[RADIOCARBON, VOL. 6, 1964, P. 233-250]

SACLAY NATURAL RADIOCARBON MEASUREMENTS I

G. DELIBRIAS, M. T. GUILLIER, and J. LABEYRIE

Service d'Electronique Physique, Centre d'Etudes Nucléaires de Saclay
B. P. no. 2, Gif-sur-Yvette (S. et O.), France

The following list shows the age measurements carried out at Saclay by the Service d'Electronique Physique, using the C^{14} method.

The apparatus employed was completed and calibrated in 1956 and the first tests were performed during the same year. The counting unit is a 1.2 L stainless steel proportional counter and the filling gas is pure CO_2 at 74 cm Hg pressure. The shield consists of 20 cm of lead, 10 cm of iron, a coincidence ring and 2 cm of bismuth. The background is 4.86 ± 0.05 counts/min. (Error is $\pm \sigma$, the duration of each counting being 24 hours.) Final purification is performed by adsorption of CO_2 on alumina at low temperature, followed by desorption at room temperature; this has proved particularly effective and gives a very good filling gas. Technique was described in detail previously by the authors (Perquis, Delibrias, and David, 1956; Delibrias and Perquis, 1958).

As a modern carbon standard we first used wood taken from the 1930 to 1945 rings of a large Douglas fir; this standard gave a net count of 6.02 counts/min. This activity, taking into account a 2% Suess-effect for this wood, was found to be 95% of the activity of the NBS oxalic-acid standard, measured in the same counter.

The NBS standard has been adopted by this laboratory since January 1961, and values given here are calculated from this new standard.

Measurements listed are dates obtained from 1956 through 1962. No reports are given here from other types of measurements carried out at Saclay, such as: (1) C^{14} content of wild plants growing in the vicinity of nuclear reactors; (2) measurement of C^{14} in blood proteins of workers of the radioactive-tracers industry; (3) Spallation cross-sections for C^{14} production in oxygen and iron by high energy protons; (4) C^{14} content of meteorites.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Leucate pool series, Aude, France

Dried marine plants (Posidoniae) imbedded in clayey sand, 5 m to 30 m above sealevel, on NE bank of Leucate pool (43° 10′ N Lat, 3° 00′ E Long). These deposits are supposedly ancient (Quaternary) lagoon formations. Coll. 1956 and subm. by A. Rivière, Faculté des Sciences, Orsay, Seine-et-Oise, France.

Sa-31. Leucate, 5 m level — **643 ± 120**
A.D. 1307

Sa-32. Leucate, 10 m level — **480 ± 120**
A.D. 1470

Sa-33. Leucate, 17 m level **Modern**

Sa-34. Leucate, 30 to 32 m level **Modern**

Comment: these very recent ages show an important transport of materials from the lagoon, probably due to strong winds.

La Brière swamp series, Loire-Maritime, France

Peat and wood (mainly chestnut, beech, oak) at various levels above green marine clay in central part of swamp of La Grande Brière. Upper surface of the clay, flat and horizontal over more than 100 km², is ca. 1.8 m above present low tide level, and ca. 2 m under present ground surface. Between the green clay and the modern surface is peat, yellow near bottom and black near surface, with a layer of bark and wood, 15 cm thick, in the middle. At present, and probably since about 2000 B.P., La Brière is a reed swamp, dry during summer and flooded with fresh water during winter. Stumps are found rooted in upper part of the green clay, and prostrate trunks are found in the peat; now hard and black, they are used locally for building (Vince, 1958). Coll. 1955 and subm. by A. Vince, St. Malo-de-Guersac, L-M, France.

Sa-35. Swamp of l'Isle **4040 ± 400**
2090 B.C.

Tree at 1.7 m depth below surface, channel of the swamp of l'Isle (47° 24′ N Lat, 2° 14′ W Long).

Sa-39. Rozé I, buried wood **4630 ± 300**
2680 B.C.

Wood rooted in upper part of green marine clay, 1.7 m below surface, in the swamp Rozé (47° 23′ N Lat, 2° 12′ W Long).

Sa-40. Rozé II, emerging tree **3880 ± 300**
1930 B.C.

Piece of oak emerging 1 m above Rozé swamp, but rooted in lower yellow peat at same locality as Sa-39.

Sa-41. Rozé III, lower peat **4480 ± 300**
2530 B.C.

Sample from lower part of yellow peat layer, in contact with marine clay, 1.7 below surface, same locality as Sa-39.

Sa-42. Rozé IV, bark **4100 ± 300**
2150 B.C.

Layer of bark remains, between yellow and dark peat, 0.9 m below surface, same locality as Sa-39.

Sa-43. Rozé V, upper peat **2770 ± 300**
820 B.C.

Black peat, 50 cm below surface, same locality as Sa-39.

Sa-46. Fedrun, tree root **4260 ± 300**
2310 B.C.

Root from upright stump, 1.5 m below surface (47° 25′ N Lat, 2° 15′ W Long).

General Comment: Flandrian transgression has probably deposited the marine green clay, filling the great granitic basin of La Brière. During a period of regression, about 4600 B.P., a forest was living on this clayey ground. From

that time till the present the small barriers of organic sand were probably formed at the upper limit of tides by combined action of the sea and of the river Loire. These natural dams prevented the seaward flow of fresh water, forming swamps with peat production. Formation of the yellow peat, between 4600 and 4100 B.P. occurred at the same time as marine transgression observed in SE England from 4850 to 4150 B.P. and attributed to a downward movement of the E of England (Q-129 to Q-474, 1961, Cambridge III). The level 0.9 m below present surface, with bark and wood remains dated 4100 B.P., is a forest soil probably formed on dried peat during a short regression or pause in the transgression, during which backing-up of fresh water ceased.

Sa-190. St. Jacques Bay, Morbihan, stem **2350 ± 150** **400 B.C.**

Oak stem, rooted in peat on shore of coast of Bretagne, 2 km E of St. Jacques (47° 35′ N Lat, 2° 45′ E Long). Coll. 1962 and subm. by G. Delibrias and J. Labeyrie. *Comment*: the peat is now 4.0 m under the highest sealevel, indicating a subsidence of this region by at least 2.50 m in 2350 yr. Subsidence had been suspected from the fact that several Megalithic monuments of the Morbihan coast are now below sealevel.

Seine Estuary series

After the melting of the ice of Wurm II, the Seine valley was gradually filled with alluvial deposits graded to a rising sealevel. The rise was interrupted by episodes of stillstand during which peat bogs were formed in former lagoons and cut off meanders. Measurements carried out on core samples of peat, buried in the alluvium, have fixed the dates of the various episodes of rise. (Jouis, 1961, p. 91-104). Coll. 1956, 1957, and subm. by E. Jouis, Inst. Natl. de la Recherche Agronomique, Rouen (Seine-et-Maritime).

Sa-60. Anneville-sur-Seine **1800 ± 160** **A.D. 150**

Peat from the subsoil of the communal meadow land of Anneville-sur-Seine (49° 20′ N Lat, 0° 30′ W Long), ca. 2.50 m above present mean sealevel. Peat is covered by only ca. 50 cm of clayey calcareous alluvium. Coll. 1956. *Comment*: peat level is probably covered by the deposit of the general transgression which occurred in the 3rd century A.D.

Sa-68. Mesnil-de-Lillebonne boring, Layer k **1740 ± 150** **A.D. 210**

Peat from core taken in swamp of Mesnil-de-Lillebonne (49° 30′ N Lat, 0° 32′ E Long), depth 8.20 to 8.40 m, Layer k. Coll. 1957.

Sa-69. Mesnil-de-Lillebonne boring, Layer o **7630 ± 350** **A.D. 5680**

Lignified peat, depth 9.90 m to 10.05 m, Layer o, in same boring as Sa-68.

Sa-70. Mesnil-de-Lillebonne boring, Layer q **7380 ± 350** **A.D. 5430**

Peat, depth 11.10 m to 11.50 m, Layer q, in same boring as Sa-68.

Sa-71. Mesnil-de-Lillebonne boring, Layer s **7100 ± 350** **A.D. 5150**

Peat, depth 11.85 m to 12.23 m, Layer s, in same boring as Sa-68.

Comment for Sa-68 to Sa-71: depths are given in meters below present mean sealevel. Present ground level is at +4.40 m; boring encountered limestone at –17.20 m. No organic matter was found below Layer s; overlying alluvium is limy sand and clay, except in pebble zone at –8.80 m to –9.25 m and in organic layers q, o, and k and four other thin peat layers (Jouis, 1961). Low rate of filling appears between –9.90 m and –8.40 m, and rapid one above –8.20 m.

II. MARINE GEOLOGIC SAMPLES

A. Coastal Samples

Villefranche-sur-Mer series, Alpes-Maritimes, France

Samples taken from the bay of Villefranche-sur-Mer for studies of rate of sedimentation (Delibrias, Perquis, and Ros, 1961). Coll. and subm. by J. Ros, Centre des Faibles Radioactivités, C.N.R.S. Gif-sur-Yvette, Seine-et-Oise, France.

Sa-101. Villefranche-sur-Mer I, 470-475 cm **2020 ± 160 / 70 B.C.**

Organic carbon from layer of leaves of Posidoniae debris, depth interval 470 to 475 cm below top of sediment from piston core taken at N end of bay, in small basin of black mud (43° 42′ 10″ N Lat, 7° 18′ 59″ E Long), water depth 16 m. *Comment*: indicates very fast rate of sedimentation in N part of bay.

Sa-106. Villefranche-sur-Mer II, 580-600 cm **3040 ± 200 / 1090 B.C.**

Total organic carbon; depth interval 580 to 600 cm below top of sediment from piston core taken in S part of bay (43° 41′ 27″ N Lat, 7° 18′ 50″ E Long), water depth 100 m.

Sa-104. Villefranche-sur-Mer III, surface **5400 ± 300 / 3450 B.C.**

Total organic carbon in surface mud, dredged at 60 m depth in entrance to bay (43° 41′ 20″ N Lat, 7° 19′ E Long).

Sa-108. Villefranche-sur-Mer IV **730 ± 100 / A.D. 1220**

Leaves of Posidoniae, from plants living on the sea floor in the roadstead (43° 41′ 40″ N Lat, 7° 18′ 38″ E Long), water depth 20 m. *Comment*: at least in roadstead, the Posidoniae evidently take their carbon from mixture of surface water and "older" deep water; the apparent age of Sa-108 reflects marked depletion ($\delta C^{14} = -8‰$). Salinity and temperature measurements previously made agree with this hypothesis, but the C^{14} content of the water itself has not been measured.

B. Mediterranean open-sea cores

All data presented here are from deep-sea cores coll. from western basin of Mediterranean sea, at distances from the French coast greater than 100 mi. Depth is constant (2600 ± 100 m) over 100,000 km²; mineralogical and hydrological studies suggest that large amounts of detrital carbonate may have been carried over the whole N part of the basin from the coast of Corsica and

Provence. Material used for dating consisted of bulk $CaCO_3$. When samples contained enough coarse fraction ($>63\ \mu$) for separate measurements, C^{14} ages from the coarse fraction and from the fine one ($<63\ \mu$) were determined. Presence of many sand and silt layers suggests that sedimentation is not regular and that a given horizon may contain reworked carbonate from continental erosion; hence measured C^{14} ages may be older than true ages. Coll. Aug. 1962 from R/V Calypso and subm. by J. Bourcart and J. Ros, Centre des Faibles Radioactivités, C.N.R.S. Gif-sur-Yvette, Seine-et-Oise, France.

Core no. C-14 series

Piston core, taken at depth of 2673 m (41° 24′ N Lat, 7° 05′ E Long), presents two well defined "turbidite" sand layers at 24 to 30 cm and 53 to 59 cm and two ill-defined turbidite layers at 6 to 15 cm and 277 to 285 cm. Dated sections appear largely undisturbed from a lithological point of view.

Sa-163. C-14, 30-50 cm — **4200 ± 250 / 2250 B.C.**

Bulk $CaCO_3$ fraction.

Sa-164. C-14, 63-83 cm — **5400 ± 300 / 3450 B.C.**

Bulk $CaCO_3$ fraction.

Sa-165. C-14, 94-110 cm — **15,200 ± 500 / 13,250 B.C.**

Bulk $CaCO_3$ fraction.

Sa-166. C-14, 110-128 cm — **13,600 ± 450 / 11,650 B.C.**

Coarse $CaCO_3$ fraction.

Sa-167. C-14, 140-150 cm — **12,800 ± 450 / 10,850 B.C.**

Bulk $CaCO_3$ fraction.

Sa-168. C-14, 160-170 cm — **>30,000**

Bulk $CaCO_3$ fraction.

Sa-169. C-14, 180-200 cm — **>30,000**

Coarse $CaCO_3$ fraction.

Sa-170. C-14, 396-416 cm — **>30,000**

Bulk $CaCO_3$ fraction.

General Comment: locally formed foraminifera are mixed with continental carbonate in variable proportions. Nevertheless, mean sedimentation rate is very fast: 120 cm per 10,000 yr at least, during the postglacial period.

Core no. C-13 series

Piston core taken at depth of 2618 m (41° 58′ N Lat, 7° 5′ E Long) on top of small submarine hill, ca. 50 m high. Core is relatively homogeneous except for thin layers of silt at 44 cm and 135 cm.

Sa-171. C-13, 3-13 cm — **6600 ± 300 / 4650 B.C.**

Bulk $CaCO_3$ fraction.

Sa-172. C-13, 43-51 cm — **23,000 ± 1500 / 21,050 B.C.**

Bulk $CaCO_3$ fraction.

Sa-173. C-13, 51-59 cm — **28,500 ± 2500 / 26,550 B.C.**

Bulk $CaCO_3$ fraction.

Sa-174. C-13, 107-113 cm — **15,500 ± 500 / 13,550 B.C.**

Bulk $CaCO_3$ fraction.

Sa-175. C-13, 136-143 cm — **18,300 ± 800 / 16,350 B.C.**

Bulk $CaCO_3$ fraction.

General Comment: the upper few cm of this core appear to have been lost during coring. Ages found for sections 43 to 51 cm and 51 to 59 cm are too old because they contain much reworked carbonate, which probably indicates that after the end of the last glacial period a very important erosion period occurred in SE France.

Core no. C-20 series

Samples from a large diam (20 cm) gravity core coll. at depth of 2580 m (41° 52′ N Lat, 6° 52′ E Long). Core contains a well-defined "turbidite" quartz sand layer at 16 to 21 cm and a significant but unusual accumulation of pteropod shells at 5 to 9 cm.

Sa-176. C-20, 5-10 cm

Fine $CaCO_3$ fraction. — **3660 ± 200 / 1710 B.C.**

Coarse $CaCO_3$ fraction. — **1410 ± 140 / A.D. 540**

Sa-177. C-20, 60-70 cm

Fine $CaCO_3$ fraction. — **11,700 ± 400 / 9750 B.C.**

Coarse $CaCO_3$ fraction. — **11,800 ± 400 / 9850 B.C.**

General Comment: the section 5 to 10 cm has significantly older age for fine fraction than for coarse one (pteropods), indicating high proportion of recently reworked carbonate. In section 60 to 70 cm the two fractions have the same age, indicating section consists only of locally produced carbonate, and giving a mean sedimentation rate of 65 ± 5 cm in 11,750 ± 400 yr: this is about 100 times the mean sedimentation rate in the deep basins of the Indian, Pacific and Atlantic oceans.

III. GEOLOGIC SAMPLES; VOLCANISM

A. France

Sa-90. Puy de la Vache, Puy-de-Dôme — **7650 ± 350 / 5700 B.C.**

Carbonized oak wood from soil under the St. Saturnin basalt flow from the Puy de la Vache prehistoric volcano (45° 39′ 28″ N Lat, 3° 5′ 32″ E Long).

A vertical section in this region shows overlying sand of granitic origin and from bottom to top: (1) ca. 50 cm of black sand containing small fragments of carbonized vegetable matter, and, in its upper 15 cm, carbonized branches; (2) white volcanic ash, 1 cm thick; (3) compact coarse black volcanic ash, 25 cm thick; (4) solid basalt, ca. 10 m thick.

Each fragment of wood is surrounded by a halo of carbonized organic matter that impregnates the sand, indicating that fragments come from roots and branches of a forest "cooked" in situ. Probably the higher branches were completely burned by the black ashfall, because no organic matter remains in upper part of ash layer (Pelletier and others, p. 2221-2222, 1959). Coll. 1944 by A. Rudel; subm. by H. Pelletier.

Sa-94. Puy Pariou, Puy-de-Dome **8580 ± 350**
6630 B.C.

Fossilized pine wood found under the Nohanent outflow of lava from Puy Pariou volcano (45° 48′ N Lat, 3° 03′ E Long). Coll. and subm. by H. Pelletier. *Comment*: this and the St. Saturnin flow (Sa-90, this date list) are believed to be results of the last volcanic eruptions in France.

B. Martinique

The following samples were taken under the principal conglomerate deposits around the big volcano of Mont Pelée in order to date the last major explosive eruptions.

Sa-30. Montagne Pelée **8100 ± 350**
6150 B.C.

Peat and wood fragments, immediately beneath a volcanic conglomerate 8 m thick, topped by a bed of volcanic ash and pumice several meters thick (14° 47′ 53″ N Lat, 61° 08′ 06″ W Long). Coll. 1955 and subm. by H. Grunevald, Observatoire de la Martinique, Fonds-Saint-Denis, Martinique. *Comment*: this conglomerate, indicated as "α Pb" on the 1958 geologic map, appears in ravines all around Mont Pelée Volcano; it is supposed to be the debris of the volcanic explosion which created the great caldera at the top of Mont Pelée.

Sa-81. Ajoupa Bouillon **5650 ± 300**
3700 B.C.

Burnt wood, under a conglomerate from Pelean cloud, 5 m thick, topped by 2 m of pumice and ash (14° 48′ 28″ N Lat, 61° 07′ 39″ W Long). Coll. 1955 and subm. by H. Grunevald. *Comment*: dated to determine if the Pelean cloud was ejected by the volcano at the same time as volcanic explosion from which comes the conglomerate (Sa-30).

Sa-83. Propreté région **1670 ± 150**
A.D. 280

Wood, in peat layer, under 3 m of pumice and volcanic ash partially transformed into clay (14° 45′ 08″ N Lat, 61° 07′ 10″ W Long). Coll. 1955 and subm. by H. Grunevald. *Comment*: this pumice eruption of Mont Pelée volcano has diverted the ancient upper Mahault river to the Capot river, and reduced the forest to thin layers of peat containing wood fragments.

Sa-82. Demare **19,500 ± 1000**
17,550 B.C.

Burnt wood, under 5 m of volcanic conglomerate (14° 49′ 54″ N Lat, 61° 06′ 20″ W Long). Coll. 1955 and subm. by H. Grunevald. *Comment*: dates ejecta of one of the first vulcanian type explosions of Mont Pelée Volcano.

Sa-80. Baie Baraban **>25,000**

Wood, partially silicified, under a volcanic conglomerate injected with small quartz veins, on shore of Caravelle Peninsula (14° 46′ 32″ N Lat, 60° 53′ 13″ W Long). Coll. 1955 and subm. by H. Grunevald. *Comment*: notwithstanding its similarity to the conglomerate of Mont Pelée (Sa-30, Sa-81 and Sa-82) that of Baie Baraban was evidently much older; it is mapped as post-Eocene (Grunewald, 1961).

C. New Zealand

Sa-91. Ngauruhoe, New Zealand **1210 ± 120**
A.D. 740

Charcoal, under layer of white lapilli and ash, 20 cm thick, slope of Ngauruhoe volcano (39° 5′ S Lat, 175° 40′ E Long). Coll. 1959 and subm. by H. Tazieff, Centre Européen de Volcanologie, Bruxelles. *Comment*: geologic dating of this ash-fall was unclear.

IV. ARCHAEOLOGIC SAMPLES

A. Egypt

Sa-12. Luxor, Egypt **2220 ± 150**
270 B.C.

Cedar wood from sarcophagus found during excavation in a "Mastaba," S of Luxor (25° 41′ N Lat, 32° 24′ E Long); dated historically at 300 ± 30 B.C.

Louvre Coptic Cloths series

Coptic cloths, belonging to the Collection of the Musée du Louvre and subm. by Father du Bourguet, 1958, Musée du Louvre, Paris.

Sa-10. Cloth no. 21 **575 ± 120**
A.D. 1375

Presumed date, 10th century A.D.

Sa-11. Cloth no. 23 **1235 ± 120**
A.D. 715

Presumed date, 11th century A.D.

Sa-51. Cloth no. 36 **450 ± 120**
A.D. 1500

Presumed date, 12th century A.D.

Sa-52. Cloth no. 45 **620 ± 120**
A.D. 1330

Presumed date, 10th century A.D. at the earliest, more probably 12th century.

General Comment: the disagreement between the results and the presumed ages has not been explained (P. du Bourguet, 1957, p. 57-59; 1958, p. 52-63).

B. Central Sahara

a) Neolithic group

The following results testify to the existence of a Mediterranean-type vegetation between ca. 6000 B.P. and 4000 B.P. in mountainous regions of Central Sahara (Tassili, Hoggar, Adrar Bous). They also date a remarkable culture based on domestic cattle. Numerous beautiful wall drawings and paintings of this culture have recently been discovered in caves and shelters in sandstone cliffs of this region. They indicate ethnic and cultural connections both with Egypt and the Niger valley (H. Lhote, 1958).

Sa-55. Taessa, Hoggar **4680 ± 300**
2730 B.C.

Fossilised guano of daman or "cony" (*Procavia rufipes*) from a rock shelter at Taessa, alt 2000 m (23° N Lat, 5° 40′ W Long). Palynological study showed abundance and variety of pollen indicating a flora of marked mediterranean character (Pons and Quezel, 1957). Coll. and subm. by P. Quezel, Faculté des Sciences d'Alger.

Sa-59. Hassi Meniet, Hoggar **5410 ± 300**
3460 B.C.

Organic soil, part of a culture layer, coll. at 45 cm depth in rock shelter of the Hassi Meniet Neolithic station, alt 900 m (25° N Lat, 4° 18′ W Long); abundant traces of an industry of fishermen with bone harpoons, ascribed to the later Saharan Neolithic period, occurred in the same deposit (Delibrias, Hugot, and Quezel, 1957); palynologic study of sample showed a xerophile mediterranean flora (Pons and Quezel, 1957). Coll. 1957 by H. Hugot; subm. by P. Quezel.

Sa-62. Sefar, Tassili n'Ajjer **5030 ± 300**
3080 B.C.

Organic material from ash layer, at surface of deposit containing bovine bone fragments and Neolithic industry, in rock shelter of Sefar Neolithic station (25° 2′ N Lat, 9° 5′ E Long), at the foot of rock paintings of bovines. Coll. 1956 by H. Lhote; subm. by P. Quezel.

Sa-65. Jabbaren I, Tassili n'Ajjer **4270 ± 300**
2320 B.C.

Charcoal, found in a layer, depth ca. 50 cm, in the "Orycterope cave" at Jabbaren (24° 29′ N Lat, 9° 44′ E Long). Coll. 1956 and subm. by H. Lhote, Musée de l'Homme, Paris.

Sa-66. Jabbaren II, Tassili n'Ajjer **5470 ± 300**
3520 B.C.

Charcoal coll. at 20 to 60 cm depth in a shelter where the main Neolithic deposit was found in 1956 (24° 29′ N Lat, 9° 44′ E Long). Coll. 1956 and subm. by H. Lhote. *Comment*: Jabbaren is a small flat sandstone hill in the Tassili mountains, with many shelters at the foot of the cliffs. In a square area 600 by 600 m more than 5000 paintings were found in 1956. On the shelter floors were many bovine bones with a Neolithic industry of flints and pottery (Lhote, 1958).

Sa-100. Adrar Bous III, Ténéré **5140 ± 300**
3190 B.C.

Charcoal from hearth in Neolithic deposit at Adrar Bous III (20° 20′ N Lat, 9° 8′ E Long). Coll. 1960 and subm. by H. Hugot, Musée du Bardo, Univ. d'Alger. *Comment*: Adrar Bous III is a very important Neolithic station (10,000 m²) of "Tenereen" culture, discovered in 1960 on the bank of a fossil lagoon. Many bones of bovines, hippopotamus, and catfish, shells of lake oysters (*Aetheria*), and an industry of beautiful polished axes of green jasper, arrows and tools of quartz, flint and haematite, crushing stones and pottery, show that the culture was based on fishing, hunting and agriculture. Like the similar Es-Shaheinab industry, dated at 5100 ± 450 and 5450 ± 380 (Arkell, 1953), it is supposed to be a western extension of the predynastic Egyptian civilization (Tixier, 1962, p. 333-348; Delibrias and Hugot, 1962, p. 71-72). Palynologic study of the diatomite floor of the dry lagoon has shown a mediterranean fauna (*Phillyrea, Quercus ilex, Pistacia lentiscas, Alnus glutinosa, Cupressus, Juniperus, Pinus, Tilia,* etc.; Quezel and Martinez, 1962, p. 313-332). Coll. 1960 and subm. by H. J. Hugot.

b) Preislamic group

Sa-78. Tejerhi, Fezzan **1190 ± 120**
A.D. 760

Dried balls of leather from Preislamic tomb at Tejerhi (24° 20′ N Lat, 14° 15′ E Long). Balls were painted with red haematite powder and located in the abdominal region of a flexed burial characteristic of the Sahara Preislamic period. The bones were found impregnated with the red haematite which had diffused after burial. Other grave furniture was scarce, but included ostrich-egg beads. Coll. 1949 and subm. 1958 by P. Bellair, Faculté des Sciences, Paris.

Sa-92. El Barkat I, Tassili n'Ajjer **1330 ± 120**
A.D. 620

Organic material with fragments of leather balls found in tomb at El Barkat (24° 52′ 5″ N Lat, 10° 09′ E Long). Coll. 1944 by M. Leschi; subm. 1959 by P. Bellair.

Sa-93. El Barkat II, Tassili n'Ajjer **1680 ± 150**
A.D. 270

Sample of leather balls from another tomb at El Barkat. Coll. 1944 by M. Leschi; subm. 1959 by P. Bellair.

General Comment: the civilization of the "flexed burials" was thought to have been extinct since the 2nd century A.D. These measurements show that it lasted at least till the beginning of Islam in central Sahara (about 9th century A.D.).

C. Southern Sahara

Sa-76. Kouga, Mali **950 ± 120**
A.D. 1000

Charcoal found in a vertical pit of the "banco" layer at top of W tumulus of Kouga, on NW shore of Lake Fati (16° 17′ N Lat, 3° 45′ W Long). Coll. 1954 by R. Mauny; subm. by Th. Monod, Inst. Français d'Afrique Noire, Dakar. *Comment*: medieval site (Mauny, 1961). The banco is a clay layer,

1 to 2 m thick, converted to a ceramic by heat from wood burned in the many small pits (2 m depth, 1 m diam) dug in this layer.

Sa-77. Koumbi Saleh, Mauritania **740 ± 120**
A.D. 1210

Charcoal from excavation M5 of the "Grande Avenue" medieval site of Koumbi Saleh (15° 46′ N Lat, 7° 58′ 30″ W Long). Coll. 1951 by R. Mauny; subm. by Th. Monod. *Comment*: Koumbi Saleh is probably the ancient town of Ghana, principal town of medieval Sahara, destroyed in A.D. 1240 (Mauny, 1961).

Sa-61. Iaye, Mali **480 ± 150**
A.D. 1470

Fragment of cailcedra wood from statuette representing an Andujo (God of the Rain), found during excavation of the cave of the village Iaye, in Bandiagara cliffs (14° 25′ N Lat, 4° 10′ W Long). Coll. 1956 and subm. by F. Di Dio, 65, rue du Mt Cenis, Paris. *Comment*: statuette from Tellem civilization, supposed to have been carved between 10th and 13th centuries A.D.

D. Morocco

Taforalt cave series, Morocco

Charcoal from Epipaleolithic layers in a large necropolis, overlying a Mousterian industry and fauna, Taforalt cave (34° 49′ N Lat, 2° 24′ E Long), Morocco. Cultural levels, numbered I to X from top downward, are imbedded in ash, accompanied by plant and animal fossils implying a colder climate than today's. Industry chiefly microlithic, with some bone tools; scarcity of geometric shapes on implements. Coll. 1953 to 1955 and subm. by J. Roche, 16, avenue du Bel Air, Paris.

Sa-13. Taforalt, Level II **10,800 ± 400**
8850 B.C.

Wood charcoal, Level II, Sec. A.B.-21,22, advanced Epipaleolithic.

Sa-14. Taforalt, Level VI **12,070 ± 400**
10,120 B.C.

Wood charcoal, Level VI, Sec. A.-29,31, middle Epipaleolithic.

Sa-15. Taforalt, Level VIII **10,500 ± 400**
8550 B.C.

Wood charcoal, in contact with yellow earth, Level VIII, Sec. K.M.-21,23, oldest Epipaleolithic.

Comment: mixed sample between Level II and Level VI was dated 11,900 ± 240 (L-399 E, Lamont V). Anomalously young age of the deepest sample (Sa-15) has not been explained.

E. South America

Sa-47. Ponsomby, Patagonia **6500 ± 400**
4450 B.C.

Wood and roots from peat deposit, bog No. 54, 150 m from the present bank, at Ponsomby, on shore of Skyring sea, strait of Magellan (52° 10′ S Lat, 71° 28′ W Long). Coll. 1953 and subm. by J. Emperaire and A. Laming,

C.N.R.S., Paris. *Comment*: formation of the peat bog corresponds to a lacustrine phase immediately following recession of glaciers. The bog was contemporary with the oldest of the four archaeological levels known at the site of Ponsomby. This level contains an industry similar to the "Pampa" industry, and remains of the extinct American horse (J. and A. Emperaire, 1959).

Sa-48. Ilha dos Ratos, Parana, Brazil **1540 ± 150**
A.D. 410

Palm nuts in "Sambaqui", Trench IV, Sec. K, Ilha dos Ratos, Guaratuba Bay (25° 52′ S Lat, 46° 34′ W Long), accompanied by human burials shells, and implements of polished stone and whale bone. Coll. 1956 and subm. by J. Emperaire and A. Laming. Sambaquis are artificial shell heaps on the flat alluvial S coast of Brazil. Some of them are very large (ca. 10,000 m^2 in area, 20 m high) (Emperaire and Laming, 1956, p. 5-163).

Sa-75. Cajarmaquilla, near Lima, Peru **340 ± 120**
A.D. 1610

Fragments of cloth found in ruins of Cajarmaquilla, near Lima (11° 56′ S Lat, 76° 51′ W Long). Coll. 1958 and subm. by R. Daudel, C.N.R.S., Paris. *Comment*: ruins, with thick clay walls, were supposedly dated between A.D. 500 and A.D. 1000 (oral communication, R. Daudel).

Sa-49. Fell cave, Ultima Esperanza, Chile **10,200 ± 400**
8250 B.C.

Dry manure of Mylodon, Sec. II, Layer C, oldest level of the Fell (or Mylodon) cave (51° 35′ S Lat, 72° 00′ W Long). Coll. 1953 and subm. by J. Emperaire and A. Laming, C.N.R.S., Paris. *Comment*: another sample (C-484) of the same layer was dated 10,832 ± 400, by the Chicago lab. (Libby, 1952). Bones of the American horse were also found in the dated level. The cave, situated in the dry pampas region, contains several archaeological levels, characterized by different shapes of arrow points (Emperaire and Laming, 1954, p. 173-206).

Sa-109. San-Pedro de Atacama, Chile **1650 ± 150**
A.D. 300

Wood from grave of the "Atacamian" (pre-Inca) civilization, near San-Pedro de Atacama (23° S Lat, 68° W Long). Coll. 1959 by Father Le Paige and subm. by H. Tazieff, Centre Européen de Volcanologie, Brussels, Belgium. *Comment*: burial sites of this culture were recently discovered in the flat and saline sandry ground of the desert of Atacama. They contain flexed mummies, directly buried in dry sand of the desert, at depth of ca. 2 m, and pottery with gold and enamel jewels.

F. Portugal

Sa-16. Moita do Sebastiâo, Muge, Portugal **7350 ± 350**
5400 B.C.

Charcoal from bottom of shell heap, under shell layers, Sec. M. L. 14-16. Sample is from the oldest level of the Mesolithic deposit of Moita do Sebastiâo, Muge (39° 06′ N Lat, 9° 00′ W Long). Coll. 1954 and subm. by J. Roche, 16 Av. du Bel Air, Paris 12°. *Comment*: the "concheiro" (shell heap) de Moita is about 15 m above the level of the Tagus river. Fauna (shells) suggests tem-

peratures and salinity higher than today's in the waters of Tagus and Muge rivers. The stone industry is microlithic, with trapezoidal forms predominating. Rough quartzite tools, bone implements, traces of habitation and tombs are also present here, described by Roche (1960).

G. Cambodia

Angkor-Vat series, Cambodia

Wood fragments coll. in the Angkor monuments (13° 26′ N Lat, 103° 50′ E Long), a temple complex representing the perfection of Kmer art. It is the mausoleum of King Souvavarman II. Coll. 1955 and subm. by L. Malleret, Ecole Française d'Extrême Orient, Saigon.

Sa-2. Bayon **1160 ± 150** **A.D. 790**

Fragment of wood (*Terminalia tomentosa*) from Central tower, W inner room, Bayon. *Comment*: supposed date (written communication, L. Malleret), late 12th or early 13th century A.D.

Sa-3. Porte de la Victoire **1270 ± 150** **A.D. 680**

Fragment of wood (*Terminalia tomentosa*) from high beam on E side, Porte de la Victoire. Supposed date, late 12th or early 13th century A.D.

Sa-4. North Kleang **880 ± 150** **A.D. 1070**

Fragment of wood (*Terminalia tomentosa*) from beam lining S inner door, main W entrance, North Kleang. Supposed date, late 10th or early 11th century A.D.

Sa-5. Baphuon **920 ± 150** **A.D. 1030**

Fragment of wood (*Terminalia tomentosa*) lining beam, N door, first floor, Gepura 2 East, Baphuon. Supposed date, A.D. 1060.

Sa-6. Angkor-Vat **400 ± 150** **A.D. 1550**

Fragment of wood (*Sphorea obtusa*) from ceiling in the Angkor-Vat Temple. Supposed date, 12th century A.D.

Museums series

Samples from wooden statues and objects, from collections of Phnom-Penh and Saïgon Museums. Subm. 1956 by L. Malleret. Numbers are reference to museum catalogue.

Sa-20. Thap-Muoi, (3445) **1620 ± 150** **A.D. 330**

Statue of the Great Buddha at Thap-Muoi. Supposed date, 5th century A.D.

Sa-21. Phong-My, (2809) **1490 ± 150** **A.D. 460**

Statue of Buddha found at Phong-My. Supposed date, 7th century A.D.

Sa-22. Da-Noi I, (R-126) **1360 ± 150** **A.D. 590**

Statue of Buddha found at Da-Noi. Supposed date, 5th century A.D.

Sa-23. Duc-Hoa I, (4840) **1490 ± 150**
A.D. 460

Statue of Buddha found at Duc-Hoa. Supposed date, 6th century A.D.

Sa-24. Duc-Hoa II, (4841) **1350 ± 150**
A.D. 600

Statue of Buddha found at Duc-Hoa. Supposed date, 6th century A.D.

Sa-25. Da-Noi II, (R-126) **1375 ± 150**
A.D. 575

Arm of statue of Buddha found at Da-Noi. Supposed date 5th century A.D.
General Comment: results agree with stylistically determined dates of wood fragments from statues; agreement is less satisfactory for wood samples from beams in various monuments at Angkor-Vat, and this may mean some reconstruction (Sa-6) or some re-use (Sa-2, Sa-3) of ancient material.

II. France

Sa-9. Paris, Quai Bourbon **450 ± 120**
A.D. 1500

Chestnut wood from a beam, in the upper framework of the building (historically known as a 17th century building), 15 Quai Bourbon in the Ile-Saint-Louis, Paris (48° 51′ N Lat, 2° 21′ E Long). Coll. 1956 and subm. by J. Labeyrie.

Sa-57. Vailly-sur-Aisne, Neolithic **5470 ± 300**
3520 B.C.

Ox and boar bones in hearth in foundations of a Neolithic hut, Vailly-sur-Aisne (49° 24′ N Lat, 3° 31′ E Long). Foundations were immediately below arable soil covering sandy alluvium of the Aisne and not far from a terrace, 4.5 m above river level. Coll. 1957 and subm. by H. Joullié, Vailly-sur-Aisne. *Comment*: with the dates established by other laboratories for Brittany (Carnic, Guissény, Finistère 5100 ± 60 [GrN-1966, Groningen IV] and Brasparts 5170 ± 60 [GrN-1983, Groningen IV]), for central France (Roucadour, Themines, Lot, from 4280 ± 125 to 5940 ± 150, [Coursaget, Giot, and Lerun, 1960]) we have now a "long" chronology for the Neolithic in France instead of a "short" one as was favored until recently.

Sa-53. Vailly-sur-Aisne, mammoth **11,550 ± 450**
9600 B.C.

Mammoth tooth from a gravel pit in region of Vailly-sur-Aisne (49° 24′ N Lat, 3° 31′ E Long). Coll. 1956 by M. Bianciotto; subm. by H. Joullié. *Comment*: date seems reasonable for one of the last mammoths supposed to have disappeared at the end of the Magdalenian period. In the same gravel pit were found two other teeth and two mammoth tusks.

Sa-56. Fontaines Salées (Yonne) **2970 ± 170**
1020 B.C.

Oak wood fragments from Fontaines Salées near Vezelay (47° 30′ N Lat, 3° 45′ W Long). From trunk of oak hollowed by fire and used as lining for a well-shaft to collect mineral water that rises through the ancient and recent alluvial deposits of the Cure River. Coll. and subm. by B. Lacroix, Mus. of Saint-Père-sous-Vezelay (Yonne). *Comment*: several burial urns found nearby

belong to the well-known urn-field culture (Hallstatt B); the installation dated here is contemporary with this civilization. It is the oldest known installation of the type. Later, this thermal station was occupied and used by the Romans (Lacroix, 1960).

Sa-67. La Plagne, Macot (Savoie) **1150 ± 150**
A.D. 400

Wood from mines of La Plagne (45° 30′ N Lat, 6° 41′ E Long). Coll. 1958 and subm. by H. Lewind, Mines de la Plagne, Aime, Savoie. *Comment*: wood from beams buried in old embankments in the mine; dated to know whether the old mine workings recently found were Roman or much more recent. The latest workings (during 19th century) yielded nothing interesting, but the Romans were supposed to have found a particularly rich vein of silver.

Sa-79. Boutigny-sur-Essonne **5410 ± 300**
3460 B.C.

Charcoal from hearth in perfectly sealed cave in Essonne Valley, Boutigny (48° 26′ N Lat, 2° 23′ E Long). Subm. by J. Baudet, Inst. de Paléontologie Humaine, Paris. *Comment*: a problematic site supposed to be early Mesolithic (J. Baudet, private communication).

Sa-89. Paris, Boul. St. Germain **Modern**

Fragment of oak wood, 6 m depth in street excavations, Boulevard Saint-Germain, Paris (48° 52′ N Lat, 2° 23′ E Long). Coll. and subm. by Centre Technique Forestier Tropical, Paris.

Sa-95. Kercado (Morbihan) **5840 ± 300**
3890 B.C.

Charcoal from the chamber in barrow of granitic gravel, Kercado (47° 35′ N Lat, 3° 05′ E Long). In the vault, the chamber was filled with earth to depth of 1 m, in which were found human bones, partially burned, with charcoal and calcium sulphate. Sample No. 635, Mus. of Carnac; subm. by Y. Rollando, Archeol. Mus., Chateau-Gaillard, Vannes (Morbihan). *Comment*: significance of gypsum is unknown; age found here is estimated to be about 1000 yr too old, according to style of barrow (P. R. Giot, private communication).

Sa-96. Mont-Saint-Michel (Morbihan) **5720 ± 300**
3770 B.C.

Charcoal from Mont-Saint-Michel barrow, at Carnac (47° 35′ N Lat, 3° 05′ E Long). Barrow is surrounded by granitic gravel. In the main vault were found vegetable matter, ashes, charcoal, burnt bones. Sample No. 823, Mus. of Carnac, subm. by Y. Rollando. *Comment*: same as for Sa-95.

Sa-102. Lascaux Cave **16,100 ± 500**
14,150 ± B.C.

Wood charcoal from cave of Lascaux, near Montignac, Dordogne (45° 04′ N Lat, 1° 10′ E Long), taken in archaeological layer of the "puits de l'homme." Coll. 1960 by A. Glory, Centre Nat. de la Recherche Sci., Paris; subm. by J. Labeyrie. *Comment*: charcoal sample from entrance of same cave, coll. by H. Breuil, was dated at 15,516 ± 900 (C-406; Libby, 1952). Another sample taken by A. Glory in 1958 in another part of the cave dated 17,190 ± 140 (GrN-1632, Groningen IV, p. 168). The Lascaux cave contains the most beauti-

ful and most famous paintings of bulls, cows, rhinoceros, stags, bison, etc. of the Aurignacian period.

Mortar series

The following dates are standardizing measurements on samples of known historic age, showing that it is possible to date non-biological samples, such as old mortars. Mortar is made by mixing water and sand with freshly calcined calcium oxide; during the following months, the mixture takes CO_2 from the ambient atmosphere, as would a growing plant. Proportion of $CaCO_3$ so formed is about 10% of total weight. The material must be tested by microscopic examination; samples containing calcareous debris, such as foraminiferan tests, are rejected (Delibrias and Labeyrie, 1963).

Sa-190. Madeleine Castle, Seine et Oise **660 ± 120**
(48° 45′ N Lat, 2° 2′ E Long) **A.D. 1290**

Mortar between sandstone blocks of N wall of the Castle; siliceous sand. Historic age: 600 ± 50 yr.

Sa-191. Roman aquaduct of Barbegal, Bouches du Rhône **1620 ± 150**
A.D. 330
(47° 40′ N Lat, 2° 45′ E Long)

Mortar from pillars, siliceous sand. Historic age: 1600 ± 60 yr.

Sa-192. Roman Terrazzo, Vannes (Morbihan) **1650 ± 150**
A.D. 300
(47° 40′ N Lat, 2° 45′ E Long)

Mortar between tegulae (tiles) of a terrazzo pavement; granitic sand. Found covered by ca. 1 m of humus, near S coast of Brittany. Historic age: 1650 ± 200 yr.

Sa-193. Wall of Gif, Seine-et-Oise **<100**

NW wall of park of Gif Castle, siliceous sand (44° 42′ N Lat, 2° 7′ E Long). Historic age: 100 ± 30 yr.

General Comment: agreement between ages deduced from C-14 content of mortars and their historical ages. This shows (1) that formation of $CaCO_3$ takes place quickly in a mortar and (2) that there is no exchange with atmospheric CO_2 after the initial formation of $CaCO_3$.

V. Atmospheric Radiocarbon: Bomb Effect

Measurements have been made since 1958 in order to know the atmospheric concentration of artificial C^{14} due to nuclear weapons tests. Collecting sites were chosen so as to be free from contamination by fuels. Organic samples were leaves, mainly oak collected in November; measured activity represents atmospheric C^{14} activity during growth. Sampled trees grew in S part of the Massif Central, France (44° 11′ N Lat, 1° 37′ E Long). Inorganic samples were obtained by pulling atmospheric air (for about 10 days for each sample) through solutions of Ba $(OH)_2$, at the station of Val-Joyeux, Seine-et-Oise (48° 49′ N Lat, 2° 1′ E Long). No mass-spectrometric measurements of the C^{13}/C^{12}

ratio were performed; values quoted are averages of Broecker's and Östlund's measurements (Lamont VI and VIII; Stockholm V).

1) Organic series		δC^{14}‰	Estimated δC^{13}‰	Δ‰
Sa-178.	F-Nov. 1958	+ 110 ± 20	− 25	+ 110 ± 20
Sa-179.	F-59 Nov. 1959	+ 190 ± 20	− 25	+ 190 ± 20
Sa-180.	F-60 Nov. 1960	+ 340 ± 20	− 25	+ 340 ± 20
Sa-181.	F-61 Nov. 1961	+ 280 ± 20	− 25	+ 280 ± 20
2) Inorganic series				
Sa-182.	59-A Feb. 1959	+ 131 ± 15	− 9	+ 95 ± 15
Sa-183.	60-I-A May 1960	+ 260 ± 20	− 9	+ 220 ± 20
Sa-184.	60-II-A Nov. 1960	+ 420 ± 20	− 9	+ 375 ± 20
Sa-185.	61-I-A May 1961	+ 230 ± 20	− 9	+ 191 ± 20
Sa-186.	61-II-A Nov. 1961	+ 320 ± 20	− 9	+ 278 ± 20
Sa-187.	62-I-A Feb. 1962	+ 365 ± 20	− 9	+ 304 ± 20
Sa-188.	62-II-A May 1962	+ 545 ± 20	− 9	+ 496 ± 20
Sa-189.	62-III-A Nov. 1962	+ 600 ± 20	− 9	+ 549 ± 20

References

Date lists:

Cambridge III	Godwin and Willis, 1961
Groningen IV	Vogel and Waterbolk, 1963
Lamont II	Kulp and Others, 1952
Lamont V	Olson and Broecker, 1959
Lamont VI	Broecker and Olson, 1959
Lamont VIII	Broecker and Olson, 1961
Stockholm V	Ostlund and Engstrand, 1963

Arkell, A. J., 1953, Shaheinab: London, Oxford Univ. Press.

Bourguet, P. du, 1957, Tissus coptes et carbone 14: Bull. du lab. du Musée du Louvre, no. 2, p. 57-59.

———— 1958, Datation des tisus coptes et carbone 14: Bull. du lab. Musée du Louvre, no. 3, p. 52-63.

Coursaget, J., Giot, P. R., Le Run, J., 1960, Neolithic dates from France: Antiquity XXXIV, v. 134, p. 147-148.

Delibrias, G., Hugot, H., Quézel, P., 1957, Trois datations de sédiments récents par le radiocarbone: Libyca, v. 5, p. 267-270.

Delibrias, G., Perquis, M. T., 1958, Datages par la méthode du carbone 14: Bull. d'Information Sci. et Tech. du Commissariat à l'Energie Atomique, no. 21, p. 1-3.

Delibrias, G., Perquis, M. T., Ros, J., 1961, Vitesse de dépôt des vases marines dans la baie de Villefranche-sur-Mer par la méthode du carbone 14: Colloque du C.N.R.S. sur l'Océanographie Géol. et Géog., Villefranche-sur-Mer, p. 29-33.

Delibrias, G., Hugot, H. J., 1962, Datation par la méthode dite "du C-14" du néolithique de l'Adrar Bous (Ténéréen): Missions Berliet Ténéré-Tchad, Arts et Métiers graphiques ed., Paris, p. 71-72.

Delibrias, G., Labeyrie, J., 1963, Le datage des mortiers par la méthode du carbone 14: Revue d'Archéologie, in press.

Emperaire, J., Laming, A., 1954, La grotte du Mylodon: Jour. de la Soc. des Americanistes, v. 43, p. 173-206.

————1956, Les Sambaquis de la Côte méridionale du Brésil: Jour. de la Soc. des Américanistes, v. 45, p. 5-163.

Emperaire, J. and A., 1959, Mission Archeologique 1955-1959: Rapport interne du C.N.R.S.

Grunewald, J., 1961, Carte géologique du Dipart. de la Martinique: Service géologique de France, Paris, Feuille N.

Jouis, E., 1961, Les alluvions de remblayages post-wurniennesen Vallée de Basse-Seine: Rev. des Soc. Savantes de Haute-Normandie, no. 21, p. 91-104.

Lacroix, B., 1960, Les Fontaines-Salées: Pub. de la Soc. des Fouilles Archéol. de l'Yonne.
Lhote, H., 1958, La Découverte des Fresques du Tassili: Arthaud ed., Paris.
Libby, W. F., 1952, Radiocarbon Dating: University of Chicago Press, p. 94.
Mauny, R., 1961, L'Ouest africain au Moyen Age: Mem. de l'Inst. Français d'Afrique Noire, I.F.A.N., Dakar, no. 61.
Pelletier, H., Delibrias, G., Labeyrie, J., Perquis, M. T., Rudel, A., 1959, Mesure de l'âge de l'une des coulées volcaniques issues du Puy-de-la-Vache (Puy-de-Dôme) par le carbone 14: Comptes Rendus de l'Acad. des Sci., v. 249, p. 2221-2222.
Perquis, M. T., Delibrias, G., David, B., 1956, Mesure en phase gazeuse de substances à très faible activité spécifique due au carbone 14: Bull. d'Inf. Sci. et Tech. du Commissariat à l'Energie Atomique, no. 11, p. 1-7.
Pons, A., Quézel, P., 1957, Première étude palynologique de quelques paléosols sahariens: Travaux de l'Inst. de Recherches Sahariennes, Alger, v. 16.
Quézel, P., Martinez, Cl., 1962, Premiers résultats de l'analyse palynologique de sédiments recueillis au Sahara méridional à l'occasion de la Mission Berliet-Tchad: Missions Berliet Ténéré-Tchad, Arts et Métiers graphiques ed., Paris, p. 313-332.
Roche, J., 1960, Le gisement mésolithique de Moita do Sebastiao: Inst. de Alta Cultura, Tipografia Portuguesa, Lisbon.
Tixier, J., 1962, Le "Ténéréen" de l'Adrar Bous III: Missions Berliet Ténéré-Tchad, Arts et Métiers graphiques ed., Paris, p. 333-348.
Vince, A., 1958, Notre Brière: Nantes, Imprimerie du Commerce.