Intraspecific Host Selection by Kleptoparasitic Kelp Gulls in Patagonia

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Abstract.—We studied kleptoparasitic behavior of Kelp Gulls (*Larus dominicanus*) feeding on fishery waste at trawl vessels in northern Patagonia, Argentina, by experimentally discarding fish. Intraspecific kleptoparasitism by gulls of all age-classes was recorded at all hauls. During experimental discarding, Kelp Gulls attempted to steal fish from other gulls in 23.5% of 1,915 cases. The length of fish handled differed between age-classes, tending to be larger in younger age classes. The size of fish being carried by victims of kleptoparasitic attempts was similar between age-classes. On the other hand, adult and sub-adult were more frequently attacked when they carried larger fish, while juveniles were victims of kleptoparasitic attempts independent of the size of the fish carried by them. The lengths of successfully stolen fish were similar between victims of different age-classes. Adult and sub-adult were successfully robbed when they carried larger fish, while juveniles were successfully robbed irrespective of the size of the fish carried by them. Gulls of different age-classes were victims of kleptoparasitic attempts, in direct proportion to the number of fish handled by each age-classes. However, juveniles were successfully robbed more often than other age-classes. Juveniles lost prey in 83% of kleptoparasitic attempts, while sub-adults and adults lost their fish in 41% and 42% of cases, respectively. Although selection of juvenile hosts to attack could be more profitable, attack rate on young birds was not higher than expected, suggesting attacks at trawlers were at random. Feeding where there is a high density of potential victims may be advantageous for juveniles compared to feeding elsewhere because they are not selectively harassed or displaced by older, foraging gulls. If so, this could contribute to juvenile survival which could contribute to an increased population size. *Received 8 March 2000, accepted 8 May 2000.*

Key words.—Kleptoparasitism, Kelp Gull, *Larus dominicanus*, host selection.

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Kleptoparasitism is a widespread foraging behavior in birds (Brockmann and Barnard 1979) and is particularly frequent among seabirds (Furness 1987). Opportunistic species such as gulls use kleptoparasitism, both inter-and intraspecific, as a way to obtain food (Hulsman 1976; Greig *et al.* 1983; Hockey *et al.* 1989; Oro and Martinez-Vilalta 1994). Kleptoparasitic attacks are often directed at individuals handling prey, which are both profitable (Thompson 1986) and vulnerable to attack (Carroll and Cramer 1985; Thompson 1986). Several studies have shown that the frequency and success of robbing can be affected by the type and size of prey and by the species and age of the host (Hopkins and Wiley 1972; Burger and Gochfeld 1981; Hulsman 1984; Steele and Hockey 1995; Ratcliffe *et al.* 1997).

Host age is one of the variables that appears to influence the frequency of kleptoparasitic attempts by gulls (*Larus* spp.) (Burger and Gochfeld 1981; Barnard and Thompson 1985; Carroll and Cramer 1985). Kleptoparasitic gulls may select juvenile hosts because juveniles are less efficient in handling prey or in avoiding kleptoparasitism (Carroll and Cramer 1985; Hudson 1989). However, as adults are more successful foragers than immature birds (Greig *et al.* 1983; Wunderle 1991), adults may present a more reliable target, offering a greater chance of reward to pirates (Tershy *et al.* 1990; Shealer *et al.* 1997).

Many seabird species gather at fishing vessels to take advantage of discarded or escaping fish (Camphuysen 1994; Furness *et al.* 1988; Oro and Ruiz 1997). Large concentrations of birds at highly aggregated food sources, such as fishing boats, provide favorable conditions for kleptoparasitism (Furness 1987; Hudson and Furness 1988). During

fishing activities, displacement and kleptoparasitism among feeding birds are frequent (Hudson and Furness 1989; Camphuysen *et al.* 1995) offering an opportunity to analyze the selection of victims by experimentally discarding selected prey of known size.

The Kelp Gull (*Larus dominicanus*) is a widely distributed seabird in coastal Patagonia, Argentina (Yorio *et al.* 1998), and one of the main species associated with coastal fisheries (Yorio and Caille 1999). Kleptoparasitism is a common behavior of Kelp Gulls foraging at trawlers (Bertellotti 1998; Yorio and Caille 1999). In this paper we analyze intraspecific kleptoparasitism between Kelp Gulls feeding on fish discards at trawl fisheries in northern Patagonia. Our aims were to: (1) quantify robbing behavior and (2) assess the relationship between robbing success and the selection of host age, prey size and prey species, through experimental discarding of prey.

STUDY AREA AND METHODS

We conducted observations of feeding behavior of Kelp Gulls on board coastal trawl vessels operating in Golfo San Matías, Río Negro, Argentina, between November 1996 and May 1997. These vessels are 19-24 m long and tow bottom nets (150-200 mm mesh size and 12-20 m mouth opening) at two to three nautical miles per hour. Trawls last between one and three hours. The main target species was Argentine Hake (*Merluccius hubbsi*). Vessels generally fished within 30 km of shore and fishing trips lastrd 3 to 6 days (3-4 hauls per day). Fish captured by trawlers are sorted on deck and non-commercial sizes and by-catch are discarded overboard.

We gathered information on kleptoparasitic behavior of Kelp Gulls for a total of 14 days (56 hauls). Every 30 minutes throughout the entire fishing operation, we counted the number of gulls associated with vessels from the top deck. We made a total of 237 counts (mean = 16.9 ± 4.3 counts per day). We recorded maximum numbers of gulls present at each haul and calculated the mean maximum number of gulls per fishing day. Results are given as means and standard deviations. We studied the frequency and success of kleptoparasitic attempts through experimental discarding of fish randomly obtained from the discard-fraction of each catch. We selected fish species on the basis of their frequency of occurrence and abundance in the discards, using data obtained during the fishing season of 1995-1996 by the On-board Observer Program (Patagonian Coastal Zone Management Plan).

A total of 23 fish species were discarded during that season, and the main discarded species were Argentine Hake, Longtail Hake (*Macruronus magellanicus*), flounders (*Paralichthys isosceles* and *Xystreurys rasile*), Skate (*Raja flavirostris*), and Brazilian Codling (*Urophycis brasiliensis*). We included in the experiments another three species that were common in the discards during the present study (Butterfish *Stromateus brasiliensis*, Blackbelly Rosefish *Helicolenus dactylopterus*, and Sea Salmon *Pseudopercis semifasciata*). The nine fish species selected represented more than 85% of the total discarded biomass in 1995-1996 (G. Caille, pers. comm.). We identified and measured fish (total length in cm), and randomly discarded one fish every ten seconds from the stern while the vessel trawled for the next catch.

We classified Kelp Gulls into three age classes on the basis of plumage characteristics (Harrison 1983): juveniles (first-year birds), sub-adults (second- and third-year birds), and adults. We considered a robbing attempt when a gull made an obvious movement towards another gull carrying prey in its beak. For each robbing attempt, we recorded if it was successful or not, and the age-class of the victim. We considered an attempt was a successful attack when the parasite took totally or partially the fish from the victim's beak. We analyzed only the cases that involved one pirate and one victim. Small numbers of other seabird species, mainly Black-browed Albatrosses (*Diomedea melanophris*), attended vessels during discarding. They took less than 3% of experimentally discarded fish and did not engage in kleptoparasitic behavior. Therefore such cases were excluded from subsequent analyses.

We used Generalized Linear Models (Baker and Nelder 1978), to assess simultaneously which explanatory variables and/or their interactions better explained the success of robbing attempts. We fitted the explanatory variables to the observed data, using the Forward Stepwise Branching Modelling Procedure (e.g., Tella *et al.* 1999). We analyzed the effects of prey species, prey length, and the age of victims on robbing success. We used the success (1) or failure (0) of each robbing attempt as the response variable, and all the above mentioned as explanatory variables. We considered a binomial distribution of errors and a logistic link, equivalent to a logistic regression (Crawley 1993).

RESULTS

Kelp Gulls were present at all hauls with a mean maximum number per day of 299 individuals (SD ± 73.4, N = 14). Individuals of all age-classes were present in all of counts, although flocks consisted mainly of adults (juveniles = 16 ± 1.8; sub-adults = 45 ± 11.8; adults = 248 ± 73.9 individuals). The proportions of each age-class at vessels did not vary significantly among fishing days (juveniles = 5.8%; sub-adults = 15.4%; adults = 78.8%; G_{26} = 21.7, n.s.).

Intraspecific kleptoparasitism involved gulls of all age-classes and was recorded in all hauls. During experimental discarding (N = 2,504), Kelp Gulls handled 1,915 (76.5%) of the discarded fish (6.0% juveniles, 20.5% sub-adults and 73.5% adults). Gulls attempted to steal fish from other gulls in 450 (23.5%) of these cases and were successful in

199 (44.2%) of those attempts. The total number of recorded thefts represented 10.4% of the number of fish handled by gulls.

The size of fish carried by victims of kleptoparasitic attempts was similar between age-classes (one-way ANOVA, $F_{2,447} = 2.55$, n.s.). However juvenile birds handled larger fish (one-way ANOVA, $F_{2,1912} = 66.0$, $P < 0.0001$; Tukey test: all contrast $P < 0.0005$).The length of fish carried by adult and sub-adult hosts was larger than that of the rest of fish handled by those age-classes, while it was similar in juveniles (Table 1).The size of successfully-stolen fish was similar between age-classes (one-way ANOVA, $F_{2,196} = 0.74$, n.s.). However, adults and sub-adults were successfully robbed when they carried larger fish, while juveniles were successfully robbed independently of the size of the fish carried by them (Table 1).

Gulls of different age-classes were victims of kleptoparasitic attempts as expected according to the proportion of fish handled by each age-classes ($\chi^2_2 = 1.4$, n.s.) (Table 2), but juveniles were successfully robbed more often than expected ($\chi^2_2 = 16.0$, $P < 0.001$, Table 2) losing prey in 83% of attempts, while sub-adults and adults lost prey in 41and 43% f cases, respectively.

The best GLM model obtained for the success of attacks included only one variable, victim age, which entered into the model at $P < 0.0001$. This model explained only a small fraction (3.5%) of the original deviance (617.8, d.f. = 449), and did not show data overdispersion (mean deviance = 1.3). The parameters estimated were: juveniles = 1.61 (SE ± 0.49), sub-adults = -1.98 (SE ± 0.54) and adults = -1.95 (SE ± 0.50), and the residual deviance was 596.8 (d.f. = 447). This model, therefore, showed that robbing success of Kelp Gulls only depended, although slightly, on the age-class of the victim, being greater in the younger victims, and did not relate with either species or size of fish (Fig. 1).

DISCUSSION

The high percentage of kleptoparasitic attacks between gulls shows the competitive nature of feeding at trawlers. Similar results were obtained by Hudson and Furness (1988), who reported that 12% of handled fish were stolen. The number and proximity between gulls in flocks around trawlers may promote this robbing behavior. Kelp Gulls of all age-classes were involved in kleptoparasitic activities and were victims of attacks as expected according to the number of fish handled by each age-classes. Similarly, Gómez-Tejedor and De Lope (1995) found that all age-classes of Lesser Black-backed Gulls (*Larus fuscus*) were victims of robbing attempts according to their relative abundance at a refuse dump in southwest Spain. In contrast, Steele and Hockey (1995) recorded a larger than expected proportion of all attacks were directed at juvenile and sub-adult Kelp Gulls at a range of feeding habitats (undisturbed rocky shore, sandy beach, refuse dump and fishing harbor) in South Africa, while Greig *et al.* (1983) found that a larger proportion of displacement attacks were directed to older Herring Gulls (*Larus argentatus*) feeding at a refuse tip. The differences with our results may be due to the different habitats. During experi-

Table 1. Mean length ± SD of fish carried by victims of kleptoparasitism attempt, successfully stolen and rest of handled fish from each Kelp Gull age-classes during experimental discarding at trawl vessels in Golfo San Matías. Sample sizes in parentheses.

	Age-classes of Kelp Gulls		
Length of fish (cm)	Juveniles	Sub-adults	Adults
Carried fish	30.9 ± 6.0 (37)	31.7 ± 5.2 (76)	30.1 ± 4.9 (337)
Stolen fish	31.4 ± 4.9 (25)	32.4 ± 5.0 (34)	30.1 ± 5.0 (140)
Rest of handled fish	33.2 ± 9.0 (84)	26.1 ± 6.0 (310)	24.7 ± 5.0 (1071)

Comparison between carried and rest of handled fish all t-test give $P<0.001$, except juveniles: n.s. and between stolen and rest of handled fish all t-test $P < 0.0001$, except juveniles: n.s.

Table 2. Observed and expected numbers of robbing attempts and fish successfully stolen in each Kelp Gull age-class foraging on experimentally discarded fish at coastal trawlers in Golfo San Matías. Percentage in parentheses. Expected number of robbing attempts and discarded fish stolen were calculated using the proportion of fish handled by each age-classes.

	Attacks on victims		Number of fish lost	
Age-class	Observed	Expected	Observed	Expected
Juveniles	30 (6.7%)	26.8 (6.0%)	25 (12.6%)	11.8 (6.0%)
Subadults	83 (18.4%)	92.3 (20.5%)	34 (17.0%)	40.8 (20.5%)
Adults	337 (74.9%)	330.9 (73.5%)	140 (70.4%)	146.3 (73.5%)
Total	450	450	199	199

mental dis-cards, individual of all age-classes were flying in a dense flock, and possibly the encounter between individuals of different ages is at random.

Kelp Gulls mostly directed their kleptoparasitic attacks at gulls carrying the largest fish. Several studies have shown that kleptoparasites select hosts with larger prey (Hopkins and Wiley 1972; Hulsman 1976; Fuchs 1977; Hackl and Burger 1988). Larger items may be more profitable in terms of energetic return (Ratcliffe *et al.* 1997), and potential victims with large prey were more vulnerable due to greater difficulty in prey handling (Furness *et al.* 1988). Mean size of stolen fish in the present study was also larger for adults and sub-adult Kelp Gull hosts, compared with the rest of fish handled by them. Other studies on seabird foraging at vessels have shown that larger fish are more likely to be stolen (Furness *et al.* 1988; Camphuysen *et al.* 1994).

Although all age classes were attacked, juveniles were successfully robbed more often than other age-classes. Considering that young birds of many species, including gulls, are less efficient than older birds in handling captured prey (see Wunderle 1991 for a review), it is likely that they would be more vulnerable to being robbed. Juvenile Kelp Gulls dropped more items than adults when feeding on discards at Golfo San Matías (Bertellotti and Yorio 2000), and they have been found to be less efficient at handling their prey when feeding on bivalves in Chile (Hockey and Steele 1990). Higher robbing success on juvenile victims may not only be because these victims are less skillful, but may also be the result of larger prey being handled by the younger individuals. However, length of fish carried by juveniles victims of kleptoparasitic attempts was similar to that carried by older birds, suggesting that young gulls were not likely to lose prey because they carried larger fish, but because these individuals were less skillful in handling them.

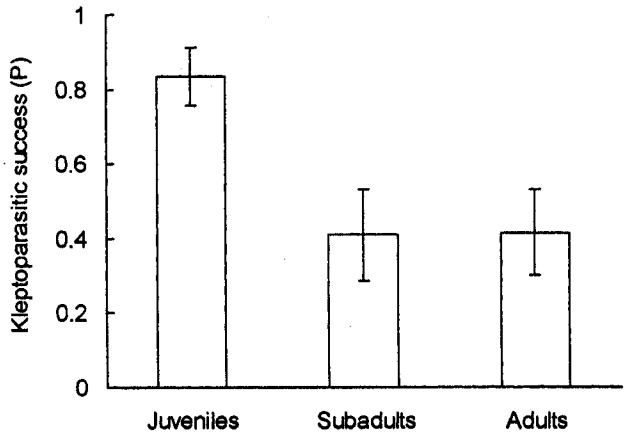

Figure 1. Success probability (±SE) of robbing attempts from different age-classes of Kelp Gull victims during experimental discarding of fish at trawl vessels in Golfo San Matías during 1996-1997.

Even though success rate when attacking a juvenile gull was significantly higher, attack rate on juveniles was not higher than expected. If juveniles are less efficient in retaining their prey and handle larger discards, as was observed in the present study, it would be more profitable for parasites to direct their attacks preferentially on younger hosts. Moreover, when a trawler emptied its net and the by-catch was pushed overboard, there was a super abundance of food, and in the ensuing chaotic scramble competition, young gulls were able to feed without being differentially targeted. A high density of potential victims may be advantageous for juveniles because they are not selectively harassed or dominated by older foraging gulls.

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