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UPPSALA NATURAL RADIOCARBON MEASUREMENTS IV

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The following list covers most of the samples measured at the Uppsala C^{14} laboratory since the last list (Uppsala III) except for all the samples utilized for determining the increase of the C^{14}/C^{12} ratio due to explosion of nuclear devices and the few samples measured with a new proportional counter.

The technique used is the same as previously described by Olsson (1958) and the pretreatment is that which has been used earlier (wood, charcoal, peat, gyttja and other organic sediments are boiled with HCl, 1 to 2%, washed with distilled water, kept in NaOH, 1 to 2%, at +80°C over night, washed with distilled water and finally acidified to pH about 3 before being dried) except for Foraminifera tests, see below.

The reference sample is 95% of the activity of the NBS oxalic-acid standard. Any corrections for apparent water ages are thus not included here, but will be discussed in later papers dealing with the marine samples. Corrections for deviations from the normal C^{13}/C^{12} ratio (–25.0‰ in the PDB scale) are applied for the unknown samples. Our oxalic acid was measured by Craig (1961) and has a C^{13}/C^{12} ratio of –18.97‰ and corresponds to the accepted standardized value, –19‰, which should be used for age determinations (Editorial Statement in Radiocarbon, v. 3). Two new combustions of oxalic acid have not shown any significant difference in their C^{13} content relative to the oxalic acid 1 sample measured by Craig.

The value 5570 yr has been used for the half-life of C^{14}. Results are expressed in years before 1950 (B.P.). Errors include the standard deviations (σ) of the counted particles as well as the error in the δC^{13} values. When the activity is very low, so that 2σ corresponds to a possibility of infinite age, 2σ has been used instead of σ.

Several samples had to be diluted with CO_2 from an old source to bring them to the normal working pressure of 3 atm.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Mediterranean Area

Western Mediterranean Sea series

Foraminifera tests from deep-sea cores. Coll. 1948 by Swedish *Albatross* Expedition (Pettersson); subm. by K. Gösta Eriksson, Kvartärgeologiska Inst., Uppsala Univ., Uppsala, Sweden. All present and previous samples of sediment core No. 210 are described by Eriksson (1964) and samples from the other two sediment cores Nos. 209 and 211 will be described later by Eriksson. The Foraminifera analyses were made by Todd (1958). *Comment*: samples did not contain enough coarse fraction ($>74\mu$) for separate measurements as suggested by Rubin and Suess (1955) and Ericson and others (1956). An investigation has been initiated in order to determine the most suitable choice of fractions for C^{14} dating; so far, 2 samples have been investigated after the material was separated into three fractions ($>44\mu$, 4-44μ, and $<4\mu$). Results show that finer fractions may give erroneous results. Another important con-

TABLE 1

Contamination of "infinitely" old material with recent material due to different dispersing media

Laboratory No.	Dispersing medium[a]	Apparent age[c] years	δC^{13}‰	Net counting rate (contamination) counts/min
U-287	Dist. H_2O	$33{,}800 \begin{smallmatrix}+2400\\-1900\end{smallmatrix}$	−7.5	0.14 ± 0.03
U-288	NH_4OH 0.1%	$32{,}000 \begin{smallmatrix}+1600\\-1400\end{smallmatrix}$	−8.2	0.18 ± 0.03
U-289	Dist. H_2O[b]	$37{,}400 \begin{smallmatrix}+3600\\-2500\end{smallmatrix}$	−7.5	0.09 ± 0.03
U-290	Boiled dist. H_2O	>40,000	−7.7	0.02 ± 0.03
U-291	NH_4OH 0.1%	$36{,}500 \begin{smallmatrix}+3100\\-2300\end{smallmatrix}$	−7.3	0.10 ± 0.03
U-292	Dil. HCl (pH = 4.0)	>40,000	−7.5	0.05 ± 0.03

[a]) 1 L medium + 0.5 L wash liquid of same composition.
[b]) Following filtration this sample was treated with 5 ml of dil. HCl (pH = 4.0) and dried in the oven at 105°C.
[c]) The apparent ages are the results, within the limits of error, corresponding to the net counting rates, due to contamination. The errors given are the statistical errors. The accepted value of 5570 yr is used for the half-life of C^{14}. The δC^{13} values give the C^{13} enrichment relative to the Chicago PDB standard (Craig, 1961). 95% of the net counting rate of the NBS oxalic acid gives 9.31 counts/min in the proportional counter.

sideration is preparation of core material. It has been shown that it is important to use water that is free from CO_2 (Table 1). The investigations are treated in detail by Eriksson and Olsson (1963) and Olsson and Eriksson (1964).

U-293. Core 20903, 145 to 155 cm, > 44 μ **14,200 $^{+480}_{-460}$**
12,250 B.C.

Core 20903 (38° 31′ N Lat, 03° 50′ E Long), depth 145 to 155 cm, depth in the sea 2596 m. Level corresponds to marked increase of *Globigerina inflata* and second increase of *Globigerinoides rubra*. *Comment*: fraction >44μ was used; dist. H_2O was dispersing medium. Diluted. $\delta C^{13} = -3.2‰$.

U-294. Core 20903, 145 to 155 cm, 4-44μ **26,600 $^{+830}_{-760}$**
24,650 B.C.

The same sample as U-293 but fraction 4-44μ was used. $\delta C^{13} = -1.2‰$.

U-295. Core 20903, 145 to 155 cm, <4μ **17,300 $^{+300}_{-290}$**
15,350 B.C.

The same sample as U-293, but fraction <4μ was used. $\delta C^{13} = 0.0‰$.

U-296. Core 21107, 428 to 440 cm, >44μ **16,700 $^{+1200}_{-1100}$**
14,750 B.C.

Core 21107 (35° 55′ N Lat, 02° 20′ W Long), depth 428 to 440 cm, depth in sea 1325 m. Dominance of *Globigerina pachyderma* and *Globigerina eggeri* and absence of warm-tolerant species. *Comment*: fraction >44μ was used; boiled dist. H_2O was dispersing medium. Diluted. $\delta C^{13} = +0.1‰$.

U-297. Core 21107, 428 to 440 cm, 4-44μ **22,300 $^{+750}_{-690}$**
20,350 B.C.

The same as U-296 but fraction 4-44μ was used. Diluted. $\delta C^{13} = -2.3‰$.

U-298. Core 21107, 428 to 440 cm, <4μ **21,200 $^{+430}_{-410}$**
19,250 B.C.

The same as U-296 but fraction <4μ was used. $\delta C^{13} = 0.0‰$.

U-251. Core 21007, 390 to 398 cm, >44μ **13,180 ± 300**
11,230 B.C.

Core 21007 (37° 26′ N Lat, 01° 05′ E Long), depth 390 to 398 cm, depth in sea 2782 m. Level is in transition zone between cool-tolerant and warm-tolerant Foraminifera species. *Comment*: fraction >44μ was used; tap water was dispersing medium. Diluted. $\delta C^{13} = -9.7‰$.

U-252. Core 21009, 527 to 537 cm, >44μ **17,250 ± 370**
15,300 B.C.

Core 21009 (37° 26′ N Lat, 01° 05′ E Long), depth 527 to 537 cm, depth in sea 2782 m. Dominance of cool-tolerant Foraminifera species. *Comment*: fraction >44μ was used; dist. H_2O was dispersing medium. Diluted. $\delta C^{13} = -2.8‰$.

U-253. Core 21011, 663 to 675 cm, >44μ **22,000 $^{+1000}_{-800}$**
20,050 B.C.

Core 21011 (37° 26′ N Lat, 01° 05′ E Long), depth 663 to 675 cm, depth in sea 2782 m. Dominance of cool-tolerant Foraminifera species. Highest abundance of *Globigerina pachyderma* in core No. 210. *Comment*: fraction >44μ was used; dist. H_2O was dispersing medium. Diluted. $\delta C^{13} = -7.1‰$.

U-254. Core 21014, 850 to 865 cm, >44μ **30,100 $^{+1200}_{-1100}$**
28,150 B.C.

Core 21014 (37° 26′ N Lat, 01° 05′ E Long), depth 850 to 865 cm, depth in sea 2782 m. Level corresponds to increase of *Globigerina pachyderma*. *Comment*: fraction >44μ was used; dist. H_2O was dispersing medium. Diluted. $\delta C^{13} = -4.3‰$.

U-255. Core 21001, 23 to 29 cm, >44μ **5880 ± 100**
3930 B.C.

Core 21001 (37° 26′ N Lat, 01° 05′ E Long), depth 23 to 29 cm, depth in sea 2782 m. *Comment*: fraction >44μ was used; dist. H_2O was dispersing medium. Diluted. $\delta C^{13} = -2.3‰$.

U-300. Core 21105, 262 to 272 cm, >44μ **10,290 ± 290**
8340 B.C.

Core 21105 (35° 55′ N Lat, 02° 20′ W Long), depth 262 to 272 cm, depth in sea 1325 m. Dominance, although a decrease, of *Globigerina pachyderma* and *Globigerina eggeri* and increase of *Globigerinoides rubra* and *Globigerina inflata*. *Comment*: fraction >44μ was used; dist. H_2O was dispersing medium. Diluted. $\delta C^{13} = -2.0‰$.

Correction to sample U-142 in Uppsala II:

U-142. Core 21104, 223 to 227.5 cm **10,800 ± 400**

Core 21104 (35° 55′ N Lat, 02° 20′ W Long), depth 223 to 227.5 cm, depth in the sea 1325 m. Level corresponds to increase of *Globigerinoides rubra* and decrease of *Globorotalia scitula*. *Comment*: fraction >4μ was used. $\delta C^{13} = +20.0‰$. *Comment*: U-142 given as previously published, with typographic errors corrected, and with reference to same standards as in Uppsala II. With oxalic acid and PDB as standards age is 10,930 ± 400 B.P. and δC^{13} is –4‰.

B. Africa

U-266. Abidjan CI 60/1 c **950 ± 70**
A.D. 1000

Salt water lagoon mollusc shells, accumulated by wave action, from Adiopodioume, Abidjan (5° 10′ N Lat, 3° 50′ W Long), Ivory Coast. Sample from a 50 cm thick layer of shells, 48 m alt. Coll. 1960 and subm. by J. Tricart. Centre de Géog. Appliquée et Inst. de Géog., Univ. de Strasbourg, Strasbourg, France. *Comment*: inner 17% was used. δC^{13} not measured but assumed to be –5.2‰.

U-265. Abidjan CI 60/1 b **990 ± 70**
A.D. 960

Shell layer surrounding the part used for sample U-266. *Comment*: layer corresponds to 34% of the shells. $\delta C^{13} = -5.8‰$.

U-264. Abidjan CI 60/1 a **970 ± 110**
A.D. 980

Shell layer surrounding the part used for sample U-265. *Comment*: layer corresponds to 42% of the shells. 7% was removed by washing. $\delta C^{13} = -4.6‰$.

C. Asia

Sogho-nor series

Shells coll. by N. Hörner at the lake Sogho-nor (42° N Lat, 101° E Long) and at Camp H82 (40° 34′ N Lat, 90° 10′ E Long) near the lake Lop-nor, Turkestan. Shells are probably freshwater but of unknown species. Finite ages may be too great, owing to recycling of carbonates, but age of two old samples is probably minimum if there has been atmospheric contamination. Measure-

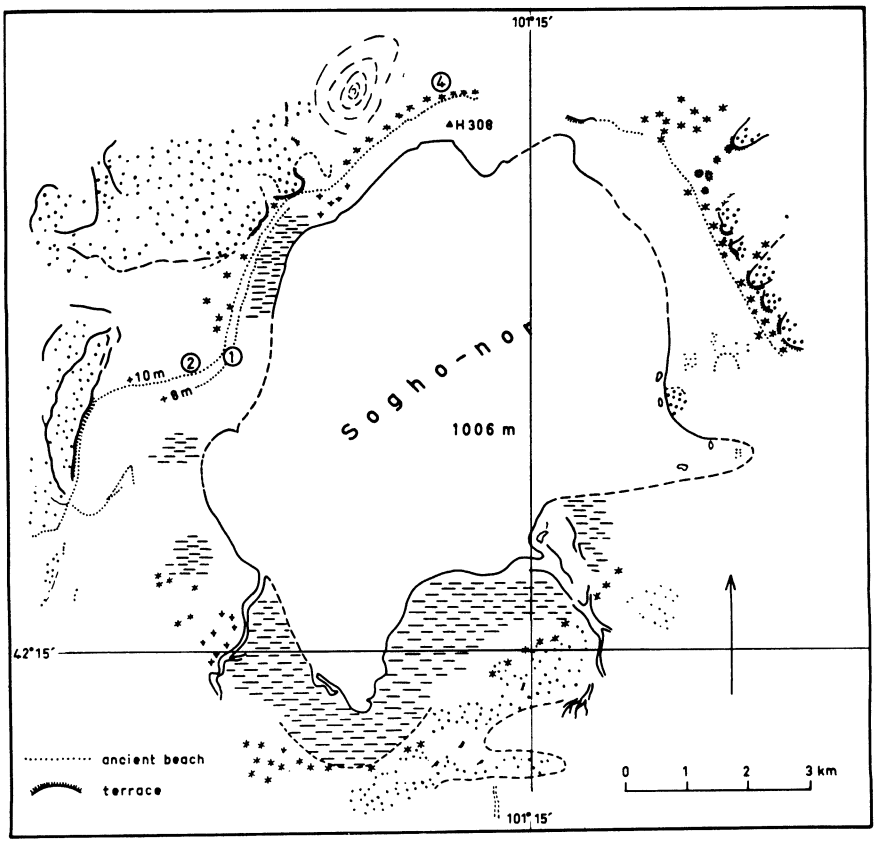

Fig. 1. Map showing the lake Sogho-nor and its beaches.

ments were undertaken in an effort to contribute some new information to an exceptionally interesting problem, described by Hörner and Chen (1935) and discussed anew by Norin (in preparation). The map (Fig. 1) shows Sogho-nor and its beaches.

U-281. Sogho-nor 040233 AB **33,700 $^{+1400}_{-1200}$**
31,750 B.C.

Shells on surface of uppermost terrace, 15½ m above level of lake on collection day, Locality 4 on the map N of Camp H308. Coll. Febr. 4, 1933 by Hörner; subm. by Erik Norin, Mineralogisk-geologiska Inst., Uppsala Univ., Uppsala, Sweden. *Comment*: inner 86% was used. $\delta C^{13} = -5.1‰$.

U-280. Sogho-nor 270530 shell **34,200 $^{+1400}_{-1200}$**
32,250 B.C.

Shells in ancient gravelly beach 8 m above level of lake on collection day, and in silt accumulated behind the ridge, Locality 1 on the map. Shells probably derived from adjoining terrace sediments. Coll. May 27, 1930 by Hörner; subm. by Norin. *Comment*: inner 57% was used. $\delta C^{13} = -4.8‰$.

U-286. Lop-nor b 230731 **3100 ± 110**
1150 B.C.

Shells from "yardang sediments" (erosional remains of ancient Tarim delta) at Camp H 82 E of ruined town of Lou-lan, Lop-nor. Coll. 1931 by Hörner. *Comment*: inner 25% was used. Diluted. $\delta C^{13} = -7.6‰$.

U-285. Lop-nor a **3020 ± 90**
1070 B.C.

Shell layer surrounding the part used for U-286. *Comment*: layer corresponds to 45% of the shells. 30% was removed by washing. $\delta C^{13} = -7.9‰$.

U-238. Avdat I, Israel **60 ± 80**
A.D. 1890

Pieces of wood from stone wall at Avdat (30° 45′ N Lat, 34° 45′ E Long), Israel. Wood was supposed to be either recent roots or to belong to construction of wall, which is ca. 2000 yr old. $\delta C^{13} = -11.6‰$.

D. Spitsbergen

Vestspitsbergen series

Peat and shells measured as a continuation of Vestspitsbergen series (Uppsala II and III; Feyling-Hanssen and Olsson, 1959-1960) and also to date pollen-analyzed peat. All altitudes are above mean sealevel.

U-206. Skansbukta 15 M h **3410 ± 230**
1460 B.C.

Humus exaracted by hot NaOH from peat used for sample U-185, Skansbukta 15 M p (78° 31.5′ N Lat, 16° 03′ E Long), Billefjorden, Spitsbergen, dated at 4800 ± 120 B.P. (Uppsala III). Diluted. $\delta C^{13} = -25.4‰$.

U-203. Anservika 334 b_1 **4500 ± 90**
2550 B.C.

Astarte borealis from Anservika (78° 28′ N Lat, 16° 23′ E Long) Billefjorden, Spitsbergen, 9.7 m alt (Feyling-Hanssen and Jørstad, 1950, p. 33

and Feyling-Hanssen, 1955, p. 58-65). Coll. 1950 and subm. by Rolf Feyling-Hanssen, Paleontologisk Mus., Oslo, Norway. *Comment*: inner 53% was used. $\delta C^{13} = +0.1‰$.

U-204. Anservika 334 a_1 **4160 ± 170**
2210 B.C.

Shell layer surrounding the part used for U-203. *Comment*: layer corresponds to 16% of the shells; 31% was removed by washing. Diluted. δC^{13} assumed 0‰.

U-279. Anservika 334 c_2 **5210 ± 90**
3260 B.C.

Astarte borealis from Anservika (78° 28′ N Lat, 16° 23′ E Long), Billefjorden, Spitsbergen, 9.7 m alt (Feyling-Hanssen and Jørstad, 1950, p. 33 and Feyling-Hanssen, 1955, p. 58-65). Coll. 1950 and subm. by R. W. Feyling-Hanssen. *Comment*: inner 25% was used. Sample was also dated in 1961, in fractions corresponding to those of U-203 and U-204 (this date list) but the fractions gave too large a difference in age at that time, and two new samples were selected, fractionated, and dated. The age difference may indicate a strong contamination. 700 years corresponds to 10% contamination with prebomb material. $\delta C^{13} = +0.9‰$.

U-278. Anservika 334 b_2 **5250 ± 90**
3300 B.C.

Shell layer surrounding the part used for U-279. *Comment*: layer corresponds to 30% of the shells. $\delta C^{13} = +1.2‰$.

U-277. Anservika 334 a_2 **5110 ± 140**
3160 B.C.

Shell layer surrounding the part used for U-278. *Comment*: layer corresponds to 33% of the shells; 12% was removed by washing. $\delta C^{13} = +1.9‰$.

U-424. Teltfjellbekken 357 c **9340 ± 140**
7390 B.C.

Astarte borealis, Arctica (= *Cyprina*) *islandica, Saxicava arctica, Macoma calcarea, Littorina littorea* from S of Teltfjellbekken (78° 38′ N Lat, 16° 44′ E Long), Brucebyen, Billefjorden, Spitsbergen, 23.0 m alt. Locality described by Feyling-Hanssen (1955, p. 82-86). Coll. 1950 and subm. by R. W. Feyling-Hanssen. *Comment*: inner 31% was used. $\delta C^{13} = +2.0‰$.

U-423. Teltfjellbekken 357 b **9490 ± 270**
7540 B.C.

Shell layer surrounding the part used for U-424. *Comment*: layer corresponds to 15% of the shells. Diluted. δC^{13} assumed +2.0‰.

U-422. Teltfjellbekken 357 a **9140 ± 190**
7190 B.C.

Shell layer surrounding the part used for U-423. *Comment*: layer corresponds to 18% of the shells. 36% was removed by washing. $\delta C^{13} = +2.3‰$.

U-261. Hornsund 1 **1390 ± 70**
A.D. 560

Brown basal peat in bog, surface alt 12 m, 55 to 60 cm depth, among moraine boulders, Hornsund (77° 00′ N Lat, 15° 28′ E Long), Spitsbergen. Bog is described by Środoń (1960) and the dates are discussed by Blake,

Środoń, and Olsson (in preparation). Coll. 1957 by A. Środoń, Inst. Botaniki, Polska Akad. Nauk, Kraków; subm. by Weston Blake Jr., Geol. Survey of Canada, Ottawa 4, Ontario. *Comment*: another sample from nearly the same depth in the same bog gave two different ages, both younger, when fractionated (U-202, U-275, this date list). $\delta C^{13} = -23.8‰$.

U-262. Hornsund 2, p **620 ± 80 A.D. 1330**

Light-brown peat from same bog as U-261, 54 to 55 cm depth, Hornsund. Coll. 1957 by A. Środoń; subm. by W. Blake Jr. *Comment*: humus fraction (U-275, this date list) was dated at 260 ± 110 B.P. $\delta C^{13} = -24.9‰$.

U-275. Hornsund 2, h **260 ± 110 A.D. 1690**

Humus extracted from the peat used for sample U-262, Hornsund. Diluted. $\delta C^{13} = -27.4‰$.

U-210. Russekeila I, 55, p **4780 ± 120 2830 B.C.**

Peat from same peat bog as U-212, Russekeila (78° 05′ N Lat, 13° 47′ E Long), Isfjord, Spitsbergen, 9.5 m above high tide level on a raised beach sloping from 12.5 to 7.5 m alt, 55 cm below surface, showing no frost cracks. Bog is pollen-analyzed by E. Norling. Coll. 1960 and subm. by E. Norling, Kvartärgeologiska Inst., Uppsala Univ., Uppsala. $\delta C^{13} = -28.3‰$.

U-211. Russekeila I, 55, h **5480 ± 130 3530 B.C.**

Humus extracted from the peat used for U-210, Russekeila, Isfjord, Spitsbergen. $\delta C^{13} = -26.0‰$.

U-212. Russekeila II, 55, p **1090 ± 80 A.D. 860**

Amblystegium peat from ca. 15 cm depth in same peat bog as U-210, Russekeila. Coll. 1960 and subm. by E. Norling. $\delta C^{13} = -29.6‰$.

U-205. Talavera O_4 h **3030 ± 290 1080 B.C.**

Humus extracted with hot NaOH from the peat used for sample. U-186, Talavera O_4 p (78° 15′ N Lat, 20° 50′ E Long), Barentsöya, Spitsbergen, dated at 6000 ± 400 B.P. (Uppsala III). Diluted. $\delta C^{13} = -22.0‰$.

Nordaustlandet series

Shells, peat, and humus collected to confirm previously obtained results on land uplift (e.g. Olsson and Blake, 1961-1962), to get a measure of accumulation rate of sediments, and to date pollen-analyzed peat.

U-227. Trippvatnet H/1 **4880 ± 120 2930 B.C.**

Limnic peat and algal mud from 59 to 68 cm above bottom of pollen-analyzed sediment core, Trippvatnet (80° 01′ N Lat, 18° 47′ E Long), Nordaustlandet, Spitsbergen, 5.2 m alt. Below sediment core was clay with pieces of schist. Described by Häggblom (1963). Coll. 1958 and subm. by Anders Häggblom, Geog. Inst., Stockholms Univ., Stockholm, Sweden. *Comment*: a sample from the same sediment and corresponding level was dated at

5290 ± 400, U-93, corrected to oxalic acid (published as 5160 ± 400, Uppsala II). Diluted. $\delta C^{13} = -26.3‰$.

U-228. Krystallvatnet H/28-58 **4940 ± 100**
2990 B.C.

Limnic peat (Fontinalis type) from 98.5 to 104.5 cm above bottom of pollen-analyzed sediment core with total length of 130 cm, Krystallvatnet (79° 58′ N Lat, 18° 40′ E Long), Nordaustlandet, Spitsbergen, 62 m alt. Below bottom of core was firm clay. Described by Häggblom (1963). Coll. 1958 and subm. by A. Häggblom. *Comment*: a sample from same sediment, but coll. 10 cm above bottom of core, was dated at 10,030 ± 550, U-92, corrected to oxalic acid (published as 9900 ± 550, Uppsala II). $\delta C^{13} = -27.3‰$.

U-263. Lady Franklinfjorden 48 **13,470 +530 −500**
11,520 B.C.

Shells and calcareous algae (*Lithothamnion*, *Balanus*, and probably *Hiatella* and *Mya*) from 2 collecting points in till at Lady Franklinfjorden (80° 12′ N Lat, 18° 42′ E Long), Nordaustlandet, Spitsbergen, 1.5 to 2 m alt. Shells are part of matrix of till, and thus give a limiting date for the time of glacier advance. Beach gravel overlies the till, and in one place peat dated at 3960 ± 100 B.P., U-276, occurs between the till and the beach gravel. Coll. 1958 by R. Bergström and W. Blake, Jr., and subm. by W. Blake, Jr. Pollen-analyzed by E. Norling (in preparation). *Comment*: only ca. 8 g was subm., too little to allow thorough pretreatment, and condition of shells was very poor, so result should be regarded as minimum age. Outer 22% was removed by washing. Diluted. $\delta C^{13} = -2.6‰$.

U-276. Lady Franklinfjorden 49 **3960 ± 100**
2010 B.C.

Plant remains mixed with till (?) or mud above main till at Lady Franklinfjorden (80° 12′ N Lat, 18° 42′ E Long), Nordaustlandet, Spitsbergen, 2 m alt. Shells in underlying till dated at >13,000 B.P., U-263. Coll. 1958 and subm. by W. Blake, Jr. $\delta C^{13} = -23.1‰$.

General Comments: the results obtained from Spitsbergen confirm previous results in showing that land uplift for the last 8000 yr has been very slow.

As shown earlier, great care must be taken in pretreatment of samples. It is not sufficient to wash shells so that e.g. 10 to 20% of the shells are removed; samples must be carefully selected from bulk material and treated individually.

Large age discrepancies between peat and humus fractions of sediments in frozen ground (Olson and Broecker, 1958) have also been observed in 4 samples presented here. The reasons are still obscure, but one may be that cryoturbation causes vertical movement of soil and stones. Water-borne humus may be carried to various depths in such an environment. Wind-borne material may also easily contaminate the samples.

E. Åland

Åland series

Gyttja from Åland, Finland, pollen-analyzed to date immigration of spruce (*Picea*) and cultivation of rye (*Secale*) on the main island. Coll., subm.,

and pollen-analyzed by Magnus Fries, Växtbiologiska Inst., Uppsala Univ., Uppsala, Sweden.

U-231. Söderängsmossen 175 to 180 **1740 ± 120**
A.D. 210

Gyttja from the bog Söderängsmossen (60° 18′ N Lat, 20° 7′ E Long), Saltvik parish, Åland, Finland. Sample from the marked increase of *Picea*, at beginning of Pollen Zone IX (Jessen), 175 to 180 cm below the reference level. Coll. 1961. $\delta C^{13} = -26.0‰$.

U-232. Söderängsmossen 172.5 to 175 and 180 to 182.5 **2050 ± 120**
100 B.C.

Gyttja above and below sample U-231, from 172.5 to 175 cm and 180 to 182.5 cm level, measured to check the unexpectedly low date of U-231. $\delta C^{13} = -34.5‰$.

U-233. Dalkarbyträsk 575 to 580 **2530 ± 90**
580 B.C.

Gyttja from Dalkarbyträsk (60° 09′ N Lat, 19° 57′ E Long), Jomala parish, Åland, Finland. Sample from the marked increase of *Picea*, at beginning of Pollen Zone IX (Jessen), 575 to 580 cm below (frozen) lake surface. Coll. 1962. $\delta C^{13} = -28.2‰$.

U-234. Dalkarbyträsk 540 to 546 **1610 ± 90**
A.D. 340

Gyttja from Dalkarbyträsk (60° 09′ N Lat, 19° 57′ E Long), Jomala parish, Åland, Finland. Sample from a level indicating beginning of cultivation of rye, Pollen Zone IX (Jessen), 540 to 546 cm below (frozen) lake surface. Coll. 1962. $\delta C^{13} = -29.1‰$.

U-236. Dalkarbyträsk 500 to 506 **1540 ± 100**
A.D. 410

Gyttja from Dalkarbyträsk (60° 09′ N Lat, 19° 57′ E Long), Jomala parish, Åland, Finland, from a level indicating a possible decrease of cultivation of rye, Pollen Zone IX (Jessen), 500 to 506 cm below (frozen) lake surface. Coll. 1962. $\delta C^{13} = -28.7‰$

U-235. Kvarnboträsk 174 to 180 **2080 ± 90**
130 B.C.

Gyttja from Kvarnboträsk (60° 17′ N Lat, 20° 04′ E Long), Saltvik parish, Åland, Finland, from the marked increase of *Picea*, at beginning of Pollen Zone IX (Jessen), 174 to 180 cm below sediment surface. Coll. 1962. $\delta C^{13} = -30.7‰$.

F. Sweden

U-445. Submarine peat, Laholm bay **10,060 ± 140**
8110 B.C.

Dark brown submarine peat, well humified and containing macrofossils of *Betula*, *Equisetum*, *Phragmites* and *Carex*, from bay outside Laholm (56° 31′ N Lat, 12° 48′ E Long), Halland, Sweden; water depth ca. 16 m. Pollen analysis (Magnus Fries) implies that peat is derived from a fen and belongs to Pollen Zone IV (Jessen). Peat appeared to be *in situ* when dredged, with no overlying sediment; judging from its altitude, locality should have been above

sealevel at time of date. Recent molluscs were removed before dating. Described by Wærn (1964). Coll. 1963 on the Sunbeam expedition by Mats Wærn and subm. by Mtgnus Fries, both Växtbiologiska Inst., Uppsala Univ., Uppsala, Sweden. $\delta C^{13} = -28.0‰$.

9830 ± 140

U-428. Levide **7880 B.C.**

Wood from trunk of *Pinus silvestris* from Hallbåter, Levide (57° 16′ N Lat, 18° 15′ E Long), Gotland, Sweden, ca. 1500 m S of Ancylus ridge below layer of sand and gravel about 1.9 m deep. Forest was destroyed by a transgression of the Baltic. Coll. 1961 and subm. by Bengt Pettersson, Växtbiologiska Inst., Uppsala Univ., Uppsala, Sweden. $\delta C^{13} = -25.1‰$.

2940 ± 90

U-429. Bunn, Bunge **990 B.C.**

Charcoal of *Pinus silvestris* from Bunn, Bunge (57° 52′ N Lat, 19° E Long), Gotland, Sweden, found with potsherds and mixed with sand. Supposedly from a dwelling-place buried by sand, ca. 2 m thick. Coll. 1957 and subm. by B. Pettersson. $\delta C^{13} = -24.2‰$.

1095 ± 80

U-427. Nyköping boat **A.D. 855**

Pine wood, part of boat, in excavation for basement of Nyköping Town Hall (58° 45′ N Lat, 17° 1′ E Long), Södermanland, Sweden. Boat imbedded in *Phragmites* peat member of lake deposit, pollen-dated as lower Zone IX, underlain by mud and Baltic sediments. Diatom analysis by Maj-Britt Florin, pollen analysis by Thorolf Candolin; described by Florin and Olsson (1964). Coll. 1959 and subm. by Sten Florin, Kvartärgeologiska Inst., Uppsala Univ., Uppsala, Sweden. $\delta C^{13} = -25.7‰$.

Land Uplift series, Eastern Central Sweden

Sediments from eastern Central Sweden, coll. from ancient lakes developed by isolation from the sea, to determine time and rate of land uplift in this part of Sweden. Described by Maj-Britt Florin (1944) and Sten Florin (1944, 1947, and 1948).

8320 ± 140

U-218. Grässjön II **6370 B.C.**

Clay-gyttja from the lake Grässjön (59° 10′ N Lat, 14° 31′ E Long), Nysund parish, Närke, Sweden; drainage threshold at 121.1 m alt. Sediment from level 200 to 207 cm below surface. Diatom and pollen analysis performed by Maj-Britt Florin (1944) and subsequent analysis performed by G. Piehl-Linnman and T. Candolin. Analyses imply that this sediment was deposited shortly after lake had been isolated from sea in early time of Zone IV (Jessen) before increase of *Corylus*. Coll. 1959 and subm. by Sten Florin. Diluted. $\delta C^{13} = -19.2‰$.

8770 ± 190

U-269. Grässjön I **5820 B.C.**

Gyttja from the lake Grässjön (59° 10′ N Lat, 14° 31′ E Long), Nysund parish, Närke, Sweden, drainage threshold at 121.1 m alt, from level 190 to 198 cm below surface and taken above sample U-218. Diatom and pollen

analysis performed by Maj-Britt Florin and others (see U-218). Coll. 1959 and subm. by Sten Florin. *Comment*: this sample more organogenic than sample U-218. Diluted. $\delta C^{13} = -24.4‰$.

Late Pleistocene vegetational series, Eastern Central Sweden

Sediments from ancient lakes in W Kolmården, E Central Sweden, described by M.-B. Florin (1944) and S. Florin (1944, 1947, and 1948). Coll. by M.-B. and S. Florin; subm. by M.-B. Florin. Diatom and pollen analyses by M.-B. Florin.

U-217. Långa Getsjön III **9140 ± 260**
7190 B.C.

Detrital gyttja with fine sand from 415 to 419 cm below surface, Långa Getsjön (58° 42′ N Lat, 16° 16′ E Long), alt 120 m (MSL). Coll. 1962. Pollen analysis implies Pre-Boreal time, Pollen Zone IV (Jessen). Diluted. $\delta C^{13} = -31.7‰$.

U-426. Långa Getsjön II **10,210 ± 140**
8260 B.C.

Clay-gyttja from 440 to 445 cm below surface, Långa Getsjön (58° 42′ N Lat, 16° 16′ E Long). Coll. 1963. Pollen analysis implies Pollen Zone IV (Jessen). Sedimented in fresh water according to diatom analysis. $\delta C^{13} = -21.8‰$.

U-425. Långa Getsjön I **19,700 $^{+1100}_{-900}$**
17,750 B.C.

Clay with one sandy layer from 455 to 465 cm below surface, Långa Getsjön (58° 42′ N Lat, 16° 16′ E Long). Coll. 1963. Pollen analysis implies late Pollen Zone III or early Pre-Boreal Pollen Zone IV (Jessen). Sedimented in fresh water according to diatom analysis. *Comment*: this sample and varved glacial clay samples from Lugnvik (U-213, U-214, and U-260, this date list), show that too high ages may be obtained if the clay contains allochtonous material. Diluted. $\delta C^{13} = -26.6‰$.

U-420. Stuggölen I **9930 ± 140**
7980 B.C.

Clay and clay-gyttja from 430 to 435 cm below surface, Stuggölen (58° 42.5′ N Lat, 16° 22′ E Long), alt 95 m. Coll. 1963. According to pollen analysis sample is correlated with Pollen Zone IV (Jessen), and diatoms show influence of the Yoldia Sea. $\delta C^{13} = -17.5‰$.

U-421. Stuggölen II **9300 ± 130**
7350 B.C.

Detrital gyttja from 425 to 430 cm below surface, Stuggölen (58° 42.5′ N Lat, 16° 22′ E Long), immediately overlying U-420. According to pollen and diatom analysis sample is correlated with Pollen Zone IV (Jessen) and sedimentation occurred in fresh water. $\delta C^{13} = -17.9‰$.

U-219. Dragby sedge bog 16 **2710 ± 100**
760 B.C.

Sedge dy and gyttja from Dragby (59° 59′ N Lat, 17° 35′ E Long),

Skuttunge parish, Uppland, Sweden. Bog is in a kettle, drainage level at 28.5 m alt. Sample from upper part of Pollen Zone VIII near boundary of Pollen Zone IX (Jessen), below the increase of *Picea*. Pollen analysis by T. Candolin. Sample near isolation contact according to diatom analysis by M.-B. Florin. Described by M.-B. and S. Florin (1960) and S. Florin (1963). Samples of archaeologic interest from Dragby are given in Uppsala II and III, Stockholm IV and V, and this paper. Coll. 1962 and subm. by S. Florin. $\delta C^{13} = -25.0‰$.

Varved glacial clay series, Lugnvik

Organic material deposited in glacial varves +29 to +82, Borell-Offerberg's (1955) time-scale, at Lugnvik (62° 55′ N Lat, 17° 55′ E Long). Concentration of organic material was almost as high as 1%. Although organic material could be expected to be mainly allochtonous and thus probably old, pollen analysis (Hörnsten) proved that part of it is contemporaneous with the sediment. Samples were determined partly to give information about origin of deposited material and partly to prove that selection of samples is important. Only authigenic material in sediments may be used for dating. Dates given here by the varve chronology are not exact since there is some uncertainty concerning the extrapolation to present time. Samples are described by Hörnsten and Olsson (1964). Coll. 1962 and subm. by Åke Hörnsten, Kvartärgeologiska Inst., Uppsala Univ., Uppsala. *Comment*: due to the low carbon content and the high ages a small contamination with modern material may change the result for U-213 and U-214 considerably so that the dates given should be regarded as lower limits. The insoluble (in hot NaOH) fractions are thus supposed to be older than 30,000 yr and 34,000 yr, respectively. A similar sample from Södermanland (U-425) has also been dated.

U-260. Lugnvik varves, +29 to +55 **≥37,000**

Varved clay dated by varved clay chronology at 6894 to 6868 yr B.C. Clay content about 43% ($<2\mu$). $\delta C^{13} = -28.6‰$.

U-213. Lugnvik varves, +56 to +82 (a) **30,000 $^{+2500}_{-2000}$**

28,000 B.C.

Varved clay dated by varved clay chronology at 6867 to 6841 yr B.C. Clay content about 38% ($<2\mu$). $\delta C^{13} = -29.4‰$.

U-215. Lugnvik varves, +56 to +82 (ah) **9000 $^{+1400}_{-1200}$**

7000 B.C.

Humus extracted with hot NaOH from clay used for U-213. Diluted.

U-214. Lugnvik varves, +56 to +82 (b) **34,000 $^{+2200}_{-1800}$**

32,000 B.C.

Varved clay from same bulk material as U-213. C[illegible]

II. ARCHAEOLOGIC SAMPLES

A. Iran

U-274. Takht-i-Suleiman **3810 ± 80 / 1860 B.C.**

Muck from Takht-i-Suleiman (36° 37′ N Lat, 47° 14′ E Long), Azerbaidjan, Iran, found in pit with artifacts about 1500 yr old. Coll. 1962 and subm. by Carl Nylander and Lars Gezelius, Inst. för Klassisk Fornkunskap och Antikens Historia, Uppsala Univ., Uppsala, Sweden. $\delta C^{13} = -19.9‰$.

B. Italy

U-267. San Giovenale 62-183 b **2420 ± 80 / 470 B.C.**

Charcoal from San Giovenale (42° N Lat, 12° E Long), province of Viterbo, Italy, found in fill with sherds dating from 600 to 300 B.C. Coll. 1962 and subm. by C. Nylander. $\delta C^{13} = -22.9‰$.

U-268. San Giovenale 62-159 d **2390 ± B.P. / 440 B.C.**

Charcoal from San Giovenale (42° N Lat, 12° E Long), di Viterbo, Italy, found in fill with sherds dating from 600 to 300 B.C. Coll. 1962 and subm. by C. Nylander. $\delta C^{13} = -24.7‰$.

C. Ireland

Raheennamadra series, Ireland

Wood and charcoal from a so-called ring-fort from Raheennamadra (52° 3′ N Lat, 8° 3′ W Long) near church of Knocklong in the Golden Vale, Co. Limerick, Ireland. The late Seán Ó Riordáin suggested collaboration with Swedish archaeologists and his intention was fulfilled in 1960-61 by Michael O'Kelly of Cork and Mårten Stenberger of Uppsala. The ring-fort has total diam of 45 m including surrounding bank with an associated outer fosse. Diam of raised platform within the bank (the site) is 20 m and close to the bank at SW is souterrain house, 8.5 x 2.5 m, of 2 rooms with stone walls, 2 m high. In center of the site are faint traces of something believed to be a hut of wattlework. Site is described in a preliminary report by Stenberger (1962). Sample coll. 1961 and subm. by Mårten Stenberger, Inst. för Nordisk och Jämförande Fornkunskap, Uppsala Univ., Uppsala, Sweden.

U-240. Raheennamadra 1 a **1280 ± 120 / A.D. 670**

Wood from wooden post supposed to have supported roof of souterrain house. $\delta C^{13} = -28.5‰$.

U-241. Raheennamadra 1 b **1430 ± 130 / 520**

U-243. Raheennamadra 2 b **1260 ± 120**
A.D. 690

Same piece of wood as U-242 but new pretreatment and combustion. $\delta C^{13} = -24.9‰$.

U-244. Raheennamadra 3 a **1330 ± 110**
A.D. 620

Charcoal from log on hearth built of clay outside and above top of E gable-wall of souterrain. $\delta C^{13} = -23.6‰$.

U-245. Raheennamadra 3 b **1300 ± 120**
A.D. 650

Same charcoal sample as U-244 but new pretreatment and combustion. $\delta C^{13} = -24.6‰$.

U-246. Raheennamadra 4 a **1200 ± 110**
A.D. 750

Charcoal from hearth in E end of souterrain. $\delta C^{13} = -24.0‰$.

U-247. Raheennamadra 4 b **1360 ± 100**
A.D. 590

Same charcoal sample as U-246 but new pretreatment and combustion. $\delta C^{13} = -26.7‰$.

U-248. Raheennamadra 5 **1840 ± 110**
A.D. 110

Charcoal from a dark layer, assumed to be a hearth, in a trial trench within what was supposed to be a hut, 114 cm below arbitrary datum. $\delta C^{13} = -26.7‰$.

D. Sweden

Dragby series

Resin and charcoal from Dragby (59° 59′ N Lat, 17° 35′ E Long), Skuttunge parish, Uppland, Sweden. Results of the excavations and geological investigations are given by Stenberger (1960, 1961), M.-B. and S. Florin (1960), Olsson (1960), Gräslund (1961), Jaanusson and Silvén (1962), Rydh (1962), Damell and Sjögren (1962), Florin (1963), and Gejvall (1963). Coll. by students and subm. by M. Stenberger. Other samples have been dated previously (Uppsala II and III; Stockholm IV and V).

U-201. Dragby 335 B **2070 ± 100**
120 B.C.

Resin from Grave 335 B. Coll. 1960. $\delta C^{13} = -29.1‰$.

U-403. Dragby 325 **2060 ± 80**
110 B.C.

Resin from Grave 325, attributed to Early Iron Age. Coll. 1963. $\delta C^{13} = -26.5‰$.

U-400. Dragby 359 V **2340 ± 170**
390 B.C.

Charcoal from Grave 359 V, attributed to Early Iron Age. *Comment*: diluted. $\delta C^{13} = -29.4‰$.

U-404. Dragby UO X, G3 **2830 ± 80**
880 B.C.

Charcoal from Pit No. 3 above layer of brittle burnt stones, 10 to 15 cm thick, on bottom of pit, one of several pits near Grave field, probably used for cooking. Sampled level consists of black clayey soil and black soil with gravel, both containing charcoal. Coll. 1963 by Per Kåks. $\delta C^{13} = -23.0‰$.

III. CROSS-CHECK SAMPLES

U-239. Lago di Nemi **2120 ± 80**
170 B.C.

Wood from Roman ships at Lake Nemi (41° 43′ N Lat, 01° 34′ E Long), Italy. Ships are attributed to Emperor Caligula (A.D. 37 to 41). Subm. by C. Cortesi and F. Bella, C^{14} Laboratory, Ist. di Geochim. dell Università Roma, Italy. *Comment*: for this determination the same gas was used as for U-68 (Uppsala I), published as 1980 ± 70 and $\delta C^{13} = +0.1‰$. These data, when recalculated to oxalic acid and PDB standards, give 2100 B.P. and –24.1‰, i.e. are indistinguishable from measurements made after 5 years' storage. For reference to other determinations see U-68 (Uppsala I, p. 100). $\delta C^{13} = -23.1‰$.

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