ACTA BIOLOGICA DEBRECINA

2002

TOM. 24

DEBRECEN, HUNGARIA

Contents

Biogeography, Community Ecology

Acta Biologica Debrecina (2002) **24**: 177–186

Investigation of parental care in avocets from the perspectives of behavioural ecology and conservation biology

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Abstract This research encompasses both basic (behavioural ecology) and applied (conservation biology) aspects of the biology of Avocets (*Recurvirostra avosetta* L.). My central question is whether adoption of alien young can be adaptive for adults and the adopted chicks. I evaluate proximate-level hypotheses by quantifying costs and/or benefits of both adopters and adoptees. I observed adoption of alien chicks in 19% of the families in 1998 and 1999. My first results suggest that adoption may be adaptive for both the adoptive adult and the adopted chick. This is because adopted chicks were more likely to fledge than their siblings remaining in their own family and the fledging success of the adopter adults' own chicks was higher than that of nonadoptive adults' chicks.

In my applied research I collect data on avocet breeding biology to find out whether the current population increase in Hungary results from the reproductive output of the Hungarian population or is maintained by an influx of birds from coastal populations. I also use these data to design and implement effective conservation measures by which to further enhance the Hungarian population of the endangered Avocet. I successfully increased the hatching success of mainland nests by erecting a fence to keep ground predators away. The fledging success of chicks also increased after a predator control in the most affected areas. By providing information about the timing of nesting to nature conservation authorities I assured the successful breeding of one fifth of Hungary's avocet population on a fishpond in 1999.

Keywords Adoption, Alloparental care, *Charadrii*, Enhancement of breeding success, Reproductive strategies, Waders.

Introduction

In spite of the spectacular development of parental care theory in recent decades, there are still some poorly known areas (Clutton-Brock 1991). Alloparental care, i.e. the care of young by adults other than the genetic

parents, is one of these areas. Adoption of young, the most widespread form of alloparental care, has been reported in over 150 mammal and 120 avian species (Brown et al. 1995). In birds, adoption has been studied in ducks, geese, gulls and terns. Some authors believe that adoption is selectively neutral in geese and ducks because there was no difference in the reproductive success of adopters and non-adoptive individuals (Bustnes and Erikstad 1991, Larsson et al. 1995), whereas others found costs (Forslund 1993), or benefits (Williams 1994) of adoption. In gulls and terns adoption is costly for parents, and is initiated by disadvantaged chicks, which increase their chances of survival by gaining adoptions into alien broods (Pierotti and Murphy 1987, Brown et al. 1995).

The parental care system of waders (suborder *Charadrii*) differs from that of the above taxa in that they have smaller broods than ducks and geese do, and in that their chicks, in contrast to gulls and terns, are fully precocial and are not fed by the parents. Therefore, the selection pressure acting on adoption in waders may be different from those in the above taxa. Nevertheless, the evolutionary background of adoption in waders has not been addressed previously, although waders frequently have been reported to show this behaviour (Hamilton 1975, Flemming 1987, Pierotti 1991). One probable reason for the lack of such studies is that the monitoring of wader broods and the quantification of fledging success are hard to achieve in the field.

The Pied Avocet (*Recurvirostra avosetta*), in which adoption is known to occur (Glutz et al. 1975, Cramp and Simmons 1983), is a suitable model species to study the adopting behaviour of waders. This is because avocet chicks can easily be marked individually by the use of colour-rings, which can be read from great distances, and because avocet broods are less attached to vegetation than broods of other wader species. These aspects make the identification and monitoring of broods, and thus the quantification of fledging success more feasible than in other wader species. The avocet is a strictly protected species in Hungary. The Hungarian population has shown a steady increase since the mid-eighties (Boros and Szimuly 1993), and the number of breeding pairs has reached 500. Although some aspects of avocet breeding biology are known (e.g. nest site preference: Boros and Szimuly 1993, feeding ecology: Boros and Mocskonyi 1993), it is not known whether the population increase is maintained by the reproduction of the Hungarian population or by the influx of individuals from coastal populations. The monitoring of the reproductive performance of the Hungarian population is essential to answer this question, which has a high conservation importance.

The aim of my basic research was to find evidence of adoption in the Hungarian population of avocets and to estimate the costs and/or benefits, and thus the adaptive value of adoption in avocets. Therefore, I measure the reproductive success of adults and the fledging success of chicks in the field and compare these parameters between adopter and non-adoptive parents, and between adopted chicks and chicks staying in their own brood.

The primary aim of my applied research was to collect data on the reproductive performance of avocets and to determine whether the reproductive output is able to maintain the Kiskunság population at its current level. My second aim in applied research is to use the data on breeding biology to design and implement effective conservation measures by which to further enhance the Hungarian avocet population. This paper summarizes the preliminary results of the first two field-seasons.

Methods

Avocets are large waders with black and white plumage and an upcurved bill nesting on the coasts and on saline inland lakes of Eurasia (Cramp and Simmons 1983). Its mating system is monogamy and it has biparental care. The clutch usually consists of four eggs which hatch after 23–24 days of incubation. The young chicks are fully precocial, i.e. they are able to walk and feed on their own a few hours after hatching. Avocets usually nest in colonies, but the parents lead the young away from the nest and the broods occupy territories in feeding areas (Cramp and Simmons 1983, personal observation).

Field research was carried out on several saline lakes (Bába-, Böddi-, Fehér-, Kelemen- és Zab-szék) and a fishpond (near the village of Akasztó) in the area of the Kiskunság National Park in 1998 and 1999. The number of breeding pairs was 90-100 pairs in 1998 and 220-230 pairs in 1999. After finding avocet nests I measured the eggs, determined their incubation stage and estimated their expected day of hatching. Chicks were individually marked with colour-rings a few hours after hatching. I followed brood movement by observations conducted with a telescope, during which I recorded the location and composition of broods. I identified cases of natural adoptions if a chick hatching in one brood was seen in another brood. Chicks that were seen alive after the fledging age (ca. 35 days) were considered fledged. Further details of the field methods can be found elsewhere (Lengyel 1999, Lengyel in press).

Results

Breeding biology

I found and monitored 449 nests in 1998 and 1999. At least one chick hatched from 51% of the nests. Hatching success was extremely low on the mainland (6%) and was high on islands (70%). A total of 767 chicks were known to hatch, of which I individually marked 476 (62%). Avocet broods often covered considerable distance from the nest to the feeding areas. The maximum distance travelled by broods was 5 km, which was observed for families that hatched their chicks on the Akasztó fishpond and led them to Bába-szék. During these movements avocet broods had to cross a main road, agricultural fields, reedbeds and channels. Travelling on land involves great risks for avocet broods because of the exhaustion of and the predation on chicks. The fledging success of chicks varied considerably according to whether the chicks were to cross land or not (Tab. 1).

Tab. 1: The number of hatched chicks and their fledging success. Fledging success is the ratio of the number of fledged vs. hatched chicks. Avocet broods covered 500 m on land from Fehér-szék and several km from the Akasztó fishponds to reach the feeding areas.

Year	Location	Chicks hatched	Fledging success
1998	Fehér-szék	143	7%
	Kelemen-szék	6	0%
	Zab-szék	31	24%
1999	Akasztó fishponds	206	16%
	Bába-szék	16	88%
	Fehér szék	42	13%
	Kelemen-szék	100	42%

The overall fledging success (ratio of chicks fledged vs. hatched) was 10% in 1998 and 27% in 1999. The main causes of chick mortality were predation in 1998 and harsh weather conditions coupled with predation in 1999.

Adoption of alien chicks

Adoptions most frequently occurred during brood movements but sometimes also on the nesting islands. In 1998 and 1999, I observed 12% of the chicks in

a brood other than their natal brood. The proportion of broods containing at least one adopted chick was 19%.

Adopted chicks were more likely to survive to fledging than their siblings remaining in their natal brood because the fledging success was 45% for adopted chicks and 19% for their siblings. This suggests that leaving the natal family and gaining adoption into an alien brood may be beneficial for chicks.

The fledging success of the chicks of adoptive adults (42%) was higher than that of chicks of non-adoptive adults (19%). This result shows that adoption may have benefits for the adopter as well. What can be the mechanism behind these results? One important factor in the choice of chicks and adults may be brood size. The average brood size (i.e. number of chicks) in families that adopted chicks departed from was 2, whereas it was over 3 in the broods in which they gained adoption. This suggests that chicks may actively search for larger families. Increasing the brood size by adopting alien chicks may also have benefits for the adopter because the chance that its own chicks get predated decreases.

Conservation of avocets

The number of chicks fledged per nesting pairs was 0.15 in 1998, which is very likely to be under the value necessary to maintain the current levels of the Kiskunság population. The population increase observed in 1999 is therefore probably a result of an influx of individuals from other populations. This is further supported by the observation that two birds that were marked by numbered leg rings as chicks in Spain successfully bred in the Kiskunság National Park in 1999. In 1999 the average fecundity was 0.34 chicks/pair, a value twice as high as in 1998. However, this value is probably still too low to maintain the population.

In 1998 the hatching success of mainland nests was close to 0. In order to increase hatching success of land nests we erected a 1 m high and 50 m long fence with the aim to keep ground predators away from the shorelines most preferred by avocets in 1999 (Fig. 1). None of the nests hatched in these areas in 1998, whereas in 1999 one-third of the 34 nests initiated in this area hatched.

The second factor limiting avocet reproductive success in 1998 was the low fledging success in areas where avocet broods had to cross land. Following my recommendations the Kiskunság National Park conducted a small-scale predator control near Fehér-szék, one of the areas most affected

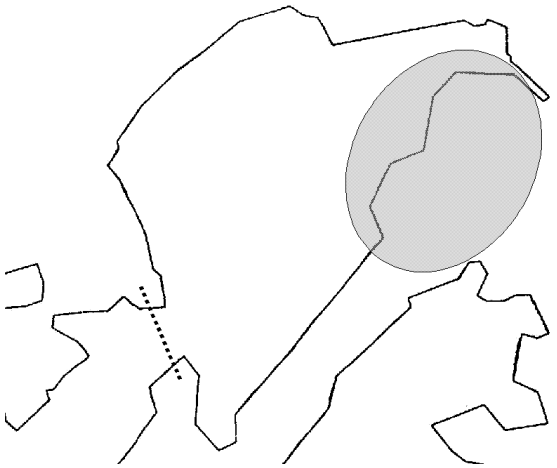

Fig. 1: Location of fence (indicated by dashed line) erected to keep ground predators away from nesting areas (indicated by gray colour).

by predation, in order to enhance fledging success. Probably as a result of the predator control the fledging success increased from 7% in 1998 to 13% in 1999.

The data that I collected often served the interests of the official nature protection authorities. In 1999, for example, 110 pairs of avocets laid their eggs in the dry bed of a fishpond near Akasztó. The owner of the fishpond planned to fill the pond in mid-May, much earlier than July 15, the earliest possible date of filling set by the Kiskunság National Park as the nature protection authority. In this unpromising situation the two negotiating parties, learning about the breeding biology data that had showed that avocets would hatch their chicks by the end of May, finally reached a compromise on the earliest date of filling. This compromise made the successful nesting of one-fifth of the Hungarian avocet population possible.

Discussion

My results have provided three important points. First, I found evidence that adoption of alien chicks is a frequent phenomenon in avocets because it occurred in almost one-fifth of the broods observed. Second, it appears that both the adopted chicks and the adopter adults gain by adoption. Chicks are likely to search for larger families, and larger broods may also be beneficial for the caring adult. In other words, it is possible that adoption is

evolutionary beneficial for both 'participants'. Third, the reproductive rate of the studied avocet population is probably lower than what is necessary to maintain the current population size. The reproductive success, however, can be increased in both the nesting and the brood-rearing phases.

My study was not detailed enough to shed light on the background mechanism of the benefits of adoption. Getting into a larger brood can have several advantages for chicks. First, larger families may be more likely to occupy territories with either more food or more hiding places available for chicks. Second, if chicks actively participate in the detection of predators, adoption may be beneficial because larger broods may be better than smaller broods at detecting predators (Forslund 1993). Finally, as a result of a 'dilution effect', chicks gaining adoption into a larger brood may decrease their chances of being predated (Larsson et al. 1995). This dilution effect can also be exploited by the accepting adult, because the chances of its own chicks being predated also declines (Pierotti 1988). Further investigations and experimental manipulations are necessary to determine whether the adopter's or the adoptee's decision is of primary importance in the formation of adoptions.

The mutual benefits found in this study are important from a conservation perspective. The eggs of avocets nesting in vulnerable conditions (e.g. on a fishpond waiting to be filled) can be collected and hatched artificially, and the chicks can be 're-patriated' by adopting them to broods living under more stable conditions. Such attempts have been made previously in the case of the Hungarian avocet population (Mödlinger 1984, Bakacsi 1991). The results of this study support the validity such nature conservation actions.

The results of this study cannot be used to evaluate whether the Hungarian avocet population can sustain itself for two reasons. First, I studied the Kiskunság population of avocets only, and we have no information on the reproductive parameters of avocets breeding on other areas of Hungary. Second, this study has been conducted for two years only, therefore, we cannot use this information to evaluate population changes on a longer time scale. My results so far, however, suggest the possibility that the observed low reproduction rate is not enough to sustain the population. A 20 years long study on the dynamics of the English avocet population found that a reproductive output of 1.1 fledged chick/nesting pair was necessary to maintain the population at its level of 40–50 breeding pairs (Hill 1988). The fecundity value measured in the Kiskunság population (two years combined: 0.29 chick/pair) was not even close to this value. Since the

hatching success found in the two years of this study (51%) was close to the usual hatching success of waders in general, the low fledging success (17%) may have been the reason for the low fecundity. The low fledging success is in no way exceptional in avocets since on the Atlantic coast of France from a 400-pair colony only 10 chicks fledge even in a good year because of predation on chicks by foxes (Girard 1997).

The population increase in Hungary is likely to be a consequence of either the good fecundity of avocets breeding in areas other than the Kiskunság in Hungary or the influx from a coastal population of avocets. My preliminary experiments suggest that both hatching and fledging success can be enhanced by artificial manipulation. Since fledging success appears to be the primary limiting factor for the population, the study of the possibilities to enhance fledging success is of highest importance. In the designing and implementation of further conservation measures (e.g. predator control, habitat reconstruction) it is necessary to consider the fact that fledging success was extremely low in areas where avocet chicks had to travel on land. Although the Hungarian population is increasing, years may come when this information can be applied and the methods can be used on a population level. This experience can also be applied in the conservation management of other species with a special habitat preference similar to that of avocets (Kentish Plover *Charadrius alexandrinus*, Black-winged Stilt *Himantopus himantopus*).

Acknowledgements Permits to conduct field-work were provided by the Kiskunság National Park, and special thanks should go to Emil Boros and Tibor Utassy for their help. I thank the Ringing Centre of the Hungarian Ornithological Society and Varga Lajos for the ringings permits. Beáta Lontay, Csaba Pigniczki, Orsolya Somogyvári and Anita Soltész was most helpful in the field. The major part of the equipment used in the field was provided by C. Richard Tracy, Director of the Biological Resources Research Center at the University of Nevada, Reno. The Behavioural Ecology Research Group of the Department of Evolutionary Zoology and Human Biology was a pleasant workplace during manuscript preparation. Financial support was provided by the Hungarian Scientific Research Fund (grants F026394 and F030403).

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