A SURVEY OF THE SPANISH EUPHYLLOPODA

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Alonso, M., 1985. A survey of the Spanish Euphyllopoda. *Misc. Zool.*, 9: 179-208.

The study of many euphyllopod populations found in various locations throughout Spain on several sampling trips has enabled the identification of 15 species: 10 anostraceans, 2 notostraceans and 3 conchostraceans. At the same time, valuable biogeographical and ecological information has been obtained of the different species because of the large area prospected and the heterogeneity of the environments involved. Some of the species are from saline environments, *Artemia salina* is from the permanent ones, while *Branchinecta cervantesi, Branchinella spinosa* and *Branchinectella media* are from the temporary ones of endorheic regions of the eastern half of the Peninsula. The remaining species colonize temporary waters. *Tanymastix stagnalis* and *Lepidurus apus* are from clear waters and follow a northerm distribution, while the rest prefer turbid waters. *Streptocephalus torvicornis* lives in the eastern half of Spain; *Branchipus schaefferi, Branchinecta ferox, Triops cancriformis simplex, Eoleptestheria ticinensis* and *Cyzicus tetracerus* in the north one, and *T. c. mauritanicus* and *C. grubei* in the south. *Chirocephalus diaphanus,* the most eurycorous and cosmopolitan, is also the species most frequently found in the mountains.

Key words: Anostraca, Notostraca, Conchostraca, Taxonomy, Ecology, Biogeography, Spain.

(Rebut: 30-I-85)

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INTRODUCTION

The Iberian Peninsula is particularly attractive for the study of epicontinental freshwater crustaceans, as its great ecological diversity enables a rich fauna of several zoological groups including the euphyllopods. Old papers published on the Iberian euphyllopods are scarce (ARÉVALO, 1915; CARVALHO, 1944; FONT DE MORA, 1923). The first consistent data are those of Margalef, which were gathered in several field trips to the northern half of the Peninsula and can be found summarized in his monography on Spanish crustaceans (MARGALEF, 1953).

An initial sampling trip around Central Southern Spain yielded interesting results (ALONSO, 1978), and later on the systematic sampling of over 700 lagoons and pools throughout the country has enabled the completion of a significant inventory of the Spanish euphyllopod fauna.

One of the main purposes of this study has been the ecology and distribution of the species, while on the other hand, the comparison with the works of GAUTHIER (1928, 1933) and COTTARELLI & MURA (1983) allows the location of the Spanish species in the biogeographical context of the western Mediterranean, and contributes to the understanding of the Iberian regional limnology.

It is important to insist on the rarity of these organisms and on their faunistic interest. Some of them are in danger of extinction because of the rapid alteration and destruction of their habitats, and it is therefore probable that part of the localities here mentioned have already disappeared.

MATERIAL AND METHODS

The material studied is the result of several sampling trips carried out over the flatlands of Spain.

The itineraries were prepared according to 1:50.000 scale-maps and guided by the catalogue of lakes of PARDO (1948). The order of sampling trips was as follows: March, 1978: North Submeseta and low Guadalquivir; November, 1978: La Mancha and low Guadalquivir; December, 1978: North Submeseta; April, 1979: Monegros, La Mancha, low Guadalquivir and Extremadura; May, 1980 Monegros, North Submeseta and Galicia; April, 1982: Eastern Andalucía; April, 1983: Areas of Central Spain. The sampled localities are listed in tables 7 and 8, and its approximate localization is shown in figure 9.

Part of the material studied in this paper comes from some sporadic sampling trips that were carried out in periods other than those mentioned, or from other collectors.

In each of the sampled lagoons the following ecological parameters were measured: transparency (only qualitative), alkalinity, chlorides and sulphates. The samples for chemical analysis were fixed "in situ" to be analyzed in the laboratory.

The entomostracean samples had only a qualitative value. Transects were taken in several directions with two normal zooplankton nets, one of theim fitted with a 250 μm mesh-size nylon netting, and the other with a 2 mm mesh-size nylon netting. In the shallow pools, the transect was done by walking across, and in the deeper ones with an inflatable boat. The content of each net was poured in a tube fixed in 4% neutralized formaldehide. When some animals were particularly interesting they were taken live to the laboratory.

The separation and identification of the samples was carried out using a stereomicroscope and a microscope. The drawings were done with a light camera. All the specimens studied in this work are kept in the Departament of Ecology of the Barcelona University.

RESULTS

Ten species of anostraceans, two of notostraceans and three of conchostraceans have been identified. *E. ticinensis* from Majorca has not been found in the Peninsula itself, however, it has been included in the list for its indoubtable interest due to the scarcity of conchostraceans in Spain.

All the species follow the descriptions of DADAY (1910, 1915-1926), LINDER (1941), LONGHURST (1955), BRTEK (1964), STRASKRABA (1966) and COTARELLI & MURA (1983). Their characteristic morphology is summarized in tables 1, 2, 3, 4 and 5, and illustrated in figures 1, 2, 3, 4, 5, 6, 7 and 8. *A. salina* is not included in this descriptions because the Spanish forms have already been carefully accounted for by AMAT (1979).

Order Anostraca

Family Artemiidae

Genus *Artemia* Leach

Artemia salina (L.)

This anostracean species is typical of clean, saline and permanent waters, and it appears in practically all brines. The populations of the central part of the country are parthenogenetic strains (MARGALEF, 1983), while those found in brines of the littoral are considered to be sexual (AMAT, 1979). Among the Spanish localities the only one that is a natural biotope is the Chiprana lagoon (Zaragoza) (table 8 and figure 10).

Family Branchinectidae

Genus *Branchinecta* Verrill

Branchinecta ferox (Milne-Edwards, 1840) (figs. 1a-1h)

A rare species which has only recently been found in the Iberian Peninsula (ALONSO,

Table 1. Morphological characters of the Spanish Anostraca species: Antenna II ♂ and Antenna II ♀.
Caracteres morfológicos de las especies españolas de Anostraca: Antena II ♂ y Antena II ♀.

	Antenna II ♂			Antenna II ♀
	Basal appendage	Apical appendage	Accessory appendages	
B. ferox	Cylindrical, rough inner surface (fig. 1a)	Conical, arises the VII thoracic segment (fig. 1a)	Vestigial (fig. 1a)	Long, laminar, lanceolate (fig. 1b)
B. cervantesi	Cylindrical, shorther than in *B. ferox* (fig. 1i)	Conical, shorter than in *B. ferox* (fig. 1 i)	Vestigial (fig. 1i)	Conical, with sensitive terminations (fig. 1k)
B. schaefferi	Forms a wide clypeus, conical middle laminae (fig. 2a)	Curved with outher medial apophisis (fig. 2a)	Frontal, flagelliform, long (fig. 2a)	Conical, with a sensitive apical area (fig. 2b)
T. stagnalis	Forms a clypeus, quadrangular middle laminae (figs. 2h, 2i)	Curved with proximal apophisis (fig. 2h)	Frontal, foliaceous with three branches, the inner longer than the external ones (fig. 2i)	Lanceolate (fig. 2j)
S. torvicornis	Cylindrical, with an antennal clubshaped appendix (fig. 3a)	Bigeniculate, with clasping apical part (fig. 3a). The var. *bucheti* without sensitive terminations (fig. 3b)	Little, triangular	Laminar and subquadrangular (fig. 3c)
B. spinosa	Forms a clypeus (figs. 3h, 3i)	Conical (fig. 3h, 3i)	Frontal, short (fig. 3h)	Laminar, lanceolate, united by a membrane in front of the head (fig. 3j)
Ch. diaphanus	Cylindrical, with an apophisis	Conical, crescent-shaped with spine apophisis in the base	Antennal, laminar, serrated, with four digitations and a big lamina in the base (figs. 4a, 4b)	Short, conical, with a shart medial protuberance (fig. 4c)
B. media	Cylindrical, with a rough distal tubercle (fig. 4a)	Conical crescent-shaped (fig. 4h)	Vestigial	Conical and short (fig. 4i)
L. occidentalis	Cylindrical, globous, with an inner denticulate apophisis (figs. 5a, 5b)	Crescent-shaped (fig. 5a)		Conical and elongated, with sharp medial and distal protuberance (figs. 5c-5e)

1978). Its area of distribution is limited to the steppic zones of the Duero basin, where it can be found quite frequently in the cold season. The largest specimens found are those from Villafáfila (Zamora).

It is found in steppic, temporary and usually shallow lagoons, even though it does appear occasionally in waters of some depth. These observations coincide with those of KERTESZ (1955). It prefers cold and not very high mineralized waters. In the localities studied, values of 0.03-0.8 g/l of Cl^- and 0.024 g/l of $SO_4^=$ are recorded (table 7). In all cases this data refers to the period of filling of the lagoons because the species disappears as salt concentration increases later on (ALONSO, 1981).

The feeding habits vary according to the size of the animal. In the intestine of the larger-sized individuals, remains of small crustaceans can be found together with dirt particles and aglomerations of organic matter.

Taxonomic considerations.– Several closely related species have been described as belonging to the *ferox* compound constituted on the basis of characteristics that vary gradually. *B. orientalis* and *B. corvantesi* are the most representative species; the first being widely extended over East Europe and Asia Minor and the second present in Spain.

The taxonomic distance between *B. ferox* and *B. orientalis* is confusing. The main criteria used for separation is the presence (*B. orientalis*) or not (*B. ferox*) of setae on the outer edge of the cercopoda. Intermediate forms have been described as *B. orientalis* when the setae cover only the last third (PESTA, 1937), or as *B. ferox* when the setae are on both sides (LINDER, 1941). Another criterion, that of KERTESZ (1955), considers the comb-shaped structure with teeth on only one of the sides of the first few setae of the endopodite I in *B. orientalis*, which had already been observed by SARS (1901), as an important distinguishing characteristic. However Kertesz himself considers the geographical distribution of the two species to be significant and accepts the possibility of the existence of two geographical races with a zone of contact in Hungary. BRTEK (1959) believes that the area of distribution of *B. orientalis* may extend even further west than that of *B. ferox*.

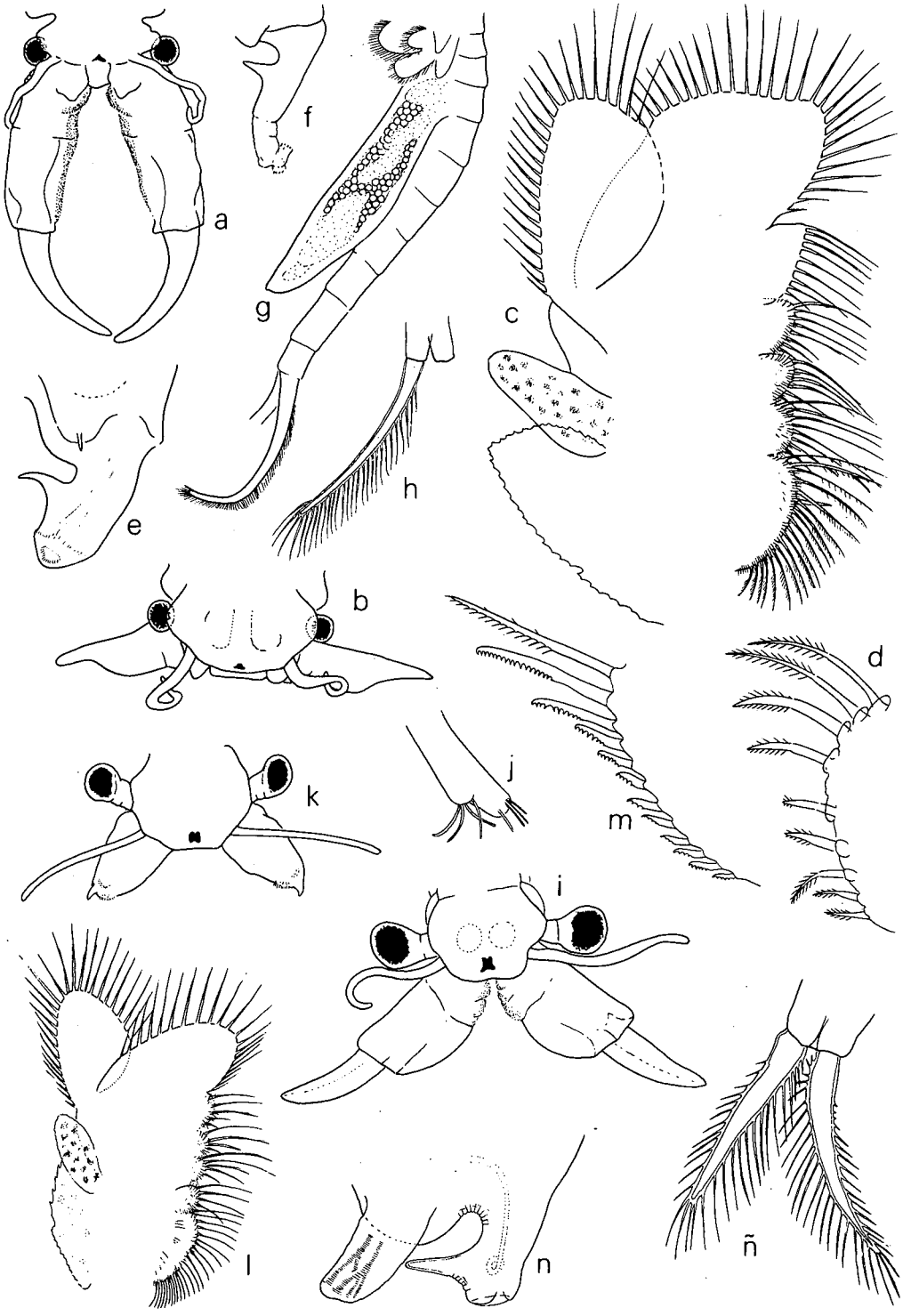
The difference between *B. orientalis* and *B. cervantesi* is even more uncertain and MARGALEF himself (1947) assigned *B. cervantesi* to the group *ferox-orientalis*. As far as the studied Spanish populations are concerned, *B. ferox* and *B. cervantesi* must be considered independent. However one could consider *B. cervantesi* synonymous with *B. orientalis* with an allowance for the ecological meaning of the water mineralization requeriments. *B. cervantesi* could be a western form of *B. ferox* adapted to waters of higher saline content (MARGALEF, 1947) and vicarious to *B. orientalis*, found typically in bicarbonate waters in Hungary (KERTESZ, 1955).

Branchinecta cervantesi (Margalef, 1947) (figs. 1i - 1ñ)

This are species is endemic to the Iberian Peninsula, and is limited to the endorheic region of La Mancha. Considering the

Fig. 1. *Brachinecta ferox* from Villafáfila: a. Head of the male; b. Head of the female; c. VI thoracic limb; d. First filtering setae of the endopodite I; e,f. Penis; g. Ovisac; h. Caudal rami. *Branchinecta cervantesi* from El Hito: i. Head of the male; j. Tip of the male, A-I; k. Head of the female; l. VI thoracic limb; m. First filtering of the endopodite I showing its particular structure; n. Basal part of the penis; ñ. Caudal rami.

Branchinecta ferox *de Villafáfila: a. Cabeza del macho; b. Cabeza de la hembra; c. Apéndice torácico VI; d. Primeras sedas filtradoras del endopodito I; e,f. Pene; g. Saco ovígero; h. Furca.* Branchinecta cervantesi *de El Hito: i. Cabeza del macho; j. Extremo de la A-I del macho; k. Cabeza de la hembra; l. Apéndice torácico VI; m. Primeras sedas filtradoras del endopodito I mostrando su particular estructura; n. Parte basal del pene; ñ. Furca.*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current state of these lagoons (ARMENGOL et al., 1975), an absolute regression of the species can be expected.

It inhabits temporary pools and flooded areas of the endorheic regions with scarce vegetation, low turbidity, and considerably mineralized waters. The mineralization values of the waters where it has been found (Laguna del Hito) are of 1 g/l of Cl^- and 3.5 g/l of $SO_4^=$ (table 7). It has been recorded in waters of 3,3-44 g/l of Cl^- and 14,6 g/l of $SO_4^=$ (MARGALEF, 1947).

The population develops in April and is made up of similar numbers of males and females belonging to the same age class.

Family Branchipodidae

Genus *Branchipus* Schäeffer

Branchipus schaefferi (Fischer, 1834)
(figs. 2a - 2g)

This species is usually not very frequent though it can be found in very different environments and throughout the year. The southernmost locality in the Peninsula is the Laguna de Albuera (Badajoz) (fig. 10), but its presence should be expected further South as there are references in Morocco (GAUTHIER, 1933).

It lives in clayey and shallow waters with scarce vegetation. It is an eurythermal species. Even though the information on the chemical composition of some of the waters where it is found is incomplete, it is illustrative that it has appeared in the mineralized lagoons of Villafáfila (Zamora) both in December, with the following characteristics: 0.03 g/l of Cl^-, 0.024 g/l of $SO_4^=$ (table 7) and 7°C, and in July, when the individuals find themselves limited to small isolated pools with supposedly higher Cl^- concentrations and up to 23°C of temperature (ALONSO, 1981).

The populations found are made up of individuals of both sexes. In some of the samples two age classes appear together (Puerto del Madero, summer 1978), so apparently it is not a monocyclic species. To the contrary of what is usual in most anostraceans the life cycle of *B. schaefferi* does not require a dry period, and it can develop, exceptionally, in permanent waters at any period of the year, if the other conditions are appropiate.

Genus *Tanymastix* (Simón)

Tanymastix stagnalis (L.)
(figs. 2l - 2n)

Rare species in the Peninsula and with an irregular distribution, to some degree attributable to its being a cold-water sthenothermal (FLOSSNER, 1972). In winter it can be found in rain puddles of the plains, while in the summer its presence is reduced to mountainous zones (fig. 10)

It is found in small-volumed temporary and transparent water bodies, preferably those that when dried out conserve some degree of humidity in the sediment. It usually prefers little mineralized waters (table 7). The conductivity values obtained fluctuate between 45 and 243 μS. It has always been found in waters overlaying an acid substrate (igneous rockies).

It is monocyclic. The populations studied were made up of individuals of the same age class and belonging to the two sexes.

Fig. 2. *Branchipus schaefferi* from puerto del Madero: a. Head of the male; b. Head of the female; c. VI thoracic limb; d. Basal parts of the penis; e. Ovisac; f,g. Caudal rami. *Tanymastix stagnalis* from Gredos: h,i. Head of the male; j. Head of the female; k. VI thoracic limb; l. Penis; m. Ovisac; n. Caudal rami.

Branchipus schaefferi *del puerto del Madero: a. Cabeza del macho; b. Cabeza de la hembra; c. Apéndice torácico VI; d. Parte basal del pene; e. Saco ovígero; f,g. Furca.* Tanymastix stagnalis *de Gredos; h,i. Cabeza del macho; j. Cabeza de la hembra; k. Apéndice torácico VI; l. Pene; m. Saco ovígero; n. Furca.*

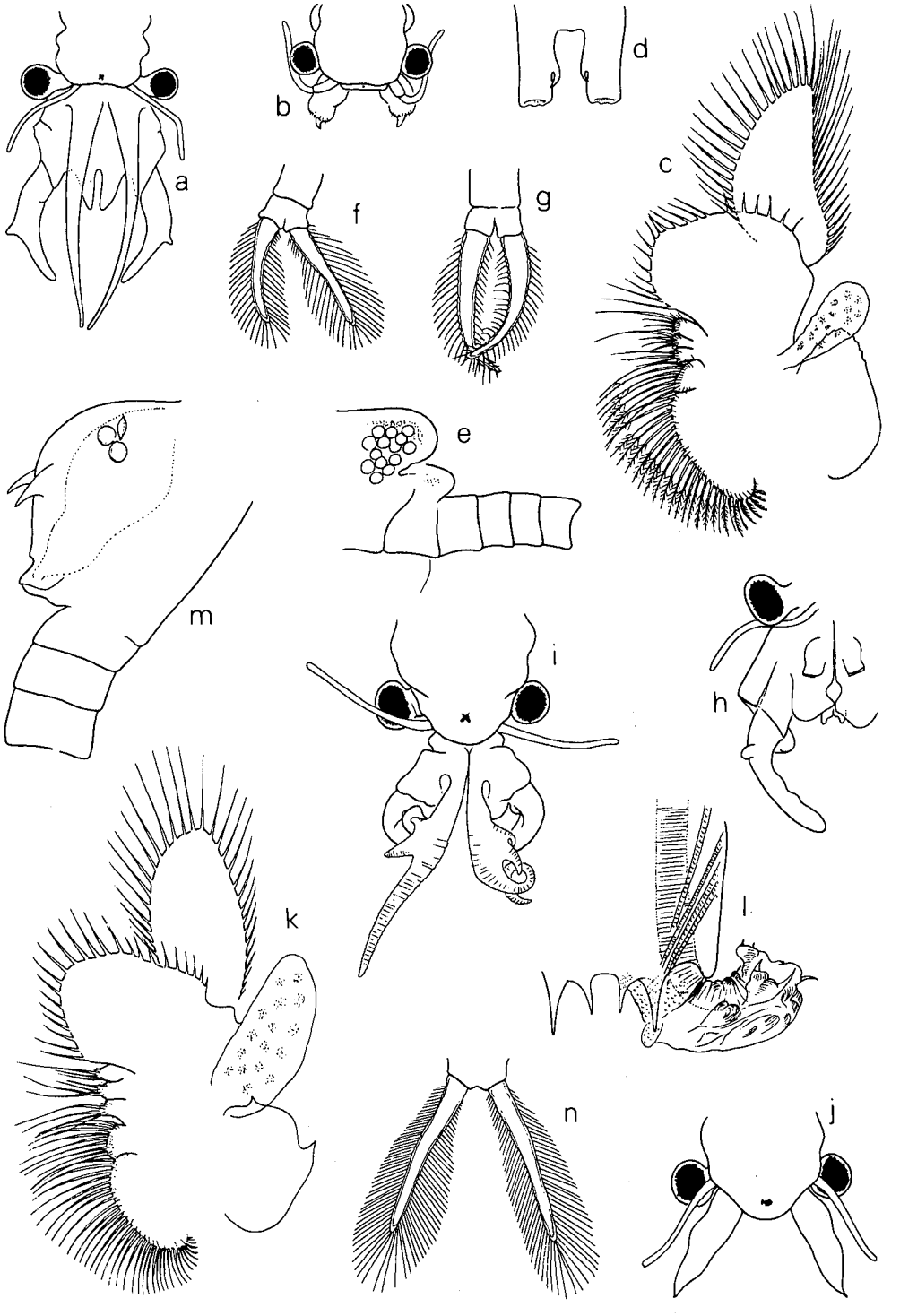
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Table 2. Morphological characters of the Spanish Anostraca species: Penis, Ovisac and Resting eggs.
Caracteres morfológicos de las especies españolas de Anostraca: Pene, Saco ovígero y Huevos de resistencia.

	Penis		Ovisac	Resting eggs		
	Basal parts	Apical parts		Color	Size, mm	Number by ovisac
B. ferox	Widely separated, cylindrical, with an inner conical appendix (figs. 1e, 1f)	Covered with spines (fig. 1f)	Conical and very long. Sometimes reaches the last abdominal segment (fig. 1g)	Light orange	0.36-0.42	50-1000
B. cervantesi	Separated, with a larger conical appendix than *B. ferox* (fig. 1n)	Retracted	Shorter than *B. ferox*	Light orange	0.22-0.32	25-54
B. schaefferi	Close, cylindrical, with inner crescentshaped appendix (fig. 2d)	Spiney until the apex	Short with a very characteristical transversal fold (fig. 2e)	Dark brown	0.20-0.30	100-200
T. stagnalis	Close, with two spines pointed backwards (fig. 2l)	With spines, curved in a spiral (fig. 2l)	Globous, with two spines (fig. 2m)	Dark brown	0.40-0.43 (lentil-shaped)	8-14
S. torvicornis	Close and elongated with denticulate inner spur (fig. 3e)	Long and spiney (fig. 3e)	Elongated with terminal fold (figs. 3e, 3f)	Reddish	0.22-0.33	10-200
B. spinosa	Close, swollen with the inner edge denticulated (fig. 3n, ñ)	Retracted	Elongated (fig. 3o)	Light brown	0.23-0.27	20-700
Ch. diaphanus	Close, short, with the inner part of the apophisis rough and quitinized (fig. 4e)	Globous, with terminal tongue	Conical, can be very long (fig. 4f)	Reddish	0.25-0.32	10-200
B. media	Close, with four terminal digitations, the inner one quitinized and rough (fig. 4k)	Retracted	Globous	Reddish	0.2	10-100
L. occidentalis	Close, cylindrical and elongated with inner spur (fig. 5g)	Finishes with a lanceolate tongue (fig. 5g)	Globous, wider than the abdominal segments (fig. 5h, i)	Light brown	0.23-0.26	10-30

Table 3: Morphological characters of the Spanish Anostraca species: Total size, thoracic limbs, Abdominal segments, and Caudal rami.
Caracteres morfológicos de las especies españolas de Anostraca : Tamaño, Extremidades torácicas, Segmentos abdominales y Furca.

	Total size mm	Thoracic limbs		Abdominal segments	Caudal rami
		Preepipodite	Number of setae of the endopodite-I each 100 μm		
B. ferox	18-50	One, serrated edges (fig. 1c)	2-4	Smooth	Long, delicate, transparent and with setae only in the inner part (fig. 1h)
B. cervantesi	13-18	One, serrated edges (fig. 1 l)	9-11, with a characteristical structure (fig. 1m)	Smooth	With setae in the two ridges (fig. 1ñ)
B. schaefferi	9-21	One, serrated edges (fig. 2c)	7-11	Smooth	Robust, reddish, sometimes curved and convergent (fig. 2f,g)
T. stagnalis	6-9	One, smooth edges with two incisions (fig. 2k)	14-16	Smooth	Long and thin, with many setae (fig. 2n)
S. torvicornis	16-21	One, edge with hooked teeth (fig. 3d)	10-12	Smooth	Long and chubby (fig. 3g)
B. spinosa	13-40	One, with a marginal incision (fig. 3k)	3-9	3-5 with two pairs of conical appendages and 6-8 with only one pair (fig. 3p)	Robust (fig. 3q)
Ch. diaphanus	17-37	Two, with serrated edge (fig. 4d)	4-8	Smooth	Short, reddish and chubby
B. media	7.7-13	Two, with slightly toothed edge (fig. 4j)	11-13	With 2 groups of denticules in a lateral distal position (fig. 4l)	Rudimentary, very variable (figs. 4n-4q)
B. occidentalis	8-15	Two, wavy edges (fig. 5f)	10-12	Smooth	Long (fig. 5j)

Family Streptocephalidae

Genus *Streptocephalus* Baird

Streptocephalus torvicornis (Waga, 1842) (figs. 3a-3g)

Abundant in the Southern half of the Peninsula (fig. 10), it becomes progressively rarer northwards where it only appears in the summer.

It is found preferably in puddles and wetlands, rich in organic detritus. It shows a preference for clayey temperate waters and appears frequently associated to indicators of this kind of waters as is *Moina brachiata* (PACAUD, 1939). It prefers little-mineralized waters, with a Cl^- concentration range of 0.008 to 1 g/l and the $SO_4^=$ between 0.012-0.21 g/l in the localities studied (table 7)

It appears in spring with populations made up of males and females in the same proportion. Sometimes two overlapping generations have been found, thus indicating that possibly it is not monocyclic. The life-cycle habitually includes dry period even though it can also be found in semipermanent waters.

In Spain both *Streptocephalus* s. str. and the var. *bucheti* appear with no apparent differences in the distribution.

Family THAMNOCEPHALIDAE

Genus *Branchinella* Sayce

Branchinella spinosa (Milne-Edwards, 1840) (figs. 3h-3q)

An infrequent species, it is found in arid zones of the South and records are also known of the steppic regions La Mancha and the Monegros (MARGALEF, 1953).

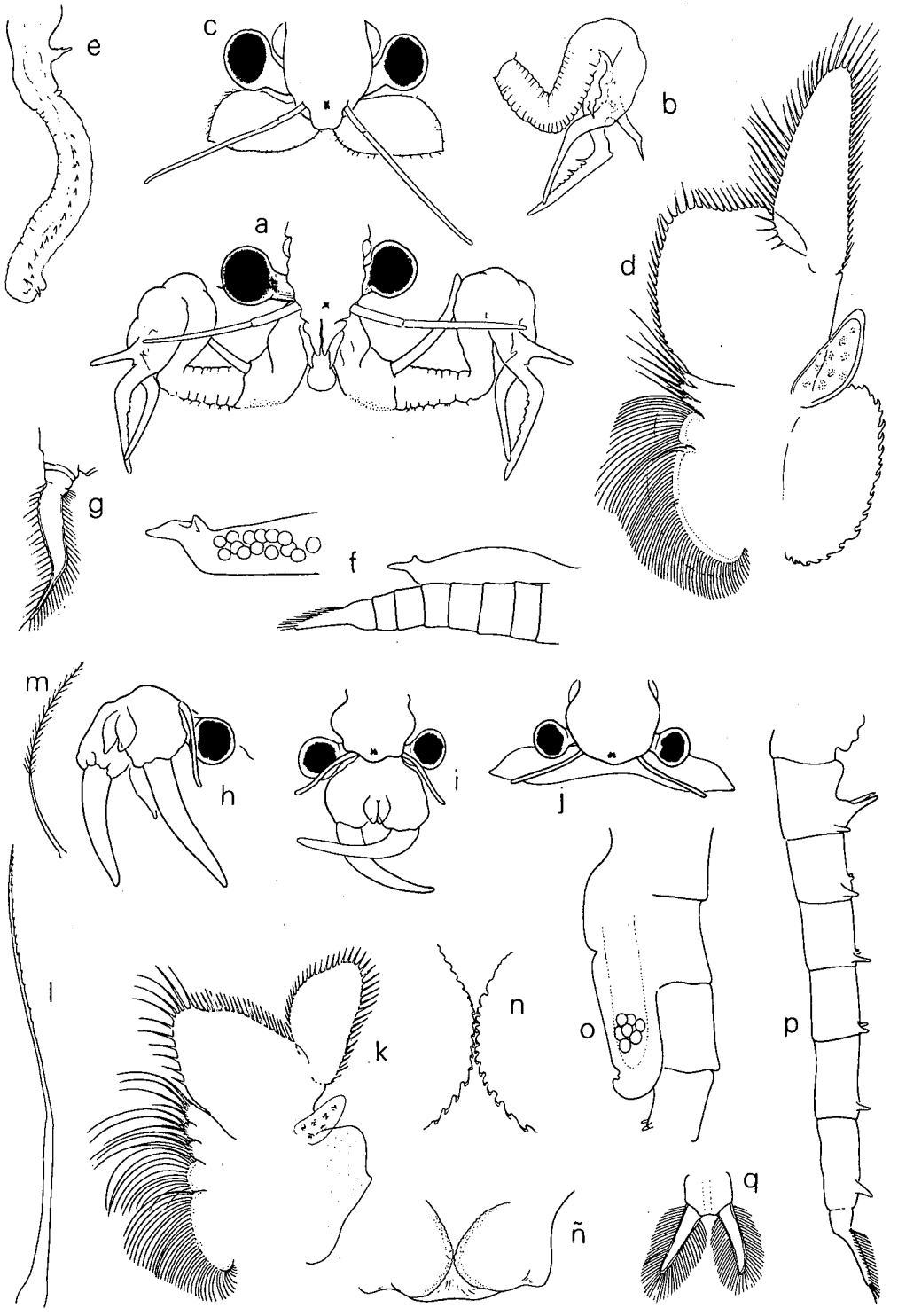
It is found in temperate shallow waters with scarce vegetation of the endorheic regions. It is halophylous and typical of clay waters. It has been found associated to the Zannichelliacea *Althenia filiformis* PETIT, also typical of waters of high chloride content (CIRUJANO, 1980; ALONSO et al., 1980) in muddy waters with 10-16 g/l of Cl^- and 1.7-14 g/l of $SO_4^=$ (table 7).

It develops at the start of spring and the eggs remain in the sediment until the following spring. MARGALEF (1953) developed a culture from sediment of saline lagoons of the Monegros. The feeding regime consists in filtering particles of clay, even though the larger forms can also take in large prey (cladocerans, copepods and anostracean eggs undoubtedly of its own species), as has been revealed through the analysis of the intestinal content. The filtering setae, especialy those of the smaller specimens, are often covered with epibionts belonging to forms close to the genus *Korshikoviella*.

Taxonomic considerations.– The different populations studied usually do not show any particular morphological variability. In the Zarracatín lagoon (Sevilla) table 7, fig. 9) two groups of different-sized individuals were observed mixed together in the samples. In one group, the sizes ranged 30-40 mm of length, while the other were between 13-20 mm, around half the size of the former group. Even if the size difference of the morphological elements in both groups

Fig. 3. *Streptocephalus torvicornis* from Los Tollos: a. Head of the male; b. Apical appendage of the A-II (var. *bucheti* from Balsa del Pinar); c. Head of the female; d. VI thoracic limb; e,f. Ovisac; g. Caudal rami. *Branchinella spinosa* from Zarracatín: h,i. Head of the male; j. Head of the female; k. VI thoracic limb; l,m. Filtering setae of the big and small forms respectively; n,ñ. Basal parts of the penis; o. Ovisac; p. Abdominal segments; q. Caudal rami.

Streptocephalus torvicornis *de los Tollos: a. Cabeza del macho; b. Apéndice apical de la A-II (var.* bucheti *de la Balsa del Pinar); c. Cabeza de la hembra; d. Apéndice torácico VI; e,f. Saco ovígero; g. Furca.* Branchinella spinosa *de Zarracatín: h,i. Cabeza del macho; j. Cabeza de la hembra; k. Apéndice torácico VI; l,m. Sedas filtradoras de ejemplares grandes y pequeños respectivamente; n,ñ. Parte basal del pene; o. Saco ovígero; p. Segmentos abdominales; q. Furca.*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cannot be considered as intraspecific variability, it is important inasmuch as it implies diverse functional possibilities, such as the larger-sized mandibules of the larger individuals. Also, an inverse relationship is observed between the lenght of the endopodite and the number of filtering setae, in the thoracic limbs. In the larger specimens the filtering setae which are also longer, is toothed denticulate in the terminal half, while in the small individuals, lines of barbules are implanted on both edges of the setae (figs. 31,3m). The presence of these two forms together can be interpreted as the coexistence of two generations which have grown under different environmental conditions. A similar situation han already been observed in a population of *Branchinecta ferox* from Turkey (COTTARELLI & MURA, 1974).

Family Chirocephalidae

Genus *Chirocephalus* Prévost

Chirocephalus diaphanus (Prévost, 1803) (figs. 4a-4g)

This anostracean species is the most frequently found in pools of the Iberian Peninsula, where its area of distribution follows no specific geographic criteria. Frequently its populations can be found together with other anostracean species (table 7). It is found in waters rich in organic material, inundated ditches and fallow-fields, and has also been recorded in flooded depressions in peat-meadows of the Pyrenees (MIRACLE, 1978) at over 2000 meters above sea level.

It appears to be indifferent to the turbidity caused by inorganic particles in suspension. Usually it prefers little mineralized waters, with Cl^- values between 0.007 and 0.8 g/l and $SO_4^=$ concentrations of 0.01 to 0.2 g/l (table 7). In the lagoons of steppic zones, which are generally more saline, it only has appeared in the first phases of flooding, when the salt concentrations are lower.

Genus *Branchinectella* Daday

Branchinectella media (Schmankewitsch, 1875) (figs. 4h-4q)

Highly infrequent in the studied lagoons, its localities are limited to the Monegros, La Mancha and the province of Sevilla (fig. 10).

The lagoons where the species is found are shallow and rich in salts. The Cl^- values are between 2-18 g/l, and those of $SO_4^=$ range between 0.7-65 g/l, concentrations which coincide with those given by MARGALEF (1947) of 15.6 g/l of Cl^- and 14-18 g/l of $SO_4^=$ of pools of La Mancha. It prefers clayey waters.

It is a monocyclic species.

Family Linderiellidae

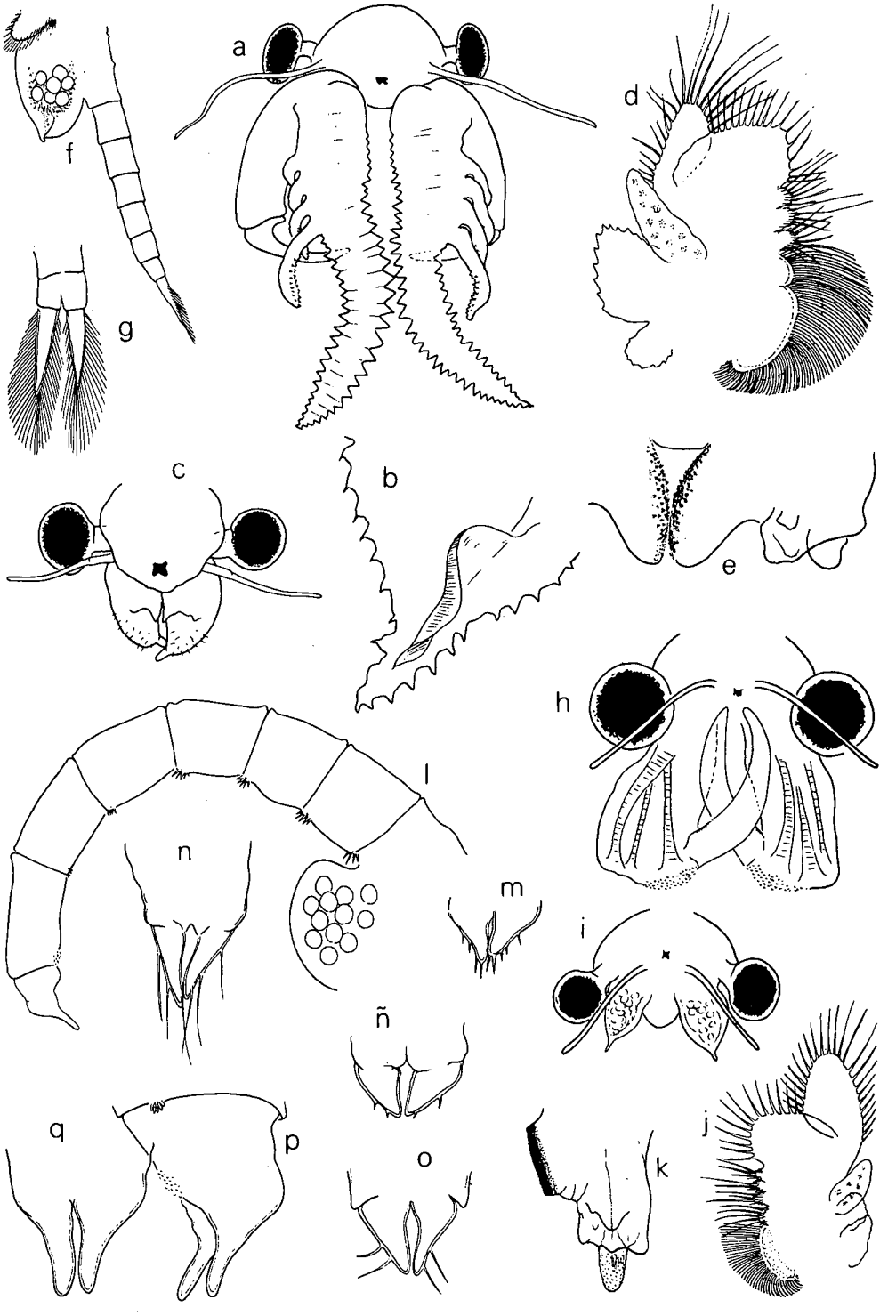
Genus *Linderiella* Brtek

Linderiella occidentalis (Dodds) (figs. 5a - 5j)

This species has only appeared in the lagoon Los Tollos (Cádiz) (fig. 10). The find is inte-

Fig. 4. *Chirocephalus diaphanus* from Cucharas: a. Head of the male; b. Basal lamina of the male antennal accessory appendage; c. Head of the female; d. VI thoracic limb; e. Basal parts of the penis; f. Ovisac; g. Caudal rami. *Branchinectella media* from Los Altillos: h. Head of the male; i. Head of the female; j. VI thoracic limb; k. Penis; l. Abdominal segments; m-q. Caudal rami of different Spanish populations, showing its high variability.

Chirocephalus diaphanus *de Cucharas: a. Cabeza del macho; b. Lámina basal del apéndice antenal accesorio del macho; c. Cabeza de la hembra; d. Apéndice torácico VI; e. Parte basal del pene,; f. Saco ovígero; g. Furca.* Branchinectella media *de los Altillos: h: Cabeza del macho; i. Cabeza de la hembra; j. Apéndice torácico VI; k. Pene; l. Segmentos abdominales; m-q. Furcas de diferentes poblaciones españolas mostrando su elevada variabilidad.*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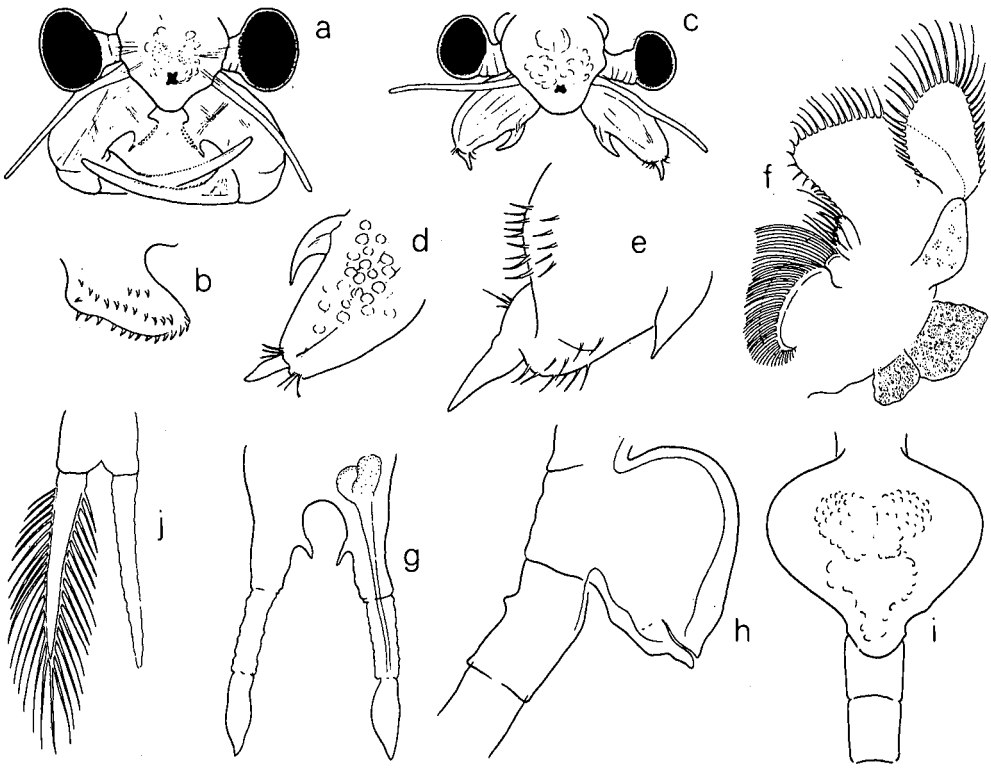


Fig. 5. *Linderiella occidentalis* from Los Tollos: a. Head of the male; b. Inner denticulate apophysis of the A-II basal appendage; c. Head of the female; d,e. A-II of the female; f. VI thoracic limb; g. Penis; h,i. Ovisac; j. Caudal rami.

Linderiella occidentalis *de los Tollos: a. Cabeza del macho; b. Apófisis denticulada interna del apéndice basal de la A-II; c. Cabeza de la hembra; d,e. A-II de la hembra; f. Apéndice torácico VI; g. Pene; h,i. Saco ovígero; j. Furca.*

resting because it is a new species in Spain and for the Paleartic zone in general. There are no other references in Europe although at the time of its appearance some specimens from pools close to Loucien, near Marseille (collected by Guerrero and Abellà) were examined.

The Spanish population was found in clayey little-mineralized waters (0.008 g Cl^-/l) (table 7), with abundant macrophytic vegetation, especially *Ranunculus* sp. It formed part of a community with *Streptocephalus torvicornis, Chirocephalus diaphanus, Triops cancriformis mauritanicus* and *Cyzicus grubei.*

In the French population, specimens belonging to different age-classes appeared together, indicating that it is not monocyclic.

Taxonomic considerations.– *L. occidentalis* was first considered member of the Brachinectidae family, until LINDER (1941) on the basis of the structure of the genital segments and the presence of two preepipodites on the thoracic limbs, included the species within the Chirocephalidae family. Later on BRTEK (1964) created for it the new family Linderiellidae, even though this same author considers that there is insuffi-

cient information concerning the internal anatomy to enable a clear taxonomic position.

The morphologic characteristics of the Spanish forms and of those from Southern France coincide with those specified by Brtek in his description. However, it would not be strange that closer and more careful examination may reveal its identity with another species or subspecies, which has now been overlooked because of its distance from its "Terra typica".

Order Notostraca

Family Triopsidae

Genus *Lepidurus* Leach

Lepidurus apus (L.)
(figs. 6a - 6k)

A rare species in the Iberian Peninsula. Most of its localities are found in the provinces of Segovia and Leon, in the Northern part of

Table 4. Some morphological characters of the Spanish Notostraca species.
Algunos caracteres morfológicos de especies españolas de Notostraca.

	L. apus	*T. c. simplex*	*T. c. mauritanicus*
Total size without the caudal rami	24-57 mm	20-40(57) mm	20-70 mm
Carina of the carapace	Smooth (fig. 6a)	Smooth (fig. 6 l)	With spines (fig. 6q)
Situation of the dorsal organ	Variable in relation to the compound eyes (figs. 6b, 6c)	Close to the eyes (figs. 6m, m')	As in the *simplex* form
First leg	With short endites. The V is twice as long as the III and IV (fig. 6d)	With very long flagellum shaped endites (fig. 6n, ñ)	As in the *simplex* form
Number of body segments	26-28	31-34	As in the *simplex* form
Apodous segments: Number	4-6	4-7	As in the *simplex* form
Dorsal armature	Pointed spines (figs. 6h, 6j, 6k)	Pointed spines	Generally more "spiney" than the *simplex* form
Ventral armature	Reduced spines	Little squame-shaped spines (fig. 6p)	As in the *simplex* form
Resting eggs: Colour	Orange	Orange	Orange
Size, mm	0.4-0.5	0.5-0.7	0.5-0.7
Telson	With supra-anal plate (fig. 6)	Without supra-anal plate, 2-4 spines in the furcal base (fig. 6o)	Generally the first furcal spine is much longer than other two (figs. 6r, 6s, 6t)

the central plains (fig. 10). Eastwards it is not found again except in the La Zaida lagoon (Zaragoza) close to that of Gallocanta, where it forms part of a very interesting community in which *Triops cancriformis simplex, Cyzicus tetracerus* and *Chirocephalus diaphanus* also appear (table 7).

Its localities are temporary pools and flooded ditches, characterized by abundant aquatic vegetation (mosses, ranunculaceae, characeae). The species is found within these pools in the shallowest areas with less vegetation. The waters are little mineralized (0.01-0.04 g/l of Cl^- and 0.04-0.08 g/l of $SO_4^=$) (table 7), distrophic and usually transparent.

The life-cycle may last several months. Most authors consider it typical of spring, although its appearance in fall has also been recorded (STELLA & MARGARITORA, 1968). In the localities here mentioned, it has been observed from February to the end of August.

Taxonomic considerations.– The discriminating characters which are frequently used in the systematics on the group level, are quite variable. In this sense the supra anal plate can appear under developed (fig. 6j) or assymetric (fig. 6g), and sometimes it is deeply grooved distally (fig. 6f). Also great variability is observed in the position of the dorsal organ in relation to the eyes (figs. 6b-6c).

Even though it is the form *L. apus lubbocki* which inhabits the circummediterranean countries (LONGHURST, 1955; COTTARELLI & MURA, 1983), the specimens examined so far in the Iberian Peninsula coincide with the description of *L. apus apus*, considered to have a Central european distribution (LONGHURST, 1955). Among the distinguishing characteristics of the latter, particularly interesting are the presence of fewer abdominal segments and the aspect of the spines at the keel of the anal plate, which are very numerous and small (fig. 6h, 6i).

Genus *Triops* Schrank, 1803

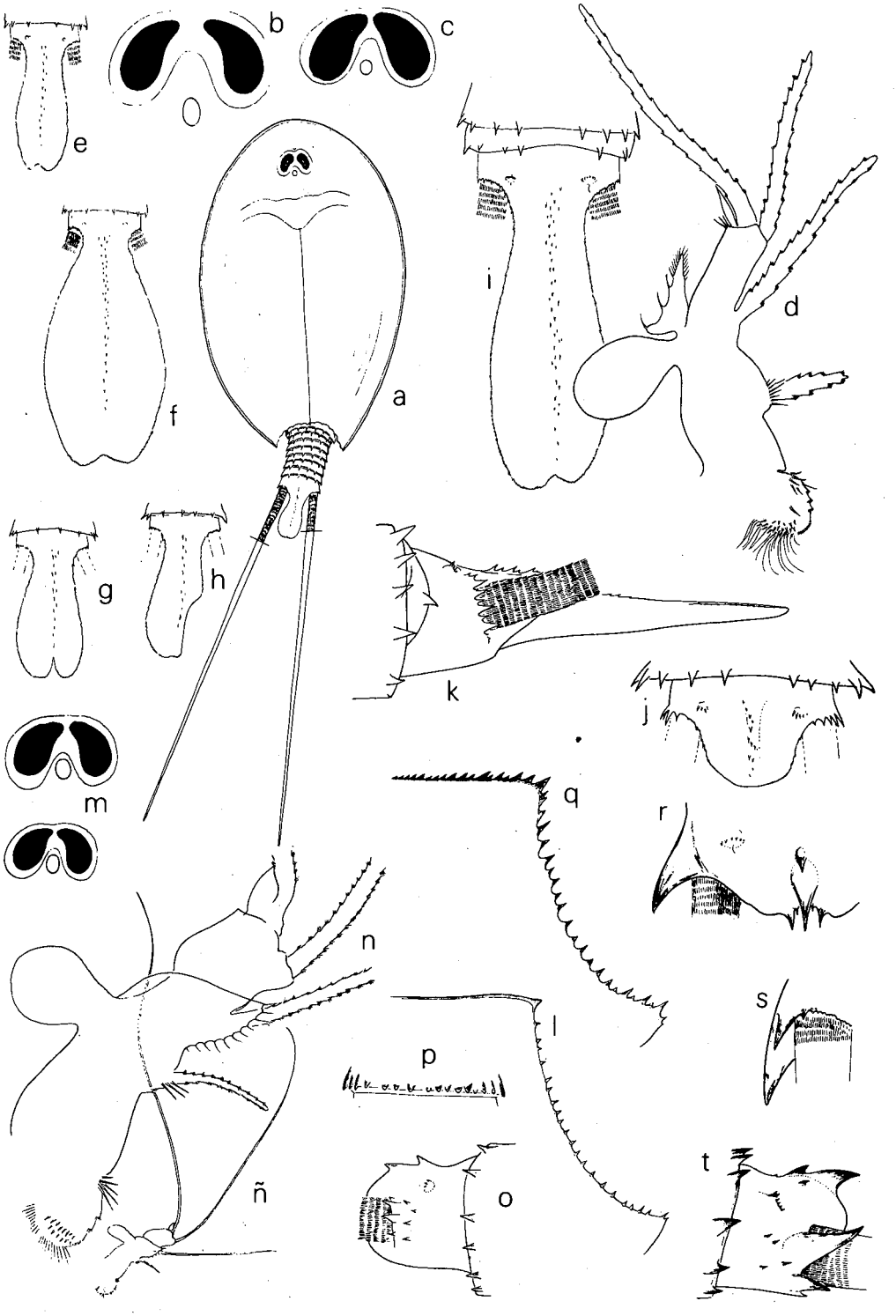
Triops cancriformis Bosc, 1801
(fig. 6l - 6t)

This species is found more frequently towards the South. The *simplex* form is distributed over the Northern half of the Peninsula, while the *mauritanicus* form is found in the Southern one, with the Central Mountain System as border between the two (fig. 10).

It is found in temporary waters, usually not very deep and rich in vegetation and remains of organic material. The waters are little mineralized (0.01-0.13 g $SO_4^=$/l and 0.007-0.06 g Cl^-/l) (table 7), although there are records in the literature that it was found in salt pools of Scotland (FLOSSNER, 1972). The *simplex* form is found both in clayey and transparent waters, while the *mauritanicus* form is more frequent in clayey waters.

Fig. 6. *Lepidurus apus* from Navahornos: a. Dorsal view; b,c. Eyes and different relative position of the dorsal organ; d. First thoracic leg; e-j. Anal plate (of population from some different Spanish localities); k. Lateral view of the telson. *Triops cancriformis simplex* from Espolla: l. End of the carina of the carapace; m. Eyes and dorsal organ; n,ñ. First thoracic leg; o. Lateral view of the telson. *Triops cancriformis mauritanicus* from Benamejí: 1. End of the carina of the carapace; r. Telson, dorsal view; s. Telson, ventral view; t. Telson, lateral view.

Lepidurus apus *de Navahornos: a. Visión dorsal; b,c. Ojos y diferente posición relativa del órgano dorsal; d. Primer apéndice torácico; e-j. Placa anal (de poblaciones de diferentes localidades españolas); k. Vista lateral del telson.* Triops cancriformis simplex *de Espolla: l. Final de la carena del caparazón; m. Ojos y órgano dorsal; n,ñ. Primer apéndice torácico; o. vista lateral del telson.* Triops cancriformis mauritanicus *de Benamejí: q. Final de la carena del caparazón; r. Telson, vista dorsal; s. Telson, vista ventral; t. Telson, vista lateral.*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Taxonomic considerations.– Four forms have been described for the Mediterranean region (GHIGI, 1921): *mauritanicus, simplex, cancriformis* and *apulius.* The last, similar to *simplex,* has a very localized distribution (GAUTHIER, 1934) while the remaining three are considered geographical races (LONGHURST, 1955). Of these, only *T.c. simplex* and *T.c. mauritanicus* live in the Iberian Peninsula. The differences between the two are very controversial. According to GURNEY (1923) all should be considered synonims of *T. cancriformis* s. str., while MARGALEF (1953), insists on the insufficient characterization of the species of the genus, and later on the same author (MARGALEF, 1958) observes a kind of combination of the characters of *T.c. mauritanicus* with the *cancriformis* form s. str., in specimens from Mahón.

Usually *T.c. mauritanicus* is more "spiney" than *T.c. simplex,* as can be seen by the characteristic most used to distinguish both species: the row of spines along the posterior half of the keel of the dorsal shield (fig. 6g). The number and degree of development of the telson spines has been used as taxonomic criterion (GHIGI, 1921; LONGHURST, 1955), considering the lack of proportion between the first spine of the furca and the much smaller ones that follow (figs. 6r, 6s, 6t) as typical of *mauritanicus.* However this characteristic is quite variable as differences are observed even between the left and right sides of a given individual. Also, the separation between the upper limit of the eyes (MARGALEF, 1953; GAUTHIER, 1934) has been considered significant, however in the populations here studied the measurement of these values overlap in both forms.

Order Conchostraca

Family Cyzicidae

Genus *Cyzicus* Audouin

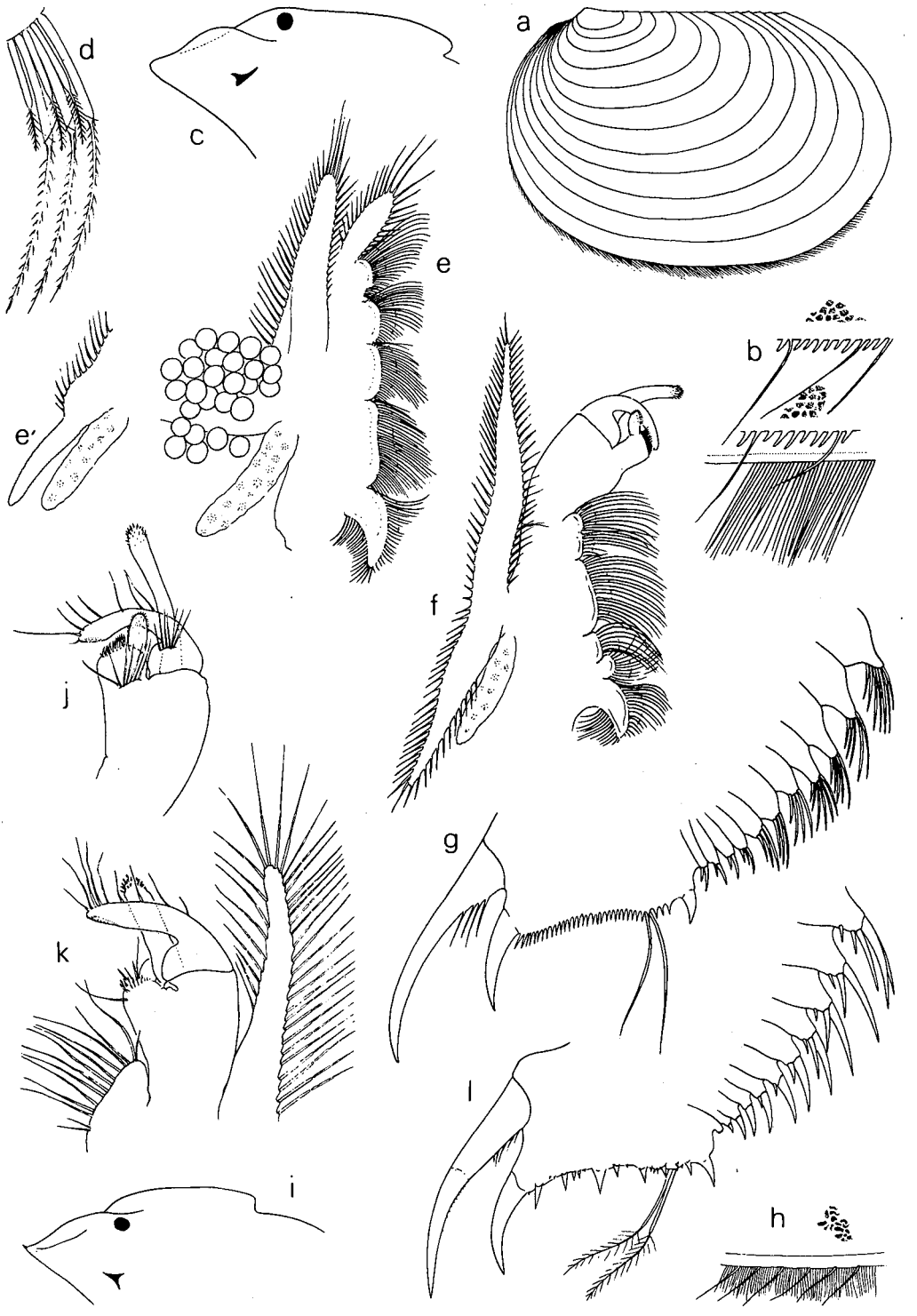
Cyzicus grubei (Simon)
(figs. 7a - 7g)

This species is endemic of the South of the Iberian Peninsula. Except for one locality in Ciudad Real (Laguna de Poleas, MARGALEF, 1953), the rest are around the low Guadalquivir (fig. 9). The largest specimens (12 mm) come from Doñana (Carlos Montes leg.).

The captures always take place in temporary, shallow and muddy waters, that are well provided with submerged vegetation and abundant organic material on the bottom. The mineralization values are low: 0.02 g of $SO_4^=$/l and 0.008-0.3 g/l of Cl^- (table 7). Frequently epibionts are observed attached to different parts of the body, preferently on the limb setae. Sometimes some areas are completely covered by chlorococcals of the *Rhopalosolen* group, and by euglenals like *Colacium.* On the shell carapace of one of the specimens, rotifers with a sessile valve belonging to the genus *Ptygura* were observed.

Fig. 7. *Cyzicus grubei* from Los Tollos: a. Shell of the female; b. Ventral rim of the shell; c. Head of the female; d. Detail of the filtering comb; e. Female thoracic limb; e'. Upper corner of the epipodite; f. Male thoracic first leg and clasper; g. Dorsal armature of the last body segments and telson. *Cyzicus tetracerus* from La Zaida; h. Ventral rim of the shell; i. Head of the female; j,k. Clasper; l. Dorsal armature of the last body segments and telson.

Cyzicus grubei *de Los Tollos: a. Valva de la hembra; b. Borde ventral de la valva; c. Cabeza de la hembra; d. Detalle del peine filtrador; e. Apéndice torácico de la hembra; e'. Angulo superior del epipodito; f. Primer apéndice torácico del macho y pinza; g. Armadura dorsal de los últimos segmentos y telson.* Cyzicus tetracerus *de La Zaida; h. Borde ventral de la valva; i. Cabeza de la hembra; j,k. Pinza; l. Armadura dorsal de los últimos segmentos y telson.*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Cyzicus tetracerus
(figs. 7h - 7l)

It is only known in one locality, and it is a new record for the peninsula: the lagoon of La Zaida (province of Zaragoza) (fig. 9, table 7). This is a large lagoon of temporary waters, slightly turbid and little mineralized (0.03 g/l of Cl^- and 0.08 g/l of $SO_4^=$). The sediment is clayey, soft and practically devoid of vegetation.

The population lives practically throughout the period in ehich the lagoon is full, from May to November. The individuals captured at the end of the period, and therefore mature, were only 8 mm long and their valves were completely covered by epibionts. It appeared together with *Triops cancriformis simplex, Lepidurus apus, Branchipus schaefferi* and *Chirocephalus diaphanus.*

Table 5. Some morphological characters of the Spanish Conchostraca species.
Algunos caracteres morfológicos de especies españolas de Conchostraca.

	C. tetracerus	*C. grubei*	*E. ticinensis*
Total size, mm	Up to 8	Up to 12	9
Head:			
Occipital point	Rounded-angular (fig. 7i)	Rounded (fig. 7c)	Angular (fig. 8b)
Rostrum ♀	Pointed (fig. 7i)	Pointed (fig. 7c)	-------
No. sensorial papillae of A-1	14-18	18-20	18
Body:			
Nº of segments	26	24	23
Nº of segments with dorsal armature	18	19	15
Dorsal armature	Conical apophisis with spines that decrease in number distally (fig. 7 1)	As *C. tetracerus* but with more slender and numerous spines (fig. 7g)	Cylindrical apophisis with long and numerous spines (fig. 8d)
Clasper ♂	See figs. 7j, 7k	Longer than that of *C. tetracerus* (fig. 7f)	See fig. 8c
Telson	Concave edge with 20-25 spines of variable sizes. (fig. 7 1)	Concave edge with 30 equal teeth (fig. 7g)	31 equal spines
Resting eggs: Color	Dark brown	Dark brown	-------
Size, mm	0.25	0.25	

Family Leptestheridae

Genus *Eoleptestheria* Daday

Eoleptestheria ticinensis (Balsamo Crivelli, 1859) (figs. 8a-8c)

There is only one Spanish locality, Laguna de Negrillos (A. Regil, leg.) and is a new record for Spain.

There is no direct information concerning the biotope where it is found. But one can suppose that the environmental requirements are similar as for *Lepidurus apus*, which appears in the same sample.

Taxonomic considerations.– The observations of the Spanish form are based on a single male specimen. Even so, some differences have been detected which distinguish them from the Central European populations. For example, the number of armed thoracic segments and that of postabdominal spines are not within the variability range defined for Czechoslovakian populations by STRASKRABA (1966) (table 6). On the other hand, the same author comments that the angular occipital point (fig. 8b) is considered exceptional in the species description.

Genus *Leptestheria* G.O. Sars

Leptestheria dahalacensis (Rüppel, 1837)

The only Spanish record of this species is in the island of Mallorca (MAYOL, 1977), although its possible presence in the Peninsula would not be strange given the fact that

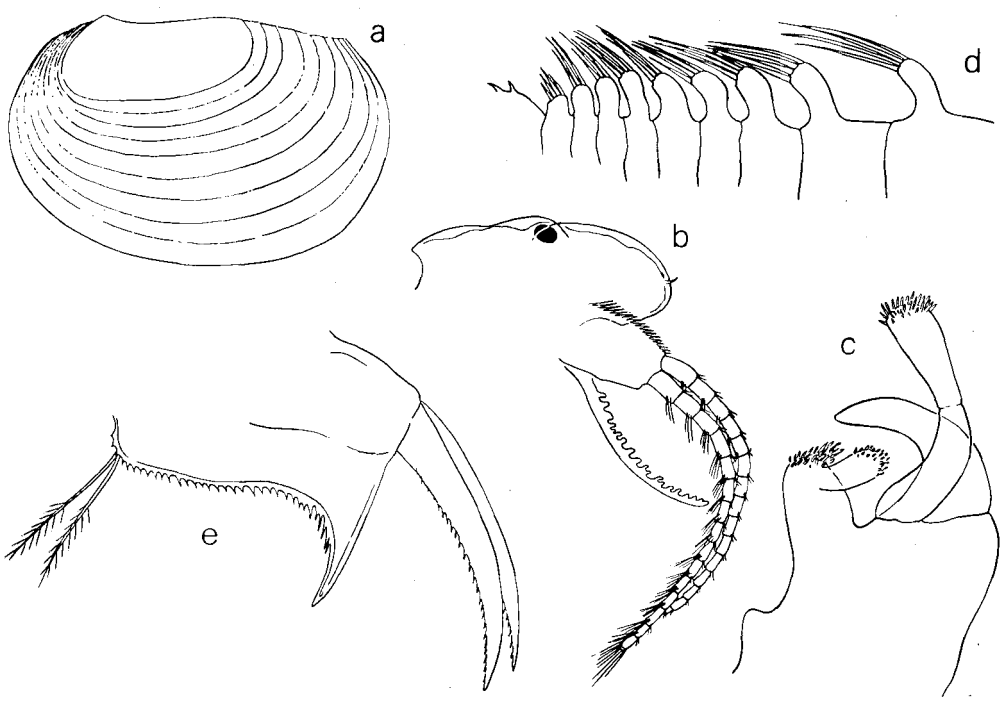

Fig. 8. *Eoleptestheria ticinensis*, male from Laguna de Negrillos: a. Shell; b. Head; c. Clasper; d. Dorsal armature of the body segments; e. Telson.

Eoleptestheria ticinensis, *macho de Laguna de Negrillos: a. Valva; b. Cabeza; c. Pinza; d. Armadura dorsal de los últimos segmentos del cuerpo; e. Telson.*

Table 6. Comparative morphological data between the Czecho-Slovakian population and the specimen from Laguna de Negrillos of *Eoleptestheria ticinensis.*

Datos morfológicos comparados entre las poblaciones checoslovacas y el especimen de Eoleptestheria ticinensis *de la Laguna de Negrillos.*

	Paratype	Czecho-Slovakia	Negrillos
Number of sensory papillae, A-1	12-16	16-19	18
Number of body segments	22-28	22-28	23
Number of armed body segments	18-22	17-28	15
Number of spines on telson	28-40	41-58	31
Occipital point	Rounded	Angular	Angular

Eoleptestheria ticinensis, conchostracan which biogeographical distribution is similar (STRASKRABA, 1966) is also found.

It was collected in a pool close to the place where Mayol himself gathered a sample of mud and achieved a culture of *T. cancriformis* (ssp. *simplex* according to MARGALEF, 1953). Therefore, one can assume that both species have similar environmental requirements. The capture took place in November.

DISCUSION

Ecology of the euphyllopods.

Most of the euphyllopods are characterized as being markedly sthenoic and therefore are very useful as ecological indicators. Their tolerance to diverse limnological parameters has been mentioned frequently in the literature (GAUTHIER, 1928; BEADLE, 1943; BAYLY & WILLIAMS, 1966), and specifically HARTLAND-ROWE (1972) proposes these organisms as a model of adaptation to life in temporary waters.

In this paper three factors have been chosen which, in different combinations accurately define the type of residences occupied by the different species (fig. 11). These factors have already been used in the typification of small water bodies (ALONSO & COMELLES, 1981). They are: periodicity, turbidity due to inorganic particles in suspension, and mineralization.

A) Little mineralized waters

The turbid and temporary waters form shallow pools on miocenic clays or marls with scarce vegetation (*Ranunculus* sp., *Chara connivens*). These waters are preferred by most of the anostraceans. In environments of these characteristics up to five species belonging to the different groups have been captured in the same sample, like for example in the lagoons of La Zaida (Zaragoza) and that of Los Tollos (table 7). The most characteristic species of these waters are *Branchinecta ferox, Branchipus schaefferi, Streptocephalus torvicornis, Triops cancriformis mauritanicus, Cyzicus grubei* and *C. tetracerus.*

Turbid and permanent waters usually originate from the artificial deepening of basins with temporary waters. The turbidity persists because of the very structure of clay, capables of forming a colloidal suspension and the frequent visits of sheep contribute while simultaneously fertilizing the water. The water level of these pools varies considerably throughout the year and can be considered mixed systems: the fluctuating part, which is not so deep, forms a ring around the lagoon allowing the presence of animals which require a dry period for the eggs. This enables *Streptocephalus torvicornis* and *Branchipus schaefferi* to establish populations throughout the year because during the wet season, the water level rises and the dry ring where the eggs were deposited is flooded. During the dry season, part of the eggs

can eventually reach the water and start developing.

In temporary and transparent waters, *Tanymastix stagnalis* and *Lepidurus apus* can be mentioned as typical species. These environments are pools and flooded roadsides with a sandy or gravely susbtrate (river terraces or "rañas", alluvial flats of Late Pliocene origin) in flatland localities or small temporary tarns in the mountains. Usually they are profusely colonized by macrophytic vegetation, for example *Isoetes* in the environments of *T. stagnalis* and *Ranunculus* sp. pl. *Chara globularis, Nitella opaca* and *Callitriche* sp. in those of *L. apus.* Some species can live in any of the above mentioned environments. *Chirocephalus diaphanus* frequently is found in transparent waters although it also colonizes the turbid ones successfully. *Triops cancriformis simplex,* more frequent in clear waters, appears sometimes in muddy waters.

B) Mineralized waters

Only those organisms that are physiologically adapted to important changes in time of the water concentration and of the ionic relationships can live in the salt athalassohaline waters. The osmotic relationships between the water and the internal medium of some species has already inspired some classifications based on fauna of other countries (HARTLAND-ROWE, 1966). In the Iberian Peninsula, *Branchinella spinosa* and *Branchinectella media* colonize the temporary and turbid waters. These lagoons, most of which are the "playa" type, are very shallow and are formed over easily eroded miocenic marls in endorheic basins. The shores are populated by *Salicornia* and among the aquatic vegetation, usually very scarce, *Althenia filiformis* (in highly chlorinated waters), *Chara galioides, Lamprothamnium papulosum* and *Ruppia maritima* can be found. When approaching the total desiccation very high saline concentrations are reached, accompanied by the formation of salt precipitates (*gypsum, thenardite, mirabilite, halite,* in Monegros. PUEYO, 1979). within which the resting eggs are sometimes found. *Brachinecta cervantesi* appears in temporary mineralized waters which do not reach very high salinities.

Artemia salina is the only anostracean adapted to conditions of permanent clean waters. The big salt lakes and the evaporation tanks of the brines are their habitual residence.

The rest of the possible natural environments do not have appropriate conditions for the euphyllopod's requeriments. In clear, not very saline and permanent waters, the frequent presence of very active predators such are fish and urodels make the development of a stable population practically out of the question. There is only a record in this sense and it is that of *Lepidurus arcticus* in the benthos of deep lakes (LUNDBLAD, 1921). On the other hand, these environments usually are more stable and mature ecosystems, and are not propitious to the presence of opportunistic organisms, which are typical of fluctuating ecosystems and of the initial stages of succession, such as the euphyllopods.

Associations of euphyllopod crustaceans

The groups are usually made up of species with similar environmental requirements that present some type of segregation in feeding or behaviour. For example, the association of several different-sized anostraceans as is the frequent case of *Branchinecta ferox* and *Chirocephalus diaphanus,* can be interpreted as a differential exploitation of the feeding resources enabled by the different sizes of the filters (table 3). The notostraceans are frequently accompanied by anostraceans and conchostraceans. *Lepidurus apus* can be found with *C. diaphanus* and with *Cyzicus tetracerus, Triops cancriformis mauritanicus* with *Streptocephalus torvicornis* and with *Cyzicus grubei,* partly coinciding with the observations of GAUTHIER (1933) in North Africa.

Table 7. Some chemical and environmental characteristics from the biotopes of the species of Euphyllopoda in Spain. King of water: 1. Little mineralized, temporary and clean waters, with abundant vegetation in the flatlands or mountains; 2. Little mineralized, temporary and turbid waters, with scarce vegetation or none, over clay; 3. Little mineralized and semipermanent waters with variable vegetation according to the degree of turbidity; 4. Karstic limnocrens; 5. Mineralized but not saline waters, scarce vegetation; 6. "Playa" lakes, usually muddy waters. The approximate situation of the localities is given in the map of figure 9.

Algunas características químicas y ambientales de los biotopos de las especies de Euphyllopoda en España. Tipo de agua: 1. Poco mineralizada, aguas temporales y limpias, con abundante vegetación en los llanos o la montaña; 3. Poco mineralizada, aguas temporales y turbias, con escasa o ninguna vegetación; sobre limo; poco mineralizada y aguas semipermanentes con vegetación variable según el grado de turbidez; 4. Cárstico limnocreno; 5. Mineralizada pero no aguas salinas, vegetación escasa; 6. Playa, lagos, generalmente aguas fangosas. La situación aproximada de las localidades se muestra en el mapa de la figura 9.

Locality	$CO_3H^- + CO_3^{-2}$ meq.l^{-1}	Cl^- g.l^{-1}	$SO_4^=$ g.l^{-1}	Kind of water	*B. ferox*	*B. cervantesi*	*B. schaefferi*	*T. stagnalis*	*S. torvicornis*	*B. spinosa*	*C. diaphanus*	*B. media*	*L. occidentalis*	*L. apus*	*T. c. simplex*	*T. c. mauritanicus*	*C. grubei*	*C. tetracenus*
1 Gredos (Ávila)	Very low mineralization			1				●										
2 Somiedo (Asturias)	Very low mineralization			1							●							
3 La Paramera (Ávila)	0.86	0.006	0.008	1				●										
4 Fuensaviñán (Guadalajara)	5.5	0.007	0.009	1							●							
5 Gamonal (Toledo)	–	0.007	–	1			●	●								●		
6 Los Tollos (Cádiz)	–	0.008	–	2					●		●		●			●	●	
7 Villalpando (Zamora)	1.2	0.009	0.048	2							●							
8 Herrera del Duque (Badajoz)	–	0.009	–	1				●										
9 Villanubla (Valladolid)	0.82	0.01	0.034	2			●											
10 Almaraz (Cáceres)	–	0.01	–	1			●				●					●		
11 Sotillo Bajero (Segovia)	2.22	0.01	0.036	1							●			●				
12 Montecillo (Zaragoza)	2.53	0.13	0.11	2							●							
13 Puerto del Madero (Soria)	1.67	0.015	0.016	3			●											
14 Riego de la Vega (León)	–	0.015	–	1				●										
15 Siétamo (Huesca)	1.90	0.02	0.034	3					●									
16 Bellver (Lleida)	–	0.02	–	3			●		●									
17 Navahornos (Segovia)	2.39	0.02	0.039	1							●			●				
18 Matisalvador (Segovia)	1.90	0.02	0.039	1							●			●				
19 Clot d'Espolla (Girona)	–	0.023	–	4											●			
20 Benamejí (Córdoba)	2.2	0.02	0.01	2							●					●		

21 La Zaida (Zaragoza)	1.56	0.028	0.085	3	
22 Longuilla (Sevilla)	1.4	0.029	0.012	2	
23 Sahagún (León)	3.34	0.03	0.04	1	
24 Ciria (Soria)	–	0.03	–	3	
25 Bamba (Zamora)	1.1	0.03	0.024	2	
26 Villaverde de Medina (Valladolid)	7.8	0.03	0.064	1	
27 Bodón del Grillo (Valladolid)	–	0.03	–	3	
28 Grande de Albuera (Badajoz)	0.4	0.03	0.02	2	
29 La Miaha (Córdoba)	2.1	0.03	0.02	2	
30 Aguasal (Valladolid)	–	0.03	–	2	
31 Lavajo del Carpio (Valladolid)	4.1	0.04	0.024	2	
32 Used (Zaragoza)	6.53	0.04	0.04	2	
33 Santas Martas (León)	2.76	0.041	0.032	1	
34 Las Cuerlas (Zaragoza)	1.2	0.05	0.11	2	
35 Fuentelsol (Valladolid)	3.4	0.05	0.072	3	
36 Balsa del Pinar (Teruel)	–	0.05	–	1	
37 La Lantejuela (Sevilla)	2.8	0.06	0.13	2	
38 Morón de la Frontera (Sevilla)	2.3	0.06	0.05	2	
39 Cucharas (Ciudad Real)	4.1	0.09	0.02	2	
40 Can Nadal (Girona)	4.7	0.11	0.001	1	
41 Salina Grande (Zamora)	2.3	0.12	0.05	3	
42 Salinas (Zamora)	1.75	0.132	0:083	3	
43 La Luisiana (Sevilla)	4.4	0.21	0.24	2	
44 Barillos (Zamora)	2.49	0.35	–	3	
45 Villerín (Zamora)	3.5	0.47	0.18	3	
46 Puertollano (Ciudad Real)	2.4	0.78	0.14	3	
47 Laguna de la Iglesia (Segovia)	17.8	0.80	–	5	
48 Los Almeros (Ciudad Real)	8.6	0.96	0.21	3	
49 El Hito (Cuenca)	3.8	0.96	3.51	5	
50 Salada Chica de Alcañiz (Teruel)	2.15	1.98	3.68	6	
51 Santed (Zaragoza)	–	2.66	0.79	6	
52 La Ballestera (Sevilla)	0.7	5.67	2.64	6	
53 Los Altillos (Toledo)	3.5	6.54	8.99	6	
54 Grande de Quero (Toledo)	23.5	10.0	65.2	6	
55 Zarracatín (Sevilla)	1.3	10.91	2,42	6	
56 La Albardiosa (Toledo)	5.7	12.0	13.5	6	
57 Salada de Campillos (Málaga)	1.5	13.6	5.5	6	
58 Gosque (Málaga)	7.2	16.6	1.75	6	
59 Conde (Córdoba)	2.9	16.9	14.3	6	
60 Salada Grande Alcañiz (Teruel)	4.7	18.7	20.2	6	

Table 8. Other localities for the Iberian Euphyllopod species. The approximate situation of the localities is given in the map of figure 9.

Otras localidades para especies ibéricas de Euphyllopoda. La situación aproximada de las localidades se muestra en el mapa de la figura 9.

	A. salina	*B. cervantesi*	*B. schaefferi*	*T. stagnalis*	*S. torvicornis*	*B. spinosa*	*C. diaphanus*	*B. media*	*L. apus*	*T. c. simplex*	*T. c. mauritanicus*	*E. ticinensis*	*C. grubei*
61 Tirez lagoon, Toledo (Margalef 1947)		●											
62 Maçanes, Barcelona (Margalef 1958)			●										
63 Cap de Creus, Girona (J. Cambra, *leg.*)				●									
64 Mancha lagoons (Margalef 1947)						●		●					
65 Zamora (J.J. Aldasoro, *leg.*)										●			
66 Laguna de Negrillos, León (A. Regil, *leg.*)									●	●		●	
67 Pirineo (Miracle 1978)							●						
68 Monegros (Margalef 1953)						●							
69 Valencia (Margalef 1953)			●							●			
70 Tarragona (Margalef 1953)			●										
71 Molins de Rei, Barcelona (Margalef 1953)			●										
72 Azambuja, Portugal (Margalef 1953)											●		
73 Ebro river Delta (Dpt. of Zoology. UB, *leg.*)										●			
74 Cuenca (Margalef 1953)									●				
75 Artesa de Lleida (F. Trepat, *leg.*)										●			
76 Salada de Chiprana, Zaragoza	●												
77 Villafáfila, Zamora (Margalef 1956)					●								
78 Doñana, Huelva (C. Montes, *leg.*)													●

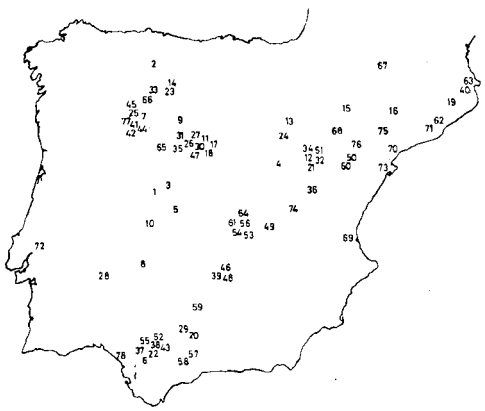

Fig. 9. Approximate situation of the localities with Euphyllopod species in the Iberian Peninsula (see tables 7, 8).

Situación aproximada de las localidades con especies de eufilópodos en la Península Ibérica (ver tablas 7, 8).

Those species that are typical of more extreme environments like *Branchinella spinosa* and *Branchinectella media* are not found with associated species. Usually they appear alone even though there are records of their coexistence (MARGALEF, 1947).

The relative proportions of the different species of the communities vary throughout the wet period of the lagoons. The notostraceans play the role of pioneers and are followed by several anostracean species that substitute one another. In Almaraz, *Chirocephalus diaphanus* is substituted by *Tanymastix stagnalis* and the latter by *Branchipus schaefferi,* coinciding with the results of AGUESSE (1957) in the Camargue. In Villafáfila (ALONSO, 1981), *B. ferox* and *C. diaphanus* are substitued by *B. schaefferi* and *S. torvicornis* in the summer.

Biogeography of the euphyllopods

A) Historical factors

From a historical point of view it is hard to distinguish whether these organisms arrived in old colonizations, previous to the Quaternary, or if they are recent immigrants to areas which have become more arid (MARGALEF, 1983).

However it seems that the presence of some of the species in the Peninsula is truly old. *Cyzicus grubei* and *Branchinecta cervantesi* could be two good examples of allopatric differentiation after the isolation of populations of *C. tetracerus* and *B. orientalis* because of climatic factors, and both live now in a very restricted area of distribution (fig. 10). On the other hand, *Branchinecta ferox, Branchinectella media* and *Branchinella spinosa* surely had in the past a more generalized area of distribution including the Iberian Peninsula and wich was divided by the Pleistocene glaciations, with the resulting Iberian-Caspic disjunction.

The distribution of some species along the South-Northeast band used as route by many aquatic birds migrating across the Peninsula (fig. 10) suggests the existence of recent colonizations from North Africa. Such are the cases of *Triops cancriformis mauritanicus, Streptocephalus torvicornis, Branchinectella media* and *Branchinella spinosa,* also widely distributed in Algeria and Morocco (GAUTHIER, 1933). However

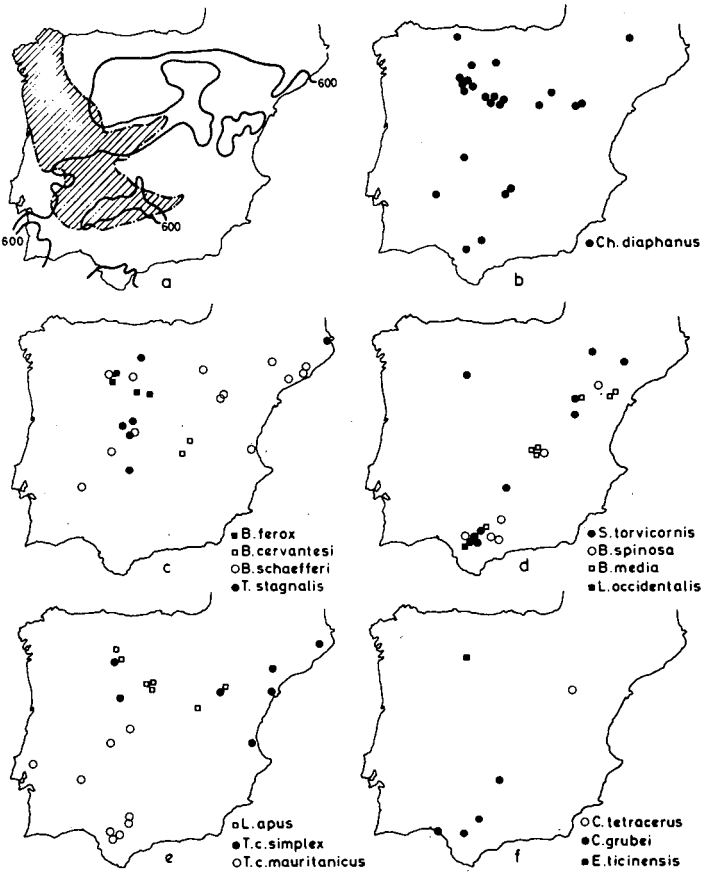

Fig. 10. a. Major environmental conditions in the Iberian Peninsula, the line encloses areas with precipitation over 600 mm, the western granitic shield is marked with striped area; b. Distribution of *Chirocephalus diaphanus* as an species; c. Anostraceans with a northern distribution; d. Anostraceans with distribution along N-S transversal band; e. Distribution of Notostraceans; f. Distribution of Conchostraceans.

a. Marco ambiental de la Península Ibérica, la línea encierra áreas con precipitación superior a 600 mm, el escudo granítico occidental está marcado por la zona rayada; b. Distribución de Chirocephalus diaphanus *como ejemplo de especie cosmopolita; c. Anostráceos con distribucion septentrional; d. Anostráceos con distribución a lo largo de la banda transversa N-S; e. Distribución de Anostráceos; f. Distribución de Concostráceos.*

the common fauna characteristics of both countries may be attributed more to the ecological characteristics than to the facility of fauna exchange. For example, *Branchinecta ferox, Branchipus schaefferi, Cyzicus tetracerus, Lepidurus apus* and *Tanymastix stagnalis* live in North Africa (GAUTHIER, 1928, 1933; LOFFLER 1978 and own data) and are not found in southern Spain while *Cyzicus grubei,* typical in southern Spain, is missing in North Africa.

B) Ecological factors

The distribution of the different water types inhabited by the eyphyllopods reveals a strong regional differentiation dependant on climate and lithology (fig. 10). It can be supposed that the species are now persisting in areas whose characteristics are similar to those that favoured their dispersion.

The steppic species are distributed throughout the Miocenic basins with a Mediterranean-continental climate. The most halophilous, like *Branchinectella media, Branchinella spinosa* and *Branchinecta cervantesi* are found in the endorheic basins of the Monegros, La Mancha and the low Guadalquivir; while *Branchinecta ferox,* not so halophilous, in less mineralized waters of the Duero basin. The typical freshwater species as are *Streptocephalus torvicornis, Branchipus schaefferi, Triops cancriformis mauritanicus* and *cyzicus grubei* follow the same regional distribution but on terrains with better drainage.

The species of more humid climates show

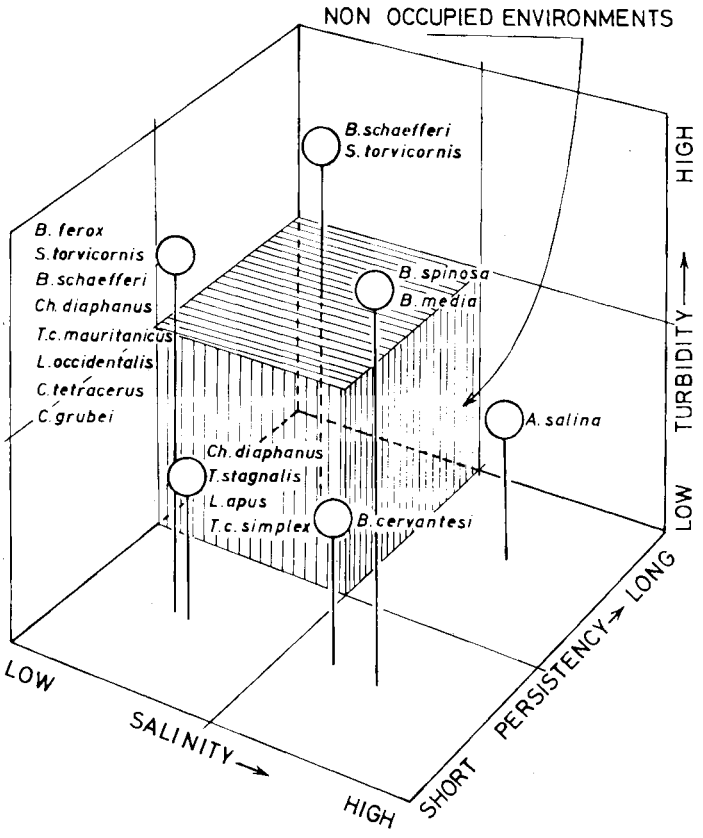

Fig. 11. Environments preferred by the different euphyllopod species, according to the combination of the considered factors: salinity, turbidity and persistence. The environment of clear, permanent and little mineralized waters is not appropiate for euphyllopod life. Arbitrary values have been taken on each axis.

Ambientes preferidos por las diferentes especies de eufilópodos en relación con distintas combinaciones de los factores ecológicos considerados: salinidad, turbiedad y persistencia. Los ambientes con aguas claras permanentes y poco mineralizadas no son apropiados para la vida de los eufilópodos. Los ejes se han dividido arbitrariamente.

a complementary distribution. *Tanymastix stagnalis* is found in the pools of siliceous Spain, in the winter in the flatlands, and in the summer in the mountains. *Eoleptestheria ticinensis* and *Cyzicus tetracerus*, considered Paleartic elements (STRASKRABA, 1966), and *Lepidurus*, which does not live in such arid environments as *Triops* (WILLIAMS, 1968), have a more Northern area of distribution.

Chirocephalus diaphanus, the most euricorous, is consequently the most cosmopolitan species, and reveals no specific diversification as is usual in other European countries. For example, in the Italian peninsula, characterized by a poor anostracean fauna at the genus level, *Chirocephalus* colonizes a wide range of environments and has achieved a notable diversification (COTTARELLI & MURA, 1983), probably through ecological allopatry.

Some examples of reduced areas with a great environmental diversity illustrate the importance of the ecological factors in the species distribution. A mere kilometer from the La Zaida lagoon, rich in species typical of clayey freshwaters (table 7), the salt pool of Santed is found, with a population of *Branchinectella media*. On the other hand, in La Mancha, *Branchinecta cervantesi* lives in mineralized waters next to *B. media* and *Branchinella spinosa* in more saline ones.

RESUMEN

Estudio de los Euphyllopoda de España.– El estudio de muchas poblaciones de Eufilópodos encontradas en varias localidades de España durante campañas de muestreo, ha permitido la identificación de 15 especies: 10 Anostráceos, 2 Notostráceos y 3 Concostráceos. Se ha obtenido también, valiosa información biogeográfica y ecológica debido a la extensión del área prospectada y a la heterogeneidad de los medios. Algunas especies son de ambientes salinos, *Artemia salina* es de aguas estancadas, mientras que *Branchinecta cervantesi, Branchinella spinosa* y *Branchinectella media* son de aguas temporales de las regiones endorheicas de la mitad este de la Península. Las restantes especies colonizan aguas temporales. *Tanymastix stagnalis* y *Lepidurus apus* son de aguas claras y distribución norteña, mientras que el resto prefieren aguas turbias. *Streptocephalus torvicornis* vive en la mitad este de España; *Branchipus schaefferi, Branchinecta ferox, Triops cancriformis simplex, Eoleptestheria ticinensis* y *Cyzicus tetracerus* en la mitad norte y *T.c. mauritanicus* y *C. grubei* en la sur. *Chirocephalus diaphanus*, la más euricola y cosmopolita es también la más frecuente en las montañas.

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