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SHORT COMMUNICATION

Sexual differences in the external measurements of Black-tailed Gulls breeding on Rishiri Island, Japan

ORNITHOLOGICAL SCIENCE

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Sex ratio is an important parameter to consider in ecological and conservation seabirds studies (Weimerskirch & Jouventin 1987). Visually assessing with certainty the sex of live seabirds, however, may be an impossible task when no obvious differences in plumage or body size exist between the two sexes. Several previous studies of Laridae species have shown that males are significantly larger than females (external measurements) and discriminant functions using measurements sex Laridae with great reliability (Shugart 1977; Ryder 1978; Fox et al. 1981; Schnell et al. 1985; Coulson et al. 1983; Evans et al. 1993; Bosch 1996; Rodriguez et al. 1996; Palomares et al. 1997).

The Black-tailed Gull *Larus crassirostris* is a medium-sized gull, endemic to the northwest Pacific, breeding extensively in coastal regions around the Japanese archipelago. Although Black-tailed Gulls are one of the most common seabird species in Japan, little is known about their biology or morphology. Similarly to other Laridae species, Black-tailed Gulls have no sexual differences in their plumage or coloration. This study is aimed at describing the external measurements of Black-tailed Gulls and determining a discriminant function using the measurements to facilitate the sexing of the gulls in the field.

METHODS

A management program controlling the number of Black-tailed Gulls was carried out by the Rishiri town office on Rishiri Island (45°05N, 141°07E), off the northwest coast of Hokkaido, Japan. In this region, gulls are a nuisance to townspeople, inflicting damage on the commercial fishery and affecting flights to and from the airport nearby. Carcasses of gulls culled during the course of this program were used to investigate the relationship between the external measurements and sex.

On Rishiri Island, about 7,900 pairs bred in 1998 and 8,600 pairs in 1999 (Hokkaido Government 1999, 2000), on a 9.12 ha area covered with dwarf bamboo *Sasa nipponica*. Gulls were shot around the colonies from 14–18 June 1998 during the incubation period, and from 17–24 June 1999 during the incubation and hatching periods (Hokkaido 1999, 2000). A total of 237 carcasses was collected and frozen less than one hour after being shot. External measurements were carried out after the carcasses had been thawed.

Ten external measurements were performed following the procedures described in Bosch (1996). Head length (HL), long bill length (LBL), short bill length (SBL), nalospi (Nal: the distance from the tip of bill to the nostril), bill depth (BD), tarsus length (Tar), foot length (FL), and middle toe length (MTL) were measured to the nearest 0.01 mm using vernier calipers. Tail length (Tail L: the length between the uropygial gland and the tip of one rectrix) and wing length (WL: natural chord) were measured to the nearest 0.1 mm and 1 mm, respectively, using rulers. Body mass was weighed to the nearest 0.1 g using an electrical balance. Several studies have found sexual dimorphism in body mass for Laridae species (Ingolfsson 1969; Ryder 1978; Threlfall & Jewer 1978; Hunt et al. 1980; Fox et al. 1981; Coulson et al. 1983; Monaghan et al. 1983; Bosch 1996; Rodriguez et al. 1996; Palomares et al. 1997). However, due to its variability throughout the breeding season (Jones

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Table 1. Average values for external measurements and MD index of Black-Tailed Gull. Standard deviations are expressed as±SD, and ranges are given in Parentheses. Significance levels were improved using the sequential Bonferroni technique.

Adult	Male (N=139)	Female (N=98)	t-value	P-value	MD index
Head Length (mm)	112.78±2.66 (105.60–118.99)	103.99±2.53 (96.82–111.35)	25.55	<0.01	8.11
Long Bill Length (mm)	74.68±2.84 (62.70–85.20)	69.03±2.77 (63.10–77.40)	15.24	<0.01	7.86
Short Bill Length (mm)	52.21±2.12 (46.75–57.10)	47.67±2.16 (42.40–55.35)	16.11	<0.01	9.09
Nalospi (mm)	24.53±1.59 (21.44–28.80)	22.39±1.51 (18.70–28.90)	10.40	<0.01	9.12
Bill Depth (mm)	17.11±1.24 (14.50–20.67)	15.09±1.01 (13.30–18.90)	13.32	<0.01	12.55
Tarsus Length (mm)	57.62±2.15 (49.85–63.35)	53.19±2.10 (45.60–57.45)	15.76	<0.01	8.00
Foot Length (mm)	104.47±3.52 (89.45–114.12)	97.36±3.46 (89.15–111.98)	15.42	<0.01	7.05
Middle Toe Length (mm)	52.12±2.25 (43.45–57.04)	48.28±2.34 (39.95–52.01)	12.72	<0.01	7.65
Tail Length (mm)	143.85±5.83 (126.5–157.0)	136.36±4.84 (124.3–149.0)	10.43	<0.01	5.35
Wing Length (cm)	39.01±0.80 (36.5–157.0)	37.39±0.75 (35.6–39.2)	15.65	<0.01	4.24

1994; Croxall 1995), sexual difference in body mass is not described here (Lorentsen & Røv 1994). Once these measurements were collected, birds were dissected and sexed based on their reproductive organs.

Each external measurement was compared between the sexes using Student's *t*-test. Sequential Bonferroni's *t*-test was performed to increase significance power. To compare the degree of sexual difference among measurements, the mean difference (MD) index was used (Agnew & Kerry 1995). The MD index was expressed as the difference of the average measurements between male and female:

$$MD = 200 \times (X.m - X.f)/(X.m + X.f)$$

where X.*m* and X.*f* are the mean of the measurements for males and females, respectively; a larger index indicating greater sexual dimorphism.

Finally, a discriminant function analysis was performed using HL and BD for sex determination of the gull, because these two measurements are readily taken during field studies (Fox et al. 1981; Palomares et al. 1997).

RESULTS

Male gulls were significantly larger than females for all external measurements (Table 1). MD indices for parameters of the head region, i.e. HL, LBL, SBL, Nal, and BD were larger than those of the extremities, i.e. WL and Tail L. The average body mass of males was 641.2 g±44.0 (SD) and 537.5 g±42.3 for females.

Using HL and BD measurements, the following discriminant function was obtained;

$$D = 150.63 - 1.22\,HL - 1.14\,BD$$
$$(F_{2,234} = 372.88,\ P < 0.0001)$$

Both two variables contributed significantly to the function (HL, $F_{1,234} = 324.21$, $P < 0.0001$; BD, $F_{1,234} = 25.41$, $P < 0.0001$). Following this function, birds were classified as males when $D < 0$ and female when $D > 0$. This discriminant function proved reliable for 95.7% of the males (133 out of 139), for 98.0% of the females (96 out of 98), and for a total of 96.6% of the birds (Fig. 1).

DISCUSSION

This study demonstrated that Black-tailed Gulls, breeding on Rishiri Island have marked sexual differences in their external measurements and can be sexed by a discriminant function using HL and BD with a total reliability of 96.6%. This discriminant function will prove useful for sexing Black-tailed

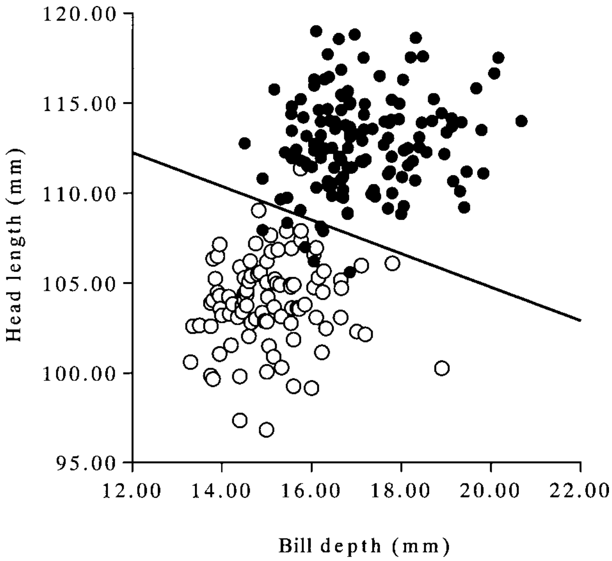

Fig. 1. Relationship between bill depth (BD) and head length (HL) to the function $1.22\,\text{HL}=150.63-1.14\,\text{BD}$. Open circles show females and closed circles show males.

Gulls in the field. Rapid sexing of a bird would contribute to shortening handling time thereby allowing researchers to release birds quickly after a minimum of disturbance. Before applying this method to other populations or age classes, however, sexing accuracy requires further testing, especially since Laridae species show inter-colonial variation in external measurements (Threlfall & Jewer 1978; Monaghan et al. 1983; Jehl 1987; Evans et al. 1993), as well as age related differences (Coulson et al. 1981; Allaine & Lebreton 1990; Palomares et al. 1997). The greater difference in size between the sexes found in the head region indicates that this region, especially the bill, may play an important role, probably in sexual display and territorial defence by males (Ingolfsson 1969). The smaller sexual dimorphism in the wing region may be related to the species' flight performance (Schnell et al. 1985; Croxall 1995).

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