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Trykt april 1974

Lavastrøm fra vulkanutbruddet på Jan Mayen høsten 1970.
Lava flow from the volcanic eruption on Jan Mayen, autumn 1970.

Innholdsfortegnelse

Notiser:

Some observations on the geology of H. U. Sverdrupfjella, Dronning Maud Land

By AUDUN HJELLE

Contents

Abstract

A lithological regional zoning of meta-supracrustals with NNE–SSW trend is traceable through the area of H. U. Sverdrupfjella. The zones which include biotite and biotite-hornblende plagiogneisses, granite gneisses, and calcareous horizons, are considered to reflect the stratigraphy of the original beds. The degree of metamorphism increases from epidote-amphibole-bearing gneisses in the west, to almandine-sillimanite-cordierite-bearing gneisses in the east.

Two main fold phases are distinguished: F1 which approximately parallels the lithological zoning, and with shallow plunge; and F2 which overprints F1 and is generally the most conspicuous, with 10–30° plunge towards the southeast.

Chemical analyses of the main types of gneissic rocks and of the post-tectonic intrusives are given.

Preface

The first geological reconnaissance in this part of Dronning Maud Land was done by the Norwegian-British-Swedish Antarctic Expedition 1949–52 (ROOTS 1953). In 1960 the Soviet Antarctic Expedition, during its regional investigations of East Antarctica, also covered parts of H. U. Sverdrupfjella (RAVICH and SOLOVEV 1966). In 1968 members of Expédition Antarctique Belge visited outcrops in the eastern part of H. U. Sverdrupfjella for comparative purposes (AUTENBOER 1972). The present work deals with observations made by A. HJELLE and T. S. WINSNES during the Norwegian Antarctic Expedition, in December and January 1970–71. The field conditions did not allow the whole area to be investigated and in the SE part of Straumsvola and the easternmost nunataks between Reecedalen and Brattskarvet only few outcrops were visited (Fig. 8).

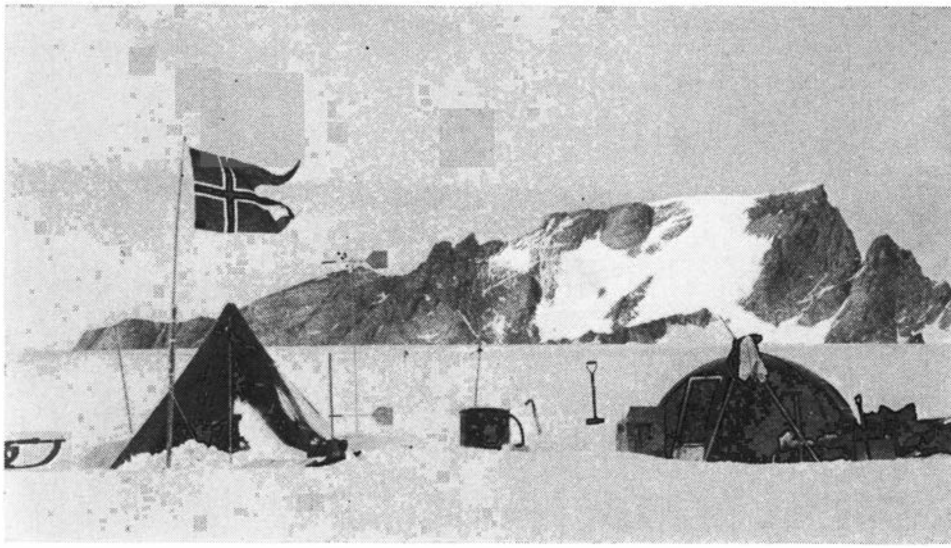


Fig. 1. *The Roerkulten nunatak (2083 m). Looking towards ESE from Camp Norway 2 (72°14.5′S–0°10.4′ W).*

From NW to SE the altitudes of the highest peaks increase from approximately 1600 metres in the Straumsvola–Jutulrøra area to a maximum of 2885 metres in Hamartind approximately 10 km ESE of Skarsnuten. Pronounced trends of the outcrops occur around 25^g and 150^g. All references to degrees in this paper refer to a 400 degree circle. When listing observations of planar structures, the strike is given assuming the dip to the right, viz 350/45 = strike NW–SE with 45^g dip to the NE. Concerning linear structures, the listed plunge is in the strike direction, viz 150/30 = 30^g plunge towards the SE.

Gneissic and migmatitic rocks

I. The Jutulrøra area. The most abundant rocks in the northern and central part of the area are biotite-hornblende plagiogneisses of granodioritic or monzodioritic composition. Layers, lenses, and boudins of amphibolite are common as well as veins and dykes of pegmatite and aplite, and younger dolerite. The modal composition of a typical gneiss from the northern part of Jutulrøra is (vol%, av. of 4 thin sections): 24% quartz, 10% microcline, 35% plagioclase (An 33), 16% biotite, 12% hornblende, and 3% accessories, mainly epidote and sphene. Epidote also occurs with quartz in pegmatitic veins and irregular segregations in the central part of Jutulrøra, north of the 1624 m peak. Quartz-albite-tourmaline veins and segregations were seen at two localities.

Towards the southern part of Jutulrøra, granitic gneisses become abundant; however more or less continuous amphibolitic layers still occur. Some of the granitic microcline-rich gneiss possesses an aplitic texture, with only a faint gneissosity.

The observations of bedding/layering suggest a main fold axis with shallow dip

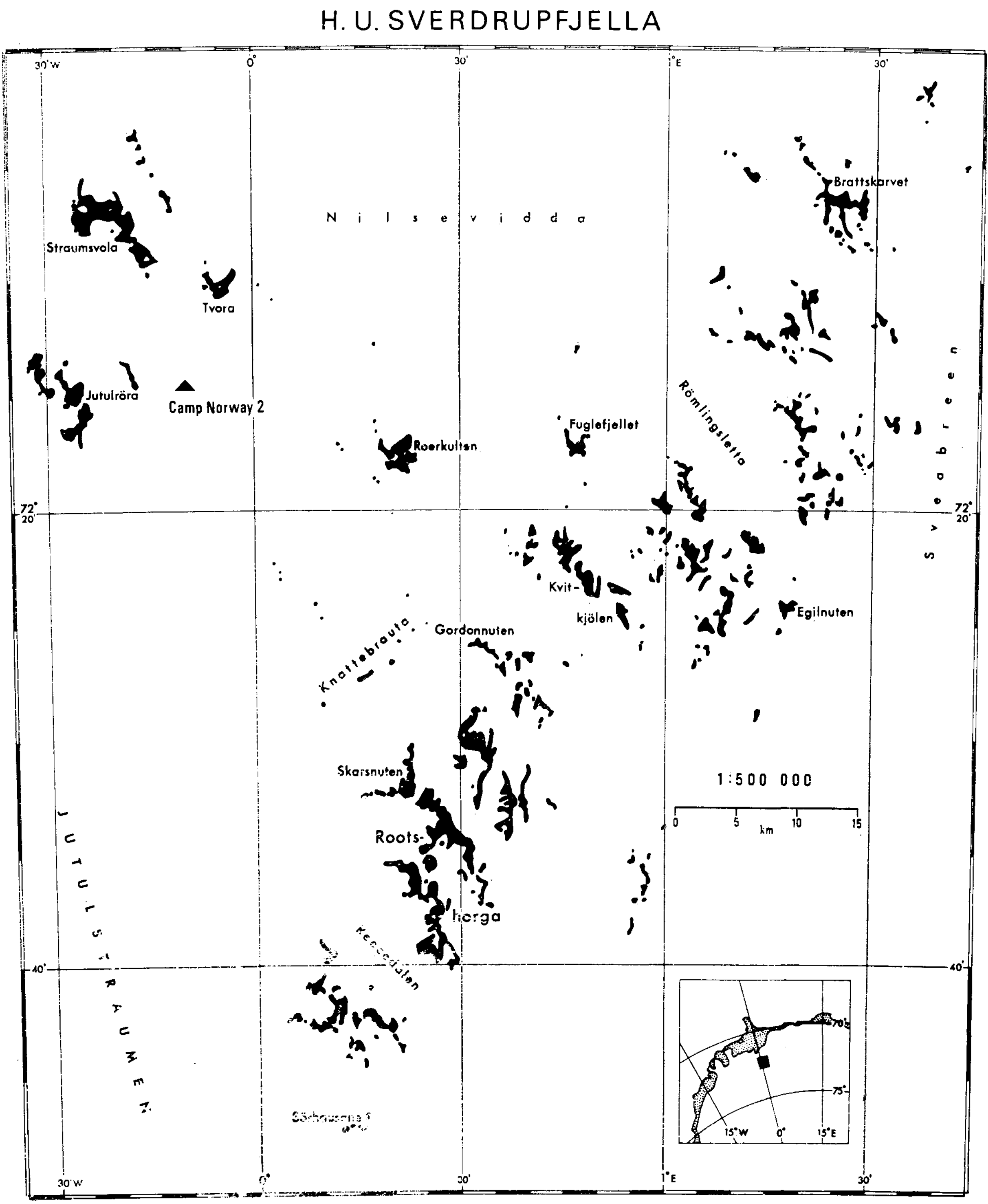


Fig. 2. *Outcrop map of H. U. Sverdrupfjella.*

H. U. SVERDRUPFJELLA

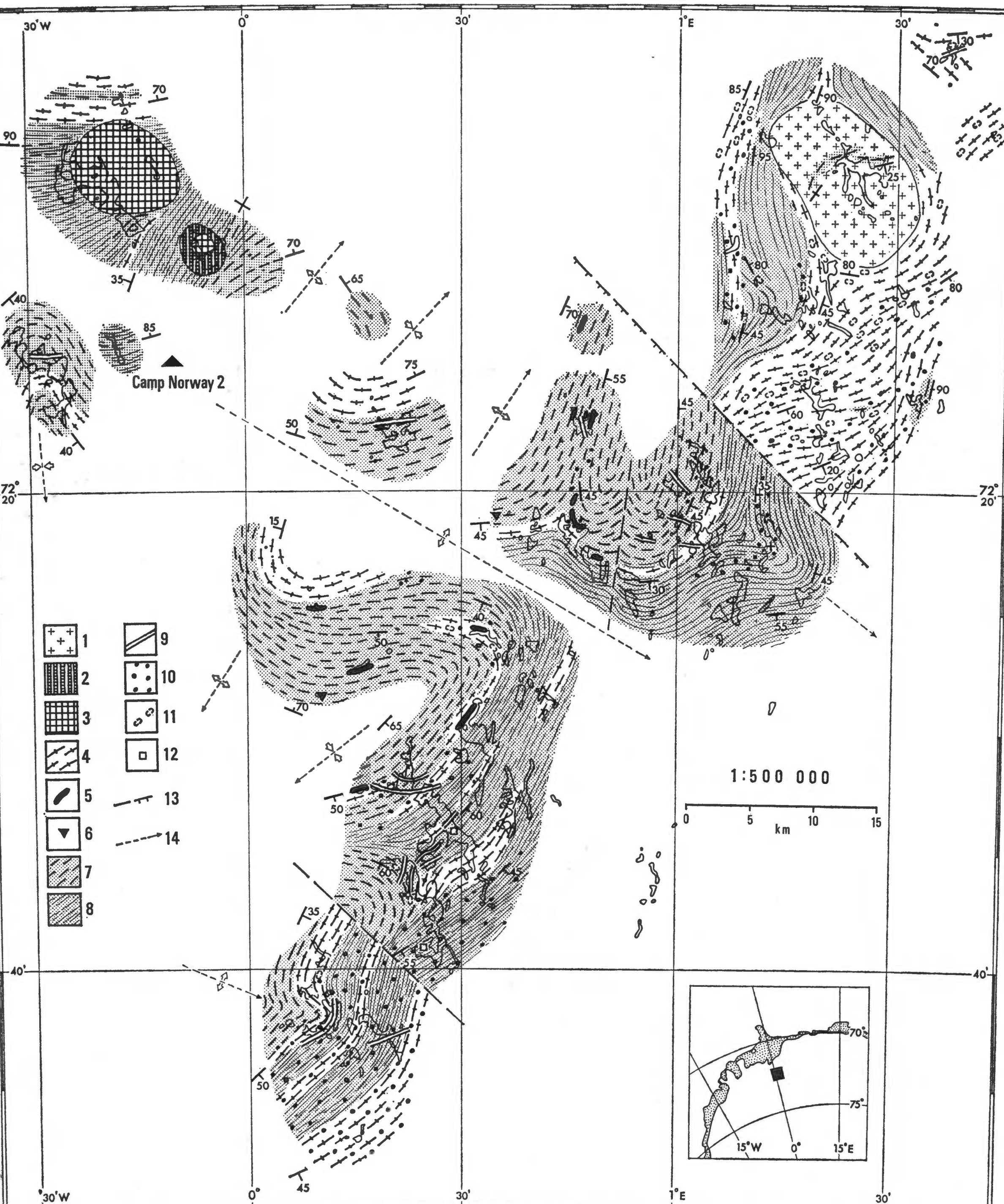


Fig. 3. *Preliminary geological map of H. U. Sverdrupfjella.* 1. *Hornblende monzonite*; 2. *Syenite*; 3. *Nepheline syenite*; 4. *Granitic biotite gneiss*; 5. *Marble*; 6. *Skarn rocks*; 7. *Biotite hornblende plagiogneiss*, 8. *Biotite plagiogneiss*; 9. *Major pegmatite and/or aplite dykes or dyke swarms.* 10. *Almandine garnet*; 11. *Feldspar augen*; 12. *Sillimanite*; 13. *Suggested faults*; 14. *Suggested fold axes. All dip angles refer to a 100 degree circle.*

towards c. 195^g. The measured mesoscopic fold axes and lineations show a pronounced maximum towards $175^g/25^g$, partly also with shallow northerly dips.

At the small ridge c. 5 km WNW of Camp Norway 2, the prevailing rocks are biotite gneisses with amphibolite layers, thus differing somewhat from the main Jutulrøra rocks. Also the mesoscopic structural elements show a different trend, with a layering strike of c. 80^g and with small fold axes plunging c. $85^g/35^g$.

II. The Straumsvola–Tvora area. Both in the southeastern and northwestern parts of Straumsvola and in the northern part of Tvora, biotite gneiss with layers of biotite amphibole gneiss and granite gneiss prevails, while more felsic gneisses, partly with subordinate layers of quartzite make up the uttermost nunataks north of Straumsvola.

The gneisses located close to the syenite intrusions are frequently considerably affected, both structurally and compositionally, by the latter. Near the southern contact with the Straumsvola nepheline syenite, syenitic schlieren and dykes occur abundantly in a roughly 50 m wide zone in the gneiss, thus making the contact more or less transitional. At the northern extension of the same syenite, veined and agmatitic migmatite gneisses were seen near the contact. The metatect of the migmatites is of syenogranitic to syenitic composition. In the northeastern part of Tvora a migmatitic contact zone is also evident, and the gneiss has suffered an intense small folding.

The two small nunataks just east of Tvora consist almost entirely of biotite hornblende gneisses, and a transition to the main area of hornblende-bearing gneisses in the south and southeast is suggested. The exposures and observations are few in this area, however, an antiform plunging northeast is tentatively assumed east of the two nunataks. Except for the Tvora area the mesoscopic fold axes concentrate in two directions, c. $305^g/25–45^g$ and $380^g/25^g$. In the Tvora area fold axes around $45^g/25^g$ prevail, thus resembling the directions in the ridge west of Camp Norway 2.

III. The Roerkulten area. The rocks which crop out in Roerkulten and the adjacent nunataks resemble those in Jutulrøra, i.e. they consist mainly of biotite-hornblende plagiogneisses with accessory epidote, and to a smaller extent various granite gneisses. Within the latter, small-folded veined migmatites occur. A modal analysis of a homogeneous granite gneiss showed (vol%): 17% microcline, 20% quartz, 45% plagioclase (An 16), 16% biotite, and 2% sphene.

At the small nunatak approximately 8 km NNE of Roerkulten, intensely small-folded banded gneiss prevails with alternating layers of mafic biotite-hornblende gneiss and sub-ordinate pegmatitic and aplitic material.

The orientation of the mesoscopic fold axes resembles those of the Straumsvola–Tvora area, with a main direction of c. $395^g/45^g$ in the northern nunatak and c. $40^g/35^g$ and c. $105^g/20^g$ at Roerkulten.

IV. The Sørhausane–Reecedalen area. The western part is dominated by biotite-hornblende plagiogneisses and granite gneiss, the eastern by almandine-bearing gneisses, both biotite plagiogneiss and granite gneiss. In general the gneisses are relatively rich in microcline, and the granite gneisses often show a migmatitic development. The modal composition of a microcline-rich granite gneiss from the western part of the area is (vol.%, av. of 3 thin sections): 32% microcline, 28% quartz, 26% plagioclase (An 25), 12% biotite, 2% undetermined. Scattered layers, boudins, and agmatitic inclusions of amphibolite occur in nearly all visited exposures, with varying thickness, from less than 50 cm to about 5 m. At Sørhausane amphibolites locally contain more than 50 vol.% garnet.

A large antiform is evident in the western part of the area (axis c. $125^{g}/20^{g}$.). The observed mesoscopic fold axes concentrate around $150^{g}/20^{g}$. An apparent lithological and structural discontinuity between the areas north and south of Reecedalen, and the relief of the ice surface northwest and NNW of Reecedalen, suggest a fault along this glacier valley.

V. The Rootshorga area. The southern part is characterized by almandine-sillimanite-bearing biotite plagiogneisses which resemble the biotite gneisses of the Sørhausane–Reecedalen area. At the southwestern part of Rootshorga, near Reecedalen, a quartzite boulder horizon was found in almandine-rich biotite gneiss (Fig. 5). The boulders, which consist of impure quartzite are semi-rounded and range in size from approximately 5 to 70 cm. They occur scattered and exhibit only poor sorting, resembling rotated fragments of a quartzite bed, or tillite boulders. Striae are, however, not recognized. The horizon, which has an uncertain thickness of about 30 m, strikes ENE, and is not recognized elsewhere.

In the western part of the area, biotite hornblende plagiogneisses are found; these are apparently comparable with the hornblende-bearing gneisses southwest of the suggested fault. In this part of Rootshorga, and also further towards the northeast, granitic dykes and sills make up a considerable part of the outcrops. The dyke intrusion activity seems also to have affected the surrounding gneiss, which often carries granitic material in 1 to 10 cm wide discontinuous veins or schlieren parallel or sub-parallel to the gneissosity. More extensive outcrops of granite gneiss occur also in the Rootshorga area; however, although the eastern parts are insufficiently covered by observations, biotite gneiss appears to be the most wide-spread rock in the area.

VI. The Knattebrauta – Skarsnuten – Gordonnuten area (including the small unnamed nunataks north and northwest of Knattebrauta). The greatest part of the area is composed of relatively mafic biotite-hornblende plagiogneisses, apparently related to the Jutulrøra rocks. Typical minor elements associated with these gneisses are marble beds and/or skarn rocks. The calcareous beds which vary in thickness from approximately 5 to 200 m (in the ridge 9 km NNW of Skarsnuten), are believed to be remnants of more extensive beds. Though the northwestern part of the area is greatly obscured by ice, scattered observations suggest megascopic fold structures with shallowly plunging axes towards southwest. Almandine-bearing rocks occur locally, especially towards the east. At Gordonnuten plagioclase porphyroblastic granitic gneisses of apparently limited extension were seen adjacent to the marble beds.

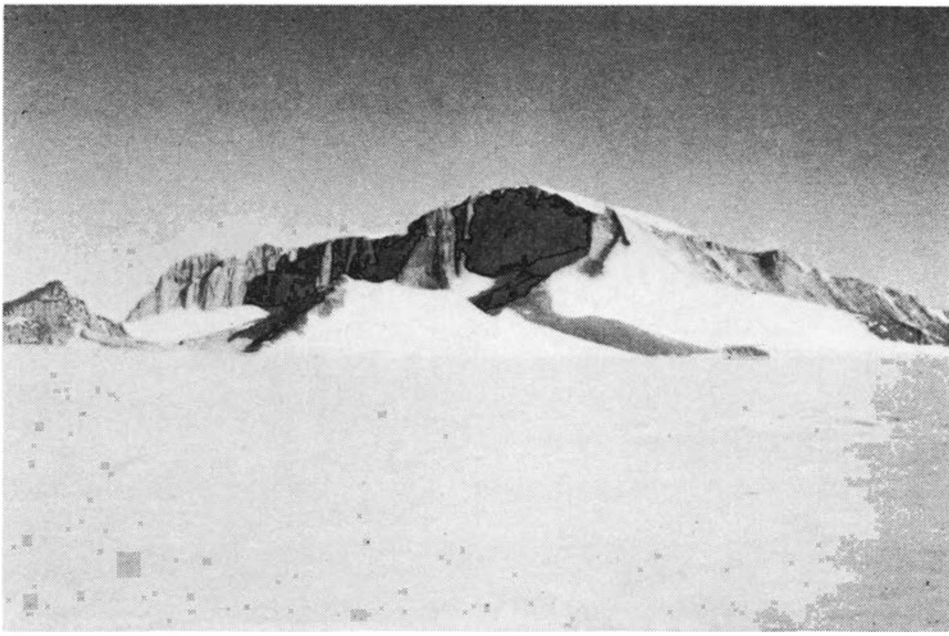


Fig. 4. *The hornblende monzonite massif of Brattskarvet (2103* m), *looking towards SE.*

Fig. 5. *Semi-rounded quartzitic boulder in garnet-rich biotite gneiss, Gavlen, SW Rootshorga.*

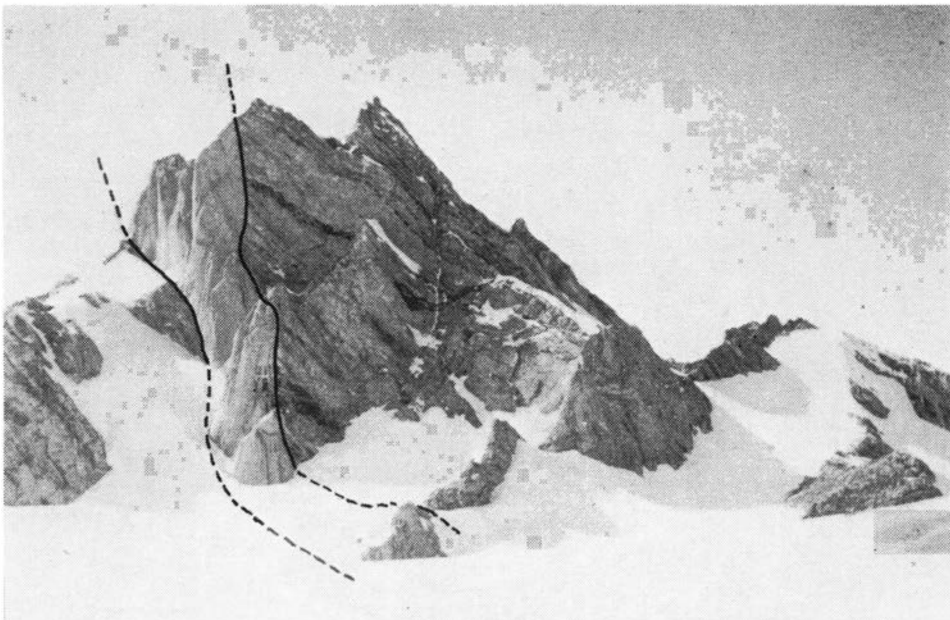


Fig. 6. *Skarsnuten (2280* m) *with a 60 m monzogranite dyke intruding biotite-amphibole gneiss with amphibolite layers. Looking towards SE.*

Granitic dykes resembling those in the western part of Rootshorga occur in and around Skarsnuten, with a main dyke (approximately 60 m wide) near the summit (Fig. 6). Small-folded and veined migmatitic gneiss with anomalous high contents of potassium feldspar occurs close to the major granitic dykes.

At the small nunataks about 12 km northwest of Knattebrauta granitic gneisses intercalate with minor layers of mafic gneisses, producing relatively felsic banded gneisses.

East of Skarsnuten–Gordonnuten biotite gneisses with layers and lenses of granitic gneiss seem to predominate.

VII. The Kvitkjølen–Rømlingsletta area. The sequence in the northern and western part of this area, which comprises biotite hornblende plagiogneisses with minor marble beds, is considered to be stratigraphically equivalent to similar rocks in area VI described above. Towards the south and east the lithology is dominated by various biotite gneisses with scattered discontinuous lenses and layers of granite gneiss, 0.5 to 10 m thick. As in area VI, the gneisses are locally almandine-bearing. Another feature common to both areas is the appearance of granite gneisses in the transition zone between the biotite hornblende gneisses and the biotite gneisses; this may reflect a primary stratigraphical horizon. SSW of Rømlingsletta, granitic dykes and dyke swarms (mainly pegmatitic) occur in a 5 to 10 km wide belt.

VIII. The area north and east of Rømlingsletta. Between this area and those to the southwest there is a marked lithological break, and a fault is presumed. While mafic matasupracrustal gneisses predominate south of the fault, relatively coarse almandine-bearing granitic augen gneisses and migmatite gneisses are common in the north, suggesting a downthrust to the south. Modal analysis of a typical sample of augen gneiss gave (vol.%): 34% quartz, 21% microcline, 30% plagioclase (An 28), 13% biotite, and 2% almandine.

Towards the west and north biotite gneiss intercalates with the granite gneiss, and banded sillimanite-bearing gneisses are recorded from two localities (not marked on the map). Agmatitic and lensoid amphibolite bodies (0.5–5 m) generally occur within the gneisses of area VIII.

Along the border of the Brattskarvet monzonite, the structures of the surrounding rocks are more or less concordant to the pluton, with contact zone rocks varying from agmatite to schlieren gneiss.

Post-tectonic intrusive rocks

The Tvora syenites. The main syenite has a coarse-grained homogeneous texture and shows a dark reddish brown weathered surface. This syenite probably occupies at least 10 km^2 and is exposed in the main part of Tvora and in the small adjacent nunatak to the north. More than two thirds of the typical rock consist of microperthite orthoclase, less than 10% of oligoclase, approximately 5% magnetite, and 10% clinopyroxene, hornblende and olivine (Table 1, No. 3).

In the northeastern part of Tvora the syenite shows intrusive contact with gneiss, through a c. 50 m wide migmatite zone. In the lower northwestern part of Tvora a coarse light grey nepheline-bearing syenite with an occasional faint zoning around $270^g/40^g$, occupies 2 to 3 km^2, suggesting a plug-like intrusion of slightly younger age than the syenite mentioned above. (Table 1, No. 2). At the contact an approximately 5 m wide zone in the nepheline-bearing syenite exhibits orthoclase with moonstone reflections.

The Straumsvola nepheline syenite. This intrusive body is suggested to occupy more than 40 km^2, with the main exposures in the northern and central part of Straumsvola, and smaller exposures in the nunataks to the northeast. The rock is rather similar both in appearance and composition to the smaller intrusion in the Tvora area; however it has a generally higher nepheline content (Table 1, No. 1). The intrusion is essentially homogeneous throughout the area, except for a nearly horizontal zoning recorded at some localities, possibly reflecting roof structures of the intruded meta-supracrustal gneisses. Observations of zoning are: at Straumsvola $380^g/20^g$ and $200^g/25^g$, and in the northeast $55^g/25^g$.

On the northern slope of Straumsvola, at approximately 1300 m above sea level there occurs a large irregular shaped body (several hundred metres in diameter) of mafic rocks with an alkali-amphibolitic composition. The main minerals are brown hornblende, green alkali clinopyroxene, plagioclase, and small amounts of nepheline and sodalite. Close to the contact, in the nepheline syenite, pink eudialyte occurs on joint surfaces. At the southernmost of the small nunataks northeast of

Straumsvola, pegmatitic cavity fillings (0.5 to 4 cm diameter) are rather common in the nepheline syenite; these contain crystals of natrolite, sodalite, acmite and leucite, and some adular and zircon.

The Brattskarvet monzonite. This intrusion, which has an estimated size of 90 to 100 km^2, has its main exposures in the Brattskarvet massif (Fig. 4). Although several varieties occur, the analysis in Table 1, No. 5 is typical of the rather homogeneous central and northern parts of the intrusion. The rock is a medium-grained quartz-bearing reddish gray monzonite, with hornblende as the main mafic mineral. A typical modal analysis is (vol.%); 18% quartz, 40%microcline, 34% plagioclase (An 7), 5% hornblende + biotite + clinopyroxene, and 3% ore minerals + orthite + apatite + sphene.

North of the summit a banding with 20^g–60^g dip towards southeast is distinguishable within the monzonite. The bands consist partly of mafic biotite augengneiss, and partly of banded or agmatitic amphibolite.

Though cross-cutting contacts to the surrounding gneisses were seen locally, observations suggest that the general structure of gneisses is more or less conformable with the monzonite body.

Granitic dykes. Pegmatite and aplite dykes and veins were recorded from almost all localities; pegmatite dykes are by far the most common types seen (approximately 85% of dykes). The aplitic dykes are typically of monzogranitic composition with (vol.%): 35–40% microcline perthite, 25–30% quartz, 25–30% plagioclase (An 10–15), approximately 5% biotite, and approximately 2% ore minerals + apatite + calcite. The pegmatite dykes have essentially a similar composition although when the dykes intrude hornblende-bearing rocks (e.g. the biotite hornblende gneisses and the Brattskarvet hornblende monzonite) hornblende might replace biotite. Tourmaline-bearing quartz-albite pegmatites were recorded locally in the central and northern parts of Jutulrøra.

More than two thirds of the recorded granitic dykes are less than 3 m wide. Relatively wide dykes (more than 5 m) were observed at several localities in the Skarsnuten–Rootshorga area, viz. the 60 m monzogranite aplite dyke at Skarsnuten (Table 1, No. 4, and Fig. 6).

Irregular masses of pegmatite in the shape of discontinuous layers, lenticular bodies and ptygmatic strings are seen to be cut by pegmatite dykes. Thus two generations of pegmatite are present. The irregular masses of pegmatites which generally follow the structure of the gneiss are considered to be syntectonic replacement pegmatites.

Mafic dykes. More than two thirds of the mafic dykes were recorded from the relatively restricted area of Jutulrøra–Straumsvola–Tvora. The size of the observed dykes varies from less than 50 cm to about 50 m, with a main range of 50 cm to 2 m.

The dykes generally have almost vertical dips ($>70^g$) and throughout H. U. Sverdrupsfjella the main trend of strike is around N-S, with a maximum in the NNW–SSE direction (Fig. 9, I).

Table 1. *Chemical analyses of typical igneous and metamorphic rocks from H. U. Sverdrupfjella, Dronning Maud Land*

	1	2	3	4	5	6	7	8	9	10	11
SiO_2	56,19	61,68	59,57	72,97	70,60	58,78	63,34	63,27	63,89	66,95	67,31
TiO_2	0,39	0,34	0,87	0,09	0,19	0,86	0,62	0,68	1,17	0,76	0,65
Al_2O_2	21,67	19,00	17,87	14,88	14,83	16,64	16,54	15,53	15,96	14,67	15,56
Fe_2O_3	0,71	0,84	1,64	tr.	1,15	2,08	0,34	1,69	0,64	0,53	0,24
FeO	2,14	2,26	3,90	0,60	0,65	4,80	3,91	4,19	6,04	4,03	4,02
MnO	0,11	0,09	0,18	0,05	0,03	0,13	0,08	0,11	0,08	0,07	0,06
MgO	0,53	0,43	0,98	0,11	0,40	3,26	2,57	3,16	2,59	1,87	1,49
CaO	0,86	1,61	3,21	1,24	1,36	5,40	3,78	4,41	2,51	3,12	2,58
Na_2O	8,67	6,52	6,19	4,00	4,48	3,47	4,34	3,51	2,22	3,27	3,44
K_2O	6,44	5,95	4,31	4,72	5,37	3,31	3,27	2,61	3,41	4,00	3,58
H_2O^-	0,10	0,14	0,18	0,01	0,02	0,08	0,03	0,06	0,03	0,02	0,02
H_2O^+	0,39	0,52	0,46	0,27	0,27	1,17	0,68	0,92	0,97	0,52	0,89
CO_2	0,35	0,12	0,08	0,20	0,12	0,06	0,10	0,07	0,01	0,05	0,09
P_2O_5	0,10	0,06	0,15	0,01	0,05	0,16	0,11	0,11	0,07	0,11	0,08
	98,65	99,56	99,59	99,15	99,52	100,20	99,71	100,32	99,59	99,97	100,01
MOLECULAR NORMS											
Q	—	—	0.9	27.7	19.7	10.8	13.1	21.3	31.3	24.2	26.8
Ab	28.4	50.8	55.3	36.4	40.4	31.7	39.0	31.9	20.6	29.7	31.5
Or	37.0	34.5	25.2	27.4	32.1	15.0	14.8	6.9	8.3	16.9	13.5
An	1.2	5.0	8.3	4.6	3.9	15.1	11.9	17.4	12.7	12.7	12.1
Ne	28.3	4.1	—	—	—	—	—	—	—	—	—
C	—	—	—	1.7	—	—	—	—	4.6	—	1.9
%An	(4)	(9)	(13)	(11)	(9)	(32)	(23)	(35)	(38)	(30)	(28)
Di	0,2	1.6	1.0	—	0.7	—	—	—	—	—	—
En	—	—	2.5	—	—	—	—	—	—	—	—
Hy	—	—	3.4	—	—	—	—	—	—	—	—
Ol	2.7	2.2	—	—	—	—	—	—	—	—	—
Bi	—	—	—	1.5	—	7.6	7.1	13.8	20.0	11.5	12.6
Ho	—	—	—	—	1.5	15.9	12.4	5.5	—	3.0	—
Mt	0.7	0.9	1.7	—	1.0	2.2	0.4	1.8	0.7	0.6	0.3
Il	0.5	0.5	1.2	0.1	0.3	1.2	0.9	1.0	1.7	1.1	1.0
Ap	0.1	0.1	0.3	—	0.1	0.3	0.2	0.2	0.1	0.2	0.1
Cc	0.9	0.3	0.2	0.6	0.3	0.2	0.2	0.2	—	0.1	0.2
No. (70/71 Hj)	19A	18C	29	23BC	35AB	5AB	9CD	21	24D	25	33AB
Lat. S.	72°8.0′	72°10.0′	72°13,0′	72°31,9′	72°6,3′	72°14.9′	72°22,8′	72°24,8′	72°37,0′	72°42,3′	72°10.0′
Long.	0°17,1′W	0° 6,3′W	0° 4,8′W	0°21,3′E	1°24,0′E	0°26,8′W	0°48,8′E	0° 8,6′E	0°24,7′E	0°10,0′E	1° 6,9′E

Igneous rocks:

1. Nepheline syenite (foyaite), Straumsvola.
2. Nepheline-bearing syenite, NW Tvora.
3. Syenite, central part of Tvora.
4. Monzogranite (60 m dyke), Skarsnuten
5. Monzonite, Brattskarvet.

Metamorphic rocks:

6. Gneiss, quartz-bearing monzodioritic comp., Jutulrøra.
7. Do., Kvitkjølen.
8. Gneiss, granodioritic comp., NW of Knattebrauta.
9. Do., Rootshorga.
10. Do., Storkvæven.
11. Do., N Rømlingane.

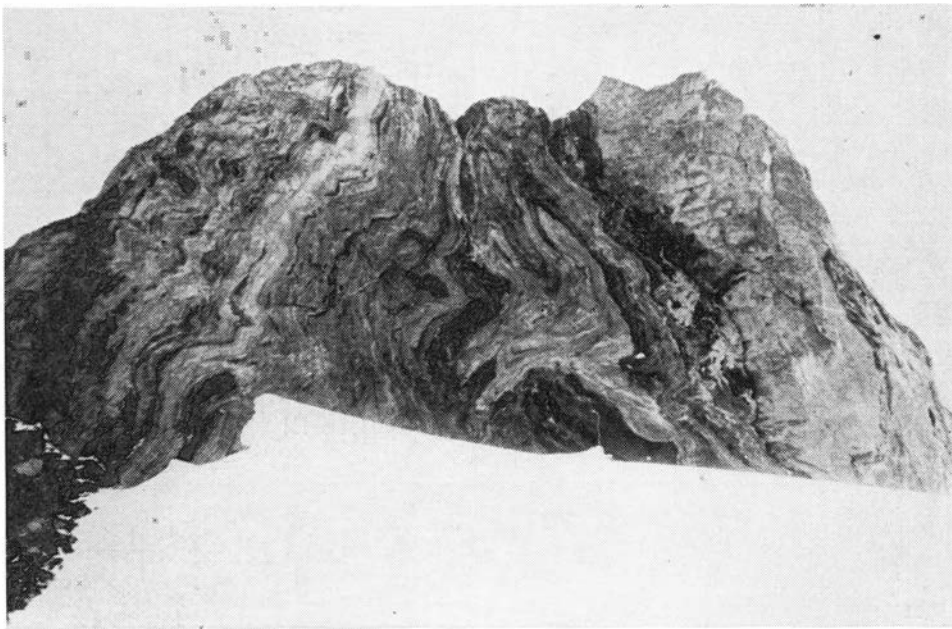


Fig. 7. *Intensely folded hornblende gneiss with layers and boudins of amphibolite and with syntectonic granitic material. SE part of Jutulrøra. Size of outcrop is approx. 300 × 100 m.*

Generally the textures are homogeneous fine to medium grained ophitic, however porphyric textures with pyroxene, hornblende, and biotite occur in the Straumsvola–Tvora area, and vesicular textures with secondary calcite and zeolites were observed in a dyke c. 10 km south of Brattskarvet.

Mineralization

A separation of strongly magnetic minerals (mainly magnetite) was carried out on samples of detrital sand (0.5–2 mm) in several 1–2 kg specimens from 51 of the visited localities. The content in the common gneisses was generally 0.1 to 2.0 vol.% of strongly magnetic minerals, average 0.60, while the values from the syenites and the Brattskarvet granite, and the gneisses most adjacent to these intrusives ranged from 1 to 20 vol.%, with an average of 6.5. The samples from the main (dark) syenite of Tvora showed the far highest values around 10–20 vol.%.

Laboratory Geiger counting of the same sand specimens showed that, while only slight differences were recorded between samples from the syenite areas and the areas of gneisses, the samples from the Brattskarvet monzonite area and the gneisses most adjacent exhibited values 2–5 times as high.

Secondary Cu-mineralizations were seen at rock surfaces at scattered localities in southeastern Jutulrøra, the northern slope of Roerkulten, the Knattebrauta area, between Gordonnuten and Skarsnuten, and south of Fuglefjellet; all these localities are within the area of biotite-hornblende-plagiogneisses. Small amounts of scheelite were found in detrial sand at Fuglefjellet.

H. U. SVERDRUPFJELLA

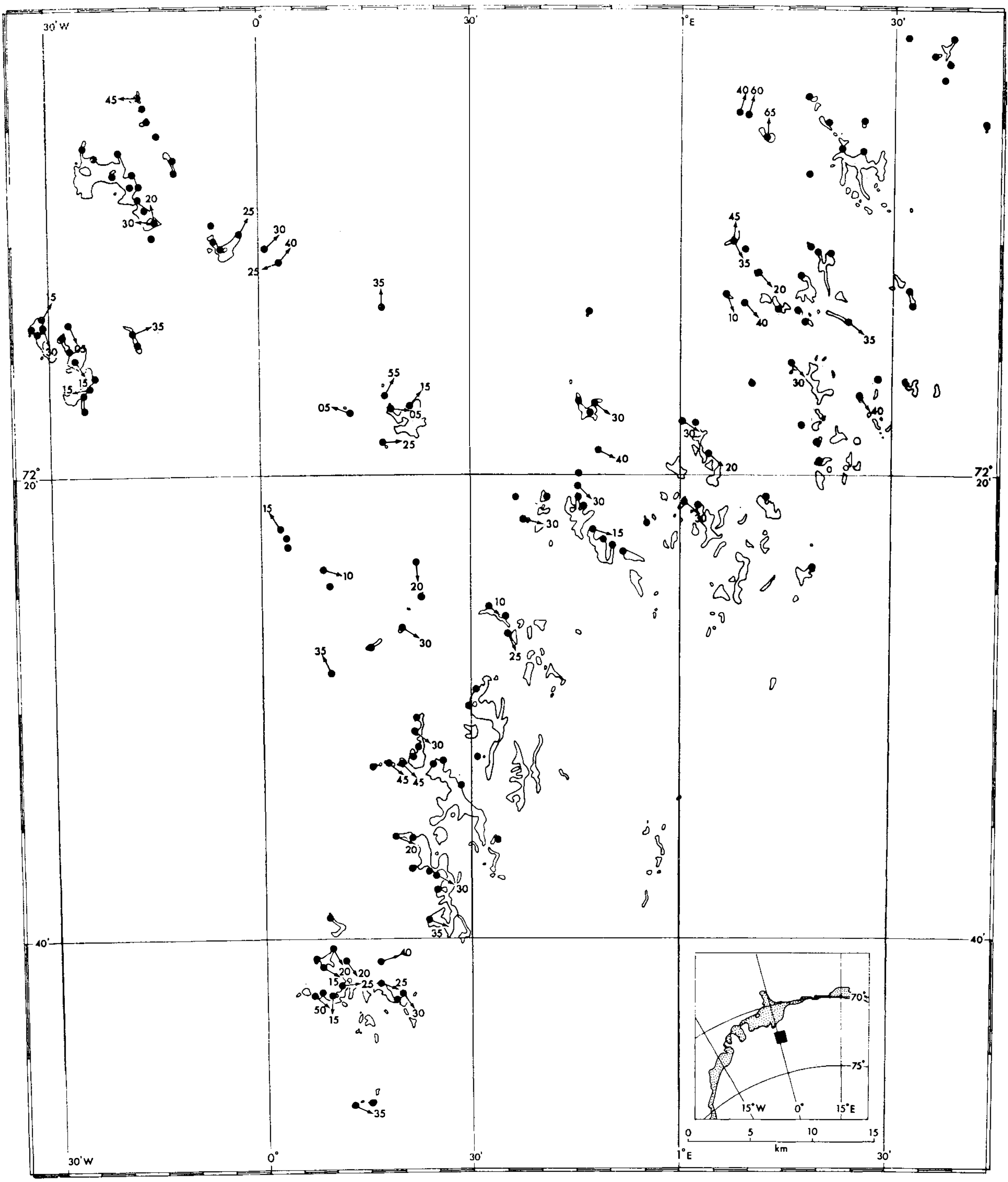
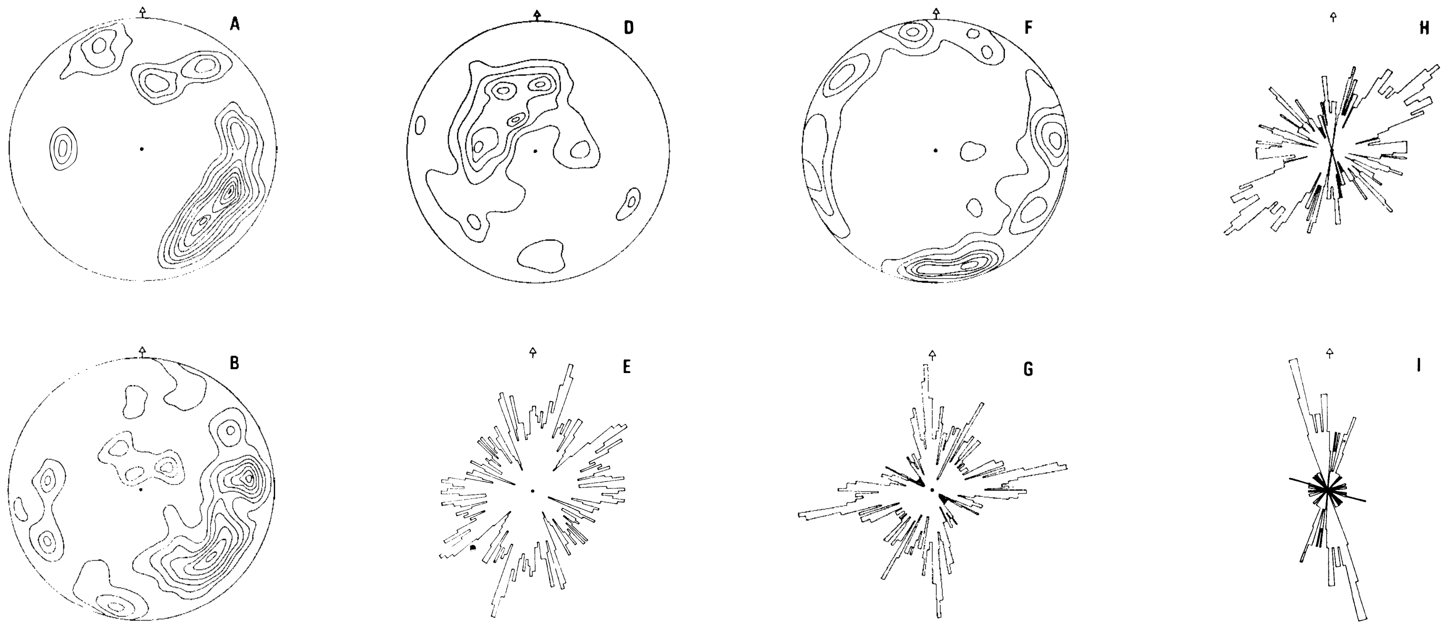


Fig. 8. *Map showing the visited exposures. Arrows indicate mesoscopic fold axes.*



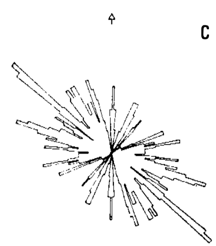


Fig. 9. *Structural elements in H. U. Sverdrupfjella. Synoptic diagrams. Contour diagrams: Stereographic projection, lower hemisphere equal area plot. Contours 1, 2, 3, 4, 5, 6, 7, 8, 9, 10% per 1% area. Strike diagrams: Every second degree counted, counting cell 5ᵍ.*

A. Poles to mesoscopic folds and associated linear structures. 141 obs. B. Poles to local β-s. 89 obs. C. Strike of mesoscopic folds and associated linear structures. 141 obs. D. Poles to layering planes and associated gneissosity planes. 441 obs. E. Strike of layering and associated gneissosity. 449 obs. F. Poles to joint planes. 244 obs. G. Strike of vertical or almost vertical joints. 220 obs. H. Strike of post-tectonic granitic dykes. 170 obs. I. Strike of post-tectonic dolerite dykes. 40 obs.

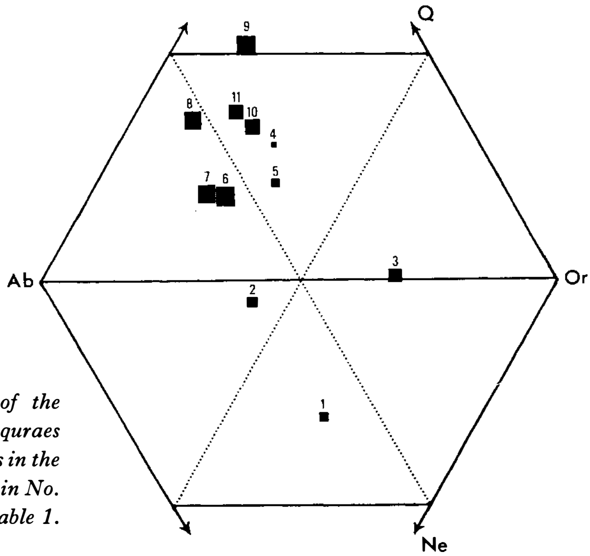


Fig. 10. *Ab–Or–Q–Ne diagram of the analyzed samples. The areas of the squraes indicate the content of mafic minerals in the norms, from 1.6% in No. 4 to 27.2% in No. 6. The nos. correspond to those in Table 1.*

Structure, stratigraphy

The map in Fig. 3 shows that a lithological regional zoning with a NNE–SSW trend is traceable through the area, although this trend is considerably obliterated by later folding. The zoning is considered to reflect the lithostratigraphy of the metasupracrustals involved. The NNE–SSW trend is also seen in the diagram of layering and gneissosity in Fig. 9 E, and also to some extent in the corresponding diagram of poles in D. The latter also shows that the layers mainly dip 30^g–50^g towards the south-east. This would suggest the upper part of the sequence to appear in the south-east. The generally higher metamorphic grade in this area compared with that in Jutulrøra and other areas in the southeast seems to contradict this.

However, the presence of cordierite (RAVICH and SOLOV'EV p. 199) indicates a low to medium pressure type of metamorphism in the east, and suggests that the generally higher metamorphic grade here does not necessarily need to be related to a great stratigraphical depth; it might be caused by a relatively shallow NNE–SSW trending zone of dynamothermal metamorphism. The occurrence of rocks of relatively high metamorphic grade around and south of the Brattskarvet monzonite suggests that a dynamothermal metamorphism might be a result of a late tectonic event preceding, and possibly related to, the monzonite intrusion.

The diagrams of mesoscopic fold axes and local β's, show pronounced maxima of axes plunging east and south-east. In the field these folds were seen to refold NNE-trending structures. The east trending small-folds and β's are mostly recorded in the gneisses adjacent to the syenite intrusions in the Straumsvola area and are possibly related to these.

Two main fold phases may then be distinguished; F1 with shallow plunge NNE–SSW, and F2 with 10^g–30^g plunge towards south-east, overprinting F1.

Below a tentative stratigraphical division is shown, the youngest units at the top.

Sveabreen Fm. Appears in the area west of Sveabreen. Mainly almandine-bearing (augen-) granite gneisses, in part sillimanite-bearing.

Rootshorga Fm. In the eastern zone from Sørhausane to Rømlingsletta. Pelitic and granite gneisses with some sillimanite, almandine, and cordierite.

Fuglefjellet Fm. In the area south and east of Roerkulten. Biotite-hornblende plagiogneisses with discontinuous horizons of marble and skarn rocks.

(*Jutulrøra Fm.*) In the Jutulrøra–Straumsvola–Tvora area and in Roerkulten. Various gneisses: biotite hornblende gneiss with epidote, biotite gneiss, and granite gneiss. Calcareous rocks are not recorded. This formation might possibly be included in the Fuglefjellet Fm.

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A new occurrence of Devonian rocks in Spitsbergen

By Tore Gjelsvik

(*With a preliminary palaeontological report by* Svein Manum)

Introduction, tectonic setting

In 1968, during investigations of the geology of the Lovénøyane in the inner part of Kongsfjorden, I observed a formation of red boulder conglomerates, and grey-green sandstones, shales and pebble-conglomerates on two of the islands, Observasjonsholmen and Midtholmen (Fig. 1). The islands are considered to consist of metamorphic Hecla Hoek rocks on existing maps (Orvin 1940), but the grey-green unit in particular appears unmetamorphosed. This unit is approximately 15 m thick on both islands, and on Midtholmen is interbedded between two beds of red conglomerate (Fig. 2); on Observasjonsholmen the lower red unit is probably below water level. The strata dip by between 30 and 50^g to the west, with steeper dips on the eastern side. Total minimum thickness is 35 m. The eastern islands consist of marbles of Hecla Hoek age, sometimes distinctly banded, which dip by between 50 and 100^g to the west. Both Storholmen and some skerries which lie immediately west of the conglomerate-bearing islands, also consist of banded marbles which mostly dip vertically with a N or NE strike. The marble is strongly tectonically brecciated in places. On some exposures near the contact with the conglomerate, a peculiar reddening and brecciation also occur; the latter does not seem to be of tectonic origin, but may represent a fossil weathering surface. On the northernmost Lovén island, Juttaholmen, faulted blocks of weathered marble and red boulder conglomerate are seen. The faults are mostly steep, with highly varied strike directions. Distinctly bedded red conglomerates with a somewhat anomalous dip (70^g NNW) occur on the tiny skerry of Rundholmen (half way between Lovénøyane and Gerdøyane to the north).

Gerdøyane consist of banded marble dipping 30^g to 70^g W, with several closely spaced shear zones occurring on the easternmost cape of the biggest island; these are subparallel to the bedding, which here dips 70^g W. This zone coincides with the steeply dipping (faulted ?) marble/schist contact in Skreifjellet (4 km to the N). In a small escarpment near the shore of Blomstrandhalvøya, just opposite Gerdøyane, another outcrop of the red boulder conglomerate is seen (Fig. 1). It is rather massive, but the topography of the outcrop indicates a dip to the west. On the western side strongly tectonized Hecla Hoek marble occurs, the eastern side is covered by glacial debris.

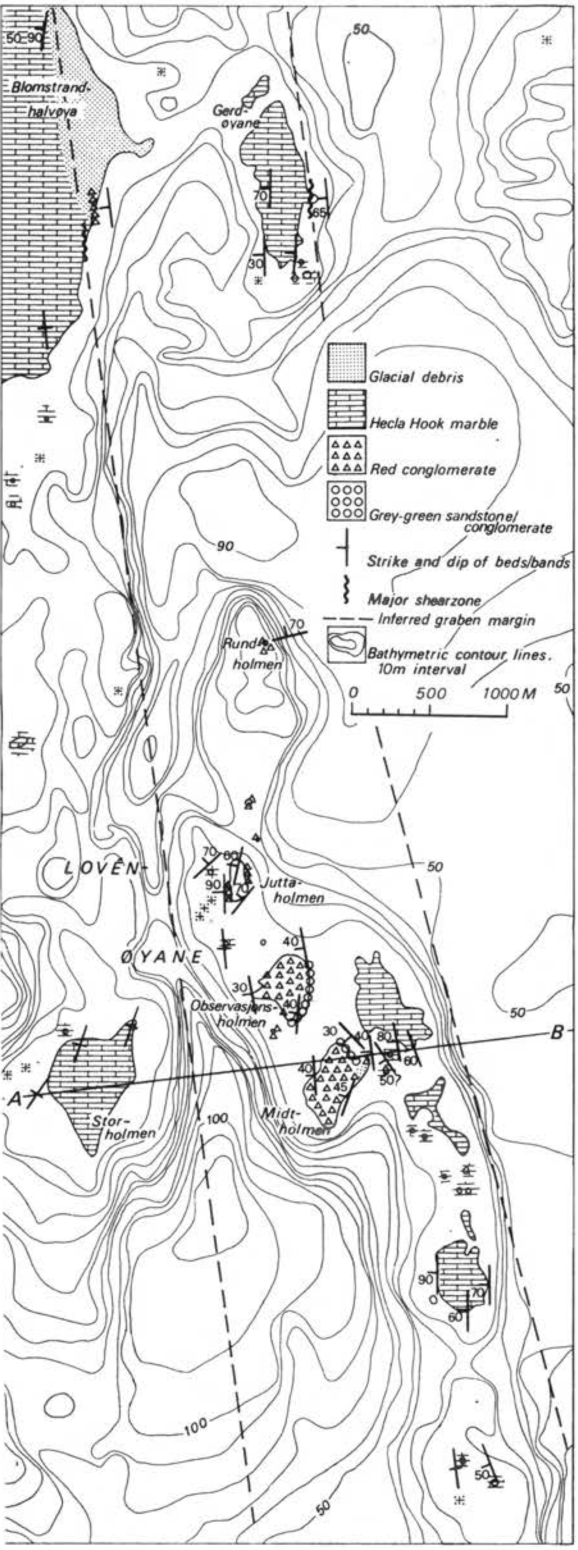

Fig. 1. *Geological map of Lernerøyane, inner part of Kongsfjorden, Spitsbergen.*

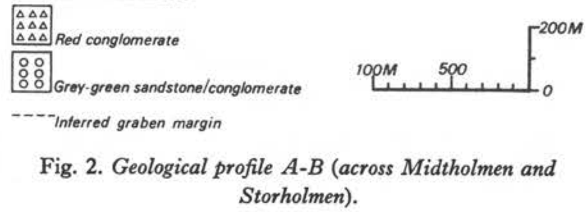

Fig. 2. *Geological profile A-B (across Midtholmen and Storholmen).*

Composition

The grey-green unit consists of alternating medium-bedded sandstones and conglomerates with semi-rounded pebbles and cobbles of marble, dolomite, quartzite, quartz, and phyllite. The sandstone consists of approximately 40% partly recrystallized carbonate grains, 30% muscovite, and 25% quartz. An appreciable proportion of the latter in fact consists of fine-grained quartzite fragments. Muscovite occurs both as detrital flakes (up to 1 mm in size), often strongly bent and somewhat altered, and as tiny crystals formed by recrystallization together with a little chlorite of the same grain size.

Graded bedding appears locally, indicating normal position of the beds.

The colour change to the overlying red conglomerate takes place over a few cm, while at the same time the fragments increase in size and become more angular. On the west side of the island, the enclosed fragments in some beds are of small to medium boulder size.

The matrix of the red conglomerate consists of coarse grains of carbonate and a few quartz grains. The matrix is partly recrystallized and intersected by carbonate veins, which also cut some fragments. A great many of the carbonate minerals in the matrix are clouded by tiny, red particles, which also occur together with larger opaque flakes along grain boundaries. Some of the fragments are also clouded by red iron particles. The fragments consist of the same low-grade metamorphic rocks which occur in the grey-green conglomerate, although marble pebbles (many of which are banded) are more abundant here (Fig. 3).

Occasional small (less than 20 cm thick) lenses of muddy shales occur interbedded in the grey-green unit. After careful search, I discovered coalified plant fossils, mostly needle-like stems (Fig. 4). The mineral composition of the most fissile parts of these shales is roughly: Carbonate 50, quartz 20, muscovite 30 per cent. The carbonate consists partly of round to oval grains (approx. 100 μ diameter) and partly of more fine-grained matrix. Quartz grains (approx. 100 μ diameter) are subangular or rounded. Both minerals are somewhat recrystallized along grain boundaries. The muscovite flakes, less than 200 μ long, are often dusty along the edges, and are concentrated in thin layers giving the rock an irregular lamination which in some places is enhanced by shearing. Opaque needles are plant remains; however, opaque minerals are also found in an echelon or cross-cutting very thin veins.

Palaeontology

SVEIN MANUM has kindly examined and described some of the fossiliferous material referred to above:

«*Macrofossils.* So far only one type of macrofossils has been distinguished: fragments of dichotomizing stems, one to a few cm long, 0.8–1.2 mm wide. Occasionally the rock surface is crowded with them, in which case they tend to show some degree of current orientation (Fig. 4).

Fig. 3. *Photo of red boulder conglomerate from Observasjonsholmen (size of compass 10 cm).*

Fig. 4. *Fragments of dichotomizing stems, referable to* Hostimella, *from grey, fissile sandstone (approx. natural size) Observasjonsholmen.*

The stems have few diagnostic features. So far, fertile ones have not been seen. Dissolving the matrix in HF yields heavily carbonized strands whose margins are irregularly serrated, indicating the loss of the enveloping tissues. HF-solution yielded no stems in their full width. By transfer preparation, however, fragments are obtained of strands enveloped in what appears to be the stem cuticle, showing rather uniform elongated cells. Stomata have not been observed.

The fossils are interpreted as simple, naked, dichotomizing stems with a vascular strand referable to *Hostimella.*

Microfossils. The palynomorph assemblages obtained in a number of macerations consist almost entirely of compressed and folded spore bodies, diameter 20–45 μ, lacking appendages and other sculpturing features. They are in general poorly preserved and much corroded. A few have distinct trilete marks and contact areas appear to be of *Retusotriletes* affinity. No achritarcs have been seen.

Age of the flora. The simple morphology of the stem fragments strongly suggests relationship to Lower Devonian Rhyniophytes.

The palynomorph assemblage of small-sized smooth spores and the absence of any more highly organized forms support the idea of a Lower Devonian flora, tentatively fairly early Lower Devonian.»

Conclusions

The examination of the fossils thus supports the impression given by the lithology, viz. that the sandstone-conglomerate formation post-dates the Caledonian orogeny. It is also lithologically distinctly different from the conglomerate-sandstone series along the NE coast of Brøggerhalvøya, outside Brandalspynten, which was considered Devonian by ORVIN (1934), but later reinterpreted as Lower Carboniferous by CUTBILL and CHALLINOR (1965). On the other hand, it is lithologically nearly identical to the Red Bay Conglomerate Formation which occurs at the base of the Devonian sequence on the north coast of Spitsbergen (HOLTEDAHL 1926); it thus seems permissible to correlate the two formations. If this correlation is correct, the macrofossils reported on in this paper are the first to be found in the basal formation of the Devonian in Spitsbergen.

The slight tectonization and recrystallization of the finer material in the beds may have taken place either during the Svalbardian phase of the Caledonian orogeny or in connection with the strong Tertiary deformation of the Kongsfjorden area.

The fragments of the conglomerates are of the same lithology as the adjacent Hecla Hoek rocks, such as the marbles of Blomstrandhalvøya and the quartz micaschists of Sarsfjellet. As with the Red Bay Conglomerate elsewhere, transport distances in Kongsfjorden have been short and deposition very rapid. More work is needed, however, to determine transport directions and in which way the beds face.

It may be concluded that the Devonian formation in Kongsfjorden is located in a narrow graben (Fig. 1), bordered by steep faults running approximately N 15–20^{g}W. The position of the eastern fault is indicated by the shear-zones on Gerdøyane, the steep marble contact on Skreifjellet, and an unusually steep underwater escarpment immediately east of Lovénøyane. The western fault is indicated by the shear-zones on Blomstrandhalvøya and a deep trench between Storholmen and Midtholmen. So far, I have found no evidence of the graben structure on Brøggerhalvøya, and it may terminate to the south against the supposed NW–SE fault in Kongsfjorden (ORVIN 1940, plate 1). Northwards the graben disappears under Blomstrandbreen and its marginal debris, but red weathering colours on ridges in the upper reaches of the glacier suggest a possible extension in that direction.

It is seen (Fig. 1) that the strike direction of the beds generally makes an angle of 20–30^g to the trend of the graben, and the exposed beds may therefore represent a greater thickness than that demonstrated on Fig. 2. However, the graben is intersected by E–W and SW–NE faults, which may have displaced the formation both laterally and vertically.

Acknowledgements

The author is grateful to SVEIN MANUM for investigation of the fossil material, to YOSHIHIDE OHTA for assisting in examination of thin sections, and to DAVID WORSLEY for critical reading of the manuscript and correcting of the English text.

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The seismicity around Jan Mayen

By T. NAVRESTAD[1] and A. SØRNES[1]

Contents

Abstract

Epicentre maps and earthquake frequency data show that the level of seismicity around Jan Mayen has increased during the last years of an 18 year study period. This increase may be associated with the September 1970 flank eruption of the Beerenberg volcano. Earthquake swarms are found to be distributed rather evenly in time and space along a NE–SW trending mid-oceanic seismic zone between Svalbard and Iceland. The seismic station on Jan Mayen records only local earthquakes within a distance of 100 km, indicating that the seismic waves are highly attenuated in the area.

Introduction

A new modern tripartite seismic station was put into operation on Jan Mayen in 1971. This station was installed and is operated by the Norwegian Defence Communications Administration. A separate report describing the station is in preparation. The main purpose of the station is to monitor the local seismic activity in the area. The intensity and pattern of the future seismic activity may provide valuable warnings of any new volcanic eruption for the small community on this isolated Arctic island. This report is prepared to provide analyses and interpretations of available seismographic data against which the future intensity and pattern of the seismic activity may be compared. The available data are from a one-component seismic station on Jan Mayen run by the University of Bergen from 1962 to 1970. The data from the new tripartite station are available from 1972. These data allow not only the distance but also the position of the events to be

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determined. So far only conjectured velocities have been used in the determination of epicentres, and since the accuracy therefore may be low, these determinations are not reported here. A regional seismic shooting survey is planned to take place in the second half of 1973 to obtain more precise information about the crustal and sub-crustal velocities in the Jan Mayen area. A more detailed study of the seismicity will be undertaken when the results of this survey become available.

Early studies

The world seismicity maps published in 1900 in the reports of the Committee on Seismological Investigations and in the immediately following years by the British Association for the Advancement of Science, show an earthquake area in the Norwegian Sea called District J. This district comprises an area centred south-east of Jan Mayen. Calculated data for unfelt pre-1900 earthquakes were given in these reports, showing that some had originated in the Norwegian Sea area. Only three earthquakes were felt on Jan Mayen before 1900 (DE MONTESSUS DE BALLORE 1900), originally documented in 1882 by an Austrian-Hungarian geophysical expedition to Jan Mayen during the International Polar Year 1882–83 (DE MONTESSUS DE BALLORE 1906).

On the world map of large earthquakes (1899–1903), published in the 1911 report of the British Association, the earthquake districts were not outlined by a circumscribing boundary, but instead some lines were drawn in. It was stated: «The dotted lines on the map which are parallel to mountain ranges or oceanic ridges and troughs, are axes of districts from which many large earthquakes have originated.» One of these lines was drawn in a NE–SW direction passing east of Jan Mayen. The details of this seismic zone of the Greenland and the Norwegian Seas have since been the subject of a very large number of seismological studies which gradually have produced evidence that the main seismic zone passes west rather than east of Jan Mayen.

Seismic activity map

The seismicity of the Jan Mayen area relative to the Nordic countries and the rest of northern Europe, is shown in Fig. 1. The isolines in this figure give a direct statistical picture of the relative seismic activity for the area shown and are calculated by BUNE et al. (1971) as follows: The term seismic activity A_k is defined as the mean number of earthquakes of a given energy class k within an area of 1000 km^2 during one year. The energy class k is defined by the formula $k = \log E$, where E is the total radiated seismic energy from an earthquake in joules, and k has the range ± 0.5. Fig. 1 shows A_{13} normalized to 50 years rather than A_{10} normalized to 1 year which is more commonly shown on such maps. The magnitudes (m_b) corresponding to $k = 13$ and 10, are 5 and 3.8 respectively.

Jan Mayen lies between the isolines 0.1 and 0.3 indicating that from one to

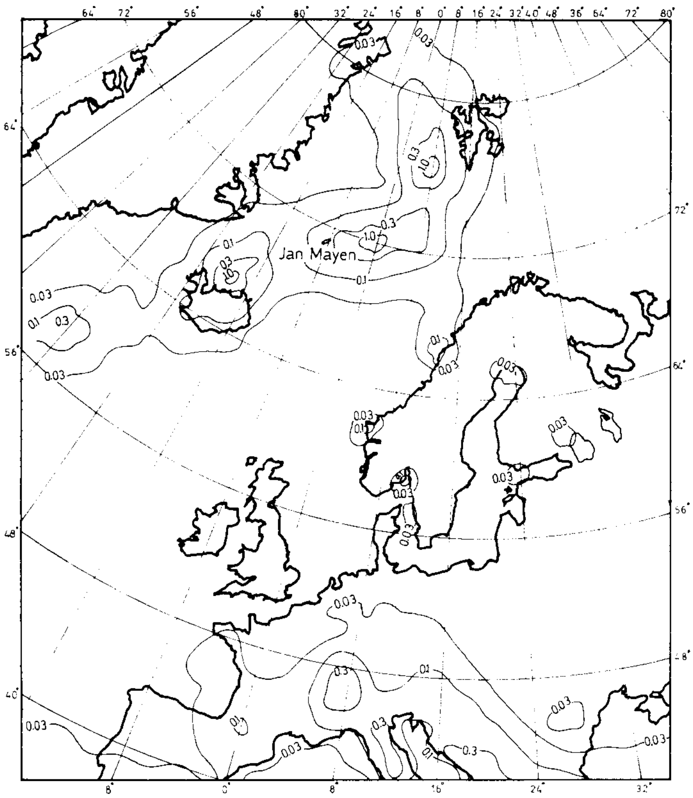

Fig. 1. *Seismic activity map 1956–1965 (redrawn after* BUNE *et al. (1971)).*

three earthquakes within the energy class k=13±0.5 will occur during a period of 100 years in an area of 5000 km². Corresponding numbers for the energy class k=10±0.5 (m_b=3.8) are 30–90 earthquakes. For the latter energy class the number of earthquakes within an area equal to the area of Jan Mayen will be 2–7 during 100 years. Data presented in this report show that the seismic activity has increased near Jan Mayen since the 1956–65 period summarized by the data in Fig. 1.

Distribution of epicentres since 1900

An important objective of this study is to try to delineate various tectonic features in the Jan Mayen area. Epicentre maps are therefore of great value if the accuracy of the epicentres is good. Many such maps published before and during the 1950's are of little value in this connection and are not quoted here. GUTENBERG and RICHTER (1954) recognized the inaccuracy of available data up to that time and stated that "between Iceland and Spitsbergen only the better located shocks are given".

The International Seismological Summary, which was published for the years

1918–1963, only included the larger earthquakes. Data for many minor earthquakes of the Arctic, therefore, are scattered throughout the literature. Epicentral data for earthquakes after 1900 collected from a variety of sources have been compiled and put on a digital tape by the Global Seismological Unit, Edinburgh. On request we were kindly supplied a printout from that tape for the area 55°N–90°N, 30°W–30°E. This printout contains many determinations for single events. The accuracy of the determinations for events in the beginning of this century is much lower than in the most recent years. For the region around Jan Mayen the accuracy is very poor even up to the 1950's due to lack of nearby observing stations. At that time the number of stations important for the study of the seismicity in the Jan Mayen area increased sharply. The Norwegian stations to be mentioned in this connection are: Isfjord, established in 1958, Tromsø in 1960, and Jan Mayen in 1962. The Jan Mayen station has the code JMI and is situated in the valley called Trolldalen (70° 55′ 41.9″N, 08° 43′ 50.9″W). All Jan Mayen data presented in this report refer to this site and are recorded by short period instruments with peak magnification near 2 Hz.

SYKES (1965) relocated all well-recorded earthquakes in the Arctic for the period January 1955 to March 1964 and claims an accuracy of epicentral location of about 10 km which is adequate for the present study. An event-file of punched cards containing the data for all events since January 1955 was made for the area from Scandinavia to Greenland. If more than one determination is available, the most accurate one chosen for the various periods are the following:

1955–1963 SYKES (1965)
1964–1970 International Seismological Center, Edinburgh.
1970–1973 Preliminary determinations of NOAA, Boulder.

The determinations made by the two last mentioned agencies have about the same accuracy as those made by SYKES (1965). Determinations of other events by other researchers or institutions for the same periods are considered to be less accurate.

The earthquake event file is useful for producing epicentre maps of specified areas and specified data selection by a computer plotter. Computer programs to produce such maps were therefore developed based on some available programs, called "The UCSD Hypermap Programs" (PARKER s.a.).

An epicentre map of the Greenland and Norwegian Seas for the last 18 years was plotted on a scale of 1:2 100 000. The epicentres are marked by three different symbols according to magnitude classes. Each of these three symbols appears in two different sizes according to whether or not the epicentre belongs to the determinations taken to be most accurate. The smaller symbols mark epicentres of the less accurate determinations and may have large errors. They do, however, supplement the picture and are therefore included. This epicentre map is more comprehensive than any other published map and shows several interesting features, but only the part of it covering the area near Jan Mayen is considered in detail in this report.

Fig. 2 is a small part of the epicentre map for the area near Jan Mayen showing

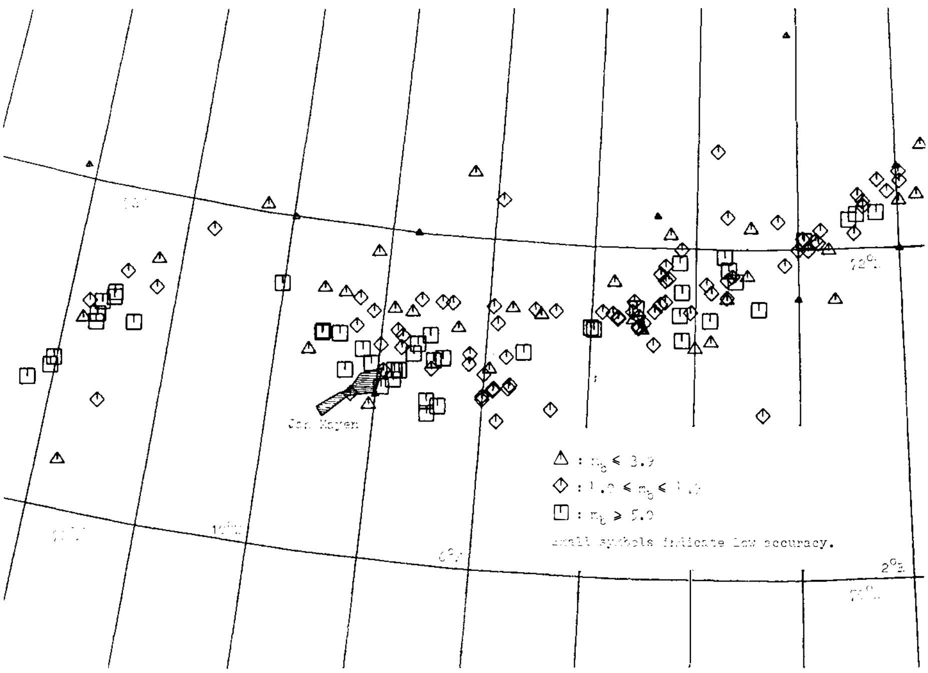

Fig. 2. *Epicentre map 1955–1972.*

all data for the last 18 years. An important point to investigate is the variation of the activity in time and space. Therefore, three other epicentre maps were plotted using the epicentres of highest accuracy only. Fig. 3 shows epicentres of earthquakes recorded during the first 31 months of the 18 year period of study. Epicentral data for 31 months prior to the eruption in September 1970 are shown in Fig. 4, while Fig. 5 shows the data for the 31 months after the September 1970 eruption. The detection and location capabilities of the seismic station network have increased during the period of 18 years covered by the different epicentre maps shown in Figs. 3–5. This increase must be taken into consideration when geophysical conclusions are drawn from these maps.

The maps in Figs. 3–5 suggest that seismic activity has increased in the area close to Jan Mayen towards the end of the 18 year study period, especially after the 1970 eruption. It is also evident that the activity has come closer to Jan Mayen after the 1970 volcanic eruption.

Earthquake swarms

An earthquake swarm is a series of events of approximately equal magnitude occurring within a small area in a short period of time. Such swarms are common in areas with recent or extinct volcanic activity, and earthquake swarms occur frequently in the Jan Mayen area. The Beerenberg eruption in September 1970

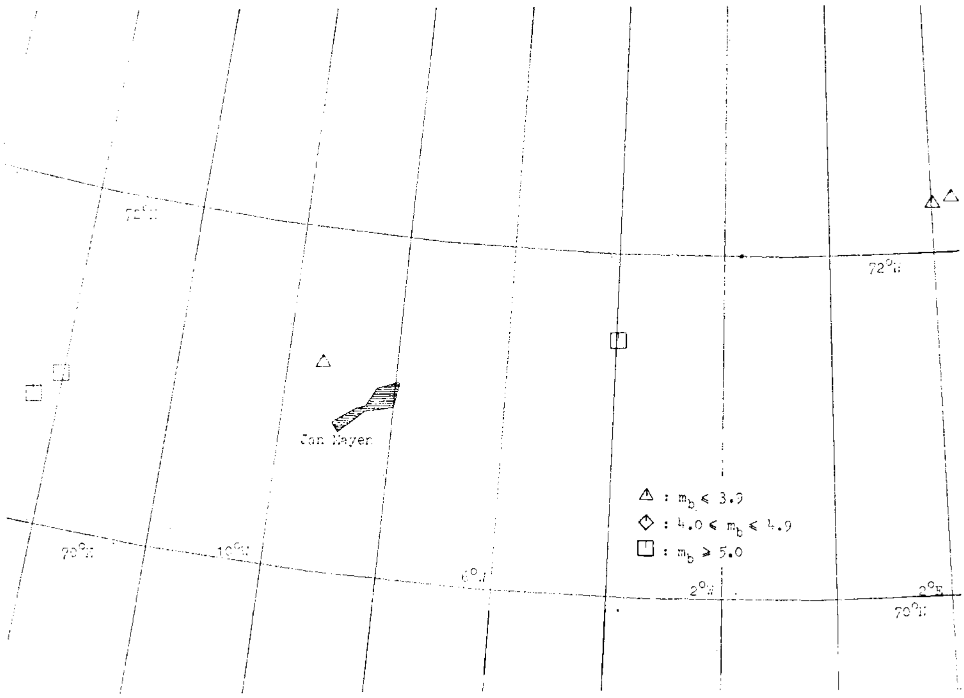

Fig. 3. *Epicentre map January 1955–July 1957.*

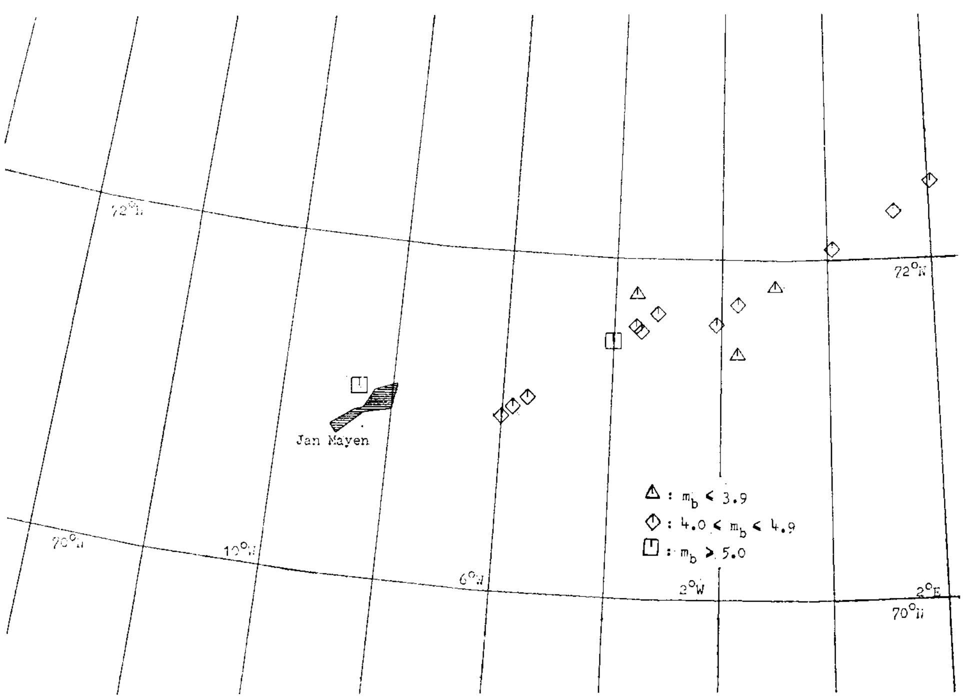

Fig. 4. *Epicentre map February 1968–August 1970.*

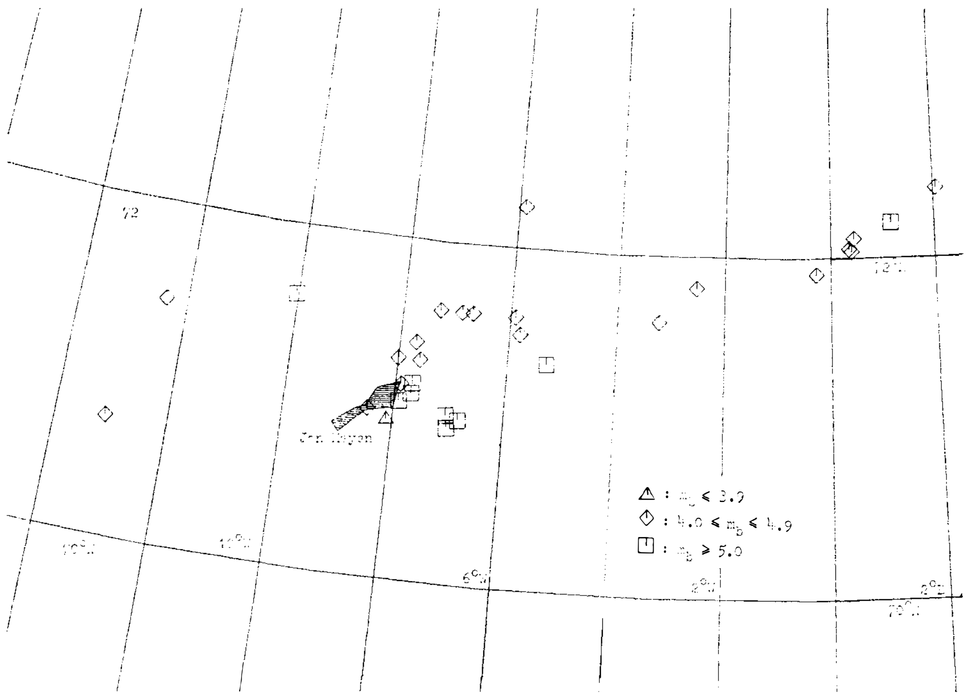

Fig. 5. *Epicentre map September 1970–March 1973.*

was accompanied by a series of earthquakes recorded at distant stations. According to ISC the largest earthquakes occurred as follows:

Date	Time (GMT)	°N	°W	Depth (km)	Mag.	No. of stations
18 Sept.	02 06 30.1 ± 0.24	71.27 ± 0.039	7.3 ± 0.12	28 ± 3.6	5.1	160
19 Sept.	20 57 10.3 ± 0.62	71.23 ± 0.087	8.0 ± 0.25	33 (assumed)	4.4	19
19 Sept.	21 32 49 ± 1.3	71.3 ± 0.17	8.1 ± 0.42	33 (assumed)	4.2	17
19 Sept.	21 58 06. ± 2.8	71.6 ± 0.12	6.6 ± 0.49	69 ± 30	(3.9)	17

The eruption was not reported until the early morning of 20 September by a passing aircraft. Some of the above earthquakes therefore may have occurred before the eruption, and all are probably associated with it. Though swarms are common around Jan Mayen, this is the only one with which volcanic activity is known to have occurred.

To predict what sort of activity we can expect in the future, we have to study the special characteristics of seismic activity such as swarm activity. Therefore a search for swarms over an 18 years study period was undertaken after a large swarm in August 1954 to determine their nature, frequency, and location. The 1954 swarm of more than 30 earthquakes occurred in the area 70.5°N – 71.5°N, 15.0°W – 15.3°W during 20–23 August. A swarm in the present search was arbitrarily defined as three or more events during 48 hours within an area less

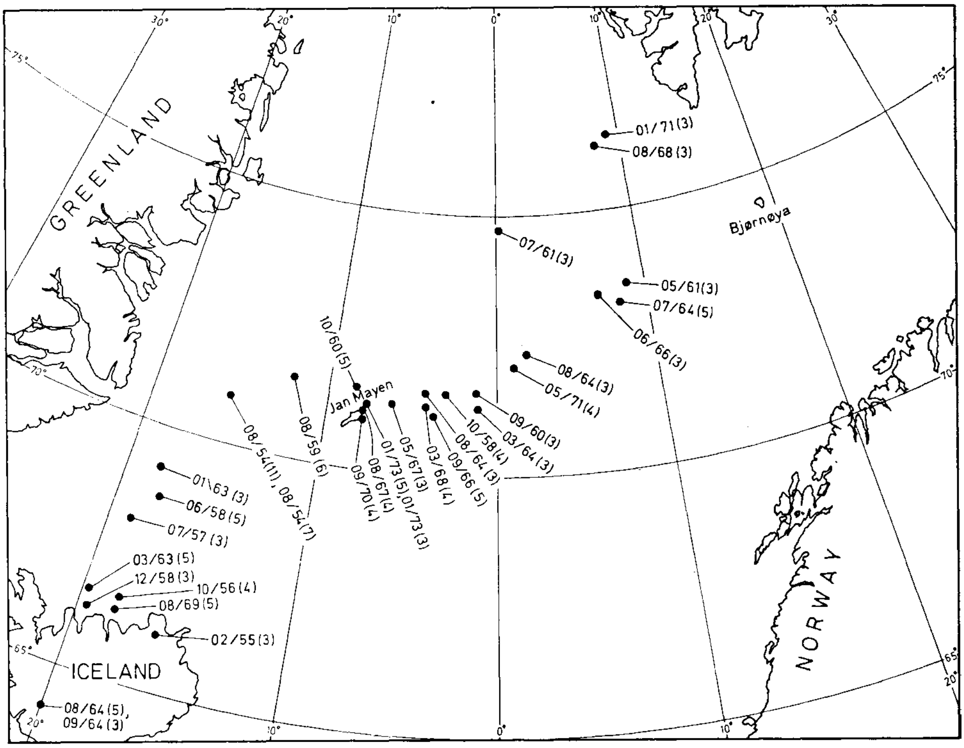

Fig. 6. *Earthquake swarms in the Norwegian Sea.*

than 1° longitude and less than 2° latitude. The search was made among events by readings from distant stations. Swarms of smaller events located only by the new tripartite station were not included in order to make the data homogenous.

The magnitude threshold for location by distant stations in this area is just below $m_b=4$, except near Iceland where it is possible to locate smaller events. The result of the search is shown in Fig. 6. The notation 08/59(6) means that the swarm happened in August 1959 and comprised 6 events.

From Fig. 6 it may be concluded that the earthquakes along the mid-oceanic seismic zone from Svalbard to Iceland have approximately the same tendency to cluster into swarms as defined above. This confirms the conclusion of SYKES (1970) and FRANCIS and PORTER (1971) that swarms generally occur along the crests of the ridge systems contrary to the larger single events which concentrate along fracture zones. The Jan Mayen fracture zone passes just north of Jan Mayen in a WNW-ESE direction (SYKES, 1965) and is most likely to be the origin of the larger single events close to Jan Mayen in Figs. 2–5 (and Fig. 8).

The number of earthquakes occurring in each swarm as a function of time is shown in Fig. 7. Only earthquakes with magnitudes greater than 4 were counted.

One of the swarms near Jan Mayen happened at the time of the Beerenberg volcanic 1970 eruption, but the number of events clustering together in swarms did not increase above an average value at the time of the eruption. Three other swarms near Jan Mayen – one in August 1967 and two in January 1973 – were

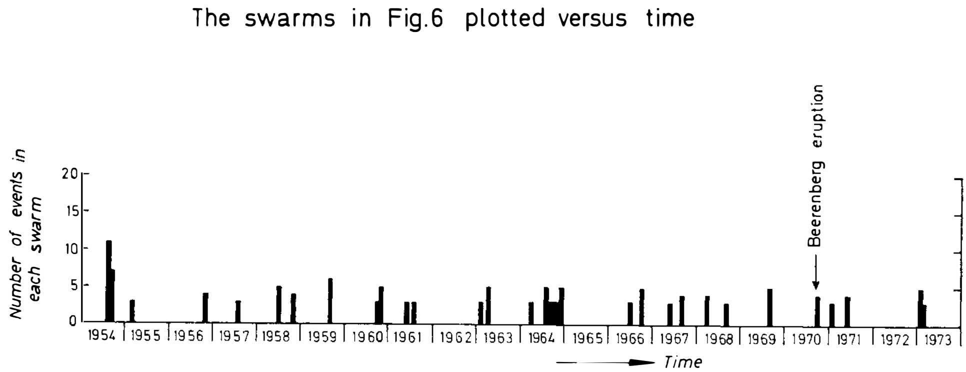

Fig. 7. *Number of earthquakes in swarms v. time.*

not accompanied by any known volcanic activity. Thus we conclude that the pattern of those events which are large enough to be located by readings at distant stations, is not useful for the prediction of volcanic eruptions at Jan Mayen. Moreover, this kind of data becomes available too late for prediction purposes.

Number of earthquakes relative to distance from the JMI-site

It was suggested above that the seismic activity of larger events seems to have moved closer to Jan Mayen in the last years. Thus, the distribution of the local events might also increase toward the JMI-site. Any such change in the seismic pattern should be found by plotting the number of events relative to the distance for the 15 months period of available data after the September 1970 volcanic eruption (January 1972 to March 1973). This plot can then be compared with corresponding plots for periods of 15 months just before the 1970 eruption (March 1969 to May 1970), and for the earliest period of available data (September 1962 to November 1963). Unfortunately there was no seismic station in operation from June 1970 to December 1971.

It turns out that such plots were very much influenced by the fact that the smaller local events are also clustered together. Plots of data for periods as short as 15 months merely show the distance to the clusters of events which by chance happened during these periods. Thus, plots of these data are not reproduced in this report.

Frequency distance plots are significant, however, for longer time periods. In Fig. 8 earthquakes are plotted for which distance could be calculated (both P and S waves identified) against distance for the time period with the most homogenous data, September 1962 to June 1970. The dotted line shows the number of events which have been located by the international network of stations. The latter events are often the larger ones which, when they occur at short distances from the station, usually saturate the record. These internationally-located earthquakes near JMI are therefore not generally included among the events for which

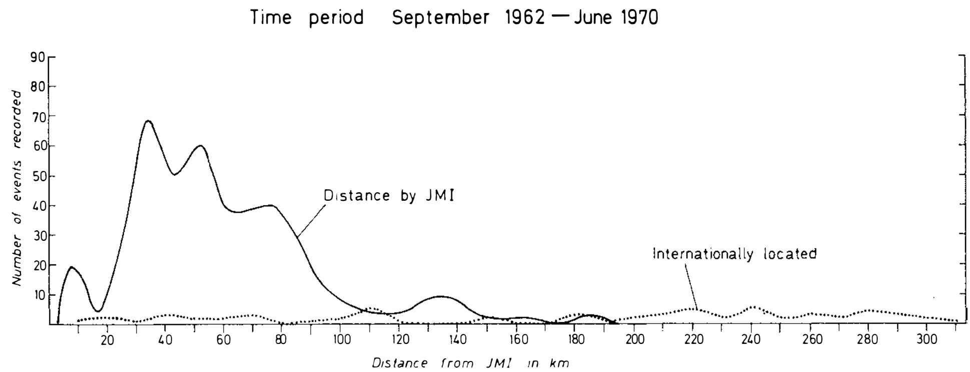

Fig. 8. *Local earthquake frequency v. distance.*

S—P distance has been calculated. The same thing happens for all locally-recorded very close events and, therefore, a low number of events is shown at distances 0—20 km.

An interesting thing to observe in Fig. 8 is the rapid decay of smaller events as the distance increases. However, the long mid-oceanic seismic zone passes close to the island and non-volcanic events with magnitudes lower than those located by the international network will certainly occur all along the zone. Even earthquakes located by the international network along the seismic zone between Svalbard and Iceland are often missing in the records on Jan Mayen.

There are two reasons why the frequency of events decays so rapidly. The first is the high seismic background noise on the island forcing the seismic station to be run at a low magnification (usually around 30 000). We suggest the second reason is that seismic waves are strongly attenuated because of the nature of the complex sequence of volcanic rocks comprising the crust in this region (FITCH 1964). A closer examination of the attenuation of the seismic waves is planned in the near future. A local magnitude scale will be developed and the new tripartite station will be used to locate the events so that even azimuthal variations in the attenuation can be searched for.

Fig. 8 clearly emphasizes that the number of local events recorded on Jan Mayen will be strongly influenced by activity very close to the island. Seismic activity which will be recorded on the island can therefore be dominated by any volcanic activity associated with the Beerenberg volcano.

Recent frequency of local earthquakes

A good visual picture of the seismicity within 100 km of JMI is shown by plotting the monthly total of local earthquakes against time (Fig. 9). All the events which could be found on the ordinary seismograms have been included. More events were found by reproducing the magnetic tape with different filter settings when the new tripartite station came into operation in September 1972. In order to keep the data homogenous such events are not counted.

The monthly number of events varies greatly. As seen above, these variations must be due chiefly to events within 100 km from the seismic station in Trolldalen. Because there is an active volcano in the area, some of the variations shown in Fig. 9 may be associated with some sort of volcanic activity.

Seismic activity was rather low from 1962 until 1965, but increased significantly in 1966–67. The activity decreased in 1969 and then increased during the first half of 1970. The data for the second half of 1970 would have been exceedingly interesting when the Beerenberg eruption occurred. Unfortunately, there was no seismic station in operation on Jan Mayen during the second half of 1970 and 1971. The available data for the first half of 1972 were rather low but increased during the second half of the year. In January 1973 the seismic activity reached the highest level ever recorded. The maximum number of local events was 90 in one day.

Fig. 9 contains basic data about the level of the local seismic activity which can serve as a standard for the activity in the future. Because the local earthquakes have a great tendency to cluster together both in time and space, the data in Fig. 9 can be used as comparison for any activity within a distance of about 100 km from Trolldalen. The figure shows that the seismic activity can be high without any surface volcanic activity on Jan Mayen itself. The past frequency of the local seismic activity together with the ability of the new tripartite seismic station to locate future earthquakes, will at least indicate the occasions when any future epicentral area on the island will have to be watched with particular care.

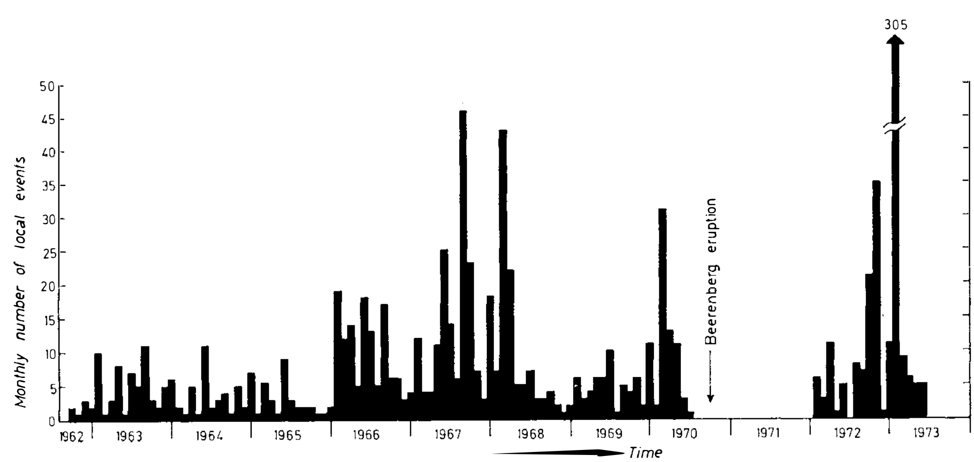

Fig. 9. *Local earthquake frequency v. time.*

Acknowledgements

The data from the new seismic station established on Jan Mayen in 1971 were made available to us by the Norwegian Defence Communications Administration which has also given other substantial support to the work reported here. This study is part of a current geophysical research program on Jan Mayen in which Chief Engineer C. A. GLØERSEN and several other staff members of the above agency, are participating. Other persons most actively engaged in this program are Engineer J. MATHISEN of Labteknikk, Moelv, Chief of Field Operation T. SIGGERUD of Norsk Polarinstitutt, Oslo, and Associate Professor A. G. SYLVESTER of the University of California, Santa Barbara. Professor SYLVESTER has critically read the manuscript of this report and made several valuable suggestions which have improved the presentation of this study. The above mentioned support and cooperation are greatly appreciated.

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Some earthquakes near Jan Mayen[1]

By ATLE AUSTEGARD[2]

Contents

Abstract

Some earthquakes near Jan Mayen were investigated in order to supply information necessary for the initial analysis of the data for near events recorded by the new tripartite seismic station.

Travel time residuals and observed travel times from nearby earthquakes indicate a typical ridge structure beneath Jan Mayen, with an upper mantle P-velocity of approximately 7.5 km/sec.

Introduction

Jan Mayen is located between Iceland and Spitsbergen, in the active seismic zone which has been proved to follow the Mid-Atlantic Ridge (SYKES 1965; JOHNSON et al. 1970). Because there are few seismic stations located in the vicinity of this zone, the determination of epicenter, depth, and origin time is rather uncertain for earthquakes near Jan Mayen. Data from the new tripartite seismic station which has been in operation on the island since October 1972, will certainly contribute to reduce this uncertainty in the future.

This report was primarily prepared to supply necessary information for the initial analysis of the data for near events recorded only by the new station. It deals with data obtained from a former station on the island, which was in operation from September 1962 to April 1969. The data, however, was of poor quality because of low magnification, caused by a high noise level. The station also suffered from many technical breakdowns.

[1] Publication No. 84 in the Norwegian Geotraverse Project.

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The structure beneath Jan Mayen

We have some information about the average structure beneath mid oceanic ridges from refraction measurements. EWING & EWING (1969), LE PICHON et al. (1965), and others have found a 5 km thick crust with a P-velocity of about 5.6 km/sec above a layer in this paper called the upper mantle, which has a P-velocity of approximately 7.3 km/sec. PALMASON (1970) found about the same structure beneath Iceland, but here the crust was in some places more than 10 km thick.

The first station on Jan Mayen, named JMI, recorded during the period 1966–1969 twenty-seven teleseismic events as iP from the epicenter interval of $30° < \triangle < 90°$. From ISC-bulletins one obtains an average travel time residual of $+1.2 \pm 0.7$ sec (stand. dev.) for these earthquakes. Because of the few observations for an azimuth being greater than 150°, it is impossible to calculate any azimuthal dependence.

Three stations in Iceland have recorded some of the above mentioned twenty-seven earthquakes and the following residuals have been found: SID: $+1.3 \pm 0.5$ sec (n=12), REY: $+1.1 \pm 0.7$ sec (n=13) and AKU: $+1.1 \pm 1.0$ sec (n=17). Considering the thirteen earthquakes only which REY and JMI have in common, the residual is $+1.1 \pm 0.7$ sec at both stations. In order to search for any azimuth dependence among the residuals at REY and JMI, an arbitrary grouping into three 120°-intervals has been made. Smaller intervals have not been used because of the low number of observations. Table 1 shows that no significant difference is found. On the average, therefore, approximately the same residuals are found on Jan Mayen and in Iceland. These two islands are both located on or close to the Mid-Atlantic ridge and are relatively close to each other. It seems likely, therefore, that the velocity distribution beneath Iceland and Jan Mayen is approximately the same.

On the other hand, considerably smaller residuals are found for stations in Fennoscandia, Scotland, and Greenland. The same is reported by many other authors, for example TRYGGVASON (1964), HERRIN and TAGGARD (1968), and LILWALL & DOUGLAS (1970). It is obvious therefore that a low velocity zone is connected with the Mid-Atlantic Ridge. The limits of this zone can be found by analysis of records from earthquakes within the zone itself recorded at near-by stations ($\triangle < 20°$). Such analyses, however, require rather accurate knowledge of epicenters, depths and origin times, and will be carried out later when additional data from the more dense station network of recent years become available.

Azimuth relative to JMI	No. of observations	Residuals in sec	
		JMI	REY
0°—120°	6	1.2	1.4
120°—240°	3	0.9	0.7
240°—360°	4	1.0	0.5
Mean		1.0	0.9

Table 1.
Mean residuals at JMI and REY from thirteen earthquakes

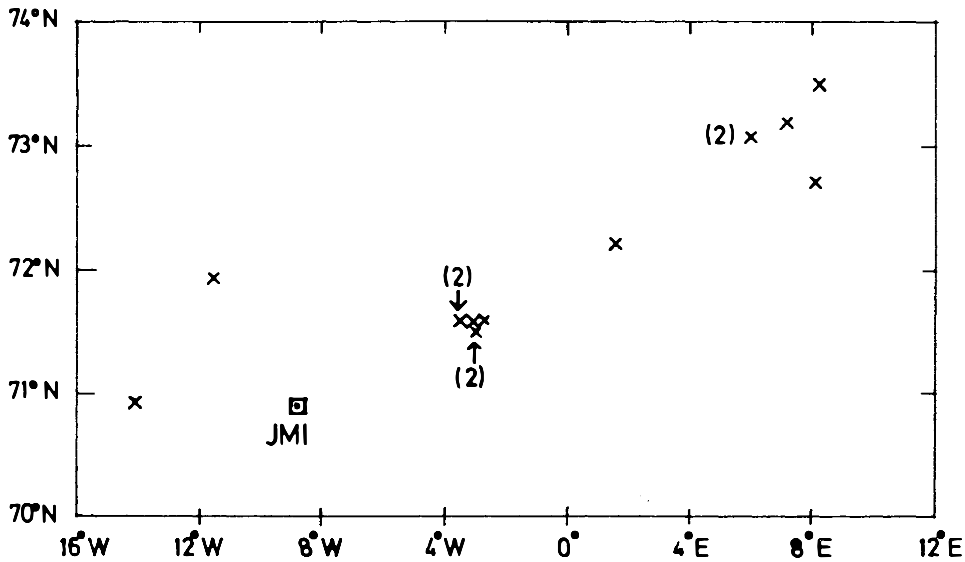

Fig. 1. *Sketch showing the JMI station and the epicenters included.*

Earthquakes near Jan Mayen

During the first station's period of operation, fourteen relatively large earthquakes were recorded at JMI within the distance interval $1° < \triangle < 6°$, (Table 2 and Fig. 1). An average velocity for the upper mantle of 8.47 ± 0.78 km/sec has been calculated by using depths and origin times reported by ISC (quoted in Table 2). In these calculations the author has compensated for a structure beneath the station having a P-velocity of 5.6 km/sec in the crust (5 km thick) and 7.3 km/sec in the upper mantle. The calculated values are unacceptably high compared with the upper mantle velocity found earlier beneath Iceland and the mid-oceanic ridges, and the standard deviation of these values is also large.

Most likely this is mainly due to errors in the reported depths and origin times in Table 2. In most cases ISC has restrained the depth to 33 km because there were none or only a few reliable pP-readings. The least square solutions based primarily on P-arrivals at distant stations are insensitive to small changes in the focal depth, and often even give negative depths for earthquakes in this region.

Trying to reduce the discrepancy between the calculated upper mantle P-velocity and the expected one, the depth of all the earthquakes was now taken to be 5 km (Table 2). Such concentration of foci near the crust-mantle interface is more acceptable in this area from a geophysical point of view. A change of the focal depth must be followed by a change of the origin time. The source anomalies for earthquakes near Jan Mayen must be taken into account too. In addition, it is well documented that the JEFFEREYS-BULLEN 1940 tables (JB-tables), which are used by the ISC, give too great travel times. Calculations of the revised origin times in Table 2 have been made with the following three points in mind:

1) Assuming the crustal model of HERRIN et al. (1968), a change in depth from 33 km to 5 km will contribute to an earlier origin time of about 3.9 sec. Changes from 19 km to 5 km (earthquake of February 1965) and from 9 km to 5 km (earthquake of December 1966) give respectively 2.1 sec and 0.6 sec earlier origin times.

2) HERRIN & TAGGART (1968) found a station anomaly at REY equal to $+2.1$ sec. The present author found on the average 0.1 sec greater residuals at JMI than at REY (Table 1). Therefore, the source anomaly for earthquakes near Jan Mayen is set to $+2.2$ sec assuming the travel-times of HERRIN et al. (1968).

3) The JB travel times are systematically in error (HERRIN et al. 1968, LILWALL & DOUGLAS 1970). FLUENDY (1969) makes a comparison of origin times for eleven surface or normal depth earthquakes obtained by the JB-tables and by the tables of HERRIN et al. On an average the latter tables gave later origin times of 1.9 ± 1.2 sec.

A change in origin time due only to 2) and 3) above, will contribute to an upper mantle P-velocity greater than 8 km/sec, and the scatter will be almost the same as in the v_1-values. Taking into account also point 1) a revised origin time of 3.9 sec + 2.2 sec − 1.9 sec = 4.2 sec, i.e. earlier than reported by ISC is obtained for a normal depth earthquake. As shown in the v_2-column in Table 2 and in Fig. 2, this will give a more acceptable upper mantle P-velocity and much less scatter. The average velocity is now 7.46 ± 0.29 km/sec. Considering only the eight nearest earthquakes ($\triangle < 2.1°$), the value is 7.43 ± 0.35 km/sec. The five earthquakes in the distance range $5° < \triangle < 6°$ give $v_2 = 7.58 \pm 0.09$ km/sec. Thus the v_2 dependence on distance is very small, and the velocity seems to be nearly constant in the first few km below Moho.

If the origin time is $\pm$ 1 sec in error, the resulting error in v_2 is $\pm$ 0.5, $\pm$ 0.2 and $\pm$ 0.1 km/sec for $\triangle = 1$, 3 and 6 degrees respectively. The consequence of a $\pm$ 10 km change in epicenter distance is $\pm$ 0.7, $\pm$ 0.2 and $\pm$ 0.1 km/s in v_2 for $\triangle = 1$, 3, and 6 degrees respectively. This explains the large difference in the standard deviation of the near ($\triangle < 2.1°$) and more distant ($5° < \triangle < 6°$) earthquakes.

Many small earthquakes near Jan Mayen were recorded during the period 1964–1969. In ISC-bulletins these quakes too are found to give negative residuals at JMI, but the scatter is large, due to errors in epicenter, depth, and origin time. To reduce this scatter only earthquakes recorded by more than 50 stations are considered here (N-column in Table 2). For the region considered this corresponds to a body wave magnitude of between 4.4 and 4.8. In the calculations, the epicenters given by ISC have not been changed, although they are based on the JB-tables and no station anomalies are taken into account. However, the largest earthquakes in the Norwegian Sea are mainly recorded by stations in Europe and North-America. Using the tables of HERRIN et al., instead of the JB-tables, it is believed from the difference in the P-travel-time curves that the epicenters are moved averagely 5 km at the maximum in an SE direction. According to LILWALL & UNDERWOOD (1970) the omission of station-anomalies in the determination of epicenters in this region will result in an epicenter bias not greater than 6 km. The present author did not use the tables of HERRIN et al. to get a redetermined origin

Table 2.
Data for earthquakes included.

Date	Data quoted from ISC							Data from this paper			
	Origin time (GMT) h m s	Epicenter	Depth km	m_b	N	$\triangle°$	T sec	v_1 km/sec	Revised depth, km	Revised origin time	v_2 km/sec
64.08.29	05 20 21.3	71.6°N,3.5°W	33	4.5	53	1.81	—6.6	9.26	5	05 20 17.1	7.65
65.02.14	17 55 42.9	73.1°N,6.0°E	19	4.9	66	5.06	—4.6	7.84	5	17 55 40.5	7.57
65.02.14	19 37 18.7	73.1°N,6.1°E	33	5.2	94	5.09	—6.1	8.20	5	19 37 14.5	7.71
66.04.23	01 03 24.0	73.5°N,8,3°E	33	4,7	55	5.82	—5.2	8.06	5	01 03 19,8	7.64
66.06.13	13 19 35.4	73.2°N,7.2°E	33	4.6	54	5.42	—4.2	7.97	5	13 19 31.2	7.54
66.06.16	17 05 24.2	71.6°N,3.1°W	33	4.5	53	1.94	—7.7	9.61	5	17 05 20.0	8.00
66.08.22	21 49 18.0	71.9°N,11.5°W	33	4.4	56	1.28	—6.7	10.26	5	21 49 13.8	7.66
66.08.31	18 15 39.5	71.5°N,3.1°W	33	4.9	102	1.93	—4.9	8.55	5	18 15 35.3	7.24
66.09.01	01 38 32.7	71.6°N,2.8°W	33	4.8	70	2.03	—6.0	8.83	5	01 38 28.5	7.50
66.09.01	19 18 01.7	71.5°N,3.1°W	33	4.9	97	1.92	—5.9	8.90	5	19 17 57.5	7.48
66.12.17	05 59 07.7	70.9°N,14.1°W	9	5.0	136	1.77	—3.6	7.37	5	05 59 06.8	7.12
67.11.21	17 02 25.8	72.7°N,8.1°E	33	5.4	193	5.56	—3.3	7.87	5	17 02 21.6	7.46
68.01.03	07 37 55.1	72.2°N,1.6°E	33	5.2	120	3.51	—2.6	7.79	5	07 37 50.9	7.15
68.03.07	07 27 43.5	71.6°N,3.6°W	33	4.9	61	1.78	—3.4	8.04	5	07 27 39.3	6.78

Remark: Before October 1965 an incorrect JMI-position was used by ISC. Therefore the $\triangle$ and the travel time residual for the three first earthquakes in the table are recomputed.
$\triangle$ = epicentral distance to JMI, T = travel time residual at JMI, reported by ISC.
v_1 = calculated P-velocity in upper mantle based on depth and origin time reported by ISC, v_2, based on revised depth and origin time.

time, but as mentioned above, used the correction found by FLUENDY (1968), based on only eleven events. There may be another value, for earthquakes near Jan Mayen, although LILWALL & UNDERWOOD (1970) find a very small origin time bias in this region.

Conclusion

Residuals at JMI and stations in Iceland and also seismic refraction measurements across Iceland and mid-oceanic ridges indicate a typical ridge structure beneath the extreme northern part of the Mid-Atlantic Ridge. A consequence of such a structure is that most of the earthquakes in the zone near Jan Mayen must be very shallow (focal depth less than 10 km), and further that the origin time given by ISC is some 4 sec too late for the earthquakes in the zone with focal depth restrained to 33 km.

This report emphasizes the need for a seismic station at Jan Mayen to determine the velocities and the parameters of earthquakes in this active seismic zone. Controlled explosions in the vicinity of the new tripartite station will contribute to still better information about the structure in this region, and will increase the accuracy of epicenter-, depth- and origin time determinations for earthquakes in the Jan Mayen area.

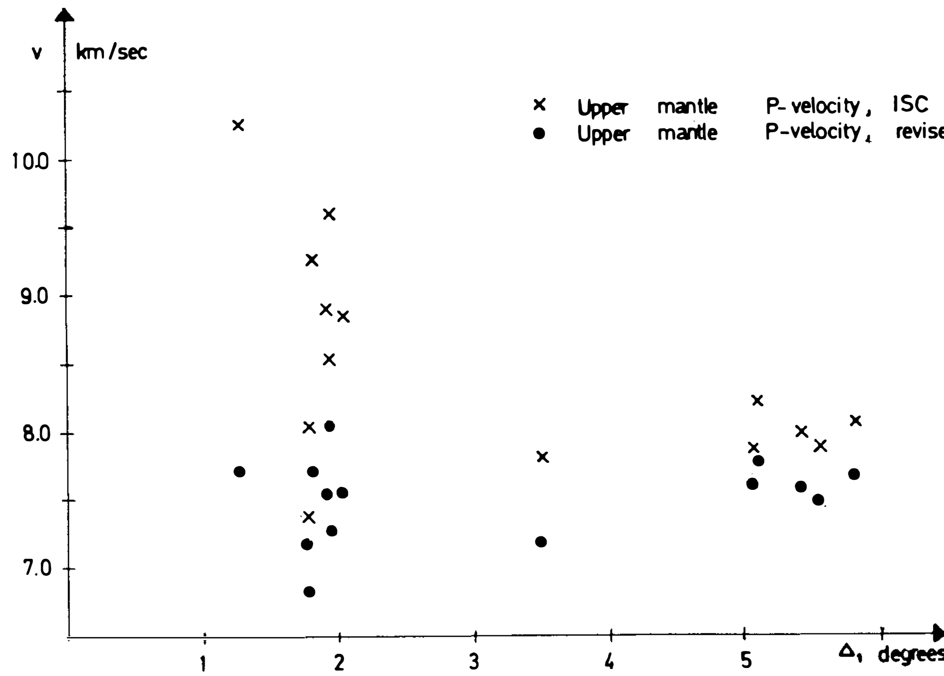

Fig. 2. *The velocities v_1 and v_2 from Table 2 plotted versus epicentral distance.*

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Bunnfaunaundersøkelsene på Bouwensonbåen
(70°40′N, 8°56′W)
og Eggvingrunnen
(70°55′N, 12°50′W)
i 1972

AV BJØRN GULLIKSEN[1]

Innhold

Abstract

The bottom fauna of Bouwensonbåen and Eggvingrunnen near Jan Mayen was investigated using SCUBA-equipment in August 1972. Observations and underwater photos showed that the bottom at 13–15 m depth on Bouwensonbåen seemed to have been glaciated. Conspicuous faunal elements at Bouwensonbåen were Porifera, Coelenterata (*Tealia felina* (L.) var. *crassicornis* (MÜLLER)), Mollusca (*Hiatella arctica* (L.), *Acmaea rubella* (FABRICIUS), *Buccinum tenue* GRAY), and Echinodermata (*Cucumaria frondosa* (GUNNERUS), *Strongylocentrotus droebachiensis* (O. F. MÜLLER), *Ophiopholis aculeata* (L.)). Dominant algae were *Alaria pylaii* (BORY) J. AG., *Euthora cristata* (L.) J. AGARDH, and *Halosiphon tomentosus* (LYNGB.) JAASUND.

The bottom at 30–35 m depth at Eggvingrunnen consisted of rocks and boulders of volcanic origin. Conspicuous faunal elements were Porifera, Coelenterata (*Tealia felina* var. *crassicornis*, *Gersemia rubiformis* (EHRENBERG)), Mollusca (*Dendronotus* sp.), Echinodermata (*Ophiopholis aculeata*, *Strongylocentrotus droebachiensis*) and Ascidia (*Didemnum albidum* (VERRILL)).

Innledning

Norsk Polarinstitutt arrangerte i august 1972 en ekspedisjon til Jan Mayen for å studere følgene etter vulkanutbruddene i september 1970 (GJELSVIK 1970). Det Kongelige Norske Videnskabers Selskab, Museet, Trondheim, var representert i ekspedisjonen med en gruppe på fire biologer, derav to marinbiologer. Marinbiologene skulle primært undersøke koloniseringen av dyr og planter på de nye

[1] Biologisk stasjon, Trondheim.

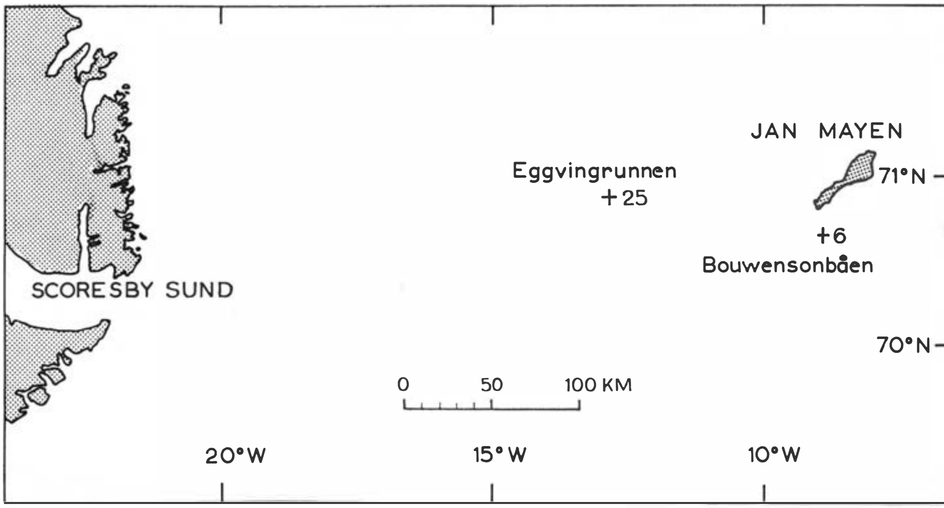

Fig. 1. *Kart som viser Bouwensonbåen og Eggvingrunnen hvor innsamlingene fant sted.*
Map showing Bouwensonbåen and Eggvingrunnen where sampling took place.

lavaområdene som ligger under vann, sekundært undersøke den marine fauna og flora rundt hele øya.

Det ble foretatt to tokter som ikke direkte faller inn under ekspedisjonen. Det ene toktet gikk til Bouwensonbåen ca. 10 nautiske mil syd for Jan Mayen, det andre til Eggvingrunnen ca. 100 nautiske mil vest for Jan Mayen (Fig. 1). På hver av disse lokalitetene ble det dykket med vanlig froskemannsutstyr, samlet inn dyr og planter for hånd og tatt undervannsfotografier. Kameraet var utstyrt med nærlinse (Calypso/Nikkor II, 1:2.5, f-35 mm med "Nikkor Close-up unit") som gjør det mulig å identifisere en del av artene. Bildene er dessuten sammenlignet med det innsamlede materialet fra disse og andre undersøkte lokaliteter på Jan Mayen. Størrelsen av den fotograferte flaten er (109 × 164) mm slik at man kan få indikasjoner om tetthetene av de forskjellige organismene.

Materialet fra innsamlingene er magasinert ved DKNVS, Museet, Trondheim.

Bouwensonbåen (70°40'N, 8°56'W)

Dykket ble foretatt 9. august 1972 på 13—15 m dyp. Vi fant ikke grunnen på 6 m som er avmerket på sjøkartet, men etter radaren ble dykket foretatt på denne lokaliteten.

Temperaturen i overflaten var 4.0°C og saltholdigheten 34.43 ‰. Prøvetagningen ble vanskeliggjort av en ganske sterk strøm, anslagsvis 1—1.5 m/s like over bunnen. I tidligere undersøkelser (Iversen 1936) fra dette området har man registrert at vannlagene ned til 25 m dyp kan ha forholdsvis høye temperaturer, 4—8°C og at en sydvestgående strøm er fremherskende.

På Bouwensonbåen var det glatt fjellbunn uten store ujevnheter eller stener, men med mange skuringsstriper. For perioden 1946—63 gikk den gjennomsnittlige

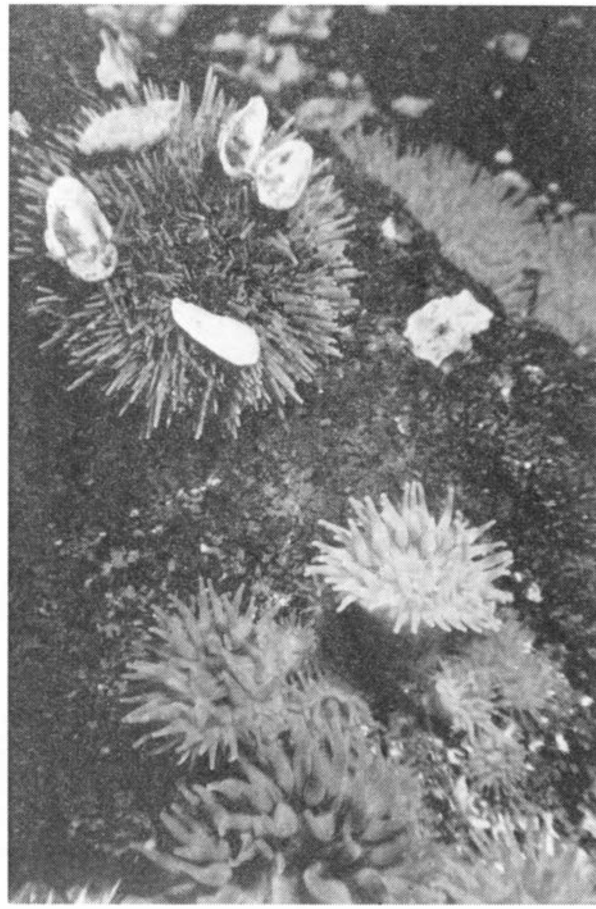

Fig. 2. *Foto fra Bouwensonbåen med sjøanemonen* Tealia felina (L.) *var.* crassicornis (MÜLLER) *og kråkebollen* Strongylocentrotus droebachiensis (O. F. MÜLLER).

Photo from Bouwensonbåen with the sea anemone *Tealia felina* (L.) var. *crassicornis* (MÜLLER) and the sea urchin *Strongylocentrotus droebachiensis* (O. F. MÜLLER).

isgrense omtrent til Jan Mayen (STEFFENSEN 1969), men isforholdene varierer meget fra år til år (IVERSEN 1936). Den østerrikske ekspedisjonen som overvintret på øya i 1882–83 observerte drivis med en gjennomsnittstykkelse på 8–10 m (WOHLGEMUTH 1886). Det er derfor sannsynlig at isen år om annet skurer bunnen på Bouwensonbåen.

Enkelte av områdene på båen hadde en kraftig tarevekst (*Alaria pylaii*), mens andre områder var helt fri. Innsamlingen og fotograferingen ble konsentrert om et parti som var fri for sterk tarevekst. Det ble tatt 15 fotografier og Tabell 1 gir en oversikt over de artene som forekom i størst antall på disse bildene.

Det fremgår at dyrene er meget ujevnt fordelt, men dette kan skyldes metodiske feil. For å få et korrekt uttrykk for dyrenes antall og fordeling skulle en større prøvestørrelse og et annet opplegg i fotograferingen vært benyttet. Dette ville imidlertid krevd mer tid og gjort artsbestemmelsene vanskeligere. Ettersom intensjonene i denne sammenheng først og fremst var å gi en kvalitativ oversikt, har jeg ikke omregnet tallene i Tabell 1 til antall individ pr. m^2.

Sjøanemonen *Tealia felina* var. *crassicornis* var en sterkt dominerende organisme (Fig. 2). På enkelte steder satt den meget tett, opptil 20 individer på (109 $\times$ 164)mm

Tabell 1

Fordeling av dyr på de 15 undervannsfotografiene fra Bouwensonbåen.
Hvert fotografi dekker en flate på (109×164) mm av bunnen.
(Distribution of animals on the 15 underwater photos from Bouwensonbåen.
Each photo covers (109×164) mm of the bottom.)

Art *Species*	Bilde nr. *Photo no.*														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Tealina felina var. *crassicornis*	10	2		6	5	1	8	8	20	6	6	7	15	1	13
Hiatella arctica				6		65	25	25				2	2	1	
Acmaea rubella					10										5
Margarites helicina					9				3						
Buccinum tenue			1				1								1
Ophiopholis aculeata		10		2		1	2					4	3	1	2
Strongylocentrotus droebachiensis	1		2		1		1			3		2	1	3	
Cucumaria frondosa		1								1	1	1			2

(Tabell 1). De største tetthetene så ut til å forekomme på de mest strømeksponerte stedene.

Muslingen *Hiatella arctica* kunne på enkelte områder oppnå en meget høy tetthet (Tabell 1). Den satt særlig i sprekker hvor den er beskyttet når isen sklir over bunnen. Døde eller inaktive *H. arctica* er ikke telt med på fotografiene idet individtallene i Tabell 1 refererer seg til antall siphonpar som er synlige.

Tre pigghuder var ganske vanlige: kråkebollen *Strongylocentrotus droebachiensis*, slangestjernen *Ophiopholis aculeata* og sjøpølsen *Cucumaria frondosa*. *S. droebachiensis* så ut til å være ganske jevnt fordelt over hele området på Bouwensonbåen. Kråkebollene er muligens et viktig næringsdyr for sjøanemonene idet det ved undersøkelser av lignende biotoper på Jan Mayen flere ganger ble observert at sjøanemoner spiste kråkeboller.

Individene av *O. aculeata* satt vanligvis forankret inne i en svamp med utstrakte armer for å filtrere næring fra vannet. Sjøpølsen *C. frondosa* lå vanligvis sammen i hauger på 3–6 individer. Dette fremgår ikke av Tabell 1 fordi sjøpølsene er så store at det ikke er plass til mer enn 1–2 individer på et fotografi.

Tre snegler var ganske vanlige: rovsneglen *Buccinum tenue* GRAY og de to herbivore sneglene *Acmaea rubella* (FABRICIUS) og *Margarites helicina* (PHIPPS). *B. tenue* så ut til å være ganske jevnt fordelt, mens de to andre forekom i størst antall på stein som var dekket med røde kalkalger. Begge disse sneglene har en rødaktig farge, og det kan være at de røde kalkalgene gjør sneglene mindre synlige for predatorer.

Andre organismer på Bouwensonbåen som ikke er tatt med i Tabell 1 er tanglopper (Amphipoda), og svamper (Porifera). Like over bunnen var det overalt ganske tett med tanglopper. Disse små, aktive åtseldyrene er vanlige rundt hele Jan Mayen, men tettheten er meget vanskelig å beregne fordi de klumper seg sammen der de finner næring. Svampene forekom særlig i loddrette vegger på bunnen.

Dominerende alger var som tidligere nevnt *A. pylaii*, dessuten *Euthora cristata* og *Halosiphon tomentosus*.

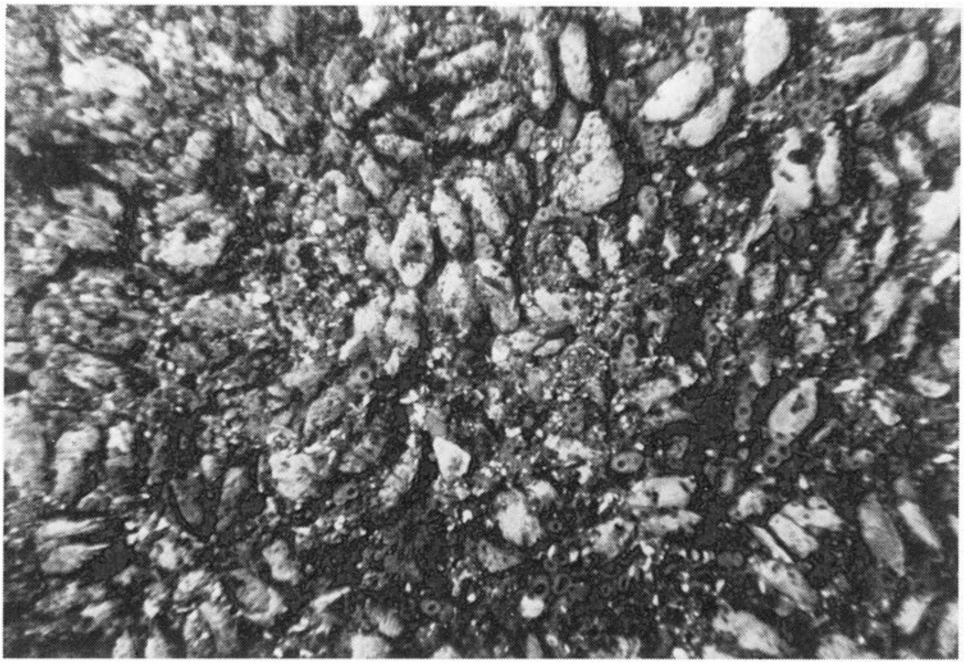

Fig. 3. *Foto fra Bouwensonbåen med mollusken* Hiatella arctica (L.).
Photo from Bouwensonbåen with the mollusk *Hiatella arctica* (L.)

Eggvingrunnen (70°55'N, 12°50'W)

Undersøkelsen ble foretatt 18. august 1972 på 30–35 m dyp. Vi fant dessverre ikke grunnen på 25 m som er avmerket på kartet (Fig. 1) og 30 m var det grunneste dyp vi registrerte i området. Strømmen var ganske sterk, men ikke så kraftig som på Bouwensonbåen, og da dykket ble foretatt vil jeg anta at strømstyrken var 0.5–1 m/s.

Eggvingrunnen var dekket med store lavablokker og stein, og isen har derfor ikke den samme betydning som på Bouwensonbåen. Det ble tatt fotografier både med nærlinse og normalobjektiv, men færre bilder enn på Bouwensonbåen. Bunnforholdene varierte enda mer her enn på Bouwensonbåen, og det er derfor ikke satt opp noen tabell over fordelingen av dyr på Eggvingrunnen.

Sjøanemonen *T. felina* var. *crassicornis* var vanlig også her, men den hadde ikke den samme tetthet som på Bouwensonbåen. Dessuten ble det funnet en annen coelenterat, *Gersemia rubiformis*, som er meget vanlig rundt hele Jan Mayen, men den ble sjelden funnet grunnere enn ca. tyve meter. En annen organisme som er vanlig ved Jan Mayen og som også ble funnet på Eggvingrunnen, var den kolonidannende ascidien *Didemnum albidum*. Den dannet et hvitt, få millimeter tykt belegg på stein. Flere lavasteiner på Eggvingrunnen var dessuten delvis dekket med svamper (Porifera) med filtrerende slangestjerner, *O. aculeata* (Fig. 4).

Andre dyr som ble observert var pigghuden *S. droebachiensis*, og nakensneglen *Dendronotus* sp. . Det var dessuten et lag av kalkalger på mange av steinene.

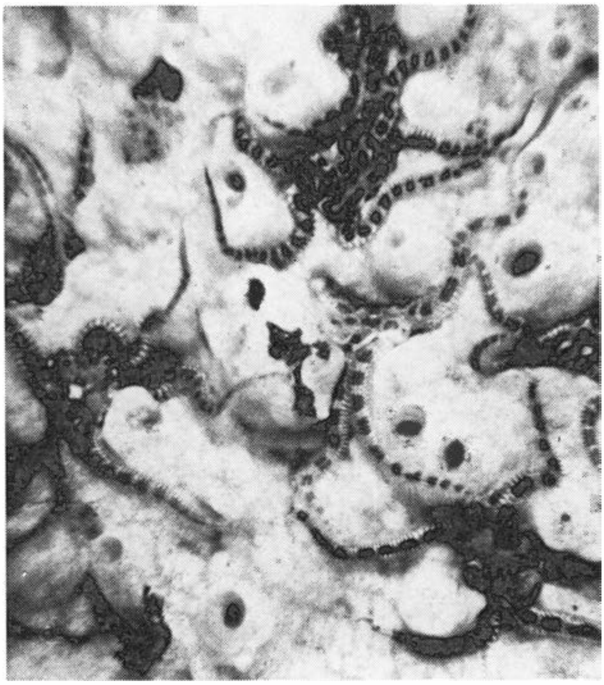

Fig. 4. *Foto fra Eggvingrunnen med svamp (Porifera) og slangestjernen* Ophiopholis aculeata (L.)
Photo from Eggvingrunnen with sponge (Porifera) and the brittle star *Ophiopholis aculeata* (L.).

På et av undervannsfotografiene er det en liten arktisk rognkjeks, *Eumicrotremus* sp., men det er dessverre ikke mulig å se om det er *Eumicrotremus spinosus eggvini* som ble fanget på Eggvingrunnen for første gang i 1955, og som KOEFOD (1956) har beskrevet.

Diskusjon

Samtlige arter som vi fant på Bouwensonbåen og Eggvingrunnen ble også registrert i undersøkelsene fra Jan Mayen, og ingen av lokalitetene skilte seg ut med hensyn til fauna og flora fra lignende lokaliteter rundt Jan Mayen. Dybdeforskjellen mellom Bouwensonbåen og Eggvingrunnen er sannsynligvis hovedårsaken til forskjellene i flora og fauna mellom disse to lokalitetene. Algeveksten i området rundt Jan Mayen ser ut til å nå ned til ca. 25—30 m, dvs. litt grunnere enn Eggvingrunnen hvor det ikke ble observert tare, mens det var god tarebevoksning på Bouwensonbåen. Dessuten er grunne områder mer eksponert overfor is, og bunnen på Bouwensonbåen så også ut til å være mer isskurt enn bunnen på Eggvingrunnen.

Takk

Jeg vil gjerne rette en takk til NAVF for økonomisk støtte, Norsk Polarinstitutt som organiserte ekspedisjonen, kollega og linemann HANS JØRGEN LØNNE og cand. real. J.-A. SNELI som har hjulpet til ved bearbeidelsen av materiale og manuskript. Dessuten takk til Dr. phil. ERIK JAASUND som har bestemt algene, Dr. HENNING LEMCHE som har bestemt nakensneglen og cand. real. ØISTEIN FRØILAND som ga meg opplysningen om rognkjeksen fra Eggvingrunnen. En spesiell takk vil jeg rette til kaptein MORTEN HANSEN med mannskap på R. K. «Sjøfareren». Uten deres støtte og velvilje ville ikke ekspedisjonen blitt vellykket.

Litteratur

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An annotated list of the vascular plants collected by the Danish Jan Mayen Expedition 1972

By JETTE BAAGØE[1] and KLAUS VESTERGAARD[2]

Contents

Abstract

41 species out of a total of 64 vascular plants native to Jan Mayen are listed, two of which, *Diphasium alpinum* (L.) ROTHM., and *Euphrasia frigida* PUGSL. are new to Jan Mayen. The geographical distribution of *Diphasium alpinum* (L.) ROTHM. is discussed, new limits of height are recorded for four species, and new localities indicated for five species already known from Jan Mayen.

Introduction

From 11 June K. VESTERGAARD took part in the Danish Jan Mayen Expedition 1972, performing zooecological investigations. The vascular plants collected in connection with these investigations plus some additional collections provided the material presented in this list.

Vascular plants have been collected by several expeditions in Jan Mayen, and the results are summarized in LID 1964. LID lists 62 species of plants natural to the island, a number which is here extended to 64. In addition LID maps the distribution of the species in Jan Mayen, and divides the island into the ten districts used here.

Our list is arranged systematically according to LID, and the Roman capital numbers refer to LID's districts. For four species new limits of height in Jan Mayen are mentioned, and the old limits brought in brackets. New localities are indicated with a note of exclamation. When nothing else is mentioned the plants have been collected by K. VESTERGAARD, but a number of plants were collected by BERA MØHL. The collected material that consists exclusively of dried specimens, is deposited in the Botanical Museum of the University of Copenhagen (C).

Apart from vascular plants, several bryophytes were collected. These collections were handed over for determination to KJELD HOLMEN, curator at the Botanical Museum, Copenhagen (C).

[1] Botanical Museum, Copenhagen. [2] Zoological Laboratory, Copenhagen.

Enumeration

EQUISETACEAE

Equisetum arvense L.

VIII: Fishburndalen, 11.7. 1972.

LYCOPODIACEAE

Diphasium alpinum (L.) ROTHM.

VIII: Håpdalen!, 15.7. 1972. Very restricted area in the lower part of the valley.

This collection which consists of sterile material (Fig. 1), represents the first find of *Diphasium alpinum* (L.) ROTHM. in Jan Mayen.

As to climatic tolerance, and thence to geographical range the species is in Jan Mayen (Aug. +5,4°, 0° isotherm) near its northern limit. Nevertheless it might be expected in the island as it is an arctic – montane plant found as far north as 72°N at Mestersvig in eastern Greenland (L. KLIIM-NIELSEN, personal information).

In general distribution it is circumpolar with gaps in arctic America and Siberia (HULTÉN 1950). It is also found in central Europe, and has its southern limit at c. 40°N in Iran N of the Persian Gulf. (MEUSEL, JÄGER, WEINERT 1965).

GRAMINAE

Festuca rubra L. var. *mutica* HARTEN

III: Kvalrossbukta, 8.7. 1972.

Festuca vivipara (L.) SM.

II: The area above Sjuhollendarbukta, 6.7. 1972.
IV: Laguneflya, 28.6. 1972.

Poa alpigena (FR.) LINDM.

III: Kvalrossbukta, 8.7. 1972.

Poa alpina L. var. *vivipara* L.

IV: Laguneflya, 28.6. 1972.
V: Bommen at Nordlaguna, 3.7. 1972.
VII: Röysflya, 11.7. 1972.
VIII: Håpdalen, 15.7. 1972.

Trisetum spicatum (L.) RICHT.

VIII: Sea-slope below Fishburndalen, 11.7. 1972.

CYPERACEAE

Carex bigelowii TORR.

VIII: Fishburndalen, 11.7. 1972. Håpdalen, 15.7. 1972.

Carex maritima GUNN.

VII: Röysflya, 29.6. 1972, leg. BERA MØHL.

Fig. 1. *Diphasium alpinum.*

JUNCACEAE

Luzula arcuata (WAHLENB.) SW.

IV: Laguneflya, eastern part, 28.6. 1972.
V: Libergsletta near the old Radio station, 26.6. 1972.
VI: Nordahl Grieglia, 27.6. 1972.
VIII: Håpdalen!, 15.7. 1972.

The specimens from Håpdalen might have been referred to *Luzula confusa* (HARTM.) LINDEB. Because of the lack of a taxonomic revision within this genus we have, however, stuck to the species delimitation of HYLANDER (1945), and maintained only one species, *Luzula arcuata* (WAHLENB.) SW.

SALICACEAE

Salix herbacea L.

II: Sjuhollendarbukta, 6.7. 1972.
V: Libergsletta near the old Radio station, 26.6. 1972.
VII: Ryggvarden, 22.6. 1972; alt. 700 m (442 m).

POLYGONACEAE

Koenigia islandica L.

V: Libergsletta near the old Radio station, 17.7. 1972.

Oxyria digyna (L.) HILL.

III: Kvalrossbukta, 8.7. 1972. Common in all parts of the island visited.

Polygonum viviparum L.

VIII: SE-facing slope below Fishburndalen, 11.7. 1972. Håpdalen, 15.7. 1972.

CARYOPHYLLACEAE

Cerastium arcticum LGE. ssp. *arcticum*

III: Kvalrossbukta, 8.7. 1972.
IV: Eastern part of Laguneflya, 28.6. 1972.
VII: Havhestberget, 11.7. 1972. Ryggvarden, 22. 6. 1972, alt. 700 m (442 m).
VIII: S-facing slope in Håpdalen, 15.7. 1972.

Cerastium cerastoides (L.) BRITTON

VIII: Fishburndalen, 11.7. 1972.

Honkenya peploides EHRH.

V: Bommen at Nordlaguna, 3.7. 1972.

Silene acaulis (L.) JACQ.

II: Guineabukta, 5.7. 1972, (white form).
V: Libergsletta, 26.6. 1972.
VIII: Håpdalen, 15.7. 1972.

According to LID (1964) the largest tufts have a size of 10–15 cm, but tufts of up to 25 cm in diameter are now common in many places.

RANUNCULACEAE

Ranunculus glacialis L.

V: Libergsletta near the old Radio station, 26.6. 1972.

Ranunculus pygmaeus WAHLENB.

I: Borgdalen!, 3.7. 1972;
II: Near Sjuhollendarbukta, 4.7. 1972.
VIII: Fishburndalen, 11.7. 1972. S-facing slope in Håpdalen, 15.7. 1972.

CRUCIFERAE

Arabis alpina L.

VIII: S-facing slope below Fishburndalen, 11.7. 1972.

Cardamine bellidifolia L.

VI: Nordahl Grieglia!, 13.7. 1972.

Cochlearia groenlandica L.

III: Kvalrossbukta, 8.7. 1972.
V: Bird's cliff c. 500 m SW of Maria Muschbukta, 21.6. 1972.

Draba alpina L.

IV: Laguneflya, 28.6. 1972.
VI: Libergsletta, 27.6. 1972.

Draba norvegica GUNN.

IV: Laguneflya, 28.6. 1972.
V: Libergsletta near the old Radio station, 26.6. 1972.
VI: Nordahl Grieglia!, 13.7. 1972.

SAXIFRAGACEAE

Saxifraga cernua L.

III: Kvalrossbukta, 28.7. 1972.
VIII: Sea-slope below Fishburndalen, 11.7. 1972. Fishburndalen, 11.7. 1972.

Saxifraga foliolosa R. Br.

VII: Vogtfjellet, 15.7. 1972, leg. Bera Møhl.

Saxifraga cespitosa L.

V: Libergsletta near the old Radio station, 26.6. 1972.
VII: Ryggvarden, alt. 700 m (442 m), 22.6. 1972.

Saxifraga nivalis L.

III: Kvalrossbukta, 8.7. 1972.
V: Libergsletta near the old Radio station, 26.6. 1972.
VII: Ryggvarden, alt. 700 m (442 m), 22.6. 1972.
VIII: Håpdalen, 15.7. 1972.

Saxifraga oppositifolia L.

V: Öwredalen, 21.6. 1972. Libergsletta near the old Radio station, 22.6. 1972.

Saxifraga rivularis L.

II: Titeltbukta, 5.7. 1972.
III: Kvalrossbukta, 8.7. 1972.
V: Bird's cliff 500 m SW of Maria Muschbukta, 21.6. 1972.

Saxifraga cf. tenuis (Wahlenb.) H. Sm. ex. Lindman

VI: Nordahl Grieglia, 13.7. 1972.
VIII: Håpdalen, 15.7. 1972.

ROSACEAE

Sibbaldia procumbens L.

II: Above Sjuhollendarbukta, 4.7. 1972. S-foot of Arnethkrateret, 5.7. 1972.
VI: Nordahl Grieglia!, 13.7. 1972. Below Krossberget near Hudsonodden, 27.6. 1972.
VIII: Håpdalen, 15.7. 1972.
(II): Recorded from Titeltbukta.

ERICACEAE

Cassiope hypnoides (L.) D. Don

VIII: Lower part of Håpdalen, 15.7. 1972. Lower part of Fishburndalen!, 11.7. 1972.

EMPETRACEAE

Empetrum nigrum L. ssp. *hermaphroditum* (Hagerup) Böcher

VIII: Fishburndalen, 11.7. 1972.
(II): Recorded from Titeltbukta, very restricted area.

BORAGINACEAE

Mertensia maritima (L.) S. F. Gray

II: Sjuhollendarbukta, 6.7. 1972.
V: Nordlaguna, 3.7. 1972.

SCROPHULARIACEAE

Euphrasia frigida Pugsl.

VIII: Fishburndalen, 11.7. 1972.

Fig. 2. *Euphrasia frigida. x c. 1.5. Jan Mayen, 11.7. 1972.*

Referring to a record by SCOTT RUSSELL, LID (1964) mentions *Euphrasia frigida* PUGSL. from Jan Mayen, but the collection of K. VESTERGAARD is the first verification of the plant's existence in the island.

The collection consists of dwarfed individuals with one or two extremely short internodes, without mature capsules, and with a corolla-lenght of c. 6 mm (Fig. 2).

This combined with the fact that Dr. P. F. YEO has described a new species of *Euphrasia*, *E. ostenfeldii* (PUGSL.) P. F. YEO (1971), which differs from *E. frigida* mainly in characters that will be either obscured by extreme dwarfing or missing in young individuals, has made the determination a bit difficult. Furthermore Dr. YEO mentions a considerable overlap in Iceland between the characters of the two species. Nevertheless these specimens have been referred to *E. frigida* mainly because of their relatively sparse indumentum. The general distribution is given by LID (1964).

Veronica alpina L.

VIII: SE-facing slope below Fishburndalen, 11.7. 1972. Fishburndalen, 15.7. 1972.

COMPOSITAE

Gnaphalium supinum L.

VIII: Håpdalen, 15.7. 1972.

Taraxacum cf. croceum DAHLST.

VIII: Håpdalen, 15.7. 1972. Young specimen.

Taraxacum cf. redens (DAHLST.) HAGL.

VIII: S-facing slope in Håpdalen, 15.7. 1972. Young specimen.

Acknowledgements

The authors want to thank the former medical officer of health, JENS JENSEN, Copenhagen, for taking the initiative in planning the expedition, and for supporting it economically.

We also want to thank the curators LARS KLIIM-NIELSEN and K. HOLMEN for valuable help during the process of determination, and for useful discussions.

The warmest thanks are due to Norsk Polarinstitutt for much kind help in arranging the expedition, and to Forsvarets Fellessamband for transporting the expedition to Jan Mayen.

The staff at the radio station in Jan Mayen is thanked for invaluable services.

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Stratigraphical and biological investigations of some Bjørnøya lakes

By ÅKE FLEETWOOD, BIRGER PEJLER, ULRICH EINSLE, and ROLF ARNEMO

Contents

Introduction

The field work and samples were done by participants in the Stockholm University expedition to Bjørnøya in May–June 1965, the main purpose of which was to obtain stratigraphical data relevant to the history of the island since the last glaciation.

The expedition was financed by the Swedish Natural Science Research Council, and the passage aboard M/S Nordsyssel was arranged by Norsk Polarinstitutt. The hospitality and help offered by the staff of the Bjørnøya Radio greatly contributed to the success of the field work.

TEMPERATURE READINGS IN LAKE AND RIVER BEDS AT BJØRNØYA

By ÅKE FLEETWOOD[1]

Investigations into permafrost and thawed zones along rivers, lakes, and sea shores have recently been carried out all over the world. Actual problems have been associated with drilling for fresh water, road-building and foundation work under arctic conditions.

An investigation of lake sediment at different elevations above sea level at Bjørnøya was carried out in May–June 1965, when certain methods and instruments were studied for measuring temperature gradients in lake and river sediments.

Various methods have been applied using thermocouples or thermistors permanently installed in holes drilled or dug for this purpose. During drilling, layers will be disturbed and one can expect readings to be influenced through altered thermal conditions. Our intention was to develop a set of light weight instruments which were easy to handle for measuring temperatures in soil, water, and waterbeds.

Measuring equipment

A thermistor, N-2, with a resistance of 2.2–3.3 kΩ was chosen as a temperature measuring device. This was fitted into a turned steelpoint, about 60 mm long having a diameter of 15 mm. The steelpoint was augered to a material thickness of 2.5 mm. To secure a good thermal connection the termistor was fixed to the steelpoint with a plastic mould. This plastic material was then used to waterproof and fasten electrical cables. The temperature-sensitive head was connected to stainless extension rods (length 1 m × diameter 10 mm × internal diameter 5.5 mm). The connection between the rods was by means of soldered nut and threads in the rod. The thermistor cable was mounted inside. A moving-coil instrument 10 μA connected as a bridge, was used as scaler and a diode arranged to stabilize the measuring current.

The bridge was reset to give full deflection in the temperature interval –0.2°C – +2.5°C. In the calibration the regression line was $T = I \cdot 0.259 - 0.2087$ where T = temperature in °C and I readings in μA. $n = 23$ ($r = 0.9993$***). Standard error 0.03°C.

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Measuring technique

Since both the calibration and the actual observations were done in water or in a water-logged material, one can safely assume that the contact between the thermistor and the material studied was constant. To make quite sure that there was no error brought about through the cooling of the steelhead and the tuning of the thermodetector instrument, readings were always taken after a set time lapse. For this reason a regular set reading routine was used in order to eliminate differences caused by irregular readings e. g. "Press the measuring probe in the point selected. Wait four minutes. Circuit the thermodetector and read after 45 seconds. Press the probe down to the next level, etc.". Before and after control was made in melting snow to zero every measuring series.

Prevalent air temperature conditions

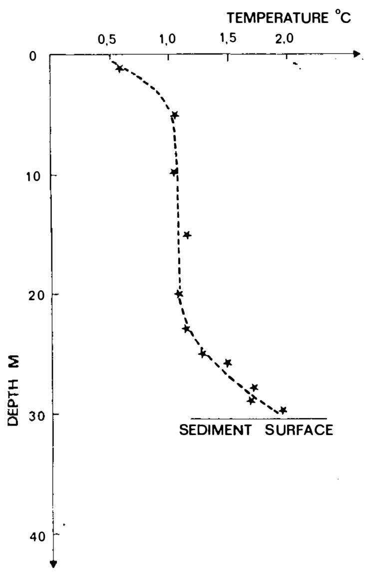
Bjørnøya is situated 74°30′N and 90°E, its climate is rather mild bearing in mind its northerly location with a maximum temperature in July of 5°C and a minimum temperature of –7°C in March. The temperature from November to May is below zero (mean values 1931–40, 51–60). Geological investigations were made in 1924 when permafrost depths of 60–70 m below land surface were found (Horn, Orvin 1928). The mean temperature during May 1965 was colder than usual, –3.1°C, with only three days during the month recording temperatures over zero.

Lake sediments

Many lakes on Bjørnøya are extremely shallow with rocky bottoms. As a rule thicker sediments were hardly ever found in lakes less than 2 m deep. Only one lake on the island, Ellasjøen, has a depth of more than 10 m. Ellasjøen has an area of 0.5 km^2 and is situated 20.8 m above sea level. Parts of the lake are approximately 30 m in depth. No sediment temperatures were measured, but a temperature profile of the lake (Fig. 1) indicates a sediment temperature of rather more than +2°C.

At lake Øyangen (area 0.2 km^2, 32.8 m a.s.l. maximum depth) there was a water temperature of 0.30°C 10 m from the beach at a depth of 1.20 m. When the measuring head was put between the rocks at the bottom a temperature of 0.50°C was recorded. Sediments were first found 100 m from the beach. At the greatest depth, 3.5 m, the sediment thickness was more than 3 m.

Water temperatures ranged from 0.30°C just below the icesheet (1.40 m) to 1.90°C at the bottom of the lake. The sediment temperature from the bottom of the lake down to 1 m was a little more than 2.6°C (just over full deflection of the instrument). The layer between 1 – 1.5 m below sediment surface showed a con-



↑ Fig. 1. *Temperature profile of Lake Ellasjøen, Bjørnøya, 19.5.1965.*

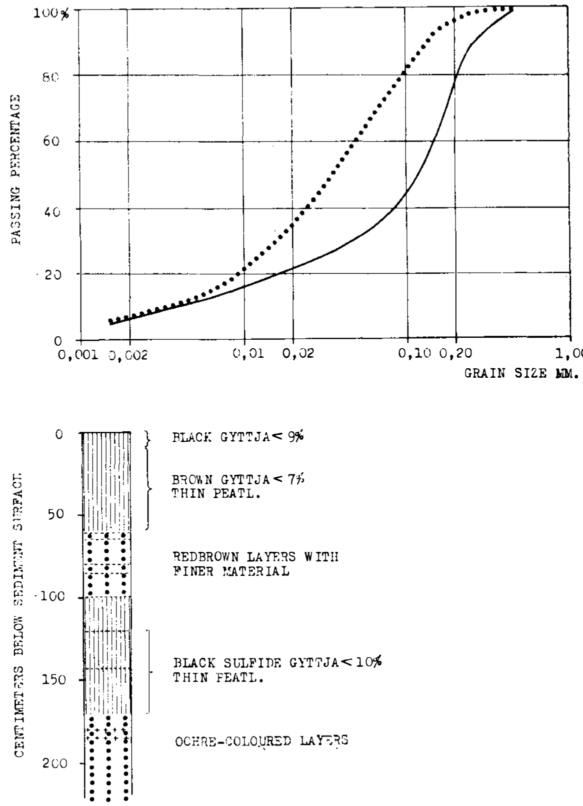


Fig. 2. *Schematic description of stratification; organic constituents and texture in investigated pool of river Fossåa (analysis by* H. HYVÄRINEN).

stant temperature of 2.56°C. From 1.5 m down to 3 m the temperature rose again to slightly above 2.6°C.

Due to swing in the stainless rods between ice and sediment it was impossible to get deeper with the probe.

River sediments

The river beds on Bjørnøya consist as a rule of a very coarse material; sediment occurs very rarely, and only then under very special conditions. The only suitable site for the planned investigation was found along Fossåa, a little river about 700 m long between Ellasjøen and the sea. Some 300 m downstream from Ellasjøen, there is a sediment filled pool, 200 m long and 100 m wide, and after a further 200 m down the river, a 9 m waterfall to the sea.

The sediment found in the pool might briefly be described as a clayish finesand, a bit coarser in the upper layer (Fig. 2).

The temperature conditions in the sediment are shown in Fig. 3. Probing in order to find out how much the zero-isotherm was bending under the shoreline was impossible because of the frozen surface. No problem was encountered in defining the frost-zone below the sediments. The probing was soft but distinctly

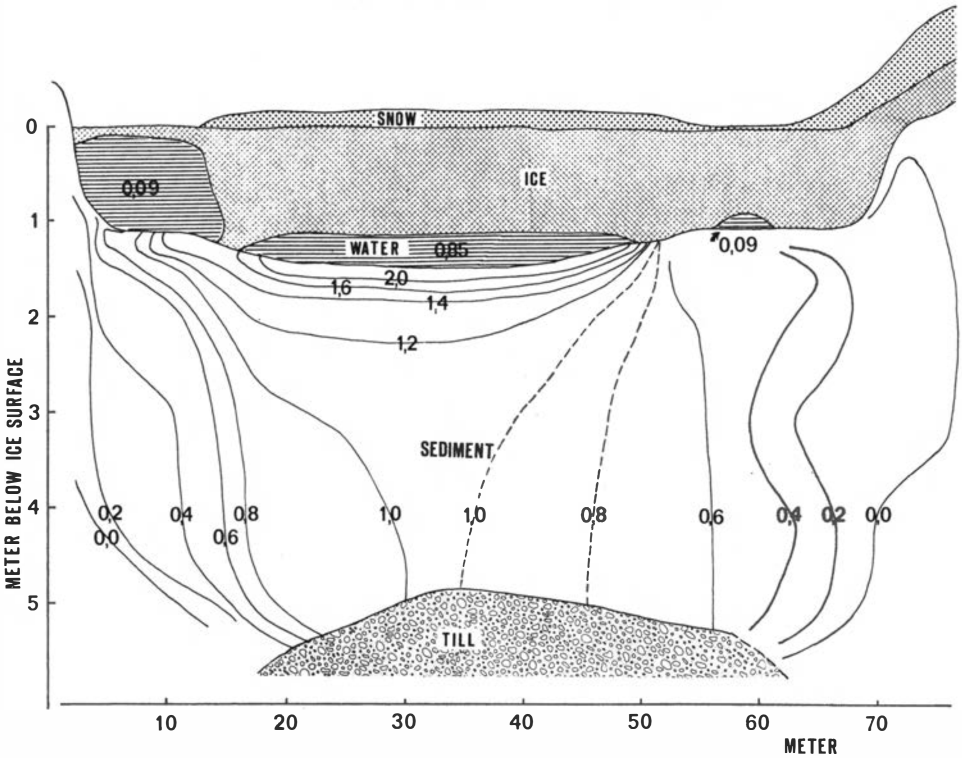


Fig. 3. *Water temperatures and isotherms (°C) in sediment of the investigated pool of river Fosså, 21.5. 1965.*

stopped by the frost-zone when a temperature of 0°C — –0.1°C was recorded. In the middle of the profile the probe stopped against a rocky layer, which was easy to feel when pushing down the probe rods.

Discussion

The measuring equipment proved easy to carry and handle. The readings were simple to make and had acceptable reproducibility. The moving-coil instrument was not damaged in spite of rough handling during skiing and transport by sledge.

No difficulty was encountered when pressing the rods into the unfrozen sediments as long as the water depth was less than 2 m. If the rod swing was more than 3 m it was almost impossible to press in the probe. On the other hand, previous tests, where the sediment thickness was greater, have shown that probing is possible down to 20 m.

Bjørnøya's lowland, an area of about 110 km^2, is extremely flat at some 35 meters above sea level and has more than 600 lakes. Observations of permafrost indicate depths of 50–75 m (HORN, ORVIN 1928). In the 25 lakes we discovered, there was only loose sediments in the central areas of the lakes, usually at a depth of more than two meters, the shore lines consisted of crumbled rock. No signs of thaw lakes with occupied thaw depressions, nor lakes enlarged by thawing could be seen.

The measured ground temperatures in the sediments indicated unfrozen zones under lakes and river beds and taliks (Gidrogeologija, Jakutski 1970) seems to be formed under continuous lake systems and river beds. The amount of ground water transported must nevertheless be negligible because of small potentials to move a ground water and rather compact silts and deeper moraines.

Acknowledgements

The writer wishes to express his thanks to the members of the expedition, S. R. EKMAN, H. HYVÄRINEN, P. KNAPE, P. SØDERMAN for assistance in the field, and to P-E. KEMPE for help with construction and assistance with instrument and preparation work.

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PLANKTONIC ROTATORIA FROM BJØRNØYA

By BIRGER PEJLER[1]

The four planktic rotifers listed below were found in netted samples from some inland waters of Bjørnøya. The signs in the table indicate high (xxx), rather high (xx) or low (x) frequency.

	Ellasjøen vertical netting 0—15 m	Laksvatnet outlet	Røyevatnet outlet	Engelskelva near Have
Date of sampling	21.5 1965	3.6 1965	2.6 1965	29.5 1965
Temperature (°C)	4	+0,3	+0,3	+0,3
Keratella hiemalis CARLIN	xxx	x	xx	
Argonotholca foliacea (EHRBG.)				x
Polyarthra dolichoptera (IDELSON)	xx	x		
Filinia teminalis (PLATE)	xx			

No previous study applying recent taxonomy seems to have been devoted to the limnic rotifer fauna of Bjørnøya. The four species listed above are known as more or less typical cold-water species. They are all found in northern Scandinavia (PEJLER 1957) and all but *Filinia terminalis* on Spitsbergen (AMRÉN 1964 and references there). Thus no endemic species has been encountered.

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PLANKTONIC CRUSTACEA FROM BJØRNØYA

By ULRICH EINSLE[1]

A net sample from Ellasjøen was investigated with regard to the *Crustacea* present. Only one individual of *Cladocera*, a *Daphnia* sp., was observed. It was too young for a certain identification.

Earlier investigations of the *Copepoda* of Bjørnøya have been made by LILLJEBORG 1900, GURNEY 1933 – Bertram leg. –, BERTRAM & LACK 1938, LINDBERG 1957. I found two species of *Cyclops* for the sample from Ellasjøen: *Cyclops vicinus* ULJANIN which was also recorded by all earlier authors, and of the second species, in my opinion *Cyclops abyssorum* SARS, I only found one female. This latter species may correspond to the *"Cyclops strenuus"* described by GURNEY (1933) and the *"Cyclops rubens medianus"* described by LINDBERG (1957). An exact identification is only possible by the chromatin-diminution method (EINSLE 1962); as my material is very limited and I have not had any possibility for this short communication to compare the material from the above authors with my own, it is impossible to make any certain conclusions about the species observed, and discuss the identifications.

However, it should be very interesting and stimulating to investigate material from northern Norway, Bjørnøya and Spitsbergen to get better information about the fauna and to make possible a discussion based upon Crustacean zoogeography of the glaciation of these regions. By investigating the sample from Bjørnøya and samples from northern Sweden and Spitsbergen and make a comparison between them I have already some evidence for a difference in the composition of the *Cyclops*-species which might contribute to the knowledge of possible connections in the prehistory of these regions. This could be obtained especially by a thorough investigation by exact methods of the *Cyclops* fauna and its zoogeography.

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THE FOOD OF THE CHAR ON BJØRNØYA

By ROLF ARNEMO[1]

The expedition collected char in three lakes and the content of thirteen stomachs was examined. Later the systematic position of the char, especially in comparison with the Scandinavian species will be investigated by Dr. NILSSON, Institute of Freshwater Research, Drottningholm, Sweden. From this a contribution to the question of the glaciation of Bjørnøya can possibly be given.

The results of the investigation of the stomachs are summarized in the following table, where the mean value of the food from the respective lakes is given as volume-% (samples were taken in May–June 1965):

	Nostoc sp.	*Chironomidae* larvae	*Chironomidae* pupae	Number of stomachs	
				with content	without content
Laksvatnet	8	92		7	0
Ellasjøen				0	3
Daudmannsvatnet			100	2	1

Nostoc sp. is most probably a circumpolar species according to Dr. KRONBORG, Institute of Limnology, Uppsala. The pupae of *Chironomidae* will be investigated later by Dr. NILSSON.

These results agree with the results of NILSSON (1955, 1960) who found that bottom fauna dominated the food of the char in the spring in Sweden. The dominant role of *Chironomidae* among the bottom fauna as fish food on Bjørnøya was also observed earlier by BERTRAM and LACK (1938), who found larvae to dominate the food in July.

As information about the composition of the bottom fauna is lacking, it can only be surmised that the small number of components of the bottom fauna found in the char by BERTRAM and LACK and the present author is probably caused by a lack of other components in the bottom fauna rather than by a high selectivity index of the fish.

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Polar bear den surveys in Svalbard in 1972

(Учет берлог белых медведей на Свальбарде в 1972 г)

By Thor Larsen

Contents

Abstract

Between 23 March and 13 May, 1972, the eastern and northern parts of Svalbard were surveyed for dens of polar bears (*Ursus maritimus*). Two Cessna 185 fixed wing aircrafts with skis were used and about 200 hours were flown, most of them before 18 April. Areas of particular interest were also surveyed from the ground. 84 dens were found: 9 on Edgeøya, 22 on Kongsøya, 27 on Svenskøya, and 26 on Nordaustlandet. The ratio between maternity dens and temporary dens could not be determined, but ground investigations indicate that there was about half of each. Some dens were found very close to each other, particularly on Kong Karls Land. These islands and the northern coast of Nordaustlandet must be considered important polar bear denning areas in Svalbard. In future den surveys, ground and air observations should be combined in order to obtain the best results possible.

Аннотация

С 23 марта по 13 мая 1972 г. были осмотрены восточные и северные части Свальбарда в целях учета берлог белых медведей (*Ursus maritimus*) с двух снабженных лыжами самолетов типа Cessna-185, летавших около 200 часов, главным образом до 18 апреля. Районы, представлявшие особенный интерес, были обследованы и наземными партиями. Всего было обнаружено 84 берлоги, а именно 9 на о. Edgeøya (Эдж), 22 на о.Kongsøya (Королевском), 27 на о. Svenskøya (Шведском) и 26 на о. Nordaustlandet (Северо-Восточной Земле). Соотношение между родильными берлогами и временными нельзя было точно определить, но наземные обследования указывают, что число обеих категорий берлог примерно одинаково. Некоторые берлоги обнаружились очень близко друг к другу, в частности на архипелаге Kong Karls Land (Земля Короля Карла), который наряду с северным побережьем Северо-Восточной Земли должен рассматриваться как важный район распространения медвежьих берлог Свальбарда. При будущих учетах берлог целесообразно будет наземные наблюдения сочетать с воздушными, чтобы приобрести как можно достоверные результаты.

Introduction

Ecological polar bear investigations have been performed in Svalbard since 1966 (LARSEN 1970). Prior to that, much information was collected by ODD LØNØ during his many winter expeditions to Svalbard (LØNØ 1970). 103 polar bears were captured and marked during 1966–1969, and there are 36 recoveries of these marked bears. Blood, milk, and teeth have been collected from captured bears, and skulls and catch data from the annual polar bear harvest in Svalbard have been collected by trappers and weather station crew. Observations have been made from aircrafts, from ships, and from the ground throughout the investigational period. Analysis of catch data, studies of migration, and recoveries of marked bears suggest that polar bears are not circumpolar migrators as suggested by PEDERSEN (1945), but rather keep within a given region from year to year. Some data indicate that Svalbard and the western Soviet arctic may share a common polar bear population (LARSEN 1970, PAROVSHCHIKOV 1967), while LØNØ (1970) claims that there are separate polar bear populations in Svalbard and the western Soviet arctic. It is of importance for the solution of this problem as well as for the general ecological polar bear research to map possible polar bear denning areas over several years in the Barents Sea area, and to compare maternity den frequencies with polar bear abundance and population composition and size.

Some information about the denning habits of the polar bear in Svalbard is already given by LØNØ (1970), based on data from trappers and others, as well as own investigations. Efforts to locate polar bear dens were made during a winter expedition to Edgeøya 1968–1969, but with poor results (LARSEN 1971). More information about polar bear denning habits comes from other regions: Franz Josef Land (PAROVSHCHIKOV 1967), Wrangel Island (USPENSKY and KISTCHINSKI 1972), the Canadian high arctic (HARINGTON 1968), and Hudson Bay and James Bay (JONKEL et al. 1972).

The objective of the present study was to learn more about the relative importance of various regions in Svalbard as denning areas for polar bears, to count the number of dens in a given area whenever possible, and to obtain data on polar bear denning habits in general. The study was planned to take place between mid March and late April. Polar bear females dig their dens in late autumn and the cubs are born in January or late December (HARINGTON 1968, LØNØ 1970). In most regions polar bear females with cubs leave their dens between late March and early April (HARINGTON 1968, USPENSKY and KISTCHINSKI 1972). On more southern latitudes, they may emerge during February and March (JONKEL et al. 1972). LØNØ (1970) states that the majority of polar bear maternity dens are abandoned during April.

Methods

Most polar bear females with young leave their dens over a relatively short period of time. When large areas are to be surveyed simultaneously, therefore, the only practical method is the use of aircrafts. In this study, fixed wing aircrafts were used, due to the relatively low cost when range and fuel consumption is taken into consideration. Two Cessna 185 with skis and cargopacks were chosen. Longyearbyen and Ny-Ålesund were used as bases. Fuel depots had been established in Tjuvfjorden, Freemansundet, and Sorgfjorden the previous summer, thus extending the range of the aircrafts considerably. In addition to the pilot, each plane normally carried two observers each covering one side of the aircraft during the surveys. Observations were made from altitudes between 70 and 150 meters, depending upon light and weather conditions and topography. Cruising speed during the surveys was between 130 and 150 km per hour.

The study was planned according to the following priority program:

1. Possible polar bear denning areas should be surveyed by means of aircraft.
2. Areas of particular interest should also be checked from the ground.
3. Dens found should be examined to determine whether they were temporary or maternity dens.
4. Den location and den construction should be described whenever possible.

Both air and ground surveys were to be repeated whenever possible, because snow and wind might cover dens soon after they had been opened.

Between 25 March and 18 April, about 150 hours were flown in 11 effective days. Flying between 19 April and 13 May totalled about 50 hours in five effective days. At the same time field parties carried out ground work in various areas: at Negerpynten, Tjuvfjorden, 25 March to 1 April (T. L., O.S.); on Kongsøya, 31 March to 10 April (E. N., J. S-M., B. W.); on Svenskøya, 10 April to 18 April (O. H., I. S.); and on Depotodden, Nordaustlandet, 6 May to 13 May (O. H., I. S., J. A.). On each aerial survey the planes worked together. They either followed a coastline at different altitudes, or each surveyed one side of a fjord, or one surveyed the coast while the other checked riverbeds, valleys, mountains or islands. Some areas were controlled repeatedly, while others could only be observed once because large areas had to be covered. When a den was found, efforts were made to determine whether it had been occupied by a family group or by a single bear. Whenever possible, observations were documented with photographs.

Results

Northern and eastern Svalbard were particularly carefully surveyed, because these regions are presumed to be important polar bear denning areas. The results were as follows:

EDGEØYA AND BARENTSØYA

Both islands were surveyed several times during late March and throughout April. Eight dens were found on 27 April at Wolkenhauerfjellet on Edgeøya. They had been dug in relatively low northeastfacing snowdrifts, close to the shore. On 28 April a single den was found in a small valley north of Middendorffberget, approximately ten km from the shore. This was the farthest inland den recorded during the survey. See Fig. 1.

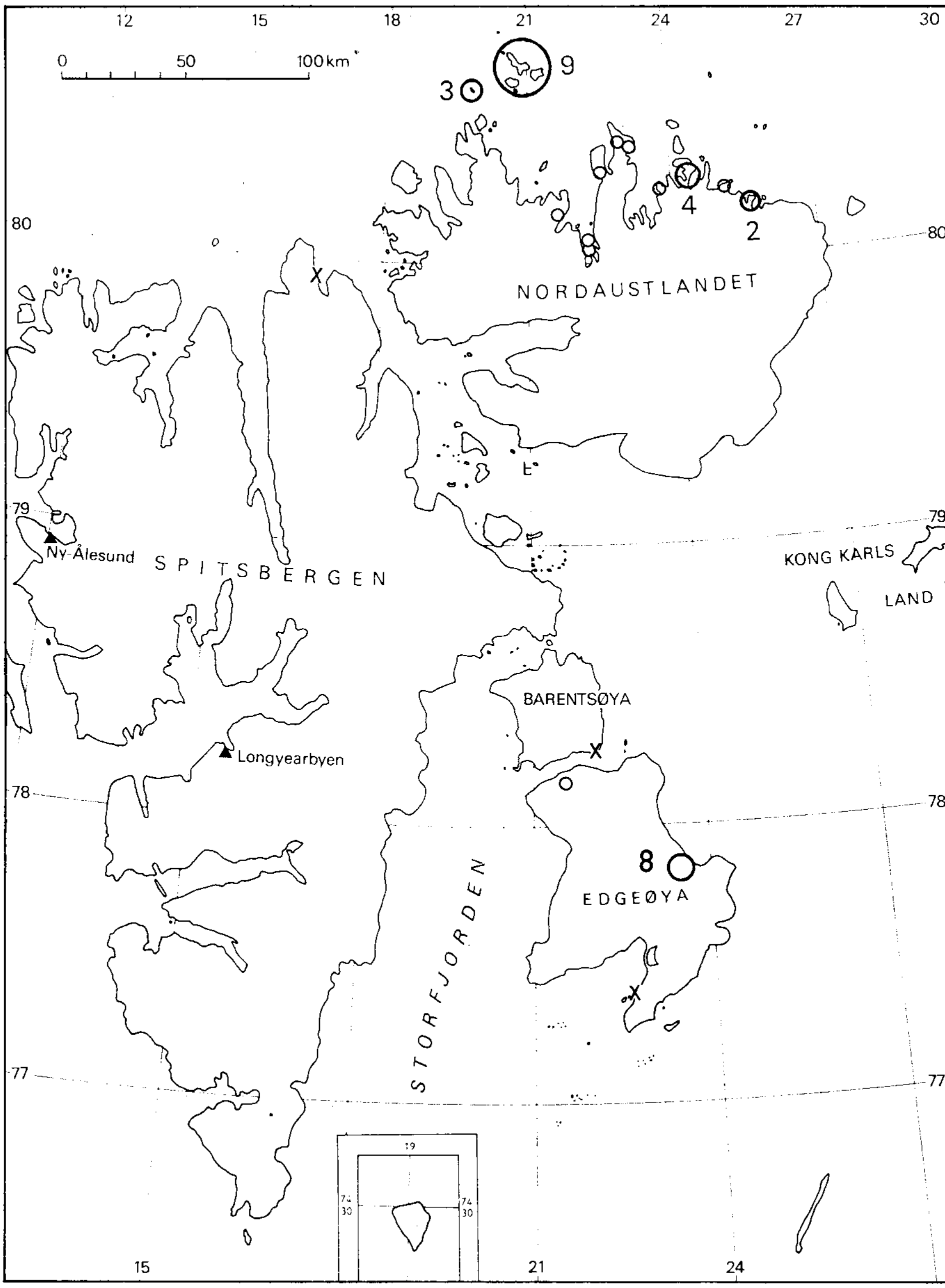

Fig. 1. *Polar bear dens recorded on Nordaustlandet and Edgeøya during aerial surveys in April and May 1972.* X *: fuel depots,* O*: single dens. Concentrations of dens are given by bigger circles and a number.*

Берлоги белых медведей, отмеченные на о-вах Северо-Восточной Земле и Эдж во время их воздушного учета в апреле-мае 1972 г. X – склад топлива, O – одиночная берлога. Скопления берлог в одной местности указаны более крупными кругами с цифрами, указывающими их число.

The field party working around Negerpynten and in Negerdalen did not find any evidence of denning. Bear tracks were far less numerous than at the same time in 1969 (LARSEN 1971). The ground work was partly prevented by bad weather and strong wind, and dens which might have been opened, would be closed by snowdrift shortly afterwards.

KONG KARLS LAND

The dens found on Kongsøya are marked on Fig. 2. Only the western mountain massif was investigated by a field party between 31 March and 10 April. Thirteen dens were found during their ten days stay, of which four days were acceptable for observations. An additional nine dens were found during a three hour aerial survey on April 10. Many dens were found along the northwestern coastline, which is partly explained by the fact that this region was more intensively surveyed than others. The relatively broken topography with small valleys, hills, etc., often made ground observations difficult. Two different types of dens were noticed. In most cases, a fringe of snow marked the opening, indicating that a den had been dug out. In some cases however, there was merely an opening in the snow, with no fringe around it, as if the den had been pushed open from the inside. Some dens were abandoned shortly after they had been opened, but there were also cases where bears stayed at the dens for several days.

The dens found on Svenskøya are marked on Fig. 3. The field party found 21 dens in seven days, of which six days were acceptable for observations. Another six dens were found during an aerial survey on April 18. All dens discovered by the field party were located on the south and west side of the island, along the upper ridge of the plateau Kjølen where snowdrifts had been formed throughout the winter. The polar bear family groups seemed to have left their dens shortly after they had been opened. Several tracks of female polar bears with cubs were registered, all heading for the pack ice. Evidence of temporary denning was also found on Svenskøya.

Some dens were found very close to each other both on Svenskøya and on Kongsøya. Sometimes the openings were separated by only a few meters. Because the field parties had no opportunity to dig out the dens, it could not be determined whether they were actually separate dens or if there were several openings to the same den.

NORDAUSTLANDET

The northern coast of this island was surveyed from aircrafts on the 8, 15, and 16 April. Prior to the last two surveys, there had been a period of more than a week with very calm weather on Nordaustlandet (E. NYHOLM, pers. comm.). Many dens may have been opened long before the last surveys therefore. Both planes were used for about 30 hours flying. 26 dens were located. In general, the dens were more scattered than on Kong Karls Land, but in some areas, as on Sjuøyane, there was a higher frequency of dens (Fig. 1). Field investigations were carried out in Brennevinsfjorden between 6 and 13 May, but no dens were found.

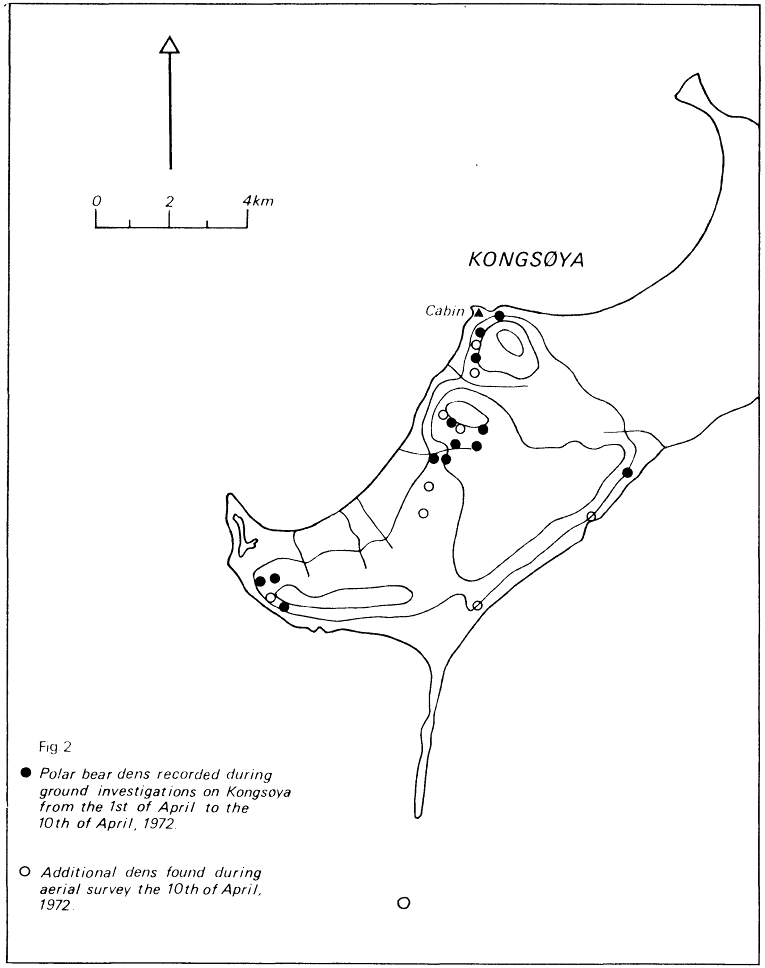

Fig. 2. *Polar bear dens recorded during ground and aerial surveys on Kongsøya, April 1972.*

Берлоги белых медведей, отмеченные во время их наземного и воздушного учета на о. Kongsøya (Королевском) в апреле 1972 г.

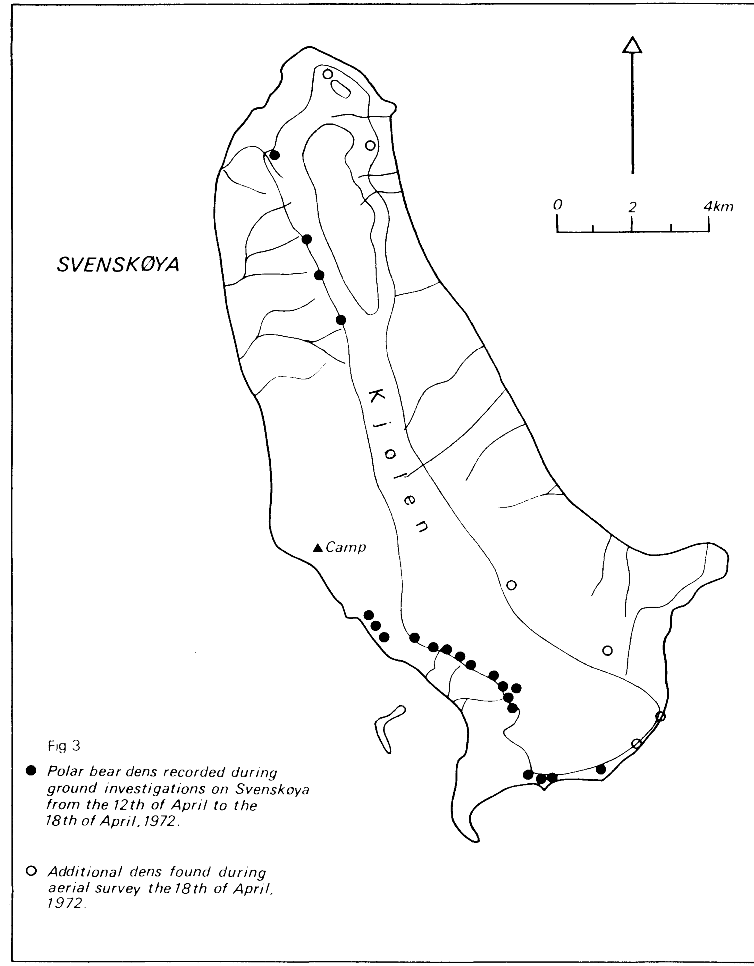

Fig. 3. *Polar bear dens recorded during ground and aerial surveys, on Svenskøya, April 1972.*

Берлоги белых медведей, отмеченные во время их наземного и воздушного учета на о. Svenskøya (Шведском) в апреле 1972 г.

NORTHERN SPITSBERGEN

The northern parts of Spitsbergen were surveyed repeatedly from planes after 8 April, but no dens or evidence of denning were found. There was, however, a relatively high bear activity in the area, particularly in Liefdefjorden and Woodfjorden.

EAST COAST OF SPITSBERGEN

The coastline between Agardhbukta and Ginevrabotnen was surveyed several times from the air in March and April, but no dens or evidence of denning were found. The general bear activity in the area was medium.

Discussion

In this study it could not be demonstrated that ground surveys of polar bear dens were superior to aerial observations or vice versa. Of the total of 84 dens observed, 50 were spotted from the air, while the rest were recorded by field parties. Observation success depends upon several factors:

1. Drifting snow may fill up and cover a recently vacated den before it is recorded. The contours of the entrance as well as tracks, urine and excrements in the vicinity may still be seen. But the number of dens counted in any area is strongly correlated with the time elapsed since the last drifting of snow.
2. The majority of polar bear females with young leave their dens over a three week period, but this may vary from one region to another. The families may stay at the dens for some days, but occasionally may leave them shortly after they have been opened. The time when the dens are opened and abandoned must therefore be known for a given area.
3. Not all dens observed are maternity dens. Some are temporary and only used by single animals for shelter or rest. In order to determine whether cubs have been born in a den, a close examination of the denning site is required. It is usually difficult to distinguish between den types from the air.
4. A broken topography may lower the efficiency of ground surveys, while aircraft speed, light conditions and observers' skill and experience affect aerial observations. By use of aircrafts large areas can be covered simultaneously, and the relative importance of various regions as denning areas can be determined. Field parties on the ground usually cover a small area, but they can perform absolute counts and detailed studies.

It is assumed that ice conditions play an important part as to where and when polar bear females will seek to the shores to dig their dens. According to VINJE (1972) the eastern and northern part of Svalbard was surrounded by ice by September. Ice conditions should hence not have prevented polar bear females from seeking out their dens in other possible denning areas as Edgeøya, Barentsøya and North Spitsbergen. Dens have been found both in Edgeøya and in Barentsøya before (LØNØ 1970, LARSEN 1971) but never as many as on Kong Karls Land and Nordaustlandet in 1972. Data from previous investigations and from the 1972

Fig. 4. *A polar bear den is easily seen from the air under good light conditions owing to the many tracks around the entrance.*

При хорошем освещении берлога белого медведя легко заметна с воздуха из-за многочисленных следов вокруг входа.

Photo: T. Larsen

Fig. 5. *Typical location of a polar bear den on Svenskøya.*

Типичная местность расположения берлоги белого медведя на о-ве Svenskøya (Шведском).

Photo: O. Hjeljord

den surveys suggest that Kong Karls Land and Nordaustlandet are by far the most important denning areas for polar bears in Svalbard. The abundance of polar bear dens in Kong Karls Land in 1972 can be compared with the densities on Wrangel Island in the eastern Soviet arctic. Wrangel Island is considered one of the most important polar bear denning areas in the world.

Most of the dens found in Svalbard in 1972 were located close to the coast, and usually less than one km inland. This can partly be explained by the fact that shorelines and small islands were more intensively surveyed than the inland areas. But there were few tracks and other signs to indicate that denning had occurred inland. The lack of dens inland may also be explained by the topography and by the relatively small size of the islands and peninsulas where the dens were found. In Wrangel Island, dens are usually found within 8 km from the coast, but some as much as 25 to 27 km inland (USPENSKY and KISTCHINSKI 1972). From the Canadian high arctic, HARINGTON (1968) reports that more than 60 per cent of the maternity dens are found within 8 km from the shore. In the Hudson Bay area, two denning areas for polar bears are centered about 20 and 70 km from the coast, respectively (JONKEL et al. 1972).

When the field parties were put ashore on Kong Karls Land in March and April, several dens had been opened and abandoned already. However, new dens were opened throughout the observation periods until 18 April when the last group left. The dens found on Edgeøya in May were not checked from the ground, but are more likely to have been temporary than maternity dens. The emergence of maternity dens is probably dependent upon latitude and climatic conditions. JONKEL et al. (1972) reports that polar bear maternity dens in the Hudson Bay area are abandoned in late February and throughout March. In Svalbard, most dens seem to be opened between late March and mid April. This is in accordance with observations from other high arctic regions (HARINGTON 1968, USPENSKY and KISTCHINSKI 1972). It is possible that dens on Nordaustlandet are abandoned somewhat later than on Kong Karls Land, but the data from 1972 are not sufficient to verify this theory.

The percentage of maternity dens of the total number of dens observed could not be determined on this survey. The field parties working on Kong Karls Land reported that perhaps half the dens observed were maternity dens, probably fewer. Future den studies in Svalbard must concentrate on intensive and repeated ground investigations. Dens found must be dug out and inspected. Ground surveys must be combined with aerial surveys with fixed wing aircrafts and/or helicopters.

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Air and ground survey of reindeer in Nordenskiöld Land and Sabine Land, Spitsbergen

By HARTMUT GOSSOW[1] and SVEIN R. THORBJØRNSEN[2]

Contents

Abstract

Results of two ground surveys (March 1971 and March 1972) and one aerial survey (July 1972) to count the reindeer population in Nordenskiöld Land and Sabine Land are presented and discussed. The population is obviously still increasing, having already reached surprisingly high population densities at least in its optimum habitat areas. The possibility of the population reaching a maximum should be taken into consideration, however, and regular control counts during the next years are recommended, therefore. It is discussed also which survey method (snow scooter teams in March or an aerial census in the beginning of July) be the better one, especially for the determination of calf percentage in an effort to give an estimated productivity rate.

Acknowledgements

We wish to express our gratitude for the cooperation of the snow-scooter teams from Longyearbyen, to dipl.ing. TIEFENTHAL (Store Norske Spitsbergen Kulkompani A/S) for permitting us to fly his plane, to the Sysselman's office for kind assistance in photoprinting of maps, and to the Deutsche Forschungsgemeinschaft, for economic support to the first author's reindeer research project during the summer of 1972, including flight costs.

Introduction

Up until now, NORDERHAUG has presented the most accurate and detailed figures for the several subpopulations of the Svalbard reindeer (*Rangifer tarandus platyrhynchus*), partly by summarizing data from several authors (1969a, b), partly by

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counting the reindeer himself (1970). The counts for the various main valleys of Nordenskiöld and Sabine Land respectively, are from different years between 1959 and 1968 (NORDERHAUG 1969b), and, therefore, can be summed up and compared only with reservation. Nevertheless it seems clear enough that at least in some areas the population is reaching a density close to what it was before human exploitation started (NORDERHAUG 1969b). Especially in the Nordenskiöld Land it is more and more often talked about an overpopulation of reindeer.

Since 1971 Longyearbyen Jeger- og Fiskeforening has organized in March each year a reindeer survey assisted by snow scooter equipped teams. GOSSOW was staying in Nordenskiöld Land for reindeer studies during the summer of 1972 and was able to do an additional aerial summer count.

Methods

The counts in March 1971 and 1972 were carried out by a number of snow scooter teams roaming synchronously within their assigned districts. No differentiation of the reindeer observed was made (sex, age, antlered or unantlered), only number of individuals registered. Since the 1972 ground count, organized by THORBJØRNSEN, the total range of Nordenskiöld Land and Sabine Land was divided into 12 main districts. The same subdivision will be used in future scooter counts (Fig. 1).

An aerial contrc l count was planned in March 1972, but because of bad weather conditions only a limited area in Adventdalen and Sassendalen could be surveyed.

A more detailed aerial census was carried out in July 1972, covering larger parts of the reindeer range, as a supplementary investigation to the reindeer study already mentioned.

We used a private aeroplane which had also been used for the March survey:

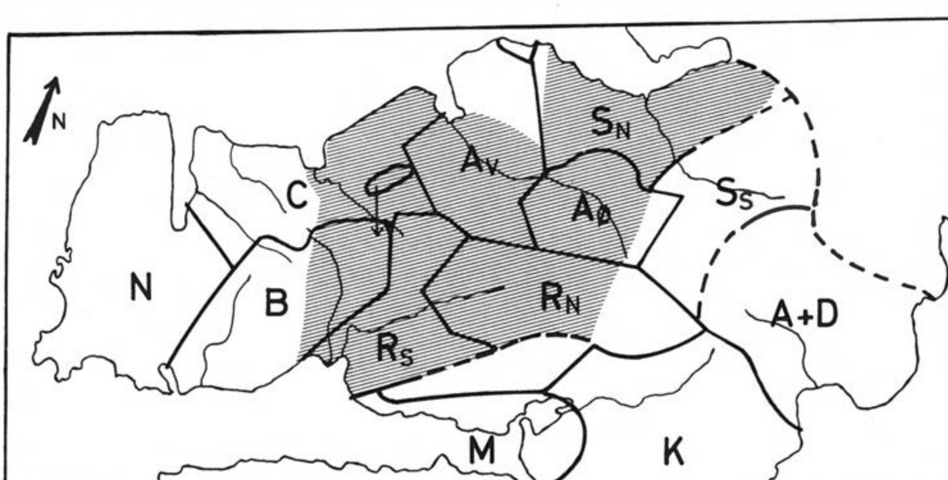

Fig. 1. *Map of Nordenskiöld/Sabine Land with the main count districts of the ground surveys 1971 and 1972, and the area (hatched) of the aerial survey 1972.*

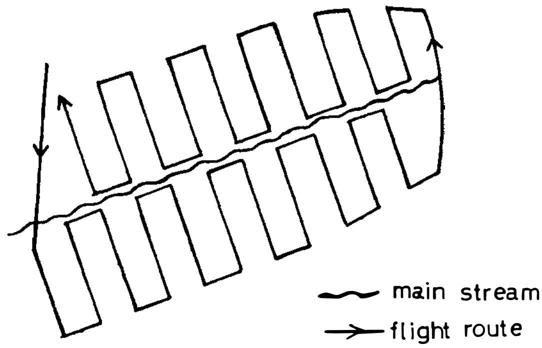

Fig. 2. *Pattern of flight routes in Reindalen (schematically).*

a JODEL DR "Ambassadøre" (registered LN-RTI), with a maximum speed of 140–155 km/hr, a cruising speed of 100–120 km/hr, and a flying duration with two persons of about five hours; the average altitude was approximately 600 ft above ground level, but for special purposes also lower (300 ft). The pilot (THORBJØRNSEN) assisted in the survey.

Some preliminary flights were made to find out about the present distribution of the reindeer (3 July, three hours). During the actual survey flights (5 and 8 July, total five hours), most of the reindeer were counted immediately and their numbers registered on photoprinted maps of the observation areas (scale 1:100 000). Larger herds, especially "nursery bands" of more than 15–20 animals, were only photographed and the actual data counted out later. We differentiated between adults and calves for all counted animals.

The flight routes were planned according to topography and reindeer distribution. Only in the Reindalen district, the most densely populated range, we preferred to follow a more complicated transect pattern (Fig. 2). This was possible withouth risking double counts because of the still flooded main stream, impossible to cross by the reindeer.

Results and discussion

Table 1 gives the results of the three surveys mentioned, supplemented by the data from NORDERHAUG (1969b, Table 2) for the 1960's.

The aerial survey covered only about 60% of the scooter counted area, because bad weather conditions prevented the remaining survey flights. This percentage, however, represents more or less the central parts of the reindeer populated habitat in Nordenskiöld Land. Population densities obviously differ to a fairly high degree in the winter and the summer. Comparisons seem possible only for few parts observed in March as well as in July 1972. Reindalen proved to have equal population densities in both seasons, whereas the corresponding figures for Colesdalen, Adventdalen, and Sassendalen differed more or less (Table 1). We have some estimates made by the Dutch Svalbard Expedition 1972 from Agardh–Dunér (v. OLPHEN, DOEKSEN, RIJVEN) for the end of June, indicating an only small and probably calfless or at least calfpoor peripheral stock during the vegetation period as well

Table 1

Observed population sizes of Reindeer in Nordenskiöld Land/Sabine Land in different years. Based on references for 1965–68, on aerial and ground surveys for 1971–72.

Main count district	Popul. estim. 65—68	Ground survey March 71	Ground survey March 72	Aerial survey July 72 Adults	Calves	Total	Calf %
Agardh-Dunér (A+D)		37	19	no survey			
Sassendalen S (Ss)		83	217	no survey			
Sassendalen N (Sn)	325*	399	209	654	76	730	10.4
Adventdalen Ø (AØ)		134	73	183	55	238	23.2
Adventdalen V (Av)		267	340	132	13	145	9.0
Colesdalen (C)		389	218	337**	60**	397**	15.1**
Nordenskiöldkysten (N)	11*	97	171	no survey			
Berzeliusdalen (B)		301	243	260**	92**	352**	26.1**
Reindalen S (Rs)	379*	163	423	497	132	629	21.0
Reindalen N (Rn)		306	431	354	127	481	26.4
Kjellströmdalen (K)		17	49	no survey			
Van Mijen- & Van Keulenfjorden (M)		25	34	no survey			
Total	715	2218	2427	2417	555	2972	18.7

* cf. NORDERHAUG 1969b, Table 2
** only partly surveyed (Fig. 1)

as in the winter, evidenced by the March count and the scooter trip observations (THORBJØRNSEN). On the other hand, Nordenskiöldkysten, the opposite coastal area, not so much exposed to winter storms from predominantly eastern directions, seems to be a comparatively favoured wintering habitat. At least it seems so when the winter density is compared with summer data from two Swiss ornithologists (FREI and WORF), working there in June and July, registering only some 40 animals between Kapp Linné and Orustosen.

Table 2 shows population densities for Nordenskiöld Land and Sabine Land giving an indication of the population increase since the 1960's.

Table 2

Observed population densities of reindeer in different areas of Nordenskiöld Land/ Sabine Land between 1965 and 1972.

Area	Estimated productive area (km²)*	Population densities (animals/km²) 65–68* (Jul.–Aug.)	71 (March)	72 (March)	72 (July)
Sassendalen–Adventdalen	202	1.609	4.38	4.17	5.51
Berzelius-, Rein-, and Kjellstrømdalen	378	1.003	2.08	3.04	3.87
Nordenskiöldkysten	184	0.060	0.53	0.93	
Mean value of these areas	764	0.935	2.32	2.82	4.61**
Nordenskiöld/Sabine Land	1224		1.82	1.97	

* after NORDERHAUG 1969b (Table 2)
** that is on only 580 km²

The figures for the productive (vegetation-covered) area are estimates by NORDERHAUG (1969b, Table 2), and the corresponding figures for the aerial survey are compiled from NORDERHAUG's data. They are probably a bit too high, but as far as the densities in Table 2, column 6, are concerned, are at least no overestimates. It can be stated that in the meantime the present population densities in Nordenskiöld Land have increased compared to data from Barentsøya and Edgeøya for 1969 (NORDERHAUG 1970).

The aerial survey also procured information on the local calf productivity (Table 1). The mean calf percentage is 18.7, which can be compared with 1969 data from Barentsøya and Edgeøya presented by NORDERHAUG (1970). Reindeer herd sizes averaged at 4.2 animals, but were 7.3 for the 258 herds with calves ("nursery bands"), and 2.4 for the 452 herds without. Compared with sociological data based on ground surveys in several areas by GOSSOW, it seems evident that the calfless bands predominantly consist of males, whereas the "nursery bands" also include most of the barren females and yearlings.

The March count prerequisites varied due to different snow conditions: in March 1971 there was only little snow and the reindeer were staying on low localities (bottom of the valleys); in 1972 a lot of snow caused the reindeer to stay higher up in the mountains on slopes and on high plateaus. Feeding craters have also been observed, a feeding habit which according to OOSTERVELD is very unusual for the Svalbard reindeer.

Since snow scootering in mountain regions is more or less hampered by deep snow and because the visibility is less good in the valleys, the March 1972 survey will probably be less exact than the one for 1971 (THORBJØRNSEN). This becomes evident also when we compare the number of adults observed on the ground with the aerial survey in 1972. Considering the much smaller area counted in July, the March count must have been underrepresentative. A change in the local herds between March and July can hardly reach such an amount and specific pattern as indicated in Table 1.

In our opinion the data shows a clear evidence of a population increase. The calf percentages are similar to those determined for Barentsøya and Edgeøya in 1969. The adult male surplus is still more remarkable in Spitsbergen (GOSSOW, in prep.) than on Barentsøya (NORDERHAUG 1970). That means we have a sex ratio quite in contrast to the usually higher percentage of females in ungulate populations. In other words: similar calf recruitment (based on the total population) but less females and higher population density (compared with the 1969 situation on Barentsøya), means a nevertheless still higher productivity rate of the Nordenskiöld Land population as well as a higher carrying capacity in Spitsbergen.

Although there is now (1972) neither an especially high observable mortality rate nor any signs of overgrazing, the population increase will probably become critical sooner or later. We recommend, therefore, a regular supervision of the reindeer population development and of range conditions.

The question arises, how such control counts could best be done. Scooter counts would probably be the cheapest way, because of the private support from Longyearbyen Jeger- og Fiskeforening. But there are at least two important methodical objections: it is not possible to get exact data about numbers of calves without disturbing the reindeer; and because it is impossible for all the voluntary members of the counting expedition to be trained equally well for such a purpose exactness and comparability of the various counts may be biased. Further difficulties may depend on the actual weather situation, especially on snow conditions (like in March 1972), but hardly more than in other seasons.

Aerial surveys, therefore, with trained people, at best also including a wildlife biologist, will be a better solution. There are several reasons why the beginning of July will probably be the best time for aerial counts. Moulting of the adults is still in progress then or just about started in females with calves, i.e. the reindeer can be very well detected against vegetated ground as well as on snow patches. Practically all the calves are born at that time but they still have their first light coat; from the middle of July onwards they are moulting it to a more grey-brown pelage, which is not always perceptible against some types of vegetation. In the beginning of July we were well able to detect and differentiate between calves and adults. A certain possibility exists of overlooking calves, standing, walking or fleeing too close to their mothers. But the small difference between a local calf percentage of 19.7 as ascertained in the aerial survey, and the calf percentage for the same area controlled four days later in a ground survey (20.1%), is very promising.

But it seems recommendable to carry out ground surveys as well in order to get more accurate sociological data of importance for discussing the population's dynamic situation more adequately.

Another advantage of counting reindeer in the first half of July, might be the fact that the main rivers are still flooded, separating the big valleys very effectively. Surveying first one half of the valley in one direction and then the second half in the other direction, becomes more easily possible without driving reindeer across the main streams and count them twice.

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Undersøkelser av ringgjess (*Branta bernicla hrota*) på Tusenøyane

(*Studies of Brent geese* (Branta bernicla hrota) *on Tusenøyane, East Svalbard*)

(Исследования черных казарок (*Branta bernicla hrota*) на архипелаге Tusenøyane, на восточном Свальбарде)

AV MAGNAR NORDERHAUG[1]

Innhold

Abstract

Data from studies of the Brent goose on Tusenøyane in the eastern part of Svalbard are summarized. From 1 July 1973 Tusenøyane are a part of the Søraust-Svalbard nature reserve. Based on data obtained from parts of Tusenøyane (mainly summer 1969), the potential importance of the area as breeding habitat for this species has been further studied on aerial photographs. Figs. 2, 3, and 4 give an evaluation of the importance of the different islands. Tables 1 and 2 summarize two alternative rough estimates of the population size in the area. An estimated population of 600–750 Brent geese (including goslings) was supposed to inhabit Tusenøyane at the end of the breeding season in the second half of the 1960's. This is approximately 30–40% of the total Svalbard population. It will probably continue to decline and is in a severe situation.

Observed young production was 3.0 young per pair (7 observed families) and 2.1 young per pair (based on proportion in collective family groups).

Аннотация

Подытоживаются данные исследований черных казарок архипелага Tusenøyane (Тысяча островов) в восточной части Свальбарда. С 1 июля 1973 г. архипелаг входит в состав недавно учрежденного Юго-восточно-Свальбардского заповедника. На основании данных, полученных из

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частей данного архипелага (гл. об. летом 1969 г.), потенциальное значение его как гнездовье данного вида подверглось более подробному изучению по материалам аэрофотографии. Рисунки 2, 3 и 4 дают сравнительную оценку значения различных островов, входящих в состав архипелага. На таблицах 1 и 2 подводятся итоги двух альтернативных приблизительних смет численности популяции этого вида в данной области. Приблизительно подсчитанная популяция в 600–750 черных казарок (включая детенышей) предположительно обитала на архипелаге Tusenøyane в конце гнездового сезона во второй половине 1960-х гг. Это число составляет примерно 30–40% всей свальбардской популяции вида, которая вероятно будет продолжать уменьшаться, находясь в тяжелом положении.

Отмеченное размножение указало по каждой паре 3.0 детеныша по 7 учтенным семьям, а 2.1 детеныша на основе пропорции потомства в коллективных семейных группах.

Innledning

Tusenøyane må regnes til de mindre besøkte delene av Svalbard, og i ornitologisk henseende foreligger det bare sparsomme opplysninger fra området. Forfatterens første kontakt med øyene skjedde under flyrekognoseringer i 1966/67. I 1966 ble det videre anledning til en kortvarig undersøkelse av mer perifere deler av området (Halvmåneøya og Zieglerøyane) i forbindelse med de innledende isbjørnundersøkelser (Norsk Polarinstitutt/Universitetet i Oslo) i de østlige Svalbardfarvann. Under Norsk Polarinstitutts sommerekspedisjon til de samme farvann i 1969 ble det anledning til å undersøke deler av Tusenøyane nærmere, dels fra ekspedisjonsfartøyet, dels ved hjelp av helikopter.

Hensikten med det foreliggende arbeid er ikke å gi en nærmere beskrivelse av de generelle ornitologiske forhold i området, men å gi en vurdering av områdets betydning som hekkeområde for ringgåsa (*Branta bernicla hrota*).

På tross av iverksatte sikringstiltak er dens situasjon meget kritisk. Bestanden synes å fortsette sin tilbakegang fra 1950/60-årene, og utgjør idag antagelig færre enn 2000 individer.

Fredningen av Tusenøyane som en del av Søraust-Svalbard naturreservat (Kongelig resolusjon av 1.6. 1973) skjedde delvis av hensyn til de ringgjess som tradisjonelt har hekket der. Det har vært antatt at området utgjør et av artens viktigste hekkeområder på Svalbard. Det foreliggende arbeid søker å belyse dette nærmere.

Jeg vil forøvrig benytte anledningen til å takke cand. real. NILS GULLESTAD som deltok som assistent under feltarbeidet, og de øvrige kolleger som deltok i Norsk Polarinstitutts sommerekspedisjon 1969.

Områdebeskrivelse

Tusenøyane består av flere mindre øygrupper og enkeltliggende øyer sør for Tjuvfjordens munning (Edgeøya). Samtlige øyer er arealmessig av forholdsvis beskjedent omfang. Størst er Halvmåneøya som egentlig ikke regnes til Tusenøyane, men er tatt med her fordi det biologisk sett er naturlig. Øyene er stort sett dannet av basalt.

Enkelte øyer er preget av rullestein og forvitret stein, mens andre preges av fuktige, vegetasjonsrike flater, tildels med mindre ferskvannsansamlinger. Øyene er ytterst værharde og farvannet må på grunn av sterke strømmer og drivismasser, regnes for noe av det vanskeligste på hele Svalbard. Følgende øyer og øygrupper utgjør hoveddelen av Tusenøyane: Kong Ludvigøyane, Bölscheøya, Utsira, Menkeøyane, Meinicheøyane, Brækmoholmane, Schareholmane, Tiholmane, samt Kulstadholmane (med Håøya).

Utførte undersøkelser

Halvmåneøya regnes som nevnt ikke til Tusenøyane, men medtas her da den regionalt sett sogner til området. Øya ble besøkt 19–20. august 1966 og det ble sett henholdsvis 10 og 19 ringgjess. Det dreiet seg om ikke-hekkende individer.

På tross av gunstige biotopforhold (småvann, fuktig mosemark m.v.) fantes det ikke tegn til at hekking hadde funnet sted. Ifølge cand. real. THOR LARSEN som oppholdt seg der i 1969, såes ett individ 14. juni og 4 par 20. juni, men hekking ble ikke påvist (NORDERHAUG 1969).

Det foreligger så vidt vites ingen nyere informasjoner om at arten har hekket på øya. Dette kan trolig skyldes den temmelig faste overvintringsvirksomheten inntil isbjørnjakten tok slutt, og det forhold at øya er stor nok til at polarrev kan oppholde seg der en tid. De nærliggende Tennholmane ble ikke undersøkt, men har trolig mindre betydning.

Bölscheøya ligger relativt isolert. Det foreligger en tidligere observasjon av 20–25 voksne ringgjess på øya 1. august 1967 (NORDERHAUG 1969). Den ble påny besøkt (med helikopter) 12. august 1969. Øya rommer flere småvann og er relativt vegetasjonsrik, blant annet med flere fuktige mosemarkområder.

På Bölscheøya ble det registrert ialt 60 voksne ringgjess med 24 unger. I tillegg ble det observert ytterligere en flokk (også med unger) som ikke lot seg telle. Bestanden på øya kan anslåes til totalt omkring 100 individer.

Tiholmane. Deler av denne øygruppen ble undersøkt med småbåt 9. august 1969. Av spesiell betydning som ringgåsbiotop er den flate Lurøya. På denne øya ble det registrert 20 voksne individer med 23 unger. I tillegg ble det sett en flokk ringgjess med unger både på Lurøya og på den største øya vest for Lurøya. Stor avstand hindret opptelling. Bestanden på Tiholmane i begynnelsen av august 1969 kan anslåes til minst 80–100 individer.

Kulstadholmane. Den største av disse øyene, Håøya, ble undersøkt 9. august 1969 fra småbåt. Det ble registrert 19 voksne ringgjess med 19 unger. De observerte ringgjessene utgjorde totalbestanden på Kulstadholmane.

Ringgjessenes biotop-preferanse på Tusenøyane

Vurderer en hvor ringgjess opptrådte på de undersøkte øyene, framtrer et relativt klart bilde av artens biotop-preferanser. Disse stemmer i det store og hele overens med det som tidligere er kjent om artens krav til produksjonsområder i Svalbardområdets vestre deler. De viktigste betingelser kan sies å være:

1. Øyer med liten menneskelig forstyrrelse.
2. Strømforhold som normalt bryter opp og borttransporterer vinterisen før hekketiden begynner (sikring mot polarrev-predasjon).
3. Øyer med begrenset arealmessig omfang.
4. Tilgang på vegetasjon og områder med fuktig mosemark.
5. Tilgang på ferskvannsdammer.

Kravene 1—3 kan sies å tilfredsstilles på alle Tusenøyane. Derimot er kravene 4—5 bare oppfylt på et begrenset antall av øyene. Dette begrenser følgelig antallet øyer hvor ringgjess hekker, og dermed den totale bestand i området.

Vurdering av egnede ringgåsbiotoper på Tusenøyane

På bakgrunn av den kritiske situasjon som Svalbards ringgåsbestand nå befinner seg i, har det betydning å få nærmere kjennskap til artens viktigste hekkeområder i de østligste Svalbardfarvann. I denne sammenheng, og inntil mer systematiske undersøkelser kan gjennomføres, kan visse vurderinger på grunnlag av de foreliggende data ha en viss verdi.

Den foreliggende vurderingen er basert på de foretatte undersøkelsene i deler av området, generelt kjennskap til artens biotopkrav, samt foreliggende vertikalfotografier av området (ca. 1:50 000), utført av Norsk Polarinstitutt. Det bør understrekes at grunnlaget ikke er tilstrekkelig for en detaljert inventering.

På kartene (Fig. 2, 3 og 4) er de ulike øyene gradert etter følgende skala:

1. *Øyer som er sikre eller høyst sannsynlige hekkeplasser*: Øyer der det er påvist ringgjess med unger og/eller hvor luftfotografier klart viser forekomst av ferskvannsdammer og fuktig mosemark.
2. *Øyer som muligens kan være hekkeplasser*: Øyer der observasjoner ikke klart viser at hekking kan finne sted, eller der luftfotografier ikke gir entydige holdepunkter for dette.
3. *Øyer som har liten eller ingen betydning som hekkeplass*: Øyer der undersøkelser eller luftfotografier viser at de viktigste biotopkrav for hekking synes å mangle.

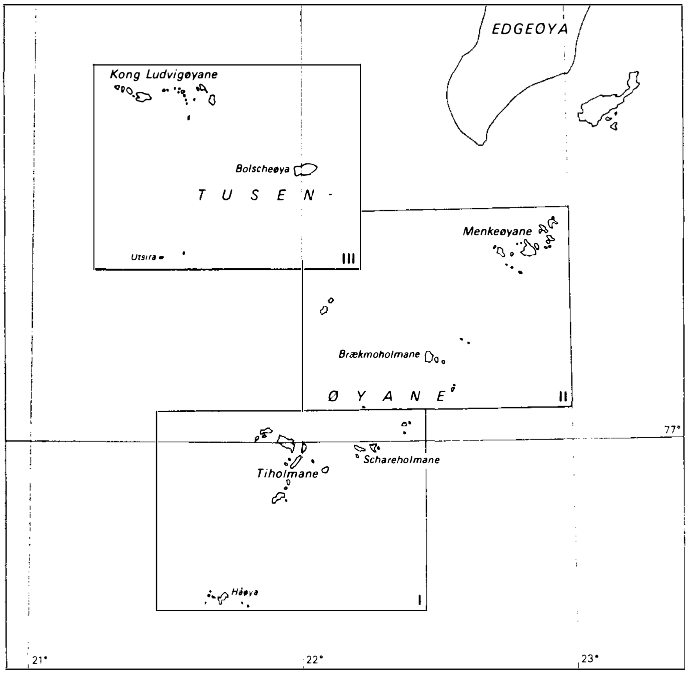

Fig. 1. *Oversiktskart over Tusenøyane.*
Survey map of Tusenøyane.
Обзорная карта архипелага Tusenøyane.

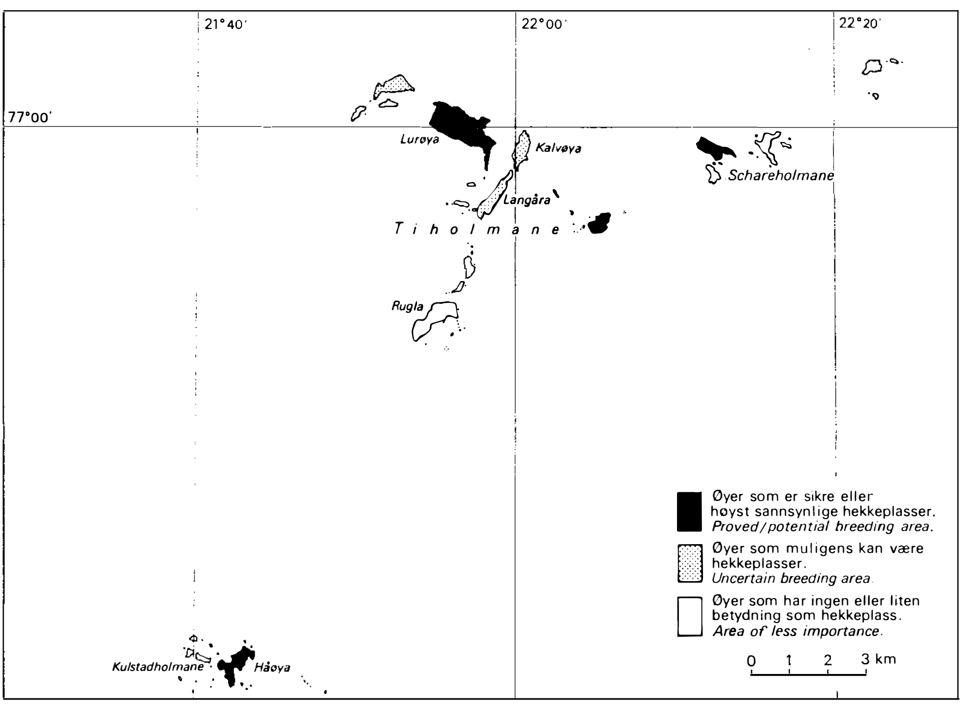

Fig. 2. *Oversikt over Tusenøyanes betydning som hekkeplass for ringgjess. Kulstadholmane, Tiholmane og Schareholmane (se Fig. 1, seksjon I).*
Importance of Tusenøyane as breeding habitat for Brent geese. Kulstadholmane, Tiholmane, Schareholmane (see Fig. 1, section I).
Обзор значения архипелага Tusenøyane как гнездовье черных казарок. Kulstadholmane, Tiholmane, Schareholmane (см. рис. 1, отрезок I).

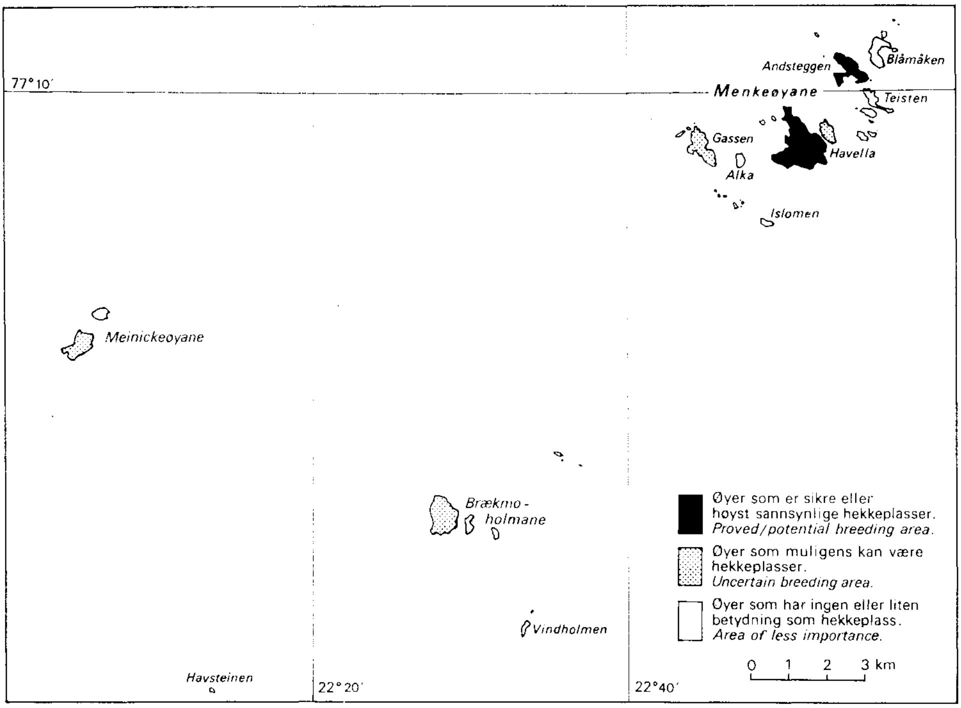

Fig. 3. *Oversikt over Tusenøyanes betydning som hekkeplass for ringgjess. Brækmoholmane, Meinickeøyane, Menkeøyane (se Fig. 1, seksjon II).*

Importance of Tusenøyane as breeding habitat for Brent geese. Brækmoholmane, Meinickeøyane, Menkeøyane (see Fig. 1, section II).

Обзор значения архипелага Tusenøyane, как гнездовье черных казарок. Brækmoholmane, Meinickeøyane, Menkeøyane (см. рис. 1, отрезок II).

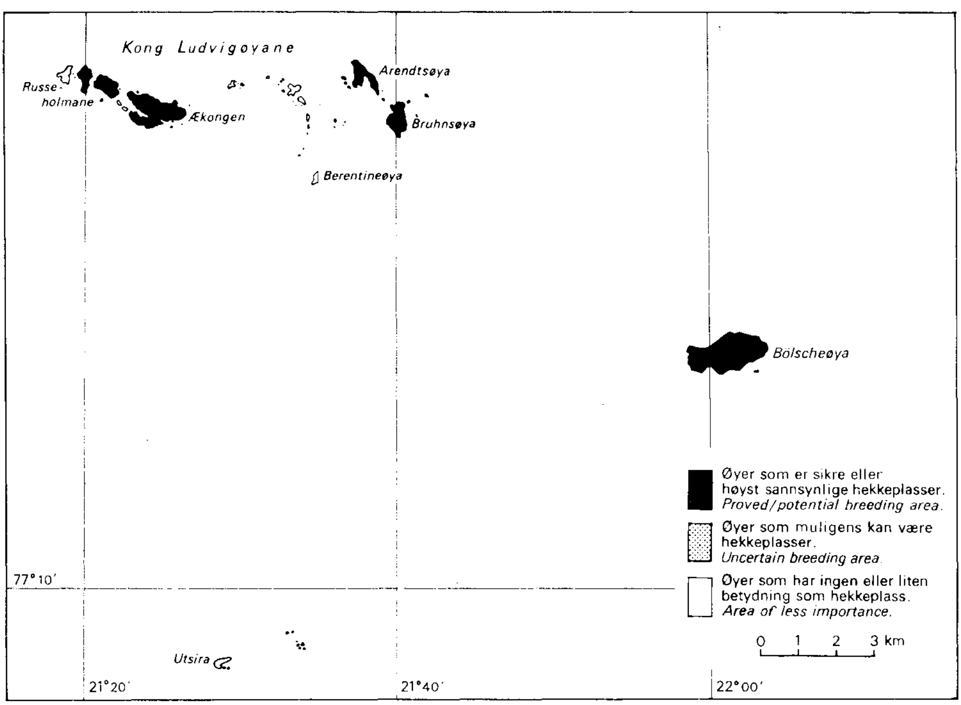

Fig. 4. *Oversikt over Tusenøyanes betydning som hekkeplass for ringgjess. Bölscheøya og Kong Ludvigøyane (se Fig. 1, seksjon III).*

Importance of Tusenøyane as breeding habitat for Brent geese. Bölscheøya and Kong Ludvigøyane (see Fig. 1, section III).

Обзор значения архипелага Tusenøyane как гнездовье черных казарок. Bölscheøya, Kong Ludvigøyane (см. рис. 1, отрезок III).

Beregninger av bestandsstørrelsen på Tusenøyane

Siden bare en del av øyene ble undersøkt er det ikke mulig å gi direkte angivelser av ringgåsbestanden i området. Visse betraktninger basert på de foreliggende data kan imidlertid gi visse grove holdepunkter.

1. På de undersøkte deler av Tusenøyane (Kulstadholmane, Tiholmane og Bölscheøya) tyder observasjonene på en samlet bestand på 218–238 individer (voksne med unger).
2. På de undersøkte øygrupper kan arealet av sikre/sannsynlige hekkeplasser beregnes. Det samme gjelder arealet av øyer som muligens kan være hekkeplasser. (I det foreliggende tilfellet er beregningene basert på kart 1:100 000.)
3. Av ovennevnte kan det foretas en grovberegning av individtettheten pr. arealenhet på de undersøkte øyer:
   a) Øyer som er sikre/sannsynlige hekkeplasser, *samt* de øyer som muligens kan være hekkeplasser.
   b) Øyer som er sikre/sannsynlige hekkeplasser.
4. I tilfelle 3a forutsettes at de observerte ringgjess utgjør totalbestanden i området som ble undersøkt, og at gjessene hekket på såvel de sikre hekkeplassene som på de øyene som muligens kan være hekkeplasser.

   I tilfelle 3b forutsettes at de observerte ringgjess utgjør totalbestanden i det undersøkte området, men at de bare hekker på øyer som er ansett som sikre hekkeplasser. Dette siste innebærer at gjess observert på øyer som må regnes som usikre hekkeplasser regnes til de øyer i vedkommende øygruppe som er sikre hekkeplasser.
5. På grunnlag av disse grovberegninger basert på data fra de undersøkte deler av Tusenøyane, kan arealberegninger foretas for resten av Tusenøyane for å finne fram til *totalarealet* av øyer som er sikre/sannsynlige hekkeplasser og av øyer som muligens kan være hekkeplasser.

På dette grunnlag er det mulig å få et grovt uttrykk for størrelsen på bestanden på dette tidspunkt.

I Tabell 1 og 2 er resultatene av disse grovberegningene gjengitt.

Tabell 1 viser resultatene basert på den forutsetning at de observerte gjess med unger har hekket både på øyer som er sikre hekkeplasser, og på øyer som muligens er hekkeplasser.

Tabell 2 gjengir resultatet basert på forutsetningen av at de observerte gjess med unger bare har hekket på øyer som er sikre hekkeplasser. Det tør framgå at sluttresultatene av de to utførte grovberegningene ikke avviker nevneverdig fra hverandre, og at bestanden i området ut fra de foretatte grovberegninger, kan anslåes til en størrelse på omkring 450–550 individer i første halvdel av august 1969. Det er imidlertid verd å merke seg at en bestandskomponent, nemlig de ikke-hekkende 2–3-åringer, neppe er kommet fullstendig med i anslaget. Endel ikke-hekkende individer kan riktignok ha vært med i de observerte flokkene, men disse synes stort sett å ha bestått av familiegrupper med unger av året.

Tidligere observasjoner tyder dessuten på at i det minste deler av de ikke-

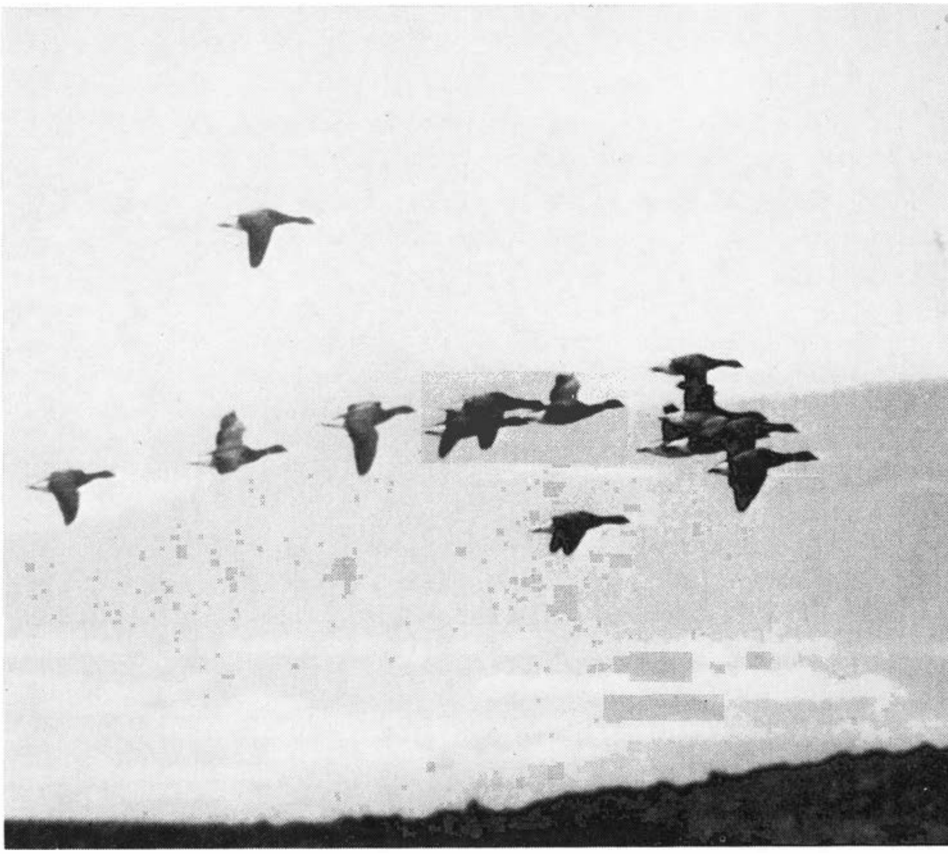

Fig. 5. *Ikke-hekkende ringgjess i Tjuvfjorden, Edgeøya, august 1966.*
Non-breeding Brent geese in Tjuvfjorden, Edgeøya, August 1966.
Негнездящиеся черные казарки в заливе Tjuvfjorden на о-ве Edgeøya в августе 1966 г.
Foto: M. NORDERHAUG

hekkende ungfugler fra foregående år kan holde seg samlet i andre deler av området i denne delen av produksjonssesongen (Fig. 5). Den 12. august 1966 såes således minst 130 ikke-hekkende individer på øst- og vestsiden av Negerpynten (Edgeøya), (NORDERHAUG 1970a). I tillegg er det realistisk å regne med at endel kan ha hatt tilhold i de egnede kystområdene nord for Kvalpynten. Det er følgelig mulig at ytterligere ca. 150–200 ikke-hekkende individer bør legges til anslaget fra Tusenøyane i 1969. Størrelsen på den totale ringgåsbestand i Tusenøyane-området i den siste delen av 1960-årene kan følgelig grovt anslåes til ca. 600–750 individer (ved slutten av hekkesesongen).

Dette antyder at ca. 30–40% av den nåværende Svalbardbestand kan ha tilhold i Tusenøyane-området, og understreker områdets betydning og verdien av at det er innbefattet i Søraust-Svalbard naturreservat.

Ungeproduksjon

Ved undersøkelsene av Tusenøyane i 1969 var det bare mulig å fastslå størrelsen på noen få ungekull fordi familiegruppene stort sett var samlet i større flokker. Av 7 observerte ungekull (6 på Bölscheøya, 1 på Håøya) varierte kullstørrelsen mellom 2 og 4 unger. Gjennomsnittlig kullstørrelse var 3.0 unger for de 7 kullene. Av de tre større ringgåsflokkene som ble opptellet, besto antagelig en flokk på Tiholmane og en flokk på Håøya nesten utelukkende av foreldrepar med unger. Forholdet mellom unger og voksne i de to flokkene var 39 voksne (tilnærmet 20 par): 42 unger, d.v.s. 2.1 unger pr kull. Forskjellen i kullstørrelse mellom de direkte observerte ungekull og ovennevnte beregning, kan tyde på at det i familiegruppene også fantes et fåtall ikke-hekkende individer.

Tabell 1

Grovberegning av Tusenøyanes ringgåsbestand, august 1969. Basert på forutsetningen at observerte gjess hekket både på øyer som er kjente hekkeplasser og øyer som muligens er hekkeplasser.*

(Rough estimate of Brent goose population on Tusenøyane, August 1969.** Based on assumption that observed geese bred both on islands considered proved/potential breeding areas and on islands considered uncertain breeding areas.)

(Приблизительная смета численности*** популяции черных казарок архипелага Tusenøyane в августе 1969 г., основанная на предположении, что отмеченные казарки гнездятся как на островах с известными гнездовыми местами, так и на островах с предположительными гнездовьями.)

	Km² Sq.km Км²	Observert/beregnet totalbestand Observed/estimated total population Общая отмеченная/подсчитанная численность популяции	Observert tetthet ind/km² Observed population density (ind/sq.km) Отмеченная плотность популяции (особи/км²)
Samlet undersøkt øyareal med kjente og sannsynlige hekkeplasser Total of surveyed potential and uncertain breeding area Общая обследованная островная площадь с известными и вероятными гнездовьями	3.71	218–238	59–64
Samlet øyareal med kjente og sannsynlige (ikke undersøkte) hekkeplasser Total of known and uncertain (not surveyed) breeding area Общая островная площадь с известными и вероятными не обследованными гнездовьями	4.65	274–298	—
Total Итого	8.36	492–536	—

* I tillegg kommer anslagsvis 150—200 ikke-hekkende individer utenfor hekkeområdet.
** In addition probably 150—200 non-breeding individuals outside the breeding area.
*** В дополнение имеются примерно 150—200 негнездящихся особей вне гнездовой области.

Tabell 2

Grovberegning av Tusenøyanes ringgåsbestand, august 1969. Basert på forutsetningen at observerte gjess hekket bare på øyer ansett som sikre hekkeplasser.*

(Rough estimate of Brent goose population on Tusenøyane, August 1969.** Based on assumption that observed geese only bred on islands considered known/potential breeding area.)

Приблизительная смета численности*** популяции черных казарок архипелага Tusenøyane в августе 1969 г., основанная на предположении, что отмеченные казарки гнездятся только на островах, считающихся установленными гнездовьями.

	Km² Sq.km Км²	Observert/beregnet totalbestand Observed/estimated total population Общая отмеченная/подсчитанная численность популяции	Observert tetthet ind/km² Observed population density (ind/sq.km) Отмеченная плотность популяции (особи/км²)
Samlet undersøkt øyareal med kjente hekkeplasser Proved/potential breeding area surveyed Общая обследованная островная площадь с известными гнездовьями	2.88	218–238	76–83
Samlet ikke undersøkt øyareal med antatt sikre hekkeplasser Known potential not surveyed breeding area Общая не обследованная островная площадь с предположительно установленными гнездовьями	3.37	256–280	—
Total Итого	6.25	474–518	—

* I tillegg kommer anslagsvis 150—200 ikke-hekkende individer utenfor hekkeområdet.
** In addition probably 150—200 non-breeding individuals outside the breeding area.
*** В дополнение имеются примерно 150—200 негнездящихся особей вне гнездовой области.

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Studier av sjøfuglkoloniene på Fuglehuken, Prins Karls Forland nasjonalpark

(*Studies of the seabird colonies on Fuglehuken, Prins Karls Forland national park*)

(Исследования колоний морских птиц мыса Fuglehuken в заповеднике о-ва Prins Karls Forland)

Av Magnar Norderhaug[1]

Innhold

Abstract

Counts from the sea bird colonies of Fuglehuken, Prins Karls Forland, Svalbard, in 1970 are summarized (Table 1).

Remarks are made on the status of the guillemot (*Uria aalge*) in Svalbard, with special reference to the situation in the northernmost known colony in the world (Fuglehuken), where 37 individuals were seen in 1970 and 33 individuals in 1971.

Аннотация

Подытоживаются результаты подсчета морских птиц птичьих колоний мыса Fuglehuken на о-ве Prins Karls Forland на Свальбарде в 1970 г. (таблица 1). Приводятся замечания о состоянии тонкоклювых кайр (*Uria aalge*) на Свальбарде с особенным учетом обстановки в самой северной в мире известной птичьей колонии (Fuglehuken), где данного вида были обнаружены в 1970 г. 37 особей, а в 1971 г. - 33.

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Innledning

Sjøfuglkoloniene ved Fuglehuken på nordspissen av Prins Karls Forland har vært kjent siden hollendertiden. Så sent som ved slutten av 1960-årene forelå det imidlertid ingen nærmere angivelser om størrelsen på disse sjøfuglkonsentrasjonene. I LØVENSKIOLD (1964) er Fuglehuken karakterisert som "an enormous bird-cliff".

I sammenheng med Norsk Polarinstitutts biologiske undersøkelser på Svalbard i 1970 arbeidet forfatteren i området i tiden 25–29 juni sammen med en assistent, cand. mag. JAN MICHAELSEN. En hovedhensikt med arbeidet var, i forbindelse med den pågående nasjonalparkplanlegging på Svalbard, å foreta en nærmere kartlegging av denne sjøfuglkolonien. (Prins Karls Forland ble fredet som nasjonalpark ved Kongelig resolusjon 1. juni 1973).

I juli 1971 ble det videre innsamlet noen supplerende data fra området. Det foreliggende gir en sammenfatning av det utførte arbeid på Fuglehuken. Dette omfatter tellinger med sikte på å gi et tilnærmet bilde av koloniens totalstørrelse, det tallmessige forhold mellom de to kvantitativt sett viktigste artene, krykkje (*Rissa tridactyla*) og polarlomvi (*Uria lomvia*), samt endel sammenfattende data om forekomsten av lomvi (*Uria aalge*) i området.

Områdebeskrivelse

Fuglehuken danner nordspissen på Prins Karls Forland og er den nordligste del av den nord/sør-gående fjellformasjon som øya består av nord for Forlandsletta.

Sjøfuglkonsentrasjonene består av et kompleks med mer eller mindre avgrensede kolonier fra nordspissen og sørover på vestsiden av øya. Østsiden er stort sett ikke besatt med sjøfugl. Den markerte konsentrasjon mot vest skyldes de gunstige lokalklimatiske forhold som sol-eksponeringen skaper på Svalbard i vest- og sørvendte skråninger (i motsetning til øst- og nordvendte skråninger).

Med sin beliggenhet utenfor Spitsbergens vestkyst, ligger Prins Karls Forland direkte i influensområdet til den nordlige gren av Golfstrømmen. De utenforliggende havområder er produktive og relativt grunne. De nærliggende kystfarvann (10 km og mer fra land) vest for Fuglehuken, er 70–80 meter dype.

Metode

Når kvantitative beregninger av sjøfuglkolonier på Svalbard har vært sparsomme, skyldes det de vanlige problemer som knytter seg til beregninger av større sjøfuglkonsentrasjoner, kombinert med de spesielle vanskeligheter som været på Svalbard medfører for slike feltarbeider.

De foretatte tellinger ble utført fra land på en vindstille dag med godt vær og innfallende lys (26. juni). Samtlige tellinger ble utført av en person med kikkert

8×30. Telleavstanden var gjennomgående 50–100 meter. Bare en telling ble foretatt i hver kolonigruppe.

I tellingen ble antall individer av krykkje og polarlomvi tatt med. Ett individ i kolonien ble under registreringen regnet som tilsvarende et par, idet ruging fortsatt pågikk. De øvrige forekommende sjøfuglarter ble bare notert for hver kolonigruppe, men av praktiske årsaker ikke opptellet.

Resultater

A. Forekommende arter

Krykkje og polarlomvi var de helt dominerende arter. I tillegg forekom havhest (*Fulmarus glacialis*) (registrert i 4 av de 26 kolonigruppene), polarmåke (*Larus hyperboreus*) (registrert i 8 av de 26 kolonigruppene), alkekonge (*Plautus alle*) (registrert i 5 av de 26 kolonigruppene), teist (*Cepphus grylle*) (registrert i 3 av de 26 kolonigruppene) og lunde (*Fratercula arctica*) (registrert i 9 av de 26 kolonigruppene).

Det er verdt å merke seg at på Prins Karls Forland har lunden utvilsomt et av sine viktigere tilholdssteder på Svalbard, uten at nærmere tallangivelser er mulig.

B. Utførte tellinger av krykkje og polarlomvi

Som tidligere nevnt, utgjør ikke sjøfuglkonsentrasjonene i Fuglehukfjellet noen direkte sammenhengende koloni, men er et system av mer eller mindre adskilte småkolonier fra nordspissen og sørover på vestsiden. Totalt sett var området inndelt i 26 kolonigrupper (Fig. 1). I de fleste tilfeller var disse naturlig avgrenset, men i visse tilfeller måtte flere adskilte smågrupper i samme fjellside slåes sammen og betraktes som en.

I Tabell 1 er resultatene av tellingene oppført. Under rubrikken «Anmerkning» er de kolonier anført hvor også andre fuglefjellarter enn krykkje og polarlomvi forekom.

C. Forekomst av lomvi

En kort sammenfatning av artens kjente opptreden på Svalbard (utenom Bjørnøya) kan først være på sin plass.

1. LØVENSKIOLD (1964) anfører at det fra områder nord for Bjørnøya ikke er noen sikre observasjoner av arten siden 1900, og at et funn fra Barentsøya i 1898 kan bygge på en forveksling av stedsnavnet Barentsøya med Bjørnøya.
2. I 1962 observerte AHLÉN (1967) flere individer ca. 100 km SV for Hornsund (ca. 76°20'N–12°50'Ø) den 28. juni.
3. Samme år anfører AHLÉN (1967) informasjoner om 2 skutte individer fra Krossfjorden, Spitsbergen, medio juni.
4. I 1964 ble ett individ sett ved Hornsunds munning 18. juni, (NYHOLM, 1966).
5. I 1966 ble 50–100 individer observert på to hyller i den nordvestre delen av Fuglehukfjellet (herunder også voksne individer med unger), i tiden 25. juli–1. august (NORDERHAUG 1968, basert på rapport fra A. WALLERS til Norsk Polarinstitutt).

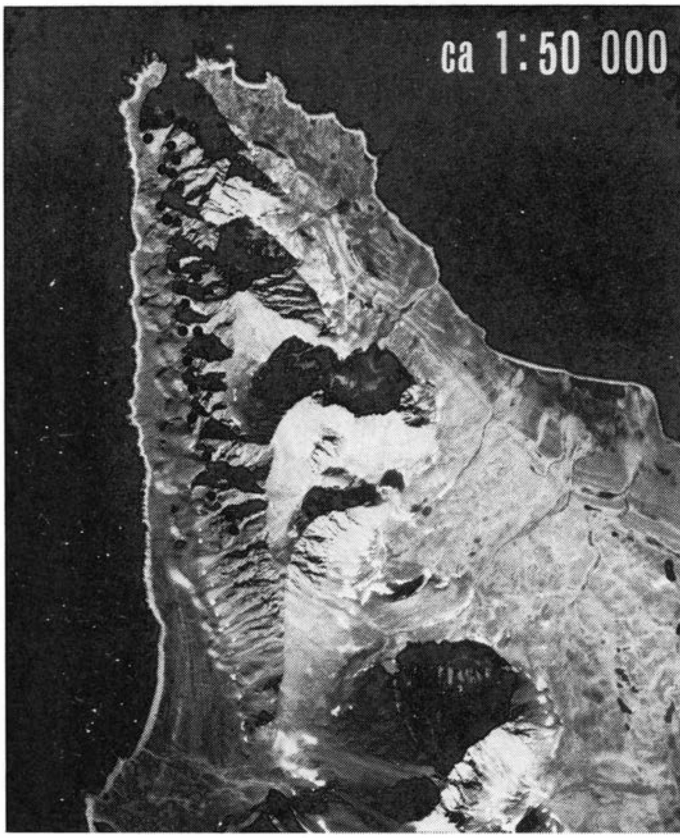

Fig. 1. *Fuglehuken (nordspissen av Prins Karls Forland). Svarte punkter angir tilnærmet lokalisering av de registrerte kolonigruppene.*

Fuglehuken (northern part of Prins Karls Forland). Dots indicate approximate distribution of colony sections observed.

Мыс Fuglehuken (северная оконечность о-ва Prins Karls Forland). Черные точки указывают приблизительное размещение учтенных участков колонии.

Foto: Norsk Polarinstitutt.

I 1970 ble det samme området som WALLERS besøkte i 1966 undersøkt på ny (26. juni). Lomvier ble også da påtruffet på samme lokalitet. Hovedmengden var samlet på et av de gunstigste og mest tettbesatte feltene i kolonien. Det var her mulig å studere forholdene i detalj på ca. 5 meters avstand. Den totale størrelsen på hele denne kolonigruppen ble anslått til 1515 par polarlomvi/lomvi (samt 455 par krykkje). I det området hvor lomviene forekom ble det foretatt tellinger på 12 hyller. På fem av dem forekom lomvi. Av de totalt registrerte 263 individer (polarlomvi/lomvi) på de 12 hyllene, var 35 individer lomvi. Av de 35 observerte lomvier var 12 ringvier (34.3 %).

Da tettheten i denne delen av kolonien var meget stor, var det ikke mulig direkte å fastslå at lomviene ruget. Det kan imidlertid neppe herske tvil om at ruging pågikk.

Det var ikke mulig å registrere lomvi andre steder i denne kolonigruppen eller i noen annen gruppe lenger sør i Fuglehukfjellet. Dette behøver imidlertid ikke

Tabell 1

Tellinger av antall par polarlomvi (Uria lomvia) *og krykkje* (Rissa tridactyla) *utført i de enkelte kolonigrupper, Fuglehuken, Prins Karls Forland, juni 1970. Gruppenummereringen fra nord til sør*

(Counts (number of pairs) of Brünnich's guillemot (*Uria lomvia*) and kittiwake (*Rissa tridactyla*) in the different colony sections, Fuglehuken, Prins Karls Forland, June 1970. Colony sections numbered from north to south)

(Подсчет пар толстоклювых кайр (*Uria lomvia*) и моевок (*Rissa tridactyla*), произведенный в отдельных участках колонии мыса Fuglehuken на о-ве Prins Karl Forland в июне 1970 г. Нумерация идет с севера на юг

Kolonigruppe *Colony section* Участок колонии	Krykkje (par) *Kittiwake (pairs)* Число пар моевок	Polarlomvi (par) *Brünnich's guillemot (pairs)* Число пар толстоклювых кайр	Anmerkning *Remarks* Примечания
1	26	—	
2	200	150	samt alkekonge/teist
3	100	150	samt havhest
4	—	50	samt alkekonge/teist/ polarmåke
5	—	80	
6	455	1 515	
7	130	720	
8	15	75	
9	314	433	samt havhest/lunde
10	—	256	samt lunde
11	40	576	samt lunde/alkekonge/ polarmåke/havhest
12	357	2 504	
13	—	760	
14	280	2 826	
15	253	2 380	samt lunde/polarmåke
16	40	470	
17	25	1 380	
18	—	2 680	
19	29	682	samt lunde/polarmåke/ alkekonge
20	—	1 000	kolonien delvis skjult i tåke
21	68	1 450	
22		658	samt lunde/polarmåke
23		285	samt lunde/polarmåke
24	265	1 506	samt lunde/polarmåke
25	127	362	samt teist/havhest/ lunde
26	188	735	samt alkekonge/ polarmåke
27	—	177	
Total	2 912	23 860	

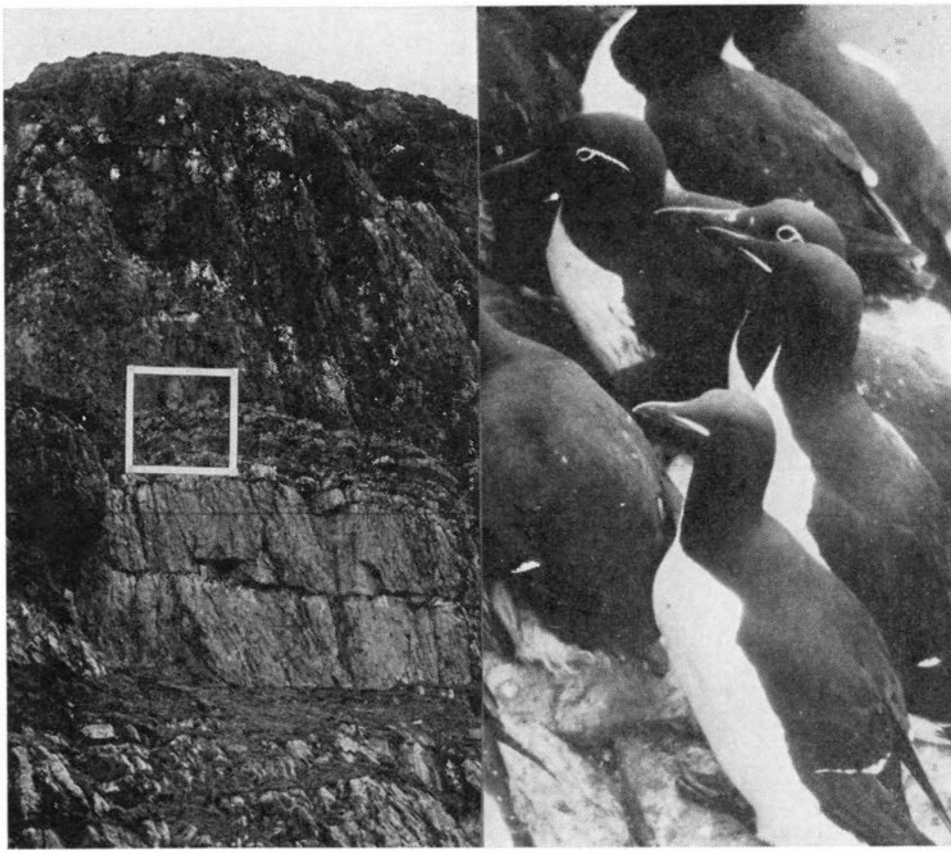

Fig. 2. *Hekkeplassen for lomvi i det nordvestre hjørnet av Fuglehukfjellet med utsnitt av lomvi og polarlomvi på den største hyllen..*

Breeding locality of guillemot in the NW corner of Fuglehukfjellet. To the right a mixed group of guillemots and Brünnich's guillemots on one of the ledges.

Гнездовье тонкоклювых кайр в северо-западном углу горы Fuglehukfjellet. Направо – смешанная группа тонкоклювых и толстоклювых кайр на наибольшем карнизе.

Foto: M. NORDERHAUG.

å bety at lomvi ikke finnes der. Bare en grundig gjennomgåelse med større kikkert kan avgjøre dette.

I tillegg til den ovennevnte lokalitet ble en ny forekomst av lomvi funnet den 29. juni i Fuglehukfjellets nordfront. Dette er trolig et funnsted som ikke ble registrert i 1966, selv om avstanden mellom de to lokalitetene bare er ca. 100 meter. På denne hyllen var det 22 polarlomvier og 3 lomvier (hvorav én ringvi). Minst to individer syntes å ruge.

Den 13. juli 1971 hadde forfatteren på ny anledning til et kortere besøk på Fuglehuken. I kolonien på fjellets nordvesthjørne ble det da observert 33 lomvier, hvorav 15 var ringvier. I samme felt hadde dessuten 39 polarlomvier tilhold.

Diskusjon

Når det ikke har vært mulig å skaffe holdbare tall for havhest, alkekonge, teist og lunde, henger det sammen med disse artenes hekkebetingelser. I Fuglehukfjellet hekker samtlige arter spredt, tildels meget høyt oppe og inne i sprekker eller steinrøyser. Enhver kvantitativ angivelse for disse arter vil følgelig bli meget usikker. Lundens hyppige opptreden i området er forøvrig verdt å merke seg. I tillegg til Fuglehukfjellet er det i 1968 (NORDERHAUG upubl.) registrert spredte kolonier (antagelig på noen hundre par) i fjellet Tvihyrningen lenger sør på Prins Karls Forlands vestside.

Under tellingene var det ikke mulig å ta hensyn til at også ikke-hekkende individer som oppholdt seg i kolonien ble registrert som «par». Generelt sett er det likevel grunn til å anta at sluttresultatene heller ligger i underkant enn i overkant. Dette skyldes blant annet enkelte tåkedotter som gjorde sikten dårlig i noen høyereliggende kolonifelt, samt mulighetene for å overse endel rugende polarlomvier (svarte rygger mot mørke bergvegger). Til en viss grad kunne resultatene ha vært mer korrekte om tellingen hadde blitt gjentatt. Av praktiske grunner lot dette seg imidlertid ikke gjøre.

I telleresultatene for polarlomvi og krykkje bør bemerkes det tallmessige forhold mellom artene (ca. 8 : 1). Dette forhold varierer betydelig i de forskjellige kolonier på Svalbard. En medvirkende årsak er trolig fjellets geologiske beskaffenhet med tilknyttet variasjon i hylledannelser, samt forvitringsforhold.

Fuglefjellets totalstørrelse på ca. 27 000 par krykkje og polarlomvi, kan forøvrig synes forholdsvis liten i forhold til den omtale Fuglehuken har fått som fuglefjell. Imidlertid ser det ut til å ha vært generell tendens til å overvurdere fuglefjellstørrelsen på Svalbard. Dette skyldes blant annet at endel kolonier ofte har en forholdsvis stor utstrekning, men med en sterkt varierende tetthet i de forskjellige deler.

Forøvrig bør det anføres at i det minste polarlomviforekomstene på Fuglehuken i stor grad er knyttet til de omliggende, nære kystfarvann i denne del av sesongen. Den 26. juni var det vindstille og havblikk på sjøen vest for Fuglehuken. Fra ca. 100 meters høyde oppe i fjellet var det med kikkert mulig å dekke et havområde på ca. 7 km langs kysten i ca. 2 km bredde. I dette området lå polarlomviene gruppevis i flokker på 15—70 individer. Opptelling av 14 grupper ga et gjennomsnitt på 43 individer pr. gruppe. Med dem som til enhver tid dykket, kan følgelig gjennomsnittstallet pr. flokk anslåes til ca. 50 individer. To opptellinger i ovennevnte område viste 300—350 slike grupper, d.v.s. 15 000—17 000 individer bare i dette begrensede kystavsnittet utenfor kolonien.

På grunnlag av de foreliggende observasjoner av lomvi (*Uria aalge*) i Fuglehukfjellet (1966—71), bør det kunne fastslåes at arten har fast tilhold og hekker i denne kolonien. Siden artens nordgrense forøvrig ligger på omkring 74°N (Bjørnøya), er Fuglehuken et dyregeografisk interessant område. Det er grunn til å anta at Golfstrømmens effekt på såvel klima som de marine forhold er medvirkende årsaker til artens opptreden i dette ekstremt nordlige område.

Litteratur

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Bericht über die Spitsbergen-Expedition des Geologisch-Paläontologischen Institutes der Universität Hamburg

Von U. LEHMANN

Das Geologisch-Paläontologische Institut der Universität Hamburg hat im Sommer 1972 eine Expedition nach Spitsbergen durchgeführt.

Teilnehmer waren:

Prof. Dr. U. LEHMANN
Präparator H. J. LIERL
Dr. FRIEDHELM THIEDIG
Dr. WOLFGANG WEITSCHAT

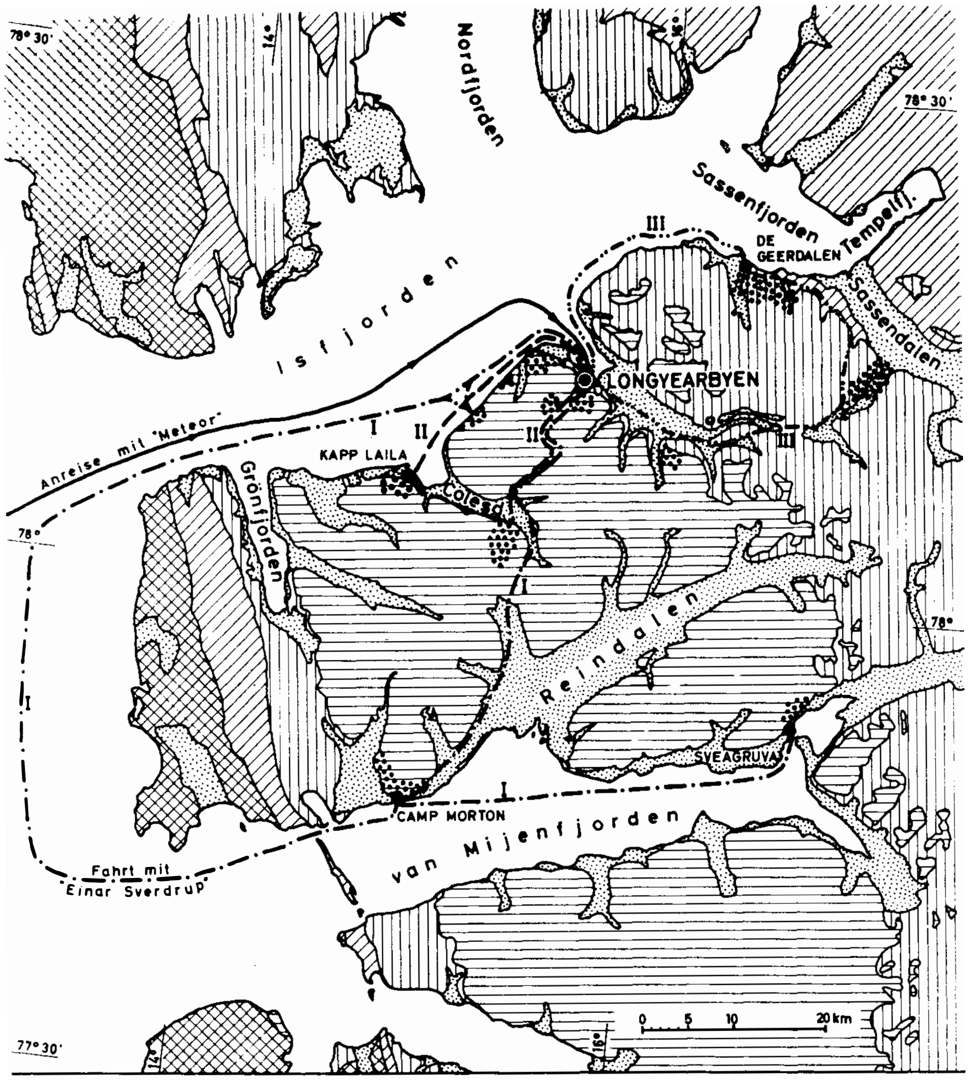
Die Expedition dauerte vom 8.7. bis zum 22.8. 1972. Hin- und Rückreise erfolgten bis Tromsö im Flugzeug. Von Tromsö aus erfolgte die Weiterfahrt an Bord des Forschungsschiffes «METEOR», wobei die Expeditionsteilnehmer Gelegenheit hatten, an den wissenschaftlichen Arbeiten und Diskussionen an Bord teilzunehmen. Dank dem Entgegenkommen der Schiffsleitung konnte am 13.7. für Interessenten ein Landausflug zusammen mit den Expeditionsteilnehmern zu einer kurzen Untersuchung des «Festungsprofiles» am südlichen Eingang zum Eisfjord durchgeführt werden.

In Longyearbyen bezogen die Expeditionsteilnehmer Standquartier in einem Unterkunftshaus der Store Norske Spitsbergen Kulkompani. Von dort aus wurden mehrere größere Unternehmungen gestartet und in der übrigen Zeit die nähere Umgebung abgegangen.

Am 20.7. begann eine Fahrt in den van Mijenfjorden. Die «Einar Sverdrup» der Store Norske nahm die Expeditionsteilnehmer bis Camp Morton mit. Später wurden LEHMANN und THIEDIG dort wieder aufgenommen, besuchten kurz Sveagruva am inneren Ende des Fjords und waren am 23.7. wieder in Longyearbyen. LIERL und WEITSCHAT erreichten Longyearbyen auf dem Landwege am 24.7.

Am 26.7 folgten eine Fahrt nach Kapp Laila, Untersuchungen der näheren Umgebung und ein Aufstieg zum Sandsteinfjellet. LEHMANN und THIEDIG gingen von dort zu Fuß zurück nach Longyearbyen, LIERL und WEITSCHAT samt Gepäck kehrten im Boot zurück. Am 31.7. waren alle wieder in Longyearbyen.

Am 2.8. begann die Fahrt zur Botneheia. Nach 7-tägiger Sammeltätigkeit gingen LEHMANN und THIEDIG zu Fuß über Sticky Keep und Passhütte durchs Adventdalen nach Longyearbyen. LIERL und WEITSCHAT transportierten das gesammelte



Expeditionsrouten des GPI / Universität Hamburg
Spitzbergen - Juli / August 1972

LEGENDE

Quartär	Anreise mit "Meteor"
Tertiär	Route I vom 20.7.-24.7.
Mesozoikum	Route II vom 26.7.-31.7.
Paläozoikum	Route III vom 2.8.-12.8.
Heklahuk Formation	Untersuchungsgebiete

Material im Boot nach Longyearbyen. Am 12.8. war dies Unternehmen abgeschlossen.

Zahlreiche kleinere Unternehmen waren dem Tertiär und der Unterkreide in der näheren Umgebung von Longyearbyen gewidmet.

Die Fahrt von Longyearbyen zurück (über Ny Ålesund) erfolgte in der «Nordstjernen» der norwegischen Küstenlinie «Hurtigruten».

In diesem Sommer herrschte auf Spitsbergen ein ungewöhnlich schneereiches Klima. Ein Hubschrauber hätte die Arbeit der Expeditionsteilnehmer wesentlich erleichtert, er war aber aus Kostengründen nicht vorgesehen. Infolgedessen waren die körperlichen Anstrengungen bei den langen Märschen durch Gebirge und Tundra teilweise groß, sie wurden aber ohne Ausfälle gemeistert. Unfälle sind nicht aufgetreten.

Die wissenschaftliche Ausbeute der Expedition entsprach leider nicht voll den Erwartungen. Hauptsächliches Ziel war es gewesen, Reste von Säugetieren zu finden, mit deren Hilfe es hätte gelingen können

1. das Alter der tiefsten und höchsten Lagen der Tertiärablagerungen, die terrestrischen Ursprungs sind, genauer zu datieren als es bisher möglich war, und
2. Aussagen über die Wanderungen der oberkretazisch-alttertiären Säugetierfaunen zu machen. Im Zusammenhang mit den neueren Vorstellungen über die Geschichte des Nordatlantiks (vgl. z.B. HARLAND 1967 u. 1969) müßte Säugetierfunden eine erhebliche Bedeutung zukommen.

Ein wesentlicher Grund für die mangelnde Ausbeute ist im Wetter zu suchen. In diesem Jahr sind ungewöhnlich viele Niederschläge gefallen und haben als Neuschnee die Untersuchung der hochgelegenen jüngsten Tertiärschichten verhindert. Daher beschränkten wir uns vorwiegend auf die T 1-Schichten der geologischen Karte, während die T 5-Schichten nur einmal am Sandsteinfjellet zugänglich waren. Hinzu kommt, daß die Tertiärschichten, speziell die terrestrisch gebildeten, nahezu frei von Kalk, dagegen aber großenteils grob- bis feinklastisch sind und damit für die Erhaltung feiner Knochen und Zähne wenig geeignet. Die Hoffnung, gelegentlich Kalklinsen in der Nachbarschaft der Kohleflöze zu finden, erwies sich leider als trügerisch, sodaß Fundsituationen wie in der eozänen Braunkohle des Geiseltales nicht auftraten.

Wenn die Suche nach Säugetierresten nach fast drei Wochen intensiver Arbeit abgebrochen wurde, so war dafür der Eindruck entscheidend, daß Wetterverhältnisse und Transportmöglichkeiten in diesem Jahr zu ungünstig waren, als daß weitere Bemühungen zu rechtfertigen gewesen wären.

Da uns andererseits von der Expedition des Jahres 1968, auf der an der Botneheia eine reiche Ausbeute an Ptychiten gelungen war, die dortigen Aufschluß- und Fundverhältnisse gut bekannt waren und die laufenden Forschungen zur Biologie von Ammoniten gerade das dortige Material als besonders erwünscht erscheinen ließen, wurde der zweite Teil der Expedition dem Sammeln von triassischem Ammoniten- und Vertebraten-Material gewidmet. Hier war die Ausbeute sehr erfreulich, nach Quantität wie nach Qualität. Ihre Beschreibung wird erst möglich sein, wenn die augenblicklich infolge Überlastung der Präparatoren nur langsam voranschreitenden Präparationsarbeiten weiter gefördert sein werden. Die Funde gelangen in Kalkknollen der tiefsten Triasschichten an der Botneheia und am Sticky Keep.

Eine Übersicht über die Unternehmungen der diesjährigen Expedition vermittelt die Karte.

Die Geldmittel für die Durchführung der Expedition verdanken wir der Deutschen Forschungsgemeinschaft. Ihr sei auch an dieser Stelle dafür gedankt.

Dank sei ferner dem Sysselman von Svalbard, sowie Herrn HARALD MAJOR für stets freundliche und entgegenkommende Hilfe und für Beratung, der Leitung der Store Norske Spitsbergen Kulkompani und ihren Angestellten für ihre Hilfe bei der Unterbringung und Verpflegung in Longyearbyen und beim Transport in den van Mijenfjorden, sowie dem Norsk Polarinstituten für Hilfe bei der Beschaffung von Literatur und Kartenmaterial.

On the significance of the age of a buried tree stump by Engabreen, Svartisen

By PETER WORSLEY[1]

Contents

Abstract

The correct radiocarbon age of the Engabreen site is 1600±100 years BP whereas previously it had been taken to be 350±100 years BP. This finding necessitates a re-appraisal of the stratigraphic significance since it now appears to be unrelated to the eighteenth century advance. The date suggests that there was a phase of glacier advance in the early first millenium AD and this is inconsistent with the previously accepted interpretation of climatic conditions at that time. Alternatively the relationships may possibly be explained by a glacier surge mechanism.

Introduction

During the preparation of the "Glacier Atlas of Northern Scandinavia" (ØSTREM, HAAKENSEN and MELANDER 1973) a summary of the knowledge of glacier variations in that area was made by GUNNAR ØSTREM. The writer was invited to review this and suggested that the laboratory reference number of the Engabreen radiocarbon date which had been quoted should be given, as this facilitates discussion of such dates. In the earlier papers reporting radiocarbon dates it was not the practice to always give the reference number and this was the case with the Engabreen date which had first been published by LIESTØL (1962), together with a description of the site and its discovery. Since the date had not been reported in the journal *Radiocarbon*, the Radiological Dating Laboratory at the University in Trondheim was contacted. As a result of this it has transpired that the previously reported

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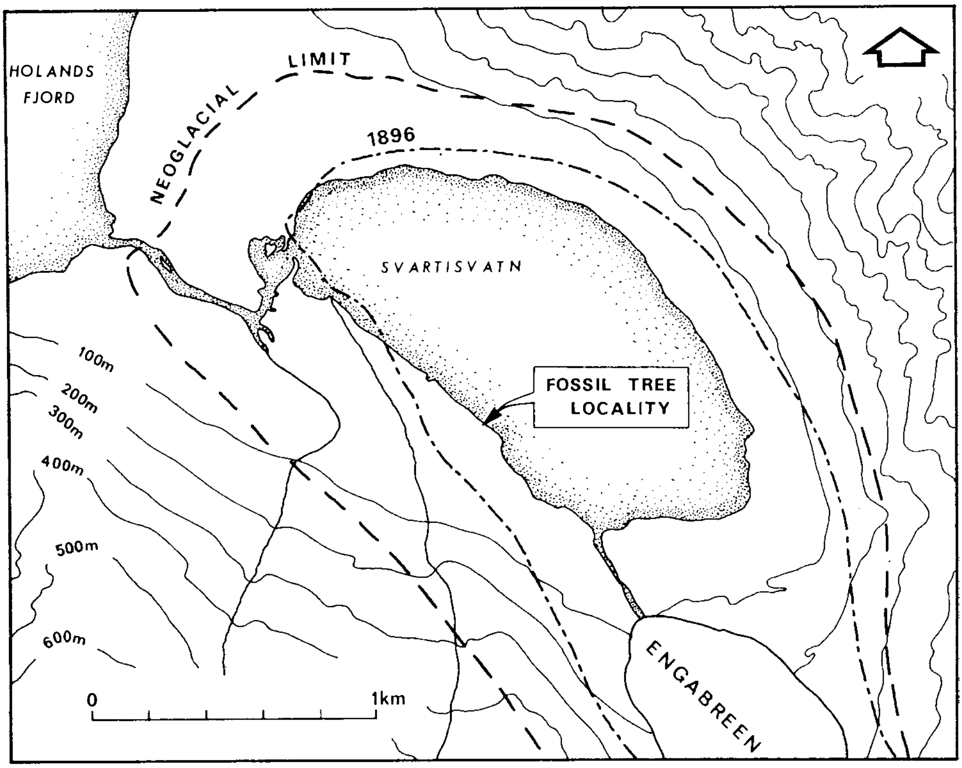

Fig. 1. *Location map of the fossil tree locality.*

date of 350±100 years BP (1600 years AD) was in error since the values for the BP and AD ages should have been read in the reverse order. Hence the radiocarbon age is in fact 1250 years older than has up to the present been assumed and it therefore follows that a revision of the significance of the result is necessary. Thus the radiocarbon age of the wood found in the proglacial zone of Engabreen should read: – 1600±100 years BP. (350±100 years AD) T –263. Since radiocarbon dates in direct association with Neoglacial sediments are currently rare in Scandinavia it seems worthwhile to consider the implications of the true Engabreen radiocarbon date with reference to the history of Scandinavian glacier variation within the Neoglacial period, that is, since the climatic optimum.

Geographical setting

Engabreen is an outlet glacier from the western ice cap of Svartisen and flows in a basically north westerly direction to descend into Holandsfjord, although the glacial morphology suggests that it never actually reached the sea during the postglacial. The map forming Fig. 1 is drawn from the recently published photogrammetric map constructed by Fjellangers oppmåling for Norges Vassdrags- og Elektrisitetsvesen (NVE) who have initiated mass balance studies of the glacier. The outermost glacial limit shown on the map is based on field examination and air photograph interpretation and this is considered to be the maximum area which Engabreen has occupied since the area was uplifted from the sea. The inner glacial limit is based upon the Norges Geografiske Oppmåling's 1:100,000 sheet J14 Meløy which was made in 1897. The present day limits of the glacier relate to the air photograph which dates from 25 August 1968. The locality to be discussed further is shown on the southern shore of the lake Svartisvatn (this is the local name of the lake but the NVE have named it Engabrevatn on their map).

The fossil tree locality

In about 1940 the recession of Engabreen revealed an area which showed *in situ* tree stumps partially covered by ground moraine. The northeastern boundary to this area is formed by the shore of Svartisvatn where wave erosion has created a cliff some 2–3 m high, affording a cross section through the fossil tree locality. In 1972 it was discovered that no *in situ* trees had survived (it is reported locally that the stumps had a curiosity value and had been excavated and taken away), but the fossil soil with patches of humus survived and was clearly visible in the cliff section lying very close to the present day land surface. Along the strand broken tree trunks were to be found and some appeared to be *in situ* within the ground moraine, below the horizon of the fossil soil. Time did not permit a thorough investigation and the latter relationship may well have resulted from slumping of the face.

The occurrence of the fossil tree stumps was originally studied by ALF BERGERSON (1953) and a University of Durham Exploration Society expedition in 1950 (TAYLOR et al. 1951). Evidently at the time all the observers were in agreement that the field relationships indicated a stand of trees which had been overridden by an advance of Engabreen. It appeared that the trunks had been snapped off just above ground level and the tree debris had been drawn out in the direction of ice movement. Fortunately the site was apparently quickly buried by the ground moraine of the glacier such that the tree stumps and root systems were preserved *in situ* with little modification to their organisation. LIESTØL (1962) reported that a sample of the wood had been identified as *Betula odorata* and that tree ring counts had indicated that the tree was over sixty years old when it was broken down. The radiocarbon age determination was made on the outermost parts of the tree stump and consequently the age determination is on a sample which became biologically inert as near as possible to the time of the event which terminated the tree growth.

Discussion

Until recently it had been generally assumed that the present day glaciers of Scandinavia reached their maximum postglacial size in the mid-eighteenth century and it followed that the outermost "recent" moraine ridges were thus dated to approximately 1750 AD. Engabreen is known from historical sources to have made a major advance in 1723 and to have respectively damaged and destroyed two farms in the process (THEAKSTONE 1965). Consequently the date as originally understood, i.e. 350±100 radiocarbon years BP was consistent with this picture and it seemed reasonable to infer that around 1600 AD the glacier would have been advancing towards its maximum, which was to be attained some 130 years later. A total forward movement in this time of 1700 m gives an average advance rate of some 13.5 m $yr.^{-1}$ which is well within the average rate of forward movement of Engabreen during the period 1966–1971. Indeed LIESTØL (1962) noted that the southern Norwegian evidence suggested that in the seventeenth century the glaciers had a similar size to those of the present day.

However, it is important to note that LIESTØL stated "whether the outermost moraine ridge found today dates from this year (1723) is not known". Although it seems reasonable to suspect that the "1750" AD advance culminated and created the outermost moraine ridges of recent aspect, unambiguous proof remains elusive. The only published dating information on a site where organic sediments have been described as having been found in direct association with an outermost moraine ridge (that is, the glacial event was responsible for disturbance of the sediments) is that describing the peat outcrop at Tverrbreen, Krondalen, Jostedalsbreen and this suggested a possible pre mid-eighteenth century advance (ANDERSON and SOLLID 1971, WORSLEY 1973). Alternatively the outermost ridge could be younger than the mid-eighteenth century event as in parts of Folgefonni (TVEDE 1972).

The true radiocarbon age from Engabreen of 1600 years BP obviously no longer has direct relevance to the eighteenth century advance as thought previously. There are naturally dangers in interpreting a single radiocarbon date, but since this result is from a period for which little positive data is available, it is submitted that in these circumstances further analysis is of some use. The correct radiocarbon age determination corresponds to a true calendar age of between 350 and 550 years AD at 1 σ, on the assumption that in the early decades of the first millenium AD the radiocarbon ages are on average some 75 calendar years too old (see, for example, the evidence presented by several workers in OLSSON 1971).

From this result it follows that the stand of trees by Svartisvatn were probably growing sometime during the third or fifth centuries AD. Since the tree from which the radiocarbon sample was taken had at least 60 growth rings, it seems likely that a mature woodland was established at the site at the time of growth and the reported thick humus layer is certainly consistent with this interpretation. It should perhaps be noted that at the present day the site does not support a climax vegetation cover as the time since the last deglacierization (about thirty years) has been insufficient for this to become established. Since the site, which lies at some 9–10 m above sea level, is well below the local tree line occurring beyond the glacial trim line, provided that stability is maintained for a sufficient period of time, there is no reason why a mature woodland should not become re-established. The moraine ridges for example, which have been exposed since the start of the present century have a cover of mature trees. In northern Norway as a general rule this is relatively uncommon since the glaciers are today normally lying above the tree line, but at Engabreen this is the norm and hence the former occurrence of a woodland at the site is nothing remarkable.

Unfortunately for the purposes of comparison it is rare at the present time to encounter glaciers which are invading woodland. Like the current situation at Engabreen, this is because the dominant trend associated with the world's temperate glaciers during the twentieth century has been for strong glacier recession. Thus despite numerous examples of contemporary glacier advances, these newly established reverses have yet to reach those areas where plant colonisation has become sufficiently developed for trees to occur and hence the advancing margins are still overriding essentially barren glacial sediments and bedrock. One of the exceptions to this general rule is demonstrated by the Taku Glacier located in the Coast Mountains, south east Alaska, which has been advancing progressively for the last fifty years. The Taku is currently destroying a mature forest along its margins (POST and LACHAPELLE 1971). The latter workers have an excellent illustration of conditions at the Taku margin in their book (Fig. 36) and this may well be representative of the kind of situation which existed at Engabreen during the early first millenium AD.

In terms of establishing a time fix on the former extent of Engabreen, the important relationship is that between the death of the tree and the ice advance over the site. If, for example, the tree in question had a considerable age at the time burial by the advancing glacier then the radiocarbon age would merely signify an older age limit for the glacial event and thus be somewhat imprecise. However, it is clear from the descriptions of those who visited the site in 1950, before any extensive excavation of the *in situ* stumps had been carried out that the very definite impression was gained that the glacier had ploughed into a living stand of trees. It is possible of course, that the tree which was dated was dead at the time of burial but, if this were so, then it is unlikely that it had been dead for very long since it is readily observable in the contemporary woodland that dead trees soon fall and start rotting in the prevailing relatively humid and windy climate. From this it appears that the age of the tree should be a reasonably reliable guide to the age of the former advance of Engabreen and that this occurred in about the third to fifth centuries AD.

The implications of this conclusion may be considered further on the basis of two assumptions: –

(*a*) *The advance was non-catastrophic*

If this was the case, then it can be said that Engabreen was more extensive than in the last decade and, as such, the net mass balance was likely to have been more positive than at the present day. Currently the ice margin is over 500 m from the site and, as noted previously, the site corresponds with the 1940 ice marginal position. It is usually inferred that in Norway during the "Roman period" of the archaeological time scale there existed relatively favourable climatic conditions with a correspondingly high firn line (LIESTØL 1960). The Engabreen radiocarbon dating evidence suggests that the climate may have then been similar to that of recent decades on the basis of comparable glacier dimensions. The pattern of recent glacier variation seems to reflect fairly faithfully those which have occurred in southern Norway. Thus the behaviour of Engabreen in the early first millenium may have been generally parallel to the trend ice marginal variations throughout Norway and the glaciers at that time may have had dimensions approximating those of the present day. Accepting this reasoning, it seems possible that the firn line was lower than previous estimates had suggested and Engabreen experienced a climatically induced advance. It should be remarked however that the data on which previous estimates of firn line height at this period have been based, are unavoidably tenuous.

(b) The advance was catastrophic

Should the interpretation tentatively suggested above prove to be inconsistent with the evidence deduced from archaeology, pollen analysis, fossil fauna, etc. there remains the possibility that the advance behaviour was out of phase with the climatic reconstructions and was linked to a mechanism of a glacier surge type. If this hypothesis is tenable, the stratigraphic relationships are the result of a catastrophic advance of the glacier. Although observations demonstrate that within the period 1966–1971 Engabreen has been advancing, the movement rate has not even approached that associated with surging glaciers, and a normal advance of the current type into a woodland could produce the type of stratigraphical relationships found. Although no Norwegian glacier has been observed to surge, there is some evidence to suggest that one may have experienced an advance similar to a surge within historic time. This concept receives support from the writings of ADOLF HOEL (1910) who at that time was probably unaware of the surge phenomena. In a discussion of the ice marginal variations of the glacier Vestre Okstindbreen, an outlet glacier from the Okstindan ice cap lying 80 km south east of Engabreen, HOEL deduced from historical records that this glacier suffered a relatively sudden major advance of some 1400 m within the period defined by the years 1875 and 1899, at a time when the other local glaciers were apparently changing very little. It is recognized that the Vestre Okstindbreen advance was of much smaller dimensions than the type found associated with the classical surging glaciers, but nevertheless something similar to the surge mechanism seems to have been operating within that glacier alone. From this it follows that the idea that Engabreen may have experienced a surge is not totally without some support from Rana, if not from Svartisen itself. Of course, it should be remembered that the surge mechanism is incompletely understood and the criteria for their recognition in the geological record are not yet available. Should Engabreen have experienced a surge which was responsible for the destruction of the woodland, then it is possible that the extent of the glacier was not indicative of the general development of the glaciers at that time and, accordingly the interpretation developed under the initial assumption, (a) above, is false.

Summary

It is evident that the true radiocarbon date from the buried tree stump in the proglacial area of Engabreen gives a new fix on the pattern of glacier variation in Scandinavia within the Neoglacial period. If it is assumed that the date is meaning-

ful, it is possible to conclude that in the early first millenium AD Engabreen was developed to a size comparable to that of the present date. The significance of this in terms of the then prevailing climatic conditions is difficult to assess in a positive manner. Two alternatives seem possible, one invokes a normal advance behaviour in response to a positive mass balance and this leads to the idea that the climate at that time may have been similar to that of the present. The other adopts a catastrophic mechanism to explain the advance of Engabreen and, if this is valid, it is possible to accommodate a more favourable climate than the present with the indisputed fact that the glacier was advancing and had a greater extent than that of the present time. Only further research will enable a more positive evaluation of the two alternatives to be made.

Acknowledgements

This note would not have been possible without the ready assistance of STEINAR GULLIKSEN of the Trondheim Radiological Dating Laboratory. Professor HANS HOLTEDAHL kindly made study facilities available at the Department of Quaternary Geology, University of Bergen, while the writer held a Leverhulme Faculty Fellowship in European Studies. BJØRN ANDERSEN and OLAV LIESTØL made critical readings of the text. Norges Vassdrags- og Elektrisitetsvesen kindly permitted their map of Engabreen to form the basis of Fig. 1.

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Måling av det frie vanninnhold i snø ved hjelp av den dielektriske metode

AV T. LAUMANN[1]

Innledning

I den glasiologiske litteratur er det beskrevet 8–9 forskjellige metoder til bestemmelse av snøens frie vanninnhold (BADER 1950, WILLIAMS 1956, LA CHAPELLE 1956, YOSIDA 1960, HOWORKA 1964, m. fl.). Av disse er nok den dielektriske metode å foretrekke. Måleprosedyren er meget enkel og kan foretas i løpet av noen få minutter. Dessuten er måleinstrumentet hendig for feltbruk. Ulempen er imidlertid at man må foreta en nitid og grundig kalibrering av instrumentet før bruk. Det følgende er en beskrivelse av kalibreringsmetode og instrument.

Metodikk

Metoden bygger på at dielektrisitetskonstanten for is er meget forskjellig fra den for vann. Dielektrisitetskonstanten for snø vil derfor være avhengig av hvor meget fritt vann som finnes i den. HOWORKA (1964) har inngående beskrevet et instrument som tar i bruk disse egenskapene til bestemmelse av fritt vanninnhold, og etter oppdrag fra Norsk Polarinstitutt ble det vinteren 1970/71 laget et instrument på Sentralinstituttet for Industriell Forskning.

Instrumentet består av to komponenter – en platekondensator som føres inn i snøen, og et apparat som gir et mål for forskjellen mellom kondensatorens kapasitet i luft og i snø. Komponentene kan settes sammen slik Fig. 1 viser.

Selve måleprosedyren er som følger: Instrumentet blir stukket inn i snøen. Kondensatorens kapasitet blir da forandret. Dette resulterer i utslag på måleinstrumentets ampèremeter. Man skrur så på en skalainndelt bryter inntil dette utslaget er borte, og leser av antall delestreker på bryteren. Det frie vanninnhold finnes tilslutt på kjente kalibreringskurver.

Nå viser det seg at dielektrisitetskonstanten for snø ikke bare er avhengig av det frie vanninnhold, men også av tetthet og krystallstruktur. Dette betyr at det ikke eksisterer noen entydig sammenheng mellom fritt vann og kapasitetsforandringen til kondensatoren, heretter betegnet med S. Ved bruk av høyfrekvent vekselstrøm (over 3 000 kH) vil imidlertid innvirkningen fra snøens strukturer

[1] Cand. real., Lillestrøm.

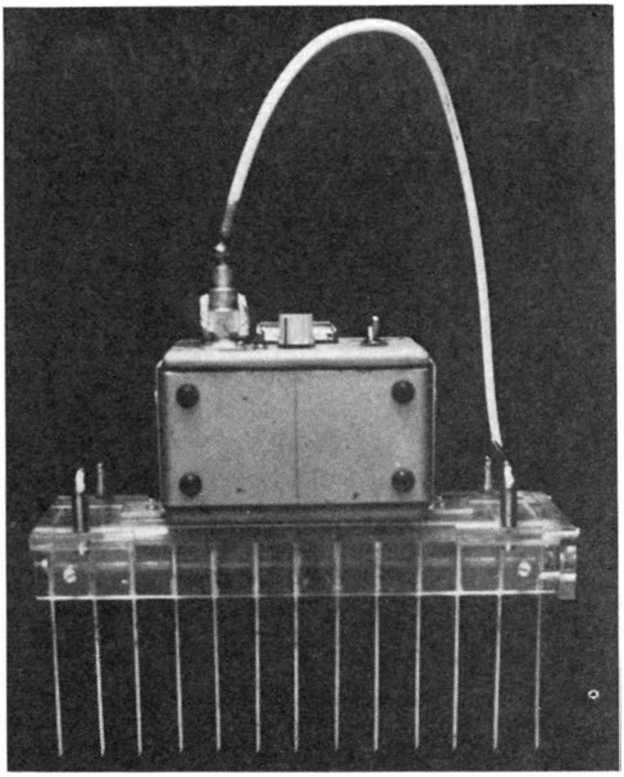

Fig. 1. *Foto av instrumentet.*

være meget liten, og en relasjon mellom de tre variable tetthet, fritt vanninnhold og S kan derfor finnes.

Denne relasjonen er funnet på grunnlag av kalibreringsmålinger foretatt både i tørr og fuktig snø. I tørr snø er det frie vanninnhold lik null. Sammenhengen mellom tørrsnøens tetthet (ρ_t) og S er vist på Fig. 2. Man ser at denne er lineær:

$$S = 52 \cdot \rho_t$$

I kalibreringsprosedyren for fuktig snø må også det frie vanninnhold måles på annen måte. Til dette er en kalorimetrisk metode blitt brukt (LAUMANN 1972). Denne metoden gir imidlertid det frie vanninnhold i vektprosent, mens relasjonen mellom fritt vann, tetthet og S blir enklest hvis man angir vanninnholdet i volumprosent. En omregning er derfor foretatt ved hjelp av følgende formel:

$$\text{Vol}\,\% = \rho_f \cdot \text{Vekt}\,\%$$

der ρ_f er tettheten til den fuktige snøen.

Resultatene av disse kalibreringsmålingene er vist på Fig. 3. Tettheten er her brukt som parameter. Verdier mellom 0.50 g/cm^3 og 0.60 g/cm^3 er på figuren innordnet under verdien 0.55 g/cm^3, og verdier mellom 0,40 g/cm^3 og 0.50 g/cm^3 under 0.45 g/cm^3. Som man ser er det ganske stor spredning på punktene. Dette skyldes for det første at usikkerhetèn til den kalorimetriske metoden er svært stor, og for det andre at man ikke får målt tetthet, fritt vanninnhold og S på eksakt samme sted i snøen.

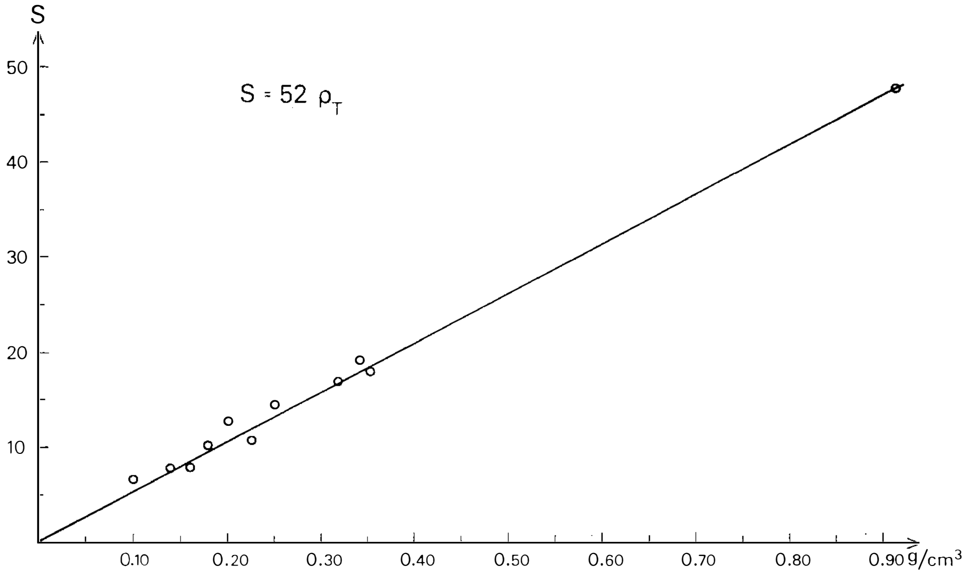

Fig. 2. *Relasjon mellom tørrsnøens tetthet og instrumentavlesning.*

Linjene som passer best til de to punktmengdene er funnet ved bruk av minste kvadratens metode. De andre linjene på figuren er trukket paralelle med disse på grunnlag av tidligere funne kurver. (HOWORKA 1964, Fig. 3, s. 74). Sammenhengen kan uttrykkes i følgende formel:

$$W = 0.20\ S - 10.3\ \rho_f \qquad (1)$$

der W er snøens frie vanninnhold i vol % og ρ_f er den fuktige snøens tetthet. Ligningen er framstilt i et nomogram på Fig. 4.

Denne ligningen (1) må benyttes hvis det frie vanninnhold i hele snødekket skal undersøkes. Man må da for hver måling av S også måle den fuktige snøens tetthet. Er man imidlertid interessert i å undersøke hvordan det frie vanninnhold varierer på ett og samme sted, f. eks. i overflaten, blir måleoperasjonene betydelig redusert hvis man bruker en korrigert tetthetsverdi som parameter. Denne korrigeringen blir foretatt ved hjelp av:

$$\rho_k = \frac{\rho_f - W/100}{1 - W/100} \qquad (2)$$

der ρ_k er den korrigerte tetthetsverdi, d.v.s. den verdi man får når man har redusert for fritt vanninnhold. Ved å løse ρ_f av denne ligningen og ved å sette inn i (1) fås

$$W = \frac{0.20S - 10.3\,\rho_k}{1.1 - 0.1\,\rho_k}$$

Sløyfes $0.1 \cdot \rho_k$ får man

$$W = 0.18\ S - 9.3\ \rho_k \qquad (3)$$

som har samme form som ligning (1). Denne ligningen er framstilt i et nomogram på Fig. 5.

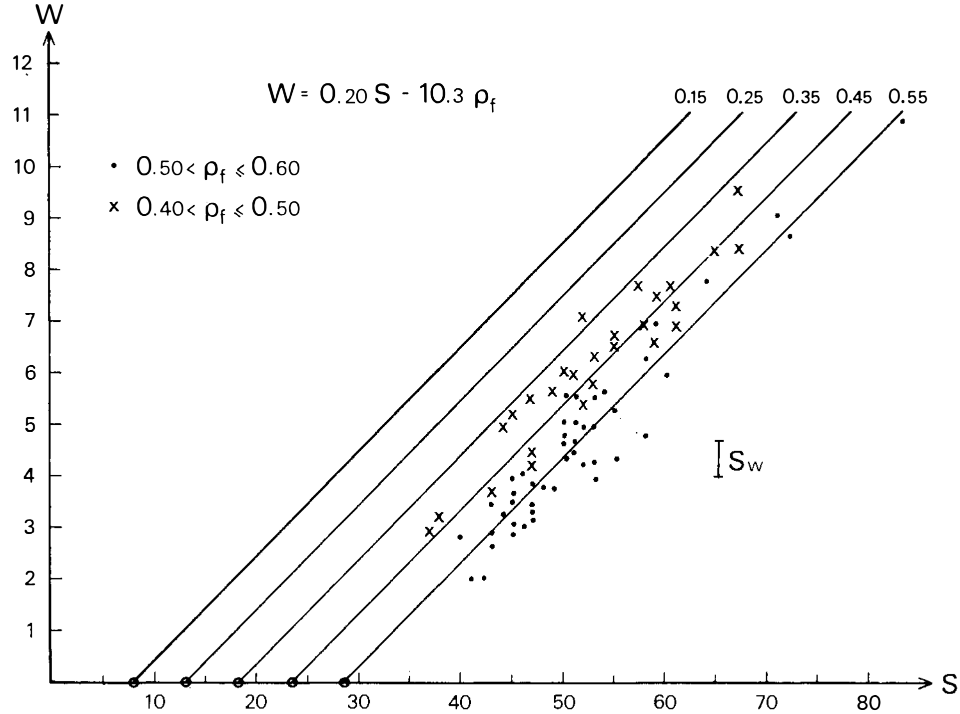

Fig. 3. *Sammenheng mellom fritt vann, tetthet og instrumentavlesning.*

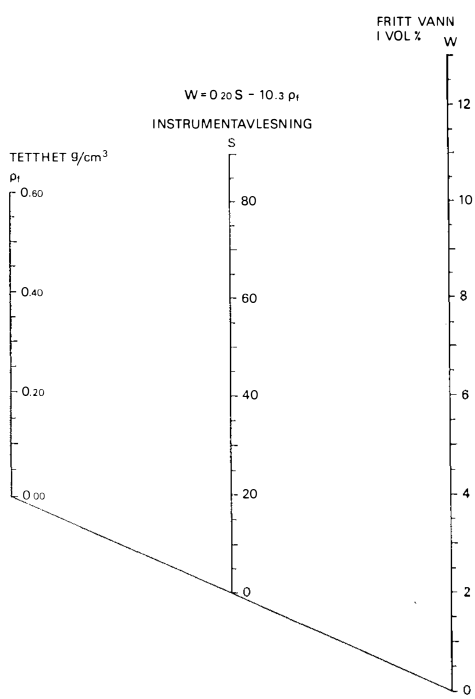

Fig. 4. *Nomogram for 0,20 S – 10.3* ρ_f

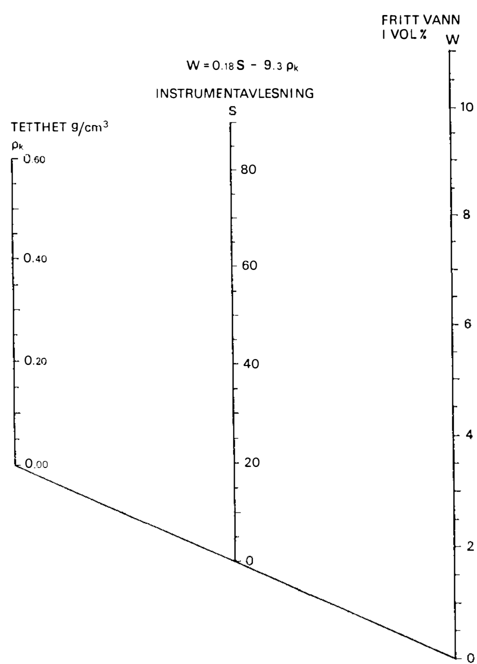

Fig. 5. *Nomogram for 0,18 S – 9.3* ρ_k.

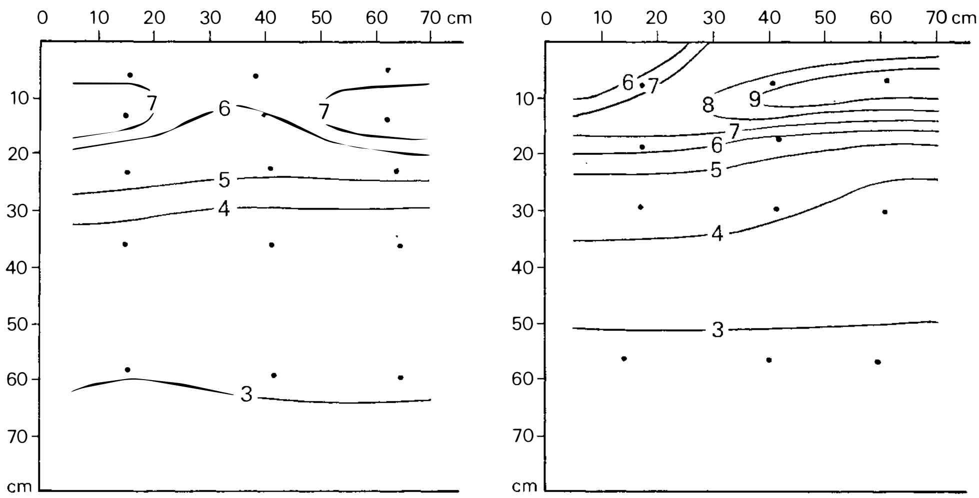

Fig. 6. *Isolinjer for fritt vanninnhold i en sjaktvegg.*

Feilen man gjør ved å sløyfe 0.1 ρ_k har sin største verdi lik 0.7 vol% og er av samme størrelsesorden som standardavviket på W. Usikkerheten ved bruk av ligning (3) er da ca. $\pm$ 1.5 vol %, mens den ved bruk av ligning (1) er ca. $\pm$ 1 vol%.

Fordelen ved å bruke (3) istedenfor (1) ligger i at man bare behøver å måle den fuktige snøens tetthet en gang og korrigere til ρ_k ved hjelp av (2). Variasjonene i det frie vanninnhold på samme sted i snødekket finnes deretter ved bare å måle S, idet man antar at «tørrsnøens» tetthet (ρ_k) holder seg konstant i måleperioden.

Instrumentet er blitt brukt til å undersøke variasjonene i snødekkets frie vanninnhold som funksjon av tiden. Målingene ble foretatt på følgende måte: Kondensatoren ble stukket inn i snøen i den sørvendte veggen i en snøsjakt. Tetthetsprøvene ble tatt så nær kondensatoren som mulig. Den samme sjakt ble brukt flere ganger. For å eliminere uønskede virkninger fra lufta, ble det for hver måleserie gravd ca. 0.5 m inn i sjaktveggen. Fig. 6 viser resultater fra to slike serier. Figurene gir et bilde av veggen i sjakten, der isolinjer for fritt vanninnhold er inntegnet. Punktene angir beliggenhet av målingene.

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Glaciological work in 1972

Гляциологические работы в 1972-м году)

By Olav Liestøl

Contents

Abstract

In 1972 mass balance studies were carried out on the two glaciers Austre Brøggerbreen and Midre Lovénbreen in Spitsbergen and on two glaciers in Norway, Storbreen and Hardangerjøkulen. Included are also measurements made on Blomsterskardbreen, a part of the glacier cap Folgefonni in south-western Norway. Only net balance was measured here. The results are shown in Table 3 together with the measurements carried out by The Norwegian Water Resources and Electricity Board.

Length fluctuations of ten glaciers were measured and all were retreating.

Аннотация

Приводятся результаты исследований вещественного баланса двух ледников на Шпицбергене (Austre Brøggerbreen и Midre Lovénbreen) и двух ледников в Норвегии (Storbreen и Hardangerjøkulen), проведенных сотрудниками Норвежского Полярного Института (Norsk Polarinstitutt). Включаются результаты измерения чистого вещественного баланса ледника Blomsterskardbreen, составляющего часть ледяного щита ледника Folgefonni на юго-западе Норвегии. Подытоживается этот материал в таблице 3 в сопоставлении с соответствующим материалом, относящимся к другим ледникам Норвегии и доставленным Ведомством по водным ресурсам и электричеству Норвегии (Norges Vassdrags- og Elektrisitetsvesen).

Измерения колебаний длины десяти ледников показывают всеобщее отступание.

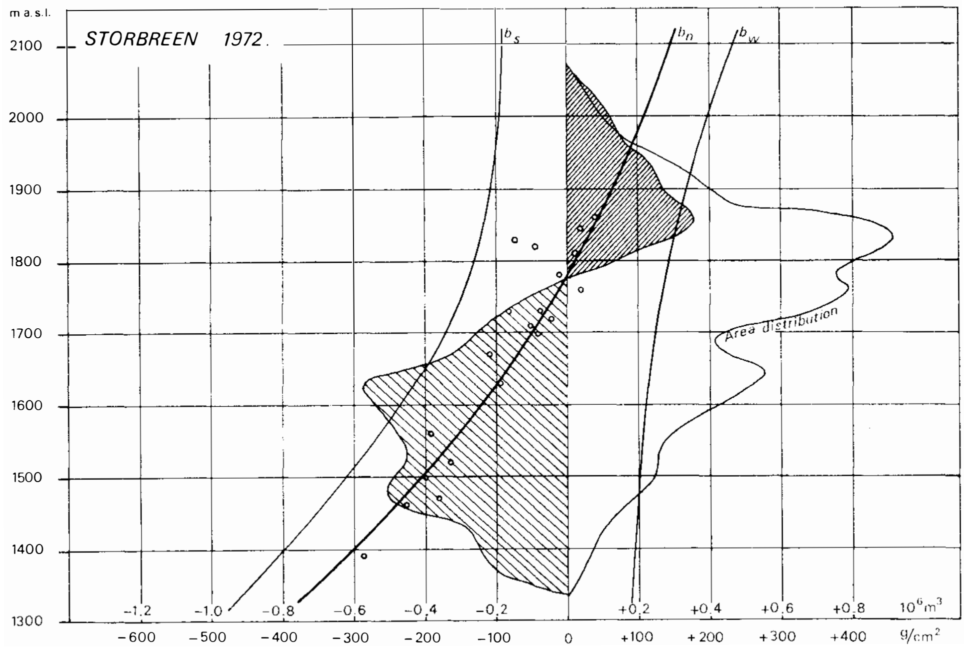


Fig. 1. *Variations in mass balance of Storbreen* 1971–72 *in relation to height above sea level.*
Вариации вещественного баланса ледника Storbreen в 1971/72 г. в зависимости от высоты над уровнем моря.

Storbreen in Jotunheimen

Precipitation during the first four months of the budget year 1971—72 was about 200% of normal. But as the rest of the accumulation period was rather dry, the result was an accumulation about normal, 139 g/cm². In the ablation period temperature was close to normal, except for July when the temperature at Fannaråki was 2.8°C above normal. The melting was 170 g/cm², which is very near to the average for the last 24 years. This does not mean that the glacier was in equilibrium as the net balance for the same years was —32 g/cm².

Hardangerjøkulen

Weather conditions were almost the same as described for Storbreen. Accumulation was large in the autumn months and moderate in spring, resulting in a nearly normal winter balance. Ablation was large in July and moderate in the other months. The result was a slight by negative balance. Measurement results are seen in Table 1.

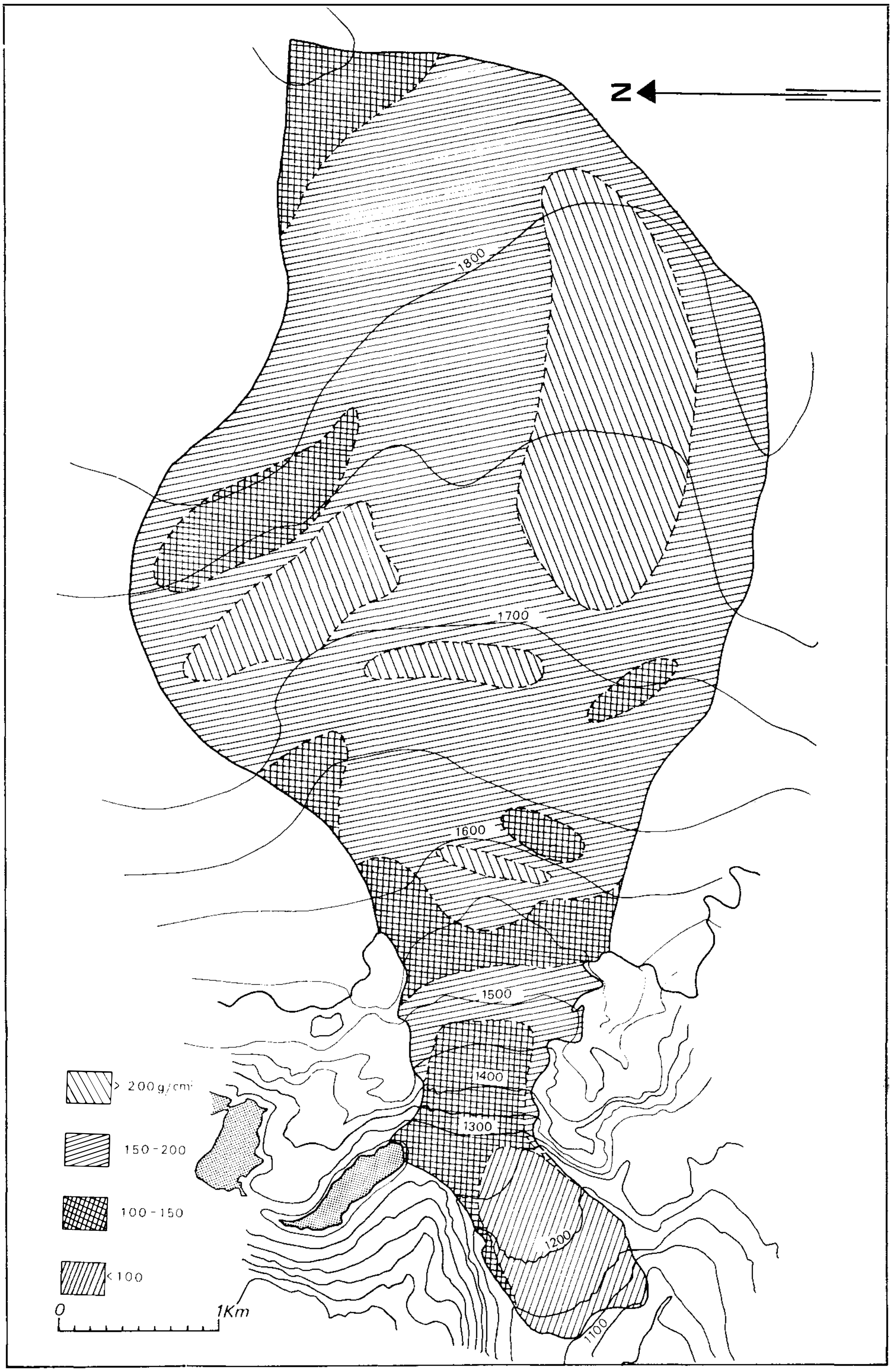


Fig. 2. *Distribution of snow accumulation in the part of Hardangerjøkulen which flows to the outlet glacier Rembesdalsskåki.*

Распределение снегонакопления в текущей на выводной ледник Rembesdalsskåki части ледника Hardangerjøkulen.

Table 1.
Hardangerjøkulen 1971–72

Height intervals m a.s.l.	Area km²	Winter balance		Summer balance		Net balance	
		10^6 m³	g/cm²	10^6 m³	g/cm²	10^6 m³	g/cm²
1 850—1 900	0.070	98	140	79	120	+ 19	+ 20
1 800—1 850	3.375	5.940	176	4.320	128	+1.620	+ 48
1 750—1 800	3.866	7 461	193	5.141	130	+2.320	+ 60
1 700—1 750	3.910	7.624	195	5.864	150	+1.760	+ 45
1 650—1 700	2.084	3.960	190	3.585	142	+ 375	+ 18
1 600—1 650	0.936	1.703	182	1.853	198	— 150	— 16
1 550—1 600	0.640	1.165	182	1.581	247	— 416	— 65
1 500—1 550	0.542	856	158	1.446	283	— 590	—125
1 450—1 500	0.319	526	165	1.204	350	— 678	—185
1 400—1 450	0.196	255	130	735	375	— 480	—245
1 350—1 400	0.112	146	130	480	428	— 334	—298
1 300—1 350	0.084	105	125	385	459	— 280	—334
1 250—1 300	0.270	275	102	1.287	477	—1.012	—375
1 200—1 250	0.315	246	78	1.569	498	—1.323	—420
1 150—1 200	0.321	186	58	1.694	528	—1.508	—470
1 100—1 150	0.115	57	50	656	571	— 599	—521
1 050—1 100	0.022	13	60	137	622	— 124	—563
1 050—1 900	17.18	30 616	178	32.016	186	—1.400	— 8

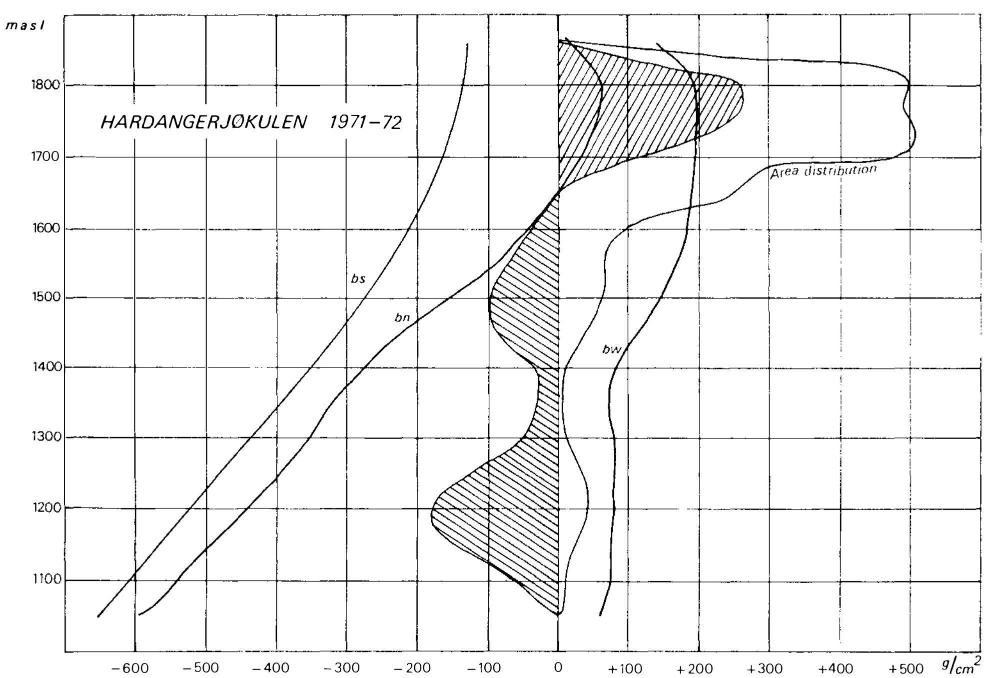


Fig. 3. *Variations in mass balance of Hardangerjøkulen (Rembesdalsskåki) 1971–72 in relation to height above sea level.*

Вариации вещественного баланса ледника Hørdangerjøkulen (Rembesdalsskåki) в 1971/72 г. в зависимости от высоты над уровнем моря.

Table 2.
Mass balance on Blomsterskardbreen, Folgefonni

Height intervals m a.s.l.	Area km²	1970 bn g/cm²	1971			1972 bn g/cm²
			bw g/cm²	bs g/cm²	bn g/cm²	
1 600—1 640	2.80	123	317	— 85	232	150
1 550—1 600	9.03	120	316	—113	203	145
1 500—1 550	7.07	94	328	—138	190	125
1 450—1 500	4.31	66	313	—148	165	95
1 400—1 450	3.16	36	305	—179	126	65
1 350—1 400	4.35	05	292	—188	104	30
1 300—1 350	3.19	— 38	276	—225	51	— 15
1 250—1 300	2.09	— 85	252	—225	27	— 55
1 200—1 250	2.88	—135	236	—275	— 39	— 99
1 150—1 200	2.46	—187	210	—299	— 89	—145
1 100—1 150	1.63	—237	199	—325	—126	—190
1 050—1 100	1.48	—300	190	—353	—163	—240
1 000—1 050	0.66	—360	176	—375	—199	—300
950—1 000	0.36	—427	147	—450	—303	—365
900— 950	0.18	—495	122	—506	—384	—445
850— 900	0.07	—562	113	—550	—437	—515
850—1 640	45.72	0	+285	—187	+ 98	+ 32

Folgefonni

In 1970 ARVE TVEDE started mass balance measurements on the glacier Blomsterskardbreen, which is part of Folgefonni in South-West Norway. The glacier occupies a larger part, 45.7 km², of the southern slope of the icecap. This area has one of the highest precipitation figures in Norway. Ten stakes were drilled into the ice in a line from the snout to the top of the glacier. The accumulation pattern is very even on this glacier, and measurements on a few stakes, therefore give a reliable basis for calculation of the mass balance.

Only net balance was calculated in 1970 and 1972 while winter and summer balances were included in 1971. The results are given in Table 2 and Fig. 5.

Blomsterskardbreen seems to have a different reaction to the climatic variation than other glaciers in South Norway. Other glaciers had their maximum advance in the 17th century, while Blomsterskardbreen had its maximum some years after 1930, caused by the large mass balance figures in this extreme maritime climate. Variations in winter precipitation will dominate the fluctuations, whereas summer temperature changes cause the variation in almost all other glaciers in Norway. This is also demonstrated by the last three years of mass balance measurements when Blomsterskardbreen had a much larger positive balance than the other glaciers measured.

Fig. 4. *Oblique aerial photo from 1955 of the glacier cap Folgefonni from the south with the outlet glacier Blomsterskardbreen in the foreground. Notice the narrow trim line along this glacier tongue.*

Косая воздушная, снятая с юга в 1955 г. фотография ледяной шапки ледника Folgefonni с выводным ледником Blomsterskardbreen в переднем плане. Обратите внимание на узкую линию вдоль ледникового языка, отмечающую максимальное продвижение ледника.

Photo: Norsk Polarinstitutt.

Glaciers in Spitsbergen

In Spitsbergen mass balance studies were carried out on Austre Brøggerbreen and Midre Lovénbreen. Accumulation measurements were carried out in the end of May on both glaciers. Soundings with intervals of 100 m were made along lines from the stakes perpendicular to the central line of the glacier. In addition to the snow accumulation the superimposed ice makes a relatively large contribution to the total winter balance. The glaciers are of the polar type with a cold firn area and with compact ice just below the surface right to the highest part of the glacier. In years with a large negative balance, blue ice is seen all over the glaciers even in

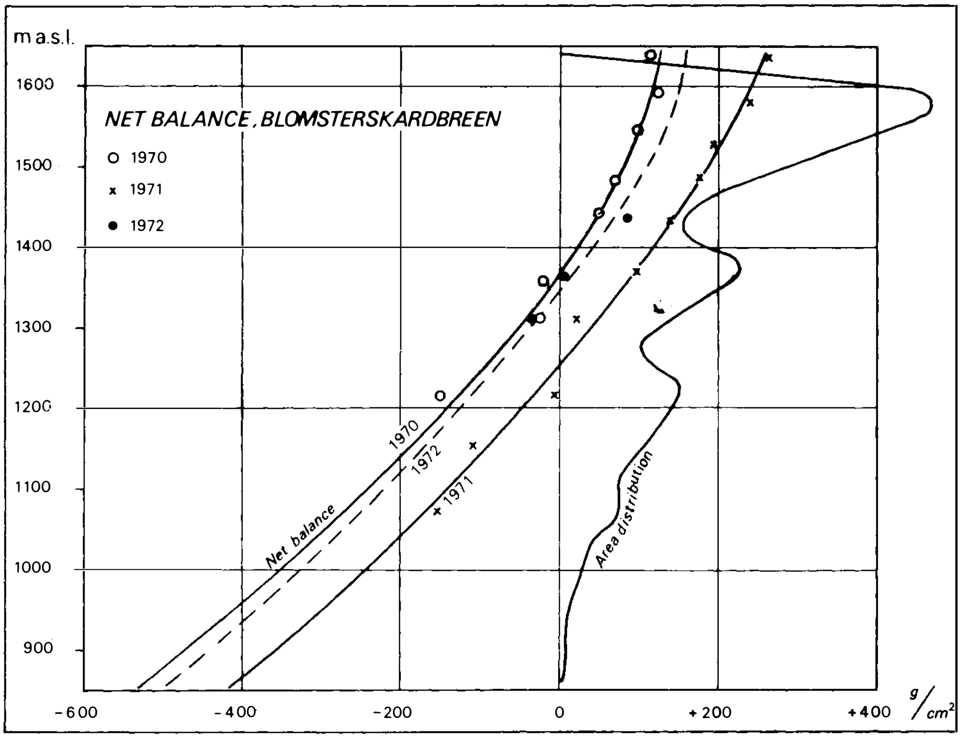


Fig. 5. *Net balance curves for the three years 1970–71–72 of Blomsterskardbreen.*
Кривые чистого вещественного баланса ледника Blomsterskardbreen, относящиеся к годам 1970, 1971, 1972.

the steep and highest cirque areas. Superimposed ice covers large parts of the upper areas and has a thickness in some places of more than 50 cm. A detailed study of the distribution and the condition for the forming of superimposed ice on Brøggerbreen has recently been initiated. It is obvious that the inclination of the surface and the spacing of the crevasses have a large influence on the formation and thickness ot this ice. In the figure for the winter balance this year the superimposed ice is calculated to give an additional accumulation of 10 g/cm².

In April 1972 three holes were drilled through the glacier Foxfonna 20 km east of Longyearbyen. This glacier overlies a coal field under exploration. Water came into the mine in one place under the glacier in the summer months. Measurements in the holes showed negative temperatures at the bottom. By means of radio-echo soundings, a map was made of the subsurface of the glacier showing a narrow valley just above the place where the water entered the mine (Fig. 8). The temperature in the mine is –0.2°C in the part that underlies the glacier. It is difficult to understand, therefore, how the water can penetrate the rock between the glacier and the mine. Fig. 9 shows a vertical section through the glacier and through two of the bore holes.

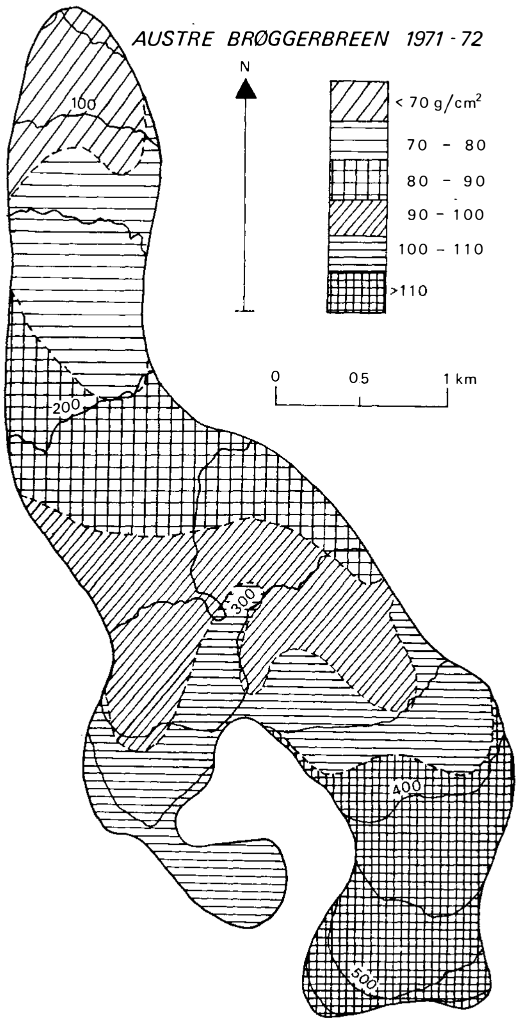


Fig. 6a. *Distribution of snow accumulation on Austre Brøggerbreen 1971–72.*
Распределение снегонакопления ледника Austre Brøggerbreen в 1971/72 г.

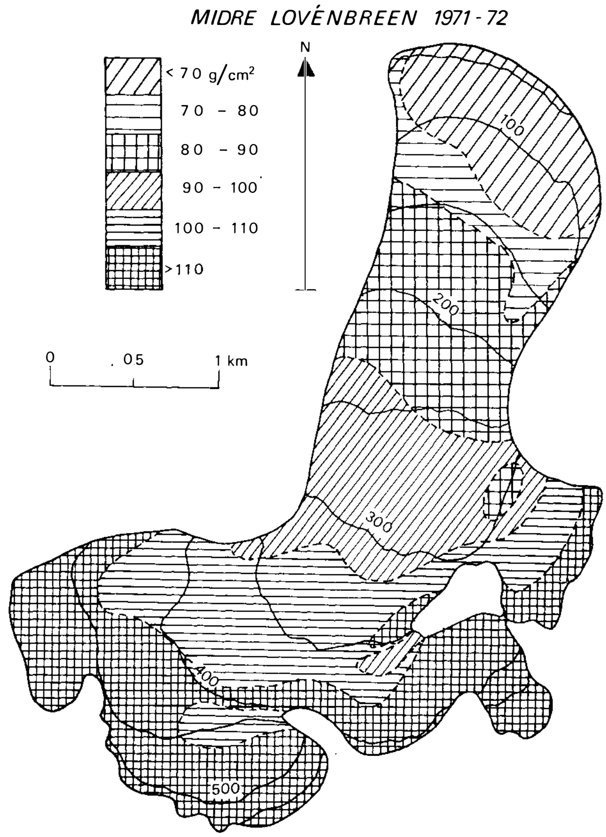


Fig. 6b. *Distribution of snow accumulation on Midre Lovénbreen 1971–72.*
Распределение снегонакопления ледника Midre Lovénbreen в 1971/72 г.

Other investigations

The Norwegian Water Resources and Electricity Board carried out measurements on glaciers in Norway of which three, Engabreen, Trollbergdalsbreen, and Høgtuvbreen, are situated in northern Norway. The results of all mass balance measurements of glaciers in Norway and Spitsbergen are presented in Table 3. The mass balance figures for southern Norway are also presented graphically in Fig. 10. As in 1971 the western and maritime glaciers have a more positive balance than the eastern and more continental glaciers.

Measurements of the fluctuations of glacier tongues were carried out on a total of 11 glaciers, and the results are presented in Table 4.

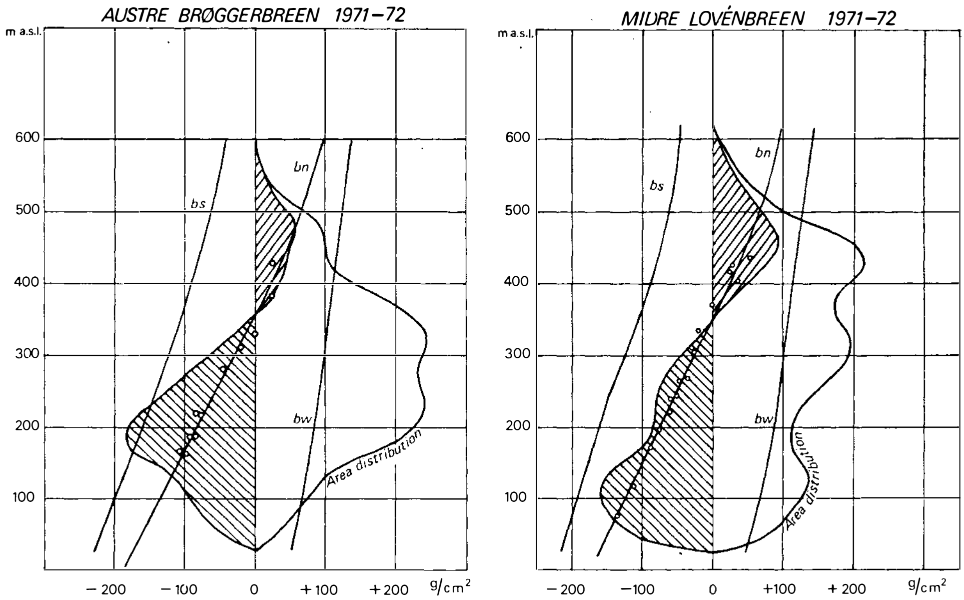


Fig. 7. *Variation in mass balance in relation to height above sea level of Austre Brøggerbreen and Midre Lovénbreen 1971–72.*

Вариация вещественного баланса ледников Austre Brøggerbreen и Midre Lovénbreen в 1971/72 г. в зависимости от высоты над уровнем моря.

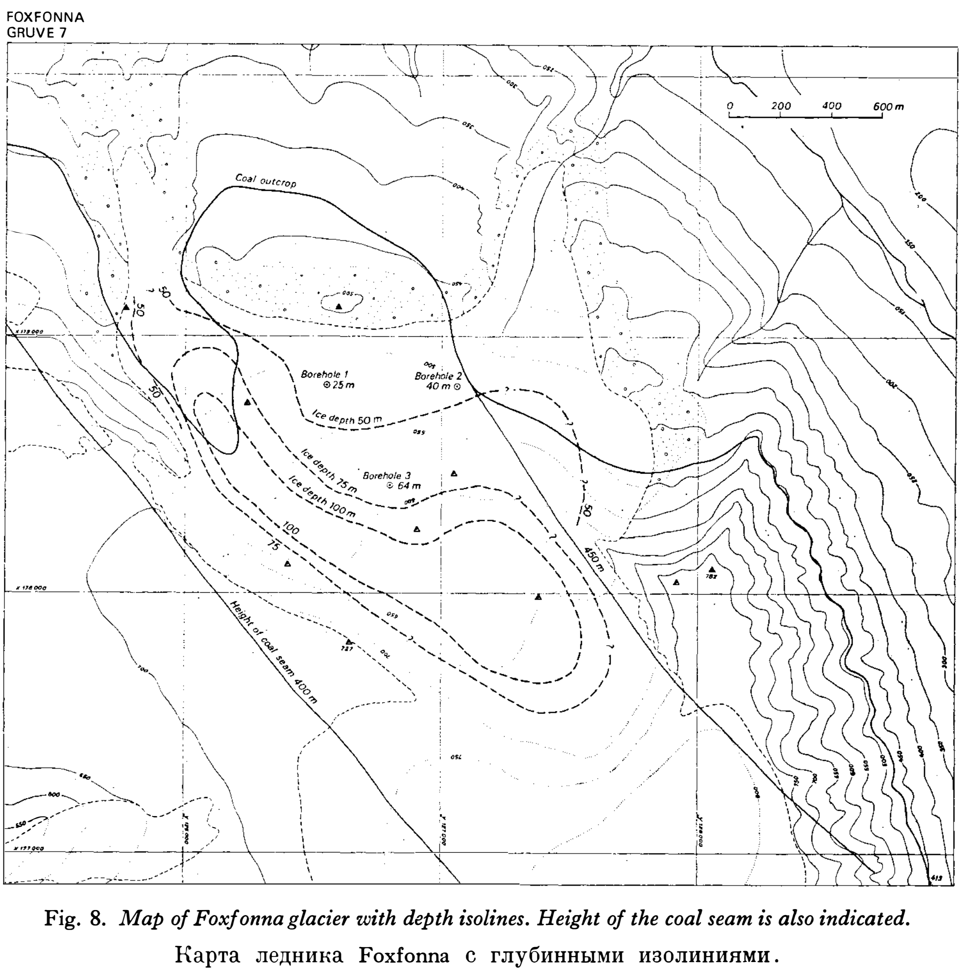


Fig. 8. *Map of Foxfonna glacier with depth isolines. Height of the coal seam is also indicated.*

Карта ледника Foxfonna с глубинными изолиниями.
Указана и высота угольного пласта.

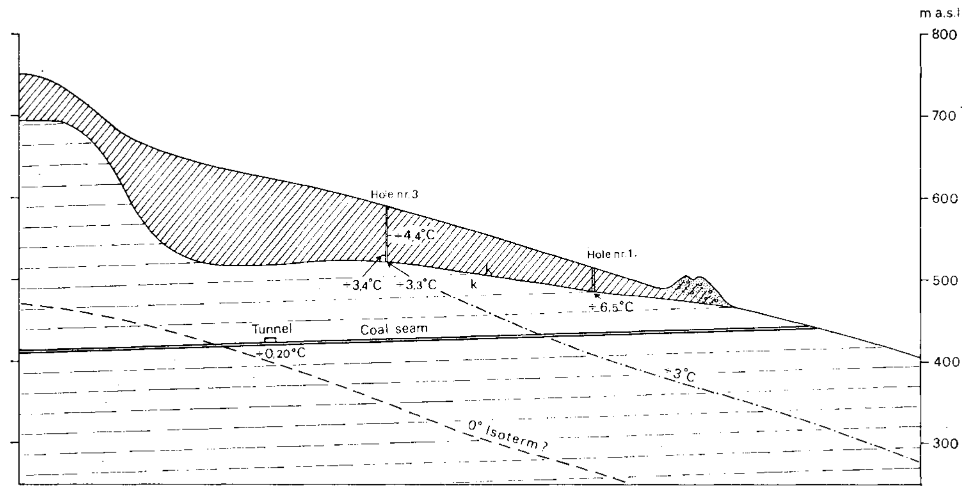


Fig. 9. *Vertical profile along Foxfonna glacier through boreholes* 1 *and* 3.
Вертикальный профиль вдоль ледника Foxfonna через буровые скважины 1 и 3.

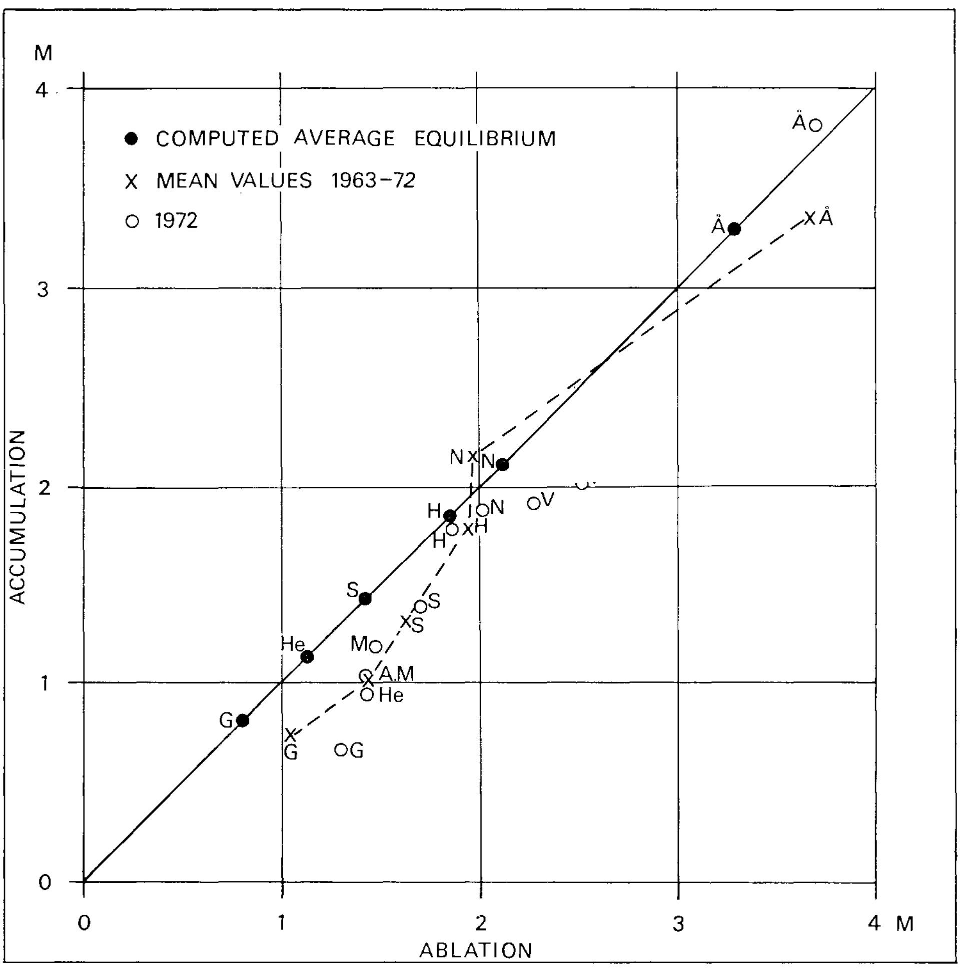


Fig. 10. *Relation between accumulation and ablation compared to the mean of the previous ten years and also to that of a year with a computed balanced budget and a «normal» mass exchange.*
B = Blomsterskardbreen. G = Gråsubreen. H = Hardangerjøkulen. He = Hellstugubreen. N = Nigardsbreen. S = Storbreen. T = Tunsbergdalsbreen. V = Vesledalsbreen. VM = Vestre Memurubre. AM = Austre Memurubre. Å = Ålfotbreen.
Взаимоотношения между аккумуляцией и абляцией в сравнении с средними значениями предыдущих десяти лет, так же как с значениями года с рассчитанным балансированным бюджетом и «нормальным» вещественным обменом.

Table 3.
Mass balance measurements

Glacier	Area km²	Winter balance m	Summer balance m	Net balance m
Southern Norway				
Ålfotbreen	4.79	3.81	3.70	+0.11
Tunsbergdalsbreen	49.85	2.02	2.52	—0.50
Nigardsbreen	46.40	1.88	2.02	—0.14
Vesledalsbreen	4.18	1.92	2.27	—0.35
Hardangerjøkulen	17.44	1.78	1.86	—0.08
Storbreen	5.40	1.39	1.70	—0.31
Vestre Memurubre	9.05	1.19	1.47	—0.28
Austre Memurubre	8.72	1.02	1.42	—0.40
Hellstugubreen	3.28	0.94	1.43	—0.49
Gråsubreen	2.53	0.66	1.30	—0.64
Blomsterskardbreen	45.72	—	—	+0.32
Northern Norway				
Engabreen	38.02	3.22	3.29	—0.07
Trollbergdalsbreen	2.02	2.44	3.68	—1.24
Høgtuvbreen	2.58	3.20	4.12	—0.92
Spitsbergen				
Austre Brøggerbreen	6.12	0.95	1.26	—0.31
Midre Lovénbreen	5.87	0.98	1.20	—0.22

Table 4.
Fluctuations in m of some glacier tongues

Jotunheimen		*Folgefonni*	
Storbreen	—10	Buarbreen	0
Styggedalsbreen	— 4	Bondhusbreen	— 7
Jostedalsbreen		*Møre*	
Briksdalsbreen	—12	Trollkyrkjebreen	— 6
Fåbergstølbreen	—66	Finnebreen	— 5
Stegaholtbreen	—50		
Austerdalsbreen	—32		
		Svartisen	
		Engabreen	—31

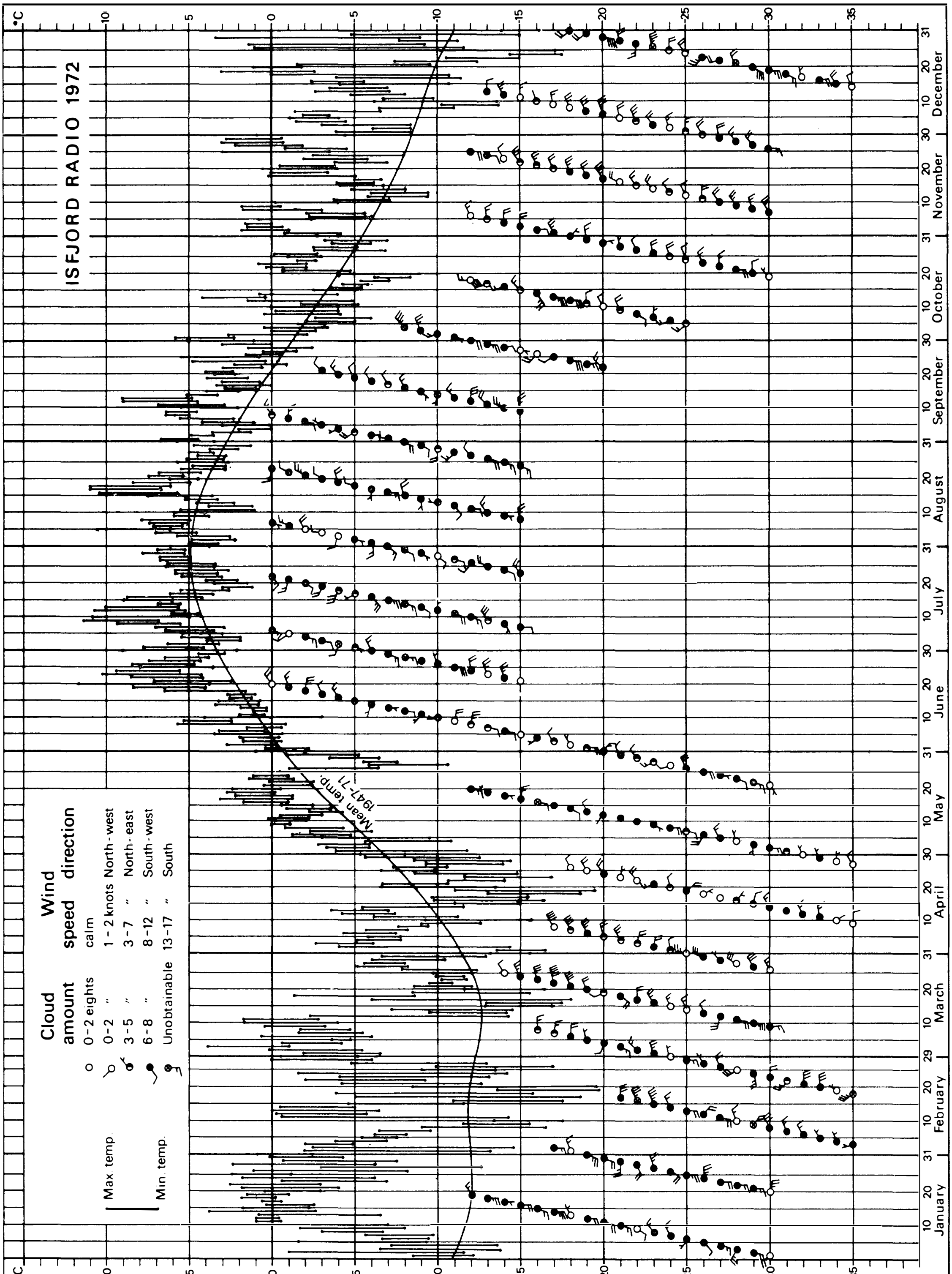
The weather in Svalbard in 1972

By Vidar Hisdal

The diagram presents some important meteorological elements observed at Isfjord Radio during 1972: the daily maximum and minimum temperatures, the cloud amount, and the direction and speed of the wind. The cloud and wind observations entered are those taken at 12 GMT. The figure also shows the average annual temperature variation for the period 1947–71. The symbols used are explained by examples in the diagram.

The table contains the monthly temperatures for Isfjord Radio, Hopen, and Bjørnøya for 1972 as well as their deviations from the monthly means based on the period 1947–71. The term "normal" used below refers to this period.

At Isfjord Radio the temperature in January was considerably above normal. A series of well-developed low-pressure systems passed over or near the Svalbard area, bringing mild, maritime air from lower latitudes. As may be seen from the diagram, January had 19 days in all with maximum temperatures above 0°C. The month of February was on the whole cooler. Periods with the same mild cyclonic weather type as in January alternated with periods dominated by advection of cold air from the Polar Basin. The lowest temperature of the year, –19.7°C, occurred on 19 February. The weather during the first eleven days of March was again strongly influenced by cyclonic passages, and the temperature was unseasonably high. The rest of the month had lower and more variable temperatures, with spells of cool easterly to northerly winds. Most days during the first half of April had above normal temperatures. During the rest of the month, however, the weather situation was to a great extent governed by high pressure areas over Greenland or adjacent regions, and advection of cold, arctic air. Except for a few days near the start and near the end of the month, May was milder than normal, with mostly cloudy weather and moderate winds. The first couple of weeks of June were characterized by a comparatively weak air flow between cyclones moving eastwards in lower latitudes, and an anticyclone centred north of Siberia. Temperatures were slightly above normal. About the middle of the month the cyclones started to take a more northerly track, and the weather became appreciably milder. The highest temperature of the year (11.7°C) occurred during this period, on 20 June. This mild weather type continued during most of July and August, with several cyclonic passages. A few cool periods occurred in connection with rather weak air flows from the Polar Basin. They were, however, relatively short-lived. All in all, frequent passages of depressions and advection of air from


ISFJORD RADIO 1972
°C
10
5
0
-5
-10
-15
-20
-25
-30
-35
Mean temp. 1947-71
Max. temp.
Min. temp.
Cloud amount
0-2 eighths
0-2 "
3-5 "
6-8 "
Unobtainable
Wind speed
calm
1-2 knots
3-7 "
8-12 "
13-17 "
direction
North-west
North-east
South-west
South
January
February
March
April
May
June
July
August
September
October
November
December

lower latitudes continued to dominate the weather situation, and seem to have been the most important factor in keeping the air temperature comparatively high during most of the summer season. Heating of the ground by solar radiation cannot have played the same decisive part in this connection. During September and October situations with mild air currents connected with travelling depressions alternated with periods when cooler air from the north swept over the islands in the rear of the low pressure areas. Periods with above-normal temperatures were more pronounced in September than in October. Most of November as well as large parts of December was characterized by moderate to strong easterly to north-easterly winds, often to the north of the paths of the cyclonic centres. These air currents were, however, not of polar origin, but came from temperate regions in lower latitudes, and the temperatures were mostly considerably higher than the long-term average. The passage of a vigorous depression near the end of the year (29–30 Dec.) gave wind of storm force.

It appears from the diagram as well as from the data tabulated below that 1972 was an exceptionally mild year. As usual in these regions the winter temperatures (which are considerably more variable than the summer temperatures) show the greatest deviations. It may be mentioned that for all three stations represented in the table, the mean temperature for January was the highest recorded for 25 years, and the annual mean was from 2.4° (Bjørnøya) to 3.0° (Hopen) higher than the 1947–71 average. In agreement with these facts the cyclonic activity over the North Atlantic was unusually high during most of the year, with a corresponding great average intensity of the Icelandic low, and a strong transport of mild, maritime air towards the Svalbard area. As would be expected, the amount of precipitation was exceptionally high as well. Thus, at Isfjord Radio the annual precipitation amounted to 750 mm, which is nearly twice the normal value, and the highest value recorded since regular observations started at this station (1935). Precipitation was especially abundant in January (122 mm), a large part of it falling as rain. Only the months of April to June, and November, had about normal precipitation quantities.

Monthly mean temperatures for 1972 (T) and their deviations (d) from the means of the period 1947–71

		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Isfjord Radio	T	−3.0	−8.6	−7.9	−9.8	−2.7	3.3	5.2	5.0	3.0	−2.6	−2.6	−7.0
	d	9.0	3.2	4.8	−0.5	0.8	1.7	0.6	0.8	2.1	0.7	4.5	2.5
Hopen	T	−3.5	−9.1	−9.9	−13.8	−4.1	1.0	3.2	3.8	2.9	−0.9	−1.4	−4.8
	d	10.3	3.6	4.2	−3.1	0.7	1.4	1.4	1.7	2.3	2.1	5.8	5.8
Bjørnøya	T	−0.4	−4.1	−4.7	−6.2	−0.9	3.8	6.1	5.8	4.1	0.6	−0.9	−1.2
	d	7.6	3.3	3.3	−0.7	0.6	2.0	2.0	1.5	1.4	0.7	2.0	4.6

Sea ice and drift speed observations in 1972

By Torgny E. Vinje

A survey of the sea ice distribution at the end of each month is shown in Figs. 1–12. The main source of data is the American satellite pictures, supplemented by observations from aircrafts, Arctic weather stations and ships. The observations have been plotted at Meteorologisk Institutt, Oslo.

By comparison of satellite pictures with surface observations, it has been found that a concentration of less than about 3/8 is not always registered on the satellite pictures.

Ice conditions north of Iceland are now near to normal, after a contineous improvement since 1968. In Vesterisen (Fig. 4) the annually reoccurring features of Odden and Nordbukta are observed during the end of April. Comparing with Fig. 3, it seems that these features which indicate an inter-mingling between the East-Greenland Current and the water in the Norwegian Sea, are found at considerably higher latitudes at the end of March.

Ice conditions west of Svalbard became very favourable during the sailing season. On the eastern and northern sides of the Archipelago the ice edge withdrew in August and September to even more northerly positions than in 1970, which was the best ice year since 1960.

In Østisen the reoccurring feature, Nordostodden, was marked during the end of January and April. The position of the ice edge in this area is close to normal for the first four months of the year. In July, August, and September the ice edge is found in more northerly areas than in 1970 which can be compared with the particularly favourable year 1960. Refreezing during October, November, and December was relatively modest, and at the end of the year the ice edge had a position which was about two degree latitudes north of normal.

In Table 1 are given some average drift speed values of giant floes as obtained from the weather satellite pictures. The positions of the floes have been plotted with the aid of a pantograph, using well marked points which can be identified in the different pictures.

Table 1

Position	Speed km/24h	Drift from	Period
80.5N—01W	18.7	NNE	15.IV—22.IV
79.5N—04W	23.4	NNE	15.IV—22.IV
80.2N—05W	10.3	NW	25.IV— 2.V
79.7N—04W	9.0	NNE	2.V —12.V
74.8N—44E	17.4	NNE	22.IV—25.IV
76.2N—44E	17.4	ENE	22.IV—25.IV
75.2N—42E	10.4	NE	3.V —13.V

The relatively great variation in drift speed for different periods and positions should be noted. The obtained values are, however, within the range of estimates made in previous years (Vinje: Årbok 1968, 1970, and 1971).

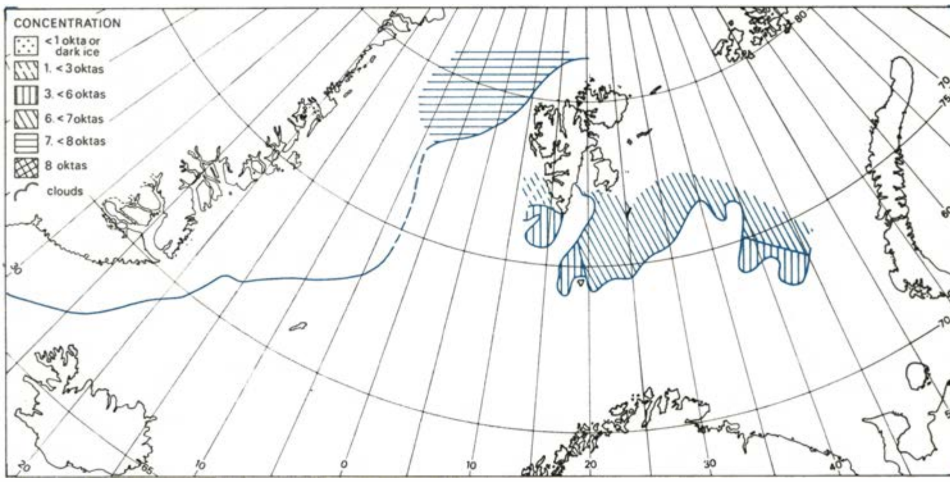


Fig. 1. *Sea ice distribution at the end of January.*

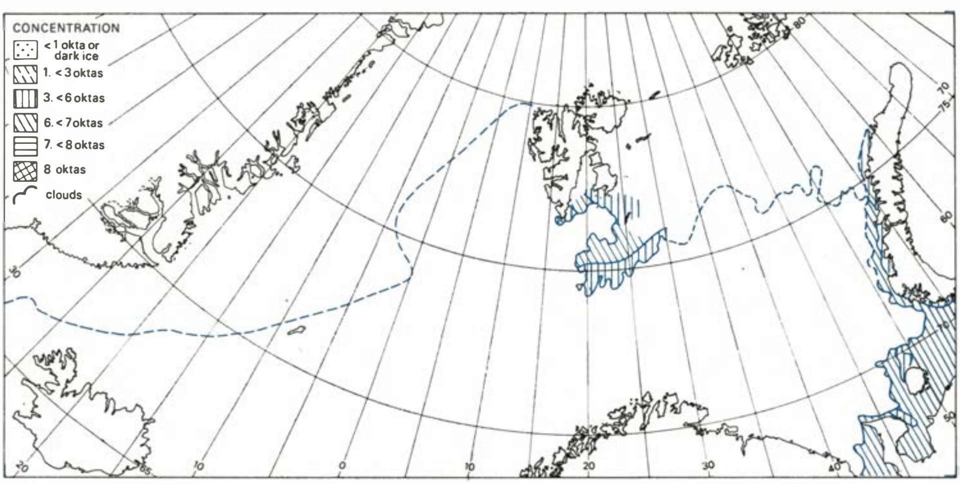


Fig. 2. *Sea ice distribution at the end of February.*

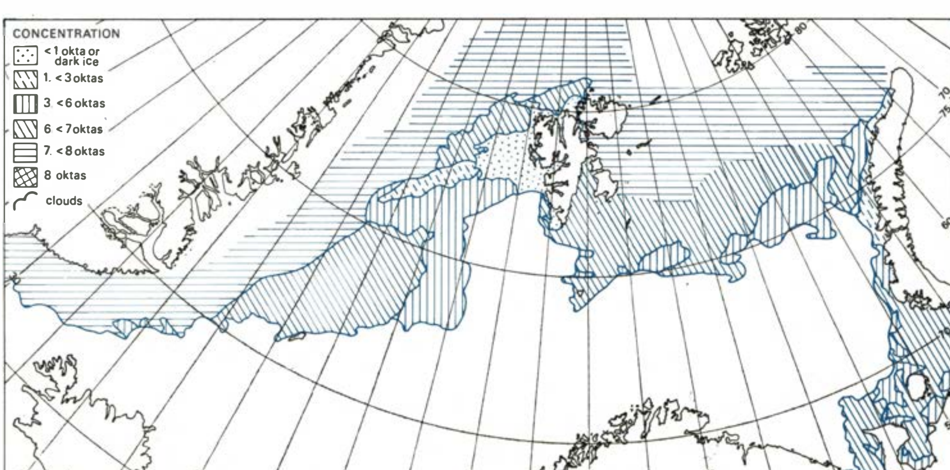


Fig. 3. *Sea ice distribution at the end of March.*

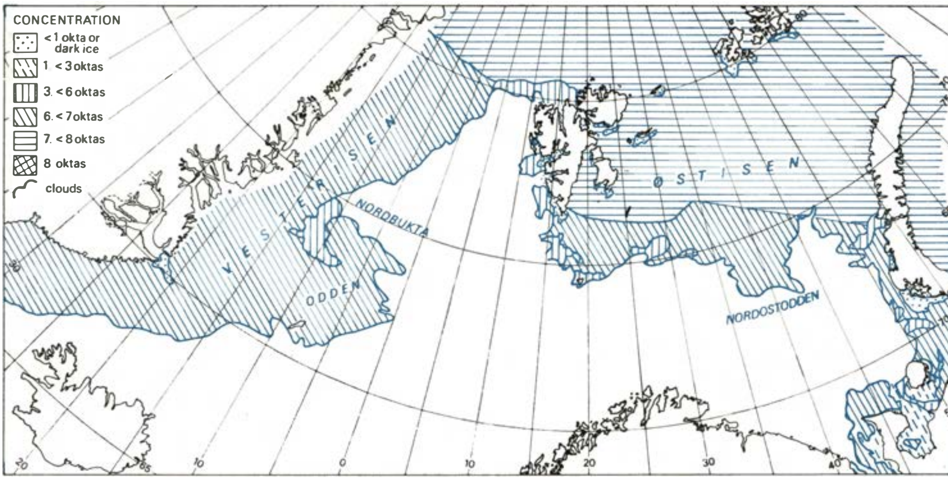


Fig. 4. *Sea ice distribution at the end of April.*

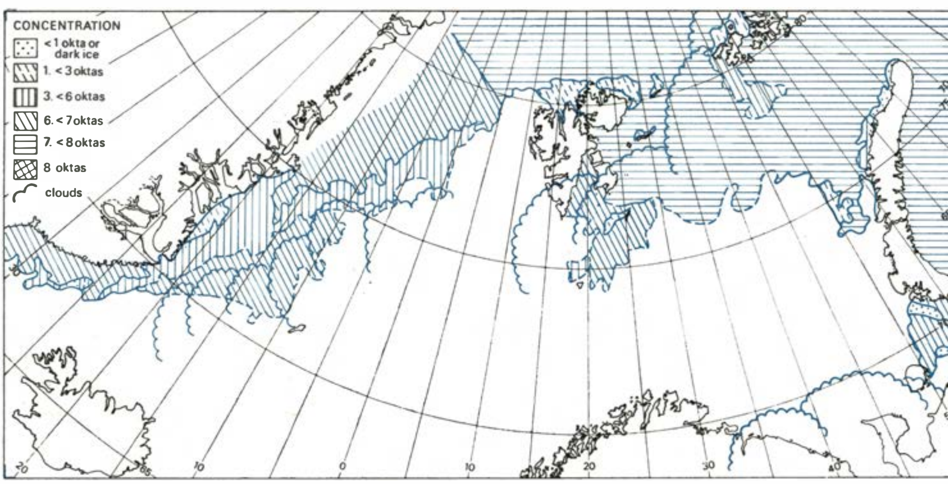


Fig. 5. *Sea ice distribution at the end of May.*

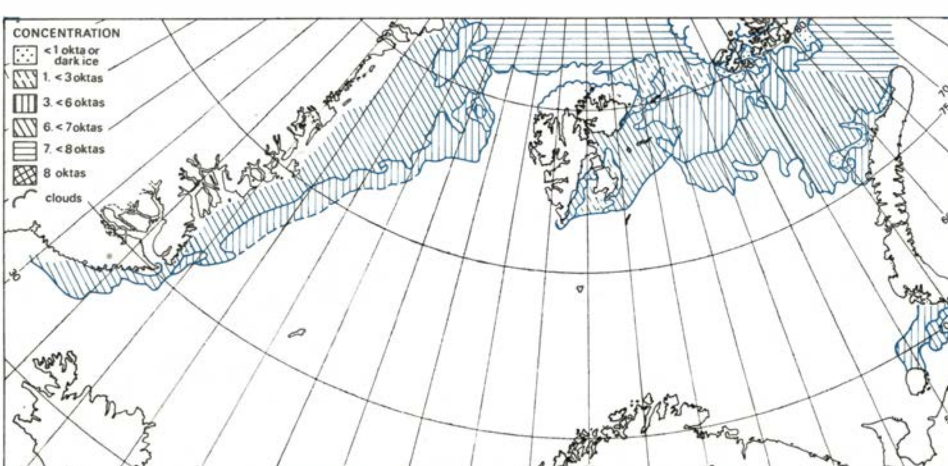


Fig. 6. *Sea ice distribution at the end of June.*

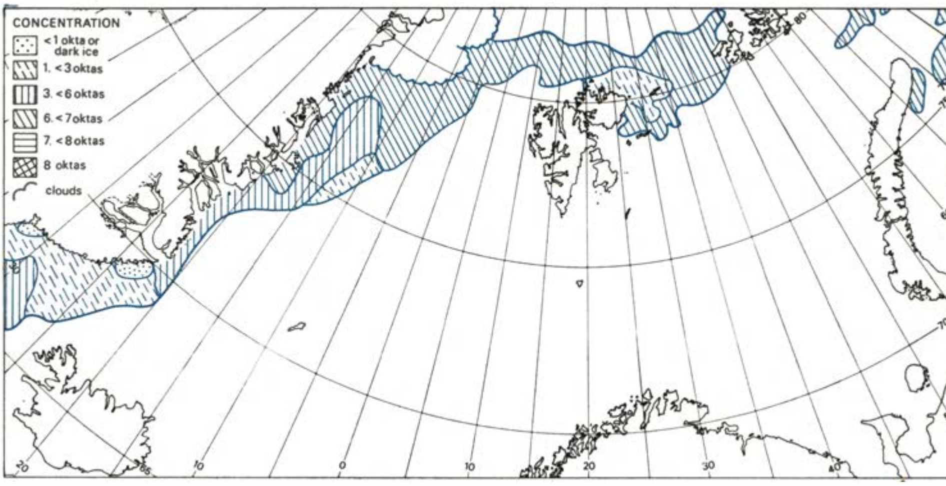


Fig. 7. *Sea ice distribution at the end of July.*

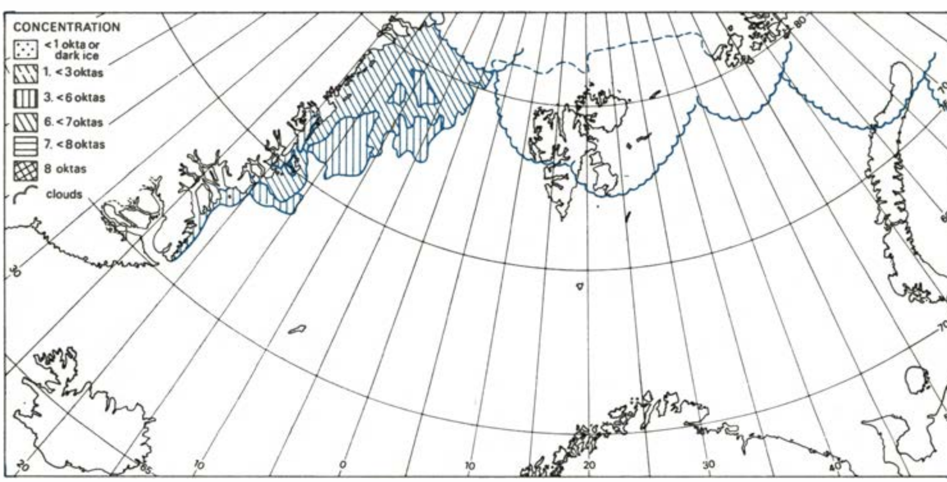


Fig. 8. *Sea ice distribution at the end of August.*

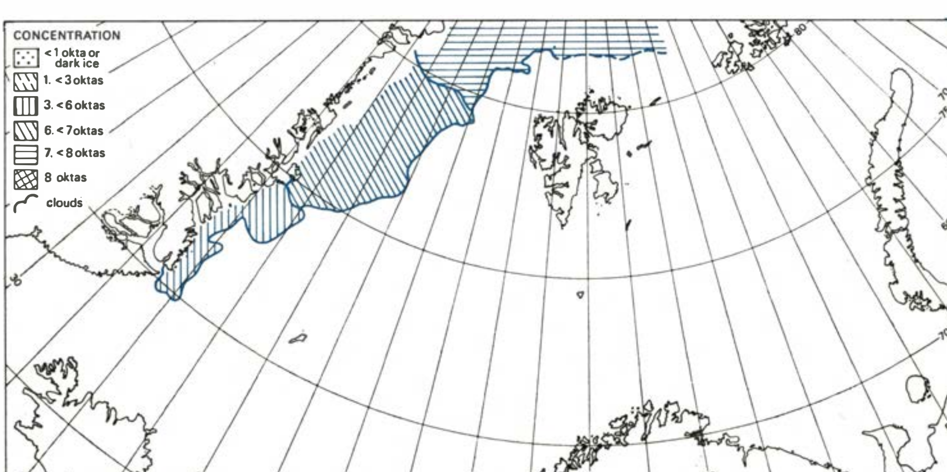


Fig. 9. *Sea ice distribution at the end of September.*

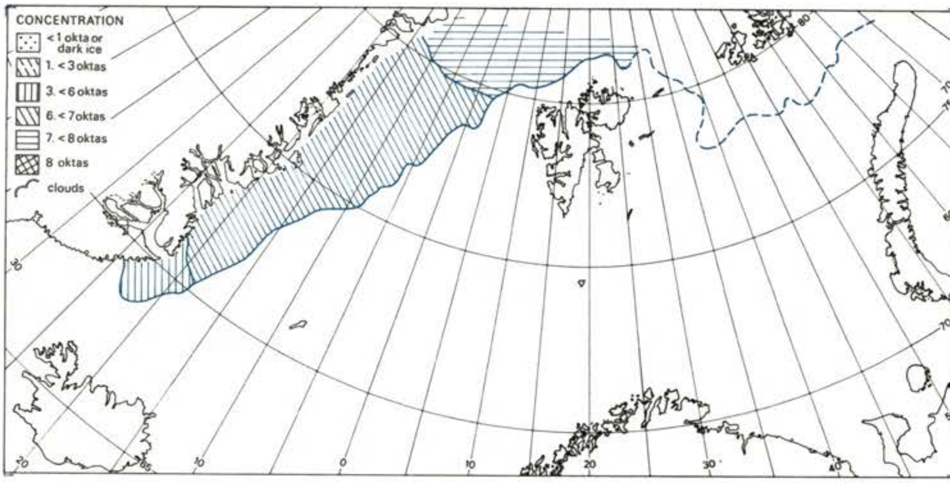


Fig. 10. *Sea ice distribution at the end of October.*

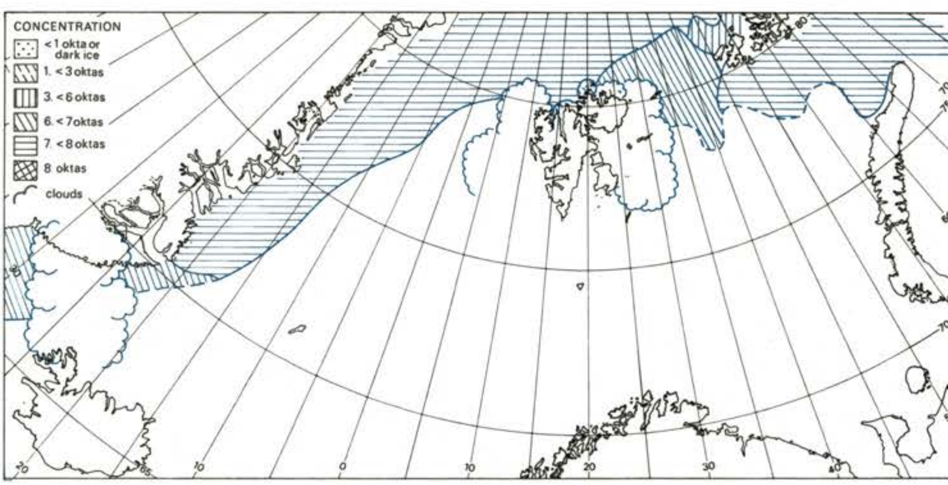


Fig. 11. *Sea ice distribution at the end of November.*

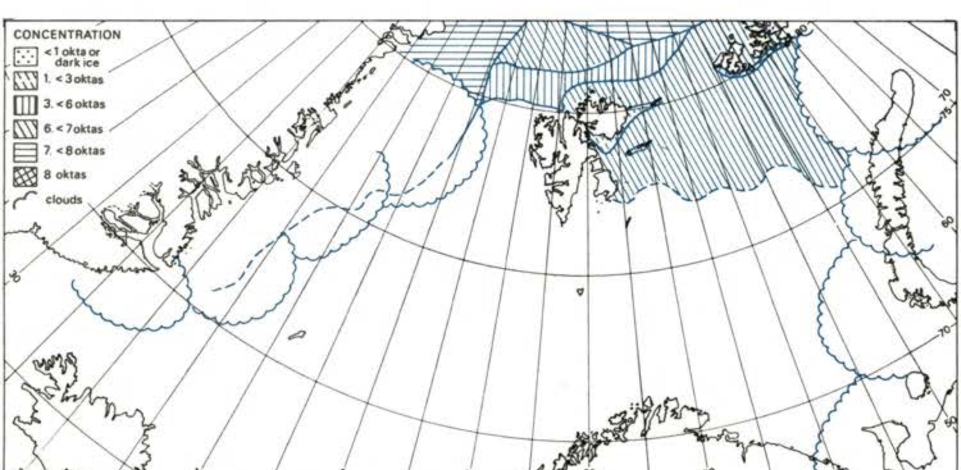


Fig. 12. *Sea ice distribution at the end of December*

Iakttagelser over dyrelivet på Svalbard i 1972

(Observations of animal life in Svalbard 1972)

(Наблюдения над фауной Свальбарда в 1972-м году)

AV THOR LARSEN

Innhold

Abstract

The present report on fauna observations from Svalbard is based on records from members of Norsk Polarinstitutt's expedition 1972 and from other persons visiting Svalbard in 1972. Several observations of walrus (*Odobenus rosmarus*) were made in Murchisonfjorden in the autumn of 1971 and the summer of 1972. About 50 harbour seals (*Phoca vitulina*) were seen at Prins Karls Forland, probably the first observations of the species in Svalbard. The expansion of the Svalbard reindeer (*Rangifer tarandus platyrhynchus*) in Wijdefjorden is described. Among the birds observed are a Ross' gull (*Rhodostethia rosea*) at Longyearbyen, a Sabine's gull (*Xema sabini*) at Kapp Linné, a curlew sandpiper (*Calidris testacea*) at Ryke Yseøyane, and snowy owls (*Nyctea scandiaca*) at Ny-Ålesund.

Аннотация

Настоящий отчет о наблюдениях над свальбардской фауной основан на сведениях, доставленных участниками летней экспедиции Норвежского Полярного Института (Norsk Polarinstitutt) 1972-го года и другими лицами, посетившими Свальбард в том же году. Не раз наблюдались моржи (*Odobenus rosmarus*) в заливе Murchinsonfjorden на Северо-Восточной Земле осенью 1971-го года и летом 1972-го года. Около острова Prins Karls Forland было обнаружено около 50 обыкновенных тюленей (*Phoca vitulina*), что вероятно представляет собой первое наблюдение этого вида на Свальбарде. Описано расширение ареала свальбардского северного оленя (*Rangifer tarandus platyrhynchus*) в районе залива Wijdefjorden. Обращает на себя внимание наблюдение розовой чайки (*Rhodostethia rosea*) около поселка Longyearbyen, вилохвостой чайки (*Xema Sabini*) на мысе Kapp Linné, краснозобика (*Calidris testacea*) на островах Ryke Yseøyane и белых сов (*Nyctea scandiaca*) около поселка Ny-Ålesund.

Innledning

Det biologiske observasjonsmaterialet for 1972 er langt mer sparsomt enn i tidligere år. Dette skyldes blant annet at Norsk Polarinstitutts biologstilling var ubesatt i vår- og sommermånedene når ekspedisjonene til Svalbard og Jan Mayen ble forberedt og avviklet. Observasjonsmaterialet er forsøkt samlet inn fra forskjellige kilder etterpå, men gir neppe noe representativt bilde av faunaforekomstene i 1972 i forhold til tidligere år. Registreringene er ikke kvantitativt representative, i og med at innrapporteringene varierer både med hensyn til tid, sted og effektivitet. Jeg har funnet det av liten interesse å omtale vanlige fugle- og pattedyrarter når disse opptrer i sine tradisjonelle utbredelsesområder. Spesielle forhold blir fremhevet når det går frem av observasjonsrapportene.

Takk

Jeg vil rette en takk til alle som har bidratt med opplysninger om fugle- og pattedyrobservasjoner på Svalbard 1972. Rapporter er mottatt fra ERLING A. M. ANDREASSEN og NJÅL OFTEDAL JACOBSEN (EA/NOJ) fra Longyearbyen, Ny-Ålesund, Bellsund, Gråhuken og Ryke Yseøyane, JENS ANGARD (JA) fra Andrée Land, ROLF E. HUSETH (REH) fra Prins Karls Forland, JOHN KROG (JK) fra Prins Karls Forland, ERIK S. NYHOLM (ESN) fra Murchisonfjorden, ERIK og KNUT SVENDSEN (ES/KS) fra Svenskøya, BJØRN WOLD (BW) fra Ny-Ålesund, og fra Naturgeografiska Institutionen ved Lunds Universitet ved JONAS ÅKERMAN fra Nordenskiöld Land og Ny-Ålesund.

Pattedyr

Svalbardrein (*Rangifer tarandus platyrhynchus*) – Under gjentatte flyvninger over den nordlige del av Spitsbergen og over nordkysten av Nordaustlandet i mars, april og mai ble det observert rein. Dyrene har nå bredd seg sørover langs Wijdefjordens vestbredd til Purpurdalen. Bestanden på Andrée Land anslås nå til ca. 100 dyr (JA). Ved flyvningene på Nordaustlandet ble det også observert spredte forekomster av rein så langt øst som til Kapp Bruun. Bestanden mellom Murchisonfjorden og Kapp Bruun anslås til en størrelsesorden på ca. 100 dyr. En reinbukk ble observert på Svenskøya i august (ES/KS). Dette er antagelig det samme individet som første gang ble observert på øya i 1967 (NORDERHAUG 1967) og som også ble sett under isbjørnundersøkelsene på Svenskøya i april 1972. Reinbukken er i godt hold, og ser ut til å greie seg bra på Svenskøya (Fig. 1).

Moskus (*Ovibos moschatus*) – 17 individer ble observert midt i det meget bratte Fuglefjella straks nord for Grumantbyen under en flyrekognosering den 6. april. Det syntes merkelig med såvidt mange moskus på dette stedet, hvor faren for steinsprang og for at de skulle falle utfor fjellet var stor.

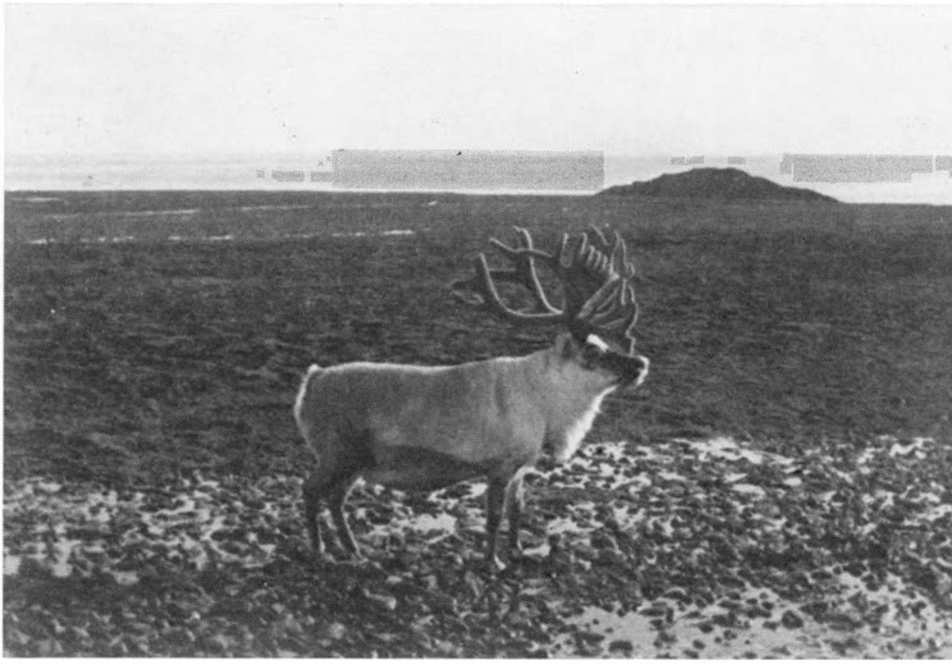


Fig. 1. *Reinsbukk på Svenskøya. Bukken har vært der minst siden* 1967.
Reindeer buck on Svenskøya. The buck has been there at least since 1967.
Олень-самец на о-ве Svenskøya (Шведском). Животное остается здесь во всяком случае с 1967 г.
Photo: ERIK SVENDSEN

Isbjørn (*Ursus maritimus*) – Under rekognoseringene etter isbjørnhi på Svalbard i mars, april og mai, ble isbjørn stadig observert i de østlige og nordlige områdene. Det var særlig stor aktivitet av bjørn i Liefdefjorden, i Woodfjorden, utenfor Nordaustlandets nordkyst og ved Kong Karls Land. Ved Edgeøya, Barentsøya og i Storfjorden var forekomstene mindre. Dette kan blant annet skyldes de spesielle isforholdene, med mye åpent vann og nyis i sistnevnte farvann. På Svenskøya ble det sett 10 voksne bjørn og 2 årsunger i august. De fleste bjørnene var påfallende magre på denne tiden (ES/KS). Fig. 2.

Steinkobbe (*Phoca vitulina*) – Ca. 50 individer ble sett ved Kap Sietoe, Prins Karls Forland, gjentatte ganger (JK). Ett individ ble skutt. Det er såvidt vites første gang steinkobbe med sikkerhet er observert på Svalbard (KROG 1973).

Hvalross (*Odobenus rosmarus*) – I september 1971 ble mange grupper hvalross sett i Murchisonfjorden, men antallet er ikke spesifisert nærmere. I august 1972 ble det på øyene i Murchisonfjorden sett småflokker med opptil 4 individer sammen, og minst 7 forskjellige individer på en og samme dag (ESN). Det foreligger dessuten rapport om observasjon av 3 hvalross ved Tusenøyane ved FINA-gruppen, men dette har ikke latt seg bekrefte.

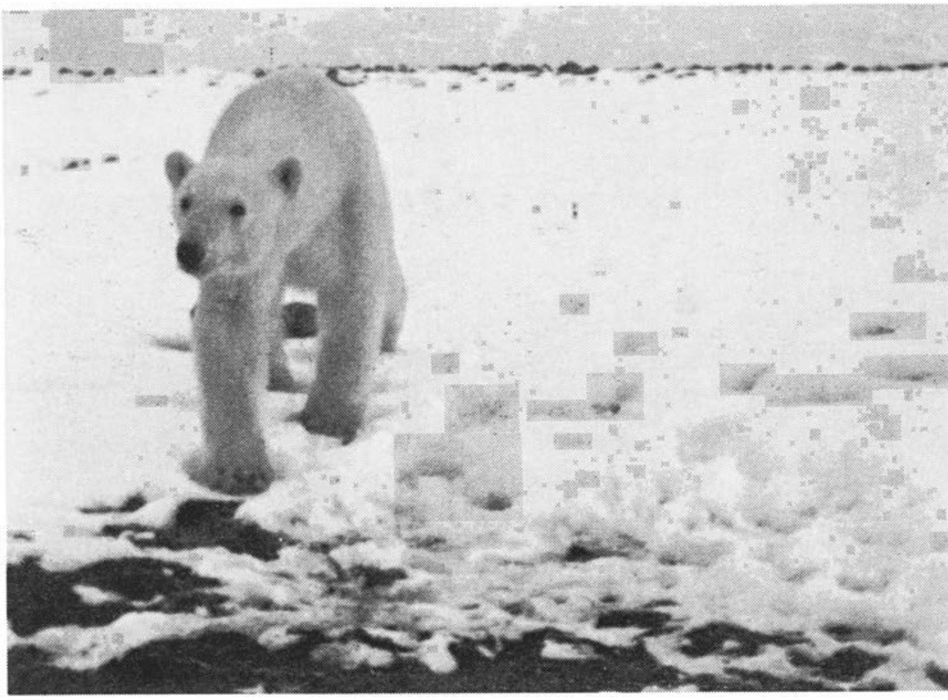


Fig. 2. *Isbjørn på Svenskøya i august. Dyret er påfallende magert.*
Polar bear on Svenskøya in August. The animal is unusually lean.
Белый медведь на о-ве Svenskøya (Шведском) в августе. Бросается в глаза худоба зверя.
Photo: ERIK SVENDSEN

Fugler

Havelle (*Clangula hyemalis*) – 6–7 par oppholdt seg på Lovénøyane i slutten av juni. Ett reir ble funnet i Blomstrandhavna (BW).

Praktærfugl (*Somateria spectabilis*) – Noen få observasjoner er fra Kongsfjordområdet (BW). 1 hann, 20 hunner og 1 hunn med 5 unger ble sett ved Kapp Martin 24/7. 1 hunn ble sett ved Ryke Yseøyane gjentatte ganger i august (EA/NOJ)

Ringgås (*Branta bernicla hrota*) – 6 individer ble sett ved Mårflodssjøen, Gråhuken 27/7 (EA/NOJ). 3 individer ble sett over Kapp Linné 15/8 (ÅKERMAN 1972).

Hvitkinngås (*Branta leucopsis*) – 2 par ble sett ved Ny-Ålesund, men hekking er ikke angitt (BW). Ved Kapp Martin ble 23 voksne og 29 unger observert 24/7 (EA/NOJ). 2 individer ble sett i Fyrsjøen ved Kapp Linné 15/8 (ÅKERMAN 1972).

Sandlo (*Charadrius hiaticula*) – Arten ble observert ved Longyearbyen 16/7 og 22/7 og ved Ny-Ålesund 19/7 (EA/NOJ)

Steinvender (*Arenaria interpres*) – 4–5 par oppgis å ha hekket ved Ny Ålesund (BW). Ett individ ble sett ved Ryke Yseøyane 1/8 (EA/NOJ). 4 individer, hvorav 2 ungfugler, ble sett ved Kapp Linné 14–17/8 (ÅKERMAN 1972).

Heilo (*Pluvialis apricaria*). Ett individ ble sett ved Norsk Polarinstitutts leir i Selvågen på Prins Karls Forland 21/7 (REH).

Polarsnipe (*Calidris canutus*) – 2 individer ble sett på Kapp Linné 16/8 (ÅKERMAN 1972).

Myrsnipe (*Calidris alpina*) – Flokker på mellom 6 og 18 individer ble sett ved Kapp Linné mellom 12. og 17/8. 6 individer ble sett i Moskuslaguna 6/8 (ÅKERMAN 1972).

Tundrasnipe (*Calidris testacea*) – Ett individ ble observert på Ryke Yseøyane 23/8 og 26/8. Observatørene oppgir at de er fortrolige med arten fra tidligere ringmerkinger (EA/NOJ).

Sandløper (*Crocethia alba*) – 2 individer ble sett ved Ny-Ålesund 19/7. 1/8 og 3/8 ble 2 individer sett på Ryke Yseøyane, og 26/8 igjen 3 individer (EA/NOJ).

Svømmesnipe (*Phalaropus lobatus*) – Ett individ ble sett ved Ny-Ålesund 19/7 (EA/NOJ) og ett ved Longyearbyen 5/8 (ÅKERMAN 1972).

Polarjo (*Stercorarius pomarinus*) – En flokk på 20–25 polarjo ble observert på Svenskøya i august (ES/KS). Arten ble observert daglig på Ryke Yseøyane i samme tidsrom, i flokker fra 2–6 individer opp til 35 individer den 23/8 (EA/NOJ). Arten hekket ikke på øyene. Ett individ ble sett i munningen av Kongsfjorden 18/8 og ett i Forlandssundet 19/8 (ÅKERMAN 1972).

Fjelljo (*Stercorarius longicaudatus*) – Ett individ ble sett ved Linnévatnet 16/8 (ÅKERMAN 1972). For øvrig ble arten stadig observert på Ryke Yseøyane i august, som enkeltindivider eller i små flokker. Den 5/8 ble en flokk på 15 individer sett (EA/NOJ).

Svartbak (*Larus marinus*) – Ett individ ble sett ved Ny-Ålesund (BW, ÅKERMAN 1972). To individer ble sett ved Kapp Martin den 24/7 (EA/NOJ).

Sabinemåke (*Xema sabini*) – Ett individ ble sett ved Kapp Linné 13/8 og 14/8 (ÅKERMAN 1972).

Rosenmåke (*Rhodostethia rosea*) – Ett individ ble sett ved Longyearbyen 21/7 (EA/NOJ). Observatørene, som begge er amatørornitologer og ringmerkere, oppgir at fuglen var lett kjennelig på en smal, svart halsring, svart tynt nebb og kileformet hale. Det foreligger bare én tidligere observasjon av denne arten fra Svalbard, fra Hotellneset 1/7 1950 (LØVENSKIOLD 1963).

Snøugle (*Nyctea scandiaca*) – 3 individer ble sett ved Engelskbukta ved Ny-Ålesund våren 1972 (BW).

Litteratur

KROG, J., 1973: Fjordsel på Svalbard. *Fauna* **26** (3), 217–218.

LØVENSKIOLD, H. L., 1963: Avifauna Svalbardensis. *Norsk Polarinst. Skrifter* Nr. 129.

NORDERHAUG, M., 1969: Iakttagelser over dyrelivet på Svalbard 1967. *Norsk Polarinst. Årbok* 1967, 197–205.

ÅKERMAN, J., 1972: *Zoologiska iakttagelser på Spetsbergen tiden* 3/8 -18/81972. Stensilert rapport, 3pp.

Norsk Polarinstitutts virksomhet i 1972

Av Tore Gjelsvik

Organisasjon og administrasjon

PERSONALE

Norsk Polarinstitutt hadde i 1972 33 faste stillinger, 1 mer enn i foregående år. Magnar Norderhaug fratrådte sin stilling som biolog 30. april. Bjarne Evensen ble innvilget ett års permisjon uten lønn fra sin stilling som karttegner I, regnet fra 8. august. Følgende ble ansatt ved instituttet i 1972: Olav Orheim som forsker II fra 27. mars, Reidunn Lund som bibliotekar fra 1. april, Yoshihide Ohta som geolog II fra 26. juni, Jan Terje Bjørke som topograf i særklasse fra 3. juli, Thor Severin Larsen som biolog fra 15. august. Alle faste stillinger var dermed besatt pr. 31. desember 1972.

Midlertidig engasjerte:

Andersen, Liv Kruge, redaksjonssekretær. Fra 9. mars.
Eeg-Henriksen, Vibeke, assistentbibliotekar. Til 31. mai.
Gulbrandsen, Grethe, assistent. Til 29. februar.
Horn, Kirsten, kontorassistent. Fra 25. mai–15. juli.
Huseth, Rolf Egil, assistent.
Knudsen, Elsa, kontorassistent. Fra 25. september.
Kristensen, Ivar Rendal, cand. mag.
Møllen, Gunstein Uleberg, cand. real. Til 31. januar.
Edwards, Marc B., Ph. D. (lønnet av NTNF på Barentshavprosjektet)
Koch, Leif, stud. real. (lønnet av NTNF på Barentshavprosjektet)

Stipend og forskningsbidrag er ytt til:

Inspektør Bjørn Arnesen, stipend til dekning av utgifter ved deltakelse i kurs om kartografi og reproduksjonsteknikk ved Tekniska Högskolan i Stockholm.

Student Elin Hegstad Gulliksen, bidrag til utarbeidelse av bibliografi om Jan Mayen.

Cand. mag. Karl Hagelund, bidrag til bearbeidelse og publisering av materiale fra ærfuglundersøkelser på Svalbard.

Cand. real. Vidar Hisdal, stipend til dekning av utgifter ved studiereise til Physikalisch-Meteorologisches Observatorium i Davos.

Professor JOHN KROG, stipend til delvis dekning av reiseutgifter i forbindelse med zoofysiologiske studier på Svalbard.

Cand. real. THOR LARSEN, stipend til dekning av utgifter vedrørende undersøkelser av alderssammensetningen for isbjørn i Arktis.

Dr. philos. ODD LØNØ, bidrag til arbeid og publisering av vitenskapelig verk om norske fangstmenns overvintringer fra 1795 til 1892, samt utarbeidelse av statistikk over polarrevfangsten på Svalbard.

B. Sc. A. J. WILLIAMS, stipend til dekning av reiseutgifter i forbindelse med undersøkelser om lomvi-arter på Bjørnøya.

Oppnevnelser:

Direktør TORE GJELSVIK til (1) medlem i Polarrådet, (2) formann i Den norske nasjonalkomité for polarforskning (gjenoppnevnt for tidsrommet 1973–76), (3) medlem av komitéen for forberedelse av Den Norske Ingeniørforenings Svalbardkonferanse 1973.

THOR SIGGERUD til medlem i Utvalg for å vurdere videre undersøkelsesarbeider for å få en overvåkning av vulkanismen på Jan Mayen.

TORGNY VINJE til medlem av et meteorologisk-oseanografisk utvalg under Nasjonalkomitéen for polarforskning for vurdering av fremtidig norsk virksomhet i forbindelse med internasjonale prosjekter i Arktis.

OLAV ORHEIM til (1) norsk medlem av SCAR arbeidsgrupper i glasiologi og logistikk, (2) viseformann i Nordisk Seksjon av International Glaciological Society, (3) sekretær i Den norske nasjonalkomité for polarforskning.

THORE WINSNES til varamann for GJELSVIK i Polarrådet.

Etter forslag fra direktøren ble det i 1972 opprettet et faglig kollegium ved Norsk Polarinstitutt med oppdrag å utarbeide forslag til perspektivanalyse og langtidsplaner for den faglige aktivitet ved instituttet. Kollegiet, som består av en valgt representant for hver faggruppe samt ekspedisjonslederen for Svalbard og planleggeren av virksomheten i Antarktis, fikk for perioden 1972/73 denne sammensetning: THORE WINSNES, OLAV LIESTØL, SIGURD HELLE, THOR LARSEN, JOH. H. CHRISTIANSEN, THOR SIGGERUD og OLAV ORHEIM. På kollegiets første møte i april ble WINSNES valgt som formann og LIESTØL som sekretær.

Kommentarer til regnskapet:

Kap. 950.

Post 9. Deltakelse i Antarktisekspedisjon. – Innsparingen skyldes at virksomheten i Antarktis innskrenket seg til deltakelse av tre forskere fra Geofysisk Institutt, Bergen Universitet i en amerikansk ekspedisjon til Weddellhavet. På grunn av tap av flere store transportfly har det ikke vært mulig å få amerikansk logistisk assistanse til å sende feltpartier til Dronning Maud Land.

Post 10. Kjøp av utstyr. – Av det oppførte bevilgede beløp, kr. 175 000,–, er kr. 32 000,– ordinær bevilgning, mens kr. 143 000,– er rest av tilleggsbevilgning for 1971. Bortsett fra kr. 14 000,– er tilleggsbevilgningen ubenyttet. Det bemerkes at posten opprinnelig var beregnet for Norges Vassdrags- og Elektrisitetsvesens behov, i fall noen av dets avdelinger skulle ha flyttet til Rolfstangen.

REGNSKAP FOR 1972

Kap. 950. Poster:		*Bevilget:*		*Medgått:*
1. Lønninger	kr.	2 085 000	kr.	2 134 300
9. Deltakelse i Antarktisekspedisjon	»	95 000	»	58 600
10. Kjøp av utstyr	» *)	175 000	»	45 600
11. Sentralbord og telefon	» *)	140 000	»	38 300
15. Vedlikehold	»	1 000	»	0
20. Ekspedisjoner til Svalbard og Jan Mayen	»	1 340 000	»	1 330 200
29. Andre driftsutgifter	» *)	1 067 000	»	954 400
30. Innredningsarbeider	» *)	735 000	»	639 200
70. Stipend	»	45 000	»	44 500
	kr.*)	5 683 000	kr.	5 245 100

*) I beløpene er inkludert overføringer av ubenyttet tilleggsbevilgning gitt i 1971 i forbindelse med flytting av instituttet fra Middelthunsgate 29 til Rolfstangveien 12.

Kap. 31. Fyr og radiofyr på Svalbard	kr.	36 000	kr.	28 300

Kap. 340. Forskningsstasjonen på Svalbard:				
9. Driftsutgifter	kr.	262 000	kr.	180 200
10. Inventar og utstyr	»	50 000	»	38 200
	kr.	312 000	kr.	218 400

Kap. 3950. Inntekter:		*Budsjettert:*		*Innkommet:*
1. Salgsinntekter	kr.	100 000	kr.	70 100
2. Refusjon fra Svalbardbudsjettet	kr.	550 000	»	550 000
3. Andre inntekter	»	20 000	»	0
	kr.	670 000	kr.	620 100

Kap. 4909. Tilfeldige inntekter:	kr.	0	kr.	13 200

Post 11. Sentralbord og telefon. – Det oppførte beløp, kr. 140 000,– er rest av tilleggsbevilgning for 1971. Innsparingen skyldes at også denne post opprinnelig var beregnet for Norges Vassdrags- og Elektrisitetsvesens behov.

Post 20. Ekspedisjoner til Svalbard og Jan Mayen. – Med Finansdepartementets tillatelse fikk instituttet anledning til å omdisponere underpostene til å kjøpe inn et elektronisk posisjonssystem for hydrograferingsbåten «Svalis». Dette ble gjort ved å spare inn leie på et helikopter, til tross for at man da mistet en del effektivitet i arbeidet for andre faggrupper.

Post 29. Andre driftsutgifter. – Det oppførte bevilgede beløp, kr. 1 067 000,–, inkluderer ordinær bevilgning, kr. 1 052 000,–, samt rest av tilleggsbevilgning for 1971, kr. 15 000,–. Innsparingen skyldes bl. a. mindreforbruk på kr. 36 000,– til trykning på grunn av forsinkelser med trykningsarbeidene og mindreforbruk på kr. 33 000,– til bygningers drift.

Kap. 340. Forskningsstasjonen på Svalbard.
Innsparingen skyldes i det vesentlige at det på grunn av mangel på kvalifiserte søkere ikke har vært mulig å få besatt stillingen som bestyrer i l.kl. 20.

Kap. 3950. Inntekter.
Mindreinntekten skyldes i det vesentlige at salget av flybilder er gått ned.

Kap. 4909. Tilfeldige inntekter.
Inntektene er i det vesentlige godtgjørelse fra Sveriges Radio for filmmateriale fra Maudheimekspedisjonen 1949–52.

Feltarbeid

NORGE

Breundersøkelser

Undersøkelsene i Norge ble som tidligere ledet av LIESTØL.

De rutinemessige målinger av breenes massebalanse på Storbreen og Hardangerjøkulen ble utført av LIESTØL, cand. real. TRON LAUMANN og cand. mag. KJELL REPP. På Folgefonni startet cand. real. ARVE TVEDE en forenklet balansemåling av Blomsterskardbreen. Både Hardangerjøkulen og Storbreen viste i 1972 et lite underskudd mens Blomsterskardbreen hadde overskudd.

Målinger av bretungenes lengdevariasjoner ble foretatt på ti steder, to ved Folgefonni, to i Jotunheimen, fire ved Jostedalsbreen, en på Møre og en i Svartisen. Samtlige breer viser tilbakegang.

Terrestriske fotogrammer ble tatt opp av Briksdalsbreen og Nigardsbreen for kartleggingsformål.

SVALBARD

Da sjøkartleggingen i Svalbardfarvann fortsatt måtte gis høy prioritet og instituttet i 1972 også måtte sende en ekspedisjon til Jan Mayen, måtte den geologiske, topografiske og biologiske aktivitet under Svalbardekspedisjonen delvis utgå eller reduseres.

Ekspedisjonen til Svalbard ble planlagt og organisert av operasjonssjef SIGGERUD. I alt deltok 22 personer utenom besetningene på ekspedisjons- og hydrograferingsfartøyene og helikoptret. Ti var instituttets fast ansatte medarbeidere, tolv var engasjerte fagmedarbeidere og assistenter.

Ekspedisjonsfartøyet M/S «Polarstar» med kaptein JOHAN HOLSTAD og 12 manns besetning ble leiet av Martin Karlsens rederi. Fartøyet gikk fra Ålesund 11/7 og lastet ekspedisjonsutstyret fra jernbanevogn i Bodø 13/7. Ekspedisjonsutstyret ble losset i Bodø til jernbanevogn 3/9. Fartøyet ble avlevert i Ålesund 5/9.

Fartøyet ble benyttet som kombinert ekspedisjons- og opploddingsfartøy. Ekspedisjonsdeltakerne ble satt ut på Prins Karls Forland, og deretter ble det

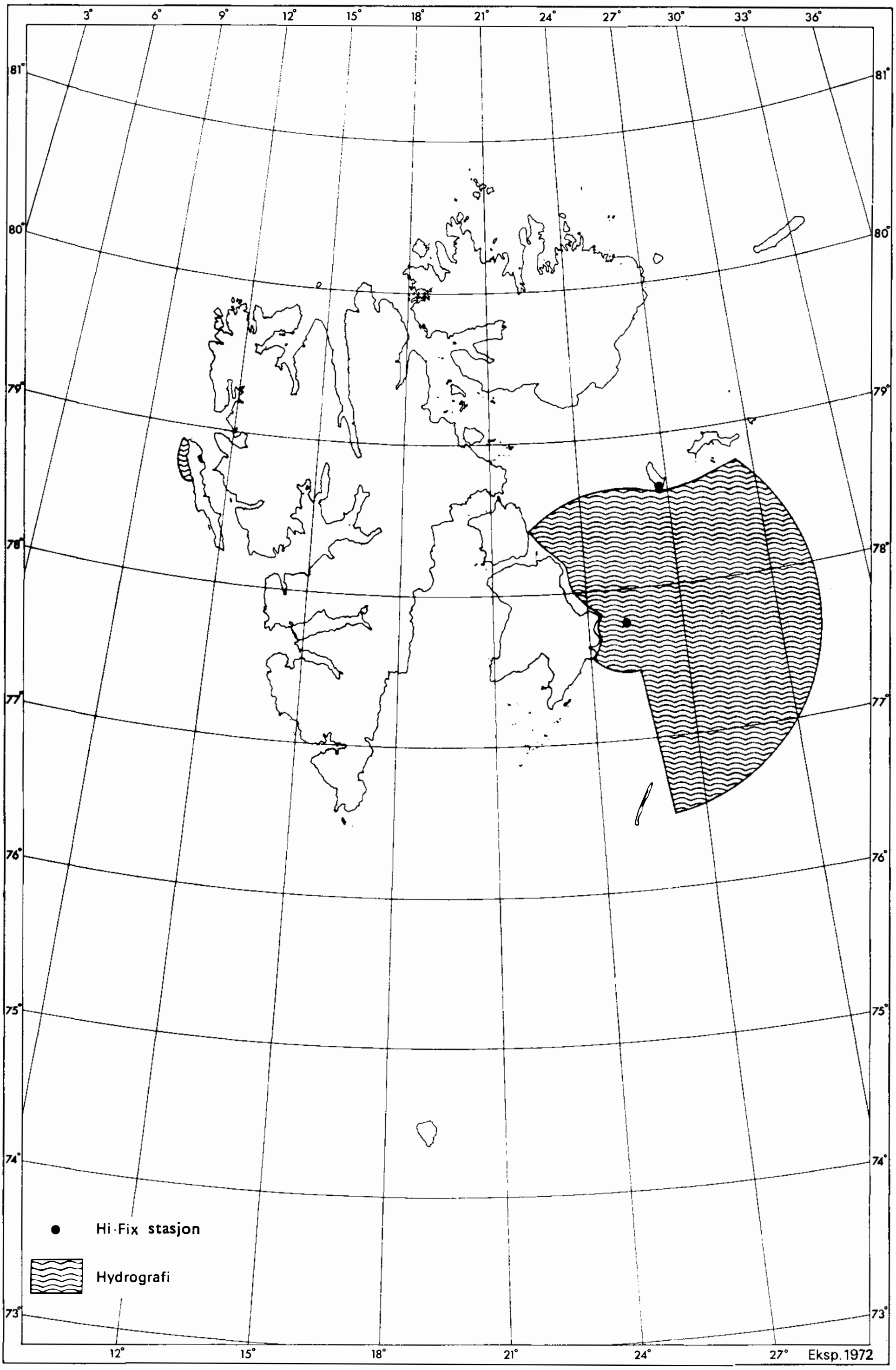


Fig. 1. *Opploddet areal i 1972.*

foretatt fyrettersyn frem til 25/7. I tiden til 28/8 ble det benyttet for opplodding. Ekspedisjonen ble hentet inn igjen i Selvågen 31/8.

Ekspedisjonens hovedoppgave var dels hydrografering, dels geologiske undersøkelser på Prins Karls Forland og i Oscar II Land. Det ble etablert en hovedbase for det geologiske arbeidet i Selvågen på Prins Karls Forland. Her var det også drivstofflager for helikopter. Radiokontakten med helikoptret ble også opprettholdt herfra.

Helikoptret, et Bell 47G4, var i regelen stasjonert i Ny-Ålesund. Helikoptret var leiet av Helikopter Service A/S. Det deltok en flyver og en mekaniker.

Opploddingen ble foretatt dels med «Svalis» i Kongsfjorden og ved Prins Karls Forland, dels med «Polarstar» i området øst for Edgeøya. Tidlig på sommeren ble det utført geofysiske målinger i Ny-Ålesund. Senere på sommeren ble det gjort breundersøkelser.

Hydrografi

I feltsesongen (18/6–11/9) fortsatte HELGE HORNBÆK, assistert av SIVERT UTHEIM og INGE FJELD, med hydrograferingsbåten «Svalis» detaljloddingen i munningen av Kongsfjorden og utenfor Prins Karls Forland. Et nytt navigasjonssystem (Motorola) for posisjonsmålinger ble tatt i bruk. Systemet viste seg meget hensiktsmessig, men på grunn av fabrikasjonsfeil som det ikke var mulig å utbedre på stedet, fikk man bare benyttet systemet en kortere tid i begynnelsen av feltsesongen. De siste tre ukene av feltsesongen ble benyttet til ombygging av «Svalis».

Sommerens tokt med M/S «Polarstar» ble ledet av CHRISTIANSEN. EINAR NETELAND hadde tilsyn med og vedlikehold av HI-FIX-systemet og annet elektronisk utstyr. Assistentene E. SVENDSEN og K. SVENDSEN, N. OFTEDAL JACOBSEN og E. MOSSIGE ANDREASSEN passet stasjonene på henholdsvis Svenskøya og Ryke Yseøyane. Utsetting av feltpartiene i Selvågen og ettersynet av radio-og lysfyrene gikk uten vanskeligheter og var fullført 25/7. Da isforholdene østpå var meget gunstige, ble det besluttet å lodde så langt NØ som mulig. HI-FIX-slavestasjonene som ble etablert på Kapp Hammerfest på Svenskøya og på Ryke Yseøyane, var på luften 1/8, og opploddingen ble påbegynt mellom Kong Karls Land og Hopen med Ryke Yseøyane som sentrum. I alt ble det gått ca. 4200 n.m. med loddelinjer. Avstanden mellom loddelinjene ble øket til 4000 m for å grovlodde et så stort område som mulig. Nedriggingen av slavestasjonene var fullført 28/8.

Geologi

Det geologiske feltarbeidet på Svalbard ble konsentrert om kartlegging av Hecla Hoek bergarter på Prins Karls Forland og i området nord for St. Jonsfjorden på Spitsbergen. AUDUN HJELLE og OHTA etablerte hovedleiren i Selvågen 18/7. Da arbeidet stort sett ville foregå i kort avstand fra kysten, ble det forsøkt brukt bare ett helikopter, et Bell 47 helikopter fra Helikopter Service A/S, med en flyver og en mekaniker. Geologassistenter var ATLE MØRK, PER OLAV MØRKESETH og ARNE AARRESTAD, mens TOM HUITFELDT og HUSETH arbeidet som radio- og leirassistenter.

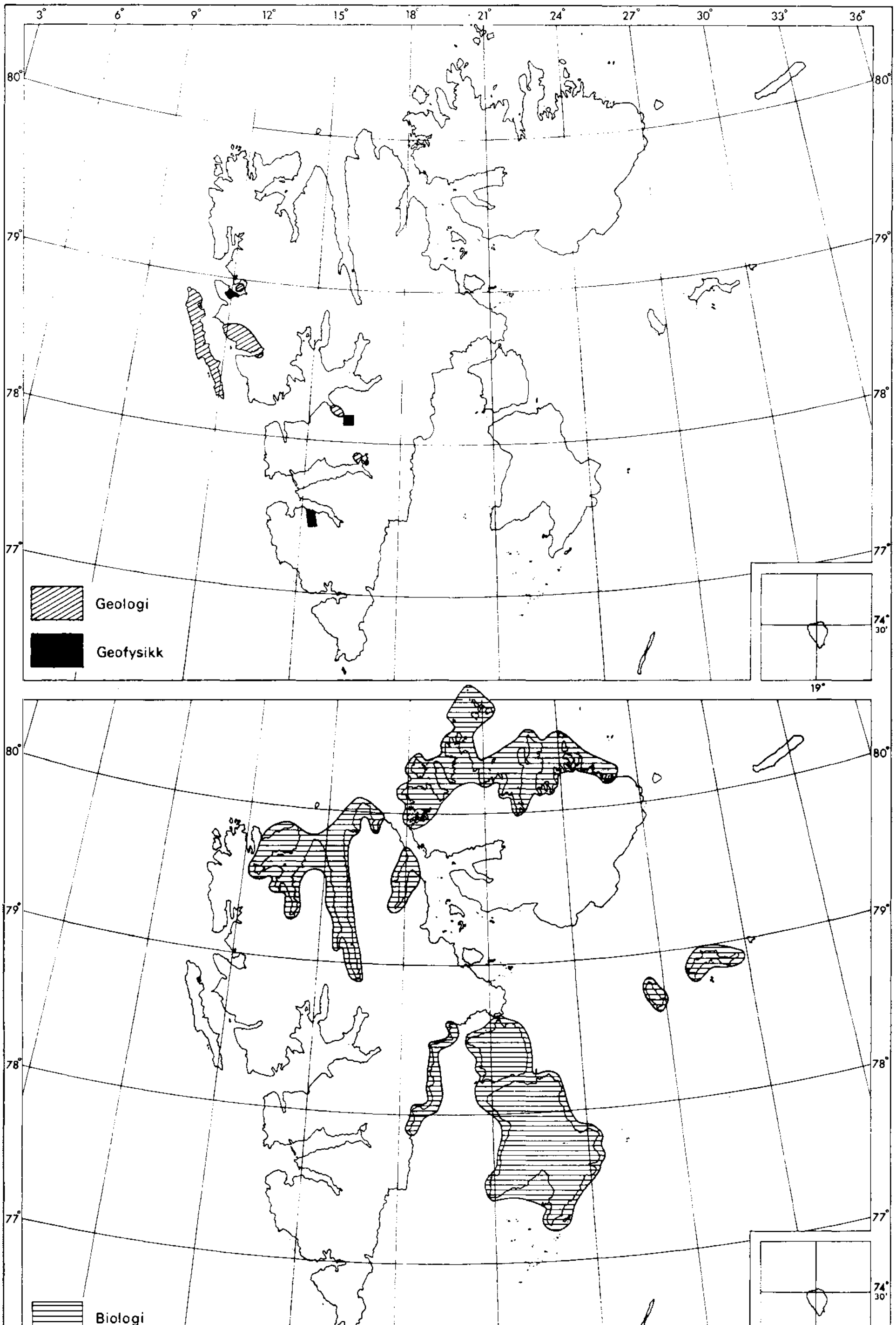


Fig. 2. *Geologiske, geofysiske og biologiske arbeidsområder i 1972.*

GJELSVIK deltok i partiets arbeid og ledet virksomheten inntil WINSNES ankom Selvågen 30/7. Arbeidet pågikk til slutten av august.

GJELSVIK måtte dra inn til Ny-Ålesund 28/7 for å løse de logistiske problemer som oppsto for geologpartiet da en sylinderskade på helikoptret satte det ut av drift i vel en ukes tid. I dette tidsrom fikk GJELSVIK besøk av den vitenskapelige direktør, professor RAVICH, ved Arktisk Geologisk Institutt, Leningrad, som ønsket å drøfte nærmere mulighetene for et geologisk samarbeid. I midten av august fikk geologpartiet besøk av en gruppe geologer fra det russiske institutt.

HARALD MAJOR arbeidet på Spitsbergen i tiden 17/7–17/8. Hovedarbeidet skulle vært undersøkelser av kullforekomstene i Gruve 7 i Longyearbyen, men dette kunne ikke gjennomføres da stollene var sperret av ras. MAJOR gjennomførte derfor undersøkelser i Gruve 3 og 6 i Longyearbyen og i prøvegruven ved Sveagruva. Dessuten målte han flere nye profiler i Sveafeltet, på sørsiden av Braganzavågen.

Geofysikk

Fra slutten av mars og ut året har strålingsdata blitt registrert hvert annet minutt i Ny-Ålesund. I mai og juni oppholdt VINJE seg der for å kontrollere og kalibrere registreringsanlegget. En ny plattform ble satt opp på taket av Forskningsstasjonen, og ca. 100 m fra stasjonen ble en strålingsbalansemåler og et solarimeter montert. Registreringer herfra kom i gang utover høsten etter hvert som tekniker HALVARD BOHOLM fikk fullført tilkoplingene. De hovedkomponenter som nå registreres er: globalstråling, diffus himmelstråling, strålingsbalansen, samt markens albedo.

HISDAL arbeidet i Ny-Ålesund i tiden 16/6–21/7, og fortsatte sin undersøkelse av globalstrålingens og himmelstrålingens spektralfordeling. Han utførte dessuten en del arbeider i forbindelse med montering av nye strålingsinstrumenter ved Forskningsstasjonen.

De helårlige massebalansemålinger på Austre Brøggerbreen og Midre Lovénbreen ble utført av JENS ANGARD og BJØRN WOLD ved Forskningsstasjonen i Ny-Ålesund. Begge breene viste underskudd for sjette år på rad.

LIESTØL foretok sammen med ingeniørene PER HALS og STEIN SANDVÆR fra Norges Vassdrags- og Elektrisitetsvesen i april en undersøkelse av Foxfonna øst for Longyearbyen. Breens dybdeforhold ble kartlagt ved hjelp av radioekko og temperaturen målt med termistorer som ble satt ned i borhull til breens bunn. Formålet med undersøkelsen var å klarlegge om vanninnsig fra breen kunne vanskeliggjøre driften av Gruve 7 som går inn under breen.

På samme tid undersøkte LIESTØL «pingoer» i Adventdalen og Reindalen, og fotograferte fra fly de framrykkende breer, Tunabreen og Marmorbreen.

I juli og august foretok LIESTØL en ny reise til Spitsbergen og utførte trianguleringsarbeider og massebalanseundersøkelser på Finsterwalderbreen og på breen ved Ny-Ålesund.

Fyr og radiofyr

Ettersyn av fyr og radiofyr ble foretatt i tiden 18.–23. juli av NETELAND assistert av ekspedisjonsdeltakere og mannskap på M/S «Polarstar».

JAN MAYEN

Norsk Polarinstitutts ekspedisjon til Jan Mayen ble planlagt, organisert og ledet av operasjonssjef SIGGERUD. I alt deltok 14 personer utenom besetningen på ekspedisjonsfartøyet.

Av deltakerne var fire fra Norsk Polarinstitutt, en fra Norges Geologiske Undersøkelse, fire fra Det Kongelige Norske Videnskabers Selskab, Museet i Trondheim, og en fra Island Universitet, Reykjavik. Dessuten deltok fire assistenter engasjert av Norsk Polarinstitutt. Ekspedisjonen ble finansielt støttet med kr. 25 000,– fra DKNVS, Museet, og kr. 35 000,– fra NATO Research Grants Programme.

Ekspedisjonsfartøyet R/K «Sjøfareren» med kaptein MORTEN HANSEN og seks manns besetning var leiet av Norsk Selskab til Skibbrudnes Redning. Fartøyet ble overtatt i Egersund 26/7 og lastet her. På grunn av spesielle sjøfartsregler måtte overseiling til Jan Mayen starte fra nordnorsk havn. 31/8 var fartøyet tilbake i Egersund, etter at deltakerne var satt av i Trondheim.

Ekspedisjonsfartøyet landsatte dels partier for arbeid på land og flyttet disse, dels ble det benyttet direkte i forbindelse med marine undersøkelser. Hovedsakelig ble det arbeidet på det nordligste området av Jan Mayen hvor vulkanutbruddet i 1970 fant sted, men hele øya ble etter hvert befart.

Det ble gjort geologiske undersøkelser, glasiologiske, oppmåling av det nye landområdet og biologiske undersøkelser, både terrestriske og marine. Den midt-atlantiske rygg, ca. 80 sjømil vest for Jan Mayen, ble besøkt og prøvetatt geologisk og biologisk ved dykking på 30 m dyp.

Værforholdene var lite gode med meget regn. Inn- og utsetning var i regelen meget vanskelig på grunn av vind og sterk brenning.

Geologi

I tiden 1/8–24/8 arbeidet tre geologpartier med undersøkelser av de geologiske forholdene på øya etter siste vulkanutbrudd. Partiene ble ledet av SIGGERUD, HARALD CARSTENS og PÁLL IMSLAND. Assistenter var HALFDAN CARSTENS, FRODE MÜLLER og KNUT VABRÅTEN. Fra 1/8–7/8 arbeidet geologene i det nye lavaområdet på Nord-Jan Mayen. Fra 7/8 til ekspedisjonens slutt arbeidet IMSLAND på Midt-Jan Mayen og CARSTENS på Sør-Jan Mayen. I dette tidsrom utførte SIGGERUD undersøkelser av spor fra den yngste vulkanismen en rekke steder på øya.

Geofysikk

ORHEIM assistert av TORE HUSETH studerte virkningene på breen av Beerenburg-vulkanens utbrudd, og startet opp et program med massebalansemålinger på Sørbreen.

Geodesi-topografi

HELLE med assistanse av TORE SKÅLTVEIT og VABRÅTEN målte den nye kystlinjen etter vulkanutbruddet høsten 1970 med tidligere trigonometriske punkter som grunnlag. Han målte dessuten magnetisk misvisning med Wild prismekompass langs noen rette linjer både på det nye og det gamle landet. Til slutt ble en seismisk stasjon i nærheten av Forsvarets Fellessambands stasjon innmålt.

Biologi

Marin-biologiske undersøkelser – B. GULLIKSEN og H. LØNNE foretok marinbiologiske undersøkelser og innsamlinger på de nydannede lavaområdene. Som referanse ble det undersøkt rundt hele Jan Mayen på forskjellige dyp og med forskjellige strøm- og bunnforhold. Arbeidet ble foretatt dels ved dykkinger og dels ved skrapetrekk.

Terrestrisk-biologiske undersøkelser – A. FRISVOLL assistert av T. LUND innsamlet og registrerte fanerogamer og bryofytter som var i ferd med å kolonisere det nye lavaområdet. I tillegg ble gammel vegetasjon registrert, med turer over store deler av Jan Mayen. Videre samlet LUND endel entymologisk materiale.

Flyfotografering

Midler som var stilt til rådighet fra NATO Research Grants Programme, muliggjorde en kontrakt med Fjellanger Widerøe A/S om flyfotografering av Jan Mayen. På grunn av værforholdene i det aktuelle tidsrom var det ikke mulig å foreta fotograferingen.

Arbeid ved avdelingene

(se også under Publikasjoner)

Hydrografi

Materialet fra havloddingene med HI-FIX i sesongene 1965 og 1971 ble bearbeidet. Montasje- og redigeringsarbeid av nye sjøkart 505 (Norge–Svalbard, nordre blad 1:750 000) og 522 (Dei Sju Isfjella–Forlandsrevet 1:100 000) ble foretatt.

Geodesi-topografi

Forberedende arbeid med tanke på databehandling av det trigonometriske observasjonsmateriale er foretatt. En ny utgave av kartet Svalbard 1:1 000 000 er under arbeid, og en foreløpig utgave av C7 Dicksonfjorden, siste gjenstående kartblad av Namnekart Svalbard 1:100 000, er ferdig. Konstruksjonen av deler av C8 Billefjorden i serien Svalbard 1:100 000 og av Finsterwalderbreen (to kartblad) i målestokk 1:20 000 er utført.

For Store Norske Spitsbergen Kulkompani A/S ble kart 1:2000 over området ved Sveagruva fullført, delvis ved konstruksjon hos Hovets Oppmåling.

En foreløpig utgave av Namnekart Dronning Maud Land 1:3 000 000 (vestre del av Dronning Maud Land) og en foreløpig utgave i 1:500 000 for kystområdene fra vestgrensen av Dronning Maud Land til 30° ø.l. er ferdige. Kartblad for området østenfor er under arbeid.

Kartbladene B7 Vestfjella Vest og C7 Vestfjella Aust i serien Dronning Maud Land 1:250 000 er trykt, og flere kartblad i samme serien er under arbeid. Foreløpige utgaver av E6 Annandagstoppane og F8 av Namnekart Dronning Maud Land er ferdige. En rekke andre kartblad samt foreløpige utgaver av Namnekart Bouvetøya 1:100 000 og Peter I Øy 1:100 000 er under arbeid.

Geologi

MAJOR fortsatte med kullpetrografiske studier av prøver fra Gruve 7 i Longyearbyen og deltok i tilrettelegging av glasiologiske undersøkelser på Foxfonna ved Gruve 7. Han deltok i drøftelser både av nye sikringsbestemmelser for Svalbard og av problemer vedrørende oljeundersøkelser og utmålspørsmål på Svalbard. Forøvrig samlet MAJOR materiale fra Svalbard til et kompendium i kullgeologi ved NTH, Trondheim.

WINSNES arbeidet med et geologisk kart over Kong Karls Land i målestokk 1:100 000 og med det geologiske kart over Svalbard i målestokk 1:500 000, sydøstre blad. Sammen med HJELLE og OHTA bearbeidet han materiale fra Prins Karls Forland og Oscar II Land. Forøvrig brukte WINSNES mye tid til administrative oppgaver vedrørende Barentshavprosjektet, den geologiske avdeling ved Norsk Polarinstitutt og instituttets perspektivanalyse.

SIGGERUD bearbeidet materiale fra Jan Mayen, med særlig vekt på undersøkelser av aldersforhold på lavastrømmene og erupsjonshyppighet på øya. Videre deltok han i planlegging og gjennomføring av videre geofysiske arbeider på Jan Mayen.

HJELLE fortsatte med bearbeidelse av materiale fra H. U. Sverdrupfjella, Dronning Maud Land. Han utarbeidet også en oversikt til et leksikon over stratigrafiske navn i dette område. Sammen med OHTA utarbeidet han en beskrivelse med kart over metamorfe facies i Hecla Hoek bergarter på Svalbard som et bidrag til et metamorfosekart over Europa i målestokk 1:2 500 000 som skal utgis av IUGS's Commission for the Geological Map of the World.

DAVID WORSLEY fortsatte med bearbeidelse av materiale fra Hinlopenstretet og Bjørnøya. En del av undersøkelsene av øvre paleozoiske karbonatbergarter fra disse områdene ble gjort i samarbeid med vit.ass ØRNULF LAURITZEN, Institutt for geologi, Universitetet i Oslo.

OHTA foretok undersøkelser av strukturer av enkelte metamorfe mineraler og bearbeidet sammen med WINSNES og HJELLE materiale fra Prins Karls Forland.

MARC EDWARDS begynte petrografiske undersøkelser av materiale samlet fra Barentshavet i 1971. Som første ledd i dette arbeidet undersøkte han prøver fra kjente stratigrafiske lokaliteter på Svalbard.

Geofysikk

LIESTØL bearbeidet glasiologisk, meteorologisk og annet feltmateriale fra Svalbard og Norge. Han utarbeidet også en betenkning for SNSK, vedlagt kart med profiler over dybdeforhold og temperaturer i breer over Gruve 7 på Spitsbergen. LIESTØL var veileder for hovedfagsstudenter i glasiologi og var sensor for hovedfagsstudenter i limnologi og fysisk geografi.

HISDAL foretok en statistisk undersøkelse av skydekkets fordeling for en del stasjoner i Arktis og på lavere bredde. En skriftlig fremstilling av resultatene er under arbeid. En tilsvarende undersøkelse av antall solskinnstimer ble også satt i gang, og nye observasjoner av den kortbølgete strålings spektralfordeling ble bearbeidet med henblikk på publisering.

VINJE utarbeidet isoversikter for den atlantiske sektor og beregnet driftshastigheter på grunnlag av satellittbilder. Han fortsatte bearbeidelsen av materialet fra siste Antarktisekspedisjon. Dette inngår som et ledd i arbeidet med å bestemme vinddraget på isen og varmeutvekslingen med luften.

ORHEIM bearbeidet glasiologisk feltmateriale fra Jan Mayen og fra Deception- og Livingston-øyene i Antarktis.

Biologi

NORDERHAUG bearbeidet det biologiske observasjonsmaterialet fra Svalbard med henblikk på publisering. Etter oppdrag fra Miljøverndepartementet utarbeidet han et grunnlagsdokument i forbindelse med forberedelsen av norsk deltakelse i FN's miljøvernkonferanse. For «Arbeidsgruppen for viltstell og naturvern på Svalbard» gjorde han våren 1972 ferdig forslag til etablering av fuglereservater, nasjonalparker og naturreservater på Svalbard og dessuten et forslag til nye jaktbestemmelser for Svalbard.

LARSEN bearbeidet tidligere innsamlet materiale om isbjørn. I samarbeid med Miljøverndepartementet deltok han i forberedelsen av et MAB-prosjekt på Svalbard, og etter oppdrag fra samme departement utarbeidet han forslag til et klassifikasjonssystem og et nytt registreringsskjema for fugler og pattedyr på Svalbard.

Bearbeidelse av materiale ved andre institusjoner

Ved Det Kongelige Norske Videnskabers Selskab, Museet i Trondheim, er under bearbeidelse marinbiologisk materiale fra de nydannede lavaområdene på Jan Mayen. Materialet ble innsamlet av GULLIKSEN og LØNNE, som deltok på instituttets ekspedisjon til Jan Mayen. Museet har også under bearbeidelse terrestrisk-biologisk materiale, innsamlet på Jan Mayen av ekspedisjonsdeltakerne FRISVOLL og LUND.

Biblioteket

I årets løp ble 245 titler registrert, herav 42 innkjøpte bøker, 60 av gammel bestand og 119 særtrykk. Småtrykksamlingen har nå 5843 nr. Seks nye bytteforbindelser ble opprettet, to ble strøket. To nye tidsskriftabonnement pluss ett gaveabonnement er opprettet. En del bøker er mottatt som gaver. Tilvekstliste for hele året ble utsendt i januar 1973. Tidsskriftsamlingen er blitt katalogisert på stensil og en gjennomgåelse av småtrykksamlingen er påbegynt.

Fra 1/4 ble REIDUNN LUND ansatt som bibliotekar, og VIBEKE EEG-HENRIKSEN, som var ansatt som assistentbibliotekar på deltid, sluttet 1/6. Fra september har kontorassistent ELSA KNUDSEN hjulpet til med det daglige arbeid i biblioteket.

Konsulent- og informasjonstjeneste

GJELSVIK ble intervjuet i TV-opptak på «Fram» i forbindelse med et Amundsen-Scott-program av BBC. Han var også intervjuet i NRK og i flere dagsaviser i forbindelse med 100-årsjubileet for Roald Amundsens fødsel. I Aftenpostens nyttårsnummer var det et større intervju med ham om arbeidet på Svalbard.

KAARE Z. LUNDQUIST ga i egenskap av instituttets kontaktmann en rekke uttalelser til pressen.

LARSEN deltok i radioens programpost «Hverdagen» og hadde et innlegg om isbjørn og naturvern på Svalbard.

SIGGERUD besvarte endel henvendelser fra pressen, vesentlig i forbindelse med utreise og hjemkomst for ekspedisjonene til Svalbard og Jan Mayen.

WINSNES deltok i et program i skolekringkastingen om Antarktis. Han ble også intervjuet i TV-opptak på «Fram» i forbindelse med BBC's Amundsen-Scott-program.

Instituttet er som vanlig blitt konsultert av norske myndigheter og av personer og institusjoner i inn- og utland.

Forskningsstasjonen på Svalbard

Virksomheten ved stasjonen har fortsatt som tidligere, hovedsakelig med registreringer for de forskjellige vitenskapelige disipliner som har prosjekter gående i Ny-Ålesund. Dataene sendes til Norge for bearbeidelse ved de institusjoner som er ansvarlig for det vitenskapelige program. Konstruktør JENS ANGARD var alene om stasjonen første halvår, men ble i juli avløst av HALVARD BOHOLM. Siste halvår har BJØRN WOLD vært ansatt som vitenskapelig assistent. Stasjonen har vært besøkt av 13 forskere med assistenter som hadde sin base her for kortere eller lengre tid om sommeren. Det er tatt opp direkte sending av seismiske data etter eventuell skjelvregistrering fra Ny-Ålesund til en seismisk datasentral.

Nye riometre er montert i løpet av høsten for Nordlysobservatoriet. VLF-mottagningen er flyttet fra stasjonen nede i bebyggelsen opp til den seismiske stasjon hvor forholdene er meget bedre for disse registreringer.

Det er problemer med ut- og innsetting av båten for de oseanografiske undersøkelser, men forøvrig har resten av virksomheten ved stasjonen gått programmessig.

Reiser, møte- og kursvirksomhet

GJELSVIK deltok 20/4—22/4 i lederkurs arrangert av NTNF på Bolkesjø. Han holdt 10/5 tale i Sandefjord ved åpningen av SCAR-symposiet «Technical and Scientific Problems Affecting Antarctic Telecommunications». Videre representerte han instituttet ved Tromsø Museums 100-års jubileum 16/10. Ved det 7. konsultative møte under Antarktistraktaten, avholdt i Wellington 30/10–10/11, møtte han som norsk delegert.

ARNESEN deltok i kurs om kartografi og reproduksjonsteknikk ved Tekniska Högskolan i Stockholm 2/10–4/10.

CHRISTIANSEN deltok i konferanse arrangert av Oceanology International 72 i Brighton 19/3–24/3.

HISDAL besøkte 3/10–8/10 Physikalisch-Meteorologisches Observatorium, Davos, for å studere instrumentelt utstyr og måleteknikk ved institusjonen.

LARSEN deltok i generalforsamling og teknisk møte i International Union for the Conservation of Nature and Natural Resources, avholdt i Banff, Canada, 4/9–8/9.

LUNDQUIST deltok i 10th International Hydrographic Conference i Monaco 11/4–22/4.

NETELAND deltok i Nordisk Hydrografisk Teleteknikerkonferanse, som ble holdt i Stockholm 22/11–25/11.

NORDERHAUG deltok i IUCN's isbjørngruppes 3. arbeidsmøte, som ble holdt i Morges, Sveits, 7/2–10/2. Sammen med LARSEN utarbeidet han en rapport fra møtet. NORDERHAUG deltok også i IBP's nordiske symposium om biologiske parametre for måling av globale forurensninger, som ble holdt på Lysebu 23/2–25/2. På møtet orienterte han om en økosystem-studie på Svalbard. Han holdt videre et foredrag om biologenes rolle i ressursforvaltningen på seminaret "Ecology and Land use", arrangert av Oslo Universitet på Tømte 29/2–1/3.

OHTA deltok i Third Annual Conference of Tectonic Study Group i Bristol 19/12–20/12.

ORHEIM deltok på årsmøte i International Glaciological Society 20/4–21/4 i Cambridge, og holdt foredrag om "The Deception Island mass balance record and interhemispheric climatic correlations". I tidsrommet 16/6–17/6 og 3/11–4/11 deltok han på møter i Europarådets arbeidsgruppe for polarforskning, holdt henholdsvis i Karlsruhe og Paris. Videre deltok han i møtene i en ekspertgruppe, nedsatt av forannevnte arbeidsgruppe, som ble holdt 24/7 og 3/10 i Bryssel. På stiftelsesmøtet til Nordisk Seksjon av International Glaciological Society som ble holdt 22/9–24/9 i Stockholm, holdt ORHEIM foredrag med tittelen «En massebalanse-serie fra Deception Island og klimakorrelasjoner mellom nordlige og sørlige halvkule».

SIGGERUD deltok i Nordisk vulkanologisk studietur til Island 11/7–26/7. Sammen med WORSLEY deltok han i Det 10. nordiske geologiske vintermøte 6/1–7/1 i Oslo.

OLA STEINE deltok i «Kartdagene 1972» 12/3–14/3 i Kristiansand S.

VINJE deltok i Norsk Oseanografisk møte på Geilo 24/8–25/8. I tiden 24/9–1/10 deltok han i symposiet "Sea Air Interaction" og i møter i "International Commission on Polar Meteorology" som ble avholdt i Leningrad.

WINSNES deltok i kurs i petroleumsgeologi, som ble holdt på Sanderstølen 9/7–21/7 i NTNFK's regi.

Forelesnings- og foredragsvirksomhet

På møte i Fellesrådet for parlamentarikere og vitenskapsmenn 29/5 hadde GJELSVIK innlegg om «Aktuelle problemer i arktiske strøk». Som vanlig har han holdt forelesning ved Forsvarets Høgskole om «Norske interesser på Svalbard og i Ishavet».

LARSEN deltok i panéldebatt om "Management of wetlands and polar lands" ved IUCN's 12. tekniske møte i Banff, Canada, i september. Han har holdt en rekke foredrag med emner fra Svalbard i bl. a. skoler, Travellers Club, World Wildlife Fund, etc.

LIESTØL holdt i vårsemesteret forelesninger i glasiologi ved Universitetet i Oslo. I Oslo Geofysikeres Forening holdt han i oktober et foredrag om «Glasiologiske problemer i Antarktis».

OHTA holdt foredrag om en spesiell mikroskopteknikk for metamorfe mineraler på "Third Annual Conference of Tectonic Study Group" i Bristol 19/12.

ORHEIM holdt i november en forelesning på Geografisk Institutt, Universitetet i Oslo. I desember holdt han foredrag i Norsk Geologisk Forening og i Oslo Geofysikeres Forening om klimaforskning i Antarktis.

SIGGERUD har holdt en rekke foredrag med emner fra Svalbard og Jan Mayen i folkeakademier, Det Norske Geografiske Selskab, Norsk Polarklubb og Arktisk Forening.

WORSLEY holdt i høstsemesteret et forelesningskurs i historisk geologi ved Universitetet i Oslo (som vikar for professor L. STØRMER).

Publikasjoner

Skrifter:

Nr. 138 – HARALD MAJOR and JENÖ NAGY: Geology of the Adventdalen map area.

Nr. 157 – P. F. FRIEND and M. MOODY-STUART: Sedimentation of the Wood Bay Formation (Devonian) of Spitsbergen: Regional analysis of a late orogenic basin.

Meddelelser:

Nr. 101 – D. C. LINDSAY: Lichens from Vestfjella, Dronning Maud Land.

Nr. 102 – ODD LØNØ: Norske fangstmenns overvintringer – Del I – 1795 til 1892.

Sjøkart:

505 Norge–Svalbard, nordre blad 1:750 000 trykt i nytt opplag.

515 Svalbard–Grønland (CONSOL) 1:2 000 000 trykt i nytt opplag med påført CONSOL-nett.

Landkart:

Dronning Maud Land 1:250 000.

37 Vestfjella Vest.

C7 Vestfjella Aust.

Instituttets medarbeidere har utenom instituttets serier publisert:

VIDAR HISDAL: Diurnal wind variations in Antarctica. *Quart. Journ. Roy. Met. Soc.* **98** (417), 1972.

THOR LARSEN og PER WEGGE: Radioinstrumentering og biotelemetri. *IBP i Norden* **10**, desember 1972.

MAGNAR NORDERHAUG: Studies of contamination trends in a high Arctic ecosystem (Svalbard). Proc. Nord. Symp. on Biol. Param. for measur. Global Pollution. *IBP i Norden*, **9**, 1972.

— Harvest and Management of the Polar Bear in Norway 1969–1971. Proc. 3rd Work. Meet. Pol. Bear Spec. Group. *IUCN Publ. New Ser., Suppl. Pap.* **35**, 1972.

— Naturvård i norr. *Sveriges Naturs Årbok* 1972.

OLAV ORHEIM, COLIN BULL, and VALTER SCHYTT: Glaciological studies of past climatic variations in the South Shetland Islands. *Ant. Journ. of the US*, **7**, (4).

OLAV ORHEIM: Volcanic activity on Deception Island, South Shetland Islands. *Antarctic Geology and Geophysics.*

— A 200-year record of glacier mass balance at Deception Island, Southwest Atlantic Ocean, and its bearing on models of global climatic change. Ohio State University Research Foundation, *Institute of Polar Studies Report* No. 42.

AUDUN HJELLE and THORE WINSNES: The sedimentary and volcanic sequence of Vestfjella, Dronning Maud Land. *Antarctic Geology and Geophysics.*

The activities of Norsk Polarinstitutt in 1972

Extract of the annual report

By TORE GJELSVIK

The institute had 33 permanent positions in 1972. This was one more than in the previous year, the new position encompassing the functions of planning and coordinating Norwegian research in the Antarctic. All positions were filled at the end of the year. Ten employees were in addition engaged on short-term contracts.

Field work

NORWAY

Glaciology

O. LIESTØL supervised the studies, and, assisted by T. LAUMANN and K. REPP, conducted routine glacier mass balance measurements at Storbreen and Hardangerjøkulen. A. TVEDE started a simplified mass balance study at Blomsterskardbreen. Storbreen and Hardangerjøkulen had a small deficit for 1972, whereas Blomsterskardbreen had a positive balance.

Frontal position variations were measured at 10 glaciers, two off Folgefonni, two in Jotunheimen, four off Jostedalsbreen, one in Møre, and one at Svartisen. All the glaciers were retreating.

Terrestrial photogrammetry was made of Briksdalsbreen and Nigardsbreen for mapping purposes.

SVALBARD

The summer expedition was organized by T. SIGGERUD. Altogether 22 persons participated, exclusive of the crews of the ship and the helicopter. This was a smaller expedition than usual, because Norsk Polarinstitutt at the same time sent an expedition to Jan Mayen.

M/S «Polarstar» transported three geological parties to and from Prins Karls Forland, working in between as a hydrographic surveying vessel in the waters between Edgeøya, Kong Karls Land, and Hopen. The helicopter, a Bell 47 G4, was used to support the geological work at Prins Karls Forland and Oscar II Land.

Hydrography

H. HORNBÆK continued the programme of detailed soundings at the entrance of Kongsfjorden and outside Prins Karls Forland. A new navigation system (Motorola) proved very suitable, although the system could not be used in the later part of the season because of a fabrication defect. The cruise of M/S «Polarstar» was led by J. H. CHRISTIANSEN with E. NETELAND as technical leader. Ice conditions were favourable east of Edgeøya, and altogether 4,200 nautical miles of sounding profiles were run between Kong Karls Land and Hopen.

Geology

A. HJELLE and Y. OHTA mapped Hecla Hoek rocks on Prins Karls Forland and in the region north of St. Jonsfjorden. T. GJELSVIK took part in and led the work until T. S. WINSNES arrived at the end of July. Breakdown of the helicopter slowed down the activity for one week. H. MAJOR investigated the coal mines in Adventdalen and Sveagruva.

Geophysics

For most of the year radiation has been recorded at two minute intervals at the Svalbard Research Station in Ny-Ålesund. T. VINJE visited the Station in May and June, calibrated instruments and established a new registration platform. At present the following components are registered: global radiation, diffuse sky radiation, radiation balance, and the albedo of the ground. V. HISDAL also visited Ny-Ålesund and continued his studies of the spectral distribution of the global and diffuse sky radiation.

The year-round mass balance measurements on the glaciers Austre Brøggerbreen and Midre Lovénbreen were carried out by J. ANGARD and B. WOLD from the Research Station in Ny-Ålesund. Both glaciers showed deficit for the sixth successive year.

O. LIESTØL accompanied by P. HALS and S. SANDVÆR, visited Foxfonna in April and mapped the thickness of the glacier by radio-echo sounding. Ice temperatures were measured in boreholes to the base of the glacier. At the same time he also investigated pingoes in Adventdalen and Reindalen, and photographed from the air the advancing glaciers Tunabreen and Marmorbreen.

LIESTØL visited the glaciers by Ny-Ålesund and Finsterwalderbreen in July and August, and carried out mass balance and triangulation work.

JAN MAYEN

Norsk Polarinstitutt's expedition to Jan Mayen was planned and led by SIGGERUD. Altogether 14 persons participated, including four from the University of Trondheim and one from the University of Iceland, in addition to the crew on the expedition vessel.

The expedition vessel M/S «Sjøfareren» was used partly to establish and support the land parties, and partly in marine studies. Most of the work was done in the northern part of the island where the 1970 volcanic eruption occurred, but eventually the whole island was visited.

Geological, glaciological and both marine and terrestrial biological studies were conducted, and the new-formed land area was surveyed. The Mid-Atlantic Ridge, about 80 nautical miles west of Jan Mayen, was visited and geological and biological samples were collected by diving to 30 m depth.

Geology

Three parties, led by T. SIGGERUD, H. CARSTENS, and P. IMSLAND, studied the geological conditions on the island following the last eruption. The groups first worked on the new lava fields, later IMSLAND worked at Midt-Jan Mayen, CARSTENS at Sør-Jan Mayen and SIGGERUD at various places on the island.

Geophysics

O. ORHEIM studied the effects of the volcanic eruptions on the glaciers, and started a programme of mass balance measurements at Sørbreen.

Geodesy-topography

S. HELLE surveyed the new coastline formed after the 1970 eruption, and he measured magnetic deviations both in the new and old lava fields.

Biology

B. GULLIKSEN and H. LØNNE conducted marine biological studies on the new submarine lavas and at various representative localities around the island. The work was done partly by divings and partly by dregging.

A. FRISVOLL registered phanerogams and bryophytes that were colonising the new lava fields, and old vegetation was registered all over Jan Mayen.

Preparation of data

Hydrography

Sounding data from 1965 and 1971 was processed. Mounting and editing work on new charts 505 and 522 was carried out.

Geodesy-topography

Preliminary work was done with view to computer processing of trigonometric data. A new edition of map "Svalbard 1:1 000 000" is being made, and a provisional edition was completed of C7 Dicksonfjorden, the last remaining sheet in the series of place-name maps "Namnekart Svalbard 1:100 000". Parts of C8 Billefjorden in the series "Svalbard 1:100 000" were constructed. A map (two sheets) of Finsterwalderbreen at the scale of 1:20 000 was made for glaciological purposes. Some maps at the scale of 1:2 000 have been constructed of the mining area Sveagruva.

Map sheets B7 Vestfjella Vest and C7 Vestfjella Aust in the series "Dronning Maud Land 1:250 000" have been printed, and several other sheets in the same series are being prepared. Several provisional editions of place-name maps (Namnekart), both from Dronning Maud Land and from Bouvetøya and Peter I Øy, have been completed or are being prepared.

Geology

H. MAJOR prepared reports on the Longyearbyen mines and continued his studies of coal petrology.

T. S. WINSNES worked on a geological map of Kong Karls Land at the scale of 1:100 000 and on the south-eastern sheet of a geologic map of Svalbard at the scale of 1:500 000. He investigated material from Prins Karls Forland and Oscar II Land together with A. HJELLE and Y. OHTA.

T. SIGGERUD studied material from Jan Mayen.

A. HJELLE worked on material from H. U. Sverdrupfjella, Dronning Maud Land. He and Y. OHTA prepared description and maps of the metamorphic facies in Hecla Hoek rocks on Svalbard as contribution to IUGS's Metamorphic Map of Europe.

D. WORSLEY continued processing material from Hinlopenstretet and Bjørnøya, partly in cooperation with Ø. LAURITZEN at the University of Oslo.

Y. OHTA investigated structures of some metamorphic minerals, and he prepared material from Prins Karls Forland together with WINSNES and HJELLE.

M. EDWARDS started petrographic investigations of material collected from Barentshavet in 1971.

Geophysics

O. LIESTØL studied glaciological, meteorological and other field material from Svalbard and Norway.

V. HISDAL made a statistical study of the distribution of cloud cover at stations in the Arctic and at lower latitudes, and a similar study of sun-shine hours was initiated. Observations of the spectral distribution of short-wave radiation were processed.

T. VINJE prepared sea ice distribution maps for the Atlantic sector, and determined drift velocities. He continued analysing the observations from the 1970/71 Antarctic expedition.

O. ORHEIM studied glaciological field material from Jan Mayen and from Deception and Livingston Islands in the Antarctic.

Biology

M. NORDERHAUG analysed biological observations from Svalbard. He completed the proposal for establishing Bird Preserves, National Parks, and Nature Preserves at Svalbard, and also completed a proposal for new hunting regulations at Svalbard.

T. LARSEN prepared material on the polar bear, and took part in the preparations for a MAB project on Svalbard. He finished a new classification and registering system for birds and mammals on Svalbard.

Preparation of data at other institutions

Marine and terrestrial biological material from Jan Mayen is being studied at the University of Trondheim by the four-man group from the university participating in Norsk Polarinstitutt's expedition to Jan Mayen in 1972. Palaeomagnetic studies of rocks from Svalbard are being conducted at the Geophysical Institute, University of Bergen.

The Research Station at Ny-Ålesund

The activities at the station have continued as normal; primary duties have been collecting data for various projects. J. ANGARD worked at the station the whole year except for July, when H. BLOM replaced him. B. WOLD worked at the station the last half of the year. Altogether 13 scientists and assistants stayed at the station for shorter or longer periods during the summer.

Direct transmission of seismic data to a data center has been initiated. New riometers have been emplaced for the auroral observatory. The VLF receiver has been moved from the main station building to the seismic station. There have been problems getting the boat in and out of the water for the oceanographic studies, but otherwise the station activities have gone as planned.

Main field work of scientific and economic interest carried out in Svalbard in 1972

By TORE GJELSVIK

Nationality	Institution or company (residence) Name of expedition	Name(s) of leader(s) Number of participants	Area of investigation Period	Work
Norwegian	Norsk Polarinstitutt	THOR SIGGERUD 23 (+transport crew)	Western Svalbard and Barents Sea June, July, August	Work in the fields of hydrography, geology, geophysics, and biology. See pp. 170—173.
	A/S Akers Drilling Company Ltd.	HARALD VETNES 4	SE area of Svalbard	Marking of claims, geology and geophysics.
	Norske Fina A/S		Edgeøya	Test drilling and transport.
	Norsk Polarnavigasjon A/S		Brøggerhalvøya	Diamond drilling for testing and geological information.
British	Aberdeen University Vestspitsbergen Expedition	CHALMERS M. CLAPPERTON 8	Kongsfjorden July	Ornitological, botanical, and glaciological studies.
	Cambridge Spitsbergen Expedition 1972	A. C. SMITH 4	Edgeøya, Tusenøyane August	Work for Norske Fina A/S, mostly hydrography.
	—»—	W. G. HENDERSON 7	Isfjorden area	Geological work for Store Norske Spitsbergen Kulkompani A/S.
Finnish	Not known	U. MANNINEN 4	Bjørnøya June 14—July 20	Ornithology.
	Not known	E. S. NYHOLM 3	Nordaustlandet Wintering from 1971	Zoological studies.
French	La Compagnie Française des Pétroles		Edgeøya	Test drilling and transport.
German	Geologisch-Paläontologisches Institut der Universität Hamburg	U. LEHMANN 1	Nordenskiöld Land July 12—August 19	Palaeontology.
	Not known	H. GOSSOW	Sassen June 22—August 19	Observation of reindeer behaviour.

Nether-lendisch	Not known	ERIC FLIPSE 1	Edgeøya Spring	Ecological studies.
	Rijksinstituut voor Natuurbeheer	H. KUPER 2	Edgeøya Summer	Ecological studies.
Polish	University of Wroclaw	STANISLAW BARANOWSKI 8	Hornsund area June 2—September 24	Glaciology.
Soviet	Scientific Research Institute of the Geology of the Arctic	D. V. SEMEVSKIJ 20 (+transport crew)	Spitsbergen, Edgeøya	Geological studies.
	Soviet Union Scientific Research Institute for Marine Geology and Geophysics	J. F. DURYUIN 30 (+transport crew)	Sea between Bjørnøya-Hopen and Sørkapp	Marine geology and geophysics.
Swedish	Expedition Spitsbergen 1972	G. WALLIN 15	Kongsfjorden June 30—August 14	General biological investigations.
	Naturgeologiske Institusjonen Lund	H. SWENSSON 7	Adventdalen August 3—19	Permafrost studies.
Swiss	Not known	H. FREI 2	Kapp Linné June 22—July 7	Ornithology.

MAIN FIELD WORK OF SCIENTIFIC AND ECONOMIC INTEREST CARRIED OUT IN JAN MAYEN IN 1972

By TORE GJELSVIK

Norwegian	Norsk Polarinstitutt	THOR SIGGERUD 14	Jan Mayen July 28—August 26	Geology, topography, glaciology, botanic and marine biology.
Danish	Universitetet i København	E. HJELMAR 4	Jan Mayen June 10—July 20	Zoology, geology.

The possible use of tools by polar bears to obtain their food

The use of "tools" by certain higher mammals has been well documented in recent years. The sea otter, for example, uses rocks to break open the molluscs upon which it feeds. Whether polar bears also use "tools" to obtain food remains an unsettled question.

Two hundred years ago FABRICIUS commented on the use of ice blocks by bears to kill walruses, and more recently explorers like HALL, LYON, RASMUSSEN, RAE, etc. mentioned such stories from the Eskimos. Even today one can hear North American and Greenland Eskimos tell stories of how their forefathers saw polar bears kill walrus by hitting them with pieces of ice or rock. R. PERRY (1966: *The World of the Polar Bear*, University of Washington Press, Seattle) has summarized the many references. No scientifically trained observer has ever recorded having witnessed such an incident, however.

Polar bears in the London Zoo have been observed to throw pieces of ice. Another bear in the Edinburgh Zoo repeatedly threw a horse's femur 3 to 4 m in the direction of its mate (*in* PERRY op. cit.).

Eskimos have many legends and myths about animals, but to dismiss this polar bear hunting behavior as just another myth would be premature. For centuries there was little communication between Greenland and North American Eskimos, but this particular story is prevalent among both groups. Therefore, there is possibly some truth to it. The following observation may be partial documentation.

On April 10, 1972, while I was sledging with two Grise Fiord Eskimos across Sverdrup Inlet, Devon Island, to collect data on polar bear productivity, one of the guides remarked that a few miles back he had observed a place where a polar

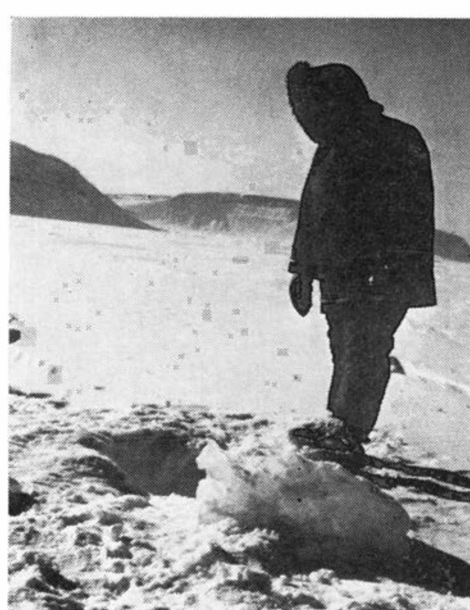


Fig. 1. *The open aglu with the piece of ice supposed to have been used by the polar bear to smash in the snow roof.*

bear had smashed in the snow roof of a seal aglu with a piece of ice. The three of us returned immediately to investigate.

The aglu had been dug out to form a small crater. The snow roof was composed of very dense snow and was approximately 1 m thick. The breathing hole, which by now had frozen over, was about 0.5 m in diameter. The bear tracks were still very clear and were probably not more than 6 hours old. From the size of the tracks it was estimated that the bear weighed between 100 and 200 kg. She was accompanied by two cubs. A bear of that weight possibly would have difficulty breaking through such a dense snow crust. Lying on the edge of the excavated aglu was a piece of fresh-water ice about 80 cm long and weighing about 20 kg. A drag trail which originated 6.5 m away led to the broken-open aglu. On examining the point of origin we discovered, partly concealed under the snow, a large piece of freshwater ice weighing several hundred kilograms frozen into the sea ice. We could see that the bear had smashed off the 20 kg piece. The breakage surface, unlike the rest of the ice block and its surroundings, was free of snow. The bear had then rolled the piece of ice to where the aglu was located. By checking the tracks, we made certain that the adult and not the cubs had rolled this piece of ice. A photographic record was made.

What happened next is not certain, but we may consider the following possibilities:

1. The bear used the piece of ice to smash through part of the snow roof. Once the roof was thinner it would be possible for the bear, using its own weight, to break through the rest. Then should the seal surface, the bear would be able to take it by surprise.

2. The bear heard the seal come to the surface and tried to smash it on the head with the piece of ice, in an attempt to stun or kill it.

3. The bear, after his unsuccessful attempt to catch the seal in the conventional way, broke off the piece of ice in "anger", frustration, or play, and rolled it towards the opened aglu, and by sheer coincidence abandoned it there.

No definite conclusions can be drawn from these observations. However, they do contribute to the circumstantial evidence which has been collected by other observers.

According to C. Jonkel (personal comm.), another incident occurred during autumn 1971, while he was trapping polar bear in the vicinity of Churchill, Manitoba, using cable foot snares. Observations of tracks in the snow indicated that certain bears were using small rocks from the trap site to spring the trap. All rocks were removed from the trap site and were replaced by wooden planks. Tracks again indicated that a bear, or bears, had moved rocks as much as two metres in order to spring the snare.

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Canadian Wildlife Service
Ottawa

Avalanche plunge-pool effect

When a snow avalanche plunges into a river or lake the effect of the burst is like an explosion. It seems that a large part of the cinetic energy of the avalanche is transferred to the water causing a shockwave. In shallow water, like in a river, the bed can be cleared and water, boulders, and snow be spread out over a large area. In deep and larger water basins the shockwave will propagate to the shores where material from the sides will be thrown up. The phenomenon can take place several times during the winter or can be repeated in periods of years. In a river where new material is continuously transported to the place, larger masses of boulders will accumulate where the material repeatedly has been thrown up.

The phenomenon was studied by the author in Leirdalen in Jotunheimen. An avalanche started on the west side of the valley on a hanging glacier and rushed down the slope into the river. Boulders from the river bed together with water and snow were thrown fan-like from the spot where the avalanche hit the river. A rounded boulder c. 40 cm in diameter was thrown more than 100 m from the river. This avalanche seemed to be larger than normal. Usually the boulders will be thrown up a few metres from the river forming a 5 m high ridge-like accumulation (Figs. 1 and 2).

Phenomena like this can be seen in many Norwegian valleys where avalanches are common. When the avalanche descends into small lakes a circular crater-shaped ridge is formed. In Fig. 3, an aerial photo from the upper part of Valldal near Trollstigen in Møre, two such lakes are seen. In the northernmost the rest of last winter's avalanche is still visible. Here a former larger lake is divided and partly filled up by a circular ridge thrown up from the bottom by the avalanche shockwave. Part of the accumulation originated from the avalanche itself. Light coloured boulders uncovered by lichens are slightly visible on the picture indicating a quite recent arrival. Some of the boulders have a brownish surface derived from a long stay at the bottom of the lake. The shockwave seems to have propagated

Fig. 1. *The accumulation in Leirdalen. The snow avalanche plunges into the river from the left side, throwing boulders from the river bed up on the right bank. Light coloured boulders have been brought up in recent years.*

Fig. 2. *Top of the accumulation in Leirdalen with rounded boulders. The size of lichen indicates the age. Many stones are broken by the explosion-like burst of snow and boulders.*

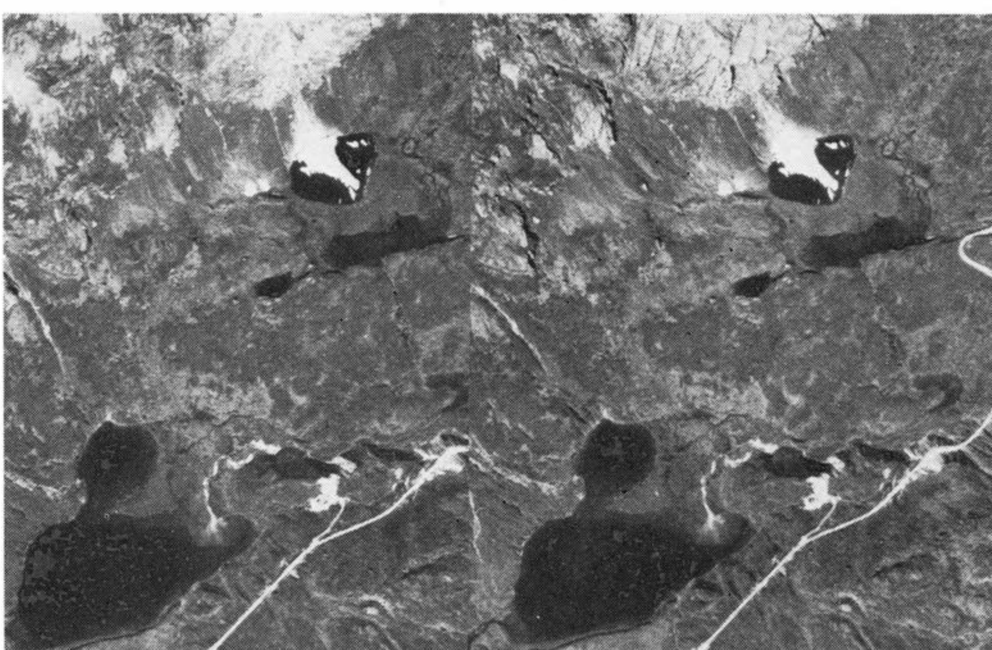

Fig. 3. *Stereo-pair of aerial photos from the upper part of Valldal NW Norway. The lake in the upper part of the picture is formed by snow avalanches, the rest of one is still seen. A ridge of gravel and boulders thrown up by snow avalanches is now damming the lake and separates it from a former larger lake.*
Photo: Fjellanger Widerøe A.S.

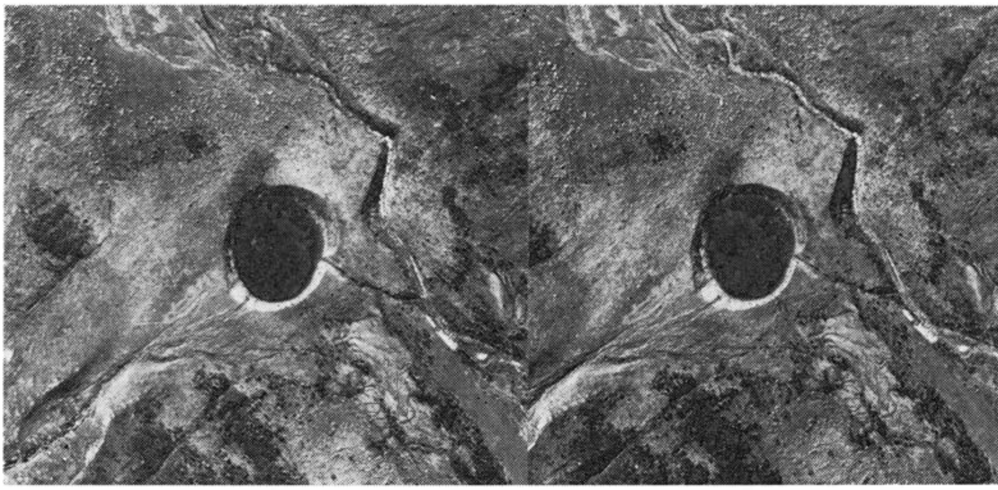

Fig. 4. *Stereo-pair of aerial photos from Andersdalen, Balsfjord, North Norway. The circular lake is probably formed by snow avalanches from the steep mountain side to the lower left in the picture.*
Photo: Fjellanger Widerøe A.S.

in all directions and material has been thrown up even on the side where the avalanche reached the lake, although the major part is found on the opposite side.

Further south a larger lake, seen on the same picture is filled with an accumulation built up in the same way. The avalanches reaching this lake are not as active as the above mentioned ones. Trees on the slope and vegetation on the thrown-up ridge indicate long periods between major avalanches causing a plunge effect.

The most spectacular example of this effect is found in Balsfjord in northern Norway. A small circular lake can be seen in the valley Andersdalen at the foot of an a alluvial cone (Fig. 4). The bottom of the valley is filled with post-glacial sediments on which the cone is accumulated. The avalanche starts in a cirque where the snow accumulates and rushes through a gully over the cone plunging into the lake. The circular shape of the lake indicates that the shockwave is active in all directions. But it is obvious that most of the material is thrown in the same direction as the avalanche forming a ridge on the opposite side. It is difficult to explain how this lake has started. It may have existed during the whole post-glacial period and started accidentally as a pond or a small lake. Its crater-like shape has gradually developed by the described effect together with the material brought down. The accumulation is now spreading across the valley floor, the river having cut a deep gorge through it. How frequently the phenomenon occurs is unknown, but the lake will soon be filled up and its steep side towards the alluvial cone disturbed when no plunge-pool is active. On the other hand vegetation on the sides indicates rather long periods.

In large and deep lakes the energy of the avalanche is spread over a larger area and volume, but the effect could nevertheless be spectacular. A reindeer-guard walking on the ice of Urdvatnet in Skafså, Telemark, observed a large avalanche coming down the steep side and breaking the ice when it hit the surface. Immediately afterwards the ice was broken on the opposite shore and thrown high up, leaving the ice surface inbetween undisturbed.

Olav Liestøl

Enkelte observasjoner av polarrev i Ny-Ålesund vinteren 1970–71

Observations of the Arctic Fox in Ny-Ålesund winter 1970–71

Abstract. – During the winter 1970–71, twelve Arctic foxes were trapped in the area around Ny-Ålesund, Svalbard. Total length and weight of ten of them are shown in Table 1. Because the majority of the white pelts from November were of a poor quality, it is suggested that the regular trapping season should not begin before December.

På Svalbard opptrer polarreven, *Alopex lagopus L.*, i en blå og en hvit form. Begge varianter kan forekomme i samme kull.

Fra langt tilbake har polarreven ved siden av isbjørn, *Ursus maritimus*, representert en viktig inntektskilde for fangstfolk på Svalbard. Siden 1970 har imidlertid fangst av isbjørn blitt pålagt stadig strengere restriksjoner, og en fem års fredning er innført fra og med 1973. Dette har stoppet den tradisjonelle overvintringsfangsten og har medført at erhvervsfangst av polarrev er sterkt avtagende. I dag foregår det stort sett bare en mer tilfeldig fangst omkring de bebodde steder på Spitsbergen.

Vinteren 1970–71 ble det i og omkring Ny-Ålesund (78°50′N, 11°30′Ø) fanget 12 polarrev, hvorav 10 hvite og to blå. Fra 10 av disse ble enkelte lengde- og vektdata notert (Tabell 1). Halen er målt fra haleroten til ytterste halespiss, eksklusiv halehår. Lengden av de ytre halehårene varierte mellom 4,5 og 7 cm. Da kraniene ikke er tilgjengelig er det vanskelig å skille mellom unger av året og eldre individer. Men erfaringer viser at årsungene er lettest å fange slik at det er sannsynlig at de fleste i dette materialet er ungrev. Andre data vedrørende lengde og vekt hos polarrev på Svalbard har det ikke vært mulig å finne, men VIBE (1967) sier at Svalbardpopulasjonen, sammen med populasjonene på de andre øyene i Nord-Atlanteren, består av forholdsvis små individer. I håndboken, «Nordeuropas däggdjur», oppgir SIIVONEN (1968) følgende verdier: vekt 2,5–8 kg, kropp 50–65 cm og hale 28–33 cm. De fleste verdiene i Tabell 1 ligger ved og tildels under de nedre grensene for vekt og lengder som SIIVONEN oppgir.

I denne fangst er det 83,3% hvitrev. VIBE (op. cit.) oppgir at i en fangst på 54 rev på Svalbard vinteren 1962–63, var 81,5% hvitrev.

Hos de fleste hvitrevene som ble fanget i siste halvdel av november, fantes det

Tabell 1
Polarrev fanget i Ny-Ålesund vinteren 1970–71.
Pelskvalitet, dårlig – god: 1–5.
(Arctic fox trapped in Ny-Ålesund winter 1970–71.
Fur quality, poor – good: 1–5.)

Dato *Date*	Farge *Colour*	Kjønn *Sex*	Vekt i gram *Weight in gram*	Lengde i cm *Length in cm*		Pelskvalitet *Fur quality*
				Kropp *Body*	Hale *Tail*	
16/11-70	Blå (Blue)	—	3350	—	—	5
21/11-70	Hvit (White)	♂	2600	50	27	3
21/11-70	Hvit	♂	2650	50	25	2
21/11-70	Hvit	♀	2600	47	23	3
21/11-70	Blå	♀	3500	52	28	5
22/11-70	Hvit	♀	2700	—	—	2
24/11-70	Hvit	♀	3050	52	27	4
25/11-70	Hvit	♀	3100	50	30	3
24/1 -71	Hvit	♂	4100	60	32	5
25/1 -71	Hvit	♀	2500	53	28	4

områder i pelsen hvor sommerens mørke ull ennå satt igjen, noe som i sterk grad reduserte pelskvaliteten. Dette fenomenet har også forekommet de tre siste årene i Ny-Ålesund hvorfra en har informasjoner (pers. medd. J. ANGARD), og tyder på at vinterpelsen ennå ikke er ferdigdannet. Fangst av polarrev på Svalbard er idag tillatt fra og med 16. oktober til og med 14. mars (Kronprinsregentens resolusjon 26. august 1955, § 3). VIBE (op. cit.) sier at på Grønland er pelsen hos hvitreven best i perioden fra og med desember til og med februar, og forut for denne tid bør det ha vært en strengere kuldeperiode. Disse forhold antyder at en bør vurdere på nytt på hvilket tidspunkt om høsten fangst av polarrev skal starte. Alt taler for at den ikke bør starte før i begynnelsen av desember for derved å oppnå best mulig pelskvalitet.

Litteratur

SIIVONEN, L., 1968: *Nordeuropas däggdjur.* Stockholm (Norstedt), 183pp.
VIBE, C., 1967: Arctic Animals in Relation to Climatic Fluctuations. *Meddr. Grønland* **170** (5), 1–227.

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