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Effects of environmental conditions on aerial feeding by Collared Pratincoles *Glareola pratincola* breeding in southwest Spain

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Abstract - During the chick-rearing period, adult Collared Pratincoles *Glareola pratincola* tended to feed in the colony or nearby on insects caught in flight. Before and after this period, they often moved further from colonies to forage in groups over areas of marshes and reeds. Daily activity was highly influenced by weather conditions. Collared Pratincole feeding density was lower on rainy, windy or cloudy or cloudy days. In general, feeding activity increased through the morning up to early afternoon and decreased after that. Food availability in marsh and reed sites was higher than in the crop site. Apart from cereals, few Collared Pratincoles fed over crops.

The Collared Pratincole *Glareola pratincola* is an insectivorous wader with small and declining numbers in southern Europe. It also occurs in north Africa and west Asia. Between 40% and 50% of the species' European population breeds in SW Spain, in an area of marshes which has mostly been reclaimed for agriculture. Although those breeding in marshland achieve a high hatching success, the general loss of habitat and high egg losses in agricultural land due to farming practices, are responsible for a large decline of Collared Pratincole numbers in the area (Calvo 1994).

Collared Pratincoles feed mainly on insects captured in flight, especially above marsh and reed habitats. Crops, except for cereals where Collared Pratincoles fed mainly on Hemiptera pest species (*Aelia* spp., Family *Pentatomidae* and *Eurygaster* spp., Family *Scutelleridae*), were hardly used (Calvo 1996). The Collared Pratincole can also be opportunistic in feeding habits and may occasionally use alternative foraging strategies and areas (Sterbetz 1974, Calvo *pers. obsv.*). They can peck at invertebrates which are forced to come up to the soil surface when fields are flooded to sow rice or behind tractors ploughing a field (together with Cattle Egrets *Bubulcus ibis*). They also fly low above pool surfaces feeding on emergent insects or over fields where stubble has recently been burnt. The higher temperature creates ascendant air currents which carry insects in it. Sterbetz (1974) says that they follow cattle as there are insects associated with them and also because, when moving they make insects come out of the vegetation. Nevertheless, they feed mainly in the air and it is this method we shall be considering in detail. In this paper we report the effect of different weather parameters on the aerial feeding of Collared Pratincoles.

The study was carried out in reclaimed marshland in southwest Spain (37°2'-37°10'N; 5°58'-6°3'W) in 1992. The area is characterised by mild winters and long hot dry summers. Rainfall occurs mainly in winter and spring, with hardly any rain during the summer months. There is a mixture of marshland fragments and agricultural land. The main crops are rice, cotton, sunflower and cereals. For a general description of the area see Barrera *et al.* (1984).

Collared Pratincole feeding density (number of birds/ha) and feeding height (under and over 5 m) were recorded by making a transect along roads passing close to several Collared Pratincole colonies (for description of methods see Calvo 1994). The transect was made twice on the same day in 19 out of 25 days to check data consistency within a day. During these transects, data on date, formation of feeding flocks, wind speed and cloudiness were recorded. When there were more than 50 individuals feeding within 500 m, it was considered to be a flock. Wind speed was measured on a three point scale following the Beaufort scale: 1. Calm (Beaufort 0, <0.6 m/s), 2. Breezy (Beaufort 1 to 3, 0.6-5.2 m/s) and 3. Windy (Beaufort >3, >5.3 m/s). Cloudiness was measured in a similar way: 1. Clear sky (no clouds), 2.

Partially cloudy (<50% clouds), 3. Cloudy (≥50%). Rainfall data from the nearest weather station were recorded for the day before, the day of, and the day after each transect count. Data were analysed with non-parametric tests (Kruskall-Wallis and Mann-Whitney) as they were not normally distributed. Only the effect of wind on birds' feeding density was analysed using an ANOVA (analysis of variance), as the data fulfilled the requirements of parametric tests. When testing for temporal variations in feeding activity three periods were considered: "incubation" (21 April to 21 May), "chick rearing" (21 May to 26 June) and "post-breeding" (27 June to 22 July). Periods were defined using data from direct observations during three breeding seasons (1989, 1990 and 1992).

During the incubation period, the number of birds feeding at different times of the day in a feeding area (reeds and shallow waters) was also recorded. At least four counts were taken per hour from 08.00 to 22.00 from 26 April to 14 May. These were only taken during the incubation period as, after the eggs have hatched, Collared Pratincoles fed mainly near the colonies.

Feeding activity

When testing the consistency of the transect data within a day, we found that numbers counted on the first count each day were correlated with numbers on the return trip (r_{17}=0.73, P<0.001). Collared Pratincole feeding density (birds/ha) within the study transect varied significantly among the three periods ($F_{2,122}$=3.76, P<0.05, LSD test P<0.05) and was higher during the incubation period (mean=75.3, S.E.=16.9, n=40) than during the chick rearing period (mean=14.4, S.E.=2.8, n=45). The increase during the post-breeding period (mean=25.9, S.E.=6.2, n=40) was not significant (LSD test, P>0.05). The number of flocks formed also followed this pattern, decreasing during the chick-rearing period. Large groups (more than 100 individuals) were only seen during the first and last of the three periods (3 and 1, respectively).

Diurnal feeding activity increased throughout the morning, reaching a peak in the afternoon and declining in the evening (Fig. 1).

Weather effect on feeding activity

Feeding density within the transect was significantly lower on windy than on breezy or calm days ($F_{2,122}$=3.83, P<0.05, LSD test, P<0.05; Table 1).

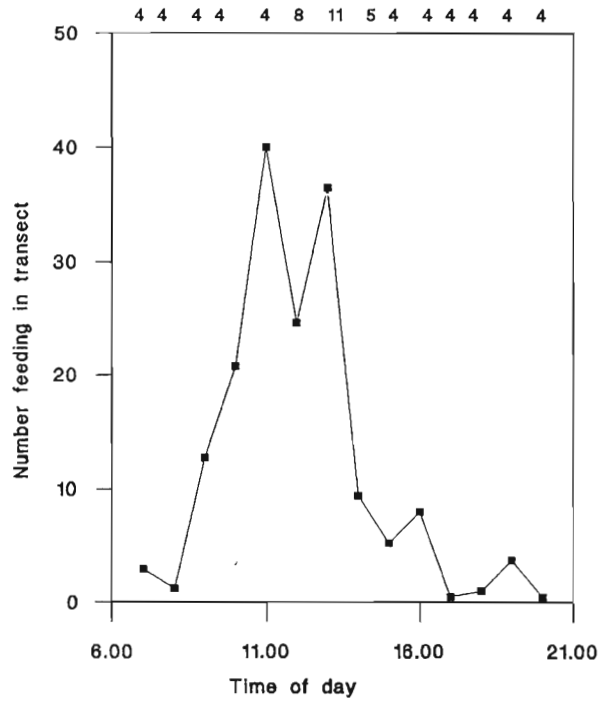

Figure 1. Mean number of Collared Pratincoles feeding over an area of reeds and cereal crops throughout the day. Number of counts on the top axis.

Flocks occurred on only one out of nine windy days. Wind also affected the height at which Collared Pratincoles fed. With stronger wind there was a higher proportion of individuals feeding under 5 m (Kruskal-Wallis, X^2=23.4, n=125, P<0.0001; Table 1).

Table 1 - Mean (±S.E.) Collared Pratincole feeding density within the transect and ratio of Collared Pratincoles below 5m to those more than 5m above ground in days with different wind speeds, with different cloud cover and with and without rain, on the sampling day and also on the next day.

	Feeding density	<5m. >5m Ratio	n
Wind			
Calm	47.3±10.38	0.6±0.1	25
Breezy	50.1±12.21	2.6±1.4	55
Windy	19.3±6.01	11.8±5.7	45
Cloudiness			
Clear sky	46.5±9.5	3.1±1.2	75
Partially cloudy	25.5±6.8	0.8±1.2	25
Cloudy	27.1±10.3	17.4±10.1	25
Rainfall (on sampling days)			
No rain	38.9±6.8	2.5±0.8	110
Rain	35.0±16.8	27.5±16.5	15
Rainfall (one day after sampling)			
No rain	40.0±7.4	3.0±0.9	100
Rain	32.0±10.4	15.3±10.1	25

Cloud cover did not significantly affect foraging activity (Kruskal-Wallis, X^2=0.83, n=125, N.S.; Table 1). On days with thick cloud cover, more birds flew lower than 5 m than on clearer days (Kruskal-Wallis, X^2=11.7, n=125, P<0.005; Table 1).

Feeding density of Collared Pratincoles on days with rain was not significantly different from that on days without rain (U=744, Z=-0.62, n=125, N.S.; Table 1), but on rainy days birds flew lower than on days without rain (U=315, Z=-3.94, n=125, P<0.001; Table 1). Looking for weather effects over longer time-periods, considering feeding activity in relation to rainfall one day after the transect was travelled, no significant differences were found (U=1229, Z=-0.13, n=125, N.S.; Table 1). Differences in feeding height were not significant in this case either (U=952, Z=-1.87, n=125, N.S.; Table 1). In no case did rain fall on the day before transects were made. Effects of rainfall on foraging behaviour appeared to be small and short-term.

The density of Collared Pratincoles recorded feeding in the air within the transect was highest during the incubation period, decreased to a minimum during the chick-rearing period and increased again afterwards. This decrease is probably due to Collared Pratincoles staying closer to their colonies (which were beyond the transect) once the eggs had hatched. They then fed near the colonies and took the food to their chicks. Numbers in the transect did not rise much after breeding as some birds had already left the area.

Feeding time of the Collared Pratincole has traditionally been considered to be at dawn and at dusk (Valverde 1960, Cramp and Simmons 1983). Contrary to this view, the pattern of daily activity obtained here was an increase during the morning which reached a peak in the afternoon and then declined in the evening (Fig. 1). In other areas, crepuscular activity has been observed. Undoubtedly, feeding activity is subject to insect prey activity and this, in turn, depends on the vegetation and soil substrate and several atmospheric parameters. Light and temperature are two factors which limit insect flight and activity. Many insect species cannot fly at low temperature (Chapman 1982) and big insects need longer to warm up than small ones (Johnson 1969). Although not a rigid rule, there are usually more insects in the air at higher temperatures (Johnson 1969). With rising temperatures, air currents carry insects upwards. On days when other factors such as rainfall or wind are not affecting the birds (see below), Collared Pratincoles feed at higher levels as the day warms. Gustafson *et al.* (1977) found that Swifts *Apus apus* flew at higher altitudes in clear weather. Our results fit with this pattern. However, in places with high day temperatures some insect species are less active during the hottest hours (Beck 1971, Ross 1973). Collared Pratincoles feeding at dawn and dusk are a common sight in this area, but usually in specific places and for a short period of time, as if the birds were exploiting a temporary food source. Although Collared Pratincoles do not usually feed at night, they have been observed feeding by artificial light (M. Máñez, *pers.comm.*) and sporadically with a full moon (Valverde 1960).

High wind speeds inhibit insect flight but light ones can stimulate it (Freeman 1945, Johnson 1969, Chapman 1982). This pattern of activity fits well with the feeding activity of Collared Pratincoles. Numbers of birds feeding on windy days were much lower and flocks were not usually formed on such days. Also flying height was affected, birds flying lower with stronger wind.

A reduced availability of food during the breeding period may affect the breeding performance of aerial insectivores (Bryant 1975). Weather conditions can alter the birds' feeding activities and reduce food availability (Turner 1983), affecting the number of feeds received by the chick (Turner 1984) or the chick growth and survival (Bryant 1975, Beintema and Visser 1989). Also, agricultural procedures may reduce the amount of food available for bird species nesting in or near fields as shown by Potts (1978) for the Grey Partridge *Perdix perdix* and suggested by Sterbetz (1974) for the Collared Pratincole. This did not seem to be the case in the study area. A previous study of Collared Pratincole food availability, chick diet and performance in colonies in marshland and farmland in the Guadalquivir marshes area (Calvo 1994) showed chick growth rates which suggested that the food supply was adequate in both habitats and that the weather was not affecting chick performance. However food supply may be altered by extreme weather conditions like the long drought suffered in the area in recent years, which affected Collared Pratincole's breeding performance (Calvo 1996).

Resumen - Durante el periodo de cría, las Canasteras *Glareola pratincola* adultas tienden a alimentarse capturando insectos al vuelo en las colonias o cerca de ellas. Antes y despues de este periodo, se desplazan a menudo a alimentarse en grupos sobre áreas de marisma y carrizales. La actividad diaria de alimentación estaba fuertemente influida por las condiciones atmosféricas. La densidad de individuos alimentándose era menor en días nublados, lluviosos o con viento. En general, la actividad de alimentación aumentaba durante la mañana hasta el comienzo de la tarde y a partir de ahí empezaba a disminuir.

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