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BERN RADIOCARBON DATES VII

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INTRODUCTION

This list contains a selection of dates from analyses carried out during the past few years. Samples are grouped in geologic-palynologic, and archaeologic sections according to main problem. When influence of human activity on pollen diagrams has been observed it has been explicitly indicated. The descriptions and comments have been written in collaboration with collectors and submitters. For the samples from Switzerland, general reference has also been made to Welten (1958a) and to sections on palynology, geology, and archaeology in work edited by the Schweizerische Gesellschaft für Ur- und Frühgeschichte (1968-1970).

Combustion of samples and gas counting have been done according to description in previous list (Radiocarbon, 1965, v. 7, p. 1-2). The samples were treated before combustion only with cold hydrochloric acid. No more elaborate procedure was performed. Results are expressed in conventional C^{14} years as defined in the Editorial Statement of Radiocarbon (w.r.t. NBS standard; $t_{1/2} = 5568$ yr; reference year A.D. 1950 = 0 B.P.). The given standard deviations σ (or "errors") are derived with the following formula

$$\sigma = \sqrt{\sigma_c^2 + \sigma_f^2}$$

where: σ_c = counting statistics including estimated uncertainties in filling temperature, barometric pressure, working voltage, etc.; σ_f = estimated uncertainty due to isotope fractionation effects. The term σ_f has been included because no $^{13}C/^{12}C$ ratios have been measured on samples of present list; it was estimated to be 80 years from the observed distribution of deviations of $\delta^{13}C_{PDB}$ (ca. $\pm$ 5‰) from the "normal" value ($\delta^{13}C_{PDB} = -25.0$‰) in wood, peat, gyttja and charcoal from European localities (Radiocarbon, v. 9, 1967, p. 113-144; v. 11, 1969, p. 519-539) considered valid only for materials derived from plants with Calvin photosynthetic cycle. The formula is not valid for materials related to plants with Slack-Hatch cycle (and lack of photorespiration) and CAM (Crassulacean Acid Metabolism) as pointed out by Lerman (ms. in prep.); in such a case the age must be increased in about (240 $\pm$ 20) yr (Lerman, 1970, p. 104-105; Radiocarbon, 1969, v. 11, p. 351, 369, 378-383). The original counting standard deviation (σ_c) can be retrieved from the given σ by:

$$\sigma_c = \sqrt{\sigma^2 - 640} \qquad \text{(in years)}$$

When considered interesting, the dates have been corrected for secular variations by means of the calibration curve suggested by Suess (1970). The derived calendar dates for the interval $\pm$ 1σ are given in

the comments to the dates. Analysis numbers between B-1001 and B-2000 have been reserved for ice dating (Radiocarbon, 1967, v. 9, p. 28).

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I. GEOLOGIC-PALYNOLOGIC SAMPLES

A. Switzerland

Ballmoos series, Appenzell, Switzerland

Sec. in bog of Ballmoos (47° 22′ N Lat, 9° 30′ E Long) alt 950 m, near Stoss pass, between Altstätten and Gais, Appenzell Ausserrhoden, Switzerland. Investigated within general program of phytopaleontologic and paleoclimatic studies in NE Switzerland. Core 8.5 m long taken with Hiller borer. Coll. 1959 and subm. by P. Wegmüller and M. Welten, Syst.-Geobot. Inst., Univ. Bern, Switzerland.

B-958. Ballmoos, 120 cm — **3680 ± 190** / **1730 B.C.**

Sphagnum peat from 110 to 130 cm depth.

B-957. Ballmoos, 190 cm — **6000 ± 100** / **4050 B.C.**

Sphagnum peat from 180 to 200 cm depth.

B-956. Ballmoos, 370 cm — **7810 ± 130** / **5860 B.C.**

Telmatic peat (*Phragmites* and Magnocarices) from 360 to 380 cm depth.

B-955. Ballmoos, 515 cm — **9330 ± 130** / **7380 B.C.**

Gyttja from 505 to 525 cm depth.

B-954. Ballmoos, 535 cm — **10,060 ± 130** / **8110 B.C.**

Gyttja from 525 to 545 cm depth.

B-953. Ballmoos, 625 cm — **7460 ± 120** / **5510 B.C.**

Gyttja from 610 to 640 cm depth, contained some mineral sediments. *Comment*: material clearly dates palynologically from Allerød and shows no evidence of younger intrusions. Discrepancy of C^{14}-date is not understood.

General Comment (M. Welten, written commun., 1970): dates form very consistent series from end of Younger Dryas to Sub-Boreal. *Abies* invaded mixed oak forest at ca. 6500 B.P. Relatively late date of upper layers fully agrees with fact that several m of upper stratum of *Sphagnum* peat have been cut away in modern times.

Oberaar series, Bern, Switzerland

Two secs. at end moraine of Oberaar Glacier (46° 32′ 52″ N Lat, 8° 15′ 23″ E Long), alt 2320 m, on S slope of Zinggenstock Mt., W of Grimsel pass, near Guttannen, canton Bern, Switzerland, ca. 500 m above present timber line; recent vegetation ranges from very young pioneer plant communities to consolidated alpine meadows. Purposes of investigation were, (1) to study vegetational history above timber line in Bernese Oberland region by means of pollen analyses in soil profiles, (2) to date moraines of Oberaar Glacier.

Pollen profiles analyzed and interpreted by K. Ammann (ms. in preparation). Coll. 1967 and subm. by K. Ammann, Syst.- Geobot. Inst., Univ. Bern, Switzerland.

B-906. Oberaar A **270 ± 90** **A.D. 1680**

Sandy terrestrial peat from 195 cm depth in transect (G II) at middle of S side of end moraine. *Comment*: compare with B-254 (Radiocarbon, 1961, v. 3, p. 19): 4600 ± 80 B.P. from wood found after dredging at 4 to 5 m depth inside same moraine (now below water level of storage lake) 100 to 200 m S of present transect (according to A. Minning, oral commun.). Thus both depth and age difference of samples indicate earlier death for B-254 than glacier advance dated by present sample. Calendar date estimated from calibration curve (see Introduction) is between A.D. 1450 and A.D. 1740. To attempt more precise dating of moraine, succession of several samples would be necessary due to wriggles in curve.

B-908. Oberaar I **5100 ± 130** **3150 B.C.**

Slightly foliated terrestrial peat in upper part of stratum, from 22 to 23 cm depth, in Cut GI, at 13 m outside end moraine. High content of Cyperaceae (60%), low content of Gramineae (20%), and high amounts of herbaceous pollen, indicate warm climate. Considered end of Atlantic.

B-907. Oberaar B **6300 ± 100** **4350 B.C.**

Slightly foliated terrestrial peat from 26 to 28 cm depth in central part of stratum in Cut GI, at 7 m outside end moraine, at ca. 6 m S of sample Oberaar I, with same pollen content (see above). *Comment*: calculated sedimentation rate averages ca. 0.5 cm/100 yr.

General Comment: last 2 dates show that well-developed alpine meadows vegetation existed at 2300 m alt in Bernese Oberland region at end of Atlantic period. Other soil profiles in Swiss Alps have been studied earlier by Welten (1958b).

Hängstli series, Bern, Switzerland

Sec. in raised bog near Hängstli (46° 47′ 5″ N Lat, 7° 50′ 0″ E Long), alt 1260 m, near Eriz, 17 km E of Thun, canton Bern, Switzerland. Core

4.6 m long taken with Hiller borer for pollenanalytical study of vegetational development in transition zone from montane to sub-alpine belts (K. Heeb, ms. in preparation). Coll. 1967 and subm. by K. Heeb, Syst.-Geobot. Inst., Univ. Bern, Switzerland.

B-927. Hängstli, 75-100 cm **1960 ± 110**
10 B.C.

Sphagnum peat from 75 to 100 cm depth. *Picea* dominant. *Fagus* increase (Sub-Atlantic). Appearance of cereals pollen. *Comment*: forest composition similar to present. From correction of C^{14} secular variations by means of calibration curve (see Introduction), calendar age is 130 B.C. to A.D. 100.

B-928. Hängstli, 315 cm **4860 ± 110**
2910 B.C.

Sphagnum peat from 315 cm depth. From 290 to 330 cm immigration of *Picea* which competes with *Abies*. Mixed oak forest with *Quercus* dominance. *Comment*: pollen spectrum shows transition to more continental climate at beginning of Sub-Boreal.

B-929. Hängstli, 390 cm **5920 ± 130**
3970 B.C.

Cyperaceous peat from 390 cm depth. From 370 to 440 cm, immigration of *Abies alba*, dominating later; mixed oak forest and *Corylus* decrease. *Comment*: transition from Boreal to Atlantic.

General Comment: profile shows typical development for alt, consisting in change of *Abies* to *Picea* forest. Correlates in general with sec. at Wachseldorn (this list) where immigration of *Picea* is synchronous. Peat sedimentation did not begin before Atlantic; mean calculated peat growth rate is ca. 8 cm/100 yr. Cereal pollen indicate human activity in historical times.

Wachseldorn series, Bern, Switzerland

Two secs. in Untermoos raised bog in Wachseldorn (46° 49′ 15″ N Lat, 7° 44′ 5″ E Long), 980 m alt, 11 km E of Thun, Aare valley, canton Bern, Switzerland. Taken to study Late Glacial vegetational history. Present dates continue previously pub. series (Radiocarbon, 1967, v. 9, p. 30-31); samples named Wachseldorn are from same cut (545 cm length) in peat wall of mentioned series. Sample B-962, Untermoos, is from cut in peat wall at 170 m ESE from previous cut, and belongs to same bog. Thickness of samples, in general, ca. 2 cm.

Aare glacier covered E region up to ca. 1000 m alt. This combined with high precipitation made growth of raised bogs possible. Special vegetational conditions observed in locality are, (1) very early beginning of peat growth, (2) exceptionally fast peat growth during Pre-Boreal, (3) exceptional composition of pollen during Late Glacial with dominance of Cyperaceae and lack of *Betula*, possibly due to poor soils of Molasse substratum.

Pollenanalytically investigated by K. Heeb (ms. in preparation). Coll. 1965 by M. Welten and K. Heeb; subm. by M. Welten.

4770 ± 100
B-692. Untermoos, 150 cm **2820 B.C.**

Sphagnum peat from 150 cm depth. *Comment*: despite immigration of *Picea,* dominance of *Abies* (Sub-Boreal). Mixed oak forest pollen from lower alts is present (mainly *Quercus,* due to decrease of *Ulmus, Fraxinus,* and *Tilia*).

6690 ± 100
B-924. Wachseldorn, 225 cm **4740 B.C.**

Sphagnum peat from 225 cm depth. *Comment*: pollen spectrum from 200 to 230 cm depth shows: decrease of *Corylus* and mixed oak forest pollen, latter due to *Ulmus* decrease; *Abies* increase (Atlantic). Change of mixed oak forest to *Abies* forest due to wetter climate of period.

8950 ± 110
B-2011. Wachseldorn, 330 cm **7000 B.C.**

Cyperaceous peat from 330 cm depth. *Comment*: pine pollen dominant but decreasing, simultaneous increase of Cyperaceae, sharp increase of *Corylus* and mixed oak forest pollen.

9680 ± 130
B-2012. Wachseldorn, 358 cm **7730 B.C.**

Cyperaceous peat from 358 cm depth. See comment to B-926 (below).

9400 ± 130
B-2013. Wachseldorn, 365 cm **7450 B.C.**

Cyperaceous peat from 365 cm depth. See comment to B-926 (below).

9250 ± 120
B-925. Wachseldorn, 387.5 cm **7300 B.C.**

Cyperaceous peat from 385 to 390 cm depth. See comment to B-926 (below).

9880 ± 120
B-926. Wachseldorn, 403.5 cm **7930 B.C.**

Cyperaceous peat from 402 to 405 cm depth. *Comment*: at 345 cm appear 1st signs of mixed oak forest. In all 4 previous samples pine pollen is dominant, with decrease (from 85% to 48%) between 360 and 400 cm and simultaneous increase of Cyperaceae. Due to extraordinarily rapid peat growth during this period (Pre-Boreal) change in pine pollen indicates climatic deterioration not usually found in other profiles; direct comparison of this deterioration with that of Piottino (Zoller, 1968) cannot be done because of lack of evidence (Lang, 1952). Similar but stronger (75% to 30%) decrease in pine with simultaneous increase of Cyperaceae (and heliophile plants as *Selaginella, Artemisia,* and *Salix*) between 410 and 430 cm indicate Younger Dryas. Compare Samples B-700:

10,320 ± 150 B.P. for 416 cm, and B-701: 10,550 ± 150 B.P. for 421 cm depth in same profile (Radiocarbon, 1967, v. 9, p. 31).

B-921. Wachseldorn, 430 cm **10,130 ± 110 / 8180 B.C.**

Cyperaceous peat from 430 cm depth. *Comment*: compare with B-702: 10,980 ± 200 B.P. from 451 cm depth in same profile (Radiocarbon, 1967, v. 9, p. 31). From 430 to 465 cm, dominance of pine (65%) and few *Juniperus, Salix,* and *Artemisia* indicate Allerød pine forest. Deeper layers indicate weak pine increase with much Cyperaceae (60%) and less *Juniperus* and *Betula,* suggesting bad climate of Older Dryas. Compare with B-703: 11,660 ± 150 B.P. from 466 cm; B-704: 11,810 ± 150 B.P. from 470 cm depth in same profile (Radiocarbon, 1967, v. 9, p. 31). At 479 cm depth *Betula nana* maximum (9%) and decrease of Cyperaceae. At 487.5 cm depth, pine pollen is rare and maximum of *Juniperus* (64%) indicates beginning of reforestation after retreat of glaciers (assumed to be Bølling). Compare with B-705: 12,345 ± 150, from 479 cm; B-706: 12,210 ± 150, from 481 cm; B-707: 12,395 ± 130, from 489 cm; B-708: 12,500 ± 150 B.P., from 491 cm depth in same profile (Radiocarbon, 1967, v. 9, p. 31). At 505 cm depth, Cyperaceae dominates (85%) and traces of *Juniperus* and pine pollen are found, showing lack of forest; considered transition Oldest Dryas/Bølling, dated as B-709: 12,915 ± 130 B.P. (Radiocarbon, 1967, v. 9, p. 31).

General Comment: profile shows very marked minerogenous sedimentation, due to local conditions present only during deterioration of climate in Pre-Boreal (365 to 380 cm depth), Younger Dryas (415 to 430 cm), and Older Dryas (465 to 475 cm). Calculated mean sedimentation rates are 6.5 cm/100 yr, from 12,900 to ca. 9500 B.P. and 4.7 cm/100 yr, from ca. 9300 to 6700 B.P. Dates B-2012, B-2013, and B-925 are explained, within statistics, by a possible faster organic sedimentation between ca. 9500 and ca. 9300 B.P.

Seeliswald series, Bern, Switzerland

Sec. in raised bog at Seeliswald (46° 42′ 19″ N Lat, 7° 36′ 0″ E Long), 618 m alt, near Reutigen, canton Bern, Switzerland. Purpose of investigation was to date beginning of organic sedimentation. General stratigraphy shows change from Cyperaceous (*Phragmites* and *Carex*) peat in lower strata to *Sphagnum* peat in upper strata. Bog is underlain by clay and sand. Four cores taken with Hiller borer for vegetational studies by W. Strasser (ms. in preparation). Coll. 1968 by W. Strasser, Schönauweg 17a, Steffisburg, Switzerland; subm. by M. Welten.

B-910. Seeliswald 2-535 **2900 ± 90 / 950 B.C.**

Sphagnum peat from 530 to 540 cm depth in Core 2.

B-911. Seeliswald 2-555 — **2900 ± 90 / 950 B.C.**
Sphagnum peat from 550 to 560 cm depth in Core 2.

B-912. Seeliswald 3-430 — **2940 ± 90 / 990 B.C.**
Sphagnum peat from 430 to 440 cm depth in Core 3.

B-913. Seeliswald 3-470 — **3000 ± 100 / 1050 B.C.**
Sphagnum peat from 470 to 480 cm depth in Core 3.

B-914. Seeliswald 4-575 — **3030 ± 130 / 1080 B.C.**
Sphagnum peat from 570 to 580 cm depth in Core 4.

B-915. Seeliswald 5-130 — **2160 ± 100 / 210 B.C.**
Sphagnum peat from 125 to 135 cm depth in Core 5, taken ca. 150 m N from Borings 1 to 4.

General Comment: beginning of young bog is dated ca. 3000 B.P. when rock slide from Moosfluh Mt. blocked Reutigen valley allowing growth of peat behind rock barrier. Younger age of Sample 5-130 is explained by later inundation of N locality.

Faninpass series, Graubünden, Switzerland

Sec. in bog at Faninpass (46° 51′ N Lat, 9° 44′ E Long), alt 2212 m, between Prättigau and Schanfigg, near Peist, Graubünden (Grisons), Switzerland. Investigated within general program of phytopaleontologic and paleoclimatic studies in NE Switzerland. Core, 260 cm long, taken by Hiller borer. Coll. 1960 and subm. by P. Wegmüller.

B-901. Faninpass, 118 cm — **4740 ± 100 / 2790 B.C.**
Sphagnum peat from 105 to 130 cm depth.

B-902. Faninpass, 168 cm — **5740 ± 100 / 3790 B.C.**
Sphagnum peat from 155 to 180 cm depth.

B-903. Faninpass, 190 cm — **6230 ± 130 / 4280 B.C.**
Sphagnum peat from 180 to 200 cm depth.

B-904. Faninpass, 218 cm — **7300 ± 110 / 5350 B.C.**
Sphagnum peat from 205 to 230 cm depth.

8200 ± 130

B-905. Faninpass, 240 cm **6250 B.C.**

Sphagnum peat and gyttja from 230 to 250 cm depth.

General Comment (M. Welten): series dates most detailed of 3 profiles and pollen diagrams between Prättigau and Schanfigg. Organic sedimentation began between 9000 and 8000 B.P. Invasion of *Picea* took place ca. 7000 B.P. Younger peat layers seem absent.

St. Moritz series, Graubünden, Switzerland

Sec. S of Lake of St. Moritz (46° 29′ 17″ N Lat, 9° 50′ 29″ E Long), at ca. 1770 m alt, Graubünden (Grisons), Switzerland. Two borings 30 m long in sediments of fluvio-glacial origin. Purpose of investigation was dating glacier advance (H. Zoller, ms. in prep.); succession of pollen horizons appears disturbed (H. Zoller, 1968, written commun.). Coll. 1966 by C. Schindler, Geotechn. Büro von Moos, Zürich, Switzerland; subm. by H. Zoller, Bot. Inst., Univ. of Basle, Switzerland.

5600 ± 120

B-875. St. Moritz 1-220 **3650 B.C.**

Peat and silt from 220 cm depth in Boring 1. *Picea* dominance, increase of *Alnus viridis*.

3660 ± 150

B-876. St. Moritz 1-250 **1710 B.C.**

Peat and silt from 250 cm depth in Boring 1. *Pinus* dominance, rich in NAP.

4450 ± 200

B-877. St. Moritz 2-247 **2500 B.C.**

Peat and silt from 247 cm depth in Boring 2. *Picea* dominance, rich in *Alnus viridis*.

General Comment: first and last samples date appearance of *Alnus viridis* in locality at 5500 to 5000 B.P., as usual in Swiss profiles. Second date seems too young and is not accepted by submitter. Dates show ca. 25 m river sediments accumulated in High Engadin valley during last 5000 yr.

Suossa series, Graubünden, Switzerland

Sec. in Suossa (46° 26′ 36″ N Lat, 9° 12′ 10″ E Long) S of San Bernardino pass at ca. 1700 m alt, near San Bernardino, Graubünden, Switzerland. Studied for pollen analysis, profile gives good general view of Late Glacial climatic changes. Samples obtained by adding material from several analyzed cores. Coll. 1967 and subm. by H. Zoller.

6400 ± 100

B-868. Suossa I **4450 B.C.**

Bryophytic peat from 520 to 523 cm depth in Cores 3-6. Begins *Picea* dominance (Atlanticum).

7080 ± 250

B-869. Suossa II **5130 B.C.**

Bryophytic peat from 568 to 570 cm depth in Cores 1, 2, 3, and 5. *Abies* maximum, immigration of *Picea* (transition Older/Younger Atlantic).

8030 ± 250

B-870. Suossa III **6080 B.C.**

Bryophytic peat from 715 to 718 cm in depth in Cores 1-4. Presence of *Abies*, increase of *Acer* and *Fraxinus* (Boreal).

10,430 ± 250

B-871. Suossa IV **8480 B.C.**

Clay gyttja with some sand from 905 to 910 cm depth in Cores I, K-N. Increase of *Betula* (end of Younger Dryas).

11,300 ± 250

B-872. Suossa V **9350 B.C.**

Sandy clay gyttja from 921 to 926 cm depth in Cores I, K-N. Pioneer phase of Allerød with much *Pinus*. Underlain by sediments rich in NAP (Older Dryas).

11,600 ± 200

B-873. Suossa VI **9650 B.C.**

10,960 ± 200

B-873a. Suossa VIa **9010 B.C.**

Sandy clay gyttja from 931 to 936 cm depth in Cores B-F and H. *Comment*: both Samples VI and VIa, from same horizon, agree within statistics but seem young according to pollen analysis which indicates pioneer phase of Older Dryas with much NAP.

13,010 ± 200

B-874. Suossa VII **11,060 B.C.**

Clayey gyttja from 943 to 948 cm depth in Cores A-H. Pioneer phase of Bølling with *Pinus* pollen underlain by sediments without pollen. *General Comment*: dates show general early retreat of glaciers S of Alps and prove (1) retreat of branch of Rhine glacier from San Bernardino pass before Bølling, (2) San Bernardino basin free of glacier ice since Bølling.

Forest appeared at locality at end of Younger Dryas. Compared with dates (H-unpub.) from lower localities at same region as Pian di Signano (Zoller, 1960) it is concluded that *Picea abies* immigrated from N into Misox valley (Ticino) across San Bernardino pass. Calculated mean sedimentation rate is ca. 8.3 cm/100 yr.

Gola di Lago series, Ticino, Switzerland

Sec. in Gola di Lago bog (46° 6′ 13″ N Lat, 8° 58′ 3″ E Long), ca. 970 m alt in pass between Isone and Cassarate valleys, (Camignolo) near Tesserete, Ticino (Tessin), Switzerland. Studied to compare vegeta-

tional development S and N of Alps since Late Glacial. Samples obtained by adding material from several analyzed cores 4.5 m long, taken with Dachnowsky sonde. Preliminary description of pollen profile, interpretation and discussion of Post-Atlantic part, by Zoller and Kleiber (1967). Coll. 1966 and subm. by H. Zoller.

4420 ± 120

B-800. Gola di Lago IV **2470 B.C.**

Sandy-clayey gyttja from 145 to 150 cm depth. 1st distinct increase of *Fagus silvatica* (Sub-Boreal).

12,580 ± 90

B-799a. Gola di Lago IIIa **10,630 B.C.**

Clay gyttja from 360 to 370 cm depth. *Comment*: strong *Pinus* increase interpreted as middle of Pre-Boreal. C^{14} result seems 2000 to 3000 yr older than expected from pollen analysis.

12,330 ± 200

B-798. Gola di Lago II **10,380 B.C.**

Clay gyttja from 385 to 388 cm depth. Strong *Betula* increase (Older Dryas).

12,610 ± 200

B-797. Gola di Lago I **10,660 B.C.**

Sand and clay gyttja from 389 to 393 cm depth. Poor AP (> 60% NAP) with brief increase of *Betula* pollen (Bølling).

General Comment: dates of deepest samples (I and II) show, (1) retreat of Ticino (Tessin) glacier into Lugano basin before Bølling, (2) appearance of forest ca. 12,000 B.P. (Allerød), compare Lago Origlio series (Zoller, 1960, p. 76; Radiocarbon, 1961, v. 3, p. 17); (3) importance of *Larix* during pioneer phases.

Upper sample dates delayed appearance of *Fagus* in Ticino (Zoller and Kleiber, 1967) compared with profile at same lat in Italy, Lago di Ledro (Beug, 1964), but synchronous with that at N of Alps (Wegmüller, 1966). Forests with *Fagus* at N of Alps formed 1000 yr earlier than at Ticino. Time discrepancy in extension of *Abies* and *Fagus* is 2000 yr in Lago di Garda and 5000 yr in Ticino. Delay of *Fagus* is thought to be caused by *Abies* occupation of forest belt. Calculated average sedimentation rate is ca. 3 cm/100 yr.

Boniger See series, Valais, Switzerland

Several secs. from lake of Bonig (Boniger- or Böhnig-See) (46° 15′ 33″ N Lat, 7° 50′ 35″ E Long), at 2095 m alt, near Törbel, Visp valley, Valais (Wallis), Switzerland. Swampy lake of Bonig lies on Moosalp terrace at ca. 10 km NW of Grächen, driest place in Switzerland (50 cm annual precipitation), near present timber-line with *Pinus cembra* and *Larix*. Staub (1927) considered Moosalp terrace to be pre-glacial valley bottom. Present lake originates from dead ice left by retreat of Visp glacier which overflowed terrace up to 2200 m alt in N slope of Augst-

bordhorn Mt. Cores taken with Hiller borer. Description of present and former vegetation, and palynologic interpretations pub. by Markgraf (1969). Coll. 1965-66 and subm. by V. Markgraf, Syst.-Geobot. Inst., Univ. Bern, Switzerland, and M. Welten.

a) Late and Post Glacial vegetational history

6030 ± 100

B-785. Boniger See 1-485 **4080 B.C.**

Detritus gyttja with leaves of *Larix* and *Pinus* (id. by V. Markgraf) from Core 1 at 460 to 500 cm depth. Core 1 is 614 cm long reaching oldest sediments of site; from inner margin of swampy island. *Comment*: dates immigration of *Abies alba* in Valais, generally accepted as 6000 B.P. for that area (Welten, 1958a).

4460 ± 100

B-787. Boniger See 4-169 **2510 B.C.**

Peat with *Sphagnum* and *Drepanocladus* from Core 4 at 150 to 180 cm depth. *Picea* increase. Core 4 is 210 cm long, from S shore which is usually dry in late summer. *Comment*: considered to be transition Younger Atlantic/Sub-Boreal.

7140 ± 120

B-788. Boniger See 4-189 **5190 B.C.**

Peat with *Sphagnum* and *Drepanocladus* from Core 4 at 180 to 200 cm depth. Pollen shows *Abies* maximum of Atlantic period. *Comment*: compared with overlying sample (4-169, see above) hiatus of nearly 3000 yr is seen, probably due to disturbing effect of dead ice as late as Atlantic time. Date pub. in description of sec. must be altered.

7990 ± 110

B-784. Boniger See 1-545 **6040 B.C.**

Algae gyttja with *Pediastrum* and some clay from Core 1 at 525 to 550 cm depth. Increase of mixed oak forest, *Corylus* and *Betula*, decrease of *Pinus cembra* pollen. *Comment*: pollen spectrum indicates slightly wetter but warm climate (transition Boreal/Older Atlantic). In Central Europe, usually dated to 7500 B.P. among others by Wegmüller (1966) and Zoller (1968), but in N Europe to 8200 B.P. (Nilsson, 1964) in agreement with present date.

10,430 ± 150

B-782. Boniger See 1-597 **8480 B.C.**

Algal gyttja with clay and some *Pediastrum* from Core 1 at 591 to 620 cm depth. Decrease of *Betula*, increase of *Pinus cembra*, Chenopodiaceae, and *Ephedra* pollen. *Comment*: pollen analysis indicates younger and drier part of Younger Dryas.

General Comment (Markgraf): samples date development of vegetation belts for area: during Allerød, timber-line with *Betula* and *Pinus cembra* was between 1800 and 2000 m, concluded from present growth of *Juni-*

perus shrubs and alpine meadow plants at 2200 m alt; in Younger Dryas time, timber line was pushed further downwards and steppe-like vegetation expanded; timber line returned to that altitude in Pre-Boreal time, indicated by presence of pollen of rich, tall herb vegetation (*Heracleum sphondylium, Geranium* sp., *Chaerophyllum hirsutum,* etc.) at 2200 m; during Boreal, *Larix* immigrated into area and since then formed forest in sub-alpine zone together with *Pinus cembra,* accompanied by *Abies* since 6000 B.P. Subsequent development was influenced by man (see *c,* below).

b) Peat development and sedimentation rate

2700 ± 150

B-846. Boniger See 2-180 **750 B.C.**

Wet peat with leaves of *Drepanocladus* and *Sphagnum* from Core 2 at 170 to 190 cm depth. Core 2, 570 cm long, from 50 m E of Core 1, on E margin of floating island. Pollen analysis shows general tree pollen (AP) decrease at every vegetation belt; herb pollen (NAP) increase, especially cultural indicators (cereals, *Plantago, Cannabis)*; and appearance of *Juglans* pollen. *Comment*: analyses interpreted as dating transition Sub-Boreal/Sub-Atlantic, generally 2600 B.P.

3230 ± 120

B-847. Boniger See 2-250 **1280 B.C.**

Peat with *Sphagnum* and some *Drepanocladus* and *Cyperaceae* rootlets from Core 2 at 230 to 295 cm depth. Dominance of *Pinus cembra* with more *Picea* and less *Abies* than in Sample 2-350 (see below). *Comment*: interpreted as older part of Sub-Boreal. Relatively fast peat growth-rate of 13 cm/100 yr (3200 to 2700 B.P.) was caused by high water level of lake.

4840 ± 120

B-848. Boniger See 2-350 **2890 B.C.**

Peat with *Sphagnum, Drepanocladus,* and fungal hyphae from Core 2 at 320 to 375 m depth. End of *Abies* expansion in *Pinus cembra* forest at 2200 m alt. Appearance of *Picea* and agricultural indicators. *Comment*: considered transition Younger Atlantic/Sub-Boreal. Calculated peat growth-rate, 6 cm/100 yr (4800 to 3200 B.P.).

5715 ± 120

B-849. Boniger See 2-435 **3765 B.C.**

Detritus gyttja with leaves of *Larix* and *Pinus* from Core 2 at 425 to 450 cm depth. Oldest *Abies* maximum in *Pinus cembra* forest. First traces of *Fagus. Comment*: calculated sedimentation rate during Younger Atlantic, 10 cm/100 yr (5700 to 4800 B.P.).

7600 ± 150

B-850. Boniger See 2-490 **5650 B.C.**

Algal gyttja from Core 2 at 475 to 500 cm depth. Immigration of *Abies* in Rhône valley. Pollen shows well developed tall herb vegeta-

tion (*Adenostyles alliariae, Lilium martagon, Heracleum sphondylium,* etc.) in *Pinus cembra-Larix* forest of sub-alpine zone. *Comment*: sedimentation rate during younger part of Older Atlantic at transition from gyttja to peat, 3 cm/100 yr (7600 to 5700 B.P.).

8370 ± 150

B-851/2. Boniger See 2-522 **6420 B.C.**

Algal gyttja with *Pediastrum* from Core 2 at 505 to 550 cm depth. Decrease of *Betula* and *Corylus,* increase of *Pinus* and mixed oak forest pollen. *Comment*: considered transition Boreal/Older Atlantic. Sedimentation rate during Older Atlantic, 4.5 cm/100 yr (8300 to 7600 B.P.). Date pub. in description of sec. must be altered.

General Comment: sedimentation rate in lake, of different organic materials, varies, ca. 3 cm/100 yr during Older Atlantic, 10 cm/100 yr during Younger Atlantic, and 14 cm/100 yr during Sub-Boreal. Development of lake vegetation started late (Markgraf, 1969) ca. Atlantic time, probably delayed by influence of dead ice in bottom of lake causing sedimentation disturbances. At beginning of Older Atlantic, dense *Potamogeton alpinus* layer with *Menyanthes* and *Sparganium* covered lake, forming rhizome networks able to collect mud. At beginning of Younger Atlantic time, peat growth started on that layer with *Drepanocladus* moss later followed by *Sphagnum* sp. Up to beginning of Sub-Atlantic, peat growth expanded over lake. Then organic development stopped, probably due to sudden rise of water level. Only central part of peat layer could then lift and start to grow again forming floating island.

c) Human influence on vegetation

4170 ± 100

B-791. Boniger See 3-30, charcoal **2200 B.C.**

3810 ± 110

B-794. Boniger See 3-30, soil with charcoal **1860 B.C.**

Two portions of black soil with microscopic wood charcoal pieces from Cut 3 at 31 to 32 cm depth. B-791 consists of charcoal particles ($>$ 0.2 mm) selected by sieving. Cut 3 is 120 cm long, opened at N margin of lake which is surrounded by 50 cm high rim originating from erosion by water level changes during Sub-Atlantic. Soil cut shows 3 wood charcoal horizons (id. by F. Schweingruber, Syst.-Geobot. Inst., Univ. Bern): at 31 to 32 cm (*Abies*), from 50 to 71 cm (*Pinus cembra*), and at 85 cm depth. Pollen analysis shows sharp decrease of AP, and 80% Gramineae. *Comment*: considerable pollen variations were found in charcoal horizons, indicating woods clearing by fire and subsequent natural reforestation by shrubs (*Corylus, Betula*) and trees. Date B-794 pub. in description of sec. must be altered.

5300 ± 100

B-790. Boniger See 3-60, charcoal **3350 B.C.**

5070 ± 100

B-792. Boniger See 3-60, soil with charcoal 3120 B.C.

Two portions of black soil with microscopic wood charcoal pieces (*Pinus cembra,* see comment to B-794, above) from Cut 3 at 50 to 71 cm depth. Sample B-790 consists of charcoal particles (> 0.2 mm) selected by sieving. Pollen shows reforestation indicators (*Pinus* increase after *Betula* and *Corylus* maximum). *Comment*: from differences in these pairs of dates (see soil samples 3-30 and 3-60) pure charcoal horizons seem to be ca. 300 yr older than soil with charcoal. Relative proportions of humus and charcoal in soil were not determined. As humic extracts have not been dated, legend "humus" in Profile 3 (Markgraf, 1969, p. 63) must be changed to "soil with charcoal".

4830 ± 100

B-789. Boniger See 3-69, soil with charcoal 2880 B.C.

Soil with charcoal pieces from Cut 3 at 68 to 71 cm depth, bottom layer in main charcoal horizon of Sample 3-60 (see above). *Comment*: sample dates beginning of clearing. Date is coincident within statistics with date of main layer (50 to 71 cm) (B-792, above). Charcoal itself would probably date to ca. 5200 B.P. if relative proportion of humus and charcoal is similar in present sample to previous (3-30 and 3-60, above).

4740 ± 100

B-786. Boniger See 1-385 2790 B.C.

Peat with *Sphagnum, Drepanocladus,* and fungal hyphae, from Core 1 at 370 to 400 cm depth. Strong increase of *Picea* and decrease of *Abies*. *Comment*: indicators of agriculture appear, showing human influence.

4870 ± 100

B-793. Boniger See 13-250 2920 B.C.

Peat with *Sphagnum, Drepanocladus,* and Cyperaceae rootlets from Core 13, at 220 to 290 cm depth. Core, 505 cm long, is from outer N margin of floating island. *Picea* increase. *Comment*: pollen diagram, not described by Markgraf (1969), is similar to that of Core 1 but compressed. *General Comment*: (Markgraf, 1969) dates indicate human activity (agriculture) and synchronous wood clearings by fire from 5300 to 3700 B.P. Natural fire is excluded for 2 reasons, (1) although possibilities of fire during earlier period with drier climate were greater, no evidence was found in cores from site; (2) cereal pollen, indicators of important agricultural activity, appear in the charcoal horizons. Vegetation changes at 5000 B.P. were greater than known variations in climate (Frenzel, 1966) might cause, and are considered mainly due to human influence. Expansion of *Picea* was probably related to clearings (V. Markgraf, ms. in prep.) because during reforestation *Picea* is favored in competition with *Abies* and *Pinus cembra,* which grow slower, especially where cattle graze.

Belalp II series, Valais, Switzerland

Sec. in bog at Belalp below and SW of Tyndall-Stein (46° 23′ 6″ N Lat, 7° 59′ 2″ E Long), alt 2290 m, N of Brig-Naters, near Naters, Valais (Wallis), Switzerland. Investigated within the general program (Welten, 1958a) of paleoclimatic studies in region of Aletsch Glacier. Compare Greicheralp and Eggen series (this list), Aletschwald series (Radiocarbon, 1959, v. 1, p. 136), and Bitsch-Naters series (Radiocarbon, 1959, v. 1, p. 136; 1961, v. 3, p. 17-18). Present core (145 cm length), taken with Hiller borer near previous boring (see Belalp series: Radiocarbon, 1961, v. 3, p. 18; 1963, v. 5, p. 305). Coll. 1968 and subm. by M. Welten.

B-981. Belalp II, 55 cm **3240 ± 100 / 1290 B.C.**

Hypnaceous and cyperaceous peat from 45 to 65 cm depth.

B-982. Belalp II, 80 cm **5700 ± 100 / 3750 B.C.**

Hypnaceous and cyperaceous peat from 70 to 90 cm depth.

B-983. Belalp II, 129 cm **6360 ± 100 / 4410 B.C.**

Hypnaceous and cyperaceous peat from 119 to 139 cm depth.

General Comment: apparent hiatus in sedimentation during Sub-Boreal (approx. between 5000 to 2500 B.P.), considered important for paleoclimatologic evaluation and correlation of diagrams from high alts.

Greicheralp series, Valais, Switzerland

Sec. in Greicheralp (46° 22′ 40″ N Lat, 8° 1′ 50″ E Long) bog at 1915 m alt, E of Hotel Riederalp, above Mörel, Valais (Wallis), Switzerland. Taken to study vegetational history since Post-Glacial and compare with other profiles in region, esp. Aletschwald series (Radiocarbon, 1959, v. 1, p. 136-137). See also Belalp series (this list) and refs. Pollen anal. by M. Welten (ms. in preparation). 440 cm core taken with Hiller borer. Coll. 1956 by M. Welten and B. Seddon; subm. 1969 by M. Welten.

B-2002. Greicheralp 92 cm **3530 ± 90 / 1580 B.C.**

Cyperaceous peat, strongly humified, from 92 cm depth.

B-2003. Greicheralp 178 cm **3940 ± 100 / 1990 B.C.**

Cyperaceous peat, weakly humified, from 178 cm depth.

B-2004. Greicheralp 240 cm **4830 ± 120 / 2880 B.C.**

Hypnaceous peat, from 240 cm depth.

B-2005. Greicheralp 340 cm **5420 ± 230**
3470 B.C.

Hypnaceous peat, from 340 cm depth.

B-2006. Greicheralp 413 cm **5630 ± 100**
3680 B.C.

Hypnaceous clayey peat, from 413 cm depth.

Eggen series, Valais, Switzerland

Sec. in Eggen (46° 22′ 13″ N Lat, 7° 59′ 22″ E Long) 1650 m alt, N of Blatten, Valais (Wallis), Switzerland. Bog deposit near moraine sampled to study sedimentation and vegetational history in relation to climatic effects of Aletsch Glacier. Present samples continue previous series (Radiocarbon, 1961, v. 3, p. 18; 1963, v. 5, p. 305; Welten, 1958a). Coll. 1956 and subm. by M. Welten.

B-970. Eggen 190 cm **3490 ± 120**
1540 B.C.

B-971. Eggen 290 cm **5840 ± 120**
3890 B.C.

Hellelen B series, Valais, Switzerland

Sec. in bog at Hellelen (46° 17′ 3″ N Lat, 7° 50′ E Long), 1510 m alt, Zeneggen, Valais (Wallis), Switzerland. New boring 840 cm long, with Hiller borer, at Hellelen-Zeneggen locality (Radiocarbon, 1966, v. 8, p. 25). Description and interpretation of pollen analyses by M. Welten (ms. in preparation). Coll. 1968 and subm. by M. Welten.

B-916. Hellelen 445 cm **8780 ± 120**
6830 B.C.

Dy from 445 cm depth (Pre-Boreal).

B-917. Hellelen 455 cm **9430 ± 120**
7580 B.C.

Dy from 455 cm depth (Pre-Boreal).

B-918. Hellelen 521 cm **12,310 ± 150**
10,360 B.C.

Clayey gyttja from 521 cm depth (beginning of Allerød).

Vidy series, Vaud, Switzerland

Three secs. W of road Vidy-Lausanne, at water-works excavation (46° 31′ 18″ N Lat, 6° 35′ 27″ E Long), ca. 380 m alt, in Vidy, Lausanne, Vaud (Waadt), Switzerland. Several borings made in lower deltaic terrace of La Chamberonne R. to determine chronology of sedimentation of Lake of Geneva (Lac Léman) and Vidy terraces. All plant remains id. by collector. Pollen analyses and interpretation by Villaret and Burri (1965). Coll. 1962-63 and subm. by P. Villaret, Inst. Botan. Syst. et Geobot., Univ. Lausanne, Switzerland.

12,100 ± 250
10,150 B.C.

B-752. Vidy Pb-55

Wood (*Pinus* sp., 32 annual rings) from 55 cm depth in Boring A, in calcareous sand interspersed with several layers of "fumier lacustre" (similar composition to B-751, below) where pollen was analyzed. *Pinus* dominant. *Comment*: from pollen and geologic analyses of sediments, considered to date Pre-Boreal (Villaret and Burri, 1965).

12,750 ± 200
10,810 B.C.

B-751. Vidy EMSE 2

"Fumier lacustre" (abundant twigs, leaves, fruits, and scales of *Betula nana*, some leaves of *Dryas octopetala*, leaves and seeds of *Juniperus communis* ssp. *nana*, numerous seeds of Caryophyllaceae, fruits of *Helianthemum* sp., *Armeria* sp., *Onobrychis* sp., *Thalictrum* sp., etc.), from 120 cm depth in Boring C, in calcareous loam. NAP dominance with 15% *Betula nana* pollen. *Comment*: date corresponds to Older Dryas age in contradiction to expected age (Villaret and Burri, 1965), Oldest Dryas.

12,400 ± 200
10,450 B.C.

B-753. Vidy 02

Wood (*Betula* sp., ca. 50 annual rings) from 10.5 cm depth in core taken near Boring B, in chalky loam. Pollen analysis shows intersection of *Pinus* and *Betula* curves. *Comment*: dates beginning of *Allerød*.

General Comment: dates and pollen analyses show deepest layers belong to Oldest Dryas, indicating sedimentation until Allerød and gap until Sub-Boreal time, attributed to (1) regression of lake, of (2) erosion by lake water during Boreal and Atlantic, later (Sub-Boreal) covered by river sediments. Estimated dates for B-752 and B-753: 1000 yr older than expected from comparison with analyses from site at 35 km, La Tourbière (Wegmüller, 1966, p. 29-31, pl. 1; Radiocarbon, 1963, v. 5, p. 307).

B. Austria

Dobramoos series, Kärnten, Austria

Sec. in Dobramoos raised bog (46° 45′ 50″ N Lat, 14° 12′ 30″ E Long), alt 902 m, St. Urban, near Klagenfurt, Kärnten (Carinthia), Austria. Pollenanalytically investigated to study chronology of vegetation in SE Alps. Description and interpretation of analyses pub. by Bortenschlager (1966). Kärnten region was also studied by Schmidt (1965, 1970) and Fritz (1967). See also Schwarzer Moor I, Keutschachersee II, and Kohlenmoos series (this list). Two cores taken with Hiller borer. Coll. 1963 by S. Bortenschlager, Inst. für Botan. Syst. und Geobot., Univ. Innsbruck, Austria; subm. by M. Welten.

B-613. Dobramoos IV-D **5860 ± 100**
3910 B.C.

Sphagnum peat from Core IV at 70 to 80 cm depth. Boring IV (3 m long) at ENE border of bog. Oldest *Fagus* maximum and immigration of *Abies*. *Comment*: considered Atlantic time.

B-614. Dobramoos IV-E **9000 ± 120**
7050 B.C.

Cyperaceous peat from Core IV at 160 to 170 cm depth. *Pinus* decrease and NAP increase (Younger Dryas).

B-593. Dobramoos V-180 **9360 ± 140**
7410 B.C.

Cyperaceous peat from Core V at 180 to 190 cm depth. Boring V (4.20 m long) ca. 50 m from Boring IV toward center of bog. Slight increase of NAP during minor dip in broad *Pinus* maximum. *Comment*: may correspond to Younger Dryas.

B-594. Dobramoos V-230 **9550 ± 150**
7600 B.C.

Cyperaceous peat from Core V at 230 to 240 cm depth. Onset of *Pinus* increase. *Comment*: pollen analysis indicates warm phase thought to be Allerød. Date is > 1000 yr too young if horizon is synchronous with Central Europe sequence.

B-615. Dobramoos IV-F **10,820 ± 150**
8870 B.C.

Cyperaceous peat from 210 to 220 cm depth in Boring IV. Strong *Pinus* pollen increase above marked NAP maximum. *Comment*: considered Older Dryas.

B-595. Dobramoos V-310 **12,610 ± 180**
10,660 B.C.

Cyperaceous peat from 310 to 320 cm depth in Boring V. Slight dip in broad NAP maximum. *Comment*: considered to be of Bølling age.

B-617. Dobramoos V-340 **12,280 ± 200**
10,310 B.C.

Cyperaceous peat from 340 to 350 cm depth in Boring V. NAP broad maximum. *Comment*: interpreted as Oldest Dryas. This date is not mentioned by Bortenschlager (1966); result not statistically different from Dobramoos V-310.

General Comment: preliminary chronology of vegetational history in Kärnten based on present dates resembles S Central Europe. Main similarity is simultaneous reforestation in both regions by *Pinus* and *Betula* during Allerød, although Dobramoos IV-F seems ca. 1000 yr too young (Bortenschlager, 1966). According to Fritz (1967) correlation of Central Europe with E Alps vegetational situation is questionable.

Recognition of Bølling and Older Dryas is difficult probably due to short length of Bølling and relatively large separation between successive pollen samples. Mean sedimentation rates are 2.7 cm/100 yr (Core IV) and 4 cm/100 yr (Core V).

Kohlenmoos series, Kärnten, Austria

Sec. in Kohlenmoos wet raised bog (46° 47′ 0″ N Lat, 13° 34′ 30″ E Long), at 846 m alt, between Lake Millstätt and Drau valley, N of Winkl, Kärnten, Austria. Pollenanalytically investigated by Schmidt (1965, 1970) to study vegetational history of outer E Alps; especially in comparison with Schwarzer Moor I and Keutschachersee II series (see below) which have less continental climate than Kohlenmoos. 870 cm core taken at N of bog with Hiller borer. Coll. 1964 by H. Schmidt, Stethaimerstr. 15, Salzburg, Austria; subm. by M. Welten.

B-618. Kohlenmoos 1 **2570 ± 100**
520 B.C.

Sphagnum peat, greatly decomposed, from 200 to 225 cm depth. *Comment*: pollen indicates increased human activity; deduced from presence of cereals and sharp decrease of *Fagus* and *Abies*.

B-619. Kohlenmoos 2 **5120 ± 100**
3170 B.C.

Cyperaceae peat of varying density, from 395 to 405 cm depth. *Comment*: *Fagus* and *Abies* horizon with cereals pollen.

General Comment: dates indicate immigration of *Fagus, Picea,* and *Abies* earlier than at N of Alps, maximum of *Fagus* extension during Atlantic and end of *Fagus* dominance at beginning of Sub-Boreal. Comparable vegetational development is reported for locality at 15 km, Lengholz (Fritz, 1967) and for Dobramoos (Bortenschlager, 1966, this list, above). Lower sample dates appearance of agriculture as far back as 5120 B.P.

Schwarzer Moor I, Kärnten, Austria

Sec. in wet raised bog Schwarzer Moor (46° 34′ 30″ N Lat, 14° 23′ 20″ E Long) at 770 m alt, E of Sattnitz Mts., SE of Klagenfurt, Kärnten (Carinthia), Austria. Pollen profile by Schmidt (1965), to study vegetational history of Sattnitz region. Pollen analyses of related localities in Kärnten reported by Schmidt (1965, 1970), Bortenschlager (1966), and Fritz (1967). Core at center of bog, 930 cm long, taken with Hiller borer. Coll. by H. Schmidt; subm. by M. Welten.

B-620. Schwarzer Moor I-3 **2490 ± 100**
540 B.C.

Cyperaceae peat, largely dry and decomposed, from 300 to 325 cm depth. Brief decrease of *Fagus* and *Abies,* NAP increase with indicators of human influence (cereals and *Plantago*).

B-621. Schwarzer Moor I-4 **5760 ± 120 / 3810 B.C.**

Detritus gyttja, dark brown, from 545 to 555 cm depth. *Abies* expansion and decrease of *Picea, Fagus,* mixed oak forest (*Ulmus* decrease) and *Corylus,* due to extensive human influence.

B-622. Schwarzer Moor I-5 **8785 ± 150 / 6835 B.C.**

Detritus gyttja, dark brown, from 745 to 755 cm depth. *Corylus* increase and mixed oak forest maximum. *Comment*: considered Boreal. At depth 720 to 550 cm (ca. 8200 to 5800 B.P.) pollen spectrum shows dominance of *Corylus* and *Picea* (Atlantic). In younger part of Atlantic, *Fagus* immigration and expansion; compare similar date, B-597: 6120 ± 100 B.P., for Keutschachersee (see below).

General Comment: as in Kohlenmoos and Dobramoos series (above), and in Keutschachersee series (below), immigration and extension of *Fagus, Picea,* and *Abies* have been dated. Transition from *Picea* dominance to *Fagus* increase occurs earlier in more oceanic parts of Kärnten (W) than in those more continental (E) as Kohlenmoos (above) (Schmidt, 1965, 1970). Calculated sedimentation rate is ca. 7.2 cm/100 yr.

Keutschachersee II series, Kärnten, Austria

Sec. in Keutschachermoor bog (46° 35′ 15″ N Lat, 14° 10′ 30″ E Long), at 508 m alt, at E of lake of Keutschach, S of Lake Wörth, in W part of Sattnitz Mts., Kärnten (Carinthia), Austria. Vegetational history of outer part of E Alps was pollen analytically investigated by Schmidt (1965, 1970), Bortenschlager (1966), and Fritz (1967). Core, 940 cm long, from center of hydrosere on E of lake, taken with Hiller borer. Coll. 1964 by H. Schmidt; subm. by M. Welten.

B-597. Keutschachersee II, KC VIII-1 **6120 ± 100 / 4170 B.C.**

Cyperaceae peat partly with "braunmosses" and *Eriophorum* leaves, from 200 to 225 cm depth. Decrease of *Picea* and increase of *Abies, Fagus,* and *Alnus. Comment*: considered end of Atlantic.

B-598. Keutschachersee II, KC VIII-2 **6910 ± 100 / 4960 B.C.**

Phragmites peat with scattered rests, strongly humified, from 360 to 370 cm depth. Onset of *Picea* maximum, decrease of *Ulmus* and *Tilia.* Very strong increase of spores of *Pteridium* and *Dryopteris* (from ca. 1% to > 200%) and increase of NAP (from 10% to 40%). *Comment*: considered transition Boreal/Atlantic.

General Comment: dates establish immigration of *Fagus, Picea,* and *Abies* earlier than at N of Alps, maximum extension of *Fagus* during Atlantic, and end of its dominance at beginning of Sub-Boreal (compare series at Kohlenmoos, Schwarzer Moor, and Dobramoos, this list) (Schmidt, 1965).

Profile shows detailed Late Glacial development from Oldest Dryas onwards, in clay from 940 to 715 cm and in chalk from 715 to 520 cm depth. Subsequent Post-Glacial development shows succession ranging from mixed oak forest to *Corylus-Picea* phase. Start of Post-Glacial appears delayed ca. 2000 yr compared to Schwarzer Moor (see above). Fern increase, at beginning of Atlantic (Sample KC VIII-2), may be related to forest clearance (Bastin, 1964) but is considered by collector to be due to wetter climate (Schmidt, 1965). Post-Atlantic development is synchronous with Schwarzer Moor (see above).

9040 ± 130

B-963. Höll, Block IV, Oberösterreich, Austria **7090 B.C.**

Wood from 50 cm depth in clay of former lake now covered by rock-fall material, at Höll (47° 38′ N Lat, 14° 28′ E Long), alt ca. 1300 m, near Linzerhaus, Spital am Pyhrn, Totes Gebirge Mts., Kirchdorf a.d. Krems, Oberösterreich, Austria. Coll. 1968 by E. Ebers, D-8121 Haunshofen, Kr. Weilheim, W Germany; subm. by V. Markgraf. Locality in 500 m long and 90 m broad widening of Teichl valley at foot of steep walls of Stubwieswipfel Mt. within subalpine *Picea* forest belt, in former lake covered by rock-fall material with numerous engravings of primitive design (Ebers, 1969). Several cuts were pollen analytically investigated by V. Markgraf to date rock-fall and engravings. *Comment*: engravings seem to date from several archaeologic times, partially related to paintings of different epochs: e.g., W France megalithic and Bronze and Iron ages (Burgstaller, 1961). At level of present date in pollen digaram, analysis shows transition from *Pinus* dominance to *Picea* increase (V. Markgraf, written commun., 1970) which corresponds well to previously dated diagrams from Austria (Fritz, 1967; Bortenschlager, 1966, 1967), where this transition ranges from 10,000 to 9000 B.P. Date agrees with dated diagrams of Seemoos and Dobramoos (this list) but erroneously pub. and interpreted as Allerød by Ebers (1969).

Seemoos series, Salzburg, Austria

Sec. in Seemoos raised bog (47° 5′ N Lat, 13° 45′ 30″ E Long), ca. 1700 m alt, in pass on Schwarzenberg Plateau, Bezirk Tamsweg in Lungau, Salzburg, Austria. Pollen analytic investigation of forest history and immigration of vegetation in glaciated valleys of E Alps (see Dobramoos, Schwarzer Moor I, Keutschachersee II, and Kohlenmoos series, this list) by Bortenschlager (1967). Human influence since Roman times is indicated. Core (8.50 m long) was taken with Hiller borer. Coll. 1963 by S. Bortenschlager; subm. by M. Welten.

880 ± 100

B-596. Seemoos I-100 **A.D. 1070**

Sphagnum peat from 100 to 125 cm depth with 1 cm thick charcoal horizon. Increase of NAP and indicators of human activity (cereals, *Plantago*, and *Rumex*). *Comment*: dates transition Older/Younger Sub-

Atlantic. Variations in *Picea* and *Pinus* pollen ratio interpreted as probable clearing by fire for pasture purposes. Age derived from calibration curve (see Introduction) between A.D. 1010 to A.D. 1210.

B-616. Seemoos I-650 **7580 ± 120**
5620 B.C.

Cyperaceous peat from 650 to 675 cm depth. Increase of *Picea* with simultaneous decrease of *Pinus*. *Comment*: interpreted as transition Boreal/Older Atlantic.

General Comment: C^{14} dates agree with chronology inferred from pollen analyses.

II. ARCHAEOLOGIC SAMPLES

A. Switzerland

Vinelz series, Bern, Switzerland

Two samples from Vinelz (ca. 47° 2′ N Lat, ca. 7° 4′ E Long), at ca. 440 m alt, in late Neolithic site on SE branch of lake of Biel (Bieler See), SE of Erlach, canton Bern, Switzerland. Samples from cultural layer overlain by 1.5 m of sand, assoc. with potsherds with food remains. Should represent small regional Lüscherz group, perhaps related to Horgen culture. Chronologic setting not completely determined; expected younger than Cortaillod culture (see Seeberg Burgäschisee-Süd series: Radiocarbon, 1959, v. 1, p. 140-142; 1961, v. 3, p. 23-24) and older than *Schnurkeramik* culture (see Auvernier series: Radiocarbon, 1967, v. 9, p. 30; (Strahm, 1965-1966, 1970). Coll. 1960 and subm. by C. Strahm, Inst. für Ur- und Frühgeschichte, Univ. Freiburg, W Germany.

B-778. Vinelz 1 **4170 ± 250**
2220 B.C.

Wood charcoal. *Comment*: date, derived from calibration of C^{14} scale with tree rings (see Introduction), is 3400 B.C. to 2600 B.C.

B-779. Vinelz 2 **4460 ± 120**
2510 B.C.

Seeds, nutshells, and charred acorns. *Comment*: date, from mentioned curve, is 3380 B.C. to 2980 B.C.

General Comment: both dates are coincident and agree with expectations.

La Baume d'Ogens series, Vaud, Switzerland

Site 1 km E of Ogens (46° 43′ N Lat, 6° 44′ E Long), at 672.90 m alt, in dist. of Moudon, ca. 13 km SE of Yverdon, Vaud (Waadt), Switzerland. Discovered 1955 (Egloff, 1965; Wyss, 1968) in a fault S oriented facing Augine R., is 1st reported Mesolithic rock shelter from Molasse formation in Jura; contains 6 Epipaleolithic hunter-gatherers occupation levels alternating with sand layers. Assoc. finds are largely similar to those of lower levels in Birsmatten-Basisgrotte (Bandi, 1964; Radiocarbon, 1961, v. 3, p. 23). Stone artifacts (sieved out with mesh 2 mm) correspond

to microlithic types made out of silex, quartzite, radiolarite, and rock-crystal, from nearby moraine. Finds include triangles, scrapers, backed bladelets, and punches. Artifacts of bone are smoothers, fragments of boar tusks, and perforated deer grandles. Similar lithic industry later discovered at Abri de la Cure in Baulmes (Egloff, 1966-67, 1967). Fauna remains, id. by P. Strinati (mainly *Cervus elaphus, Capreolus capreolus, Sus scrofa, Meles meles, Vulpes vulpes,* and *Martes).* No pollen has been conserved, but in charcoal layer are found macroscopic plant remains, id. by M. Villaret, Mus. Bot. Lausanne (*Quercus, Corylus avellana, Sorbus torminalis, Fraxinus,* scarce *Pinus,* and *Cornus sanguinea*); considered to represent younger part of Boreal (M. Villaret, 1970, written commun.).

Stratigraphic excavation 1964-66 and coll. 1964-65 by M. Egloff, Mus. Cantonal Archéol., Neuchâtel, Switzerland; subm. by R. Kasser, Univ. of Geneva, Switzerland.

8530 ± 100

B-764. La Baume d'Ogens 1 **6580 B.C.**

Charred wood and nutshells from Layer 4b (penultimate occupation level) at +25 cm from ref. level.

8735 ± 150

B-765. La Baume d'Ogens 2 **6785 B.C.**

Small pieces of charcoal from Layer 13, oldest occupation level at −50 cm from ref. level.

General Comment: dates agree with previous radiocarbon dates for similar archaeologic material (Radiocarbon, 1961, v. 3, p. 23; Gfeller, 1964) but seem somewhat older than Younger Boreal (compare: Zoller, 1968, p. 29) suggested by macrofossils analyses above.

B. Egypt

Kellia series, Beheira, Egypt

Four samples from Qouçoûr' Isâ Sud I, complex ca. 75 m × 70 m, with > 100 chambers and 2 basilicas, in Kellia (30° 45′ N Lat, 30° 22′ E Long), coptic monasteries site at E border of Libyan desert, some km from Nile Delta in Marquaz, Dilingat, prov. of Beheira, Egypt; was rediscovered in 1964. More than 1200 constructions with walls made of unburnt bricks covered with mortar have been found in area (12 km × 3.5 km). Most common type of monastery has yard (average 20 m × 30 m) with water well, garden, and basins, limited by rectangular wall. At W, cells, prayer rooms, and kitchen. Assoc. finds consist of abundant ceramics, numerous wall decorations and inscriptions, and some coins; sculpture rarely present. Organic rests consist of bones and wood charcoal. Main purpose of research was to date ceramics and glass-ware, and study architectural evolution of site; 9 other dates are known from same site (Hv-unpub., M. A. Geyh, 1969, written commun.) and are discussed below. Site described by Kasser (1967) and Daumas and Guillaumont (1969). Subm. by D. Weidmann, Fouilles Coptes, Univ. Geneva, Switzerland.

1950 ± 100

B-802. Qouçour 'Isâ Sud I, Pit 1, Layer 3 **A.D. 1**

Wood charcoal from Layer 3, ca. 3.50 m depth in Refuse Pit 1 assoc. with ceramics, glass-ware and kitchen trash. Constantine coin (A.D. 379 to 395) gives expected date for sample. Coll. 1966 by R. Kasser, Fac. of Letters, Univ. Geneva, Switzerland. *Comment*: date derived from calibration curve (see Introduction) is 140 B.C. to A.D. 100, considered too old by collector, who attributes discrepancy to fossil resin or bitumen in sample. Deeper Layer 10 (see below) was dated somewhat younger.

1650 ± 100

B-803. Qouçour 'Isâ Sud I, Pit 1, Layer 10 **A.D. 300**

Wood charcoal from Layer 3, in Pit 1; ca. 4.50 m depth. Expected contemporary with dated sample of charcoal at 4 m depth in Pit 2 (Hv-2388: 1585 ± 60 B.P., = A.D. 400 to A.D. 510 after conversion to calendar yr), and not older than A.D. 379 (see comment, above, to Layer 3). Coll. 1966 by R. Kasser. *Comment*: corresponding date derived from calibration curve(see Introduction) is A.D. 180 to A.D. 450, agrees with expectations.

1310 ± 120

B-804. Qouçour 'Isâ Sud I, Tomb 5 **A.D. 640**

Human bone at 2 m depth in cemetery with ca. 200 tombs. Skeletons are found buried in sand without any dated object. Cemetery believed in use until ca. A.D. 700 above ruins of part of abandoned monastery (from date of S.50, below). Coll. 1966 by D. Weidmann. *Comment*: date corrected for secular variations in C^{14} (see Introduction) is A.D. 600 to A.D. 840, agrees with expectations. Correction for isotopic fractionation would make age from 90 to 270 yr older depending on C^{13}/C^{12} ratio (Radiocarbon, 1967, v. 9, p. 114, 116, 117; 1969, v. 11, p. 351).

1530 ± 100

B-988. Qouçour 'Isâ Sud I, S.50 **A.D. 420**

Large wood charcoal pieces from ca. 1 m depth in kitchen, assoc. with abundant ceramics (pots, amphorae). Date expected not older than A.D. 610, based on assoc. with Heraclius coin. Coll. 1967 by D. Weidmann. *Comment*: corrected C^{14} date (see Introduction) is A.D. 310 to A.D. 580. Another charcoal sample from same kitchen was dated (Hv-2390): 1295 ± 75 B.P. (converted to A.D. 630 to A.D. 820 by use of calibration curve). Coin and present radiocarbon date do not disagree if a 2σ interval is taken. Preferred explanation is that wood was re-used from older churches, as suggested by traces in charcoal pieces.

General Comment: dates 2 phases of occupation: (1) construction of monastery with large trash pits containing abundant and typical pottery, glass-ware, and refuse (bones, fish-bones, vegetables, etc.) dated to 1st half of 5th century A.D. by Samples B-803 (this series) and Hv-2388 (charcoal in Pit 2): 1585 ± 60 B.P., Hv-2619 (charcoal at base of tower, S.64):

1565 ± 55 B.P., B-802 (this list) and Hv-2617 (fish-bone in amphora, S.65): 3305 ± 245 B.P., should be contemporary according to assocs.; (2) last occupation of Qouçoûr 'Isâ Sud I and perhaps whole site Kellia. Dated in kitchen ovens of 3 different constructions between end of 7th and beginning of 8th centuries A.D., by samples B-988 (this series) and Hv-2390: 1295 ± 75 B.P. (charcoal in kitchen, S.50) Hv-2389: 1310 ± 45 B.P. (charcoal in kitchen from Building 6), and Hv-2621: 1335 ± 60 B.P. (charcoal from Kitchen SO in Building 366). Most recent date from inscription in Kellia is A.D. 739; arabic sources comment that site was in ruins and almost uninhabited in 9th century A.D., thus agrees with Hv-2622: 1010 ± 50 B.P. dating charcoal in ruins (Room B, Building 366) assoc. with atypical ceramics and arabic (moslem) coins younger than A.D. 644. Standard deviation is too large for other 2 samples (Hv-2618: 1685 ± 265 in ashes and charcoal from Kitchen S.82, and Hv-2620: 1810 ± 255 in ashes and charcoal from Site S.48) which could provide information about development during middle occupation period.

C. Alaska

Kodiak Island series, Alaska, U.S.A.

Two samples from 2 sites in Anton Larsen Bay (57° 52′ N Lat, 152° 40′ W Long), arm of Kizhuyak Bay, at NE of Kodiak I., Alaska. Sites are ca. 500 m from each other. First sondage in 1959 with subsequent exposure allowed study of artifacts by Clark (1964). Sites provide information about change of Kachemak tradition to Eskimo Koniag phase (Clark, 1964, 1966, 1968, 1970). Present dates belong to general Kodiak I. series (Radiocarbon, 1966, v. 8, p. 367-369). Coll. 1964 to 1966 by D. W. Clark, Dept. Anthropol., Univ. Wisconsin, U.S.A.; subm. by H. Müller-Beck.

1100 ± 100

B-835. Crag Point, Site 241 **A.D. 850**

Charred material, probably sea mammal oil, scraped from potsherds in upper part of site. Expected to date end of site occupation with unsuccessful attempt to introduce pottery into area. Sherds considered not intrusive from re-occupations. *Comment*: date derived from C^{14} calibration curve (see Introduction) is A.D. 770 to A.D. 1050, agrees with expectation to date end of occupation and early changes to Eskimo Koniag phase between ca. A.D. 1050 and 1100. Deeper sample of same site gave reasonable, older date, P-1057 (Radiocarbon, 1966, v. 8, p. 369): 2033 ± 52 B.P.

600 ± 100

B-836. Kizhuyak, Site 240 **A.D. 1350**

Small charcoal particles from lower midden layer, 3 m thick. Expected to provide early date for Koniag phase, and to differ 100 to 200 yr from Crag Point sample (see above). *Comment*: date derived from calibration curve (see Introduction), is A.D. 1270 to A.D. 1420, thus agrees with expectation. This is oldest of 6 charcoal dates (Radiocarbon, 1966, v. 8, p. 368) from Koniag phase.

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