

DISTRIBUTION, AUTECOLOGY AND BIOGEOGRAPHY OF DRYOPIDAE AND ELMIDAE (COLEOPTERA, DRYOPOIDEA) IN THE BALEARIC ISLANDS

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ABSTRACT

The distribution of the Dryopidae and Elmidae in the Balearic Islands was studied. Three species of Dryopidae —*Dryops algiricus* (Lucas, 1949), *D. gracilis* (Karsch, 1881) and *D. sulcipennis* (Costa, 1883)— and one of Elmidae —*Oulimnius echinatus* Berthélemy, 1979— were found. Bibliographical data of other three species of Dryopidae exist, but their presence is either refuted —*Dryops lutulentus* (Erichson, 1847)— or requires confirmation —*Dryops luridus* (Erichson, 1847) and *D. rufipes* (Krynicky, 1832)—. *Dryops gracilis* and *D. sulcipennis* are recorded for first time in the archipelago. The first autecological data of the different species in the archipelago and a biogeographical analysis are provided.

Key words: Dryopidae, Elmidae, autecology, biogeography, Balearic Islands.

RESUMEN

Distribución, autoecología y biogeografía de los Dryopidae y Elmidae (Coleoptera, Dryopoidea) en las islas Baleares

Se realiza un estudio sobre la distribución de los Dryopidae y Elmidae en las islas Baleares. Tres especies de Dryopidae —*Dryops algiricus* (Lucas, 1949), *D. gracilis* (Karsch, 1881) y *D. sulcipennis* (Costa, 1883)— y una de Elmidae —*Oulimnius echinatus* Berthélemy, 1979— han sido halladas. Existen datos bibliográficos de otras tres especies de Dryopidae, pero su presencia es excluida —*D. lutulentus* (Erichson, 1847)— o se considera que debe ser confirmada —*D. luridus* (Erichson, 1847) y *D. rufipes* (Krynicky, 1832)—. *Dryops gracilis* y *D. sulcipennis* se citan por primera vez en el archipiélago. Se aportan los primeros datos sobre la autoecología de las diferentes especies en las islas y se realiza un análisis biogeográfico.

Palabras clave: Dryopidae, Elmidae, autoecología, biogeografía, Islas Baleares.

Introduction

The first references to the Dryopidae of the Balearic Islands were published in the previous century by Cardona (1872, 1875), while those of the Elmidae appeared at the beginning of this century in the work of Breit (1909). From then on, most of the published information has been

restricted to faunistic records or compiler catalogues; no ecological studies have been carried out.

This work attempts primarily to accomplish a faunistic revision of the two families of aquatic Coleoptera, and additionally, to provide the first ecological information on the different species in the archipelago.

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Material and methods

A total of 246 sites (120 in Mallorca, 68 in Menorca, 41 in Ibiza and 17 in Formentera) were sampled in the winter (February and March) and spring (May and June) of 1988 (García-Avilés, 1990) using a 30cm² net of 100 µm mesh size. Further samples from Menorca collected between 1982 and 1986, and material held by the National Museum of Natural Sciences (Madrid) have also been included in the revision.

Figure 1 shows the geographical location of the Balearic Islands. Table 1 provides the location and characteristic of the sampling sites where Dryopidae and Elmidae were present (codes of sampling sites are those of García-Avilés, 1990).

Physicochemical characteristics of water were measured on site with WTW instruments (temperature, conductivity and pH) and a Merck test kit for alkalinity (titrimetric method).

Results and discussion

The presence of three species of Dryopidae and one Elmidae has been verified. The species encountered are indicated below, as well as those that have been cited in the literature of the Balearic Islands. Figures 2 and 3 show the distribution of the different species found. The material studied for each

species found is shown, with the code of the sampling station indicated in brackets, followed by the sampling date and the number of adult specimens collected. The paragraph referring to the bibliographic data of each species only includes references based on authors' own collections, or that gathered data unpublished at that time, or that belong to new revisions of existing material. Other references exclusively of compilations of previous data can be found in Montes & Soler (1986).

Species

Family ELMIDAE

Oulimnius echinatus Berthélemy, 1979

MATERIAL STUDIED (fig. 2): Mallorca: (27), 4-II-88, 4 ex.; (71), 19-V-88, 2 ex.; (81), 28-V-88, 2 ex.; (88), 17-V-88, 3 ex.; (91), 25-II-88, 1 ex.; (92), 26-V-88, 1 ex.; (94), 25-II-88, 1 ex.; (100), 25-II-88, 8 ex.; (100), 26-V-88, 1 ex. Menorca: (148), 5-III-88, 3 ex.; (148), 1-VI-88, 64 ex.; (149), 25-VI-82, 2 ex.; (149), 22-V-84, 22 ex.; (149), 21-VI-86, 11 ex.; (149), 1-VI-88, 65 ex.; (151), 6-III-88, 1 ex.; (151), 4-VI-88, 1 ex.; (157), 7-III-88, 2 ex.; (157), 1-VI-88, 23 ex.; (159), 23-VI-82, 7 ex.; (159), 19-V-84, 23 ex.; (159), 21-VI-86, 14 ex.; (159), 7-III-88, 5 ex.; (159), 1-VI-88, 11 ex.; (160), 21-VI-86, 6 ex.; (160), 7-III-88, 6 ex.; (160), 1-VI-88, 25 ex.; (163), 8-III-88, 17 ex.; (163), 3-VI-88, 6 ex.; (164), 8-III-88, 4 ex.; (170), 24-V-84, 6 ex.; (170), 17-VI-86, 12 ex.; (170), 8-III-88, 16 ex.; (178), 1-VI-88, 3 ex.; (186), 6-VI-88, 13 ex.; (251), 17-VI-86, 16 ex.; (254), 21-VI-82, 2 ex.

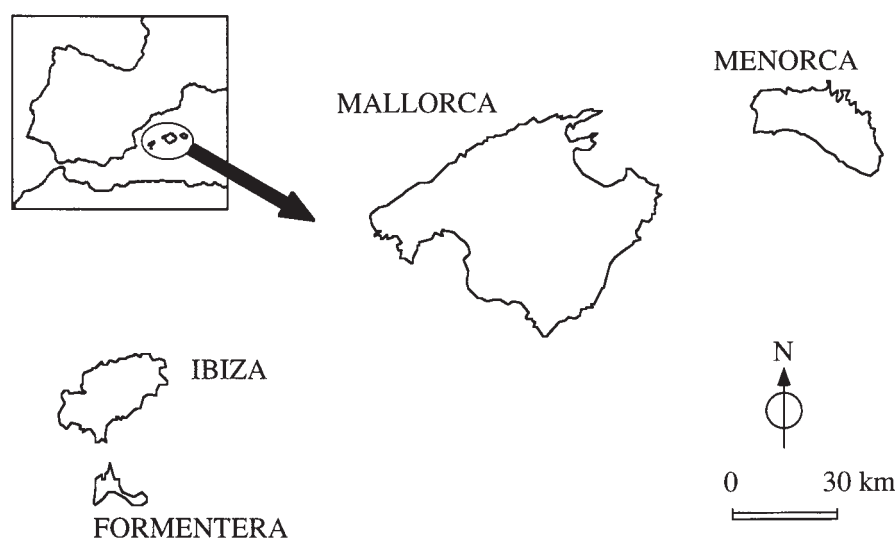


Fig. 1.— Geographical location of the Balearic Islands.

Fig. 1.— Situación geográfica de las islas Baleares.

Table 1.— Location and characteristics of the sampling sites where Dryopidae and Elmidae were found. Habitat type: 1 (stream), 2 (pond), 3 (irrigation tank), 4 (spring).

Tabla 1.— Localización y características de las localidades donde se encontraron Dryopidae y Elmidae. Hábitat: 1 (arroyo), 2 (charca), 3 (depósito de irrigación), 4 (fuente).

Code	Sites	UTM	Altitude (m)	Habitat type
MALLORCA				
6	Torrente de Comafreda	31SDE900065	620	1
7	Torrente de Manut	31SDE913104	500	1
9	Torrente de Ternelles	31SEE006159	80	1
10	Torrente de Massanella	31SDE967003	60	1
11	Torrente de Almedrà	31SDE853003	360	1
14	Torrente Sa Riera	31SDD611855	160	1
27	Torrente de Es Cocó d'en Llorito	31SDD697997	180	1
33	Fuente de Es Prat de Massanella	31SDE856047	800	4
62	Highway drainage ditch in Petra	31SED108836	80	1
71	Alberca by highway C-710	31SDE867086	620	3
81	Torrente Major de Sóller	31SDE754011	60	1
84	Torrente de Fornalutx	31SDE779035	100	1
88	Torrente de Sa Farinera	31SED352923	40	1
91	Fuente Major in Sa Granja	31SDD618909	380	4
92	Torrente de Esporles	31SDD618909	380	1
94	Torrente de Banyalbufar	31SDD586937	10	1
98	Fuente de Sa Menta	31SDD570917	180	4
99	Pileta in Fuente de Sa Menta	31SDD570917	180	3
100	Channel in Estellencs	31SDD562898	140	1
104	Torrente "Mal Torret de Massana"	31SDE975061	60	1
105	Torrente de Sant Miquel	31SDE970048	20	1
120	Alberca in Fuente de S'Estret	31SDD689941	260	3
MENORCA				
132	Torrente de Es Puntarró	31SFE057228	10	1
140	Torrente de Binimel-là	31TEE894323	10	1
141	Pond on Playa de Cavalleria	31TEE919350	2	2
148	Torrente de Algendar	31SEE823240	10	1
149	Torrente de Algendar	31SEE823240	10	1
150	Clot d'Els Tres Jurats	31SFE037219	10	2
151	Torrente de Es Puntarró	31SFE030224	20	1
156	Sa Bassa Verda de Algaiarens	31TEE799343	120	2
157	Torrente de Algendar	31SEE823229	10	1
159	Torrente de Algendar	31SEE825257	20	1
160	Torrente de Algendar	31SEE826258	20	1
161	Torrente de Algendar	31TEE847296	40	1
163	Fuente de En Simón	31SFE055177	3	4
164	Channel in Fuente de En Simón	31SFE055177	3	1
170	Fuente de Torre Solí	31SEE913186	3	4
171	Torrente de Son Boter	31SEE903192	5	1
178	Pond in Barranco de Algendar	31SEE822239	10	2
179	Fuente de S'Alberg Vell	31SEE830265	60	4
184	Torrente en Ets Alocs	31TEE848340	5	1
186	Torrente de Fuente Na Vermella	31SFE033241	40	1
187	Fuente de Ses Font-rodones	31SEE912241	80	4
249	Pond in Barranco de Algendar	31SEE822239	10	2
251	Channel in Fuente de S'Engollador	31SEE901199	20	1
252	Torrente de Son Boter	31SEE902198	10	1
254	Channel in Fuente de En Simón	31SFE055177	10	1
IBIZA				
190	Río de Santa Eulalia	31SCD639191	120	1
191	Channel in Brols d'es Bosquetell	31SCD582202	100	1
201	Pond in Cala de Xarraca	31SCD701287	5	2
229	Pond in Fuente Paredada	31SCD570084	100	2

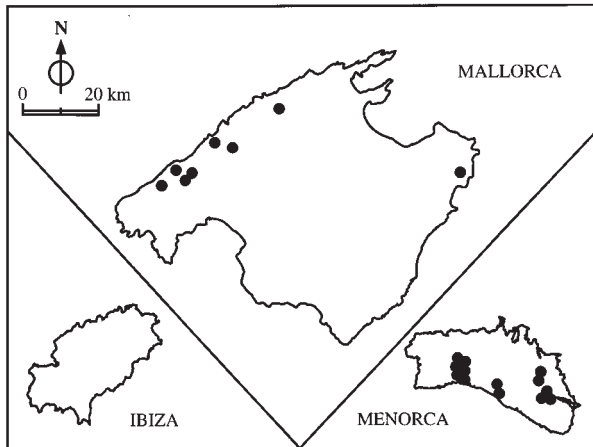


Fig. 2.— Distribution of *Oulimnius echinatus* in the Balearic Islands.

Fig. 2.— Distribución de *Oulimnius echinatus* en las islas Baleares.

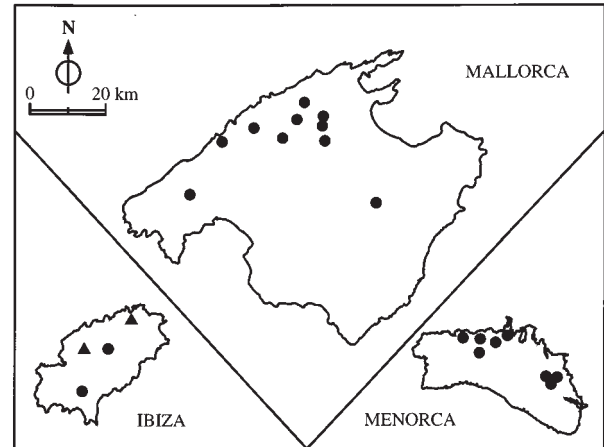


Fig. 3.— Distribution of *Dryops algiricus* (dots) and *D. gracilis* (triangles) in the Balearic Islands.

Fig. 3.— Distribución de *Dryops algiricus* (puntos) y *D. gracilis* (triángulos) en las islas Baleares.

BIBLIOGRAPHICAL DATA: Mallorca: Breit (1909), Tenenbaum (1915), and Sietti (1931) sub *Limnius tuberculatus*; Berthélemy (1979). Menorca: Vilarrúbia & Español (1933) (sub *Limnius tuberculatus*), Pons (1987), Rico (1996).

Family DRYOPIDAE

Dryops algiricus (Lucas, 1849).

MATERIAL STUDIED (fig. 3): Mallorca: (6), 1-II-88, 1 ex.; (6), 19-V-88, 1 ex.; (7), 19-V-88, 3 ex.; (10), 18-V-88, 1 ex.; (11), 2-II-88, 1 ex.; (11), 18-V-88, 1 ex.; (14), 3-II-88, 6 ex.; (27), 4-II-88, 1 ex.; (62), 20-II-88, 1 ex.; (62), 14-V-88, 6 ex.; (84), 28-V-88, 1 ex.; (104), 26-II-88, 8 ex.; (104), 18-V-88, 1 ex.; (105), 18-V-88, 1 ex. Menorca: (132), 30-V-88, 1 ex.; (140), 4-VI-88, 1 ex.; (141), 2-VI-88, 2 ex.; (150), 4-VI-88, 1 ex.; (151), 6-III-88, 1 ex.; (151), 4-VI-88, 2 ex.; (156), 6-III-88, 2 ex.; (156), 2-VI-88, 12 ex.; (161), 1-VI-88, 1 ex.; (184), 5-VI-88, 1 ex.. Ibiza: (190), 6-V-88, 1 ex.; (229), 12-V-88, 3 ex.

BIBLIOGRAPHICAL DATA: Mallorca: Breit (1909), Tenenbaum (1915), Dodero (1918), Sietti (1931). Ibiza: Soler & Montes (1977).

OBSERVATIONS: First record from Menorca.

Dryops gracilis (Karsch, 1881).

MATERIAL STUDIED (fig. 3): Ibiza: (191), 8-II-88, 1 ex.; (191), 7-V-88, 1 ex.; (201), 10-II-88, 1 ex.; (201), 7-V-88, 4 ex.

OBSERVATIONS: First record from the Balearic Islands.

Dryops luridus (Erichson, 1847).

BIBLIOGRAPHICAL DATA: Balearic Islands: Estelrich *et al.* (1885), Fuente (1929) (sub *D. intermedius*). Mallorca: Tenenbaum (1915). Menorca: Cardona (1875), Pons (1987).

OBSERVATIONS: In the two records of *Dryops luridus* from Menorca (Cardona, 1875; Pons, 1987) the determination of this species was doubtful. One female of Cardona's material, held in the National Museum of Natural Sciences (Madrid), without its own identification label, but located near other specimens with a general label of "*Parnus luridus*", is a *Dryops sulcipennis*. The reference of Estelrich *et al.* (1885) is in all probability a bibliographical summary of Cardona's record. Due to the antiquity of the remaining records and the lack of recent captures, its presence in the Balearic Islands is in need of confirmation.

Dryops lutulentus (Erichson, 1847).

BIBLIOGRAPHICAL DATA: Balearic Islands: Estelrich *et al.* (1885). Menorca: Cardona (1872).

Table 2.— Ranges of some physico-chemical variables of sampling sites where species were found.

Tabla 2.— Rangos de algunas variables físico-químicas de las localidades donde se encontraron las especies.

Species	Island	Conductivity ($\mu\text{S cm}^{-1}$)	pH	Alkalinity (mEq l ⁻¹)	Temperature (°C)
<i>Dryops algiricus</i>	Mallorca	499-1778	7.4-8.7	4-6.7	9-22
	Menorca	640-6110	6.6-9.6	0.6-10.3	7.6-28
	Ibiza	1264-1523	7.3-7.6	7.1-7.8	16-19.5
<i>Dryops gracilis</i>	Ibiza	782-1601	7.3-8.2	5.8-7.5	13.5-19
<i>Oulimnius echinatus</i>	Mallorca	569-1569	7-8.7	3.2-7.5	12.5-17.5
	Menorca	1061-2850	7.2-8.3	3.5-8.4	8.7-21

OBSERVATIONS: Cardona's material from Menorca attributed to this species (one male and one female) is housed in the National Museum of Natural Sciences (Madrid). The revision of the material shows that the male and female are *Dryops sulcipennis*. It is very likely that the Estelrich *et al.*'s (1885) reference is a bibliographical summary of Cardona's record. Therefore, we suggest that there is no evidence of the presence of this species in the Balearic Islands.

***Dryops rufipes* (Krynicky, 1832).**

BIBLIOGRAPHICAL DATA: Mallorca: Tenenbaum (1915).

OBSERVATIONS: This species is generally easily recognizable because of its small size, but the largest specimens are in the size range of other species that are present in the Balearic Islands, e.g., *D. sulcipennis*. For this reason, and because of the antiquity of Tenenbaum's record, we suggest that the presence of this species in the Balearic Islands requires confirmation. It has not been recorded from any other west-Mediterranean islands.

***Dryops sulcipennis* (Costa, 1883).**

MATERIAL STUDIED: Menorca: National Museum of Natural Sciences (Madrid), Cardona leg.: one male (sub *Parnus lutulentus*) and two females (one sub *Parnus lutulentus*, and the other without an identification label, but located near other specimens with a general label of *Parnus luridus*; see above).

OBSERVATIONS: First record from the Balearic Islands.

Autecology

Elmidae is a family of rheophilic insects; only a few species are also present in lentic aquatic systems in Europe, and these are all member of the genus *Oulimnius* —*Oulimnius rivularis* (Rosenhauer, 1856), *O. tuberculatus tuberculatus* (Müller, 1806), *O. tuberculatus perezii* (Sharp, 1872)—. *Oulimnius echinatus* lives in the permanent lotic aquatic systems (streams and springs) of the islands of Mallorca and Menorca, and is not present in the lentic systems. The absence of this species from Ibiza can be explained by the fact that all the fluvial systems of this island are temporary.

Oulimnius echinatus is present in the non-polluted courses, with or without aquatic vegetation, and a diverse substratum (mainly pebbles and gravel). The water is moderately mineralised, with maximum conductivity values of 2850 $\mu\text{S/cm}^{-1}$, and a wide range of temperature (8.7-21.0 °C) (table 2). The associated fauna of this species are the beetle, *Hydraena balearica* d'Orchymont, 1930, and the bug, *Velia hoberlandti* Tamanini, 1949, in Mallorca, and the beetles, *Haliphus lineatocollis* (Marsham, 1802), and *Ochthebius dilatatus* Stephens, 1829, in Menorca.

Most species of the Dryopidae family are amphibious, inhabiting either fluvial or palustrine ecosystems. In the Balearic Islands, *Dryops algiricus* is the most euryoic species. It is usually present in permanent streams with very slow to moderate currents, with or without aquatic vegetation, and a diverse substratum (pebbles, gravel and slime). However, it also occurs in small ponds associated with springs, primarily in Ibiza and, to a lesser extent, in Menorca. The waters are fresh to subsali-

ne (high carbonate waters), with a maximum conductivity of $6110 \mu\text{S cm}^{-1}$ associated with a groundwater source 500 m from the sea, and feature a very wide range of temperature ($7.6\text{--}28.0 \text{ }^\circ\text{C}$) (table 2). The associated fauna of this species are the beetles, *Haliphus lineatocollis* (Marsham, 1802), and *Deronectes brannani* (Schaufuss, 1869), the dragonfly, *Sympetrum striolatum* (Charpentier, 1840), and the bug, *Velia hoberlandti* Tamanini, 1949, in Mallorca; the beetles, *H. lineatocollis*, *Graptodytes flavipes* (Olivier, 1795), *Stictonectes optatus* (Seidlitz, 1887), *Ochthebius dilatatus* Stephens, 1829 and *Anacaena lutescens* (Stephens, 1829), the dragonfly, *Lestes viridis* (Vander Linden, 1825), and the bugs, *Corixa affinis* Leach, 1817, *Plea minutissima* Leach, 1817 and *Gerris thoracicus* Schummel, 1832, in Menorca; and the beetles, *H. lineatocollis*, *S. optatus* and *Anacaena bipustulata* (Marsham, 1802), the dragonfly, *S. striolatum*, and the bug, *Microvelia pygmaea* (Dufour, 1833) in Ibiza.

Dryops gracilis is the rarest species in the studied area. It is present in permanent lentic aquatic systems associated with springs, with abundant aquatic vegetation, and a sandy substratum. The waters are moderately mineralised, with a maximum conductivity of $1601 \mu\text{S cm}^{-1}$, and a limited temperature range ($13.5\text{--}19.0 \text{ }^\circ\text{C}$) (table 2). In Ibiza this species always occurred together with *Microvelia pygmaea*.

There are no data about the habitat and ecology of *Dryops sulcipennis* in the Balearic Islands because the material studied, that deposited in the National Museum of Natural Sciences (Madrid), came from an unspecified location in Menorca. Olmi (1976) claims that it is a fluvial species, and Gil *et al.* (1990) locate it in head-waters with reduced levels of mineralisation in the Segura catchment (S.E. Spain).

Biogeographical aspects

The only elm mid present in the Balearic Islands, *Oulimnius echinatus*, is endemic. There are a remarkable number of species of this genus that are endemic in the ibero-balearic territory (Rico, 1996). In contrast with other endemic Iberian species, whose speciation processes may be representative of those of ecosystems maturing in geologically ancient areas that are not subject to severe environmental variations —e.g. glaciations— (Rico, 1992), the speciation of *O. echinatus* must

be attributed to the geographical isolation of the archipelago. The most recent isolation of the Balearic Islands from the continent occurred with the marine transgression of the Pliocene epoch, after the Messinian crisis of the Mediterranean sea (Peres, 1989). Thus, the beginning of the speciation process can be placed in this epoch.

This endemism follows the same pattern of other endemic aquatic insects of the Balearic Islands. In this way, the endemic aquatic insects of the archipelago are characterized by their dependence on permanent lotic aquatic systems, and a limited flight capacity. This is the case for the stonefly, *Leuctra balearica* Pardo et Zwick, 1993, the hydraenid beetles, *Hydraena balearica* d'Orchymont, 1930 and *Limnebius minoricensis* Jäch, Valladares et García-Avilés, 1996, the dytiscid beetle, *Deronectes brannani* (Schaufuss, 1869), or the bug, *Velia hoberlandti* Tamanini, 1949. There are no endemic species in the Balearic Islands of aquatic insects with great flight capacities or less strict ecological requirements, e.g., dragonflies, other dytiscid beetles, etc.

There are no species of Dryopidae endemic to the Balearic Islands. All the species whose presence has been confirmed (*Dryops algiricus*, *D. gracilis* and *D. sulcipennis*) have a Mediterranean focus of distribution. Their distribution extends to the east and west, to a greater or lesser extent, but in Europe they are restricted to southern areas, all of them being present on other Mediterranean islands. Using the terminology of Olmi (1976), their distribution may therefore be described as Mediterranean or Mediterranean-Macaronesian.

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