University of Aberdeen

EXPEDITION SVALBARD 1987

FINAL REPORT

August 1988

Edited by

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". . . savage beares and hungrey foxes which are not only the civilest but also the onely inhabitants of that comfortlesse Countrey."

From the journal of the first explorers to winter on Spitsbergen, 1630.

Part 1

GENERAL REPORT

INTRODUCTION

Expedition Svalbard 1987 was a small biological expedition undertaken by five recent graduates of the University of Aberdeen during the summer of 1987. The main aim was to carry out a programme of scientific research along the coastline of Daudmannsøyra on the island of Spitsbergen, the largest island of the Svalbard group. A film was also made.

Planning started in April 1986, and led to the production of the expedition prospectus in November of that year. Approval was granted by the University of Aberdeen in December, when the expedition also won the B.P. Expedition Award for 1987. Further approval and support came from the British Ecological Society in February 1987, the Royal Geographical Society in March, and the Scott Polar Research Institute (via the Edward Wilson Memorial Fund) in April.

Fieldwork took place in July and August, when four weeks were spent in the study area. Although last minute changes in the main study were found to be necessary on arrival, this phase of the expedition was very successful, and a large amount of data was collected for subsequent analysis. A Preliminary Report

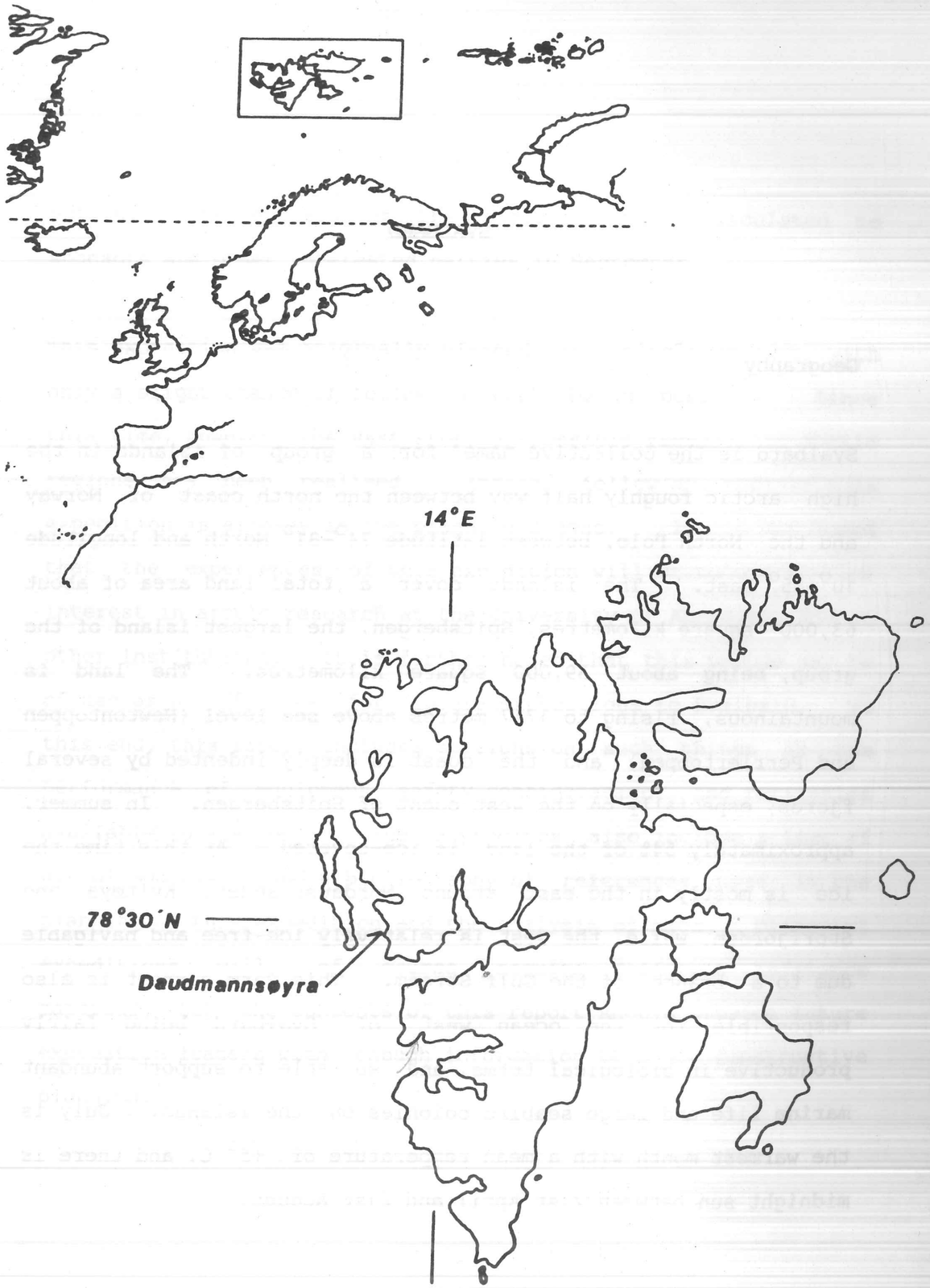
outlining the success of the expedition was circulated to sponsors and other interested parties in September.

This expedition was originally planned as a single venture, with only a slight chance of follow-up work being possible. Since this time, however, the vast scope of possible research in arctic regions has been realised. Indeed, follow-up work to this expedition is already in the planning stages. It is now hoped that the experiences of this expedition will stimulate further interest in arctic research at the University of Aberdeen, and at other institutions. It is further hoped that this volume may be of use as a reference for future expeditions to Svalbard. To this end, this report includes sections on such things as the performance of equipment, safety considerations, and facilities available to visitors. The appendices also include a list of useful addresses, and a bibliography of references used in the planning of this expedition and the analysis of data. Different expeditions will, of course, require different reference material, but the contents of this report should provide future expedition leaders with enough information to start constructive planning.

SVALBARD

Geography

Svalbard is the collective name for a group of islands in the high arctic roughly half way between the north coast of Norway and the North Pole, between latitude 74^{o}-81^{o} North and longitude 10^{o}-35^{o} East. The islands cover a total land area of about 63,000 square kilometres, Spitsbergen, the largest island of the group, being about 39,000 square kilometres. The land is mountainous, rising to 1717 metres above sea level (Newtontoppen and Perriertoppen) and the coast is deeply indented by several fjords, especially on the west coast of Spitsbergen. In summer, approximately 54% of the land is ice-covered. At this time the ice is mostly in the east around Nordaustlandet, Kvitøya and Storfjorden, while the west is relatively ice-free and navigable due to a branch of the Gulf Stream. This warm current is also responsible for the ocean west of Svalbard being fairly productive in biological terms, and so able to support abundant marine life and large seabird colonies on the islands. July is the warmest month with a mean temperature of $+5^{o}$ C, and there is midnight sun between 21st April and 21st August.



Svalbard

History

The archipelago was first discovered by the Vikings in the year 1194, when the Icelandic annals describe a land with a cold coast (the literal translation of "Svalbard") to the north of Hafsbotn, four days sailing from Iceland. Hafsbotn, or Trollabotn, was the name used by the Norsemen for the ocean north of Norway and north-east of Greenland, known today as the Barents and Greenland Seas. The islands were of little interest to the Vikings, and were forgotten until 1596 when the merchants of Amsterdam, seeking a fast route to Cathay and the Spice Islands, equipped an expedition of two ships under the command of Rijp and van Heemskerke. The chief pilot for the expedition was Willem Barents. On the 10th June the explorers arrived at an island which they christened Bear Island, after having fought a two hour battle with a twelve foot polar bear. Here Rijp and Barents fell out. Barents wanted to head east to reach Novaya Zemlya, but was out-voted. Four days later they came within sight of an unknown group of islands which they named Spitsbergen on account of its sharp-pointed mountains. Again the islands attracted little interest, until Henry Hudson reported the abundance of whales, seals and walrus in the waters around the group, a feature that the Dutch had missed. Whaling began about 1615 and the large Greenland whale was soon driven out of the fjords, but

the hunting continued out at sea for almost two hundred years. At this time , Svalbard was thought to be a part of Greenland, so in 1620 Christian IV of Denmark claimed sovereignty of the land, and named it Christiansbergen. This is a name that never came into common usage, as is also the case for the name East-Greenland, as used by Scoresby. In 1814, Denmark ceded Norway by the Kiel treaty, and the Danish lands were divided between the two nations. However, Svalbard was not mentioned in this treaty, and effectively became a no-man's land for more than a century.

Scientific survey work began in the middle of the nineteenth century. Biological, geological and meteorological expeditions gathered data every year, the islands were circumnavigated and systematic exploration and mapping began. The discovery of coal in Svalbard started a period of international mineral exploitation, with companies from Norway, Russia, Holland, Britain, Germany and the United States participating. The Scottish Spitsbergen Syndicate started mining operations at Advent City on Adventfjorden, but the main mining centre was to be at the other side of the fjord at Longyear Valley City, named after an American developer, and today known as Longyearbyen. It became clear that the disputes over mining claims could only be settled by deciding the question of sovereignty, and by the

Paris treaty of 1920, Norway was accorded "full and absolute sovereignty over Svalbard".

Conservation

Since taking over the administration of Svalbard, the Norwegian authorities have put considerable effort into nature conservation. Several Acts laid down by Royal Decree have resulted in a series of environmental regulations covering the entire archipelago. Provisions were also made for the establishment of three National Parks in North-West and South-West Spitsbergen and Prins Karls Forland, three Nature Reserves in Nordaustlandet, South-East Svalbard and Moffen, two Plant Reserves in inner Isfjorden, and fifteen Bird Sanctuaries along the west coast of Spitsbergen and Prins Karls Forland. Forty-four percent of Svalbard's land area is incorporated into at least one of these protected areas. Measures have also been taken to conserve cultural monuments on the islands. These include standing stones, cairns, burial sites, dwelling sites and runic inscriptions, where these can be assumed to antedate 1900. Protection is also given to movable objects such as weapons and hunting tools, again antedating 1900. Tromsø Museum is responsible for protecting cultural monuments, and also co-ordinating any excavation of sites.

Svalbard Today

Today the Svalbard group has a resident population of approximately 3400. The main settlement and administrative centre is Longyearbyen, a town of about 1100 Norwegian inhabitants on the south-west shore of Adventfjorden, a branch of Isfjorden. It is still mainly a mining community, but the Governor's Office, the airport and Svalbard Radio are also here. The Norwegians also have another mining settlement of about 90 persons at Svea, on Van Mijenfjorden. The Soviet Union have two mining communities at Barentsburg and Pyramiden, both in the Isfjord area, with a total population of about 2200. Scientific research is carried out by Norsk Polarinstitutt who run a small scientific research station at Ny Ålesund, on Kongsfjorden.

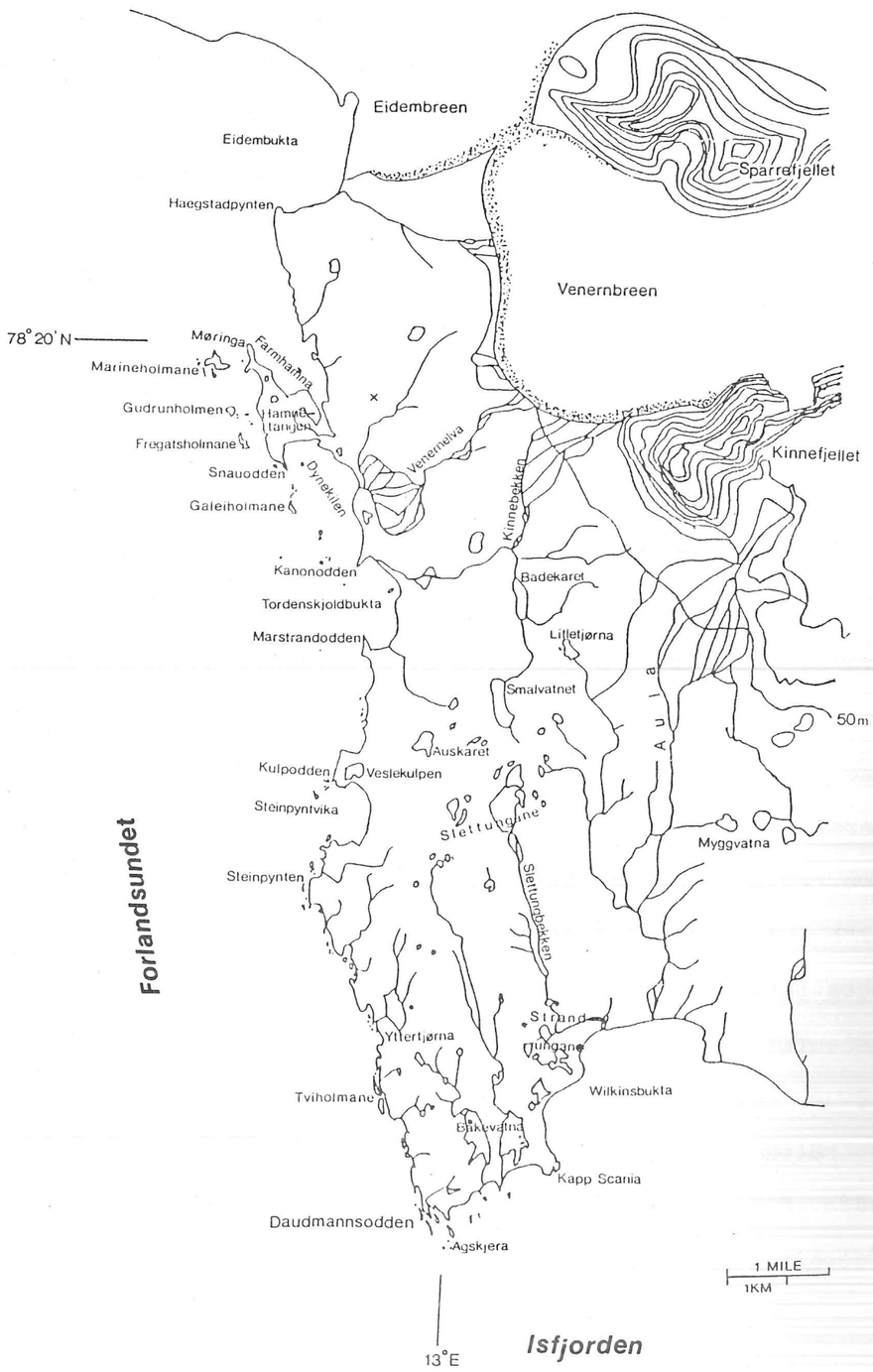
In recent years the authorities have undertaken a re-naming of place names on Svalbard. This has generally taken the form of changing an English name into the nearest Norwegian equivalent, e.g. Kings Bay has become Kongsfjorden, Prince Charles Foreland has become Prins Karls Forland, and Edge Island has become Edgeøya. The purpose behind this was to standardise the place names, as many used to have alternative names. The main island of the group, originally known as West Spitsbergen, became Vestspitsbergen, and today is known simply as Spitsbergen, while

the group as a whole, often refered to previously as Spitsbergen, is now called Svalbard. This should clear any confusion caused by the change in terminology. It should be noted that as it is originally a Dutch word, Spitsbergen should be spelt with an "s" in the middle and not a "z", as this is a German derivation.

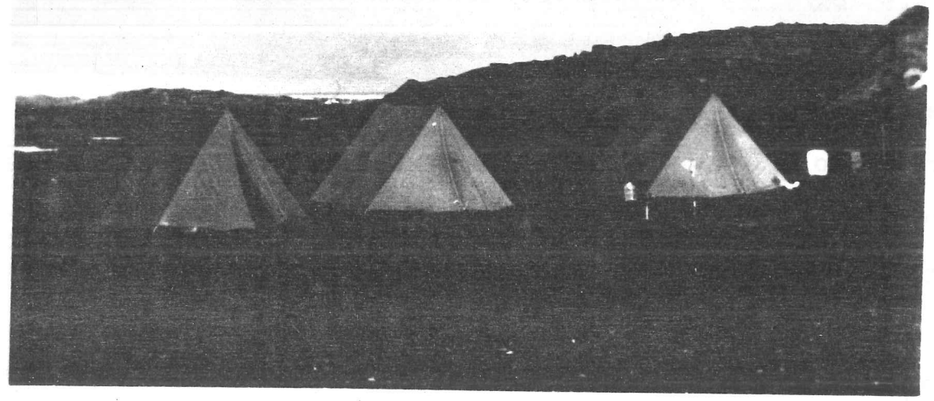
The Study Area

This expedition was based on Daudmannsøyra, a low lying coastal plain on the island of Spitsbergen with a maximum elevation of less than fifty metres above sea level. This plain is located on the north shore of Isfjorden, where the fjord meets Forlandsundet, and is bordered by mountains, glaciers and moraine to the north and east, and by sea coast on all other sides. There are many pools and streams, and two main glacial outwash rivers, the Venernelva and the Aula, which split the plain into three regions: North, Central and East. North Daudmannsøyra (north of the Venernelva) is typified by a series of parallel ridges running roughly south-west to north-east. There are many rock outcrops, and in some areas frost shattering has produced an un-even bed of rock slabs projecting obliquely from the substratum. The terrain is typically a mixture of rock and tundra. Stone polygons caused by the contraction and fissuring of desiccated soils are also common. In contrast with this, the

Daudmannsøyra



central region of Daudmannsøyra is fairly level, with few rock outcrops and stone polygons, and is mainly tundra. This expedition did not enter the region east of the Aula. There have been two other British expeditions to Daudmannsøyra in the last ten years: the Oakham School Spitsbrgen Expedition in 1979, and the Barnacle Goose Project organised by the Wildfowl Trust in 1986.



Base camp. Its location is shown by an x on the map opposite.

PERSONNEL

David S. Robertson B.Sc. (Expedition Leader)

Ornithologist and mammalogist.

Experienced in winter mountaineering and qualified in first aid. (St. Andrews Ambulance Assoc.)

Alison E. Duncan B.Sc. (Transport Organiser)

Ornithologist and ringer.

Qualified B.T.O. ringer. (C Permit)

Susan M. Duncan B.Sc. (Treasurer)

Ornithologist and mammalogist.

Glen Docherty B.Sc.

Marine biologist and mammalogist.

Experienced in hillwalking and diving, qualified in first aid. (St. Andrews Ambulance Assoc.)

Alastair R. Lyndon B.Sc.

Ornithologist with particular reference to wildfowl.

National Wildfowl Count participant since 1985, experienced in mountaineering.

The expedition team.

L to R, Back row: Glen, Alastair, David.

Front row: Susan, Alison.

NARRATIVE

The expedition left Scotland in the early afternoon of Thursday 9th July 1987, flying from Aberdeen to Oslo. As we had been unable to book connecting flights, we had to spend four nights in Oslo before continuing our journey north. After leaving much of our luggage at the airport, we caught a bus across the city to Bjerke, where we settled into the Bjerke Studentheim, a student hall of residence used as a youth hostel during the summer. The next day we headed for the city centre to look around. Alastair and Glen bought "Oslocards". Designed for tourists, these entitled the bearer to unlimited free travel on the buses, trains, trams and ferries in the Oslo area, and free entry to the various museums in the city, for three days. These turned out to be excellent value, giving them more freedom to move about the city. As the weather was excellent - sun, clear sky, light breeze and a temperature of about 28^{o} C - we spent a lot of time outdoors, walking in the city or along the ski trails in the forest behind the city. Part of a day was also spent on Hovedøya, a small island in Oslofjorden with a ruined monastery. Everybody was impressed by Oslo, especially by how clean and quiet it was for a capital city in the height of summer.

The next leg of our journey was not until the evening of the 13th, however we moved our luggage down to the airport, and reclaimed the things we had left there, during the morning. David and Glen went back into the city for some food, and returned with the greenest bananas in Oslo. These became ripe after about a week in our study area, where fresh fruit was not available, and were enjoyed as a luxury! The flight to Tromsø in northern Norway went by way of Trondheim, Bodø and Eveness, and revealed some spectacular scenery of mountains and fjords. In Tromsø we had time for a quick snack before being called to the flight that would take us to Svalbard. There was a bank of cloud over the Barents Sea, enshrouding Bear Island, but fortunately this cleared as the aircraft flew over Storfjorden, giving us our first glimpse of Svalbard.

We landed at Longyearbyen airport in the early hours of the 14th. It was distinctly cold as we left the 'plane, only 1.5^{o}C. After reclaiming our luggage we reported our arrival to the Governor's representative at the airport. Some of us got a little sleep in the airport, but we had to vacate the building when it closed at 04.30. As most of our equipment, including our tents, had been freighted to the town of Longyearbyen, some four miles from the airport, and the agent's warehouse didn't open until 08.00, we didn't really have anywhere to go. We moved our things into the

lee of the camp site hut, and left Susan to guard them while the rest of us went to explore Longyearbyen and later get the freight. We returned with the tents and some of the food, and officially checked into the camp site after breakfast. After catching up on some lost sleep we went to explore along the coast from the camp site.

Next day we went into Longyearbyen and made contact with the captain of the boat we had chartered to take us to our study area on Daudmannsøyra. After discussing our landing point, we collected the remainder of our freight and moved it to the quay side ready for loading, then purchased a few essentials such as paraffin and toilet rolls. We returned to the airport camp site, struck the tents and packed our rucksacks for going on board that evening.

The boat's departure was delayed until the middle of the next morning, July 16th. Strong winds, approaching force ten, the previous night left a considerable swell in Isfjorden, especially near the tip of Daudmannsodden, however the crossing was completed in a little over five hours. Our landing point was at Farmhamna, a sheltered bay in the north of Daudmannsøyra. The boat anchored a couple of hundred metres offshore and we were ferried in by zodiac. Our first job on arrival was to survey the local area to

find a suitable camp site. This we found about a kilometre south-east of Farmhamna. We moved all our belongings to this site, hurrying towards the end to get the camp established before a fog descended upon us.

Our first two days on Daudmannsøyra were not very productive. The fog that was closing in on us as we set up the camp had worsened, so we were reduced to exploring the area near to the camp. We were, however, able to establish where we were on our maps. We also found and ringed two broods of Purple sandpipers, and started the record of wildfowl for the area. By the third day the fog had cleared. We fitted the telescopic sight onto the rifle, and went to zero it a short distance from the camp. Nearly an inch of rain had fallen the night before, and a few things in the tents had become wet. We spent part of the day re-arranging the camp in a manner we hoped would reduce the chances of rain damaging our provisions. This done, we continued our reconnaissance of the local area, and caught and ringed a Grey phalarope with one chick. On our way back to the camp we took our expedition group photograph with light from the midnight sun.

We soon completed our survey of the coastal areas in north Daudmannsøyra and turned our attention inland, checking the lakes and rivers there for groups of geese. Reconnaissance visits were

also made to the lakes and coastal areas of central Daudmannsøyra, and regular checks were maintained on known groups of geese in the northern area. During one of these forays to the south a group of reindeer took an inordinate interest in us, and tried to give chase. They were dissuaded from this when we fired some shots over their heads.

Once we had been on Daudmannsøyra for almost a week we had accumulated a sufficient amount of rubbish to make burning it worth while. We took the rubbish to the beach at Hamnetangen and started a small fire using some driftwood. We were nearly finished this chore when a zodiac entered Farmhamna. On seeing us, the occupants altered course and came ashore a few metres from our fire. They turned out to be two doctors from Tromsø, spending their holiday cruising the Spitsbergen coast by zodiac. We invited them for coffee at our camp that evening, when we introduced them to the Scottish delicacy of Dundee cake!

Half way through the second week, we completed our survey of breeding Barnacle geese on Daudmannsøyra. The result of this survey was not encouraging. From the periodical reports we had received before departure concerning the melting of the sea ice, which we had extrapolated to estimate snow cover on the tundra, we had expected the geese to be in the middle of their hatching

period, with some birds still incubating. What we found, however, was that hatching was long past, and indeed most broods had already fledged. It was clear that little work of value could be achieved by pursuing our original aim of studying the breeding ecology of the geese using the small sample size available. Therefore, it was decided that the emphasis of the main study would be shifted to Arctic Fox predation on the geese. The next day we started collecting data relating to fox diet by analysing fox scats (faeces), and identifying the remains of animals killed or scavenged by foxes.

We lost a couple of days work due to bad weather, but by early in the third week we had completed transecting most of the northern and inland areas for scats and kills. We decided to leave the areas that were fairly close to our camp until such times that going further afield would be impossible, and so opted to continue work further south. On the 2nd August we headed south toward the lakes near Daudmannsodden. On the way we transected the coastal area, and stopped periodically to make notes on any birds seen and any marine life found. We spent a while exploring the point. Glen found a grave, presumably the one that Sir Martin Conway found in 1895 when he named the promontory "Dead man's point". We had noticed during the morning that the wind was gradually rising, but, as this was a common occurrence, had paid

little attention to it. As we started our return journey the wind was becoming very strong. It was the worst place for a storm to hit us. We were about as far from the camp as we could get, a walk of approximately six hours. We were further delayed when we tried to cross the Venernelva. The river was already in spate, and had altered its channel in the twelve hours since we had crossed it. When we arrived back at the camp we found a scene of minor devastation. Two of the tents had almost lost their flysheets, guy ropes had snapped, and all the tents were flooded to some extent. The wind had come from our least sheltered side, and once the flysheets had been blown against the inner tents the rain had poured in. We effected a few minor repairs, but not much could be done until the wind abated. One tent had suffered only slight flooding and we were able to dry it out. We then took turns sleeping in this tent and sitting on the flysheets to hold the tents down. The next day was much the same, although we were able to get a drying line erected in the evening when the wind had gone down a bit. By the third day the worst of the storm was past, however the wind remained quite strong. We managed to get more repairs done on the tents and got the paraffin stoves lit, giving us our first hot meal in three days. We were beginning to relax after our meal when we heard voices outside. A Norwegian fishing boat passing through Forlandsundet had seen our tents and sent five men to investigate.

They stayed only long enough to see that we were okay and had survived the storm. We arranged a rota for watching the tents, checking them every half hour, but there was no further damage, and by the next day the wind was down to a light breeze.

The storm had left us with some damage to clear up, which took the best part of a day. The flooding of the store tent had caused water damage to some of our food supply. This did not leave us short of food as we had some spare rations, however it did necessitate the reorganisation of the remaining supplies. More serious was the damage to the tents. Two flysheets were torn, some of the pegging loops had been ripped each of the flysheets, and one ridgepole was buckled. This meant that the tents could no longer be considered as weatherproof as before, and were, in fact, quite delicate. They would be unable to withstand even a moderate wind and rain could easily get in. Therefore, it was no longer possible to go far afield for fear that the weather would deteriorate and further wreck the camp. Fortunately we still had work to do near to camp.

We had arranged to rendezvous with our charter vessel at Farmhamna on the 6th August to finalise the details for picking us up a week later. The weather was excellent, and there was almost a holiday atmosphere as we made our way to where we had landed three weeks

earlier. We all appreciated the opportunity to relax for a while. As it seemed likely that we would be at Farmhamna for most of the day we took the chance to carry out our marine biology project, surveying the intertidal shoreline for anything that was there. The rendezvous was successful, and the appropriate arrangements were made. We finished our marine transects, then went to look for some King Eider before returning to camp.

Our last week on Daudmannsøyra was spent finishing off our various studies. We transected the local area for fox scats and kills, and found Hamnetangen to be very productive of data. Footage was taken for the expedition film of scat analysis and some aspects of camp life not already filmed. Our last working day was the 11th August, giving us a day to pack everything before our return voyage. During our four weeks on our study area we had found and analysed more than five hundred fox scats and eighty kills. Detailed records of birds, wildfowl and flowering plants had been kept, thirty birds had been ringed and an intertidal survey completed.

We met the charter boat at 11.30 on the 13th August, and were back in Longyearbyen by 19.00. We had been lucky with the weather during the previous week, no high winds and no rain at all. Some of our equipment was put into temporary storage under the camp

site hut, allowing us to combine parts from all the tents to get two working ones. Showers had never been so welcome as those in the camp site hut. The next day we went into town and reported our safe return to the Governor's Office. We also visited the shop for some fresh fruit and Norwegian chocolate! During our short stay before flying home we had a chance to visit the small cultural museum in Lonyearbyen. This museum is excellent, and is recommended to all visitors. It documents the history of the islands, and some of the pioneering expeditions that explored them, moving on to the scientific work done by modern expeditions and Norsk Polarinstitutt. Our flight south left Svalbard Airport shortly before 04.00 on the 18th August. We flew by way of Tromsø, where we cleared customs, then on to Oslo. We had a lay over of almost a day there before continuing on to Aberdeen, arriving about 09.30 on the 19th August.

Part 2

SCIENTIFIC REPORTS

ANALYSIS OF ARCTIC FOX DIET

The Arctic fox, *Alopex lagopus*, is a small canid which is virtually restricted to the arctic biome. It is somewhat smaller than the Red fox, *Vulpes vulpes*, common throughout much of Europe and North America, this being a morphological adaptation to arctic conditions (Chesemore, 1975). Both Arctic and Red foxes are descended from a common ancestor, the Alopecoid fox, *Vulpes alopecoides* Campana (*Alopex praeglacialis* Kormos), a species which was common in southern Europe during the late Pliocene and early Pleistocene (Kurten, 1968). During the middle Pleistocene, Arctic foxes ranged across much of Europe, down as far as the Iberian peninsula. However, by the end of the Pleistocene the two present day species had diverged, with *Alopex* restricted to the arctic tundra. The two species were once thought to be separated by the Arctic fox's tolerance of very low temperatures. While being anatomically similar, the most striking morphological difference between the two species is the density of the Arctic fox's under-fur. Approximately 70% of the fur fibre in *Alopex* consists of fine under-fur, compared to 20% in *Vulpes* (Cole and Shackelford, 1946). The insulating properties of its pelt are so effective that the Arctic fox's metabolic rate does not start to increase until the temperature

drops as low as -50°C, the foxes beginning to shiver only after almost an hour at -70°C (Scholander *et al*, 1950). Under similar conditions, an Alaskan Red fox's metabolic rate began to rise at -13°C, and had almost doubled by -50°C (Irving *et al*, 1955). However, the Red fox is sometimes found in even colder places than the Arctic fox (Macdonald, 1985). Thus, it is more likely that the two species are separated by food competition rather than by environmental temperature. *Vulpes* can be up to twice as heavy as *Alopex* (*ibid*), and has a correspondingly greater food requirement which cannot be sustained in areas such as the circumpolar tundra where prey is sparce. However, *Alopex* is able to balance its energy costs with gains made from a low prey density, and so successfully colonise such areas. The southern limit of the Arctic fox's range is effectively set by the Red fox which uses its larger size to intimidate the Arctic where the two species occur sympatrically.

The diet of the Arctic fox has been examined by several workers, mainly in Canada and Alaska (e.g. Freuchen, 1935; Macpherson, 1969; Underwood, 1975). From these studies it is clear that microtine rodents, particularly lemmings, play a very important role in the foxes' diet, and are, in fact, a preferred species of prey, sought out even when in low abundance. Macpherson (*op.cit.*) found that lemmings averaged up to 90%, and never less

than 50%, of total remains in scats, other items of food being birds, eggs, caribou (as carrion), fish, insects and berries. Research in east Greenland (Cabot *et al*, 1984) showed the importance of Arctic fox predation on young Barnacle geese, the foxes being attracted to breeding colonies by the loud calling made by the adult geese when encouraging thier goslings to jump from the nest ledges. Other prey observed at fox dens included lemmings, Long-tailed skua chicks and adult Barnacle geese taken when flightless during their moult. Eiders are also important prey for foxes. Quinlan and Lehnhausen (1982) describe the destruction of an entire Eider colony in north west Alaska by a single fox. Although the foxes show a fairly catholic diet, lemmings remain the most important item of prey for Arctic foxes in North America.

In contrast with the situation in North America, relatively little work has been done on Arctic foxes in Svalbard, a land which differs from most other High Arctic areas in that a small mammal fauna is completely absent. In this situation the foxes must utilise any available species of prey, possibly including some species that would not be considered as prey elsewhere. The aim of this study was to investigate the feeding habits of the Arctic fox in Svalbard, and to assess the relative importance of different species of prey in its diet.

Methods

Data relating to fox diet were collected in two ways: analysis of the contents of scats (faeces), and identification of the remains of animals killed or scavenged by foxes. A series of transect lines approximately thirty metres wide and up to two kilometres in length covered the entire northern area, the western coast, and much of the inland area of Daudmannsøyra. These transect lines were walked at a slow pace and any material found was examined *in situ*. Despite being of small size, scats were fairly easy to locate as the vegetation was short, and being white/grey in colour they contrasted with the tundra. They also tended to be concentrated in prominent places, along ridges or near rock outcrops, perhaps playing a role in social communication. The scats were teased apart and the contents identified to species level where possible, and to family level where the species could not be determined with accuracy. The size of quill bases, and the colour, size, shape and structure of feathers were all used as pointers toward the identity of avian prey. Other items of prey found did not require such a sophistocated analysis. Carcases were also easily located as they were somewhat larger than the fox scats. These were included in the analysis if there was clear evidence, such as teeth marks or bitten off quills, that foxes had either killed or

scavenged the body. A kill made by a fox was easily distinguished from those made by gulls or skuas, as foxes frequently bite the head off their prey and leave the wings, feet and sternum, while avian predators leave the neck vertebrae intact but pull the skin inside-out over their victims head.

The data obtained by both collecting methods were compared statistically (2x2 chi-squared) to check whether the proportion of each item of prey recorded from scat analysis was reflected in the proportion which it contributed to the carcases found. From this it was possible to make some assessment of possible errors in each of the two techniques.

Results

The results of the analyses of scats and carcases are given in Tables 1 and 2 respectively, and are illustrated graphically in Figures 1 and 2. Two observations are immediately apparent from these results. Firstly, a better identification of prey items was obtained from the carcases. This is not suprising as most carcases had much more recognisable material to assist in identification than did most scats. Only 3.7% of carcases were not positively identified, compared with 12.5% of scats. Secondly, a greater variety of items of prey were found in the

Table I : Analysis of fox scats.

	Number of scats where present	% of scats
Fulmar	**1**	**0.22**
Geese	**114**	**25.45**
Eider	**13**	**2.90**
Waders	7	1.56
Gulls	**5**	**1.12**
Auks	**262**	**58.48**
Snow Bunting	**79**	**17.63**
Crab	6	1.34
Echinoderm	4	0.89
Reindeer Fur	16	3.57
	40	

Table II : Analysis of carcases.

	Number of carcases	% of carcases
Fulmar	**4**	**5.06**
Pink-footed Goose	3	3.80
Barnacle Goose	12	15.19
Goose sp.	10	12.66
Combined Geese	**25**	**31.65**
Eider	**1**	**1.27**
Glaucous Gull	3	3.80
Kittiwake	6	7.59
Combined Gulls	**9**	**11.39**
Brunnich's Guillemot	26	32.91
Black Guillemot	1	1.27
Little Auk	9	11.39
Combined Auks	**36**	**45.57**
Snow Bunting	**4**	**5.06**
	41	

analysis of scats compared to that of carcases. Reasons for this are discussed later.

Due to the low frequency of some species in the sample as a whole, and the absence of some species from either scats or carcases, a statistical comparison of the two techniques was only possible on three groups: Combined Geese, Combined Auks and Snow Buntings. There was no statistical difference between the proportions found in scats and carcases for either the combined geese group or the combined auks group ($p<0.05$). However, Snow Buntings did show a statistically significant difference between the two methods ($p>0.05$). This difference can be accounted for, and is discussed later.

ANALYSIS OF FOX SCATS

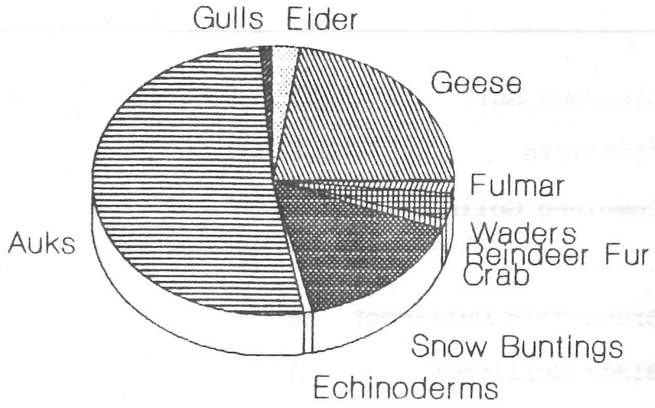


FIG. 1

ANALYSIS OF CARCASES

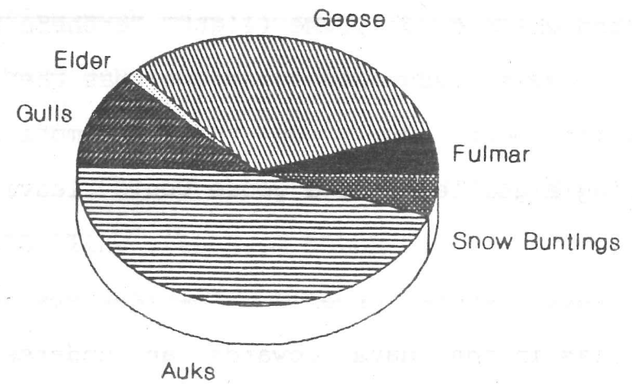


FIG. 2

Discussion

Although the two techniques used to analyse fox diet give slightly different answers for the relative importance of some species of prey, both techniques clearly show that auks and geese play a major role in Arctic Fox diet. The analysis of fox scats also appears to show that Snow Buntings are an important species of prey, although this is not supported by the carcase data. The discrepancies between scat and carcase data can be explained if the likely feeding habits of the fox are taken into account. It has been shown that a Red Fox consuming a medium to large sized bird does not eat the entire body, but leaves the wings, many feathers and occasionally the feet, while small birds are either eaten whole or only the flight feathers rejected (Lockie, 1959). It seems reasonable to assume that the Arctic Fox would show similar behaviour. On this assumption, an Arctic Fox encountering a guillemot or a goose would leave a recognisable carcase (as described under methods), while Snow Buntings would either be eaten whole or only a few feathers left. This would cause a bias in the data towards an underestimation of the predation on this species from the analysis of carcases. This also explains why waders are found in scats but are not represented in carcases. Waders are small and would have the same fate as Snow Buntings, so given their low occurence in scats

(1.56%) it is not suprising that no carcases were found. In addition, it should be noted that the number of feathers consumed from a particular item of prey could affect the apparent importance of that species in tha analysis of scats, so it seems probable that Snow Buntings are over-represented in the scats.

It is worth pointing out here the observation that many auk feathers were left on the body before consumption by a fox, as evidenced by the relatively small numbers of these feathers present around carcases. This may reflect the inability of the fox to effectively pluck feathers below a certain size, and this suggestion is supported by the fact that fresh goose carcases were invariably surrounded by very large numbers of body feathers, indicating much more thorough plucking of the bird. Goose feathers were considerably bigger than those of either auk species. In spite of this difference in the handling of carcases, however, the statistical analyses show that the estimated proportion of both species groups in the diet is consistant between scats and carcases.

A further factor which will influence the significance of any item of prey in the diet is its relative size. In this case, although geese were only half as frequently recorded in scats as auks, they are on average almost twice the size (mean adult

Barnacle Goose weighs 1700g (Owen, 1980); mean adult Brunnich's Guillemot weighs 900g (Gaston and Nettleship, 1981)). This implies that both these species groups are of roughly equal importance. Snow Buntings on average weigh only 38g (Belman, 1981) and this fact, combined with their probable over-representation in scats, suggests that they do not represent as large a part of the diet as might have been thought from scat analysis alone.

Clearly, from what has been said above, analysis of the contents of fox scats alone is not a sufficiently accurate indicator of diet to quantify the types of prey. However, in conjunction with an analysis of the remains of prey it is possible to draw some meaningful conclusions on the relative proportions of various species in the diet.

The high proportion of auks taken by foxes in the study area suggests opportunistic feeding. The nearest auk breeding cliffs to the study area were at Alkhornet, a little beyond the south-eastern tip of Daudmannsøyra, so it is likely that most of the auks eaten by foxes were scavenged, becoming available when washed ashore. A study in north Iceland has shown that the size of territory held by a social group of foxes is determined by the need of an adequate length of productive coastline to support the

group (Hersteinsson and Macdonald, 1982). Further evidence for scavenging comes from the presence of crabs and echinoderms in the diet as these are only likely to become available to foxes when washed up on the shore after storms. Reindeer fur also suggests scavenging as foxes would be unable to bring down even an ailing animal. Opportunistic scavenging provides foxes with an important, although somewhat unpredictable, food source in an area where the density of prey is very low. This feeding habit also results in the diet reflecting the seasonal distribution and abundance of prey. No attempt was made to investigate seasonal aspects of fox diet composition during the work described here.

This study represents a valuable preliminary investigation into Arctic Fox predation on Svalbard. The strengths and weaknesses of the two methods of collecting data have been identified, and hopefully this will lead to the development of more sophistocated techniques in the future. Opportunistic scavenging has been shown to be important as a source of food, and two groups of avian species, auks and geese, have been identified as the main items of prey. This provides a starting point for future work which will try to accurately quantify the trophic links between the Arctic Fox and other animals, and so further current knowledge of the structure of arctic animal communities.

RINGING

Metal rings for small waders, Snow buntings and geese were supplied by the Stavanger Museum ringing scheme, Norway. Coloured plastic rings with three letter sequences were supplied by the Wildfowl Trust, Slimbridge, for use on Barnacle geese, and were of the same type as those used by the Trust for marking geese on Daudmannsøyra the previous year.

Geese

It was planned to ring Barnacle geese on behalf of the Wildfowl Trust by catching the geese when they became flightless during wing moult. Moulting geese may be caught by herding birds on a loch towards and into a catching pen. The net catching pen was successfully constructed at the edge of one loch, but it was not possible to herd the small flock of geese into it. This failure was due to two factors. Firstly, the inflatable dinghy being used was slow and difficult to manoeuvre, enabling the geese to swim past the dinghy when they approached the pen. Secondly, as the juveniles had fledged by this time, there were no pulli in the flock to slow the adult birds down. This combination meant that the geese could easily evade being herded into the pen. After a

number of attempts the venture was abandoned.

Snow buntings

No snow buntings were ringed. The Snow bunting breeding season was found to be almost over on arrival at Daudmannsøyra. During the first week, an adult male was observed feeding recently fledged juveniles near the camp, but none of the adults seen subsequently appeared to have second broods. Only two nests were found, in rocky crevices, both empty. Snow buntings breeding in Svalbard are thought to winter in Norway, however there are no ringing recoveries, as yet, to prove this.

Waders

The only species of wader found breeding on Daudmannsøyra were Purple sandpiper and Grey phalarope. It is relatively easy to identify breeding adults, as birds attending chicks alarm and perform distraction displays when approached. in particular, Purple sandpipers perform a "rodent-run", attempting to lead intruders away from their young by running in zig-zags, with wings drooped or fluttering, and calling (Roselaar, 1983).

Broods of chicks were located by observing adult behaviour, and

were caught by hand. Adults were caught by "flicking" with a mist net, a long narrow net of very fine braid. This was laid on the ground and held between two people, who flicked it upright when the adult flew between them. Twenty-four pulli and four adult Purple sandpipers, and one pullus and one adult Grey phalarope were caught in this way. All the adults caught were males, as in common with many wader species breeding in the arctic, the female deserts before or just after hatching, leaving the male only to look after the chicks. One Purple sandpiper nest with 4 eggs, and one Grey phalarope nest with 3 eggs were found by flushing the incubating bird off the nest by chance. The Grey phalarope nest later failed, and the fate of the Purple sandpiper nest was uncertain.

All the ringed birds were measured and weighed. The Purple sandpipers were also fitted with a blue colour ring above or below the metal ring to indicate whether ringed as pullus or adult, and an orange leg on the other leg. This was done in conjunction with a study on Purple sandpipers being carried out at Ny Ålesund. It is hoped that these may be sighted on their wintering grounds. The wintering area of the Svalbard breeding population is still unknown.

In winter, at least two populations, a short-billed and a

long-billed population, of Purple sandpipers are present in Britain. Expeditions colour ringing Purple sandpipers in Norway have found that the short-billed breeding population in Norway winters in eastern Britain and further south (Summers, 1985; Rae *et al*, 1986). Purple sandpipers with long bills occur in Canada, Russia and Iceland (Summers *et al*, 1987). An expedition to Iceland in 1986 found a long-billed population breeding there, whose bill lengths correlated closely with those of long-billed Purple sandpipers wintering in Britain, but whose wing lengths were longer, and they concluded that this population probably winters in Iceland and does not migrate to Britain (Summers *et al*, 1987).

The bill lengths of the four breeding males caught (mean = 28.98 mm) correspond with measurements of of long-billed males wintering in Britain (mean = 29.8 mm), and their wing lengths (mean = 130.0 mm) are within the range of long-billed males wintering in Britain. However, little can be concluded from such a small sample of biometrics, and only recoveries of breeding birds in their wintering areas can establish where these are. The chances of recovery of birds, ringed in winter, on their breeding grounds in sparsely populated areas such as the arctic are extremely low, therefore ringing breeding birds in the arctic, with the hope of them being recovered in winter to establish their wintering

grounds, is very valuable.

Purple sandpiper.

SYSTEMATIC AVIFAUNAL LIST

A total of 25 bird species were seen during the course of the expedition, of which 23 were observed on Daudmannsøyra, with 8 species definitely breeding in this area. The remaining species were seen in Isfjord and Longyearbyen. In the following list, the species are given in Voous order (Voous, 1973 & 1977). Norwegian names are given in brackets.

Key to symbols:

B	breeding on Daudmannsøyra
♂;♂♂	male; males
♀;♀♀	female; females
ad.	adult
imm.	immature
juv.	juvenile

Daudmannsøyra

Red-Throated Diver (Smålom) *Gavia stellata* B Two pairs on nests July 25, no young seen. Maximum seen in a day was 6 on July 25. Up to 3 seen on other occasions.

Great-Northern Diver (Islom) *Gavia immer* One ad. Dynekilen, July 26 was the only certain record.

Fulmar (Havhest) *Fulmarus glacialis* Frequently seen on the coast and over the tundra.

Pink-Footed Goose (Kortnebbgås) *Anser brachyrhynchus* B See "Wildfowl on Daudmannsøyra".

Barnacle Goose (Hvitkinngås) *Branta leucopsis* B See "Wildfowl on Daudmannsøyra".

Eider (Aerfugl) *Somateria mollissima* B See "Wildfowl on Daudmannsøyra".

King Eider (Praktaerfugl) *Somateria spectabilis* See "Wildfowl on Daudmannsøyra". Largest counts were 16 ♂♂ Eidembukta, July 18; 146 Eidembukta, August 1; and 32 between camp and Daudmannsodden, August 2. All other counts were less than 10.

Long-Tailed Duck (Havelle) *Clangula hyemalis* Single ♀♀ on freshwater at Smalvatnet on July 23 and at Litletjørna on July 25. No evidence of breeding. Most birds were on the sea, with the largest counts being : Dynekilen - 70, July 17; 120, July 23; 132, July 26; 69, August 9; Eidembukta - 23, August 1; 24 August 6. All other counts involved under 5 birds.

Ringed Plover (Sandlo) *Charadrius hiaticula* Only one seen, Hamnetangen, August 10.

Purple Sandpiper (Fjaerplytt) *Calidris maritima* B See "Ringing Report". Highest count in a day was 30 at Hamnetangen, August 11. Largest number of apparently non-breeding or failed birds was 10, 23 July.

Turnstone (Steinvender) *Arenaria interpres* Only one seen, south of Marstrandodden,August 2.

Grey Phalarope (Polarvømmesnipe) *Phalaropus fulicarius* B Two pairs bred, one of which failed. Also see "Ringing Report".

Pomarine Skua (Polarjo) *Stercorarius pomarinus* Three sightings, probably of the same, dark-phase bird around Hamnetangen on July 28, August 10 and August 11.

Arctic Skua (Tyvjo) *Stercorarius parasiticus* Minimum of 6 birds present in the area, with sightings of 4 light-phase and 1 dark-phase on August 2, and 5 light-phase on August 7.

Great Skua (Storjo) *Stercorarius skua* One Dynekilen, July 25; one Hamnetangen, August 11.

Glaucous Gull (Polarmåke) *Larus hyperboreus* B Mainly coastal, with a few singles inland. About 7 successful pairs on offshore islets, with 10 juvs. seen. Biggest count was 31 at Daudmannsodden on August 2. The total number in the area was estimated to be 70. Only 3 immature birds were seen, with one each of 1st, 2nd and 3rd summer types being present.

Greater-Black Backed Gull (Svartbak) *Larus marinus* Only seen twice, both times around Hamnetangen, with 2 ad. on Fregatsholmane, July 26 and 1 ad., August 11.

Kittiwake (Krykkje) *Rissa tridactyla* Most abundant seabird, frequently seen over the tundra. Peak count was 500 north of Farmhamna, August 1.

Arctic Tern (Rødnebbterne) *Sterna paradisaea* Almost always coastal, with a few birds seen amongst glacial moraine and on shingle flood-plains inland. Peak count was 22 Hamnetangen, August 11.

Brunnich's Guillemot (Polarlomvi) *Uria lomvia* Most common auk on the coast. Largest count was 100 past Daudmannsodden (mostly flying east), August 2.

Black Guillemot (Teiste) *Cepphus grylle* Largest group was 33 south of Marstrandodden, August 2.

Little Auk (Alkekonge) *Alle alle* Small numbers at sea. One seen flying inland, August 6.

Snow Bunting (Snøspurv) *Plectrophenax nivalis* B Widespread on the tundra, but never more than 4 seen together. Fledged young were seen being fed by males, but although nests were found, none contained clutches or broods.

Longyearbyen

Ringed Plover At least 3 on the hills behind the airport, August 15.

Turnstone One at the campsite, July 14.

Pomarine Skua One light-phase chasing Kittiwakes, Adventfjorden, July 15.

Ivory Gull (Ismåke) *Pagophila eburnea* One ad. seen around the town, and campsite, August 14, 15 and 17.

Arctic Tern Three nests found on the shore and in the town, with several other probable sites. Peak count was 33, August 16.

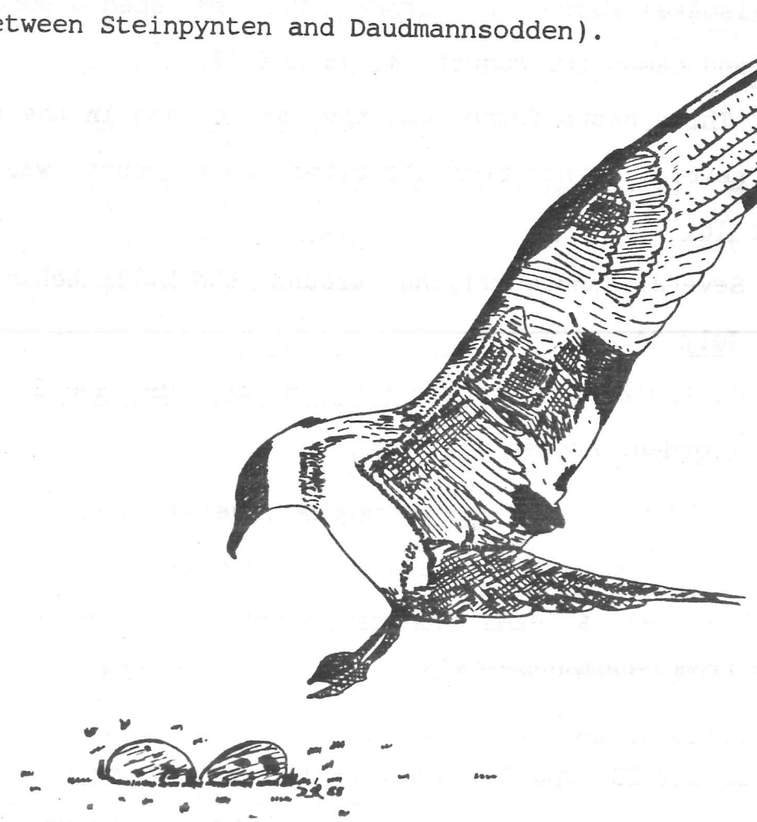
Little Auk Several hundred flying around the hills behind the town, July 14.

Puffin (Lunde) *Fratercula arctica* Two in Isfjorden and 3 in Adventfjorden, August 13.

Past Records from Daudmannsøyra

In addition to the 23 species noted by the current expedition, 4 others have previously been reported from Daudmannsoyra, these being Brent Goose (single undated record of 10 birds (Persen,

1986)), Puffin, Sanderling (2 pairs with young east of Wilkinsbukta, 1979 (Needham, 1979)) and Lapland Bunting (3 pairs south of Marstrandodden, 1986 (Owen, 1987)). The 1979 expedition (Needham, 1979) also recorded evidence of breeding for King Eider (2 broods on Strandungane lakes), Long-Tailed Duck (1 failed nest on Bakevatna East), Arctic Tern (ca. 60 pairs on Bakevatna East and a small colony on the west coast) and Black Guillemot (between Steinpynten and Daudmannsodden).



Arctic Skua.

WILDFOWL ON DAUDMANNSØYRA

Five species of wildfowl were present on the study area and the adjacent coastline, these being : Pink-Footed Goose; Barnacle Goose; Common Eider; King Eider; and Long-Tailed Duck. Opportunistic counts were made throughout the study period, with more systematic surveys of the goose and eider species being undertaken on August 1st and 2nd. Over these two days the entire coastline from Eidembukta to Kapp Scania (excluding Hamnetangen) was covered, as well as all lakes within 1.5km of the coast, thus reducing the likelihood of double counting. Long-Tailed Ducks were only seen in flocks at the two areas mentioned in the avifaunal list (*q.v.*), and this species is not considered further here.

Geese

In 1986, Daudmannsøyra was visited by a party from the Wildfowl Trust Barnacle Goose Project, and there were found to be 360 adult and yearling Barnacle Geese with 107 associated juveniles in the area. The corresponding figures for Pink-Footed Geese were 148 adults and 49 juveniles (Owen, 1987). The counts made by the present expedition on August 1st and 2nd 1987 showed there to be

a minimum of 299 adult and 24 juvenile Barnacle Geese, while for Pink-Footed Geese several counts made south of the Venernelva after July 22nd indicated a minimum of 46 adults and 29 juveniles. Only 6 Pink-Footed Geese were seen north of the Venernelva, none being present there after July 19th. The Barnacle Goose count in 1987 corresponds to 2.8% of the total Svalbard population in that year of 11,400 (Owen, pers. comm.) while that for Pink-Footed Geese represents 0.5-0.75% of the estimated population (Ekker, 1981).

With regard to Barnacle Geese, the 1987 counts give the percentage of juveniles present as 7.43% compared to 22.91% in 1986 (Owen, 1987) and a minimum of 14.4% in 1979 (Needham, 1979). The difference between the figures for 1986 and 1987 represents a decline of more than two-thirds in the proportion of young present, suggesting that 1987 was a poor year for breeding on Daudmannsoyra. Admittedly, not all the lakes south of the Venernelva were checked on August 2nd when the count in this area was made, and some birds could have been missed. However, those lakes not included (Badekaret, Litletjørna and Smalvatnet) had previously held a maximum of only 24 adults and 3 juveniles which, if they were missed, would have made very little difference to the overall percentage of young in the area. The extreme south-eastern part of Daudmannsøyra (not shown on map)

was not covered at all during the course of the expedition, but it seems unlikely that any significant numbers of geese were present there as this area was considered unsuitable breeding habitat by both the 1979 Oakham Schools Expedition and the 1986 expedition. The former group found no geese east of the River Aula, while the latter omitted almost all of this area from their survey work. Thus the present counts are compatible with those from 1986 in terms of the area covered, and this suggests that the observed decrease in breeding success was not artifactual.

The reasons for the poor breeding success in 1987 are not very clear, especially since Daudmannsøyra was identified by the 1986 expedition as the most successful area visited with regard to Barnacle Goose productivity (Owen, 1987). One contributary factor may have been the very late spring in 1987, with pack ice preventing shipping movements around West Spitsbergen up to the end of May (John Cook Agencies, pers. comm.), suggesting that extensive snow cover might have persisted on the breeding grounds until the beginning of June. It is known that nesting by Barnacle Geese is delayed when snow persists (Owen, 1980) and that under such circumstances fewer pairs attempt to breed than in milder years (Owen, 1987). The resultant effect on breeding success has been observed as a reduced percentage of juveniles on the wintering grounds (Owen,1986). In the winter of 1987 - 1988

the population on the Solway included 9% juveniles (Owen, pers. comm.), which was slightly less than the figure for the previous year of 11.9% (Owen, 1987). The data obtained on Daudmannsøyra in 1987 obviously do not take account of any mortality during the migration from the breeding to the wintering grounds, implying that birds of the year accounted for less than 7% of the geese from Daudmannsøyra wintering in Scotland. The fact that this proportion is somewhat less than in the population as a whole supports the suggestion that 1987 was a particularly bad year for breeding on Daudmannsøyra.

It is possible that in 1987 nesting was delayed by about a fortnight. However, this explanation does not fully account for the very low numbers of juveniles present, since the spring of 1986 was also noted as being later than usual, as was that of 1979, although the timing of the thaw was not given in either case. Other factors, for which no data was available in 1987, may also have had a significant effect on the numbers of birds successfully raising young, for instance, the condition of the birds on arrival at the breeding grounds. Interestingly, the condition of Barnacle Geese leaving the Helgeland staging grounds in 1986 was exceptionally high compared to previous years (Owen, 1987).

Considering Pink-Footed Geese numbers, it is clear that in 1987 there were far fewer present than the previous year, although the percentage of juveniles was greater, being 38.67% compared to 24.87%. The number of juveniles was confirmed by two separate counts on July 23rd and 25th which were within one individual of each other, while the total number of birds seen on July 23rd agreed closely with the count of about 80 made on August 2nd. On the latter date, a group estimated at 70 adults and juveniles was on the sea at Steinpyntvika and a further 12 adults were on Yttertjørna. This suggests that coverage of Pink-Footed Geese in the area was fairly complete and that few, if any, birds were overlooked.

Several Pink-Footed Goose nests were found south of the Venernelva, with one on the eastern side of Smalvatnet and three or four on a rock outcrop beside Kinnebekken, quite near the coast. Of these, the one at Smalvatnet and one of the others appeared to have been used in 1987, since there were down and moulted flight feathers in and around the nest cups. The presence of a pair with young on the lake near Farmhamna suggests that there may also have been a nest site in this area, but none was found. Family parties of Pink-Footed Geese, as opposed to larger groups, were observed on two occasions, with three broods of 2, 4 and 1 respectively being seen. Along with other observations on

small groups of adults and juveniles, this implies a mean brood size of between 2 and 3, suggesting that the Pink-Feet on Daudmannsøyra represented 10 to 15 breeding pairs which had hatched young, along with 16 to 26 non-breeders or failed breeders. The mean clutch size of Spitsbergen Pink-Footed Geese is quoted as 4.2 (Owen, 1980), and, using this figure, it is possible to estimate the loss of eggs and young in the period between laying and 4 weeks post-hatching, the latter being the approximate age of the goslings when the counts were made. The mean value for mortality during this time was thus between 25% and 50%, assuming that all clutches originally comprised 4 eggs. It should be stressed, however, that these figures do not include the loss of clutches or broods by failed pairs, which would obviously increase the estimated mortality, whilst there will also be a certain degree of error resulting from age differences between the broods.

Eiders

An aerial survey of the West Spitsbergen coastline in mid-August 1984 (Karlsen and Mehhum, 1986) revealed an estimated total of 43,500 moulting and feeding eiders (species were not differentiated). The Daudmannsøyra coast was one of ten areas regarded as being important for moulting, although no specific

numbers were given. To see whether this was still the case, a survey of eider numbers was undertaken during the course of the current expedition, with extensive counts being done on August 1st and 2nd, north and south of the Venernelva respectively. In the north, observation was quite easy, and it is unlikely that any birds were missed other than in the Hamnetangen area, which was not covered. However, in the south, between Steinpynten and Daudmannsodden, it was often not possible to get close to the shore due to the broken, rocky terrain. As a result of this it is probable that a number of birds were missed because of their being close inshore. Therefore, it is important to emphasise that the following counts represent minimum estimates of the numbers present. (Note : these areas were highly unlikely to hold geese since access to the shore was so difficult. Thus, the above considerations do not affect the estimates of goose numbers). The figures obtained from the survey for the numbers of eiders in the vicinity of Daudmannsøyra were 18 Common Eiders with 146 (138 ♂♂ + 8 ♀♀) King Eiders in the north, and 1050 Common Eiders (including 20 juveniles) with 32 (15 ♂♂ + 17 ♀♀) King Eiders in the south the following day. Combining the data for both days gives estimates of 1050 Common Eiders and 155 King Eiders, leading to a minimum total of 1205 birds.

It is likely that the Common Eiders seen in the north were

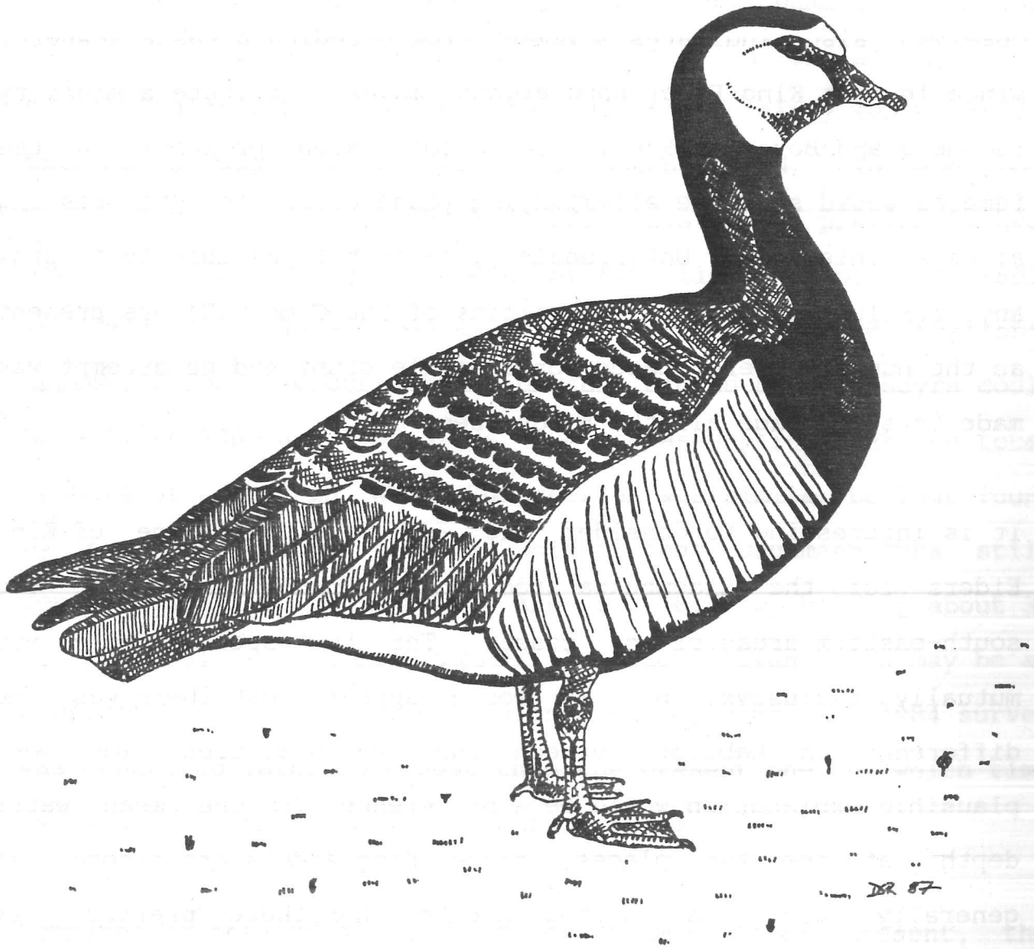
different birds to those counted the following day, whilst in addition, a previous count made on July 26th had revealed 49 female Common Eiders with 15 juveniles near Hamnetangen. These latter birds were probably not included in the survey counts since females with young were observed to be fairly sedentary and this area was not covered, as noted above. In addition, Wilkinsbukta was not checked, this area having previously been noted as holding large numbers of King Eiders on occasion (800+ in late July 1979; Needham, 1979). Thus, a more realistic approximation of eider numbers present around Daudmannsøyra could be between 1300 and 1400 birds. On the assumption that the total numbers of eiders in West Spitsbergen was similar to that found by the 1984 study, it is clear that Daudmannsøyra still represents a locally important area for eiders, holding about 3% of the population in late summer. In fact, even this may be an underestimate of the area's significance, since the 1984 survey was conducted later in August than the present one, by which time the moult flocks may have further increased in size.

Compared to the overall numbers of Common Eider present, the number of juveniles was very small at 35 individuals. This suggests either that there were a high number of non-breeding birds around Daudmannsøyra or that there was an influx of moulting birds from surrounding areas towards the end of the

summer. For King Eiders there would appear to be an influx from other areas since there was no evidence of breeding on Daudmannsøyra. The fact that a large preponderance of males was observed also indicates movement from breeding areas elsewhere, since in most King Eider populations males constitute a minority (Gooders and Boyer, 1986). This conclusion presumes that the females would still be accompanying young close to the nesting sites at this time. Unfortunately, it is not possible to to draw any conclusions on the the origins of the Common Eiders present as the numbers were based on a single count and no attempt was made to sex or age all the birds seen.

It is interesting to consider the apparent preference of King Eiders for the Eidembukta area, and of Common eiders for the south-eastern areas of the coast. The two species were not mutually exclusive, but it would appear that there was some difference in habitat between the two localities. The most plausible explanation would be a difference in the mean water depth at the two places, since King eiders are recorded as generally feeding at depths greater than those preferred by Common Eiders (Gooders and Boyer, 1986). Certainly, as far as could be judged, Eidembukta appeared deeper than the waters around the inshore islets further south where Common Eiders were most frequent. However, in the absence of detailed soundings for

the locations in question, this must remain speculative.



Barnacle Goose.

SYSTEMATIC BOTANICAL LIST

In this list, the species order is that given by Moore (1982). English names are given either where known or, in the absence of an English name, where one was easily derived from the Latin binomial.

Daudmannsøyra

Twenty-nine species of higher plant, including two grasses were identified in the study area as follows :-

Salix polaris	Arctic Dwarf Willow
Polygonum viviparum	Alpine Bistort
Oxyria digyna	Mountain Sorrel
Minuartia rossii	
Cerastium cerastoides	Starwort Mouse-Ear
Cerastium alpinum	Alpine Mouse-Ear
Cerastium arcticum	Arctic Mouse-Ear
Silene wahlbergella	Northern Catchfly
Silene acaulis	Moss Campion
Ranunculus nivalis	
Ranunculus hyperboreus	

Papaver dahlianum	Arctic Poppy
Draba alpina	Alpine Whitlow Grass
Draba fladnizensis	Yellow Whitlow Grass
Cochlearia fenestrata	Scurvy Grass
Sedum arcticum	Arctic Stonecrop
Saxifraga nivalis	Arctic Saxifrage
Saxifraga hirculus	Marsh Saxifrage
Saxifraga cespitosa	Tufted Saxifrage
Saxifraga hyperborea	
Saxifraga cernua	Drooping Saxifrage
Saxifraga oppositifolia	Purple Saxifrage
Dryas octopetala	Mountain Avens
Potentilla norvegica	Norwegian Cinquefoil
Cassiope tetragona	Cassiope
Mertensia maritima	Oyster Plant
Pedicularis hirsuta	Lousewort
Alepocurus alpinus	Alpine Fox-Tail
Eriophorum schenchzeri	Arctic Cotton Grass

In addition to the above, one further species was found near to Longyearbyen :-

Cardamine nymani	Cuckoo Flower

About 12 species of moss were collected on Daudmannsøyra, but these have not yet been identified. Specimens of 20 flowering plant species were pressed and brought back to Aberdeen. These specimens, along with the mosses, have been donated to the small Spitsbergen botanical collection maintained in the herbarium of Aberdeen University's Plant Science Department.

Arctic Poppy.

BOTANICAL SURVEY

The botanical survey was a subsidiary study within the aims of the expedition, and as such it wasn't possible to spend enough time on it to obtain meaningful quantitative data regarding the distribution and abundance of the flora present. However, sufficient observations were made to allow a qualitative analysis of distribution and relative abundance for certain species.

Most of the species identified in the botanial list (*q.v.*) occurred throughout the study area. Nevertheless, it was very obvious that the relative abundance of some species changed markedly according to location, both on the microhabitat scale and at the level of coastal plain as a whole. The best examples of this variation were the moss campion and four of the saxifrages (purple; drooping; marsh; and tufted).

With respect to microhabitats, it was noticed that north of the Venernelva, where the terrain was ridged, most of the flowering plants were concentrated around the ridges, with relatively few being found on the lower-lying, damp ground in-between. The sides of the ridges were drier and supported dense cushions of mosses and lichens, while on the ridge-tops the

ground was very dry with very few mosses and mainly encrusting lichens.

Moss campion was most abundant on the tops of the ridges, where it was also the commonest flowering plant. The only other flowers found regularly in this situation were the purple and tufted saxifrages, but neither occurred in large numbers. Very occasionally, small clumps of marsh saxifrage were observed on ridge tops.

On the sides of the ridges, drooping saxifrages were common, often occurring in dense patches, whilst tufted and purple saxifrages were also abundant in this situation. Marsh saxifrages were most frequent on the slightly damp ground at the base of the ridges and on raised hummocks in the troughs between ridges.

On the overall habitat scale sevaral interesting observations were made. Firstly, while they were widely distributed in the area, purple saxifrage and, to a lesser extent, tufted saxifrage appeared to be particularly associated with what were subjectively classified as marginal environments. These included coastal shingle, where the former species formed large mats and coastal 'heath', which was slightly further from the sea but was

generally very open and relatively dry. In addition, as noted above, both species were present on the very dry ridge tops, whilst both were also found on glacial moraine in the east of the area. This suggests that both of these species are to some extent pioneers capable of colonising inhospitable environments devoid of other plant life, and it would be of interest to perform more detailed ecological and physiological studies on them to confirm this.

Another point of interest was the difference in occurrence of moss campion between the northern area and that south of the Venrenelva. To the north this species was very common, whereas to the south it was much less frequently encountered. The reasons for this difference were not clear, but it seems likely that the less ridged topography and generally damper terrain to the south of the Venernelva may be a prime factor. Again, further work on the habitat requirements of moss campion, which would appear to include a dry environment and very low or encrusting surrounding vegetation, would be useful in explaining this species distribution on the tundra.

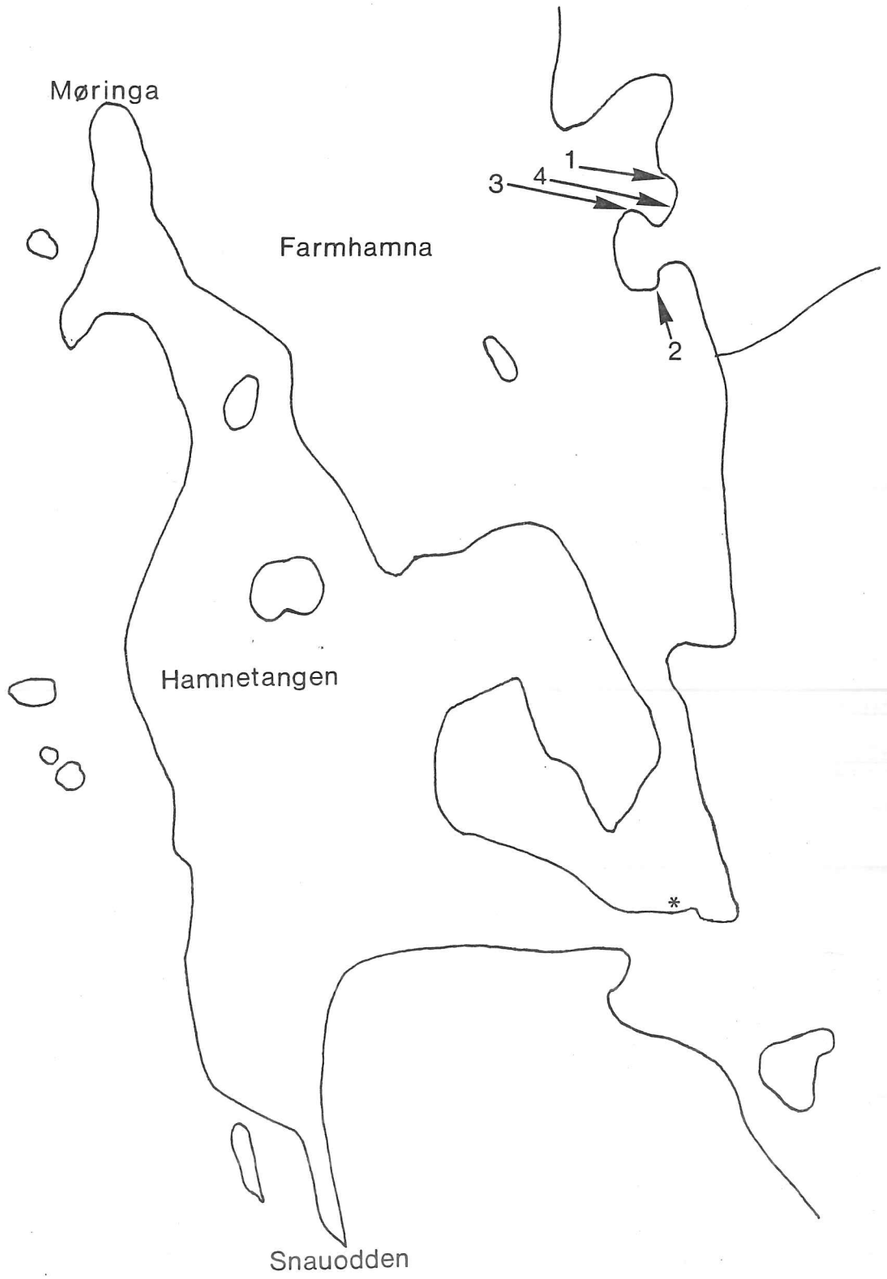
MARINE INTERTIDAL SURVEY

The primary aim of the marine survey was to carry out intertidal transects in order to obtain information on the abundance and distribution of the species present. It was not intended to test any particular hypothesis, but rather to provide baseline data from which future studies could be planned. The Daudmannsøyra coastline lies adjacent to the main shipping lane on the west coast of Spitsbergen, which passes through Forlandsundet. Most of the traffic is involved in commercial fishing operations, with cod (*Gadus morhua*) being the principle species involved. However, if current oil exploration proves successful, this situation could change dramatically. Pollution was evident throughout the area in the form of plastic bottles, aerosols and other debris which had presumeably been thrown overboard from passing boats. This rubbish was predominantly Norwegian as determined from legible labels, with a few items of Soviet origin.

Materials and Methods

Four transects were laid out on August 6th, around a promintory on the eastern shore of Farmhamna (see map overleaf), each of

Map of the Hamnetangen Area, Indicating the Positions of the Intertidal Transects (numbers) and the Place Where the Pteropod was Found (asterisk).



which was divided into 25cm squares running the length of the intertidal zone. The transects were chosen so as to cover different aspects and gradients of the shore, and as a result the number of quadrats in each varied according to its slope. Details of each transect are given in table III. Within each quadrat the percentage coverage of algae was estimated to the nearest 5%, whilst counts were made of all the invertebrates present. In addition, all littorinids were scored for shell colouration. High water was at approximatly 10.45 hrs (local time), with sampling being conducted between 14.00 hrs and 19.00 hrs. The tidal range was approximately 90cm, the tide being a neap. All invertebrate counts were converted to densities expressed as individuals per square metre, whilst the approximate vertical height of each quadrat on the shore was estimated by simple geometry, assuming a distance of 1 metre between the high water spring mark and low water on the day. It should be noted that the bottom quadrat of transect 2 was not done due to the incoming tide.

Results

The main results are shown in tables III to VI. From the data shown graphically for transect 4, there does not appear to be any clear relationship between the extent of algal cover and the

Table III : Details of intertidal transects.

Transect	True Bearing	No. of quadrats	Gradient
1	245	15	0.26
2	115	3 ⋆	vertical
3	300	9	0.44
4	264	11	0.36

Note : True bearings were derived from magnetic bearings using a corection of 6 W.

⋆ Only 3 quadrats out of 4 were taken due to the incoming tide.

Table IV : Species found in transects.

	Code in Table VI
Algae	
Fucus spiralis	1
Spongomorpha arcta	2
Molluscs	
Littorina saxatilis	C
Crustaceans	
Gammarus locusta	B
Balanus balanoides	A

Table V : Frequencies of *Littorina saxatilis* shell colour types in the survey transects.

Colour	Frequency
Grey	644
Black	8
Grey with yellow bands	6
Grey with yellow stripe	2
Blue	1
Grey speckled	1

distribution of *Littorina* on the shore. This was eqully true of almost all the invertebrates in the transects, with the exception of *Gammarus* in transect 1. Here there appeared to be a rough correlation of *Gammarus* densities on the lower shore with the amount of algae in a given quadrat. There is some suggestion that *Spongomorpha* may be more abundant on the lower shore where *Fucus* tended to become less common, this assertion being qualitatively supported by the data from tansect 1. It was also noticeable that *Spongomorpha* occurred much less frequently on the two steeper transects, although statistical comparison was

Table VI : Data from intertidal transects.

Transect No.	Quadrat	Vertical Ht. Below H.W.	Comments	Algal Cover %		Species Density per m^2 A	B	C
				1	2			
1	1	3.33	Dry	5	-	-	-	-
	2	10.00	Dry	55	-	-	-	-
	3	16.67	Wet from	95	-	-	16	-
	4	23.33	here on	95	-	-	-	-
	5	30.00		75	-	-	-	-
	6	36.67		95	-	16	-	80
	7	43.33		35	-	16	-	96
	8	50.00		100	-	48	144	448
	9	56.67		100	-	240	160	528
	10	63.33		90	-	-	144	640
	11	70.00	* the amount	55	*	-	32	320
	12	76.67	of species 2	35	*	-	48	480
	13	83.33	was not dif-	25	*	-	48	336
	14	90.00	ferentiated	80	*	-	160	448
	15	96.67	as it was	95	*	-	112	192
2	1	12.50	very spars-	60	-	2352	-	608
	2	37.50	ely distri-	100	-	1264	64	416
	3	62.50	buted.	95	-	-	192	544

Transect No.	Quadrat	Vertical Ht. Below H.W.	Comments	Algal Cover %		Species Density per m^2 A	B	C
				1	2			
3	1	5.56		40	-	-	-	208
	2	16.67		80	-	576	-	1248
	3	27.78		100	-	16	112	688
	4	38.89		100	-	16	-	912
	5	50.00		100	-	544	144	672
	6	61.11		90	-	32	144	560
	7	72.22	Rocks	90	5	-	-	96
	8	83.33	covered	90	-	-	224	256
	9	94.44	in gravel	95	-	-	128	80
4	1	4.55		5	-	-	-	-
	2	13.64		55	<5	-	-	-
	3	22.73		85	10	-	-	-
	4	31.82		80	15	-	-	32
	5	40.91		90	-	-	48	64
	6	50.00		75	5	-	-	400
	7	59.09		50	10	-	64	352
	8	68.18		20	15	-	-	176
	9	77.27		30	20	-	-	32
	10	86.36		5	60	-	-	-
	11	95.45		-	5	-	-	-

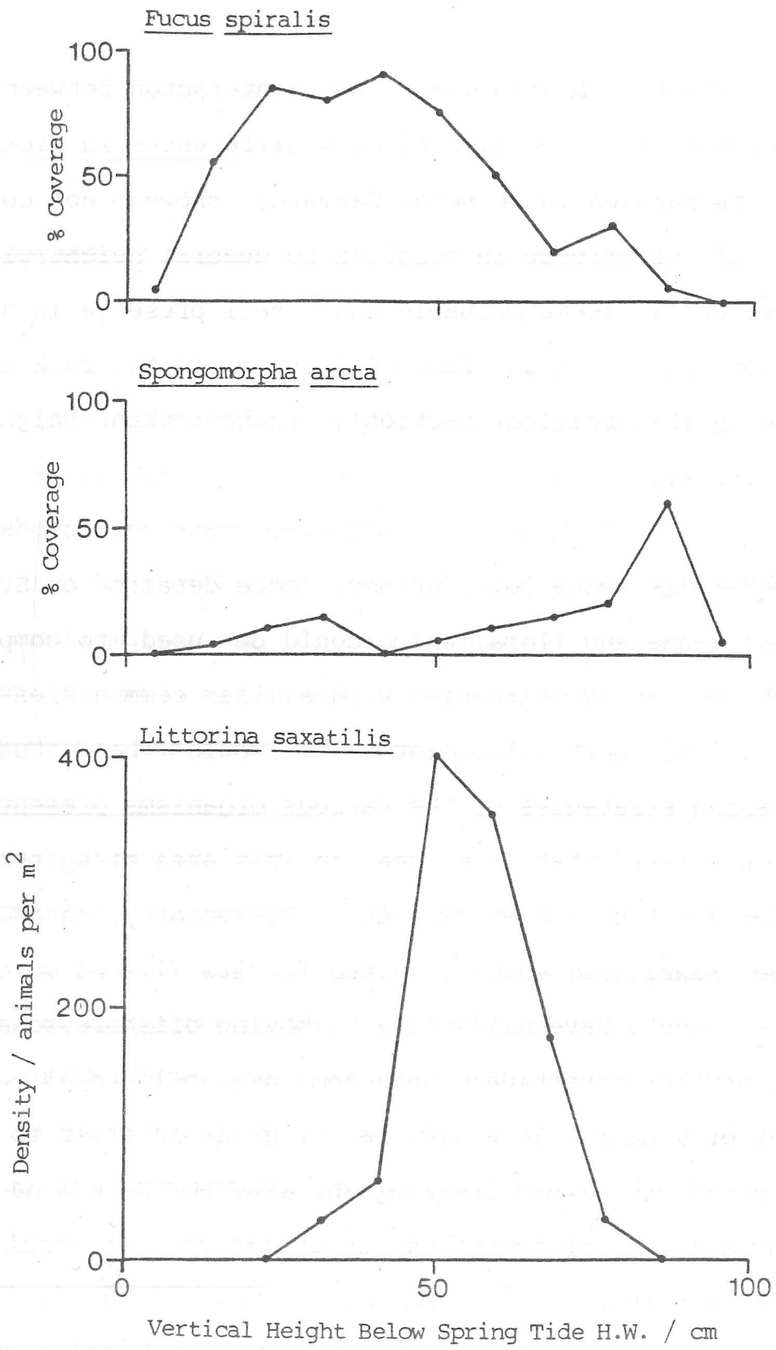
unfortunately not possible. With regard to shell colouration in *Littorina*, it is clear that the vast majority of specimens observed were of the grey colour morph. Interestingly, the rock at Farmhamna was predominantly of a similar grey colour (see also 'Additional Observations').

In addition to the species given in table IV, three small, off-white "worms" were found, but could not be positively identified. They were most probably nematodes, but the specimens were lost in transit so that this was not confirmed.

Discussion

From the data obtained it is clear that only *Littorina saxatilis* and *Fucus spiralis* were found at all levels on the shore, although this was not necessarily true within each transect. *Balanus* occurred in relatively narrow bands at fairly low density in each of the three transects where they were present, but although the heights of these bands overlapped, there was no consistent upper limit for this species as has been observed on some temperate coasts (Lewis, 1972). Interestingly, it appears that *Balanus* and *Spongomorpha* may be mutually exclusive, as they never occurred in the same quadrat, with no barnacles being present in transect 4 where *Spongomorpha* was most widespread and

Figure 3 : Percentage cover of algae and density of Littorina saxatilis with vertical height below spring high tide for transect 4.



N.B. - The % coverage of algae refers to that in each 25 x 25cm quadrat, i.e. in $0.0625m^2$.

abundant. Whether this is due to some interacton between the two species or whether it merely reflects differences in microhabitat requirements remains to be seen. Gammarus showed no consistent pattern of occurrence in relation to quadrat height within the transects, and it seems probable that their presence is dependent on suitable cover in the form of fissures in the rock and algae (as noted in the results section), rather than height on the shore in itself.

Clearly there is scope for further, more detailed on Svalbard's intertidal fauna and flora, which could be used to compare this unique high arctic situation with similar communities at lower latitudes. Of particular interest would be studies on overwintering strategies of the various organisms present, in the light of the fact that the sea in this area of Spitsbergen is frozen for 4 - 5 months every year. Presumeably, an animal like *Littorina saxatilis*, which is noted for its limited movements on the shore, would have difficulty in moving offshore to avoid the freezing of the intertidal and shallow sub-littoral zones with the onset of winter. It would be of great interest to discover how these molluscs avoid freezing and also to determine whether such an ability, if it exists, is shared by *L. saxatilis* living in warmer climates.

ADDITIONAL OBSERVATIONS

Invertebrates

The most interesting invertebrate encountered during the expedition was a marine Pteropod mollusc of the genus *Spiratella*. A single specimen was found in very shallow water near Hamnetangen (the exact position is indicated by an asterisk on the enlarged map of Hamnetangen) and was preserved in formalin to allow confirmation of its identification. Before it was killed, notes and figures were made of its general external morphology and movements, and these are reproduced in figure 4.

Littorina saxatilis was common on the shoreline all round Daudmannsøyra and, as was noted in the report of the intertidal survey, the majority of individuals were grey in colour. However, at one point on the coast near to Steinpynten, there was an area of red rock, and here all the specimens of *Littorina* seen were of a rich, red colour similar to that of the substrate. This colour form was not observed at all elsewhere in the study area, which suggests that cryptic colouration may be important to the suvival of *Littorina* on these shorelines. Clearly, such an hypothesis implies that visual predation is an important

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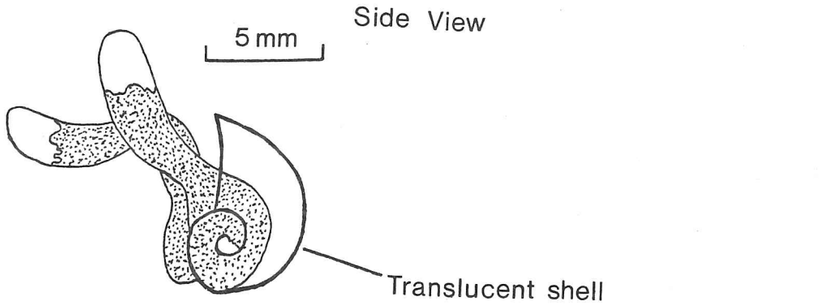
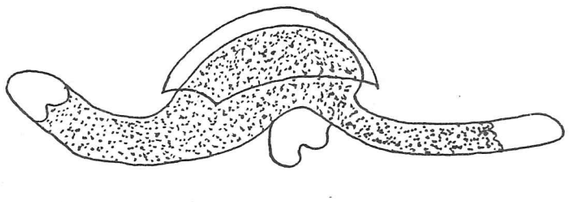
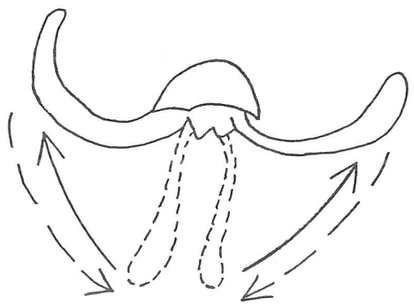
Figure 4 : Diagrams of the Pteropod Mollusc Spiratella sp. found near Hamnetangen, 26.7.87.





N.B.: stippled areas indicate dark grey colouration



determinant of mortality in these populations.

Remains of crabs, whelks (*Buccinum undatum*) and large barnacles (*Balanus balanoides*) were found on the shore and tundra in the north of the area. Presumeably these had been washed up during storms and subsequently scavenged by seabirds and foxes.

Some of the freshwater lakes were found to contain cladocerans similar in appearance to *Daphnia*, along with a predatory branchiopod crustacean *Triops sp.*. The lake east of Farmhamna contained large numbers of both species, although the cladocerans were far more numerous.

Insects were also present around lakes and on the tundra, although on most occasions they were seen walking on the ground, conditions either being too windy or too cold for flight. On two occasions under calm, sunny conditions, swarms of dipterans (taken to be chironomids), were seen over pools of standing water. Very few biting insects were present in the area, and insect repellents were never required.

Mammals

Three mammal species were seen on Daudmannsøyra, these being

arctic fox (*Alopex lagopus*), reindeer (*Rangifer tarandus*) and ringed seal (*Pusa hispida*). Arctic foxes were observed on three separate occasions, two of these near to the campsite probably being the same individual. The third sighting was particularly interesting, as it included an interaction with a group of pink-footed geese on the tundra. The fox was seen moving along a slope towards a fairly scattered group of about 70 geese (including young) which were walking across the tundra, presumeably between two lakes. Initially the fox appeared to be chasing snow buntings, but it had no success and eventually made a direct move towards a small group of about five geese, ignoring several smaller groups. On close approach, the adult geese present made aggresive gestures towards the fox including spreading and flapping their wings and arching their necks. The fox withdrew in the same direction from which it had originally come, without making any visible attempt to attack the geese other than moving to within about three metres of them. This observation supports previous suggestions that pink-footed geese are capable of successfully fending off attacks by arctic foxes (Owen , 1980), whilst it also agrees with the assertion that foxes must rely on absolute surprise in order to capture geese (G. Wright, pers. comm.).

Evidence of other mammals in the area was found in the form of

skeletal remains. Cetacean bones were quite common on the beaches, especially around Dynekilen and Daudmannsodden, with jaws and vertebrae being most frequently encountered. Several large jawbones were found near to Hamnetangen, and these were probably from bowhead whales (*Balaena mysticetus*), a species which was frequent around Svalbard until excessive exploitation in the 17th and 18th centuries led to a drastic reduction in numbers from which the population never recovered. No live cetaceans were seen during the present expedition.

Seal remains were found around Hamnetangen, and these were almost certainly from ringed seals, which are the commonest seal in the Svalbard archipelago.

Half of a polar bear jaw (mandible) was found embedded in moss and lichens near to the campsite. It was from a young animal, as indicated by its size (length = 220mm) and the presence of a partially errupted molar. No other signs of polar bears were seen in the area.

Part 3

LOGISTICAL AND ADMINISTRATIVE REPORTS

EQUIPMENT

A detailed list of equipment carried by this expedition is given in Appendix II. Below are short accounts on the performance of equipment, and comments on the suitability of certain items to the Svalbard environment.

Tents

Three Vango Force Ten Mk.5 tents were used, two for sleeping and one for storage of equipment. Throughout most of the expedition the performance of these tents was excellent, although severe damage was caused by high winds during a storm (as described in the narrative). The high profile of the Mk.5, and the large area of the side panels may have been contributing factors to the extent of this damage. The addition of an extra A-frame in the centre of the ridge pole would have provided more support for these panels, and would also have strengthened the frame structure. The fitting of a heavy duty valance to the bottom of the flysheet would have allowed more effective weighting of the flysheet using rocks. Double guying of the A-frames would have given a more secure attachment to the ground. It should be noted that the terrain on Daudmannsøyra was far from ideal for

the pitching of a tent, and that given better terrain, or when pitched head-on to the wind, the tents would almost certainly have overcome the storm.

Water purification

A water filter was taken to extract glacial flour from meltwater streams, but was not required as a clear freshwater stream was situated close to the camp. All water from this source was treated with sterilising tablets before use for drinking, cooking or cleaning of teeth. Two makes of tablet were taken: "Micropur", made by Katadyn of Switzerland, and "Puritabs". Of the two, Micropur was considered to be preferable, and definitely worth the extra cost. These tablets use oligo-dynamic silver atoms to kill all vegitative germs in the water, are odourless and tasteless, and are harmless in overdose. Puritabs use a chlorination process to kill bacteria, and leave a distinct taste to the water. Water was collected and purified in a five litre folding bottle. This was a very useful item, and an extra one, or possibly two, could have been used.

Catering

Meals were cooked in camping pans on primus stoves. This

arrangement was quite satisfactory, although pans without dimples in the bottom are recommended. Metafuel tablets were used to prime the stoves in preference to methylated spirit, mainly for convenience in handling and transport. Paraffin was stored in a twenty litre tank with a tap at the bottom, and transferred to Sigg bottles as required. A Sigg filler cap was very useful when pouring fuel into the stoves. The quantity of fuel required was overestimated: forty litres were bought, but less than half of this actually used. This was partly a contingency measure in that the melting of ice or snow might have been necessary, although the lack of demand for hot drinks other than soup was also a contributing factor (see section on provisions).

Waterproofs

The ideal waterproof for summer conditions in Svalbard should be capable of protecting the wearer from heavy rain, and at the same time allow enough ventilation that perspiration does not build up during a long hike across rough ground. Breathing waterproofs such as "Gore-Tex" or "Cyclone" are the most suitable fabrics currently available. Waxed cotton jackets did not prove to be well suited to use in these conditions, as without efficient drying facilities they tended to remain wet.

Footwear

Owing to the frequency of crossing rivers and walking across marshy ground, it was essential that footwear was waterproof up to approximately knee height. Berghaus "Yeti-gaiters" were quite effective, when used with suitable boots, for most terrain other than moderately deep rivers. In these circumstances waders were found to be most useful. These were often worn in place of boots on days when it was known that a river crossing would be made, and where the wearer was comfortable walking reasonable distances in them. Waders and wellington boots also proved useful when loading and unloading the zodiac.

DEFENCE

Polar bears are present in large numbers over the whole of Svalbard. Although there are relatively few of them in summer, they are particularly dangerous at this time as they are often starving. As these animals constitute a considerable danger to visitors, the Norwegian authorities recommend that all expeditions carry a large game rifle, calibre 7.62 mm or heavier, for defence. It should be emphasised that the polar bear is totally protected on Svalbard, and may only be shot in self-defence, the skin and carcass of shot bears remaining the property of the state.

This expedition carried a Parker-Hale midland 2100 rifle, calibre .308 (equivalent to 7.62 mm) fitted with a Rifle Scope telescopic sight. This rifle was selected as it has a simple but reliable mechanism, allowing easy maintenance and cleaning. The Mauser type non-rotating extractor removes spent cartridges reliably, ejecting them to the right as the bolt is opened. The magazine holds four cartridges, sufficient for most eventualities. The optical sight gave a 4x40 (wide angle) magnification, and allowed more accurate aiming of the rifle. Such sights are easier to use than metal sights, especially for the less experienced, but do

require periodical zeroing to maintain accuracy. The ammunition carried was Norma "Patroner" .308 Win, 13 gram, 200 grain. This is a soft- nosed hunting round with high stopping power. Prior to departure each expedition member was given training in the use and maintenance of this weapon, ensuring that the expedition was not reliant upon only one person for defence.

In addition to carrying the above firearm, this expedition also took precautions to be alerted to the approach of a bear towards the camp. A trip-wire was errected around the perimeter of the camp, and was attached to two trip-guns (Longstaff "Alarm Mines"). When any animal (bear, fox or expedition member) hit this trip-wire, the trip-guns would fire a blank shotgun cartridge, alerting persons inside the tents of possible danger. Baikal and Fiocchi 12 bore game cartridges were used. It was found that this system worked better if the trip-guns were protected from the elements by a plastic bag with holes cut for the attachment of the trip-wire and the blast from the cartridge. Miss-fires occurred on several occasions, and the fault could not be isolated as being due to the trip-guns or the cartridges, however, the system did work adequately for much of the time. Expeditions intending to use this system should make the trip-wire from a lightweight (but strong) line, as a heavy line will pull out in high winds. Fishing line proved to be ideal.

When considering their defence requirements, expeditions should bear in mind that Svalbard is a rabies infected area, and that the Arctic Fox is a carrier of this disease.

Rifle training.

PROVISIONS

In order to maximise daily working hours, two substantial meals were prepared at breakfast and dinner, and snacks provided for the time in between. This allowed work to be carried out some distance from base camp without the need to return for meals, nor to prepare a packed meal in advance and carry this while working. Below is a generalised ration list. Numbers in brackets refer to the frequency of use, *e.g.* (3/7) indicates that an item was used on average three days out of seven.

Breakfast : Muesli (4/7)
Grapenuts (3/7)
Milk c. 200 ml. per day

Biscuits, oatcakes, crispbread or healthy life
Meat paste, tinned fish, cheese, jam or honey (5/7)
or
Scrambled eggs and baked beans (2/7)

Snacks : 1 bar of chocolate (6/7)
or
2 crunchy bars (1/7)

2 packets KP mixed nuts and raisins *or* salted peanuts

Dinner : Soup

Dehydrated meal (6/7)
or
Corned beef hash with vegetables (1/7)

Cheesecake (1/7)
or
Angel delight (2/7)
or
Fruit and custard (1/7)
or
Dundee *or* ginger cake (2/7)

Drinks : Fruit juice, c. 200 ml. per day
Coffee, tea, cocoa as required

The dehydrated meals were very convenient and easy to prepare, and certainly reduced freighting costs as they were of low bulk and weight. Although these products were supposed to be ready to eat after five minutes boiling, they improved with a longer

cooking time. The rice provided with some of these products remained hard even when boiled for fifteen to twenty minutes, while that provided with other products rehydrated satisfactorily within the stated time. Rice intended for use as rice pudding was used to supplement the main meals, replacing the inedible hard rice. Expeditions are strongly recommended to test the suitability of dehydrated foods before purchasing a bulk order, as rehydration may pose a problem, especially at altitude. The inclusion of corned beef hash in the menu was very good for moral, as expedition members tired of the taste of soya protein, a tendency that became more noticable toward the end of the expedition. The instant potato used in making this meal proved very satisfactory, tasting reasonably good and being extremely easy to prepare. Dried fruit made an excellent dessert, and could be left in water to rehydrate during fieldwork. Packet cheesecakes were also very convenient as they were quick and easy to prepare. Relatively little of the coffee, tea and cocoa taken was actually consumed, the demand for fruit juice and water being much higher. Soup, however, was very popular, especially in cold weather. Individually wrapped portions of powdered soup were used, as these were of low bulk and weight, and could also be prepared quickly. Supplies of corned beef, tuna fish, chocolate and crunchy bars were very useful during the storm when the primus stoves could not be lit.

MEDICAL SUPPLIES

As Svalbard is a large area, much of which is remote, it is essential that any expedition has its own independant medical supplies, and adequate knowledge to use them effectively. In an emergency, hospital facilities are available in Longyearbyen, and the general rescue service can be alerted via the Governor's Office, the airport control tower or Svalbard Radio. Rescues on Svalbard are carried out at the Governor's expense. British expeditions should note that a mutual agreement exists between Norway and the U.K. covering the cost of hospitalisation and ambulance transport.

This expedition was provided with a basic first aid kit by the University of Aberdeen Student Health Service. This kit was considerably expanded according to Illingworth's (1984) recommendations. The contents of this kit are listed in Appendix II.

Enquiries concerning the transport of a first aid kit through Norway should be addresses to the Norwegian Department of Health (Helsedirektoratet). This address may be found in Appendix III.

LOGISTICS

Transport

Food, camping equipment and scientific equipment were packed in fifteen cardboard boxes and shipped in June from Aberdeen to Bodø and then on to Longyearbyen. This was arranged through John Cook (Agencies) Ltd. in Aberdeen. The Store Norsk Spitsbergen Kulkompani acted as receiving agents in Longyearbyen. No freight was shipped back as the bulk of the original consignment had been food. Camping and scientific equipment were taken back as personal luggage.

Expedition members flew on Scandinavian Airlines System flights, leaving Aberdeen for Oslo on 9th July, continuing to Tromsø on 13th July and Longyearbyen on 14th July. Return flights to Aberdeen were on the 18th and 19th August.

Transport from Longyearbyen to Daudmannsøyra was by boat. The "Iskongen" was chartered for an outward journey on 17th July, and the return on 13th August. The journey took about five hours each way. Considering the time and distance involved, this was the most expensive stage of the journey, but it was the only

means of transport available.

Conditions of Entry

Svalbard is ruled under Norwegian sovereignty according to the spitsbergen treaty of 1920. There are no restrictions on expeditions as access is protected by the same treaty. Passports are not required for entry into Svalbard, but are required for travel to and from Norway. All expeditions must register with the Governor's Office on arrival, and provide a detailed description of their route and plans. This is essential as much of Svalbard is protected by special conservation laws, details of which can be found in the booklet "Environmental Regulations for Svalbard and Jan Mayen", available from the Norwegian Ministry of Environment, or the Governor's Office.

Visitors to Svalbard are also required to be adequately equipped to manage on their own. Equipment may be checked by the authorities on arrival in Svalbard, and persons arriving without adequate or proper equipment will be refused entry. Firearms and ammunition may be brought into Svalbard from any Norwegian port without special permission, provided the person concerned is in possession of a current licence from their own country. The

operation of a radio requires a licence from the Norwegian Telecommunications Administration. Svalbard is a duty-free area, visitors clearing customs in Tromsø.

Campsite at Longyearbyen

The campsite at Longyearbyen was situated about 20 metres below the airport, at an altitude of approximately one metre. The camping hut was only open between the hours of 09.00 to 12.00 and 17.00 to 21.00 local time. There was a camping charge of 35 NOK per person per night which included the use of the following camping hut facilities: a large kitchen with four electric rings, two sinks for washing up, tables and benches; washing machine and dryer (free); payphone; showers and toilets. The shower was operated by a 5 NOK token allowing four minutes hot water, provided no-one else was running the hot water. Footwear had to be removed before entering the hut to prevent the coal dust making the floors dirty. There were two dry toilets along the road from the hut for use when the hut was closed (but not recommended!). The area under the wooden camping hut could be used to store equipment etc. There was plenty of space to camp, although the ground was very stony and permafrost near the surface made pegging out tents difficult.

Facilities at Longyearbyen

The town of longyearbyen offers few facilities to expeditions. It is not possible to supply an expedition with food, although there is a cafe where a good meal can be had for a reasonable price. There is also a store where drinks, fruit, chocolate and souvenirs can be obtained, and a kiosk selling much the same. Paraffin and other fuels can be bought from the Store Norsk Spitsbergen Kulkompani, although this should be confirmed with the company in advance. There is also a bank, a post office, a telegraph office, a telephone service and a church. For entertainment, a cinema shows a film once per week.

FINANCIAL STATEMENT

Income

Sponsorship and financial support:	
British Ecological Society	750
University of Aberdeen	585
B.P. Petroleum Development Ltd.	500
Christian Salvesan plc	215
Gilchrist Educational Trust	200
Cran Bequest	100
Edward Wilson Memorial Fund	100
Royal Geographical Society	100
Skene Bequest	100
Clydesdale Bank plc	50
	2700
Donations	52
Fund-raising	183.94
Personal contributions	1950
	4885.94

Expenditure

Flights	2110
Boat charter	1461.65
Insurance	313.62
Equipment	320.20
Food	273.16
Freight	160.13
Secretarial	97.86
Camping charges	82.26
Bank charges	7.00
Production of reports	59.88
	4885.94

The original estimate of £4780 for the total cost of the expedition was remarkably close to the actual expenditure of £4885.94. The cost of flights was greater than anticipated due to non-availability of economy seats at the time of travel, however this was balanced by the costs of equipment and food being less than estimated, due to a combination of donations and discounts from sponsors and borrowing items of equipment. Accurate estimates were available for all major costs except freighting, where the exact weight and volume of freight was not known in advance.

ACKNOWLEDGEMENTS

Deepest thanks are due to the following organisations for providing financial support for this expedition:

British Ecological Society

B.P. Petroleum Development Ltd.

Christian Salvesan plc

Clydesdale Bank plc

Gilchrist Educational Trust

Royal Geographical Society

Scott Polar Research Institute

University of Aberdeen

Aberdeen University Social Club

Thanks are also due to the following companies for donation of products or discount on purchases:

Booker Belmont Wholesale Ltd.

Brooke Bond Oxo Ltd.

Colgate-Palmolive Ltd.

Drinkmaster Ltd.

Haldane Foods Ltd.

Jessop of Leicester Ltd.

Kavli Ltd.

KP Foods

Manley Ratcliffe Ltd.

Marshall Mountain & Ski Equipment Ltd.

Paterson Jenks plc

Reckitt & Colman Products Ltd.

Tate & Lyle Industries Ltd.

R. Twining & Co. Ltd.

United Biscuits (UK) Ltd.

This expedition is also indebted to the following for advice and assistance:

Dr. I.J. Patterson, Prof. G.M. Dunnet & Dr. D.G. Raffaelli; University of Aberdeen Culterty Field Station.

Prof. W. Mordue & Mr. R. Smith; University of Aberdeen Department of Zoology.

Prof. C.H. Gimmingham; University of Aberdeen Botany Department.

Drs. C. Clapperton & J. Maizels, & Mr. H. Ross; University of Aberdeen Geography Department.

Dr. M. Owen; The Wildfowl Trust.

Mr. M. Robertson, (Home Agent for expedition)

Mr. B. O'Connell; Cawdor Rifle Club.

Mr. R. Swann.

Mr. G. Wright; Nature Conservency Council.

Drs. G. Cranmer & L. Terry; A.U.M.S.

Dr. C. Tod; Gatty Marine Laboratory.

Stavanger Museum.

Scandinavian Airline System, Aberdeen.

Royal Botanic Gardens, Edinburgh.

Waterston Library, Scottish Ornithologist's Club.

Special thanks are also due to the Sysselman på Svalbard and to Norsk Polarinstitutt for granting permission for this expedition to carry out scientific research on Svalbard.

Part 4

APPENDICES

APPENDIX I

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APPENDIX II

Equipment Lists

Camp Equipment

Tents, Vango Force Ten Mk.5	3
Folding shovel	1
Primus stoves	2
Metafuel tablets	
Paraffin	
Fuel bottles	2
Matches	
Cooking pans	
Kettle	1
Can opener	2
Scourers	
Dish cloths	
Drying cloths	4
Washing-up liquid	
Water bottles (1 litre)	5
Folding bottle (5 litre)	1
Waterfilter	1

Water purifying tablets	
Basin	
Spurtle	1
Wooden spoon	1
Clothes line	1
Clothes pegs	

Survival Equipment

Rifle	1
Ammunition	
Rifle cleaning kit	
Tripguns	2
Tripwire	
Compasses	3
Whistles	5
Miniflare Mk.3	1
"Housewife" repair kit	
Rope, 30m of 9mm kernmantle	
Karabiners, screwgate	4
Slings	2
Deadmen	2
Ice axe	1
Survival bags	5

Scientific Equipment

Telescopes	2
Tripods	2
Ringing pliers	2
Circlips pliers	2
Spring balance	1
Vernier calipers	1
Wingrule	1
Mistnet, single shelf	1
Clapnet	1
Sample jars	
Formalin	

Personal Equipment

Rucksack	
Sleeping bag, four season	
Karrimat	
Warm clothing	
Boots	
Gaiters	
Waders	
Waterproofs	

Binoculars	
Camera	
Mug	
Cutlery	
Wash kit	

Miscellaneous Items

Inflatable boat	1
Cine cameras	2
Books	

First Aid Kit

First Aid manual	1
Triangular bandages	8
Crepe bandages, 10cm	3
7.5cm	1
Open weave bandages, 5cm x 5m	3
Tubular bandage	
Band aid plasters	
Band aid dressing strip, 6cm x 15cm	2
Melolin gauze, 5cm x 5cm	5
10cm x 10cm	10

Sterile dressing, BCP No.8	2
Sterile dressing pack	1
Extra large dressing	1
Steri-Strip, 1/4in x 3in	3
1/8in x 3in	10
Micropore tape	
Zinc oxide plaster	
Cotton wool	
Cotton swabs	
Safety pins	
Detol	
Savlodil antiseptic	
Acriflavine antiseptic	
Cetavlex antiseptic cream	
Caladryl cream	
Paracetamol	
Asprin	
Fortral	
Dequacaine	
Penicillin V	
Erythromycin	
Senokot	
Lomotil	
Piriton	

Sulphacetamide eye ointment

Bonjella

Boracic crystals

Mycil, ointment & powder

Sting relief

Lip salve

Lip balm

Vapour rub

Indigestion tablets

Thymol glycerin

APPENDIX III

Useful Addresses

A/S Lufttransport
9170 Longyearbyen
Svalbard
Norway

Den Norske Turistforening
(The Norwegian Tourist Association)
Stortingsgaten 28
0161 Oslo 1
Norway

Expedition Advisory Centre
1 Kensington Gore
London SW7 2AR

Helsedirektoratet
(Norwegian Health Department)
Postboks 8128 Dep.
Oslo 1
Norway

Justisdepartementet
Polaravdelingen
Postboks 8005 Dep.
0030 Dep. Oslo 1
Norway

Miljøverndepartementet
(The Ministry of Environment)
Polarseksjonen
Postboks 8013 Dep.
0030 Oslo 1
Norway

Norsk Polarinstitutt
Rolfstangveien 12
Postboks 158
1330 Oslo Lufthaven
Norway

Oslo Politikammer
(Police Headquarters)
Postboks 8101 Dep.
0032 Oslo 1
Norway

Royal Geographical Society

1 Kensington Gore

London SW7 2AR

Royal Norwegian Consulate General

86 George Street

Edinburgh EH2 3BU

Royal Norwegian Embassy

25 Belgrave Square

London SW1X 8QD

Scandinavian Airlines System

52 Conduit Street

London W1R 0AY

Scott Polar Research Institute

32 Lensfield Road

Cambridge CB2 1ER

Stavanger Museum

Musegt. 16

N-4000 Stavanger

Norway

Store Norske Spitsbergen Kulkompani

9170 Longyearbyen

Svalbard

Norway

Svalbard Sparebank

N-9170 Longyearbyen

Svalbard

Norway

Sysselmannen på Svalbard

(The Governor of Svalbard)

9170 Longyearbyen

Svalbard

Norway

Teledirektoratet

(Norwegian Telecommunications Administration)

Postboks 6701 St. Olavs Plass

Oslo 1

Norway

Tromsø Museum

(conservation of cultural monuments)

Folkeparken

9000 Tromsø

Norway

Universitetsforlaget

Postboks 2977

Toyen

Oslo 6

Norway

The Wildfowl Trust

(research projects on arctic geese)

Slimbridge

Gloucester GL2 7BT

APPENDIX IV

An Arctic Primer

I. CONDITIONS

a) Coal dust: a fine black powder found everywhere in the vicinity of Longyearbyen; a substance that mysteriously permeates everything and everywhere.

b) Dry: that which is about to become wet; an ideal state rarely attained on expeditions, closest approximation achieved inside a tent.

c) Damp: that which is becoming wet; the state achieved inside a tent.

d) Wet: what everything on expeditions is or becomes, invariably involving water in some form.

e) Lichen: a dark polymorphous organic matter found everywhere on Daudmannsøyra; a substance that mysteriously permeates everything and everywhere.

f) Clean: that which is about to become dirty; an ideal state never attained on expeditions.

g) Dirty: what everything on expeditions is or becomes, invariably involving coaldust or lichen.

h) Clean and dry: an impossible state.

i) Warm: a rare state, sometimes achieved inside a sleeping bag.

j) Hot: a state achieved when in contact with a lit stove.

k) Cold: a state achieved at all other times.

II. TIME

a) Day: any period between 12 midnight one day and 12 midnight the next (see "night").

b) Chronological time: the actual time and date according to Norwegian summer time.

c) Psychological time: the time that the body or parts thereof (brain, stomach etc.) think that it is, not necessarily corresponding to chronological time. *e.g.*
Psychological morning: the period of time between when the brain perceives that the individual has woken and the stomach demands its second feed of the day.

d) Night: time of day only existing in psychological terms.

III. WEATHER

a) Cloud: fog more than three feet above the ground.

b) Fog: cloud less than three feet above the ground.

c) Sun: a round, bright, yellow object usually appearing in the sky shortly after the onset of psychological night.

IV. ACTIVITIES

a) Washing: an action involving cold water (clean or otherwise) and optionally, in extreme circumstances, with soap.

b) Flysitting: the action, or inaction, of sitting on the flysheet of a tent, thereby preventing the tent from being blown out to sea during a storm. Flysitter is the noun.

c) Transecting: a technique of collecting data which relies on the principle that if researchers are cold and uncomfortable they will be prepared to work hard for the reward of getting back to camp.

d) Bloodshed: a course of action contemplated by the research team when the leader insists on transecting for too long.

V. FOOD

a) Water: sometimes clear, colourless liquid requiring purification before consumption. Normally contains a proportion of coal dust or lichen.

b) Real food: edible matter that does not require reconstitution with water. Dreamt about on expeditions.

c) Expedition food: supposedly edible matter that requires reconstitution with water. Sometimes contains a small proportion of recognisably real food.

d) Whisky: an amber liquid that induces a pleasant feeling of warmth, comfort and contentedness; may be used by the leader as an incentive for transecting (*q.v.*), and in exceptional circumstances may also be used as a sleeping bag cleaner.

VI. EQUIPMENT

a) Trip-gun: cunning device that warns people in the camp of the approach of other expedition members.

b) Anemometer: precision scientific instrument capable of recording a ninety knot wind inside a tent and flat calm during a storm.

c) Primus stove: a temperamental and malevolent heating device with a tendency to hiss and spit at the unwary.

VII. WILDLIFE

a) *Branta*: a genus of goose notable for its ability to fly during moult.

b) Isbjørn: a near mythical creature that haunts the imagination of Arctic travellers; an animal to which all strange noises are attributed.

c) Glaucous Gull: an Arctic scaffy.

d) Reindeer: quiet, docile, gentle ungulates which eat lichen and flowers, also have large horns and a mean streak.

e) King Eider: an exotic species of Arctic duck, the search for which may be used as an excuse to delay the return to camp, especially when the return is interpretted as flysitting (*q.v.*).

VIII. MISCONCEPTIONS

a) "Svalbard has a low rainfall during the summer."

b) "This is as bad as it can get."

c) "It will be a nice day tomorrow."

d) "I'll meet you at the airport at 5 o'clock."

e) "It can't rain like this for much longer."