

79

-



THE SEVERN WILDFOWL TRUST EXPEDITION TO CENTRAL ICELAND, 1951

By Peter Scott, James Fisher and Finnur Guðmundsson

CONTENTS

									puge
Summary							• •	 • •	79
Introduction								 	79
The Breeding	Distril	oution	of the	Pink-f	ooted	Goose		 	81
The Pink-foot	ed Gee	ese of t	he Þjó	rsárver	við Ho	ofsjökul		 	84
Notes on the l	Birds o	of the 1	þjórsár	ver við	Hofsjö	kul		 	101
Notes on Inve	rtebrat	tes						 	110
List of Plants								 	112
References								 	114

SUMMARY

A PARTY of four assisted by Icelandic farmers spent five weeks (between 28 June and 2 August 1951) at what may prove to be the world's largest breeding colony of Pink-footed Geese (*Anser brachyrhynchus*). The history of this and other breeding colonies is outlined. The colony is in an oasis at the south-east side of the Hofsjökul in the centre of Iceland at a height of 2000 feet. Studies were mainly concentrated on marking, with a view to population measurement, and on behaviour. It was estimated that there were probably about 2300 nests in the oasis and that the population including adults and goslings may have been of the order of 13,000 birds. Recaptures of marked birds were used in making these estimates. Food, predation, nests, eggs and goslings, behaviour of parents and broods are described and discussed. Methods of capture were discovered which throw light on the functions of ancient ruined 'goose-folds' found in the area. Five large drives were made, in one of which 267 geese were caught. During the whole period 1151 geese and goslings were marked, some with Swedish-type wing-tags.

A list with notes on status and behaviour of thirty-two species of birds seen in the oasis is followed by notes on invertebrates, flowering plants and hot springs.

INTRODUCTION

During the summer of 1951 the Trust sent an expedition to the Central Highlands of Iceland in order to study and mark Pink-footed Geese. This formed part of the general study and census of this species and followed upon the successful rocket-netting of the previous winter, when 643 Pinkfeet had been marked.

The expedition was supported by a grant from the Royal Society, and consisted of the authors and Miss Philippa Talbot-Ponsonby, under the leadership of Peter Scott.

Pink-footed Geese breed in Greenland, Iceland and Spitsbergen. Several colonies were previously known in Central Iceland. The largest of these consisted of some 200 pairs nesting on the river gorges of the Skjálfandafljót. A more extensive colony was believed to exist on an oasis of vegetation at a height of 2000 feet above sea level near the headwaters of the Þjórsá, Iceland's largest river, where a number of tributary streams run out from the south-east side of the Hofsjökul.

No ornithological survey had ever been made of this area during the incubation period of the geese, and this was therefore the expedition's objective.

The party left Reykjavík on 22 June by chartered bus and on the same evening reached Ásólfsstaðir, the highest farm on the Þjórsá, which lies just across the valley from the volcano Hekla. With two Icelandic farmers as guides, and a cavalcade of seventeen ponies, the journey began on the following day, and after four days' riding the oasis was reached. The Base Camp was set up on the banks of the river at the edge of a marsh in which many Pinkfeet were nesting. The colony was found to be even larger than expected. At least 1500 pairs are believed to have been breeding in the forty-four square miles of tundra-bog, and the number was probably about 2300 pairs. Some nests still had eggs on 26 June but many had already hatched.

The farmers with their ponies returned to the farm and the four of us explored the area on foot for about a fortnight. On 10 July a second ponytrain arrived with additional stores and from then onwards one farmer, Valentínus Jónsson, remained, with seven ponies. The new mobility provided by the ponies not only increased the range of exploration, but made possible the capture and marking of geese, now that the adults had moulted their wing feathers and were flightless, and the young were large enough to be ringed (for they were large enough also to escape when pursued on foot).

By the time that the third pony-train arrived at the oasis on 1 August to load up for the return journey, 1151 Pinkfeet had been marked, as well as twenty-three Whooper Swans, five Ptarmigan and one Red-throated Diver. To begin with the geese were caught after pursuit on horseback, but later a technique was evolved for herding them together at the tops of the low glacial hills and driving them into a cage of rabbit-netting. In this way 267 geese were caught at one catch and 201 at another ; several catches scored over a hundred. Ancient ruins of stone pens, known to the farmers as goose-folds, indicated that a similar method must have been used on these same hills in the Middle Ages and possibly as early as the days of the Sagas. The latest reference to these goose-folds was made in 1638 by Gísli Oddsson, Bishop of Skálholt (see p. 96). No tradition of their function, however, remains with the present-day farmers of the Þjórsá valley.

In addition to the ornithological work of the expedition (which was concentrated on marking and behaviour), collections were made of fish, invertebrates and flowering plants; hot springs were mapped, their temperatures recorded and samples of their algae taken.

Contact by radio was made most evenings with Gufunes Radio Station near Reykjavík.

On 30 July, stores, cine-film and mail were dropped at the camp by a Catalina flying-boat of the Airline Company, Flugfélag Islands, flying fifty

feet above the tents. The expedition was extremely grateful to the company for this service which was provided free.

The party returned with the train of seventeen ponies to the farm at Asólfsstaðir on 5 August having recorded their adventures on some three thousand feet of colour film and more than four hundred still photographs.



THE BREEDING DISTRIBUTION OF THE PINK-FOOTED GOOSE

The Pinkfoot's breeding-range was unknown a century ago. The first naturalists who saw the nests of wild Pinkfeet were E. Evans and W. Sturge, who found them in Ice Fjord, West Spitsbergen, in June 1855, though at the time they believed them to be those of Greylags. It was in 1864 that Alfred Newton and the Swedish ornithologist A. J. Malmgren identified the breeding grey geese of Spitsbergen as Pinkfeet. In 1870 a grey-goose feather was picked up by R. Copeland of the German *Hansa* expedition on Jackson Island, off the northern part of East Greenland. It was at the time thought to be that of a Whitefront; and it was not until 1891 that the breeding grey geese of North-East Greenland were identified, in Scoresby Sound, as Pinkfeet by E. Bay (1894).

SPITSBERGEN

As a breeding species the Pinkfoot in Spitsbergen appears to be confined to the main island, West Spitsbergen, and to one valley of Edge Island, southeast of it. Small groups, never exceeding a hundred individuals and seldom exceeding ten pairs, live in twenty or thirty valleys or raised beaches from near South Cape to Reindeer Peninsula in the north, particularly in Ice Fjord, perhaps the highest population being in Sassen Valley. Evidence of the presence of Pinkfeet on the King Karl (Wyches) Islands east of West Spitsbergen is forthcoming (A. G. Nathorst, 1899, 1900), but breeding has never been proved there, or in North-East Land or in Franz Josef Land. The Spitsbergen population is apparently small—possibly not enough to account for the most easterly wintering flock, the group averaging about four thousand birds that annually winters in Germany, the only regular winter flock outside England and Scotland.

GREENLAND

The breeding distribution of the Pinkfoot in Greenland is well summarized by F. Salomonsen (1950). The most southerly outpost is at Mikisfjord, just east of Kangerdlugssuaq in King Christian X Land, otherwise it breeds in suitable country (there are long stretches of lifeless waste) from Scoresby Sound north certainly to Hochstetter's Foreland and possibly to Dove Bay. The Greenland population does not appear to be large and it seems quite possible that a big migratory flock of 1000 to 1500 seen by F. S. Chapman (1932) on 31 May 1930 near Angmagssalik, on its way north, may have comprised a large proportion of the total. At only one place, at Constable Point in Hurry Inlet, Scoresby Sound, does it seem likely that there may be more than a

hundred nests. The only vegetation-oases that appear to be occupied at all densely are those of Jameson Land and the Muskox Fjord-Loch Fyne areas.

ICELAND

The first formal identification of the interior geese, the heidagaes or inlandgeese of Iceland, was not made until 4 June 1929 at the Krossá confluence of the River Skjálfandafljót. The British ornithologists Congreve and Freme (1930), who made it, by doing so cleared up a muddle that had lasted for over a century, since the days when the great pioneer ornithologist Friedrich Faber (1822, 1826) in Iceland in 1819–21 identified Iceland's supposed breedinggeese as Whitefronts and Bean-Geese. It is beyond the scope of this paper to recount the history of the development of our knowledge of Iceland's breeding geese, which is to be published elsewhere (Scott and Fisher, in press); here we shall simply list the present-known breeding-grounds of the Pinkfoot with relevant historical notes.

It breeds or has bred near the main streams and some tributaries of four of the rivers that drain the interior plateau of Iceland and the Hofsjökul and Vatnajökull icecaps—the Skjálfandafljót, Jökulsá á Fjöllum, Jökulsá á Brú and Þjórsá. No other certain Icelandic breeding grounds have been recorded.

Skjalfandafljót

Some geese shot in flightless summer moult in August 1894 at Dingev about 15 miles from the mouth were identified by H. H. Slater (1901) as Pinkfeet. These had probably come down-river from its headwaters. Further up the river the breeding geese of Goðafoss were identified by C. W. Shepherd (1867) in 1862 and F. Coburn (1901) in 1899 as Greylags : the Pinkfeet breed further still upstream,¹ the lowest perhaps at Aldeyjarfoss-more certainly at Hrafnabjörg, and up the Svartá tributary, where Magnús Björnsson (1932-34; and see G. Timmermann, 1933) encountered them in 1932; and other 'colonies' at the Krossá confluence (1929, 1932, and found here also by David Haig-Thomas in 1933 and by Finnur Guðmundsson in 1945); in Kiðagil (Guðmundsson in 1945); perhaps at Hraunárgljúfur and Langadrag on an upper tributary of the Hrauná (Björnsson in 1932); further up the main stream in Ytra-Fljótsgil (G. in 1945); and in Sydra-Fljótsgil (B. in 1933, G. in 1945), particularly the oasis Stóraflæða. In 1945 Guðmundsson found that the main breeding-stations in the whole Skjálfandafljót river-system were in the ghylls Krossárgil (near the Krossá confluence), Kiðagil, Ytra-Fljótsgil and Syðra-Fljótsgil, and he notes that at none of the other nine breeding-places encountered either by Björnsson or himself did the number of occupied nests exceed ten. He came to the conclusion that in 1945 there were most likely not more than 200 nests in the system.

Laxa

In 1932 Björnsson found small groups which he described as Pinkfeet at the Krákárbotnar and some other places along the river Kráká, which flows into the Laxá at the place where that river leaves the great duck-lake Mývatn. Timmermann, however, to whom Björnsson told his experiences soon after they had occurred, states that no Pinkfeet were observed on this occasion (early August) but that Björnsson found breeding-places of the Greylag only in the

¹ Shepherd was told by locals that 'large flocks' of geese bred near the source of the Skjálfandafljót.

Kráká headwaters. He adds : "Here, for the first time, nine young geese were ringed." Fortunately one of these was recovered ; it was recorded by Witherby and Leach (1933) as ring Reykjavík 2.76, ringed Ódáðahraun 2 August 1932, recovered Inverness 22 Nov. 1932 ; and it had certainly been placed on a Greylag !

In 1945 Guðmundsson investigated the Kráká area thoroughly and found no geese breeding there, neither Greylags nor Pinkfeet.

Björnsson states, rather equivocally, in another part of his paper, that Greylag and Pinkfoot "overlap . . . both on the Svartá and the Kráká, south from Mývatn." The Svartá here referred to is a tributary of the Skjálfandafljót whose headwaters are very close to those of the Kráká.



Jökulsá á Fjöllum

Shepherd was told in 1862 that large flocks of geese bred near the source of this river, and the inland goose-colonies here appear to have been known to the farmers, and raided by some of them, for many years. The lowest nests were seen by E. G. Bird (1934) and David Haig-Thomas in 1933 at the confluence of the Grafarlandaá and the Jökulsá. Others have been found at the near-by oasis Grafarlönd and by the banks of the Lindaá tributary (the lower of the two Jökulsá tributaries of that name), which indeed appear to have been the source of 'Whitefront' eggs which reached collectors, including M. U. Hachisuka (1927) in 1925, and to have been known to the farmers since the turn of the century, if not before. Bird and Haig-Thomas found no Pinkfeet in Grafarlönd in 1933, nor any on the banks of the lower Lindaá or in the oasis Herðubreiðarlindir, where eggs had been previously taken, though at this last B. B. Roberts (1934) and P. Falk thought there was probably a colony in 1932. In 1933 Björnsson saw Pinkfeet in Arnardalur, on the east side of the Jökulsá not far from here.

Further up the Jökulsá J. P. Koch (1912) found breeding grey geese (which he did not identify) in 1912 at Svartárbotnar at the confluence of the Svartá, and not far from the source of the Jökulsá more geese breeding 'along the riversides' of the oasis Hvannalindir. In 1932 Roberts and Falk found none in Hvannalindir. But Björnsson found a family party there in 1933, and he saw Pinkfeet also in the neighbouring oases of Grágæsadalur¹ and Fagridalur. In 1948 P. Beckett (personal communication) also found breeding Pinkfeet in Hvannalindir.

¹This name means Grey Goose Valley.

F2

Jökulsá á Bru

In his exploration of 1933, Björnsson found Pinkfeet in the tongue of land between the Jökulsá á Brú and its tributary the Kringilsá, and found nests (probably empty) on the upper moraine of the glacier Brúarjökull, part of northeast Vatnajökull.

Þjórsá

This is the only southward-flowing river so far proved to harbour breeding Pinkfeet. In 1894 Pearson and Pearson (1895) penetrated no farther than its lower reaches and found only Greylags plentiful, as they are still, on the islands in this part of the river. In 1931 Björnsson found a Pinkfoot breedingplace further up, in the upper-middle reaches of the river at Gljúfurleit (where we found three nests on the cliffs of the basalt gorge on 24 June 1951).

In 1932 Björnsson was told of colonies in the Kisubotnar, basalt gorges of the headwaters of the Djórsá's tributary, the Kisa. On 4 August 1876, on a crossing of Central Iceland by the Sprengisandur route, C. le Neve Foster (1879) camped at the Arnarfell oasis under Hofsjökul, and on the following day saw 'plenty of swans and wild geese' as he crossed the glacier-streams of the Djórsárver oases (of the right bank). This casual statement is the first indication of the whereabouts of what may prove to be the world's largest breeding-ground of the Pinkfoot, and nothing more is to be found in the literature concerning it as a breeding ground of Pinkfeet until after Björnsson's journey of 1932. When Björnsson made his way across from the south-west to the Djórsárver oases he found deserted goose-nests and saw Pinkfeet at the end of July "to the south-east of the glacier." Along Arnarfellsmular, the terminal moraine of the retreated south-east tongue of the Hofsjökul glacier, in 1950, the Icelandic geologist Guðmundur Kjartansson (personal communication) estimated a hundred nests. Across the Djórsá from here, in the oasis Eyvindarkofaver, Björnsson met fairly large Pinkfoot flocks with nearly flying young on 27 and 28 July; but he did not find any empty nests.

It had become clear by 1950 that there was a large breeding-population of the Pinkfoot still unaccounted for in Iceland, and that it was probable that such was harboured by this largest central oasis of Iceland. Guðmundsson's investigations, and particularly his conversations with the farmers of Þjórsárdalur who come up-river to its source to collect their sheep and hunt foxes in the late summer and autumn, also led him to this view. These farmers had seen many heiðagaes in the Þjórsárver við Hofsjökul.

THE PINK-FOOTED GEESE OF THE ÞJÓRSÁRVER VIÐ HOFSJÖKUL

The Extent of the Colony

The first Pinkfeet were seen in flight between Asólfsstaðir and Stöng on 23 June—a single bird and a flock of sixteen. The first nests (3) were located on the cliffs 'Dröngubásar' of the Djórsá gorge at Gljúfurleit on 24 June. (There was some evidence that Pinkfeet were breeding further down at the confluence of the Tungnaá though some broods seen there were definitely identified as Greylags. Five families of Pinkfeet were seen there on 3 August but might have been hatched further up.) Pinkfeet were evidently nesting on the lower reaches of the Dalsá; although no nests were found, droppings of small

Annual Report 1951-52

goslings were found there on the return journey. A hatched or robbed nest was found at Eyvafen, and half-grown goslings were caught in this area later on. The main area in which nests were found, however, was the oasis which included Tjarnarver, Oddkelsver, Illaver, Múlaver, Arnarfellsver, Þúfuver and Eyvindarkofaver. This consisted of some forty-four square miles of suitable habitat lying in a square with sides of approximately thirteen miles, and bounded on one side by the Hofsjökul Icecap and on the other three by desert. This area may be described as the Þjórsárver við Hofsjökul (The Bull's River's Meadows at the Shrine Glacier). It is mainly made up of meadows of marshy vegetation interspersed with pools and tarns, and divided by swift-flowing glacier-streams of milky water running over black shingle and creating many quicksands.

Food

The brilliant green vegetation of the oasis consists chiefly of the low-growing willows Salix glauca and Salix lanata. No less than 104 flowering plants were identified (pp. 112–14) and certainly many of them are eaten by the geese and goslings. Areas covered with the very tiny and very bright green Salix herbacea were not especially favoured by the Pinkfeet in contrast to the Lesser White-fronted Geese (A. erythropus) in Lapland, for which this plant was found to be an important food. The principal food seems to have been grasses and Equisetum. The bases of the stems of Carex were favoured and there was evidence that mosses and Selaginella were often eaten.

Predation

Good food-supply, lack of disturbance by man, and reasonable freedom from heavy predation seem to be the factors influencing the choice of breedinggrounds for geese. On the other hand a large colony is bound to attract some predators. We were surprised that the particularly large colony had not attracted more. By far the most destructive species, as far as the geese were concerned, was the Great Black-backed Gull (Larus marinus), yet it is unlikely that the number in the whole area was much above forty, and there was no evidence of breeding. The gulls were frequently seen to eat eggs; on occasion they dropped these from a height of fifty feet in order to break them; they also hunted the young goslings. A few Iceland Falcons (Falco rusticolus), were living in the oasis and were preying upon goslings. No evidence of nesting was found, but on one occasion a pair was seen together. From the number of times Falcons were seen, it seems possible that one, or perhaps two pairs were nesting within operational range of the area, but probably not more. A single immature White-tailed Eagle (Haliaeetus albicilla) was living on goslings, Ptarmigan (Lagopus mutus) and possibly adult geese (an eagle feather was found beside the remains of an adult Pinkfoot, but the goose may have died from other causes). A single adult male Snowy Owl (Nyctea scandiaca) was seen in the oasis and was probably feeding on goslings, although no positive evidence of this was obtained. Moulted geese, with goslings, running towards the owl altered course when they saw him.

The relationship between the Arctic Skua (*Stercorarius parasiticus*) and the geese remained rather obscure. No direct evidence was found that the Skuas were either taking Pinkfoot eggs or killing goslings although one persistently attacked a gull which was robbing a goose's nest, and another attacked a gull eating a gosling. Though it is not proved, it seems likely that eggs or young

of geese must frequently be eaten, if not originally destroyed by the Skuas. A pair was seen feeding on a gosling killed by a Falcon. Two were seen chasing a Dunlin. There are unlikely to have been more than ten pairs of Skuas breeding in the oasis (p. 109).

Whooper Swans (*Cygnus cygnus*) were seen on two occasions attacking broods of goslings, whose parents were attempting to counter-attack. Since eleven Whoopers' nests or broods were recorded in the oasis, there must be some gosling losses from this cause each year. The swans were evidently preserving territory or 'family distance' (a mobile form of territory inside which certain intruders will always invite attack).

Only two mammalian predators are at present significant—the Arctic Fox (*Alopex lagopus*) and Man. There is some risk that the Mink (*Mustela vison*), which has recently escaped from fur farms in Iceland and has spread rapidly at the expense of some bird populations, may reach the area and affect the status of the geese.

The fox is strenuously controlled by the farmers, because of the lambs. Special fox-hunters are sent into the interior each year to eliminate foxes. One came to the oasis with the second pony-train in July. None of the known earths was then occupied and he saw no foxes. The earths, however, were surrounded with goose-bones. Two traditional Pinkfoot nest sites were within ten yards of the fox warren. Only one fox was seen during the expedition. It came along the slope of the east bank of the Þjórsá, opposite the Base Camp, found a deserted goose's nest, ate the eggs, defæcated and then went to sleep curled up on the nest. In two predated nests in Tjarnarver, however, fox fæces were found indicating that at least one fox was living on the west side of the river, and one was heard barking in Oddkelsver during the night of 23–24 July.

Disturbance by man during the incubation period is of rare occurrence. The journey to the oasis in early summer, when the snow (non-glacial) rivers are still high, is uncertain, somewhat dangerous and extremely costly. The expedition was not delayed by the river-crossings in late June, through a combination of exceptional weather and very skilful guides. Later in the season the area is visited by farmers in order to collect their sheep. A large party rides up in September and smaller ones in October and sometimes even November (usually a hazardous trip). These farmers do not interfere with the geese, and in any event all nesting and moulting is usually finished by the time the sheep are collected. Parties of ornithologists may wish to visit this large breedingcolony in future. There is of course a risk that they may do so too often for its well-being. It is important that it should not be visited during the incubation period more than very occasionally, as some disturbance is inevitable and some losses are bound to result. The Icelandic Government is, however, well aware of these dangers and is taking the necessary steps to see that the geese continue to find sanctuary at this oasis.

Nesting

During the whole period of the expedition 212 Pinkfoot nests were found --mostly hatched and empty. By the end of July it was not altogether easy to distinguish a nest of the year from those of the previous year or even earlier. This was particularly so of nests with little or no down (of which there were some known to be of the current year). The nest sites were surprisingly variable. In almost all cases the nest was placed where the sitting goose could

Annual Report 1951-52

get a reasonably good view of the surrounding area. It appeared to be equally important (if not more so) that a suitable look-out point should be available for the gander within fifteen feet. It is evidently essential for the two birds to be close together, probably because only as a pair can they successfully repel predators. At Gljúfurleit, in the Djórsá gorge forty miles below the Base Camp, the nests were on ledges of precipitous basalt cliffs, as they are up the Kisa (p. 84) and Skjálfandafljót (p. 82). No such sites were available in the area of the main colony. Instead the birds were breeding in the tundra marshes, commonly on the tops of low frost mounds.¹ Although a site on the edge of a pool or stream was often selected, near-by water was by no means essential. All sites selected were on dry, well-drained places such as banks and small mounds; no nest was found in the very wet central parts of Illaver and Oddkelsver. Many nests were strung along the old terminal moraine of the glacier at the foot of the ice-cap. Fifty-nine nests were counted by us in 1951, and about a hundred estimated in the previous year by Kjartansson, along this uneven bank thickly grown up with herbage. Possibly this estimate was too high. In many cases the nearest water was a hundred yards away or more. Beside the fast-flowing Hnífá, on the other hand, there were nests on every minor eminence against the water's edge, and several nests on a small island in the stream. One Pinkfoot's nest was placed on top of an old Whooper Swan's nest-a high pile of dead moss. Another nest was against the wall of an ancient goose-fold; and another was on top of a kofi, one of the small huts, with stone walls and a turf roof overgrown with vegetation, which are built at various points by the farmers as occasional shelter for men and animals during the autumn sheep-collecting expeditions.

Many nests were placed on traditional sites, the manure round the nest having produced richer vegetation, which in turn had built up the immediate surroundings of the nest. Thus, these traditional nest mounds were often a foot or more high and must have been used annually for many generations. One such site was in the middle of a complex of hot springs, with a pool of water at 44° C within a few feet of the nest. Some mounds were occupied by geese whose nests were more or less free of droppings. There is great individual variation in nest sanitation, but clean nests on mounds of rich vegetation suggest that previous tenants had not been so clean.

Some nests were found by first noticing the very large pear-shaped droppings (more than 1 inch in diameter) made by the female goose when she leaves the nest once daily during incubation. They are seldom more than thirty yards away from the nest, and often there are quite a number in the same area. Other nests were found by first noticing the patch of short broken droppings left by the gander at the place near the nest where he usually stands guard.

No Pinkfoot nests were found closer than fourteen yards apart, and the average, even in areas of concentration, was considerably more. Such concentrations were found several times; one of them consisting of sixteen nests was in the marsh overlooked by the Base Camp, indeed one hatched nest was within five yards of the main tent. These sixteen nests were in a marsh occupying 0.42 sq. km., on the other hand they were concentrated in the central and northern part of it, and a line drawn round them enclosed only 0.168 sq. km., or about $41\frac{1}{2}$ acres. Thus even unusually dense concentrations of Pinkfoot

¹Below these mounds permafrost was found at 40 cm. in early July, and at the same depth on 1 August.

nests do not in any way compare with the crowded nesting colonies of Ross's Geese (A. rossi), Brent Geese (Branta bernicla), or indeed many other goose species.

Behaviour of the adult geese at the nest varied widely. The majority of females would leave the nest and its vicinity as soon as a human was sighted within half a mile or more. Near hatching time individuals were braver and would sit crouching on the nest, although in full view, to ranges as low as thirty yards. The boldest allowed herself to be photographed without a hide at about fifteen yards, and two others were almost equally confiding. The ganders, however, did not stay but always went off at about seventy yards, except in one case where the young were already hatched and the gander crouched beside the nest until less than thirty yards ahead. One female whose eggs were chipping returned to the nest within five minutes in spite of a newly erected hide some thirty yards away. Others did not return even when the hide was fifty yards from hard-set eggs. One Pinkfoot female had a Barnacle gander (Branta leucopsis) as mate. This was the only Barnacle seen. He was tamer than the female, returning and standing by the nest long before the female returned. This nest of four eggs was subsequently predated, probably by a gull.

Eggs

Of the 212 Pinkfoot nests found, only nineteen were still occupied either with eggs or young goslings less than forty-eight hours old (after which they leave the nest returning sometimes during the first days to roost in the nestdown at night). On our arrival at the colony on 26 June we found that the majority of nests had hatched. From the average size of the goslings we were led to the conclusion that the peak hatching date must have been about 22 June. Allowing twenty-eight days incubation period the peak date for complete clutches must have been about 25 May and for the first eggs 12 May. The nineteen occupied nests contained the following clutches of eggs (or newlyhatched goslings) :

Number of eggs in cl	utch	 	1	2	3	4	5	6	7	Average 4.5
Number of nests	• •	 • •	0	0	6	3	5	4	1	Total 19

Most of the eggs were fairly heavily stained reddish-brown, but some clutches were rather unexpectedly white although hard set. Whenever possible they The following measurements were obtained (in mm.): were measured. $81\cdot3 \times 53\cdot7$; $75\cdot7 \times 52\cdot6$; $81\cdot5 \times 53\cdot8$; $81\cdot4 \times 51\cdot4$; $82\cdot3 \times 52\cdot5$; $82\cdot0 \times$ $53\cdot3$; $82\cdot6 \times 53\cdot3$; $82\cdot9 \times 54\cdot3$; $81\cdot3 \times 53\cdot6$; $84\cdot7 \times 53\cdot4$; $82\cdot4 \times 54\cdot7$; 79.6 \times 55.3 ; 78.2 \times 55.3 ; 85.6 \times 51.8 ; 85.5 \times 53.6 ; 81.0 \times 52.2 ; 82.1 \times 51.7; 79.0×50.3 ; 73.3×48.8 ; 78.2×48.2 ; 72.8×45.7 ; 69.8×44.7 ; 82.0×53.8 ; 87.8×52.8 ; 84.0×53.8 ; 85.6×53.3 ; 73.2×52.0 ; 71.3×52.7 ; 73.7×52.1 ; 78.0×53.0 ; 78.8×52.6 ; 81.7×53.0 ; 80.8×55.4 ; 80.2×54.3 ; 81.3×53.6 ; 81.7×52.4 . Average of 36 eggs 80.1×52.5 . Maximum 87.8×52.8 ; 80.8×55.4 . Minimum 69.8×44.7 .

It was noticed rather frequently that one egg had been eaten by predators while the others had survived to hatch. The explanation may be that predation occurred after hatching to any unhatched egg. Unhatched eggs were found in only one nest (out of 212). It is to be supposed that they are taken by predators very soon after the nest is left. Another mystery is the disposal

of the egg shells after hatching. Hatched nests normally contained broken shells and egg membranes, but in most cases much less than would have been expected from several eggs.



Goslings

Pinkfoot Goslings

It is believed that the majority of goslings hatched on 22 June. They are not dry for at least thirty-six hours after the eggs are chipped and since they do not normally leave the nest during the night (perhaps due to the temperature, as it is, of course, quite light) they are often forty-eight hours old or more before they start walking. At this age they are extremely beautiful. The principal colour is olive-green, patterned with yellowish on the face, on the wings, in a spot behind the wings and on the underparts. There is a dark patch through the eye. The vividness of the yellow is subject to considerable individual variation, and fades as the gosling grows, until at a later stage the bird is pale grey with only a tinge of greenish.

From the droppings of the goslings it appears that they are only rarely taken back to the nest for the night. Roosting-places on the banks of tarns and streams were found several times. In one case the female was still making the large pear-shaped droppings of the incubation period although her goslings were eight days old. It seems that the enlargement of the cloaca caused by egg-laying persists until some time after hatching although the enlarged droppings are probably made only at night when the bird might not wish to disturb the goslings she is brooding more frequently.

Goslings are able to dive almost as soon as they leave the nest. It was frequently noticed that in diving they turned back on an opposite course to that on which they had been swimming on the surface. This must, of course, be an innate behaviour pattern, and one which may be used by only a certain proportion of goslings. There seems to be a strong urge to run uphill when danger threatens. Goslings released, after marking, on the edge of a stream, all turned and ran back up the shore among humans and ponies. This was the initial direction which they had been taking before being caught, which may have been the cause of this strange behaviour.

The tendency of goslings to regard humans as their parents was frequently observed and sometimes found embarrassing (the same was observed in Whooper cygnets). On several occasions it was difficult to get away after marking a

young brood without being followed by them. A gosling of about two weeks which had become separated from its parents and the rest of the brood ran up to P. S. when he called it and sheltered at his feet. On another occasion by waving his arms and flapping his coat he was able to catch the attention of two goslings about three weeks old, which then ran up to within twenty yards. One gosling he was trying to catch seemed to regard him (or his horse) as a fellow escapee. When he got ahead of it, it ran on towards him. When he slowed down, it slowed down, and when he stopped, it stopped, and stood below looking up at him in the most delightful way. A flock of thirty goslings nearly able to fly, but with no adults among them were completely oblivious of his approach on horse-back and only moved off when he was about forty yards away. If an adult had been with them they would have started running at three quarters of a mile.



The behaviour of the adults with goslings was variable. One female with newly hatched young ran a few yards ahead of them with wings spread, from time to time turning to face the enemy. No other parent was so brave. The gander of this pair flopped out onto the river as if almost flightless. He had not moulted, however, and this was the nearest to injury-feigning observed among the Pinkfeet. No other gander was seen to behave in this way.

After the disturbance of a party of three families on a small pool, two of the families united and went off with one set of parents leaving another pair without any young following. This mixing of the families by disturbance may be an important factor in family grouping later in the year. What appear to be families may not, in fact, be 'natural' families, but rather the product of accidental mixing after acute disturbance. On this occasion two goslings crouched. Almost at once a Great Black-backed Gull appeared and took one of the goslings, although it was only a few feet from one of the Pinkfoot ganders. The gull carried the gosling about two hundred yards away and ate it (being dived on, the while, by an Arctic Skua). The gull then returned to the pond and landed near the second gosling in very shallow water. First the gosling ran towards it, evidently regarding it as a parent, then it became doubtful and finally ran away behind a tiny island. The gull was evidently not hungry; he washed his bill and drank, pranced up to the gosling once or twice, but left it. The gosling made its way across the pool towards P. S. and crouched when it reached the bank. He caught and marked it. When he let it go the pair of geese without young were standing at the far side of the pool about sixty yards away, and calling incessantly, yet the gosling remained crouched on the near side. After much 'shooing' it set off across the pool towards the calling adults. They waited for it and led it gently away. It is far from certain that it actually belonged to them, as the young were all of about the same age.

The following quotation from P. Scott's diary of 14 July illustrates parent behaviour in face of another predator species. 'As we proceeded from this series of captures we saw a commotion of birds below us on the slope. A Pinkfoot gander, parent no doubt of the smaller goslings we had just marked, had settled on the ground, disturbing a group of three birds. Two of them were Arctic Skuas, but the third, which was being mobbed by the skuas, was a large rather dark and brown Iceland Falcon. The skuas were evidently a great nuisance to it, as it ducked every time they dived. Eventually it flew off ... fairly low over where the Pinkfoot gander was standing. As it approached, the gander turned and faced it and spread its wings. Afterwards, when the gander too had flown off, I rode over the ridge behind which most of this drama had been enacted. I found a dead gosling where the gander had been standing. A skua rose from beside it. Its neck had been almost severed at the back of the head. What was most interesting to me was that the gander, assisted (unwittingly) by the skuas, had driven the falcon from its kill. It seems likely, therefore, that properly attended goslings are capable of withstanding attack by an Iceland Falcon'.

This occasion followed immediately upon the capture of some geese for marking. Such hunts usually resulted in the scattering of the party of geese. The fact that the majority of parents are so wild and desert their goslings must operate largely against their survival although there is evidently some mechanism for regrouping. As soon as the goslings are about a week old the families begin to form up into flocks which steadily agglomerate during the summer. At three to four weeks fifty is a common number-later a hundred or more. These flocks are held together by a strong bond, as will be seen later, but if hard pressed by pursuit they will scatter, some of them crouching. This scattering is remarkably even, the goslings running out in a star from the scattering point. On several occasions there was evidence that, after about half an hour, regrouping began. Goslings would be seen coming back to the scattering point, and flying parents also returned to the area in which they had last seen their young. The same thing was observed with goslings of Ross's Goose (A. rossi) and the Lesser Snow Goose (A. caerulescens hyperboreus) on the Perry River in Arctic Canada. The evolution of the scattering technique requires an efficient method of regrouping. If goslings were certain to be lost and to die after scattering there would be no point in this fairly wellorganised procedure. It would be better for them to stay bunched, with an increased risk of being eaten by the predator, than to scatter to certain death.

That lost and entirely unattached goslings can and do survive is shown by the case of two marked on 14 July, when they were estimated to be no more than two and a half weeks old. No parents were within a mile of these goslings and they had evidently become lost many hours before, if not on the previous day. Nevertheless the two rings were recovered from a poulterer's shop in Lanark (Scotland) on 1 December, four and a half months later.

The Pinkfoot families did not apparently remain in the vicinity of the nesting area. (In this they were in direct contrast to the families of Whooper Swans.) From the recapture of marked birds it was possible to trace the local movements of families. There was some evidence of a tendency for the geese to move slowly down the Djórsá, but this was probably no more than the mechanical effect of flocks crossing the river (about two hundred yards at its narrowest point), and ending up several hundred yards below where they started. A wingtagged gosling marked in its nest with four others on 29 June was recaptured

from a brood of three with parents 4 km. away on 7 July.

Because of the habit of collecting in flocks it was hard to count broods that were more than a week old. Ten broods counted in the first half of July were as follows : 3 2 2 6 3 5 5 7 5 6, average 4.4.

A group of fifty birds on 21 July consisted of eight pairs of adults and thirty-four goslings—an average of 4.2. The average of nineteen nests with eggs or newly hatched goslings was 4.5 which seems to indicate a low mortality rate during the first month. Adult-juvenile ratios in the large catches (discussed later) are influenced by two sources of error : an unknown component of non-breeding flightless adults (indistinguishable from parent adults), and the possibility of 'trap-shyness' in adults.

Evidence of growth rate was not extensive but one gosling, marked in the nest, weighed $2\frac{1}{4}$ lb at twenty-five days. The main bulk of the goslings was not yet able to fly when the last catch was made on 1 August, but one bird could just do so. On the other hand in a week many more would have been able to fly. Thus, it seems that Pinkfoot goslings should fly for the first time during their seventh week after hatching—in this case, for the majority, about 6 August.

A large proportion of goslings which appeared perfectly healthy and normal were infested with a tapeworm subsequently identified as *Hymenolepis lanceolata* (Bloch), a species widely distributed among Anseriform birds.

Specimens

Three goslings were taken as specimens, one was killed by the kick of a horse and fifteen were killed by accident in the nets—twelve in the first big catch and three subsequently. Crop contents were examined, viscera perserved for the identification of parasites, skins were prepared, ectoparasites collected, and the flesh finally eaten. The muscles on the breast were poorly developed, but the leg muscles were greatly developed and made an excellent meal.

Details of Specimens

Food of 9 goslings

- Equisetum (stems) Grasses and sedges (leaves) Polygonum viviparum (leaves and bulbs)
- 2. Leaves of sedges (dominant) Mosses (trace)
- 3. Sedges (remains of leaves)
- 4. Equisetum (stems) Sedges (leaves) 1 spider
- 5. Sedges (leaves)
- 6. Sedges (remains of leaves)
- 7. Sedges and grasses (leaves)
- 8. Sedges (remains of leaves)
- 9. Sedges (leaves dominant but rootstocks also present)

No. 1 was killed by a falcon in Oddkelsver 14.7.1951.

Nos. 2–9 were killed during the big catch 25.7.1951.

On the goslings Mallophaga belonging to the genera Trinoton, Anaticola and Anatoecus were found.

Wing-Moult

The flight-feathers of adult Pinkfeet (as in all *Anatidae* except *Anseranas*) are moulted simultaneously so that the birds are flightless until the new flight-feathers have grown again sufficiently to give the necessary lift for flight (which may be a few days before they have completed their growth).

Pinkfeet do not breed until they are at least two years old, and probably not usually until three years old. Thus, yearlings and two-year-olds which are not yet sexually mature may be found in the breeding area, although in this case so few as to indicate a separate moulting area for sexually immature birds. Non-breeding birds moult before the parents of broods. This occurs in many if not all species of true geese. P. S. has observed it among communities of Ross's geese, Lesser Snow Geese, Taverner's Canada Geese (*Branta canadensis taverneri*) and Lesser Whitefronts.

The first definitely flightless non-breeding adult Pinkfeet were eleven in a flock of seventeen seen on 4 July. The first flightless parent was a female with goslings of between two and three weeks old on 10 July. The gander could still fly. On 12 July the first flightless adult was caught-a female, but not definitely a parent. On 17 July the female of a pair with a brood was flightless although the male could still fly. It is possible that female Pinkfeet always moult before the ganders. (Whooper Swan pens appeared to moult before the cobs.) It is almost certain that some non-breeding Pinkfeet seen on 1 July had moulted, but the evidence was incomplete. In the case of Ross's and Lesser Whitefronts the first non-breeders moulted only a day or two after the peak hatching date, but in this case the first flightless non-breeders were seen twelve days after the estimated hatching date. Non-breeders frequenting areas away from the breeding colony (areas still to be discovered, but the large numbers of yearlings and two-year-olds must moult somewhere) may become flightless earlier. The moulting-time of parents who have lost nests early and have not re-nested, is still obscure, but it is likely that they, too, moult substantially before the parents with broods. The first goose flying on new primaries was just able to take off on 28 July. This is twenty-four days after the first flightless birds were seen. The period is likely to be longer rather than shorter because a single flying bird among flightless flocks is conspicuous, whereas the first flightless bird might easily have passed unnoticed. Thus the flightless period for Pinkfeet is probably at least twenty-eight days.

There is evidence that some loss of the powers of flight takes place before the primaries and secondaries are actually moulted. Ross's Geese which still had black wing-feathers were unable to fly out of a net cage three feet high. Lesser Whitefronts flew away very low when the rest of the flock was already flightless. Of the seventeen Pinkfeet seen on a small lake in Illaver on 4 July three sat on the water with heads erect watching our approach and finally took off in a perfectly normal manner. Fourteen sank low in the water and swam away with necks stretched forward, till they reached the shore. Having climbed out, three more took wing, but flew very low as though with difficulty. They were apparently affected by imminent flightlessness.

The behaviour of moulted Pinkfeet is interesting. Whereas most geese (Ross's, Lesser Snow, White-fronted, Taverner's Canada, etc.) make for river or lake when surprised, the Pinkfeet of the Djórsárver (like Brent observed by J. F. in Spitsbergen and the Lesser Whitefronts in Lapland) set off up the nearest hill. They all start running as soon as the intruder comes into sight, no matter how far away—whereas those still capable of flight stand and watch

for some time first and then fly. Those without broods run very fast, those with broods usually stay with the goslings and, therefore, go much more slowly. The low hills (Icelandic name, *alda* = wave) are mainly bare of vegetation and therefore easier to run across than the grass of the bogs and marshes; their summits provide a good look-out from which the danger can be surveyed; they also provide a background against which a crouching goose is least visible and most likely to be taken for another stone. Finally, a goose—and even quite a small gosling—can run faster up hill than a man (and perhaps also faster than an Arctic Fox), whereas the man goes faster down hill and the goose frequently trips up. So, sometimes, does the man.

The Pinkfeet of Spitsbergen as often take to water or to the sea as to the hills. In Iceland occasionally parties disturbed on the brink of the $\oint j \circ r s a$ or Miklakvísl would swim across. When so doing they adopted the tightly packed formation characteristic of flightless geese on the water—each bird touching the next.

When one such party landed on the far shore, already a quarter of a mile away, some of the young and, indeed, some of the adults began to flap their wings and even to stop to preen. However a sense of urgency was communicated to them by one or two adults (probably by alarm notes though they were too far away to be heard) and they rushed on again, obviously reluctantly.

Normally when released after being marked, adult geese would continue to run at full speed until out of sight. Attempts to keep families together by releasing the goslings first in the hope that the adults would slow down when they caught up with them were unsuccessful. On one occasion only was there a startling departure from the normal behaviour of escape. After the big catch of 25 July many of the goslings ran down into one of the tarns in Falcon Marsh, not three hundred yards from the summit of the hill where they had been caught. Here they tended to collect and quite a number of adults stayed with them on the water until there were over a hundred, and one old goose had twenty-seven goslings. After a while a number of well-grown goslings became hungry and went ashore to feed. Some adults followed. These birds fed, preened, and even slept within three hundred yards of the catching party with their ponies in full view on top of the hill. Beyond them on the marsh was a large and very white female Iceland Falcon, and a second Falcon was present in the area. Some of the geese uttered typical alarm-notes, while others fed and preened. It would seem that the flock found the presence of humans and falcons on opposite sides equally stimulating, and that as a result it was "held" between them. When so "held" a flock often preens and feeds, as we noticed when the birds had been assembled on the hill-tops in front of the nets.

The overcoming, or domination of escape-drive by flocking-drive was often shown when geese which had been taken from the crowd in the net, marked and released, would frequently attempt to get back through the netting into the cage with the rest of the flock.

Marking Methods

Wing-tags of the type developed in Sweden were used for goslings whose legs were not yet big enough to carry rings. These are described on p. 24.

It was found that the feet of goslings between three and four weeks old were large enough to prevent the rings slipping off. If the clip-type rings were slightly flattened after being put on they were even less likely to come

Annual Report 1951-52

off. Both tags and rings carried the inscription MUS. NAT. REYKJAVIK ICELAND and the number.

166 tags were used on geese. Five of the tagged birds were ringed as well. 985 others were ringed. The total number marked was 1151.

Catching Methods

The first goslings were tagged in the nest when still too young to leave it, or rounded up fairly easily in their first couple of days. After that they became much more difficult to catch and when more than fourteen days old they were scarcely catchable on foot, being able to run as fast or faster than the pursuer, except downhill. As soon as ponies were available it was possible to overtake both adults and young on horseback. When overtaken the family or flock would scatter and many would crouch. A stealthy approach, not directly towards the bird, often resulted in a successful capture. Adults and young could both be picked up in this way. Evidently the inertia involved in crouching is only overcome by a sharp stimulus, such as a sudden approach. If the approach is slow enough the bird remains inert, as though this were easier than deciding at what moment to jump up. This powerful inertia was variable not only with individuals but with occasions. On certain days more seemed to allow themselves to be picked up than on others. No obvious correlation with weather conditions could be discovered, except that they did not sit close during the only hunt made in heavy rain.

The success of a pony-hunt was directly dependent on the crouching of the birds. The most successful hunt (20 July) was made in long grass on a flat marsh and yielded twenty-eight birds (thirteen adults and fifteen goslings). One of the party (P. T.-P.) was rather better at picking up adult geese than the others and on this occasion picked up five adults. Valli, the Icelandic farmer, usually caught the largest number as his horsemanship made him the most mobile.

Small hand-nets were made with wire hoops attached to the tubular aluminium uprights of the photographic hides. These were extremely successful and enabled us to catch geese which jumped up just out of hand reach. But when, in spite of these nets, a good average catch after a pony-hunt was fifteen geese (of which only three or four would be adults), out of a flock of perhaps a hundred geese or more, it seemed essential to find a more efficient method —especially as the hunts were disruptive to the flocks and families. Clearly the 175 yards of rabbit netting, which was part of the equipment, must be brought into play.

It was first set in a V across a dip or pass on one of the ridges, and an attempt was made to drive the geese into it. The drive was a complete failure and the geese ran up on to the crest of a different hill. The net was therefore reset on this hill (which was called the North Crest of Oddkelsalda) for use several days later. The first catch made on 17 July yielded fifteen geese, and the second, on 20 July, only ten geese. These catches failed through insufficient preparation of the drives, and perhaps through a shortage of geese in the marsh below the hill. On 25 July, however, a successful catch was made—which turned out to be the largest single catch of the expedition. In spite of errors and disasters 267 geese were caught, of which 98 were adults and included two previously ringed in Britain, one in S.E. Scotland and the other near the Wash.¹ One of

¹ These were not the first British marked birds to be recorded by the expedition. On 4 July an adult with a red-dyed tail and tail-coverts was seen among a flock of families running up a hill. This bird must have been caught near the Solway Firth in March 1951.

these two was known to be a yearling. An account of this catch is given on pp. 116-20.

The net was left on the same hill, and three days later, on 28 July, a catch of 97 was made by a similar drive. On the same day a part of the net was taken up and later set out on another hill called Arnarfellsalda. The setting was done just over the crest of the hill, so that the geese in the marsh below saw nothing, and a drive was made immediately which resulted in a catch of 180, bringing the day's catch to 277 (described on pp. 120–22).

On 31 July another drive was made towards Arnarfellsalda and a further 114 geese were caught. Meanwhile a new technique had been suggested by a small catch made on 26 July in Eyvafen. In the course of a pony-hunt a group of sixteen goslings, most of them nearly able to fly, were bunched together and held between three riders while the fourth rigged up a short length of net to make a cage, into which the bunch of goslings was gently herded. The possibilities of this method became apparent on 1 August, when a large flock of geese was herded on to the top of a hill (which became called Round-up Hill) and held there for half an hour (during which two adults managed to fly out) while a cage of netting with short wings was erected. Then the whole flock was moved slowly into the cage-203 birds in all including two goslings which escaped-83 adults and 120 goslings (pp. 123-24). The sex-ratio of the adults was thirty males, four doubtful males, forty-three females, five doubtful females, one doubtful. Too little time was available for cloacal sexing so that the above ratio, based on external characters, should be treated with reserve. If all the adults were parents the brood size in this catch (which had the advantage of eliminating the possibility of trap-shyness) was 2.9. A small addition of non-breeding birds would greatly increase this figure, which is therefore likely to be too low. It seems likely that any future marking expedition in the area would find this last catching method the most economical of time and material. But to be really successful it requires a somewhat larger party. A group of eight or nine capable riders would be much more successful than only five.

Goose-folds

The last catch demonstrated the use of the ancient goose-folds which had hitherto been a mystery. Some nine of these folds were known to the farmers. The expedition visited four of these, and, in addition, found five more apparently hitherto unnoticed in recent times.

The folds consist of a stone wall which must originally have been about four feet high built in the shape of a narrow U. The largest (at Nautalda) was about thirty-eight feet long and six or seven feet wide. Another (near Nauthagi) was not quite so long and was curved. The rest were much smaller, being only fifteen feet long; and in most cases these were completely ruined, indicating a much earlier origin than the large ones.

From the writings of Gísli Oddsson (1593–1638) Bishop of Skálholt, in South Iceland,¹ we know that the folds were in use during his lifetime, but

¹ De Mirabilibus Islandiæ, 1638. The original, which was written in Icelandic, is lost, but a Latin translation made by Ketill Jörundsson, a minister at Skálholt cathedral during Gísli Oddsson's episcopate, is in Bodley's Library, Oxford (MS Bor. 84, 4to), and has been printed in Islandica, New York (1917), vol. 10. A translation of the relevant part runs as follows:

'I speak of fowl which come from abroad; throughout the winter these do not dwell among us and are not even observed. Such are commonly the wild geese, the graagaaser,

there is some likelihood that the technique had already been developed in the eleventh century. At that time the whole Φ jórsá valley was inhabited. The most important of the farms in the valley was Stöng, the home of Gaukur Trandilsson, a hero of the Sagas (S. Þórarinsson, 1943). All the farms in the upper valley were ruined by an eruption of the volcano Hekla, probably by its first eruption in historical times, in the year 1104 (not 1300 as Φ órarinsson first thought). This eruption buried the farms and the upper part of the valley has since then been deserted. It is possible that some winter food at Stöng in Gaukur's time was provided from the older and more ruined goose-folds of the Φ jórsárver við Hofsjökul.

Size of the Breeding Colony

Although by all calculations there must have been many thousands of geese within the thirteen-mile square which encompassed the breeding grounds, one of the most striking features of the summer was that so few of them were in evidence. For example on 28 June, two days after the expedition's arrival, seventy-four geese were counted in the air, and this was very much the largest flock we had then seen. On the following day a hundred were estimated in Falcon Marsh. On 4 July the whole face of Arnarfellsalda appeared to be covered with geese, yet, when counted, there were only ninety adults with their goslings in an estimated square mile. Only once was a really large number of geese to be seen. From the top of Arnarfellsalda on a very clear day at least five hundred adults with goslings were spread out across the flat marsh to the north.

Otherwise, by far the largest assemblies of geese were those resulting from our drives, which nearly always brought in more than we expected.

- Two methods of estimating the population were available :
- (1) Counts of nests found in measured areas, from which the total number of nests in the oasis could be calculated.
- (2) The number of birds already marked which were recaptured in subsequent catches could provide estimates of the population of both adults and goslings.

1. Nest Counts.—The total area of the biotope was found to be 114 sq. km. (44 sq. miles), of which 82 sq. km. was explored, 32 sq. km. remaining unvisited. In transects totalling 102 km. in length sixty-seven nests were found. It was not possible to maintain a constant width of transect-strip but the mean width

was about 20 m., so that the area searched was 102 $\times \frac{20}{1000} = 2.04$ sq. km.

so called from their ashy colour. These are somewhat smaller than swans, and in springtime they occupy the island in an almost countless number; in winter, however, they are nowhere to be seen. The common report is that every year in autumn they make for the neighbouring countries of England, Ireland [he writes *Hiberniam, Irlandiam*] and Scotland and in spring leave those countries and wait upon us. I must put on record the most remarkable usefulness of these birds. By the generosity of Providence they provide for us, and leave bountifully [he writes *like loot*] exceedingly tasty eggs, their own flesh to feed on and feathers to use. Our bird-catchers keep a careful look-out for the time (which appears miraculous) when the young geese, half-grown, and exceedingly fat, and living for the most part in deserted places, have not yet become able to fly—the time when their parents are also unable to fly, having no strength left, and their wing-feathers being moulted [*sucked down to the blood*]. Then, I say, our hunters are at hand; they prepare beforehand fixed fences, mounds or pens whither with no trouble they drive the flocks of birds like sheep to the slaughter; when they are shut up they then kill all they choose, since the geese have no chance left to them of escaping by the help of their wings'.

G

with a nest density of 33 nests per sq. km. (84 per sq. mile). If this density was typical the number of nests in the whole area was 33×114 , or about 3700. But this is almost certainly too high since much of the area was bog and tundra pools which could not be transected (or colonised).

More intensive search of a small area showed that the nests were not distriouted uniformly or randomly even over apparently suitable terrain but occurred in groups. In view of this discontinuous distribution it was considered that the mean density of nests might be of the order of fifteen nests per square kilometre rather than the higher figure indicated by the transects. This would make the number of nests in the colony about 1700. It would require much more extensive sampling to obtain an accurate estimate of the size of the breeding population by this method.

2. Recaptures.—1151 geese were marked (382 adults and 769 goslings). Sixty-two birds marked from 28 June onwards were recaptured on or before 1 August (seven adults and fifty-five goslings; one gosling recaptured twice). The two geese ringed in Britain and recaptured on 25 July have no bearing on this estimate of population and are not included as 'recaptures' in these calculations.

Estimation of the size of a population (T) from the recapture of previously marked birds (x) in a catch of n individuals is based on the ratio T: m: n: x or T = m.n where m is the number of birds marked and released prior to the

day of sampling. This index has been used in estimating populations of many kinds of animals. Ricker (1948) in a review of its applications has listed six conditions which must be complied with if its use is to be valid.

1. The natural mortality of marked and unmarked animals must be the same.

- 2. Marked animals must not lose their marks.
- 3. All marked animals must be recognized on recapture.
- 4. The amount of recruitment to the population being sampled during the sampling period must be negligible.
- 5. Marked animals must be as subject to sampling as unmarked ones.
- 6. The marked animals must become randomly mixed with the unmarked ones, *or*, the distribution of sampling effort must be proportional to the number of animals in different parts of the habitat being studied.

The first four requirements are thought to have been satisfied in this problem. Because the technique of capture involved driving the geese to the trap, condition 5 was probably not satisfied. There is some evidence that previously caught geese show 'trap-shyness'. This probably affects adults more than goslings and, since they are in any case less easy to catch than young birds, has made it desirable to use separate estimates of the numbers of adults and goslings.

The mixing of marked and unmarked geese was not random, first, because geese remain in family parties and in larger aggregates (though these are much less stable than families) rather than disperse individually, and second, because the intervals of time between successive catches were of necessity so short that the amount of intermingling possible could not have resulted in randomness. Some effects of these limitations are shown in the table of estimates and the notes which follow. But, since catches were made in many parts of the habitat

Annual Report 1951-52

and roughly in proportion to the numbers of geese in those parts, the application of the index should provide useful estimates of the total population, though the standard of accuracy attainable is not high.

Recently Bailey (1951, 1952) has shown that $m \cdot \left(\frac{n+1}{x+1}\right)$ provides a better estimate of the population size than $m \cdot \frac{n}{x}$ and this modified form of the index

has been used but, in view of the limitations of accuracy just noted, it has seemed inappropriate to employ the measures of variance suggested by him.

The five large catches made by driving the geese into nets may each be used to give a population estimate (Table A). The results are widely different (adults 2,020-10,580, goslings 1,930-18,330). Some of the reasons for the lack of agreement are apparent. Two of the catches (Oddkelsalda 28 July, Arnarfellsalda 31 July) were made at sites where geese had been caught only three days before. It is evident that the much higher proportions of recaptures obtained in these two catches are due to the continued presence in the vicinity of birds taken in the earlier catches. The resulting enhanced values of xreduce the values of T, very obviously in the gosling estimates and rather less strikingly in the adult estimates, and these two sets of results therefore provide estimates of total population which are almost certainly much too low. The totals given by the catch of 1 August are, by contrast, probably too high because the birds sampled were more or less isolated from the sites of earlier marking operations by the presence between them of the Base Camp. Thus the number of marked birds available for recapture in the Round-up Hill area was probably artificially reduced, so that the values of x are small, giving very large values of T.

Another source of weakness in the calculations is the small total number of recaptures, particularly of adults. In general large values of m, n and x lead to more accurate estimates of T than small ones. For this reason, in the second set of three estimates, we have had recourse to grouping and this has the additional advantage of combining catches in which the proportion of recaptures is known to be too high with one in which it is likely to have been too low. Thus these two sources of error may minimize, though they are unlikely to eliminate, each other.

Even when the catches are grouped the three sets of estimates are not in close agreement, but the mean values are thought to be the best estimates of the size of the population that can be obtained from the recapture data.

Relative Numbers of Adults and Goslings

The ratios of adults : goslings in the various catches do not represent the true proportion in the population, because of the greater unwillingness of adults to be driven into nets. The only catch in which the ratio is thought likely to resemble the true one is that of 1 August, when a large measure of surprise was achieved, so that the adults had less opportunity to escape. The adult : gosling ratio in this catch was 85 : 120. This may be used to give additional estimates of the total numbers of each class, as in Table B.

The proportion of non-breeding adults present is not known, though evidence of their presence is provided by one of the recaptures of British-ringed birds, since this bird was less than one year old when ringed in the autumn of 1950 and so could not have been sexually mature in the summer of 1951.

G2

TABLE A

ESTIMATES OF THE PINKFOOT POPULATION AT ÞJÓRSÁRVER VIÐ HOFSJÖKUL FROM RECAPTURE OF MARKED GEESE

		1	Adults		Go.			oslings		
Dates and sites of Catches used for sampling	Number Marked Previously <i>m</i>	Number Captured n	Number of Marked Adults Recaptured x	Estimated Total of Adults in oasis $T_a = m$. $\left(\frac{n+1}{x+1}\right)$	Number Marked Previously <i>m</i>	Number Captured n	Number of Marked Goslings Recaptured <i>x</i>	Estimated Total of Goslings in Oasis $T_y = m\left(\frac{n+1}{x+1}\right)$		
25 July, Oddkelsalda	76	98	2	2510	269	165	4	893 <mark>0</mark>		
Oddkelsalda	174	23	1	2090	438	74	16	1930		
Arnarfellsalda	174	55	2	3250	438	125	4	11,040		
Arnarfellsalda	252	15	1	2020	616	99	23	2570		
Round-up Hill	252	83	1	10,580	616	118	3	18,330		
25 July and later 28 July and later 31 July and 1 August	76 174 252	276 178 98	3 4 2	5260 6230 8320 mean 6660	269 438 616	583 418 217	15 28 26	9820 6330 4970 mean 7040		

NOTES.—1. It may safely be assumed that none of the birds captured on Oddkelsalda on 28 July could have reached Arnarfellsalda by the time of the second catch on that day, and, similarly, that birds captured on 31 July at Arnarfellsalda could not have reached Round-up Hill by the following morning.

The recaptures used here are only those marked *before* the first recapture date given,
 e.g., the fifteen marked birds recaptured on and after 25 July were all marked before 25 July.
 The mean values are obtained from the three totals based on the grouped catches (below the line), excluding the totals based on single catches.

TABLE B

SIZE OF BREEDING COLONY OF PINK-FOOTED GEESE AT ÞJÓRSÁRVER VIÐ HOFSJÖKUL IN 1951

Method of Estimation	Nests	Adults	Goslings	Total	Remarks
1. Nest-count by transects	3700	8400*	11,900	20,300	Too high because of uncolo- nized bog and water
2. Nest-count by area den- sity	1700	4400*	6200	10,600	_

* An arbitrary figure of 1000 is added as non-breeding adults are not otherwise accounted for.

Annual Kedori 1951–54	Annual	Report	1951-52
-----------------------	--------	--------	---------

Method of Estimation	Nests	Adults	Goslings	Total	Remarks
3. Recaptures	—	6700	7000	13,700	Goslings too low due to inade- quate mixing. Adults too high because of trap-shyness
4. Recaptures of adults and $\frac{\text{adult}}{\text{gosling}}$ ratio for goslings	_	6700	9300	16,000	_
5. Recaptures of goslings and $\frac{\text{adult}}{\text{gosling}}$ ratio for adults	_	5000	7000	12,000	More accurate than 4 because of more gosling recaptures than adult recaptures
6. Estimate based on assessment of value of various methods	2300	5500	7500	13,000	_
				11/2	

TABLE B—continued



NOTES ON THE BIRDS OF THE ÞJORSÁRVER VIÐ HÖFSJOKUL

[Raven (Corvus corax).—Seen in the \mathfrak{P} jórsá valley during the return journey, about sixty miles from the oasis. It is remarkable that a bird so common in Iceland should have been so completely absent from the Pinkfoot colony.]

1. Snow-Bunting (Plectrophenax nivalis) .-- Not uncommon breeding bird. Several pairs seen in oasis. One nest (C.5) found 26 June in wall of kofi (shepherd's hut). Hatching-date was not certain ; eventually three young flew on 20 July. Nest had two entrances; male always entered and left by the same entrance, female left by this entrance but always entered by the other. On 9 July the nest was watched from a hide from 11.58 till 15.12. During the $3\frac{1}{4}$ hours the male brought food twelve times, the female seventeen times and in addition the female brooded the young for periods of $20\frac{1}{2}$ mins., 5 mins. and $4\frac{1}{2}$ mins. All feeds consisted of black flies except one which consisted of green sawfly larvæ (taken from Salix glauca). During period female was seen to emerge with fæcal sac seven times, male once. Male always sang in flight after leaving nest. Weather warm for first half, cool and rainy for second half. Parents' visits no less frequent in rain except for 20 minutes brooding period. On 10 July the nest was watched from 13.03 to 14.49. In the $1\frac{3}{4}$ hours the male brought food ten times, the female thirteen; and the female also brooded the young for periods of three, two, two and two minutes. The female emerged with fæces seven times, with a dead grass-blade once; the male never emerged with fæces. On this day the male was feeding, almost entirely, green caterpillars which he collected from distances up to 400 yards away (near the camp). The female brought spiders and harvestmen; once there were some green caterpillars in a beakful of these. For identification

of some of these animals see p. 110. The first fledged young in the oasis were seen at the Hnífá on 12 July.

2. Meadow-Pipit (Anthus pratensis).—Not an uncommon breeding bird. One nest found near camp on 16 July with five fresh eggs. Fledged birds of the year first seen on 14 July.



Blue-headed Wagtail

3. Blue-headed Wagtail (Motacilla flava).—On 15 July, at the cold springs at Nautalda, we all saw in good light at twenty to thirty yards a wagtail with bright sulphur-yellow underparts, a greenish back and a dark slate head, with even darker cheeks. Its tail did not seem to be particularly long and as it fed about the springs at this place it made chirps which two of us thought very like those of *M. flava*. In flight it uttered a louder, more penetrating and slightly metallic chirp and showed white outer tail-feathers. The greenish back (among other characteristics) leads us to determine it as a member of one of the dark-headed races of *M. flava* rather than *M. cinerea* the Grey Wagtail. This is a new species for Iceland, though vagrant Grey Wagtails have occasionally been recorded before.

4. White Wagtail (*Motacilla alba*).—A few appeared on passage at the Base Camp at the end of July. One 29 July, two or three 30 July, one 1 August.

5. Wheatear (*Oenanthe oenanthe*).—Two immature birds seen near Arnarfellsbrekka on 21 July. They flew well and had, therefore, probably been hatched elsewhere. Two seen on passage, Bólstaður, end July.



6. Snowy Owl (*Nyctea scandiaca*).—An adult male seen on 17 July and probably the same bird again on 18 July. (A known breeding ground of this species is some forty miles from the oasis.)

7. White-tailed Eagle (*Haliaeetus albicilla*).—A single immature with dark tail was living in the area and was frequently seen. He was remarkably tame, allowing a mounted approach to within fifty or sixty yards. Ptarmigan, goslings and possibly even an adult Pinkfoot (see p. 85) are known to have been part of his diet.



Annual Report 1951-52



8. Iceland Falcon (Falco rusticolus).--Single birds seen on many occasions and a pair seen together on 25 July. These birds were feeding on Pinkfoot goslings. There was no evidence of breeding, but one or two pairs might well have been breeding not far away.

9. Whooper Swan (Cygnus cygnus).-Discovered breeding at Arnarfellsbrekka by W. L. Watts (1876) in 1875 and Foster in 1876. On 14 August 1881 J. Coles (1882) found a flightless flock of 12 at the mouth of the Hnífá, and on 15 August another flock, of which only one could fly and at least four were cygnets, in Dúfuver. Some twenty pairs were probably breeding in the oasis in 1951, including Dúfuver. Eleven nests or broods were found there and five more were found on the journeys in and out.

The clutch sizes were as follows :

Number of eggs or cygnets 5 4 3 2 1 0 Number of nests or broods 3 3

1 The empty nest was attended and may have been recently predated.

The nests were large mounds of reddish moss, built among pools (but not usually on islands), which had dried up some time before hatching time. They were, therefore, in all cases easily accessible. The eggs were heavily stained reddish brown-the colour of the mud in the dried-up beds of the pools.

6

2 -

The behaviour of nesting Whoopers was very variable. Most females left the nest as soon as the intruder came into sight. One pen crouched on the nest and did not leave it until approached to within about seventy-five yards. This was unique and occurred on 25 June, apparently at least a week before the hatching date. Two pairs of swans showed extreme shyness when a photographic hide was erected more than sixty yards from their nests. One pair deserted and in the other case the hide was only just removed in time.

On one occasion a pen left a nest as a result of hearing the alarm note of a Pinkfoot, while the intruders were still out of sight over a ridge. She apparently left in a hurry as the eggs had not been covered.

The first cygnets were seen on 2 July, and most nests were hatched by 11 July although one still had eggs on 14 July.

The very pale grey (almost white) down of a Whooper cygnet is stiffer than that of ducks and geese and makes the bird softer, more resilient, more velvety to the touch. The peaky bill is grey, with a patch of flesh colour near the base. The legs are quite bright orange pink.



Whooper Cygnet

Whooper cygnets would sometimes follow humans even when at least a week old. Newly hatched cygnets usually followed, and a hasty retreat was necessary if they were not to be led away from the nest. Older cygnets would feign death when handled, hanging their necks in a lifeless attitude. This was particularly noticed in a brood estimated to be about two weeks old, and again in one of about $4\frac{1}{2}$ weeks.

One newly hatched cygnet had a kink in its neck and was totally unable to lift its head or to move from the nest. It was destroyed and the skin preserved.

The behaviour of parent Whoopers with cygnets was also variable. Some deserted their brood and flew away at a range of several hundred yards. Others remained to protect their young and were photographed at less than thirty yards. A characteristic brood was found on 12 July and is described in P. S.'s diary :

'Ahead of us was another pair of swans, this time with three cygnets. Again Finnur and I went after them. The parents were very brave and stayed until we were about twenty yards away. Then they only flew fifty yards, and later another fifty. We tagged the three cygnets and let them away. They were quite young, but not a bit inclined to follow us. This may have been because the pen was only a hundred yards away and, although out of sight over the ridge, she was still calling. They ran off in her direction and as we retreated, so the pen started to come back. By the time we reached the horses, she had breasted the ridge, and suddenly saw the cygnets. She bowled down the hill at a good pace to meet them. Her first sight of them and final meeting with them were delightfully reflected in a change of note in her almost continuous calls. As she began to lead the young ones away the cob flew round and settled with them. The family was safely reunited barely two hundred yards from us. In the distance I saw a single swan flying, and presently the cob took off. I thought he was interested in the intrusion of the other swan, but he settled ahead of us as we proceeded and began to walk away. As we rode towards him he rose

again and settled another few hundred yards ahead. I believe this was an attempt to lead us away. We all agreed that this family of swans had given us a great deal of sentimental pleasure. They were noble birds and they had behaved nobly. We had succeeded in marking the young and the whole operation had been performed quickly, tidily, and without risk of loss to the family. We rode on in good spirits in spite of the drizzling rain.'

On 8 July a pair of swans with one cygnet swam through the territory of an Arctic Tern and were repeatedly attacked. The swans ducked their heads every time the Tern dived.

The swan families (unlike the Pinkfeet) did not form flocks and wander in the oasis, but remained separate and in the same general area as the nest. On two occasions swans were seen driving off goose families with vigour. In both cases the goose parents were counter attacking, but the fight was too far away to assess casualties.

The first flightless swan was the female of a broodless pair seen on 22 July. The cob flew off and the pen remained on a small lake refusing to be driven ashore. On 24 July the first flightless parent was seen (and marked). This was also a pen, with three cygnets two weeks old. The cob was still able to fly. This pen had pale blue-grey eyes (the iris is normally brown). Of a pair with four cygnets (about four weeks old) encountered on the Dalsá during the return journey on 3 August the pen was flightless but the cob was still able to fly. Besides the above only one of a broodless pair encountered on 1 August was flightless and it was thought to be the pen. Thus there is some evidence that female Whooper Swans (as is perhaps the case with Pink-footed Geese) moult before the males.

One adult female and twenty-two cygnets were marked with wing-tags.

[Grey Lag Goose (Anser anser).—Breeds commonly in lower Djórsá valley (see p. 84). Pairs with small young were seen on the river on 24 June, the second day of the journey in, at the junction of the Tungnaá with the Djórsá. This is some fifty miles south of the oasis. At dawn on 26 June a flock was heard flying along the river at Kjálkaver, some twenty miles below the oasis. No single Greylag was seen during the summer on the Djórsárver við Hofsjökul.]

10. Pink-footed Goose (Anser brachyrhynchus).—See pp. 84–101. Probably the commonest bird in the oasis (Dunlin next).

11. Barnacle Goose (*Branta leucopsis*).—A single gander was mated to a female Pinkfoot which had a nest of four eggs on 29 June. The nest was later predated. (The species occurs in Iceland on passage to and from the breeding grounds in North-east Greenland.)



12. Pintail (Anas acuta).—A few pairs were breeding in the oasis. Two nests of fresh eggs were found close together on 28 June and four newly hatched ducklings were seen with the mother on 12 July. These were all close to the Base Camp. On 28 June two drakes and one duck were seen in the marsh where the four ducklings subsequently appeared. These were the only Pintail seen.

13. **Teal** (*Anas crecca*).—A recently predated nest was found at Kjálkaver, on the inward journey, on 25 June. One female was seen near Arnarfellsbrekka on 21 July. It was not thought to be breeding. Flank feathers of a drake were found at the hot springs at Nauthagi.

14. Scaup (Aythya marila).—No males seen. One female with seven hard set eggs on 11 July. Four ducklings with mother on 22 July, which could have been from the same nest but probably were not. One other female seen on 15 July, thought to be nesting but no nest found.

15. Long-tailed Duck (Clangula hyemalis).—The commonest duck in the oasis, but not more than twenty to thirty seen altogether. The majority of these appeared to be non-breeders, and in plumage in which the sexes were not easy to distinguish. Five seen together on 15 July on a pool in marsh were performing low intensity display activities. All five looked at first sight like females, but one had more white about the face and was darker on the back. It is unlikely that long-tailed ducks breed in their first year. (Their near relations the eider-ducks and the goldeneyes do not do so.) Thus these birds may have been yearlings of both sexes.

No nests were found, but two broods of newly hatched young were seen on 15 July (three and seven). Another brood of three was seen on 20 July.

16. Harlequin Ducks (*Histrionicus histrionicus*).—Two females were seen on the Hnífá, on various dates in July, but there was no evidence of breeding. This river is not glacial and its water is clear. Glacier rivers such as the Þjórsá and its higher tributaries evidently do not provide a suitable habitat for this species. A pair of Harlequins was seen on 25 June during the journey in, at a clear burn, the Hölkná, some thirty miles south of the oasis.

17. Great Northern Diver (*Colymbus immer*).—One seen 27 June, a pair flying up the river on 30 June. Not apparently breeding in the area.

18. Red-throated Diver (Colymbus stellatus).—A few pairs breeding in the oasis. Two small young on 2 July, and two more on 7 July. The only food available for miles around appeared to be Sticklebacks (Gasterosteus aculeatus) which were found by us in the Miklakvisl, from the hot springs of Nauthagi to its mouth. No other fish occurs in the oasis as the glacier rivers are unsuitable for trout or char. For some time one diver was watched by two of us, through powerful glasses in good light, attending its young with a small fish in its mouth which strongly resembled (but could not be proved to be) a Stickleback. However, it is quite possible that the local divers fetched some of their food from lakes containing trout or char, even though the nearest are probably over twenty-five miles to the south, in the Veiðivötn area. It is well known that in





107



Red-necked Phalaropes seen together on 4 July

other parts of Iceland Red-throated Divers may nest a long distance from their staple food.

One of the 7 July brood was found sitting on shore, apparently ailing. It was marked, but probably did not survive as only one young bird was in evidence on 19 July. Chick's down was dark sooty grey, to black—not 'mouse-brown' as has been described. The bill, legs and eyes were black (iris being indistinguishable from pupil).

One chick was seen to dive in alarm when its mother flew down to settle on the water beside it. One adult, disturbed on a long, narrow tundra-lochan, first dived, and then flew away in the direction opposite to that of its dive, pattering for over a hundred yards before taking off down-wind.

19. Whimbrel (Numenius phaeopus).—Many pairs breeding in the oasis, although no nests or young found (except young already able to fly). Behaviour of adults indicated eggs or young in vicinity on many occasions but time was not available to search for them. One nest of four eggs found at Starkaðsver (about fifty miles from the oasis) on 24 June, during the journey in.

Generally, however, the bird is not so common in the Central Highlands as it is in the farmlands of Iceland.

[Snipe (Capella gallinago).—One was seen at Kjálkaver, on the inward journey on 25 June.]

20. Red-necked Phalarope (*Phalaropus lobatus*).—A few pairs were breeding. A nest with four hard set eggs was found near the Base Camp on 26 June. Not nearly so common in the Central Highlands as in other parts of Iceland. On 4 July a bird was seen in full winter plumage, in company with a female in full summer plumage. As usual with this species they were very tame and photographs were obtained of this interesting bird at ranges of ten to fifteen feet. They were seen to be feeding on the crustacean *Lepidurus*. On the same date a flock of seventeen was playing on a tundra-lochan.

21. Dunlin (*Calidris alpina*).—Probably the second commonest bird in the oasis (Pink-footed Goose commonest). In spite of this only two nests found : 27 June, four eggs; 20 July, female sitting on two bad eggs. A young bird just able to fly was seen on 21 July. Hovering song-flight was still at its height in late June but was no longer commonly heard after end of first week in July. Dunlins were seen in flocks on 4 July. Twenty-five were together on 10 July. On the inward journey we saw a large flock at Hólaskógur on 23 June.

The curious association of Dunlins with other species, notably Golden Plovers, was frequently noted. 'Plover's Page' is a local name for the Dunlin.



A translation of the Icelandic name is 'Plover's Slave'. Golden Plovers were rarely seen without Dunlins in attendance. The Plover apparently plays a passive part, but the relationship is evidently rather complex. Dunlins also fraternized with Purple Sandpipers. The most curious case was a Dunlin seen on 28 June which stood regularly within six inches of an incubating Arctic Tern. From time to time the Dunlin left to feed and preen at the water's edge, always returning to the same spot beside the nesting Tern.

On 3 July a Dunlin performed high-intensity injury-feigning and 'rodent-run'. The bird ran away crouching with white tail lowered and dark central tailfeathers forming a narrow black line (conceivably suggesting a rodent's tail). When it stopped it was always in a hollow crouching almost out of sight, as if at pains not to give a clear view of itself to the enemy. The performance was accompanied by a loud squealing noise, quite unlike any normal Dunlin call note, but remarkably like the squeal of a rat.

22. **Purple Sandpiper** (*Calidris maritima*).—Not a common breeding bird. No eggs found but parents maintained territories ; a young bird only just able to fly was seen on 21 July, a fledged brood on 28 July and a small chick on 29 July. Both parents of the last feigned injury, and one (probably the female) performed a remarkable 'rodent-run', accompanied by a shrill squeal totally unrelated to any normal call-note of this species.

23. **Redshank** (*Tringa totanus*).—One heard at night 26 June. A flying young bird (traces of down still visible on head) seen at the warm springs at Nauthagi 29 July. The complete absence of the species from the area between these dates indicates that the young bird had been hatched elsewhere.

24. Ringed Plover (*Charadrius hiaticula*).—Rather less common than the Purple Sandpiper but several pairs nesting on shingle-banks beside braided channels of streams, or on bare gravel mounds and hillocks. No eggs found but small young seen on 22 July and 31 July. In both cases parents feigned injury; in the latter both parents took part, but female at higher intensity; the tail was spread, sharply depressed and drooped on the side towards the enemy.

25. Golden Plover (*Pluvialis apricaria*).—Only slightly less numerous than the Dunlin. All present were visibly of the subspecies *altifrons*. Ubiquitous



breeding species in the oasis, but no eggs or young found until flying young were seen on many occasions in late July (dates not recorded). Golden Plovers standing near nests or young were frequently attended by Dunlins.

On 7 July injury-feigning is described in P. S.'s diary : 'At one place on the river (Hnífá) a Golden Plover did the best injury-feigning I have seen from this species. The bird sat looking normal in front of us, then the tail was depressed, slightly at first and then sharply down to the ground ; then the wings began to droop, one more than the other. Then she flitted across the river, both legs dangling ; and once on the other side she ran through the scrub in a very plausible "rodent-run". The male joined her and also performed the "rodent-run". Then the female came back and repeated the performance exactly.'

26. Arctic Tern (Sterna macrura).—A very few pairs were breeding in the oasis. Only one nest was found, on 28 June. The eggs were collected and the bird had laid again in the same nest when the site was revisited on 15 July. The first clutch was two eggs, the second only one. A Tern was seen vigorously attacking a pair of Whooper Swans with a cygnet on 8 July; it was evidently attempting to drive them away from the vicinity of its own eggs or young. Small numbers of Terns which may have been on passage were seen hawking across the marshes in late July. On one occasion three or four Terns were seen following and mobbing a tiercel Iceland Falcon, which appeared completely oblivious of their presence.



27. Great Black-backed Gull (*Larus marinus*).—Commonly seen in small numbers throughout the summer but no evidence of breeding. Thirty or forty believed to be living in the oasis. This is the principal species living on the eggs and goslings of the Pinkfeet.

28. Arctic Skua (*Stercorarius parasiticus*).—Probably not room for more than about ten breeding pairs in the oasis. Only two nests found, one in Illaver on 4 July with a single but well-incubated egg and one on the Hnífá on 12 July with two eggs. Of perhaps thirty different birds seen only two were of the light phase, and one was intermediate. Typical injury-feigning was seen on several occasions. Once both birds performed immediately beyond the nest, thus leading the intruders towards it. Food, see p. 85.

29. Ptarmigan (Lagopus mutus).—A few pairs breeding in the oasis. No this-year's nests were found. By 17 July only two birds had been seen ; on that date a cock performed the display flight, rising in a long glide, stalling and then parachuting down on quivering wings with loud crowing. The first brood was seen on 21 July on the terminal moraine of the glacier, Arnarfellsmúlar. Five of the young were wing-tagged, two being recovered later in the summer by members of the British Schools Exploring Society's Expedition. A brood already capable of flight (although the young were, of course, still quite small) was seen at Eyvafen on 26 July, and another brood of eleven with both parents in attendance was seen in Tjarnarver on 29 July.

NOTES ON INVERTEBRATES

AMONG the insects encountered by the expedition in the Φ jórsárver were numerous Diptera, notably Chironomids of the genus *Diamesa*, Simuliidae of the genus *Simulium*, Empididae, Cordyluridae of the genus *Scatophaga*, Syrphidae of the genus *Helophilus*; Neuroptera, *Limnephilus picturatus*; Hymenoptera, notably larvae of Sawflies (Tenthridinidae, Nematinae), probably of the genera *Pristiphora*, *Amauronematus* or *Nematus* (the green caterpillars that the Snow-Buntings (p. 101) were feeding to their young); Coleoptera, notably the larvae of a beetle, probably *Colymbetes dolobratus*. Unfortunately we made the mistake of preserving many insects in alcohol, so that the Entomological Department of the British Museum (Nat. History) could pursue them no farther than their genus. Six species of Lepidoptera were identified : *Xanthorhoë montanata*, *Epirrhoë alternata*, *Perizoma blandiata*, *Eupithecia nanata*, *Entephria caesiata* and *Euphyia bilineata*; most of these are common British moorland geometrids ('carpets' and 'pugs'). Besides these at least two species of fast-flying noctuids eluded capture.

Running on the surface of the water and mud round the hot springs at Nauthagi we found the bug (Hemiptera) Salda littoralis.

The most noticeable arachnids were the spider Lycosa tarsalis and the very variable harvestman Mitopus morio.

In certain tundra pools which apparently dry up in a normal summer large numbers of the interesting and primitive crustacean *Lepidurus arcticus* were found. These ranged from nearly $\frac{3}{4}$ inch across to about one-third of that size. (Red-necked Phalaropes were seen to be eating them.)

The relative abundance of other crustaceans in the tundra pools is illustrated by the following analysis of a sample collected at Base Camp, from the pool from which we drew our drinking water, and which must also, in many years, dry up in late summer.

Cladocera				E	Approximat number in sample
Bosmina coregoni var.	obtusir	ostris	 		30
Eurycercus lamellatus			 		15
Polyphemus pediculus			 		15
Daphnia pulex			 		10
Simocephalus vetulus	••	•••	 		10
Macrothrix hirsuticorn	is a <mark>rcti</mark>	са	 		10
Alona affinis			 		2
Chydorus sphaericus		• •	 		2
Acroperus harpae			 • •		1
Copepoda					
Diaptomus castor glaci	alis		 		1000
Diaptomus minutus		• •	 		20
Cyclops sp	• •		 	• •	1

These animals were the observed or putative food of many birds, notably Long-tailed Duck, Red-necked Phalarope, Dunlin and Arctic Tern.

The freshwater gastropod mollusc *Limnaea peregra* (ovata) was fairly common in many places in the oasis, and may have been of some importance as food for some species of birds, *e.g.* the ducks.

SKETCH MAP OF HOT SPRINGS AT NAUTHAGI

Vater	tem	peratures	1
1		28° C.	÷
2		31° C.	-
3		40° C.	;
4		22° C.	÷
5		41° C.	:
6		44° C.	
7		35° C.	:
8		44° C.	÷
9		41° C.	Se
10		29° C.	1
11		32° C.	7
12		37° C.	R
13		36° C.	je.
14		44° C.	a,
15		37° C.	ar
16		30° C.	4
17		17° C.	a
18		12° C.	+
19		24° C.	10
20		33° C.	26
21		29° C.	
22		24° C.	-
23		24° C.	3
24		25° C.	-
25	• •	28° C.	
26	••	26° C.	
27	••	32° C.	*



HOT SPRINGS

ON 29 July 1951 a sketch map was made of the hot springs at Nauthagi and the water temperatures were measured. The highest temperature recorded was 44° C. (111° F.). Sticklebacks (*Gasterosteus aculeatus*) were found in shoals in a pool at 29° C. (84° F.). Samples of *Algae* were taken from pools three and five (40° C. and 41° C.), and a whitish filamentous substance like thick cobwebs (thought to be *Algae* with a chemical deposit—either silica or a sulphurous substance) was taken from pool eleven (32° C.). Unfortunately no growth could be obtained from these samples after the expedition returned to England, and the plant or plants remain, therefore, unidentified.

On the same day hot springs below Jökulkriki were visited (about $1\frac{1}{2}$ miles N.W. of Nauthagi). These were considerably hotter than the springs at Nauthagi, the highest water temperature being 62° C. (144° F.)—just too hot for the hand. *Algae* were growing in water up to 52° C. (126° F.). The growth was richer and greener at temperatures between 35° C. and 40° C. No subsequent growth was obtained from samples taken at this spring.

ACKNOWLEDGMENTS

THE expedition would have been impossible without a substantial grant from the Royal Society, which we most gratefully acknowledge. The Icelandic Government, through its Natural History Museum Fund, also made an important contribution, besides giving much help and certain privileges. The Geographical Magazine also made a grant, and other contributions to the expedition funds came from the publication of articles in The Times and Manchester Guardian, and from broadcast talks.

We would also like to thank Mr Jack Greenway, British Minister in Iceland. for kindnesses too numerous to mention; and Flugfélag Islands (for arranging an air-drop of stores), Miss Cynthia Longfield, Dr E. B. Ford, F.R.S., Professor H. Munro Fox, F.R.S., and Messrs S. Prudhoe, J. P. Harding, D. E. Kimmins and T. H. Savory (for the identification of specimens), and Drs H. G. Vevers and S. F. Winter, Miss Jean W. Fisher and Mr S. T. England (for translations) and Mr Hugh Boyd (for statistical work on population estimates).

Finally we owe a great debt to our patient, cheerful and skilful guides, the Icelandic farmers Jóhann Sigurðsson, Snjólfur Snjólfsson, Ágúst Sveinsson and Valentínus Jónsson.

LIST OF PLANTS

(PTERIDOPHYTA AND SPERMATOPHYTA)

Found in the þjórsárver við Hofsjökul (north of Fjórdungssandur), 1951

I. Pteridophyta

Ophioglossaceae 1. Ophioglossum vulgatum L. var. polyphyllum A. Br.

2. Botrychium lunaria (L.) Sw.

Equisetaceae 3. Equisetum arvense L.

Selaginellaceae 4. Selaginella selaginoides (L.) Lk.

II. Spermatophyta

Potamogetonaceae 5. Potamogeton alpinus Balbis

Graminae

- 6. Phleum commutatum Gaud.
- 7. Agrostis stolonifera L.
- 8. Calamagrostis neglecta (Ehrh.) G., M. & Sch.
- 9. Deschampsia alpina (L.) R. & Sch.
- 10. Trisetum spicatum (L.) P. Richter
- 11. Poa glauca Vahl
- 12. " alpina L.
- 13. Festuca rubra L.
- vivipara (L.) Sm. 14. "

Cyperaceae

- 15. Eriophorum Scheuchzeri Hoppe
- angustifolium Honck. 16. 39

17. Kobresia myosuroides (Vill.) F. & Paol.

- 18. Carex canescens L.
- 19. Lachenalii Schkuhr. ,,
- 20. " rariflora (Wg.) Sm.
- 21. rostrata Stokes ,,
- 22. saxatilis L. "
- 23. Goodenoughii Gay. ,,
- Lyngbyei Hornem. 24. "" 25.
 - rigida Good. ...

Juncaceae

- 26. Juncus arcticus Willd.
- 27. " biglumis L.
- 28. articulatus L.
- 29. Luzula spicata (L.) D. C.
- 30. " arcuata (Wg.) Sw.
 - Liliaceae
- 31. Tofieldia pusilla (Michx.) Pers.

Orchidaceae

32. Caeloglossum viride (L.) Hartm.

Salicaceae

- 33. Salix glauca L.
- 34. " lanata L.
- 35. " herbacea L.
- " phylicifolia L. 36.

Betulaceae

37. Betula nana L.

Annual Report 1951-52



Polygonaceae

- 38. Rumex Acetosa L.
- 39. Oxyria digyna (L.) Hill.
- 40. Koenigia islandica L.
- 41. Polygonum viviparum L.

Caryophyllaceae

- 42. Stellaria crassifolia Ehrh.
- 43. Cerastium cerastoides (L.) Britton.
- 44. alpinum L. ,,
- 45. Sagina intermedia Fenzl.
- 46. Minuartia rubella (Wg.) Hiern.
- 47. biflora (L.) Schinz & Thell.
- 48. Arenaria norvegica Gunn.
 49. Viscaria alpina (L.) Don.
- 50. Silene maritima With.
- 51. " acaulis (L.) Jacq.

Ranunculaceae

- 52. Ranunculus acris L.
- pygmaeus Wg. 53. ,,
- 54. reptans L.
- 55. Thalictrum alpinum L.

Cruciferae

- 56. Draba rupestris R. Br.
- 57. Cardamine pratensis L.
- 58. bellidifolia L.
- 59. Arabis alpina L.
- 60. Cardaminopsis petraea (L.) Hiit.

Crassulaceae

- 61. Sedum villosum L.
- 62. " roseum (L.) Scop.

Saxifragaceae

63. Saxifraga caespitosa L. hypnoides boreali-atlantica 64. ,, Engl. & Irmsch.

65. Saxifraga cernua L. 66. rivularis L. 79 67. oppositifolia L. 32 68. Hirculus L. 69. nivalis L. tenuis (Wg.) H. Sm. 70. 22 71. stellaris L.

33 72. Parnassia palustris L.

Rosaceae

- 73. Sibbaldia procumbens L.
- 74. Comarum palustre L.
- 75. Potentilla Crantzii (Cr.) G. Beck
- 76. Dryas octopetala L.
- 77. Alchemilla glomerulans Bus.

Geraniaceae

78. Geranium silvaticum L.

Violaceae

79. Viola palustris L.

Onagraceae

- 80. Chamaenerion latifolium (L.) Sweet.
- 81. Epilobium palustre L.
- 82. anagallidifolium Lam. ,,
- 83. lactiflorum Hausskn.
 - - *Hippuridaceae*
- 84. Hippuris vulgaris L.
 - Umbelliferae
- 85. Archangelica officinalis Hoffm.

Pyrolaceae

86. Pyrola minor L.

Ericaceae

- 87. Cassiope hypnoides (L.) Don.
- 88. Vaccinium uliginosum L.
 - Empetraceae

89. Empetrum nigrum L.

Plumbaginaceae

90. Armeria vulgaris Willd.

Gentianaceae

- 91. Gentiana tenella Rottb.
- " nivalis L. 92.
- 93. Menyanthes trifoliata L.



Saxifraga Hirculus

113

Ħ

of Nauthagi : Ophioglossum vulgatum, Potamogeton alpinus, Agrostis stolonifera, Carex canescens, Stellaria crassifolia, Ranunculus reptans, Comarum palustre, Menyanthes trifoliata, Rhinanthus minor.

Juncus articulatus was only found at the hot spring in Jökulkriki.

Cardamine bellidifolia was only found on Ólafsfell. The tiny Draba specimens found on Ólafsfell proved on examination to be a variety of Draba rupestris, which by some authors is thought to be a distinct species (Draba norvegica).

The following is a complete list of the species growing on the roof and in the walls of the *kofi* or hut of stone and turf near the Base Camp at Bólstaður. There was a hatched Pinkfoot's nest on the roof of this *kofi*. The vegetation is therefore typical of a Pinkfoot nesting site.

- 1. Poa glauca.
- 2. " alpina.
- 3. Festuca rubra.
- 4. Carex rigida.
- 5. Luzula spicata.
- 6. Salix glauca.
- 7. " lanata.
- 8. " herbacea.
- 9. Rumex Acetosa.
- 10. Polygonum viviparum.
- 11. Cerastium alpinum.
- 12. Sagina intermedia.
- 13. Minuartia rubella.
- 14. Silene acaulis.
- 15. Thalictrum alpinum.
- 16. Draba rupestris.
- 17. Cardaminopsis petraea.
- 18. Saxifraga caespitosa.
- 19. " oppositifolia.
- 20. Potentilla Crantzii.
- 21. Chamaenerion latifolium.
- 22. Armeria vulgaris.
- 23. Thymus arcticus.
- 24. Galium pumilum.
- 25. Taraxacum sp.

REFERENCES

BAILEY, N. T. J. (1951). On estimating the size of mobile populations from recapture data. *Biometrika*, 38: 293. (1952). Improvements in the interpretation of recapture data. J. Anim. Ecol. 21: 120–27.

BARING-GOULD, S. (1863). Iceland, its scenes and sagas. London.

BAY, E. (1894). Den østgrønlanske Expedition udført i Aarene 1891-92 under Ledelse af C. Ryder. I. Hvirveldyr. *Medd. Grønland*, 19: no. 1; 51 pp. (32-33).
BIRD, E. G. (1934). Notes on the geese, etc. of lceland. *Ibis* (13) 4: 170.

BJÖRNSSON, M. (1932–34). Nokkur orð um grágæsir og helsingja. Náttúrufræðingurinn Reykjavík, 2: 143–52; 3: 17–22, 75–78, 129–32; 4: 30–40, 166–75.

CHAPMAN, F. S. (1932). Some field-notes on the birds of East Greenland. Geogr. J. 79: 493-96.

COBURN, F. (1901). Brief notes on an expedition to the north of Iceland in 1899. Zoologist (4) 5: 401-19 (408-09).

COLES, J. (1882). Summer travelling in Iceland ; ... London, pp. 53-54, 56.

114

Pinguicula

Labiatae

Scrophulariaceae

Lentibulariaceae

Rubiaceae

Compositae

percome Om.

Systematic arrangement after Stefán

Several of the above plants had a very

restricted distribution. Thus the following

species were only found at the hot springs

94. Thymus arcticus (Dur.) Ronn.

95. Rhinanthus minor L.

98. Pedicularis flammea L.

99. Veronica fruticans Jacq.

101. Pinguicula vulgaris L.

105. Gnaphalium supinum L.

102. Galium pumilum (L.) Murr.

103. Erigeron boreale (Vierh.) Simm.

107. Hieracium alpinum (L.) Backh.

Stefánsson's Flóra Islands (1948 ed.).

uniflorum L.

alpina L.

96. Bartsia alpina L.

97. Euphrasia sp.

37

100.

104.

108.

...

106. Taraxacum sp.

••

vulgaris

- CONGREVE, W. M. (1929). Breeding of the Pink-footed Goose in Iceland. Auk, 46: 533-34. (1929b). The Pink-footed Goose (Anser brachyrhynchus) nesting in Iceland. Bull. Brit. Ool. Assoc. 2: 128-31. (1943). Obituary. Major Sydney William Patrick Freme. Ibis, 85: 522-23.—and FREME, S. W. P. (1930). Seven weeks in eastern and northern Iceland. Ibis (12) 6: 193-228.
- Evans, E. and Sturge, W. (1859). Notes on the birds of western Spitzbergen, as observed in 1855. *Ibis*, 1: 166-74.
- FABER, F. (1822). Prodromus der isländischen Ornithologie. Copenhagen. (1826). Über das Leben der hochnordischen Vögel. Leipzig.
- FOSTER, C. LE N. (1879). Across the Bursting-Sand in 1876, ch. XI, pp. 263-81 of C. G. W. Lock, *q.v.*
- FREME, S. W. P. (1930). Notes on an ornithological trip to North Iceland. Northw. Nat. 5: 8-12.

GEODÆTISK INSTITUT (1945). Uppdráttur Íslands. series of 1: 100,000 maps of Iceland.

HACHISUKA, M. U. (1927). A Handbook of the Birds of Iceland. London, Taylor and Francis.

HANTZSCH, B. (1905). Beitrag zur Kenntnis der Vogelwelt Islands. Berlin, Friedländer.

KOCH, J. P. (1912). Den Danske Ekspedition til Dronning Louises Land og tværs over Nordgrønlands Inlandsis, 1912–1913. Geogr. Tidsskr. Kjøbenhavn, 21: 165–91, 257–64 (259).

LOCK, C. G. W. (1879). The home of the eddas. London.

- NATHORST, A. G. (1899). Kung Karls Land. Ymer Stockholm, 19: 1-32. (1900). Två Somrar i Norra Ishafvet. Stockholm, Beijers, 2 vols.
- NEWTON, A. (1863). Notes on the ornithology of Iceland, appendix A, pp. 399–421, of S. Baring-Gould, q.v. (414). (1864). On above Ibis, 6: 131–33. (1865). Notes on the birds of Spitsbergen. Ibis (2) 1: 199–219, 496–525.
- NUNN, J. L. (1934). Pink-footed Geese in Wexford. Brit. Birds, 27: 306.
- ODDSSON, G. (1917). De Mirabilibus Islandiae. Islandica, 10.
- PEARSON, H. J. and PEARSON, C. E. (1895). On birds observed in Iceland in 1894, with a list of the species hitherto recorded therefrom. *Ibis* (7) 1: 237-49 (243).
- RICKER, W. E. (1948). Methods of estimating vital statistics of fish populations. Indiana University Publication, Science Series No. 15.
- ROBERTS, B. (B.) (1934). Notes on the birds of Central and South-east Iceland, with special reference to food-habits. *Ibis* (13) 4: 239–64 (249–50).
- SAEMUNDSSON, B. (1936). İslensk Dýr III. Fuglarnir (Aves Islandiae). Reykjavík, pp. 608–11.
- SALOMONSEN, F. (1950). Grønlands Fugle. København, Munksgaard, part 1; 49-53
- SCOTT, P. and FISHER, J. (1952). Pink-footed Geese in Iceland. Geogr. Mag. 24: 606-15. (1953). A Thousand Geese. London, Collins, in press.
- SHEPHERD, C. W. (1867). The North-west Peninsula of Iceland : being the journal of a tour in Iceland in the spring and summer of 1862. London, pp. 140–41.
- SLATER, H. H. (1901). Manual of the birds of Iceland. Edinburgh, David Douglas, pp. 40-44.
- THIENEMANN, F. A. L., BREHM, L. and THIENEMANN, G. A. W. (1838). Systematische Darstellung der Fortpflanzung der Vögel Europa's mit Abbildung der Eier. Leipzig, part 5; 28.
- TIMMERMANN, G. (1933). Die Kurzschnabelgans in Island. J. Orn. 81: 322–30. (1938–49). Die Vögel Íslands. Vísind Ísland. nos. 21; 1–110: 24; 111–238: 28; 239–524 (1949, 355–58).
- WATTS, W. L. (1876). Across the Vatna Jökull; or, scenes in Iceland; being a description of hitherto unknown regions. London, p. 157.
- WITHERBY, H. F., and LEACH, E. P. (1933). Movements of ringed birds from abroad to the British Isles and from the British Isles abroad. Addenda II. Brit. Birds, 26: 352-61 (356).
- Þórarinsson, S., in A. Roussell and others (1943). Forntida Gårdar i Island. Meddelanden från den Nordiska Arkeologiska Undersökningen i Island Sommaren 1939. København, Munksgaard, pp. 313–16.

H2