Gromadzka, J. 1989. Breeding and wintering areas of Dunlin migrating through southern Baltic. *Ornis Scand.* 20: 132-144.

Rosner, H.-U. 1990. Sind Zugmuster und Rastplatzansiedlung des Alpenstrandläufers *Calidris alpina alpina* abhängig vom Alter ? *J. Orn.* 131: 121-139.

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Status and breeding biology of Kentish Plover *Charadrius alexandrinus* in Hungary - a progress report

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A study of the status and breeding biology of Kentish Plover in Hungary was started in 1988. Here some results of the first year are presented. In Hungary the Kentish Plover breeds both on alkaline grasslands and on the bottoms of dried-out fish ponds. In both types of habitat vegetation is very scarce. Hatching success was 45.3% and the most important predators of eggs were mammals. I found no significant difference in morphology between the sexes but parental behaviour differed during both incubation and whilst attending young.

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INTRODUCTION

The Kentish Plover *Charadrius alexandrinus* is a widely distributed cosmopolitan bird. It breeds on coasts and on saline inland wetlands (Johnsgard 1981; Cramp & Simmons 1983). In Europe, the population is about 8,000 breeding pairs, the bulk breeding on the coasts of Spain, Portugal, France and West-Germany, with only a small population breeding inland in the Carpathian Basin (Bankovics 1984; Piersma 1986; Kohler 1988). While Rittinghaus (1956, 1961) and Lessells (1984) studied the birds in West Germany and France, respectively, hardly any information exists on the breeding biology in the Carpathian Basin. Here I report some results from the first year of a longer study.

STATUS OF KENTISH PLOVER IN HUNGARY

Old information suggests that in Hungary the Kentish Plover has always been restricted to alkaline habitats. Reports say that it bred in the vicinity of Budapest (Schenk 1934), and possibly the largest population was found in Fehér-tó near Szeged, where 20-100 nests occurred between 1947 and 1950 (Sterbetz 1963). In the 1950s, the Fehér-tó was converted into a fish-pond, and only small fragments of these alkaline grasslands have survived.

Recent estimates of the breeding population give 60-80 pairs for the whole of Hungary (Bankovics 1984). Three breeding areas can be identified: the southern part of the Great Hungarian Plain, Kiskinság, and Hortobágy (Figure 1). The main breeding habitats are alkaline grasslands (Figure 1) but recently the birds have also bred on the bottoms of dried-out declines at both Kiskunsag and Hortobágy (Table 1).

STUDY SITES

Kentish Plovers were studied in five localities (Figure 2). The areas between the study sites are cultivated agricultural lands and human settlements.

1. Fülöpszék. The shallow ephemeral lake Fülöpszék dried out at the end of May and Kentish Plovers started to breed there. The bottom of the lake is bare ground covered by salts. The vegetation is very scarce, consisting of halophyte plants

Figure 1 Recent distribution of breeding Kentish Plovers in Hungary (●) (After Bankovics 1984). The distribution of alkaline soils is indicated by ( ) (Toth 1987).

Table 1. Number of breeding pairs in two localities, Kiskunság and Hortobágy (Bankovics 1981, 1982, 1983, 1985 and Kovács 1983, 1984a, 1984b, 1985).

	Year					
	1980	1981	1982	1983	1984	1985
Kiskunsag	12	10	8	4	3	?
Hortobagy	10-12	6-8	5-6	4	0	1

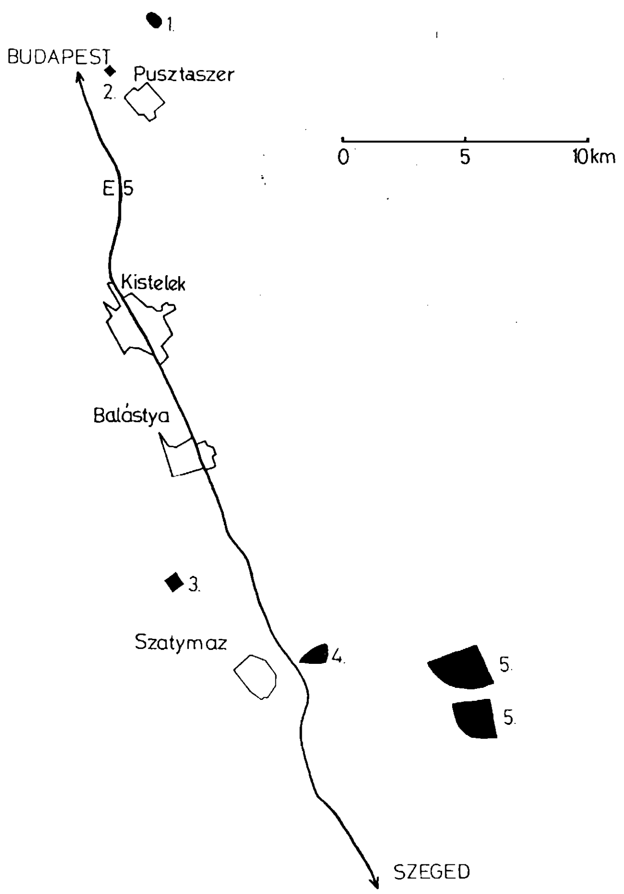

Figure 2. Study sites in South Hungary: 1 Fülöpszek, 2 Libanevelö, 3 Makraszék, 4 Székalj, 5 Fertö.

such as *Suaeda maritima, Crypsis aculeata* and of clumps of *Puccinellia distans.* The area is 31.1 ha.

2. Libanevelö. The grassland is an extensive goose-farm, and it was heavily grazed by geese the year before the fieldwork. The bare ground is covered either by salts or by plants such as *Puccinellia distans* or *Camphorosa annua.*

3. Makraszék. A grassland grazed by sheep. The most common plants are *Suaeda maritima* and *Puccinellia distans.* The area is about 9 ha.

4. Székalj. This grassland consists mainly of *Camphorosma annua* and *Puccinellia distans* and is grazed by sheep. The area is 22.8 ha.

5. Fertö. The fifth study plot was one pond of the Szeged-Fertö fishing farm. The pond was emptied in early spring and it remained empty up to the end of the breeding season. Most of the bottom was just bare ground without any vegetation, but some plants occurred, *e.g. Polygonum amphibium, Matricaria chamomilla* and *Myosurus minimus.* The area of the fish pond is 10.8 ha.

METHODS

Kentish Plovers started to breed at the beginning of April. Since fieldwork was carried out between 15 May and 10 July, limited information exists on those breeding attempts started before mid-May. During fieldwork we tried to find nests as early as possible: all nests were checked every other day. Just before hatching nests were visited usually twice a day, with a minimum of one visit/day. Young were usually first caught and ringed in the nest, or very near to the nest and later regularly recaptured by the help of an assistant. The adults were caught in tunnel traps either at the nest or by placing the young under a sieve in the trap (C.M. Lessells pers. comm.). All birds were given a numbered metal ring; adults were also given individual combinations of colour rings. The birds are easy to sex on the basis of plumage characteristics. Morphological measures followed Cramp & Simmons (1983), and Prater & Marchant (1977), while bill was measured at the anterior end of nostrils.

Observations on incubating birds were made at exact hours (05.00, 06.00 etc), and more than one observation per bird and day was allowed. Observations on birds attending young were made when the family was seen and when young were recaptured.

RESULTS

Size and weight of adults

No significant morphological difference was found between the sexes. Females tended to be heavier than males but the difference was not significant (Table 2). There was no clear correlation between study sites and the quality of bird *e.g.* weight, wing length, etc.

Table 2. Measurements of adult Kentish Plovers (mean + S.D.). The asterisk indicates a significant effect of locality on either male or female measurements (t-test, * : $p < 0.05$, ** : $p < 0.25$, *** : $p < 0.0010$.

	Males	Females
Weight (g)	41.7 ± 3.1	42.4 ± 2.5**
Wing (mm)	110.8 ± 3.0	11.1 ± 2.6
Tarsus (mm)	30.5 ± 1.0**	29.9 ± 1.1
Bill length (mm)	16.2 ± 1.0*	16.2 ± 1.1
Bill width (mm)	4.4 ± 1.0***	4.3 ± 1.1
Bill tip distance from the nalospi (mm)	11.2 ± 2.3	10.7 ± 0.6
No of birds	16	22

Vegetation of the breeding ground

In general, plant cover was very scarce and the vegetation was low (Table 3). The lowest coverage was in Fertö where at the time of breeding, plant cover was 10%. In Fulopszek one nest was found just beside a 60 cm height clump of *Puccinellia distans.* The only object found in the vicinity of nests was a *ca.* 0.5 m long wooden stick in Libanevelö.

Clutch size and egg measurements

Clutch-size was almost invariably 3, among 26 clutches only one completed clutch was found with 1 egg. The clutch with one egg hatched successfully. The smallest egg was 28.8 x 21.7 mm, the largest one 33.8 x 23.8 mm. The mean length of eggs was 31.7 (± 0.92) mm while the mean breadth was 23.06 (± 0.55) mm. Weight of fresh eggs was between 8.5 and 9.8 g, decreasing by the end of incubation to 6.33 - 8.17 g. The weight of a fresh clutch is approximately 65% of female body weight.

Table 3. Habitat characteristics of Kentish Plover's nests (mean ± S.D.). The mean height of vegetation was estimated at five points. All estimates were made within 5 m around the nests.

	Fülöpszék	Libanevelö	Makraszek	Székalj	Fertö
Mean height of vegetation (cm)	6.5 ± 4.6	9.1 ± 4.5	3.0 ± 1.9	4.0 ± 1.4	9.2 ± 2.0
% vegetation cover	38.3 ± 24.8	65.0 ± 7.1	32.0 ± 10.9	57.0 ± 4.5	10.0 ± 0
No. of nests	6	2	5	5	2

Breeding success

Twenty-six nests were found either by myself or by local ornithologists. The first egg was found on 12 April, while the last completed nest with three eggs was discovered on 26 June. Hatching success for these nests was 45.3% (Table 4). The main causes for failure were predation by mammals and desertion. Both dogs and foxes were observed at the study sites and their tracks and eggshell were found in destroyed nests. Birds can potentially also endanger clutches: I saw potential predators such as Rooks *Corvus frugilegus*, Jackdaws *Corvus monedula*, Black-headed Gulls *Larus ridibundus* and Rollers *Coracias garrulus* forage regularly at the study sites but no sign of bird predation was detected. Desertion might have been caused by human activities close to the nests, *e.g.* busy roads and heavy agricultural machines. The trapping activity did not cause desertion. Hatching success of early nests is unknown, and since presumably early nests suffered higher losses than late ones, the hatching success for the whole breeding season is probably lower than the value reported above.

Parental care

Both sexes share parental duties. During incubation males tend to attend the nests during the morning hours, in the evening and possibly during the night (Figure 3). Also, both sexes can take part in leading young. Up to six days after hatching both sexes may lead the young, while later on one sex always deserted. In 10 out of 16 cases the female deserted, and the reverse was true for the other six cases.

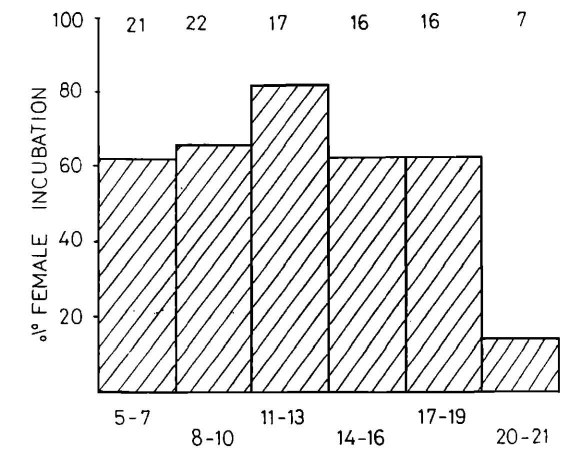

Figure 3. Sharing of incubation by sexes during daylight hours. Number of observations on both sexes is indicated above the bars.

Table 4	Fülöpszék	Libanevelö	Makraszék	Székalj	Fertö	Total
Number of eggs hatching	4	3	3	11	3	24
Eggs predated by mammals	3	3	5	1	3	15
Eggs deserted	6	0	3	2	0	11
Eggs disappeared	0	0	2	1	0	3
Fate unknown	3	12	7	0	0	22
Number of eggs	16	18	20	15	6	75
Number of nests	6	6	7	5	2	26

Table 5. Recaptures of the adult Kentish Plovers during the same breeding season.

	Date of first capture	No of days between captured/recaptured	Situation when captured/recaptured	Weight change (g)
Male	15 June	24	on eggs/with young	-3.9
Male	30 June	10	on eggs/on eggs	-4.1
Male	30 June	9	on eggs/with young	-4.3
Female	22 May	36	with young/on eggs	+1.6
Female	11 June	18	on eggs/on eggs	-1.2
Female	11 June	9	on eggs/on eggs	-3.0
Female	19 June	12	on eggs/on eggs	-1.0

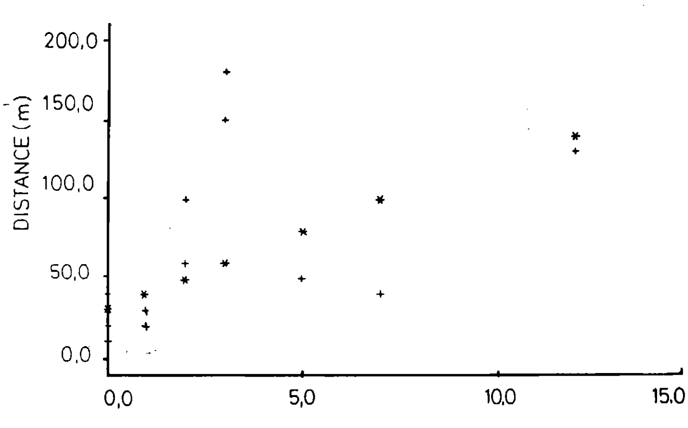

Figure 4. The distance from the nest that young were captured in relation to their age. + signs indicate observed values, * indicates fitted ones. DISTANCE = 34.9 + 9.0 x AGE (t-test, $p < 0.05$).

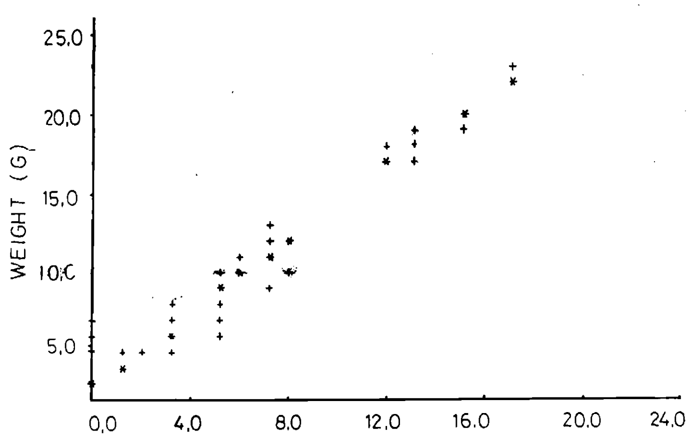

Figure 5. Weight of young of known age. + signs indicate the observed values, * indicates the fitted ones (t-test, $p < 0.001$). Note: hatching weights were not included in the line-fitting.

Parental care has costs. One possible cost of caring is weight loss of parents (Table 5). The number of observations is very low, but may suggest that during incubation and whilst attending young, males loose more weight than females (Table 5).

Growth of young

Within two hours after hatching the chicks are able to leave the nest. The young are led by the parents to various parts of the breeding habitat. In spite of extensive searches, in no case were the chicks found outside the study areas. The distance of young from the nest increased significantly with their age (Figure 4).

The average weight of freshly hatched chicks was 5.7 ± 0.4 g (n=14) and both on the first and the second day of their life chicks lost weight. From the third day onwards the weight increased approximately linearly with age, and the increase could be described as WEIGHT = 2.83 + 1.15 x AGE (Figure 5).

The tarsus of the young increased in length linearly from hatching onwards within the studied age (TARSUS = 20.28 + 0.46 x AGE, $p < 0.001$). Bill length also increased linearly (BILL LENGTH = 7.68 + 0.40 x AGE, $p < 0.001$).

DISCUSSION

Three aspects of the breeding biology might deserve particular attention. The first question is, why do Kentish Plovers almost always lay three eggs? Lack (1968) suggested that clutch-size of precocial birds can be limited by the egg-formation ability of the female, since her food-supply can be limited. The second idea is that the incubation ability of parents sets the upper limit to clutch-size since in a large clutch, eggs cannot be incubated properly. Another possible factor is possible limitations relating to parental care. Walters (1982) suggested that young of precocial birds need parental care, both in protection from predators and in location of food. Also, during the first day of life the chicks have poor thermoregulatory capacity, so they also need brooding (Visser *et al.* in press). The fourth hypothesis emphasizes predation as a selective pressure acting against large clutch-size. Since it takes longer to lay a large than a small clutch, a large clutch is exposed to predators for a longer time. Also, one may assume a large clutch is easier to spot by a visual predator than a small one.

The egg-limitation hypothesis seems to be poorly supported in waders, *e.g.* lost clutches are easily replaced. Rather food availability affects egg-laying intervals (Lank *et al.* 1985). A rich food supply can also induce additional clutches (Graul 1978).

Safriel (1975) artificially enlarged the broods of Semipalmated Sandpiper *Calidris pusilla* and found a marked drop in fledging success, because the adults were unable to protect the young effectively. In another field experiment, Kålås & Lofaldli (1987) added eggs to Dotterel *Charadrius morinellus* clutches. The results supported the incubation ability hypothesis. The latter study however, suffered from various defects, *e.g.* small sample size and lack of a real control. At present our knowledge is too scarce to evaluate any of these hypotheses for the Kentish Plover.

Another aspect of the reproductive biology of waders is low hatching success. Usually hatching success in Charadrii is between 66 and 96% (Hale 1980). However, Lessells (1984) reported only 10% for Kentish Plovers breeding on dikes in the Camargue. Probably the reason for this low success was systematic searching of the dikes by predators. Warriner *et al.* (1986) found that 40-74% of Snowy Plover *Calidris alexandrinus* eggs hatched in a Californian populations. The most important reasons for failure were human disturbance, and predation by birds and mammals. The highest hatching success of Kentish Plovers was reported 94% by Rittinghaus (1956), but he studied birds on an island, where they were almost out of reach of predators. Since clutch-size seems to be limited, the only possibilities to increase breeding performance are either to improve the quality of offspring or to lay more clutches.

The third interesting aspect of the breeding biology of waders is parental behaviour. No known specific hypothesis has been suggested for different incubation schedules of sexes (Figure 3). One idea could be, that the male avoids midday hours at the nest, since he is more brightly coloured than the female. Therefore he is more vulnerable to either overheating by the sun or to detection by predators. Support for this idea is that the sexes of both Ringed Plover C. *hiaticula* and Little Ringed Plover C. *dubius* are quite alike, and neither species has sex biased incubation (Cramp & Simmons 1983). Another hypothesis is that the male is engaged in territory protection during the day and thus cannot incubate during the daylight hours. One observation against this is that, in my study areas, no territorial behaviour was observed during incubation.

Wader young are precocial and need not be fed by the parents. However, the adults protect them from predators, show the chicks good food patches and brood them. A few days after hatching one sex usually deserts. Lessells (1984) and Warriner *et al.* (1986) found more female desertion, while Rittinghaus (1956) stated that the parental share of the female generally increases towards fledging. Dawkins & Carlisle (1976) hypothesised, that the sex which is first able to desert does so. According to Rittinghaus (1956) two sexes are needed for incubation but not for attending the young. If Dawkins & Carlisle's hypothesis would operate, we should expect both sexes to desert at the same rate. Trivers (1985) suggested that differences in parental certainty accounts for sex-differences in desertion. According to his hypothesis that sex deserts which is less certain about its kinship with the offspring. In birds fertilization is internal, so one would expect the mother to be sure of parentship, the father not. Consequently we would expect male rather than female desertion. This hypothesis cannot explain female desertion, so in order to understand the parental care system of the Kentish Plover we need a more detailed study.

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REFERENCES

Bankovics, A. 1981. A KNP területen költö fontosabb madárfajok állománya 1980-ban koltoparonkent. *Mad. Táj.* 3: 129.

Bankovics, A. 1982. A Kiskunsági Nemzeti Parkban és a Péteri-tó területén költö fontosabb madárfajok állománya 1981-ben. *Mad. Táj.* 1: 26-29.

Bankovics, A. 1983. A Kiskunsági Nemzeti Park, a Péter-tó és a Szelidi Tó körzetében költö fontosabb madárfajok állománya 1982-ben. *Mad. Táj.* 1: 19-22.

Bankovics, A. 1984. A székilile. *In* : Haraszthy, L. (ed.) *Magyarország fészkelö madarai.* Natura, Budapest.

Bankovics, A. 1985. A Kiskunsági Nemzeti Park, a Péteri-Tó és a Szelidi Tó körzetében költö fontosabb madárfajok állománya 1983-ban és 1984-ben. *Mad.Táj.* 1: 16-22.

Cramp, S. & Simmons, K.E.L. 1983. *The Birds of the Western Palearctic Vol. III.* Oxford Univ. Press, Oxford.

Dawkins, R. & Carlisle, T.R. 1976. Parental investment, mate desertion and a fallacy. *Nature* 262: 131-132.

Graul, W.D. 1976. Food fluctuation and multiple clutches in the Mountain Plover. *Auk* 93: 166-167.

Hale, W.G. 1980 *Waders.* Collins, London.

Johnsgard, P.A. 1981. *The Plovers, Sandpipers and Snipes of the World.*Univ. of Nebraska Press, Lincoln.

Kålås, J.A. & Lofaldli, L. 1987. Clutch size in the Dotterel *Charadrius morinellus:* an adaptation to parental behaviour? *Ornis Scand.*18: 316-319.

Kohler, B. 1988. Die Brutstände von Flussregenpfeifer *Charadrius dubius*, Seeregenpfeifer *Charadrius alexandrinus*, Uferschnepfe *Limosa limosa* und Rotschenkel *Tringa totanus*im Seewinkel in den Jahren 1986 and 1987. *BFB-Bericht* 66: 13-26.

Kovács, G. 1983. Fészkelési adatok a Hortobágyi Nemzeti Parkból és környékéröl. *Mad. Táj.*1: 16-18.

Kovács, G. 1984a. 1983-as fészkelési adatok a Hortobágyi Nemzeti Parkból és környékéröl. *Mad. Táj.* 1: 25-27.

Kovács, G. 1984b. 1984-es fészkelési adatok a Hortobágyról és környékéröl. *Mad. Táj* 4: 207-210.

Kovács, G. 1985. 1985-ös fészkelési adatok a Hortobágyról és környékérol. *Mad. Táj.* 2: 34-36.

Lack, D. 1968. *Ecological adaptations for breeding in birds.* 3 Methuen, London.

Lank, D.B., Oring, L.W. & Maxson, S.J. 1985. Mate and nutrient limitation of egg-laying in a polyandrous shorebird. *Ecology* 66: 1513-1524.

Lessells, C.M. 1984. The mating system of Kentish Plover *Charadrius alexandrinus. Ibis* 126: 474-483.

Piersma, T. 1986. Breeding Waders in Europe. *Wader Study Group Bull.* 48 *Suppl.* .

Prater, A.J. & Marchant, J. 1977. *Guide to Identification and Aging of Holarctic Waders.* BTO, Tring.

Ritinghaus, H. 1956. Untersuchungen am Seeregenpfeifer *Charadrius alexandrinus* Lauf der Insel Oldeoog. *J. Orn.* 97: 117-155.

Rittinghaus, H. 1961. *Der Seeregenpfeifer.*Wittenberg Lutherstadt.

Safriel, U.N. 1975. On the significance of clutch size in nidifugous birds. *Ecology* 56: 703-708.

Schenk, J. 1934. Széki lile fészkelése Budapesten. *Term. tud. Kozl.* 66: 45-46.

Sterbetz, I. 1963. A Szégedi Fehertavi tajveltozasokkal kapcsolatos madártelepülések. *Áll. Közl.* 50: 129-134.

Toth, A. (ed.) 1987. *Áldás és átok a viz.* Kisujjszállás.

Trivers, R.L. 1985. *Social Evolution.* Benjamin Cummings, Menlo Park.

Visser, G.H. Beintema, A.J. & von Kampen, M. in press. *Development of thermoregulation in chicks of Charadriiform birds.* Proceedings of the Thermal Physiology Symposium, 1989.

Walters, J.R. 1982. Parental behavior of Lapwings (Charadriidae) and its relationships with clutch sizes and mating systems. *Evolution* 36: 1030-1040.

Warriner, J.S., Warriner, J.C., Page, G.W. & Stenzel, L.E. 1986. Mating system and reproductive success of a small population of polygamous Snowy Plovers. *Wilson Bull.* 98: 15-37.