

# Acoustic Communication of the Black-tailed Gull (*Larus crassirostris*): the Structure and Behavioral Context of Vocalizations

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Key Words:

*Larus crassirostris*  
Vocal repertoire  
Contact call  
Alarm call  
Aggressive call

**Vocal repertoires of the Black-tailed gull (*Larus crassirostris*) were studied at established reproductive colonies. The Black-tailed gull has eleven different vocal signals which can be grouped into three different call classes according to behavioral functions: contact call, alarm call (attention call), and aggressive call. The contact call or mew call is the most frequently used and functions as means of recognition among individuals, particularly between parents and young. Our results show that each call plays an important role in particular social relationships in a high-density breeding colony.**

Numerous attempts have been made to reveal the messages conveyed by the auditory signals of animals. There are clear signs that a basis recognition may be mainly auditory rather than visual, particularly with bird breeding in dense colonies (Stevenson et al., 1970). Some studies on acoustic communication have revealed a large differentiated vocal repertoire that effectively conveys different kinds of information (Smith, 1977; Witt, 1977).

Gulls (*Laridae*) have a particularly large and complex vocal repertoire (Stout et al., 1969; Beer, 1976) and some calls have been categorized according to different functions and circumstances (Beer, 1969; Stout et al., 1969). In general, the vocal repertoire is further complicated by the rapid repetition of individual calls, either of the same note or of distinctly different calls. Variations in pitch, frequency modulation, duration, and repetition rate of calls are common both within and between species (Evans, 1986).

With the onset of locomotor ability soon after hatching, chicks of some gull species are physically able to intermingle with other broods. However, brood-mixing in the colony is not typical, due, apparently, to the ability of parents and young mutually to recognize members of the family unit (Evans, 1970; Miller and Emlen, 1975). Parents-young recognition might be expected to be particularly well-developed at an early age in colonial species. Individual chicks learn the characteristics of their parents' vocal signals, and after leaving natal sites their learned signals are used for their entire social lives (Thiekle, 1970). Black-tailed gull

chicks are relatively precocial in that they develop locomotor powers at an early age and may leave the breeding territory when only three to four days old. During daylight hours they mostly spend their time within bushes. When parents return to the territory with food, the chicks reappear at nest sites and peck the bill of parents as begging behavior (Rho and Park, 1993). In common with the Laughing gull (*L. atricilla*) (Beer, 1979), Black-tailed gull chicks can recognize their parents' voices from the age of three days although their parents cannot distinguish the vocalizations of their own chicks from those of foreign chicks (Rho and Park, 1993).

Although some studies have been carried out on aspects of foraging habit, ecology, and kin recognition of Black-tailed gulls (Watanuki, 1988; Rho and Park, 1993), the relation of vocal repertoire to behavioral context has not previously been studied. In this paper, as a result of call analyses and behavioral observations in breeding colonies, we deal with the characteristics and social function of the vocal repertoires and in particular, we report on calls during the parent-young recognition.

## Materials and Methods

Call recordings and behavioral observations were made from 28 April to 3 June in 1993 and from 10 May to 27 May in 1994 at Hong Island (34° 31' 87" E, 128° 43' 88" S), Tongyoung-City, Kyeong-Nam, Republic of Korea, known as a major habitat of the Black-tailed gull. Behavioral observations were made from blinds placed on platforms 1.5 m above ground level, near the edge of the colony or at areas remote from colonies, where binoculars were used. A total of

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eight nesting pairs were subjects of observation and recording within 20 m from our blind. During parents-young recognition experiments, in order to distinguish individuals, chicks were color-marked with a felt marking-pen on the day of hatching, and then left with their parents except when removed to cages or kept at separate sites for experimental purposes. Call recordings were made at a tape speed of 19 cm/sec using a Uher 4000 Report IC tape recorder, with a condenser microphone (Sennheiser MKH 816 P48) that was placed within a 1-2 m distance from the nest. The comments were spoken into a second microphone (Uher M518A) and recorded onto the second tape track. Vocalizations were analyzed with a Kay sonagraph (Model 5500), set for a wide band spectrum. Frequency and time of calls were measured from the sonagram displayed, and spectrograms produced. For statistical analyses, the SPSSPC+ program was used.

## Results

### Vocal repertoire of the Black-tailed gull

#### Contact calls - Call Type 1, Call Type 2, Call Type 3

**Acoustic Characteristics:** Contact calls are subdivided into three different types. Call Type 1 consists of seven or eight harmonic bands, of which the first, second, and third show higher intensity than the others. The intensity of harmonic bands shows a gradual increase and decrease over the duration of the call. The call duration is  $347 \pm 65$  ms ( $n=25$ ) and the fundamental frequency, 220-820 Hz (Fig. 1). Call Type 2 consists of nine or ten harmonic bands of which the fundamental, first, and second show higher intensity than the others. The fundamental frequency is 280-290 Hz, the cell

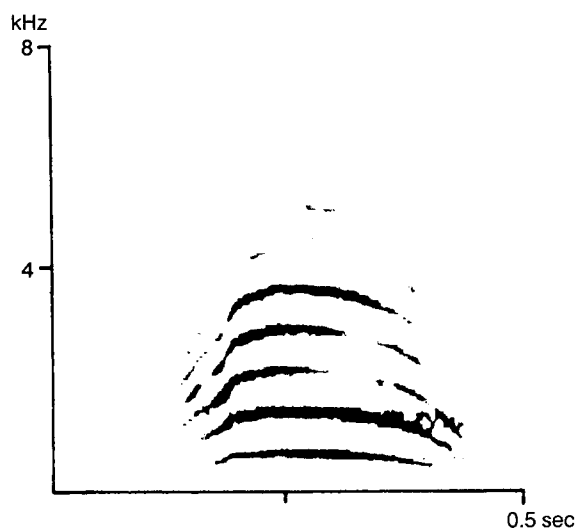


Fig. 1. Call Type 1 (mew call) of Contact calls. The call has seven or eight harmonic bands.

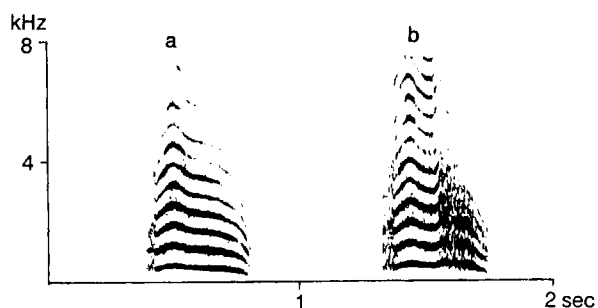


Fig. 2. Call Type 2 of Contact calls. Figure a shows a typical form and b is an individually variable call with a noisy terminal component.

duration  $460 \pm 44$  ms ( $n=26$ ), and the interval between calls  $1.16 \pm 0.34$  s ( $n=23$ ) (Fig. 2a). This call shows a particularly steep initial increase of band number, and occasionally exhibits individual variation with a noisy terminal component (Fig. 2b). Call Type 3 consists of several elements, one of which resembles a  $\wedge$  form on the sonagram. The first and second harmonic bands show higher intensity than the others. The fundamental frequency is 340-700 Hz, the call duration  $111 \pm 32$  ms ( $n=18$ ), and the interval between elements  $94 \pm 44$  ms ( $n=14$ ) (Fig. 3).

**Behavioral category:** Call Type 1 is used more frequently than any other call, and is generally known as the 'mew' call because it sounds similar to a cat's cry (Tinbergen, 1957). Black-tailed gulls use call Type 1 when they return to the nest site from foraging, when parents communicate with their chicks, when a bird takes over the role of guarding the nest from its mate, and when many birds are flying in synchrony. Call Type 2 is commonly used by males and females during their courtship behavior, especially in association with head-tossing. Males may respond to the calling behavior of females by courtship feeding, and regurgitating in front of the female. In some cases, copulation occurs immediately after males give call Type 2 in response to the calling of females. Call Type 3 is initiated by the male during copulation and increases in intensity during genital-cloacal contact, ceasing after the male dismounts.

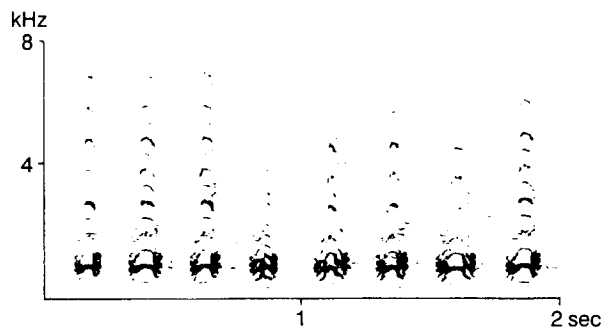


Fig. 3. Call Type 3 of Contact calls. The call consists of several elements.

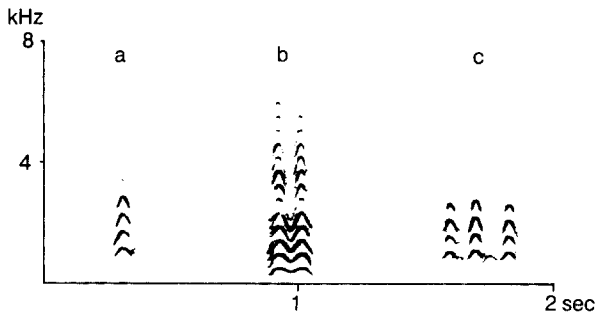


Fig. 4. Call Type 1 of Alarm calls. Each figures show different forms according to call duration.

Alarm calls (Attention calls) - Call Type 1, Call Type 2

Acoustic characteristics: Alarm calls are categorized broadly into two different types. Call Type 1 is similar to contact call Type 3 except for the composition of each separate element. The first, second, and third harmonic bands show higher intensity than the others, and the interval between calls is highly variable, from 0.6 to 2.6 s. The fundamental frequency is 160-540 Hz. Call Type 1 is further subdivided into three different forms (Fig. 4a-c) according to call duration,  $108 \pm 16$  ms (n=20),  $217 \pm 16$  ms (n=14), and  $331 \pm 20$  ms (n=19), respectively. Call Type 2 consists of five to eight elements showing eight to nine harmonics. The fundamental frequency of the elements varies from 360-920 Hz. The duration of the elements is  $324 \pm 157$  ms (n=22), and the interval between elements,  $123 \pm 140$  ms (n=18). The duration of the whole call is  $3.4 \pm 0.8$  s (n=18) (Fig. 5). Although both males and females commonly give this call, males use it more frequently (female 30%, male 70%).

Behavioral category: Call Type 1 is usually made when an intruder is approaching the nest. With progressive reduction of distance, the call changes sequentially from Type 1a to Type 1b and 1c, and the interval between calls also becomes shorter. Call Type 2 is initiated with the calling individual's head inverted between its legs and continues as the neck is raised, ceasing when the neck is fully erect. In particular, neighboring individuals use this call consecutively after one individual initiates its own call. It is also frequently

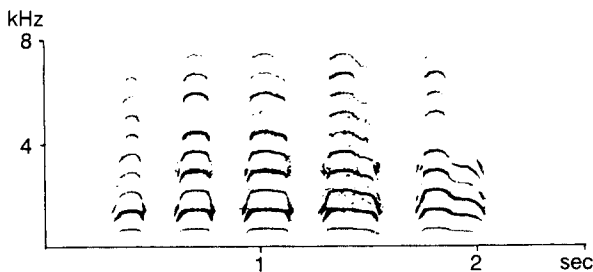


Fig. 5. Call Type 2 of Alarm calls. The call consists of five to eight elements showing eight to nine harmonics.

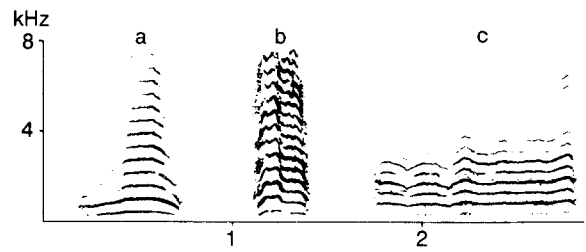


Fig. 6. Typical form (a) of Aggressive calls having constant frequency. B and c are subtypes according to the modulation of frequency.

given immediately after an individual returns to its nest, having left due to human disturbance.

Aggressive calls

Acoustic characteristics: The aggressive call may resemble contact call Type 1 in having constant frequency (Type 1a), but other subtypes are recognized according to the modulation of frequency (Types 1b and 1c). The call shows more tonal components than other call types. The fundamental frequency is 300-900 Hz, and the call duration  $535 \pm 197$  ms (n=18) (Fig. 6a-c).

Behavioral category: The aggressive call is mostly produced by a territory owner when an intruder enters its territory. When a mounted Cattle egret (*Bubulcus ibis coromandus*) was exhibited in an occupied territory, the owner directed the call toward the 'intruder' while flying in circles of 20-30 m radius centered over the 'threatened nest'. The aggressive call undergoes transition from Type 1a to Type 1b, and if the 'intruder' does not then retreat, Type 1c, a longer aggressive call, is presented. Occasionally the owner uses its legs to force aside the 'intruder', and only rarely attacks using its beak, with violent aggressive calling.

Vocalization for parents-young recognition

We monitored chicks, approximately four to five days old, in order to observe the behaviors and record the calls of chicks and parents. In most cases, parents returning to nest sites show continuous calling behavior until visual contact is established with chicks. Chicks from each of eight nest sites were observed to respond to the calls and approach their own parents. In each case the calls correspond to contact call Type 1 (mew call) (Fig. 9a). Mew calls from parents returning to nests were recorded and analyzed. The mew calls show different characteristics among individuals (dominant frequency:  $F=18.070$ ,  $df=3, 36$ ,  $p<0.001$ ; call duration:  $F=93.347$ ,  $df=3, 36$ ,  $P<0.001$ ; Figs. 7, 8). When a chick approaches its parents, the parents occasionally present another mew call having a noisy component (Fig. 9c). The mew call of chicks (Fig. 9b, d) has a peak intensity at a frequency 1 kHz higher than that of the parents' mew call (1.3-1.5kHz). The duration of

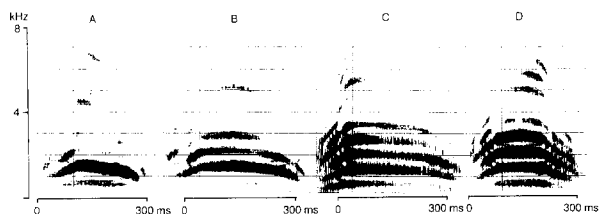


Fig. 7. The sonogram of mew calls emitted by four gulls (A-D).

the chick's mew call is rather variable,  $264.7 \pm 67.5$  ms ( $n=20$ ). In experiments where chicks were exchanged between two nests, the parents gave the mew call as usual on returning to the nest, but the exchanged chicks did not show any response. At other times, parents gave the mew call only when they heard their chicks' sounds. When no chick sounds are present, the mew call is only produced by parents during the time of initial arrival at their nest.

**Discussion**

In many socially-organized vertebrates, successful parental care depends on individual recognition (Thorpe, 1968). There are clear signs that the basis for recognition may be mainly auditory rather than visual, particularly with birds breeding in dense colonies.

In Laridae, the mew call has been known as a signal for hostile as well as pairing behavior, and also parental care of chicks (Moynihan, 1958). In this study, the mew call was generally produced when one of a pair is absent from the nest site or when parents seek their chicks on returning after being away from the nest. Chicks can usually recognize the mew call of their parents (Beer, 1969; Evans, 1977; Knudsen and Evans, 1986). Our results, obtained by experiments on chick separation, show that *L. crassirostris* chicks can also recognize and approach their parents using the parents' mew call (Rho and Park, 1993). The physical characteristics of mew calls, such as frequency and duration, vary among individuals. These results imply

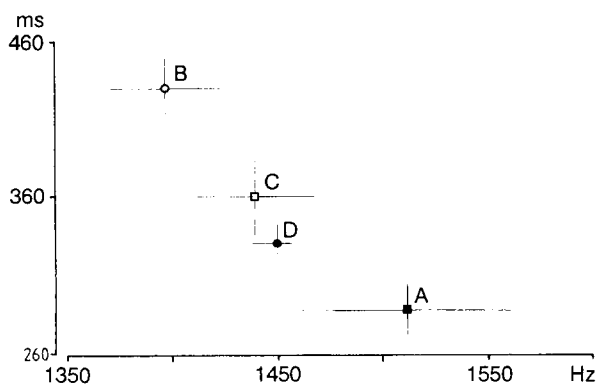


Fig. 8. The correlation between call duration and frequency of main intensity of mew calls recorded from four gulls (A-D,  $n=10$ ).

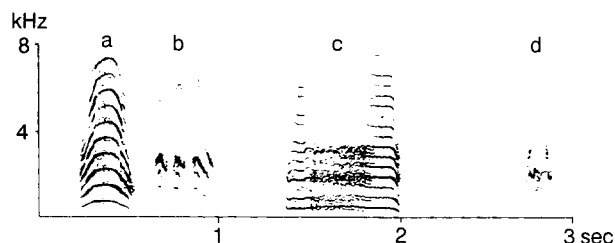


Fig. 9. The mew calls of mothers (a, c) and infants (b, d).

that chicks can distinguish their parents from other adults using the physical characteristics of the mew call. However, the function of the mew call in relation to aggressive activity is not yet clear. Our results suggest that the mew call has a function in the development of hostile situations with intruders, in that individuals frequently present the mew call before aggressive calling behavior.

In Laridae, an alarm call (Type 1) is used for a potential predator approaching the colony (Evans, 1980). *Larus crassirostris* may also use this call for spreading alarm signals. During our observations, after one individual gave alarm calls when an intruder was approaching a breeding colony, many individuals consecutively gave alarm calls. Alarm call Type 2 has been known as a long-distance threat call, used to block an intruder approaching the territory (Stout et al., 1969). This call is especially frequent in situations of colony disturbance, hostile fighting, and territorial disputes. Tinbergen (1959) and Moynihan (1958) described this type of call (oblique cum long call) as an aggressive display of Laridae in general. Veitch and Booth (1954) and Vermeer (1963) observed the call in the hostile fighting and territorial disputes of *L. glaucescens*.

Tinbergen (1959) states that the oblique cum long call and posteus, when produced by an intruder or near-intruder, would probably stimulate an attack by the territory owner. We also place the long call in a separate category as a long distance threat or attention call, as it is a loud call, and feel that it would prevent entry into the territory.

The aggressive call is related to attack behavior in many gulls (*L. argentatus* and *L. ridibundus*, Tinbergen, 1957; *L. pipixcan* and *L. atricilla*, Burger and Beer, 1975; *L. glaucescens*, Amlaner and Stout, 1978; *L. minutus*, Veen and Piersma, 1988). There is a particular difference in the aggressive call of *L. minutus* between calls produced prior to attack and during real attack (Veen and Piersma, 1986). According to the level of excitement, the aggressive call of *L. crassirostris* changed in call duration and frequency modulation from constant to saw-tooth-shaped features. To regulate social interactions, *L. crassirostris* uses acoustic signals showing many similarities to the vocal strategies of other Laridae. These results show that each call plays an important role in various social relationships in a

high-density breeding colony.

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[Received June 12, 1997; accepted August 14, 1997]