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MICROCRUSTACEAN ZOOPLANKTON AS POTENTIAL FOOD OF *RECURVIROSTRA AVOSETTA* IN SODIC WATERS OF THE HUNGARIAN PLAIN

L. Forró[1] and E. Boros[2]

1 Department of Zoology, Hungarian Natural History Museum 1088 Budapest, Baross u. 13., Hungary
2. Hungarian Ornithological and Nature Conservation Society, 1121 Budapest, Költő u. 21., Hungary

ABSTRACT

The distribution of Avocet was observed between March and June in 1992 and 1993 at several sodic waters and at the same time quantitative zooplankton samples were collected. High positive correlations were found between zooplankton density (Cladocera and Copepoda combined) and bird numbers and even stronger correlation was shown between density of Copepoda and Avocet distribution. These correlations were changing in time, highest correlations were found in April, but in spite of high zooplankton densities in May the correlation was less strong between zooplankton and Avocet. These results very likely indicate that in spring the distribution of Avocet has been influenced by the zooplankton abundance while in the nesting period zooplankton abundance seems a less important factor in determining the distribution of Avocet in the Hungarian Plain.

INTRODUCTION

The Avocet is a characteristic sodic bird nesting at sodic waters in the Hungarian Plain. Previous Hungarian studies dealt with various aspects of the biology and ecology of the species, i. e. with the habitat requirements, breeding biology, behaviour etc. In spite of this, however, little attention was paid to the feeding ecology, although the connection between the habitat selection and the food resources was investigated with more emphasis in several European countries. In this paper an attempt is made to correlate results form two, seemingly

remote disciplines, such as ornithology and hydrobiology. These results are of informatory nature and we hope to provide impetus for further researches in this field.

The species composition of the bird communities of the sodic waters in Hungary is well known. As an indicator species the Avocet has also been studied, some connections between habitat features, such as vegetation, water depth etc. and habitat choice of the Avocet were clearly described (Molnár, 1986; Boros 1993a). Already in these investigations emerged the question if there is any relation between the feeding behaviour of the species and the microcrustacean fauna of sodic waters (Bankovics, 1984), thus e. g. *Arctodiaptomus spinosus*, the most characteristic copepod of the sodic waters in the Carpathian basin, was considered as an important food organism, however, no attempt was made to quantify the presumed relationship. The traditional and previously preferred method of studying food selection in birds is the analysis of stomach content, nowadays it is questionable in the case of strictly protected species as the Avocet. Few data on stomach content can be found in the Hungarian literature, for the Avocet only two records are available (Sterbetz, 1988). More data are given by Glutz *et al.* (1977) and Cramp (1983) for the food selection of this species based on stomach content analyses. Mostly speciemens from coastal biotopes were investigated, where Polychaeta (e. g. *Nereis diversicolor*) and arthropods dominated in the stomach content. Within the Arthropoda two main groups, crustaceans (e. g. *Cladocera*, *Copepoda*, *Artemia* sp., *Corophium* sp., *Palamonetes* sp.) and insects (e. g. *Coleoptera* and *Diptera*) were recorded. There were seasonal differences in the proportions of the food items, insects were preferred in the nesting period when the birds are residing on dry shelves or waste land.

More recently Moreira (1992) found, that in saline coastal lagunes there is a positive correlation between the distribution of the Avocet in the area and the available food. These literature data gave us the idea to carry out simultaneous investigations on the abundance of microcrustacean zooplankton of sodic waters and to find out if they are correlated. In the first year, 1992, studies were made at two sodic waters in the Kiskunság National Park. The first results indicated strong correlation between the abundance of the formerly mentioned calanoid copepod (*A. spinosus*) and the site selection of the Avocet (Boros and Mocskonyi, 1993). Based on these results a more extensive study was carried out in 1993.

MATERIALS AND METHODS

In 1993 various water bodies were included in the investigations, taking into aconsideration the fact, that in the last years the number of natural sodic waters sharply decreased and the Avocet started expanding to artificial aquatic habitats as reflected by the bird counts (Boros, 1993b; Borosd and Szimuly, 1993). Large numbers of breeding and migrating Avocets regularly occur in most cases at large fishponds (e. g. Szeged, Fehér-tó), which were built on former sodic lakes or marshes. In addition, mainly in the nesting period are important some small, shallow ponds now used for goose breeding. For these reasons zooplankton sampling and bird counting were carried out at the following localities (see also **Figure 1**):

Sodic waters: Fülöpszállás: Kelemen-szék, Fehér-szék, Sátánhalom; Szabadszállás: Zab-szék; Kardoskút: Fehér-tó; Soltszentimre: Állam-puszta; Dunatetétlen: Sósér;
Fishponds: Szeged: Fertő; Tömörkény: Csaj-tó; Dunatetétlen: Sóséri-halastó;
"Goose pond": Békéssámson.

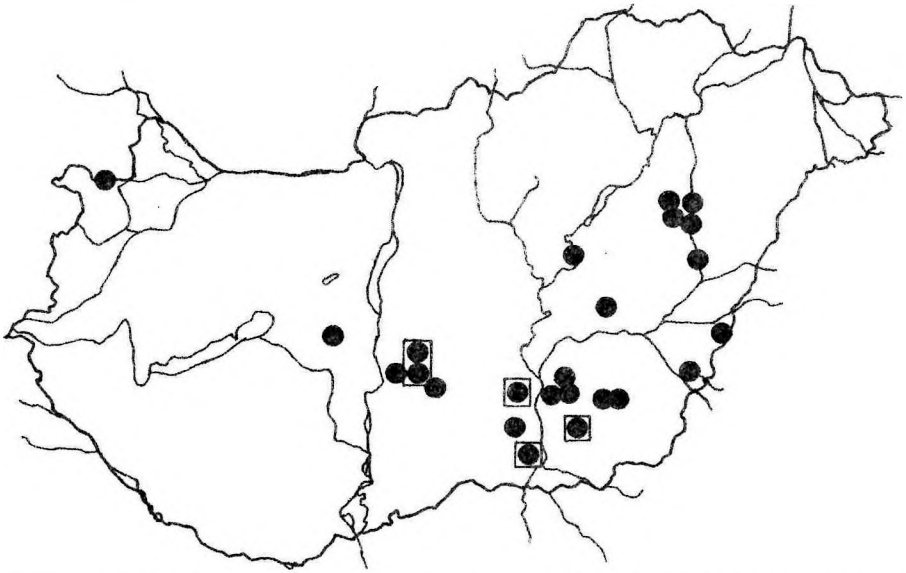


Figure 1: Map of Hungary, black dots indicate areas where Avocet was observed, dots in squares are collecting localities of the present study

This study was planned for the whole year but because of the dry weather the small waters dried up by mid-summer, thus data could be obtained only between March and June. The artificial fishponds were still filled after the nesting period, we could not establish sites where the Avocets assemble before migration.

Zooplankton samples were collected by wading into the waters (depth mostly less than 50 cm), 30 liters, taken from several points, 1 liter aliquots were filtered through a planktonnet of 100 μ mesh size. The samples were preserved in the field with formol. The abundance is given in individuals/liter. At the same time all Avocets at the given water body were counted, without considering their feeding or other behaviour. These two variables were used in the correlation analyses, where the microcrustacean abundance was the independent and the number of avocets was the dependent variable.

RESULTS

1. Composition of the microcrustacean fauna

In 1992, between May and July, eleven samples were collected from Kelemen-szék and Zab-szék, before they were drying out. Six species (4 Cladoxera and 2 Copepoda) were found in Kelemen-szék, while in Zab-szék only three species occurred. In both waters the *Moina brachiata* - *Arctodiaptomus spinosus* communities dominated, the other species were not percentual composition of microcrustacean zooplankton in Kelemen-szék as shown in Figure 2. The abundance has greatly increased from May onwards to the desiccation, changing from the first value of 145 ind./l to almost 7000 ind./l. Three samples were collected from Zab-szék, the abundance increased here from 814 to 7192 ind./l, until the desiccation of the pond.

Nine water bodies were investigated in 1993, 24 species (16 Cladocera and 8 Copepoda) were found (**Table 1**). The most frequently occurring species were *Daphnia magna, Moina brachiata, Macrothrix hirsuticornis, Arctodiaptomus spinosus, A. bacillifer* and *Megacyclops viridis*. *Daphnia*-species (*D. magna* and *D. atkinsoni*) dominated in April with two *Arctodiaptomus*-species, thereafter in May *Moina brachiata* was the dominant cladoceran taxon. Within copepods the *Arctodiaptomus-Cyclops* ratio was variable, in the

more sodic, smaller ponds (such as Zab-szék) species of the first genus dominated, frequently no *Cyclops* at all was found.

Table 1: List of species collected in 1993 (Numbers refer to the following localities: 1 = Fülöpszállás, Kelemenszék, 2 = Szabadszállás, Zabszek, 3 = Fülöpszállás, Fehérszék, 4 = Fülöpszállás, Sátánhalom, 5 = Soltszentimre, Állampuszta, 6 = Dunatetétlen, Sós-éri halastó, 7 = Dunatetétlen, Sós-er, 8 = Tömörkény, Csaj-tó, 9 = Szeged, Fertő)

Cladocera			Copepoda		
1.	*Daphnia magna*	1,3,4,5,6,7,9	17.	*Arctodiaptomus bacillifer*	1,5,6,7,9
2.	*Daphnia atkinsoni*	1,2,5	18.	*Arctodiaptomus spinosus*	1,2,3,5
3.	*Daphnia pulex*	2,3,4	19.	*Eucyclops serrulatus*	3,5
4.	*Ceriodaphnia reticulata*	3	20.	*Cyclops strenuus*	4,5
5.	*Simocephalus vetulus*	3,4	21.	*Cyclops vicinus*	8,9
6.	*Scapholeberis rammeri*	5	22.	*Acanthocyclops robustus*	5,9
7.	*Megafenestra aurita*	4	23.	*Megacyclops viridis*	1,2,4,5,9
8.	*Bosmina longirostris*	8	24.	*Metacyclops planus*	5
9.	*Moina micrura*	8			
10.	*Moina brachiata*	1,2,3,4,5,6,7,9			
11.	*Macrothrix rosea*	1,2,5			
12.	*Macrothrix hirsuticornix*	1,4,9			
13.	*Ilyocryptus agilis*	9			
14.	*Alona rectangula*	1,6			
15.	*Pleuroxus aduncus*	3			
16.	*Chydorus sphaericus*	1,3,4,5			

In the less sodic lakes mostly one or two *Cyclops* species were dominant. Also, in Csaj-tó, which was used as a fishpond for a long time, only these species occurred. Changes of abundance in Kelemen-szék are shown in **Figure 2**. The abundance was much lower in this year, than in the previous one, even the last sample before desiccation contained relatively few specimens. Very few individuals were found in April, in the first sample. Maximum abundance, 1252 ind./l occurred early May, most of the animals belonged to *Moina brachiata*.

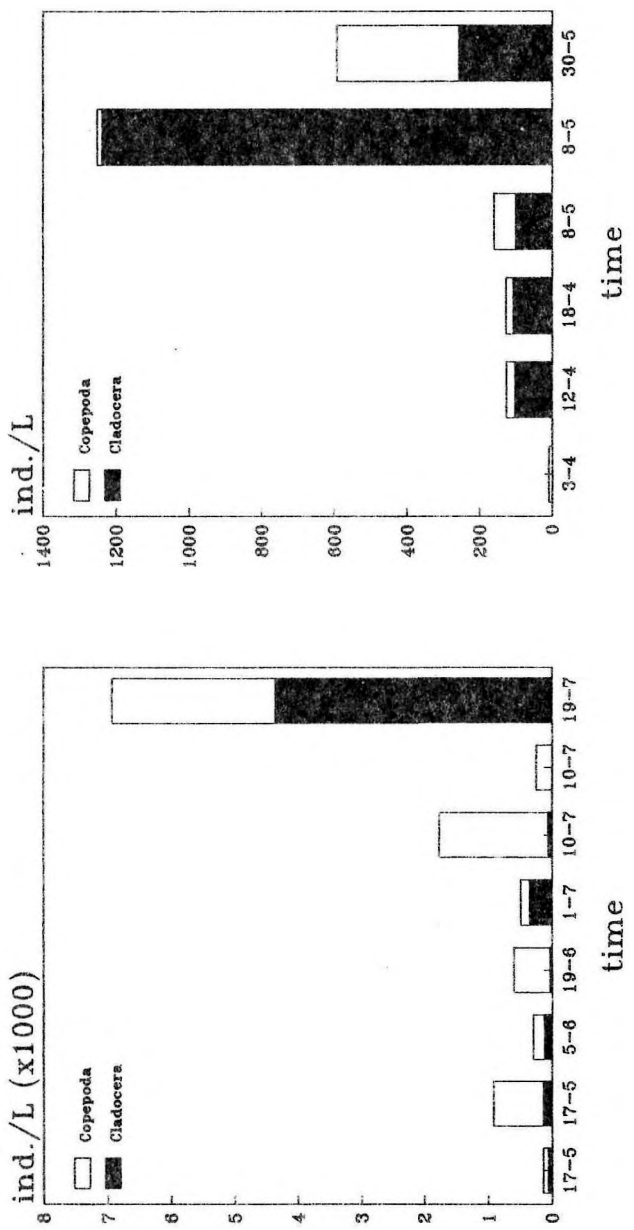


Figure 2: Microcrustacean abundance in Kelemen-szék, 1992 and 1993

There are less regular data from the other lakes. The abundance in Zab-szék was also lower in 1993, maximum value was more than 6000 ind./l, all specimens belonged to *A. spinosus*. In the other waters a few hundred ind./l was the maximum abundance. Extremely high was the density in April in Csaj-tó (885 ind./l), over 50 % of it was composed of nauplius larvae.

2. Correlations between the abundance of microcrustaceans and Avocets

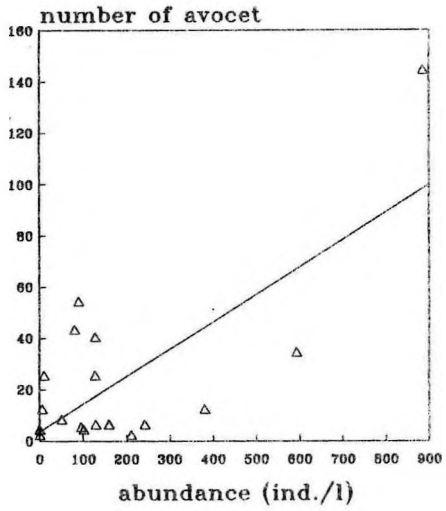
The correlation analyses were made only with the data from April and May 1993 because sufficient data were available only from this period. Analyses were done on the total data set and several separate data sets were analysed, for the two months separately and also for the dominant orders and genera. The results are shown in **Table 2**, where the values of the correlation coefficients above 0.7 are in bold. **Figure 3** provides graphical presentations of the data used in the analyses.

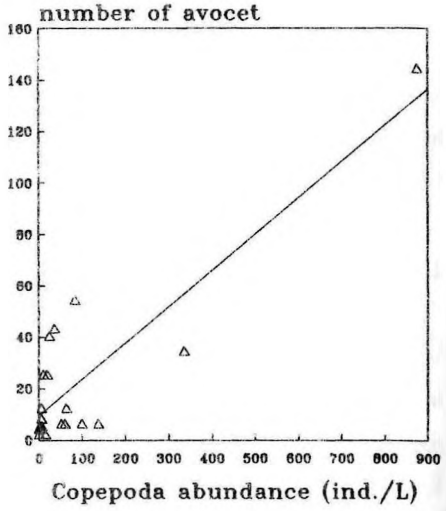
Considering the abundance of total microcrustaceans relatively strong correlations were found, the strongest one occurred in April (**Table 2**). Using the data of the two orders separately, the number of Avocets showed very slight correlation with the abundance of cladocerans, while with copepods strong correlations were detected for total and separated data sets, as well.

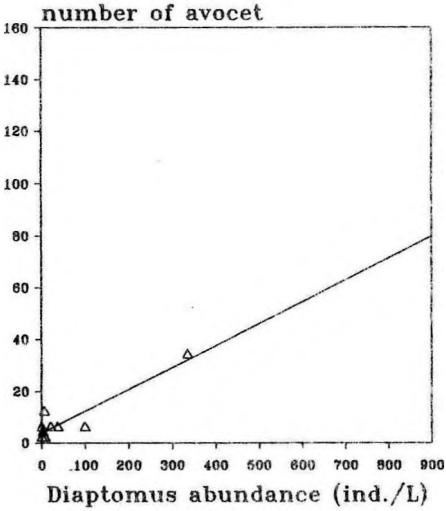
Table 2: Results of the correlation analyses between the number of Avocets and density of microcrustaceans

	Cladocera and Copepoda	Cladocera	Copepoda	Cyclops	Arcto-diaptomus
April-May	**0.715**	0.019	**0.865**	**0.872**	0.007
April	**0.933**	- 0.199	**0.939**	**0.929**	- 0.258
May	**0.906**	0.599	**0.926**	- 0.110	**0.924**

The correlation between the number of Avocet and zooplankton abundance was less strong in May. Cladocera showed again less strong relation, while copepods were strongly related, however this month the abundance of *Arctodiapromus* showed very strong relation.







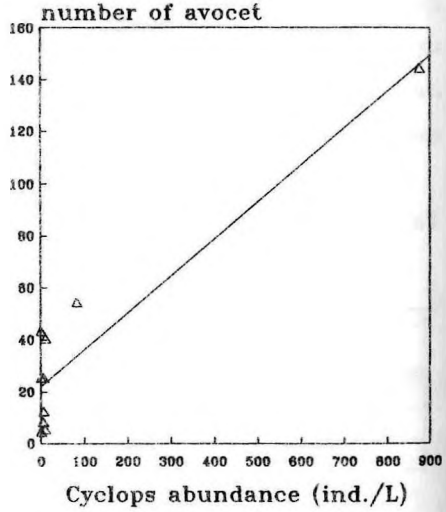


Figure 3: Relationships between the number of Avocets and the abundance of different microcrustacean taxa, based on data from 1993

DISCUSSION

The Avocet is distributed in coastal areas and at continental saline waters in Europe. Festetics (1971) considered it, together with *Charadrinus alexandrinus*, as halophilius species. In the Camargue Avocet is one of the three bird species that show the wildest salinity areas (Britton and Johnson, 1987). In the Carpathian Basin its distribution was limited to the so-called white sodic lakes, which are more saline than the black ones. This species is regularly occurring in this area, it was recorded also in recent years in the eastern part of Austria (in Seewinkel, at the eastern side of Neusiedler See) (Festetics and Leisler, 1970; Festetics, 1971; Kohler and Rauer, 1990) and in Hungary (Bankovics, 1983, 1984; Kárpáti, 1991; Hadarics et al., 1992; Boros, 1993a, 1993b). Boros and Szimuly (1993) reported its occurrence at less saline waters as well, which might be due to the decreasing number of sodic waters.

In the Hungarian literature the Avocet was reported to feed by scything, moving the head and bill from side to side, from the water or soft mud (Beretzk, 1938, 1950; Bankovics, 1984). According to Keve (1958) the food is made up by insects and other invertebrates, while Bankovics (1984) mentioned microcrustaceans, aquatic insects and their larvae as main food items. In the Seewinkel (Austria) Seitz (1942) found that Avocets occurred in greater numbers as those lakes where the anostracan *Branchinecta orientalis* was abundant. Festetics and Leisler (1970) accepted Seitz's opinion, however, they considered water bugs also as important food. They also stated that the Avocet is an extreme specialist in feeding because while scything it can cath bigger food items only. Goutner (1985) and Britton and Johnson (1987) also found that in brackish areas the Avocet was feeding on larger crustaceans, on Gammarus in the Evros delta and on Artemia in the Camargue. Moreira (1995a, b) observed winter feeding of Avocet on intertidal areas, here the ingested prey was bigger than a minimum treshold dimension of around 1.5 mm. These results are based on analyses of droppings.

In the present study we found that the microcrustacean zooplankton was very abundant in the sodic lakes, similar results were published for this region by Megyeri (1980) and Nógrády (1956). Cladocerans and copepods occurred in large numbers and biomass, while now *Branchinecta* was not found at all in these waters. Boros (unpublished) took mud samples, which contained very few chironomid larvae only. Ferencz (1980) studied the

zoobenthos of three waters, including Kelemen-szék and Zab-szék. In Zab-szék she collected 16 specimens (mean 2 specimens/sample). In Kelemn-szék 44 specimens were found (mean 5.5 specimens/sample). The animals were oligochaets and insects.

We collected droppings in July near the nests at the Kelemen-szék, very few remains could be identified. Some remains were chironomids and a few ephippia of cladocerans also were found. The ephippia are strongly chitinized cases of cladoceran resting eggs, most likely only these parts of the microcrustacean remained recognizeable after digestion, thus it is at least a positive indication that the Avocet is fedding on small crustaceans.

Comparing the abundance of microcrustacean zooplankton and numbers of Avocet at some localities we could show highly positive correlation between them. Since fairly shrimps were not found at this time and the benthic abundance was low it can be presumed that microcrustaceans were the most abundant potential food for Avocet. This is a migrating bird, it usually arrives early March in the Carpathian Basin, nesting period begins in May. As the correlation was stronger in April than in May, it can be concluded that in the nesting period the zooplankton abundance is less important in determining the distribution of Avocet. The ephippia found in droppings collected in July certainly indicate that the Avocet fed also later in the season on microcrustaceans.

In conclusion we think these results show that in the case of the sodic waters the microcrustaceans are important food organism of the Avocet, particularly before the nesting period, though they can be smaller than 1.5 mm, the minimum treshold food size pointed out by Moreira (1995b). Further research is needed to provide a better quantification of the relationship between Avocet and its food resources.

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