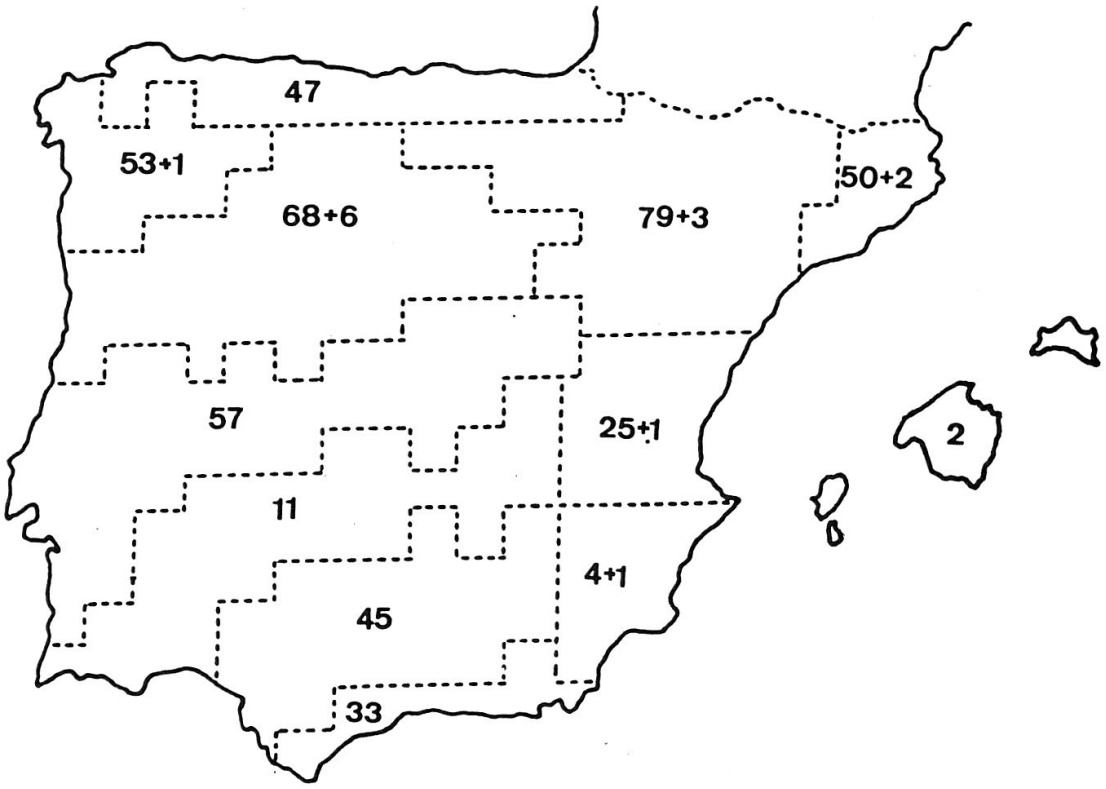

Fig. 2. Plecoptera species distribution by basins in the Iberian Peninsula and the Balearic Islands.

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 (BRITTAIN, 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.).

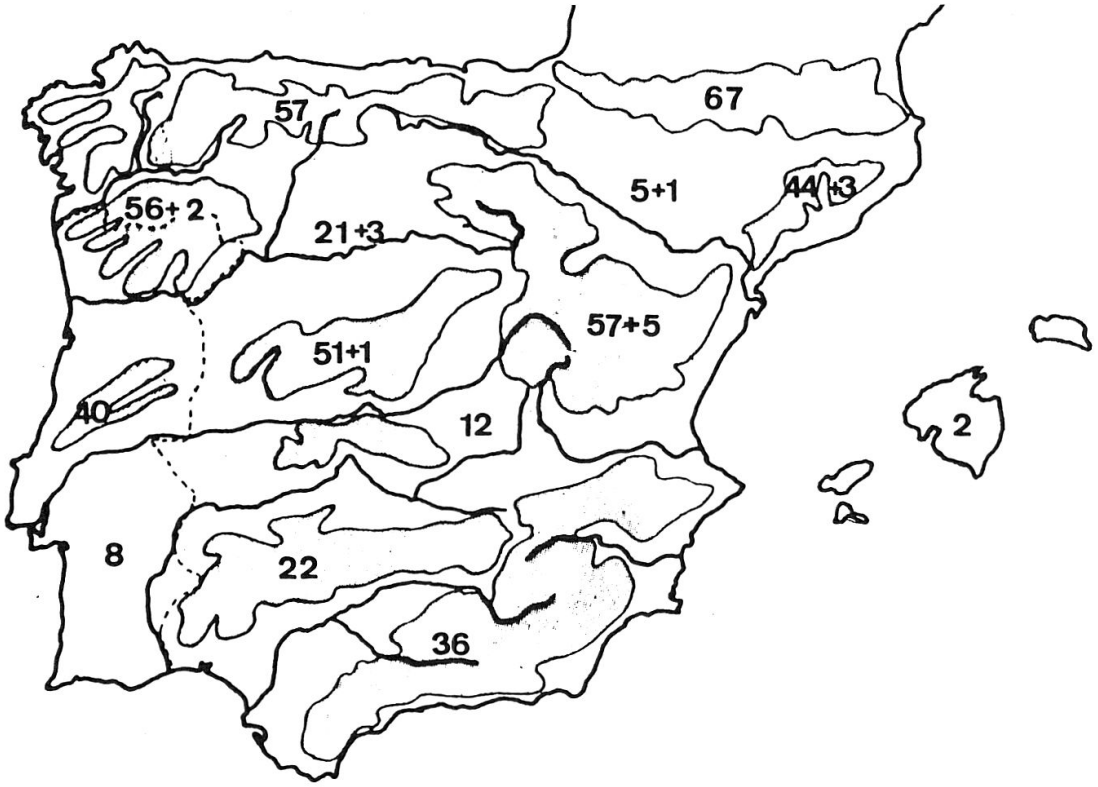

Fig. 3. Plecoptera species distribution by mountain systems in the Iberian Peninsula and the Balearic Islands.

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 actogaeic-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 a 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)

Marthamea selysii
Leuctra balearica
Leuctra bidula
Leuctra wilmae
Marthamea vitripennis
Leuctra besucheti
Leuctra estrela

SPECIES IN DANGER OF DISAPPEARANCE IN THE IBERIAN PENINSULA

Dictyogenus ventralis
Eoperla ochracea
Leuctra digitata
Tyrrhenoleuctra tangerina
Isoperla moselyi
Nemoura rifensis
Leuctra gallica

VULNERABLE SPECIES (R.D.B. 2; UICN W)

a. Global

Isoperla acicularis guadarramica
Brachyptera vera cordubensis
Brachyptera vera vera
Rhabdiopteryx christinae

b. In the Iberian Peninsula

Perlodes dispar
Leuctra alticola
Capnopsis schilleri
Leuctra franzi paenibetica

RARE SPECIES (R.D.B. 3)

LEST RISK (UICN LR)

a. Global

Isoperla acicularis acicularis
Chloroperla acuta

b. In the Iberian Peninsula

Xanthoperla apicalis
Brachyptera seticornis
Taeniopteryx nebulosa
Leuctra kempnyi

INSUFFICIENT DATA (UICN DD)

Amphinemura hibernatarii
Protonemura culmenis
Capnioneura brachyptera
Leuctra berthelemyi
Leuctra gallaeca
Leuctra leptogaster
Leuctra pseudocylindrica
Leuctra thomasi
Protonemura brevistyla
Nemoura cambrica
Capnioneura petitpierrae
Leuctra clerguae
Leuctra hexacantoides
Leuctra mortoni
Leuctra rauscheri

ENDEMIC SPECIES (RDB 5J)

Guadalgenus franzi
Isoperla acicularis cantabrica
Isoperla bipartita
Isoperla moselyi
Isoperla pallida
Perla madritensis
Chloroperla breviata
Siphonoperla baetica
Brachyptera vera vera
Rhabdiopteryx christinae
Amphinemura guadarramensis
Protonemura alcazaba
Protonemura culmenis
Protonemura hiberiaca
Protonemura intricata iberiaca
Protonemura pyrenaica pyrenaica
Protonemura tuberculata
Nemoura ceciliae
Isoperla acicularis acicularis
Isoperla acicularis guadarramica
Isoperla curtata
Isoperla nevada
Isoperla viridinervis
Chloroperla acuta
Chloroperla nevada
Brachyptera arcuata
Brachyptera vera cordubensis
Rhabdiopteryx thienemanni
Amphinemura hibernatarii
Protonemura beatensis beatensis
Protonemura globosa
Protonemura hispanica
Protonemura navacerrada
Protonemura pyrenaica asturica
Protonemura vandeli
Nemoura linguata

Tab. 1. (Suite)

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

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 Associalion 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 *Isoperla 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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Appendix 1. Distribution, by mountain systems, of Iberian species and subspecies of Plecoptera (Pi: Pyrenees; Cc: Cantabrian Cordillera; Ca: Coastal Catalonian 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
Arcynopteryx compacta	X	X	X			X								
Dictyogenus ventralis						X		X	X?					
Guadalgenus franzi				X		X			X	X	X			
Perlodes dispar				X						X				
Perlodes intricata	X					X?								
Perlodes microcephalus	X	X	X	X		X	X	X	X			X		
Hemimelaena flaviventris		X		X		X	X		X	X	X	X		X
Isoperla a. acicularis	X		X											
Isoperla a. cantabrica		X		X										
Isoperla a. guadarramica									X					
Isoperla bipartita				X							X			
Isoperla curtata		X		X		X			X	X	X			
Isoperla grammatica	X	X	X	X		X		X	X	X	X	X		X
Isoperla moselyi	X													
Isoperla nevada												X		
Isoperla pallida									X		X			
Isoperla viridinervis	X													
Dinocras cephalotes	X	X	X	X		X	X	X	X			X		
Eoperla ochracea			X			X	X					X		
Marthamea selysii				X		X		X				X		
Marthamea vitripennis			X		X	X		X						
Perla bipunctata	X	X					X							
Perla burmeisteriana		X				X			X					
Perla grandis	X	X	X			X						X		
Perla madritensis	X	X		X		X		X	X	X				
Perla marginata	X	X	X	X		X	X		X			X		X
Chloroperla acuta				X										
Chloroperla breviata	X	X	X											
Chloroperla nevada				X						X		X		
Chloroperla tripunctata	X	X		X		X			X	X				
Siphonoperla baetica												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	X		X					
Brachyptera arcuata		X	X?	X		X			X	X				
Brachyptera auberti						X			X	X	X	X		
Brachyptera braueri		X	X		X?	X	X	X	X					
Brachyptera monilicornis		X		X	X	X	X		X	X	X			
Brachyptera risi	X	X	X			X								
Brachyptera seticornis	X			X?										
Brachyptera trifasciata					X	X		X						
Brachyptera vera vera							X		X					
Brachyptera v. cordubensis											X			
Rhabdiopteryx christinae						X						X		X
Rhabdiopteryx thienemanni				X?			X		X	X	X			
Amphinemura hibernatarii				X										
Amphinemura standfussi	X													
Amphinemura sulcicollis	X	X	X	X		X								
Amphinemura guadarramensis				X		X?			X	X	X			X
Amphinemurs triangularis		X	X			X						X		
Protonemura alcazaba												X		X
Protonemura brevistyla	X													
Protonemura b. beatensis	X	X	X	X		X?								
Protonemura culmenis	X													
Protonemura globosa				X						X				
Protonemura hiberiaca		X		X		X								
Protonemura hispanica		X		X					X	X				
Protonemura intricata	X	X	X	X		X	X		X	X				
Protonemura meyeri	X	X	X	X		X	X		X		X	X		
Protonemura navacerrada		X		X		X			X	X				
Protonemura praecox	X	X	X	X										
Protonemura p. pyrenaica	X		X											
Protonemura p. asturica		X	X	X		X			X	X				

	Pi	Cc	Ca	Ga	Di	Si	Sn	Ss	Sc	EB	Sm	Sb	BA	EP
Protonemura risi spinulosa	X	X	X											
Protonemura tuberculata	X		X?											
Protonemura vandeli	X		X			X?								
Nemoura cambrica	X								X					
Nemoura ceciliae		X		X		X			X	X				
Nemoura cinerea	X	X	X	X		X			X	X	X	X		X
Nemoura erratica	X					X								
Nemoura fulviceps	X		X	X		X	X	X	X	X	X	X		
Nemoura lacustris	X	X	X	X		X		X	X	X	X	X		
Nemoura linguata	X		X											
Nemoura moselyi	X	X												
Nemoura rifensis												X		
Nemoura uncinata	X	X	X			X			X					
Nemurella pictetii	X	X	X											
Capnia bifrons		X	X			X	X?		X	X				
Capnia nigra	X	X			X	X			X	X		X		
Capnia vidua	X		X											
Capnioneura brachyptera	X													
Capnioneura gelesae											X			
Capnioneura libera				X					X	X				
Capnioneura mitis	X	X	X	X		X	X		X	X	X	X		
Capnioneura petitpierrae											X	X		
Capnopsis schilleri										X	X	X		
Leuctra alosi	X	X	X	X		X	X		X	X				
Leuctra alticola	X													
Leuctra andalusiaca												X		
Leuctra auriensis				X										
Leuctra aurita	X	X	X	X		X								
Leuctra balearica													X	
Leuctra besucheti				X		X?								
Leuctra berthelemyi	X													
Leuctra bidula												X		
Leuctra castillana	X	X	X	X		X	X		X	X				
Leuctra cazorlana												X		
Leuctra clerguae	X													
Leuctra despaxi		X	X	X		X				X				
Leuctra digitata			X											
Leuctra espanoli	X	X												
Leuctra estrela										X				
Leuctra franzi franzi		X		X		X			X					
Leuctra franzi paenibetica												X		
Leuctra fusca	X	X	X	X		X	X		X			X		
Leuctra gallaeca				X										
Leuctra gallica										X				
Leuctra geniculata	X	X	X	X		X	X?	X	X		X	X		
Leuctra hexacanthoides	X													
Leuctra hiberiaca				X					X	X				
Leuctra hippopus	X	X	X	X		X	X		X					
Leuctra hispanica		X		X		X			X	X				
Leuctra iliberis												X		
Leuctra illiesi		X		X					X	X	X			
Leuctra inermis	X	X	X	X		X			X	X		X		
Leuctra kempnyi	X													
Leuctra lamellosa	X	X				X								
Leuctra leptogaster	X	X	X											
Leuctra lusitanica				X			X?			X				
Leuctra madritensis		X		X		X	X		X	X				
Leuctra major	X	X	X			X			X					
Leuctra maroccana				X		X	X		X			X		X
Leuctra mortoni	X													
Leuctra occitana									X					
Leuctra pseudocylindrica	X													
Leuctra rauscheri	X													
Leuctra stupeningi				X					X	X				
Leuctra thomasi	X													
Leuctra wilmae		X												
Pachyleuctra benllochi	X													
Pachyleuctra bertrnndi	X													
Tyrrhenoleuctra minuta											X	X	X	
Tyrrhenoleuctra tangerina												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: Guadiana Basin; Ju: Júcar Basin; Se: Segura Basin; Guq: Guadalquivir Basin; SA: Southern Mediterranian Basin; Ba: Balaearic Islands).

	Mi	CC	Eb	Cat	Du	Ta	Gu	Ju	Se	Guq	SA	Ba
Arcynopteryx compacta		X	X	X	X?							
Dictyogenus ventralis						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. guadarramica					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	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 guadarramensis	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 qlobosa	X				X	X						
Protonemura hiberiaca	X		X		X							
Protonemura hispanica	X	X			X	X						
Profonemura 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									

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

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