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MEASUREMENTS, WEIGHTS AND MOULT OF WADERS ON THE BANC D'ARGUIN, MAURITANIA, OCTOBER 1988

Rob Lensink & Peter L. Meininger

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Data on measurements, weights and moult of 789 waders captured on the Banc d'Arguin, Mauritania in October 1988 are presented and discussed. Taking "pairs" of measurements (bill-total head, tarsus-tarsus & toe, first secondary-wing length) proved to be a useful check for errors in the data, since these "pairs" are highly correlated. In Dunlin, Sanderling and Turnstone clap-netting in the village of Iouik caught a higher proportion of juveniles than in mist-net catches elsewhere. The weights of juvenile birds in the village did not differ from those captured elsewhere. Foreign ringed waders captured included one Ringed Plover, two Sanderlings, one Knot and five Turnstones.

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INTRODUCTION

Between 28 September and 24 October 1988 Rob Bijlsma, Rob Lensink and Peter Meininger visited the Parc National du Banc d'Arguin, Mauritania. The main purpose of this visit was to capture, ring and measure as many waterbirds, and waders in particular, as possible. Our study was part of a larger project, carried out by WIWO (Foundation Working Group for International Wader and Waterfowl Research) in collaboration with the Netherlands Marine Science Foundation.

The Banc d'Arguin is an area of major international importance for migrant waders and terns, both as a staging and as a wintering area (*e.g.* Dick 1975, Altenburg *et al.* 1981, Ens *et al.* 1989). At present more is known about the condition of waders in this area in spring (Ens *et al.* 1989) than in autumn. The only information currently available on condition, measurements and origin of waders using the area in autumn was collected by a British expedition in autumn 1973 (Dick 1975, Dick & Pienkowski 1979). Our major aim was to collect additional data, to trap at some other sites and to collect more measurements of birds captured. Additional measurements of birds captured may cast light on the geographical origin (Engelmoer *et al.* 1987).

Compared with the project in 1973 (Dick 1975) the 1988 team had a much shorter stay (3.5 weeks), fewer participants (three), no cannon nets, no transport, plenty of moon, wind and locusts swarms (the latter also in the mist-nets.....). In spite of all this a total of 1,036 birds were newly ringed: 789 waders, 210 "other waterbirds" (mainly gulls and terns) and 37 passerines. Twenty birds captured already carried a ring ("controls"). Five Turnstones *Arenaria interperes* and five Slender-billed Gulls *Larus genei* had been ringed locally during previous recent expeditions. Other controls included foreign ringed Ringed Plover (1), Sanderling (2), Knot (1), Turnstone (5) and Common Tern (1 from UK).

METHODS

Two simple clap-nets (each 5x12 m) were used on 11 days between 30 September and 22 October, exclusively in the village of Iouik (19°52'N 16°18'W), to trap waders and Slender-billed Gulls feeding on fish remnants and garbage among the fishermen's huts and along the shore. In 64 successful attempts (at least one bird captured) we mainly trapped Sanderlings (up to 500 present) and Turnstones (up to 1,100 present).

Mist-nets were used at the Baie d'Aouatif, E of Iouik (up to 240 m in 17 nights between 29 September and 19 October), at Ebelk Aiznay, 3 km N of Iouik (190 m in three nights between 5 and 9 October; up to 500 m in five nights between 19 and 23 October), and at Cap Timiris (19°23' N, 16°32' W; up to 300 m in three nights between 12 and 15 October).

Birds captured were kept in linen bags or cages and ringed, measured and weighed as soon as possible after capture. Weights presented here have not been corrected for loss of weight after capture. Mean times between capture and weighing have, however, been calculated and are mentioned for each species. Birds were weighed using electronic balances or Pesola spring balances, rounded to whole grams.

The following measurements were taken for each bird: bill (measured with calipers from bill-tip to the edge of feathering, to the nearest 0.1 mm); total head (with calipers to the nearest 0.1 mm (cf. Green 1980)); wing, flattened and straightened (using a stopped ruler to the nearest mm (cf. Evans 1986)); first secondary (distance between outer edge of wing bow to tip of first secondary, flattened and straightened using a ruler to the nearest 0.5 mm); tarsus (using calipers to the nearest 0.1 mm); tarsus plus toe (using a stopped ruler, to the nearest 0.5 mm (Piersma 1984)).

Birds were aged using plumage characteristics, primary wear and moult patterns of remiges (cf. Prater *et al.* 1977). Primary moult scores were recorded following Ginn & Melville (1983). Plumage was scored to a simple scale from 1 (complete winter plumage) to 7 (complete summer plumage). Moult of body feathers (head, back and underparts) was recorded to be present or absent.

Birds were ringed with rings of Musée Hist. Nat. Paris, aluminum rings applied above the tarsus, steel rings on the tarsus. Rings of birds already carrying a ring were not replaced.

All data collected were filled in immediately on a pre-printed file card. Data were processed using a LOTUS computer programme.

RESULTS

Table 1 summarizes all ringing recoveries of waders resulting from the expedition in autumn 1988.

In the following species accounts all references made to data collected on the Banc d'Arguin in autumn 1973 are based on Dick (1975) or Dick & Pienkowski (1979).

Oystercatcher *Haematopus ostralegus* (Table 2)

A total of five Oystercatchers were captured in mist nets: three in the Baie d'Aouatif and two at Ebelk Aiznay (Table 2). All birds had chisel-shaped bills (cf. Swennen *et al.* 1983). Weights were low compared to those recorded in the Dutch Waddensea in October: for adults mean 548 g, s.d. 36.3 (n=167), range 420-690 (Cramp & Simmons 1983).

Ringed Plover *Charadrius hiaticula* (Tables 3 and 4)

A total of 26 Ringed Plovers were captured (65% juveniles): seven (6 juv.) at Iouik village, five (4 juv.) at the Baie d'Aouatif, 11 (6 juv.) at Ebelk Aiznay, and three (1 juv.) at Cap Timiris. The percentage of juveniles captured with clap nets was 86%, with mist nets 58%.

Measurements. Bill and wing measurements found in October 1988 were very similar to those found in autumn 1973.

Weights. Mean time between trapping and weighing was 1 h 40 mins. Mean weights of juvenile and adult birds were 3.2 and 2.9 g respectively less than those found in October 1973.

Moult. Eight out of nine adult birds had moulting primaries, with total moult scores of moulting birds varying between 29 and 44. One bird had completed primary moult. Primary moult score did not show a clear trend during the trapping period (Table 4). Secondary moult in at least two birds showed two and three series of simultaneously growing feathers respectively.

Eleven out of 16 first year birds, and all adults showed moulting body feathers. All adult birds were in winter plumage.

Kentish Plover *Charadrius alexandrinus* (Table 5)

Ten Kentish Plovers were captured with mist-nets: eight (5 juv., 3 ad.) at Ebelk Aiznay and two adults at Cap Timiris. One juvenile was missing a leg and a foot and one adult had no middle toe.

Measurements. The measurements of both wing and bill lengths in both age groups were slightly larger than found in autumn 1973, although sample sizes during both years were small (19 in 1973, 10 in 1988).

Weights. In October 1988 mean time between trapping and weighing was 2 h 30 mins in juvenile birds and 22 mins in adult birds. Mean weights of both juvenile and adults in October 1988 (38.0 and 41.2 g respectively) were similar to those in October 1973 (37.8 and 39.0 g respectively).

Moult. Three out of five adults had completed primary moult. Single adults captured on 6 and 22 October (the latter being the bird with the missing toe) still clearly had the outermost primary growing (total score 49). All six adults captured in autumn 1973 (the first captured on 6 October) had completed primary moult. In NW Europe adult Kentish Plovers finish primary moult in September (PLM, unpublished). All ten birds showed moulting body feathers.

Grey Plover *Pluvialis squatarola* (Table 6)

Six Grey Plovers were captured: one juvenile with a clap net (at Iouik village) and five adults with mist nets (Cap Timiris 3, Ebelk Aiznay 2).

Measurements. Mean bill and wing lengths of adults birds closely resembled those found in autumn 1973.

Weights. All birds were weighed within one hour of capture. Two adults weighed twice (one and three hours after capture) lost 8 and 4 g respectively (mean 3 g/hour). Mean weight of adults in October 1988 (212 g) was slightly higher than in October 1973 (190 g, n=6). This may well have been due to a longer period between trapping and weighing in the 1973 sample. The single juvenile captured (feeding

Table 1. Ringing recoveries of waders resulting from the expedition to the Banc d'Arguin, Mauritania, 28 September-23 October 1988. v = controlled by ringer

RINGED PLOVER Charadrius hiaticula

London NV 14070 ringed: 30 April 1983, >2cy male, Waterfoot, Annan, Scotland (54.58 N, 3.15 W)
. found: v 15 October 1988, Cap Timiris, Mauritania (19.23 N, 16.32 W; 4113 km)

SANDERLING Calidris alba

Arnhem H 190992 ringed: 13 May 1986, >1cy (72 g), Hansweert, Netherlands (51.26 N, 04.00 E)
. found: v 15 October 1988 (49 g), Cap Timiris, Mauritania (19.23 N, 16.32 W; 4000 km)

London NS 39489 ringed: 14 May 1983, >1cy male, Waterfoot, Annan, Scotland (54.58 N, 3.15 W)
. found: v 15 October 1988, Cap Timiris, Mauritania (19.23 N, 16.32 W; 4113 km)

TURNSTONE Arenaria interpres

Helsinki AT 96281 ringed: 24 June 1988, pullus, Pernaja, Finland (60.17 N, 26.09 E)
. found: v 17 October 1988 (97 g), Iouik, Mauritania (5616 km)

Helsinki AT 103760 ringed: 13 July 1988, pullus, Uusikaupunki, Finland (61.01 N, 21.13 E)
. found: v 11 October 1988 (85 g), Iouik, Mauritania (5452 km)

Hiddensee 7283926 ringed: 7 August 1988, 1cy, Langenwerder, Wismar, DDR (54.02 N, 11.30 E)
. found: v 21 October 1988 (90 g), Iouik, Mauritania (4476 km)

Paris M 5048 ringed: 29 March 1985, >2cy (107 g) Iouik, Mauritania
. found: v 2 October 1988 (93 g), Iouik, Mauritania

Paris M 5185 ringed: 25 April 1985, 2cy (88 g) Iouik, Mauritania
. found: v 11 October 1988 (99 g), Iouik, Mauritania

Paris M 5284 ringed: 15 February 1985, >2cy (108 g) Iouik, Mauritania
. found: v 6 October 1988 (104 g), Iouik, Mauritania

Paris M 6063 ringed: 3 May 1988, >2cy male (131 g) Iouik, Mauritania
. found: v 2 October 1988 (95 g), Iouik, Mauritania

Paris M 6065 ringed: 6 May 1988, >2cy male (116 g) Iouik, Mauritania
. found: v 2 October 1988, (96 g) Iouik, Mauritania

Stockholm 4153464 ringed: 4 August 1988, 1 cy (95 g) Ottenby, Sweden (56.12 N, 16.24 E)
. found: v 5 October 1988, (101 g) Iouik, Mauritania (4877 km)

Stockholm 4153493 ringed: 6 August 1988, 1 cy (105 g) Ottenby, Sweden (56.12 N, 16.24 E)
. found: v 6 October 1988, (102 g) Iouik, Mauritania (4877 km)

KNOT Calidris canutus

Paris M 8908 ringed: 20 May 1985, >1cy Triaize, Vendee, France (46.23 N, 1.12 W)
. found: v 7 October 1988, Iouik, Mauritania (19.52 N, 16.18 W)

Table 2. Measurements (mm), weights (g) and moult of Oystercatchers, Banc d'Arguin, 2-22 October 1988.

date	age	bill	head & bill	bill height	wing	tarsus	tarsus & toe	weight	primary moult score 12345678910	total
02.10.88	1 cy	75.7	118.3	9.0	252	56.4	102.0	432	-	
06.10.88	>2 cy	78.0	116.8	-	255	-	-	352	5530000000	13
07.10.88	>2 cy	73.6	-	8.9	250	-	-	390	5555542000	31
19.10.88	>1 cy	80.2	122.4	10.7	266	57.6	98.5	291	5555432000	29
22.10.88	>2 cy	80.0	117.0	9.8	268	54.6	97.0	472	5555543100	33

Table 3. Summarized measurements (mm) and weights (g) of Ringed Plovers, Banc d'Arguin, 30 September-23 October 1988.

	1st year				>1st year			
	mean	s.d.	range	n	mean	s.d.	range	n
bill	14.5	0.66	13.2-15.9	17	14.5	0.33	14.1-15.3	9
head & bill	40.5	0.87	39.2-41.7	17	41.5	0.76	40.6-42.6	9
wing	129.7	2.6	125-137	17	131.0	3.3	126-137	7
1st secondary	56.6	4.61	43.0-68.5	17	56.6	3.91	49.0-62.0	7
tarsus	25.9	0.82	24.9-27.8	17	26.9	1.10	25.7-29.0	9
tarsus & toe	45.5	1.38	43.5-48.5	17	46.3	2.27	41.5-49.5	9
weight	44.9	4.44	37-54	17	47.0	3.05	41-51	9

Table 4. Primary and secondary moult scores of Ringed Plovers, Banc d'Arguin, 7-22 October 1988.

date	primaries 1-10	total score	secondaries
07.10.88	5555554200	36	300000000000
07.10.88	5555555521	43	active
15.10.88	5555555321	41	530005300015
15.10.88	5555555531	44	5430015.....
18.10.88	5555555555	50	?
18.10.88	5555540000	29	?
19.10.88	5555553200	35	?
21.10.88	5555555420	41	?
22.10.88	5555555300	38	?

Table 5. Summarized measurements (mm) and weights (g) of Kentish Plovers, Banc d'Arguin, 6-23 October 1988.

	1st year				>1st year			
	mean	s.d.	range	n	mean	s.d.	range	n
bill	16.1	0.65	15.1-16.8	5	15.8	1.35	14.4-17.5	5
head & bill	43.3	1.04	42.0-44.8	5	42.9	1.14	41.5-44.0	5
wing	114.2	2.9	110-118	5	114.3	0.94	113-115	3
1st secondary	52.2	1.50	51.0-55.0	5	52.4	1.02	51.0-54.0	5
tarsus	29.7	0.77	28.6-30.7	5	29.3	0.60	28.7-30.4	5
tarsus & toe	49.1	0.86	48.0-50.5	5	48.2	0.87	47.5-49.5	5
weight	38.0	4.43	32-44	5	41.2	2.31	37-44	5

Table 6. Measurements (mm), weights (g) and moult of Grey Plovers, Banc d'Arguin, 13-20 October 1988.

date	age	bill	head & bill	wing	first second.	tarsus	tarsus & toe	weight	primary moult score 12345678910	total
18.10.88	1 cy	29.0	67.1	191	79.0	46.9	81.5	141	-	
13.10.88	>1 cy	31.4	69.9	-	-	50.0	88.0	222	5555554100	35
14.10.88	>1 cy	32.0	69.6	200	81.5	49.9	82.5	207	5555555410	40
15.10.88	>1 cy	30.7	66.8	207	87.0	47.1	83.5	228	5555420000	26
20.10.88	>1 cy	31.6	69.8	199	-	50.6	85.0	191	5555541000	30
20.10.88	>1 cy	31.2	69.7	-	82.0	49.1	85.0	212	5555555542	46
mean	>1 cy	31.4	69.2	202	83.5	49.3	84.8	212		
s.d.	>1 cy	0.48	1.32	4.4	3.0	1.36	2.08	14.3		

in the village) was clearly in poor condition and probably a recent arrival (*cf.* Dick 1975).

Moult. Primary moult score of six adult birds (Table 6) fitted into the pattern found in the majority of Grey Plovers in autumn 1973. All four adult birds checked for this showed moulting secondaries. All adult birds were in winter plumage and showed moult of body feathers.

Knot *Calidris canutus* (Table 7)

A total of 60 Knots were captured: two (juv.) at the village of Iouik, 19 (6 juv.) at the Baie d'Aouatif, 29 (9 juv.) at Ebelk Aiznay, and 10 (2 juv.) at Cap Timiris. Studies in autumn 1973 showed that juveniles are more likely to be captured in mist-nets than adults, compared to cannon net catches. Our percentage of juveniles (44%, n=58) may therefore well be higher than in the overall population.

Measurements. Measurements of Knots captured in October 1988 are summarized in Table 7. Mean adult bill length of 35.6 mm was another confirmation that Knots occurring in Mauritania belong to the (long-billed) Siberian breeding population *C. c. canutus* (*cf.* Dick *et al.* 1976). Mean measurements of wing, bill, head & bill, and tarsus & toe were comparable to those in the springs of 1985 and 1986 (Piersma, in Ens *et al.* 1989). Mean wing length of adults with old primaries was 169.0 (n=22), and of adults with new primaries 166.5 (n=8).

Weights. In October 1988 mean time between trapping and weiging was 1 h 30 min in both age groups. In three hours three individuals lost 3, 4 and 5 g respectively (mean 1.3 g/hour). Mean juvenile weights in October 1973 (88.5 g, s.e. 2.5, n=44) were lower than those in October 1988 (101.8 g; t=4.03, df=26, p<0.01). Adults weights were somewhat lower as well (1973: 121.2 g, s.e. 1.2, n=112; 1988: 128.9 g; t=3.22, df=144, p<0.01). Figure 1 shows the frequency distribution of weights of Knots captured in October 1988. Dick (1975) stressed the poor condition of juvenile Knots in autumn 1973, both based on catches and visual observations, and questioned whether the situation in 1973 might be a regular feature. Our (limited) data suggest that juvenile Knots in autumn 1988 had higher weights than in 1973; visual observations in 1988 did not reveal large numbers of juvenile Knots in poor condition, and only ten birds were found dead (of which one was adult).

In October 1988 mean weight of adults in primary moult did not differ from adults which had completed primary moult (in moult: 129.3 g, s.d. 9.29, n=26; after moult: 127.5 g, s.d. 14.69, n=8; t=0.33, df=9, n.s.). There was no clear trend in weight during the catching period.

Moult. Primary moult patterns of Knot fitted into those found in autumn 1973. Our data did not allow a detailed analysis of the "three apparent groups" found in autumn 1973.

Table 7. Summarized measurements (mm) and weights (g) of Knots, Banc d'Arguin, 1-22 October 1988.

	1st year				>1st year			
	mean	s.d.	range	n	mean	s.d.	range	n
bill	34.3	1.92	29.2-39.2	26	35.6	2.42	30.3-41.9	34
head & bill	63.0	1.86	57.3-66.5	26	63.9	2.28	59.6-68.9	34
wing	162.6	4.0	154-170	26	168.3	3.8	161-178	30
wing ad. old prim.					169.0	4.0	161-178	22
wing ad. new prim.					166.5	3.1	163-172	8
1st secondary	70.5	2.22	67.5-76.0	26	72.5	2.49	67.0-77.0	24
tarsus	31.7	1.16	29.1-33.2	26	33.0	1.35	30.4-36.0	34
tarsus & toe	57.3	1.56	53.0-59.5	26	59.3	1.96	56.5-63.5	34
weight	101.8	11.0	85-130	26	128.9	10.4	116-161	34

Total primary moult score showed a clear increase in time:

3-10 Oct.: 35.0, s.d. 10.0, range 13-50, n=14;
11-14 Oct.: 39.0, s.d. 6.3, range 32-50, n=9;
18-21 Oct.: 42.0, s.d. 5.8, range 31-50, n=11.

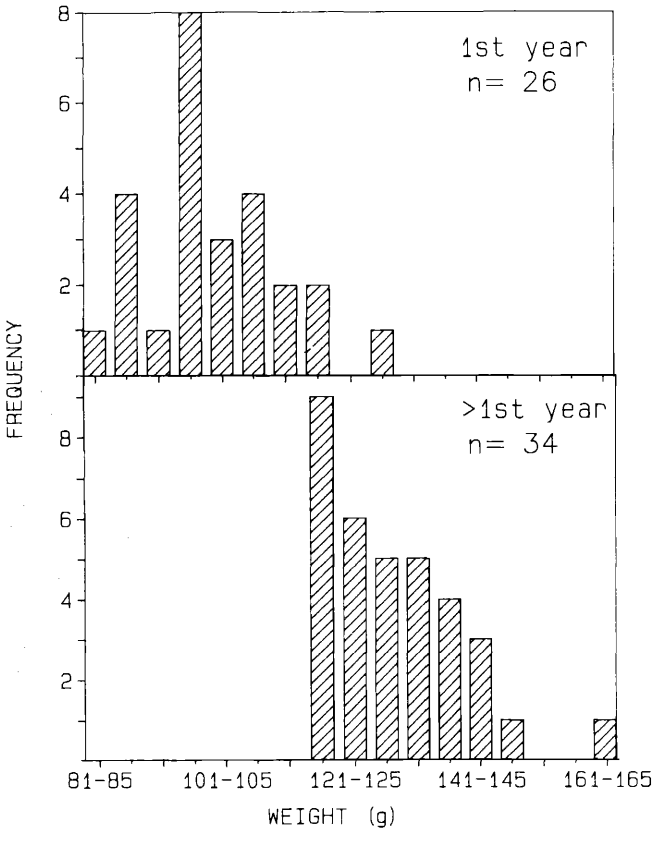

Figure 1. Frequency distribution of weights (g) of Knots captured at the Banc d'Arguin, Mauritania, 1-22 October 1988.

Sanderling *Calidris alba* (Table 8)

A total of 105 Sanderlings (excluding 8 recaptures) were captured: 69 (59 juv.) at the village of Iouik, one adult at the Baie d'Aouatif, 22 (6 juv.) at Ebelk Aiznay, and 13 (1 juv.) at Cap Timiris. The percentage of juveniles in the sample captured with clap-nets in Iouik was 86% (n=69), but with mist-nets at various localities only 19% (n=36) (X^2=44.22, df=1, p<0.005).

Measurements. Measurements of Sanderlings captured in autumn 1988 have been summarized in Table 8. Mean wing length of juveniles in October 1988 (125.0 mm, n=66) was almost the same as in autumn 1973 (124.8 mm, s.e. 0.35, n=32). Mean wing length of adults with old primaries was 124.3 mm (n=18) in 1988, 125.5 mm (s.e. 1.05, n=13) in 1973; of adults with new primaries 124.2 mm (n=8) in 1988, and 126.6 mm (s.e. 0.31, n=65) in 1973.

Mean bill length of juveniles in 1988 was 24.9 mm (n=66), and 25.3 mm (s.e. 0.24, n=30) in 1973. Mean bill lengths of adults in 1973 and 1988 were identical (25.1 mm).

Weights. In October 1988 the mean time between trapping and weighing was 51 mins in juvenile birds and 1 h 17 mins in adult birds. Mean weights of juveniles in October 1973 and 1988 were almost identical: 43.9 g (n=15) and 44.0 g (n=66), respectively. Mean adult weights in 1973 were 45.4 g (s.e. 0.5 n=61), and 47.4 (n=39) in 1988.

In October 1988 mean weight of adults in primary moult was 47.1 g (s.d. 3.77 n=31), and of adults which had completed primary moult 48.6 g (s.d. 2.73, n=8) (t=1.05, df=37, n.s.).

There was no clear trend in weight during the catching period (juveniles r=0.0290, n.s.; adults r=0.167, n.s.). Seven birds were captured twice with intervals between 3 and 19 days: weight changes in five birds varied between -2 g and +3 g. One bird gained 6 g in 7 days. The mean weight increase was 0.13 g/day (n=7).

Mean weight of juveniles captured with clap-nets in the village was 43.8 g (s.d. 4.89, n=59), and with mist-nets at various localities 46.1 g (s.d. 5.46, n=7) (t=1.16, df=64, n.s.). Mean weights of adults in the village was 47.0

Table 8. Summarized measurements (mm) and weights (g) of Sanderlings, Banc d'Arguin, 30 September-21 October 1988.

.	1st year				>1st year			
.	mean	s.d.	range	n	mean	s.d.	range	n
bill	24.9	1.58	22.3-28.5	66	25.1	1.33	23.0-28.2	39
head & bill	49.9	1.87	46.5-53.9	66	49.9	1.73	47.4-53.8	39
wing	125.0	3.0	118-132	66	124.3	2.3	118-129	26
wing ad. old prim.					124.3	1.8	122-129	18
wing ad. new prim.					124.2	3.2	118-128	8
1st secondary	56.7	1.80	53.0-61.5	65	57.0	1.18	54.0-59.0	23
tarsus	25.0	1.01	23.0-26.9	66	25.3	0.91	23.8-27.2	39
tarsus & toe	44.4	1.47	41.0-47.5	66	44.6	1.43	40.5-47.5	39
weight	44.0	5.0	33-55	66	47.4	3.6	41-55	39

g (s.d. 3.79, n=10), and at other localities 47.6 g (s.d. 3.57, n=29) (t=0.45, df=37, n.s.). Juveniles were significantly lighter than adults (t= 4.03, df=37, p<0.01).

Moult. Of 39 adults captured in October 1988, 31 (79%) were actively moulting primaries (total scores between 22 and 49); eight (21%) had completed primary moult (score 50). There was no clear trend in primary moult scores during the catching period: mean score in both the first and second 10-day period of October was 40.5. Moult scores noted in October 1988 fitted within the pattern found in autumn 1973.

All birds captured were in full winter plumage. Moult of body feathers was noted in 94% of juveniles (n=66) and in 95% of adults (n=39).

Little Stint *Calidris minuta* (Tables 9 and 10)

We captured 12 Little Stints (67% juv.): two (juv.) at Iouik village, nine (5 juv.) at the Baie d'Aouatif, and one (juv.) ad Ebelk Aiznay.

Measurements. Sample size was too small to make a reasonable comparison with measurements presented by Dick (1975). A juvenile with a (long!) wing of 111 mm also had the largest bill, total head and first secondary, but an average tarsus.

Weights. Mean time between trapping and weighing was 2 h 40 mins. Mean juvenile weight (21.0 g) was only slightly less than mean adult weight (21.5 g). The lightest adult was 21 g, while among the juveniles, weights of 18, 19 and 20 g were recorded.

Moult. All five adults captured showed moult of primaries, scores varying between 4 and 41 (Table 10). Fourteen adults captured in October and November 1973 had scores between 29 and 49. All birds captured had moulting body feathers. Three of the five adults still had some summer plumage feathers.

Curlew Sandpiper *Calidris ferruginea* (Table 11)

A total of 36 Curlew Sandpipers were captured (50% juv.): six (juv.) at Iouik village, eight (5 juv.) at Baye d'Aouatif, 12 (5 juv.) at Ebelk Aiznay and ten (2 juv.) at Cap Timiris. Percentage of juveniles captured with clap nets in the village was 100% (n=6) and with mist nets at various localities was 40% (n=30) (X^2 = 7.20, p<0.001).

Measurements. Measurements of Curlew Sandpipers captured in autumn 1988 have been summarized in Table 11. Since no mean bill and wing lengths of the 767 birds captured in autumn 1973 have been published, a comparison is impossible. Bimodality in bill lengths, found in both age groups in autumn 1973, which can be explained by the sexual dimorphism (Cramp & Simmons 1983) was less clear in the (small) 1988 sample which indicated a predominance of males (Figure 2).

Weights. In October 1988 the mean time between trapping and weighing was 1 h 30 mins in juvenile and 2 hours in adult birds. The weight (37 g) of an adult bird missing a leg and which was clearly in poor condition has been excluded from the analyses. Mean weights of both age groups were very similar to those found in October 1973. There was no clear trend in weights during the catching period. Mean weights of juveniles captured in the village (47.2 g, s.d. 2.73, n=6) did not differ

Table 9. Summarized measurements (mm) and weights (g) of Little Stints, Banc d'Arguin, 2-21 October 1988.

.	1st year				>1st year			
.	mean	s.d.	range	n	mean	s.d.	range	n
bill	18.6	0.59	17.8-19.9	8	17.9	0.38	17.5-18.3	4
head & bill	39.2	0.90	38.3-40.6	7	38.4	0.48	37.6-38.9	4
wing	101.0	4.5	95-111	7				
wing ad. old prim.					95.5	1.6	93-97	4
1st secondary	49.4	4.41	46.0-59.0	6	45.5	0.41	45.0-46.0	3
tarsus	22.0	0.61	21.3-23.1	7	22.0	0.38	21.5-22.3	3
tarsus & toe	40.0	0.60	39.0-41.0	7	39.5	0.61	39.0-40.5	4
weight	21.0	2.6	18-26	6	21.5	0.9	21-23	4

Table 10. Primary moult scores of Little Stints captured at the Banc d'Arguin, 3-21 October 1988.

date	primaries 1-10	total score	secondaries
03.10.88	5554310000	23	old
04.10.88	1111000000	4	old
07.10.88	5555555200	37	active
18.10.88	5555555420	41	?
21.10.88	5555553100	34	?

Table 11. Summarized measurements (mm) and weights (g) of Curlew Sandpipers, Banc d'Arguin, 4-22 October 1988.

	1st year				>1st year			
	mean	s.d.	range	n	mean	s.d.	range	n
bill	38.0	2.32	33.1-42.7	18	37.8	3.01	32.9-44.3	18
head & bill	61.7	2.62	57.2-67.0	18	61.3	3.41	55.2-68.6	18
wing	130.9	2.4	127-135	18				
wing ad. old prim.					132.1	3.4	126-140	12
1st secondary	58.8	1.74	56.0-62.0	18	59.5	2.00	55.0-62.5	15
tarsus	31.1	1.35	29.0-34.4	18	31.1	1.73	25.6-34.1	18
tarsus & toe	54.3	1.98	51.5-59.5	18	54.2	2.18	48.5-57.5	18
weight	47.8	7.3	32-68	18	53.8	4.9	47-62	17

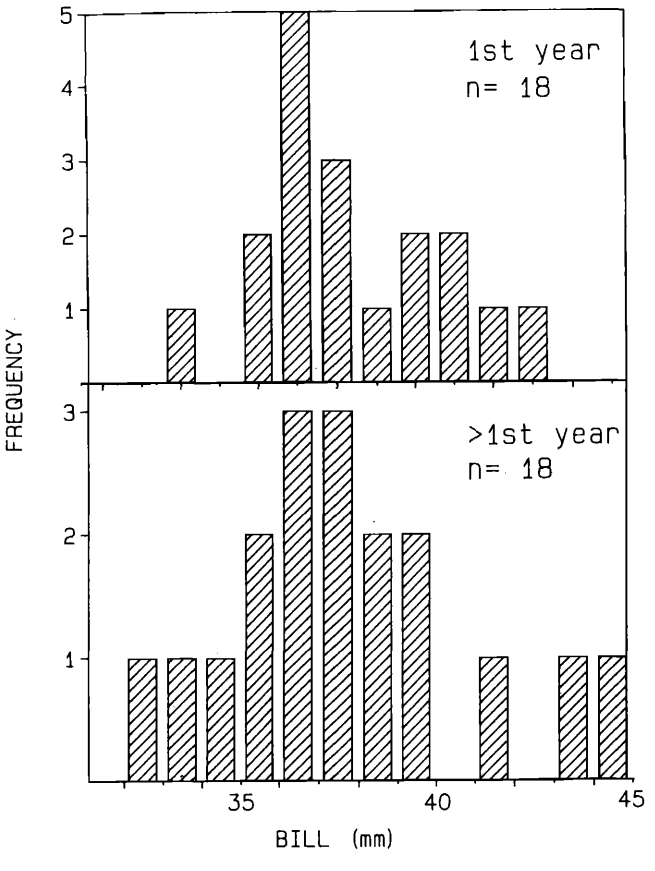

Figure 2. Frequency distribution of bill lengths (mm) of Curlew Sandpipers captured at the Banc d'Arguin, Mauritania, 4-22 October 1988.

significantly from those captured with mist nets at other localities (48.2 g, s.d. 8.75, n=12).

Moult. Primary moult scores of adults generally fitted into the pattern found in autumn 1973. One bird (on 12 Oct.) had suspended moult after moulting the first primary: secondaries 1 and 5-8 were new, the others old. One bird in poor condition and missing a leg (20 Oct.) had not yet started moult of remiges. Moult scores of the remaining birds varied between 15 and 47.

There was a clear tendency that shorter-billed

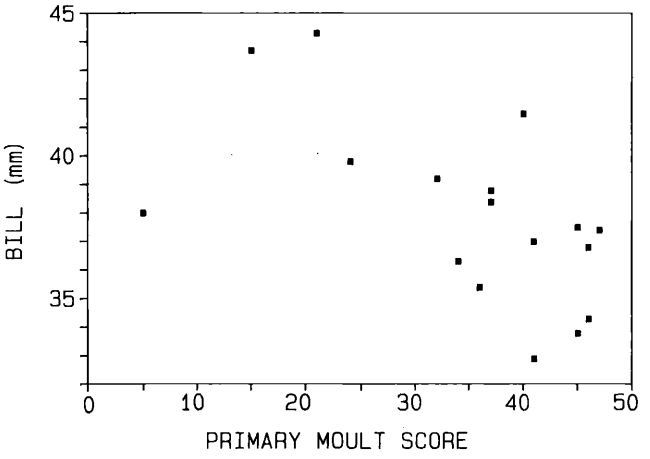

Figure 3. Relation between primary moult score and bill length in Curlew Sandpipers captured at the Banc d'Arguin, Mauritania, 4-22 October 1988.

birds had progressed primary moult further than longer-billed birds (Figure 3), suggesting that males start moult before females. Dick (1975) calculated a mean starting date for males in mid-July, and for females about three weeks later. This difference in onset of moult is consistent with observations on the breeding grounds that females depart first, in mid-July (Portenko 1959).

Moulting body feathers were noted in 39 % of the juveniles (n=18) and in all adult birds (n=18). All adult birds were in winter plumage.

Dunlin *Calidris alpina* (Table 11)

A total of 300 Dunlins were captured (excluding 14 retraps): 14 (14 juv.) at the village of Iouik, 201 (127 juv.) at the Baie d'Aouatif, 67 (42 juv.) at Ebelk Aiznay, and 18 (10 juv.) at Cape Timiris. The percentage juveniles in the sample captured with clap-nets in the village was 100% (n = 14) and in the sample captured with mist-nets at various localities 62.3% (n = 284) (X^2 = 8.23, $p < 0.001$). In the same period in 1973 this percentage was 71.6%. According to Kersten (in Ens *et al.* 1989) in Mauritania birds with bill ≤ 30.5 mm are males and birds with bill ≥ 31.5 mm are females (see also Pienkowski & Dick 1975) and almost all belong to the race *C. a. schinzii*. Of the 193 juvenile birds 183 could be sexed in this way:

Table 12. Summarized measurements (mm) and weights (g) of Dunlins, Banc d'Arguin, 29 September-23 October 1988.

	1st year				>1st year			
	mean	s.d.	range	n	mean	s.d.	range	n
sexes combined:								
bill	30.3	2.48	26.1-37.0	193	31.1	2.49	25.5-37.9	107
head & bill	53.0	2.68	47.9-61.4	193	53.6	2.76	47.2-60.9	107
wing	115.0	2.99	107-122	192	115.0	3.83	107-127	69
wing ad. old prim.					113.5	3.29	108-122	22
wing ad. new prim.					116.0	3.81	107-127	47
1st secondary	54.6	1.66	50.5-59.0	192	54.7	1.61	51.0-59.0	90
tarsus	24.6	1.02	21.8-27.5	193	24.8	1.08	20.4-27.2	107
tarsus & toe	46.8	1.82	40.0-52.5	193	46.9	1.93	40.5-51.5	107
weight	36.0	4.33	21-49	193	42.0	4.17	32-52	107
males: bill <30.5 mm:								
bill	28.5	1.05	26.1-30.5	115	28.8	1.25	25.5-30.5	46
head & bill	51.1	1.23	47.9-54.5	115	51.1	1.39	47.2-53.8	46
wing	114.0	2.25	107-119	114	113.0	2.43	107-117	33
wing ad. old prim.					112.3	2.30	109-116	13
wing ad. new prim.					113.7	2.35	107-117	18
1st secondary	54.0	1.52	50.5-59.0	115	53.8	1.02	51.0-55.5	37
tarsus	24.1	0.84	21.8-26.0	115	24.3	0.86	21.2-26.6	46
tarsus & toe	46.0	1.46	40.0-49.5	115	45.8	1.80	40.5-51.5	46
weight	33.9	2.99	24-43	115	39.1	3.09	32-46	46
females: bill >31.5 mm:								
bill	33.3	1.16	31.5-37.0	68	33.3	1.40	31.5-37.9	48
head & bill	56.1	1.44	53.6-61.4	68	56.0	1.69	52.1-66.9	48
wing	117.0	2.84	107-122	68	117.0	3.60	110-127	28
wing ad. old prim.					116.5	3.20	114-123	6
wing ad. new prim.					118.6	3.26	113-127	20
1st secondary	55.6	1.40	52.5-59.0	67	55.5	1.55	52.5-59.0	42
tarsus	25.5	0.73	23.7-27.5	68	25.3	1.08	20.4-27.2	48
tarsus & toe	48.1	1.70	42.0-52.5	68	48.0	1.52	43.0-50.5	48
weight	39.3	4.19	21-49	68	44.8	3.16	37-52	48

115 males (63%) and 68 females (37%). In the springs of 1985 and 1986 the ratio was 66 : 34 (Kersten in Ens *et al.* 1989), and there was a similar ratio in autumn 1973. Of the 107 adult birds 94 could be sexed: 46 males (49%) and 48 females (51%). In the springs of 1985 and 1986 this ratio was strikingly different: 69:31 (Kersten in Ens *et al.* 1989) (X^2 = 8.268, $p<0.005$).

Measurements. Measurements of Dunlins captured in October 1988 are summarized in Table 12. The mean wing length of juveniles was smaller than in 1973, 115.0 mm (s.d. 2.9) respectively 117.3 mm ($t=9.36$, $df=1597$, $p<0.001$). Wing length of adult birds that had completed moult was 116.0 mm (s.d. 3.8, n=47). Birds still moulting had an average wing length of 113.0 mm (s.d. 3.2, n=22). Following the criteria given by Kersten (in Ens *et al.* 1989) juvenile male and female birds had a wing length of 114.0 mm (s.d. 2.2) and 117.0 mm (s.d. 2.8) respectively and adult male and female of 113.0 (s.d. 2.4) and 117.0 mm (s.d. 3.6) respectively. The mean bill length of juvenile birds was 30.3 mm (s.d. 2.4), of adults 31.1 mm (s.d. 2.4). When separating the sexes according to bill length, juvenile males and females had a mean bill length of 28.8 mm and 33.3 mm respectively, and adult males and females of 28.8 mmand 33.3 mm respectively. Figure 4 shows the frequency distribution of bill lengths.

Most measurements are highly positively correlated so that the length of head & bill, 1st secondary, tarsus, tarsus & toe are also larger in females than in males. The measurements of wing, head & bill, and tarsus & toe for both ages and sexes were very similar to those found in the springs of 1985 and 1986 (Kersten in Ens *et al.* 1989).

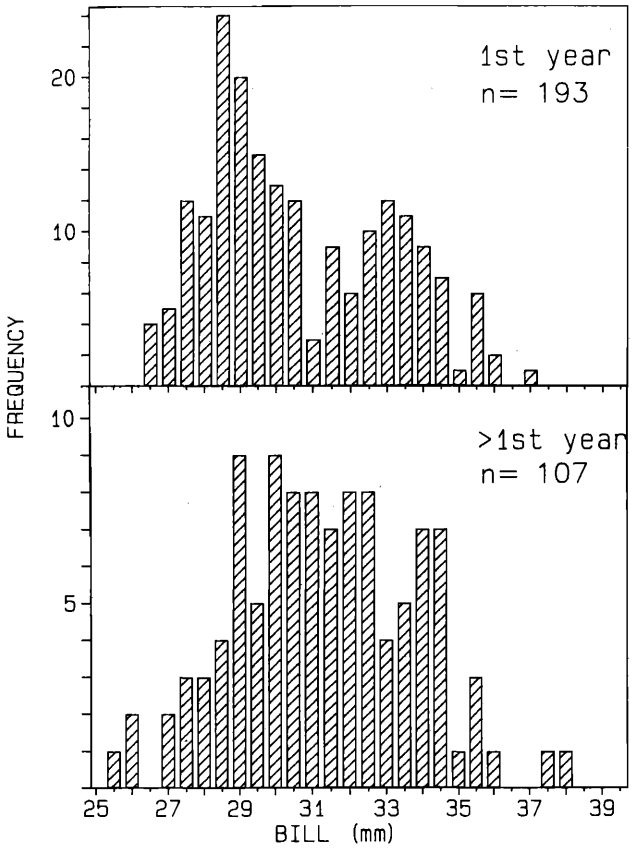

Figure 4. Frequency distribution of bill lengths (mm) of Dunlins captured at the Banc d'Arguin, Mauritania, 29 September-23 October 1988.

Weights. The mean time between trapping and weighing was 2 h 7 mins in adult birds and 1 h 51 mins in juveniles. Four birds lost 2, 2, 1, and 0 g in a three hour period: mean 0.4 g/hour. The mean weight of adults was almost the same as in October 1973; 42.0 g compared to 41.3 g. The juvenile birds captured in October 1988 were 2.4 g lighter on average than in 1973: 36.0 g versus 38.4 g ($t=6.50$, $df=194$, $p<0.01$). The lightest juvenile had a weight of 21 g. This birds was completely exhausted and was captured by hand.

There was no trend in the weights of adults captured during October ($b= -0.006$, $r=0.0000$, $n=107$), while the mean weight of juveniles showed a decrease ($b= -0.164$, $r=0.2688$, $n=193$, $p < 0.001$). The weight of 11 juvenile birds that were retrapped showed a decrease (average 0.5 g/day, weight corrected for weight loss after capture). The single adult captured twice gained 1 g in four days. This decrease in weight amongst the juveniles was also found in 1973, as well as the drop in weight of juveniles during October. The birds that had completed moult of primaries had a mean weight of 43.1 g (s.d. 4.16, n=60) and birds still moulting primaries of 41.2 g (s.d. 3.95, n= 47) ($t=2.39$, $df=105$, $p<0.02$). The juvenile males were the lightest birds (33.9 g), the adult females the heaviest (44.8 g).

Moult. Of the adult birds 56% (n = 107) were actively moulting primaries (total scores between 10 and 49) and 44% had already completed moult. The presumed females had a higher average moult score (46.4) than the presumed males (43.8). Birds with completed moult had a larger bill and total head than birds still moulting, suggesting that females complete moult before males. This seems logical since females also start moult earlier (Greenwood 1983). The primary moult score increased from 44.7 during the first ten days of October to 47.3 during the last days of our stay.

Most birds showed (generally light) body moult (juveniles 75%, adults 96%). On 2 October an adult bird was captured that was still half in summer plumage. This bird also had the lowest primary moult score recorded (10). Over half of the birds (59%) were already in full winter plumage, 36% still showed a trace of summer plumage and 3% had a quarter of summer plumage. One of these 3 birds (captured on 19 October) showed suspended moult in the primaries (5555000000).

Bar-Tailed godwit Limosa lapponica (Table 13)

Fifteen Bar-tailed Godwits were trapped: three juveniles with clap-nets in the village of Iouik, three juveniles at the Baie d'Aouatif and nine (1 ad.) at Ebelk Aiznay (Table 13).

Measurements. If birds with a bill of <89 mm are considered to be males, and birds with a bill ≥89 mm females (*cf.* Piersma in Ens *et al.* 1989) we caught 10 males and five females. A comparable predominance of males was also noted in previous studies (Dick 1975, Piersma, in Ens *et al.* 1989).

Weights. Mean time between trapping and weighing was 2 h 22 mins. Compared to juvenile males in the springs of 1985 and 1986 (mean 204

Table 13. Summarized measurements (mm) and weights (g) of Bar-tailed Godwits, Banc d'Arguin, 3-23 October 1988. Males are birds with bill <89 mm, females with bill ≥89 mm.

.	1st year males				1st year females				>1st y male
.	mean	s.d.	range	n	mean	s.d.	range	n	(19 Oct. 1988)
bill	75.6	4.16	71.2-82.0	9	95.2	3.88	90.6-99.1	5	81.7
head & bill	111.0	5.55	104.4-119.1	9	132.1	5.39	128.8-138.3	5	116.7
wing	203.7	4.7	197-212	9	214.0	6.0	204-215	5	217
1st secondary	88.5	2.31	86.0-93.0	9	94.7	2.59	92.5-99.0	5	90.5
tarsus	50.4	1.84	46.8-53.4	9	56.7	0.99	55.2-57.8	5	53.6
tarsus & toe	85.4	3.1	80.0-89.0	9	95.2	2.8	91.0-98.5	5	89.0
weight	174.2	15.7	151-210	9	227.2	17.1	206-245	5	233

g, s.d. 22.8, n=23; Piersma in Ens *et al.* 1989) and in autumn 1973 (mean 211 g, n=46; Dick 1975) juveniles males captured in autumn 1988 weighed on average 30-35 g less. Several juvenile birds captured in mist-nets were feeding on eelgrass *Zostera* wreck, and visibly in poor condition. Our sample is no doubt not representative for the population present.

Moult. The single adult captured was in active primary moult (primary scores 4332100000). Compared to birds captured in autumn 1973 it was slightly behind schedule, although the weight was normal. The adult and two out of nine juveniles showed moulting body feathers.

Whimbrel *Numenius phaeopus* (Table 14)

We captured four Whimbrels: one by hand at Iouik and three with mist nets at Ebelk Aiznay (Table 14).

Redshank *Tringa totanus* (Table 15)

We captured ten Redshanks (30% juveniles): two at the Baie d'Aouatif and seven at Ebelk Aiznay with mist-nets, and one by hand at Iouik (an adult in very poor condition).

Measurements. Mean bill and wing lengths of both ages were comparable with those found in autumn 1973, and matched those of breeders in Western Europe (Dick 1975).

Weights. Mean time between trapping and weighing was 2 hours and 20 mins. Weights in October 1973 and in October 1988 were comparable.

Moult. Six out of seven adult Redshanks captured during October had advanced primary moult scores of 42-50, fitting into the patterns found in October 1973. The single adult captured on 5 October, which had not yet commenced moult of remiges, was in very poor condition. Only one out of 171 adults captured in autumn 1973 had not commenced primary moult; this individual was recovered in Senegal in February 1974 (Dick 1975). All birds captured showed moult of body feathers.

Greenshank *Tringa nebularia* (Table 16)

Details of biometrics and weight of the single Greenshank captured (at Cap Timiris) are given in Table 16. Details on a juvenile found dead at Iouik (as a prey remain of a raptor) have also been included.

Common Sandpiper *Actitis hypoleucos* (Table 17)

A single Common Sandpiper was captured at Iouik (Table 17).

Table 14. Measurements (mm), weights (g) and moult of Whimbrels, Banc d'Arguin, 11-22 October 1988.

date	age	bill	head & bill	wing	first second.	tarsus	tarsus & toe	weight	primary moult score 12345678910	total
11.10.88	1 cy	59.3	95.9	237	110.0	56.3	96.5	(176)	-	
21.10.88	1 cy	79.2	116.7	243	113.0	57.1	98.0	375	-	
21.10.88	>1 cy	81.9	122.2	-	118.0	61.5	105.5	423	5555555431	43
22.10.88	>1 cy	86.4	123.7	268	120.0	61.4	104.0	447	5555554210	37

Table 15. Measurements (mm), weights (g) and moult of Redshanks, Banc d'Arguin, 5-23 October 1988.

date	age	bill	head & bill	wing	first second.	tarsus	tarsus & toe	weight	primary moult score 12345678910	total
06.10.88	1 cy	41.6	73.0	159	82.0	50.7	85.0	118	-	
19.10.88	1 cy	45.7	76.8	155	80.0	51.9	88.0	108	-	
20.10.88	1 cy	46.9	78.0	163	83.5	50.2	86.5	116	-	
05.10.88	>1 cy	42.7	73.4	160	82.0	51.0	85.0	74	0000000000	0
06.10.88	>1 cy	40.9	72.1	-	86.0	50.1	82.5	112	5555555541	45
07.10.88	>1 cy	47.2	78.3	-	83.0	52.2	89.5	121	5555555554	49
19.10.88	>1 cy	41.2	72.4	155	77.5	47.8	82.0	92	5555555555	50
19.10.88	>1 cy	41.5	72.8	152	78.0	46.6	82.0	98	5555555555	50
19.10.88	>1 cy	43.1	73.4	-	82.0	45.9	79.5	102	5555555421	42
21.10.88	>1 cy	47.2	77.8	167	86.0	50.6	85.5	127	5555555555	50
mean	1 cy	44.7	75.9	159	81.8	50.9	86.5	114		
s.d.	1 cy	2.78	2.61	4.0	1.76	0.87	1.5	5.3		
mean	>1 cy	43.4	74.3	158.5	82.1	49.2	83.7	109*		
s.d.	>1 cy	2.71	2.60	6.6	3.40	2.40	3.25	13.7		

* excluding bird captured by hand

Table 16. Measurements (mm), weights (g) and moult of Greenshanks captured or found at the Banc d'Arguin, 2-13 October 1988.

date	age	bill	head & bill	wing	first second.	tarsus	tarsus & toe	weight	primary moult score 12345678910	total
02.10.88	1 cy	53.3	90.0	186	-	57.8	98.0	(92)	-	
13.10.88	>1 cy	59.0	95.6	198	94.0	56.9	101.0	206	5555555410	40

Table 17. Measurements (mm) and weight (g) of Common Sandpiper, Iouik, Banc d'Arguin, 29 September 1988.

date	age	bill	head & bill	wing	first second.	tarsus	tarsus & toe	weight	primary moult score 12345678910	total
29.09.88	1 cy	23.6	49.1	111	-	24.2	48.0	30	-	

Table 18. Summarized measurements (mm) and weights (g) of Turnstones, Banc d'Arguin, 30 September-22 October 1988.

	1st year				>1st year			
	mean	s.d.	range	n	mean	s.d.	range	n
bill	23.7	0.94	21.7-25.5	161	23.5	0.99	21.6-25.7	51
head & bill	51.6	1.18	48.6-55.1	161	51.5	1.20	49.2-54.2	51
wing	154.5	3.65	144-163	161	155.0	4.46	145-163	51
wing ad. old prim.					155.0	4.19	149-163	27
wing ad. new prim.					158	-	-	1
1st secondary	69.5	2.03	64.0-75.0	160	70.3	1.9	66.5-74.0	38
tarsus	26.9	0.88	24.9-28.9	161	26.7	0.9	24.9-28.5	51
tarsus & toe	53.5	1.53	49.0-58.0	160	53.4	1.5	50.0-57.0	50
weight	99.1	9.52	72-125	160	99.5	7.4	85-119	50

Turnstone *Arenaria interpres* (Table 18)

A total of 212 Turnstones were captured, of which 181 (151 juv.) with clap-nets in the village of Iouik, two (1 juv.) with mist-nets at Ebelk Aiznay and 29 (9 juv.) at Cape Timiris. The percentage of juveniles captured with clap-nets (83%) differed significantly from those captured with mist-nets (32%) (X^2 = 37.92, $p<0.001$). The proportion of juveniles captured with mist-nets was similar to that in October 1973: 29%.

Measurements. Table 18 shows the measurements of the Turnstones captured. Bill, total head, wing, tarsus, and tarsus & toe of juvenile and adult birds are similar. Only the length of the first secondary of juvenile birds was somewhat smaller ($t=2.21$, $df=196$, $p<0.05$). Weight was best correlated with total head length ($r = 0.4021$, $p<0.001$).

Weights. Mean time between trapping and weighing was 58 mins in juvenile birds and 57 mins in adult birds. In four hours three birds lost 2, 2, and 4 g respectively (mean 0.7 g/hour). The mean weights of adult and juvenile birds did not differ significantly ($t=0.31$, $df=51$, n.s.), either for birds captured with mist-nets and with clap-nets. Weights recorded in October 1988 were about the same as in October 1973: 102.9 and 100.8 g respectively, but somewhat higher than in spring 1985-86 (Ens in Ens *et al.* 1989). Hence the birds might lose some weight during winter, although Dick (1975) found a slight increase in weights in autumn 1973. Three juvenile birds retrapped showed weight changes of - 9 g in 16 days, - 1 g in 5 days and + 9 g in 20 days. The latter bird was possibly accumulating fat reserves for onward migration. During the catching period neither juveniles or adults showed a change in mean weight ($r = 0.11$, n.s.; $r = 0.00$, n.s.). Birds that had almost completed primary moult (score >47) were about 6 g heavier than birds in earlier in moult stages (104.8 g, s.d. 3.9, n=8, respectively 98.5 g, s.d. 7.5, n=42; $t=3.50$, $df=9$, $p<0.01$). There was no significant difference between the mean weight of adults captured in the village (100.4 g, s.d. 7.21, n=29) and those with mist-nets on the mudflats (98.2, s.d. 7.35, n=21) ($t=1.06$, $df=48$, n.s.). Figure 5 shows the frequency distribution of weights of Turnstones.

Moult. Only two adults had completed moult. Primary moult score increased from 37.2 during

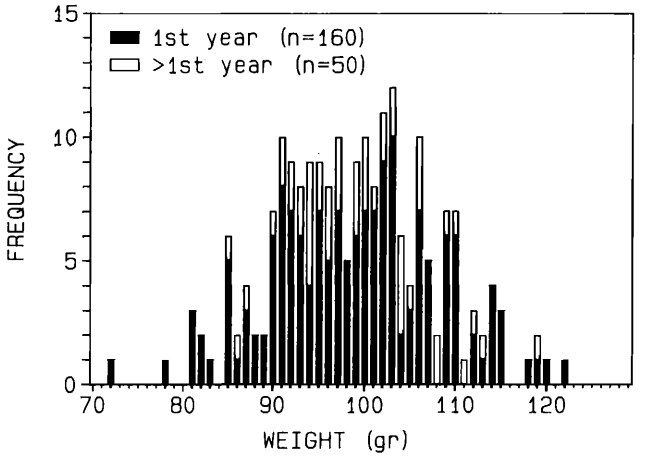

Figure 5. Frequency distribution of weights (g) of Turnstones captured at the Banc d'Arguin, Mauritania, 30 September-22 October 1988.

the first ten-day period of October to 40.7 in mid-October and 47.0 in late October, fitting well into the pattern found in 1973. Most adult birds (82%) showed light body moult, the remaining 18% moderate body moult. Of the juveniles only 65% showed light, 27% moderate and 5% heavy body moult; 3% had no visibly moulting body feathers. In the first ten days of October 41% of the adult birds were in full winter plumage. This increased to 74% in mid October and 100% in late October.

Controls. Ten Turnstones already carrying rings were captured: five had been ringed locally and five were ringed as first year birds earlier in autumn 1988 in the Baltic region (Table 1).

DISCUSSION

During the project in autumn 1973 the only measurements taken of the birds captured were wing length and bill length. In this study we present some additional measurements of various wader species. These additional measurements may prove to be a useful reference for future studies, for example in the analysis of the geographical origin of birds visiting the Banc d'Arguin, and to reveal patterns of sexual segregation in winter-quarters (*e.g.* in Dunlins).

Although the measurements of bill and total head, tarsus and tarsus & toe, first secondary and wing length are highly correlated in waders, taking "pairs" of these measurements proved to be useful during the processing of data. Inevitably mistakes were made during measuring, writing down the data in the field, and processing the material by computer. By plotting various "pairs" of measurements (*e.g.* tarsus *versus* tarsus & toe) we were able to audit our data since errors became clear. For example a Dunlin with bill 24.6 mm and total head 61.1 mm: should have had a total head of 51.1 mm). Without this check several errors in the data-set would have gone unnoticed.

In Dunlin, Sanderling and Turnstone clap-netting in the village of Iouik resulted in a higher proportion of juveniles than in mist-net catches. The high percentage of juvenile waders captured in the village may have been caused by a difference in behaviour between adults and juveniles, the latter being less wary and less experienced and consequently easier to capture with a clap-net.

The weights of the juvenile birds in the village did not differ significantly from those captured elsewhere with mist-nets. The number of juvenile Dunlins present in the village was small, and for this species the village and adjacent beach was a marginal feeding site. Sanderlings apparently successfully combined their stay on the beach adjacent to the village with additional feeding in the village.

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BIAS IN THE COLLECTION OF MUSSEL SHELLS OPENED BY OYSTERCATCHERS

J.Speakman

The foods which are eaten by wading birds are of interest for a variety of different reasons - from studies of community structure, niche separation, resource depletion and carrying capacity, to individual food requirements, energy balance and survival. Only a limited amount of information on the prey selected can be obtained by direct observation of feeding birds. When more detailed information is required such observations must be supplemented, or replaced, by other methods. For some waders which feed on relatively large bivalve molluscs one potential technique is to recover the shells which remain at the site of each prey capture. This recovery technique has been used previously by many studies to infer diet choice of the Oystercatcher (*Haematopus ostralegus*) when feeding on cockles (*Cerastoderma edule*) and on mussels (*Mytilus edulis*) (Drinnan 1957, Sutherland 1982, Speakman 1984, Zwarts and Drent 1981).

Cayford has recently highlighted a potential bias which may occur with the recovery technique. This is that human searchers for shells may collect larger shells more reliably than small shells because they are more visible. Cayford (1988) assessed the extent of this bias by getting an assistant to distribute opened shells on a mussel bed and then searching for them. He found that for shells lying on the mud there was indeed a bias in collection towards larger shells. The extent of bias detected by Cayford (1988) however does not necessarily reflect the bias involved in recovering shells during studies of prey selection. Firstly, in Cayford's experiment shells were distributed at a very high density (300 in an area measuring 7m by 7m, *i.e.* over 6 per square metre) which greatly exceeds the density of shells opened and discarded by foraging Oystercatchers. Secondly the collector has *a priori* knowledge of the numbers of shells in each size class and this may have influenced the searching behaviour. Finally Cayford spent a very long time (almost two hours) searching the small area for shells, "..until trampling of the mud made further searching unprofitable.", which far exceeds the time spent searching for shells over larger areas in previous studies.

In my previous study of the diet choice of the Oystercatcher (Speakman 1984), which was based upon the recovery of opened and discarded mussel shells, I performed a similar experiment to assess collector bias. The design of my experiment overcomes the above criticisms of Cayford's procedures. Firstly, marked mussels were distributed over a mussel bed measuring 20m by 20m, at a density of less than 0.4 per square metre. Variable numbers of each size class, between 12 and 20 per class, which were unknown to the collector prior to searching were used. Finally the area was searched for 20 minutes, which was the same time spent searching similar sized plots during the diet choice study.

The results of this experiment are illustrated in Figure 1. I discovered a bias in the collection towards larger mussels which was also subsequently found by Cayford (1988). However in my study mussels in the largest classes (51 to 60 mm) were approximately 3.8

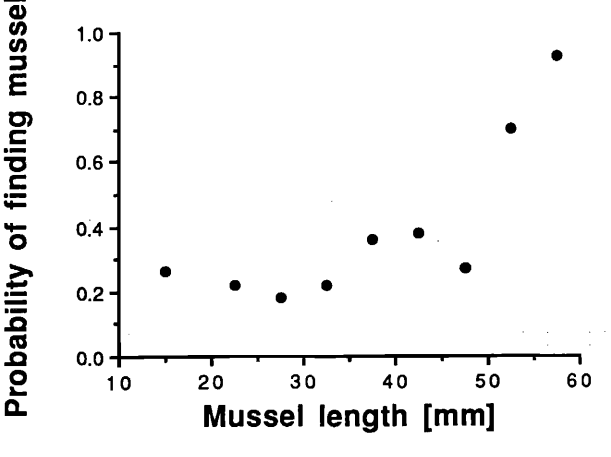

Figure 1. The probability of a collector recovering an opened mussel from the surface of a mussel bed, during a time limited search, plotted against mussel length.