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Feeding success and relationships of some species of waterbirds in the «Valli di Comacchio» (Italy)

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Abstract - The feeding success of Black-headed gull, Common tern and Little egret was studied in the "Valli di Comacchio" lagoon (northeastern Italy), both in presence and absence of intra and interspecific interactions. Sometimes gulls and terns feed on the same areas and on particular occasions aggregate with other waterbirds, but little is known about the feeding success and behavioural interactions among them. The aim of this work was to evaluate the interactions and the feeding success of gulls and terns foraging sintopically with Little egrets. The Little egret had a very high feeding success, but the intraspecific territorialism strongly reduced the time available to fish. The Common tern had difficulties to dive because of the presence of Black-headed gull swimming in the water. The gull was equally successful both in presence and absence of intra and interspecific competition. Then, the observed feeding rate were higher than data from literature; this let to suppose that the birds were attracted by a favourable food supply. I suggest that the observed species are independently attracted to a rich food source.

Introduction

The foraging behaviour of the Little egret *Egretta garzetta*, Black-headed gull *Larus ridibundus* and Common tern *Sterna hirundo* in the Eastern Italian wetlands has been described (Boldreghini *et al.*, 1988; Fasola *et al.*, 1989; Fasola and Bogliani, 1990). Usually their feeding niches don't overlap, because of the different habits of the three species. The Little egret forages along the shore or near the shingle banks, where the water level is low (height under the tarsus) and, sometimes, perched on rocks (Cramp and Simmons, 1983; Fasola, 1986). Usually the Common tern feeds at some distance from shore (Erwin, 1977; Fasola and Bogliani, 1984; Duffy, 1986). The Black-headed gull feeds also in open water, but usually in low current (Vernon, 1972; Gotmark, 1984). In the salted lagoons the gulls try to become more eclectic, visiting areas with shallow and medium-high water, often joining with Little egrets and Common terns (the association here described; Saino *et al.*, 1988).

Some quantitative analyses have been carried out to evaluate the feeding success (Dunn, 1973; Frugis, 1975; Fasola, 1993) and the interspecific behaviour of waterbirds in multi-species assemblages (Ashmole and Ashmole, 1967; Sealy, 1973; Hulsman, 1976; Schneider, 1982; Duffy, 1986; Fasola, 1994). Recently some authors focused their attention on the interactions between species over patches of prey, such as species' dominance interactions, mutualistic locating of prey and kleptoparasitism (Hoffman *et al.*, 1981; Duffy, 1983, 1986). These local and temporary situations can force the birds to aggregate over shoals of prey, where success of foraging attempts were affected by group density. In fact, wading birds have been shown to join aggregations because of foraging benefits (Caldwell, 1981; Hafner *et al.*, 1982; Erwin *et al.*, 1985). These benefits accrue because of social facilitation or because aggregations tends to occur in the best feeding sites (Krebs, 1974; Cezilly *et al.*, 1990). Groups typically form where prey availability is high, defensibility is low and distribution of prey is patchily (Bell, 1991). Master *et al.* (1993) suggested as the major benefits gained by feeding participants in mixed-species may include increased feeding success and reduced energy expenditure. Particularly the authors stressed the importance of the benefits deriving from the position of a particular species within an aggregation, the foraging behaviours, the prey characteristics, the prey responses to disturbance by predators and habitat structure. Finally, few studies attempted to predict how a given species respond flexibly to the variability of foraging resources through space-time (Wiens and Rotenberry, 1979; Wheelwright, 1986; Becker *et al.*, 1987; Twedt *et al.*, 1991). Recently, Fasola (1994) investigated whether resource use concentrates opportunistically upon the locally available resources, is determined by the independent preferences of each consumer, or is constrained by competition among coexisting species. Particularly, in some species prey size has been found

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as the main factor in segregating syntopic species of birds (Hespenheide, 1975; Reynolds and Meslow, 1984; Cooper *et al.*, 1990). On the occasion here described Common gulls, Common terns and Little egrets exploit the same trophic resource, because of the easy availability of the source of food and the favourable site. The present study reports the relationships among the three species and the feeding success rate in a gate of a fishing canal.

Methods

The study was carried out along a ditch of the Comacchio lagoon (RA, North-East Italy). The canal was used by some species of fish during the daily and seasonal migrations from lagoons to sea related to the reproductive seasons. It is already known that many species of fish, following a saline gradient, entered fresh-water for mating and migrate back to the sea with the fries. The presence of the gate made the density of fish so much that it represented an important food source for piscivorous birds. In the research period the crossing of sand-smelt *Atherina boyeri* and mullets *Mugil cephalus* was remarkable. The canal was composed by 24 small gates (less than 1 m wide), separated each other by two piers of cement. Each grid permitted the feeding on the water. The quantity of fish migrating in the canal was estimated by measuring the amount of fish (sand-smelt) present in the surface of the water facing every grid. Three categories were adopted:

1 - HIGH DENSITY GRIDS - HDG. The surface of the water was fully covered by fish (100%)

2 - MEDIUM DENSITY GRIDS - MDG. The covering ranged from 25 to 75%.

3 - LOW DENSITY GRIDS - LDG. The covering was less than 25%.

Data were collected from 15/6 to 5/7 1990 (presumably during the breeding season for most individuals), in different hours of the same day and on subsequent days. The observations were made from a hide settled on one side of the canal, close to the gate (about 5 meters far from the water and 15 m from the centre of the gate). From this point I observed 225 birds (75 for each species), for standard observation periods of 5 min each. For each focal bird, position of the individual, intra and interspecific behaviour were recorded. All the aggressive interactions among foraging birds were recorded. The feeding success (number of preys captured per unit of time) was estimated by counting the number of fishes caught during each observation session. The number of preys were detected by using a 60X telescope and the feeding rate was evaluate in presence and absence of any kind of antagonistic displays, in order to detect the influence of the competition. A sample of 50 Common terns were also observed diving 20-50 m far from the gate, in order to quantify the feeding success in the open water of the canal (less abundance of prey). In order to uniform the data I included in the analysis only the birds seen foraging on sand-smelts.
Because of the large size and the maintenance of fixed position for long time, the existence of natural markers (such as size, legs and eyes color, presence or absence of breeding plumage, etc.) was occasionally useful to identify few egrets, particularly birds tending to take possession of fixed perch.

Results

Little egrets, Black-headed gulls and Common terns foraged together on a gate of the sluice, where the concentration of fish was highest; the density of sand-smelts was high and uniform close to the grid, decreasing from the middle of the canal to the external grids.

Intra and interspecific behaviour

While fishing the Little egret held a grid and all the grids were occupied. Some individuals keep "fixed" position. This was confirmed by observing the same bird reoccupying repeatedly the same grid during long observation sessions (1-4 hours). All the birds seen on the HDG and, secondarily, on the MDG showed a strong tendency to the territoriality, but it was never

Tab.1 a - Number of birds (as percentage) of the three species displaying aggressions between conspecifics and heterospecifics (combined).
b - Average number of preys captured (per minute) in presence or absence of aggressions. Values are given as mean ±SD.

	Percentage of birds (a)		Prey capture rate (b)	
	Presence of DT	Absence of DT	Presence of DT	Absence of DT
Little Egret	69	31	7.78±3.31	2.14±0.98
Black-headed Gull	25	75	6.26±2.54	6.50±1.98
Common Tern	0	100		1.80±0.23

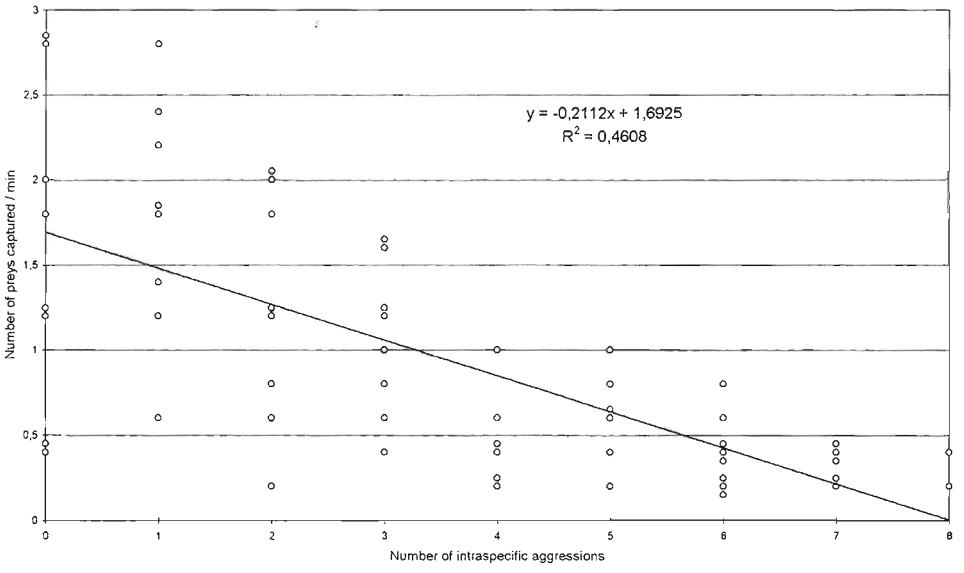

Fig. 1 - Aggression rate among conspecifics Little egrets (no. aggressions / standard observation session) in relation to average food intake. The average number of prey is related to unit of time (minute), while the number of aggressions is referred to the sample unit of observation (5').

observed in birds feeding in the external grids (LDG). The difference in mean number of antagonistic displays of the three situations was significant (ANOVA, $F_{2,52} = 5.44$, $P<0.01$). The birds holding an HDG didn't tolerate the presence of conspecifics in the individual feeding territory (the grid and the touching water), neither their presence on the near foot-bridge. Newcomers often tried to hold fully or to a some extent a feeding position. Usually the newcomers were attacked and forced to leave the site. The only way to occupy the HDG was the arrival of a dominant bird.

The activity of territorial defence was shown by the 69% of the egrets and reduced the time available for feeding (see Tab. 1 a). The egrets showed 1-8 aggressive displays for sample of 5', capturing only 27.5% of prey if compared to birds not engaged in defense of feeding territory, and the difference was significant (Mann-Whitney U-test, n=49 and 20, U=63.9, P<0.01). The correlation between number of antagonistic displays and fishing success was also significant (ANOVA, $F_{8,50}=6.71$, $P<0.01$; see Fig. 1).

The Black-headed gull fed swimming and took the fishes just under the water surface. This technique caused to avoid the mainteinance of a stable territory and, then, less time spent in territorial displays. The defense of a temporary feeding site took place through a short pursuit ending with the removal of the invader. The structures related to the grid made the gulls tame and they preferred to alternate the foraging with short escaping. However 25% of the birds feeding near the gate showed antagonistic displays. A maximum number of 2 interactions for 5' were recorded. This activity was extremely fast and didn't lower the fishing success (Mann-Whitney U-test, n=18 and 52, U=55, n.s.). None events of intraspecific kleptoparasitism has ben documented. The gull (2 cases) showed a kleptoparasitic behaviour toward the egret, displaying a mobbing that induced the heron to leave the prey (a mullet about 20 cm long), suddenly catched by the gull. Then, the gull swimming in the water recovered the fishes caught and fallen from the egrets (usually 3-5 sand-smelts were captured together and only a part of them were ingested). The presence near the gate of the gulls didn't affect the feeding activity of the egrets, but reduced the water surface useful to dive to the Common tern.

The Common tern fed diving and so it couldn't catch prey too close to the gate. It didn't show any kind of territorial interactions and was limited only by the number of gulls swimming in the water. Few attempts of food-piracy were recorded, but all were unsuccessful.

Feeding success

The egrets captured an average of 7.78±3.31 SD preys per minute if undisturbed and only 2.14±0.98 in presence of DT, with a decrease of feeding rate success of 3.6 times (Mann-Whitney U-test, U=299.5, P<0.01). Sometimes the egrets fed only upon a medium-size prey, with a feeding success of 1±0.67 preys per minute. The number of DT affected the feeding success in a proportional dimension way, as showed in Tab. 2.

The gulls captured 6.26±2.54 preys per minute in the first case and 6.5±1.98 in the second one (U=123.5, n.s.). If compared with gull, the feeding technique of the egret resulted more effective of 19%, assuming that both species captured the same tipology of prey (as confirmed by observations).
The Common terns captured an average of 1.8±0.23 preys per minute. The fishing success was 65.5% outside and 81% close to the grid, despite of the interspecific disturbance. The disturbance coming from the presence of the gulls prevented the tern from diving at the same extent as some meters out of the gate, where it had sligthly more successful plunges (U=344.5, n.s.).

Discussion

Terns, gulls and egrets are scarcely influenced each other in the feeding site. Aggressions will be infrequent against heterospecifics; the aggressions occur frequently between conspecifics and are related to the intensity of competition for the individual feeding site.
The presence of the gulls swimming close to the gate reduce strongly the possibility of foraging of the Common terns. Anyway, the terns have a low feeding success also in open areas far from the gate. The availability of food didn't force the terns to food-piracy, and the data from literature underlined as this behaviour is related to birds fish-carrying to the colony. In this area, some authors (Canova and Fasola, 1993) suggested that the time spent in foraging trips is related to prey catching success. Because of the presence of closer colonies with chicks, many of the birds foraging in the canal were carrying food to the nest. The high availability and the absence of competition could confirm the hypothesis that the "following" behaviour by low success tern is totally unrelated to the feeding success of more efficient foragers.
The Common gulls appeared able to optimize foraging in the particular site described, gaining the best results. In fact, the rates of food intake in presence and absence of competition are comparable and showed as the time spent in antagonistic activities was scanty and little affected the foraging behaviour. Yet well described (Vernon, 1972), the clearest interspecific behaviour of the gull was the kleptoparasitism. It was performed only toward the Little egret when the egret captured a large size fish. In this case the risk of a wound by a strong reaction of the egret appears rewarded by the energy input; when the egret is feeding on small preys, seems easy and suitable to collect the fishes fallen from the beak.
The Little egrets foraging in the most favourable position (central grids of the canal) have to engage in aggressive interactions toward conspecifics, in order to maintain the feeding territory. Assuming that the defense of territory was performed only by some "dominant" birds placed on the central grids, the foraging close to the territory of the "dominant" seemed to be advantageous. In this case the shorter time spent in territorial displays permits to capture more preys, notwithstanding of the marginal grids. During foraging, the egrets are known to be the most aggressive species among herons. The number of aggressions between conspecifics herons occured at low rate (one case every 15 hours of exposition to another foraging Little egrets) and a peak has been described for the interactions with Night herons, that was attacked once every 3 hours (Fasola, 1994). In coastal lagoons of Camargue (Watmough, 1978), a rate of 5.9 attacks/h toward Night heron appeared still low if compared with the present data of egrets exploiting the most favourable position of the canal.
Both gulls and terns captured a large amount of preys per unit of time. The values for the gulls were higher than the 1.6±1.0 for adults and 0.8±0.05 preys/minute for Juveniles known for the species in close similar environments, such as coastal lagoons on the Po delta (Frugis, 1975). Data from literature showed a low feeding success rate for terns also, ranging from 0.12 at neap tides up to 0.66 preys/minute in rising sprind tides in estuary area (Taylor, 1983); in open sea 0.23 to 0.5 preys item per min (Dunn, 1973); overall rate proposed by Erwin (1977) 0.34 prey item per min; 0.2-0.3 prey captured per min in Atlantic sea (Safina and Burger, 1989). Also the fishing success is higher than the data reported elsewhere (22 to 39%, Dunn, 1973; 54,7% Cramp and Simmons, 1983). In similar environmental tipologies (middle Po river) a predator efficiency of 50.3% was reported by Boldreghini *et al.* (1988), and confirmed previous data (Bogliani, unpublished data). Egrets also are known to feed mainly on saltwater fishes in the Po delta (Fasola *et al.*, 1993), with particular regarding to small prey items (Fasola *et al.*, 1981; Fasola, 1994). In the Lagoon of Comacchio the egrets fed mainly on fish, and has been described how most of their food intake comes from only one or two prey categories (Fasola *et al.*, 1993). The relation between seasonal abundance of prey and the food exploited has been highlighted by the same authors.
The comparison of the fishing success in different foraging sites could be misleading of the energetic input because of the diversity of preys on which the birds fed upon. However, studies on the diet of the related species Little tern *Sterna albifrons* in the same area (Bogliani *et al.*, 1992) confirmed as the sand-smelt is largely the main preys caught in the "Valli di

Comacchio" lagoon, both in number of prey items and biomass. Fasola and Bogliani (1990) discussed the relative lenght of preys captured and these results are well in accordance with the present observations. Boldreghini *et al.* (1988), by investigating comparatively the feeding habits of Little and Common terns in the Lagoon of Comacchio, suggested that sand-smelts are only a minor fraction of the whole preys carried to the chicks by Common terns nesting and that other fishes with similar low weight/lenght ratio are preferred. This confirmed the occasional exploitation of an exceptional food supply described in the feeding site. To date, the lack of information on the difference in the diet of adults and chicks and the absence of knowledge on the digeribility rate of different fishes, are strong limitations when attempting to undertake comparisons. The general picture of the particular situation here described suggests that the three species are optimal and opportunistic foragers, despite of the numerically high interspecific aggregation.

I believe that the birds were forced to forage in the site because of the high food supply, also considering the concentration close to the grid. Indeed, Fasola *et al.* (1993) by evaluating the diet of Little egret and other herons in Northern Italy, underlined as prey types varied markedly in frequency throughout the season, with patterns that presumably reflect the seasonal availability of different prey types. These consumers appeared adaptable, and would suffer little pressure from both intra-species and inter-species competition (Morse, 1971). This is well in accordance with the hypothesis that the segregation observed within animal assemblages is related to non-interactive resource use, and not dependent by competitive pressures (Connell, 1980; Wiens, 1989). In fact competition is considered to be more pronounced in predators, large-sized animals and in freshwater habitats (Schoener, 1974, 1983; Connell, 1983; Gurevitch *et al.*, 1992). Evidences of benefits of foraging in mixed-species seem to be contrasting. Some species of american herons exibited a significant increase in capture rate and efficiency, while others do not (Master *et al.*, 1993). The Little egrets improved their foraging success in southern France (Hafner *et al.*, 1982; Cezilly *et al.*, 1990). and the importance of prey uniformity was noted. On the same species Erwin *et al.* (1985) found a different pattern, suggesting a reduced capture efficiency in larger flocks.

In conclusion, the wide overlap in species composition suggests that waders foraging aggregations have not coevolved to collaborate in more efficiently exploiting prey, but that species are independently attracted to rich food sources. Differences in flock size and composition over different types of prey may arise because species' differences in foraging ability make exploitation of some situations more profitable than others for each species.

A direction for future research in the same area could be to investigate the fishing efficiency in different conditions of species aggregations and prey density.

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