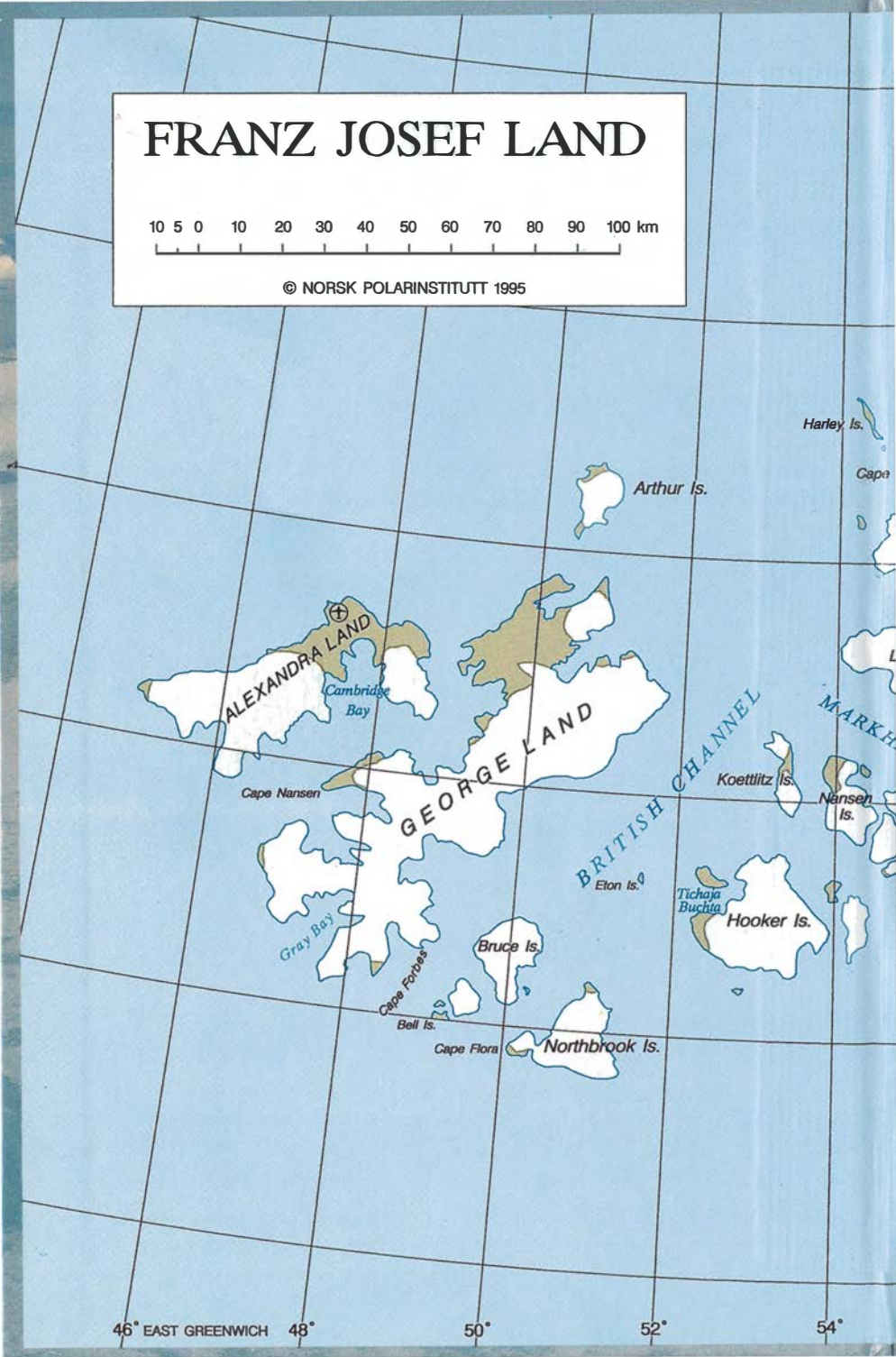
FRANZ JOSEF LAND

Editor: SUSAN BARR

NORSK POLARINSTITUTT


FRANZ JOSEF LAND
10 5 0 10 20 30 40 50 60 70 80 90 100 km
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Harley Is.
Cape
Arthur Is.
ALEXANDRA LAND
Cambridge Bay
GEORGE LAND
Cape Nansen
BRITISH CHANNEL
MARKH
Koettlitz Is.
Nansen Is.
Eton Is.
Tichaya Buchta
Hooker Is.
Gray Bay
Bruce Is.
Cape Fortuna
Bell Is.
Cape Flora
Northbrook Is.
46° EAST GREENWICH
48°
50°
52°
54°


Cape Fligely
Cape Saulen
Teplitz Bay
Rudolf Is.
Eva-Liv Is.
SEVERO-VOSTOCHNYI STRAIT
81°30'
Alexander Is.
Jackson Is.
Hoffmann Is.
Norvegia
81°
Kane Is.
La Ronsière Is.
Ziegler Is.
Greely Is.
GRAHAM BELL IS.
Salisbury Is.
Wiener-Neustadt Is.
Cape Heller
WILCZEK LAND
Champ Is.
80°30'
Hayes Is.
AUSTRIAN STRAIT
Newcomb Is.
Alger Is.
Hall Is.
Mc Clintock Is.
Hochstetter Is.
80°
Cape Tegetthoff
Salm Is.
Wilczek Is.
Lamont Is.
79°30
56°
58°
60°
62°
64°

POLARHÅNDBOK No. 8

FRANZ JOSEF LAND

EDITOR: SUSAN BARR

NORSK
POLARINSTITUTT

UNIVERSITY OF
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OSLO 1995

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FOREWORD

This publication is the result of an idea born at the annual meeting near Gdansk, Poland of scientists working in the European and Soviet (later Russian) Arctic.

The opening of the former USSR around 1990 led to a steep rise in both commercial and scientific activity in the Franz Josef Land area, which has made the compilation of such a handbook a natural step. The last comparable book of the area was published by the Norwegian Polar Institute in 1930, at the time Franz Josef Land became closed to outsiders.

In the period between, scientific information from the archipelago was mainly unavailable. The international cooperation on this handbook tries to fill the gap from 1930, and to present both Soviet/Russian and western history and present activities.

The book is not intended to be a scientific compendium. Instead it presents an overview of the history and nature of Franz Josef Land based on today's knowledge and available literature. It is aimed both at the general public who wish to know more about this northernmost archipelago, and to function as a basis for scientists intending to do research in the area.

The editing committee is painfully aware of the dilemma involved in presenting information about a vulnerable area. Such a publication may contribute to a further increase in number of visitors which can have a detrimental effect on the environment. On the other hand the knowledge presented here will hopefully lead to a greater understanding of the need to protect both the nature and the historical remains of Franz Josef Land.

The diversity of authors who have made this book reflects the internationality of the subject both in the past and present. This aspect is also evidenced by the support given to achieve the publication. The editing committee would like to thank the Norwegian Polar Institute for publishing the book and the following institutions for additional financial support towards publication:

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Susan Barr, Heinz Slupetzky and Jan-Marcin Węsławski

Spring landscape. Photo: H. W. Zwettler

GEOGRAPHICAL POSITION AND GENERAL CHARACTERISTICS OF THE FRANZ JOSEF LAND ARCHIPELAGO

A.F. GLAZOVSKIJ

Franz Josef Land is located in the extreme north of the Eastern Hemisphere. It lies only 900 km from the North Pole and ca. 750 km from the nearest point on the Eurasian mainland, the Yamal Peninsula. The nearest large arctic islands – northeastern Svalbard and the northern tip of Novaja Zemlja – are situated 260 km to the west and 360 km to the southeast, respectively.

Franz Josef Land is an archipelago consisting of 191 islands located between 79°46' and 81°52'N and 44°52' and 65°25' E., and stretching 375 km from west to east and 234 km from south to north. Cape Fligely on Rudolf Island is the most northern point, Lamont Island the southernmost, with Cape Olney on Graham Bell Island furthest east and Cape Mary Harmsworth on Alexandra Land the westernmost point. However, the islands themselves occupy less than 20% of the area of the archipelago.

Whereas the total area of the islands themselves is 16,135 km^2, the length of the coastline is 4425 km, i.e. this represents a little over 3.6 km^2 of the area of the islands per 1 km of the Franz Josef Land coastline. This indicates the high dissection rate of the archipelago (in comparison, Severnaya Zemlya, the archipelago to the east of Franz Josef Land, totals 36,770 km^2 and the length of its coastline is 3498 km, which translates to 10.5 km^2 per 1 km of the coastline). This high dissection distinguishes Franz Josef Land from other arctic archipelagos of Eurasia, which mainly consist of fewer and larger islands (Govorucha 1970).

Small islands dominate, but the 135 small islands amount to only 0.4% of the archipelago's total area. George Land is the largest island measuring 2741 km^2, followed by: Wilczek Land 2054 km^2, Graham Bell Island 1708 km^2 and Alexandra Land 1051 km^2. Five islands measure 500 to 1000 km^2 – Hall, Salisbury, McClintock, Jackson and Hooker.

Widespread glaciers predominate in the archipelago, covering 13,735 km^2 or 85 % of the total land area. The area of ice-free land amounts to only 2400 km^2 or 15 % of the total land area.

Large land areas without ice cover occur only on the large islands, principally George Land (Armitage Peninsula 499.8 km^2), Graham Bell Island (Kholmistyi Peninsula 493.7 km^2), Alexandra Land (Central'naya Susha 270 km^2), Wilczek Land (Ganza Point 162.7 km^2), Hayes Island (84.2 km^2). Most of the small islands are not glacier covered, but the total area is rather limited (Grosval'd et al. 1973).

Where the surface of the archipelago is free of glaciers, it is evident that the bedrock is composed of horizontal or gently dipping layers, relatively friable sedimentary rocks underlying more massive basalts and dolerites. As the whole archipelago originates from a gentle, dome-shaped tectonic rise, young rocks (e.g. basalts) crop out in a wide arc along its northern, western and southern periphery forming vast basaltic plateaus, which usually dip gently from the centre to the periphery. Inside the "basaltic arc", sheets of dolerite are exposed, armouring most of the northern islands. As a consequence of the geological structure, the islands of the "basaltic arc" and those comprised of dolerite are mainly the remnants of a vast plateau rising to an elevation of 50–100 to 500–600 m above sea level. Similar volcano-structural plateaus occur elsewhere in the world, e.g. the Putorana Plateau in Central Siberia, and Ethiopia (Grosval'd et al. 1973).

On the eastern islands, the basaltic cover and the doleritic sheets have been destroyed by erosion over many millions of years, and the surface of the islands is composed of friable sedimentary rocks, pierced by dykes (cross-cutting intrusions filling fractures in the sedimentary rocks) which brought lava to the basaltic cover. Here, a relief of low plains built of horizontal strata, intensively eroded and turned into badland, is very common. Steep, narrow ridges formed by weathered dykes create sharp contrasts in the dominant smooth relief of these islands.

Earth movements and denudation have cut the plateau into many fragments. The British Channel and the Austrian Strait divide the archipelago into three groups of islands: western, central and eastern. The Markham Strait divides the central group into a northern and a southern part. The Severo-Vostochnyi ("Northeastern") Strait separates Graham Bell Island from the eastern part.

The islands of the central group are high. The highest point of the archipelago, 670 m above sea level, is on Wilczek Land. Most of the straits separating the islands of this group are narrow – from a few hundred metres to 2–3 km, while the depth of the straits reaches 500–600 m, i.e. about 150–300 m deeper than the Barents Sea shelf, on which the northern periphery of the archipelago is located. Thus, the total altitudinal difference from the bottom of the straits to the top of the islands may reach 1000–1200 m.

An analysis of bathymetric maps of the Franz Josef Land archipelago (Grosval'd et al. 1973) showed that the straits and fjords between the islands are only a part of a ramifying system of submarine valleys which extend beyond the archipelago, dissecting the shelf surface and stretching to its periphery, to the larger submarine valleys – the troughs of Franz Josef-Victoria in the west, St. Anna in the east and Sedov in the north. This is a typical relief of glacial shelves, i.e. the submarine peripheries of the continents, which experienced several periods of glaciation. Their configu-

ration proves that the centre of the Pleistocene ice sheet during the peak periods of glaciation in the last few millions of years, was located south of the archipelago, on the Barents Sea shelf, and that the ice flow was channelled through these valleys, across the archipelago.

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Fig. 1. The Krenkel meteorological station, Hayes Island, 1992. Photo: Heinz Slupetzky.

CLIMATE

VIDAR HISDAL

The climate of Franz Josef Land is strongly influenced by the extensive glacier cover of the islands and by the sea ice. The sea around and between the islands starts to freeze in late September and early October. The ice concentration usually reaches its annual maximum in March or early April. During this period more than 95% of the sea surface is covered with ice. The ice concentration starts to decrease in May, followed by substantial melt in June. The melt and divergence of the pack ice reduces the ice concentration quickly in the course of July and the minimum occurs in August or early September. However, in cold summers the sea ice may remain within the archipelago and even along the shore of the outermost islands in the eastern part (Atsumu Ohmura, pers. comm.).

Practically the whole of the Franz Josef Land archipelago is situated in the latitudinal zone between 80° and 82°N. At 81°N the period with the sun (whole solar disc) continuously above the horizon (midnight sun) starts about 12th April and ends about 30th August, i.e. 141 days in all. The period with the whole solar disc continuously below the horizon (polar night) lasts from about 19th October to about 23rd February, or 128 days in all. It should also be noted that at 81° even the noon sun at summer solstice does not reach an altitude of more than 32.4°.

These astronomically-based facts not only indicate characteristic features of the light conditions, they also imply that even on a clear day in the middle of summer the solar energy reaching the ground must be comparatively low. Due to the small angle of incidence of the solar rays, the radiative energy is spread over a relatively large area, and, in addition, the rays are considerably weakened after their long path through the atmosphere. A further attenuating factor is the cloudiness, which is particularly high in this part of the Arctic.

Other important climatological conditions are a result of the position of the islands in relation to the large-scale atmospheric circulation. Broadly speaking, the weather situations may be divided into two main types. The first type is characterized by depressions moving towards east or northeast over or near the archipelago, giving easterly to southerly winds and cloudy, often stormy, weather. The other main type is dominated by high pressure areas, with more stable weather conditions, generally moderate winds and frequently clear skies. The influence on the climate of these two weather types is strongly dependent on seasonal factors.

In winter "low pressure weather" usually means transport of comparatively mild air from lower latitudes. Precipitation and strong winds are com-

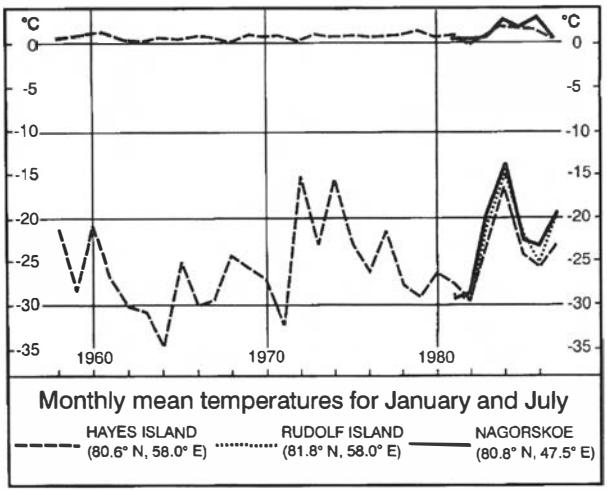


Fig. 2. Monthly mean temperatures for January and July.

mon elements of this weather picture. Short spells with temperatures slightly above freezing point may occur during such situations, even in midwinter. On the other hand, when high pressure areas dominate, clear skies are a prevailing feature, leading to strong radiation heat loss from the ground, and the temperature may drop to around -40°C. Low temperatures are also often observed in the rear of cyclones, when cold air from the Polar Basin invades the islands.

At coastal stations the monthly mean temperature for January seems to stay between -20° and -30°C, as shown in Fig. 2 by means of a 30-year long series from Hayes Island. Judging from the far shorter series from the 1980s, the same applies to Rudolf Island and Nagurskoe, although for these two stations the temperature seems to be slightly higher. The diagram also illustrates the large change from year to year of the winter temperature, depending on whether the season has been dominated by a cyclonic or an anticyclonic circulation pattern. The transition between these two weather systems is often strongly marked. Thus, a temperature change of 20° and more within a few hours is not seldom observed. Obviously, the large variability of the winter temperatures makes it absolutely necessary to use data from the same set of years when comparing temperature conditions at different stations in the area.

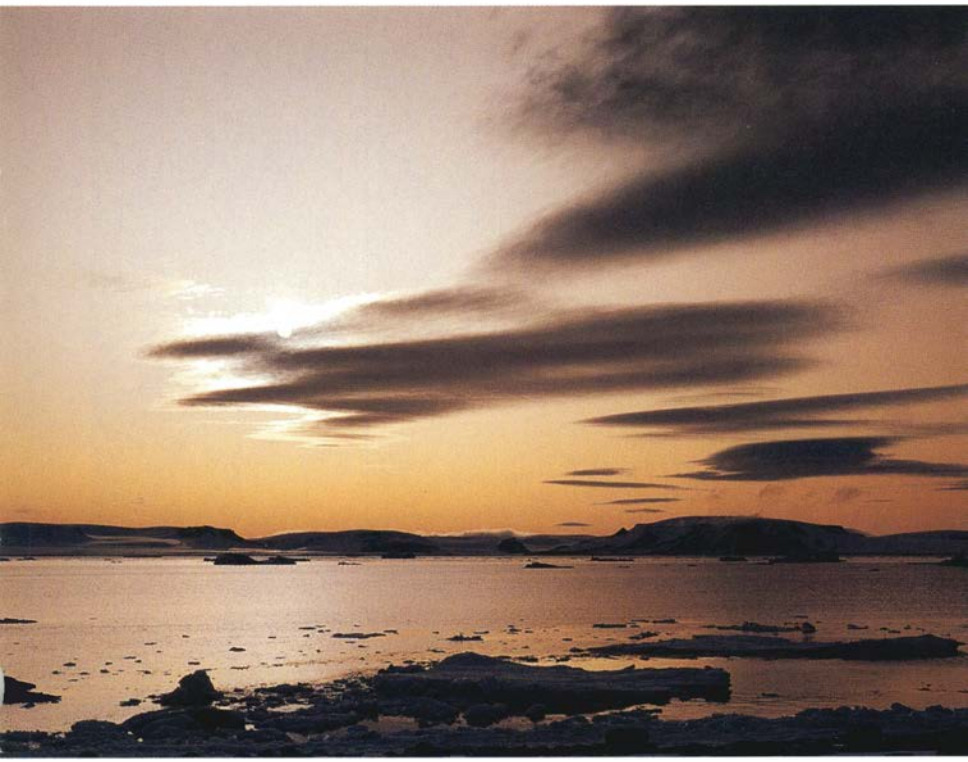
Moving westwards, to Svalbard, which is more strongly influenced by the warming effect connected with low pressure passages, the winter temperatures increase notably. This applies especially to the west coast of Spitsbergen, where the January means are about 8° higher. To the southeast of Franz Josef Land, however, on Cape Čeljuskin (77.7°N,104.3°E) on the Russian mainland, the corresponding mean is about 8° lower. Here the cold

winter climate of the continent makes itself felt. Even lower are the winter temperatures in the Canadian Arctic archipelago.

As indicated by Fig. 2 the temperature is far more conservative during the summer season. The July mean for Hayes Island stays between 0° and 2°C. The weather at the two other stations mentioned above seems occasionally to be slightly milder. (The Rudolf Island means follow those of Nagurskoe quite closely and are not entered.) These summer temperatures are on an average 3° to 5° lower than the corresponding ones on the west coast of Spitsbergen, on Cape Čeljuskin and on stations in the Canadian Arctic archipelago.

The reason for the relatively cool summers must obviously be sought in several factors: (1) the extensive, surrounding ocean areas are cold and partly ice-covered even in summer, having a strong cooling effect on mild

Fig. 3. Altocumulus lenticularis Foehn clouds over Markham Sound, seen from Hayes Island. Photo: Heinz Slupetzky.



air coming from lower latitudes, (2) frequent and long periods with cloudy skies (or fog) further weaken the moderate solar energy received from a low sun, and (3) when in addition the ground is covered with snow, most of the radiation is reflected by the surface, or used for melting processes.

In winter, easterly to northerly winds are strongest and most persistent, while during the summer season the winds have more variable directions and are notably weaker. Fog, on the other hand, is most frequent in summer. The typical arctic advection fog, which may be very persistent, forms when relatively mild, humid air from southerly directions moves slowly over snow and ice, or a cold ocean water surface.

The amount of precipitation is low. The annual mean is generally from 100 to 150 mm at coastal stations, with July–September as the normally "wettest" period. The amount of precipitation may be considerably higher in more elevated areas, where mountain and glacier slopes force the air currents to ascend. The main reason for the modest precipitation is simply that cold air cannot contain much water vapour.

Fig. 4. Field camp in a snowstorm, Jackson Island, August 1990. Photo: Susan Barr.

GLACIERS

BERNARD LEFAUCONNIER and HEINZ SLUPETZKY

Glaciation is a main feature of the environment of Franz Josef Land, even more than in the neighbouring Svalbard or Novaja Zemlja. Although a number of small islands are free of ice, about 85% (13,700 km^2) of the total land area of the archipelago is covered by glaciers and 60% (2650 km) of the coast line consists of glacier ice. The mean ice thickness is about 180 m, corresponding to a storage of 2500 km^3 of water, and representing a ca. 6 mm (eustatic) rise in the level of the world ocean if this ice were to melt completely.

Due to the difficulties of accessibility, few substantial glaciological investigations have been carried out in the archipelago. Therefore all the components of the present glaciation are neither completely known nor fully understood. However, under the programme of the International Geophysical Year (IGY), the former USSR carried out extensive glaciological studies in 1957, '58 and '59. The work conducted at this time is the main source of the information presented here. Various other smaller research expeditions before or after the IGY permit the completion of a fairly good general overview of the present day glacier extent. In recent years there is a new phase of glaciological research being carried out, mainly through internationally coordinated projects, for example on the Graham Bell ice cap.

Glaciers of more than 300 km^2 area in Franz Josef Land (from Grosswald, M.G.: Glaciers of Franz Josef Land, Moscow 1973, p. 21).

Name of island	Area of glacierization km^2	Total area km^2	Percentage glacierized area
George Land	2241.2	2741.0	81.8
Wilzcek Land	1891.8	2054.5	92.1
Graham Bell Is.	1214.7	1708.4	71.1
Alexandra Land	780.8	1050.8	74.3
Hall Is.	921.5	982.8	93.8
Salisbury Is.	875.7	923.5	94.8
McClintock Is.	579.6	623.0	93.0
Jackson Is.	463.0	509.7	90.8
Hooker Is.	444.0	508.0	87.4
La Ronsière Is.	406.2	441.0	92.1
Ziegler Is.	364.5	404.0	90.2

Fig. 5. Sedov glacier calving into Tichaja Buchta, Hooker Island. 1991. Photo: Heinz Slupetzky.

The glaciers can be classified into three main categories: ice caps, valley glaciers, and small glaciers as defined below. Ice caps or plateau glaciers are generally dome shaped, sometimes with a remarkably regular convex shape, and they cover relatively large areas. The altitude of the glacier domes is generally 350–500 m a.s.l., with a thickness of 300–450 m. The maximum elevation of the ice in the archipelago (about 670 m a.s.l.) is the top of the southern ice cap of Wilczek Land.

In general the ice is thick enough to cover the underlying bedrock relief in the centres of the islands almost completely, leading to a gentle, undulating glacier surface. The ice flows radially from the domes and feeds numbers of ice streams or valley glaciers, the drainage pattern of the ice being determined by the relief of the bedrock. Most of the ice streams and valley glaciers reach the sea and calve there. Only a few valley glaciers terminate on land, where they spread into piedmont lobes on the strandflat.

Small glaciers – mainly cirque, hanging and wall-sided glaciers – may be the result of a division of major ice masses into individual parts due to a recent reduction of the glaciation. Detached from the main accumulation areas, they for ` mainly small, residual glaciers. However, wall-sided glaciers located on the leeward (north-western side) of the islands have a wind-drift origin, because wind-blown snow is accumulating constantly in winter time on the glacier.

The archipelago is situated near the northern boundary of the principal cyclonic tracks from southwest to northeast, and precipitation is mainly associated with southerly to easterly winds. The cold air does not contain much humidity, resulting in a rather low amount of precipitation: 150–200 mm on average close to sea level, and up to several hundred mm in the uppermost parts of the glaciers. Nevertheless there is enough snowfall to provide substantial accumulation. The snow is for a large part redistributed during blizzards, resulting in the fact that the amount of solid precipitation measured at a meteorological station often differs markedly from that accumulated on the glacier surface.

The period of deposition of solid precipitation (accumulation period) on the archipelago lasts for about 10 months, while the period of melting (ablation period) only lasts for about two months.

The mean summer temperature is relatively low, usually between 0° and 2°C at sea level. Measurements by Russian scientists indicate a mean vertical gradient of –0.6°C/100 m. Thus, at an elevation of 500 m a.s.l., mean air temperature at the glacier surface ranges between –1° and –3°C. At sea level during the warm summer 1984 a mean air temperature of 1.4°C was recorded at the Krenkel station on Hayes Island; the sum of temperatures during days above zero corresponded to a total of 120 (positive) degree days. In 1987, with a mean temperature of –0.3°C, only 34 degree days were recorded. It is therefore likely that, during cold summers (such as in 1987), only a very limited ablation occurs at the summit of the higher ice caps. During mild summers the entire surface of glaciers from the edge at sea level to the uppermost parts may be subjected to important ablation.

In the firn area the meltwater percolates through the snow pack and refreezes (formation of 'superimposed ice'). The release of latent heat involved warms up the cold snow, but this process is not effective enough to raise the entire snow and ice masses to freezing point. The Franz Josef Land glaciers do not possess any temperate part, the ice temperature is always below 0°C. They are 'cold' or polar glaciers (and not sub-polar or 'polythermal' as are most of the Svalbard glaciers).

Usually the temperature increases from the upper part of the ice cap to the bedrock, and decreases from the bedrock centre to the border of the ice mass. A good example of this is given by the result of a recent Russian expedition to the ice cap on Graham Bell Island, where, at the ice/bedrock

Fig. 6. Regular-shaped ice cap on Hayes Island seen from Krenkel station, 1991. Photo: Heinz Slupetzky.

interface, the temperature varied from –3°C in the centre to –10°C close to the border (Glazovskij et al. 1995).

From a bird's eye view three different zones on the glacier surface of an ice cap are usually seen near the end of the ablation season: an inner zone where firn forms the surface, a first ring of superimposed ice, followed by a zone of bare ice (with some patches of snow and superimposed ice) extending to the edge. The lower boundary of the firn zone is the 'firn line', the lower boundary of the superimposed ice the 'equilibrium line' where accumulation equals ablation. Above this line is the accumulation area where a net gain of mass takes place, and below the line is the ablation area where a net mass loss is observed. It is important at which altitude the line lies every year. In warm summers it is high up, leaving a small accumulation area. The balance at the glacier surface (not taking calving into account) will then be negative. When it is situated low at the end of the summer, the accumulation area is large compared to the ablation area,

resulting in a positive balance at the glacier surface. On Hooker Island during the IGY investigations, the lower boundary of firn was located around 380 m a.s.l., and the lower boundary of the superimposed ice around 300 m a.s.l.

The average altitude of this equilibrium line over some years gives a good indication of the mass balance, and in consequence of the climatic conditions and the state of the glaciers. In Franz Josef Land the average equilibrium line altitude is at 200 to 300 m and represents one of the lowest in the Northern Hemisphere.

It is possible to estimate the mass balance of a glacier from the size of the accumulation area at the end of the summer, which shows how much of the glacier surface is still covered by firn and superimposed ice after the ablation period. Only a few mass-balance investigations have been carried out in the area. In total during the investigations of the IGY, a general negative balance of the glaciers over the entire archipelago was assessed, and moreover it was calculated that these years were representative of the mean value over the period 1930–1959.

Outlet glaciers and almost all valley glaciers reach the sea, filling up embayments or protruding into the sea. Maximum movement rates of between 50 and 150 m per year have been recorded at the front of outlet glaciers. It is nevertheless likely that some active calving fronts may reach velocities of several hundred metres a year. The total length of calving fronts is about 1600 km, the ice cliffs being mostly 20–40 m high, only rarely more. During the years 1957–58 and '59, the total calving from the archipelago was estimated to be 2.5 billion m^3 per year.

Russian maps from 1957 show a great number of calving fronts. The mapped fronts can be compared with recent satellite images and observations conducted in 1992 (Lefauconnier 1992), when over 96 fronts located in the eastern part of the archipelago were investigated. The comparison shows that the fronts have retreated during this period, but that most of them are still in a calving position today.

The ice fronts which are partly floating produce tabular icebergs which float into the Barents Sea. Of the 96 observed fronts, 26 are thought to be able to calve several small tabular icebergs up to 100 m long every year, while 17 are assumed to be able to calve tabular icebergs up to 300–400 m long. The Znamenityj glacier (Renown or Famous glacier), located on the eastern coast of Wilczek Land, calves annually several tabular icebergs of more than 1 km length, with a width of 150–400 m and a thickness of 120 m or more. This glacier shows the largest retreat recorded in the archipelago. The total retreat has been more than 10 km after the Little Ice Age maximum extension. (The 'Little Ice Age' is a period of cool climate with advancing glaciers from the 16th to the middle of the 19th century – on Franz Josef Land possibly from the 14th to the beginning of the 20th). Be-

tween 1957 and 1992, the retreat has been 45-65 m/year over a more than 6 km wide front. These icebergs disintegrate slowly, and several icebergs of 300–400 m length are regularly observed in the northern part of the Barents Sea.

Recent reduction of glaciation is also indicated by a well-defined distance between present glacier margins and lateral or frontal moraines, formed during the advance period. The glacier retreat can also been deduced from fresh morphological features in the proglacial areas, and is further supported by comparison between the actual stage of the ice cover and that documented on diverse older maps. The recession period most likely started in the 1920s, and seems to have been fairly consistent over the entire archipelago.

An interesting phenomenon has been observed on Graham Bell Island. The northern edge of the glacier dome has been surveyed at different periods, and it was found that in one location the edge had retreated by 30 m between 1953 and 1961, while between 1961 and 1981 it advanced by about 40 m (Govorucha 1988). Of course, it is difficult to relate such a change in edge position directly to mass balance or climatic change.

In all probability the total mass balance over the archipelago will remain negative for a long period, due to the considerable calving. It would require a more distinct climatic cooling over decades or more, if a long-term positive mass balance and advance of the glacier fronts should be realized.

Geomorphological evidence, such as moraine ridges and raised shore lines, give insight into the postglacial history of the climate and glacier variations (Grosval'd et al. 1973). By the end of the Late Pleistocene, appr. 10,000 years ago, the Franz Josef Land glaciers had disappeared almost completely, maybe entirely. Afterwards, several stages of reglaciation and glacier advances occurred, corresponding to periods of colder climate. The youngest glacier advance is hear named the 'Victoria stage' and corresponds to the 'Little Ice Age'. All the Holocene stages in the archipelago were probably synchronous with the climatic changes and glacier variations of other Arctic regions.

Literature

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GEOLOGY

A.F. GLAZOVSKIJ

Geological maps of the Arctic show that Franz Josef Land is situated at the northern edge of a large geostructure, the Barents Sea platform, within the area where Mesozoic sedimentary cover rocks are exposed. The crystalline rocks of the ancient folded basement are not exposed within the archipelago; their structure and age can only be determined by using borehole data and comparable geological evidence from the crystalline basement in Svalbard.

The stratigraphy and tectonics of the sedimentary cover of the Barents-Kara platform were first studied by J. Payer, and subsequently by R. Ketlits, F. Nansen, R.L. Samoilovich, T.N. Spizharsky, K. Frebold, V.D. Dibner and others. The most detailed description has been given by V.D. Dibner (1969, 1970) who distinguished four units separated by regional erosion surfaces: the Upper Palaeozoic, Lower Mesozoic, Upper Mesozoic and uppermost Mesozoic-Tertiary. Their total thickness is 2000 m.

The Upper Palaeozoic unit is poorly exposed. Its presence was revealed by exposures of Middle Carboniferous terrigenous deposits containing coal found in the southern parts of George Land, and dolomites and limestones of the same age found on Victoria Island, to the west of the archipelago. In Svalbard, the rocks of this unit overlie Lower Palaeozoic rocks which were folded during the Caledonian period, and a sharp angular unconformity separates them.

The Lower Mesozoic succession is composed of coastal and marine sediments dating from the Upper Triassic and all three subdivisions of the Jurassic. The rocks of its lower part (Triassic and Lower Jurassic) are present on most of the islands and evidently also occur on the bottom of straits. Sediments of the Middle and Upper Jurassic are not so widespread; they are known on the islands of Bell, Northbrook, Hooker and Wilczek Land. The Upper Triassic rocks are composed of limestones, shales, sandstones and conglomerate. The Middle and Upper Jurassic strata consist of shaley and sandy calcareous rocks. The total thickness of the Lower Mesozoic is about 1500 m.

The Upper Mesozoic (Lower Cretaceous) is widespread on the islands of the western part and in the south of the central part of the archipelago. It consists of massive effusive rocks composed of basaltic sheets separated by volcanic ashes and tuffs, and terrigenous rocks with brown coal layers. The effusive succession contains up to 20 basaltic flows, each ranging in thickness from 2–3 m to 60 m. The succession consists of two suites, the Tikhaya Bukhta and Salisbury Island suites, separated by intrusive dolerite sheets.

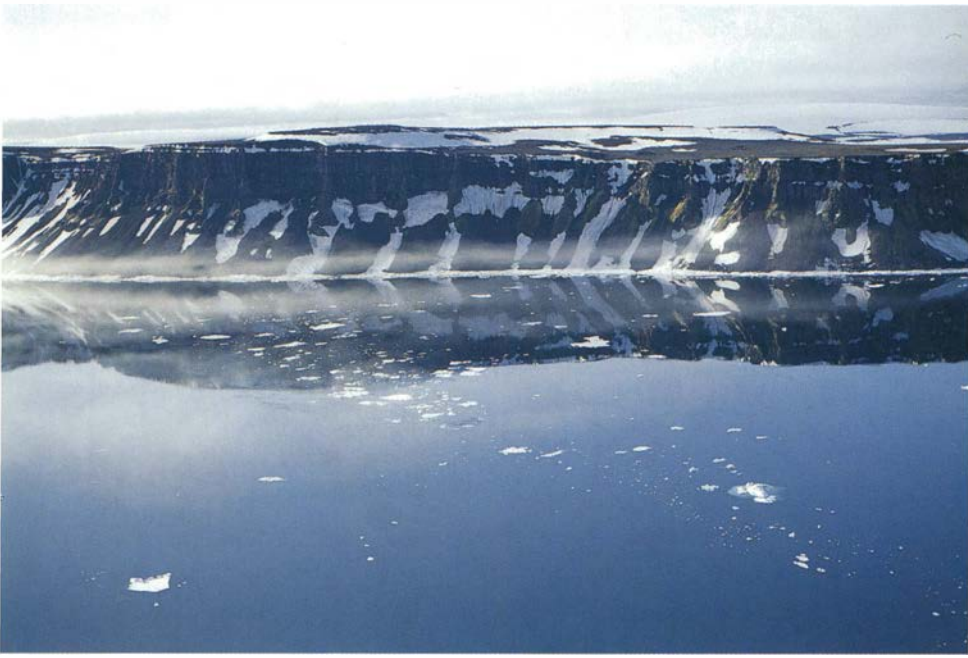

Fig. 5. Younger Mesozoic plateau rocks from the south of the archipelago. Photo: Heinz Slupetzky.

The uppermost Mesozoic-Tertiary succession is preserved mainly on the sea floor. Upper Mesozoic sediments are known from Hoffmann Island, where they are represented by marine quartz sandstones and shales containing a Lower Cenomanian fauna, and also from the seafloor in the northeastern part of the archipelago, where they include quartz sandstones (Danian age). Palaeogene rocks evidently also occur on the seafloor, Lower Eocene diatomites in particular. This part of the succession is crowned by Neogene sediments which, together with the Cenomanian sediments, are so far only known from Hoffmann Island.

The basalt lavas and dolerite sheets and dykes of Franz Josef Land, dating from 120–150 million years ago (Upper Jurassic-Lower Cretaceous), relate to the plate tectonic opening of the Arctic and Atlantic Oceans, which is also typical for the Svalbard region further to the west.

The sedimentary rocks and lavas of the Mesozoic contain numerous intrusive sheets and cross-cutting dykes of dolerite and gabbro-dolerite. They often reach 100 m in thickness and cover extensive areas. Dykes are especially common in the eastern part of the archipelago where basaltic layers do

Fig. 8. Basalt cliff, Cape Nansen. Photo: Gunnar Horn/Norsk Polarinstitutt.

not occur and the contacts to the friable sedimentary rocks can be clearly seen. They fill northeast- and northwest-trending fractures extending for many tens or even hundreds of kilometres, and can be identified both under glaciers and under water (Graham Bell Island, Wilczek Land, La Ronsier Island, Newcomb Island, Harley Island). One of them, named by V.D. Dibner the 'Diagonal naya', stretches for 140 km from Hochstetter Island across Hall, Hayes and Champ Islands to Cape Petigax on Luigi Island. Usually, their thickness ranges from 20 m to 30 m. However, at intersections with fractures of different orientation, they may reach a thickness of 100 m to 200 m, occasionally even up to 600 m (Rubini Rock on Hooker Island). The contacts of dykes with the surrounding sedimentary rocks are nearly vertical, and the dykes sometimes look like water systems on the surface. Dykes of dolerite and gabbro-dolerite typically show columnar jointing, whereas pillow-like jointing is characteristic for instrusive sheets of the same composition.

The crust of the Franz Josef Land area became rigid in the Middle Palaeozoic, and subsequently suffered oscillatory movements typical for a platform. Crustal subsidence caused periods of marine sedimentation, especially in the Carnian and Jurassic. Coal-bearing and fine-grained terrigenous sediments were deposited when small uplifts occurred. Larger uplifts took place before the Late Triassic, at the Jurassic-Cretaceous boun-

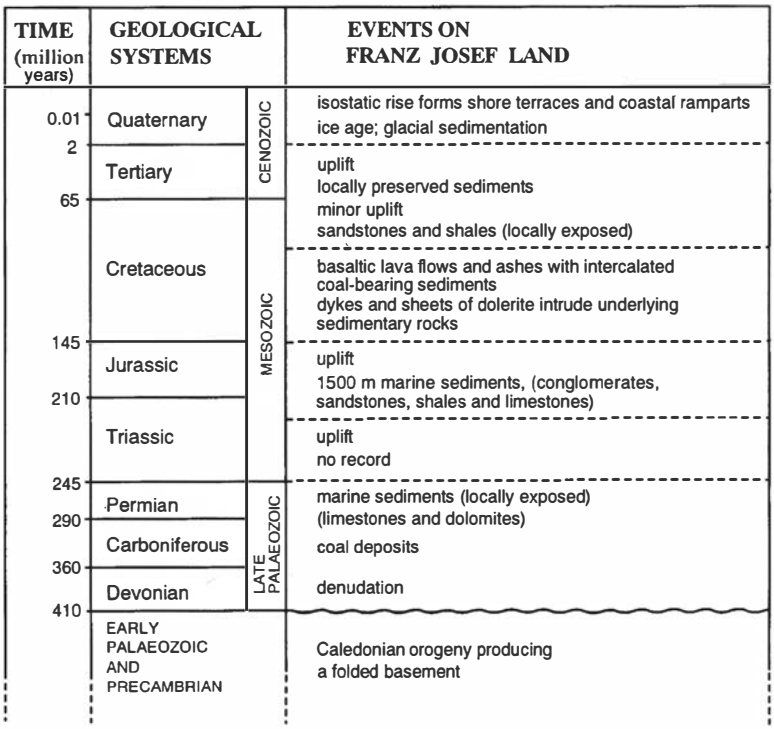

Fig. 9. Geological time table for Franz Josef Land.

dary (and to a lesser degree at the end of the Cretaceous) and are reflected by breaks in sedimentation, with traces of erosion, giving angular unconformities (up to 15°) at the boundary surfaces between the stratigraphic units described above. Before the uplift during the Late Cretaceous, the crust became heavily fractured and basic lava poured through the cracks, forming intrusive sheets. Some blocks moved along faults, forming fault and shear structures with throws up to 200 m. They are seen in the Mesozoic rocks on the islands of Hooker, Northbrook and Hayes, as well as on Wilczek Land.

The Quaternary sediments in the archipelago are represented by a thin cover of marine and glacial deposits (Late Pleistocene and Holocene). Where the coasts have been free of ice and snow, a series of coastal ramparts up to 50 m high, formed during the Holocene period due to the glacio-isostatic rise of the archipelago, may be seen, and these produce a most picturesque landscape of shore terraces.

The melting of the large Barents Sea ice sheet, about 10,000 years ago, led to isostatic compensation of the crust, with the result that the archipelago of Franz Josef Land is now rising by an average rate of 2.5–3 mm per year (Naslund et al. 1994; Glazovskiy et al. 1992). This causes continuous adjustments and changes in coastal areas, such as interactions between glaciers and the sea, shifts in the lower reaches of rivers and streams, formation of lagoons and coastal lakes and changes in the morphology of the coastal margins.

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FRESHWATER SYSTEMS

A.F. GLAZOVSKIJ

With the coming of the short summer, numerous small streams form and flow from the glaciers and snow patches. The runoff lasts only 2–3 months. The melting and first signs of runoff occur in early or mid-June, occasionally at the end of May, and the end of the melting period can be observed in late August–early September. On most islands the runoff water does not form large streams, as surface runoff is most typical due to permafrost. Only large islands with significant land areas free of ice also show greater numbers of small lakes and rivers.

There are several rivers 5–7 km long on Alexandra Land, with the longest river reaching 8.4 km. They are fed from snow patches and the Lunnyi and Kropotkin ice caps, and flow mainly to the north along the slope of the basaltic plateau.

In this respect, George Land resembles Alexandra Land: small rivers, the longest being 19 km, start from the lakes located close to glaciers and flow to the north into the sea, each forming a tiny delta at the mouth.

Within the Kholmistyi Peninsula on Graham Bell Island, the small rivers and streams show a dense tree-like drainage pattern. Some of them start from snow patches in the centre of the peninsula at an elevation of 50–60 m, others originate from an ice cap. The drainage area does not exceed 100–150 km^2.

The braided rivers are not deep, on the average about 70–80 cm. A maximum depth of 100–120 cm has been measured in a river at Ganza Point on Wilczek Land.

The effect of the glacio-isostatic rise of the archipelago also lowers the base level of erosion of the rivers, and therefore erosion is on the increase. Simultaneously, the receding glaciers increase the proglacial areas and the outwash processes, which in turn causes the deltas to extend toward the sea. For example, the delta of the Romantika River on Hayes Island, as described by D.S. Govorukha, is advancing toward the sea at a rate of 2–3 m per year in spite of the short hydrological summer and counteracting erosive forces due to drifting ice. The Romantika River is typical for the whole archipelago. Its length is 10 km and the greater part of its drainage area, totalling 40 km^2, is situated on the ice caps. It has cut a valley of 10–20 m deep, with a flood plain measuring 10–100 m in width. The average velocity of the current during the low-water period is 1–2 m/sec, and 3 m/sec during the spring flood. The average annual flow is 4 m^3/sec, increasing up to 10 m^3/sec, which amounts to about 40 million m^3 per year (Govorucha 1970). The annual water runoff on the archipelago totals approximately

3.5–4 km^3, and the runoff volume per unit of area is estimated at 8 litres/sec (Uspenskij et al. 1986).

There are about a thousand lakes on Franz Josef Land, the greater part of them being situated on Alexandra and George Land. In general, the lakes are located in the depressions formed by glacial erosion. There are also lakes belonging to the lagoon type. The area of the lakes varies from

Fig. 10 a (left) and b (right). Fresh water from melt processes, Jackson Island. Photos: Heinz Slupetzky.

0.004–2.0 km². Normally the lakes are shallow, measuring less than 2 m, and many of them freeze right through as the thickness of the lake ice can be 2–2.5 m. Only a few of the lakes are 4–5 m deep, with a maximum depth of 10 m.

The water in the lakes shows low salinity: less than 314 mg/litre, and the pH varies around 6.41–7.54. The warmest water in the lakes is near the bottom: up to 5.2°C, and toward the surface the temperature decreases. The lakes are covered with ice for 10–11 months per year, and usually the ice does not melt completely throughout the year. There are no water vascular plants in the lakes, but there are about 30 Cyanophytae and Diatomea species, among which benthic forms prevail (Govorucha 1970).

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SOIL

A.F. Glazovskij

Severe climate and permafrost are the limiting factors for soil development on the archipelago. Significant areas are completely deprived of soil. Soil occurs in spots, often within the boundaries of permafrost polygons. Various forms of typical arctic soils are formed on the exposures of basalts and dolerites which, under weathering, give products rich in Al, Fe, Ca and Mg oxides. They are characterized by polygonal forms, shortened and incomplete soil profile, high content of iron, and neutral or slightly acid reaction. The brown-coloured upper humus horizon contains about 3% of organic matter; only on some individual areas on the southern islands does the portion of organic matter in the soil increase to 5–7 and even 8.5%. Chemical reduction of the lower soil layer by ground water (gleying) is not developed due to low soil temperature.

Arctic desert soils occur mainly on the islands of the eastern group on sedimentary rocks, poor in oxides and bases. Humus horizons in these soils occur in the form of individual spots under plant tussocks. In the late summer, when the surface gets drier, these soils suffer noticeable wind erosion. Semi-bog arctic soils with moisture from running water occur near the edge of glaciers and snow patches. Stone flats with spots of arctic polygonal soils prevail on high basaltic plateaus (Mikhajlov 1970).

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Fig. 11. Polygons on Jackson Island. Photo: Heinz Slupetzky.

VEGETATION

Based on manuscripts by I.N. SAFRONOVA and A.F. GLAZOVSKIJ

The general picture of vegetation in the archipelago is represented by the vegetation of all its islands, each island complementing it by its peculiar features. This is due to the different natural conditions of the islands, to which plants are sensitive; everything is important, from the relief of the island, whether there are rivers and lakes, the geology, length of time since the glacier retreated, how long the snow lies during the summer, and so on. The lack of a certain species on an island can usually be explained by the lack of a certain type of suitable environment. Vegetation on some islands is very poor; vascular plants are scarce and perhaps only lichens grow on the stones. On other islands the diversity of plant communities is striking. All stages of vegetation may be seen, from the first establishment of single plants where glaciers have recently retreated or on young marine terraces,

Fig. 12. Vegetation growing along the cracks in polygonal tundra. Photo: Irena Safronova.

to splendid dense communities of bright green mosses and grasses bordering streams and lakes.

Settling along the frost clefts, plant turf forms different patterns on the so-called polygonal tundra. Plants either follow the form of the clefts as a thin line, or expand to occupy the marginal parts of the polygons on the surfaces of which lichens are spread and single vascular plants are scattered.

Stony slopes of hills broken up as a result of weathering may be covered with bright parti-coloured vegetation as they are most favourable habitats for plants. They get thoroughly warmed by the sun and are well-drained. Fertilization from bird cliffs will encourage additional growth.

Usually vegetation covers no more than 5–10% of the ground surface. Only in extreme circumstances, such as under bird colonies, does it cover 100%. Vegetation gets poorer from southwest to northeast. The number of species decreases, as does the cover, and grass stand becomes sparse. It also changes with the elevation; generally within the belt from 0 to 120–130 m there is grass-moss arctic desert, within the belt from 120–130 to 175–200 m there is moss-lichen arctic desert, from 175–200 to 250–315 m lichen arctic desert, and from 315 m and higher lifeless snow desert, although lichens may occur on nunatak surfaces, and sparse colonies of snow algae may be found on glacier surfaces (Govorucha 1970).

No trees, shrubs or tall plants can exist in the harsh climate. In most cases bryophytes form the foundation of the grassy turf, with about 150 species. Two thirds are mosses and one third liverworts. Some mosses (*Aulacomnium, Ditrichum, Drepanocladus, Orthothecium, Tomenthypnum*, etc.) are abundant wherever it is possible to grow, while other genera (*Hylocomium, Hypnum, Polytrichum, Racomitrium, Tortula*, etc.) are also spread, but are less abundant in the wetter areas. *Bryum, Calliergon, Scorpidium* and others like wet places. A few genera (*Andreaea, Schistidium*, etc.) prefer dry places, where lichens usually predominate.

Lichens are the most widely spread flora type, growing both together with mosses and also on stones. There are in excess of 100 species which are divided into crustaceous, fruticose, tubular and foliose lichens. Crustaceous lichens (*Caloplaca, Lecanora, Lecidea, Ochrolechia, Rinodina*, etc.) play a great role in the vegetation, being spread more or less everywhere. Fruticose lichens (*Alectoria, Cetraria, Cornicularia, Stereocaulon*, etc.) are most abundant on dry stone surfaces. Tubular lichens (*Cladonia, Thamnolia*) grow practically everywhere, but not in such variety. The importance of foliose lichens (*Parmelia, Peltigera, Umbiliaria* and others) is not great.

The mosses and lichens colour the stony ground brown, green, yellow, white, grey and black. In wet areas bright green mosses form soft, luxurious cushions, sometimes with splashes of bright red. The dry stones and rocks can be covered with colourful lichens. Yellow prevails in the summer when the herbs begin to flower.

Fig. 13. Deep cushions of colourful moss. Photo: Irena Safronova.

Of the possibly more than 1000 vascular plants known from the arctic tundra, only 57 species are reported from the archipelago. More than half of the small number of plants which have been collected by botanists, are difficult to find as they are encountered rather seldom and always in small numbers. The remainder are widely spread in the area. Some of them, such as polar poppies and saxifrages, (*Papaver polare, Saxifraga cespitosa, S. cernua, S. nivalis, Cerastium arcticum, Poa alpigena, P. arctica, Draba micropetala, D. pauciflora, Cardamine bellidifolia*) grow everywhere, showing no preference for any particular habitat. The polar poppy is one of the most widely spread species on the archipelago. The same can be said about *Cerastium arcticum* and *Stellaria longipes* of Caryophyllaceae, although they are never as abundant in plant communities as polar poppy. Saxifrages grow on all the islands without exception. It is the most numerous genus on the archipelago, with nine species. Four of these are rather rare, but *Saxifraga cespitosa*, *S. nivalis* and *S. cernua* are quite common. *Saxifraga oppositifolia* and *S. hyperborea* are met with often, the former choosing drained places and the latter moist ones.

In wet places species like alpine foxtail and buttercups (*Alopecurus alpinus, Deschampsia borealis, Cerastium regelii, Saxifraga foliolosa,*

Fig. 14. A display of lichens. Photo: Susan Barr.

Ranunculus sulphureus, Stellaria longipes, Phippsia algida, Cochlearia groenlandica) are abundant. Other species, such as polar willow, (*Salix polaris, Saxifraga oppositifolia, S. flagellaris subsp. platysepala, Luzula confusa, Potentilla hyparctica, Draba subcapitata, Poa abbreviata, Minuartia rubella*) prefer drier places. These are most frequently found growing in lichen and moss turf, rising above it by only 3–15 cm. Some species, such as *Alopecurus alpinus* and *Papaver dahlianum*, can be as high as 30 cm.

There are 16 species of grasses. Some of them are rare while others, such as *Alopecurus alpinus, Poa alpigena, Phippsia algida, Deschampsia borealis, Poa arctica and P. abbreviata*, are typical for the archipelago. *Phippsia algida* always settles as one of the first on new surfaces just released from glaciation or snow cover. *Alopecurus alpinus* sometimes forms brakes or borders. The two other species *Pleuropogon sabinii* and *Dupontia fisheri*, which like water, are also capable of forming brakes. They grow on the banks of lakes and rivers.

The archipelago's flora also includes about 100 species of terrestrial algae, mainly Cyanophytae and Diatomea.

Fig. 15. Rich vegetation at Cape Flora. Photo: Susan Barr.

The plants have compact growth forms, helping them to keep the heat of the lower air layer and preventing too much evaporation which is intensified by constant winds. Dwarf shrubs, of which there are two species: *Salix polaris* and *S. arctica*, grow close to the ground, grasses and Luzula are cespitose plants (growing in thick clumps), herbs often grow as cushions or rosette plants.

There are no annual plants on Franz Josef Land as the short summer makes it impossible to complete the cycle from shoots to ripe seeds. Most of the plants are perennials, where the buds are close to the ground and are thus protected during the winter by a snow cover. Of biennials there is only *Cochlearia arctica* (Aleksandrova 1983). In most of the flowering plants the growth of the inflorescence is initiated the season preceding flowering, so the tundra bursts into blossom as soon as the snow has melted, in the first half of July. The pink flowers of *Saxifraga oppositifolia*, the yellow of *Ranunculus sulphureus*, yellow and white of *Draba* and white of *Cardamine bellidifolia* are amongst the first to appear. Other species start to flower a little later. In the second half of July the tundra is a beautiful sight

when there is a mass flowering of polar poppy and saxifrages. Some plants produce seeds during the one to two month long summer. Others are unable to do this and produce fruit and ripen seeds in the course of the second summer. Autumn starts at the beginning of August, when the vegetation becomes more dominated by red colours before disappearing under the winter snow.

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MARINE ENVIRONMENT AND WILDLIFE

J. M. Węsławski and L.Stempniewicz

Marine environment

Bottom topography

The Franz Josef Land archipelago lies on the edge of the Barents and Kara Sea shelves. Three deep troughs connect this area with the Central Arctic (Nansen Basin): one on the west side of the archipelago (Franz Josef-Victoria Trough), one in the middle (British Channel) and another on the east side (St. Anna Trough). Relatively deep (up to 400m) channels occur in some places between the islands. The British Channel divides the archipelago into two parts: two large islands – Alexandra Land and George Land – lie in the west while all other large islands are in the eastern part. The sea bottom in the archipelago is covered with glacial mud, in many places furrowed by icebergs calved from tidal glaciers.

Sea currents

Two main sea currents influence the archipelago. The cold Makarov Current flows in from the north, while the Arctic (also referred to as the East-Spitsbergen) Current flows from the northwest. These two currents contribute up to 50–70% of the arctic water inflow to the Barents Sea. From the south the relatively warm Novaja Zemlja Current flows northwards with remnants of Atlantic waters from the Barents Sea. Along the southern edges of Franz Josef Land the coastal, arctic water current flows from east to west. The average sea current velocity in the area is estimated to be between 2 and 5 cm/sec. The tidal component is very strong and is estimated to be 15 cm/sec. in coastal areas.

Hydrology

Water masses in the archipelago are common with northeast Svalbard and northern Severnaja Zemlja, covering the northern borders of the Barents and Kara Seas. They originate from three different sources. The Atlantic waters from the Novaja Zemlja Current are characterised by salinity more than 34 ppt and a temperature over 0.5°C. Cold waters from the Makarov and Arctic currents range in salinity from 30 to 33 ppt, with temperatures below 0°C in summer. Local waters are formed during autumn and winter in areas where freezing takes place. Then dense, cold, bottom water is formed (salinity over 34.5 ppt and temperature below -1.7°C). In the peak of the summer, local surface waters are formed from melting ice (salinity below 30 ppt and temperature over -1°C).

The horizontal distribution of water masses shows relatively far-

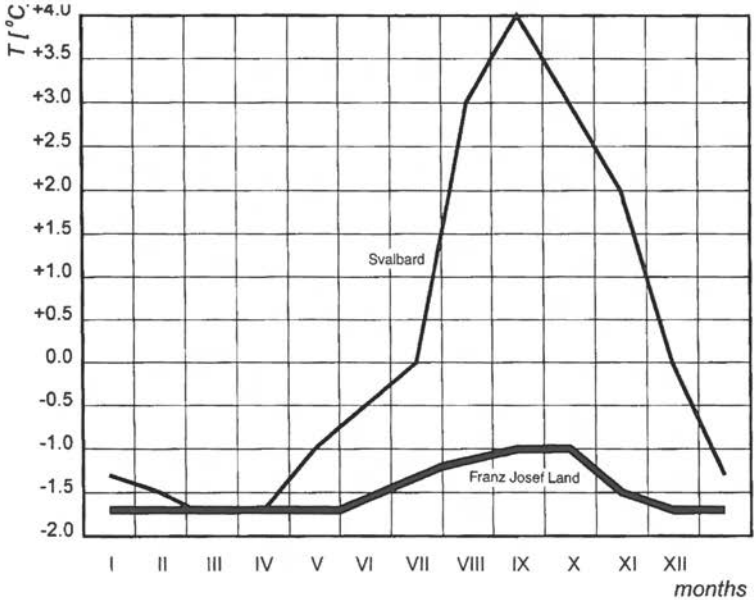


Fig. 16. Seasonal run of the sea surface temperature in the centre of the archipelago (after Averintsev 1989) compared to temperature from a Spitsbergen fjord (own data).

reaching penetration of warm Atlantic waters into southern and central parts of the archipelago. The summer vertical cross section shows a weak pycnocline caused by brackish water. The seasonal run of sea temperature is shown in Fig. 16. Positive temperatures in surface waters occur less than 30 days per year, near-bottom waters are cold (-1.7°C throughout the year). Tides are irregular, with maximum amplitude about 40 cm and a period of 11 to 12 hours.

Floating ice

Floating ice comes from glaciers (icebergs and growlers), from local fast ice and from the pack ice. Glacier ice originates locally, while sea ice can be both of local origin and from the Central Arctic Basin. Pack ice occurs all year in the Franz Josef Land area with minimal extent in August–September. The extent of the pack ice varies strongly both seasonally and interannually. The one-year (winter) ice forms in autumn (October) and reaches up to 1.5 m thickness in the following spring. Multi-year fast ice grows to 2.5 m and in some sheltered places remains stranded on the coast

Fig. 17. Drifting ice between the islands in August. Photo: Susan Barr.

all the year round. Icebergs are common throughout the area. The huge (up to 1000 m in length and up to 30 m in height) tabular icebergs originating from tidal glaciers are especially noticeable. The period of glacier activity (calving) is very short, usually lasting some weeks in late July–August. An icefoot (rim of ice frozen to the shore) covers large parts of the unglaciated coast even in the peak of the summer. Often the multi-year snow forms steep, inaccessible barriers in the littoral.

Polynias – regular open water areas within the pack ice – are known from the northwest part of the archipelago, and locally from some bays and straits with strong tidal currents. The cryolittoral is a peculiar form of ice in the sea. It is found in some of the areas of Franz Josef Land with the harshest climatic conditions, ie. in the eastern and central parts of the archipelago. There, the permafrost emerges in the intertidal. In effect a belt of pure ice, several meters wide, occurs on the sea bottom close to the shore.

Suspended matter

Suspended matter in the waters around Franz Josef Land comes mainly from mineral particles transported with the meltwater discharge. Amounts of suspended matter in summer range from 11 mg/l in coastal waters to 50 mg/l close to the glacier fronts. It gives a corresponding reduction of water transparency from 13 to 2 m. These values are relatively small when compared with Svalbard, where "warm" subarctic glaciers discharge muddy water to the sea and can reduce water transparency in large areas to less than 0.5 m.

Marine ecology

Phytoplankton

One-cellular pelagic algae from Franz Josef Land count over one hundred taxons (classification groups). The summer bloom is formed predominantly by diatoms, flagellates appear later in the season. *Thalassiosira antarctica* and *Chaetoceros decipiens* are the most common diatom species in summer. Densities range from 50 to 600 mln cells/m^3, which correspond to 0.5 to 7 mg wet weight. The bloom starts in late May – at the time of ice melting – and lasts until the end of August. The prolonged vegetation is caused by high solar radiation, relatively good water transparency, vivid water exchange through the deep straits of Franz Josef Land and ice-algae contribution.

Table 1. Estimated number of species (some taxonomic groups) inhabiting Franz Josef Land

Taxon	Number of species
Phytoplankton (all taxonomic groups)	120
Macrophytobenthos	35
Foraminifera	104
Actiniae	10
Hydrozoa	24
Polychaeta	113
Pantopoda	10
Bivalvia	50
Gastropoda	54
Harpacticoida	71
Calanoida	15
Amphipoda	70
Isopoda	5
Crinoidea	2
Holothurioidea	8
Asterioidea	16
Echinoidea	3
Ascidiae	10
Fishes	33
Nesting birds	14
Land mammals	1
Sea mammals*	15

* observed in the sea both within and around the archipelago (only 3 breeding species found)

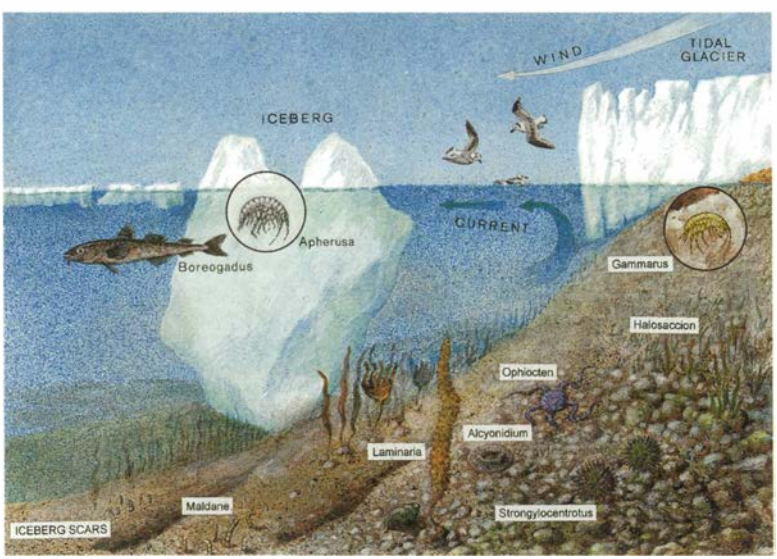
Zooplankton

Zooplankton counts about 50 species in the archipelago and is strongly dominated by calanoids. Large, arctic species like *Calanus glacialis* and *C. hyperboreus* form the bulk of the biomass. Summer densities range from 1000 to 5000 specimens/m^3. This corresponds to a biomass range of 0.5 to 2 g wet weight/m^3. The predominant zooplankton community is made up of the high arctic species, but some atlantic elements can be traced in the southern area of archipelago (eg. krill *Meganyctiphanes norvegica*). The seasonal development is very pronounced. Juveniles and larvae are produced in spring and early summer only. Hence, the life span of small planktonic crustaceans is at least 1.5 years, probably 2.5 years. The yearly peak of the zooplankton biomass comes at the end of August-beginning of September.

Benthic fauna

Sea-bottom organisms in the archipelago count 34 species of macroalgae and not less than 500 species of macrofauna. Leading forms are crustaceans represented by numerous amphipods and shrimps, sediment-burrowing polychaets and echinoderms with abundant sea bristles. Densities of macrofauna range from 10 to more than 1000 individuals/m^2. The biomass ranges from 50 to 500 g wet weight/m^2. A vertical cross section from the shore to the sea shows a well-defined zonation. The shallowest zone is the littoral – be-

Fig. 18. Cross section of the Franz Josef Land coastal waters zonation.



tween low and high water marks. That zone is very poor, partly due to the ice scouring. No more than three motile crustacean species dwell there with *Gammarus setosus* as the leading form. Macroalgae, periwinkles and barnacles are absent in the Franz Josef Land littoral.

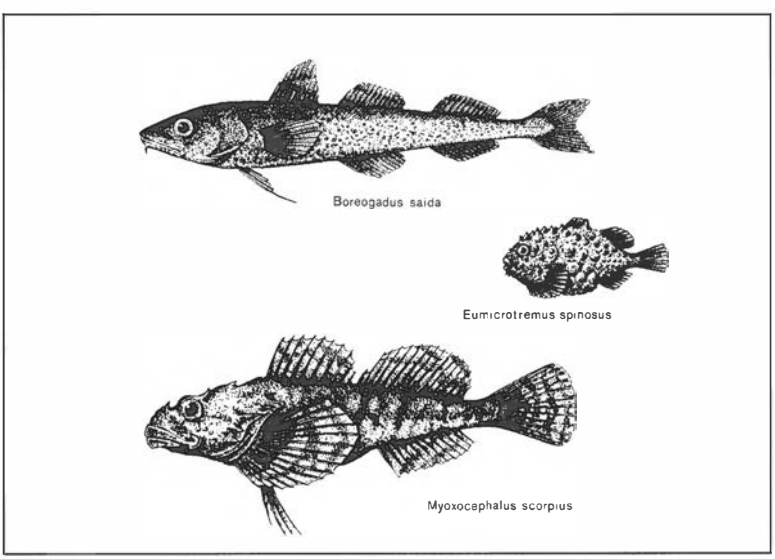
Below a depth of 2 m lies the sublittoral, where macroalgae occur down to about 25 m. Four laminaria species (with *Laminaria sachcharina* as the most common) and red-algae (eg. *Phycodrys rubens*) predominate. Below 15 m the bottom is usually covered with fine glacier sediment. There, polychaete worms and sea bristles, especially *Ophiocten sericuem*, are abundant. Hard bottoms – usually underwater cliffs – are covered with sea anemones and hydroids (Fig. 18).

Seasonality is very pronounced, marked in spring by heavy organic sedimentation from the phytoplankton bloom. Autumn and winter is the time of egg incubation among most of the invertebrates. The larvae and juveniles of Mollusca, Cirripedia, and Amphipoda are hatched in May-June. Typically for the high Arctic, the life cycles are usually long, most of the crustaceans grow slowly and live two (minor forms) to six (large amphipods, decapods) years.

Fish

Fish are not abundant in Franz Josef Land waters. The ichtyofauna count 33 species. There are no commercially-exploited species among them. Small,

Fig. 19. Common fish species from Franz Josef Land coastal waters.



coastal species are relatively common, with polar cod *Boreogadus saida* as the most biologically-important species. This fish reaches up to 20 cm in length and occurs underneath ice floes, as adult also pelagically. Benthic fishes, Liparididae (sea snails) of 5 to 15 cm length with *Liparis fabricii* as the most common, are represented by four species. They live on soft bottoms at depths between two and 400 m. In shallow water among kelp on diversified bottoms, sculpins, *Myoxocephalus scorpius, Triglops spp, Icelus bicornis*, and lumpsuckers, *Eumicrotremus spinosus*, are most common (Fig. 19). Their principal food is small hyperbenthic crustaceans.

Zoogeography

Franz Josef Land, along with the northeast part of the Svalbard archipelago, belongs to the high European arctic marine zoogeographical province. Other divisions place Franz Josef Land within the Barents Sea zoogeographical province (based on benthic fauna). With regard to the surface water plankton, Franz Josef Land belongs to the high arctic zoogeographical province. The majority of invertebrate marine fauna inhabiting the archipelago belong to the circumpolar high arctic species (60%). Other important groups are arctic-boreal forms of atlantic origin (25%), a small amount of cosmopolitic, widely-dispersed species (10%) and some arcto-boreal species of pacific origin (5%).

There are no endemic species for the archipelago area. The shelf waters of Franz Josef Land were released from the ice cover about 6000 to 8000 years ago. Then, a large inflow of atlantic water along with its corresponding fauna started. High-arctic coastal species evolved during glacial stages between 1 million and 20,000 years ago. Pacific cold water forms are the oldest inhabitants; most of those species immigrated into the area before glaciation started.

The Franz Josef Land marine fauna shares most of its important species with other high-arctic archipelagos. The atlantic and boreo-atlantic forms are common with Svalbard, while only a few high-arctic species are common with the Severnaja Zemlja archipelago to the east.

Birds

Habitats, numbers and distribution

Despite Frans Josef Land being an ornithologically attractive region, its avifauna is poorly studied. In fact, Gorbunov's paper written more than 60 years ago, compiling observations carried out during early Russian and foreign expeditions, is still considered fundamental. Later papers are usually occasional and fragmentary or based on old data. This can be attributed to difficulties of access to the archipelago as well as severe climatic conditions. Russian scientific activity in the region, which was significant in the 1920s and 1930s, decreased markedly after the closing of the Tichaja Buchta

Table 2. List of bird species observed in the Franz Josef Land archipelago

SPECIES		STATUS
Red-throated diver	*Gavia stellata*	CB
Black-throated diver	*Gavia arctica*	AV
Fulmar	*Fulmarus glacialis*	CB
Bewick's swan	*Cygnus bewickii*	(?) AV
Pink-footed goose	*Anser brachyrhynchus*	AV
Barnacle goose	*Branta leucopsis*	AV
Brent goose	*Branta bernicla*	IB
Common eider	*Somateria mollissima*	CB
Gyrfalcon	*Falco rusticolus*	AV
Ptarmigan	*Lagopus mutus*	AV (PB?)
Moorhen	*Gallinula chloropus*	AV
Crane	*Grus grus*	AV
Golden plover	*Pluvialis apricaria*	AV
Purple sandpiper	*Calidris maritima*	CB
White-rumped sandpiper	*Calidris fuscicollis*	AV
Sanderling	*Crocethia alba*	AV
Turnstone	*Arenaria interpres*	AV
Red-necked phalarope	*Phalaropus lobatus*	AV
Pomarine skua	*Stercorarius pomarinus*	CV, PB
Arctic skua	*Stercorarius parasiticus*	CB
Long-tailed skua	*Stercorarius longicaudus*	CV
Great skua	*Stercorarius skua*	AV
Herring gull	*Larus argentatus*	AV
Glaucous gull	*Larus hyperboreus*	CB
Great black-backed gull	*Larus marinus*	(?) AV
Kittiwake	*Rissa tridactyla*	CB
Ross' gull	*Rhodostethia rosea*	AV
Ivory gull	*Pagophila eburnea*	CB
Arctic tern	*Sterna paradisaea*	CB
Brünnich's guillemot	*Uria lomvia*	CB
Black guillemot	*Cepphus grylle*	CB
Little Auk	*Alle alle*	CB
Puffin	*Fratercula arctica*	AV
Snowy owl	*Nyctea scandiaca*	CV
Swift	*Apus apus*	AV
Shore lark	*Eremophila alpestris*	AV
Swallow	*Hirundo rustica*	AV
Wheatear	*Oenanthe oenanthe*	AV
Redwing	*Turdus iliacus*	AV
Hooded crow	*Corvus corone*	AV
Redpoll	*Acanthis flammea*	AV
Lapland bunting	*Calcarius lapponicus*	AV
Snow bunting	*Plectrophenax nivalis*	CB

CB – common breeder
IB – rare or irregular breeder
PB – breeding probable but not confirmed
CV – common visitor
AV – irregular or accidental visitor
? – finding not confirmed

station (Hooker Island) in 1959. Since 1991, however, several ornithologists from Belgium, the Netherlands, Norway, Poland and Russia have worked there during the summer seasons.

Due to its severe climate, Franz Josef Land is inhabited by relatively small numbers of bird species. In total, 41 species have been observed in the archipelago. An additional two (Bewick's swan *Cygnus bewickii* and the great black-backed gull *L. marinus*) have been reported, but not confirmed. Of these, 14 species breed there (breeding of ptarmigan *Lagopus mutus* is likely but not confirmed) (Table 2).

The limited area of unglaciated and snow-free flat tundra, characterised by low vegetation production – except at sites close to big seabird colonies – is responsible for the very low number of herbivorous birds (eg. geese), waders and passerines. Also waterbirds using flat tundra as their breeding habitat, eg. divers, ducks, skuas, suffer from spatial and temporal limitations (snow-free ground is accessible for no longer than two months). Moreover, the high number of polar bears on the small areas of unglaciated tundra makes breeding aggregations of birds in easily-accessible sites difficult or impossible (Fig. 20).

Along with increasing climate severity from southwest to northeast, the number of breeding species decreases, 13 species nesting on westernmost Alexandra Land and nine on eastern Graham Bell Island. Of course, the size and topography of particular islands (eg. presence or absence of steep cliffs) may markedly influence the number of breeders.

Only typical seabirds (fulmar *Fulmarus glacialis*, kittiwake *Rissa tridactyla*, Brünnich's guillemot *Uria lomvia*, black guillemot *Cepphus grylle* and little auk *Alle alle*) seem to have adapted to the climate. They nest colonially and utilise abundant marine food resources. For this reason the factors influencing food availability in the sea (dates of ice breaking up and water freezing, pack-ice movements, etc.) are crucial for them. The five seabird species mentioned above are the most common and numerous throughout the archipelago.

Seven species, first of all nesting on flat tundra (common eider *Somateria mollissima*, purple sandpiper *Calidris maritima*, arctic skua *Stercorarius parasiticus*, glaucous gull *Larus hyperboreus*, ivory gull *Pagophila eburnea* (which also nests in cliffs), arctic tern *Sterna paradisaea* and snow bunting *Plectrophenax nivalis*), are common but not numerous. Red-throated diver *Gavia stellata* and brent goose *Branta bernicla* breed in very low numbers at a few sites only. The remainder of the bird species noted in Franz Josef Land are visitors, often represented by single specimens (Table 2).

Table 3. Characteristics of the Franz Josef Land breeding avifauna. ▶

Species	Nesting*	Habitat*	Population size***	Arrival	Departure	Food	Breeding localities	Locality symbols
Red-throated diver Gavia stellata	S	F	I	JUN (2nd half)	AUG (end)	fish, invertebrates (marine, freshwater)	Aa,Be,Ko,Ma,Ne,Sc	Aa-Aagaard I. Ag-Alger I.
Fulmar Fulmarus glacialis	C	Cl	III	APR (MAR-MAY)	SEP	polar cod, sculpin, polychaets	Be,Ge,Ho,Ma,,Ru,Sa,Wn	Al-Alexandra L. Ap-Apollonoff I.
Brent goose Branta bernicla	S	F	I	JUN (1st half) (MAY)	SEP (end)	tundra plants	Ag,El,Gb,Ho	Be-Bell I. Br-Brosh I.
Common elder Somateria mollissima	S,C	F	II	MAY/JUN	SEP	gastropods benthic amphipods	Aa,Al,Et,Gb,Hh,Ho,Mt,Ne,Ru,Sc	By-Brady I. Ch-Champ I.
Purple sandpiper Calidris maritima	S	F	I	MAY/JUN	AUG/SEP	freshwater, marine (tidal) invertebrates	Gb,Ho,Ko,Na,No,Sc,	El-Elisabeth I. Et-Etherige I.
Arctic skua Stercorarius parasiticus	S	F	I	JUN (1st half)	SEP	fish, crustaceans (piracy on auks & gulls)	Be,Ga,Gb,Ge,Ho,Ko,Ne,No,Ru,Sc,Wi	Ga-Gall I. Gb-Graham-Bell I.
Glaucous gull Larus hyperboreus	S,C	Cl, R	II	APR (MAR-MAY)	SEP	eggs,young auks,kittiwakes polar cod,carrion	Be,Br,By,Ga,Gb,Ge,Ha,Hh,Ho,Ja,Ka, Kl,Ma,Mc,Na,Nc,No,Ru,St,To,Wi	Ge-Prinz Georg L. Ha-Hall I.
Kittiwake Rissa tridactyla	C	Cl	IV	APR	SEP	polar cod,amphipods	Be,Br,Ch,Gb,Ge,Ho, Ja,Mc,No,Ru,St,Wi,Wl	Hh-Hochstetter I. Hs-Hayes I.
Ivory gull Pagophila eburnea	C	F,Cl	II	MAR	SEP/OCT	fish,crustaceans, carrion	Al,Gb,Ho,Hs,My,Ru,	Ja-Jackson I Ka-Kane I.
Arctic tern Sterna paradisea	C	F	II	JUN (2nd half)	SEP	gammarids,small fish	Al,Be,Gb,Hh,Ho,Mt,Ne,	Kl-Klagenfurt I. Ko-Koettitz I.
Brünnich's guillemot Uria lomvia	C	Cl	IV	MAR/APR	August	polar cod,amphipods	Be,Ge,Ho,Ja,Ma,Mc,No,Lu,Sa	Kx-Karl Alexander I. Lu-Luigi I.
Black guillemot Cepphus grylle	C	Cl,R	III	MAR	Sept./Oct.	polar cod,amphipods decapods	Ap,Be,Br,By,Ga,Ge,Ha,Hh,Ho,Ja,Ka,Kl, Kx,Lu,Ma,Mc,Nc,No,Ru,Sa,St,To,Wi,Wn	Ma-Mabell I. Mc-McClintock I.
Little Auk Alle alle	C	R, Cl	IV	FEB/MAR	AUG/SEP	copepods,amphipods euphausids,small fish	Ap,Be,Br,By,Ge,Ha,Hh,Ho,Ja,Ka,Kl,Kx, Lu,Ma,Mc,No,Ru,Sa,Sc,St,To,Wi,Wl,Wn	Mt-Mertvogo Tulenia I. My-May I.
Snow bunting Plectrophenax nivalis	S	R	I	APR	SEP/OCT	seeds terrestrial invertebrates	Al,Gb,Ge,Ho,Ne,No,Ru	Na-Nansen I. Nc-Newcombe I.

Note:
* S - solitary; C - colonial
** F - flat ground; Cl - cliffs; R - rock debris
*** I-100 pairs (I)
101-1 000 pairs (II)
1 001-10 000 pairs (III)
10001-100 000 pairs (IV)

Ne-Newton I.
No-Northbrook I.
Ru-Rudolph I.
Sa-Salisbury I.
Sk-Scott-Keltie
St-Stolichky I.
To-Torup I.
Wi-Wilczek I.
Wl-Wilczek L.
Wn-Wiener-Neustadt I.

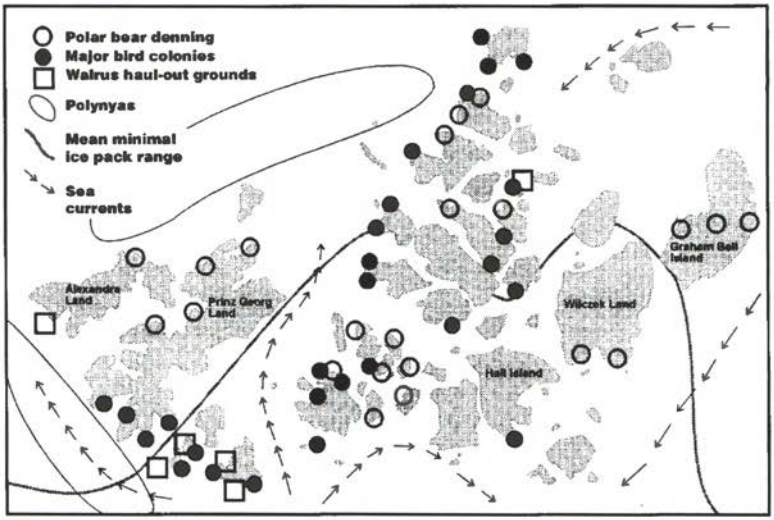


Fig. 20. Major seabird colonies, polar bear denning areas and walrus haul-out grounds in the archipelago.

Fig. 21. Black guillemots Cepphus grylle *resting on an ice floe. Photo: Trygve Aas*

Table 4. Numbers of bird species observed in Franz Josef Land and Svalbard archipelagos

Taxonomic group	Svalbard*			Franz Josef Land		
	Breeding	Visiting	In total	Breeding	Visiting	In total
Divers	2	2	4	1	1	2
Tubenoses	1	3	4	1	–	1
Geese	3	5	8	1	2	3
Ducks	4	18	22	1	–	1
Raptors	–	6	6	–	1	1
Waders	9	23	32	1	5	6
Gulls	7	5	12	3	2(3?)	5(6?)
Auks	6	–	6	3	1	4
Passerines	4	41	45	1	7	8
All species	42	121	163	14	27(29?)	41(43?)

NOTE:
* After Mehlum 1990 (Birds and mammals of Svalbard)
? Finding not confirmed

Numerous polynias in the archipelago make it possible for some seabirds (fulmar, common eider, glaucous gull, Brünnich's and black guillemots) to spend part of their prelaying and postbreeding period there, or even to overwinter (ivory gull, little auk, Brünnich's guillemot). However detailed data from the winter season are lacking.

Breeding birds

Basic information concerning status, distribution and breeding habitat of 14 species of breeding birds found in the archipelago is presented in Table 3.

Comparison with Svalbard

A comparison of bird species numbers both breeding and visiting the Franz Josef Land and Svalbard archipelagos is shown in Table 4. The differences in avifauna are dramatic in spite of relatively small distances separating the areas. They are a result of geographical location, range and impact of warm sea currents and climate. In addition, the far more detailed ornithological exploration of Svalbard is partly responsible for the high number of bird species noted there. Differences are not so drastic in the case of typical seabirds and concern mainly tundra-utilising species like geese, ducks, waders and passerines.

Mammals

Pinnipeds

Three species of seals are common in the archipelago. Probably the most numerous is the greenland or harp seal *Phoca groenlandica.* In summer harp seals are common among islands of the southern part of archipelago. These fish and crustacean-eating animals usually occur in groups of 5 to 50 seals along the ice pack. They breed in early spring on the sea ice in the White Sea region. The small, pelagic-feeding ringed seal *Phoca hispida* is less numerous, and occurs closer to the shores, in shallower waters among islands. It breeds in April giving birth to a single pup, usually in a snow den on the fast ice. The large, bearded seal *Erignathus barbatus* which feeds on benthic fauna is common, but not abundant. Single specimens are often observed on ice floes in bays and coastal waters. There have been reports of occasional observations of grey and hooded seals in the archipelago, but scientific confirmation is lacking.

Walruses *Odobenus rosmarus* are common throughout the archipelago. Walrus hunting started at the very beginning of the archipelago's discovery and hunting has reduced the number of walruses drastically. International

Fig. 22. Rubini Rock, the biggest seabird colony in Franz Josef Land. In front, buildings from the Russian station Tichaja Buchta. Photo: Susan Barr.

protection was introduced in 1952, and apparently the walrus stocks have slowly increased in the Barents Sea area since then. Today, a rough estimation gives a number between one and three thousand walruses inhabiting Franz Josef Land waters. The majority of walruses observed there during the summer are females with calves and sub-adult specimens. The walruses are most often observed on the ice pack, although a few haul-out grounds are known. Apparently the Franz Josef Land walrus population is common with Svalbard and northern Novaja Zemlja.

Whales

The Franz Josef Land archipelago lies on the northernmost edge of the whales' summer range. Minke *Balaenoptera acutorostraca* and white whale (beluga) *Delphinapterus leucas* are relatively common. Small pods of narwhals *Monodon monoceros* and orcas (killer whales) *Orcinus orca* are occasionally observed. A local, small population of the greenland whale (bowhead) *Balaena mysticetus*, once common and now almost extinct in the European Arctic, is a great rarity and attraction in this area. These slow-swimming whales, with characteristic v-shaped blow, have recently been

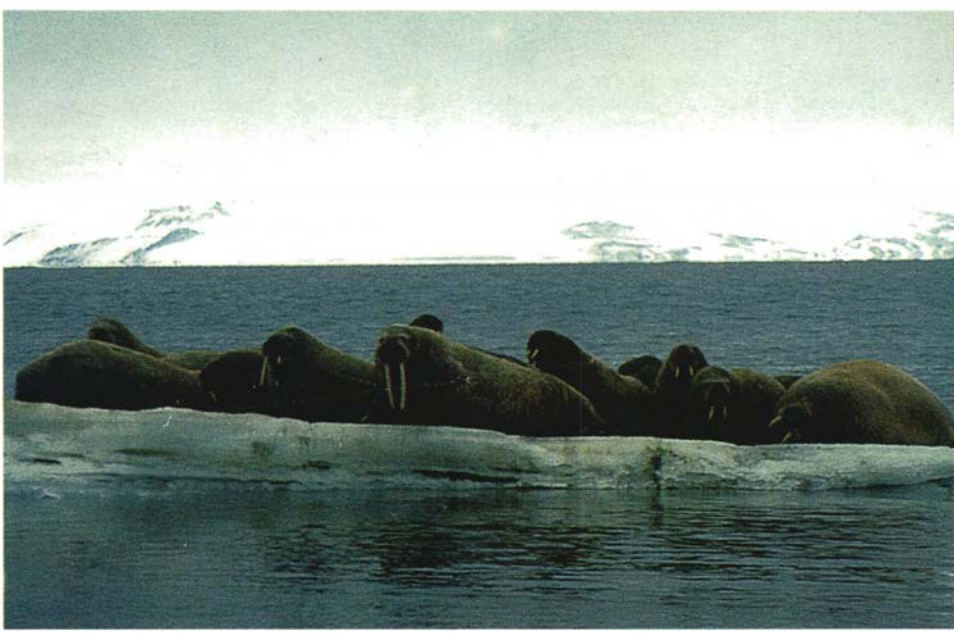


Fig. 23. Group of walruses hauled out on the ice. Photo: Wojciech Moskal.

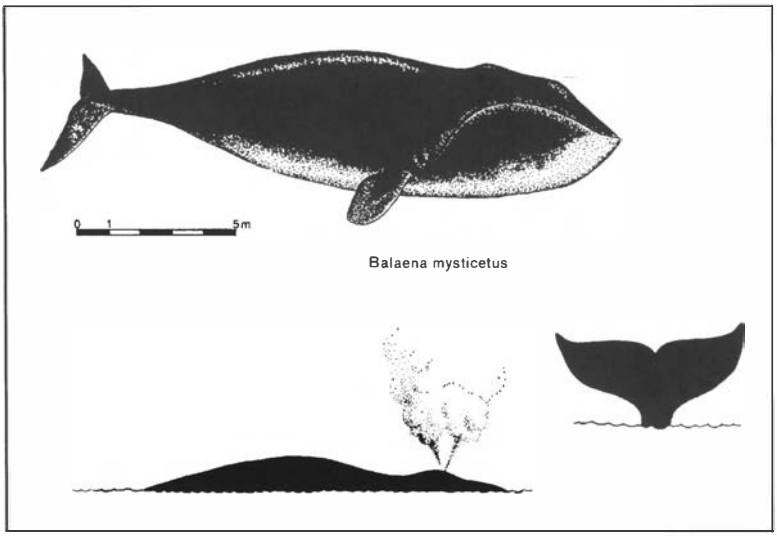


Fig. 24. Greenland (bowhead) whale characteristic features.

observed in the southern and central parts of the archipelago, not far from the shores (Fig. 24).

Carnivores

Polar bears *Ursus maritimus* in Franz Josef Land belong to a population common for the area from East Greenland to Severnaja Zemlja. The population number usual for Franz Josef Land is not known, but for the whole common area is estimated at 5000. Bears migrate all over the area and are likely to be found in all places where the ice pack occurs. Since no regular hunters were using Franz Josef Land during what was the peak hunting period in Svalbard, 1929–1973, bears were hunted there only occasionally and thus less extensively than in Svalbard. International protection was introduced in 1973. Large islands in Franz Josef Land belong to the important polar bear denning areas in the European Arctic. Breeding females spend about five months in winter in a snow den, giving birth to their cubs around January 1st and emerging around March/April.

The polar bear is an opportunistic omnivore. It most often hunts seals. Sporadically it attacks walruses, belugas and narwhals. Moreover, polar bears are scavengers and cannibals (especially adult males). Their diet also consists of both marine and terrestrial plants. Food composition is very dif-

Fig. 25. Female polar bear with two cubs in an encounter with visitors to Jackson Island. Photo: Susan Barr.

ferentiated due to local and temporal food availability. Birds may constitute a supplementary prey during the summer. Polar bears are often observed in the vicinity of big seabird colonies. They will search along a cliff foot for dead birds, eggs and chicks. They also plunder nests situated low on the cliffs and dig out eggs, chicks and adult little auks nesting in the rock debris below.

The arctic fox *Alopex lagopus* occurs in summer in small numbers almost exclusively on those islands where big seabird colonies exist. Eggs, chicks and adult birds of all species nesting in accessible sites, as well as carrion, constitute its main food. The most attractive are little auks because of their number and relatively easy nest availability. The arctic fox also plunders low and marginally situated cliff ledges occupied by guillemots and kittiwakes. During the winter it is associated with polar bears, relying on remnants of their preys. It often visits seabird colonies to recover food stored in summer, as well as scavenging at year-round polar stations.

The arctic fox is territorial (territory size ranges from 10–20 km^2), hence usually only one or two families occupy an island with one seabird colony. Mating takes place in March and pups are born in May and leave their den in July–August. Dens are located in rock crevices or under large boulders, usually in the vicinity of bird aggregations.

High Arctic Ecosystem

Ice-associated flora and fauna

Well-developed cryoflora and cryofauna, known as sympagic organisms, are very characteristic for the high Arctic. Such plants and animals are associated with multi-year sea ice, hence they are very common and important in Franz Josef Land. After the second or third winter pack-ice floes may reach up to 4 m in thickness. Such ice is richly sculptured, containing crevices and channels giving surface for algae growth and shelter for animals. Ice-living algae are dominated by the diatoms *Aulacosira granulata, Nitschia frigida, N. cylindrus.*

During the blooming period long "beards" of *Melosira spp* may occur, reaching up to several centimetres in length. Accompanying animals are predominantly sympagic crustaceans – large, 5 cm long *Gammarus wilkitzkii* and smaller, whitish *Apherusa glacialis*. Schools of polar cod are often sandwiched between ice floes, perfectly safe from seabirds. Densities of sympagic crustaceans reach up to 1000 individuals and biomass up to 1 g wet weight/m^2. For this reason ice-associated communities play an important role in the energy flow through the ecosystem.

Sympagic crustaceans and fishes constitute an important source of food for seabirds and seals in Franz Josef Land. The pack ice is utilised as a resting place by seabirds, walruses (beaches are scarce in the area) and seals. The latter (ringed and greenland seals) also breed on ice. Drifting ice is used as a means of transportation by auks (flightless young and moulting adult birds), arctic fox and polar bears, which most often hunts seals there.

Depending on the situation (time, place, movements, density, etc.) pack ice may involve positive or negative consequences. Long-lasting, dense pack ice at the foot of cliffs may contribute to a high mortality of young Brünnich's guillemots leaving the breeding colony: they have no free water to land in when jumping down from the ledges, and get struck against the ice. Those which succeed in reaching the water have serious problems with leaving the ice-filled bays and straits. As a result, mass mortality occurs in some years, providing abundant food for predators and scavengers (polar bear, arctic fox, glaucous gull).

Trophic relationships

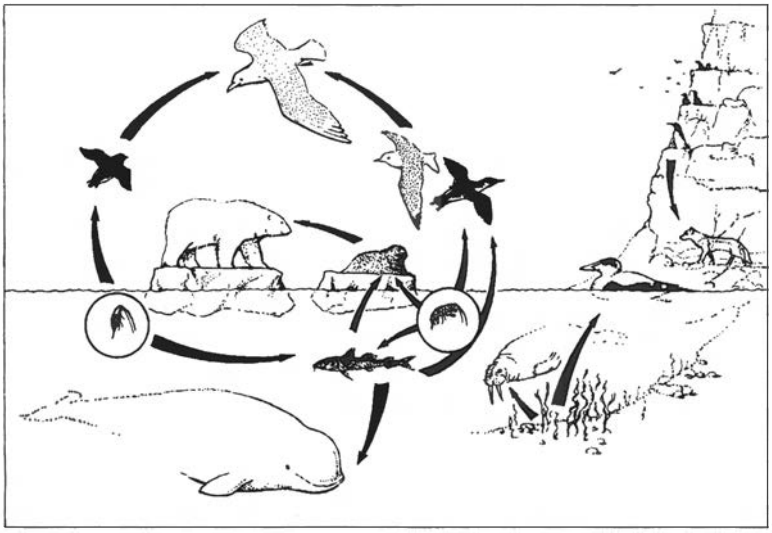
The food web of the Franz Josef Land ecosystem resembles that of other high arctic areas. The great majority of organic matter is produced in the sea and the terrestrial part of the ecosystem relies almost entirely on energy of marine origin. Phytophages are not numerous either on land or in the sea (except for planktonic calanoids), so only a minor portion of primary production is consumed. The rest dies away, thus contributing abundant food resources for detritophages. *(Fig. 26).*

However, some characteristic features of the ecosystem (distinguishing

it eg. from Svalbard) merit attention. First is the great role of the ice and ice-associated organisms in energy flow. This is a result of the permanent presence of pack ice in the area during the summer season. The second is the nearly-negligible importance of the terrestrial part of the ecosystem. An extremely limited area of ice- and snow-free tundra, a very short period of vegetation and low temperatures result in very small productivity of land plants and animals. In general, three main parts may be distinguished in the Franz Josef Land ecosystem food web:

The terrestrial part consists of tundra plants occupying a very limited area and characterised by a small number of plant and animal (invertebrate and vertebrate) species, occurring in low densities and thus giving little production (exceptions are the areas close to big seabird colonies). Typical land herbivores are almost completely lacking. Lemmings *Lemmus sp.*, hares *Lepus sp.*, muskoxen *Ovibos moschatus* and reindeer *Rangifer tarandus* do not occur (bones and antlers of reindeer found in the southern part of the archipelago belong most probably to failed winter immigrants from Novaja Zemlja). Only single geese and ptarmigans are observed in the area, although ptarmigan breeding is likely. Snow buntings, which feed on plant seeds and invertebrates, are the only common but not numerous terrestrial bird species. Waders, of which only the purple sandpiper is quite common, but also not numerous, rely mainly on freshwater and tidal zone inverte-

Fig. 26. Schematic presentation of the trophic net in Franz Josef Land coastal waters.



brates. The arctic fox, the only land mammal, feeds on eggs, nestlings and adult birds during the summer.

The coastal water part of the food web, restricted to shallow waters around the islands, is based mainly on littoral production (benthic molluscs and crustaceans). The most conspicuous are benthic-feeding bearded seals (feeding on large gastropods) and walruses (feeding on bivalves). Eiders also belong here (taking small gastropods and crustaceans), as well as black guillemots (mainly taking amphipods). There is also an important permanent supply to this part of the ecosystem of organic matter of outside origin. Powerful tidal currents push considerable amounts of pelagic macrozooplankton into the coastline. These half-dead animals become a regular source of food for kittiwakes.

The shelf waters part of the food web is based on the primary production of phytoplankton in the water column and ice algae. Primary production can be estimated at 60–100 gC/m^2/year. There are relatively few herbivores among the planktonic crustaceans, and very few herbivores in the benthic fauna (few species of gastropods). So, the largest part of the algae bloom falls to the sea bed enriching benthic communities of detritophagic invertebrates. Hence benthos is more abundant here than in Svalbard. Higher trophic levels (birds and mammals) rely mainly on polar cod. This fish constitutes the primary food of guillemots, kittiwakes and other gulls, fulmars and ringed seals. Next in importance are sympagic crustaceans *Gammarus wilkitzkii, Apherusa glacialis* and pelagic *Themisto libellula* taken by most seabirds as secondary food items. These food items provide 10% to 25% of the energy intake by seabirds in summer. The smallest but numerous alcid – the little auk – feeds on abundant pelagic calanoids (*Calanus glacialis* and *C. hyperboreus*) and hence occupies a well-separated trophic niche. Top predators and scavengers (polar bear, arctic fox, glaucous gull) operate in all parts of the ecosystem.

Sea-land connections

Most of the homoiothermic vertebrates inhabiting the archipelago, including all numerous birds and mammals, are amphibious. They feed in high-productive sea and breed on poor land (or ice). As a result they bring considerable amounts of organic matter from sea to land. A notable part of that marine-origin matter remains on land as guano and dead organic matter (food remnants, dead eggs, young and adult birds and mammals). Since the decomposition rate is very low in the Arctic, the carrion remains for a long time and usually becomes a food source for the scavengers.

The fertilisation of the tundra by bird droppings is of special importance. The organic fraction is used as food by coprophagic invertebrates common near bird colonies. Biogenic salts from the guano are easily assimilated by plants, thus making possible the relatively rich vegetation in the

vicinity of big seabird colonies. As a consequence, herbivores, scavengers and carnivores concentrate here. Large seabird colonies are nearly the only sites in Franz Josef Land where the tundra plants and animals occur in relative abundance.

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THE HISTORY OF WESTERN ACTIVITY IN FRANZ JOSEF LAND

SUSAN BARR

Discovery

The honour of being the *first* discoverer of a geographical point or area can be a matter of intense personal or national discussion in cases where the fact cannot be indeniably proved. In the arctic areas where gradual discovery and mapping often were a consequence of sealing and whaling activities, the discovery of new land and therefore new possible hunting areas was often kept more or less secret to prevent competition. Such early discoveries could later be referred to for the purpose of supporting national interests.

In the case of the first discovery of Franz Josef Land there are at least two candidates. The sealing ship *Spidsbergen* with skipper Nils Fredrik Rønnbeck and harpuner Johan Petter Aidijärvi is alleged to have met uncharted land when sailing east from north-east Svalbard in 1865. This must have been part of Franz Josef Land. They gave it the name North-East Spitsbergen, or Rønnbeck Land (Horn 1930). This discovery is most likely a fact. However, the discovery was not published at the time, and was unknown to the next expedition to visit the archipelago.

The Austro-Hungarian expedition eight years later (see next chapter) actually introduced Franz Josef Land to the world, and was therefore obviously of greater practical importance.

Hunting

Once the existence of the archipelago was established, it was naturally included in the hunting area of the small Norwegian ships which ventured up to the ice over the whole area between eastern Greenland and Franz Josef Land. These summer expeditions ("summer" is almost a misleading adjective in this area) were after, in particular, seals, walrus and polar bears. They continued in most years when ice conditions were favourable, after 1923 with the help of engine-powered vessels to push through the ice (Lønø 1972, p. 206), until access to the area was closed by the Soviet authorities after 1931. A handful of British hunting expeditions also visited the archipelago in the 1890s. According to a survey made in Norway in 1930 (Horn 1930, p. 36–37) an approximate total of 112 expeditions visited Franz Josef Land in the years 1865–1928 for the purpose of hunting. Of these 105 were Norwegian. There were probably even more, unregistered, expeditions, both from Norway and other countries but, considering Norway's geographical proximity and the tradition of hunting in arctic waters, the absolute majority

Fig. 27. The Norwegian ship Bratvaag and crew with shot walrus, Franz Josef Land 1930. Photo: Gunnar Horn/Norsk Polarinstitutt.

were without doubt Norwegian. A result of the experience gained by Norwegian boats, skippers and crews in these and other arctic waters, was that they were much in demand for transport and assistance to the expeditions of other countries venturing into the area (see later under Expeditions).

An idea of the extent of the catch can be gained from the following figures (Horn 1930; Lønø 1972; Gjertz et al. 1992): *Baleana* of Dundee (previously the Norwegian *Mjølner*), Captain Thomas Robertson, took in 1897 ca. 2 000 walrus, 14 polar bears and a Greenland whale. This was an exceptional catch. Normal catches of walrus varied between up to 10 in the least successful seasons to a few hundred in the most successful. It is estimated that more than 8000 walrus were killed by hunters in Franz Josef Land. Beside the tusks, walrus was especially attractive for its thick, strong skin which was used for rope and machine belts. Walrus became a protected species by international law of June 1952, although it is known that some were caught after this (Lønø 1972).

The closing of Franz Josef Land by USSR after 1930 was obviously considered by Norwegian hunters to be a severe curtailment of their traditional hunting rights (see later under Rights and Annexations).

Expeditions

The story of the Austro-Hungarian Tegetthoff expedition to Franz Josef Land in 1872–74 is told in detail in the next chapter. This expedition was originally called a North Pole expedition, but intended at least to find the Northeast Passage to the Far East. Caught in the grip of the ice, it happened by chance on Franz Josef Land and spent seven months in the winter 1873–74 there. The expedition's contribution to the mapping and scientific discovery of the archipelago was significant.

Despite the difficult climatic conditions which regulated approach to its shores, Franz Josef Land attracted a number of expeditions with other purposes than hunting in the years between its discovery and its closing. In the same way as Svalbard, the archipelago caught the imagination and interest of scientifically-interested explorers as well as those with the sole aim of reaching the North Pole.

The Dutch Expedition for the Exploration of the Barents Sea, in the schooner *Willem Barents*, sighted the archipelago in 1879, but was frightened away by the ice (Grant 1881, p. 216). However it was the British who were first out with extended expeditions to the islands, in the gentleman-explorer tradition of the time, which took them to most corners of the globe.

Leigh Smith's expeditions 1880 and 1881–82

Mr Benjamin Leigh Smith was already an experienced arctic traveller and collector of scientific data when he had the 350 ton barque *Eira* specially constructed for a trip through ice-filled arctic waters in 1880 (Credland 1980). The yacht was steam powered, with a 50 hp engine which ran not only on coal, but also on seal blubber. There were 25 men on board, including the crew. The photographer W.J.A. Grant, newly arrived home from the above-mentioned expedition to Svalbard and Novaja Zemlja with the Dutch ship *Willem Barents*, was amongst the group. The final port of departure, Lerwick in Shetland, was left on June 22nd. According to Grant: *Now as to where we were going no one on board knew – not even Mr. Leigh Smith himself, for he wisely determined to be guided entirely by circumstances, and if the ice prevented him from getting far north, or finding anything fresh to do in one direction, he could then try somewhere else* (Grant 1881, p. 213).

The first idea was to explore Jan Mayen and the east coast of Greenland. However fog and heavy ice stopped progress, but allowed the tanks to be filled up with seal blubber. By mid-July they were at the northwest coast of Spitsbergen, where there again was heavy ice. They therefore decided to go south of Svalbard and make for Franz Josef Land. After a considerable amount of battering through the pack-ice, the *Eira* arrived in the south of

Franz Josef Land on August 14th. Being now some 80 km to the west of Wilczek Island, they reckoned that all land they discovered to their west could be considered entirely new-found land.

Walrus and basaltic rocks were features which first caught their eye. Seventeen walrus as well as seven ivory gulls were the immediate catch. While dodging around in the ice in the next few days, three polar bears were added to the list. Specimens of rocks, flora and marine bottom fauna were collected from various sites. Regarding the flora they remarked on the great quantities, but few species. A record of the visit was soldered into a tin case and left on one of the islands. On the 18th August they discovered the fine natural harbour at Bell Island which they named Eira Harbour, and which they used as a safe base for more exploring. Two polar bear cubs were captured alive and the mother shot, but baby walruses proved too difficult to catch. Driftwood and whale bones were abundant, but even more interesting were the finds of fossilized wood and even fir cones on the hillside near Eira Harbour.

On a push westwards the *Eira* was stopped by the ice at 80°20'N and ca. 45°E. They could see a land area running northwestwards, and wondered whether it continued right to the North Pole. The Eira then turned eastwards to McClintock and Wilczek Islands, but again the way further east or north was blocked by ice. By now it was the end of August, and the expedition turned southwards and then back to Svalbard, down the coast of Norway and to the starting point of Peterhead on October 12th.

In the tradition of the time the expedition was a grand mixture of exploration, hunting and scientific work. Meteorological observations were taken, and geological specimens and samples of flora and fauna were presented to museums for analysis. To quote W.J.A. Grant: *People are often inclined to wonder what good can be got out of such expeditions, but every little helps, and as long as we are able to add something, however small, to the world's store of knowledge, we cannot be said to have laboured in vain* (Grant 1881, p. 220). Leigh Smith was awarded the Royal Geographical Society's patron's gold medal for this voyage (Credland 1980, p. 135).

The next year Leigh Smith made a repeat expedition with the same ship and same number of men. Peterhead was left on June 14th (Proceedings… 1883). The *Eira* sailed, again battering through ice, towards Novaja Zemlja before striking north for Franz Josef Land, which was sighted on July 23rd. They had arrived at the southern coast of Alexandra Land, further west than the year before. The first landing was made in Gray Bay on southern George Land, where they had found a reasonable harbour the year before. In the course of a few days 52 walrus were shot, new flower species were found and more fossil wood was collected.

In the second week of August a large and solid store house was built on Bell Island, with materials they had brought with them. It was christened

Fig. 28. Eira Lodge, Bell Island in 1990. Photo: Susan Barr.

Eira Lodge[1]. On August 15th the *Eira* steamed eastwards for the purpose, besides further exploration, of searching for the *Jeanette*[2]. A landing was made at Cape Flora. Ice blocked further progress eastwards for the time being, so time was spent collecting fossils and plant specimens. On August 21st disaster struck when the *Eira* was pressed by the pack ice, holed and sunk off Cape Flora. There had been time to get men, stores and the ship's boats off first, but the ice prevented the group from reaching the house they had erected on Bell Island.

A wintering hut of turf and stones was built at Cape Flora and driftwood and fresh meat (walrus, bears and looms) were collected and stored. Ample provisions had been saved from the ship, and coal and salt were fetched from Bell Island on September 1st so that, all in all, the situation was reasonable. Despite the cramped, damp and frozen quarters, the men had sufficient food and fresh meat and blood to prevent scurvy, and were kept occupied with hunting, clothing repairs and various amusements which had been saved from the ship (musical instruments and cards). In the style of the time even this improvised hut was divided into separate quarters for the officers and men. The wintering would not be entirely gloomy as they had saved from the *Eira* 320 litres of rum, 36 bottles of champagne, 60 of beer, 12 of gin, 18 of whisky and some sherry (Credland 1980, p. 138).

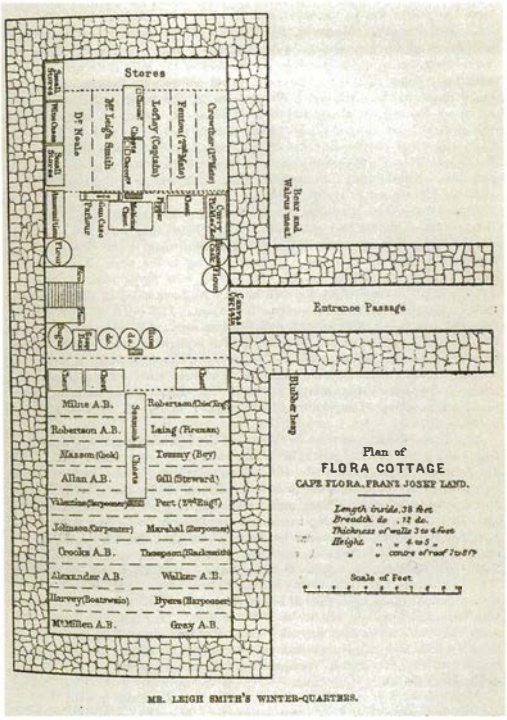


Fig. 29. Leigh Smith's plan of 'Flora Cottage', the wintering hut at Cape Flora. From Proceedings ... p. 215.

Leigh Smith regretted the lack of sledges, which would have enabled them to explore a larger area, but many observations were made which would be of use for later parties. There was, for example, more than sufficient wildlife to support groups through the harsh winter. Twenty-four walrus and 34 polar bears were killed during the wintering. Bird life returned in February. A portion of reindeer antler was discovered, which they thought indicated that reindeer had once roamed the islands. Full meteorological reports were also made.

On June 21st they set off in the four boats for Novaja Zemlja. It was a hard struggle in places through the pack ice. After 43 days, on August 2nd, they sighted land and were able to haul the boats up the beach at the entrance to Matočkin Šar, Novaja Zemlja. Here they met both the *Willem Barents* and two British vessels, the *Hope,* sent out to search for the *Eira* expedition, and the *Kara* with, amongst others, W.J.A. Grant, Leigh Smith's expedition photographer and naturalist on the previous voyage, onboard. Leigh Smith was now 54 years old and this expedition saw the end of his active arctic engagement, though not of his interest.

Jackson's expedition 1894–97

Although both the *Tegetthoff* and *Eira* expeditions had resulted in the loss of the ships, they had contributed a great deal to the extremely sparse knowledge of Franz Josef Land. They had shown that it was possible to winter there, and they had given hope that this might be a feasible way to

the North Pole. The next expedition to venture there, *The Jackson-Harmsworth Expedition 1894–97,* had both these ideas in mind. When Jackson planned his expedition, only the mid and southern parts of the archipelago were mapped in any way. Northwards there was presumed to be a land mass called Petermann Land, possibly stretching most of the way to the North Pole. Westwards was thought to be another land mass, Gillis Land[3], stretching towards Svalbard. Jackson's plan of laying depôts on the land as he moved northwards, was to be quickly thwarted as he unravelled the fact that Franz Josef Land is a group of small islands, stretching far less north than thought[4].

In 1893 Jackson took a preparatory expedition to Jugorskij Šar and Vajgač. It was here that he became convinced of the merits of hardy ponies in arctic exploration, later advising Capt. Robert F. Scott to use them in the Antarctic as opposed to dogs.

The expedition to Franz Josef Land was financed by the newspaper magnate Alfred C. Harmsworth (later Lord Northcliffe). Fridtjof Nansen's brother Alexander was amongst those who assisted with equipment (sledges, skis, furs). When the expedition left London in the *Windward* on July 12th 1894, Nansen and the *Fram* had been gone for a year. Since Jackson had published his plans in 1892, Nansen knew when he left of Jackson's impending expedition, but not with the certainty that it would actually be carried out. On August 6th the *Windward* left the mainland – represented by Archangel'sk – behind and headed, via Novaja Zemlja, for "the great white North". On board, beside Jackson and the crew of the *Windward*, were eight expedition members, none of whom had been to the Arctic before.

Franz Josef Land was sighted on August 25th in the vicinity of Cape Crowther and Bell Island. Owing to the ice, however, they were unable to get ashore before September 8th at Cape Flora. A roofless and dripping wet Eira Cottage was the first object that met their eyes. After taking a look eastwards towards Cape Barents, it was decided to make Cape Flora the main base and the unloading began. Bitter cold, snow, rain and high winds hampered the work, but four wood-and-canvas huts were gradually erected for storage, together with a log dwelling cabin, doghouse and stable for the four ponies. The base was named *Elmwood. Windward* was moored close by and the two more or less separate communities, the shore party and the ship's crew of 18, settled into their winter routines. Standing orders and other official business between Jackson and members of the expedition were written, one such order being that Jackson should be informed whenever a bear was sighted and before a chase was started. Bear hunting was one of the main activities during the short and cold autumn days. Fifteen bears and seven walrus were taken for the larder in the first 2 ½ months, and a number more were injured or killed and lost. As a precaution against

Fig. 30. Elmwood and Windward in March 1895. From Jackson Vol. I.

scurvy, the scourge of polar expeditions, Jackson froze and kept the blood to be added to soups, etc.

Jackson was an eager photographer, and interior photographs taken by candlelight with five hours' exposure show how practical and cosy the log cabin became. Jackson also threw himself and his shore group into the business of collecting scientific results with great thoroughness and enthusiasm. He slept on the roof of the log cabin in the coldest weather to try different patents of sleeping bags, and the shore group all tried eating polar bear liver, having heard that it could have adverse effects, and proving that this was so!

In March they could begin sledging expeditions, firstly with the purpose of laying depôts for the planned thrust towards the North Pole, later for general exploration as they discovered the actual extent of the archipelago. On May 2nd they reached their "furthest north", Cape Mill, the cape just to the north of Cape Norvegia, where Nansen and Johansen were soon to settle down for the coming winter. Jackson often had Nansen and his party in his thoughts, naturally enough as both expeditions were braving the arctic isolation at the same time, and he intended the many depôts they laid down also to be used by Nansen and the *Fram* party should they be shipwrecked and manage to struggle to Franz Josef Land.

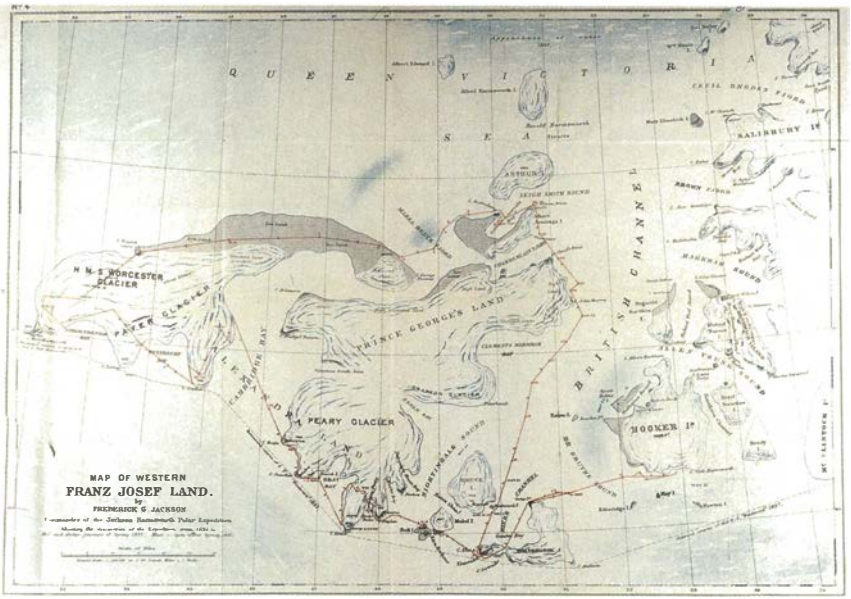


Fig. 31. Jackson's map of Franz Josef Land.

In the course of his sledge and, in the summer periods, boat journeys, Jackson redrew the map of Franz Josef Land, determining its geographical limits and finding the existence of large land masses improbable. Information about the northeast he obtained from Nansen during the time Nansen and Johansen spent at Elmwood. Capes and islands were named, in one way or other mostly in honour of expedition members, friends and well wishers. These names survive in the main to the present day, and together with the place names of other expeditions, provide us with an interesting approach to the expedition history of the archipelago. We can be glad that the Soviet system did not sweep these names away and replace them with revolutionary names with no connection to the area.

In the middle of June Mouatt, a crew member who had been ill through most of the winter, died and was buried at the foot of the cliff behind Elmwood. Work started, through sawing and blasting, to get the *Windward* free from the surrounding ice as there had been open water nearby for some time. The ship was finally able to depart on July 3rd, leaving the eight members of the expedition proper waving, somewhat sadly, from the land. Jackson's account exudes, however, cheerfulness and determination, and part of the group was soon on its way westwards by boat, charting the southern border of the archipelago as far as Cape Mary Harmsworth on the

Fig. 32. Aren't you Nansen? *Reconstructed photograph of the meeting between Nansen and Jackson at Cape Flora. From Jackson Vol. II.*

southwestern corner of Alexandra Land. The boat with the six men was very nearly lost in a storm on the return journey, the difference between success and disaster once again falling on the lucky side. The *Windward* also had problems, being beset in the ice again further south and not finally getting free until the beginning of September. Two more deaths and much sickness occurred before they reached Vardø in northern Norway.

Amongst the various scientific specimens collected by the expedition was a piece of reindeer antler, indicating that reindeer had once roamed the area. Leigh Smith had also found a piece of antler in the same area.

By the beginning of the second winter three of the four ponies were dead, one on a sledging trip in the spring, one of illness and one by accidental hanging in its stall. The fourth was in fine shape and had accustomed itself to eating meat. Eleven dogs had also died, mostly by killing each other, but they also reproduced themselves. The first sledge journey in the spring – in mid-March – was delayed a few days by the weather being too mild and the snow too wet and heavy. It was early in this first expedition in March 1896 at Jackson came to the definite conclusion that *..this together with the experiences of last spring satisfy me that I shall have to find another route north, as this land is evidently only an archipelago of islands, and the continental mass that the maps portray vanishes into thin air. It is very disappointing thus to have one's plans upset by the fallaciousness of what were considered as facts* (Jackson 1899, vol. II, p. 13–14).

For almost a year now Jackson's expedition had, of course, not been alone on the archipelago. Unknown to each other, Jackson and Nansen with companions had each lived in their isolated worlds[5]. On June 17th one of Jackson's companions spotted a man on the ice some distance away and Jackson went to meet him. It was first after some minutes wondering who this filthy, bedraggled person could be that Jackson suddenly recognized Nansen, whom he had met once in London, and the Stanley-Livingstone situation was a fact. *Aren't you Nansen? Yes, I am Nansen.* Apart from the ingrained dirt, Jackson's impression was that Nansen looked pale and anæmic and was very fat and out of condition. Johansen looked even dirtier, but the picture of health. *A splendid little chap* as Jackson called him after some days' aquaintance (Jackson 1899, Vol. II, p. 78). According to Jackson, Nansen was still most uncertain as to where they in fact were, partly because Payer's map of Franz Josef Land was incorrect in the northern part, and of course Nansen had no idea that Jackson was at Cape Flora, so *a more remarkable meeting than ours was never heard of* (Jackson 1899, Vol. II, p. 66).

The two were washed and brushed up and given the full hospitality of the base. Nansen was extremely full of the need to talk to new people, and after a night's sleep they sat up for 48 hours talking. Jackson remarks that Nansen was an ardent politician and very patriotic. Jackson tried as best he could to avoid political discussions, as his political view was the opposite of his guest's. On a safer vein Nansen was able to fill in some geographical details of the area north of Jackson's farthest north, while Jackson could show Nansen his preliminary maps of the archipelago. Nansen also discussed with Jackson his plans for reaching the South Pole, and Jackson strongly advised him to use ponies. Some three weeks after the meeting, Jackson obliged Nansen by photographing him and Johansen in the clothes and situations they had encountered during their trek. Several of these photographs were used to illustrate Nansen's book.

On July 26th the *Windward* at last arrived back to the delight of all, and especially Nansen and Johansen. Nansen's first question concerned the health of his wife. Otherwise everyone was eager to hear all the latest news. Jackson had hoped to use the ship for exploring and collecting marine specimens, but it was contracted to return to England as soon as possible so those plans had to be dropped. It was also very disappointing that four reindeer had been sent instead of fresh ponies. Jackson regarded reindeer as totally unsuitable for the area, and in fact two died within the first few days on land.

On August 7th the Windward left together with Nansen and Johansen, crates of geological and other specimens, and two of the shore party. Jackson was sorry to see them all go, but reckoned that he still had two more years' work to do in Franz Josef Land, including an attempt over the ice to get perhaps further north than Nansen and Johansen. Jackson was originally

Fig. 33. Nansen outside Jackson's log cabin at Cape Flora. From Jackson Vol. II.

extremely pleased about his meeting with Nansen, both because of his admiration for the Norwegian scientist and explorer and because he felt his connection with Nansen would boost his own fame. However he later became embittered about the matter as Nansen's fame soared while Jackson, who had most probably saved Nansen's life and the whole outcome of the *Fram* expedition, received only fleeting publicity (Riffenburgh 1993, p. 155–156).

In the spring of 1897 Jackson and Armitage, with 12 dogs and the pony, travelled round the entire western part of the archipelago, mapping George Land and Alexandra Land. The changeable weather, constantly swinging from severe cold to mild wetness, took its toll and after a month seven of the dogs and finally the pony died. From the top of the glacier on the west of Alexandra Land they had a clear view northwestwards and looked in vain for Gilles Land, which Nansen had planned to use as a stepping stone to Svalbard. As Jackson wrote: *What a part of the world this is for "Fly-away Lands!"* (Jackson 1899, Vol. II, p. 138). The journey was completed in eight weeks.

On July 7th they thought *Windward* had returned. Closer inspection revealed, however, that it was the *Balæna* of Dundee on a walrus-hunting trip. This provided a welcome break and fresh news, amongst which the fact that both Nansen and the *Fram* had arrived safely back in Norway. A second hunting ship, the *Diana*, arrived shortly after, and on July 22nd the *Windward* indeed arrived and precipitated the expedition's return to England a year earlier than Jackson had planned. The news of his mother's

Fig. 34. Cape Flora in August. Photo: Susan Barr.

death, together with certain other news and the facts that no new ponies had been brought and the ship could not be used for summer exploring as hoped, made it pointless to spend yet another year at Cape Flora.

Together with the buildings, a large amount of provisions and equipment was left at Elmwood for the use of any future shipwrecked travellers. Jackson particularly had the Swedish balloonist S.A. Andrée in mind, who was currently making an attempt to fly to the North Pole. On August 6th the Windward steamed away westwards, leaving Elmwood at the mercy of the elements, and possibly also the crews of passing hunting ships. A trip was taken ashore at Cape Mary Harmsworth, where specimens were collected, before the sea area to the west was checked to make sure that Gilles Land really did not exist. The Thames was reached on September 3rd and Jackson was soon receiving the congratulations of what he described as *The Old Guard of the Arctic* (Jackson 1899, Vol. II, p. 371).

Jackson's three-year expedition redrew and filled in much of the map of Franz Josef Land. In addition it added considerably to the knowledge of the flora, fauna, geology, climate and other conditions of the archipelago.

The Nansen and Johansen wintering 1895–96.[6]

Fridtjof Nansen's amazing expedition with the ship *Fram* across the ice-filled Arctic Basin started from Norway in 1893. The main goal was to prove the theory of icedrift from east to west and to explore the physical and geographical conditions of the area. Nansen had hoped the ship would drift over the North Pole. When it became obvious that this would not be the case Nansen, with Hjalmar Johansen, three sledges, 28 dogs and two kayaks, left *Fram* and their companions on March 14th, 1895 at 84°4'N on an extremely hazardous strike for the Pole.

Nansen left the safety of his ship knowing it would be impossible to find its position again and return. Acknowledging the need to turn at the furthest north point of 86°14'N on April 6th, Nansen and Johansen set off on their lonely struggle south again, heading for Cape Fligely, of which Nansen knew from Payer's expedition. According to Payer's observations the two islands King Oscar and Petermann Land should lie to the north of the Cape. Nansen and Johansen had a unique starting point for geographical discoveries in the high Arctic making, as they did, their approach from the north. They were thereby able to make an important contribution to the geographical knowledge of Franz Josef Land by discovering that the archipelago did not in fact extend north of 82°. In addition they first met land to the east of Rudolf Island, and were able to make the first sketch map of this northeastern part of the archipelago.

On July 24th they at last saw land for the first time for nearly two years, and on August 10th they were able to get ashore on a little ice-covered island, which they called Adelaides Island. The first islands they had seen were named Eva Island and Liv Island after Nansen's wife and baby daughter. These are in fact one island, now called Eva-Liv Island. Nansen called this area Hvidtenland (the white land). Owing to the fact that they one day had forgotten to wind Johansen's watch, while Nansen's went irregularly, the two were uncertain of their longitude calculations and Nansen was never entirely sure where they actually were until they met Jackson at Cape Flora.

The last of the sledge dogs had been shot as the expedition approached land and the journey southwards continued by kayak. On August 15th the two men stood on bare ground on Houens Is. and saw moss and flowers again (arctic poppies, saxifraga and arctic chickweed *(stellaria)*). An indescribable feeling! However, *Where we are, becomes more and more unexplainable* (Nansen 1897, p. 207) as the terrain did not agree in any way with the area Nansen thought they might be in according to Payer's map. At what Nansen thought to be Payer's Coburg Islands, he redrew this part of the map. The largest island, Torups Island, seemed to him to be the most beautiful place he had ever seen on earth, with its beach of white shells beside the clear water, and the birdcliff with a myriad of cheerful and busy inhabitants.

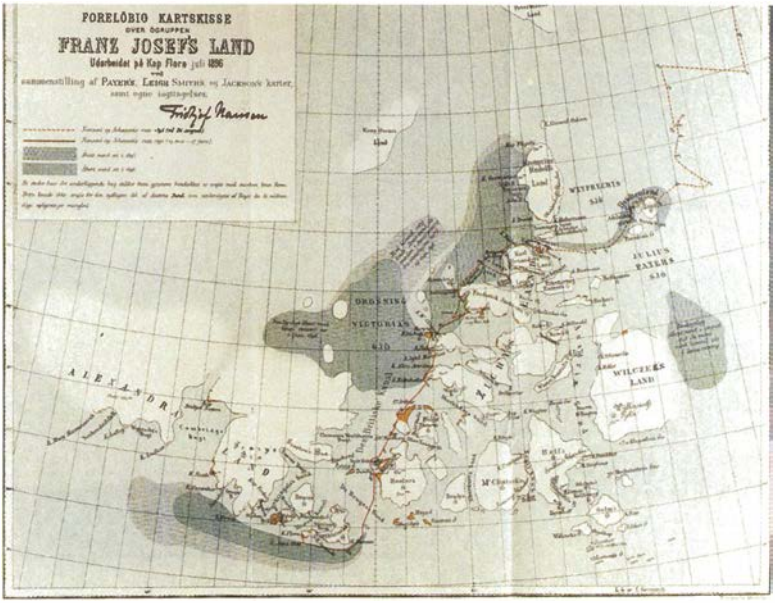


Fig. 35. Nansen's map of Franz Josef Land, compiled at Cape Flora.

Feeling that they must be on the west side of Franz Josef Land, Nansen's intention was to reach Svalbard in the kayaks, using Gilles Land as a stepping stone on the way. This was the land that Jackson was soon to prove non-existant, and Nansen and Johansen would have faced 400 km of open sea had they carried out this intention. It can be questioned whether they then would have survived. As the weather and ice conditions continually stopped their progress, the possibility of a new wintering became more and more of a certainty. Nansen now thought they must be north of Leigh Smith's Cape Lofley on the south of Alexandra Land, but he was uncertain as to whether they would still find a cabin at Eira Harbour. On August 28th conditions were such that they had no recourse but to dig in where they were and wait to travel on the next summer.

They were in fact on southwest Jackson Island, as Nansen later named it, in the middle of the archipelago, and had reached this far with no little luck. The physical exertions of the haul over the shifting pack ice with its dangers and hinders, the ice so ready to betray a false step, the suddenly-opening leads of water, the jumbled piles of screw ice, the kayak sailing in gales and ice, the curious and hungry polar bears, could have caused deep misfortune many times over. Johansen had in fact once been a hair's breadth from death with his head in an attacking polar bear's mouth. His

Fig. 36. Nansen's and Johansen's winter hut at Cape Norvegia 1895–96. Photo: Fridtjof Nansen.

laconic *You had better be quick Mr Nansen* (an approximate translation) has become as well known as the many similarly-understated quotes from famous Viking heroes. Nansen had once nearly met his end in the freezing water as he swam after the kayaks which had drifted off. Nansen also suffered greatly in periods from back pains and rheumatism, and had to be helped and nursed by Johansen. In addition to all this, came the psychological side of being two men completely isolated in the unmapped high Arctic, with no other persons in the world knowing where they were or being able to give any assistance. Nansen had in addition the worry of having, in a way, deserted his ship and crew on a drift which leading polar experts of the day had described as totally irresponsible.

A shelter for the winter had to be made with the few and primitive tools and materials they had around them. A temporary shelter was used on the chosen site at Cape Norvegia while the winter dwelling was erected. A hollow was scraped and dug using the shoulder-blade of a walrus, a ski stick, a cut-off sledge runner and a walrus tooth. Walls were built up round the hollow of stones from the nearby tallus and holes were plugged with moss. They were lucky to find a large driftwood log to support the roof of walrus hides, as there is little driftwood otherwise in the area. The finished

Fig. 37. The remains of the winter hut in 1990. Photo: Susan Barr.

hut was no larger than 2 x 3 m and 2 m high. Throughout the long, cold and dark winter it was lit by a primitive blubber lamp, which also provided the only means of warming food. The two men lived almost exclusively on walrus and bear meat and blubber. They slept and lay long hours in the double sleeping bag in order to keep warm and had little exercise apart from occasional bear shooting in the immediate neighbourhood of the hut.

The two were from very different backgrounds, Nansen from the well-educated upper class and Johansen from ordinary circumstances, military service and with a reputation as a gymnast. Maybe their differences helped them through the 15 months in only each other's company and the 7 ½ months together in the primitive shelter. At Christmas they scraped some of the dirt layer from their skin with knives and turned their filthy clothes inside out and felt much better for it. At New Year they went through the formal process of agreeing to call each other by the familiar form of *du* (you) instead of the formal *De*.

On May 19th they were ready to continue their journey. A note was left in the hut describing briefly what had happened up to then, and what they intended to do further. Nansen wrote that he presumed they were on Gilles Land, and that they would travel southwest to sail over to Spitsbergen. This note was found by Baldwin during his Franz Josef Land expedition in 1902.

The hut was also visited by two members of Fiala's expedition in 1904[7]. They found that bears had begun tearing the walrus hides off the roof, and otherwise that the ground around was covered with walrus and bear skeletons (The Arctic Diary of Anton M. Vedoe). It is possible that Soviet scientific personnel visited the site after 1930, but the site was apparently unknown when it was rediscovered by a joint Norwegian-Soviet expedition in 1990 (Barr 1991). The hut had by then been collapsed for some time, but the site was unmistakable. Great quantities of bones could still be seen, although mostly covered by the deep moss growth.

As related above, Nansen and Johansen had the remarkable luck to meet up with Jackson's expedition and to travel to Norway with their ship. We can seriously doubt whether the two would have managed to arrive home according to Nansen's original plan. Nansen and Jackson together changed and filled in much of the map of Franz Josef Land, not least fixing the western and northern limits. Nansen's and Johansen's expedition show the amazing ability that exceptional people have of adapting themselves to the environment and surviving against the greatest odds with the absolute minimum of aids.

Wellman's expedition 1898–99

Now that the geography and other physical factors of Franz Josef Land were becoming known, it became for a period attractive as a starting point for attempts to reach the elusive North Pole. The American journalist Walter Wellman, correspondent for *The Chicago Record-Herald*, led one such attempt in 1898, sponsored by the National Geographic Society. His first expedition northwards, in Svalbard in 1894, had reached 81°N, his Franz Josef Land expedition would not quite make 82°.

To Franz Josef Land went, beside Wellman, three Americans and five Norwegians[8]. The Americans were Lieut. Evelyn B. Baldwin of the US Weather Bureau, Dr. Hoffman (medical officer and naturalist) and Mr. Harlan (physicist), and the Norwegians were Paul Bjørvik (who had accompanied Wellman in 1894), Bernt Bentsen, Emil Ellefsen, Daniel Johannesen and Olaf Ellefsen. The Norwegian sealer *Frithjof* transported the group to Franz Josef Land, leaving Tromsø at the end of June, but returning to Vardø in mid July for more coal, having had some difficulties with ice. Eighty three dogs had been taken onboard at Archangel'sk. On July 27th they finally arrived off Franz Josef Land, making a short visit to Leigh Smith's cabin at Eira Harbour before continuing towards Cape Flora. From Elmwood the expedition took with them one of Jackson's octagonal store huts with sailcloth roof, and a good deal of the supplies that had been left there, before continuing eastwards. Winter ice between the islands blocked attempts to sail northward so, after circumnavigating the Wilczek and Salm Islands, the expedition's base had to be established far south, at

Fig. 38. Wellman's base at Cape Tegetthoff in 1905. From Fiala 1907.

Cape Tegetthoff on the south of Hall Island. While sailing they had spotted human tracks on one of the islands showing that they were not alone in the archipelago[9], and on July 30th they had contact with the steamship *Hekla*, which could report a catch of 212 walrus and 70 bears[10].

The equipment and dogs were unloaded, and *Frithjof* left them on August 3rd. Almost immediately, on the 5th, three of the Norwegians and Baldwin started northwards with 40 dogs. By now the snow and ice were poor, and there was much open water. According to Bjørvik, the sledges were not solid enough for the job and nor were the canvas boats particularly suitable. Some of the sledges were a very special tube-like construction of tinned copper with runners on the sides. The idea was that they could continue even after tipping over. They were also watertight to be able to float. The group was joined by the two other Norwegians, and struggled to Cape Frankfurt on the northeast of Hall Island and over the strait to Cape Hansa on the south of Wilczek Land. Most of the other necessities for a successful sledging expedition were also poor, or non-existant, and the men suffered a good deal from cold, hunger and other discomforts.

Four of the Norwegians returned to Wellman's base for more equipment. Jackson's hut formed the hub of the main cabin, and it was therefore named Harmsworth House after Jackson's sponser. Here it was apparently decided that Bjørvik and Bentsen[11], should winter at a northern camp. Bjørvik complained in his diary that it seemed as though the two of them would have to endure a winter alone with a minimum of food and equipment and then reach the North Pole for the Americans, who would spend the winter in comfort at the main base.

The field group returned to Baldwin by boat, and then continued to Wiener-Neustadt Island, where they were however unable to land because of the ice. A landing was therefore made at Cape Heller on the west of Wilczek Land. On September 13th work was started on Bjørvik's and Bentsen's winter shelter. At least one of the discomforts was alleviated for the time being as they had been able to shoot a fair number of bears and walrus for food. According to Bjørvik's diary (see also Lønø 1991) the wintering hut was in many ways like Nansen's and Johansen's. It was built of stones, was approximately 4 x 2 m and 1 m high, and had a driftwood log supporting the low roof of ca.1000 kg of walrus hides. Six bearskins inside helped to keep out the draughts. The outpost was called Fort McKinley.

Bjørvik complained often in his diary of Baldwin, who apparently did very little other than to order the Norwegians around like slave labour. He also kept the Norwegians on a diet of walrus and bear meat while he secretly ate other supplies they had with them. Unfortunately we do not have Baldwin's side of the story, which would make an interesting comparison, but we do know that he was not particularly popular on his own expedition to Franz Josef Land a few years later (see under).

In preparation for the winter, moss was collected to serve both as fuel and in a blubber lamp. Baldwin had only allowed them four candles for the entire winter. A ton of walrus meat was cut up and stored for the sledge trip north in the spring, and a snow wall was built to give the 27 dogs shelter. On October 22nd the rest of the group left for Cape Tegetthoff, and Bjørvik and Bentsen were left in their meagre dwelling with barely enough fuel for cooking and none to spare for heating. Bjørvik wrote that the food supplies only allowed for two meals a day, bear meat and coffee midday and coffee and bear meat in the evening, but he mentions other food later. Much time was spent shivering in their wet and almost worn-out sleeping bags and reading *The Three Musketeers* by the weak light of the moss lamp. The inside temperature kept more or less constantly around -20°C.

Already on November 2nd Bjørvik noted that Bentsen had been ill with stomach trouble for three days. They had no medicines, and there were 31° of frost. By the 8th Bentsen was talking incoherently. Bjørvik looked after him as best he could, but also stayed a good deal outside in the freezing weather as it was no colder than inside, but lighter ! At the end of Novem-

ber Bentsen recovered slightly and could get up for the first time for a month, but by mid December he was at times incoherent again. The two had food enough, but froze terribly as the hairs had worn off both the sleeping bags and the fur clothes. Bjørvik tried to keep Bentsen "comfortable" by changing him and cleaning his clothes as best he could, for the sick man could not control his functions.

Bentsen died on January 2nd, 1899. Bjørvik left him in the freezing sleeping bag in the cold hut, as he had no possibility of burying the body safely outside. The two had previously agreed on this of fear that bears and foxes would scavenge on the body (Wellman 1900). Two days later Bjørvik had his 42nd birthday. The only present he wished for himself was dry bedclothes. His sense of duty was quite extraordinary, in fact almost misplaced. For amongst the provisions he was guarding for the sledge trip in the spring were paraffin and fur clothes! With great bad conscience he started to use a little paraffin. Bjørvik longed now for company to reach him from Cape Tegetthoff. He kept his spirits up by singing and reciting poetry, and used up some time by digging the sledges, boats and equipment out of the winter snowdrifts. He took to having three dogs to sleep on the sleeping bag with him for warmth.

At long last, on February 27th, Wellman arrived with the three other Norwegians and was horrified to see how Bjørvik was living. Bjørvik had only praise for Wellman and his concern for his men, and put all the blame for the misery on Baldwin, rather than Wellman. He was sure Wellman would not have allowed them to winter alone had he known of the conditions. Bentsen was buried outside the hut on the 28th[12]. On March 7th Wellman and the four, with a total of 42 dogs, set off northwards. By March 21st they were off the east side of Rudolf Is. and camped for the night, when a storm set the ice in violent motion. They managed to escape on to safer ice, but lost most of their equipment and eight of the dogs, and Wellman injured his foot. There was nothing else to do but return to Cape Tegetthoff, pulling Wellman on the sledge and reaching the base on April 9th. Bjørvik was struck by the difference between the main camp and the hole he and Bentsen had been apportioned for the winter. Twenty five bears had been shot there since *Frithjof* had left them.

On April 26th Baldwin and the four Norwegians set off on a sledge trip round Wilczek Land and Graham Bell Island. Bjørvik's diary finishes on May 19th, when they had reached Cape Heller on the return journey. In August 1899 the expedition was transported back to Norway by the Norwegian sealer *Capella* (Horn 1930, p. 15). As an attempt on the North Pole Wellman's Franz Josef Land expedition was no more successful than his later attempts from Svalbard. The expedition did, however, make an important contribution to the gradual mapping of Franz Josef Land by filling in details of the eastern part.

The Duke of Abruzzi's expedition 1899–1900

Before Wellman left Franz Josef Land, he met the next expedition arriving to make an attempt on the North Pole. The expedition of His Royal Highness Luigi Amedeo of Savoy, Duke of the Abruzzi had as its goal *to sail as far to the north as possible along some coast-line, and then to travel on sledges towards the Pole from the place where the winter had been passed* (Savoy 1903)[13]. The Norwegian sealer *Jason* of Sandefjord was bought for the purpose and renamed *Stella Polare*. Besides Abruzzi (aged 26) and his second-in-command Umberto Cagni, 36 yrs and captain in the Italian navy, there were nine other Italians and nine Norwegians. Four of the Italians were mountain guides from the Italian Alps, while the Norwegians were ship's crew and carpenter. Supplies were taken for four years, as well as the scientific instruments for observations and investigations which were usual for expeditions of the time (meteorology, gravitation, astronomy, oceanography, etc.). Photographic equipment was also taken and well used: Abruzzi's book contains excellent photographic illustrations of the expedition.

The expedition left Oslo on June 12th, having had much help from Nansen during the preparations. It was Nansen's contact in Archangel'sk, Alexander Ivanov Trontheim, who supplied the 121 sledge dogs which were taken onboard there. Departure from Archangel'sk and civilisation was on July 12th. After a delay in the ice Northbrook Island was sighted on July 21st. At Cape Flora they found that the stores in the two remaining of Jackson's four octagonal wood-and-canvas huts were mostly spoiled. The log cabins were in good shape, and Leigh Smith's wintering shelter was still standing, although dilapidated. Abruzzi left some stores at Cape Flora for emergency use, before turning *Stella Polare* northwards, with the intention of reaching Rudolf Island for the wintering.

On August 6th, while they were stuck in the ice in the southern part of the British Channel, the *Capella* was sighted and Wellman was transported over to them in the ship's boat, having to be lifted onboard owing to his injured foot. Captain Støkken of the *Capella* also visited as his son was engineer on the *Stella Polare*. This was to be the last time he saw his son. As the conditions rapidly improved the *Stella Polare* sailed northwards with no further ice hindrance until they were just north of Rudolf Island. Abruzzi had nursed a slight hope that King Oscar and Petermann Lands might in fact exist after all, but they could see so far north in the clear weather that this was obviously not the case. It was therefore necessary to establish the winter camp on the northernmost island, Rudolf, by the northernmost bay, Teplitz. Here the ship was moored for the winter.

Towards the end of August new ice had formed alongside the ship strong enough for them all to skate on. The snow was also sufficiently hard for Abruzzi, nine dogs and two others to undertake a sledge exploration of

Fig. 39. Stella Polare *and the base at Teplitz Bay. Savoy 1903.*

Rudolf Island. On September 8th already, the fate of the expedition took a drastic turn. Strong winds from the southwest drove the ice into the bay and holed the *Stella Polare* almost at once. Rising water and the sharp angle of the ship made life onboard impractical. The planned wintering onboard was therefore abandoned, the ship was unloaded and a winter dwelling was constructed on land by erecting the two tents, which were large enough to house all twenty men, using the canvas awning from the deck as a fly-sheet to cover both tents, and then covering this again with a third tent made up of the ship's sails and spars. The dogs were housed in kennels nearby.

Before winter set in they worked hard on the ship, repairing and alleviating as much damage as possible. The ice pressure had been so strong that it had in fact pushed the structure out of shape, thus causing more serious leaks than the holed planking alone. They did, however, hope they would be able to sail home. The winter was passed in relative comfort. Especially the Italian cook was praised for his tireless contribution to the expedition's well-being. The only slight problem was the lack of new subjects for conversation in the evenings, and the men therefore gradually spoke less and less. The scientific observations and measurements were kept regularly, although with practical difficulties as the weather worsened. A large volume of *Scientific Observations* was published after the expedition's return, in addition to Abruzzi's written account which is full of useful information concerning the natural conditions.

The journey to the North Pole in the Spring was planned with a main group of three men, and three other detachments of three men each, which would act as supporting parties and would turn back in stages on the way. The sledging provisions were carefully calculated from the data available from similar expeditions by Greely, Nares and Nansen. The sledges, two kayaks and cooking stove followed the pattern of Nansen's. Abruzzi, after freezing the ends of two fingers so they needed amputation, handed the command of the Pole party to Captain Cagni, as he feared his own disability would delay or cause failure to the expedition. The expedition left on February 21st: 12 men, 104 dogs and 13 sledges, with provisions for 45 days for the Pole group. On the 23rd, however, they arrived back as three days on the pack ice had shown deficits which needed to be corrected should they have a chance of reaching the Pole safely.

The second attempt started on March 11th. Abruzzi and Gini the cook were the only Italians left at the camp, together with six of the Norwegians. Captain Evensen was to return after the first two days' travel. At the end of March a temporary hut made of a tent surrounded by snow walls was erected at Cape Fligely, where a small group was to await the gradual return of the detachments. The first detachment, consisting of Ltn. Francesco Querini, Henrik Alfred Støkken and alpine guide Felice Ollier failed, however, to return. The second detachment arrived at the main camp on April 18th, and could report that Querini's group had set off back a week before them. The fate of the three was never discovered, but it is reasonable to suppose that they perished on the pack ice. Although there was no real hope of finding them, Abruzzi sent three Norwegians east in the direction of Nansen's Hvidtenland (Eva-Liv Island, etc.) in case they might have reached there instead. They reached two-thirds of the distance in the time allotted before they had to turn back.

In the middle of June work was started to extricate the ship from the ice, and the first birds' eggs of the season were found. On June 23rd, Abruzzi was staying his turn at Cape Fligely, when he received the joyful message that the Pole party had arrived back at Teplitz Bay, having reached 86°34'N, thereby beating Nansen's and Johansen's so-far furthest-north record. They had in fact not been able to reach Cape Fligely on the way south owing to the poor state of the ice, and had struggled south to Harley Island, off Jackson Island, before being able to leave the ice floes and turn north-east back to Rudolf Island. Cagni's group of four had been away for 104 days and had travelled a distance of ca.1200 km. Based on the experiences of Nansen and Cagni, Abruzzi began to doubt whether it was possible to reach the Pole over the ice. He recommended, amongst other improvements, to try from the far northwest of Greenland.

The expedition was now ready to leave Franz Josef Land. The ship had been prepared as far as possible. It remained only for the ice to let them out.

The meltwater flowing from the nearby glacier was channeled round the ship to assist the melting, gunpowder charges were exploded to break up the ice, and a tremendous amount of backbreaking work was put into hacking and moving blocks of ice. By the beginning of August new ice was again forming, but on August 14th they moved back onboard and on the 16th the expedition left Teplitz Bay. As usual a large amount of provisions was left on land, and also eight dogs, most of the others being killed. The reason for this was a vague hope that the three missing men would turn up, although Abruzzi writes clearly that they had given up all hope that the three were still alive.

The *Stella Polare* became severely stuck in the ice in the British Channel near Eaton Island, an illustration of the very different conditions to be experienced at the same time in different years. On August 31st they finally reached Cape Flora, where there again was no sign of the missing three, but a packet of letters for them had been brought by the *Capella* on July 13th. On September 3rd they were at last clear of the ice and on the 5th they arrived at Hammerfest in northern Norway.

Støkken 1901

Captain Støkken from Sandefjord, father of the missing Norwegian from the Abruzzi expedition, searched Cape Flora and the south coast of the archipelago the following summer for traces of his son and the two Italians

Fig. 40. The monument at Cape Flora to Støkken, Querini and Ollier. Photo: Susan Barr.

(Horn 1930, p. 16). The expedition, with the *Capella*, was unsuccessful, but a monument to the three was erected on Cape Flora. The inscription read: *F. Querini H. Støkken F. Ollier Stella Polare 1900.*[14]

Baldwin-Ziegler 1901–02[15]

In the first years of this century it was the turn of Americans to set their mark on Franz Josef Land through two separate expeditions, both financed generously by the wealthy William Ziegler of New York[16]. The aim of both was to reach the North Pole, probably encouraged by the fact that the "furthest north" point so far had been reached from the archipelago. Evelyn Briggs Baldwin was the man chosen to lead the first expedition, having gained arctic experience as meteorological observer on Peary's north Greenland expedition in 1893, a voyage to Svalbard in 1897, and Wellman's expedition to Franz Josef Land in 1898–99 (see over).

The expedition left Vardø in northern Norway on July 27th 1901 in the steam yacht *America* (ex *Esquimaux*, a Scottish whaler). The ship was heavily loaded with coal and stores, 15 Siberian ponies, over 400 dogs and the 42 American, Scandinavian and Russian expedition members[17], *like a floating haystack* as the artist Russell Williams Porter put it[18]. At Cape Flora they met up with their extra supply ship *Frithjof*, and transferred three years' extra food supplies.

Fig. 41. Camp Ziegler, Alger Island in 1930, with the Soviet flag in the foreground. Photo: Gunnar Horn/Norsk Polarinstitutt.

Fig. 42. Kane Lodge on Greely Island, May 1902. Photo: Copyright Wm. Ziegler.

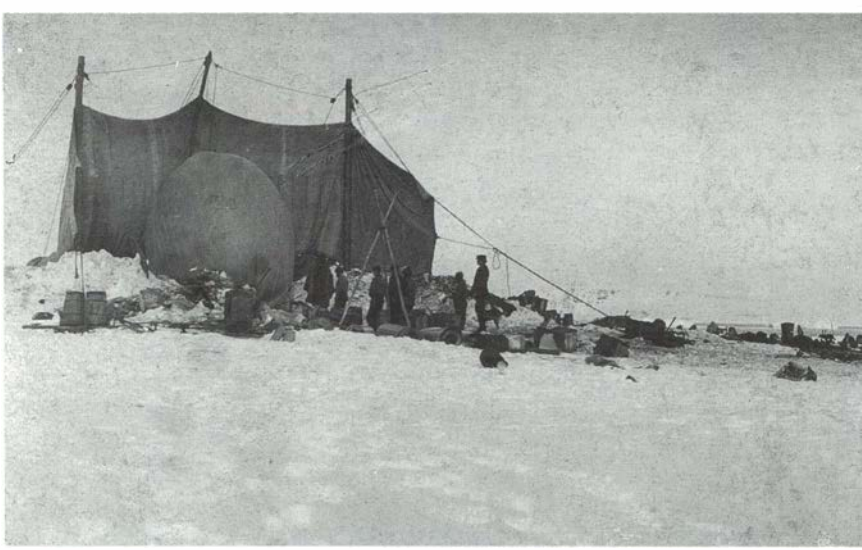
More than 30 dogs had sickened and died before the expedition established its base camp, named Camp Ziegler, on Alger Island in the mid-south of the archipelago, and before the sledging season began in the Spring, more than half of the dogs had died from internal parasites. At Camp Ziegler two portable huts were erected[19] and the ponies were let loose. A similar hut was erected 10 km further west on the island and named West Camp Ziegler. The *America* was moored for the winter on October 12th close to the main camp and was already frozen in five days later. Previous to this, attempts had been made to sail the *America* further north, but the ice conditions this summer prevented any advance – a very different situation from that encountered by the Italian expedition two years before. Baldwin's North Pole attempt had thus a huge disadvantage in starting point compared with Abruzzi's.

Seven men were assigned to winter on land and to care for the dogs and ponies – the ponies fared rather better than the dogs, only three of them dying during the course of the expedition. The remaining men wintered on the ship and a telephone connection was rigged up between the ship and the camp. Mr. Leffingwell (in fact skilled in mapping unknown territories, but scarcely allowed by Baldwin to practice), Mr. Rilliet, Secretary Barnard, Assistant Secretary Dickson, Doctors Seitz and De Bruler, Meteorologist

Fig. 43. Nansen's winter hut on Jackson Island, as found by Baldwin in 1902. The hut has been dug free of snow, and the walrus hides over the roof pole may clearly be seen. Photo: Anthony Fiala.

Loth, Photographer Fiala, Artist Porter, Sketch Artist Joseph Knowles Hare, Messrs. Vedoe and Vinyard, and Lucas and Michael are participants named in Baldwin's account. Regular meteorological and astronomical observations were made, as well as a photographic record, and the winter was otherwise spent in preparations for the coming sledge journeys.

According to Porter[20] the very first sledge journey started a lasting discontent with Baldwin's leadership. He refused the men sleeping bags, needed to prevent frostbite when they inevitably had trouble with the route in the winter dark, as that would mean cutting down on the amount of supplies they could haul. Any trips for scientific investigations off the hauling

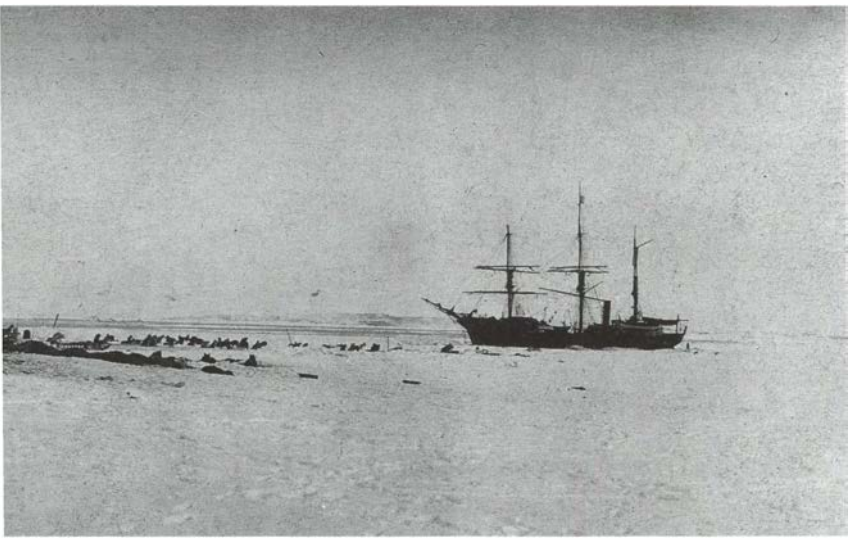


route were forbidden, so that the scientific profit from the expedition was inevitably minimal. It was also forbidden for expedition participants to keep diaries.

From January sledge parties set about establishing depôts northwards across Markham Sound. Baldwin mentions that such a party could consist of 28 men, 13 ponies and 160 dogs, which would appear to be a formidable logistic apparatus in itself considering the food, fodder, fuel, water and organisation required to move it along. The depôts were finally concentrated at three main points: Kane Lodge south on Greely Island – an area abounding in walrus and polar bears –, near Coburg Island between Alexander and Rudolf Islands, and at Cape Auk on southwestern Rudolf Island.

Towards the end of May it seems that Baldwin considered most of the season's work done. A chain of well-supplied depôts had been established along the length of the archipelago to the northernmost island and there was no mention of actually striking further north across the sea ice. Baldwin seems to have been content to pave the way for a start towards the Pole, not to actually attempt the feat. Time was therefore allowed for an extra trip by Baldwin, Fiala and Porter to Jackson Island to visit the site of Nansen's and Johansen's wintering, which was known to be at Cape Norvegia. The hut itself took a little time to find as it was more or less covered and filled with snow. Otherwise it seemed to be just as the two had left it with the blubber

Fig. 44. Inflating a balloon at Camp Ziegler, with America in the background. Photo: Copyright Wm. Ziegler.



lamp and the copper pipe from a primus containing Nansen's message. After a lecture about arctic exploration in Washington D.C. in December 1930, Baldwin presented Nansen's note to the Norwegian legation who sent it to Norway in the safe of the steamship d/s *Stavangerfjord*. The note is now in the University Library in Oslo. The hut was otherwise thoroughly photographed and sketched during the two days the group spent there.

Throughout June about 300 messages conveyed by 15 balloons were dispatched into the wind in the hope that they would carry the request for more coal supplies to the outside world. The early break-up of the ice around the ship had necessitated getting up steam power for manouvering, and the coal supply was down to 67 tons. Other balloons with reports attached to cork buoys telling of the expedition's progress had been sent up during the year, and one of these was found by Soviet scientists on the southern part of Novaja Zemlja in May 1932[21]. *America* left Camp Ziegler on July 1st, but despite using dynamite and other force, did not clear Franz Josef Land for another 16 days. The documenting of Nansen's hut and message, together with the general observations throughout the wintering, were the main results of the expedition, and Baldwin received much criticism as the meagre result of his North Pole expedition became known (Geographical Journal[22]). One of the participants, Anton Vedoe, later referred to the expedition as having been characterized by dissension and poor management, and he brushed it off as a wasted effort (Vedoe, p. 10).

Fiala-Ziegler 1903–05[23]

Disappointed with the lack of results from Baldwin's expedition, Ziegler immediately arranged for a new expedition to continue the attempt to reach the North Pole, his crowning desire being *to link his name with some scientific achievement which would be considered great when compared with others of the 20th Century* (Fiala 1907). Baldwin was naturally removed from command and the choice of new leader fell on the photographer and second-in-command from the previous expedition, Anthony Fiala, who had the advantage of having the experience and knowledge of the dispositions of the previous expedition. Ziegler unfortunately died on May 24th 1905, before the return of the expedition.

Left from the last expedition was the *America*, which had been left in Tromsø, and 183 dogs and five Siberian ponies "in store" on an island further south. All the men and goods needed had to be found in the short space of time available. Captain Edwin Coffin from Martha's Vineyard was chosen as ship's captain, and amongst the crew he got together were a number of whalers. Several of the members of Baldwin's expedition applied to return with Fiala, including the artist Russel W. Porter, doctor Charles L. Seitz, quartermaster Chas. E. Rilliet and second assistant electrical engineer Anton Vedoe[24]. William J. Peters was sent as scientific representative from

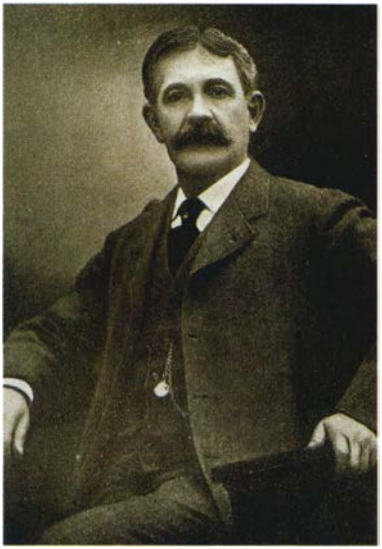


Fig. 45. William Ziegler. From Fiala 1907.

Fig. 46. Anthony Fiala. From Fiala 1907.

the National Geographic Society (whose President at this time was Dr. Alexander Graham Bell, cf. Graham Bell Island). He was also second-in-command. Altogether 35 Americans[25], three Norwegians[26] and one Englishman participated.

The *America* was moved to Trondheim for refitting and loading, and the Ziegler Polar Expedition sailed from there on June 23rd, 1903. At Archangel'sk an extra 25 dogs and 25 ponies had been collected for them by Alexander Trontheim, together with 800 furs for clothing. They then sailed back to Vardø for the last coal supplies, before leaving for Franz Josef Land on July 10th. The ice conditions were against them this year, and Cape Flora was not reached until August 12th. The ice in the British Channel presented a far greater hindrance than Abruzzi's *Stella Polaris* had experienced, and other possible routes north were also blocked this summer. However, by August 29th they had managed to reach Cape Mill on Jackson Island, and on the last day of the month they had sailed to 82°14'N where they turned back to find winter quarters for the ship in Teplitz Bay.

The Abruzzi base from 1899–1900 had largely collapsed, but food and fuel stores were found in good condition. A new base camp was made by erecting a wooden house for the 16 members of the shore group, together with tents for the dogs and ponies. Baldwin's depôt from Cape Auk was collected and, in fact, the site at Cape Auk disappeared the following sum-

mer under a large rock fall. An electric cable with lights was rigged up between the ship and the shore base. On October 22nd a fierce storm broke the ship loose and she drifted helplessly for three days before being able to make her way back to Teplitz Bay, where the winter ice formed almost immediately. After this experience Fiala judged it wisest to live onboard the ship to be able to take charge in the event of a similar crisis occurring. Detailed written instructions were left for the shore party concerning the running of the base. Only three weeks later, on November 12th, the ship was temporarily evacuated due to the crushing ice pressure. The crew was able to return, however, until the final wave of ice ridges came on December 21st and crushed the *America* beyond repair. The wreck of the ship stayed frozen in the ice until it disappeared during a wild storm on January 22nd. Whether the ship had sunk or been carried away in the ice was never ascertained. The shore house was enlarged to accomodate the entire expedition. The base at Teplitz Bay finally consisted of a good number of large and small buildings, as shelters and huts were erected to house the different scientific instruments for astronomical, magnetic and meteorological observations.

The dark months were spent in preparation for the strike across the ice to the North Pole. In the same way as Abruzzi, Fiala also planned for several groups to accompany the Pole party, turning back gradually as their support mission was completed. There would be 26 men, 16 ponies and sledges and nine dog teams and sledges altogether, divided into three supporting parties and one main group. This latter party would consist of six men with six dog sledges, five pony sledges and rations for 82 days, and should have a total of 135 possible days in the field. Detailed written instructions were drawn up for the sledge parties, ending with point *19: No riding on sledges to be allowed without permission* (Fiala 1907, p. 77). The cooking tent was ingeniously constructed on a sledge with all equipment inside and had only to be raised to be ready for use. Fiala himself was one of the two permanent cooks on the sledge journeys.

The first attempt north started on March 7th, but returned from Cape Fligely on the 11th owing to bad weather and various faults which needed to be put right. The second attempt left on March 25th, but lasted for only two days. A short advance on to the sea ice from Cape Fligely had convinced Fiala that the sledging equipment would have to be revised and the next attempt postponed until the following winter. Most of the men had by now lost heart and desired to retreat to Cape Flora to await the planned relief ship in July or August. Porter and Anton Vedoe had meanwhile made a round trip to Kane Lodge on Greely Island to inspect the conditions of the depôt and the route south in that direction. On the way back they visited the site of Nansen's and Johansen's wintering in 1895–96. Porter had already been there two years before with Baldwin. The roof was still more or less

covered by walrus hides, although they had partly been torn off by polar bears. The interior was filled with snow, but the skeletons of bears and walrus that littered the ground outside were clearly visible. Vedoe killed another visiting bear while they were inspecting the site, and took one of Nansen's bear skulls as a souvenir (Vedoe, p. 105–107).

On April 30th 14 men (only those expressing continued enthusiasm) were left at Camp Abruzzi while Fiala led the rest, with the remaining ponies and eight dog teams, towards Cape Flora. The route went via the Italian Channel to the British Channel and without trouble as far as Koettlitz Island. From there on the broken ice was a hindrance, but Cape Flora was finally reached on May 16th where tents were raised and the wait for the relief ship began. The group was assured plenty of stores as, besides those they had with them, there were supplies left by previous expeditions. One of Jackson's octagonal store houses was still whole enough to house eight of the men, while the other 17 moved into Jackson's log cabin. The long wait was partly alleviated by bear hunting and the collecting of fresh birds' eggs. Seventeen bears, 16 walruses, 16 seals and ca. 250 birds' eggs were the summer's catch. The fuel situation for a possible wintering at Cape Flora was saved when a vein of coal was discovered in the cliff 600' above Elmwood. Twenty tons were mined out as it began to seem unlikely that the ship would get into Cape Flora that summer.

An exploring party from Camp Abruzzi arrived at the beginning of July, having carried out mapping between the Camp, Kane Lodge and Camp Ziegler. At the end of August three more arrived from Camp Abruzzi with the news that the Norwegian stoker Sigurd B. Myhre had died on May 16th after an illness of several weeks. He had been buried on a plateau towards Cape Säulen[27].

Finally a new wintering became a fact for the twenty-five homesick men at Cape Flora, and Fiala faced the responsibility of two separate groups on the archipelago until the relief ship hopefully could reach them the next summer. In fact a third group of three men wintered at Camp Ziegler as one of the men froze a foot on the way back north and could not travel further. The expedition was luckily well supplied with fresh meat from the summer hunting. In addition supplies were to be sledged down from Camp Abruzzi to Camp Ziegler and fetched from there by the Cape Flora group. Although Fiala was careful in his printed account of the expedition, it is obvious that there was a good deal of bitterness, depression and a sense of uselessness amongst the group that had hoped to leave, and Fiala had no desire to be amongst them more than absolutely necessary. In fact it was his plan to await the relief ship the next summer at Camp Ziegler, rather than with the main group. Anton Vedoe also mentions carefully that there was a great amount of ill feeling and potential trouble between the men at Cape Flora (Vedoe, p. 129, 131).

Fig. 47. Sigurd B. Myhre's grave at Cape Säulen. From Fiala 1907.

In fact the relief ship, the *Frithjof*, had made two attempts to get through the ice to Franz Josef Land that summer, but to no avail. The following summer, in addition to the ship sent to Franz Josef Land, the *Magdalena* was sent from Sandefjord, southern Norway, to northeast Greenland in case Fiala's expedition had crossed the Pole and reached land there.

It took from September 27th to November 20th for Fiala and companions to sledge back to Camp Abruzzi, with the autumn storms, approaching darkness and mixture of open water and unsafe ice hindering them. New plans for a march to the Pole had to be made in view of the depleted number of men and dogs available and the total lack of ponies. There would now be only two men in the Pole party, with three dog teams, and the supporting parties would be two parties of two men with dogs and one party of four men with dogs.

On March 15th, 1905 the third and final attempt on the Pole began. This time the sledge train did not go towards Cape Fligely, but crossed Rudolf Island to Cape Habermann in the southeast and down to the sea ice. A week's struggle out from base they arrived at 82°N and met a lead of open water amongst the jumbled pressure ridges. Here Fiala allowed himself to be persuaded to return, with the argument that the men at Cape Flora might have to face yet another forced wintering. *But beyond and stronger than pain at heart in being disappointed in my wish to go North, was the realisation that the ultimate responsibility was mine and that the right thing for*

me to do was to turn back and take up the reins of government once more. In the face of possible danger to the lives of those I had left behind, I must not proceed. (Fiala 1907, p. 174) It took them ten days to get back to Camp Abruzzi the same way as they had come.

The remainder of the sledging season was spent in various trips, mostly for moving supplies, between the camps and depôts at Kane Lodge, Camp Ziegler and Cape Flora. One group visited Wellman's house at Cape Tegetthoff, but found *nothing of value* (Vedoe, p. 170) there. Altogether there was a considerable amount of sledging traffic moving between the various huts and bases which had been built in the central part of the archipelago by various expeditions.

On May 26th Fiala, apparently as the last, left Camp Abruzzi, arriving at Camp Ziegler on June 19th. Anton Vedoe, Tessem and Rilliet had, however, been sent back to Camp Abruzzi to help the move south, and arrived on June 26th to find the camp deserted. However, by mid July the entire expedition was in the south of the archipelago to await the relief ship, but in three groups: at Cape Flora, at Camp Ziegler and with six men at Cape Dillon on the southwest of McClintock Island to watch for the ship on behalf of the Camp Ziegler group. Hunting was continued to gather fresh meat in case of a third winter, and as July drew to a close the men became anxious. On the 30th the great event happened: the relief ship *Terra Nova*, with Captain J. Kjeldsen, arrived off Cape Dillon – the same *Terra Nova* which was to carry Robert F. Scott to the Antarctic in 1910. The men at Cape Flora were taken on board first, then the remainder of the expedition, and the *Terra Nova* was out of the ice in the open sea by August 6th. Three days later Norway was sighted.

One of the extensive appendices printed in Fiala's account is Russell Porter's description of the sledge journey he and one other made, on Fiala's

Fig. 48. An August day at Cape Flora in 1904. Fireman Hovlick and his anvil and forge. Seaman Myers blowing the bellows. From Fiala 1907.

orders, from Cape Flora, via Camp Ziegler to Camp Abruzzi. Porter was to be with the Pole party, but arrived at Camp Abruzzi the day after they left. His account paints a blacker picture of the conditions at Cape Flora and Camp Ziegler than appears in Fiala's account. For example he calls Cape Flora *a starvation camp* (Fiala 1907, p. 258) and mentions that it was a surprise that the men there were all alive after the winter (Fiala 1907, p. 279). A third winter would, in that case, probably have seen a number of deaths.

Once again very little had been done to perpetuate Ziegler's name as he had hoped. The main results of the two years were accomplished by Peters and Porter, the former with scientific investigations and observations and the latter with the mapping of various previously uncharted small islands, channels, capes and headlands. Fiala's report in the National Geographic Magazine of September 1905 that *The relations between the members of the expedition were most cordial and all took turns at duty, doing the hard work willingly* can be said to be a slight white washing of the truth.

Worsley-Algersson 1925 (Worsley 1927)

This expedition came about as a result of Grettir Algarsson's plans to reach the North Pole by air from Svalbard.[28] When he failed to obtain a sufficiently large enough airship in time, he and Commander F.A. Worsley decided to carry out the ship-borne part of the expedition anyway. This was originally to carry the air expedition to Svalbard and then to undertake exploration between Svalbard and Franz Josef Land. The ship was the sailing schooner *Lady of Avenel*, rechristened *Island*. Algarsson was born in British Columbia, Canada, but the expedition was in all other respects British. A considerable amount of (moving) film was taken along.

The *Island* sighted Northbrook Island on August 21st, apparently the first sailing vessel (without engine) to reach Franz Josef Land. Landings at Cape Flora and Eira Harbour were prevented by the ice, but a successful landing was made at Cape Barents on August 26th. The ship then sailed up the British Channel, but was stopped by heavy ice off Cape Murray, northern George Land. At the end of August they sailed back towards Svalbard.

As Algarsson's North Pole expedition was changed to the above-mentioned, the expedition's name was also changed, to the British Arctic Expedition 1925.

Expeditions in connection with the Italia *and* Latham *disasters 1928* (Horn 1930)

In 1928 Umberto Nobile's Italian expedition to the North Pole by the airship *Italia* crashed on the sea ice northeast of Svalbard. Amongst the many rescue attempts was Roald Amundsen's in the French aircraft *Latham*. This disappeared into the sea in the neighbourhood of Bjørnøya, southern Sval-

bard. Some of the search vessels operated near Franz Josef Land. These included Amundsen's earlier expedition companion Hjalmar Riiser-Larsen who cruised in the *Hobby* along the coast of Alexandra Land to Cape Flora, where Jackson's hut was found to be in a dilapidated condition. Materials for a new hut were put ashore, but the *Hobby* had to move to more shelter in Eira Harbour before the building could be erected. The expedition then returned to Svalbard.

Another of Amundsen's faithful expedition companions, Captain Wisting, passed in *Veslekari* the area of Cape Mary Harmsworth before moving west to the Svalbard area.

The Russian *Krasin* expedition, which had Adolf Hoel, director of the Norwegian Polar Institute (then called Norges Svalbard- og Ishavs-undersøkelser, NSIU) onboard as arctic expert, and which had successfully rescued seven of the survivors from Italia, is described in the chapter on Russian activities. Another Russian expedition, with Captain Voronin in the ice-breaker *Georgij Sedov*, explored the south coast from Cape Flora to Cape Mary Harmsworth.

Rights and Annexations[29]

Until 1926 Franz Josef Land was considered to be Terra Nullius, No Man's Land. On April 15th, 1926 the Soviet Union followed Canada's example by declaring the Sector Principle: that all land lying in the sector between the Soviet mainland and the North Pole was to be considered Soviet territory, a principle which has never been internationally recognized. Even internally this decree was partly unknown for some time, as atlases published by the Soviet government in Moscow in 1928, based on all territorial changes up to 1.1.1927, still had not incorporated the archipelago in the USSR. Protests were voiced from many sides in Norway and the government was urged to respond. It was particularly in view of the Norwegian economic interests in the Franz Josef Land area, which without a doubt were totally dominating, and the traditional Norwegian use of the area that the Soviet claim was felt to be daylight robbery. In the same period Norwegian interests were being curtailed in the White Sea and Novaja Zemlja areas to the east and were in conflict with Danmark in Greenland in the west, which naturally accentuated the reactions. The government chose however, to remain passive.

Up to 1929 Norwegian ships continued hunting unhindered in the area (12 ships in 1928). In 1929 heavy ice conditions stopped access. The fear that Soviet would establish a meteorological station, and thus enforce their claim, had led to a suggestion by Norges Svalbard- og Ishavs-undersøkelser (NSIU, later Norsk Polarinstitutt) that an expedition be sent in 1929 to establish a Norwegian meteorological station, which would anyway be of great use to Norwegian weather forecasting. In addition the six-man wintering expedition should carry out scientific investigations and hunting. On the

way to the archipelago, Victoria Island (between Svalbard and Franz Josef Land) should also be annexed[30], but an annexation of Franz Josef Land was not mentioned. The government took its time deciding, and finally only covered a part of the required budget, the remaining being supplied by a private person, Lars Christensen in Sandefjord, who is particularly known for his important whaling interests in the Antarctic at the time. An article in a Norwegian newspaper in 1961 (*Aftenposten* 1.6.61) relates that the skipper of the *Thorsnes*, Rudolf Svendsen, still had in his possession a document from Lars Christensen stating that he was to occupy the archipelago in Christensen's name, but no mention of this intention seems to exist in the files of NSIU. The reason given officially was to ascertain the right of Norwegians to continue their hunting in the area. A pattern such as that in practice in Svalbard was suggested, ie. that Soviet could have the sovereignty, but Norwegians and Soviet citizens would have equal rights in economic activities[31].

However, the Norwegian expedition did not manage to reach Franz Josef Land through the heavy ice, and had to stand helplessly by while the Soviet ice-breaker *Georgij Sedov* steamed into the archipelgo and established a meteorological station at Tichaja Buchta on Hooker Island. The iron Soviet flag was again hoisted, as it had been the year before from *Krasin*.

In *Isvestija* for 31st May, 1930 there was a notice that the Soviet Academy of Science had suggested changing the archipelago's name to "Fridtjof Nansens Land" to honour his memory. Nansen had just died and his name was remembered with gratitude in much of the Soviet Union for his unique work for refugees after World War I and the victims of the hunger crises in Russia and Armenia in 1921 and 1925. The Norwegian Foreign Ministry was most uncertain as to how they should react to this. On the one hand Norway could not condone the new name without thereby accepting Soviet's sovereign right to make the change. On the other hand it should be more difficult for Soviet authorities to chase Norwegian hunters away from the archipelago if it had newly been given a Norwegian's name. The problem, with the suggestion, seems to have died away of itself. In fact it is an almost remarkable fact that the Soviet regime did not go in for changing the already-given place names on the archipelago, – many of them commemorating western capitalists – either then or later. We can therefore still today enjoy the variety of names left by the various expeditions of discovery, and use them as a source for the history of the gradual mapping of the archipelago.

In 1930 NSIU again applied to the government for funds for an expedition to the archipelago with the argument that they should collect scientific data to have a stronger position in discussions with Soviet about rights of access. The first cases of Norwegian hunting ships being turned away from the archipelago occurred this year and prompted the first official protest

Fig. 49. The Norwegian expedition in 1930 building a cabin at Cape Forbes. Bratvaag *at anker. Bell Island in the fog. Photo: Gunnar Horn/Norsk Polarinstitutt.*

from the Foreign Ministry against the violation of Norwegian rights in the area. Soviet intimated that Norway could be granted hunting rights for a limited period if it recognized Soviet sovereignty, but the Norwegian government would not accept the limitation in time.

Although Norway felt the annexation was a violation and that something should be done, it was difficult to know just *what* should be done. The annexation was a fait accompli and the Norwegian legation in Moscow advised that protests or international press would be to no avail, but would only irritate. Norway should apply to retain hunting rights, although this would also mean a recognition of Soviet jurisdiction. As it was, the government granted NSIU the sum needed for the scientific expedition, but denied the permission to establish a meteorological station with the explanation that the necessary data could be obtained from the Soviets, which in fact did not turn out to be the case.

The NSIU expedition in 1930, with *Bratvaag* and led by Gunnar Horn, had both scientific investigations and hunting on its programme.[32] After the visits to Svalbard and Victoria Island the expedition sighted Franz Josef

Land on August 8th. This was Cape Grant, the southern tip of George Land. Thick fog was a hindrance at times, but a landing was made at Cape Forbes to the northeast where a small cabin was erected and stores left as a help for other hunters and expeditions. Northbrook Island was the next landing place, where scientific observations and collections were made, and then Alger Island where, amongst other things, Camp Ziegler was visited. It was noted that a Soviet visit had newly taken place there, and a Soviet flag had been set up. The expedition then sailed back to Northbrook Island and visited Cape Flora, where they noted that only remnants of Elmwood now stood. The memorial to the missing three from Abruzzi's expedition was also noted. Leigh Smith's cabin at Eira Harbour was next on the list and here again a Soviet flag had been set up. The ship was then sailed up Cambridge Bay to Cape Nansen, where the existing map was given a number of corrections and more collections were made. The last landing was made at Cape Mary Harmsworth before the archipelago was left behind on August 25th.

Expeditions in 1931

In 1931 *Isbjørn*[33], one of the Norwegian ships which had been turned away the previous year, arrived at Franz Josef Land as a tourist ship with the French Count Gaston Micard onboard. This time the ship visited the Soviet station at Tichaja Buchta and the expedition was given a hearty welcome. A note was, however, later delivered from the Soviet legation in Oslo requesting that Norwegian ships in future respect the Soviet regulations for the archipelago. This possibly illustrates the known fact that if one can circumvent the authorities and get direct to those living and working on isolated arctic stations, one is usually guaranteed a warm reception! A Swedish-Norwegian expedition with *Quest*, led by professor Hans W:son Ahlmann, was also in the archipelago this summer, as was the German *Graf Zeppelin* airship expedition.

This airship was 235 m long, and with 84,000 m^3 hydrogen gas capacity, accomodation for 20 passengers and a crew of 40 (Nelson 1993). The International Association for Exploring the Arctic by Means of Airships (Aeroarctic, founded by Fridtjof Nansen in 1926) stood behind the original plans, as Nansen hoped to use the *Graf Zeppelin* for an arctic expedition, but he died in 1930 before it could be realized. With sponsorship from the American newspaper magnate William Randolph Hurst the plans were extended to include a meeting at the North Pole of the airship and Hubert Wilkins'submarine *Nautilus*. However, the *Nautilus* failed to live up to expectations and the meeting was rescheduled to be with the Russian icebreaker *Malygin* at Franz Josef Land. Lincoln Ellsworth was one of the passengers on the airship, as were scientists from four countries. The *Graf Zeppelin* touched down briefly on the water in Tichaja Buchta where mail

Fig. 50. Graf Zeppelin *over* Malygin *in Tichaja Buchta in 1931. From Kohl-Larsen 1931.*

was exchanged with the *Malygin* according to the agreement with Hurst. Here, Lincoln Ellsworth was surprised to meet Umberto Nobile, a passenger on the *Malygin*, and Ivan Papanin was also present. Several places on the *Malygin* had been sold by the Soviet tourist agency *Inturist*, which was trying to beat the Svalbard tourist market. The main scientific contribution of the airship expedition was aerial photography of part of the archipelago.

Not taking into account the German weather station during World War II (see under), these were probably the last western expeditions to be permitted to visit Franz Josef Land before the Soviet-Norwegian historical expedition in 1990 (see under), although French geophysicists apparently partook in ionospheric research at Hayes Island in 1967.

Internal discussions as to what Norway should or could do with regard to its traditional use of Franz Josef Land continued in the appropriate circles throughout the 1930s[34], but Norwegian interests were in reality powerless against the Soviet authority. One small recognition of the Norwegian case came from Anthony Fiala in America. In a letter to Adolf Hoel at NSIU he stated his disagreement with the Soviet annexation as they had done so little on the archipelago compared with Norway, Great Britain and USA. He offered Camp Ziegler and his other cabins to the Norwegian government, even though ... *I suppose it would be like presenting something that was already in the pocket of a burglar*[35]. However the Norwegian government did not feel it right to accept, considering the circumstances. Hoel suggested that they otherwise could be given to a Norwegian society or private person, but he was unable later (1941) to ascertain how the matter had been concluded.

An account of the various Soviet expeditions to Franz Josef Land is found in a separate chapter.

World War II and Franz Josef Land

During the war of 1939–45, knowledge of weather conditions was crucial to both sides for operations in the far north. The Allies had a hold over most of the Arctic. They were able to hold manned weather stations in northern North America, Greenland, Iceland and Jan Mayen. The Norwegian and Soviet mining settlements in Svalbard were evacuated in August 1941, but a garrison was established there again by the Allies in May 1942. In Franz Josef Land the crew of the Soviet geophysical station at Tichaja Buchta was not relieved until after the war. However, the Germans managed secretly to establish at various times during the war years manned or automatic weather stations in all these areas.

The manned German weather station in Franz Josef Land[36] was established 500 m inland from Cambridge Bay on Alexandra Land when ten men were landed there in September 1943. The journey from Tromsø had taken three days by the weather-observing ship *Kehdingen*, escorted by the

Fig. 51. German submarine at Novaja Zemlja late summer 1943 during Operation "Wunderland", when they also went close to Franz Josef Land. Photo: Hanns Tollner.

submarine *U-387*. The station was called Schatzgräber and was operated efficiently through the winter and early spring. An emergency depôt was established at Cape Nimrod on the north coast. Polar bear meat had been approved as extra fresh meat, even though the danger of trichinosis, an acute parasitic disease, was known. Since previous expeditions to the archipelago had eaten a large amount of bear meat, and especially since Nansen and Johansen had suffered no ill effects, despite having little fuel for proper cooking, there was thought to be no danger.

In the last half of May 1944 supplies were twice dropped by aircraft. At the end of May newly-shot bear meat was eaten raw (as beef tartare) by most of the men. A few days later, the first of the men became ill, with sickness, fever and pains in the joints. More were to follow. By mid June the sending up of sonde balloons had to stop, both because of damage to the sondes dropped in May, and because there were too few men still capable. The crew thought they had been hit by an epidemic illness, perhaps caused by the tinned food. The expedition leader forbade contact with Tromsø, as

he meant they should manage themselves. However, as he became so ill that he had to relinquish command to another, a telegram was sent. Trichinosis was immediately assumed to be the cause, but not dangerous enough to require immediate assistance. This was, however, insisted on by the crew, some of whom were in considerable difficulties. Apart from the desperate medical condition of some of the men, the remainder were left with too many practical difficulties to manage in their weakened condition. Melt water flooded the hut, the stove pipe was stopped up by drifting snow, etc.

It was decided to fly in a doctor who could jump out by parachute if it was impossible to land on the roughly-made landing strip nearby. Bad weather delayed the attempt time after time, and by the beginning of July the situation was desperate for the Schatzgräber men. On July 7th a Condor plane managed to land, not on the hopeless strip, but on more or less firm ground 5 km away, but still a wheel was damaged. A submarine, *U-354,* had also reached the ice edge off Cambridge Bay. The men were evacuated with considerable difficulty. An extra wheel for the plane had to been flown in and dropped, together with stretchers, and the men had to be carried the long and rough way to the plane. It took 12 hours to convey the first stretcher. At the same time the plane was being repaired and a runway was created out of the rough terrain. The rescuers were by now so exhausted that a new method had to be found to transport the sick. This was done by converting a cart from the station, so that the remaining eight could be transported to the plane in six hours. The plane left on the evening of July 10th.

The station was left complete with equipment and provisions as a new group, with the callname Goldschmied, was planned to take over for the winter 1944–45. This group was, however, diverted to Greenland to replace a group there which had been captured. In October 1944 the submarine *U-387* was again despatched to Alexandra Land to remove the stores and equipment and to set up an automatic weather station instead. They were, however, unable to approach through the ice to Cambridge Bay and the station had to be left as it was. The automatic station was erected on Novaja Zemlja instead.

The Schatzgräber group had placed landmines round their station to protect them from surprise attack. When they left unexpectedly the mines were also left behind. After the war the Germans made several attempts to establish contact with the appropriate Soviet authorities to give information about the minefields, but without success. The station itself was discovered and partly emptied by the Soviets

During the Cold War two large military bases were established in Franz Josef Land, the one on northern Graham Bell Island in the east and the other at Nagurskoe on the north coast of Alexandra Land, just north of the site of the Schatzgräber station. The German landing strip by the station was developed into an airfield for the new base. The Graham Bell base also

Fig. 52. Memorial plaque to Nansen and Johansen, set up in 1990 at their wintering site. Photo: Susan Barr.

had an airfield, but both bases were serviced by helicopters from Dickson during the summer melt season.

Recent western expeditions

In 1990 the hold of secrecy on Franz Josef Land was loosened and a joint Soviet-Norwegian historical expedition was able to travel on the archipelago. The Norwegians, led by Morten Berle with Susan Barr as historical consultant, and the Soviets, led by Aleksandr Sjumilov, were able, amongst other things, to rediscover and document the remains of Nansen's and Johansen's wintering site from 1895–96. At the same time, with information from Franz Selinger and a member of the Scharzgräber group, Rudolf Garbaty, S. Barr was able to inform the authorities in the area of the presence of the minefields on Alexandra Land. The information was treated as a sensation and received coverage in *Pravda.* Barr was informed that the main hut of the German station had been burnt down, possibly many years ago. The second hut was still standing. A two-storied base for Soviet scientists had been built to the west of the station. A great number of objects and remains from the German station were scattered over the area. Cambridge Bay was used as a harbour for the military base, especially for oil supplies, so this part of the island could no longer be regarded as "wilderness" ! The group visited the Graham Bell base which had also left a large mark on the landscape, and several sites of historical interest (Barr 1991; 1992). The Institute of Culture in Moscow has both in 1990 and in the succeeding years organised historical-archaeological expeditions to the archipelago under the leadership of Petr Bojarskij (Bojarskij 1990).

Later in 1990 the Sov-Nor-Pol base at Tichaja Buchta was established as a cooperation between the Marine Biological Institute in Murmansk, the Norwegian Polar Institute in Oslo and the Arctic Ecology Group of the Institute of Oceanography at the University of Gdansk. Ecological studies of walrus, seabirds, flora, glaciers and sea ice have been particularly stressed, as well as the general development of scientific cooperation in this area of the Arctic (Gjertz & Mørkved (eds.) 1992; 1993). Access to Franz Josef Land for non-Russian scientists is now reasonably uncomplicated.

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A HISTORY OF THE AUSTRIAN DISCOVERY OF FRANZ JOSEF LAND

THE AUSTRO-HUNGARIAN TEGETTHOFF EXPEDITION 1872 –1874 [37]

HEINZ SLUPETZKY

On June 13th, 1872, the *SS Tegetthoff* and its crew left Bremerhaven on their way to unknown regions of the Arctic Ocean. This Austro-Hungarian arctic expedition was led by Julius Payer and Carl Weyprecht. They were about to make a major contribution to the discovery and exploration of the Arctic regions (Payer 1876; Hamann 1974; 1983).

It would be a mistake to use our modern technology and knowledge as a base for the evaluation of the efforts and achievements of this expedition and the scientific knowledge obtained. Instead it will be necessary to retrace our steps to the time this expedition took place. This voyage to the Arctic regions was carried out in the classical tradition characteristic for the age of exploration of the previous century. The technology and equipment used

Fig. 53. Julius Payer. Photo: Bildarchiv d. Österr. Nationalbibliothek, Vienna.

Fig. 54. Karl Weyprecht. Photo: Bildarchiv d. Österr. Nationalbibliothek, Vienna.

were rather modest and simple in comparison with that of later polar expeditions. At the time the Austro-Hungarian expedition was being prepared, the map of this area showed blanks of unknown territory. The Arctic Ocean still remained, to a large extent, unexplored and unknown, and so far no human being had set foot on either of the Poles. One of the many dreams tempting the seafaring explorers since the early days of exploration of the Arctic seas, had not yet come true: the sailing through a supposed 'North-East Passage'. The goal was to reach the Far East, sailing from northern Europe along the northern and eastern continental margins of Asia. The original purpose of the Austro-Hungarian arctic expedition was to advance as far as the North Siberian Sea and possibly to exit through the Bering Strait (A.E. Nordenskiöld accomplished this feat six years later).

At that time, even the Northwest Passage still remained a challenge. Twenty years prior to this expedition, in 1845, Sir John Franklin had set out with two ships and a crew of 129, in order to find the Passage. The ships and their crew disappeared with hardly a trace, only a few remains and tools were found much later in the Canadian Arctic. At the time of the departure of the *Tegetthoff* expedition, the world was still under the impression of the mysterious fate of the Franklin expedition, and it is understandable that their horrible misfortune had caused a certain reluctance toward further polar explorations, particularly in the Anglo-Saxon world.

The preparation of the Austro-Hungarian polar expedition

Prior to the main expedition, an exploratory expedition was organized. On June 20, 1871, the *Isbjørn* expedition sailed from Tromsø and returned on October 4th, 1871. The main challenge of this expedition was to venture into the northern Barents Sea, into regions that so far had possibly only been seen by whalers, but had remained unexplored by scientists. The expedition ventured as far as 79°N and discovered a sea mostly free of ice east of Spitsbergen and northwest of Novaja Zemlja. This led to the conclusion that an exploration further to the north would be possible, an idea which previously had mostly been met with doubt and uncertainty. The main protagonists of the actual expedition to follow were Julius Payer and Carl Weyprecht; both had worked together for the first time during the exploratory expedition. Another important member of the team onboard was Count Hans Wilczek, who was the principal supporter and promoter of the expeditions which, to a large measure, were financed with private funds. In order to raise the necessary funds for the planned expedition and the building of the ship *Tegetthoff*, the *Verein zur Förderung der österreichischen Nordpolexpedition* (Association for the Promotion of the Austro-Hungarian North Pole Expedition) was founded. The positive attitude of the Imperial Academy of Sciences, as well as the active support of the Geographical Society in Vienna proved to be most beneficial for the cause of the Asso-

ciation. Wilczek, an enthusiastic supporter of the sciences and research, made a donation of 52 000 guilders. The total cost of the *Tegetthoff* expedition amounted to 220.000 guilders; it took only a few months to raise the necessary funds. The project was met with a great deal of enthusiasm by all levels of society and different national groups (within the old Monarchy) sparked by the promotional lecture tours which Payer and Weyprecht organized in Vienna and the Crown lands of the Monarchy. The nobility as well as the bourgeoisie together with the Emperor, the Ministries, the banks and the Army made a major contribution toward the project, and last but not least many towns, scientific associations and schools also contributed to the building and equipment of the ship through active fund raising. (In order to illustrate the value of the guilder at the time of the expedition: the annual salary of a teacher amounted to 600 guilders, a civil servant of the lowest rank earned 300 guilders, the highest-ranking, a minister, 5000 guilders per year.)

The ship *Tegetthoff*, named after Admiral Wilhelm Tegetthoff, was built in Bremerhaven at the Tecklenborg shipyard. The three-masted schooner was 32 m long and 7.3 m wide with a displacement and tonnage of 520 t and equipped with an engine of 100 hp. The provisions were calculated for a voyage lasting three years. Although the equipment of the ship and the expedition in general met with the highest standards existing at the time, it was extremely modest in comparison with the far more advanced technology used in later arctic expeditions. The clothing, the type of food supplies and medication, the furnishing on board, as well as the machinery and instruments were of a nature which made it an arctic voyage in the classic and traditional sense. Although the ship was equipped with an engine-driven screw, its sails set a special symbolic tone. Instead of today's motor boats, caterpillars, ski-doos, radio communication and helicopters, rowing boats, dog sleds, candles and petrol lamps had to be used. Instead of vitamin tablets, cabbage and lemon juice – to quote an example from the food category – were supplied.

The crew of the *Tegetthoff* numbered 24, including two officers and the leaders of the expedition, Payer and Weyprecht. The composition of the crew represented a cultural cross-section of the old Austrian Empire. Italian was the official language, but in addition German, Hungarian and Slavic languages were spoken on board. Two participants, A. Klotz and J. Haller (Haller 1959), came from South Tyrol (now part of Italy). There was no participant on board originating from the provinces of present-day Austria. The only non-Austrian on board was the Norwegian Olaf Carlsen, harpooner and expert on polar ice. The leadership roles of the two organizers were strictly defined: Weyprecht's role was limited to the sea, and Payer's to the land. Carl Weyprecht, born on September 8th, 1838 in Darmstadt/Germany had served in the Navy of the Monarchy – he combined thorough training

and experience at sea with a certain amount of expertise in the natural sciences. Julius von Payer, born on September 2nd, 1841 in Schönau near Teplitz (Northern Bohemia), was a graduate of the Military Academy Maria-Theresia in Wiener Neustadt near Vienna. Together with his mountaineering and glacier experience in the Alps, his talents as a writer and draftsman were the best prerequisites for the tasks of the forthcoming arctic expedition (Müller 1956). Photography had already been invented, but was still in its early development. Although a number of photographs had been taken during the *Isbjørn* expedition in 1871, the subsequent *Tegetthoff* expedition was not equipped with photographic gear. This meant that the many impressions, landscapes, etc. had to be recorded by means of drawings and sketches.

The primary goal of this trip was not to reach the North Pole but to explore the still-unknown areas of the northern Arctic Ocean, starting from the northern coast of Novaja Zemlja, and – in the event of favourable ice conditions – to venture as far as the Bering Strait. Since the area to be explored remained within the Russian-Siberian realm, the expedition had obtained – for a case of emergency – a written declaration from St. Petersburg, in which Tsar Alexander II guaranteed the help and assistance of his Russian subjects toward the Austrians.

Ice-bound

The *Tegetthoff* weighed anchor in Bremerhaven on June 13th, 1872, at 6 am. On July 3rd, it reached Tromsø and took captain Olaf Carlsen on board. On the morning of July 14th, the ship left the harbour under steam for the open sea. Once in the open water, the engines were stopped and the sails set. They sailed past the North Cape on the way to the Barents Sea.

Contrary to the experiences made the previous year when the *Isbjørn* met with favourable sea and ice conditions, the circumstances this time proved very different. Already a few days after their departure, the ship met with the first ice-floes and by July 30th, it was locked in by the ice at 74° 39'N. Only under extreme difficulties could the voyage continue.

On August 12th, the expedition met with the *Isbjørn* with Count Wilczek on board. One of the purposes of this voyage was to establish certain depôts for the return of the expedition and in case of an emergency; for example, a depôt of coal and provisions was organized on the Barents Islands off northwest Novaja Zemlja. On August 18th, a joint celebration of the birthday of Emperor Franz Joseph took place. On August 21st, the two ships separated, with the *Tegetthoff* attempting to continue on her journey further north. However, already on the same day, the ice rapidly closed in on the ship. They had reached 76° 22'N and 62° 3'E under their own steam. The ship was not meant to reach open waters again, and Payer remarks in his notes: *No longer were we explorers, but passengers of the ice against*

Fig. 55. The Tegetthoff *and* Isbjørn *part, 21st August 1872. Painting by Adolf Obermüllner after a sketch by Julius Payer. Kärntner Landesmuseum Klagenfurt.*

our free will (Payer 1876). All further attempts to continue under their own steam and to force open a narrow channel with the help of ice saws and picks were in vain. In September, the pressure of the ice increased, and at the same time the temperature dropped and winter set in with snow storms. In October, the pressure of the ice increased to such a degree that the danger of destruction of the *Tegetthoff* became a constant concern. The eleven months of continuous ice drift had begun. The darkness of the polar night which started in November, the crashing sounds of the ice, the creaking of the lopsided ship being pushed upward, the extreme cold dropping to -46° and the snow storms …., all this and an uncertain destiny required an iron discipline from each and every member of the crew. On February 19th, after five months of darkness and ice, the first sunlight returned, an unforgettable experience for everyone. During the months to follow, every attempt to free the ship by carving a narrow channel failed, even the use of explosives was ineffective. There was great hope that with the coming of summer the ship would be set free of the rigid embrace of the ice. Yet another winter amidst the ice appeared likely. The ship in the meantime had almost totally been pushed up out of the surrounding ice, a special design of the

ship's hull preventing it from being crushed. Payer and Weyprecht finally had to give up all hope of leading the expedition to a successful end. However, they were still unaware of the fact that the continuous ice drift – which they recorded regularly (Petermann 1875) – gradually moved the ship toward a new land, a land located in the northernmost region of the Old World.

The discovery of Franz Josef Land

The unexpected happened: on August 30th, 1873, the ship had reached 79°43'N and 59°33'E, when around noon the fog lifted. Suddenly, the outlines of a mountainous region emerged in the northwest. It was with great joy and jubilation that the crew greeted and celebrated the discovery of the new land. At home, the arctic explorers were already considered missing, but in fact the 'missing' explorers had made the discovery of a new land. Payer named the elevation they had discovered first 'Cape Tegetthoff'. At this time, the ship was still 46 km away from shore, and it was only by November that the ice conditions around the ship permitted longer exploratory trips away from the ship.

On November 1st, 1873 at noon, in the dim light of the polar winter – the sun had already set a few days earlier, and the second period of the polar night had already begun for the people on board the *Tegetthoff* – for the first time the explorers set foot on the new land, in fact on Wilczek Island, named after the illustrious supporter of the expedition. The island at the time was covered by thick glacier ice, glaciation having been far greater than today, and the winter storms had already covered the island in ice and snow. Despite all this, the explorers felt as though they were entering paradise and were thankful for their fortunate fate when at long last they could step on solid ground. On the following day, Payer took possession of the land in the name of the reigning monarch, Franz Joseph, with the Austro-Hungarian flag in hand. The crew erected a stone cairn and, in the centre, placed a tin containing a document, signed by Payer and Weyprecht, relating all the important events of the expedition and above all, the actual discovery of the new land. This document also contained a statement that read*: The entire region discovered (by us) was to be named Franz Joseph Land, according to the rights and privileges of the original discoverers* (Kirsch 1875). Until recently it was believed that this document had been removed to archives in the former USSR. However, in 1991 an expedition with the ship *Icesail*, under the leadership of A. Fuchs (Fuchs 1991), discovered pieces of paper still in the cairn. An examination with modern techniques revealed this to be the original document signed by Payer and Weyprecht (Slupetzky et al. 1994). The document is currently in the Schifffahrtsmuseum in Bremerhaven, Germany.

At the time, a closer exploration of the region was not yet possible since

Fig. 56. The site of the first landing, Wilczek Island. Krisch's grave and a cairn are to be found on the cliff. Photo: Heinz Slupetzky.

the second period of polar darkness lasting 125 days had already begun. Only on occasions was it interrupted by a fantastic display of the Aurora Borealis. The ship was locked in by the ice near Wilczek Island, and again formed the crew's winter quarters, although they would have preferred to live on land and escape the ever-present danger of the destruction of the ship by the constant pressure of the ice. The trials and tribulations of a second winter in the ice had begun, however, this time with the realization of a successful expedition and the victory of having discovered the new land – the explorers could look forward to returning home with great and exciting news. The return, however, was very uncertain in view of the fact that the hopelessly stalled ship would have to be left behind in the summer to come, in which case the expedition was to try to reach Novaja Zemlja to the south by crossing the Arctic Ocean with their boats and sleds. This de-

Fig. 57. A photograph taken under UV-light, showing part of the document of the discovery by the Austro-Hungarian polar expedition. Signed by Julius Payer, 1st November 1873. Bundeskriminalamt Wiesbaden, Kriminaltechnisches Institut/Archiv Deutsches Schiffahrtsmuseum.

cision had already emerged in February 1874 and, in principle, was considered firm and definite. All attempts to free the ship had failed and it was unlikely – in view of the experiences made in the past years – that the ice-bound ship would be driven southward. Moreover, part of the crew was in ill health weakened by scurvy, which would have made a third winter in the ice extremely difficult. In addition, their supplies of food and medication had been depleted to a dangerous level (already very limited by modern standards in the first instance).

The exploration of Franz Josef Land

So far in the course of the entire expedition, Payer and Weyprecht had been busy making scientific observations and collecting data through carefully recorded measurements. For example, observations of the weather and temperature patterns, precise measurements of the drift of the *Tegetthoff*, observations of the Aurora Borealis, etc., and also of the *Metamorphosis of the Polar Ice* (Weyprecht 1879) were conducted. However, the most valuable

Fig. 58. A full-size copy of the Tegetthoff, *left by the Austrian broadcasting company ORF at Ziegler Island 1993–94. Photo: Ch. Höbenreich.*

part of the scientific research and the cartographic records was still to come. Despite the considerable risks and hardships to be expected, Payer decided to further explore the unknown regions of Franz Josef Land. In this present day and age, it is hard to imagine the iron discipline and will power with which the investigation of the interior was carried out despite frostbite, sickness, incredible physical efforts and mental pressures. In addition, the time factor represented a further problem. In March, Payer left for a second and longer exploratory trip with a small team of men who were still in relatively good physical shape. He was fully aware of the fact that the remaining crew of the ship would be leaving the *Tegetthoff* in order to attempt the return as early as in May. It was necessary for him to bring his investigations to a conclusion prior to this time and, together with his companions, to return to the ship again. He had to reckon with the possibility that the crew might be leaving without them should they fail to return in time. In order to warrant a successful return it would have been irresponsible to wait much longer beyond this date and every delay would have meant a slimmer chance for a safe return and survival.

Payer's team started to explore the new land as soon as the March sun grew stronger, carrying out three exploratory trips over a total of ten weeks. They travelled by dog sleds, on foot, and sometimes pulling the sleds themselves. As we realize today, it must have been extremely difficult to form an accurate picture of the actual distribution of the land and sea due to the innumerable small and big islands, and the multitude of bays and estuaries branching off in all directions. In addition, at this time of the year, the sea between the islands was to a great extent clogged by ice, with the drifting snow obliterating the limits of the coast line. Another factor also comes into consideration. During the past century, the glaciers covering the islands were far more extensive than is the case today; which meant that at the time the visible land mass free of ice was considerably smaller. In view of all this, the exact mapping of the newly-discovered land was immensely difficult.

The first exploratory journey (March 10th–15th, 1874) as well as the third (April 29th–May 3rd, 1874) were of short duration and directed towards the west and northwest as far as Hall Island and McClintock Island. Unfortunately, there was too little time to verify the extension of the area further west. The longest exploratory trip (March 26th–April 22nd, 1874) took the team to the north in order to establish the extension of the land in the direction of the Pole. A small team consisting of seven men attempted to push as far north as possible with the help of three dogs and one sled. Payer made good use of the increasing daylight hours in order to make fast progress. However, the cold, snow storms, difficult terrain, crevassed glacier ice, etc. made this progress rather difficult. Also orientation became somewhat inaccurate since the compass readings this far north tend to be unreliable. The unknown confusing topography, as well as the snow which constantly erased the visible limits between land and sea presented further problems. Fog clouds glistening in the bright sunlight could easily be mistaken for snow-covered elevations, dark ice-free spots in the sea (polynyas) that would remain open even in winter could appear like islands on the horizon. A few accidents – falls into crevasses – happened on the way, fortunately without any further consequences. Some of the participants suffered severe frostbite and had to stay behind to be picked up on the return trip; on March 14th, 1874, during the first such sled trip, the temperature dropped to -51°C, the lowest temperature measured. The journey followed a northerly direction along an ice-covered strait laced with icebergs: the so-called 'Austria Sound', a name which is still used today. Payer never tired of drafting maps of the new land, making sketches and establishing triangulation points as a first step for the determination of geographical locations. The explorers gave names to islands, summits, glaciers, capes and straits, many relating to the names of places and persons of the old Austrian monarchy. In April 1874, after the first signs of the not too distant Arctic

Fig. 59. Säulen Cape on Rudolf Island. Painting by Adolf Obermüllner after a sketch by Julius Payer. Kärntner Landesmuseum Klagenfurt.

Ocean, they reached the rocky towers of the 'Säulenkap', and on the following day the northernmost point on this third journey at 82° 5'N, Cape Fligely. In fact this 'Rudolf Island' (named after Crown Prince Rudolph, the son of Emperor Franz Joseph) is the northernmost island of the archipelago. Two more islands, 'King Oscar' and 'Petermann Land', were thought to be located even further north but later proved to be non-existent. After 17 days the team had reached the most northerly point of the land mass and marked the spot with the Austrian flag. Payer left behind a document stating the fact that the expedition had reached this most northerly point. About twenty-five years later this document was found by the Italian *Stella Polare* expedition organized by Duke Ludwig Amadeus of Abruzzi.

Return to the ship

The journey back to the ship was again an ultimate challenge for all involved. The now-open areas of the sea had to be circumvented in big circles. They left all unnecessary material and equipment behind. Their depleted provisions were to last for only 10 more days. The previously established food depôt on Schönau Island proved to be a great help. Despite their relatively weakened physical conditon, they climbed the summit of Cape Tyrol on the Island Wiener Neustadt in order to gain a better overview of the area for their cartographical records. With growing suspense, they finally approached Wilczek Island wondering whether the *Tegetthoff* would still be there. Would there already be open water preventing direct access over the ice to the ship? Increasingly they had to chose a route over land. Fortunately, the ship was still there and had not drifted away; they also found a path back to the waiting ship over the ice that was just breaking up; and on April 23rd they returned safely to the ship.

Fig. 60. Krisch's grave on Wilczek Island, with the original plaque. Photo: Heinz Slupetzky.

During their three exploratory trips, they had covered 833 km. This first exploration of Franz Josef Land, despite the difficult conditions, had been a great success – every possible opportunity had been used to achieve maximum results. Of course this tremendous feat will, in no small way, always be remembered together with the name of Julius Payer. Apart from sheer good luck, it was mostly due to Payer's experience and circumspection that all participants of the *Tegetthoff* expedition could return safe and sound. It almost borders on a miracle that almost the whole crew was able to return back home. There was only one death to be deplored during the entire Austro-Hungarian arctic expedition. The ship's engineer, Anton Krisch, weakened by scurvy, died of tuberculosis; it is certain that he had been infected with the deadly disease already prior to the expedition. On March 19th, 1874, Krisch was buried on Wilczek Island, not far from the spot where the Austrians first set foot on land. The sad occasion of this funeral has been vividly illustrated in a picture by Adolf Obermüller, based on a drawing made by Payer (Andrée 1985).

Departure from the ship

During the various exploratory trips by Payer and his team, every possible preparation for the abandoning of the ship and the return home was being carried out. It was planned to leave everything behind that could not be transported on the three sleds or, as the case might be, in the four boats available. Of course, all research material, the sketches and results of measurements which had to be packed in water-proof boxes had top priority. Most of the personal belongings had to be left behind, also the skins of 67 bears (bear meat was one of the most important food supplements during the expedition – every member had consumed the meat of at least four bears!). On May 20th, 1874, the final departure from the *Tegetthoff* took place. The ship, despite the limitations of the simple and modest living quarters, had served the crew as a relatively comfortable and safe place to live on amidst the inhospitable polar environment. On the day of the departure, four bottles containing messages were placed on different icebergs; the information gave details as to the discovery itself and of the attempted journey south towards safety. There was a slim chance of these messages ever reaching any destination. Surprisingly, one of the messages (handwritten by Payer) was found about half a century later. In 1921, a Norwegian expedition under Olaf Holtedahl returned with the precious document from Novaja Zemlja. A Russian fisherman had found it on the beach of Suchoj Nos and entrusted the Norwegians with it. The old Russian Empire – the letter had been addressed to the Admiralty of the Tzar – had already ceased to exist by the time it was found! Later, this unique document was forwarded to the Geographical Society in Vienna. Unfortunately, the original letter has disappeared and only a copy of it is still in existence.

Upon departure from the ship, the plan was to turn south to find open water which would enable them to make use of the boats and reach Novaja Zemlja, where Count Wilczek had established a depôt of food supplies two years previously. Under the existing circumstances, the chance of survival and a safe return was extremely slim. In Europe the expedition was already considered lost and vanished.

Return journey

Meanwhile, the 23 members of the expedition believed dead were making their way south in an ultimate effort using all their remaining energy. They hauled the heavy loads and boats over the pack-ice, over ice pinnacles, ice floes and deep cracks, through slush, pools of water and ever-increasing channels between the ice which they crossed with the help of the boats. In the process of these travels, the boats had to be unloaded and reloaded innumerous times. Thirst, hunger, cold, sleepless nights, scurvy and other diseases, constantly wet to the bone – all this made their progress southward extremely difficult, but they persevered in an extreme show of effort. However, the worst was still to come when, on July 15th, after an odyssey of about two months, they discovered in the distance the *Tegetthoff* afloat. Panic-stricken, some of the participants of the expedition wanted to return to the ship, and Weyprecht had to use all his powers of persuasion to prevent them from doing so. What had happened? The progress of their southward journey had been impeded as a result of head winds which had driven the pack ice in a northerly direction, literally 'under their very feet'.

Once the wind had turned to a northwesterly direction they were finally able to make some real progress to the south. On August 7th, their hopes were raised even more when they noticed a slight but regular heaving and falling movement of the ice indicating that the open sea could not be far away. Around the middle of August (at 77° 40'N), after approximately three months, they reached open waters at last and were finally able to use their boats to continue their journey south. In order to reach this point in their journey, the crew had travelled over twice the actual distance required: they had covered a distance of 556 km instead of 242 km as the crow flies (Petermann 1877). On August 16th, land finally came into sight with the snow-covered mountains of Novaja Zemlja emerging on the horizon near Cape Nassau (not far from here W. Barents had perished in 1597). Unfortunately, they could not reach the depôts previously established on this island due to very high surf. Consequently, their food supplies dropped to a dangerously low level.

The rescue

They all harboured high hopes that they would soon reach safety, but it was by pure chance when, at this point in their travels, they were spotted and

Fig. 61. "Nie zurück" (Never back). Weyprecht persuades the expedition members that they cannot return to the Tegetthoff. *Julius Payer. Heeresgeschichtliches Museum, Vienna.*

picked up by two Russian schooners, belonging to fishermen who happened to be delayed in these waters. On August 24th, 1874, in the remote Dunen Bay, captain F. Voronin took the exhausted explorers on board his schooner *Nikolaj*, where they were received with warm hospitality and assistance. On board, they also learned of all the events that had occurred during their long absence. They were told that there was peace in Europe, that Napoleon had died, but also that a Norwegian fishing vessel had stranded near the Barents Islands off Novaja Zemlja in the autumn of 1872 and been crushed by the ice, its crew barely escaping death – a similar experience to that of the Austro-Hungarian expedition. The captain took them to Vardø in Norway where their arrival was celebrated with great enthusiasm on September 3rd. The expedition had lasted 812 days. The postal steamer *Finmarken* then carried the group to Tromsø, from where one of the members, the Norwegian Carlsen, was able to return home.

The news of the rescue of the explorers, until then believed to have perished, travelled fast from Norway around the world. Emperor Franz Joseph, in a telegram, was the first to congratulate them. The journey back

home was like a triumphal procession, but this was only the beginning of a long series of ceremonies on a national and international level over the following weeks and months, in honour and recognition of the expedition members. These events were followed by the scientific evaluation of the data collected, a series of conferences as well as the publication of the observations and results of the expedition (Weyprecht 1874).

The achievements of the Tegetthoff expedition and its leaders

There are a number of claims as to the early discovery of this northernmost arctic archipelago, by the Norwegians on the one hand (see previous chapter) and, on the other hand, by the Russians (Atlas of the Arctic 1985) who claimed that the islands had been known by Russian trappers even earlier. Already towards the end of the 1860s, Russian scientists had expressed their hypothetical belief in the existence of this land, subsequently confirmed by Payer's discoveries (see Russian research, pp. 129–147). However, it is the Austro-Hungarian expedition, beyond any doubt, that deserves the merit of having proven to the world the existence of this unknown northern land, having returned with ample documentation thereof.

The Austrian expedition achieved a first-time exploration of Franz Josef Land and enriched all the relevant sectors of the natural sciences with innumerable new observations and discoveries. It was also Payer who had carefully documented these findings and observations and, thanks to his detailed publications, enabled future generations to benefit from this knowledge (Payer 1876). Even to this day, Payer is highly recognized in scientific and academic circles for his achievements as an arctic explorer. He is also well known as a pioneer of several mountain ranges in the Alps, for example, the Ortler Mountains, as a cartographer, as well as an artist. After his return from this arctic expedition, he was in great demand for his expertise on the Arctic as well as a lecturer. In the course of 18 years he gave no less than 1228 lectures. After 1884, Payer gradually lost the sight of one eye and increasingly suffered from various illnesses and died in loneliness and isolation in Vienna on August 29th, 1915.

Apart from the actual discovery and the resulting far-reaching consequences for the geographical and scientific research of the arctic regions, another outcome of this exploration was the proposal of celebrating 'International Polar Years', an idea which originated with Weyprecht.

Upon the return from the expedition Weyprecht fell seriously ill. This, however, did not prevent him from starting to work incessantly on the realization of his idea. The first successful initiative was launched with the *First International Polar Year* 1882/83, an example that would not remain without effect on future research projects on an international level. Eleven countries with fourteen polar stations participated in this project. Again it was Count Wilczek who was responsible for the financing of the Austro-

Fig. 62 Payer's map of Franz Josef Land.

Hungarian contribution. All participating countries took part in the simultaneous measuring and recording of scientific data in the Arctic. Unfortunately, Weyprecht did not live to see the realization of his idea. He died on March 29th, 1881, at the age of 43, seven years after his return from Franz Josef Land.

The completion of the 'Payer' map of Franz Josef Land at the turn of the 20th century

The discovery of Franz Josef Land created a stimulating effect with regard to further exploration and research of the arctic regions. In the course of the years to follow the archipelago became the goal as well as starting point for several expeditions. Gradually, with the increase in information, the topography of Franz Josef Land became well known and defined (see previous and next chapter). These findings, to a great extent, confirmed the scientific results obtained by the *Tegetthoff* expedition.

Soon after the Austro-Hungarian arctic expedition, its original goal was accomplished. In 1878–79, Finnish-Swedish A.E. Nordenskiöld, for the first time, sailed from the North Cape to the Bering Strait along the Northeast Passage on board the *Vega*. This accomplishment ended a 300-year history of numerous attempts by different arctic explorers to find this passage. With regard to the Norwegian Fridtjof Nansen's important discovery (see previous chapter) that the so-called Petermann Land did not exist, and his questioning of the actual existence of King Oscar Land, this caused Nansen to harbour certain doubts about the accuracy of some of the other discoveries made by Payer (Brosch 1900). Later, however, Nansen was able to confirm Payer's measurements and observations, which to a large extent proved to be accurate. On May 6th, 1898, the two famous arctic explorers met at an academic celebration organized by the former Geographical Society in Vienna (today known as Austrian Geographical Society) and Nansen publicly expressed his recognition and admiration for Payer's great achievements.

What remains of the former Austrian activities in the Arctic?

To begin with, it is a fact that the original place names in Franz Josef Land used by the Austrians within the archipelago have, with a few exceptions, been maintained up to the present even by the Russians (although there have been a number of attempts by Russia to change some of the given names). Many of these names recall prominent public figures and localities connected with the old Monarchy, as well as supporters, scientists and academics of neighbouring countries. Such an abundance of place names reflecting the original connection with Austria is to be found nowhere else in the world. With respect to further Austrian activities in the Arctic, research projects have been on a definite decline after the Second International Polar Year. Of course, the participation of Austrians in the activities in the Arctic during World War II, at the time of the alliance with Germany, is a different story altogether (Selinger 1991).

In recent years, the scientific pioneering achievements of the historical Austro-Hungarian arctic expedition have been brought into public light again. For the present generation, there was ample opportunity to recall

those past achievements during the Centennial Celebration honouring the discovery of Franz Josef Land (ÖGG-catalogue 1973). This festive occasion was marked by a special exhibition, a number of publications, as well as the issue of a special postage stamp. Also an original letter written by Carl Weyprecht aroused many memories connected with the early period of exploration. On August 19th, 1978, a Russian scientist, Vladimir Serov, discovered the box containing this letter on Lamont Island; Weyprecht had placed it there just after the final departure from the *Tegetthoff* in 1874. At the request of the Austrian authorities, this letter was handed over to the Austrian Ministry for External Affairs by Russia and finally to the Austrian Academy of Sciences on January 9th, 1980 (Hamann 1980).

The story of the discovery of Franz Josef Land has become the topic of a number of new publications (Straub 1990; Hamann 1984). Also a recent novel has sparked renewed interest in the adventures and discoveries of the historical expedition. In his novel *Die Schrecken des Eises und der Finsternis* ("The Horrors of the Ice and Darkness" – a title directly adopted from Payer's book) the author Christoph Ransmayr illustrates, through his protagonist, a descendant of a member of the (*Tegetthoff*) expedition, the chronicle of the dramatic events in the arctic environment of today; the story is set in the region of Spitsbergen (Ransmayr 1984).

Austrian activities in Franz Josef Land today

As of December 1988, a number of efforts and activities have been initiated in Austria by Dr. Alois Roithinger from Salzburg (continued by Feucht in Germany), Egon Reichhardt from Graz, as well as by Karl Habsburg-Lothringen in order to organize a 'Payer-Weyprecht Commemorative Journey'. The goal of this journey was to erect a plaque on Wilczek Island in commemoration of the 115 years since the Austro-Hungarian arctic expedition. However, the request for permission for such an undertaking was ignored by the Russian authorities, despite the strong support granted to this project by influential public figures and institutions. In the meantime, the military restrictions governing Franz Josef Land were lifted by the Russians opening an era of renewed international activities in the archipelago. In the summer of 1990, the first joint expeditions to Franz Josef Land by teams of Russians, Norwegians and Poles took place. Since 1991, it has also been possible for tourists to visit the archipelago (Ritter 1993; Fuchs 1991). On February 3rd, 1991, H. Slupetzky stressed to the Federal Ministry for Sciences and Research in Vienna, Austria, the importance of new initiatives to participate in the research activities in Franz Josef Land. H. Slupetzky participated in the second Russian-Norwegian-Polish expedition after having taken part in a trip on board the ship *Professor Molchanov* organized by a German travel agency (Brand 1991) to Franz Josef Land. The purpose of these journeys was to explore the logistics of research

possibilities and also to follow the paths of the former Austrian explorers.

On the occasion of the second international expedition, Karl Habsburg-Lothringen, the grandson of the last Emperor of Austria, Karl I, also figured as one of the participants; in August 1991, for the first time, a member of the house of Habsburg was able to set foot on Franz Josef Land, named after his forefather. On Wilczek Island the visitors payed their honours at the northernmost grave site of an Austrian, the ship's engineer Otto Krisch. The original wooden cross and brass plate marking the spot where he was buried still exist. The inscription reads: *Here lies Otto Krisch, Engineer of the Austrian Arctic Expedition, who died on board the 'Tegethoff' on March 16, 1874, at the age of 29. Peace be with him!* During the whole expedition, Otto Krisch had kept a diary. In 1992 it was offered for sale to a Munich antique book dealer at the price of DM 20,000 (Krisch 1992). Due to the efforts of A. Roithinger and H. Slupetzky, the Austrian National Library accepted this proposal and acquired this diary, thus an important historical document has been added to the Austrian heritage.

In the spring of 1991, Roithinger and Slupetzky approached the different departments of the Austrian Broadcasting System (ORF) in Vienna with the suggestion to revive the topic 'Franz Josef Land' and its historical connotations with Austria in view of the changed situation in the former USSR. The Austrian television initiated the preparation of an important documentary under the title *Arctis Nordost* (Arctic Northeast) under the direction of H. Voitl and Dr. E. Guggenberger, to be presented to the public as part of the celebrations of the millenium '1000 Years Austria' in 1996, beginning with an initial series of documentaries already in 1995.

After the first exploratory expedition, in the summer of 1992, H. Slupetzky took part in the ORF Expedition (an expedition of the Austrian Broadcasting System in collaboration with the Arctic and Antarctic Institute of St. Petersburg). A further goal of this expedition was to explore and examine, in collaboration with the Russian authorities, the possibility of establishing a new Polar Research Station on behalf of the Federal Ministry for Sciences and Research in Vienna (Slupetzky 1992). The idea and impulse for such a project had originated with the ORF. However, due to the extremely high costs of approx. 70 million Austrian Shilling, this project had to be shelved at least for the time being. In the summer of 1993 as well as in the late winter/spring of 1994, the third and fourth ORF Expedition spent several months at a time in Franz Josef Land.

In view of these latest developments, it is obvious that a new phase, offering promising opportunities in the research and exploration of Franz Josef Land, has begun for the sciences in Austria. Naturally, there is a close cooperation with the international scientific community engaged in polar research.

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RUSSIAN RESEARCH IN FRANZ JOSEF LAND

ALEXANDR N. KRENKE[38]

The *Morskoj Sbornik* ("Sea Review", founded during the time of Catherine the Great in St. Petersburg) published in the May 1865 issue an article by a 37-year-old German naval officer, baron N.G. Schilling, a full member of the Russian Geographical Society. It read:

The fact of relatively easy navigation along the western side of Novaja Zemlja, Svalbard and Greenland, protected by these islands from floating ice, proves the existence of a current going from northeast to southwest. There could be no doubt as to the existence of such a current, which should also be held mainly responsible for the successful navigation along the western side of Svalbard mentioned above. However, the Svalbard archipelago alone is unlikely to hold large ice masses of several thousand square miles in a constant position between Svalbard and Novaja Zemlja. In the light of these circumstances, along with the relatively easy navigation to the northern part of Svalbard, could it be possible that there is an unknown land between this island and Novaja Zemlja, a land which stretches farther to the north than Svalbard, and creates an obstacle to the flow of ice? If this were not so, then due to the southwestern current, the North Cape and the whole Laplandian coast would probably be covered under eternal pack ice very much like the Siberian coasts.

This report did not attract any special attention. Five years passed and the famous Russian climatologist, A.I. Voejkov, and a merchant, M.K. Sidorov, submitted a project for an expedition to the Northern Sea to the Russian Geographical Society. On December 18th, 1870, in order to deliberate on this project, the Society formed a commission, consisting of 11 members, and chaired by Schilling. On May 17th, 1871, the secretary of the commission, an outstanding geographer, who later became the founder of the Russian anarchist movement, prince P.A. Kropotkin, presented the report of the commission (Doklad 1871). In this report Schilling's ideas were repeated even to the point of using the same words and expressions, and the search for the new land was proclaimed as one of the expedition's aims. Kropotkin's support of the Schilling idea led to the assumption by many people that the idea of the new archipelago originated with Kropotkin. The Society supported the reported project with the expedition planned for 1873, and exploratory navigation to take place in 1871. However, one member of the Society, the Minister of Transportation, K.S. Pos'et, expressed his own opinion to the effect that accurate mapping of already-known

coasts, and the construction of a seaport in the Pechora River mouth, were to have top priority (Kremer 1957). The commission of the Marine Ministry was not very enthusiastic about the project, which required the purchase of a ship. First, they rejected the idea of an exploratory navigation to the north of the Barents Sea, and in 1872, the Ministry also refused 200,000 rubles to be granted to the president of the Geographical Society, F.P.Litke, for the organisation of the main expedition. As early as one year prior to the planned Russian expedition, the *Tegetthoff* set out from Bremerhaven to the Barents Sea; and a year later, the new archipelago was discovered. With this began a period of research and exploration by western expeditions both with goals of a scientific as well as sporting nature (using Franz Josef Land as a starting point to the North Pole). Accounts of these kinds of adventures and expeditions are common lore in Russia.

It was not unusual for western expeditions to get support in Russia, which is reflected in the following instances: F.I. Voronin, who had come from a family of merchant marine masters, brought Payer and Weyprecht's expedition on his ship *Nikolaj* to Vardø in Norway; this expedition had previously left the *Tegetthoff* and reached the southern island of the Novaja Zemlja archipelago on August 24th, 1874. Payer later reimbursed the losses Voronin had incurred as a result of the interruption in his commercial fishing business. Then followed a series of expeditions: Jackson (England) in 1894, Wellman (USA) in 1898, the duke of Abruzzi in 1899, all of which were equipped in Archangel'sk. Jackson bought his dogs in the Jugorskij Šar, and Fridtjof Nansen in Chabarovo in 1893[39].

The first Russian in Franz Josef Land – supposedly, the Russian inhabitants of the White Sea coast had not reached it before – was obviously the carpenter Varakin, a member of Jackson's expedition, who built an "izba" (a log hut) on Cape Flora in the autumn of 1894 (Pinchenson 1962). After having returned to Norway, Fridtjof Nansen publicly thanked the outstanding Russian traveller, Ėduard Toll', for his advice concerning the best choice of place for the *Fram* to successfully enter the ice field. Six years later, Toll' perished in the East Siberian Sea (Pinchenson 1962).

The first Russian expedition to Franz Josef Land took place in 1901, twenty-eight years after it had been discovered by the Austrians. It was the second test journey of the ice-breaker *Ermak* built in 1899 on a proposal of admiral S.O. Makarov, and with the support of the Minister of Finances, Vitte, who persuaded the Tzar to grant 3 million rubles for its construction. Originally, Makarov had planned to get to the North Pole by way of the ice-breaker, a feat which only came true 70 years later. The *Ermak* was a ship of 9,000 tons displacement and had an engine of 10,000 hp instead of the 40,000 hp needed to crush the ice in order to reach the North Pole. It was planned that two ice-breakers would be working simultaneously, but the second ice-breaker was never built. Shortcomings revealed during the first

navigation (eg. a screw in the bow) were then eliminated. The ice-breaker, under the command of captain M.P. Vasil'ev, and with the participation of several scientists, started from Tromsø in May 1901, and was followed by a Swedish-Russian expedition whose goal was to measure the meridian. On July 24th, Makarov turned to Cape Flora and then to the Hochstetter Islands in the east. On August 20th, the ice-breaker returned to Tromsø (S.O. Makarov 1943). The expedition discovered a branch of the Gulf Stream to the south of the archipelago, and also obtained samples of plants, fossils, and soils. However, for many years after this expedition, no ice-breaker was to reach the Arctic. In 1903, upon parting with captain Vasil'ev – a year before his death in the Russian–Japanese war, Makarov spoke about their common unfinished work.

Eleven years later, on March 10th, 1912, captain Georgij Ja. Sedov, a hydrographer, aroused renewed interest in Franz Josef Land. An enthusiast of the Northern Sea Route which he had supported as far back as in 1906 in a series of articles in the *Ussurijskij Vestnik*, and a participant of the Russian–Japanese war, Sedov, using his experience obtained during the war, forwarded a message to the head of the Main Hydrographic Department, A.I. Vil'kickij, concerning the organization of an expedition from Franz Josef Land to the North Pole. Simultaneously, in Austria, the son of J. Payer was working towards a similar project. This time the Russian project was going to be put into effect. Without any governmental support (the Vil'kickij commission with the participation of A.V. Kolčak – the future leader of the White Russian forces in Siberia during the Civil War – had found the project interesting, but not thoroughly enough planned), Sedov formed an expedition using private funds raised by A.S. Suvorin's national patriotic newspaper *Novoe Vremja*. Among the sponsors were the opera singers F.I. Šaljapin, L.V. Sobinov, A.V. Neždanova and others. They bought the *St. Foka*, a boat with a displacement of 273 tons and an engine of 1000 hp. The boat was old but comfortable and proved to be a good vessel for the planned expedition. However, in the hurry many useful things had not been included, such as a radio.

The *St. Foka* left Archangel'sk on August 15th, 1912, five months after the message had been submitted. The expedition led by an enthusiast from the "lower classes" included outstanding scientists – a geographer, V.Ja. Vize, a geologist, A.M. Lavrov, as well as an artist and photographer, N.V. Pinegin. The crew consisted of 27 people, five of whom returned home after the first wintering in Novaja Zemlja, which was forced by the ice. After having completed interesting research in Novaja Zemlja and getting free from the ice, the expedition advanced to Franz Josef Land, and on September 1st reached Cape Flora. Struggling through ice, the expedition stopped for the second wintering in Tichaja Buchta on Hooker Island on September 7th.

Fig. 63. Tichaja Buchta and the Čiurlionis ice cap. Photo: Heinz Slupetzky.

There again, the expedition obtained interesting research results: a geological study of the island, observations of the drift ice, the first snow measurements, as well as interesting observations regarding the magnetic field: it was discovered that the changes of the magnetic field occurred within a cycle of 15 years. Meteorological observations were held from September 14th to July the following year. Topographical mapping of the nearest islands was carried out by means of astronomic surveying techniques.

Thanks to Pinegin, the map of the archipelago acquired the name of Čiurlionis: *If you look to the south from the place of "Foka" landing, you will see a huge rock there – the Rubini Rock Peninsula. Its 200 m cliffs are quite inaccessible, except for its eastern part. On a hazy day, when we first saw the capes they looked like phantoms by the fantastic artist Čiurlionis. Later on, when surveying Tichaja Buchta, these capes were called the Čiurlionis Mountains* (Pinegin 1933). The Čiurlionis ice cap covering these mountains served in 1947–52 and 1957–59 as a base for two expeditions by the Arctic Institute and the Institute of Geography of the USSR Academy of Sciences.

The second wintering turned out to be hard. Scurvy set in, and the machinist I.A. Zander died and was buried at Tichaja Buchta. However, Sedov, with the obstinacy of a maniac, insisted again and again on a march to the Pole, maintaining that they would undoubtedly be successful if they pushed through the ice to Rudolf Island. He had, however, neither any experience of marching on sea ice, nor enough room for provisions, etc. He considered it possible to reach the Pole and come back, or to continue to Canada within half a year. On December 16th, Vize tried to stop him, but failed. On February 15th, 1914, still during the polar night, Sedov, being ill at the time, started the suicidal march together with two sailors. He had hoped to get better, but on the way his condition deteriorated. However, he did not want to turn back. The sailors pulled him in a sledge towards the log hut left on Rudolf Island by the Abruzzi expedition, but he died before reaching it, on March 6th, having kept his diary until March 3rd. The sailors struggled back to Tichaja Buchta on March 19th.

The expedition, which contributed a lot to the study of the archipelago, started back on July 30th, 1914, during the first days of World War I. On August 1st, a meeting occurred on Cape Flora, similar to the meeting of Nansen and Jackson in that very place 20 years earlier. However, this time it was not the meeting of two victors, but of two tragic expeditions. The navigator V.I. Al'banov and the sailor A. Konrad, two weeks after having

Fig. 64. Monument to Sedov, near Cape Säulen. Photo: Heinz Slupetzky.

reached Cape Flora, met there with the only two survivors of the 11 sailors who had left the steam yacht *St. Anna* 160 km to the north of Rudolf Island with the rest of Georgij L. Brusilov's expedition, which never returned. Brusilov had wanted to sail Nordenskiöld's route through the Northeast Passage, but his ship became ice-bound near the Jamal Peninsula and was carried by the ice far to the north, to the centre of the Arctic Ocean. The crew of the expedition parted because of internal disagreements. Those who left were in better luck. Al'banov, after the most challenging route, reached Alexandra Land, described the "Lunnyj" (which translates to "a silver new moon") ice cap and lost five of seven kayaks, which forced the group to separate, one to continue on foot, the other by kayak. Only one kayak reached Cape Flora, the other one went down. The group on foot were never found, either by Al'banov or by the *St. Foka* or the *Hertha (Gerta)*, which arrived on August 29th, 1914, sent by the Administration of Hydrography to rescue Sedov's expedition. The captain of the *Hertha*, I.I. Isljamov hoisted the Russian flag, made of iron, on Cape Flora, thus proclaiming for the first time the Russian sovereignty over the archipelago. This was a result of war time and the fear of a possible confrontation with the enemy in the archipelago.

Also this summer the pilot Jan Nagórski (a Pole serving in the Russian air forces) had flown towards Franz Josef Land in search of Sedov's expedition. On September 8th, yet another attempt to find the missing group of Al'banov's expedition, who had left on foot, was made by another rescue boat named *Andromeda*, but it was unable to break through the ice. The main achievements by Al'banov was the rescue of Brusilov's expedition materials and, after having sailed where two islands, Peterman Land and King Oscar Land, were supposed to be located according to the maps, he was able to prove that these islands did not exist at all. The Brusilov expedition had discovered the St. Anna submarine trough to the east of the archipelago. This trough serves in the exchange of water between the Kara Sea and the central Basin. The *St. Foka* returned to Murmansk on August 30th, and to Archangel'sk on September 5th. The first woman to visit Franz Josef Land was the medical sister Ermina Zdanko from the crew of the *St. Anna.*

After the war, the archipelago was visited by Russian ships and their researchers conducting hydrological and biological studies along certain sections in the Barents Sea. These visits took place in 1923 and 1924 by the *Persej*, in 1925 by the *Ėl'ding*, and in 1927 by the *Zarnica* (Belov 1969). On April 15th, 1926, the islands were proclaimed a territory of the USSR, as part of the Archangel'sk Oblast'. However, it was necessary to secure the area. After Umberto Nobile's flight, Italy pronounced its claims to the archipelago, since it had acquired the region of Triest from Austria, where Payer's expedition had previously been equipped and supported (Belov

Fig. 65. The Russian ice-braker Krasin in 1928. Photo: Rolf Tandberg/Norsk Polarinstitutt.

1969). Also Norway stipulated special interests in the archipelago. This caused the Soviet Government to speed up the actual development of the archipelago. On September 22nd, 1928, the ice-breaker *Krasin* led by R.L. Samojlovič after successful participation in the rescue of seven participants of Nobile's expedition, pulled into Cape Neal on George Land and hoisted the Soviet red flag, which was also made of iron. However, they did not

Fig. 66. The Russian ice-breaker Georgij Sedov in 1929. Photo: Gunnar Horn/Norsk Polarinstitutt.

succeed in building a hut due to a worsening of the ice situation. This was the latest recorded ship's visit to the archipelago with return the same season.

The Polar Commission of the Academy of Sciences (under the chair of A.E. Fersman) developed a project for a permanent polar station in Tichaja Buchta. In 1929, an expedition headed by Otto Ju. Šmidt, Samojlovič and Vize started out for Franz Josef Land. The captain of the ice-breaker *Georgij Sedov* was V.I. Voronin, a descendant of the manufacturer who had rescued Payer. On July 21st the ice-breaker left Archangel'sk; on July 29th it arrived at Cape Flora, where again the iron flag was hoisted. Šmidt was elected "the Soviet comissar of Franz Josef Land". On August 12th the expedition landed in Tichaja Buchta which was selected for the location of a polar weather station. While the team was settling on the shore, the ice-breaker reached Rudolf Island, where another location was selected for a permanent station, upon which the ice-breaker returned. On August 29th, Šmidt announced the official opening of the polar weather station, a radio station and, for the fourth time, hoisted the flag of his country. A team of seven men overwintered at the Tichaja Buchta station. Also in the 1929 season, a Norwegian schooner carrying construction materials for a permanent radio-meteorological station failed to push through the sea ice.

In 1930 the Norwegians were already demanding permission to enter

Fig. 67. The station at Tichaja Buchta in 1990. Photo: Susan Barr.

the territorial waters of the USSR. In this year too a change of crew at the Tichaja Buchta station took place. A new team of ten men and the first woman to winter, Nina Petrovna Rjabceva-Demme, took over. In September the research vessel *Nikolaj Knipovitč*, led by Nikolaj N. Zubov, made a hydrographic survey of the southern islands.

In 1931 the German expedition of the Graf Zeppelin airship, also carrying the Russian researchers: geologist Samojlovič, with the airologist P.A. Molčanov, as well as a telegraphist, E.T. Krenkel' landed at Tichaja Buchta. The Germans took aerial photographs of the western archipelago. A magnetic observatory was constructed at Tichaja Buchta this summer.

In 1932, during the Second International Polar Year, a weather station on Rudolf Island was opened (ice-breaker *Malygin*, expedition led by N.V. Pinegin) and the first wintering took place. Another ship, the *N.M. Knipovič*, captained by N.N. Zubov, sailed to Rudolf, Eva-Liv and Graham Bell Islands and thereby made what is called the first circumnavigation of the archipelago. It, incidentally, also made the first Russian visit to Victoria Island (between Franz Josef Land and Svalbard), where the Soviet flag was raised. The 1932–33 wintering at Tichaja Buchta was led by Papanin.

In 1933, the expedition of the Arctic Institute (AUAI, later the Arctic and Antarctic Scientific Research Institute AANII), led by N.N. Zagrubskij, compiled a topographic map on the scale of 1:200,000 (Belov 1969). In 1934 a geological expedition, also including glaciology, was working in the

Fig. 68. The station at Teplitz Buchta, 1990. Photo: Heinz Slupetzky.

archipelago. N.P. Lupanova, T.N. Spižarskij, M.N. Ivanyčuk formed part of its team. In the winter of 1934–35, V.D. Volosjuk flew 100 hours over the archipelago in one-man amphibious airplanes based at Hooker Island, to carry out cartographic corrections. On August 28th, 1935, an expedition with the ice-breaker *Sadko*, captained by G.A. Ušakov and N.N. Zubov, arrived at Graham Bell Island from the east, but was unable to land. The biologist V.G. Bocharov, the geologist M.M. Ermolaev and others participated in the expedition. The same year, the ice-breaker *Tajmyr* called at the archipelago.

In the years 1934–36 sixty people wintered at Tichaja Buchta, led by I.F. Bitrič, and the first three babies were born there.

In 1936, N.N. Vodopyanov and V.M. Makhotin, both involved in preparing an expedition to the Arctic by airplane, flew to Tichaja Buchta, then landed on Rudolf Island and considered its ice caps a convenient base. Alternative landing sites in case of fog or snowstorms were designated on the sea ice of the straits. The ice-breakers *Rusanov* and *Hercen* brought

Fig. 69. The wreck of an airplane at Teplitz Buchta, 1990. Photo: Susan Barr.

equipment for a drift-ice research unit headed by I.D. Papanin to Rudolf Island, where twenty-four people wintered and constructed a large airstrip for heavy airplanes on the glacier at 250 m height. In 1937, the drift-ice research unit *North Pole* was organized and serviced from this base, with four heavy airplanes starting for the North Pole on April 18th. B.L. Dzerdzeevskij was in charge of the weather forecasts for the expedition, and simultaneously studied the circulation in the central Arctic. Along with the drifting ice station, the weather station on Rudolf Island secured flights of V.P. Čkalov and others, who were the first to reach the North-American continent by plane across the Arctic Ocean, and flights in light aircraft were also used between islands in the archipelago. The same year, due to late arrival, two ships which had brought supplies for the expedition to try to rescue the missing transpolar pilot S.A. Levanevskij were held up in the archipelago. The air search for Levanovskij started from Rudolf Island, but was in vain. The ships were held up in ice with 107 people onboard, and more than 300 persons wintered in the archipelago. Not until May 31st,

1938 was the ice-breaker *Ermak* able to set them free. In 1937, a large oceanographic expedition by AUAI carried out research in the straits of Franz Josef Land.

In 1938 Boris A. Kremer led the wintering in Tichaja Buchta, organising several sledge trips for geological research in neighbouring islands.

As a result of the start of the Second World War, the research activities in the archipelago were reduced. In 1941, the weather station on Rudolf

Fig. 70. Krenkel station on Hayes Island, 1991. Photo: Heinz Slupetzky.

Island was temporarily closed down. Only one group of winterers was left at Tichaja Buchta, unsupplied from the mainland throughout the war. They had no idea that close to them, on Alexandra Land, the Germans had established a weather station under the code name *Schatzgräber*, operating from September 1943 to July 1944. They no doubt noticed, however, that their station was photographed by a German airplane on September 23rd 1943. In 1945 the navy ice-breaker *J. Stalin* arrived for three days and took six of the winterers back to the mainland, leaving the remainder for a sixth year.

In the years to follow, the "cold war" gave a new impulse to the research in Franz Josef Land. From 1947–1956, Franz Josef Land was considered "the unsinkable aircraft carrier". On Alexandra Land, at the same location where previously the Germans had been based, an aerodrome and a meteorological station were constructed in 1952. This base was named Nagurskoe after the first arctic pilot in the Russian navy, the Pole Jan Nagórski, who in 1914 had flown in search of Sedov's expedition and had found the message at Cape Pankrat'ev on Novaja Zemlja describing Sedov's start to Franz Josef Land. From 1949–1952, an expedition to Hooker Island was organized by the Arctic Institute, one of its aims being to assess the possibilities of constructing military airfields on and inside the ice caps. The first wintering took place under the direction of professor P.A. Šumskij, who studied the glaciology of the island and, on the basis of the data obtained, developed the theory of ice formation (Sumskij 1955, chapter *Glaciers*). Later V.B. Ivanov contributed substantially to the research on snow cover. In 1955, an expedition by airplane, aimed at the study of the snow cover, was organized with landings on many ice caps on different islands, where snow accumulation and glaciation zones were defined. Leading glaciologists of the USSR, Šumskij and G.A. Avsjuk, participated in the expedition. In 1955, E.N. Cykin wintered on Hoffmann Island on a low and gentle ice cap and measured ice temperatures of the glacier. In 1956, the military concept of the USSR changed. Intercontinental missiles were to replace aircraft. The expedition to Hoffmann Island was stopped before the end of the wintering. Classified scientific materials of the AUAI 1949–52 expedition were released for scientific circulation and publication by the members of the following expedition of the Institute of Geography during the International Geographical Year and the International Geophysical Years in 1957–59 (Groswal'd et al. 1973).

In 1955, the USSR joined the programme of the International Geophysical Years 1957–58 and 1958–59, which introduced a new stage in the research of the Arctic, a stage determined by the policy of the "thaw". According to this programme, the geophysical observatory *Družnyj* was established on Hayes Island in 1957, after an airstrip had been organised there the previous year, for the permanent use of locally-based AN-2

planes. Extensive research was carried out including investigations of the atmosphere by means of high-altitude weather rockets. Its programme was coordinated with the geophysical research conducted in the Antarctic as well as the French research on the Kerguelen Islands. This observatory is still being maintained as part of the global network of geophysical reference stations. Unfortunately, after 1958, the meteorological station on Hooker Island was closed and moved to the new station on Hayes Island. At the same time, the activities at the pioneer polar station *Buchta Tichaja* were reduced, and finally the station was closed down in 1959. In the same year, an expedition by the Arctic Geology Research Institute (NIIGA) led by V.D. Dibner compiled an integral description of the archipelago's geology.

In 1957–1959, under the initiative of G.A Avsjuk, the Institute of Geography of the Academy of Sciences of the USSR organized winter camps on the Čiurlionis ice cap on Hooker Island, restoring the AANII expedition base. Since the over-snow vehicle was out of order, the entire equipment for the camp had to be carried to the ice cap by the crew on foot or by dog team. Only in the second year was the vehicle replaced and a new house could be built, in addition to the hut which had been left by the AANII expedition, now buried in the ice. At a depth of 15 m inside the glacier, a laboratory was installed. Here, with a constant temperature around -10°C, glacier core samples taken from the boreholes were studied (Markin & Suchodrovskij 1963; Krenke 1961). A similar expedition worked on a glacier on Novaja Zemlja using the field station for direct observations, while the main base remained on the coast. The expedition to Franz Josef Land by the Institute of Geography was directed by V.L. Suchodrovskij. M.G. Grosval'd was responsible for the geological-geomorphological part of the investigations. A.N. Krenke was responsible for the study of climatological and glacial cycles of the arctic environment. Further interesting results were obtained by: O.N. Vinogradov, who measured, for the first time, the ice movement on the caps; N.G. Razumejko, who studied the glacier temperature; V.A. Markin who studied the heat balance of the glaciers; and L.V. Bazanov, who organized deep drilling and ice core sampling in those years.

The expedition worked mainly on Hooker Island, although a few studies were conducted on Hayes Island. The entire archipelago was under constant monitoring from the air. Thus, detailed research (based on the polygon model), together with the analysis of aerial photographs and the observations of other expeditions, resulted in fairly complete and representative conclusions regarding the whole area. The results of the expedition were supplemented by the expedition of Suchodrovskij and Markin to Alexandra Land and Graham Bell Island in 1961, as well as by an expedition carried out from the air by AANII in 1960, during which new ice-core samples from the tops of some ice caps were taken. This important

Fig. 71. Krenkel station, built around a freshwater lake, in –26°C in March 1992. Photo: H.W. Zwettler.

additional material concerning the refreezing of melt water on the fairly cold glacier surface facilitated the assessment of the distribution of ice-accumulation zones on glaciers and the main patterns of ice accumulation within the entire archipelago.

Between the International Geophysical Year and the period of *glasnost'* in the Soviet Union, most activity in Franz Josef Land was considered to have military implications and was therefore secret. Not only Western, but also Soviet scientists know little about activities there, and it is only now that information is becoming available. However, French geophysicists apparently took part in ionospheric research at Hayes Island in 1967. In 1970 the Zoological Institute at St. Petersburg carried out hydrobiological investigations by diving. In 1972 the crew of the ice-breaker *Ob* erected a memorial pillar to Sedov on Rudolf Island. In 1979 botanists from St. Petersburg were at work, and in the same year the Russian women's skiing group *Mietiel* carried out a ski trip from Rudolf Island as a memorial gesture to Sedov.

In 1980 AANII (AARI in the English translation) organized a few short-term visits to Franz Josef Land glaciers, and an airborne survey of

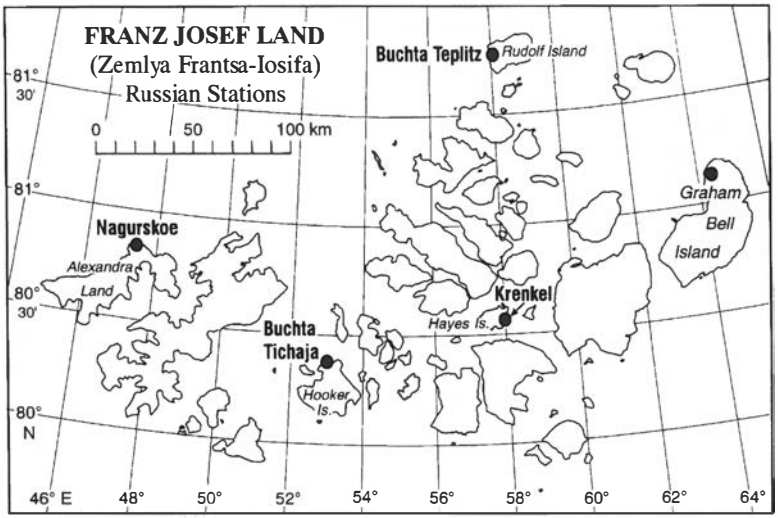

Fig. 72. Map of the Russian stations in Franz Josef Land. Compiled by Norsk Polarinstitutt.

seabird colonies was carried out by S.E. Belikov. Three biologists spent the winter 1980–81 at Hayes Island where they performed diving investigations. Ornithological studies were carried out in 1981 on Graham Bell Island (S.E. Belikov) and Hooker Island (P.S. Tomkovitč, T.E. Randla).

In 1990 the Marine Biological Institute in Murmansk conducted a number of biological expeditions in Franz Josef Land, and organised a biological station in Tichaja Buchta, in cooperation with Norsk Polarinstitutt, Norway and the Institute of Oceanography, Polish Academy of Science. In the same period expeditions devoted to the history of the exploration of Franz Josef Land occurred, such as the Soviet-Norwegian historical expedition and an expedition by the Institute of Culture, Moscow (see earlier chapter).

Also in 1990, the Institute of Geography of the Academy of Sciences resumed glaciological research in Franz Josef Land during the polar summer, with a main emphasis on Alexandra Land (on the Lunnyj Ice Cap). New techniques of satellite navigation and survey methods (global positioning systems, GPS) were successfully used together with remote sensing and aerial photography to map the actual state of glaciation in the archipelago as a base for future comparative surveys. The necessary ground control was carried out and methods were developed for the correct interpretation of the different surface layers on the glaciers due to the accumulation and ablation processes, the ice temperature and the ice thickness. In co-

operation with the University of Stockholm new data on the glacio-isostatic rise of the archipelago were obtained. (Uplift on Alexandra Land in post-glacial time was up to 23 m due to the decreasing weight of the melting ice cap).

In 1992 the Moscow State University, together with the Marine Biological Institute, Murmansk and American scientists, studied the Quaternary history of the archipelago. The geological organization *Sevmorgeologija* began geophysical and geological studies of the area. In May 1994 the Institute of Geography of the Russian Academy of Sciences, the Scott Polar Research Institute at Cambridge, and Ohio State University successfully carried out an airborne radio-echo sounding of the Franz Josef Land glaciers (ca. 3000 km of profiles) and shallow drilling of ice caps on Graham Bell, Hall, Hayes and Alexandra Land Islands.

Russian research has considerably contributed to the scientific investigations of Franz Josef Land and to our knowledge of the arctic environment. Due to recent constraints it has become difficult to maintain the Russian research stations and other scientific activities in Franz Josef Land and to continue the research.

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HUMAN IMPACT AND ENVIRONMENTAL MANAGEMENT

RASMUS HANSSON and STEFAN NORRIS

Nature qualities: status and historical trends

Except for a few recent biological surveys, no detailed investigations have been carried out to evaluate the overall environmental situation in Franz Josef Land. No updated figures are available of the distribution and abundance of the species that occur in the area, the level of contaminants in the ecosystem, physical encroachments in the landscape, etc. Still, based on reports from visitors to the archipelago during recent years, the general impression is that most of Franz Josef Land and its ecosystems are relatively undisturbed by man.

Franz Josef Land is relatively close to, and not far north of, the neighbouring archipelago of Svalbard. However, geophysical, ecological and historical differences between the two areas have resulted in differences in the current environmental situation. The Svalbard environment is partly subarctic, influenced by warm Atlantic ocean currents, with relatively large biological productivity due to rich upwelling of nutrients from the shallow surrounding continental shelf. Franz Josef Land is a typically high arctic environment, dominated by cold, arctic water in deep straits (250–300 m)

Fig. 73. Examples of littering, here at the Krenkel station, Hayes Island. Photo: Heinz Slupetzky. ▶

between the islands. There is less upwelling of nutrients, more sea ice, and lower marine biological productivity. The land areas are more heavily glaciated than Svalbard, with extremely limited vegetation cover and almost no terrestrial fauna.

As Franz Josef Land was discovered much later than Svalbard and has been less accessible and less attractive for human activities, the archipelago has been less influenced by such activity. The heavy whaling and walrus hunting era in the 17th and 18th centuries that followed the discovery of Svalbard, did not affect Franz Josef Land. Later, only a small number of hunting expeditions have visited the islands.

As a result, there are more or less undisturbed populations of marine mammals and sea birds in the area. In fact the walrus population provided the basis for the recent re-colonisation of Svalbard's historical walrus areas. In addition, a small remnant population of bowhead whales has survived in the archipelago. This species was hunted to extinction in the rest of the north Atlantic and Barents Sea and is today among the rarest mammals in the world.

Recent human activity

The only substantial human activity in the area has been the Soviet military bases and scientific (mainly geophysical) stations that were established from the 1930s and on when the archipelago, as the northwestern corner of

Fig. 74

the Soviet empire, marked the northern limit of the iron curtain between the "capitalist" and communist spheres. Contrary to what might be expected from Soviet military activity in an area of high military tension, this situation appears to have contributed to the preservation of Franz Josef Land's environment for future generations.

No detailed information has been published on the construction, manning, equipment or activities of the stations. It is not known what kinds and amounts of weapons, aviation fuels, oil and other potential environmental pollutants that have been stored, or how these were used or disposed of in the area. Most reports from the Franz Josef Land stations that have been visited during the last few years describe heavily disturbed local environments at the station sites. The level of physical destruction of soil and vegetation is high, there is a large degree of littering, relatively large amounts of oil and other chemical products appear to have leaked out or been disposed of on site, and there seems to be no treatment of sewage water or other emissions. Apart from the visible effects, no data are available on possible indirect effects of these impacts on local and surrounding ecosystems.

Likewise, there is little information available about the extent and types of activities that have been carried out outside the stations. However, according to Russian sources, the station crews have as a rule had little access to the areas outside the immediate station surroundings. This is partly due to military restrictions, partly to lack of suitable vehicles. The total number of residents in the archipelago has probably rarely exceeded some hundreds. With the exception of possible accidents and leakage or dumping of dangerous environmental contaminants, this limited "population" is not likely to have caused large-scale or long-term damage to the Franz Josef Land environment. Most of the local wildlife is reported to have been protected by Soviet law, although there has been some egg gathering and trapping and hunting, including of walrus and polar bears.

The existence of long series of sea-ice and biological surveys from Franz Josef Land confirms that there have been regular cruises and reconnaissance flights in the area for many years. In addition, there has been supply shipping as well as military activity. There are, however, no reports of operations and activities of significant size on land outside the stations. Neither Russian environmental authorities and scientific institutions, nor the various scientific crews and tourist groups that have travelled in the archipelago during recent years, have reported signs or remains of such activities. On the contrary, the first western scientist to visit the area in 1990 found that even important historical sites like the Nansen and Johansen wintering hut (see pp. 74–76) had hardly been visited by man since the two Norwegians left it a hundred years ago. On the other hand, large areas of Franz Josef Land still remain to be surveyed for environmental impacts.

Fig. 75. Modern Russian ice-breaker south of Franz Josef Land in August. Photo: Susan Barr.

Recent changes in activities

Due to the improved foreign relations between Russia and the West, as well as the current financial constraints of the Russian army and fleet, the permanent, mostly military activity in Franz Josef Land has recently been substantially reduced. This reduction is not well documented, but observations from recent visitors to the archipelago indicate that the presence of Russian personnel has declined markedly.

The base on Graham Bell Island is more or less evacuated by the military. Some ideas for other use, such as a scientific station or helicopter base for tourism have been presented. The Nagurskoe base on Alexandra Land is closed by the military, possibly except for a small military (border guard) post and a Moscow Institute of Geography summer station. The six-man Teplitz Bay geophysical observation station on Rudolf Island is possibly closed. The scientific crew on Krenkel station on Hayes Island is reduced from ca. 70 to 12–14. The station might be closed or used for international cooperation. The Tichaya Buchta geophysical station on Hooker Island was abandoned in 1959, but now has some summer activity through cooperation

between Murmansk Marine Biological Institute, the Norwegian Polar Institute and the Polish Academy of Science.

On the other hand the military have not given up the islands entirely to nature conservation and tourism, and there has recently been a tightening of military formalities and restrictions on access to the islands. These restrictions are also linked to the recent developments concerning nature conservation in and around Franz Josef Land.

Nature conservation

In April 1994 the Russian Prime Minister Viktor Černomyrdin signed a declaration establishing a 42,000 km^2 nature reserve which includes Franz Josef Land and the surrounding marine areas. The new reserve is now the largest marine protected area in the Arctic. The plan for the Franz Josef Land nature reserve was worked out by the All Russian Institute for Nature Protection and the Russian State Committee for Northern Affairs in co-operation with western nature conservation organisations.

The reserve is of the *zakaznik* category. Usually large federal reserves in Russia attain the *zapovednik* category of protection. This implies a very strict regime of protection, including a large staff of wardens and scientists. The *zakaznik* level of protection is much more flexible, and may be adjusted to a wide range of local management regimes. Franz Josef Land was placed in the *zakaznik* category due to its remoteness which implies staffing problems, and apparently because there are strong interests in developing the area for tourism.

The formal responsibility for the Franz Josef Land *zakaznik* lies with the Ministry of Environment Protection and Natural Resources of the Russian Federation. It will be managed by the Ministry through the Archangel'sk Regional Committee for Environmental Protection. There is however some conflict concerning the administrative responsibilities at the oblast' (county) level. Archangel'sk oblast' has the formal responsibility at this level, but both the Krasnojarsk oblast', as well as the cities of Murmansk and Moscow have stated an interest in handling the administrative functions of the new nature reserve. This is no doubt linked to the potential for substantial financial gains through handling tourist traffic and scientific activity in the area.

Visitors and tourists

This potential is already to a certain extent being realised. Though the introduction of 'entry fees' to the Russian Arctic has not formally been approved, there are already certain tour operators who charge such fees.

The tourist operations attracting the greatest attention are currently tours to the North Pole with large Russian nuclear-powered ice-breakers, as well as tours through the Northeast Passage, both of which call in on Franz

Fig. 76. An ice-going cruise ship visits the archipelago. Photo: Heinz Slupetzky.

Josef Land. There has also been an increased traffic of tours specifically to Franz Josef Land on regular ships. The impacts of the ship traffic itself are probably limited. On the other hand, the potential for accidents is increasing with increasing ship activity. Major oil spills, not to speak of accidents with nuclear-powered ships, may have serious and wide-ranging consequences.

The most-visited sites are easily accessible areas with vegetation, bird cliffs and walrus haul-out areas like Cape Flora and Tichaya Buchta/Cape Rubini, historical remains such as the Nansen and Johansen wintering hut on Jackson Island, Russian scientific stations and recent installations like the Austrian-built 1993 full-size model of Payer's and Weyprecht's ship *Tegetthoff* from 1872. The number of accessible and, from a human perspective, attractive areas in this archipelago of glaciers and rocks, is indeed limited. Most of the tourist traffic will thus tend to be concentrated to this very small number of sites, which are obviously the same sites that the first people entering Franz Josef Land also found most attractive.

Fig. 77. Large Russian helicopters, often operated from ships, can bring tourists into the most inaccessible areas. Photo: Heinz Slupetzky.

The impacts from tourists on the fragile vegetation, wildlife and historical remains at these sites may thus be disproportionately heavy although the total number of visitors to Franz Josef land may not be particularly high for such a large area. Historical artefacts and natural features removed or damaged by the increased tourist traffic are not well documented. Much of such remains of human activity are still to be found on the islands. A number of artefacts have been removed in recent years by Russian archaeological expeditions. This has in part been done to secure 'conservation' of the artefacts, but much of this collection has not been properly documented. The fact that a large number of the historical sites and artefacts are the result of earlier western activities (see under The history of western activity, pp 54–106), means that their fate is of the greatest concern internationally.

Future trends

The future of the Franz Josef Land *zakaznik* now depends on the ability of Russian authorities to regulate and monitor properly the activities in this very remote archipelago. A limited degree of tourism and scientific activities will not disturb the area, provided the necessary precautions are

Fig. 78. The Monarch Portable Cooking Range stood outside the remains of Jackson's Elmwood at Cape Flora in 1990. Perhaps the kettle had brewed tea for Nansen? Anyway, it has all gone now. Photo: Susan Barr.

taken. If wisely handled, such activities might be beneficial both to the Russian economy and to the international understanding of the need for protection of the arctic wilderness.

Currently, other economical activity does not seem likely to affect Franz Josef Land. The present Russian oil and gas exploration in the Barents Sea takes place relatively far south of the archipelago. However, a large-scale increase in oil production and transport from the Russian Arctic further east, will increase the potential for oil spills and other accidents in the entire area. Not even the very remote Franz Josef Land is safeguarded against possible effects of such impacts.

By designating the Franz Josef Land reserve (in addition to other established and planned arctic reserves) Russia now leads the way in nature conservation in the Eurasian Arctic. Though the *zakaznik* allows a limited human activity in the area, the Franz Josef Land reserve declaration was the first to acknowledge the necessity of preserving both land and marine resources in large, interconnected systems. This allows the preservation of processes which take place in an interaction between such large systems as

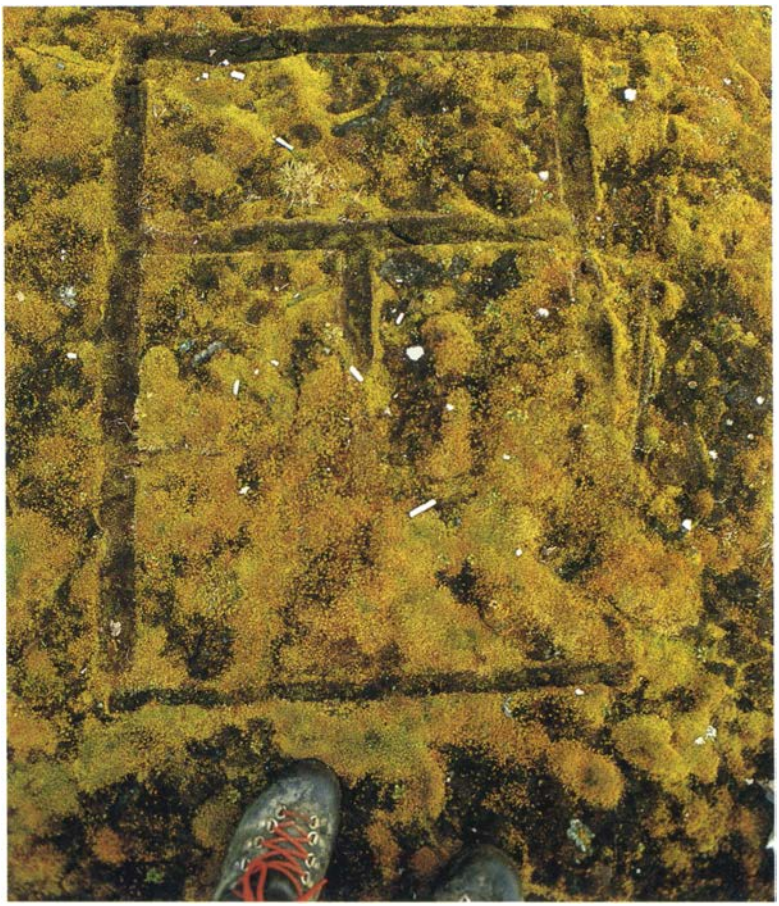


Fig. 79. Traces of historical remains may still be visible at sites on the islands. They give us indications of some past human activities. But if the remains themselves are not allowed to lie in peace, we can only guess at what might have been. Photo: Heinz Slupetzky.

arctic ice flows, ocean currents, marine and terrestrial primary production and the movements of birds and marine mammals. The designation points to the need for increased international cooperation in conserving arctic marine habitats and ecosystems, particularly in unique areas of high biological productivity, nearly-undisturbed ecosystems and shared populations of mammals and birds such as the northern Barents Sea.

Sammendrag

Den russiske øygruppen Frans Josef Land ligger 900 km fra Nordpolen, øst for Svalbard og nordvest for Novaja Zemlja. Øygruppen består av 91 øyer som dekker et område på 16 135 km² i en utstrekning av 375 km fra vest til øst og 234 km fra syd til nord. Øyene omfatter imidlertid bare 20% av området. De største øyene er George Land, 2741 km², og Wilczek Land, 2054 km². Isbreer dominerer og dekker ca 85% av den totale landmasse. Geologisk sett er øygruppen en slak, tektonisk betinget høyde eller et platå. De oppstikkende øvre delene består av forholdsvis unge bergarter; i nord, vest og sør dekker mesozoisk basaltlava store områder. Det er også tallrike dolerittganger og i øst, hvor basalten for det meste er erodert, ser man at gangene har skåret seg gjennom de løse avsetningsbergartene som ligger under. Bevegelser i jordskorpen har brutt det opprinnelige platået opp i mange deler og 'British Channel' og 'Austrian Strait' deler nå området i tre grupper av øyer. Det høyeste punktet, på Wilczek Land, ligger 670 m o. h.

Frans Josef Lands arktiske klima er sterkt påvirket av det omfattende isbredekket, samt av havisen. Den årlige middeltemperaturen, ca –10°C, må ansees for relativt høy på denne breddegraden, selv om middeltemperaturen for varmeste måned – som enten er juli eller august – er lav: ca 1°C på land, ved havnivå. Den lave sommertemperaturen skyldes delvis det omfattende skydekket, mens påvirkningen fra lavtrykkspassasjer med mildere luft fra syd medvirker til at temperaturen om vinteren ikke blir så lav som man normalt skulle vente. Nedbøren varierer over arkipelet, men den gjennomsnittlige årlige nedbør er blitt målt til fra 100 til 150 mm ved kyststasjoner. Polarnatten varer ca 128 dager, fra midt i oktober til sent i februar, mens perioden med midnattsol er fra midt i april til slutten av august.

Breene på Frans Josef Land produserer et stort antall isfjell, noen av dem tabulare og opp til 400 m lange. Havisdekket bidrar til øygruppens arktiske preg og kan i stor grad holde seg uoppbrukket mellom øyene gjennom kalde somre.

Ferskvannet på øygruppen stammer hovedsakelig fra smeltevann fra breer og snøflekker. Permafrosten hindrer for det meste dannelse av store, dypt skjærende elver, og i stedet sprer de små elvene og bekkene seg ut i et treformet dreneringsmønster. Det finnes imidlertid noen store elver, opp til 19 km lange på George Land og over 1 m dype på Wilczek Land. Det er ca 1000 innsjøer på øygruppen, flest på Alexandra og George Land, og de finnes normalt i fordypninger dannet av breene. De er isfrie bare en eller to måneder om sommeren.

Der forholdene ligger til rette for vegetasjon, dekker den allikevel ikke mer enn 5–10%, selv om den, ved gunstige forhold slik som under fuglefjell, kan dekke 100%. Ingen trær, busker eller høyere vekster kan leve i det harde klimaet. Lav og mose danner vegetasjonsgrunnlaget, med ca 100 ar-

ter hver. Det finnes også ca 50 arter av levermose. Denne vegetasjonen kan være meget fargerik, og i fuktige områder kan de fargesterke mosetuene være dype og frodige. Av de mer enn 1000 karplanteartene kjent fra den arktiske tunda er bare 57 funnet på Frans Josef Land. Noen av disse er i tillegg funnet sjelden og i lite antall. 16 arter gress og ca 100 arter av landalger fullstendiggjør vegetasjonsbildet.

Det finnes ikke store mengder fisk i havet rundt Frans Josef Land og ingen kommersielt utnyttbare arter. Polartorsk er biologisk den viktigste fiskesorten. Bare ca 40 fugleslag finnes på øygruppen og kun 14 arter hekker der. Sjøfugler er så å si enerådende. Deres tilpasning til marine omgivelser gjør dem lettere istand til å klare seg i det strenge klimaet. Tre selarter er vanlige: grønlandssel, ringsel (snadd) og storkobbe. Hvalross er vanlig over hele øygruppen; Svalbard har faktisk nylig igjen fått en egen, naturlig hvalrossbestand, «utvandret» fra Frans Josef Land. Vågehval, hvithval (kvitfisk), narhval og spekkhogger, og til og med mindre bestander av den sjeldne grønlandshvalen finnes i området.

Isbjørnstammen ved Frans Josef Land hører til en fellesbestand for området fra øst-Grønland til Severnaja Zemlja, og er anslått til omkring 5000 individer. Polarrev forekommer i et mindre antall, fortrinnsvis på øyer med store fuglekolonier. Reven er det eneste virkelige landpattedyret på øygruppen, og områdets økosystem er i overveldende grad avhengig av ressurser tilknyttet havet.

De opprinnelige navnene på øyene, stredene, breene og kappene er fremdeles i bruk og de gjenspeiler historien om oppdagelsen og utforskningen av øygruppen. Antagelig ble Frans Josef Land først sett av den norske selfangstskuta *Spidsbergen,* ført av Nils Fredrik Rønnbeck, i 1865. Det var imidlertid den østerriksk/ungarske *Tegetthoff*-ekspedisjonen (1872–74), ledet av Julius Payer og Carl Weyprecht, som presenterte øygruppen for utenverdenen, og ga den dens navn. Frem til begynnelsen av 1930-årene var Frans Josef Land åstedet for diverse fangstekspedisjoner sommerstid, de fleste av dem norske. I tillegg ble et antall betydelige vinterekspedisjoner av inntil tre års varighet gjennomført med vitenskapelig utforskning og kartlegging av den lite kjente øygruppen som mål, og/eller mer eller mindre seriøse forsøk på å nå Nordpolen over havisen fra Frans Josef Land.

Den første russiske ekspedisjonen til øygruppen fant sted i 1901. Frem til 1912 kom alle de overvintrende ekspedisjonene fra Vesten: Østerrike/Ungarn, England, Italia, Norge og USA, mens den første russiske overvintring fant sted i 1912–14. Inntil 1926 ble Frans Josef Land betraktet som terra nullius – Ingenmannsland. Den 15. april 1926 erklærte Sovjetunionen at alt land mellom det sovjetiske fastland og Nordpolen skulle være sovjetisk territorium. Norge protesterte til ingen nytte, og øygruppen ble lukket for andre nasjoner fra begynnelsen av 1930-årene.

Det ble drevet regelmessige sovjetiske vitenskapelige aktiviteter, spe-

sielt geofysiske, på stasjoner etablert på øygruppen, helt opp til våre dager, da mangel på økonomisk støtte har ført til stengning eller drastisk reduksjon av store deler av aktivitetene. Til og med under 2. verdenskrig forble en stasjon bemannet uten unnsetning, mens en tysk meteorologisk stasjon ble drevet i en kortere periode på Alexandra Land. Fra siste halvdel av 1950-årene ble Frans Josef Land stadig mer en militær sone, en skanse mot Vesten under den kalde krigen. Følgelig ble adgangen begrenset også for sovjetiske vitenskapsmenn. Denne situasjonen har forandret seg damatisk i 1990-årene, med militær tilstedeværelse redusert til et minimum.

De klimatiske og militære forholdene har faktisk bidratt til å bevare miljøet og kulturminnene på Frans Josef Land, ved å begrense adgangen til øygruppen. Miljøforstyrrelser er store i den umiddelbare nærhet av de forskjellige russiske stasjonene, mens den ser ut til å være minimal i andre områder. Den nåværende økning i menneskelig aktivitet over store deler av øygruppen, i form av turisme og internasjonal vitenskapelig aktivitet, gir grunn til bekymring med tanke på bevaring av naturen og kulturminnene. Russland har imidlertid vist vei ved i april 1994 å opprette et 42 000 km^2 stort naturreservat i et område som omfatter Frans Josef Land og de omliggende havområdene. Forhåpentlig vil turoperatører og fremtidige besøkende på øygruppen respektere behovet for å bevare miljøet og kulturminnene på Frans Josef Land.

Zusammenfassung

Der russische Archipel Franz Josef Land ist 900 km vom Nordpol entfernt und liegt östlich von Svalbard und nordwestlich von Novaja Zemlja. Der Archipel besteht aus 191 Inseln mit einer Fläche von 16.135 km². Er erstreckt sich über 375 km von West nach Ost und über 234 km von Süd nach Nord, die Inseln selbst jedoch nehmen nur 20 % der Gesamtfläche des Archipels ein. Die größten Inseln sind George Land mit 2.741 km² und Wilczek Land mit 2054 km². Die Gletscher sind vorherrschend, sie bedekken etwa 85 % der gesamten Landmasse.

Der geologische Ursprung des Archipels geht auf eine sanfte, kuppenförmige tektonische Aufwölbung zurück, die mit jungenVulkaniten, die ausgedehnte Basaltplateaus in den nördlichen, westlichen und südlichen Randgebiete bilden, verknüpft ist. Innerhalb dieser Aufwölbung sind Dolerit-Schichten aufgeschlossen. Im Osten wurden das Basaltplateau und die Dolerit-Schichten erodiert. Die jetzige Oberfläche besteht aus brüchigem Sedimentgestein, durchsetzt von Basaltgängen oder -intrusionen. Durch tektonische Bewegungen der Erdkruste ist das ursprünglich geschlossene Plateau in viele Teile zerbrochen, so daß der Britannia Kanal und der Austria Sund den Archipel heute in drei Inselgruppen gliedern. Auf Wilczek Land liegt die höchste Erhebung mit etwa 670 m.

Das arktische Klima Franz Josef Lands wird sehr stark von der ausgedehnten Vergletscherung und vom Meereis beeinflußt. Die jährliche Durchschnittstemperatur um -10°C ist für die hohe geographische Breite als relativ hoch zu bezeichnen, jedoch ist die Durchschnittstemperatur für den wärmsten Monat – es kann dies im Juli oder August vorkommen – mit etwa 1°C (gemessen am Land etwa in Meereshöhe), eher niedrig. Die reichliche Bewölkung während des Sommers ist teilweise für die niedrigen Sommertemperaturen verantwortlich zu machen, während der Einfluß von vorbeiziehenden Tiefdruckgebieten, die mildere südliche Luftströmungen auslösen, zu den eher nicht sehr tiefen Wintertemperaturen beiträgt. Der Niederschlag ist auf der Inselgruppe unterschiedlich, der mittlere Jahresniederschlag an Küstenstationen reicht von 100 bis 150 mm. Die Polarnacht dauert ungefähr 128 Tage, von Mitte Oktober bis Ende Februar, während die Mitternachtssonne von Mitte April bis Ende August dauert.

Von den Gletschern in Franz Josef Land lösen sich zahlreiche Eisberge, von denen manche tafelförmig und bis zu 400 m lang sind. Die Meereisbedeckung trägt zum arktischen Charakter des Archipels bei; in kalten Sommern kann zwischen den einzelnen Inseln eine weitgehend geschlossene Eisdecke verbleiben.

Die Seen und fließenden Gewässer des Archipels stehen in Zusammenhang mit den Schmelzwasserabflüssen von den Eiskappen und Schneefeldern. Aufgrund des vorherrschenden Permafrostes wird die Bildung von

größeren und stärker eingetieften Flußläufen überwiegend verhindert und bewirkt stattdessen ein verzweigtes dendritisches Entwässerungsnetz der Bäche und Flüsse. Trotzdem gibt es auch einige größere Flußläufe, z.B. mit einer Länge von bis zu 19 km auf George Land, und auf Wilczek Land mit einer Eintiefung von über einem Meter. Es gibt auf dem Archipel ungefähr 1000 Seen, vor allem auf Alexandra und auf George Land; sie liegen zumeist in glazial geformten Senken. Sie sind im Sommer nur ein bis zwei Monate eisfrei.

Dort, wo Vegetation überhaupt möglich ist, nimmt diese meist nur 5–10 % der Fläche ein, wobei jedoch unter günstigen Bedingungen, wie unterhalb von Vogelkolonien, eine 100 %-ige Deckung vorkommen kann. Bäume, Büsche oder höherwüchsige Pflanzen können in diesem rauhen Klima nicht existieren. Flechten und Moose – mit jeweils etwa hundert verschiedenen Arten – bilden die Grundlage der Vegetation. Es gibt auch ca. 50 verschiedene Arten von Lebermoosen. Insgesamt kann die Vegetation ungemein farbenprächtig sein, in nassen Gebieten können die bunten Moospolster tief und üppig sein. Von den über tausend verschiedenen Gefäßpflanzen, die man in der arktischen Tundra kennt, findet man in Franz Josef Land nur 57 Arten. Von diesen wiederum sind manche eher selten und kommen nur in geringer Zahl vor. Das Vegetationsbild wird durch 16 verschiedene Grasarten und etwa 100 verschiedene terrestrische Algen ergänzt.

Das Meer um Franz Josef Land ist nicht gerade fischreich, es gibt dort auch keine Arten, die kommerziell gefischt werden. Der Polardorsch (Kabeljau) ist, biologisch betrachtet, die wichtigste Fischart. Nur etwa 40 Vogelarten sind im Archipel heimisch, und nur 14 haben hier ihre Brutstätten. Es kommen fast nur Seevögel vor, die durch die Bindung an die marine Umwelt leichter imstande sind, sich an das strenge Klima anzupassen. Drei Robbenarten kommen häufig vor: die Sattelrobbe, die Eismeer-Ringelrobbe, und die Bartrobbe. Walrosse sind im ganzen Archipel verbreitet, Spitzbergen ist in jüngster Zeit sogar von Franz Josef Land aus auf natürlichem Weg wieder besiedelt worden. Zwergwale und Weißwale, Narwale und Schwertwale, und sogar eine kleine Population des seltenen Grönlandwales kommen in diesem Gebiet vor.

Die Eisbären auf Franz Josef Land gehören zur einer Population, die im Gebiet von Ostgrönland bis Severnaja Zemlja allgemein verbreitet ist, und die auf ungefähr 5000 Tiere geschätzt wird. Der Polarfuchs kommt nur in geringer Zahl vor, meist auf Inseln mit großen Seevögel-Kolonien. Der Fuchs ist das einzige wirkliche Landsäugetier auf dem Archipel. Das Ökosystem der Region ist zum weitaus überwiegenden Teil an die Ressourcen des marinen Lebensraumes angewiesen.

Die Originalnamen der Inseln, Meeresstraßen, Gletscher und Kaps sind immer noch gebräuchlich und spiegeln die Geschichte der Entdeckung und

Erforschung der Inselgruppe wider. Franz Josef Land wurde sehr wahrscheinlich zum ersten mal von Norwegen im Jahre 1865 während des Robbenfangs mit dem Schiff *Spidsbergen,* unter der Führung von Kapitän Fredrik Rønnbeck gesichtet. Jedoch war es die österreichisch-ungarische *Tegetthoff* Expedition in den Jahren 1872–74, angeführt von Julius Payer und Carl Weyprecht, die den Archipel für die damalige Welt bekannt machte und diesem den Namen gab. Bis anfangs der 1930iger Jahre war Franz Josef Land der Schauplatz zahlreicher Jagdexpeditionen, vor allem überwiegend von Norwegern. Außerdem wurden eine ganze Reihe von bedeutenden Expeditionen mit Überwinterungen und bis zu drei Jahren Dauer mit dem Ziel einer wissenschaftlichen Erkundung und Kartierung dieses wenig bekannten Archipels durchgeführt und/oder mehr oder minder ernsthafte Versuche, den Nordpol von Franz Josef Land aus über das Meereis zu erreichen unternommen.

Die erste russische Expedition zum Archipel fand im Jahre 1901 statt. Bis 1912 gingen alle Überwinterungsexpeditionen von westlichen Ländern aus: von Österreich-Ungarn, England, Italien, Norwegen und den USA, wogegen die erste russische Überwinterung während der Jahre 1912 bis 1914 geschah. Bis zum Jahre 1926 wurde Franz Josef Land als 'Terra Nullius', also als Niemandsland, betrachtet. Am 15. April 1926 erklärte die (damalige) Sowjetunion das ganze Territorium zwischen dem sowjetischen Festland und dem Nordpol als sowjetisches Hoheitsgebiet. Sämtliche Proteste von Norwegen blieben erfolglos, und der Archipel wurde für andere Nationen Anfang der 1930iger Jahre völlig abgeriegelt.

Bis vor kurzem wurden die sowjetischen wissenschaftlichen, insbesonders geophysikalischen Aktivitäten auf den Polarstationen, die im Archipel errichtet worden waren, auf geregelte Art betrieben, als der Mangel an finanziellen Mitteln zur Beendigung oder drastischen Einschränkung vieler dieser Aktivitäten führte. Selbst während des 2. Weltkriegs blieb eine Station bemannt, ohne abgelöst und ohne versorgt zu werden, während für kurze Zeit auch eine deutsche meteorologische Station auf Alexandra Land betrieben wurde. Von der zweiten Hälfte der 1950iger Jahre an wurde Franz Josef Land mehr und mehr zu einer militärischen Zone und zu einem vorgerückten Bollwerk gegen den Westen während der Jahre des 'Kalten Krieges'. Dementsprechend wurde der Zugang zu diesem Gebiet auch für sowjetische Wissenschaftler stark eingeschränkt. Dieser Zustand hat sich in den 1990iger Jahren mit der Verringerung der militärischen Präsenz auf ein Minimum drastisch reduziert.

Die klimatischen Bedingungen und militärischen Gegebenheiten haben jedoch effektiv dazu beigetragen, die Umwelt und die kulturhistorischen Überreste auf Franz Josef Land durch den eingeschränkten Zugang zur Inselgruppe zu bewahren. In unmittelbarer Nähe der verschiedenen russischen Stationen ist die Zerstörung der natürlichen Umwelt beträchtlich, je-

doch erscheint die Beeinträchtigung in allen anderen Gebieten eher gering zu sein. Die jüngst vor sich gehende Zunahme der Aktivitäten des Menschen in großen Teilen des Archipels in Form von Tourismus und internationaler wissenschaftlicher Tätigkeit gibt Anlaß zur Besorgnis hinsichtlich der Bewahrung der Natur und der historischen Stätten. Durch die Errichtung eines Naturreservates mit 42.000 km^2 im April 1994 in einer das Franz Josef Land und die umliegenden Meeresgebiete umfassenden Region hat Rußland jedoch einen Weg in die Zukunft aufgezeigt. Es ist zu hoffen, daß Reiseveranstalter und zukünftige Besucher des Archipels auf die Notwendigkeit, die Natur und die historischen Stätten auf Franz Josef Land zu beschützen und zu bewahren, entsprechend Rücksicht nehmen werden.

Streszczenie

Rosyjski archipelag Ziemi Franciszka Józefa leży 900 km od Bieguna Północnego, na wschód od Svalbardu i na Północ od Nowej Ziemi. Archipelag składa się ze 191 wysp o łącznej powierzchni 16.135 km^2, rozciągających się na 375 km ze wschodu na zachód i 234 km z północy na południe. Wyspy zajmują jednak tylko około 20% powierzchni archipelagu. Dominują na nich lodowce pokrywające około 85% powierzchni lądu. Największe wyspy to Ziemia Georga (2741 km^2) i Ziemia Wilczka (2054 km^2). Pod względem geologicznym archipelag powstał z łagodnego, kopulasto sklepionego grzbietu tektonicznego, z młodymi skałami formującymi rozległe bazaltowe plateau wzdłuż północnych, zachodnich i południowych granic. Wewnątrz tego łuku odsłonięte są pokłady dolorytów. Na wschodzie, bazaltowa pokrywa i pokłady dolorytów zostały zerodowane i warstwa powierzchniowa złożona jest z kruchych skał osadowych poprzecinanych dajkami lub intruzjami. Ruchy skorupy ziemskiej pocięły pierwotne plateau na wiele części. Kanał Brytyjski i Cieśnina Austriacka dzielą archipelag na trzy grupy wysp. Najwyższy szczyt archipelagu (670 m npm) znajduje się na wyspie Ziemi Wilczka.

Na arktyczny klimat archipelagu wyraźny wpływ wywiera rozległa pokrywa lodowców i lodu morskiego. Średnia roczna temperatura wynosi około -10^{o} C i może być uważana za względnie wysoką jak na tę szerokość geograficzną. Z drugiej strony średnia temperatura najcieplejszego miesiąca (lipca lub sierpnia) jest niska - wynosi około 1^{o}C na poziomie morza. Rozległa pokrywa chmur jest jedną z przyczyn niskich temperatur lata, a przejścia cyklonów z cieplejszym powietrzem z południa podwyższają temperaturę zimą. Opady są zróżnicowane w obrębie archipelagu, a ich średnia roczna waha się od 100 do 150 mm na wybrzeżu. Noc polarna trwa około 128 dni, od połowy października do lutego, dzień polarny zaczyna się w połowie kwietnia i trwa do końca sierpnia.

Lodowce Ziemi Franciszka Józefa produkują wielkie ilości gór lodowych, niektóre typu stołowego osiągające do 400 m długości. W czasie chłodnego lata lód morski może pozostawać niepołamany pomiędzy wyspami, co przyczynia się do wysokoarktycznego charakteru archipelagu.

Wody słodkie archipelagu związane są z odpływem wód wytopiskowych z lodowców i śniegu. Wieczna zmarzlina zapobiega powstawaniu dużych, głęboko wciętych rzek, zamiast tego odpływ odbywa się silnie rozgałęzionym systemem wielu płytkich strumyków. Mimo to na archipelagu można znaleźć kilka większych rzek dochodzących do długości 19 km na Ziemi Grahama i głębokości ponad 1m (Ziemia Wilczka). Na obszarze archipelagu znajduje się ponad 1000 jezior powstałych w polodowcowych zagłębieniach. Jeziora zlokalizowane głównie na Ziemi Aleksandry i Ziemi Georga są wolne od lodu tylko przez jeden lub dwa miesiące w roku.

Tam, gdzie może występować roślinność, pokrywa ona zwykle 5 do 10% powierzchni. Wyjątkiem są żyzne obszary pod ptasimi koloniami, gdzie pokrywa roślinna sięga 100%. W wysokoarktycznym klimacie Ziemi Franciszka Józefa nie występują krzewy i drzewa a większość gatunków roślin stanowią mchy i porosty, każde reprezentowane przez

około 100 gatunków. Występuje też około 50 gatunków wątrobowców. Pokrywa mchów i porostów może też być bardzo bogata i barwna, szczególnie w wilgotnych miejscach. Spośród ponad 1000 gatunków roślin naczyniowych znanych z tundry arktycznej tylko 57 znaleziono na Ziemi Franciszka Józefa, wiele z nich to formy występujące bardzo rzadko i nielicznie. Około 100 gatunków glonów lądowych dopełnia listę flory archipelagu.

W wodach archipelagu brak przemysłowo eksploatowanych ryb, a wśród niewielu gatunków najważniejszy jest dorszyk polarny. Tylko 14 gatunków ptaków gniazduje regularnie na wyspach, a łącznie zaobserwowano tu 41 gatunków. Dominują wśród nich ptaki morskie, którym ścisłe powiązania ze środowiskiem morskim pozwala na łatwiejsze znoszenie klimatu arktycznego. Pospolicie występują trzy gatunki fok: grenlandzka, brodata i obrączkowana. Morsy są częste i dość liczne na całym obszarze, i to właśnie populacja z Ziemi Franciszka Józefa dokonała rekolonizacji Svalbardu w ostatnich latach. Wieloryby karłowate (minkie), białuchy, narwale i orki jak również rzadkie wiekoryby grenlandzkie spotykane są w rejonie archipelagu.

Niedźwiedzie polarne występujące na archipelagu należą do wspólnej populacji ze Wschodnią Grenlandią, Svalbardem i Ziemią Północną, a jej liczebność szacowana jest na 5000 osobników. Lis polarny (piesiec) jest pospolity, lecz nieliczny i występuje przede wszystkim w pobliżu ptasich kolonii. Lis jest jedynym prawdziwie lądowym ssakiem archipelagu, którego ekosystem oparty jest niemal w całości o zasoby związane z morzem.

Pierwotne nazwy wysp, cieśnin, lodowców i przylądków są wciąż używane i odzwierciedlają historię zdobycia i poznania archipelagu. Najprawdopodobniej, pierwszy dostrzegł Ziemię Franciszka Józefa w 1865r kapitan Nils Fredrik Rønnbeck ze statku łowczego Spidsbergen. Jednak to austro-węgierska ekspedycja na statku Tegetthoff (1872-74) prowadzona przez Juliusa Payera i Karla Weyprechta pierwsza doniosła opinii publicznej o istnieniu archipelagu i nadała mu obecną nazwę. Aż do lat 1930-tych, archipelag był celem licznych, letnich wypraw myśliwskich, głównie norweskich. Oprócz tego przeprowadzono kilka znaczących wypraw naukowych (trwających do 3 lat), których celem było kartowanie archipelagu i badania naukowe. Odbyło się też kilka mniej lub bardziej poważnych prób zdobycia Bieguna Północnego.

Pierwsza rosyjska wyprawa do archipelagu odbyła się w 1901r. Aż do 1912 wyprawy zimujące organizowane były tylko przez kraje "zachodnie" (Austro-Węgry, Anglię, Włochy, Norwegię i USA), pierwsze rosyjskie zimowanie odbyło się w latach 1912-14. Do roku 1926 Ziemia Franciszka Józefa uznawana była za Terra Nullius, Ziemię Niczyją. 15 kwietnia 1926r Związek Sowiecki ogłosił swoim terytorium wszystkie ziemie leżące pomiędzy granicami ZSRR i Biegunem Północnym. Protesty Norwegii nie odniosły skutku i Ziemię Franciszka Józefa zamknięto dla obcych od początku lat 1930-tych.

Sowiecka działalność naukowa, głównie w zakresie geofizyki, prowadzona była regularnie z kilku stacji działających aż do ostatnich lat, kiedy to kryzys gospodarczy doprowadził do znaczącego ograniczenia aktywności. Stacje polarne prowadziły działalność nawet w latach II wojny światowej, kiedy to Niemcy założyli na krótko swoją stację meteorologiczną na Ziemi Aleksandry. Od połowy lat 50-tych Ziemia Franciszka Józefa stawała się

coraz bardziej zmilitaryzowana, będąc zewnętrznym przyczółkiem bloku wschodniego w okresie zimnej wojny. Militaryzacja ograniczyła też zakres działania naukowców sowieckich. Sytuacja zmieniła się radykalnie w 1990r wraz z ograniczeniem do minimum obecności wojskowej na archipelagu.

Surowy klimat i militaryzacja ograniczające dostęp do archipelagu pomogły zachowaniu nieskażonej przyrody i nietkniętych stanowisk archeologicznych. Zniszczenia środowiska są wprawdzie bardzo poważne w bezpośrednim sąsiedztwie stacji polarnych, lecz poza tymi obszarami można je uznać za znikome. W ostatnich latach rozwinęła się w obszarze archipelagu turystyka i międzynarodowa działalność naukowa, co daje powody do niepokoju o środowisko przyrodnicze i historyczne pamiątki. W kwietniu 1994r Rosja proklamowała rezerwat przyrody obejmujący 42000 km^2 archipelagu wraz z przyległymi obszarami morskimi. Można mieć nadzieję, że turyści i organizatorzy wyjazdów na Ziemię Franciszka Józefa wykażą należytą dbałość o zachowanie nieskażonej przyrody i obiektów historycznych archipelagu.

Резюме

Принадлежащий России архипелаг Земля Франца-Иосифа (ЗФИ) расположен в 900 км от Северного полюса, восточнее Свальбарда и к северо-западу от Новой Земли. Архипелаг состоит из 191 острова, покрывает 16135 км² и имеет протяженность 375 км с запада на восток и 234 км с юга на север. Острова же занимают только 20% площади архипелага. Самыми большими островами являются Земля Георга, 2741 км², и Земля Вильчека, 2054 км². Преобладают ледники, покрывающие около 85% общей площади суши. Геологически архипелаг происходит из пологого, куполообразного тектонического поднятия, с молодыми породами, образующими обширные базальтовые плато по северным, западным и южным перифериями. В пределах этой »дуги» на поверхность выходят щиты долеритов. На востоке базальтовый покров и щиты долеритов уничтожены эрозией, а поверхность состоит из рыхлых осадочных пород, пронизанных дайками или интрузиями. Подвижки земной коры разрезали первоначальное плато на многочисленные обломки, с Британским и Австрийским каналами, разделяющими архипелаг на три островные группы. Самая высокая точка, на Земле Вильчека, достогает приблизительно 670 м.

На арктический климат ЗФИ сильно влияет обширный ледяной покров и морские льды. Среднюю годовую температуру воздуха, около -10°C, можно считать относительно высокой для этой широты, хотя средняя температура самого тёплого месяца, приходящаяся на июль или август, низкая, около 1°C на суше вблизи от уровня моря. Обширный облачный покров в летнее время обусловливает низкую летнюю температуру, тогда как влияние проходящих циклонов, приносящих более мягкий, южный воздух, способствует менее низким зимним температурам, чем можно было бы ожидать. Осадки над архипелагом различны в различных его частях, но на прибрежных станциях средние годовые величины были измерены от 100 до 150 мм. Полярная ночь длится около 128 суток, с середины октября по последние дни февраля, в то время как период полуночного солнца длится с середины апрелы до конца августа.

Ледники ЗФИ производят большое количество айсбергов, некоторые из которых представляют собой столообразные айсберги длиной до 400 м. Морской ледяной покров способствует арктическому характеру архипелага и может не вскрываться между островами летом в холодные годы.

Пресноводные системы архипелага связаны с талой водой, стекающей с ледников, ледяных куполов и снежников. Как правило, вечная мерзлота препятствует образованию крупных, глубоко врезанных рек, а взамен распространяет мелкие речки и потоки по древовидному сточному узору. Однако встречаются отдельные крупные реки, длиной до 19 км на Земле Георга, и глубиной больше 1 метра на Земле Вильчека. На архипелаге имеется около тысячи озёр, главным образом на Землях Александры и Георга, обыкновенно расположенных в прорезанных ледником впадинах. Летом они свободны ото льда только один-два месяца.

Где возможна растительность, она покрывает обычно не более 5-10% ареала, хотя при благополучных условиях, как бывает под птичьими базарами, она может быть стопроцентной. Никакие деревья, кусты или высокие растения не могут существовать при таком суровом климате. Основу растительности составляют лишайники и мхи, каждые насчитывающие около ста видов. Имеется также около 50 видов печёночниц. Эта растительность может быть весьма красочной и на мокрых

участках яркие подушки мха могут быть глубокими и буйными. Изо всех 1000 с небольшим видов сосудистых растений, известных с арктических тундр, только 57 встречаются на ЗФИ. Кроме того, некоторые из них встречаются редко и малочисленны.16 видов злаковых и около 100 видов наземных водорослей дополняют картину растительности.

Воды вокруг ЗФИ не изобилуют рыбой и никакие местные виды коммерчески не используются. Биологически наиважнейшей рыбой является полярная тресочка или сайка. На архипелаге обитает около 41 вида птиц, из которых только 14 гнездится там. Почти исключительно преобладают морские птицы, связь которых с морем позволяют им гораздо легче приспосабляться к суровому климату. Обитают три вида тюленей: гренландский тюлень или лысун, кольчатая нерпа и морской заяц. Моржи обитают по всему архипелагу и, в частности, Свальбард был недавно заново заселён моржами, прибывшими с ЗФИ. В этом районе встречаются острорылые киты и белухи, нарвалы и косатки, и даже мелкая популяция редкого гренландского кита.

Белые медведи ЗФИ относятся к популяции, общей для региона, простирающегося с севера Гренландии до Северной Земли, и оцениваемой приблизительно в 500 особей. Песец, единственное действительно наземное млекопитающее архипелага, всречается в малом числе, главным образом на островах с большими базарами морских птиц. Экосистема архипелага в наивысшей степени зависит от ресурсов моря.

Первоначальные названия островов, проливов, ледников и мысов употребляются по-прежнему, отражая историю открытия и исследования архипелага. ЗФИ вероятно была впервые увидена экипажем норвежского зверобойного судна »Спидсберген», ведомого капитаном Н. Ф. Рэнбекком в 1865 г. Однако австро-венгерская экспедиция на судне »Тегеттгофф», руководимая Юлиусом Пайером и Карлом Вайпрехтом, ознакомила внешний мир с открытым ею архипелагом, дав ему имя. До начала 1930-х гг. ЗФИ была областью многочисленных охотнических летних экспедиций, главным образом норвежских. Кроме того, ряд значительных зимовочных экспедиций, длившихся до трёх лет, был совершён с целью научного исследования и картирования этого ещё малоизвестного архипелага, и были предприняты более или менее серьёзные попытки достигнуть Северного полюса с ЗФИ через морские льды.

Первая русская экспедиция на архипелаг состоялась в 1901 г. До 1912 г. все зимовочные экспедиции были »западные»: из Австро-Венгрии, Англии, Италии, Норвегии и США, в то время как первая русская зимовка была осуществлена в 1912-14 гг. До 1926 г. ЗФИ считалась ничей землёй, но 15-го апреля 1926 г. Советский Союз объявил всю расположенную между советским материком и Северным полюсом сушу советской территорией. Протесты со стороны Норвегии оказались бесполезными и архипелаг был совсем закрыт для других наций с начала 1930-х гг.

Советская научная деятельность, особенно геофизическая, на полярных станциях, расположенных на архипелаге, велась регулярно до настоящего времени, когда недостаток средств привёл к прекращению или сильному сокращению её объёма. Даже во время Второй мировой войны без смены продолжал работу коллектив одной из станций и в то же время на Земле Александры непродолжительно работала немецкая метеорологическая станция. С последней половины 1950-х гг. ЗФИ более и более стала военным полигоном как внешним оплотом против Запада во время

»холодной войны». Соответственно доступ стал ограниченным и для советских научных исследователей. Эта ситуация коренным образом изменилась в 1990-х гг. с сокращением военного присутствия до минимума.

Климатические и военные условия на деле содействовали сохранению окружающей среды и культурных остатков ЗФИ, ограничив доступ на архипелаг. Нарушение окружающей среды сильно в непосредственной близости от русских станций, но минимально во всех остальных местах. Недавний рост человеческой деятельности, охватившей обширные области архипелага в виде туризма и международной научной деятельности, вызывает тревогу о сохранности природы и исторических участков. Однако Россия показала дорогу, создав в апреле 1994 г. заповедник в 42.000 км² в области, охватывающей ЗФИ и окружающие морские районы. Хочется надеяться, что организаторы туристических рейсов и будущие посетители архипелага будут уважать необходимость сохранения окружающей среды и исторических мест Земли Франца-Иосифа.

Résumé

L'archipel russe Franz Josef Land se situe à 900 km du Pole Nord, à l'est du Svalbard et au nord ouest de la Novaja Zemlja. L'archipel rassemble 191 îles sur une surface de 16.135 km^2 avec une envergure de 375 km d'est en ouest et de 234 km du nord au sud. Les îles n'occupent que 20% de la surface de l'archipel. Les îles les plus grandes sont George Land, 2741 km^2, et Wilczek Land, 2054 km^2. Les glaciers prédominants, couvrent près de 85% des terres. D'un point de vue géologique, l'archipel est le résultat d'un léger bombement tectonique, avec de jeunes venues basaltiques formant de vastes plateaux le long des périphéries septentrionales, occidentales et orientales. Au cœur du bombement, des strates doliritiques sont mises à nu. A l'est, la couverture basaltique et les strates doliritiques ont été érodées, laissant apparaître des roches sédimentaires friables entrecoupées par des dykes ou des intrusions. Le plateau original a été découpé en de nombreux fragments lors des mouvements de l'écorce terrestre. Le British Channel et le Austrian Strait séparent l'archipel en trois groupes d'îles. Le point le plus élevé, sur Wilczek Land est situe approximativement à 670 m.

Le climat arctique de Franz Josef Land est fortement influencé par la vaste couverture glaciale et par la glace de mer. La température moyenne annuelle, −10°C environ, est relativement haute en regard de la latitude, alors que la moyenne du mois le plus chaud, juillet ou août, est basse : 1°C sur la terre proche du niveau de la mer. La vaste couverture de nuages durant l'été est partiellement responsable des basses températures de cette saison, alors que des courants cycloniques chargés d'air doux méridional sont la cause partielle de températures hivernales plus élevées que la normale. Les précipitations varient au dessus de l'archipel, mais on a mesuré le long des côtes 100 à 150 mm en moyenne annuelle. La nuit polaire dure environ 128 jours, de la mi-octobre jusqu'à la fin de février, alors que la période du soleil de minuit s'étend de la mi-avril jusqu'à la fin août.

Les glaciers de Franz Josef Land produisent de nombreux icebergs, parmi lesquels des glaciers tabulaires mesurant jusqu'à 400 mètres de long. La glace de mer, en restant intacte entre les îles durant les étés froids, contribue au climat arctique de l'archipel.

Le système d'eau douce de l'archipel est alimenté par la fonte des glaciers, de la couverture de glace, et des plaques de neiges. Sauf exceptions, le permafrost empêche la formation de larges et profondes rivières, et provoque l'étalement arborescent des petites rivières et ruisseaux. De larges rivières existent cependant, longues de plus de 19 km sur George Land, profondes de plus d'un mètre sur Wilczek Land. On dénombre un millier de lacs dans l'archipel, la plupart sur Alexandra et George Land, et en général situés à l'intérieur de dépressions creusées par des glaciers. Ils ne dégèlent que pendant un ou deux mois, en été.

Dans les zones où la végétation est possible, seulement 5 à 10% sont recouverts. En présence de conditions aussi favorables qu'une colonie d'oiseaux, la couverture peut atteindre 100%. Aucun arbre, arbuste ou herbe haute ne résiste au rude climat. Les mousses et lichens forment la base de la végétation (approximativement une centaine d'espèces de chaque). On dénombre aussi une cinquantaine d'hépatiques. Cette végétation est parfois très colorée, et on peut trouver de somptueux et profonds parterres de mousses dans les zones humides. Sur le plus d'un millier d'espèces de plantes vasculaires connues dans la toundra arctique, seulement 57 sont répertoriées sur Franz Josef Land, certaines représentées en très petit nombre. Seize espèces d'herbes et environ une centaine d'espèces d'algues terrestres viennent compléter ce paysage végétal.

Le poisson n'est pas abondant autour de Franz Josef Land, et aucune espèce n'est pêchée commercialement. La morue arctique est le poisson biologiquement essentiel. Environ 41 espèces d'oiseaux peuplent l'archipel, et seulement 14 en sont natives. Les oiseaux de mers dominent presque exclusivement car profitant de l'environnement marin ils s'adaptent plus facilement au rude climat. Trois espèces de phoques sont communes, le phoque du Groenland, le phoque barbu et le phoque marbré. Les morses sont communs à l'intérieur de l'archipel, et le Svalbard a récemment été naturellement recolonisé par des morses de Franz Josef Land. On trouve dans cette zone des rorquals, des baleines blanches, des narvals, des orques et même une petite population de rares baleines de Groenland.

Les ours blancs de Franz Josef Land font partie d'une population de 5000 individus peuplant la zone comprise entre l'est du Groenland et la Severnaja Zemlja. Les renards polaires sont présents en petit nombre, principalement sur les îles peuplées par de grandes colonies d'oiseaux de mers. Le renard est vraisemblablement le seul mammifère terrestre de l'archipel, où l'écosystème est entièrement dépendant des ressources liées à la mer.

Les noms originaux des îles, détroits, glaciers et caps sont toujours utlisés et renvoient à l'histoire de la découverte et de l'exploration de l'archipel. Franz Josef Land a sans doute été aperçue pour la première fois par le bateau norvégien de chasse au phoque Spidsbergen, commandé par Nils Fredrik Rønnbeck, en 1865. C'est cependant l'expédition austro-hongroise Tegetthoff de 1872–1874, dirigée par Julius Payer et Carl Weyprecht, qui fît connaître l'archipel et lui donna son nom. Jusqu'au début des années trente, Franz Josef Land était le lieu de nombreuses parties de chasse estivales, la plupart norvégiennes. A cela s'ajoutent des expéditions hivernales, parfois longues de trois ans, menées à des fins d'exploration et de cartographie de cet archipel peu connu, et/ou relevant de tentatives plus ou moins sérieuses d'atteindre le Pole Nord par la glace de mer à partir des îles de l'archipel.

La première expédition russe vers l'archipel eut lieu en 1901. Jusqu'en

1912 toutes les expéditions hivernantes étaient "occidentales": Empire Austro-hongrois, Italie, Norvège et USA, alors que le premier hivernage russe eut lieu en 1912–14. Jusqu'en 1926 Franz Josef Land était considérée Terra Nullius, un No Man's Land. Le 15 avril 1926, l'Union Soviétique déclara être propriétaire de tous les territoires compris entre les côtes soviétiques et le Pole Nord. Les protestations norvégiennes furent vaines et l'accès à l'archipel fut interdit à toutes les autres nations après le début des années trente.

Les activités scientifiques soviétiques, en particulier géophysiques, à partir de bases installées sur l'archipel ont été menées régulièrement jusqu'à nos jours, où un manque de fonds a causé la cessation ou la réduction drastique de la plupart des activités. Une station a été administrée en permanence pendant la deuxième guerre mondiale, alors même qu'une station météorologique allemande est restée en service pendant une courte durée sur Alexandra Land. A partir de la fin des années cinquante Franz Josef Land s'est progressivement militarisée devenant un poste avancé contre l'Ouest durant la guerre froide. Cette situation a radicalement changé en 1990, où la présence militaire a été réduite au strict minimum.

Les conditions militaires et climatiques ont en fait participé à la préservation de l'environnement et de l'héritage culturel de Franz Josef Land en restraignant l'accès à l'archipel. L'environnement, gravement perturbé dans la proximité immédiate des bases soviétiques, semble avoir été très peu affecté partout ailleurs. La récente vague d'activités humaines sur de plus grandes parties de l'archipel, sous forme de tourisme et d'activités scientifiques internationales, soulève le problème de la sauvegarde de la nature et des sites historiques. La Russie a cependant montré la voie en créeant en avril 1994 un parc naturel de 42.000 km2 dans une zone comprenant Franz Josef Land et les mers alentours. Espérons que les agences de voyages et les visiteurs de l'archipel respecteront le besoin de préservation de l'environnement et des sites historiques de Franz Josef Land.

Notes

1 This building was visited by S. Barr in 1990 and found to be in excellent condition. For more details see Barr 1991 and 1992.
2 The American North Pole expedition with the *Jeanette*, under the command of G.W. de Long, had entered the ice from the Bering Strait in 1879 and its fate was unknown. In fact the ship was crushed by the ice in June 1881 and the survivors struggled south to the Siberian coast, arriving at the mouth of the Lena in September. The find of wreckage from the *Jeanette* off southern Greenland in 1884 was a direct inspiration for Fridtjof Nansen's Arctic Ocean drift with *Fram*.
3 Giles or Gillis Land, first presumed seen and named by Cornelis Giles and Outger Rep on a voyage near Svalbard in 1707.
4 The main source of information on this expedition has been Jackson's own account: Jackson 1899.
5 Nansen's expedition is described after Jackson's.
6 The main source for this description is Nansen:1897 *Vol.* II.
7 See about these expeditions under.
8 The main source for this description is the diary written by one of the Norwegians, Paul Bjørvik. See *Paul Bjørvig dagbok*. Notices about the expedition in the *Geographical Journal* for 1898 and 1899 are also used. Wellman published an account of the expedition in *Wide World Magazine*, January 1900.
9 According to Horn 1930:33 six Norwegian hunting expeditions visited the archipelago in 1898, including one carrying Mr Arnold Pike, an English sportsman whose name, like Wellman's, is connected to Virgohamna in Svalbard.
10 Horn does not mention this ship. Possibly there is a mixup with the *Hertha* in Horn's lists.
11 Bernt Bentsen had been on the *Fram* expedition with Nansen in 1893–96.
12 Soviet seientists reburied Bentsen's remains at the same place in 1960, as the original grave was in bad condition (Bojarskij 1990, p. 43).
13 The Duke will be called Abruzzi in this chapter.
14 This is still standing firmly.
15 Information from Baldwin 1903 (well-illustrated with photographs); *The Geographical Journal* Vol XX, 1902, pp. 344, 438; and Horn 1930, pp. 16–17.
16 Ziegler had amassed a huge fortune as founder and owner of the Royal Chemical Company, which specialized in baking powder (Riffenburgh 1993, p. 156).
17 There were six Russian dog and pony drivers, and a Hungarian machinist later joined the expedition from the *Frithjof*. See Vedoe, pp. 14, 25.

18 Quoted in the *Arctic Diary* of Vedoe, p. 25.
19 Remains are still standing, see Barr 1991.
20 Quoted in Vedoe, pp. 26–27.
21 Quoted from the *San Francisco Chronicle* of June 6th, 1932, in Vedoe, p. 18.
22 The Geographical Journal Vol.XXVI, 1905, 335.
23 Fiala 1907; *The Arctic Diary of Anton M. Vedoe; The Geographical Journal* 1905; Horn 1930. The diaries of four expedition members, together with 500 photographs from the rescue of the expedition, are now in the Stefansson Collection at Dartmouth College, New Hampshire, USA. In his diary Vedoe mentions that Rilliet took some "moving pictures" (Vedoe, p. 116).
24 Anton's brother John also participated in Fiala's expedition. The two were born in Sweden of Norwegian parents and moved to the USA in their teens.
25 Sergeant Francis Long, weather observer, had been a member of A.W. Greely's ill-fated arctic expedition in 1881–84.
26 Norwegian Peter L. Tessem lost his life on Roald Amundsen's *Maud* expedition in 1919.
27 Myhre's wife died in Norway before the expedition returned. The original carved cross from the grave at Cape Säulen was collected by the crew of the Soviet meteorological station at Teplitz Bay in 1990 after it had fallen over. The intention was to repair and replace it. See Barr 1991.
28 Roald Amundsen made an unsuccessful aircraft attempt on the Pole this summer, and a successful one by airship the following year.
29 Based on material in the archives of Norsk Polarinstitutt, Oslo.
30 This was done privately in 1930, but was not formalized by the Norwegian government and was ignored by Soviet.
31 According to the Treaty of Spitsbergen, ratified in 1925, Norway has the sovereignty over Svalbard, but – amongst other limitations – citizens of the countries which have acceeded to the Treaty have equal rights of economic activities.
32 See Horn 1931. On the way the expedition discovered on Kvitøya, Svalbard the last camp of the Swedish balloon expedition towards the North Pole, led by S.A. Andrée in 1897, and annexed Victoria Island as mentioned above.
33 Not the same *Isbjørn* that sailed for Payer and Weyprecht in 1871. See p.108.
34 Norges Ishavskomité (The Norwegian Arctic Seas Committee) drew up a summary of the subject in 1941. This was signed by Adolf Hoel, C. Marstrander and Gustav Smedal. Gunnar Horn's anthology published in

1930 (Horn 1930) was also drawn up in connection with Norwegian discussions concerning possible action in the question of rights and sovereignty over Franz Josef Land.

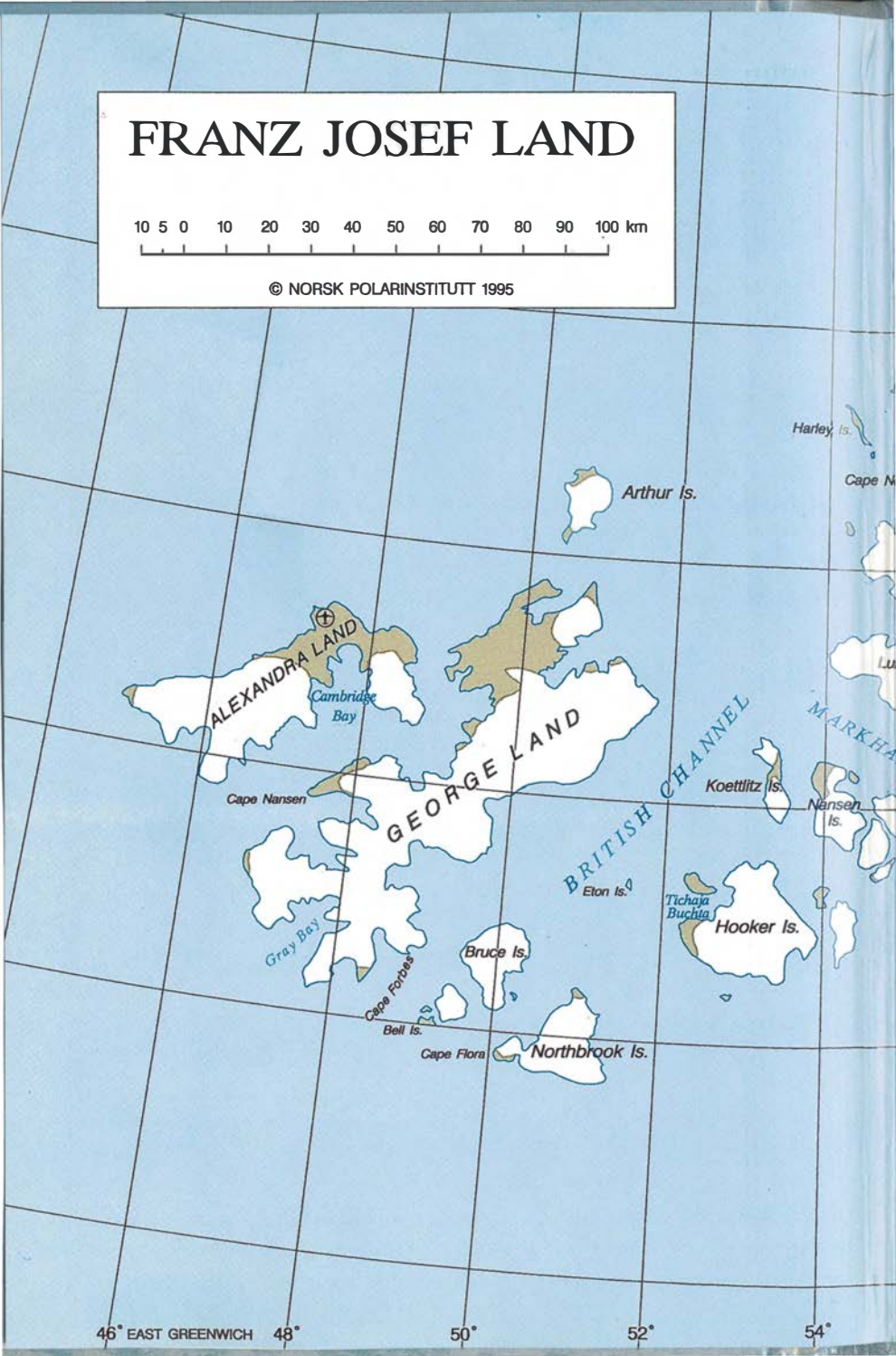
35 Letter in the archives of Norsk Polarinstitutt, Oslo.

36 Most of the information in this account has come from Selinger 1986 and personal correspondanse with F. Selinger. See also Selinger & Schwerdtfeger 1982.

37 Historical facts and basic information used by the author of this treatise are based on the publications by G. Hamann (1974, 1983); further detailed references are included in the listed publications.

38 Additional information has been supplied by J.M. Węsławski.

39 In these and the following comments it is referred, up to 1947, to the *History of Discovery and Development of the Northern Sea Route,* which comprises four volumes. The references to its volumes will be given below.


FRANZ JOSEF LAND
10 5 0 10 20 30 40 50 60 70 80 90 100 km
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Harley Is.
Arthur Is.
ALEXANDRA LAND
Cambridge Bay
GEORGE LAND
Cape Nansen
BRITISH CHANNEL
Koettlitz Is.
Nansen Is.
Eton Is.
Tichaja Buchta
Hooker Is.
Gray Bay
Bruce Is.
Cape Forbes
Bell Is.
Cape Flora
Northbrook Is.
46° EAST GREENWICH
48°
50°
52°
54°


Cape Fligely
Cape Saulen
Teplitz Bay
Rudolf Is.
Eva-Liv Is.
SEVERO-VOSTOCHNYI STRAIT
81°30'
Alexander Is.
Jackson Is.
Hoffmann Is.
81°
Kane Is.
La Ronsiere Is.
GRAHAM BELL IS.
Greely Is.
Ziegler Is.
Salisbury Is.
Wiener-Neustadt Is.
Cape Heller
WILCZEK LAND
Champ Is.
80°30'
Hayes Is.
AUSTRIAN STRAIT
Newcomb Is.
Alger Is.
Hall Is.
Mc Clintock Is.
Hochstetter Is.
80°
Cape Tegetthoff
Salm Is.
Wilczek Is.
Lamont Is.
79°30'
56°
58°
60°
62°
64°