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Flight speed of Ross's Gull *Rhodostethia rosea* and Sabine's Gull *Larus sabini*

ANDERS HEDENSTRÖM[1]

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ABSTRACT. I report here for the first time measured flight speeds of Ross's and Sabine's gulls, obtained by optical range finder on the northeast Taymyr peninsula, Siberia. For two flocks of Ross's gulls, airspeeds were 12.2 m/s and 14.6 m/s. Mean airspeed for the Sabine's gulls was 13.9 m/s (SD = 3.4 m/s, N = 6). A comparison of these measured airspeeds with characteristic speeds predicted from aerodynamic theory showed that the Sabine's gulls were flying significantly faster than predicted minimum power speed, but their speed was not significantly different from maximum range speed. Sabine's gulls adjusted the airspeed in relation to head- and tailwinds, which is in agreement with aerodynamic theory.

Key words: flight speed, optical range finder, wind response, *Rhodostethia rosea*, *Larus sabini*

RÉSUMÉ. Je rapporte ici pour la première fois les mesures de vitesse de vol de la mouette rosée et de la mouette de Sabine, prises au télémètre optique dans la presqu'île de Taïmyr en Sibérie. Pour deux volées de mouettes rosées, la vitesse dynamique était de 12,2 m/s et de 14,6 m/s. La vitesse moyenne pour les mouettes de Sabine était de 13,9 m/s (écart-type = 3,4 m/s, N = 6). Une comparaison de ces mesures de vitesse de vol avec les vitesses caractéristiques prédites d'après la théorie aérodynamique montrait que les mouettes de Sabine volaient bien plus vite que la vitesse minimum prédite, mais que cette vitesse n'était pas très différente de la gamme maximum de vitesses. Les mouettes de Sabine ajustaient leur vitesse de vol en fonction des vents de face ou arrière, ce qui correspond à la théorie aérodynamique.

Mots clés: vitesse de vol, télémètre optique, réaction au vent, *Rhodostethia rosea*, *Larus sabini*

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Flight speed in birds is a trait determined by morphology (wingspan, wing area, body mass) and ecological context (Pennycuick, 1975; Hedenström and Alerstam, 1995). Flight theory predicts a U-shaped relationship between power and speed, which immediately suggests different characteristic flight speeds depending on the ecological situation (Hedenström and Alerstam, 1995). For example, the flight speed associated with maximum range (V_{mr}) is predicted to be about 1.32 times the flight speed associated with minimum power (V_{mp}) (ideal bird *sensu* Pennycuick, 1975). However, information on measured flight speed of birds is not very abundant in the literature (cf. Welham, 1994), especially for species breeding in remote areas. Here, I report measured flight speed in two arctic gulls, Ross's gull *Rhodostethia rosea* and Sabine's gull *Larus sabini*. The biology of these enigmatic species is still very little known (Blomqvist and Elander, 1981). To my knowledge, flight speeds in these species have never been reported.

I had the opportunity to study these birds during a shipborne Swedish-Russian expedition, "Tundra Ecology – 94" in summer 1994 (Grönlund and Melander, 1995). The data were obtained at site 10 on the northeast Taymyr peninsula (76˚12′N, 111˚22′E), where the expedition stopped between 30 June and 2 July. Our field camp was about 18 km from the coast near a small lake. When we arrived on 30 June, we found about 150 Ross's gulls in the area, but during the course of the day they began to leave in small flocks. We also found a breeding colony (about 15 pairs) of Sabine's gulls, and I could track them while they were commuting between their breeding colony and foraging areas.

Flying birds were tracked by means of an optical range finder (WILD, 80 cm, 11.25×) with azimuth and elevation scales. Fixes were read every 15 s. I measured wind speed and direction by means of a hand-held cup anemometer immediately after each flight track registration. Because some tracked birds were flying significantly higher than the height of wind measurements, the wind gradient in a boundary layer is a potential source of error in calculating the airspeed (cf. Oke, 1987). However, as data on surface roughness are lacking for the tundra landscape in question, I have used the uncompensated wind measurements when reducing the data (the effect will in any case be small). Wind speed varied between 4 and 11 m/s. Heading and airspeed were obtained by calculating vectors of flight tracks and wind.

Data on wing morphology used in aerodynamic calculations were obtained from two individuals caught during the expedition. An adult Sabine's gull had a wingspan of 0.91 m and wing area of 0.0870 m^2 (aspect ratio = 9.5), and a juvenile Ross's gull had a wingspan of 0.74 m and wing

[1] Department of Animal Ecology, Lund University, Ecology Building, S-223 62 Lund, Sweden; anders.hedenstrom@zooekol.lu.se

TABLE 1. Range finder tracking data of Ross's gull (RG#) and Sabine's gull (SG#) from NE Taymyr 1994, track direction (North = 0˚), V_g is ground speed and V_a is airspeed.

Flock#	Date	Flock size	Flight altitude (m)	Duration (s)	Track direction (Deg)	V_g (m/s)	V_a (m/s)
RG1	30 June	14	40	105	127	16.1	12.2
RG2	30 June	15	50	45	218	14.5	14.6
SG1	1 July	1	<5	45	323	15.9	15.1
SG2	1 July	2	>5	60	167	10.4	16.1
SG3	1 July	1	15	165	43	14.5	8.2
SG4	1 July	1	10	45	184	10.2	13.9
SG5	2 July	1	20	45	179	16.3	12.2
SG6	2 July	1	<5	75	333	7.0	17.8

area of 0.0621 m^2 (aspect ratio = 8.8). The body mass of the Sabine's gull was 210 g; in contrast, I used a body mass of 160 g from Cramp and Simmons (1983) to represent an adult Ross's gull for aerodynamic calculations.

Ross's gulls were leaving the area during the day of 30 June, and the track directions were towards SSW and SE for the two flocks, respectively (Table 1). Probably the Ross's gulls were departing on migration towards breeding areas farther south, a notion further supported by the fact that these birds were flying quite a lot higher than the Sabine's gulls (Table 1). Observed flight speeds of two flocks of Ross's gulls and six registrations of Sabine's gulls are shown in Table 1. The two flocks of Ross's gulls had airspeeds of 12.2 m/s and 14.6 m/s (mean 13.4 m/s). Mean airspeed for the Sabine's gulls was 13.9 m/s (SD = 3.4 m/s, N = 6).

Predicted V_{mp} and V_{mr} from Pennycuick (1989) using program 1 and default settings (air density = 1.23 kg/m^3) were as follows: Ross's gull V_{mp} = 6.3 m/s, V_{mr} = 10.8 m/s; Sabine's gull V_{mp} = 6.3 m/s, V_{mr} = 10.7 m/s. The values are very similar for the two species because they have similar wing morphology. However, recent wind tunnel studies have shown that the default body drag coefficient (C_{Db} = 0.4 in Ross's gull and C_{Db} = 0.387 in Sabine's gull) used in Pennycuick (1989) probably needs a revision downwards to C_{Db} = 0.08 in bird species with streamlined body shape, such as gulls (Pennycuick et al., 1996). With this new value of the body drag coefficient, the characteristic airspeeds for Sabine's gull are V_{mp} = 9.3 m/s, V_{mr} = 16.3 m/s. Values for Ross's gull are almost identical. Hence, we may conclude that the Sabine's gulls were flying significantly faster than their predicted V_{mp} ($p < 0.05$, confidence limit test), but their speed was not significantly different from the predicted V_{mr} ($p > 0.05$).

Another prediction from flight mechanical theory says that birds should adjust their airspeed in relation to head- and tailwinds (Pennycuick, 1978), so that flying into a headwind will increase airspeed and in a tailwind airspeed should decrease compared to the still wind situation. This possible airspeed adjustment was analyzed for Sabine's gull by regressing airspeed versus the wind speed increment/decrement (V_g-V_a): $V_a = 13.2-0.47 (V_g-V_a)$ ($t = 3.96$, $p < 0.05$). Hence, Sabine's gulls show this adaptive wind response in relation to headwind or tailwind. From this regression equation we may infer that the still wind airspeed in Sabine's gull was 13.2 m/s, which is also significantly higher than the predicted V_{mp} ($p < 0.05$). Furthermore, if the birds had actually been flying at their minimum power speed, the observed wind adjustment of airspeed would not be expected. Hence, we may conclude that the flight speed of these gulls was not V_{mp}. However, we do not know if it was V_{mr} or another optimal flight speed larger than V_{mp} (cf. Hedenström and Alerstam, 1995).

In conclusion, I report for the first time measured flight speeds in Ross's gull and Sabine's gull. These are valuable data as such, but I also show that the Sabine's gull adjusts its airspeed in relation to wind as predicted from flight mechanical theory.

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