Biometrics and Primary Molt of Common Tern and Sandwich Tern in Autumn in Puck Bay, Southern Baltic

WLODZIMIERZ MEISSNER[1] AND ROBERT KRUPA[2]

[1]Avian Ecophysiology Unit, Department of Vertebrate Ecology and Zoology, University of Gdansk
Al. Legionów 9, 80-441 Gdańsk, Poland
Internet: w.meissner@univ.gda.pl

[2]Department of Zoology, Warmia and Masuria University, Oczapowskiego 5, 10-957 Olsztyn, Poland

Abstract.—Data were collected at one of the important stop-over sites in the southern Baltic between 1989 and 1995. Sandwich Terns were not only more advanced in primary molt than Common Terns, but also replaced their flight feathers faster due to larger number of primaries growing simultaneously. All caught adult Sandwich Terns were in active molt, whereas over 21% Common Terns either had not started primary molt or suspended it. The difference in migration strategy may be the main reason for the discrepancy between these two species in molt advancement. Biometrical analysis showed that juveniles of both species did not reach adult size at this stage of migration. Sandwich Terns caught in late summer in northeast England had shorter wings than birds from Puck Bay probably due to different origin of birds caught at these two sites. Common Terns caught in Puck Bay were larger than birds from German and Scottish breeding colonies and also from birds measured in northeast England. Moreover in Puck Bay, 84% of Common Terns were replacing primaries during autumn migration, whereas only 45% in Teesmouth did it at the same time. It seems that Common Terns from west Europe and terns passing the Baltic Sea belong to different populations, which differ in the distance they cross between breeding and wintering grounds and also in biometrics. *Received 27 April 2006, accepted August 3 2006.*

Key words.—molt, biometry, Baltic, autumn migration, Common Tern, Sandwich Tern.

Waterbirds 30(1): 158-163, 2007

The majority of published data on biometrics and primary molt of Common Tern (*Sterna hirundo*) and Sandwich Tern (*Sterna sandvicensis*) come from west European breeding colonies and stop-over sites (Glutz von Blotzheim and Bauer 1982; Ward 2000). However, there were almost no detailed information on biometrics and advancement of molt of these species from Baltic coasts, despite quite intensive autumn migration through this area (Meissner 1999).

In the southern Baltic autumn migration of these two species differed in phenology and in the composition of young and adult birds during the season (Meissner 1999). There are several reasons for these inconsistencies. Firstly, origins of individuals of each species differ and phenology and breeding success can be influenced by completely different weather conditions (Meissner 1999). Secondly, Sandwich Terns move with whole families to places abundant in fish and young birds are fed by parents until they reach the wintering grounds (Dunn 1972), whereas a large fraction of first-year Common Terns become independent in August and September (Glutz von Blotzheim and Bauer 1982). This may influence differences between adults of these two species due to differences in overall migration speed and primary molt schedules because terns require good flight performance to forage effectively.

This paper presents data on biometrics and molt of the Common Tern and Sandwich Tern from a Baltic stopover site with special emphasis on differences between two species. This may help to understand differences in migration patterns observed across Europe (Glutz von Blotzheim and Bauer 1982; Ward 2000)

METHODS

Data were gathered between 1989 and 1995. Fieldwork was conducted from mid-July to the end of September in Puck Bay at a narrow sandy peninsula near Rewa village (54°38'N, 18°31'E). The main trapping method was cannon-netting. Some terns were caught also by mist-nets at dusk and at dawn, mainly by flushing them out towards the nets.

Birds in the first calendar year (juveniles) and after the first calendar year (adults) were distinguished. Wing length (maximum chord), total head length, bill length and tarsus plus toe length were measured. Before 1991 all measurements were taken to the nearest 1 mm using a ruler with a stop. From 1991 onwards callipers were used to measure total head and bill lengths (accuracy of 0.1 mm). To combine these measurements of differing degrees of precision, the more precise measurements of the lengths of bill and total head were rounded to 1 mm classes. Birds were also weighed to the nearest 2 g by PESOLA spring balance. For calculation of condition index, body mass was corrected for body size using the weight/wing length ratio (Owen and Cook 1977). Ringers were checked every year with respect to comparability of the measuring accuracy similar to the procedure described by Busse (1994). In adults the growth and replacement of primaries was recorded using a scoring system from 0 (old feather) to 5 (new, fully grown feather) according to Ashmole (1962). A total of 428 Common Terns and 46 Sandwich Terns were measured. Data on migration dynamics and origin of birds passing in autumn Puck Bay are published elsewhere (Meissner 1999).

RESULTS

Common Tern

Averages of all linear measurements except tarsus plus toe length were significantly higher in adults than in juveniles (Table 1). On average, adults also weighed more than juveniles, but this difference disappeared when body mass had been corrected for body size (Table 1). Bimodality was conspicuous only for total head length distribution in juveniles (Fig. 1). There were no significant differences in the mean condition index of adults caught in successive half-month periods (ANOVA, $F_{2,127} = 0.16$, $P = 0.86$—data from September were omitted due to small sample size). In the case of juveniles birds caught in September had significantly higher condition index than those migrating in July and August (ANOVA, $F_{2,221} = 12.1$, $P < 0.001$ and Tukey post-hoc test at $P < 0.05$).

Molt score was recorded in 154 adults. Among them, 25 (16.2%) had not started primary replacement. The median molt score was 5 and the highest 25 concerned three birds with five full-grown innermost primaries and five old ones. In eight Common Terns molt was suspended. In other eight birds molt status suggested that primary replacement was resumed after suspension, because gap from shed feather occurred between new, full grown and old feathers.

In the second half of July and the first half of August, when the majority of adults pass the study area, the proportion of molting and non-molting birds was similar (χ^2 test, $\chi^2 = 2.29$, $P = 0.13$). There was also no relationship between molt score and date of capture (Spearman rank coefficient $r_s = 0.06$; $P > 0.10$); Fig. 2). The second primary was dropped before the first had finished its growth (Table 2). In the majority of cases the third primary was shed when the first one completed its growth and the development of the second was finished or well advanced. In the Common Tern the most often 2 primaries were growing simultaneously (52%, N = 121). Three and four primaries growing at the same time were observed only in 3 and 1 individual respectively.

Sandwich Tern

All linear measurements of adults were longer than measurements of juveniles (Table 3). There were no statistical differences between two age classes either in body mass or in condition index (Table 3). Body mass of all Sandwich Tern ranged from 160g and 282 g, with a mean of 234.6g (SD = 23.0).

Among adults (N = 23) all had started replacement of primaries. The median molt score was 18 and the highest score was 29.

Table 1. Comparison of the measurements and condition index of adult and juvenile Common Terns caught in Puck Bay between 1989 and 1995.

	Adults			Juveniles			t-test or Cochran-Cox test	
Measurement	Mean	SD	N	Mean	SD	N	t or t'	p
Total head length	78.80	2.69	25	73.60	2.53	240	9.8	p < 0.001
Bill length	37.70	2.42	25	32.50	1.90	240	12.8	p < 0.001
Wing length	277.70	6.88	15	262.80	6.44	229	8.7	p < 0.001
Tarsus+toe length	42.40	2.94	25	42.70	1.53	172	0.5	p = 0.651
Body mass	142.30	15.10	24	134.20	17.52	236	2.2	p < 0.050
Condition index	0.53	0.06	14	0.52	0.08	224	0.4	p = 0.677

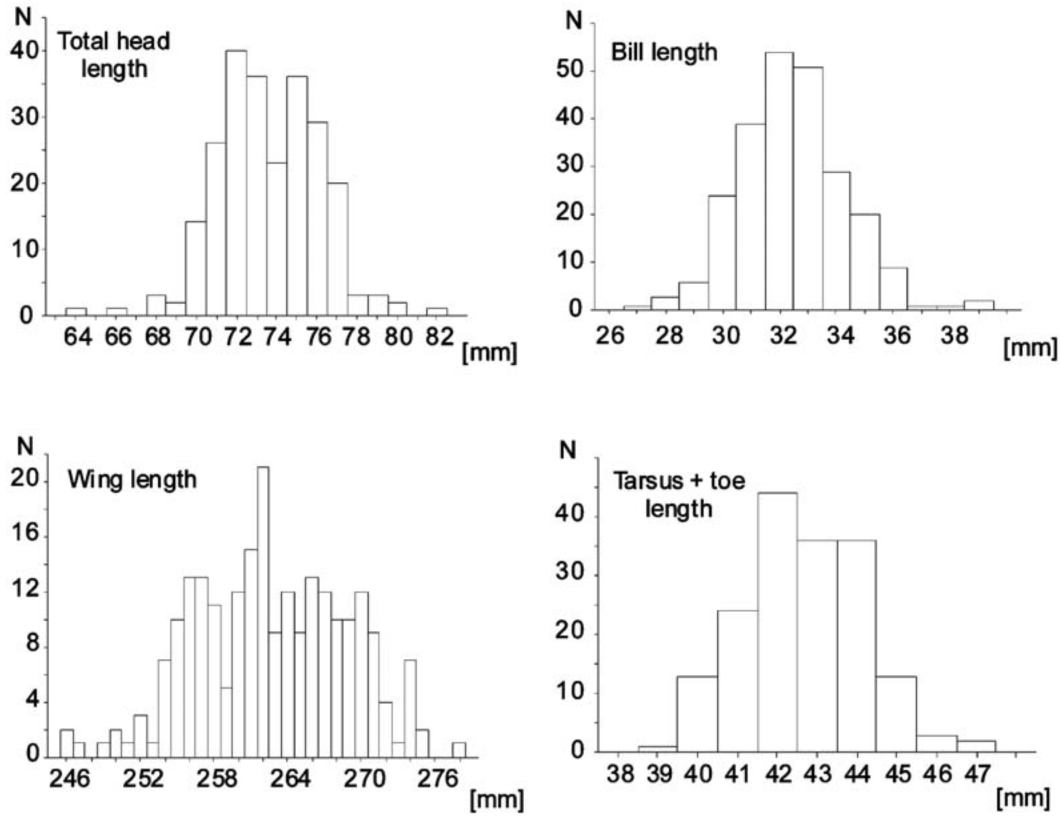

Figure 1. Distributions of measurements of juvenile Common Tern caught in Puck Bay in autumn. Data from years 1989-1995 were joined.

Only one adult was at the initial stage of molting, having shed the innermost primary. Other birds had at least 1 new fully grown feather. In three adults, five new primaries had their grown finished. The number of primaries growing simultaneously was higher than in Common Tern (U-test, Z = 3.32, $P < 0.001$). Two and three feathers growing simultaneously were recorded in 22% and 30% of examined adults (N = 23). Two Sandwich Terns molt five primaries at the same time. The correlation between date of capture and molt score was significant (Spearman rank coefficient $r_s = 0.69$; $P < 0.05$; Fig. 2).

DISCUSSION

In Common Terns, males are larger than females (Glutz von Blotzheim and Bauer 1982, Cramp 1985), however due to substantial overlap, the majority of measurement distributions did not show bimodality (see also Ward 2000). However, Bainbridge (1977) found a weak two-peak pattern in bill length distribution. The mean wing length of adult Common Terns caught in Puck Bay was somewhat larger than in birds from German and Scottish breeding colonies (Craik and Becker 1992) and from birds caught in Teesmouth, England (Ward 2000). Differences between means obtained in Puck Bay and west European sites ranged from 2.6 to 9.6 mm and it is unlikely that this discrepancy was due to differences in measurement routines as, in all studies, the maximum chord method was used. Common Terns from west Europe and terns passing the Baltic region belong to different populations, which differ in migration timing (Meissner 1999) and also in distance between breeding and wintering grounds (Neubauer 1982). Ward (2000) noted that the wing length of Common

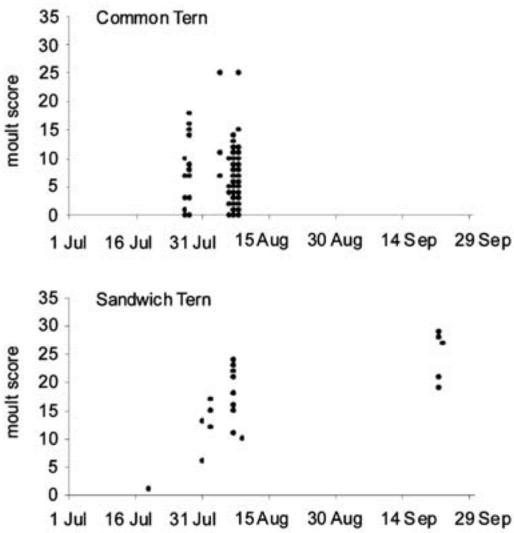

Figure 2. Individual molt score of adult Common Tern and Sandwich Tern in Puck Bay plotted against the date of capture. Data from years 1989-1995 were joined.

Terns caught in Teesmouth showed great variability and mean wing length increased significantly between mid July and mid September. Analysis of ringing recoveries confirmed that in Teesmouth percentage of juveniles ringed in Baltic colonies increased gradually. More detailed comparison of migration phenology of this species between different parts of Europe is difficult due to large variability of migration pattern in following seasons (Meissner 1999). However, apparently this species starts migration later in England than in the Baltic, where about 70% of birds pass Puck Bay in August (Meissner 1999).

The average body mass of adult Common Terns in Puck Bay was 10-20 g higher than in birds caught during the breeding season (Szulc-Olechowa 1964; Cymborowski and Szulc-Olechowa 1967; Craik and Becker 1992) and higher than in the case of terns caught in August and September near Liverpool and at Teesmouth (Bainbridge 1977a; Ward 2000). However, birds from German and Scottish breeding colonies had, on average, shorter wings and differences in body mass became negligible when corrected for body size. Birds from Liverpool did not put on weight until September and the majority of them belong to local breeding populations (Bainbridge 1977a, b). In Teesmouth, body masses of Common Terns fluctuated throughout with no directionality.

Juvenile Common Terns migrating in September had higher energetic stores than birds from July and August. Such phenomena occurs also in other species (e.g., Greve and Gloe 1974; Pienkowski *et al.* 1979; Meissner 1997; Meissner and Kamont 2005). In Puck Bay, the proportion of Common Terns which began primary molt was much higher than in north-east England (84% and 45% respectively) (Ward 2000). The most advanced adult Common Terns had new, full grown fifth primaries. Similar results were obtained by Bainbridge (1977a) and Ward (2000) in England and by Walters (1979) in the Dutch coast. Olsen and Larsson (1995) claimed, that only 10% of birds initiate primary molt by late July and early September. In contrast to these, the majority of birds caught in Puck Bay were in active molt and some of them probably resumed primary replacement after suspension. Common Terns making stop-over in Puck Bay come from northeastern Europe and also from breed-

Table 2. Molt stages in adult Common Terns when the subsequent primaries were shed according to data from Puck Bay gathered between 1989 and 1995.

Second primary shed		Third primary shed		Fourth primary shed	
Molt stage	N	Molt stage	N	Molt stage	N
1100000000	7	3210000000	1	4421000000	1
2100000000	3	4410000000	1	5331000000	1
3100000000	5	5210000000	1	5541000000	2
4100000000	4	5310000000	3	5551000000	1
		5410000000	6		
		5510000000	7		

Table 3. Comparison of the measurements and condition index of adult and juvenile Sandwich Terns caught in Puck Bay between 1989 and 1995.

	Adults			Juveniles			U-test	
Measurement	Mean	SD	N	Mean	SD	N	Z	p
Total head length	106.0	3.86	27	95.40	5.67	19	5.28	$p < 0.001$
Bill length	56.1	2.66	27	45.10	4.42	19	5.72	$p < 0.001$
Wing length	309.4	7.37	15	298.40	6.68	16	3.44	$p < 0.001$
Body mass	238.4	15.48	26	229.00	30.50	18	1.44	$p = 0.150$
Condition index	0.80	0.04	14	0.76	0.10	15	0.80	$p = 0.424$

ing colony about 40 km eastwards (Glutz von Blotzheim and Bauer 1982; Cramp 1985; Meissner 1999). Possibly, among caught terns there were actively molting local birds, birds prior to departure with suspended molt and also birds which had resumed molt after arrival at Puck Bay before the next migration stage. Moreover, the difference of proportion of molting birds between Puck Bay and Teesmouth suggests that majority of Common Terns being in primary molt in the Baltic do not stop in the northeast England. Furthermore, molt score did not change with time, which suggests that Common Terns at Puck Bay have a high turnover rate, with continuous incoming of birds at early stages of molt during the season. The molt of Sandwich Terns, on the contrary, looks more synchronous. The rather small Baltic population of Sandwich Tern occupies the northeasternmost breeding area of this species in Europe and Puck Bay was probably used by the same group of birds from the start to the end of the season. Analysis of ringing recoveries showed that in the study area Sandwich Terns from eastern and western Baltic colonies were recorded (Meissner 1999). In the light of present knowledge, the regular occurrence of birds from Western Europe in the Baltic seems to be impossible (Glutz von Blotzheim and Bauer 1982; Cramp 1985).

Despite the small sample size, Sandwich Terns seem not only to be more advanced in primary molt than Common Terns, but also replace their flight feathers faster due to larger number of primaries growing simultaneously. All caught adult Sandwich Terns were in active molt, whereas over 21% Common Terns either had not started primary molt or had suspended it. Ward (2000) noted that 87.5-91.7% of Sandwich Terns caught at Teesmouth had begun primary molt. The main reason for the discrepancy between these two species in molt could be difference in migration strategy. Sandwich Tern presents a remarkable post-breeding dispersal, moving in whole families to rich feeding grounds (Cramp 1985; Schuman 1987; Meltofte *et al.* 1994). Young birds learn fishing and are fed during the whole migration period (Dunn 1972). Thus, in July and August the migration speed of this species is very slow and ranging about 2.3-11.1 km/day (Møller 1981), which is much lower than the Common Tern (Kasparek 1982). Moreover, the body mass of adult Sandwich Terns caught in Puck Bay and in German breeding grounds are quite similar (Glutz von Blotzheim and Bauer 1982) and this also supports hypothesis about rather slow migration of this species in the Puck Bay area. On the contrary, a large fraction of juvenile Common Terns becomes self-dependent already in August and in September (Glutz von Blotzheim and Bauer 1982) and adults migrate on average earlier than young birds (Meissner 1999). Faster migration towards wintering grounds requires preservation of efficient flight capability, thus remige replacement in Common Tern occurs slowly. Low number of primaries growing simultaneously results in smaller gap in wing area which benefits birds in terms of energetic cost of flight.

Sandwich Terns passing the Puck Bay in autumn belong almost exclusively to Baltic breeding population, whereas Common Terns originate both from costal and inland areas of north-eastern Europe and from colonies localized along the Baltic coast (Glutz von Blotzheim and Bauer 1982; Cramp 1985;

Meissner 1999). Thus, all Sandwich Terns caught in June and August were in initial stages of autumn migration, and among Common Terns were birds in different stages of migration and some from local breeding population. Sandwich Terns caught in late summer in north-east England had shorter wings than birds from Puck Bay and had different mean body masses (Ward 2000). Juveniles in Puck Bay were lighter and adults heavier than in Teesmouth. These differences may be due to different origin and stage of migration of birds caught at these two sites. Moreover, juveniles from Teesmouth had growing process of primaries not finished (Ward 2000).

In both species there was no difference between adults and juveniles in condition index. This is somewhat surprising, especially in the case of Common Terns, where adults and juveniles migrate separately and young birds fish less efficiently than adults (Källander 1991). To compensate for his difference juvenile Common Terns have to spend more time on feeding than adults (Källander 1991) and so maintain a condition index similar to that of adults.

ACKNOWLEDGMENTS

Studies on autumn migration of terns would not be possible without help of many people taking part in ringing camps of the KULING Group. We acknowledge all of them. The camps were organized with a financial support from Student's Scientific Circle from University of Gdan´sk and Warmia and Masuria University in Olsztyn. Legal permissions to close section of beach for tourists were kindly given by the Marine Office in Gdynia and local authorities of Kosakowo Community. This is paper no 104 of the Waterbird Research Group KULING.

LITERATURE CITED

Ashmole, N. P. 1962. The Black Noddy *Anous tenuirostris* on Ascension Island. Ibis 103: 235-273.

Bainbridge, I. P. 1977a. Biometrics and molt of Common Terns at Seaforth Dock, Liverpool. Bird Ringing in South West Lancashire 7: 34-40.

Bainbridge, I. P. 1977b. Controls and recoveries of Common Terns caught at Seaforth Dock, Liverpool. Bird Ringing in South West Lancashire 7: 40-42.

Busse, P. 1994. Key to sexing and ageing of European Passerines. Beitrage zur Naturkunde Niedersachsens, Sonderheft 37: 1-224.

Craik, J. C. A. and P. H. Becker. 1992. Temporal and spatial variations in body-weights of Common Terns and Arctic Terns. Seabird 14: 43-47.

Cramp, S. (Ed.). 1985. Birds of Europe the Middle East and North Africa. Vol. 4. Oxford University Press. Oxford.

Cymborowski, B. and B. Szulc-Olechowa. 1967. Comparison of postembrional development of Common Tern, *Sterna hirundo* L. in natural and artificial conditions. Acta Ornithologica 10: 213-225.

Dunn, E. K. 1972. Effect of age on the fishing ability of Sandwich Terns *Sterna sandvicensis.* Ibis 114: 360-366.

Glutz von Blotzheim, U. N. and K. M. Bauer. 1982. Handbuch der Vögel Mitteleuropas. Vol. 8/II. Akademische Verlag. Wiesbaden.

Greve, K. and P. Gloe. 1974. Durchzug und Masse von Bekassinen (*Gallinago gallinago*) im Braunschweiger Rieselfeld. Ornithologische Mitteilungen 26: 154-157.

Källander, H. 1991. Differences in prey capture efficiency of adult and juvenile Common *Sterna hirundo* and Arctic *S. paradisaea* terns. Ornis Svecica 1: 121-122.

Kasparek, M. 1982. Zur Zuggeschwindigkeit der Flußseeschwalbe *Sterna hirundo.* Journal für Ornitologie 123: 297-305.

Meissner, W. 1997. Autumn migration and biometrics of the Common Sandpiper *Actitis hypoleucos* caught in the Gulf of Gdańsk. Ornis Fennica 74: 131-139.

Meissner, W. 1999. Autumn migration of the Common Tern *Sterna hirundo* and the Sandwich Tern *Sterna sandvicensis* in the Puck Bay. Ring 21: 41-54.

Meissner, W. and P. Kamont. 2005. Seasonal changes in body size and mass of Red Knots *Calidris canutus* during autumn migration through southern Baltic. Ornis Svecica 15: 97-104.

Meltofte, H., J. Blew, J. Frikke, H.-U. Rösner and C. J. Smit. 1994. Numbers and distribution of waterbirds in the Wadden Sea. IWRB Publications 34.

Møller, A. P. 1981. The migration of European Sandwich Terns *Sterna s. sandvicensis.* Vogelwarte 31: 79-94: 141-168.

Neubauer, W. 1982. Der Zug mitteleuropäischer Flußseeschwalben *Sterna hirundo.* nach Ringfunden. Ber. Vogelwarte Hiddensee 2: 59-82.

Olsen, K. M. and H. Larsson. 1995. Terns of Europe and North America. Helm Identification Guides. Christopher Helm, London.

Owen, M. and W. A. Cook. 1977. Variations in body weight, wing length and condition of Mallard *Anas platyrhynchos* and their relationship to environmental changes. Journal of Zoology (London) 183: 377-395.

Pienkowski, M. W., C. S. Lloyd and C. D. T. Minton. 1979. Seasonal and migrational weight changes in Dunlins. Bird Study 26: 131-148.

Schuman, K. 1987. Zug und rast der Brandseeschwalbe *Sterna sandvicensis.* auf Helgoland in den Jahren 1969-1983. Seevögel 8: 1-14.

Szulc-Olechowa, B. 1964. Studies on the postembrional development of *Larus ridibundus* L. and *Sterna hirundo* L. Acta Ornithologica 10: 415-442.

Underhill, L. G. and R. P. Prys-Jones. 1986. The primary molt of the Common Tern: a recording system, observed patterns in the Southwestern cape, and an appeal for information. Safring News 15: 44-49.

Walters, J. 1979. The onset of the postnuptial molt in the Common Tern *Sterna hirundo* near Amsterdam. Ardea 67: 62-67.

Ward, R. M. 2000. Migration patterns and molt of Common Terns *Sterna hirundo* and Sandwich Terns *Sterna sandvicensis* using Teesmouth in late summer. Ringing and Migration 20: 19-28.