

## AN ANALYSIS OF HABITAT DISTRIBUTION AND ASSOCIATIONS IN THE ODONATA OF THE BALEARIC ISLANDS, SPAIN

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*Received February 3, 1994 / Revised and Accepted February 6, 1995*

Spatial structure of the odon. community is analysed. The different abundance of the spp. and their most characteristic habitats in the islands are indicated. The reproduction of 19 spp. on the Balearic Islands is confirmed. *Coenagrion scitulum* is recorded for the first time from the archipelago. The associations of spp. existing on each of the islands were established by means of factor analysis (correspondence analysis); a total of 9 associations are defined. This study has been made on larvae exclusively. *Sympetrum striolatum* is the most abundant sp. in the Balearic Islands. Previous records are discussed.

### INTRODUCTION

The Balearic Islands are relatively well known as far as their odonate fauna is concerned. RAMIS (1814) was the first to make reference to this order in the Balearic Islands (Menorca). Later studies by NAVAS (1910, 1914, 1924, 1928a, 1928b), EIDMANN (1927), VILLARRUBIA & ESPAÑOL (1933), ROSENBAUM (1934), MARGALEF (1952, 1953), COMPTE (1952, 1960) GARCÍAS (1953) and BUCHHOLZ (1955) are reviewed by COMPTE (1963), who also included his own data. Knowledge of the Odonata of the archipelago was further extended by COMPTE (1967, 1968), SCHUMANN (1968) and OCHARAN (1987).

However, the above studies are almost completely based on imagos. This study concentrates exclusively on the larvae, thereby indicating those species which re-

produce on the islands, their ecological preferences and the associations of species present in the various habitats.

### MATERIAL AND METHODS

A total of 246 sites (120 on Mallorca, 68 on Menorca, 41 on Ibiza and 17 on Formentera) were sampled in winter (February and March 1988) and spring (May and June 1988) (GARCIA-AVILES, 1990). Extensive sampling was carried out using a 30 cm square net with 100  $\mu$ m mesh size. Figure 1 shows the location of the sites which were sampled; Table I provides a summary of the types of habitat.

Specimens were identified using the keys of CARCHINI (1983) and ASKEW (1988) primarily; these were complemented with the keys of FRASER (1950), AGUESSE (1968) and FRANKE (1979).

In order to establish the different associations of species present on each of the islands a multiple correspondence factorial analysis, SPAD.N version (LEBART et al., 1987), was applied. This was carried out separately for each of the islands. In this analysis presence/absence data were used. Those stations where no Odonata were found were not eliminated from the analysis since this category was

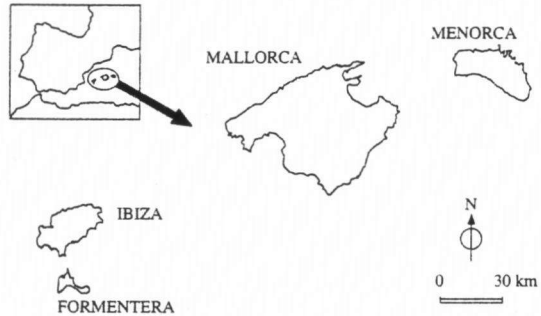


Fig. 1. Geographic location of the Balearic Islands.

Table I  
Types of habitat at the sampling sites

Habitat	Mallorca	Menorca	Ibiza	Formentera
Stream	2,3,6,7,8,9,10,11,12,14, 15,26,27,28,31,34,36,37 38,39,62,63,65,66,69,72, 73,81,83,84,85,86,88,90, 92,94,100,103,104,105, 108,109,111,112,119	125,126,132,136,137,138, 139,140,142,145,147,148, 149,151,157,158,159,160 161,164,165,167,168,171, 172,174,175,181,182,183, 184,186	190,191,208,209,213,216, 223	237,238,239
Pond	4,13,17,18,19,20,21,22, 23,24,25,47,48,50,52,53, 54,55,57,58,61,93,116,117	121,122,124,131,134,135, 141,143,144,150,152,154, 155,156,162,176,178,185	201,207,229	234,240,241,243,244,246
Small man-made pond	16,43,51,56,59,60,67,71, 77,78,79,80,89,95,96,97, 99,106,110,114,120	153,166,173,188	189,192,195,196,197,200, 203,205,210,212,214,215, 217,218,219,220,221,222	242
Marsh	29,30,35,40,41,42,44,45, 46,101	123,127,128,129,130,133, 146,169,177	202,226	230,231,232,235,236,245
Spring	1,5,32,33,49,64,68,70,76, 82,87,91,98,102,107,113, 115,118	163,170,179,180,187	193,194,198,199,204,206, 211,224,225,227,228	233
Reservoir	74,75			

also considered in the case of active variables.

Based on the resulting scores of each of the multiple correspondence analyses, a cluster of 20 fixed groups was formed for all of the cases considered in each analysis. These were then organized into five classes in order to maximize objectivity of the results.

## SPECIES

A total of 19 species were captured, one of which (*Coenagrion scitulum*) is recorded for the first time from the Balearic Islands. The species, the islands and the sites where they were found, their abundance on each island (Tab. II), their preferred habitats, their general distribution and other factors are mentioned below.

*Calopteryx haemorrhoidalis* (Vander Linden, 1825)

Mallorca: rare (sites: 92, 100, 108). –

Menorca: scarce (sites: 148, 149, 157, 159, 160, 171, 179).

Found mainly in streams with aquatic vegetation, moderate to fast currents and fresh water.

According to COMPTE (1963) MARGALEF's note of *C. virgo* (Linnaeus, 1758) for Menorca (MARGALEF, 1952) and NAVAS' note of *C. splendens* (Harris, 1782) for Mallorca (NAVAS, 1914) are identification errors; both were *C. haemorrhoidalis*.

*Sympetma fusca* (Vander Linden, 1820)

Mallorca: very rare (site: 90). – Menorca: common (sites: 121, 131, 136, 137, 139, 150, 154, 156, 174, 176, 183).

Found in ponds with abundant vegetation and in the mouths of streams with macrophytes present.

*Lestes barbarus* (Fabricius, 1798)

Menorca: scarce (sites: 121, 122, 125, 137, 175, 176).

Found in ponds and in streams with almost no current, abundant aquatic vegetation and fresh or slightly brackish water.

*L. viridis* (Vander Linden, 1825)

Mallorca: scarce (sites: 2, 10, 11, 12, 16, 27, 63, 81, 86, 88, 89, 93, 97, 105, 108, 120). – Menorca: abundant (sites: 125, 126, 132, 137, 140, 142, 148, 149, 150, 151, 154, 157, 160, 161, 174, 175, 176, 178, 179, 181, 183, 187, 188). – Ibiza: scarce (sites: 201, 223, 229).

Found in very diverse habitats, with ponds, small man-made ponds and streams of slow to fast currents as the most frequent; also in slightly brackish water. Normally where aquatic macrophytes were present.

COMPTE's (1952) listing of *L. dryas* Kirby, 1890 for Mallorca is an identification error according to the same author (COMPTE, 1963); it was *L. viridis*.

*Erythromma viridulum* (Charpentier, 1840)

Table II  
Assessment of the status of a species  
on an island

Status	Proportion of sites from which recorded
Very abundant	> 50%
Abundant	30% - 50%
Common	15% - 29%
Scarce	5% - 14%
Rare	< 5%
Very rare	only 1 site

**Mallorca:** very rare (site: 89).

Found only in a very old and stable man-made freshwater pond, which is 70 cm deep and contains abundant vegetation reaching the surface in some parts. It is fed by the stream of Sa Farinera.

*Cercion lindeni* (Sélys, 1840)

**Mallorca:** very rare (site: 90). – **Menorca:** rare (sites: 139, 174).

The three sites where this species was found are in streams, near their mouths, with practically no current, a sand substrate and abundant vegetation emerging along the banks.

*Coenagrion caeruleascens* (Fonscolombe, 1838)

**Menorca:** scarce (sites: 157, 159, 160, 167).

Found mainly in streams with slow to moderate currents and containing abundant emerging vegetation. It is quite restricted with three of the sites in the Algendar stream.

*C. scitulum* (Rambur, 1842)

**Mallorca:** very rare (Site: 89). – **Menorca:** very rare (site: 121). This species is new for the fauna of the Balearic Islands.

Found on Menorca, in a pond, and Mallorca, in a small man-made pond; both more than 60 to 70 cm deep, with clear water and abundant carophytes.

*Ischnura elegans* (Vander Linden, 1820)

**Mallorca:** scarce (sites: 28, 29, 30, 36, 39, 40, 88, 89, 90, 101, 102, 117, 119). – **Menorca:** abundant (sites: 121, 130, 131, 134, 135, 136, 137, 138, 139, 140, 148, 149, 150, 154, 155, 156, 157, 159, 160, 167, 168, 171, 172, 174, 175, 176, 181, 183). – **Ibiza:** scarce (sites: 190, 208, 210, 216). – **Formentera:** very rare (site: 233). This species is recorded for the first time from Formentera.

Found in streams with slow to moderate currents and in ponds and marshes; all containing abundant aquatic vegetation.

COMPTE (1963) indicates that the note by VILLARRUBIA & ESPAÑOL (1933) of *I. graellsii* (Rambur, 1842) for Menorca is an identification error; it was *I. elegans*.

*Ceriagrion tenellum* (de Villers, 1789)

**Mallorca:** rare (sites: 81, 102). – **Menorca:** common (sites: 148, 149, 157, 159, 160, 170, 171, 172, 178, 179, 181).

Found on Mallorca and Menorca mainly in streams with slow currents, and in three springs; all containing abundant aquatic vegetation and fresh water.

During this study extensive sampling was carried out in those areas of Ibiza where COMPTE (1967) found imagos of this species. No individuals were found; thus its reproduction on this island cannot yet be confirmed.

*Aeshna affinis* Vander Linden, 1823

**Mallorca:** very rare (site: 62). This species is recorded for the first time from this island.

The only captured individuals were found in a small stream located along the side of the disused Petra to Manacor road, approx. 2 km from Petra. This is a fresh water stream with a slow current, a mud and gravel substrate and abundant coverage by terrestrial and aquatic vegetation.

Previously cited only for Menorca (OCHARAN, 1987). The lack of captured individuals on this island during the study makes it impossible to confirm its reproduction here.

*A. mixta* Latreille, 1805

Mallorca: very rare (site: 90). – Menorca: scarce (sites: 121, 132, 140, 148, 149, 151, 172, 176). – Ibiza: very rare (site: 229). This species is recorded for the first time from Menorca and Ibiza.

Found mainly in streams with slow or very slow currents and in ponds; all containing abundant vegetation.

*Anax imperator* Leach, 1815

Mallorca: scarce (sites: 12, 16, 18, 47, 51, 67, 80, 89, 93, 97, 105, 106, 114, 120). – Menorca: very rare (site: 131). – Ibiza: common (sites: 189, 190, 192, 203, 207, 210, 217, 221, 222).

Found mainly in small man-made ponds, with or without vegetation, of fresh or slightly brackish water. It was also found in a few ponds with abundant macrophytes.

*A. parthenope* (Sélys, 1839)

Mallorca: very rare (site: 90). – Ibiza: very rare (site: 220). This species is recorded for the first time from Ibiza.

Found on Mallorca close to the mouth of the Canyamel stream where there is practically no current and abundant emerging vegetation. On Ibiza it was found in a small man-made pond 70 cm deep with considerable numbers of carophytes.

*Orthetrum cancellatum* (Linnaeus, 1758)

Mallorca: rare (sites: 43, 52, 80). – Ibiza: scarce (sites: 217, 218, 220).

Found mainly in small man-made ponds with or without aquatic vegetation, almost always with fresh to slightly brackish water and with a mud substrate.

Based on captured imagoes, it has been considered common or abundant on the Balearic Islands (COMPTE, 1963, 1967; OCHARAN, 1987), though this study, based on larvae, considers it rare on Mallorca and scarce on Ibiza and it was not found on Menorca, from where it was cited by COMPTE (1963, 1968) and OCHARAN (1987). The lack of captured larvae on Menorca during this study makes it impossible to confirm its reproduction here.

*O. coerulescens* (Fabricius, 1798)

Mallorca: very rare (site: 108). – Menorca: scarce (sites: 148, 149, 171, 172, 179, 187). – Ibiza: rare (sites: 191, 193).

Found mainly in streams with slow to fast currents, always containing abundant vegetation. It was also found in springs. The case of Ibiza is quite interesting in that there are practically no streams on this island and this species was captured in the only lotic sites present, i.e. a small irrigation canal and a spring or artesian well flowing towards another irrigation canal.

*Crocothemis erythraea* (Brullé, 1832)

Mallorca: scarce (sites: 16, 18, 43, 52, 78, 80, 89, 90, 114, 117, 120). – Menorca: scarce (sites: 121, 167, 168, 183). – Ibiza: scarce (sites: 190, 217, 220, 221, 222). –

**Formentera:** very rare (site: 233). This species is recorded for the first time from Formentera.

Found on Mallorca and Ibiza in small man-made and natural ponds with or without vegetation and with fresh or brackish water. On Menorca it was found mainly in streams with slow currents and macrophytes present. On Formentera it was found in a spring constituting the only permanent non-salty water habitat sampled on this island.

*Sympetrum fonscolombei* (Sélys, 1840)

**Mallorca:** rare (sites: 17, 20, 23, 53, 110). – **Menorca:** rare (sites: 121, 134, 135). – **Ibiza:** scarce (sites: 200, 207, 217). – **Formentera:** scarce (sites: 238, 244).

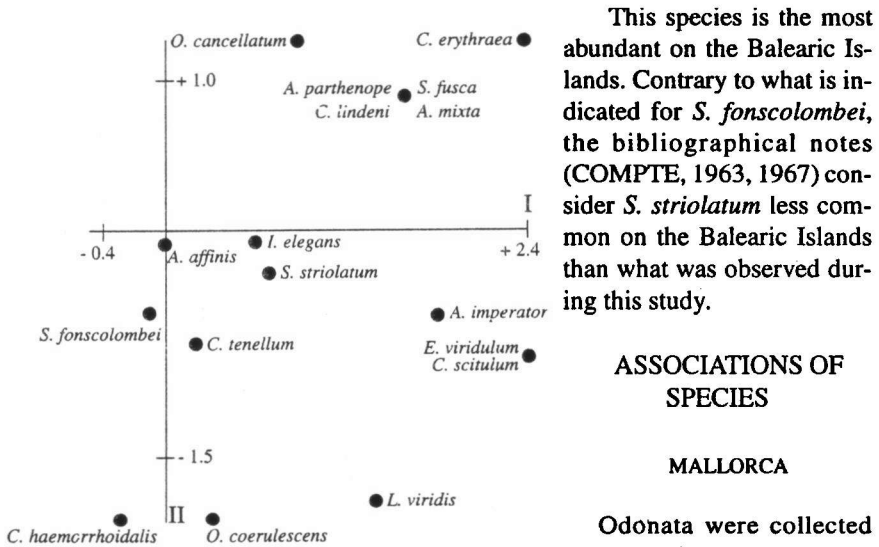
Found always in stagnant water. Usually in natural ponds and a few small man-made ponds containing aquatic vegetation and fresh water.

We can not confirm the frequency assigned to this species on the Balearic Islands in the literature (COMPTE, 1963, 1967), where it is generally considered, as very frequent or very common, particularly so on Mallorca. Our evidence indicates its scarcity in the archipelago.

*S. striolatum* (Charpentier, 1840)

**Mallorca:** abundant (sites: 2, 3, 7, 9, 10, 11, 12, 15, 16, 17, 18, 20, 21, 22, 23, 28, 30, 36, 43, 47, 48, 52, 53, 55, 57, 61, 62, 63, 66, 80, 81, 84, 85, 86, 88, 89, 90, 91, 93, 94, 101, 104, 105, 108, 110, 115, 117, 119, 120). – **Menorca:** abundant (sites: 121, 126, 131, 132, 134, 136, 137, 138, 139, 140, 142, 147, 151, 160, 161, 165, 167, 172, 175, 178, 181, 183, 186). – **Ibiza:** common (sites: 190, 191, 192, 193, 206, 207, 216, 221, 222, 229).

Found in all habitat types, though particularly in streams with slow or very slow currents and in ponds; all containing macrophytes and fresh or brackish water.



This species is the most abundant on the Balearic Islands. Contrary to what is indicated for *S. fonscolombei*, the bibliographical notes (COMPTE, 1963, 1967) consider *S. striolatum* less common on the Balearic Islands than what was observed during this study.

ASSOCIATIONS OF SPECIES

MALLORCA

Odonata were collected from 62 of the 120 sampled sites on the island of Mallorca.

Fig. 2. Plot of the first two axes of the multiple correspondence analysis for the odonate species of Mallorca.

ca. Of the 19 species present on the Balearic Islands, 17 are found on Mallorca, though these were captured at only a few sites (mostly less than 3). Only one species, *S. striolatum*, was captured throughout most of the island (49 sites). Another four were present at more than 10 sites (*L. viridis*, *I. elegans*, *A. imperator*, *C. erythraea*).

The variances for the first two axes of the correspondence analysis account for 25.72% and 15.87% (total 41.59%) of the total variance. The first axis is defined by two frequent species at its positive end (*C. erythraea*, *A. imperator*), along with two species

which appear only once, *E. viridulum* and *C. scitulum* (Fig. 2). The second axis is associated at its negative end with three species, *C. haemorrhoidalis*, *O. coerulescens* and *L. viridis* (Fig. 2). Comparing this with the habitats of these species it appears that the positive end of axis 1 is defined by lentic habitats (small man-made ponds and ponds), whereas the negative end of axis 2 is defined mainly by streams (Fig. 3). The remaining axes of the analysis are associated only with stations where a species appeared once, and are therefore impossible to define.

A cluster analysis was made based on the scores obtained from the preceding factorial analysis (Fig. 4) and the resulting groups were divided into five classes (Tab. III). Class 1 is made up of the sites of accidental species, lacking those which define the remaining groups.

In general, the following associations can be defined for the island of Mallorca as a whole:

- (1) Permanent streams (three streams located in the Sierra de Tramuntana): Class 2 with *C. haemorrhoidalis* as the characteristic species.
- (2) Permanent lentic habitats (ponds, small man-made ponds and lentic areas of streams): Class 4 with *A. imperator*, *C. erythraea* and *L. viridis*.
- (3) Seasonal lentic habitats: (a) Small man-made ponds (Class 5), with *C. erythraea* and *O. cancellatum*; – (b) Ponds in the Marina de Lluçmajor (Class 3), with *S. fonscolombeii*.

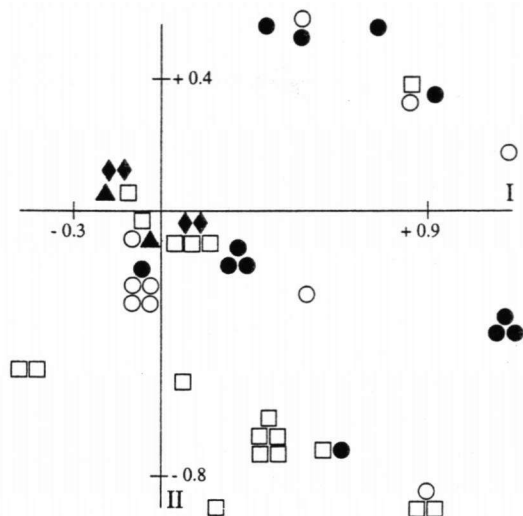


Fig. 3. Ordination of the sampling sites of Mallorca on the first two axes of the multiple correspondence analysis. – [Symbols used for the habitat types: ▲ springs, □ streams, ● small man-made ponds, ○ ponds, ◆ marshes].

Table III  
Occurrence of the associations of characteristic species.  
[- = no defined association, accidental assemblages only]

Island	Class	Cluster groups	Localities	Association
Mallorca	1	2,3,4, 5,6,7	2,3,7,9,10,11,15,21,22,27,28, 29,30,36,39,40,48,55,57,61,62, 63,66,81,84,85,86,88,91,94, 101,102,104,115,119	—
	2	8,9	92,100,108	<i>C. haemorrhoidalis</i>
	3	10	17,20,23,53,110	<i>S. fonscolombei</i>
	4	11,12, 13,14, 15,16, 17,18	12,16,18,47,51,67,78,89,90,93, 97,105,106,114,117,120	<i>A. imperator</i> <i>C. erythraea</i> <i>L. viridis</i>
	5	19,20	43,52,80	<i>C. erythraea</i> <i>O. cancellatum</i>
Menorca	1	1,2,3, 4,5	121,134,135,167,168,183	<i>C. erythraea</i> <i>S. fonscolombei</i> <i>I. elegans</i>
	2	6,7,8, 9,10	122,125,131,136,137,139,150, 154,156,174,175,176	<i>S. fusca</i> <i>C. lindeni</i> <i>L. barbarus</i> <i>I. elegans</i>
	3	17,18, 19,20	148,149,157,159,160,171,172, 179	<i>C. haemorrhoidalis</i> <i>C. tenellum</i> <i>O. caerulescens</i> <i>C. caerulescens</i> <i>I. elegans</i>
	4	11,12, 13,14, 15	The rest of the island	—
Ibiza	1	1,2,3, 4,5,6, 7	189,194,195,196,197,198,199, 200,201,202,203,204,205,206, 208,209,211,212,213,214,215, 218,219,223,224,225,226,227, 228	—
	2	8,9	191,193	<i>O. caerulescens</i>
	3	11,12, 13,14, 15,16, 17, 18, 19	190,192,207,210,216,217,221, 222	<i>A. imperator</i> <i>C. erythraea</i> <i>S. striolatum</i>



MENORCA

Of the 19 species present in the archipelago, 15 were captured at 43 of the 68 sites sampled on Menorca. Three of these are abundant on the island, viz. *L. viridis*, *I. elegans* and *S. striolatum*. They were present at approximately 40% of the sites. *S. fusca* and *C. tenellum*, were found at 11 sites while the remaining 10 species can be considered scarce or rare.

In the multiple correspondence factorial analysis for all 68 sampled sites, the first two axes account for 22.6% and 18.72% (total 41.32%) of the variance. Figure 5 shows the species with respect to these axes. Five species are associated with the negative end of the first axis (*A. mixta*, *C. tenellum*, *C. haemorrhoidalis*, *C. caerulescens* and *O. coerulescens*), whereas the second axis presents the following species associated with its positive end: *C. erythraea*, *C. scitulum*, *S. fonscolombeii*, *C. lindeni*, *S. fusca* and *L. barbarus*. The three most common species on the island appear in the upper left square (-/+ ) and are not defined by either of the two axes. Upon observing the distribution of the sites in regard of these first two axes (Fig. 6) both are seen to separate groups of streams which, as a whole, are presented on a gradient with respect to the first two axes; from the mouths of streams of the southern versant (positive end of axis 2) up to those sites located far from the mouths of streams (negative end of axis 1).

A cluster analysis, based on the resulting axes of the correspondence analysis (Fig. 4), established four site classes (Tab. III), each characterized by a different association of species. The fourth class is characterized by the absence of species that define the three previous classes, having only accidental species.

As a whole the following associations can be defined for Menorca:

- (1) Lentic habitats. (a) In general (a group of ponds and the lentic areas of 3 streams): Class 1 with *C. erythraea*, *S. fonscolombeii* and *I. elegans*; - (b)

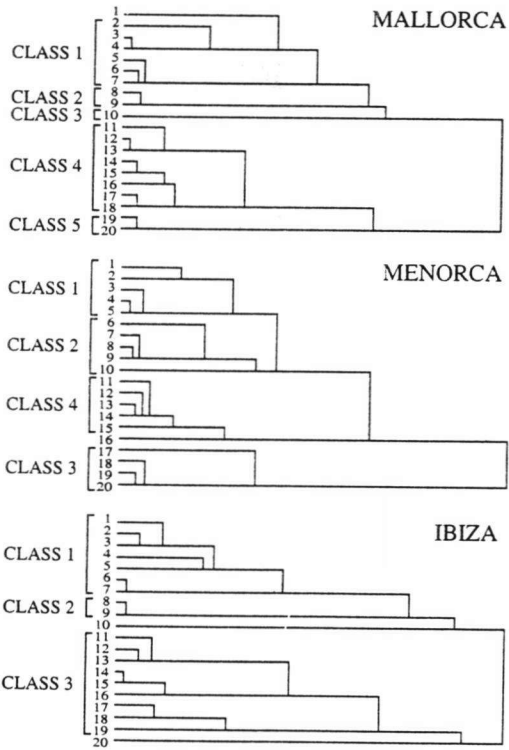
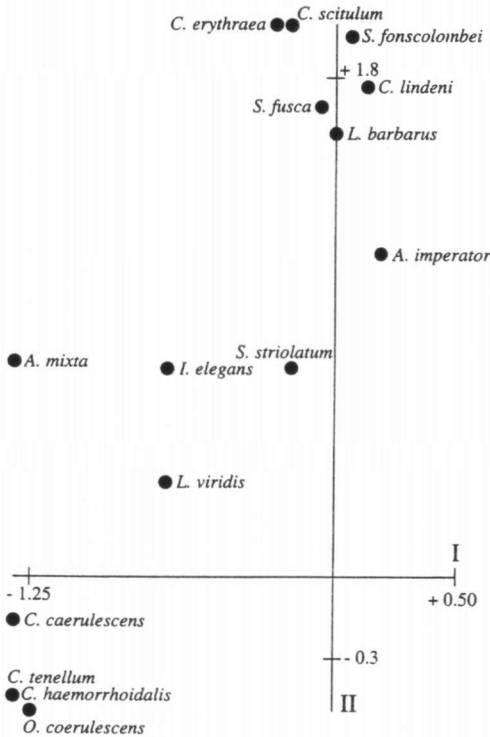


Fig. 4. Dendrograms based on the scores of the multiple correspondence analyses.

Lentic habitats on the northern coast (permanent ponds and the mouths of streams): Class 2 with *S. fusca*, *C. lindeni*, *L. barbarus* and *I. elegans*.

- (2) Permanent streams (sites located far from the mouths of permanent streams, in particular the Algendar stream): Class 3 with *C. haemorrhoidalis*, *C. tenellum*, *O. coerulescens*, *C. caerulescens* and *I. elegans*.



IBIZA

Of the 19 Balearic species, only 10 were evidenced on Ibiza. They were found at 20 of the 41 sites sampled during this study. *S. striolatum* and *A. imperator*, were captured at 40% of the odonate sites on the island.

The results of the correspondence analysis are shown in Figures 7 and 9 for the first two axes of the analysis. These axes account for 22.71% and 17.94% (total 40.65%) of the total variance. Axis 1 appears to be defined by the opposition of six species, viz. *L. viridis*, *A. mixta* and *O. coerulescens* (associated with the positive end of the axis) versus *C. erythraea*, *S. fonscolombei* and *A. imperator* (associated with the negative end) (Fig. 7). This axis separates the artificial habitats (small man-made ponds), which are the most permanent on Ibiza,

Fig. 5. Plot of the first two axes of the multiple correspondence analysis for the odonate species of Menorca.

from the natural habitats (springs, streams and ponds), which are almost always temporal (Fig. 8). Axis 2 appears to be defined mainly by *S. striolatum*, *A. mixta* and *O. coerulescens*, at its positive end (Fig. 7).

A cluster was formed based on the groups of axes resulting from the correspondence analysis (Fig. 4). It was divided into three classes (Tab. III). Class 1 covers the majority of the island and is characterized by the absence of the three most common species, *S. striolatum*, *A. imperator* and *C. erythraea*. These sites contain only a few of the rare species and have no clear associations.

Two associations of species can be defined for the island of Ibiza as a whole:

- (1) Permanent lotic habitats (two irrigation canals supplied by the springs): Class

2 with *O. coerulescens*.

- (2) Permanent lentic habitats (small man-made ponds and the lentic areas of two streams): Class 3 with *A. imperator*, *S. striolatum* and *C. erythraea*.

#### FORMENTERA

Of the 17 sites sampled on this island, odonates were captured at only three. *I. elegans*, *C. erythraea* and *S. fonscolombei* were recorded. The first two were captured in a permanent pond associated with a spring, whereas *S. fonscolombei* was present at two sites, both in lentic habitats (a pool in Ses Fontanelles stream and a pond).

#### CONCLUSIONS

A total of 8 species cited by other authors were not found during this study. It must be noted that 6 of these are either old records, or based on very few individuals, therefore their occurrence is accidental and their reproduction on the islands is uncertain. These species are: *P. latipes* Ramb. [mentioned for Mallorca by NAVAS, 1910], *A. cyanea* (Müll.) and *O. brunneum* (Fonsc.) [cited for Mallorca by NAVAS, 1914], *I. pumilio* (Charp.) [one individual recorded by COMPTE, 1967, on the islet of Los Ahorcados, close to Ibiza], *H. ephippiger* (Burm.) [4 individuals recorded by COMPTE, 1963, from Mallorca] and *L. depressa* L. [cited for Mallorca by NAVAS, 1914, and for Menorca by COMPTE, 1963]. On the other hand, *A. isosceles* (Müll.) has been mentioned by several authors for Mallorca (NAVAS, 1914; COMPTE, 1963; SCHUMAN, 1968) and Menorca (COMPTE, 1963; OCHARAN, 1987), but always based on imagos. Since no larvae were evidenced during this study, we are unable to confirm its reproduction in the archipelago. Lastly, *S. nigra* (Vander L.) has been cited for Mallorca (ROSENBAUM, 1934; GARCÍAS, 1953; COMPTE, 1960; HAGEN, 1991) and COMPTE (1963) confirmed its reproduction on the Balearic Islands after observing numerous exuviae in the small man-made ponds of a small area in the vicinity of Palma. This has not

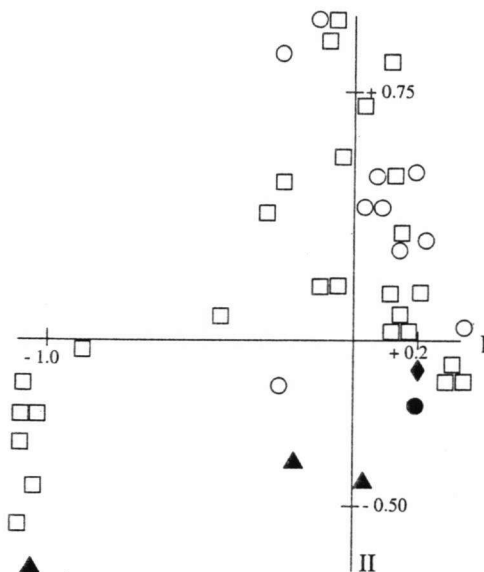


Fig. 6. Ordination of the sampling sites of Menorca on the first two axes of the multiple correspondence analysis. — [Symbols used for the habitat types:  $\blacktriangle$  springs,  $\square$  streams,  $\circ$  small man-made ponds,  $\diamond$  marshes].

been confirmed during our survey.

The 19 species found on the Balearic Islands are widely distributed throughout the Mediterranean area, particularly in the West. Most are present on the Iberian Peninsula, in France, Italy, Corsica, Sardinia, Sicily and North Africa. The sole exceptions are *I. elegans*, which to date has not been cited for Corsica, Sardinia, Sicily or North Africa, and *O. coerulescens*, which has not been found in North Africa or on Sardinia (CAR-

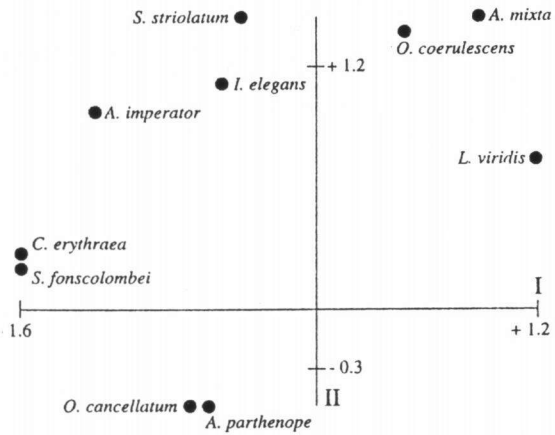


Fig. 7. Plot of the first two axes of the multiple correspondence analysis for the odonate species of Ibiza.

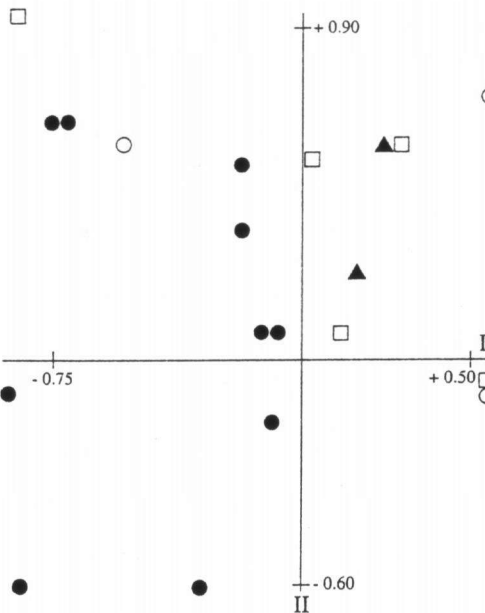


Fig. 8. Ordination of the sampling sites of Ibiza on the first two axes of the multiple correspondence analysis. — [Symbols used for the habitat types: ▲ springs, — □ streams, — ● small man-made ponds, — ○ ponds].

CHINI et al., 1985; MICHIELS, 1988; ASKEW, 1988; OCHARAN, in press).

The several associations defined during this study for each of the islands, group the aquatic habitats into two classes, viz. permanent lotic habitats and lentic environments.

Permanent lotic habitats (streams on Mallorca and Menorca and, in the unusual case of Ibiza, two irrigation canals) have as the characteristic species *C. haemorrhoidalis* on Mallorca and Menorca and *O. coerulescens* on Ibiza. On Menorca *C. haemorrhoidalis* is associated with *C. tenellum*, *O. coerulescens* and *C. caerulescens*.

The large variety of lentic habitats offers a greater diversity of associations. The most characteristic species is *C. erythraea*, which is especially associated with *A. imperator* in the permanent lentic habitats on Mallorca and Ibiza, with *O. cancellatum* in the temporal man-

-made ponds on Mallorca and with *S. fonscolombi* in the lentic habitats on Menorca. In addition, an association found exclusively on Menorca, consists of *S. fusca*, *C. lindeni* and *L. barbarus*, which are characteristic of the lentic environments on the northern coast of the island.

#### ACKNOWLEDGEMENTS

We are indebted to Dr J.A. PALAZÓN and Dr J.F. CALVO SENDÍN for their help with the statistical methods.

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