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Plant and arthropod remains from the palaeo-Eskimo site on Qeqertasussuk, West Greenland

Jens Böcher & Bent Fredskild

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Samples from the excavation of a palaeo-Eskimo site, settled cà. 3900–3100 ^{14}C yrs BP on a raised beach, were analyzed for pollen and botanical and entomological macro-remains.

In the dwelling area the original vegetation of grasses and *Saxifraga* spp. was covered by thick culture layers; under the midden *Elymus mollis* formed the original vegetation. During short uninhabited periods different grasses dominated. Following the termination of the habitation a mossy heath spread over the area.

The sediments contained abundant well-preserved fragments of insects and other arthropods. Besides oribatid mites, spiders and fly puparia, remains of beetles are predominant. *Micralymma brevilingue* plays a prominent role, but also *Simplocaria metallica*, *Byrrhus fasciatus* and the heteropteron *Nysius groenlandicus* are fairly numerous. A former warm period is indicated by the finds of species at or well north of their present northern limit.

The succession of arthropod assemblages agrees with the palaeobotanical and archaeological evidences. The fauna indicates the transition from typical arctic conditions: few species and low density, to stages with much higher diversity and density following fertilization, but also to stages of inferior conditions for plants and insects as a result of intensive human activity.

A lake pollen diagram shows that after a short pioneer zone first *Salix glauca*, then ca. 6400 ^{14}C yrs BP, *Betula nana* immigrates. Shortly before 3000 BP more cool/humid conditions are indicated in accordance with the general trend in the Holocene climatic development of West Greenland, which is briefly discussed and summarized.

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Report from the Qeqertasussuk Project No. 1.

Key words:
Palaeo-Eskimo, palaeo-ecology, palaeo-botany, palaeo-entomology, palaeo-climate, pollen-analysis

Introduction

In 1983 a palaeo-Eskimo settlement with extremely well preserved organic remains was found in the permafrozen peaty sediments on the island of Qeqertasussuk in the southeastern part of Disko Bugt, West Greenland (Fig. 1). The former settlement is situated on a series of raised beaches between the island and a former skerry. As a result of submergence the lowest part is eroded (Fig. 2). Through the years 1984–87 excavations were carried out in three parts: Area A, with freely exposed cooking places at the highest elevation, ca. 11 m a.s.l., Area B in the thickest part of the midden, and Area C where remains of two or three "mid-passage dwellings" were found under midden layers from younger phases of the Saqqaq culture, the West Greenland representative of the cultural complex termed Arctic Small Tool tradition. The site was used as part of a larger settlement pattern through almost a millenium (ca. 3900–3100 ^{14}C yr BP). The different use and the change in season is illustrated by the different importance in the layers of the 44 game species, ranging from cod to seals, sperm whale, caribou and birds, including the now extinct great auk (Grønnow 1988; Grønnow, personal communication 1992, Grønnow & Meldgaard 1991; Meldgaard 1988).

The multidisciplinary excavation, conducted by the Qasigiannguit/Christianshåb Museum, also included the present authors. Preliminary results have been published in the periodical "Grønland" (1991, 97–224).

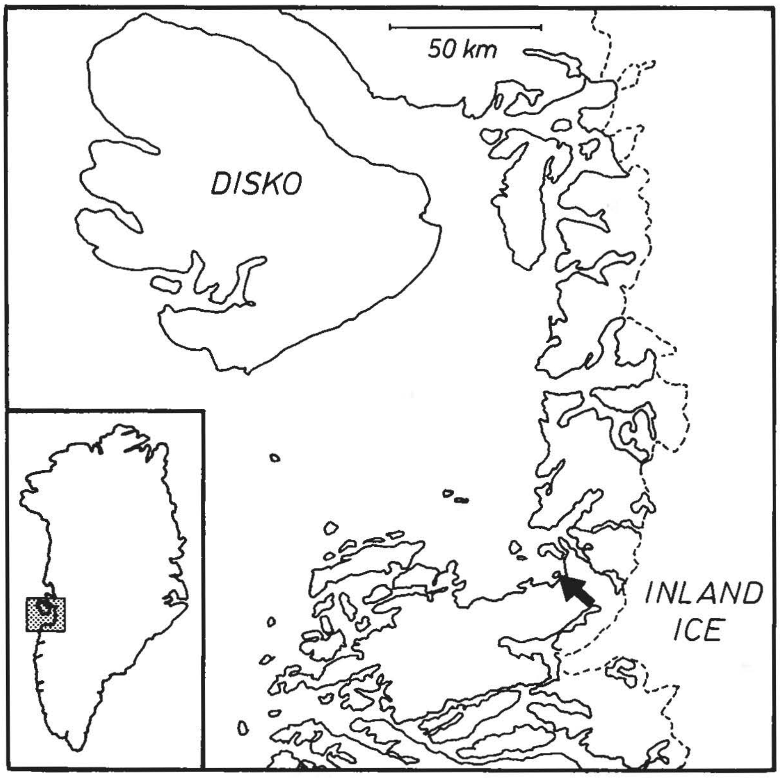


Fig. 1. Map of the investigation area. Arrow shows the position of the island of Qeqertasussuk.

Present environment, flora and arthropod fauna

The 4 × 2 km island of Qeqertasussuk (68°35'N, 51°05'W) consists of gneissic bedrock, in most places falling steeply into the sea. Rounded, east-west running ridges peak at 220 m a.s.l. The climate is low-middle arctic and, judging from the flora, fairly oceanic. At Ilulissat/Jakobshavn, ca. 70 km north of the island, the mean temperatures for July and February are ca. 8°C and −15°C, and for five months temperatures are above zero. The yearly precipitation is here about 270 mm.

The major part of the island is covered by different types of heaths. On top of the ridges and in very shallow, south-facing soil, open *Carex rupestris-Saxifraga tricuspidata*-lichen communities are found, with *Saxifraga paniculata*, *Poa glauca*, *Woodsia ilvensis* and, less frequently, *Artemisia borealis* and *Campanula gieseckiana*. On dry, slightly thicker soil, heath of *Betula nana-Vaccinium uliginosum* ssp. *microphyllum* rich in *Salix glauca* occurs. On more protected slopes and level ground *Empetrum hermaphroditum-Ledum palustre* ssp. *decumbens* heath is found which, on even thicker soil and/or in more snow protected situations, is replaced by almost pure *Ledum*-moss heath. *Rhododendron lapponicum* is very common in several of the heath types. Mossy *Cassiope tetragona* heath is found on steep, north-facing slopes, while heath types dominated by *Empetrum*-moss and *Vaccinium vitis-idaea* ssp. *minus*-moss occur on more gentle, north and west-facing slopes.

The few and very small snow-patches are dominated by *Salix herbacea* and mosses. Herbslope vegetation as well as willow copses are totally missing. Only at one place, on almost level ground at 25–50 m a.s.l., are some *Eriophorum* spp.-*Carex rariflora* fens with *Carex saxatilis* and *C. stans*. Here, often on raised marine clay, are also some tiny ponds and puddles rich in species, e.g. *Utricularia ochroleuca*, *U. intermedia*, *Eleocharis acicularis*, *Potamogeton filiformis* and, in one puddle, *Limosella aquatica*.

In the northernmost, lowest part of the former settlement (at Areas B and C, Fig. 2) the vegetation is a fairly poor, mossy heath dominated by *Empetrum hermaphroditum*, *Salix glauca*, *Poa glauca* and *Equisetum arvense*. Towards south the heath becomes drier, the mosses are replaced by lichens and at the highest elevation (at Area A, Fig. 2) vegetation cover is scanty. Further south, on the south-facing sea-slope, the vegetation is dominated by *Elymus mollis*, also with *Salix glauca*, *Sedum rosea*, *Plantago maritima*, *Stellaria longipes*, *Poa glauca*, *Carex glareosa*.

A frequency list of the 129 species of phanerogams

Fig. 2. View looking southeastwards over the former settlement. A: cooking places, B: midden, C: dwelling place. Bjarne Grønnow phot.

found on Qeqertasussuk is given in Fredskild *et al.* (1987). Nomenclature follows T. W. Böcher *et al.* (1978).

The arthropod fauna of the island appears to be very typical of the southeastern Disko Bugt area. As usual for the Arctic, Diptera (flies) dominate, in particular the families Culicidae, Chironomidae, Mycetophilidae, Dolichopodidae, Phoridae, Syrphidae, Agromyzidae, Ephydridae, Scathophagidae, Anthomyidae, Muscidae and Calliphoridae. Of blowflies two species were caught (*Cynomya mortuorum* (L.) and *Calliphora uralensis* Villeneuve).

The Hymenoptera are represented by a number of Ichneumonidae and Braconidae, but the bumble bee, *Bombus polaris* Curtis, is also a common flower visitor to the island.

A few species of Noctuidae and two butterflies, *Colias hecla* Lefebre and *Clossiana chariclea* (Schneider), make up the Lepidopteran part of the fauna.

Coleoptera are represented by only four species (*Hydroporus morio* Aubé, *Colymbetes dolabratus* (Paykull), *Micralymma brevilingue* Schiödte and *Coccinella transversoguttata* Faldermann), but one more (*Bembidion grapii* (Gyllenhal)) was caught on the neighbouring mainland, SE of Qeqertasussuk. The water beetles (Dytiscidae), *Hydroporus morio* and *Colymbetes dolabratus,* are very common in vegetated ponds and pools. Pitfall traps in heath vegetation close to excavation area C in the settlement area yielded *Micralymma brevilingue* (Staphylinidae) and *Coccinella transversoguttata* (Coccinellidae). *M. brevilingue* was also collected in *Elymus mollis*-vegetation south of Area A (Fig. 2) and in shaded gorges with a luxuriant vegetation at some distance from the settlement area.

Several species of Hemiptera are found on Qeqertasussuk. The two common Greenlandic Heteroptera, *Nysius groenlandicus* (Zetterstedt) (Lygaeidae) and *Chlamydatus pullus* (Reuter) (Miridae) are very frequent. The leafhopper, *Deltocephalus lividellus* Zetterstedt (Homoptera, Cicadellidae), is especially numerous in the *Elymus*-vegetation mentioned above, and a psyllid (*Psylla* (?) *groenlandica* Sale) is common on *Betula nana*. A number of Aphidoidea and two species of Coccoidea (one is *Orthecia cataphracta* Olafsen) were collected.

Spiders, in particular Lycosidae (and mainly *Pardosa groenlandica* (Thorell)) were abundant in the pitfalls, together with mites (Parasitiformes, Trombidiformes, Oribatida) and Collembola.

Field work

The present vegetation of Qeqertasussuk was investigated in 1986 by B. F. who also cored a lake in order to analyze the past vegetation. In 1987 J. B. investigated the present arthropod fauna by means of pitfall traps, yellow water traps, sweep netting and searching. He further sampled two transect columns in the excavation.

In 1986 Charlie Christensen, Danish National Museum, measured and sampled a 20 m long trench in Area C (Fig. 2), the dwelling place (Christensen 1990). Shorter transects in Area B, the midden, were measured, described and sampled by C. Christensen in 1986 and by Morten Meldgaard, Zoological Museum, Copenhagen in 1986–87. Based on this, a short summary description of the layers that have been analyzed for macrofossils and pollen is given below, including formulae of the Troels-Smith (1955) system.

Methods

The pollen samples, taken in the freshly cut wall in the excavation, have been treated following standard procedures including acetolysis, treatment overnight in 40% hydroflouric acid and mounting in glycerol. The lake samples are counted "absolutely" using the weighing method (Jørgensen 1967). Besides making possible the calculating of pollen number per ml this makes the calculation of yearly pollen influx possible once the sedimentation rate is known from ^{14}C dates. The macrofossil samples, mostly 50–100 g fresh weight, were taken from two roughly 10 × 10 cm columns brought back to the laboratory, washed on a 0.4 mm sieve and inspected under a low power microscope. In some very fibrous samples part of the suspended material was removed by a curved forceps (Fredskild & Humle 1991). The content of sand (Figs. 6, 8) is given as dried, decanted sand per 100 g fresh sample.

Three samples from Area B and seven from Area C (Table 2) originated in the kerosene float fraction of the samples analyzed for arthropod remains. Accordingly, these flora remains (in particular seeds) are biased for those which float in water or kerosene.

Samples for arthropod analyses were taken in two places: the midden area (Area B) and the habitation area (Area C). In each place a column measuring 25 × 50 cm in cross section was dug out, following the archaeologically defined layers, and the sediment samples were stored in plastic bags.

A complete series of sediments was obtained from the habitation site (C), whereas permafrost at the bottom of the midden site (B) made this series incomplete.

The laboratory work was carried out in the Zoological Museum, University of Copenhagen (ZMUC). A number of samples, each of one litre sediment, were processed approximately following the kerosene procedure described by Coope (1986). However, because of the high organic content, the sediments are poorly suited for flotation with kerosene. In some cases the volume of the arthropod concentrate was no less than 20% of the original volume, and the varying content of charcoal, feathers and hairs made the microscopic examination difficult.

The arthropod remains were preserved in 70% alcohol. The most interesting pieces were mounted on cardboard and insect pins for further study. The material is kept in the ZMUC.

Sediment description and dating

Area B

The relevant part of the trench wall is shown in Fig. 3.

Layer 1. Slightly sandy peat (Th$^{1-2}$3, Tl^{1}++, Th^{0}1, Tl^{0}+, Ga++), covered by recent, mossy vegetation. No cultural remains.

2. Brown humified silty peat, cryoturbated (Th^{3}4, Tb^{2}+, Tl^{3}+, Th^{0}++, Ag+++, Ga+, rud. cult.+). Few cultural remains in the deepest centimetres.

3. Brownish black humified peat, fine grained (Th^{2}4, Tb^{2}++, Tl^{2}+, Ag+, rud. cult. (+)). Single artefacts, no bones.

5a. Dark brown very felty peat (Th^{1}4, Tb^{1}+, Tl^{1}+, Ga(+), rud. cult.+). A few twigs and cultural remains.

5b. Black peat, rich in charcoal, bones, and artefacts (Th^{1}4, Tb^{1}(+), Tl^{1}+++, rud. cult. 1).

5c. Brownish black very fibrous-felty peat formed mainly by grasses. Only few cultural remains (Th^{1}4, Tb^{1}(+), Tl^{1}+, rud. cult.+).

5d. Brownish black fairly humified grass peat (including *Elymus*), rich in cultural remains. (upper part: Th^{1}4, Tb^{1}(+), Tl^{1}++, Ga(+), rud. cult.+++; lower part: Th^{2}3, Tl^{1}1, Ga(+), rud. cult. 1).

6. Black humified loose peat, very rich in cultural remains and twigs (Th^{2}2, Tb^{2}++, Tl^{1}2, Ga+, rud. cult. 1).

8. Blackish brown fibrous-felty grass peat, including many *Elymus* leaves. The few cultural remains presumably thread in (Th^{1}4, Tb^{1}++, Tl^{1}(+), Ga++, rud. cult. (+)).

9a. Slightly gravelly beach sand with stones.

32–33. In a nearby hole samples for macroscopic analysis were taken in layer 32 and in the upper part of 33. These two layers correspond to layers 2–3 and 5–6 respectively.

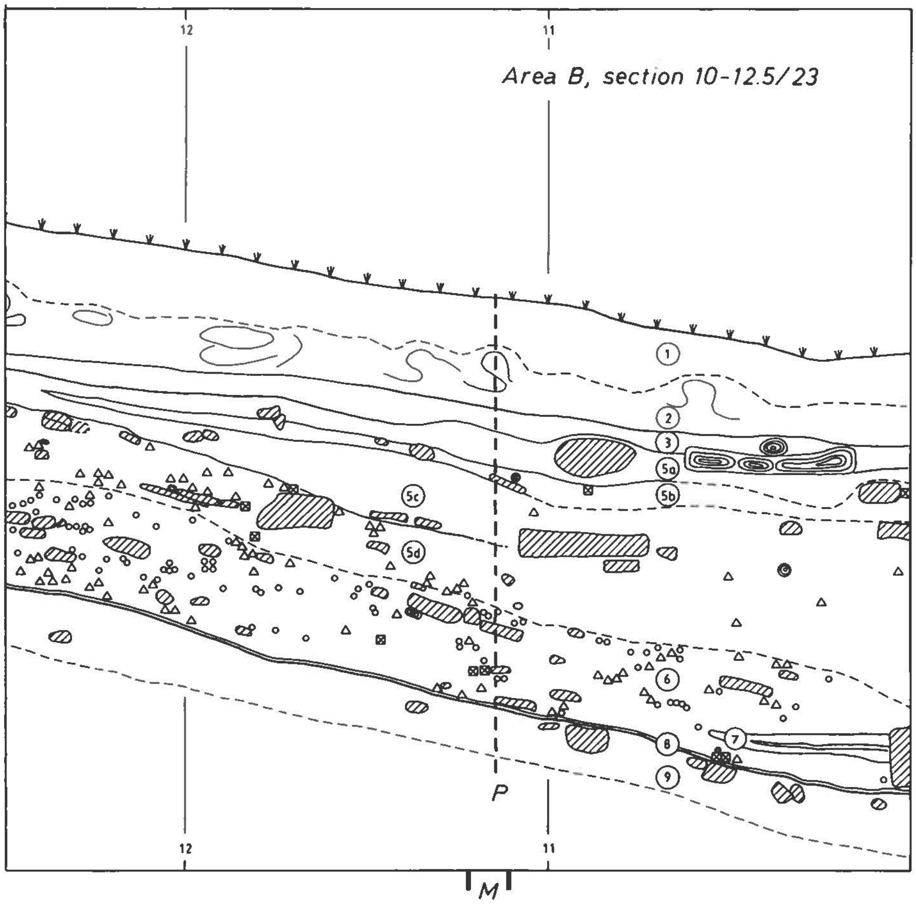


Fig. 3. Part of a trench in Area B with marked layers (circled numbers) and artefacts (signs: see Fig. 4). The column 11.13–11.24/23 (M) was analyzed for botanical macroscopic remains (Fig. 6). The series of pollen samples was taken at 11.15/23 (P) (Fig. 5).

Area C

The relevant part of the transect is given in Fig. 4.

Layer 9. recent hummocky vegetation, dominated by *Empetrum*, with many grasses, sedges, *Salix glauca* and *Equisetum arvense*. Only few mosses.

10. The same as layer 1 in sector B.

11. Brown humified, silty peat ($Th^3 4$, $Tb^2 +$, $Tl^3 +$ Ag+++, Ga+, $Th^0 ++$, rud. cult.+). The silty bands are linear in the deepest part and cryoturbated in the upper. Few charcoal bits and chips of "killiaq", the kind of stone used for tools, especially in the deepest part.

14. Black peat, rich in charcoal and cultural remains ($Th^2 4$, $Tb^2 ++$, $Tl^2 (+)$, Ga++, rud. cult. 1).

15. Bright brown fibrous-felty peat with scattered cultural remains ($Th^1 4$, $Tb^1 (+)$, $Tl^1 +$, Ga(+), rud. cult.++). Mainly formed by grasses, including *Elymus*. Locally many mosses.

16. Black peat, loose because of great content of twigs and cultural remains, including charcoal, bones, tools and waste ($Th^2 1$, $Tb^2 ++$, $Tl^{1-2} 3$, Ga+, rud. cult. 1). Twigs often with leaves (mostly *Empetrum*, but also *Betula nana* and *Salix*).

15a. Like 15, yet $Th^1 3$, $Tb^1 1$, $Tl^1 ++$, Ga(+), rud. cult. ++. Seeds and leaves of *Empetrum*. This layer appeared just behind the wall between layers 16 and 18.

18. Black fairly humified felty peat with few cultural remains in the upper part. ($Th^2 4$, $Tb^2 ++$ $Tl^2 +$ Ga++, rud. cult.++). Resting on a raised stony beach.

Radiocarbon dating

Among the many datings carried out on the material from the excavation, the dates relevant to the present work are listed in Table 1 which also includes four samples given in the pollen diagram from the cored lake (Fig. 10).

For calibration the 20 years atmospheric record in the University of Washington computerized calibration program has been used (Stuiver and Reimer 1986).

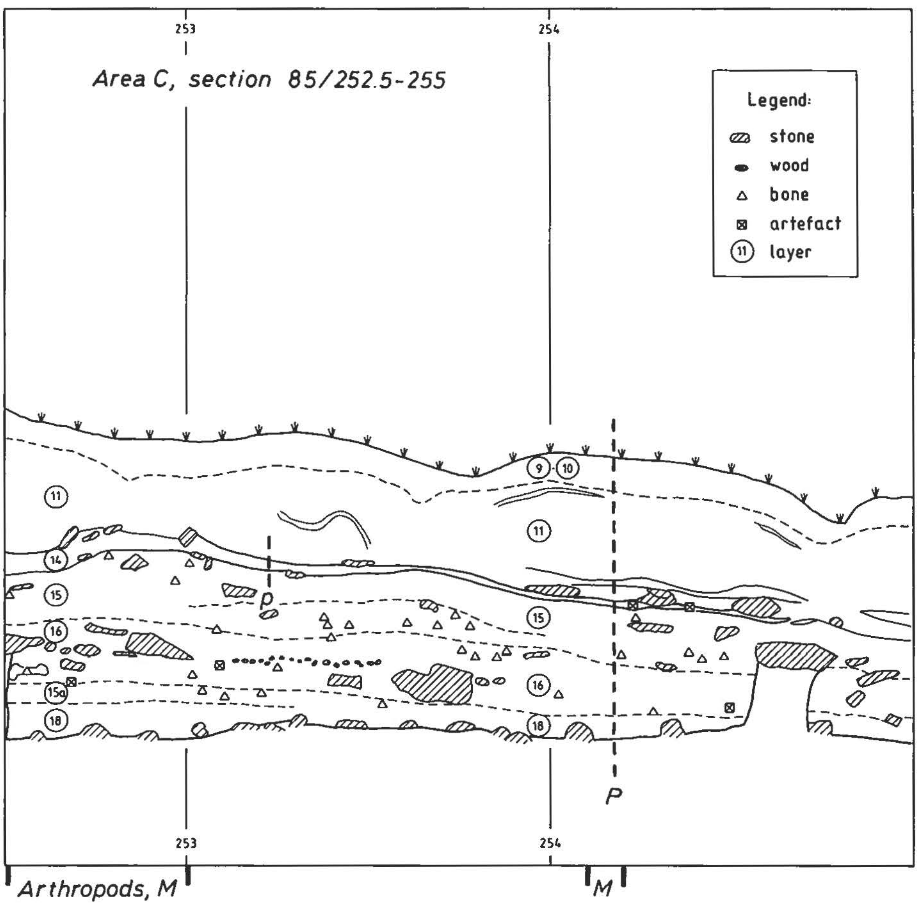


Fig. 4. Part of a trench in Area C with marked layers (circled numbers). Analyses were carried out in the column at 252.50–253.00 (arthropods, see Figs 21–22, and botanical macroscopic remains (M), see Table 2) and at 254.11–254.22 (M: botanical macroscopic remains, see Fig. 8). The main series of pollen samples analyzed (see Fig. 7) was taken at P, supplemented by a short series at p.

Table 1.

Position	Layer	K-no	^{14}C convBP	Cal. ± 1 δ B.C (Pearson & Stuiver 1986)
Area B				
10.5–11.0/23.0	5, uppermost 3 cm	4561	3390± 80	1870–1610
	5, lowermost 3 cm	4562	3690± 80	2200–1970
	6, lower part	4563	3720± 80	2280–2030
13.0–13.25/24.0	5, upper part	4564	3730± 80	2280–2030
	5, lower part	4565	3750± 80	2300–2040
	6, lowermost 3 cm	4566	3880± 85	2480–2210
Area C				
84.5/249.5	15, uppermost 2 cm. Peat >2.4 mm	4816	3310± 80	1690–1515
	15, lowermost 1–2 cm. Peat >2.4 mm	4817	3680± 85	2200–1950
	16, twigs	4818	3650± 85	2175–1910
	15a, upper part. Peat >2.4 mm	4819	3780± 85	2350–2045
85/253	11, lowermost (max.) 2 cm. Peat >0.7 mm	4820	3150± 80	1515–1325
	16, uppermost 4–5 cm. Twigs	4821	3760± 80	2315–2040
	16, lowermost 4–5 cm. Twigs	4822	3640± 75	2130–1915
	18, peat >2.4 mm	4823	3980± 85	2555–2495
Lake				
	cm below water surface			
	524–527, clay-gyttja	4951	6300±100	
	506–509, gyttja	4952	6430±100	
	446–449, gyttja	4953	4940± 90	3775–3705
	370–373, gyttja	4954	2760± 75	1000– 830

Table 2.

Layer (u = upper, l = lower part)	9–10	11u	11l	Area C 14	15	16	15a	32u	Area B 32l	33
Dwarf-shrubs										
Betula nana, fruits			1	5	8	36	18	8	8	40
catkin-scales						1				2
male catkins						3	3			3
female catkins										2
leaves						1				2
buds				1		10	+			
twigs				3						1
Salix glauca type, buds, budscales				5		7	2	7		
capsules							2			4
twigs							5			
Salix herbacea, twig							1			
Cassiope tetragona, capsules		3							2	1
twig										1
Empetrum hermaphroditum, stones	13	3	5	12	6	7	17	1		6
seeds					1		2	3	6	16
drupes	1		1	1		1	5		3	9
leaves				7	15	17		5	5	41
twigs										5
Ledum decumbens, leaves						5				2
capsules						2			1	1
Vaccinium microphyllum, leaves						2	1			1
twig										1
seeds										2
Herbs, dicotyledons										
Oxyria digyna, achene					1					
Rumex acetosella, achenes				1	2	3	1	1	1	5
Arabis alpina, seed				1						
Potentilla sp., achenes				1						1
Stellaria humifusa, seeds			16		3					
Cerastium alpinum/arcticum, seeds				1			5	1	1	1
Silene acaulis, seed										1
Saxifraga oppositifolia, seed									1	
Undetermined seeds		1				2		1		
Herbs, monocotyledons										
Carex bigelowii, nuts						2				
Carex nardina, nut						1				
Carex cf. saxatilis, nut				1						
Carex sp. (tristigmate), nut										1
Luzula sp., seeds	1		1				1	5	2	1
Elymus mollis, rachis fragments						2				
Gramineae sp. (non *Elymus*), fruits/seeds			2			21	7			2
Poa cf. *pratensis,* seeds				1						1
Juncus cf. *biglumis,* seed					1					
Varia										
Equisetum arvense, rhizome fragments	+	5	4	2				3	4	1
Equisetum variegatum, stem fragments										1
Chara sp., oogonium	1									
Cenococcum geophilum, scleroties		3	3				4	1		
Mosses, div.					+	+	+	(+)	(+)	+
Polytrichaceae						+		+		1
Sphagnum					+	(+)	+	(+)		+

(+) = very few.

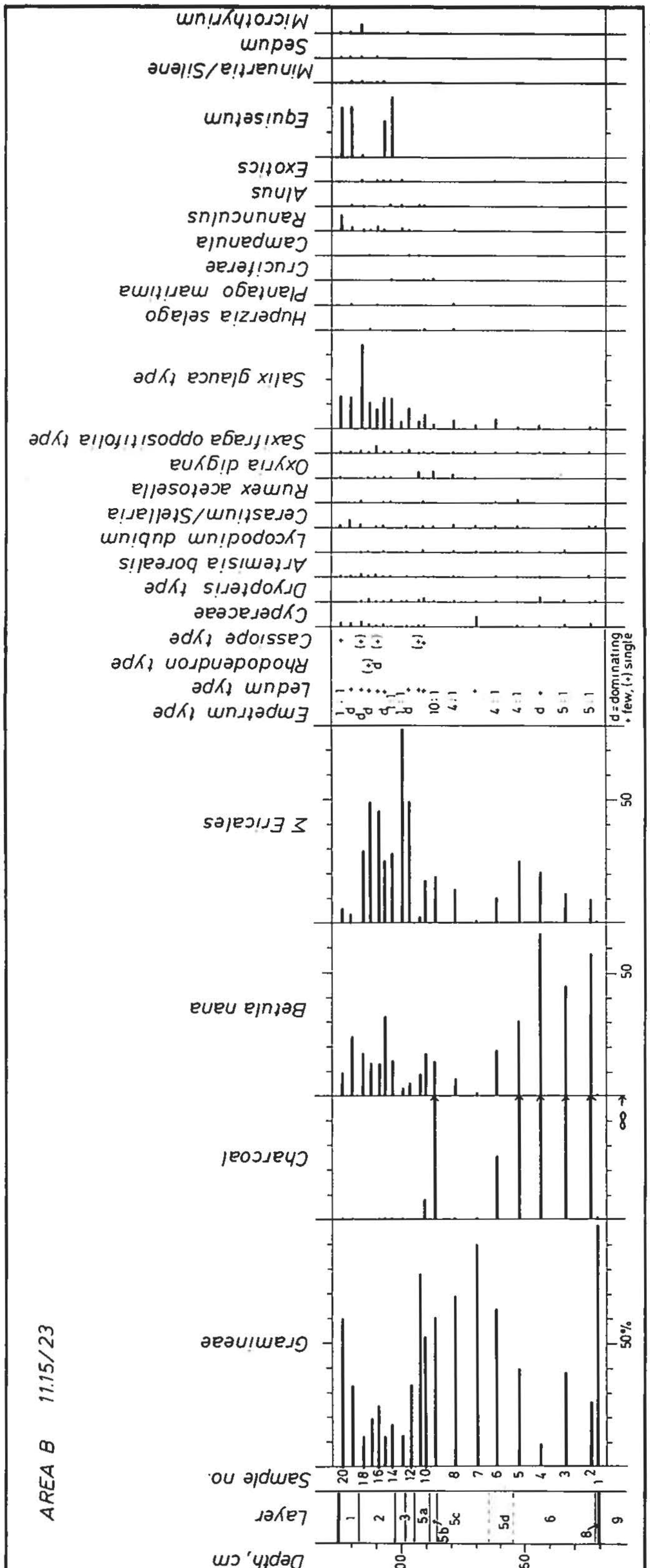


Fig. 5. Pollen diagram from Area B, see Fig. 3.
The pollen sum ranges from 500 to 560 per sample.

Results

Botanical analyses

Area B (Fig. 3)

Layer 8. The totally dominating grass pollen (98%, Fig. 5) and the many *Elymus* leaves point to an almost pure vegetation cover of this species on the raised beach when the Saqqaq people settled.

Layer 6. The culture layer rich in twigs is interpreted as a midden. Whether the twigs have been collected for fuel or originate from coating of floor or bed can not be told, but the many leaves and fruits of *Betula nana* indicate collecting in late summer before defoliation. Abundance of *Betula* pollen might indicate collecting of some twigs in early summer but the pollen of this prolific pollen producer may well have been adhering to the densely pubescent young twigs. The frequent grass pollen indicate a cover of the midden by a vigorous grass mat as often seen at manured places. One achene with lemma in the 35–40 cm sample is from *Puccinellia*, most likely *P. vaginata*, and some loose lemmae are of same size and shape. However, other undetermined lemmae were of other species (not *Elymus*). The many *Empetrum* seeds and the three *Oxyria* fruits but no pollen of this anemophilous species indicate that they may come from human faeces. Quite many of the moss fragments were of *Sphagnum*, a genus never growing on a midden like this. They may have been adhering to twigs and other plant material brought in by the Eskimos.

Layer 5d. As to pollen as well as macroscopical fragments this layer resembles layer 6, the main difference being less charcoal and *Betula* pollen in layer 5d, possibly connected with a marked lower content of twigs.

Layer 5c. At this time a dense vegetation mainly of grasses had probably spread over the midden. Of eight grass fruits only two, both of *Poa* sp., contained achenes, the remainder were empty lemmae. The vegetation also included *Sagina* and *Carex*. Judging from the pollen samples the 114 *Vaccinium* seeds in the 70–74 cm sample hardly originate from an *in situ* plant. Instead, they probably are from bird or fox droppings. Micro- as well as macroscopic charcoal is rare, especially in the upper part where pollen, leaves and a few stones indicate that *Empetrum* was growing on the very spot.

Layer 5b. This is another culture layer with twigs and charcoal. 3% of the pollen are of *Oxyria*, hardly growing at the midden during the habitation period but pos-

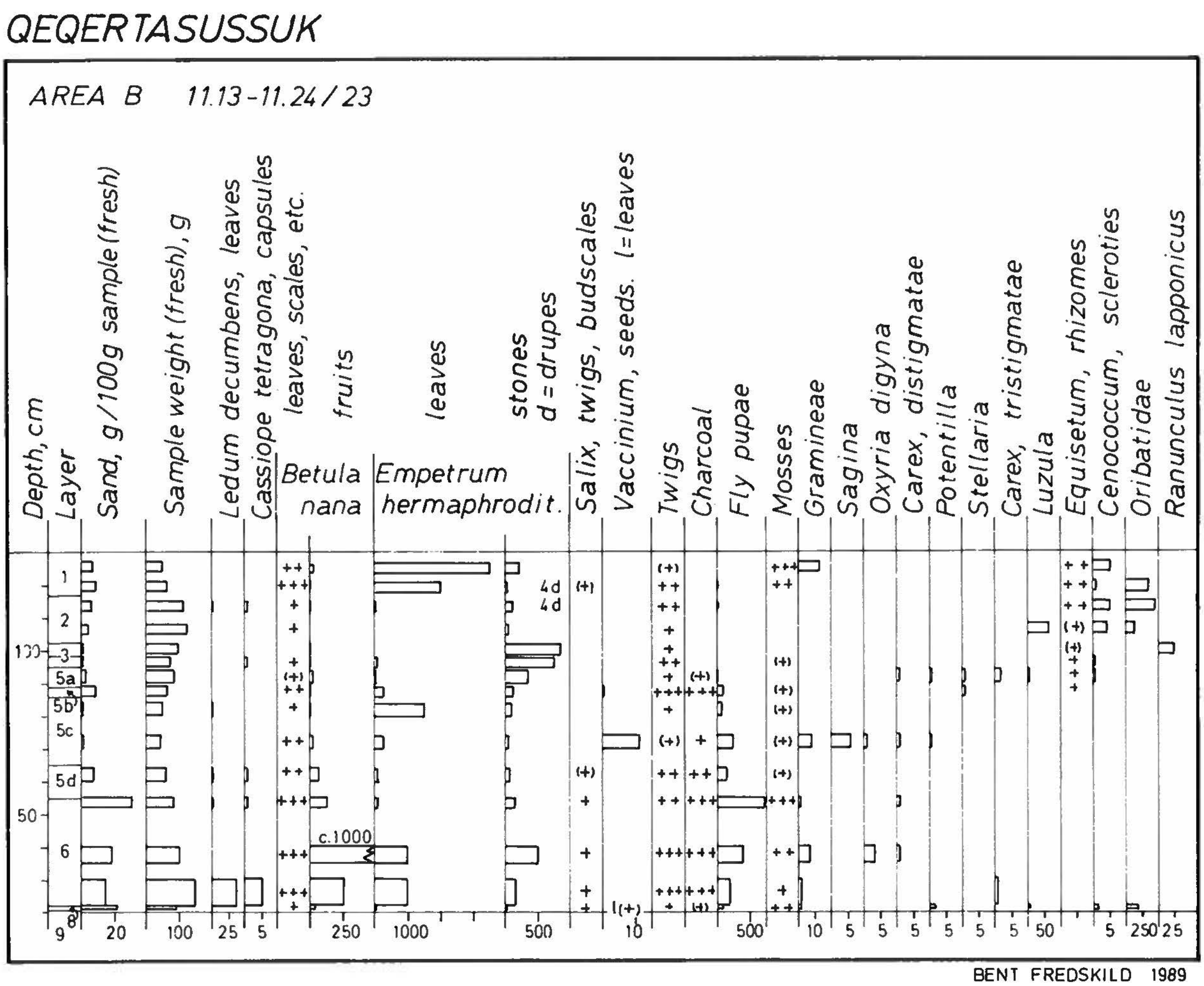


Fig. 6. Botanical macroscopic remains in the Area B column given as number (bar) or estimate, ranging from single (+) to thousand(s) +++.

sibly collected and eaten; this is known from one of the Qilakitsoq mummies (Fredskild 1989). In sample B 32, corresponding to layers 5–6, five *Rumex acetosella* nuts were found. This species, preferring dry, warm rock shelves was not found on Qeqertasussuk, but it grows rarely on the nearby mainland, where it is near its present northern limit. As shown by the pollen diagram from the lake (Fig. 10) it was more common during the mid-Holocene warm period and may have grown on the island but hardly on the midden. Its shoots, containing oxalic acid like *Oxyria*, may also have been eaten.

Layer 5a. This layer was still slightly influenced by habitation in the beginning, yet a grass dominated vegetation with herbs like *Carex* (several species), *Stellaria*, *Potentilla* and presumably also *Salix glauca* was spreading. The many *Empetrum* stones compared to the very few leaves might indicate latrine. However, if these very resistant stones are from the transition to the next layer, which is highly decomposed, their dominance may be due only to the destruction of the leaves.

Layer 3. The coincident occurrence of stones and pollen of *Empetrum* may indicate that it was growing in the local vegetation, which probably was fairly moist, as shown by the 22 achenes of *Ranunculus lapponicus*, a species which always grows in damp moss or in bogs.

Layer 2. This layer formed under an undisturbed *Empetrum-Betula*-heath with *Ledum*, *Rhododendron*, *Salix*, *Luzula* and *Equisetum*. Undoubtedly it was mossy, but because of the high degree of humification the delicate moss leaves disintegrated as did the *Empetrum* leaves. The *Equisetum* rhizomes from this layer are found 10–15 cm deeper (layer 5b). Sclerotia of *Cenococcum geophilum* are usually found in humous soil under heaths.

Exotic pollen, mainly from *Pinus* and *Picea*, occur in

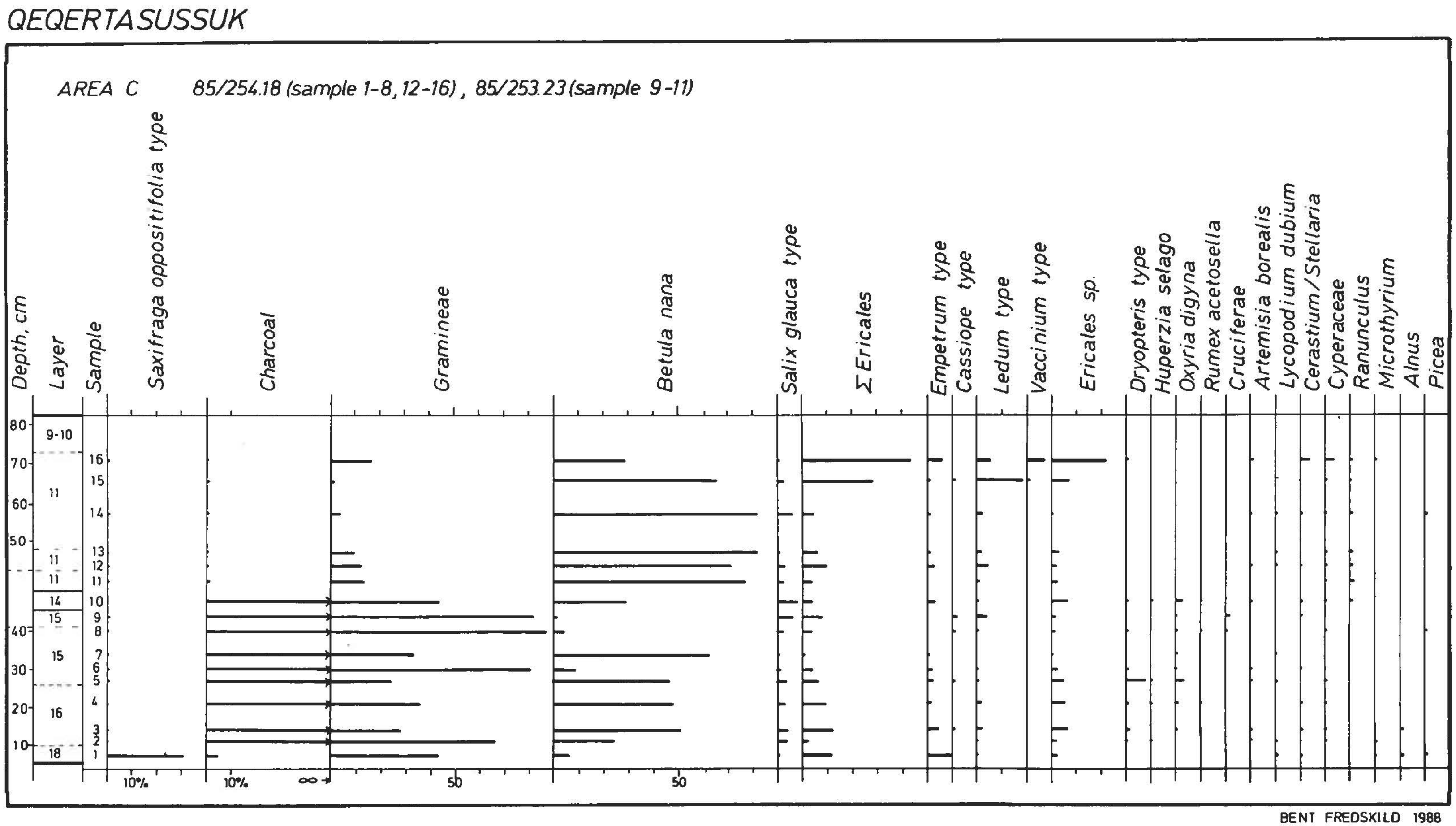


Fig. 7. Pollen diagram from Area C, see Fig. 4. The pollen sum ranges from 500 to 655 per sample.

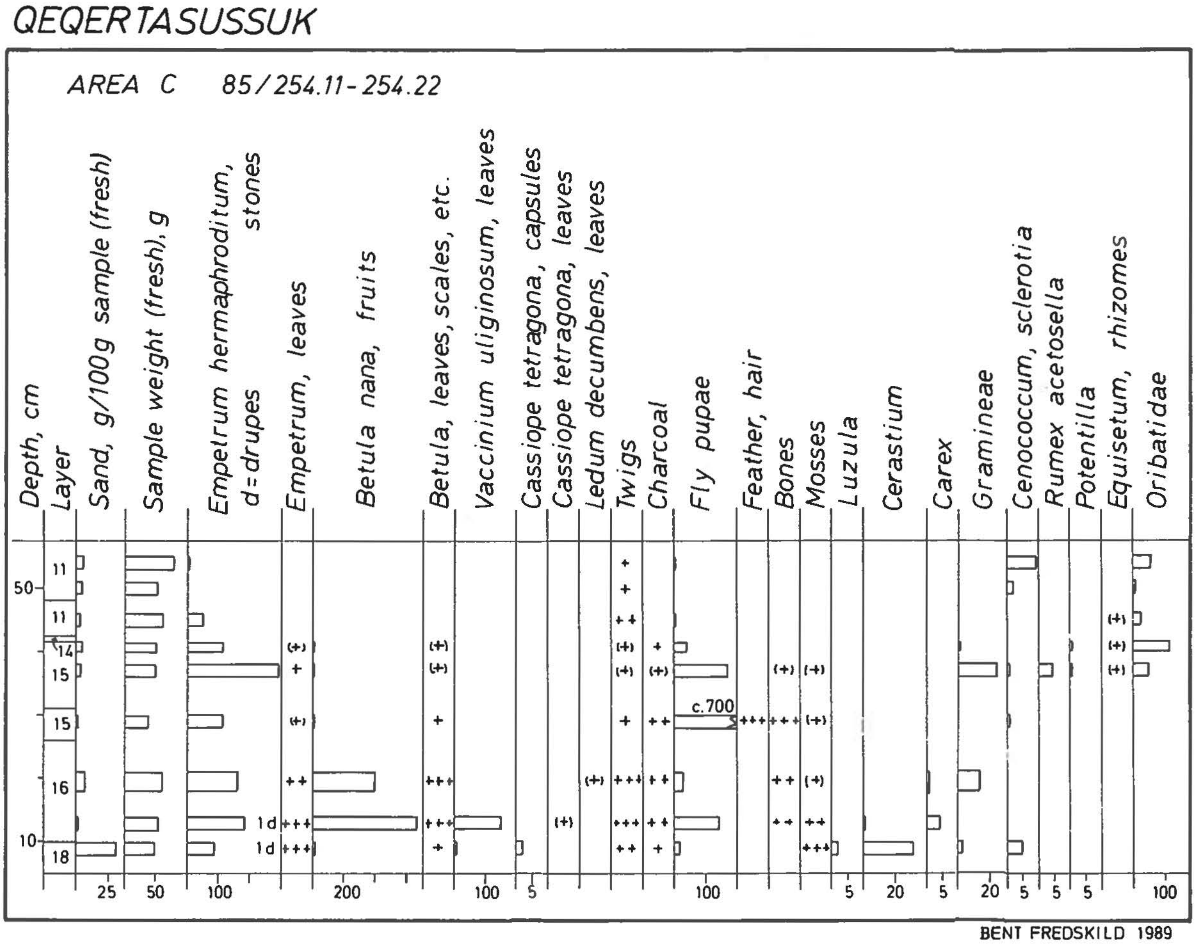


Fig. 8. Botanical macroscopic remains in the Area C column given as number (bar) or estimate, ranging from single (+) to thousand(s) +++.

five of six pollen samples in the deeper layers. This indicates a much faster sedimentation rate of the deeper layers, more so as the exotic pollen influx was greater at that time as shown in the lake pollen diagram.

Layer 1. This layer is less humified, as seen from the many mosses and *Empetrum* leaves. It was formed by a grassy-mossy vegetation, dominated by *Poa* sp. with some *Empetrum*, *Ranunculus*, *Equisetum*, *Salix* and others.

Area C (Fig. 4)

Layer 18. The layer rests on the raised beach. It corresponds to layer 8 of Area B yet is more humified as a result of its position higher up on the slightly N-facing slope. The pollen of Gramineae and *Saxifraga oppositifolia* type (Fig. 7) often occurred in small lumps as did those of *Cerastium*/*Stellaria* type, indicating growth *in situ*. Only few Gramineae pollen were of *Elymus* type and no leaf fragments of this species were seen. Also included in the *Saxifraga oppositifolia* type are *S. tricuspidata*, *S. aizoides* and *S. paniculata*, all present today on Qeqertasussuk. This sandy, humous soil with *Cenococcum* sclerotia was formed under a fairly dry, mossy *Empetrum* heath with grasses, possibly *Hierochloë alpina*, which is the most common grass on the isle today. Further, *Cerastium alpinum*/*arcticum*, *Luzula* sp. and *Saxifraga* (most likely *S. tricuspidata* and/or *S. oppositifolia*) was growing locally. Peat normally does not accumulate in such vegetation.

Layer 16. *Betula nana* and *Empetrum* seem to have been the most eagerly gathered dwarf-shrubs but also *Vaccinium uliginosum*, *Ledum decumbens*, *Salix glauca* and *Cassiope tetragona* were used, the last mentioned commonly used as fuel as it can burn even when fresh (Porsild 1920). The grass pollen can roughly be separated into three types: the large *Elymus* type; the big, coarsely scabrate *Alopecurus alpinus* type; and a type (here termed *Poa* type), common to all other species. Most pollen in this layer are of the *Poa* type, quite many of *Alopecurus* type, fewer of *Elymus* type. Most likely the *Poa* type mainly represents *Puccinellia vaginata* which, like *Alopecurus alpinus*, is very common at inhabited places around Disko Bugt. Most if not all of the 21 more or less destroyed grass achenes and/or lemmas in sample C18a were of *Puccinellia*. In this sample also two rachis fragments of *Elymus* are found. This species, which is visible at long distance because of the bluish green colour, is often connected with manuring whether at bird cliffs, inhabited places or former Eskimo sites. *Rumex acetosella* seeds and *Empetrum* stones indicate (human) faeces.

Layer 15. For pollen and seeds this layer exhibits no major difference from layer 16. The main difference is the markedly smaller content of twigs. The seeds of *Rumex acetosella*, *Oxyria* and *Juncus* cf. *biglumis* must have been brought to the place by man.

Layer 14. Some of the macrofossils were charred. The pollen spectrum and the two macro samples give a rather confusing picture, illustrating the heterogenous composition of this culture layer. The seed of *Arabis alpina* growing in herb-slopes and willow scrubs must definetely have been brought in as must the *Carex* nut if it really is a *C. saxatilis*, which grows at margins of lakes and ponds.

Layer 11. It is highly decomposed and the number of macrofossils low. Judging from the pollen spectra a *Betula* heath with ericaceous plants covered the site, to be replaced later on by a *Ledum* dominated heath with other ericaceous dwarf-shrubs and *Betula*. *Stellaria humifusa* must have spread from the seashore to the manured soil as its seeds are found in a sample in the lower part of the layer. Capsules of *Cassiope* in the upper part may indicate a local growth, if not blown in with the sand and charcoal.

Layer 9–10. Neither pollen nor botanical samples for macroscopical analysis were studied from these layers, but stones and one drupe of *Empetrum* and a seed of *Luzula* is found in an arthropod sample. The occurrence of an oogonium of *Chara* sp. (identified by J. Matthews) needs an explanation, as no Characeae were found on Qeqertasussuk.

Lake coring

In a peat deposit the effect on the natural vegetation of a human settling will completely hide that of any climatic change during and in a long period following the habitation period. Contrary to the Sermermiut excavation 70 km to the north, where the millennium that passed between the Saqqaq and Dorset periods registered in the more than one metre thick peat was long enough to register climatic changes (Fredskild 1967), the time between the habitation phases at Qeqertasussuk was too short. To get, if possible, a reflection in the natural vegetation on the island of the Holocene climatic changes, the only, very small lake, ca 60 m long, was cored. It is situated in a narrow gorge 80 m a.s.l. just above the upper marine limit (Fig. 9). The width at the narrowest place between the 10–15 m vertical rocks is only ca. 15 m. A pollen diagram based on 33 samples has been made, and some selected curves for terrestrial plants are given (Fig. 10). At the main coring site 24 cores were taken in 120 cm tubes at varying depths. The sediment can briefly be described as:

0–306 cm: water
306–433 cm: homogenous, dark olive-brownish fine detritus gyttja.
433–498 cm: layered, more or less bright, olive fine detritus gyttja. Upwards gradually darker and the layering vague.
498–500 cm: almost pure sand.
500–505 cm: clayey, dark gyttja with coarse detritus.
505–525 cm: olive, clayey, layered fine detritus gyttja, with but small content of sand.
525–537 cm: greyish, clayey-sandy layers alternating with slightly brownish, olive fine detritus gyttja.
537–544 cm: layered, bright brownish-olive gyttja with many 2–3 mm sand stripes.

The characteristic sand layer at 498–500 cm was found at depths ranging from 492–493 to 502–503 cm in the 10 cores reaching that deep. Below this, the thickness of the often obliquely laminated, more or less minerogenous layers varied much between the 32 mm wide tubes. The coring was often stopped at varying depths due to stones. The irregular sedimentation in the very beginning of the limnic phase, possibly with sediment focusing, must be responsible for the inversion in the oldest ^{14}C datings, which are based on pooled samples taken from the same depth in four (524–527 cm) and nine (506–509 cm) cores. However, the sand layers from 500–543.5 cm are very thin in the core used for pollen analysis and the pollen curves do not indicate any rebedding in this core.

It should be borne in mind in the following discussion that a pollen diagram from such a small basin may be subject to irregularities, caused for example by macroscopic contamination by sedimentated flowers or stamens. The slides of the 500 cm sample clearly showed macroscopic pollution and is disregarded. Four pollen zones can be separated:

Zone A: *Minuartia/Silene*-Gramineae-Cyperaceae pioneer zone with *Oxyria*, *Plantago maritima*, *Empetrum* and other ericaceous dwarf-shrubs. This zone only lasts few centuries, estimated by extrapolation and judging from other West Greenland diagrams (Fredskild 1983).
Zone B: *Salix*-Cyperaceae-Gramineae zone, still with large, but decreasing amount of pioneer plants.

Fig. 9. The raft in position in the middle of the cored lake. Charlie Christensen phot. 1986.

Zone C: *Betula nana* zone. The marked decrease in *Salix* and others is partly a statistical artefact caused by the immigration of the very great pollen producer *Betula nana*. Even if the sedimentation rate is unchanged at the sediment border the decrease in number of *Salix* pollen per ml would indicate fewer *Salix* in the surroundings. Most likely, however, the sedimentation rate decreases when the minerogenic outwash almost stops at ca. 500 cm, further pointing at a reduction in number of flowering *Salix* as a result of competition with *Betula*. *Rumex acetosella* is found in every sample right from its first appearance at 505 cm. The change in sediment from highly minerogenous to mainly organic at the zone border B-C indicates that by that time *Betula nana* dominated dwarf-shrub heaths covered the major part of the ground, protecting it against wind and water erosion.

Zone D: *Betula*-Ericales zone. The zone border is placed at the end of the continuous *Rumex acetosella* and *Pinus*/*Picea* curves, the beginning of the continuous *Tofieldia* curve and the decrease in *Salix* pollen from usually above, to constantly below 1000/ml. The frequency of Ericales pollen gradually increases from 5% in zones A, B and the beginning of C to 15–20% in the past millennium.

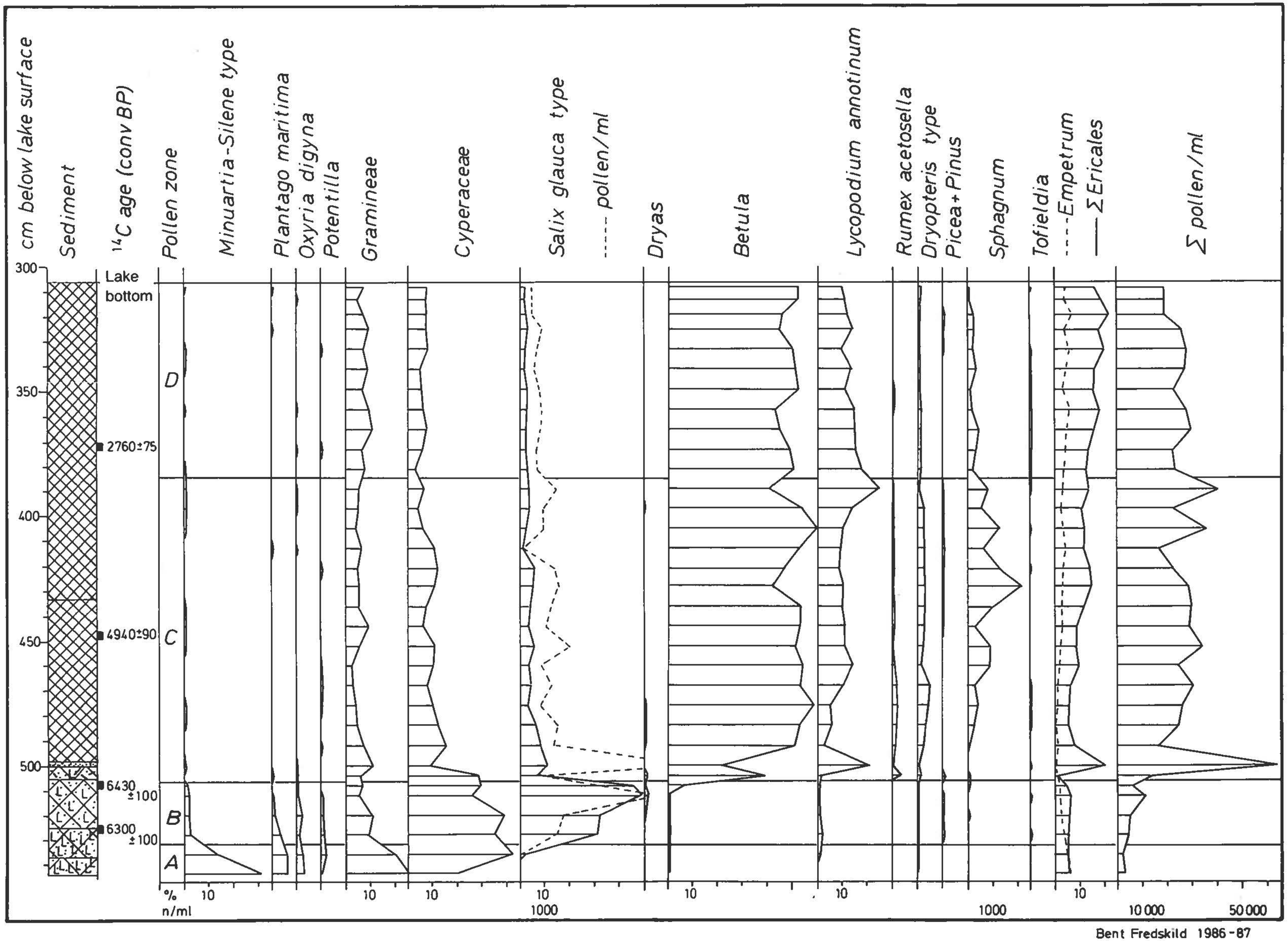
Entomological analyses

In general, the state of preservation of the arthropod material is extremely good, with hairs and scales and the ommatidia of compound eyes retained (see Figs 12, 14, 16, 19, 20). Very often the fragments are still articulated (Fig. 12) and presumably the fragmentation in most cases is caused by the sifting and flotation procedures. Extraordinary preservation is further reflected by the presence of fossils of a large number of soft bodied arthropods like Araneae, Hemiptera and adult Diptera.

In general, fossil arthropod assemblages are dominated by beetles (Coleoptera) because of their highly resistant exosceletons. Despite the very subordinate role of Coleoptera in the Arctic and especially in Greenland (see below and Böcher 1988), beetles also make up a surprisingly high proportion of the record from Qeqertasussuk.

The state of exploration of the present Greenlandic fauna precludes identification of some of the unusually well preserved fossils. For example, some of the dominant taxa of terrestrial arthropods, Diptera except for a few small families, Hymenoptera parasitica and Araneae, badly need a modern revision. However, the Coleoptera and Heteroptera of Greenland are relatively

QEQERTASUSSUK (68°35'N, 51°07'W)



well known, and most conclusions regarding the palaeoecological conditions are based on these taxa. The large collection of oribatid mites has been handed over to P. Gjelstrup, The University of Århus, for identification.

Taxonomical treatment

The appendix (p. 34) gives a list of the arthropod taxa. Figs 21 and 22 show the distribution of the arthropods within the sediment sequences. The following comments refer to selected species and higher taxa.

Carabidae, ground beetles

Bembidion grapii is one of the most widespread beetles in Greenland, on the west coast found north to Ukkusissat Fjord east of Svartenhuk (Böcher 1988). However, it is rare in the northern part of its area, being found only at some distance from the outer coast, in scattered places with a warm microclimate, e.g. on south-facing slopes with a low and fairly sparse vegetation cover. The general distribution is circumpolar, subarctic to low arctic (Böcher 1988). In Scandinavia and North America it is confined to the high boreal and birch region, on dry, sandy surfaces with sparse vegetation, e.g. on forest fringes (Lindroth 1945, 1955, 1963, 1985–86).

B. grapii was not found living on Qeqertasussuk, but was caught on the mainland, immediately south of the island. Here it occurred under stones on a south-facing slope with xerophilous vegetation, dominated by *Kobresia myosuroides*, *Calamagrostis purpurascens*, *Campanula gieseckiana*, *Vaccinium vitis-idaea* and lichens.

In Greenland as elsewhere *Trichocellus cognatus* very often occurs together with *B. grapii*, but is markedly less frequent and widespread (Böcher 1988). Its present northern limit appears to be in the interior at the head of Kangerlussuaq/ Søndre Strømfjord (Fig. 11), ca. 200 km south of Qeqertasussuk, where the climate is highly continental.

Outside Greenland *T. cognatus* is not an arctic species and only exceptionally met with north of and above the tree line. It is perfectly circumpolar and widespread in temperate-subarctic areas. In northern Europe it occurs in glades and outskirts of coniferous forests, further south it prefers oligotrophic bogs (Brundin 1934; Lindroth 1945, 1968, 1985–86).

Fig. 10. Selected pollen curves from the lake coring. The pollen sum in the deeper samples (500–543.5 cm) ranges between 226 and 447, in the upper samples between 469 and 657.

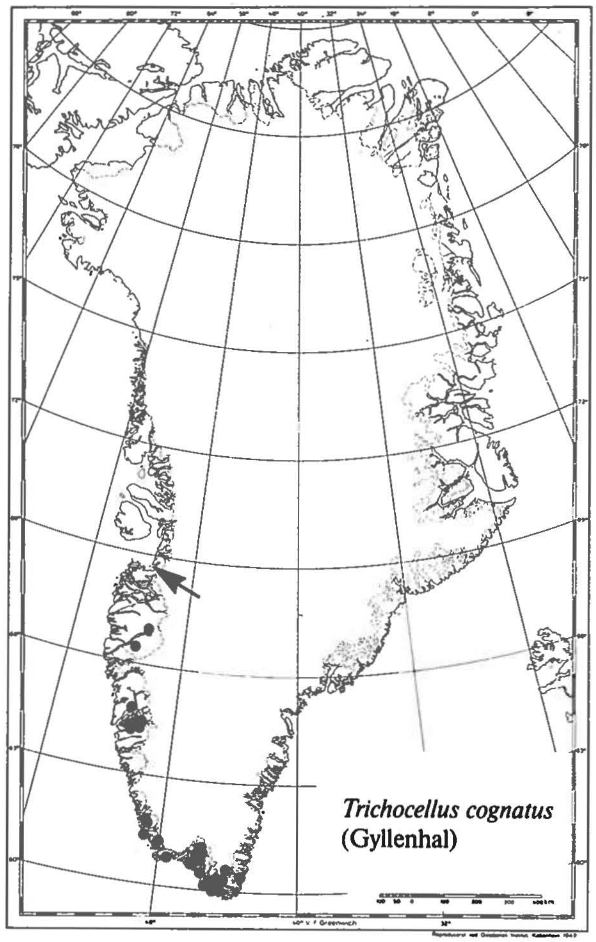


Fig. 11. Known present distribution of *Trichocellus cognatus* (Gyllenhal). The arrow shows the position of Qeqertasussuk.

Dytiscidae, predacious water beetles

Hydroporus morio, the smaller of the two Greenlandic dytiscid species, is very common and widespread along the entire west coast of Greenland; it has not been recorded from Northeast Greenland and there are only two finds from North Greenland (Böcher 1988). Its general distribution is circumpolar, boreal to arctic.

Colymbetes dolabratus, the large Greenlandic dytiscid, is one of the most common and widely distributed of Greenlandic insects. It occurs along both coasts almost to 75°N. The general distribution is circumpolar, boreal to arctic.

Remains of both species of Greenlandic Dytiscidae are found scattered throughout the layers (Fig. 21). Quite possibly these water beetles were attracted by small puddles or other shining surfaces in the settlement area and then have perished there.

At present both *H. morio* and *C. dolabratus* are very common in small pools and ponds on Qeqertasussuk. Remains of both species were found in Holocene lake sediments from two places in South Greenland. At Qassiarsuk the oldest find of *H. morio* and *C. dolabratus* were from 8600 and 3900 years BP (Fredskild *et al.* 1975).

Staphylinidae, rove beetles

Among the multitude of fragments of *Micralymma*, some deviated in different respects, but except for one fossil: a complete abdomen, are typical of the species, *M. brevilingue*. This abdomen is much broader (1.09 mm) than in any of *M. brevilingue* specimens in the modern (dried) material at the ZMUC (0.91 ± 0.13 mm, N = 28). It falls within the breadth of modern *Micralymma marinum* from Greenland (1.06 ± 0.04 mm, N = 14) and also agrees entirely with this species in shape and microsculpture.

M. marinum is a marine insect, with a holarctic, amphiatlantic, temperate to subarctic distribution (Lindroth 1931, 1957; Campbell 1980). In Greenland it is found scattered along the west coast northwards to Kronprinsens Ejland in Disko Bugt, almost at the same latitude as Qeqertasussuk. The habitat is stones and rocks in the tidal zone, where it is regularly submerged during high tide (Böcher 1988). However, the species has sometimes been found above the high water mark, in one case together with *M. brevilingue* (Böcher 1988), and accordingly it is not too surprising to find it in the sediments from Qeqertasussuk.

M. brevilingue is represented in all layers by many fragments, in nearly every possible combination, including some almost entire bodies (Fig. 12) and larvae.

Apart from fly puparia, *M. brevilingue* is the dominant insect species in the whole series of cultural layers, accounting for ca. 70–100% of the total beetle fauna, and especially numerous in layer 111 (cf. p. 29). This is surprising considering the impression of a nowadays widely dispersed, but fairly scarce species (see below). Undoubtedly the human impact on Qeqertasussuk created ideal living conditions for *M. brevilingue*.

Micralymma brevilingue is widespread in Greenland (Fig. 13), with aproximately the same distribution as *Colymbetes dolabratus* (p. 17). It is, however, inconspicuous, living a secrete life in humid places, most often close to the beach, where it may be found under stones. The habitat appears to include both the upper part of the tidal zone (to some extent overlapping the habitat of *M. marinum*) and damp places in different situations further inland (Böcher 1988, p. 35). The general distribution of *M. brevilingue* is circumpolar and arctic.

On Qeqertasussuk *M. brevilingue* was caught in two localities of the settlement area (see p. 5). A few specimens were from *Empetrum*-heath close to Area C, but the species was more abundant in *Elymus mollis*-vegetation immediately south of Area A.

The fossils of the rare rove beetle *Atheta hyperborea* (Fig. 14, a, b) represent at least 27 specimens, which is most surprising as Qeqertasussuk is well north of its known northern limit (Böcher 1988). So far, only three specimens of this species have been collected in Greenland, from two widely separated areas: Igaliku and Qassiarsuk in subarctic South Greenland, and Eqalummiut nunaat at the head of Nordre Strømfjord, a fairly dry, continental low arctic locality. Apart from Greenland the species is palaearctic and boreal, hitherto only known from Scandinavia.

Byrrhidae, byrrhid beetles

Simplocaria metallica (Fig. 16, d) has been found in scattered localities along the southern part of the Greenland west coast, from Frederiksdal to Disko (Fig. 15). Accordingly, Qeqertasussuk is close to the present northern limit of the species in Greenland. It is most often found close to water (fjord beaches, river banks, along brooks); however, the most important precondition may be the occurrence of the right species of mosses to feed upon (Böcher 1988). The general distribution is holarctic (absent from Asia), boreal to low arctic (in Europe boreo-alpine).

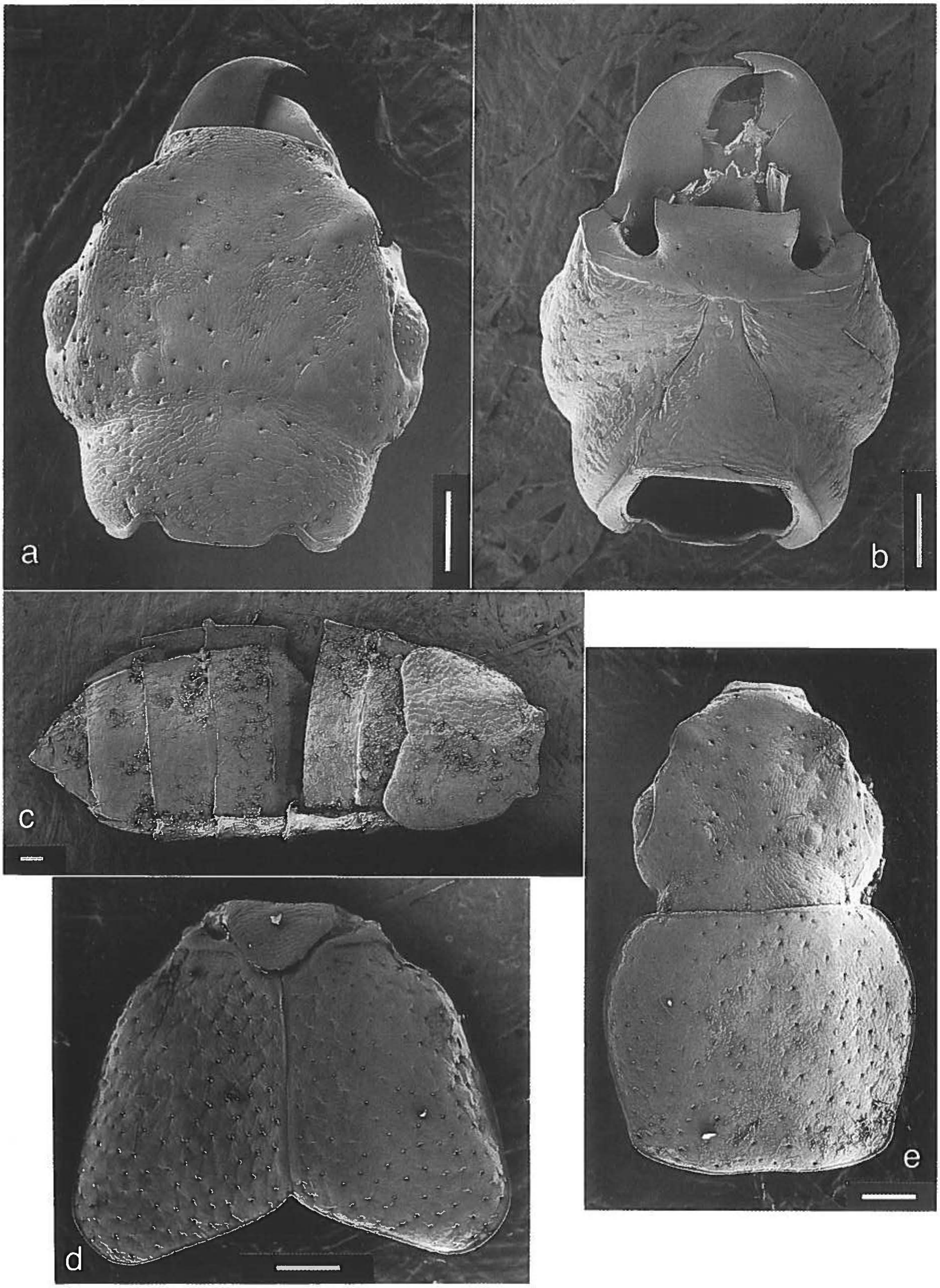
Byrrhus fasciatus (Fig. 16, a, b, c) is common and widespread in low arctic Greenland, especially in the south; it extends into the High Arctic along both the west and the east coast. It is commonly found under stones and vegetation, especially mosses, but otherwise the species is highly eurytopic (Böcher 1988). The general distribution is perfectly circumpolar, temperate to arctic.

Coccinellidae, ladybird beetles

Coccinella transversoguttata has the widest distribution of the terrestrial Greenlandic beetles, ranging from Upernavik in the northwest to Kejser Franz Joseph Fjord in the northeast. It is most common in inland areas with dry, warm summers, especially in heaths with *Betula nana* and *Salix glauca* (Böcher 1988). The food is small insects, mainly aphids and psyllids, both taxa being represented in the fossil material from Qeqertassusuk. The general distribution is holarctic, temperate to arctic; the species is absent from Europe.

C. transversoguttata (one specimen) together with *Micralymma brevilingue* were the only terrestrial beetles found during the collecting efforts on Qeqertasussuk in 1987 (pitfalls in an *Empetrum*-heath close to the excavations, see p. 5).

Fig. 12. Fossil remains of *Micralymma brevilingue* Schiödte (Staphylinidae). a: Head from above; b: Head from below; c: Articulated abdomen + meso- and metathorax; d: Articulated elytra; e: Articulated head + prothorax. Scales: 100 mμ.


a
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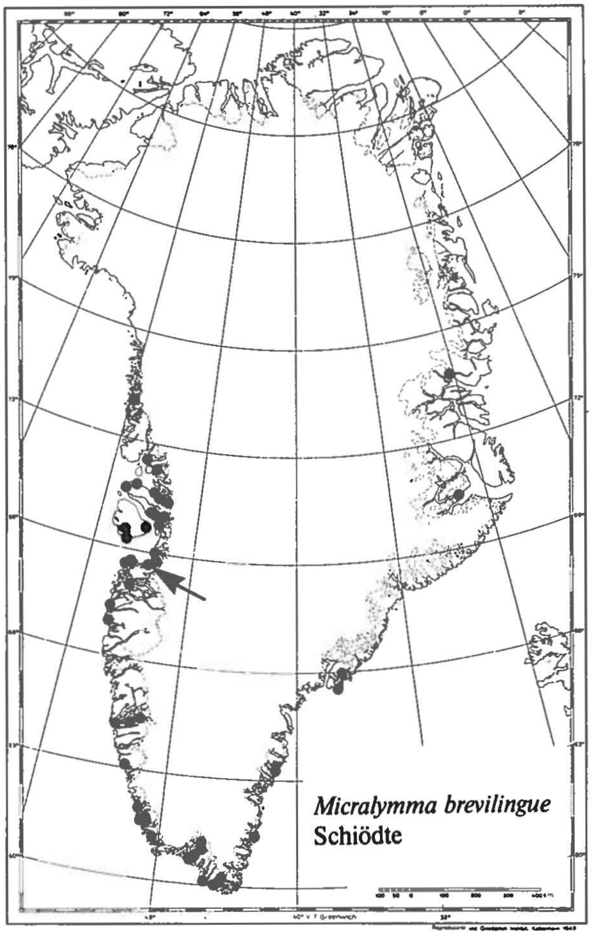


Fig. 13. Known present distribution of *Micralymma brevilingue* Schiödte in Greenland. The arrow shows the position of Qeqertasussuk.

Latridiidae, latrid beetles

Corticaria rubripes has only been collected in two Greenlandic localities, both close to Kangerlussuaq/Søndre Strømfjord in the continental middle West Greenland (Böcher 1988) – *i.e.* about 200 km south of Qeqertasussuk. The species feeds on moulds. The general distribution is palaearctic, temperate to low arctic; southwards mainly in mountain coniferous forests (Böcher 1988).

Curculionidae, weevils

Dorytomus imbecillus (Fig. 14, c, d) is considered a rare species in Greenland, known from only five localities along the southwestern coast (Fig. 17), the northernmost more than 250 km to the south of Qeqertasussuk. The species is found in coppices of *Salix glauca* and probably feeds on this and other species of willow (Böcher 1988). The general distribution is holarctic, boreal to low arctic; it is absent from Europe.

Siphonaptera, fleas

The bird flea, *Ceratophyllus vagabundus*, mainly parasitizes sea birds like eiders (*Somateria* spp.) and gulls (*Larus* spp.), but it also occurs on geese (*Branta leucopsis*, *Anser brachyrhynchus*; Franzmann 1976), and birds of prey (eagles, falcons and hawks; Brinck-Lindroth, personal communication 1991). The species is circumpolar and mainly low arctic (Danks 1981), but in Greenland it has hitherto only been found in Northeast Greenland (Henriksen 1939, Franzmann 1976).

The finds from Qeqertasussuk undoubtedly stem from bags of sea birds.

Diptera, flies

Remains of flies, mainly puparia, constitute a large fraction of the insect material from the Qeqertasussuk layers (Figs 18, 21). Apparently puparia of Anthomyidae, Muscidae and Calliphoridae are dominating (Ferrar 1987).

In nearly all layers also fragments of adult Diptera occur. Especially in layers 15a and 33 a large number of amazingly well preserved thoraces and heads were found (Fig. 19), but only two species have been identified. However, most of the heads are undoubtedly from Piophilidae spp. (Fig. 19, e), the larvae of which are typical inhabitants of refuse dumps with abundant animal material.

Tipula arctica is an arctic circumpolar species. In Greenland it is very common and distributed almost throughout the country.

Aedes nigripes (Fig. 19, d), the common Greenlandic mosquito, is distributed throughout the country and is abundant along the southern west coast, especially in inland areas. The general distribution is holarctic, yet missing in Europe. The identification is tentative, because the closely allied and very similar species, *A. impiger* Walker (= *A. nearcticus* Dyar) has also been reported from West Greenland, but may be less frequent (Nielsen & Nielsen 1966, Danks 1981).

Calliphoridae, blowflies, are represented by *Protophormia terraenovae*, which today is very common and found almost all over Greenland. The larva lives in carcasses and is common in refuse dumps (Rognes 1991). The general distribution is holarctic.

Because of the limited number of Greenlandic blowflies, it is possible tentatively to identify the puparia of this species (Fig. 19, b, c) in Greenlandic material, according to descriptions and figures in Hall (1948) and Zumpt (1965). The percentage of the total number of puparia made up by *P. terraenovae* varies from zero to 84%, with the highest percentages in layers from the midden (32, 33). The species is absent from the uppermost layers (9–10, 11) – in good agreement with the

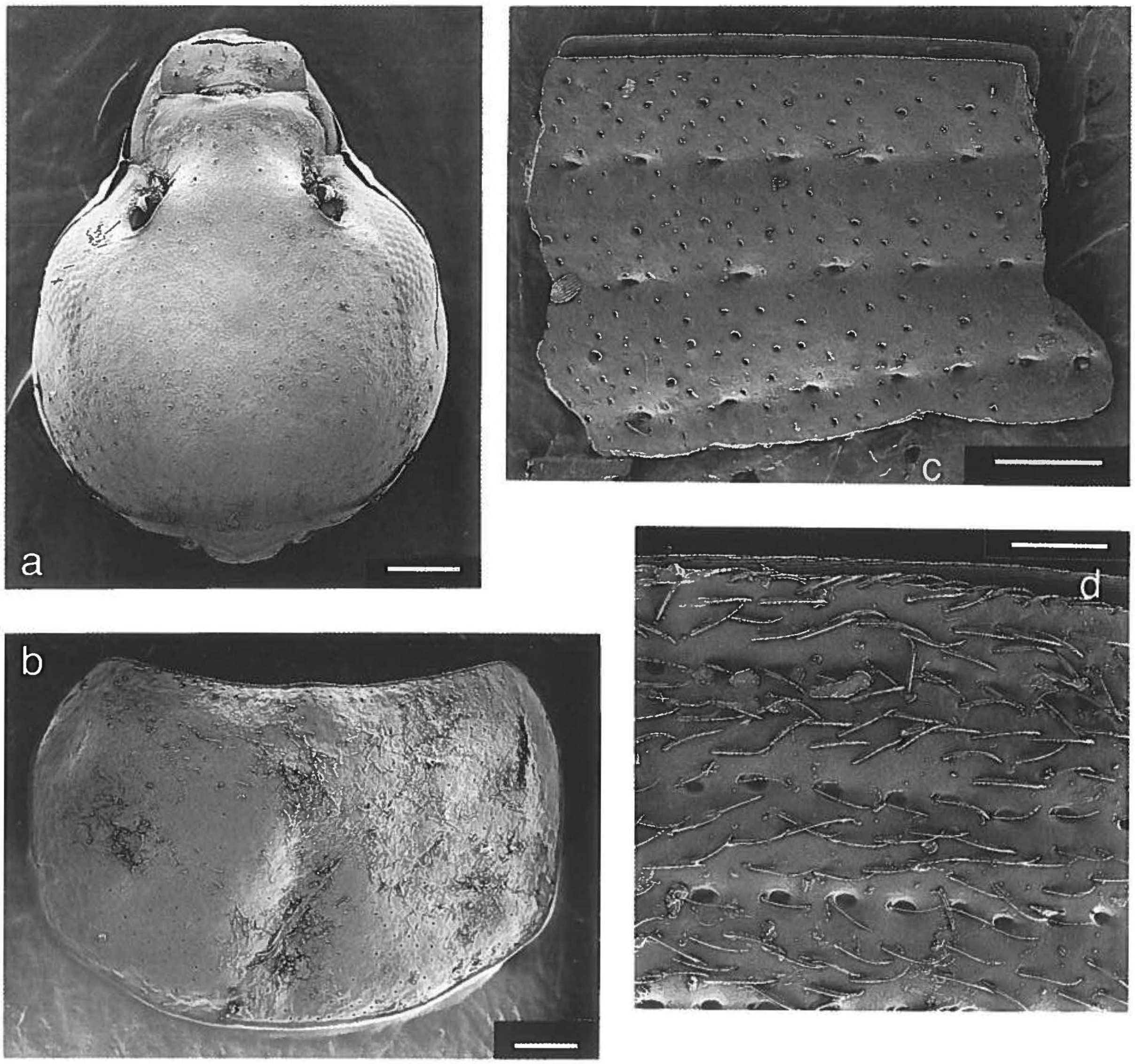


Fig. 14. Fossil remains of Coleoptera. Head (a) and pronotum (b) of *Atheta hyperborea* Brundin (Staphylinidae); c: Elytron fragment of *Dorytomus imbecillus* Faust (Curculionidae); d: Part of elytron from a modern specimen of *D. imbecillus*. Scales: 100 mμ.

decreasing human influence at the site, e.g. fewer carcasses, in these layers. The species was not caught on Qeqertasussuk in 1987.

Lepidoptera, butterflies and moths

Fragments of larvae and pupae of Lepidoptera are fairly common in the layers (Fig. 21). The most common remains are larval mandibles (Fig. 20, c) which are probably not identifiable. A few thoraces of adults were found, in one case a thoracal fragment bearing hind wings from a small phrenate species.

Hemiptera, true bugs

The lygaeid *Nysius groenlandicus* (Fig. 20, a, b) is an extremely widespread, characteristic and common insect in Greenland, however, most abundant in inland areas with a dry and warm summer, in particular in steppe-like plant communities. It is fairly frequent on Qeqertasussuk. The species is a polyphagous seed feeder with a univoltine (annual) life cycle (Böcher 1972, 1975, 1976).

N. groenlandicus appears to be distributed from Greenland and Iceland through the Scandinavian

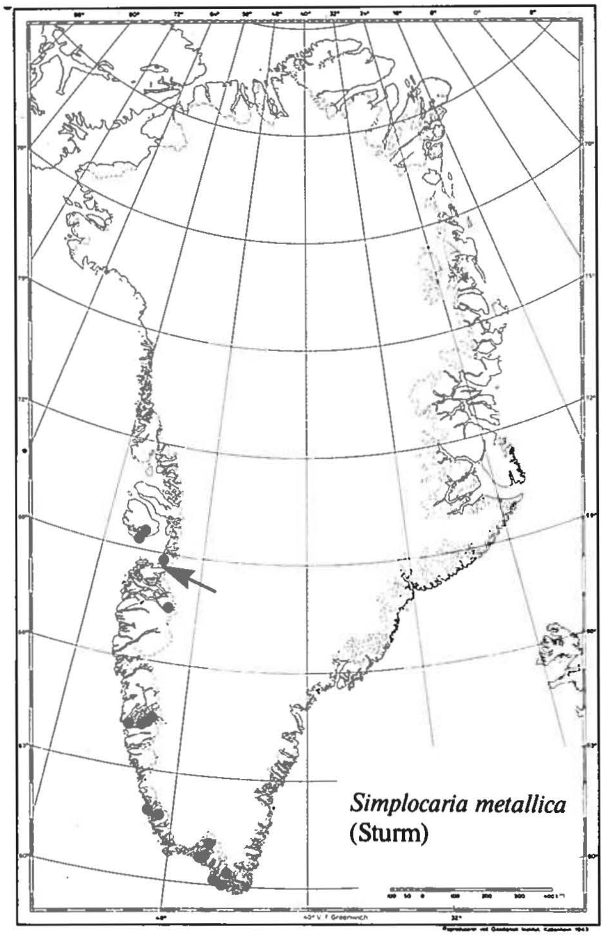


Fig. 15. Known present distribution of *Simplocaria metallica* (Sturm) in Greenland. The arrow shows the position of Qeqertasussuk.

mountains and Siberia to the mountains of central Asia. It is also recorded from subarctic North America (Danks 1981), although that record is still doubtful.

Chlamydatus pullus, a mirid, is widespread, even in high arctic Northeast Greenland. It is almost always found together with *Nysius groenlandicus* in dry and warm situations, yet is generally less frequent. The species is frequent on Qeqertasussuk, especially in dry heath areas with *Betula nana* and *Salix glauca*.

C. pullus is parthenogenetic in Greenland. It is a sapsucker on different herbaceous plants, in particular *Potentilla* spp., occasionally a predator of small insects. In Greenland *C. pullus* has only one annual generation (Böcher 1971).

The Greenlandic Psyllidae need a revision, and accordingly it is not possible at the moment to comment on the present distribution of *Psylla groenlandica* to which species some fragments have been tentatively attributed (Fig. 20, d).

Psocoptera, booklice

Two fairly complete specimens of *Liposcelis* sp. (Troctidae) were found in layers 14 and 33. The finds are remarkable since, according to Henriksen and Lundbeck (1918), the only Greenlandic record of Psocoptera is that of "*Troctes divinatorius* Müll." reported by O. Fabricius (1780). However, the possibility that the present finds originate from pollution in the ZMUC cannot be totally excluded.

Arachnida

Fragments of spiders (Araneae) commonly occur in the layers: prosomas, chelicers, palps and leg joints (Fig. 20, e, f). According to N. Scharff, ZMUC, the content of well preserved palps renders the material highly valuable, because these make identification to species possible. However, a prerequisite is a modern revision of the total Greenlandic fauna of Araneae. Not even a complete checklist is at hand.

The material certainly includes representatives of the families Lycosidae and Linyphiidae. Among the lycosid fragments are many well-preserved palps originating from the genus *Pardosa*. The material referred to Linyphiidae comprises many prosomas and palps of the genus *Erigone* (Fig. 20, f). Identification to species is, however, difficult due to a great homogeneity in the genus.

In addition to fossils of spiders, remains of oribatid mites (Acarina) occur with varying frequency throughout the series of deposits (Fig. 21). In general the specimens are almost complete and very well preserved. Haarløv (1967) identified nine species of Acarina from peat samples taken in the palaeo-Eskimo settlement, Sermermiut, at Ilulissat/ Jakobshavn, Disko Bugt.

Arthropod succession

Figures 21 and 22 indicate the relative abundance of the arthropod taxa in the different strata at the site.

The number of individuals must be considered a minimum, because the flotation is not totally efficient. Furthermore, for instance, 5 heads + 4 nota + 6 elytra are counted as 5 individuals (the least possible number of individuals represented by the fragments), but might well originate from 15 individuals. In Fig. 21 the columns not provided with a scale simply give relative frequency of fragments or (with fly puparia and oribatid mites) more or less complete individuals.

The oldest, rather thin layer (18) was deposited among stones and remains of grass-tufts on the original dry surface where the settlement started. The fauna is very sparse, but is already comprising of the small rove beetle *Micralymma brevilingue* which later on becomes abundant. It is not surprising to find *M. brevilingue* here, since the species in most cases has been collected on or close to beaches in Greenland, most often under

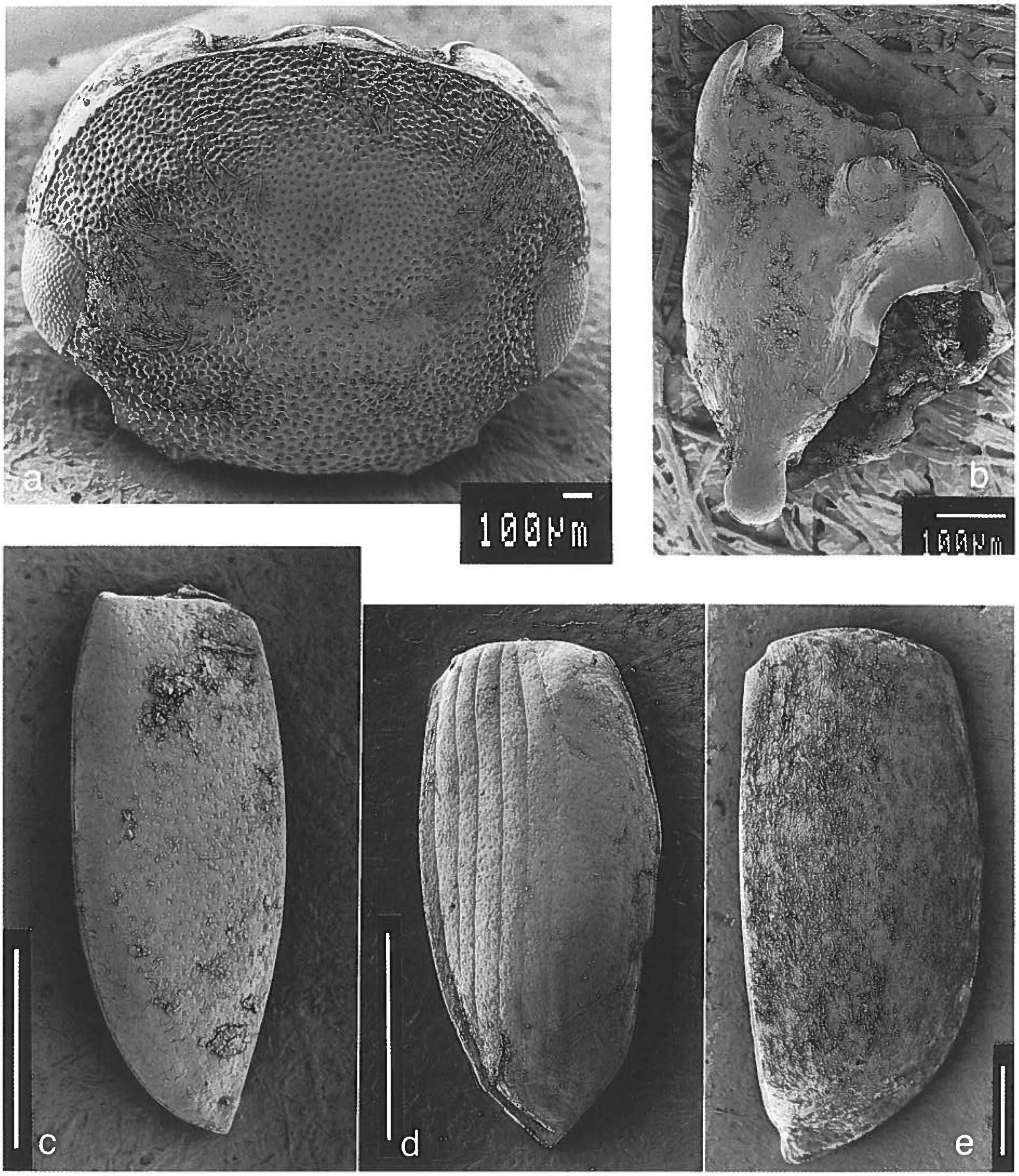


Fig. 16. Fossil remains of Coleoptera. a, b, e: Head, larval mandible and elytron of *Byrrhus fasciatus* Forster (Byrrhidae); c, d: Elytra of *Hydroporus morio* Aubé (Dytiscidae) and *Simplocaria metallica* (Sturm) (Byrrhidae). Scales: 1 mm unless otherwise indicated.

stones. The presence of *Byrrhus fasciatus*, an obligate moss-feeder, indicates moss-vegetation on the beach.

During the subsequent human colonisation the fertilization of the area presumably resulted in the development of rich vegetation (layer 15a). This was utilized by the lygaeid bug, *Nysius groenlandicus*, which is polyphagous on seeds (Böcher 1972). Layer 15a also contained the other widespread Greenlandic Heteropteron, the mirid *Chlamydatus pullus*, which, like *N. groenlandicus*, today is found in dry, warm situations, sucking

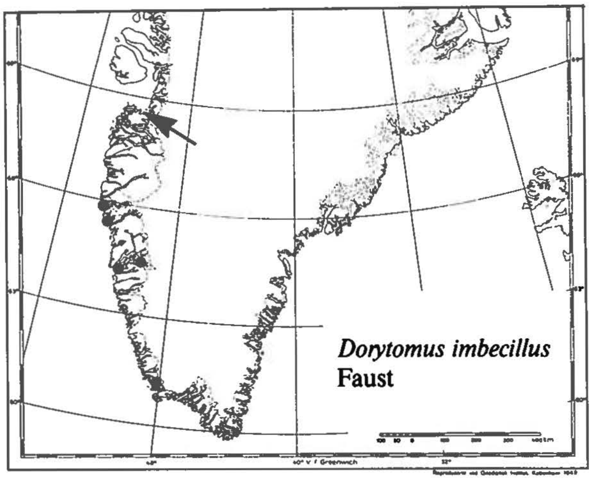


Fig. 17. Known present distribution of *Dorytomus imbecillus* Faust in Greenland. The arrow shows the position of Qeqertasussuk.

sap from a number of herbaceous plants, especially *Potentilla* spp. (Böcher 1971).

The greater plant productivity gradually created a peaty soil, favouring oribatid mites which became frequent. The increased production of dead organic matter

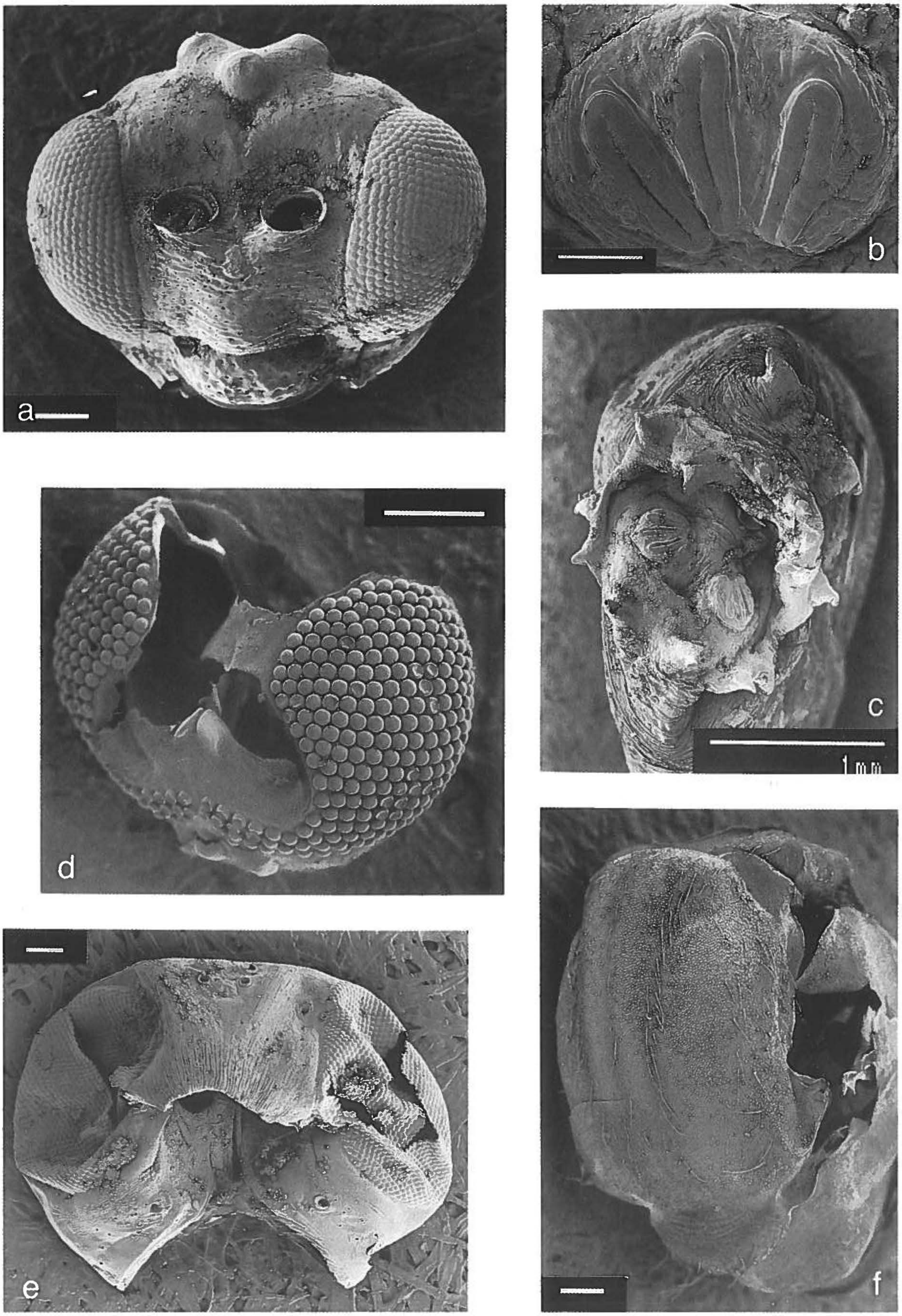
Fig. 19. Fossil remains of Hymenoptera and Diptera. a: Head of Ichneumonidae sp.; b, c: Puparium of *Protophormia terraenovae* Robineau-Desvoidy (Calliphoridae), posterior spiracles and posterior end; d: Head of *Aedes* sp. (Culicidae); e: Head of Piophilidae sp.; f: Thorax of Chironomidae sp. Scales: 100 mμ unless otherwise indicated.

also means improved conditions for different dipterous larvae, and, consequently, large numbers of fossil puparia are present. It is astonishing that in this layer numerous, well-preserved parts of adult flies are also found. Some have been identified: a thorax of the ubiquitous mosquito, *Aedes nigripes*, and a head of the common blowfly, *Protophormia terraenovae*. Simultaneously with the increase in mites and Diptera is a rise in frequencies of important predators: spiders (Araneae) and parasitoid wasps (Ichneumonidae, Braconidae).

In layer 15a two fragments of Siphonaptera (fleas) have been found. Identification to species is impossible, but they presumably represent the bird flea *Ceratophyllus vagabundus*, originating from bags of sea birds.

There is a marked change to lower diversity and frequency from layer 15a to layer 16. This may be due to the fact that during the formation of layer 16, the sam-

Fig. 18. Horizontal view of section in Area C with numerous fly puparia *in situ*. Geert Brovad phot.



a
b
c
1mm
d
e
f

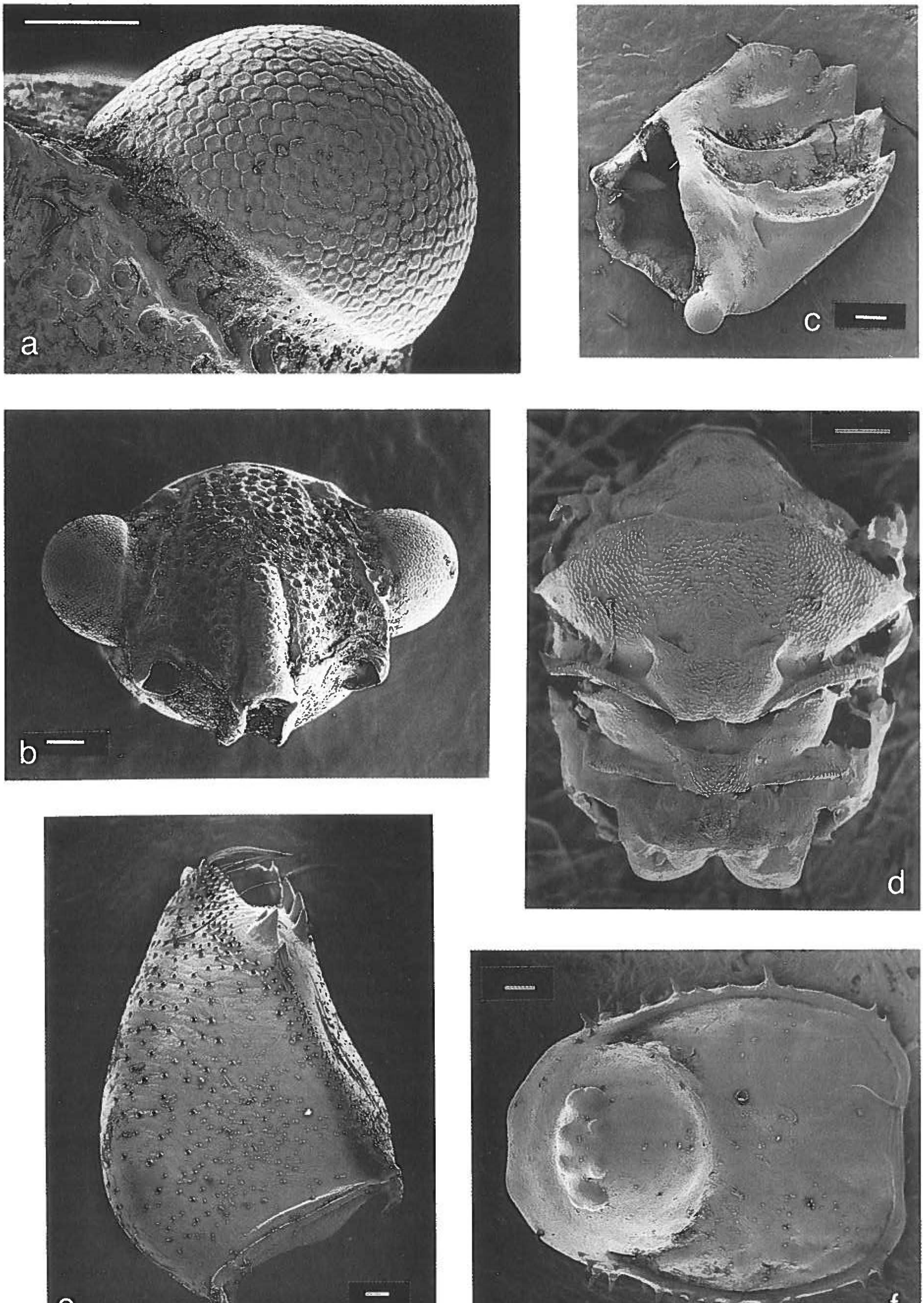

a
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Fig. 20. Fossil remains of Hemiptera, Lepidoptera and Araneae. a, b: Compound eye and head of *Nysius groenlandicus* (Zett.) (Lygaeidae): c: Larval mandible of Lepidoptera sp.; d: Thorax of *Psylla* cf. *groenlandica* Sale (Psyllidae); e: Chelicer of Araneae sp., probably Lycosidae; f: Carapace of *Erigone* sp. (male) (Linyphiidae). Scales: 100 mμ.

pled site was for most of the time inside a tent-house (the stones seen in Fig. 4 are part of a fire place). Through the next layers (15, 14) the fauna becomes somewhat richer. Layer 15 is made up by the mat-like remains of a luxuriant, and probably fairly uniform grass vegetation with reduced living conditions for most insects (Coleoptera, Heteroptera). With increased human activity (layer 14), the vegetation cover probably became highly reduced. Through the layers 16–14 *Nysius groenlandicus* is scarce and *Chlamydatus pullus* was not found. The small carabid *Bembidion grapii* was present during the two periods (layers 14 and 16) with most intensive cultural influence.

The invertebrate fauna indicates a pronounced change in the settlement area from layer 14 to layer 11l, undoubtedly caused by a depopulation of the settlement, or at least a change from continuous to occasional habitation (B. Grønnow, personal communication 1991).

The fertilization resulting from centuries of accumulation of anthropogenic organic matter in combination with a vanishing human wear and tear now apparently gave rise to optimal conditions for plant production. Presumably the vegetation rapidly became lush and blooming, similar to the nitrified vegetation found below bird cliffs (Salomonsen 1979); consequently, the area presented a fairly varied environment, with optimal conditions for both *Micralymma brevilingue* (cool and humid surroundings), and at the same time the xerophilous and thermophilous conditions required by *Nysius groenlandicus*. The frequency of fossils of both *Byrrhus fasciatus* and *Simplocaria metallica* show that also mosses were abundant. Especially interesting is the occurrence in this layer of the rare rove beetle *Atheta hyperborea*.

Remains of Lepidoptera, including fragments of pupae and larval mandibles, are found in all layers, yet most frequently in layer 11l – another indication of a diverse flora. Also the main parasites of Lepidoptera – the parasitoid wasps – attain by far their highest densities in this layer (e.g. average of 85 fragments per l).

The copious deposition of minerogenic material in layer 11 is puzzling. One explanation might be a seasonal violent human activity, in places destroying the vegetation and causing soil erosion (B. Grønnow, personal communication 1991). This would also explain the broad scale of ecological conditions suggested by the insect fauna. Another explanation might be that the sand and the scattered traces of culture, found all through the layer, are rebedded from Area A as a result of wind erosion, whether caused by local or more regional climatic conditions.

In layer 11u both the byrrhids and *Micralymma brevilingue* are less frequent, but *Nysius groenlandicus* is still common, possibly indicating drier conditions.

In layers 9–10 the fauna approaches the present one, except for *Byrrhus fasciatus* which was not found living on the island during the investigations in 1987. *Micralymma brevilingue*, nowadays fairly scarce on Qeqertasussuk, apparently was numerous during deposition of layers 9–11. This may partly be explained by the three to four times slower sedimentation rate of the layers 9–11 than of the underlying culture layers (15, 16, 15a).

The different living conditions between the habitation area (C) and the midden (Area B) is reflected in the arthropod faunas. Thus, the density of fly puparia and adult flies is much higher in Area B compared to Area C, whereas the opposite is the case regarding beetles and in particular Heteroptera.

The fossil frequency of the moss feeding byrrhids, *Simplocaria metallica* and *Byrrhus fasciatus*, none of which have been found on Qeqertasussuk today, possibly indicate more humid conditions, especially in the period following the end of the habitation period.

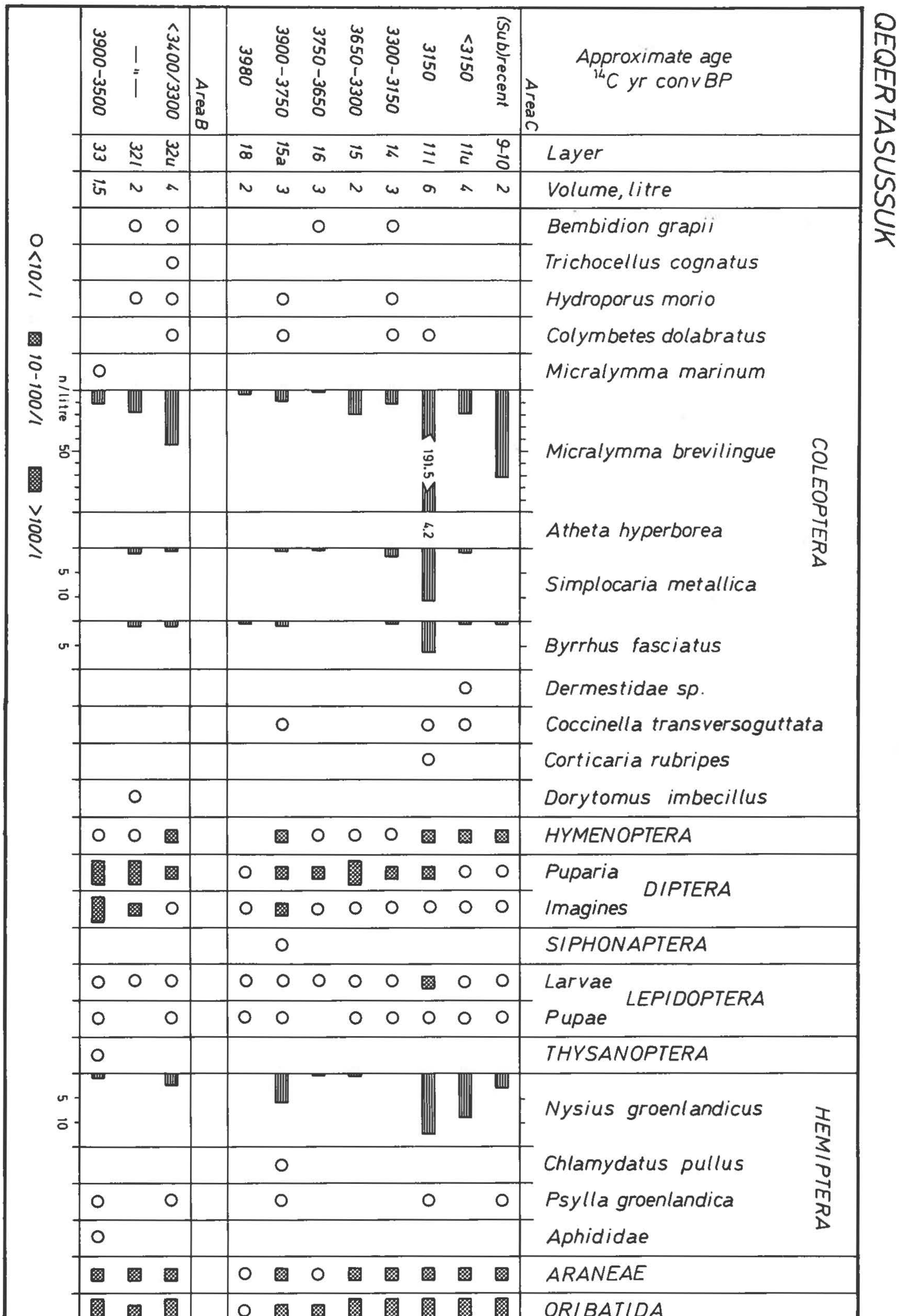
Discussion

Palaeo-entomology

Insect faunas from archaeological sites have been widely used as a valuable tool for interpretation of palaeo-environmental conditions (e.g. Osborne 1973, Kenward 1978, Buckland and Coope 1985, Lemdahl 1990).

Haarløv (1967) mentioned nine species of Acarina and unidentified fragments of Diptera, other insects and spiders from the former palaeo-Eskimo settlement Sermermiut at Ilulissat/Jakobshavn in Disko Bugt. Apart from this publication, the present study appears to be the first concerning fossil insects and other arthropods associated with a prehistoric Eskimo settlement. However, similar investigations were carried out in the Norse settlement Vesterbygden (in the Nuuk/Godthåb area, West Greenland), dating from medieval time (Buckland 1988, Buckland *et al.* 1983). A number of the more frequent and widespread beetle species are in common: *Bembidion grapii*, *Trichocellus cognatus*, *Hydroporus morio*, *Colymbetes dolabratus*, *Simplocaria metallica*, *Byrrhus fasciatus* (Buckland 1988).

The number of beetles represented in the sediments is surprising, regarding both number of species and frequency of fragments. Leaving out the dubious piece of a dermestid beetle, 12 species (36%) have been found of the presently known total of 33 indigenous Greenlandic species (Böcher 1988). Qeqertasussuk is placed in the


QEQERTASUSSUK
Approximate age 14C yr conv BP
Area C
(Sub)recent
<3150
3150
3300–3150
3650–3300
3750–3650
3900–3750
3980
Area B
<3400/3300
— " —
3900–3500
Layer
9-10
11u
11l
14
15
16
15a
18
32u
32l
33
Volume, litre
Bembidion grapii
Trichocellus cognatus
Hydroporus morio
Colymbetes dolabratus
Micralymma marinum
Micralymma brevilingue
191.5
Atheta hyperborea
4.2
Simplocaria metallica
Byrrhus fasciatus
Dermestidae sp.
Coccinella transversoguttata
Corticaria rubripes
Dorytomus imbecillus
COLEOPTERA
HYMENOPTERA
Puparia
Imagines
DIPTERA
SIPHONAPTERA
Larvae
Pupae
LEPIDOPTERA
THYSANOPTERA
Nysius groenlandicus
Chlamydatus pullus
Psylla groenlandica
Aphididae
HEMIPTERA
ARANEAE
ORIBATIDA
n/litre
50
5
10
O <10/l
10-100/l
>100/l

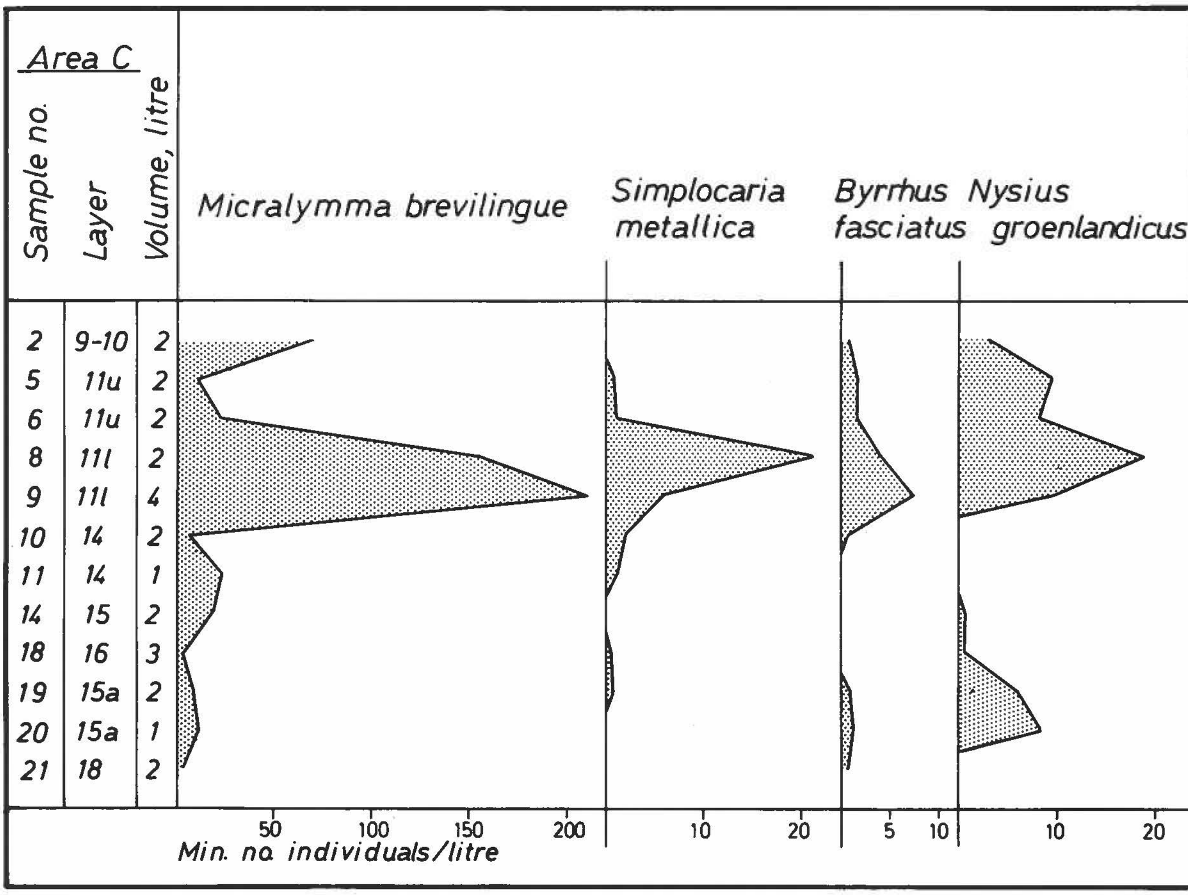


Fig. 22. Minimum numbers of individuals per litre along the section in Area C of the four dominant insect species (apart from Diptera). Confer Fig. 21.

faunal district nSW in which 21 beetle species have been recorded (Böcher 1988, p. 69), and thus more than half of these are known as fossils from Qeqertasussuk.

For all the species, except the Dytiscidae (Fredskild *et al.* 1975), the fragments represent the oldest specimens known from Greenland.

It should be borne in mind that the Qeqertasussuk sediments are autochtonous, *i.e.* representing the very living place of most of the arthropods. Exceptions are the dytiscids (p. 17), mosquitoes and possibly other Diptera belonging to the "background fauna" (Kenward 1978), and the Siphonaptera introduced with the hunters' bags. However, the remains of most arthropods are from individuals which have been living *in situ*, and knowing the rate of sedimentation it should be possible to estimate a minimum value for the populations per square metre.

Fig. 21. Diagrammatic presentation of the total outcome of the arthropod samples, given as minimum numbers of individuals per litre (bars) or numbers of fragments per litre in three quantity classes.

As an example, the thickness of layer 11l, of which a 0.125 m^2 column was sampled, is ca. 6 cm. This sample, ca. 7,5 l, contained fragments representing at least 192 individuals of *Micralymma brevilingue* per l. If it was deposited during 500 years this would correspond to at least 23 individuals per m^2.

These 23 *M. brevilingue* per m^2 represent a "death assemblage" (Kenward 1978) – the number of the population which died and were preserved per square metre per year. Presumably the actual annual living population was much larger.

Corresponding values for other species in layer 11l are: *Simplocaria metallica*: 1.3/m^2, *Byrrhus fasciatus*: 0.7/m^2, *Atheta hyperborea*: 0.5/m^2, *Nysius groenlandicus*: 1.5/m^2. In comparison, the present population density of *N. groenlandicus* in favourable localities frequently surpasses 100/m^2 (Böcher 1976).

Some of the species apparently were more frequent when the sediments were formed than met with in any known locality today. This is most marked in the case of *Atheta hyperborea* in layer 11l, but also regarding *Micralymma brevilingue* in the same layer.

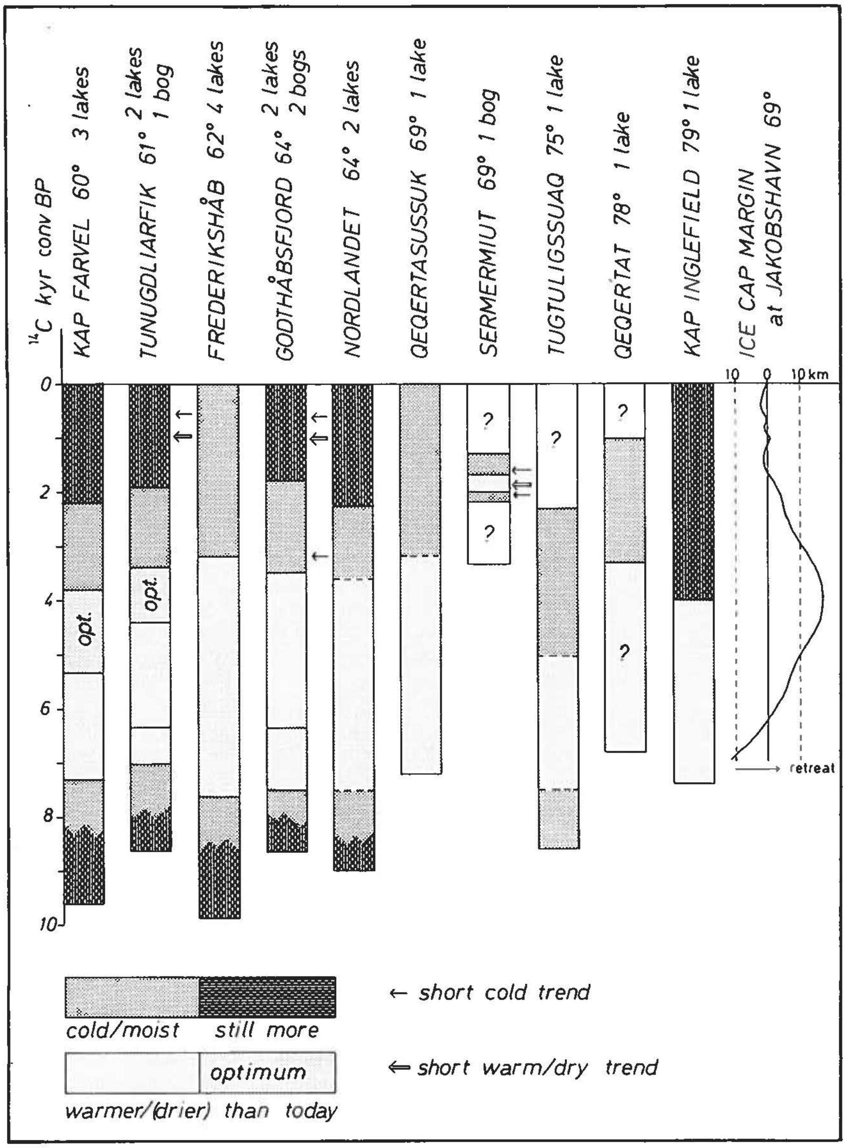


Fig. 23. Inferred Holocene climatic conditions in the western half of Greenland. Sources: see text. ^{14}C dates are uncalibrated.

Generally, the ecological development of the Eskimo settlement at Qeqertasussuk indicated by the fauna is in good agreement with the botanical data.

Climatic changes

The general trends in the Holocene climate of West Greenland are illustrated in Fig. 23, showing a period warmer than today beginning 7500–7000 BP (uncalibrated ^{14}C). In the pollen diagram from the lake (Fig. 10) zone A and B give no clear indication of a climate essentially different from that of today because of the unstable soil with pioneer plants followed by waves of new immigrants. However, in zone C *Rumex acetosella* and the lower frequencies of ericaceous plants, especially *Empetrum* point to drier/warmer conditions, connected with a northward displacement of the polar front and a consequently higher frequency of southwesterly winds, bringing conifer pollen from North America to the lake (Fredskild 1984). Judging from the surprisingly constant number of pollen pr. ml sediment the sedimentation rate in the past 6000 years has been almost constant, and thus the zone border C–D is dated by interpolation at 3200 yr BP which, of course, is not an exact dating of a marked climatic change. The gradual expansion of ericaceous heaths, especially rich in *Empetrum*, and the continuous *Tofieldia* curve indicate more humid conditions during zone D.

As seen from Fig. 23 the close of the Holocene hypsithermal between 4000 and 3000 BP is registered in 16 lakes all over West Greenland, only one, the extremely oceanic Tuttulissuaq in Melville Bugt differs somewhat. The temperature indications from the Inland Ice cores confirm this picture which is also reflected in the position of the ice margin. Thus, Weidick *et al.* (1990) have shown that the maximum recession of Jakobshavn Isbræ happened around 4000 BP when the Saqqaq people first settled at Disko Bugt. This made the ice free area and thereby the reindeer hunting grounds on the mainland twice as large as today's. In the middle of the Saqqaq period the ice margin advanced again.

Finally, a number of beetle species found in the culture layers well north of or close to their present northern limit clearly indicate a warmer climate than today (*Trichocellus cognatus*, *Micralymma marinum*, *Atheta hyperborea*, *Simplocaria metallica*, *Corticaria rufescens*, *Dorytomus imbecillus*).

A somewhat deviating picture is seen when looking at the conditions in the sea. By means of the content in raised marine beds of boreal molluscs, now extinct in Greenland waters, Funder and Weidick (1991) have shown that during the interval from 8400 to at least 4900 BP the summer surface temperature in the southern Disko Bugt was 1–3°C higher than today. As the onset of the warm period is out of phase with the climatic change on land, including the Inland Ice, they conclude that it was caused by a decrease in inflow of cold polar water and/or increase in inflow of warm atlantic water into Davis Strait. At what time this warm interval ended is not known since sediments younger than 4900 BP are now submerged.

pochorous plants, only apophytes (native plants profiting by the habitation). However, apart from the great content in the culture layers of dwarf-shrubs with casually adhering herbs and mosses gathered for fuel or coating, there are also indications of human consumption of *Empetrum* and *Vaccinium* (berries), as well as of *Oxyria digyna* and *Rumex acetosella*. No instances of arthropods directly related to man (inquilines, parasites) were detected.

The sediment succession presents a striking example of the change in living conditions for plants and arthropods imposed by prehistoric man in an arctic environment. The effect of the fertilization of the soil is most marked when the human activity decreases towards the end of the habitation period, with ensuing lower wear and tear of the vegetation.

The finding in the culture layers of insects well north of their present northern limit as well as indications from pollen-analyses of the lake sediments indicate warmer conditions than today. This should be combined with the finds of extinct boreal, marine molluscs in Orpissooq, only 8 km from Qeqertasussuk, with the position of the ice margin, and with the air temperature at that time (as revealed by ice cap cores).

Together, these lines of evidence (Fig. 23) unambigously show a climate warmer than today during the first part of the settlement period. However, towards the end a climatic change to cooler/moister conditions is registered. How this influenced the subsistence of the people, who depended on a very wide spectrum of animals, cannot be deduced from the present investigations.

Concluding remarks

The macro- and microfossils in the peaty sediments have shown the succession of the vegetation and its arthropod inhabitants through the past four millenia. The Saqqaq people settled on a fairly dry, mossy *Empetrum*-heath, and especially close to the sea there were also almost pure stands of *Elymus mollis*. During the habitation period the enriched soil caused spreading over the site of lush grass vegetation, presumably mainly of *Alopecurus alpinus* and *Puccinellia vaginata*, to be gradually replaced by fairly moist, mossy dwarf-shrub heaths when the human utilization of the site ceased.

Migrating Eskimoes may spread plants as indicated e.g. by the find of *Elymus mollis*, which is often used as kamik-grass (Fredskild 1989), at an Eskimo site almost 1000 km north of its northern limit in Canada (Porsild & Cody 1980), and possibly also by the only Greenland occurrences at some former Eskimo sites on Clavering Ø, North-east Greenland of *Chrysosplenium tetrandrum*, common on enriched soils in arctic Canada. The present investigation has revealed no definite anthro-

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Thanks are due to our colleagues at the Zoological Museum, University of Copenhagen, for their efforts regarding the identification of arthropod fragments. Bent W. Rasmussen did the SEM-photography.

Finally, useful comments on a first version of the paper by John Matthews, Geological Survey of Canada, Ottawa, and Charlie Christensen, the Danish National Museum, are highly appreciated. John Matthews also identified some fossils.

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Appendix

Taxonomical survey of fossil remains of Arthropoda from Qeqertasussuk. The nomenclature of Coleoptera is in accordance with Silfverberg (1979).

Insecta

Coleoptera
Carabidae
Bembidion grapii Gyllenhal.
Material: Heads (3), elytron, prosterna (2), meso- and metasternum. In layers 14, 16, 32u, 32l.
Trichocellus cognatus (Gyllenhal).
Material: One head in layer 32u.
Dytiscidae
Hydroporus morio Aubé.
Material: Pronota (2), elytra (5), 1. + 2. sternites (2). In layers 14, 15a, 32u, 32l.
Colymbetes dolabratus (Paykull).
Material: Heads (3 + 1 fragment), pronotum, elytron fragments (2), sternal fragments (2), mesonotum fragment, femora (2), tibiae (5), hind trochanters (2). In layers 11l, 14, 15a, 32u.
Staphylinidae
Micralymma marinum (Ström).
Material: One abdomen in layer 33.
Micralymma brevilingue Schiödte.
Material: A large quantity of fragments in nearly every possible combination, including some almost entire bodies (Fig. 12). Also a few larval fragments. In all layers.
Atheta hyperborea Brundin.
Material: Heads (23), pronota (5), elytra (5), meso + metasterna (10), sternites (12). (Fig. 14, a, b). In layers 11l, 14, 15a.
Byrrhidae
Simplocaria metallica (Sturm).
Material: Almost all sceletal parts, in particular elytra, pronota, heads, sterna, sternites, and legs. (Fig. 16, d). In layers 11u, 11l, 14, 16, 15a, 32u, 32l.
Byrrhus fasciatus Forster.
Material: Almost all sceletal parts, in particular elytra (most often fragments), pronota, heads, sterna, sternites, coxae, legs, and mandibles of both larvae and imagines. (Fig. 16, a, b, e). In layers 9–10, 11u, 11l, 14, 15a, 18, 32u, 32l.
Dermestidae
Genus et species indet.
Material: Two anterior sternites (articulated) in layer 11u.
Coccinellidae
Coccinella transversoguttata Falderman.
Material: Fragments of elytra (2), femora (6), two anterior sternites. A pronotum from the excavations in 1985 (Qt 85 12/23: 3). In layers 11u, 11l, 15a.
Latridiidae
Corticaria cf. *rubripes* Mannerheim.
Material: One elytron, probably belonging to this species, the only species of *Corticaria* considered indigenous to Greenland (Böcher 1988). In layer 11l.
Curculionidae
Dorytomus imbecillus Faust.
Material: A single, tiny fragment of an elytron is referred to this species (Fig. 14, c). In layer 32l.

Hymenoptera
Ichneumonoidea
Genera et species indet.
Material: A large number of fragments – heads, thoracal pieces and petiola – represent an unknown number of species of mainly Ichneumonidae (Fig. 19, a), but also Braconidae. According to O. Lomholdt and B. Petersen (personal communication 1989), it is not possible to get further into the identification, especially as the numerous Greenlandic Hymenoptera Parasitica have not been revised recently. In all layers except 18.

Siphonaptera
Ceratophyllidae
Ceratophyllus cf. *vagabundus* Boheman.
Material: One fragment consisting of meso– and metathorax + abdomen, and one abdomen, in layer 15a. Another abdomen from the excavations in 1986 (Qt 86 FB 13/23: 10). The specimens are all females with spermatheca retained. According to G. Brinck-Lindroth (personal communication 1991) who studied the material, the identification to genus is certain and to species highly probable.
Diptera
Tipulidae
Tipula arctica Curtis.
Material: Two female cerci in layers 11u and one in layer 14. The cercus from layer 14 is fairly different in shape from the two others and almost without denticles, but all fall within the great variation found among the specimens in the ZMUC-collection.
Chironomidae
Genera et species indet.
Material: A complete thorax in layer 33 (Fig. 19, f). However, a number of the unidentified thoraces probably are from chironomids.
Culicidae
Aedes cf. *nigripes* Zetterstedt.
Material: Two heads and one complete thorax. (Fig. 19, d). In layers 15a, 18 and 33.
Piophilidae, Muscidae, Anthomyidae.
Genera et species indet.
Material: Heads, thoracal fragments, puparia.
Probably in all layers.
Calliphoridae
Protophormia terraenovae (Robineau-Desvoidy).
Material: One head in layer 15a. Puparia in all layers except 9–10, 11u. (Fig. 19, b, c).
Genera et species indet.
Material: Puparia. In all layers.

Lepidoptera
Genera et species indet.
Material: A few complete thoraces and thoracal fragments, in one case bearing hind wings from a small phrenate species. Larval and pupal fragments; most common are larval mandibles (Fig. 20, c). In all layers.

Thysanoptera
Genus et species indet.
Material: One almost complete specimen, in layer 33.

Hemiptera-Heteroptera
Lygaeidae
Nysius groenlandicus (Zetterstedt).
Material: Heads, prothoraces and other thoracal fragments, sternites, outer female genitalia. (Fig. 20, a, b). In layers 9–10, 11u, 11l, 15, 16, 15a, 32u, 33.
Miridae
Chlamydatus pullus (Reuter).
Material: One head and one pronotum in layer 15a.

Hemiptera-Homoptera
Psylloidea
Psylla cf. *groenlandica* Sale.
Material: Thoraces (2), wings (3 total, 6 fragments). (Fig. 20, d). In layers 9–10, 11n, 15a, 32u.

Aphidoidea
Genus et species indet.
Material: One front wing in layer 33.

Psocoptera
Troctidae
Liposceles sp.
Material: Two fairly complete specimens (one without head) in layers 14 and 33.

Arachnida

Araneae
Taxa indet. Material: Numerous chelicers, palps, leg joints. (Fig. 20, e, f). In all layers.
Acarina
Oribatida
Genera et species indet.
Material: Numerous more or less complete specimens. In all layers.

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