WADER MIGRATION ALONG THE ATLANTIC COAST OF MOROCCO, MARCH 1981

Report of the Netherlands Morocco Expedition 1981

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1 INTRODUCTION

In recent years considerable research efforts have been made to determine the importance for waders of the intertidal areas along the European coastline (see summaries in e.g. Prater 1981, Smit & Wolff 1980). For a part, this interest is due to the (proposed) rapid development, e.g. reclamation and industrialization, of these areas which poses a serious threat to the survival of several species of coastal waders. Information on the importance of intertidal areas along the coast of West Africa is difficult to obtain and therefore still scanty. Since ringing recoveries clearly show that many North European waders winter in West Africa, information on these areas is of obvious importance for a proper management and conservation of the wader populations concerned.

Large numbers of waders occur along the Atlantic coast of Morocco in autumn (Pienkowski 1972 & 1975). About one hundred thousand waders, sometimes many more (Blondel & Blondel 1964), stay in Morocco during the winter. The largest concentrations are always found in Merja Zerga (Zwarts 1972, Kersten & Peerenboom 1978). Almost nothing, however, is known about the numbers of waders which make use of the intertidal areas along the Atlantic coast of Morocco during spring migration.

At least three million coastal waders spend the northern winter in areas south of the Sahara; about two million of them on the Banc d'Arguin in Mauritania (Engelmoer 1982) and another million around the Archipel des Bijagos in Guinnée-Bissau (Fournier & Dick 1981, Zwarts in prep.). By the end of the winter the total biomass of benthic invertebrates on the Banc d'Arguin, which form the major food source for waders, is very low compared to the biomass in more temperate regions (Piersma 1982). In view of the relatively small food source and the long distance to travel to Northwestern Europe, the question becomes apparent which strategy these birds use on their northbound migration. One might suggest that these waders have to interrupt their journey for some time along the way, e.g. in Morocco, to feed and to store fat before they are able to continue their flight to the next stopover areas in Northwestern Europe and to the subarctic and arctic breeding grounds. This might mean that the intertidal areas along the Atlantic coast of Morocco form an indispensable refuelling station for waders wintering further south.

Former expeditions to Morocco (Pienkowski 1972 & 1975, Moser 1981) had shown that the small estuarine and salt-pan area near Sidi Moussa

offered excellent opportunities to catch waders with mist-nets. Due to its relatively small size, it is possible to count all the waders in this area in a short time. This would allow the ringing and marking of reasonable numbers of waders, to do regular counts and thus to measure migration rates of waders through the area. Extrapolation of the results for this small area, would enable us to consider the importance of the whole Atlantic coast of Morocco for waders during spring migration.

Only very limited qualitative information on the macrobenthic invertebrates (the main prey of waders) of the intertidal areas in Morocco was available (Joyes 1975). To get an idea of the quality of the refuelling station, the biomass and species composition of macrobenthos was assessed of sites where the foraging behaviour of waders was also studied.

These, along with the very personal desire to extend our knowledge of southern countries and waders, were the reasons for organizing the Netherlands Morocco Expedition 1981. In this report we have tried to present most of the results in a clear, but sometimes summary and preliminary, way. Thus, we have not tried to put all our work into perspective, and so this report cannot be compared with the comprehensive report of the Netherlands Ornithological Mauritanian Expedition 1980 (Altenburg et al. 1982). We plan to publish the detailed and interpreted results, in conjunction with the results of the follow-up of this expedition (the Netherlands Wader Expedition to Morocco 1982, which worked at Sidi Moussa in April 1982) in ornithological and biological journals. Meanwhile a short general paper (Kersten et al. 1981) has been published and a review-paper on wintering and migrating waders in Morocco (Kersten & Smit 1983) has been produced.

The text of this report is written in a language somewhat similar to English, but summaries are given in Dutch, French and Arabic only. Those English-speaking persons who dislike reading the whole text and who are nevertheless interested in the results, are therefore invited to try a foreign language as well.

Last but not least, we are very happy to acknowledge the discovery of an hitherto undescribed isopod-(invertebrate) species by taxonomists at the Zoological Museum in Amsterdam in the material collected at Sidi Moussa by the expedition. Details of this rare animal, called Monodanthura maroccana, are given in Appendix 5.

2 ACKNOWLEDGEMENTS AND FINANCIAL ACCOUNT

2.1 Acknowledgements

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Finally, we are very grateful to the Research Institute for Nature Management that this report could be published in the institute's report series.

2.2 Financial account

	Income Dfl	Expenditure Dfl
1. Personal contribution (4x750,-)	3000,-	
2. Beijerinck Popping Fonds	2000,-	
3. Prins Bernhard Fonds	4500,-	
4. British Ecological Society	2071,92	
5. British Ornithologists' Union	751,63	
6. Vehicle hire		3249,99
7. Insurance		494,70
8. Petrol		2435,80
9. Ferries and tolls		363,45
10. Food and overnight accomodation during journey		1319,65
11. Food		3054,60
12. Material		280,45
13. Administration etc.		630,05
14. Preparation of report (estimated)		494,86
Totals	12 323,55	12 323,55

Along the Atlantic coast of Morocco a series of wetlands exist. An (incomplete but illustrative) overview of these wetlands can be found in Figure 3.1. Morgan & Boy (1982) developed an ecological classification system for the wetlands in north west Africa while Morgan (1982) gives short site descriptions of most of the wetlands in Morocco. Our fieldwork was confined to two sites: 1) the estuary of Sidi Moussa and 2) the Merja Zerga.

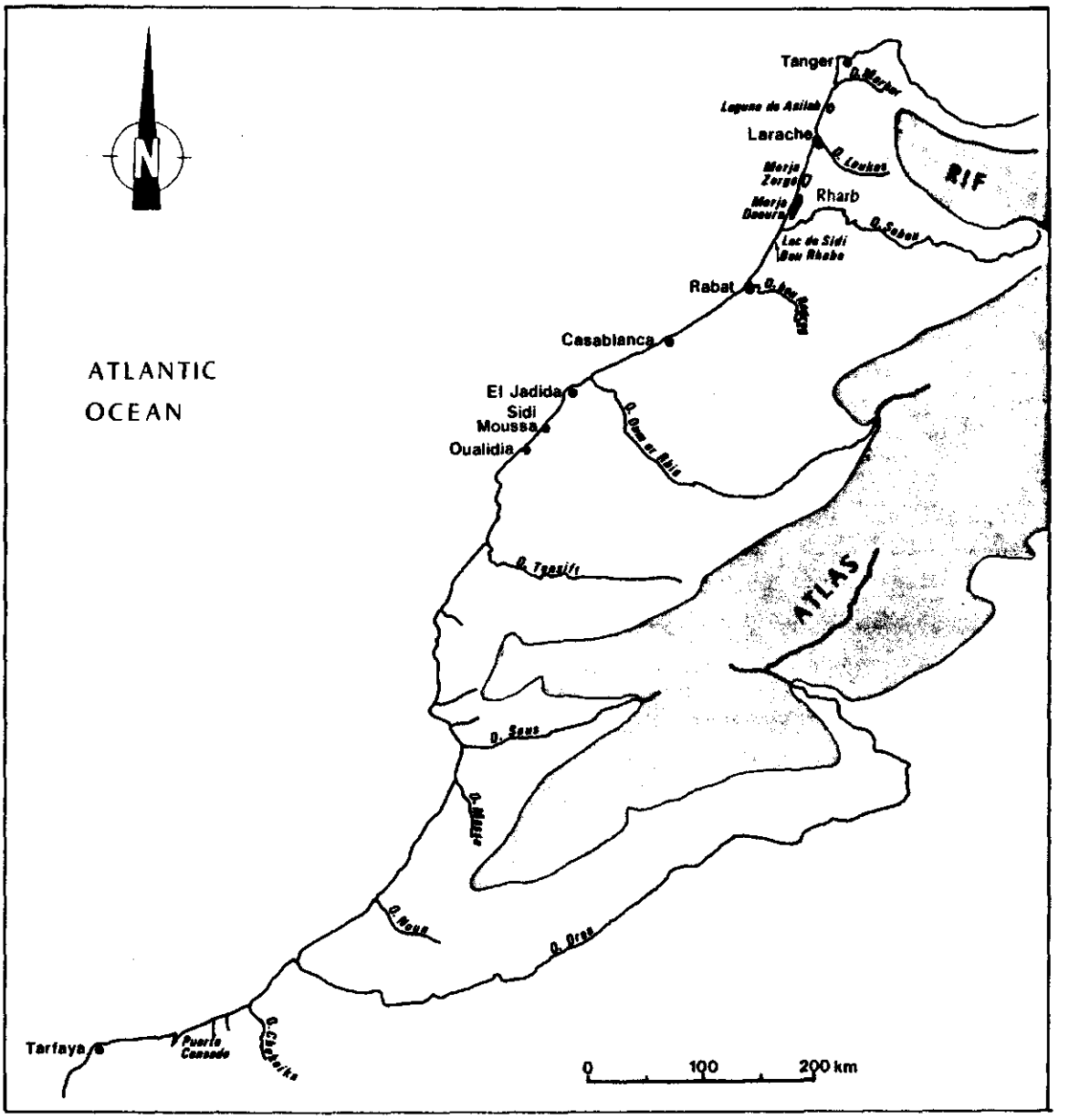


Figure 3.1. Map of Morocco, indicating the most important wetlands along the Atlantic coast.

3.1 The estuary of Sidi Moussa

Along some 35 km of Atlantic coast, between El Jadida and Oualidia (Figure 3.1), a series of elongated wetlands has been formed, separated from the Atlantic Ocean by a long dune system. At two places (near Oualidia in the south and Sidi Moussa in the north) the sea breaks through the dunes thereby creating tidal lagoons (Figure 3.2). Actually, as we realised only when we returned from Morocco, the tidal system near Sidi Moussa represents a proper, though tiny, estuary. Barnes (1974) defined an estuary as "a region containing a volume of water of mixed origin derived partly from a

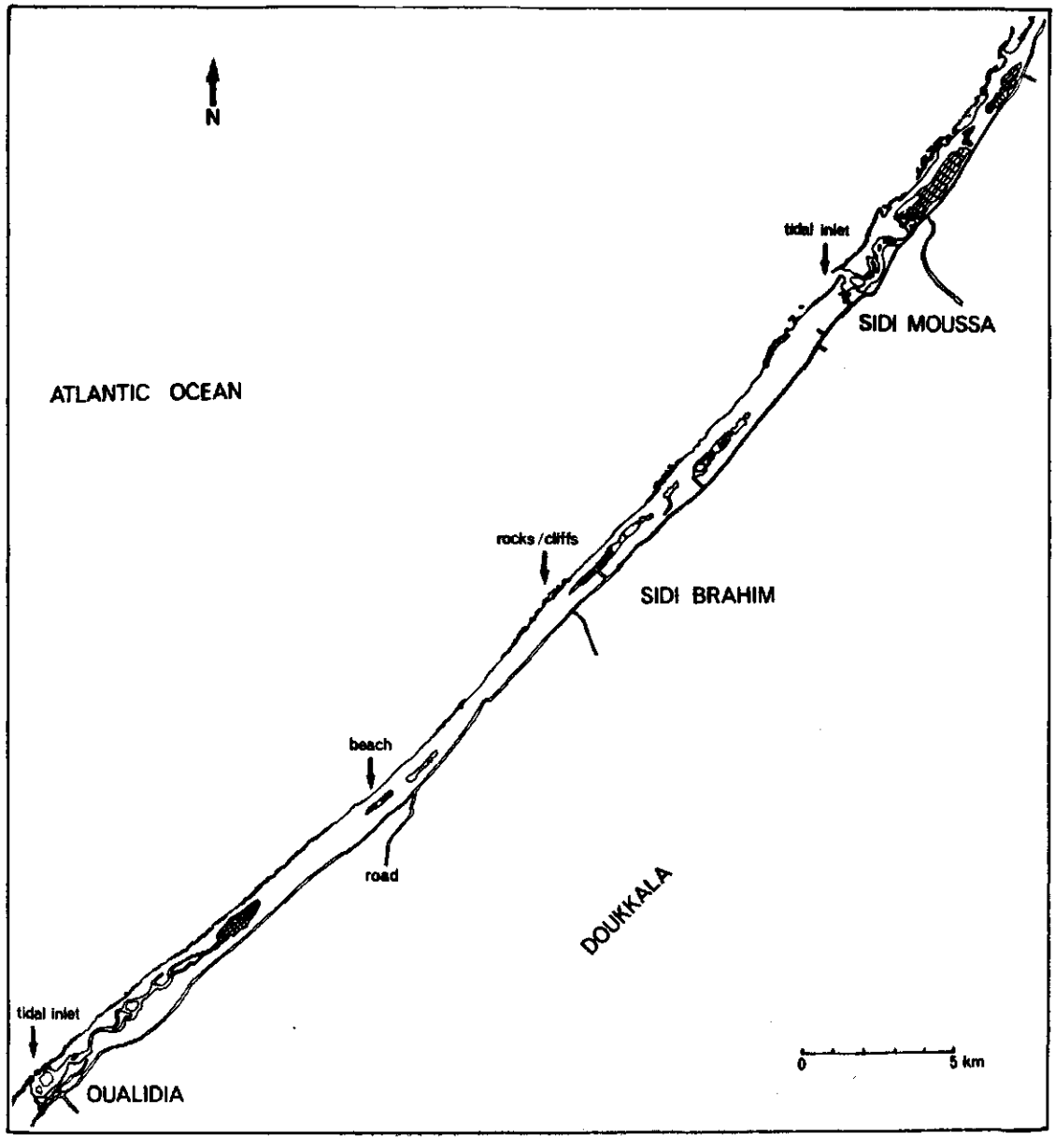


Figure 3.2. General outline of the coastal zone between Sidi Moussa and Oualidia.

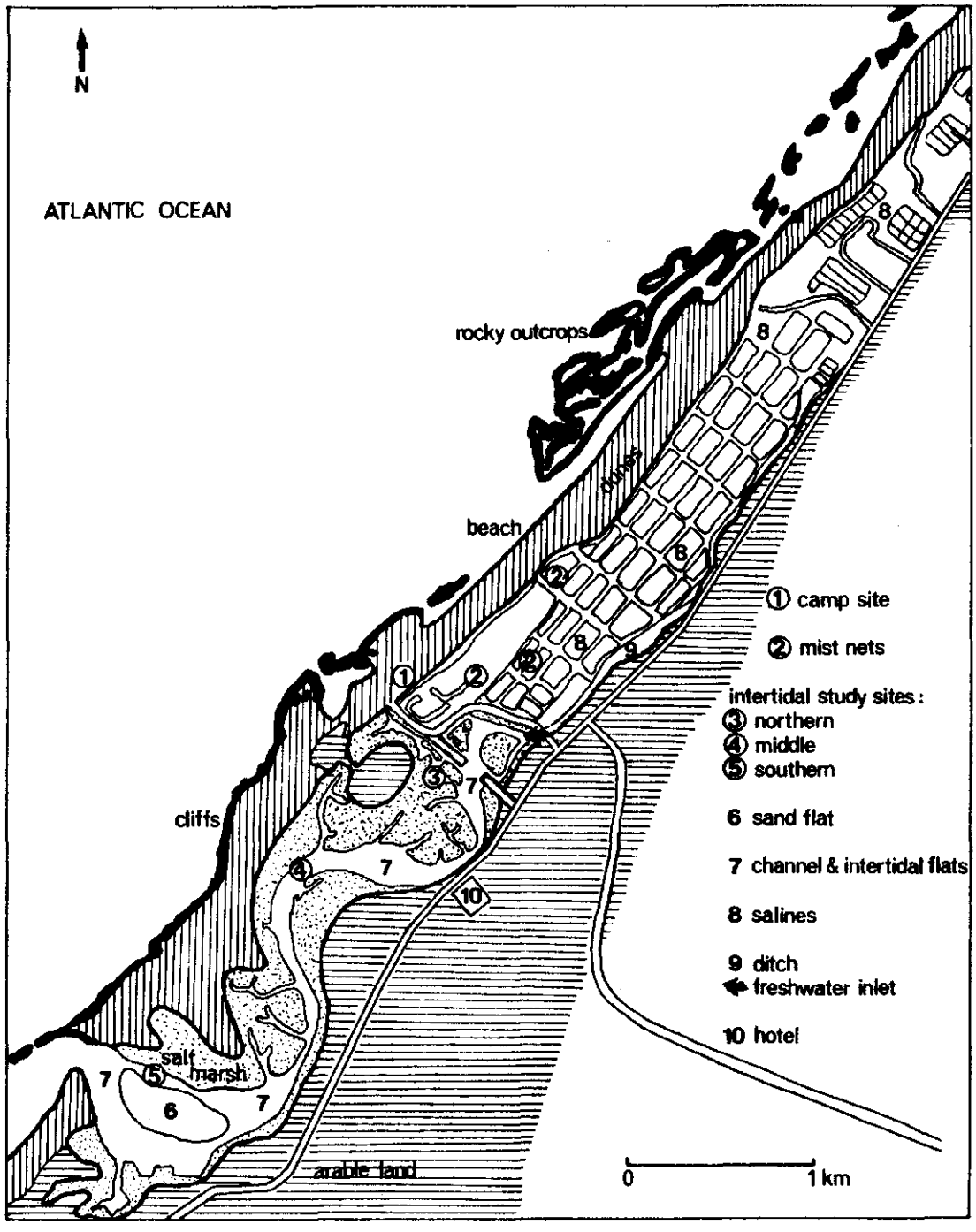


Figure 3.3. Map of the study area at Sidi Moussa.

discharging river system and partly from the adjacent sea; the region usually being partially enclosed by a land mass". Figure 3.3 shows that where the saltmarshes border the salines there is a freshwater outlet. At this place fresh water seeps continually, from a large ditch bordering the salines, into the tidal channel. During low water there probably will be a gradient in salinities from north to south, with brackish water in

the north, near the source of fresh water, and pure sea water approx. 3 km to the south, near the tidal inlet. Beaubrun (1976a) presents a detailed description of the, very similar, tidal lagoon system near Oualidia. Here, salinities, measured during low tide, range from 0.5 °/oo (mixo-oligohaline) in the north to 30-40 °/oo (sea water, euhaline) in the south.

Morgan (1982) classified the coastal area between Sidi Moussa and Oualidia as a vegetated sebkhet (type 2): "shallow mixohaline waterbodies in which the salinity may range higher for short periods in the summer prior to seasonally drying out. They have clay/silt or sandy bottoms and the salinity is low enough to allow the growth of several macrophyte species: *Ruppia*, *Potamogeton pectinatus*, Characeae and *Scirpus maritimus*. In the less saline sites these are joined by *Phragmites australis*, *Typha angustifolia* and *Scirpus lacustris* and here emergent vegetation covered up to 35% of the area. Submerged vegetation can cover the whole bottom." The actual study area near Sidi Moussa (Figure 3.3), however, consists of a tidal flats and saltmarsh part and a formerly tidal part which has been transformed into a saltpan area. The type of wetland that is given in the characterization of Morgan can be found near Sidi Brahim, some 10 km to the south.

A geomorphological impression of the Atlantic coast at Sidi Moussa is presented in the cross-section in Figure 3.4. The mainland is bordered by a low rocky ridge. At many places, the sediments on this ridge have eroded away, leaving bare rock. Seaward of the ridge there is a trench, filled with marine sediments, which, on its turn is bordered by aeolian sediments: the dunes. The dunes are stabilised by, and protected from the ocean swell by rocky outcrops and locally some 20-30 m high cliffs.

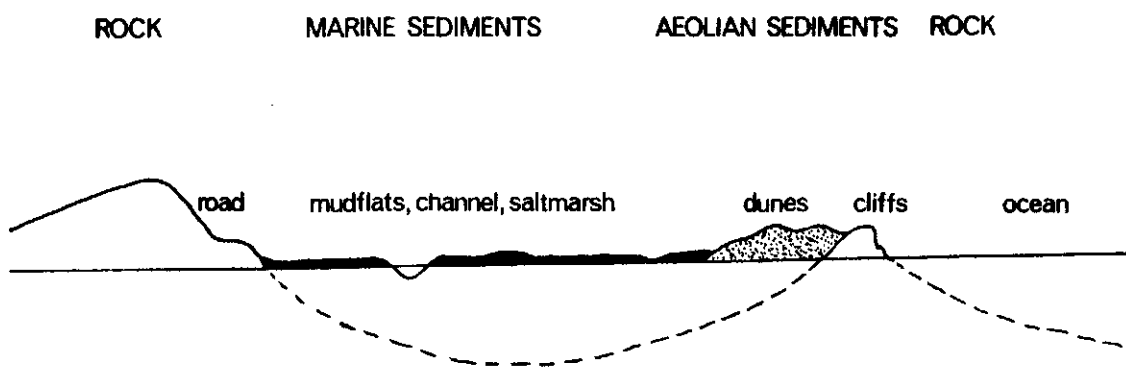


Figure 3.4 Schematic cross-section from east (left) to west (right), of the coast at Sidi Moussa looking in a southern direction.

The saltmarshes are extensive and intersected by a fine and complex pattern of gullies and channels. The vegetation is dense and consists of *Salicornia*, *Suaeda*, *Limonium*, *Halimione* and *Aster* spp. The mudflats (mainly occurring along the main channel) are covered (especially in the northern part) by a dense layer of green algae (*Ulva* and *Enteromorpha* spp). In the north a lot of brown algae occur on the mudflats as well. In many places in the estuary small patches of *Spartina* cf. *maritima* can be found.

The salt-pan part of the study area consists of a complex of rectangular pans containing variable and changing amounts of water. A proper map of this area is unavailable (Figure 3.3 gives only the impressions of the general outlines) and therefore we cannot give detailed descriptions of outlines, water depths and salinities. In general, however, salinities increase from the corner near the camp site (where sea water is pumped into the complex) to the final salt extraction pans in the north and the south-east. The small lagoon in front of our tents is used only as a sea water basin and water depth was therefore always 50 cm or more. From this basin, water is pumped into the saltpans proper. The saltpans are separated from each other by 3-15 m wide clay banks, which are sparsely vegetated by salt-tolerant (and arid looking) plants. The dunes are covered by a vegetation of locally dense *Mimosa* and *Eucalyptus* bushes, grasses, hottentot figs, and by modest cereal fields. The arable land is to a large extent covered by tomato-fields (within and outside large plastic greenhouses). Some arable land is set apart to produce vegetables and mint (for tea!) for the local people.

Human pressure on the natural environment of Sidi Moussa is very high. The saltmarshes and the dunes are heavily grazed by people (!) collecting material plant for food (for the animals) and fuel, and by donkeys, cattle and (three) dromedaries. During every diurnal low tide, many (15-30) girls and elder women are busy on and in the mudflats searching for edible molluscs (probably mainly specimens of the locally rare *Venerupis decussata*). Many old fishermen are always angling from the cliffs. During some week-ends there were a few (non-local) sportsmen shooting waders in the salt-pans and on the saltmarshes. When the weather is fine some tourists may be found on the beaches.

Along the Atlantic coast of Morocco, differences in tidal range vary between 1 m at neap tides, to about 2.5 m at spring tides. This has the result that, at Sidi Moussa at neap tides, the saltmarshes remain completely dry during high tide but submerge completely during spring tides. Beaubrun (1976a) showed that the timing and heights of the tides at Oualidia correspond closely with the tides at Casablanca. By inference we assume that the differences between the tides at Casablanca and the Sidi Moussa tidal inlet will also be very small. Table 3.1 shows some tidal parameters as

Table 3.1 Tide table Casablanca 1981, corrected for El Jadida (33.15 N 08.31 W)

Predicted figures.

[1] odd numbered = low-tide

even numbered = high-tide

Date	Sequence number [1]	Time	Height in m	Sequence number	Time	Height in m	Sequence number	Time	Height in m	Sequence number	Time	Height in m	Sequence numbers	Δ water level low high-tide	Sequence numbers	Δ water level low high-tide
27-2	1	01.11	1.5	2	07.38	2.6	3	13.46	1.6	4	20.19	2.5	1-2	1.1	3-4	0.9
28-2	5	02.35	1.6	6	09.02	2.5	7	15.12	1.6	8	21.45	2.6	5-6	0.9	7-8	1.0
1-3	9	04.06	1.5	10	10.27	2.6	11	16.32	1.5	12	22.57	2.8	9-10	1.1	11-12	1.3
2-3	13	05.14	1.4	14	11.30	2.8	15	17.31	1.3	16	23.51	3.0	13-14	1.4	15-16	1.7
3-3	17	06.05	1.2	18	12.18	3.0	19	18.18	1.1				17-18	1.8		
4-3	20	00.36	3.2	21	06.48	0.9	22	13.00	3.2	23	19.00	0.9	19-20	2.1	21-22	2.3
5-3	24	01.17	3.5	25	07.27	0.7	26	13.41	3.4	27	19.40	0.7	23-24	2.6	25-26	2.7
6-3	28	01.57	3.6	29	08.06	0.5	30	14.20	3.5	31	20.29	0.6	27-28	2.9	29-30	3.0
7-3	32	02.37	3.8	33	08.46	0.4	34	15.00	3.6	35	20.59	0.5	31-32	3.2	33-34	3.2
8-3	36	03.18	3.8	37	09.26	0.4	38	15.41	3.6	39	21.41	0.5	35-36	3.3	37-38	3.2
9-3	40	04.00	3.8	41	10.08	0.5	42	16.24	3.6	43	22.25	0.6	39.40	3.3	41-42	3.1
10-3	44	04.45	3.6	45	10.54	0.7	46	17.09	3.4	47	23.12	0.8	43-44	3.0	45-46	2.7
11-3	48	05.34	3.4	49	11.43	0.9	50	18.00	3.2				47-48	2.6	49-50	2.3
12-3	51	00.07	1.0	52	06.31	3.1	53	12.41	1.1	54	19.01	3.0	51-52	2.1	53-54	1.9
13-3	55	01.15	1.2	56	07.41	2.9	57	13.53	1.3	58	20.16	2.8	55-56	1.7	57-58	1.5
14-3	59	02.42	1.3	60	09.07	2.7	61	15.22	1.4	62	21.43	2.8	59-60	1.4	61-62	1.4
15-3	63	04.14	1.3	64	10.33	2.7	65	16.43	1.3	66	22.59	2.9	63-64	1.4	65-66	1.6
16-3	67	05.26	1.2	68	11.40	2.8	69	17.45	1.2	70	23.58	3.1	67-68	1.6	69-70	1.9
17-3	71	06.19	1.0	72	12.30	3.0	73	18.32	1.1				71-72	2.0		
18-3	74	00.44	3.2	75	07.01	0.9	76	13.09	3.1	77	19.10	0.9	73-74	2.1	75-76	2.2
19-3	78	01.23	3.3	79	07.36	0.8	80	13.44	3.2	81	19.44	0.8	77-78	2.4	79-80	2.4
20-3	82	01.57	3.4	83	08.06	0.7	84	14.16	3.2	85	20.14	0.8	81-82	2.6	83-84	2.5
21-3	86	02.30	3.4	87	08.36	0.7	88	14.47	3.3	89	20.45	0.8	85-86	2.6	87-88	2.6
22-3	90	03.01	3.4	91	09.04	0.7	92	15.17	3.3	93	21.15	0.8	89-90	2.6	91-92	2.6
23-3	94	03.32	3.3	95	09.34	0.8	96	15.48	3.2	97	21.46	0.9	93-94	2.5	95-96	2.4
24-3	98	0.403	3.2	99	10.04	0.9	100	16.20	3.1	101	22.19	1.0	97-98	2.3	99-100	2.2
25-3	102	04.37	3.1	103	10.37	1.1	104	16.54	3.0	105	22.55	1.1	101-102	2.1	103-104	1.9
26-3	106	05.14	2.9	107	11.12	1.2	108	17.33	2.8	109	23.37	1.3	105-106	1.8	107-108	1.6
27-3	110	05.57	2.7	111	11.55	1.4	112	18.21	2.7				109-110	1.4	111-112	1.3
28-3	113	00.30	1.4	114	06.55	2.6	115	12.54	1.5	116	19.28	2.6	113-114	1.2	115-116	1.1
29-3	117	01.48	1.5	118	08.18	2.5	119	14.19	1.6	120	20.55	2.6	117-118	1.0	119-120	1.0
30-3	121	03.23	1.5	122	09.48	2.6	123	15.51	1.5	124	22.16	2.8	121-122	1.1	123-124	1.3
31-3	125	04.39	1.4	126	10.56	2.7	127	16.58	1.4	128	23.16	3.0	125-126	1.3	127-128	1.6

predicted for Casablanca for our study period. The tidal delay within the estuary of Sidi Moussa (i.e. between the tidal inlet and the northern intertidal study site) was somewhat less than one hour.

Annual fluctuations in water temperatures for the estuary at Oualidia (which, as already mentioned, is very similar to the estuary at Sidi Moussa) are shown in Figure 3.5. Minimal sea water temperatures (about 18^{o} C) occur in December and January, whereas maximum water temperatures of about 23^{o} C occur in July and August. Water temperatures further from the tidal inlet fluctuate more: in December temperatures are as low as $15\text{-}16^{o}$ C,

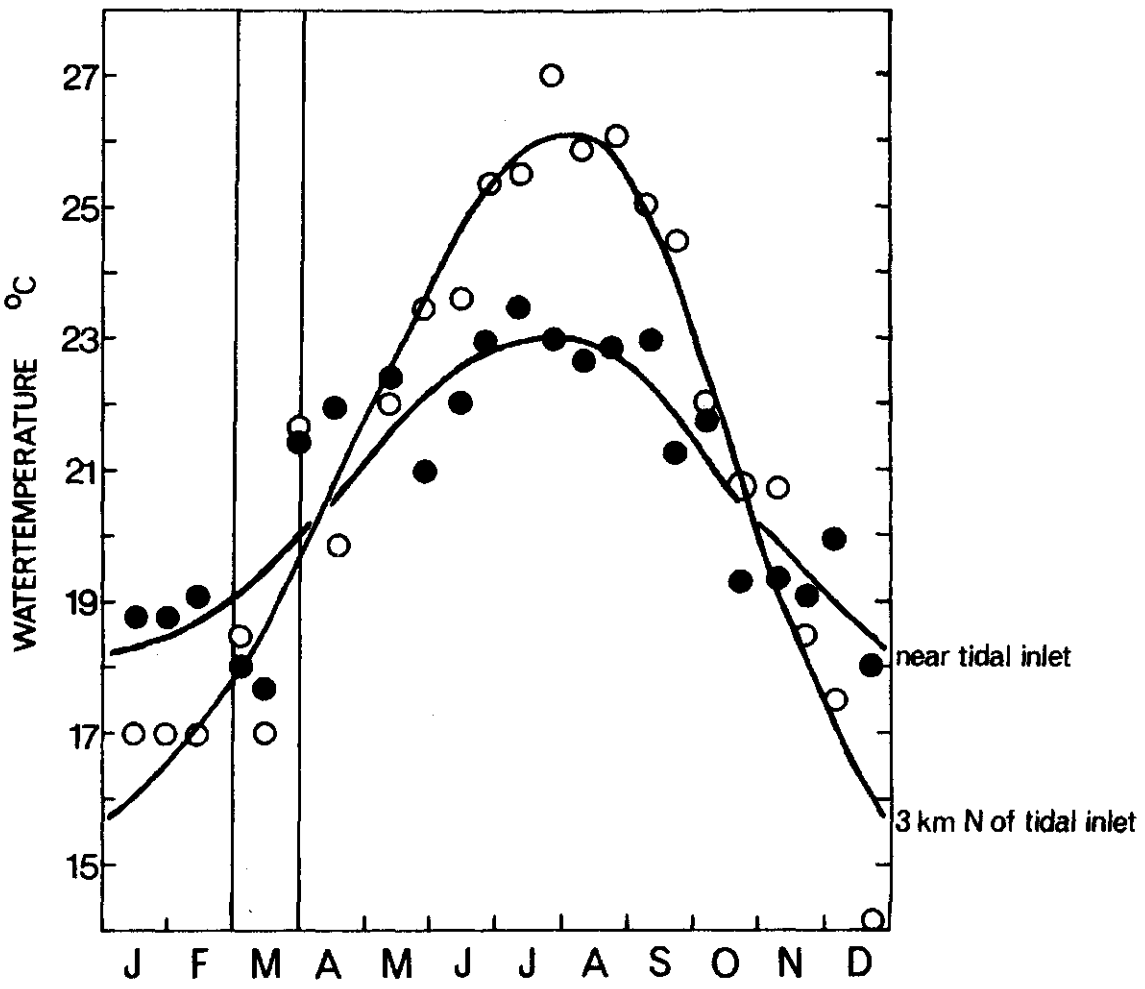


Figure 3.5. Annual fluctuations in watertemperature during low water at two stations in the estuary of Oualidia (data collected in 1970; after Beaubrun 1976a).

whereas in July temperatures rise to 26° C. During our study we did not measure water temperatures but we did measure mud temperatures on the northern intertidal study site (temperature at 2-3 cm below surface of the substrate). The data collected during low water are presented in Figure 3.6. They show a clear diurnal pattern, apparently independent from the timing of the tides. Temperatures varied between 15° C in the early morning to 19-22° C in the early afternoon.

Further impressions of the landscape around Sidi Moussa are given in the accompanying pictures.

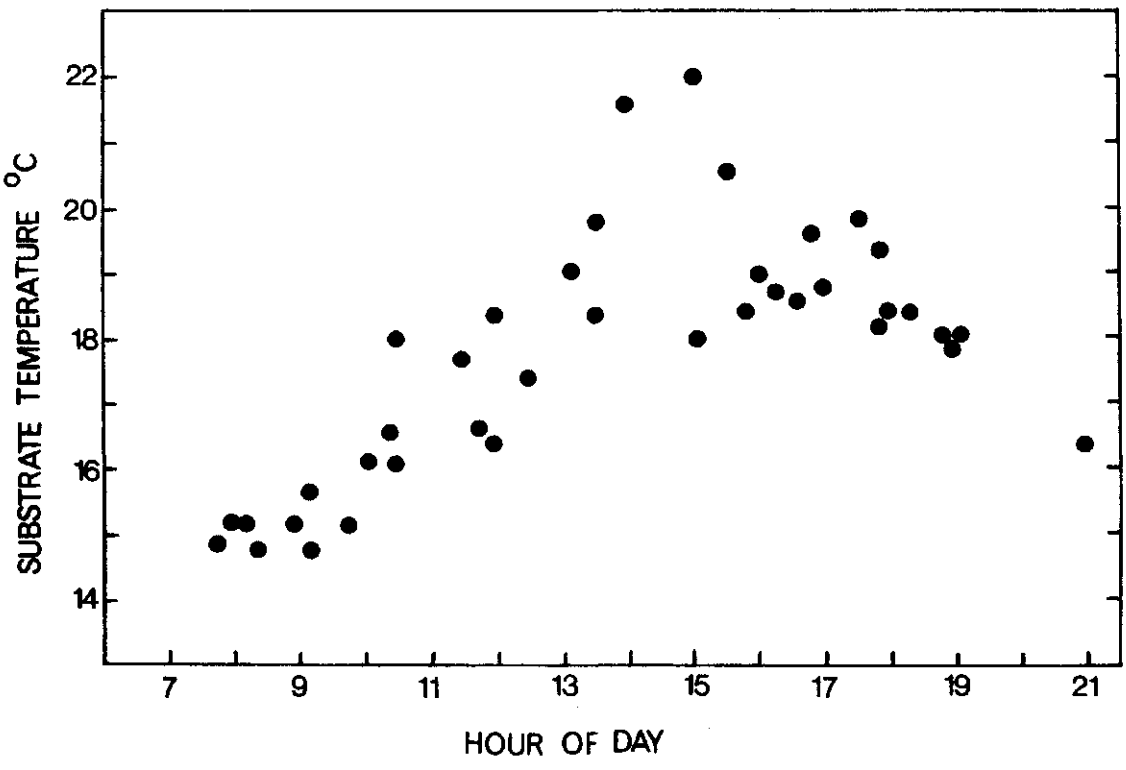


Figure 3.6. Daily fluctuations in substrate temperature at the northern intertidal study site. The temperature was measured 2-3 cm below the surface of the substrate. The data were collected from 12 to 21 March 1981.

View from the dunes to Sidi Moussa; base camp in the middle.

Farmer, after collecting plant material near the camp at Sidi Moussa.

3.2 The Merja Zerga

The Merja Zerga is a large tidal lagoon between Kenitra and Larache, filled with a flat layer of soft mud. Morgan (1982), who classified the Merja Zerga as a marine wetland, gives a description of the area, which will be summarised below.

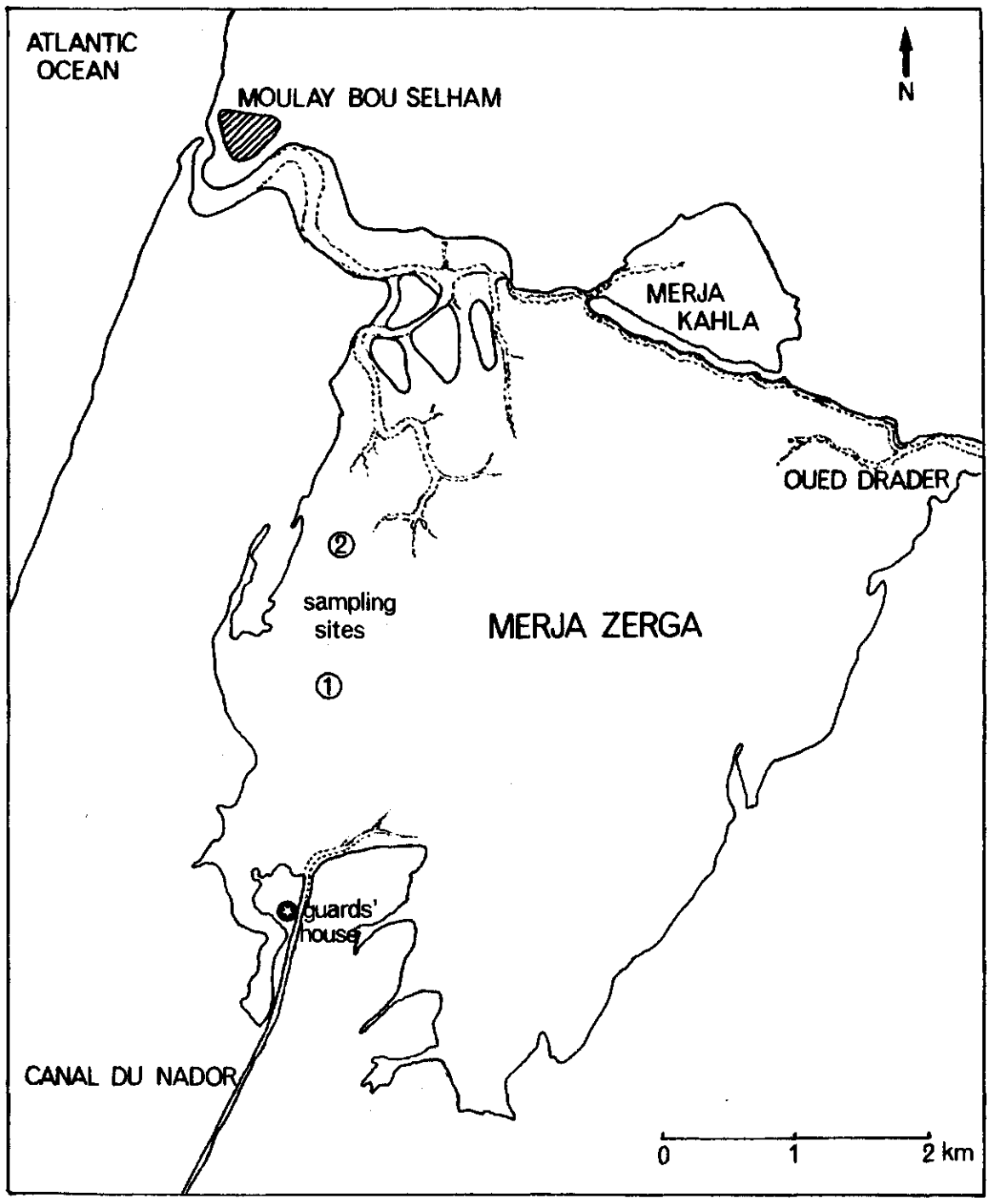
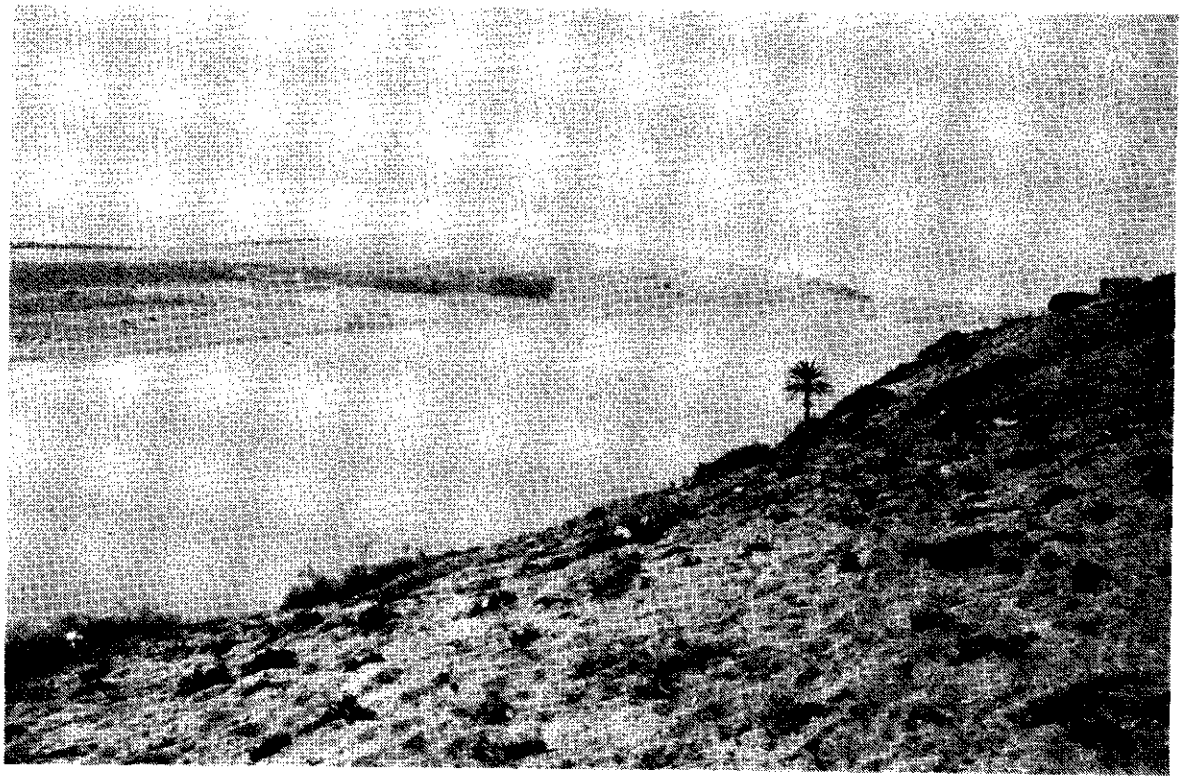


Figure 3.7. Map of the Merja Zerga.

The tidal lagoon is about 1500 ha in extent and connected at high tide to a small lagoon, the Merja Kahla. It is separated from the Atlantic Ocean by an ancient dune system through which a channel connects it to the sea near Moulay Bou Selham (Figure 3.7). This channel used to open and close over periods of time, in relation to wave action depositing and eroding a bar of sand at the entrance (for details see Beaubrun 1976b). Since 1953, when a drainage canal (Canal du Nador) was constructed between Sidi Mohammed Ben Mansour, Merja Daoura and the Merja Zerga, this connection with the sea has remained open. However, in the autumn of 1982 after heavy storms, the connection with the sea closed again, leaving the Merja Zerga as a lake, at least to spring 1983. In winter, fresh water flows in from Canal du Nador and Oued Drader. At low tide an area of water remains in the centre while vast mudflats are exposed. In summer, only the channels through the mudflats contain water at low tide and the whole of the bottom of the Merja Zerga is exposed. There are extensive growths of *Zostera noltii*, *Ruppia cirrhosa*, *Ulva*, *Enteromorpha* and *Cladophora* on the mudflats. Around the shores, *Scirpus maritimus*, *S. lacustris* and *Phragmites* grow in the wet grassland/saltmarsh, and are grazed down by cattle and ducks. The Merja Kahla, which is an integral part of the site, is almost cut off from the Merja Zerga, except for a small channel at high tide, and contains a mixture of sea water and fresh water from the Oued Drader. It is very shallow and the bottom is covered with a dense carpet of *Cladophora* and *Ruppia cirrhosa*. The Merja Zerga is exploited by fishermen for *Mugil*, *Solea*, *Anguilla*, *Mullus barbatus*, *Dicentrarchus labrax* and *Atherina*. Shelfish are dug up by parties of women. The international importance of the Merja Zerga, based on Heiligenhafen criteria, has been acknowledged by the Moroccan authorities. All shooting, which was previously heavy, was stopped as from 2 January 1978, and the shooting butts and huts have been dismantled. Guardians have been appointed and a national park of about 7000 ha was declared in the spring of 1978.

Additional information on the hydrology and sedimentology of the Merja Zerga can be found in Beaubrun (1976b).



The tidal inlet of Merja Zerga in April 1981

Edge of the saltmarshes in the southern part of Merja Zerga

4 ITINERARY

On 22 February at eight o'clock a.m. we left Groningen and began our ca. 10 000 km trip with a VW minibus to Marocco, and back again. The journey through Europe passed without problems. Custom officers were kind and not very interested in the contents of our car. Only at the Spanish border we had to open the car but we were lucky. It had just become dark so distinguishing anything inside the car was difficult. The Spanish custom officer took a lamp but.....it did not work. He looked sadly at the lamp and said to us: "you may go". It was not necessary to say that once more and so San Sebastian was reached on the evening of a day which appeared to be a stirred day for Spain: members of the Guardia Civil had occupied the Parliament. Two and half days we travelled through this country and in the afternoon of 26 February the crossing was made from Algeciras to Ceuta. In suspense we drove to the Moroccan border: what would happen there? After the usual passport-check they asked us to empty the car, which was against our wishes. It would mean a delay of some hours, but obviously we had no choice. Slowly we began to put our things on a stone table, one by one, while a Moroccan custom officer checked them. More was put on the table, still more. The custom officer began to check our things reluctantly, whilst he perspired more and more. Finally he was fed up with it and made clear that we could put our things back in our vehicle: where most of the contents still was! We performed this quicker than the other way around. After all, we had a delay of one hour only: we were satisfied. And so we reached Morocco, a country where the sun practically always shines, apart from the inside of the prisons of Rabat, Fez and Casablanca in which political prisoners are held.

On the 27 February we visited Mr. Ramdani and Mr. Thevenot at the Institut Scientifique in Rabat, to discuss our plans and to get bird-rings and permits. One day later our study area in Sidi Moussa was reached. A journey without problems.

To carry out our activities we stayed at Sidi Moussa until 29 March. Our stay there gave no problems, except that four mist-nets were stolen (as it appeared one year later, temporarily, as we got the nets, undamaged, back!), and that three of us had a short illness of maximally 24 hours.

We could get water and some of the food, at a short distance; for other things we went to El Jadida twice a week. From a neighbour of a tomato-nursery,

tomatoes were obtained. In the beginning, we got a few of these fruits and later more, every day. In the end of our stay we were eating tomatoes at breakfast, at lunch and at dinner and even, between the meals! But we were glad with the contacts with our neighbour (El Bachri) Bouchta. Sometimes he also guarded our camp when we were all away. At the day of our departure we were invited to a cous-cous meal at his home. During our stay he had also brought us cooked cous-cous with meat: excellent meals. Other contacts with the people were "medical contacts". After two weeks some people came warily to us with wounds or wounded children. We helped them as much as possible.

In the middle of our stay two of us left the camp for some days to visit Merja Zerga, a distance of 350 km to the north of Sidi Moussa. The aim of this journey was to check this area for marked birds.

During our stay Jan de Leeuw (Netherlands) and Mohamed Ramdani (Institut Scientifique, Rabat) visited us for a longer period. Jan de Leeuw worked on a map of the area and Mohamed Ramdani cooperated with us on the benthos research and told us much about Morocco.

In the afternoon of 29 March our return journey started. That night we were the guests of Mohamed Ramdani at Rabat. The next day we visited the Institut Scientifique in order to arrange the ringing administration with Mr. Thevenot. The same day we drove on, to the Merja Zerga. On the 31st of March a reconnaissance trip was made, and at the same time birds were checked for colour dye and tapes. On 1 April we completed a successful count. On 2 April we left Merja Zerga. In the morning of 3 April the Spanish border was reached where we expected an extensive control of our car. Indeed, it looked as if this would happen. While a custom officer indicated that some things had to be taken out of the car, we showed our letters of recommendation to a custom officer of highest rank available. This had a miraculous effect. A moment later we were allowed to drive on. In Spain we had a half-day break at the Ebro-Delta and in France we visited the Camargue for two days. In the night of 9/10 April we returned in Groningen. Tired but satisfied.

5 INVESTIGATIONS OF THE BENTHIC MACROFAUNA

5.1 Introduction

Because of our interest in intertidal macrobenthic invertebrates as food for waders, we attempted to measure density and biomass of macrobenthos at the sites where we also studied (foraging) waders.
The data obtained serve two aims:

- to document prey weights and densities to be used in the analysis of the factors determining wader densities at low tide, and in the calculations on food intake of the wader species observed;
- to investigate the question: to what extent do macrobenthos production rates match the predation pressure at migratory stations of waders? Are food resources depleted during the migration period and, if this is the case, what is the measurable effect on their use by waders?

The purpose of the present analysis is to provide a baseline for the above-mentioned (and further) studies. A species-list is given and data on species composition, densities and biomass of macrobenthos at a few sites, are presented.

5.2. Methods

Sampling of the infaunal and epifaunal macrobenthos were taken by a corer with a sampling area of 84 cm^2 (1/120 m^2), to a depth of 25 cm. In a few instances, to sample Shorecrabs *Carcinus maenas*, a certain measured area of mud, sand or eelgrass cover was taken to a depth of 3-4 cm. The samples were washed through a sieve of mesh 1 mm. The sieved samples were stored in a cool place before sorting in low white plastic trays. After the sorting, series of sorted samples were counted. During the procedure maximum lengths of some species (*Cerastoderma edule*, *Abra tenuis*, *Scrobicularia plana*, *S. cottardi* and *Nereis diversicolor*) were measured on graph-paper with millimetre divisions. The specimens were then either preserved in 96% alcohol or dried for one to two days at 60 - 70^{o} C in a small transportable oven, heated by a gas flame. The dried samples were stored and transported in tightly closed plastic containers. To be sure they remained dry, silica-gel was added to the contents of the containers. In the Netherlands the dried samples were weighed and ignited for three hours at 500^{o} C, to obtain ash weights and, by subtraction, ash-free dry weights (abbreviated as AFDW).

Table 5.1

	Sidi Moussa 1 salt marsh	Sidi Moussa 2 north channel	Sidi Moussa 3 centre channel	Sidi Moussa 4 south channel	Merja Zerga 1 mud-flats	Merja Zerga 2 channel
MOLLUSCA-GATROPODA						
Gibbula umbilicalis			x	x		
Monodonta c.f. *turbinata*				x		x
Monodonta lineata				x		
Hydrobia ventrosa	x	x				
Peringia ulvae	x	x	x	x	x	
Rissoa membranacea				x		
Bittium reticulatum		x				
Ocenebrina aciculata		x				
Nassa (Amyclina) pfeifferi		x				
Nassa reticulata				x		x
Nassa (Hinia) incrassata		x				
Haminea temarana		x		x	x	
Phylina c.f. *aperta*				x		
Armina tigrina						x
Aplysis punctata						x
Aplysia c.f. *depilans*						x
Alexia myosotis	x					
Alexia firmini	x					
MOLLUSCA-BIVALVIA						
Musculus costulatus		x				
Mytilus galloprovincialis		x				
Loripes lacteus		x				
Parvicardium exiguum		x				
Cerastoderma edule		x	x			
Cerastoderma glaucum					x	
Venerupis decussata		x			x	
Abra tenuis		x	x			
Scrobicularia plana		x			x	
Scrobicularia cottardi		x			x	

	Sidi Moussa 1 salt marsh	Sidi Moussa 2 north channel	Sidi Moussa 3 centre channel	Sidi Moussa 4 south channel	Merja Zerga 1 mud-flats	Merja Zerga 2 channel
ANNELIDA-POLYCHAETA						
Nereis diversicolor		x	x			
Platynereis dumerilii				x		
Neanthes caudata				x		
Diopatra neapolitana					x	
Scoloplos c.f. *armiger*				x		
Capitella capitata		x	x			
Mysta picta				x		
Malacoceros fuliginosa				x		
CRUSTACEA-AMPHIPODA						
Urothoe grimaldi				x		
Microdeutopus chelifer				x		
Melita palmata				x		
CRUSTACEA-ISOPODA						
Idotea spec.				x		
Idotea chelipes				x		
Cyathura carinata					x	
Monodanthura maroccana				x		
CRUSTACEA-DECAPODA						
Crangon crangon						x
Carcinus maenas		x	x	x		x
Pachygrapsus marmoratus				x		
Palaemon serratus				x		
Uca tangeri					x	

Table 5.1 Theoccurrence of the macrobenthic invertebrate species at different (inter-)tidal sites along the Moroccan coast. For more information on and a description of the sites, see text.

In the Merja Zerga the sampling procedure was slightly different as there was no time here to dry the collected material. Samples were sorted on board the rowing-boat at the sampling sites and the specimens obtained were put immediately into 4% formalin. After return to the Netherlands, the specimens were measured and dried for three days at 60° C, after which they were also ignited. According to J.J. Beukema (pers.comm.), storage in 4% formalin has no appreciable effect on the AFDW measurements, as long as the preservation of the organic material is successful. As the formalin solution removed from the samples was still very clear, no organic material had gone into solution, and we consider therefore, that our figures for AFDW's at the Merja Zerga are accurate.

At Sidi Moussa, most of the sampling took place between 20 and 24 March 1981, whereas in the Merja Zerga the samples were taken on 1 April.

Specimens preserved in alcohol were sent for identification to specialists at the Zoological Museum in Amsterdam (molluscs and crustaceans), to L. Amoureux in Angers, France (polychaetes), and to C. Swennen on Texel (nudibranch molluscs).

In this report biomass (also called "standing stock" or "standing crop" in the literature) will be expressed in grams ash-free dry weight per square meter ($g.AFDW.m^{-2}$).

5.3 Results

A complete list of macrobenthic species, collected at three study sites at Sidi Moussa (Figure 3.3) and two study sites in the Merja Zerga (Figure 3.7), is given in Table 5.1. Short descriptions of the study sites together with the quantitative data on macrobenthos are presented below, separately for each site. The amount of data collected differs considerably from site to site, depending whether wader foraging studies were carried out on the site simultaneously (which was the case on the first study site, Sidi Moussa, north channel).

5.3.1 Sidi Moussa, northern part of the channel.

In the northern part of the channel 9 study plots of 20 x 20 m and 1 study plot of 10 x 40 m (i.e. 0.04 ha in all cases) were established on an intertidal area surrounded by saltmarsh (Figure 5.1). The mudflats were partially covered by water, green algae (*Ulva* spec.) or eelgrass (*Zostera* spec.). The extent of these in the 10 plots are shown in Figure 5.2. The mean percentages of the 10 plots taken together, were 17% water, 24%

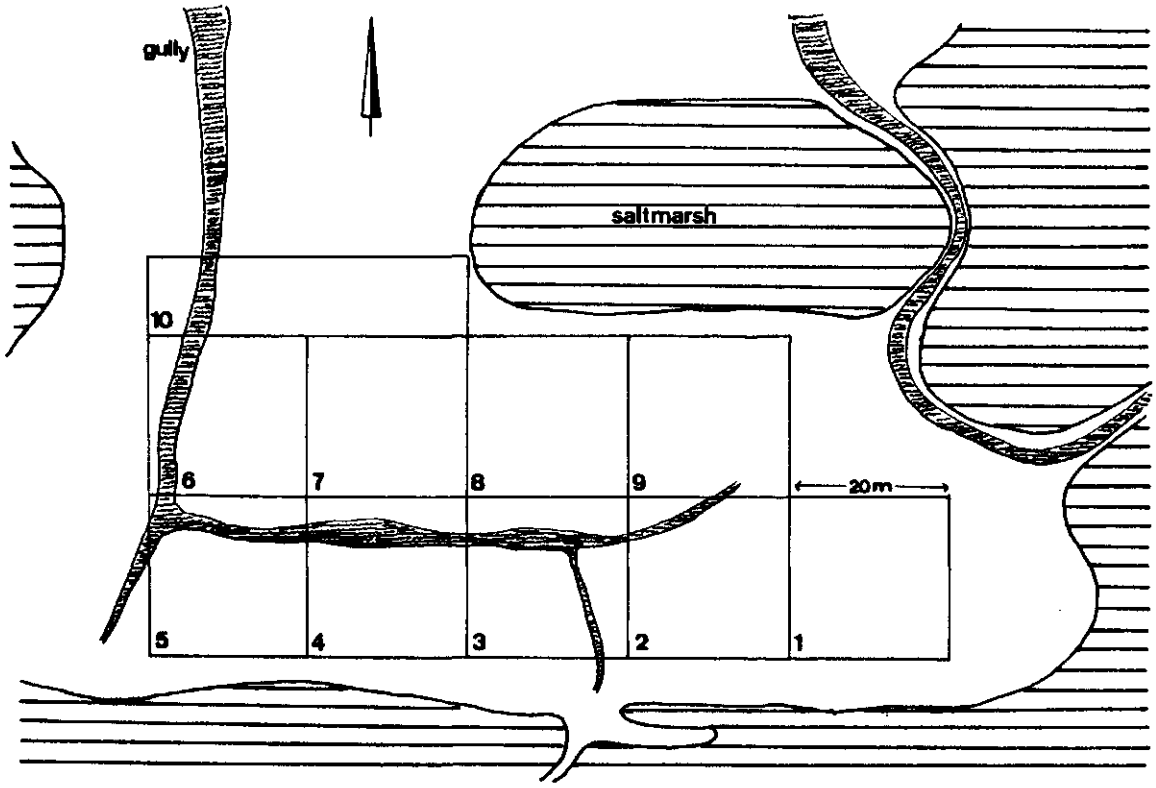


Figure 5.1. Location of 10 study plots on an intertidal area in the northern part of the channel at Sidi Moussa (see Figure 3.3).

10 15%water 15%barren	70%ulva			
20%water 30%barren 50%ulva 6	10%water 10%barren 80%ulva 7	5 %water 60%barren 10%ulva 8 25%zostera	5%water 55%barren 10%ulva 9 30%zostera	
20%water 20%barren 60%ulva 5	20%water 15%barren 65%ulva 4	25%water 15%barren 60%ulva 3	25%water 10%barren 65%ulva 2	20%water 10%barren 70%ulva 1

Figure 5.2. Proportional coverages of 10 study plots of 0.04 ha, situated in the northern part of the channel at Sidi Moussa.

barren mud, 54% green algae and 5% eelgrass.

In this intertidal area 19 macrobenthic invertebrate species were encountered (Table 5.1) although only a few species were important numerically or according to biomass (Table 5.2). On the neighbouring salt marsh (Figure 5.1) four species of macrobenthic invertebrates were found. The small snail *Peringia ulvae* was most numerous in the intertidal area, occurring in densities of about 15000 ind.m^{-2} and contributing, despite its small individual biomass (0.67 mg.AFDW.ind^{-1}), to almost half of the total biomass. The snail *Nassa pfeifferi* and the polychaete *Nereis diversicolor* (Ragworm) contributed together most to the other half of the total biomass.

	n.m^{-2}	±	SD	g.AFDW.m^{-2}	±	SD
Gibbula umbilicalis	3.1		5.6	0.07		0.11
Peringia ulvae	14 699.0		5 909.0	9.8		4.0
Nassa pfeifferi	139.9		71.9	3.6		1.4
Haminea temarana	2.2		5.2	0.01		0.02
Cerastoderma edule	19.0		21.1	0.8		1.1
Abra tenuis	312.9		226.8	0.4		0.3
Scrobicularia plana	3.4		8.6	0.13		0.31
Scrobicularia cottardi	47.6		64.0	0.5		0.7
Nereis diversicolor	518.2		177.6	5.4		2.4
small polychaete spec.	4.4		10.4	0.01		0.01
insect larvae *(Chironomidae)*	20.9		21.7	0.02		0.02
Total biomass				20.79		

Table 5.2 Density and biomass values of macrobenthic invertebrates on the mudflat of Sidi Moussa, north channel. Means and standard deviations of the means of 10 study plots (Figure 5.1) are given. Total number of samples for which the means are calculated is 116, apart from *P. ulvae*, which was counted in 81 samples.

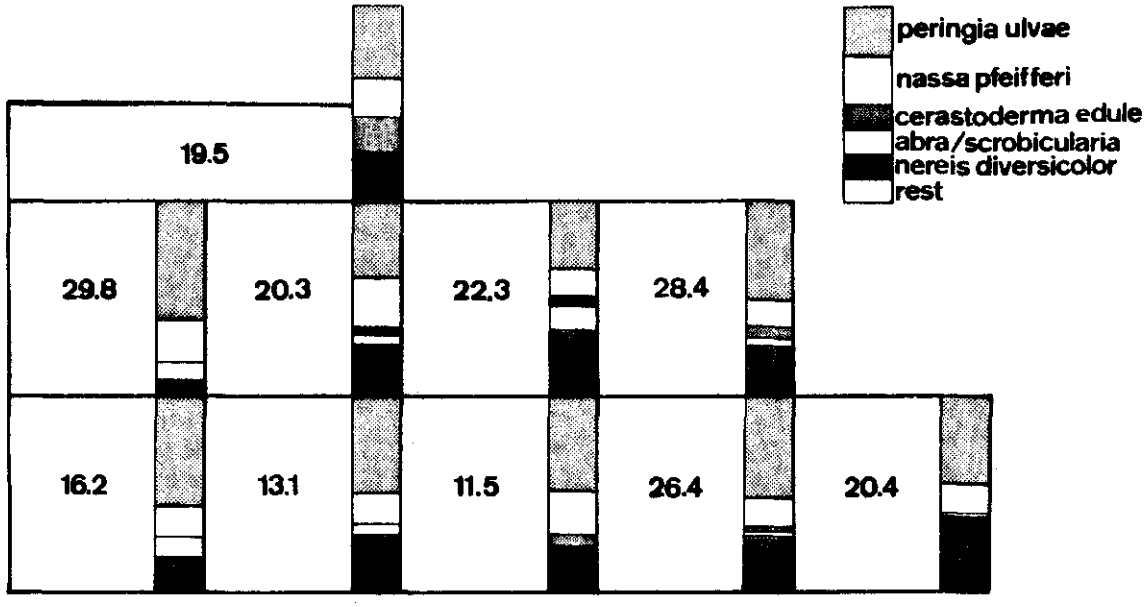


Figure 5.3. Total biomass (figures) and proportional contributions (columns) to total biomass, of different macrobenthic species, or species groups on 10 study plots of 0.04 ha (Figure 5.1). The number of samples on which the figures are based is 8-16 per study plot. Total biomass in g.AFDW.m^{-2}.

In view of the differences in the type of coverage of the different plots, the relative contributions of the macrobenthic species differed between the plots. In Figure 5.3 the total biomasses and weight proportions of different species or species groups are presented for the 10 different 0.04 ha plots.

A peculiarity is presented by the Shorecrab *Carcinus maenas*. Individuals of this species were seen to be eaten by Grey Plovers *Pluvialis squatarola* in our study plots, and some were found dead along the shoreline. However, none were found alive in the samples, despite the fact that we sampled a total area of approx. 1 m^2 with corers and an extra 1 m^2 to a depth of 3-4 cm especially for crabs. The density of Shorecrabs was therefore very low but, although they are not represented in Table 5.2, they will add at least something to the real total biomass.

The size frequency distribution of *Abra tenuis* at this site is given in Figure 5.4. It shows a clear unimodal distribution, suggesting that only one age-class was present at the time, although the extreme sizes differed by a factor 9. The size frequency distribution of *Scrobicularia cottardi* is given in Figure 5.5. Sizes are in a range of 7-17 mm, and several age-classes (3?) may be recognized.

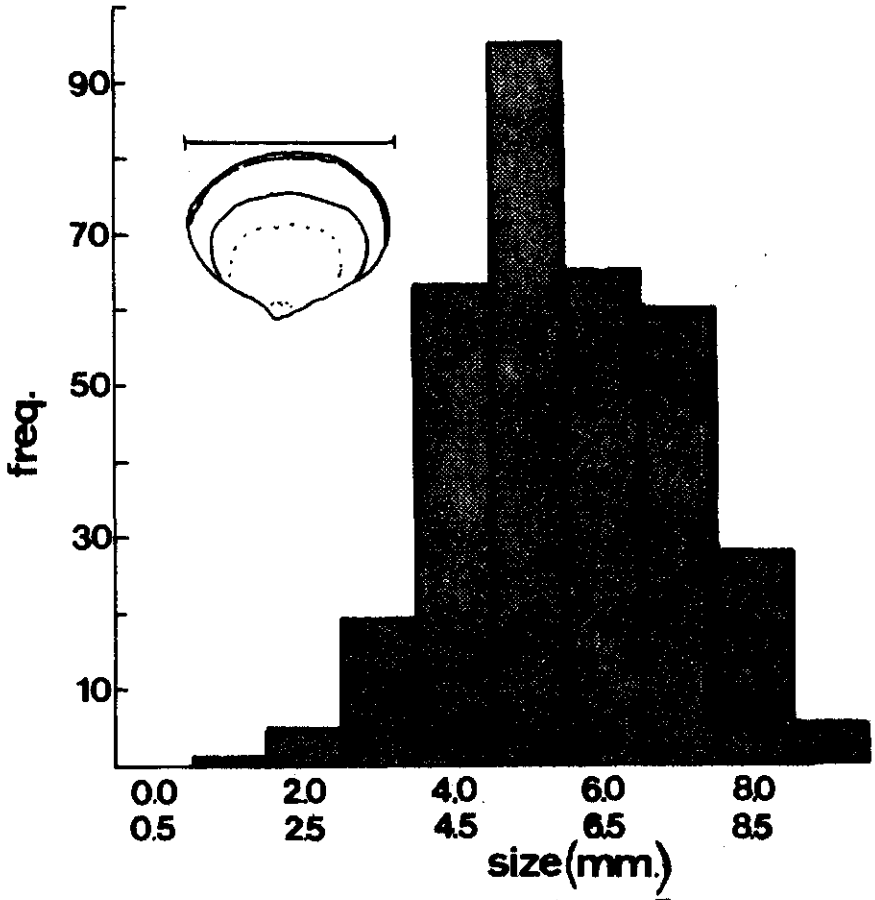


Figure 5.4. Size frequency distribution of *Abra tenuis* at the 10 study plots in north channel, Sidi Moussa, 20-24 March 1981.

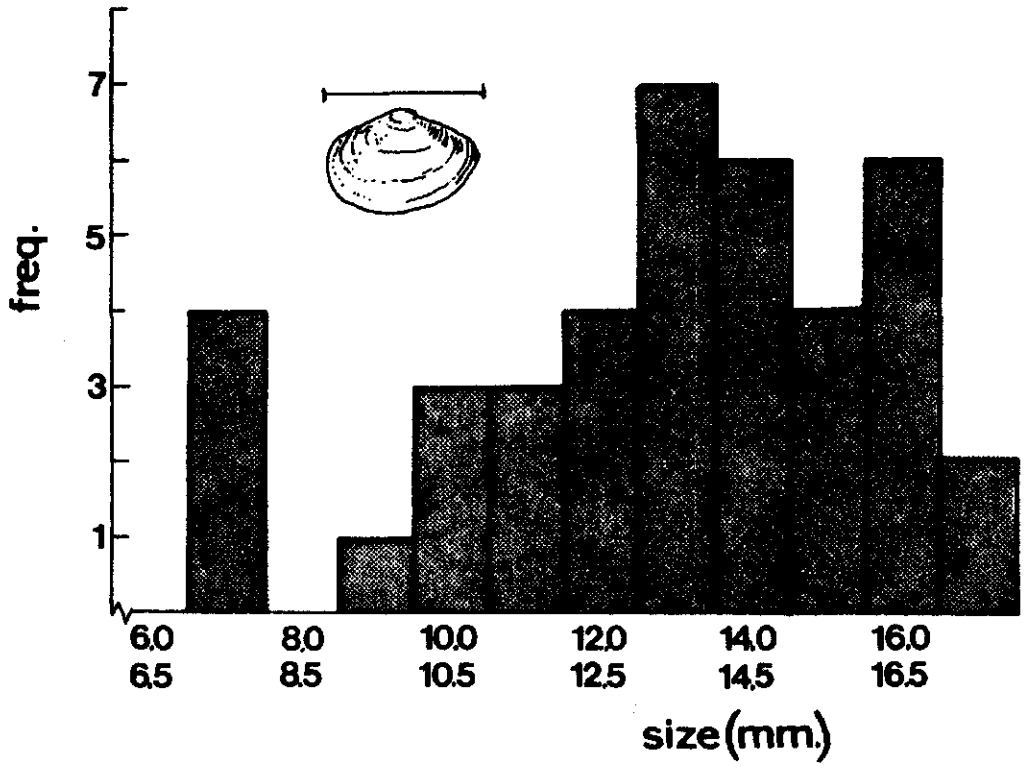


Figure 5.5. Size frequency distribution of *Scrobicularia cottardi* at the 10 study plots in north channel, Sidi Moussa, 20-24 March 1981.

In two plots (5 and 10) macrobenthos was sampled twice, on 10/11 and 24 March. The results of the successive samplings at plot 5 are presented in Table 5.3. There was a decrease in the densities and biomass values of most species. However, the density measurements show large standard deviations and the differences were not generally statistically significant. Nevertheless, the decrease in total biomass by one quarter (24%) may still mean a noteworthy downward trend in macrobenthic biomass values in March. A comparable picture was obtained for plot 10 (Table 5.4) and, although some species showed an increase in densities and biomass, the decrease in total biomass was still 11%. Density and biomass changes of *Abra tenuis* in plot 5 and *Nereis diversicolor* in plot 10 are interesting because both species showed opposite trends in these changes. The density of *Abra tenuis* on the second sampling date seemed to have increased while the biomass decreased due to the high proportion of smaller individuals on the second date. The density of *N. diversicolor* decreased between the sampling dates, whereas the biomass increased slightly, due to heavier Ragworms on the second sampling date. Seeming inconsistencies like these may be related to size-selective predation and/or to growth of the individuals of a species. The effect is investigated more thoroughly below for *N. diversicolor*.

	11 March (n = 10)			24 March (n = 8)			% change in biomass
	$n.m^{-2}$	± SD	$g.AFDW.m^{-2}$	$n.m^{-2}$	± SD	$g.AFDW.m^{-2}$	
Gibbula umbilicalis	12.7	40.2	0.493	0		0	-100%
Peringia ulvae	14 071	7 198	10.272	13 478	5 670	9.030	- 12%
Nassa pfeifferi	165.1	247.2	3.167	95.3	112.6	2.380	- 25%
Cerastoderma edule	25.4	53.5	0.515	0		0	-100%
Abra tenuis	190.5	318.2	0.606	269.9	467.6	0.307	- 49%
Scrobicularia cottardi	94.4	80.3	1.459	95.3	89.8	1.248	- 14%
Nereis diversicolor	889.0	672.0	4.185	333.4	318.0	2.958	- 29%
Chironomid larvae	25.4	53.5	0.015	31.8	58.8	0.034	+127%
Total biomass			20.712			15.957	- 24%

Table 5.3 Density and biomass changes in study plot 5 between two sampling dates in March 1981.

	10 March (n = 10)			24 March (n = 8)			% change in biomass
	$n.m^{-2}$	± SD	$g.AFDW.m^{-2}$	$n.m^{-2}$	± SD	$g.AFDW.m^{-2}$	
Gibbula umbilicalis	12.7	40.2	0.493	0		0	-100%
Peringia ulvae	7 633	7 535	5.572	10 827	4 791	7.254	+ 30%
Nassa pfeifferi	317.5	248.7	6.090	158.8	232.7	3.965	- 35%
Cerastoderma edule	38.1	61.3	2.726	47.6	65.7	3.340	+ 22%
Abra tenuis	508.0	803.2	1.615	79.4	134.7	0.093	- 94%
Scrobicularia cottardi	50.8	160.6	0.777	0		0	-100%
Nereis diversicolor	749.3	611.8	4.538	365.1	283.5	4.667	+ 3%
Chironomid larvae	25.4	53.5	0.015	47.6	94.5	0.051	+240%
Total biomass			21.826			19.370	- 11%

Table 5.4 Density and biomass changes in study plot 10 between two sampling dates in March 1981.

In Figure 5.6 the size frequency distributions of *N. diversicolor* in the two plots on the two dates, are given. Most of the Ragworms had lengths between 1 and 5 cm but some were longer, up to 10 cm. If we consider the Ragworms with lengths of 1 to 5 cm to belong to one age group (or cohort), we can calculate mean weights and densities of this cohort on the successive sampling dates. From these, estimates for production (ΔP) and mortality (ΔM) during the period can be obtained, using the methods outlined by Crisp (1971). Thus, with this calculation-method, we can tentatively separate production and predation (obviously related to mortality) of a species during a certain period. The way the calculations are carried out and the results are presented in Table 5.5. Estimated mortality (possibly due to predation by waders and, perhaps, by fishes) was one and a half to twice as high as production during the period of two weeks in March. This suggests that the production rate cannot match the predation pressure at this site during this time of the year. Obviously, the results are not more than indicative, as the methods of calculation have several shortcomings. For instance, size-selective predation (which probably occurs) will influence the outcome of the calculations. If waders selected the largest worms of the cohort, both production and mortality would have been under-

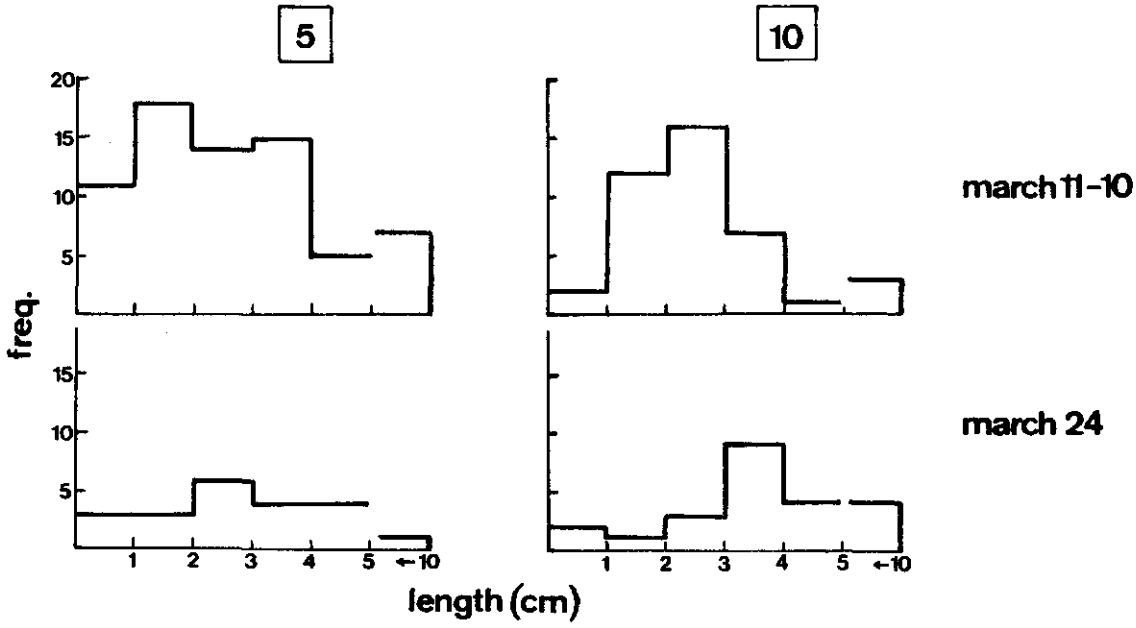


Figure 5.6. Length frequency distributions of *Nereis diversicolor* at study plots 5 and 10 on two dates.

	w	N	N x w	$\bar{N}$	$\bar{w}$	$-\Delta N$	Δw	ΔP $(=\bar{N}\Delta w)$	ΔM $(-\bar{w}\Delta N)$
date	mean ind. weight in mg	density $n.m^{-2}$	biomass $g.AFDW.m^{-2}$	average number	aver.mean weight in mg	$n.m^{-2}$	mg	$g.AFDW.m^{-2}$	$g.AFDW.m^{-2}$
Plot 5									
March 11	5.996	791	4.743	-	-	-	-	-	-
March 24	7.915	317	2.509	554	6.956	474	1.919	1.063	3.297
Plot 10									
March 10	5.639	695	3.919	-	-	-	-	-	-
March 24	9.587	302	2.895	497	7.613	383	3.948	1.962	2.915

Table 5.5 Growth and survival of a population of *Nereis diversicolor* on an intertidal area at Sidi Moussa (Morocco) during two weeks in March 1981, measured at two study plots of 0.04 ha each. The calculation method follows Crisp (1971).

estimated. If waders took relatively more of the smallest worms, the opposite would be the case. Perhaps, the main shortcoming may be that the way of distinguishing between cohorts is not very accurate in this case. However, letting this criticism pass for a moment, we can ask ourselves whether the production rates are relatively low (and whether this is the reason for mortality rates being so much higher), or if they are already elevated at this time of the year. An indication can be obtained by calculating the daily turnover ratio (P/B(day) ratio). For plot 5 (with a daily Ragworm production of 1.063/13 = 0.082 g.AFDW.day^{-1}), P/B(day) = 0.082/3.626 = 0.0226. In the case of plot 10 (with a daily Ragworm production of 1.962/14 = 0.140 g.AFDW.day^{-1}), P/B(day) = 0.140/3.407 = 0.04109. Chambers & Milne (1975) and Heip & Herman (1979) give annual P/B ratios for *Nereis diversicolor* of 1.8 and 2.5,respectively. If we assume a growing season of 180 days in both cases, we arrive at daily turnover ratios of 0.010 and 0.014, respectively. This may indicate that the production rates of the Ragworm at Sidi Moussa can be considered to be relatively high during this period in March.

We hope to follow these lines in April 1982, using better size measurements (e.g. body width), and more accurate estimations of density, together with visual observations on foraging birds, to obtain an indication of size-selectivity of the predators.

	n.m^{-2}	±	SD	g.AFDW.m^{-2}
Peringia ulvae	20 180.0		10 991.0	14.33
Cerastoderma edule	12.7		40.2	0.07
Abra tenuis	266.7		356.5	0.24
Nereis diversicolor	63.5		89.8	0.14
small polychaete spec.	76.2		241.0	0.05
insect larvae *(Chironomidae)*	12.7		40.2	0.01
Total biomass				14.84

Table 5.6 Density and biomass of macrobenthic invertebrates of the mudflat of Sidi Moussa, middle part channel. Densities are the means of the results of 10 samples.

5.3.2 Sidi Moussa, middle part of the channel

Along the middle part of the channel, elongated intertidal flats are found, with a little growth of *Ulva* spec. and, more extensively, eelgrass (*Zostera* spec.). The substrate consisted of sandy mud. Seven macrobenthic invertebrate species live on the site (Table 5.1). Compared with the other intertidal sites, this area looks rather impoverished. Over 96% of the biomass of about 15 g.AFDW.m^{-2} is provided by *Peringia ulvae* (Table 5.6).

5.3.3 Sidi Moussa, southern part of the channel

In the sandy substrate, and between the eelgrass vegetation of the intertidal flats near the mouth of the estuary, 22 invertebrate species live on the site (Table 5.1). Although biomass values were low (Tables 5.7 and 5.8) the polychaete and crustacean fauna was rich in species, many of them living within the eelgrass vegetation. Snails (*Gibbula umbilicalis* and *Nassa pfeifferi*) contributed about 90% of the macro- (epi-) benthic biomass in the eelgrass cover of the flats (Table 5.8).

An undescribed isopod species was found in our material from this site, belonging even to an undescribed genus! The genus is called *Monodanthura* (after Théodore Monod) and the species *Monodanthura maroccana* nov.gen.nov. spec. (Wägele & Platvoet 1982). For more information, see Appendix 5.

	n.m^{-2}	±	SD	g.AFDW.m^{-2}
Nassa pfeifferi	10.6		36.7	0.13
small polychaete spec.	1 375.8		1 609.0	0.76
amphipods	74.1		157.5	0.04
isopods	105.8		169.8	0.11
insect larvae	21.2		73.3	0.01
Total biomass				1.05

Table 5.7 Density and biomass of macrobenthic invertebrates of the sandflat of Sidi Moussa, south channel, an intertidal area lightly covered (± 10%) with eelgrass (*Zostera* spec.). Densities are the means of the results of 12 samples.

	$n.m^{-2}$	$g.AFDW.m^{-2}$
Gibbula umbilicalis	270	4.3
Peringia ulvae	10	-
Nassa pfeifferi	230	2.9
amphipods	160	0.1
isopods	140	0.1
Palaemon serratus (prawns)	80	0.4
brittle stars *(Ophiuroidea)*	100	0.3
Total biomass		8.1

Table 5.8 Numbers and biomass of some invertebrates living between the eelgrass-leaves on 1 m^2 sandflat, heavily covered (C.90%) with eelgrass at Sidi Moussa, south channel. Numbers were obtained by sorting out the eelgrass growing on 0.5 m^2 sandflat.

5.3.4 Merja Zerga, mudflats

On two locations on the (soft) mudflats in the western half of Merja Zerga (Figure 3.7), 10 bottom samples were taken. On one location (probably slightly brackish) 3 species were found and on the other site 5 species (Table 5.9). Biomass values were moderately high (20 and 25 $g.AFDW.m^{-2}$, respectively) and were mainly composed of *Cerastoderma glaucum* and *Scrobicularia cottardi* on the first site and *S. plana* on the second. The relative size frequency distribution of *S. plana* is given in Figure 5.7. On the sandier mudflats near Moulay Bousselham some other species were found with the help of local people (Table 5.1), but the densities of these were not quantified. In the brackish, soft muddy southeastern part of Merja Zerga we saw Grey Plovers taking large polychaetes, which are probably specimens of *Nereis diversicolor*.

	Merja Zerga, southwest (1)			Merja Zerga, west (2)		
	$n.m^{-2}$ ±	SD	$g.AFDW.m^{-2}$	$n.m^{-2}$ ±	SD	$g.AFDW.m^{-2}$
Haminea temarana				12.7	40.0	0.05
Cerastoderma glaucum	152.4	205.7	13.99			
Abra tenuis				114.3	152.0	0.05
Scrobicularia plana				1 104.9	423.5	24.19
Scrobicularia cottardi	165.1	104.6	5.60	139.7	184.0	1.21
Cyathura carinata	12.7	40.2	0.01	63.5	89.8	0.04
Total biomass			19.60			25.54

Table 5.9 Density and biomass of macrobenthic invertebrates on the mudflats of Merja Zerga on 1 April 1981. Means of the results of 10 samples at each site are given.

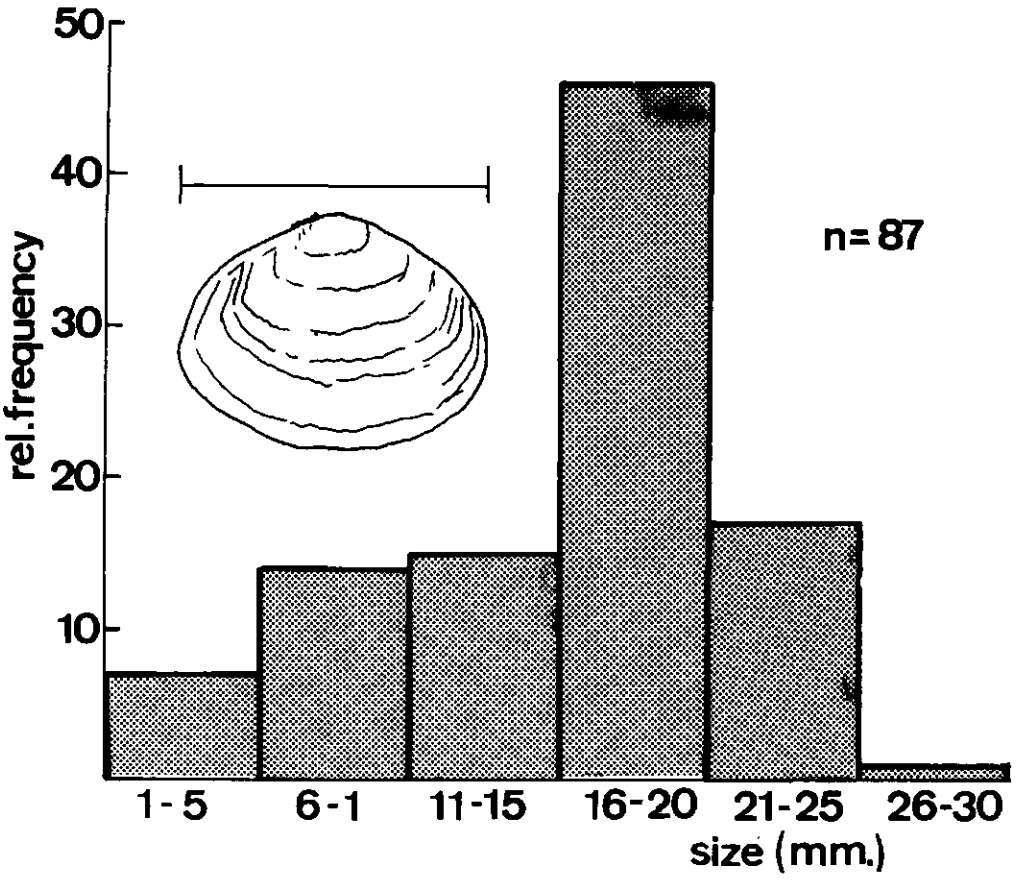


Figure 5.7. Relative frequency distribution of the size of *Scrobicularia plana* at the Merja Zerga, 1 April 1981.

5.3.5 Merja Zerga, channel

The fishermen of Moulay Bou Selham and Douar Riah caught their fish with nets which occasionally scraped the bottom of the 3-7 m deep channel, which connects the Merja Zerga with the Atlantic Ocean. Therefore, 7 macrobenthic species living subtidally, could be collected as catch remains in the rowing boats. These species are listed in Table 5.1.

Mudsampling at Sidi Moussa.

6 NOTE ON THE CATCHING OF WADERS

An important part of our time at Sidi Moussa we spent catching waders: a total of 26 nights. Apart from the first and last night of our stay, we did not catch on two other nights. In total 652 waders, presented in Table 6.1 and including retraps and controls, were not sly enough to avoid our mist-nets. Appendix 3 gives a survey of the numbers of waders caught per day.

		Newly ringed	Controls	Retraps	Totals
Black-winged Stilt	*Himantopus himantopus*	2			2
Avocet	*Recurvirostra avosetta*	1			1
Ringed Plover	*Charadrius hiaticula*	4	1		42
Kentish Plover	*Charadrius alexandrinus*	19	1		20
Grey Plover	*Pluvialis squatarola*	5		1	6
Knot	*Calidris canutus*	6			6
Little Stint	*Calidris minuta*	24			24
Curlew Sandpiper	*Calidris ferruginea*	12		1	13
Dunlin	*Calidris alpina*	391	20	5	416
Ruff	*Philomachus pugnax*	4			4
Snipe	*Gallinago gallinago*	2			2
Redshank	*Tringa totanus*	88	7	7	102
Greenshank	*Tringa nebularia*	5			5
Common Sandpiper	*Actitis hypoleucos*	1			1
Turnstone	*Arenaria interpres*	8			8
Totals		609	29	14	652

Table 6.1 Numbers of waders caught at the Sidi Moussa saltpan complex from 1 to 28 March 1981. Note that this list deviates slightly from the figures given earlier by Kersten et al. (1981). The figures listed above, form the definitive list!

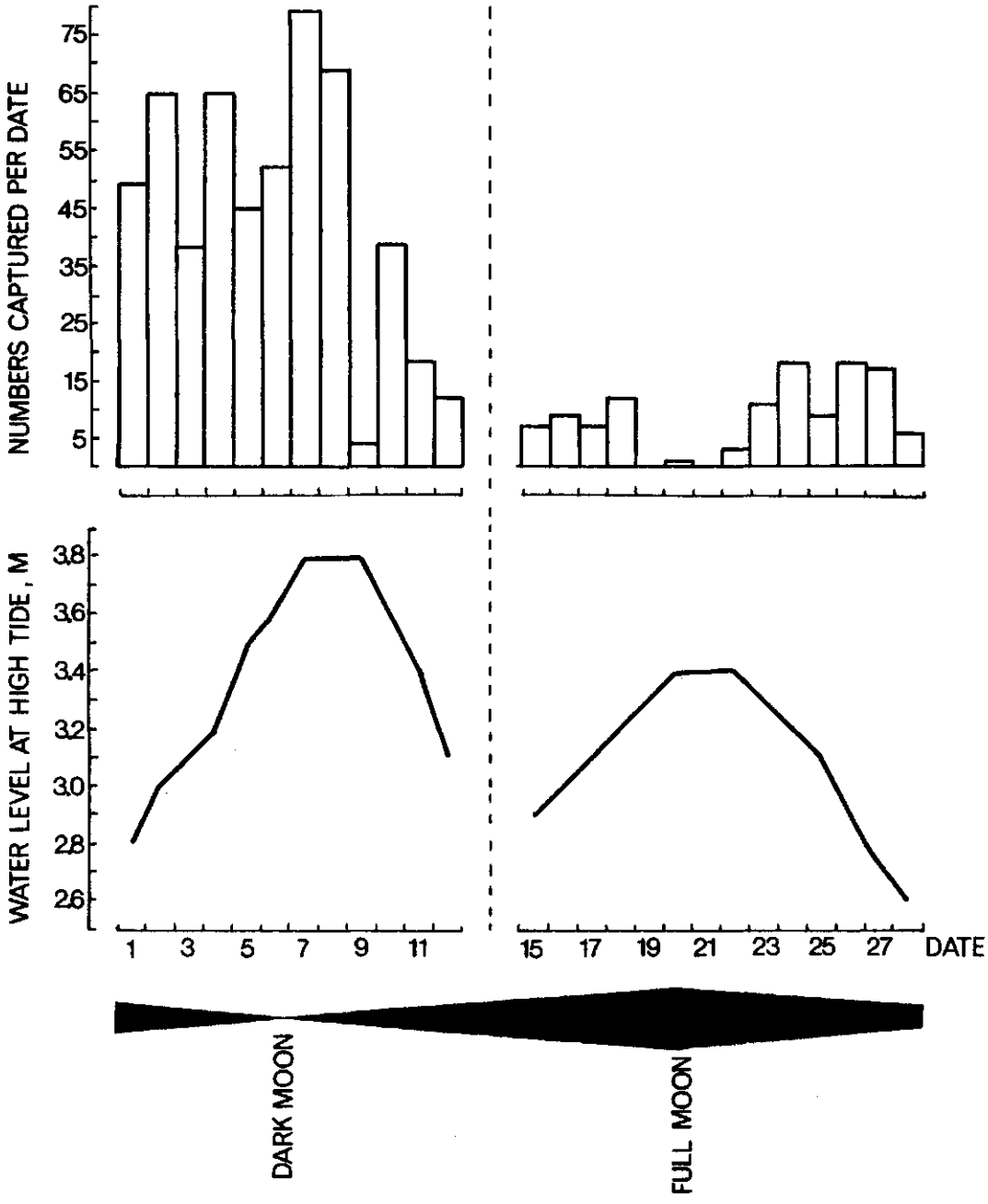


Figure 6.1 Numbers of waders caught in March 1981 in relation to moonlight and water level at high tide. For more information on water levels, see also Table 3.1.

All nets were put in the non-tidal area (see Figure 3.3). In addition to high-tide roosts in the tidal area, the birds also formed high-tide roosts in this area. These latter roosts became more important in periods with high tides. In the lagoon in front of our camp, where we put most of our nets, the possibilities to do so were limited by the depth of the water, which was often more than 60 cm. The location of the nets in this area was more or less constant during the whole catching period. Once we moved them a short distance, when the bottom had deteriorated so much that walking along the nets was very difficult. In the saltpans we moved the nets regularly. The saltpans were either dry or held a maximum of 30 cm water. During one of the last nights, four nets were stolen.

We started to catch during a dark-moon period and a period of increasing water levels at high-tide (Figure 6.1). Results during the first 10 nights were good. After that period the nights became lighter because it became full-moon. In addition, the water levels at high-tide decreased (Figure 6.1). Hence, the birds had more possibilities to roost in the tidal area during high-tide. Accordingly, the catching results were bad. During the full-moon period, high-tide water levels increased again, but did not reach the 'dark-moon-period-levels'. There was no improvement of the catching results. Undoubtedly the disturbance in the area caused by our nightly activities will also have played a role in the decrease of the numbers of waders caught.

During most nights 20 mist-nets were used, each 12 m long. We mostly worked in groups consisting of two persons. One group worked the first part of the night, the other group the second part. In this way nobody lost his night's rest entirely and sufficient fitness remained for other activities. Nets were controlled at night at approximately two hours intervals. After taking the birds from the nets they were brought to our camp-site where they were kept in plastic crates. How the birds were handled can be read in Chapter 7. On average we completed our catching activities at nine o'clock a.m. During the day the nets were closed only if there was a strong wind, so we sometimes caught a wader by day. Table 6.2 lists the details of birds controlled by us and ringed previously at Sidi Moussa or elsewhere.

Besides 652 waders, we also caught, as a hobby, 200 passerines in the shrubs around the camp. When the nets were set they were controlled every 45 minutes. Captured birds were weighed and ringed. The results are included in Chapter 10. By using the nets for these activities, two problems were met. Many beetles were caught when the nets were closed shortly before sundown. It was very difficult to free these animals from the nets. We also had to be alert to grazing sheep and cattle. When they encountered the nets, they did not avoid them, but tried to get through them! Some nets were severely damaged by this behaviour.

		Ringing details			
Species	Ring number	Date	Place	Age	Date of control
Ringed Plover	Paris SA 621805	16-9-1980	Sidi Moussa, Morocco	4	8-3-1981
Kentish Plover	Paris SA 621800	16-9-1980	ditto	3	7-3-1981
Dunlin	Paris SA 621694	14-9-1980	ditto	3	1-3-1981
Dunlin	Paris SA 621846	16-9-1980	ditto	4	1-3-1981
Dunlin	Paris SA 621750	14-9-1980	ditto	?	2-3-1981
Dunlin	Paris SA 556050	4-11-1979	ditto	2	4-3-1981
Dunlin	Paris SA 621880	17-9-1980	ditto	3	4-3-1981
Dunlin	Paris SA 621881	17-9-1980	ditto	3	4-3-1981
Dunlin	London BX 71307	3-5-1977	Collister Pill, Newport Gwent Wales 51.34 N 02.48 W	6	4-3-1981
Dunlin	Paris SA 621325	7-9-1980	Sidi Moussa, Morocco	3	4-3-1981
Dunlin	Paris SA 621714	14-9-1980	ditto	3	5-3-1981
Dunlin	Paris SA 621350	7-9-1980	ditto	3	5-3-1981
Dunlin	Paris SA 621431	8-9-1980	ditto	3	7-3-1981
Dunlin	Paris SA 621792	15-9-1980	ditto	3	7-3-1981
Dunlin	Paris SA 621443	8-9-1980	ditto	3	7-3-1981
Dunlin	Paris SA 606025	11-10-1978	Oued Massa, Morocco 30.02 N 09.39 W	2	7-3-1981
Dunlin	Paris SA 621607	12-9-1980	Sidi Moussa, Morocco	4	8-3-1981
Dunlin	Paris SA 621757	14-9-1980	ditto	4	8-3-1981
Dunlin	London BX 14533	10-9-1972	ditto	4	8-3-1981
Dunlin	Paris SA 607030	5-9-1980	ditto	3	9-3-1981
Dunlin	Paris JA 301633	19-10-1980	ditto	2	26-3-1981
Dunlin	Stockholm 3322275	18-9-1976	Ottenby,Oland,Sweden 56.12 N 16.24 E		27-3-1981
	Hiddensee 83054683	1-8-1977	Bessin,Hiddensee,Rügen,DDR 54.35 N 13.09 E		
		controlled again: 25-7-1979 at Ottenby,Oland Sweden			
Redshank	Paris GF 22623	18-9-1980	Sidi Moussa, Morocco	4	2-3-1981
Redshank	Paris GF 22620	18-9-1980	ditto	4	2-3-1981
Redshank	Paris GF 22796	15-9-1980	ditto	3	2-3-1981
Redshank	Paris GF 22613	17-9-1980	ditto	4	4-3-1981
Redshank	Paris GF 22628	18-9-1980	ditto	4	4-3-1981
Redshank	Copenhagen 6058518	8-7-1980	Af landshage, Amager Sjaelland Denmark 55.33 N 12.36 E	2	6-3-1981
Redshank	Paris GF 22612	17-9-1980	Sidi Moussa, Morocco	4	26-3-1981

Table 6.2 List of waders controlled during the Netherlands Morocco Expedition 1981. All birds were controlled at Sidi Moussa, El Jadida, Morocco 32.50 N 08.46 W. Age in Euring code (2= full grown, unknown age; 3= 1 st calendar year; 4= after 1 st calendar year; 5= 2 nd calendar year; 6= after 2 nd calendar year).

7 WADER STUDIES

7.1 Introduction

Most of the information collected on waders during the expedition will be summarized in this chapter. The data will be presented separately for the different species. Only wader species (listed below) for which sufficient information was available are dealt with in this chapter. Data for other species are incorporated in the Avifauna (Chapter 10).

List of species:

7.2 Methods

7.2.1 Counts

Between 1 March and 26 March we counted the numbers of waders and waterfowl in the study area (Figure 3.3) five times. All counts were carried out within two hours either side of high tide. The results are given in Appendix 1. Results of supplementary counts in Merja Zerga and in a small area of artificial saltpans about one km to the north of our study area, are given in Appendix 2.

7.2.2 Catching

A total of 631 waders were caught, with mist-nets, in the study area (see details in preceding chapter). Catching activities were restricted to the southern part of the salt-pan area and most birds were caught in the abandoned saltpans in front of the camp site (Figure 3.3). Appendix 3 gives the numbers caught each night.

After capture, the birds were brought to the camp site where they were weighed and ringed immediately in order to keep the difference between the weight at capture and at the time of our measurement as small as possible. After all the birds had been weighed, did we start the rest of processing. The following data were collected:

Age and sex determination whenever possible, following the criteria given by Prater et al. (1977). Though at the time of our study (March) birds which were born in 1980 were already in their second calendar year, for reasons of convenience we will refer to these birds as juveniles, whereas older birds are referred to as adults. Since in many species the differences between adults and juveniles become less pronounced in the course of the winter, many birds could not be classified according to age.

Moult Every bird was checked for growing tail- and flight-feathers. Because of the time of the year this moult was noted only incidentally. When moult was noticed we classified growing primaries according to the widely used 5-point system (Ginn & Melville 1983). In addition, we looked for moult of body feathers on the breast and belly which was scored as either absent, light, medium or heavy.

State of the plumage (as between winter and summer; i.e. outfit) was scored according to the instructions for the Wader Study Group data forms.

Wing-, bill-, and total head length Wing length was measured by the maximum chord method (Evans 1964) to the nearest mm. The bill was measured to the nearest 0.1 mm from the tip of the upper mandible to the feather-margin. In addition, total head length was taken with the same accuracy from the tip of the bill to the dorsal end of the head as described by Green (1980), since this might produce more consistent results as compared to bill-length measurements. In Redshanks, we also measured nalospi length (Prater et al. 1977).

Weight was measured with Pesola spring balances. The accuracy of the readings was within 2% of any particular weight, excluding errors of the observer. Since processing and marking took much time, there was sometimes a significant time interval

between weighing at first handling and at further processing, especially in nights when large catches were made. During those nights we weighed the birds for a second time, the difference giving information on the rate of weight loss. The weights used in the analysis are always the first measurements.

7.2.3 Marking

The majority of the birds were marked with colour dye and a coloured plastic tape around the ring. Different colour combinations of dye and tape were used to identify the dates of capture. Since sample sizes were rather small for most species we pooled the date specific combinations into four longer periods coinciding with the intervals between the counts (Table 7.1). Table 7.2 gives for each species the number that was marked in each period.

We differentiated between relatively light and heavy birds by putting the dye on breast and belly for heavy birds and on the underparts behind the legs for light birds. The criteria for classifying birds as being heavy or light are given in Table 7.3 and were chosen such that we expected (hoped) that about half of the number caught, belonged to either category.

Table 7.1 Colour combinations of dye and tape used on different days.

Dates	Colour dye	Colour tape	Period
1 March- 3 March	methyl-violet	white	A
3 March- 5 March	methyl-violet	red	A
5 March- 8 March	methyl-violet	green	A
9 March-12 March	methyl-violet	yellow	B
18 March-19 March	Sevron-blue	white	C
22 March-24 March	Sevron-blue	red	D
24 March-27 March	Sevron-blue	green	D

Table 7.2 Numbers of waders marked and released in different periods.

Species	Period				Total
	A 1-8 March	B 9-12 March	C 18-19 March	D 22-27 March	
Ringed Plover	29	7		2	38
Kentish Plover	4	1		10	15
Grey Plover	3	1	1		5
Knot	3		2		5
Little Stint	10	5		6	21
Curlew Sandpiper	8	1		2	11
Dunlin	287	25	10	30	352
Redshank	46	6	4	19	75
Turnstone	1		3	3	7

Table 7.3 Weight criteria for heavy birds. Birds that weighed less than the given figure were marked as light ones.

Species	Weight criteria for heavy birds
Ringed Plover	≥ 53 g
Kentish Plover	≥ 35 g
Grey Plover	≥ 200 g
Knot	≥ 120 g
Little Stint	≥ 22 g
Curlew Sandpiper	≥ 50 g
Dunlin	≥ 43 g
Redshank	≥ 120 g
Turnstone	≥ 105 g

7.2.4 Marked bird samples

The proportion of marked birds in the study area was sampled simultaneously with the counts and again on the first day following the counts. Most data were collected while the birds were feeding on the mudflats. Additional observations were made in the saltpans during high water. With telescopes, we looked at as many birds as possible to check whether they were marked or not. Sample size, number of marked birds and details of the marks were recorded.

Unfortunately, the dye sometimes faded away very quickly. This was especially true for the 7% methyl-violet solution that we used during the first three days. After we discovered this, a saturated solution was applied which held much better (Figure 7.1). Fortunately the tapes lasted very well. Only once did we observe a bird that was dyed but lacked its tape. This might have been one out of two birds that escaped between dyeing and taping. As a consequence all our sampling efforts were directed to the tapes. Whenever a marked bird was observed that lacked the dye, it was thought to have been dyed with methyl-violet and dated accordingly. Since Sevron-blue held much better and was used only a few days prior to our departure, misinterpretations are very unlikely.

For each species the number of marked birds still present in the study area was estimated by:

$$\hat{M} = N\ (M/S) \qquad (1)$$

where, $\hat{M}$ is the estimated number of marked birds, N is the total number of birds counted in the study area, S is the sample size and M is the number of marked birds in the sample. The difference between $\hat{M}$ and the cumulative number of birds that were marked and released up to that particular date "R", gives the number of marked birds that left the study area in the period between marking and sampling.

We define emigration as the total number of birds that left the study area between two consecutive counts and immigration as the number that entered the area. Assuming that all the birds that were marked during the interval between two counts were already present at the time of the first count, we calculated emigration from the formula

$$\text{Emigration} = N_1 \left(1 - \frac{\hat{M}_2}{\hat{M}_1 + R_2 - R_1}\right) \qquad (2)$$

N_1 (and N_2) are the numbers counted in the study area during the first and the second count respectively, $\hat{M}_1$ and $\hat{M}_2$ are calculated from formula (1) for both days and the difference "$R_2 - R_1$" is the additional number of birds marked and released between the two counts. The ratio $\hat{M}_2/(\hat{M}_1 + R_2 - R_1)$ defines the fraction of marked birds that stayed in the study area and consequently $1 - (\hat{M}_2/(\hat{M}_1 + R_2 - R_1))$ is the fraction of marked birds which left. When there is no emigration then $\hat{M}_2 = M_1 + R_2 - R_1$.

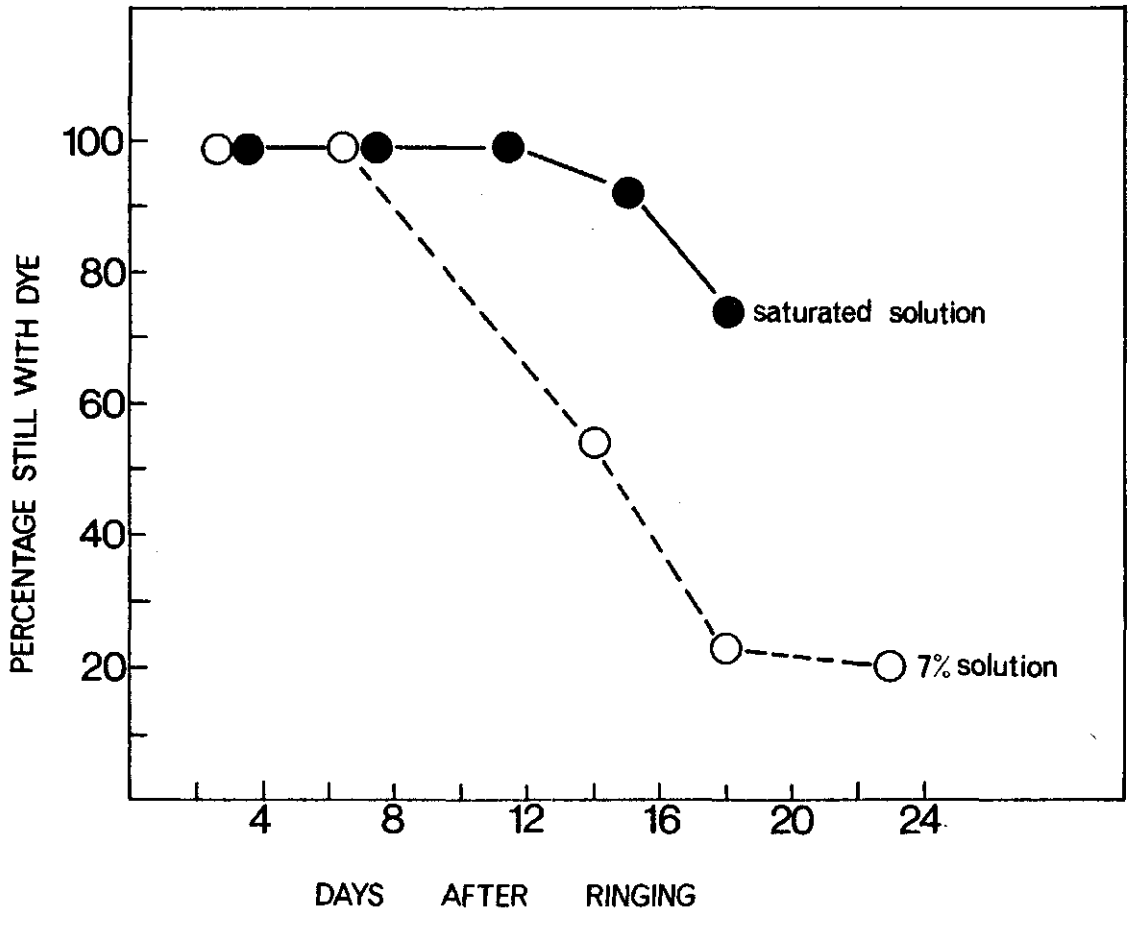


Figure 7.1 Fading away of two alcohol-solutions of the methyl-violet dye. Birds from which the dye had faded could still be recognized by date specific coloured tapes around the ring.

The assumption that all the marked birds were already present during the first count is usually not completely met. However, deviations do not cause serious problems when the number of birds entering the area is small compared to the number that stayed, which is thought to be the case when the time interval between the two counts is short.

Immigration (defined as the number of birds entering the study area between two counts) is calculated by:

$$\text{Immigration} = N_2 - N_1 + \text{Emigration} \qquad (3)$$

This can be shown easily since $N_2 = N_1$ - Emigration + Immigration. Here we assume that no birds left the area in the same period as they arrived. Otherwise this causes an underestimation, but the error is probably small when the period is short. Sources of errors are discussed in detail elsewhere (Kersten & Smit 1983).

7.2.5 Analysis of body composition

Some birds did not survive capture and handling. For most of these birds this was probably due to their poor condition, since the sample of dead birds was strongly biassed towards birds with very low body weights. The sample size was increased by dead or injured birds brought to us by local people. All these birds were measured and sexed. The right-sided breast muscles (pectoralis and supracoracoïdeus) were removed from the body. Subsequently lean dry weight and fat weight of the carcasses were determined.

Carcasses and breast muscles were dried in a small oven heated by a gas flame for two days at about 60°C. They were then stored in dark containers filled partially with silica-gel in order to keep the carcasses dry and the decomposition to a minimum. In the laboratory, some weeks later, carcasses and muscles were dried again for one day at 60°C. Afterwards dry weights were determined on a Mettler balance to an accuracy of 0.1 g. Fat was extracted from the dry carcasses and breast muscles with petroleum-ether (boiling traject 40 - 60°C) in a Soxhlet-apparatus for two days. After extraction they were dried again and the lean dry weight measured. The amount of fat in a bird was calculated from the difference between dry weight and lean dry weight. The raw data are given in Appendix 4.

7.2.6 Low tide counts

Waders were counted every half an hour during the diurnal low tide periods of 12, 13, 14, 20 and 21 March on a mudflat area in the northern part of the estuary (see Chapter 5 for a description). We noted if waders were

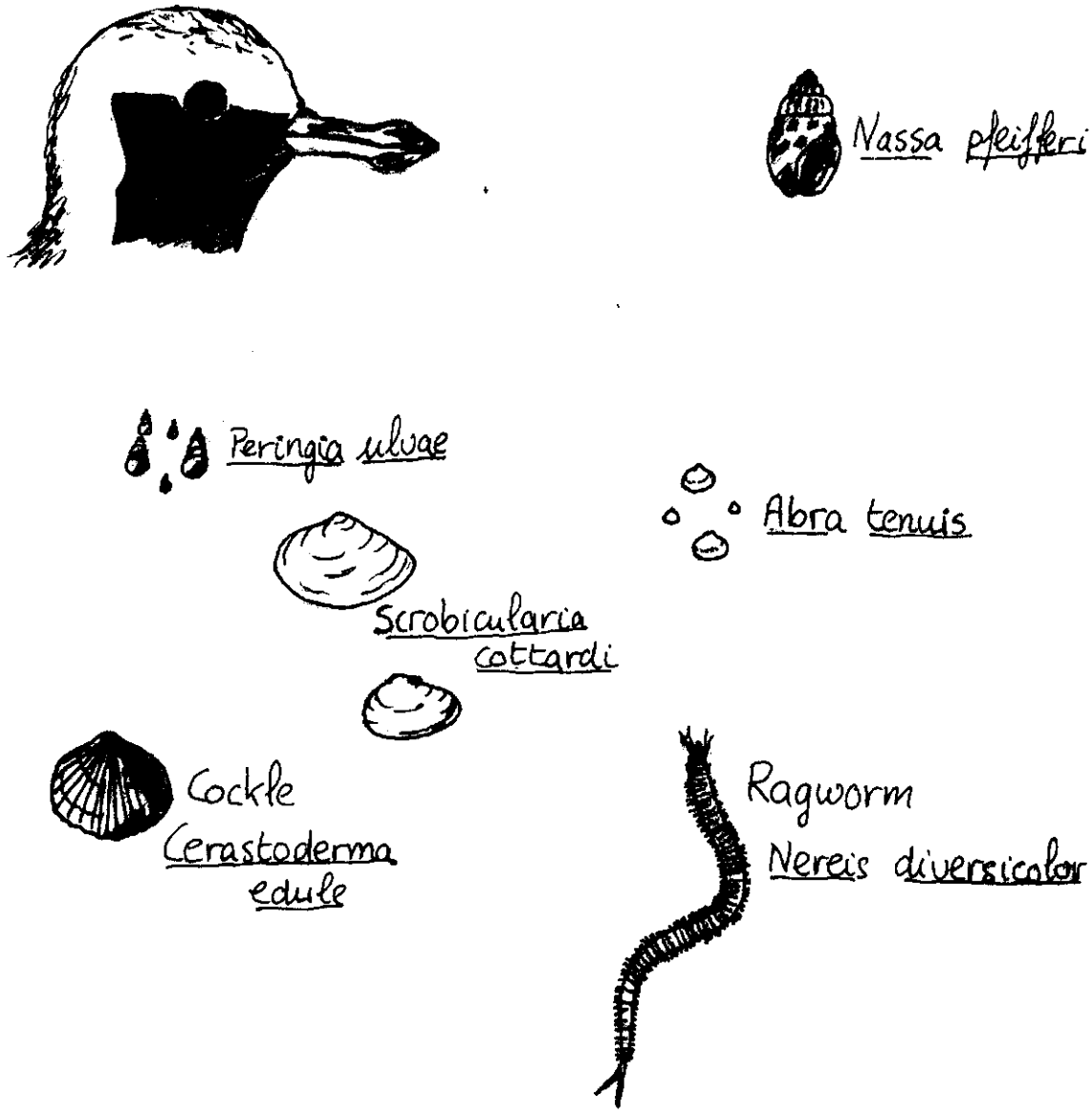
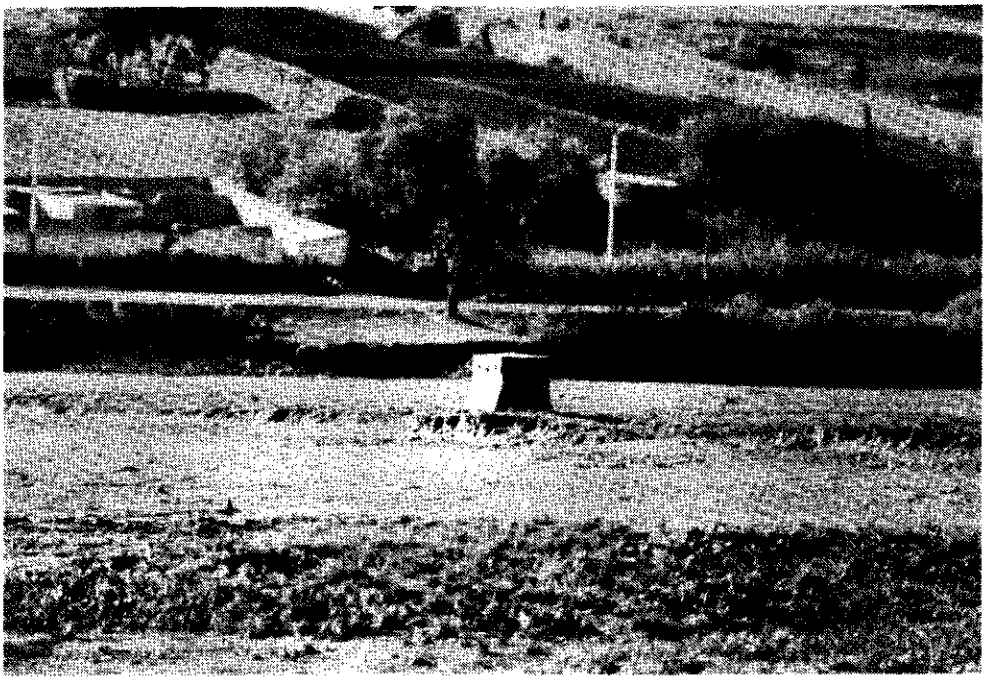


Figure 7.2 Food items of waders foraging on the intertidal area at Sidi Moussa. The animals are drawn to scale. The length of the bill of a Grey Plover is 3 cm.

foraging or not (resting or preening). The data for the different days were assembled according to the time relative to the moment of low tide. This allowed us to calculate densities of waders during an average low water period and the percentage of birds foraging. The last parameter is assumed to indicate the time spent foraging by 'average' individual birds.

7.2.7 Observations on foraging

On several days foraging waders were studied at low tide on the intertidal mudflats in the northern part of the estuary and occasionally in the saltpans. We described method of foraging and when possible tried to determine prey choice (see Figure 7.2). In addition,we sometimes tried to get some information on feeding rates using a stopwatch. During all observations we used a 15X - 60X telescope.



The observation hide near the 0.4 ha study plot in the northern part of the intertidal area at Sidi Moussa.

7.3 Ringed Plover *Charadrius hiaticula*

7.3.1 Numbers and migration

The numbers of Ringed Plovers in the study area declined slowly from 372 birds on 1 March to 258 birds on 26 March. About half the population spent the high water period in the salines (Figure 7.3).

The results of the marked bird samples show that marked birds were leaving the area up to 17/18 March and again between 21/22 and 26/27 March (Table 7.4). On this last date we estimated that only 29% of the total number marked were still in the study area. So there must have been considerable emigration.

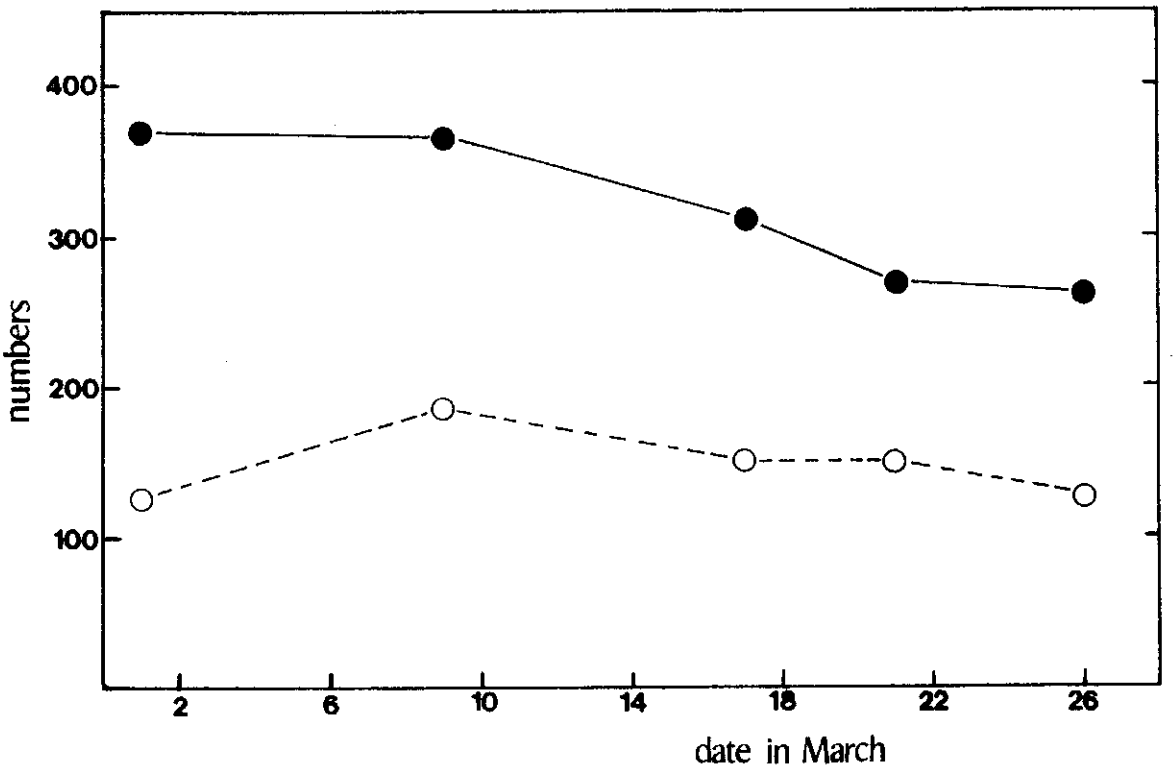


Figure 7.3 Numbers of Ringed Plovers counted in the Sidi Moussa study area. Closed dots denote total numbers and open dots numbers roosting in the salt-pans during high tide.

Table 7.4 Results of the marked bird samples for Ringed Plovers.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in the study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	114	6	6A	19	29
17/18	134	9	7A, 2?	21	36
21/22	136	11	9A, 1B, 1?	21	36
26/27	139	6	4A, 1B, 1?	11	38

Most birds were marked during the first period, 1-9 March, and they could be distinguished from the others by their colour combinations. If we assume that these birds form an unbiassed independent sample of the population in the study area on 1 March, we are able to calculate which part of that population was still present on the following counting dates. The results (Figure 7.4) show that the number of "first of March birds" dropped between 1 March and 9 March, remained remarkably constant up to 21 March and dropped again after that date. It is also apparent that other birds entered the area between 1 March and 9 March since the total number remained nearly constant between these dates. According to our calculations, all these new birds must have left the area before 21 March since on that day almost all birds in the study area were thought to be already present on 1 March.

This indicates that different groups of Ringed Plovers followed different migratory strategies. Some 250 birds stayed for a rather long time. They were already present on 1 March and started to leave the area from 21 March onwards. These birds stayed for at least three weeks, but it is also possible that they belonged to the wintering population.

The rest of the Ringed Plovers are transitory birds which stayed for a much shorter time. All transitory birds that were marked during the first week of March had already left the area on 9 March. The number of birds marked after this date was too small to determine how long transitory

birds stayed in the area. However, since virtually no transitory birds were present on 21 March, we may conclude that they stayed for at most two weeks but probably for a much shorter period.

The calculated rates of emigration and immigration are shown in Figure 7.5. Throughout the observation period, birds were continuously leaving and entering the area. According to our estimates a total of about 250 new birds arrived, while some 350 birds left. The total number of Ringed Plovers that used the study area between 1 March and 27 March is estimated at 625 birds.

Unexpectedly, a higher proportion of relatively light Ringed Plovers than of heavier birds caught between 1 March and 9 March, left the study area soon after capture (Table 7.5)!

On 8 March we controlled a Ringed Plover which was ringed on 16 September 1980 by the Durham University Sidi Moussa Expedition at the same locality.

In Merja Zerga we looked at 188 Ringed Plovers on 15 March and at 37 birds on 1 April, but no marked birds were found.

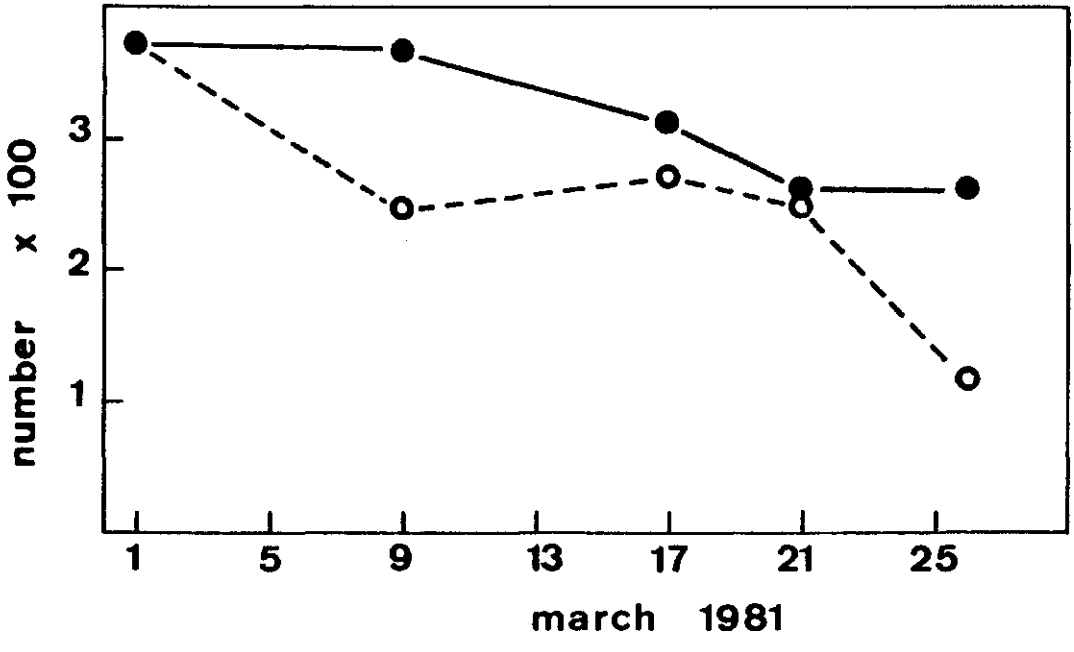


Figure 7.4 Total numbers of Ringed Plovers counted in the Sidi Moussa study area (closed dots) and the estimated numbers of the birds present on 1 March that remained in the study area (open dots).

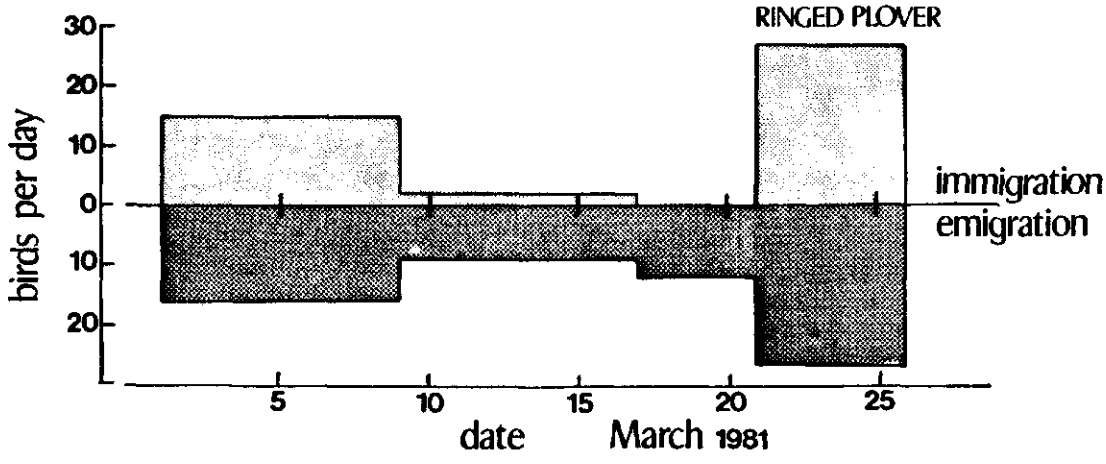


Figure 7.5 Migration rate (in birds per day) of Ringed Plovers through the Sidi Moussa study area in different periods in March 1981.

Table 7.5 Differences in emigration of light and heavy Ringed Plovers caught between 1 and 9 March. The expected values were calculated under the assumption that the likelihoods of departure were equal for light and heavy birds.

	Weight (g)		
	⩾ 53	< 53	
marked, 1-9 March	10	19	
observed, 9-26 March	14	12	$X^2 = 4.31$, $p < 0.05$
expected	9	17	

7.3.2 Biometrics

Data on biometrics are given in Table 7.6. Surprisingly, juveniles dominate the population in March, which is quite the reverse from the situation in autumn when adults formed 92% in August-September 1971 and 71% in September 1972 of the catches respectively (Pienkowski 1972 & 1975) and 65% in September 1980 (Moser 1981). Probably juveniles arrive later in NW Africa than adults.

Table 7.6 Biometric data for Ringed Plovers.

	Juveniles (n=29)		Adults (n=4)		All birds (n=41)	
	mean	SD	mean	SD	mean	SD
wing length (mm)	130.9	3.3	131.5	3.7	131.3	3.5
bill length (mm)	14.3	1.0	13.8	1.1	14.2	1.0
total head length (mm)	40.8	0.9	41.0	0.8	40.9	0.9
weight (g)	50.1	4.5	54.5	3.9	51.1	5.0

There is a significant weight difference between adults and juveniles ($p < 0.05$, X^2 test). Mean wing and bill length and bill and total head length are shown in Figure 7.6 and Figure 7.7. Whether the bimodality for total head length is due to differences in sex or geographical origin is still unclear, but age seems to be unimportant.

Weight loss after capture is plotted for 20 juveniles and two adults in Figure 7.8. Juveniles lost weight with a rate of about 0.5 $g.hr^{-1}$. Adults seem to lose weight at a slower rate than juveniles.

Many Ringed Plovers showed active moult of body feathers. The proportion of moulting birds increased from 56% (n=16) between 1 March and 7 March up to 80% (n=25) from 8 March onwards. Moulting birds tended to be heavier than non-moulting ones (Table 7.7), although there was much variation in the weights of non-moulting birds. For instance, two non-moulting Ringed Plovers, weighing 66 g and 60 g, were the heaviest Ringed Plovers caught.

Table 7.7 Moult of body feathers and weights of Ringed Plovers. Weight difference between moulting and non-moulting birds is statistically significant ($p < 0.05$, X^2 test).

Moult of body feathers	n	Weight (g) mean	SD
none	12	48.9	7.3
intermediate	19	51.5	3.3
heavy	9	52.7	4.2

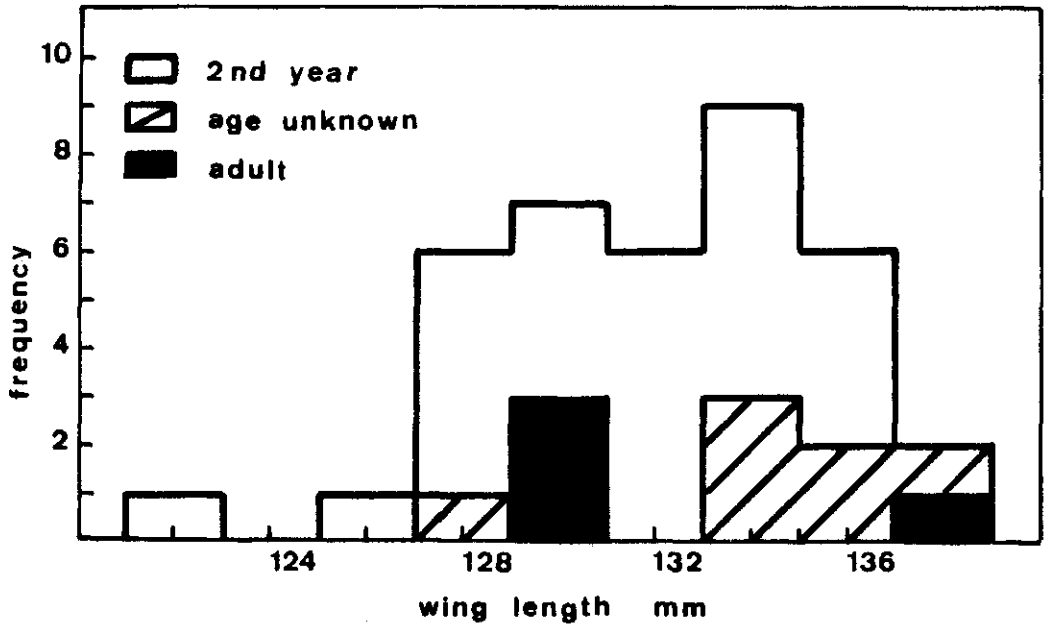


Figure 7.6 Frequency distribution of wing length of Ringed Plovers in Sidi Moussa in March 1981.

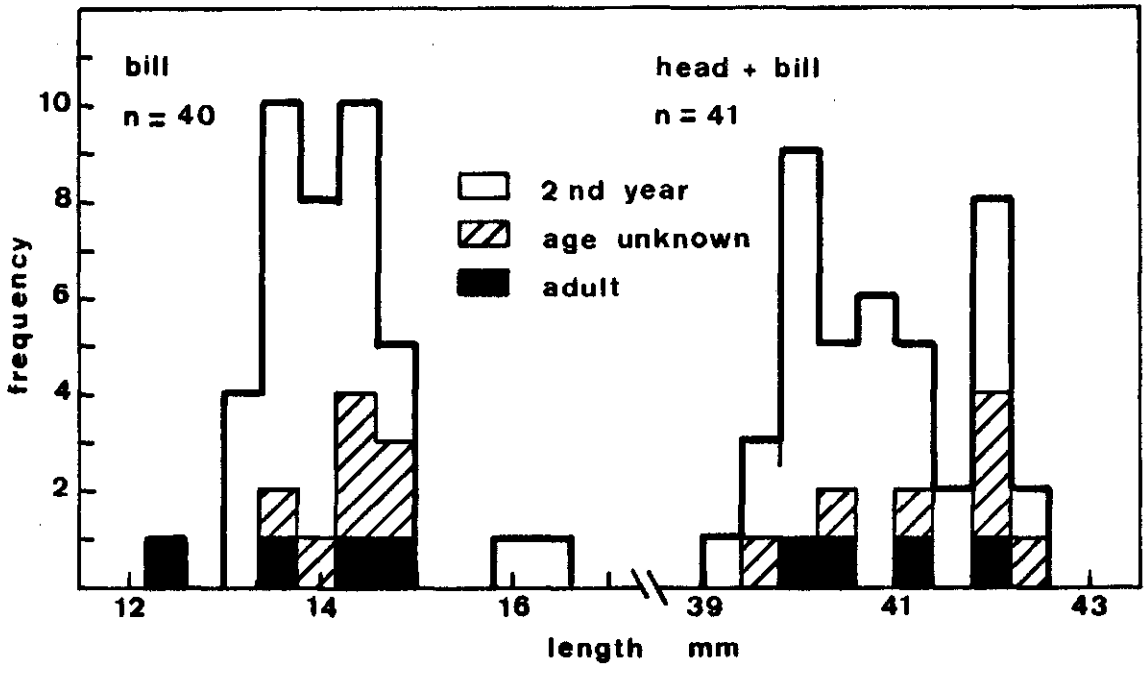


Figure 7.7 Frequency distribution of bill and total head length of Ringed Plovers at Sidi Moussa in March 1981.

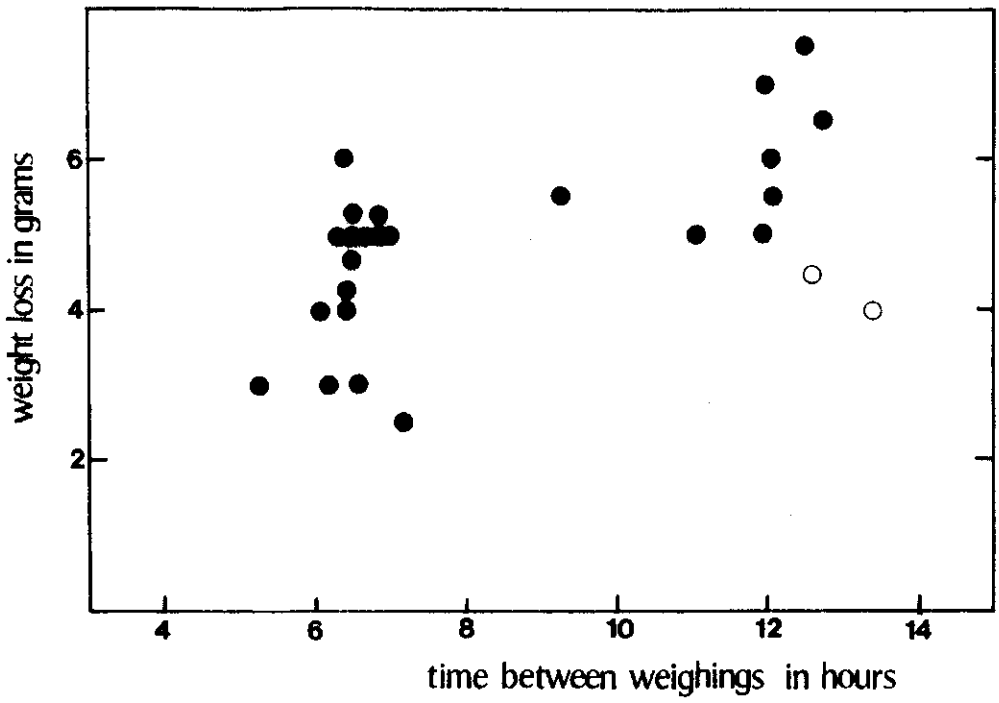


Figure 7.8 Weight loss of Ringed Plovers held in captivity after capture. Closed dots denote juveniles, open dots adults.

Probably we captured these birds just before their departure.

The controlled bird, ringed by the Durham University Sidi Moussa Expedition, weighed 47 g in March, while its weight in September 1980 was 65 g. This shows that weight changes in individual Ringed Plovers may amount up to 40% of the lean weight of the bird!

7.3.3 Body composition

The body composition of two juvenile Ringed Plovers, one male and a female, was analysed. The fresh weight of the male was 53 g and it carried 2.7 g of fat. The female was much lighter, 44 g with only 0.8 g of fat. So, only a small proportion (21%) of the 9 g difference in body weight was due to the weight of body lipids. The rest of the weight difference might be explained by the larger body size of the male as indicated by its longer wing (135 mm versus 128 mm for the female).

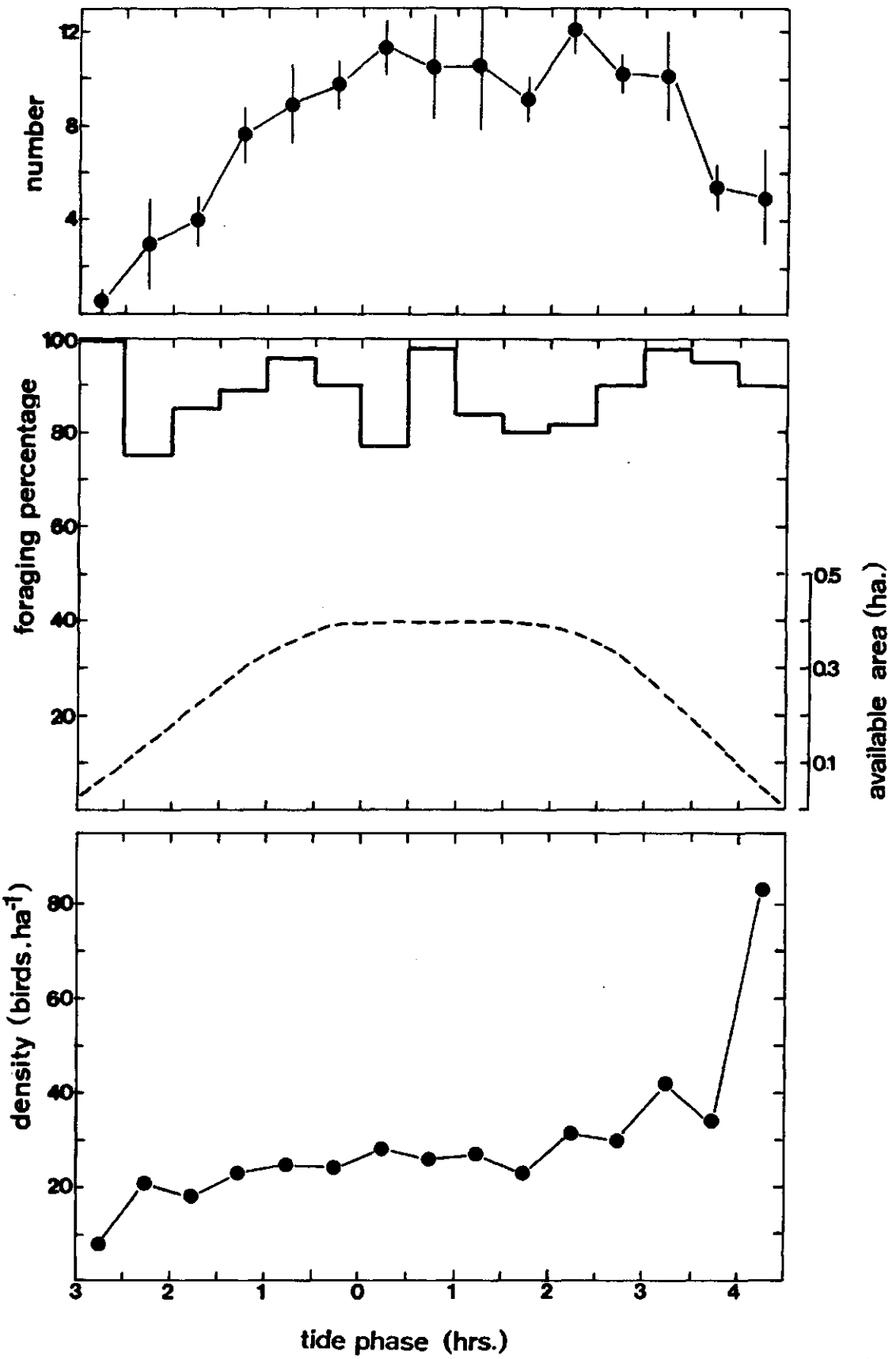


Figure 7.9 Numbers, percentages of birds foraging, and densities of Ringed Plovers on the 0.4 ha study plot in the course of a low water period. Bars around mean numbers indicate $\pm$ 1 standard deviation.

7.3.4 Food and foraging

Many, perhaps even all Ringed Plovers were defending feeding territories on the mudflats in the Sidi Moussa intertidal area. Food consisted of small unidentifiable items and Ragworms *Nereis diversicolor* removed from between the *Ulva* and eelgrass vegetation. Figure 7.9 gives the density measurements on the study plot in the northern part of the estuary. During low water 8 to 12 Ringed Plovers were found on this area of 0.4 ha. This means that the mean density from one hour before to two hours after time of low tide amounted to 26 birds per ha available area (27 counts). When the mudflats emerged, Ringed Plovers entered the area in proportion to the surface already uncovered. With the rising tide however, the birds were driven together to the highest parts of the mudflat which caused the density to rise to 80 Ringed Plovers per ha available area. The mean percentage of birds foraging was 95%.

Woman collecting bivalves on the study plot.

7.4 Kentish Plover *Charadrius alexandrinus*

7.4.1 Numbers and migration

The total number of Kentish Plovers in the study area dropped from 240 on 1 March to about 160 birds on 9 March and remained rather stable after this date (Figure 7.10). The majority of the birds spent the high water period in the salt-pans. Some of them occupied breeding territories on the dikes between the salt-pans and stayed there also during the low water period.

Only 15 marked birds were released and sample sizes were too small to detect departure of marked birds (Table 7.8). In Merja Zerga we checked 239 Kentish Plovers on 15 March and another 300 birds on 1 April, but no marked birds were seen.

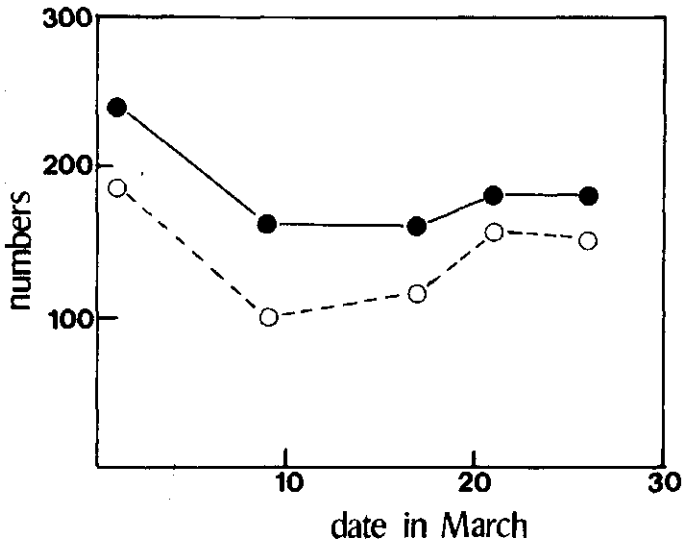


Figure 7.10 Numbers of Kentish Plovers counted in the Sidi Moussa study area. Closed dots denote total numbers and open dots the numbers roosting in the salt-pans during high tide.

Table 7.8 Results of the marked bird samples for Kentish Plovers.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in the study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	46	0			4
17/18	97	0			5
21/22	54	1	1A	3	5
26/27	61	2	2D	6	15

7.4.2 Biometrics

Data on biometrics are given in Table 7.9. For both adults and juveniles mean wing length of our birds is well above the mean figure for birds caught during autumn migration (Table 7.10). The same applies, to a lesser extent, also for the data on bill length. Part of the difference in mean wing length between autumn and spring might be explained by the abrasion of old primaries in autumn. Since only a proportion of the adult birds in autumn had old primaries, while others had already completely renewed flight feathers, it seems unlikely that this could explain a difference of over 4 mm. Moreover, this cannot account for the same difference measured in juvenile birds. From this information we infer that the majority of the Kentish Plovers that travel along the Moroccan coast in August-September are smaller sized animals than the birds we encountered in March. It remains unclear whether this size difference is correlated with different breeding areas.

The average weight loss of four Kentish Plovers after capture amounted to 0.3 $g.hr^{-1}$ (Figure 7.11).

On 7 March 1981 we controlled a bird that was ringed at Sidi Moussa on 16 September 1980 and retrapped there on 18 September 1980 by the Durham University Sidi Moussa Expedition. This juvenile bird weighed 38 g in September and 40 g in March.

Only one of the birds caught showed active moult of body feathers. This bird was caught on 24 March and weighed 39 g.

Biometric data for Kentish Plovers.

	Juveniles (n=6)		Adults (n=7)		All birds (n=17)	
	mean	SD	mean	SD	mean	SD
ı (mm)	112.0	2.5	114.8	1.6	113.5	2.6
ı (mm)	15.5	0.5	15.4	0.7	15.6	0.6
length (mm)	42.0	0.7	42.0	1.3	42.1	0.9
	36.5	2.6	38.1	4.2	37.3	3.4

Mean wing length, bill length and weight of Kentish Plovers caught in Morocco on autumn migration (Pienkowski 1972 & 1975 and Moser 1981), on spring migration (this study) and in Mauritania in late autumn (Dick 1975).

		Morocco			Mauritania
		August-September 1971/72	September 1980	March 1981	September-October 1973
h (mm)	ad.	110.5	110.4	114.8	110.8
	juv.	110.8	109.9	112.0	110.8
h (mm)	ad.	15.1	15.1	15.4	15.3
	juv.	15.1	14.7	15.5	15.5
	ad.	38.3	39.2	38.1	38.7
	juv.	37.8	37.8	36.5	36.5

ly composition

d the body composition of two adult males and one male of unknown resh weight of these birds varied from 32 g to 37 g; the average was about 2 g below the mean figure for the live-caught birds. e birds carried only small amounts of fat; mean 0.8 g and a 1.1 g. Although the mean fresh weight of the Kentish Plovers

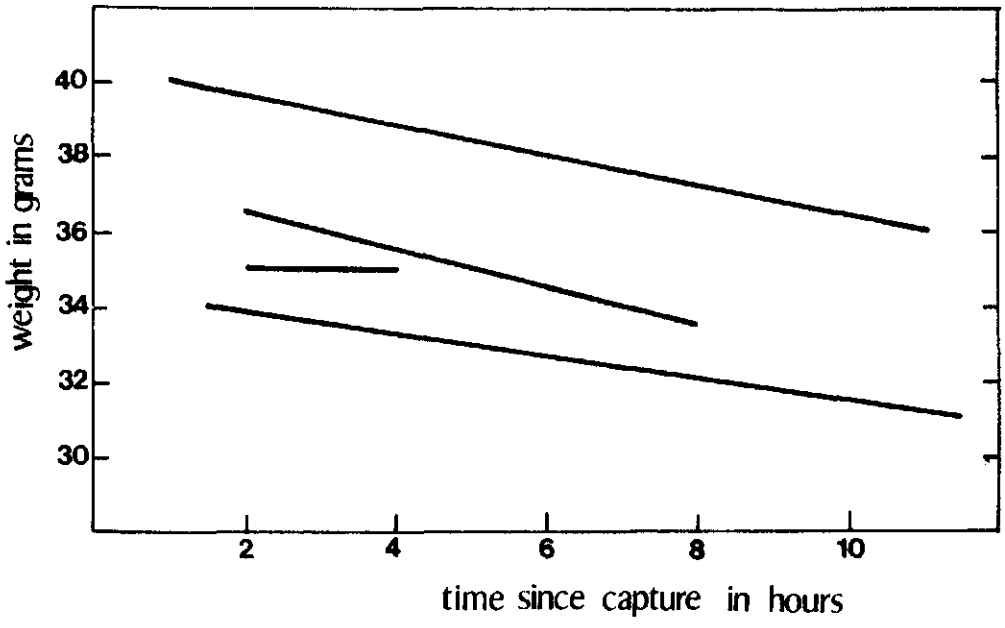


Figure 7.11 Weight loss of Kentish Plovers held in captivity after capture.

caught was a little higher, it is unlikely that many of them carried large fat reserves. Only three out of 18 birds weighed more than 40 g. These were all adults and are thought to be the only ones that might have been capable of migrating any significant distance.

7.5 Grey Plover *Pluvialis squatarola*

7.5.1 Numbers and migration

There must have been considerable immigration of Grey Plovers between 1 March and 21 March since the numbers in the study area increased during this period from 242 up to 661 birds (Figure 7.12). During the last days of our stay the numbers dropped again to 408 birds. Only a minority of the birds spent the high water period in the salt-pans.

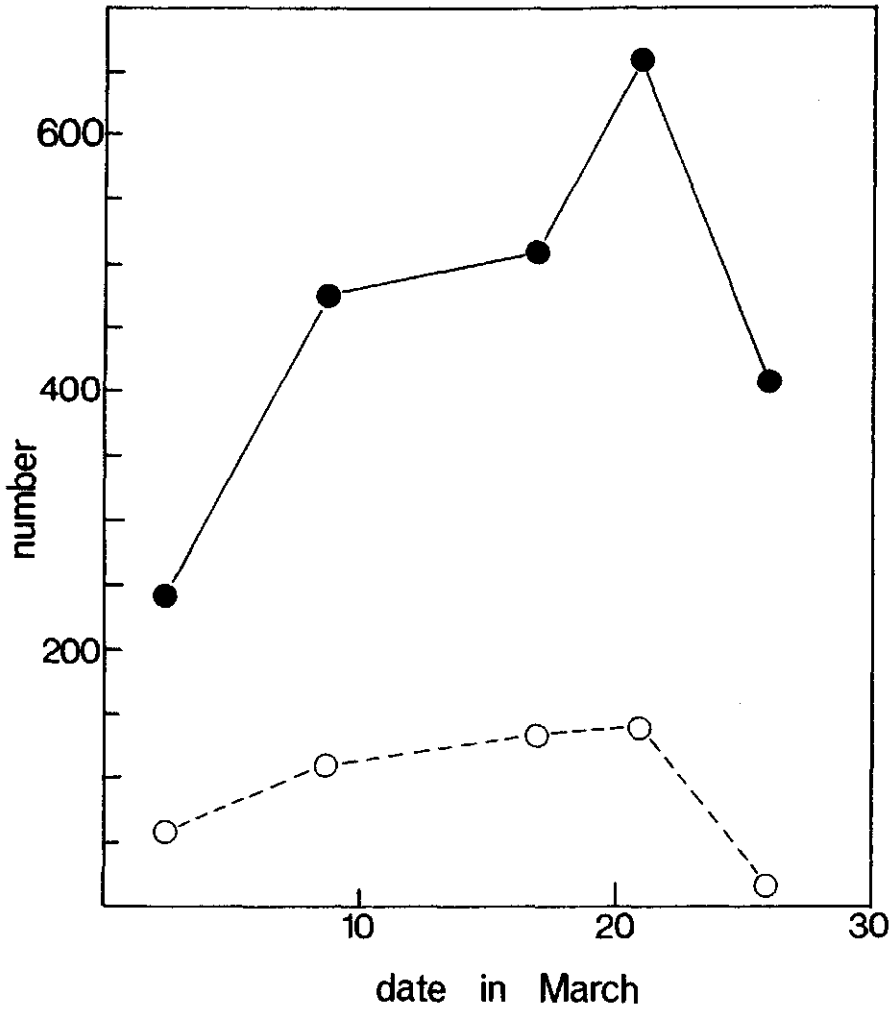


Figure 7.12 Numbers of Grey Plovers counted in the Sidi Moussa study area. Closed dots denote total numbers and open dots the numbers roosting in the salt-pans during high tide.

Table 7.11 Results of the marked bird samples for Grey Plovers.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in the study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	108	1	1A	4	3
17/18	88	1	1?	6	4
21/22	97	1	1A	7	5
26/27	130	1	1?	3	5

Although we released only 5 marked Grey Plovers the results of the dyed birds samples suggest that there was probably no emigration up to 21 March (Table 7.11). During this period the estimated number of marked birds in the study area was very close to or little above the cumulative number of birds that were marked. This is due to the fact that random sampling errors have relatively large influence when the total number of marked birds is small (see Kersten & Smit 1983). During the last week the estimated number of marked birds dropped 40% under the total number marked and this is in accordance with a 38% drop in the numbers present in the study area. In the afternoon of 22 March we observed the departure of a flock of 15 Grey Plovers; there were two marked birds in the flock!!

At Merja Zerga we checked 1109 Grey Plovers on 15 March and 1000 on 1 April, but no marked birds were found.

7.5.2 Biometrics

Data on biometrics are given in Table 7.12. The only bird, which was definitely classified as adult, was the smallest one of the five we caught and had the lowest weight. In August and September the mean weight of adult Grey Plovers caught in Morocco was a little higher (mean 201 g, SD 16.5 g, n=17;Pienkowski 1975).

Two birds, both juveniles, were kept in captivity for a few hours and their average weight loss amounted to 1.4 $g.hr^{-1}$ (Figure 7.13). One of these birds, caught on 4 March with an initial weight of 200 g, was retrapped on 10 March and weighed only 180 g.

Table 7.12 Biometric data for Grey Plovers.

	Juveniles (n=4)		Adult (n=1)	All birds (n=5)	
	mean	SD		mean	SD
wing length (mm)	203.3	4.7	198	202.0	4.7
bill length (mm)	30.2	0.2	27.2	29.6	1.4
total head length (mm)	69.6	1.3	66.1	68.9	1.9
weight (g)	208.2	7.7	189	204.4	10.9

All five birds were still in full winter plumage and had not even started to moult their body feathers. However,the adult bird and one of the birds of unknown age showed active moult of tail feathers, with 5 and 2 growing feathers, respectively.

7.5.3 Food and foraging

We have collected far more information on the food and foraging of this species than on any of the other waders. For this reason these data are discussed in a separate chapter (Chapter 8).

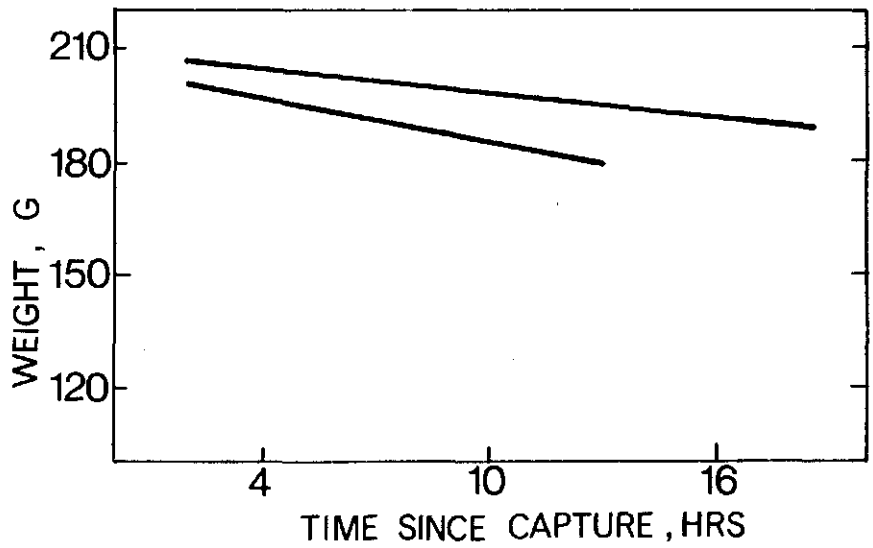


Figure 7.13 Weight loss of Grey Plovers held in captivity for some time after capture.

7.6 Knot *Calidris canutus*

7.6.1 Numbers and migration

Only small numbers of Knots were present in the study area and usually they were not seen in the salt-pans (Figure 7.14). However, the numbers given are minimum estimates (and probably not very accurate) since species which occur in small numbers are easily overlooked by the observer (Kersten et al. 1981). Especially during the second part of our stay the numbers are known to be underestimated since at low tide we sometimes observed larger flocks foraging on the mudflats than the number counted at high tide.

Since the counting results are not accurate enough we are not able to estimate the number of marked birds in the study area from the samples of dyed birds (Table 7.13). At least two birds, caught between 1 March and 5 March, did not leave the study area before the end of March. This suggests that at least part of the Knot population consisted of semi-resident birds.

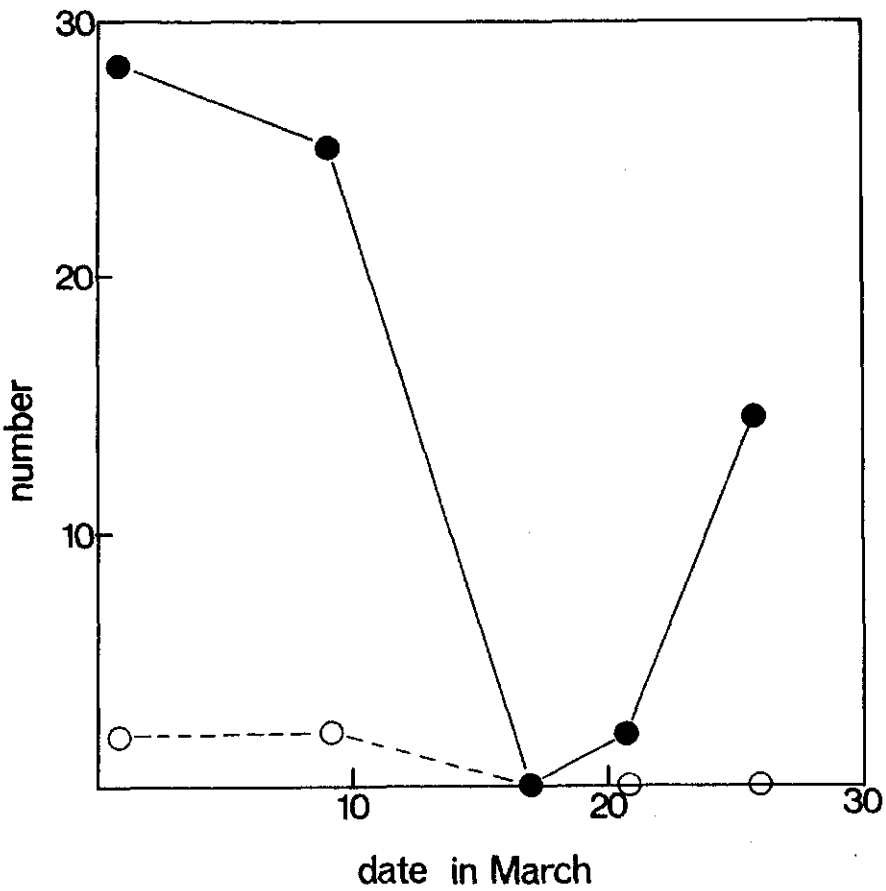


Figure 7.14 Numbers of Knots counted in the Sidi Moussa study area. Closed dots denote total numbers and open dots numbers roosting in the salt-pans during high tide.

Table 7.13 Results of the marked bird samples for Knots.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in the study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	13	1	1A	2	3
17/18	2	0		-	3
21/22	48	1	1A	$\geq$ 1	5
26/27	51	3	1C, 2A	$\geq$ 3	5

7.6.2 Biometrics

Data on biometrics are given in Table 7.14. Only two birds could be classified according to age. Dick et al. (1976) showed that Knots breeding in Greenland and NE Canada have, on average, shorter bills than birds of Siberian origin. Mean bill lengths for Nearctic birds are 32.2 mm, SE=0.2 mm, n=92 for males and 34.0 mm, SE=0.2 mm, n=71 for females; measurements of birds of Palearctic origin are 34.5 mm, SE=0.2 mm, n=26 for males and 35.9 mm, SE=0.3 mm, n=17 for females. According to its large bill of 37.1 mm, the adult bird caught in Sidi Moussa was probably a female belonging to

Table 7.14 Biometric data for Knots.

	Juvenile (n=1)	Adult (n=1)	All birds (n=5)	
			mean	SD
wing length (mm)	157	174	166.6	6.7
bill length (mm)	33.7	37.1	33.7	2.4
total head length (mm)	63.0	67.0	63.6	2.4
weight (g)	120	143	129.8	10.2

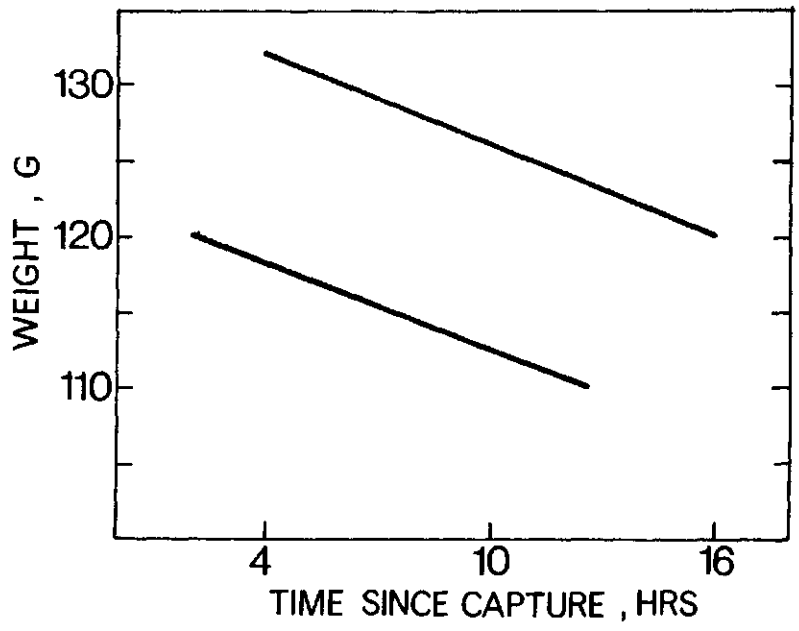


Figure 7.15 Weight loss of Knots held in captivity after capture.

the Siberian breeding population.

The mean bill length of our small sample, 33.7 mm, SD=2.4 mm, n=5 does not allow us to classify them definitely as belonging to the Siberian population, although Dick et al. (1976) argue that Knots spending the winter in Africa are of Palearctic origin.

The weight of Knots caught during autumn migration in Morocco is much below the spring weight (juveniles 99.9 g, SE=0.8 g, n=140 and adults 123.6 g, SE=3.4 g, n=5; Pienkowski 1975).

Two birds were kept in captivity for some hours and lost weight at an average rate of 0.9 $g.hr^{-1}$ (Figure 7.15).

All three Knots caught between 1 March and 5 March were in full winter plumage, but two of them had just started to moult their body feathers. The other two birds, caught on 17 March, showed signs of summer plumage; one of them showed active moult of body feathers, the other not. This last bird had one growing tail feather.

7.7 Little Stint *Calidris minuta*

7.7.1 Numbers and migration

A highly variable number of Little Stints was counted in the study area (Figure 7.16). The birds were always found, both during low and high tide, in the non-tidal salt-pan complex. Only once, on 1 March, a single bird was observed in the tidal area.

According to our counts there was an influx of at least 130 birds into the area in the first week of March. Results of the marked birds samples (Table 7.15) suggest that during this period there may have been emigration as well, since no dyed birds were discovered on 9/10 March; the sample checked however is rather small. Between 10 and 17 March at least 150 birds left the area (Figure 7.16). This emigration is also indicated by the results of the marked birds samples since we found only one bird (dyed in

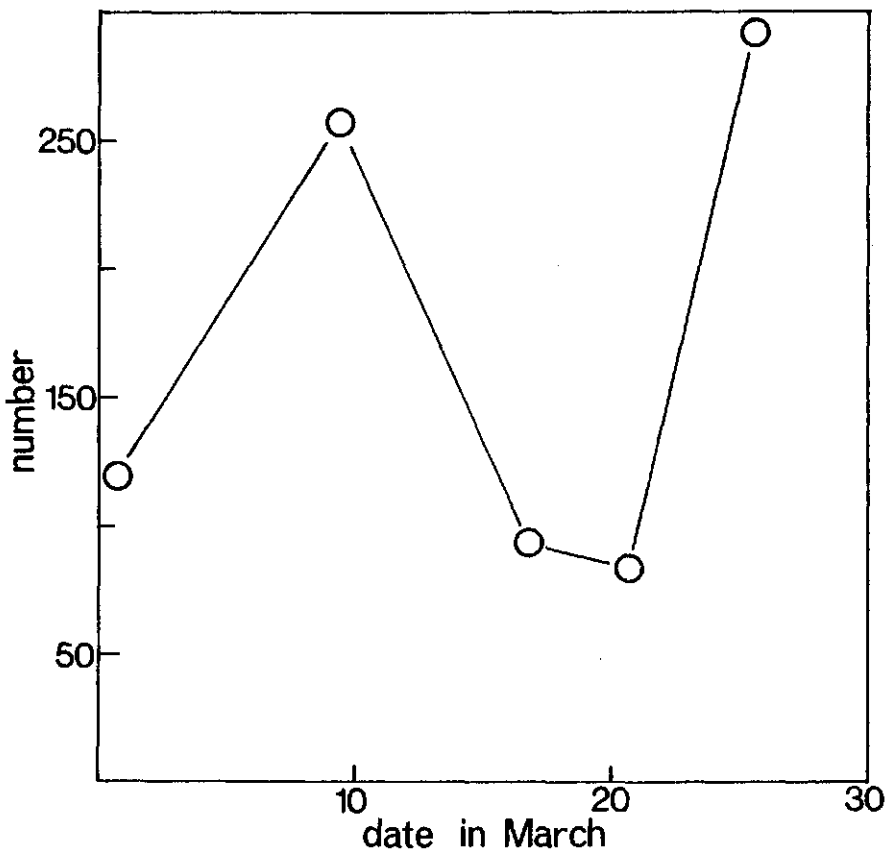


Figure 7.16 Numbers of Little Stints counted in the salt-pan part of the Sidi Moussa study area. No Little Stints were found roosting in the tidal part of the study area.

Table 7.15 Results of the marked bird samples for Little Stints.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	31	0		$\geqslant 0$	13
17/18	117	1	1A	1	16
21/22	0	-		-	16
26/27	0	-		-	23

the first week of March) in a large sample of 117 Little Stints on 17/18 March. Between 21 and 26 March there was a second influx of about 200 birds. Assuming that at least two different groups of birds moved through the area, 120 + 130 + 200 = 450 Little Stints used the area in March 1981, though the actual number may well have been considerably higher.

7.7.2 Biometrics

We experienced great difficulty in ageing this little wader: we only found one definite juvenile and four adults. Mean lengths of bill and wing (Table 7.16) correspond very closely to the values obtained earlier in Morocco in autumn by Pienkowski (1972 & 1975) and Moser (1981). Weights were rather low compared to autumn weights and corresponded best to the autumnal juvenile weights as given by Pienkowski (1975). The mean weight of our Little Stints was 3 g (14%) lower than the values obtained by Moser (1981) for birds caught in the preceding autumn at the same place.

In captivity Little Stints lost weight (Figure 7.17) at an average rate of 0.2 $g.hr^{-1}$ (SD=0.10, n=12).

All the 23 Little Stints caught were still in full winter plumage. No bird of the 15 individuals examined before 12 March showed any traces of body moult but 5 of the 8 examined after this date did!

Table 7.16 Biometric data for Little Stints.

	Juvenile (n=1)	Adults (n=4)		All birds (n=23)	
		mean	SD	mean	SD
wing length (mm)	98	96.8	2.2	98.8	5.1
bill length (mm)	16.9	17.5 (n=3)	1.5	18.0 (n=22)	1.1
total head length (mm)	37.5	38.4	1.0	39.5	1.3
weight (g)	18.5	20.7	2.1	21.4	1.8

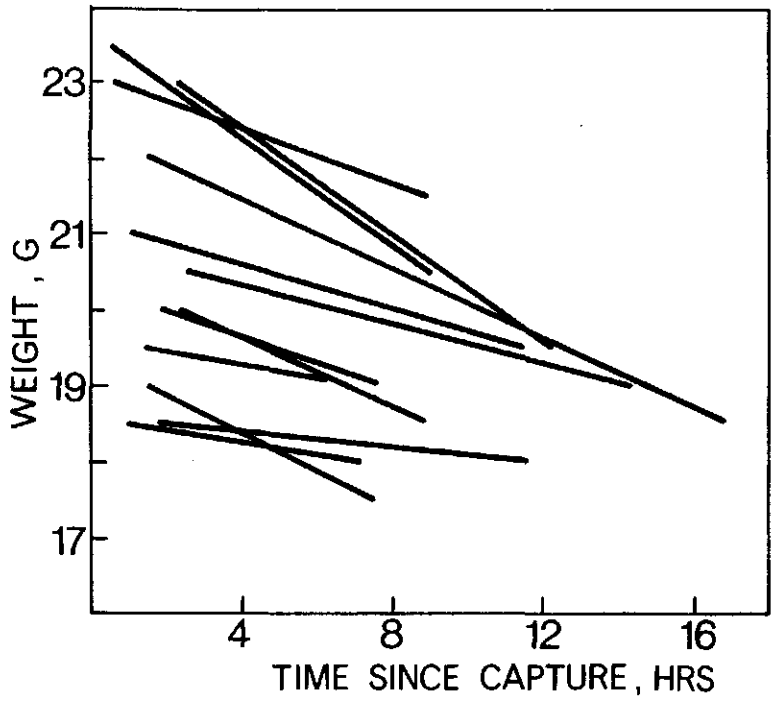


Figure 7.17 Weight loss of Little Stints in captivity.

7.7.3 Body composition

Three Little Stints (all males of unknown age) were analysed. The birds, weighing 20, 19 and 20.5 g contained respectively 0.2, 1.3 and 1.2 g of extractable lipids. Although the values may seem to be rather low, these fat weights nevertheless represent a mean 4.4% of the fresh body weights of the birds.

7.8 Curlew Sandpiper *Calidris ferruginea*

7.8.1 Numbers and migration

Only small numbers of Curlew Sandpipers were present in the study area. Most of them spent the high water period in the salt-pans (Figure 7.18). The numbers counted are probably underestimated since small numbers of Curlew Sandpipers are thought to be easily missed in larger mixed flocks of Dunlins, Ringed Plovers and other species (Kersten et al. 1981).

Numbers counted in autumn were much higher, usually several hundreds of birds in the same area (Pienkowski 1972 & 1975). Very large numbers spent the winter in areas south of the Sahara; in Mauritania (Dick 1975 and Piersma et al. 1980), Guinnée-Bissau (Fournier & Dick 1981) and in Namibia (Underhill & Whitelaw 1977) and South Africa (Summers et al. 1977). Wilson et al. (1980)suggest that the majority of these birds do not follow the Atlantic coast during spring migration, but instead cross the Sahara on a more inland route. Indeed, large numbers of Curlew Sandpipers were observed in Tunisia during spring migration (Johnson & Hafner 1972). However, the migration did not take place before mid-April. Since our observation period ended about two weeks earlier, it is impossible to conclude whether the areas along the Atlantic coast of Morocco are used extensively or not during spring migration.

We released 11 marked birds and some of them were observed during the sampling for marked birds (Table 7.17). Since we probably underestimated the total number of Curlew Sandpipers, we do not think it is correct to estimate the total number of marked birds still in the study area from these data. However, the fact that sample sizes were relatively large, especially on 17 March and 26 March, and that only 3-4% of the birds were marked, suggest that there must have been emigration of Curlew Sandpipers during the observation period. Even if the actual number of birds present was five times as high as the number counted, the estimated number of marked birds in the study area on 17 March would have been only 5. Since 9 marked birds were released up to that date, this would still indicate that about 50% of the initial population had left the study area. The same argument holds for the data of 26 March.

On the other hand, there were certainly some birds that stayed in the study area for a rather long period. Both on 17 March and 27 March we observed a bird, not necessarily the same individual, that was marked between 1 March and 3 March.

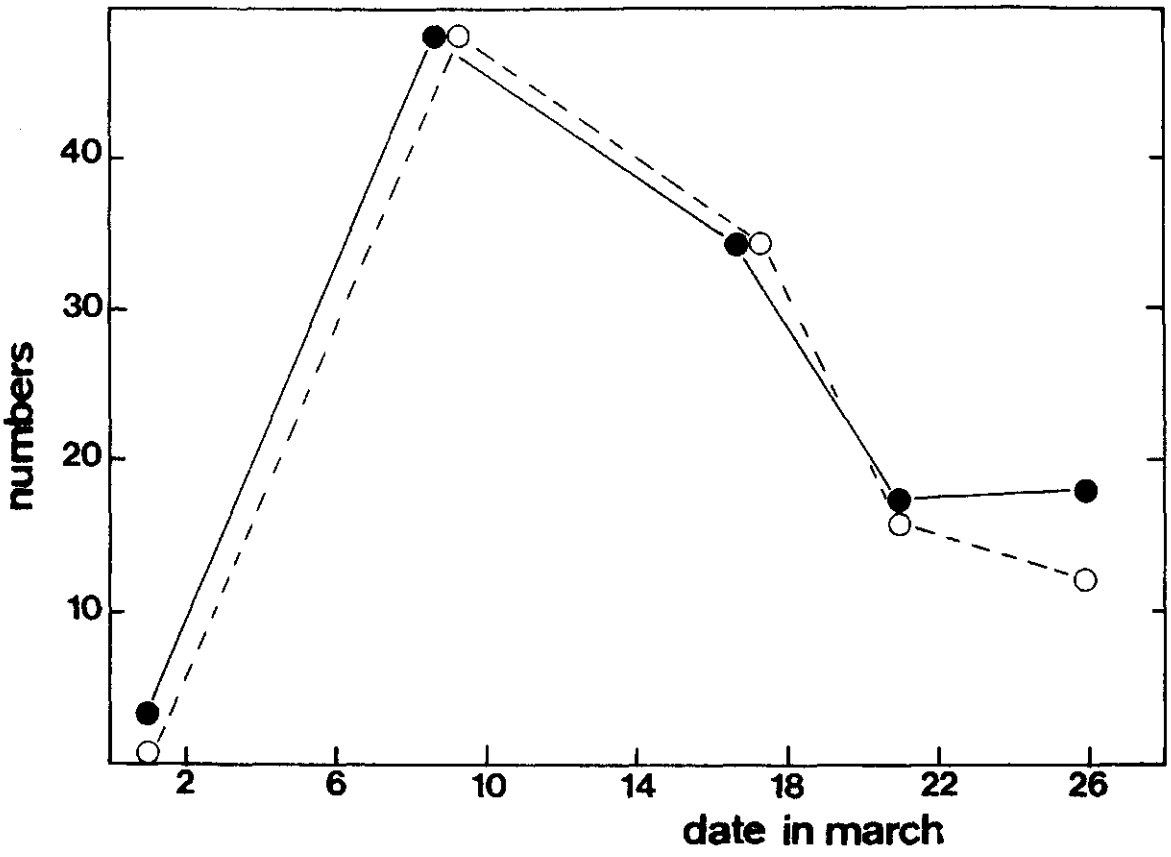


Figure 7.18 Numbers of Curlew Sandpipers counted in the Sidi Moussa study area. Closed dots denote total numbers and open dots numbers roosting in the salt-pans during high tide.

Table 7.17 Results of the marked bird sampling for Curlew Sandpipers.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in the study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	2	0		?	8
17/18	30	1	1A	?	9
21/22	5	1	1A	?	9
26/27	24	1	1A	?	11

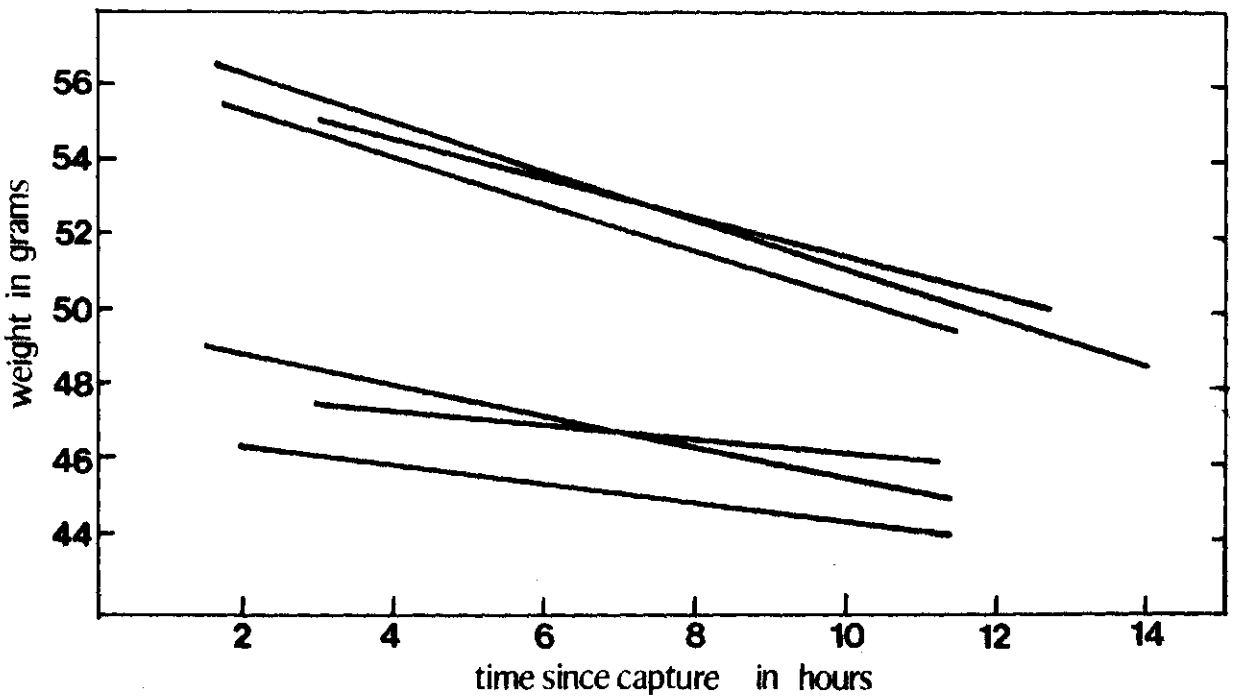


Figure 7.19 Weight loss of Curlew Sandpipers in captivity.

7.8.2 Biometrics

Biometric data are given in Table 7.18. Mean wing and bill lengths are close to the values measured during autumn migration. However, the mean weight of birds caught in autumn was 5-10% higher in 1971 and 1972 (Pienkowski 1972 & 1975) and 15% higher in 1980 (Moser 1981). Stanley & Minton (1972) give a mean weight of 46 g for recently arrived juveniles in Britain on autumn migration. This agrees with the weight of our juvenile bird.

The average weight loss of 6 Curlew Sandpipers after capture was 0.4 $g.hr^{-1}$, SD=0.17 (Figure 7.19). The three relatively heavy birds seemed to lose more weight than the light ones; 0.53 versus 0.28 $g.hr^{-1}$. One bird was retrapped 12 days after ringing and had increased its weight from 49 g on 3 March to 56 g on 15 March. This weight gain indicates the accumulation of reserve fat at a rate of about 0.5 $g.day^{-1}$.

All 12 birds caught were in full winter plumage. Only two birds showed active moult of body feathers; one was an adult caught on 1 March and the other was a bird of unknown age caught on 26 March. Another bird of unknown age had one tail feather that had just been renewed while another one was still growing.

Table 7.18 Biometric data for Curlew Sandpipers.

	Juvenile (n=1)	Adults (n=4)		All birds (n=12)	
		mean	SD	mean	SD
wing length (mm)	132	133.3	1.7	132.7	3.1
bill length (mm)	36.8	39.2	2.7	37.9	2.4
total head length (mm)	60.0	63.1	3.4	61.7	2.9
weight (g)	46.5	52.9	3.7	51.9	3.8

Some birds with traces of breeding plumage were observed during the last two weeks of March. In South Africa nearly all Curlew Sandpipers show signs of the breeding plumage in March (Elliott et al. 1976). Apparently the moult into the breeding plumage starts much later in NW Africa as compared to southern Africa.

7.8.3 Body composition

One bird was analysed, a juvenile female. The fresh weight of 55 g indicated that it was in good condition, which was supported by the fact that it carried 3.3 g of extractable fats. The bird showed slight moult of body feathers but was still in complete winter plumage.

7.9 Dunlin *Calidris alpina*

7.9.1 Numbers and migration

The number of Dunlins declined continuously from 2821 birds on 1 March to 1188 birds on 26 March (Figure 7.20). More than 50% of the population spent the high water period in the salt-pans, and often many of them were seen foraging there as well. At low tide nearly all these birds went to the intertidal mudflats.

The results of the marked birds samples are presented in Table 7.19. Figure 7.21 shows that many of the 287 Dunlins that were marked before 9 March had left the study area within one week after capture while others stayed until the end of March. There was no indication that heavy birds ($\geq$ 43 g) were more likely to depart than light ones (Table 7.20). We made the assumption that the 287 Dunlins that were marked before 9 March formed an unbiassed independent sample of the population present in the study area on 1 March.

Whereas Dunlins were leaving the study area relatively continuously throughout the observation period (Figure 7.22), immigration mainly occurred between 1 and 9 March and between 22 and 26 March.According to our calculations a total of 1817 Dunlins entered the study area during the observation period. Since 2821 birds were already present on 1 March, the total number of Dunlins that used the area between 1 March and 26 March amounted to 4650 birds.

Table 7.19 Results of the marked bird samples for Dunlins.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in the study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	617	32	32A	122	287
17/18	883	51	44A, 6B, 1?	111	312
21/22	1070	70	56A, 2B, 8C, 4?	112	322
26/27	980	54	33A, 6B, 5C, 3D, 7?	65	352

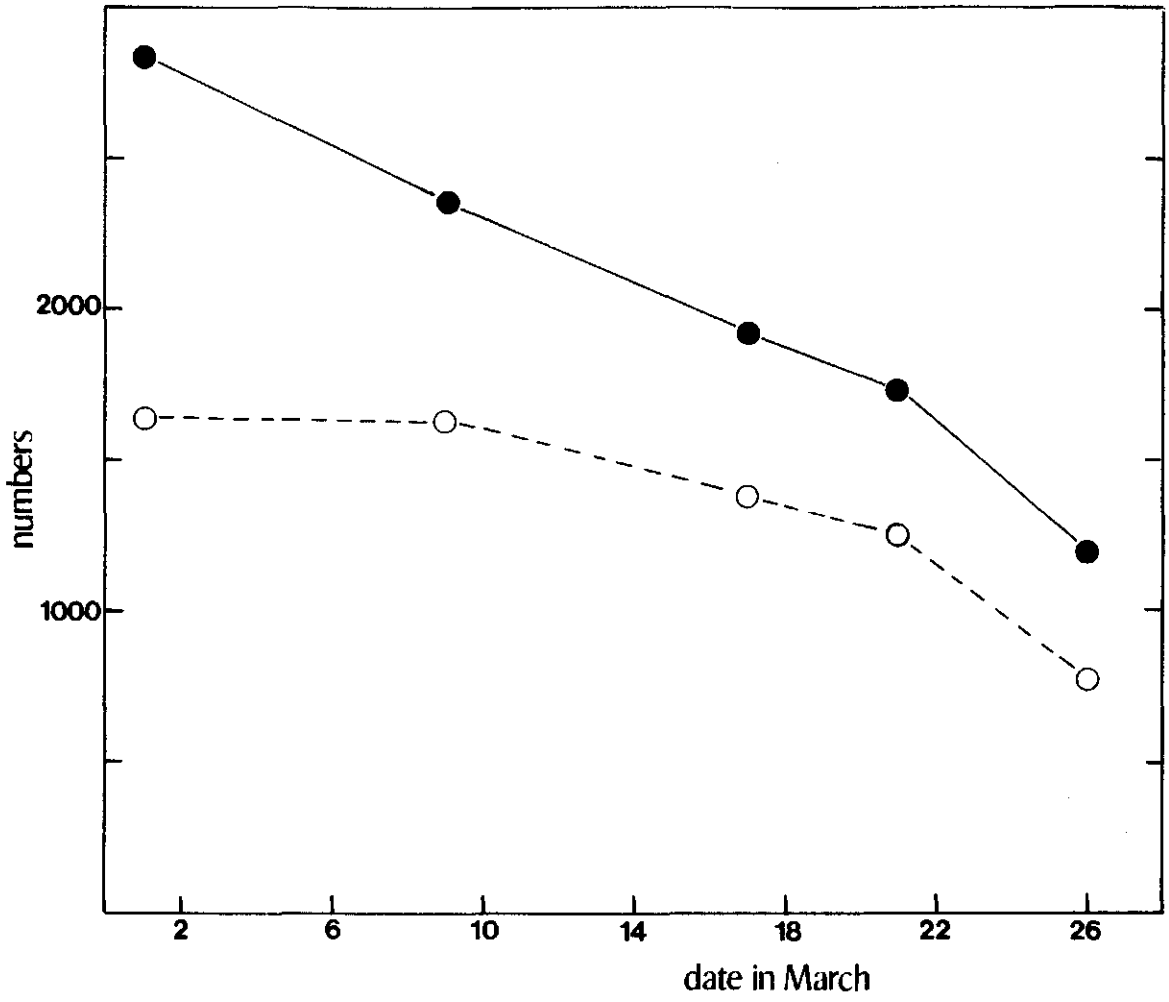


Figure 7.20 Numbers of Dunlins counted in the Sidi Moussa study area. Closed dots denote total numbers and open dots the numbers roosting at high tide in the salines.

Table 7.20 Emigration of light and heavy Dunlins marked between 1 and 9 March from the study area. The expected values were calculated under the assumption that light birds were as likely to depart as were heavy birds.

	Weight (g)		
	⩾ 43	< 43	
marked, 1-9 March	137	154	
observed, 9-26 March	55	65	$X^2 = 0.08$, N.S.
expected	55.5	63.5	

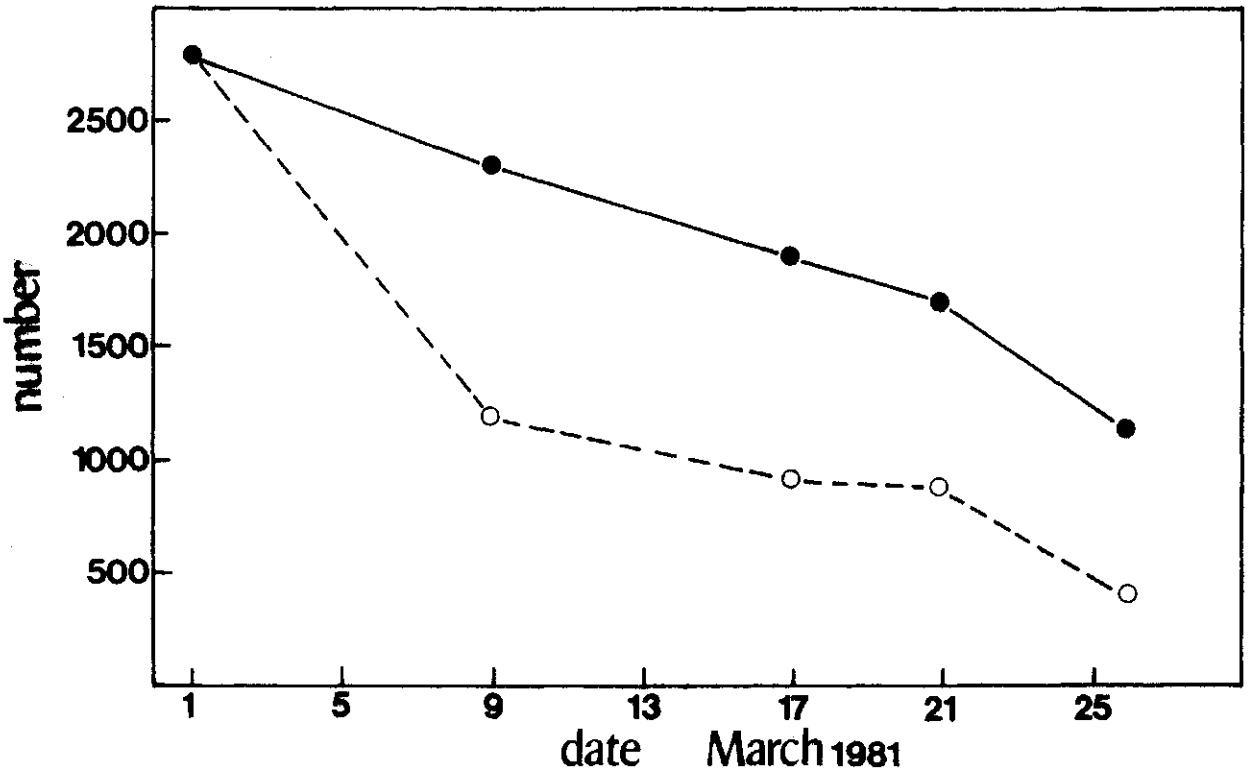


Figure 7.21 Total numbers of Dunlins in the Sidi Moussa study area (closed dots) and the number of birds present on 1 March that remained in the study area (open dots).

We controlled 20 previously ringed Dunlins. Most of these birds (14) were ringed during the preceding autumn by the Durham University Expedition to Sidi Moussa in September 1980. A further three were birds ringed by others in the Sidi Moussa-Oualidia salt-pan complex in the autumns of 1972, 1979 and 1980. One bird was ringed in the estuary of the Oued Massa further south on the Atlantic coast of Morocco in the autumn of 1978. The other two birds were foreign ringed controls, one coming from Britain while the other carried two rings, one from Sweden and one from East Germany.

Of the birds ringed by the Durham University Expedition to Sidi Moussa 8 were ringed at the same site where we captured them, while 6 were ringed in the salt-pans near Sidi Brahim, some 3 km to the south of our study area. All these controls were made before 9 March, representing 4.3% of the numbers caught up to that date. Assuming that the proportion of previously ringed Dunlins in our catch approximates to the proportion of ringed birds in the field, we infer that about 120 Dunlins ringed in September 1980 were present in the study area during the period 1-9 March. It seems likely that most of these birds had spent the winter in this area since one would not expect that one third of the 365 Dunlins ringed in September 1980 returned at the same time to such a small area during the next spring migration.

No Dunlins ringed in September 1980 were controlled after 9 March (Table 7.21). This suggests that the majority of the winter population had departed by that date, although one other bird ringed in this area in October 1980 was controlled as late as 26 March, indicating that some birds stayed at least until the end of March. The control rate (number of controls/number caught) of all Dunlins ringed during previous autumns in the Sidi Moussa area dropped from 4.9% between 1 March and 9 March to 1.3% between 10 and 28 March. This difference is not statistically significant ($X^2 = 2.05$, $0.1 < p < 0.05$) probably due to the small number of birds caught during the second period.

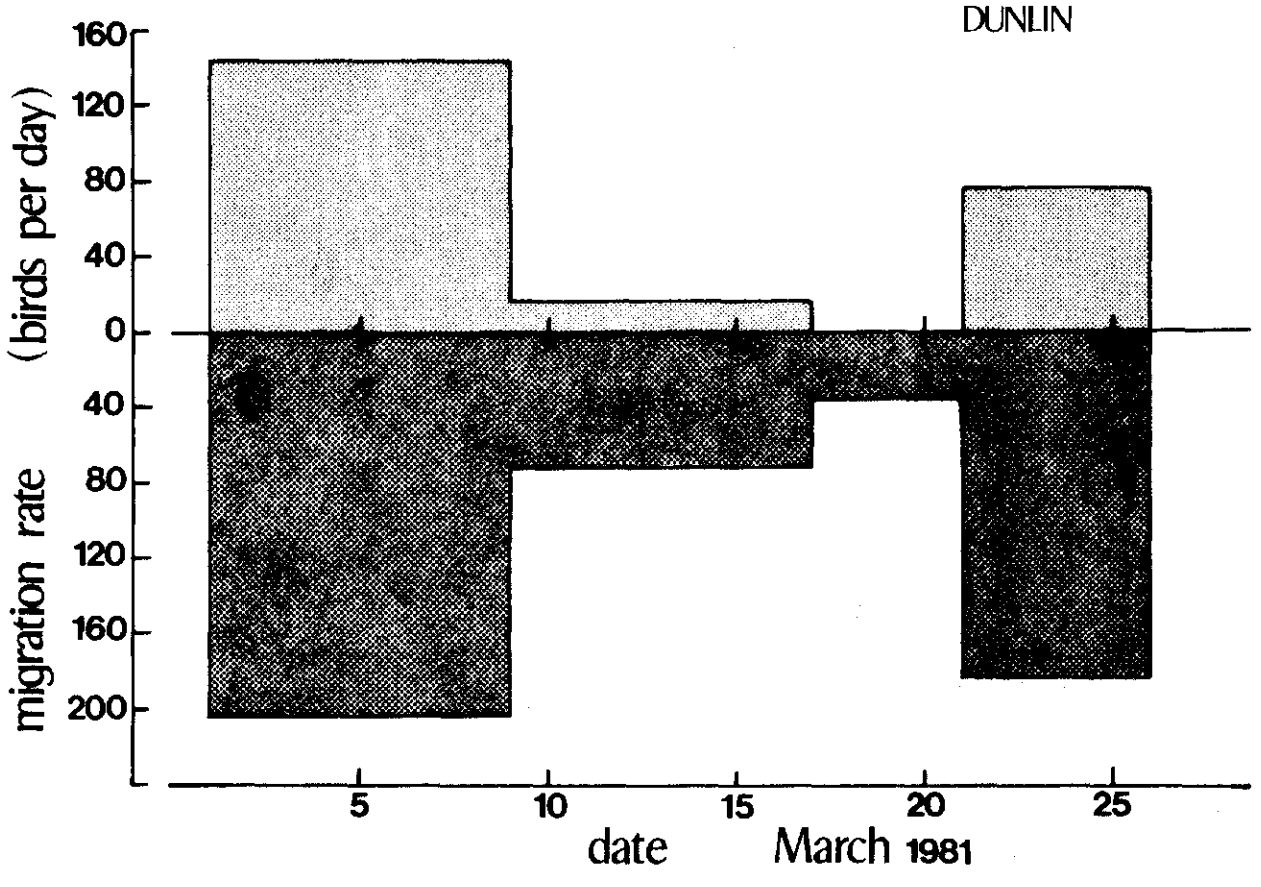


Figure 7.22 Migration rate (in birds per day) of Dunlins through the Sidi Moussa study area in different periods in March 1981.

Table 7.21 Numbers of Dunlins ringed during the Durham University Expedition to Sidi Moussa in September 1980 and controlled in March 1981.

	1 March-9 March	10 March-28 March	Total
number caught in March 1981	326	80	406
number of controls	14	0	14

7.9.2 Biometrics

Frequency distributions of wing, bill and total head length are shown in Figure 7.23. Average values of these measurements and weight are given in Table 7.22. The apparent bimodality in some of the frequency distributions probably arises from the fact that females are on average a little larger than males. Since this difference is most pronounced in bill length (Soikkeli 1974), Pienkowski & Dick (1975) and Moser (1981) estimated the sex ratio from the point of inflexion in a percentage cumulative frequency distribution (PCF) diagram of bill length and calculated average values for males and females separately according to a method described by Harding (1949). Figure 7.24 shows the PCF diagram of bill length in our samples of adult and Figure 7.25 for juvenile Dunlins. In juveniles the PCF diagram does not reveal any bimodality in the measurements, but in adults there appeared to be an excess of long-billed birds, probably females, over short-billed "males", the ratio being approximately 60:40.

Table 7.22 Biometric data for Dunlins.

	Juveniles (n=99)		Adults (n=81)		All birds (n=409)	
	mean	SD	mean	SD	mean	SD
wing length (mm)	116.4	3.6	117.6	3.9	116.7	3.7
bill length (mm)	30.9	2.7	31.9	2.7	31.2	2.8
total head length (mm)	54.0	3.1	55.1	3.0	54.3	3.1
weight (g)	42.0	4.3	45.4	6.0	43.0	4.9

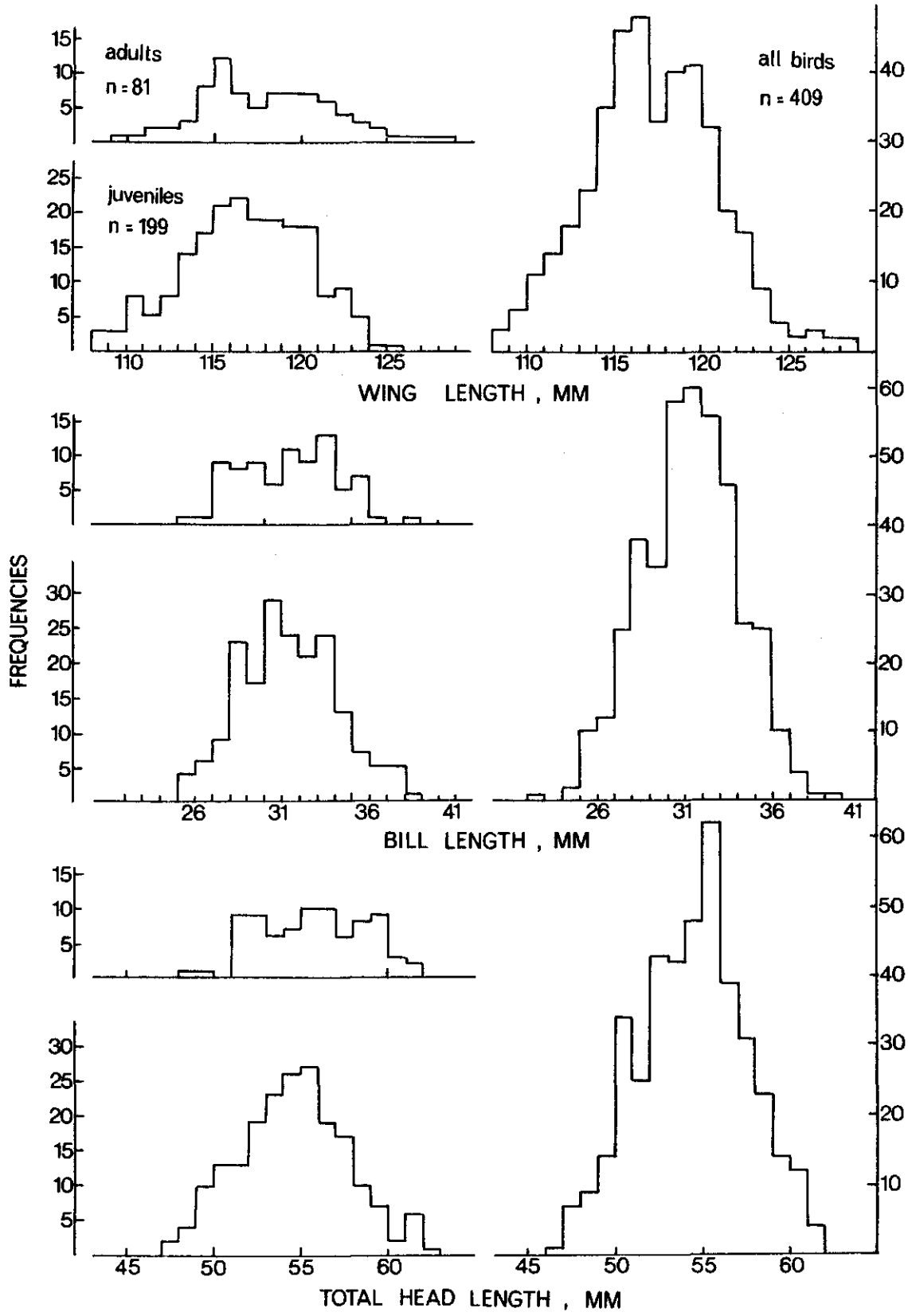


Figure 7.23 Frequency distributions of wing, bill and total head length of Dunlins caught at Sidi Moussa in March 1981.

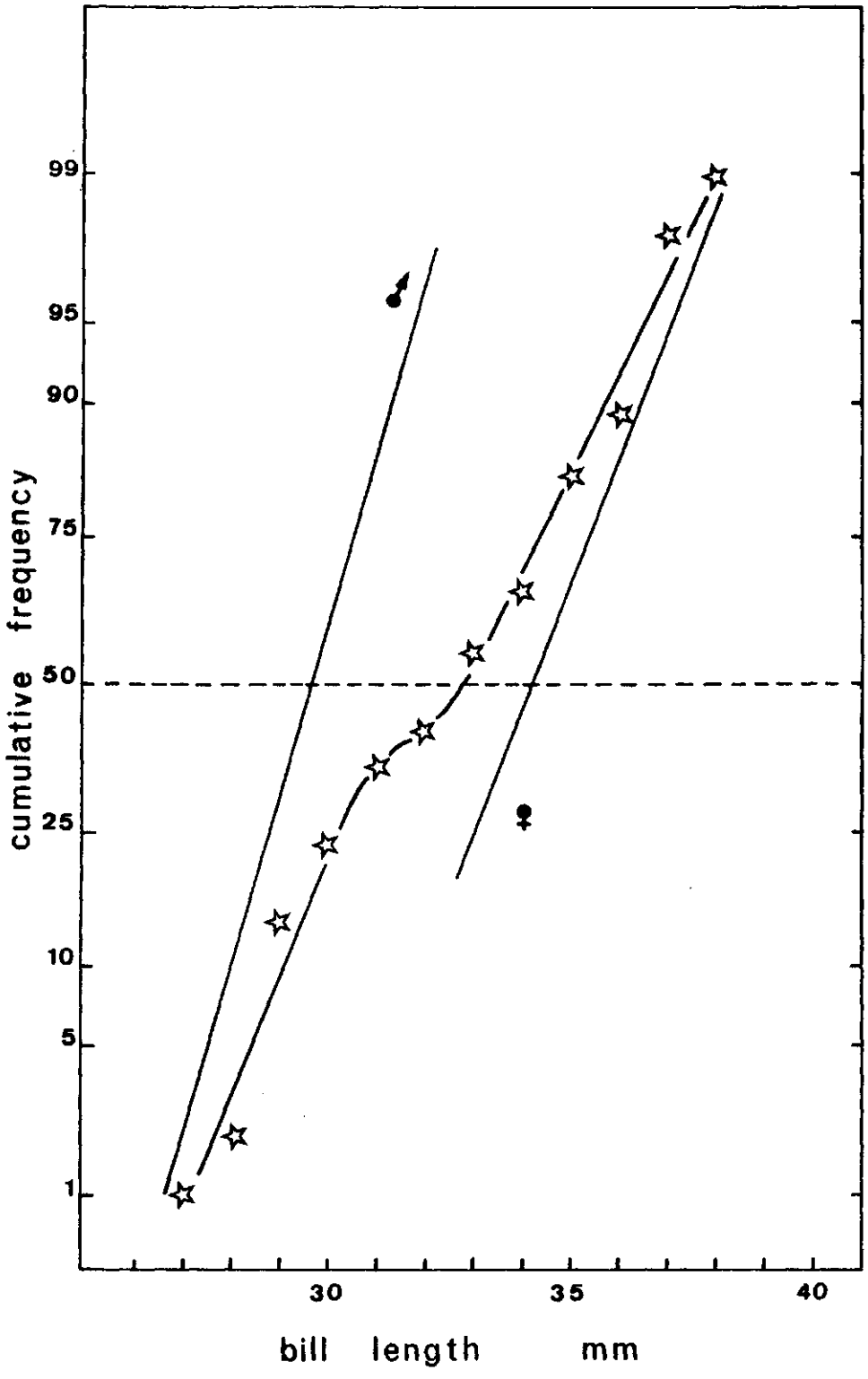


Figure 7.24 Percentage cumulative frequency distribution of bill lengths of adult Dunlins caught at Sidi Moussa in March 1981.

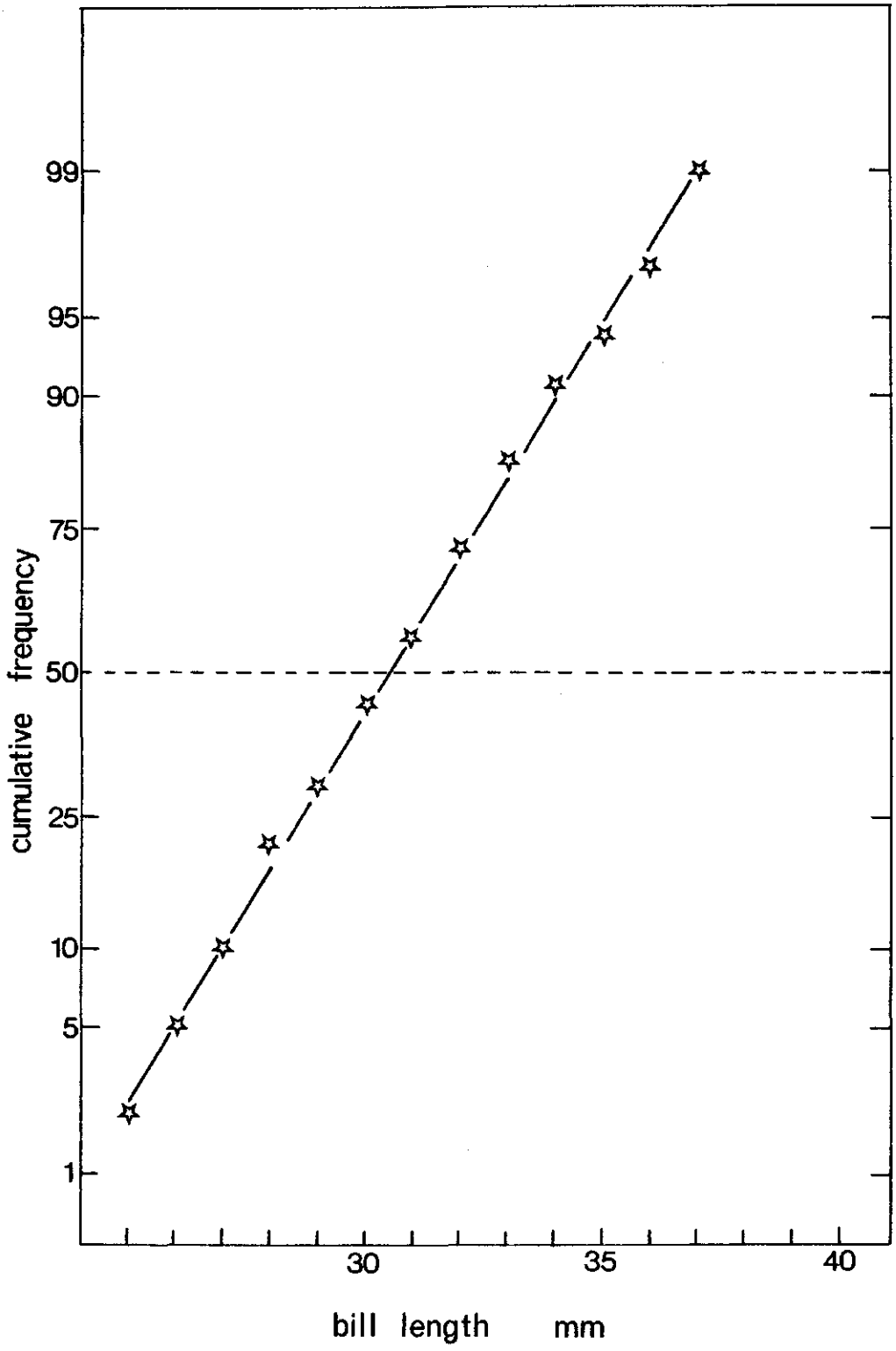


Figure 7.25 Percentage cumulative frequency distribution of bill lengths of juvenile Dunlins caught at Sidi Moussa in March 1981.

The average bill length of presumed adult males, derived from the population line drawn in Figure 7.24, resembles the estimates for juvenile males caught in Morocco in autumn (only very few adults were caught) but the average bill length of the presumed females is considerably larger (Table 7.23). Comparison of the estimated bill lengths with measurements from the breeding areas of different subspecies (Table 7.24) suggests that the Moroccan population contains individuals of both the *alpina* and *schinzii* subspecies.

The proportion of *C.a.alpina* in the Moroccan population might be estimated from the number of birds with very long bills in our sample. If the birds were sampled from a population of Icelandic *schinzii* exclusively, we would expect that 2.5% of the females had bills longer than 34.9 mm (mean (32.8)

Table 7.23 Estimated average bill lengths of male and female Dunlins in Morocco. Sources: 1) this study, 2) Moser 1981, 3) Pienkowski & Dick 1975.

	Presumed males		Presumed females	
	mean	SD	mean	SD
1) Adults, March 1981	29.5	1.1	34.1	1.7
2) Juveniles, September 1980	28.5	2.2	31.9	1.9
3) Juveniles, July-Sept. 1971-73	29.5	1.8	32.8	1.8

Table 7.24 Bill length data of adult Dunlins (in mm). Sources: 1) Morrison & Wilson in Pienkowski & Dick 1975, 2) Griffiths 1970, 3) Morrison & Wilson in Pienkowski & Dick 1975 4) this study

Origin (subspecies)	Males		Females	
	mean	SD	mean	SD
1) Greenland *(C.a.arctica)*	26.0	1.7	29.7	1.6
2) N. Eurasia *(C.a.alpina)*	31.3	1.3	35.2	1.3
3) Iceland *(C.a.schinzii)*	28.4	1.3	32.8	1.1
4) Morocco	29.5	1.8	34.1	1.8

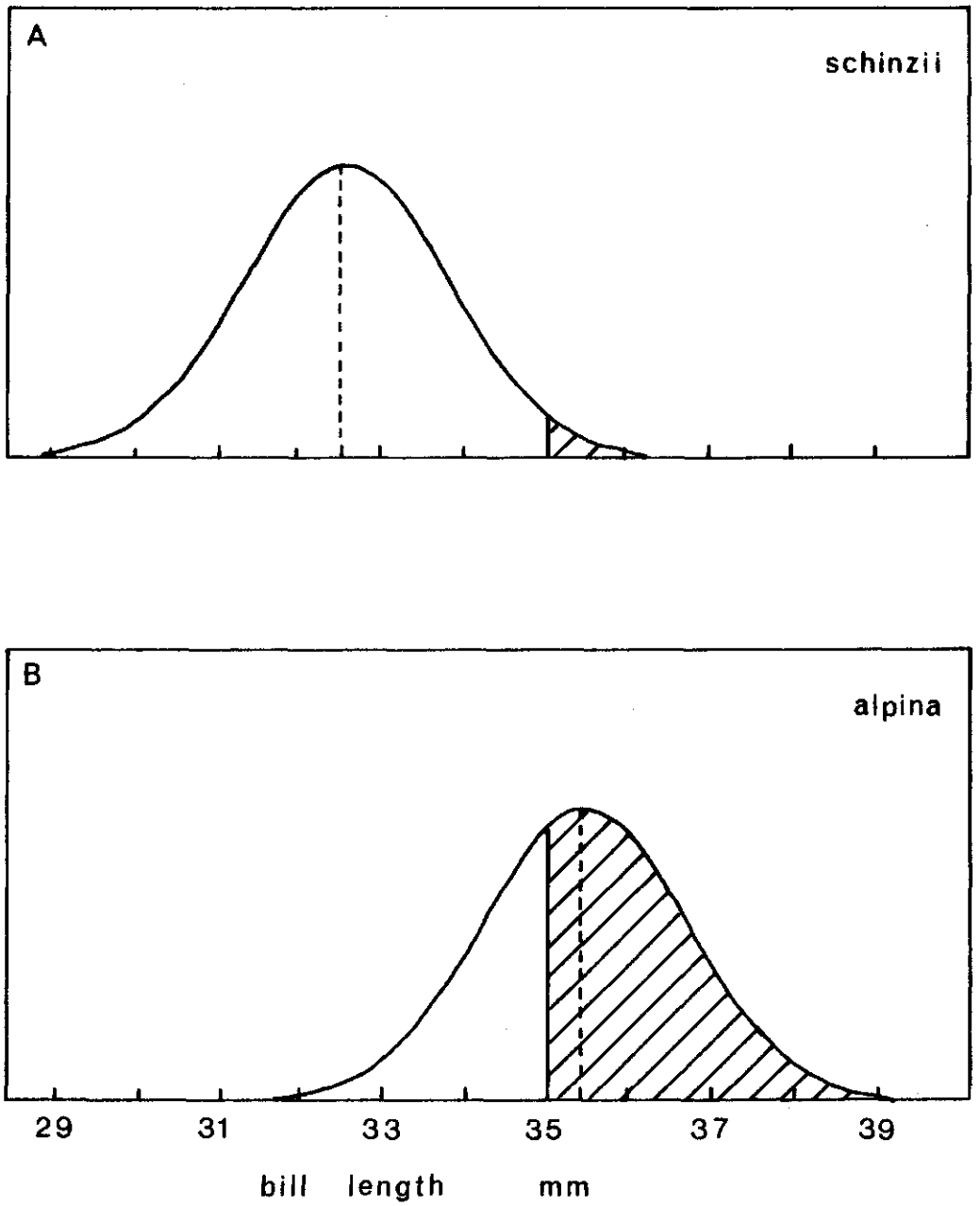


Figure 7.26 Theoretical distributions of the bill lengths of two subspecies of Dunlins; see text. A: *Calidris alpina schinzii*, B: *C. a. alpina*.

+ 2 * SD (1.05) = 34.9 mm; Table 7.24 and see Figure 7.26A). Since we estimated the sex ratio at 60:40 in favour of "females", the expected figure for the total adult population is 0.6 * 2.5 = 1.5% which roughly corresponds with 1 or 2 birds out of 81 caught. In fact we caught 14 adults with bill lengths over 34.9 mm indicating that probably at least 12 of them were female *alpina*.

According to the data of Martin-Löf (in Griffiths 1970; Table 7.24 and see Figure 7.26B) 59% of all female *alpina* have bills longer than 34.9 mm. So we estimate the number of female *alpina* in our sample at (100/59) * 12 = 20 birds and, under a 60:40 sex ratio, the total number of *alpina* at (100/60) * 20 = 34 birds. This suggests that some 42% of the adult Dunlins at Sidi Moussa in March belong to the *alpina* subspecies.

The same kind of analysis performed the other way round, calculating the number ofdefinite male *schinzii* within the subpopulation of short-billed birds, arrives at an estimate of 53% *alpina* in the population!

Since the average bill length of male *alpina* is intermediate to that of male and female *schinzii*, it seems likely that some male *alpina* are counted as "females" in the PCF diagram and are responsible for the apparently unbalanced sex ratio. The mixing of several subspecies with different but still overlapping bill length distributions may at least cause the bimodality to disappear, which possibly happened in juveniles (Figure 7.25).

Our estimate of the proportion of adult *alpina* in Sidi Moussa is about twice as high as the 20-25% estimated by Pienkowski & Dick (1975) based on the results of autumnal expeditions between 1971 and 1973. Although the calculations as performed above are probably not very accurate, since they are rather sensitive to stochastic sampling variation (especially when they deal with the extremes of frequency distributions), we still think that the proportion of *alpina* in the Dunlin population was higher in March than it was in August-September. Furthermore, since spring migration had probably already started before our arrival, the proportion of *alpina* in the wintering population might be even higher than our estimated 50% in March for two reasons:

- departure of *alpina* to NW-Europe before March
- at the same time arrival in Morocco of *schinzii* coming from more southern wintering areas (i.e. Banc d'Arguin, Mauritania).

The proportion of Dunlins with active moult of body feathers increased from some 10% during the first half of March to values over 40% towards the end of the month (Table 7.25). Black belly feathers of the summer plumage did not emerge before mid-March. This implies that many Dunlins departed from the study area being still in winter plumage.

Shortening of wing length over the winter season was investigated for the 11 juvenile Dunlins ringed by the Durham University Expedition in September 1980 which were controlled by us in March 1981 (Figure 7.27). Wing lengths were on average 1.6 mm shorter in March than they were in September of the preceding year, but there was much variation between individual birds (range 0-6 mm).

Table 7.25 Prenuptial moult of Dunlins at Sidi Moussa in March 1981.

Date in March	Number caught	Moulting number	Moulting percentage	Number with black belly feathers
1-2	44	4	9%	0
2-3	38	2	5%	0
3-4	33	3	9%	0
4-5	36	2	4%	0
5-6	50	5	10%	0
6-7	59	10	17%	0
7-8	47	3	6%	0
9-10	19	4	21%	0
10-12	14	0	0%	0
15-19	18	5	28%	4
23-27	30	16	53%	13

Figure 7.28 shows the frequency distribution of the Dunlin weights. Adults were on average 3.4 g heavier than juveniles (Table 7.26). This difference is statistically significant ($t=4.8$, p 0.01). The average weight of adults and juveniles captured in September 1980 resembled spring weights (Table 7.26) but weights of individual birds caught in autumn and spring did change markedly (Figure 7.29). Most of these birds lost weight between September and March.

Data on weight loss after capture are presented in Figure 7.30. The slope of the linear regression equation suggests that Dunlins lost on average 0.3 g body weight per hour in captivity. However, this figure underestimates the actual rate of weight loss since the relation is in fact not linear. Figure 7.31 shows that the average rate of weight loss dropped from about 0.6 $g.hr^{-1}$ for birds kept only a few hours to about 0.4 $g.hr^{-1}$ for birds kept more than 10 hours in captivity. In addition heavy birds tended to lose weight at a slightly faster rate as compared to light ones (Table 7.27), but at a slower rate when considered as a percentage of body weight.

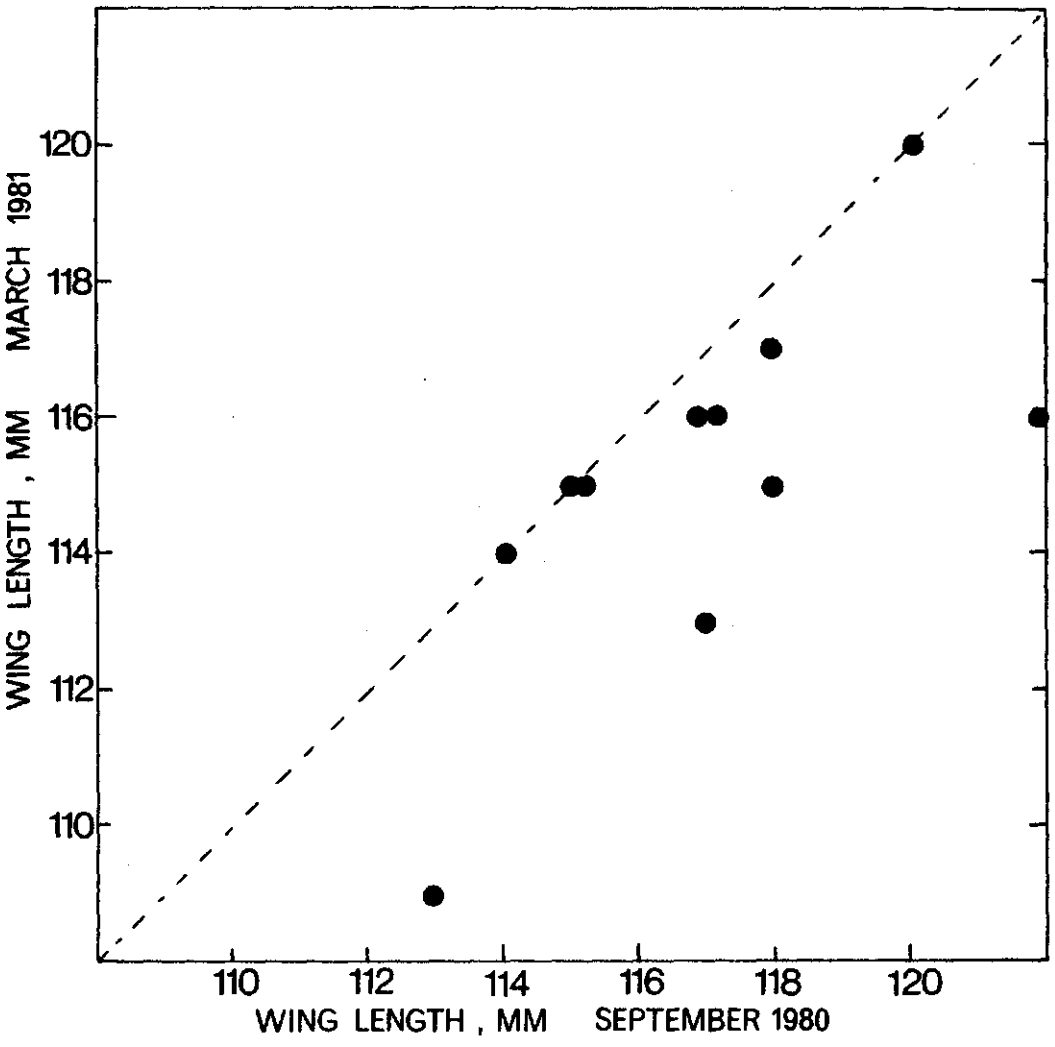


Figure 7.27 Wing length in individual juvenile Dunlins caught both in September 1980 and March 1981.

Table 7.26 Body weight of Dunlins caught during autumn and spring migration at Sidi Moussa. Data for September 1980 are taken from Moser (1981).

	March 1981 body weight (g)			September 1980 body weight		
	mean	SD	n	mean	SD	n
adults	45.4	6.0	81	44.8	6.2	48
juveniles	42.0	4.3	199	43.0	5.3	318
all birds	43.0	4.9	409			

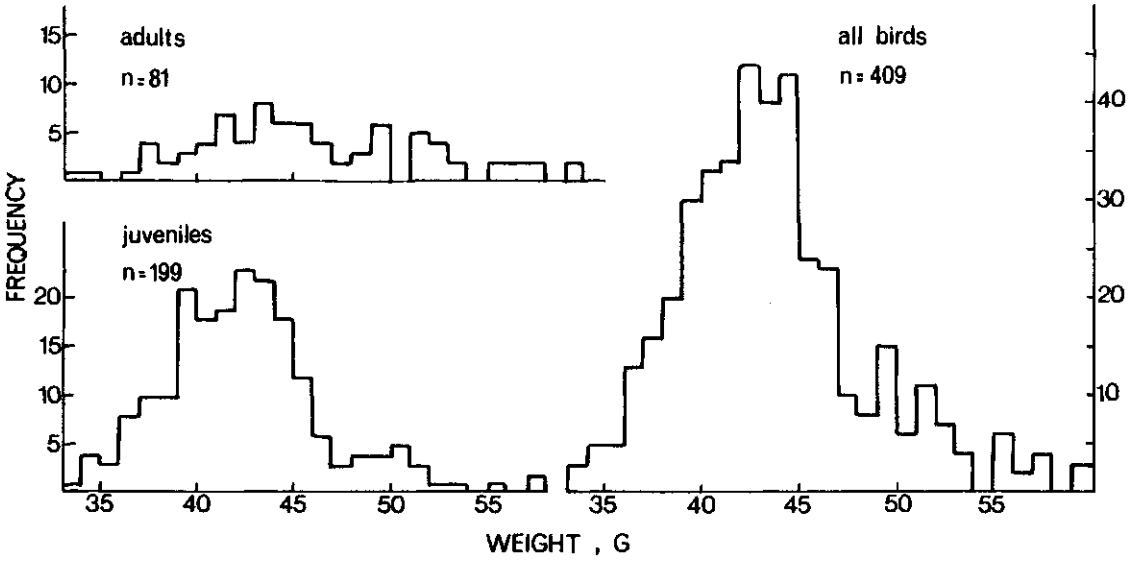


Figure 7.28 Frequency distribution of the weights of Dunlins captured at Sidi Moussa in March 1981.

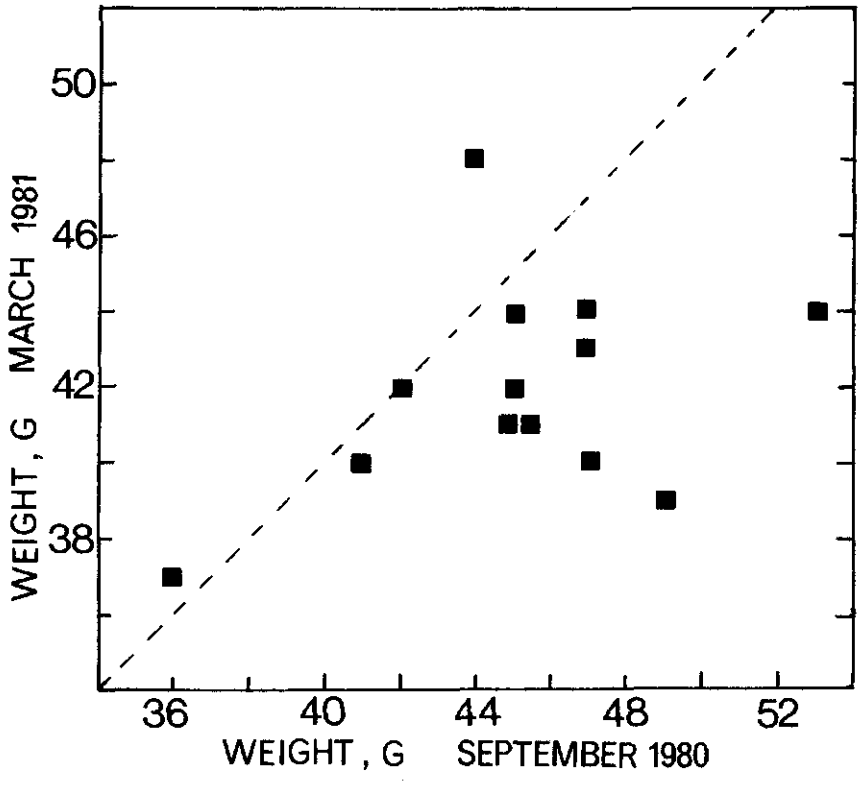


Figure 7.29 Weight change of individual Dunlins ringed in September 1980 and controlled in March 1981.

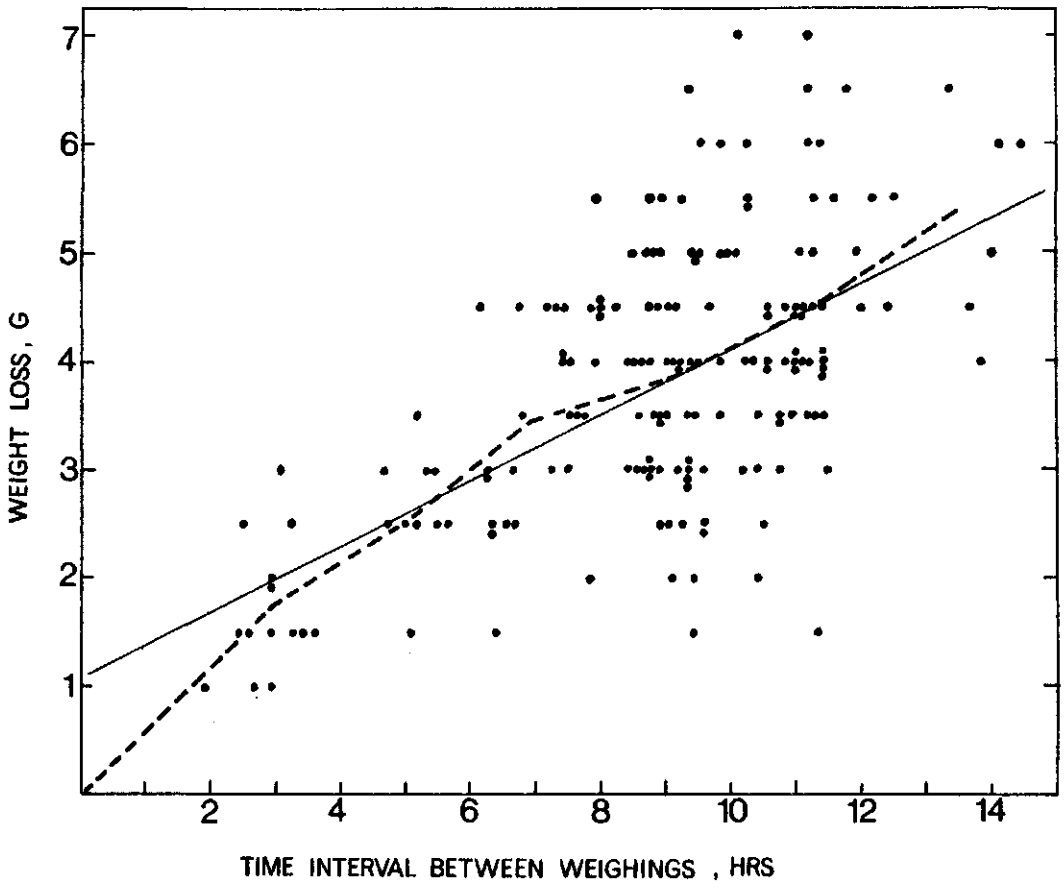


Figure 7.30 Weight loss of Dunlins after capture. First weighing was usually within 3 hrs after capture. The thin straight line gives the linear regression through all data points ($y = 0.3\ x + 1.1$, $r^2 = 0.38$, n=176). The broken line connects the means for two hour periods.

Table 7.27 Average rate of weight loss of Dunlins after capture according to their body weight at first weighing.

Body weight (g)	n	Weight loss ($g.hr^{-1}$)	
		mean	SD
< 40	42	0.42	0.13
40-50	111	0.45	0.14
⩾ 50	23	0.48	0.09

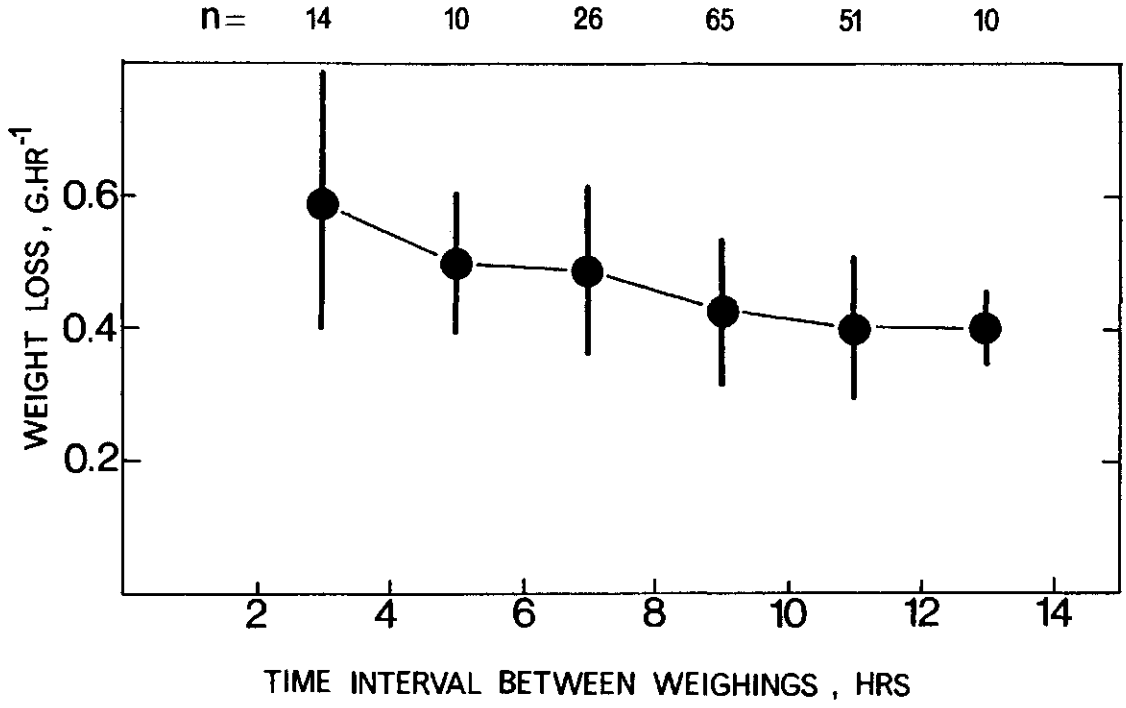


Figure 7.31 Rate of weight loss of Dunlins after capture.

7.9.3 Body composition

The body composition of 16 Dunlins (10 juveniles and 6 adults) was analysed. The sample is biassed towards light birds; mean weight was 38.9 g (SD=5.0 g) which is 90% of the mean weight of all birds captured. Figure 7.32 shows the relationship between fresh body weight and weight of extractable fats. Birds with body weights lower than 36 g contain no extractable fats. They even seem to have been forced to rely on other (energy) reserves, for example muscle proteins: they had a mean muscle index (SMV) (Evans & Smith 1975) of 0.176 (SD=0.022, n=4) compared to a mean muscle index of 0.223 (SD=0.035, n=12) for birds heavier than 36 g. We can only suggest that these, somewhat emaciated, birds had reached the study area shortly before being captured after a demanding migratory flight. Figure 7.32 shows that the gain in weight above 40 g is, to a considerable extent, attributable to the deposition of fat.

7.9.4 Food and foraging

Quantitative observations on the foraging of Dunlins are very difficult to obtain because of the fast rate with which this species probes and pecks, and because of the small food items it eats. Occasionally however, we saw

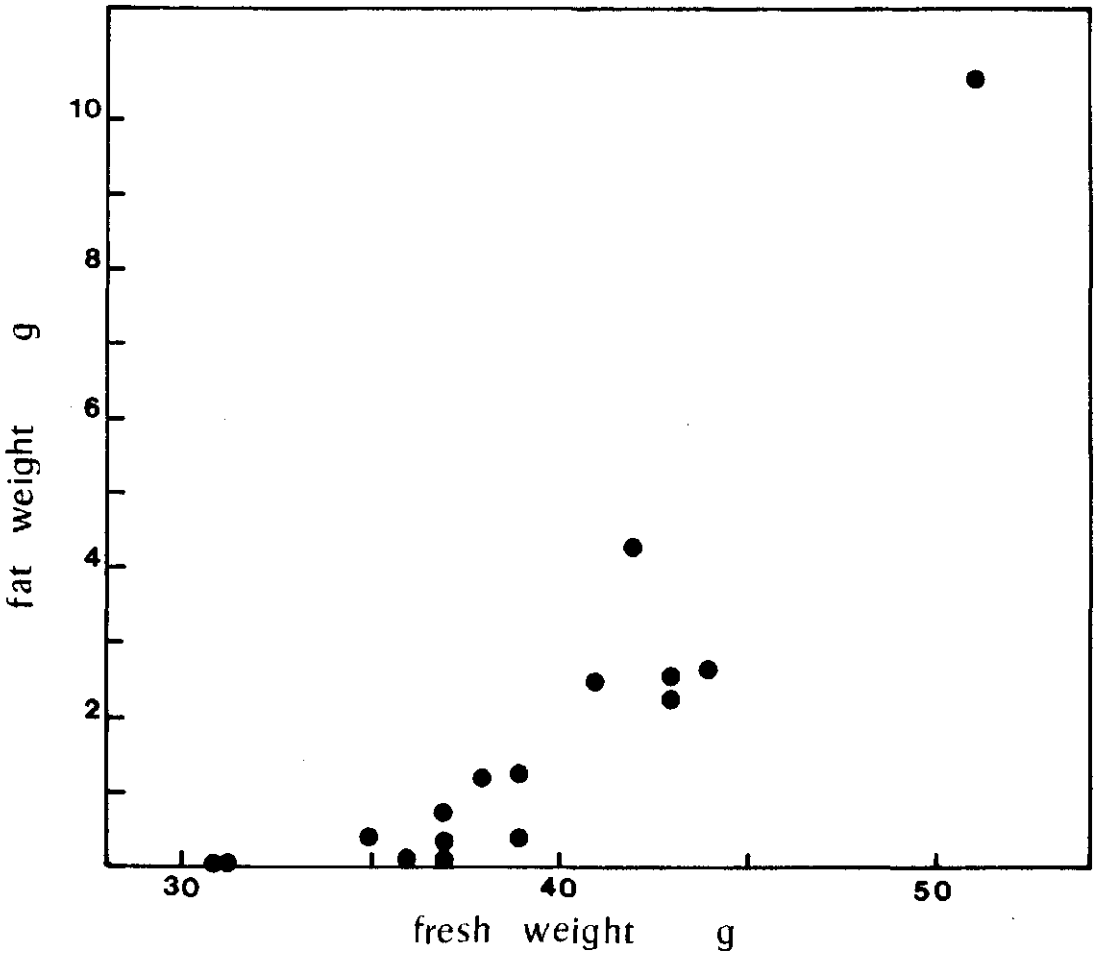


Figure 7.32 The relationship between fat weight and fresh body weight of a sample of Dunlins captured at Sidi Moussa in March 1981.

a Dunlin eating identifiable Ragworms *Nereis diversicolor*. On 20 March three quantitative observations were made. One measurement (an observation period of 2.00 min) showed a probe rate of 34 per minute during which the bird obtained 3.5 small prey items per minute (10% of all pecks were successful). Another observation period (of 10.45 min) indicated a success rate of 2.6 small items per minute; these were captured at a depth of about 2 cm. This bird made several probes to eat prey item discovered. During a third observation period of 2.35 min a Dunlin had a success rate of 6.0 captures per min. In this case the bird was probably eating *Peringia ulvae*, which it took from between the eelgrass leaves. Sometimes Dunlins emptied Cockles *Cerastoderma edule* opened by Turnstones.

Figure 7.33 shows the results of the density and activity measurements on the study plot in the northern part of the estuary. The mean low tide density (from 1 hour before to 2 hours after the time of low tide) was as high as 103 birds per ha available area (27 counts). With the rising tide

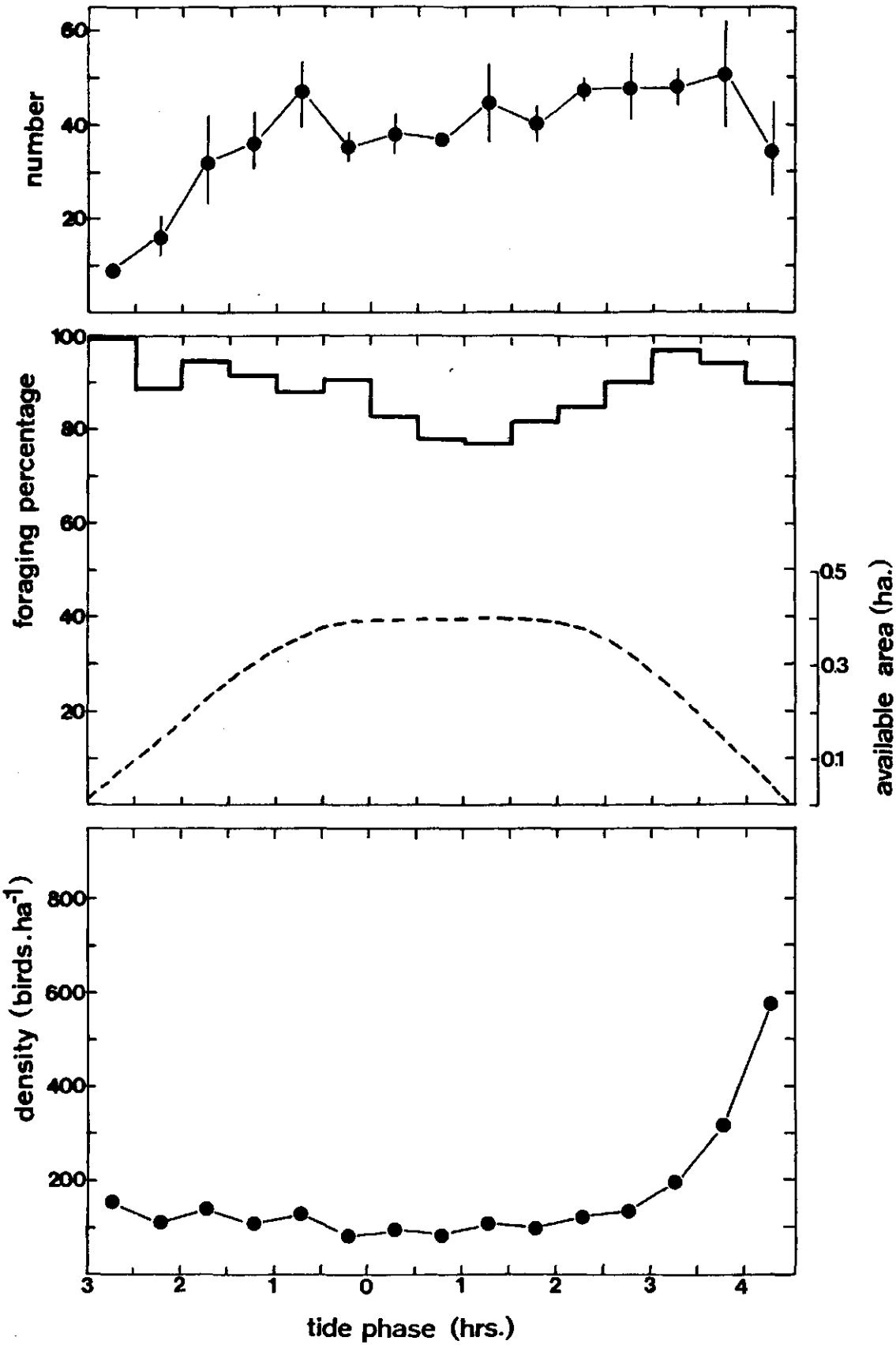


Figure 7.33 Numbers, percentages of birds foraging, and densities of Dunlins on the 0.4 ha study plot in the course of a low water period.

the Dunlins were concentrated to densities of 580 birds per ha available area. The percentages of birds which were foraging were lowest around 1 hour after low tide (about 80%). The mean percentage of birds foraging was 89%.

View to the east along the northern part of the intertidal area at Sidi Moussa

7.10 Bar-tailed Godwit *Limosa lapponica*

7.10.1 Numbers and migration

Numbers of Bar-tailed Godwits dropped from 65 birds on 1 March to 17 birds on 17 March (Figure 7.34). Between 17 and 21 March at least 160 birds entered the study area but all birds had left again by 26 March. Although the numbers were rather small, the considerable fluctuation in the numbers present suggest rapid passage of godwits through the study area. This indicates that individual godwits stayed only for a few days.
Bar-tailed Godwits were never encountered in the (non-tidal) salt-pan area, which is probably the reason we were unable to catch any of this species.

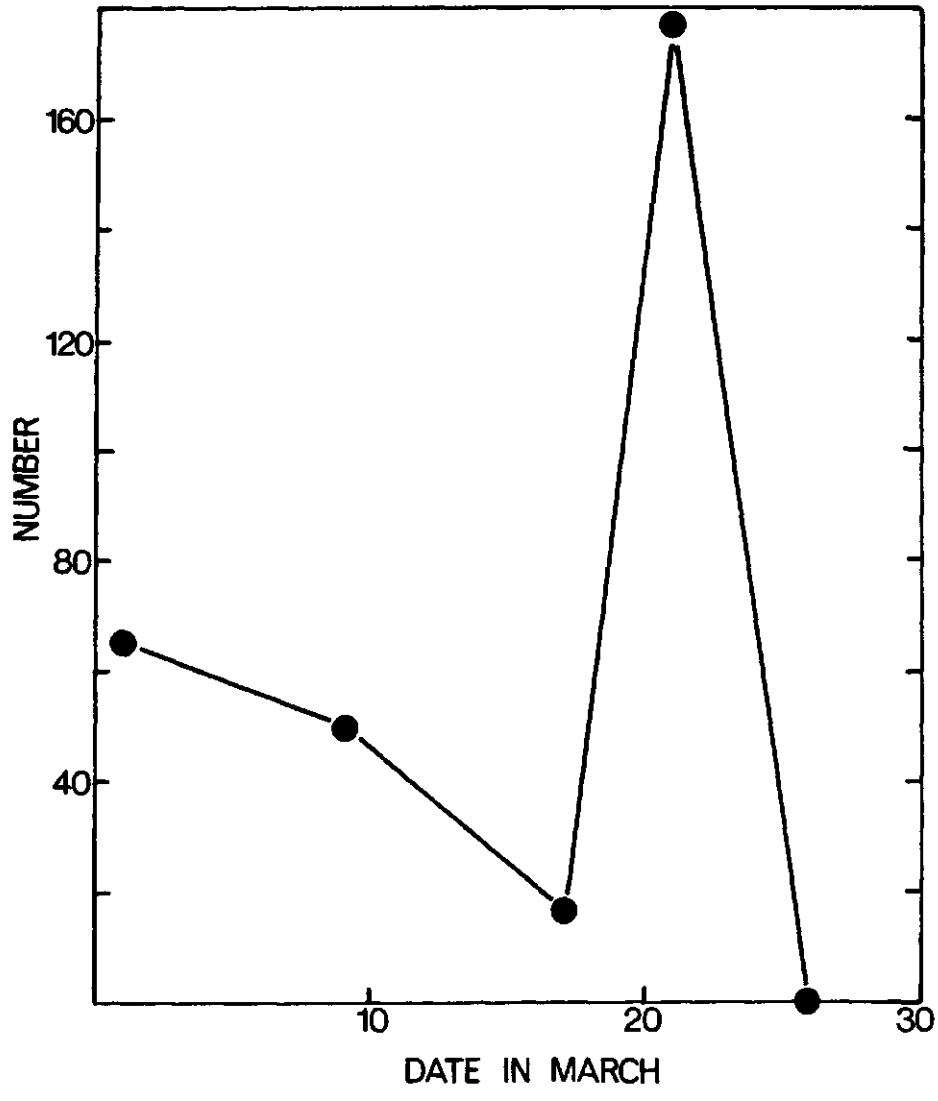
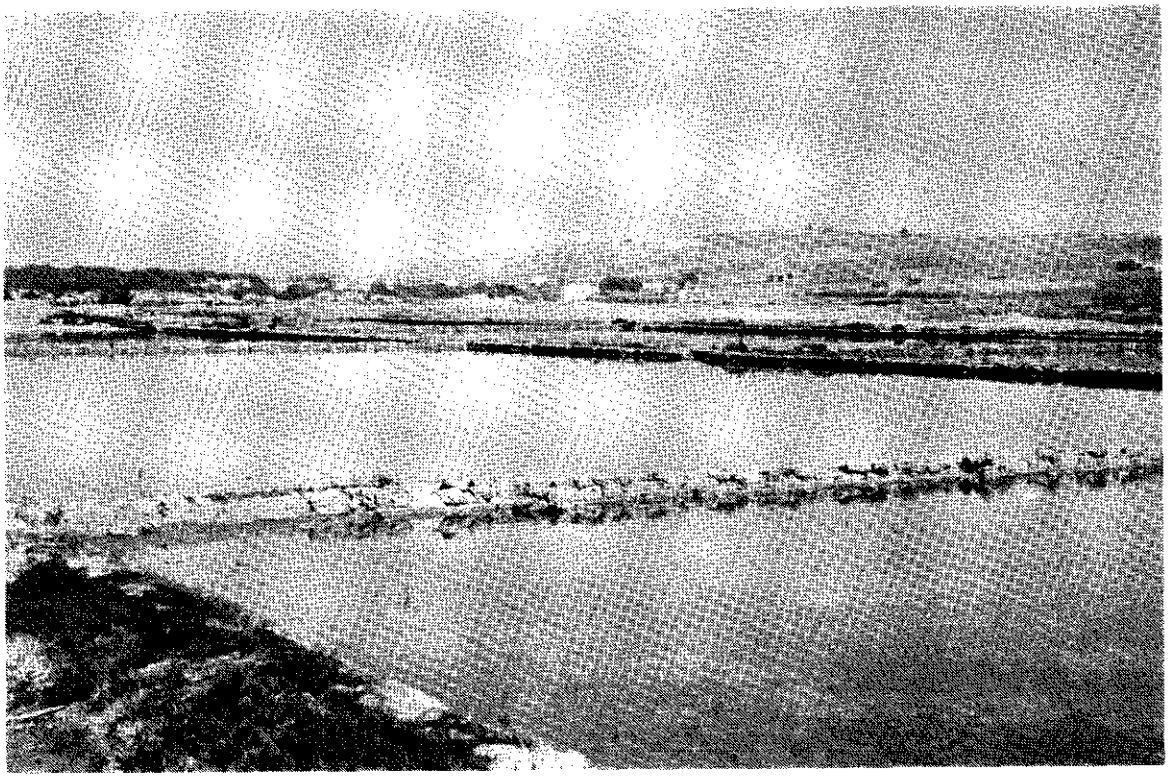


Figure 7.34 Numbers of Bar-tailed Godwits counted in the Sidi Moussa study area.

7.10.2 Food and foraging

The food of Bar-tailed Godwits appeared to consist presumably entirely of Ragworms *Nereis diversicolor*. Once, a godwit was observed for some time during which it made 141 probes and caught 10 Ragworms of approximately bill length (7-9 cm); this makes a percentage success of 7%. All worms caught by Bar-tailed Godwits were washed before being swallowed; this is in contrast to the behaviour of Grey Plovers which never did so. Numbers of Bar-tailed Godwits on the study plot and correspondingly, densities during low water, were highest during the outgoing and incoming tides; the godwits seemed to follow the tide line to some degree (Figure 7.35). From 3 to 1 hours before low tide the mean density was 8 birds per ha (14 counts) and from 2 to 4.5 hours after low tide the mean density was 11 birds per ha available area (19 counts). The mean low tide density was 4 birds per ha (27 counts). The mean percentage of birds foraging was as high as 97%.



Salines in the northern part of the study area in Sidi Moussa

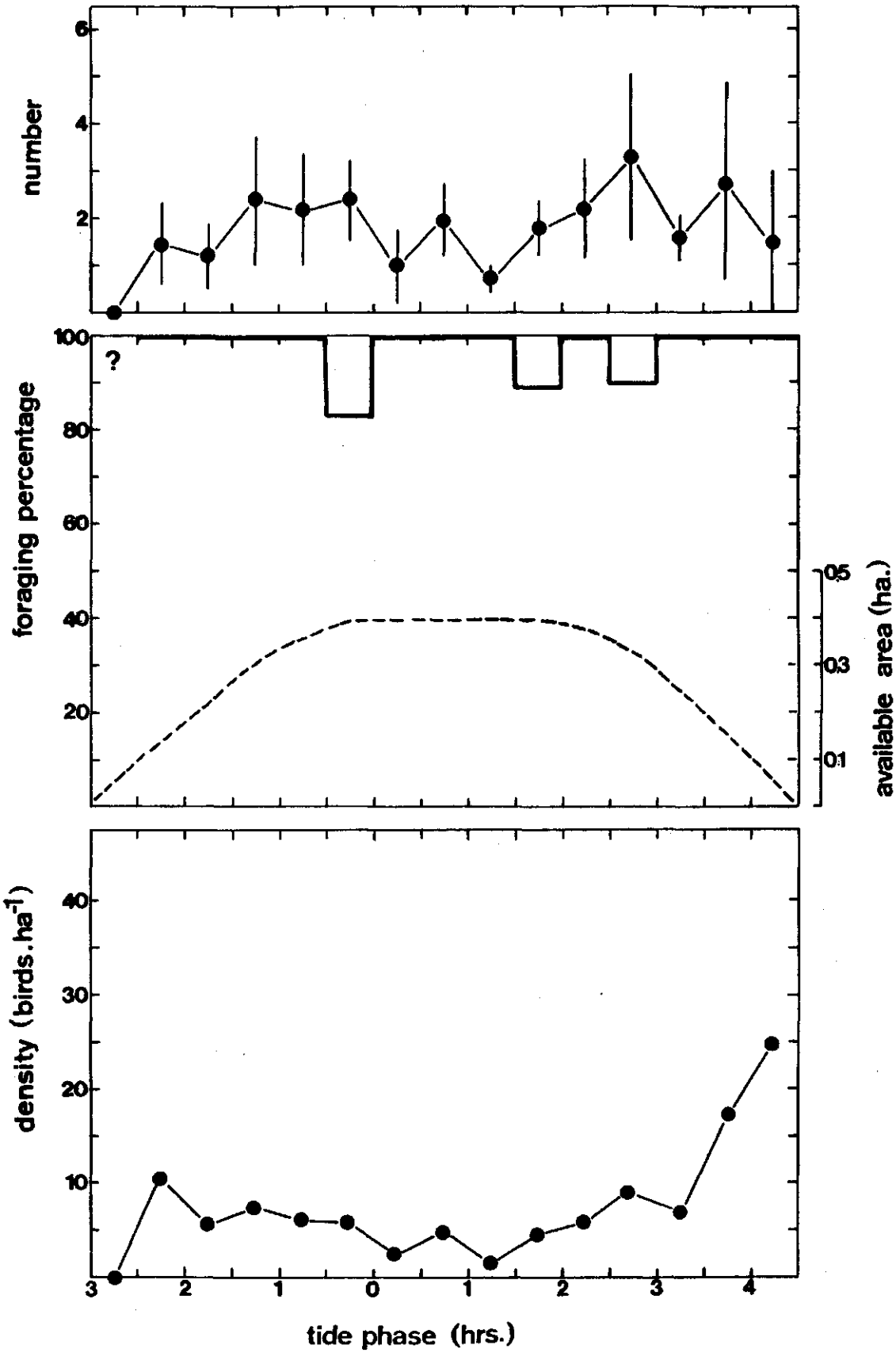


Figure 7.35 Numbers, percentages of birds foraging, and densities of Bar-tailed Godwits on the 0.4 ha study plot in the northern part of the channel in the course of a low water period.

7.11 Redshank *Tringa totanus*

7.11.1 Numbers and migration

In the first week of March 1981 numbers of Redshanks present in the study area declined from 505 to 330 birds (Figure 7.36). Until 21 March numbers increased again, to 421 birds, and in the following five days numbers dropped again to 294 birds. During high tide about half of the population roosted in the non-tidal area (Figure 7.36).

Results of our marking program of Redshanks are shown in Table 7.28. Figure 7.37 shows that the whole decline in numbers in the first week of March can be explained completely by the emigration of Redshanks already present on 1 March. During this period very few, if any, Redshanks arrived in the study area (Figure 7.38). The number of 'first of March birds'

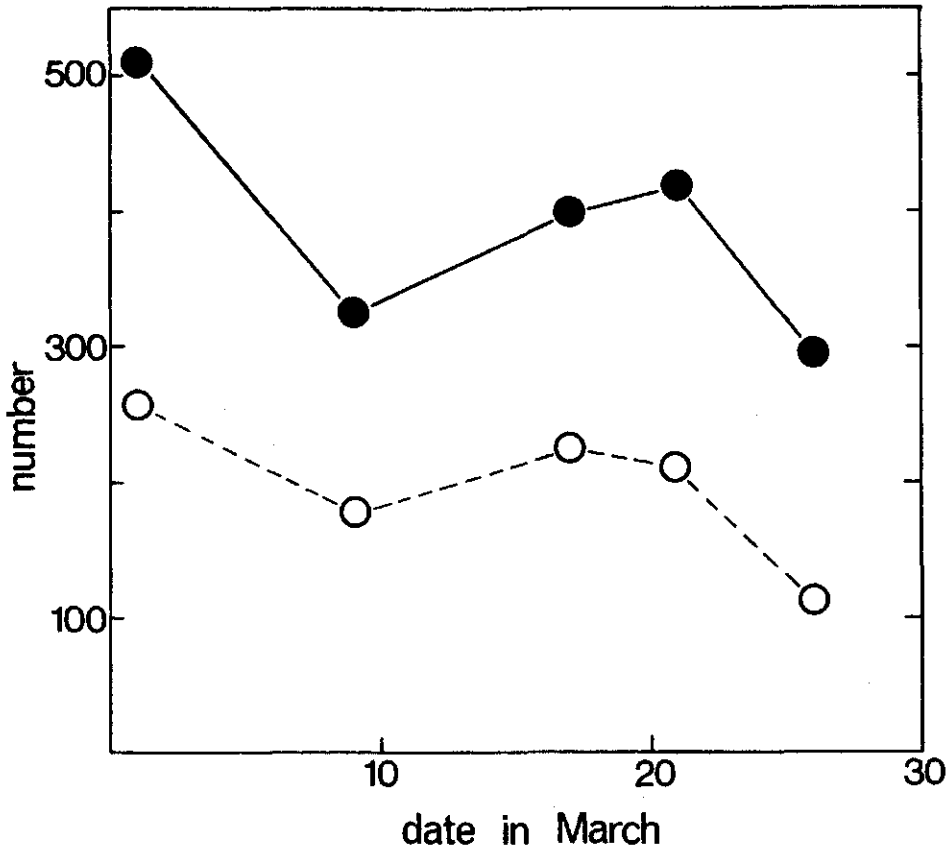


Figure 7.36 Numbers of Redshanks counted in the Sidi Moussa study area. Closed dots denote total numbers and open dots the number of birds roosting at high tide in the salt-pan area.

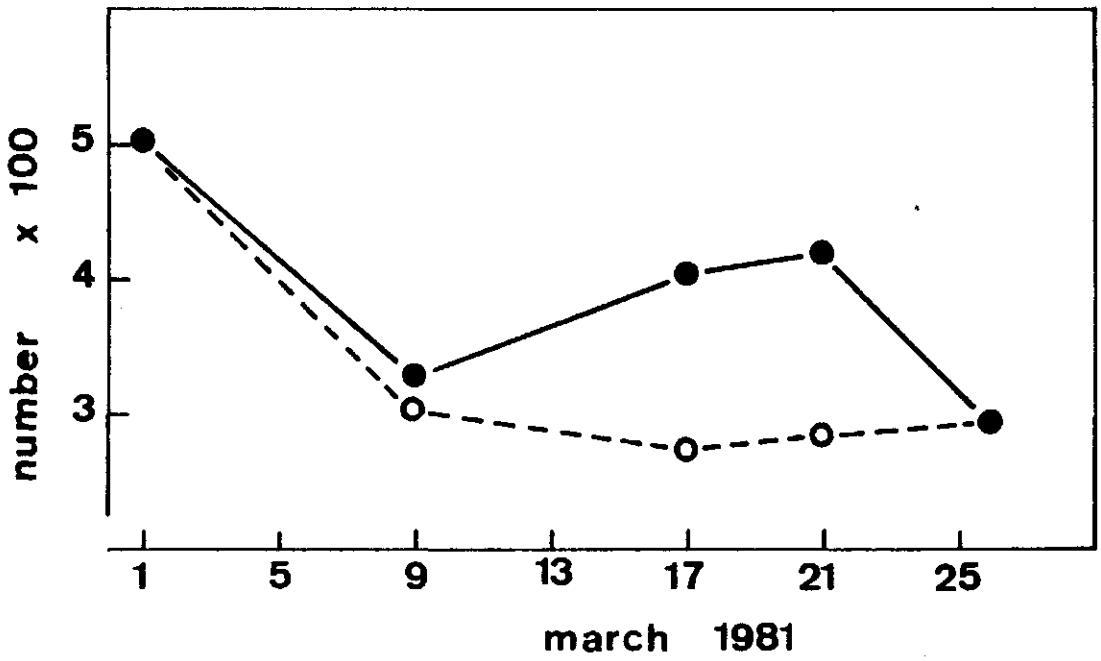


Figure 7.37 Total numbers of Redshanks counted in the Sidi Moussa study area (closed dots) and numbers of birds present on 1 March that remained in the study area (open dots).

Table 7.28 Results of the marked birds samples for Redshanks.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in the study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	155	13	13A	28	46
17/18	145	10	8A, 1B, 1?	28	52
21/22	97	8	6A, 1B, 1C	35	56
26/27	98	11	9A, 1B, 1D	33	75

remained constant in the rest of the month. All Redshanks arriving in the study area between 9 and 21 March had left Sidi Moussa again by 26 March; most of these transient birds arrived between 9 and 17 March and departed between 21 and 26 March (Figure 7.38); they stayed for about 10 days.
Our calculations showed that in March 188 Redshanks entered the study area whereas 505 individuals were already present on 1 March. Therefore, the total

number of Redshanks using the study area in March 1981 amounted to about 700 birds. We found no indications that relatively heavy Redshanks were more likely to leave the study area as compared to relatively light birds (Table 7.29).

We controlled six Redshanks which were all ringed by the Durham University Expedition to Sidi Moussa in September 1980. Five of these birds were caught between 1 and 5 March (the sixth on 26 March), representing some 12% of all the birds caught in this period. If we assume that the proportion of Redshanks ringed in September 1980 in our catch approximates the proportion of ringed birds in the population we see that about 0.12 * 505 = 61 Redshanks

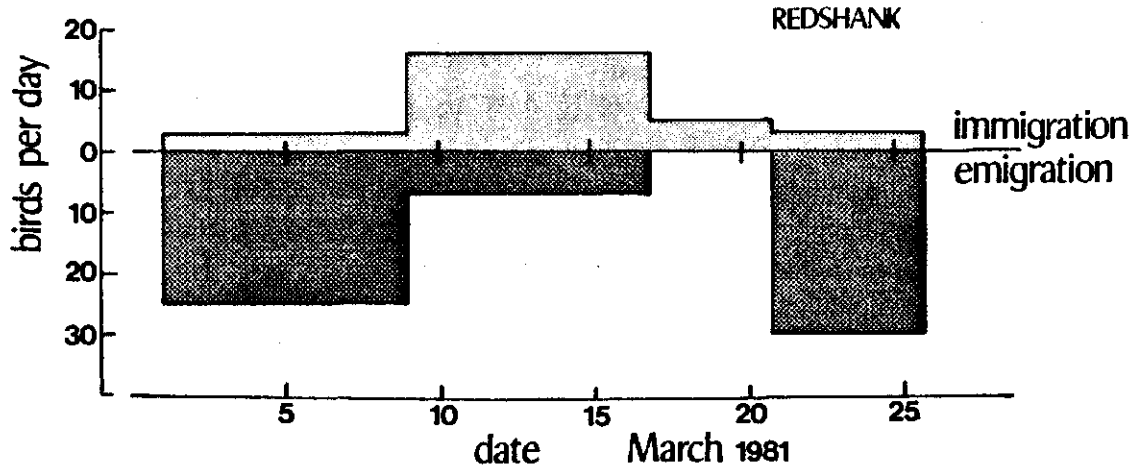


Figure 7.38 Migration rate of Redshanks through the Sidi Moussa study area in different periods in March 1981.

Table 7.29 Emigration of light and heavy Redshanks, marked between 1 and 9 March, from the study area. The expected values were calculated under the assumption that the likelihoods of departure were equal for light and heavy birds.

	Weight (g)		
	⩾ 120	< 120	
marked, 1-9 March	12	34	
observed, 9-26 March	7	18	$X^2 = 0.07$, N.S.
expected	6.4	18.6	

ringed in September 1980 were present in the study area on 1 March 1981. Since the Durham University Expedition ringed only 66 Redshanks we might conclude that most of the birds present in September 1980 were still present in the study area in March 1981 and therefore probably belonged to a resident wintering population.

7.11.2 Biometrics

Average values of the biometrical measurements are given in Table 7.30. The values presented here for wing and bill length compare closely with the other Moroccan data (Pienkowski 1975, Moser 1981). Wing length

Table 7.30 Biometric data for Redshanks.

	Juveniles (n=20)		Adults (n=28)		All birds		
	mean	SD	mean	SD	mean	SD	n
wing length (mm)	159.4	3.9	162.0	3.9	161.8	4.7	88
nalospi length (mm)	32.3	1.8	33.5	1.3	33.0	1.5	90
bill length (mm)	42.2	2.4	43.5	1.7	43.1	1.9	90
total head length (mm)	74.3	2.4	75.5	1.8	75.1	2.0	90
weight (g)	106.3	9.8	110.2	13.7	109.5	18.1	91

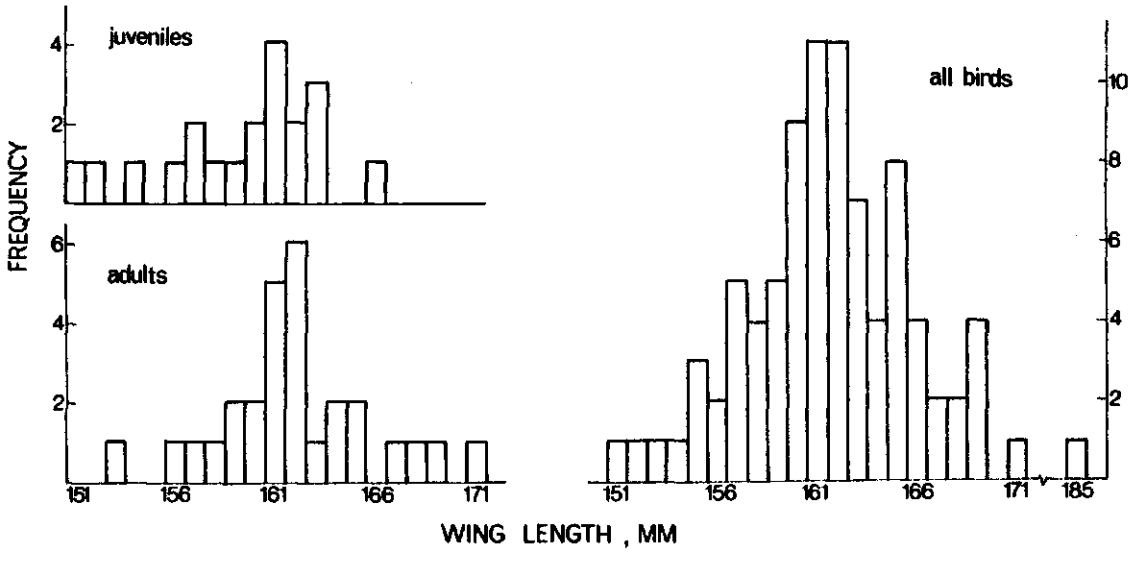


Figure 7.39 Frequency distribution of wing lengths of Redshanks at Sidi Moussa in March 1981.

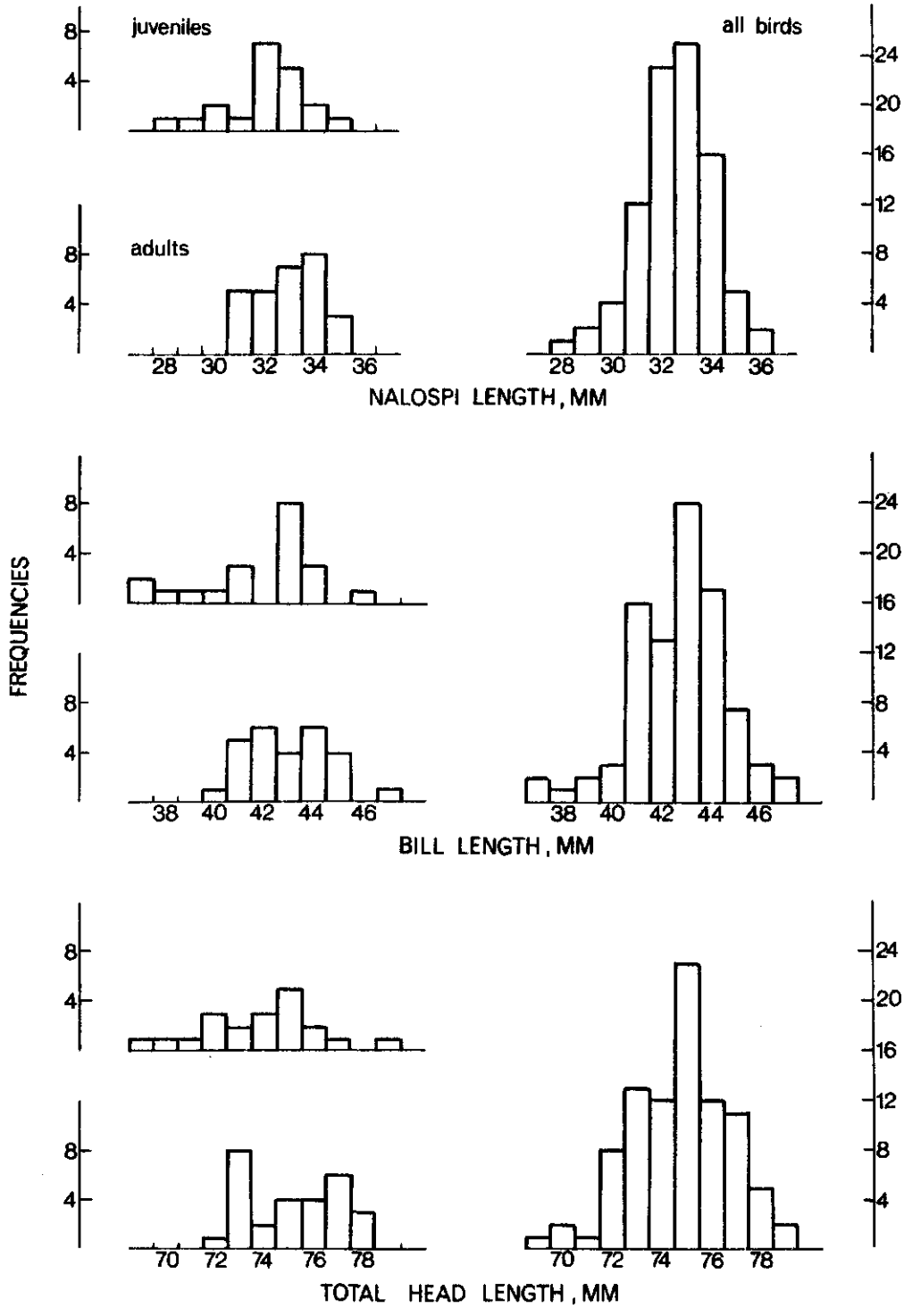


Figure 7.40 Frequency distributions of nalospi, bill and total head lengths of Redshanks at Sidi Moussa in March 1981.

distribution (Figure 7.39) closely corresponds to the distribution presented by Koopman et al. (1982) for (breeding) birds caught inland in Friesland, Netherlands. This fact, and the control of a bird ringed during the breeding season in Danmark support the conclusion of Pienkowski (1975) that the Redshanks found in Morocco in autumn (but, as we have seen earlier, also in winter and spring) are from the breeding populations around the Baltic and along the Eastern North Sea coast. One bird, with a wing length of 185 mm, may originate from the Icelandic breeding population.

Measurements of both wing, and nalospi, bill and total head length (Figure 7.40 and Table 7.30) show that juveniles are somewhat smaller than adults.

Weights of Redshanks caught in March 1981 (Figure 7.41) are somewhat smaller than those of the birds in autumn (Pienkowski 1975, Moser 1981). This is supported by the generally lower weights of individual birds caught both in autumn and spring (Table 7.31). Only two relatively heavy birds showed a higher weight in spring as compared to autumn and may belong to the emigrating part of the population since one (ad 2) was caught on 4 March and the other (ad 1) on 26 March, both during periods with a large emigration (Figure 7.38).

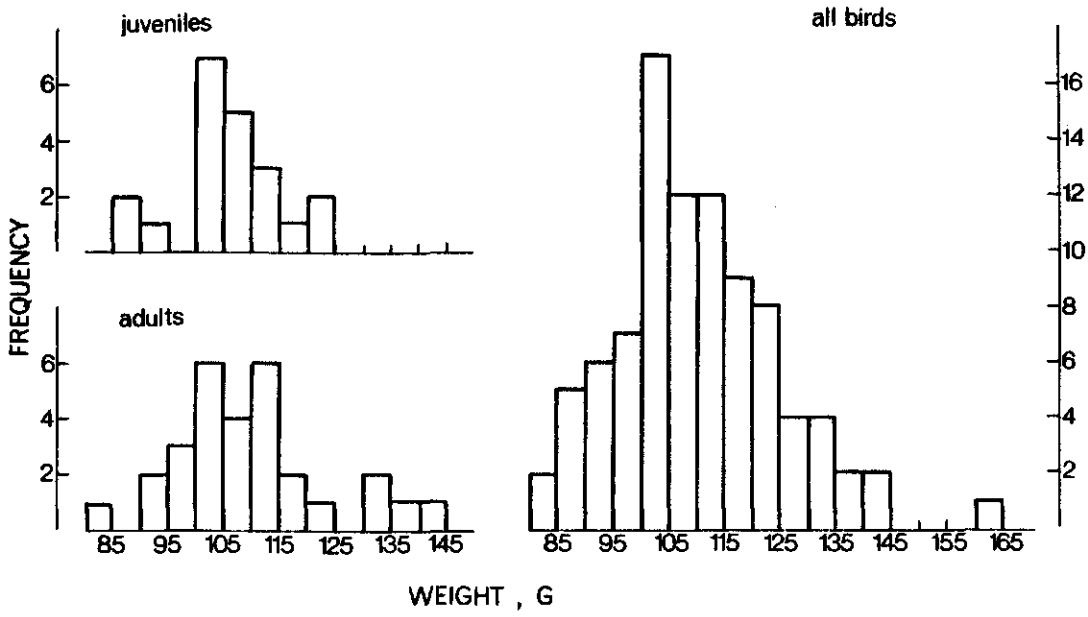


Figure 7.41 Frequency distribution of weights of Redshanks at Sidi Moussa in March 1981.

Table 7.31 Weight changes of individual Redshanks caught both in autumn and the successive spring at Sidi Moussa. In autumn, all adults caught were in wing moult.

	Weight (g)	
	15-18 September 1980	March 1981
adult 1	129	139
adult 2	126	145
adult 3	122	103
adult 4	117	111
adult 5	105	104
juvenile	122	98

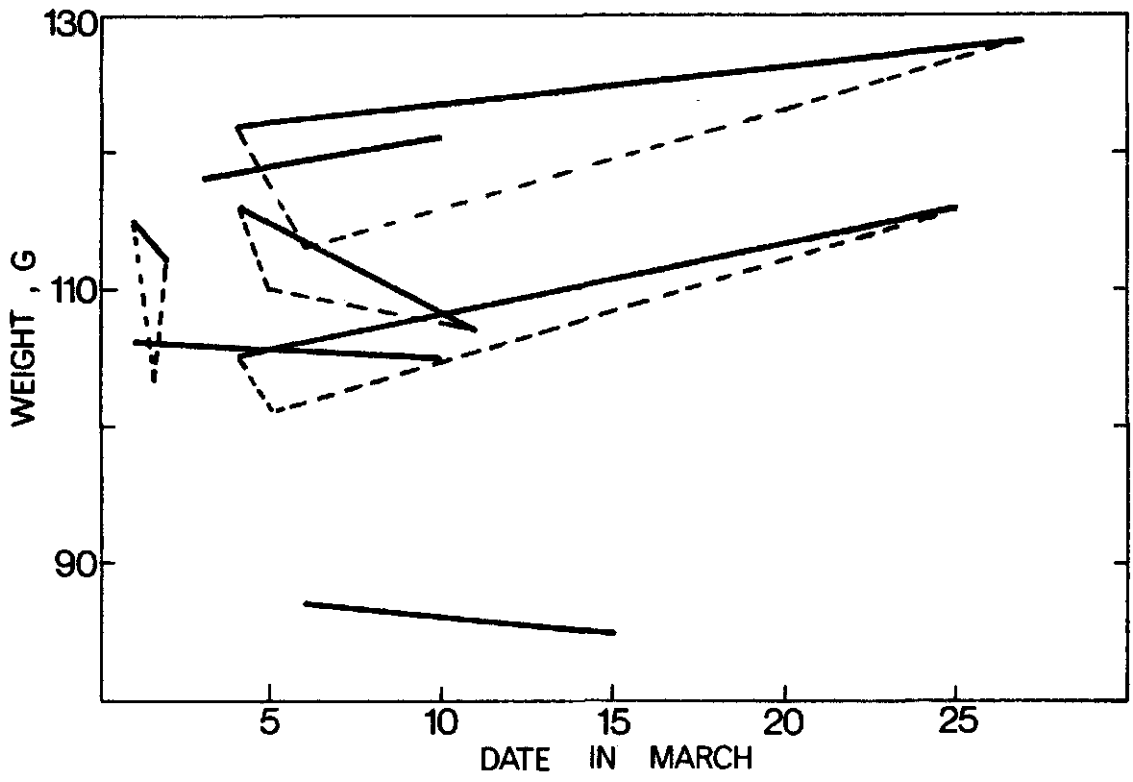


Figure 7.42 Weight changes of Redshanks captured twice in March 1981. Dashed lines denote weight loss in captivity and the subsequent recovery.

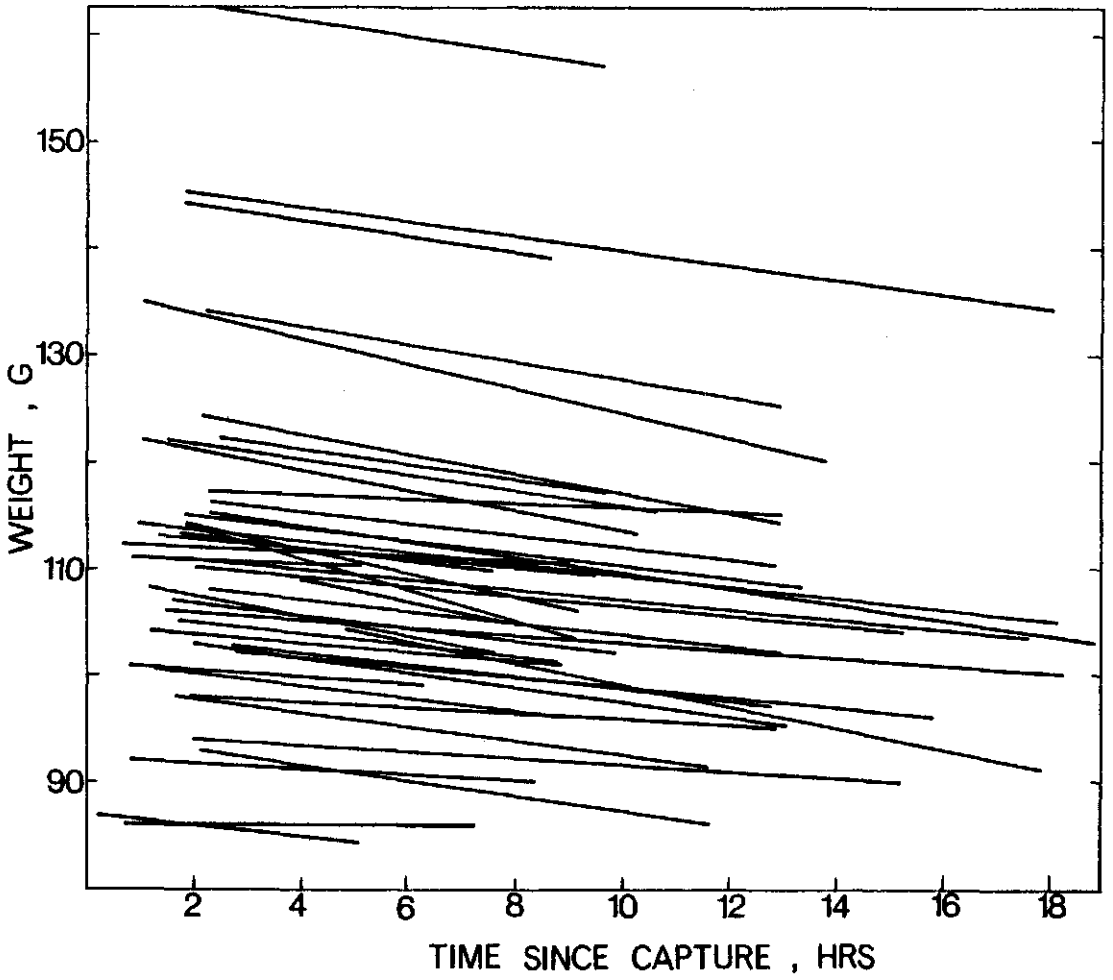


Figure 7.43 Weight loss of Redshanks held in captivity after capture.

Figure 7.42 shows the weight changes of Redshanks caught twice in March. It seems that in the first half of March weights of individuals declined whereas individuals recaptured in the last week of March showed a gain in weight.

Data on weight loss after capture are presented in Figure 7.43; Redshanks lost on average 0.6 $g.hr^{-1}$ (SD=0.29, n=43). Light Redshanks in captivity lost weight at a slower rate than heavy ones (Table 7.32). Expressed as a percentage of mean body weight the birds weighing less than 100 g lost $0.47\%.hr^{-1}$ and birds weighing more than 120 g lost $0.60\%.hr^{-1}$. Birds can recover quickly after release as is exemplified by a bird (Figure 7.42) which lost 12 g (115 to 103 g) during captivity (16.6 hr) but which had recovered to 112 g when it was recaptured only 7.5 hrs after its release.

About a quarter of the Redshanks caught showed body moult (Table 7.33). Incidence of body moult was lowest in the birds caught in the middle of March.

Table 7.32 Average rate of weight loss of Redshanks after capture according to their body weight at first weighing.

Body weight (g)	n	Weight loss ($g.hr^{-1}$)	
		mean	SD
< 100	6	0.43	0.28
100-120	27	0.57	0.29
⩾120	10	0.80	0.19

Table 7.33 Incidence of prenuptial body moult in Redshanks caught at Sidi Moussa in March 1981.

Date in March	Number caught	Number moulting	Percentage moulting
1-3	24	7	29%
3-5	17	5	29%
5-9	12	2	17%
10-12	11	2	18%
15-18	8	0	0%
22-28	24	7	29%

7.11.3 Body composition

The bodies of nine Redshanks were analysed. Average weight of the sample of birds examined, was 5 g less than the mean weight for all Redshanks caught in March 1981. Figure 7.44 shows the relationship between fat reserves and breast muscle index and fresh weight. Birds with weights less than 90 g contained no extractable fats and had breast muscles which appeared depleted as well. These individuals were probably caught upon arrival after a long migratory flight. Birds with larger fat reserves and body weight also had larger breast muscles.

7.11.4 Food and foraging

Redshanks foraged in relatively low densities on the mudflats in the Sidi Moussa area. At least some of them were defending feeding territories. Regularly we saw them engaged in border disputes: mainly running to and fro alongside each other over distances of 5 to 15 m. The prey observed consisted of unidentifiable small prey items caught from between eelgrass

leaves (about 20 prey taken per min), individuals of the small snail *Peringia ulvae* from the surface, small bivalves (presumably *Abra tenuis*) from a depth of 1 or 2 cm, and small fishes caught in pools in areas covered with eelgrass. During an observation period of 7.4 min about 86 *Peringia ulvae* per min were captured. Densities over the low water period varied from 4 to 13 birds per ha available area (Figure 7.45). Mean low tide density (from 1 hour before to 2 hours after time of low tide) was 6 birds per ha (27 counts). The mean percentage of birds foraging was 87%.

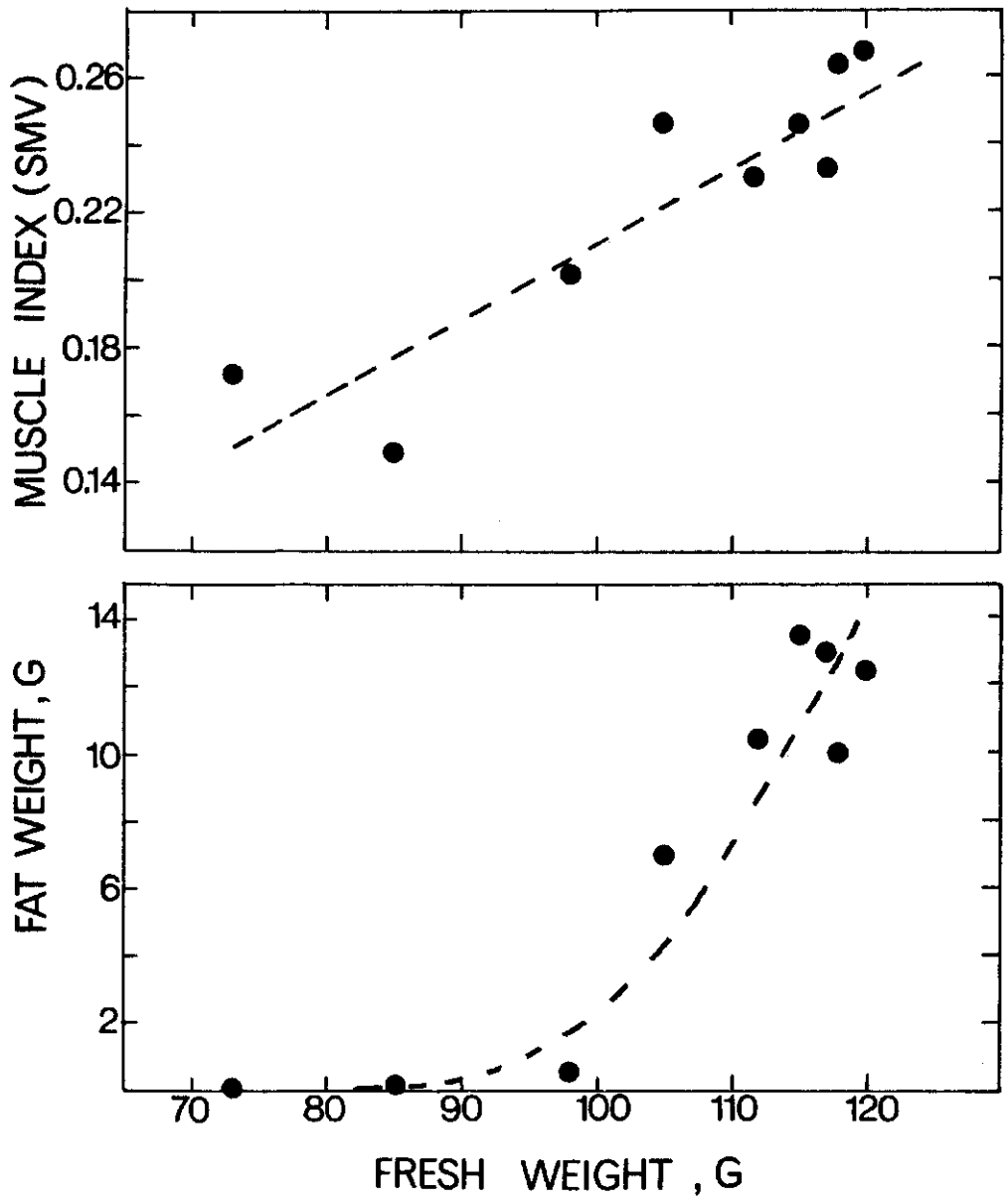


Figure 7.44 Relationship between fresh body weight of Redshanks and the amounts of extractable fats and relative muscle size. The muscle index is the quotient of lean dry weight of the breast muscles (both sides) and the Standard Muscle Volume calculated according to the method of Evans & Smith 1975. The lines are fitted by eye.

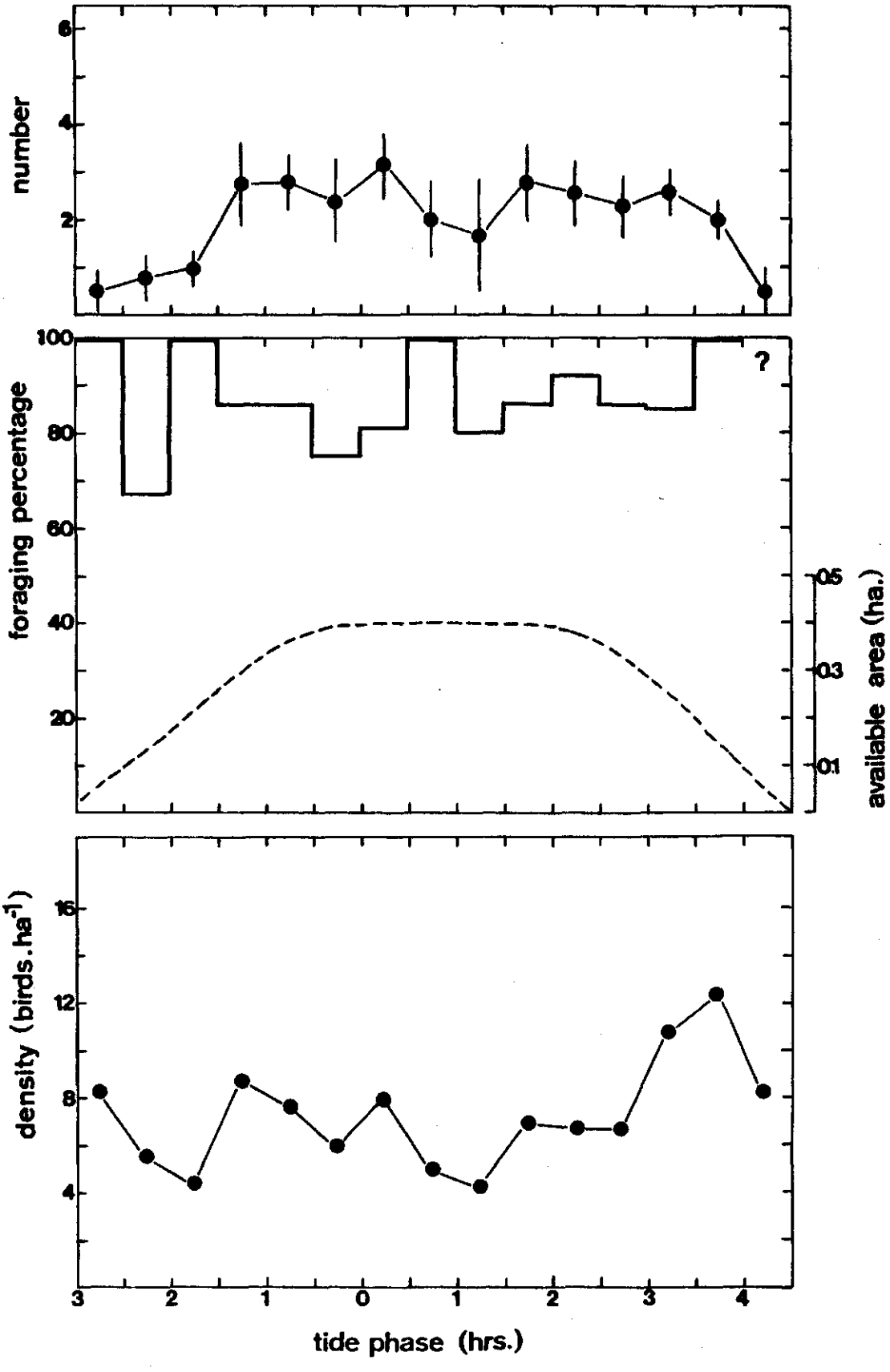


Figure 7.45 Numbers, percentages of birds foraging, and densities of Redshanks on the 0.4 ha study plot in the course of a low water period.

7.12 Turnstone *Arenaria interpres*

7.12.1 Numbers and migration

The number of Turnstones counted in the study area is given in Figure 7.46. There must have been at least some emigration during the first week of March since the numbers dropped from 237 to 159 birds. Between 21 and 26 March the number of Turnstones increased again from 162 to 223 birds, indicating arrival of new birds. Less than 50% of the population spent the high water periods in the salt-pan area during daylight hours.

Only five marked birds were released and one of these birds was seen on 21 March, 3 or 4 days after marking (Table 7.34). No conclusions on migration can be drawn from these data.

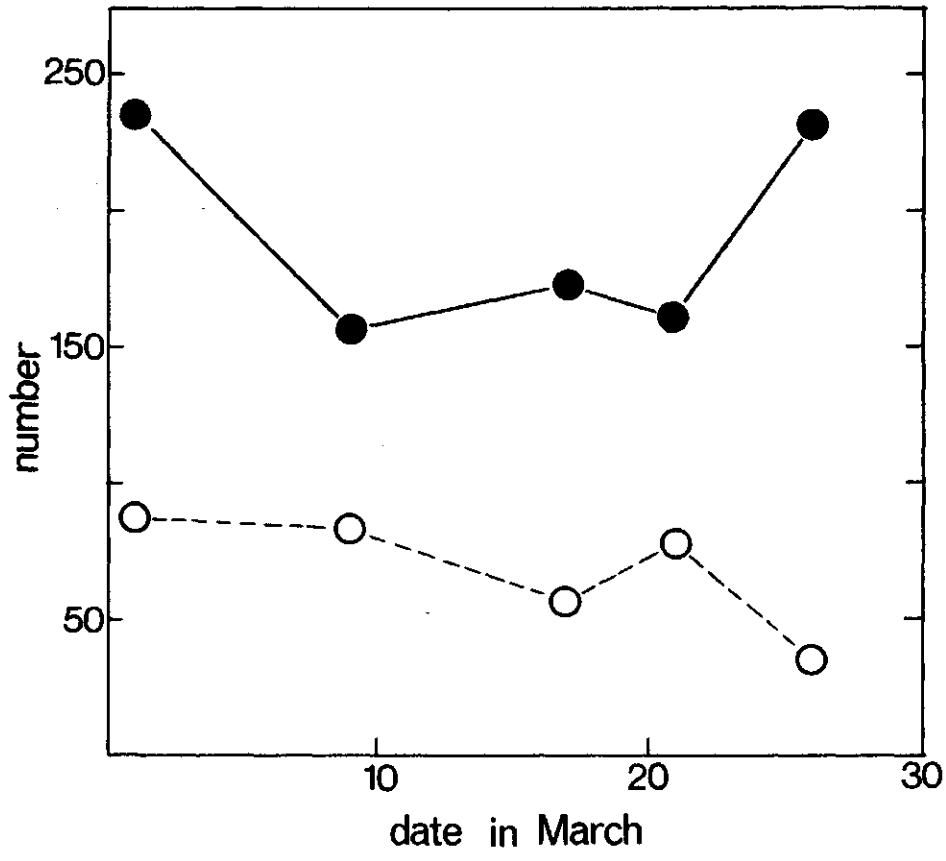


Figure 7.46 Numbers of Turnstones counted in the Sidi Moussa study area. Closed dots denote total numbers and open dots the numbers of birds roosting in the salt-pan area.

Table 7.34 Results of the marked bird samples for Turnstones.

Dates in March	Sample size	Marked birds seen in sample		Estimated number of marked birds in the study area	Cumulative number of marked birds released
		total	from each marking period		
9/10	35	0		0-13	1
17/18	31	0		0-14	2
21/22	66	1	1C	1-12	4
26/27	75	0		0-9	5

7.12.2 Biometrics

Data on the biometrical measurements of the birds caught is summarized in Table 7.35. Unfortunately none of these birds could be positively identified as being adult.

Only one juvenile Turnstone was caught in autumn by the British expeditions in the early Seventies (Pienkowski 1972). This bird had a wing length of 158 mm and a bill length of 24 mm. Mean wing and bill length for 143 juvenile Turnstones caught in Mauritania in late autumn 1973 were 154.8 mm and 23.7 mm respectively (Dick 1975). Our birds had longer wings but smaller bills compared to those caught in Mauritania.

We kept one Turnstone in captivity for seven hrs and during this time interval its weight decreased from 98 to 95 g. The estimated delay between capture and first weighing of this bird was two hrs.

The mean weight of our birds is very close to the minimum weights of Turnstones in the Dutch Wadden Sea which occurs in March too, just prior to the start of fat accumulation for the spring migration (mean=104.7 g, SD=5.5 g, n=24; data of Boere in Smit & Wolff 1980). The relatively low weights of our birds indicate that these birds had only small fat reserves and were probably not able to migrate over any significant distance.

7.12.3 Food and foraging

Turnstones fed on several prey types. Often they foraged on 1-2 cm large Cockles *Cerastoderma edule*. Most of the Cockles were opened and eaten below the surface of the muddy substrate. Some of them were taken to the surface before being opened. There was a risk in taking a Cockle to the surface as Grey Plovers often chased Turnstones away from the opened Cockles and took

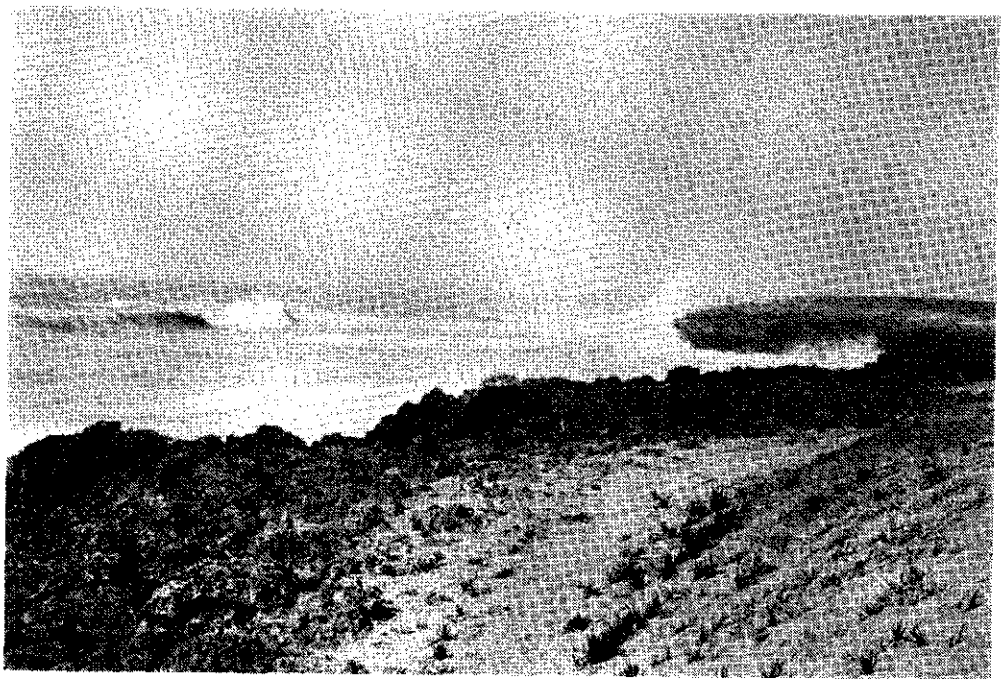
Table 7.35 Biometric data for Turnstones.

	Juveniles (n=4)		All birds (n=8)	
	mean	SD	mean	SD
wing length (mm)	159.5	2.6	159.8	2.0
bill length (mm)	22.6	0.9	22.6	0.9
total head length (mm)	52.0	0.9	51.8	0.7
weight (g)	101.3	2.2	104.8	5.9

what was left. Normally Turnstones were able to take the fleshy foot of the Cockle but sometimes they were chased away by Grey Plovers or other Turnstones, before being able to eat anything. It was observed that some Grey Plovers followed a Turnstone for more than a quarter of an hour; i.e. for as long as it foraged in the Grey Plover's feeding territory. When this was the case, the Grey Plover emptied áll the opened Cockles! Dunlins also fed on the remains of Cockles opened by Turnstones, the Dunlins in turn following the Grey Plovers.

One Turnstone, observed for 8.5 min pecked 17 times per min and obtained 2.4 Cockles per min. Another Turnstone, observed for 10 min, caught 1.1 Cockles per min. Other prey eaten by Turnstones were worms (probably Ragworms *Nereis diversicolor*, unidentifiable small prey items and Shorecrabs *Carcinus maenas*). One crab with a carapace width of approx. 1.5 cm was swallowed completely. During the handling of a crab of 3 cm width, a Turnstone was chased away from its prey by a Grey Plover. Thus, Turnstones were rarely left alone by other waders and therefore suffered heavily from inter- (and intra-) specific kleptoparasitism.

Densities of Turnstones were too low to give the sort of reliable data on foraging densities and activity, as we obtained for some other species.



The cliffs along the Atlantic coast at Sidi Moussa.

View to the northwest of the tidal area near Oualidia.

8 ASPECTS OF THE FORAGING BEHAVIOUR OF GREY PLOVERS

8.1 Introduction

When we started our observations on densities and foraging activity of waders on the 0.4 ha study plot in the northern part of the channel (methods and results are presented in Chapter 7), we soon noticed that all Grey Plovers *Pluvialis squatarola* occurring in the area, occupied specific areas and that they were even individually recognizable by size, colour and habits. Frequently, pairs of Grey Plovers were engaged in activities that resembled the territorial behaviour of Curlews *Numenius arquata* during border disputes (Ens & Zwarts 1980). The fact that we could recognize individuals offered the opportunity for more thorough research than "simply" recording mean densities, activities and diets. Therefore, from 12 to 21 March 1981, we collected information on time budgets, prey selection and distribution of individual Grey Plovers. Most of the time (1922 of the 1962 minutes of observation) we followed the Grey Plover that had its territory in front of our hide. We named this bird Corrie (although obviously we do not know its sex, as is suggested by its feminine name).

Pending more detailed analysis of the data, we here present some very preliminary descriptions of dispersion pattern, time budget and diet of Grey Plovers at the Sidi Moussa intertidal area.

8.2 Methods

In addition to the general measurements on foraging density and activity, as outlined in the preceding methods section (Chapter 7.2), we followed individual Grey Plovers and recorded peck rate, success rate, prey type, behaviour and location, for one-minute periods. During the procedure one observer followed the birds whilst a second observer wrote up the information and noted time. Figure 8.1 shows the periods during which our main study-subject Corrie, was watched, in relation to tide and the times of sunrise and sunset. The behavioural categories that were distinguished are: foraging, territorial behaviour (i.e. as soon as a bird's behaviour appeared to be strongly influenced by a neighbouring bird and during the very obvious border disputes that always followed), preening, sleeping and flying. Each 20 by 20 m square of the study plot (see Chap-

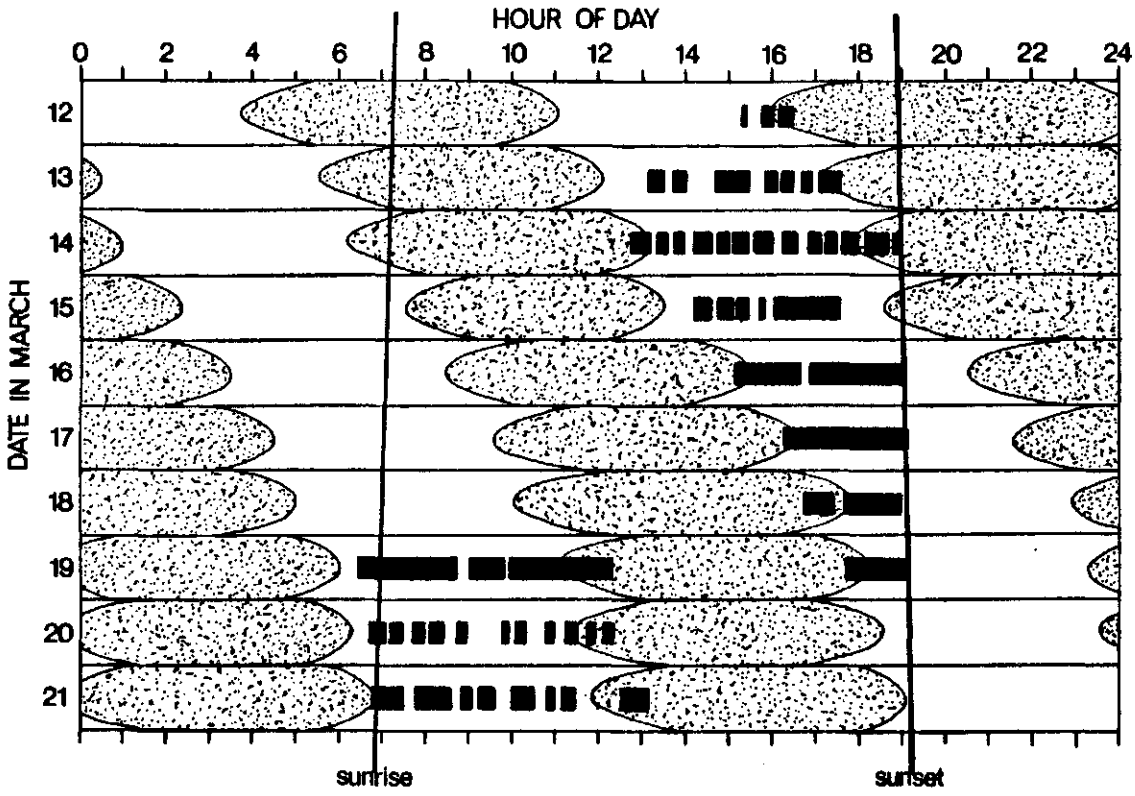


Figure 8.1. Periods of observation of Grey Plover Corrie on 10 days in March 1981. The black bars denote the observation periods and the stippled areas denote the periods when the territory was (partly) covered by water.

ter 5) was divided into four 10 by 10 m squares. During each minute of observation the presence of a bird was attributed to one of these small squares. In this way we could measure the use of different parts of a territory on a fine scale. All border disputes seen in the study area were recorded on a map and afterwards a provisional and generalised territory-map for Grey Plovers could be prepared. Although changes occurred in the size of at least some territories (as will be shown for Corrie), the data are insufficient to show this properly for all territories. Therefore, something like the "mean outlines" of the territories are given.

8.3 Results and discussion

During each low water period, 5 to 6 Grey Plovers occurred on the 0.4 ha study plot (Figure 8.2), corresponding with densities of about

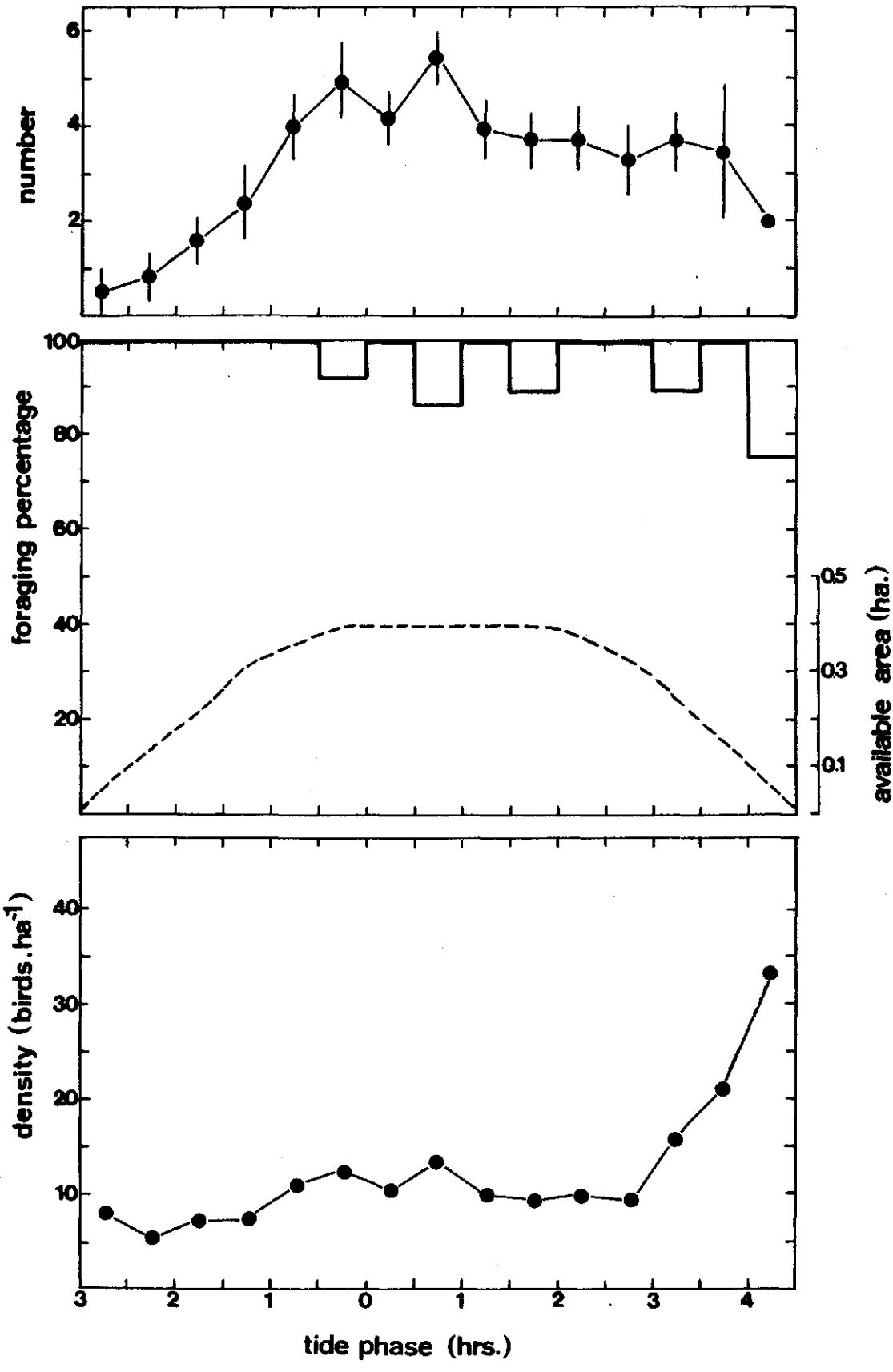


Figure 8.2. Numbers, foraging percentages and densities of Grey Plovers on the 0.4 ha study plot in the course of a low water period (see explanations on methods in Chapter 7.2).

10 birds per ha. Figure 8.3 shows the simplified distribution pattern of Grey Plover territories over the study area. The study plot covered eight territories and part of a ninth territory. The mean surface of the eight completely outlined territories is 641 m^2 (SD = 121, range 450 - 800).

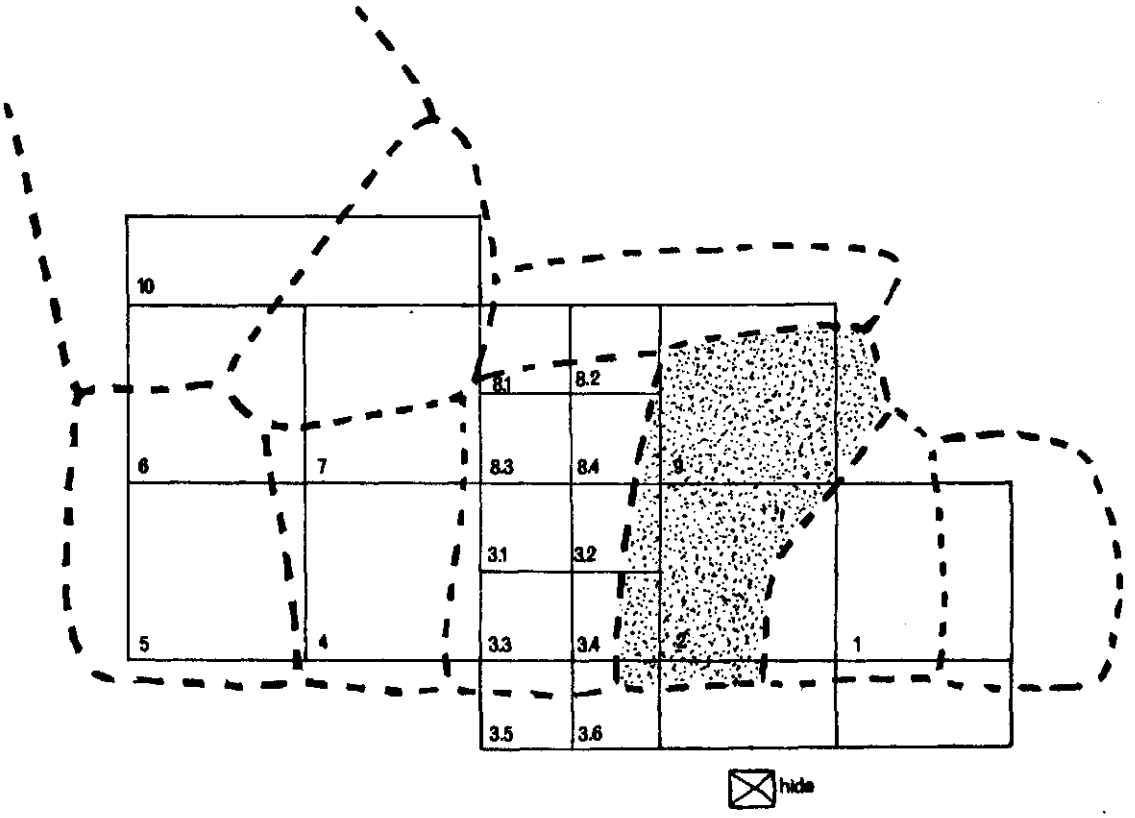


Figure 8.3. Map of the generalised outlines of the territories of Grey Plovers in the study area. The stippled area is the territory of Corrie. An example of the numbering of the finer grid is also shown.

Figure 8.4 shows the time spent by Corrie in the different squares on the successive days. Almost half of its time was spent in square 2. Corrie's favourite spot was certainly the small square 2.3, where it spent 31.1% of its time (Figure 8.5). In the course of the study period the bird spent a growing percentage of time in the northern squares 9 and 9.5. This is reflected in more border disputes in these squares, as is apparent in Figure 8.6 which shows in detail the locations of the border disputes involving Corrie on the successive days. We may thus argue that Corrie enlarged its territory somewhat to the north during the last three days of observation, possibly as a consequence of improving feeding conditions in this part of its territory.

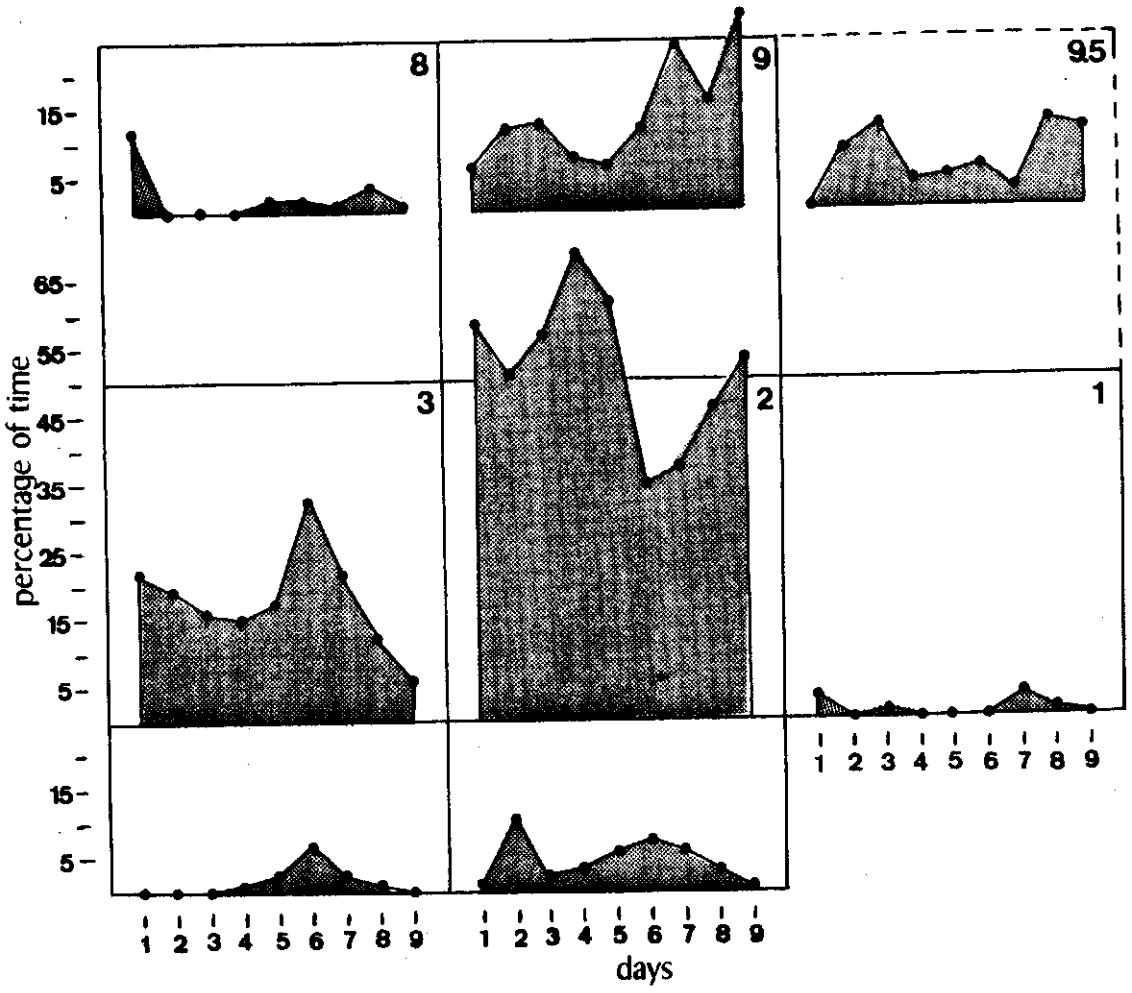


Figure 8.4. Proportions of total observation-time spent by Corrie in different squares on nine successive days. Day 1 is 13 March 1981.

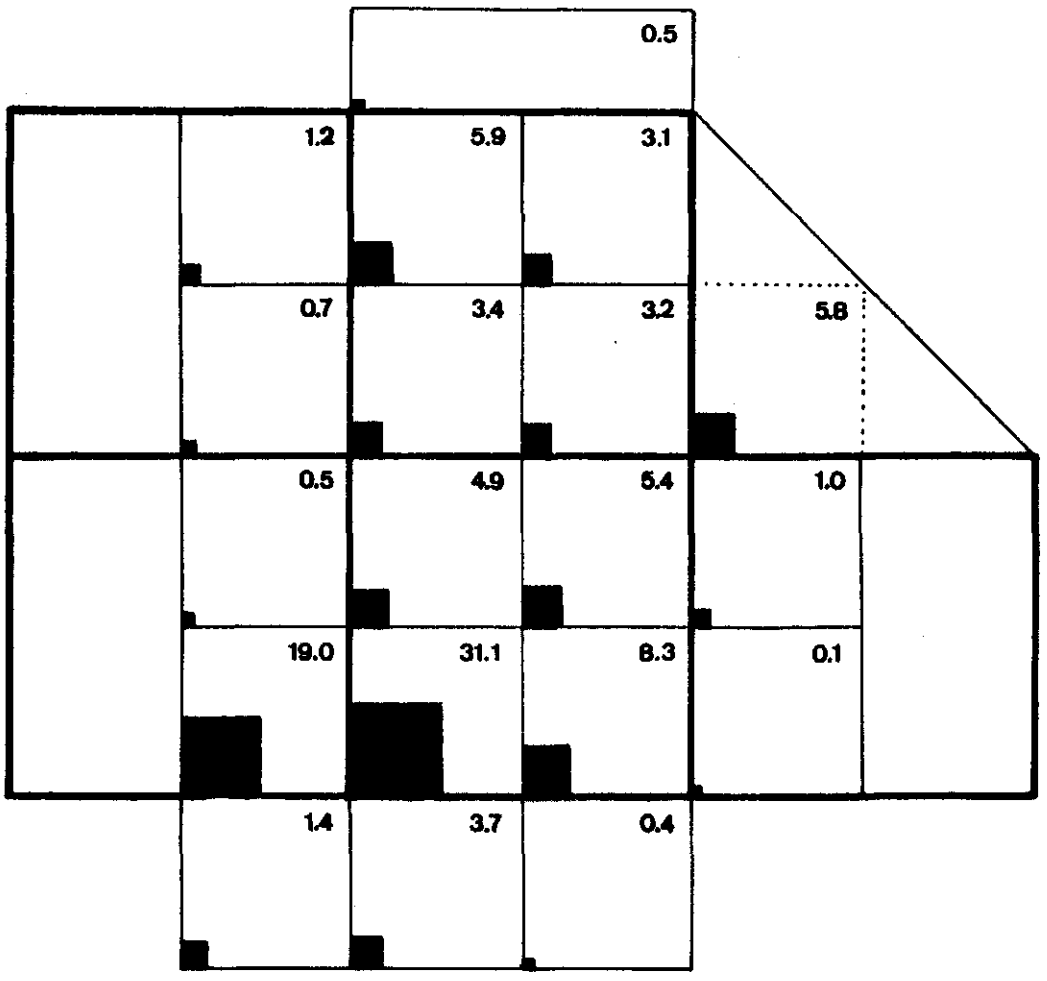


Figure 8.5. Percentages of time spent by Corrie in different (mainly 10 by 10 m) squares during nine days in March 1981. The relative amount of black within a square is equal to the proportion of time spent in that square (given by a figure in the upper right side corner as well).

Table 8.1 shows that Corrie spent 90% of its time foraging, 5.5% of its time in territorial display and 4.3% of its time preening. The time spent foraging is somewhat less than the mean foraging percentage of 95% (Figure 8.2) of all Grey Plovers on the study plot. This difference, however, may be due to our inability to distinguish territorial behaviour from foraging behaviour, when we scanned the birds for the density and activity measurements.

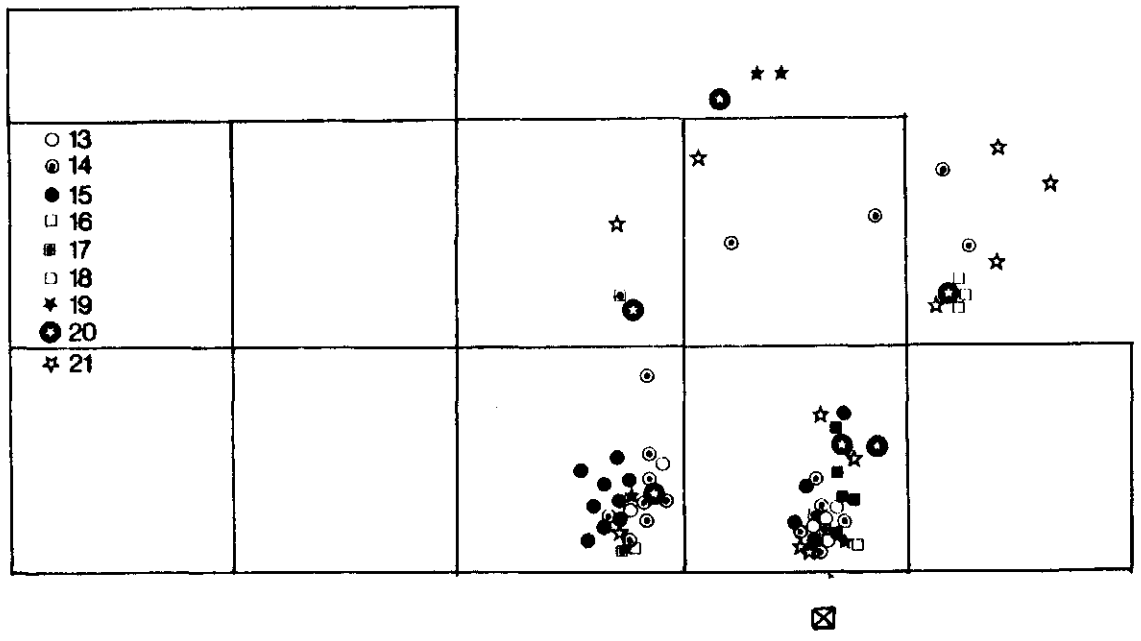


Figure 8.6. Locations of the border disputes of Corrie with its neighbours on nine days in March 1981. Figures give the dates in March.

date	foraging	territorial behaviour	preening	sleeping	flying	number of observation minutes
12 March	100.0	0	0	0	0	45
13 March	87.6	7.6	3.9	0.6	0.3	179
14 March	91.6	6.5	1.8	0	0.1	255
15 March	92.3	6.5	1.1	0	0.1	145
16 March	94.1	2.6	3.1	0	0.2	213
17 March	92.9	6.2	0.8	0	0.1	167
18 March	87.4	7.1	5.5	0	< 0.1	109
19 March	93.3	3.3	3.3	0	0.1	408
20 March	77.8	8.0	14.1	0	0.1	198
21 March	86.3	6.7	7.0	0	< 0.1	203
mean	90.0	5.5	4.3	0.1	0.1	1922

Table 8.1. Time-budget of Grey Plover Corrie during low water on 10 days in March 1981 at Sidi Moussa intertidal area. Time spent in different behaviours is given in percentages (of the sum of all minutes of observation).

Table 8.2 shows the diet of Grey Plovers in the study area. It is clear that Ragworms *Nereis diversicolor* and Shorecrabs *Carcinus maenas* were by far the most important prey items. As estimated, they accounted for respectively about 75% and 20% of the total intake in terms of biomass (preliminary figures). Sometimes the Grey Plovers followed Turnstones *Arenaria interpres* and, presumably after chasing the Turnstones away, cleaned the large ($\geq$1.5 cm shell length) Cockles *Cerastoderma edule* lifted from the substrate and opened by these birds. The Cockles that were lifted by Grey Plovers themselves, were all of small size ($<$1.5 cm) and were swallowed as a whole.

prey species	number	percentage
Nereis diversicolor	1694	70.3%
Carcinus maenas	247	10.3%
Cerastoderma edule	206	8.6%
remnants of *C. edule* opened by Turnstone	13	0.5%
remnants of *C. edule* possibly opened by Turnstones	26	1.1%
Peringia ulvae	75	3.1%
unidentifiable small items	148	6.1%
Total number of prey observed	2409	

Table 8.2. Diet of Grey Plovers on the intertidal area at Sidi Moussa in March 1981.

We have indications that most of the Grey Plovers foraging in the intertidal area of Sidi Moussa were defending feeding territories, even in the relatively poor (in terms of macrobenthic biomass, see Chapter 5) areas near the mouth of the estuary. The only flock foraging we noticed was in a flock of about 20 Grey Plovers which was frequently encountered in the dune area near our campsite and was possibly feeding there during low water as well. Hence, assuming that many Grey Plovers use the Sidi Moussa area as a stop-over site, and given the fact that most of the Grey Plovers set up feeding territories, we may argue that even Grey Plovers that stay a short time in the area, set up a territory. This suggests that relatively short-term benefits may play a role in the establishment of feeding territories of Grey Plovers.

9 FAUNA OF THE NON-TIDAL WATERS AT SIDI MOUSSA

9.1 Introduction

It is a peculiarity of the Sidi Moussa area that within a few hectares, waters with widely differing chemical compositions can be found (Table 9.1). Therefore, at four sites hydrobiological samples were taken, using sampling nets and bottom corers, to obtain information on the invertebrate species composition. For each of four sites (Figure 9.1): 1) Freshwater ditch, 2) Small lagoon, 3) Algae ditch and 4) Salines, species lists are given below, with some comments.

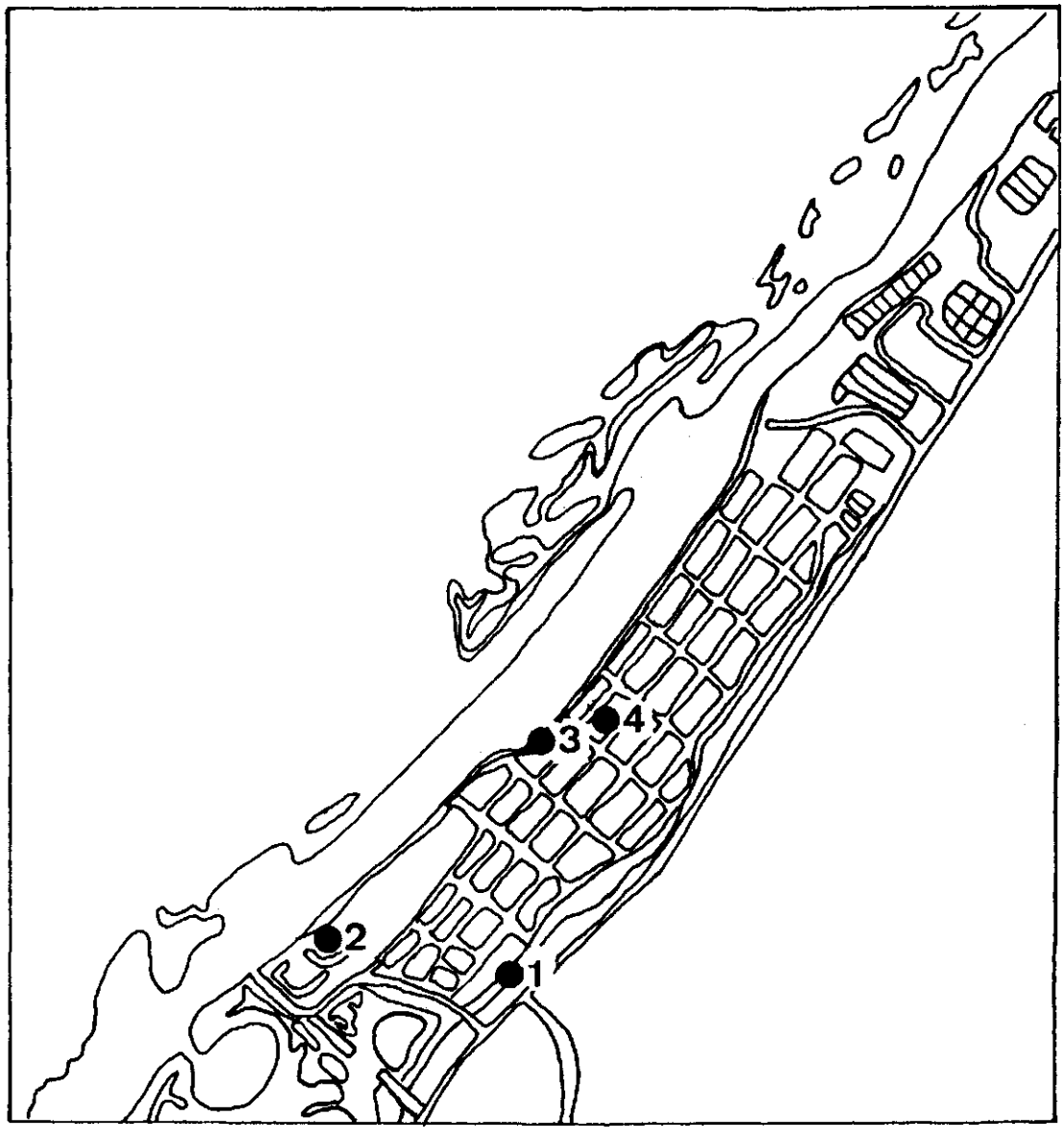


Figure 9.1. Map of the northern part of the Sidi Moussa area. For reference see Figure 3.3. Figures indicate the hydrobiological sampling stations.

	Chloride concentration ($g.Cl^{-}.1^{-1}$)	Calcium concentration ($mg.Ca^{2+}.1^{-1}$)
1. Freshwater ditch	1.1	92
2. Small lagoon	32.0	1800
3. Algae ditch	12.0	1210
4. Salines	?	5150
(5. Channel north (tidal)	9.0	480)

Table 9.1. Ion concentrations in some waters of the Sidi Moussa area. The water sampling sites are indicated in Figure 9.1. The analyses were performed at the Institut Scientifique in Rabat.

9.2 Freshwater ditch (1)

MOLLUSCA - Gastropoda

Hydrobia ventrosa

Planorbis planorbis

Physa acuta

Lymnaea peregra

INSECTA - Odonata

Coenagriidae: *Ischnura graellsi*

Aeschnidae: *Anax parthenope*

- Heteroptera

Pleidae: *Plea leachi*

Corixidae: *Micronecta scholzii*

Naucoridae: *Naucoris maculatus conspersus*

- Diptera

Chironomidae

- Coleoptera

Haliplus guttatus

Anacoena globulus

Enochrus spec.

Ochthebius impressicollis

VERTEBRA - Amphibia

Bufo mauritanicus

9.3 Small lagoon (2)

MOLLUSCA - Gastropoda
Hydrobia ventrosa
Peringia ulvae
- Bivalvia
Cerastoderma glaucum

INSECTA - Heteroptera
Sigara selecta
Plea leachi
- Diptera
Chironomidae
Stratiomyidae
- Coleoptera
Anacoena globulus
Berosus affinis
Enochrus bicolor
Ochthebius impressicollis
Potamectes cerisyi

Comment

The fauna of the freshwater ditch and the small lagoon in the Sidi Moussa area resembles closely the fauna of the Merja Sidi Boughaba and the waters of the estuaries of the Moulouya and Oued Massa (Ramdani pers. obs.). The fauna does not show any obvious peculiarity and is characteristic of Palearctic Mediterranean brackish waters. Most of the faunal elements are found in the coastal zones of northern Africa, in the marismas of the Guadalquivir in Spain and the Camargue in France, too.

9.4 Algae ditch (3)

MOLLUSCA - Gastropoda
Hydrobia ventrosa
- Bivalvia
Cerastoderma glaucum
Scrobicularia cottardi

INSECTA - many larvae (for species: see 9.2 and 9.3).

Comment

The three mollusc species were living in a layer of filamentous algae, which covered the 50 cm deep ditch. Near the surface, the algal layer was compact but near the smelly muddy bottom algal threads were more sparse. The molluscs occurred mainly in the upper half of the algal layer, living in a, so called, semi-pelagic way (see for example Ivell 1979). When we sampled the ditch, on 11 March 1981, *Cerastoderma glaucum* occurred in densities of 40-50 individuals per m^2 surface area. *Scrobicularia cottardi* occurred in densities of 30-40 individuals per m^2 while densities of *Hydrobia ventrosa* amounted to 30 000 per m^2! In the muddy bottom Chironomid larvae were found in densities of about 4 000 individuals per m^2.

9.5 Salines (4)

On 11 March 1981 we sampled the muddy bottom of one saltpan bordering the dunes. The only animals in the mud were larvae of Chironomidae and one Coleoptera larva. Densities of Chironomid larvae amounted to 4 000 - 5 000 individuals per m^2.

Base camp with the laboratory (-tent) in front.

10 AVIFAUNA

10.1 Introduction

This chapter summarizes observations of birds which were made in Morocco from 26 February - 2 April 1981. Observations were mainly carried out during our stay in Sidi Moussa and during two short visits to Merja Zerga. However, four pairs of eyes were continuously eagerly watching the Moroccan scenery as we drove through the country from Ceuta, Tetouan, Souk-el-Arba, Rabat, Cacablanca and El Jadida to Sidi Moussa and via the same way back. Though some interesting observations were made it may be clear that driving in a van with 80 km/h (or less) is not the best way to enjoy Moroccan birds and to see a lot of species.

Abbreviations used in this chapter stand for:

CB = Cap Blanc (15 km south of El Jadida)
c.y. = calendar year
EJ = El Jadida
LOS = Lagune de l'Oued Smir (small lake near M'diq, between Ceuta and Tetouan)
MBS = Moulay-Bousselham (at the mouth of Merja Zerga)
MZ = Merja Zerga
P & GA = Pineau & Giraud-Audine (1979)
SM = Sidi Moussa
N = north(ern)
E = east(ern)
S = south(ern)
W = west(ern)

Systematic order and scientific nomenclature are according to Voous, 1973, 1977a and 1977b. English names were taken from these sources too and from Sharrock (1976). French names were taken from Pineau & Giraud-Audine (1979) and Thévenot et al. (1980).

Information on the position of the camp site, Hotel la Brise, the borders of the tidal and non-tidal part of the study-area and the location of the salines, all mentioned in the text of this chapter, can be found in chapter 3 of this report.

10.2 Species observed in Morocco between 26 February and 2 April 1981

TACHYBAPTUS RUFICOLLIS/ Little Grebe/ Grèbe castagneux
Counts in the SM study area yielded following numbers:

1 March: 24
9 March: 47
17 March: 48
21 March: 34
26 March: 35

The largest concentrations were observed in the channel in the intertidal part of the study area. In the saline- and salt-marsh area N of the study area no Little Grebes were seen. One bird was mist-netted on 6 March.

PODICEPS NIGRICOLLIS/ Black-necked Grebe/ Grèbe à cou noir

On 26 March 3 were counted in the SM study area.

SULA BASSANA/ Gannet/ Fou de bassan

On 26 February 4 were seen during the crossing between Algeciras and Ceuta.

PHALACROCORAX CARBO/ Cormorant/ Grand cormoran

Single individuals were seen regularly, flying over the SM study area, during our whole stay. Six single birds were also seen at sea between SM and EJ. Counts in the SM study area yielded no Cormorants at all. The birds were white necked and probably belonged to the subspecies *P.c. maroccanus*.

PHALACROCORAX ARISTOTELIS/ Shag/ Cormoran huppé

Observations comparable to those of Cormorant. Counts in the SM study area yielded 1 Shag on 9 March and 3 on 21 March.

BUBULCUS IBIS/ Cattle Egret/ Héron garde-boeufs

Abundant, especially in N Morocco. On 26 February 63 were seen from the car while driving from Ceuta to Tetouan, 200 between Tetouan and Chechaouên, 66 between Chechaouên and Ouezzane and 170 between Ouezzane and Souk-el-Arba. On 27 February 353 were seen between Souk-el-Arba and Kenitra and 17 between Kenitra and Rabat. On 28 February 78 were seen between Rabat and Casablanca and 84 between Casa and EJ. Numbers seen on our way back were somewhat smaller. In the SM study area now and then 30-35 were present but counts of 1,9,17, and 21 March yielded no Cattle Egrets at all. The surroundings of MZ appeared not to be very rich in Cattle Egrets, however on 14 March 60 were seen in and near MZ. One adult bird was mist-netted in SM on 25 March.

EGRETTA GARZETTA/ Little Egret/ Aigrette garzette

Counts in the SM study area yielded following numbers

1 March: 13
9 March: 27
17 March: 23
21 March: 27
26 March: 35

In the salines ans saltmarshes N of the SM study area 4 were observed on 3 March and 6 on 9 March. On 4 March a flock of 30 was seen along the channel and in the saltmarshes in the intertidal part of the SM study area. On several occasions at sunset flocks of 200-250 Little Egrets gathered at the ponds E of the camp site to leave in S direction afterwards. The species was also observed along the coast between CB and EJ (22 on 13 March), in EJ and MZ (up to 7). On 1 April 32 were seen in MZ during the simultaneous count. Part of these birds were feeding socially, together with flocks of Spoonbills and some Grey Herons. Small numbers were seen here and there in N Morocco.

ARDEA CINEREA/ Grey Heron/ Héron cendré

On 26 February 7 Grey Herons were seen at LOS. Counts in the SM study area yielded following numbers:

1 March: 0
9 March: 22
17 March: 13
21 March: 15
26 March: 8

On 3 March and 9 March another 5 were counted in the salines and saltmarshes N of the SM study area. On 13 March 2 were seen along the coast between CB and EJ. On 1 April 105 Grey Herons were counted in MZ, some of these foraging socially together with Spoonbills and Little Egrets.

ARDEA PURPUREA/ Purple Heron/ Héron pourpré

On 14 March, 31 March and 1 April 1 was seen in MZ. During counts in the SM study area 1 bird was observed on 21 and 26 March. During spring migration the first Purple Herons have been observed in N Morocco by early March (P & GA).

CICONIA CICONIA/ White Stork/ Cigogne blanche

Abundant all over N Morocco. On 26 February 2 were seen between Ceuta and Tetouan, 2 between Tetouan and Chechaouèn, 8 between Chechaouèn and Ouezzane and 16 between Ouezzane and Souk-el-Arba. On 27 February 36 were seen between Souk-el-Arba and Kenitra. Breeding in Rabat. On 28 February 2 were seen between Rabat and Casablanca. Nested in many places near SM, i.e. 5 pairs in palm trees in front of Hotel la Brise and 2 in a tree 100 m further S. About 3 km N of la Brise there was a tree with 3 nests. Storks from these nests were seen foraging in the SM estuary and salines and in the arable fields nearby. In all villages surrounding MZ nests were occupied too. Several dozens were frequently seen foraging in MZ. On 1 April 21 were recorded during the simultaneous count in MZ.

PLATALEA LEUCORODIA/ Spoonbill/ Spatule blanche

On 1 March 10 Spoonbills were seen in the intertidal part of the SM study area, on 9 March and 10 March 6 were seen there. On 4 March 1 Spoonbill was passing over SM in S direction. Counts in the SM study area yielded following numbers:

1 March: 10
9 March: 6
17 March: 4
21 March: 9
26 March: 11

On 20 March 22 Spoonbills were seen between SM and Oualidia. These were the only Spoonbills present in the whole area during that day. On 1 April 115 Spoonbills were counted in MZ, partly foraging socially with Little Egrets and some Grey Herons.

PHOENICOPTERUS RUBER/ Greater Flamingo/ Flamant rose

On 26 February 1 Flamingo was seen in LOS. On 3 March 75 were passing over SM in S direction. On 5 March 14 were seen halfway between SM and Oualidia, on 10 March 24 were seen in SM, while 110 were flying over in N direction. On 17 March 35 passed SM to N, on 20 March 9 went to S. A count later that day yielded 35 between SM and Oualidia. Counts in the SM study area yielded following numbers:

1 March: 1
9 March: 19
17 March: 56
21 March 31
26 March: 0

On 15 March a count in MZ yielded 3400 Flamingos. During our second visit to MZ 6656 were counted.

ANSER ANSER/ Greylag Goose/ Oie cendré

A single bird was seen in MZ on 31 March, 2 were seen there on 1 April.

TADORNA TADORNA/ Shelduck/ Tadorne de belon

Simultaneous counts in the SM study area yielded following numbers:

1 March: 1
9 March: 111
17 March: 70
26 March: 2

Migrating Shelducks were seen in SM on 7 March (25 to S) and 22 March (20 to N). On 1 April 1170 Shelducks were counted at MZ.

ANAS PENELOPE/ Wigeon/ Canard siffleur

Counts in the SM study area yielded 800 Wigeon on 1 March, 150 on 9 March and 2 on 21 March. On 17 and 26 March the species was not observed. Resting flocks of Wigeon were mainly staying at sea during the day, probably as a result of frequent disturbance in the intertidal area. On 26 February Wigeon were also seen at LOS, but no count was carried out there. On 1 April 1850 were counted at MZ.

ANAS STREPERA/ Gadwall/ Canard chipeau

On 1 April 4 Gadwall were counted at MZ.

ANAS CRECCA/ Teal/ Sarcelle d'hiver

On 26 February the species was observed at LOS. No count was carried out there. On 21 March 1 was seen in the SM study area. Simultaneous counts in this area yielded no further observations. On 1 April 4 Teal were counted at MZ.

ANAS PLATYRHYNCHOS/ Mallard/ Canard colvert

On 1 April 423 Mallards were counted at MZ. No other records of this species.

ANAS ACUTA/ Pintail/ Canard pilet

Simultaneous counts in the SM study area yielded following numbers:

1 March: 250
9 March: 229
17 March: 0
21 March: 0
26 March: 6

The great majority of the birds present during the first 2 counts was seen resting at open seen during the day. On 1 April 5 Pintail were counted at MZ.

ANAS QUERQUEDULA/ Gargeney/ Sarcelle d'été

Simultaneous counts in the SM study area yielded following numbers:

1 March: 6
9 March: 100
17 March: 16
21 March: 0
26 March: 2

On 4 March 4 were seen migrating N over Hotel la Brise, on 10 March 50 were seen at sea near SM. On 1 April 16 were counted at MZ.

ANAS CLYPEATA/ Shoveler/ Canard souchet

Simultaneous counts in the SM study area yielded following numbers:

1 March: 120
9 March: 250
17 March: 90
21 March: 2
26 March: 2

Most of these birds were seen at sea during the day, however on 9 March 20 were present in the channel near the camp site, in the intertidal part of the study area. One adult female was mist-netted on 7 March. On 26 February the species was present at LOS, but no count was carried out. On 1 April 400 were counted at MZ.

MARMARONETTA ANGUSTIROSTRIS/ Marbled Teal/ Sarcelle marbrée

On 28 February 2 were seen near the SM camp, on 9 March 17 were counted in the intertidal part of the SM study area. Simultaneous counts in SM and MZ yielded no other observations.

AYTHYA FERINA/ Pochard/ Filigule milouin

Simultaneous counts in the SM study area yielded following numbers:

1 March: 6
9 March: 13
17 March: 15
21 March: 4
26 March: 5

MILVUS MIGRANS/ Black Kite/ Milan noir

On 27 February 4 were seen between Souk-el-Arba and Kenitra, on 30 March 1 in MZ, on 1 April 4 in the S part of MZ, on 2 April 1 between Ouezzane and Tetouan.

CIRCUS AERUGINOSUS/ Marsh Harrier/ Busard des roseaux

On 26 February 2 Marsh Harriers were seen between Ouezzane and Souk-el-Arba; on 27 February 1 between Kenitra and Rabat; on 6 March 1 in SM; on 15 March 2 in MZ; on 17, 18, 19, 21 and 23 March 1 in SM; on 31 March 2 in MZ; on 1 April 1 in MZ; on 2 April 2 between Souk-el-Arba and Ouezzane and 1 between Ouezzane and Tetouan.

BUTEO RUFINUS/ Long-legged Buzzard/ Buse féroce

On 28 February 1 Long-legged Buzzard was seen between Rabat and Casablanca; on 15 March 2 were seen in MZ; on 29 March 1 between EJ and Casa and on 31 March 1 in MZ.

PANDION HALIAETUS/ Osprey/ Balbuzard pêcheur

On 14 March and 1 April 1 Osprey was seen in MZ.

FALCO NAUMANNI/ Lesser Kestrel/ Faucon crècerellette

On several occasions up to 5-6 Lesser Kestrels were seen near CB, where the species was probably breeding. It was often seen together with Kestrels. On 2 April 1 was seen near Ouezzane.

FALCO TUNNINCULUS/ Kestrel/ Faucon crècerelle

On 26 February 1 Kestrel was seen between Chechaouèn and Ouezzane and 2 between Ouezzane and Souk-el-Arba. On 27 February 1 between Kenitra and Rabat; on 28 February 1 between Rabat and Casablanca and 4 between EJ and SM. Frequently seen near CB in the weeks afterwards, probably some pairs were breeding there. On 1 March 1 was seen near Hotel la Brise. Kestrels were probably also breeding on the cliffs near the SM camp site, one pair was frequently seen there. Kestrels were also regularly observed in EJ, especially near the Citerne Portugaise, though some of these birds may also have been Lesser Kestrels. On 14, 15 and 16 March 1 Kestrel was seen near MBS, on 31 March 2 were observed there.

ALECTORIS BARBATA/ Barbary Partridge/ Perdix gambra

On 16 March 2 were seen in a Eucalyptus wood S of MBS.

COTURNIX COTURNIX/ Quail/ Caille des blés

Frequently heard in arable land on the S edge of the SM study area from mid-March onwards. Calling Quails were heard on several places around MZ on 31 March and 1 April. One Quail was mist-netted in SM on 16 March, weighing 100 g.

PORZANA PORZANA/ Spotted Crake/ Marouette ponctuée

On the 1st, and 17th and 21st of March a single bird was seen in dense shore vegetation along the brackish lake E of the camp in SM. Probably the species was more abunbant there.

GALLINULA CHLOROPUS/ Moorhen/ Poule d'eau

On 26 February Moorhens were seen at LOS, but no count was carried out. Simultaneous counts in the SM study area yielded following numbers:

1 March: 11
9 March: 5
17 March: 30
21 March: 25
26 March: 33

Nearly all of these birds were seen in the brackish pond E of the camp. On 6 March 12 birds were seen there.

FULICA ATRA/ Coot/ Foulque macroule

Simultaneous counts in the SM study area yielded strongly fluctuating numbers:

1 March: 0
9 March: 560
17 March: 795
21 March: 71
26 March: 247

On 26 February and 2 April the species appeared to be present at LOS, but no count was carried out there. On 1 April 663 Coots were counted at MZ.

HAEMATOPUS OSTRALEGUS/ Oystercatcher/ Huîtrier pie

Counts in the SM study area yielded following numbers:

1 March: 5
9 March: 43
17 March: 12
21 March: 6
26 March: 3

On 28 February 2 were seen along the coast between EJ and SM. During the count of 9 March 9 were present on the beach near the camp site and 34 near the tidal inlet, 3 km S of the camp. The species was not observed in the salines and saltmarshes N of the study area. The coast between CB and EJ hosted 9 Oystercatchers on 13 March. On 14 and 16 March at least 35 were present in MZ. On 31 March 7 were seen near MBS, on 1 April 6 were seen there. On 1 April 105 Oystercatchers were counted in MZ.

HIMANTOPUS HIMANTOPUS/ Black-winged Stilt/ Echasse blanche

Counts in the SM study area yielded following numbers:

1 March: 322
9 March: 278
17 March: 293
21 March: 334
26 March: 327

The salines and saltmarshes N of the SM study area supported 27 Stilts on 3 March and 130 on 17 March. On 13 March no Stilts were seen along the coast between CB and EJ. On 1 April 8 were counted in MZ, on 2 April 2 were recorded in LOS, but no real count was carried out there.

Two adult Stilts were caught in SM on 2 and 4 March. Measurements:

wing length (mm): 254/232

bill length (mm): 65.8/66.2

weight (g): 153/161

No signs of moult were registered. Both birds were marked individually. There were regular sightings of one of these birds in the weeks after the catch along the pond E of the camp site, the other one was sighted on 9 March in the salines in the N part of the study area.

RECURVIROSTRA AVOSETTA/ Avocet/ Avocette

The counts in the SM study area yielded following numbers:

1 March: 546
9 March: 173
17 March: 183
21 March: 182
26 March: 119

On 3 March 13 were seen leaving the N part of the study area, migrating N; on 9 March a flock of 24 was observed leaving in the same direction; on 21 March 25 were seen doing the same. On 25 March 20 were observed flying S, later during that day a flock of the same size migrated N again. On 26 March 17 passed the SM camp flying N. On 1 April 2708 Avocets were counted in MZ. One adult Avocet was caught in SM on 10 March. Measurements:

wing lenght (mm): 228

bill length (mm): 85.6

total head length (mm): 118.6

weight (g): 240

The bird was not in moult.

BURHINUS OEDICNEMUS/ Stone Curlew/ Oedicnème criard

On 26 February 1 Stone Curlew was observed near LOS.

GLAREOLA PRATINCOLA/ Pratincole/ Glaréole à collier

The first Pratincole, arriving from the S, was seen in SM on 17 March. On 19 March 3 were counted in the study area, numbers increasing to 8 in the days following. During the third March-decade a steady through-passing of Pratincoles flying N was observed in SM as well. During this period birds present in the study area were displaying intensively. In MZ no Pratincoles were seen during our first visit (on 14 and 15 March), however by the end of March they were present all over the area, concentrated in the saltmarshes where they will breed. A total number of 30 Pratincoles was counted on 1 April, but probably many more have been present.

CHARADRIUS HIATICULA/ Ringed Plover/ Grand gravelot

The counts in the SM study area yielded following numbers:

1 March: 372
9 March: 363
17 March: 310
21 March: 262
26 March: 258

In the salines and saltmarshes N of the study area 62 were present on 3 March and 15 on 17 March. On 13 March 75 were counted along the coast between CB and EJ. On 14 March 30 were seen leaving the study area in the evening.

On 1 April 108 Ringed Plovers were counted in MZ. More detailed information on Ringed Plovers in SM is given in chapter 7.3 of this report.

CHARADRIUS ALEXANDRINUS/ Kentish Plover/ Gravelot à collier interrompu

Counts in the SM study area yielded following numbers:

1 March: 241
9 March: 162
17 March: 158
21 March: 180
26 March: 179

In the salines N of the SM study area 79 were present on 3 March and 61 on 17 March. On 13 March 7 were counted along the coast between CB and EJ. On 1 April 472 Kentish Plovers were counted in MZ. More detailed information on Kentish Plovers in SM is given in chapter 7.4 of this report.

PLUVIALIS APRICARIA/ Golden Plover/ Pluvier doré

On 10 March 2 were seen in the tidal part of the SM study area. On 13 March 6 were counted along the coast between CB and EJ.

PLUVIALIS SQUATAROLA/ Grey Plover/ Pluvier argenté

The counts in the SM study area yielded following numbers:

1 March: 242
9 March: 476
17 March: 510
21 March: 661
26 March: 408

In the salines N of the study area 40 were counted on 3 March and 1 on 17 March. On several occasions high tide roosts of birds foraging in the SM estuary were present in the dunes near the camp site, possibly as a result of disturbance in the salines. On 22 March 15 Grey Plovers were seen leaving the study area in N direction. On 13 March 59 Grey Plovers were counted along the coast between CB and EJ. On 1 April 3207 were seen in MZ. More detailed information on Grey Plovers in SM is given in chapter 7.5 of this report.

VANELLUS VANELLUS/ Lapwing/ Vanneau huppé

On 26 February 1 was seen between Ouezzane and Souk-el-Arba. On 9 March 2 were passing SM in N direction. On 31 March several Lapwings were observed on the S edge of MZ.

CALIDRIS CANUTUS/ Knot/ Bécasseau maubèche

Counts in the SM study area yielded following numbers:

1 March: 30
9 March: 27
17 March: 0
21 March: 2
26 March: 14

In the salines N of the SM study area only 1 Knot was seen on 3 March, on 17 March no Knot were recorded there. On 13 March 6 were counted along the coast between CB and EJ. On 1 April 20 Knots were seen in MZ. More detailed information on Knots in SM is given in chapter 7.6 of this report.

CALIDRIS ALBA/ Sanderling/ Bécasseau sanderling

Counts in the SM study area yielded following numbers:

1 March: 35
9 March: 139
17 March: 42
21 March: 12
26 March: 20

In the salines N of the SM study area 33 were counted on 3 March and 13 on 17 March. On 13 March 13 Sanderlings were counted along the coast between CB and EJ. On 14 and 16 March 1 was seen on the beach near MBS, on 1 April 8 were recorded in MZ.

CALIDRIS MINUTA/ Little Stint/ Bécasseau minute

Counts in the SM study area yielded following numbers:

1 March: 123
9 March: 255
17 March: 92
21 March: 85
26 March: 292

In the salines N of the SM study area 8 were counted on 3 March and 62 on 17 March. Little Stints were not recorded on 13 March along the coast between CB and EJ. On 1 April 656 were counted in MZ. More detailed information on Little Stints in SM is given in chapter 7.7 of this report.

CALIDRIS FERRUGINEA/ Curlew Sandpiper/ Bécasseau cocorli

Counts in the SM study area yielded following numbers:

1 March: 3
9 March: 48
17 March: 34
21 March: 17
26 March: 18

In the salines N of the SM study area 1 was counted on 3 March and 14 on 17 March. Curlew Sandpipers were not recorded along the coast between CB and EJ on 13 March. On 1 April 156 were counted in MZ. More detailed information on the species in SM is given in chapter 7.8 of this report.

CALIDRIS ALPINA/ Dunlin/ Bécasseau variable

Counts in the SM study area yielded following numbers:

1 March: 2821
9 March: 2353
17 March: 1928
21 March: 1718
26 March: 1188

In the salines N of the study area 72 were counted on 3 March and 391 on 17 March. On 13 March 285 Dunlins were counted along the coast between CB and EJ. Flocks of Dunlins leaving the SM study area were heard on 2 occasions over night on 27 March. On 1 April 15,238 Dunlins were counted in MZ. More detailed information on Dunlins in SM is given in chapter 7.9 of this report.

PHILOMACHUS PUGNAX/ Ruff/ Chevallier combattant

Counts in the SM study area yielded following numbers:

1 March: 46
9 March: 88
17 March: 153
21 March: 145
26 March: 189

In the salines N of the study area 10 Ruffs were counted on 3 March and 62 on 17 March. In the MZ 60 were counted on 1 April.
Ruffs were caught in SM on 6,7,23 and 26 March. One of these birds was a 2nd c.y., the other three after first c.y. Measurements of these birds:
wing length (mm): 152/160/161/167
bill length (mm): 31.1/30.8/29.4/29.4
total head length (mm): 60.5/61.7/60.3/62.2
weight (g): 86/85/94/94
None of these birds was moulting.

GALLINAGO GALLINAGO/ Snipe/ Bécassine des marais

Counts in the SM study area yielded following numbers:

1 March: 13
9 March: 30
17 March: 5
21 March: 15
26 March: 13

In the salines and saltmarshes N of the SM study area 4 Snipes were counted on 3 March and 2 on 17 March. The count in the MZ on 1 April yielded 2.
On 2 March a Snipe was caught in SM (after first c.y.), on 5 March another one (second c.y.). Measurements of these birds:
wing lengh (mm): 132/138
bill length (mm): 67.4/71.0
weight (g): 92/102

Both birds showed no signs of moult.

LIMOSA LIMOSA/ Black-tailed Godwit/ Barge à queue noire

Counts in the SM study area yielded following numbers:

1 March: 359
9 March: 205
17 March: 188
21 March: 87
26 March: 60

In the salines N of the study area 1 Black-tailed Godwit was counted on 3 March and 17 March. On 9 March small flocks (of 4 birds) were seen leaving the SM study area. On 1 April 659 were present in MZ.

LIMOSA LAPPONICA/ Bar-tailed Godwit/ Barge rousse

Counts in the SM study area yielded following numbers:

1 March: 65
9 March: 50
17 March: 17
21 March: 177
26 March: 0

In the salines N of the SM study area no Bar-tailed Godwits were seen. On 13 March along the coast between CB and EJ 3 were counted. On 1 April 4 were recorded in MZ. More detailed information on Bar-tailed Godwits in SM is given in chapter 7.10 of this report.

NUMENIUS PHAEOPUS/ Whimbrel/ Courlis corlieu

The species was not recorded in the SM study area on 1 March and 26 March. On the 9th 9 were counted, on the 17th and 21st 1. Additionally small numbers were regularly seen on the rocky coast near the SM camp site. On 13 March 9 were counted along the coast between CB and EJ. On 1 April no Whimbrels were seen in MZ.

NUMENIUS ARQUATA/ Curlew/ Courlis cendré

Counts in the SM study area yielded following numbers:

1 March: 3
9 March: 245
17 March: 178
21 March: 187
26 March: 65

In the salines N of the SM study area 2 were counted on 3 March and none on 17 March. On 13 March 1 Curlew was recorded along the coast between CB and EJ. During our stay in SM and MZ migrating Curlews were seen almost every day and night. Generally flocks of 10-25 birds were involved, almost always flying N. On several occasions arrival of Curlews from the S was seen. On 1 April 112 Curlews were counted in MZ.

TRINGA ERYTHROPUS/ Spotted Redshank/ Chevalier arlequin

Counts in the SM study area yielded following numbers:

1 March: 112
9 March: 66
17 March: 14
21 March: 9
26 March: 9

No Spotted Redshanks were seen in the salines N of the SM study area on 3 March, 8 were recorded there on 17 March. On 1 April 5 were counted in MZ.

TRINGA TOTANUS/ Redshank/ Chevalier gambette

Counts in the SM study area yielded following numbers:

1 March: 505
9 March: 330
17 March: 403
21 March: 421
26 March: 294

In the salines N of the SM study area 48 Redshanks were counted on 3 March and 84 on 17 March. On 13 March 59 were recorded along the coast between CB and EJ. On 1 April 521 Redshanks were counted in MZ. Flocks of 15-36 were seen leaving the SM study area on 21 and 27 March. More detailed information on Dunlins in SM is given in chapter 7.11 of this report.

TRINGA NEBULARIA/ Greenshank/ Chevalier aboyeur

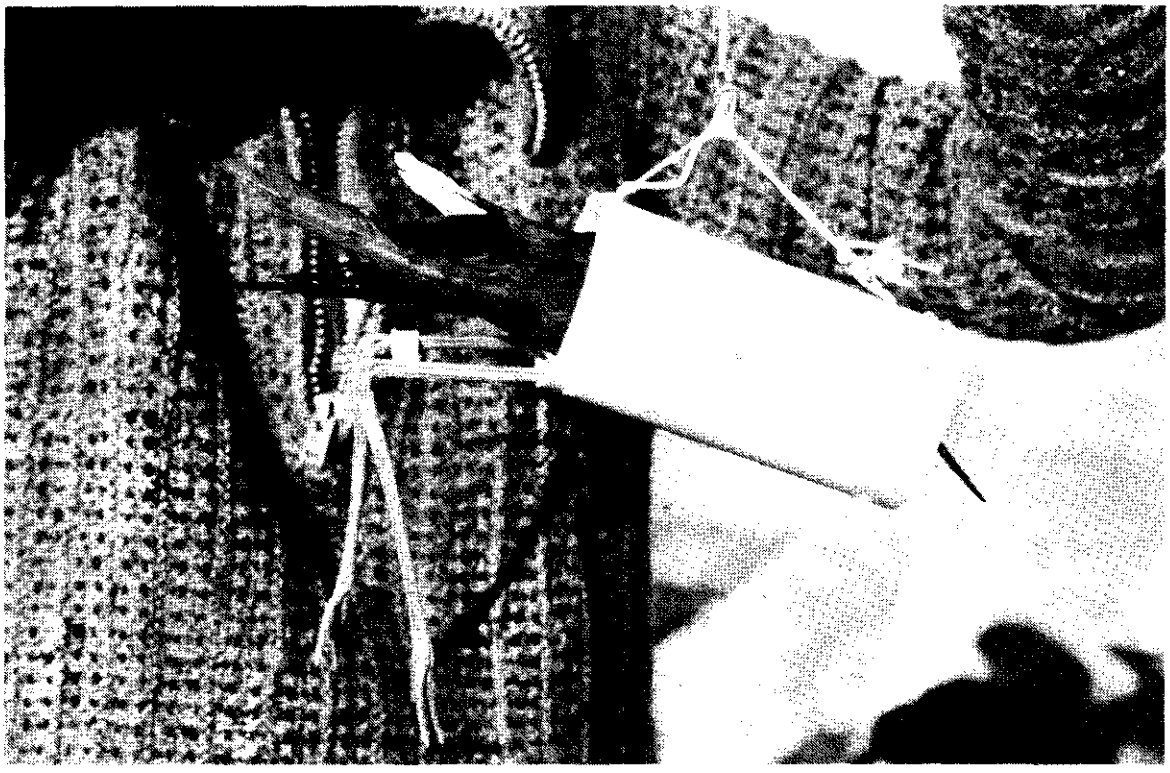
Counts in the SM study area yielded following numbers:

1 March: 23
9 March: 9
17 March: 2
21 March: 15
26 March: 6

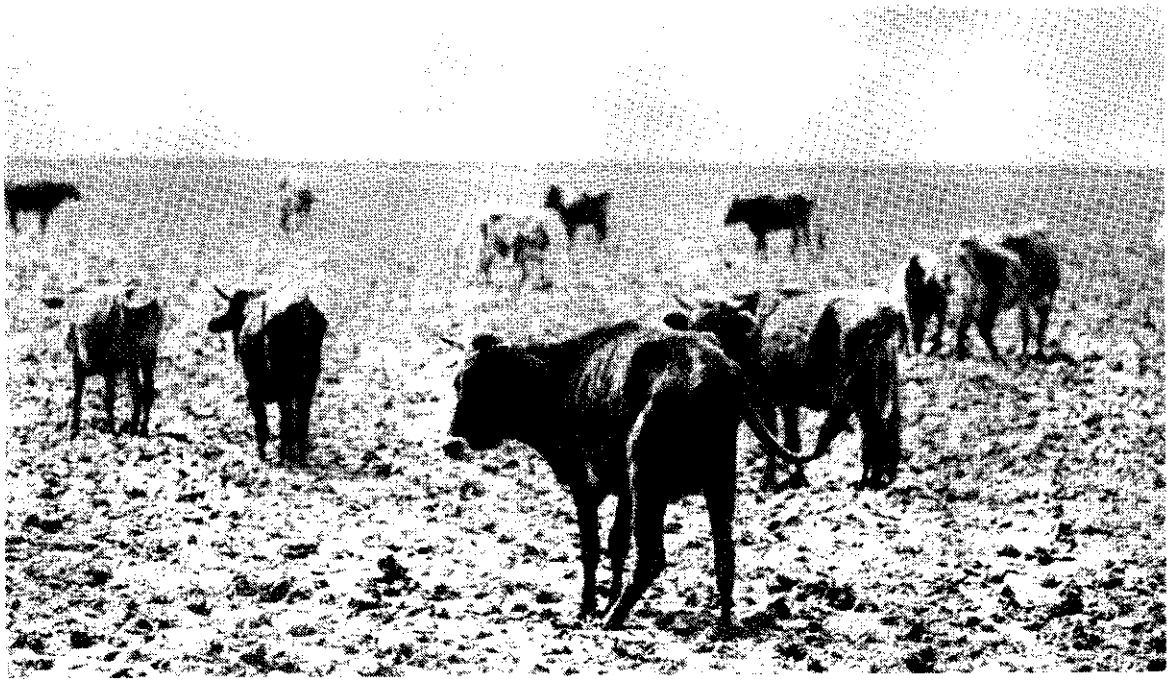
In the salines N of the SM study area and along the coast between CB and EJ no Greenshanks were seen. On 1 April 33 were counted in MZ.
Five Greenshanks were mist-netted and one was found freshly dead. Two of these were adults, one was in its second c.y. Of 2 birds age could not be determined (after first c.y.). Measurements of these birds:

	adult	after 1st c.y.	2nd c.y.
wing length (mm)	199/192	201/192/194	162
bill length (mm)	54.0/53.8	54.9/53.8/55.4	59.6
total head length (mm)	93.2/91.3	91.6/92.7/92.1	99.1
weight (g)	184/139	161/137/163	162

One of these birds was heavily moulting body feathers.



Weighing of a Black-winged Stilt in Sidi Moussa



A flock of waders in Merja Zerga

TRINGA OCHROPUS/ Green Sandpiper/ Chevalier culblanc
Solitary Green Sanpipers were only observed in the SM study area on 1, 6 and 26 March. The species was not recorded elsewhere.

TRINGA GLAREOLA/ Wood sandpiper/ Chevalier sylvain
Solitary Wood Sandpipers were only observed in the SM study area on 1, 17, 22 and 26 March. The species was not recorded elsewhere.

ACTITIS HYPOLEUCOS/ Common Sandpiper/ Chevalier guinette
One Common Sandpiper was observed along LOS on 26 February. Counts in the SM study area always yielded 1-4 Common Sanpipers. In the salines N of the study area 2 were recorded on 17 March. The species was not seen in MZ.
On 4 March a 2nd c.y. bird was caught in SM. Measurements of this bird:
wing length (mm): 110
bill length (mm): 25.4
total head length (mm): 50.0
weight (g): 44.5
The bird showed no signs of moult.

ARENARIA INTERPRES/ Turnstone/ Tournepierre à collier
Counts in the SM study area yielded following numbers:
1 March: 237
9 March: 159
17 March: 172
21 March: 162
26 March: 223
In the salines N of the study area 34 were counted on 3 March and 16 on 17 March. On 13 March 152 Turnstones were counted along the coast between CB and EJ. On 1 April 22 were counted in MZ. More detailed information on Turnstones in SM is given in chapter 7.12 of this report.

PHALAROPUS FULICARIUS/ Grey Phalarope/ Phalarope à bec large
On 31 March 1 was seen in a small pond in the S part of MZ.

STERCORARIUS PARASITICUS/ Arctic Skua/ Labbe parasite
On 14 March 1 was seen flying over sea near MBS.

STERCORARIUS SKUA/ Great Skua/ Grand labbe
On 26 February two were recorded between Algeciras and Ceuta.

LARUS RIDIBUNDUS/ Black-headed Gull/ Mouette rieuse

On 26 February small numbers were seen during the crossing between Algeciras and Ceuta and 50 in LOS. On 27 February some dozens were seen in and around Rabat. Counts in the SM study area show gradually decreasing numbers:

1 March: 190
9 March: 100
17 March: 37
21 March: 27
26 March: 3

In the salines N of the SM study area 52 were counted on 3 March and 8 on 17 March. No Black-headed Gulls were recorded along the coast between CB and EJ on 13 March. Small numbers were seen in MBS on 14 and 16 March and 1 April. In MZ 11 were counted on 1 April.

One adult Black-headed Gull was mist-netted on 5 March and 5 2nd c.y. birds were mist-netted on 22 March. The latter 5 were measured:

wing length (mm): 295/290/281/297/279

bill length (mm): 31.5/31.0/33.8/31.5/31.0

weight (g): 209/217/213/220/206

None of these birds was moulting.

LARUS FUSCUS/ Lesser Black-backed Gull/ Goéland brun

One was seen between Algeciras and Ceuta on 26 February, several dozens were present in Rabat on 27 February, hundreds along the coast between EJ ans SM on the 28th. Counts in the SM study area yielded only 25 Lesser black-backed Gulls on 9 March, in the salines N of the study area 13 were seen on 3 March. On 15 March 10 were observed in MZ, a day later 3 near MBS. A count in the MZ on 1 April yielded none. On 3 April 10 were seen between Ceuta and Algeciras.

LARUS ARGENTATUS/ Herring Gull/ Goéland argente

Small numbers were seen on 26 February between Algeciras and Ceuta. Many dozens were seen in Rabat a day later. On 28 February 30 were seen between Rabat and Casablanca and some between Casa and SM. Counts in the SM study area yielded following numbers:

1 March: 0
9 March: 22
17 March: 3
21 March: 0
26 March: 3

In the salines N of the study area none were seen. Very small numbers (1-4 birds) were seen near MBS from 14-16 March and on 31 March. In the MZ 11 were counted on 1 April. On 3 April 50-100 were seen between Ceuta and Algeciras.

LARUS MARINUS/ Great black-backed Gull/ Goéland marin
On 26 February some were seen between Algeciras and Ceuta, on the 28th about 40 between Rabat and Casablanca. Counts in the SM study area yielded 11 on 17 March, 20 on 26 March and none during the other days. In the salines N of the study area 1 was seen on 17 March. On 1 April 1 was seen near MBS. A count later that day in MZ yielded no additional Great black-backed Gulls.

RISSA TRIDACTYLA/ Kittiwake/ Mouette tridactyle
On 26 February a juvenile Kittiwake was seen during the crossing from Algeciras to Ceuta.

GELOCHELIDON NILOTICA/ Gull-billed Tern/ Sterne hansel
On 20 March probably 1 was seen in SM, on 31 March 2 were seen in MZ. The count on 1 April also yielded 2.

STERNA CASPIA/ Caspian Tern/ Sterne caspienne
On 15 March 24 were seen in MZ. On 31 March 70 were present near MBS. The count in the MZ on 1 April yielded 23.

STERNA SANDVICENSIS/ Sandwich Tern/ Sterne caugek
On 26 February 1 was seen between Algeciras and Ceuta. Counts in the SM study area yielded following numbers:

1 March: 0
9 March: 12
17 March: 62
21 March: 40
26 March: 10

In the salines N of the study area 1 was present on 3 March. Along the coast between CB and EJ 6 were present on 13 March. On 14 March 3 were seen near MBS, on 15 March about 100 were recorded in the MZ. A day later 28 were seen near MBS. On 31 March 10 were seen there, on 1 April a count in the MZ yielded 30.

STERNA HIRUNDO/ Common Tern/ Sterne pierregarin
On 21 March 4 were counted in SM, on 15 March 5 were seen in MZ.

CHLIDONIAS HYBRIDA/ Whiskered Tern/ Guifette moustac
From 17-26 March 1-2 were foraging in the pond E of the camp site in SM. On 1 April 4 were counted in MZ, on 2 April 1 was seen at LOS.

FRATERCULA ARCTICA/ Puffin/ Macareux moine
On 3 April 40 were seen flying W during the crossing from Ceuta to Algeciras.

STREPTOPELIA TURTUR/ Turtle Dove/ Tourtelle des bois
From 21 March onwards Turtle Doves were seen and heard regularly around the SM camp. In N Morocco this species arrives from 1 April onwards (P&GA), our first observation therefore is rather early.

CLAMATOR GLANDARIUS/ Great spotted Cuckoo/ Coucou geai
On 1 and 4 March 2-3 were seen in thickets in the dunes near the SM camp.

ATHENE NOCTUA/ Little Owl/ Chouette chevêche
On 26 February 1 was seen near the LOS, on 30 March 1 near Douar Kbir (MZ), on 1 April 2 S of MZ and 1 S of MBS; on 2 April 1 Little Owl was seen between Tetouan and Ceuta.

ASIO CAPENSIS/ Marsh Owl/ Hibou du Cap
On 31 March 3 were seen on the saltmarshes of MZ.

APUS APUS/ Swift/ Martinet noir
Continuously present during our stay and seen in many places.

APUS PALLIDUS/ Pallid Swift/ Martinet pâle
Though often difficult to distinguish from the former species, we believe to have observed this species throughout our stay in Morocco in the same areas as *Apus apus*.

APUS AFFINUS/ House Swift/ Martinet à croupion blanc
This partly sedentary species appeared to be common in Rabat and EJ. It was seen throughout our stay in Morocco.

ALCEDO ATTHIS/ Kingfisher/ Martin-pêcheur
Seen near the camp at SM on 1 March (2 individuals), 1 was seen there on 3, 4, 9 and 17 March. One was caught on 7 March, weighing 41.5 g, bill length 46.8 mm.

MEROPS APIASTER/ Bee-eater/ Guêpier d'Europe
On 1 April strong migration in N direction was recorded in MZ, flocks of up to 40 birds were seen passing. This coincides with earlier observations in N Morocco (P&GA).

UPUPA EPOPS/ Hoopoe/ Huppe fasciée
Now and then single birds were observed near the camp site in SM, probably these were migrating birds. One was captured here on 23 March (weight 63 g).

One Hoopoe was seen between Casablanca and EJ on 28 February, and 1 at MZ on 30 March. Several times living Hoopoes were offered to us for sale in the streets of EJ.

CALANCRELLA RUFESCENS/ Lesser Short-toed Lark/ Alouette pispolette
On 24 March 2 birds were caught in SM. Weight: 19.0 and 19.1 g. We have no indications of a more abundant occurence of this species in our study areas.

GALERIDA CRISTATA/ Crested Lark/ Cochevis huppé
Seen regularly in SM as well as in MZ. We did not find indications of the occurence of Thekla Larks in our study areas.

ALAUDA ARVENSIS/ Skylark/ Alouette des champs
In March Skylark song was heard occasionally in SM.

RIPARIA PALUDICOLA/ African Sand Martin/ Hirondelle paludicole
Two to 4 African Sand Martins were permanently present near the camp-site at SM.

RIPARIA RIPARIA/ Sand Martin/ Hirondelle de rivage
On 1 March dozens were observed near the SM camp. In the following 3½ weeks the species was considerably less abundant in the area. A maximum of 1-2 birds was present then.

HIRUNDO RUSTICA/ Swallow/ Hirondelle de cheminée
Seen very regularly during our whole stay in Morocco. Strong northward migration at SM was noted from 10 March on. A total of 11 Swallows was caught in our mist-nets. Figure 10.1 shows weights versus catching time.

HIRUNDO DAURICA/ Red-rumped Swallow/ Hirondelle rousseline
Only two records of this species, both from the SM camp. On 10 March and 22 March one bird was seen migrating N.

DELICHON URBICA/ House Martin/ Hirondelle de fenêtre
On 27 February 10 between Souk-el-Arba and Kenitra, on 1 March some near SM, on 5 March 1 near Oualidia. Small numbers of House Martins migrating N were seen at SM on 10 March, 22 March and 23 March.

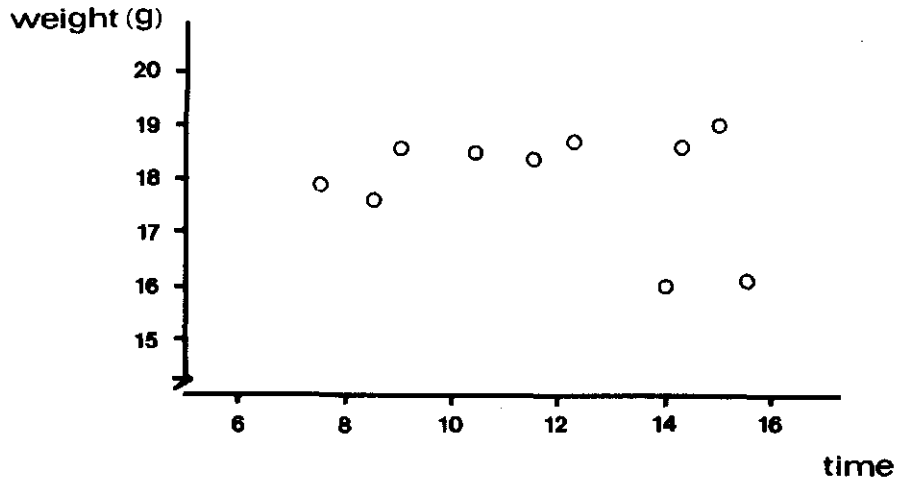


Fig. 10.1 Weights of Swallows, captured in Sidi Moussa, in the course of the day.

ANTHUS PRATENSIS/ Meadow Pipit/ Pipit des près
Single birds, probably this pipit-species, were quite regularly observed in the SM study area.

ANTHUS CERVINUS/ Red-throated Pipit/ Pipit à gorge rousse
One bird was caught in the night of 5-6 March in SM. Weight 19.6 g.

ANTHUS SPINOLETTA SPINOLETTA/ Water Pipit/ Pipit spioncelle
Single Water Pipits were observed regularly during our stay in the SM study area. They were mostly seen while foraging on the algae-covered ditches between the salines.

MOTACILLA FLAVA/ Yellow Wagtail/ Bergeronnette Printanière
Birds of both *flava* and *iberica* subspecies were observed regularly in the SM study area. Mostly single birds were seen, but on 1 March a flock of about 20 birds was recorded. On 13 March a pair *(iberica)* was caught, weighing 16.1 and 16.2 g. The species was also sighted at Oualidia (5 March) and MZ (31 March and 1 April).

MOTACILLA ALBA/ White Wagtail/ Bergeronnette grise
Apart from regular sightings of individual birds and small flocks in and near the SM study area this species was seen in many places on our way S towards the study area. On 26 February we recorded 2 between Tetouan and Chechaouèn, 7 between Chechaouèn and Ouezzane and 11 between Ouezzane and Souk-el-Arba. On 27 February we saw 12 between Souk-el-Arba

and Kenitra and on 28 February 6 between Rabat and Casablanca, 1 between Casa and EJ and 1 between EJ and SM. White Wagtails were also present on 14 March in MZ but were not seen during our second visit there. They were not sighted on our home journey through Morocco.

PYCNOTUS BARBATUS/ Common Bulbul/ Bulbul obscur
Regularly seen near Hotel La Brise in SM and probably breeding there.

ERITHACUS RUBECULA/ Robin/ Rouge-gorge familier
Regularly seen in the dunes near the camp in SM, especially during the first 2 weeks of our stay. A total number of 9 catches was made, including 4 retraps. One bird, mist-netted on 3 March was recaptured on 13 March, 1 caught on 5 March was recaptured on 10, 13 and 18 March. Average weight of the birds was 16.1 $\pm$ 0.7 g. During our journey S to SM, Robins were seen between Tetouan and Ouezzane (4 birds) and between Rabat and Casablanca (1).

LUSCINIA MEGARHYNCHOS/ Nightingale/ Rossignol philomele
No sightings but 4 catches in SM:
10 March (07.00 h), weighing 16.0 g
22 March (08.00 h), 19.7 g
24 March (07.30 h), 19.5 g
24 March (07.30 h), 18.6 g

PHOENICURUS OCHRUROS/ Black Redstart/ Rougequeue noir
Two were seen on 26 February between Chechaouèn and Ouezzane. On the same day 1 between Ouezzane and Souk-el-Arba. On 28 February 1 was seen between EJ and SM and on 1 March 1 in SM.

SAXICOLA RUBETRA/ Whinchat/ Traquet tarier
Only sighted during our journey towards the study area in N Morocco. On 26 February 2 were seen between Tetouan and Chechaouèn, 6 between Chechaouèn and Ouezzane and 5 between Ouezzane and Souk-el-Arba. On 28 February 1 between Rabat and Casablanca.

SAXICOLA TORQUATA/ Stonechat/ Traquet pâtre
A total of 55 was seen on 26 February between Tetouan and Souk-el-Arba. On 2 April, on our journey N, comparable numbers were seen in the same area. Further S considerable fewer Stonechats were observed:

on 27 February 1 was seen between Souk-el-Arba and Kenitra, on 28 February 1 between Rabat and Casablanca and on 6 March 1 at SM.

OENANTHE OENANTHE/ Wheatear/ Traquet motteux
On 5 March 1 was seen in a saltmarsh near Oualidia.

TURDUS MERULA/ Blackbird/ Merle noir
Small numbers were seen during our whole journey through Morocco. Small numbers were present near the camp in SM, the birds' song was heard occasionally. One Blackbird was caught on 13 March, weighing 94.0 g.

TURDUS PHILOMELOS/ Song Thrush/ Grive musicienne
Seen infrequently during our stay in SM, though on 4 March large numbers were present in the dunes. Two catches: on 4 March a bird weighing 66.0 g, on 22 March 1 weighing 68.0 g.

CISTICOLA JUNCIDES/ Fan-tailed Warbler/ Cisticole des joncs
Was observed in many places in the SM study area during our whole stay there. The species was also heard between EJ and SM and between Oualidia and SM. Was observed in several places in MZ as well. In SM 2 Fan-tailed Warblers were caught on 11 and 26 March, but only 1 could be weighed: 8.7 g.

ACROCEPHALUS SCHOENOBAENUS/ Sedge Warbler/ Phragmite des joncs
On 6 March 1 bird was caught in SM, weighing 9.5 g. According to P&GA Sedge Warblers pass through N Morocco between early March and early May.

HIPPOLAIS POLYGLOTTA/ Melodious Warbler/ Hypolaïs polyglotte
Two were caught on 23 March, weighing 8.8 and 8.9 g.

SYLVIA CANTILLANS/ Subalpine Warbler/ Fouvette passerinette
The species was seen during our whole stay in SM in small numbers. Weights of birds caught are given in fig. 10.2. Average weight was 9.3 ± 0.7 g (n = 9). One bird, caught 4 March, was retrapped on 6 March.

SYLVIA MELANOCEPHALA/ Sardinian Warbler/ Fouvette melanocéphale
Small numbers were recorded near the camp during our whole stay in SM. A total of 14 birds was caught showing an average weight of 10.7 ± 1.1 g. Weights are shown in fig. 10.3. One control was made on 5 March: ringed Paris 2568000.

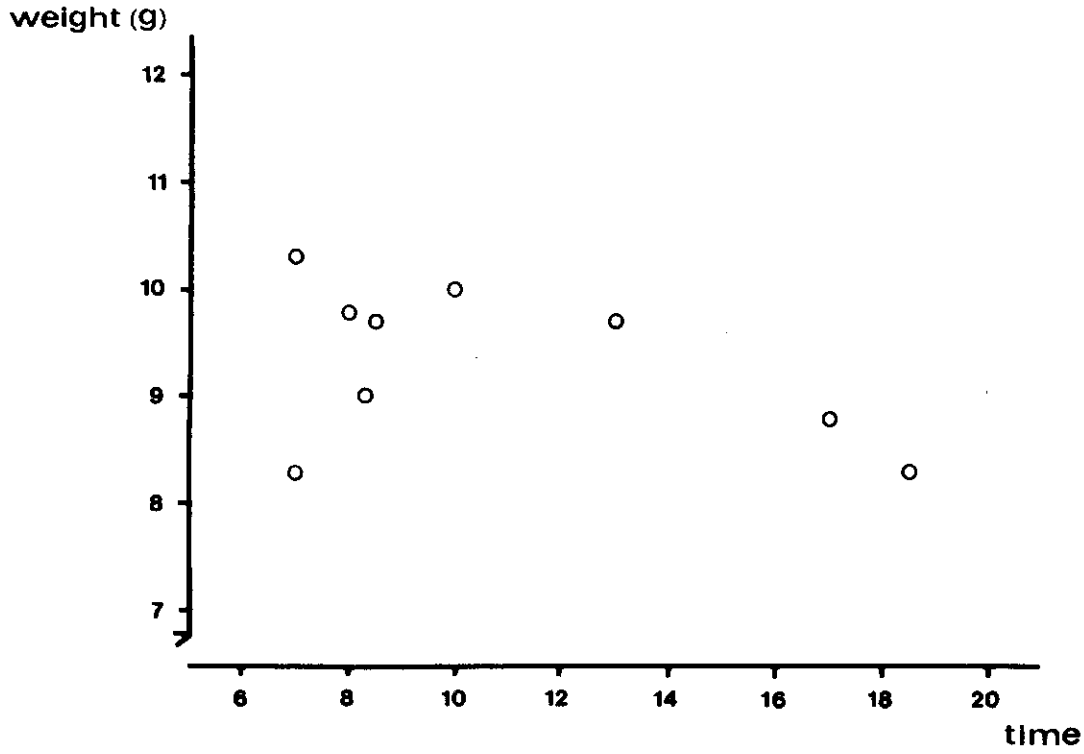


Fig. 10.2 Weights of Subalpine Warblers, captured in Sidi Moussa, in the course of the day.

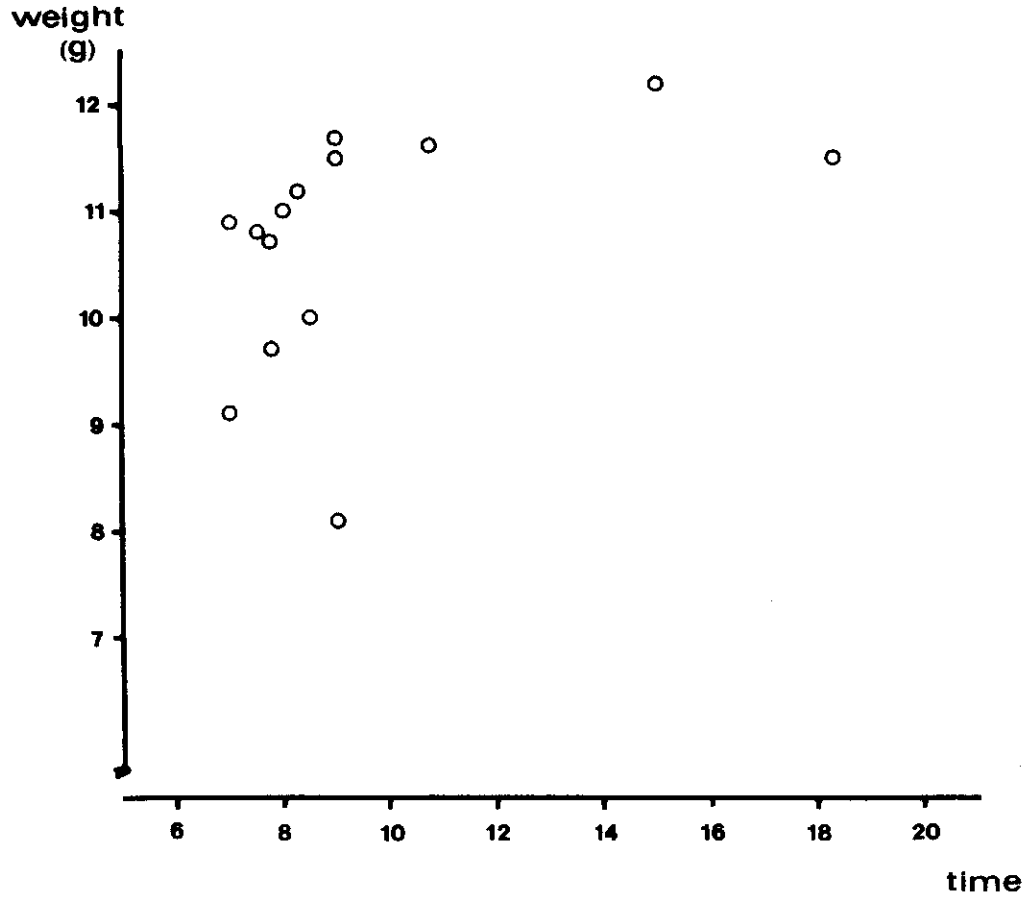


Fig. 10.3 Weights of Sardinian Warblers, captured in Sidi Moussa, in the course of the day.

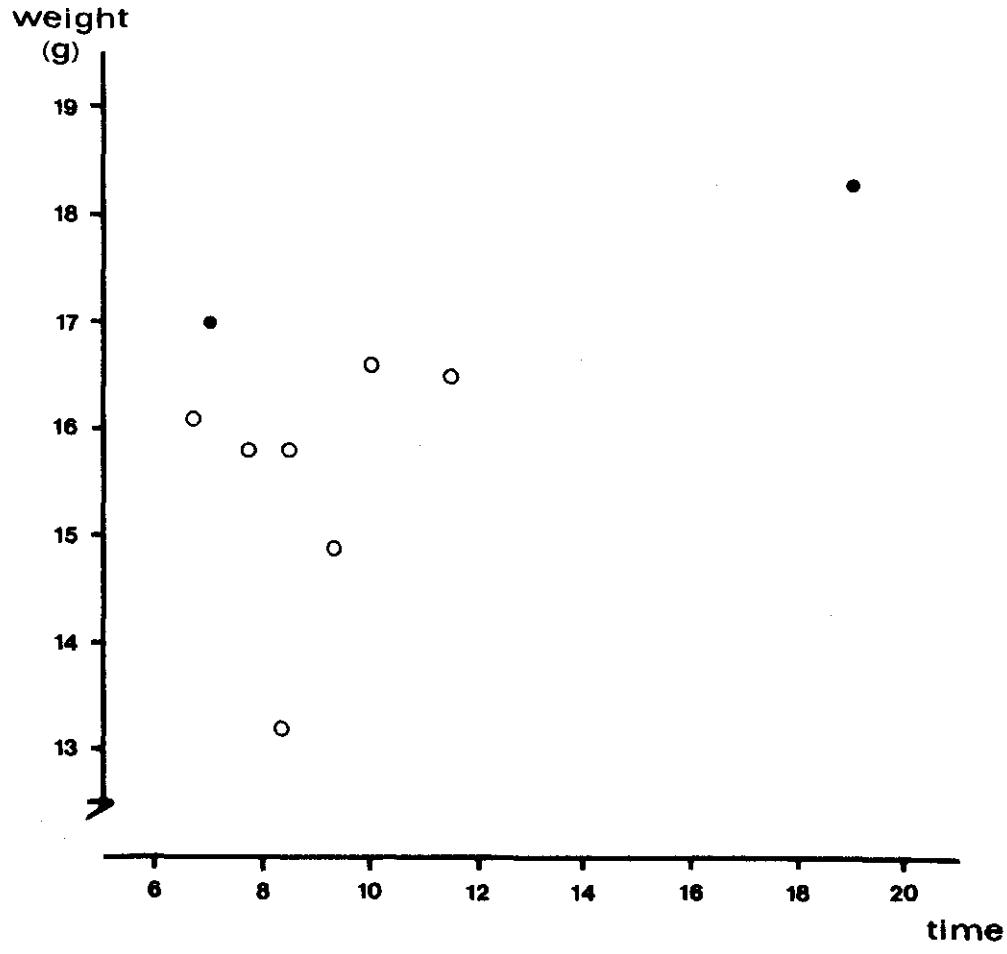


Fig. 10.4 Weights of Blackcaps, captured at Sidi Moussa, in the course of the day. Solid dots refer to a bird caught twice.

SYLVIA ATRICAPILLA/ Blackcap/ Fauvette à tête noire

Blackcaps appeared to be common in gardens in Rabat on 27 February. The species was also recorded near Hotel La Brise, in the dunes of SM and near MBS. Nine birds were caught, weighing 16.0 $\pm$ 1.4 g on average. Fig. 10.4 shows weights. One bird was retrapped on the same day. Weight of 1 bird could not be determined.

PHYLLOSCOPUS COLLYBITA/ Chiffchaff/ Pouillot véloce

The species' song was often heard in the dunes near the SM camp. A total of 36 catches and 4 retraps was made, showing (fig. 10.5) a significant weight increase during the day. Weights of birds captured before 10 a.m. were 6.4 $\pm$ 0.6 g on average (n = 11), those of birds captured after 10 a.m. were 7.4 $\pm$ 1.0 g (n = 30) (Student-t-test; $p < 0.001$).

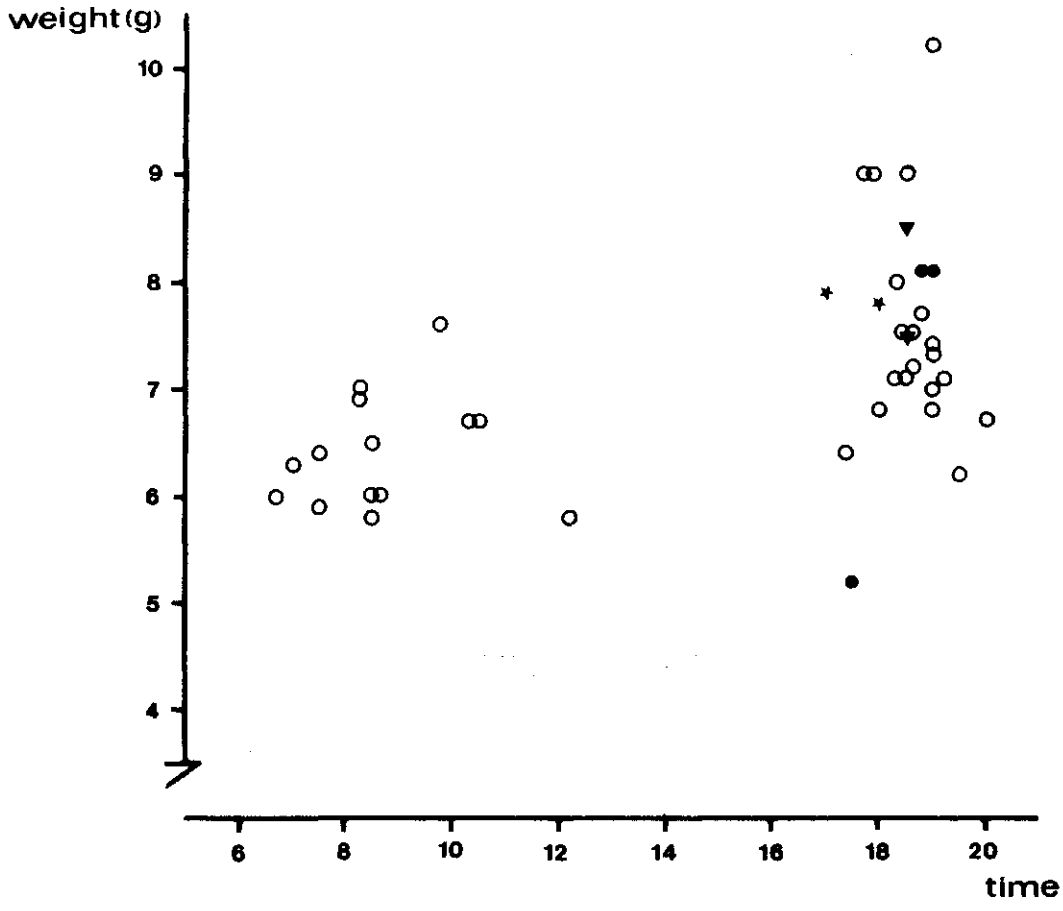


Fig. 10.5 Weights of Chiffchaffs, captured at Sidi Moussa, in the course of the day. Stars and triangles refer to birds caught twice, solid dots to a bird caught 3 times.

PHYLLOSCOPUS TROCHILUS/ Willow Warbler/ Pouillot fitis
Catches were made throughout our stay in SM. A total of 6 birds were caught, weighing 8.2 ± 0.7 g on average. Catched were made on 7 March, 10 March, 23 March (2), 24 March and 25 March. In N Morocco Willow Warbler passage starts by mid-March and culminates by the end of that month (P&GA).

LANIUS EXCUBITOR/ Great Grey Shrike/ Pie-grièche grise
Great Grey Shrikes were only seen in the N part of Morocco. On 26 February 2 were seen between Tetouan and Chechaouèn, 15 between Chechaouèn and Ouezzane and 5 between Ouezzane and Souk-el-Arba. On 28 February we saw 1 between Rabat and Casablanca. On 2 April, on our way N, 7 were seen between Ouezzane and Tetouan.

LANIUS SENATOR/ Woodchat Shrike/ Pie-grièche a tête rousse
One bird was observed at MZ on 1 April, 2 were seen between Ouezzane and Tetouan on 2 April. According to P&GA in N Morocco spring migration is recorded from about 10 March onwards.

CORVUS MONEDULA/ Jackdaw/ Choucas des tours
Jackdaws appeared to be common in N Morocco between the border and Chechaouèn. Both on our way N and on our way S flocks of dozens of birds were recorded here. On 2 April a small flock was recorded N of Ouezzane.

CORVUS CORONE/ Crow/ Corneille noire
About 10 Crows were recorded between Tetouan and Chechaouèn on 26 February.

CORVUS CORAX/ Raven/ Grand corbeau
Ravens were observed only now and then. On 26 February 1 was seen between Tetouan and Chechaouèn and 2 between Chechaouèn and Ouezzane. On 28 February 2 were observed between EJ and SM. On 30 March 2 were present along the S border of the MZ. On 2 April 1 was seen near Ouezzane and 3 between Ouezzane and Tetouan.

STURNUS UNICOLOR (VULGARIS)/ Spotless Starling (Starling)/ Etourneau unicolor (Sansonnet)
Small flocks and individual (Spotless) Starlings were seen during our whole stay in Morocco in many places. Some of these were positively Spotless Starlings. Generally, however, insufficient attention was given to the birds to distinguish between the two species.

PASSER DOMESTICUS/ House Sparrow/ Moineau domestique
A common bird observed in many places during our whole stay in Morocco, in cities, villages as well as in the country.

FRINGILLA COELEBS/ Chaffinch/ Pinson des arbres
The N African subspecies, *F.c. spodiogenys*, was seen only in small numbers in the N part of the country, except for some observations between Casablanca and EJ. They were not seen near the SM camp but several were recorded near MBS and the MZ.

SERINUS SERINUS/ Serin/ Serin cini
This birds' song was heard quite regularly near the SM camp and surroundings and near MZ. Travelling in a van, however, appeared to be unsuitable for detecting this species presence. Except for our study areas, it was therefore not determined elsewhere. One bird was caught in SM on 6 March, weighing 10.6 g.

CHLORIS CHLORIS/ Greenfinch/ Verdier d'Europe
On 26 February 2 were seen between Chechaouèn and Ouezzane. Up to 10 were

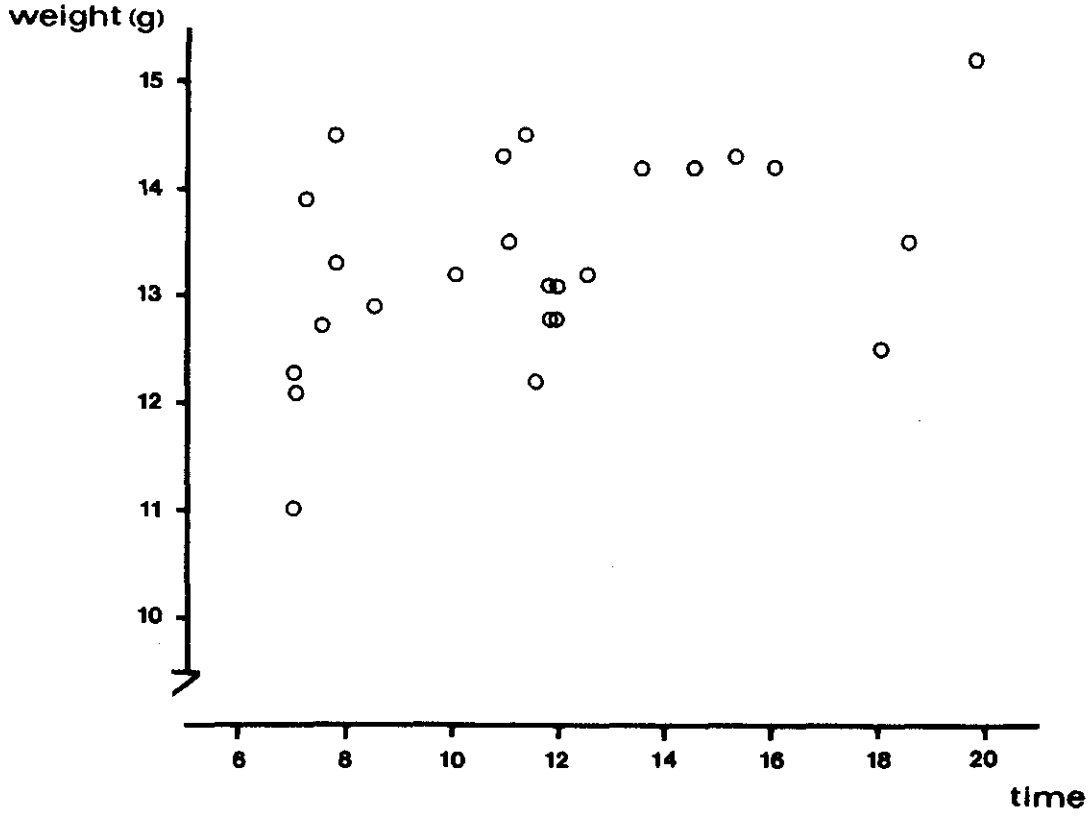


Fig. 10.6 Weights of Goldfinches, captured in Sidi Moussa, in the course of the day.

seen in the surroundings of MZ on 14 March and 1 April. Greenfinches were not seen in SM.

CARDUELIS CARDUELIS/ Goldfinch/ Chardonneret

Common in all areas we visited, especially between Chechaouèn and Souk-el-Arba. Driving through this area we saw hundredson 26 February. Dozens were present in our study area in SM and near the MZ. A total number of 28 Goldfinches was caught, excluding 6 retraps. Fig. 10.6 shows weights of these birds. No significant weight differences between sexes could be determined. Birds caught before 10 a.m. on average weighed 12.8 $\pm$ 1.1 g (n = 8), birds caught after 10 a.m. weighed 13.6 $\pm$ 0.8 g (n = 17), a non-significant difference ($p > 0.05$, Student-t-test).

CARDUELIS CANNABINA/ Linnet/ Linotte mélodieuse

Very small numbers were seen on our way S towards SM between Tetouan and Ouezzane on 26 February. In SM Linnets proved to be very abundant in the dune shrub and in the salines. Linnets were also frequently recorded near MZ. A total number of 51 birds were caught in SM, excluding 5 retraps. Average weight of females was 15.3 $\pm$ 2.1 g (n = 21), of males 15.9 $\pm$ 1.0 g (n = 29), a non-significant difference. Birds caught before 10 a.m. generally

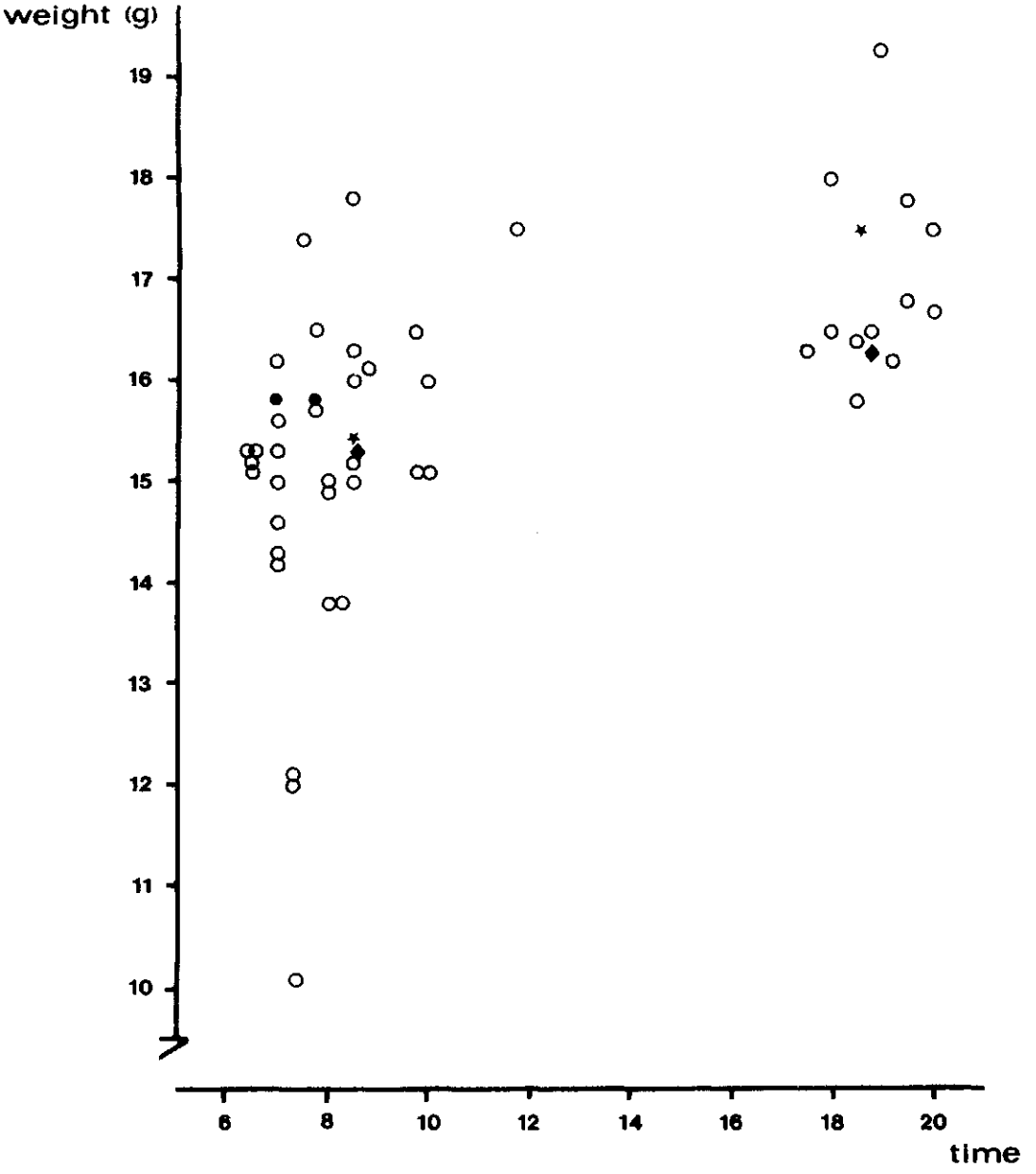


Fig. 10.7 Weights of Linnets, captured in Sidi Moussa, in the course of the day. Solid dots, stars and triangles refer to birds caught twice.

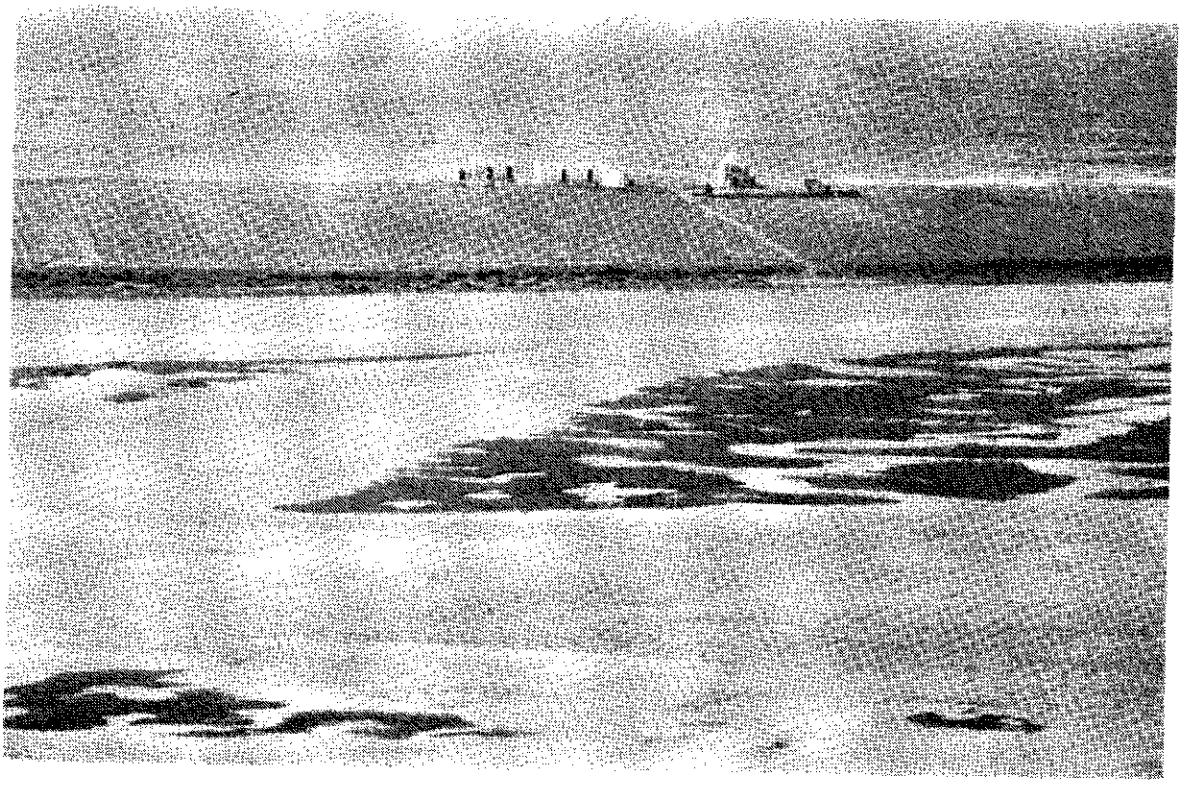
were lower in weight than birds caught later during the day (fig. 10.7). Differences were 15.1 $\pm$ 1.5 g (n = 33) and 16.9 g $\pm$ 1.0 g (n = 18) respectively. This weight increase amounts to 12% and is significant ($p < 0.001$; Student-t-test).

EMBERIZA STRIOLATA/ House Bunting/ Bruant striolé

Singing males were observed in EJ on 11 March and 19 March.

MILIARIA CALANDRA/ Corn Bunting/ Bruant proyer

Rather common all over N Morocco. Corn Buntings were also frequently seen near SM and MZ and between EJ and SM.



The lagoon of Oualidia, a few km north of this town, the Atlantic Ocean in the background.

The expedition camp at Sidi Moussa.

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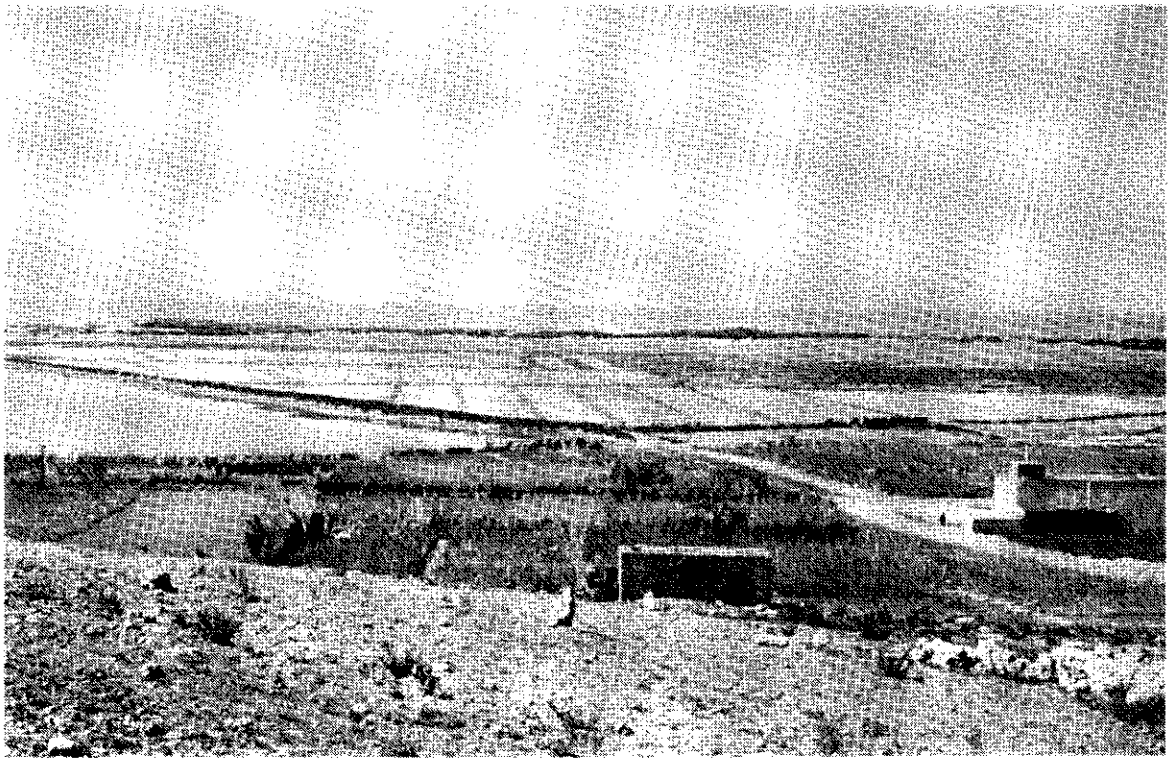


The study area in Sidi Moussa, seen from the east. The intertidal area is situated to the left, the salines to the right.

Appendix 1. Results of the waterbird-counts, performed at high tide in the Sidi Moussa study area in March 1981.

		1 March	9 March	17 March	21 March	26 March
Little Grebe	*Tachybaptus ruficollis*	31	47	48	34	35
Grey Heron	*Ardea cinerea*	14	22	13	15	8
Little Egret	*Egretta garzetta*	29	27	23	27	35
Spoonbill	*Platalia leucorodia*	10	6	4	9	9
White Stork	*Ciconia ciconia*	4	?	?	?	?
Greater Flamingo	*Phoenicopterus ruber*	1	19	56	31	0
Shelduck	*Tadorna tadorna*	157	111	90	70	2
Pintail	*Anas acuta*	250	229	0	0	6
Wigeon	*Anas penelope*	800	150	0	2	0
Garganey	*Anas querquedula*	6	100	16	0	2
Shoveler	*Anas clypeata*	120	250	90	2	2
Pochard	*Aythya ferina*	6	13	15	4	5
Moorhen	*Gallinula chloropus*	11	5	30	25	33
Coot	*Fulica atra*	1438	570	635	71	247
Oystercatcher	*Haematopus ostralegus*	5	43	12	6	3
Black-winged Stilt	*Himantopus himantopus*	322	278	293	334	327
Avocet	*Recurvirostra avosetta*	546	173	183	182	119
Ringed Plover	*Charadrius hiaticula*	372	363	310	262	258
Kentish Plover	*Charadrius alexandrinus*	241	162	158	180	179
Grey Plover	*Pluvialis squatarola*	242	476	510	661	408
Knot	*Calidris canutus*	30	27	0	2	14
Sanderling	*Calidris alba*	35	139	42	12	20
Little Stint	*Calidris minuta*	123	255	92	85	292
Curlew Sandpiper	*Calidris ferruginea*	3	48	34	17	18
Dunlin	*Calidris alpina*	2821	2353	1928	1718	1188
Black-tailed Godwit	*Limosa limosa*	359	205	188	87	60
Bar-tailed Godwit	*Limosa lapponica*	65	50	17	177	0
Whimbrel	*Numenius phaeopus*	0	9	1	1	0
Curlew	*Numenius arquata*	3	245	178	187	65
Spotted Redshank	*Tringa erythropus*	112	66	14	9	9
Redshank	*Tringa totanus*	505	330	403	421	294
Greenshank	*Tringa nebularia*	23	23	2	15	6
Common Sandpiper	*Actitis hypoleucos*	3	1	3	4	3
Wood Sandpiper	*Tringa glareola*	1	0	1	0	1
Green Sandpiper	*Tringa ochropus*	1	0	0	0	1
Ruff	*Philomachus pugnax*	46	88	153	145	189
Turnstone	*Arenaria interpres*	237	159	172	162	223
Common Snipe	*Gallinago gallinago*	13	30	5	15	13
Pratincole	*Glariola pratincola*	0	0	1	3	8

Appendix 2: Numbers of waders and other shorebirds in the salines north of the study area in Sidi Moussa, 10 km of coastline between Cap Blanc and El Jadida and in Merja Zerga.

	northern salines		coast	Merja Zerga
	3 March	17 March	13 March	1 April
Tachybaptus ruficollis		1		
Phalacrocorax carbo			6	
Phalacrocorax aristotelis			6	
Egretta garzetta	2	2	22	32
Ardea cinerea	5		2	105
Ardea purpurea				1
Ciconia ciconia	1			21
Platalea leucorodia				115
Phoenicopterus ruber				6656
Anser anser				2
Tadorna tadorna				1170
Anas penelope				1850
Anas strepera				4
Anas crecca				4
Anas platyrhynchos				423
Anas acuta				5
Anas querquedula				16
Anas clypeata				400
Fulica atra				663
Haematopus ostralegus			9	105
Himantopus himantopus	27	130		8
Recurvorostra avosetta				2708
Glareola pratincola				30
Charadrius hiaticula	62	15	75	108
Charadrius alexandrinus	79	61	7	472
Pluvialis apricaria			6	
Plvialis squatarola	40	1	59	3207
Calidris canutus	1		6	20
Calidris alba	33	13	13	8
Calidris minuta	8	61		656
Calidris ferruginea	1	14		156
Calidris alpina	72	393	285	15238
Philomachus pugnax	10	62		60
Limosa limosa	1	1		659
Limosa lapponica			3	4
Numenius phaeopus			9	
Numenius arquata	2		1	112
Tringa erythropus		8		5
Tringa totanus	48	84	59	523
Tringa nebularia				33
Actitis hypoleucos		2		
Arenaria interpres	34	16	152	22
Phalaropus fulicarius				1
Larus ridibundus	52	2		
Larus fuscus	2			
Larus argentatus	2	2		11
Larus marinus		1		1
Gelochelidon nilotica				2
Sterna caspia				23
Sterna sandvicensis	1		6	30
Chlidonias hybrida				4

Appendix 3. Numbers of waders caught per day, including retraps and controls.

	Date, March 1981																										
	1	2	3	4	5	6	7	8	9	10	11	12	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Himantopus himantopus		1		1																						
Recurvirostra avosetta										1																
Charadrius hiaticula	2	2	3	5	1	1	2	15	1	3	2	2		1									1	1		
Charadrius alexandrinus		2		1		2	1				1	1		1						1		3	2		3	2
Pluvialis squatarola		1		1			1			2								1								
Calidris canutus	1	1	1		1										2											
Calidris minuta	1	3	3	2	2				1	1	3	2								1	1	1	1	1	1	
Calidris ferruginea	2		5	1				1		1			1									1		1		
Calidris alpina	36	39	20	34	37	46	69	49	2	22	8	5	3	5	1	9					3	9	4	8	6	1
Philomachus pugnax						1	1														1			1		
Gallinago gallinago		1			1																					
Tringa totanus	7	15	6	15	2	2	5	3		8	4	2	3	1	3	1				1	5	4	1	6	5	3
Tringa nebularia				3	1					1																
Actitis hypoleucos				1																						
Arenaria interpres								1						1	1	2					1				2	
Totals	49	65	38	64	45	52	79	69	4	39	18	12	7	9	7	12	0	1	0	3	11	18	9	18	17	6

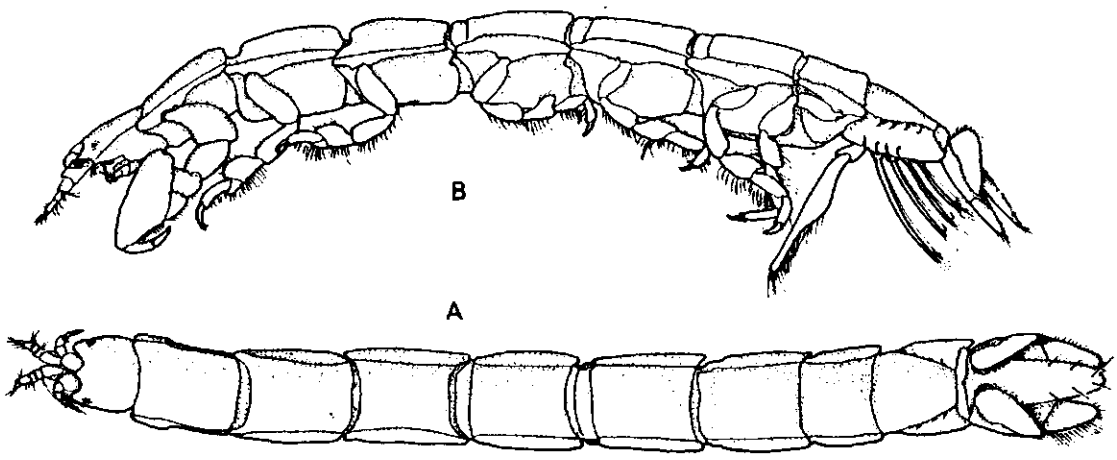
Appendix 4. Results of the analysis of body composition of casualties at Sidi Moussa in March 1981. Standard Muscle Volume is calculated from a set of skeletal measurements as outlined by Evans & Smith (1975).

Individual	Ring (if any)	Date	Age	Sex	Wing (mm)	Bill (mm)	Total head (mm)	SMV (cm^3)	Fresh weight (g)	Lean dry weight (g)	Fat weight (g)	Fresh weight breast muscle (g)	Lean dry weight breast muscle (g)
Ringed Plover 1	SA696278	8 March	Juvenile	♀	128	14.0	40.7	5.185	44.0	13.65	0.77	4.2	1.43
Ringed Plover 2	-	11 March	Juvenile	♂	135	13.7	42.3	6.158	53.0	16.27	2.65	5.1	1.26
Kentish Plover 1	-	6 March	Adult	♂	114	15.1	43.0	2.893	37.0	11.99	0.86	3.0	0.77
Kentish Plover 2	-	12 March	Adult	♂	117	16.2	43.5	3.310	36.5	11.95	1.12	3.3	0.89
Kentish Plover 3	SA696440	28 March	Unknown	♂	118	15.9	42.7	3.392	32.0	10.60	0.63	3.3	0.84
Knot 1	421003	2 March	Unknown	♂	164	29.6	60.0	11.521	114.0	35.51	3.57	11.9	3.02
Little Stint 1	2610521	4 March	Unknown	♂	111	17.3	39.0	2.383	20.0	6.19	0.18	2.1	0.52
Little Stint 2	-	12 March	Unknown	♂	96	18.5	39.0	2.049	19.0	6.26	1.27	2.1	0.59
Little Stint 3	2610529	11 March	Unknown	♂	110	19.0	39.0	2.128	20.5	6.70	1.17	1.9	0.59
Curlew Sandpiper 1	-	1 March	Juvenile	♀	132	41.2	65.1	6.079	55.0	15.30	3.33	6.2	1.55
Dunlin 1	SA696066	3 March	Unknown	♂	115	30.0	52.7	3.828	42.0	13.77	4.31	4.0	1.10
Dunlin 2	SA696063	2 March	Unknown	♂	116	30.2	52.2	4.593	35.0	12.18	0.35	3.0	0.78
Dunlin 3	-	3 March	Juvenile	♂	122	32.6	56.3	4.718	38.5	10.67	1.32	?	0.81
Dunlin 4	-	4 March	Juvenile	♂	114	30.0	52.6	3.610	37.5	10.60	1.23	3.5	0.77
Dunlin 5	-	4 March	Unknown	♂	122	32.2	55.6	4.283	42.5	10.68	2.63	3.7	0.81
Dunlin 6	-	4 March	Juvenile	♀	120	30.4	53.6	4.672	38.5	12.13	0.35	3.4	0.84
Dunlin 7	-	6 March	Unknown	♀	119	33.4	55.6	4.973	44.0	13.22	2.69	4.3	1.10
Dunlin 8	SA696125	5 March	Juvenile	♂	116	31.1	55.5	4.638	36.0	11.41	0.14	3.6	0.89
Dunlin 9	-	7 March	Juvenile	♀	116	32.4	54.9	4.532	37.0	12.45	0.28	3.4	0.86
Dunlin 10	SA696244	7 March	Juvenile	♀	116	34.1	57.3	4.082	41.0	11.69	2.52	3.4	0.97
Dunlin 11	SA696274	8 March	Unknown	♂	114	27.9	51.3	3.773	31.0	9.87	0.07	3.1	0.73
Dunlin 12	-	8 March	Juvenile	♀	118	32.1	54.5	4.258	43.0	12.96	2.32	4.4	1.14
Dunlin 13	SA696301	8 March	Juvenile	♀	120	31.9	55.5	4.051	37.0	12.08	0.21	3.8	0.94
Dunlin 14	SA607030	9 March	Juvenile	♂	116	27.5	50.0	3.887	37.0	11.74	0.77	3.7	0.92
Dunlin 15	-	9 March	Unknown	♂	111	24.5	51.6	3.934	31.0	9.85	0.10	2.5	0.58
Dunlin 16	-	25 March	Juvenile	♂	115	28.8	57.7	4.699	51.0	13.90	10.56	4.3	1.19
Common Snipe 1	-	5 March	Juvenile	♂	138	71.0	97.8	11.812	102.0	30.37	8.93	13.3	3.30
Redshank 1	-	1 March	Unknown	♂	160	39.2	71.6	12.063	117.0	33.46	12.99	11.7	2.81
Redshank 2	GP22796	2 March	Juvenile	♂	165	47.3	73.5	10.769	98.0	31.04	0.68	6.8	2.15
Redshank 3	GC77954	2 March	Juvenile	♀	166	43.7	75.0	11.591	112.0	34.29	10.44	10.7	2.67
Redshank 4	GC77968	2 March	Unknown	♀	160	41.0	73.5	10.352	85.0	28.25	0.16	7.2	1.49
Redshank 4	GC77802	7 March	Unknown	♂	160	41.1	75.0	10.994	118.0	32.71	10.04	11.8	2.90
Redshank 6	BC77804	7 March	Unknown	♀	165	42.5	74.7	10.081	120.0	35.89	12.45	11.4	2.97
Redshank 7	-	12 March	Adult	♂	157	41.3	72.6	9.812	73.0	24.81	0	7.2	1.65
Redshank 8	-	24 March	Adult	♂	155	45.0	74.8	11.934	115.0	33.38	13.57	10.0	2.95
Redshank 9	-	28 March	Unknown	♀	156	44.9	74.2	9.987	105.0	33.33	6.99	9.6	2.68

Appendix 5. Discovery of a new isopod-species.

In the taxonomic-material collected during the expedition in the southern part of the estuary of Sidi Moussa, an hitherto undescribed species of Isopoda (Anthuridae, Crustacea) was found. The discovery of this species solved an old confusion among taxonomists concerning the status of another Anthuridae-species (Cyathura liouvillei Monod 1925) which did clearly nót belong to the genus Cyathura proper. The last species is now placed along with the Sidi Moussa specimens in the genus Monodanthura. The 'new' species, which is shown in the accompanying Figure, is called Monodanthura maroccana by its describers Johann Wolfgang Wägele and Dirk Platvoet (Wägele & Platvoet 1982).

Figure A5. Drawing of the holotype of Monodanthura maroccana nov. gen., nov. spec. in dorsal (A) and lateral view (B). The total length of this non-reproductive adult is 11.5 mm.



1 INLEIDING

De laatste jaren is er veel onderzoek verricht naar het belang voor steltlopers van de getijdengebieden langs de Europese kusten. Deze belangstelling is voor een deel te wijten aan de (voorgestelde) snelle "ontwikkeling", zoals inpolderingen en industrialisatie, van deze gebieden. Op deze manier zullen de toch al zeldzame voedselterreinen van steltlopers verloren gaan of van kwaliteit verminderen, waardoor verscheidene soorten steltlopers in hun voortbestaan bedreigd worden. Informatie over het belang van de getijdengebieden langs de Westafrikaanse kusten is moeilijk verkrijgbaar en daarom maar zeer beperkt beschikbaar. Niettemin hebben terugmeldingen van geringde vogels duidelijk gemaakt dat veel van de in West-Europa doortrekkende steltlopers in West-Afrika overwinteren. Kennis van deze gebieden is daarom uitermate belangrijk voor een goed beheer en een goede bescherming van de betrokken steltloperpopulaties.

Hoewel reeds bekend was dat grote aantallen steltlopers langs de kusten van Marokko overwinteren, en er in de herfst doortrekken, was nog helemaal niets bekend over de aantallen steltlopers die tijdens de voorjaarstrek van deze gebieden gebruik maken. In het kort komt het erop neer dat wij geprobeerd hebben deze leemte in kennis te vullen.

Tenminste 3 miljoen steltlopers overwinteren in kustgebieden ten zuiden van de Sahara, waarvan 2 miljoen op de Banc d'Arguin in Mauritanië en één miljoen rond de Bijagos Archipel in Guineé-Bissau . Aan het einde van de winter is de hoeveelheid steltlopervoedsel (de wadbodembewonende ongewervelde dieren die groter zijn dan 1 mm = macrobenthos) op de Banc d'Arguin erg klein, vergeleken met de hoeveelheid in bijvoorbeeld de Waddenzee. Gezien de relatief geringe voedselvoorraad en de grote afstand die steltlopers moeten afleggen (vanaf West-Afrika naar West-Europa) is het de vraag <u>hoe</u> ze het klaarspelen om die afstand te overbruggen. We zouden ons kunnen voorstellen dat de steltlopers hun tocht naar de arctische broedgebieden onderweg, bijvoorbeeld in Marokko, (moeten) onderbreken om voedsel te zoeken en om vet aan te leggen (als het ware om 'bij te tanken') alvorens door te(kunnen) vliegen naar de volgende stopplaatsen in Europa zoals de Nederlandse Waddenzee. Dit zou betekenen dat de getijde-gebieden langs de Atlantische kust van Marokko onmisbare tankstations vormen voor de miljoenen steltlopers die zuidelijker overwinteren!

Eerdere, Britse, expedities hadden ontdekt dat het kleine estuarium en zoutpannen-gebied bij Sidi Moussa uitstekende mogelijkheden biedt om stelt-

lopers met mistnetten te vangen. Aangezien het gebied relatief klein is (7 km bij 500 m), kan men alle aanwezige steltlopers in korte tijd tellen. Deze omstandigheden zouden het ons mogelijk maken om behoorlijke aantallen steltlopers te vangen en te merken, om regelmatig tellingen te doen en om zo 'doortreksnelheden' van steltlopers door dit gebied te meten. Door extrapolaties van de resultaten voor dit proefgebied zouden we kunnen komen tot een waardering van het belang van de gehele Atlantische kust van Marokko voor steltlopers tijdens de voorjaarstrek.

Er was tot nog toe weinig, en dan alleen kwalitatief, informatie aanwezig over de hoeveelheid aanwezig voedsel voor steltlopers (de biomassa van het macrobenthos) in de Marokkaanse wadgebieden. Om een indruk te krijgen van de kwaliteit van de doortrekgebieden hebben we onderzocht hoeveel, en wat voor soort voedsel, er in de wadplaten bij Sidi Moussa, waarop de steltlopers foerageren, aanwezig is.

Dit waren, samen met het verlangen onze kennis van zuidelijke landen en steltlopers uit te breiden, de redenen voor ons om de 'Nederlandse Marokko Expeditie 1981' te organiseren. In dit verslag is geprobeerd de verzamelde gegevens overzichtelijk maar vaak nog op een voorlopige manier te presenteren. We zijn van plan de geïnterpreteerde gegevens te publiceren samen met de resultaten van de opvolger van deze expeditie, de 'Nederlandse Steltloper Expeditie naar Marokko 1982', die in maart-april bij Sidi Moussa werkte.

Tenslotte willen we nog graag melding maken van de vondst door taxonomische specialisten van het Amsterdamse Zoölogisch Museum van een nog onbeschreven diersoort in het door ons bij Sidi Moussa verzamelde materiaal. Dit slijkgarnaalachtig wadbeestje werd Monodanthura maroccana gedoopt.

2 DANKZEGGING EN FINANCIEEL OVERZICHT

3 BESCHRIJVING VAN HET STUDIEGEBIED

Langs de 60 km lange Atlantische kust tussen El Jadida en Oualidia (figuur 3.1), liggen een aantal langgerekte 'wetlands' (figuur 3.2). Ze zijn van de oceaan gescheiden door een duinenrij die verankerd ligt op rotsige ondergrond (figuur 3.4). De kust bestaat afwisselend uit kliffen en smalle witte stranden. Op twee plaatsen, bij Sidi Moussa in het noorden en Oualidia in het zuiden, heeft de zee zich door de duinenrij gebroken om zo tussen kust en het hoger gelegen land, getijdengebieden te creëren. De noordelijke, en verst van de monding, gelegen delen van deze getijdengebieden zijn in cultuur gebracht: er zijn zoutpannen aangelegd. Het studiegebied bij Sidi Moussa (figuur 3.3)

bestaat uit een ca. 3 km lang getijdengebied met kwelders en slenken en een ca. 4 km lange serie zoutpannen. Aan de vastelandszijde van de zoutpannen loopt een sloot met zoet water (vermoedelijk gevoed door bronwater uit het hogere land) die continu water in het getijdengebied loost. Hierdoor bestaat er in het getijdengebied van noord naar zuid een gradiënt in het water van brak naar zout, waardoor we hier kunnen spreken van een echt estuarium(pje). De bevolkingsdruk op het gebied is hoog: de kwelders worden intensief begraasd door mensen die er plantenmateriaal (veevoer en gedroogde brandstof) verzamelen en tevens door ezels, koeien en (drie) dromedarissen. Tijdens iedere laagwaterperiode zoeken 15-30 vrouwen naar eetbare mollusken op het wad. Oudere mannen vissen met hengels vanaf de kliffen en soms wordt er in de weekenden op steltlopers en eenden gejaagd door (niet-lokale) sportjagers. Op de prachtige stranden vinden we soms zonaanbiddende toeristen. Op de hogere kleiïge gronden langs de kwelders vinden we tomatenkwekerijen en langs en op de duinen enige schrale graanveldjes.

De Merja Zerga (figuur 3.7), is een grote ondiepe, met zachte modder gevulde, getijdeninham. Zoet water wordt (voornamelijk 's winters) vanuit het zuiden en noordoosten door resp. een kanaal en een riviertje op de Merja Zerga afgevoerd. In 1978 werd de Merja Zerga tot Nationaal Park verklaard waardoor aan de (vroeger zeer intensieve) jacht op watervogels een einde kwam. Nu zijn er tevens bewakers aangesteld.

Tabel 3.1 Voorspelde hoog- en laagwatertijden en getijhoogten voor Casablanca, 1981.

Figuur 3.1 Kaart van Marokko waarop de meeste belangrijke 'wetlands' langs de Atlantische kust zijn aangegeven.

Figuur 3.2 Kaart van de Atlantische kuststreek tussen Sidi Moussa en Oualidia.

Figuur 3.3 Kaart van het studiegebied bij Sidi Moussa.

Figuur 3.4 Schematische doorsnede van oost (links op de figuur) naar west (rechts) van de kust bij Sidi Moussa, kijkend in zuidelijke richting.

Figuur 3.5 Jaarlijkse fluctuaties in de watertemperatuur tijdens laagwater op twee meetstations in het estuarium van Oualidia (gegevens verzameld in 1970; naar Beaubrun 1976a).

Figuur 3.6 Dagelijkse fluctuaties in de temperatuur van de wadbodem in het proefvlak in het noordelijk deel van het estuarium bij Sidi Moussa. De bodemtemperatuur werd 2-3 cm onder het wadoppervlak gemeten. De gegevens werden verzameld van 12 tot 21 maart 1981.

Figuur 3.7 Kaart van de Merja Zerga.

4 REISBESCHRIJVING

5 ONDERZOEK VAN DE BENTHISCHE MACROFAUNA

De ongewervelde dieren die in en op de wadbodem leven en groter zijn dan 1 mm, noemen we de benthische macrofauna. Deze dieren vormen het belangrijkste voedsel van steltlopers, en dat is de eerste reden waarom we in hen geïnteresseerd zijn. Gegevens over macrobenthos hebben we om twee redenen verzameld:

1) om prooidichtheden en prooigewichten vast te leggen, om die vervolgens respectievelijk te gebruiken om correlatief de factoren te kunnen nagaan die de verspreiding van steltlopers over het wad bepalen en om voedselopname van steltlopers te kunnen berekenen;
2) om de vraag te onderzoeken of voedselproduktie de gelijktijdige consumptie door steltlopers evenaart, of dat er sprake is van een geleidelijke uitputting van het voedsel tijdens de voorjaars-doortrekperiode.

In dit verslag proberen we de basisgegevens betreffende de benthische macrofauna in het estuarium van Sidi Moussa vast te leggen. Daarnaast worden de resultaten gegeven van monsteringen op twee plaatsen in de Merja Zerga.

De macrobenthische biomassa was het grootst in het noordelijke, en waarschijnlijk het meest brakke, deel van het estuarium van Sidi Moussa (21 g asvrij drooggewicht (AFDW) per m^2) en werd kleiner in zuidelijke richting, dichterbij de monding naar zee (respectievelijk 15 g en 1 - 8 g.AFDW.m^{-2} halverwege het estuarium en nabij de monding). Metingen aan Zeeduizendpoten Nereis diversicolor, een van de belangrijkste soorten, wezen uit dat de groei van deze dieren weliswaar relatief snel was gedurende onze periode van studie, maar dat de predatiedruk door o.a. steltlopers hoger was dan deze groeisnelheid.

In de Merja Zerga vonden we macrobenthische biomassa's van 20 en 25 g.AFDW.m^{-2}. Deze biomassa werd vrijwel helemaal gevormd door tweekleppige mollusken.

Tabel 5.1 Het voorkomen van macrobenthische ongewervelden op verschillende plaatsen in getijdengebieden langs de Marokkaanse kust.

Tabel 5.2 Dichtheden en biomassa van macrobenthische organismen op het wad in het noordelijke deel van het estuarium van Sidi Moussa. Gemiddelden en standaardafwijkingen van de resultaten voor de 10 blokken van het proefvlak (zie fig. 5.1) worden gegeven. Het totale aantal monsters (van 1/120 m^2 bij een diepte van 25 cm) waarover de gemiddelden berekend werden bedraagt 116; alleen wadslakjes Peringia ulvae werden slechts in 81 monsters geteld.

Tabel 5.3 Veranderingen in de dichtheid en biomassa van macrobenthos in blok 5 tussen 11 en 24 maart 1981.

Tabel 5.4 Veranderingen in de dichtheid en biomassa van macrobenthos in blok 10 tussen 10 en 24 maart 1981.

Tabel 5.5 Groei en overleving van Zeeduizendpoten Nereis diversicolor gedurende twee weken in maart 1981, gemeten in twee blokken van het proefvlak in het noordelijke deel van het estuarium van Sidi Moussa. De berekeningen zijn uitgevoerd volgens de methoden van Crisp (1971).

Tabel 5.6 Dichtheid en biomassa van macrobenthos in het middelste gedeelte van het estuarium van Sidi Moussa. De dichtheden zijn gemiddelden van de resultaten van tien monsternemingen.

Tabel 5.7 Dichtheid en biomassa van macrobenthos op de zandplaat nabij de monding van het estuarium van Sidi Moussa. De plaat is licht begroeid (ca. 10% bedekking) met Zeegras Zostera spec. De dichtheden zijn gemiddelden van de resultaten van 12 monsters.

Tabel 5.8 Dichtheid en biomassa van enkele ongewervelden die tussen de Zeegrasbladen leven op een voor 90% met Zeegras bedekt gedeelte van de zandplaat bij de monding van het estuarium van Sidi Moussa. De aantallen werden gevonden door de van 0,5 m^2 verwijderde zeegrasbegroeiing uit te zoeken.

Tabel 5.9 Dichtheid en biomassa van macrobenthos op twee plaatsen in de Merja Zerga op 1 april 1981. Van beide plaatsen zijn de gemiddelden gegeven van de resultaten van tien monsters.

Figuur 5.1 De plaats van 10 (20 x 20 m) blokken in het 0,4 ha grote proefvlak in het noordelijke gedeelte van het estuarium van Sidi Moussa (zie fig. 3.3).

Figuur 5.2 Procentuele bedekkingen door water, kaal wad, zeegras en zeesla van de 20 x 20 m blokken van het proefvlak in het noordelijke gedeelte van het estuarium van Sidi Moussa.

Figuur 5.3 Totale biomassa in g.AFDW.m^{-2} (cijfers) en procentuele bijdragen aan die biomassa van verschillende macrobenthische soorten of soortgroepen (kolommen) in de 10 blokken van het proefvlak (fig. 5.1). Het aantal monsters per blok bedraagt 8-16.

Figuur 5.4 Verdeling van de groottes van Abra tenuis in de 10 blokken van het proefvlak, Sidi Moussa, 20-24 maart 1981.

Figuur 5.5 Verdeling van de groottes van Scrobicularia cottardi in de 10 blokken van het proefvlak, Sidi Moussa, 20-24 maart 1981.

Figuur 5.6 Verdeling van de lengtes van Zeeduizendpoten N. diversicolor in de blokken 5 en 10 van het proefvlak op 10/11 en 24 maart 1981.
Figuur 5.7 Relatieve frekwentieverdeling van de groottes van Platte Slijkgapers Scrobicularia plana in de Merja Zerga, 1 april 1981.

6 OPMERKINGEN OVER HET VANGEN VAN STELTLOPERS

In 26 nachten werden 652 steltlopers gevangen. De meeste vogels werden gevangen in de eerste 10 nachten. Dit was de periode rond nieuwe maan, die bovendien gepaard ging met hoge vloedstanden (figuur 6.1). Tijdens deze hoge vloedstanden waren er voor de vogels in het getijdengebied minder mogelijkheden om een hoogwaterrustplaats te vinden dan tijdens lagere vloedstanden. Hierdoor kwamen meer vogels het niet-getijdengebied (de zoutpannen) binnen. In dit gebied waren de mistnetten opgesteld (figuur 3.3).
De meeste nachten werden 20 mistnetten van 12 m gebruikt. De netten geplaatst in het zeewaterbasin vlak voor het kamp werden tijdens de vangperiode slechts eenmaal over een korte afstand verplaatst. De netten in de zoutpannen werden regelmatig verplaatst. Appendix 3 geeft een gedetailleerd overzicht van de aantallen gevangen steltlopers per dag voor de verschillende soorten.
Een overzicht van de door ons gecontroleerde, eerder geringde, vogels wordt gegeven in tabel 6.2. Behalve steltlopers werden ook nog 200 zangvogels gevangen. Deze werden geringd en gewogen. De resultaten zijn in Hoofdstuk 10 opgenomen. Het vangen van de zangvogels gebeurde in de struiken rond het kamp. Een aantal van de hier opgestelde netten werd ernstig beschadigd door grazend vee.

Tabel 6.1 Aantallen gevangen steltlopers te Sidi Moussa, maart 1981. De aantallen zijn onderverdeeld in nieuw door ons geringde, gecontroleerde en door ons geringde én teruggevangen dieren.
Tabel 6.2 Lijst van steltlopers gecontroleerd tijdens de N.M.E. 1981. Alle vogels werden gecontroleerd te Sidi Moussa, El Jadida, Marokko (32.50 N, 08.46 W). Leeftijd (age) wordt gegeven met de Euring code.
Figuur 6.1 Aantallen gevangen steltlopers in maart 1981 in relatie tot de hoeveelheid maanlicht (de maanstand) en de waterstand tijdens hoogwater. Zie voor nadere informatie over waterstanden ook tabel 3.1

7 STELTLOPERONDERZOEK

7.2 Methode

Tussen 1 en 26 maart is vijfmaal tijdens hoogwater het aantal watervogels in het studiegebied geteld. De resultaten van deze tellingen zijn samengevat in Appendix 1. De resultaten van aanvullende tellingen in een zoutpannengebied ongeveer 1 km ten noorden van het studiegebied en in Merja Zerga staan in Appendix 2.

Met mistnetten konden 631 steltlopers worden gevangen (Appendix 3). Van deze vogels werden biometrische gegevens verzameld en zij werden gemerkt met een verfstof en een vlaggetje van gekleurd plakband rond de aluminium ring. Om de drie dagen werd de kleurencombinatie van verfstof en plakband veranderd, zodat bij waarneming van een gemerkte vogel in het veld duidelijk was in welke periode deze was gemerkt.

Tegelijk met de tellingen werd steekproefsgewijs de fractie gemerkte vogels in het gebied bepaald. Door combinatie van dit gegeven met de telresultaten en het aantal gemerkte vogels dat was losgelaten kon worden berekend hoeveel vogels het gebied in de voorafgaande periode hadden verlaten en hoeveel nieuwe er waren bijgekomen.

Om een indruk te krijgen van de conditie waarin de vogels verkeerden, werd van een klein aantal gestorven vogels in het laboratorium het vetgehalte bepaald. De foerageeractiviteit, voedselkeus en voedselopname van steltlopers werd op vijf dagen tijdens laagwater gemeten in een proefvlak van 0,4 ha in het noordelijke deel van de getijdenzone (zie figuur 3.3).

7.3 Bontbekplevier

Het aantal Bontbekplevieren daalde van 372 op 1 maart tot 258 op 26 maart (figuur 7.3). Van de vogels die gedurende de eerste week van maart werden gemerkt, was op 9 maart reeds een aanzienlijk deel verdwenen (figuur 7.4), waaruit geconcludeerd kon worden dat er in die periode veel vogels wegtrokken. Tegelijkertijd moet er ook aankomst van nieuwe vogels hebben plaatsgevonden aangezien het totale aantal Bontbekplevieren in die periode slechts weinig afnam (figuur 7.4). Figuur 7.5 geeft de berekende intensiteit van wegtrek en aankomst gedurende de periodes tussen de tellingen. Hieruit werd berekend dat tussen 1 en 26 maart naar schatting 250 vogels in het gebied aankwamen, terwijl ongeveer 350 vogels het gebied weer verlieten. In totaal maakten in

die periode zo'n 625 Bontbekplevieren gebruik van het gebied.

Er werden 41 Bontbekplevieren gevangen. Adulte vogels waren gemiddeld 3 gram zwaarder dan juveniele exemplaren (tabel 7.6). De gewichtsafname na het vangen bedroeg gemiddeld $0,5$ g.hr^{-1}. Eén Bontbekplevier was reeds geringd en wel in hetzelfde gebied in september 1980 door een expeditie van de universiteit van Durham. Deze vogel woog toen 65 gram en in maart nog slechts 47 gram!

Twee dode vogels, een juveniel mannetje en een juveniel vrouwtje, hadden slechts weinig reservevet; respectievelijk $2,7$ en $0,8$ gram. Veel Bontbekplevieren verdedigden tijdens laagwater een voedselterritorium. Het voedsel bestond voor een deel uit Zeeduizendpoten Nereis diversicolor en voor de rest uit onbekende kleine prooidieren. In het proefvlak bedroeg de gemiddelde dichtheid tijdens laagwater 26 vogels per ha, terwijl 95% van de tijd foura-gerend werd doorgebracht (figuur 7.9).

7.4 Strandplevier

Het aantal Strandplevieren schommelde rond 200 exemplaren (figuur 7.10). Enkele vogels verdedigden reeds een broedterritorium op de dijken tussen de zoutpannen. Er konden geen berekeningen van de doortrek worden uitgevoerd omdat slechts 15 vogels werden gemerkt. Gemiddeld waren de door ons gevangen vogels iets groter, maar niet zwaarder dan de Strandplevieren die in augustus-september op dezelfde plaats werden gevangen (tabel 7.10). De gewichtsafname na het vangen bedroeg gemiddeld $0,3$ g.hr^{-1} (figuur 7.11). Het vetgehalte van drie dode mannetjes was zeer laag: gemiddeld 0.8 gram met een maximum van 1.1 gram.

7.5 Zilverplevier

Tussen 1 en 26 maart steeg het aantal Zilverplevieren van 242 tot 661 exemplaren (figuur 7.12). Er moeten dus honderden vogels uit zuidelijker gelegen overwinteringsgebieden zijn aangekomen. Helaas werden slechts 5 Zilverplevieren gevangen, zodat het niet mogelijk is om nauwkeurige berekeningen over het aantal doortrekkende vogels uit te voeren. Tabel 7.12 geeft afmetingen en gewichten van de gevangen vogels. Twee van deze vogels die enige uren in gevangenschap verbleven, namen gemiddeld $1,4$ g.hr^{-1} in gewicht af (figuur 7.13). De gegevens met betrekking tot foerageeractiviteit en

voedselopname worden uitgebreid besproken in hoofdstuk 8.

7.6 Kanoetstrandloper

Tijdens hoogwater werden slechts kleine aantallen geteld (figuur 7.14). Soms echter werden tijdens laagwater grotere aantallen waargenomen waardoor het aannemelijk lijkt dat de aantallen tijdens hoogwater enigszins zijn onderschat. Er werden slechts vijf Kanoetstrandlopers gemerkt, zodat geen berekeningen over de doortrek konden worden uitgevoerd.

Tabel 7.14 geeft afmetingen en gewichten van de gevangen vogels. De gewichten in maart zijn aanzienlijk hoger dan die van vogels die in augustus-september tijdens de herfsttrek in Marokko zijn gevangen (juvenielen 99,9 gram, S.E. = 0,8 gram, n = 140 en adulten 123,6 gram, S.E. = 3,4 gram, n = 5; Pienkowski 1975). De gewichtsafname van twee vogels die enige uren in gevangenschap werden gehouden bedroeg gemiddeld 0,9 $g.hr^{-1}$ (figuur 7.15).

7.7 Kleine Strandloper

Het aantal Kleine Strandlopers was aan sterke schommelingen onderhevig (figuur 7.16). Hoewel 23 vogels konden worden gemerkt, werd tijdens de steekproeven slechts éénmaal een gemerkte Kleine Strandloper waargenomen. Dit wijst erop dat deze vogels slechts korte tijd in dit gebied verblijven.

Afmetingen en gewichten van de gevangen vogels worden gegeven in Tabel 7.16. Gemiddeld waren de in maart gevangen Kleine Strandlopers 3 gram lichter dan de vogels die in september 1980 in hetzelfde gebied waren gevangen (Moser 1981). Figuur 7.17 geeft de gewichtsafname van 12 vogels die enige uren in gevangenschap verbleven. De gemiddelde gewichtsafname bedroeg 0,2 $g.hr^{-1}$. Het vetgehalte van drie dode mannetjes was zeer laag; gemiddeld 0,9 gram, maximum 1,3 gram.

7.8 Krombekstrandloper

Tijdens de tellingen werden slechts weinig Krombekstrandlopers waargenomen (figuur 7.18). Het is mogelijk dat de aantallen enigszins zijn onderschat, omdat kleine aantallen Krombekstrandlopers in gemengde groepen met vooral Bonte Strandlopers Calidris alpina gemakkelijk over het hoofd worden gezien. In ieder geval zijn de aantallen tijdens de herfsttrek belangrijk hoger; in augustus-september werden in dit gebied vele honderden exemplaren geteld (Pienkowski 1972 & 1975). Gegevens uit Tunesië wijzen er echter op dat de

voorjaarstrek van deze soort pas na half april goed op gang komt (Johnson & Hafner 1972). Elf vogels werden gemerkt, waarvan slechts een enkeling werd waargenomen tijdens de steekproeven (tabel 7.17). Dit suggereert dat de eerste vogels het gebied reeds verlieten. Andere vogels echter bleven de gehele maand pleisteren getuige de waarneming op 27 maart van een Krombekstrandloper die tussen 1 en 3 maart was gemerkt.

Tabel 7.18 geeft de gemiddelde afmetingen en gewichten van de gevangen vogels. Het gemiddelde gewicht van deze vogels was 15% lager dan dat van vogels die hier in september 1980 werden gevangen (Moser 1981). De gewichtsafname na het vangen bedroeg gemiddeld 0,4 $g.hr^{-1}$ (figuur 7.19). Eén Krombekstrandloper, geringd op 3 maart, werd op 15 maart teruggevangen; in deze periode nam het gewicht van de vogel toe van 49 naar 56 gram, een toename van gemiddeld 0,5 gram per dag. Een juveniel vrouwtje, met een versgewicht van 55 gram, had een vetgehalte van 3,3 gram.

7.9 Bonte Strandloper

Het aantal Bonte Strandlopers nam geleidelijk af van 2821 exemplaren op 1 maart tot 1188 exemplaren op 26 maart (figuur 7.20). 352 vogels werden gemerkt. Gedurende de gehele periode vond wegtrek plaats, maar aankomst van nieuwe vogels was geconcentreerd in de periode van 1 tot 9 maart en 22 tot 26 maart (figuur 7.22). Volgens onze berekeningen arriveerden er in totaal 1817 Bonte Strandlopers in het gebied. Opgeteld bij de 2821 exemplaren die op 1 maart reeds aanwezig waren levert dit een aantal van ongeveer 4650 vogels die tussen 1 en 26 maart van het gebied gebruik maakten. Er werden 14 Bonte Strandlopers gevangen die in september 1980 in hetzelfde gebied waren geringd door een expeditie van de universiteit van Durham. Al deze vogels werden voor 9 maart gevangen (tabel 7.21) en vertegenwoordigden 4.3% van de vangst. Als van de 2821 vogels die op 1 maart aanwezig waren ook 4,3% geringd was, dan betekent dit dat ongeveer 121 in september geringde vogels op dat moment nog aanwezig waren. Dit is 33% van het aantal Bonte Strandlopers dat in september 1980 werd geringd. We veronderstellen dat deze vogels in dit gebied hebben overwinterd.

Gebruikmakend van de frequentieverdeling van de snavellengte van adulte Bonte Strandlopers (figuur 7.23 en 7.24) werd op twee manieren berekend in welke verhouding de kleinere ondersoort *Calidris alpina schinzii* en de grotere ondersoort *Calidris alpina alpina* in de populatie voorkwamen.

Beide schattingen kwamen erop neer dat ongeveer 50% van de adulte vogels tot schinzii behoorde en de andere helft tot alpina. Figuur 7.28 geeft de frequentieverdeling van het gewicht van de gevangen vogels. Adulte vogels waren gemiddeld 3,4 gram zwaarder dan juvenielen ($t = 4,8$, $p < 0.01$, tabel 7.26). Van de vogels die hier zowel in september 1980 als in maart 1981 werden gevangen, was het grootste deel in maart lichter dan in september (figuur 7.29). De snelheid van gewichtsafname in gevangenschap was afhankelijk van de duur dat de vogels werden vastgehouden (figuur 7.31). Vogels die slechts enkele uren in gevangenschap verbleven verloren gemiddeld 0,6 $g.hr^{-1}$, terwijl vogels die meer dan 10 uur gevangen werden gehouden afnamen met gemiddeld 0,4 $g.hr^{-1}$. Tabel 7.27 laat bovendien zien dat zware vogels meer gewicht verliezen dan lichte vogels.

Bonte Strandlopers met een lichaamsgewicht lager dan 36 gram bleken vrijwel geen reservevet bij zich te dragen (figuur 7.32). Mogelijk hadden deze lichte vogels zelfs een deel van hun spierweefsel als brandstof verbruikt, aangezien hun borstspier-index (drooggewicht van de borstspier gerelateerd aan de grootte van het borstbeen, zie Evans & Smith 1975) lager was dan dat van hun zwaardere soortgenoten, respectievelijk 0,176 $\pm$ S.D. 0,022 ($n = 4$) en 0,223 $\pm$ S.D. 0,035 ($n = 12$). Gewichtsverschillen tussen vogels zwaarder dan 40 gram worden grotendeels veroorzaakt door verschillen in vetinhoud (figuur 7.32).

Af en toe werd waargenomen dat een Bonte Strandloper een Zeeduizendpoot Nereis diversicolor at, maar meestal bestond het voedsel uit kleine niet determineerbare prooidieren. Soms werden ook de restanten gegeten die Steenlopers achterlieten in door hen gevonden en geopende Kokkels Cerastoderma edule. De gemiddelde dichtheid tijdens laagwater in het proefvlak bedroeg 103 vogels per ha. Gemiddeld werd 89% van de tijd gefourageerd (figuur 7.33).

7.10 Rosse Grutto

Er werden slechts kleine aantallen Rosse Grutto's waargenomen (figuur 7.34). Geen enkele vogel kon worden gevangen omdat ze tijdens hoogwater niet naar de zoutpannen kwamen. In het proefvlak werden vrijwel uitsluitend Zeeduizendpoten gegeten. De dichtheid van de Rosse Grutto's varieerde hier van 8 vogels per ha omstreeks het tijdstip van laagwater tot 11 vogels per ha tijdens opkomend en afgaand water (figuur 7.35). Gemiddeld werd 97% van de tijd gefourageerd.

7.11 Tureluur

Het aantal Tureluurs varieerde van 300 tot 500 exemplaren (figuur 7.36). Op grond van de steekproeven van gemerkte vogels kon worden berekend dat tussen 1 en 26 maart 188 vogels in het gebied aankwamen. Opgeteld bij de 505 vogels die op 1 maart reeds aanwezig waren, maakt dit dat gedurende die periode zo'n 700 Tureluurs van het gebied gebruik maakten. Er werden 6 Tureluurs gevangen die in september 1980 in hetzelfde gebied geringd waren door de expeditie van de universiteit van Durham. Vijf van deze vogels werden gevangen tussen 1 en 5 maart en vormden 12% van het aantal gevangen Tureluurs. Als dit percentage representatief is voor de gehele populatie op dat moment, zou dit betekenen dat op 1 maart ongeveer 60 geringde Tureluurs in het gebied aanwezig waren. Aangezien er in september 1980 in totaal 66 exemplaren werden geringd, wijst dit erop dat de in september aanwezige vogels hier overwinteren en dit gebied in de loop van maart weer verlaten. De vleugellengtes van de door ons gevangen vogels komen overeen met die van broedvogels uit Friesland. Dit, en de vangst van een Tureluur die tijdens het broedseizoen in Denemarken was geringd, doet vermoeden dat de in Noordwest Marokko overwinterende Tureluurs hun broedgebied hebben rond de Oostzee en het oostelijke deel van de Noordzee.

De gewichten in maart waren gemiddeld iets lager dan die in augustus-september. Vogels die door ons tweemaal werden gevangen, vertoonden in de eerste helft van maart een gewichtsafname, maar later in maart was er sprake van een toename (figuur 7.42). Gemiddeld namen Tureluurs in gevangenschap 0,6 $g.hr^{-1}$ in gewicht af (figuur 7.43). De gewichtsafname van relatief zware Tureluurs was sterker dan die van lichte vogels (tabel 7.32). Vogels met een lichaamsgewicht lager dan 90 gram hadden geen reservevet en waarschijnlijk hadden zij ook een deel van hun spierweefsel als brandstof verbruikt (figuur 7.44).

Een deel van de vogels verdedigde een voedselterritorium. Tot de prooi-dieren behoorden het wadslakje Peringia ulvae, kleine schelpdieren (waar-schijnlijk Abra tenuis), en kleine visjes. De dichtheid in het proefvlak bedroeg gemiddeld 6 vogels per ha, terwijl 87% van de tijd fouragerend werd doorgebracht.

7.12 Steenloper

Het aantal Steenlopers varieerde tussen 150 en 240 exemplaren (figuur 7.46). Tabel 7.35 geeft gemiddelde afmetingen en gewichten van de 8 gevangen Steenlopers. Tot de waargenomen prooien behoorden de Kokkel Cerastoderma edule, Zeeduizendpoot Nereis diversicolor, Strandkrab Carcinus maenas en kleine niet geïdentificeerde prooidieren. Enkele malen werd waargenomen dat Steenlopers die zojuist een Kokkel hadden gevonden en geopend door een Zilverplevier werden verjaagd, waarna deze laatste de inhoud van de Kokkel verorberde.

Tabel 7.1 Kleurencombinatie van verfstof en plastic vlaggetje die op verschillende dagen zijn toegepast.

Tabel 7.2 Aantallen steltlopers die in verschillende periodes werden gemerkt.

Tabel 7.3 Gewichtscriteria ter onderscheid van relatief zware en relatief lichte vogels.

Tabel 7.4 Resultaten van de steekproeven ter bepaling van het aantal gemerkte Bontbekplevieren in het gebied.

Tabel 7.5 Het aantal zware en lichte Bontbekplevieren gemerkt tussen 1 en 9 maart en waargenomen tussen 9 en 26 maart.

Tabel 7.6 Gemiddelde lengte van vleugel, snavel en kop plus snavel en het gemiddelde gewicht van de gevangen Bontbekplevieren.

Tabel 7.7 Het gemiddelde gewicht van Bontbekplevieren tijdens verschillende stadia van de rui van lichaamsveren. Ruiende Bontbekplevieren zijn significant zwaarder dan niet-ruiende vogels.

Tabel 7.8 Resultaten van de steekproeven ter bepaling van het aantal gemerkte Strandplevieren in het gebied.

Tabel 7.9 Gemiddelde lengte van vleugel, snavel en kop plus snavel en het gemiddelde gewicht van de gevangen Strandplevieren.

Tabel 7.10 Gemiddelde afmetingen en gewichten van Strandplevieren gevangen in Marokko tijdens de herfsttrek (Pienkowski 1972 & 1975 en Moser 1981), tijdens de voorjaarstrek (dit verslag) en in het late najaar in Mauretanië (Dick 1975).

Figuur 7.1 Duurzaamheid van de verfstof methyl-violet op het verenkleed van steltlopers. Vogels waarbij de verfstof was verdwenen konden worden herkend aan het vlaggetje van plastic plakband rond de aluminium ring.

Figuur 7.2 Prooidieren van steltlopers in het getijdengebied van Sidi Moussa. De prooien zijn op schaal getekend, de snavellengte van de Zilverplevier is ongeveer 3 cm.

Figuur 7.3 Aantallen Bontbekplevieren geteld in het onderzoekgebied. Zwarte punten geven het totale aantal, open rondjes het aantal dat in de zoutpannen verbleef.

Figuur 7.4 Het totale aantal Bontbekplevieren in het onderzoekgebied (zwarte punten) en het aantal vogels dat reeds op 1 maart aanwezig was en hier nog steeds verbleef.

Figuur 7.5 Aankomst en wegtrek (aantallen per dag) van Bontbekplevieren gedurende de periodes tussen de tellingen in maart 1981.

Figuur 7.6 Frequentieverdeling van de vleugellengtes van de Bontbekplevieren in Sidi Moussa in maart 1981.

Figuur 7.7 Frequentieverdeling van de snavellengtes en de lengtes van kop plus snavel van de Bontbekplevieren in Sidi Moussa in maart 1981.

Figuur 7.8 Gewichtsafname van Bontbekplevieren na de vangst. Zwarte punten zijn juveniele, open rondjes adulte vogels.

Figuur 7.9 Aantal, dichtheid en percentage fouragerende Bontbekplevieren tijdens laagwater in een proefvlak van 0,4 ha. Verticale strepen geven 1 standaard-deviatie rond het gemiddelde.

Figuur 7.10 Aantallen Strandplevieren geteld in het onderzoekgebied . Zwarte punten geven het totale aantal, open rondjes het aantal dat in de zoutpannen verbleef.

Figuur 7.11 Gewichtsafname van Strandplevieren na de vangst.

Figuur 7.12 Aantallen Zilverplevieren geteld in het onderzoekgebied . Zwarte punten geven het totale aantal, open rondjes het aantal dat in de zoutpannen verbleef.

Figuur 7.13 Gewichtsafname van Zilverplevieren na de vangst.

Figuur 7.14 Aantallen Kanoetstrandlopers geteld in het onderzoekgebied . Zwarte punten geven het totale aantal, open rondjes het aantal dat in de zoutpannen verbleef.

Figuur 7.15 Gewichtsafname van Kanoetstrandlopers na de vangst.

Figuur 7.16 Aantallen Kleine Strandlopers geteld in het onderzoekgebied . Alle vogels verbleven tijdens hoogwater in de zoutpannen.

Figuur 7.17 Gewichtsafname van Kleine Strandlopers na de vangst.

Figuur 7.18 Aantallen Krombekstrandlopers geteld in het onderzoekgebied . Zwarte punten geven het totale aantal, open rondjes het aantal dat in de zoutpannen verbleef.

Figuur 7.19 Gewichtsafname van Krombekstrandlopers na de vangst.

Figuur 7.20 Aantallen Bonte Strandlopers geteld in het onderzoekgebied . Zwarte punten geven het totale aantal, open rondjes het aantal dat in de zoutpannen verbleef.

Figuur 7.21 Het totale aantal Bonte Strandlopers in het onderzoekgebied (zwarte punten) en het aantal vogels dat reeds op 1 maart aanwezig was en hier nog steeds verbleef (open rondjes).

Figuur 7.22 Aankomst en wegtrek (aantallen per dag) van Bonte Strandlopers gedurende de periodes tussen de tellingen in maart 1981.

Figuur 7.23 Frequentieverdelingen van vleugellengte, snavellengte en de lengte van kop plus snavel van de Bonte Strandlopers in Sidi Moussa in maart 1981.

Figuur 7.24 Relatieve cumulatieve frequentieverdeling van de snavellengtes van adulte Bonte Strandlopers in Sidi Moussa in maart 1981.

Figuur 7.25 Relatieve cumulatieve frequentieverdeling van de snavellengtes van juveniele Bonte Strandlopers in Sidi Moussa in maart 1981.

Figuur 7.26 Theoretische frequentieverdeling van de snavellengte van twee ondersoorten van de Bonte Strandloper (zie de tekst).
A: Calidris alpina schinzii, B: Calidris alpina alpina.

Figuur 7.27 Verandering van de vleugellengte van juveniele Bonte Strandlopers die zowel in september 1980 als in maart 1981 werden gevangen.

Figuur 7.28 Frequentieverdeling van de gewichten van Bonte Strandlopers gevangen in Sidi Moussa in maart 1981.

Figuur 7.29 Gewichtsverandering van Bonte Strandlopers die zowel in september 1980 als in maart 1981 werden gevangen.

Figuur 7.30 Gewichtsafname van Bonte Strandlopers na de vangst. De doorgetrokken lijn geeft de lineaire regressie door alle gegevens ($y = 0,3x + 1.1$, $r^2 = 0,38$, $n = 176$). De onderbroken lijn verbindt de gemiddelden van iedere periode van twee uur.

Figuur 7.31 Gewichtsverlies ($g.hr^{-1}$) van Bonte Strandlopers na de vangst.

Figuur 7.32 Het verband tussen vetgehalte en versgewicht van een aantal Bonte Strandlopers die in maart in Sidi Moussa werden gevangen.

Figuur 7.33 Aantal, dichtheid en het percentage fouragerende Bonte Strandlopers tijdens laagwater in een proefvlak van 0,4 ha.

Figuur 7.34 Aantallen Rosse Grutto's geteld in het onderzoekgebied.

Figuur 7.35 Aantal, dichtheid en het percentage fouragerende Rosse Grutto's tijdens laagwater in een proefvlak van 0,4 ha.

Figuur 7.36 Aantallen Tureluurs geteld in het onderzoeksgebied. Zwarte punten geven het totale aantal, open rondjes het aantal dat in de zoutpannen verbleef.

Figuur 7.37 Het totale aantal Tureluurs in het onderzoeksgebied (zwarte punten) en het aantal vogels dat reeds op 1 maart aanwezig was en hier nog steeds verbleef (open rondjes).

Figuur 7.38 Aankomst en wegtrek (aantallen per dag) van Tureluurs in de periodes tussen de tellingen in maart 1981.

Figuur 7.39 Frequentieverdeling van de vleugellengte van Tureluurs in Sidi Moussa in maart 1981.

Figuur 7.40 Frequentieverdelingen van de nalospi-lengte (dit is de kortste afstand tussen neus en snavelpunt), snavellengte en de lengte van kop plus snavel van Tureluurs in Sidi Moussa in maart 1981.

7.41 Frequentieverdeling van de gewichten van Tureluurs in Sidi Moussa in maart 1981.

Figuur 7.42 Gewichtsverandering van Tureluurs die in maart 1981 tweemaal werden gevangen. Onderbroken lijnen geven de gewichtsafname na de vangst en de daaropvolgende toename.

Figuur 7.43 Gewichtsafname van Tureluurs na de vangst.

Figuur 7.44 Verband tussen het versgewicht van Tureluurs en het vetgehalte en de spierindex. De spierindex is het quotiënt van het vetvrij drooggewicht van beide borstspieren en het standaardspiervolume berekend volgens de methode van Evans & Smith (1975). De lijnen zijn op het oog getrokken.

Figuur 7.45 Aantal, dichtheid en het percentage fouragerende Tureluurs tijdens laagwater in een proefvlak van 0,4 ha.

Figuur 7.46 Aantal Steenlopers geteld in het onderzoekgebied..

8 FOERAGEERGEDRAG VAN ZILVERPLEVIEREN

Bij Sidi Moussa zijn Zilverplevieren Pluvialis squatarola territoriaal: elk individu verdedigt een vast stukje wad tegen soortgenoten om er alleen te kunnen foerageren. Het verdedigen van een voedselterritorium (grensincident) bestaat uit een geritualiseerd gedrag waarbij beide betrokken vogels "typische" houdingen aannemen. Slechts in een minderheid van de grensincidenten komt het tot een geëscaleerd vechten (pikken en slaan met de vleugels). Het bleek

mogelijk te zijn om alle Zilverplevieren die foerageerden op en rond ons proefvlak in het noordelijk deel van het estuarium, individueel te herkennen. Dit maakte het ons mogelijk om een individu, dat we Corrie doopten (overigens is het geslacht onbekend!), gedurende de laagwaterperiodes van een tiental achtereenvolgende dagen vrijwel continu te volgen. Tijdens de waarnemingen (figuur 8.1) werden, per minuut, de aktiviteit, het aantal pikken, het aantal en het soort prooien, de plaats van voorkomen en de interacties met buren, bijgehouden. Deze metingen verschaften ons informatie over plaats- en tijdsbesteding en prooikeus van Zilverplevieren tijdens de voorjaars-doortrekperiode in het estuarium van Sidi Moussa. In dit verslag presenteren we alleen de nauwelijks geïnterpreteerde basisinformatie.

Tijdens laagwater foerageerden Zilverplevieren in dichtheden van ca. tien vogels per ha (figuur 8.2). Het proefvlak bedekte (delen van) de territoria van negen Zilverplevieren (figuur 8.3). De gemiddelde grootte van de territoria bedroeg 641 m^2. Figuur 8.4 laat zien dat Corrie ongeveer de helft van "haar" tijd doorbracht in blok 2 waarbinnen blokje 2.3 (figuur 8.5) duidelijk favoriet was. In de loop van de tien waarnemingsdagen ging Corrie meer en meer in het noordelijke deel van het territorium foerageren, wat "ze" mogelijk zelfs uitbreidde en waar steeds meer grensincidenten plaatsvonden (figuur 8.6). Het grootste deel van haar tijd (90%) besteedde Corrie aan foerageren en de rest vooral aan territoriaal gedrag en poetsen. Tabel 8.2 laat duidelijk zien dat de Zilverplevieren bij Sidi Moussa voornamelijk Zeeduizendpoten (N. diversicolor) en Strandkrabben (C. maenas) aten. Het feit dat Zilverplevieren die hoogst waarschijnlijk op doortrek zijn en daarom relatief kort in het gebied verblijven, toch voedselterritoria vestigen, zou een aanwijzing kunnen zijn voor het idee dat ook op korte termijn het bezit van een voedselterritorium belangrijke voordelen heeft.

Tabel 8.1 Tijdbudget van Zilverplevier Corrie tijdens laagwater op tien dagen in maart 1981 in het getijdengebied bij Sidi Moussa. De tijd besteed aan verschillende aktiviteiten (resp. foerageren, territoriaal gedrag, poetsen, slapen en vliegen) wordt gegeven als percentage van het totale aantal waarnemingsminuten op een dag.

Tabel 8.2 Voedselkeus van Zilverplevieren in het getijdengebied bij Sidi Moussa in maart 1981.

Figuur 8.1 Perioden, gedurende tien dagen in maart 1981, waarin de Zilverplevier Corrie werd gevolgd. Zwarte balken geven de waarnemingsperioden aan en het gestippelde gebied geeft de perioden aan waarbij het voedselterritorium (gedeeltelijk) onder water staat.

Figuur 8.2 Aantallen, foerageerpercentages en dichtheden (vogels per ha) van Zilverplevieren op het 0,4 ha grote proefvlak, in de loop van een gemiddelde laagwaterperiode.
Figuur 8.3 Kaart van de voedselterritoria van Zilverplevieren op en rond het proefvlak. Het gestippeld aangegeven gebied is het territorium van Corrie. Met nummers staat tevens aangegeven hoe wij een fijnschalige gebiedsverdeling benoemden.
Figuur 8.4 Plaatsbesteding van Corrie op negen achtereenvolgende dagen in maart 1981. Dag 1 is 13 maart 1981. De percentages van de totale waarnemingstijd die Corrie doorbracht in de verschillende blokken op de verschillende dagen worden gegeven.
Figuur 8.5 Percentages van de tijd die Corrie gedurende negen dagen in maart 1981 doorbracht in verschillende (10 x 10 m) blokjes. Het relatieve aandeel zwart binnen een blok is recht evenredig met het percentage van de tijd die Corrie in dat blok doorbracht. Dit percentage wordt ook nog eens gegeven in de rechterbovenhoek van het blok.
Figuur 8.6 Plaats van de grensincidenten van Corrie en "haar" buren op tien dagen in maart 1981. De cijfers geven de data in maart aan.

9 ZOET- EN BRAKWATERFAUNA VAN SIDI MOUSSA

Een eigenaardigheid van het studiegebied bij Sidi Moussa is dat we binnen een kleine oppervlakte een grote verscheidenheid van zoutgehaltes vinden in de aanwezige sloten en plassen (tabel 9.1). Op vier plaatsen (figuur 9.1) zijn met schepnetten en grondboren monsters genomen om een indruk te krijgen van de diersoorten die deze sloten en plasjes bevolken.

Soortenlijsten worden, afzonderlijk voor de vier gebiedjes, gegeven. Er werden geen opmerkelijke soorten gevonden: het blijkt dat we met een typische Palearctisch-Mediterrane brakwaterfauna te maken hebben. In de brakke sloot langs de zoutpannen bevond zich een dikke laag draadalgen waarin grote aantallen mollusken (de Brakwaterkokkel Cerastoderma glaucum, een endemische slijkgaper Scrobicularia cottardi en een brakwaterhorentje Hydrobia ventrosa) leefden. Niet het sediment van de bodem, maar de laag draadalgen vormde het substraat waarin ze leefden. In de literatuur wordt dit een semi-pelagische leefwijze genoemd. In de bodem van deze sloot troffen we muggelarven (Chironomidae) aan. De zoutpannen worden bevolkt door grote aantallen Chironomidelarven .

Tabel 9.1 Concentraties van chloride- en calciumionen in enkele sloten en plasjes bij Sidi Moussa. De plaatsen waar de (water-)monsters zijn genomen staan in figuur 9.1.
De chemische bepalingen werden verricht door het Institut Scientifique te Rabat.

Figuur 9.1 Kaartje van het noordelijke deel van het studiegebied bij Sidi Moussa. Zie figuur 3.3 voor een legenda. De getallen geven de vier monsterplaatsen aan.

10 AVIFAUNA

Dyed and marked Dunlin.

1 INTRODUCTION

Au cours de ces dernières années les zones intertidales le long des côtes européennes ont souvent été étudiées du point de vue de leur importance pour les limicoles. Ce qui a suscité l'intérêt de ces problèmes, c'est surtout le développement rapide (projeté) de ces zones, tel que la réalisation de polders et l'industrialisation. Une fois ces projets réalisés, en effet, les terrains de gagnage, déja rarissimes, des limicoles se perdront à jamais ou se détérioront ce qui résultera en une menace sérieuse à l'existence même de plus d'une espèce de limicole.

Il est difficile de recueillir des renseignements sur l'importance des zones intertidales le long des côtes de l'Afrique occidentale, aussi est-il presque impossible d'en disposer. Néanmoins, les résultats de baguage démontrent nettement que beaucoup de limicoles, de passage en Europe occidentale, hivernent en Afrique occidentale. Pour cette raison même il est extrêmement important de connaître ces zones afin de pouvoir bien gérer et protéger les populations de limicoles en question.

Bienqu'il fût connu que beaucoup de limicoles hivernent sur la côte du Maroc et y sont de passage en automne, aucun renseignement n'était disponible sur l'effectif de limicoles visitant ces zones pendant la migration printanière. Bref, nous avons essayé de combler cette lacune.

Trois millions de limicoles au moins hivernent dans les zones côtières au sud du Sahara, dont deux millions au Banc d'Arguin en Mauritanie et le reste autour l'Archipel Bijagos en Guinée-Bissau. La nourriture des limicoles se compose d'animaux invertébrés vivant dans les vasières et ayant plus d'un macrobenthos est minime au Banc d'Arguin, comparée aux quantités disponibles dans la mer des "Wadden" néerlandaise p.e. Nous avons essayé de repondre à la question de savoir comment les limicoles réussisent à survoler un trajet aussi long -depuis l'Afrique occidentale jusqu'à l'Europe occidentale- vu leur réserve d'aliments relativement petit. Une possibilité est selon nous que les limicoles, en route pour les régions de reproduction arctiques, font (obligatoirement) escale au Maroc p.e., afin de fourrager et d'engraisser ("pour faire le plein") avant de (pouvoir) s'envoler vers les haltes suivants en Europe tels que la mer des "Wadden". Ceci impliquerait que les zones intertidales le long de la côte atlantique du Maroc forment des relais indispensables pour des milliers de limicoles hivernant plus vers le sud!

Ce sont les Anglais qui ont découvert plus tôt que le petit estuaire de Sidi Moussa et la zone de poêles à sel contiguë offre des possibilités

magnifiques de capturer des limicoles au moyen de filets ultra-fins. Vue l'étendue relativement petite de cette aire (de 7 km à 0.5 km) il est possible de recenser en peu de temps l'effectif de limicoles présents. Ces circonstances nous permettraient de capturer pas mal de limicoles, de les marquer, de faire régulièrement des recensements et d'enregistrer ainsi à quelle vitesse les limicoles "passent" à travers la zone. En extrapolant les résultats des recherches faites dans notre aire, nous pourrions en venir à une valorisation de l'importance de toute la côte atlantique du Maroc pour les limicoles pendant leur migration printanière.

Jusqu'ici nous ne disposions que de peu de renseignements - et qualitatifs seulement - sur la quantité de nourriture (la biomasse macrobenthique) pour les limicoles dans les vasières du Maroc. Pour avoir une impression de la qualité des zones de passage nous avons fait des recherches sur la quantité et sur la sorte de nourriture disponible dans les vasières près de Sidi Moussa, où les limicoles vont en fourrage.

Voilà nos raisons pour organiser "l'Expedition néerlandaise au Maroc 1981", le désir d'aggrandir nos connaissances des pays africains et des limicoles s'y ajoute naturellement. Dans ce compte-rendu nous avons essayé de présenter méthodiquement bienque souvent provisoirement les données recueillies. Nous avons l'intention de publier les données interprêtées avec les résultats d'une expédition ultérieure: "l'Expédition néerlandaise du Limicole au Maroc 1982", effectuée près de Sidi Moussa en mars-avril 1982.

Pour terminer nous tenons à mentionner le fait que les spécialistes taxonomiques du Musée Zoologique d'Amsterdam ont trouvé une espèce non-décrite jusqu'ici dans la matière prélevée par nous près de Sidi Moussa. Ils ont baptisé cet animal Monodanthura maroccana.

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Finalement nous tenons à témoigner notre reconnaissance envers le RIN pour la publication de ce compte-rendu dans la série de rapports de cet institut.

3 DESCRIPTION DE L'AIRE ÉTUDIÉE

Sur la côte atlantique on trouve, sur une distance de 60 km entre El Jadida et Oualidia (Figure 3.1), quelques longues zones humides (Figure 3.2), séparées de l'océan par une rangée de dunes qui est ancrée dans le sol rocheux (Figure 3.4). Des falaises et d'étroites plages blanches s'y alternent. A deux endroits, près de Sidi Moussa au nord et à Oualidia au sud, la mer a percé à travers cette rangée créant ainsi des zones intertidales entre la côte et l'arrière-pays plus élevé. Les parties nord de ces zones, c.à.d. les parties les plus éloignées de l'embouchure, ont été cultivées: on y a construit des poêles à sel. L'aire de recherches près de Sidi Moussa (Figure 3.3) se compose d'une zone intertidale longue de trois km environ avec des terres vaseuses et d'une série de poêles à sel longue de quatre km environ. Du côté de la terre les poêles à sel sont bordées d'un fossé d'eau douce (fort probablement alimenté par l'eau d'une source venue de terres plus élevées) qui verse sans arrêt son eau dans la zone intertidale. Dans cette zone, par conséquent, on trouve en allant du nord au sud des salinités différentes: de l'eau saumâtre d'abord, puis de l'eau de plus en plus salée, ce qui fait que nous pouvons parler ici d'un vrai (petit) estuaire. La zone en question avec ses terres vaseuses est exploitée intensivement: les indigènes y ramassent des plantes (les utilisant soit comme nourriture pour les animaux soit, après séchage, comme combustibles) et puis des ânes, des vaches et trois dromadaires y vont en pâturage. A marée basse 15 à 30 femmes y cherchent des

mollusques comestibles. Quelques hommes âgés se postant sur les falaises y pêchent et parfois pendant les fins de semaines des sportifs allogènes y vont à la chasse aux limicoles et aux canards. Ici et là on rencontre des touristes qui prennent un bain de soleil sur les plages magnifiques. Sur les terres plus élevées, argileuses, le long des vasières, on cultive des tomates et dans les dunes il y a quelques champs de blé arides.

La Merja Zerga (Figure 3.7) est une grande crique peu profonde, vaseuse, qui se remplit et se vide au gré des marées. Elle reçoit de l'eau douce (surtout en hiver) d'un canal - au sud - et d'une petite rivière - au nord-est. En 1978 la Merja Zerga a été déclarée "Parc National", de sorte que la chasse aux oiseaux de mer (autrefois très intensive) a pris fin. En plus on a nommé des gardiens à présent.

Tableau 3.1 L'horaire pronostiquée des marées hautes et basses pour Casablanca.
Figure 3.1 Carte du Maroc. Nous avons indiqué les zones humides les plus importantes, le long de la côte atlantique.
Figure 3.2 Carte de la zone côtière atlantique entre Sidi Moussa et Oualidia.
Figure 3.3 Carte de l'aire de nos recherches près de Sidi Moussa.
Figure 3.4 Coupe schématique de la côte près de Sidi Moussa. Façant le sud: le côté gauche de la figure est à l'est, le côté droit est à l'ouest.
Figure 3.5 Fluctuations annuelles dans les températures d'eau à marée basse aux deux stations scientifiques dans l'estuaire d'Oualidia (données recueillis en 1970; d'après Beaubrun 1976a).
Figure 3.6 Fluctuations quotidiennes dans les températures des vasières dans l'aire de recherches dans la partie nord de l'estuaire près de Sidi Moussa. La température de la vasière a été prise à 2 à 3 cm sous la surface. Les données ont été recueillies du 12 au 21 mars '81.
Figure 3.7 Carte de la Merja Zerga.

4 L'HISTOIRE DU VOYAGE

5 LES RECHERCHES SUR LA MACROFAUNE BENTIQUE

Nous désignons par " macrofaune bentique" les animaux invertébrés, vivant dans et sur les vasières et ayant plus d'un millimètre de longueur. Ces animaux forment la nourriture principale des limicoles et c'est pour cette raison surtout que nous nous y intéressons. Nous avons rassemblé des données sur cette macrofaune bentique pour les deux raisons suivantes:

1. Pour déterminer les densités des proies et les poids de celles-ci afin de pouvoir étudier corrélativement les facteurs qui déterminent la dispersion des limicoles sur la vasière et, en même temps, pour pouvoir faire des calculs de la quantité de nourriture avalée par les limicoles.
2. Pour étudier de plus près s'il est question d'un équilibre entre la production de nourriture et la consommation simultanée par les limicoles ou, au contraire, s'il est question d'un épuisement graduel des provisions pendant la période de passage printanier.

Dans ce compte-rendu nous essayons de déterminer les données de base concernant la macrofaune bentique dans l'estuaire de Sidi Moussa. En plus nous présentons les résultats des échantillonnages effectués dans deux endroits de la Merja Zerga. La biomasse macrobentique était au plus grand dans la partie nord de l'estuaire de Sidi Moussa, probablement la partie dont l'eau est la plus saumâtre (21 grammes le mètre carré - Poids Secs Sans Cendre (AFDW-abréviation anglaise)) et allait en diminuant vers le sud, plus proche de l'embouchure (resp. 15 g et 1 à 8 g.AFDW.m^{-2} à mi-chemin de l'estuaire et près de l'embouchure).

En mesurant les polychètes Nereis diversicolor, une des espèces les plus importantes ici, nous avons pu constater que, malgré la croissance relativement rapide de ces animaux pendant la période de nos recherches, la pression prédatrice par les limicoles entre autres, était plus grande que cette rapidité de croissance. Dans la Merja Zerga nous avons trouvé des biomasses macrobentiques de 20 et de 25 g.AFDW.m^{-2}. Cette biomasse se composait presque uniquement de mollusques bivalves.

Tableau 5.1 La présence d'animaux invertébrés macrobentiques à différents endroits dans les zones intertidales le long de la côte marocaine.

Tableau 5.2 La densité et la biomasse d'organismes macrobentiques sur la vasière dans la partie nord de l'estuaire de Sidi Moussa. Nous présentons les moyennes et les déviations-standard des résultats pour les dix carrés de l'aire de nos recherches (voir Figure 5.1). Le nombre total des échantillons (de 1/120 m^2 à une profondeur de 25 cm) sur lequel nous avons calculé les moyennes s'élève à 116. Des mollusques Peringia ulvae n'ont été comptés que dans 81 échantillons seulement.

Tableau 5.3 Changements dans la densité et dans la biomasse de macrobenthos au carré 5, entre le 11 et le 24 mars 1981.

Tableau 5.4 Changements dans la densité et dans la biomasse de macrobenthos au carré 10, entre le 10 et le 24 mars 1981.

Tableau 5.5 Croissance et survie des polychètes Nereis diversicolor pendant deux semaines en mars 1981, mesurées dans deux carrés différents de l'aire de recherches dans la partie nord de l'estuaire de Sidi Moussa. Les calculs ont été faits d'après les méthodes de Crisp (1971).

Tableau 5.6 La densité et la biomasse de macrobenthos dans la partie centrale de l'estuaire de Sidi Moussa. Les densités sont les moyennes des résultats de dix échantillonnages.

Tableau 5.7 La densité et la biomasse de macrobenthos sur le banc de sable près de l'embouchure de l'estuaire de Sidi Moussa. Ce banc est peu couvert (pour 10% environ) de zostères Zostera spec. Les densités sont les moyennes des résultats de douze échantillonnages.

Tableau 5.8 La densité et la biomasse de quelques animaux invertébrés vivant entre les feuilles des zostères sur une partie, dont 90% couvert de zostères, du banc de sable près de l'embouchure de l'estuaire de Sidi Moussa. Ces chiffres ont été obtenus en fouillant la végétation d'un fragment de 0,5 m^2.

Tableau 5.9 La densité et la biomasse de macrobenthos à deux endroits dans la Merja Zerga, le 1^{er} avril '81. Des deux endroits nous donnons les moyennes des résultats de dix échantillonnages.

Figure 5.1 La situation des dix carrés (20 m x 20 m) dans l'aire de recherches, grande de 0,4 hectare, dans la partie nord de l'estuaire de Sidi Moussa (voir Figure 3.3).

Figure 5.2 Les pourcentages de recouvrements par l'eau, par la vasière nue, par les zostères et par les algues Ulva lactuca des carrés de 20 m x 20 m de l'aire de Sidi Moussa.

Figure 5.3 La biomasse totale en g.AFDW.m^{-2} (les chiffres) et les pourcentages de la contribution à cette biomasse par les espèces ou groupes d'espèces macrobentiques différents (les colonnes) dans les dix carrés de l'aire de recherches (Figure 5.1). Le nombre d'échantillonnages s'élève à 8-16 par carré.

Figure 5.4 Répartition des tailles des Abra tenuis dans les dix carrés de l'aire de recherches, Sidi Moussa, le 20-24 mars 1981.

Figure 5.5 Répartition des tailles Scrobicularia cottardi dans les dix carrés de l'aire de recherches, Sidi Moussa, le 20-24 mars 1981.

Figure 5.6 Répartition des tailles des polychètes Nereis diversicolor dans les carrés 5 et 10 de l'aire de recherches, Sidi Moussa, le 10/11 et le 24 mars 1981.

Figure 5.7 Répartition de fréquence relative des tailles des Scrobicularia plana dans la Merja Zerga, le 1^{er} avril '81.

6 REMARQUES SUR LA CAPTURE DES LIMICOLES

Nous avons capturé 652 limicoles au cours de 26 nuits. La plupart de ces oiseaux ont été capturés pendant les dix premières nuits: c´etait une période de nouvelle lune, période en outre pendant laquelle la marée haute atteignait des niveaux extrêmes (Figure 6.1). Pendant ces marées "très" hautes les oiseaux avaient moins de chances de trouver un refuge dans la zone intertidale que pendant les marées "moins" hautes. Par conséquent, beaucoup plus d'oiseaux entraient dans la zone non-intertidale (les poêles à sel). Aussi avions-nous tendu nos filets ultra-fins dans cette zone (Figure 3.3). Le plus souvent nous avons utilisé 20 filets de 12 m. Ces filets, placés dans le bassin d'eau de mer juste devant le camp, n'ont été déplacés qu'une fois pendant la période des captures, et seulement sur une courte distance. Les filets dans les poêles à sel ont été déplacés régulièrement. L'appendixe 3 donne un aperçu détaillé de l'effectif de limicoles capturés par jour, avec l'indication des différentes espèces. Un aperçu des oiseaux contrôlés par nous, bagués antérieurement, est donné au Tableau 6.2. Outre des limicoles nous avons capturé 200 Passeriformes, que nous avons bagués et pesés. Les résultats se retrouvent au chapitre 10. Ces Passeriformes ont été capturés dans les buissons autour du camp. Un certain nombre de filets placés ici a été endommagé sérieusement par le bétail en pâturage.

Tableau 6.1 L'effectif de limicoles capturés à Sidi Moussa en mars '81. Nous avons fait une subdivision dans ces nombres: il y a des oiseaux que nous avons bagués, des oiseaux que nous avons contrôlés et des oiseaux que nous avons bagués et re-capturés.

Tableau 6.2 Liste des limicoles contrôlés pendant l'"Expédition Néerlandaise au Maroc 1981". Tous les oiseaux ont été contrôlés à Sidi Moussa, à El Jadida au Maroc (32.50 N., 08.46 0.). Nous donnons l'âge (age) en "Euringcode".

Figure 6.1 L'effectif de limicoles capturés en mars 1981 par rapport à la quantité de clarté lunaire (la phase de la lune) et le niveau d'eau à marée haute. Au Tableau 3.1 vous trouverez de plus amples informations sur les niveaux d'eau.

7 RECHERCHES SUR LES LIMICOLES

7.2 La méthode

Entre le 1er et le 26 mars l'effectif des oiseaux aquatiques présents dans l'aire de recherches a été recensé cinq fois à marée haute. Les résultats de ces recensements sont résumés dans l'Appendice 1. Les résultats des recensements supplémentaires effectués dans une zone de poêles à sel à 1 km environ au nord de notre aire de recherches et dans la Merja Zerga se trouvent dans l'Appendice 2. A l'aide de filets ultrafins nous avons su attraper 631 limicoles (voir l'Appendice 3), dont nous avons recuelli les données biométriques, et puis nous les avons marqués d'une peinture et d'un petit drapeau fait d'un adhésif coloré, attaché autour de la bague aluminée. Tous les trois jours nous changions la combinaison chromatique de la peinture et de l'adhésif de sorte que, repérant un oiseau marqué dans l'aire de recherches, il était facile de dire quand celui-ci avait été marqué.

En même temps que les recensements nous avons déterminé par sondages la fraction d'oiseaux marqués. En combinant cette donnée avec les résultats des recensements et avec le nombre d'oiseaux marqués relâchés nous avons pu calculer combien d'oiseaux avaient quitté la zone pendant la periode précédente et combien de "nouveaux" s'y étaient présentés.

Pour avoir une impression de la condition physique des oiseaux la teneur en graisse de quelques exemplaires a été déterminée au laboratoire. Pendant cinq jours, à marée basse, nous avons enregistré l'activité fourragière, le choix de nourriture et l'ingestion de la nourriture; ceci dans un champ d'expérimentation de 0,4 hectare dans la partie nord de la zone intertidale (voir Figure 3.3).

7.3 Le Grand Gravelot

L'effectif des Grands Gravelots diminuait de 372 le 1er mars à 258 le 26 mars (Figure 7.3). Une partie considérable des oiseaux marqués pendant la première semaine du mois de mars avait déja disparu le 9 mars (Figure 7.4), ce qui amène à la conclusion que pendant cette période beaucoup d'oiseaux partaient. En même temps de nouveaux oiseaux doivent être arrivés vu le nombre total de Grands Gravelots qui ne diminuait que légèrement (Figure 7.4). La Figure 7.5 donne l'intensité supputée de départs et d'arrivées pendant les périodes entre les recensements. A partir de ces données nous avons

calculé qu'entre le 1er et le 26 mars un nombre estimé de 250 oiseaux est arrivé dans la zone, tandis que 350 oiseaux l'ont quittée à leur tour. Pendant la période nommée ci-dessus quelque 625 Grand Gravelots en tout ont visité la zone.

41 Grands Gravelots ont été capturés. Les oiseaux adultes pesaient en moyenne 3 grammes de plus que les juvéniles (Tableau 7.6). La perte de poids après la capture était de 0,5 $g.hr^{-1}$ en moyenne. Un seul Grand Gravelot avait été bagué déja: dans la même zone en septembre 1980 par une expédition de l'Université de Durham. Cet oiseau pesait alors 65 grammes, en mars 47 g seulement.

Deux oiseaux morts, un mâle et une femelle, juvéniles tous les deux, n'avaient que peu de graisse de réserve: respectivement 2,7 et 0,8 g. Beaucoup de Grands Gravelots défendaient un territoire de gagnage à marée basse. La nourriture consistait partiellement en Nereis diversicolor et d'autre part en petites proies animales inconnues. Dans le champ d'expérimentation la densité moyenne à marée basse était de 26 oiseaux par hectare, pour 95% du temps ils étaient occupés à fourrager (Figure 7.9).

7.4 Le Gravelot à collier interrompu

L'effectif des Gravelots à collier interrompu tournait autour de 200 (Figure 7.10). Quelques-uns des oiseaux défendaient déjà un territoire de reproduction sur les digues entre les poêles à sel. Il était impossible de faire des calculs sur la migration parce que 15 oiseaux seulement ont été marqués. En moyenne les oiseaux capturés par nous étaient un peu plus grands, mais non pas plus lourds que les Gravelots capturés au même endroit en août-septembre (Tableau 7.10). La perte de poids après la capture était de 0,3 $g.hr^{-1}$ en moyenne (Figure 7.11). La teneur en graisse de trois mâles morts était minime: 0,8 g en moyenne (1,1 g au maximum).

7.5 Le Pluvier argenté

Entre le 1er et le 26 mars l'effectif des Pluviers argentés augmentait de 242 à 661 (Figure 7.12). Par conséquent des centaines d'oiseaux doivent être arrivés des zones d'hivernage situées plus vers le sud. Malheureusement nous n'avons capturé que 5 Pluviers argentés de sorte qu'il nous est impossible de faire calculs précis sur le nombre d'oiseaux en migration. Le Tableau 7.12 donne les tailles et les poids des oiseaux capturés.

Deux d'entre eux vivant en captivité pendant quelques heures perdaient 1,4 $g.hr^{-1}$ en moyenne (Figure 7.13). Au chapitre 8 nous discuterons amplement des données sur l'activité fourragière et l'ingestion de la nourriture des Pluviers argentés.

7.6 Le Bécasseau maubèche

A marée haute de petits nombres seulement ont été comptés (Figure 7.14). Pourtant à marée basse nous avons enrégistré parfois des nombres plus élévés, aussi pourrait-on admettre que les effectifs à marée haute sont quelque peu sous-estimée. 5 Bécasseaux maubèches seulement ont été marqués, de sorte qu'il nous était impossible de faire des calculs sur leur migration.

Le Tableau 7.14 donne les tailles et les poids des oiseaux capturés. Les poids enrégistrés en mars sont considérablement plus élevés que ceux des oiseaux capturés au Maroc en août-septembre pendant la migration automnale (les juvéniles 99,9 g, S.E. = 0,8 g, n = 140 et les adultes 123,6 g, S.E. = 3,4 g, n = 5; Pienkowski 1975). La perte de poids de deux oiseaux tenus en captivité pendant quelques heures était de 0,9 $g.hr^{-1}$ en moyenne (Figure 7.15).

7.7 Le Bécasseau minute

L'effectif des Bécasseaux minutes variait énormément (Figure 7.16). 23 oiseaux ont bien été marqués, mais pendant les sondages nous n'avons vu qu'une seule fois un Bécasseau minute marqué. Ceci indique que ces oiseaux ne font qu'un bref séjour dans la zone.

Les tailles et les poids des oiseaux capturés sont donnés au Tableau 7.16. En moyenne les Bécasseaux minutes capturés en mars pèsent 3 g de moins que les oiseaux capturés en septembre 1980 dans la même zone (Moser 1981). La Figure 7.17 donne la perte de poids de douze oiseaux tenus captifs pendant quelques heures. La perte de poids était de 0,2 $g.hr^{-1}$ en moyenne. La teneur en graisse de trois mâles morts était minime: 0,9 g en moyenne (1,3 g au maximum).

7.8 Le Bécasseau cocorli

Lors des recensements nous n'avons repéré que peu de Bécasseaux cocorlis (Figure 7.18). Il se peut que les nombres soient quelque peu sousestimés, parce qu'on laisse échapper facilement les petits nombres de Bécasseaux cocorlis dans les groupes mélangés surtout avec des Bécasseaux variables *Calidris alpina*. En tout cas,le nombre est nettement plus élevé pendant

la migration automnale: en août-septembre des centaines d'exemplaires ont été comptées dans la même zone (Pienkowski 1972 & 1975). Les données obtenues de la Tunisie n'indiquent pourtant un démarrage de la migration printanière de l'espèce en question qu'après la mi-avril (Johnson & Hafner 1972). 11 oiseaux ont été marqués, dont un ou deux seulement a été retrouvé pendant les sondages (Tableau 7.17). Ceci fait penser que les premiers-venus quittaient la zone déjà. D'autres oiseaux y faisaient halte pendant tout le mois, d'après le repérage du 27 mars d'un Bécasseau cocorli marqué entre le 1er et le 3 mars. Le Tableau 7.18 donne les tailles et les poids moyens des oiseaux capturés. Le poids de ces oiseaux était en moyenne 15% de moins que celui des oiseaux capturés ici en septembre 1980 (Moser 1981). La perte de poids après la capture était de 0,4 $g.hr^{-1}$ en moyenne (Figure 7.19). Un seul Bécasseau cocorli, bagué le 3 mars, a été re-capturé - le 15 mars; entretemps le poids de l'oiseau avait augmenté de 49 g à 56 g, une augmentation de 0,5 g par jour en moyenne. Une femelle juvénile, pesant 55 g à la capture, avait une teneur en graisse de 3,3 g.

7.9 Le Bécasseau variable

L'effectif des Bécasseaux variables diminuait peu à peu de 2821 exemplaires comptés le 1er mars à 1188 exemplaires le 26 mars (Figure 7.20). 352 oiseaux ont été marqués. Pendant toute la période il y avait des départs, mais l'arrivée de nouveaux oiseaux s'est concentrée aux périodes du 1er au mars et du 22 au 26 mars (Figure 7.22). D'après nos calculs 1817 Bécasseaux variables en tout sont arrivés dans la zone. Ajoutés aux 2821 exemplaires déjà présents le 1er mars nous en arrivons à quelques 4650 oiseaux qui ont visité la zone entre le 1er et le 26 mars. Nous avons capturé 14 Bécasseaux variables qui avaient été bagués en septembre 1980 dans la même zone par une expédition de l'Université de Durham. Tous ces oiseaux ont été capturés avant le 9 mars (Tableau 7.21) et représentaient 4,3% de la capture. Si 4,3% des 2821 oiseaux présents le 1er mars étaient bagués aussi, quelques 121 oiseaux bagués en septembre étaient toujours présents à ce moment-là, c'à.d. 33% de l'effectif des Bécasseaux variables bagués en septembre 1980. Nous supposons que ces oiseaux aient hiverné dans cette zone.

Utilisant la répartition de fréquence de la longueur du bec des Bécasseaux adultes (Figures 7.23 & 7.24) nous avons calculé de deux façons sous

quel rapport les deux sous-espèces (Calidris alpina schinzii, qui est relativement petit, et Calidris alpina alpina, qui est plus grand) étaient représentées dans la population. Les deux estimations donnent comme résultats que 50% environ des oiseaux adultes appartenaient à la sous-espèce des schinzii, l'autre moitiée à celle des alpina. La Figure 7.28 donne la répartition de fréquence du poids des oiseaux capturés. Les oiseaux adultes pesaient 3.4 g en moyenne de plus que les juvéniles ($t = 4.8$, $p = 0.01$, Tableau 7.26). La plupart des oiseaux capturés ici en septembre 1980 aussi bien qu'en mars 1981, pesaient moins en mars qu'en septembre (Figure 7.29). La rapidité de la perte de poids lors d'une captivité dépendait de la durée de cette captivité (Figure 7.31). Les oiseaux tenus captifs pendant quelques heures seulement perdaient 0.6 $g.hr^{-1}$ en moyenne, tandis que les oiseaux emprisonnés pendant plus de 10 heures perdaient 0.4 $g.hr^{-1}$ en moyenne. Le Tableau 7.27 montre en plus que les oiseaux lourds perdent plus que les oiseaux légers.

Les Bécasseaux variables pesant moins que 36 g s'avéraient n'avoir point de graisse de réserve (Figure 7.32). Il est probable que ces oiseaux légers avaient utilisé comme combustibles même une partie de leur tissu musculaire, vu le fait que leur indice pectoral (le poids sec du muscle pectoral par rapport à la taille du sternum, voir Evans & Smith 1975) était plus bas que celui de leurs congénères plus lourds, respectivement 0.176 $\pm$ S.D. 0.022 ($n = 4$) et 0.223 $\pm$ S.D. 0.035 ($n = 12$). Les différences en poids entre les oiseaux plus lourds que 40 g sont le plus souvent causées par les différences en teneur en graisse (Figure 7.32).

De temps en temps nous avons vu un Bécasseau variable mangeant un Nereis diversicolor, mais dans la plupart des cas la nourriture se composait de petites proies animales non-déterminables. Parfois aussi ils mangeaient les restes laissés par les Tournepierres à collier dans les coques Cerastoderma edule, que ceux-ci avaient trouvées et ouvertes. La densité moyenne à marée basse dans le champs d'expérimentation était de 103 oiseaux par hectare. A la marée montante cette densité arrivait à une valeur de 500 oiseaux par hectare. En moyenne pendant 89% du temps ils étaient occupé à fourrager (Figure 7.33).

7.10 La Barge rousse

Nous n'avons vu que peu de Barges rousses (Figure 7.34). Aucune Barge n'a pu être capturée parce qu'à marée haute elles ne venaient pas aux poêles à sel. Dans le champ d'expérimentation elles mangeaient presque uniquement

des Nereis diversicolor. La densité des Barges rousses variait ici de 8 oiseaux par hectare vers l'heure de la marée basse à 11 oiseaux à la marée montante et descendante (Figure 7.35). En moyenne pendant 97% du temps elles étaient occupées à fourrager.

7.11 Le Chevalier gambette

L'effectif des Chevaliers gambettes variait de 300 à 500 exemplaires (Figure 7.36). En nous basant sur les sondages d'oiseaux marqués nous avons pu estimer l'arrivée de 188 oiseaux dans la zone entre le 1er et le 26 mars. Ajoutés aux 505 oiseaux déjà présents le 1er mars, on en arrive à 700 Chevaliers gambettes qui ont visité la zone pendant cette période. Nous avons capturé 6 Chevaliers gambettes qui avaient déjà été bagués dans la même zone en septembre 1980 par l'expédition de l'Université de Durham. 5 d'entre eux ont été capturés entre le 1er et le 5 mars et ils représentaient 12% des Chevaliers gambettes capturés. Si ce pourcentage est représentatif de toute la population à ce moment-là, cela signifierait qu'il y avait environ 60 Chevaliers gambettes dans la zone. Attendu qu'en septembre 1980 66 exemplaires en tout avaient été bagués, ceci indique que les oiseaux présents en septembre hivernent ici et quittent la zone au cours du mois de mars. Les longueurs des ailes des oiseaux capturés par nous correspondaient à celles des oiseaux-couveurs de la Frise. Ceci, et la capture d'un Chevalier gambette bagué pendant la saison de reproduction au Danemark, fait penser que les Chevaliers gambettes hivernants au nord-est du Maroc ont leur zone de reproduction autour de la Mer Baltique et dans la partie est de la Mer du Nord.

Les poids enrégistrés en mars étaient un peu moins élevés en moyenne que ceux enrégistrés en août-septembre. Les oiseaux capturés deux fois par nous démontraient une perte de poids dans la première moitié de mars, mais à une date plus tardive en mars il était question d'une augmentation de poids (Figure 7.42). En moyenne les Chevaliers gambettes perdaient du poids (0,6 $g.hr^{-1}$) pendant leur captivité (Figure 7.43). La perte de poids des Chevaliers gambettes relativement lourds était plus prononcée que celle des oiseaux légers (Tableau 7.32). Les oiseaux pesants moins de 90 g n'avaient aucune réserve de graisse et probablement eux aussi avaient utilisé comme combustibles une partie de leur tissu musculaire (Figure 7.44). Une partie des oiseaux défendaient un terrain de gagnage. Parmi les

proies animales étaient le Peringia ulvae, de petits coquillages (probablement Abra tenuis) et de petits poissons. La densité dans le champs d'expérimentation était de 6 oiseaux par hectare en moyenne, tandis que 87% du temps étaient consacrés à fourrager.

7.12 Le Tournepierre à collier

L'effectif des Tournepierres à collier variait de 150 à 240 exemplaires (Figure 7.46). Le Tableau 7.35 donne les tailles et les poids moyens des 8 Tournepierres capturés. Parmi les proies étaient la coque Cerastoderma edule, le Nereis diversicolor, le Carcinus maenas et de petites proies animales non-identifiées. Plusieurs fois nous avons vu que les Tournepierres, venant de trouver et d'ouvrir une Cerastoderma edule, étaient chassés par un Pluvier argenté que ne tardait pas de consommer le contenu de la Cerastoderma edule.

Tableau 7.1 La combinaison chromatique de la peinture et du drapeau en plastique, appliquée pendant les jours successifs.

Tableau 7.2 L'effectif des limicoles marqués pendant les périodes différentes.

Tableau 7.3 Les critères pondéraux pour distinguer les oiseaux relativement lourds d'avec les oiseaux relativement légers.

Tableau 7.4 Les résultats des sondages pour déterminer l'effectif des Grands Gravelots marqués, présents dans la zone.

Tableau 7.5 L'effectif des Grands Gravelots lourds et légers marqués entre le 1er et le 9 mars et repérés entre le 9 et le 26 mars.

Tableau 7.6 La longueur moyenne des ailes, du bec et de bête plus le bec et le poids moyen des Grands Gravelots capturés.

Tableau 7.7 Le poids moyen des Grands Gravelots pendant les stades successifs de la mue. Les Grands Gravelots muants pèsent significativement plus que leurs congénères non-muants.

Tableau 7.8 Les résultats des sondages effectués pour déterminer l'effectif des Gravelots à collier interrompu marqués, présents dans la zone.

Figure 7.1 La durabilité de la peinture méthyl-violet appliquée au plumage des limicoles. Les oiseaux qui avaient "perdu" leur peinture étaient reconnaissables au drapeau adhésif en plastique attaché à la bague aluminée.

Figure 7.2 Les proies animales des limicoles dans la zone intertidale de Sidi Moussa. Les proies ont été dessinées à l'échelle; la longueur du bec du Pluvier argenté est de 3 cm environ.

Figure 7.3 L'effectif des Grands Gravelots recensés dans l'aire de recherches. Les points fermés indiquentle nombre total, les points ouverts le nombre d'oiseaux qui séjournaient dans les poêles à sel.

Figure 7.4 L'effectif total des Grands Gravelots dans l'aire de recherches (points fermés) et l'effectif des oiseaux présents de 1er mars et y séjournant encore (points ouverts).

Figure 7.5 L'arrivée et le départ des Grands Gravelots par jour pendant les périodes entre les recensements en mars 1981.

Figure 7.6 La répartition de fréquence des longueurs des ailes des Grands Gravelots à Sidi Moussa en mars 1981.

Figure 7.7 La répartition de fréquence des longueurs du bec et des longueurs de la tête plus le bec des Grands Gravelots à Sidi Moussa en mars 1981.

Figure 7.8 La perte de poids des Grands Gravelots après la capture. Les points fermés indiquent les oiseaux juvéniles, les points ouverts les adultes.

Figure 7.9 L'effectif, la densité et le pourcentage de Grands Gravelots fourrageant à marée basse dans un champ d'expérimentation de 0,4 hectare. Les traits verticaux indiquent une déviation-standard autour de la moyenne.

Figure 7.10 L'effectif des Gravelots à collier interrompu recensés dans l'aire de recherches. Les points fermés indiquent le nombre total, les points ouverts indiquent le nombre d'oiseaux qui séjournaient dans les poêles à sel.

Figure 7.11 La perte de poids des Gravelots à collier interrompu après la capture.

Figure 7.12 L'effectif des Pluviers argentés recensés dans l'aire de recherches. Les points fermés indiquent le nombre total, les points ouverts le nombre d'oiseaux qui séjournaient dans les poêles à sel.

Figure 7.13 La perte de poids des Pluviers argentés après la capture.

Figure 7.14 L'effectif des Bécasseaux maubèches recensés dans l'aire de recherches. Les points fermés indiquent le nombre total, les points ouverts le nombre d'oiseaux qui séjournaient dans les poêles à sel.

Figure 7.15 La perte de poids des Bécasseaux maubèches après la capture.

Figure 7.16 L'effectif des Bécasseaux minutes recensés dans l'aire de recherches. Tous les oiseaux séjournaient dans les poêles à sel à marée haute.

Figure 7.17 La perte de poids des Bécasseaux minutes après la capture.

Figure 7.18 L'effectif des Bécasseaux cocorlis recensés dans l'aire de recherches. Les points fermés indiquent le nombre total, les points ouverts le nombre d'oiseaux qui séjournaient dans les poêles à sel.

Figure 7.19 La perte de poids des Bécasseaux cocorlis après la capture.

Figure 7.20 L'effectif des Bécasseaux variables recensés dans l'aire de recherches. Les points fermés indiquent le nombre total, les points ouverts indiquent le nombre d'oiseaux qui séjournaient dans les poêles à sel.

Figure 7.21 L'effectif total des Bécasseaux variables dans l'aire de recherches (points fermés) et le nombre d'oiseaux présents le 1er mars et y séjournant encore (points ouverts).

Figure 7.22 L'arrivée et le départ des Bécasseaux variables par jour pendant les périodes entre les recensements en mars 1981.

Figure 7.23 Les répartitions de fréquence de la longueur des ailes, du bec et de la tête plus le bec des Bécasseaux variables à Sidi Moussa en mars 1981.

Figure 7.24 La répartition, relative cumulative, de fréquence des longueurs du bec des Bécasseaux variables adultes à Sidi Moussa en mars 1981.

Figure 7.25 La répartition, relative cumulative, de fréquence des longueurs du bec des Bécasseaux variables juvéniles à Sidi Moussa en mars 1981.

Figure 7.26 La répartition de fréquence de la longueur du bec de deux sous-espèces du Bécasseau variable (voir le texte)
A: Calidris alpina schinzii, B: Calidris alpina alpina.

Figure 7.27 Le changement dans la longueur des ailes des Bécasseaux variables capturés aussi bien en septembre 1980 qu'en mars 1981.

Figure 7.28 La répartition de fréquence des poids des Bécasseaux variables capturés à Sidi Moussa en mars 1981.

Figure 7.29 Le changement de poids des Bécasseaux variables capturés aussi bien en septembre 1980 qu'en mars 1981.

Figure 7.30 La perte de poids des Bécasseaux variables après la capture. Le trait in-interrompu représente la régression linéaire, visible à travers toutes les données ($y = 0,3x + 1,1$; $r^2 = 0,38$; $n = 167$). Le trait interrompu lie les moyennes de chaque période de 2 heures.

Figure 7.31 La perte de poids ($g.hr^{-1}$) des Bécasseaux variables après la capture.

Figure 7.32 Le rapport entre la teneur en graisse et le poids frais de quelques Bécasseaux variables capturés à Sidi Moussa en mars 1981.

Figure 7.33 L'effectif, la densité et le pourcentage de Bécasseaux variables fourrageant à marée basse dans un champ d'expérimentation de 0.4 hectare.

Figure 7.34 L'effectif des Barges rousses recensées dans l'aire de recherches.

Figure 7.35 L'effectif, la densité et le pourcentage de Barges rousses fourrageant à marée basse dans un champ d'expérimentation de 0,4 hectare.

Figure 7.36 L'effectif des Chevaliers gambettes recensés dans l'aire de recherches. Les points fermés indiquent le nombre total, les points ouverts indiquent le nombre d'oiseaux qui séjournaient dans les poêles à sel.

Figure 7.37 L'effectif total des Chevaliers gambettes dans l'aire de recherches (points fermés) et le nombre d'oiseaux présents le 1er mars déjà et y séjournant encore (points ouverts).

Figure 7.38 L'arrivée et le départ (oiseaux par jour) des Chevaliers gambettes pendant les périodes entre les recensements en mars 1981.

Figure 7.39 La répartition de fréquence de la longueur des ailes des Chevaliers gambettes à Sidi Moussa en mars 1981.

Figure 7.40 Les répartitions de fréquence de la longueur "nalospi" (c.à.d. la distance la plus courte entre le nez et la pointe du bec),

la longueur du bec et de la longueur de la tête plus le bec des Chevaliers gambettes à Sidi Moussa en mars 1981.

Figure 7.41 La répartition de fréquence des poids des Chevaliers gambettes à Sidi Moussa en mars 1981.

Figure 7.42 Le changement de poids des Chevaliers gambettes capturés par deux fois en mars 1981. Les traits interrompus indiquent la perte de poids après la capture et l'augmentation (de poids) ultérieure.

Figure 7.43 La perte de poids des Chevaliers gambettes après la capture.

Figure 7.44 Le rapport entre le poids frais des Chevaliers gambettes et la teneur en graisse et l'indice musculaire. Cet indice est le quotient du poids sec sans graisse des deux pectoraux et le volume musculaire standard, calculé suivant la méthode d'Evans & Smith (1975). Les traits ont été dessinés "à main levée".

Figure 7.45 L'effectif, la densité et le pourcentage de Chevaliers gambettes fourrageant à marée basse dans un champ d'expérimentation de 0,4 hectare.

Figure 7.46 L'effectif des Tournepierres à collier recensés dans l'aire de de recherches.

8 LA CONDUITE FOURRAGIÈRE DES PLUVIERS ARGENTÉS

Près de Sidi Moussa les Pluviers argentés Pluvialis squatarola sont territoriaux. Chaque individu défend une partie déterminée et fixe de la vasière contre ses congénères pour pouvoir y fourrager seul. La défense d'un terrain de gagnage ("un différend de délimitation") consiste en un comportement ritualisé pendant lequel les deux oiseaux prennent une attitude typique. Ce n'est que dans très peu de cas que les oiseaux en arrivent à un combat réel (donner des coups de bec, frapper avec les ailes). Il s'est avéré possible de reconnaître individuellement tous les Pluviers argentés qui fourrageaient sur et autour de notre aire de recherches dans la partie nord de l'estuaire. Ceci nous a permis de suivre de façon à peu près continue un de ces individus, que nous avons baptisé "Corine" (bien que le sexe de la bête nous soit inconnu!), pendant les périodes de marée basse d'une dizaine de journées à la suite. Pendant les périodes d'observation (Figure 8.1)

nous avons noté minute par minute les activités de Corine, le nombre de tentatives d'attraper une proie, le nombre et l'espèce des proies, l'endroit où se déroulaient les "différends" avec les voisins. Ces notes nous informent sur l'emploi du temps, réparti dans les différents endroits de la vasière, et sur le choix des proies des Pluviers argentés pendant la période de passage printanier dans l'estuaire de Sidi Moussa. Dans ce compte-rendu nous ne présentons que l'information de base à peine interprêtée.
A marée basse les Pluviers argentés fourrageaient en densités de dix oiseaux par hectare (Figure 8.2). L'aire de nos recherches couvrait (des parties de) les territoires de neuf Pluviers argentés (Figure 8.3). La taille moyenne des territoires était de 641 m^2. Figure 8.3 démontre que Corine passait la moitié de son temps environ au carré 2, à l'intérieur duquel le sous-carré 2.3 était nettement favori. Au cours des dix journées d'observation, Corine allait de plus en plus en fourrage dans la partie nord de son territoire, qu'"elle" aggrandissait même probablement et où se déroulaient de plus en plus de "différends" (Figure 8.6). Corine employait la plupart de son temps (90%) à fourrager et le temps qui lui restait était consacré à la conduite territoriale et au nettoyage. Tableau 8.2 démontre nettement que les Pluviers argentés près de Sidi Moussa se nourrissent notamment de polychètes Nereis diversicolor et de crabes Carcinus maenas. Le fait que Pluviers argentés, qui sont fort probablement de passage, et pour cette raison même ne feront qu'un bref séjour dans cette zone, établisent cependant des terrains de gagnage, pourrait indiquer que la possession d'un tel territoire a des avantages importants.

Tableau 8.1 Le budget temporel du Pluvier argenté Corine, à marée basse, pendant dix journées en mars 1981 dans la zone intertidale près de Sidi Moussa. Nous présentons le temps consacré aux différentes activités (resp. fourrager, conduite territoriale, nettoyage, dormir et voler dans le ciel) comme pourcentage du nombre total de minutes d'observation en une journée.

Tableau 8.2 Le choix alimentaire des Pluviers argentés dans la zone intertidale près de Sidi Moussa en mars 1981.

Figure 8.1 Les périodes, au cours de dix journées en mars 1981, pendant lesquelles le Pluvier argenté Corine a été suivi. Les barres noires indiquent les périodes d'observation et la zone pointillée indique les périodes quand son terrain de gagnage se trouve (partiellement) sous l'eau.

Figure 8.2 L'effectif, les pourcentages de fourrages et les densités (oiseaux par hectare) des Pluviers argentés sur l'aire de recherches, grande

de 0.4 hectare, au cours d'une période moyenne de marée basse.
Figure 8.3 Le plan des terrains de gagnage des Pluviers argentés sur et autour de l'aire de recherches. La zone pointillée représente le territoire de Corine. Nous avons indiqué aussi, avec des numéros, comment nous avons fait une répartition de cette zone de façon plus détaillée.
Figure 8.4 L'usage que Corine a fait de son territoire au cours de neuf journées à la suite en mars 1981. Jour 1, c'est le 13 mars 1981. Nous donnons les pourcentages du temps total d'observation que Corine a passé dans les différents carrés pendant les journées successives.
Figure 8.5 Les pourcentages du temps que Corine a passé dans les différents carrés au cours de neuf journées en mars 1981. La partie relative noire à l'intérieur d'un carré est proportionnelle au pourcentage du temps que Corine a passé dans ce carré. Ce pourcentage est donné une deuxième fois dans l'angle, en haut à droite dans le carré.
Figure 8.6 Les endroits où les "différends" se sont produits entre Corine et ses voisins, au cours de dix journées en mars 1981. Les chiffres indiquent les dates en mars.

9 LA FAUNE D'EAU DOUCE ET D'EAU SAUMÂTRE À SIDI MOUSSA

Notre aire de recherches près de Sidi Moussa présente la particularité d'avoir une grande diversité de salinité dans les eaux stagnantes, sur une surface petite en dimensions (Tableau 9.1). A quatre endroits (Figure 9.1) nous avons pris des échantillons avec des trubles et au moyens de sondes pour avoir une impression des espèces qui peuplent les petits fossés et les étangs. Nous donnons les listes des espèces, pour les quatre minizones une liste chacune. Nous n'avons pas trouvé d'espèces remarquables: il se trouve que nous avons affaire à une faune typiquement paléarctique méditerranéenne, d'eau saumâtre. Dans le fossé d'eau saumâtre le long des poêles à sel il se trouvait une couche épaisse d'algues filamentaires dans laquelle vivaient de nombreux mollusques: les bivalves Cerastoderma glaucum et Scrobicularia cottardi, et le gastropode Hydrobia ventrosa. Ce n'était pas le sédiment du sol, mais la couche d'algues filamentaires qui formait le substrat dans lequel ils vivaient. Dans la littérature on appelle cela une façon de vivre "semi-pélagique". Dans le fond de ce fossé nous avons trouvé des larves de moustiques (Chironomidae). Les poêles à sel sont peuplées, elles aussi, de larves de Chironomides.

Tableau 9.1 Les concentrations d'ions de chloride et de calcium dans quelques-uns des fossés et des étangs près de Sidi Moussa. Les endroits où les échantillons (d'eau) ont été pris sont indiqués sous Figure 9.1. Les analyses chimiques ont été exécutées par l'Institut Scientifique de Rabat.

Figure 9.1 Le plan de la partie nord de l'aire de recherches près de Sidi Moussa. Voir Figure 3.3 pour une légende. Les chiffres indiquent les quatre endroits où les échantillons ont été pris.

10 L'AVIFAUNE

Sampling the study area in Sidi Moussa for marked birds.

من الملاحظ ان صنفي الحلازيات البحرية وذو هما مين يفرقان حجما نظيريهما بانك، دارڤال (هلونـــــدا) هناك عدد كبير من الطيور التي تأكل الكلـــــا من احواض الملـــح التي لا توفـــر لهـــم الاپڤروهات ذوات الجناحين من الحشـــرات (Chironomidae)

لاحظنا ان بعض الاصناف ظهرت بسلوك اقليميـــة في منطقة التموين الموجودة بالمواحـــل.

لسوحظت خفة وزن معظم هذه الطيور: حوالي 50% مجهلول متغير تزن اقل من 45 جرام . 525 طائرا لوحظت بطلاء ازرق وتاريخ الاسر موضوع فوق الركبة . لاحظنا كذلك نسبة من الطيور الملونة بسيدي موسى بعد الافراج عنها .

إذا اخذنا بعين الاعتبار نتائج الاحصاء يبدو ان معظم الطيور غادرت المنطقة وهذا يدل على الهجرة من الجنوب . بعض الطيور مكثت طويلا بنفس المكان والدليل على ذلك، وجود الاصناف المطلات والمختمة في 1 و 2 مارس قبل مغادرتنا سيدي موسى في اواخر شهر مارس .

قمنا بزيارتين للمرجة الزرقاء لنتاكد هل الطيور بسيدي موسى تحج الى مواحل مغربية اخرى نحو الشمال. في 14 و 15 مارس احصينا 3500 طائر (مجهلول متغير محشم من طرف الانجليزيين وواحد اخر ملون من طرفنا بسيدي موسى). في آخر مارس وفاتح ابريل احصينا 3706 طائر من بينها 2 جهلول متغير قدما من سيدي موسى.

غذاء وتموين الطيور المستنقعاتية

نتائج عينات الحيوانات اللافقرية الكبيرة Macrobenthos. القاطنة بقاع المواحل هي كالتالي:

كتلة الاحياء تتراوح ما بين 5جم / م^2 في الاساس الرملي جنوب ميدان البحث و 21جم /م^2 (الوزن الجاف بدون رماد) في الاساس الوحلي شمال المنطقة .

الفصيلات المهمة فيما يخص كتلة الاحياء والتغدية مكونة من:

صنف من الحلقات البحرية: **Nereis diversicolor**

صنف من ذي صماميين: **Cerastoderma edule**

صنف من معديات الارجل: **Peringiae ulvae**

الاحصاءات :

5 احصاءات اجريت بسيدي موسى واخرى بالمرجة الزرقاء. معظم الاصناف المحصات بسيدي موسى يشير عددها الى انخفاض بطيء ومتواصل ناتج عن هبوط المجمرع العام من 6100 في فاتح مارس الى 3700 في 26 مارس.

باستثناء **Calidris alpina** فان جميع فصيلات **Calidris** ظهرت باعداد ذات تغيرات غير منتظمة قد تكون ناتجة عن صعوبة تمييزها من بين جماعة **Calidris alpina, Charadrius hiaticula**.

الاسر:

ما يفوق 600 طائر أسرت قرب سيدي موسى. من بين 28 طائر مختم 21 منها ختمت في نفس المنطقة اثناء الخريف المنصرم من طرف البعثة الجامعية - دورهام بسيدي موسى.

معظم الطيور المحصات ختمت من طرف بعثات انجليزية عملت من قبل في نفس المكان خلال الهجرة الخريفية.

هذا لايؤكد ان هذه الطيور لم تغادر هذه المنطقة في فصل الشتاء او انها شتت في الجنوب لكن هذه الملاحظات تبرهن على وفاء كبير تجاه هذه المنطقة باستثناء وقت الحضن.

80% من هذه الطيور أسرت ما بين 1 و 12 مارس 115 طائرا أسرت ما بين 15 و 28 مارس وفي كلا الحالتين بذلنا نفس المجهودات. قد يكون العامل الاساسي في انخفاض عدد الاسرى خلال المدة الاخيرة هو ضوء القمر الذي كان كاملا ليلة 20 مارس.

ـ ملخص ـ

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علمنا بفضل نتائج البعثات الانجليزية خلال العشر سنوات الاخيرة (بينكو ڤسكي 1972و1975، موزبير 1981) أن المناطق الساحلية الغربية بالمغرب لها اهمية كبرى بالنسبة لفصيلات الطيور المستنقعاتية اثناء الهجرة الخريفية. غير اننا لانملك معلومات تتعلق بعدد هذه الطيور اثناء الهجرة الربيعية بنفس المناطق الساحلية المغربية.

قمنا بزيارة المواحل واحواض الملح قرب سيدي موسى (الجديدة) منذ فاتح مارس الى غاية 28 منه سنة 1981 لندرس هجرة هذه الطيور في فصل الربيع.

5 كلم هي طول ميدان البحث الواقع شمال مجموعة احواض الملح بسيدي موسى ـ الوالدية. خليج صغير قرب سيدي ابراهيم يمتلىء اثناء المد وبذلك يكون الحدود الجنوبية للميدان. اخترنا هذه المنطقة نظرا لسهولة مسالكها وانطباقها مع طريقة الاسر بواسطة الشباك الرقيقة.

الاهداف الرئيسية لبعثتنا هي:

1 ـ إحصاء دقيق لعدد الطيور المستنقعاتية داخل ميدان البحث حتى نسجل التغيرات الطارئة على الطيور الطائرة

2 ـ أسر ووضع علامة لاكبر عدد ممكن من الطيور قصد الحصول على مبحث تطبيق القواعد الاحصائية على الاحياء، على الوزن وعلى الانسلاخ.

3 ـ اخذ عينات دقيقة لعدد الطيور المهاجرة العابرة بميدان البحث اثناء إقامتنا.

4 ـ الحصول على المعلومات الخاصة بكمية المجموعات اللافقرية القاطنة بهذه المواحل واخذ نظرة عن غذاء وتموين الطيور المستنقعاتية في المنطقة الساحلية.

هجرة الطيور المستنقعاتية على طول الساحل الأطلسي المغربي في مارس 1981

LA MIGRATION DES LIMICOLES LE LONG DE LA COTE ATLANTIQUE DU MAROC EN MARS 1981

"تقرير البعثة" الطيراتية" الهولندية" بالمغرب في 1981

RAPPORT DE L'EXPEDITION ORNITHOLOGIQUE HOLLANDAISE AU MAROC - 1981

Marcel Kersten — مارسيل كيرستن
Theunis Piersma — تونيس بيرزما
Cor Smit — كور سميت
Piet Zegers — پيت زيكرز